INSTRUCTION MANUAL

DIGITAL OSCILLOSCOPE

MODEL COM7202A

First Edition

KIKUSUI ELECTRONICS CORPORATION

9003116

TABLE OF CONTENTS

'90.5.31

90311BB

'90. 5. 31

9003119A

1. GENERAL

1.1 Description

The COM7XXXA Series Oscilloscopes have been designed on new and advanced concepts for accurate, reliable, and easy ways of man-machine communication.

The COM7202A has been designed with a special emphasis on the ease of operation in view of that, although it is a digital storage oscilloscope, it can be operated with a feeling close to that of a real time oscilloscope. The ease of opertion, in return, renders a wider applicability of the COM7202A as a digital storage oscilloscope.

The COM7202A has a frequency bandwidth of DC to 200 MHz (for both real time mode and digital storage mode), a highest sweep rate of 1 ns/DIV, a highest digital-storage sampling rate of 100 MS/s simultaneously for two channels, and a GP-IB interface provision.

1.2 Features

(1) High speed waveform processing

The waveform data porocessing speed for the storage function is high and the displayed waveform is rapidly stabilized. This feature, combined with the full-program feature, allows to make up a high speed measuring system.

(2) Four-channel display

The COM7202A has four input channels for both real mode and storage mode. The multi-mode select system allows to select any one or ones of the four channels. The highest frequency response is 200 MHz either at the BNC input terminal or at the probe tip.

(3) CRT readout

Various items of information concerning measurement, together with the signal waveform to be measured, are displayed on the CRT for accurate and rapid measurement. The displayed items include the vertical de-

flection factor, input coupling mode, voltage step-down ratio of the probe, time base sweep rate and delay time, and the value determined between cursors and the values measured by the internal voltmerer and frequency counter.

(4) Measurement with cursors

Two cursors are displayed on the CRT. As you move these cursors to the points of measurement, the differential voltage or period or phase between the two points is automatically determind and digitally displayed on the CRT, eliminating the chance of human reading error and calculation mistakes. When in the tracking mode the two cursors can be translated keeping the distance between them constant, allowing you to compare amplitudes and periods very conveniently.

(5) Functions of digital voltmeter and frequency counter

The oscilloscope has a digital voltmeter circuit and a frequency counter circuit. The digital voltmeter is a 3-1/2 digit multimeter which measures the DC voltage, AC rms voltage or peak-to-peak voltage of the signal applied to the input terminal of channel 1. The frequency counter is a 4-digit auto-range counter which measures the frequency of the trigger signal selected by the trigger source switch. The measured values are displayed on the CRT.

(6) Full employment of IC's and calibration verification feature

A number of newly developed IC's are employed for most part of the major circuits of the oscilloscope, thereby reducing the number of discrete components to the minimum and improving the reliability and maintainability. The circuits are self-calibrated for reliable measurement.

(7) Ease of operation

The panel switches and controls are laid out for most efficient and easy operation. The major functions are selectable by simple operation of individual switches, while less frequently used switches and controls are collectively located and classified by the natures of their functions, thereby making the instrument panel neat and highly functional.

(8) Memory for panel setting

All data of the panel settings are stored in the internal memory of the oscilloscope and are not lost even when the power is turned off. When the power switch is turned on again, the panel settings are automatically restored releaving you from resetting the panel controls each time the power switch is turned on.

(9) Compact and light

The oscilloscope is very compact and light for its high performance and reliability. It is 31.8 cm (12.5 in.) wide, 15.0 cm (5.91 in.) high, 40.0 cm (15.7 in.) deep, and weighs 10 kg (22 lbs).

(10) 50-ohm input circuits

The input impedance of channels 1 and 2 of COM7202A is selectable between 1 meg-ohms and 50 ohms. The 50-ohm input circuits are incorporated with an overvoltage protector.

(11) CRT with bright and sharp images

The COM7202A Oscilloscope employs a 20-kV CRT that displays bright and sharp images even for rapidly changing phenomena.

(12) On any line voltage

The COM7202A Oscilloscope operates on any AC line voltage within a range of 90 to 250 V AC without requiring any switching procedure. Since it employ no large power transformer, it is compact and light.

(13) Automatic triggering level control, requiring no manual adjustment

(14) 4-channel alternate triggering, allowing successful triggering of input signals of different frequencies

(15) A TV synchronizing separate function for TV.V or TV.H, and a TV line select function

(16) A linear focus control circuit, requiring no manual focus adjustment each time intensity is varied

(17) 3-channel X-Y operation

Features of Digital Storage Section

(18) Sampling rate up to 100 MS/sec

The maximum sampling rate is as fast as 100 MS/sec and the vertical resolution is as high as 8 bits, allowing you to capture one-shot phenomena of up to 40 MHz.

(19) Digitizing of signals of up to 200 MHz

In the equivalent sampling mode, signals of up to 200 MHz can be successfully captured. The equivalent sampling rate in this case is as high as 10 GS/sec.

(20) Envelope mode to detect one-shot glitches as fast to 5 ns

The oscilloscope has a peak-value detector circuit which is able to capture a pulse of narrow duration of down to 5 ns within a sampling clock period and to display the maximum and minimum values. Thus the circuit allows detection of narrow pulses involved in a slowly changing repetitive signal and, even when the input signal frequency has become higher than one-half of the sampling frequency, aliasing that may cause measuring errors can be discriminated.

(21) Reference memory to store up to four waveforms

The storage section has a reference memory (other than the display memory) for up to four waveforms which can be re-written as required. The reference memory is internally backed up and the stored data can be maintained for a long period.

(22) GP-IB interface functions

The oscilloscope is compatible with the GP-IB interface system, allowing programmed remote control of the oscilloscope and transfer of status data displayed on the CRT readout or waveform data stored in memory. A hardcopy of data can be readily obtained by calling out a GP-IB plotter with a HP-GL command. It also is possible to send the panel set up data of a COM7202A to another COM7202A running on the same GP-IB bus.

(23) Various functions with the digital storage provision

The digital storage provision renders various advantageous functions, namely, the pretriggering function and window function which allow to view the signal waveform preceding the trigger point, the interpolation function which provides a convenient means for measurement of high-speed one-shot signals, the time base expansion function to display the stored signal on a time base magnified up to 100 times, the rolling display function which allows convenient viewing of a low speed signal, the delayed magnification function which allows high speed sampling of any portion of a signal sampled at a slow rate, and the average waveform data acquisition function.

(24) Programmable oscilloscope

By using Remote Controller RC02-COM, the oscilloscope can be used as a programmable instrument. Up to 100 items of panel settings can be programmed and called by simple panel key operation.

By using Probe Selector PS01-COM, up to 16 probes (8 probes for each of CH1 and CH2) can be connected to the oscilloscope making up an instrument of 16 input channels. The probes are selectable with the Remote Controller.

2. SPECIFICATIONS

○ Vertical Axes

Item	Specification	Remarks
CH1, CH2		
Deflection Factor	1 mV/DIV to 5 V/DIV	1-2-5 sequence, 12 ranges
Accuracy of Deflection Factor	5 mV/DIV to 5 V/DIV: ±2% 1 mV/DIV and 2 mV/DIV: ±4%	15 to 35°C (59 to 95°F) 1 kHz, 4 - 5 DIV reference. When in real mode
Vernier Control of Deflection Factor	Continuously variable attenuation to 1/2.5 or less of set value	
Frequency Bandwidth	DC to 200 MHz, within -3 dB DC to 50 MHz, within -3 dB (1 mV/DIV, 2 mV/DIV) Low limit frequency of AC coupling: 10 Hz	50 kHz, 8 DIV reference 15 to 35°C (59 to 95°F)
Square wave Characteristics	Overshoot 10 mV/DIV: 4% Other ranges: 6% Other distortions 10 mV/DIV: 3% Other ranges: 5%	When in real mode 15 to 35°C (59 to 95°F)
Input Impedance	1 MΩ ±1%, 18 pF ±3 pF, 50 Ω ±2%	
CH3, CH4		
Deflection Factor	0.1 V/DIV, 0.5 V/DIV	2 ranges
Accuracy of Deflection Factor	±5%	15 to 35°C (59 to 95°F) 1 kHz, 4 - 5 DIV reference
Frequency Bandwidth	DC to 200 MHz, within -3 dB Low limit frequency of AC coupling: 10 Hz	50 kHz, 8 DIV reference 15 to 35°C (59 to 95°F)

Item	Specification	Remarks
CH3, CH4 (cont'd)		
Square wave Characteristics	Overshoot 0.1 V/DIV, 0.5 V/DIV: 7% Other distortions 0.1 V/DIV, 0.5 V/DIV: 5%	When in real mode 15 to 35°C (59 to 95°F)
Input Impedance	1 MΩ ±1%, 18 pF ±3 pF,	
Maximum Safe Input Voltage	1 MΩ circuit: 400 Vpeak (DC + AC peak) 50 Ω circuit (CH1 and CH2 only) : 5 V (with overvoltage protector)	AC components not higher than 1 kHz
Input Coupling	AC, GND, DC	
Rise Time	Approx. 1.75 ns Approx. 7 ns (1 mV/DIV, 2 mV/DIV)	Theoretical values When in real mode
Channel Modes	CH1, ADD (CH1 + CH2), CH2 CH3, CH4 Any combination of the above channels in a multi-mode select system. MULT (CH1 x CH2). X-Y display with CH1 as X and any one or ones of CH2, CH3 and CH4 as Y.	The MULT function is available only when in the storage mode. For X-Y operation in the storage mode, combination of CH1 and CH2 alone is available.
Time Difference Among Channels	<±500 ps (of all channels)	(Except 1 mV/DIV, 2 mV/DIV ranges)
Signal Delay Time	40 ns ±10 ns	
Chop Frequency	500 kHz to 1 MHz	
Bandwidth Limiter	20 MHz ±5 MHz, within -3 dB	
Polarity Select	For CH2 only	
CH1 Signal Output	Approx. 50 mV/DIV when output terminal is open	
	Approx. 25 mV/DIV when output terminal is terminated with 50Ω	
	Frequency bandwidth DC to 100 MHz -6dB.	

○ Triggering

Item	Specification	Remarks
A Trigger		
Triggering Signal Sources	CH1, CH2, CH3, CH4, LINE, and V-MODE (When in V-MODE, channels operating in VERT mode are used as signal sources. When in ADD (MULT) mode, CH1 is used as signal source. When in CHOP mode or AUTO LEVEL mode, the leftmost one of the operating channels indicated by VERT mode lamps on panel is used as signal source.)	V-MODE is effective when in ALT SWEEP mode or SINGLE SWEEP mode and in AUTO LEVEL mode is released.
Coupling	AC, LF.REJ, HF.REJ, DC, TV.V, and TV.H	Pedestal clamp function is available when in TV.V or TV.H.
Polarity	+ or −	
Sensitivity	DC to 10 MHz: 0.4 DIV DC to 200 MHz: 1.5 DIV TV.V, TV.H: 1.0 DIV AC: Attenuates signal components of 10 Hz and lower LF.REJ: Attenuates signal components of 50 kHz and lower HF. REJ: Attenuates signal components of 50 kHz and higher	TV.V, TV.H: When in NTSC full field color bar signal
AUTO LEVEL	Satisfies the above values with 0.5 DIV added to each of them	For sinusoidal waves

Item	Specification	Remarks
Modes	AUTO: When no triggering signal is applied, sweep runs automatically. NORM: When no triggering signal is applied, sweep is in a ready state and does not run. SINGLE: When triggering signal is applied, sweep runs only once. When RESET key is pressed, sweep is reset to READY state. When in READY state or sweeping, READY lamp illuminates	When in real mode

Item	Specification	Remarks
B Trigger		
Triggering Signal Sources	CH1, CH2, CH3, CH4, and V-MODE (When in V-MODE, channels operating in VERT mode are used as signal sources. When in ADD (MULT) mode, CH1 is used as signal source. When in CHOP mode or AUTO LEVEL mode, the leftmost one of the operating channels indicated by VERT mode lamps on panel is used as signal source.)	V-MODE is effective when in ALT SWEEP mode or SINGLE SWEEP mode and in AUTO LEVEL mode is released.
Coupling	AC, LF.REJ, HF.REJ, and DC	
Polarity	+ or -	
Sensitivity	DC to 10 MHz: 0.4 DIV DC to 200 MHz: 1.5 DIV AC: Attenuates signal components of 10 Hz and lower LF.REJ: Attenuates signal components of 50 kHz and lower HF.REJ: Attenuates signal components of 50 kHz and higher	
AUTO LEVEL	Satisfies the above values with 0.5 DIV added to each of them	For sinusoidal waves

○ Time Base (Horizontal Axis)

Item	Specification	Remarks
A Sweep		
Sweep Speeds	Real mode: 10 ns/DIV to 0.5 s/DIV Storage mode: 10 ns/DIV to 5 s/DIV	1-2-5 sequence
Accuracy of Sweep Speeds	±2%	15 to 35°C (59 to 95°F) Accuracy for 8 DIV at center of CRT
Vernier Control of Sweep Speeds	Continuously variable to a speed slower by 2.5 times or more of set value	When in real mode
Variable Holdoff	Provided	When in real mode
B Sweep		
Sweep Speeds	Real mode: 10 ns/DIV to 0.5 s/DIV Storage mode: 10 ns/DIV to 0.5 s/DIV * Note	* Note: When in ALT mode for two or more channels
Accuracy of Sweep Speeds	±2%	15 to 35°C (59 to 95°F) Accuracy for 8 DIV at center of CRT
Delayed Sweep		
Type of Sweep	Continuous delay, triggered delay	
Delay Jitter	< 1/10,000	
Sweep Magnification	10 times Maximum sweep speed: 1 ns/DIV	When in ALT mode, B sweep alone is magnified. When in real mode
Accuracy of Sweep Magnification	5 ns/DIV to 0.5 s/DIV: ±4% 1 ns/DIV, 2 ns/DIV: ±8%	15 to 35°C (59 to 95°F) For 8 DIV at center of CRT. Excluding 10% portions at both ends of sweep. When in real mode

Item	Specification	Remarks
X-Y Mode		
Channels for Axes	X-axis: CH1 Y-axes: CH2, CH3, CH4 (X-Y operation of up to 3 channels)	Y-axis: CHOP mode [When in storage mode, CH2 alone can be used for Y-axis.]
Deflection Factor	Identical with those of CH1, CH2, CH3, and CH4	
Accuracy of Deflection Factor	X-axis: ±3% (5 mV/DIV to 5 V/DIV) ±5% (1 mV/DIV, 2 mV/DIV) Y-axes: ±2% (CH2) ±5% (CH3, CH4)	15 to 35°C (59 to 95°F) 1 kHz, 4 - 5 DIV reference
Frequency Bandwidth	When in real mode DC to 4 MHz, within -3dB When in storage mode DC to 200 MHz, within -3dB	X-axis: For CH1 Y-axes: Identical with CH2, CH3, CH4
X-Y Phase Difference	When in real mode < 3° (DC to 200 kHz) When in storage mode < 3° (DC to 15 MHz)	

o TV Sync.

Item	Specification	Remarks
Pedestal Clamp	Stability of pedestal clamp level: < 0.1 DIV (against 2 - 8 DIV of input video signal amplitude)	For full field color bar signal
TV Line Select	NSTC: Line No. 1 - 525 PAL: Line No. 1 - 625 (Any line number with the above ranges can be selected.)	For full field color bar signal

○ CRT Readout

Item	Specification	Remarks
Setting Display	CH1, CH2, CH3, CH4 scale factors and coupling modes CH1, CH2, UNCAL status Use of 10:1 probe (manual setting) * Automatic switching of use of 10:1 probe or 100:1 probe A sweep, B sweep scale factors A sweep UNCAL status Holdoff, bandwidth limiter status ΔREF cursor, Δ cursor Delay time, ΔT, 1/ΔT, ΔV, Phase difference, Frequency counter reading, DVM reading (AC, DC, p-p) Pedestal clamp status PAL, NTSC, and TV line No. select status	When in real mode * When special readout probes are used.
	CH1, CH2, CH3, CH4 scale factors and coupling modes CH1, CH2, UNCAL status Use of 10:1 probe (manual setting) * Automatic switching of use of 10:1 probe or 100:1 probe A sweep, B sweep scale factors Bandwidth limiter status ΔREF cursor, Δ cursor Delay time, ΔT, 1/ΔT, ΔV Pedestal clamp status PAL, NTSC, and TV line No. select status Scale factors and coupling modes of reference memory units 1 - 4 Reference memory time base scale factor, trigger point, trigger point (or data of time from trigger point), magnification point, delayed start point, view time, number of AVG cycles set and that executed, status set for ENV, X-Y display start position data and sampling start data	When in storage mode * When special readout probe are used.

Item	Specification	Remarks
DLY	Delay time and ΔT display	
Delay Time Range	0.50 to 10.00 times of A sweep setting of highest sweep speed range to 0.5 s/DIV range	
Delay Time Accuracy	±2% (when in the time intervals measured with delayed B SWEEP)	
ΔT	Time interval between ΔREF cursor and Δ cursor is displayed.	
Measuring Range	±4.6 DIV or more from center of CRT	
Measuring Accuracy	±(3% of reading + 0.05 DIV)	x10 MAG off
1/ΔT	Reciprocal (frequency) of ΔT is displayed.	
ΔV	Voltage between ΔREF cursor and Δ cursor is displayed.	When in CH2 SINGLE SWEEP mode or when in CH2 and CH3/CH4 channel modes, scale factor is as that of CH2; in other cases, scale factor is as that of CH1.
Measuring Range	±3.6 DIV or more from center of CRT	
Measuring Accuracy	±(3% of reading + 0.05 DIV)	
Time Ratio	Displays the ratio of time interval between ΔREF cursor and Δ cursor with respect to 5 DIV on CRT as reference (100%).	When in ΔT measurement, SWEEP VARIABLE is displayed in UNCAL status.
Measuring Range	±4.6 DIV or more from center of CRT	
Measuring Accuracy	±(3% of reading + 0.05 DIV)	x10 MAG off

Item	Specification	Remarks
Phase Difference	Displays in degrees the phase difference between ⊿REF cursor and ⊿ cursor with respect to 5 DIV on CRT as reference (360 degrees).	When in 1/⊿T measurement, SWEEP VARIABLE is displayed in UNCAL status
Measuring Range	±4.6 DIV or more from center of CRT	
Measuring Accuracy	±(3% of reading + 0.05 DIV)	x10 MAG off
Voltage Ratio	Displays the ratio of voltage between ⊿REF cursor and ⊿ cursor with respect to 5 DIV on CRT as reference (100%).	When in ⊿V measurement, GAIN VARIABLE is displayed in UNCAL status.
Measuring Range	±3.6 DIV or more from center of CRT	
Measuring Accuracy	±(3% of reading + 0.05 DIV)	
⊿Delay	Measures ⊿T or 1/⊿T by using B sweep instead of ⊿REF cursor and ⊿ cursor.	Operates in ALT sweep and B sweep modes at the same time.
Measuring Range	3.6 DIV or more to right and left from center of CRT	
Measuring Accuracy	±(2% of reading + 0.05 DIV) (Excluding 0.5 DIV from left hand end of CRT)	x10 MAG off
DVM	Displays with 3-1/2 digits in the CH1 input (AC voltage, DC voltage, p-p voltage) for up to ±7 DIV on CRT	Not effective when in storage mode
AC	Measures AC voltage in rms value for 20 Hz to 100 kHz Measuring accuracy 5 mV/DIV to 5 V/DIV: ±(3% of reading + 0.05 DIV) 1 mV/DIV, 2 mV/DIV: ±(3% of reading + 0.1 DIV)	For 4 DIV at center of CRT, within *Tcal ±5°C (±9°F)

* Tcal: Reference temperature for auto calibration of oscilloscope 20 to 35°C (68 to 86°F)

Item	Specification	Remarks
DVM (cont'd)		
DC	Measures DC voltage Measuring accuracy: 5 mV/DIV to 5 V/DIV: ±(3% of reading + 0.05 DIV) 1 mV/DIV, 2 mV/DIV: ±(3% of reading + 0.1 DIV)	For 4 DIV at center of CRT, within *Tcal ±5°C (±9°F)
p-p	Measures peak-to-peak voltage for 20 Hz to 100 MHz Measuring accuracy: For 20 Hz to 20 MHz: 5 mV/DIV to 5 V/DIV: ±(4% of reading + 0.05 DIV) 1 mV/DIV, 2 mV/DIV: ±(4% of reading + 0.1 DIV) 20 MHz to 100 MHz: Within ±3 dB	For 4 DIV at center of CRT, within *Tcal ±5°C (±9°F)
FREQ	Measures frequency of input channel signal selected by TRIG SOURCE switch. 4-digit display, auto-range	Displays at the same time with DVM. Not effective when two or more triggering source signals are selected, or in storage mode.
Measuring Ranges	1 Hz to 200 MHz	
Measuring Accuracy	±0.1%	

○ Storage Mode

Item	Specification	Remarks
Vertical Axis A/D Converter Resolution	8 bits	
Vertical display Resolution	Max. 12 bits (400 points/DIV)	When in AVG or IPL mode
Time Base (Horizontal Axis) Resolution	10 bits (100 points/DIV)	
Sampling Rates	20 samples/sec to 100M samples/sec	
Accuracy of Sampling Rate	±0.02%	
Accuracy of Deflection Factor	CH1, CH2 5 mV/DIV to 5 V/DIV: ±(2% + 1 LSB) 1 mV/DIV, 2 mV/DIV: ±(4% + 1 LSB) CH3, CH4 ±(5% + 1 LSB)	15 to 35°C (59 to 95°F) 1 kHz, 4 - 5 DIV reference
Effective Storage Frequency	40 MHz: When in SINGLE SWEEP mode with 1 µs/DIV or faster ranges, or when in IPL mode. 200MHz, -3dB: At time base range for REPEAT mode. For periodic signal.	With sine interpolation
Effective Rise Time	< 16 ns: When in SINGLE SWEEP mode with 1 µs/DIV or faster ranges, or when in IPL mode. Approx. 1.75 ns: AC time base ranges for REPEAT mode. For periodic signal.	With pulse interpolation
Sweep Channels	SINGLE SWEEP: CH1, CH2, CH3, CH4, ADD, MULT ALT: Any combination of CH1 through CH4 CHOP: CH1 and CH2	When in storage mode, the ADD (MULT) function is available only for between CH1 and CH2 in CHOP mode.

Item	Specification	Remarks
REPEAT Mode	0.5 µs/DIV to 10 ns/DIV	Except when in SINGLE SWEEP mode in random equivalent time sampling
ROLL Mode	5 s/DIV to 0.1 s/DIV automatic operation	When in single channel mode or 2-channel, CHOP mode
AVG (average) Mode for Vertical channels	2 - 256 sampling cycles for averaging	Selectable in 2^n steps. Except when in ROLL or IPL mode
ENVELOPE Mode	Operable ranges: ENV∞: 50 ms/DIV to 10 µs/DIV ENV 1: 5 s/DIV to 10 µs/DIV Single-pulse detection performance Pulse width 5 ns: >70% of amplitude Pulse width 10 ns: >90% of amplitude Dead time of detection: 20 ns/sampling	ENV1 in 5 s/DIV to 0.1 s/DIV ranges is available only when in single-channel mode or in 2- channel CHOP mode. 15 to 35° (59 to 95°F) ±4 DIV reference
Waveform Magnification	Time base ranges of up to 100 times (Max. 10 ns/DIV) Reference position for magnification: Center of CRT Interpolation: Sine or pulse	When in PAUSE status (Except when in ENV mode)
Display Memory	(Max. 4096 words per channel) X 4	For display on CRT, any part of 1024 words per channel is selectable with the window function
Reference Memory	For 4 waveforms: (1024 words per reference) X 4	Data can be saved in reference memory when in SAVE status.
Triggering points	Fixed at center of 4096 words of display memory	Data can be acquired for up to 2048 words before and after the triggering point
View Time	0 to approx. 10 sec, 4 steps	

'90.5.9

9031137A

○ GP-IB Interface Functions

Item	Specification	Remarks
Interface Functions (IEEE488-1978) (IEC625)	SH1: All source handshake functions AH1: All acceptor handshake functions T5: Talker function L3: Listener function SR1: All service request functions RL1: All remote/local functions PP0: No parallel poll function DC1: All device clear functions DT0: No device trigger function C0: No control function	
Programmable Functions	All functions except VERNIER, FOCUS, and TRACE ROTATION	
Formats	Device commands: ASCII Waveform data: Binary or ASCII (selectable)	

○ Programmable Control Functions

Item	Specification	Remarks
Program Steps	100 (00 to 99)	
Programmable Functions	All functions except INTEN, FOCUS, and TRACE ROTATION controls	By using RC02-COM in conjunction.
Program Backup Functions	Provided	
External Control Functions	Probe selector (PS01-COM)	By using RC02-COM in conjunction.
Remote Controller RC02-COS		
Step Address Display	00 to 99, 7-segment LED's	
Control Functions	COPY: Transfer of data between steps WR: Storing of settings START: Setting of START address END: Setting of END address PROB: Setting of probe number selected by probe selector CONT: VR function selected by RC02-COM RESET: Resetting to START address DEC: Decrement of step address by 1 step INC: Increment of step address by 1 step	
Remote Control Functions	CH1, CH2, CH3 and CH4 vertical positioning and horizontal positioning, REF cursor or DLY positioning, and Δ cursor positioning (verniers); automatic step address increment.	
Setting Protective functions	Two types: Instrument panel protect Control function protect	With selector switch
Step Address Input/Output	BCD signal	

○ Z-axis

Item	Specification	Remarks
Sensitivity	Intensity modulation discernible with 3 Vp-p input signal. Negative-going signal for brighter trace and positive-going signal for dimmer trace.	
Frequency Range	DC to 10 MHz	
Input Resistance	5 kΩ ±10%	
Maximum Safe Input Voltage	50 Vpeak (DC + AC peak)	AC components not higher than 1 kHz

○ Signal Outputs

Item	Specification	Remarks
Sweep Signal Output	A sweep signal, approx. 1 Vp-p	BNC terminal at rear panel Output impedance approx. 1 kΩ
Sweep Gate Signal Outputs	A sweep gate signal output: Approx. 5 Vp-p B sweep gate signal output: Approx. 5 Vp-p	BNC terminals at rear panel Output impedance approx. 1 kΩ

○ Calibration Signal

Item	Specification	Remarks
Waveform	Positive pulse signal	
Frequency	1 kHz ±0.1%	
Output Voltage	0.5 Vp-p ±2%	
Output Resistance	Approx. 2 kΩ	

○ Pen Out Signals

Item	Specification	Remarks
Output Signals for X-Y Recorder	Delivered when in storage mode	Operate when in PAUSE status
X-axis output	0.1 V/DIV ±10% (Speed automatically varies in response to Y-axis amplitude.)	BNC terminal at rear panel (common with sweep signal output terminal)
Y-axis Output	0.1 V/DIV ±10%	BNC terminal at rear panel
SYNC Output	TTL level (When in Pen Out: "HIGH")	BNC terminal at rear panel (common with A sweep gate terminal)

○ CRT Circuit

Item	Specification	Remarks
Cathode-ray Tube	6-inch square screen, with internal white graticule Effective screen area: 8 x 10 cm (3.15 x 3.94 in.) Acceleration voltage: Approx. 20 kV	1 DIV/1 cm

○ Power Requirements

Item	Specification	Remarks
Line Voltage	90 to 250 V	No voltage selection required.
Line Frequency	50/60 Hz	
Power consumption	Approx. 120 watts	

- Memory Backup:

  Data protected: Panel setting data, calibration data, waveform data, and RC02-COM setting data.

  Backup battery: Lithium battery (life expectancy 10 years or more from shipment from factory, at 20°C (68°F))

- Probe power Supplies: For two active probes, through terminals at rear panel,

- Operable Environments: 0 to 50°C (32 to 122°F), 95% RH or less

- Environments for Performance to Specification: 5 to 45°C (41 to 113°F), 90% RH or less

- Mechanical Dimensions

  Overall Sizes: 318 W x 150 H x 400 D mm (Mainframe)
  (12.52 W x 5.91 H x 15.75 D in.)

  380 W x 200 H x 465 D mm (Maximum)
  (14.96 W x 7.87 H x 18.31 D in.)

  Weights: Approx. 10 kg (22 lbs)

- Accessories

Power code	One
Instruction manual	One
Probes	Two P250-3 probes (10:1)

3. PRECAUTIONS BEFORE OPERATING THE OSCILLOSCOPE

3.1 Unpacking the Oscilloscope

The oscilloscope is shipped from the factory after being fully inspected and tested. Upon receipt of the instrument, immediately unpack and inspect it for any damage which might have been sustained when in transportation.
If any sign of damage is found, immediately notify the bearer and/or the dealer.

3.2 Environments

The normal operable ambient temperature range of this instrument is 0 to 50°C (32 to 122°F). Operation of the instrument outside of this temperature range may cause damage to the circuits.

Do not use the instrument in a place where strong magnetic or electric fields exist. Such fields may disturb the measurement.

3.3 CRT Intensity

In order to prevent permanent damage to the CRT phosphor, do not make the CRT trace excessively bright or leave the spot stationary for an unreasonably long time.

3.4 Maximum Safe Input Voltages

The maximum safe input voltages applicable to the input terminals and probes are as shown in the below table. Do not apply any voltages higher than these limits.

Input Terminals	Maximum Safe Input Voltage
CH1, CH2, CH3, CH4, (1 MΩ)	400 V peak (DC + AC peak)
CH1, CH2 (50 Ω)	5 V rms
Probes	600 V peak (DC + AC peak)
Z-axis	50 V peak (DC + AC peak)

4. OPERATING

4.1 Description of Front Panel

This section gives descriptions of the front panel items referring to Figure 4-1.

*: Functions of the items indicated by the asterisk marks partially differ when in the storage mode. Refer to Section 4.2.

o CRT circuits

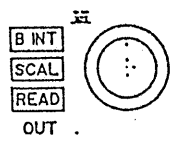
POWER ..... ① The main power switch of the oscilloscope. When power is turned on, the LED illuminates.

INTEN ..... ② Controls brightness of the spot or trace. For approximately 1 second after this knob is pushed in, the beam finder function is brought into effect and the direction in which the beam has been deflected off and lost from the CRT screen can be identified.

TRACE ROTATION ..... ③ Semi-fixed potentiometer for aligning the horizontal trace with graticule lines.

FOCUS ..... ④ For focusing the trace to the sharpest image.

* B INT, SCAL, READOUT .. ⑤ Each time as you press this control, its function is switched over to B INT (B sweep intensity control), SCAL (graticule illumination control), or READOUT (CRT readout character brightness and cursor brightness control).



When in the A sweep mode, its function is switched over to SCAL or READOUT only.

Bezel ..... ㊶ Acts as a base to install a camera mount (OU-1).

Filter ..... ㊷ Filter (grey) to improve contrast of waveform displayed on CRT. Readily removable.

o Vertical Axes

CH1 & X input ..... ⑧ CH1 vertical axis input terminal. X-axis (horizontal direction) input terminal when in X-Y mode.

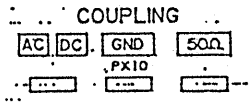
CH2 input ..... ⑫ CH2 vertical axis input terminal. Y-axis (vertical direction) input terminal when in X-Y mode.

* CH3 input ..... ⑭ CH3 vertical axis input terminal. Y-axis (vertical direction) input terminal when in X-Y mode.

* CH4 input ..... ⑱ CH4 vertical axis input terminal. Y-axis (vertical direction) input terminal when in X-Y mode.

Each of the BNC input terminals ⑧, ⑫, ⑭ and ⑱ has a readout probe sensor. When the readout probe is connected, the vertical deflection factor of the channel is automatically switched by the sensor.

AC/DC, GND, 50Ω .... ⑨ ⑬ Switches to select coupling of input terminal to vertical amplifier of CH1 and CH2.

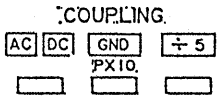


AC/DC: Each time as you strike this key, coupling mode is changed to AC or DC.

GND: Input of vertical amplifier is grounded and input terminal is made open.

50Ω: To select input impedance between 50Ω and 1MΩ. When 50Ω is selected, LED illuminates.

AC/DC, GND, ÷5 ..... ⑮ ⑲ Switches to select coupling of input terminal to vertical amplifier of CH3 and CH4.

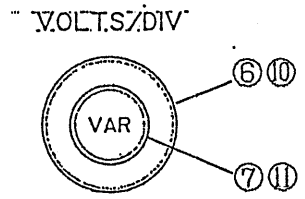


AC/DC: Each time as you strike this key, coupling mode is changed to AC or DC.

GND: Input of vertical amplifier is grounded and input terminal is made open.

÷5: Each time as you strike this key, deflection factor is changed between 0.1 V/DIV and 0.5 V/DIV. When 0.5 V/DIV is selected, LED illuminates.

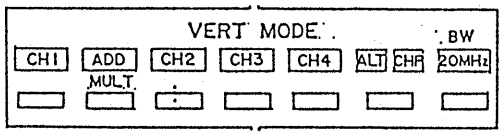
VOLTS/DIV ..... ⑥ ⑩ To select deflection factor of CH1 or CH2, from 1 mV/DIV to 5 V/DIV in 12 ranges. The selected range is digitally displayed on CRT.



VARIABLE ..... ⑦ ⑪ Vernier adjustment of deflection factor of CH1 or CH2. Adjustment is down to 1/2.5 or less of the deflection factor indicated by VOLTS/DIV switch. When this knob is pushed in (calibrated position), deflection factor is as indicated by VOLTS/DIV switch. When this knob is pushed out (uncalibrated position), it acts as a vernier control.

* POSITION ..... ㉟ ㊲ ㊳ ㊵ Vertical positioning of trace or spot. CH1 POSITION ㊵ acts also as a horizontal positioning control when in X-Y mode. CH2 POSITION ㊳ acts also as an INV switch and the polarity of the CH2 signal is inverted each time as you press this knob.

* VERT MODE ..... ㊴ To select vertical modes. You may strike CH1, ADD (MULT), CH2, CH3 and CH4 keys to select them in any combination. The LED lamps of the selected ones illuminate and the corresponding signals are displayed on CRT. As you strike keys again, the corresponding LED lamps and displayed signals go out, except when in single channel mode.



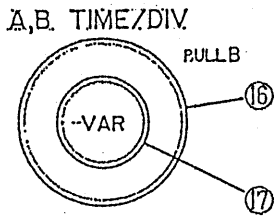
ADD: Algebraic sum or difference of CH1 and CH2 signals is displayed.

ALT/CHOP: Selects ALT mode or CHOP mode. When in ALT mode, channels are swept alternately with one complete sweep cycle for each channel. When in CHOP mode, channels are swept in turn being chopped at a frequency of approximately 1 MHz.

20MHz BW: Limits the bandwidth of vertical amplifier at approximately 20 MHz. This mode is used to cut off undesirable frequencies wider than 20 MHz and is selectable irrespective of settings of other switches.

o Time Base (Horizontal Axis)

A, B TIME/DIV ..... ⑯ Selects sweep time of A sweep or B sweep (delayed sweep). The pushed-in position of the knob is for A sweep and the pulled-out position is for B sweep.



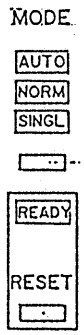
Even when the knob is in the pulled-out position, however, if HORIZ MODE ㊱ is set for A sweep, this switch is for A sweep.

Either when in A sweep or B sweep, sweep time is digitally displayed on CRT.

* VARIABLE ..... ⑰ Vernier control of A sweep time, for up to 2.5 times or more slower than the speed selected by A TIME/DIV switch.
The switch remains disabled when in the storage mode.

When the knob is set in the pushed-in position (calibrated position), sweep speed is as selected by A TIME/DIV switch. When the knob is set in the pulled-out position (uncalibrated or vernier position), sweep speed is continuously adjustable.

* MODE ..... ㉓ Select sweep mode as below, and act also as a RESET switch when in the SINGL mode.

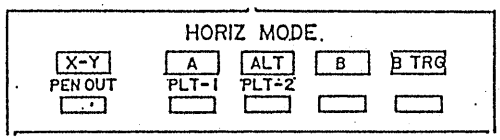


AUTO: When no triggering signal is applied or when triggering signal frequency is lower than 50 Hz, sweep runs automatically in a free mode.

NORM: When no triggering signal is applied, sweep is in a standby state and no trace is displayed on CRT.
This mode is used primarily for viewing of signals of lower than 50 Hz.
When in the TV LINE SELECT mode, the oscilloscope automatically selects the NORM sweep mode.

SINGL: When a triggering signal is applied, the sweep runs one time.
As you press the RESET switch after the sweep is over, the sweep circuit is rest to the READY state and the READY lamp illuminates.
The READY lamp goes out when the sweep is over.

* HORIZ MODE ..... ㊱ Select X-Y mode, A sweep mode or B sweep mode, as follows.



X-Y: For X-Y mode of operation with CH1 for X-axis and CH2, CH3, and/or CH4, for Y-axes. Y-axes are selectable with VERT MODE ㊴. If no selection for Y-axes (CH2 - CH4) is made before selecting the X-Y mode, CH1 and CH2 are automatically selected for the X-Y mode of operation.

A: Selects A sweep alone for single time base mode of operation.

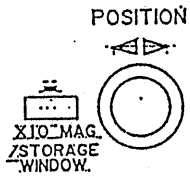
ALT: A sweep (regular sweep) and B sweep (delayed sweep) run alternately.

A sweep is with accentuated brightness for the section to be magnified. B sweep is for display of the magnified waveform.

B: Selects B sweep (continuously delayed sweep). Sweep speed is as selected by B TIME/DIV switch.
Sweep starts when period preset by DELAY TIME POSITION ㉝ has elapsed.

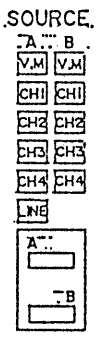
B TRIG: Selects triggered delay, and is enabled when in ALT or B sweep mode. B sweep starts as triggered by B trigger signal after delay time set by DELAY TIME POSITION ㉝ has elapsed. When in the B TRIG mode, the AUTO LEVEL ㉗, TRIG SLOPE ㉘, and TRIG LEVEL ㉚ are changed to B trigger function and their green lamps illuminate as well as those of the TRIG SOURCE ㉔ and TRIG CPLG ㉕ to indicate the setting of B trigger as well as that of A trigger.

* POSITION ..... ⑳ For horizontal positioning of the trace or spot. When in the ×10 MAG mode, the horizontal position of the beam spot (trace) is adjustable for a range of approximately 20 DIV with the POSITION control. As you turn the control to the full clockwise or counterclockwise position (to the end position), the beam spot (sweep) moves automatically and continuously to the right or left, respectively. To stop the moving beam spot (trace), turn the control in the reverse direction from the end position.
When in the ALT DELAY mode, B sweep alone is magnified.



○ TRIGGERING

SOURCE ..... ㉔ Selects a triggering signal source. Switch A selects the A triggering. Switch B selects the B triggering only when HORIZ MODE ㊱ is set for the ALT mode or for the B sweep and the B TRIG mode.



V-MODE: (V.M) The input signal selected by VERT MODE ㊴ is used as the triggering source signal. When in a multi-channel mode, triggering is made in ALT mode, and V-MODE lamp and the indicator lamps of the selected channels illuminate. When CHOP mode is selected by VERT MODE ㊴ or when AUTO LEVEL ㉗ is selected, however, the left most one alone of the indicator lamps of the selected channels illuminates indicating that the corresponding channel signal is selected for the triggering source signal.

CH1: CH1 input signal is used as triggering source signal.

CH2: CH2 input signal is used as triggering source signal.

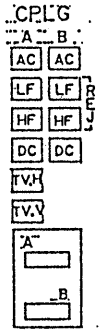
CH3: CH3 input signal is used as triggering source signal.

CH4: CH4 input signal is used as triggering source signal.

LINE: AC line signal is used as triggering source signal. The A TRIG mode alone is selectable.

Note: When in the A TRIG mode, an orange lamp illuminates; when in the B TRIG mode, a green lamp illuminates.

CPLG ..... ㉕ These switches select the coupling mode between the triggering signal source and the trigger circuit. Switch A selects the A triggering mode (the orange lamp illuminates) and switch B selects the B triggering mode (the green lamp illuminates).
When in the A triggering, these switches also select the coupling to TV sync circuit. The B triggering can be selected only when the HORIZ MODE ㊱ is set for the ALT or B TRIG mode.



AC: AC coupling, eliminating DC components

LF-REJ: Components lower than 50 kHz are rejected.

HF-REJ: Components higher than 50 kHz are rejected.

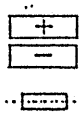
DC: DC coupling

TV.H: Triggering is made with TV horizontal sync signal. Effective for A TRIG mode only.

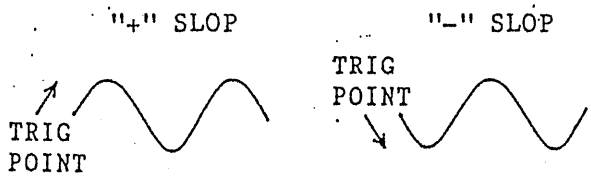
TV.V: Triggering is made with TV vertical sync signal. Effective for A TRIG mode only.
As you select the TV line select mode (TV.LN mode), the oscilloscope is automatically set to the TV.H mode. When the TV.LN mode is selected, the triggering mode is initially set to NORM and it cannot be changed to AUTO.

SLOPE ..... ㉘ Selects either positive-going slope or negative-going slope for triggering point.

+: Triggering occurs when a positive-going signal crosses the trigger level.

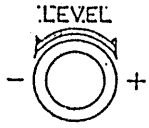


-: Triggering occurs when a negative-going signal crosses the trigger level.



NOTE: When in the A TRIG mode, an orange lamp illuminates; when in the B TRIG mode, a green lamp illuminates.

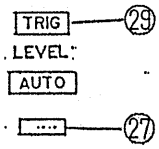
LEVEL ..... ㉚ Controls the triggering level to adjust the starting point of the waveform displayed on CRT.



When A/B TRIG selector switch ㉖ is set for A TRIG, this knob is used to adjust the A TRIG level; when set for B TRIG, this knob is used to adjust the B TRIG level.

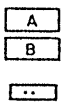
When in the A TRIG mode, TRIG LED ㉙ illuminates.

LEVEL AUTO ..... ㉗ When in the LEVEL AUTO mode, the LEVEL control ㉚ is disabled and the triggering level is maintained at an optimal level covering from the minimum amplitude to the maximum amplitude.



Note: When in the A TRIG mode, the orange lamp illuminates; When in the B TRIG mode, the green lamp illuminates.

A/B ..... ㉖ Selects either the A or the B triggering mode for the SLOPE ㉘, LEVEL ㉚, and LEVEL AUTO ㉗ which are used in common for both the A and the B triggering. Each time as you press this switch, either the A or the B triggering mode is selected.
This switch is effective only when the HORIZ MODE ㉟ is set for the ALT mode or for the B sweep for the B TRIG mode.



Immediately after the HORIZ MODE ㊱ is set to the ALT mode or to the B sweep for the B TRIG mode, the B indicator lamp illuminates and the above common-use controls are set for the B triggering.

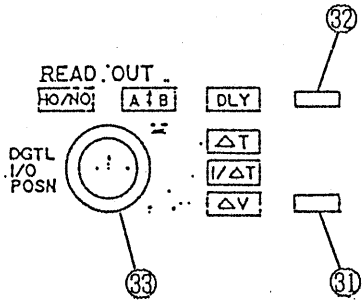
Unless the HORIZ MODE ㊱ is set for the B TRIG mode, the A/B switch does not operate, the A lamp illuminates, and the above mentioned common-use controls are in the A triggering mode.
When the B lamp is illluminating, the above keys are effective for B triggering; when the A lamp is illuminating, they are effective for A triggering.

o CRT Readout

The functions of the CURSOR SW ㉛ and the SUB CURSOR SW ㉜ for data to be displayed on the CRT readout can be set mutually independently for each of the A, ALT, and the B sweep modes which are selectable with the HORIZ MODE ㊱. For example, you may set the CURSOR SW ㉛ for the $1/\Delta T$ measuring function for the ALT sweep mode and for the ΔT measuring function for the B sweep mode. With this setting, simply by selecting the HORIZ MODE ㉛ thereafter, measurement will automatically become OFF when in the A sweep mode, frequency ($1/\Delta T$)measurement when in the ALT sweep mode, or period (ΔT) measurement when in the B sweep mode. The above, however, is not applicable to other cursor functions. If the TRIG CPLG ㉕ is set to TV.H or TV.V, each time as you press the 2nd FUNCTION key and TV.LN ㊺ simultaneously, the pedestal clamp circuit is turned on or off. When the pedestal clamp circuit is on, message "C_{LP}" appears on the CRT.
The switches related to the readout when in the HORIZ mode are described below.

(1) When HORIZ MODE ㊱ is set for A sweep

* CURSOR SW ..... ㉛ This switch selects four states (measurement of ΔT, $1/\Delta T$ or ΔV with cursor and measurement off). As this switch is changed, functions of the READOUT control ㉝ are changed automatically.



When in any one of the above types of measurement, position of the dotted-line cursor is adjustable with the READOUT control ㉝. The adjustable range is approximately ±1 DIV from center of screen. As you turn the control to the full clockwise or counterclockwise position (to the end position), the cursor moves automatically and continuously. To stop the moving cursor, turn the control in the reverse direction from the end position.

The cursor line can be changed to broken lines or to dotted lines by pressing the knob.
When both cursor lines are dotted, they are in the tracking mode and can be moved keeping the distance between them constant.
Each time as you press the knob, the cursor changes in the order of broken line → tracking mode → dotted line tracking mode → broken line.

△T: Differential time between two vertical cursors (one is broken line and the other is dotted or broken line) is determined and digitally displayed on CRT.

When SWEEP VARIABLE ⑰ is set in the on state, time ratio with reference to 5 DIV as 100% is determined and displayed. This mode of operation is convenient for measurement of the duty ratio of pulse wave.

1/△T: Differential time between two vertical cursors (one with broken line and the other with dotted or broken line) is determined and its reciprocal is calculated and dig-

itally displayed as frequency.
When SWEEP VARIABLE ⑰ is set in the enabled state, phase with reference to 5 DIV as 360 degrees is determined and displayed.
This mode of operation is convenient for measurement of phase difference.

ΔV: Differential voltage between two horizontal cursors (one with broken line and the other with dotted or broken line) is determined and digitally displayed on CRT.

Scale factor is as that of CH1, except when CH2 single channel is selected by VERT MODE ㊴ in which case scale factor is as that of CH2.

When the VARIABLE knob is in the pushed out state (UNCAL state), voltage ratio with reference to 5 DIV as 100% is determined and displayed.

* SUB CURSOR SW ..... ㉜ This switch changes READOUT control ㉝ to holdoff control function when in ΔT, 1/ΔT, or ΔV measurement in the A sweep mode.

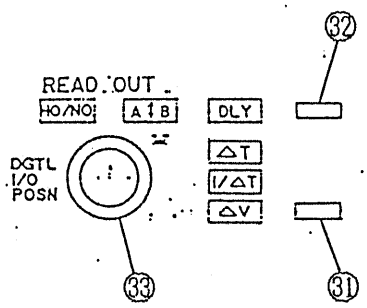
As you press this switch, HO/TV: lamp illuminates and holdoff period becomes adjustable. As you press this switch again or press the READOUT control ㉝, HO/TV lamp goes out and cursor measurement resumes. When none of ΔT, 1/ΔT and ΔV is selected, the cursor measurement function is turned off.

When in A sweep mode				
Function selectable with SUB CURSOR SW ㉝ (LED)		Function selectable with CURSOR CURSOR SW ㉛ (LED and READOUT)	Control function with READOUT CONTROL ㉝	States selectable by pushing in/out of READOUT control ㉝
Cursor select mode (⊿T, 1/⊿T, ⊿V)		All off	— — —	— — —
		⊿T	Cursor position	To select control cursor
		1/⊿T	Cursor position	To select control cursor
		⊿V	Cursor position	To select control cursor
HO/NO mode	＊1	HO	Holdoff time	— — —

＊1: When TV.LN mode is not selected.
For operation when the TV.LN mode is selected, refer to Para. (5) "TV.LN function".

(2) When HORIZ MODE ㊱ is set for ALT sweep

＊ CURSOR SW ..... ㉛ This switch selects the functions of the READOUT control ㉝ for delay time setting (DLY) or time interval measurement (⊿T, 1/⊿T) with delayed sweep.



When in the ⊿T or 1/⊿T measuring mode, controllable intensity modulation sections can be changed by pressing the READOUT control ㉝.

When in the tracking mode, as in the case of measurement with cursors, two intensity-modulated sections can be moved keeping the distance between them constant.

Each time as you press the control knob, control function changes in the order of intensity modulation A → tracking mode → intensity modulation B → tracking mode → intensity modulation A.

DLY: READOUT control ㉝ acts as delay time control for B sweep. The delay time is digitally displayed on CRT.

When SWEEP VARIABLE ⑰ is set in the on state, delay time displayed on the CRT is in the unit of DIV.

ΔT: Differential time between two intensity-modulated sections on A sweep is determined and digitally displayed on CRT.

When in single channel mode, two intensity-modulated sections are displayed on the same trace.

When in multi-channel mode and VERT MODE ㊴ is set for ALT mode but TRIG SOURCE ㉙ is not set for V-MODE triggering, intensity-modulated sections are displayed on channels with priority in the order of CH1, CH2, CH3, CH4, and ADD, with one intensity modulated section on the trace of an odd number channel and the other intensity modulated section on the trace of an even number channel, for measurement of differential time between channels.
When an odd number of channels are measured, however, two intensity-modulated sections are displayed on the trace of the lowest-priority channel. When in the five-trace mode (CH1, CH2, CH3, CH4, and ADD), one intensity-modulated section is displayed on CH1 trace and the other

intensity-modulated section on CH2 trace, while both intensity-modulated sections are displayed on each of CH3, CH4, and ADD traces.

When SWEEP VARIABLE ⑰ is set in the on state, time ratio with reference to 5 DIV as 100% is determind and displayed.

1/ΔT: Differential time (period) between intensity-modulated sections on A sweep is determined and its reciprocal (frequency) is calculated and displayed.

When the SWEEP VARIABLE ⑰ is set in the on state, phase difference is measured and displayed with a reference of 5 DIV as 360 degrees.

* SUB CURSOR SW ..... ㉜ This switch selects the function of READOUT control ㉝ between holdoff function when in DLY, ΔT or 1/ΔT mode and trace separation function.

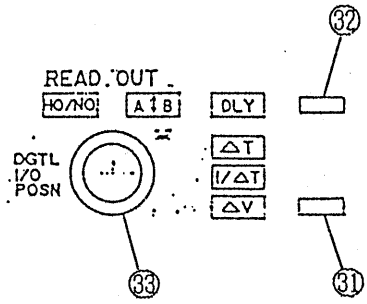
As you press this switch, HO/TV lamp illuminates and holdoff time becomes adjustable. As you press this switch again, A↕B lamp illuminates and B sweep position with respect to A sweep position is vertically adjustable when in ALT mode. As you press this switch once more, DLY,ΔT or 1/ΔT measurement resumes.

When in A sweep mode			
Function selectable with SUB CURSOR SW ㉝ (LED)	Function selectable with CURSOR CURSOR SW ㉛ (LED and READOUT)	Control function with READOUT CONTROL ㉝	States selectable by pushing in/out of READOUT control ㉝
Alternate controll select mode (⊿T, 1/⊿T, ⊿V)	DLY	Delay time position	— — —
	⊿T	Intensity modulation position	To select intensity modulation control position
	1/⊿T	Intensity modulation position	To select intensity modulation control position
Trace separation mode (A ↕ B)	All off	Trace separation	— — —
		between A and B	
HO/NO mode ＊1	HO	Holdoff time	— — —

＊1: When TV.LN mode is not selected.
For operation when the TV.LN mode is selected, refer to Para. (5) "TV.LN function".

(3) When HORIZ MODE ㊱ is set for B sweep

＊ CURSOR SW ..... ㉛ This switch selects the functions of the READOUT control ㉝ for delay time setting or time interval measurement (⊿T, 1/⊿T) with delayed sweep.



When in ⊿T or 1/⊿T measuring mode, controllable B sweep can be changed by pressing the READOUT control ㉝.

Each time as you press this knob, the control function changes in the order of B sweep a → tracking mode → B sweep b → tracking mode → B sweep a.

DLY: Delayed and magnified sweep is displayed on CRT, with delay time controllable with the READOUT control

㉝. Delayed time is digitally displayed on CRT.
When SWEEP VARIABLE ⑰ is set in the on state, delay time is displayed in the unit of DIV.

ΔT: Differential time between two B sweeps is determined and digitally displayed on the CRT.

When in single channel mode or CHOP mode, differential time between two points on the same signal waveform is displayed.

When in multi-channel mode and the VERT MODE ㊴ is set for ALT mode but TRIG SOURCE ㉔ is not set for V-MODE triggering, it measures the period of time between one point on the trace of the odd-number channel and the other point on the trace of the even-number channel, with channel priority in the order of CH1, CH2, CH3, CH4, and ADD. When an odd number of channels are displayed, differential time between two points on the same trace is measured for the channel of the lowest priority. Except when in the 5-trace mode with CH1, CH2, CH3, CH4 and ADD, differential time between CH1 and CH2 and that between two points on each of the remaining traces are displayed.

When in triggered delay mode, a sign of inequality on CRT is affixed to prevent reading errors.

When SWEEP VARIABLE ⑰ is set in the on state, time ratio with reference to 5 DIV on A sweep as 100% is measured and displayed.

1/ΔT: Differential time (period) between two points on B sweep is determined and its reciprocal (frequency) is calculated and displayed.

When SWEEP VARIABLE ⑰ is set in the on state, phase difference with reference to 5 DIV on A sweep as 100% is measured and displayed.

* SUB CURSOR SW ..... ㉜ This switch selects function of READOUT control ㉝ between holdoff function and trace separation function when in DLY, ⊿T or 1/⊿T mode.

When trace separation function is selected, all traces displayed on CRT are of B sweep mode. The trace which is movable with the knob is of the lowest priority channel.

To return to DLY, ⊿T or 1/⊿T mode, press again this switch

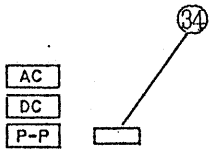
When in A sweep mode			
Function selectable with SUB CURSOR SW ㉝ (LED)	Function selectable with CURSOR CURSOR SW ㉛ (LED and READOUT)	Control function with READOUT CONTROL ㉝	States selectable by pushing in/out of READOUT control ㉝
Alternate controll select mode (⊿T, 1/⊿T, ⊿V)	DLY	Delay time position	— — —
	⊿T	Delay time position	To select double delayed sweep mode Ba or Bb
	1/⊿T	Delay time position	To select double delayed sweep mode Ba or Bb
Trace separation mode (A ↕ B)	All off	Trace separation between A and B	— — —
HO/NO mode *1	HO	Holdoff time	— — —

*1: When TV.LN mode is not selected.
For operation when the TV.LN mode is selected, refer to Para. (5) "TV.LN function".

9031161

(4) Digital voltmeter and frequency counter functions

* DVM SW ..... ㉞ This switch selects the DVM function to measure the AC, DC, or peak-to-peak voltage of the signal applied to CH1 input.
The measured value is digitally displayed on CRT.



When the DVM is set in the on state, frequency of the triggering source signal selected by TRIG SOURCE ㉔ also is measured in an auto-range system and displayed on CRT. DVM and counter are disabled when in storage mode.

Each time as you press the switch, measurement is changed in the sequence of AC voltage, DC voltage, peak-to-peak voltage, and off.

Note: Note that measurement by DVM may involve larger errors when the measured signal amplitude is unreasonably small or large.
Note also that frequency counter may not operate when the signal pulse width is very narrow, the signal amplitude is very small, or when the signal is in a state such that no triggering is successfully effected.

AC: Measures the AC voltage (true rms value) of the signal applied to CH1 input for a range of 20 Hz - 100 kHz.

When COUPLING ⑨ of CH1 is set to AC-coupling, rms value of AC voltage signal is measured; when it is set to DC-coupling, DC + AC rms value is measured.

DC: Measures the DC voltage of the signal applied to CH1 input.

p-p: Measures the peak-to-peak voltage of the signal applied to CH1 input, for a frequency range of 20 Hz - 10 MHz.

Symbols displayed on CRT are as shown in the following table.

DVM SW ㉞	CH1 COUPLING ⑨	Symbol
AC	AC	$\widetilde{V}$
	DC	$\widetilde{\overline{V}}$
DC	AC	?V
	DC	$\overline{V}$
p-p	AC, DC	P...V

(5) TV.LN function (TV line select function)

TV.LN SW ..... ㊺ This switch is for the TV.LN mode and allows to select NTSC or PAL. When in the TV.LN mode, the TV.LN LED, HO/NO LED, and TV.H LED automatically illuminate and TV line number selection can be done with the READOUT CONTROL knob ㉝.

Each time as you press the TV.LN ㊺, the modes sequentially change in the order of NTSC, PAL, and OFF. When in the storage mode, they sequentially change in the order of NTSC, PAL, and TV.H.

When the TV.LN mode is selected, if the preceding triggering mode is AUTO, the NORM mode is selected automatically. The AUTO mode is unavailable when in the TV.LN mode.

To exit from the TV.LN mode, press the

TV.LN ⑮ to set to the OFF (TV.H) mode or press the CPLG A ㉕ to select other mode than TV.H.

Functions selectable with TV.LN SW ⑮. (LED and Readout)		Functions controllable with READOUT CONTROL knob ㉝
NTSC		NTSC line number select
PAL		PAL line number select
OFF (TV.H)	Readout	Holdoff time
	Storage mode	— — — — — —

(6) CLP function (pedestal clamp function)

TV.LN (CPL) SW ..... ⑮ As you press the 2ND FUNCTION key ㊸ and the TV.LN SW ⑮ simultaneously the pedestal clamp function is turned on or off, when the trigger CPLG A is set to TV.H or TV.V (or when the TV.LN mode is selected, as a matter of cource).

○ Others

CAL (Vp-p) ..... ㉒ This terminal provides a 1 kHz ±0.1% squarewave 0.5 Vp-p calibration signal with ±2% voltage accuracy. Output resistance is approximately 2k ohms.

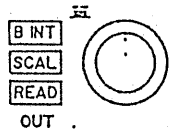
 ..... ㉑ Ground terminal

4.2 Description of Front Panel (for Storage Mode)

This section gives descriptions of the front panel items for the storage mode. For other front panel items, see Section 4.1.

o CRT Circuits

B INT, SCAL, READOUT .. ⑤ Each time as you press this knob, its function is changed to SCAL (adjustment of graticule illumination brightness) or READOUT (adjustment of readout character and cursor brightness). When in the storage mode, this knob is not changed to B INT.



o Vertical Axes

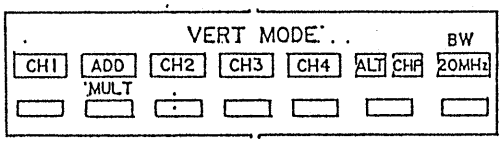
CH3 input ..... ⑭ CH3 vertical axis input terminal.

CH4 input ..... ⑱ CH4 vertical axis input terminal.

POSITION ..... ㉟ ㊲ ㊳ ㊵ Vertical positioning of trace. Enabled even when in PAUSE state.

VERT MODE ..... ㊴ Select vertical axes. Any combination of CH1, CH2, CH3, and CH4 can be selected.

When in single channel mode or ALT mode, the lamps of the selected channels illuminate. For CHOP mode, CH1 and CH2 alone are selectable.



As you press again the switch, the lamp goes out except when in the single channel mode.

The MULT mode can be selected by pressing the 2nd switch and ADD switch simultaneously.

ADD: Algebraic sum or difference betweem CH1 and CH2 signals is displayed with the center of CRT as the center of display. For details, refer to Section 5.1, (11) "ADD".

MULT: The product of multiplication of CH1 signal by CH2 signal is displayed with the center of CRT as the center of display. The product signal waveform is displayed with a reduced scale factor. For details, refer to Section 5.1, (12) "MULT".

ALT, CHOP: Selects ALT or CHOP mode for multi-channel operation.

When in ALT mode, the signals are acquired alternately for the selected channels. When TRIG SOURCE ㉔ is set for V-MODE, triggering is made in ALT mode.

When in CHOP mode, CH1 and CH2 signals are acquired simultaneously.

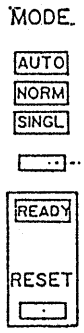
20MHz BW: Limits the bandwidth of approximately 20 MHz on vertical amplifier. This switch ope-rates independent of other switches.

o Time Base (Horizontal Axis)

A,B TIME/DIV ..... ⑯ Selects sweep time of A sweep or B sweep (delayed sweep).
The pushed-in position of the knob is for A sweep and the pulled-out position is for B sweep. Even when the knob is in the pulled-out state, however, if HORIZ MODE ㊱ is set for A sweep, this switch is for A sweep.
The sweep time is digitally displayed on the CRT, either when in A sweep or B sweep. The 1 s/DIV to 5 s/DIV ranges are for the storage mode only. When A sweep is in one of the 1 s/DIV to 5 s/DIV ranges, B sweep (delayed sweep) is disabled.

VARIABLE ..... ⑰ This control remains disabled when in storage mode. Time base is as set by A or B TIME/DIV ⑯ irrespective of setting of this control.

MODE ..... ㉓ Selects sweep mode. Sweep operation differs between the regular sweep mode and the ROLL mode which is performed with the CHOP function when the sweep speed is 0.1 s/DIV or slower.



When in the regular mode

AUTO: When no triggering signal is applied or triggering signal frequency is lower than 50 Hz, sweep runs automatically in a free run mode.
The AUTO mode is unavailable when in the TV.LN mode.

NORM: When no triggering signal is applied or no triggering is effected, the waveform of the current sweep cycle is kept displayed and the sweep circuit is in the standby state for the next trigger signal. When the TV.LN mode is selected, the triggering mode is initially set to NORM.

SINGL: When a triggering signal is applied, sweep runs only for one sweep cycle. When the sweep cycle is over, the READY lamp goes out and the data acquisition function pauses.

As you press the RESET switch, the READY lamp illuminates to indicate that the sweep circuit is ready for the next cycle of one-sweep run in response to the next event of triggering. Note, however, that the period for the initial 2k words immediately following the resetting constitutes a holdoff period during which the next triggering remains disabled.

The VIEM TIME ㊼ remains in the disabled state.

When in the ROLL mode

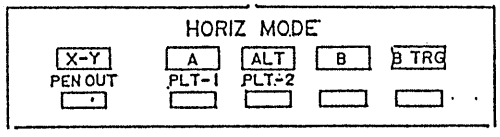
AUTO: The Sweep runs automatically in a free run mode, irrespective of triggering signal. Displayed waveform can be made stationary by PAUSE ㊹.

NORM: When the VIEW TIME is OFF:
Sweep runs in a free run mode irrespective or triggering signal.

When the VIEW TIME is ON:
Sweep runs in a free run mode until triggering is effected. When triggering is effcted, waveform becomes stationary at the point set by the TRIG POINT and remains in this state for the period set by the VIEW TIME ㊼. When the period has elapsed, the free run mode will resume.

SINGL: Sweep runs in a free run mode until triggering is effected. When triggering is effected, displayed waveform becomes stationary at the point set by the TRIG POINT ㊽.

HORIZ MODE ..... ㊱ Select X-Y mode, A sweep mode or delayed B sweep mode as follows.



X-Y: The oscilloscope operates as an X-Y scope, with CH1 for X-axis and CH2 for Y-axis (automatically set as you strike the X-Y key). The sampling rate is displayed instead of the TIME/DIV factor of the time base axis.

A: Selects A sweep alone for single time base mode of operation.

ALT: This mode is to select on A sweep a section of waveform (the section to be magnified on B sweep).
Symbol D is displayed above the A sweep waveform to indicate the starting point of magnification. In this case, TRIG POINT automatically becomes 0 DIV.

T is not displayed and the WINDOW function remains disabled.

B: This mode is for continuous delayed sweep operation. Each sweep cycle starts after a period set by B TIME/DIV switch and DELAY TIME POSITION control (READOUT control ㉝) has elapsed.
The range for viewing with the WINDOW function can be moved with the TIME/DIV of B sweep for up to 2k words with the D position (delay time position) as the center of movement, either in the direction of before or after the D position.

B TRIG: This switch selects the triggered delay mode. This switch is effective when in B sweep mode.

B sweep is triggered by B triggering signal when the period set by DELAY TIME POSITION has elapsed.

When this switch is pressed, the AUTO LEVEL ㉗, TRIG SLOPE ㉘ and TRIG LEVEL ㉚ are changed to the B triggering function and the green lamps illuminate to indicate the set status. Of the TRIG SOURCE ㉔ and TRIG CPLG ㉕ also, the green lamps illuminate indicating that they are set for the B triggering function and switch B is enabled.

POSITION (WINDOW) ..... ⑳ For horizontal positioning of the trace or spot. When the knob is in the pushed-in state (the state for the WINDOW function), any 1k word range of the 4k word display memory data can be viewed on the CRT.

As you turn the knob to the clockwise or counterclockwise end position, the window will move automatically and continuously rightward or leftward, respectively. To stop the moving window, turn the knob in the reverse

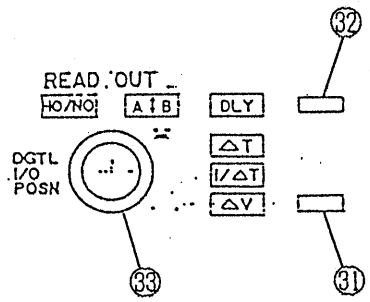
direction from the end position.

The message "◂T□□ms" on the CRT indicates the time interval from the left hand end of the CRT screen to the TRIG point. When in the ROLL mode, the message "□□□□/4095" indicates the location of the address of which data is currently displayed in the center of the CRT, with reference to the addresses of the 4k word display memory.

o CRT Readout

When in the storage mode, the CURSOR SW ㉛ is enabled provided that the HORIZ MODE ㊱ is set for the A sweep mode--it is disabled if the HORIZ MODE ㊱ is set for the ALT or B sweep mode.
The SUB CURSOR SW ㉜ and the DVM SW ㉞ are disabled--if you need the DVM function, select the real mode.

CURSOR SW ..... ㉛ Selects ΔT, $1/\Delta T$ or ΔV measurement with cursors or measurement off when HORIZ MODE ㊱ is set for A sweep mode. As you press this switch, function of READOUT control ㉝ also is changed.



When measuring of any one of the above items, position of the dotted-line cursor is adjustable with READOUT control ㉝. The adjustable range is approximately ±1 DIV from mid-position setting of the control knob. As you turn the control to the full clockwise or counterclockwise position (to the end position), the cursor moves automatically and continuously. To stop the moving cursor, turn the control in the reverse direction from the end position.

Cursor can be change between that of broken line and dotted line by pressing the knob. When both cursors are of dotted lines, they can be moved on CRT keeping the distance between them constant. Each time as you press the knob, cursor changes in the sequence of broken line → tracking mode →

dotted line → tracking mode → broken line.

ΔT: Differential time between two vertical cursors (one with broken line and the other with dotted or broken line) is measured and digitally displayed on CRT.

$1/\Delta T$: Differential time (period) between two vertical cursors (one with broken line and the other with dotted or broken line) is determind and its reciprocal (frequency) is calculated and displayed on CRT.
When in the storage mode, the RATIO function (time ratio measuring function) and PHASE function (phase measuring function) are disabled.

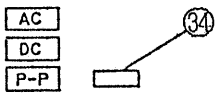
ΔV: Differential voltage between two horizontal cursors (one with broken line and the other with dotted or broken line) is measured and digitally display on CRT.

When the vertical axis is in the UNCAL state, the RATIO measurement (measurement of voltage in percentage with an amplitude of 5 DIV as 100%) can be done.

Note: Scale factor is as that of CH1, except when CH2 single channel mode is selected by VERT MODE ㊴ in which case scale factor is as that of CH2.

SUB CURSOR SW ..... ㉜ When in the storage mode, this switch remains disabled regardless of whether the HORIZ MODE ㊱ is set to the A, ALT, or B sweep mode.

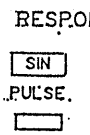
DVM SW ..... ㉞ Disabled when in storage mode.



o Storage Circuit

MODE ..... ㊶ Selects real mode or storage mode. When in storage mode, STRG lamp illuminates.

RESPONSE ..... ㊵ This switch selects either sine interpolation or pulse interpolation. This switch is enabled when time base is magnified after PAUSE mode or when SINGLE SWEEP operation is used at ranges higher than the maximum sampling rate 0.5 μs/DIV.



SINE lamp illuminates when in sine interpolation for sine wave. Almost full sine waveform interpolation can be successfully done when the number of the sampled data items per cycle is 2.5 or more.

When in pulse interpolation, SINE lamp does not illuminate and the points representing the sampled data values are connected with straight lines. Pulse interpolation is especially effective for interpolation of pulse waves, although it allows almost full sine waveform interpolation for sine waves also when the number of the sampling points per cycle is 10 or more.

ENV (DOT) ..... ㊴ Selects the envelope mode, which displays the maximum and minimum values between sampling points.
The envelope mode provides two types of functions, namely, ENV1 and ENV∞.

The envelope mode allows you to identify narrow pulses which may exist between sampling clock pulses and detect aliasing when input signal frequency is higher than one half of the sampling frequency.

When in a range of 50 ms/DIV to 10 μs/DIV, the ENV∞ function can be selected. This function is such that the waveform is displayed with its maximum value constantly updated.

The ENV mode is enabled when the ENV lamp is illuminating with a range of 5 s/DIV to 10 μs/DIV. With a ranges of 5 s/DIV to 0.1 s/DIV, the ENV1 function is available only when in a single channel operation or in a CHOP sweep mode of operation.

The waveform which has been acquired by PAUSE in the ENV mode cannot be displayed with magnification. The ENV function cannot be used together with the AVG function.

By pressing this switch and the 2nd switch simultaneously, the display can be changed alternately between the regular mode (vector mode) and the dot mode.

AVG ..... ㊽ This switch sets the number of sampling cycles for averaging, in a sequence of 2 → 4 → 8 ...→ 256 → OFF. When the oscilloscope is in the AVG mode, the AVG lamp illuminates and the set number and the executed number of sampling cycles are displayed on the CRT. Although the resolution of the AD converter is 8 bits, data displayed on the CRT may be with a highest resolution of 12 bits depending on the set number of sampling cycles for averaging.

The AVG function is disabled when in the ROLL, IPL, or X-Y mode. The AVG function cannot be used together with the ENV function.

VIEW TIME ..... ㊼ Selects a period during which same waveform is kept displayed on CRT, for approximately 1 sec, 3 sec, 10 sec, and off (continuous viewing of displayed waveforms).

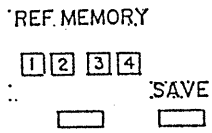
View time is indicated on CRT with a triangular symbol as follows.

: Approx. 1 sec
: Approx. 3 sec
: Approx. 10 sec

This switch is disabled when in AUTO SWEEP mode, SINGLE SWEEP mode or REPEAT mode.

REF MEMORY ..... ㊻ Select reference memory units for saving of data of up to 4 waveforms.

SAVE ..... ㊺ Data is saved as you press PAUSE ㊹ to halt acquiring of data, press REF MEMORY ㊻ to select a memory unit or units in which data is to be stored, and then press SAVE ㊺.



The memory units which are selectable by pressing REF MEMORY ㊻ are as follows.

When in single channel mode:

Any one of memory units 1 - 4 can be selected.

When in 2-channel mode:

Combination of memory units 1 and 2 or memory units 3 and 4 can be selected. The left most selected channel of the VERT MODE ㊴ is assigned to an odd-number memory unit.

For this numbering system, each of ADD and MULT is handled as an item of 1.5 channel.

When in 3-channel mode:

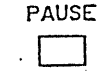
The channels selected by VERT MODE ㊴ are assigned to the corresponding numbers of memory units.

When in 4-channel mode:

The four channels are assigned to the four corresponding numbers of memory units.

Once the reference memory units are selected, they remain unchanged in the selected state (even when the number of vertical channels is changed) so far as they are not changed with the SELECT switch ㊺. That is, data stored in the reference memory units can be displayed irrespective of change in the number of vertical channels selected.

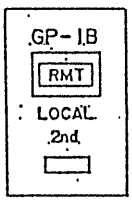
PAUSE ..... ㊹



The current waveform is kept displayed continuously, halting acquisition and display of a new waveform. As you press the switch again, the halted state is released.

Transfer of data into reference memory and sweep magnification up to 100 times are enabled only when in the PAUSE mode.
(See Section 5.1 (9) PAUSE.)

LOCAL SW ..... ㊸
(2nd FUNCTION KEY)



Selects either the remote control mode with GP-IB or the local control mode with panel switches. When in the remote control mode, the RMT lamp illuminates.

This switch acts also as a second function key. If you press the switch together with X-Y of HORIZE MODE ㊱, contents of reference memory are delivered via X-Y recorder output terminal on rear panel.
If you press the switch together with GND

of COUPLING ⑨ ⑬ ⑮ ⑲, the vertical scale factor is changed for direct use with 10:1 probes.

If you press the switch together with DVM SW ㉞, the calibration verification mode for the vertical axes, horizontal axes and storage circuits is selected. If you press the switch together with SUB CURSOR SW ㉜, the system reset mode for resetting the system when it has become abnormal is selected.

If you press the switch together with INV SW ㊾, either the vector or dot display mode is selected. If you press the switch together with VIEW TIME SW ㊼, either the RPT (repeat) mode or the IPL (interpolation) mode within a range of 0.5 μs/DIV to 10 ns/DIV is selected.

If you press the switch together with the ADD SW ㊴, the MULT mode is selected.

If you press the switch together with HORIZ MODE A SW ㉟, the output signal is delivered to the HP-GL plotter. If you press the switch together with the ALT SW ㊱, the amplitude of the output signal delivered to the HP-GL plotter is doubled.

By using the RC02-COM Remote Controller (optional device) in conjunction, the following functions can be attained: Data for up to 100 types of panel settings can be stored in the STEP memory of the oscilloscope. By pressing the switch together with B SW ㉟, the panel setting data stored in the STEP memory of the oscilloscope (designated to be a talk-only device) can be copied onto the STEP memory of other COM7202A oscilloscopes (up to fourteen devices designated to be listen-only).

If you press the 2nd FUNCTION key ㊸ and the READOUT control ㉝ simultaneously, the mode for centering of CRT display and digital I/O (output for the plotter) is selected. As you move the cursor to the center of the graticule with READOUT control ㉝ and press the 2nd FUNCTION key ㊸ again, the positional relationship is calibrated at the center of the screen. This function may be used when the display position (either in the real or storage mode) has been shifted due to terrestrial magnetism or other unfavorable environmental conditions.

4.3 Description of Rear Panel

This section gives descriptions of the rear panel items, referring to Figure 4-3.

CH1 OUT ..... ㊷ Delivers CH1 output signal of approximately 50 mV/DIV. When 50-ohm terminated, output voltage is approximately 25 mV/DIV.

Z AXIS IN ..... ㊸ Accepts an external intensity modulation signal. Trace becomes dim with positive-going signal. Clearly discerniable intensity modulation is effected with 3 Vp-p signal.

B GATE ..... ㊹ Delivers positive TTL-level gate signal corresponding to B sweep.

A GATE/SYNC OUT ..... ㊺ Delivers positive TTL-level gate signal corresponding to A sweep.

When PEN output signal is delivered in storage mode, positive TTL-level sync output signal corresponding to PEN output signal is delivered.

A SWEEP/PEN X OUT ..... ㊻ Delivers A sweep output signal of 0 to approximately +1 V. When in storage PEN output mode this terminal delivers X-axis output of 0 to approximately +1 V.

PEN Y OUT ..... ㊼ Delivers Y-axis output of 0 to approximately ±0.5 V when in storage PEN output mode.

Power Connector and Fuse ..... ⑱

AC line power connector which acts also as fuse holder.

To replace the fuse, disconnect the power cord and then ply the nail of the fuse with a screwdriver.

Studs (Cord Takeups) .... ⑲

Act as studs and also as cord takeups.

GP-IB Connector ..... ⑫

Connector which complies with IEEE- 488-1978 GP-IB Standards.

GP-IB Switches ..... ⑬

For setting of talk address (MTA) for response by interface and control of TALK ONLY (TON) local messages.

REMOTE Connector ..... ⑭

For connection to Remote Controller RC02-COM or Probe Selector PS01-COM.
For the RC02-COM and PS01-COM, refer to respective instruction manuals.

PROBE POWER ..... ⑪

Provide power for active probes

Fan ..... ⑩

Cooling fan air outlet

Note: Pay attention so that air flow from the outlet is not impeded.

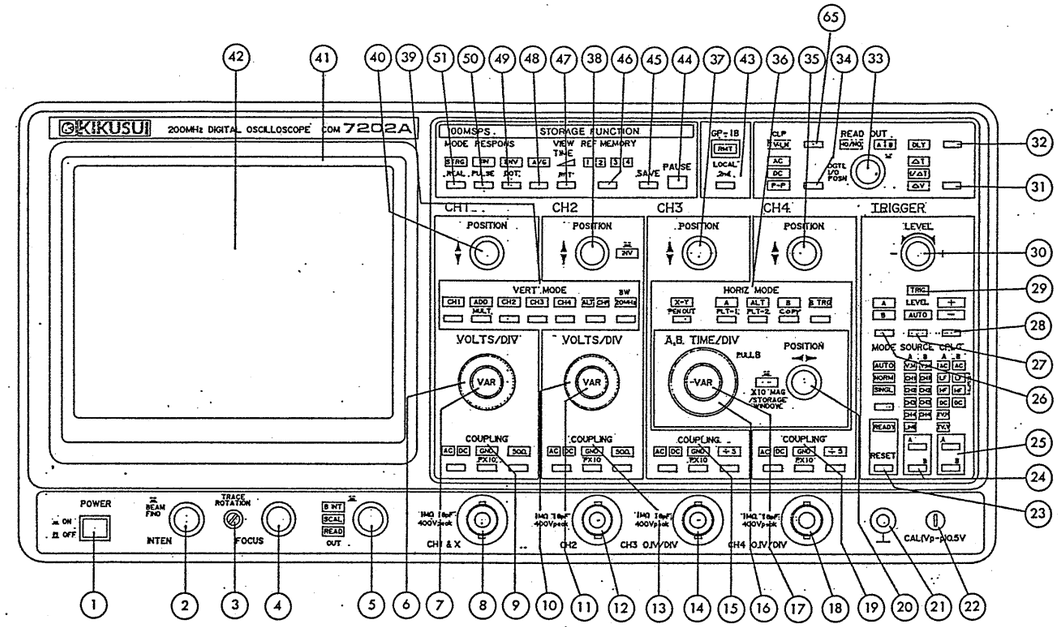


Figure 4.1. Front Panel

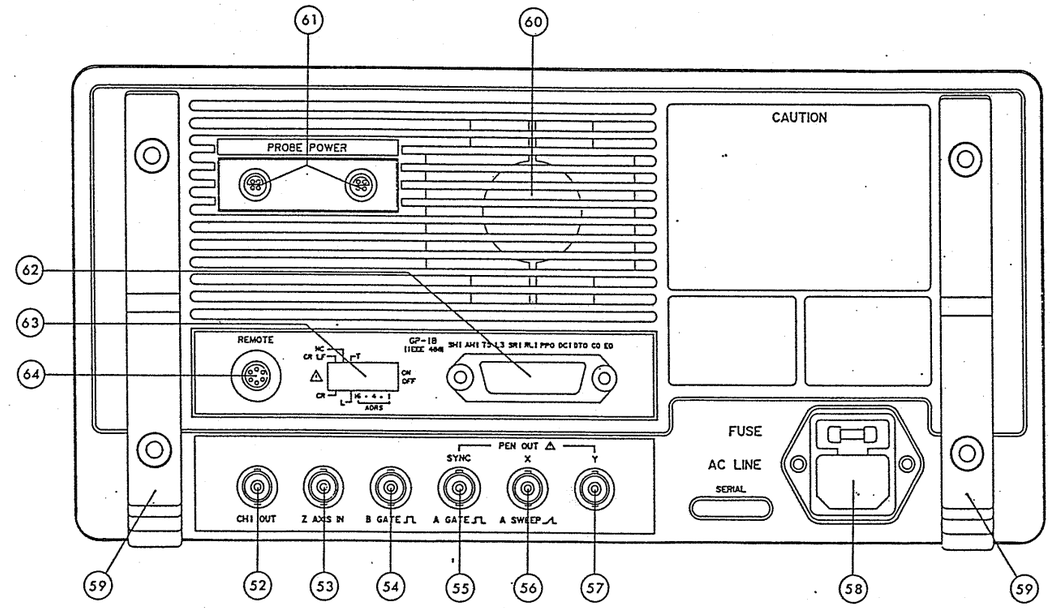


Figure 4-2. Rear Panel

4.4 Description of CRT Readout

○ This section explains the CRT readout when in the real mode.

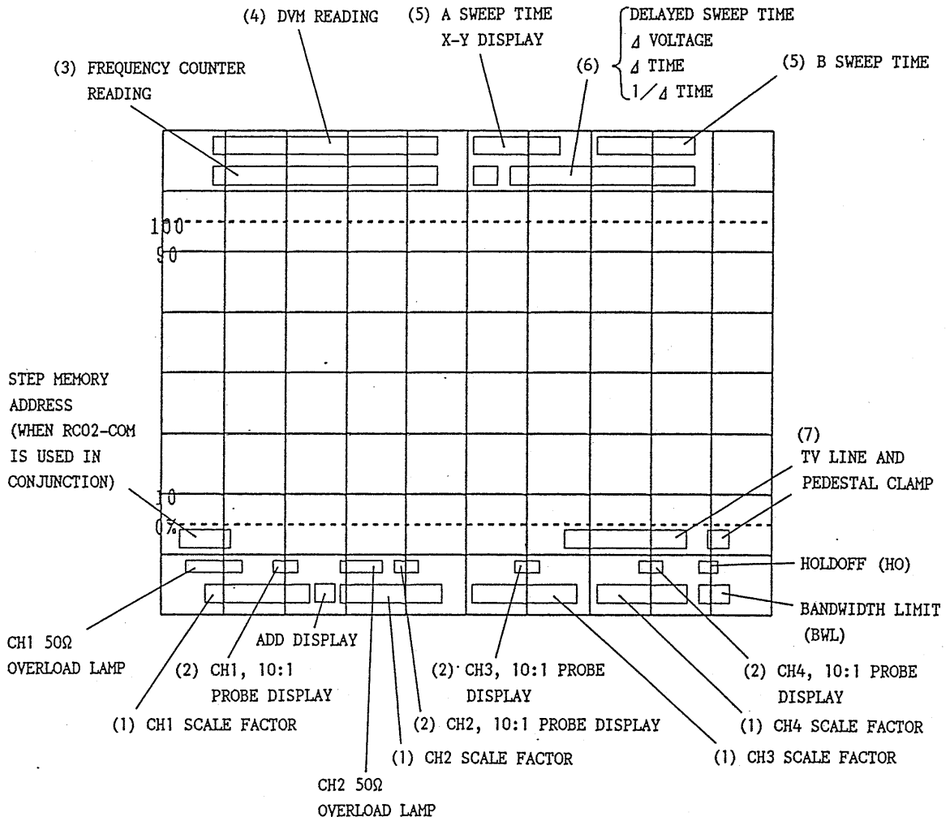
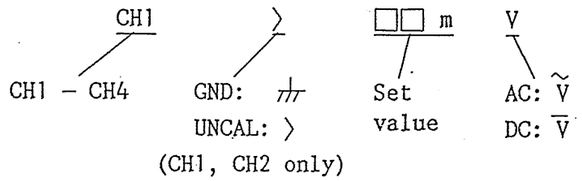


Figure 4-3

(1) CH1 – CH4 scale factor



(2) 10 : 1 probe display: P × 10 (common for storage mode)

(3) Frequency counter reading

CH1 – CH4
Linked to TRIG SOURCE

4-digit display, auto range.
When no triggering is effected: NO TRIG

(4) DVM reading

Fixed at CH1

p-p measurement: P
DC measurement: +/-
AC measurement: Blank

3-1/2 digits,

AC rms: $\widetilde{V}$
DC + ACrms: $\widetilde{\overline{V}}$
DC: $\overline{V}$
p-p: V

(5) A/B sweep time

A sweep: A
B sweep: B
(when in ALT, B)

UNCAL: 〉,〈
CAL: Blank

Set time

(6) Delayed sweep time

Delay

Triggered delay: 〉
Continuous delay: Blank

Set time

CAL: s – ns
UNCAL: DIV

ΔT measurement

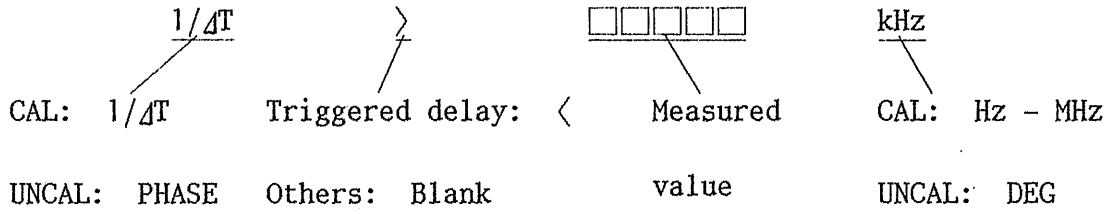
CAL: ΔT
UNCAL: RATIO

Triggered delay: 〉
Others: Blank

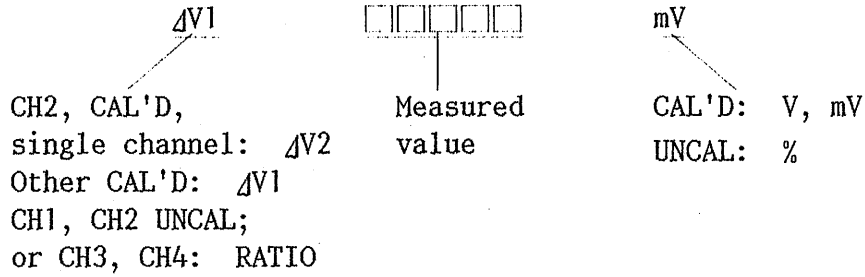
Set time

CAL: s – ns
UNCAL: DIV

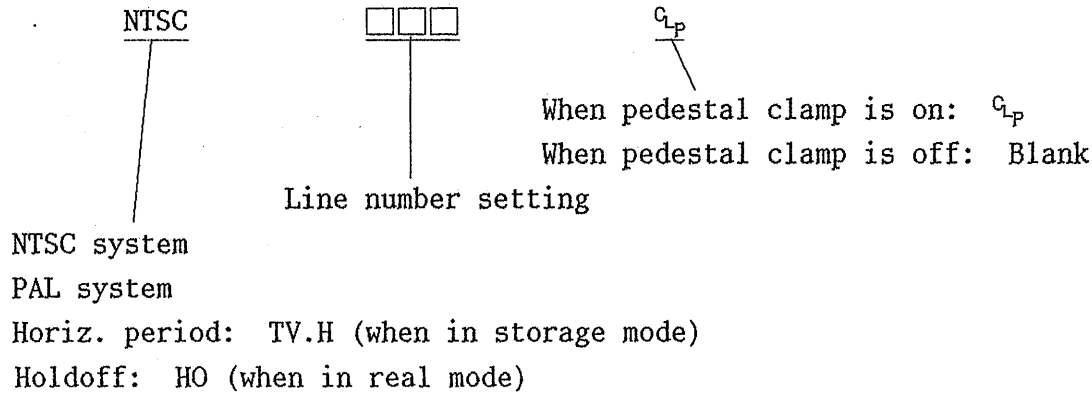
1/ΔT measurement



ΔV/measurement



(7) TV signal measurement



o This section explains the CRT readout when in the storage mode.

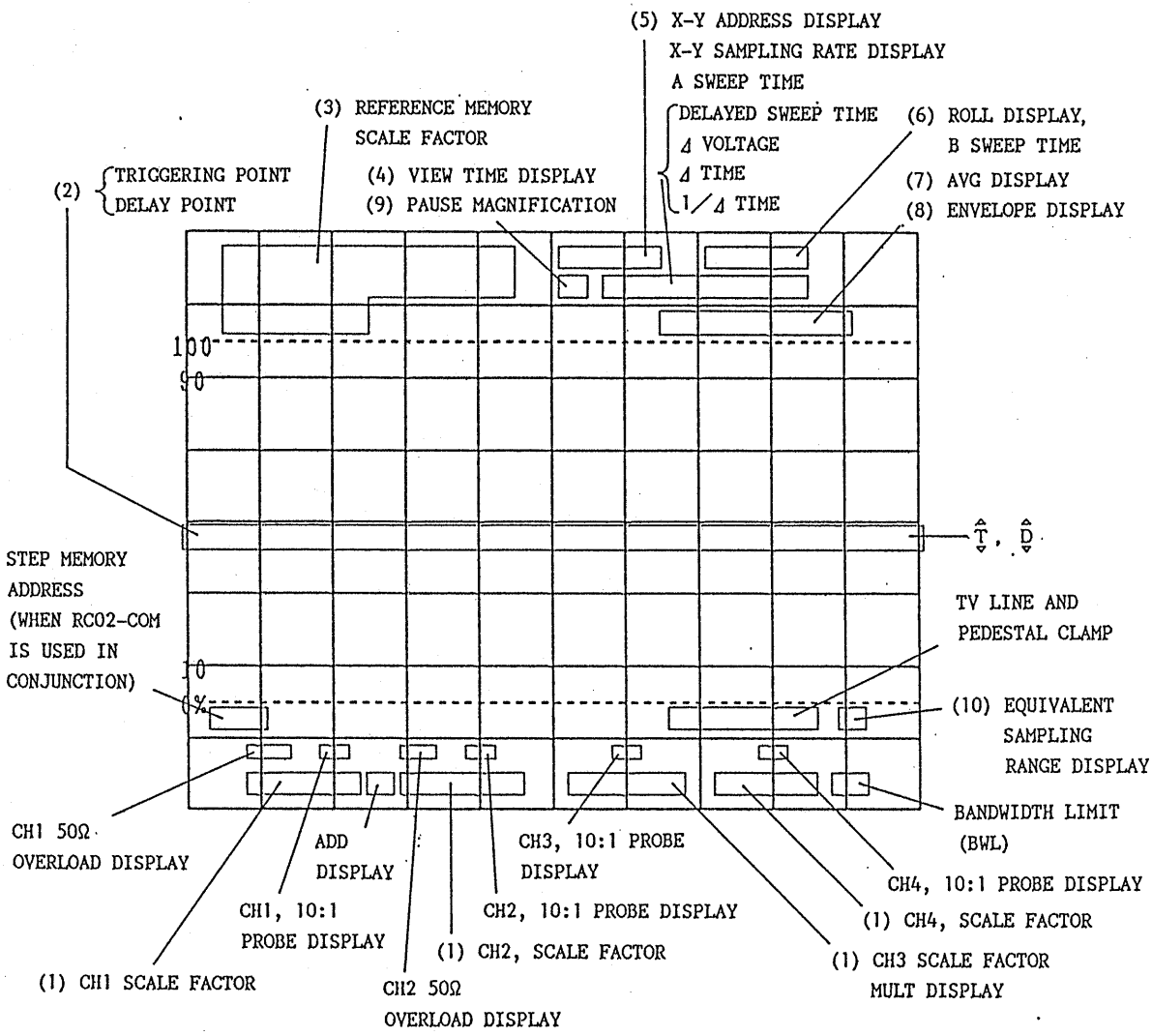
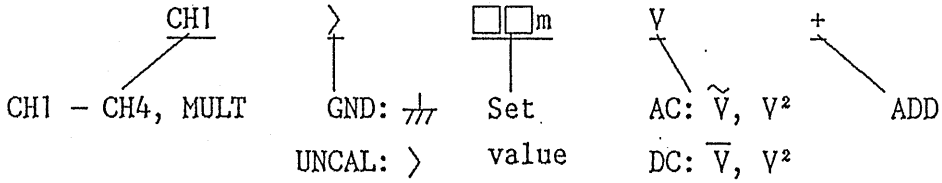


Figure 4-4

(1) CH1 - CH4 and ADD MULT scale factor



(2) Triggering point, triggering point position and delay point

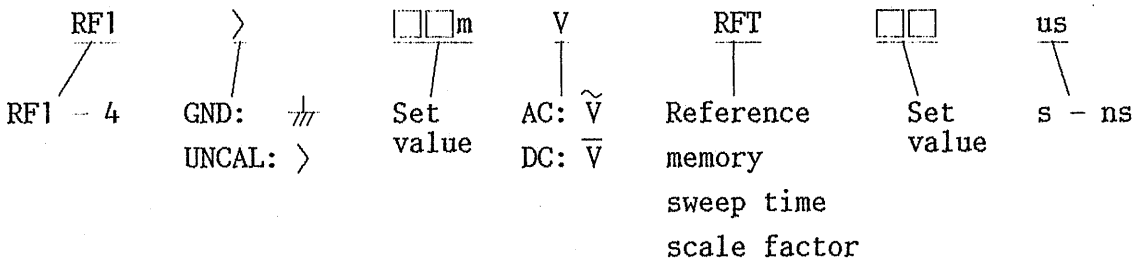
Position mark

Triggering point: T

Triggering point position: □.□□μsT▶

Delay point: D

(3) Reference memory scale factor (Note)



Note: If the scale factors of CH1 and CH2 are the same when in the ADD mode, the scale factor is displayed; if they are different, "?" is displayed. For the vertical scale factor when in the MULT mode, "?" is displayed. For the vertical or horizontal scale factor for external waveform data entered externally via GP-IB, "?" is displayed.

(4) Viewtime display

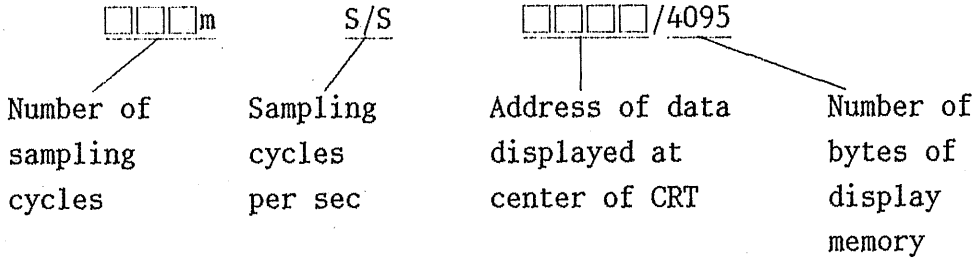
Continuous: Blank

Approx. 1 sec:

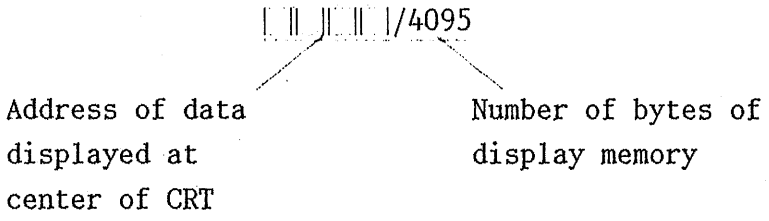
Approx. 3 sec:

Approx. 10 sec:

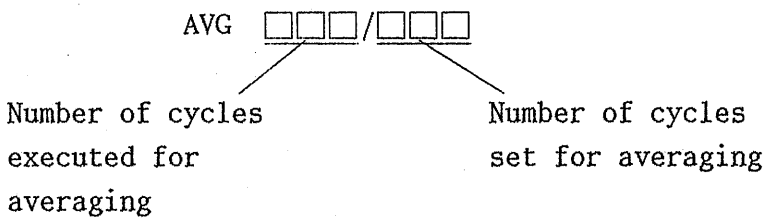
(5) X-Y display



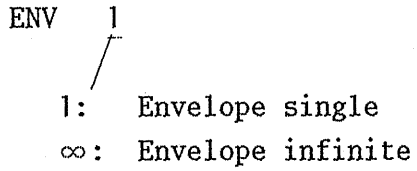
(6) ROLL display



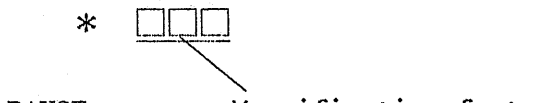
(7) AVG display



(8) ENV display



(9) PAUSE magnification



(10) Equivalent sampling range

RPT: Repetitive sampling mode
IPL: Interpolation mode

4.5 Initial Setting

To operate the oscilloscope, set initially the panel switches and controls as instructed in this section. For the storage mode, refer to Section 5.1.

Note: Be sure to rotate each control knob 30 degrees or more from the existing position. Note that the positional date of the control may not be correctly recognized unless it is turned as above.

(1) Turn on the POWER switch ①.

(2) Press the READOUT knob ⑤ the required number of times to select the readout intensity control function. Set the knob at a mid-position and check that readout is displayed on CRT. Adjust focusing with the FOCUS control ④.

(3) Set the switches and controls as follows.

Switch or Control	No.	Setting
INTEN	②	3 o'clock position
SCALE	⑤	Fully counterclockwise
VERT MODE	㊴	CH1 only.
POSITION	㊵	Mid-position
VOLTS/DIV	⑥	10 mV/DIV (displayed on CRT)
VAR	⑦	CAL'D (pushed-in state)
COUPLING	⑨	GND (AC or DC)
A.B TIME/DIV	⑯	0.5 ms/DIV
VAR	⑰	CAL'D (pushed-in state)
SWEEP MODE	㉓	AUTO (top position)
TRIG SOURCE	㉔	V-MODE, CH1 (top position)
TRIG CPLG	㉕	AC (top position)
A/B TRIG	㉖	A (disabled)
LEVEL AUTO	㉗	AUTO
SLOPE	㉘	+
TRIG LEVEL	㉚	Mid-position (disabled)
CURSOR SW	㉛	HO
SUB CURSOR SW	㉜	Disabled

To be continued

Switch or Control	No.	Setting
READOUT CONTROL	㉝	Fully counterclockwise (HOLDOFF function off)
DVM SW	㉞	Off
POSITION	⑳	Position where trace is displayed at center of CRT
STORAGE MODE	㊶	REAL

(4) When the above setting is done, a trace will appear on the CRT. If no trace appears even when more than 60 seconds has elapsed after the above setting is done, repeat the procedure of (3).

(5) When the trace is displayed, adjust it with the INTEN control ② and FOCUS control ④.

(6) Adjust the trace so that it is parallel with the graticule lines by turning the TRACE ROTATION control ③ with a screwdriver. This adjustment will be necessary each time as you remove the oscilloscope or change its direction.

(7) When the image display position in the real or storage mode has been largely shifted due to large change in environmental conditions, calibrate the position referring to the operation method of the LOCAL SW.

4.6 Calibration of Probes

The probes act as wide frequency band attenuators. Unless they are properly adjusted for phase compensation, displayed waveform may be distorted and measuring errors may be introduced. Be sure to properly calibrate them before measurement.

As you press the GND REF switch (see Figure 4-5), the probe output is shorted to the GND line allowing you to identify the ground reference level without requiring to turn the CPLG switch of the oscilloscope to the GND position.

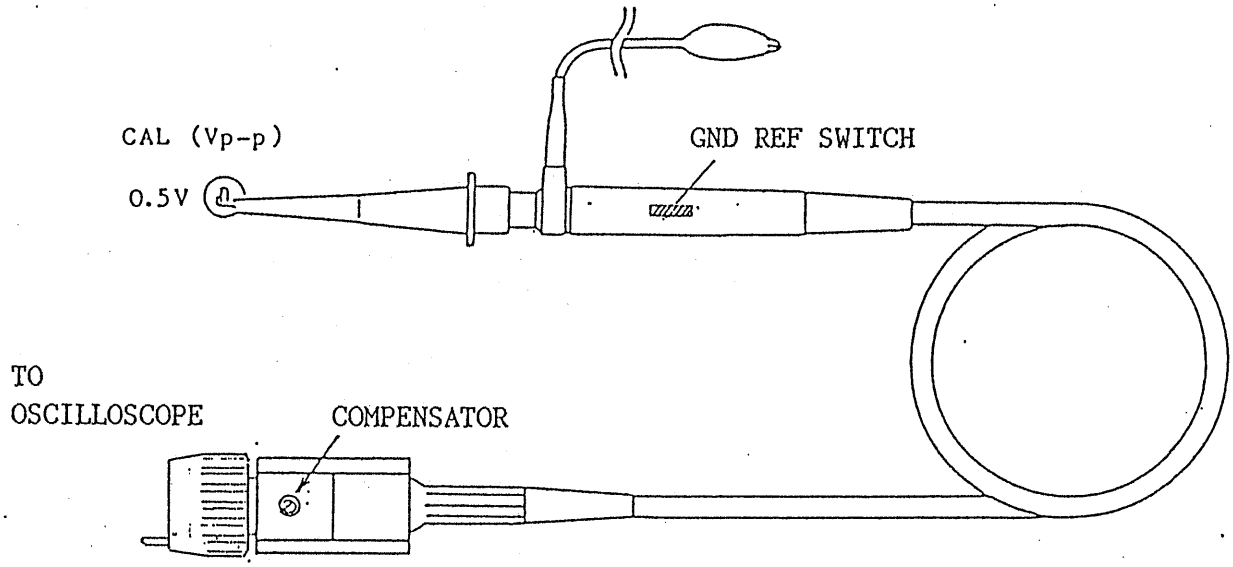


Figure 4.5

To calibrate the probes use the signal of the CAL terminal ㉒ on the front panel of the oscilloscope and proceed as follows:

Connect one of the probes to the CH1 INPUT terminal ⑧ and set the VOLTS/DIV switch ⑥ at 0.1 V. Connect the probe tip to the CAL terminal. Observing the waveform displayed on the CRT, adjust the compensator (see Figure 4-5) with a screwdriver so that an ideal waveform is obtained (see Figure 4-6).

Calibrate the other probe for CH2 in the same method as above.
When using a probe with its switch set at X10, change the readout factor refering to Section 4.7.

The manual change procedure, however, is not necessary for the probes which accompany the oscilloscope because the readout factors are automatically changed when these probes are used.

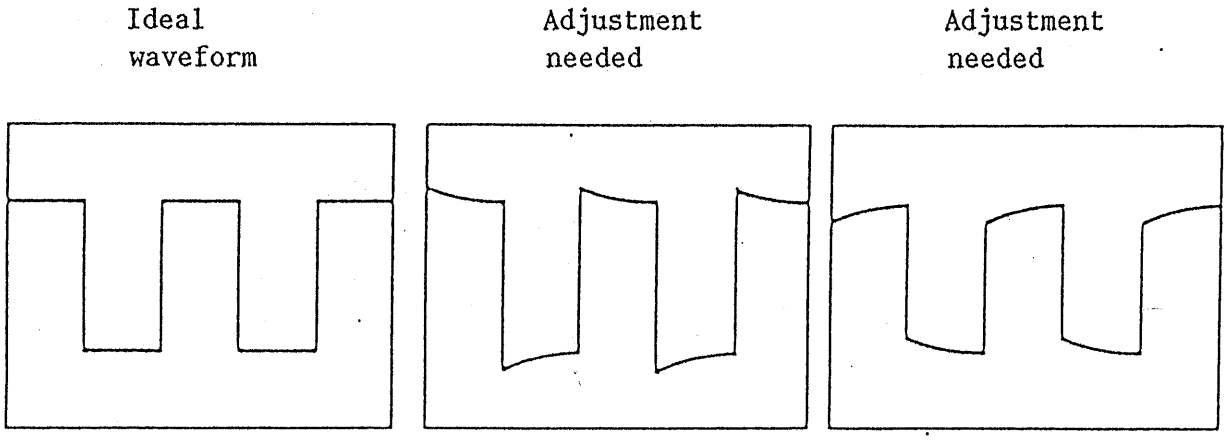


Figure 4-6

4.7 To Change Readout Factors for Probes (Except Probes Which Accompany Oscilloscope)

The values of vertical deflection factor and ⊿V measurement displayed on the CRT readout are as that of the signal at the probe tip. When a 10:1 probe is used, the factor for displaying the value on the CRT readout can be changed to display directly the value at the probe tip.

To change the factor, proceed as follows:
Press the GND switch of COUPLING ⑨ ⑬ ⑮ ⑲ of the channel to which the probe is connected within the period the CRT is in the beam find status after pressing the INTEN ② knob once and releasing your hand from the knob.

When this is done, the value indicated on the CRT readout is multiplied by a factor of 10 on the selected input and a message "P X10" is displayed on the CRT.

To reset to the regular state from the above state, repeat the same procedure as above.

4.8 Beam Finder

When the trace is deflected and lost from the CRT screen or when its intensity is insufficient and it is undescernible, you may press the INTEN knob ② so that an intensified trace is displayed on the CRT screen for a few seconds.

The key acts also as a second function key. This key may be pressed together with the GND key to change indication of the probe used.

4.9 2-channel Mode (except in storage mode)

If you press the CH2 key of VERT MODE selector ㊴ in addition to the setting for CH1 single channel mode of Section 4.5 (3), the oscilloscope operates in a 2-channel mode with CH1 and CH2, the CH1 and CH2 indicator lamps illuminate, and the vertical deflection factors of these channels are displayed at the bottom of the CRT.
When in this mode, the ALT or CHOP lamp of VERT MODE ㊴ illuminates. Either the ALT or CHOP sweep mode is selectable. For measurement of rapidly changing signals or higher frequency signals, use the ALT sweep mode to sweep the traces alternately (if the CHOP mode is used, the displayed traces may become dotted lines due to chopping). For measurement of slowly changing signals or lower frequency signals, use the CHOP mode to sweep the traces being chopped by a high frequency (if the ALT mode is used, the displayed traces may flicker due to low-frequency alternate sweeps).

Regardless of the above, however, the CHOP sweep mode may be used even when a higher sweep speed is employed if there are irregular phenomena to be measured at the same time. In addition to the above, the ALT sweep mode may be used when the frequencies of the two channel signals are not correlated and alternate triggering is needed.

Any combination of two of the four channels (CH1 - CH4) can be selected with the VERT MODE switch ㊴ for this 2-channel mode of operation.

4.10 ADD (MULT) Mode

When the ADD (MULT) switch of VERT MODE ㊴ is pressed and channels CH1 and CH2 only are selected, a waveform representing the algebraic sum of the two channel signals is displayed on the CRT. When the CH2 POSITION knob ㊳ is pushed in and the INV lamp has illuminated, a waveform representing the algebraic difference between the two channel signals is displayed.

If you press the 2nd function key together with the ADD (MULT) switch when in the storage mode, the MULT mode is selected and a waveform representing the product of multiplication of CH1 signal by CH2 signal is displayed.

For accurate ADD operation, adjust in beforehand the vertical deflection factors of the two channels to the same value with VARIABLE controls ⑦ and ⑪.

When in the ADD (MULT) mode, both POSITION controls ㊵ and ㊳ are enabled. To maintain good linearity of the vertical amplifiers, use the central sections of the position controls.

4.11 X-Y Mode

As you press the X-Y key of HORIZ MODE selector ㊱, the X-Y lamp illuminates and the oscilloscope operates in an X-Y mode with the CH1 signal as X-axis signal.

If the oscilloscope is in the real mode of X-Y operation, the switches related to triggering are disabled and their indicator lamps go out; if it is in the storage mode, the NORM and SINGLE modes of triggering are enabled.

If the frequency counter function is selected by pressing the DVM switch ㉞, however, the SOURCE ㉔, CPLG ㉕, LEVEL AUTO ㉗, SLOPE ㉘ and LEVEL ㉚ are enabled and their indicator lamps illuminate.

If you press the X-Y switch when the oscilloscope is operating in the regular sweep mode and in CH1 or CH2 single channel mode or in CH1 and CH2 dual channel mode, the oscilloscope operation is automatically changed to an

X-Y operation with CH1 as X-axis and CH2 as Y-axis.

By selecting with VERT MODE ㊴ switch any one or combination of CH2, CH3 and CH4, operate as Y-axis channels in X-Y mode. In this case the traces are swept in the CHOP mode and the indicator lamps of the selected Y channels of VERT MODE ㊴ illuminate.

To return to the regular mode from the X-Y mode, press the A, ALT or B switch of HORIZ MODE ㊳.

4.12 3-channel or 4-channel Mode

If you press all of the CH1, CH2, CH3 and CH4 switches of VERT MODE ㊴ the oscilloscope operates in a 4-channel mode and four traces are displayed on the CRT. If you press the ADD switch also, fifth traces will be displayed representing an algebraic sum of the CH1 and CH2 signals.

As above, the oscilloscope is able to display from a single trace to up to five traces simultaneously on its CRT screen. The traces can be successfully triggered and displayed by alternate triggering even when there are no correlations among the channel signal frequencies, provided that VERT MODE ㊴ is set for ALT, LEVEL AUTO ㉗ is set for OFF, and SOURCE ㉔ is set for V-MODE.

4.13 Voltage Measurement

The oscilloscope allows you three types of voltage measurement. First, voltage can be determined by means of the CRT graticule. Second, ΔV (differential voltage) between two points can be determined by means of cursors. Third, the CH1 input signal voltage can be directly measured with the internal digital voltmeter.

(1) ⊿V Measurement (except in ALT, B sweep mode or X-Y mode)

The ⊿V lamp illuminates and two horizontal cursors (one with dotted line and the other with broken line) are displayed on the CRT as you press CURSOR SW ㉛ when HORIZ MODE ㉟ is set for A sweep. Position of the broken line cursor is vertically adjustable with the READOUT control ㉝. Move the cursor to the required measuring point with the control.

Next, press twice the READOUT control ㉝ and the broken line cursor will become a dotted line cursor and the dotted line cursor will become a broken line cursor after both cursors becoming dotted line cursors. Now move the new broken line cursor to the required measuring point in the same manner as above.

The differential voltage is digitally displayed on CRT with the scale factor of VOLTS/DIV ⑥ ⑩ of CH1, except when in a single channel mode with CH2 or multi-channel mode with CH2 plus CH3 and/or CH4 in which case the scale factor of CH2 is employed.

When both cursors are broken lines, they are in the tracking mode and they can be moved on the CRT keeping the distance between them constant.

The range is adjustable with the READOUT control ㉝ to approximately 1 DIV in upward and downward directions from the mid-position of the control knob. As you turn the control to the full clockwise or counterclockwise position (to the end position), the cursor moves automatically and continuously. To stop the moving cursor, turn the control in the reverse direction from the end position.

Measurement of ⊿V with cursors is enabled only when the HORIZ MODE selector ㉟ is set for the A sweep mode. It is disabled when the selector is set for the ALT, B, or X-Y mode.

When in a single channel mode with CH3 or CH4 alone, or dual trace mode with CH3 and CH4, ⊿V measurement is disabled and ratio measurement is enabled in its stead, and the measured voltage ratio is displayed on CRT readout.

(2) DVM Measurement (except in storage mode)

If you press the DVM SW ㉞ when a signal is applied to CH1 input, the DVM lamp illuminates and the CH1 input signal voltage is measured by the internal DVM and digitally displayed at top left on the CRT screen.

When AC is selected by DVM SW ㉞, the true-rms value of the signal for 20 Hz - 100 kHz is measured. If the input COUPLING switch ⑨ is set for AC, the rms value of the AC signal is measured; if the switch is set for DC, the DC + AC rms value is displayed. The displayed units of measure are $\tilde{V}$ and $\tilde{\tilde{V}}$, respectively.

When DC is selected by DVM SW ㉞, the DC voltage of the CH1 input signal is measured. For this DC voltage measurement, the input COUPLING switch ⑨ must be set for DC. (If it is set for AC, a symbol "?" is dis-played on the CRT.) The displayed unit of measure is V.

When p-p is selected by DVM SW ㉞, the peak-to-peak voltage of the CH1 input signal for 20 Hz - 10 MHz is measured. The displayed unit of measure is V, with affix P for identification before the measured value.

The DVM measurement is for CH1 input signal only. The signal is measured and displayed even when CH1 is not selected by VERT MODE ㊴. Even when in the X-Y mode, the CH1 signal (X-axis signal) is measured and displayed if DVM SW ㉞ is selected.

Note, however, that large measuring errors may occur for extremely large (such as overflowing from the CRT screen) or small signals.

When the STORAGE mode is selected by the MODE SW ㊶, DVM measurement ceases and the measured value disappears from the CRT readout. As you return the oscilloscope to the REAL mode, DVM measurement resumes with the function settings as existed before.

4.14 Voltage Ratio Measurement (except in ALT, B sweep mode or X-Y mode)

The ratio of the voltage of a signal with respect to the voltage of a reference signal can be measured. A typical example is measurement of the ratio of an overshoot voltage with respect to a reference voltage.

For voltage ratio measurement, proceed as follows: Display two cursors on the CRT with the procedure of Section 4.13 (1). Move the cursors to the 0% position and 100% position of the graticule with the READOUT control ㉝. Apply the signal to be measured to the CH1 input terminal ⑧ and adjust its amplitude to 5 DIV with the VARIABLE control ⑦. A message "RATIO 100.0%" will be displayed on the CRT. Next, move the cursors to the positions for the required voltage section (for example, overshoot section of a pulse wave). The ratio (percent) of the section with respect to the reference amplitude (5 DIV for 100%) will be directly indicated on the CRT.

For voltage ratio measurement when in a single trace mode with CH1 or ADD or when in a multi-trace with CH1 and other channels, set the VARIABLE control ⑦ to the UNCAL state. For voltage ratio measurement when in a single trace mode with CH2 or 2-trace mode with CH2 and ADD or multi-channel mode with channels except CH1, set the VARIABLE control ⑪ to UNCAL state. For voltage ratio measurement with CH3 or CH4, the voltage level of the input signal must be set at 5 DIV as displayed on the CRT.

4.15 Time Interval Measurement (except in ALT or B sweep mode of storage operation)

The time interval ⊿T (differential time or period) between two vertical cursors can be measured. (Typical examples are measurement of rise or fall time of a pulse wave, and measurement of the period between two points on a signal.)

For time interval measurement, proceed as follows: When HORIZ MODE ㊱ is set for A sweep, press CURSOR SW ㉛. The ⊿T lamp will illuminate and two vertical cursors, one with dotted line and the other with broken line, will be displayed on the CRT. Move the broken line cursor with the READOUT control ㉝ to a measuring point on the waveform (for example, to the 10% amplitude point on a pulse wave). Next, press twice the READOUT control ㉝.
The types of the cursor lines will be changed between dotted line and broken line, after both cursors have changed to broken lines. Move the new broken line cursor to another measuring point on the waveform (for example, to the 90% amplitude point on the pulse wave). The time interval between the two points (the rise time of the pulse wave in this example) is measured with the scale factor set by the A TIME/DIV switch ⑯ and the measured value is digitally displayed on the CRT.

When both cursors are with broken lines, they are in the tracking mode and they can be moved on the CRT keeping the distance between them constant.

The range adjustable with the READOUT control ㉝ is approximately 1 DIV to right and left from the mid-position of the control knob. As you turn the control to the full clockwise or counterclockwise position (to the end position), the cursor moves automatically and continuously. To stop the moving cursor, turn the control in the reverse direction from the end position.

Measurement of ⊿T with cursors is enabled only when the HORIZ MODE selector ㊱ is set for the A sweep mode. When it is set for the ALT or B sweep mode, ⊿T measurement with delayed sweep can be done.

4.16 Time Ratio Measurement (except in storage mode)

The ratio (percent) of a time interval with respect to a reference time interval is measured using two vertical cursors as in the case of ΔT measurement. A typical example is measurement of duty cycle of pulsed waveforms.

To measure duty cycle of a pulse wave, for example, proceed as follows:
Set the oscilloscope as in the case of ΔT measurement. Adjust the sweep span of one cycle of the displayed waveform to 5 DIV (100%) with the SWEEP VARIABLE control ⑰. (Hereafter, exercise care so that the set position of the control is not disturbed so far as this measurement is continued.) Move the two cursors to the two measuring points (rise and fall edge) of the pulse using the READOUT control ㉝. The duty cycle of the pulse wave will be digitally displayed in percent on the CRT.

4.17 Frequency Measurement

The oscilloscope allows you three types of frequency measurement. First, by determining the period of one cycle of the signal on the graticule and calculating the reciprocal of the period. Second, by 1/ΔT measurement with cursors. Third, by direct measurement with the internal frequency counter.

(1) 1/ΔT Measurement (except in ALT or B sweep mode of storage operation)

For 1/ΔT measurement, proceed as follows: Set HORIZ MODE ㊱ for A sweep and press CURSOR SW ㉛. The 1/ΔT lamp will illuminate and two verti-cal cursors, one with broken line and the other with dotted line, will appear on the CRT. Move horizontally the broken line cursor with the READOUT control ㉝ to a measuring point (for example, to the rise up point of a pulse wave). Next, press twice the READOUT control ㉝. The types of cursor lines will be changed between dotted line and broken line, after both cursors being changed once into those with broken lines. Now move the new broken line cursor to another measuring point (for example, to the rise up point which is apart by one cycle from that where the previous broken line cursor was set). The signal frequency calculated as the reciprocal of the period between the two cursors with the scale factor set by A TIME/DIV ⑯ will be digitally displayed on the CRT.

When both cursors are broken lines, they are in the tracking mode and they can be moved on the CRT screen keeping the distance between them constant.

The range adjustable with the READOUT control ㉝ is approximately 1 DIV to right and left from mid-position of the control knob. As you turn the control to the full clockwise or counterclockwise position (to the end position), the cursor moves automatically and continuously. To stop the moving cursor, turn the control in the reverse direction from the end position.

Measurement of 1/ΔT with cursors is enabled only when the HORIZ MODE selector ㊱ is set for A sweep mode. When it is set for the ALT or B sweep mode, 1/ΔT measurement with delayed sweep can be done.

(2) Measurement with Frequency Counter (except in storage mode)

When the DVM function is enabled by pressing DVM SW ㉞, the signal frequency of the channel selected as triggering signal source by the TRIG SOURCE switch ㉔ is measured by the internal frequency counter and displayed on the CRT, as well as the signal voltage measured by the internal digital voltmeter is displayed.

The counter circuit is disabled when the TRIG SOURCE selector ㉔ is set for the V-MODE for two channels or more. Even when an input signal is being applied, the counter circuit is disabled if the TRIG LED lamp ㉙ is not illuminated indicating that no triggering is being accomplished.

Note that measurement may be unreliable when pulse widths are very narrow or when signal voltage is unreasonably low.

As you set the MODE SW ㊶ to the STORAGE mode, frequency measurement ceases and the measured frequency data disappears from the CRT readout as well as the voltage data measured by the DVM function disappears.
As you set the MODE SW ㊶ back to the REAL mode, frequency measurement and voltage measurement resume with the settings as existed before.

4.18 Measurement of Phase Difference (except in storage mode)

Phase difference between two signals of the same frequency can be measured. (A typical example is measurement of phase difference between input signal and output signal of an amplifier.) Measurement is done using vertical cursors and the measured value is displayed in degrees.

For this measurement, proceed as follows:
Set the oscilloscope as in the case for $1/\Delta T$ measurement. Apply the reference signal (for example the input signal of the amplifier) to the CH1 input terminal ⑧ of the oscilloscope, move the displayed waveform to the center of the CRT with the CH1 POSITION control ㉟, and adjust the time base with the SWEEP VARIABLE control ⑰ so that one cycle of the signal is displayed with a span of 5 DIV. Next, apply the signal to be compared (for example the output signal of the amplifier) to the CH2 input terminal ⑫ and display its waveform with the same amplitude and at the same position as that of the CH1 signal waveform by adjusting the CH2 VOLTS/DIV switch ⑩, VARIABLE control ⑪, and POSITION control ㊳. Move one of the cursors to the point where the CH1 input signal crosses the horizontal center line of the graticule and the other cursor to the point where the CH2 input signal crosses the horizontal center line. The phase difference between the two signals will be displayed on the CRT.

Note: When the TRIG SOURCE selector ㉔ is set for the V-MODE, the phase difference measurement is unreliable as the alternate triggering function is brought into effect. The measured value may be unreliable also when the lengths of the cables used to connect the signals to the CH1 and CH2 input terminals ⑧ and ⑫ are different or when there are other causes of signal delay in the connecting circuits.

4.19 Delayed Sweep (except in storage mode)

The oscilloscope allows you an alternate delay mode (alternate sweeps between intensity-modulated delay-preparation sweep and delayed B sweep) and delayed B sweep mode. For each of these two modes, either continuous delay sweep mode or triggered delay sweep mode (B TRG) can be selected.

(1) Alternate Delay Mode (ALT)

This mode is for display of two traces--one is an intensity-modulated trace for preparation for delayed sweep and the other is a delayed B sweep.
As you change the HORIZ MODE selector ㊱ from A to ALT, part of the trace being displayed on the A sweep is intensified and at the same time another trace which is a magnified waveform of the intensified section is displayed on the B sweep for the full span of the CRT.

The length of the intensified section of the A sweep (the length which represents the B sweep time) is adjustable with the A, B TIME/DIV control ⑰ set in the pulled out state. Both A sweep time and B sweep time are digitally displayed on the CRT.

The delay time (from the starting point of writing of the A sweep to that of the intensity-modulated section) is adjustable with the READOUT control ㉝ by setting the CURSOR SW ㉛ to the DLY state. The adjustable range is approximately 1 DIV to right and left. As you turn the control to the full clockwise or counterclockwise position (to the end position), the cursor moves automatically and continuously. To stop the moving cursor, turn the control in the reverse direction from the end position. When in this mode of operation, the delay time together with characters "DLY" is displayed on the CRT readout.

If you press the SUB CURSOR SW ㉜ when the DLY lamp is illuminating, the HO and A↕B lamps will illuminate sequentially in addition to the DLY lamp. When the HO lamp is illuminated, the READOUT control ㉝ acts as a holdoff time control. When the A↕B lamp is illuminated, the READOUT control ㉝ acts as a trace separation control to move the delayed B sweep from the A sweep to ±4 DIV or more. As you press again the SUB CURSOR SW ㉜ or press the READOUT control ㉝, the DLY lamp alone illuminates.

(2) Delayed B Sweep Mode

Depending on sweep frequencies, the ALT mode may be inconvenient as the displayed waveforms may flicker or may become dim. To avoid this, change the HORIZ MODE selector ㊱ from ALT to B. The delayed B sweep will be displayed on the CRT, with less flicker and higher intensity.

When in the B sweep mode, the sweep speed can be made slower by turning counterclockwise the A-B TIME/DIV ⑯ in the pulled out state.
The speed, however, cannot be made slower than that of A sweep.

3) Triggered Delay (B TRIG) Mode

When in the continuous delay mode, the B sweep starts at the instant the delay time preset by the delay time control has elapsed. However, if you press the B TRIG switch of HORIZ MODE selector ㊱ when in the ALT or B mode, the triggered delay mode is brought into effect. When in this mode, the B sweep starts at the instant the signal has crossed the B trigger level after the delay period has elapsed. Even when the magnification factor is large, the displayed waveform jitters are suppressed as the start of B sweep is controlled by B triggering.

Even when you turn the READOUT control ㉝ to change the delay time, the intensity-modulated section of the waveform on the A sweep does not move continuously but it moves in steps at the point where the signal crosses the B trigger level.

As you press the B TRIG switch of the HORIZ MODE ㊱, the AUTO LEVEL ㉗, the TRIG SLOPE ㉘ and the TRIG LEVEL ㉚ are automatically changed to the B trigger mode and their green lamps illuminate as well as those of the TRIG SOURCE ㉔ and the TRIG CPLG ㉕, indicating that settings of these controls can be changed.

To change them to the A trigger mode, press the A/B switch ㉖. The TRIG SOURCE ㉔ and the TRIG CPLG ㉕, however, can be set for the A or the B trigger mode irrespective of setting of the A/B switch ㉖.

When the B TRIG switch is not pressed, all lamps are orange indicating that the switches are for A trigger mode.

4.20 Time Interval Measurement with Delayed Sweeps

When the HORIZ MODE selector ㊱ is set for the A sweep mode, time interval between two points on the displayed waveform can be measured by means of the cursors. Depending on the type of the displayed waveform, however, this measurement is not always accurate due to the difficulty of setting the cursors accurately at the required points. Time interval measurement with delayed sweeps is more accurate since this method allows to overlap accurately the required points of the waveforms displayed on two delayed B sweeps. For time interval measurement with delayed sweeps when the oscilloscope is operated with a single channel for example, proceed as follows:

(1) Display the waveform on the CRT by adjusting the VOLTS/DIV, A TIME/DIV, and POSITION.

(2) Set the HORIZ MODE ㊱ to ALT. Operate sweep in the continuous delay mode by releasing from the B TRIG mode.

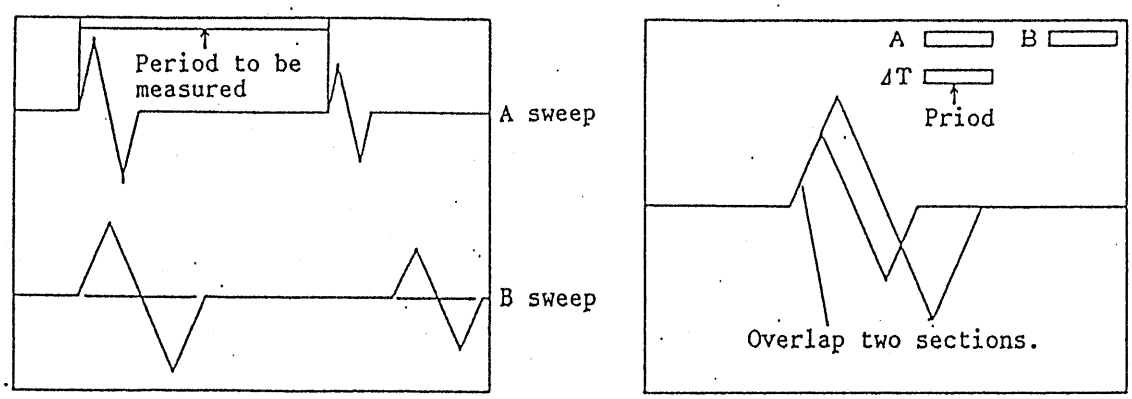
(3) Set the CURSOR SW ㉛ to ΔT. An A-sweep waveform with two intensity modulated sections and a B-sweep waveform with sections representing the same intensity-modulated sections but with delayed timings will appear on the CRT. (See Figure 4-7 A.)

(4) With the RREADOUT control ㉝, move the two intensity-modulated sections to the positions between which the time interval is to be measure.
It also is possible to move the two intensity-modulated sections in a tracking mode keeping the distance between them unaltered.

(5) Pull out the A-B TIME/DIV ⑯ and set the B sweep time for more fine viewing of the measuring points on the delayed B sweep. Now you may set the HORIZ MODE ㊱ to the B sweep mode so that the B-sweep waveform alone is displayed. When in the B sweep mode, you may employ the ×10 MAG functon.

(6) By adjusting the READOUT control ㉝, overlap the two measuring points on the B sweep waveform. (See Figure 4-7 B.)

(7) The time interval measured as above will be displayed on the CRT read-out.



(A) ALT (B) B Sweep Mode

Figure 4-7. Time Interval (Period) Measurement with Delayed Sweep

The above example was for the case of a single channel mode of operation. By employing a 2-channel mode of operation, it is possible to measure time difference between two points on two different signals which are mutually related in time. When in the 2-channel mode, only one intensity-modulated section per channel is displayed on the A-sweep waveforms and also only one corresponding section per channel is displayed on the delayed sweep.

Note: When the repetitive rates of the two signals are different, pay attention when selecting the triggering signal source. In general, the one whose repetitive rate is slower is selected for the triggering source signal.

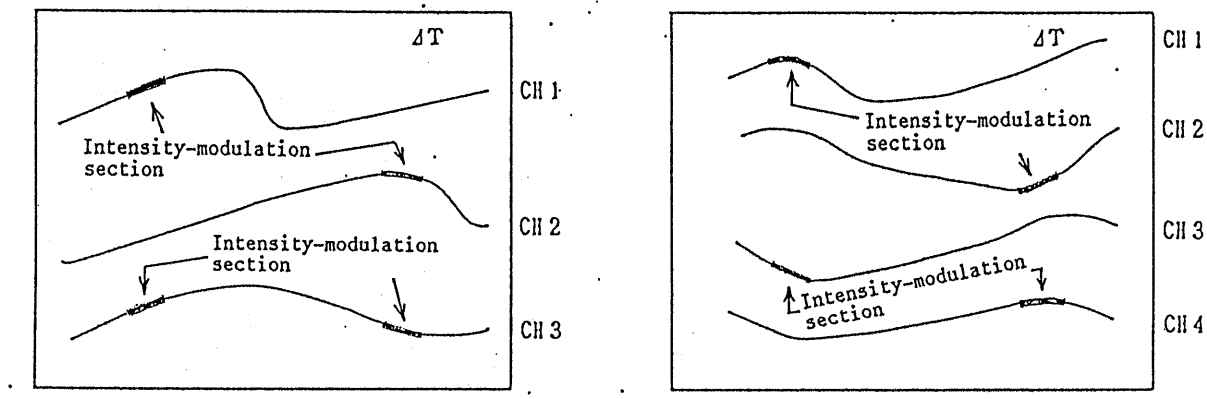
When the oscilloscope is operated with three or more traces, intensity-modulated sections are displayed as described in the following.

When the HORIZ MODE ㊱ is set for the ALT mode, the intensity-modulated sections on the A-sweep waveforms are displayed as follows:

When in the 3-trace mode, one intensity-modulated section is displayed on each of the waveforms of the two leftmost channels as indicated at the VERT MODE ㊴ and two intensity-modulated sections are displayed on the waveform of the remaining channel. For example, when in a 3-trace mode with CH1, CH2 and CH3, one intensity-modulated section is displayed on each of the CH1 and CH2 waveforms and two intensity-modulated sections are displayed on the CH3 waveform. (See Figure 4-8 A.)

When in a 4-trace mode, one intensity-modulated section is displayed on each of the channel waveforms. (See Figure 4-8 B.)

When in a 5-trace mode (four input signal traces plus one ADD trace), two intensity-modulated sections are displayed on the ADD trace.



A. 3 traces B. 4 traces

Figure 4-8. Multi-trace Delayed Sweeps

The priorities of traces are in the order of CH1, CH2, CH3, CH4, and ADD. When the number of traces is even, a pair of traces is formed in the due priorities and time interval between the pair of traces is measured. When the number of traces is odd, time interval between two points only on the trace of the least priority alone is measured.

When the HORIZ MODE ㊱ is set for the CHOP mode or when the TRIG SOURCE ㉔ is set for the V-MODE and the channel indicator lamps of two or more channels are on and sweeps are running in the alternate triggering mode, two intensity-modulated sections are displayed on each of the delay preparation waveforms, thereby allowing to measure time interval between two points on the waveform of each channel.

4.21 Measurement of TV Signals (in real mode or storage mode)

The oscilloscope is incorporated with features convenient for TV signal measurement, such as a TV synchronizing separator circuit, a pedestal clamp circuit, and an NSTC/PAL system TV line select circuit.

- TV Synchronizing Separation Function

As you set the trigger coupling selector to TV.H, the TV synchronizing separator circuit is connected to the trigger circuit and a TV signal waveform triggered by the horizontal synchronizing signal of the TV signal can be displayed. This function is enabled only when in the A trigger mode. As you set the trigger coupling selector to TV.V, the TV synchronizing separator circuit is connected to the trigger circuit and a TV signal waveform triggered by the vertical synchronizing signal of the TV signal can be displayed.

- Pedestal Clamp Function (for CH1 and CH2 only)

When the trigger CPLG is set to TV.H or TV.V, as you press the 2nd FUNCTION key ㊸ and the TV.LN SW ㊺ simultaneously, the pedestal clamp circuit is connected to both CH1 and CH2. With this setup, the back portch amplitude of the TV signal is maintained constant and the waveform is stably displayed being less affected by drift or hum. When this function is turned on, a message "C_{LP}" apears on the CRT. The function is turned off as you press again the 2nd FUNCTION key ㊸ and TV.LN SW ㊺ simultaneously.

Even when the pedestal clamp function is effected, the displayed waveform may sharply move in vertical directions if triggering is not correctly effected. This symptom, however, is not an indication of any abnormality. The symptom will be remedied by correct tirggering.

○ TV Line Select Function

As you press the TV.LN SW ⑮, the trigger CPLG is automatically set to TV.H and the REAOUT to HO/NO. By pressing the TV.LN SW ⑮ repeatedly, the settings can be switched in the sequence of NTSC → PAL → HO → NTSC if the oscilloscope is in the real mode or in the sequence of NTSC → PAL → TV.H → NTSC if the oscilloscope is in the real mode.

When NTSC or PAL is selected, a line number for triggering can be selected by turning the READOUT control ㉝ within a range of 1 to 525 for NTSC or 1 to 625 for PAL. The selected line number is displayed on the CRT, as "N: 525" for the 525-th line of NTSC for example. The selected line number denotes the line at which the triggering is to be effected or being effected currently. When in the real mode, it is located at the left hand end of the CRT; when in the storage mode, it is located at the center of the 4k word memory.

In the above operation, the triggering mode is fixed at NORM.

The range of fields selectable for the above operation with the oscilloscope is up to 2 fields. Due to this, the oscilloscope is unable to discriminate between the 1st and 3rd fields or between the 2nd and 4th fields of a color 4-field sequence of NTSC, or among the 1st, 3rd, 5th and 7th fields or among the 2nd, 4th, 6th and 8th fields of a color 8-field sequence of PAL.

The trigger mode is set to NORM only when in the AUTO mode. The AUTO mode is disabled when in the TV.LN mode.

○ When the trigger coupling selector is set to TV.V, a TV signal can be displayed being triggered by its vertical synchronizing signal.
When in this mode of operation, no fields are discrimated and all fields are triggered alternately.

5. STORAGE MODE

5.1 Storage Operation

The COM7202A can be operated in a storage mode by pressing its STORAGE MODE ㊶ switch. This section describes the functions available when the oscilloscope is in the storage mode.

(1) VERT Mode

The channel(s) to be displayed on the CRT can be selected with the VERT MODE ㊴ selector when in the storage mode as well as when in the real mode.

When in the storage mode, the MULT function can be selected by striking the 2nd key and ADD key simultaneously.

If the V-MODE is selected by the TRIG SOURCE switch when in the storage mode, triggering is made in the ALT TRIG mode as well as when in the real mode.

The ALT and CHOP modes of operation when the oscilloscope is set in the storage mode are as follows: When in the ALT mode, data of channels selected by the VERT MODE selector ㊴ are acquired alternately for individual channels. When in the CHOP mode, data of the selected channels (CH1 and CH2 only are selectable in this case) are acquired simultaneously. (If you attempt to select a 3- or 4-channel mode or a 2-channel mode with CH3 and CH4 when the oscilloscope is in the CHOP mode, it will be automatically changed to the ALT mode.)

(2) HORIZ Mode

Either a single time base mode (A sweep) or a delayed sweep mode (ALT, B sweep) can be selected with the HORIZ MODE selector ㊱.

When in the A sweep mode, the oscilloscope can operate with the storage function at all time base ranges of 5 s/DIV to 10 ns/DIV. In this case, waveform display is in the ROLL mode if the time base is 5 s/DIV - 0.1 s/DIV or in the REPEAT mode if the time base is 0.5 μs/DIV or faster.

Delayed sweep operation in the storage mode is available when the time base is 5 s/DIV - 10 ns/DIV. If you press the B TRIG switch when in the B sweep mode, the oscilloscope operates in the triggered delay mode.

For the delayed sweep mode of operation, see Section 5.5.

If you set the A TIME/DIV selector at 0.1 s/DIV or slower when the oscilloscope is in the delayed sweep mode with the CHOP display, it will automatically change to the A sweep mode with the ROLL display. Also when in the ALT display in the delayed sweep mode, the oscilloscope will automatically change to the A sweep mode if you set the A TIME/DIV selector at 1 s/DIV or slower.

(3) REPEAT Mode

When in the repeat mode, waveform data is acquired in an equivalent time sampling method--that is, data of the waveform to be displayed on the CRT is sampled being divided into a multiple number of sampling, thereby allowing to acquire data of signals whose frequencies are higher than the maximum effective storage frequency available in the realtime sampling method.
Of the COM7202A Oscilloscopes, the maximum realtime sampling rate is 100M samples/sec.
By employing the equivalent time sampling method for the 0.5 μs/DIV or faster ranges, data of repetitive signals can be acquired with sampling rates of 200M samples/sec to 10G samples/sec.

Since a random sampling method is employed for equivalent time sampling, the pretriggering function is effective even when the oscilloscope is in the REPEAT mode, allowing you to measure data which existed before triggering as well as when in realtime sampling.

Note: When in the REPEAT mode, data of the displayed waveform is acquired being divided into a multiple number of samples. Therefore, data can be correctly acquired only of "repetitive" signals.

(4) ROLL Mode

The ROLL mode allows you to view continuously on the CRT a slowly changing signal or a signal of very low repetitive frequency. The waveform scrolls from right to left on the sweep. If you set the WINDOW at the right hand end of the CRT, the newest data is displayed there.

If you employ a regular triggering mode to display the waveform of a very slowly changing signal, quite a long period elapses before the waveform is swept for the full sweep cycle and, even though the waveform may change meantime, such change cannot be known until such change point is swept by the next sweep cycle. This rather intermittent display is inconvenient for setting of triggering conditions.

When in the ROLL mode of display and triggering is set to AUTO, the waveform constantly scrolls on the CRT. At the instant you have noticed on the scrolling waveform an event which you may want to analyze, you may strike the PAUSE key ㊹. As you do this, the oscilloscope stops acquiring further data and the data of the event is maintained.

If a sweep cycle is triggered with the SINGLE sweep function when triggering is set to NORM and the VIEW TIME function is on, the triggered point moves to the center of memory and stays there.

The ROLL mode with CHOP sweep is automatically selected as you select a time base of 5 - 0.1 s/DIV. However, the oscilloscope is automatically reset from the ROLL mode if you select a multi-channel ALT mode.

Types of the ROLL mode of operation are selectable with the MODE selector ㉓ as shown in Table 5.1.

Table 5.1

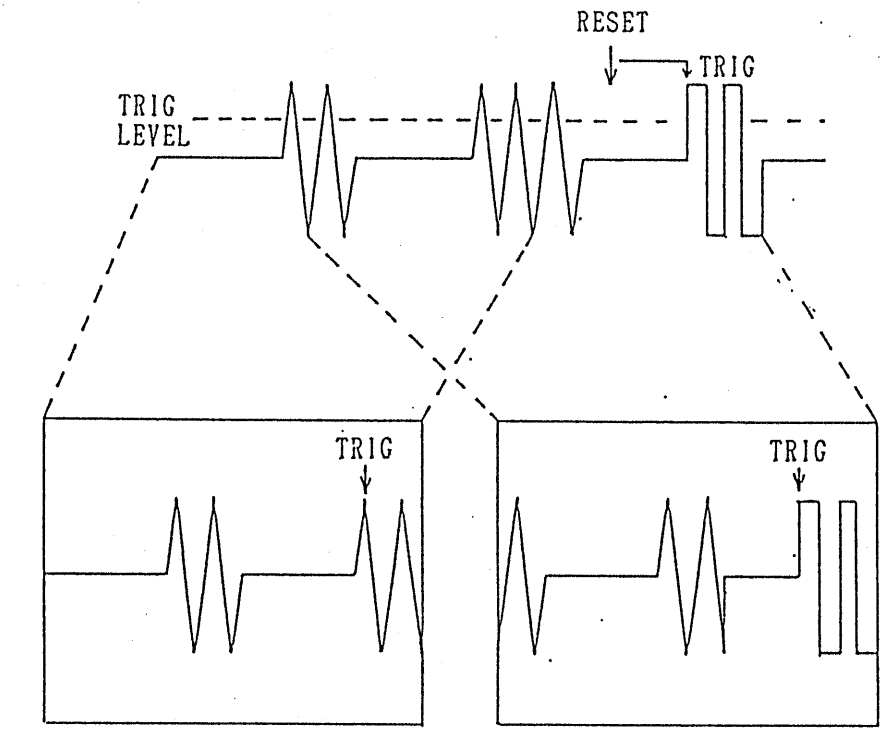
MODE Selector		Type of ROLL Mode
AUTO		Displayed waveform scrolls continuously, irrespective of triggering. Suitable for continuous viewing of the waveform of a signal changing very slowly.
NORM	VIEW TIME OFF	
	VIEW TIME ON	Displayed waveform scrolls continuously until the input signal meets the triggering conditions and the triggering point which has been set by the TRIG POINT is reached. After this point is reached, the displayed waveform remains stationary for the period preset with the VIEW TIME ㊼ and then it resumes scrolling.
SINGLE		Displayed waveform scrolls continuously until the input signal meets the triggering conditions and the triggering point which has been set by the TRIG POINT ㊽ is reached. After this point is reached, the displayed waveform remains stationary.

When in the ROLL mode the function which unconditionally inhibits triggering in order to acquire data before the triggering point is disabled. Due to this, when in such state that triggering occurs continuously, the function to acquire data for 2k words before the triggering point is disabled. However, it is possible to acquire data of all points. When data of points before the triggering point is required, such setup must be used that no triggering is effected for a data acquisition period of 20 DIV at least.

When a SINGLE sweep is effected in the ROLL mode, the TRIG LED ㉙ illuminates and the displayed waveform scrolls until the triggered point on the waveform reaches the point preset by the TRIG POINT.
Then the displayed waveform becomes stationary.

When the waveform is displayed in the ROLL mode with the NORM sweep and with the VIEW TIME control set for a certain period, the waveform resumes scrolling when the view time is over.
When the ROLL mode has resumed, triggering is enabled immediately.

The above operation, for a case of a SINGLE sweep operation, is illustrated in Figure 5-1.



Waveform currently display

Waveform displayed when no HOLDOFF period is provided

Figure 5-1. Waveforms Displayed in ROLL mode with SINGLE Sweep

When in the ROLL mode, the TRIG LAMP ㉙ may go off for a short period in spite of the fact that a valid trigger signal is being applied. Before the sweep ends in the SINGLE sweep mode in the ROLL mode, the TRIG and READY lamps may go out or may go out once and then illuminate and go out again after the sweep is over. Regardless of such lamp indications, the triggering for the ROLL operation is valid and waveform data is acquired normally.

(5) Time Base Magnification and Interpolation

When in the state that acquisition of data is paused by pressing the PAUSE switch ㊹, the time base for the displayed waveform can be magnified.
The center of magnification is fixed at the center of the screen and the displayed part of the waveform can be moved as required with the WINDOW function. The magnification factor is selectable within a range of 1 time to 100 times with the TIME/DIV switch.

As the waveform is magnified, the number of the sampling points of the displayed part of the waveform is reduced. In this case, data for intermediate points are provided by interpolation. Two types of interpolation, namely, PULSE interpolation and SIN interpolation are selectable with the RESPONSE ㊿.

PULSE interpolation is made by connecting each two adjoining sampling points with a straight line. A waveform substantially identical with the original sine waveform can be restored if there are more than approximately 10 sampling points per cycle. This type of interpolation is suitable for interpolation of pulsive waves. If the peak value of the original waveform is not sampled, however, the waveform restored by PULSE interpolation will not be identical with the original waveform.

SIN interpolation is suitable for interpolation of sinusoidal waves.
A waveform substantially identical with the original waveform can be restored if there are 2.5 or more sampling points per cycle.

(6) SINGLE SWEEP Operation When in Storage Mode

It should be noted that, of the waveform data which is acquired on a SINGLE sweep in the storage mode, if you change the TIME/DIV SW ⑯ without setting the oscilloscope to the PAUSE mode, a discrepancy may occur between displayed waveform and its range indication.

If the oscilloscope is set for the SINGLE SWEEP mode in the repeat mode range, irrespective of time base setting, waveform captured at a rate of 1 μs/DIV is magnified with interpolation for display.

For example, when the oscilloscope is operated with a single channel at the 0.1 μs/DIV range in the SINGLE SWEEP mode, the waveform displayed on the CRT has already been magnified by a factor of 10.

1 μs/DIV ÷ 0.1 μs/DIV = 10

o SINGLE SWEEP Operation When in Storage Mode

When the VERT MODE ㊴ is set for a multi-channel ALT mode, the waveform data of the channels of the first highest priority is acquired by the first sweep cycle and that of the second highest priority is acquired by the second sweep cycle. (The priorities of the channels selected by the VERT MODE ㊴ are higher in the order of elder numbers, namely, in the order of CH1, ADD, CH2, CH3, and CH4.)

It should be note that, if you change the A, ALT or B switch of HORIZ MODE ㊱ or the TIME/DIV switch before the waveform data of all of the set channels is completely acquired, a discrepancy may occur between displayed waveform and its range indication.

If you operate the PAUSE switch before the waveform data of all of the set channels is completely acquired, although sweep magnification with the TIME/DIV ⑯ can be done, acquisition of waveform data after resetting from the PAUSE state resumes starting by the channel of the highest priority.

(7) ENVELOPE Mode

When in the ENVELOPE mode, the maximum or minimum value between each two adjoining sampling points is stored as data and an waveform is displayed by connecting with a straight line between each two data value points. By this function, this mode allows you to detect even very narrow pulses (glitches) which may exist between sampling points and are unable to be detected when in the normal data acquisition mode, and also allows you to discriminate aliasing.

Aliasing may occur when the input signal frequency has become higher than one-half of the sampling frequency (Nyquist's theorem). When the

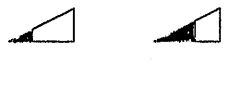
input signal is a sinusoidal wave and its frequency has become close to an integer-multiplication frequency of the sampling frequency, an apparently decent sinusoidal wave may be displayed on the CRT, deceiving you into judging that its data has been correctly acquired. The ENVELOPE mode allows you to discriminate such aliasing.

Glitches are very elusive and can hardly be detected, while succesful detection and seizure of glitches are essential for analysis of digital instruments and devices. The ENVELOPE mode allows you to capture such glitches.

(8) VIEW TIME Switch

When in the regular mode of operation, a new waveform is displayed immediately after the data for a full sweep cycle is acquired and this operation is continuously repeated. When you want to observe the same waveform for a long period, you may press the PAUSE switch ㊹ so that acquisition of new data is paused.

When you want to display the same waveform for a certain period and to display a new waveform after this period has elapsed and to repeat this operation, you can set the period with the VIEW TIME switch ㊼. Each time as you press the switch, the period is changed as 1 sec → 3 sec → 10 sec → OFF (continuous) → 1 sec.



If you set the VIEW TIME switch at a certain period when the display is in the ROLL mode and the MODE selector ㉓ is set for the NORM mode, the roll operation is paused for the set period after the trigger signal is applied. After the set period has elapsed, the roll operation resumes.

The VIEW TIME switch is disabled when the oscilloscope is in the SINGLE SWEEP mode or in the REPEAT mode, or when the MODE selector ㉓ is set for the AUTO mode.

(9) PAUSE Switch

As you press the PAUSE switch, acquisition of waveform data is paused and a message "PAUSE" is displayed on the CRT. As you press it again, acquisition of waveform data resumes. When in the PAUSE state, the time base of the displayed waveform can be magnified up to 100 times in 6 steps with the TIME/DIV switch.

When in the PAUSE state, the switches and controls except the below-mentioned ones are locked in the existing states and cannot be changed.

RESPONSE ⑤⓪
REF MEMORY ④⑥
SAVE ④⑤
CURSOR SW ③① (only when in A sweep mode)
V POSITION ③⑤, ③⑦, ③⑧, ④⓪
H POSITION ②⓪
A,B TIME/DIV ①⑥
VERT MODE ADD (MULT)
DOT (VECTOR) ④⑨
CH2 INV ③⑧
PEN OUT
PLOT OUT
Auto calibration
System reset
Version indication
LOCAL SW
REAL/STRG SW
Switches and controls of CRT circuit

(10) REFERENCE Memory and SAVE Switch

The COM7202A Oscilloscopes have a REFERENCE memory (four units) which is used in a rather offline mode to store data for later use, in addition to the DISPLAY memory which is used in a rather online mode to store data of the waveform currently displayed on the CRT. The REFERENCE memory is backed up with a battery and the data stored in it is not lost even when the POWER switch of the oscilloscope is turned off.

The REFERENCE memory may be used to compare the current acquired waveform with the reference waveform which has been stored in the REFERENCE memory. A typical example is that, on the adjusting line of a manufacturing plant, the waveform of the completely adjusted products is stored in the REFERENCE memory and the waveforms of the products being manufactured are compared with the former waveform as a reference.
The waveform stored in the REFERENCE memory can be called up onto the CRT screen by pressing the REF MEMORY switch ㊻.

To save data of the DISPLAY memory by transferring it to the REFERENCE memory, press the PAUSE switch ㊹ to pause acquisition of new data, select the required REFERENCE memory by pressing the REF MEMORY switch ㊻, and then press the SAVE switch ㊺.

Through a GP-IB system, data can be written onto or read from the REFERENCE memory.

The four units of REFERENCE memory are assigned depending on the number of channels selected by the VERT MODE selector ㊴ as follows:

1-channel mode: One of units 1 - 4 can be selected with the REF MEMORY switch ㊻ at a time, allowing you to use the four units in turns to save up to four waveforms. Each time as you press the REF MEMORY switch ㊻, the unit number advances in the order of 1 → 2 → 3 → 4 → OFF → 1.

2-channel mode: A combination of units 1 and 2 or that of units 3 and 4 can be selected. Up to two waveforms per channel can be saved. To the odd number memory units, the left hand channels as indicated at the VERT MODE switches ㊴ are assigned. Each time as you press the REF MEMORY switch ㊻, the unit number advances in the order of 1-2 → 3-4 → OFF → 1-2.

3-channel mode: The memory units of the numbers the same with those selected by the VERT MODE switches ㊴ are assigned. Each time as you press the REF MEMORY ㊻ switch, the unit number advances in the order of 1-2-3 → OFF.

4-channel mode: All memory units are turned on at the same time, assigned to the respective channel numbers. Each time as you press the REF MEMORY switch ㊻, the unit number advances in the order of 1-2-3-4 → OFF.

The reference memory units are assigned as selected by the REF MEMORY switch ㊻ to the channels selected by the VERT MODE switch ㊴.
Indication of memory assignment remains unchanged even when you have changed the number of channels with the VERT MODE switch ㊴. As you press the REF MEMORY switch ㊻ again, the reference momory is turned off. As you press the switch once more, the reference memory units are assigned to the channels you have selected. (See Figure 5-2.)

An example of clever use of the above function is given here.
First, specify a range by drawing a high and low limit lines with CH1 and CH2 base lines with thier inputs zero, and save the data of this setup in the reference memory. Next, turn off CH2 and apply to CH1 the signal to be analyzed. The signal can be analyzed with reference to the high and low limit lines.

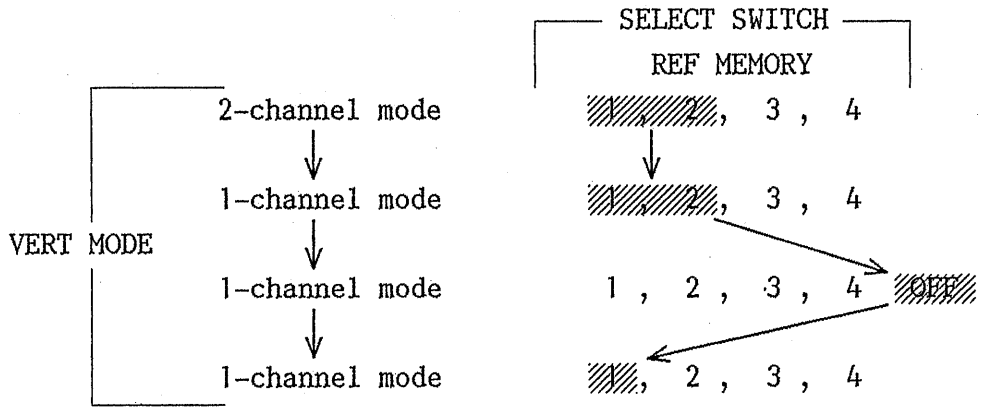


Figure 5-2. Relationship Between Vertical Channels and Reference Memory Units

(11) ADD Operation

An algebraic sum or difference of CH1 and CH2 signals is displayed with referece to the center of display (at the center of screen if it is selected for the reference line). The value above the reference line (horizontal center line) is for positive and that below the reference line is for negative. For example, when CH1 is 1 DIV above the reference line and CH2 is 1 DIV below the reference line, the result of the ADD operation is on the reference line itself (+1 DIV plus -1 DIV = 0 DIV).

If the CH2 INV switch ㊳ is on when in the above operation, the CH2 signal is added with its polarity inverted.

The ADD operation is done on data of waveforms which have already been acquired and displayed on the screen. Therefore, the ADD operation is effective for data of all waveforms which are displayed on the screeen.

When the resultant waveform of ADD operation is paused and saved in the REF memory, if the ranges of CH1 and CH2 are the same, the same range is used for the resultant waveform also. If the ranges are different, "?" is indicated for the range message. Although the function is effective when in PAUSE, it is not effective for the data of waveforms stored in the REF memory.

(12) MULT Operation

The product of multiplication of CH1 and CH2 signals is displayed with referece to the center of display (at the center of screen if it is selected for the reference line). The value above the reference line (horizontal center line) is for positive and that below the reference line is for negative. For example, when one of the two channels is on the reference line (horizontal line of zero level, the resultant signal is zero reardless of the value of the other channel.

The ADD operation is done on data of waveforms which have already been acquired and displayed on the screen. Therefore, the ADD operation is effective for data of all waveforms which are displayed on the screeen.

For ease of viewing, the product waveform of multiplication is displayed with reduced amplitudes. The reduction factor is 5.12 and remains constant at this value. For readout, therefore, the vertical amplitude value of the product waveform is multiplied by a factor of "5.12".
When signals are multiplied between scale factors 10 mV/DIV (CH1) and 20 mV/DIV (CH2), for example, the scale factor of the MULT waveform is 10 mV x 20 mV x 5.12 = 200 x 10-6 V x 5.12 = 1.024 mV^2 and the MULT sccale factor is given as "1.02 mV^2/DIV".

When in the MULT mode and ΔV cursor measurement, the MULT waveform can be measured in terms of the MULT scale factor. Simply by moving the Δ cursor and REF cursor to the required points on the the MULT waveform, the value can be directly read in terms of the MULT scale factor. When the MULT waveform is saved in the REF memory by pausing the MULT waveform, however, the scale factor of the saved waveform data is indicated as "?".

Although the operation is effective even when in the PAUSE mode, it is not effective for the waveform data stored in the REF memory.

(13) X-Y Scope

When in the storage mode, X-Y operation of the oscilloscope is limited only to that with CH1 for the X-axis and CH2 for the Y-axis. On the other hand, however, unlike when in the real mode, the X-Y operation in the storage mode is not limited by the speed of the time base and signals of up to the maximum frequency ranges of the vertical amplifiers can be analyzed.

Indications of scale factors when in the X-Y mode is idential with those when in other modes. In addition, the data acquisition speed (A-D conversion speed) also is indicated when in the X-Y mode.

The WINDOW function in the the X-Y mode is available even when in the data acquisition status or after the PAUSE operation, as in the cases of other modes. However, while the window position in other modes is with reference to the center of the 4k word memory (the position is with reference to the trigger point), that in the X-Y mode is with reference to the center of the waveform displayed on the screen (the position is

indicated in terms of the address number corresponding to the center of screen). That is, the waveform being displalyed on the screen is of a memory area of 512 addresses of each of before and after the address corresponding to the center of screen.

The displayed X-Y waveform cannot be saved into the REF memory.
The waveform stored in the REF memory cannot be displayed in the X-Y mode.

(14) WINDOW Mode of Viewing

The oscilloscope has a memory device of total 4k words (2k words before and after, respectively, the trigger point).

The WINDOW function allows you to view the waveform of any 1k words of the memory regardless of whether the oscilloscope is in the data acquisition state or in the pause state, except when in the ALT sweep mode with B seep and A sweep and except partial data when in interpolation magnification.

When in the ALT sweep mode, the trigger point is fixed at the left hand end of the screen and the WINDOW function is disabled in order to prevent operation errors which could be caused by contradictory double commands for WINDOW control and DLY POINT control.

For display with interploation in the IPL mode or for that by magnification after a PAUSE state, the viewing window cannot be moved to either beginning verge or ending verge of the memory due to conditions imposed by the sine interpolation system or the palse interpolation system. This is because interpolation processings for data at the verge positions are unavailable. The unavailable range differs depending on the magnification factor, TIME/DIV range, and type of interpolation.

The WINDOW function is unavailable for the waveforms stored in the REF memory because each of REF1 to REF4 units occupies 1k words and the waveform displayed on the screen is for 1k words and includes all data of the 1k memory unit.

(15) RPT Mode and IPL Mode

When in the 0.5 μs/DIV to 10 ns/DIV ranges, the oscilloscope operates in an equivalent sampling mode. The oscilloscope employs a random sampling type of equivalent sampling system and provides a pre-delay function allowing to view waveform before the trigger point. The equivalent sampling system is basically and primarily for a continuously repetitive signal (periodical signal). A waveform is build up by sampling the input signal for a multiple number of times with a multiple number of triggering events. On the other hand, since the oscilloscope employs a random sampling system, it also is possible to build up a waveform by interpolation connecting a certain number of sampling points on only a single event of triggering. In this manual, the former type of sampling mode is referred to as RPT mode (repeat mode) and the latter as IPL mode (interpolation mode). Switching between RPT and IPL modes can be done by pressing the VIEW TIME switch and the 2nd switch at the same time.

If a repetitive signal is displayed by triggering it in the AUTO or NORM mode and sampling it in the IPL mode, jitter may occur on the displayed waveforms of different display cycles due to asynchnchronization between the triggering point for the input signal and the internal sampling pulse. The amplitude of jitter depends on the TIME/DIV range. In an extreme case, it may be as large as 1 DIV with the 10 ns/DIV range. It may be smaller with the slower ranges, such that it is up to approximately 0.5 DIV with the 20 ns/DIV range and up to approximately 0.2 DIV with the 50 ns/DIV range. If the jitter is untolerable, use the RPT mode. The above, however, is highly effective for analysis of a high speed signal of which repetition rate is very low.

As you set the oscilloscope to the SINGLE trigger mode, it automatically selects the IPL mode and disables the RPT mode.

Message "PRT" or "IPL" is displayed on the CRT readout to indicate the currently existing mode of the oscilloscope.

(16) DOT Image and VECTOR Image

The image mode is selectable between DOT and VECTOR by pressing the END switch and the 2nd switch simultaneously. When in the former mode, the data points are displayed with respective dots; when in the latter mode, the data is displayed with straight lines connecting the mutually adjoing data points. Either mode can be selected as required without any particular restrictions. The VECTOR mode may be effectively employed to discriminate aliasing in the ENV mode or to analyze the maximum and minimum values of a waveform in the form of blurred portions of a waveform in the ENV∞ mode.

No messages to indicate the DOT or VECTOR mode appear on the CRT readout as they are evident at a glance.

(17) AVG Mode

The AVG (average) mode can be effectively employed to improve the S/N ratio of a signal by eliminating the non-periodical noise of the signal. For the AVG operation, a pseudo moving average system is used. For up to "n" number of times, a moving average operation is done; for "n+1" or more number of times, a weighted average operation with a factor of 1/(set number of times) is done.

The AVG mode is availabe except when the oscillosocope is in the ROLL, ENV, SINGLE, or IPL mode. The number of sweep cycles for averaging is selectable in 2^n-steps within a range of 2 to 256 times. The number of executed averaging cycles also is displayed on the CRT readout.

Although the A/D converter of the oscilloscope is an 8-bit type, when the number of averaging cycles is up to 8, the capability is raised to 12 bits for display.

As you alter the position control, vertical range switch or trigger level control, the displayed number of the executed averaging cycles is reset to zero and a new counting starts.

5.2 Effective Storage Frequency and Frequency Bandwidth

The frequency characteristics of a digital oscilloscope depends on its effective storage frequency and frequency bandwidth. The maximum frequency of a sinusoidal wave signal which can be stored depends largely on the sampling rate and processing of the acquired waveform data. The maximum storable sinusoidal wave signal frequency is referred to as "effective storage frequency."

The sampling rate is determined by setting of the TIME/DIV selector ⑯.
The horizontal axis resolution of the COM7202A Oscilloscopes is 10-bit and a waveform is displayed with 100 data points/DIV on the horizontal axis.
When the TIME/DIV selector is set at the 1 ms/DIV range for example, the sampling period is 10 μs and the sampling rate is 100 kHz. The sampling rate in general is expressed as follows:

Sampling rate = (Number of sampling points per DIV) ÷ (TIME/DIV)

With SIN interpolation, the original waveform can be substantially faithfully restored if there are 2.5 or more sampled points per cycle. When a waveform is sampled with a sampling frequency of 100 kHz, the maximum restorable frequency is 40 kHz (100 kHz ÷ 2.5 points = 40 kHz). Thus, the effective storage frequency with SIN interpolation can be expressed as follows:

Effective storage frequency = (Sampling rate) ÷ 2.5

Thus, the original waveform can be substantially faithfully reproduced provided that the stored signal has no frequency components higher than the effective storage frequency.

With PULSE interpolation, the original waveform can be substantially faithfully restored if there are 10 or more sampled points per cycle. Therefore, the effective storage frequency with PULSE interpolation can be expressed as follows:

Effective storage frequency = (Sampling rate) ÷ 10

The frequency bandwidth is not affected by the sampling rate and remains the same for all timebase ranges. It is 200 MHz (-3 dB) for COM7202A.

Chart of Fucntions in STORAGE Mode

TIME/DIV RANGE	SAMPLING /SEC	SAMPLING SYSTEM	ACQUISITION SYSTEM				ENVELOP		AVERAGE	VIEW TIME	TRIG MODE			SWEEP	
			ROLL	NORM	RPT	IPL	ENV∞	ENV 1	AVG	(TRIG NORM MODE ONLY)	AUTO	NORM	SINGL	A SWEEP	B SWEEP
10ns	10G	REPETITIVE SAMPLING	ROLL AQUISITION (FOR SINGLE CHANNEL, CHOP 2-CHANNEL ONLY)	NORMAL AQUISITION (FOR ALT MULTI-CHANNEL ONLY)	REPITITIVE SAMPLING AQUISITION (EXCEPT SINGLE SWEEP)	INTERPOLATION AQUISITION	ENVELOPE INFINITY	ENVELOPE SINGLE (FOR ROLL AQUISITION ONLY)	AVERAGE (EXCEPT IPL AQUISITION)	VIEW TIME (EXCEPT RPT AQUISITION)	AUTO SWEEP	NORMAL SWEEP/TRIG'D SWEEP	SINGLE SWEEP (FOR IPL AQUISITION ONLY)	A SWEEP	B SWEEP (EXCEPT WHEN A-SWEEP IS ROLL OR 1s/DIV)
20ns	5G														
50ns	2G														
0.1μs	1G														
0.2μs	500M														
0.5μs	200M														
1μs	100M	NORMAL SAMPLING													
2μs	50M														
5μs	20M														
10μs	10M														
20μs	5M														
50μs	2M														
0.1ms	1M														
0.2ms	500k														
0.5ms	200k														
1ms	100k														
2ms	50k														
5ms	20k														
10ms	10k														
20ms	5k														
50ms	2k														
0.1s	1k														
0.2s	500														
0.5s	200														
1s	100														
2s	50														
5s	20														
	ALL RANGES														
X—Y	YES	YES	YES	YES	YES	YES	YES	YES	NO	YES	YES	YES	YES	—	—

ROLL MODE ---- For single or CHOP only.

X—Y MODE ---- Fixed as CH1 for X-axis and CH2 for Y-axis, and simultaneous sampling for X- and Y-axis.

Simultaneous use of AVG and ENV is inhibited.

5.3 ΔT, 1/ΔT and ΔV Measurement with Cursors

When in the storage mode and the HORIZ MODE selector ㊱ is set for A sweep, ΔT, 1/ΔT and ΔV measurement with cursors can be performed as when in the real-time mode. When in the ALT or B sweep mode, however, this measurement is unavailable. Voltage ratio, time ratio and phase measurement are unavailable when in the storage mode.

5.4 DVM and Frequency Counter

The internal digital voltmeter and frequency counter are disabled when in the storage mode. To enable them, use the realtime mode (set the MODE switch ㊶ to the REAL).

5.5 Delayed Sweep

Even when in the storage mode, magnification with B sweep is available as in the realtime mode.

As you set the HORIZ MODE selector ㊱ to ALT, an A-sweep waveform with the triggering point changed to the left hand end position of the graticule (the latter is instead of an intensity-modulated delayed trace and B sweep in the case of the realtime mode) are displayed on the CRT.

Depending on the mode which existed before the ALT mode is selected, the WINDOW lamp may light although the WINDOW function remains disabled.
To enable the WINDOW function in the ALT mode, set the oscilloscope to the PAUSE mode.

At the top of the CRT screen, symbol $\overset{\triangle}{\underset{\triangledown}{T}}$ which indicates the starting point of magnification is displayed instead of symbol $\overset{\triangle}{\underset{\triangledown}{D}}$ which indicates the triggering point when in the A sweep mode. Move the starting point symbol to the required point with the READOUT control ㉝. As you set the HORIZ MODE selector ㊱ to B sweep, waveform will be displayed on delayed B sweep.
The ALT and the B sweep modes are unavailable when the time base is at the 5 to 1 s/DIV ranges.

The CHOP sweep mode is unavailable when the time base is at 5 to 0.1 s/DIV.

When in the B sweep mode, triggered delay sweep with the B TRIG switch is available. When in the ALT sweep mode, the B TRIG switch is disabled.

5.6 PENOUT Signal

Data stored in the reference memory and displayed on the CRT can be delivered via rear terminals of the oscilloscope for an external X-Y recorder.

For recording, connect the PEN Y OUT ㊼, PEN X OUT ㊻ and SYNC OUT ㊺ terminals of the oscilloscope to the Y INPUT, X INPUT and PEN UP/DOWN terminals of the X-Y recorder, respectively.

The X- and Y-axis output signals are 100 mV/DIV and the SYNC output signal is of a TTL level.

When in the PAUSE state, as you press the X-Y switch of the HORIZ MODE ㊱ together with the 2nd FUNCTION KEY ㊸, the X-Y recorder pen will move to the starting point of recording. In several seconds as the pen is set down onto the recording paper by the SYNC OUT signal, the X-Y recorder starts drawing the waveform data which has been stored in the reference memory.

On the CRT screen, the waveform is traced with a beam spot in the same manner as it is drawn with the pen on the X-Y recorder. Since the pen drive speed rate in the X direction is changed with respect to the amplitude in the Y direction of the waveform to be recorded, almost any model of X-Y recorder can be used (without requiring any high speed model of X-Y recorder).

When the pen has moved to the end point of waveform drawing, the pen is lifted up from the recording paper, remains in this position for several seconds, and then moves to the starting point of recording. Then the oscilloscope is reset from the PEN OUT mode to the PAUSE state.

When two or more waveforms are displayed, the above sequence is repeated and, after all waveforms are recorded, the oscilloscope exits from the PEN OUT mode.

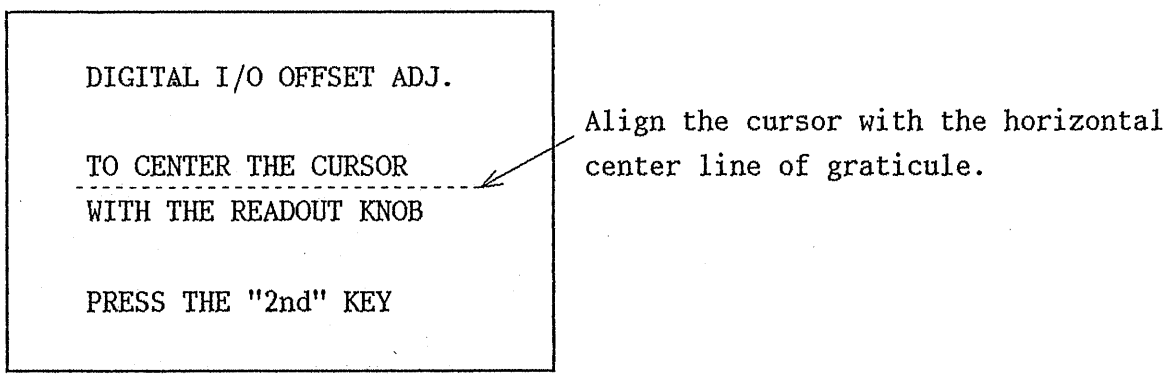
To abort the above sequence halfway, press the LOCAL (2nd) switch of GP-IB ㊸. The oscilloscope will be reset from the PEN OUT mode to the PAUSE state.

5.7 Digital I/O Offset Adjustment

The COM7202A, which operates either in a real time mode or in a storage mode, is incorporated with I/O functions for operation on a GP-IB bus and for sending data to a GP-IB plotter. To render these functions, the oscilloscope involves various circuit blocks.
The levels of effects caused by ambient temperature, terrestrial magnetism and other environmental conditions on these circuit blocks slightly differ depending on the type of operation, such as viewing a waveform on the CRT screen or printing out a hardcopy of the waveform with a printer.

The oscilloscope is incorporated with a function for calibration of the positional relationship of the displayed waveforms between the real time mode and the storage mode and for that between the storage mode and the GP-IB plotter (HP-GL) mode.

To calibrate the oscilloscope with this function, proceed as follows:
Press the 2nd FUNCTION key ㊸ and the READOUT CONTROL knob ㉝ simultaneously. A message as shown below will appear on the CRT. Move the cursor to the center of CRT with the READOUT CONTROL knob ㉝ and then press the 2nd FUNCTION key ㊸.



6. GP-IB INTERFACE

6.1 General

The oscilloscope complies with GP-IB (IEEE 488-1978), allowing itself to be remote-controlled from and to transact data with a host computer and other devices. The major functions available by this provision are as follows:

(1) Panel control: Panel keys can be remote-controlled from an external controller or other device.

(2) Step control: Panel settings of up to 100 types can be stored in internal step memory of the oscilloscope, and the panel can be instantaneously set to the required setting by giving a STEP command.

(3) Sending of data: Data of stored waveforms, DVM or cursor measurements can be sent to a controller or other device.

(4) Receiving of data: Waveform data received from the host computer can be stored in the reference memory.

(5) Direct copy by GP-IB plotter:
When in the STORAGE mode, waveform data and other information can be directly sent to a GP-IB plotter (HP-GL compatible type), without requiring any controller.

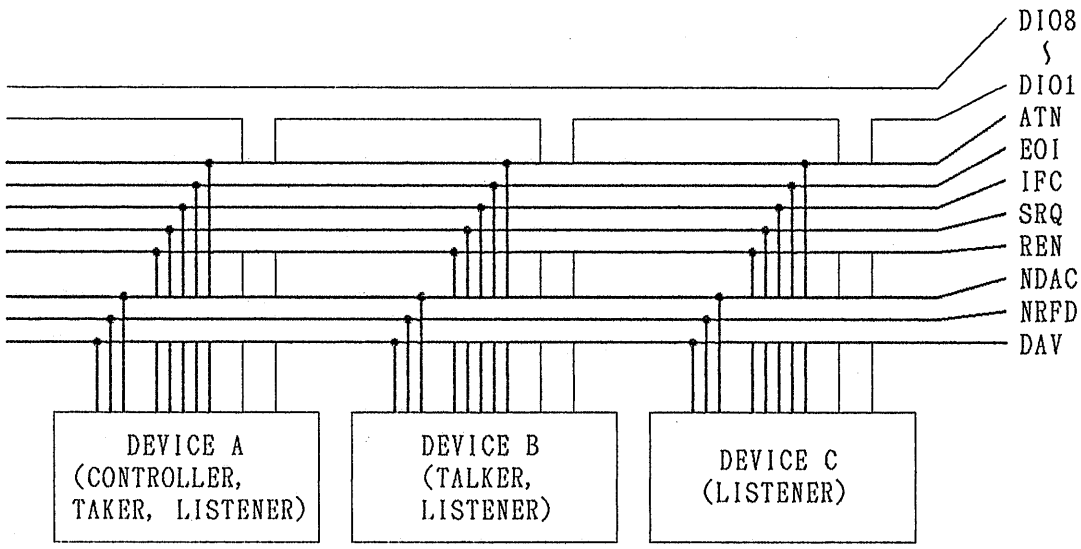
The GP-IB (General Purpose Interface Bus) allows to makeup a programmable instrumentation system by connecting various devices provided that they meet the requirements of the interface bus system.

The signals are transmitted in an 8-bit-parallel byte-serial format on a bidirectional bus. Data is transmitted in a 3-wire handshake system.

For each of the devices connected on the bus, one or more of the functions can be specified talker, listener or controller.

Data can be sent from a device designated to be a talker to one or more devices designated to be listeners. The controller controls sending/ receiving of data and manages interfacing of the devices connected on the bus.

The bus is comprised of 8 data lines, 3 handshake lines and 5 bus management lines (16 lines in total) plus a ground line. In the below illustration, DIO1 - DIO8 are data bus; NDAC, NRFD and DAV are handshake bus; and ATN, EOI, IFC, SRQ and REN are management bus.



6.2 GP-IB Specifications

6.2.1 Standards

ANSI/IEEE 488-1978

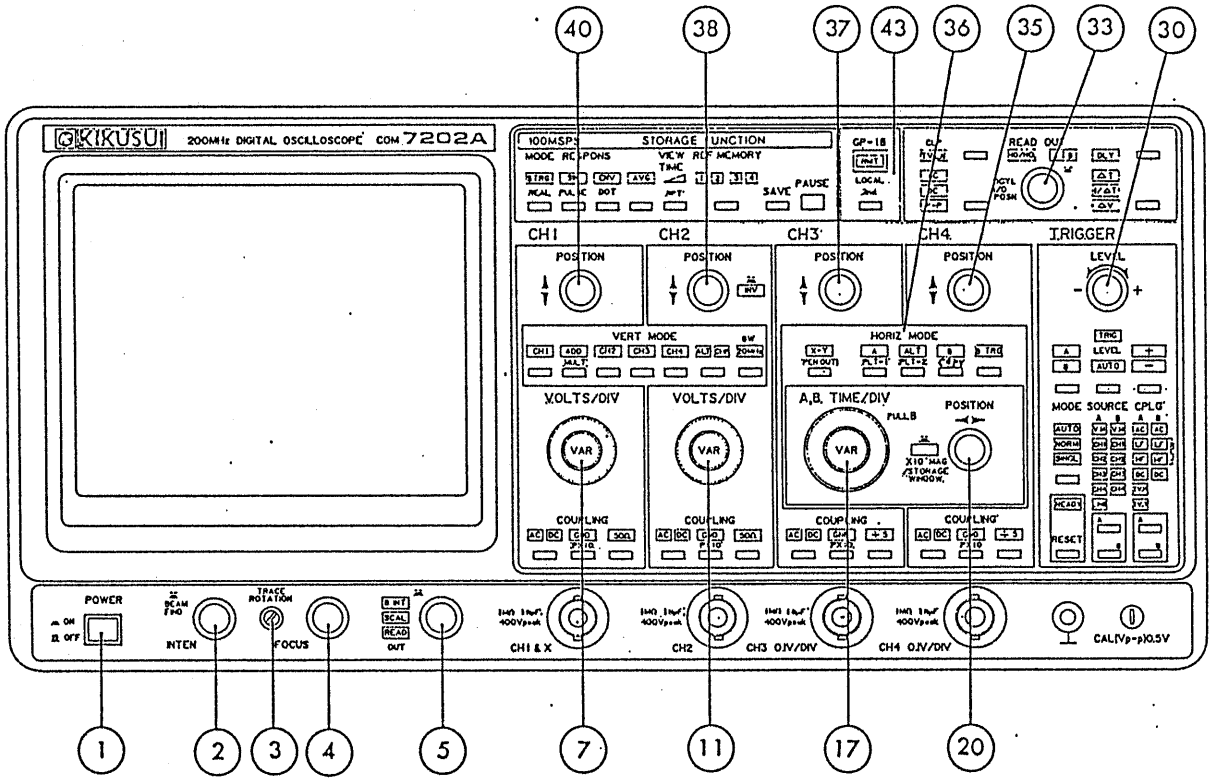
6.2.2 Interface Functions

Code	Function
SH1	With all SH functions
AH1	With all AH functions
T5	With basic talker function, serial poll function, talk only function, and talker release function by listener designation.
L3	With basic listener function, listen-only function and listener release function by talker designation
SR1	With service request function
RL1	With remote/local change function
PP0	Without parallel polling function
DC1	With device clear function
DT0	Without device trigger function
C0	Without controller function

6.3 Descriptions for Operation

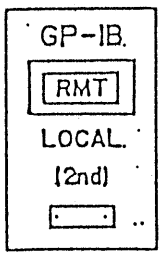
6.3.1 Remote Status and Local Status

(1) Description of Front Panel and Initial State of Remote mode



LOCAL SW ..... ㊸
(2nd FUNCTION KEY)

This switch changes the oscilloscope from remote status to local status.



When the oscilloscope is set to remote status by an external controller through GP-IB, panel keys except the ones mentioned in the below table are disabled. As you press this key, the oscilloscope is changed to local status and panel keys are enabled.

When the oscilloscope is designated to be in LLO (local lockout) status, this key is disabled and message "LOCKOUT" is displayed on CRT.

The RMT lamp illuminates when in remote mode. It goes out when in local mode.

Swoth or Control		Function Which Differs from When in Local Status
POWER	①	See Note 1.
INTEN	②	Offset can be applied through GP-IB.
TRACE ROTATION	③	
FOCUS	④	
B INT, SCALE, READOUT	⑤	SCALE and READOUT can be ON/OFF controlled through GP-IB.
VARIABLE	⑦ ⑪	
VARIABLE	⑰	
POSITION	⑳	
POSITION	㉟ ㊲ ㊳ ㊵	Offset can be applied through GP-IB. Acts as vernier control.
LEVEL	㉚	The same as above
READOUT CONTROL	㉝	The same as above

Note 1: Turn on power of all of the devices connected on the bus, even of devices which are not currently used.

When the oscilloscope is changed from the local status to the remote status, the items mentioned in the following table are changed as mentioned there. Other items remains in the local status.

Item	Initial State
INTEN	0 (center)
POSITIONS	0 (center)
A/B LEVEL	0 (center)
A/B SEPARATION	0 (center)
CURSOR	0 (center) after executing MOVE command
EOI	ON
SRQ	ON
WAVE CODE	BINARY
START	DISPLAY
END	DISPLAY

HORIZ MODE ..... ㊱
(PLT 1), (PLT 2)

As you press this switch together with the 2nd FUNCTION KEY ㊸ when in the STORAGE mode, a message "PLOT OUT" is displayed on CRT and waveform data is sent to the GP-IB plotter. This function is available only when the GP-IB switches of the oscilloscope are set for the TALK ONLY mode and those of the GP-IB plotter for the LISTEN ONLY mode.

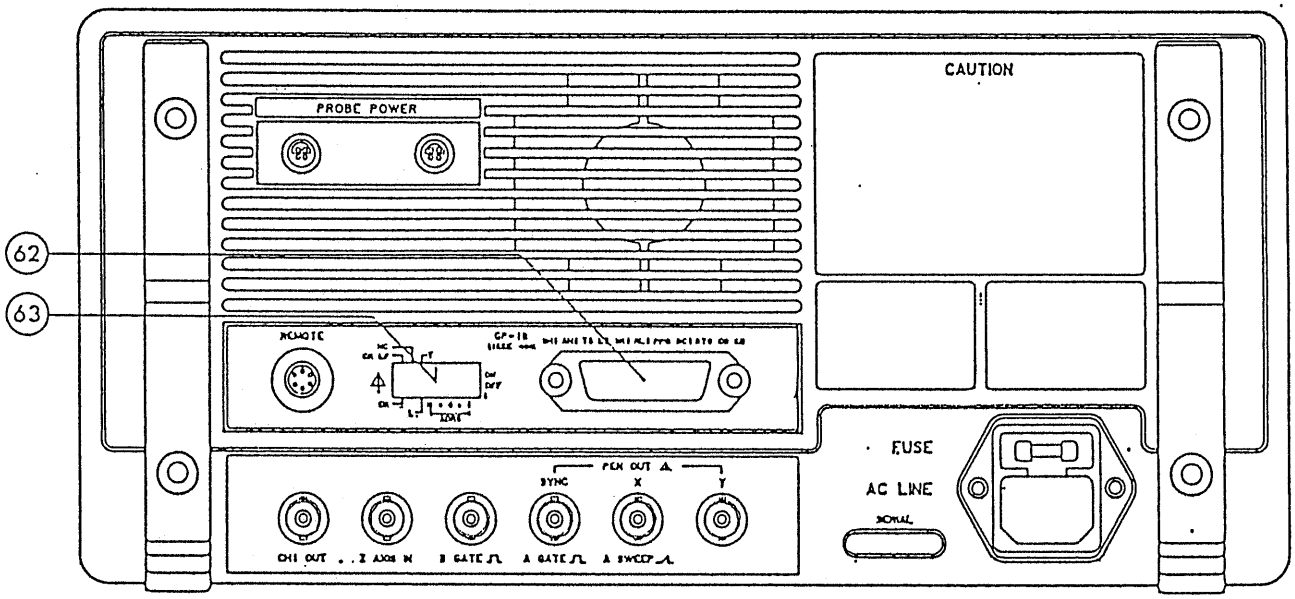
PLT 1

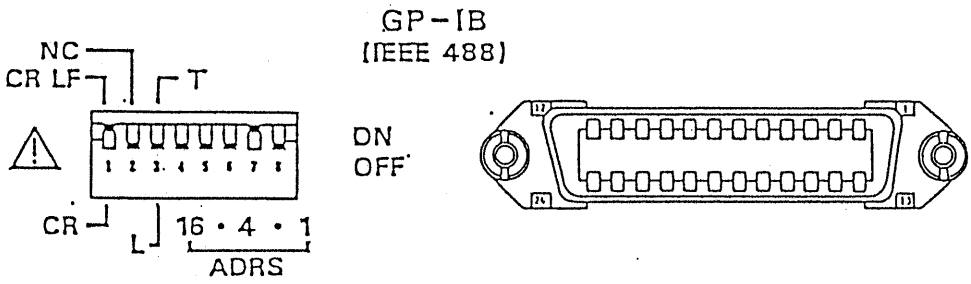
2nd + "A": Data is delivered with scale double of that of CRT graticule.

PLT 2

2nd + "ALT": Data is delivered with scale identical with that of CRT graticule.

(2) Description of Rear Panel and Setting of Delimiters





GP-IB Connector ..... ⑥② 24-pin connector which accepts GP-IB cable.

Note: When stacking up units by using piggy-back connectors, up to three units are allowable.

GP-IB Switches ..... ⑥③ DIP switches to set oscilloscope address (MLA, MTA) and delimiters

Address Setting

For address setting, use the five or six rightmost ones of the DIP switches.

o Normal Address (0 - 30)

The ADRS section of the DIP switches is marked "16.4.1", which stands for "16 8 4 2 1". The set address number is the sum of the switches set in the ON position. When all switches are set in the OFF position, the address number is 0. To set the address number at 19 for example, set the switches as follows: Since 19 = 16 + 2 + 1, set the "16", "." (which stands for 2) and "1" switches in the ON position.

Note: When the oscilloscope is shipped from the factory, the address number is set at 2.

o TALK ONLY

Set all switches of the ADRS section in the ON position and the T/L switch (switch 3) also in the ON position.

Note: When set in this state the oscilloscope is fixed as a TALKER and it cannot be remote-controlled.
The address switches of the objective GP-IB plotter connected to the bus line must be set in the LISTEN ONLY mode.

o LISTEN ONLY

Set all switches of the address section in the ON position but the T/L switch (switch 3) in the OFF position.

Note: When set in this state the instrument is fixed as a LISTENER and it cannot send out the measured data or any other information.

o Setting of Delimiters

Five types of delimiters as follows can be used.

(1) EOI
(2) CR
(3) CR + EOI
(4) CR + LF
(5) CR + LF + EOI

CR: Carriage Return
LF: Line Feed
EOI: End or Identify

Delimiters can be set with GP-IB switches ⑥③ and EOI command. When in transfer of binary data, however, EOI only can be used irrespective of switch setting.

Delimiter	GP-IB Switches ⑥③	EOI Command
EOI	Either setting	ONLY
CR	CR	OFF
CR + EOI	CR	ON
CR + LF	CR + LF	OFF
CR + LF + EIO	CR + LF	ON

Even when delimiter is other than "EOI ONLY", handshake terminates if EOI is given.

Notes: 1. When the oscilloscope is shipped from the factory, the delimiter switches are set for CR LF.

2. When in transfer of binary data blocks, EOI alone is effective irrespective of delimiter switch setting.

Note: Refer to the notes for GP-IB siwtches.

3. The set states of GP-IB switches are read only once when turning on the oscilloscope. When power is continuously on, the address and delimiters do not change in response to change of switch settings. To change them, turn off power, change the switch settings, and then turn on the oscilloscope.

4. Other requirements comply with GP-IB (IEEE 488-1978) Standard.

(3) Device Funcrions

- Transfer of Commands and Data
  - ① Remote control of panel setting
  - ② Transfer of setting data
  - ③ Transfer of measured data
  - ④ Transfer of waveform data

① Remote Control of Panel Setting

Front panel setting of the oscilloscope can be remote-controlled from an external controller through the GP-IB bus.

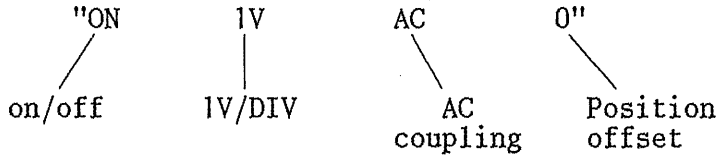
For example, to set the input coupling mode of CH1 to AC, send a character train of "CH1 COU AC" to the oscilloscope. The oscilloscope will decode the character train and will set the CH1 input coupling circuit to the AC mode.

By using "STEP" commands, setting is not made one by one but can be accomplished instantaneously.

② Transfer of Setting Data

Data on setting of panel items of the oscilloscope can be sent to an external device, such as a host computer.

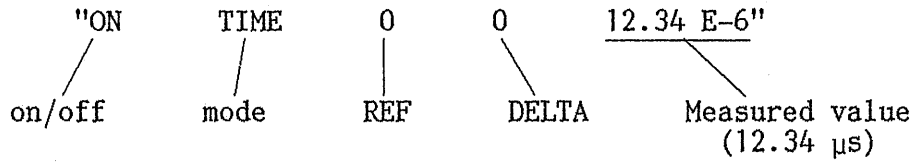
For example, when you want to read and send the set status of CH1, send a character train of "CH1?" to the oscilloscope. The oscilloscope will decode the character train and write the set status data of CH1 on the send buffer. Now designate the oscilloscope to be a talker, and a message representing the set status of CH1 will be sent. An example of message is shown below.



③ Transfer of Measured Data

Data measured with cursors, DVM and frequency counter are displayed on the CRT readout of the oscilloscope. This data can be transmitted to an external controller or other device.

For example, when you want to read and send the time interval measured with the cursors, send a character train of "CUR?" to the oscilloscope (provided that the cursors are in the ΔT mode).
The oscilloscope will decode the character train and write the cursor mode and measured data on the send buffer. Now designate the oscilloscope to be a talker, and the data will be read and sent as follows:



When you want to read and send the measured value alone, send a character train of "CUR DAT" to the oscilloscope. It will read and send the measured value alone as "12.34 E-6".

④ Transfer of Waveform Data

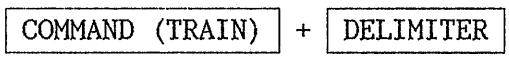
The oscilloscope has four memory units, with memory capacity of 4096 (reference memory: 1024) points per unit. Data stored in these units can be transferred in ASCII or binary coded format to a computer for storing in a larger capacity, to a printer or a plotter for hardcopies, or to other devices for other purposes. (Max. memory: 1024 points for ASCII)

o Device Clear Function

As the oscilloscope receive a DEVICE CLEAR command, it clears its status bytes and send/receive buffers.

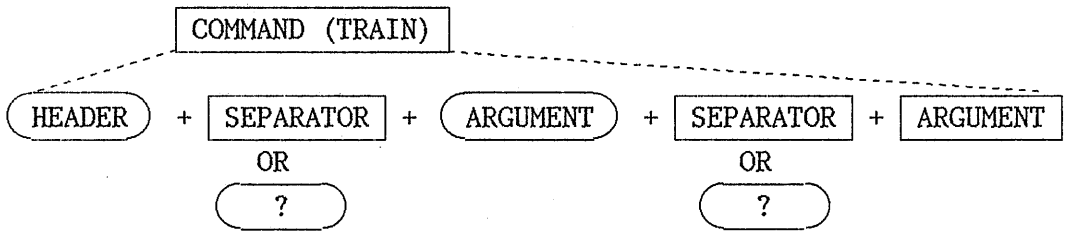
6.3.2 Command and Data Formats

To remote-control the oscilloscope with GP-IB, send data from the controller (host computer) in the following format:



(1) Command Format

Each command should be a train of characters complying with ASCII Codes, and should be comprised of a header and arguments, and separators between them in a format as shown in the following example.

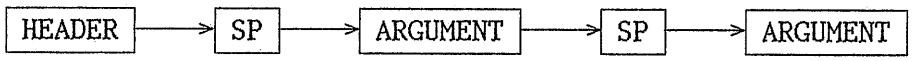


o Header

The header identifies the type of command, such as "CHANNEL 1" or "DVM".

○ Separators

A blank space code for one or more characters can be used as separators. A space code is used between header and argument or between two arguments.



○ Arguments

Two types of arguments can be used. One is a train of characters, such as "ON" or "AC". The other is a numerical data, such as "15" or "-20".

○ Parameter "?"

This parameter is placed at the end of a command requesting to read and send.

(2) Waveform Data Formats and Blocks

Waveform data formats are selectable between ASCII codes and binary codes with "WAVE CODE" command as follows:

○ ASCII Codes

"NUMERAL, NUMERAL, NUMERAL, ····, NUMERAL " + DELIMITER

The range for the numerals is "0000" to "4095".
All types of delimiters are effective.

○ Binary Codes

"NUMERAL NUMERAL NUMERAL NUMERAL····NUMERAL NUMERAL EOI"

The numerals are with eight bits for "00000000" to "11111111".
For delimiters, EOI alone is effective.

○ Word Data

"NUMERAL H NUMERAL L NUMERAL H NUMERAL L···NUMERAL H NUMERAL L EOI"

NUMERAL H is for higher 8 bits, "00000000" - "00001111".
NUMERAL L is for lower 8 bits, "00000000" - "11111111".
For delimiters, EOI alone is effective.

(3) Delimiters

One of CR+LF(+EOI), CR(+EOI) and EOI can be used as delimiter.
See page 119 "Setting of Delimiters".

(4) Abbreviations of Commands

As a general rule, commands including headers and arguments can be abbreviated into a string of three characters.

Examples: "ATRIGGER" → "ATR"
"COUPLING" → "COU"
"CHANNEL1" → "CH1"

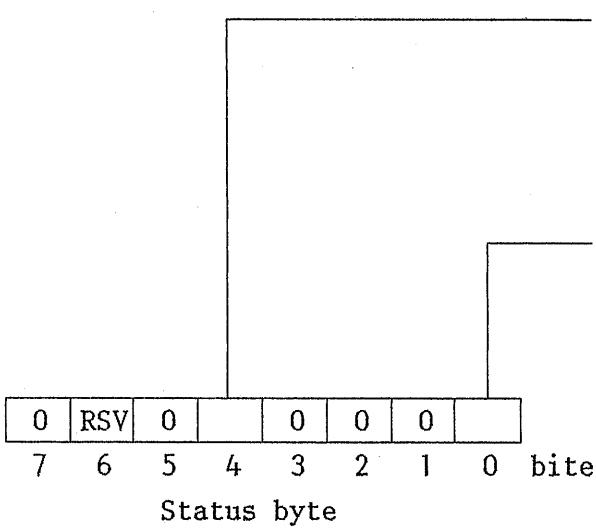
Abbreviations of headers and arguments are shown being enclosed in parentheses in the table of commands.

(5) SRQ and Status Byte

The oscilloscope is allowed to originate a service request (SRQ) to send information on its internal events to the external controller, and displayed "SRQ" on the readout R2 of CRT. (See page 114 front panel). Events are identified by respective bits of a status byte, allowing the controller to identify the types of events.

When the oscilloscope is set to the local status, the SRQ becomes the ON state. To inhibit sending of service requests from the oscilloscope, give it a "SRQ OFF" command.

The relationships between the events and the corresponding bits of status byte are as shown below.

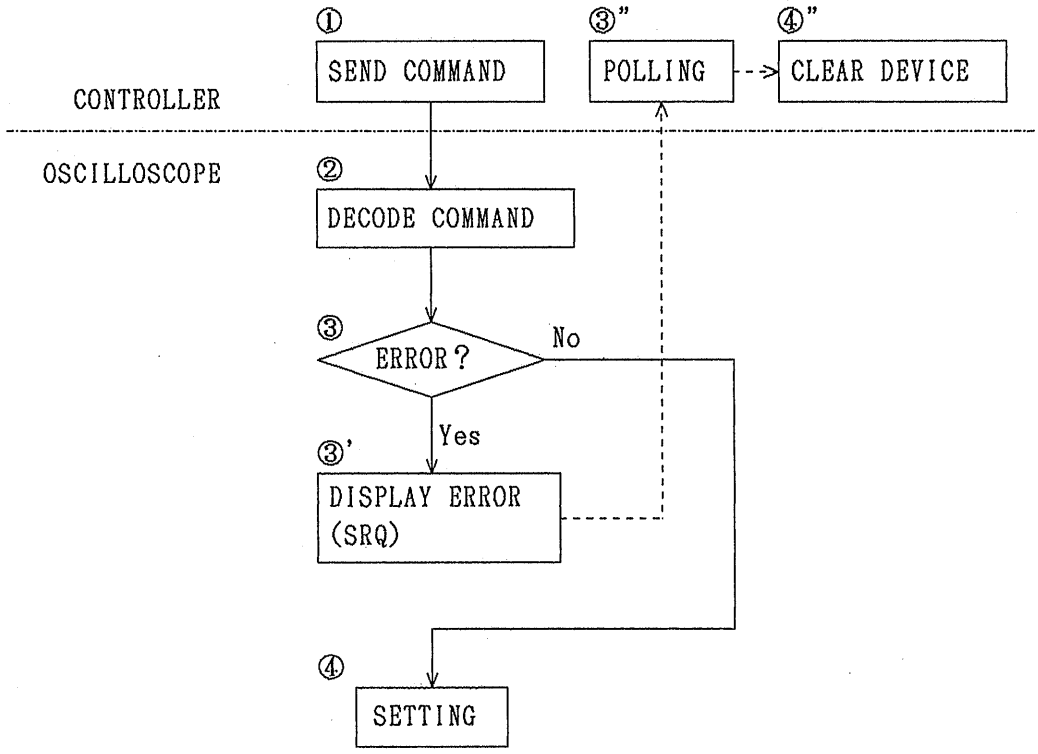


When power of the oscilloscope is turned on, "0" is set for all bits of the status byte.

6.3.3 Data Send/Receive Sequence

The basic sequence of oscilloscope control by GP-IB is as described in this section.

(1) To Set Oscilloscope



① Designate oscilloscope for listener and send command.

② Decode command stored in receive buffer of oscilloscope.

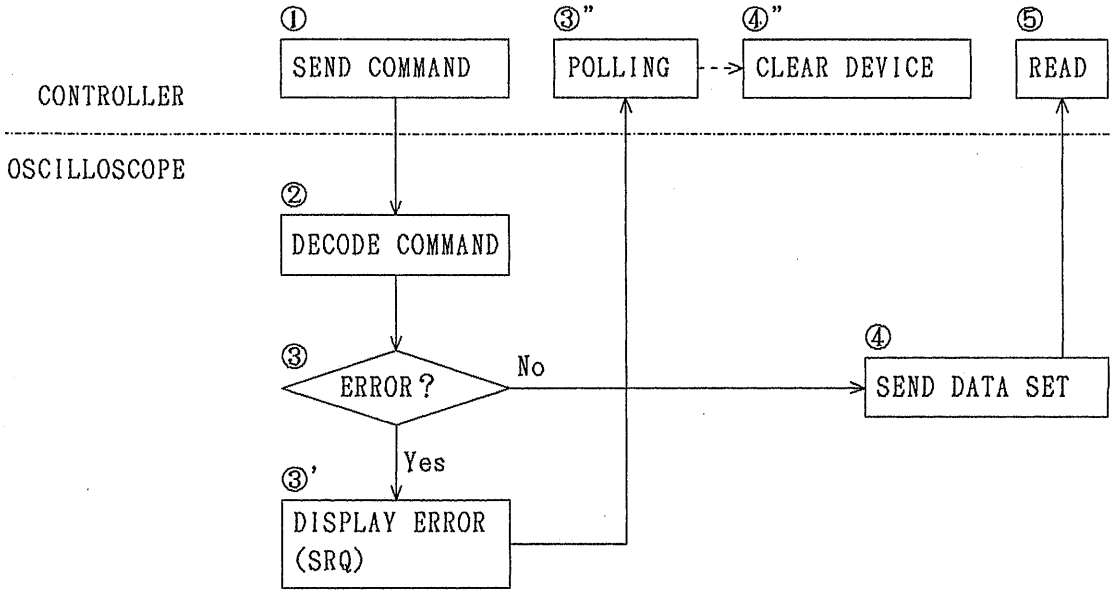
③ Check for errors.

③' Display errors, if any. (If SRQ function is enabled, send SRQ to controller.)

③" In response to SRQ, perform serial polling and read status byte and then clear device.

④ Perform setting.

(2) To Read Data



① Designate oscilloscope for listner and send command.

② Decode command stored in receive buffer of oscilloscope.

③ Check for errors and, if any, take necessary steps as in the case of (1).

④ Set specified data in send buffer.

⑤ Designate oscilloscope for talker to send data.

6.4 Table of Commands

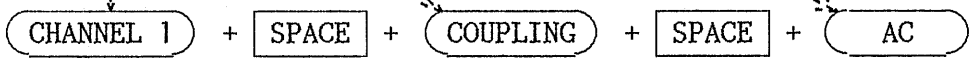
○ Items Indicated in Table

The table indicates individual commands which are used to control the oscilloscope. Each command is indicated together with its function and data to be sent when the oscilloscope is designated for a talker. Examples of writing programs referring to the table are given in this section.

(1) To Set the Oscilloscope

○ To set CH1 input coupling to AC

CHANNEL 1 (CH1)	ON		Turn on CH1.
	OFF		Turn off CH1.
	COUPLING (COU)	AC	Set CH1 input coupling to AC.
		DC	Set CH1 input coupling to DC.
		GROUND	Set CH1 input coupling to GND.



Command is as
"CHANNEL1 COUPLING AC"
or abbreviated as "CH1 COU AC"

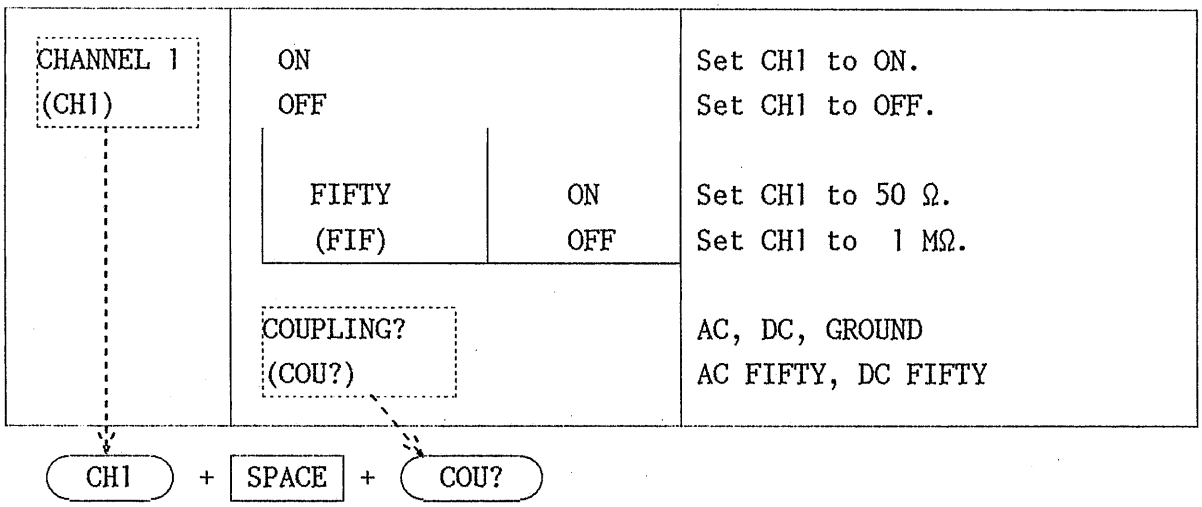
○ To Turn on CH2 and then invert it

Commands are written with abbreviations as follows:

"CH2 ON"
"CH2 INV ON"

(2) To read set range or measured data of oscilloscope

○ To read CH1 input coupling setting



"CH1 COU?"

With this command, data on the current setting of CH1 input coupling of oscilloscope is written in the send buffer of oscilloscope. To read and send this data, designate the oscilloscope for a talker.

For PC-9801: INPUT @2; A$ (Substitute character variable
(NEC) A$ with data.)

For HP-9816: ENTER 702; A$ (Substitute character variable
A$ with data.)

Programs for the above can be written as follows:

```
PC-9801 (NEC)
    10 PRINT @2; "CH1 COU?"
    20 INPUT @2; A$

HP-9816
    10 OUTPUT 702; "CH1 COU?"
    20 ENTER 702; A$
    30 END
```

Thus, setting data such as "AC" or "DC" can be read.

○ To read setting of CH1

	POSITION? (POS?)	-128 ～ 127
CHANNEL 1? (CH1?)		[ON/OFF] [VOLT] [COUPLING] [POSITION]

CH1 ?

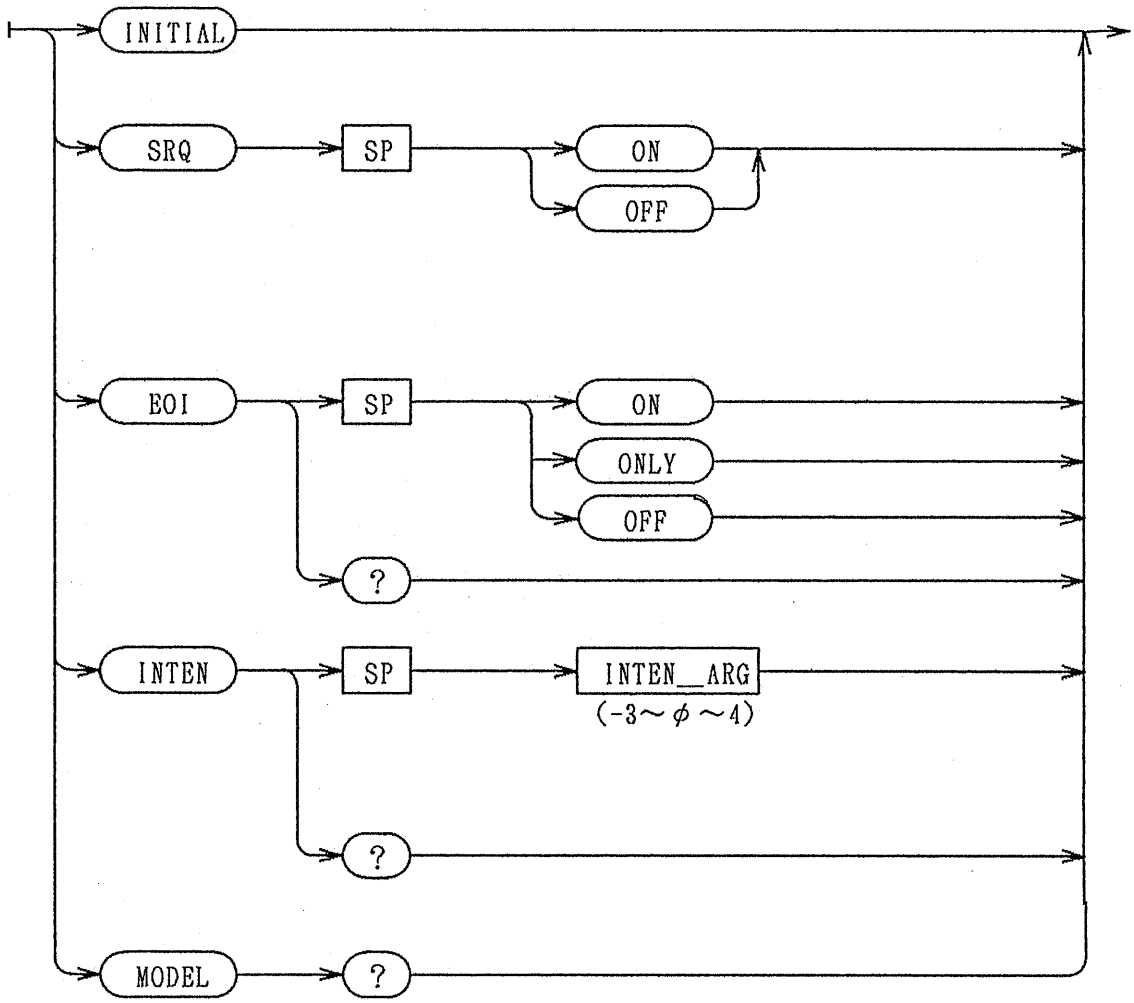
Example of set data as it is read:

"ON 5V DC 0"

[ON/OFF] [VOLT] [COUPLING] [POSITION]

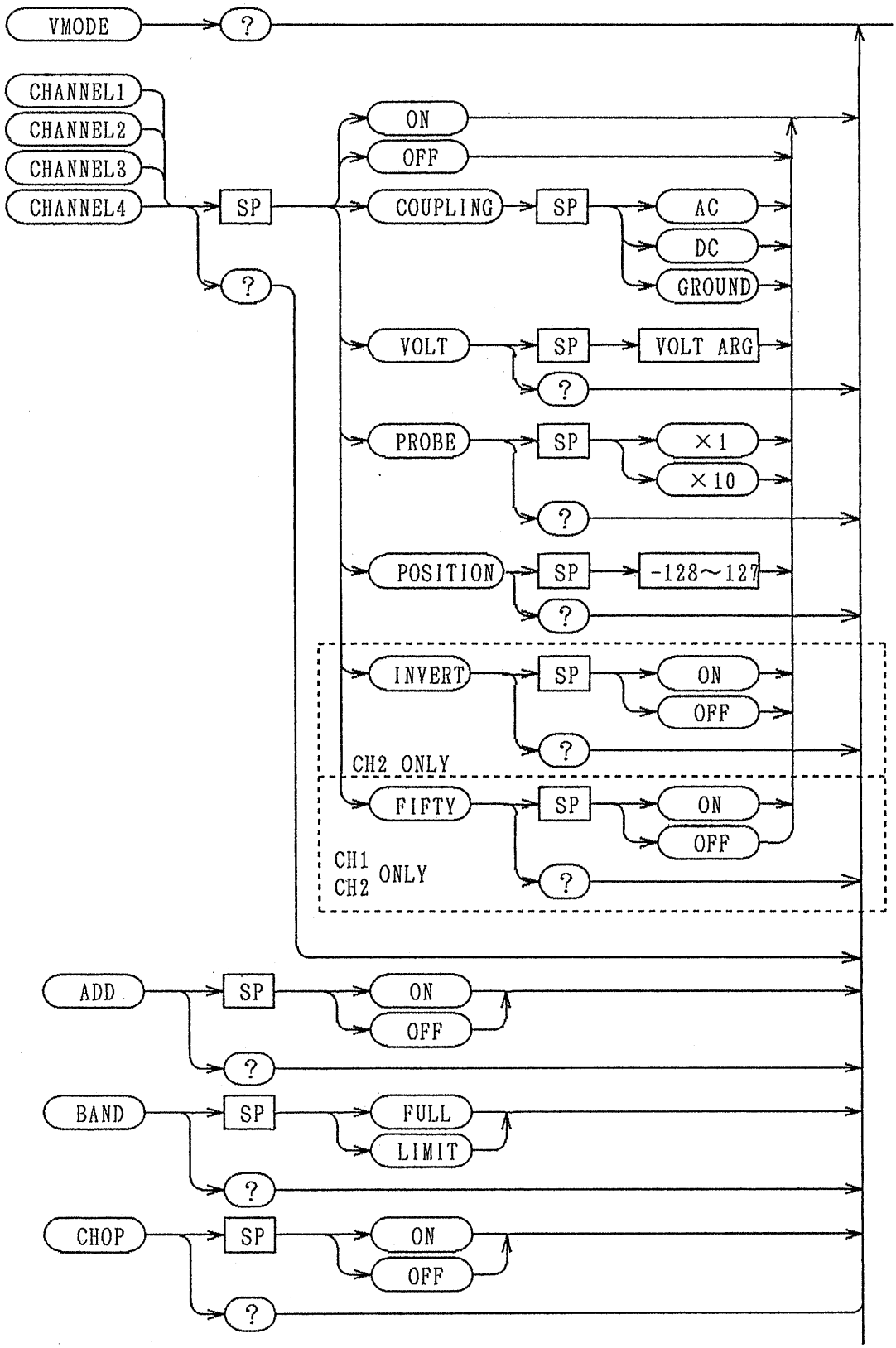
A blank space is placed between two set values.

6.4.1 System Commands



Header	Argument	Action
INITIAL (INI)		Set to status identical with system reset.
SRQ SRQ?	ON OFF	Enable SRQ. Disable SQR. ON, OFF
EOI EOI?	ONLY (ONL) ON OFF	Limit delimiter to EOI only when send. Enable EOI when send. Disable EIO when send. ON, OFF, ONLY
INTEN (INT) INTEN? (INT?)	-3 ～4	Offset INTEN ②. -3(dark) ↔ 4(bright) -3, -2, ---- 3, 4
MODEL?		Model name COM7202A

6.4.2 Commands for Vertical Axis



Header	Argument		Action
VMODE? (VMO?)			VERT MODE such as CH1, CH2, ALT
CHANNEL1 (CH1)	ON OFF		Turn on CH1. Turn off CH1.
	COUPLING (COU)	AC DC GROUND (GRO)	Set CH1 input coupling to AC. Set CH1 input coupling to DC. Set CH1 input coupling to GND.
	COUPLING? (COU?)		AC, DC, GROUND AC, DC
	FIFTY (FIF)	ON OFF	Set CH1 input coupling to 50Ω. Set CH1 input coupling to 1MΩ.
	FIFTY? (FIF?)		ON, OFF
	VOLT (VOL)	5V 2V 1V .5V .2V .1V 50MV 20MV 10MV 5MV 2MV 1MV	Set CH1 sensitivity to 5 V/DIV Set CH1 sensitivity to 2 V/DIV Set CH1 sensitivity to 1 V/DIV Set CH1 sensitivity to 0.5V/DIV Set CH1 sensitivity to 0.2V/DIV Set CH1 sensitivity to 0.1V/DIV Set CH1 sensitivity to 50mV/DIV Set CH1 sensitivity to 20mV/DIV Set CH1 sensitivity to 10mV/DIV Set CH1 sensitivity to 5 mV/DIV Set CH1 sensitivity to 2 mV/DIV Set CH1 sensitivity to 1 mV/DIV
	VOLT? (VOL?)		5V ~ 1mV
	PROBE (PRO)	X1 X10	Set CH1 probe and input sensitivity display to 1:1. Set CH1 probe and input sensitivity display to 10:1.
	PROBE? (PRO?)		X1, X10
	POSITION (POS)	-128 ~ 127	Set CH1 POSITION. (See Note 1.)
	POSITION? (POS?)		-128 ~ 0 ~ 127
CHANNEL1? (CH1?)			[ON/OFF] [VOLT (X10) (UNCAL)] [COUPLING] [POSITION]

Note 1: Be sure to set POSITION when in remote mode of operation.

Header	Argument		Action
CHANNEL2 (CH2)	ON OFF COUPLING FIFTY VOLT PROBE POSITION		The same as that for CH1
	INVERT (INV)	ON OFF	Enable CH2 INV. Disable CH2 INV.
	INVERT? (INV?)		ON, OFF
CHANNEL2? (CH2?)			The same as that for CH1
CHANNEL3 (CH3)	ON OFF		Turn on CH3. Turn off CH3.
	COUPLING (COU)	AC DC GROUND (GRO)	Set input coupling to AC. Set input coupling to DC. Set input coupling to GND.
	COUPLING? (COU?)		AC, DC, GROUND
	VOLT (VOL)	.5V .1V	Set CH3 sensitivity to 0.5V/DIV. Set CH3 sensitivity to 0.1V/DIV.
	VOLT? (VOL?)		0.5V, 0.1V
	PROBE (PRO)	X1 X10	Set CH3 probe and input sensitivity display to 1:1. Set CH3 probe and input sensitivity display to 10:1.
	PROBE? (PRO?)		X1, X10
	POSITION (POS)	-128 ~ 127	Set CH3 POSITION. (See Note 1.)
	POSITION? (POS?)		-128 ~ 127
CHANNEL3? (CH3?)			[ON/OFF] [VOLT] [COUPLING] [POSITION]

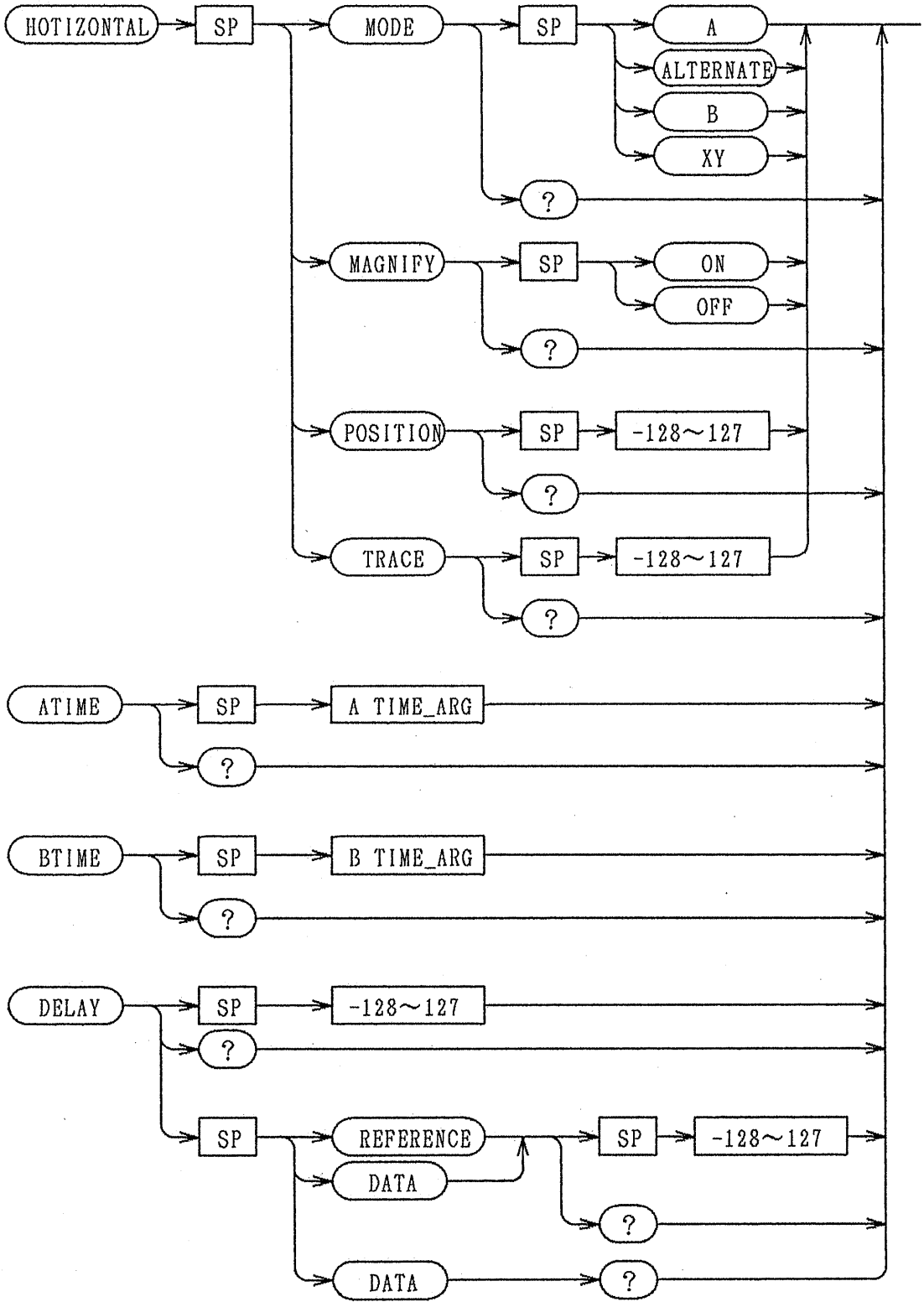
Note 1: Be sure to set POSITION when in remote mode of operation.

9032254

Header	Argument	Action
CHANNEL4 (CH4) CHANNEL4? (CH4?)	ON OFF COUPLING VOLT PROBE POSITION	} The same as that for CH3
ADD ADD?	ON OFF	Enable ADD. Disable ADD. ON, OFF
MULT (MUL) MULT? (MUL?)	ON OFF	Enable MULT. (STORAGE mode only) Disable MULT. ON, OFF
BAND (BAN) BAND? (BAN?)	FULL (FUL) LIMIT (LIM)	Without bandwidth limit. (BWL OFF) With bandwidth limit. (BLW ON) FULL, LIMIT
CHOP (CHO) CHOP? (CHO?)	ON OFF	Enable CHOP for multi-traces. Disable CHOP for multi-traces.(=ALT) ON, OFF

Note: It is not available to turn on the ADD function and the MULT function (in storage mode only) simultaneously.

6.4.3 Commands for Time Base (Horizontal Axis)



Header	Argument		Action
HORIZONTAL (HOR)	MODE (MOD)	A ALTERNATE (ALT) B XY	Set sweep mode to A. Set sweep mode to ALT. Set sweep mode to B. Set to X-Y mode.
	MODE? (MOD?)		A, ALT, B, XY
	MAGNIFY (MAG)	ON OFF	Enable X 10 MAG for horiz axis. Disable X 10 MAG for horiz axis.
	MAGNIFY? (MAG?)		ON, OFF
	POSITION (POS)	-128 ～ 127	Set HORIZ POSITION.
	POSITION? (POS?)		-128 to 127
	TRACE (TRA)	-128 ～ 127	Set TRACE SEPARATION.
	TRACE? (TRA?)		-128 to 127
HORIZONTAL? (HOR?)			[MODE] [MAG] [POS] [TRACE]
HOLDOFF (HOL)	0～255		Set HOLDOFF.
HOLDOFF? (HOL?)			0 to 255
ATIME (ATI)			STORAGE 5s ～ 50ns, 20ns, 10ns REAL 0.5s ～ 50ns, 20ns, 10ns
ATIME? (ATI?)			(UNCAL)
BTIME (BTI)			(See Note 1.)
BTIME? (BTI?)			0.5s ～ 50ns, 20ns, 10ns

Note 1: B TIME/DIV cannot be set at a range slower than that of A TIME/DIV.

Table 6-1

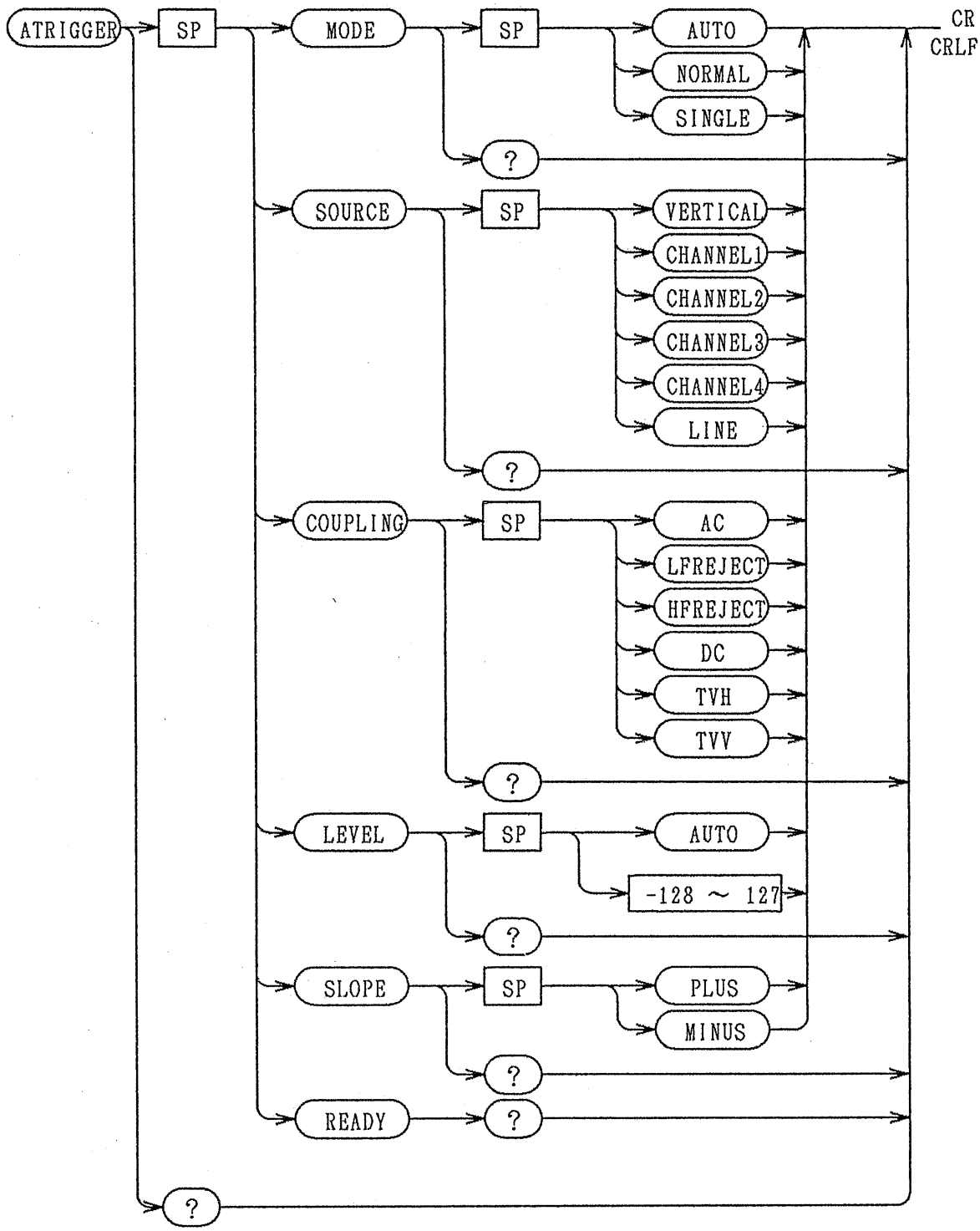
Range		Argument	COM7202A
Note	5s	5S	↑
	2s	2S	
	1s	1S	
.5s		.5S	
.2s		.2S	
.1s		.1S	
50ms		50MS	
20ms		20MS	
10ms		10MS	
5ms		5MS	
2ms		2MS	
1ms		1MS	
.5ms		.5MS	
.2ms		.2MS	
.1ms		.1MS	
50μs		50US	
20μs		20US	
10μs		10US	
5μs		5US	
2μs		2US	
1μs		1US	
.5μs		.5US	
.2μs		.2US	
.1μs		.1US	
50ns		50NS	
20ns		20NS	
10ns		10NS	↓

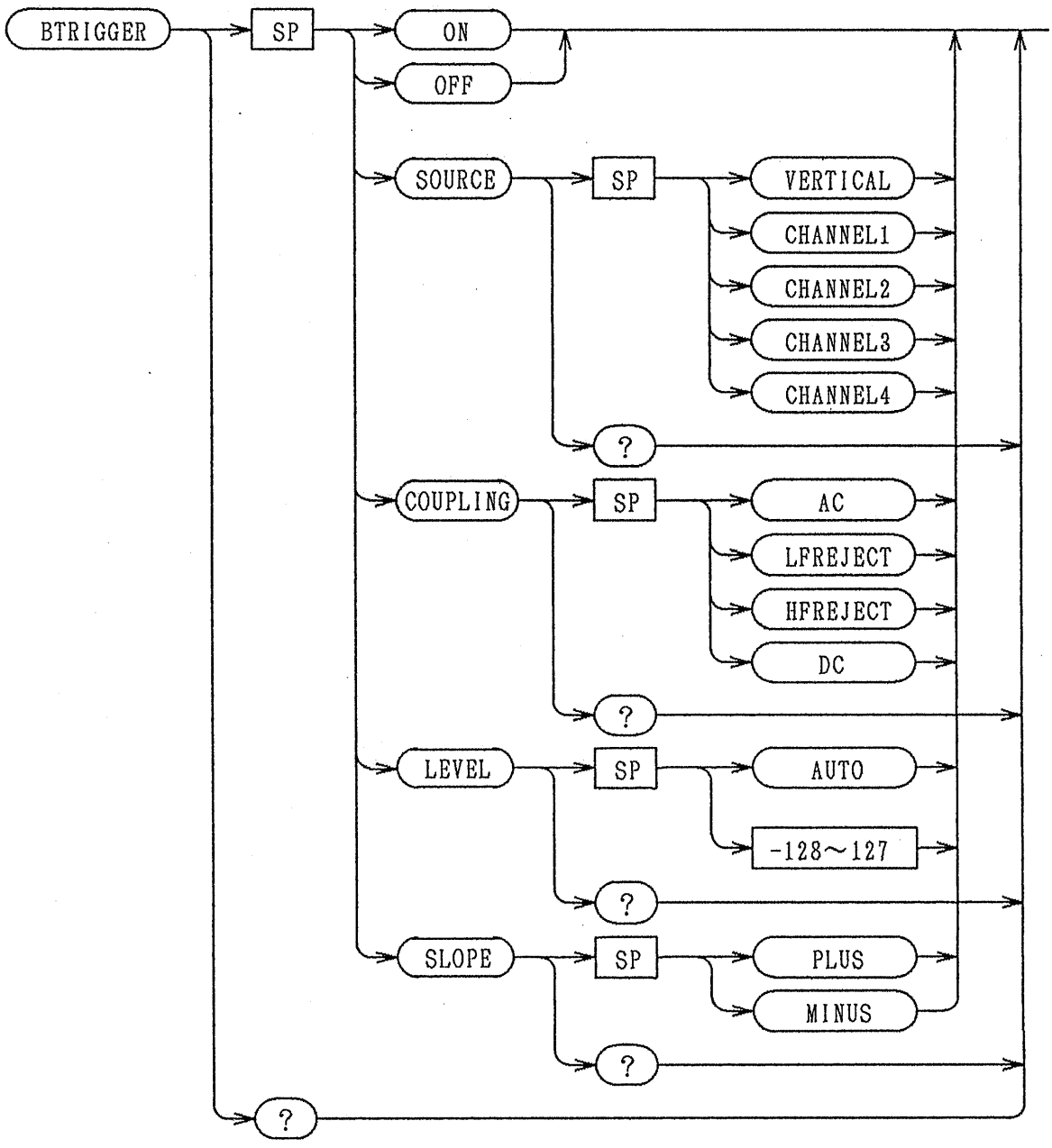
Note: For storage mode only.

Header	Argument		Action
DELAY (DEL)	MODE (MOD)	DELAY (DEL)	Set to DELAY mode.
		TIME (TIM)	Set to double delay ΔT mode.
		PERTIME (PER)	Set to double delay 1/ΔT mode.
	MODE? (MOD?)		DELAY, TIME, PERTIME
	-128 ~ 127		Set DELAY POSITION.
	REFERENCE (REF)	-128 ~ 127	Set DELAY (REF) POSITION.
	REFERENCE? (REF?)		0 ~ 4095
	DELTA (DEL)	-128 ~ 127	Set DELAY(DELTA) POSITION.
	DELTA? (DEL?)		0 ~ 4095
	DATA? (DAT?)		Value of DELAY ΔT or 1/ΔT. (See Note 1.)
DELAY? (DEL?)			[MODE] (REF) (DELTA) [DATA]

Note 1: When SWEEP VARIABLE ⑰ is enabled, unit of measure is DIV.

6.4.4 Commands for Triggering

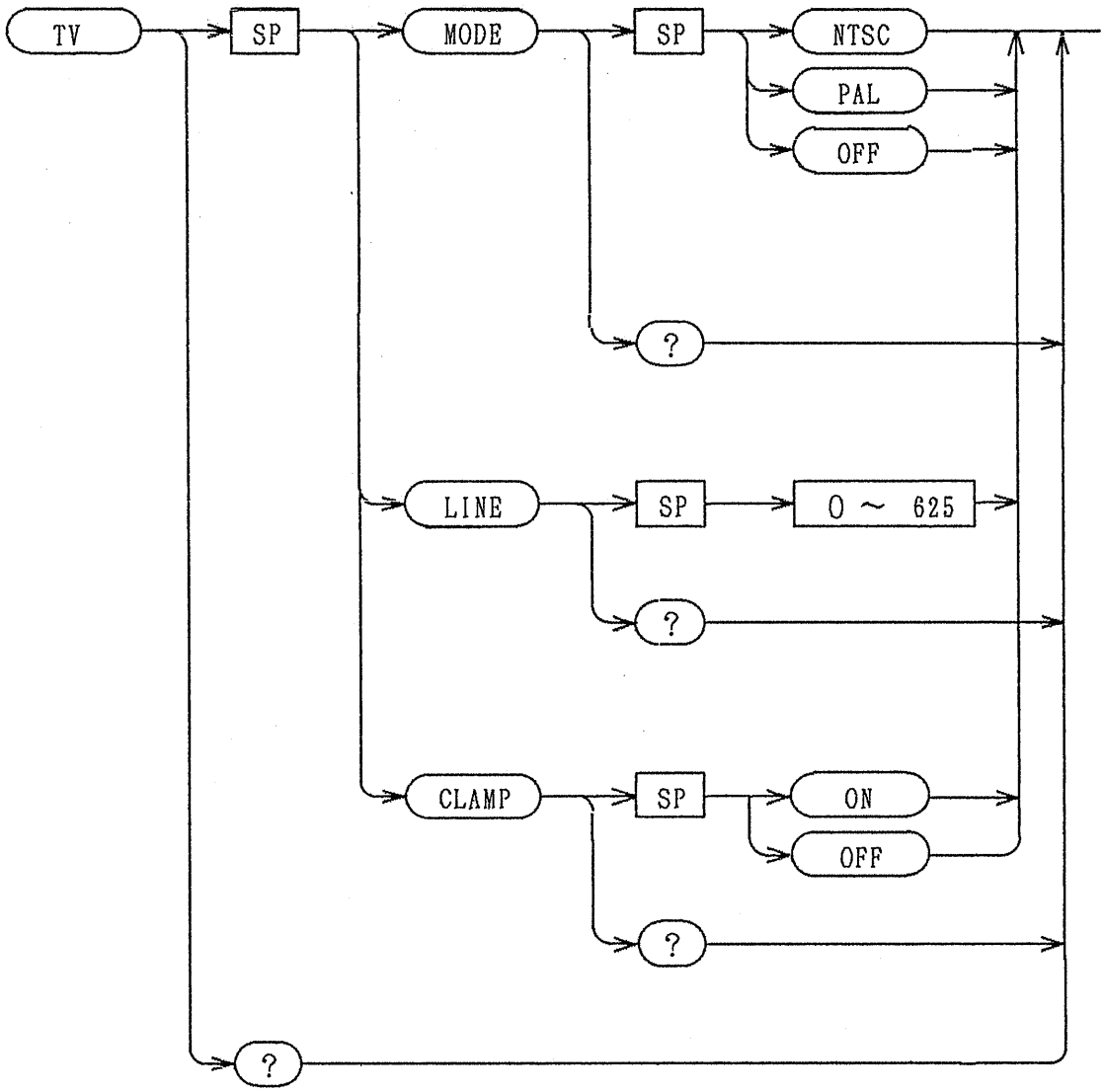



BTRIGGER
SP
ON
OFF
SOURCE
SP
VERTICAL
CHANNEL1
CHANNEL2
CHANNEL3
CHANNEL4
?
COUPLING
SP
AC
LFREJECT
HFREJECT
DC
?
LEVEL
SP
AUTO
-128～127
?
SLOPE
SP
PLUS
MINUS
?
?

Header	Argument		Action
ATRIGGER (ATR)	MODE (MOD)	AUTO (AUT)	Set A trigger to AUTO mode.
		NORMAL (NOR)	Set A trigger to NORMAL mode.
		SINGLE (SIN)	Set A trigger to SINGLE mode.
	MODE? (MOD?)		AUTO, NORMAL, SINGLE
	SOURCE (SOU)	VERTICAL (VER)	Set A trigger source to VERT.
		CHANNEL1 (CH1)	Set A trigger source to CH1.
		CHANNEL2 (CH2)	Set A trigger source to CH2.
		CHANNEL3 (CH3)	Set A trigger source to CH3.
		CHANNEL4 (CH4)	Set A trigger source to CH4.
		LINE (LIN)	Set A trigger source to LINE
	SOURCE? (SOU?)		VERT, CH1, CH2, CH3, CH4 LINE
	COUPLING (COU)	AC	Set A trig-in coupling to AC.
		LFREJECT (LFR)	Set A trig-in coupling to LF-REJ.
		HFREJECT (HFR)	Set A trig-in coupling to HF-REJ.
		DC	Set A trig-in coupling to DC.
		TVH	Set A trig-in coupling to TVH.
		TVV	Set A trig-in coupling to TVV.
	COUPLING? (COU?)		AC, LFR, HFR, DC, TVH, TVV
	LEVEL (LEV)	-128～127	Set A trigger level.
		AUTO	Set A trigger level to AUTO.
	LEVEL? (LEV?)		-128 ～ 127, AUTO

ATRIGGER (ATR) (cont'd)	SLOPE (SLO)	PLUS (PLU)	Set A trigger slope to "+"
		MINUS (MIN)	Set A trigger slope to "-"
	SLOPE? (SLO?)		PLUS, MINUS
ATRIGGER? (ATR?)			[MODE] [SOURCE] [COUPLING] [LEVEL] [SLOPE]
BTRIGGER (BTR)	ON		Turn on B trigger.
	OFF		Turn off B trigger.
	SOURCE (SOU)	VERTICAL (VER)	Set B trigger source to VERT.
		CHANNEL1 (CH1)	Set B trigger source to CH1.
		CHANNEL2 (CH2)	Set B trigger source to CH2.
		CHANNEL3 (CH3)	Set B trigger source to CH3.
		CHANNEL4 (CH4)	Set B trigger source to CH4.
	SOURCE? (SOU?)		VERT, CH1, CH2, CH3, CH4
	COUPLING (COU)	AC	Set B trig-in coupling to AC.
		LFREJECT (LFR)	Set B trig-in coupling to LFR.
		HFREJECT (HFR)	Set B trig-in coupling to HFR.
		DC	Set B trig-in coupling to DC.
	COUPLING? (COU?)		AC, LFR, HFR, DC
	LEVEL (LEV)	-128 ~ 127	Set B trigger level.
		AUTO	Set B trigger level to AUTO.
	LEVEL? (LEV?)		-128 ~ 127, AUTO
	SLOPE (SLO)	PLUS (PLU)	Set B trigger slope to "+".
		MINUS (MIN)	Set B trigger slope to "-".
	SLOPE? (SLO?)		PLUS, MINUS
BTRIGGER? (BTR?)			[ON/OFF] [SOURCE] [COUPLING] [LEVEL] [SLOPE]

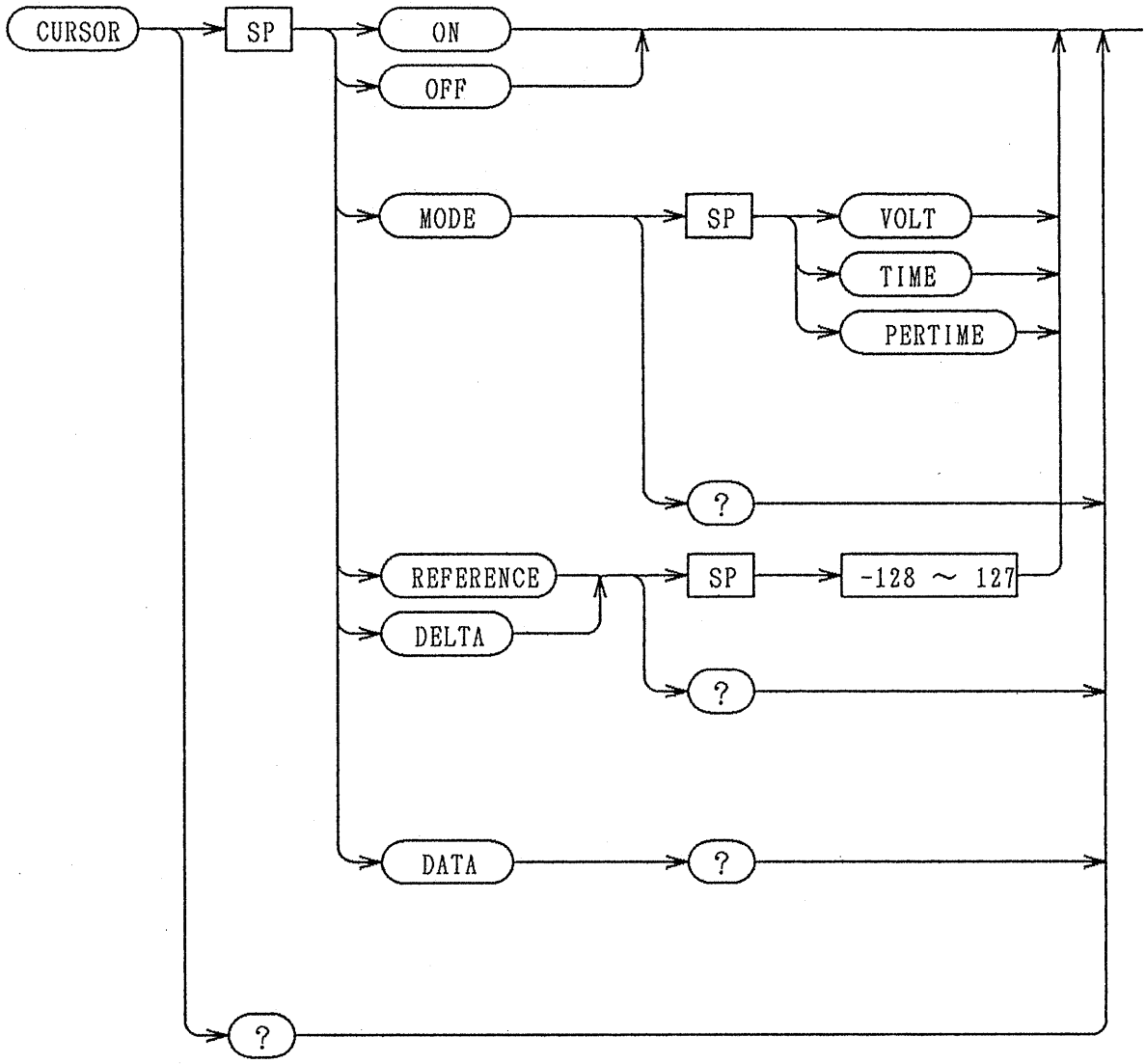
6.4.5 Commands for TV signal



Header	Argument		Action
ATRIGGER (ATR)	COUPLING (COU)	TVH	Set A-trigger input coupling to TVH. Necessary for setting of TV line select mode.
TV	MODE (MOD)	NTSC (NTS) PAL OFF	Set TV line select mode to NTSC. Set TV line select mode to PAL. Set TV line select mode to OFF.
	MODE? (MOD?)		NTSC, PAL, OFF
	LINE (LIN)	1 ~ 625	Set TV line select number. NTSC : 1 ~ 525 PAL : 1 ~ 625
	LINE? (LIN?)		1 ~ 625
TV	CLAMP (CLA)	ON OFF	Set pedestal clamp to ON. Set pedestal clamp to OFF.
	CLAMP? (CLA?)		ON, OFF
TV?			[ON/OFF] [MODE] [LINE] [CLAMP]

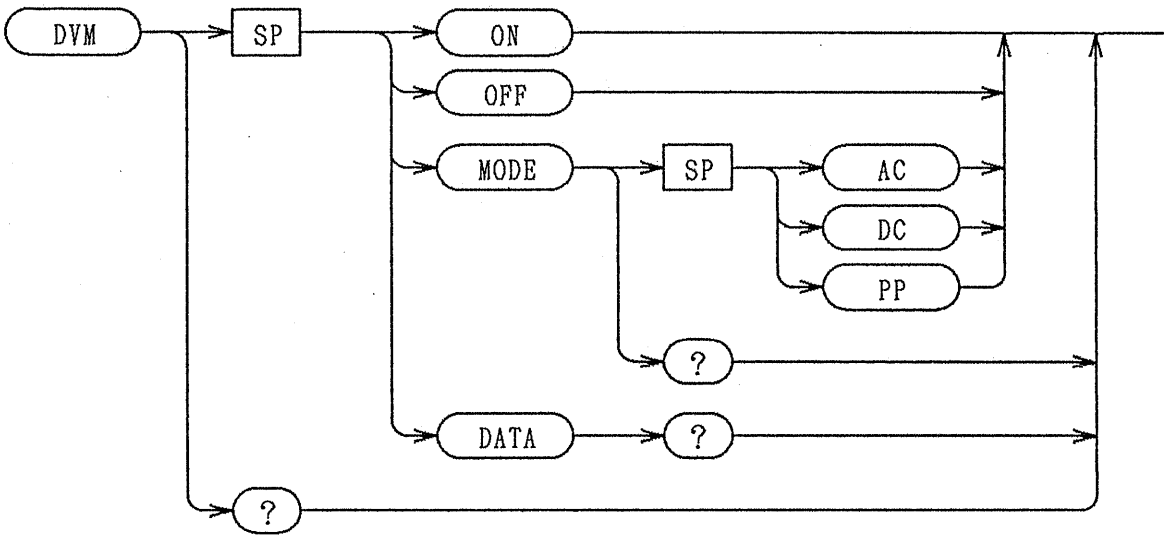
Note: The TV mode is enabled only when A-trigger coupling is set to TVH. TV CLAMP mode is enabled when A-trigger coupling is set to TVH or TVV.

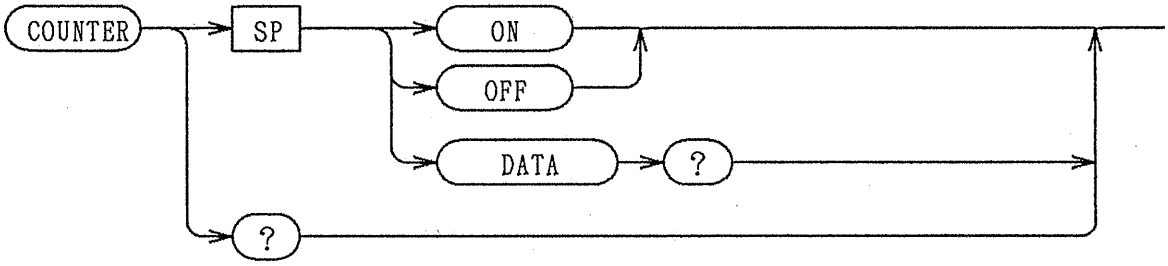
6.4.6 Commands for Cursors



Header	Argument		Action
CURSOR (CUR)	ON		Turn on cursor.
	OFF		Turn off cursor.
	MODE (MOD)	VOLT (VOL)	Set cursor mode to ΔV.
		TIME (TIM)	Set cursor mode to ΔT.
		PERTIME (PER)	Set cursor mode to 1/ΔT.
	MODE? (MOD?)		VOLT, TIME, PERTIME
	REFERENCE (REF)	-128 ～ 127	Set CURSOR (REF) POSITION. 0 ～ 4095
	REFERENCE? (REF?)		
	DELTA (DEL)	-128 ～ 127	Set CURSOR (DELTA) POSITION. 0 ～ 4095
	DELTA? (DEL?)		
	DATA? (DAT?)		Value measured with cursors.
CURSOR? (CUR?)			[ON/OFF] [MODE] [REFERENCE] [DELTA] [DATA]

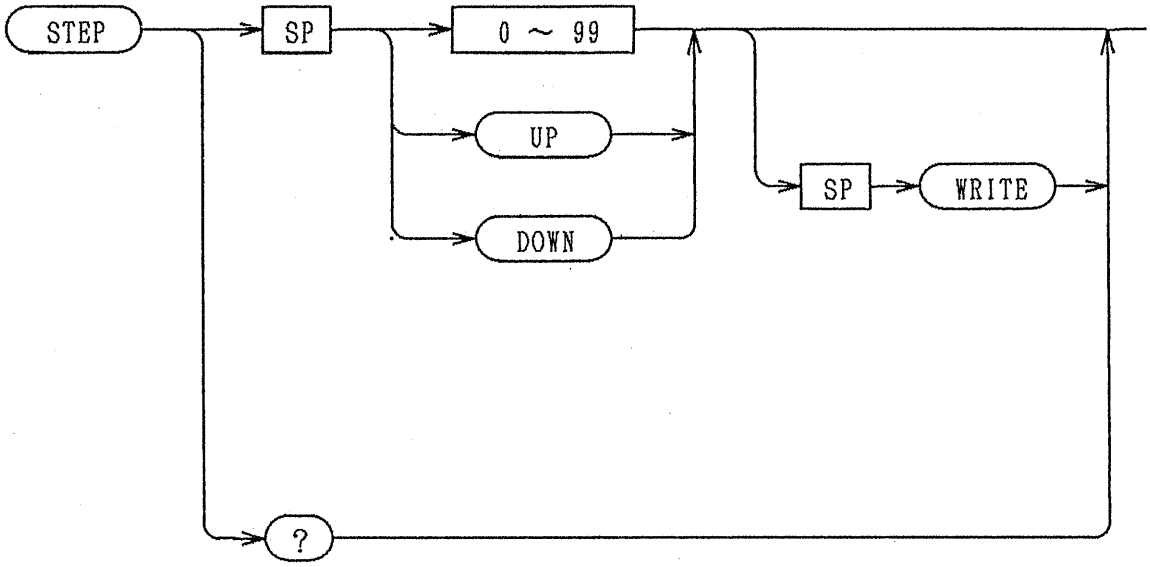
6.4.7 Comands for DVM and Counter





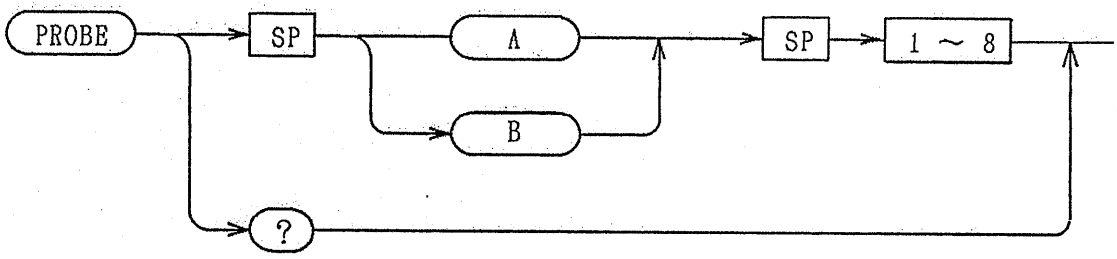
Header	Argument		Action
DVM	ON		Turn on DVM.
	OFF		Turn off DVM.
	MODE (MOD)	AC DC PP	Set DVM mode to AC. Set DVM mode to DC. Set DVM mode to p-p.
	MODE? (MOD?)		AC, DC, PP
	DATA? (DAT?)		Value measured with DVM.
DVM?			[ON/OFF] [MODE] [DATA]
COUNTER (COU)	ON		Turn on counter.
	OFF		Turn off counter.
	DATA? (DAT?)		Value measured with counter.
COUNTER? (COU?)			[ON/OFF] [DATA]

6.4.8 Commands for Step Control



Header	Argument		Action
STEP (STE)	0～99		Read data on step memory.
		WRITE (WRI)	Write data on step memory.
	UP		Increment step address by 1.
		WRITE (WRI)	Increment step address by 1 and then write data on memory.
	DOWN (DOW)		Decrement step address by 1.
		WRITE (WRI)	Decrement step address by 1 and then write data on memory.
STEP? (STE?)			Current step address 0 ～ 99

6.4.9 Commands for Probe-Selector Control
(Adapted Probe-Selector only)



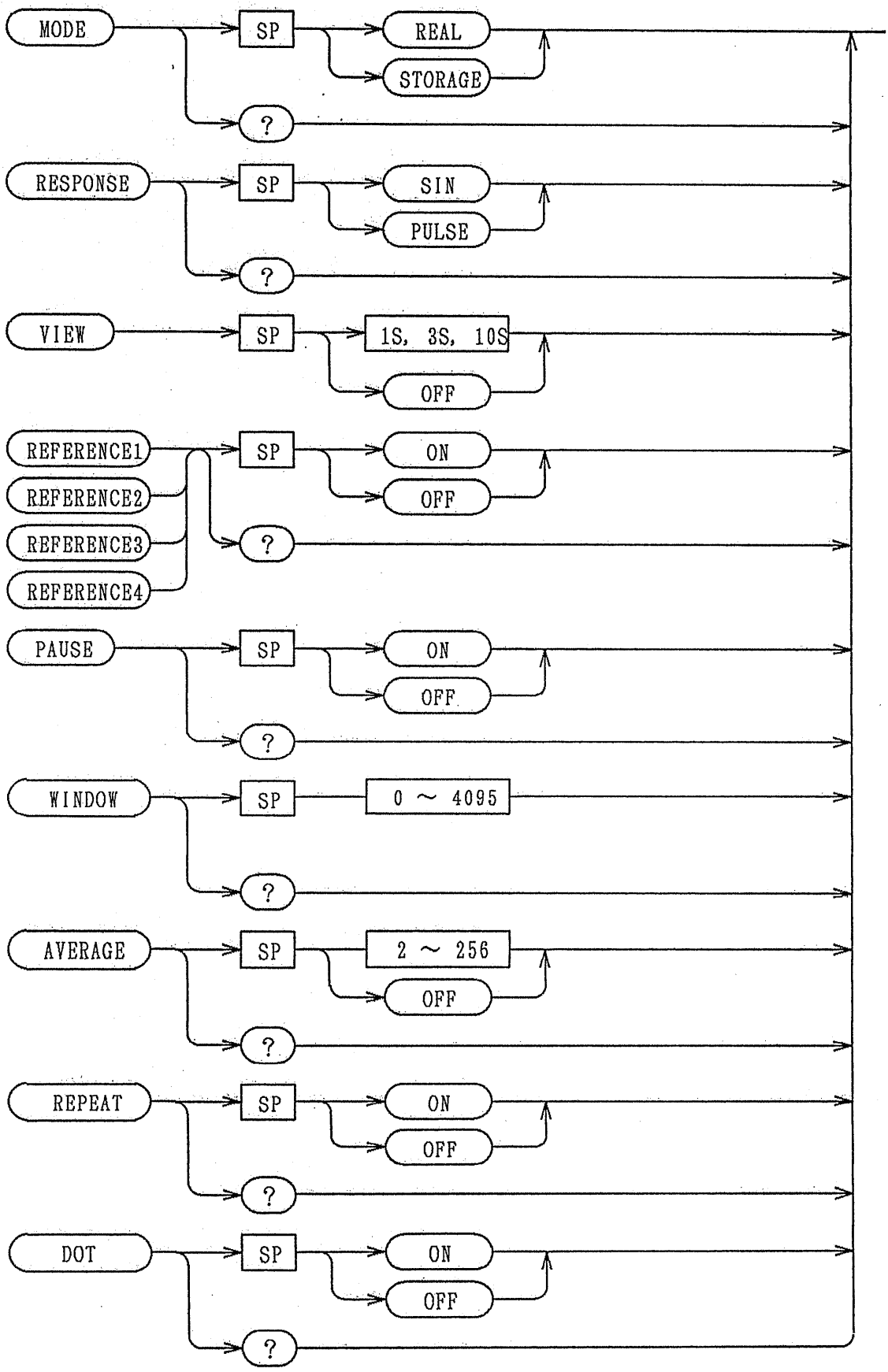
Header	Argument		Action
PROBE (PRO)	A B	1 ～ 8 1 ～ 8	Set A Channel of Probe-Serector. Set B Channel of Probe-Serector.
PROBE? (PRO?)			Current Set A1 ～ 8　B1 ～ 8

'90.5.31

903524A

6.4.10 Commands for Storage

(1) Commands which always operate when in storage mode



Header	Argument	Action
MODE (MOD)	REAL (REA) STORAGE (STO)	Set to real time mode. Set to storage mode.
MODE? (MOD?)		REAL, STORAGE
RESPONSE (RES)	SIN PULSE (PUL)	Set to sine interpolation. Set to pulse interpolation.
RESPONSE? (RES?)		SIN, PULSE
VIEW (VIE)	OFF, 1S, 3S, 10S	Set view time. Unit in sec.
VIEW? (VIE?)		OFF, 1S, 3S, 10S
REFERENCE1 (REF1)	ON OFF	Turn on REF1. Turn off REF1.
REFERENCE1? (REF1?)		ON, OFF [ON/OFF] [VOLT(UNCAL)] [COUPLING] [TIME/DIV]
REFERENCE2 (REF2)	ON OFF	Turn on REF2. Turn off REF2.
REFERENCE2? (REF2?)		ON, OFF
REFERENCE3 (REF3)	ON OFF	Turn on REF3. Turn off REF3.
REFERENCE3? (REF3?)		ON, OFF
REFERENCE4 (REF4)	ON OFF	Turn on REF4. Turn off REF4.
REFERENCE4? (REF4?)		ON, OFF
PAUSE (PAU)	ON OFF	Turn on PAUSE. Turn off PAUSE.
PAUSE? (PAU?)		ON, OFF

'90. 5. 31

9003271A

Header	Argument	Action
WINDOW (WIN)	～	Set WINDOW value. (See Note.)
WINDOW? (WIN?)		～
AVERAGE (AVE)	OFF 2 4 8 16 32 64 128 256	Turn off AVG function. Set AVG cycles to 2. Set AVG cycles to 4. Set AVG cycles to 8. Set AVG cycles to 16. Set AVG cycles to 32. Set AVG cycles to 64. Set AVG cycles to 128. Set AVG cycles to 256.
AVERAGE? (AVE?)		OFF, 2～256
REPEAT (REP)	ON OFF	Turn on RPT function. Turn off RPT function.
REPEAT? (REP?)		ON, OFF
DOT	ON OFF	Turn on DOT display. Turn off DOT display.
DOT?		ON, OFF

Note: The displayed part of waveform data with the WINDOW function is with the center of screen as the reference point for display. That is, the displayed part can be changed by changing the reference point in the 4k word memory. The range within which the reference point can be set is as shown in the following tables.

'90. 5. 31

9032772A

Ranges within which reference point for WINDOW viewing can be set

1. When not in IPL mode

Time/DIV Range	Low Limit	High Limit
5 s～10ns	512	3583

2. When in IPL mode

2.1 When in data acquisition by repetitive interpolation

(1) Pulse interpolation

Time/DIV Range	Low Limit	High Limit
・5 μs	516	3579
・2 μs	522	3573
・1 μs	532	3563
50 ns	552	3543
20 ns	612	3483
10 ns	712	3383

(2) Sine interpolation

Time/DIV Range	Low Limit	High Limit
・5 μs	520	3575
・2 μs	532	3563
・1 μs	552	3543
50 ns	592	3503
20 ns	712	3383
10 ns	912	3183

2.2 When in magnification with interpolation

(1) Pulse interpolation

Magni. Factor	Low Limit	High Limit
＊1	512	3583
＊2	258	3837
＊2.5	207	3888
＊4	130	3965
＊5	105	3990
＊10	54	4041
＊20	28	4067
＊25	23	4072
＊40	15	4080
＊50	13	4082
＊100	8	4087

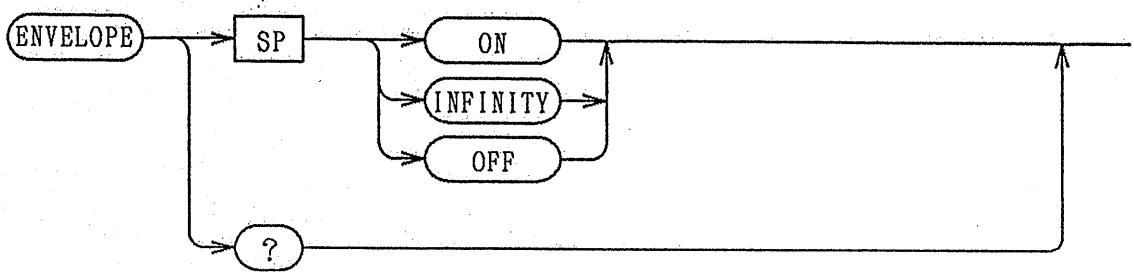
(2) Sine interpolation

Magni. Factor	Low Limit	High Limit
＊1	512	3583
＊2	260	3835
＊2.5	209	3886
＊4	132	3963
＊5	107	3988
＊10	56	4039
＊20	30	4065
＊25	25	4070
＊40	17	4078
＊50	15	4080
＊100	10	4085

'90. 5. 31

9003273A

(2) Commands for 50ms/DIV - 10μs/DIV

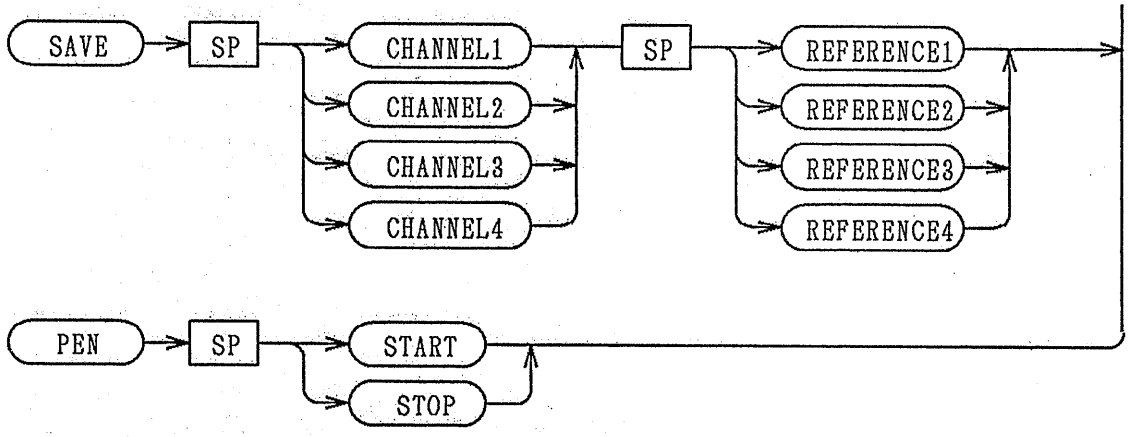


Header	Argument	Action
ENVELOPE (ENV)	ON INFINITY (INF) OFF	Turn on ENVELOPE mode. Set ENVELOPE mode to INTENSITY. Turn off ENVELOPE mode.
ENVELOPE? (ENV?)		ON, INTENSITY, OFF

'90. 5. 31

9032744A

(3) Commands which are effective only when in PAUSE ON

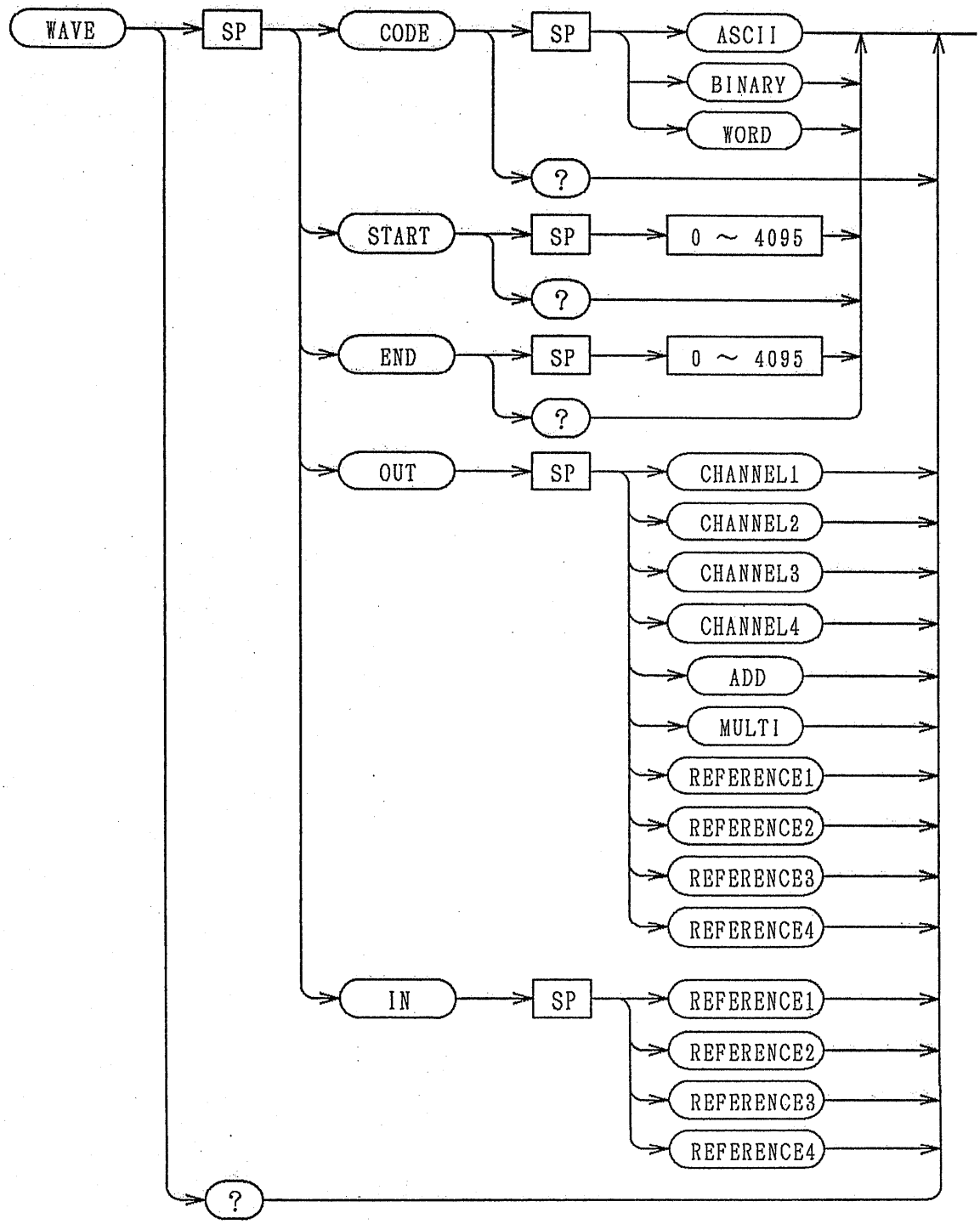


Header	Argument		Action
SAVE (SAV)	CHANNEL1 (CH1) CHANNEL2 (CH2) CHANNEL3 (CH3) CHANNEL4 (CH4)	REFERENCE1 (REF1) REFERENCE2 (REF2) REFERENCE3 (REF3) REFERENCE4 (REF4)	Save waveform data in reference memory. Error message is sent if specified channel is not ON. If specified reference memory is OFF, it is automatically turned ON.
PEN	START (STA) STOP (STO)		Start PEN output. Stop PEN output.

'90.5.31

90327SA

(4) Commands for send/receive of waveform data



'90. 5. 31

9003276A

Header	Argument		Action
WAVE (WAV)	CODE (COD)	ASCII (ASC)	Use ASCII codes for waveform data transfer. (See Note.)
		BINARY (BIN)	Use binary codes for waveform data transfer. (See Note.)
		WORD (WOR)	Use binary words for waveform data transfer. (See Note.)
	CODE? (COD?)		ASCII, BINARY, WORD
	START (STA)	0~4095	Set starting block of waveform data. (See Note.)
		DISPLAY (DIS)	Set starting block of waveform displayed on CRT.
	START? (STA?)		
	END	0~4095	Set ending block of waveform data. (See Note.)
		DISPLAY (DIS)	Set ending block of waveform displayed on CRT. (See Note.)
	END?		
	OUT	CHANNEL1 (CH1)	Send waveform data of CH1.
		CHANNEL2 (CH2)	Send waveform data of CH2.
		CHANNEL3 (CH3)	Send waveform data of CH3.
		CHANNEL4 (CH4)	Send waveform data of CH4.
		ADD	ADD
		MULTI (MUL)	MULT
		REFERENCE1 (REF1)	Send waveform data of REF1.
		REFERENCE2 (REF2)	Send waveform data of REF2.
		REFERENCE3 (REF3)	Send waveform data of REF3.
		REFERENCE4 (REF4)	Send waveform data of REF4.

'90.5.31

9032774

Header	Argument		Action
WAVE (WAV) (cont'd)	IN	REFERENCE1 (REF1)	Receive waveform data onto REF1.
		REFERENCE2 (REF2)	Receive waveform data onto REF2.
		REFERENCE3 (REF3)	Receive waveform data onto REF3.
		REFERENCE4 (REF4)	Receive waveform data onto REF4.
WAVE? (WAV?)			[CODE] [START] [END]

Note: o *"WAVE IN" is for binary bytes and words only.*

o *Starting or ending with "WAVE IN" is for display.*

o *Waveform data transfer with ASCII codes is available for up to 1024k words. Set the starting and ending words within this range.*

'90. 5. 31

9003278A

6.5 Output for GP-IB Plotter

With the conventional oscilloscopes, no hardcopies of waveform data displayed on the CRT screen can be obtained unless a rather troublesome method with a camera or a computer system is employed.
The COM7202A Oscilloscope delivers an output corresponding to the waveform data displayed on the CRT, allowing you to directly obtain hadcopies by operating it in the storage mode and employing a GP-IB plotter (HP-GL compatible type). All data displayed on the CRT can be hardcopied, except that, when in the storage mode, the plot start position is fixed at the right hand end of the scale and no output data is delivered for VIEW TIME "⊿" and PAUSE.

Note: Note that the plotter used for this purpose must be HP-GL compatible.

(1) Connecting the Instruments

Connect a GP-IB plotter or plotters directly to the COM7202A Oscilloscope. (No other instruments are needed.)

(2) Setting the Instrument

COM7202A: Before turning on power of the oscilloscope, set the GP-IB switches ㊸ to the TALK ONLY mode.
(See page 118 TALK ONLY.)

Plotter: Set the plotter to the LISTEN ONLY mode.

Note 1: If the oscilloscope has already acquired a waveform data with its GP-IB switches ㊸ set at a normal address (0 - 30) and turning on its power, save the waveform data in the reference memory, turn off power of oscilloscope once, set the GP-IB switch ㊸ to the TALK ONLY mode, and then turn on power again.

Note 2: The positional relationship between the displayed waveform and the cursor can be self-calibrated. When the positional relationship between the CRT and the plotter has bcome largely shifted, set the oscilloscope to the DISPLAY I/O OFFSET ADJ mode by pressing the 2nd FUNCTION key ㊸ and the READOUT

CONTROL knob ㉝ simultaneously, move the cursor to the center of CRT with the READOUT CONTROL knob ㉝, and press once more the 2nd FUNCTION key ㊸.
Refer to Section 5.7 "Digital I/O Offset Adjustment."

(3) Operating Procedure

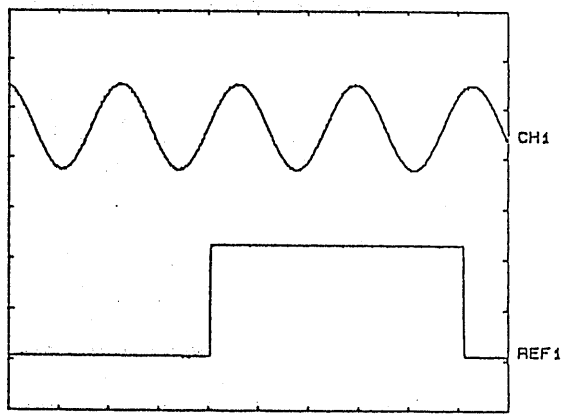
(a) Set the oscilloscope to the STORAGE mode and display on its CRT screen the CRT readout data and waveform data to be hardcopied.

(b) If the center lines of the graticule are not required to be hardcopied, turn off the SCALE ⑤ (graticule illumination control).

If the CRT readout data (data indicated with characters) is not required to be hardcopied, turn off the READOUT ⑤.

(c) 1. Keeping pressed the 2nd FUNCTION KEY ㊸, press the "(PLT 1)" key of the HORIZ MODE ㊱. The hardcopy will be drawn with a scale factor of double of that of the CRT graticule.

2. Keeping pressed the 2nd FUNCTION KEY ㊸, press the "(PLT 2)" key of the HORIZ MODE ㊱. The hardcopy will be drawn with a scale factor identical with that of the CRT graticule.



(d) To abort hardcopying in progress, press the 2nd FUNCTION KEY.

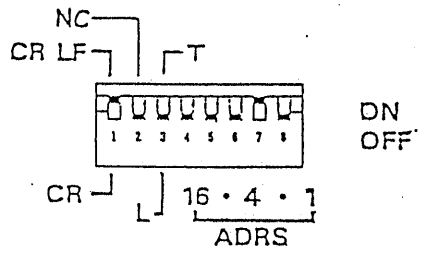
6.6 Programming Examples

6.6.1 Examples of Programming for PC-9801 Computer of NEC

(1) Initial Setting

Set an address for the PC-9801 (personal computer used as controller) and that for the oscilloscope with GP-IB switches ⑥③. For this programming example, set them as shown in the following table.

	Address	Delimiter
PC-9801	0	CR LF
COM7202A	2	CR LF



(2) Programming Example for Panel Control

This programming example is for controlling the oscilloscope from the computer keyboard to the functions the same with those made with the oscilloscope panel controls. In response to the "COMMAND?" prompt displayed on the computer, enter commands (characters for the required functions) from the keyboard. For the Execution Example of Program (1.1), enter the underlined characters. Symbol ↵ denotes the RETURN key (line feed key).

Program (1.1)

```
10  ISET IFC : ISET REN
20  CMD DELIM=0
30  INPUT "COMMAND" ; COMMAND$
40  PRINT @2 ; COMMAND$
50  FOR I=0 TO 300 : NEXT I
60  WBYTE &H14;
70  GOTO 30
```

(Comments)

10 Initialize interface and set REN to true.
20 Specify CR and LF for delimiters.
30 Receive command entered from keyboard.
40 Send command received from keyboard.

```
50 Timer
60 Send device clear command for in case of error.
   (This statement may be deleted if not required.)
70 Go to statement 30 to receive next command.
```

Remarks: If an invalid command is given, an error message "GPIB ERR" is displayed on the oscilloscope and an SRQ is generated. To cope with this, there are two methods: One is to release the SRQ by stopping the program once and running it again so that the interface is initialized. The other is to use a command (such as statement 50) irrespective of occurrence of errors. If a device clear command is received when the processing for the command sent by statement 40 is in progress, the processing is aborted and terminated. In order to wait until the processing is complete, statement 50 "Timer" should be inserted.

Execution Example of Program (1.1)

① To select CH1 input coupling:

COMMAND?	CHANNEL1 COUPLING AC↵
Abbreviation	CH1 COU AC↵

② To select storage mode:

COMMAND?	MODE STORAGE↵
Abbreviation	MOD STO↵

③ To set to PAUSE:

COMMAND?	PAUSE ON↵
Abbreviation	PAU ON↵

④ To set to SAVE:

COMMAND?	SAVE CHANNEL1 REFERENCE1↵
Abbreviation	SAV CH1 REF1↵

Of other panels also, the functions of the controls can be dictated through the computer keyboard. That is, all commands except "WAVE IN" and "WAVE OUT" can be given through the computer keyboard.

(3) Programming Examples to Read Panel Setting and Measured Values

Examples of programs to read the panel setting values and measured values, and to reset the system automatically when an invalid command is given are described below.

Program (1.2)

```
10  ISET IFC : ISET REN
20  CMD DELIM=0
30  INPUT "COMMAND" ; COMMAND$
40  PRINT @2 ; COMMAND$
50  INPUT @2 ; DAT$
60  PRINT TAB(9) ; DAT$
70  GOTO 30
```

(Comments)

10 Initialize interface and set REN to true.
20 Specify CR and LF for delimiters.
30 Receive command entered from keyboard.
40 Send command received from keyboard.
50 Receive setting value or other data.
60 Display the received setting value or other data.
70 Go to statement 30 to receive next command.

If an invalid command is given in the above program, it will stop at statement 50 and an SRQ is generated. Therefore, a program to release the SRQ must be added.

Program (1.3)

```
10    SRQ OFF
20  ISET IFC : ISET REN
30  CMD DELIM=0
40    ON SRQ GOSUB *SRQSUB
50    SRQ ON
60  INPUT "COMMAND" ; COMMAND$
70  PRINT @2 ; COMMAND$
80    FOR I=0 TO 300 : NEXT I
90  INPUT @2 ; DAT$
100  PRINT TAB(9) ; DAT$
110  GOTO 60
```

'90.5.31

9003283A

```
120  '
130  *SRQSUB
140   SRQ OFF
150     POLL 2, STB
160     WBYTE &H14 ;
170     PRINT "SRQ / GP-IB ERROR"
180   SRQ ON
190  RETURN 60
```

(Comments)

10 Disable once SRQ reception in order to cope with such state that SRQ has already been generated when starting program.
20 The same with that of Program (1.2)
30 The same with that of Program (1.2)
40 Specify processing routine to be employed when SRQ is generated.
50 Enable SRQ reception.
60 The same with that of Program (1.2)
70 The same with that of Program (1.2)
80 If an invalid command is sent, an error is caused and an SRQ is generated. Allow a period for generating the SRQ.
90 The same with that of Program (1.2)
100 The same with that of Program (1.2)
110 The same with that of Program (1.2)
120
130 SRQ processing routine.
140 Disable SRQ reception.
150 Perform serial polling.
160 Clear device.
170 Display error message.
180 Enable SRQ reception again.
190 Go to statement 60 and receive next command.

'90.5.31

9032844A

Execution Example of Program (1.3)

① Setting state of CH1

COMMAND?	CHANNEL1 COUPLING?↵
Abbreviation	CH1 COU?↵
Display ex.	DC

② Setting state of MODE

COMMAND?	MODE?↵
Abbreviation	MOD?↵
Display ex.	REAL

③ To set to ATIME

COMMAND?	ATIME?↵
Abbreviation	ATI?↵
Display ex.	10US

Of other panels also, the functions of the controls can be dictated through the computer keyboard. The underlined itens of the above commands are those to be manually entered through the keyboard. That is, all commands except "WAVE IN" and "WAVE OUT" can be given through the computer keyboard.

'90.5.31

(4) Programming Example to Set Panel Controls and to Read Setting Values

This program is a modified one of Program (1.3) so that setting of panel controls also can be done.

Program (1.4)

```
10     SRQ OFF
20  ISET IFC : ISET REN
30  CMD DELIM=0
40    ON SRQ GOSUB *SRQSUB
50    SRQ ON
60  INPUT "COMMAND" ; COMMAND$
70  PRINT @2 ; COMMAND$
80    FOR I=0 TO 300 : NEXT I
90  IF RIGHT$(COMMAND$, 1) <> "?" THEN 60
100  INPUT @2 ; DAT$
```

9032285A

```
110  PRINT TAB(9) ; DAT$
120  GOTO 60
130  '
140  *SRQSUB
150   SRQ OFF
160     POLL 2, STB
170     FOR I=0 TO 300 : NEXT I
180     WBYTE &H14 ;
190     PRINT "SRQ / GP-IB ERROR"
200   SRQ ON
210  RETURN 60
```

(Comments)

10 The same with that of Program (1.3)
20 The same with that of Program (1.3)
30 The same with that of Program (1.3)
40 The same with that of Program (1.3)
50 The same with that of Program (1.3)
60 The same with that of Program (1.3)
70 The same with that of Program (1.3)
80 The same with that of Program (1.3)
90 If the command is not of the type which calls for reading of setting value or other data, go to statement 60 and wait for the next command.
100 The same with that of Program (1.3)
110 The same with that of Program (1.3)
120 The same with that of Program (1.3)
130
140 SRQ processing routine
150 The same with that of Program (1.3)
160 The same with that of Program (1.3)
170 The same with that of Program (1.3)
180 The same with that of Program (1.3)
190 The same with that of Program (1.3)
200 The same with that of Program (1.3)
210 The same with that of Program (1.3)

'90. 5. 31

9032886A

(5) Examples of Commands for Control of Cursors and Reading of Measured Values

Examples of commands for control of cursors and reading of values measured with cursors, using the program (1.4) are given below.

① "CURSOR MODE" command, with program of (1.4)

COMMAND?	CURSOR MODE VOLT↵
Abbreviation	CUR MOD VOL↵

② "CURSOR DELTA" command, with program of (1.4)

COMMAND?	CURSOR DELTA 50↵
Abbreviation	CUR DEL 50↵

Note: Even when in the remote mode, the cursors can be vernier-controlled with the READOUT control.

③ Moving the cursors with the READOUT control, read the measured value. "CURSOR DATA?" command, with program of (1.4)

COMMAND?	CURSOR DATA?↵
Abbreviation	CUR DAT?↵
Display ex.	12.34 E-3

The underlined items of the above commands are those to be manually entered through the keyboard. For "↵", press the RETURN key.

(6) Examples of Commands for Control of DVM and Counter, and Reading of Measured Values

Examples of commands for control of the DVM and counter and reading of the measured values, using the program (1.4) are given below.
When in the remote mode with GP-IB, the DVM and the counter can be ON/OFF-controlled independently.

① "DVM MODE" command, with program of (1.4)

COMMAND?	DVM MODE AC↵
Abbreviation	DVM MOD AC↵

② "DVM DATA?" command, with program of (1.4)

COMMAND?"	DVM DATA?↵
Abbreviation	DVM DAT?↵
Display ex.	12.34 E-3

③ "COUNTER" command, with program of (1.4)

COMMAND?	COUNTER ON↵
Abbreviation	COU ON↵

④ "COUNTER DATA?" command, with program of (1.4)

COMMAND?	COUNTER DATA?↵
Abbreviation	COU DAT?↵
Display ex.	12.34 E-6

The underlined items of the above commands are those to be manually entered through the keyboard. For "↵", press the RETERN key.

(7) Examples of Programs for Transfer of Waveform Data

This section introduces programs to send waveform data acquired in the storage mode to the host computer or other devices. The programs (1.1) through (1.4) are not usable for this purpose. Examples of programs for individual cases are shown below.

① Program to send data (binary) from oscilloscope to PC-9801 of NEC

Program (1.5.1) (binary byte)

```
100  DIM WAVDAT%(4095)
110  ISET IFC : ISET REN
120  CMD DELIM=0
130  PRINT @2 ; "MOD STO"
140  PRINT @2 ; "PAU ON"
150  PRINT @2; "WAV STA DIS"
160  PRINT @2; "WAV END DIS"
170  PRINT @2 ; "WAV COD BIN"
180  PRINT @2 ; "WAV OUT CH1"
190  WBYTE 64+2, 32+0;
200  FOR LOOP=0 TO 1023
210   RBYTE ; WAVDAT%(LOOP)
220  NEXT LOOP
```

(Comments)

100 Declare array and secure data area.
110 Initialize interface and set REN to true.
120 Specify CR and LF for delimiters.
130 Set to STORAGE mode.
140 Turn on PAUSE so that waveform data can be sent.
150 Specify start point of waveform data transfer at left hand end of CRT display.
160 Specify end point of waveform data transfer at right hand end of CRT display.
170 Specify binary byte for waveform data codes.
180 Request CH1 waveform output.
190 Designate oscilloscope for talker and designate controller (computer) for listener. If addresses differ, modify this statement.
200 Prepare number of loops corresponding to number of data items.
210 Enter transferred data item into array variable WAVDAT%, sequentially.
220 Repeat until loops terminate.

Program (1.5.2) (binary word)

```
100 DIM WAVDAT%(4095)
110 ISET IFC : ISET REN
120 CMD DELIM=0
130 PRINT @2 ; "MOD STO"
140 PRINT @2 ; "PAU ON"
150 PRINT @2; "WAV STA DIS"
160 PRINT @2; "WAV END DIS"
170 PRINT @2 ; "WAV COD WOR"
180 PRINT @2 ; "WAV OUT CH1"
190 WBYTE 64+2, 32+0;
200 FOR LOOP=0 TO 1023
210  RBYTE; WAVH
220  RBYTE; WAVL
230  WAVDAT%(LOOP)=WAVH*256+WAVL
240 NEXT LOOP
```

(Comments)

100 Declare array and secure data area.
110 Initialize interface and set REN to true.
120 Specify CR and LF for delimiters.
130 Set to STORAGE mode.
140 Turn on PAUSE so that waveform data can be sent.

'90. 5. 31

9003289A

150 Specify start point of waveform data transfer at left hand end of CRT display.
160 Specify end point of waveform data transfer at right hand end of CRT display.
170 Specify binary word for waveform data codes.
180 Request CH1 waveform output.
190 Designate oscilloscope for talker and designate controller (computer) for listener. If addresses differ, modify this statement.
200 Prepare number of loops corresponding to number of data items.
210 Read higher byte of waveform data.
220 Read lower byte of waveform data.
230 Enter transferred data item into array variable WAVDAT%, sequentially.
240 Repeat until loops terminate.

② Program to send data (binary) from PC-9801 to oscilloscope

For the above program it is assumed that the preceding program of (1.6) has been executed and waveform data has already been stored in WAVDAT%(LOOP).

Program (1.6)

```
210 PRINT @2; "MOD STO"
220 PRINT @2; "REF1 ON"
230 PRINT @2; "PAU ON"
240 PRINT @2; "WAV COD BIN"
250 PRINT @2; "WAV IN REF1"
260 WBYTE 64+0, 32+2;
270 FOR LOOP=0 TO 1022
280  WBYTE; WAVDAT%(LOOP)
290 NEXT LOOP
300 WBYTE; WAVDAT%(1023)@
```

(Comments)

210 Set to STORE mode.
220 Turn on REFERNCE 1.
230 Turn on PAUSE to transfer waveform data.
240 Specify binary for waveform data codes.
250 Specify waveform data entry to REFERENCE 1.
260 Designate oscilloscope for listener and designate controller (computer) for talker.
If addresses differ, modify this statement.

270 Prepare number of loops corresponding to number of data items-1.
280 Transfer data sequentially from array variable WAVDAT%.
290 Go to statement 280 until all loops are over.
300 Deliver final data item and EOI.

As in the case of ①, part of waveform data can be sent by using "WAVE START" and "WAVE END" commands.

(8) Step Control

This section introduces examples of programs for panel settings making use of step memory (0 - 99). In this simple method, programmed control for up to 100 types of oscilloscope panel settings can be realized.

① To write panel setting on step memory

Program (1.7)

```
10  ISET IFC
20  CMD DELIM=0
30  STEPNO=0
40  IRESET REN
50  PRINT "STEP No = " ; STEPNO
60  INPUT "PANEL SET & HIT RETURN", A$
70  COMMAND$="STE"+STR$(STEPNO)+"WRI"
80  ISET REN
90  PRINT @2; COMMAND$
100  IF STEPNO<99 THEN STEPNO=STEPNO+1
110  FOR I=0 TO 1000 : NEXT I
120  GOTO 40
```

(Comments)

10 Initialize interface and set REN to true.
20 Specify CR and LF for delimiters.
30 Initialize step number.
40 Set to LOCAL mode.
50 Display step number.
60 Set panel and wait for pressing of RETURN key.
70 Connect commands.
80 Set REN to true.
90 Write panel setting on step memory.
100 Increment step by 1.
110 Timer

120 Go to statement 40 and repeat setting.

(Note)

When in the LOCAL mode, even though you may adjust the vertical position, horizontal position, trigger level, holdoff, and trace separation controls, the adjustment data cannot be written on the memory. If you want to write the adjustment data on the step memory, adjust the controls in the REMOTE mode and then directly execute the step command without returning to the LOCAL mode.

② To read panel setting data on step memory

Program (1.8)

```
10  ISET IFC : ISET REN
20  CMD DELIM=0
30  INPUT "STEP NO = " ; STEPNO
40  IF STEPNO<0 OR STEPNO>99 TEHN 30
50  COMMAND$="STE " +STR$(STEPNO)
60  PRINT @2; COMMAND$
70  GOTO 30
```

(Comments)

10 Initialize interface and set REN to true.
20 Specify CR and LF for delimiters.
30 Enter step number.
40 Check step number.
50 Connect commands.
60 Read panel setting data which is written on step memory.
70 Go to statement 30 and repeat setting.

(9) Example of SRQ Processing

If the oscilloscope is set in a storage SINGLE TRIGGER STANDBY status, storing of waveform data in memory automatically starts as the triggering is effected. When storing in all addresses is over, an SRQ is generated. Thus, completion of data acquisition can be known by receiving the SRQ signal. An example of reception program is shown in the following.

Program (1.9)

```
10  SRQ OFF
20  ISET IFC : ISET REN
30  CMD DELIM=0
40  ON SRQ GOSUB *ACQEND
50  PRINT @2; "MOD STO"
60  PRINT @2 ; "PAU OFF"
70  PRINT @2 ; "ATR MOD SIN"
80  SRQ ON
90  GOTO 90
100  '
110  *ACQEND
120   SRQ OFF
130    POLL 2, STB
140    PRINT "ACQUISITION END !"
150   RETURN 70
```

(Comments)

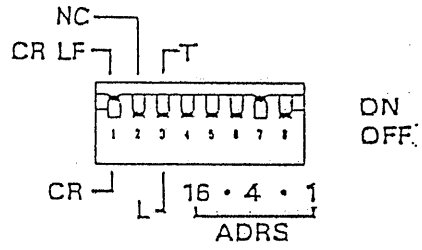
10 Disable once SRQ reception in order to cope with such state that SRQ has already been generated when starting program.
20 Initialize interface and set REN to true.
30 Specify CR and LF for delimiters.
40 Specify processing routine to be followed when SRQ is generated.
50 Set to STORE mode.
60 Release PAUSE.
70 Set to SINGLE TRIGGER STANDBY status.
80 Enable SRQ reception.
90 Wait for SRQ generation.
100
110 SRQ processing routine.
120 Disable SRQ reception.
130 Perform serial polling.
140 Display acquisition completion message.
150 Go to statement 70 and set again to SINGLE TRIGGER STANDBY status.

6.6.2 Examples of Programming for Model 9826 Computer of HP

(1) Initial Setting

Set an address for the Model 9826 (personal computer used as controller) and that for the oscilloscope with GP-IB switches ⑥③.
For this programming example, set them as shown in the following table.

	Address	Delimiter
MODEL 9826	0	CR LF
COM7202A	2	CR LF



(2) Programming Example for Panel Control

This programming example is for controlling the oscilloscope from the computer keyboard to the functions the same with those made with the oscilloscope panel controls. In response to the "COMMAND?" prompt displayed on the computer, enter commands (characters for the required functions) from the keyboard. For the Execution Example of Program (2.1), enter the underlined characters. Symbol ↵ denotes the ENTER key (line feed key).

Program (2.1)

```
10  ABORT 7
20  REMOTE 7
30  ASSIGN @Com TO 702
40  INPUT "COMMAND ?",Command$
50  OUTPUT @Com;Command$
60  WAIT 1
70  CLEAR @Com
80  GOTO 40
90  END
```

(Comments)

10 Initialize interface.
20 Set REN to true.
30 Assign attribute.
40 Receive command entered from keyboard.

50 Send command received from keyboard.
60 Timer
70 Send device clear command for in case of error.
(This statement may be deleted if not required.)
80 Go to statement 40 to receive next command.

Remarks: If an invalid command is given, an error message "GPIB ERR" is displayed on the oscilloscope and an SRQ is generated. To cope with this, there are two methods: One is to release the SRQ by stopping the program once and running it again so that the interface is initialized. The other is to use a command (such as statement 70) irrespective of occurrence of errors. If a device clear command is received when the processing for the command sent by statement 50 is in progress, the processing is aborted and terminated. In order to wait until the processing is complete, statement 60 "Timer" should be inserted.

Execution Example of Program (2.1)

① To select CH1 input coupling:

COMMAND?	CHANNEL1 COUPLING AC↵
Abbreviation	CH1 COU AC↵

② To select storage mode:

COMMAND?	MODE STORAGE↵
Abbreviation	MOD STO↵

③ To set to PAUSE:

COMMAND?	PAUSE ON↵
Abbreviation	PAU ON↵

④ To set to SAVE:

COMMAND?	SAVE CHANNEL1 REFERENCE1↵
Abbreviation	SAV CH1 REF1↵

Of other panels also, the functions of the controls can be dictated through the computer keyboard. That is, all commands except "WAVE IN" and "WAVE OUT" can be given through the computer keyboard.

(3) Programming Examples to Read Panel Setting and Measured Values

Examples of programs to read the panel setting values and measured values, and to reset the system automatically when an invalid command is given are described below.

Program (2.2)

```
10  ABORT 7
20  REMOTE 7
30  ASSIGN @Com TO 702
40  INPUT "COMMAND ? ",Command$
50  OUTPUT @Com;Command$
60  ENTER @Com;Dat$
70  PRINT Dat$
80  GOTO 40
90  END
```

(Comments)

```
10  Initialize interface.
20  Set REN to true.
30  Assign attribute.
40  Receive command entered from keyboard.
50  Send command received from keyboard.
60  Receive setting value or other data.
70  Display the received setting value or other data.
80  Go to statement 40 to receive next command.
```

If an invalid command is given in the above program, it will stop at statement 60 and an SRQ is generated. Therefore, a program to release the SRQ must be added.

Program (2.3)

```
10  ABORT 7
20  REMOTE 7
30  ASSIGN @Com TO 702
40  ON INTR 7 GOTO Srq_rou
50  ENABLE INTR 7;2
60  INPUT "COMMAND ?",Command$
70  OUTPUT @Com;Command$
80  WAIT .5
90  ENTER @Com;Dat$
```

```
100  PRINT Dat$
110  GOTO 60
120  !
130  Srq_rou: !
140                DISABLE INTR 7
150                Stb=SPOLL(@Com)
160                WAIT .5
170                CLEAR @Com
180                PRINT "SRQ/GP-IB ERROR"
190                ENABLE INTR 7;2
200                GOTO 60
210  END
```

(Comments)

10 The same with that of Program (2.2)
20 The same with that of Program (2.2)
30 The same with that of Program (2.2)
40 Specify processing routine to be employed when SRQ is generated.
50 Enable SRQ reception.
60 The same with that of Program (2.2)
70 The same with that of Program (2.2)
80 If an invalid command is sent, an error is caused and an SRQ is generated. Allow a period for generating the SRQ.
90 The same with that of Program (2.2)
100 The same with that of Program (2.2)
110 The same with that of Program (2.2)
120
130 SRQ processing routine.
140 Disable SRQ reception.
150 Perform serial polling.
160 Timer
170 Clear device.
180 Display error message.
190 Enable SRQ reception again.
200 Go to statement 60 and receive next command.

Execution Example of Program (2.3)

① Setting state of CH1

COMMAND?	CHANNEL1 COUPLING?↵
Abbreviation	CH1 COU?↵
Display ex.	DC

② Setting state of MODE

COMMAND?	MODE?↵
Abbreviation	MOD?↵
Display ex.	REAL

③ To set to ATIME

COMMAND?	ATIME?↵
Abbreviation	ATI?↵
Display ex.	10US

Of other panels also, the functions of the controls can be dictated through the computer keyboard. The underlined items of the above commands are those to be manually entered through the keyboard. That is, all commands except "WAVE IN" and "WAVE OUT" can be given through the computer keyboard.

'90.5.31

(4) Programming Example to Set Panel Controls and to Read Setting Values

This program is a modified one of Program (2.3) so that setting of panel controls also can be done.

Program (2.4)

```
10  ABORT 7
20  REMOTE 7
30  ASSIGN @Com to 702
40  ON INTR 7 GOTO Srq_rou
50  ENABLE INTR 7;2
60  INPUT "COMMAND ?",Command$
70  OUTPUT @Com;Command$
80  WAIT .5
90  IF Command$[LEN(Command$)]<>"?" THEN 60
100  ENTER @Com;Dat$
```

9032982A

```
110  PRINT Dat$
120  GOTO 60
130  !
140  Srq_rou: !
150              DISABLE INTR 7
160              Stb=SPOLL(@Com)
170              WAIT .5
180              CLEAR @Com
190              PRINT "SRQ / GP-IB ERROR"
200              ENABLE INTR 7;2
210              GOTO 60
220  END
```

(Comments)

10 The same with that of Program (2.3)
20 The same with that of Program (2.3)
30 The same with that of Program (2.3)
40 The same with that of Program (2.3)
50 The same with that of Program (2.3)
60 The same with that of Program (2.3)
70 The same with that of Program (2.3)
80
90 If the command is not of the type which calls for reading of setting value or other data, go to statement 60 and wait for the next command.
100 The same with that of Program (2.3)
110 The same with that of Program (2.3)
120 The same with that of Program (2.3)
130
140 SRQ processing routine
150 The same with that of Program (2.3)
160 The same with that of Program (2.3)
170 The same with that of Program (2.3)
180 The same with that of Program (2.3)
190 The same with that of Program (2.3)
200 The same with that of Program (2.3)
210 The same with that of Program (2.3)

(5) Examples of Commands for Control of Cursors and Reading of Measured Values

Examples of commands for control of cursors and reading of values measured with cursors, using the program (2.4) are given below.

① "CURSOR MODE" command, with program of (2.4)

COMMAND? CURSOR MODE VOLT↵

Abbreviation CUR MOD VOL↵

② "CURSOR DELTA" command, with program of (2.4)

COMMAND? CURSOR DELTA 50↵

Abbreviation CUR DEL 50↵

Note: Even when in the remote mode, the cursors can be vernier-controlled with the READOUT control.

③ "CURSOR DATA?" command, with program of (2.4)

Moving the cursors with the READOUT control, read the measured value.

COMMAND? CURSOR DATA?↵

Abbreviation CUR DAT?↵

Display ex. 12.34 E-3

The underlined items of the above commands are those to be manually entered through the keyboard. For "↵", press the ENTER key.

(6) Examples of Commands for Control of DVM and Counter, and Reading of Measured Values

Examples of commands for control of the DVM and counter and reading of the measured values, using the program (2.4) are given below.
When in the remote mode with GP-IB, the DVM and the counter can be ON/OFF-controlled independently.

① "DVM MODE" command, with program of (2.4)

COMMAND? DVM MODE AC↵

Abbreviation DVM MOD AC↵

'90. 5. 31

9033300A

② "DVM DATA?" command, with program of (2.4)

COMMAND?"	DVM DATA?↵
Abbreviation	DVM DAT?↵
Display ex.	12.34 E-3

③ "COUNTER" command, with program of (2.4)

COMMAND?	COUNTER ON↵
Abbreviation	COU ON↵

④ "COUNTER DATA?" command, with program of (2.4)

COMMAND?	COUNTER DATA?↵
Abbreviation	COU DAT?↵
Display ex.	12.34 E-6

The underlined items of the above commands are those to be manually entered through the keyboard. For "↵", press the ENTER key.

(7) Examples of Programs for Transfer of Waveform Data

This section introduces programs to send waveform data acquired in the storage mode to the host computer or other devices. The programs (2.1) through (2.4) are not usable for this purpose. Examples of programs for individual cases are shown below.

① Program to send data (binary) from oscilloscope to Model 9826 of HP

Program (2.5.1) (binary byte)

```
10  INTEGER WAVDAT(4095)
20  OUTPUT @Com; "MOD STO"
30  OUTPUT @Com; "PAU ON"
40  OUTPUT @Com; "WAV STA DIS"
50  OUTPUT @Com; "WAV END DIS"
60  OUTPUT @Com; "WAV COD BIN"
70  OUTPUT @Com; "WAV OUT CH1"
80  ENTER @Com USING "%, B"; WAVDAT(*)
90  END
```

'90.5.31

9033301A

(Comments)

10 Declare array and secure data area.
20 Set to STORAGE mode.
30 Turn on PAUSE so that waveform data can be sent.
40 Specify start point of waveform data transfer at left hand end of CRT display.
50 Specify end point of waveform data transfer at right hand end of CRT display.
60 Specify binary byte for waveform data codes.
70 Request CH1 waveform output.
80 Enter transferred data item into array variable WAVDAT%, sequentially.

Program (2.5.2) (binary word)

```
10  INTEGER WAVDAT(4095)
20  OUTPUT @Com; "MOD STO"
30  OUTPUT @Com; "PAU ON"
40  OUTPUT @Com; "WAV STA DIS"
50  OUTPUT @Com; "WAV END DIS"
60  OUTPUT @Com; "WAV COD WOR"
70  OUTPUT @Com; "WAV OUT CH1"
80  ENTER @Com USING "%, W"; WAVDAT(*)
90  END
```

(Comments)

10 Declare array and secure data area.
20 Set to STORAGE mode.
30 Turn on PAUSE so that waveform data can be sent.
40 Specify start point of waveform data transfer at left hand end of CRT display.
50 Specify end point of waveform data transfer at right hand end of CRT display.
60 Specify binary word for waveform data codes.
70 Request CH1 waveform output.
80 Enter transferred data item into array variable WAVDAT%, sequentially.

'90. 5. 31

9033032A

② Program to send data (binary) from Model 9826 to oscilloscope

For the above program it is assumed that the preceding program of (2.5) has been executed and waveform data has already been stored in Wavdat (*).

Program (2.6)

```
100  OUTPUT @Com;"MOD STO"
110  OUTPUT @Com;"REF1 ON"
120  OUTPUT @Com;"PAU ON"
130  OUTPUT @Com;"WAV COD BIN"
140  OUTPUT @Com;"WAV IN REF1"
150  OUTPUT @Com USING "B";Wavdat(*) END
160  END
```

(Comments)

100 Set to STORAGE mode.
110 Turn on REFERNCE 1.
120 Turn on PAUSE to transfer waveform data.
130 Specify binary for waveform data codes.
140 Specify waveform data entry to REFERENCE 1.
150 Transfer data sequentially from array variable Wavdat (*).

As in the case of ①, part of waveform data can be sent by using "WAVE START" and "WAVE END" commands.

(8) Step Control

This section introduces examples of programs for panel settings making use of step memory (0 - 99). In this simple method, programmable control for up to 100 types of oscilloscope panel settings can be realized.

① To write panel setting on step memory

Program (2.7)

```
10  ABORT 7
20  ASSIGN @Com TO 702
30  Stepno=0
40  LOCAL 7
```

```
50  PRINT "STEP No = " , Stepno
60  INPUT "PANNEL SET & HIT ENTER" , A$
70  Command$="STE "&VAL$(Stepno9&" WRI"
80  REMOTE 7
90  OUTPUT @Com;Command$
100  IF Stepno<99 THEN Stepno=Stepno+1
110  WAIT 1
120  GOTO 40
130  END
```

(Comments)

10 Initialize interface.
20 Assign attribute.
30 Initialize step number.
40 Set to LOCAL mode.
50 Display step number.
60 Set panel and wait for pressing of ENTER key.
70 Connect commands.
80 Set REN to true.
90 Write panel setting on step memory.
100 Increment step by 1.
110 Timer
120 Go to statement 40 and repeat setting.

(Note)

When in the LOCAL mode, even though you may adjust the vertical position, horizontal position, trigger level, holdoff, and trace separation controls, the adjustment data cannot be written on the memory. If you want to write the adjustment data on the step memory, adjust the controls in the REMOTE mode and then directly execute the step command without returning to the LOCAL mode.

② To read panel setting data on step memory

Program (2.8)

```
10  ABORT 7
20  REMOTE 7
30  ASSIGN @Com TO 702
40  INPUT "STEP No = " , Stepno
50  IF Stepno<0 OR Stepno>99 THEN 40
```

```
60  Command$="STE " &VAL$(Stepno)
70  OUTPUT @Com;Command$
80  GOTGO 40
90  END
```

(Comments)

```
10  Initialize interface.
20  Set REN to true.
30  Assign attribute.
40  Enter step number.
50  Check step number.
60  Connect commands.
70  Read panel setting data which is written on step memory.
80  Go to statement 40 and repeat setting.
```

(9) Example of SRQ Processing

If the oscilloscope is set in a storage SINGLE TRIGGER STANDBY status, storing of waveform data in memory automatically starts as the triggering is effected. When storing in all addresses is over, an SRQ is generated. Thus, completion of data acquisition can be known by receiving the SRQ signal. An example of reception program is shown in the following.

Program (2.9)

```
10  ABORT 7
20  REMOTE 7
30  ASSINGN @Com TO 702
40  ON INTR 7 GOTO Acq_end
50  OUTPUT @Com;"MOD STO"
60  OUTPUT @Com;"PAU OFF"
70  OUTPUT @Com;"ATR MOD SIN"
80  ENABLE INTR 7;2
90  GOTO 90
100  !
110  Acq_end: !
120            DISABLE INTR 7
130            Stb=SPOLL(@Com)
140            PRINT "ACQUISITION END !"
150            WAIT 1
```

```
160             GOTO 70
170  END
```

(Comments)

10 Initialize interface.
20 Set REN to true.
30 Assign attribute.
40 Specify processing routine to be followed when SRQ is generated.
50 Set to STORAGE mode.
60 Release PAUSE.
70 Set to SINGLE TRIGGER STANDBY status.
80 Enable SRQ reception.
90 Wait for SRQ generation.
100
110 SRQ processing routine.
120 Disable SRQ reception.
130 Perform serial polling.
140 Timer.
150 Display acquisition completion message.
160 Go to statement 70 and set again to SINGLE TRIGGER STANDBY status.

'90. 5. 31

9033064

7. INITIAL MODE SETTING AND DIAGNOSTIC FUNCTIONS

7.1 Initial Mode Setting

The oscilloscope is a microprocessor-based instrument and all of its functions are dictated by the microprocessor. When CPU operation has become abnormal due to external noise or other causes, it can be reset to normal operation by performing initial mode setting.

For initial mode setting of COM7202A, press the SUB CURSOR SW ㉜ while keeping the 2nd FUNCTION KEY ㊸ pressed.

When initial mode setting is done, the oscilloscope is reset as follows:

COUPLING:	AC
VERT MODE:	CH1, CH2, ALT, BW ON
CH1, CH2 VOLT/DIV:	0.5V/DIV
TIME/DIV:	10μs/DIV
HORIZ MODE:	A
SWEEP MODE:	AUTO
TRIG SOURCE:	V-MODE CH1
TRIG LEVEL:	AUTO
TRIG CPLG:	AC
TRIG SLOPE:	"+"
CURSOR:	ΔT (50μs)
MODE:	REAL

If the abnormal state is not remedied by the above initial mode setting, turn off the oscilloscope and then repeat the initial mode setting procedure.

If the abnormal state is not remedied still, check the conditions of use of the oscilloscope and, if they are found to be normal, consult your Kikusui agent.

'90. 5. 31

9033307A

7.2 Diagnostic Functions

The oscilloscope is incorporated with two types of self diagnostic functions: one is that automatically done when power is turned on and the other is that effected when the 2nd FUNCTION key is pressed.

When power of the oscilloscope is turned on, the software version (ROM version) is automatically displayed for several seconds and the contents of the memory which stores panel setting data and internal circuit calibration data are automatically checked. If an error is found, the oscilloscope is automatically set to the self calibration mode (see Section 8.1). Let the oscilloscope perform the self calibration. When the self calibration is over, the panel setting is reset to that of the initial one and a message "INIT SYS DATA" appears on the CRT. The message disappers as you press the INTEN knob ② twice.

When power of the oscilloscope is turned on, messages as shown in Figure 7.1 appear on the CRT for about 5 seconds.

If error messages as mentioned below are displayed when self diagnosis is done, if the same error messages are still displayed even when self diagnosis is repeated, or if self calibration is continuously repeated when power is turned on, check the conditions of use of the oscilloscope, and, if they are normal, consult your Kikusui agent.

- RAM ERR
- LED RAM ERR
- CHR RAM ERR
- ROM CHECK SUM ERR
- SEQ RAM ERR

'90. 5. 31

9003308A

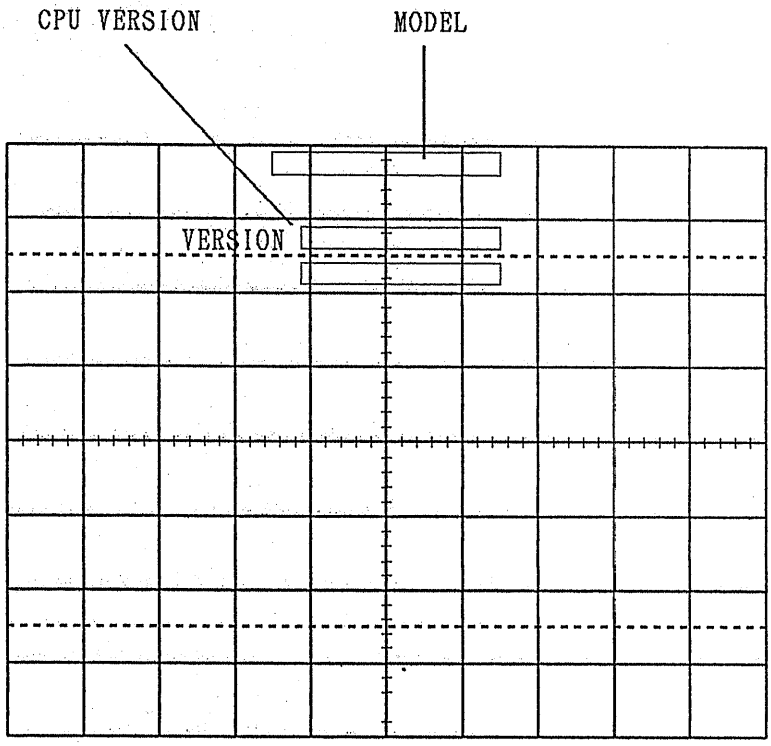


Figure 7.1 Diagnostic Messages Displayed on CRT

8. CALIBRATION AND MAINTENANCE

8.1 Self Calibration

The basic functions of the oscilloscope, such as vertical axis DC offset, vertical axis deflection factor, and time base, are automatically adjusted by the microprocessor of the oscilloscope, eliminating the requirements of special calibration instruments and operator's skills. Calibration is accomplished rapidly.

The calibration functions are classfied into Type 1 and Type 2. The former is for shifts of traces or cursors which can be caused by terrestrial magnetism, and for inconformity of trace positions between real mode and storage mode or between storage mode and HP-GL plotter mode which can be caused by ambient temperature change or other unfavorable environmental conditions. The latter is for overall basic performance of the oscilloscope.

Be sure to perform Type 1 calibration before performing Type 2 calibration. When a message "BACK UP DATA BROKEN" has appeared on the CRT (see Section 7.2), be sure to perform Type 1 calibration first and Type 2 calibration next.

'90. 5. 31

8.2 Type 1 Calibration

To perform Type 1 calibration, proceed as follows: Keeping the 2nd FUNCTION key ㊸ pressed, press the READOUT CONTROL knob ㉝.
A calibration procedure guide and a cursor will appear on the CRT.
Move the cursor to the horizontal center line of the graticule with the READOUT CONTROL knob ㉝. Press once more the 2nd FUNCTION key ㊸. Type 1 calibration is complete by this procedure. When the calibration is over, the panel setting which existed before starting the calibration resumes.

9033310A

8.3 Type 2 Calibration

To perform Type 2 calibration, proceed as follows: Press the 2nd FUNCTION key ㊸ and the DVM SW ㉞ simultaneously, and the contents of calibration will be displayed on the CRT. The calibration takes 60 to 120 seconds.

The items of self calibration are as follows:

- CH1 and CH2 DC offset, position center, and deflection factor
- DVM DC offset, sensitivity
- A sweep and B sweep accuracies, and starting positions.
- DELAY time offset
- Adjustment of storage circuit
- For storage mode: DC offset, positional center, vertical sensitivity, and random sampling time calibration

When the calibration is over, the panel setting which existed before starting the calibration resumes.

'90.5.31

8.4 Calibration Failure or Unreliable

If the self calibration of either Type 1 or Type 2 fails, a message "SELF CAL ERROR!!" will appear on the CRT. Repeat the calibration and, if the error message appears still, order your Kikusui agent for repair.

Calibrate the oscilloscope in favorable environments. After tuning on power of the oscilloscope, allow a stabilization time of 15 minutes of more. A recommendable ambient temperture is 25°C (77°F). Note that calibration which has been done in unfavorable conditions can be rather unreliable when favorable conditions are attained.

Regardless of the fact that the self calibration is automatically performed when power of the oscilloscope is turned on, it is recommended to repeat the self calibration when the oscilloscope is stabilized (allowing a stabilization time of 15 minutes of more).

9033311A

8.5 Self Calibration of Envelope in ROLL Mode

In the ENV1 operation in the ROLL mode, the oscilloscope may display abnormally wide traces without any input signals when it has been operated for a long period or immediately after its power is turned on. This is caused by temperature drift of the envelope circuit.
Calibration of this circuit alone can be done by setting the oscilloscope to the PAUSE state. The PAUSE time required for this calibration is approximately 5 seconds.

8.6 Inspection and Calibration

Although the oscilloscope is incorporated with automatic self calibration provision, it should be manually calibrated at appropriate intervals.
Manual calibration of the oscilloscope requires special instruments and skills. It is recommended to entrust your Kikusui agent for calibration service of your oscilloscope.

WARNING: Note that the oscilloscope employs hazardously high voltages. Never attempt to repair high voltage charged circuits for yourself.

8.7 Calibration Procedure

Calibration procedures of the oscilloscope are given below, excluding adjustment of high frequency characteristics and that of storage circuit. Do not attempt to make any adjustment other than those explained in the following.

(1) Removing the Case

To remove the case, proceed as follows: Remove the four studs (which act also as power cord takeups) and remove the rear panel. Holding the front panel, pull out the chassis unit from the case.

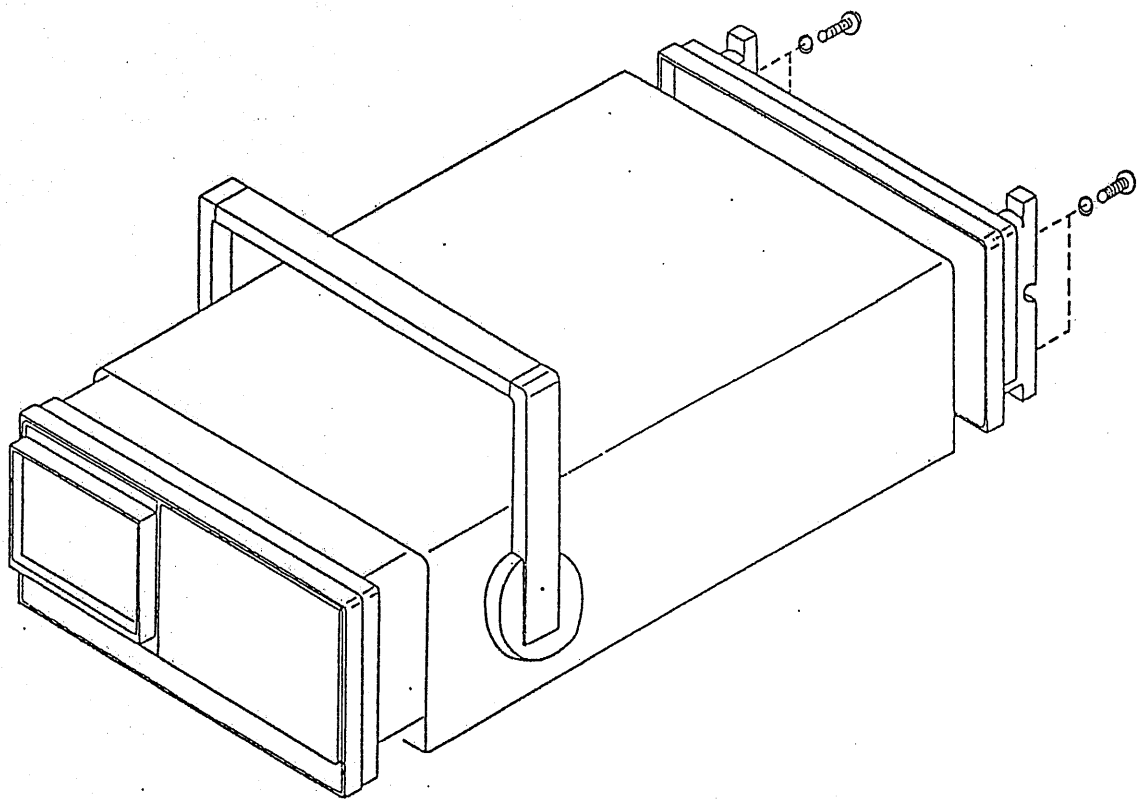


Figure 8.1 Removing the Case

(2) Check and Adjustment of Supply Voltages

The items to be checked first of all when calibrating the oscilloscope are supply voltages. If they are not within the tolerances, adjust at first the +12V supply voltage and then check other voltages.

Nominal Supply Voltage	Tolerance
+140 V	+139 to +142 V
+40 V	+38 to +42 V
+12 V	+11.90 to +12.10 V
+5 V (A)	+4.7 to +5.3 V
+5 V (D)	+4.9 to +5.2 V
-12 V	-11.90 to -12.10 V
-2100 V	-2050 to -2150 V

The locations of the check points and controls are shown in Figure 8.2. Those for the -2100V supply is on PCB A6.

Note: When supply voltages are changed, they substantially affect vertical deflection factors and sweep time base. Be sure to perform self calibration and adjustments of the subsequent items after adjusting the supply voltages.

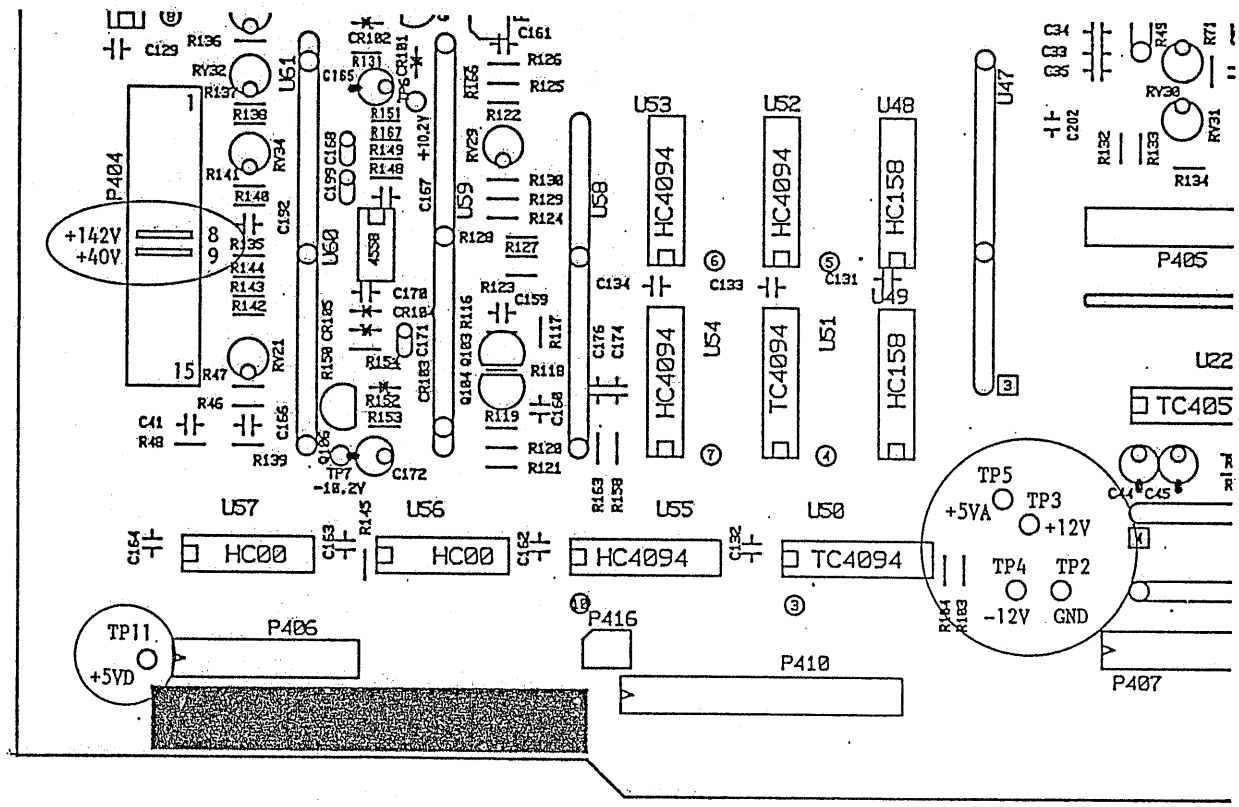


Figure 8.2 Locations of Supply Voltage Check Points and Controls

(3) Adjustment of Vref 30mV

This voltage is used as a reference voltage for self calibration. Adjust RV1 of PCB A4 so that the voltage across resistor R3 of PCB A4 becomes 30.01 to 29.99 mV.

(4) Adjustment of CRT Circuits

o GEOMETRY

Adjust RV4 of PCB A6 so that the pattern displayed on the CRT becomes normal as shown in Figure 8.3.

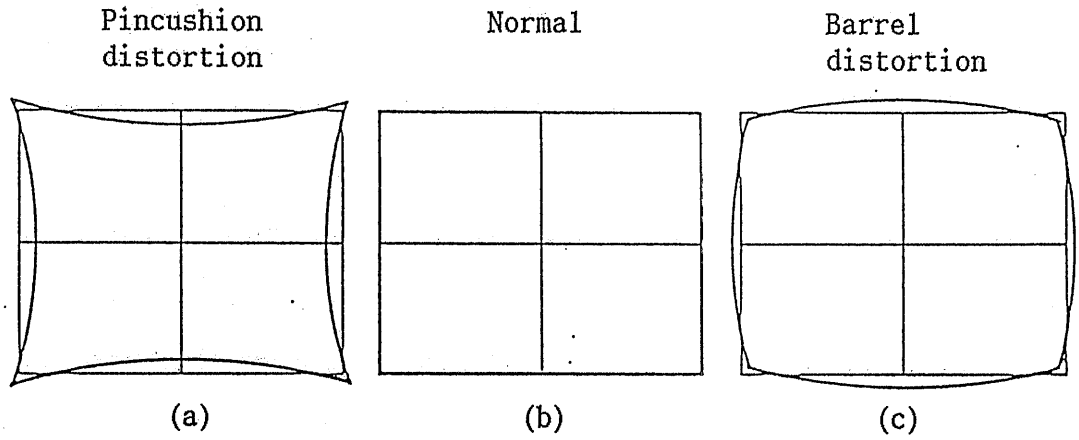


Figure 8.3 Patterns Displayed on CRT

○ ASTIG HALATION

Display the beam spot at the center of CRT screen (X-Y mode) and the readout at peripheries, and adjust to best focussing the spot with the FOCUS control and ASTIG control (RV5 on PCB A6) and the readout with the FOCUS control and HALATION control (RV6 on PCB A6).

○ SUB FOCUS

Set the FOCUS control at mid-position (noon position) and adjust RV3 of PCB A6 so that best focusing is obtained.

○ SUB INTEN

Adjust RV2 of PCB A6 so that the spot (X-Y mode) disappears as the INTEN control is set at 10 o'clock position.

(5) Adjustment of Vertical Axis (Y-axis) Gain

This adjustment is to adjust the Y-axis deflection factor to the self-calibrated value. Set the CH1 deflection factor to 10 mV/DIV, apply a calibration signal of 50 mV, and adjust RV3 of PCB A5 so that the signal is displayed with an amplitude of 5 DIV in the center of the CRT graticule.

(6) Adjustment of Horizontal Axis (X-axis) Gain

This adjustment is to adjust the X-axis deflection factor to the self-calibrated value. Set the time base at 1 ms/DIV, apply a time marker signal of 1 ms, and adjust RV7 of PCB A5 so that the 1st and 9th marker peaks are aligned with the corresponding graticule lines.

(7) Adjustment of Cursor X and Y GAIN and POSITION

Set ΔV cursor for the maximum vertical span and adjust RV21 of PCB A4 so that the cursor is displayed for 8 DIV on the CRT, and also adjust RV22 of PCB A4 so that the above state is attained with the POSITION control set at mid-position.

Set ΔT cursor for the maximum horizontal span and adjust RV33 of PCB A4 so that the cursor is displayed for 10 DIV on the CRT, and also adjust RV32 of PCB A4 so that the above state is attained with the POSITION control set at mid-position.

'90. 5. 31

(8) Adjustment of ADD BAL

Adjust RV22 of PCB A4 so that the trace is displayed at the center of CRT when the traces of CH1 and CH2 are set at the center of CRT and the mode is changed to ADD.

(9) Adjustment of TRIG LEVEL CENTER

Apply a 50-kHz sine wave and adjust RV25 (A TRIG) and RV26 (B TRIG) of PCB A4 so that the trace for TRIG AUTO starts from the center of CRT.

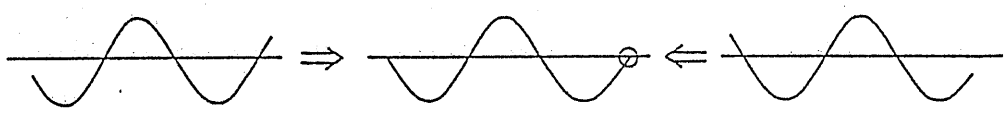


Figure 8.4 TRIG LEVEL CENTER

9033164

(10) Adjustment of TRIG DC OFFSET

Apply a 50-kHz sine wave to each of the channels, adjust the TRIG LEVEL control so that the trace starts at the center of CRT, and adjust the TRIG DC OFFSET control so that the starting point of trace does not change when the TRIG COUPLING switch is changed from AC to DC.

CH1	RV6 of PCB A4
CH2	RV8 of PCB A4
CH3	RV10 of PCB A4
CH4	RV12 of PCB A4

(11) Adjustment of CH3 GAIN and POSITION

Set the CH3 deflection factor to 0.1 V/DIV, apply a 0.5-V calibration signal, and adjust RV16 of PCB A4 so that the signal is displayed with an amplitude of 5 DIV on CRT. Next, set the INPUT COUPLING switch to GND and adjust RV14 of PCB A4 so that the trace is displayed at the center of CRT with the CH3 POSITION control set at the mid position.

'90.5.31

(12) Adjustment of CH4 GAIN and POSITION

In the same manner as in the case of CH3, adjust GAIN with RV17 of PCB A4 and POSITION with RV15 of PCB A4.

(13) Adjustment of X-Y GAIN and CENTER

Set CH1 deflection factor at 10 mV/DIV, apply a 50-mV calibration signal, and adjust RV31 of PCB A4 so that the signal is displayed with an amplitude of 5 DIV in the X-Y mode.

Next, change the INPUT COUPLING switch ⑧ to GND and adjust RV30 of PCB A4 so that the spot is displayed at the center of CRT with the CH1 POSITION control ㊵ set at the mid-position.

9033178

(14) Adjustment of CH1 SIG OUT OFFSET

Apply the CH1 SIG OUT (without 50-ohm termination) to the CH2 input. Set the CH2 deflection factor at 10 mV/DIV and adjust RV18 of PCB A4 so that the trace remains at the same position when the INPUT COUPLING ⑱ switch is changed from GND to DC.

(15) Adjustment of COMP START

Set the time base at 1 ms/DIV and check, by using a time marker signal, that the horizontal axis (X-axis) GAIN has been calibrated.

Set the A sweep to 1 ms/DIV and the B sweep to 10 μs/DIV, set the readout to ΔT 7.999 ms, and set the DISPLAY A mode to ALT.

Set INPUT to GND and adjust RV29 of PCB A4 so that the distance between the two spots on the CRT becomes 8 DIV. Then perform self calibration.

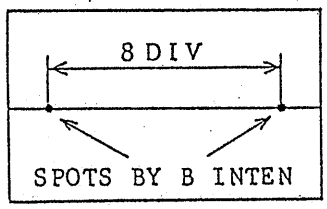


Figure 8.5 COMP START

(16) Adjustment of SWEEP LENGTH

Set the time base at 1 ms/DIV and adjust RV27 (A sweep) and RV28 (B sweep) of PCB A4 so that the time base sweep length becomes 11.2 DIV. When in the B sweep, set the A sweep to 2 ms/DIV.

(17) Adjustment of Time Base x10 MAG GAIN

Set sweep time at 1 ms/DIV x10 MAG, apply a 0.1-ms time marker signal, and adjust RV34 of PCB A4 so that the 1st and 9th peaks are aligned with the corresponding graticule lines.

(18) Adjustment of 5 ns, 2 ns, 1 ns COMPEN

For time base 50 ns, 20 ns, 10 ns/DIV x10 MAG (or 5 ns, 2 ns, 1 ns/DIV ranges), apply sine wave signal of 50 MHz, 100 MHz or 200 MHz, and adjust linearity and sweep time with RV8 and CV5 of PCB A5.

(19) Adjustment of ATT COMPEN Input Capacitance, and 1 mV COMPEN

Apply a 10-kHz pulse signal to each channel and adjust the ATT COMPEN and 1 mV COMPEN (CH1 and CH2) so that the displayed pulse wave rises up without overshoots or undershoots.

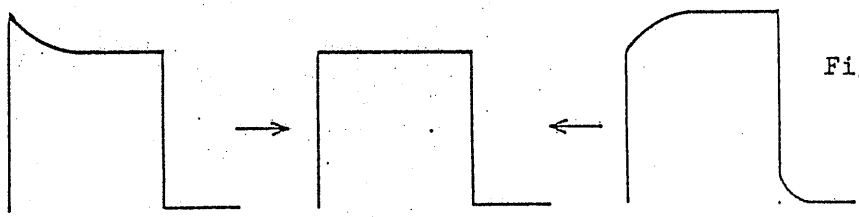


Figure 8.6
ATT COMPEN

	Adjustment of ATT COMPEN and INPUT Capacitances	
CH1, CH2	1/10 ATT (0.1 V/DIV)	1/100 ATT (1 V/DIV)
CH3, CH4	1/5 ATT (0.5 V/DIV)	

Using a capacitance meter, adjust the input capacitance of attenuator of each channel to the same value with that of the reference range (1/1 ATT).

(20) Adjustment of DVM COMPEN

Adjust the CH1 deflection factor to 10 mV/DIV, apply a pulse wave of 50 mVp-p and 1 MHz, and measure the signal of U21 PIN NO. 16 using another oscilloscope. Adjust RV19 of PCB A4 so that the pulse wave rises up without overshoots or undershoots.

(21) Adjustment of DVM GAIN

Set the CH1 sensitivity to 10 mV/DIV and set the DVM to the P-P mode. Apply a pulse signal of 50 mVp-p and 1 MHz to CH1 and adjust RV24 of PCB A4 so that the readout indicates "P50.00mV".

(22) Adjustment of Calibration Signal Voltage

Adjust RV1 of PCB A8 so that the voltage of the signal delivered to the CAL output terminal on the front panel of the oscilloscope becomes 0.5 Vp-p ±2%.

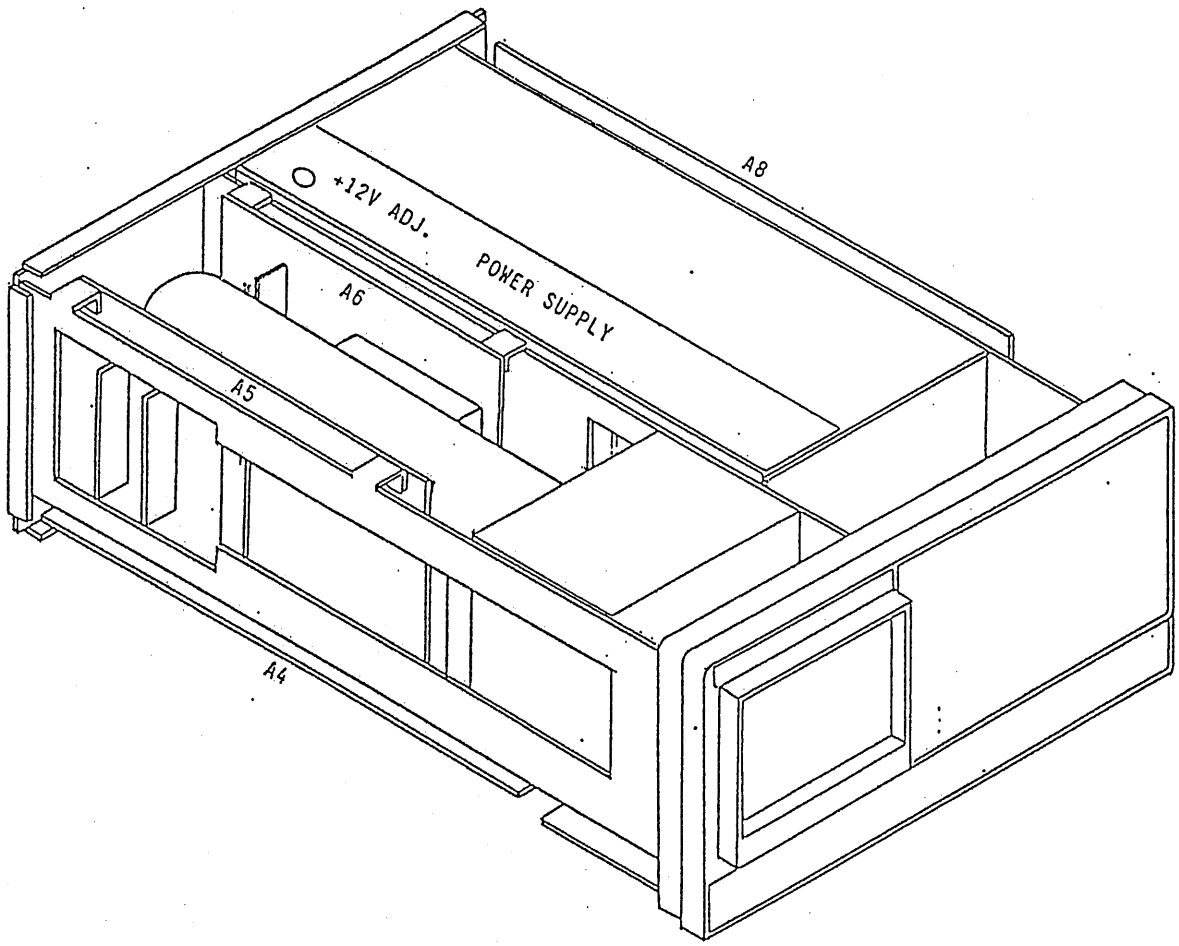


Figure 8.7 Locations of PCB's

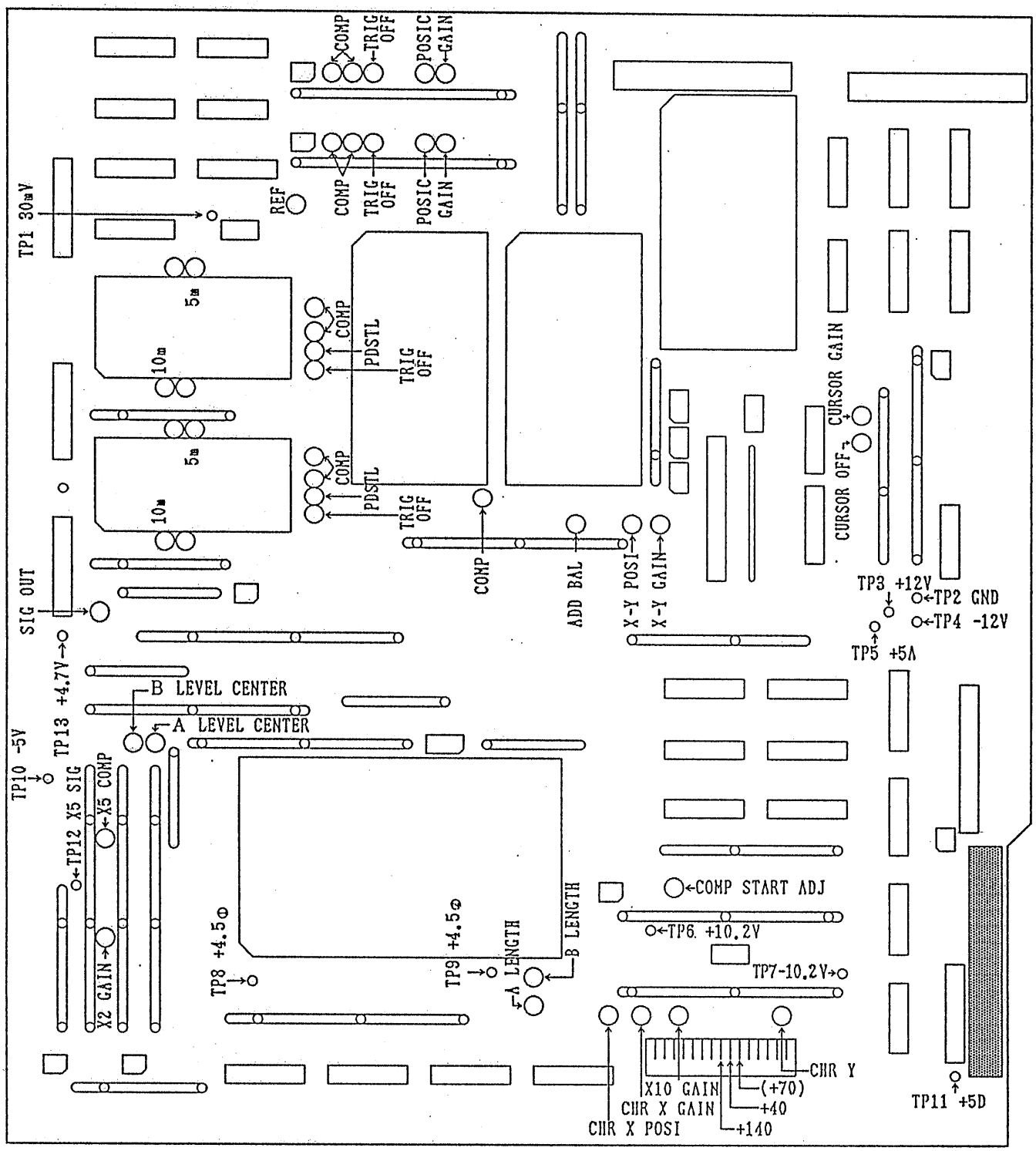
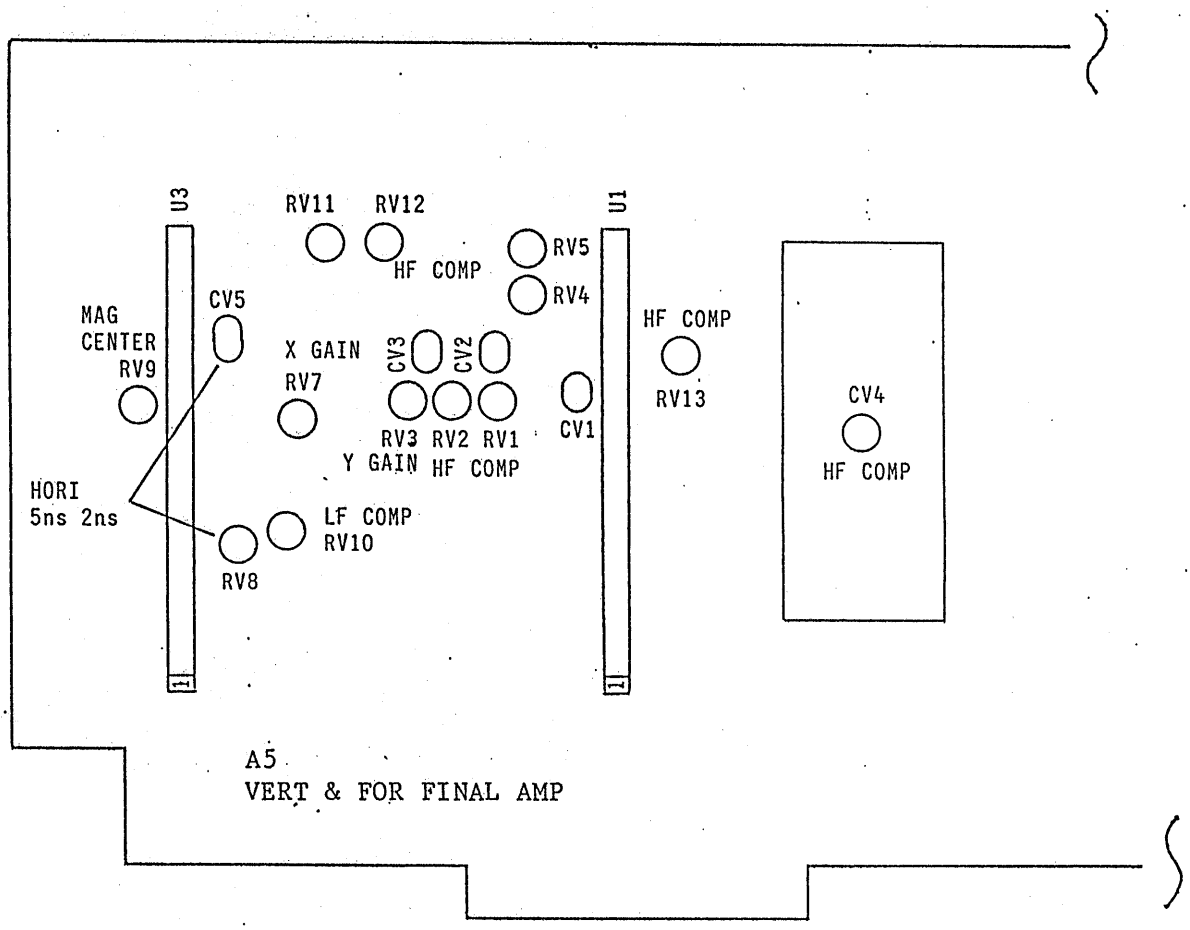


Figure 8.8 Layout of Controls on PCB A4



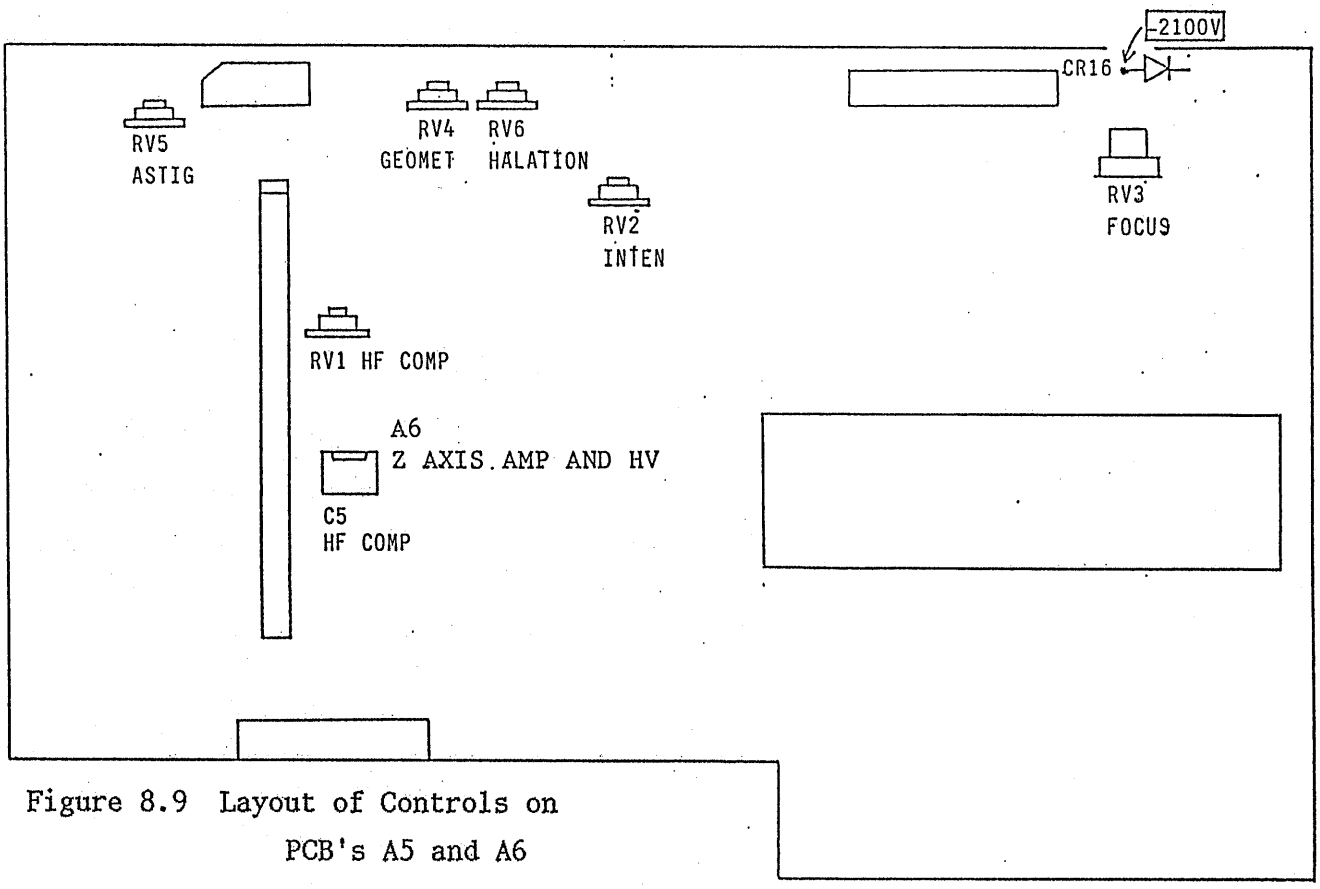
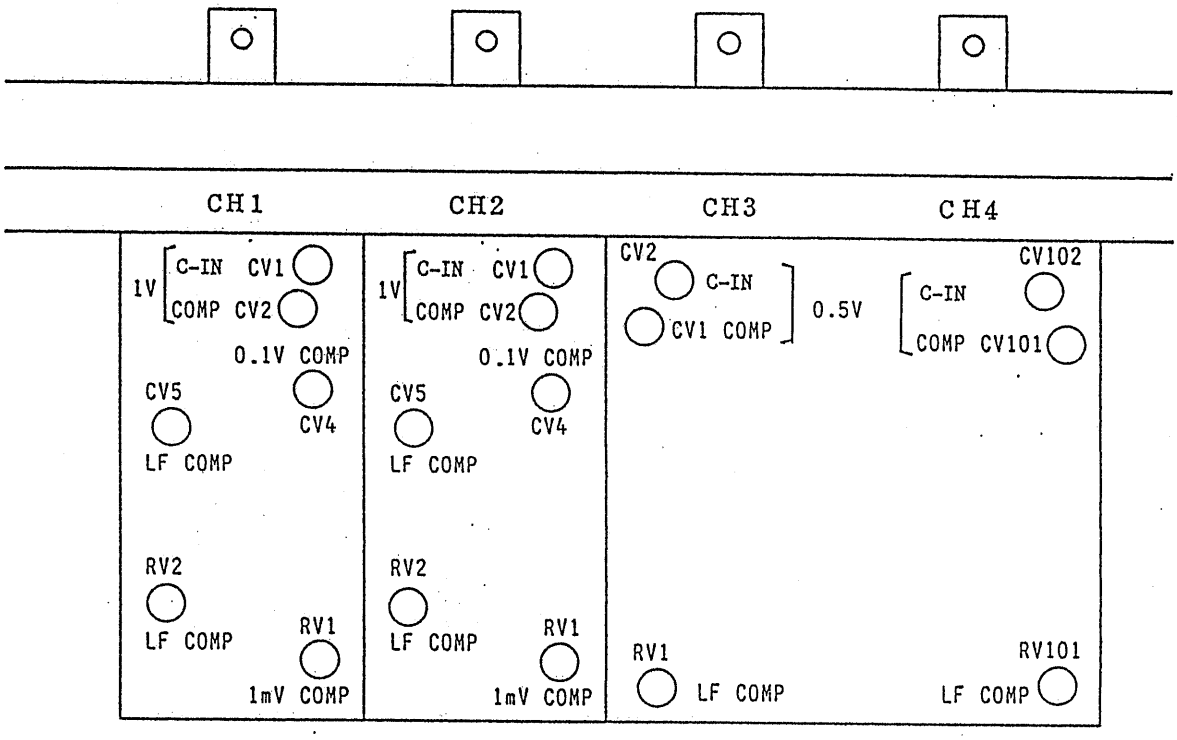


Figure 8.9 Layout of Controls on PCB's A5 and A6



C-IN: Input capacitor

Figure 8.10 Locations of Attenuator Controls

'90. 5. 31

9033323A