KENWOOD

PROGRAMMABLE DIGITAL
STORAGE OSCILLOSCOPE

DCS-8200

INSTRUCTION MANUAL

KENWOOD CORPORATION

 B63-0059-10(N)
16312

SAFETY

Simbol in This Manual

⚠ This symbol indicates where applicable cautionary or other imformation is to be found.

Power Source

This equipment operates from a power source that does not apply more than 250 V rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

Grounding the Product

This equipment is grounded through the grounding conductor of the power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting to the equipment input or output terminals.

Use the Proper Power Cord

Use only the power cord and connector specified for your product.

Use the Proper Fuse

To avoid fire hazard, use a fuse of the correct type.

Do not Operate in Explosive Atmospheres

To avoid explosion, do not operate this product in an explosive atmosphere.

Do not Remove Cover or Panel

To avoid personal injury, do not remove the cover or panel. Refer servicing to qualified personnel.

Voltage Conversion

If the power source is not applied to your product, contact your dealer. To avoid electrical shock, do not perform the voltage conversion.

* There are items in this manual that are indicated by a ⚠ mark.
  This mark is used to indicate items with which caution must be used to protect the safety of the customer using this instrument, and to prevent damage or destruction of the instrument.
  Please read the manual carefully, and use this instrument correctly.

CONTENTS

1. OUTLINE AND FEATURES

Because the DCS-8200 has a large capacity memory for each channel, even at the very low sampling time of 500s per division, continuous measurements on two channels simultaneo usly can be performed for 11 hours.

- 80-division pre-triggering that utilizes the advantages of the large capacity memory and 10,000-division post-triggering (delay triggering) are possible. Also, the values are converted into time units and displayed.

- It has an Auto Set function in which a knob on the panel is set automatically by a single button operation.

- With this machine alone, a program with as many as 20 steps can be executed, and full remote control is possible with the GP-IB.

- Video signals can also be stored with memory to spare, and with the large capacity memory, the before and after relations of the signals can be analyzed over a wide range.

- The waveforms of CH1 and CH2 can be displayed as a direct waveform by the 4-arithmetic operations (+, −, × and ÷). Also, by saving the CH1 and CH2 waveforms in the reference memory, the original waveform and the calculated waveform can be displayed on the screen at the same time.

- It is equipped with waveform processing functions such as averaging, envelope, sine interpolation, linear interpolation, etc.

- After the single sweep hold, there is a time stamp function that can record the sweep time.

- Besides, of course, data transmission, the GP-IB interface and RS-232C plotter interface, that can be operated from the panel, are standard equipment.

- X-axis/Y-axis output that can be used with your pen recorder is provided.

- For very small portions that are difficult to observe with the digital oscilloscope, this instrument can be used as a real-time or a programmable oscilloscope.

- Because of the newly developed original gate array used in the readout section and logic section of the A/D converter unit, the reliability is increased, and miniaturization is achieved.

2. SPECIFICATIONS

【Real-Time section】

CRT

Type	: 150 mm rectanguler with internal graticule
Acceleration voltage	: 12 kV
Effective Surface	: 8×10 div (1 div = 10 mm)

Vertical Axis (CH1 and CH2)

Sensitivity	: 1 to 5 mV/div ±3 %
Attenuator	: 1 to 5 mV/div 1-2-5 step, 5 ranges
Input impedance	: 1 MΩ±1 %, 22pF ± 3pF
Freq. responce	: DC: DC to 50 MHz -3dB (5mV to 5V/div) DC to 5 MHz -3dB (1 to 2mV/div) AC: 5 Hz to 50 MHz -3dB (5mV to 5V/div) 5 Hz to 5 MHz -3dB (1 to 2mV/div)
Rise time	: 7 ns or less (50MHz)
Operation modes	: CH1, CH2, ALT, CHOP, ADD (CH1+CH2)
CHOP frequency	: Approx. 250 kHz
Channel polarity	: Possible only with CH2
⚠Max. input voltage	: 800Vp-p, or 400V (DC+AC peak)

Horizontal axis (CH2 input, except for ×10 magnification)

Operation modes	: Switchable to X-Y mode with horizontal mode, CH1: Y-axis CH2: X-axis
Sensitivity	: Same as vertical axis (CH2)
Input impedance	: Same as vertical axis (CH2)
Freq. responce	: DC: DC to 1 MHz (-3dB) AC: AC to 1MHz (-3dB)
X-Y phase difference	: 3° or less at 100 kHz
⚠Max. input voltage	: Same as vertical axis (CH2)

Sweep

Sweep system	: NORM, AUTO, SINGLE
Sweep time	: 0.5s/div to 0.1μs/div ±3 %, 1-2-5 step, 21 ranges
Sweep magnification	: 10 times ±5 % (real-time only)
Linearity	: ±3 % (×10MAG : ±5 %)

Triggering

Internal trigger	: CH1, CH2, LINE
External trigger	: EXT
External trigger input impedance	: 1 MΩ
⚠Max. external trigger input voltage	: 800Vp-p, or 400V (DC+AC peak)
Trigger coupling	: AC, $HF_{REJ.}$, DC, TV-FRAME, TV-LINE

Trigger sensitivity :

	Frequency Range	Internal	External
DC	DC to 10 MHz	1 div	0.1 Vp-p
	DC to 50 MHz	2 div	0.2 Vp-p
AC	10 Hz to 10 MHz	1 div	0.1 Vp-p
	10 Hz to 50 MHz	2 div	0.2 Vp-p
HFrej	Increased minimum sync amplitude for above 10kHz.		
TV	FRAME, LINE	1 div	0.1 Vp-p

AUTO : Same as above specification for above 50Hz.
FIX : Same as above specification for above 40Hz.

Calibration voltage : Square wave, positive polarity, 1 Vp-p ±2 %, 1 kHz ±3 %

【Storage section】

Vertical resolution

Data length : 8-bit (25 dot/div)
Dynamic range : Approx. 10 div

Freq. responce

Effective storage frequency : DC: DC to 8 MHz, (sin interpolation)
AC: 5 Hz to 8 MHz, (sin interpolation)
Equivalent sampling : DC: DC to 50 MHz
AC: 5Hz to 50 MHz

Rise time

Effective rise time : 80 ns or less

Memory capacity

NORM	: Display memory (including REF memory)	2KW × 2/CH (200 dot/div)
	Acquisition memory	16KW/CH
	REF memory	16KW/CH
Equivalent sampling	: Display memory (including REF memory)	2KW × 2/CH (200 dot/div)
	Acquisition memory	2KW/CH
	REF memory	2KW/CH
Roll	: Display memory (including REF memory)	2KW × 2/CH (200 dot/div)
	Acquisition memory	16KW/CH
	REF memory	16KW/CH
Averaging	: Display memory (including REF memory)	2KW/CH (200 dot/div)
	Acquisition memory	5KW/CH
X-Y	: Display memory (including REF memory)	2KW/CH (200 dot/div)
	Acquisition memory	2KW/CH
	REF memory	2KW/CH

REF memory data backup (32KW) :
System : Capacitance system
Life : 7 days or more

Sweep time

Equivalent sampling : 20 ns/div to 5μs/div
NORM : 0.1 μs/div to 100 ms/div (0.1 μs/div to 5μs/div is magnification range).
Roll : 0.2s/div to 500s/div
* Max. sampling speed is 20 MS/s, 2-channel sync.

Storage system

NORM : Data updated for every trigger input
SINGLE : Single sweep write
AVERAGE : 2 to 256 times, average of adding (2, 4, 8...256)

PEAK DETECTOR : 100 ns glitch detection
Effective sweep range (500s/div to 0.1ms/div)
ROLL : Data is recorded on screen continuously and updated.
Equivalent sampling : Sequential sampling system

Magnification and reduction

Magnification and reduction are performed centered on the CRT with SWEEP TIME/DIV control (when the starting point is set at the left edge of the screen.).

Magnification : Max. 100×
Reduction : Max. ×1/10

Interpolation

Systems : Linear interpolation, sin interpolation

Trigger delay

Pre-trigger : Up to -80 times of SWEEP TIME/DIV setting (integer times setting)
Post-trigger : Up to +10,000 times of SWEEP TIME/DIV setting (integer times setting)

X-Y

NORM : DC to 800 kHz
Equivalent Sampling : DC to 50 MHz

PEN OUT

Output : CRT display and hard copy (25 KW)
Y axis Output voltage, 0.5V/div
Output impedance, approx. 2kΩ
Readout speed, 10ms/word and 50ms/word
X axis Output voltage, 0.5v/div
Output impedance, approx. 2kΩ
Readout speed, 10ms/word and 50ms/word

PEN DOWN

Output level : TTL level ("L" during operation)

Waveform operation

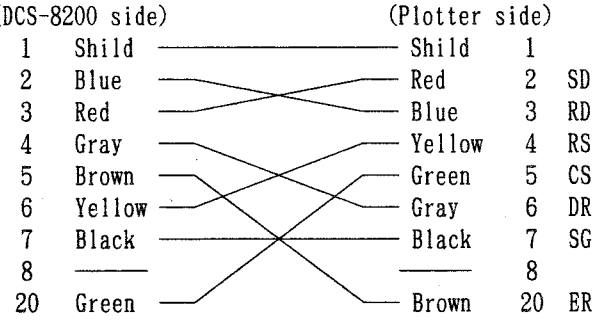
CH1 + CH2, CH1 − CH2, CH1 × CH2, CH1 ÷ CH2

Plotter output

Output : RS-232C, HP-GL command (made by Muto Industries, for HP-GL plotter), for CRT hard copy, data transmission only.
Baud rate : 9600, 4800, 2400 and 1200 bps.
Transfer system : Data length 8-bit, no parity, stop bit is 2-bit fixed, hardware-hand shake.
Signals : FG (Frame Ground)

SD (Send Data)	→ plotter
RD (Receive data)	← plotter
RS (Request to send)	→ plotter
CS (Clear to Send)	← plotter
DR (Data Set Ready) Request to send from plotter	← plotter
ER (Data Terminal Ready) Permission to send from plotter	→ plotter
SG (Signal Ground)	

Connections : (DCS-8200 side) (Plotter side)



【Readout section】

Calendar

Calendar display : Year, month, day, O'clock and minute (set with panel switch)
Clock accuracy : ±2 min./month
Battery life : approx. 30,000 hours

Setting values

Displays ●CH1/CH2 Scale Factor (with probe detector) ●GND ●V-UNCAL ●CH2 INVERT
●Sweep Scale Factor (MAG conversion) ●H-UNCAL ●Four operations (+, −, ×, ÷)
●Scroll Address ●AVG times setting ●Trigger Point (Post-trigger, Pre-trigger)
●EQU ●ROLL ●AUTO SET setting ●Program Steps ●REF Memory Condition Setting
●Trigger Time ●PEAK DETECTOR Setting

Cursor

Cursor mode

ΔV1 : Voltage difference between ΔREF and ΔCURSOR due to CH1 scale factor
ΔV2 : Voltage difference between ΔREF and ΔCURSOR due to CH2 scale factor
ΔT : Time difference between ΔREF and ΔCURSOR due to sweep scale factor
1/ΔT : Frequency between ΔREF and ΔCURSOR due to sweep scale factor
RATIO : Voltage ratio and time ratio between ΔREF and Δcursors, supposing 5-division on the CRT as 100%
PHASE : Phase difference between ΔREF and Δcursors, supposing 5-division on the CRT as 360°
TRACKING : Move ΔREF CURSOR and ΔCURSOR in parallel.

Cursor measurment

Measurment accuracy ±2 %
Measuring range Vertical direction : ±3.6 div or more from center of CRT
Horizontal direction : ±4.6 div or more from center of CRT

【Other functions】

Program

Program range :
CURSORS, VERT MODE, VOLTS/DIV, ▲▼ POSITION, AC/DC, GND, ◀▶ POSITION, SWEEP TIME/DIV, ×10MAG/EQU, HORIZONTAL MODE, TRIGGERING SLOP, TRIGGERING SOURCE, STORAGE, HOLD, PEAK, SINE, LINEAR, TRIG DLY, DISP.ADDR, AVG, REF DISP
No. of steps : Max. 20 steps

Auto Range

Vertical axis : 2, 4 and 6 divisions
Horizontal axis : 2 and 5 cycles

PEAK DETECTOR

MAX value display
MIN value display
MAX/MIN value display

【General specifications】

Power supply : AC 100, 120, 220, 240V ±10 % (Max. 250V) 50/60 Hz, approx. 75W
Dimensions : 319 mm wide ×132 mm high ×380 mm deep
Max. dimensions : 341 mm wide ×132 mm high ×442 mm deep
Weight : Approx. 11 kg
Specifications temperature and humidity:
10 to 35℃, not more than 85% humidity
Operation temperature and humidity:
0 to 40℃, not more than 85% humidity
Accessories : 1 instruction manual, 2 PC-33 probes, 1 power cord, 2 Replacement fuses.

【Interface unit】

GP-IB (Complies with IEEE Standard 488-1978).

Subsets SH1 : (Transmission handshake) all functions
AH1 : (Reception handshake) all functions
T5 : (Talker) Basic talker, serial pole, and talker only mode. Has talker release function with MLA.
TE0 : (Talker address extension) Does not have function.
L4 : (Listener) Basic listener. Has listener release function with MTA.
LE0 : (Listener address extension) Does not have function.
SR1 : (Service request) Has all functions
RL2 : (Remote/local) Has remote/local function. Does not have local lock out (LLO) function.
PP0 : (Parallel pole) Does not have function.
DC1 : (Device clear) Has all functions.
DT0 : (Device trigger) Does not have function
C0 : (Controller) Has no functions.
Delimiter : CR/LF and EOI
Data code : ASCII code and binary code

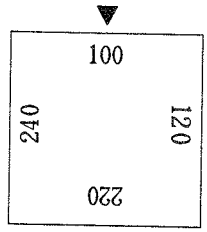
Status bytes

b8	b7	b6	b5	b4	b3	b2	b1
Extension Status	SRQ	Error	BUSY	Status Code			

(41H) Waveform write complete
(42H) Output finished
(61H) Command error
(62H) Command parameter error
(64H) Data error

3. PRECAUTIONS

1. Before using this instrument, be sure to check the power supply voltage. On the set's rear surface, on the left side of the AC input terminal, there is a fuse holder and voltage switch. The value that is aligned next to the arrow on the holder is the voltage setting.
   Changing the voltage that is used may cause trouble with the instrument, so please be careful. After this voltage has been verified, connect the power cord. If the power source voltage changes, refer to themaintenance items.



In this case,
the switch is
set to 100V.

2. Avoid conditions under the conditions shown below.
   ① Places subject to direct sunlight
   ② Rooms with high temperature and humidity
   ③ Rooms with strong mechanical vibration
   ④ Locations close to equipment which generates strong magnetic lines of force or impulse voltages.
   ⑤ Near locations where explosive gases are generated or stored.

3. Make sure that the voltages applied to each input terminal do not exceed the maximum input withstand voltage.
   ⚠ CH1 and CH2 input: 800V p-p or 400V (DC + AC peak)
   EXT TRIG : 800V p-p or 400V (DC + AC peak)
   Also, do not apply external voltages to output terminals.

4. Do not increase brightness beyond the required level.

5. Do not leave the instrument on for long periods of time with the brightness line adjusted to a spot.

6. Avoid placing objects on the set, because blocking the ventilation holes or fan vent holes may increase the temperature inside the set and cause trouble.

7. Do not insert items such as wires, pins, etc., in the case ventilation holes or rear panel fan ventilation holes.

8. High voltages are applied to the inside of the machine, so when the case is to be removed, refer to the maintenance items.

9. Before using this instrument, be sure to connect the ground terminal to an earth ground.

10. Because there is a READOUT detector terminal on the accessory PC-33 probe, it can be scratched by using it with other instruments, so avoid this.

11. The calendar and time displays were adjusted at the time of shipment, if there are errors at the time of purchase, please adjust them (Refer to maintenance and adjustment items).

12. The calendar, time and panel settings are backed up by an internal battery, and when the battery life nears the end of its life, a "Battery Down" display appears with the calendar and time display. Also, the rear panel settings cannot be maintained in the "Power Off" state, and the initial settings (see below) are returned to. In this case, the battery must be replaced, so please contact the Kenwood dealer from whom you purchased the instrument.

【Initial settings】

STORAGE	→ OFF (REAL state)
VERTICAL MODE	→ CH1
CH1 AC-DC	→ AC
H-MODE	→ AUTO
TRIG-SOURCE	→ CH1
TRIG-COUPLING	→ AC
TRIG-SLOP	→ +
CH1 VOLTS/DIV	→ 50MV/div
SWEEP TIME/DIV	→ 50μs/div

13. Please allow about 5 seconds between turning the POWER switch on and off. When the switch is turned on and off successively, the instrument may not operate properly. Also, due to noise from outside, inconsistencies may occur in panel settings, and in this case, turn off the power switch, and turn it on again after about 5 seconds. At this time, the settings will return to the initial settings or to the previous correct settings.

4. PANEL EXPLANATION

4-1 Front Panel

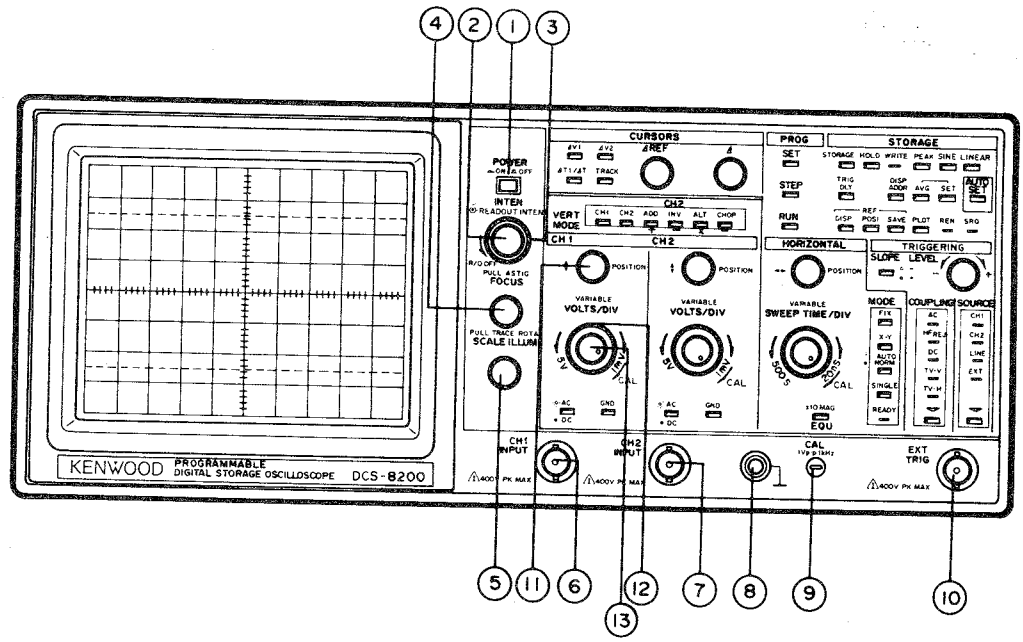


Fig. 1

① POWER ■ ON/ ■ OFF Switch

This is the power switch. When it is pushed in, the power supply is on, and when it is pushed again and released, the power is off.

② INTEN (REAL) Control

This is used to adjust the intensity of the trace line.
When it is turned clockwise, the brightness increases.

③ INTEN (READOUT) Control

This is used to adjust the intensity of the readout. When it is turned clockwise the brightness increases, and when it is turned counterclockwise the readout is turned off, and the characters disappear.

④ FOCUS/PULL ASTIG Control

FOCUS : This is the focus adjustment.

ASTIG : When the knob is pulled outward, the astigmatism of the trace or the spot can be adjusted. It is used to adjust both the focus and the waveform to their optimum appearance, and is adjusted so that the spot appears round.

⑤ SCALE/ILLUM/PULL TRACE ROTA Control

SCALE ILLUM : This is used to adjust the intensity of the scale on the CRT. When the photograph background light is too intense, halation occurs. In this case, adjust the intensity with this knob.

TRACE ROTA : This is used to adjust the slope of the horizontal trace line. Adjust this when the trace line slants due to the effect of ground magnetism, etc.

⑥ CH1 INPUT Terminal

This is the vertical axis input terminal of CH1. This is the input for the Y axis during the X-Y operation.

⑦ CH2 INPUT

This is the vertical axis input terminal of CH2. This is the input for the X axis during the X-Y operation.

⑧ ⏚ Ground Terminal/Binding Post

This is the instrument ground terminal.

⑨ CAL 1V p-p 1kHz

This outputs a 1V p-p, 1kHz positive square wave for calibration. Before using a probe, always calibrate it using this terminal. A probe that is not properly calibrated will not provide correct measurements.

⑩ EXT. TRIG Terminal

This is the input terminal for an external trigger signal.

To use external trigger, set the SOURCE switch to EXT and apply the external trigger signal to this terminal.

⑪ CH1 ▲▼ POSITION Control

This is used to adjust the vertical position of the CH1 waveform shown on the CRT. In the X-Y operation, this controls the position of the Y axis. In the storage mode RUN state (when the WRITE LED ㊲ is lit), this the CH1 DC OFFSET control, and controls the DC level of the input signal. When it is turned clockwise, the DC level is increased with respect to the GND level, and when turned counterclockwise, a negative DC level is added.

During HOLD, it is used to adjust the vertical position of the CH1 wave form shown on the CRT. When a REF wave form is displayed and the REF POSI LED ㊺ is lit, this control is used to adjust the vertical position of the CH1 waveform displayed on the CRT.

NOTE

When basic arithmetic operations are performed in the STORAGE mode, and then the HOLD state is entered, the vertical position is adjusted with the CH1 POSITION control.

⑫ CH1 VOLTS/DIV Control

The vertical sensitivity is adjusted by turning the knob of the CH1 vertical axis attenuator. This knob is used to adjust the sensitivity from 1V/div to 5V/div (when the READOUT PC-33 Probe is used, 10mV to 50V) in 1-2-5 steps.

When the VARIABLE ⑬ control is set to the CAL position, the calibrated vertical axis sensitivity is obtained. This is the Y axis control during the X-Y operation. Verify the vertical axis sensitivity with the CRT READOUT.

⑬ CH1 VARIABLE Control

This the CH1 vertical axis attenuation adjustment control. It provides continuous control over the VOLTS/DIV range. In its extreme clockwise CAL position, the attenuator is calibrated. In the X-Y operation, this is the Y axis attenuation adjustment control.

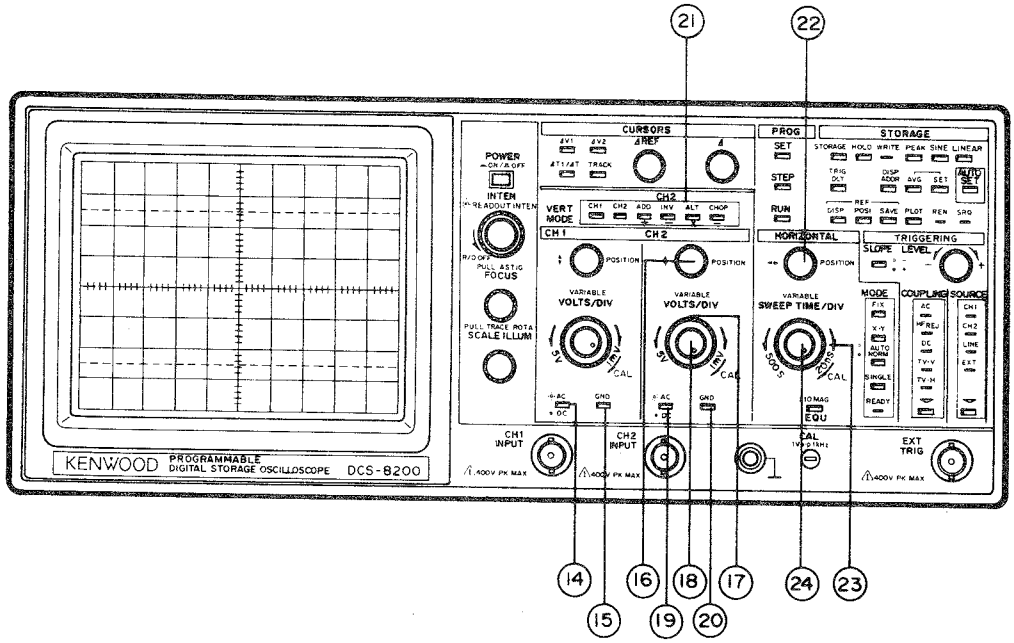


Fig. 2

⑭ CH1 AC/DC Switch

This is used the method of coupling of the CH1 vertical axis input signal, and serves as the Y axis input selector in the X-Y operation. When the switch is pressed, the LED lights, the input signal uses AC coupling, and the DC component of the signal is removed. When the switch is pressed again and released, the LED goes out, DC coupling is used for the input signal and the DC component of the signal can also be observed.

NOTE

When the GND LED ⑮ is lit, the input signal is isolated from the vertical amplifier, and the vertical amplifier input is grounded.

⑮ CH1 GND

When this switch is pressed, the input signal is isolated from the vertical amplifier, and the amplifier input is grounded, and the ground potential can be verified. When the switched is pressed again, the LED goes out and the CH1 input signal is connected to the vertical amplifier.

⑯ CH2 ▲▼ POSITION Control

This is used to adjust the vertical position of the CH2 waveform displayed on the screen. For CH2, the operation is the same as that of CH1 ▲▼ POSITION for CH1.

NOTE

- The X axis position in the X-Y operation is adjusted with ◀▶ POSITION ㉒.
- In the X-Y operation in the storage mode, the center of the CH2 ▲▼ POSITION becomes the center of the X axis.

⑰ CH2 VOLTS/DIV Control

This is the vertical attenuator for CH2. This operates the same as CH1 VOLTS/DIV ⑫ for CH1, and is the X axis attenuator in the X-Y operation.

⑱ CH2 VARIABLE

This is the vertical attenuation adjustment control for CH2. This operates the same as CH1 VARIABLE ⑬ for CH1, and is the X axis attenuation adjustment control in the X-Y operation.

⑲ CH2 AC/DC Switch

This is used in the method of coupling of the CH2 vertical axis input signal, and serves as the Y axis input selector in the X-Y operation. Its operation is the same as that of the CH1 AC/DC switch ⑭.

⑳ CH2 GND Switch

This is the ground switch for CH2. The operation is the same as that of the CH1 GND switch ⑮.

㉑ VERTICAL MODE (V-MODE) Switches

They are used to select the vertical axis operation mode. When a switch is pressed, the LED lights to indicate that this channel is selected. When a lighted switch is pressed again, the LED goes out, and the channel selection is cancelled.

CH1 : CH1 input signal is displayed on the CRT.

CH2 : CH2 input signal is displayed on the CRT.

ADD/+ : The algebraic sum of CH1 and CH2 signals is displayed on the CRT, but when the CH2 INV is set, the difference between CH1 and CH2 is displayed.

CH2 INV/−: When the switch is pressed, the LED lights, the polarity of the CH2 signal is reversed, and the normal state is restored.

NOTE

In the X-Y mode, the CH2 INV cannot be selected.

ALT/× : CH1 and CH2 signals are alternately displayed on the CRT.

CHOP/÷ : CH1 and CH2 signals are displayed on the CRT with the 250 kHz chopping system.

NOTE

Chopping is not activated in the single-trace mode. When switching from dual-trace to the single -trace mode, the CHOP LED goes out. It lights again, and chopping is activated when dual-trace operation is selected again.

The operations listed below can be operated in the storage mode.

CH1 : CH1 storage waveform is displayed on the CRT.

CH2 : CH2 storage waveform is displayed on the CRT.

ADD/+ : The CH1 and CH2 storage waveforms are added together and displayed on the screen, but when CH2 INV is set, the difference between CH1 and CH2 is displayed.

CH2 INV/−: CH2 storage waveform is subtracted from CH1 storage waveform, and the result is displayed on the CRT.

NOTE

CH2 INV cannot be set in the storage mode. The CH2 INV setting must be made in the Real-time mode.

ALT/× : The product of a multiplication operation of CH1 and CH storage waveforms is displayed on the CRT.

CHOP/÷ : The quotient of a division operation of CH1 and CH2 storage waveforms is displayed on the CRT.

NOTE

- In the arithmetic operations in the storage mode, make the calculations assuming that the level in the center of the CRT is 0.
- In the dual-trace mode, when switching from the trigger input standby state to the arithmetic operation mode, the switching can be activated from the following trigger signals.

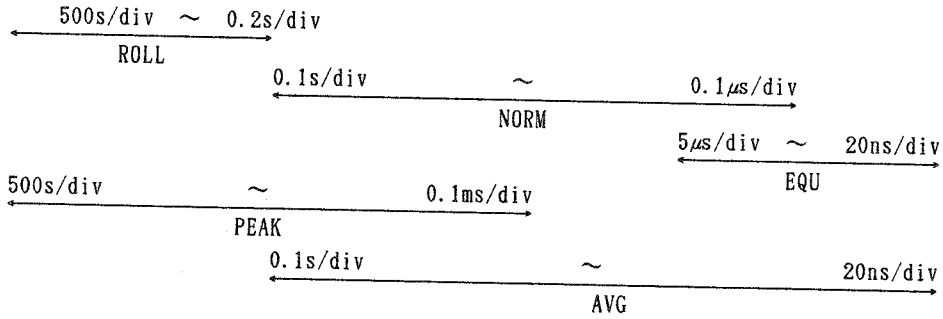
㉒ ◀▶ POSITION Control

This is the horizontal position adjustment control, and it can be used to shift the waveform in the horizontal direction. During the X-Y operation, it is the X axis horizontal position adjustment control.

㉓ SWEEP TIME/DIV Control

In the real-time mode, the sweep time can be switched from 0.5s/div to 0.1μs/div in steps of 1-2-5 in 21 ranges. In the extreme clockwise position of VARIABLE Control ㉔, the calibrated value is indicated. Verify the sweep time value with the READOUT display on the CRT. When the H-MODE ㉖ Control is set to X-Y, the SWEEP TIME /DIV display disappears, and X-Y is displayed.

The operations shown below can be performed in the storage mode.



ROLL mode : This mode is entered automatically when the SWEEP TIME/DIV Control ㉓ is set to 500s to 0.2s/div.

NOTE

When the V-MODE Control ㉑ is set for single-sweep, and HOLD is pressed, because the 2-channel sync. sampling system is used in the ROLL mode, the data of the channel that is not selected is rewritten.

NORMAL mode : This normal sampling mode is activated when the SWEEP TIME/DIV Control ㉓ is set to 0.1s to 0.1μs/div.

NOTE

Because the 5μs/div to 0.1s/div values are in the magnification range, the resolution is lowered, so if observation is difficult, use interpolation (SINE ㊴ or LINEAR ㊵).

EQUIVALENT SAMPLING mode: When SWEEP TIME/DIV Control ㉓ is set to 5μs/div to 0.1 μs/div, and the EQU ㉕ is pressed, the EQUIVALENT SAMPLING mode is activated. This mode is in the 5μs/div to 20ns/div sweep time range.

NOTE

When HOLD ㊱ is selected in the ROLL, NORMAL or EQUIVALENT SAMPLING modes, the magnification and reduction modes are activated, and to select other modes, the HOLD ㊱ must be cancelled.

PEAK mode : When the SWEEP TIME/DIV ㉓ Control is set to 500s/div to 0.1ms/div, and PEAK ㊳ is pressed, the peak detector mode is activated.

AVG mode : When the SWEEP TIME/DIV ㉓ Control is set to 0.1s/div to 20ns/div, and AVG ㊸ is pressed, the average detector mode is activated.

㉔ SWEEP VARIABLE Control

This is the fine adjustment control for the sweep time. It provides continuous control throughout the TIME SWEEP/DIV range. In the extreme clockwise CAL position, the sweep time can be calibrated, but in the storage mode (except for the EQUIVALENT SAMPLING mode), the calibration state is activated but adjustments cannot be made.

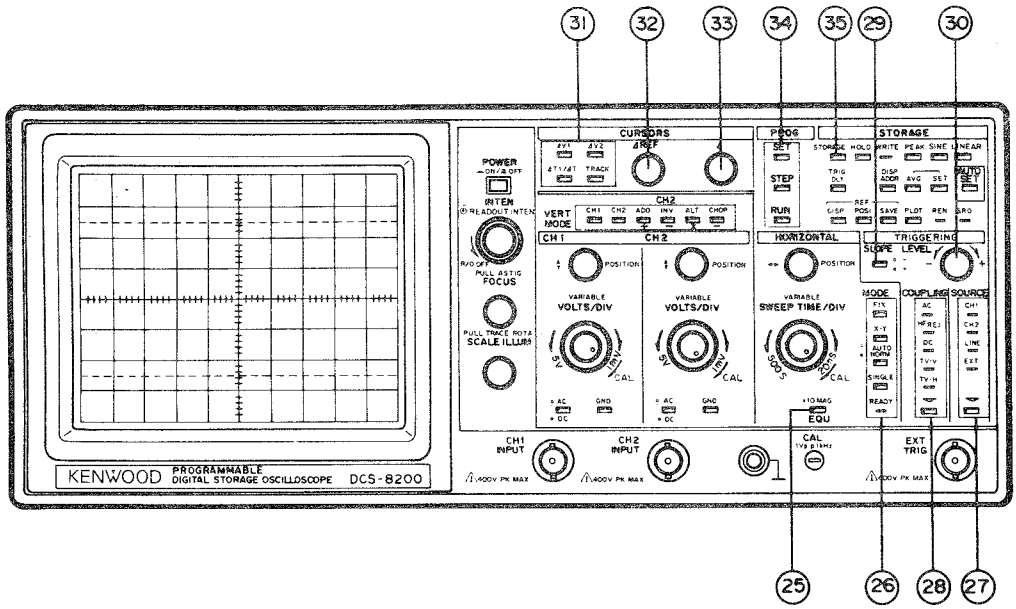


Fig. 3

㉕ ×10MAG/EQU Switch

Real-time mode: When the switch is pressed, the LED lights, and the sweep time can be made 10 times as fast. If the switch is pressed again, the LED goes out and the normal mode is returned to.

Storage mode : When the SWEEP TIME/DIV Control is set to 5 μs/div to 0.1 μs/div and this switch is pressed, the LED lights and the EQUIVALENT SAMPLING mode is activated. In this mode, the SWEEP TIME/DIV operates between 5 μs/div and 20ns/div.

When the switch is pressed again, and the LED is lit, or when the SWEEP TIME/DIV is in the 10μs/div range and the LED is lit, the NORMAL mode is activated.

NOTE

When HOLD ㊱ is selected, the mode cannot be switched from the EQUIVALENT SAMPLING to NORMAL, so the HOLD ㊱ must be cancelled to make this switch.

㉖ HORIZONTAL MODE (H-MODE) SWITCHES

FIX : When this switch is pressed, the LED lights and the trigger level becomes fixed. When the switch is pressed again, the LED goes out and the normal state is returned to.

X-Y : When this switch is pressed, the LED lights and the X-Y Oscilloscope operation is activated, in which CH1 is the Y axis and CH2 is the X axis. This X-Y operation has no relation to the setting of the vertical axis mode. When the switch is pressed again, the LED goes out and the dual-trace display is activated.

Because the capacity of the memory in the storage mode is 2 KW, the magnification and reduction of the HOLD cannot be performed.

AUTO/NORM : When this switch is pressed, the LED lights and the AUTO state is entered. Sweep can be performed with the trigger signal, but when there is no trigger signal, the sweep is free-running, and the bright line appears. When this switch is pressed again, the NORMAL state is returned to. The sweep can be performed with the trigger signal, but, unlike the AUTO state, if there is no suitable trigger signal, the trace line does not appear.

SINGLE : When this switch is pressed, the LED lights and the single-sweep operation is activated. This also serves as a reset switch during the single-sweep operation. When the single-sweep mode setting is released, press the AUTO/NORM switch to select the AUTO setting. In the STORAGE mode, the single-sweep trigger input time is displayed. When a trigger signal is input from the SINGLE-READY state, a "T" is displayed before the time display in the upper left part of the CRT, and the trigger signal time is displayed until either the SINGLE-READY state or the AUTO/NORM sweep is activated.

READY : When the SINGLE switch is pressed during the single-sweep operation, the LED lights, the READY state is in effect, and the LED remains lit until the sweep, is finished.

AUTO/NORM+SINGLE: When the AUTO/NORM and SINGLE switches are pressed at the same time, The LED lights, and the calendar and clock correction mode is in effect. When settings are made in this state, the original mode will be returned to automatically in about 5 seconds.

- Calendar and clock ON/OFF

  If the AUTO/NORM switch is pressed in the correction mode, if the calendar and clock are displayed, they will disappear, and if they are not displayed, the state in which they are displayed will be returned to.

- Calendar and clock correction

  If the SINGLE switch is pressed in the correction mode, the "month" portion of the calendar and clock display will flash.
  The "month" settings are made with the SWEEP TIME/DIV Control ㉓.
  When the SINGLE switch is pressed again, the flashing portion switches to the "Day" display, and the "day" settings can be performed with the SWEEP TIME/DIV Control ㉓.
  This operation is repeated until all the settings through the "minute" setting are made. Then, when the SINGLE switch is pressed again, the calendar and clock correction mode is finished, and the original mode is returned to.
  At this time, the minute units becomes 0 seconds.

NOTE

This cannot be performed when set to SINGLE sweep, so do it after changing the setting to AUTO sweep.

㉗ TRIGGERING SOURCE Switch

This is used to select the triggering source. When switch▽ is pressed, the selected LED moves downward in sequence, and after EXT. moves to CH1.

CH1 : The CH1 vertical input signal becomes the trigger signal.

CH2 : The CH2 vertical input signal becomes the trigger signal.

LINE : The triggering is synchronized with the commercial power source frequency.

NOTE

The COUPLING ㉘ is set to AC. If another signal source is selected, the previous state is returned to.

EXT : The signal applied to EXT. TRIGGER ⑩ becomes the sync. signal.

㉘ TRIGGERING COUPLING Switches

These are used to select the coupling mode of the trigger signal. When the ▽ switch is pressed, the selected LED moves downward in sequence, and after the TV-H, moves to AC.

AC : The trigger signal of the sweep is AC coupled, and the DC component is removed.

HFrej : The trigger signal of the sweep is coupled through a low-pass filter to the sync. circuit. Because the high frequency component is attenuated, the low frequency component can be triggered stably.

DC : The trigger signal of the sweep is DC coupled to the sync. circuit, and triggering in cludes the DC component.

TV-V : Triggered by the vertical sync. signal of the video signals.
TV-H : Triggered by the horizontal sync. signal of the video signals.

㉙ TRIGGERING SLOPE Switch

This is the sync. polarity selector switch for the sweep signal. When the switch is pressed, the LED lights, and triggering at the trailing edge of the input waveform is selected. When the switch is pressed again, the LED goes out, and triggering at the leading edge of the input waveform is selected.

㉚ TRIGGERING LEVEL Control

This is the triggering level control for the sweep. It is used to set a starting point for the sweep on the slope of the triggering signal waveform. If COUPLING Switch㉘ is set to TV, and the TV-H and H-MODE Switches ㉖ are set to FIX, triggering level adjustment is unnecessary.

㉛ CURSORS (CURSOR MODE) Switches

These are used to select the cursor measurement mode.
When the 3 LEDs are off, the cursor measurement mode is off. At this time, the cursor, cursor measured mode and cursor measurement value are not displayed on the CRT.
When the cursor measurement mode is set to off, pressing the LED that is lit (ΔV1, ΔV2, ΔT•1/ΔT) the LED to go out.

ΔV1 : Two cursors are displayed in the horizontal direction on the CRT, and the voltage difference and voltage ratio between these cursors are displayed in the upper right part of the screen following the cursor measurement mode.
When the CH1 VARIABLE Control ⑬ is in the CAL state, voltage measurements are made, and the value calculated according to the setting of the CH1 VOLTS/DIV Control ⑫ is displayed after the ΔV1.
When the CH1 VARIABLE Control ⑬ is in the UNCAL state, voltage ratio measurements are made, value calculated using the 5 div. 100% as a standard are displayed after the RATIO.
When the Δcursor is below the ΔREF cursor, a minus value is displayed.

NOTE

When the V-MODE Switches are set to CH-2, no selection can be made. When the setting is ADD, and the VOLTS/DIV of CH1 and CH2 are in the same range, voltage difference measurements are made, and when not in the same range, voltage ratio measurements are made.

ΔV2 : Two cursors are displayed in the horizontal direction on the CRT, and the voltage dif ference and voltage ratio between these cursors are displayed in the upper right part of the screen following the cursor measurement mode.
When the CH2 VARIABLE Control ⑱ is in the CAL state, voltage measurements are made, and the value calculated according to the setting of the CH2 VOLTS/DIV Control ⑰ is displayed after the ΔV2.
When the CH2 VARIABLE Control ⑱ is in the UNCAL state, voltage ratio measurements are made, value calculated using the 5 div. 100% as a standard are displayed after the RATIO.
When the Δcursor is below the ΔREF cursor, a minus value is displayed.

NOTE

① When the V-MODE Switches are set to CH1, no selection can be made. When the setting is ADD, and the VOLTS/DIV of CH1 and CH2 are in the same range, voltage difference measurements are made, and when not in the same range, voltage ratio measurements are made.
② When the H-MODE switches are set to X-Y, the X-axis measurements are performed.

ΔT・1/ΔT: Each time this switch is pressed, a ΔT → 1/ΔT → OFF → ΔT sequence is performed. Verify the cursor measurement mode with the CRT READOUT.

NOTE

When the H-MODE Switches ㉖ are set to X-Y, the ΔT side and 1/ΔT side measurements cannot be made.

ΔT : Two cursors are displayed in the horizontal direction on the CRT, and the time difference and time ratio between these cursors are displayed in the upper right part of the screen following the cursor measurement mode.
When the SWEEP VARIABLE Control ㉔ is in the CAL state, time difference measurements are made, and the value calculated according to the setting of the SWEEP TIME/DIV Control ㉓ is displayed after the ΔT.
When the SWEEP VARIABLE Control ㉔ is in the UNCAL state, time ratio measurements are made, and the value calculated using the 5 div. 100% as a standard is displayed after the RATIO.
When the Δcursor is on the left of the ΔREF cursor, a minus value is displayed.

1/ΔT : Two cursors are displayed in the horizontal direction on the CRT, and the frequency and phase difference between these cursors are displayed in the upper right part of the screen following the cursor measurement mode.
When the SWEEP VARIABLE Control ㉔ is in the CAL state, frequency measurements are made, and the value calculated according to the setting of the SWEEP TIME/DIV Control ㉓ is displayed after the ΔT.
When the SWEEP VARIABLE Control ㉔ is in the UNCAL state, phase difference measurements are made, and the value calculated using the 5 div. 360° as a standard is displayed after the PHASE.
When the Δcursor is on the left of the ΔREF cursor, a minus value is displayed. However, the absolute value of the frequency is displayed.

NOTE

With the 1/ΔT, when the 2 cursors come close together, and the measurement limit is exceeded, a "?" appears before the measured value, showing that the value is invalid.

TRACK : When the tracking switch is pressed, the LED lights, the tracking mode is activated, and when it is pressed again, the LED goes out and the normal mode is returned to. In the tracking mode, the ΔREF knob can be used to move the ΔREF and the Δcursor at the same time in parallel (The cursor measurement value remains as it is).
When either the ΔREF or the Δcursor is moved to the edge of the CRT, it cannot be moved any further. Also, the Δknob can be used to move the Δcursor independently (The cursor measured value changes).

ΔV1+ΔV2: In the storage mode when PEAK is in a position other than ON:
When ΔV1 and ΔV2 switches are pressed simultaneously, both LEDs light, AUTO SET mode and the constant setting mode are activated. When settings are not made in this state, the original mode is returned to after about 5 seconds. In the setting mode, a "MODE:VH V:2 H:2" display is show in the upper right part on the CRT, and when the ΔT・1/ΔT switch is pressed, the colon before the VH part of the display flashes. When the ΔREF Control ㉜ is turned counterclockwise, the display changes from VH to H to V.

VH: The vertical and horizontal range AUTO SET operation is activated.

H : The vertical range remains as it is and the horizontal AUTO SET operation only is activated.

V : The horizontal range remains as it is and the vertical AUTO SET operation only is activated.

When the ΔT・1/ΔT switch is pressed again, the flashing shifts to the colon before the

constant value of V. When the ΔREF Control ㉜ is turned clockwise, the display changes from 2 to 4 to 6. When set to 2, the AUTO SET operation is performed so that the vertical level of the input signal is in the 2 div., and the same is true with the 4 and 6 divisions.

When the ΔT•1/ΔT switch is pressed again, the flashing shifts to the colon before the constant value of H
When the ΔREF Control ㉜ is turned clockwise, the display changes from 2 to 5. When set to 2, the AUTO SET operation is performed so that the number of vertical peaks in the input signal becomes 2, and when set to 5, the number of peaks becomes 5.
When the ΔT•1/ΔT switch is pressed again, the AUTO SET setting mode ends, and the original mode is returned to.
In the storage mode when PEAK is ON:
When the ΔV1 and ΔV2 switches are pressed at the same time, both LEDs light, and the PEAK DETECTOR setting mode is activated. When settings are not made in this state, the original mode is returned to after about 5 seconds.
In the PEAK setting mode, a "PEAK:MAX/MIN" or "PEAK:MAX" or "PEAK:MIN" display is show in the upper left part on the CRT, and when the ΔT•1/Δ switch is pressed, the colon after the PEAK of the display flashes. When the ΔREF Control ㉜ is turned counterclockwise, the display changes from MAX/MIN to MIN to MAX.
When the ΔREF control ㉜ is turned clockwise, the display changes from MAX to MIN to MAX/MIN.

MAX/MIN : The maximum and minimum values of the waveform are displayed alternately for every sampling.
MIN : The minimum value of the waveform is displayed for every sampling.
MAX : The maximum value of the waveform is displayed for every sampling.

When the ΔT•1/ΔT switch is pressed, the PEAK DETECTOR setting mode ends and the original mode is returned to.

㉜ ΔREF control : This serves as the adjustment controls listed below, according to the function.

Cursor measurement: It becomes the movement adjustment control for the standard cursor with the fine dotted line displayed on the CRT. When the control is turned clockwise, the cursor moves up or to the right. When it is turned counterclockwise, it moves down or to the left.
Trigger delay : It becomes the coarse adjustment control for the delay time setting of the TRIG DLY switch ㊶.
Display address : It becomes the coarse adjustment control for the address setting of the DISP ADDR switch ㊷.
Average : It becomes the fine adjustment control for the average number of times setting of the AVG SET switch ㊸.
AUTO SET : It becomes the adjustment control for the mode selection and constant value setting of the AUTO SET switch ㊾.

㉝ Δcontrol : This serves as the adjustment controls listed below, according to the function.

Cursor measurement: It becomes the movement adjustment control for the measuring cursor with the coarse dotted line displayed on the CRT. When the control is turned clockwise, the cursor moves up or to the right. When it is turned counterclockwise, it moves down or to the left.
Trigger delay : It becomes the fine adjustment control for the delay time setting of the TRIG DLY switch ㊶.
Display address : It becomes the fine adjustment control for the address setting of the DISP ADDR switch ㊷.

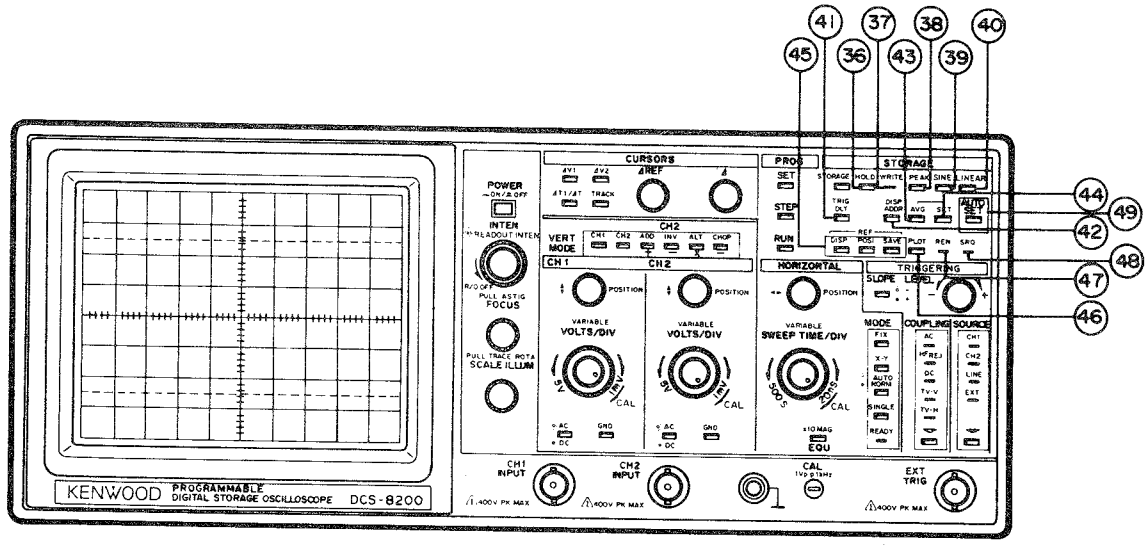


Fig. 4

㉞ PROGram Switches

SET : When the switch is pressed, the LED lights, and the program write mode is activated.
When the panel setting is performed to activate the write mode is performed, and the STEP switch is pressed, the setting details from the panel are written. When the write mode is activated, the CRT clock display disappears, and the "STEP-W1 RUN" or "STEP-W1 SKIP" display appears, then the panel surface is set with the programmed STEP 1 details. When the switch is pressed again, the LED goes out, and the program mode is finished.

STEP: When the PROG STEP switch is pressed in the program write mode, the panel setting details are written into that STEP No., the program moves to the next STEP No., and the panel is set with those details.
When this switch is pressed in the program run mode, the STEP No. moves to the next STEP No., and the panel surface is set with those details. When the switch is held down, the STEP No. advances continuously, the panel surface is set with those details, and when the switch is released, the panel surface is set with the STEP No. details.

RUN : When PROG SET LED is lit, the selection of whether the STEP No. is to be executed, or skipped is made.
And whenever the switch is pressed, the sequence is changed to RUN → SKIP → RUN.
When PROG SET LED is not lit, the LED lights when the RUN switch is pressed, and the program execution mode is activated. Every time the STEP switch is pressed, and the panel surface is set with the details of that STEP No. When the RUN switch is pressed again, the LED goes out and the program mode is finished.

㉟ STORAGE Switch

When the switch has been pressed and the LED is lit, the digital storage operation is performed. Writing into and reading from the memory is performed. When the WRITE LED ㊲ is lit, the write operation is in progress. When the knobs are turned during the write operation, a correct waveform may not be produced, so this should be avoided. When the switch is pressed again, the LED goes out, and this machine can be operated as a real-time oscilloscope. Writing into the memory cannot be performed at this time.

㊱ HOLD Switch

When the switch is pressed, and the LED is lit, the HOLd operation is activated. The storage waveform is only that of the read out operation, and writing into the memory cannot be performed. When the switch is pressed again, the LED goes out, and writing into or reading out from the memory can be performed, and the storage memory is normally updated.

NOTE

- In the HOLD position, VOLTS/DIV Controls ⑫ and ⑰ cannot be operated.
- When magnification is performed using the SWEEP TIME/DIV Control ㉓ in the HOLD operation, the center of the CRT becomes the magnification point.
- When the AUTO SET operation is performed in the real-time mode, the memory contents are cleared.

㊲ WRITE Switch

When the LED is lit, data is being write into the memory.

㊳ PEAK Switch

When the switch has been pressed and the LED is lit, the PEAK DETECTOR operation is activated.
With the contents selected in the PEAK mode, the maximum and minimum values of the sampling are displayed for each sampling. For setting methodas, refer to the ΔV1+ΔV2 items "when using STORAGE mode PEAK ON" on page 18 of the ㉛ CURSORS section.

NOTE

The PEAK mode can be used in the range of 500s/div to 0.1ms/div. When used outside this range, it in automatically released. In the HOLD mode, reduction (compression) and interpolation cannot be performed.

㊴ SINE Switch

When this switch has been pressed and the LED is lit, the sine interpolation operation is activated.
In the HOLD mode, when magnification (up to X 100) is performed using the SWEEP TIME/DIV Control ㉓, or when the 5 μs/div. to 0.1μs/div. magnification range is used, the horizontal resolution is decreased, and it becomes difficult to observe the waveform. In this case, the data during sampling can be increased by sine interpolation, and this makes it easily to observe the waveform by using the normal resolution.
When the switch is pressed again, the LED goes out, and the normal display is activated.

㊵ LINEAR Switch

When this switch has been pressed and the LED is lit, the linear interpolation operation is activated.
Using the same operation as that for SINE switch ㊴, the interpolation method becomes the linear interpolation.
When the switch is pressed again the LED goes out and the normal display is activated.

NOTE

- Because a choice must be made between the sine interpolation method and the linear interpolation method, when the SINE switch ㊴ is chosen and the LINEAR switch ㊵ is pressed, the SINE LED goes out and the LINEAR LED lights.
- Sine interpolation cannot be used when the H-MODE switch ㉖ is in the X-Y position.

㊶ TRIG DLY Switch

When this switch has been pressed and the LED is lit, the delay operation (pre-trigger and post-trigger) is activated, and the delay time from the trigger point is indicated by a "DELAY ×××" message in the upper right on the CRT. If a negative value delay time is set with the ΔREF Control ㉜ or the

ΔControl ㉝, the pre-trigger operation is activated, and the waveform can be observed before triggering occurs.
When the delay time is within the CRT setting (0 to -10div), the cursor is moved in the vertical direction, and the trigger point is displayed.
When a positive value is set, the post-trigger operation is activated, and the delay after the triggering starts can be performed. The delay time settings become the time settings for every division.
When the switch is pressed again the LED goes out and the normal operation is activated.

NOTE

When the setting of the DISP ADDR Switch ㊷ is a value other than "0" (in the range of the 5μs/div to the 0.1μs/div, when the address value is other than that of the regular address display that is adjusted to the magnification rate), and when magnification or reduction is performed in the HOLD mode, because the trigger point and the delay time of the waveform on the CRT are not the same, a "DELAY ? ×××" message is shown in the readout display.

㊷ DISP ADDR Switch

When this switch has been pressed and the LED is lit, the scrolling operation is activated, an "ADDR ××-×××" message appears, and the position of the 16KW memory that is being displayed is indicated. The ΔREF ㉜ is shifted to the portion that you wish to observe with the Δ㉝. When the switch is pressed again, the LED goes out and the address position is registered, and the memory contents at that position are displayed.

NOTE

After the waveform observation using the scrolling is finished, use a DISP ADDR setting between 0 and 2047 (in the range of the 5μs/div to the 0.1μs/div, use the value of the regular address display that is adjusted to the magnification rate). Method of Use.
When the TRIG DLY is used, using a DISP ADDR setting of other than "0" may cause the trigger point and the delay time to be different.

㊸ AVG Switch

When this switch has been pressed and the LED is lit, the scrolling operation is activated, an "AVG ××/××" message appears in the lower middle of the CRT, the average number of times and its setting value are displayed.
This used in the observation of a multi-sweep signal when random noise is included in the signal, to eliminate only the random noise and observe the waveform. When the switch is pressed again the LED goes out and the normal operation is activated.

NOTE

- When the H-MODE Switch ㉖ is set to SINGLE operation, the storage operation for the number of settings is performed, and the operation ends.
- During the averaging operation, the memory capacity is 5KW.

㊹ SET Switch

When the switch has been pressed and the LED is lit, the setting mode for the number of times of averaging is activated. An "AVG 1/××" display appears on the center of the CRT, and the number of times of averaging is set with the ΔREF control ㉜. There are 8 different settings : 2, 4, 8, 16, 32, 64, 128 and 256.
When the switch is pressed again, the LED goes out and the setting mode is ended.

㊺ REF Switches

DISP: When this switch is pressed the LED lights, and a reference waveform is displayed on the CRT. However, during the ROLL mode execution, the reference waveform can not be displayed, so display the reference waveform after placing the machine in the HOLD mode.

NOTE

- Because the reference waveform cannot be either enlarged or reduced, so save the reference signal with a suitable SWEEP TIME. After displaying the storage waveform and the reference waveform simultaneously, if the storage waveform is magnified, the reference waveform is displayed at 2KW from the DISP ADDRESS start address.
- Arithmetic operations cannot be performed for the reference waveform.
- When AVG ㊸ is performed, the reference waveform is cleared.

POSI: When this switch is pressed, the LED lights and the ▲▼ POSI ⑪ and ⑯ become the vertical position adjustment controls for the reference waveform.
When the switch is pressed again the LED goes out, and the ▲▼ POSI ⑪ and ⑯ revert to normal operation.

SAVE: When the DISP switch has been pressed and the LED is lit, when the SAVE switch is pressed the LED lights, the storage waveform of the CH1 or CH2 being displayed is saved in the reference memory. After it is saved, the LED goes out.

NOTE

The reference save cannot be performed in the magnification range of 5μs/div to 0.1 μs/div.

㊻ PLOT Switch

When HOLD ㊱ is in the hold mode, when the PLOT switch is pressed the LED lights, data output to the PEN OUT terminal or the RS-232C connector on the rear panel. When the output is finished, the LED goes out. If the switch is pressed again while the LEDS is lit, the data output is stopped and normal operation is resumed.
When the ANALOG/DIGI switch ㊶ on the back panel is set to ANALOG, the waveform displayed on the CRT becomes a bright spot display, so be sure to reduce the INTENSITY ② for this operation.

㊼ REN Switch

During GP-IB control, the LED is lit in the REMOTE state. Panel operation is not possible while this LED is lit.

㊽ SRQ Switch

During GP-IB control, the LED is lit when a service request is being output by this machine.
When the serial pole is finished, the LED goes out.

㊾ AUTO SET Switch

When this switch is pressed the LED lights, and a suitable range setting (VOLTS/DIV, SWEEP TIME/DIV) can be made for the input signal. When the range setting is finished the LED goes out, and the input signal is displayed on the CRT.
After AUTO SET is finished, set the input coupling switches ⑭ and ⑲ to AC, the H-MODE switches ㉖ to FIX and AUTO, and the TRIG COUPLING switch ㉘ to AC.

NOTE

- The frequencies that can be detected by AUTO SET are 50 Hz to 5 MHz (sine wave). An error sometimes occurs, depending on the shape of the input signal.

4-2 Rear Panel

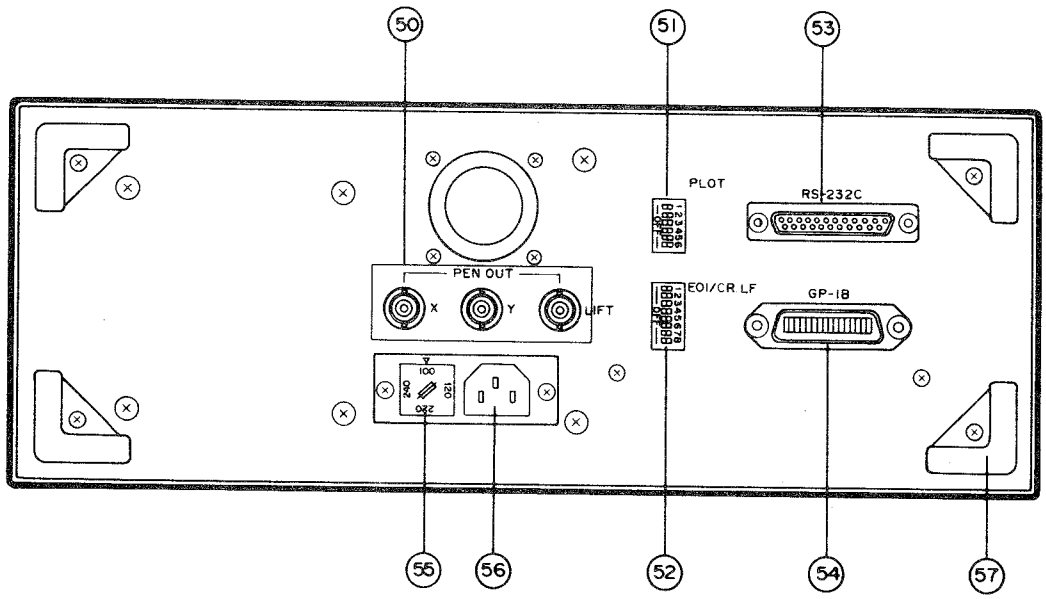


Fig. 5

⑤⓪ PEN OUT Terminal

Output terminal for the pen-recorder.

The storage waveform for the CRT is output from this terminal. (See the operating procedure items for details).

X : This is the output terminal for the X-Y recorder X axis sweep signal.
When H-MODE switch ㉖ is set to X-Y, the CH2 storage waveform is output.

Y : This is the output terminal for the pen recorder (X-Y) and the X-Y recorder Y axis. The storage waveform selected with the V-MODE switch ㉑ is output.

LIFT : This is the terminal that controls the up and down movement of the recorder pen. With the TTL level output, pen output is provided with the "L" level.

⑤① PLOT setting switch

This is the setting switch for the pen recorder and X-Y plotter.

ANALOG/DIGI. : This switch selects whether the output storage wave on the CRT is to output by the pen recorder or the X-Y plotter. When it is set to the ANALOG side, the PEN OUT ⑤⓪ output is performed. When it is set to the DIGI. side, the digital signal in response to the HP-GL command is output at the RS-232C terminal ⑤③.

10ms/50ms : This is used to select the readout speed of the storage waveform to PEN OUT ⑤⓪.
With the 10ms/word setting, the storage waveform readout for 1 channel takes 20.48 sec.
With the 50nms/word setting, it takes 102.4 sec. Use the setting that matches the response speed of the pen recorder.

9600
4800
2400
1200 bps : This is the setting switch for the baud rate to the X-Y plotter.
Set it to match the X-Y plotter.

⑫ GP-IB setting switch

This is used to make the settings of the delimiter, and the ADDRESS settings of this machine for GP-IB control.

EOI/CR.LF : This is used to select whether the delimiter setting is to be done with EOI or CR.LF. However, EOI detection is used even with the CR.LF setting when commands using binary data are employed.

5 ┐ : ADDRESS settings of this machine for GP-IB interface are made with binary data.
4 │
3 ADDRESS
2 │
1 ┘

NOTE

Because the delimiter and ADDRESS settings must be made with the power on, turn the power on to make changes in the settings.

⑬ RS-232C Connector

This is the interface connector used to connect the X-Y plotter.

⑭ GP-IB Connector

This is the GP-IB interface connector.

⑮ Fuse holder and voltage selector

For 100V and 120V sources, a 1.6A fuse is used, and for 200V and 240V, a 1A fuse is used. To change the power supply voltage selection, with the power cord removed from the outlet, change the setting to match the specified voltage. (See the maintenance items).

⑯ Power supply connector

This is the AC power supply input connector.

⑰ Power cord hooks

These are used to wind the power cord on for transportation or storage, and they also serve as legs for vertical installation.

4-3 Readouts

1 Display positions

The calendar, each scale factor, cursor measurement value, etc., are displayed on the CRT scales as shown in the figure below.

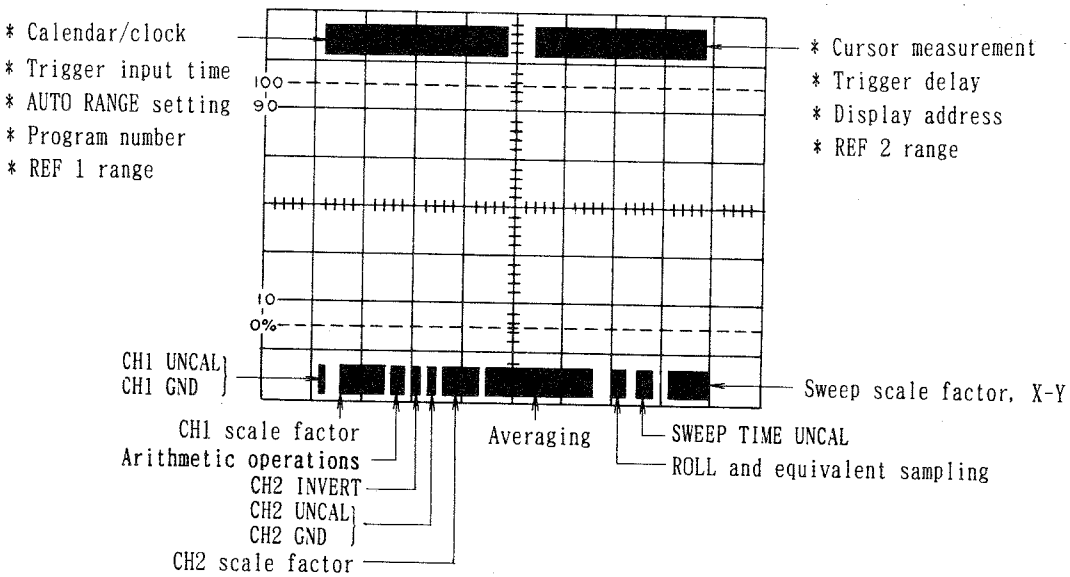


Fig. 6

2 Display functions

1) Calendar/clock

The calendar and clock are displayed in the sequence shown below.

Month - Day - Year O'clock : Minute

Month : JAN, FEB, MAR, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV, DEC

Day : 01 to 31

Year : 01 to 99 (last two digits of Christian year)

O'clock : 00 to 23

Minute : 00 to 59

2) Trigger input time

When using single-sweep display in the storage mode, enter a "T" before the time display to maintain the trigger input time.

Month - Day - Year T O'clock : Minute

3) AUTO range setting

Used to display the mode and constant in the AUTO SET mode.

"MODE : V V : 2 H : 2"

MODE : V, H, VH

V : 2, 4, 6 (div)

H : 2, 5 (cycle)

4) Program no.

Used to display the Step No. in the program mode.

"STEP-W 1 RUN"

Write mode : STEP-W
Execute mode : STEP-R
Step No. : 1 to 20
Step execution : RUN
Step skip : SKIP

5) REF 1 range

When the reference memory is displayed, the range at the CH1 memory save is displayed.

"REF 1 50mV 50ms"

6) Cursor measurements

The cursor mode and the cursor measurement values are displayed using a combination of operation knobs.

Cursor modes : ΔV1, ΔV2, ΔT, 1/ΔT, RATIO, PHASE
Cursor measurement values : The contents measured by the two cursors are displayed. With 1/ΔT, when the two cursors come near each other, and the measurement limit is exceeded, a "?" appears before the measured value, showing that the value is invalid.

7) Trigger delay

The pre-trigger and post-trigger delay times are displayed.

"DELAY" 0 μs"

Pre-trigger: DELAY −50μs
Post-trigger: DELAY +50μs

8) Display address

When the memory scrolling is performed, memory address display is also performed.

"ADDR 0-2047"

9) REF 2 range

When the reference memory is displayed, the range at the CH2 memory save is displayed.

"REF 2 50mV 50μs"

10) CH1 scale factor

The vertical axis sensitivity for 1div of CH1 is displayed.

With the UNCAL setting, a ">" is displayed before the CH1 vertical axis sensitivity display. However, when CH1 is grounded, a "⫫" is displayed, and in the UNCAL state, the ">" is not, displayed.

Also, when the AC/DC switch ⑭ of CH1 is set to AC, a "~" is displayed upper the unit of the vertical axis sensitivity display.

11) Arithmetic operations

According to the setting of the V-MODE switches ㉑, the four operations are displayed.

Real-time mode ADD : +
Storage mode algebraic sum : +
Storage mode algebraic difference : −
Storage mode algebraic product : ×
Storage mode algebraic quotient : ÷

12) CH2 INVERT

When the CH2 INVERT of the V-MODE switch ㉑ is selected, an arrow "↓" is displayed.

13) CH2 scale factor

The vertical axis sensitivity for 1div of CH2 is displayed.

With the UNCAL setting, a ">" is displayed before the CH2 vertical axis sensitivity display. However, when CH2 is grounded, a "⏚" is displayed, and in the UNCAL state, the ">" is not displayed.

Also, when the AC/DC switch ⑲ of CH2 is set to AC, a "~" is displayed upper the unit of the vertical axis sensitivity display.

14) Averaging

When the averaging operation and averaging setting mode, the number of times of averaging, and the number of settings, is displayed.

"AVG 1/256"

Number of times of averaging : 1 to 256

Number of settings : 2, 4, 8, 16, 32, 64, 128, 256

15) ROLL and equivalent sampling

In the ROLL and equivalent sampling modes, either R or E is displayed.

ROLL mode : R

Equivalent sampling mode : E

16) SWEEP scale factor

The sweep range is displayed using the SWEEP TIME/DIV Control ㉓.

When the sweep time is UNCAL, a ">" is displayed before the sweep range.

Note: In the real-time mode, when X-Y is selected with the H-MODE switch ㉖, the SWEEP scale factor goes out, and "X-Y" is displayed.

5. OPERATING PROCEDURES

Items

Preparations Before Operation

Before turning on the power supply, preset the controls as shown in the figure below. For details of the controls, refer to the "Panel Explanation". When a probe is to be used, refer to the instruction manual of the probe and the "Probe Calibration" of the (Maintenance and Adjustment) section in this manual.

INTEN ② ····· Center
R/O INTEN ③ ····· 3 o'clock position
FOCUS/ASTIG ④ ····· Center
ILLUM/ROTA ⑤ ····· PUSH/fully counter clockwise.
CH1, CH2, AC/DC ⑭, ⑲ ····· AC
VERT MODE ㉑ ····· CH1
VARIABLE ⑬, ⑱, ㉔ ····· Fully clockwise.
TRIGGERING SOURCE ㉗ ····· CH1
TRIGGERING COUPLING ㉘ ····· AC
TRIGGERING SLOPE ㉙ ····· +
H-MODE ㉖ ····· AUTO. and FIX not lit
TRIGGERING LEVEL ㉚ ····· Center
▲▼ POSITION ⑪, ⑯ ····· Center
◀▶ POSITION ㉒ ····· Center
X 10 MAG ㉕ ····· Not lit
Cursor mode ㉛ ····· None lit
STORAGE ㉟ ····· Not lit

[A] Normal Oscilloscope Operation

1 Normal sweep display

1) When the power switch is pressed, the power is turned on, and one of the LEDs on the panel is lit.

2) A trace line appears in the center of the CRT. If the trace line does not appear, make the setting shown below.

Adjust the CH1 vertical position.
Next, adjust the intensity of the trace line with the INTENSITY control, and the FOCUS and ASTIG as needed to make the line easy to observe.

3) Apply an input signal to the CH1 INPUT terminal adjust the CH1 VOLTS/DIV control to adjust the waveform to a suitable size.
When the VERT MODE switches is set to CH2, two channels, CH1 and CH2 are displayed. When the VERT MODE switch and the TRIG SOURCE are set to CH2, a signal is applied also to CH2, and the CH2 input signal is displayed on the CRT by the same operation as that for CH1.
When ADD is selected with the VERT MODE, a combined waveform of CH1 and CH2 is displayed on the CRT (the algebraic sum of CH1 and CH2), and when the CH2 INV switch is turned on in this state, the algebraic difference between CH1 and CH2 (CH1-CH2) is displayed. When the setting value of the VOLTS/DIV sensitivity during ADD is the same for both channels, the sensitivity is that VOLTS/DIV value.

4) When the waveform being observed moves, and cannot be synchronized, and you wish to move the trigger point, perform the following trigger operation.

Trigger operation

To observe the input waveform, you must trigger the SWEEP circuit correctly to stabilize the waveform. There are 3 ways to do this, triggering the sweep with the input signal being observed, applying a signal having a constant time relation to the input signal to another channel, and using it as the triggering signal, or triggering with a signal having the same frequency as the AC power supply.

① The Channel of the signal that is to be used as a trigger signal is selected with the SOURCE switch ㉗. By setting the SOURCE switch ㉗ to CH1, CH2 or EXT, the input signal of the trigger circuit becomes the input signal of the selected channel.
Also, when LINE is selected, the signal can be trigger with the frequency of the currently used AC power supply.

② After setting the SOURCE, the trigger point can be set by turning the TRIG LEVEL control ㉚.

③ Next, select the coupling with the COUPLING switches ㉘.

AC : Because AC (capacity) coupling is used, the DC component of the trigger signal is cut out, and the triggering is done with AC only. As a result, stable triggering without any relation with the DC component is achieved, and its use is convenient in this range. However, when the trigger signals are at frequencies of 20 Hz or lower, the trigger signal level is attenuated, and the triggering becomes difficult to apply, so use DC coupling.

HF_{REJ} : Because the trigger signal is supplied through a low-pass filter, the high frequency component (above 10kHz) is removed, and triggering is done with the low frequencies only. When much high frequency noise is overlapped in the trigger signal, the high frequency noise is eliminated, and the triggering becomes stable.

DC : A waveform including the DC component of the input signal, as an input signal, is input into the trigger circuit as it is. This is convenient for triggering with frequencies of 20 Hz or lower and lamp waveforms, etc., with low repetition or change like the DC.

TV-V : The trigger signal can synchronized with the vertical sync. signal of a video signal. At this time, it can be synchronized stably with no relation to the LEVEL switch ㉚. If the polarity of the synchronization pulse is negative, set the polarity of the SLOPE switch ㉙ to "−", and if the polarity is positive set the SLOPE ㉙ to "+".

TV-H : The trigger signal can synchronized with the horizontal sync. signal of a video signal. At this time, it can be synchronized stably with no relation to the LEVEL switch ㉚. If the polarity of the synchronization pulse is negative, set the polarity of the SLOPE switch ㉙ to "−", and if the polarity is positive set the SLOPE switch ㉙ to "+".

④ TRIG LEVEL

The trigger point setting of the waveform can be set with the LEVEL and SLOPE controls. Level of the trigger point shall be adjusted as necessity requires.

⑤ AUTO TRIGGER

When the H-MODE Switch ㉖ is set to AUTO, because the SWEEP circuit runs free when there is no trigger signal, this is convenient when checking ground levels. When a trigger signal is supplied, the trigger point can be set and observed with LEVEL and SLOPE controls, as it is with normal triggering. The sweep is free running when the trigger point is outside the triggering range, and the waveform is not stable.

NOTE

When AUTO SWEEP is used, and the input frequency signal is 50 Hz or lower, trigger cannot be achieved. In this case, use normal SWEEP.

⑥ Normal

The trigger point setting is done with the LEVEL and SLOPE controls, just like for AUTO triggering. This is used when the frequency of the input signal is 50 Hz or lower, and when observing the low repetition frequency.

NOTE

When the H-MODE is NORM, and there is no trigger signal, or when the trigger range is exceeded, the sweep stops, and the trace line does not appear.

⑦ FIX

By setting the H-MODE switch ㉖ to FIX, the complexity of the trigger level adjustment can be eliminated. The trigger point normally falls on the waveform in the area of its center.

With the H-MODE switch ㉖ set to NORM, when the trigger point is set to fall at one end or the other of the wave amplitude, when the input signal becomes small, the trigger point soon moves off the signal, and the sweep stops.

When the H-MODE switch ㉖ is set to FIX, even if the amplitude changes, the trigger level is usually set so that it falls near the center of the waveform, and the trigger functions regardless of its level.

Also, even if the waveform of the input signal suddenly changes from a square wave to a pulse wave, usually if the trigger level is not readjusted, the trigger point falls on the "-" side of the waveform.

Therefore, when the trigger point is preset to the "—" side of the square wave, and the input signal changes to a pulse wave, the trigger point may move off the waveform and cause the sweep to stop.

In this case, if the H-MODE Control ㉖ is set to FIX, the trigger point usually falls on the wave form near the crest value point, and stable waveform observation is possible.

⑧ SINGLE

This is used in the photographing operation when a single sweep is used with an aperiodic wave.

The H-MODE is set to AUTO or NORM, a signal having almost the same amplitude and frequency as the wave to be displayed is input as the trigger signal, and the trigger level is set. When the H-MODE is set to SINGLE, the READOUT display disappears.

When the SINGLE switch has been pushed, the READY LED lights, indicating that the signal standby status is activated.

This LED goes out when the sweep is finished.

When this check is finished, connect the signal that you wish to observe, set the READY mode to activate the signal standby state. When the trigger signal is applied, one sweep only is performed, and the LED goes out.

NOTE

When the V-MODE is set for multi-sweep, since simultaneous observation is not possible with the ALT setting, use the CHOP setting.

5) Set the SWEEP TIME/DIV Control ㉔ so that a suitable display appears. In this way, a normal sweep display is obtained.

2 Sweep magnification

When the time axis of part of the waveform is extended to observe it on the CRT, and the sweep time is made faster, the part of the waveform to be observed may move off the CRT screen. In this case,

the use of sweep magnification will enable waveform observation.
Adjust the ◀▶ POSITION Control ㉒ to move the portion you wish to observe to the center of the CRT. Next, by pressing the ×10MAG switch ㉕, the part to be observed will be magnified 10 times. The sweep time will be displayed on the CRT.

NOTE
Sweep magnification cannot be performed when the H-MODE switch ㉖ is set to "X-Y".

3 X-Y operation

By operating the machine as an X-Y oscilloscope, phase difference measurements, etc., can be made.
Set the H-MODE switch ㉖ to X-Y. CH2 will be displayed as the horizontal (X) axis, and CH1 as the vertical (Y) axis.
Y axis adjustments are made with the vertical positioning control of CH1, and the X axis adjustments with the horizontal positioning control.
The sensitivity during the X-Y operation is determined according to the VOLTS/DIV and VARIABLE settings for the X and Y channels.

4 Video signal observation

Triggering can be applied to the vertical or horizontal sync. signals of a video signal.

1) Input the video signal to be observed, and set the SLOPE according to the input signal.

2) When you wish to triggering to the vertical sync. signal of the video signal, set the COUPLING switch ㉘ to TV-V. and to triggering to the horizontal sync. signal , set the control to TV-H.

5 Single sweep

This is used to perform a single sweep of an aperiodic signal.

1) Set the H-MODE switch ㉖ to SINGLE. Input a signal having almost the same amplitude and frequency as the wave to be displayed as the trigger signal, and set the trigger level.

2) When the SINGLE switch has been pushed, the READY LED lights, indicating that the signal standby status is activated.
This LED goes out when the sweep is finished.

NOTE
When the V-MODE is set for multi-sweep, since simultaneous observation is not possible with the ALT setting, use the CHOP setting.

[B] Readout Display

1 Readout of set information

When the READOUT INTEN Control ③ is turned clockwise, setting information characters appear on the CRT. Adjust the brightness as needed. The setting information displayed consists of values shown in the "Panel Explanation" and "Readouts" items.

NOTE

When the calendar and clock diplays are turned off, they are not displayed on the CRT. For calendar and clock settings, see the maintenance and adjustment items.
When READOUT displays are made, a real-time waveform may be intensity-modulated. In this case, turning the R/O INTENSITY fully counterclockwise and turning the READOUT off.

2 Cursor measurements

When CURSOR measurements are made, the ON/OFF switching of the cursor measurement, and the switching of the cursor mode can be performed as follows with the CURSOR MODE switches ㉛
ΔV1, ΔV2, ΔT•1/ΔT

1) When making voltage difference measurements, set the cursor mode to ΔV1 or ΔV2, and the voltage difference measurements can be made for both CH1 and CH2 with two horizontal cursors.
The Δcursor and ΔREF cursor values are shown as+/− on the CRT.
When the VARIABLE of the measured channel is set to UNCAL, a voltage ratio (RATIO) assuming that 5 divisions = 100% is displayed.
When X-Y is selected in the H-MODE, and ΔV2 is also selected, the voltage difference is displayed with vertical cursors.

2) When making time difference measurements, set the cursor mode to ΔT, and the time difference measurements can be made for both CH1 and CH2 with two vertical cursors.
The Δcursor and ΔREF cursor values are shown as+/− on the CRT. Operate the ×10 MAG and the converted values will be displayed.
When the SWEEP VARIABLE of the measured channel is set to UNCAL, a time ratio (RATIO) assuming that 5 divisions = 100% is displayed.

3) When making frequency measurements, set the cursor mode to 1/ΔT, and the frequency measurements can be made for both CH1 and CH2 with two vertical cursors.
The Δcursor and ΔREF cursor values are shown as+/− on the CRT. Operate the ×10 MAG and the converted values will be displayed.
When the SWEEP VARIABLE of the measured channel is set to UNCAL, a phase difference (PHASE) assuming that 5 divisions = 360° is displayed.

4) The tracking operation is convenient for making comparative measurements of data corresponding to specified values, by operating the ΔREF cursor so that the Δcursor moves at the same time.
The ON/OFF of the tracking operation of the Δcursor and the ΔREF cursor is performed with the CURSOR TRACK switches ㉛.

5) Cursor operation
The ΔREF cursor ㉜ can perform the following operations, depending on the mode setting.

Cursor measuring	: The ΔREF cursor is moved.
STO TRIG DELAY	: The PRE div No. or POST div No. is changed.
STO DISP ADDR	: The DISPLAY ADDRESS is changed.
AVERAGE SET	: The No. of times of averaging is changed.
AUTO SET	: The AUTO SET mode and the of V and H setting value are changed.

The Δcursor ㉝ can perform the following operations, depending on the mode setting.

With the cursor on : The Δcursor is moved.
STO TRIG DELAY : The PRE div No. or POST div No. is changed.
STO DISP ADDR : The DISPLAY ADDRESS is changed.

When the ΔREF cursor and the Δcursor are turned clockwise, they move in the direction of increase, to the right and upward. When making the TRIG DELAY time settings and the DISP ADDR address settings, the ΔREF cursor is used to make the coarse settings, and the Δcursor to make the fine settings.

[C] Digital Storage Oscilloscope Operation

Operation as a digital storage oscilloscope is almost the same as that for operation as a normal real-time oscilloscope.

1 NORMAL sampling

1) Press the STORAGE switch ㉟ to activate the storage mode. When individual storage functions are not selected, NORMAL sampling is performed.

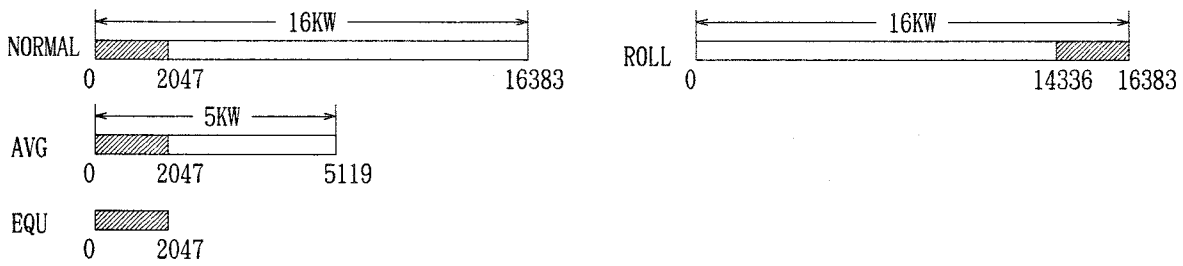
2) By making the same settings as those used for real-time operation, such as selection of channel to be observed, trigger source settings, synchronization operations, etc., digital conversions of the signals can be displayed on the CRT.

① HOLD

When observing the storage waveform, the updating of the waveform can be stopped by pressing the HOLD switch, and the immediately preceding input waveform data can be stored.
During the HOLD period, new signal data cannot be stored, and the data that is stored is displayed continuously. Vertical and horizontal positioning can be done also during the HOLD period.

② DISPLAY ADDRESS

In them normal sampling mode, the memory capacity is 16KW, and of this, the part shown on the CRT is 2KW. Therefore, this function is used to display data contained in memories outside the CRT.
When the DISP ADDR switch ㊷ is pressed, the position at which this 2KW portion of data is displayed can be adjusted with the ΔREF cursor or Δcursor.
AN "ADDR xxxx-xxxx" address is displayed on the CRT. When the DISP ADDR switch ㊷ is pressed again, and the LED goes out, the address value just before the setting is stored.



③ Single sweep

The single sweep setting can be made in the same way as in the real-time operation.
Use when you want to perform waveform observation of the single phenomenon, or waveform observation for each trigger.

2 Pre- and post-trigger

By selecting the TRIG DELAY, the triggering position of the signal to be stored can be set over a wide range.

1) Perform the selection of the channel to be observed, the trigger source setting, and the trigger level setting.

2)

① PRE TRIG

Set the required time ("DELAY-xxx") with the ΔREF cursor and the Δcursor.

Pre-triggering is the function in which the data just before the trigger point is stored and displayed only for the time set on the ΔREF cursor. With single and burst sweep, use the single sweep setting.

The setting range is 0 to -80 div (for time, the equivalent of 0 to -80 div). When the 0 to ,-10 div (CRT internal trigger point setting) setting is used, the trigger is displayed with the cursor.

② POST TRIG

Set the required time ("DELAY+xxx") with the ΔREF cursor and the Δcursor.

Post-triggering is the function in which the data just after the trigger point is stored and displayed only for the time set on the ΔREF cursor. With single and burst phenomena, use the single sweep setting.

The setting range is 0 to 10,000 div (for time, the equivalent of 0 to 10,000 div).

NOTE

When making the TRIG DELAY time setting, the coarse setting is made with the ΔREF cursor, and the fine setting with the Δcursor.

3 Equivalent sampling

With sweep having speeds of 5 μs/div or faster, data storage can be performed with the equivalent sampling method.

By using the equivalent sampling, high-speed repetition signals can be stored with maximum resolution with this machine.

1) Perform the selection of the channel to be observed, the trigger source setting, and the trugger level setting.

2) Set the SWEEP TIME/DIV control in the required range of 5 μs/div or higher.
Press the EQU switch ㉕.

3) The HOLD function is performed the same as it is for NORMAL sampling.

4 ROLL sweep

Data storage can be performed with ROLL sweep in the 0.2s/div range or below. Because the input signal can be converted to digital form and continuously displayed using the ROLL sweep, all the sweeps of the signal can be observed. Also, since the operation has no relation to the type of triggering, the trigger source selection is not required.

1) Select the channel to be observed.

2) Set the SWEEP TIME/DIV in the required range of 0.2s/div or lower.

3) The HOLD function is performed the same as it is for NORMAL sampling.

5 Peak detector mode

When a signal is being observed using a sweep time that is slow in comparison with the sweep frequency of the signal being observed, depending on conditions, aliasing (Note 1) occurs, which sometimes makes it impossible to obtain correct measurements.

Also, with low speed sweep, when there are spikes at least 1000 times as high as the main frequency being observed, there times when correct storage cannot be performed for the following reasons.

Because the horizontal direction data resolution of this machine is 2000 points, it is possible for spikes in a signal such as that described above to exceed the horizontal resolution. In this case, there is a chance that the data of spikes, etc., may not be displayed.

If a peak detector is used when observing these signals, aliasing is avoided, and if the spikes have a time width greater than the ratings of this machine, they can certainly be displayed.

1) Perform the selection of the channel to be observed, the trigger source setting, the trigger level setting and the SWEEP TIME/DIV (500s/div to 0.1ms/div) setting.

2) Press the PEAK switch ㊳.

3) Set the PEAK mode (MAX/MIN, MIN, MAX display). (For setting methodas, refer to the ΔV1+ΔV2 items "when using STORAGE mode PEAK ON" on page 18 of the ㉛ CURSORS section.)

4) Display the maximum and minimum values (Note 2) of the input signal.

If a high-frequency signal is observed at low sweep speed, the periphery of the signal is the envelop.

Note 1 Aliasing :

When a certain band of signals is sampled at intervals of 1/2 or less as long as those of the sampled signals, the frequency component of the signal being observed and the sampling period difference are composed, the difference components are displayed by the digital storage oscilloscope, and there are cases where correct observation cannot be performed.

Because the accuracy and stability of the conversion timing clock used for digital conversion in this machine is very high, when the frequency stability of the signal being observed is high, the waveforms that are composed above appear to be stable, and this may lead to observation errors in some cases.

Note 2 Maximum values (and minimum values) :

Maximum and minimum values are maximum and minimum values of the input signal that occur within 1 sampling time interval of the sweep time that is set.

6 Averaging

When there is random noise in the signal being observed, if it is a repetition signal, the algebraic average is taken every repetition, and inprove the signal to noise ratio can be attained.

With this machine, average value processing can be performed from 2 to 256 times.

1) Perform the selection of the channel to be observed, the trigger source setting, the trigger level setting and the SWEEP TIME/DIV setting.

2) Press the AVERAGE switch ㊸. The number of times setting for the averaging can be made with the SET switch ㊹ as needed.

3) The HOLD function is performed the same as it is for NORMAL sampling.

7 Interpolation functions

High-speed phenomena observation, which is needed for observation of signals above the highest resolution range (max. 10 μs/div), can be performed with high resolution by using equivalent sampling and repetition phenomena but equivalent sampling cannot be used with single phenomena or burst phenomena. Also, if the storage waveform is held, and magnified with SWEEP TIME/DIV, the horizontal resolution is lowered, and the waveform observation becomes difficult. In this case, data interpolation can be performed using the interpolation function to increase the resolution of low resolution data.

1) Perform the selection of the channel to be observed, the trigger source setting, the trigger level setting and the SWEEP TIME/DIV setting.

2) Select interpolation function ㊴ or ㊵.

① LINEAR interpolation

The intervals between sampling data is interpolated using the straight-line.

② SINE interpolation

The intervals between sampling data is interpolated using the function SINx/x. Physically, this is the equivalent of performing filtering with an ideal low-pass filter having a band 1/2 half that of the highest sampling frequency.

8 Reference memory operation

This machine, in addition to having a 16,000-word acquisition memory for each channel, also has a 16,000 -word reference memory for each channel. This reference memory can be used to retain the contents of the acquisition memory.

1) Perform the selection of the channel to be observed, the trigger source setting, the trigger level setting and the SWEEP TIME/DIV setting, and store the data.

2) Press HOLD switch ㊱ to hold the data.

3) Press the REF DISP switch ㊺ to display the REF waveform.

4) Next, when the SAVE switch ㊺ is pressed, the contents of the acquisition memory are copied as they are to the reference memory, transferred and stored (when the reference memory display is turned on with the REF DISP switch ㊺).

NOTE

Since the transfer of the acquisition memory contents is done only for the channel that is being displayed, it is necessary to select the channel with the data you wish to store in the reference memory with the VERT MODE switch ㉑, and display it. Disable the display of the channel in which you do not want to change the reference memory contents.

5) The ON/OFF setting for the reference memory display can be made with the REF DISP ㊺. Thus, the reference memory display and the acquisiton memory display of each channel can be observed at the same time.

6) When the REF POSI switch ㊺ is pressed, the reference memory vertical position can be adjusted by the ▲▼ POSITION of each channel.

9 Operation functions

This machine can perform operations between the channels that have been strage.

1) Perform the selection of the channel to be observed, the trigger source setting, the trigger level setting and the SWEEP TIME/DIV setting, and store the data.

2) The four arithmetic operations below can be performed by the selection of the V-MODE switch ㉑.

① + (ADD)

The storage waveforms of CH1 and CH2 can be added (CH1 + CH2) and displayed. When the CH2 INV is set, the results of CH1-CH2 are displayed.

② − (CH2 INV)

The CH2 storage waveform is subtracted from that of CH1 (CH1-CH2) and displayed.

③ × (ALT)

The storage waveforms of CH1 and CH2 are multiplied together (CH1×CH2) and displayed. The operation assumes that 1 div of the CRT screen has the value of 1.

④ ÷ (CHOP)

The storage waveform of CH1 is divided by that of CH2 (CH1/CH2) and displayed.

NOTE

The CH2 INV setting cannot be made in the storage mode. When the CH2 INV setting is performed, make the setting in the real-time mode.

NOTE

Because the 4 arithmetic operations are performed in the storage mode using center of the CRT as 0, in case division, when the CH2 data is in the center part of the CRT, the operation results may extend off the CRT.

10 Others

1) TRIG TIME STAMP function

With the single sweep in the storage mode, the trigger input time is displayed in the calendar display position. At that time, a "T" is displayed between the time and the month and day.

2) Storage X-Y operation

This machine can operate as an X-Y oscilloscope with the CH1 as the Y axis, and the CH2 as the X axis.

The H-MODE setting has no relation to the X-Y operation.

Unlike the X-Y of the real-time operation, when the TRIGGERING is not set, as in the NORM mode of storage, the WRITE operation is not performed, so use a TRIG setting that is suitable for the wave form observation.

NOTE

- In the storage X-Y mode, the memory capacity is 2KW, and the DISP ADDR is fixed at 0 to 2047.
- The HOLD magnification cannot be performed.
- When the X-Y mode is used with magnified range (5μs/div～0.1μs/div) the SWEEP TIME/DIV is changed automatically to 10μs/div.

[D] Programmable Oscilloscope Operation

1 Programmable WRITE

The panel setting state can be programmed. The program steps are from 1 to 20.

1) Press the PROG SET switch ㉞ to activate the program WRITE state.
A STEP-W1 RUN or a STEP-W1 SKIP message appears in the calendar display position on the CRT, and the panel details become the same ones that were set the previous time.

2) Connect a signal to the input terminal, and set channel that uses the V-MODE switch ㉑.
Perform the settings that are necessary for the waveform observation.

3) Press the PROG STEP switch to write the panel setting state. The setting contents are written in the address that is displayed. The program step number becomes 2.

4) Repeat sequences 2) and 3) as needed. Each time, the setting contents are written into the displayed address, and the step number increases by 1 each time.

5) After the required sequences are completed, press the PROG RUN switch. For example, if the write operation has been completed through Step 10, the CRT display will show,"STEP-W11-RUN". At this time, if PROG RUN is pressed, "STEP -W11- SKIP" will be displayed, and STEP 11 is SKIP will be set. In this SKIP setting state, if the PROG STEP switch is pressed, and Step 11 is written as a SKIP, and when it is read out, and the program will jump from STEP 10 to STEP 12.
If all the steps from STEP 11 to STEP 20 are set to SKIP, the program will return from STEP 10 to STEP 1.

6) Press the PROG SET switch to end the program write.
With this, the steps from STEP 1 to STEP 20 are written.

2 Program Readout

To read out the program that was written, perform the following procedure.

1) To read out the program that is set, press the PROG RUN switch.

2) "STEP-R1" is displayed in the calendar display position on the CRT, and the panel switches are in the programmed state.
Perform observations as needed in this state.

3) When the PROG STEP switch is pressed, the state written into STEP 2 becomes the panel setting. If this STEP is repeated, the step number increases by 1 each time. The step for which SKIP was written is jumped over, and the control moves to the next step.

4) After STEP 20, the program control returns to STP 1 and the above sequence is repeated.

NOTE

In the program readout mode, the panel settings can be changed, but the changed contents will not be stored.

[E] Pen Recorder and Plotter Output Methods

1 Analog pen recorder output

Before the output, verify the output setting (ANALOG setting) for the pen recorder with the DIP switch ㊶ on the rear panel. Now select the pen recorder speed (10ms/w, 50ms/w).

1) Perform the selection of the channel to be observed, the trigger source setting, the trigger level setting and the SWEEP TIME/DIV setting, and store the data.

2) Press the HOLD ㊱ to hold the data.

3) To start the output, verify the connection of the pen recorder to the PEN OUT BNC terminal on the rear panel of the machine. When the PLOT switch ㊻ is pressed, the output begins.

NOTE

Because the CRT display becomes a spot during the analog pen recorder output, reduce the intensity.

2 Digital plotter output

Before the output, verify the output setting (DIGI setting) for the digital plotter with the DIP switch ㊶ on the rear panel. Now select the according baud rate to the X-Y plotter.

1) Perform the selection of the channel to be observed, the trigger source setting, the trigger level setting and the SWEEP TIME/DIV setting, and store the data.

2) Press the HOLD ㊱ to hold the data.

3) To start the output, verify the connection of the digital plotter to the PLOTTER OUT (RS-232C) terminal on the rear panel of the machine. When the PLOT switch ㊻ is pressed, the output begins.

NOTE

Because electrical stress is occurs to this machine and the plotter when the plotter is connected and disconnected, be sure that the power supply switches of both are off before performing these operations.

[F] AUTO SET (Automatic Range Setting) Operation

1 AUTO SET (Auto Range setting)

When AUTO SET switch ㊾ is pressed, the range setting is made automatically according to the input.

NOTE

This function will not operate in the conditions shown below:

- When the H-MODE is set to SINGLE
- When TRIG-SOURCE is set to EXT
- During STORAGE-HOLD
- When STORAGE-EQU and ROLL are used.

1) Select the channel to be observed and make the trigger source selection. (Perform the SWEEP TIME/DIV and VOLTS/DIV settings as needed according to the mode).

2) When the AUTO SET switch ㊾ is pressed, the vertical range setting is made automatically. The horizontal range setting is performed automatically for the channel selected by the trigger source.

NOTE

When AUTO SET is performed, the panel settings are as shown below:
- Input coupling : AC
- POSITION : Center
- H-MODE : FIX, AUTO
- TRIG COUPLING : AC

3) The details of the AUTO SET settings can be changed.
The function that can be set is the AUTO SET mode.
VH : The AUTO SET operation is performed for the vertical and horizontal ranges.
H : The AUTO SET operation is performed for the horizontal range only.
V : The AUTO SET operation is performed for the vertical range only.
The peak value of V can be set to 2, 4 or 6, and the number of cycles of H can be set toeither 2, or 5.

① Press the cursor mode ΔV1 and ΔV2 switches at the same time.
Both LEDs light and the AUTO SET and No. of cycle setting mode are activated. (If settings are not made at this time, about 5 seconds later the normal mode will automatically be restored).

② In the setting mode, "MODE:VH V:2 H:2" is displayed in the upper left part of the CRT. If the ΔT•1/ΔT switch is pressed now, the ":" before the VH flashes. When the ΔREF control is turned counterclockwise, the "VH" display changes from "VH" to "H" to "V". If the ΔT•1/ΔT switch is pressed again, the flashing part changes to the ":" of "V:2". At this time, the mode is set.

③ Make the settings for the V (peak value) and H (No. of cycle) in the same way.

④ When the H (No. of cycle) setting is finished, and then the ΔT•1/ΔT switch is pressed, the control returns from the AUTO SET setting mode to the normal waveform observation mode.

NOTE

The range of the signals that can be set frequency is 50 Hz to 5 MHz and amplitude is 2mV to 40Vp-p with AUTO SET.
Also, there are cases in which waveform detection cannot be performed for waveforms with extreme duty ratios or waveforms with bad signal to noise ratios. In such cases, use the 50mV/div and 50μs/div range settings.

[G] External Control Operation With GP-IB

1 GP-IB control operation

By using a GP-IB interface, with the exception of the power switch and some functions around the CRT, this machine can perform control of settings, verification of setting states and external output of storage data that has been stored in the internal memory from the input terminal. With this machine, by programming the settings for data measurements, an environment in which the sequential collection of automatic measuring data is possible. Also, because better operations for the data that is collected can be performed by a computer, more efficient measuring can be performed.

1) Program your desired measurement sequence after referring to the (GP-IB) command reference of the instruction manual for this machine.

2) Enter the program into the controller equipped with the GP-IB driver. Also, verify the settings of the DIP switches, device address numbers and delimiter on the rear panel of this machine, and check the GP-IB cable connection.

3) Check whether or not the signal to be measured is connected to the input terminal of this machine. Execute the program.

NOTE

Because electrical stress is occurs to this machine and the computer when the GP-IB cable is connected and disconnected, be sure that both power supply switches are off before performing these operations.

NOTE

Because delimiter and device address settings are made with this machine's power supply on, turn on the power after changing settings.

NOTE

With GP-IB control, and the REN display interval set to remote, switches and controls on this panel, such as the intensity control, etc., that are not controlled by GP-IB, cannot be operated.

6. EXAMPLES OF APPLICATION

CONTENTS

3 Low frequency signal measurements
1) Long time measurements (Unattended measurements)
2) Roll mode
3) Peak detector applications
4 Repetition phenomena measurements
1) Extraction of signals hidden by noise
2) High-speed phenomena measurements
5 Waveform data relative measurements
1) Use of reference data
6 Data output
1) Plotter output
2) Pen output

[C] Programmable Oscilloscope Applications

1 Applications for fixed form measurements
1) Program function applications with a separate oscilloscope
2) Program function applications using GP-IB

Before actually starting the measurements, be sure that the calibrations shown below have been made.

【Probe Compensation】
To obtain accurate measurements using the probe, it is necessary to calibrate the probe properly.

【Trace rotation Compensation】
Of the bright line is slanted with respect to the horizontal scale, this can cause measurement errors.

For details of each calibration, refer to the description of calibration operations on the "Maintenance and ADjustment" pages.

[A] Examples of Applications Common to Real-time and Storage Oscilloscopes

1 Voltage measurements

1) DC voltage measurement methods
There are 2 kinds of measurement methods, the normal measurement method and the measurement method using the cursor.

a) Normal procedures
To measure the waveform DC level, perform the following operations.

① Connect a signal to the input terminal. Set the AC/DC switch to DC, and the V-MODE to use channel, and set each control for normal sweep.
Next, adjust the VOLTS/DIV and SWEEP TIME/DIV controls so that the waveform is easy to measure.
Set the VARIABLE to the CAL position.

② Set the H-MODE switch to AUTO, and the GND switch to ON. At this time, the trace line indicates the GND position (reference line).
Set the trace line to the reference line of the scale with the ▲▼ POSITION control. After the reference line is set, do not move the POSITION control.

③ Set AC/DC switch to DC. Reset the VOLTS/DIV and ▲▼ POSITION controls so that a waveform including the DC componets are displayed on the CRT.

④ Adjust the ◀▶ POSITION control so that the point to be measured falls on the vertical scale line in the center of the CRT.

⑤ Measure the vertical distance between the reference line and the measuring point. (The reference line is shown when the GND switch is on). The DC voltage is found by multiplying this vertical distance by the setting value of the VOLTS/DIV. If the waveform is above the reference line, the voltage is positive, and if it is below the reference line, the voltage is negative.

a) With measurements using the PC-33 probe or direct measurements
DC level = vertical distance (div) × VOLTS/DIV setting value

b) With measurements using the 10 : 1 probe
DC level = vertical distance (div) × VOLTS/DIV setting value × 10

b) Cursor measurement procedures

① Display the GND (ground) line using normal procedures item ① and ②.

② Set the cursor mode to the ΔV mode of the channel to be measured.

③ Adjust the ΔREF cursor (reference line) to the GND trace line.

④ Set the AC/DC switch to DC

⑤ Set the Δcursor to the position to be measured.

⑥ The measurement results are displayed following the Δ V1 or Δ V2 in the upper right of the CRT.

NOTE

When the accessory PC-33 probe is used, the measurement results including the attenuation ratio is displayed, but when a probe not that does not match the READOUT is used, the measurement results is multiplied by the attenuation ratio. When the Δcursor is below the ΔREF cursor, the voltage is negative, and "−" is displayed.

2) AC voltage measurements

a) Measuring the voltage between 2 points on the waveform

To measure the voltage between 2 points on the waveform, or the peak-to-peak voltage, a procedure the same as that of the DC voltage measuring method in 1) can be used.
Measure the distance between the 2 points, and multiply the result by the VOLTS/DIV setting value.
When the 10 : 1 probe is used, multiply the voltage found by 10.
Also for cursor measurement, set the ΔV1 or ΔV2 of the channel using the cursor mode, Align the ΔREF cursor with a point on the lower side of the signal to be measured, and align the Δcursor with a point on the other side. The measured result is displayed following the ΔV1 or ΔV2 in the upper right of the CRT.

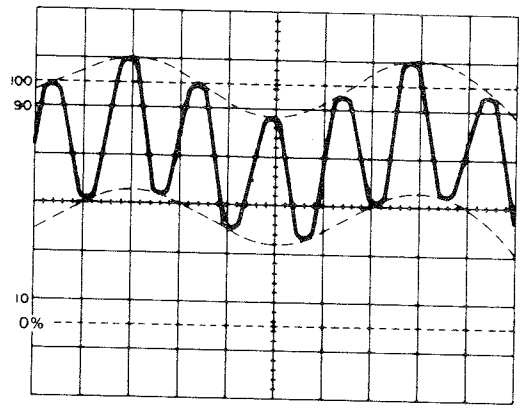
b) Elimination of undesired signal components

When the ADD mode is used, the undesired component of the signal is eliminated, and the display of the necessary components only can be performed (with the CH1 and CH2 ADD mode setting).

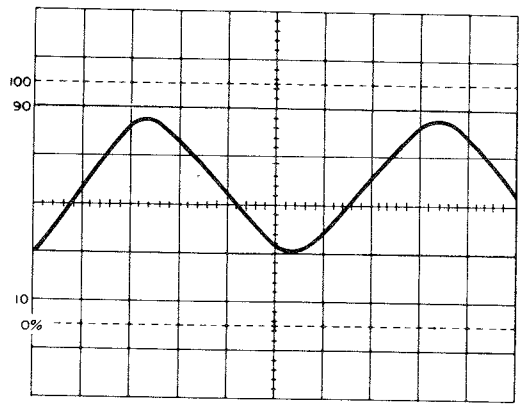
① Connect a signal, including the undesired component, to the CH1 INPUT. and connect a signal from which the undesired component has been removed to the CH2 INPUT.

② Set the V-MODE to CHOP, and the TRIG SOURCE to CH2, and verify that the CH2 input has an opposite waveform from that of the envelope of the undesired component.

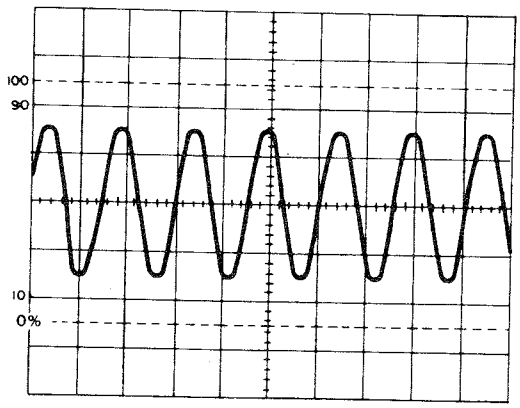
③ Set the V-MODE to CHOP, and the TRIG SOURCE to CH1, and adjust the CH2 VOLTS/DIV and VARIABLE for maximum elimination of the undesired component.



Signal Including the Undesired component (The dotted lines indicate the envelope of the undesired component).



Undesired Component Signal



Necessary Signal With the Unnecessary Component removed

Fig. 7

3) Voltage ratio measurements

a) Overshoot

The measurement of the overshoot, etc., of a square wave is performed in the following manner.

① Connect the signal to the INPUT terminal of CH1 and CH2.
In the channel using the V-MODE, set the AC/DC to DC (GND switch off), and adjust each control so that the ordinary sweep can be obtained.
Next, adjust the VOLTS/DIV and SWEEP TIME/DIV controls so that the waveform is easy to measure.

② Adjust the vertical axis (CH1, CH2) VARIABLE, and adjust the amplitude on the CRT to the 5div (0%, 100%) scale marker. Adjust the POSITION as needed.

NOTE

When the vertical axis is in the UNCAL state, the RATIO measurement is selected.

③ Select the desired cursor mode, ΔV1 or ΔV2, according to the channel to be used.

④ Align the ΔREF cursor to the 100% scale division.

⑤ Align the Δcursor to an overshoot to be measured.

⑥ Voltage ratio of overshoot supposing 5-division as 100% is displayed in percentage following the RATIO in the upper right of the CRT.

2 Time measurements

1) Time measurements

a) Normal procedures

① Connect a signal to the input terminal. In the channel that uses the V-MODE, set the AC/DC switch to DC (GND switch OFF), and adjust each control for a normal sweep. Next, adjust the VOLTS/DIV and TIME SWEEP/DIV so that the wave form is easy to measure. Set the VARIABLE and SWEEP TIME/DIV of each channel to CAL.

② Align the measuring point with one of the vertical scale lines using the ◀▶ POSITION control.

③ Measure the horizontal distance between the measuring points. Multiply this horizontal distance by the setting value of the SWEEP TIME/DIV.

Time = horizontal distance (div) × SWEEP TIME/DIV setting value

b) Cursor measurement procedures

① As in the normal procedures, adjust the waveform to be observed to an easy to measure position.

② Set the cursor measurement mode to ΔT.

③ Align the ΔREF cursor with the left side of the distance between the 2 points to be measured, and the Δcursor with the right side.

④ The measured result is displayed following the ΔT in the upper right of the CRT.

2) Time difference measurements

a) Normal procedures

The time difference between two signals with a synchronous relationship can be measured.

① Connect two signals to the INPUT terminal of CH1 and CH2, set the V-MODE switch to either ALT or CHOP.
Generally, the higher frequency signal is used with ALT, and the lower frequency one with CHOP.

② Set the various controls so that a normal sweep can be obtained. Next, select SOURCE for the signal with the faster timing (reference signal), and adjust the VOLTS/DIV and SWEEP TIME/DIV so the waveform is easy to measure. Set the VARIABLE of each channel to CAL, and the VARIABLE of the SWEEP TIME/DIV to the CAL state.

③ Move the waveform to the center with each ▲▼ POSITION control. Align the reference signal with the vertical scale with the ◀▶ POSITION control.

④ Measure the horizontal distance between the two signals, and multiply this distance by the setting value of the SWEEP TIME/DIV.

Time difference = horizontal distance (div) × SWEEP TIME/DIV setting value.

b) Cursor measurement procedures

① As in the normal procedures, adjust the waveform to be observed to an easy to measure position.

② Set the cursor measurement mode to ΔT.

③ Align the ΔREF cursor with the left side of the distance between the 2 points to be measured, and the Δcursor with the right side.

④ The measured result is displayed following the ΔT in the upper right of the CRT.

3) Pulse width measurements

a) Normal procedures

The pulse width is measured in the following manner.

① Connect the pulse signal to the INPUT terminal. Set the V-MODE in the channel to be used.

② Adjust the VOLTS/DIV, VARIABLE and ▲▼ POSITION so that the waveform is easy to measure and so that the horizontal scale in the center of the CRT is aligned with the center of the pulse amplitude.

③ Set the SWEEP TIME to CAL, and multiply this horizontal distance by the SWEEP TIME/DIV setting value.

Measure the horizontal distance to the point where the pulse waveform intersects with the horizontal scale line in the center of the CRT.

Pulse width = horizontal distance (div) × SWEEP TIME/DIV setting value

b) Cursor measurement procedures

① As in the normal procedures, Adjust the waveform to be observed to an easy to measure position.

② Set the cursor measurement mode to ΔT.

③ Align the ΔREF cursor with the left side edge of the distance between the 2 points to be measured, and the Δcursor with the right side edge.

④ The measured result is displayed following the ΔT in the upper right of the CRT.

4) Rise time measurements

a) Normal procedures

The rise (fall) time is found by measuring the time between the 10% and 90% of the amplitude points.

① Connect the pulse signal to the INPUT terminal. Set the V-MODE in the channel to be used. Adjust the VOLTS/DIV and VARIABLE so that the waveform peak-to-height 5 divisions of the CRT.

② Adjust each control so that a normal sweep is obtained, and adjust the ▲▼ POSITION so that the waveform is in the center of the CRT. Adjust the SWEEP TIME/DIV to as high a speed as possible within the measurable range. Set the SWEEP TIME VARIABLE to CAL.

③ Operate the ◀▶ POSITION control to move the 10% point of the waveform above the horizontal scale line, and measure the horizontal distance between the 10% and 90% points. Multiply this horizontal distance by the SWEEP TIME/DIV setting value.

NOTE

The CRT provides scale lines representing 0, 10, 90, and 100%, where 5 divisions = 100%. These lines should be used for this measurement.

Rise time = Horizontal distance (div) × SWEEP TIME/DIV setting value

The rise (fall) time can be measured even if the details at item ③ and below are as shown in the following.

④ Move the 100% point of the waveform to scale line in the center of the CRT with the ▲▼ POSITION control, and measure the distance to the point where the rise (fall) portion intersects the horizontal scale line in the center of the CRT. This distance is D1. Move the 90% point of the waveform to scale line in the center of the CRT with the ◀▶ POSITION control, and measure the distance to the point where the rise (fall) portion intersects the horizontal scale line in the center of the CRT. This distance is D2.
The horizontal distance of the rise (fall) is found by adding D1 to D2.
Multiply this horizontal distance by the SWEEP TIME/DIV setting value.

Rise (fall) time = (D1 + D2) (div) × SWEEP TIME/DIV setting value

b) Cursor measurement procedures

① As with the normal procedures, adjust the ▲▼ POSITION control so that the waveform peak-to-peak height 5 divisions of the CRT, and align the waveform to be measured with the 0% and 100% CRT scale marks.

② Set the cursor measurement mode to ΔT.

③ Aligh the ΔREF cursor to the point where the waveform to be measured intersects the 10% scale line and the Δcursor to the point where the waveform intersects the 90% scale line.

④ The measured result is displayed following the ΔT in the upper right of the CRT.

5) Time ratio measurements

a) Duty ratio

The square wave duty ratio measurements are performed as follows.

① Connect the signal to the INPUT terminal. Select the channel to be used with the V-MODE, set the AC/DC to DC (GND switch off), and adjust each control so that the normal sweep can be obtained.
Next, adjust the VOLTS/DIV and SWEEP TIME/DIV so that the waveform is easy to measure.

② Adjust the SWEEP VARIABLE so that one cycle occupies 5 div of the CRT scale, and if necessary align it while operating the ◀▶ POSITION control.

③ Set the cursor measurement mode to ΔT.

NOTE

Time ratio can be measured if the SWEEP TIME is not set to CAL.

④ Align the ΔREF cursor with the left side of the distance between the 2 points to be measured, and the Δcursor with the right side.

⑤ The duty ratio is displayed as a percentage following the RATIO display in the upper right of the CRT, supposing 5 divisions as 100%.

3 Frequency measurements

1) Frequency measurements

a) Normal procedures

Because the frequency is found as the reciprocal of the period, by finding the time of 1 cycle (period), the frequency can be determined.
In the "Time measurements" in Item 2, the time of one cycle is measured. This is the period of the signal.
The frequency is the reciprocal of this period.

$$\text{Frequency} = 1/\text{period}$$

In the above method, the frequency was found by directly finding the period, but it can also be found by counting the cycles shown on the CRT.

① Connect a signal to the input terminal. Select the channel to be used with the V-MODE. Set each control to obtain a normal sweep. Set the VARIABLE used channel and SWEEP TIME/DIV to CAL.

② Count the number of cycles between two scale lines of a suitable vertical axis. Fined the time of that number of cycles by this horizontal distance and the setting value of the SWEEP TIME/DIV, and multiply the reciprocal of the time by the number of waveform cycles.
However, when the number of cycles is small, measurement errors may occur with this method.

$$\text{Frequency} = \frac{\text{No. of cycles}}{\text{Horizontal distance} \times \text{SWEEP TIME/DIV setting value.}}$$

b) Cursor measurement procedures

① Connect a signal to the input terminal. Select the channel to be used with the V-MODE, set the AC/DC switch to DC (GND switch OFF), and adjust each control for a normal sweep.
Next, adjust the VOLTS/DIV and SWEEP TIME/DIV so that the waveform is easy to measure. Set the VARIABLE used channel and SWEEP TIME/DIV to CAL.

② Set the cursor measurement mode to ΔT.

③ Align the ΔREF cursor with the left side of the distance between the 2 points to be measured, and the Δcursor with the right side.

④ The measured result is displayed following the $1/\Delta T$ in the upper right of the CRT.

2) Phase difference measurements

a) Normal procedures

The phase difference between two sine wave signals of the same frequency can be measured.

① Connect two signals to the input terminals of CH1 and CH2, then select either ALT or CHOP for the V-MODE.

② Adjust each control for normal sweep display. Select the TRIG SOURCE switch for the signal with the leading phase (reference signal). Adjust the VOLTS/DIV and VARIABLE controls to make the amplitude of the two signals equal.

③ Adjust the VOLTS/DIV and VARIABLE controls so that one cycle of the signal occupies 8 divisions on the CRT. Adjust the ▲▼ POSITION controls to move both signals to the center of the CRT. By the above operation, one division equals 45 (360/8 div = 45°), therefore, display the sweep ratio as an angle of 45 ° /div.

④ Measure the horizontal distance between two corresponding points of the two signals, and multiply the result by the sweep ratio (45° /div).

Phase difference (deg) = horizontal distance (div) × 45° div

In the above method, the sweep ratio is 45° but to further increase the accuracy, magnify the waveform without changing the VARIABLE, using the SWEEP TIME/DIV.
Adjust the TRIG LEVEL as needed. In this case, to make the setting value of the SWEEP TIME/DIV that was set to 8 div per cycle more accurate, the phase difference can be found as follows using the newly set SWEEP TIME/DIV.

Phase difference = the horizontal distance of new sweep range (div) × 45° div

$$\times \frac{\text{the new SWEEP TIME/DIV setting value}}{\text{the SWEEP TIME/DIV setting value used as a reference}}$$

An easy method is to use ×10 MAG, which provides the sweep coefficient of 4.5°

b) Cursor measurement procedures

① Using Items ① and ② of the normal procedures, adjust the waveform to be observation to a position where it can be easily measured.

② Adjust the SWEEP TIME/DIV and VARIABLE so that 1 cycle equals 5 div. Move the two signals to the center of the CRT using the ▲▼ POSITION controls.

NOTE : With cursor measurements, 5 divisions equal 360 ° .

③ SET the cursor measurement mode to 1/ΔT.

NOTE : Phase difference can be measured when the SWEEP TIME is not set to CAL.

④ Align the ΔREF cursor with the point where the signal with the leading phase intersects the center horizontal scale line, and align the Δcursor with the point where the signal with the lagging phase intersects the center horizontal scale line.

⑤ The measurement results are displayed following the PHASE display in the upper right of the CRT.

4 Relative measurements

When the amplitude of the signal used as a reference, and the repetition time are known, the unknown signal voltage, period, etc., can be measured without using the SWEEP TIME/DIV display value.
In this method, the relative units necessary for the measurements obtained by with the reference signal are used for the unknown signal.

1) Voltage

This is the setting for the relative vertical sensitivity used by the reference signal

① Connect the reference signal to the INPUT terminals, and adjust each control to obtain a sweep that does not flicker.
Adjust the VOLTS/DIV and VARIABLE controls carefully so that the vertical amplitude occupies several divisions of the scale. After this adjustment is made, do not move the VARIABLE control.

② Divide the amplitude voltage of the reference signal is the product of the vertical amplitude found in Item ① and the VOLTS/DIV setting value.

$$\text{Vertical coefficient} = \frac{\text{Reference signal voltage (V)}}{\text{Voltage amplitude (div)} \times \text{VOLTS/DIV setting value}}$$

③ Disconnect the reference signal, connect the unknown signal to the input terminal, and use the VOLTS /DIV to set the waveform in an easy to measure.
Measure the waveform amplitude, and the voltage of the unknown signal can be calculated as follows.

Unknown signal voltage = vertical distance (div) × vertical coefficient
× VOLTS/DIV setting value

2) Period
This is the setting of the relative sweep coefficient using a reference frequency.
① Connect the reference signal to the INPUT terminals, and adjust each control to obtain a normal sweep display.
Next, use the VOLTS/DIV and VARIABLE to set the waveform in an easy to measure.
Adjust the VOLTS/DIV and VARIABLE controls carefully so that one cycle of the occupies several divisions (horizontal distance) of the scale. After this adjustment is made, do not move the VARIABLE control.

② Divide the period of the reference signal is the product of the horizontal distance (div) found in Item ① and the VOLTS/DIV setting value.

$$\text{Horizontal coefficient} = \frac{\text{Reference signal period (sec.)}}{\text{Horizontal distance (div)} \times \text{SWEEP TIME/DIV setting value}}$$

③ Disconnect the reference signal, connect the unknown signal to the input terminal, and use the SWEEP TIME/DIV to set the waveform in an easy to measure position. Measure the horizontal distance of 1 cycle of the waveform, and the period of the unknown signal can be calculated as follows.

Unknown signal period =
horizontal distance (div) × vertical coefficient × SWEEP TIME/DIV setting value.

5 Applications of X-Y operation

1) Phase
Phase measurement can be performed using the X-Y operation. A typical application is the measurement of phase distortion of circuits and audio amplifiers that are design so that certain phase shifts occur.
Amplitude distortion measurement can be performed at same time.
Phase measurements are performed as follows.

① Apply a sin wave with little distortion to a test audio circuit.

② Adjust the audio oscillator output to the normal level of the test circuit. Observe the circuit output on the CRT. If the input signal of the test circuit is too large, the waveform will be clipped, therefore reduce the signal level.

③ Connect the CH1 probe to the input of the test circuit.

④ Set the H-MODE to X-Y.

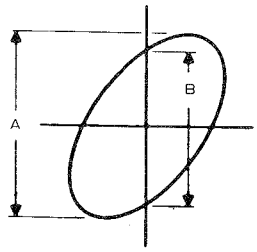
⑤ Connect the CH2 probe to the input of the test circuit.

⑥ Adjust the gain of both channels, and adjust the Lissajous' pattern to a suitable size.

⑦ When the 2 signals are in phase, the Lissajous' pattern is a straight line. Also, when the vertical and horizontal gain are equal, a 45° angle is formed.
When the phase difference is 90° the Lissajous' pattern is round. When the phase difference is more or less than 90° the Lissajous' pattern is elliptical.
The actual phase difference can be measured and calculated as shown below.

Phase difference calculation:

$\sin\phi = B/A$ ϕ = Phase angle



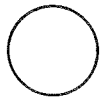
 No amplitude distortion or phase difference	 Phase difference, but no amplitude distortion
 Amplitude distortion, but no phase difference	 Both phase difference and amplitude distortion
 No amplitude distortion, 180 phase difference	 No amplitude distortion, 90 phase difference

Fig. 8

2) Frequency
The frequency measurement can be made from the Lissajous' pattern in the same manner as the phase measurements.

① Connect a sine wave of known frequency to the CH2 input of the machine. Then, set the H-MODE to X-Y.

② Connect the CH1 probe to the signal to be measured.

③ Adjust the gain of CH1 and CH2.

④ The Lissajous' pattern that appear shows the ratio between the two frequencies.

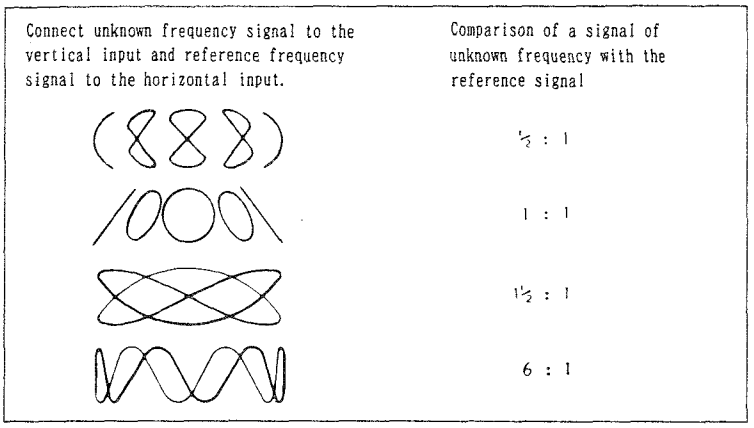


Fig. 9

[B] Examples of Storage Oscilloscope Applications

1 Storage waveform measurement using the hold mode

Even in the storage oscilloscope mode, it was explained using the method of use that measurements can be made with the same operations as the waveform measurements in the normal real-time oscilloscope mode. However, in the storage mode, measurements are possible that are not possible with the real-time mode. Especially in the measurements of single-phenomena and burst-phenomena, to be explained later, a data storage function is required. Even with repetition phenomena, when the different repetition wave forms change, for example, when an aperiodic component is superimposed on a repetition signal containing noise, in the real-time mode, the waveforms for each repetition are superimposed on each other, and are difficult to measure.

1) In the above case, select the storage NORM mode (the state in which all the LEDs except the that of the STORAGE switch ㉟ of the storage unit are out), input the waveform, and use the hold function to store and display the preceding input signal data.

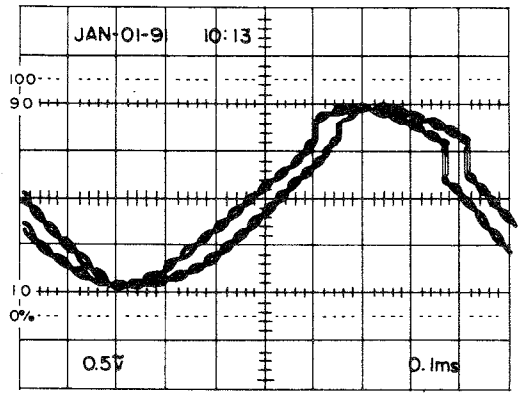
① Connect the signal to the input terminal. Select the uses channel with the V-MODE. Adjust the controls for a normal sweep display. Then, adjust the VOLTS/DIV until the waveform becomes easy to measure. (The above operation can be performed in either the real-time or storage mode).

② Select the storage NORM mode, and after storing the data, press the hold switch.

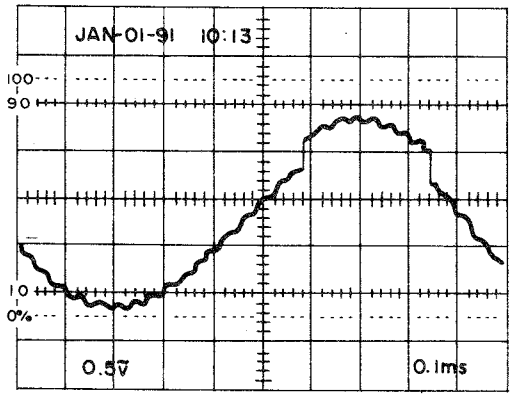
③ When the observation can not be completed with one display, the DISP ADDR can be used to scroll through 8 displays data to complete the observation.

④ If necessary, release the hold, store data again, and repeat steps ② and ③.

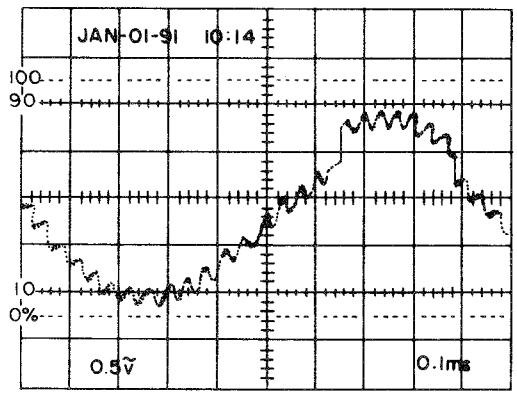
⑤ Also, you can use the DISPLAY ADDRESS to scroll the 2KW of data displayed on the screen from the 16KW of data stored in the memory, and observe the changes in the waveform.



Waveform with change for each trigger



Trigger 1 waveform



Trigger 2 waveform

Fig. 10

2 Single-phenomena measurements

Single-phenomena and burst-phenomena signals that hard to observe on the normal oscilloscope can be easily observed on the storage oscilloscope.

1) Waveform observation before the trigger point

For example, there are case where images are entered in a computer through a sensor, etc., and data processing is performed. In this case , the external image (analog data) is generally converted into digital data with an A/D converter or comparator, and then processed.

To observe this series of operations on an oscilloscope, because the triggering is more easily performed with the comparator output than with the analog data, the relations of analog values are difficult to observe, and even when the analog data is triggered, it is often unstable and difficult to observe.

The procedure used to observe the sweep described above (The waveform of the analog data in the phenomena is formed, and converted to digital data) is shown below.

① In the storage NORM mode, set the single-sweep mode with the same operations as those for the real -time operation.

② Next, select TRIG DLY mode, and make the time setting in the minus direction. This is used to set the point in time, from the trigger point of the waveform to be observed to the previous phenomena, at which the measurement is to be performed. The setting value is set with the ΔREF cursor or the Δcursor.

③ Using the comparator output as a trigger source, set the trigger point and trigger slope.

④ Verify that the READY LED lights when the SINGLE switch is pressed.

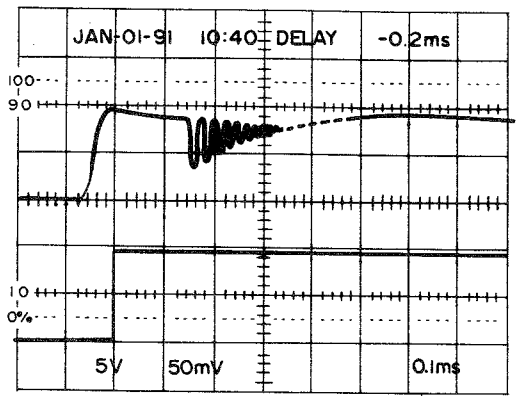
⑤ Store and observe the signal. If necessary, repeat steps ②, ③ and ④.

⑥ Here, the time (Tpr) the from the trigger point of the observed waveform is:

Tpr = (PRE TRIG setting value (div) −
the no. of divisions from the left edge of the CRT) × sweep range (s/div)

When the PRE TRIG unit is time

Tpr = PRE TRIG setting value (time) −
{the no. of divisions from the left edge of the CRT × sweep range (s/div)}



PRE TRIG waveform

Fig. 11

2) Waveform observation after the trigger point

Using the digital data output as control data, in a system where the digital data changes are related to the analog data changes, there are cases in which the digital data output is used to trigger the oscilloscope to observe the analog data. For this kind of phenomena, the phenomenon have repetition periods above a certain value can be observed with a real-time oscilloscope, but as in Item 1), aperiodic signals or those for which the response of analog data from the digital data output takes time can be observed using the procedure shown below.

① In the storage NORM mode, set the single-sweep mode with the same operations as those for the real -time operation.

② Next, select TRIG DLY in the storage trigger mode, and make the time setting in the plus direction. This is used to set the point in time, from the trigger point of the waveform to be observed to the after phenomenon, at which the measurement is to be performed. The setting value is set with the ΔREF cursor or the Δcursor.

③ Using the comparator output as a trigger source, set the trigger point and trigger slope.

④ Verify that the READY LED lights when the SINGLE switch is pressed.

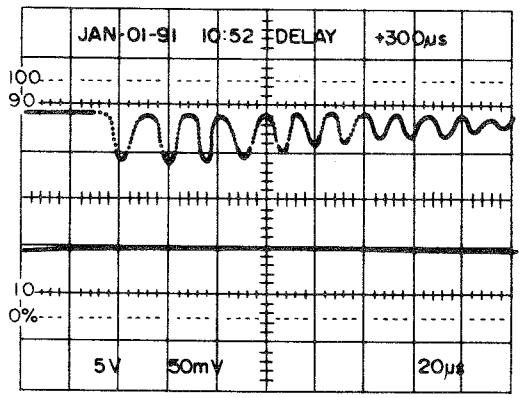
⑤ Store and observe the signal. If necessary, repeat steps ①, ② and ③.

⑥ Here, the time (Tpt) the from the trigger point of the observed waveform is:

Tpt = (POST TRIG setting value (div) −
the no. of divisions from the left edge of the CRT) × sweep range (s/div)

When the PRE TRIG unit is time

Tpt = POST TRIG display value (time) −
{the no. of divisions from the left edge of the CRT × sweep range (s/div)}



POST TRIG waveform

Fig. 12

3) Measurements using data interpolation

In the storage mode of this machine, since the highest sampling time is 50ns, time axis resolution of the CRT is 2000 samples, therefore:

50ns × 2000 samples = 100 μs = 10 μs/div.

At ranges above this, (1μsto 0.5 μs/div), the magnification mode is activated, and the resolution in the time axis direction becomes coarse.

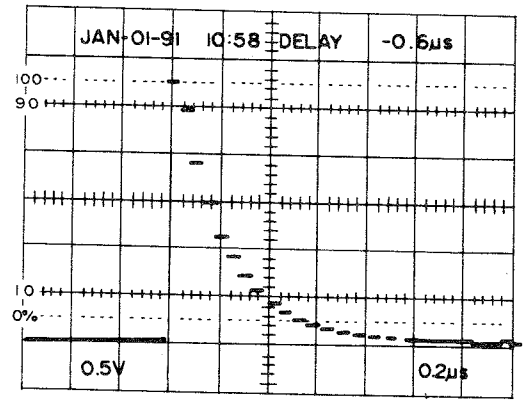
In the ranges above 5 μs/div as a method of measuring single-phenomenon signals while maintaining the time axis resolution, there is data interpolation.

In the normal magnification mode ranges, this is the previous value retention (interpolation) used to maintain the latest sampling data until the next sampling point.

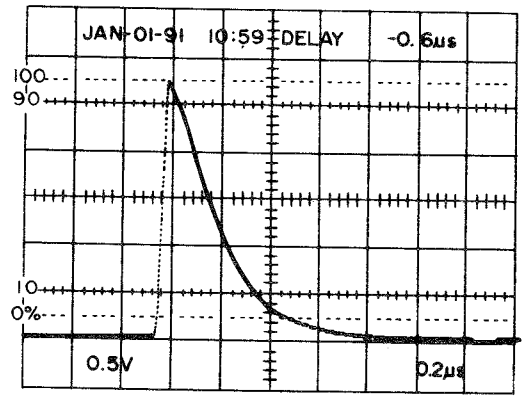
① When you wish to evaluate only sampling data, select the previous value interpolation.

② When you wish to verify the overall appearance or features of waveform data, use the LINEAR interpolation that connects between the sampling data in a straight line.

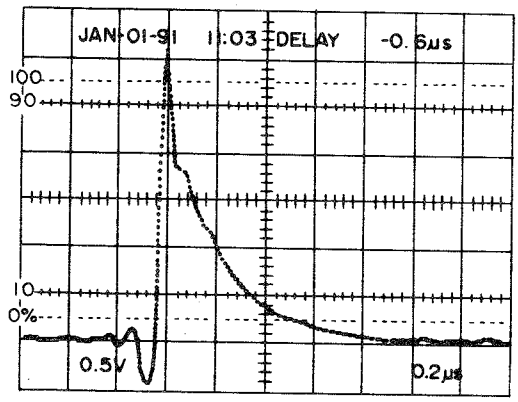
③ When you wish to perform interpolation smoothly between samplings while retaining sampling data, select the digital filter process that uses a frequency about 2.5 times that of the sampling frequency as a roll off frequency, and the SINE interpolation based on the related sampling theorem.



Previous value interpolation



Linear interpolation



Sine interpolation

Fig. 13

3 Low frequency signal observations

1) Long time observations (unattended measurements)

Very low frequencies and low speed phenomenon with aperiodic characteristics are difficult to observe on the real-time oscilloscope. Because the lowest sweep range of this machine is 500s/div, long time observation is possible (Max. 11 hrs. continuous at 16KW).

Also, in the observation of low frequency of single-phenomenon, has a function by which the trigger point time is registered on the CRT and can be verified (TRIG TIME STAMP function), so unattended measurements are possible.

2) ROLL mode (0.2s/div to 500s/div)

When you want to continuous observe low frequency signals, use the ROLL mode. In the ROLL mode, because input signals can be stored and displayed regardless of the triggering, and it is used for observing signals without triggering, or minute changes that can not be triggered.

3) Peak detector applications

With the storage oscilloscope, because the resolution of data is determined commonly in the amplitude direction and the time direction, the high frequency part of spikes occurring in low speed signals often leak out of normal sampling.

For example:

When the sweep time = 0.2 s/div, the sampling interval Sw, the time axis resolution for 1 screen (10 divisions) is 2KW (2000 sample), therefore:

Sw = 0.2 s × 10 div/2000 sample = 2 ms/sample.

Here, if there are 1 ms wide spikes in the signal being observed, sometimes this is shown in the sampling, as shown below, and sometimes it is not, and the probability (Ps) of being sampled is:

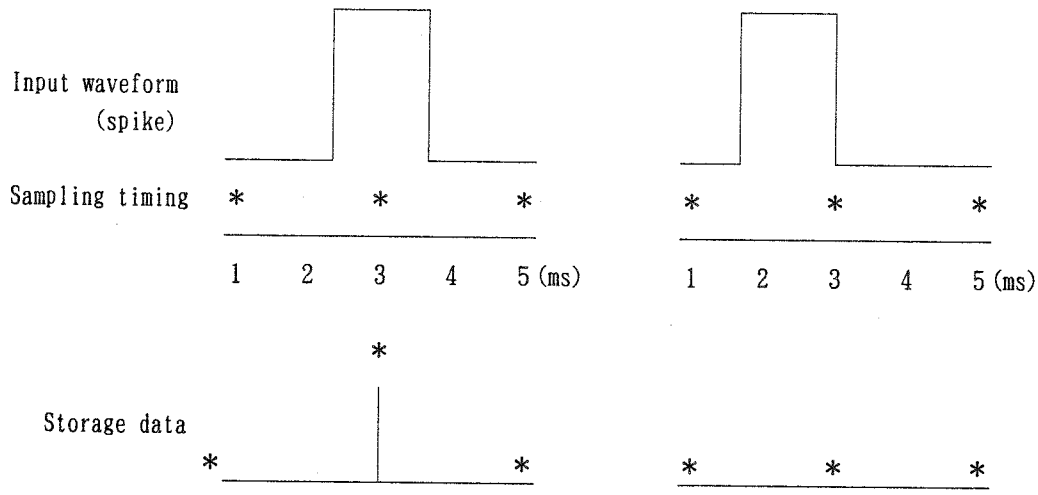
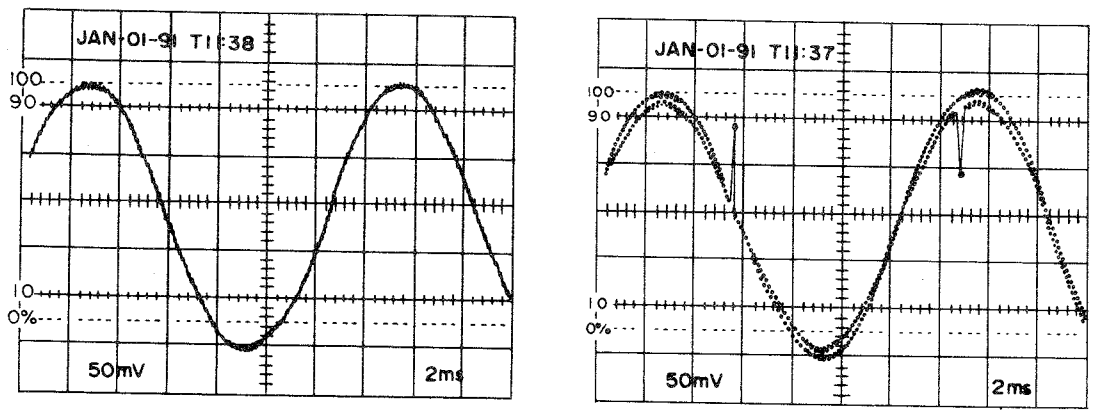


Fig. 14

Ps = 1 ms (spike pulse width) /2 ms (sampling interval) = 0.5 (50%)

In this case, if the peak detector function is used, the spikes, etc., cannot escape, and are detected. When PEAK is selected in the storage mode, regardless of the sweep time, the sampling interval is always highest value (50 ns/sampling), and because the largest and smallest values are compared for every sampling, spikes like those shown above cannot escape, and are stored.



Peak detector OFF

Peak detector ON

Fig. 15

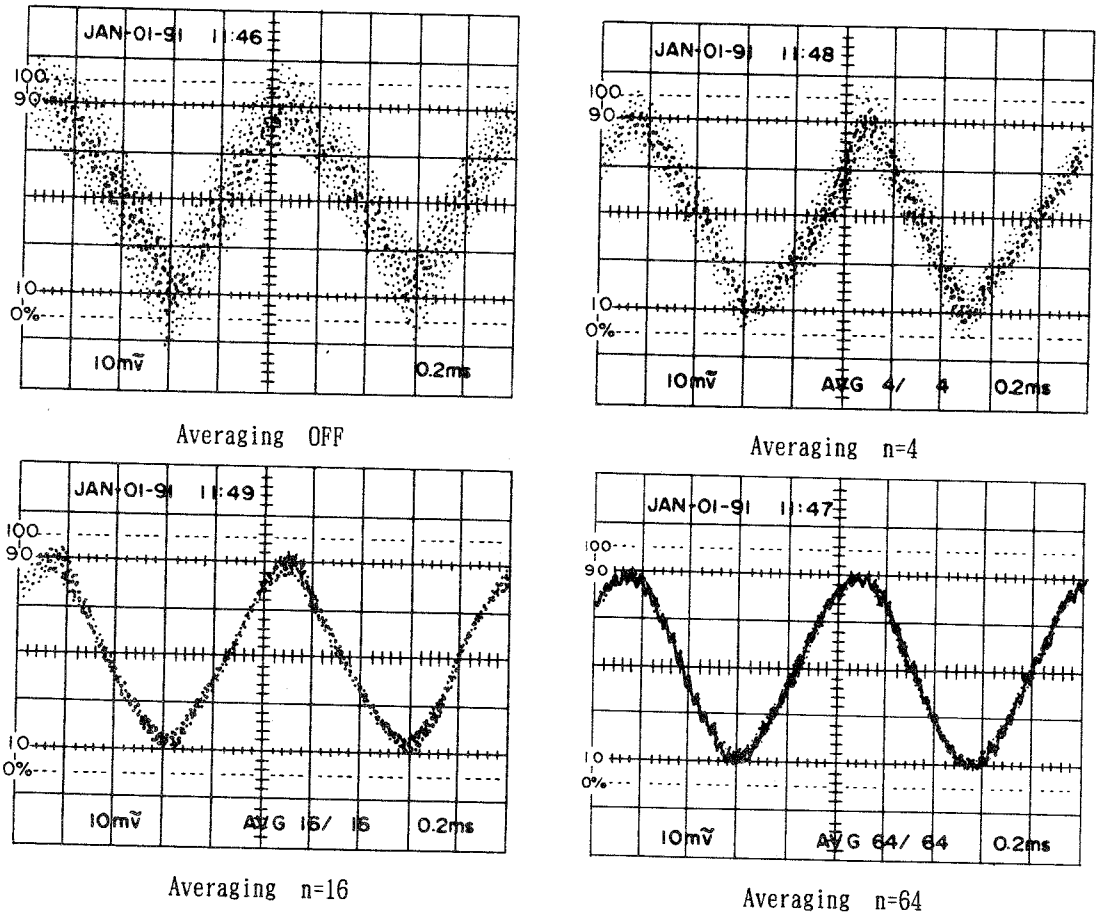
4 Repetition phenomena measurements

1) Extraction of signals hidden by noise

Many repetition signals are buried in external noise or system noise in the actual measurements, but those kind of signals are very difficult to observe with the real-time oscilloscope.

In the sampling of signals with periodicity buried in this type of noise, the signal to noise ratio

can be improved by a mathematical operation called addition averaging. When AVG is selected in the storage mode, the addition average is performed based on the number of times of averaging setting of the SET control. At this time, if the degree of improvement of the signal to noise ratio, if the number of settings is n, is $1/\sqrt{n}$.



Averaging OFF

Averaging n=4

Averaging n=16

Averaging n=64

Fig. 16

2) High speed phenomena measurements

In the storage mode of this device, since the highest sampling time is 50ns, time axis resolution of the CRT is 2000 samples, therefore:

50ns × 2000 samples=100 μs=10 μs/div.

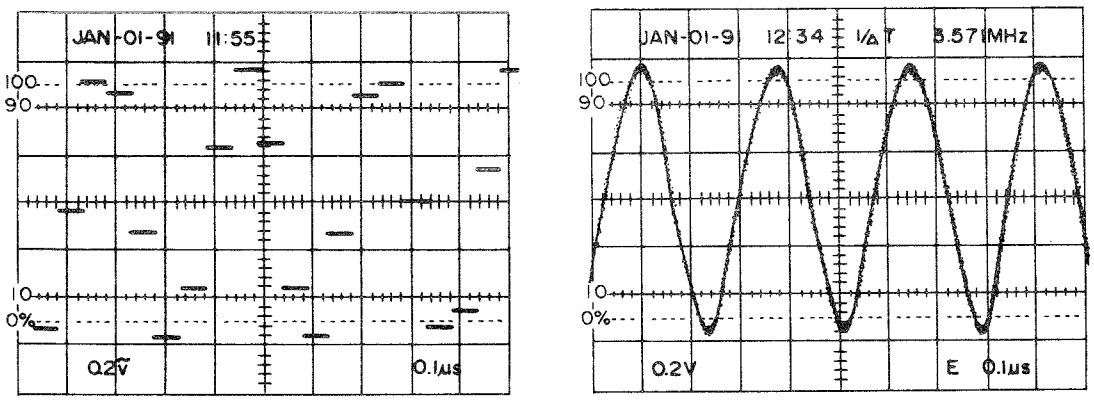
Above this range (1 μs to 0.5 μs/div), the mangification mode is entered, and the time axis direction resolution becomes coarse. In the range above 5μs/div., the observations use the mesurement method with the data interpolation, and if repetition phenomena is observed, the method with equivalent sampling. Because the equavalent sampling data is all the display data that is not data interpolation data, and is the actual input data, when high speed, stable, repetition phenomena data is needed, use this mode.

For example, with high speed sweep 20ns/div, when equivalent sampling is used, because the time axis direction resolution 2000 samples are used, equivalent sampling time:

(20ns × 10 div)/ 2000 samples = 0.1ns (100 ps)/sample,

and high resolution time axis mesurements are possible.

As shown above, the equivalent sampling, in which the time axis direction resolution becomes coarse (5 μs/div and above), can be selected with the EQU switch㉕.



Equivalent sampling OFF　　Equivalent sampling ON

Fig. 17

5 Waveform data relative measurements

1) Use of reference data

When waveform comparisons are made in the observance of signals of the same signal source or of the same type, accurate waveform comparisons can be made by using reference data with the following procedure.

Example : Rise time characteristics of a regulated power supply circuit that obtains a DC output voltage from an AC voltage input are to be measured.
As basic characteristics, the output characteristics when a separate DC voltage source is used in place of the AC voltage source are used.

① Select the storage mode, and set the single-sweep mode.

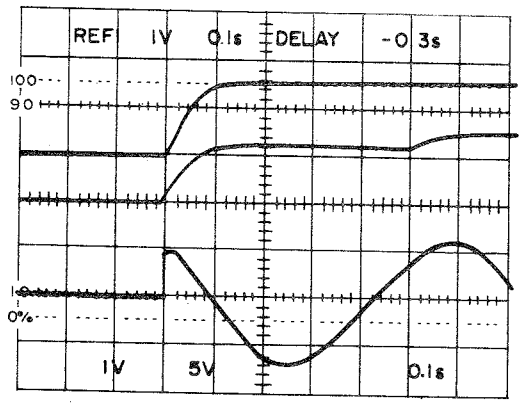
② Make CH1 the input when the DC voltage source is applied, and apply the output CH2. Using CH1 as the TRIG SOURCE, and the DC voltage source input point as the trigger, store the data. At this time, set the TRIG DLY as needed.

③ After storing the data, press the REF DISP switch to turn on the reference memory, and then press the SAVE switch. The aquisition memory contents will now be copied as that are in the reference memory, transmitted and stored.

④ Next, use the actual AC power source as the input, and store the input and output in the same manner.

⑤ Since the reference data is not updated, repeat step 4) to store data until the waveforms thought necessary are obtained.

⑥ Compare the reference data with the data stored later, and study it.



Waveform compared with reference data

Fig. 18

6 Data output

1) Plotter output

There are several ways to store the measurement data, but when large volumes must be output as waveform data, but running costs can be held lowest with plotter output and recorder output.

Example : When storing a large number of relay of chattering data

① Connect the drive input for the relay to CH1, and connect the relay contacts waveform to CH2. in the storage NORM mode, use an operation the same as that for real-time operation to set the single-sweep mode.

② Next, choose CH1 for the trigger source, adjust the sweep time, select TRIG DLY and set the time, and even though CH1 and CH2 can be observed simultaneously, set them in the minus direction (PRE TRIG).

③ Press the SINGLE switch and verify that the LED is lit.
then operate the relay drive input.

④ After checking the data storage, check the plotter output setting of this machine and the plotter preparations, Press the PLOT switch to output data to the plotter (Refer to the "panel explanation ⑤1 PLOT Setting Switch".)

Data can be stored easily by repeating the operations of the above procedure.

2) Pen output

The running cost of storing observation data as waveform data can be held low with pen output, just as with plotter output. The points which differs from plotter output are that the output scale can be set as you wish with pen output, data recorded with other output means (including hand writing) can be written over, and data comparison becomes clear.

Assuming measurements the same as plotter output

① Perform the operations of plotter output steps ① to ③ (Refer to the panel explanation ⑤1 PLOT Setting Switch".)

② After checking the data storage, check the settings of the analog pen recorder output of this machine.
Because the pen recorder output of this machine is 0.5V for each scale division of the CRT, perform the recorder range setting, and if needed, a test output, and match the form to be used for output (specifications, etc.) with the scale.

③ After the above settings are made, press the PLOT switch to start recorder data output.

With this procedure, the comparison of specification data, etc., becomes clear.

[C] Programmable Oscilloscope Applications

1 Applications of fixed form measurements

1) Program function applications with a separate oscilloscope
Measurement of pulse separation and pulse rise time of aperiodic pulse trains
Most of the pulse signal trains used in computer control have no periodicity, and for the measurement of the pulse separation, delay time, etc., the storage oscilloscope is more suitable than the real-time oscilloscope.
Because most of these pulse trains are generated by high speed digital ICs, the transition time of the rise time and fall time are rather high speed, and when accurate measurements cannot be made, a high speed real-time oscilloscope is more useful.
Because this machine has both of these functions, all the measurements can be made, but when the two types of measurements described above are performed, the sequences can be programmed to perform more efficient measurements.

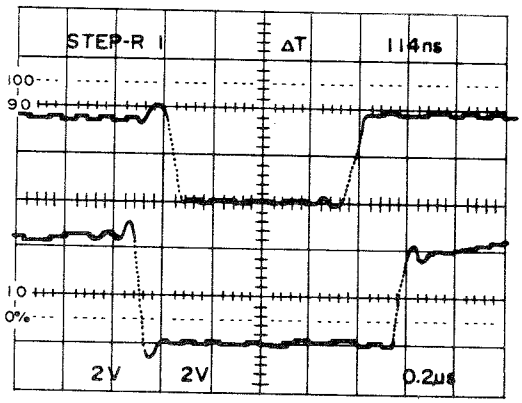
Example : The two measurements above have a synchronous relationship, but regarding the aperiodic pulse trains, when measurements of the delay time between pulse trains, and the rise time, are to be made, use the following procedure.

① Press the PROG SET switch to activate the program write state.
The STEP W-1 RUN or STEP W-1 SKIP is displayed in the calendar display position on the CRT, and the contents of settings previously made on the panel are displayed.

② First, to measure the pulse separation, press the STORAGE switch ㉟ to set the storage mode.

③ Connect the pulse train signal to be observed to the CH1 and CH2 input terminals, select the observation channel, and perform the trigger source setting (CH1), the trigger level and the SWEEP TIME/DIV settings.

④ Set the cursor mode to ΔT, and measure the delay time between the pulses.

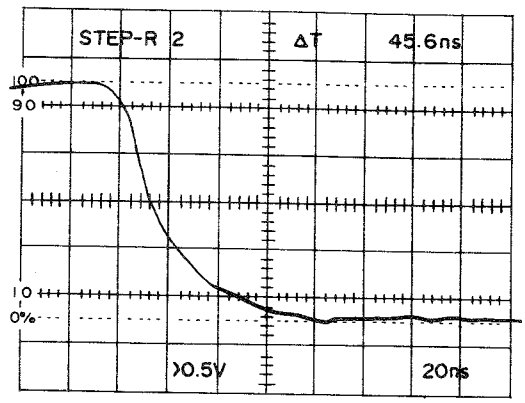


Delay time between the pulses

Fig. 19

⑤ Press PROG STEP to write the state that is set.
The contents are written into the step No. 1 that is displayed, and the program step No. becomes 2.

⑥ Press the STORAGE switch to return to the real-time mode, and set the SWEEP TIME/ DIV to a range where the pulse rise time can be measured.
Also, select the channel to measure the rise time, and set the voltage range to 1V/div.



Rise time between the pulses

Fig. 20

⑦ Set the cursor mode to ΔT, and measure the rise time between the pulses.

⑧ Press PROG STEP to write the state that is set,
The contents are written into the step No. 2 that is displayed, and the program step No. becomes 3.

⑨ Press the PROG RUN switch.
The STEP W-3 RUN display in the CRT calendar display position changes to STEP W-3 SKIP, and the SKIP state is entered. Then press the PROG STEP switch to perform the writing. Repeat this procedure up to Step 20, and the Steps from Step 3 upward are kept.

⑩ Press the PROG SET switch, and the program writing is finished.
With this, setting contents are written into Steps 1 and 2.

⑪ To read out the program that was written, perform the following procedure.
Press the PROG RUN switch.
The STEP-R1 display is shown in the calendar display position on the CRT, and the panel is in the programmed state. In this state, perform measurements as needed.

⑫ When the PROG STEP switch is pressed, the state written in Step 2 is activated. In this state, perform measurements as needed.

⑬ From Step 2, return to Step 1 and repeat the above operations.

7. GP-IB INTERFACE

Cautions on Using GP-IB

When using GP-IB for remote control of this machine, pay attention to the following points in the preparation of the controller software.

* Insert "WAIT" before program END.
* When sending continuous commands, insert "WAIT" before the "STATUS" command.

7-1 OUTLINE

GP-IB interface is standard equipment on the DCS-8200, and by connecting it to a host computer with a control function, the remote control and waveform data support of this machine is possible.

7-2 GP-IB SPECIFICATIONS

The GP-IB interface of this machine complies with the IEEE Standard 488-1978.

1) Bus line configuration

The GP-IB bus line is composed of 8 control signal lines (3 for handshake and 3 for control), 8 data signal lines and 8 ground lines. A device connection diagram is shown in Fig. 1, and the GP-IB bus line configuration is shown in Table 1.

Table-1 GP-IB Bus Line Configuration

Type	Signal Name	Function Explanation
Handshake Control Line	DAV : Data Valid	Indicates that the information on the data bus is valid
	NRFD : Not Ready For Data	Indicates that the listener that is connected is ready to receive the information on the data bus
	NDAC : Not Data Accepted	Indicated that the listener that is connected has received the information on the data bus
Supervisor Control Line	IFC : Inter face Clear	Initializes the GP-IB interface unit
	ATN : Attention	Indicated the type of data on the data bus LOW : Address command HIGH : Data
	SRQ : Service Request	Requests service from the controller
	REN : Remote Enable	Specifies remote control or local control
	EOI : End or Identify	Indicates the end of the transmitted data block
Data Bus	DIO 1~8: Data Input Output	The data bus consists of 8 bidirectional signal lines, and transfers information in the byte serial form.

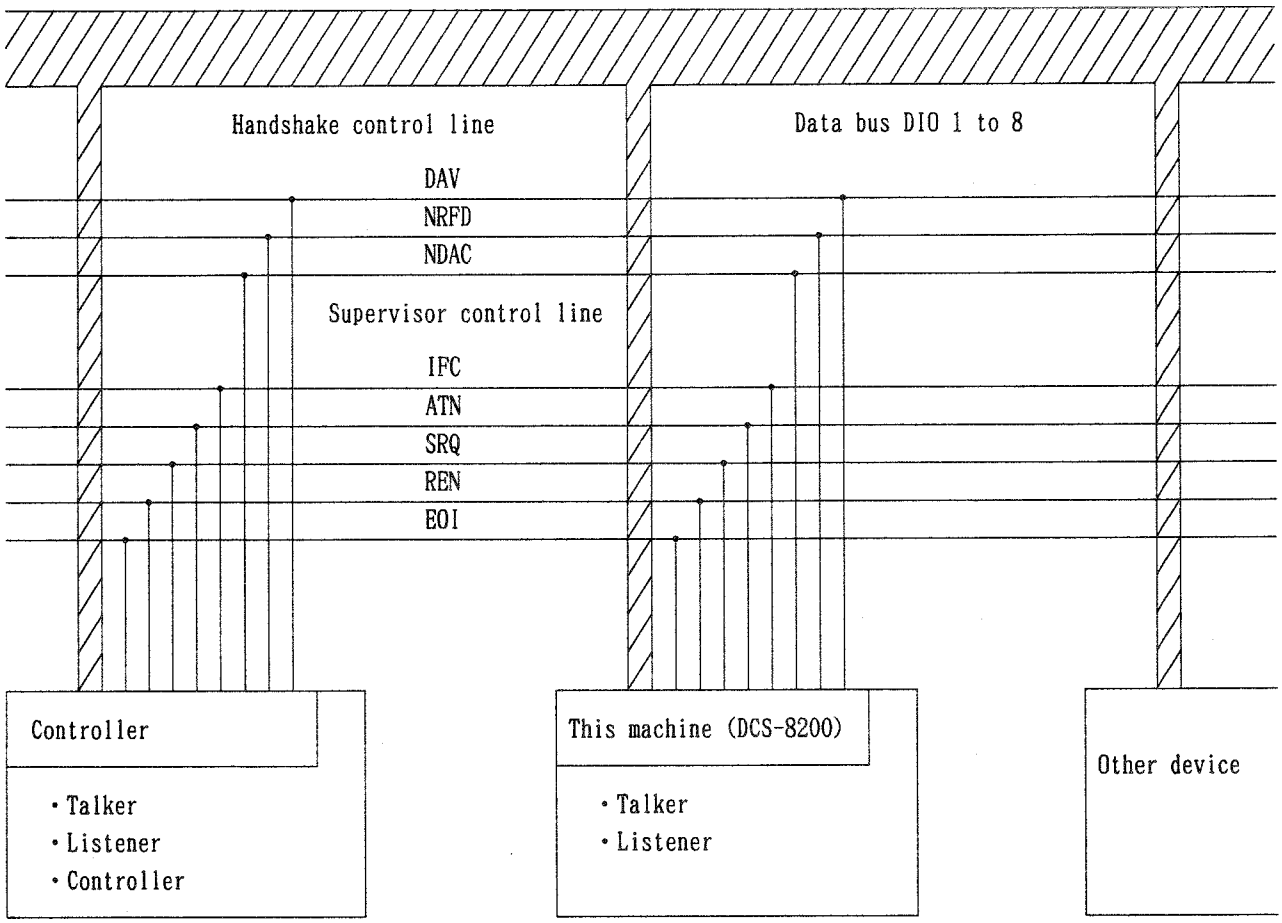


Fig. 21 Device Connection Diagram

2) Interface function

① SH (Source handshake)
This is the function that transmits the data on the data bus, and this machine has all functions at the SH1 level.

② AH (Accepter handshake)
This is the function that receives the data on the data bus, and this machine has all functions at the AH1 level.

③ T (Talker)
This is the function that transmits data through the data bus to other devices such as a host computer. The support level of this device is T5, and it releases the talker function by the receipt of basic talker, serial polling and MLA (My Listen Address) signals.

④ L (Listener)
This is the function that receives data through the data bus from other devices. The support level of this device is L4, and it releases the listener function by the receipt of basic listener and MTA (My Talk Address) signals.

⑤ SR (Service request)
This is used to send asynchronous service requests to the controller. The support level of this device is SR1.

⑥ RL (Remote/local)
This device selects whether the control will be remote control (program control through the GP-IB) or local control (by the panel switch operations). The support level of this device is RL2, and it has the remote/local function, but it cannot support the local lockout (LLO) function.

⑦ PP (Parallel polling)
This device is PP0, and does not have a parallel polling function.

⑧ DC (Device clear)
This device is DC1, and has all device clear functions.

⑨ DT (Device trigger)
This device is DT0, and does not support device trigger functions.

⑩ C (Controller)
This device is C0, and does not support controller functions.

* The implementation of the interface functions described above is given in the "multiline interface message command" section.

3) Multiline interface message commands

The response of this device to the IEEE standardized message commands is given in the following.

The interface message commands are classified as shown below.

- Primary command group (PCG)
  - Address command group (ACG)
  - Universal command group (UCG)
  - Listener address group (LAG)
  - Talker address group (TAG)
- Secondary command group (SCG)

A list of interface message command codes is given in Table-2.

This device does not support any of the secondary command group (SCG).

Table-2 Interface Message Command Code List

Bits ② b_7 b_6 b_5 / b_4 b_3 b_2 b_1 / Column / Line	0 0 0	① MSG	0 0 1	MSG	0 1 0	MSG	0 1 1	MSG	1 0 0	MSG	1 0 1	MSG	1 1 0	MSG	1 1 1	MSG
	0		1		2		3		4		5		6		7	
0 0 0 0 / 0	NUL		DLE		SP		0		@		P				p	
0 0 0 1 / 1	SOH	GTL	DC1	LLO	!		1		A		Q		a		q	
0 0 1 0 / 2	STX		DC2		"		2		B		R		b		r	
0 0 1 1 / 3	ETX		DC3		#		3		C		S		c		s	
0 1 0 0 / 4	EOT	SDC	DC4	DCL	$		4		D		T		d		t	
0 1 0 1 / 5	ENQ	PPC③	NAK	PPU	%		5		E		U		e		u	
0 1 1 0 / 6	ACK		SYN		&		6		F		V		f		v	
0 1 1 1 / 7	BEL		ETB				7		G		W		g		w	
1 0 0 0 / 8	BS	GET	CAN	SPE	(		8		H		X		h		x	
1 0 0 1 / 9	HT	TCT	EM	SPD	)		9		I		Y		i		y	
1 0 1 0 / 10	LF		SUB		*		:		J		Z		j		z	
1 0 1 1 / 11	VT		ESC		+		;		K		[		k		(	
1 1 0 0 / 12	FF		FS		,		<		L		\		l		!	
1 1 0 1 / 13	CR		GS		−		=		M		]		m		)	
1 1 0 ① / 14	SO		RS		.		>		N		^		n		~	
1 1 1 1 / 15	SI		US		/		?	UNL	O		−		o		DEL	

MLA assigned to the device

MTA assigned to the device

Meaning is defined by PCG

Meaning is defined by PCG

④

Address command group (ACG)

Universal command group (UCG)

Listen address group (LAG)

Talk address group (TAG)

Primary command group (PCG)

Secondary command group (SCG)

NOTE : ① MSG = Interface signal
② b_1 = DIO1 •••• b_7 = DIO7, DIO8 is not used
③ Used with secondary command
④ Most often used subset (column 010 to 101)

MLA : My Listner Address
MTA : My Talk Address

① Address command group (ACG)

MSG	Message Command Name	This Machine's Answer
GTL	Go to Local	Make the Local state.
SDC	Select Device Clear	Initialize with power on.
PPC	Parallel Poll Configure	No response
GET	Group Execute Trigger	No response
TCT	Take Control	No response

② Universal command group (UCG)

MSG	Message Command Name	This Machine's Answer
LLO	Local Lockout	No response
DCL	Device Clear	Initialize with power on.
PPU	Parallel poll uncondigure	No response
SPE DPD	Serial Poll Enable Serial Poll Disable	Serial poll operative, status byte transmitted

4) Uniline commands

The controller, by accessing the interface control line, controls the GP-IB device.

This machine's response to the uniline command

① IFC (Interface Clear)
Initialize the GP-IB interface unit. In other words, this command is used to initialize the interface unit when there is an inconsistency between the specified initial address and the number of transmitted data, and the transmission is suspended by the 3-line handshake, when waveform data is transmitted.

Because generally when an inconsistency occurs, matching of the controller and this device cannot be obtained with the interface command clear only, it is necessary to initialize this device with the device clear command in the multiline interface message command.

② REN (Remote Enable)
When this device is remotely controlled by the controller, it is necessary to place this device in the remote status using this command.

When this device assumes the remote status, the panel becomes unable to receive this operation, and only the remote control from the controller is effective.

When the remote control from the controller ends, perform Remote Disable with this command. The panel operation is now effective.

7-3 GP-IB HARDWARE SETTINGS

1) Connections

The connections between the controller and this machine are made with standard GP-IB cable.

2) DIP switches

Using the DIP switches on the rear panel of this machine (lower side), the GP-IB address and the delimiter control can be set.

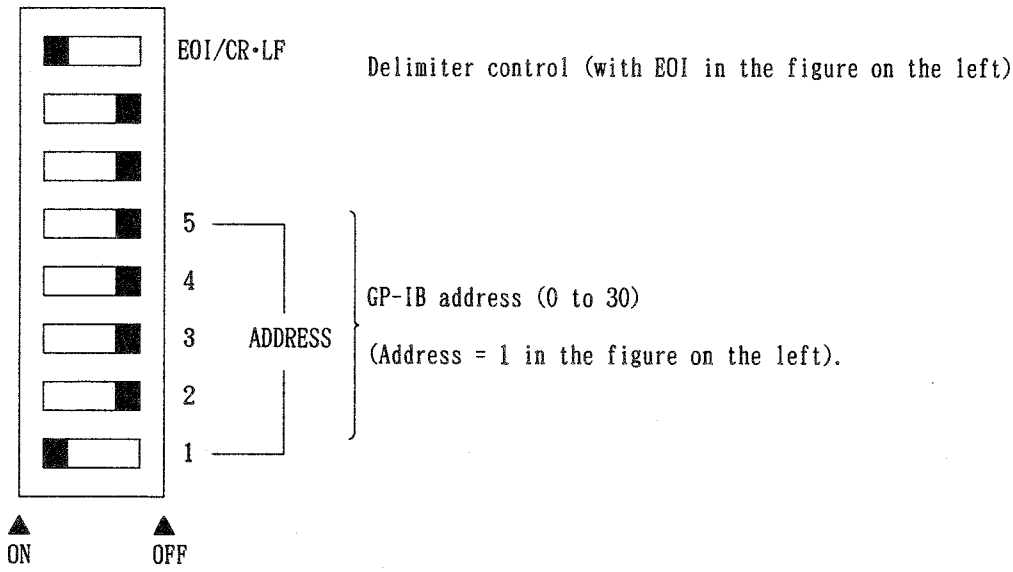


Fig. 22

Because the reading of the DIP switches is only done once with the power on, set the DIP switches before turning on the power.

① GP-IB address
The addresses that can be set are from 0 to 30.
The listener address is added for this setting value as 20H in hexadecimal, and the talker address as 40H.

② Delimiter control
Either the method using CR/LF as the delimiter that indicates the end of the transmitted data block or the method in which the EOI signal is applied to the last data byte (with EOI) can be selected.
However, the delimiter using CR/LF is used only with ASCII code, and for binary data transmission, regardless of the setting of these DIP switches, the delimiter with EOI is always used.
For details, see the command format.

7-4 BASIC STRUCTURE OF COMMAND FORMAT

1) Command format

The GP-IB format consists of one or a number commands, a multistatement function consisting of the separator ":" that separates the commands, and a delimiter. Using the selection switches (DIP switches) on the rear panel, either CR/LF or EOI can be selected. However, regarding the commands using binary data, the delimiter can only use EOI, regardless of the setting of the selection switches.
The arrangement of the commands, separators and delimiter are as shown below.

C : <delimiter>
C : C : C : C <delimiter>

C	command,
:	separator,
<delimiter>	EOI or CR/LF

2) Commands

GP-IB commands basically consist of the 7 fields (T to Z) shown below. In the 3 fields, U, V and W, one parameter is constructed, and the parameters are separated by Y fields. The X field is the data portion, and the data may ASCII or binary.
The required fields and their data length, and the effective data range are determined for the parameters of each command and operand.

T	Command and Operand	3 to 6 alphabetic characters, essential
U	Symbol	+, − (Used in common with V field)
V	Numbers	0 to 9 and 7 characters including decimal point
W	Index numbers	Index number portions starting E (Used in common with V field)
X	Data portion	ASCII : The data from 0 to 255 are aligned and separated by commas (","). Binary : Binary data from 0 to FF (H)
Y	Sub-delimiters	"," used to separate parameters when several are in a line (U, V, W)
Z	Separators and delimiters	Separator ":" used with a multi-statement, the end is delimiter CR/LF or EOI.

GP-IB commands start with a T field and proceed as U, V, W, Y, U, V, W, Y.....U, V, W.
The data portion continues after the parameters, and a Z field comes at the end. When each field is output from the controller, even the adjustable lengths are operated, and spaces are ignored.
The output from this device always has the data length that agrees with the command specifications, and the data is always on the end of the command.

Example : Output from this device (Fixed length fields are pushed toward the rear.)

ΔVOLTD1	Δ10E-3:
T field = 6	V field = 3

(Δ= space)

Output from controller (Variable length, space ignored)
VOLTS Δ1, 10E-3:

An example of the command format (field alignment) is shown below.

TZ : Operand only
TVZ : Operand and parameters (numbers)
TUVWZ : Operand and parameters (Symbols + numbers + index portion)
TUVZ : Operand and parameters (Symbols + numbers)
TVYVYZ : When there are several parameters
TVYVYXZ : When data is included

3) Command functions

There are commands output by the controller, and those output by this device. Each have the functions shown below.

Commands output by controller

Remote control (panel status transmission)
Panel status requests
Storage waveform data transmission requests
Waveform data write (waveform data and condition transmission)

Commands output by this device

Waveform data response (Response to waveform data transmission requests, waveform data and condition transmission)
Panel status response (Response to panel status requests, panel status transmission)

4) Processing when errors occur

When commands from the controller are not stored or execution is impossible, this device does nothing except output a command error service request.
When the command parameters output by the controller are outside the setting range, this device does nothing except output a command parameter error service request.
During multistatement operation, when 1 statement at a time is executed, an error occurrence statement is used to output an error service request, and the statements after that continue, ignoring the part before the delimiter (to prevent multiple errors).

5) Processing when parameters are omitted

When parameters are omitted, basically the parameter that is omitted uses the preceding value as the default, and setting are made only for the parameters that are not omitted. Therefore, if all the parameters are omitted, none of them are set, and no error is indicated.
However, when there is only one parameter, and that is an ON/OFF designation, the ON/OFF switching is perf ormed. Also, because depending on the command, there are cases when the operation with omitted parameters differs from the basic operation, for details, refer to the "Command Specifications".

6) Processing when there are field abbreviations

When the U field is omitted, the default value becomes "+". Only the abbreviation of the Vfield causes a parameters error.
When the W field is omitted, the default value becomes "E-0". Regarding the X field, when the number of data is insufficient, the received data is rewritten, and a data error service request is output. When the data is received, because every time it is received, it is rewritten, when the number of data is too large, only the number of data specified is rewritten, the rest of the data is ignored, and a data error service request is output.

7) GP-IB remote mode

Before using GP-IB control, it is necessary to select the remote mode. To do this, the GP-IB REN (Remote Enable) signal is set to "Low". If the REN signal is set to "High", the local mode is activated.
In the remote state, none of the panel operations can be performed, and operation can be performed only with remote control commands.

8) Service requests

In this device, when an error occurs, when the operation is ended, a service request is output by the serial polling. When the service request is detected by the controller, read the status byte and perform processing in accordance with its contents. The status byte has a meaning in each bit.

D08 : Expansion status bit "0"
D07 : SRQ (This indicates that a service request has been generated, always in 1)
D06 : Error
D505 : Busy
D04 to D01 : Status bit

9) Expansion status bytes

There are standard status bytes and expansion status bytes.
They are separated by D08 bits. When the D08 bit is "0", the standard status byte is indicated, and when it is "1", the expansion status bit is indicated. In the current DCS-8200, the expansion status byte is not used, so the D08 bit is always "0".

10) Status bytes

① End status
41 (H) : Waveform store complete
42 (H) : Plotter output complete
43 (H) : VPRSET complete
44 (H) : Auto set complete
45 (H) : Undefined
46 (H) : Undefined
47 (H) : Undefined
48 (H) : Undefined
49 to F (H) : Undefined

② BUSY status
51 (H) : Undefined

52 (H) : Outputing to plotter
53 (H) : VPRSET execution
54 (H) : AUTO SET execution
55 (H) : Undefined
56 (H) : Undefined
57 (H) : Undefined
58 (H) : Undefined
59 to F (H) : Undefined

③ Error status

61 (H) : Command error
Unstored commands received
According to real-time or storage mode, commands that became invalid were received.
62 (H) : Command parameter error
Out of range parameter specified. Parameter format error.
63 (H) : Undefined
64 (H) : Data error
In data transmission, data exceeded the range, and the number of data did not match.
65 (H) : Undefined
66 (H) : Undefined
67 (H) : Undefined
68 (H) : Undefined
69 to F (H) : Undefined

7-5 LIST OF COMMANDS

1 Status requests

1) STATUS : Panel setting status request

Format

T	Y	T(V)	Y	T(V)	Y	Z
STATUS	,	Request status...				Separator

Parameters

Request status (3 to 6 digits)	Command operand responding to status requested (T and V fields)

Function

Requests panel status from controller to this device.
In the parameters of 1 statement (up to the separator), the operands of the status requested are aligned and separated by Y-field commas (","). The status request can be performed only by the command operand in corespond to the remote control command. Basically, a parameter is not needed in the requested command operand. However, parameters for the channel numbers, memory numbers, etc., can be attached. For details, refer to each command. Output is not performed from this device.

Note : Select EOI as the delimiter.

[Example] STATUS, VOLTD, VPOSI, COUPLE :
VOLTS/DIV, vertical position and coupling are requested.

2 Vertical axis

1) VOLTD : VOLTS/DIV

Format

T	V	Y	V	W	Z
VOLTD	Channel No.	,	VOLTS/DIV	Unit	Separator

Parameters

Channel No. (1 digit)	1 : Channel 1 2 : Channel 2 3 : Channel 1 reference (Remote control cannot be performed) 4 : Channel 2 reference (Remote control cannot be performed)
VOLTS/DIV (3 Digits)	0.1, 0.2, 0.5, 1, 2, 5 : VOLTS/DIV constant portion in : V units.
Unit (3 digits)	Space : V E-3 : mV

Function

When output from the controller, the VOLTS/DIV setting of the designated channel is changed. With remote control, the channel number can only be designated as 1 or 2. However, if the channel number is omitted, the VOLTS/DIV of the previously designated channel number is changed. If the VOLTS/DIV is omitted, it will not operate.

When outputted during a status request, the command will be the VOLTS/DIV status request for to this device. In the case of a status request, the channel can be designated from 1 to 4. Also, if the channel number of the status request is not designated, the status request will respond to the VOLTS/DIV of all channels from 1 through 4.

```
[Example] VOLTD1, 50E-3          : Set CH1 VOLTS/DIV to 50mV.
          VOLTD2, 0.1            : Set CH2 VOLTS/DIV to 0.1V.
          STATUS, VOLTD1, VOLTD2 : Set previously set CH to 0.2V.
          STATUS, VOLTD          : Request VOLTS/DIV of CH1, CH2, reference 1 and reference 2.
```

2) COUPLE : Coupling

Format

T	V	Y	V	Z
COUPLE	CH No.	,	Coupling	Separator

Parameters

CH No.	1 : CH1
(1 digit)	2 : CH2
Coupling	1 : AC
(1 digit)	2 : DC

Function

When output from the controller, the input coupling setting of the designated channel is changed. If the channel number is omitted, the previously designated channel number will be controlled. If the COUPLE is omitted, it will not operate. The ground setting has priority over the input coupling, so turn the ground setting off when setting the input coupling. When outputted during a status request, the command will be the input coupling status request for to this device. In the case of a status request, the channel can be designated from 1 to 2. Also, if the channel number of the status request is not designated, the status request will respond to the coupling of all channels from 1 through 2.
From this device, as the response to the input coupling status request, this is output as the current input coupling setting status.

```
[Example] COUPLE 1, 1     : Set CH1 input coupling to AC.
          COUPLE 2, 2     : Set CH2 input coupling to DC.
          STATUS, COUPLE1 : CH1 coupling status request
```

3) GND : Ground

Format

T	V	Y	V	Z
GND	CH No.	,	ON/OFF	Separator

Parameters

CH No.	1 : CH1
(1 digit)	2 : CH2
ON/OFF	0 : OFF
(1 digit)	1 : ON

Function

When output from the controller, the ground setting of the designated channel is changed. If the channel number is omitted, the previously designated channel number will be controlled. When the GND ON/OFF parameter is omitted, the ground ON/OFF switching will be activated. When outputted during a status request, the command will be the ground status request for to this device. In the case of a status request, the channel can be designated from 1 to 2. Also, if the channel number of the status request is not designated, the status request will respond to the ground status of all channels from 1 through 2.

From this device, as the respons to the ground status request, this is output as the current ground setting status.

[Example] GND1, 0 : Set CH1 GND to OFF.
GND1 : Switch CH1 GND on and off.

4) VPOSI : Vertical position

Format

T	V	Y	U	V	Z
VPOSI	CH No.	,	Symbol	Position	Separator

Parameters

CH No. 1 : CH1
(1 digit) 2 : CH2
SYMBOL + : Above CRT center (CRT center : +0)
(1 digit) − : Below CRT center
Position 0.000 to 5.000 : Using CRT center as "0", −5.00 to +5.00 is disignated to the division.
(4 digits, 3 places after decimal point)

Function

When output from the controller, the vertical position setting of the designated channel is changed. All parameters are necessary. However, If the channel number is omitted, the previously designated channel number will be controlled. When the position is omitted, nothing will operate. When output during a status request, the command will be the vertical position status request for to this device. In the case of a status request, the channel can be designated from 1 to 2. Also, if the channel number of the status request is not designated, the status request will respond to the vertical position status of all channels from 1 through 2.

From this device, as the response to the vertical position status request this is output as the current vertical position.

[Example] VPOSI1, +0 : Centers the position
VPOSI1, −1.00 : Moves 1 division downword from the position center

5) VMODE : VERT MODE

Format

T	V	Z
VMODE	VERT-MODE	SEPARATOR

Parameters

		Real-time	Storage
VERT MODE	1 :	CH1	CH1
(1 digit)	2 :	CH2	CH2
	3 :	ALT	DUAL
	4 :	CHP	+
	5 :	ADD	-
	6 :		×
	7 :		÷

Function

When output by the controller, the VERT MODE setting is changed. If the parameter is omitted, nothing will operate. Because this control command corresponds to the VERT MODE on the panel, when switching between real-time and storage, the VERT MODE must be switched to the same position as that for panel operation.

When output during a status request, the command will be the VERT-MODE status request for to this device. From this device, the current vertical mode is output by this device as a response to the VRT-MODE status request.

[Example] Set ALT in the real-time mode, and DUAL in the storage mode.

6) INV : CH2 INV

Format

T	V	Z
INV	ON/OFF	Separator

Parameters

ON/OFF	0 :	OFF
(1 digit)	1 :	ON

Function

When output by the controller the CH2 INV setting will be changed. However, it can operate only in the real-time mode. When this command is output in the storage mode, it constitutes a command error. If the parameter is omitted, the CH2 INV ON/OFF switching can be performed . Because this control command corresponds to the panel CH2 INV, when switching between the real-time and storage modes, the VERT MODE changes as it does in the panel operation.

When output during a status request, the command will be the CH2 INV status request for to this device. From this device, the current CH2 INV setting state is output by this device as a response to the CH2 INV status request.

[Example] INV1 : CH2 input inversion is designated.

3 Horizontal axis

1) TIMEDA : TIME/DIV

Format

With remote control

T	V	W	Z
TIMEDA	TIME/DIV	Unit	Separator

With status request

T	V	Y	V	W	Z
TIMEDA	Reference	,	TIME/DIV	Unit	Separator

Parameters

CH No. 0 : Current TIME/DIV
1 : CH1 reference TIME/DIV
2 : CH2 reference TIME/DIV

TIME/DIV (4 Digits) 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000, 5000
TIME/DIV constant portion in : sec. units.

Unit (3 digits) Space : s/div
E-3 : ms/div
E-6 : μs/div
E-9 : ns/div

Function

When output by the controller, the TIME/DIV setting will be changed. Only the TIME/DIV parameter is necessary. Do not make the channel number designation because it will result in a parameter error. If the parameter is omitted nothing will operate. When output during a status request, it will become the TIME/DIV status request for this device. The channel number parameter can be designated.
When the channel number is omitted, it will respond to the current TIME/DIV and to the TIME/DIV of all the CH1 and CH2 references.

[Example] TIMEDA1OE-3 : Set to 10ms/div
STATUS, TIMEDA0 : Request current TIME/DIV

2) HPOSI : Horizontal axis position

Format

T	U	V	Z
HPOSI	Symbol	Position	Separator

Parameters

Symbol + : To the right of "0", with "0" being the CRT center
− : To the left of "0", with "0" being the CRT center
Position 0.000 to 6.000 : Set the position to −6div to +6div.
(4 digits, 3 positions to the right of the decimal point)

Function

When output by the controller, the horizontal position setting changes. If the parameter is omitted, nothing operates.
If output during the status request, it becomes the horizontal position status request for this device. From this device, as a response to the horizontal position status request, the current horizontal position is output.

[Exanmple] HPOSI +2.00 : Move the horizontal position 2 divisions to the right.

3) MAG : ×10MAG

Format

T	V	Z
MAG	ON/OFF	Separator

Parameters

ON/OFF	0 : OFF
(1 digit)	1 : ON

Function

When output by the controller, the ×10MAG setting changes. To control the ×10MAG switch on the panel, as in panel operation, it can operate only in the real-time mode. If this command is output in the storage mode, a command error will result. If the parameter is omitted, the ×10MAG ON/OFF switching is activated.
If output during the status request, it becomes the ×10MAG status request for this device.
From this device, as a response to the ×10MAG status request, the current ×10MAG status is output. However, in the storage mode, it responds to the ×10MAG setting status of the real-time mode that was in effect before the storage mode.

[Example] MAG1 : Set the ×10MAG to ON.
MAG : ×10MAG ON/OFF switching possible.

4) EQU : Equivalent sampling

Format

T	V	Z
EQU	ON/OFF	Separator

Parameters

ON/OFF	0 : EQU=OFF
(1 digit)	1 : EQU=ON

Function

When output by the controller the EQU setting changes. To control the EQU switch on the panel, as in panel operation, it can operate only in the storage mode. If this command is output in the realtime mode, a command error will result. If the parameter is omitted, the EQU ON/OFF switching is activated. When output during the status request, it becomes the EQU status request for this device. From this device, as a response to the EQU status request, the current EQU setting status is output. However, in the realtime mode, it responds to the EQU setting status of the storage mode that was in effect before the realtime mode.

[Example] EQU1 : Set the EQU ON.

5) HMODE : Horizontal axis operation mode

Format

T	V	Z
HMODE	Horizontal operation mode	Separator

Parameters

Horizontal axis operation mode (1 digit)	1 : AUTO 2 : NORM 3 : SINGLE

Function

When output by the controller, the horizontal axis operation mode setting changes. If the parameter is omitted, nothing operates.
When output during the status request, it becomes the horizontal axis operation mode status request for this device.
From this device, as a response to the horizontal axis operation mode status request, the current horizontal axis operation mode is output. In the storage mode, it ends with SINGLE operation, and an end service request is output.

[Example] HMODE2 : Set the horizontal axis operation mode to NORM.

6) XYS : X-Y mode

Format

T	V	Z
XYS	ON/OFF	Separator

Parameters

ON/OFF (1 digit)	0 : OFF 1 : ON

Function

When output by the controller, the X-Y mode setting changes. If the parameter is omitted, X-Y mode ON/OFF switching becomes possible.
When output during the status request, it becomes the X-Y mode status request for this device.
From this device, as a response to the X-Y mode status request, the current X-Y mode setting status is output.

[Example] XYS1 : Set the X-Y mode to ON.

4 TRIGGER

1) TRCPL : Trigger coupling

Format

T	V	Z
TRCPL	Trigger coupling	Separator

Parameters

Trigger coupling (1 digit)	1 : AC 2 : HF_{REJ} 3 : DC 4 : TV-V 5 : TV-H

Function

When output by the controller, the trigger coupling setting changes. If the parameter is omitted, nothing operates.
When output during the status request, it becomes the trigger coupling status request for this device. From this device, as a response to the trigger coupling status request, the current trigger coupling setting status is output.

[Example] TRCPL3 : Set the trigger coupling to DC.

2) SOURCE : Trigger source

Format

T	V	Z
SOURCE	Trigger source	Separator

Parameters

Trigger source
(1 digit)
1 : CH1
2 : CH2
3 : LINE
4 : EXT

Function

When output by the controller, the trigger source setting changes. If the parameter is omitted, nothing operates.
When output during the status request, it becomes the trigger source status request for this device. From this device, as a response to the trigger source status request, the current trigger source setting status is output.

[Example] SOURCE4 : Set the trigger source to EXT.

3) SLOPE : Trigger slope

Format

T	V	Z
SLOPE	Trigger slope	Separator

Parameters (1 digit)
1 : +
2 : −

Function

When output by the controller, the trigger slope setting changes. If the parameter is omitted, the +/- switching becomes possible.
When output during the status request, it becomes the trigger slope status request for this device. From this device, as a response to the trigger slope status request, the current trigger slope setting status is output.

[Example] SLOPE1 : Set the trigger slope to "+".

4) FIX : Fix mode

Format

T	V	Z
FIX	ON/OFF	Separator

Parameters (1 digit)
0 : OFF
1 : ON

Function

When output by the controller, the FIX setting can be performed. If the parameter is omitted, the FIX ON/OFF switching can be performed. When output during the status request, it becomes the FIX status request for this device. From this device, as a response to the FIX status request, the current FIX setting status is output.

[Example] FIX1 : Set the FIX mode to ON.

5 Cursor

1) CURSOR : Cursor mode and measured value

Format

Cursor mode control

T	V	Z
CURSOR	Cursor mode	Separator

With status request

T	V	Y	U	V	W	Z
Cursor	Cursor mode	,	Symbol	Measured value	Index	Separator

Parameters

Cursor mode (1 digit)
0 : Cursor OFF
1 : ΔV1
2 : ΔV2
3 : ΔT
4 : 1/Δ T

Symbol, Cursor setting, Index : Current cursor measured value
(1 digit) (5 digits) (3 digits)

Function

When output by the controller, the cursor mode setting changes. For the cursor mode setting, the cursor measured value parameter is not needed. If the parameter is omitted, nothing operates.
When output during the status request, it becomes the cursor mode and measured value request for this device.
From this device, as a response to the cursor mode status request, the current cursor mode and measured value is output.
When the cursor mode is off, the measured value response is space.

[Example] CURSOR1 : Select the ΔV1 cursor mode.
STATUS, CURSOR : Request cursor mode and measured value

2) CTRACK : Tracking designation

Format

T	V	Z
CTRACK	ON/OFF	Separator

Parameters

ON/OFF (1 digit)
0 : OFF
1 : ON

Function

When output by the controller the tracking setting changes. If the parameter is omitted, tracking ON/OFF switching is activated.
When output during the status request, it becomes the tracking status request for this device.
From this device, as a response to the tracking status request, the current tracking setting status is output.

[Example] CTRACK1 : Set the tracking to ON.

3) REFCS : ΔREF cursor movement

Format

T	U	V	Z
REFCS	Symbol	Position	Separator

Parameters

Symbols + : Top, using the CRT center as "0"
− : Bottom, using the CRT center as "0"

Position (4 digits, with 2 places after the decimal point)

With ΔV :
0.00 to 4.00 : −4 div to +4 div designation, using the CRT center as "0"
(When X-Y operation, ΔV2 is −5 div to +5 div designation)

With ΔT and 1/ΔT :
0.00 to 5.00 : −5 div to +5 div designation, using the CRT center as "0"

Function

When output by the controller, the ΔREF cursor position changes. If the parameter is omitted, nothing operates. When the tracking is on, when the ΔREF cursor is moved, the Δcursor moves the same distance.
When output during the status request, it becomes the ΔREF cursor position status request for this device.
From this device, as a response to the ΔREF cursor position status request, the current ΔREF cursor position is output.

[Example] REFCS+1.23 : Set ΔREF cursor position to 1.23 div.
TRACK1 : REFCS+2.00: In the tracking mode, set the ΔREF cursor to 2 div, and move the Δcursor for the same distance as the ΔREF cursor.

4) DELTA : Δcursor movement

Format

T	U	V	Z
DELTA	Symbol	Position	Separator

Parameters

Symbols +: Top, using the CRT center as "0"
−: Bottom, using the CRT center as "0"

Position (4 digits, with 2 places after the decimal point)

With ΔV :
0.00 to 4.00 : −4 div to +4 div designation, using the CRT center as "0"
(When X-Y operation, ΔV2 is −5 div to +5 div designation)

With ΔT and 1/ΔT :
0.00 to 5.00 : −5 div to +5 div designation, using the CRT center as "0"

Function

When output by the controller, the Δcursor position changes. If the parameter is omitted, nothing operates. When output during the status request, it becomes the Δcursor position status request for this device.
From this device, as a response to the Δcursor position status request, the current Δcursor position is output.

[Example] DELTA−1.00: Set the Δcursor position to −1 div.

6 Programs

1) SET : Program SET

Format

T	V	Z
SET	ON/OFF	Separator

Parameters

ON/OFF (1 digit) 0 : OFF
1 : ON

Function

When output by the controller, the same function as the panel program SET is performed. When the parameter is on, the program SET status is activated, and when off, the program SET status is released. If the parameter is omitted, SET status ON/OFF switching is activated. When output during the status request, it becomes the program set status request for this device. From this device, it is output as a program set status request. It responds with "ON" in the program set mode.

[Example] SET1 : Set the program write mode.

2) RUN : Program RUN

Format

T	V	Z
RUN	ON/OFF	Separator

Parameters

ON/OFF (1 digit)	0 : OFF 1 : ON

Function

When output by the controller the same function as the panel program RUN switch is performed. When the parameter is on, the program RUN mode is activated, and when off, the program RUN mode is released. If the parameter is omitted, program RUN mode ON/OFF switching is activated. When output during the status request, it becomes the program RUN status request for this device.
From this device, it is output as a program RUN mode status request. It responds with "ON" in the program RUN mode.

[Example] RUN1 : Set the program RUN mode.

3) STEP : STEP

Format

T	V	Z
STEP	Step No.	Separator

Parameter

Step No. (2 digits)	Step No. from 1 to 20

Function

When output from the controller, a function equivalent to pressing the STEP switch is performed.
Functions only in the program write and execution modes. When it is output under other conditions, a command error results.
In the program write mode, if the parameter is a space, program write is performed, and the next step is proceeded to. When the parameter step number is specified, the resulting movement (SKIP function) is the same as that when the STEP switch is held down.
Program writing is performed to the current step, the next designated step number is skipped to, and the programs are not written into the steps that are skipped.
If parameter is omitted in the program write mode, the following steps are executed. When the parameter step number is designated, the steps before the designated step number are skipped, and the program of the designated step is executed. However, in the program execution mode, if the designated step number is set to skip, that step is skipped, and the control moves to the next step number that is set to skip.
Also, when output during the status request, it becomes the current step number request for this device. From this device, it inserts the step number in the parameter, and is output as a response to the step number request. Except in the execution mode and write mode, it always responds with "Step No. 1".

[Example] STEP : Next STEP
STEP 10 : Step No. skips to Step No. 10.

4) SKIP : SKIP

Format

With remote control

T	V	Z
SKIP	ON/OFF	Separator

With status request

T	V	Y	V	Z
SKIP	Step No.	,	ON/OFF	Separator

Parameters

Step No. (2 digits)	Step No. from 1 to 20
ON/OFF (1 digit)	0 : OFF 1 : ON (Skip setting)

Function

When output from the controller in the program write mode, the program skip setting is performed. Only the parameter ON/OFF parameter is needed, and when ON, skip is performed, and when OFF, skip is released and RUN is activated. When performed in a status other than the program write mode, a command error occurs. Also, when output during the status request, it becomes the current step number skip setting status request for this device. From this device, as a response to the step number request, it outputs the current step number and skip setting. Except in the program write mode, it always responds with "0".

[Example] SKIP1 : Set skip to ON.
SKIP10, 0 : STEP=10 responds with the step release status.

7 Storage

1) STOR : Storage mode

Format

T	V	Z
STOR	ON/OFF	Separator

Parameters

ON/OFF (1 digit)	0 : OFF (REAL) 1 : ON (STOR)

Function

When output from the controller the real-time mode/storage mode switching is activated. If the parameter is omitted, storage mode ON/OFF switching becomes possible. When output during the status request, it becomes the real-time mode/storage mode inquiry for this device.
From this device, it is output as a response to the real-time mode/storage mode status request. When the storage mode is on, it responds with "real-time mode OFF".

[Example] STOR1 : Set to storage mode.

2) HOLD : HOLD

Format

T	V	Z
HOLD	ON/OFF	Separator

Parameters

ON/OFF	0 : OFF (RUN)
(1 digit)	1 : ON (HOLD)

Function

When output from the controller, the RUN/HOLD switching is activated. But it is only performed in the storage mode, and if output during the real-time mode, a command error occurs. If the parameter is omitted, the HOLD ON/OFF switching is activated. Also, when output during the status request, it becomes the RUN/HOLD status inquiry.

From this device, it is output as a response to the RUN/HOLD status request. When the HOLD is ON, it responds with "OFF" during the RUN mode. However, in the real-time mode, it responds with the setting of the preceding storage mode.

[Example] HOLD1 : HOLD setting

3) DELAY : Trigger delay

Format

T	V	U	V	Z
DELAY	ON/OFF	Pre/post	Trigger delay	Separator

Parameters

ON/OFF	0 : OFF (Trigger delay OFF)
(1 digit)	1 : ON (Trigger delay ON)
Pre/Post	+: Post-trigger
(1 digit)	−: Pre-trigger
Trigger delay :	Post-trigger = 0～10,000div
	Pre-trigger = 0～80div

Function

When output from the controller the trigger delay setting is changed, but it is only performed in the storage mode, and if output during the real-time mode, a command error occurs. The delay time setting is set for every division.

If the parameter is omitted, nothing operates. Also, when output during the status request, it becomes the trigger delay status request.

From this device, as a response to the trigger position status request, it outputs the current trigger delay setting value. However, in the real-time mode, it responds with the setting of the preceding storage mode.

[Example] DELAY1, -10 : Set the pre-trigger to −10div with trigger delay ON.

4) DISPAD : Display address

Format

T	V	Y	V	Z
DISPAD	ON/OFF	,	Display address	Separator

Parameters

ON/OFF (1 digit)	0 : OFF (Display address OFF)	
	1 : ON (Display address ON)	
Display address (5 digits)	0 to 16383 :	The first designated display address
		When the memory size is 16KW, 0 to 16383
		When the memory size is 2KW, 0 to 2047
		When the memory size is 5KW , 0 to 5119

Function

When output from the controller, the display address is changed, but it is only performed in the storage mode, and if output during the real-time mode, a command error occurs. If the parameter is omitted, nothing operates. Also, when output during the status request, it becomes the display address status request.

From this device, as a response to the display address status request, it outputs the current display address.

[Example] DISPAD1, 1000 : Set the display address to 1000 with display address is ON.
DISPAD0 : Display address is OFF.

5) REF : REF-DISP ON/OFF

Format

T	V	Z
REF	ON/OFF	Separator

Parameters

ON/OFF (1 digit)	0 : REF-DISP OFF	
	1 : REF-DISP ON	

Function

When output from the controller, the REF-DISP ON setting is performed, but it is only performed in the storage mode, and if output during the real-time mode, a command error occurs. If the parameter is omitted, ON/OFF switching is activated. Also, when output during the status request, it becomes the REF-DISP ON/OFF status request.

From this device, as a response to the REF-DISP ON/OFF status request, it outputs the current REF-DISP ON/OFF status. However, in the real-time mode, it always responds with "OFF".

[Example] REF1 : Set REF-DISP to ON.

6) SAVE : REF-SAVE

Format

T	Z
SAVE	Separator

Function

When output from the controller, a function the same as pressing the REF-SAV switch is performed. When output when the REF is not on, a command error occurs. Also, the command error occurs even when the command is output in the real-time mode. Status requests cannot be performed.
Output cannot be performed from this device.

[Example] SAVE : SAVE command

7) DPEAK : DETECT PEAK

Format

T	V	Y	V	Z
DPEAK	ON/OFF	,	Mode	Separator

Parameters

ON/OFF (1 digit)
0 : Peak detector off
1 : Peak detector on

Mode (1 digit)
1 : MAX
2 : MIN
3 : MAX/MIN

Function

When output from the controller, the peak detector ON/OFF switching is activated. However, it only functions in the storage mode. If output during the real-time mode, a command error occurs. If the parameter and mode is omitted, the peak detector ON/OFF switching is activated. Also, when output during the status request, it becomes the peak detector status request.
From this device, as a response to the peak detector status request, it outputs the current peak detector setting status. However, in the real-time mode, it responds with the setting of the preceding storage mode.

[Example] DPEAK1 : Set the peak detector to ON.
DPEAK, 3 : Set the peak detector to MAX/MIN. (ON/OFF not switching)
DPEAK1, 1 : Turn peak detector ON and set to MAX.

8) INTERP : Interpolation system

Format

T	V	Z
INTERP	Interpolation system	Separator

Parameters

Interpolation system (1 digit)
0 : Previous value interpolation
1 : LINEAR interpolation
2 : SIN interpolation

Function

When output from the controller, the interpolation system setting is performed. However, it only functions in the storage mode. If output during the real-time mode, a command error occurs. If the

parameter is omitted, nothing operates. Also, when output during the status request, it becomes the interpolation system status request.
From this device, as a response to the interpolation system status request, it outputs the current interpolation system. However, in the real-time mode, it responds with the setting of the preceding storage mode.

[Example] INTERP2 : Set SIN interpolation.

9) AVERAG : Averaging

Format

T	V	Y	V	Z
AVERAG	ON/OFF	,	Number of times	Separator

Parameters

ON/OFF (1 digit)	0 : AVG OFF 1 : AVG ON
Number of times (3 digits)	2 : twice 4 : 4 times 8 : 8 times 16 : 16 times 32 : 32 times 64 : 64 times 128 : 128 times 256 : 256 times

Function

When output from the controller the averaging ON/OFF and number of times settings are changed. However, it only functions in the storage mode. If output during the real-time mode, a command error occurs. If the parameter is omitted, with that setting remaining as it is, only the settings with designated parameters are performed. However, if all the parameters are omitted, only the averaging ON/OFF switching can be performed. Also, when output during the status request, it becomes the averaging ON/OFF and number of times status request.
From this device, as a response to the averaging status request, it outputs the averaging ON/OFF status and the number of times. However, in the real-time mode, it responds with the setting of the preceding storage mode.

[Example] AVERAG1, 4 : Turn averaging on and set number of times to 4 times.
AVERAG : Switch the averaging ON/OFF.
AVERAG1 : Set the averaging to ON.
ACERAG, 32 : Set the number of times to 32 times.

10) PLOT : Plotter output

Format

T	V	Z
PLOT	ON/OFF	Separator

Parameters

		Control	Status
ON/OFF	0 : OFF	Stop plotter	Plotter output ended
(1 digit)	1 : ON	Start Plotter	Plotter output inprogress

Function

When output from the controller, the plotter output control is performed. When ON is output, the plotter starts, and when OFF is output, the plotter output stops. If the parameter is omitted, the ON/OFF switching is activated. During the plotter output, SRQ is ON and the BUSY status (52H) is output. During the plotter output, the SRQ is on and the busy status (52H) is output. However, the PLOT 1 command only is ignored.

When the plotter output is finished, the END status (42H) is output. Other commands cannot be received during the plotter output. Also, "STATUS" response is not output.

Since this command cannot be used except during the storage mode when the HOLD is ON, when it is used under conditions other than these, an error status (61H) is output.

[Example] PLOT1 : Start the plotter output.

11) VPRSET : Reference level adjustment of VPOSI

Format

T	Z
VPRSET	Separator

Function

Command used to align VPOSI center value (VPOSI 0) with waveform data center value (125). When waveform data transfer (WREAD) is executed, if it is used in combination with this command, the center value of VPOSI 0 is automatically corrected to its value when it is A/D converted (125).

During the correction, BUSY status (53H) is output.

After completion, the END status is output. However, becouse this can be used only with STORAGE mode normal sampling, if it used in another condition, an ERROR status (61H) is output.

"STATUS" response cannot be performed.

[Example] VPRSET : Automatic correction of VPOSI 0

8 AUTO SET

1) AUTOR : Auto set

Format

T	V	Y	V	Y	V	Y	V	Z
AUTOR	ON/OFF	,	Mode	,	V constant	,	H constant	Separator

Parameters

		Control	Status
ON/OFF	0 : OFF	Constant setting	Auto set ended
(1 digit)	1 : ON	Start auto set	Auto set in progress

Auto set mode (1 digit)	1 : Auto set mode V 2 : Auto set mode H 3 : Auto set mode VH
V constant (1 digit)	2 : V constant 2 div 4 : V constant 4 div 6 : V constant 6 div
H constant (1 digit)	2 : H constant 2 cycles 5 : H constant 5 cycles

Function

When output from the controller, the auto set starts and the constant setting is performed. If the ON/OFF parameter is set to 1, the auto set starts. If the ON/OFF parameter is set to 0, only the mode, V constant and H constant settings are performed. When either the mode, V constant or H constant command is omitted, the omitted setting remains unchanged and only the specified performed are set.
When all the parameters are omitted, the auto set starts with the conditions set as they are. Also, when output during the status request, it becomes the auto set status request.
From this device, as a response to the auto set status request, it responds with the auto set execution conditions (When auto-set OFF state only), mode, V constant and H constant.
During the execution of AUTOSET, a BUSY status (54H) is output.

Note: During the execution of "AUTOR" when the HOLD is ON, an SRQ (61H) is output. However, when it is executed with constant settings attached, the settings are updated.

[Example] AUTOR1, 3, 2, 2 : Execute auto set with VH mode, 2div V constant, and 2-cycle H constant.
AUTOR : Execute auto set with conditions that are set.
AUTOR0, 1, 4, 5 : Set to V mode, 4div V constant, and 5-cycle H constant.
AUTOR1...2 : Set the H constant to 2-cycle and its execution.

9 Data transfer request

1) WREAD : Data transfer request (From DCS-8200 to controller)

Format

T	V	Y	V	Y	V	Y	V	Y	V	Z
WREAD	CH No.	,	Memory	,	Data system	,	Start address	,	No. of data	Separator

Parameters

Channel (1 digit)	1 : CH1 2 : CH2
Memory (1 digit)	1 : Acquisition memory 2 : Reference memory
Data system (1 digit)	1 : ASCII 2 : Binary
Memory address (5 digits)	0 to 16383 : When effective memory is 16KW 0 to 2047 : When effective memory is 2KW 0 to 5119 : When effective memory is 5KW (with averaging)

No. of data	1 to 16384	: When effective memory is 16KW
(5 digits)	1 to 2048	: When effective memory is 2KW
	1 to 5120	: When effective memory is 5KW (with averaging)

Function

A data transfer request is made from the controller to the this device. If the parameters are omitted the settings for which the parameters were omitted remain as they were, and the data transfer request. This command can be executed only in the storage mode when HOLD is in the ON status. A status request cannot be performed. The response to this command is performed with the data transfer command (WOUT) format.

Note : The center value of the waveform will be 125.

[Example] WREAD1, 1, 1, 0, 2048 : Request the 2048-word data transter from the beginning of the CH1 waveform memory.

WREAD : Request data transfer with the conditions that are set.

10 Data transfer

1) WOUT : Waveform data transfer (From controller to DCS-8200)

Format

T	V	Y	V	Y	V	Y	V	Y	V	Y	X	Z
WOUT	CH No.	,	Memory	,	Data system	,	Start address	,	No. of data	,	Data portion	Delimiter

Parameters

Channel	1 : CH1	
(1 digit)	2 : CH2	
Memory	1 : Acquisition memory	
(1 digit)	2 : Reference memory	
Data system	1 : ASCII	
(1 digit)	2 : Binary	
Memory address	0 to 16383	: When effective memory is 16KW
(5 digits)	0 to 2047	: When effective memory is 2KW
	0 to 5119	: When effective memory is 5KW (with averaging)
No. of data	1 to 16384	: When effective memory is 16KW
(5 digits)	1 to 2048	: When effective memory is 2KW
	1 to 5120	: When effective memory is 5KW (with averaging)

Data portion

With ASCII, the data are separated by ","
000 to 255
With binary
00 to FF (hex)

Delimiter

With ASCII, with setting of the DIP switches on the rear panel, CR/LF or EOI can be selected. With binary, only EOI can be used.

Function

Data transfer is performed from the controller. When the parameter is "space", the data is transferred in its priginal condition.
However, this command can be executed only in the storage mode when HOLD is in the ON state.
When data is transferred from the controller to this device, every time data is received, the rewriting of the data in the memory is performed. For this reason, even when an error is generated during transfer, the data is rewritten until the error occurs. Status requests cannot be made. To request waveform data, use the waveform data request command (WREAD).

[Example] WOUT1, 1, 1, 0, 2048, 010, 023, 033,...120
Transfer 2048-word data from the beginning of the CH1 waveform memory.
WOUT .....123, 126, 140.....
Transfer data with the conditions that are set.

7-6 PROGRAM EXAMPLES

Examples of programs that for the controller (with the PC-98) that performs remote control of this device are shown below.

Program example 1 **** The program used to the VOLTS/DIV of CH1 to 50mV.

Note: Set the delimiter on the rear panel to "EOI".
Set the controller GP-IB address to "0", and the DCS-8200 GP-IB address to "1".

```
10  '
20  '************************************
30  '*   CS-REM  :  Remote Control      *
40  '*                                  *
50  '*                                  *
60  '*    Example Program               *
70  '************************************
80  '
90  '
100 '
110 ''**** GP-IB Initialize
120 '
130     ISET IFC          ' GP-IB Interface Clear
140     ISET REN          ' Remote Enable
150 '
160 ''**** Enable Service Request
170     ON ERROR GOTO *END.P     ' If the control does not end within 5 seconds, go to line 560.
180     ON SRQ GOSUB *RCVSRQ     ' Set SRQ ON to go to line 470.
190     SRQ  ON
200 '
210 ''**** Set Time Out Timer
220 '
230     CMD TIMEOUT=5     ' Set the timer to 5 seconds.
240 '
250 '
260 ''**** Delimitter Control
270 '
280     CMD DELIM=3       ' 0: CrLf
290                       ' 1: Cr
300                       ' 2: Lf
310                       ' 3: with EOI
320                       ' Select the timing of EOI.
```

```
330 ''************************************
340 '
350 ''**** Message Send Process
360 '
370     PRINT@1; "VOLTD1,50E-3:" @
380                     ' Set the CH1 VOLTS/DIV to 50mV
390                     ' Last Data with EOI  ( @ )
400 '
410     PRINT
420     PRINT "VOLTD1, 50E-3"     ' Display the send command on the CRT
430     PRINT
440 '
450     GOTO   *END.P
460 '
470 ''**** SRQ Receive Process
480 '
490 *RCVSRQ
500     POLL 1,CS.STAT    ' Set SRQ ON for the status byte display.
510 '
520     PRINT "CS-Unit Status = ";HEX$  ( CS.STAT )
530     SRQ ON
540     RETURN
550 '
560 ''**** END Process
570 '
580 *END.P
590     FOR I=0 TO 5000 : NEXT I ' Wait
600     IRESET REN        ' Disable Remote Control
610     END
```

Program example 2 ···· The program used to display the range to which the VOLTS/DIV of CH1 is set.

```
10  '
20  '************************************
30  '*   CS-REM  :  STATUS GET          *
40  '*                                  *
50  '*                                  *
60  '*    Example Program               *
70  '************************************
80  '
90  '
100 '
110 ''**** GP-IB Initialize
120 '
130     ISET IFC          ' GP-IB Interface Clear
140     ISET REN          ' Remote Enable
150 '
160 ''**** Enable Service Request
170     ON ERROR GOTO *END.P      ' If recsiving can not be performed within 5 seconds, go to *END.P.
180     ON SRQ GOSUB *RCVSRQ      ' Set SRQ ON to go to *RCVSRQ
190     SRQ  ON
200 '
210 ''**** Set Time Out Timer
220 '
230     CMD TIMEOUT=5     '  Set the timer to 5 seconds.
240 '
250 '
260 ''**** Delimitter Control
270 '
280     CMD DELIM=3       ' 0: CrLf
290                       ' 1: Cr
300                       ' 2: Lf
310                       ' 3: with EOI
```

```
320                     ' Select the timing of EOI.
330 ''*************************************
340 '
350 ''**** Message Send Process
360 '
370     PRINT@1; "STATUS,VOLTD1:" @
380                     ' What range is the VOLTS/DIV of CH1 set to ?
390                     ' Last Data with EOI  ( @ )
400 '
410 '
420 ''**** Answer Read Process
430 '
440     INPUT@1; A$, B$
450 '
460 ''**** Print Out Message
470 '
480     PRINT
490     PRINT    "STATUS, VOLTD1=" ; B$ ' The command sent to the CRT, and the range of CH1 is displayed.
500     PRINT
510 '
520     GOTO *END.P
530 '
540 ''**** SRQ Receive Process
550 '
560 *RCVSRQ
570     POLL 1,CS.STAT   ' Get STB from CS-Unit
580 '
590     PRINT "CS-Unit Status = ";HEX$  ( CS.STAT )
600     SRQ ON
610     RETURN
620 '
630 ''**** END Process
640 '
650 *END.P
660     FOR I=0 TO 5000 : NEXT I '  Wait
670     IRESET REN       ' Disable Remote Control
680     END
```

Program example 3 **** An example of replacing the contents of the waveform memory of the DCS-8200 with the waveform data sent from the controller.

Object channel : CH1
Memory : Acquisition memory

Data format : ASCII

Memory address : From address number 0
Number of data : 10 werds

Transfer data : 125, 126, 127, 128, 129, 130, 131, 132, 133, 134

```
10  '
20  '************************************
30  '*   CS-REM  :  WAVE DATA PUT      *
40  '*                                 *
50  '*                                 *
60  '*    Example Program              *
70  '************************************
80  '
```

```
90  '
100 '
110 ''**** GP-IB Initialize
120 '
130     ISET IFC          ' GP-IB Interface Clear
140     ISET REN          ' Remote Enable
150 '
160 ''**** Enable Service Request
170     ON ERROR GOTO *END.P      ' If the control does not end within 5 seconds, go to *END.P
180     ON SRQ GOSUB *RCVSRQ      ' Set SRQ ON to go to *RCVSRQ
190     SRQ  ON
200 '
210 ''**** Set Time Out Timer
220 '
230     CMD TIMEOUT=5     '  Set the timer to 5 seconds.
240 '
250 '
260 ''**** Delimitter Control
270 '
280     CMD DELIM=3       ' 0: CrLf
290                       ' 1: Cr
300                       ' 2: Lf
310                       ' 3: with EOI
320 '                     ' Select the timinng of EOI.
330 ''************************************
340 '
350 ''**** Message Send Process
360 '
370     PRINT@1; "WOUT1, 1, 1, 0, 10, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134 :"@
380                       ' Data from the first address "0" to address "10" is transmitted in ASCII format
                            to the acquisition memory of CH1.
390                       ' Last Data with EOI  ( @ )
400 '
410     PRINT
420     PRINT "WOUT1, 1, 1, 0, 10"     'Display the send command on the CRT
430     PRINT
440 '
450     GOTO *END.P
460 '
470 ''**** SRQ Receive Process
480 '
490 *RCVSRQ
500     POLL 1,CS.STAT    ' Get STB from CS-Unit
510 '
520     PRINT "CS-Unit Status = ";HEX$  ( CS.STAT)
530     SRQ ON
540     RETURN
550 '
560 ''**** END Process
570 '
580 *END.P
590     FOR I=0 TO 5000 : NEXT I
600     IRESET REN        ' Disable Remote Control
610     END
```

Program example 4 ▪▪▪▪ Example of reading out the waveform data of the DCS-8200 with the controller.

Object channel : CH1
Memory : Acquisition memory

Data format : ASCII

Memory address : From address number 0
Number of data : 20 words

The data read out in this program example is displayed on the CRT screen.

```
10  '
20  '************************************
30  '*   CS-REM  :  WAVE DATA GET       *
40  '*                                  *
50  '*                                  *
60  '*    Example Program               *
70  '************************************
80  '
90  '
100     DIM F$ ( 50 )    ' Secure the memory area
110 '
120 ''**** GP-IB Initialize
130 '
140     ISET IFC          ' GP-IB Interface Clear
150     ISET REN          ' Remote Enable
160 '
170 ''**** Enable Service Request
180     ON ERROR GOTO *END.P      ' If the receive does not end within 5 seconds, go to *END.P
190     ON SRQ GOSUB *RCVSRQ      ' Set SRQ ON to go to *RCVSRQ
200     SRQ  ON
210 '
220 ''**** Set Time Out Timer
230 '
240     CMD TIMEOUT=5     '  Set the timer to 5 seconds.
250 '
260 '
270 ''**** Delimitter Control
280 '
290     CMD DELIM=3       ' 0: CrLf
300                       ' 1: Cr
310                       ' 2: Lf
320                       ' 3: with EOI
330                       ' Select the timing of EOI.
340 ''************************************
350 '
360 ''**** Message Send Process
370 '
380     PRINT@1; "WREAD 1, 1, 1, 0, 20 :"@
390                       ' The CH1 memory contents are recived in the first address "0" to address "20".
400                       ' Last Data with EOI  ( @ )
410 '
420     PRINT
430     PRINT "WREAD"
440     PRINT
450 '
460 ''**** Answer Read Process
470 '
480     LINE INPUT @1 ; D1$
490 '
500 '
510 ''**** Print Out Wave Data
520 '
530     PRINT D1$
540     PRINT
550 '
560 ''**** Wait Key-Board Input
570 '
580     PRINT "PUSH Any Key"
590 '
600 *KB.WAIT
```

```
610     KB$ = INKEY$
620     IF KB$ = "" THEN *KB.WAIT
630     GOTO *END.P
640 '
650 ''**** SRQ Receive Process
660 '
670 *RCVSRQ
680     POLL 1, CS.STAT  ' Get STB from CS-Unit
690 '
700     PRINT "CS-Unit Status = ";HEX$  ( CS.STAT )
710     SRQ ON
720     RETURN
730 '
740 ''**** END Process
750 '
760 *END.P
770     FOR I = 0 TO 5000 : NEXT I ' Wait
780     IRESET REN       ' Disable Remote Control
790     END
```

Examples of programs that for the controller (with the IBM PC) that performs remote control of this device are shown below.

Language BASICA

Program example 1 **** The program used to the VOLTS/DIV of CH1 to 50mV.

Note: Set the delimiter on the rear panel to "EOI".
Set the controller GP-IB address to "0", and the DCS-8200 GP-IB address to "1".

```
100 '
110 '*****************************************************************
120 '*                      DCS Remote Control                       *
130 '*   Computer  :  IBM PC / AT (R)                                *
140 '*      I / F  :  National Instruments (R) GP-IB ( IEEE-488 )    *
150 '*                    Example Program No.1                       *
160 '*****************************************************************
170 '
180 ' Set up
190 '
200  CLEAR ,60000! : IBINIT1=60000! : IBINIT2=IBINIT1+3
210  BLOAD "\bib.m", IBINIT1
220  CALL IBINIT1 ( IBFIND, IBTRG, IBCLR, IBPCT, IBSIC, IBLOC, IBPPC, IBBNA, IBONL, IBRSC, IBSRE, IBRSV, IBPAD, IBSAD,
                    IBIST, IBDMA, IBEOS, IBTMO, IBEOT, IBRDF, IBWRTF, IBTRAP, IBDEV, IBLN )
230  CALL IBINIT2 ( IBGTS, IBCAC, IBWAIT, IBPOKE, IBWRT, IBWRTA, IBCMD, IBCMDA, IBRD, IBRDA, IBSTOP, IBRPP, IBRSP,
                    IBDIAG, IBXTRC, IBRDI, IBWRTI, IBRDIA, IBWRTIA, IBSTA%, IBERR%, IBCNT% )
240 '
250 ' Initialize
260 '
270  UDNAME$ = "dcs"
280  CALL  IBFIND ( UDNAME$, DCS% )
290  IF DCS% < 0 THEN GOTO 570
300  CALL  IBCLR ( DCS% )                          ' Send device clear
310  ON ERROR GOTO 540
320 '
330  V% = 9 : CALL  IBTMO  ( DCS%, V% )            ' Time out
340  V% = 1 : CALL  IBEOT  ( DCS%, V% )            ' End of string with EOI
350 '
360 ' Send message
370 '
380  WRT$ = "VOLTD1,50E-3:"                        ' DCS command
```

```
390   CALL  IBWRT ( DCS%, WRT$ )
400   MASK% = &H4800                              ' Time out or SRQ
410   CALL  IBWAIT ( DCS%, MASK% )
420   FOR I=0 TO 500 : NEXT I
430   IF ( IBSTA% AND &H800 ) <> 0 GOTO 490       ' On SRQ go to "Device Status"
440   PRINT WRT$                                  ' Print DCS command
450   GOTO 540
460   '
470   ' Receive device status
480   '
490   CALL IBRSP ( DCS%, SPR% )
500   PRINT "DCS-UNIT STATUS = ";HEX$ ( SPR% )    ' Print DCS-UNIT STATUS
510   '
520   ' End process
530   '
540   CALL IBLOC ( DCS% )                         ' Send device local
550   END
560   '
570   PRINT "IBFIND ERROR"
580   END
```

Program example 2 **** The program used to display the range to which the VOLTS/DIV of CH1 is set.

```
100   '
110   '*****************************************************************
120   '*                      DCS Remote Control                       *
130   '*   Computer   :  IBM PC / AT (R)                              *
140   '*      I / F   :  National Instruments (R) GP-IB ( IEEE-488 )   *
150   '*                    Example Program No.2                       *
160   '*****************************************************************
170   '
180   ' Set up
190   '
200   CLEAR ,60000! : IBINIT1=60000! : IBINIT2=IBINIT1+3
210   BLOAD "\bib.m", IBINIT1
220   CALL IBINIT1 ( IBFIND, IBTRG, IBCLR, IBPCT, IBSIC, IBLOC, IBPPC, IBBNA, IBONL, IBRSC, IBSRE, IBRSV, IBPAD, IBSAD,
                     IBIST, IBDMA, IBEOS, IBTMO, IBEOT, IBRDF, IBWRTF, IBTRAP, IBDEV, IBLN )
230   CALL IBINIT2 ( IBGTS, IBCAC, IBWAIT, IBPOKE, IBWRT, IBWRTA, IBCMD, IBCMDA, IBRD, IBRDA, IBSTOP, IBRPP, IBRSP,
                     IBDIAG, IBXTRC, IBRDI, IBWRTI, IBRDIA, IBWRTIA, IBSTA%, IBERR%, IBCNT% )
240   '
250   ' Initialize
260   '
270   UDNAME$ = "dcs"
280   CALL  IBFIND ( UDNAME$, DCS% )
290   IF DCS% < 0 THEN GOTO 590
300   CALL  IBCLR ( DCS% )                        ' Send device clear
310   ON ERROR GOTO 560
320   '
330   V% = 7 : CALL  IBTMO  ( DCS%, V% )          ' Time out
340   V% = 1 : CALL  IBEOT  ( DCS%, V% )          ' End of string with EOI
350   '
360   ' Send message
370   '
380   WRT$ = "STATUS, VOLTD1:"                    ' DCS command
390   CALL  IBWRT ( DCS%, WRT$ )
400   RD$ = SPACE$ ( 20 )
410   CALL  IBRD ( DCS%, RD$ )                    ' Receive DCS data
420   MASK% = &H4800                              ' Timeout or SRQ
430   CALL  IBWAIT ( DCS%, MASK% )
440   FOR I=0 TO 500 : NEXT I
450   IF ( IBSTA% AND &H800 ) <> 0 GOTO 510       ' On SRQ go to "Device Status"
460   PRINT "STATUS", RD$                         ' Print DCS data
470   GOTO 560
```

```
480  '
490  ' Receive device status
500  '
510   CALL IBRSP ( DCS%, SPR% )
520   PRINT "CS-UNIT STATUS = ";HEX$ ( SPR% )      ' Print DCS-UNIT STATUS
530  '
540  ' End process
550  '
560   CALL  IBLOC ( DCS% )                         ' Send device local
570   END
580  '
590   PRINT "IBFIND ERROR"
600   END
```

Program example 3 **** An example of replacing the contents of the waveform memory of the DCS-8200 with the waveform data sent from the controller.

Object channel : CH1
Memory : Acquisition memory

Data format : ASCII

Memory address : From address number 0
Number of data : 10 werds

Transfer data : 121, 122, 123, 124, 125, 126, 127, 128, 129, 130

```
100  '
110  '*********************************************************************
120  '*                      DCS Remote Control                           *
130  '*   Computer  :  IBM PC / AT (R)                                    *
140  '*      I / F  :  National Instruments (R) GP-IB ( IEEE-488 )        *
150  '*                    Example Program No.3                           *
160  '*********************************************************************
170  '
180  ' Set up
190  '
200   CLEAR ,60000! : IBINIT1=60000! : IBINIT2=IBINIT1+3
210   BLOAD "\bib.m", IBINIT1
220   CALL IBINIT1 ( IBFIND, IBTRG, IBCLR, IBPCT, IBSIC, IBLOC, IBPPC, IBBNA, IBONL, IBRSC, IBSRE, IBRSV, IBPAD, IBSAD,
                     IBIST, IBDMA, IBEOS, IBTMO, IBEOT, IBRDF, IBWRTF, IBTRAP, IBDEV, IBLN )
230   CALL IBINIT2 ( IBGTS, IBCAC, IBWAIT, IBPOKE, IBWRT, IBWRTA, IBCMD, IBCMDA, IBRD, IBRDA, IBSTOP, IBRPP, IBRSP,
                     IBDIAG, IBXTRC, IBRDI, IBWRTI, IBRDIA, IBWRTIA, IBSTA%, IBERR%, IBCNT% )
240  '
250  ' Initialize
260  '
270   UDNAME$ = "dcs"
280   CALL  IBFIND ( UDNAME$, DCS% )
290   IF DCS% < 0 THEN GOTO 570
300   CALL  IBCLR ( DCS% )                         ' Send device clear
310   ON ERROR GOTO 540
320  '
330   V% = 7 : CALL  IBTMO  ( DCS%, V% )           ' Time out
340   V% = 1 : CALL  IBEOT  ( DCS%, V% )           ' End of string with EOI
350  '
360  ' Send message
370  '
380   WRT$ = "STOR1:HOLD1:WOUT1,1,1,0,10
       121,122,123,124,125,126,127,128,129,130:"   'DCS command
390   CALL  IBWRT ( DCS%, WRT$ )
```

```
400   MASK% = &H4800                              ' Timeout or SRQ
410   CALL  IBWAIT ( DCS%, MASK% )
420   FOR I=0 TO 500 : NEXT I
430   IF ( IBSTA% AND &H800 ) <> 0 GOTO 490       ' On SRQ go to "Device Status"
440   PRINT "WOUT1, 1, 1, 0, 10"                  ' Print DCS command
450   GOTO 540
460   '
470   ' Receive device status
480   '
490   CALL IBRSP ( DCS%, SPR% )
500   PRINT "CS-UNIT STATUS = ";HEX$ ( SPR% )     ' Print DCS-UNIT STATUS
510   '
520   ' End process
530   '
540   CALL IBLOC ( DCS% )                         ' Send device local
550   END
560   '
570   PRINT "IBFIND ERROR"
580   END
```

Program example 4 ···· Example of reading out the waveform data of the DCS-8200 with the controller.

Object channel : CH1
Memory : Acquisition memory

Data format : ASCII

Memory address : From address number 0
Number of data : 20 words

The data read out in this program example is displayed on the CRT screen.

```
100   '
110   '*****************************************************************
120   '*                      DCS Remote Control                       *
130   '*   Computer  :  IBM PC / AT (R)                                *
140   '*      I / F  :  National Instruments (R) GP-IB ( IEEE-488 )    *
150   '*                    Example Program No.4                       *
160   '*****************************************************************
170   '
180   ' Set up
190   '
200   CLEAR ,60000! : IBINIT1=60000! : IBINIT2=IBINIT1+3
210   BLOAD "\bib.m", IBINIT1
220   CALL IBINIT1 ( IBFIND, IBTRG, IBCLR, IBPCT, IBSIC, IBLOC, IBPPC, IBBNA, IBONL, IBRSC, IBSRE, IBRSV, IBPAD, IBSAD,
                     IBIST, IBDMA, IBEOS, IBTMO, IBEOT, IBRDF, IBWRTF, IBTRAP, IBDEV, IBLN )
230   CALL IBINIT2 ( IBGTS, IBCAC, IBWAIT, IBPOKE, IBWRT, IBWRTA, IBCMD, IBCMDA, IBRD, IBRDA, IBSTOP, IBRPP, IBRSP,
                     IBDIAG, IBXTRC, IBRDI, IBWRTI, IBRDIA, IBWRTIA, IBSTA%, IBERR%, IBCNT% )
240   '
250   ' Initialize
260   '
270   UDNAME$ = "dcs"
280   CALL  IBFIND ( UDNAME$, DCS% )
290   IF DCS% < 0 THEN GOTO 600
300   CALL  IBCLR ( DCS% )                        ' Send device clear
310   ON ERROR GOTO 570
320   '
330   V% = 7 : CALL  IBTMO  ( DCS%, V% )          ' Time out
340   V% = 1 : CALL  IBEOT  ( DCS%, V% )          ' End of string with EOI
```

```
350 '
360 ' Send message
370 '
380  WRT$ = "STOR1:HOLD1:WREAD1,1,1,0,20:"        ' DCS command
390  CALL  IBWRT ( DCS%, WRT$ )
400  FOR I=0 TO 500 : NEXT I
410  RD$ = SPACE$ ( 80 )
420  CALL  IBRD ( DCS%, RD$)                      ' Receive DCS data
430  MASK% = &H4800                               ' Timeout or SRQ
440  CALL  IBWAIT ( DCS%, MASK% )
450  FOR I=0 TO 500 : NEXT I
460  IF ( IBSTA% AND &H800 ) <> 0 GOTO 520        ' On SRQ go to "Device Status"
470  PRINT "DATA", RD$                            ' Print DCS data
480  GOTO 570
490 '
500 ' Receive device status
510 '
520  CALL  IBRSP ( DCS%, SPR% )
530  PRINT "CS-UNIT STATUS = ";HEX$ ( SPR% )      ' Print DCS-UNIT STATUS
540 '
550 ' End process
560 '
570  CALL  IBLOC ( DCS% )                         ' Send device local
580  END
590 '
600  PRINT "IBFIND ERROR"
610  END
```

Note : "IBM" is a trademark of International Business Machines Corp.
"National Instruments" is a trademark of National Instruments Corp.

8. MAINTENANCE AND ADJUSTMENT

Items

[A] Maintenance

1 Fuse replacement
2 Power Supply voltage changes

[B] Adjustment (Compensation)

1 Probe compensation
2 Trace rotation compensation
3 Calendar and clock settings

[A] Maintenance

NOTE

When performing the work shown below, always turn off the power and remove the power cord plug from the outlet.

1 Fuse replacement

When the fuse blows, this device will not operate. When a fuse is blown, investigate the cause, remove the fuse from the fuse holder on the rear panel with a screwdriver, and insert a new fuse.

100 to 120V : 1.6A

220 to 240V : 1A

2 Power supply voltage changes

Remove the set's rear panel fuse holder with a screwdriver, align the ▼ mark with the desired voltage, and insert the fuse holder. When changing from 100 to 120V to 220 to 240V, replace the 1.6A fuse with a 1A fuse.

NOTE

When changing the power supply voltage, verify the fuse rating before replacing it.

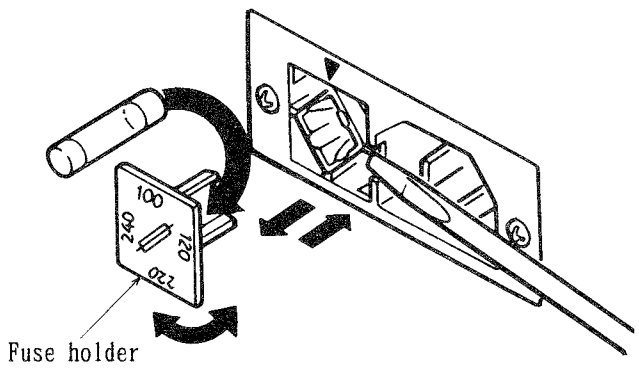


Fig. 23

[B] Adjustments (compensation)

1 Probe compensation

To make correct measurements, compensate the probe correctly before performing the measurements.

1) Connect the probe to the input, and adjust the controls to obtain a normal sweep.

2) Connect the probe to the front panel terminals, and adjust the SWEEP TIME/DIV control to display several cycles of this signal.

3) Adjust the probe trim to perform correct compensation of the CRT waveform.

2 Trace rotation compensation

If the trace line is rotated from the horizontal scale, this can be the source of measuring errors.

1) Adjust the controls to obtain a normal sweep display.

2) Turn on the GND switch, and set the H-MODE switch to AUTO.

3) Next, adjust the ▲▼ POSITION control to align the trace line over the horizontal scale in the center of the CRT.

4) If the trace line is rotated, adjust the TRACE ROTATION of the front panel to, align the trace line with the horizontal scale.

3 Calendar and time settings

When you wish to change the calendar and clock settings on the readout screen, or to reset them after replacing the battery, or to perform ON/OFF switching of the screen display, perform the following operations.

1) Press the AUTO/NORM of the H-MODE switch ㉖ and the SINGLE switch at the same time, and both LEDs light. This status is the calendar and clock correction mode.
(When adjustments are not made in this status, after about 5 seconds, the previous status is returned to).

2) When the SINGLE switch is pressed again, the month portion of the CRT display calendar flashes.
When the SWEEP TIME/DIV control ㉓ is turned, the month display changes.
When the SINGLE switch is pressed after adjusting to the desired month, the flashing shifts to the second digit of the day display, and at that time, the month is set.
Next, as you did in the second digit of the day display, adjust the time display to the desired time with the SWEEP TIME/DIV control ㉓ and press the SINGLE switch. Finally, when the SINGLE switch is pressed, the calendar and time correction mode is ended, and the original status is returned to.

3) To turn the calendar and clock display on and off, after selecting the above described correction mode (by pressing the AUTO/NORM and SINGLE switches at the same time), press the AUTO/NORM switch.
With this operation, the calendar and clock CRT display goes out, and also, when the display is off, this operation can be used to turn the display on.

NOTE

During the operation in Item 2), the second position setting is set to "0" when returning from the correction mode to the normal mode.

NOTE

In the correction mode, when the clock is being adjusted, the panel controls and switches, except for the intensity, focus, astigmatism, illumination and trigger level, cannot be operated normally. To operate the panel controls and switches, release the correction mode.

OPTIONS

OPTIONAL ACCESSORIES

Probe Pouch (MC-78) ••••••••••••••• Y87-1600-00

This soft vinyl pouch attaches to the top side oscilloscope housing and provides storage space for two probes and the operators manual. Install the probe pouch as follow:

1 Unsnap the probe pouch from the retainer plate.

2 Align the retainer plate with 4 holes on the top side of the case, with 4 snaps at the top.

3 Attach the 4 corners of the retainer plate to the oscilloscope case with the 4 nylon rivets supplied.

4 Attach the pouch to the retainer plate using the snap fastener.

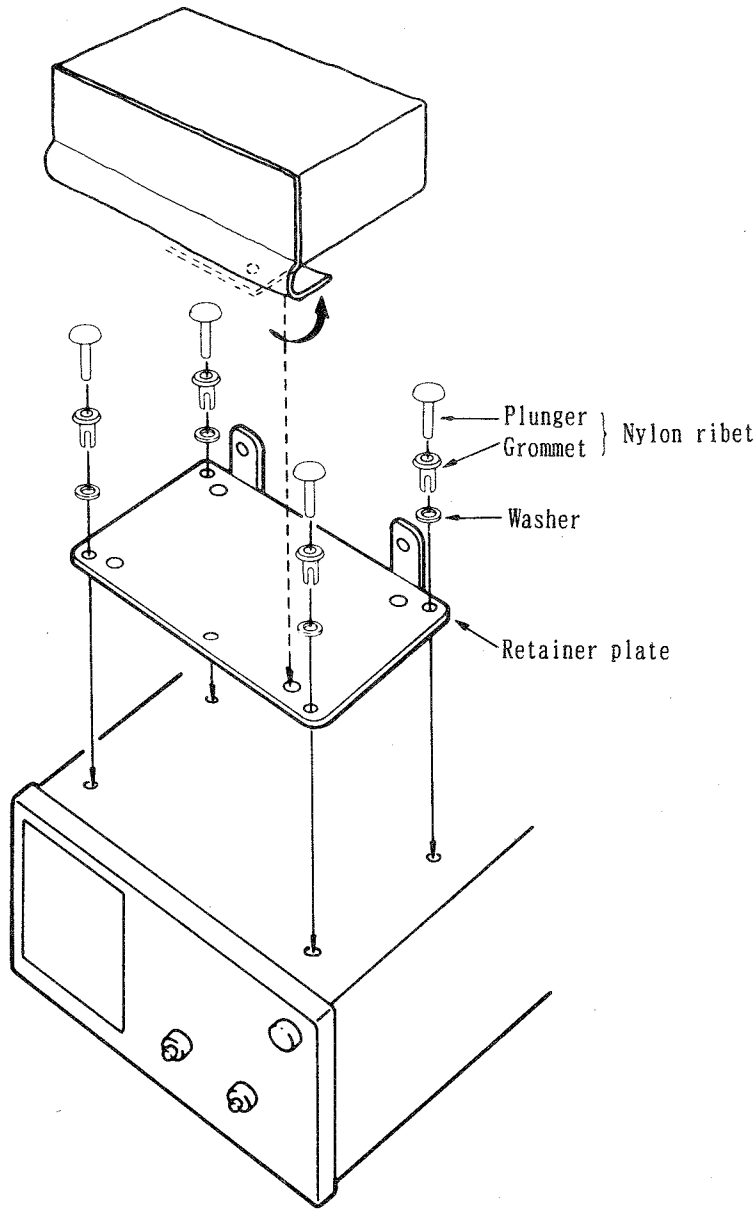


Fig. 24

A product of
KENWOOD CORPORATION
17-5, 2-chome, Shibuya, Shibuya-ku, Tokyo 150, Japan