MODEL V-1150

OSCILLOSCOPE

OPERATION MANUAL

Hitachi Denshi, Ltd.

NOTE

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

- To clean the enclosure or the front panel, use neutral detergent. Refrain from using thinner, benzine, alcohol or other chemicals.

- For safety operation, be sure to connect the ground lead of the GND (ground) terminal to earth ground, if a two-wire AC power system is used. Failure to complete the ground system may allow the chassis and cabinet of this instrument to be elevated above ground potential and pose a shock hazard.

- The V-1150 has an offset cancelling function for DVM.
  When offset occurs at input line, selecting the "DVM 0 ADJ" through the menu on the CRT will compensate for the offsets of DVM and GND REF.
  For further details, refer to item 5, (5) Functions of CURSOR, COUNTER, and MENU, page 30 .

- Overvoltage protector is provided.
  The oscilloscope is protected from possible overvoltage by the built-in overvoltage detector.
  However, the overvoltage detector can be actuated by electric shock such as discharge of static electricity. When the overvoltage detector is actuated, all the lamps are gone off. In this time, set the POWER switch to off, and allow a minute to turn on the POWER switch. Then, the oscilloscope will normally actuate.
- Since the instrument is used without selecting the AC voltage from 100 V to 240 V, fuse can be blown out when turning on/off the power switch repeatedly in a short time. Do not repeat the power on-off in a short time.

CONTENTS

1. FEATURES

The Hitachi V-1150 is a portable read-out oscilloscope with a bandwidth of DC to 150 MHz. The V-1150 is designed to provide measurement reliability and ease of operation by employing a microprocessor.
The major features are:

(1) Character display of set-up information

The measurement information is alphanumerically displayed on the CRT as shown below;

* VOLTS/DIV setting of Channels 1 and 2.
* TIME/DIV of A and B
* CAL or UNCAL
* Converged data at MAG mode
* Delay time
* CH2 INVERT mode
* 20 MHz Bandwidth Limit mode
* ADD mode
* Trigger source
* Input coupling mode

Since troublesome setting operation procedures are eliminated, an operator can concentrate on the displayed data for measurement.

(2) Cursor read-out function

The distance between the two cursors displayed can read out the following;

V : Absolute voltage from the GND
Δ V : Voltage between the reference cursor and the delta cursor

Δ V% : Amplitude ratio

Δ T : Time between the reference cursor and the delta cursor

1/Δ T: Reciprocal of the time

PHASE: Phase for one period of five divisions

Δ T% : Time ratio

The displayed data eliminates conventional troublesome and calculation procedures. Moreover, miscalculation of the scale can be completely avoided.

(3) Digital measuring function

The following items are displayed.

- o DC voltage (Channel 2 only)
- o Effective value of AC voltage (50 Hz to 10 MHz, Channel 2 only)
- o Frequency counter (10 Hz to 150 MHz, CH1 to CH4 A TRIG signal)

(4) Event counter

Counts the events during the delay time or sweep time B. Enables the burst signal which can not usually measured by a frequency counter to be measured.

(5) Ground reference function

Zero level cursor for ground can be always displayed.
By this function, troublesome check of zero level is eliminated.

(6) Menu function

Through the menu displayed on the CRT, probe factor, cursor mode, DVM, comment, and other setup can be selected.

(7) Comment display function

Comment such as date of measurement measuring conditions, and measuring data can be displayed on the comment display area of the CRT.

(8) Four channel inputs

In addition to Channels 1 and 2, Channels 3 and 4 have 0.5 V/DIV or 0.1 V/DIV deflection range that are most useful for digital measurement

(9) Wide bandwidth

Wide frequency bandwidth from DC to 150 MHz is available.

(10) High sensitivity

High sensitivity of 2 mV/DIV is ensured.

(11) Internal graticule

Internal gratidule lines eliminate parallax-viewing error between the trace and the graticule lines.

(12) Delayed sweep

With delayed sweep, a partial signal can be magnified for measurement. The delayed time is digitally displayed.

(13) Auto trigger level

Auto measuring function of a trigger level is employed, so that a small-amplitude signal is easily and stably read out.

(14) TV triggering

TV triggering circuit technology provides stable TV signal measurements.

(15) Alternate triggering

Input signals of Channels 1 and 2, which are out of synchronization, can be triggered.

(16) Ground free-run

Sweep free-runs in the NORM mode when the input coupling, whose channel is set for a trigger source, is GND. In the ADD VERT MODE, sweep free runs by setting the input coupling of CH1 and CH2 to GND.

(17) Trace finder, free-run

The finder free run mode is set and sweep free-runs when the TRACE FINDER switch is pressed, in the NORM mode.

2. ACCESSORIES

The V-1150 Oscilloscope is shipped with the following standard accessories:

2 Probes (AT-10AN 1.5)
1 AC power cord
1 Operation manual
1 Fuse (2A for 250 V AC Power source)
1 Dust proof cover

3. PRECAUTIONS

Precautions should be observed to lengthen the service life of this instrument.

Installation site

* Avoid installing this instrument in an extremely hot or cold place.
  - o Avoid placing this instrument in a place exposed directly to sunlight for a long period of time, in a closed car in midsummer, or near a heating device.
  - o The maximum operating ambient temperature is 50°C.

* Do not use instrument that has been left outdoors or stored at sub zero temperatures. The operating ambient temperature is -10°C or more.

* Avoid excessively damp, wet, or dusty conditions. The operating ambient humidity is 35 to 85%.
  Avoid accidental spillage of liquids that may enter the cabinet.

* Do not place the instrument in a place where vibration is strong. Avoid using the instrument in the presence of violent vibrations. Since the oscilloscope is a precision instrument, excessive vibrations may cause damage.

* Do not place the instrument near a magnet or strong magnetic field. An oscilloscope uses an electron beam and may be effected by a strong external magnetic field.

Handling

* Do not put a heavy object on the oscilloscope.
* Do not block the ventilation holes.
* Do not apply a heavy shock to the oscilloscope.
* Do not insert a wire, pin, etc. through the ventilation holes.
* Do not drag or carry the set, leaving the probe attached to it.
* Do not leave a hot soldering iron on the cabinet or the screen.
* Do not set the instrument on its face, otherwise knobs may be broken.
* Do not use the instrument upright, leaving BNC cable connected to EXT BLANKING, GATE OUTPUT, CH2 OUTPUT terminals on the rear panel. The cables may be damaged.

Faulty operation

* Recheck the operating procedure. If problem persists, contact a local service facility.

Care and repair

* Removal of stain from the case

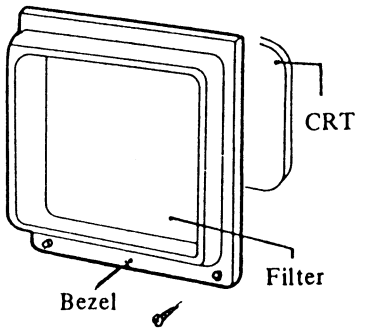
- o When the outside of the case is stained, remove the stain by first wiping it lightly with a cloth moistened with neutral washing agent and then wipe the surface with a dry cloth.
- o When the panel surface is stained, remove the stain with a clean, soft cloth. When heavy stains are present, first remove the stains by wiping the surface lightly with a cloth moistened with a diluted neutral washing agent and then wipe thoroughly with a dry cloth.
- o When dust has accumulated inside, remove it by using a dry brush, or by using compressed air.

Note:
Always make sure you remove power supply plug before opening case.
When cleaning the inside, insure beforehand that no charge remains in the power supply capacitors.

* CRT cleaning

Dirty surface on the CRT screen tends to cause measuring errors. Remove the stains on CRT and filter by using a clean and soft cloth, paying attention not to damage them. With bad stains, wash with neutral washing agent and then leave them to stand until all the moisture has dried.

o If the screenis installed while it is moistened, water rings may be formed and the waveform may be blurred. Also, pay attention not to leave finger prints on them.



Maintenance

(1) Use and store the oscilloscope carefully, not to damage the built-in precise components.
(2) Clean the CRT screen and the scale plate from time to time with a clean soft cloth.
(3) Side panel can be removed by unscrewing the screws.
(4) The recommended ambience is 20°C, 65%.

Cautions to be observed before measurement

*** Line voltage check**

The operating voltage range of this oscilloscope is 90 to 250 V AC. Check the line voltage without fail before turning on the power switch.

The V-1150 is provided with the supply cable of the standard component.

*** Use only specified fuses**

The VC-1150 is protected by a 2 A fuse on the primary side of the power supply.

When this fuse blows, thoroughly check for the cause, repair any faults present, and then replace with a specified fuse. Do not try to use any fuse other than the specified ones.

Otherwise, further damage may occur and this could be dangerous.

(IMPORTANT: Use only the fuse of same size and rating asspecified.)

	Shape (Diameter x length) mm	Type
2A	5.2 x 20	MQ4-2A

* **Do not use excessive brightness**
  This will reduce eye strain and reduce the risk of burning. The fluorescent surface of the CRT.

* Do not exceed the rated input voltage of the connector or the probe. Never apply a voltage higher than specified as follows:

INPUT direct	400 V (DC + peak AC at 1 kHz)
With probe	500 V (DC + peak AC at 1 kHz)
EXT BLANKING	20 V (DC + peak)

Calibration interval

To maintain instrument accuracy, calibration is recommended at least every 1000 hours, or every six months if used infrequently.

4. PANEL ILLUSTRATIONS

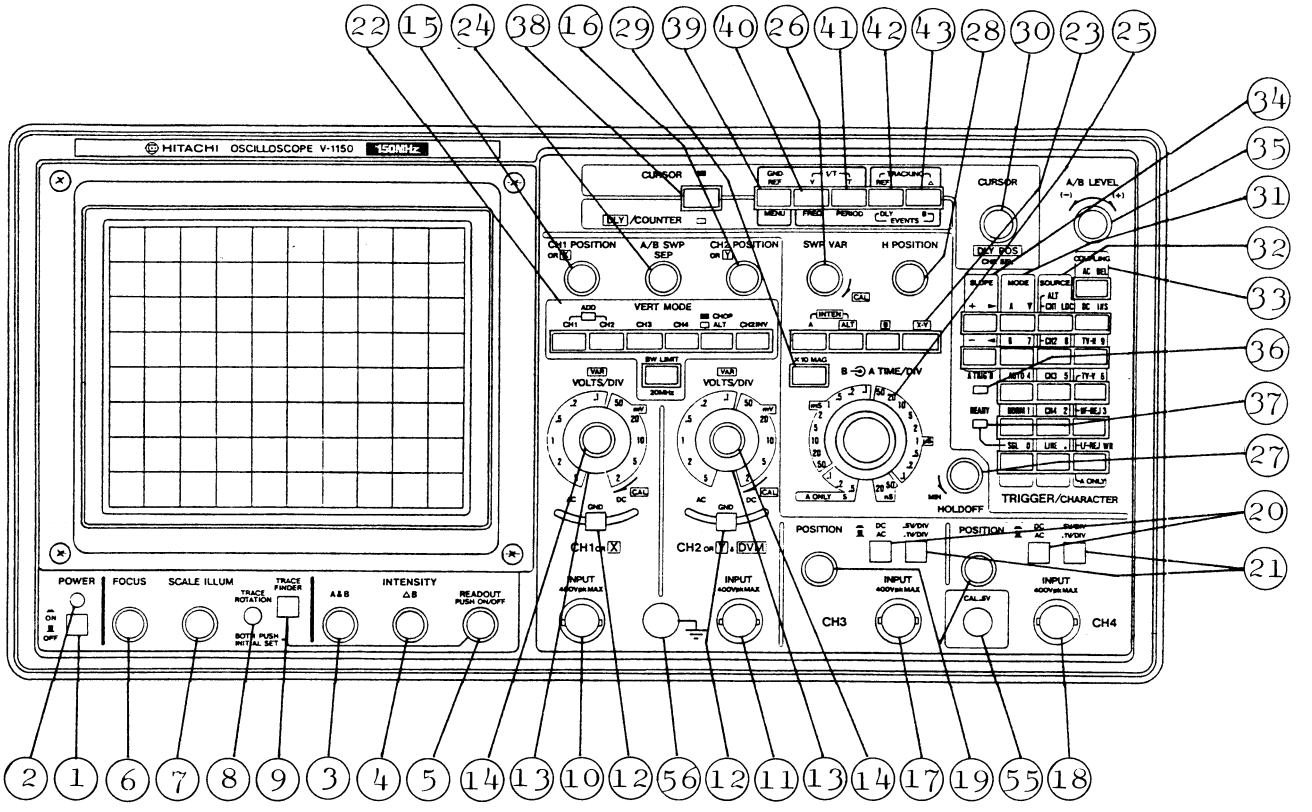


Fig. 4-1 Front View (A)

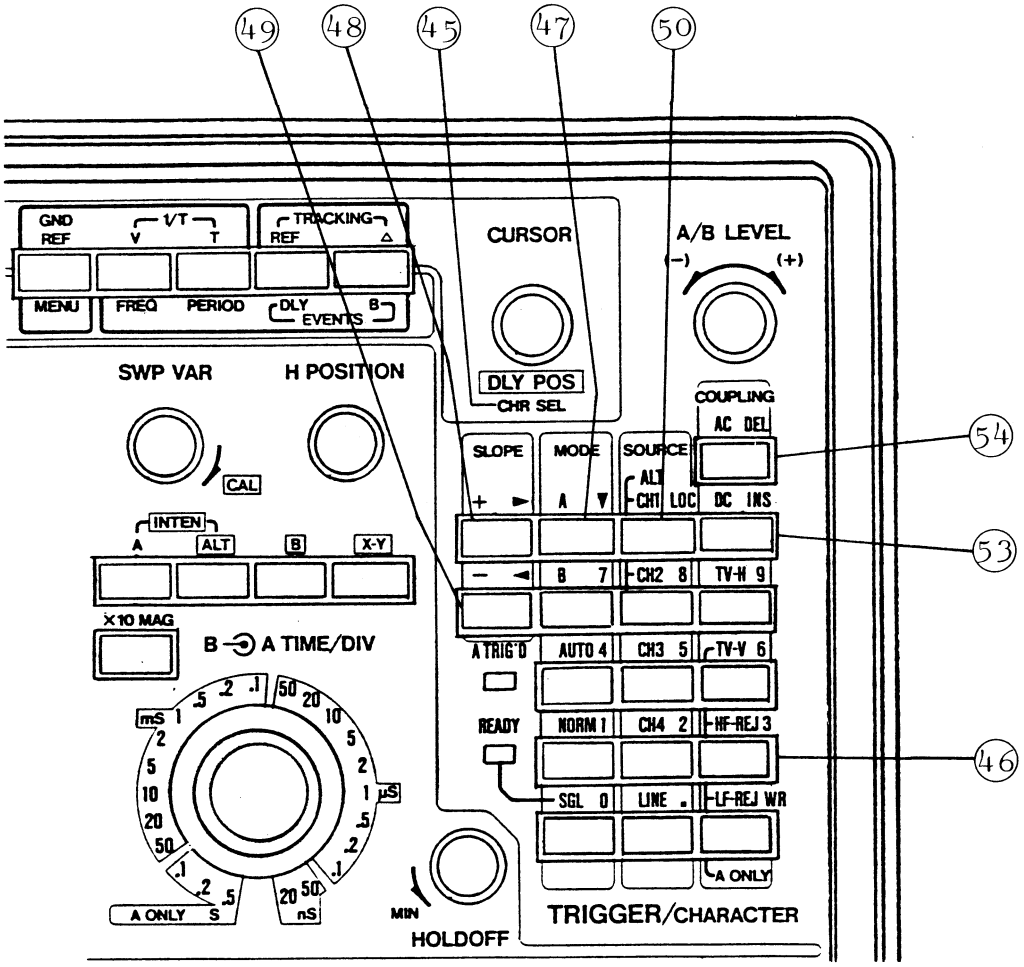


Fig. 4-2 Front View (B)

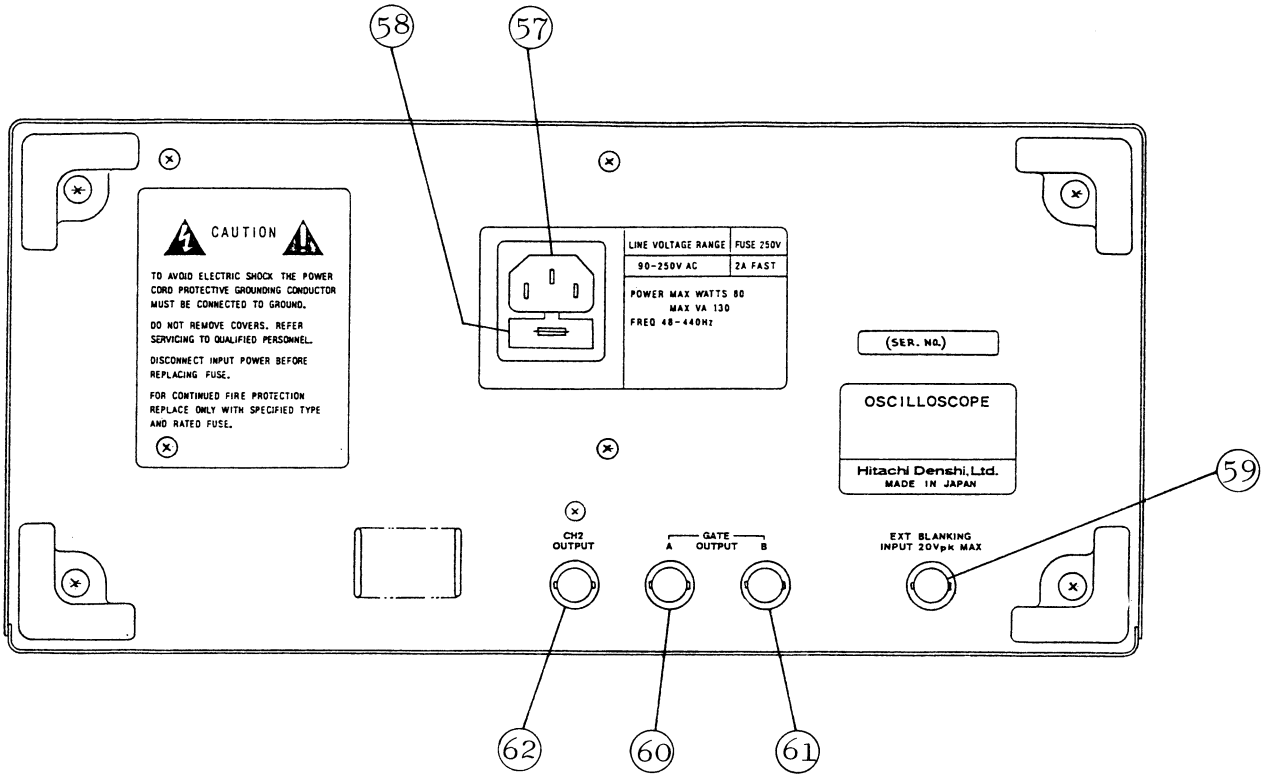


Fig. 4-3 Rear View

5. PANEL DESCRIPTION

(1) Power and CRT

① POWER switch

Power is ON in the pressed mode (_⊓_), and OFF in the released mode (_⊓_).

② POWER lamp

Lights in green with POWER ON.

INTENSITY controls

③ A & B

Adjusts the intensity of the main sweep (A) and the delayed sweep (B). Clockwise adjustment increases intensity.

④ Δ B

Adjusts the intensity of the delayed sweep (B). Clockwise adjustment increases intensity.

⑤ READOUT

Adjusts the intensity of characters displayed on the CRT. Characters will alternately appear or disappear by each pressing the READOUT control.

⑥ **FOCUS control**

After obtaining an appropriate brightness by operating the INTENSITY control, adjust the FOCUS control until the trace has best definition. Although the FOCUS is corrected automatically when the INTENSITY control is rotated, the focus can be slightly shifted. In this case, adjustment is required.

⑦ **SCALE ILLUM control**

Controls graticule illumination. Useful when photographing or viewing waveforms in a dark area.

⑧ **TRACE ROTATION control**

Corrects a slight tilting of trace caused by external magnetic fields. Align the trace with the horizontal graticule line by rotating the control.

⑨ **TRACE FINDER switch**

Compresses the display within the graticule area, when the trace is located off-screen.
Trace finder free-run is executed in the NORM mode.

(2) Vertical deflection system

⑩ **CH1 or X INPUT connector**

This BNC connector provides external signal to Channel 1.
The applied signal is supplied to the horizontal deflection system in the X-Y operation.

⑪ **CH2 or Y INPUT & DVM connector**

This BNC connector provides external signal to Channel 2 and DVM. The applied signal is supplied to the vertical deflection in the X-Y operation.

⑫ **AC-GND-DC switches**

Select the method of coupling the input signal to the vertical deflection system.

AC: Input signal is capacitively coupled to the vertical attenuator. The DC component of the input signal is blocked.

GND: The input of the vertical amplifier is grounded to provide a ground reference. This provides ground free run function in the NORM of the trigger mode.

DC: All frequency components of the input signal are coupled to the vertical attenuator.

⑬ **VOLTS/DIV switches (CH1 and CH2)**

Selects the sensitivity level of the input signal to Channel 1 or 2 in 11 steps from 2 mV/DIV to 5 V/DIV.
The deflection factor set by these switches is shown on the lower left side of the CRT. In the case of a 10:1 probe, multiply the displayed value by 10 times.
The deflection factor corresponding to probes can be displayed by following the procedure of Item 8-(1)-(b).

⑭ **VAR controls**

* Provide a continuous variable deflection factor. Attenuation of less than 1/2.5 is obtained by counter-clockwise rotation.

* These controls are used when comparing two waveforms or when measuring the rise time of a square wave.
* To measure a voltage by the use of the deflection factor indicated by VOLTS/DIV, turn the VAR controls fully clockwise (to the CAL position).
* Δ cursor measurement is available by turning on the VAR controls with the V key (40) pressed in the CURSOR mode (38). (Refer to item 8-(5)-(a).)

NOTE:
Observation of signals in the high-sensitivity range of 2 mV/DIV and in the CHOP mode, it is sometimes difficult to obtain a stable trigger.

a. Apply a high-level signal synchronized with the observing signal to the vacant channel as trigger signal source.
b. For observing low frequency signals under 50 kHz, select the HF-REJ by the COUPLING switch in the A trigger mode.

(15) CH1 POSITION control

Sets the vertical position of the Channel 1 signal display. Clockwise rotation moves the associated trace upward while counterclockwise rotation moves it downward.

(16) CH2 POSITION control

Sets vertical position of the Channel 2 signal display.

(17) CH3 INPUT connector

The BNC connector provides external signal to Channel 3.

(18) CH4 INPUT connector

The BNC connector provides external signal to Channel 4.

⑲ **POSITION controls**

Set vertical positions of Channel 3 and Channel 4 signal displays.

⑳ **DC/AC switches (CH3 and CH4)**

Set input coupling to Channels 3 and 4. AC coupling is accomplished with the function switch out (_┌┐_), while DC coupling is with the function switch in (_┌─┐_).

㉑ **.5 V/DIV-.1 V/DIV switches**

Set the deflection factor of Channel 3 or 4 to .5 V/DIV, function switch in (_┌─┐_) or .1 V/DIV, function switch out (_┌┐_).

㉒ **VERT MODE keys**

When one of these keys is pressed, the indicator of the selected key will light. One more press of the illuminated key will release the corresponding key function.

CH1: Displays the Channel 1 signal.
CH2: Displays the Channel 2 signal.
CH3: Displays the Channel 3 signal.
CH4: Displays the Channel 4 signal.
ADD: Displays the algebraic sum of Channels 1 and 2 when both CH1 and CH2 keys are pressed.
ALT: Channel 1, 2, 3, and 4 signals are alternately displayed at each sweep.
Used for the multitrace observation of flicker free waveforms in the sweep time ranging from 0.5 ms/DIV to 20 ns/DIV.

CHOP: Channel 1, 2, 3, and 4 signals are switched at about 250 kHz rate regardless of the sweep and they are simultaneously displayed on the CRT.
This is used for multitrace observation of waveforms in the low sweep time ranging from 1 ms/DIV to 0.5 s/DIV.
To prevent triggering from noise occurred at chop switching, select the COUPLING switch to the HF REJ or set the A trigger LEVEL control to the optimum level.

CH2INV:
Allows the polarity of the CH2 signal to invert. It is recommended to use this function when comparing with the different polarity waveforms or when observing the subtracted signal ([CH1]-[CH2]).

BW LIMIT 20 MHz:
Reduces interference from undesired high-frequency signals when viewing low-frequency signals.
Reduces the bandwidth of Channels 1 to 4 to approximately 20 MHz.

(3) Horizontal deflection system

㉓ Horizontal display keys

When one of these keys is pressed, the indicator of the selected key will light.
Select the operation mode of the horizontal deflection.

A: Main sweep (A) appears on the CRT.
This setting is used in normal cases.

ALT: Both main sweep (A) and delayed sweep (B) are displayed alternately.

INTEN:
Intensifies the main sweep (A) for the duration of the delayed of the delayed sweep (B) by simultaneously pressing both the A and ALT switches.

B: Magnifies the intensified portion of the main sweep (A) over the full screen. The sweep time is controlled by the B time base.

X-Y: Used for an X-Y operation. Signals applied to Channels 1 and 2 become signals of X axis and Y axis, respectively.
The vertical deflection factor is read on CH2 VOLTS/DIV and horizontal deflection factor on CH1 VOLTS/DIV.
CH1 POSITION control sets horizontal position of the waveform and CH2 POSITION control sets vertical position in the X-Y mode.

㉔ A/B SWP SEP control

Adjusts the vertical position of the delayed sweep (B) in the ALT sweep mode.

㉕ A TIME/DIV switch (outer)

Sets the sweep speed of the main sweep (A) in 23 steps from 20 ns/DIV to 0.5 s/DIV.

㉕ B TIME/DIV switch (inner)

Sets the sweep speed of the delayed sweep (B) in 20 steps from 20 ns/DIV to 50 ms/DIV.
The scale factors of the A and B TIME/DIV switches are displayed on the lower right side of the CRT.
The independent setting is available by the two knobs.

㉖ SWP VAR control

Continuously varies the sweep speed of the main sweep (A).
The sweep is delayed by 2.5 times or more at the fully counterclockwise position.
Normally, the knob is left rotated fully clockwise (CAL).

㉗ HOLDOFF control

Increases the holdoff time to trigger and aids triggering on complex displays such as high-frequency signal, irregular signal and digital words.
Rotate the HOLDOFF control to obtain stable triggering. Normally, set this control to MIN.

㉘ H POSITION control

Used to adjust the horizontal position. Display is moved to right side when the control is rotated clockwise and to left side with counterclockwise rotation.

㉙ x10 MAG control

Used to magnify A and B sweeps to 10 times. In this case the sweep time is 1/10 times the value indicated by TIME/DIV. Bring the portion of the waveform to be magnified to the center of the scale by the H POSITION control ㉘ . Then press the x10 MAG switch and the lamp lights, and the waveform placed at the center is magnified.
By controlling the x10 MAG, sweep speed becomes 10 times the sweep set by the TIME/DIV control and the sweep rate displayed on the CRT becomes 1/10 the sweep time set at initial time.

㉚ DLY POS control

Used to set the delay time of the delayed sweep (B) starting point with respect to the main sweep (A) starting point. The delay time is displayed on the upper left side of the CRT.
The CURSOR and DLY/COUNTER key must select the DLY/COUNTER, while the indicator is turned off. In this state, DLY POS operation is available.

NOTE:
This control moves the cursor when the CURSOR and DLY/COUNTER key selects (CURSOR); the indicator lights.

(4) Trigger system

The SLOPE, MODE, SOURCE or COUPLING selection is performed by pressing the keys arranged vertically. The LED selected button lights. The black characters on the TRIGGER/CHARACTER section keys indicate the setting of TRIGGER system, and the blue characters indicate that of CHARACTER (Comment display) system. In the comment display mode, all the LEDs indicating TRIGGER system go off.

(31) **MODE keys**

A: The MODE A or MODE B LED lights to indicate the selected mode.

B: When the A key of horizontal display keys (23) is selected, MODE is automatically set to A.
When the ALT, INTEN, or B key of horizontal display keys (23) is pressed, push either MODE A or MODE B to select the trigger mode.

AUTO: The instrument will automatically display a sweep without an input signal being applied or out of trigger.
Normal trigger will be established by setting trigger level when a signal is applied to the input. This setting is convenient in most cases.

NORM: No sweep will appear, unless a signal is present or out of trigger. Use this MODE when effecting synchronization to a very low frequency signal (30 Hz or less).
Sweep free runs in the NORM mode when the input coupling, whose channel is set for a trigger source, is GND. (only CH1 and CH2)

SGL: Displays a single sweep by A trigger source. Used for photography.

NOTE:
Characters are not displayed on the CRT when the SGL key is pressed and the READY LED lights. When signal is supplied, single sweep is executed and characters are momentarily displayed. Press the SGL key again for one more single sweep.

(32) **SOURCE keys**

Select the triggering signal source - CH1, CH2, CH3, CH4 or LINE.

CH1: The signal applied to CH1 is selected for the source.

CH2: The signal applied to CH2 is selected.

CH3: The signal applied to CH3 is selected.

CH4: The signal applied to CH4 is selected.

LINE: The frequency of the mains (AC power) is selected. Functions only in the A trigger mode.

ALT: When the ALT key is pressed in the A trigger mode, (CH1 / CH2) press the keys CH1 and CH2 at the same time for alternate trigger mode. CH1 and CH2 signals can be triggered even if the two signals have no relationship of synchronization. COUPLING is automatically set to DC.

㉝ COUPLING keys

Select coupling method for the triggering signal.

AC: Blocks DC and cuts off the very low frequency components.

DC: Directly connects the triggering signal to the trigger circuit.
Used when triggering by a very low frequency signal.

TV-H: Used when observing the entire horizontal video signal.

TV-V: Used when observing the entire vertical video signal.

NOTE: When TV-V is selected in the A trigger mode, TV-H is automatically established in the B tirgger mode.

HF-REJ: Among the AC component for triggering, the high frequency components of more than 50 kHz will be attenuated.
A stabilized triggering will be unaffected by noise of more than 50 kHz, can be obtained.

LF-REJ: Among the AC component for triggering, the low components of less than 50 kHz will be attenuated.
A stabilized triggering will be unaffected by noise of less than 50 kHz, can be obtained.

(HF-REJ, LF-REJ, and TV-V function only in the A trigger mode.)

㉞ SLOPE keys

Select the triggering polarity of (+) or (-). The (+) or (-) LED lights to indicate the selected polarity.

Explanation of trigger polarity SLOPE

At time of
⊕ SLOPE

Triggered on the continuous line

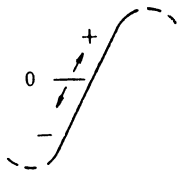
At time of
⊖ SLOPE

㉟ A/B LEVEL control

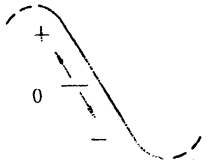
Sets the triggering level of the main sweep (A) when the triggering mode is A.

Sets the triggering level of the delayed sweep (B) when the triggering mode is B.
By controlling the trigger level, the sweep start point of the waveform is set.

Explanation of trigger LEVEL



At the time of
⊕ SLOPE



At the time of
⊖ SLOPE

(36) A TRIG'D indicator

Lights when the main sweep (A) is triggered.

(37) READY indicator

Lights to indicate that the oscilloscope is ready for single sweep.
Goes off when single sweep is started.

(5) Functions of CURSOR, COUNTER, and MENU

(38) CURSOR and DLY/COUNTER key

Selects the function of CURSOR or DLY/COUNTER key.
When the CURSOR and DLY/COUNTER indicator is illuminated, the CURSOR mode is selected. The upper side key functions are available. On the other hand, when the indicator turns off, the COUNTER or MENU mode is selected. The lower side key functions are available.
In addition, DLY POS operation is available in this mode.
(Refer to No. (30) , DLY POS on page 25.)

(a) CURSOR function (When CURSOR and DLY/COUNTER key is illuminated.

(39) GND REF key

When the GND REF key is pressed, the GND reference cursor is displayed on the CRT. The GND reference cursor moves corresponding to the vertical POSITION control.
Channels 1 and 2 can display the GND REFerence cursor, the alternate long and short dash line is for CH1, the dotted line for CH2.

NOTE:
Channels 3 and 4 do not display the GND REFerence cursor. In the triple or quad trace of VERT MODE, and in the ALT of the horizontal display mode, the GND REFerence cursor is not displayed.

(40) V key

Two horizontal cursors appear by pressing this key. The voltage between the two cursors is displayed with cursor menu on the upper side of the CRT. It corresponds to the setting of VOLTS/DIV.

(41) T key

Two vertical cursors apppear by pressing this key. The time between two cursors is displayed with cursor menu on the upper side of the CRT. It corresponds to the setting of TIME/DIV.

1/T key

When both the V and T keys are pressed, two vertical cursors appear. The reciprocal of the time (frequency) between two cursors is displayed with cursor menu on the upper side of the CRT. It corresponds to the setting of TIME/DIV. (GND REF, V, and T keys are interlocked.)

(42) **REF key**

Moves the reference cursor of the alternated long and short dash line by turning the CURSOR control.

(43) **Δ key**

Moves the delta cursor of the dotted line by turning the CURSOR control.

TRACKING key

When both the REF and Δ keys are pressed, the two cursors displayed on the CRT are moved simultaneously by turning the CURSOR control.
(REF and Δ keys are interlocked.)

(30) **CURSOR control**

A clockwise turn moves the cursor up or screen right side; counterclockwise turn moves the cursor down or screen left side.

NOTE:
This control activates when the CURSOR and DLY/COUNTER key selects DLY/COUNTER; the indicator is turned off.

(b) COUNTER, and MENU functions (when the CURSOR and DLY/COUNTER indicator turns off.)

In the COUNTER mode, frequency, period, event pulse count will be displayed on the upper side of the screen.
In the MENU mode, the DVM, character setting, and other setting functions are selectable.

(39) MENU key

When the MENU key is pressed, the menu of probe factor, cursor mode, DVM, comment, and other setup is displayed. Then the desired function is selected by keying the menu number.
When the DVM is selected, DC voltage or AC voltage of the signal applied to CH2 is displayed.

(40) FREQ key

When the FREQ key is pressed, the frequency of the signal selected by the A TRIG SOURCE (CH1, CH2, CH3, or CH4) is displayed on the upper right side of the screen.
When no triggering, the frequency is not counted. Instead, "NO TRIG'D" is displayed.

(41) PERIOD key

When the PERIOD key is pressed, the period of the signal selected by the A TRIG SOURCE (CH1, CH2, CH3, or CH4) is displayed on the upper right side of the screen.

(42) EVENTS DLY key

When the EVENTS DLY key is pressed, the number of the pulses which corresponds to the interval between the starting point of the main sweep and that of the delay sweep is counted. A trigger pulse or B trigger pulse is selected through the menu.

(43) ENENTS B

When the EVENTS B key is pressed, the number of the pulses which corresponds to the interval between the starting point and the end point of the delay sweep signal waveform displayed on the CRT is counted.
A trigger pulse or B trigger pulse is selected through the menu.

(6) Comment display function

Comment (30 characters in total in two lines) can be displayed on the CRT by pressing the keys in the TRIGGER/CHARACTER section.

(42) CHR (Character)

Press the MENU key, and a cursor "___" (underline) will blink on the CRT. Set the desired comments, combining the keys (44) to (54) and the CHR SEL control.
In the comment display mode, each key on the TRIGGER/CHARACTER section performs its shifted function (marked in blue on the upper right of each button).

(44) 0 to 9 and . keys

Figures 0 to 9 and a period can be displayed.

㊺ CHR SEL control

The number of letters, symbols, etc. can be selected and displayed.
When the CHR SEL control is rotated closkwise in the COMMENT mode, displays are made in the sequency of A, B, C.... When the CHR SEL control is rotated counterclockwise, displays are made in the reverse sequency of →, ←, ↓....
Displayed letters or symbols can be registered by pressing the WR (Write) key.

㊻ WR (Write) key

When the WR key is pressed after setting every letter or symbol by the CHR SEL control, the selected letter or symbol is registered as a comment.

㊼ ▼

The comment display can be moved to the next line. After reaching the bottom (7th) line of the comment display area, the character cursor moves to top (2nd) line.

㊽ ▶ key

When the ▶ key is pressed, the character cursor is shifted to the right column. However, when the character cursor is at the right end of a line, the cursor is not shifted.

(49) [◄] key

When the [◄] key is pressed, the character cursor is shifted to the left column. However, when the character cursor is at the left end of a line, the cursor is not shifted.

(50) [LOC] (Location) and [►] keys

When the [LOC] and [►] keys are pressed simultaneously, all the comments of the cursor line are shifted to the right column. However, when the character cursor is at the right end of a line, the comments are not shifted.

(51) [LOC] (Location) and [◄] keys

When the [LOC] and [◄] keys are pressed simultaneously, all the comments of the cursor line are shifted to the left column. However, when the character cursor is at the left end of a line, the comments are not shifted.

(52) [LOC] (Location) and [▼] keys

When the [LOC] and [▼] keys are pressed simultaneously, all the comments of the cursor line are shifted downward by one line. When the comments to be shifted are at the bottom line, they are shifted to the top line. When a comment is already set right below the cursor line.

(53) [INS] key

When the [INS] key is pressed, a blank space is inserted at the left side of the cursor. However, when the character cursor is at the right end of a line, a blank space is not inserted.

⑭ DEL key

When the DEL key is pressed, the character on the character cursor is deleted, and the following comments are shifted left.

(7) Miscellaneous

⑮ CAL 0.5 V terminal

A 0.5 V-1 kHz squarewave signal is available through a tip terminal for probe calibration.

⑯ GND terminal

Earth terminal grounding.

(8) Rear panel

⑰ AC input connector

Provides the connection point for the AC power source to the instrument.

⑱ FUSE holder

For fuse replacement, disconnect the power cable.
After replacement, secure the cover by rotating it clockwise.

⑲ EXT BLANKING INPUT connector

This is a terminal for applying a blanking signal from an external source. The trace displayed on the screen may be intensity-modulated where pulse signal or time-scale marks are required.

⑥⓪ , ⑥① GATE OUTPUT connectors

A: Output terminal for a positive squarewave simultaneously occurring with the A trigger sweep.
(Output: TTL level)

B: Output terminal for a positive squarewave simultaneously occurring with the B trigger sweep.
(Output: TTL level)

⑥② CH2 OUTPUT connector

Makes the channel 1 input signal available for further analysis.

NOTE:
Do not use the CH2 OUTPUT when the vertical sensitivity is 2 mV/div. The CH2 OUTPUT signal may contain noise in that mode.

6. HOW TO PRODUCE THE TRACE

Before turning ON the POWER switch, insure the AC supply voltage is within the range of 90 to 250 V AC supply.
Connect the power cord on the rear panel to an AC outlet and set the controls as follows.

AC-GND-DC	GND
POSITION	Midrange

Turn the POWER switch on, set the sweep mode to A, set the trigger mode to AUTO, and rotate the INTENSITY A & B control clockwise, and a trace appears.
Adjust the FOCUS control to obtain the sharpest trace.
When this instrument is not used, with power supplied, rotate the INTENSITY control counterclockwise to decrease the intensity. This protects the CRT from image burn.

NOTE:
For normal operation, the following function must be set in the 'CAL' position.

VAR: Push in and rotate in the direction of arrow. In this case the VOLTS/DIV is calibrated to the indicated value.

SWP VAR: Rotate in the direction of arrow. In this case the TIME/DIV is calibrated to the indicated value.

Align the trace with the horizontal graticule line at the center of the screen by operating CH1 POSITION control. In some cases, the trace may be slightly oblique to the scale by the effect of earth magnetism.
In this case, align the trace with the horizontal graticule line at the center of the screen by properly adjusting the semi-fixed variable resistor TRACE ROTATION on the front panel.

General measurement

(1) Observing a single waveform

Use Channel 1 or 2 when not observing the phase difference between two waveforms or when engaging in an operation other than X-Y operation.

Make the following settings when using Channel 1.

VERT MODE switch	CH1
A trigger MODE switch	AUTO
A trigger SOURCE switch	CH1
AC-GND-DC switch	AC or DC

Under thise settings all repetitive signals higher than 30 Hz applied to Channel 1 can be triggered on and observed by adjusting the A trigger LEVEL control, with a TIME/DIV range between 2 ms/DIV and 20 ns/DIV. Since the A trigger MODE is set to the AUTO position. A trace appears even when no signal is present or when AC-GND-DC switch is in the GND position. Therefore, DC voltage measurement can be made when the switch is placed to DC. When observing low frequency signals below 30 Hz, the following switch settings are required;

A trigger MODE:	NORM
A trigger COUPLING:	DC

Triggering can be effected by operating the LEVEL control under this setting. When using only Channel 2, set the following switches to CH2;

VERT MODE:	CH2
A trigger SOURCE:	CH2

(2) Observing two waveforms

Observation of two waveforms can be made easily by pressing the ALT or CHOP key of the VERT MODE. Set the VERT MODE to ALT for observation of high repetition frequency signals. While for low frequency signals, set it to CHOP. When the TIME/DIV switch is set to 1 ms or slower, select CHOP mode for flicker free observation.

ALT: 0.5 ms/DIV to 20 ns/DIV

CHOP: 1 ms/DIV to 0.5 s/DIV

To measure phase difference, trigger on the leading signal.

(3) Observing waveform in the X-Y mode

X-Y oscilloscope is available by pressing the X-Y key, in the horizontal display mode.

Input and position controls are as follows.

	Input connector	Position control
X-axis signal (Horizontal axis signal)	CH1 INPUT	CH1 POSITION
Y-axis signal (Vertical axis signal)	CH2 INPUT	CH2 POSITION

For the X-Y operation, set the x10 MAG key and the BW LIMIT 20 MHz key to off.

The LEDs for trigger do no light in X-Y operation.

7. METHOD FOR CONNECTING SIGNALS

The first step of measurement is to connect the signal to the oscilloscope properly. Do it with utmost care.

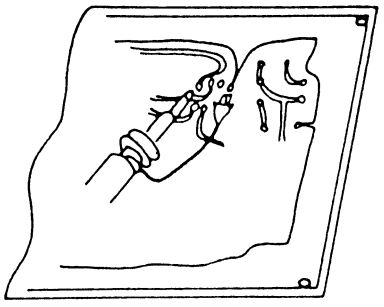
(1) When using a probe

Use the AT-10AN 1.5 probe when measuring a high frequency signal. Since the input signal is attenuated by this probe to 1/10, this probe is not recommended for low level signals. Bandwidth limitings will occur when using the 1:1 probe. Therefore, all high frequency measurement must be made with a 10:1 selection.

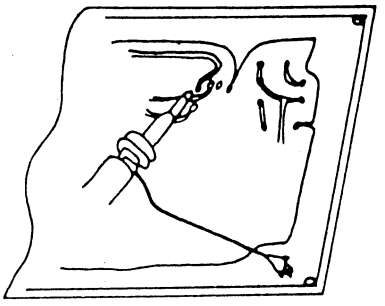
<CAUTIONS>

- o Do not apply a signal to the input in excess of 500 V (DC + peak AC at 1 kHz).
- o Connect the probe ground lead as close as possible to the point being measured especially when measuring a fast rise time or a high frequency signal. Long probe ground leads may cause waveform distortions, such as ringing and overshoot.
  For better measurements, it is recommended to be use the standard ground lead attachment be used with the AT-10AN 1.5 probe.

Connection of ground lead

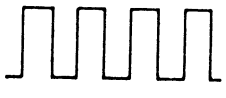


(a) Proper



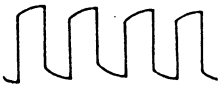
(b) Improper

- To avoid measurement error, probe calibration must be done especially when probes are changed on the instrument. Connect the probe tip to the CAL output terminal and the probe tip to the GND terminal. A 1 kHz square wave should be displayed with flat tops. Any distortion in the presentation is caused by incorrect probe compensation. If overshoot or undershoot is present, turn the screwdriver adjustment in the probe for a flat-top presentation.



(a) Optimum

(b) Capacity too small



(c) Capacity too large

(2) When using direct correction

If Your are connecting signals without using a probe AT-10AN 1.5, pay attention to the following points in order to minimize measurement error.

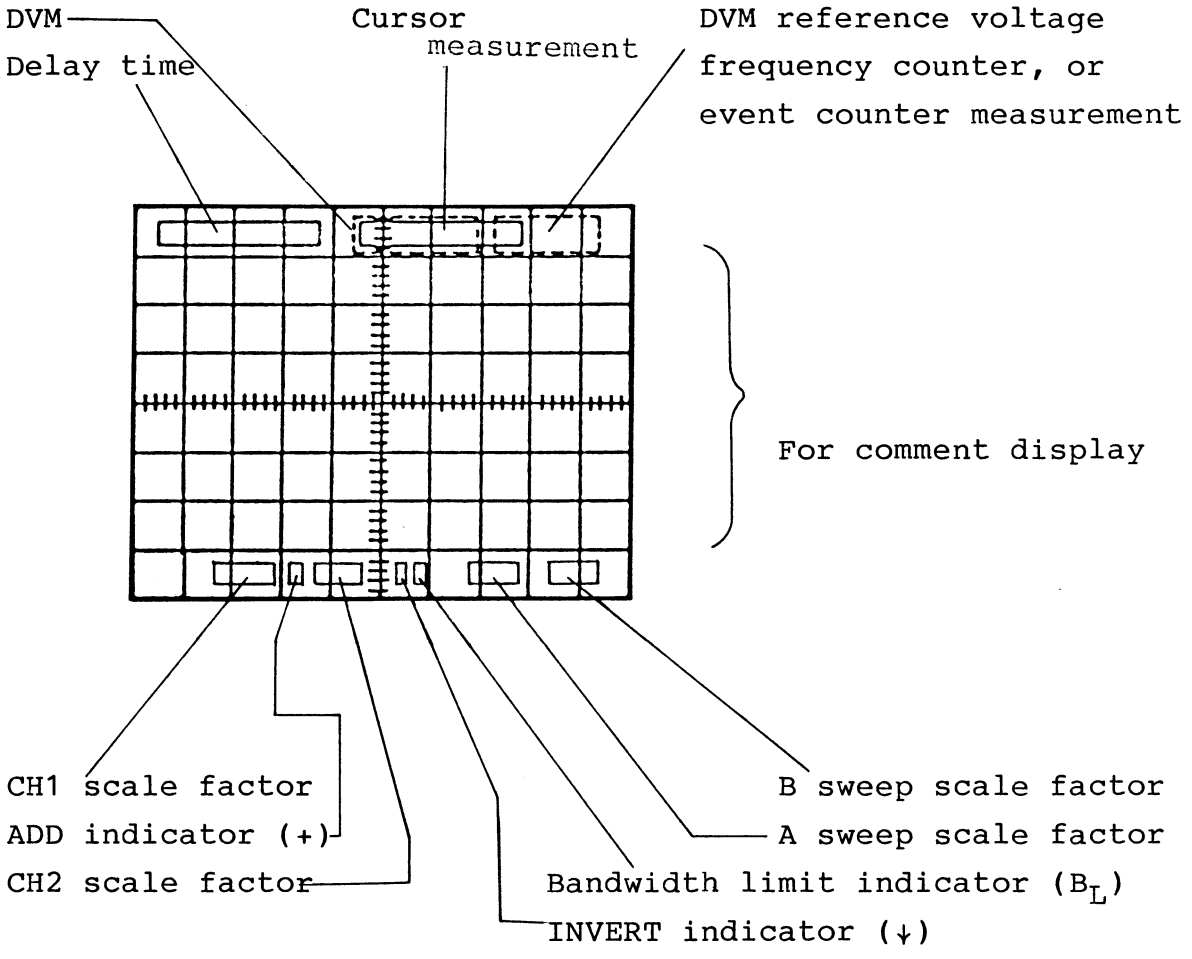
- o When using unscreened leads there should be no trouble provided they are high level signals from a low impedance source. However, in most cases, measurement errors may be caused by stray coupling with other circuits or power line interference.
  This can cause errors even at low frequencies.
  In general, avoid measuring with non-shielded wire. When using a shielded wire, connect one end of the shield to the ground terminal of the oscilloscope and the other end to the ground of the circuit to be measured. It is desirable to use a coaxial cable with a BNC type connector.
- o The following precautions must be observed when performing a wide bandwidth measurement. It is necessary to terminate the cable with a characteristic impedance, when measuring a fast rise waveform or a high frequency wave.
  The absence of a termination resistor will necessarily lead to a measurement error derived from ringing phenomenon in long cable. Some measuring circuits require a termination resistor equal to the characteristic impedance of the cable also be applied at the measurement point.
  A BNC type termination resistor (50 Ω) is recommended for this purpose.
- o In order to perform measurements with the circuit put it in a proper operating state, it is sometimes necessary to terminate the cable with an impedance which corresponds to the circuit being measured.

- The stray capacity of the sheild wire must be taken into account when performing measurements with a long shield.
  Since the shield wire normally in use has a capacity of about 100 pF per meter, its effect on the circuit to be measured cannot be ignored.
  Use a x10 probe to minimize the effect on the circuit.
- When the length of the shield wire used or when the length of the non-terminated cable reaches 1/4 the wave length or its multiples within the band of the V-1150 (1/4 the wave length is about 0.5 meter when using a coaxial cable at 100 MHz), oscillation may be caused near 2 to 5 mV/DIV range.
  This is caused by the reasonance between the externally connected high-Q inductance and the input capacity. Reduce the Q by connecting the cable or shield wire to the input connector by the resistors connected in series, or by performing measurements at another VOLTS/DIV range.

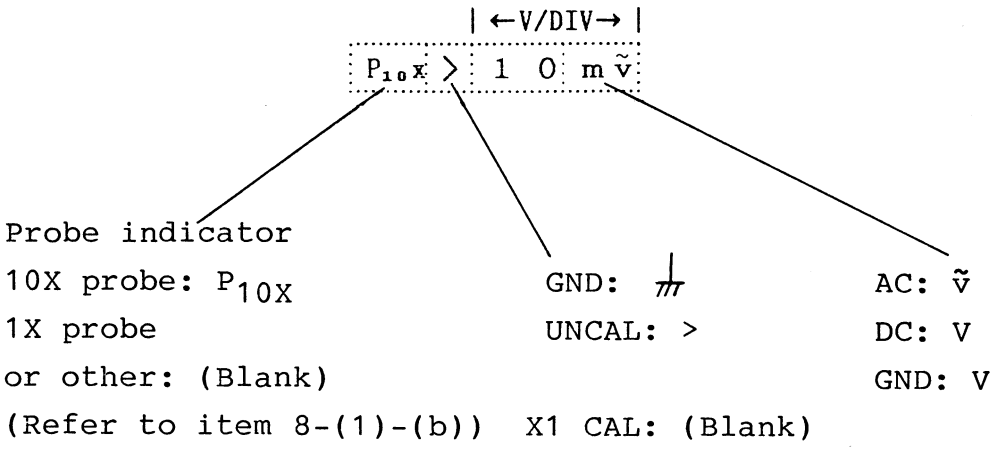
8. MEASURING PROCEDURES

(1) Readout function

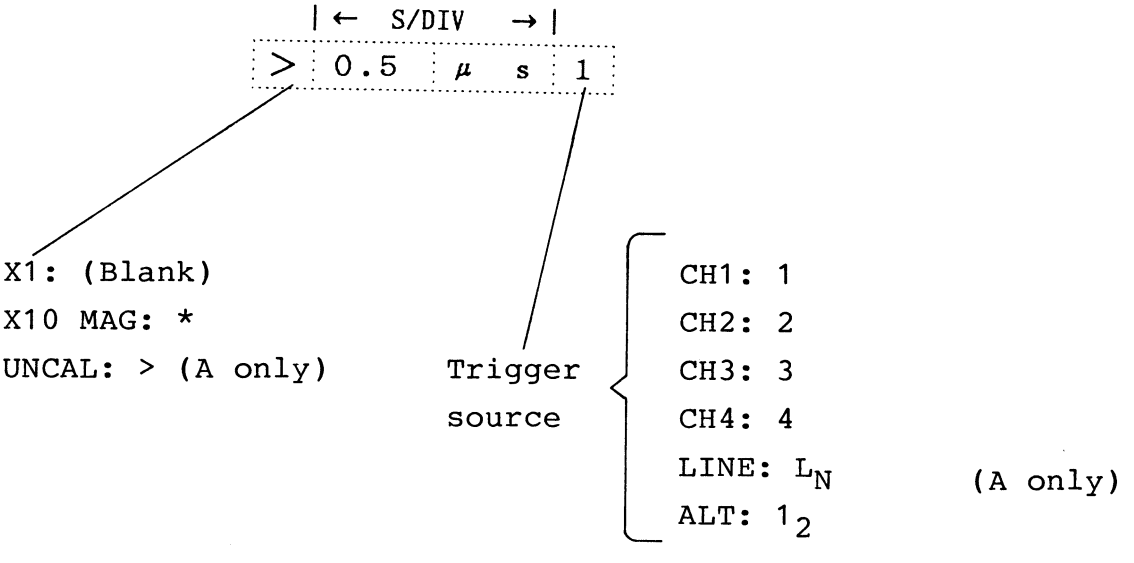
(a) Display allocation on the CRT



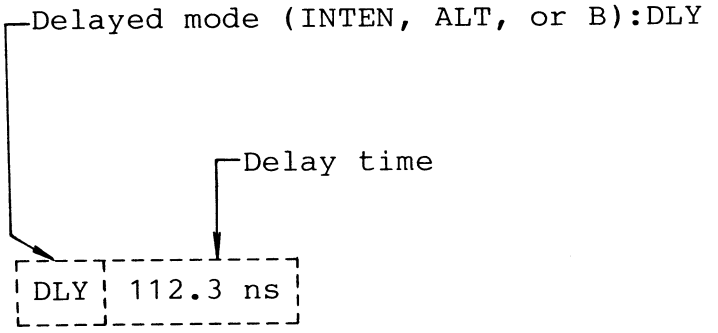
(i) Scale factor format of CH1 and CH2



(ii) Scale factor format of A and B' sweeps



(iii) **Delay time**



(a) The unit becomes 'div' in the uncalibrated sweep rate.

(b) A mark greater than '>' is displayed on the left of numerals in the NORM of B trigger MODE.

(c) When the A sweep rate is faster than B, the warning 'DLY A<B' is displayed.

(iv) **Measuring value of DVM**

Units of DVM mode are shown below. Fow setting of DVM mode, refer to Item 8 MEASURING PROCEDURES especially page 85, Item of Setting of DVM.

i) CURSOR mode

Function	Cursor menu	Units
(a) V	V1 and/or V2+(-)	mV (or V, mṽ, ṽ)
(b) ΔV	ΔV1 and/or ΔV2+(-)	mV (or V)
(c) ΔV%	ΔV1 and/or ΔV2+(-)	%
(d) ΔT	ΔT +(-)	ns(or μs, ms, s)
(e) ΔT%	ΔT +(-)	%
(f) 1/ΔT	1/ΔT	MHz (or kHz, Hz)
(g) PHASE	PHASE +(-)	o
(h) dB		dB

NOTE:

o (a),(b),(c) ..... V1 and V2 indicate the measuring channels, V1 for channel 1 and V2 for channel 2.

o (a) ..... The units are displayed corresponding to the input coupling, 'mṽ' or 'ṽ' for AC, 'mV' or 'V' for DC.

o Refer to pages 46 to 102 for basic operations of cursor measurement.

ii) Units in DVM mode

	DC V	AC V
DVM measuring value	mV, V	mṽ, ṽ, dB
DVM reference voltage	mV, V	mṽ, ṽ

NOTE:

In the REL mode of DCV function, 'Δ' is displayed at the left side of the numerals.

(b) How to apply various attenuation of the probe

(1) The scale factor of the vertical sensitivity for CH1 and CH2 can be changed with menu selection, according to the attenuation of the probe used.

For instance, when changing the probe from x1 to x10 at 10 mV/DIV range, set the CURSOR, and DLY/COUNTER key to the DLY/COUNTER, and press the MENU key, so that the menu is displayed. Select the menu for probe factor, and set for P10X.

When changing the probe from x10 to x1, do the same as above.

The menu is selected by pressing the corresponding numeric key.

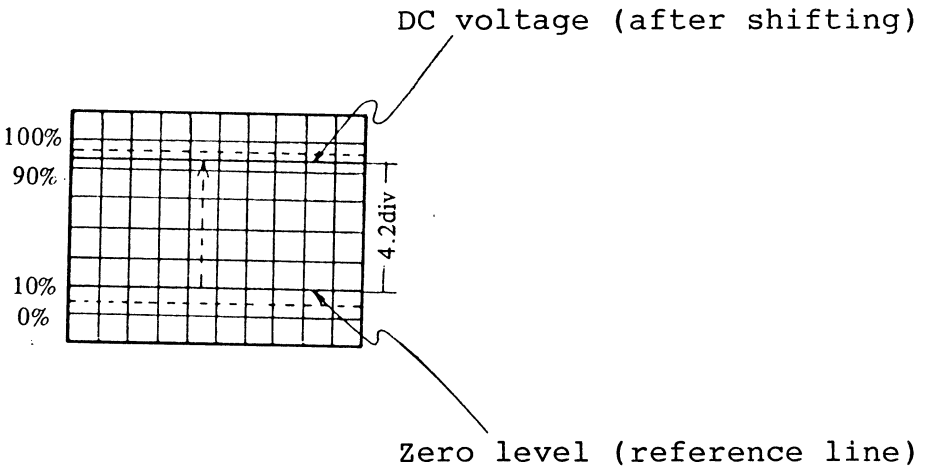
Note: The PB31 probe can not switch between X10 and X1.

(2) Basic triggering method

Set the horizontal display mode switch to A. The oscilloscope will automatically set the A mode trigger.
When the display mode switch is set to ALT, INTEN or B, select A mode trigger (main sweep) or B mode trigger (delayed sweep) by pressing the MODE A or B key.
In this case, the TRIGGER keys are illuminated according to the trigger mode being selected.

(3) DC voltage measurement

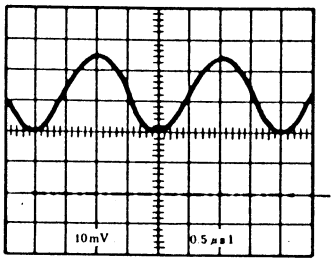
(a) Observing measurement (Conventional method)



Set the AC-GND-DC switch to GND and obtain the base-line trace. Set the AC-GND-DC switch to DC and set the VOLTS/DIV switch to obtain an optimum amplitude waveform. Since the trace shifts by the amount of DC voltage, the DC voltage of the signal can be obtained by multiplying the shift by the indicated value of VOLTS/DIV. When VOLTS/DIV is 50 mV/DIV, then 50 mV/DIV x 4.2 = 210 mV (However, if a 10 x probe is in use, the true value of the signal becomes 10 times the value, it will be 50 mV/DIV x 4.2 x 10 = 2.1 V).

(b) GND reference function

GND reference function



CURSOR and DLY/COUNTER : CURSOR
GND REF : ON
REF : ON

Ground reference cursor

To activate the cursor for GND reference, set the CURSOR and DLY/COUNTER key to the CURSOR. Press both the GND REF and REF keys. A horizontal cursor indicating GND reference is always displayed on the CRT. This GND referece function saves the conventional check of GND level in each measurement. The GND reference cursor interlocks with the signal and POSITION control rotation. The GND reference function is available for Channel 1 and Channel 2.

NOTES:

- o When the ground level is off the screen, the GND reference cursor will blink as a warning indicator.
- o In the CH3 or CH4 VERT MODE and in the ALT horizontal display mode, the GND reference cursor is not displayed.

(c) V cursor measurement

To activate cursor measurement, the CURSOR and DLY/COUNTER key must be set to CURSOR (The LED lights). Press both the GND REF and Δ keys, two horizontal cursors appear on the CRT.

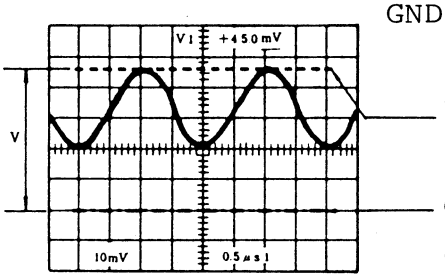
Position the reference cursor of the alternate long and short dash line by rotating the POSITION control and the delta cursor of the dotted line by turning the CURSOR control, the voltage from ground is displayed with the cursor menu "V" on the upper side of the CRT. The polarity of the voltage corresponds to the two cursor positions;

+: Delta cursor is located on the upper side of the reference cursor.

-: Delta cursor is located on the lower side of the reference cursor.

V cursor measurement for
the voltage from ground

CURSOR and DLY/COUNTER : CURSOR
GND REF : ON
Δ : ON



Clockwise turn of the CURSOR control moves a cursor to the upper side; counterclockwise turn moves it to lower side.

NOTES:

o GND reference cursor measuring function is available for Channels 1 and 2, but this function is available only for Channel 1 in the dual trace mode.
In the CH3 or CH4 VERT MODE and the ALT horizontal display mode, the GND reference cursor measuring function is not available.
Measuring numerals are displayed in div in the UNCAL mode.

(d) DVM measurement

To activate the DVM function, set the CURSOR and DLY/COUNTER key to the DLY/COUNTER (The LED lights).
Press the MENU key, and select the DVM measurement and then the DCV measurement. Press the DLY key for normal measurement. The DC voltage of the signal applied to Channel 2 will be displayed on the upper side of the CRT.

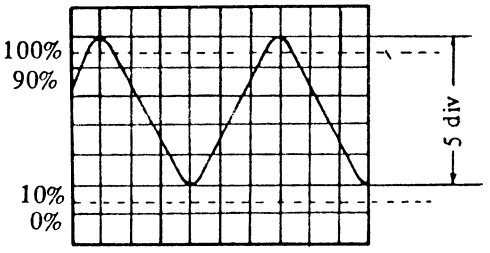
NOTE:

o When the CH2 input coupling is AC, 'DCV?' is displayed.

(4) AC voltage measurement

(a) Observing measurement (Conventional method)

The measuring method is same as [3] - (a) "DC voltage measurement", but there is no need of matching the zero level with the scale line. Position the base-line trace for easy observation. When magnifying a small-amplitude signal superimposed on a high DC voltage, set the AC-GND-DC switch to AC. The DC component will be blocked, therefore it is possible to increase the sensitivity. When one division represents 1 Vp-p, five divisions equal to 5 Vp-p.



(b) ΔV cursor measurement

To activate the cursor function, the CURSOR and DLY/COUNTER key is required to be set to the CURSOR (The LED lights). Press the [V] key, and two horizontal cursors appear on the CRT. Set the reference and delta cursor to a position to be measured by pressing the REF or [Δ] key and turning the CURSOR control. Then, the voltage between the reference cursor and the delta cursor is displayed with the cursor menu "ΔV" on the upper side of the CRT.

When pushing both the REF and Δ keys, the cursor function is in TRACKING mode. Two cursors move simultaneously by turning the CURSOR control.

NOTE:

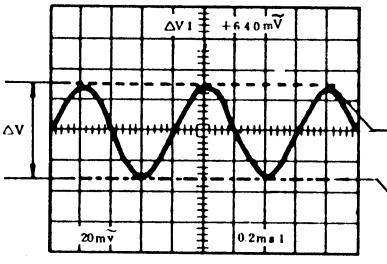
ΔV cursor measurement is available for Channel 1 and Channel 2. But this function for the Channel 2 is available only in CH2 VERT MODE.

In the ADD VERT MODE, the V cursor measuring function is available if Channel 1 and Channel 2 are the same range.

When the channels 3 and 4 are selected, ΔV div is displayed.

ΔV% cursor measurement for an overshoot

CURSOR and DLY/COUNTER
: CURSOR
V : ON
REF : ON
(Δ : ON)



(c) DVM measurement

To activate the DVM function, set the CURSOR and DLY/COUNTER key to the DLY/COUNTER (The LED lights), and input coupling to AC.
Press the MENU key, and select the DVM measurement and then the ACV measurement.
Press the DLY key, and AC voltage of the signal applied to Channel 2 is digitally displayed on the upper side of the CRT.

NOTEs:

- o The unit becomes '$m\tilde{v}$' or '$\tilde{v}$'. When the deflection factor of the Channel 2 is uncalibrated, a word 'UNCAL' is displayed instead of the numerals.
- o The ACV measurement is accurate only for a sine wave. Refer to item 8-(16).
- o When a message 'OVER RANGE' is displayed, make a signal smaller in the screen by changing the VOLTS/DIV range.

(5) Amplitude ratio measurement

(a) ΔV% cursor measurement

This cursor function is effective to measure the amplitude ratio which is based on 2 to 8 DIV (=100%), especially for overshoot measurement, etc.

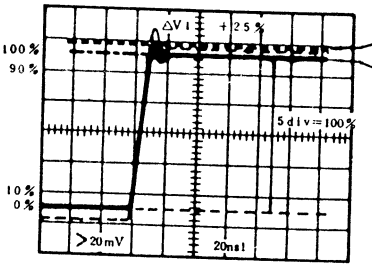
To activate the cursor function, set the CURSOR and DLY/COUNTER key to the DLY/COUNTER (The LED is distinguished).

Press the MENU key, and select the CURSOR MODE, and the screen turns into the mode for ratio cursor measurement.

Set the vertical division from 2 to 8 as 100%, using a numeric key.

Press the V key and the horizontal cursors appear on the CRT. The amplitude of the square waveform as shown below requires a 5 DIV display by rotating the VAR control. Position the reference cursor to a 100% amplitude by pressing the REF key and turning the CURSOR control. Position the delta cursor to overshoot point by pressing the Δ key and turning the CURSOR control. Then, the amplitude ratio between the reference cursor and the delta cursor is displayed with the cursor menu "ΔV" on the upper side of the CRT.

ΔV% cursor measurement for an overshoot



Delta cursor

Reference cursor

CURSOR and DLY/COUNTER : CURSOR
V : ON
CH1 UNCAL : ON
REF : ON
(Δ : ON)

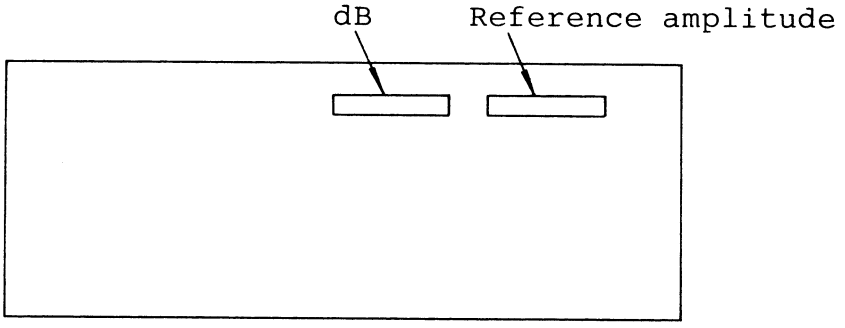
(b) DVM measurement

This measurement is effective to compare the amplitudes of two signals.

Apply an input signal from a circuit to Channel 2. Set the CURSOR and DLY/COUNTER key to the DLY/COUNTER, and press the MENU key. Select the DVM measurement and then the ACV measurement.

Then, press the Δ key. This will cause to input signal to be memorized as the reference at 0 dB. Apply an output signal from the circuit to Channel 2. The ratio of the output to the input, circuit gain, will be displayed in dB on the upper side of the CRT.

Push the REF and Δ keys simultaneously. The reference voltage will be displayed on the upper right side of the CRT.



(6) Frequency and period measurement

(a) Observing measurement (Conventional method)

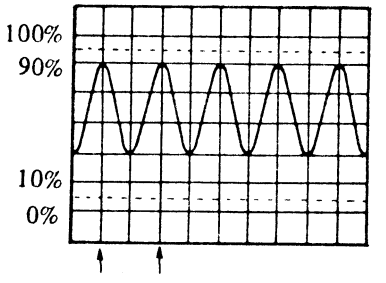
The below illustration shows one period of time between A and B, which represents 2.0 DIV.
When the sweep time is 1 ms/DIV, the period is given by

$1\ ms/DIV \times 2.0 = 2.0\ ms$

$(2.0 \times 10^{-3} s)$

Accordingly, the frequency is

$1/(2.0 \times 10^{-3}) = 500\ Hz$



Time A Time B

(b) ΔT cursor measurement

To activate CURSOR measurement, the CURSOR and DLY/COUNTER key must be set to the CURSOR.
Press the T key, and two vertical cursors appear on the CRT. Set the reference and delta cursors, so they appear on the positive or negative edge of the one period by pressing the REF or Δ key and turning the CURSOR control.
The time difference (ΔT) between the reference and delta cursors will be displayed on the upper side of the CRT.

The positive or negative polarity corresponds to the two cursor positions;

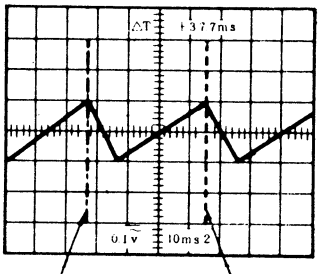
+: The Delta cursor is located on the right side of the reference cursor.

-: The Delta cursor is located on the left side of the reference cursor.

Clockwise turn of the CURSOR control moves a cursor to right side; counterclockwise turn moves it to left side.

When pushing both the REF and delta keys, the cursor function is in TRACKING mode. Two cursors move simultaneously by turning the CURSOR control.

ΔT cursor measurement for a period



Reference cursor Delta cursor

CURSOR and DLY/COUNTER

: CURSOR

T : ON

REF : ON

(Δ : ON)

NOTE:

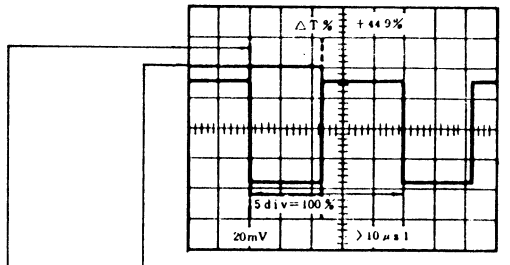
In ALT or X-Y operation of the horizontal display mode, the ΔT cursor measurement is not available.

ΔT cursor does not move when the CURSOR mode is set to RATIO CURSOR.

(c) 1/ΔT cursor measurement

To activate cursor measurement, the CURSOR and DLY/COUNTER key must be set to CURSOR.
Push both the V and T keys and two vertical cursors will appear on the CRT.
When the two cursors are superimposed at two edge points of the one period waveform by the CURSOR control, the reciprocal number of delta-time between two cursors is displayed on the upper side of the CRT.

1/ΔT cursor measurement for frequency



CURSOR and DLY/COUNTER
: CURSOR
V : ON
T : ON
1/T : ON
REF : ON
(Δ : ON)

Reference cursor Delta cursor

NOTE:
In ALT or X-Y operation of the horizontal display mode, the 1/ΔT cursor measurement is not available.
1/ΔT cursor does not move when the CURSOR mode is set to RATIO CURSOR.

(d) FREQ counter measurement

Set the CURSOR and DLY/COUNTER key to the DLY/COUNTER, and press the FREQ key. The frequency of the input signal of the channel (CH1 - CH4) selected in the A TRIG mode is digitally displayed on the upper right of the CRT.
The frequency is measured from the trigger point since the counter is interlocked with trigger. A specific frequency in a complex waveform can be measured by varing the level.
For instance, when applying the signal shown below, the frequency of the whole waveform is measured in case the trigger point is A, or the frequency of the bigger pulse is measured in case the trigger point is B.

NOTE:
The FREQ counter measurement is not activated when the signal is not synchronized. In this case, the "NO TRIG'D" message is displayed. The FREQ counter does not operate when the trigger signal source is in the ALT or LINE mode.

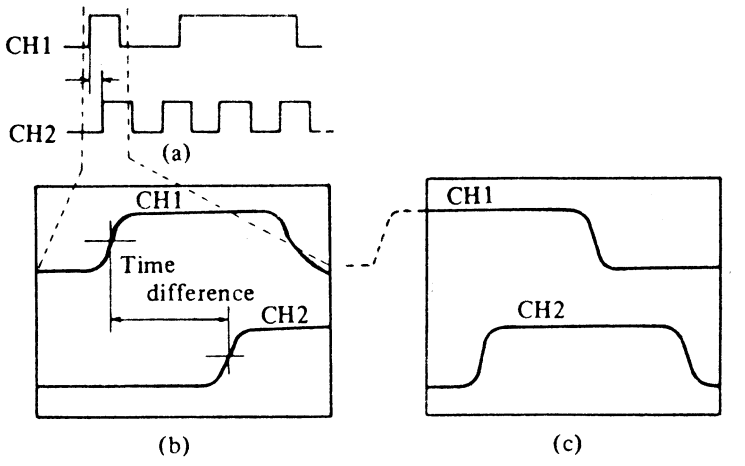
(e) PERIOD counter measurement

Set the CURSOR and DLY/COUNTER key to the DLY/COUNTER position, and press the PERIOD key. The period of the input signal of the channel (CH1 - CH4) selected by A TRIG is digitally displayed on the upper right of the CRT.

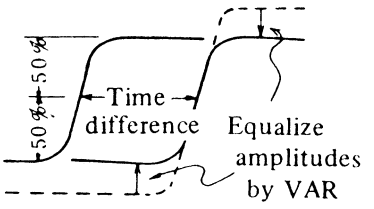
(7) Time difference measurement

(a) Observing measurement (Conventional method)

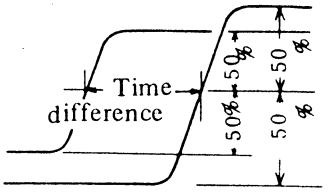
Select a "SOURCE" for the reference signal when measuring the time difference between two signals. Assume a pair of pulse trains are displayed as shown in (a), with CH1 selected as the trigger source. A signal delay appears between CH1 and CH2(b).



The delay time is measured between the 50% amplitude points on both pulse leading edges. Accuracy of the reading will be based on the amplitude displayed for each pulse train. Therefore, the attenuators for CH1 and CH2 should be set to the same voltage settings. Care should be taken in selecting the starts with B and advances to C, D, E, F,...and allows screen (c).



(a) Equal amplitude measuring method



(b) Superimpose measuring method

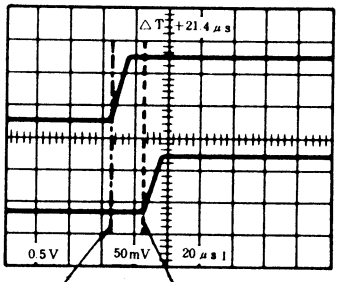
<CAUTIONS>

Proper circuit termination is required since high frequency components of the square wave are present. Therefore, use of correct probe or coaxial cable is necessary, with the ground lead kept as short as possible.

(b) ΔT cursor measurement

To activate ΔT cursor measurement, the CURSOR and DLY/COUNTER key must be set to CURSOR.
Press the T key and two vertical cursors appear on the CRT. When the two cursors are placed at two measuring points on the waveform by the CURSOR control, the time difference (ΔT) between the two cursors is displayed on the upper side of the CRT.

ΔT cursor measurement for time difference



Reference cursor Delta cursor

CURSOR and DLY/COUNTER

	:	CURSOR
T	:	ON
REF	:	ON
(Δ	:	ON)

NOTE:
In the ALT or X-Y operation of the horizontal display mode, the ΔT cursor measurement is not available.

(8) PHASE cursor measurement

This cursor function is used to measure the phase difference of two signals, whose period is set to T DIV (T = 2 to 8, corresponding to 360°).

For instance, the case of 5 DIV per period is described hereafter.

To activate the cursor function, set the CURSOR and DLY/COUNTER key to the DLY/COUNTER (The LED is distinguished).

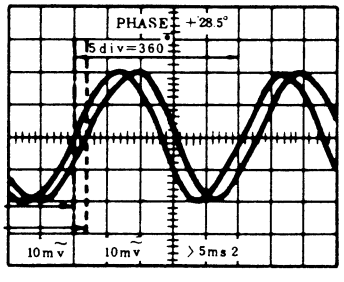
Press the MENU key, and select the CURSOR MODE, so that the screen turns into the mode for ratio cursor measurement.

Set the vertical division from 2 to 8 as 100%, using a numeric key.

Push the V key and the T key at the same time, so that two vertical cursors appear on the CRT. A single period signal shown below is set to 5 DIV by pulling and rotating the SWP VAR control.

Set the two cursors at the measurement points selected on the one period waveform by pressing the REF or the △ key and turning the CURSOR control. The phase difference between the two cursors is displayed on the upper side of the CRT.

PHASE cursor measurement



Reference cursor

Delta cursor

CURSOR and DLY/COUNTER : CURSOR

V : ON

T : ON

1/T : ON

REF : ON

(△ : ON)

SWP VAR : ON

NOTE:

In the ALT or X-Y operation of the horizontal display mode, the PHASE cursor measurement is not available.

(9) Rise time and fall time measurement

(a) Observing measurement (Conventional method)

To measure the rise time, attention must be observed to measurement error. The following relationship exists among the rise time Trx of the waveform to be measured, the rise time Trs of oscilloscope, and the rise time Tro displayed on the screen.

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

When the rise time of the pulse going to be measured is sufficiently longer than the rise time of the oscilloscope (less than 2.3 in our case), measurement error caused by the rise time of the oscilloscope can be neglected. However, if both are close each other, measurement error may be caused. The true rise time is given by

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

In a circuit free from waveform distortion such as overshoot and sag, the following relationship is established between the frequency band and the rise time.

$$fc \times tr = 0.35$$

where, fc : Frequency band (Hz)
tr : Rise time(s)

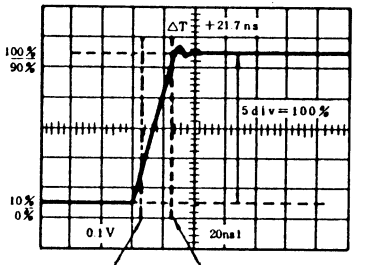
The rise time and fall time are determined by the time elapsed between the 10% to 90% values of pulse width.

(b) ΔT cursor measurement

To activate cursor measurement, the CURSOR and DLY/COUNTER key must be set to CURSOR.
In case "REF" is set to 5 div through the MENU, square waveform amplitude requires to be set to 5 DIV from 0% to 100% on the CRT as shown below by rotating the VAR control and the vertical POSITION control.
Push the REF or Δ key and turn the CURSOR control for setting a cursor at a 10% point of the leading edge (or trailing edge) and the other cursor at a 90% point of leading edge (or trailing edge).
Then, the rise time or fall time between the reference and delta cursors is displayed on the upper side of the CRT.

$_{\Delta}$T cursor measurement for rise (fall) time

CURSOR and DLY/COUNTER
: CURSOR
T : ON
REF : ON
(Δ : ON)



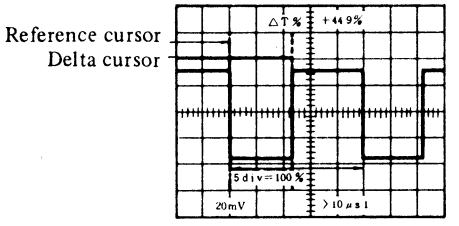
Reference cursor Delta cursor

NOTE:
In ALT or X-Y operation of the horizontal display mode, the $_{\Delta}$T cursor measurement is not available.

(10) ΔT% cursor measurement for duty cycle

The activate cursor measurement, set the CURSOR and DLY/COUNTER key to the CURSOR, press the MENU key, and the menu is displayed on the CRT. Select the CURSOR MODE, and select the number of division, close to the period of the waveform to be measured, as a reference sync.
If the period is selected to be 5 DIV, for instance, press the 5 key and then press the T key.
Set one period of the square waveform shown below to 5 DIV corresponding to 100% by rotating the SWP VAR control.
Push the REF key and rotate the CURSOR control for setting the reference cursor at the leading edge of the waveform and then push the Δ key and rotate the CURSOR control for setting the delta cursor at the trailing edge. Then, the duty cycle between the two cursors is displayed on the upper side of the CRT.

ΔT% cursor measurement for duty cycle



CURSOR and DLY/COUNTER		
	:	CURSOR
T	:	ON
REF	:	ON
(Δ	:	ON)
SWP VAR	:	ON

NOTE:
In ALT or X-Y operation of the horizontal display mode, the ΔT% cursor measurement is not available.

(11) Measurement of event pulses

(a) EVENTS IN DLY

Used to measure event pulses correspond to the delay time.

1. Set the horizontal display mode to ALT, INTEN, or B.
2. Set the CURSOR and DLY/COUNTER key to DLY/COUNTER.
3. Press the EVENTS DLY key for counting the event pulses during the delay time (between the start point of the A sweep and that of the B sweep).

Delay time is set by rotating the DLY POS control in the DLY/COUNTER mode.

Examples of measuring of the event pulses are shown below.

The number of event pulses of CH2 which occurred during the period X of the CH1 pulses is measured in Fig. A.

The number of event pulses of CH1 which occurred until the irregular pulse (of the same CH1) is measured in Fig. B.

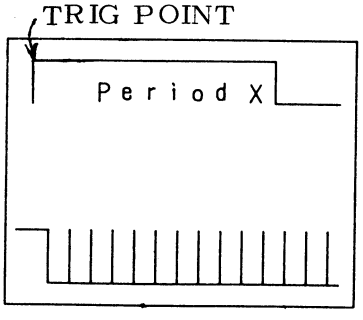


Fig. A

CURSOR/COUNTER:	COUNTER
EVENTS DLY:	ON
EVENTS SEL:	B TRIG
TRIG:	
A TRIG SOURCE:	CH1
B TRIG SOURCE:	CH2
B TRIG MODE:	NORM

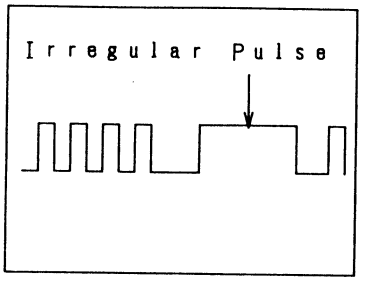


Fig. B

CURSOR/COUNTER:	COUNTER
EVENTS DLY:	ON
EVENT SEL:	A TRIG
TRIG:	
A TRIG SOURCE:	CH1

When the horizontal display mode is set to A or X-Y, the EVENTS DLY does not function. Instead, "NO EVT IN A SWP" or "NO EVT IN X-Y" is displayed.

(b) EVENTS IN B

Used to measure the event pulses of the B sweep.

1. Set the horizontal display mode to ALT, INTEN, or B.
2. Set the CURSOR and DLY/COUNTER key to DLY/COUNTER.
3. Press the EVENTS B key for counting the event pulses of the B sweep.

Since the event counter interlocks the trigger mode, the input signal which is selected by the A TRIG or B TRIG is counted. In the no triggered mode, events counter does not function, while the "NO TRIG'D" is displayed.
When the B TRIG is selected by the MENU key, set the NORM mode for the B TRIGGER.
A trigger or B trigger signal is selectable.
Select the OTHER SETUP by the MENU key, then select the A trigger or B trigger.

(12) Single-shot signal measurement

Single sweep is conveniently used in signal photography and waveform measurements of irregular repetition (such as impulse waves, sound waves, switching noise).
[Test measurement]

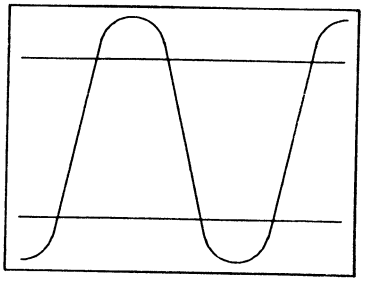
Press the NORM key for the A trigger MODE. Apply a signal or repetitive waveform equivalent to a signal to a channel, and trigger it by rotating the LEVEL control. Then push the SGL key and check that single sweep is executed.

Remove the vertical axis input signal by setting the AC-GND-DC switch to GND. Press the SGL key and check that the READY indicator lights. Apply the signal to be observed. After the single sweep, the READY indicator goes off.
Since single sweep is executed by changing the trigger level, even if no signal is supplied, do not rotate the trigger LEVEL control after pushing the SGL key.

(13) Triggering method

(a) Auto trigger level

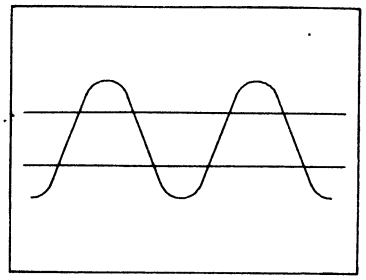
The AUTO TRIGGER LEVEL mode is established by the MENU key (for details, refer to page 87, setting of OTHER SETUP.), and by setting the A TRIG mode to AUTO.
While the usual trigger level is set regardless of the input level, trigger level is set according to the amplitude of input signal in the AUTO TRIGGER LEVEL mode as shown in Figs. (a) and (b).
The AUTO TRIGGER LEVEL setting function eliminates troublesome triggering.



Maximum trigger level (LEVEL control fully rotated clockwise.)

Minimum trigger level (LEVEL control fully rotated counter-clockwise.)

Input signal of large amplitude



Maximum trigger level
(LEVEL control fully
rotated clockwise.)

Minimum trigger level
(LEVEL control fully
rotated counter-
clockwise.)

Input signal of small amplitude

NOTES:

1. When the GROUND REFERENCE cursor is used, set the AUTO TRIGGER LEVEL to off.
2. Jitter can occur when the signal frequency is less than 500 Hz.
3. Edge of waveform can not be triggered when the trigger level is changed.

(b) Alternate triggering

When the CH1 and CH2 signals are not triggered, set on the ALT, CH1, and CH2 keys of the VERT MODE, and press the ALT CH1 and the CH2 keys simultaneously.
The CH1 and CH2 indicators will light, and a stabilized alternate waveform is obtained.

NOTES:

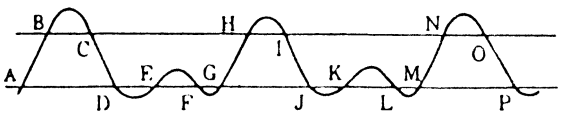
1: Trigger coupling is automatically set to the DC mode in the alternate triggering mode.
When the VERT MODE setting is changed from the ALT mode to the other modes, the trigger source is automatically set as follows.

VERT MODE	SOURCE
ALT → CH1	CH1
ALT → CH2	CH2
ALT → CHOP	CH1

2: Alternate triggering is available only at the dual trace display of CH1 and CH2.

(c) Triggering of complexed waveform

In the case shown in Fig. (a) where waveforms are greatly different in amplitude, the waveform is doubled if the trigger level is not set properly. In the case where the trigger level is selected by line Y, two waves will appear, one starting with A and advancing to B, C, D, E, F,... and the other starting with E and advancing to F, G, H, I..., will appear alternately on the screen. They will be doubled as shown in Fig. (b), for which no triggering can be taken. In such a case, rotate the LEVEL control clockwise until the trigger level comes to Y' line. Then the waveform on the screen becomes the one as shown in Fig. (c) which starts with B and advances to C, D, E, F,... and allows triggering.



Y' Trigger level
Y setting line

(a) Signal waveform

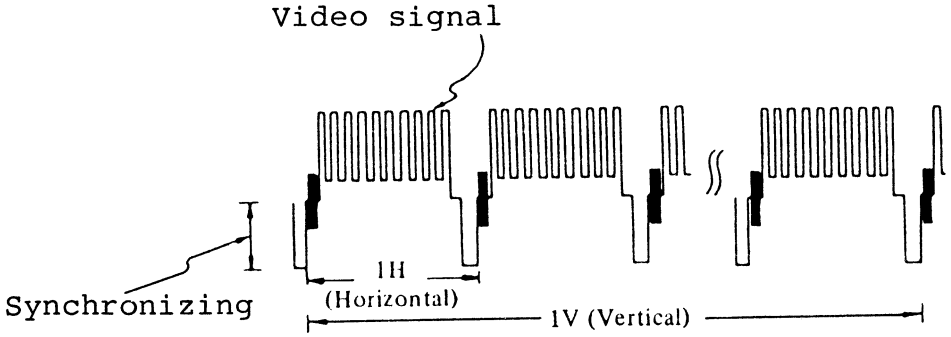
(b) When the trigger setting level is Y

(c) When the trigger setting level is Y'

Triggering of complexed waveform

(d) TV trigger

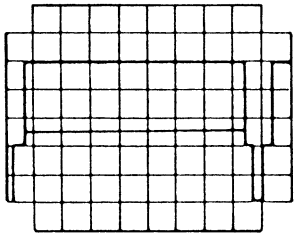
① Video signal of TV



In video work complexed signals containing video signal and sync signal are often measured.

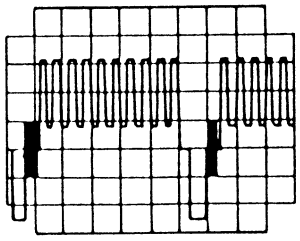
② Operation

To observe vertical signal



A/B: A
COUPLING: TV-V
TIME/DIV: 0.1 ms/div to
0.2 s/div
SLOPE: -

To observe horizontal signal



COUPLING: TV-H
TIME/DIV: 50 µs/div to
20 ns/div
SLOPE: -

To select the polarity of the video and sync signals, press the [+] or [-] key of the SLOPE section in the TRIGGER. It is not required of setting of trigger level in the TV mode.

NOTE:
When the TV mode, B trigger slope interlocks A trigger slope.

(14) Operating procedure of delayed sweep

Delayed sweep is used to magnify and observe any portion of a complexed waveform in the horizontal direction. There are two delay sweeps, one is AUTO delay sweep (continuous delay sweep) and the other NORM delay sweep (triggering delay sweep). These are selected by the B trigger MODE key. Usually, the instrument is used in the AUTO mode.

Although the AUTO delay sweep is easy to operate, the maximum magnification factor is limited to a few hundred times by delay jitter. On the other hand, since no jitter is generated in NORM delay sweep, this sweep has the feature to increase the magnification factor. The magnification factor is limited by the brightness of CRT to a few thousand times.
For setting of delay time, the CURSOR and DLY/COUNTER key must be set to DLY.

(a) AUTO (Continuous delay sweep)

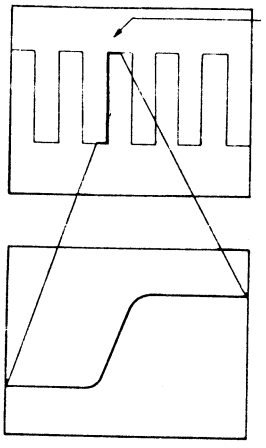
Effect triggering by A sweep and set the switches as follows.

Horizontal display mode	: ALT (or INTEN)
A TIME/DIV	: As desired
B TIME/DIV	: Set B TIME/DIV at a faster sweep time than the one set by A TIME/DIV
Trigger mode	: B
B TRIG MODE	: AUTO

The high brightness portion of A sweep will appear (if not, adjust INTENSITY ΔB).
Turn the DLY POS control, and the high brightness portion will move continuously. Bring this high brightness portion to the position desired to be magnified. Then, the high brightness portion is magnified to occupy the full area of the screen. (When the horizontal display mode is set to INTEN, it is required to change the mode from INTEN to B.)

Horizontal display mode:
INTEN

Horizontal display mode:
B



Bright portion

The time from a starting point of A sweep to that of the brightness portion is displayed on the upper side of the CRT. The sweep time is given by the B TIME/DIV.

NOTE:

The LEDs of SOURCE and COUPLING for B trigger do not come on in the AUTO mode of B trigger, since the SOURCE and COUPLING are of no effect.

In the AUTO mode of B trigger, the start point of B sweep is set by the DLY POS control.

(b) NORM (Triggering delay sweep)

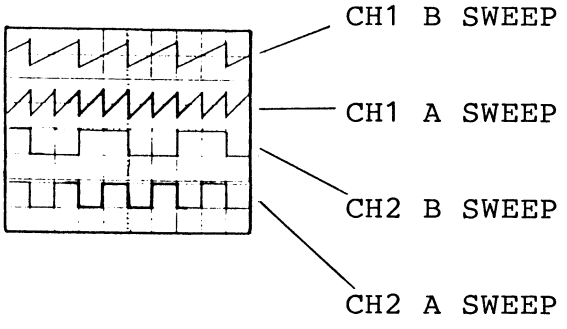
Effect triggering by A sweep and set the controls as follows.

Horizontal display mode	: ALT (or INTEN)
A TIME/DIV	: As desired
B TIME/DIV	: Set B TIME/DIV at a faster sweep time than the one set by A TIME/DIV
Trigger mode	: B
B TRIGGER MODE	: NORM
SLOPE	: Select (+) or (-) by the SLOPE key.

Rotate the A/B LEVEL control, and the high brightness portion of A sweep appears. (This state is called the B-triggered state.) Rotate the DLY POS control, and the high brightness portion moves to the next peak. Bring this high brightness portion to the position desired to be magnified by using DLY POS control and LEVEL. Then the high brightness portion is magnified to occupy the full area of the screen. (When the display mode is set to INTEN, it is required to change the mode from INTEN to B.)
The sweep time is given by the B TIME/DIV. In the NORM mode, a mark greater than '>' is displayed on the left side of the delay time numerals.

(c) ALT sweep

The ALT sweep function alternately displays main sweep (A) and delayed sweep (B) on the CRT.
The below figure shows the display in the ALT sweep mode.



A sawtooth waveform is applied to Channel 1 and a square waveform to Channel 2 in this case.
The B sweep trace can be moved up to about four divisions above the A sweep trace for the convenience of observation by the A/B SWP SEP control. By setting on the CH1, CH2, CH3, and CH4 keys of the VERT MODE in the ALT sweep mode for quad traces, four more traces, eight traces in total, appear on the CRT.

NOTE:
Since traces are alternately displayed in the ALT sweep mode, flicker can occur in the slow sweep rate.
To avoid this, set the TIME/DIV switch to the 0.2 ms/DIV or higher.

(d) Delay sweep in TV mode

i) In the TV-V or TV-H mode for the A trigger COUPLING, the B trigger COUPLING is automatically set to TV-H.
The B COUPLING cannot be set to TV-H independent of A trigger.

(15) MENU selection

(a) Contents of menu

(i) PROBE FACTOR

For setting the attenuation of the probe for CH1 and CH2.

(ii) CURSOR MODE

For selecting the unit as follows when using a cursor.

Normal measurement : V, S, Hz (absolute value)

Ratio measurement : %, ^{o} (degree) dB (relative value compared with the reference value)

(iii) DVM

For the DCV or ACV measurement.

(iv) COMMENT

For comment display.

(v) OTHER SETUP

For turning ON/OFF the auto trigger level, setting the event counter signal to be measured, adjusting the DVM offset, and initializing.

(b) Functions of keys in the MENU mode

The oscilloscope turns into the MENU mode by setting the CURSOR and DLY/COUNTER key to DLY/COUNTER and pressing the MENU key. In the MENU mode, the TRIGGER/CHARACTER keys have functions (0 - 8 and ◀) indicated in blue above the keys. The ◀ key is used to return to the preceding screen. The selected item is indicated by an index mark ☞ .

NOTE:

To return to the normal mode while selecting the MENU, press the MENU key.

(c) Operating methods

(i) Setting of PROBE FACTOR

1) Set the CURSOR and DLY/COUNTER key to DLY/COUNTER, and push the MENU key. the menu is displayed as shown in Fig. 8-1.

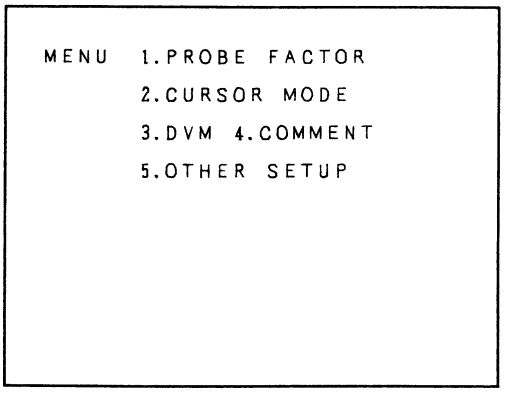


Fig. 8-1

2) Press the 1 key, and the display in Fig. 8-2 appears.

3) Press the key (1 - 6) corresponding to the attenuation of the probe to be used. The attenuation is set and the oscilloscope turns into the normal mode.
The set value or default value is indicated by the index mark ☞ as shown in Fig. 8-2.

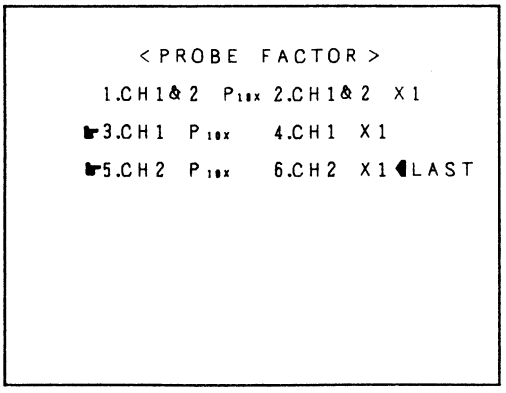


Fig. 8-2

(ii) Setting of CURSOR MODE

1) Set the CURSOR and DLY/COUNTER key to DLY/COUNTER, and press the MENU key.
The menu is displayed as shown in Fig. 8-3.

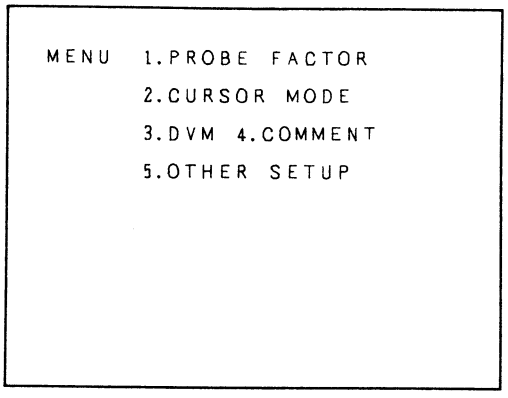


Fig. 8-3

2) Press the 2 key, and the display in Fig. 8-4 appears.

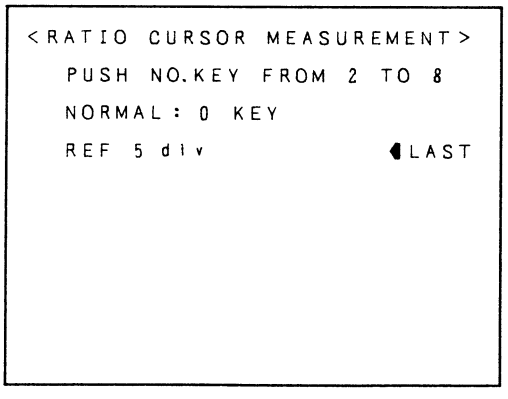


Fig. 8-4

3) To change the cursor mode from normal to ratio, or to change the reference value of the ratio cursor measurement, press a numeric key (2 - 8) corresponding to the reference value.
The display in Fig. 8-5 appears.
The latest reference value is displayed as "REF (1 - 8) div".

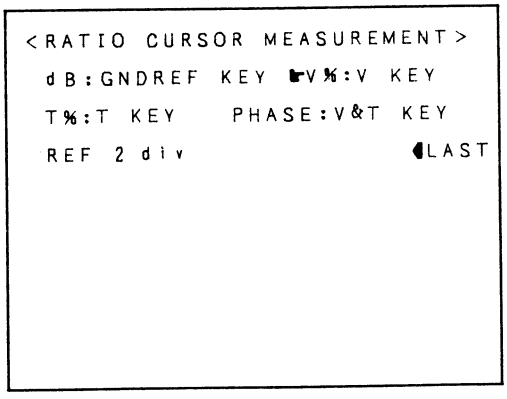


Fig. 8-5

4) Press the key corresponding to the item to be measured.

NOTE:
To return to the normal mode while setting the cursor mode, press the 0 key when "RATIO CURSOR MEASUREMENT" is displayed.

(iii) Setting of DVM

1) Set the CURSOR and DLY/COUNTER key to DLY/COUNTER, and press the MENU key. The menu is displayed as shown in Fig. 8-6.

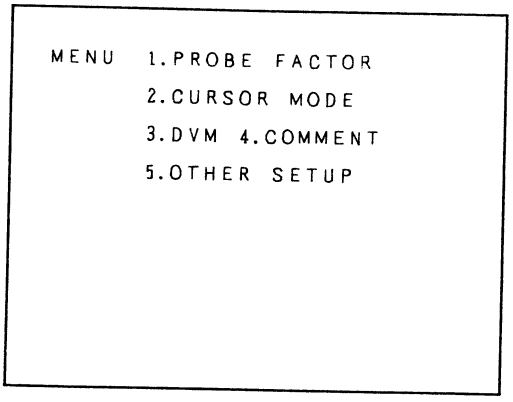


Fig. 8-6

2) Press the 3 key, and the display in Fig. 8-7 appears.

3) Press the key corresponding to the item to be measured.

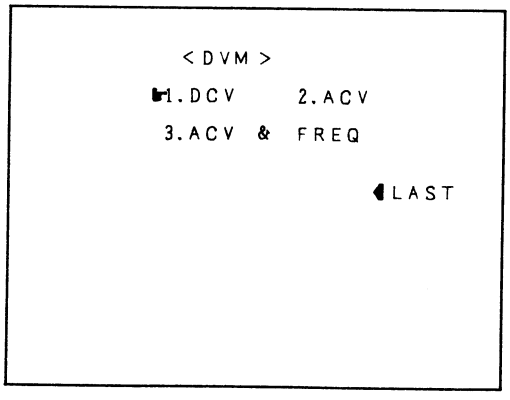


Fig. 8-7

4) The display in Fig. 8-8 appears.

5) Press the REF key, and the results of measuring the signal applied to CH2 is displayed.

6) Press the Δ key, and the difference value, by comparing the signal applied to CH2 with reference value, is displayed. In case of DCV, the difference value from the reference voltage is displayed. In case of ACV, dB measurement compared to the reference voltage (0 dB) is displayed.

7) When the REF key and the Δ key are pressed simultaneously, the value of the signal applied to CH2 and the compared value are displayed.

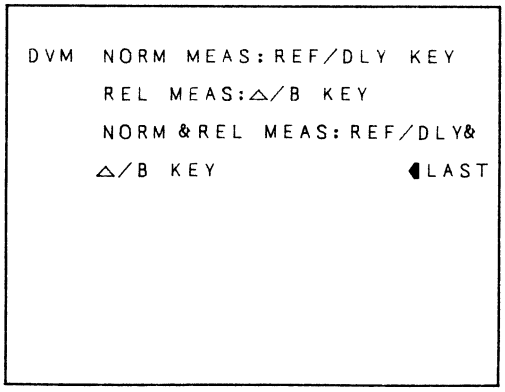


Fig. 8-8

NOTES:

1. To terminate the DVM measurement, press the MENU key.
2. During the DVM measurement, the cursors and the event counter are not activated at the same time.

(iv) Setting of COMMENT

1) Set the CURSOR and DLY/COUNTER to DLY/COUNTER, and press the MENU key. The menu is displayed as shown in Fig. 8-9.

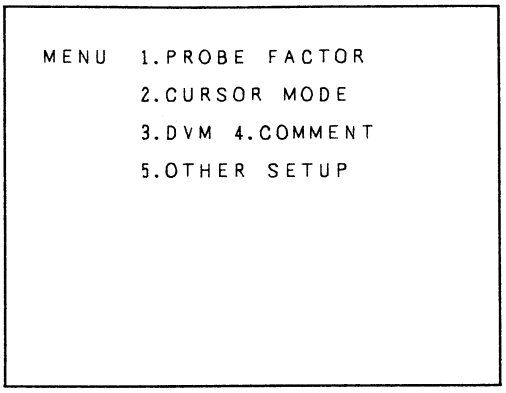


Fig. 8-9

2) Press the 4 key, and the character cursor blinks, and the oscilloscope turns into the comment mode.

3) Refer to item (16) for detail procedures of the comment display.

NOTE:
To return to the normal mode from the comment mode, press the MENU key.

(v) Setting of OTHER SETUP

1) Set the CURSOR and DLY/COUNTER to DLY/COUNTER, and press the MENU key. The menu is displayed as shown in Fig. 8-10.

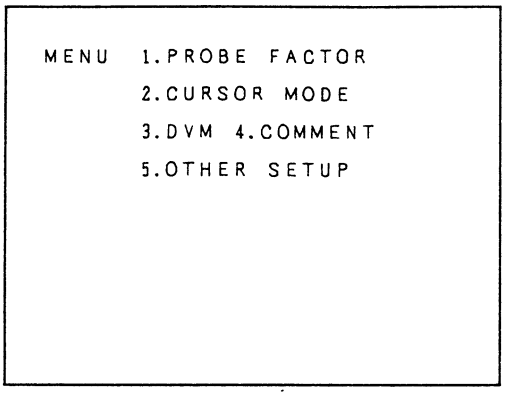


Fig. 8-10

2) Press the 5 key, and the display in Fig. 8-11 appears.

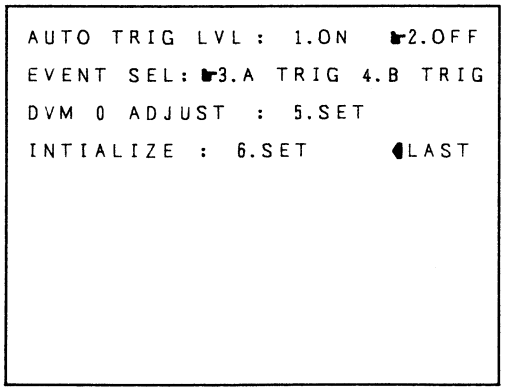


Fig. 8-11

i) AUTO TRIG LVL

1 : AUTO TRIG LVL (A TRIG) is turned on.

2 : AUTO TRIG LVL (A TRIG) is turned off.

ii) EVENT SEL

Select A TRIG or B TRIG for the signal to be measured when the event counter is activated.

When B TRIG MODE is AUTO, the input signal selected by A TRIG is measured.

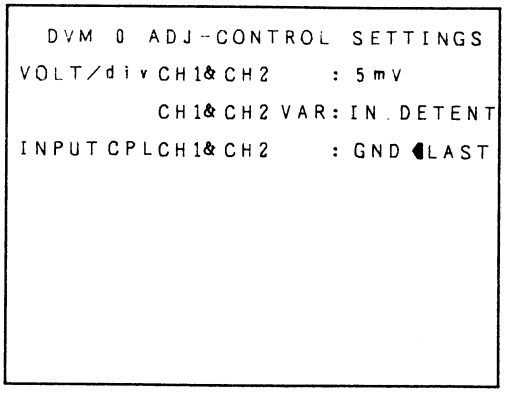


Fig. 8-12

iii) DVM 0ADJ

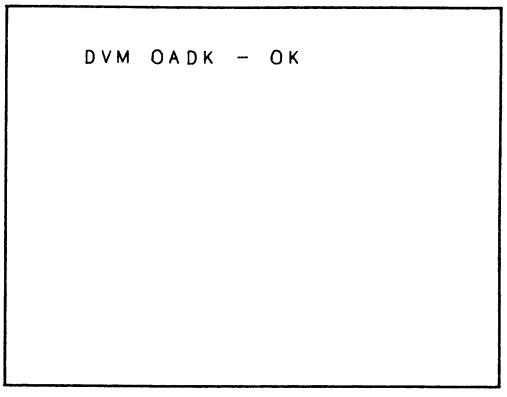


Fig. 8-13

- o Press the 5 key, and the display in Fig. 8-12 appears.
- o Set the attenuator range of CH1 and CH2 to 5 mV (50 mV in case of P10x).
- o Set the input coupling of CH1 and CH2 to GND, and the DVM offset is performed.

o The display in Fig. 8-13 remains for 2 seconds approx., and the oscilloscope turns into the normal mode.

iv) INITIALIZE

Press the 6 key, and the settings are initialized.

(16) Comment display

(a) Display specifications

i) Number of line: 2 lines (Can be displayed in any specified vertical locations of 6-line on the CRT)

Number of characters: 30 characters maximum

Kind of characters:

Figures: 0,1,2,3,4,5,6,7,8, and 9

Letters: A,B,C,D,E,F,G,H,I,J,K,L,M,N, O,P,Q,R,S,T,U,V,W,X,Y, and Z

Symbols and others:

Z, [ ] (space), .(period), +, -, *, /, :, <, >, m, n, μ, k, s, z, d, i, v, o, Δ (delta), %, °(degree), ↑, ↓, ←, →

ii) Display location

The CRT provides eight lines for display, however, available lines for the comment display are six excluding the top and bottom lines. The comment can be set in two lines among the six lines.

The top and bottom lines are used to display the measured values and set values, respectively.

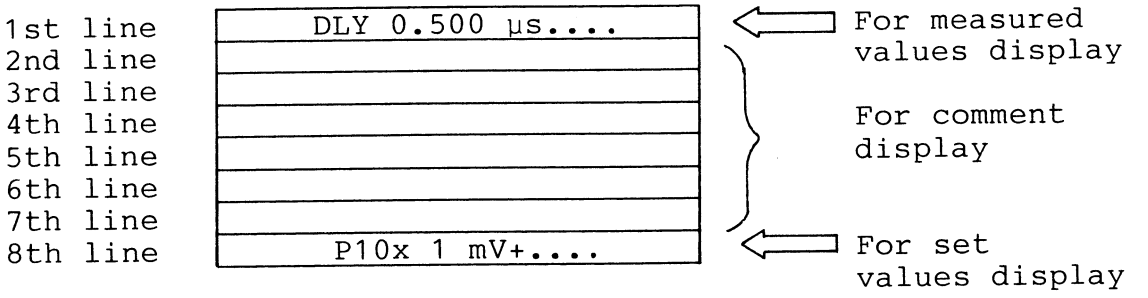


Fig. 8-1 Comment display location

(b) Comment display method

i) Display setting.....[MENU]
Press the [MENU] key to select the COMMENT mode. Then a blinking cursor will appear on the CRT.

ii) Cursor
A cursor "_" (underline) blinks to show the next display/input position.

iii) Figures and [.] (period) display
Figures and period can be displayed by the 0 to 9, and . keys. When the key is pressed, the selected figure or period is registered as a comment, and the cursor is shifted right by one column.
Example:

198_
Press the key [6].

1986_ ..... Figure 6 will be displayed.

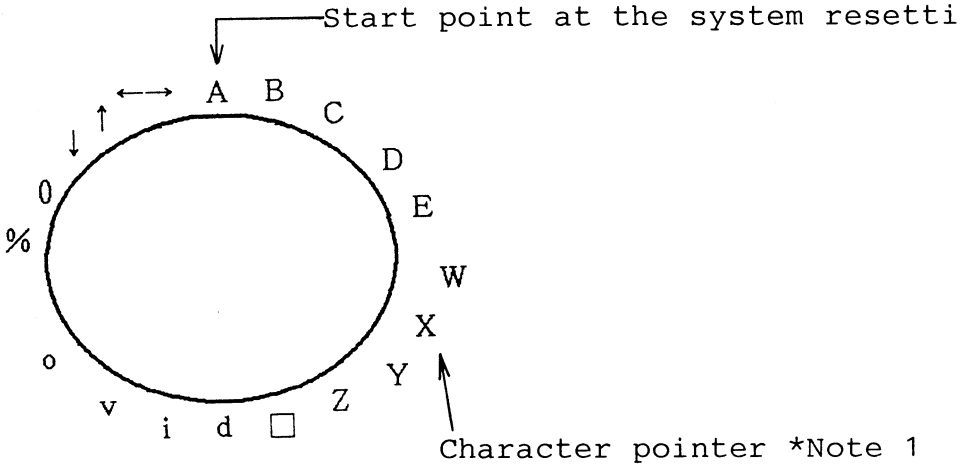
iv) Letters, symbols, etc.
Letters, symbols, etc. can be selected and displayed by the [CHR SEL] control. When the control continues to be rotated, character is changed one after another.

The clockwise rotation makes the displays in the sequence of A, B, C .... When the last character "→" is displayed, the first character "A" will replace "→" in the next sequence. The counterclockwise rotation makes the displays in the reverse sequence of →, ←, ↓.... When A is displayed, [→] will be next displayed.

Character display sequence is shown below:

A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z, (space), . (period), +, -, *, /, :, <, >, m, n, μ, k, s, z, d, i, v, o, Δ (delta), %, ° (degree), ↑, ↓, ←, → (last character)

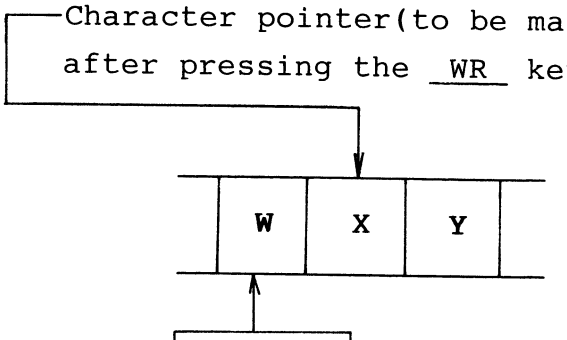
After displaying a letter or symbol by the [CHR SEL] control, press the [WR] key to register the selected character as a comment and to shift the cursor right by one column.



*NOTE 1:

Character pointer means a character which is to be registered when pressing the [WR] key.

For example, when selecting a letter after registering letter X, rotate the [CHR SEL] control clockwise to select Y or rotate it counterclockwise to select W. In this time, X is masked. To select X again, rotate the [CHR SEL] key.



Rotate the CHR SEL control clockwise.

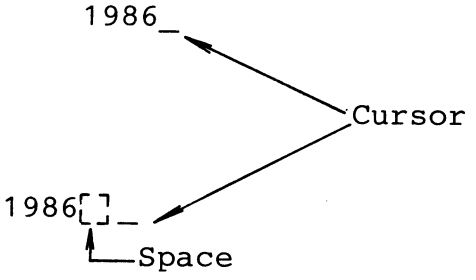
Rotate the CHR SEL control counterclockwise.

v) Space display

To display a space by a method other than that of Item (b)-iv), press the WR key before displaying a character.

Example:

Press the WR key.

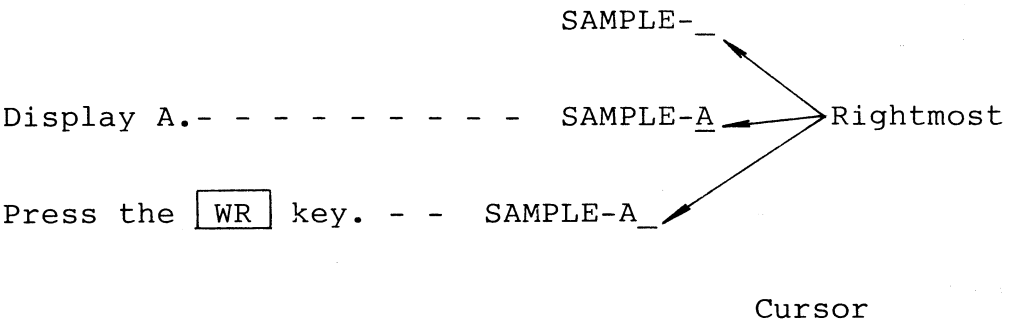


vi) When the cursor is on the rightmost position

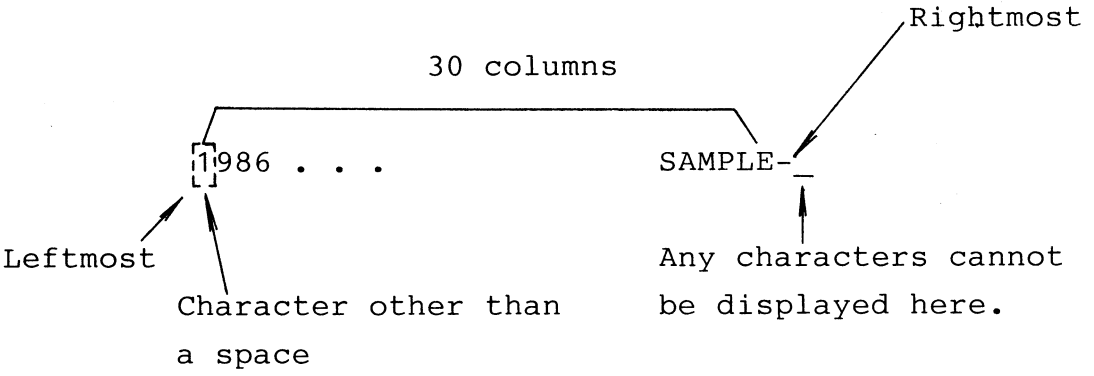
In the case that the cursor is on the rightmost position, display a character on the rightmost position, and the whole comment is shifted left by one column to register the character. (See Example 1.)

However, if a character other than a space is on the leftmost position, any characters cannot be displayed. (See Example 2.)

[Example 1:]



[Example 2:]



vii) Comment display location shift

Comment can be shifted down by one line by pressing the ▼ and the LOC keys simultaneously.

When the comment is shifted to the 7th line, it is next shifted to the 2nd line. The comment can be shifted right by pressing the ▶ and the LOC keys simultaneously.

(When the cursor is on the rightmost position, the comment cannot be shifted right.)

The comment can be shifted left by pressing the ◀ and the LOC keys simultaneously.

(When the top character of the comment is on the leftmost position, the comment also cannot be shifted left.)

viii) Comment correction

Press the [DEL] key to shift the character left by one column and to delete the character presented at that new position of the cursor. (Excluding the case that the cursor is on the leftmost position)

Press the [INS] key to insert a blank space at the left side of the cursor.

ix) Check of comment display

Since keys in the CHARACTER mode are not illuminated when they are pressed, check that the correct comment is displayed on the CRT.

x) End of comment display mode

Press the [MENU] key to terminate the comment display mode, to set the TRIGGER mode and to display A-trigger setting conditions.

(c) Comment storage

The last comment and its display location is registered until the initial setting function is performed.

(d) Comment display procedures

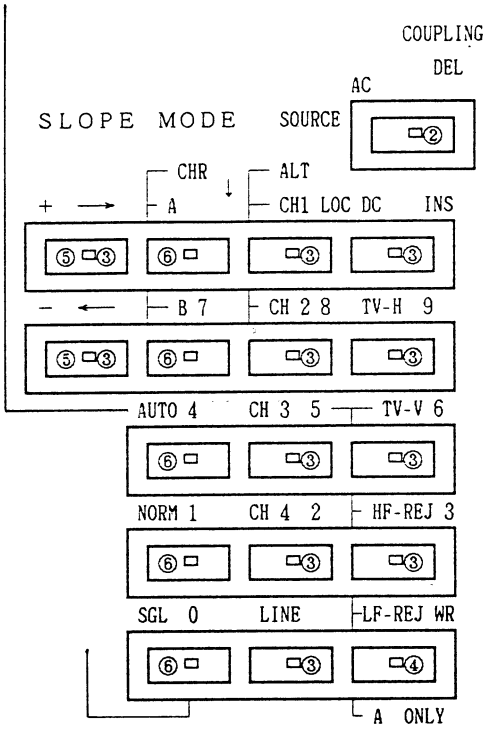


Fig.8-2 Keys for comment display

(TRIGGER/CHARACTER section)
(Figures on each key correspond to those of the procedures shown right.)

START

1. Press the MENU key to select COMMENT.
2. Move the cursor to the desired position by the ▶ ◀ ▼ keys.
3. Display characters by 0 to 9, and . keys and the CHR SEL control.
   For display correction, press the DEL or the INS keys.
4. Register letters, symbols, etc. displayed by pressing the WR key.
5. Shift the comment to the desired column by pressing the LOC and ▶, or LOC and ◀ keys.
6. Press the MENU key to terminate the comment display mode and to set the TRIGGER mode.

END

(e) Comment display example

A comment display example according to the procedures described in (d) is shown below:

Desired comment: 1986/7/18 SAMPLE-A

i) Press the [MENU] key to select COMMENT. (Comment display mode start.)

ii) Press the [1], [9], [8], and [6] keys.

iii) Select "/" by rotating the [CHR SEL] control, and press the [WR] key.

iv) Press the [7] key.

v) Rotate the [CHR SEL] control to select "/", and press the [WR] key.

vi) Press the [7] and [8] keys.

vii) Press the [WR] key once to display a space.

viii) Select "S" by rotating the [CHR SEL] control, and press the [WR] key. Display and register A, M, P, L, and E by the same procedure as S.

ix) Press the [LOC] and the [▼] keys simultaneously until the comment is moved to the desired line.

x) Holding down the [LOC] key, press the [▶] button until the comment is shifted to the desired position.

xi) Press the [MENU] key.

Refer to Fig. 8-3 "Example of comment display."

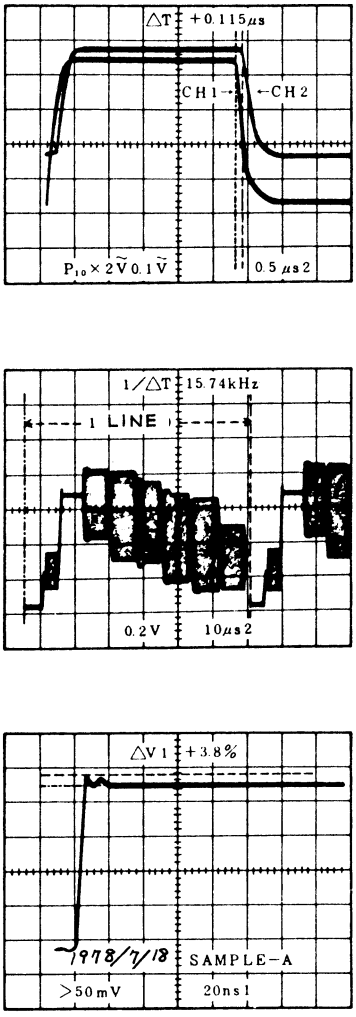


Fig. 8-3 Example of comment display

(17) System reset

In cases of abnormal AC power or something, the built-in microprocessor can malfunction. In this case, press the TRACE FINDER switch and the READOUT control simultaneously or set the POWER switch to ON, OFF, and then ON to reset the microcomputer. Allow 3 seconds for the microcomputer to operate normally again.

Initial setting function

All the functions of the oscilloscope can be returned to initial setting by the initial setting function.
Press the TRACE FINDER switch and the READOUT control simultaneously, holding down the AUTO key in the MODE section, or press the MENU key to select OTHER SETUP, and then to select INITIALIZE so that the function is executed.

* **System resetting is as follows:**

① Comment display:
- o Comment: Nothing
- o Cursor: Sixth line, 21st column (for date display)
- o Letter selection: Begins with A

② Trigger setting:

	A-trigger	B-trigger
o SLOPE:	+	—
o MODE:	AUTO	AUTO
o SOURCE:	CH1	—
o COUPLING:	DC	—
o A/B	A	—

③ Probe selection: x10

④ Vertical mode: CH1

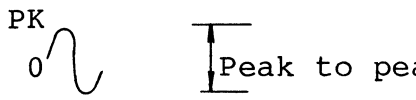
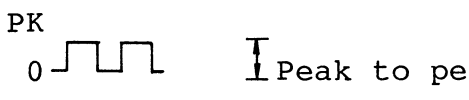
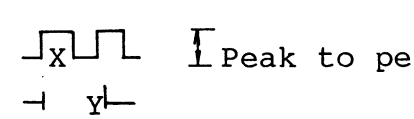
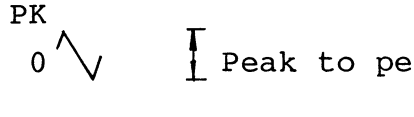
⑤ Horizontal display: A

Notes:

(1) *: Select the REF and Δ keys corresponding to the desired cursor.
(2) Cursor menus V1 and ΔV1 are for the CH1, and V2 and ΔV2 are for the CH2.
(3) X: Any of 1 to 8 div.
(4) When the vertical mode is ADD, "V1 2" is displayed as a cursor menu.
   ① When the ranges of the CH1 and the CH2 are same, the GND REF, the V, and the ΔV cursor measurement is available.
   ② When the ranges of the CH1 and the CH2 are different,
      GND REF: available
      V: "2" is displayed
      ΔV: division is displayed.
   ③ When the CH1 and/or the CH2 are in the UNCAL mode,
      GND REF: available
      V: "UNCAL" is displayed
      ΔV: percentage is displayed.
(5) The cursor mode is set by the cursor menu.
(6) When the measurement range is in the UNCAL mode, the division is displayed.
(7) When the ΔV and the ΔV% function, the division is displayed for the measurment for the channels other than the CH1 and the CH2.

(19) DVM ACV mode measurement

In the DVM ACV measurement mode, V-1150 measures the average of the signal and displays r.m.s. for a sinewave signal. Therefore, signals except a sinewave are not measured accurately.
The relationships of some signals except a sinewave and its displayed numerals are shown below.

Input signal	Display	R.M.S.	Peak to peak	0 to peak	Average
	1.00	1.000	2.828	1.414	0.900
	1.00	1.000	1.414	1.414	0.900
	1.00	1.414	2.828	2.828	0.900
	1.00	0.900	1.800	0.900	0.900
	1.00	1.272	1.800	1.800	0.900
(50% duty) D=X/Y 	1.00	0.9D1/2	0.9/D	0.9/D	0.9/D
	1.00	1.038	3.600	1.800	0.900

9. SPECIFICATIONS

o CRT

Configuration and useful screen:	6-inch rectangular screen with internal graticule; 8 x 10 div (1 div = 1 cm), marking for measurement of rise time
Accelerating potential:	20 kV approx.
External intensity modulation:	Voltage: 5 Vp-p or more Bandwidth: DC to 3.5 MHz Maximum input voltage: 20V (DC + peak AC) Input impedance: 12 kΩ (typical)
Scale illumination:	Variable

o VERTICAL DEFLECTION

Sensitivity:	[CH1 and CH2] 2 mV /(div) to 5 V/div in 11 calibrated steps ±2%, (2 mV/div ±4%) at +10 to 35°C, continuous variable control between steps at least 1:2.5 (with UNCAL displayed) [CH3 and CH4] 0.1 V/div, 0.5 V/div ±2% (at +10 to 35°C) in 2 calibrated steps
Bandwidth:	[CH1 and CH2] DC to 150 MHz, -3 dB (2 mV/div: DC to 20 MHz, -3 dB) [CH3 and CH4] DC to 150 MHz, -3 dB
Rise time:	2.3 ns (2 mV/div: 17.5 ns)
Delay time:	Permits viewing leading edge of displayed waveform.
Maximum input voltage:	400 V (DC + peak AC at 1 kHz)

Input coupling:	[CH1 and CH2]: AC-GND-DC, [CH3 and CH4]: AC-DC
Input impedance:	Direct: 1 MΩ, approx. 22 pF
Display modes:	CH1, CH2, CH3, and CH4 (Any combination is available.) ALT, CHOP (approx. 250 kHz), ADD (DIFF mode can be established when the CH2 is in the INV mode.)
Quad mode:	Permits positioning independently.
Bandwidth limitation:	20 MHz approx.
Polarity switching:	+ or - (CH2 only)
X-Y operation	CH1: X axis, CH2: Y axis
Sensitivity:	2 mV/div to 5 V/div
Phase error:	3^{o} or less from DC to 1 MHz
X bandwidth:	DC to 2 MHz, -3 dB
Dynamic range:	8 div or more
Common-mode rejection ratio:	At least 20 dB at 20 MHz
Delay difference:	Between CH1 and CH2: 0.5 ns max. Others: 1 ns max.

o HORIZONTAL DEFLECTION

Trigger mode:	Trigger, Automatic trigger, Single sweep
Auto level:	Possible
Trigger source:	A: CH1, CH2, CH3, CH4, ALT (CH1 and CH2), LINE B: CH1, CH2, CH3, CH4
Trigger coupling:	A: AC, DC, HF-REJ, LF-REJ, TV-V, TV-H B: AC, DC, TV-H
TV trigger	Sync pulse more than 1 div

Trigger sensitivity:

	DC to 30 MHz	30 to 150 MHz
CH1 and CH2	0.3 div	1.5 div
CH3 and CH4	0.5 div	1.5 div

Trigger variable range: ±8 div approx.

AUTO low bandwidth: Approx. 30 Hz

Trigger slope: A: + or -, B: + or -

Time base

A (Main) sweep: 20 ns/div to 0.5 s/div ±2% in 23 calibrated steps, 1-2-5 sequence (at 10 to 35°C), Uncalibrated continuous control between steps at least 1:2.5

B (Delay) sweep: 20 ns/div to 50 ms/div ±2% in 20 calibrated steps, 1-2-5 sequence (at 10 to 35°C)

A trigger variable holdoff: Adjustable control permits a stable triggering of repetitive complex waveform

Display modes: A only, alternate, A intensitied by B, B delayed

Delay time: 1 µs to 5 s

Delay time jitter: Better than 1: 20,000

Sweep magnification: 10 times (±4%)

Maximum sweep rate: 2 ns/div

o READOUT FUNCTION

Panel setting displays:

Vertical axis:	V/div (CH1 and CH2 only), INVERT, ADD, BW LIMIT 20 MHz, UNCAL, Input coupling
Horizontal axis:	s/div, UNCAL, MAG (converted value)
Others:	Delay time, Trigger source

Digital measurement:

DVM (CH2 only)	DC voltage: Corresponds to the screen. AC voltage: 50 Hz to 10 MHz (Conversion method: Average measurement), dB display is available.
Frequency counter:	Interlocking operation with the trigger signal Frequency: 10 Hz to 150 MHz

AC volts meter specifications: (CH2 only)

VOLTS/DIV switch	Full scale	Resolution	Accuracy (X1 probe)
2mV/div	V/div x 2.8284 (< 3 div)	0.02mV	Not specified.
5mV/div		0 05mV	Frequency: 1kHz to 1MHZ ±(2% of reading + 1.8% of full scale)
10mV/div		0.1mV	
20mV/div		0.2mV	
50mV/div		0.5mV	
0.1V/div		1mV	Frequency: 50Hz to 5MHz ±(5% of reading + 1.8% of full scale)
0.2V/div		2mV	
0.5V/div		5mV	
1V/div		0.01V	Frequency: 5 to 10 MHz ±(10% of reading + 1.8% of full scale)
2V/div		0.02V	
5V/div		0.05V	

* Over 2 divisions signals are recommended for AC V measurement.

** Additional error ±1.5% when using X10 probe.

DC volts meter specifications: (CH2 only)

VOLTS/DIV switch	Full scale	Resolution	Accuracy (X1 probe)
2 to 50mV/div	±499.7mV	1/2000 of full scale	±(1% of reading + 0.25% of full scale)
0.1 to 0.5V/div	±4.997V		±(2% of reading + 0.25% of full scale)
1 to 5V/div	±49.97V		

* Set the DC-GND-AC switches to DC.

** Additional error ±1.5% when using X10 probe.

*** Although resolution range is 1/2000 (2.5) of the full scale (5000), the least significant digit is displayed in steps of 0, 2, 5, and 7.

Frequency counter specifications:

Frequency measurement:

Source : A trigger signal (CH1, CH2, CH3, and CH4)

Measuring range: 10 Hz to 150 MHz

Time base error: ±50 ppm (15 to 35°C)

Ranges	Display format (Max. frequency)	Resolution	Accuracy
10Hz ≦ f < 100Hz	99.990Hz	0.01Hz	±(|time base error| + resolution)
100Hz ≦ f < 1kHz	999.90Hz	0.1Hz	
1kHz ≦ f < 10kHz	9.9990kHz	1Hz	
10kHz ≦ f < 100kHz	99.999kHz	1Hz	
100kHz ≦ f < 1MHz	999.99kHz	10Hz	
1MHz ≦ f < 10MHz	9.9999MHz	100Hz	
10MHz ≦ f < 150MHz	149.999MHz	1kHz	
150MHz < f	Over range		

Period measurement: Source : A trigger signal (CH1, CH2, CH3, and CH4 only)

Measuring range: 6.7 ns to 100 ms

Time base error: ±50 ppm (15 to 35°C)

Ranges	Display format	Resolution	Accuracy
10ms ≦ T < 100ms	99.999ms	1µs	±(|time base error| + resolution)
1ms ≦ T < 10ms	9.9999ms	100ns	
0.1ms ≦ T < 1ms	0.99999ms	10ns	
10µs ≦ T < 100µs	99.999µs	1ns	
1µs ≦ T < 10µs	9.9990µs	1ns	
0.1µs ≦ T < 1µs	0.99990µs	100ps	
6.7ns ≦ T < 100ns	99.990ns	10ps	
≦ T < 6.7µs	Over range		

Event counter

1) EVENT IN DELAY TIME

Source: A trigger signal or B trigger signal (CH1, CH2, CH3, and CH4)

Maximum count: 2^{19-1}

Accuracy: A value of reading ±1 count

Maximum frequency: 20 MHz

2) EVENT IN B TIME

Source: A trigger signal or B trigger signal (CH1, CH2, CH3, and CH4)

Maximum count: 2^{19-1}

Accuracy: A value of reading ±1 count

Maximum frequency: 20 MHz

Cursor readout functions:

Cursors: REF, Δ

Voltage to the ground:	V	: Δ-GND
Voltage deviation:	ΔV	: Δ-REF
Amplitude ratio:	ΔV%	: %
	dB	: dB
		$\frac{\Delta - REF}{2 \text{ to } 8 \text{ div}} \times 100\%$
Time difference:	ΔT	: Δ-REF
Time ratio:	ΔT%	: %
		$\frac{\Delta - REF}{2 \text{ to } 8 \text{ div}} \times 100\%$
Frequency:	1/T	: Δ-REF
Phase:	PHASE	: ^{o} (degree)
		$\frac{\Delta - REF}{2 \text{ to } 8 \text{ div}} \times 360^{o}$

GND REF function: Displays GND reference cursor of CH1 and CH2.

Comment display function:

Number of line: 2 lines

Number of characters: 30 characters max.

Kind of characters:

Figures: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9

Letters: A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z

Symbols and others:

[ ] (space), . (period), :, -, ↑, ↓, ←, →, /, +, <, >, m, n, μ, k, s, z, %, Δ (delta), d, i, v, ° (degree), *

Available lines for comment display:

Any two lines among six lines excluding the top and bottom lines

o OUTPUT SIGNALS

CH2 output

Output voltage:	Approx. 25 mV/div (corresponding to the full scale on the CRT screen) terminated into 50Ω
Frequency response:	DC to 100 MHz
Output impedance:	Approx. 50Ω
Gate signal output:	TTL positive gate pulse from A and B

o CALIBRATOR

Waveform:	1 kHz ±0.1% square wave
Voltage:	0.5 V ±1%

o POWER SUPPLY

Voltage:	90 to 250 V AC (not selectable)
Frequency:	48 to 440 Hz
Power consumption:	Approx. 75W

o OUTER DIMENSIONS:	Approx. 330(13 in)(W) x 160(6.3 in)(H) x 410(16.2 in)(D) mm
o WEIGHT:	Approx. 10(22 lb) kg
o ENVIRONMENT	
Temperature:	Operating: -10 to +50°C
	Specification: +10 to +35°C
	Storage: -20 to +70°C
Humidity:	Operating: 35 to 85%

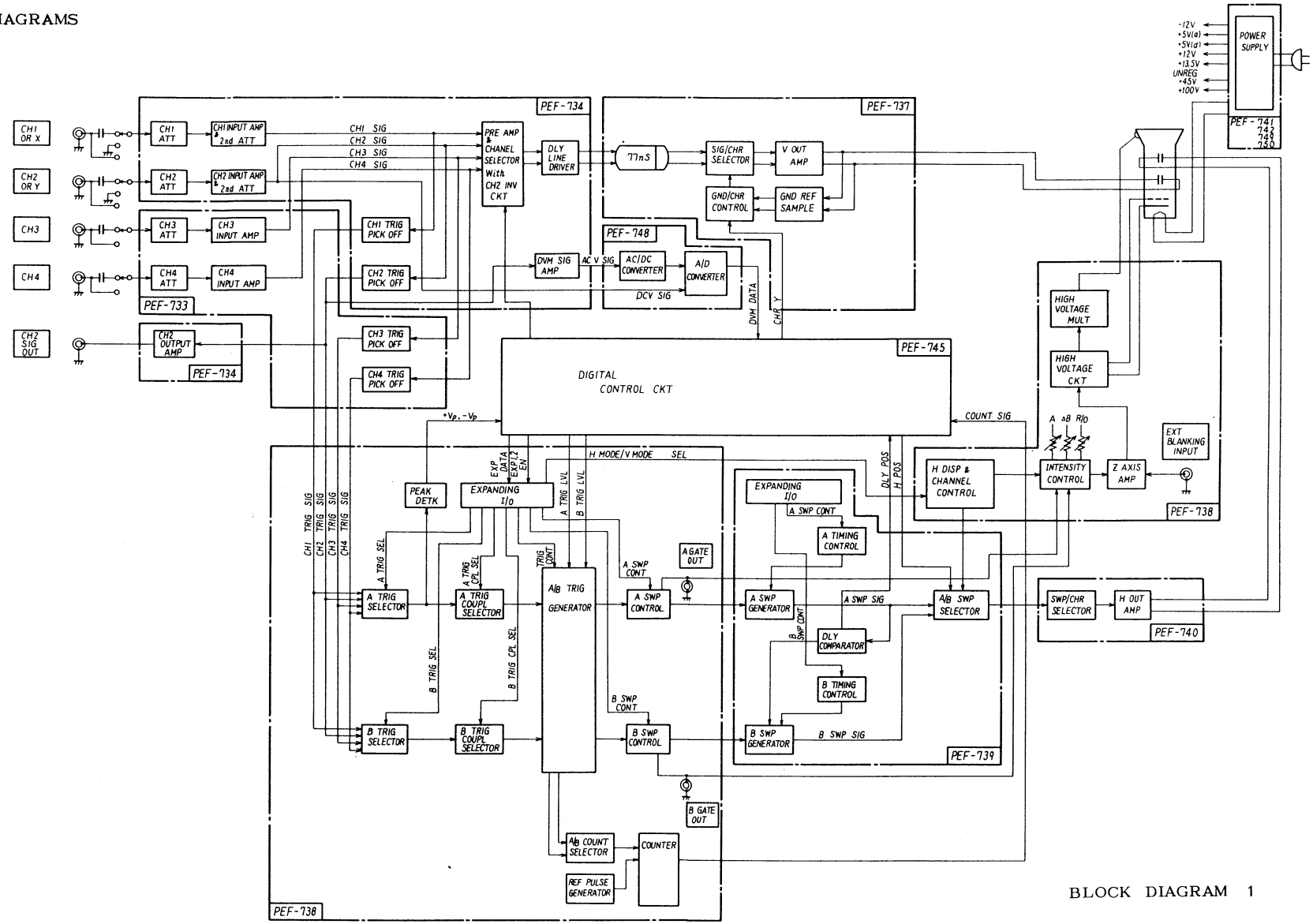
(18) List of cursor functions

	Function	Operation									Cursor menu	Unit	Measurement and display	Inhibiting setting
		CURSOR mode (Note 5)	CSR/ COUNTER	GND REF	V	T	REF	Δ	Others	CURSOR control				
1	GND REF	NORM	CSR	ON	OFF	OFF	ON	OFF	V. MODE: CH1 and/or CH2	CH1 position or CH2 position		-	Displays the GND REF cursor.	V MODE: CH3,CH4 H MODE: ALT X-Y
2	V	NORM	CSR	ON	OFF	OFF	OFF	ON	V.MODE: CH1 and/or CH2	CH1 position or CH2 position Cursor	V1 (V2)	mV, V mV, V	Measures the voltage between the GND REF cursor and the delta cursor.	
3	ΔV	NORM	CSR	OFF	ON	OFF	*	*		Cursor	ΔV1 (ΔV2)	mV, V	Measures the voltage between the REF cursor and the delta cursor.	H MODE: X-Y
4	ΔT	NORM	CSR	OFF	OFF	ON	*	*		Cursor	ΔT	ns, μs ms	Measures the time between the REF cursor and the delta cursor.	H MODE: ALT X-Y
5	1/ΔT	NORM	CSR	OFF	ON	ON	*	*		Cursor	1/ΔT	Hz, kHz MHz	Measures the 1/time between the REF cursor and the delta cursor.	
6	ΔV%	RATIO	CSR	OFF	ON	OFF	*	*		Cursor	ΔV1 (ΔV2)	%	x div = 100% $\frac{\Delta - REF}{x \text{ div}} \times 100\%$	H MODE: X-Y
7	ΔT%	RATIO	CSR	OFF	OFF	ON	*	*		Cursor	ΔT	%	x div = 100% $\frac{\Delta - REF}{x \text{ div}} \times 100\%$	H MODE: ALT X-Y
8	dB	RATIO	CSR	ON	OFF	OFF	*	*		Cursor		dB	x div = 0 dB $20 \log \frac{\Delta - REF}{x \text{ div}}$	H MODE: X-Y
9	PHASE	RATIO	CSR	OFF	ON	ON	*	*		Cursor	PHASE	o	x div = 360° $\frac{\Delta - REF}{x \text{ div}} \times 360^\circ$	H MODE: ALT X-Y

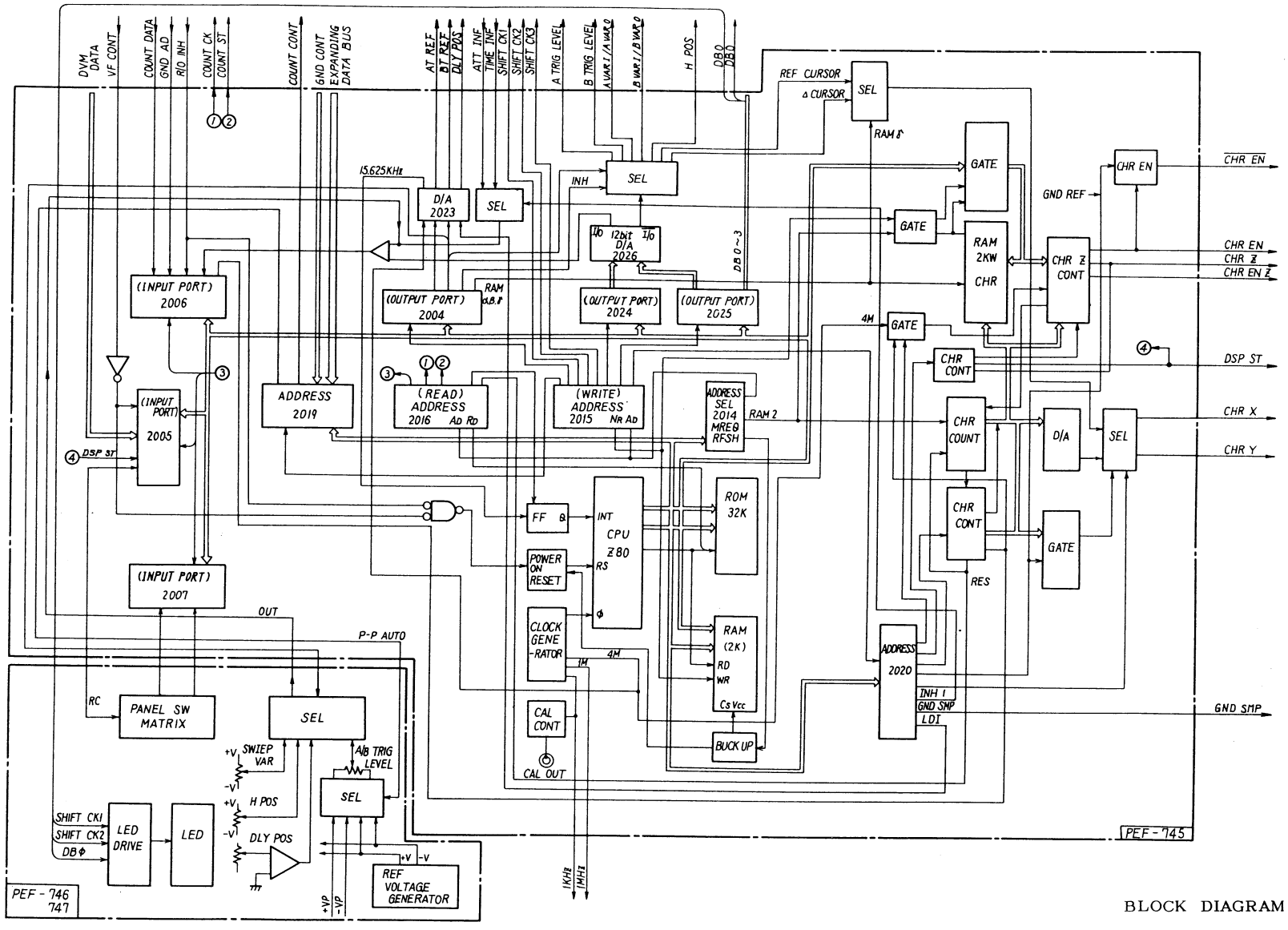
Interlocking operation

Interlocking operation

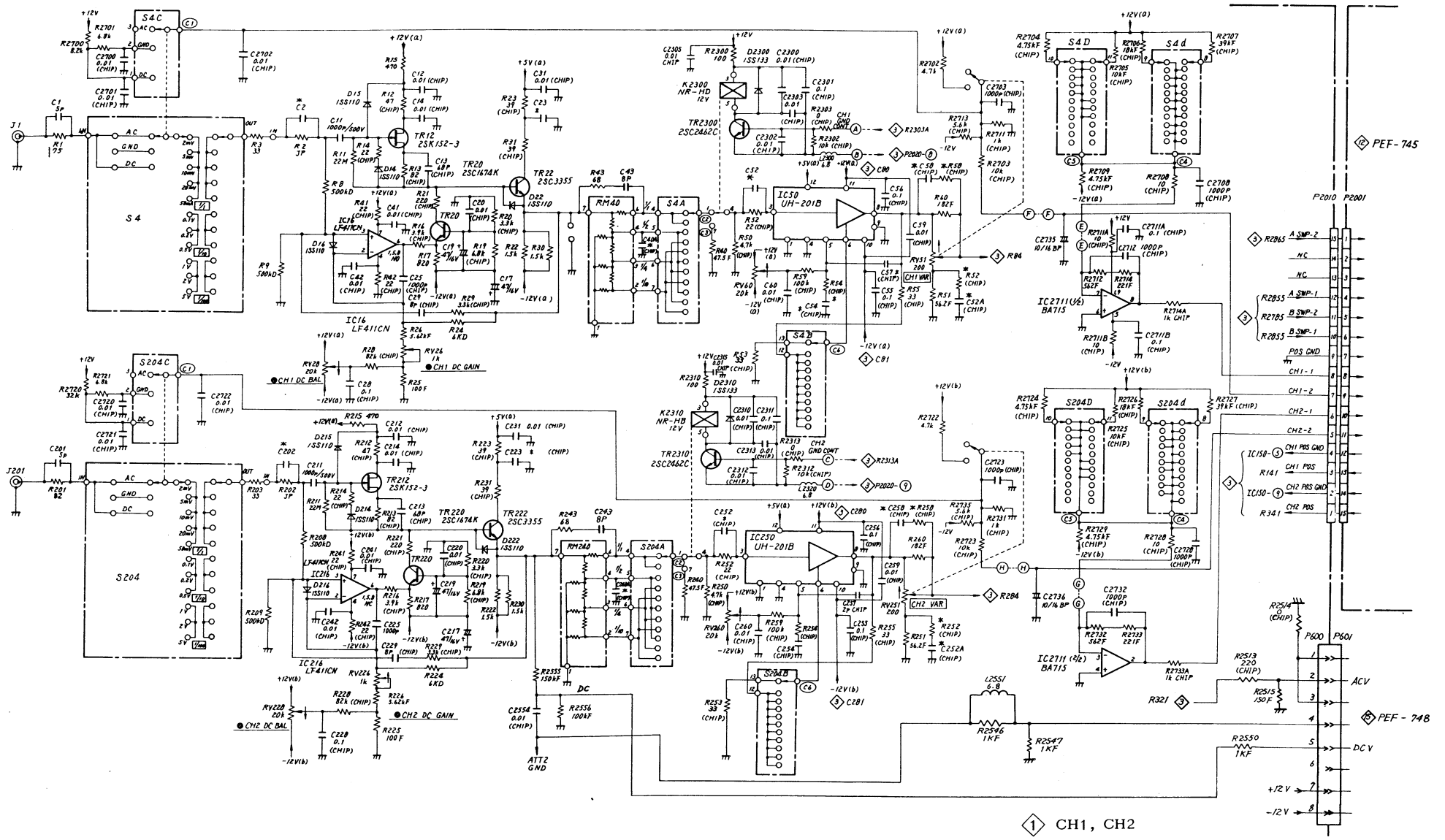
(See Notes on the next page.)



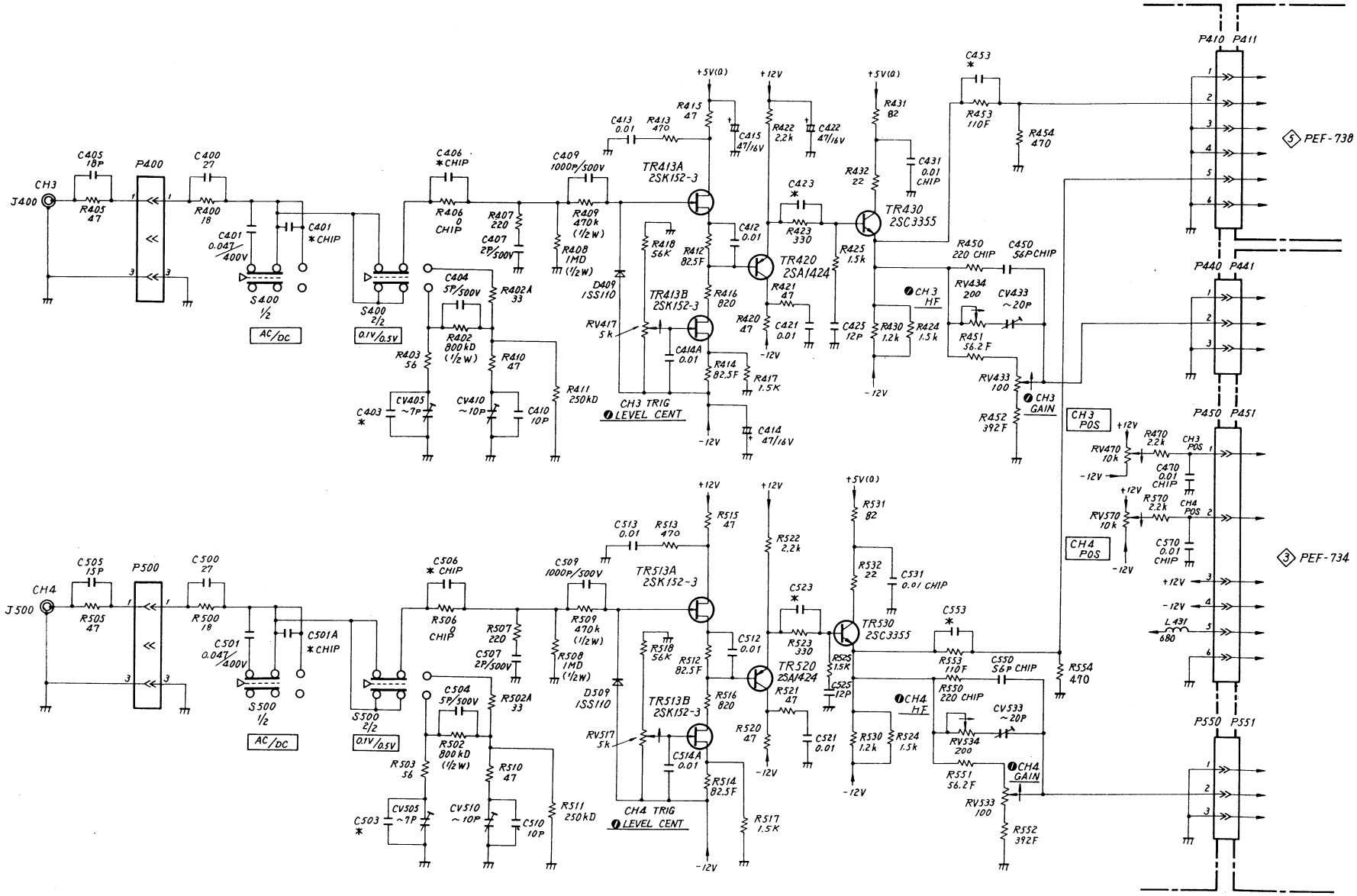
BLOCK DIAGRAM 1

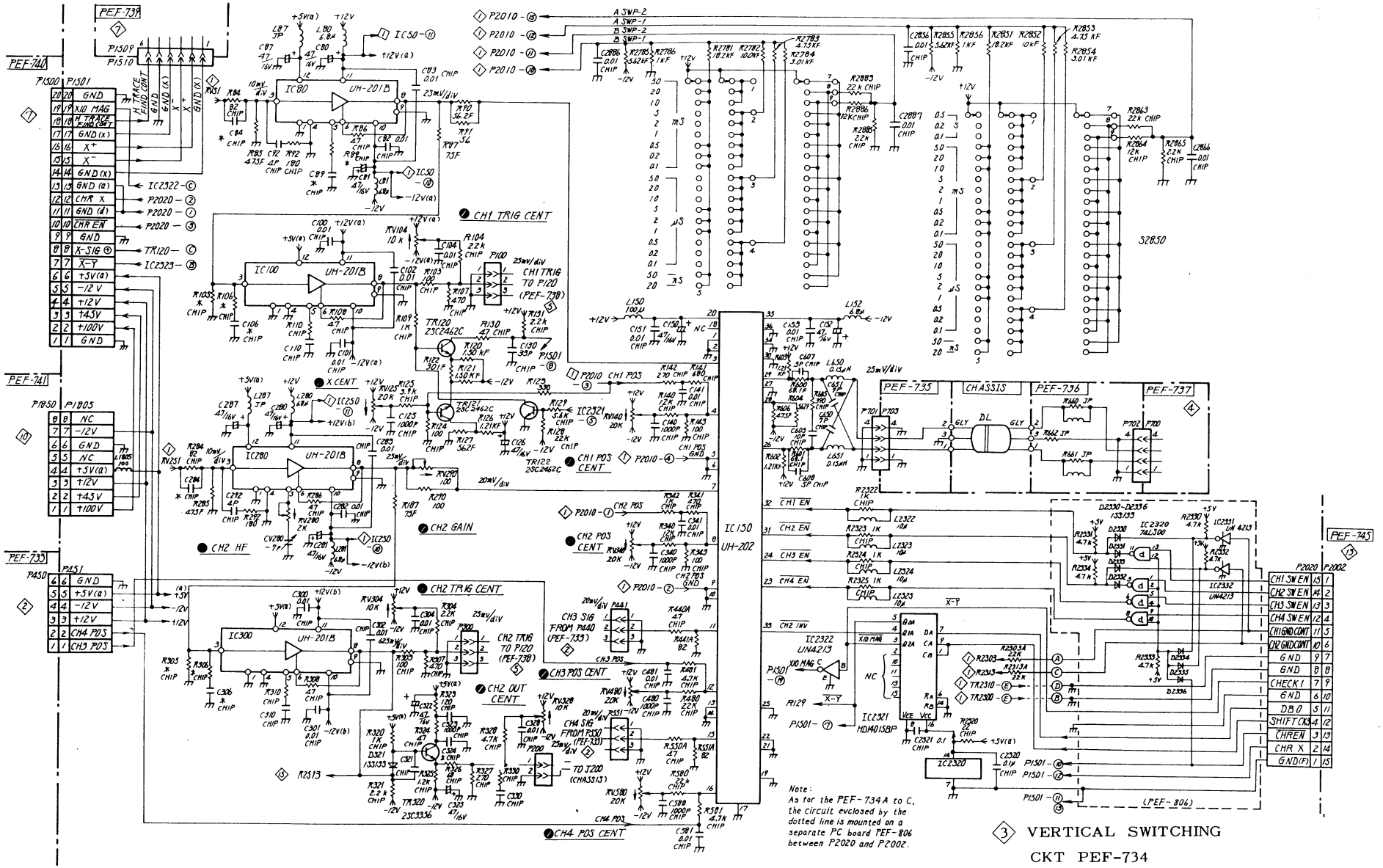


BLOCK DIAGRAM 2



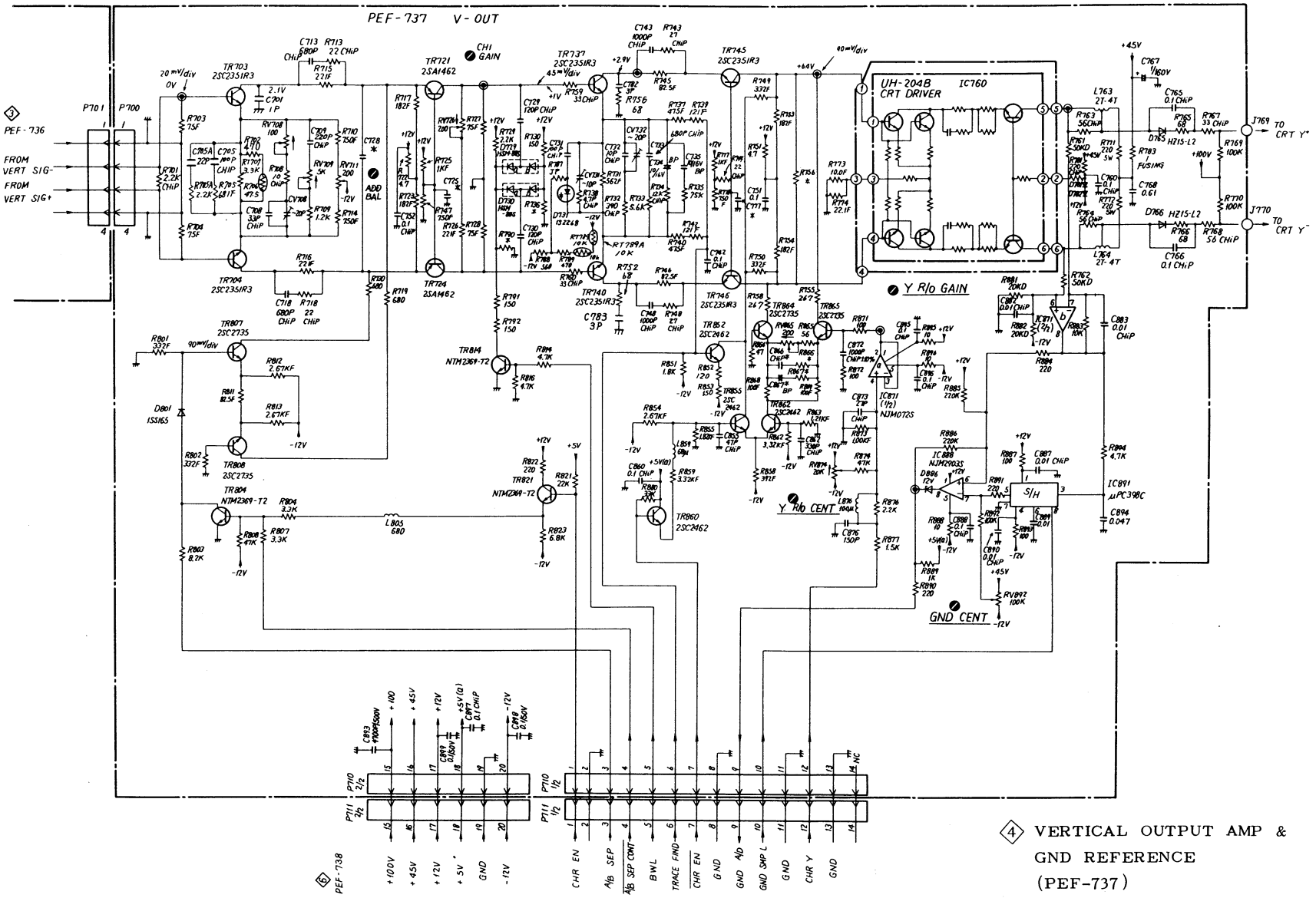
① CH1, CH2
PRE AMP (PEF-734)


CH3
J400
P400
C405 18P
R405 47
C400 27
R400 18
C401 0.047/400V
C401 *CHIP
S400 1/2
AC/DC
S400 2/2
0.1V/0.5V
C406 *CHIP
R406 0 CHIP
C407 2P/500V
R407 220
C404 5P/500V
R402A 33
R402 800kΩ (1/2W)
R403 56
CV405 ~7P
C403 *
R410 47
CV410 ~10P
C410 10P
R411 250kΩ
C409 1000P/500V
R409 470k (1/2W)
R408 1MΩ (1/2W)
D409 1SS110
TR413A 2SK152-3
TR413B 2SK152-3
RV417 5k
R418 56K
R412 82.5F
R416 820
CA14A 0.01
R414 82.5F
R417 1.5K
CH3 TRIG
LEVEL CENT
C414 47/16V
C413 0.01
R413 470
R415 47
C415 47/16V
+5V(0)
+12V
-12V
R422 2.2k
C422 47/16V
C423 *
R423 330
TR420 2SA1424
C412 0.01
R421 47
R420 47
C421 0.01
R425 1.5k
C425 12P
TR430 2SC3355
R432 22
R431 82
C431 0.01 CHIP
C453 *
R453 110F
R454 470
R450 220 CHIP
C450 56P CHIP
RV434 200
CV433 ~20P
R451 56.2F
R430 1.2k
R424 1.5k
CH3 HF
RV433 100
CH3 GAIN
R452 392F
CH3 POS
P410 P411
P440 P441
P450 P451
RV470 10k
R470 2.2k
C470 0.01 CHIP
CH4 POS
RV570 10k
R570 2.2k
C570 0.01 CHIP
L431 680
5 PEF-738
3 PEF-734
CH4
J500
P500
C505 15P
R505 47
C500 27
R500 18
C501 0.047/400V
C501A *CHIP
S500 1/2
S500 2/2
C506 *CHIP
R506 0 CHIP
C507 2P/500V
R507 220
C504 5P/500V
R502A 33
R502 800kΩ (1/2W)
R503 56
CV505 ~7P
C503 *
R510 47
CV510 ~10P
C510 10P
R511 250kΩ
C509 1000P/500V
R509 470k (1/2W)
R508 1MΩ (1/2W)
D509 1SS110
TR513A 2SK152-3
TR513B 2SK152-3
RV517 5k
R518 56K
R512 82.5F
R516 820
CA14A 0.01
R514 82.5F
R517 1.5K
CH4 TRIG
LEVEL CENT
C513 0.01
R513 470
R515 47
C512 0.01
R522 2.2k
C523 *
R523 330
TR520 2SA1424
R521 47
R520 47
C521 0.01
R525 1.5K
C525 12P
TR530 2SC3355
R532 22
R531 82
C531 0.01 CHIP
C553 *
R553 110F
C550 56P CHIP
R554 470
R550 220 CHIP
CV533 ~20P
RV534 200
R551 56.2F
R530 1.2k
R524 1.5k
CH4 HF
RV533 100
CH4 GAIN
R552 392F
P550 P551
2 CH3, CH4
PRE AMP (PEF-733)

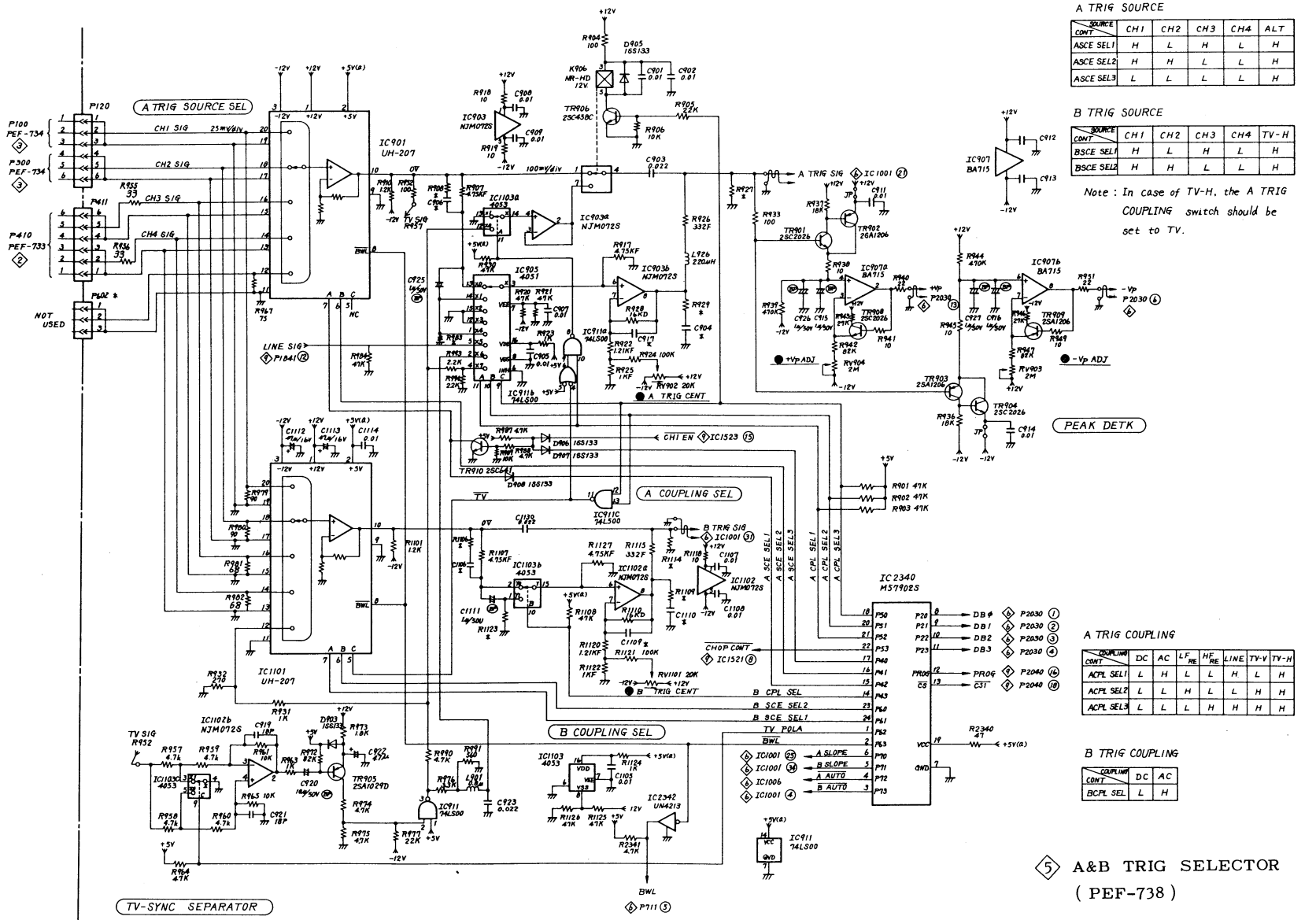


Note :
As for the PEF-734A to C, the circuit evcloased by the dotted line is mounted on a separate PC board PEF-806 between P2020 and P2002.

③ VERTICAL SWITCHING CKT PEF-734



4 VERTICAL OUTPUT AMP & GND REFERENCE (PEF-737)

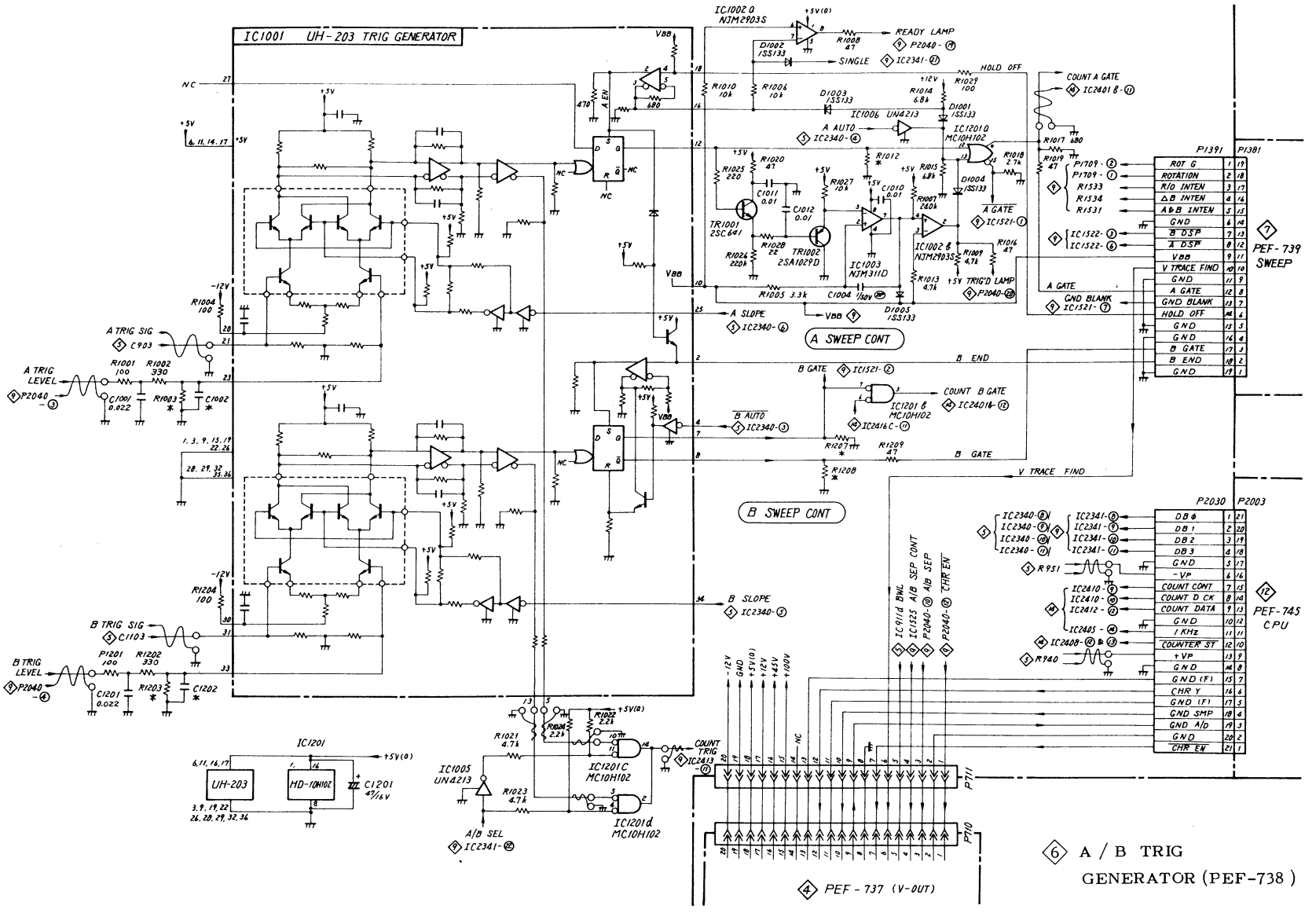


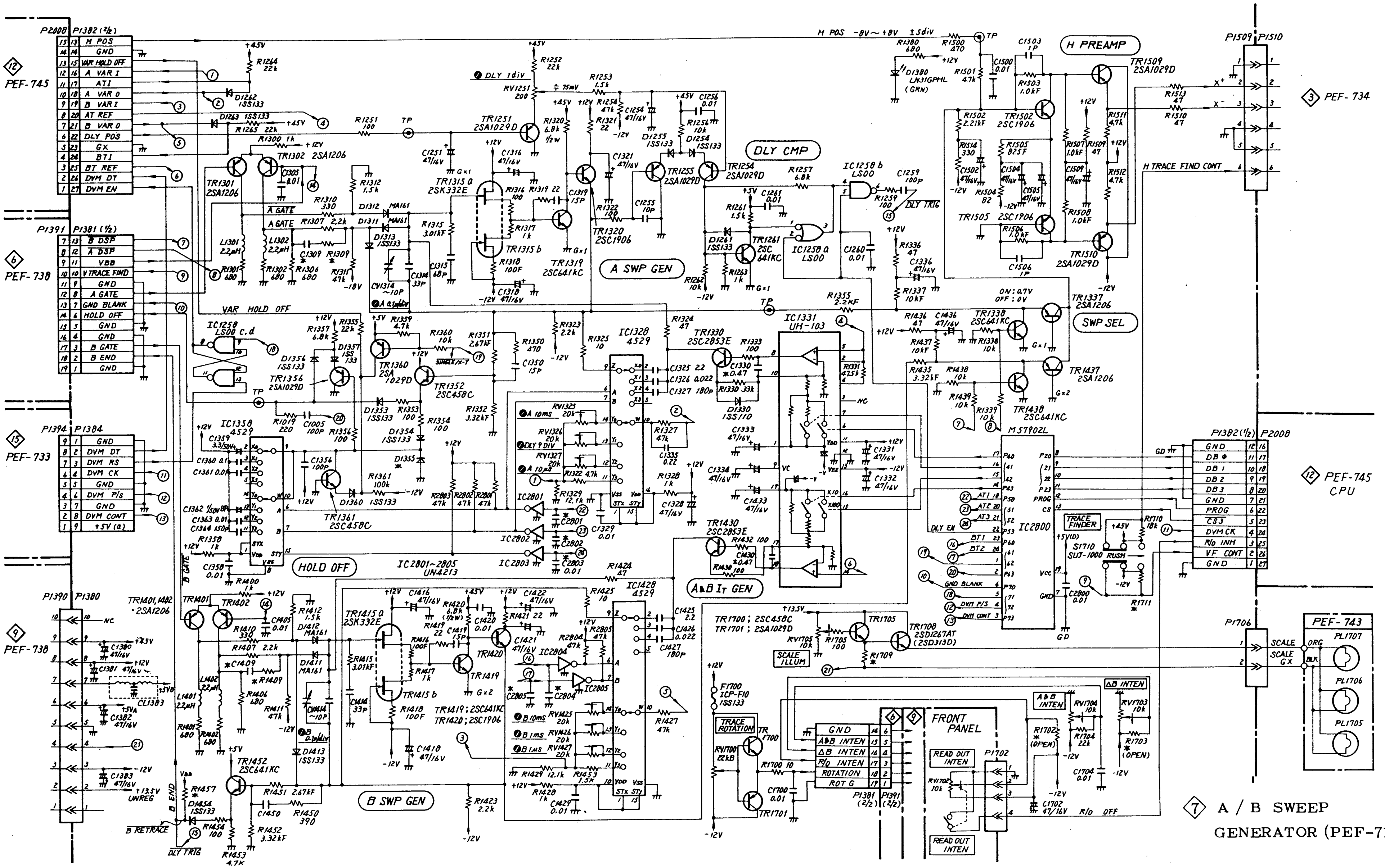
A TRIG SOURCE CONT	CH1	CH2	CH3	CH4	ALT
ASCE SEL1	H	L	H	L	H
ASCE SEL2	H	H	L	L	H
ASCE SEL3	L	L	L	L	H

B TRIG SOURCE CONT	CH1	CH2	CH3	CH4	TV-H
BSCE SEL1	H	L	H	L	H
BSCE SEL2	H	H	L	L	H

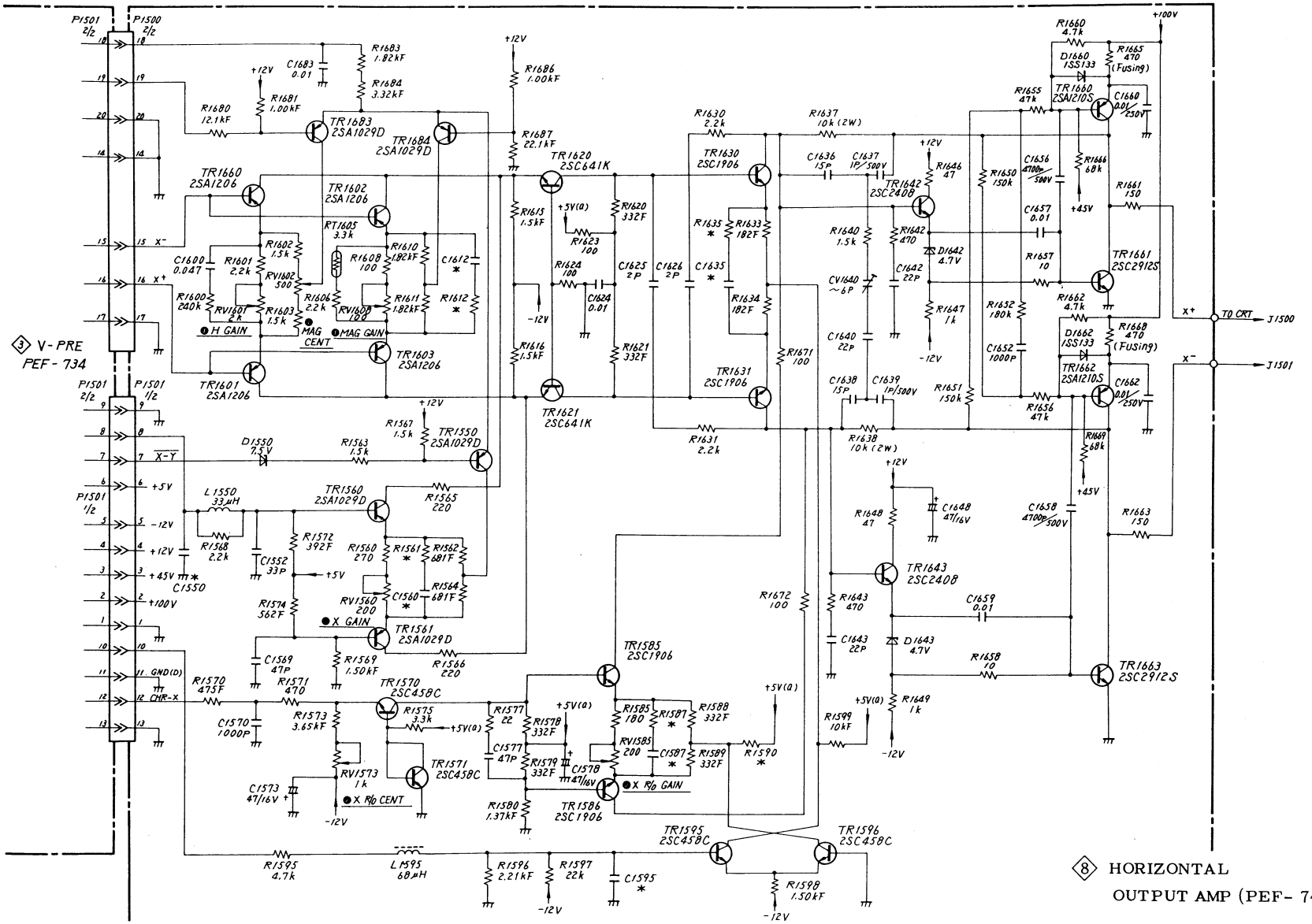
A TRIG COUPLING CONT	DC	AC	LF RE	HF RE	LINE	TV-V	TV-H
ACPL SEL1	L	H	L	L	H	L	H
ACPL SEL2	L	L	H	L	L	H	H
ACPL SEL3	L	L	L	H	H	H	H

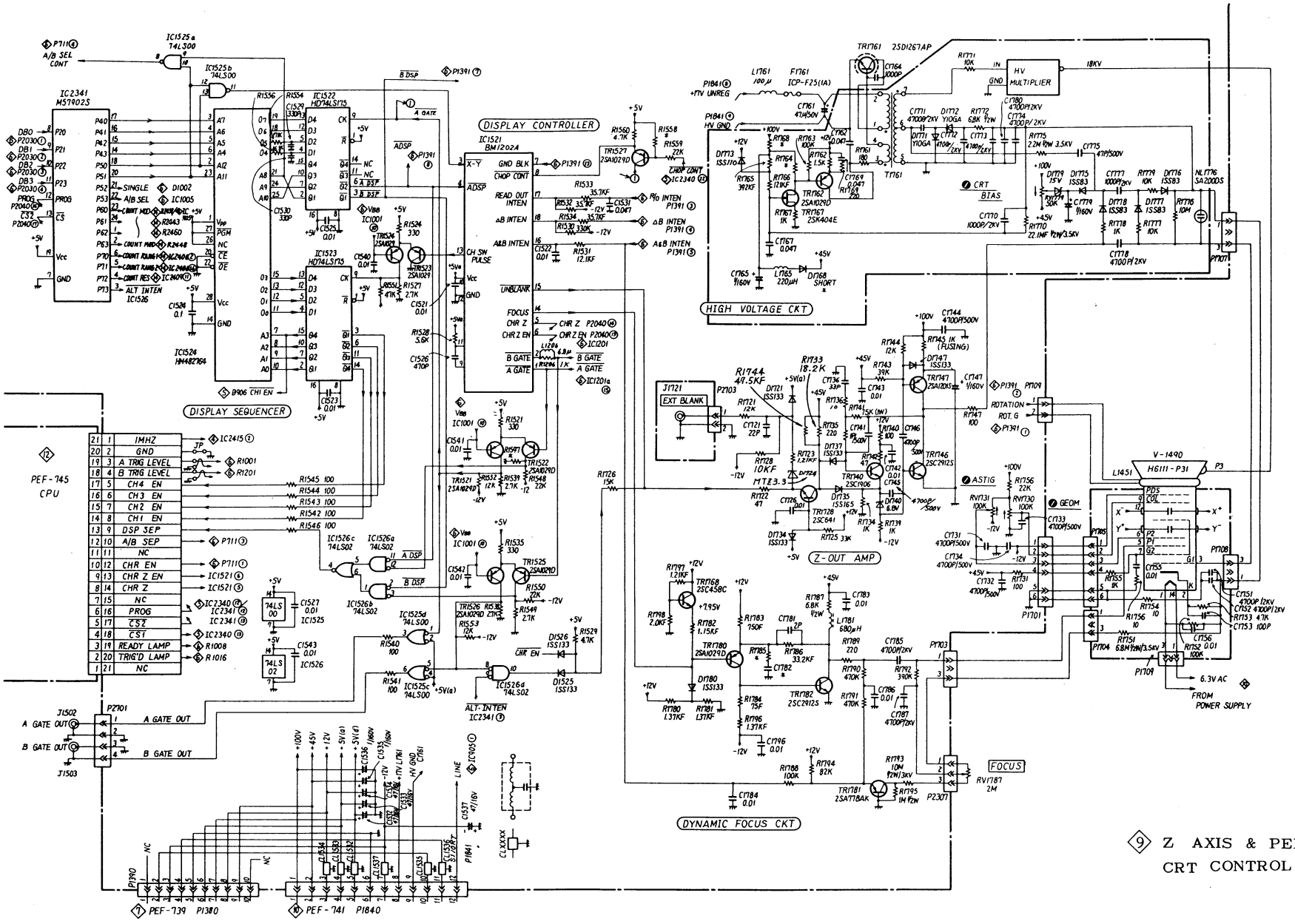
B TRIG COUPLING CONT	DC	AC
BCPL SEL	L	H


IC1001 UH-203 TRIG GENERATOR
A SWEEP CONT
B SWEEP CONT
A TRIG LEVEL
B TRIG LEVEL
A TRIG SIG
B TRIG SIG
A SLOPE
B SLOPE
A GATE
B GATE
B END
V TRACE FIND
GND BLANK
HOLD OFF
READY LAMP
SINGLE
COUNT A GATE
COUNT B GATE
TRIG'D LAMP
A AUTO
B AUTO
A/B SEL
COUNT TRIG
P1391
P1381
P2030
P2003
P1709 - ②
P1709 - ①
R1533
R1534
R1531
IC1522 - ③
IC1522 - ⑥
P2040 - ⑰
P2040 - ⑱
IC2341 - ㉗
IC2401 B - ⑪
IC2340 - ④
IC1521 - ⑦
IC1521 - ②
IC2340 - ③
IC2340 - ⑤
IC2340 - ㉖
IC2340 - ㉗
IC2340 - ㉘
IC2340 - ㉙
IC2341 - ②
IC2341 - ③
IC2341 - ⑩
IC2341 - ⑪
R951
R940
IC2410 - ⑨
IC2410 - ⑩
IC2412 - ⑫
IC2405 - ⑭
IC2408 - ⑫ & ⑬
IC2416 C - ⑪
IC2401 A - ⑫
IC911d BWL
IC1525 A/B SEP CONT
P2040 - ⑲ A/B SEP
P2040 - ⑳ CHR EN
P1711
P1710
⑦ PEF-739 SWEEP
⑫ PEF-745 CPU
④ PEF-737 (V-OUT)
⑥ A / B TRIG GENERATOR (PEF-738)

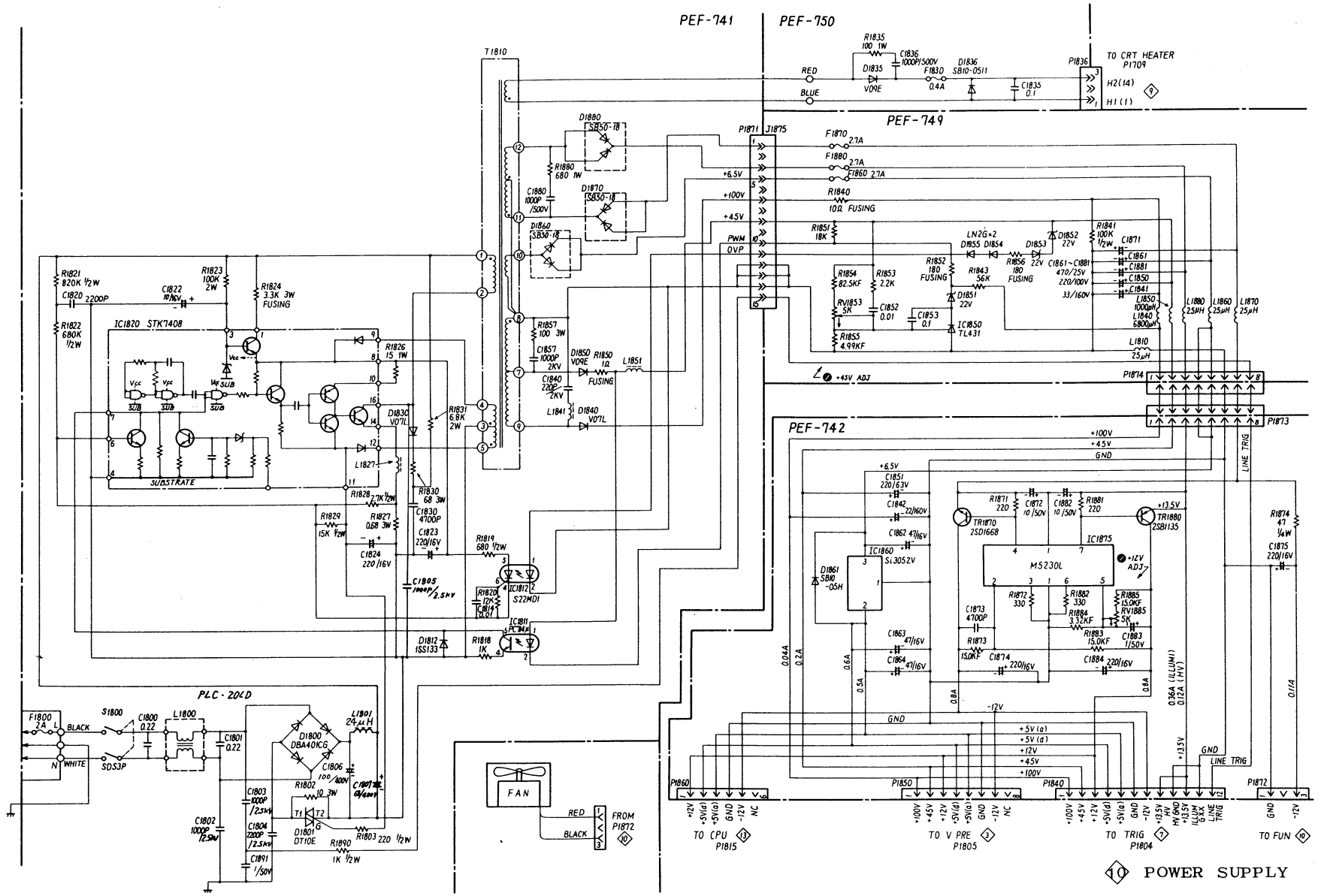


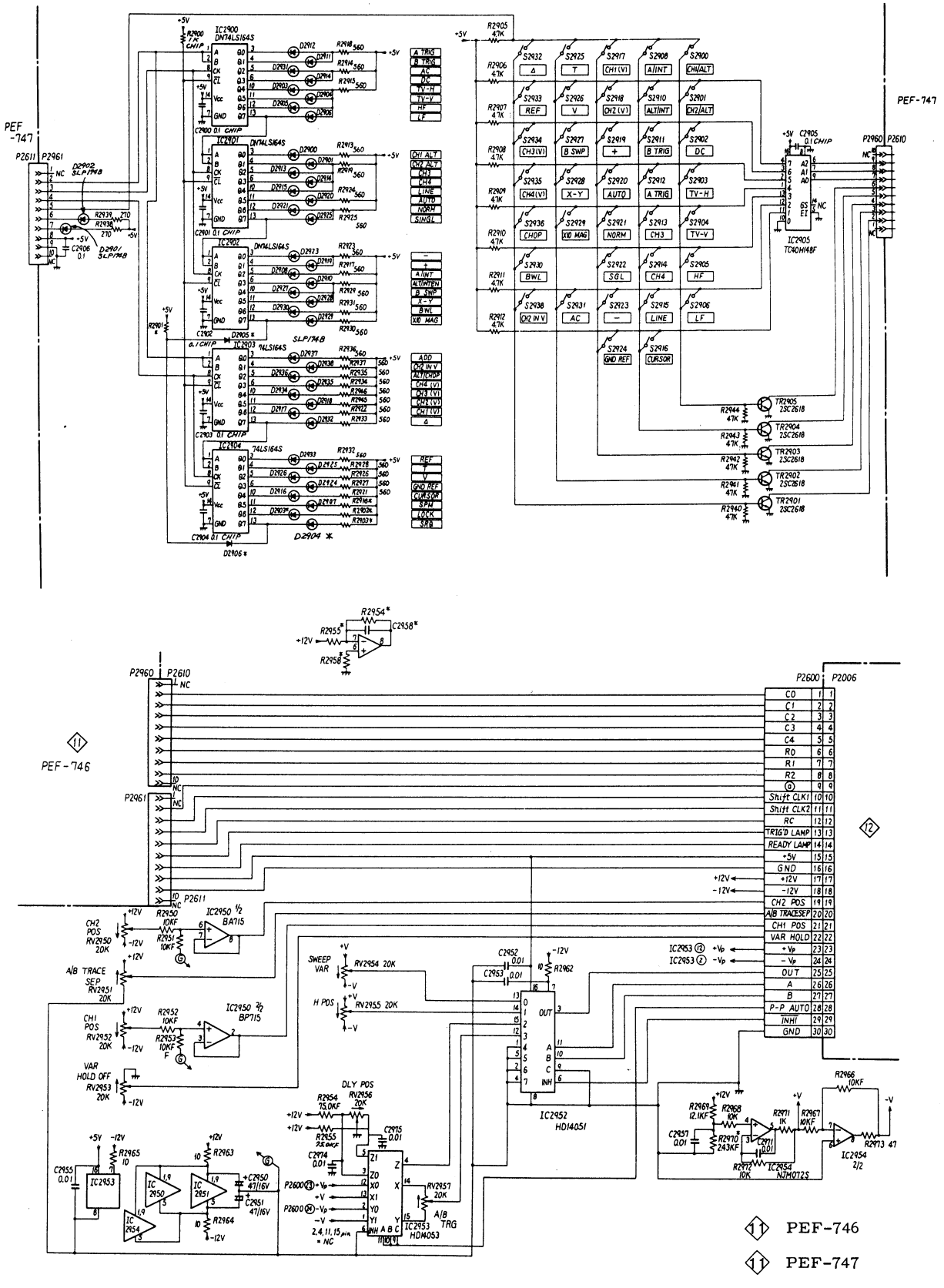
⑦ A / B SWEEP GENERATOR (PEF-739)

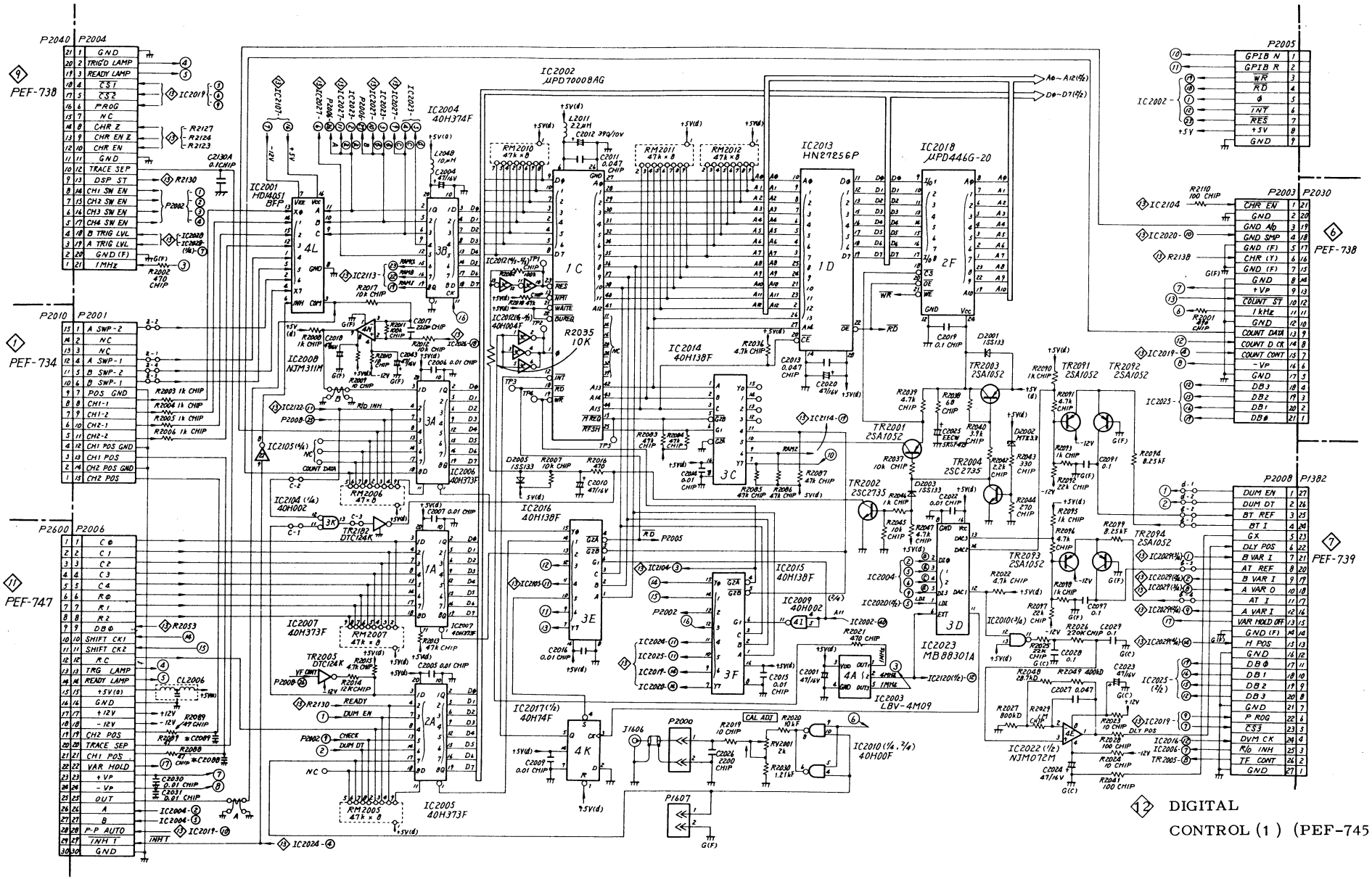

③ V-PRE
PEF-734
P1501 2/2
P1500 2/2
P1501 1/2
X-Y
+5V
-12V
+12V
+45V
+100V
GND(D)
CHR-X
X-
H GAIN
MAG CENT
MAG GAIN
X GAIN
X Rθ CENT
X Rθ GAIN
+5V(Q)
TR1600 2SA1206
TR1601 2SA1206
TR1602 2SA1206
TR1603 2SA1206
TR1620 2SC641K
TR1621 2SC641K
TR1630 2SC1906
TR1631 2SC1906
TR1642 2SC2408
TR1643 2SC2408
TR1660 2SA1210S
TR1661 2SC2912S
TR1662 2SA1210S
TR1663 2SC2912S
TR1683 2SA1029D
TR1684 2SA1029D
TR1550 2SA1029D
TR1560 2SA1029D
TR1561 2SA1029D
TR1570 2SC458C
TR1571 2SC458C
TR1585 2SC1906
TR1586 2SC1906
TR1595 2SC458C
TR1596 2SC458C
D1550 7.5V
D1642 4.7V
D1643 4.7V
D1660 1SS133
D1662 1SS133
L1550 33μH
L1595 68μH
TO CRT
J1500
J1501
⑧ HORIZONTAL
OUTPUT AMP (PEF-740)

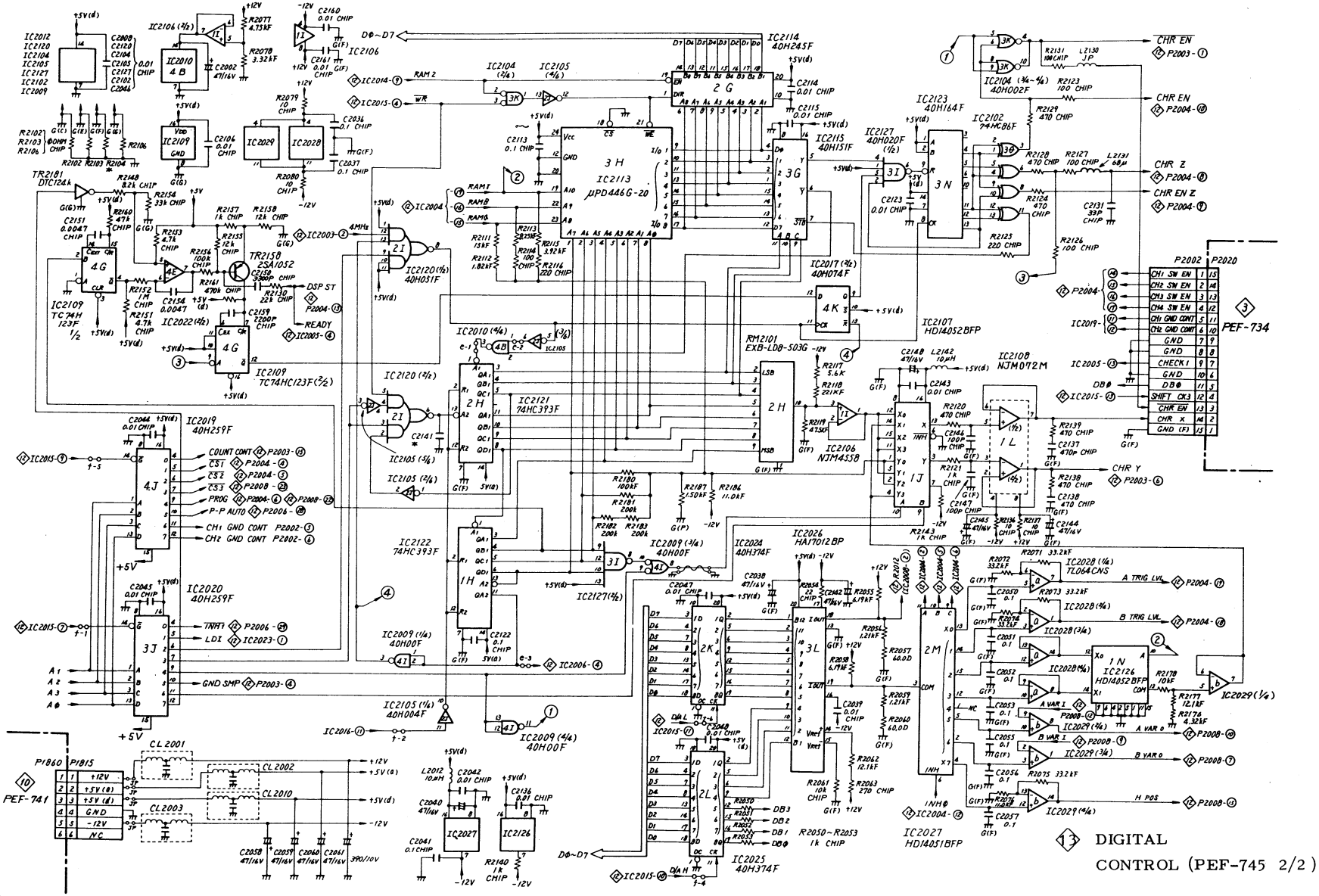


⑨ Z AXIS & PEF-738 CRT CONTROL

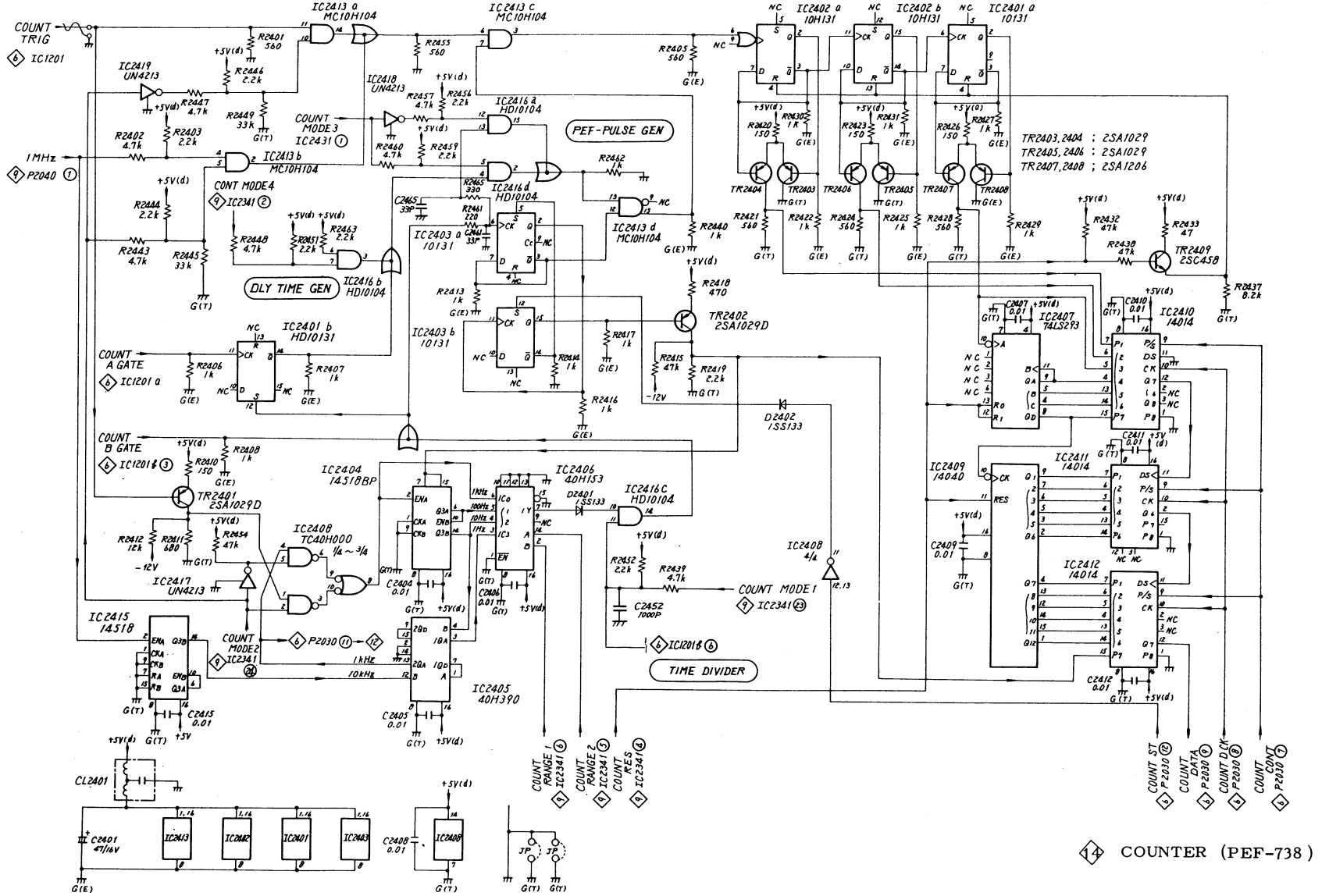

PEF-741
PEF-750
PEF-749
PEF-742
PLC-20CD
T1810
IC1820 STK7408
SUBSTRATE
IC1811 PC714V
IC1812 S22MD1
IC1850 TL431
IC1860 Si3052V
IC1875 M5230L
TR1870 2SD1668
TR1880 2SB1135
D1800 DBA40IC6
D1801 DT10E
FAN
TO CRT HEATER P1709
H2(14)
H1(1)
RED
BLUE
+6.5V
+100V
+45V
PWM
OVP
+45V ADJ
+12V ADJ
+13.5V
GND
-12V
LINE TRIG
TO CPU P1815
TO V PRE P1805
TO TRIG P1804
TO FUN
FROM P1872
POWER SUPPLY

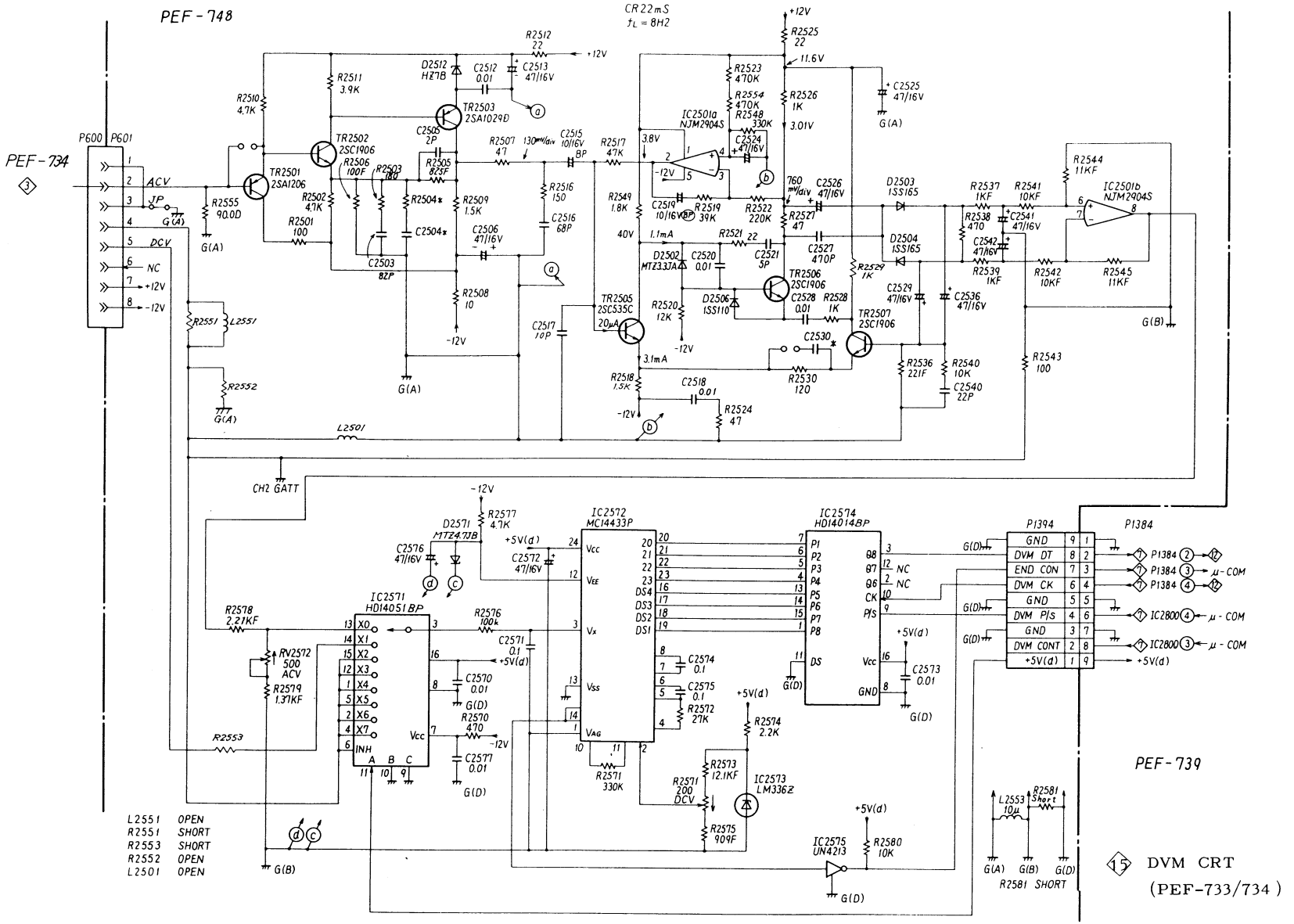

PEF-747
PEF-746
PEF-747
IC2900 DM74LS164S
IC2901 DM74LS164S
IC2902 DM74LS164S
IC2903 74LS164S
IC2904 74LS164S
IC2905 TC40H148F
IC2950 1/2 BA715
IC2950 2/2 BP715
IC2951
IC2952 HD14051
IC2953 HDM053
IC2954 NJM072S
P2611 P2961
P2960 P2610
P2600 P2006
TR2905 2SC2618
TR2904 2SC2618
TR2903 2SC2618
TR2902 2SC2618
TR2901 2SC2618
A TRIG
B TRIG
AC
DC
TV-H
TV-V
HF
LF
CH1 ALT
CH2 ALT
CH3
CH4
LINE
AUTO
NORM
SINGL
ADD
CH2 INV
ALT/CHOP
CH4 (V)
CH3 (V)
CH2 (V)
CH1 (V)
REF
GND REF
CURSOR
SPM
LOCK
SAB
CH2 POS RV2950 20K
A/B TRACE SEP RV2951 20K
CH1 POS RV2952 20K
VAR HOLD OFF RV2953 20K
SWEEP VAR RV2954 20K
H POS RV2955 20K
DLY POS RV2956 20K
A/B TRG RV2957 20K
C0
C1
C2
C3
C4
R0
R1
R2
Shift CLK1
Shift CLK2
RC
TRIG'D LAMP
READY LAMP
+5V
GND
+12V
-12V
CH2 POS
A/B TRACESEP
CH1 POS
VAR HOLD
+Vp
-Vp
OUT
A
B
P-P AUTO
INH
GND
PEF-746
PEF-747

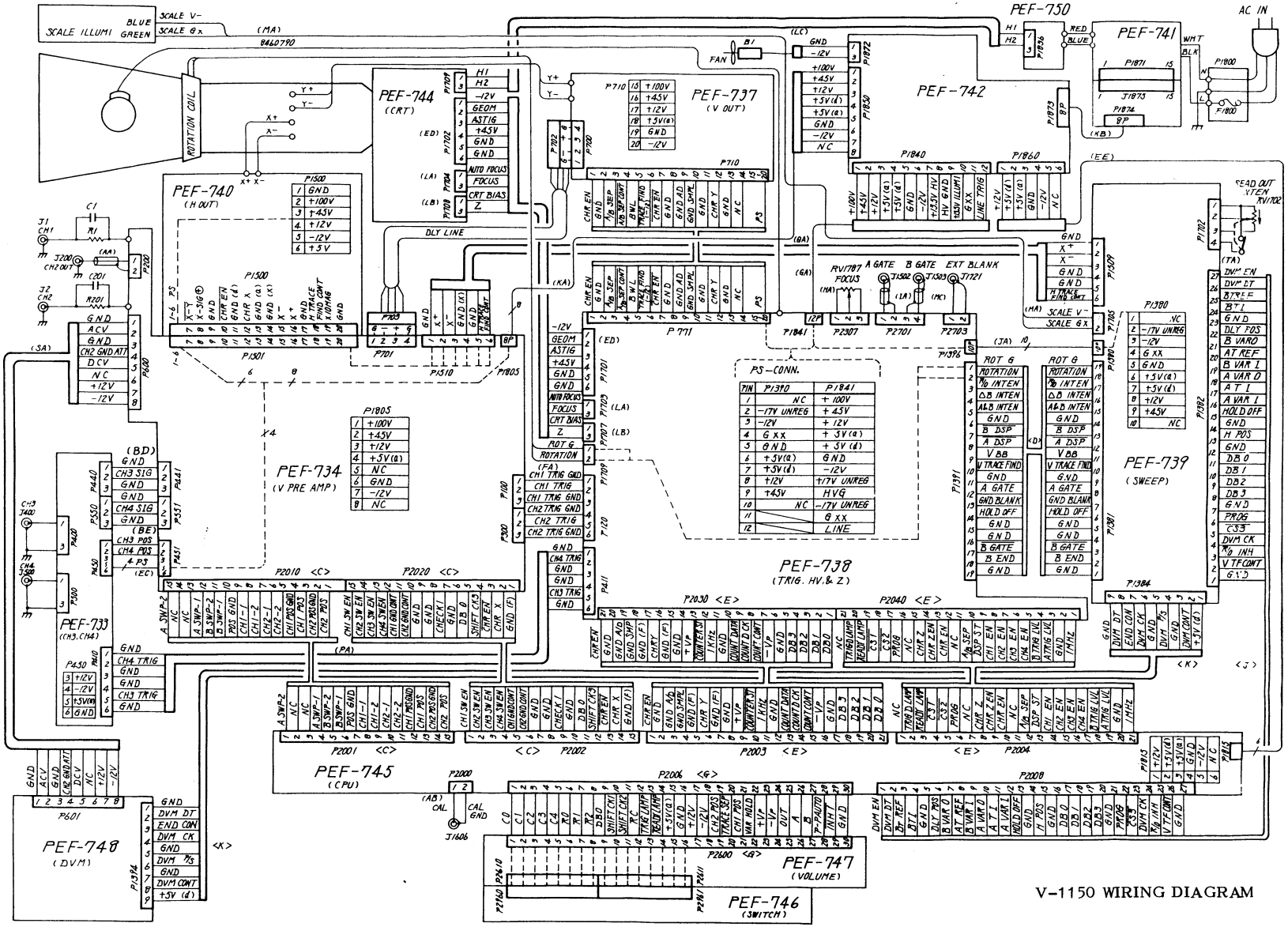

P2040 P2004
GND
TRIG'D LAMP
READY LAMP
CS1
CS2
PROG
NC
CHR Z
CHR EN Z
CHR EN
GND
TRACE SEP
DSP ST
CH1 SW EN
CH2 SW EN
CH3 SW EN
CH4 SW EN
B TRIG LVL
A TRIG LVL
GND (F)
1MHz
PEF-738
P2010 P2001
A SWP-2
NC
NC
A SWP-1
B SWP-2
B SWP-1
POS GND
CH1-1
CH1-2
CH2-1
CH2-2
CH1 POS GND
CH1 POS
CH2 POS GND
CH2 POS
PEF-734
P2600 P2006
C0
C1
C2
C3
C4
R0
R1
R2
DB0
SHIFT CK1
SHIFT CK2
RC
TRG LAMP
READY LAMP
+5V(0)
GND
+12V
-12V
CH2 POS
TRACE SEP
CH1 POS
VAR HOLD
+VP
-VP
OUT
A
B
P-P AUTO
INH T
GND
PEF-747
IC2002 μPD70008AG
IC2001 HD14051 BFP
IC2004 40H374F
IC2008 NJM311M
IC2005 40H373F
IC2006 40H373F
IC2007 40H373F
IC2013 HN27256P
IC2018 μPD4446G-20
IC2014 40H138F
IC2015 40H138F
IC2016 40H138F
IC2009 40H002
IC2004 40H002
IC2017 40H74F
IC2010 40H00F
IC2023 MB88301A
IC2003 LBV-4M09
IC2022 NJM072M
TR2001 2SA1052
TR2002 2SC2735
TR2003 2SA1052
TR2004 2SC2735
TR2091 2SA1052
TR2092 2SA1052
TR2093 2SA1052
TR2094 2SA1052
TR2102 DTC124K
TR2005 DTC124K
P2005
GPIB N
GPIB R
WR
RD
ø
INT
RES
+5V
GND
P2003 P2030
CHR EN
GND
GND A/D
GND SMP
GND (F)
CHR (Y)
GND (F)
GND
+VP
COUNT ST
1 kHz
GND
COUNT DATA
COUNT D CK
COUNT CONT
-VP
GND
DB3
DB2
DB1
DB0
PEF-738
P2008 P1382
DUM EN
DUM DT
BT REF
BT I
GX
DLY POS
B VAR I
AT REF
B VAR I
A VAR O
AT I
A VAR I
VAR HOLD OFF
GND (F)
H POS
GND
DB0
DB1
DB2
DB3
GND
P ROG
CS3
DVM CK
R/G INH
TF CONT
GND
PEF-739
P2000
P1607
J1606
CAL ADJ
12 DIGITAL CONTROL (1) (PEF-745 1/2)



13 DIGITAL CONTROL (PEF-745 2/2)


COUNT TRIG
IC1201
1MHz
P2040
PEF-PULSE GEN
DLY TIME GEN
COUNT A GATE
COUNT B GATE
COUNT MODE 1
COUNT MODE 2
COUNT MODE 3
CONT MODE 4
TIME DIVIDER
TR2403,2404 ; 2SA1029
TR2405,2406 ; 2SA1029
TR2407,2408 ; 2SA1206
TR2401 2SA1029D
TR2402 2SA1029D
TR2409 2SC458
D2401 1SS133
D2402 1SS133
IC2401 a 10131
IC2402 a 10H131
IC2402 b 10H131
IC2403 a 10131
IC2403 b 10131
IC2404 14518BP
IC2405 40H390
IC2406 40H153
IC2407 74LS293
IC2408 TC40H000
IC2409 14040
IC2410 14014
IC2411 14014
IC2412 14014
IC2413 a MC10H104
IC2413 b MC10H104
IC2413 c MC10H104
IC2413 d MC10H104
IC2415 14518
IC2416 a HD10104
IC2416 b HD10104
IC2416 c HD10104
IC2416 d HD10104
IC2417 UN4213
IC2418 UN4213
IC2419 UN4213
COUNT RANGE 1
COUNT RANGE 2
COUNT RES
COUNT ST
COUNT DATA
COUNT D.CK
COUNT CONT
14 COUNTER (PEF-738)


PEF-748
PEF-734
PEF-739
CR 22 m.S
fL = 8H2
P600 P601
ACV
VP
DCV
NC
+12V
-12V
G(A)
G(B)
G(D)
CH2 GATT
L2501
L2551
R2551
R2552
R2553
R2555 90.0D
R2501 100
R2502 4.7K
R2503 180
R2504*
R2505 825F
R2506 100F
R2507 47
R2508 10
R2509 1.5K
R2510 4.7K
R2511 3.9K
R2512 22
R2516 150
R2517 47K
R2518 1.5K
R2519 39K
R2520 12K
R2521 22
R2522 220K
R2523 470K
R2524 47
R2525 22
R2526 1K
R2527 470P
R2528 1K
R2529 1K
R2530 120
R2536 221F
R2537 1KF
R2538 470
R2539 1KF
R2540 10K
R2541 10KF
R2542 10KF
R2543 100
R2544 11KF
R2545 11KF
R2548 330K
R2549 1.8K
R2554 470K
C2503 82P
C2505 2P
C2506 47/16V
C2512 0.01
C2513 47/16V
C2515 10/16V BP
C2516 68P
C2517 10P
C2518 0.01
C2519 10/16V BP
C2520 0.01
C2521 5P
C2524 47/16V
C2525 47/16V
C2526 47/16V
C2528 0.01
C2529 47/16V
C2530*
C2536 47/16V
C2540 22P
C2541 47/16V
C2542 47/16V
D2502 MTZ33JA
D2503 1SS165
D2504 1SS165
D2506 1SS110
D2512 HZ7B
TR2501 2SA1206
TR2502 2SC1906
TR2503 2SA1029D
TR2505 2SC535C
TR2506 2SC1906
TR2507 2SC1906
IC2501a NJM2904S
IC2501b NJM2904S
11.6V
3.01V
760 mV/div
130 mV/div
3.8V
40V
1.1mA
20μA
3.1mA
IC2571 HD14051BP
IC2572 MC14433P
IC2573 LM336Z
IC2574 HD14014BP
IC2575 UN4213
D2571 MTZ4.7JB
R2570 470
R2571 330K
R2572 27K
R2573 12.1KF
R2574 2.2K
R2575 909F
R2576 100k
R2577 4.7K
R2578 2.21KF
R2579 1.37KF
R2580 10K
RV2572 500 ACV
R2571 200 DCV
C2570 0.01
C2571 0.1
C2572 47/16V
C2573 0.01
C2574 0.1
C2575 0.1
C2576 47/16V
C2577 0.01
L2553 10μ
R2581 Short
R2581 SHORT
P1394
P1384
GND
DVM DT
END CON
DVM CK
GND
DVM P/S
GND
DVM CONT
+5V(d)
NC
μ-COM
IC2800
L2551 OPEN
R2551 SHORT
R2553 SHORT
R2552 OPEN
L2501 OPEN
15 DVM CRT
(PEF-733/734)


PEF-744 (CRT)
PEF-740 (H OUT)
PEF-737 (V OUT)
PEF-742
PEF-750
PEF-741
PEF-734 (V PRE AMP)
PEF-738 (TRIG. HV. & Z)
PEF-739 (SWEEP)
PEF-733 (CH3, CH4)
PEF-745 (CPU)
PEF-748 (DVM)
PEF-747 (VOLUME)
PEF-746 (SWITCH)
ROTATION COIL
DLY LINE
SCALE ILLUMI
AC IN
FAN
RVI787 FOCUS
A GATE
B GATE
EXT BLANK
PS-CONN.
V-1150 WIRING DIAGRAM