

MODEL V-209

OSCILLOSCOPE

OPERATION MANUAL

 **Hitachi Denshi, Ltd.**

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MODEL V-209

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NOTE

- This instrument should be adjusted at an ambient temperature of $+20^{\circ}\text{C}$ for best overall accuracy.
Allow at least 15 minutes warmup before proceeding.
- Polyvinyl chloride (PVC) film is attached on the enclosure and the front panel of the oscilloscope to protect the metal surface. If the PVC film is damaged by scratches, remove it.
- To clean the enclosure or the front panel, use neutral detergent. Refrain from using thinner, benzine, alcohol or other chemicals.
- For safety operation, the instrument chassis and cabinet are 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.

1. FEATURES

The Hitachi V-209 is a handy-type, advanced-class oscilloscope with a bandwidth of DC to 20 MHz designed with the emphasis on operability and portability and has a following features.

(1) Wide bandwidth:

The instrument has a bandwidth from DC to 20 MHz.

(2) High sensitivity:

Sensitivity is 1 mV/div

(3) 3.5-inch screen:

Employment of an internal graticule CRT permits the waveform observation to be made without parallax error.

(4) 3-way operation:

The instrument is operated with AC-line, external DC and Battery Pack AD-209.

(5) TV synchronization:

Employment of a new TV sync separator circuit allows the instrument to observe TV signals stably.

(6) Auto focusing:

Focusing shift is automatically corrected.

2. ACCESSORIES

This instrument is shipped with the following standard accessories.

- 2 Probes (AT-10AR1.5)
- 1 Fuse 1A for 100V set or 0.5 A for 200V set
- 1 Fuse 2A for DC line
- 1 AC power supply cord
- 1 DC power supply cord
- 1 Operation manual.

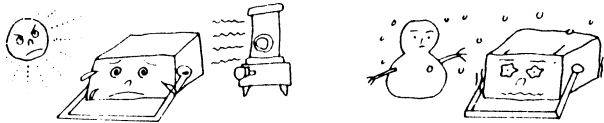
3. PRECAUTIONS

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

Installation site

- * Avoid installing instrument in an extremely hot or cold place.
 - Avoid placing this instrument in a place exposed to sunlight for a long period of time, in a closed car in mid-summer, or near a room heating device such as a stove.
 - The operating maximum ambient temperature is $+50^{\circ}\text{C}$.
- * Do not use instrument that has been left outdoors on a cold winter day.

The operating ambient temperature is 0°C or more.



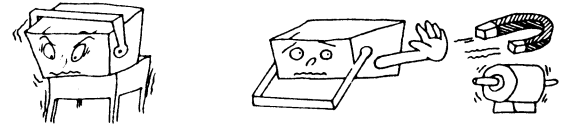
- * Avoid moving the instrument rapidly from a hot place to a cold place or vice versa, or condensation may form on inside of the instrument.
- * Keep the instrument away from damp air, water, and dust. Unexpected trouble may be caused when the instrument is placed in a damp or dusty place.

The operating ambient humidity is 35–85%.

Since an accidental intrusion of water may also cause troubles, do not place a water-filled containers such as a vase on the oscilloscope.



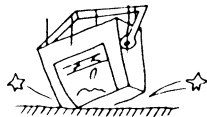
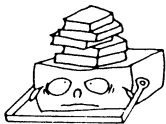
- * Do not place the instrument in a place where vibration is strong. Avoid using the instrument at a place vibrating violently. Since the oscilloscope is a precision instrument, excessively strong vibrations may cause damage.
- * Do not place the instrument near a magnet or magnetic body. An oscilloscope is an equipment using electron beam. Therefore, do not bring a magnet close to the instrument or do not use the instrument near an equipment generating strong magnetic force.



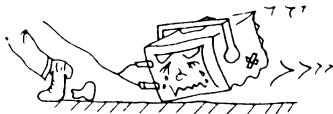
Handling

- * Do not put a heavy objects on the oscilloscope.
- * Do not block the ventilation holes.

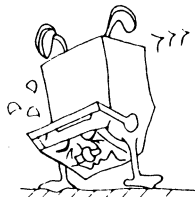
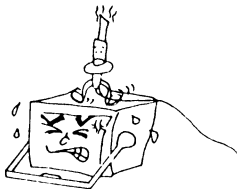
- * Do not apply a heavy shock to the oscilloscope.



- * Do not insert a wire, pin, etc. through the ventilation hole.
- * Do not drag the set, leaving the probe attached to it.



- * Do not leave a hot soldering iron on the cabinet or the screen.
- * Do not try to turn the instrument upside down. Otherwise, knobs may be broken.



- * Do not use the instrument upright, leaving BNC cable connected to EXT BLANKING terminal on the rear panel. Otherwise, the cable may be damaged.



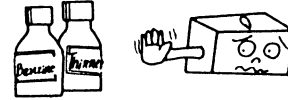
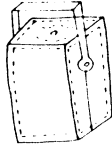
Handle

The handle of the V-209 can be positioned for carrying or as a tilt-stand for the instrument. To position the handle, press in at both pivot points and turn the handle to the desired position. 15 positions are provided for convenient carrying or viewing.



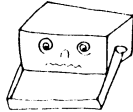
When not in use

When not in use, put the dust-proof cover on the instrument and store it with care.



When Operation is faulty

Recheck the operating procedure and if problem persists, contact a nearby service station or agent.



Care and repair

- * Removal of stain from the case.
 - 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.
- * Never use strongly volatile agent such as benzine and thinner.

- When the panel surface is stained, remove the stain in similar way with a clean, soft cloth. When heavy stains are present, first remove the stains by wiping the surface lightly with a cloth moistened with diluted neutral washing agent or with alcohol and then wipe thoroughly with a dry cloth.
- When dust has accumulated on the inside, remove it by using dry brush, or by using the exhaust of a compressor or a vacuum cleaner.

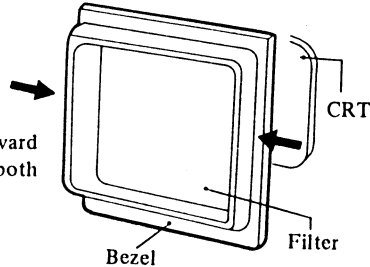
NOTE: When opening the case, pull out the power supply plug beforehand without fail.

When cleaning the inside, insure beforehand that no electricity remains in the condensers of the power supply circuit.

- * Cleaning of CRT
Dirty surface of CRT screen tends to cause measuring errors. The screen surface becomes visible when the bezel is removed.
Remove the stains on CRT and filter by using a clean and soft cloth, paying attention not to impair them.
When the stain is extremely heavy, wash them with neutral

washing agent and then leave them stand until the moisture is removed naturally.

- If the screen is installed while it is moistened, water rings may be formed and the waveform may be blurred to make observation hard. Pay attention not to leave finger prints on it.



To dismount it, pull it toward you pressing it at the both ends.

Operation precautions

- * Check the line voltage is in the range specified in the table below.

Rating	Allowable line voltage (50/60Hz)
AC100V	AC90V – 130V
AC200V	AC180V – 260V

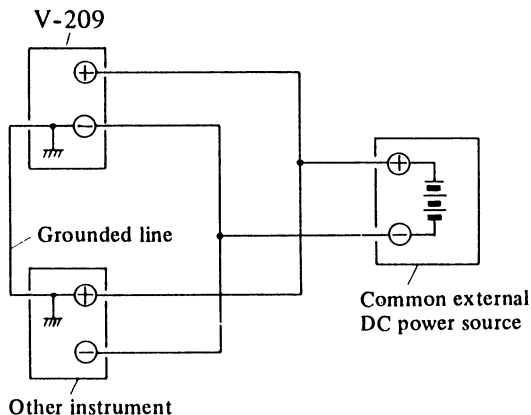
Usually the voltage selector switch on the rear of the V-209 has been set to 100V AC at the factory. When this is operated on 200AC voltage, set the selector switch to 200 V AC. (Rated voltages are marked above the power connector on the rear panel.)

- * Use only specified fuses

In order to protect the circuit against over-current, a 0.5A (in primary side of power circuit) and 2 A (in secondary side of power circuit) are used. When the fuses blow out, check thoroughly the cause, repair any faulty point present, and then replace them with specified fuses. Do not try to use the fuse other than the specified ones. Otherwise, fault may be caused or danger may be invited. (Particularly, do not use a fuse different from the specified one in current capacity and in length.) The standards of the fuses are as follows.

Shape (Diameter x length) mm		JIS type name
2A	6.35φ x 31.8	MF61NM250V 2A AC
1A	6.35φ x 31.8	MF61NM250V 1A AC
0.5A	6.35φ x 31.8	MF61NM250V 0.5A AC

- * -(negative) terminal of EXT DC IN is inside connected to case ground. Do not connect - (negative) terminal of the V-209 to the + (positive) grounded case of other instruments with common external DC power source to the V-209. If not, it is very dangerous because a large current flows through the grounded line.



< DANGEROUS CONNECT >

- * Do not apply reverse polarities to EXT DC IN.
- * Do not increase the brightness too much. Your eyes may be strained and the fluorescent surface of CRT may be burnt.
- * Do not apply an excessive voltage.

The maximum voltage of each input is as follows.

INPUT direct	250V (DC+ peak AC at 1 kHz)
When x10 Probe is used	250V (DC+peak AC at 1 kHz)
EXT TRIG INPUT	250V (DC+peak AC)
EXT BLANKING	50V (DC +peak AC)

4. CONTROLS AND CONNECTORS

(1) Power supply and CRT

Operating voltage and fuse

This model can be operated from either a 100 volts or a 200 volts nominal line voltage source. The line voltage select switch on the rear panel, turn the instrument from one operating range to the other. In addition, this switch changes the primary connections of the transformer to allow selection of one of two regulating ranges. Use the following procedure to convert this instrument between normal line voltage or regulating ranges.

- a. Disconnect the instrument from the power source.
- b. To convert from 100 volts nominal to 200 volts nominal line voltage or vice versa, remove the protector of the line voltage select switch. Change the line voltage select switch from 100 volts to 200 volts and remounting the protector.
- c. Before apply the power to the instrument, check that the indicating tabs on the rear panel.

Selection of power supply mode

This oscilloscope can make operation by using three kinds of AC power supply, external DC power supply and AD-209 battery pack.

The switches are set as shown in the table below to establish each power supply mode.

Power supply mode \ Switches	Power source select switch ⑦	Power mode select switch ⑧
AC power supply	AC	DC OP
External DC power supply*	DC	DC OP
Battery Pack (AD-209)	DC	DC OP
When charging (AD-209)	DC	BATT CHARGE

* DC 11 to 14V is supplied via EXT DC INPUT connector.

< WARNING >

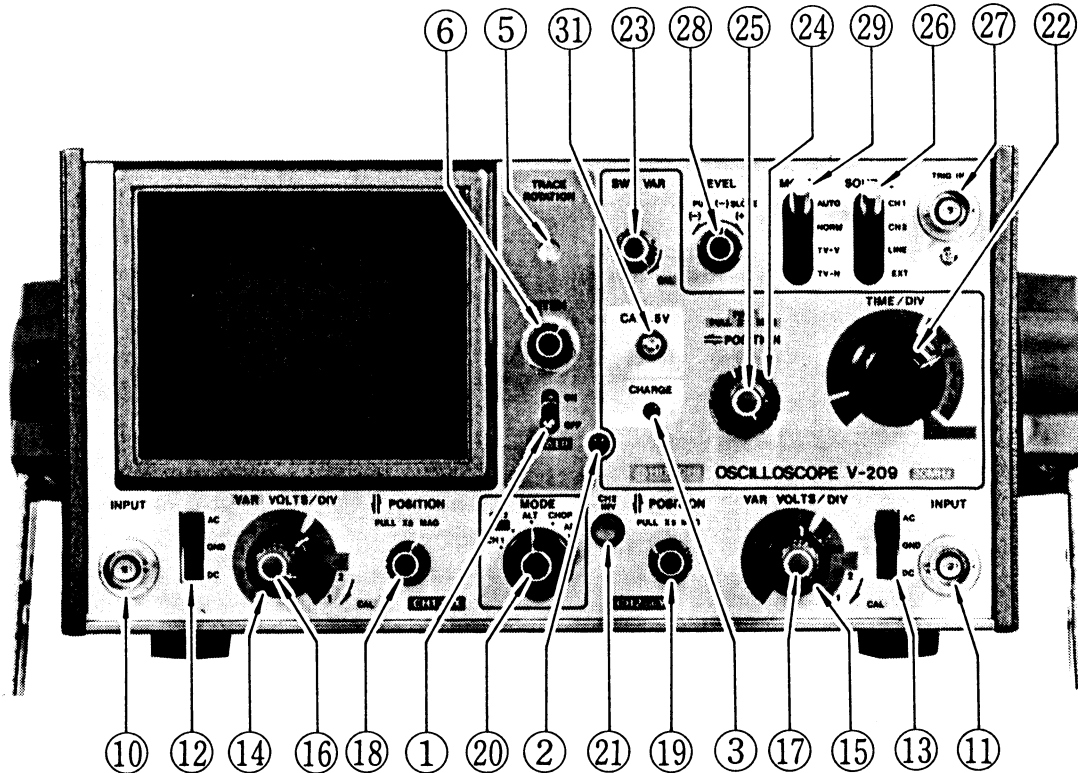
- After completing the charge of AD-209, be sure to set power mode select switch to DC OPE.
- When the output voltage of DC power supply becomes less than 11V, the power lamp is blinking. When the output voltage is less than approx. 10.5V, it stops the operation to prevent the battery overdischarge.
- When instrument is operated by using the AD-209, refer to chapter 5, "Battery Operation."
- When the AD-209 is not used, it is possible that the CHARGE lamp is illuminated by setting the Charge mode.

External DC operation

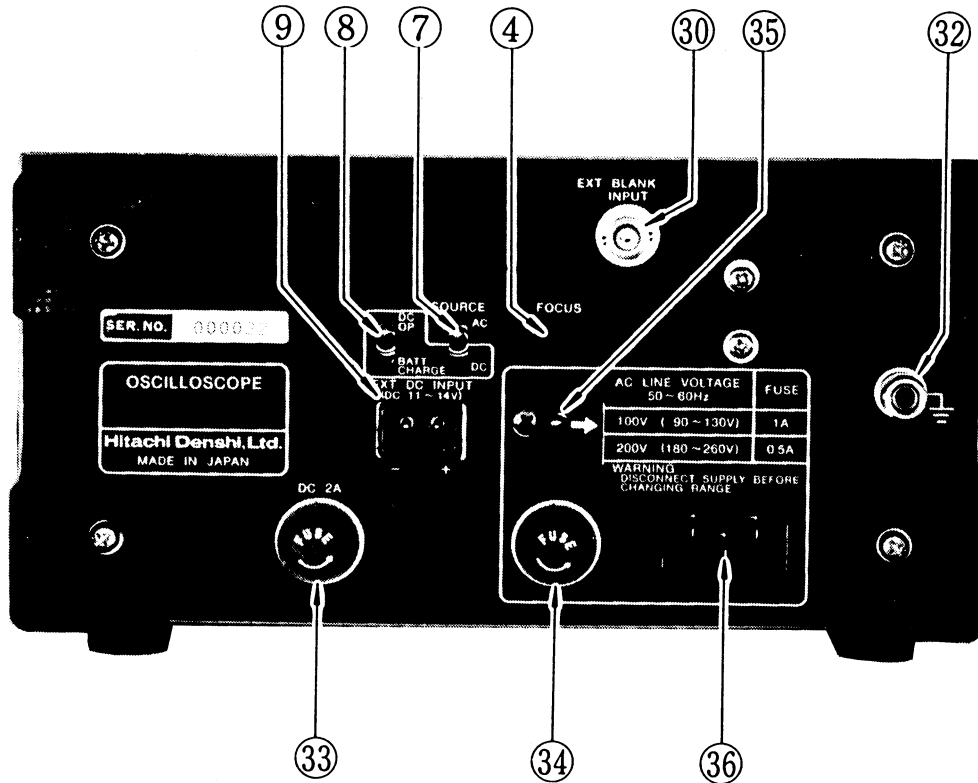
The V-209 can be operated by external DC source (11 to 14 volts)

In this case, DC source is supplied by the attached external DC source cable. Connect the white line of source cable to plus (+) side. Reversing polarity connection may cause blow of the fuse.

AD-209 and external DC source are automatically switched by inserting the external DC source cable into EXT DC INPUT connector.



Front View



Rear View

① **POWER switch**

After checking the line voltage select switch, set POWER switch set to OFF and then connect the AC cord to AC wall socket.

② **POWER lamp**

This lamp goes on in red when the power supply is in ON state.

③ **CHARGE lamp**

This lamp goes on in red in the battery charge mode. When the battery is completely charged, this becomes dim.

④ **FOCUS control**

After obtaining an appropriate brightness by operating INTENSITY, adjust FOCUS until the bright line becomes clearest. Although the focus is also corrected automatically when INTEN is rotated, the focus is sometimes slightly shifted.

⑤ **TRACE ROTATION control**

Used to align the trace of CRT with the horizontal graticule.

⑥ **INTENSITY control**

Works as the brightness adjustment. Brightness is increased by rotating INTENSITY clockwise.

⑦ **Power source select switch**

Used to select the power sources.

AC Operated with the AC power source

DC Operated with the AD-209 or external DC power source

⑧ **Power mode select switch**

Used to select the power mode.

See Selection of Power supply mode.

< CAUTION >

Do not set the Power mode select switch to the BATT CHARGE except charging batteries.

⑨ **EXT DC INPUT connector**

See External DC operation.

(2) **Controls of vertical deflection system**

⑩ **CH1 INPUT connector**

BNC connector for vertical axis input

The signal input to this terminal becomes the X-axis signal when the instrument is used as an X-Y oscilloscope.

⑪ CH2 INPUT connector

The same as CH1, but when the instrument is used as an X-Y oscilloscope, the signal input to this terminal becomes the Y-axis signal.

⑫ ⑬ Input coupling switches (AC-GND-DC)

Used to select the coupling system between the input signal and vertical axis amplifier.

AC At this setting, the signal is connected through a condenser. The DC component of the input signal is cut off and only the AC component is displayed.

GND At this setting, the input to the vertical axis amplifier is grounded.

DC At this setting, the input signal is directly connected to the vertical axis amplifier and displayed unchanged, including the DC component.

⑭ ⑮ VOLTS/DIV select switches

A step attenuator which selects vertical deflection factor. Set it to an easily observable range corresponding to the amplitude of the input signal.

Multiply the reading by 10 when the 10:1 probe is used in combination with the instrument.

⑯ ⑰ VARIABLE controls

Fine tuning device is used to vary the vertical deflection sensitivity continuously. Attenuation of less than 1/2.5 is obtained when this device is rotated in the reverse direction of the arrow to the full.

This control is used when comparing waveforms or when measuring the rise time of a square wave in 2-channel observation. Normally this control is left rotated in the direction of the arrow to the full.

⑱ ⑲ POSITION controls

Used to adjust the position of the vertical axis.

The image rises with the clockwise rotation of this knob and falls with the counterclockwise rotation. When the knob is at PULL position, (pulled up state) the gain of the vertical axis is magnified 5 times and the maximum sensitivity becomes 1mV/DIV.

⑳ ㉑ MODE select switch

Used to select the operation mode of the vertical deflection system.

CH1 Only the signal that has been applied to CH1 appears on the screen.



CH2 Only the signal that has been applied to CH2 appears on the screen.

ALT Signals applied respectively to CH1 and CH2 appear on the screen alternatively at each sweep. This setting is used when the sweep time is short in 2-channel observation.

CHOP At this setting, the input signals applied respectively to CH1 and CH2 are switched at about 250 kHz independent of the sweep and at the same time appear on the screen. This setting is used when the sweep time is long in 2-channel observation.

ADD The algebraic sum of the input signals applied respectively to CH1 and CH2 appears on the screen..

②① CH2 INV button

Used to inverse the polarity of the input signal applied to CH2. Inversion occurs in a state where the knob of the pushbutton is depressed () and restored to normal when the knob is in protruded state (). This switch is conveniently used in the comparison of two waveforms having different polarity or in the observation of the waveform of the difference signal [CH1] - [CH2] between CH1 and CH2 using ADD.

(3) Controls of horizontal deflection system

②② TIME/DIV select switch

Sweep time ranges are 18 steps from 0.5 μ s/div to 0.2s/div.

X-Y This position is used when using the instrument as an X-Y oscilloscope.

In this position, the X (horizontal) signal is connected to the input of CH1; the Y (vertical) signal is applied to the input of CH2 and has a deflection range from less than one millivolt to 5 volts/div at a reduced band-width of 200 kHz.

②③ SWP VARIABLE control

Works as CAL and the sweep time is calibrated to the value indicated by TIME/DIV.

TIME/DIV of sweep can be varied continuously when shaft is out of CAL position.

Then the control is rotated in the direction of arrow to the full, the CAL state is produced and the sweep time is calibrated to the value indicated by TIME/DIV. Counterclockwise rotation to the full delays the sweep by 2.5 times or more.

②④ FINE PULL $\times 10$ MAG \rightleftharpoons POSITION control

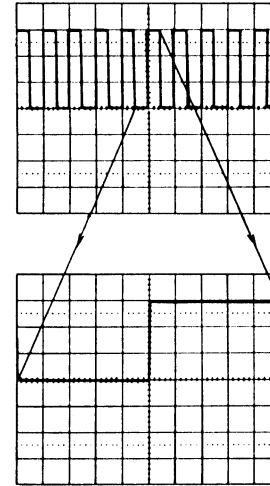
Used to move the bright line in horizontal directions.

It is indispensable to the measurement of the time of waveform.

Bright line is moved toward right when the knob is rotated clockwise and toward left with counterclockwise rotation. The outer shaft is for coarse adjustment and the inner shaft for fine adjustment.

②⑤ x10 MAG control

A and B sweeps are magnified 10 times by pulling out FINE knob (inner shaft) of POSITION. In this case, the sweep time is 1/10 of the value indicated by TIME/DIV. Bring the position of the waveform to be magnified for observation from the center of the scale by operating \rightleftharpoons POSITION of the horizontal axis. Next, switch x10 MAG switch to PULL (pulled out state). Then the waveform placed at the center is magnified in right and left directions. The sweep time in this case is 10 times of the sweep speed obtained by TIME/DIV, in other words, the reading is 1/10 of the sweep time indicated.



Magnified waveform

(4) Synchronization system

②⑥ SOURCE select switch

Used to select the triggering signal source A sweep.

- CH1 The input signal applied to CH1 becomes the triggering signal
- CH2 The input signal applied to CH2 becomes the triggering signal.

LINE This setting is used when observing a signal triggering with power supply line frequency.

EXT External triggering signal applied to TRIG INPUT becomes the triggering signal.

This setting is used when triggering with a special independency of the vertical axis signal.

27) TRIG INput connector

Input terminal used for external triggering signal of A sweep.

28) TRIG LEVEL control

Used to decide at which portion of the waveform the sweep should be started by setting trigger level.

This control is also enabled to switch SLOPE.

Depressed position (normal state) is for \oplus SLOPE and PULL position (state in which the knob is protruding) is for \ominus SLOPE.

Explanation of synchronization polarity SLOPE

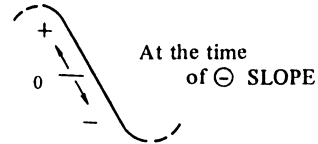
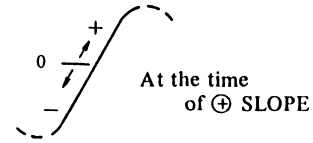
Push
at time of
 \oplus SLOPE



Pull
at time of
 \ominus SLOPE



Explanation of synchronization level LEVEL



29) TRIG MODE select switch

AUTO Brought into automatically triggering sweep in which sweep is always conducted.

In the presence of triggered signal, normal triggered sweep is obtained and the waveform stands still. In the case of no signal or out of triggering, sweep line will appear automatically. This setting is convenient in usual cases.

NORM Triggered sweep is obtained and sweep is conducted only when triggering is effected. No sweep line will appear in the case of no signal or out of synchronization. Use this MODE when effecting synchronization to a very low fre-

quency signal (30 Hz or less).

TV(V) This setting is used when observing the entire vertical picture of television signal.

TV(H) This setting is used when observing the entire horizontal picture of television signal.

(NOTE) Both TV V and TV H synchronize only when the synchronizing signal is negative.

(5) Miscellaneous

③① EXT BLANK connector

Input terminal for brightness modulation. It is of the DC coupling. The brightness is reduced with a positive signal and increases with a negative signal.

③② CAL 0.5V tip

Output terminal of calibration square wave of about 1 kHz and 0.5V. It has a tip terminal. It is used to calibrate the probe combination.

③③ GND terminal

Earth terminal of the oscilloscope.

5. BATTERY OPERATION

Operation of battery pack AD-209

- 1) Set the Power source select switch ⑦ to DC and the Power mode select switch ⑧ to DC OP.
- 2) Turn on the POWER switch ①. Then the V-209 starts to operate on the power from the AD-209.

The continuous operation time is one hour and half. If the battery is operated in excess of this period, the terminal voltage will decrease sharply and the battery will be in the over-discharged condition.

In this model, an alarm circuit will be activated before the over-discharging and the POWER lamp ② starts to flash. In this case, charge the battery immediately.

Note: When the alarm circuit is energized and the voltage is lowered down to 10.5V, the power of the V-209 is off automatically to prevent the over-discharge of the AD-209.

The selection of the AD-209 and an external DC source is made by the external DC input connector ⑨.

Charging of battery

- 1) Connect the AC cord to an AC outlet and set the AC-DC switch ⑦ to DC and the DC OP BATT CHARGE switch ⑧ to BATT CHARGE.
- 2) Turn on the power switch ① and the charging will start. In this case, the POWER lamp is not illuminated.
- 3) The CHARGE lamp ③ is being illuminated during the charge. It will take about 15 hours until the battery is charged completely. When the charging is completed, the CHARGE lamp becomes dim.
- 4) When the V-209 is operated on the AC source, while it is connected with the AD-209, the AD-209 is in the trickle charge mode.

Operating considerations

- Do not short the both polarities.
- Do not throw the battery pack into fire.

- a) Charge the battery in the ambient temperature from 10 to 35°C.
Do not charge the battery for three days or 48 hours in succession. This will shorten the life of the battery.
- b) Store the battery pack in a cool and dark place and in the ambient temperature from -15 to 35°C.

When a battery stored for an extended period is used, charge it for 15 hours.

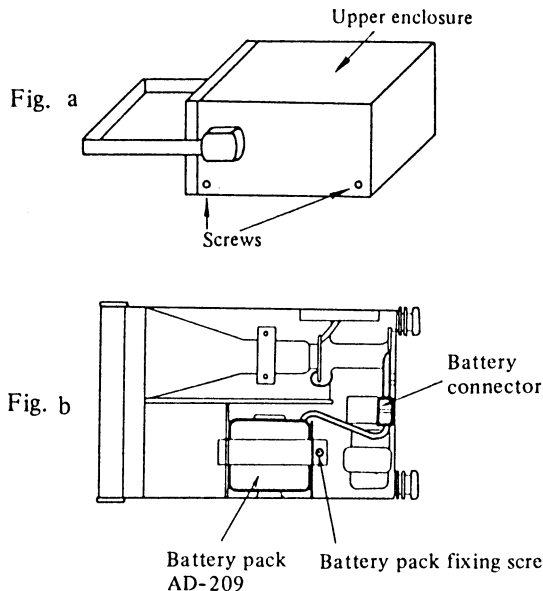
- c) The life of the battery pack is subject to the ambient temperature, load condition and continuous operation.
Usually, the number of the charge and discharge is over 300.
If a charge and discharge is made once a day, the life will be more than one year. If the life is over, the battery can not operate normally. In this case, replace the battery.
- d) Charge the spare battery once a month to prevent a self-discharge of the battery.

AD-209 battery pack replacement procedure

- 1) Disconnect the power cord.
- 2)
 - a) Remove four screws on the upper enclosure, then remove the upper enclosure (Refer to the Fig. a). Remove the screws and the plate shown in the Fig.b.
 - b) Disconnect the connectors between the battery pack and the oscilloscope and take out the battery pack AD-209.
 - c) Install the new battery pack AD-209 to the compartment as shown.

Then connect the battery pack connector to the connector of the oscilloscope.

- d) Mount the plate with screws.
- e) Fix the upper enclosure on the oscilloscope with four screws.



< CAUTION >

When mounting the battery pack AD-209, take care not to damage the connecting cables and components.

6. HOW TO PRODUCE THE BRIGHT LINE

Before turning ON the POWER switch, insure the power supply voltage is within the range of 90–130V for AC 100V set, 180–260V for AC 200V set.

Insert the plug of the power cord on the rear panel into the power supply wall socket and set the controls as follows.

POWER	OFF
INTEN	Counterclockwise to the full
FOCUS	Midrange
AC-GND-DC	GND
↑↓ POSITION	Midrange (the knob is left depressed)
V. MODE	CH1
TRIG	AUTO
TRIG SOURCE	CH1
TIME/DIV	0.5 ms/div
⇌ POSITION	Midrange

Set all the levers of the switches to the upper side.

After ending all the setting mentioned above, turn ON the POWER and, 15 second later, rotate the INTEN knob clockwise. Then the sweep bright line will appear. If the observation is to be started immediately, set the FOCUS control at a point where the bright line is sharpest.

If the instrument is not used with the power supply turned on, rotate the INTENSity counterclockwise to reduce the brightness and also blur the FOCUS.

NOTE

For usual observation, leave the following non-calibrating function section set to "CAL" position.

VARIABLE	Rotate in the direction of arrow. In this case, the VOLTS/DIV is calibrated to its indicating value.
SWP VAR	Leave the knob in depressed state. In this case, the TIME/DIV is calibrated to its indicating value.

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

GENERAL MEASUREMENT

(1) In the case of observing a single waveform.

Use CH1 or CH2 when not observing the phase difference between two waveforms or when engaging in a operation other than X-Y operation. Make the following settings when using CH1.

MODE Switch of Vertical deflection system CH1
 MODE Switch of TRIG AUTO
 TRIG SOURCE CH1

Under these settings, almost all the repetitive signals of about 30 Hz or more applied to CH1 can be synchronized and observed by adjusting TRIG LEVEL. Since the MODE of horizontal axis is at AUTO position, the bright line appears even when no signal is present or when input coupling switch is at GND position. This means that the measurement of DC voltage can be measured. The following switching is needed when observing low frequency signals of about 30 Hz or less.

MODE of TRIG NORM

Synchronization can be effected by operating LEVER knob under this setting.

When using only CH2, use the instrument after making the following settings.

MODE Switch of Vertical Axis
TRIG SOURCE

CH2
CH2

(2) When observing two waveforms

Observation of two waveforms can be made easily by setting the MODE switch of vertical axis to ALT or CHOP. When observing two waveforms of high repetition frequencies, set the MODE switch to ALT and, in the case of low frequencies, set it to CHOP.

Measurement of the phase difference is performed after effecting synchronization with leading phase signal.

(3) When observing waveform with X-Y

Set the MODE switch of vertical deflection system to CH2 (X-Y) and TIME/DIV switch to X-Y. Then the instrument works as an X-Y oscilloscope.

Each input is applied to the instrument as follows.

X-axis signal (horizontal axis signal) CH1 INPUT
Y-axis signal (vertical axis signal) CH2 INPUT

In this case, leave the horizontal axis magnification switch (PULL-MAG x 10 inner shaft knob) at depressed position.

7. METHOD FOR CONNECTING SIGNALS

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

(1) When using a probe

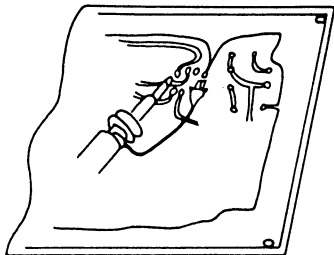
Use the attached probe, when measuring a high frequency wave with high accuracy.

It should be noted, however, that since the input signal is attenuated by this probe to 1/10 before it is input to the oscilloscope, the use of the probe is disadvantageous for low signals, and that at the same time, the measuring range is extended by that amount for high signals.

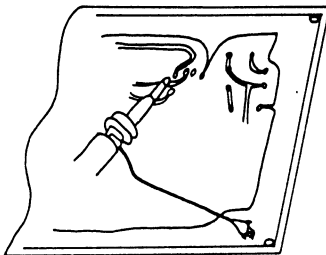
< CAUTIONS >

- Do not apply a signal which exceeds 250V (DC + peak AC at 1 kHz).
- Bring the grounding point of the earth lead wire of the probe close to the point to be measured when measuring a rapid rising signal or a high frequency signal. Long earth lead wire may cause waveform distortions such as ringing and overshoot.

Connection of earth lead wire



(a) A good example



(b) A bad example

For better measurement, it is required to use an earth attachment available at option.

- Multiply the reading of VOLTS/DIV by 10.

For example, if the VOLTS/DIV is 50mV/DIV, then read the waveform as

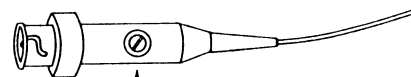
$$50\text{mV/DIV} \times 10 = 500\text{mV/DIV}$$

- To avoid measurement error, put the probe in the following correction state and check it before measurement without fail.

Connect the tip of the probe to the output terminal CAL 0.5V of 1kHz calibration square wave voltage.

When this correction capacity value is at optimum, the waveform takes the shape as shown in Fig. (a) as follows.

If the waveform is as shown in Fig. (b) or Fig. (c), rotate the semifixed adjusting screw on the matching box of the probe by using a screwdriver until the optimum state is obtained.



Capacitance correction trimmer



(a) Optimum



(b) Capacity too small



(c) Capacity too large

(2) At time of direct connection

When connecting a signal directly to the oscilloscope not using the attached probe, pay attention to the following points in order to minimize the measurement error.

- When performing observation using a bare lead wire, no trouble occurs on the circuit to be measured at low impedance and high level.

However, note that, in most cases, measurement error may be caused by static stray coupling with other circuit and power line.

This measurement error cannot be ignored even in low frequency region.

In general, it is safe to avoid measuring with non-shielded connecting wire. When using a shielding wire, connect one end of the shield to the earth terminal of the oscilloscope and the other end to the grounding of the circuit to be measured. It is desirable to use a coaxial cable with BNC type connector.

- The following cautions must be observed when performing a wide band measurement. It is necessary to terminate with the characteristic impedance of the cable when measuring a rapid rising waveform or a high frequency wave.

Especially when using a long cable, the absence of a terminating resistor will necessarily lead to a measurement error derived from ringing phenomenon. Some measuring circuits require a terminating resistor equal to the characteristic impedance of the cable also on the measurement terminal side.

BNC type terminating resistor (50Ω) is conveniently used for this purpose.

- In order to perform measurement with the measuring circuit put in proper operating state, it is sometimes necessary to terminate the cable with an impedance which corresponds to the circuit to be measured.
- The stray capacity of the shield wire must be taken into account when performing measurement with a long shield wire. 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 probe to minimize the effect on the circuit.

- When the length of the shield wire is used or when the length of the non-terminated cable reaches $1/4$ wave length or its multiples within the band of V-209 type ($1/4$ wave length is about 3 meter when using a coaxial cable at 20 MHz), oscillation may be caused near 5 mV/DIV range.

This is caused by the resonance between the externally connected high-Q inductance and the input capacity and can be avoided by reducing the Q.

Connect the cable or shield wire to the input connector by way of a serially connected 100Ω to 1Ω resistor, or perform measurement at other VOLT/DIV range.

8. MEASURING PROCEDURE

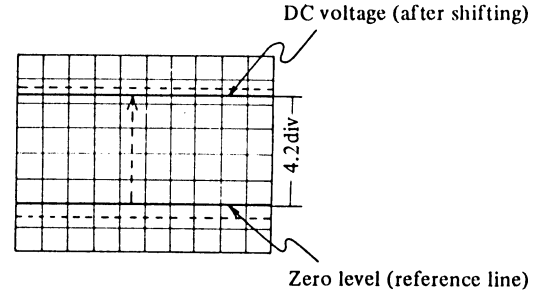
The first things to do are as follows.

- Bring the brightness and FOCUS at optimum positions for easy read out.
- Display the waveform as large as possible to minimize the read error.
- Check the capacity correction when using a probe. (Refer to paragraph (1) “When using a probe” of Section 7. “Method for connecting signals” for correcting capacity.)

(1) DC voltage measurement

Set input coupling to GND and decide the zero level properly.

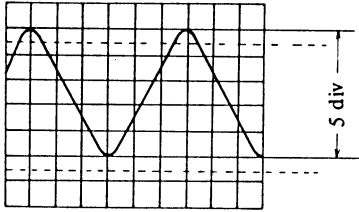
Set VOLTS/DIV appropriately and set AC-GND-DC to DC. Since the bright line shifts here by the amount of DC voltage, the DC voltage of the signal can be obtained by multiplying the shift width by the indicated value of VOLTS/DIV. When VOLTS/DIV is 50 mV/DIV, then $50 \text{ mV/DIV} \times 4.2 = 210 \text{ mV}$ (However, if the probe (10:1) is in use, the true value of the signal becomes 10 times of the value, or $50 \text{ mV/DIV} \times 4.2 \times 10 = 2.1 \text{ V}$.)



(2) AC voltage measurement

The same as paragraph 8 (1), “DC voltage measurement”, but here there is no need of align the zero level with the scale line. Set the zero level to the position that can be easily observed.

In the drawing as follows, VOLTS/DIV is 1V/DIV, $1\text{V}/\text{DIV} \times 5 = 5 \text{ Vp-p}$ (50 Vp-p at time using the probe (10:1)). When magnifying and observing a small-amplitude signal, superimposing on a high DV voltage, set the input coupling to AC. The DC voltage is cut off and AC voltage can be observed by increasing sensitivity.



(3) Measurement of frequency and period

This will be explained with the following figure.

One period covers the time A and time B, which are separated from each other by 2.0 DIV on the screen.

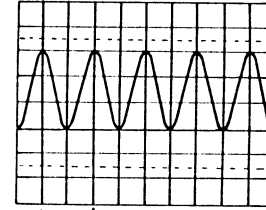
When the sweep time is 1ms/DIV, the period is given by

$$1 \text{ ms/DIV} \times 2.0 = 2.0 \text{ ms} \\ = 2.0 \times 10^{-3} \text{ s}$$

Accordingly, the frequency is

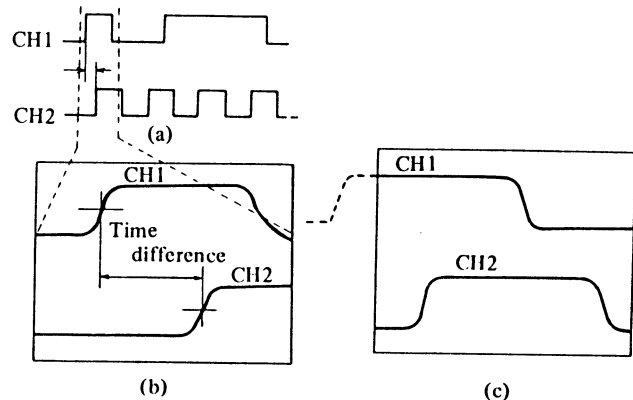
$$1/(2.0 \times 10^{-3}) = 500 \text{ Hz}$$

(However, when the knob MAG $\times 10$ is at pulled out position, TIME/DIV must be converted to 1/10 since the sweep is magnified.)



(4) Measurement of time difference

Triggering signal source "SOURCE" is selected as an offering reference signal when measuring the time difference between two signals. Assume that pulse trains as shown in (a). Then (b) shows the case when CH1 is taken as the triggering signal source and (c) the case where CH2 is taken.

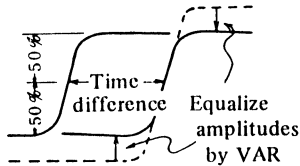


This means that CH1 is used as the triggering signal when investigating the length of time by which the signal of CH2 is delayed from the signal of CH1. CH2 is used in the reversed case. In other words, the signal leading in phase is selected as the triggering signal source.

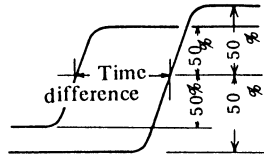
If this process is reversed, the portion to be measured may sometimes not appear on the screen. Thereafter, equalize the amplitudes of the two signals appearing on the screen or superimpose one on another.

Read the time difference between 50% amplitude points of the two signals.

Sometimes the superimposing method is more convenient from the point of view of procedure.



(a) Equal amplitude measuring method



(b) Superposition measuring method

<CAUTIONS>

Since the pulsed wave contains many high-frequency wave components (higher harmonics) depending on its width or

period, pay the same attention as given to high frequency signals when handling it. Accordingly, use a probe or coaxial cable and shorten the earth lead wire as much as possible.

(5) Measurement of rise (fall) time

To measure the rise time, pay attention not only to the abovementioned items but also to measurement error.

The following equation is provided for the relation among the rise time T_{rx} of the waveform to be measured, the rise time T_{rs} of oscilloscope, and the rise time T_{ro} displayed on the screen.

$$T_{ro} = \sqrt{T_{rx}^2 + T_{rs}^2}$$

When the rise time of the pulse going to be measured is sufficiently longer than the rise time of the oscilloscope (17.5ns in our case), the effect of the rise time of the oscilloscope on the measurement can be neglected. However, if both are close to each other, measurement error may be caused.

The true rise time is given by

$$T_{rx} = \sqrt{T_{ro}^2 - T_{rs}^2}$$

Moreover, in general, in a circuit free from waveform distortion such as overshoot and sag, the following relation is established between frequency band and rise time.

$$f_c \times t_r = 0.35$$

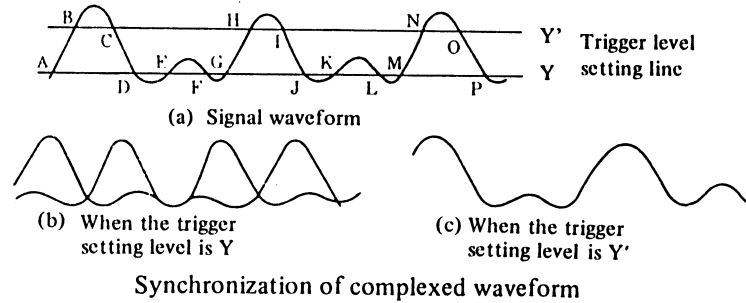
Where, f_c : Frequency band (Hz)
 t_r : Rise time (s)

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

(6) Synchronization of complexed waveform

In the case shown in the Fig. (a) below where two waveforms have difference in amplitude alternate, the waveform is doubled if the trigger level is not set properly. In the case where the trigger level is selected as Y line two waveforms, 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 synchronization can be taken.

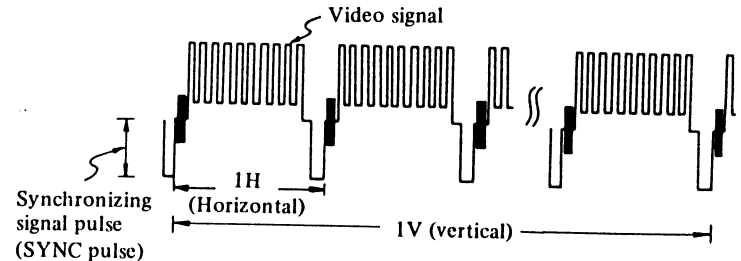
In such a case, rotate LEVEL clockwise until the trigger level comes to Y' line. Then the waveform on the screen becomes the one shown in Fig. (c) above which starts with B and advances to C, E, F, . . . and which allows synchronization.



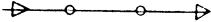
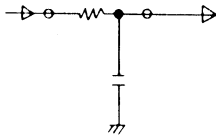
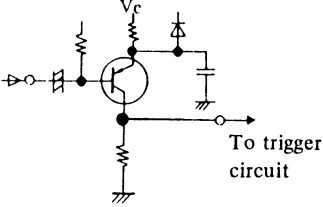
(7) How to use TV exclusive synchronization

① On the image waveform of TV

In the work concerned with TV, complexed signals containing video signal, blanking pedestal signal, and synchronizing signal are often measured. However, since the waveform is complexed, a special circuit is needed to effect a stable synchronization with vertical waveform.

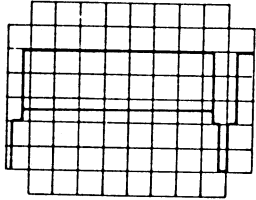


② Difference in the circuits

Exclusive circuit for conventional oscillograph		Exclusive circuit for this instrument (Principle drawing)	
General circuit	Simple synchronizing circuit	TV exclusive synchronizing separator circuit	
<p>Circuits</p>	<p>Video signal</p> <p>To trigger circuit</p> 	<p>To trigger circuit</p> 	
	<p>Hard to synchronize, because video signal is applied directly as trigger signal.</p>	<p>Synchronization is more easily effected than in the circuit shown at left, because the signal is integrated to remove high frequency components.</p>	<p>After picking up the SYNC pulse, the vertical synchronization is separated. Then, the stable synchronization is obtained.</p>

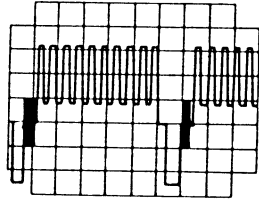
③ Operation

To observe vertical signal



TRIG MODE: TV-V

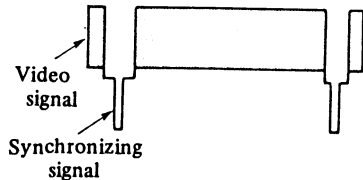
To observe horizontal signal



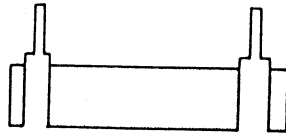
TRIG MODE: TV-H

(NOTE) This oscilloscope synchronizes with only (-) synchronizing signal.

(REFERENCE)



(a) Example of (-) synchronizing signal

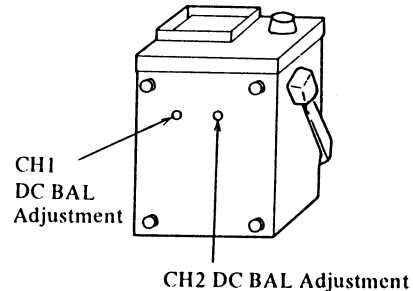


(b) Example of (+) synchronizing signal

9. ADJUSTMENTS

The ATT balance of the vertical axis can be made easily.

- ① Set the input coupling switches of CH1 and CH2 to GND and set the TRIG MODE to AUTO. Then position the bright line to the center.
- ② Turn the VOLTS/DIV switch to 5mV-10mV and adjust it so that the bright line does not move (Remove the cover).



10. MAINTENANCE

- 1) Since semiconductors, precision components, etc. are employed in this oscilloscope, use utmost care for operation and storage.
- 2) Clean the scale with soft tissue periodically.
- 3) Store this oscilloscope in the ambient temperature from -15 to +60°C (except for the battery pack AD-209).

11. SPECIFICATIONS

CRT

Type

3.5-inch rectangular CRT with internal graticule.

Phosphor

P31 standard

Graticule

8 x 10 div (div = 6.85 mm)

Internal graticule

Focussing

Possible (with automatic focus correction circuit)

Trace rotation Present

Brightness adjustment Possible

Z-AXIS INPUT (INTENSITY MODULATION)

DC-coupled, positive-going signal decreases intensity:
5Vp-p signal causes noticeable modulation at normal
intensity: DC to 1 MHz

Input impedance Approximately 50 k ohm

Maximum input voltage 50V (DC + peak AC)

Coupling DC

VERTICAL DEFLECTION SYSTEM (2 identical channels)

Bandwidth and rise time

DC to at least 20 MHz and rise time 17.5 ns or less. DC to at least 5 MHz and rise time 70ns or less at magnifier extends. The AC coupled lower -3dB point is 10Hz or less.

Deflection factor

5mV/div to 5V/div in 10 calibrated steps in a 1-2-5 sequence. Uncalibrated continuous control extends deflection factor to at least 12.5 Volts per division in the 5 Volts/div position. x5 MAG increases sensitivity of each deflection factor setting to 1 mV/div.

Accuracy

±3% (+10 to +35°C)

Additional error for magnifier ±2%

Display modes

CH1, CH2 (normal or invert), Alternate, Chopped (approximate 250kHz), Added

Input impedance

1MΩ ±1.5% in parallel with 30 ±3pF

Maximum input voltage

250V (DC + peak AC) or 500Vp-p AC at 1kHz or less

Input coupling

AC, GND, DC

HORIZONTAL DEFLECTION SYSTEM

Time base

0.5μs/div to 0.2s/div in 18 calibrated steps in a 1-2-5 sequence. Uncalibrated continuous control extends deflection factor to at least 0.5 seconds per division in the 0.2 sec/div position. x10 MAG extends maximum sweep rate to 50ns/div.

Accuracy

±3% (+10 to +35°C)

Additional error for magnifier ±2%

TRIGGERING SYSTEM

Trigger modes

Automatic, Normal, TV (TV-H or TV-V)

Trigger source

Internal (Ch1, Ch2), Line, External

Trigger slope

+, -

TV sync polarity

TV(-)

Triggering level variable rangeInternal; ± 4 div or moreExternal; approximately $\pm 1V$ **Triggering sensitivity and frequency**

Frequency	Internal	External
20 Hz – 5 MHz	0.5 div	150 mV
5 MHz – 20 MHz	1.5 div	500 mV

TV-V sensitivity: SYNC section less than 0.7 div or 200mV

AUTO low band : Approximately 30Hz

A trigger coupling

AC : 20 Hz to full bandwidth

External trigger input impedance1M Ω $\pm 20\%$ in parallel with 30 $\pm 6pF$ **Maximum input voltage**

250V (DC + AC peak)

X-Y OPERATION (CH1; Horiz, CH2; Vert)**Deflection factor**

Same as vertical deflection

AccuracyY: $\pm 3\%$ (+10 to +35°C)X: $\pm 5\%$ (+10 to +35°C)Additional error for magnifier $\pm 2\%$ **X-bandwidth**

DC to at least 500kHz

Phase error

3°C or less from DC to 100kHz

CALIBRATORAn approximate 1kHz frequency 0.5V ($\pm 1\%$) square wave

POWER SUPPLY

VOLTAGE (50/60Hz)	FUSE
100V (90–130V)	1A
200V (180–260V)	0.5A

Power supply frequency: 50, 60, 400Hz

Power consumption: Approx. 18W

EXT DC power supply: DC11V–14V Approx. 0.8A

ENVIRONMENT

Limit of operation temperature 0–+50°C

Limit of operation humidity 35–85%

Rated range of use temperature +10–+35°C

Rated range of use humidity 45–85%

Storage and transport temperature -20–+70°C

DIMENSIONS AND WEIGHT

Approx. 215(W) x 110(H) x 330(D) mm
(8.6(W) x 4.4(H) x 6.4(D) inch)

Approx. 4.5 kg (10 lbs)

Option

Accessory pouch

Hood

Shoulder belt

AD-209 type Battery PACK

Batteries 10 rechargeable
A nickel-cadmium cells

Nominal capacity 1800 mAh

Nominal voltage 12V

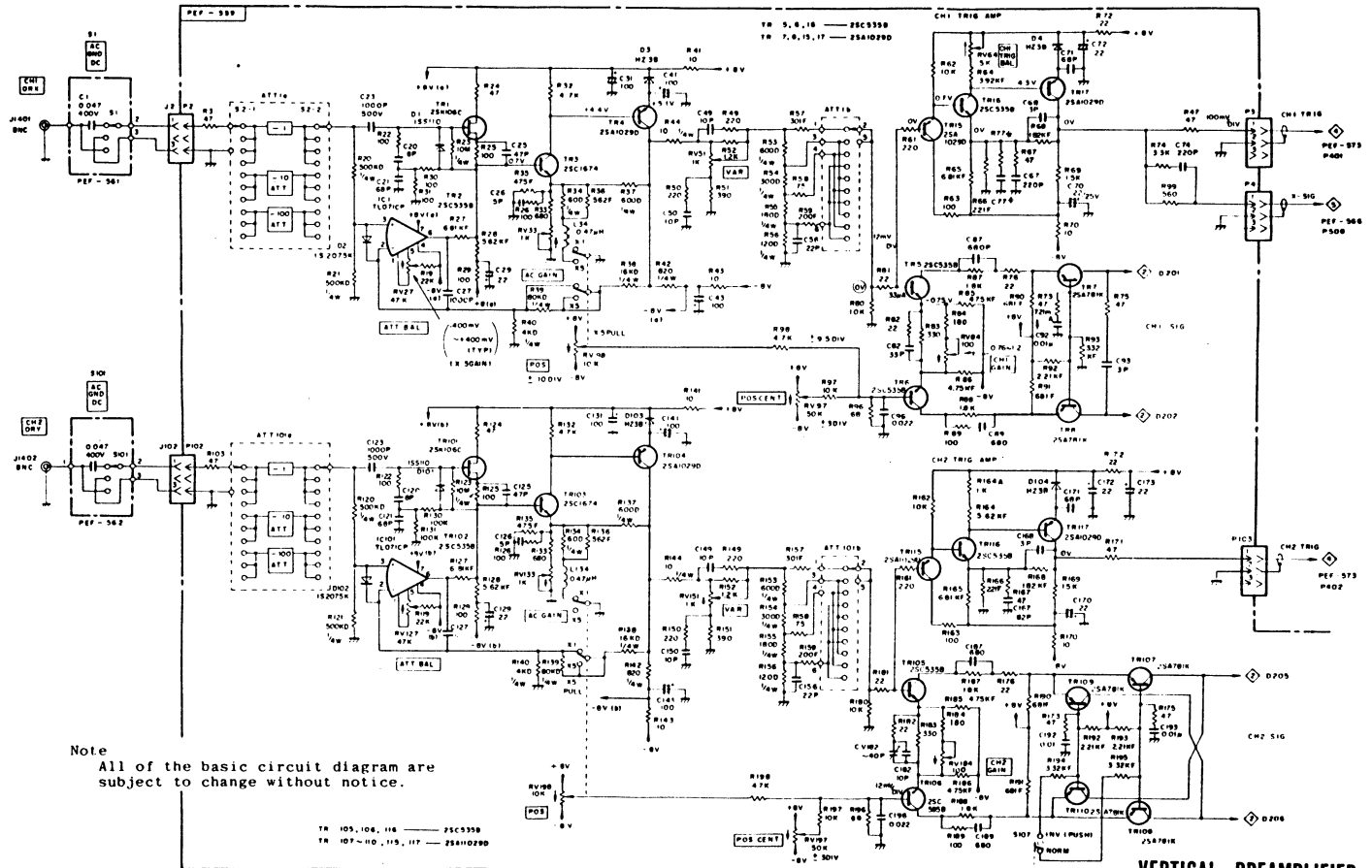
Battery excessive discharge protection

Instrument operation automatically interrupted when battery charge drops to approximately 10.5V.

Charge current Approx. 180 mA

Charge time 13–16 hours for full charge

3. SCHEMATIC DIAGRAMS



Note
 All of the basic circuit diagram are
 subject to change without notice.

TR 105, 106, 116 — 25C3358
 TR 107 - 110, 115, 117 — 25A10290

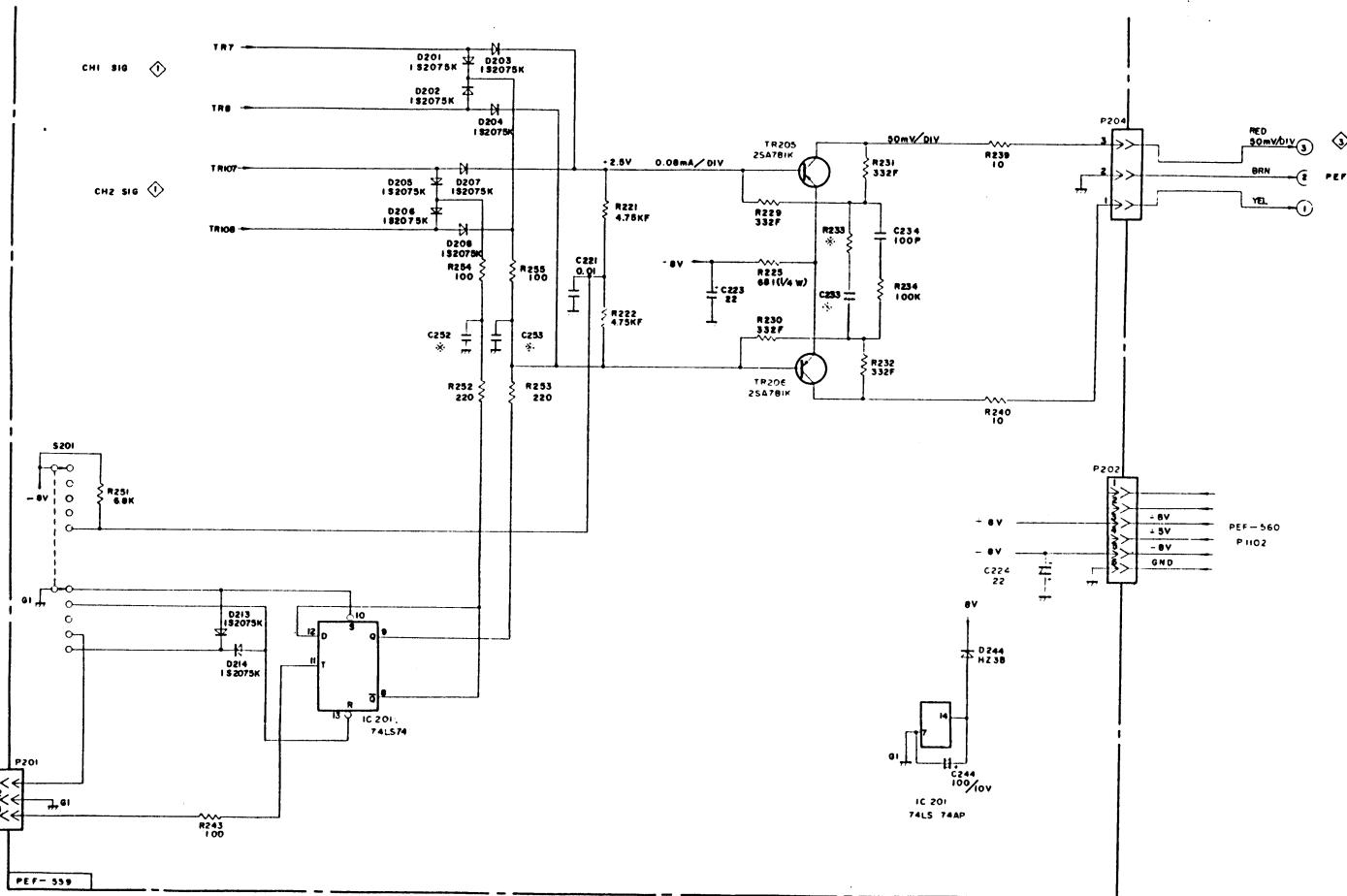
POS CENT
 RV99 10K
 -5V 20V

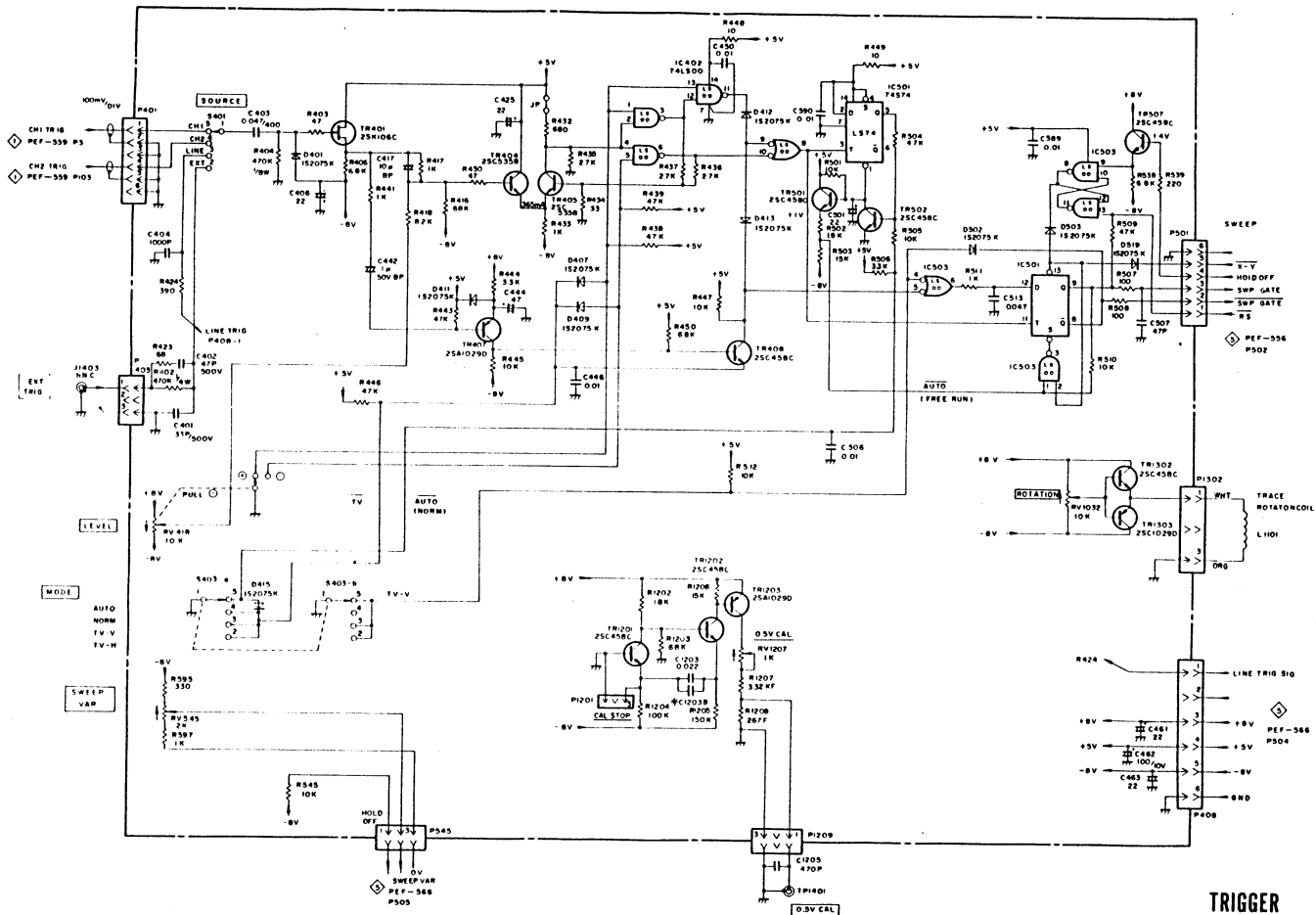
VERTICAL PREAMPLIFIER

[REVIEW]

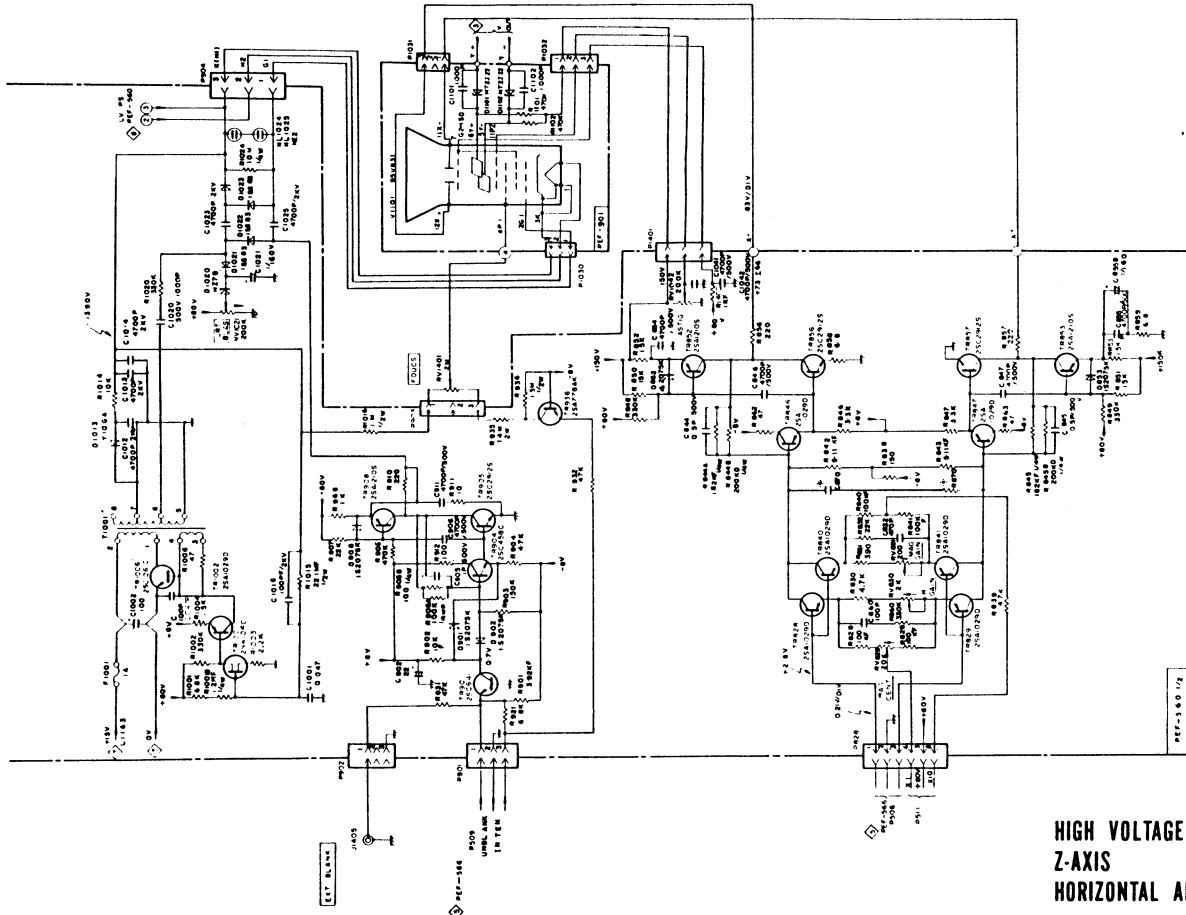
MODE
 CH 1
 CH 2 (X-Y)
 ALT
 CHOP
 ADD

◇

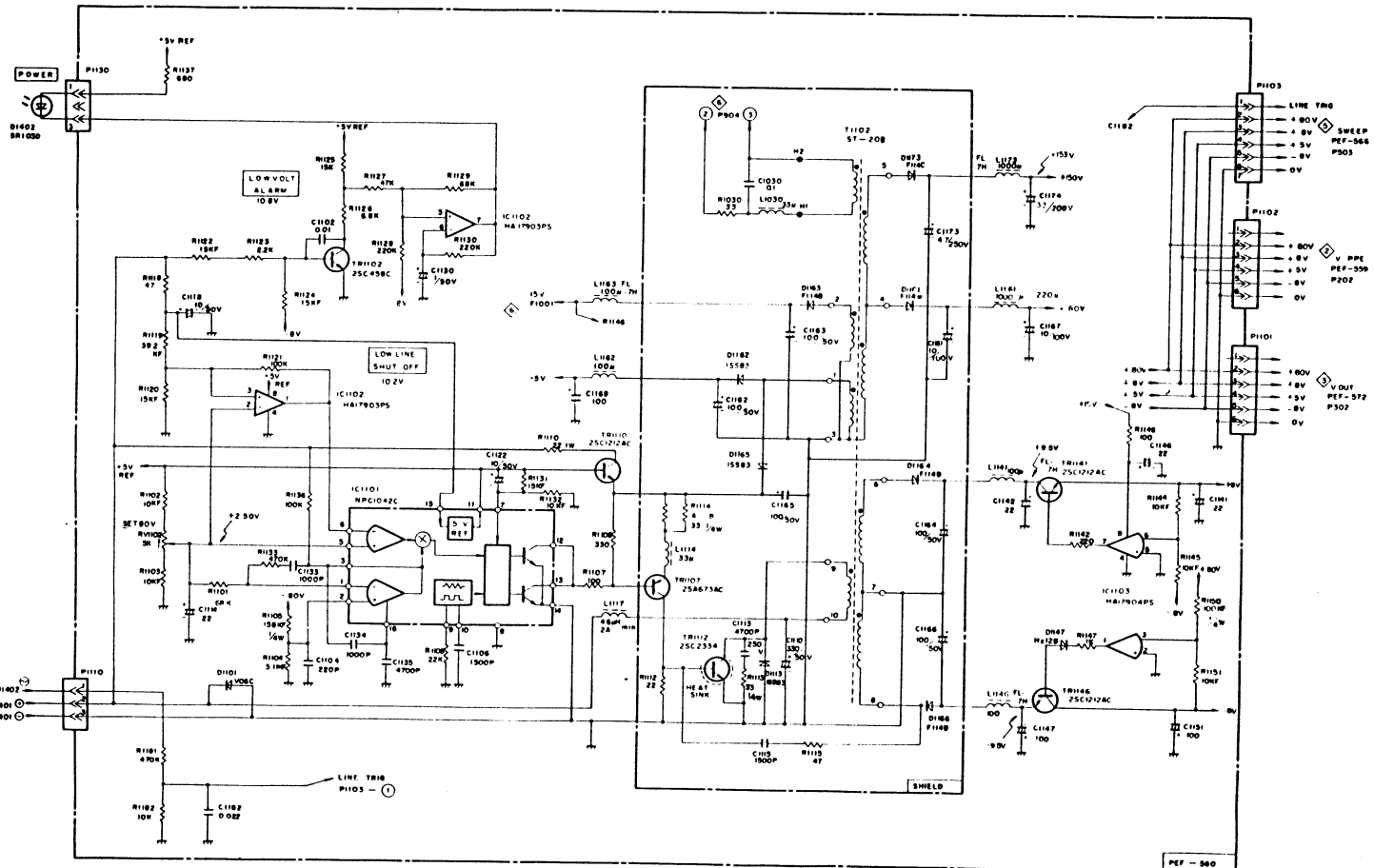




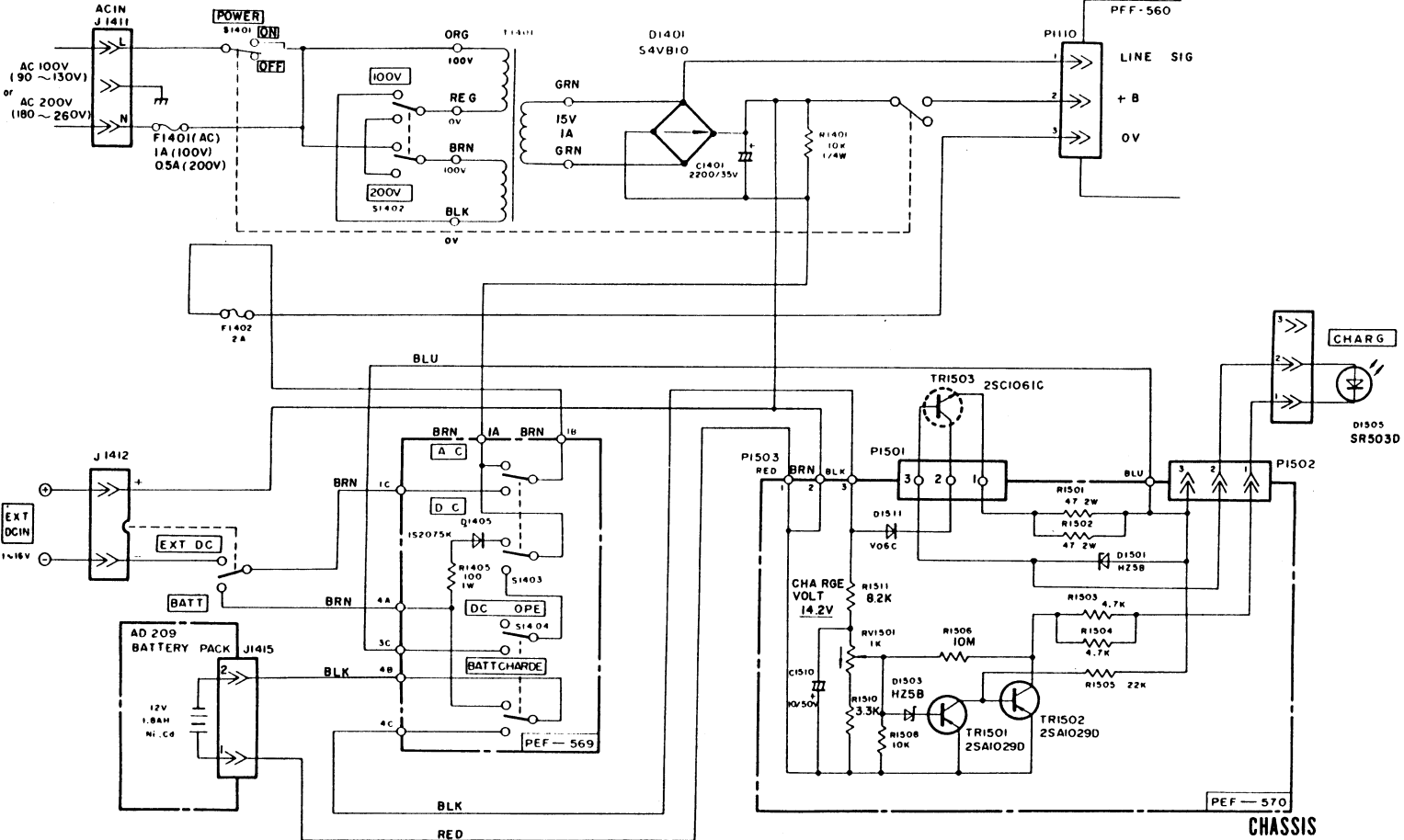
TRIGGER



**HIGH VOLTAGE
Z-AXIS
HORIZONTAL AMPLIFIER**



POWER SUPPLY



CHASSIS BATTERY CHARGER

14. OPTIONAL ACCESSORIES

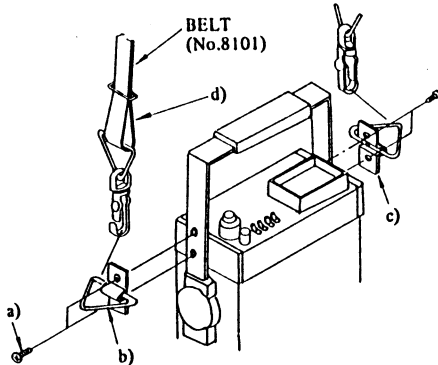
Shoulder belt

1. Check the following parts packed along with the shoulder belt (No. 8101) in the Polybag.

- a) Binding screw M3 x 6
(Code XCA6306) Four pieces
- b) Triangle clasp
(D#8301104) Two pieces
- c) Clasp (D#x8301102) Two pieces
- d) Belt (D#x876416) One piece

2. Mounting

To carry the model V-209 oscilloscope with the shoulder belt hung up, execute the hooking of the shoulder belt (No. 8101) as follows.



- 1) Mount the triangle band clasps on the positions shown in the figure, using the screws a).
- 2) Then, hang the clasp mounted across the shoulder belt (No. 8101) into the triangle clasps mounted as 1).

Accessory pouch

Mount the accessory pouch to the model V-209 oscilloscope.

- 1) Insert the edge ① of the accessory pouch into the body ①'.
- 2) Bend the accessory pouch and insert the section ② into ②'.

