

E5-2512

pantos®

INSTRUCTION MANUAL
for
UNICORDER
U - 2 2 8

Read this instruction manual thoroughly before use.

**PANTOS CO., LTD
Kyoto, JAPAN**

Thank you for purchasing this product.

Please read this manual carefully to ensure safe operation and a long service life.

Safety Precautions

To prevent malfunctions, personal injury, or potentially fatal accidents, be sure to observe all cautions indicated in this page, because they are important for Safety.

We cannot accept responsibility for any damage or accidents that may occur if the Safety Precautions are not heeded.

Safety Symbols

The following safety symbols are used in the manuals for this unit.

Symbol	Meaning	Explanation
	General caution	Indicates an unspecified, general caution, warning, or danger
	Electric shock	Indicates the potential for electric shock
	Fire	Indicates the potential for fire
	Explosion	Indicates the potential for explosion
	Pinch	Indicates the potential for finger injury from pinching

CAUTIONS	
	Danger of injury and property damage may be caused.
	Be sure to ground the unit. Grounding prevents electric shock and noise.
	Use only the specified fuse. Use of incorrect fuse may cause a fire or malfunction.
	Supply only the specified voltage. Supplying incorrect voltage may cause a fire or malfunction.
	Do not overload an electrical outlet. Overloaded circuits may cause a fire.
	Do not expose to chemicals, moisture, or gas. A leak or spark may cause a fire, electric shock, or malfunction.
	Do not allow metal or foreign objects to infiltrate. A fire or malfunction may result.
	Do not supply power when disassembled or broken. Electric shock or malfunction may result.
	Do not cover the unit while the power is on. Heat will accumulate, causing the unit to deform. Fire may result.
	Never carelessly put your hands in the pen moving area. Personal injury or mechanical breakdown may result.
	Never touch the metal of the input terminals. Electric shock may result.

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1. OUTLINE

PANTOS Model U-228 Desk-top Automatic zero balancing DC-servo Recorder is a device to continuously record waveform corresponding to input signal on chart paper which moves at a constant speed by pens which are automatically balanced by means of servo system; a method known as a self-balancing method or so called zero method. Based on years of our experience, U-228 recorder was developed giving emphasis on substantial specifications and improved performance and versatility in operation in addition to consideration on style as well as compactness and light weight. As a result, this recorder has many outstanding features, as described in the following:

2. OUTSTANDING FEATURES

- (1) In addition of being compact and light weight, it is designed as being easily carried by one hand from one place to other wherever necessary.
- (2) Having an extended writing panel, the state of recording can be easily observed.
- (3) Having no obstacles on the right side of the writing panel, entry of data into the chart paper is easy.
- (4) Employing a pulse motor for chart drive, a great variety of chart speed selections as many as 24 steps and 23 speeds are freely available. Incorporating a tuning fork oscillator, stable and highly accurate driving speed are assured.
In addition to externally starting and stopping, the chart paper can be driven in a speed proportional to the frequency of external signal source.
- (5) Equipped with a fast forward switch that makes the position correction of the chart paper easy.
- (6) Rewind switch allows the chart paper to be easily retracted to a desired position.
- (7) Because the chart take-up device is designed so as to be optionally built into the recorder without having to externally attaching it, only a minimum space is required for the operation (optional).
- (8) Equipped with a chart paper end alarm, the end of the chart paper is notified by a buzz and a flashing lamp.
- (9) Either rolled or folded chart paper can be used if a chart drum having a sprocket is specified.
- (10) Using cartridge type fiber tip pens, such trouble as sudden "out of ink" cannot happen during the recording. The maintenance is easy, too.
- (11) The polarity of signal input can be changed by a switch.
- (12) An additional filter can be mounted for improving NMRR without impairing the characteristics of the recorder (optional).
- (13) Calibration of full scale can be easily achieved by a built-in DC calibrator.

- (14) Having a superimposed event marker as a standard feature, entries of marks can be made on any part of the chart. This feature is also helpful in knowing the recorded time lag between the pens.
- (15) The reliability is further improved by virtue of employing a torque reduction device for film potentiometer and DC servo motor.

3. SPECIFICATIONS

Models	U-228(-500)	
Number of Channels	1 or 2 (Please specify.)	
Measuring System *1	Automatic Zero Balancing DC-servo	
Writing width	250mm	
Pen Speed *2	Less than 1/3sec	
Zero Point	Right Zero of the chart paper.	
Zero Set Range	+100% from right zero center.	
Zero Point Check Switch	Provided	
Measuring Range	1, 2, 5, 10, 20, 50, 100, 200, 500mV 1, 2, 5, 10, 20, 50, 100, 200V (17 ranges)	
Fine Adjust for Measuring Range (Range Vernier)	*3 Option	
Polarity Switch	Provided.	
Input Impedance	1MΩ (constant)	
Tolerable Signal Source Resistance	Less than 10kΩ	
Accuracy *4	±0.3%(23°C) Temperature Coefficient; 0.025%/°C MAX.	
Errors Between Ranges	2mV~50mV Range : ±0.15%(23°C). Temperature Coefficient ;0.005%/°C MAX. 0.1V~200V Range : ±0.2%(23°C). Temperature Coefficient ;0.0075%/°C MAX.	
Dead Band	0.1%	
Linearity	±0.25%	
Noise Rejection *5	CMRR	DC Over 160dB
		AC (50/60Hz) Over 160dB
	NMRR	AC (50/60Hz) 64dB TYP. (Pulse width; Over 50μ sec)

Models	U-228(-500)	
Temperature Characteristics *6	Zero drift upon introduction of power	Less than $\pm 5 \mu V$ (at constant room temperature)
	Zero drift upon stabilization	Less than $\pm 1.5 \mu V/10^\circ C$
Chart Speed *7	<p>(1) 1, 1.5, 2, 3, 4, 6, 10, 15, 20, 30, 40, 60cm/min, cm/h 24 steps and 23 speeds (1cm/min and 60cm/h are overlapping)</p> <p>*8 (2) Chart Drive by External Signal:</p> <ul style="list-style-type: none"> • Chart Speed: 1/60mm/Pulse (1mm/min at 1Hz, 600Hz max.) • Input Impedance: Over $4.7k\Omega$ • External Power: Voltage: High Level; $+2V \sim +20V$ Low Level; $+0.8V \sim -20V$ (operable at TTL level) Signal Waveforms: Pulse, sine wave, square wave, triangular wave, etc. (Pulse width; Over 50μ sec) 	
Chart Fast Forward Switch	Provided	
Chart End Alarm	<p>Following actions take place when chart paper comes to an end:</p> <ul style="list-style-type: none"> • Buzzer is sounded. • Chart drive is stopped. • Pen is stopped. • Lamp is flashed. 	
Chart Rewind Device	Provided	
Chart Paper	No.2516P50, 20m long, right zero	
Recording Pens	Cartridge Type Fiber Tip Pen	
Ink Colors	Channel 1: Red Channel 2: Green	
Pen Lift	Individually and manually operated (Distance between pens: 4mm)	
Torque Reduction Circuit	Provided *9	
Event Marker	Superimposing Amplitude: $+3.5 \pm 1$ graduation Time: $0.2 \sim 0.4$ sec	
Event Marker Switch *10	Provided	
Calibration Voltage	Voltage: Highest sensitivity range value (1V MAX.) Accuracy: $\pm 0.2\%$ ($23^\circ C$) Temperature Coefficient: $0.007\%/\text{ }^\circ C$	

Models	U-228(-500)	
Environment	Temperature: 0~45°C Humidity: 45~85%	
Power	Voltage Range	AC100V±10%
		Common for 50Hz and 60Hz.
	Number of Channels	Power Consumption (TYP) When Balanced Max.
	1	19VA 32VA
	2	21VA 47VA
Insulation Resistance	Power-Chassis (GND): Over 50MΩ (DC500V megger)	
	Input Terminal- : Over 100MΩ (DC500V megger) Chassis(GND)	
Dielectric Strength	Power-Chassis (GND): AC1000V for 1 minute	
	Input Terminal- : AC1000V for 1 minute Chassis(GND)	
External Dimensions	430(W) × 123(H) × 354(D)mm	
Weight	Number of Channels	Weight
	1	7 kg
	2	8 kg
Accessories	Chart Paper No.2516P50 1 Recording Pens Number of Channels × 1 Pulley Positioning Rod 1 Fuse 1A 1 Dust Cover 1 Instruction Manual 1 Power Cord Adaptor 1	

[Notes]

*1 A short recording pen is for channel 1 and a long recording pen is for channel 2.

*2 Time required for travelling 99% of input signal.

*3 Each of the measuring ranges can be expanded up to 2.5 times. (Option)

*4 •Value from measurement at maximum sensitivity range is shown.

•Includes linearity.

*5 Value from measurement at maximum sensitivity range is shown.

When noise rejection is a special concern, both CMRR (AC) and NMRR can be improved as much as approx.

30dB by using an additional input filter (optional).

*6 Value from measurement at maximum sensitivity range is shown.

•Warm-up time required for reaching at a stable condition is approx. 30 min.

*7 Chart drive may be remotely operated. In this case, an external control terminal "CHART DRIVE" is used.

*8 An external signal is applied to external control terminal "CHART OSC" upon setting chart speed unit selection switch on the panel to "EXT" position.

*9 It is a device to protect DC servo motor when voltage exceeding the measuring range is applied frequently or for a long time.

*10 External control is also possible. In such a case, an external control terminal "MARK" is used.

4. OPERATING PROCEDURE

4.1 Descriptions and Functions of Parts:

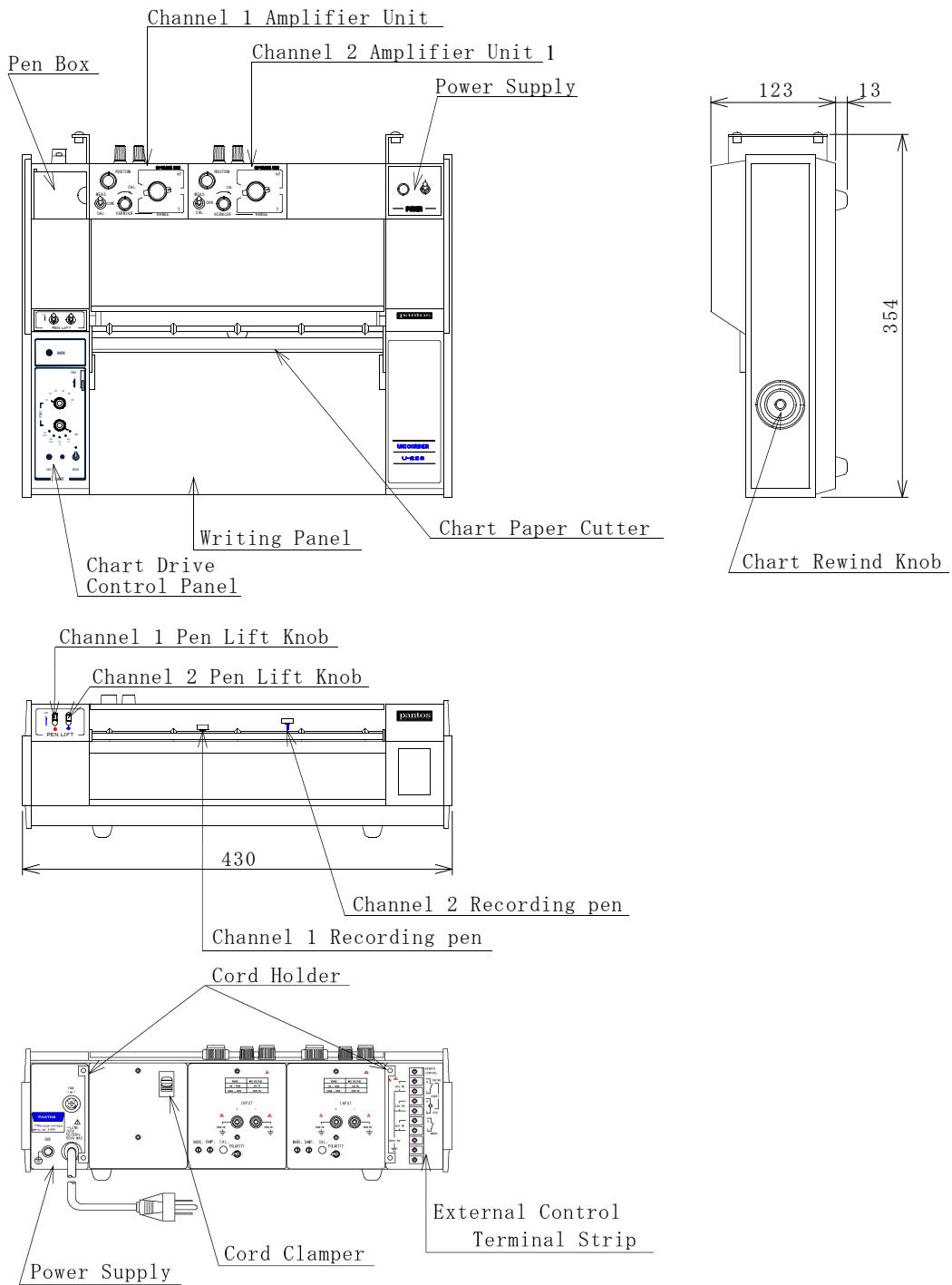


Fig. 4.1 Descriptions of Sections

4.1.1 Power Supply

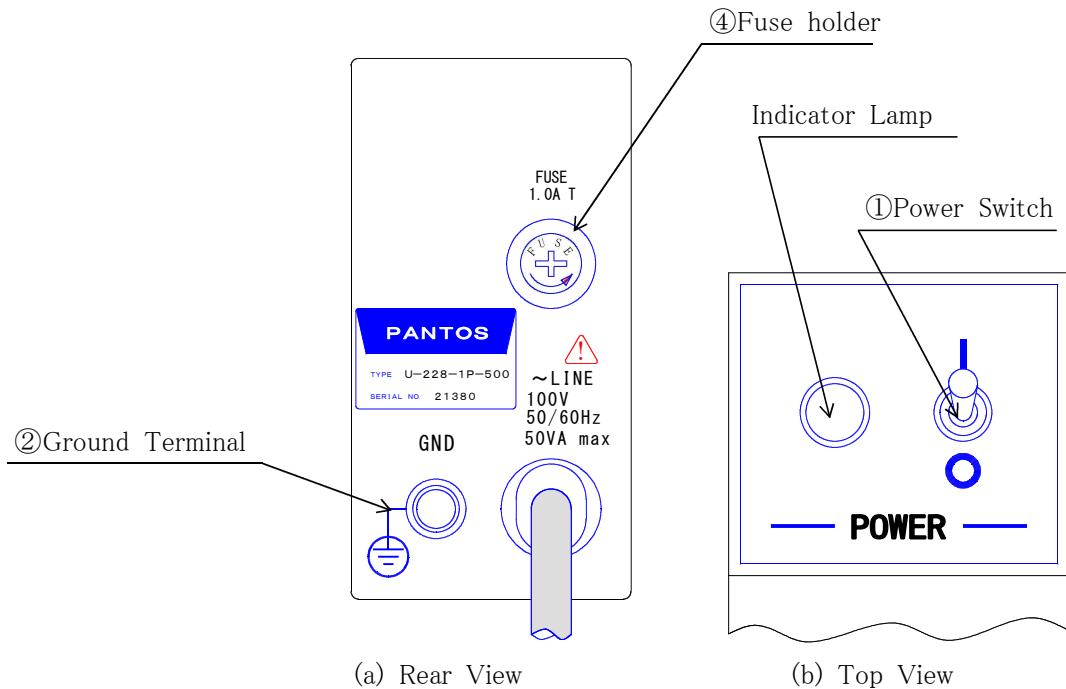


Fig. 4.2 Power Supply Panel

- ① Power Switch : This switch is for turning on and turning off all of the power required for operating the recorder. The indicator lamp is lighted by setting. This switch at "ON" position and the light goes off by setting this switch at "OFF" position.
- ② Ground Terminal "GND" : This terminal is for grounding the recorder to equalize the potentials of the recorder chassis and the ground. It not only assures a stable measurement but also protects an operator from an electric shock. Please be sure to ground the recorder.
- ③ Fuse holder : The fuse of AC power supply line is contained. Turn fuse cap toward the marked direction and remove it. Please be sure to use an appointed fuse.

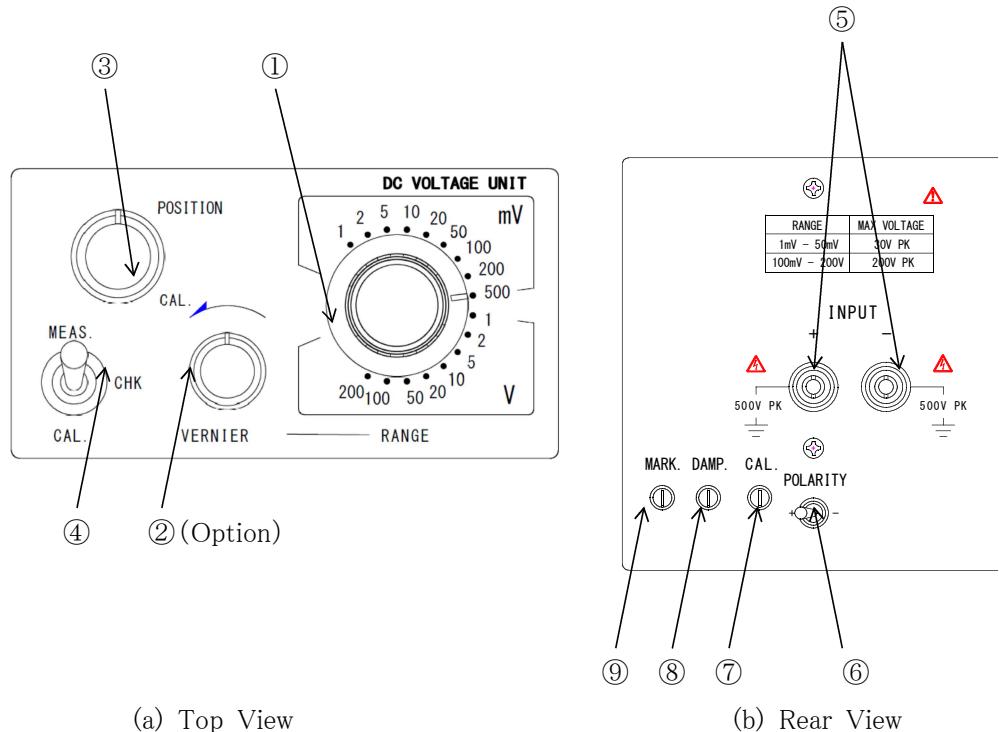
Attention

If it is used on different power supply voltage, there is a possibility of causing a fire.

Be sure to use it on the suited power supply voltage.

Be sure to pull out the power supply cable from the outlet when replacing a fuse.

4.1.2 Amplifier Unit:



(a) Top View

(b) Rear View

Fig. 4.4 Amplifier Unit

①	Measuring Range Selection Switch	⑥	Polarity Selection Switch
②	Measuring Range Fine Adjuster (Option)	⑦	Full Span Voltage Calibrator
③	Zero Control	⑧	Damper
④	Zero Point Check Switch	⑨	Marker Amplitude Adjuster
⑤	Input Terminals		

① Measuring Range : This is a voltage divider for input signal, and it is to be adjusted correspondingly to the level of input voltage (this switch is not provided with a single range version).

② Measuring Range : This switch expands each of the measuring range on the measuring range selection switch up to 2.5 times so that the input signal can be recorded in a necessary amplitude by adjusting between the ranges to desired measuring range.
Each of the measuring ranges represents the value when this control is fully turned to "CAL" position.

③ Zero Control : It is for setting the zero position of the recording pen.
"POSITION" The recording pen moves rightward by turning this switch clockwise and leftward by turning it counterclockwise.
The recording pen can be set at the zero position of the chart paper even when the input voltage of +100% of the measuring range is applied.

④ Zero Point Check: An ON-OFF switch for input signal. The zero position of the recording pen can be checked irrespective of the input signal when this switch is set at "CHK" position.
Switch The input signal can be measured when this switch is set at "MEAS." position. When this switch is set at "CAL." position, the calibration voltage of +1mV is applied so that the largeness of indication value by recording pen can be compared from the indication obtained when operating full span voltage calibrator "CAL."

⑤ Input Terminal : An input terminal for the signal which is desired to be recorded. The recording pen moves leftward when a positive voltage is applied upon the "+" side of the input terminal in relation to the "-" terminal.
"INPUT" Connect a high impedance in relation to ground at "+" terminal and a low impedance at "-" terminal.

⑥ Polarity : A switch for selecting the polarity of the recorder.
Selection Switch The recording pen moves leftward at + position and moves rightward at - position when positive voltage is applied upon "+" side of the input terminal.
"POLARITY +, -"

⑦ Full span Voltage: It is for comparing the largeness of indication value made by recording pens in relation to input signal.
Calibrator "CAL." This control is adjusted in a high precision by the manufacturer before shipment from factory, and therefore, do not touch this control in a normal operation.
(Refer to paragraph 6.3 for adjustment.)

⑧ Damper "DAMP.": It is for adjusting the damping of recording pen.
The damping effect becomes greater when it is turned clockwise and the damping effect diminishes when it is turned counterclockwise.
(Refer to paragraph 6.2 for adjustment.)

⑨ Marker Amplitude:
Adjuster "MARK." It is for adjusting the amplitude width of the marker superimposed on each of the recordings. The amplitude width becomes greater when this switch is turned clockwise.

4.1.3 Chart Drive Unit:

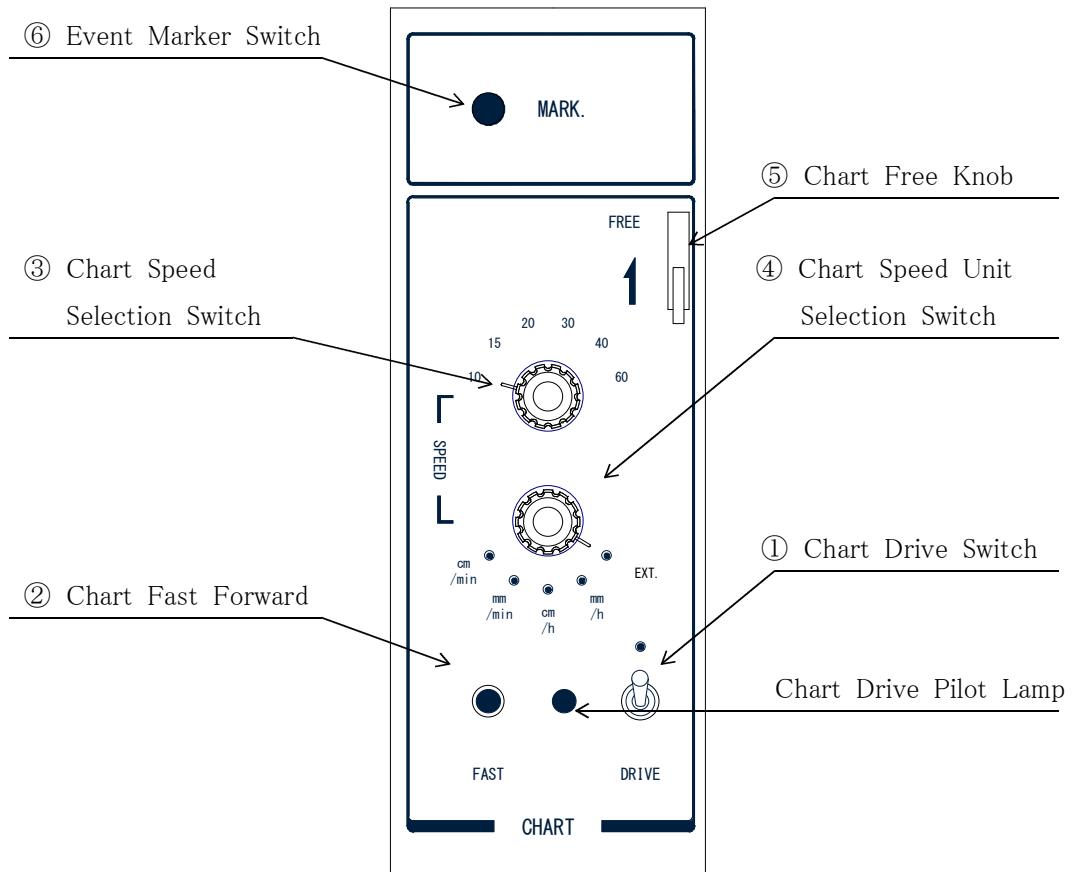


Fig.4.5 Chart Drive Unit

① Chart Drive Switch : It is for driving and stopping the chart paper. When this switch is set at "ON" position, the pilot lamp lights up and the chart paper is advanced. By setting this switch at "OFF" position, the light on the pilot lamp goes off and the chart paper stops.

② Chart Fast Forward Switch : By pressing this switch, the chart paper advanced in a speed of 60cm/min irrespective of "ON" or "OFF" position of the chart drive switch, the position selected by chart speed unit selection switch and chart speed selection switch.

③ Chart Speed Selection Switch : It is for setting the chart speed. The values indicated on the setting positions indicates the chart speed.

- ④ Chart Speed : It selects the unit of speed of the chart drive.
Unit Selection
Switch
- ⑤ Chart Free Knob : By setting this switch at "FREE" position, the chart paper "CHART FREE" may be advanced or rewound by hand.
- ⑥ Event Marker : By pressing this switch during the recording, the marking "MARK." superimposed on the recording can be entered by all of the pens.

4.1.4 External Control Terminal Strip:

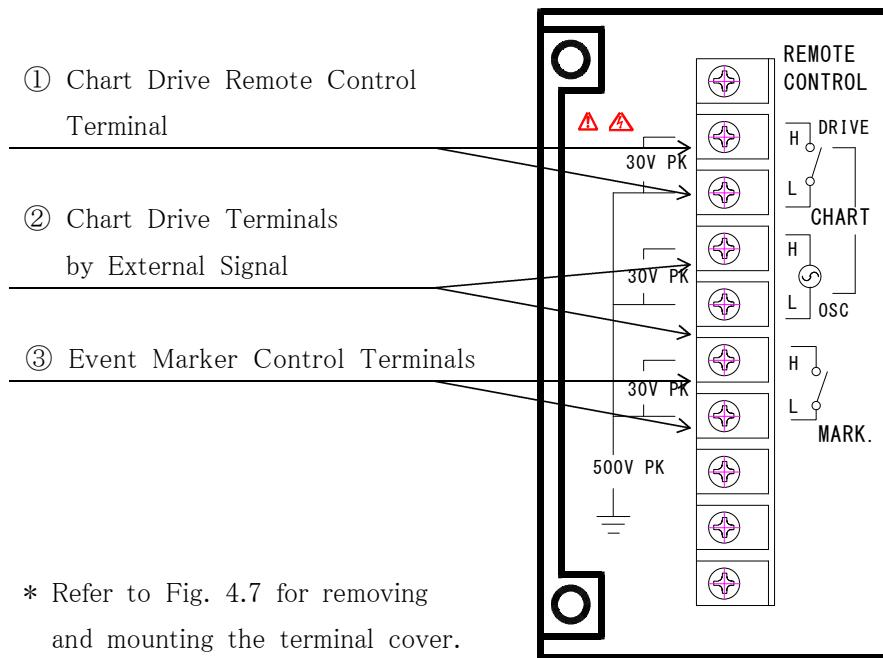


Fig. 4.6 External Control Terminal Strip

- ① Chart Drive Remote Control Terminals "CHART DRIVE": The recorder chart can be driven or stopped by closing or opening these terminals while setting chart drive switch "CHART DRIVE" at "OFF" position.
- ② Terminals for Chart Drive by External signal "CHART OSC": "CHART OSC" terminals are used upon setting chart speed unit selection switch "CHART DRIVE" at "EXT." position. By connecting external signal to "CHART OSC" terminals (refer to descriptions related to chart speed in "2. SPECIFICATION" for frequency and voltage ranges of the signal), the chart drive proportional to the frequency of the external signal source can be chosen.
- ③ Event Marker Control Terminals "MARK.": By closing these terminals, the marks can be entered on the recording by all of the pens.

*1. The switching can be controlled by a transistor, also.

In such case, the collector and emitter of the transistor (of an open collector output) are connected to "H" and "L" terminals, respectively.

The minimum capacity: DC10V, 1mA

"H" terminal is higher than "L" terminal in potential.

*2. Please be noted that all "L" terminals of each Control Terminal are connected in common.

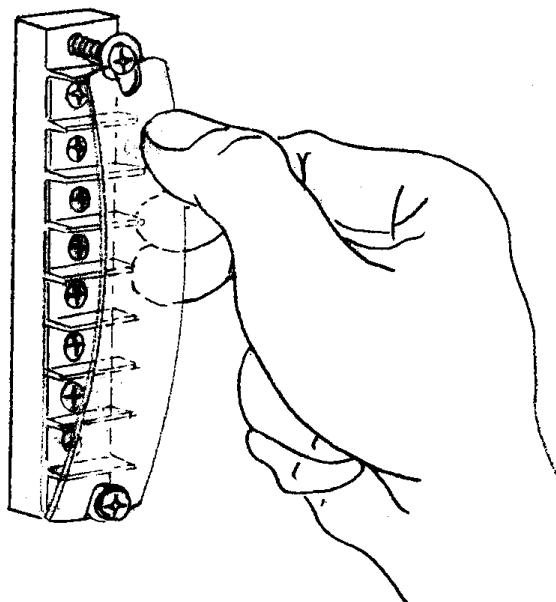


Fig. 4.7 Removing or mounting the external control terminal strip cover

4.1.5 Others:

- ① Pen Lift Knob : The recording pens can be raised or lowered by lifting or lowering this knob.
- ② Pen Box : This box is for storing unused pen or pen cap while using the pen.
- ③ Chart Paper Cutter : It is used when separating the chart paper. Press center of the cutter by a finger and tear the chart paper away by other hand lifting the paper from its edge.
- ④ Chart Rewind Knob : After setting the chart free control at a position pointed by an arrow mark, pull this knob outward and turn clockwise to rewind.

4.2 Preparation and Measurement:

Check preparation in the following order before operating the recorder:

(1) Set controls in the following positions:

- Power Switch "POWER" : "OFF" position
- Chart Drive Switch : "OFF" position
- "CHART DRIVE"
- Chart Speed Selection : At a desired speed.
- Switch "CHART SPEED"
- Chart Speed Unit Selection : At a desired unit of speed.
- Switch
- Pen Lift Knob : "UP" position
- "PEN LIFT"
- Zero Point Check Switch : "CHK" position
- "MEAS.-CHK-CAL."
- Measuring Range Selection : At a desired range
- Switch "RANGE" (not required in a single range.)
- Polarity Selection switch : Set at "+" side when measuring positive voltage and set at "-" side when measuring negative voltage.
- "POLARITY, +, -"

(2) Ground the recorder by "GND" terminal.

(3) Connect power cord to power source.

(4) Load recording chart (refer to 4.3).

(5) Mount the recording pen upon pen carriage (refer to 4.4).

(6) Connect input signal lines to input terminals "INPUT" on each of the input units.

(7) Set power switch "POWER" at "ON" position.

(8) Lower the recording pen by "PEN LIFT" knob.

(9) Adjust recording pens at zero positions by zero adjuster "POSITION" on the input unit.

(10) Advance the chart paper by setting chart drive switch "CHART DRIVE" at "ON" position.

(11) Set zero point check switch on each of the input unit at "MEAS" position.

This completes the preparation procedure. When a highly accurate measurement is desired, warm up the recorder for more than 30 minutes before commencing the measurement.

4.3 Loading the Chart Paper (refer to Fig. 4.8):

Load the chart paper in the following order:

- (1) Set chart free knob at a position indicated by an arrow mark.
- (2) Open writing panel.
- (3) Fit fixed axis chart paper holder into the right side of the chart core as viewed from the direction toward which the chart paper is fed and fit movable axis chart paper holder on the other end.
- (4) Fit chart paper holder from the left bearing so as the movable axis chart paper holder comes left side, and fit the fixed axis chart paper holder on the right bearing while turning the chart paper counterclockwise.
- (5) Turn rewind knob or chart paper to fit concave on the chart paper holder axis with the convex on the rewind axis.
- (6) Pass end of the recorder chart along the chart paper guide plate, set chart free knob at the position to the opposite direction indicated by an arrow mark and load the chart paper while rotating the drum by setting chart fast forward switch "FAST" at "ON" position.
- (7) When 5~10cm of the chart paper emerges above the drum, set chart fast forward switch "FAST" at "OFF" position and close writing panel.
- (8) Let the chart paper drawn from the top of the drum pass through between the writing panel and paper bail.
- (9) It checks that the sprocket of a chart paper sending drum fits into perforations of chart paper both ends.
- (10) Check that the chart paper is properly driven by using chart fast forward switch "FAST".

This completes the loading of the chart paper on the recorder.

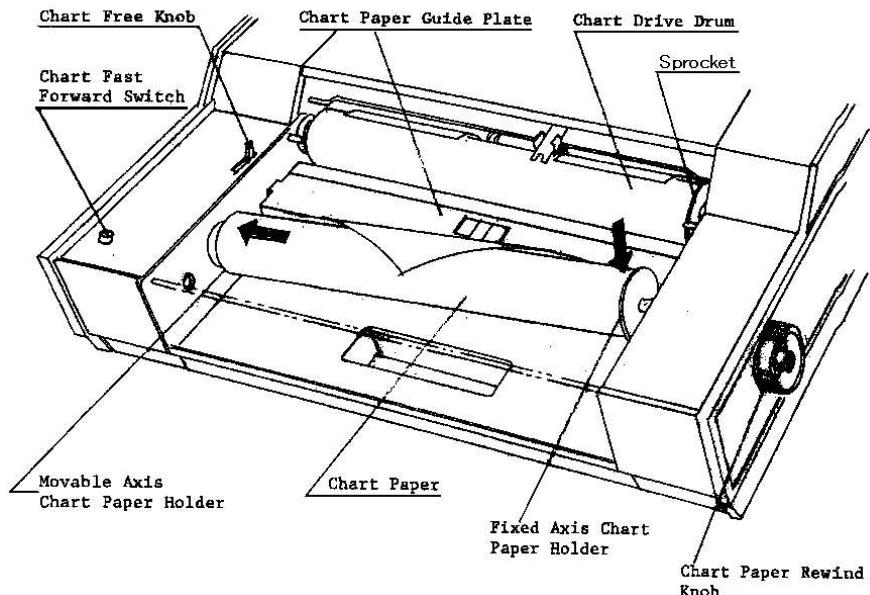


Fig. 4.8 Loading the Chart Paper

4.4 Mounting the Writing Pen (Refer to (a) and (b) parts in Fig. 4.9):

- (1) Open writing panel and move pen holders to the center.
- (2) Hold the pen holder and slide in the writing pen into the holder
(refer to (a) part in Fig. 4.9).

Check that the pen is firmly mounted (refer to (b) part in Fig. 4.9).

This completes the mounting of the recording pen.

When detaching the pen, revert the procedure followed when mounting the pen.

- Keep the pen cap in the pen box during the recording.
- Be sure to cover the writing pen by a pen cap when the pen is not used.

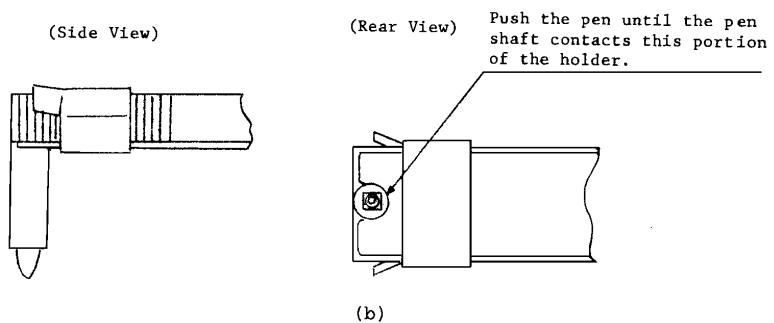
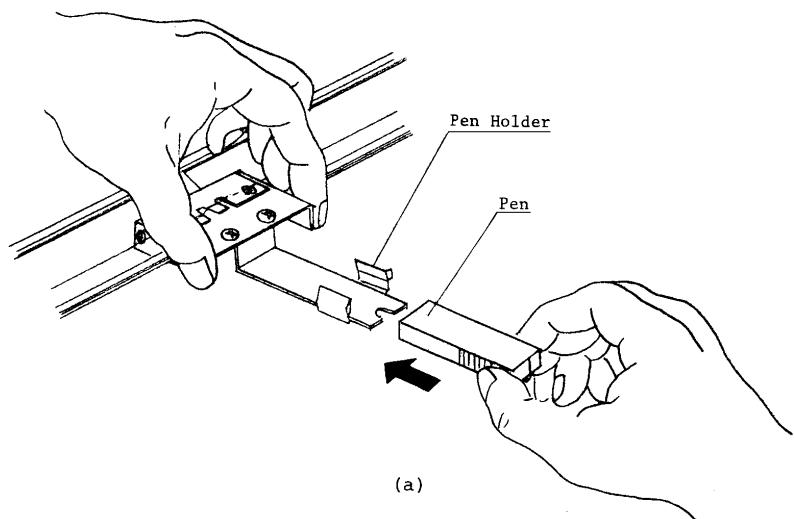


Fig. 4.9 Mounting the pen.

5. CAUTIONS ON USE

5.1 Writing Pen:

Because fiber tip is employed for the writing pen, the ink may dry up so that the pen may not write any longer if the pen is left unused for a long time. Be sure to cover the pen with the pen cover supplied with the instrument.

5.2 Ground Terminal:

Please do not fail to ground the recorder in order to ensure a stable measurement as well as safety.

5.3 Environment:

Operate the recorder in an environment where the temperature is in a range of 0~45°C and the humidity is in a range of 45~85%. Choose a spot where vibration and dust are minimum.

5.4 Chart Drive:

Because a pulse motor is employed for driving the chart, a step-like action may be observed when the chart paper is driven at a low speed. Do not be concerned about this step-like drive, for the said step-like drive is in a pitch which presents no problem at all to the record.

5.5 Maximum Input Voltage:

Although a protection circuit using zener diodes is provided in the input circuit of this recorder, the circuit is caused to be damaged if any input exceeding the input voltage tolerated as shown in Table 5.1 is introduced into the recorder, and therefore, please be sure to operate within the ranges specified.

	Measuring Range	Range of Input Voltage Tolerated
Versions with	1mV~50mV	Within 30V
Multiple Ranges	100mV~200V	Within 200V

Table 5.1 Input Voltage Tolerated

5.6 Common Mode Voltage:

Nominal dielectric strength between input terminal "INPUT" and chassis (GND) is AC1000V 1 min.

The common mode voltage which can be continuously applied is less than AC500V rms (50Hz/60Hz), DC500V.

Considering the common mode rejection ratio (CMRR) of this recorder, the voltage which can be applied within the range where the effect on the record is less than 0.1% is less than 30V AC rms (50Hz/60Hz), 100V DC in the range of maximum sensitivity of 1mV/full span.

5.7 Connection of Input Signal Line:

Connect input signal lines using shielded wires, as shown in Fig. 5.1. In a state of operation where the signal lines become long and the noise presents a problem, the recommended method of connection is to use double shielded wires for the input signal line and ground one end of the outer shields as shown in Fig. 5.2.

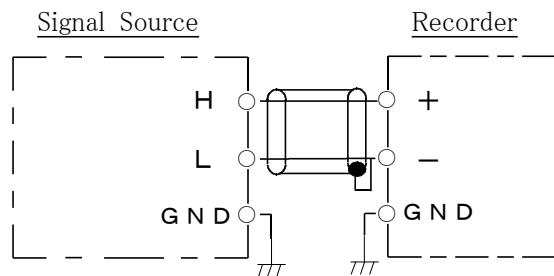


Fig. 5.1 Connection of Signal Lines (an ordinary method of signal line connection)

Note: The low impedance side, in relation to the ground, of the signal source output terminals "H" and "L" is indicated "L" and the high impedance side is as "H".

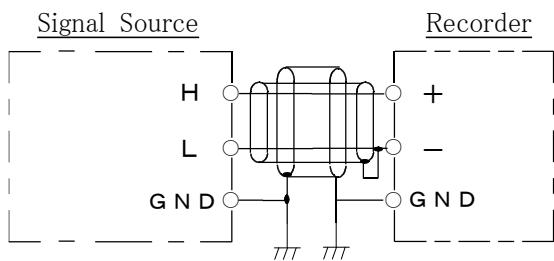


Fig. 5.2 Connection of Signal Lines (a method of signal line connection when noise presents a problem)

Note: The low impedance side, in relation to the ground, of the signal source output terminals "H" and "L" is indicated "L" and the high impedance side is as "H".

5.8 Influence of Signal Source Resistance:

If the internal resistance of the signal source which is to be measured is too great, an error may be created between the signal voltage and measured value or movement of the pen may be over damped by the influence of the filter circuit of the recorder, and therefore, operate the recorder under a low signal source resistance within the specification wherever practicable.

The range in which the damping state is affected, however, when the signal source resistance is great, is only $1\text{mV} \sim 50\text{mV}$ range.

Because an error is created in the recorded value when the signal source resistance is great, correct the reading by the following equation:

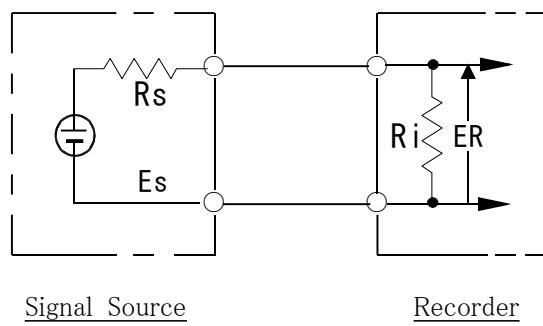


Fig. 5.3 Influence of Signal Source Resistance

$$E_s = \left(\frac{R_s}{R_i} + 1 \right) \times E_R$$

Where, E_s : signal voltage

R_s : signal source internal resistance

R_i : recorder input resistance

E_R : recorded voltage

6. MAINTENANCE

6.1 Adjusting Damper "DAMP.":

The best response and a recording most faithful to the input signal are obtained when the damper is adjusted at a most suitable damping state as shown in Fig.6.3. The damper is normally not required to be adjusted. When inspecting and adjusting the damping state, have the recorder record square wave input signal and adjust the damper "DAMP." at a suitable damping state shown in Fig. 6.3.

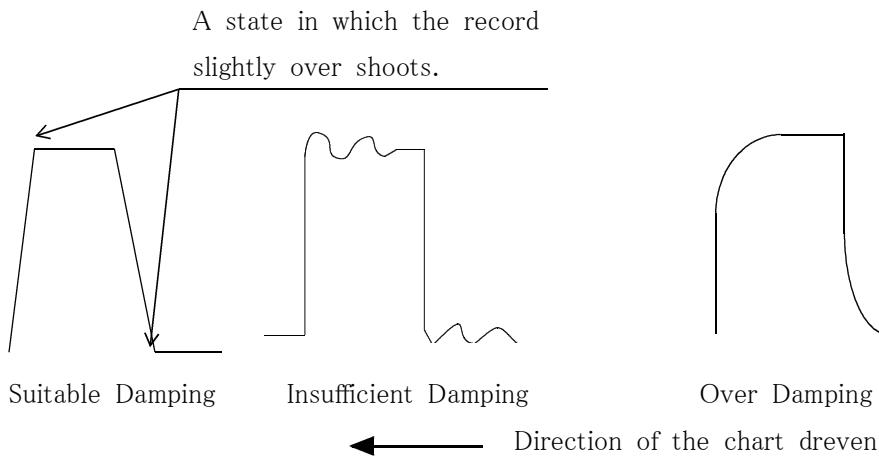


Fig. 6.3 Damping state when recording square wave input signal.

6.2 Calibrating Full Span Voltage "CAL.":

The full span voltage is adjusted by the manufacturer before shipment from the factory so that it is normally not required to be adjusted.

The adjustment shall become necessary, however, when any of the following parts is replaced:

- (1) Potentiometer or servo unit.
- (2) Amplifier or any part of the reference power circuit in the amplifier.

6.2.1 Calibrating Procedure:

This recorder has a built-in calibrating power supply.

Calibrate the full span voltage in the following steps:

- (1) Set "RANGE" switch at its maximum sensitivity range.
- (2) Set Zero check switch MES. - CHK - CAL. switch at "CHK" and adjust the recording pen at the position of 0% on the chart paper by zero adjuster POSITION.
- (3) Because the recording pen deflects to the direction of 100% of the chart paper which is caused by the built-in calibration power supply when the zero check switch MEAS - CHK - CAL is set at "CHK" position, calibrate the recording pen at 100% position by the full span voltage calibrator CAL. Because the chart paper is subject to expansion or contraction by humidity, each recorder is

calibrated at 250 mm oscillation by using a steel scale before shipment from the manufacturer's factory.

6.3 Adjusting the marker oscillation adjuster "MARK":

The marker oscillation adjuster is for adjusting the marker which is superimposed on the recording, and it can be adjusted in a range of approx.

0 ~ +7% of the full scale.

Because the marker oscillation is factory adjusted at $+3.5 \pm 1\%$ /full scale, it is not required to be adjusted in a normal circumstances. If the marking oscillation is not suitable for the waveform of the recording, make an appropriate adjustment.

6.4 Oiling:

In order to invariably keep the recorder in a good operating condition, a periodical oiling is essential. Oil the recorder one every 2 ~ 3 months. Drop one or two drips of refined machine oil.* Oil generally over all moving sections. Be sure to wipe away any dust or foreign matter on the oiling point.

* Refined machine oil: No.1 or No.2 spindle oil.

The oiling points are as follows:

(1) On the rails of the recording pen.

Wipe away the dirt and thinly apply the oil.

(2) On the bearing section of the chart paper bail.

(3) Rotary shaft on the chart drive mechanism.

(4) Generally over other moving parts.

In no event oil on any electric part.

Other than oiling, moving parts with as pen guide rail, etc. are required to be cleaned periodically.

Any part of the descriptions of this manual is subject to change for improvement without notice.