IM-A-395 '95.5

Signal Conditioners

CDV/CDA-700A Series

Instruction Manual

KYOWA

CONTENTS

Thank you for your purchase of this Kyowa CDV/CDA-700A Series Signal Conditioner. Read this instruction manual carefully, in order to make full use of the high performance capabilities of this instrument. Do not operate the instrument in a manner other than instructed in this manual.

Features

The CDV/CDA-700A series signal conditioner comes with a built-in DC bridge power unit, and thereby features higher response, higher input impedance, and better non-linearity than a carrier type strain measuring instrument. In addition to these general features common to DC type strain amplifiers, the CDV/CDA-700A provides the following features unique to it.

- **Small size**
  Smaller by 12% in cubic volume than the forerunner.
- **Digital panel meter and bar-graph meter provided as standard**
  Monitoring of dynamic strain signals is possible, nothing to say of static strain signals.
- **Measuring conditions are memorized.**
  Measuring conditions which were lastly set are memorized in an nonvolatile memory when the power is switched off.
- **Dual output**
  Two output systems, independent of each other, are provided.
- **DC amplifier functions provided**
  Capable of 10,000 amplifications as a DC amplifier.

Carefully observe the instructions given in the manual. For unclear matters, if any, contact your KYOWA representative or KYOWA.

Standard accessories

The instrument is composed of the following components. After unpacking, please check to be sure that all the of the listed components are included.

Signal conditioner	1
AC power cable (P-16)	1
Conversion plug CM-32	1
Output cables (U-05, U-58)	2
Short-circuit plate	1
Fuse, midget type (3A)	1
Small screwdriver	1
Inspection (calibration) sheet	1
Warranty card	1
Instruction manual	1

Handling precautions

Take cares as follows when handling the CDV/CDA-700A signal conditioner.

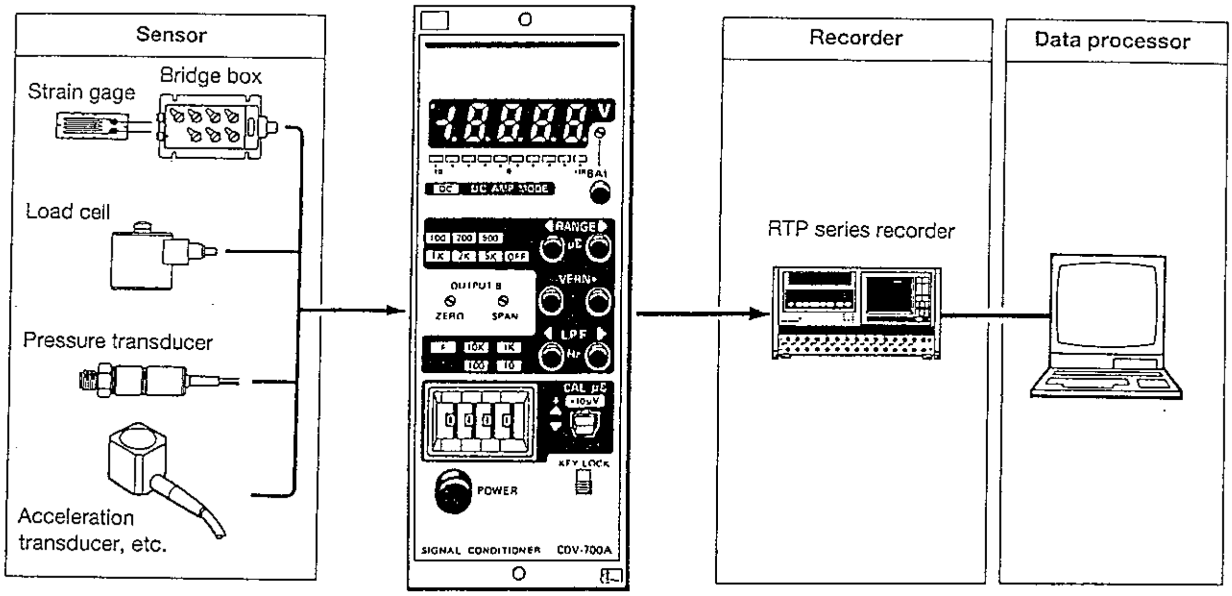
- <u>Make it a point to perform balancing whenever you have changed a bridge voltage.</u>
  If a bridge voltage switch is used, it may cause a zero point to change.
- <u>Do not switch power off immediately after you have entered or renewed parameters but do it in about three seconds.</u>
  Parameters are saved in an nonvolatile memory, but correct saving may fail by switching power off immediately after they were entered.
- <u>Take care that the fine balancing control is in a proper position.</u>
  If the fine balancing control is not in a proper position, there may be a residual voltage despite of balancing having been achieved. A regular position of the fine balancing control is such a position with which the monitor reads 0 when the range is set to [OFF].
- **Avoid extremely high or low temperature environments.**
  The signal conditioner will perform to the specifications when used within a temperature range of −10 to +50°C. Prepare a sunscreen or shield the unit from the direct rays of the sun. When using it extremely cold, take proper measures to maintain the unit's temperature within the specified range.
- **Avoid use in high humidity environments.**
  Operate the signal conditioner in a humidity range below 80% relative. Exposure to rain, or use in very humid conditions, may cause deterioration of internal insulation, or cause other problems within the instrument.
- **Do not use in a dusty environment.**
  Dust entering the instrument will lower the unit's performance. Take care to avoid dust during operation and storage.
- **Avoid strong vibrations.**
  The signal conditioner's vibration resistance conforms to MIL-STD-810C and can withstand the following.
  In all three X, Y and Z directions –
  2G (19.6m/S^2) at 10 to 500Hz frequency and
  3G (29.4m/S^2) at 5 to 55Hz frequency;
  both in 12 cycles, lasting 15 minutes each cycle.
  Greater vibrations may cause a failure of the instrument, or deteriorates its performance.
  Be sure to shock-mount the unit with sufficient vibration absorbing materials.
- **Special precautions for D.C. operation**
  Damage may be caused by contact of the input or output cable with the battery terminal, or by using the unit on a power line to which another instrument of the positive ground is connected.
  Before operating the instrument, see [2-2. Connection of power] thoroughly.
- **For 1-gage method measurement, etc. using strain gages connected to a bridge box, be sure to use a shortest possible cable and use a shielded cable for connection.**
  Or else, extra large noise may be generated.

Before you read the later pages of the manual

- This manual gives instructions in two separate parts: one part refers to basic operations, and the other to advanced operations.
- To express strain, "10^{-6} strain", "μm/m" or "με" is used. This instruction manual uses "με" on the panel, and "10^{-6} strain" to express strain in general.
- Terms used in this manual, relating to strain, conform with NDIS4001-87 [Terms Expressing Strain Measuring Instruments], Japan Non-destructive Inspection Association.
- Terms with a suffix of "*" are explained in "Glossary of Terms" in the end of this manual.
- Traditional units given in this manual are followed by SI conversions in parentheses.

System Configuration

A sample system configuration is shown below for measurement of dynamic strains using the CDV/CDA-700A series signal conditioner.



A sample system configuration for dynamic strain measurement

As above illustrated, the CDV/CDA-700A series signal conditioner is to connect with a strain-gage transducer or a strain gage.

To connect with a strain gage, normally a bridge box is used between a strain gage and the signal conditioner. A micro electric signal, corresponding to a physical quantity, sensed by a strain gage is amplified and put out by the signal conditioner. This output is available in several volts to permit direct connection with a recorder or a voltmeter.

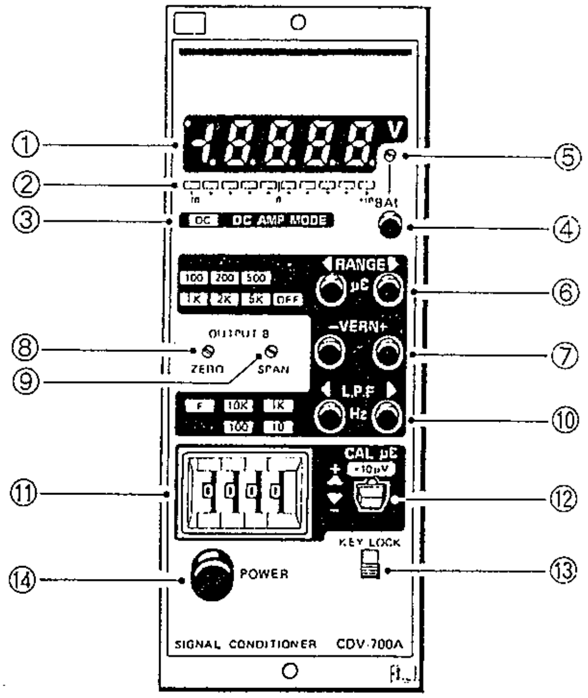
To measure a strain quantity converted in an electric signal, a calibration signal is used. The calibration signal of the CDV/CDA-700A series signal conditioner is verified using a standard calibrator which KYOWA maintains.

See an appendix in the end of this manual for how to use a strain gage or how to calculate stress from strain.

1. Controls and functions

Controls and their functions on the front and rear panels are the following.

1-1 Front panel



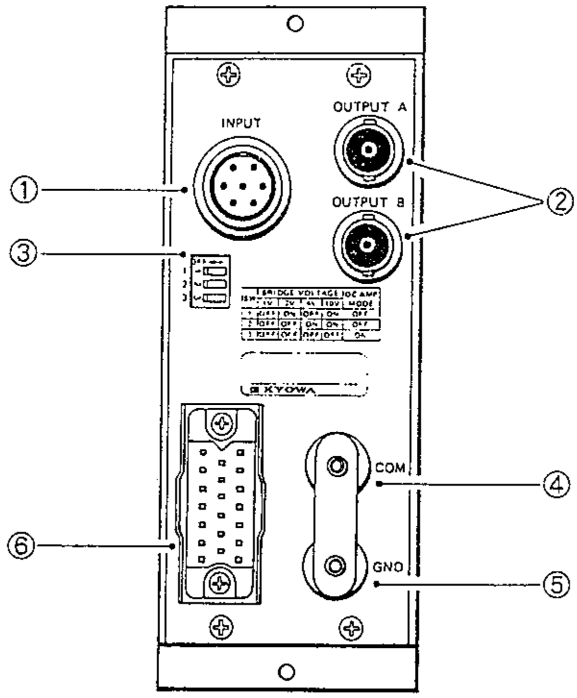
① Panel meter	Presents a digital reading of output available at OUTPUT A in voltage.
② Bar-graph meter	Displays an output voltage available at OUTPUT A in bar length. Each LED segment corresponds to about 2V.
③ DC amplifier indicator	Lights up by setting dip SW3, provided on the rear panel, to [ON]. In this situation, a calibration value itself is a voltage value. See [4-13 Bridge voltage].
④ Balancing key	Push this key two times within 0.5 seconds to execute balancing. See [4-4 Balancing]
⑤ Fine balancing control	Lets you perform fine balancing after execution of balancing. See [4-4 Balancing].
⑥ Range selecting keys	Push these keys to set a range. See [3-5-1 Range setting] and [4-6 Range]. ◀ key lets you select a lower range, and ▶ key, a higher range. The LED on a selected range lights up.
⑦ Vernier control keys [+], [–]	Push these keys to adjust output voltages which are available at OUTPUT A and B. See [3-5-4 Setting Vernier] and [4-7 Vernier]. [+] key selects a larger value, and [–] key, a smaller value.
⑧ Zero control on OUTPUT B	Turn this control to move a zero point on OUTPUT B. See [4-5 Moving a zero point].
⑨ Span control on OUTPUT B	Turn this control to adjust a voltage on OUTPUT B. See [4-2 Output].
⑩ Low-pass filter selecting keys	Push these keys to select a cutoff frequency of the low-pass filter. ▶ key selects a smaller frequency value, and ◀ key, a larger frequency value. The LED on a selected frequency lights up. See [4-8 Low-pass filter].
⑪ Calibration value setter	Lets you set a calibration value using a 4-digit integer. See [3-5-2 Setting a calibration value] and [4-9-4 Calibration value].

⑫ Calibration execution key .... Sets a calibration value using a 4-digit integer.
See [3-5-2 Setting a calibraiton value] and [4-9 Calibratin value].

⑬ Key-lock key .... Prohibits key operations when pushed upwards.
See [4-10 Key-lock].

⑭ Power switch.. Turns power on when pushed. Another push turns power off.
See [3-3 Turning power on and off].

1-2 Rear panel



① Input connector .... Connects with a strain-gage transducer or a bridge box.
See [3-1 Connecting input signals] and [4-1 Input].

② Output connectors, OUTPUT A and B .... At these connectors, output signals are available. Connects with a recorder or a voltmeter.
See [3-2 Connecting output signals] and [4-2 Output].

③ Bridge voltage setting switch .... Lets you select a bridge voltage using a combination of SW1 to 3.
See [4-13 Bridge voltage] and [4-6-3 Using as a DC amplifier].

④ Common terminal .... Connected internally to common electrical potentials in the circuitry.
See [4-11 Use of the converging connector].

⑤ Ground terminal... Used to ground the instrument.
See [2-3 Grounding].

⑥ Converging connector .... Used to connect with power normally. When housed in a housing case, this connector can handle some control signals and others.

2. Preparation for measurement

The following preparation is necessary before switching power on.
The following relate to measurement using a single unit of the CDV/CDA-700A series signal conditioner. If you are to operate a multichannel system comprising two or more units housed in a dedicated cabinet, read [5-5 Housing cabinet] too.

2-1 Setting up input/output instruments

When strain is to be measured with the CDV/CDA series signal conditioner, connect an input instrument, an output instrument, and power. An output instrument may be omitted.

(1) Input instrument
Prepare a strain-gage transducer or a strian gage formed in Wheatstone Bridge.
If a strain gage is to be connected to the signal conditioner, also prepare a bridge box, an option.
As regard to a bridge box, read [5-1 Bridge box].
For how to connect an input instrument, read [3-1 Connection of input].

(2) Output instrument
Prepare a recorder or a voltmeter. Either of them is necessary to read amplified signals. The CDV/CDA-700A series signal conditioner is provided with a digital panel meter, and so it eliminates the need for a regular voltmeter.
Using an output cable attached to an output instrument, connect it to the signal conditioner.
Detailed descriptions of connection with an output instrument are given in [3-2 Connection of output], [4-2 Output] and [4-14 Output instrument].

2-2 Connection of power

The CDV/CDA-700A series signal conditioner needs to be powered by either AC or DC power.
In either case, make sure of a correct power voltage before connection of power.

(1) AC power supply
Connect the signal conditioner to an AC power outlet, whose voltage you have specified in your order. (Fig. 2-1)

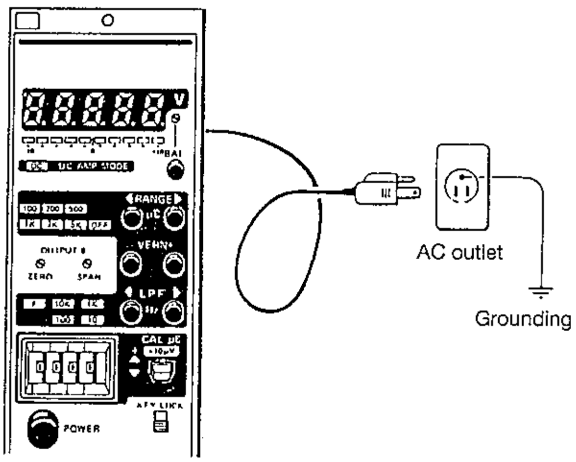


Fig. 2-1 Connecting to AC power

Caution

Perform neutral grounding on a 3-prong power system without fail.

(2) DC power supply

The signal conditioner is operable on DC power or on a battery — in a voltage range of 10.5 to 15Vdc.

A DC power cable is not attached to the signal conditioner. When it is operated on DC power, purchase connector plugs (S-1620C, a product of Hirose Electric), and perform connection in the manner shown in Fig. 2-2.

For how to connect with DC power, read [4-11 Use of the converging connector].

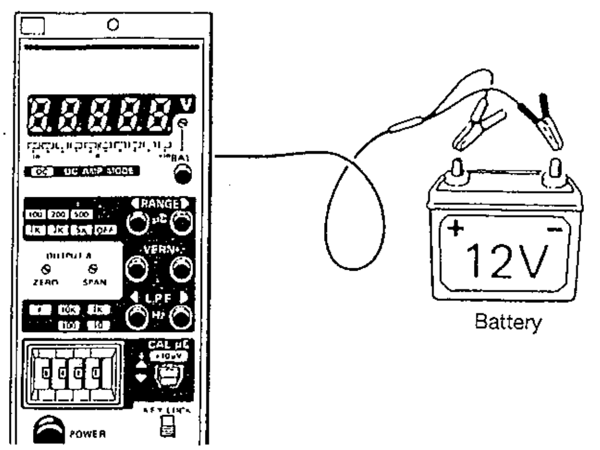


Fig. 2-2 Connection of DC power

2-3 Grounding

Make sure to perform correct grounding, in order to maintain safety.

The accessory AC power cable (3P) automatically performs grounding if used to connect with AC power.

- L = power wire
- N = grounding wire
- E = Ground

3. Basic operations

This chapter offers guidance on basic operations of the CDV/CDA-700A series signal conditioner. If you are to use a KYOWA signal conditioner for the first time, try to operate it as instructed below.

For caution's sake, the following relates to measurement using a single unit of the signal conditioner. If you are to operate a multichannel system housed in a housing cabinet, also see [5-5 Housing case].

3-1 Connecting input signals

Connect a strain-gage transducer or a strain gage to the input connector on the CDV/CDA-700A series signal conditioner.

A strain gage must be formed in Wheatstone Bridge in advance.

For how to wire a bridge circuit to a bridge box, see Table 5-1.

If a strain-gage transducer has a 7-pin plug made by Tajimi Musen on the end, insert it directly in the input connector of the CDV/CDA-700A series signal conditioner. See Fig. 3-1.

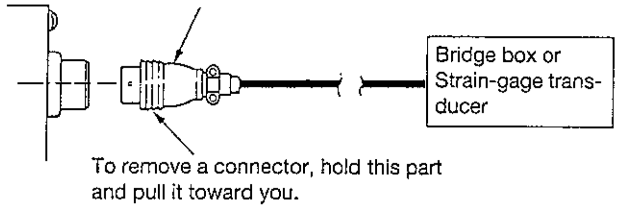


Fig. 3-1 Connection of input

If a strain-gage transducer has no plug on the end, or a strain gage is to be connected directly, two connecting methods are possible.

One is to connect via a bridge box. For this, read [5-1 Bridge box].

The other method is to connect a bridge to a plug in advance, and connect a plug to the input terminal. How to is shown in Fig. 3-2-1. A plug used here is PRC03-12A10-7M10, a product of Tajimi Musen.

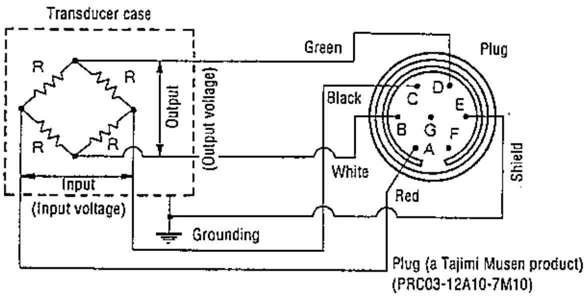


Fig. 3-2-1 Connection of a bridge to a plug (4-wire system)

The cable of a strain-gage transducer adopts either 4-wire system or 6-wire system.

How to connect the 6-wire system to a plug is shown in Fig. 3-2-2. If the F and G terminals are not connected, the system will work as the 4-wire system.

If the 6-wire system is used on a strain-gage transducer to connect with the CDV-700A, it activates a remote sensing circuit in a bridge exciter block, and highly accurate measurement is thereby possible even when using an extended cable.

Remote sensing is a function which compensates a bridge voltage drop induced by cable resistance.

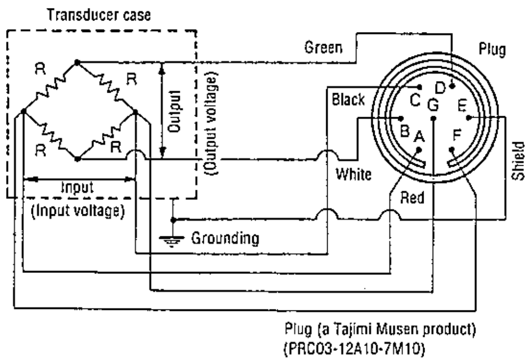
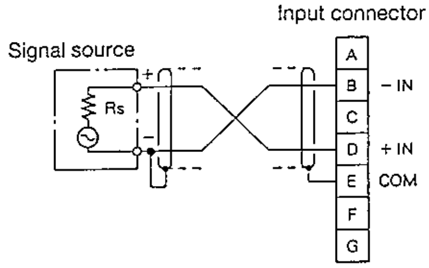


Fig. 3-2-2 Connection of a bridge to a plug (6-wire system)

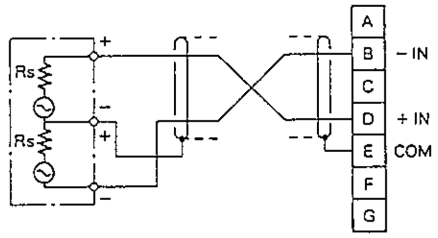
Use of a bridge box facilitates connection of a strain gage except that a bridge is formed using the 4-gage method*. See [5-1 Bridge box] which explains the 4-gage method.

When CDV/CDA-700A is to be used as a DC amplifier, connect a signal source to the signal conditioner's input connector. Fig. 3-3 shows how to wiring.

A plug used here is PRC03-12A10-7M10, a product of Tajimi Musen.



(1) Dealing with unbalanced signals



(2) Dealing with balanced signals

Fig. 3-3 Connection of a signal source to a plug

3-2 Connecting output signals

The CDV /CDA-700A comes with two output systems, OUTPUT A and OUTPUT B. The systems are independent of each other, and you can hence connect two different external instruments at the same time to the output connectors.

Either of the output connectors at OUTPUT A and OUTPUT B is a BNC connector. Use the accessory output cables to connect them to external instruments. The output impedance is rated at about 2Ω for both of the connectors.

Fig. 3-4 at right shows how to connect with external instruments.

Note that external instruments should be in the DC voltage measurement mode.

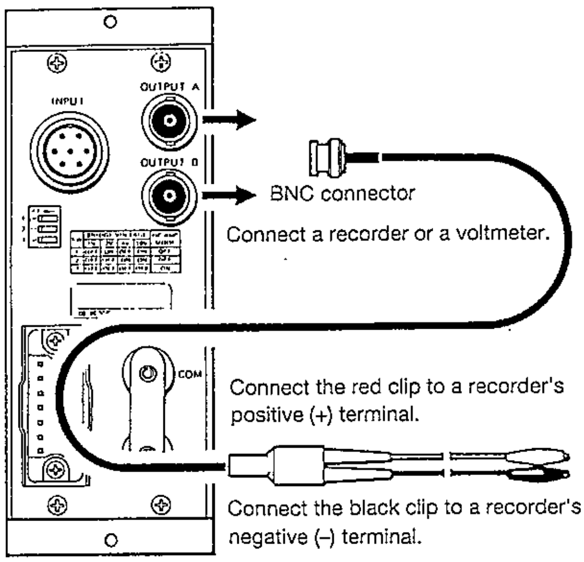


Fig. 3-4 Connection of output

3-3 Switching power on and off

Switching power on/off is one of the most important operations, so carefully read the following.

3-3-1 Switching power on

Before you switch power on or off, make sure that connection of input signals and power is correct.
For how to connect these, see:
[2-1 Setting up input/output instruments],
[3-1 Connection of input],
[3-2 Connection of output].

To switch power on, press the power switch. <u>Do it till you feel resistance.</u>

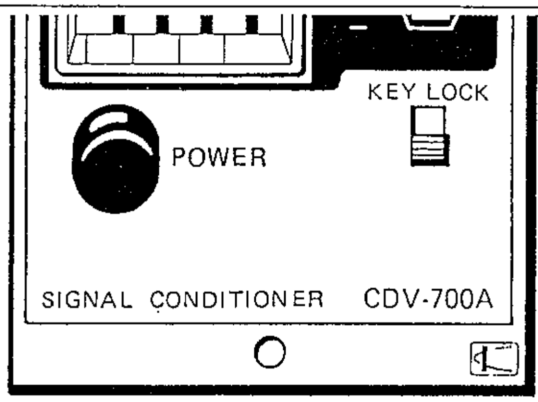


Fig. 3-5 Power switch

Once you switch power on, all LEDs except the bar-graph meter will illuminate for about five second, and after that, the following state will take place.

Panel meter .... The meter will light up in green. A different reading will appear on occasion.

Bar-graph meter .... Meter LEDs will light up in about same length as the panel meter indication.

Range .... The range will be set to a value which is in the internal memory.

Low-pass filter .... The low-pass filter will be set to a value which is in the internal memory.

> ***Caution***
>
> If Er 0 should appear after all LEDs go on, it is the indication of abnormality of the control program. In this case, contact your KYOWA representative or KYOWA.

3-3-2 Switching power off

To switch power off, press the power switch. All displays will then go out.
At the same time, the following measuring parameters will be saved in the internal memory.

Balancing value
Range value
Low-pass filter value
Vernier value

> ***Caution***
>
> The CDV/CDA-700A saves measuring parameters in its nonvolatile memory. However if power is switched off immediately after entry or renewal of parameters, correct saving may fail.
> Take care therefore to switch power off about three seconds or longer after you have entered or renewed parameters.

3-4 Basic balancing

The CDV/CDA-700A performs completely electronic balancing.

To execute balancing, press the balancing key two times in succession within 0.5 seconds after you have made sure of connection of input signals.

When achieved, balancing cancels unbalanced components no matter how other functions, the range, etc., have been set. You can monitor this occurrence on the panel meter.

You may happen to read not 0V but a residue of several mV on the panel meter when you have executed balancing by pressing the balancing key.

If necessary, execute fine balancing using the fine balancing control, which you will find above the balancing key. Using a small screwdriver, turn the control clockwise (into the positive [+] direction) or counterclockwise (into the negative [–] direction).

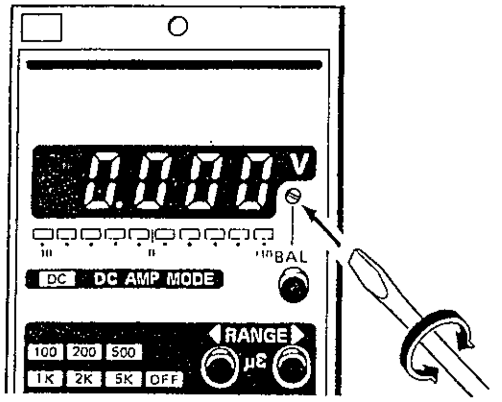


Fig. 3-6 Balancing key and Fine balancing control

Notes

Er 5 appears if you press the balancing key while the range is in the [OFF] position. If it appears, set the range to other than [OFF], and after that, press the balancing key.

3-5 Setting up measuring conditions

The most important factor in quality strain measurement is proper setting of a range and calibration value.

3-5-1 Setting a range

To set a proper range is necessary, in order to grasp the quantity of a strain correctly. Here we explain a basic way of setting a range. For more detailed information, see [4-6 Range].

First of all, you estimate the quantity of a strain for you to measure.

When using a strain-gage transducer, find a smallest possible range value that can be used, range which is decided by its rated capacity and rated output. Find the rated output in the calibration sheet of a transducer. Once you have found a possibly smallest range value, also take into consideration your practical measurement requirements, and thus decide on a most suitable range.

When using a strain gage, estimate the quantity of a strain, quantity which is influenced by the material and structure of a measurement object. Once a strain value is estimated, take it as a basic value, thus decide on a range.

When using the signal conditioner as a DC amplifier, estimate an input voltage. Take it as a base and decide on a range.

Here, let us simply select a range of [5k] (5000) με .

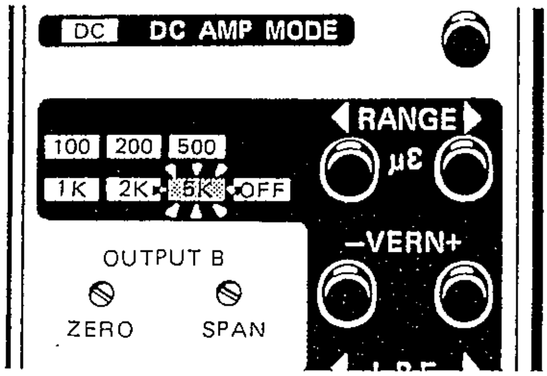


Fig. 3-7

3-5-2 Setting a calibration value

To measure signals from a stain-gage transducer, you select and set a calibration value according to the rated output of a transducer.

To measure stain gage signals, it is difficult to correctly grasp the quantity of a strain in advance. In this case, you set an approximate calibration value at first, then give a practical load to a strain gage. According to the quantity of a strain thus obtained, you select and set a proper calibration value.

To use the signal conditioner as a DC amplifier, you select and set a calibration value according to a voltage value of input signals.

Here, let us simply set "5000με ", which is same as the range value.

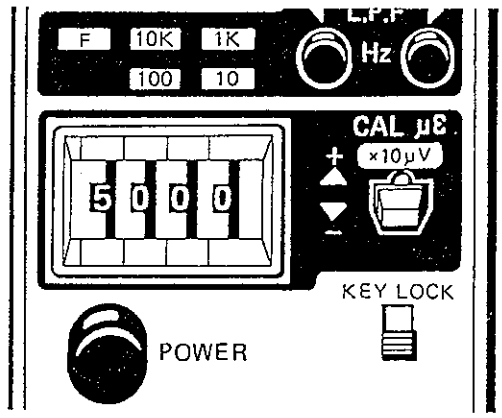


Fig. 3-8

3-5-3 Setting the low-pass filter

Normally a low-pass filter is used to set limits to frequency response. But here, you select the [F] (flat) position, which activates no low-pass filter function. We do so just because we are in the basic operations.

For detailed descriptions of the low-pass filter, see [4-8 Low-pass filter] and [7. Appendix].

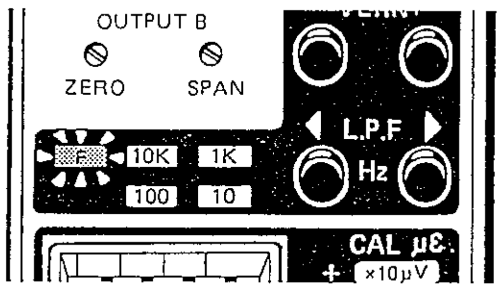


Fig. 3-9

3-5-4 Setting Vernier*

Using the vernier, you make fine adjustment on OUTPUT A, whose balancing has already been achieved.

As a basic operation, try to set OUTPUT A exactly to 1.000V. Here's how.

(1) Press the balancing key two times in succession within 0.5 seconds. The panel meter will then indicates about 0V, i.e. a voltage at OUTPUT A.
(2) Turn the fine balancing control, and thereby obtain an exact reading of 0V.
(3) Push the calibration execution key to the upper position, and keep it there.
(4) While the calibration key is in the upper position, push the vernier control key [+] if the panel meter indicates less than 1.000V or push the vernier control key [–] if the panel meter indicates over 1.000V.
If pushed continuously, the vernier control keys cause a large change in reading.
Take care to push them instantly to achieve fine adjustment.

A continuous push of the vernier control keys may further cause the range to change. For details, see [4-7 Vernier].

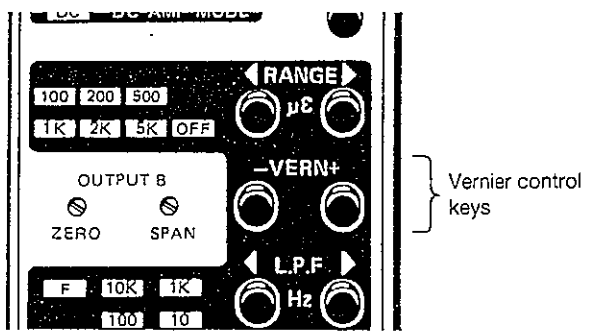


Fig. 3-10

Caution

Er 8 appears if you push the vernier key while the range is in the [OFF] postion.
Set the range at other than [OFF], then operate the vernier control keys.

3-6 How to monitor output

Note that how to monitor OUTPUT A is different from OUTPUT B.

3-6-1 How to monitor OUTPUT A

Monitor signals, which were sent from the OUTPUT A on the monitor of a recorder or a voltmeter connected (we call them output instruments hereafter). A reading will be approximately 0V if the balancing key has not been used.

Push the calibration execution key into the upper position, and make sure that a reading has changed to approximately 1.000V on the display of an output instrument connected.

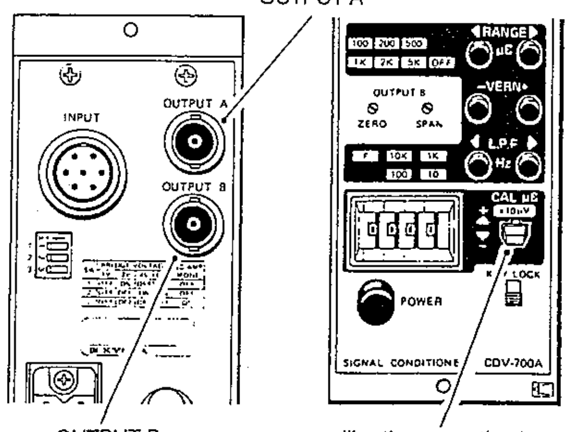


Fig. 3-11

> ***Note***
> A reading on the panel meter may not necessarily agree with that on an output instrument connected to OUTPUT A. This results from respective instruments' indication errors.

3-6-2 How to monitor OUTPUT B

OUTPUT B presents an output value which combines an OUTPUT A value and effects of both span adjusting mechanism and zero adjusting mechanism.

Here's how to adjust a zero point and an output voltage at OUTPUT B, using the zero control and the span control, both provided on it.

Disconnect an output instrument from OUTPUT A, then connect it to OUTPUT B.

(1) Turn the span control on OUTPUT B clockwise, using the small accessory screwdriver.
(2) Turn the zero control on OUTPUT B with the small accessory screwdriver, to read approximately 0V on an output instrument.
(3) Push the calibration execution key into the upper position and keep it in that position.
(4) Turn the span control on OUTPUT B, thereby reading approximately 1.000V on an output instrument.
Let the calibration execution key be free.
(5) If you find a zero point having moved through adjusting the span control on OUTPUT B, operate (2) through (4) once again.

All this puts OUTPUT A and OUTPUT B under the approximately same condition.

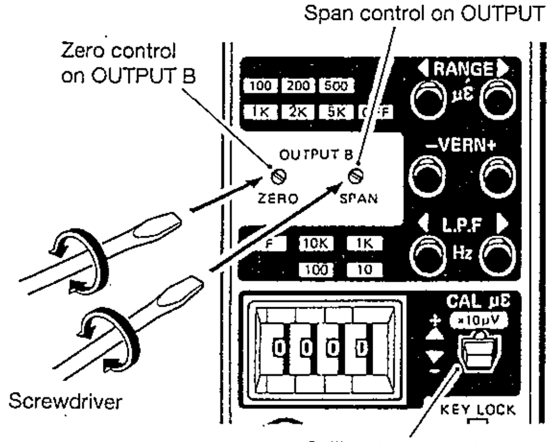


Fig. 3-12

3-7 Let's start to operate the signal conditioner.

We have now gone through the general setting by this time. So let's actually operate the signal conditioner in the manner as follows. You will be asked to change some measuring conditions, too.

(1) Making input signals to change

If it is a strain gage that you have connected to the input connector, touch it slightly with your finger.
If it is a strain-gage transducer that is connected, make its output to change somehow. With a pressure transducer, put your lips against its pressure inlet and breath upon it. If a load cell is in use, press its sensor with your hand.

While making input signals to change, observe readings on the panel meter or on an output instrument. Thus, make sure of changing output from the signal conditioner. Also make sure that display varies on the bar-graph meter, too. Further, roughly grasp what change was made in an output voltage against varying input.

We have set the range simply to [5k] (5000με). This may cause little change in output. In that case, set the range to a smaller value, for instance to "2kμε " or "1kμε ", in order to increase the conditioner's sensitivity. Also set the calibration value setter to the same value as the range.

(2) Measure the quantity of a strain

Push the calibration execution key into the upper position, and a positive calibration value will then appear as output. Compare this value with the output voltage value which you have found through changing input. The following equation lets you calculate approximately what strain has been generated.

$$\textbf{Magnitude of strain } [10^{-6} \textbf{ strain}] = \frac{\textbf{Output voltage against varied input}}{\textbf{Output voltage after calibration}} \times \textbf{ Calibration value}$$

Change some other measuring conditions from among those you have set, and try to operate the signal conditioner freely.

4. Advanced operations

This parts of the manual aims to explain features unique to the CDV/CDA-700A series signal conditioner, and advanced operations using those features.

4-1 Input

The CDV/CDA-700A series signal conditioner is a strain measuring instrument itself, and it can also work as a DC amplifier.
Connectable sensors are the following.

- Strain gage
  Generally speaking, direct connection of a strain gage to the input terminal is not recommended. To connect a strain gage, prepare a bridge box, an option. [5-1 Bridge box] explains how to use a bridge box.
- Strain-gage transducer
  For how to connect a strain-gage transducer, see [3-1 Connecting input signals].
- Using as a DC amplifier
  When the signal conditioner is to be used as a DC amplifier, connect it to a measuring object according to [3-1 Connecting input signals].

Cautions

If instruments or sensors other than mentioned above are used, the signal conditioner may not perform properly.
What's more, if two or more input instruments are connected each other on an input line, failure of the signal conditioner may occur. Take care to avoid it.

Allowable maximum strain input is unlimited while the signal conditioner performs to the specifications within ranges as follows. (See Table 4-1.)

Bridge voltage 10V: About 25000x10^{-6} strain
Bridge voltage 4V: About 62500x10^{-6} strain
Bridge voltage 2V: About 125000x10^{-6} strain
Bridge voltage 1V: About 250000x10^{-6} strain

When you are using a bridge box, we recommend to use a shielded cable to connect a strain gage to that bridge box, in order to reduce induction noise, etc.
Note that a panel meter indication will blinks if an incoming strain quantity is large or a range value is small. In this case, replace a range value by a larger one till the panel meter stops blinking.

In case the signal conditioner is used as a DC amplifier, its input impedance is rated at 10MΩ. So it will not adversely affect a signal source. Connect, however, a signal source whose internal impedance is below 1kΩ. Common mode input voltage must be below ±10V.

Caution

Failure of the CDV/CDA-700A series signal conditioner may occur if it is given a common mode input voltage in excess of ±10V. Take care to avoid it.

4-2 Output

The CDV/CDA-700A series signal conditioner is provided with two independent output systems. The two output connectors can connect with entirely different external instruments simultaneously.

Failure of one instrument, does not affect the other.

Either OUTPUT A or B can supply ±10V or a higher voltage against a load of 5kΩ or higher. On OUTPUT A and OUTPUT B, you can adjust their respective output levels and zero points, using the vernier control keys and fine balancing keys. You can also adjust OUTPUT B's output level by using the span control, and zero point by the zero control, respectively. The both controls are provided on OUTPUT B.

These controls increase respective values when turned clockwise, and decrease them when turned counterclockwise.

4-3 Pre-heating

Once powered, the signal conditioner instantly goes under the operating condition. Its internal electric parts and semiconductors do not, however, get thermally stabilized soon. If the bridge power circuit in particular is thermally unstable, it can cause a change in sensitivity* and a zero drift. So make it a point to give 10 to 15 minutes' preheating time to the instrument, in order to ensure its operational stability.

When you are to measure micro strains, i.e. about several 100×10^{-6} strain, or you are to continue measurement for a long time, we recommend to pre-heat the instrument for 30 to 60 minutes.

4-4 Balancing

A resistive unbalance component* exists in a strain gage bridge. It is hence necessary to remove this component, in order to ensure high accuracy of measurement.

4-4-1 Balancing range

A resistive unbalance component can be reduced up to ±2%, that is, $\pm 10000 \times 10^{-6}$ strain. The CDV/CDA-700A series permits you to achieve this balancing using a single switch.

4-4-2 How to execute balancing

Just press the balancing key, which is provided on the front panel, two times in succession within 0.5 seconds. This simple operation is enough to execute balancing.

You can make sure of correct balancing achieved on the panel meter. If the panel meter sees about "0 (zero)" after you have pushed the balancing key, it is the indication of correct balancing having been achieved. Indication of a value within ±20mV can be taken to be normal. To read exact "0 (zero)" on the panel meter, use the fine balancing key.

If the panel meter indicates a large value or blinks, it is the indication of some fault or other. In this case, consult with [6-2 Impossible initial balancing] in this manual and discover the cause.

You can execute this balancing using an external control signal, too. To do it, refer to [4-12 Remote control].

Note

The CPU controls balancing to make a residual voltage possibly smallest. If one time of operation is not enough, the CPU will repeat balancing several times. In this case, up to three seconds may be required to complete balancing. This does not mean a failure.

4-5 Zero drift

You can move respective zero points on OUTPUT A and OUTPUT B. This function can be conveniently used when moving a base line on an output instrument and others. How to move a zero point and a movable range on OUTPUT A differs from OUTPUT B.

OUTPUT A: ±0.1V or more, using the fine balancing key
OUTPUT B: ±0.1V or more or ±30mV or more on OUTPUT B alone, using the fine balancing key and the zero control on OUTPUT B.

You can observe a zero point of OUTPUT A on the panel meter.

Notes

To move a zero point on OUTPUT B, you can use either the fine balancing key and the zero control on OUTPUT B. The fine balancing key will, however, affect both OUTPUT A and OUTPUT B.

So move a zero point on OUTPUT A first, using the fine balancing key, and after that, move a zero point on OUTPUT B using the zero control on OUTPUT B.

4-6 Range

Selection of the largest range value of [5k] με lets you cover all measuring ranges. This range will however cause poor measurement accuracy on a small strain input, for example, 100×10^{-6} strain because output cannot be more than 100mV.

By contrast, selection of a small range value causes saturation when a large strain comes in.

It is therefore necessary to select a proper range that matches the quantity of an incoming strain signal.

Available ranges are: 100, 200, 500, 1k(1000), 2k(2000), 5k(5000), and OFF – seven in all. The smaller the range is, the larger the gain grows, thereby causing greater noise.

If [OFF] is selected, a calibration value and a strain signal output cannot be obtained.

To select a range, use the range selecting keys ◀ and ▶. When using the vernier at its maximum capacity at 2V bridge voltage, about 1V output voltage is available at OUTPUT A against a strain input of the range value (Fig. 4-1). For further details of the vernier, refer to [4.7 Vernier].

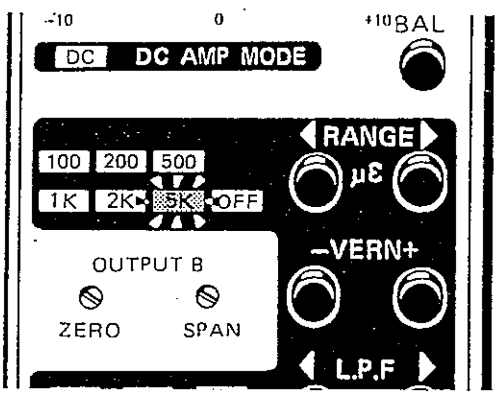


Fig. 4-1 Setting a range

The following is how to select a proper range that matches a sensor in use. Table 4-1 show the relationship between a range value and a measurable strain quantity.

> ***Note***
> The range is interlocked with the vernier. So you can select the most suitable range, using the vernier control keys only.

4-6-1 When using a strain gage

The following is how to select the most suitable range when using a strain gage.

(1) Estimate a strain quantity to be measured.
(2) Set a calibration value to the estimated strain quantity.
(3) Hold down the vernier control key, [+] or [–], till you get 1V output voltage while the calibration execution key is in the upper position.

4-6-2 When using a strain-gage transducer

A strain-gage transducer has a fixed rated output, which is normally expressed in unit of mV/V. It denotes an output voltage per 1V bridge voltage at a rated capacity.

A strain-gage transducer comes with a calibration sheet that describes a strain output. Depend on this description and select a range which is larger than a strain output but closest to it.

Even if a calibration sheet does not carry description of a strain output, you can calculate a strain output provided that a gage factor Ks* is known. Multiply a rated output expressed in µV/V by a gage factor Ks. The product of this multiplication denotes a strain output.

[Example] Find the most suitable range for a strain-gage transducer whose rated output is 1.567mV/V and gage factor is 2.00.
First, convert a rated output of 1.567mV/V in unit of µV/V. The result is 1567µV/V, which is then converted in strain as follows.

$$1567 \times 2 = 3134\ (\times 10^{-6}\ \text{strain})$$

So you select a range of 5k (5000) µε.
For your information, if you are to use a strain-gage transducer at a half or less of its capacity, you may increase its sensitivity accordingly, thereby taking advantage of noise reduction.

[Example] Find the most suitable range for a strain-gage transducer whose rated output is 1.567mV/V and gage factor is 2.00. This transducer is to be used at 20% of its rated capacity.
What can be obtained is as small strain as 626.4×10^{-6} (20% of a rated output). The most suitable range will then be 1k (1000) µε.

<Information> In Fig. 4-1, you see this: the range is set to 5k (5000) µε, the vernier is at its maximum, and a bridge voltage is set to 2V.
If an input of 5000×10^{-6} strain is given in this situation, an approximately 1V output is available at OUTPUT A.

Table 4-1 (1/2) Range values vs. measurable strain quantities

RANGE (με)	VERN (vernier)	Calibration values vs. measurable strain quantities			
		1V bridge voltage		2V bridge voltage	
		Measurable range ($x10^{-6}$)	CAL (με)	Measurable range ($x10^{-6}$)	CAL (με)
100	MAX	5~ 2000	5~2000	2.5~1000	2~1000
	MIN	ABT 12.5~ 5000	12~5000	ABT 6~ 2500	6~2500
200	MAX	10~ 4000	10~4000	5~ 2000	5~2000
	MIN	ABT 25~ 10000	25~9999	ABT 12.5~ 5000	12~5000
500	MAX	25~ 10000	25~9999	12.5~ 5000	12~5000
	MIN	ABT 31.3~25000	31~9999	ABT 15.6~ 12500	15~9999
1k	MAX	50~ 20000	50~9999	25~ 10000	25~9999
	MIN	ABT 125~ 50000	125~9999	ABT 62.5~25000	62~9999
2k	MAX	100~ 40000	100~9999	50~ 20000	50~9999
	MIN	ABT 250~ 100000	250~9999	ABT 125~ 50000	125~9999
5k	MAX	250~ 100000	250~9999	125~ 50000	125~9999
	MIN	ABT 625~ 250000	625~9999	ABT 313~ 125000	313~9999

Table 4-1 (2/2) Range values vs. measurable strain quantities

RANGE (με)	VERN (vernier)	Calibration values vs. measurable strain quantities			
		1V bridge voltage		2V bridge voltage	
		Measurable range ($x10^{-6}$)	CAL (με)	Measurable range ($x10^{-6}$)	CAL (με)
100	MAX	1~ 500	1~ 500	1~ 200	1~ 200
	MIN	ABT 2.5~1250	2~1250	ABT 2.5~ 500	2~ 500
200	MAX	2~ 1000	2~1000	2~ 400	2~ 400
	MIN	ABT 5~ 2500	5~2500	ABT 5~ 1000	5~1000
500	MAX	5~ 2500	5~2500	5~ 1000	5~1000
	MIN	ABT 12.5~6250	12~6250	ABT 12.5~2500	12~2500
1k	MAX	10~ 5000	10~5000	10~ 2000	10~2000
	MIN	ABT 25~ 12500	25~9999	ABT 25~ 5000	25~5000
2k	MAX	20~ 10000	20~9999	20~ 4000	20~4000
	MIN	ABT 50~ 25000	50~9999	ABT 50~10000	50~9999
5k	MAX	50~ 25000	50~9999	50~10000	50~9999
	MIN	ABT 125~ 62500	125~9999	ABT 125~25000	125~9999

Note: Calibraion values contained in the tables are standard values.

4-6-3 When using as a DC amplifier

You can use the CDV/CDA-700A series simply as a DC amplifier provided that it does not require excitation voltage, which is to excite a strain-gage bridge.

For this use, set the bridge voltage setting switch on the rear panel as follows.

SW1: OFF
SW2: OFF
SW3: ON

The switches having been set as above, the DC amplifier indicator lights up on the front panel, and a calibration value is given as a voltage value, which is 10 times larger than a value which you have set using the calibration value setter on the front panel. The unit of this voltage is μV.

Here's an example. You set a calibration value of "1000" using the calibration value setter on the front panel. Consequently, such a calibration signal is given as corresponding to 10000μV (10mV) when converted into input. Ranges' respective gains are given in Table 4-2.

Observe the following procedures to select the optimum range for the signal conditioner acting as a DC amplifier.

(1) Estimate a voltage to be measured.
(2) Set a calibration value to an estimated voltage value.
(3) While the calibration execution key is in the upper position, continuously push the vernier control key, [+] or [–], and thereby set an output voltage to 10V.

Table 4-2 Range vs. gain

RANGE (με)	VERN (vernier)	GAIN (multiplied by)
100	MAX MIN	10000 4000
200	MAX MIN	5000 2000
500	MAX MIN	2000 800
1k	MAX MIN	1000 400
2k	MAX MIN	500 200
5k	MAX MIN	200 80

4-7 Vernier

The vernier plays a supplemental role in range setting to OUTPUT A and OUTPUT B. In each range it enables adjustment of x1 to x1/2.5. If adjustment is made exceeding these limits, a range is automatically switched to another. Using the vernier only, you are accordingly able to change the instrument's sensitivity from minimum to maximum in one range and another.

The vernier presents two control keys. To get higher sensitivity, push the vernier control key [+], and to get lower sensitivity, push the vernier control key [–].

To activate the vernier, first set a certain value to the calibration velu setter. Then make sure that the calibration execution key is in the upper position. And after that, push either vernier control key while watching panel meter indications.

The vernier works at four different speeds depending on how the vernier control key, [+] or [–], is pushed. The longer the keys are pushed, the faster change is caused.

When the vernier is working fast, you cannot read panel meter indications. So to reach a desired value, put your finger off for once from whichever key, then again push either [+] or [–] key only shortly, thus making a fine setting.

[Example] Suppose that you have set a range and a calibration value to 1k (1000) $\mu\varepsilon$ and 2000$\mu\varepsilon$, respectively. Push the calibration execution key in this situation, and you will then read 1.260V on the panel meter. Now you are to change the reading to 2.000V using the vernier. Here's how.

(1) Hold up the calibration execution key into the upper position.
(2) Continuously push the vernier control key [+] for about 6 seconds, and suppose that you then read 2.025V on the panel meter.
(3) This reading is too large. So push the vernier control key [–], thereby reading about 2.000V. Then push the vernier control keys, [+] and [–], very shortly each time, finally to achieve an exact reading of 2.000V.

Note

Adjusting the vernier on its full range may cause a zero point vary by about 10mV on the panel meter. If necessary, correct a zero point anew using the fine balancing key.

4-8 Low-pass filter

The CDV/CDA-700A series comes with a built-in 4-pole low-pass filter, featuring an amplitude flat (Butterworth) characteristic. It provides four cut-off frequencies – 10, 100, 1k and 10kHz – and [F] (pass).

Amplitude attenuates by about 70% against a flat area and causes phase delay by 180 degrees at a point of cut-off frequency. A roll off characteristic is –24dB/oct. This means that when a frequency is doubled in the attenuation zone above a cut-off frequency, amplitude attenuates to 1/16.

The low-pass filter plays the following roles.

(1) It removes unnecessary high frequency components from input signals.
(2) It decides a frequency characteristic of the whole measuring system including a sensor, i.e. a strain gage or a strain gage transducer.
(3) It gives a same characteristic to paths that data go through in multi-channel simultaneous measurement.

To select a cut-off frequency, use the low-pass filter selecting keys, ◀ and ▶ .
If input signals are changing in sinusoidal form, use a cut-off frequency which is two to five times larger than the frequency of input signals.

Note

Phase delay of a low-pass filter of amplitude flat characteristic comes to be disproportionate to a given frequency in the vicinity of a cut-off frequency.

Over-shoot or under-shoot may thereby occur if fast rising or falling signals are given. In this case, set a cut-off frequency which is about ten times larger than the frequency of input signals.

4-9 Calibration value

To measure the quantity of an input, a calibration value (a standard equivalent strain or a standard strain voltage) is used.

A calibration value denotes a strain quantity or a voltage, and it is set in a 4-digit interger using the calibration value setter on the front panel.

In the case of strain, a calibration value can be set at from 1με through 9999με , incremental by 1με : and in the case of voltage, from 10μV through 99990μV, incremental by 10μV.

To set a calibration value, it is necessary to properly estimate the quantify of an input in advance. How to depends on sensors.

4-9-1 When using a strain gage

When using a strain gage to measure a strain, too, you set a calibration value to an estimated strain value only if estimation is possible.

If estimation cannot be made in advance, take an expedient of setting a probable value, and later replace it by a value matching the true quantity of a strain.

For instance, when about 950×10^{-6} strain is estimated, set a calibration value to 950με .

4-9-2 When using a strain-gage transducer

A strain-gage transducer has its own rated capacity. Its calibration sheet also mentions a strain ouput which corresponds to a rated capacity. So set a calibration value depending on a strain output mentioned.

For your infomation, we give some smaples as follows. Note however that the calibration values and others given below are just samples, and not that they should be so all the time.

[Example] A load of rated capacity is to be measured, using a load cell, whose capactiy is 2tf (19.6133kN) and calibration factor is 0.0004997 (0.0049N)/1×10^{-6} strain. What can a range and a calibraiton value be?

A strain output against a rated capacity of 2tf is caluculated as:

$$2 \div 0.0004997 = 4002.4\ [\times 10^{-6}\ \text{strain}]$$

So a range is to be set to 2k (2000)με , and a calibration value to 4002με .
Adjusting an output voltage to 2.000V after calibration allows simple relationship between an output voltage and a load quantity.

[Example] The signal conditioner is to be used in combination with a pressure transducer, whose rated capacity is 5kgf/cm^2 and rated output is 3993×10^{-6} strain. What can a calibration value be?

Set a calibration value to 3993με which is the rated capacity of a transducer.
Adjust an output voltage after calibration to 5.000V, and 5.000V will then correspond to 5kgf/cm^2.

4-9-3 Using the signal conditioner as a DC amplifier

If you can estimate in advance a voltage that will occur, set a calibration value to it. And if you cannot estimate it, set a certain value just as an expedient, and later replace it by a true voltage value.

For instance, when a voltage is expected to be about 950μV, set a calibration value to 950μV.

4-9-4 Inserting a calibration value

Once a proper calibration value has been set, insert it using the calibration execution key provided to the right of the calibration value setter. A push of the key into the upper position inserts a positive [+] calibration value in input signals, and a push into the lower position, a negative [–] calibration value.

A calibration value is inserted continuously during holding the calibration execution key up or down. Using an external control signal, remote control of calibration is also possible.

For remote control signals, see [4-12 Remote control].

> ***Note***
> Upon calibration having been executed, a display will change after a short interval but not instantly. But this is not a fault.

4-10 Key-lock

The CDV/CDA-700A series is provided with a key-lock function. If used, this function prevents measuring conditions from changing in the event of careless touching on keys.

The following functions can be key-locked.

- Execution of balancing
- Range
- Vernier
- Low-pass filter
- Execution of calibration

The key-lock function is made active by setting the key-lock key to the upper position. It is also possible to activate the key-lock function through a remote control signal.
For remote control signals, see [4-12 Remote control].

4-11 Converging connector and its applications

The CDV/CDA-700A series is provided with a converging connector on its rear.

Normally the accessory power cable is used to connect the signal conditioner to AC power.

This converging connector can be connected with, in addition to AC power, DC power through pins provided as mentioned in [2-2 Connection of power]) and also input/output signals. Table 4-3 shows the names and functions of these signals.

For external control signals mentioned in the table, refer to [4-12 Remote control].

Table 4-3 Names and functions of signals that the converging connector can connect with

Pin No.	Signal name	INPUT/OUTPUT	Function and what to connect with
1	+12V	INPUT	Connects with the positive side[1] of DC power input.
2	REM BAL[2]	INPUT	Connects with an external balancing signal, valid at "L".
3	N.C[3]		
4	N.C[3]		
5	COM –	—	Connects with common electric potential.
6	N.C[3]		
7	AC100V	INPUT	Connects with AC power.
8	N.C[3]		
9	N.C[3]		
10	REM KEYLOCK[2]	INPUT	Connects with an external key-lock signal, valid at "L".
11	GND	—	Internally connected in the case.
12	N.C[3]		
13	N.C[3]		
14	0V	INPUT	Connects with the negative side[1] of DC power.
15	OUTPUT A	OUTPUT	Internally connects with OUTPUT A.
16	OUT COM –	OUTPUT	Connects with the common side of OUTPUT A.
17	REM +CAL[2]	INPUT	Connects with an external calibration execution signal, valid at "L".
18	REM –CAL[2]	INPUT	Connects with an external calibration execution signal, valid at "L".
19	N.C[3]		
20	AC 100V	INPUT	Connects with AC power

Connector plug: S-1620-C, a product of HIROSE ELECTRIC

Notes: 1) Use a heat-resistant vinyl cable thicker than 0.3mm².
2) The electric potential of Pin No.5 COM– is common to these pins.
3) N.C stands for unnecessary wiring (an unused pin).

4-12 Remote control

The CDV/CDA-700A series makes it possible to control the following functions.

- Execution of balancing
- Execution of calibration
- Activation and cancellation of the key-lock function

When remotely controlled, these functions act in the pretty much same manner as operated with their respective key-switches. If a key-switch on the front panel is in the ON position, it has priority over a corresponding remote control signal.

4-12-1 Remote control signals

Fig. 4-7 at right shows a control signal input circuit.

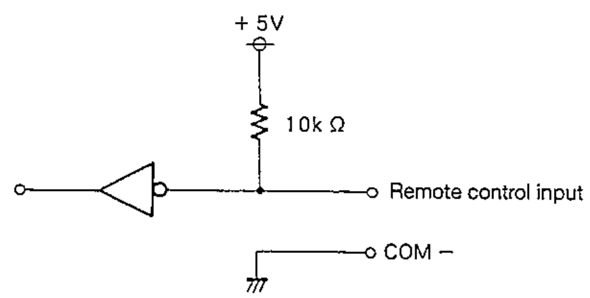
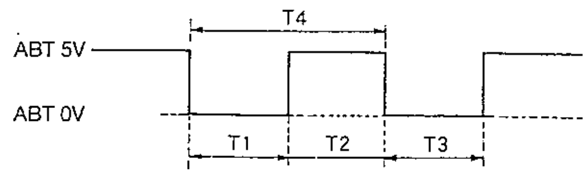


Fig. 4-7 Remote control signal input circuit

External control signals are valid when they are at "L" (0V) level. Their respective functions are executed for the duration of this level, except a remotely demanded balancing function which is activated just one time. See Fig. 4-3 at right.



T1, 2, and 3 (duration of validity) must be longer than 50mSEC.
T4 (cycle length) must be longer than 100mSEC and shorter than 500mSEC.

Fig. 4-3 Balancing through remote control signals

The duration of signal validity of T1, 2 and 3 must be longer than 50mSEC.
The time length of one cycle must be longer than 100mSEC and shorter than 500mSEC.

Notes

- If an external control signal is invalid, a level of about 5V is brought to effect.
- Take care to avoid chattering of a control signal which is rising or falling.

4-12-2 External connection

For remote control, make use of the terminals of the converging connector, which was explained in [4-11 Converging connector and its applications].

Remove the housing from the converging connector and perform necessary wiring.

Caution

The converging connector connects with AC power too. Be sure therefore to disconnect the converging connector from an AC outlet before you start remote control wiring.

Fig. 4-4 shows a circuit we recommend to use for remote control. If you are to use a different circuit, contact KYOWA for necessary information.

In either case, remote control is brought to effect when a MAKE contact is switched on.
Take care to avoid chattering of a switch.

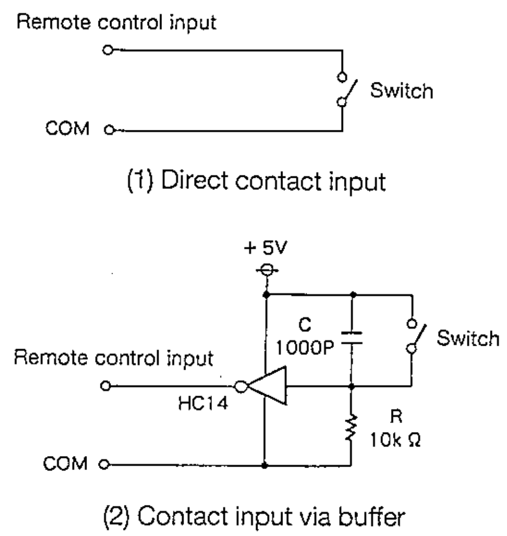


Fig. 4-4 Recommended external circuit

4-13 Bridge voltage

The CDV/CDA-700A series signal conditioner permits selection of a bridge voltage to excite a strain-gage bridge.

As shipped from the factory, 2V is set to CDV-700A, and 120Ω 5mA to CDA-700A, respectively.

To select a bridge voltage, use the bridge voltage setting switch on the rear of the unit. (Fig. 4-5)

The gray area of the table at right shows the condition of the bridge voltage setting switch as shipped from the factory.

Setting the bridge voltage switch to [DC AMP MODE] lets the DC amplifier indicator light up on the front panel and, at the same time, turns a calibration value into a voltage value.

> ***Caution***
>
> Be sure to perform balancing without fail whenever a bridge voltage has been renewed.

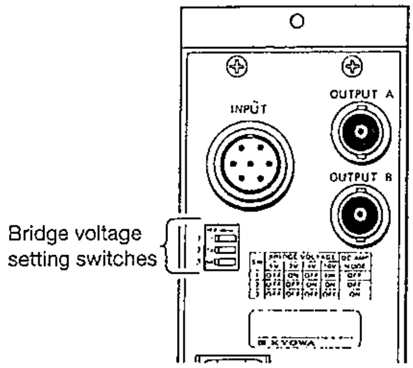


Fig. 4-5 Selecting a bridge voltage

Table 4-2 Range values and gains

	Bridge voltage	SW1	SW2	SW3
CDV	1V	OFF	OFF	OFF
	2V	ON	OFF	OFF
	4V	OFF	ON	OFF
	10V	ON	ON	OFF
	DC AMP MODE	OFF	OFF	ON
CDA	120Ω 5mA	OFF	OFF	OFF
	350Ω 5mA	ON	OFF	OFF
	120Ω 25mA	OFF	ON	OFF
	350Ω 25mA	ON	ON	OFF
	DC AMP MODE	OFF	OFF	ON

It gives you convenience if you select a bridge voltage of 1V in the cases as follows .

- Strain measurement is to be performed on materials, such as plastic or wood, that are poor in radiation of heat.
  A strain gage is heated by a large current running through it. Poor radiation of heat by a measuring object disables precision measurement.
  A bridge voltage is hence reduced to 1V so as to lower a strain gage's self-heating.
- An extra large strain is to be measured.
- A strain gage shorter than 1mm in gage length is to be used.

4-14 Output instruments

External instruments must satisfy the following requirements for connection to the CDV/CDA-700A series.

(1) Voltage input type instrument whose input impedance is 5kΩ or higher.

(2) Current input type instrument whose maximum input current is rated below 10mA.

4-15 User-specified registration function

The user-specified registration function is a function whereby the user can register a particular measuring condition that he specifies.

Once a measuring condition has been registered, a calibration value is automatically corrected to match that condition, in order to prevent deterioration of measuring accuracy.

- The signal conditioner is far from a strain-gage bridge or a strain-gage transducer.
- To improve measuring accuracy, it is wanted to convert a measuring value using a practical resistance value of a strain-gage transducer.
- It is wanted to use a strain gage or a strain-gage transducer whose bridge resistance is other than 120Ω or 350Ω.

Either constant voltage or constant current bridge excitation system has advantage on one side and disadvantage on the other side. The user-specified registration function is to cover this disadvantage.

4-15-1 Items that the user can register

Items that the user can register are different on the CDV-700A and on the CDA-700A. Once the user registers numeric values, they are maintained in the internal nonvolatile memory.

4-15-2 Items that can be registered on CDV-700A

With the CDV-700A, a constant voltage excitation instrument, you can register both bridge resistance and cable resistance.

(1) Bridge resistance

You can register bridge resistance exclusive of cable resistance which is seen from the side of bridge exciter.
Bridge resistance values can be set in a range of:
60.0Ω to 999.9Ω
or 60Ω to 9999Ω.

Note however that if a bridge voltage is at 10V, you can not set bridge resistance below 350.0Ω .

[Example] You are to convert a measurement value at actual bridge resistance on a pressure transducer whose nominal resistance is 350Ω.

Suppose that the input/output resistance of this transducer is stated as follows in its calibration sheet.
Input resistance: 351.6Ω
Output resistance: 349.3Ω
In this case, set input resistance of "351.6Ω" as bridge resistance.

[Example] Suppose that a pressure transducer is in use, whose input resistance is 945.5Ω and output resistance, 925.2Ω. In this case, bridge resistance is to be set to input resistance of "945.5" Ω.
For your information, in the case of the CDV-700A, bridge resistance is at "350.0Ω" and cable resistance at "0.0Ω" as shipped from the factory. Correction of a calibration value is not however made unless the user-specified registration is executed.

(2) Cable resistance

As cable resistance, you are to set a one-way resistance value of a cable extending from a measuring instrument to a bridge.

It can be set in a range of:

0.0Ω to 200.0Ω

> **[Example]** To connect the aforementioned pressure transducer to the signal conditioner, cable extension has to be made up to 25m, using a 4.4Ω/100m cable. Suppose that this pressure transducer has 350Ω resistance, and its measurement value is to be converted at actual bridge resistance.
>
> First, set an input resistance value of "351.6"Ω as a bridge resistance value. Next, calculate a one-way resistance value of a cable, 25m in length.
>
> One way cable resistance value = 4.4 x 25/100
>
> = 1.1 (Ω)
>
> Set this value as a cable resistance value.

4-15-3 Items that can be registered on CDA-700A

Only bridge resistance can be registered on the CDA-700A.

How to find a value to be set is same as with the CDV-700A.

As shipped from the factory, bridge resistance is at "120.0Ω" or "350.0Ω" according to a setting of the dip switches on the rear. Unless registration of a user-specified bridge resistance is performed, a calibration value is not corrected.

4-15-4 How to register user-specifications

(1) Set the key-lock key to the upper position.

(2) Push the range setting switches, ◀ and ▶ , simultaneously, and the following will then appear on the digital monitor.

"in br"

This means that an input of bridge resistance is acceptable.

To interrupt entering bridge resistance, push the calibration execution key.

(3) Push the calibration execution key into the upper position.

Now the panel meter presents varied readings according to models and dip switch settings.

On the CDV-700A, the following will appear irrespective of dip switch settings.

"350.0"

On the CDA-700A, the panel meter will present either one of the following readings according to a dip switch setting.

In either case a dip switch setting is at 120Ω/5mA or 120Ω/25mA,

"120.0" will appear.

When a dip switch setting is at 350Ω/5mA or 350Ω/25mA,

"350.0" will appear.

(4) Set a bridge resistance value, using the range setting keys, ◀ and ▶ , together with the vernier control keys, [+] and [–].

Use the range setting keys, ◀ and ▶, to go to the digit that you want to change. A push of the ◀ key moves the position of blinking to left, and a push of the ▶ key, to right.

A push of the ◀ key on the top digit effects a measuring range of 60Ω to 9999Ω.

Use the vernier control keys, [+] and [–], to select a numeric value. A push of the [+] key effects a larger value, and a push of the [–] key, a smaller value.

(5) Upon having set a desired value, push the calibration execution key into the upper position.

A bridge resistance value will then be registered.

All this completes user-specified registration on the CDA-700A.

If the CDV-700A is in use, you further go to a setting of cable resistance.

6)After the procedure (5), the following will appear on the panel meter.
"in Lr"

This means that input of cable resistance is acceptable.

(7) Push the calibration execution key into the upper position.
The panel meter will then indicate "0.0" which was entered when shipped from the factory. Set a cable resistance value in the same manner as setting a bridge resistance value.

(8) Again push the calibration execution key into the upper position.

By all this, the user-specified registration is completed. Hereafter, correction is made each time calibration is executed.

Caution

With the CDA-700A — if a dip switch setting is changed on the rear after user-specified registration, a calibration value is corrected in a manner to match a resistance renewal.

5. Options

We explain options that are helpful in operation of the CDV/CDA-700A series signal conditioner.
All options are available singly for your purchase.

5-1 Bridge box

A bridge box facilitates strain measurement using a strain gage. A KYOWA bridge box comes with highly stable resistors built-in to allow composition of a variety of strain-gage bridges.

5-1-1 Functions of a bridge box

A KYOWA bridge box has three fixed resistors built-in. Using these fixed resistors, it is possible to compose the following kinds of strain-gage bridges.

In other than the 4-gage method, built-in fixed resistors are used as dummy gages.

(1) 1-gage method (2-wire and 3-wire systems)
(2) 2-gage method
(3) 4-gage method

5-1-2 KYOWA bridge box models

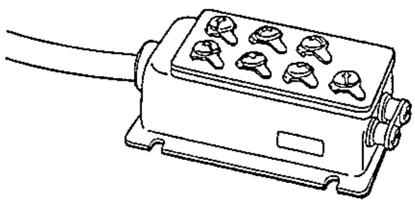
The following models are available.

(1) DB-120B, DB-120L, DBB-120A
These bridge boxes are used with 120Ω strain gages.
(2) DB-350P
Use this bridge box with 350Ω strain gages.

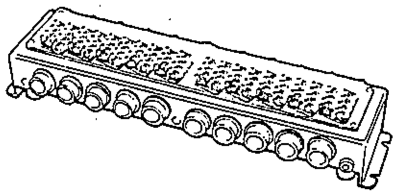
5-1-3 Wiring to a bridge box

Table 5-1 shows how to perform wiring to a bridge box to compose strain-gage bridges.

DB-120P
DB-350P



DBB-120A



DB-120L

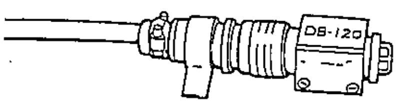
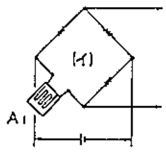
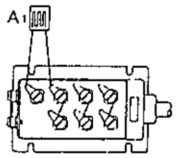
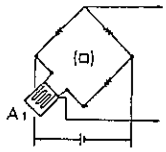
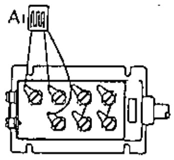
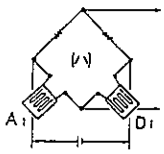
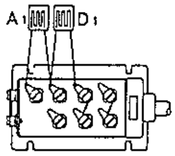
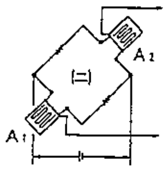
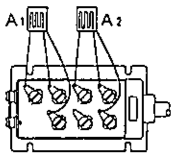
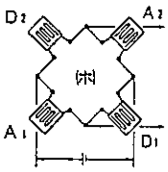
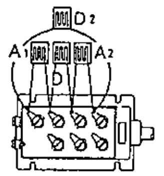


Fig. 5-1 Bridge boxes

Notes

- It is recommended to solder wires at a bridge box as much as possible, in order to reduce contact resistance.
- Use shortest possible wires to connect a strain gage to a bridge box. It is ideal if they are shorter than 1 meter.
- Use a shielded cable for measurement of dynamic strains. The cable has the advantage of reducing external noise.

Table 5-1 How to perform wiring to a bridge box

Measuring method	Bridge circuit	Wiring to a bridge box
1-gage method (2-wire system)		
1-gage method (3-wire system)		
2-gage method		
2-gage method (3-wire system, active-active)		
4-gage method		

5-2 Amplifier stand, FA-1B

This rubber made stand is used to fix a single unit of the CDV/CDA-700A series signal conditioner.

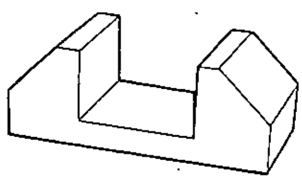


Fig. 5-2 FA-1B amplifier stand

5-3 Extension cables, N

These cables are used to connect a remote bridge box or strain- gage transducer to the CDV/CDA-700A Series signal conditioner. The cable is provided with a connector at each end, and is available in five lengths.

- N-81, 5m long
- N-82, 10m long
- N-83, 20m long
- N-84, 40m long
- N-85, 50m long

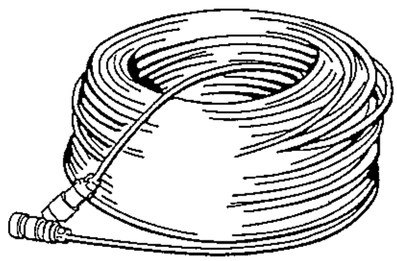


Fig.5-3 N-series extension cable

5-4 Noise filters, F

Used in the CDV/CDA-700A series signal conditioner, these filter protect it against external high frequency noise.
They are directly attached to input and output connectors.

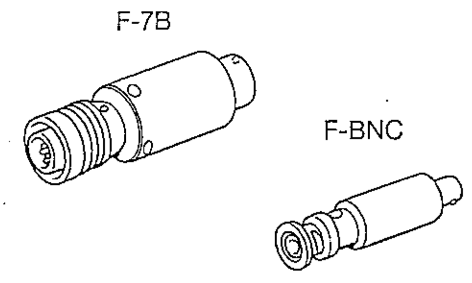


Fig. 5-4 F noise filters

5-5 Housing case

The following four models are available, accommodating 3 channels through 8 channels.

- YB-503A 3 channels
- YB-504A 4 channels
- YB-506A 6 channels
- YB-508A 8 channels

Each model comes with switches for blanket control of signal conditioners housed.

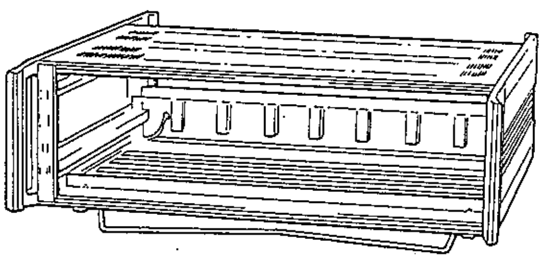


Fig. 5-5 dedicated housing case

5-5-1 Functions

Dedicated housing cases provide, among others, the following features.

- A blanket balacing key.
- A blanket calibration execution key.
- A blanket power switch.
- Internal connection achieved for carrier snychronization. (For the DPM-700B series dynamic strain amplifiers)
- A blanket key-lock key.

In addition, rack-mounting fixtures are available, conforming to JIS and DIN stadards.

Notes

- A housing case can accommodate signal conditioner units and DPM-700B series dynamic strain amplifier units at one time.
- The balancing, calibration or key-lock function can be effected on all channels simultaneously, using the blanket control key.
- Blanket balancing and blanket calibration are operable even when the key-lock function is active. So take care to avoid error.

6. Troubleshooting

If your conditioner does not operate as expected or is found unstable, do not immediately take it that the conditioner has failed but check the operating environment for possible causes.

This chapter explains typical troubles, causes and remedies. So try proper remedies in the first place, and if they do not work, contact your local KYOWA representative or KYOWA.

We may deny repairs when the product has been damaged through improper usage (i.e. not conforming to guidelines described in this manual), or when the product has been disassembled or modified by the user.

6-1 The conditioner cannot be powered

If the panel meter and display lamps do not light up after turning the power switch on, the cause can be the breaking of the power cable or the fuse having burnt out inside. In the first place, check the conductivity of the power cable.

The fuse is in the unit case. For fuse replacement, be sure to disconnect in advance the plug of the power cable from an AC outlet or a battery. Replace the burnt out fuse by:

a DC power fuse, midget type 3A

If a replacement also gets melted, the cause can be failure of the circuit. In this case, contact KYOWA.

• How to replace a fuse

The fuse is on the parts side of the board. Replace it in the following order.

① Remove four screws that fasten the conditioner cover.

② Pull the conditioner cover upward while widening it a little at its bottom.

③ Look through a rectangular hole on the control board and make sure that the fuse has burnt out.

④ Remove eight M3 screws that fasten the amplifier board.

⑤ Insert a flat-blade screwdriver between the top of the amplifier board and the mainframe, thereby disconnecting the board from the connector.

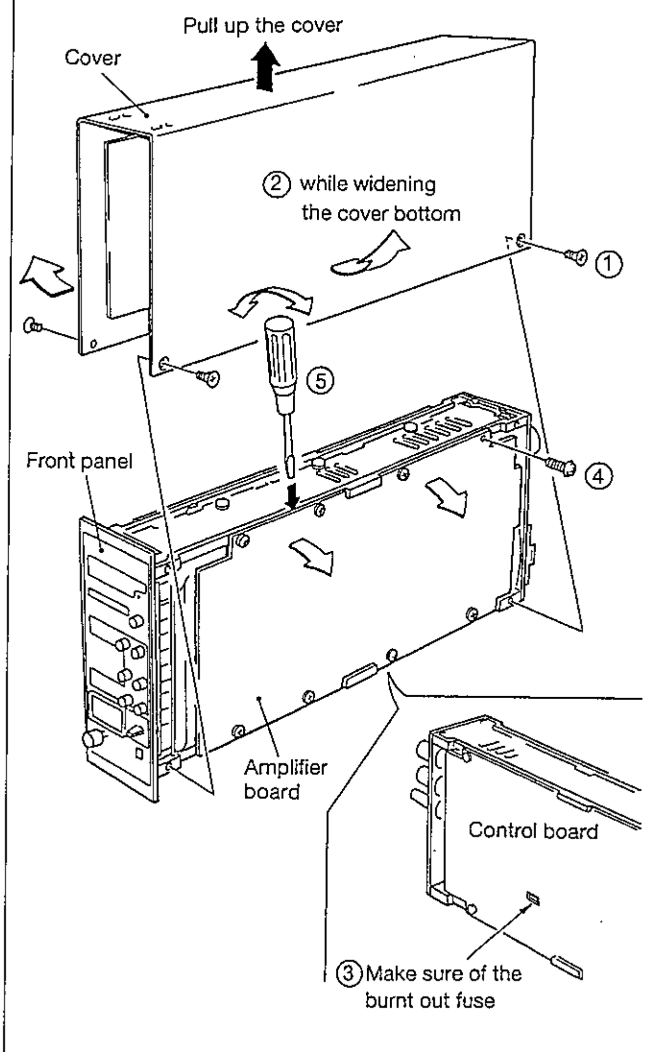


Fig. 6-1 How to relace a fuse

⑥ Remove a screw that fastens the shield case on the control board.
Straighten a metal fixture, which fastens the shield case, alongside of a board groove.
⑦ Remove the shield case from the control board.
⑧ Replace the burnt-out fuse on the control board by a new one.
⑨ Attach the shield case to the control board, and assemble other parts in the order just reverse to the disassembly.
When assembling, take care not to catch a vinyl cable.

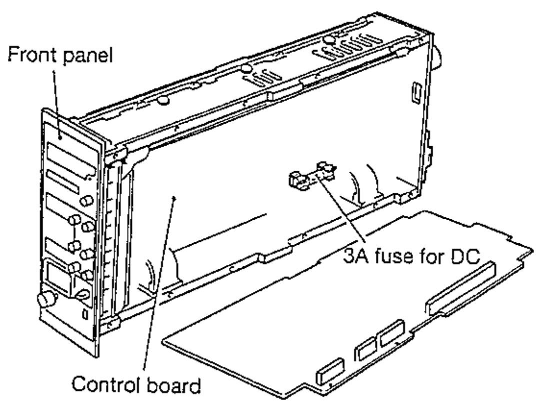


Fig. 6-2 How to replace a fuse

6-2 Initial balancing is impossible.

- **A reading on the panel meter keeps in excess of ±10V**
  This can result from a fault in a strain-gage bridge which is connected to the input connector.
  Causes of this fault can be the following. Check the strain-gage bridge to discover and remove the cause
  - Breaking, short-circuiting or lowered insulation of arms of the strain-gage bridge.
  - Breaking of leadwire/s coming from the strain-gage bridge.

- **Using a bridge box**
  Check resistance values between the terminals of a bridge box and the terminals of the input connector.
  With a 120Ω bridge, a normal bridge box provides such resistance values as stated in the figure at right.
  When with a 350Ω bridge,
  120Ω should read 350Ω
  240Ω should read 700Ω

- **A bridge box has proven normal, but still initial balancing is disabled.**
  The cause can be a fault in a strain gage which is connected to a bridge box, or faulty connection of connector pins.
  Replace the strain gage or the bridge box, and see what will happen.

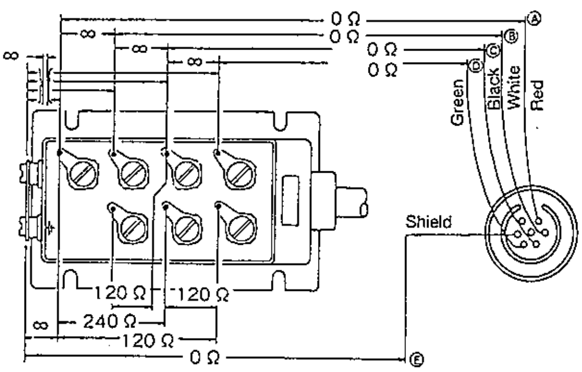


Fig. 6-2 Resistance values in a bridge

Balancing can be disabled if a long cable connects the terminals of a bridge box to a strain gage, and external noise is accordingly large. The causes can be:
(1) The 1-gage method is in use with long leadwires.
(2) The 2-gage method is in use while a shielded cable is used on one gage, and a vinyl cable is used on the other gage.
(3) An extension cable which connects a bridge box is not proper and thus affected by large external noise.

- **Several 10mV remain no matter how many times balancing is repeated by pushing the balancing execution key**

The cause can be the maladjusted fine balancer.
Set the [RANGE] to [OFF], then turn the fine balancing key so as to read an output voltage of 0, and after that, push the balancing key once again.

If the above remedy fails, contact KYOWA.

6-3 No output is available.

- **The range is in the [OFF] position.**

Set the range to other than [OFF].

- **The span control is in the minimum position on OUTPUT B.**

Turn the control to a proper position. This however applies to OUTPUT B only.

- **The panel meter presents varying readings, but no output is available.**

The cause can be a fault in the output cable. Check the output cable to make sure of its conductivity.
The cause can also be the span control which is in the minimum position on OUTPUT B. So check this too.

If the above remedies fail, contact KYOWA.

6-4 The zero point is unstable.

After initial balancing, if the zero point floats despite of no input given, the following matters can be the cause.
- Insulation has deteriorated in a strain gage or in its lead-wires.
- Insufficient temperature correction effected on a strain gage.
- A fault in a fixed resistor incorporated in a bridge box.

If all these are found normal, contact KYOWA.

6-5 Large noise

The following matters can be the cause. Take proper measures to remedy each causal matter.

- **Inductive interference**

If there is in the vicinity such equipment as large in leakage magnetic flux, it may cause induction noise. Namely, they are a large-capacity motor, transformer and ferro-resonant constant-voltage equipment.

If a measuring point is remote, induction noise may occur.

In these cases, applicable remedies are:
- Put a proper distance between such equipment and the signal conditioner.
- For connection with a strain gage, use a 2-conductor shielded cable as much as you can.
  Also connect the shield wire to the terminal E of a bridge box.
- Ground a measuring object and the signal conditioner independently at a same grounding point.

- **Interference due to an electric potential**
  This interference occurs when a measuring object has a certain DC or AC electric potential,

In this case, it does not necessarily bring about a good result to ground the signal conditioner. But connection of a measuring object to the signal conditioner can be a solution sometimes.

When it comes to induction interference or interference by the electric potential of a measuring object, the problem can seldom be solved by a simple measure.

Today many instruments tend to stay in one same measuring environment, and these instruments thus come to affect each other as noise sources.

The remedy mentioned above is only one instance. Measures must meet environmental conditions. So thoroughly investigate the environment of a measuring site, and take proper measures to achieve a best possible result.

6-6 Error messages

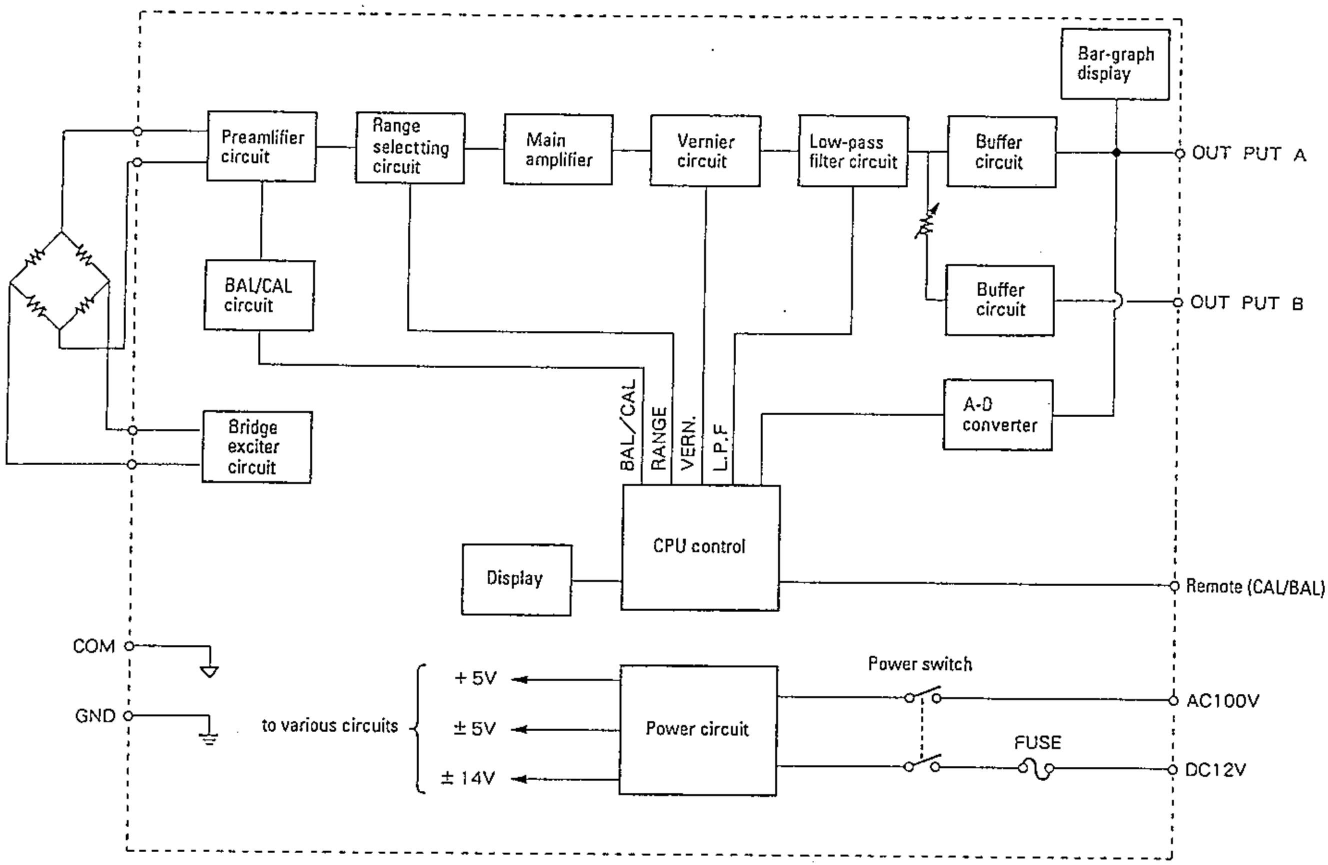
Error messages and their respective meanings are as follows on the CDV/CDA-700A signal conditioner.

If an error message other than ERR-5 and 6 appears, it is the indication of a fault inside the instrument. If it appears, contact your local KYOWA representative or KYOWA.

Er 0: RAM check error
Er 1: TIME-OUT error in detection of timing for PWM writing
Er 2: (Used internally)
Er 3: (Used internally)
Er 4: (Used internally)
Er 5: Balancing operation attempted at RANGE_OFF.
Er 6: A resistance value registered by User-Specified Registration is out of the range.
Er 7: Memory check error
Er 8: Vernier operation attempted at RANGE OFF
Er 9: Preserved
Er10: Preserved
Er11: Preserved
Er12: Improper PWM value

7. Block diagram & Operational principle

7-1 Block diagram

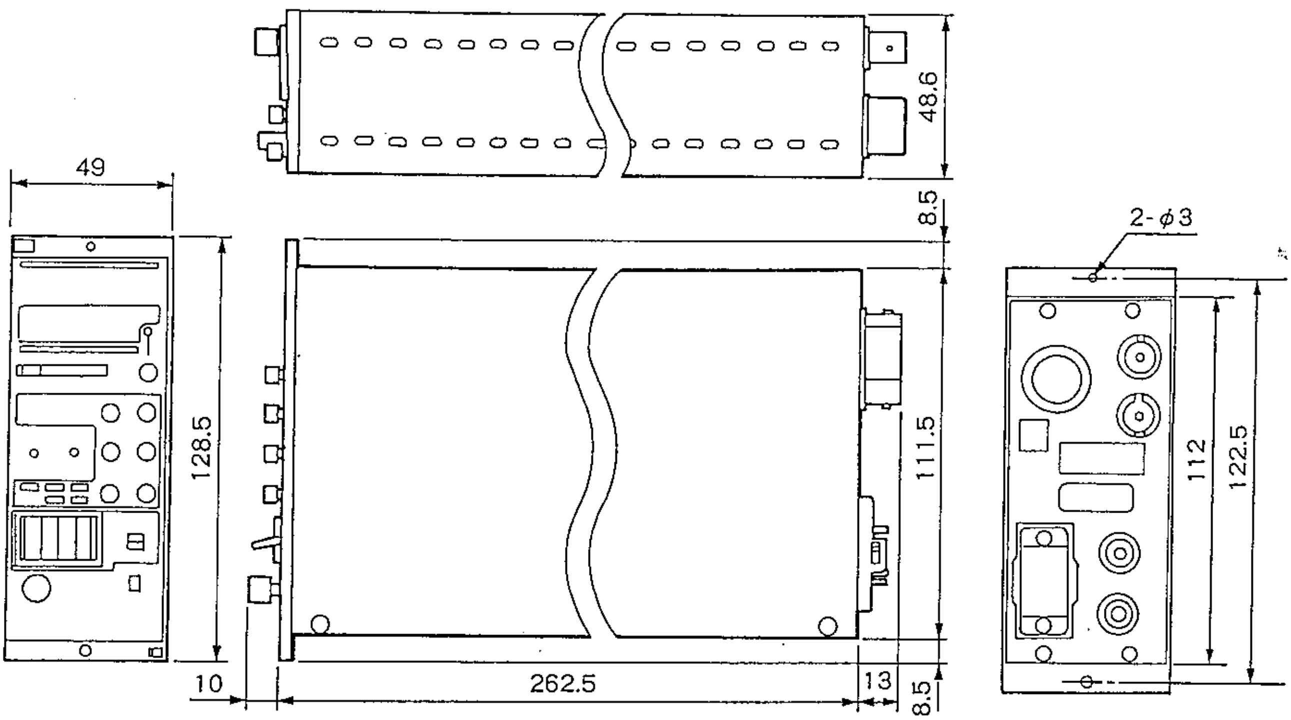


7-2 Operational principle

This explanation is based on the block diagram above. A change in various physical quantities is detected as a change in the resistance of a strain gage, and converted into electric signals. An output from a strain-gage bridge at this time is a micro DC voltage in several 100μ volts or thereabouts at its maximum.

This bridge output is amplified by the preamplifier, an instrumentation amplifier, up to several millivolts, and further amplified to several volts by the main amplifier, and put out through the vernier circuit and buffer circuit in the stated order on the next stage.

7-3 Dimensional drawing



8. Appendixes

8-1 How to calculate a strain

The following explains how to measure a strain and a stress using the CDV/CDA-700A signal conditioner.

8-1-1 Using strain gage/s

Suppose that a strain waveform was obtained as shown in Fig. 8-1.

In the figure the record of a positive (+) calibration signal is seen at the top of the strain waveform. We call the signal's direction "[elongation]" for later convenience.

A time factor of the waveform can be found using Tc, i.e. a time marker's interval.

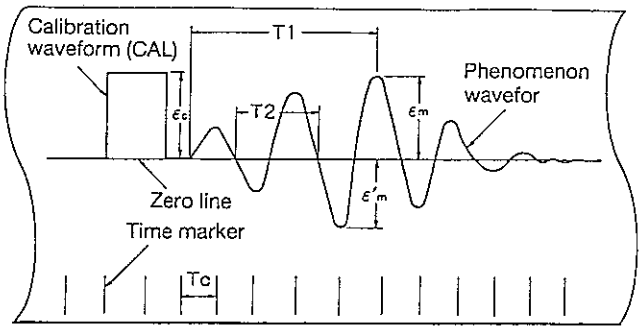


Fig. 8-1 Sample strain waveform record

Now we will calculate various values, depending on the Fig. 8-1.

(1) Calculation of a maximum strain ε m and maximum stress σ m.

Using a scale, measure the height of the calibration value and that of the maximum strain above the zero base line.
Now suppose that the measurement of εc is he [mm], and that of εm is hm [mm].
The maximum strain εm is then calculated by:

$$\varepsilon'm = \varepsilon c \times \frac{hm}{hc}$$

εm is in the same direction as +εc, it therefore denotes [elongation].
Once a strain ε has been found, a stress σ at that point is given by the equation below (provided that this is a uniaxial stress system).

$$\sigma = E \times \varepsilon$$

where E denotes Young's modulus at the measuring point, and it is also provided that the gage's axial direction is in accord with that of a stress.
A maximum strain σm is then calculated by:

$$\sigma m = E \times \varepsilon m$$

(2) Calculation of a strain ε ' m and a strain σ'm

Because ε 'm is in the direction opposite to + εc, it denotes [contraction]. Suppose that the height of ε'm measures h'm [mm], its value is calculated by:

$$\varepsilon 'm = \frac{hm}{hc}$$

A stress σ'm is calculated by (provided that it is a uniaxial stress system):

$$\sigma m = E \times \varepsilon m$$

(3) **A time length from the start of a phenomen to the occurence of a mximum strain**
Use time markers to find T1, a time length from the start of a waverom to a maximum strain recorded. Measure intervals of about 10 time markers and obtain an average, i.e. Tc [mm] against Time Tc. Suppose that Time T1 measurs t1 [mm], and T1 can be calculated by:

$$T1 = \frac{t1}{tc} \text{ x } Tc \text{ [sec]}$$

(4) **Strain waveform cycles**
If vibrations of a phenomenon is cyclical, it is possible to calculate its cycle time. To find a cycle time T2, measure the length of about 10 cycles, then obtain an average cycle t2 [mm]. Compare this to tc, a time marker's intavel [mm].

$$T2 = \frac{t2}{tc} \text{ x } Tc \text{ [sec]}$$

Frequency f is found from T2 using the equation below.

$$f = \frac{1}{T2} \text{ [Hz]}$$

(5) **Analysis of a phenomenon**
If a phenomenon is simple so that measurement at one point is enough, you will know all about it by only finding the quantity of a strain and how it is related to time.

If a phenomenon is complex on the contrary, the need arises for simultaneous or independent measurement on a number of points.

The calculation methods introduced above can clarify the quantity of a strain and how it is related to time. But this is not enough to grasp a complex phenomenon.

In multi-point measurement, you need to investigate the relationship between all measuring points in terms of strain quantity and time axis, in addition to analyses on single points.

A different measuring purpose may call for a different analysis technique. So you cannot depend a uniform way of analyzing. In a practical measurement, however, you may be able to estimate the relationship between measuring points. So analyze waveforms on points singly, then relate these analysis results to each other, in order to figure out a total phenomenon.

8-1-2 Correction required to match the number of strain gages used

The preceding calculation presupposes that a single strain gage is used as an active gage, whose connection is shown at right.

If two or more gages are used, the result of measuring has to be corrected accordingly.

- ε: Strain after compensation
- ε_0: Measuring results
- σ : Stress
- E: Young's modulus (Modulus of longitudinal elasticity)

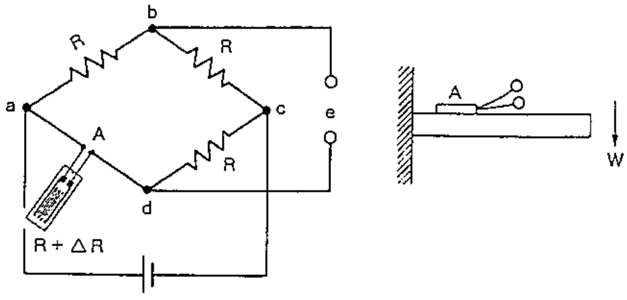


Fig. 8-2 Sample of one-gage method

(1) Where both active and dummy gages are used to detec a strain

① Where two gages are used and arranged as shown at right, multiply ε_0 , a measured value, by 1/2.

$$\varepsilon = \frac{\varepsilon_0}{2} \qquad \sigma = E \times \varepsilon = \frac{\varepsilon_0}{2} \times E$$

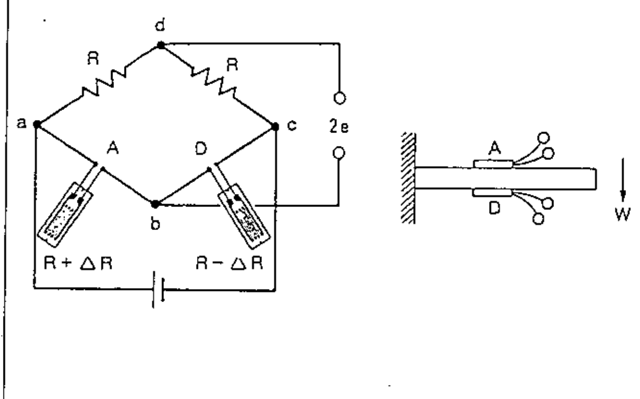


Fig. 8-3 Sample of 2-gage method

② When four gages are used and arranged as shown at right, multiply ε_0, a measured value, by 1/4.

$$\varepsilon = \frac{\varepsilon_0}{4} \qquad \sigma = E \times \varepsilon = \frac{\varepsilon_0}{4} \times E$$

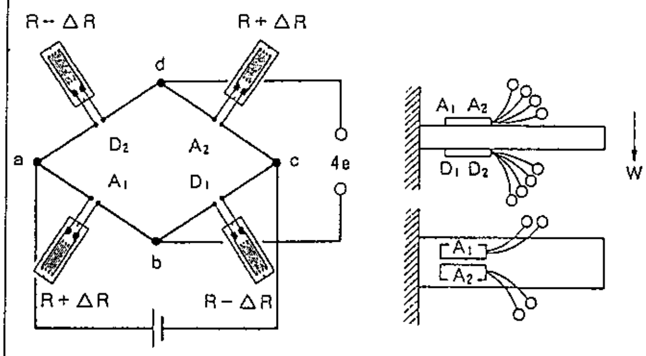


Fig. 8-4 Sample of 4-gage method

(2) When using A(Active) gage and D(Dummy) gage, which is at a right angle to the former

① When two gages are used and arranged as shown at right

Multiply ε_0 , a measured value, by $\frac{1}{(1+\nu)}$.

$$\varepsilon = \frac{\varepsilon_0}{(1+\nu)}$$

$$\sigma = E \times \varepsilon = \frac{\varepsilon_0}{(1+\nu)} \cdot E$$

where ν : Poisson's ratio

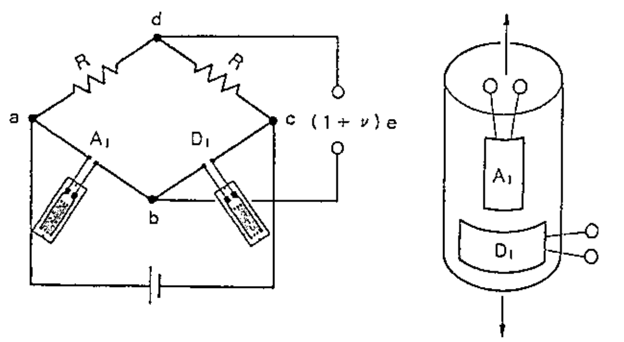


Fig. 8-5 Sample of special 2-gage method

② When four gages are used and arranged as shown at right

Multiply ε_0, a measured value, by $\frac{1}{2(1+\nu)}$.

$$\varepsilon = \frac{\varepsilon_0}{2(1+\nu)}$$

$$\sigma = E \times \varepsilon = \frac{\varepsilon_0}{2(1+\nu)} \cdot E$$

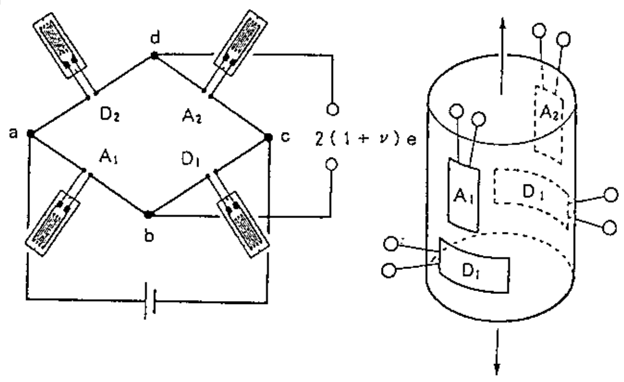


Fig. 8-6 Sample of special 4-gage method

8-1-3 When using strain gages whose gage factors are other than 2.00

Correct measured values, using the equation below.

$$\varepsilon = \frac{2.00}{Ks} \times \varepsilon_0$$

$$\sigma = E \cdot \varepsilon = \frac{2.00}{Ks} \times \varepsilon_0 \cdot E$$

where Ks: The gage factor of a gage in use

8-1-4 How to calculate when using strain-gage transducers

Using a strain-gage as its sensor, a strain-gage transducer detects and converts into an electric quantity such a physical quantity as load, pressure, torque, displacement or acceleration.

The CDV/CDA-700A series is dedicated to measurement of strain quantities. Hence the necessity for conversion of a measurement into a physical quantity when a strain-gage transducer was used as a sensor. This conversion uses a calibration factor or a rated output value stated in the calibration sheet of a strain-gage transducer.

(1) How to calculate a physical quantity using a calibration factor

Multiply a strain quantity you have obtained through a strain-gage transducer by a calibration factor described in the calibration sheet of that transducer, and the product will denotes a physical quantity.

[Example] Suppose that a strain quantity of 2900×10^{-6} strain was found, using a load cell, whose capacity and calibration factor is 2tf and 0.0004997tf (0.0049N), respectively. A load that was given can then be calculated as follows.

0.0004997 x 2900 = 1.44913 [tf]

(2) How to calculate a physical quantity using a rated output value

The calibration sheet that accompanies a strain-gage transducer states an output value (a rated output value or output voltage sensitivity) against a rated load given.

It is then possible to find a physical quantity in a manner almost like direct reading through adjusting this rated output together with a dynamic strain amplifier's calibration factor and output. Examples are given in the next page.

[Example] In the case that the CDV/CDA-700A is combined with the PG-5KU pressure transducer, whose rated capacity and rated output are 5kgf/cm² and 3993x10⁻⁶ strain, respectively.

Set the conditioner's calibration value to $3993\mu\varepsilon$, i.e. the transducer's rated output, and push the calibration execution key into the [+] position. Then adjust the range and the vernier so that you get an output voltage of 5.000V. After that, give a pressure to the transducer, and 5.000V will then come to correspond to 5kgf/cm².

[Example] In the case that the CDV/CDA-700A is combined with the an acceleration transducer, whose rated capacity and rated output are 20G (196m/S²) and 850x10⁻⁶strain, respectively.

Set the conditioner's calibration value to $850\mu\varepsilon$, then make adjustment so that you get an output voltage of 2.000V when you operate the calibration key, and 2.000V will then come to correspond to 20G.

When a recorder is use, make adjustment so that a swing width of 20 or 200mm is obtained on record paper when a calibration of value of $850\mu\varepsilon$ is entered, and either swing will corresponds to 20G.

8-1-5 Correction required to match an extension cable used

Laboratory measurement seldom requires an extension cable. In field measurement on the contrary, a measuring instrument will sometimes have to be remote from a measuring point. If that happens, you place a bridge box near to a measuring point, and use an extension cable to connect a bridge box to a measuring instrument. Measurement values thus collected inevitably contain measurement error induced by an extension cable in use. The longer an extension cable is, the larger measurement error grows.

Note, however, that the CDV-700A under remote sensing and the CDA-700A are free from error inducible to an extension cable.

To correct error induced by an extension cable simply, multiply measurement values by a suitable correction factor from among those stated in the table below. This correction method is not, however, still free from certain error effected by the kind of an extension cable and an ambient temperature.

To achieve more successful correction, see [4-15 User-specified registration function].

Table 8-1 Extended cable lengths VS. correction factors

Extended cable length / Bridge resistance	5m	25m	50m	75m	100m	200m
120Ω	1.000	1.016	1.032	1.049	1.066	1.132
350Ω	1.000	1.005	1.010	1.016	1.022	1.044

The cable contains correction factors applicable to KYOWA extension cable (0.5mm², 4-conductor shielded cab-tire cable).

8-2 Glossary of terms

- **Wheatstone bridge**
  A 4-arm bridge, whose opposite two arm connections respectively connect with a power supply and an ammeter. Used to detect micro resistance changes other than low resistances.

- **1-gage method**
  A measurement method using a bridge, whose one arm is formed by a strain gage.

- **2-gage method**
  A measurement method using a bridge, whose two adjacent or opposite arms are formed by strain gages.

- **4-gage method**
  A measurement method using a bridge, whose all four arms are formed by strain gages.

- **Output impedance**
  The impedance seen from the output terminal of an instrument which is under the operating condition.

- **Preheating time**
  Time required for an instrument to perform to its all specifications after it is switched on.

- **Unbalanced component**
  A residual voltage induced by the resistance deviation of a strain-gage bridge.

- **Balancing range**
  A range in which it is possible to correct the resistance deviation of a strain-gage bridge circuit. It is expressed in percentage to gage resistance.

- **Sensitivity**
  The ratio of a change in transducer output to a change in mechanical input under a certain condition which is set.

- **Gage factor Ks**
  The ratio of a change in resistance to a change in strain affected on a strain gage. It is normally 2 for strain gages formed by metal wire.

- **Bridge voltage**
  A voltage of power supplied to a Wheatstone bridge. Can be either AC or DC. The larger the bridge voltage is, the higher the output voltage of a Wheatstone bridge grows, and at the same time strain gages' self-heating keeps increasing. A proper bridge voltage must therefore be determined by considering the kind of a measuring object and that of strain gages.

- **Dummy gage**
  A gage which is used merely as a resistor to form a bridge.

- **Active gage**
  A gage which is placed where strain is generated.

- **Vernier**
  A device that makes possible a finer setting of a measuring instrument.

KYOWA

KYOWA ELECTRONIC INSTRUMENTS CO., LTD.

Overseas Department:

Address: 1-22-14, Toranomon, Minato-ku, Tokyo 105-0001 Phone:03-3502-3553 Fax:03-3502-3678

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