IM-A-365B '06.01

Dynamic Strain Amplifiers

DPM-700B

SERIES

Instruction Manual

KYOWA

Contents

Thank you for purchasing the DPM-700B series dynamic strain amplifier. Read this instruction manual carefully, in order to make full use of the amplifier's high performance capabilities.
Do not operate the amplifier in a manner other than instructed in this manual.

Preface

The DPM-700B series dynamic strain amplifier is a carrier type strain amplifier that incorporates an AC bridge exciting power. When compared to a DC type strain amplifier, a carrier type amplifier generally marks high stability, sensitivity and lower noise. In addition to these, the DPM-700B series comes with unique features as follows.

- A compact size
  Its cubic volume takes a small percentage of 86 to the conventional Kyowa dynamic strain amplifier.
- A digital panel meter and a bar-graph meter are standard provisions.
- Measuring parameters can be saved.
  Measuring parameters used lastly are stored in an internal nonvolatile memory when the amplifier is switched off.
- A dual output facility
  Two output systems, independent from each other, are provided.
- A bridge check function
  This function checks breaking of wires in the strain-gage bridge, and the panel meter indicates what wires are broken.
- Built-in comparators
  Two built-in comparators allow setting optional signal levels.

Be sure to operate the amplifier in the correct manner following the instruction manual. If you have questions, contact your Kyowa sales representative.

Standard accessories

The amplifier comes with the following accessories. After unpacking, check to be sure that they are included.

Mainframe	1
AC power cable	1
Conversion plug, CM-32	1
Output cable	1
Shortcircuiting plate	1
Fuses, midget type (0.5A and 1A)	1 set
Small screwdriver	1
Calibration sheet	1
Warranty	1
Instruction manual	1

Handling precautions

- **Avoid synchronous connection of the amplifier with an amplifier having a different carrier frequency.**
  The DPM-700B series amplifier can achieve carrier synchronization through parallel connection of OSC terminals. With a different carrier frequency, however, neither synchronization nor correct amplifier operation is possible.
- **Do NOT connect the amplifiers, whose SW1 switches are set to ON (INT) respectively.**
  When making synchronous connection of multiple channels, be sure to set SW1 switch to ON (INT) on one channel only, and all other channels to OFF (AUTO).
- **Perform balancing whenever the bridge voltage has been changed.**
  If SW3 switch is turned from OFF (2V) to ON (0.5V), and vice versa, the zero point can move.
- **Do NOT switch the amplifier off immediately after adjustment or setting, but wait for more than three seconds.**
  Adjusted values and set values are stored in the nonvolatile memory. If the amplifier is switched off immediately after values were entered, they can not be memorized correctly.
- **Pay attention to the setting position of the fine balance key.**
  A voltage can remain even after balancing was achieved if the position of the fine balance key is improper. The key's standard position is such a position as enabling the indication of zero when the range is set to OFF.
- **Avoid using in extremely high temperature environments.**
  The amplifier can perform to the specifications within a temperature range of −10 to +50°C. Prepare a sunscreen when using it in direct sunlight and keep it warm when using it outdoors in a cold district.
- **Avoid using in highly humid environments.**
  Use the amplifier under humidity below 85%RH. Exposure to rain or highly humid environments can cause internal trouble such as deterioration of the insulation resistance.
- **Avoid dusty environments.**
  Dust that entered the amplifier deteriorates its performance. Take care to keep the amplifier from dust both during operation and storage.
- **Be cautious about exposure to severe vibration.**
  The amplifier provides vibration resistance in conformity with MIL-STD-810C and performs against vibration as follows.

  In X, Y and Z directions.....
  vibration, 10 to 500Hz; acceleration 2G ($19.6m/s^2$):
  vibration, 5 to 55Hz; acceleration 3G ($29.4m/s^2$):
  sweeping time, 15 minutes per cycle —12 cycles

  Exposure to vibration in excess of the above can cause trouble or deterioration of the performance.
- **Carefully handle the amplifier during operation on DC power.**
  If the input or output cable comes in contact with the terminal of a battery, or if another instrument of PLUS grounding is used on a same power line, unexpected trouble can occur.

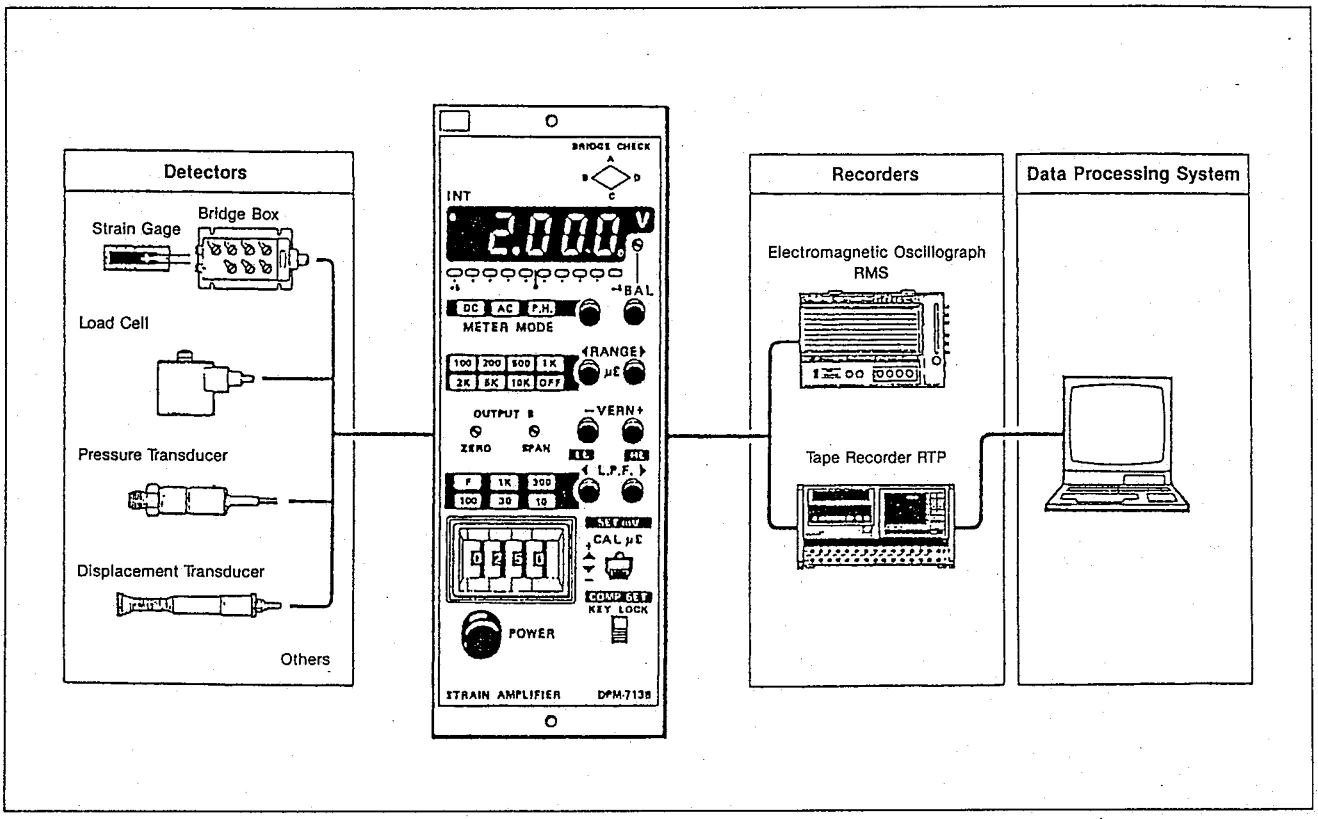
Devices used for the compilation of the manual

The following devices are used to compile the manual.

- The basic method of operation is introduced first, and the details of the functions are explained later.
- To express strain, "10^{-6} strain" or "$\mu m/m$" is used popularly. This manual uses "$\mu\epsilon$" pertaining to the on-panel indications, and "10^{-6} strain" when referring to strain in general.
- The words suffixed by "*" are explained in the glosary at the end of the volume.
- The value converted in an SI unit is given in parentheses after each conventional expression of a unit.

System configuration

Shown below is a general system configuration for measurement of dynamic strains.

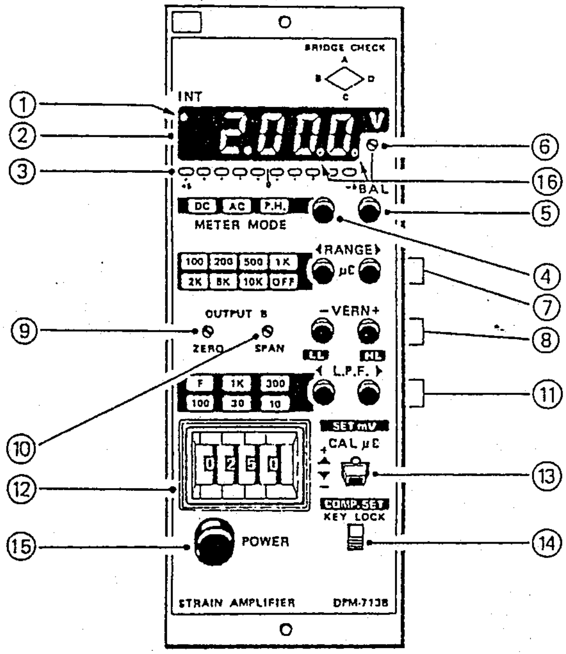


The dynamic strain amplifier DPM-700B series adopts the system configuration shown above, whereby its input terminal connects with a strain-gage transducer or a strain gage. For connection of the latter, a bridge box is used generally.
The strain amplifier amplifies minute voltage signals sensed by a strain gage, and provides an output of several volts after amplification in general cases. This allows connection of the amplifier directly to a recorder or a voltmeter.

To measure the magnitude of a strain converted in electric signals, a calibration signal is used. The amplifier uses a calibration signal that has been certified through a standrdizing equipment Kyowa maintains.
For how to use strain gages or about their applications, refer to the appendix in the end of this volume or "Instruction Manual—Kyowa Strain Gages."

1. Parts and functions

1-1 Front panel



① Internal indicator .... Illuminates when the amplifier is the source of a carrier frequency.

② Panel meter .... Indicates an output voltage from OUTPUT A in digital form.

③ Bar-graph meter .... Indicates an output voltage from OUTPUT A by the length of a bar. One LED segment corresponds to about 1V.

④ Meter mode selection key .... Used to select a meter mode from three—DC, AC and PH. (page 11) The LED on a mode illuminates when selected. "DC" mode is activated when the power is turned [ON].

⑤ Balance key .... Executes balancing when pushed two times within 0.5 seconds. (page 10) Checks wire breaking of the bridge when held down one time.

⑥ Fine balance key .... Used to achieve fine balancing after rough balancing was executed. (page 17)

⑦ Range selection keys, ◀ ▶ .... Renew a range when pushed. (pages 11 and 18) ◀ renews a range to a smaller one; and ▶, to a larger one. The LED on a range goes on when selected.

⑧ Vernier keys, [+] [−] .... Adjust voltages output from OUTPUT A and OUTPUT B when pushed. (pages 12 and 18) [+] key increases a voltage, and [−] decreases it.

⑨ Zero point trimmer on OUTPUT B .... Used to move the zero point on OUTPUT B. (page 17)

⑩ Span trimmer on OUTPUT B .... Used to adjust an output voltage on OUTPUT B. (page 15)

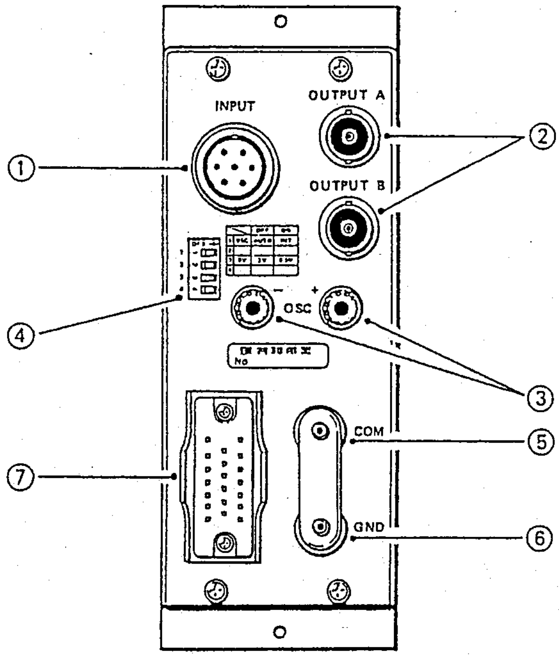
⑪ Low-pass filter selection keys, ◀ ▶ ...... Used to select a cutoff frequency of the low-pass filter. ◀ key goes to a smaller frequency, and ◀ key goes to a larger frequency. The LED illuminates on a selected frequency. (page 20)

⑫ Calibrator/comparator setter .... Used to set a calibration value or a comparator value using a four-digit number. (pages 11, 12 and 13)

⑬ Calibration key .... Enters a calibration value in OUTPUT A or OUTPUT B. When pushed up, it enters a [+ (plus)] value, and when pushed down, a]− (minus)] value. (page 21)

⑭ Key-lock/comparator mode key .... Locks the keys or sets a comparator mode when pushed up. (page 22)
⑮ Power switch .... Switches power [ON] when pushed. One more push switches power [OFF]. (page 9)
⑰ Comparator monitor .... Blinks in response to the two kinds of comparator outputs. (page 23)

1-2 Rear panel



① Input connector .... Connects with a strain-gage transducer or a bridge box. (pages 8 and 15)
② Output connectors—OUTPUT A and OUTPUT B ....
Provide output signals. Connect with a recorder or a voltmeter. (pages 9 and 15)
③ Synchronous signal input/output terminals ....
Used for synchronous operation of multiple units through parallel connection of [+] and [CON]. (page 24)
④ Synchronous signal selection switches . Used to set the oscillator to AUTO INT and to select a bridge voltage. Using SW1, select AUTO INT. Set SW1 to ON, and INT will be activated compulsively. When using multiple units of DPM series dynamic strain amplifier in parallel connection, set SW1 to ON on one unit only. (page 24)
Select a bridge voltage using SW3. Set SW3 to ON to select 0.5V, and to OFF to select 2V.
⑤ COM terminal.. It is connected internally to the common electric potential of the circuitry. (page 25)
⑥ GND terminal.. Grounding terminal. (page 6)
⑦ Converging connector .... Connects with power normally. When the amplifiers are housed in the carrying case, it enables to connect them with certain control signals. (pages 25 and 31)

2. Preparation

This chapter introduces how to use a single unit of amplifier.
For how to use multiple units (channels) housed in the exclusive carrying case, also read [5-5 Exclusive carrying case].

2-1 How to set up input/output instruments

Connect input and output instruments and power to the amplifier. An output instrument can be omitted in some cases.

(1) Input instrument
Prepare a strain gage or a strain-gage transducer. When using a strain gage, also prepare a bridge box.

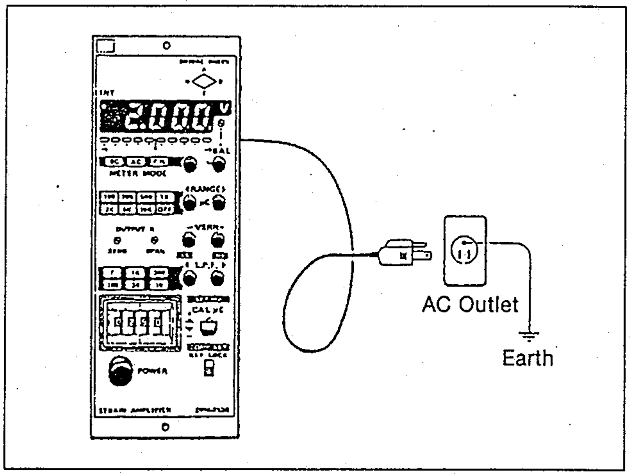
(2) Output instrument
Prepare a recorder or a voltmeter, which is necessary to read amplified signals.
The amplifier is provided with a digital panel meter, which lets you monitor its output.
Connect an output instrument to the amplifier using the output cable, an accessory.

2-2 Connection of power

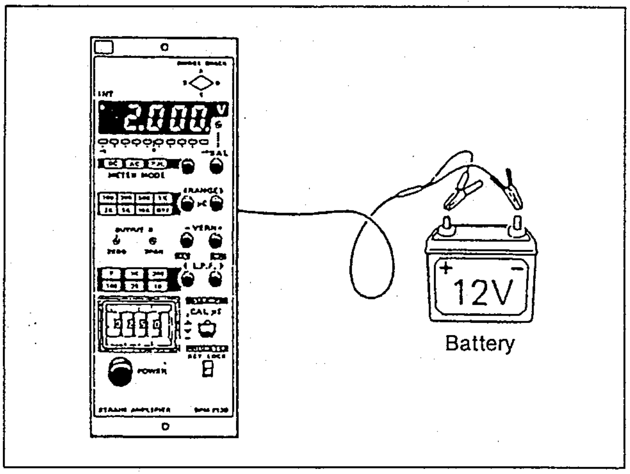
AC or DC power is required. In either case, make sure of a power voltage prior to connection.

(1) AC power
Using the accessory power cable, connect the amplifier to an AC power outlet (as shown at right).

> ***Caution***
> Ground the middle prong of the three-prong plug without fail.



(2) DC power
A DC power in a voltage range of 10.5V to 15V, or a battery is connectable.
A DC power cable is not attached to the amplifier. Therefore prepare a connector plug (HIROSE ELECTRIC's S-1620-C or the equivalent), then use it as shown at right.
For connection to the converging connector, refer to [4-15 Applications of the converging connector].



(3) Grounding
Be sure to carry out correct grounding, in order to prevent accidents and assure the safety of the operator.
When using AC power, connect the amplifier to a power source using the accessory AC power cable (3-prong). The grounding will then be carried out automatically.

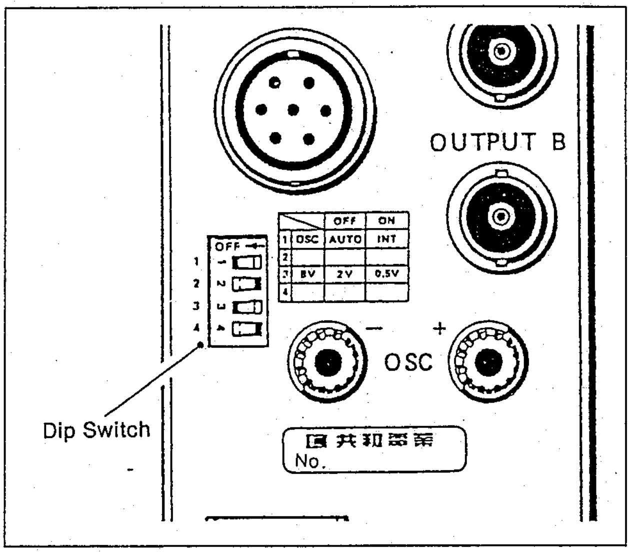
Caution

When using the accessory 3-prong to 2-prong conversion adaptor (NEMA plug), be sure to ground its earth terminal (green in color).

- L = Line
- N = Neutral
- E = Earth

2-3 Initial setting

Set SW3 switch provided on the rear to OFF.
SW1 can be set to either ON or OFF. For convenience, it is set to OFF at this time.
Note however that SW1 is not necessarily set to OFF when operating multiple units at a time. For this refer to [7-14 Carrier synchronization].



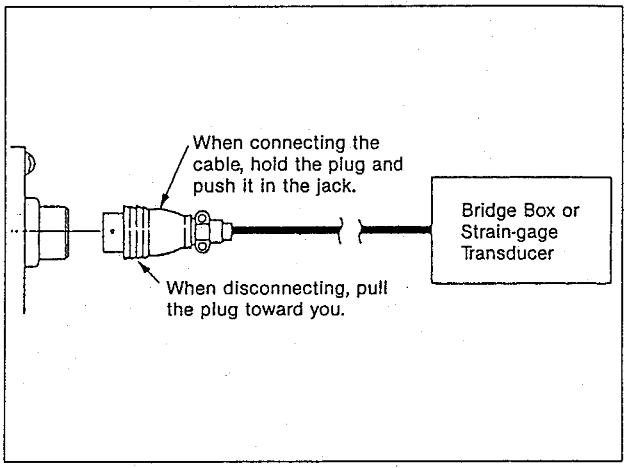
3. Basic operation

The method of basic operation is as follows.
If this is the first time that you use a Kyowa amplifier, proceed with the operation examples given below.
If you ever used it, you may not read all through.

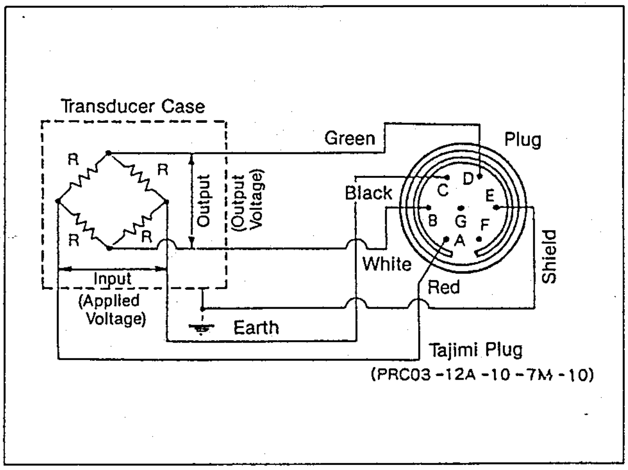
The instructions given in this chapter pertain to the usage of a single unit. For operation of multiple channels using the exclusive carrying case, refer alto to [5-5 Exclusive carrying case].

3-1 Connection of input

Connect a strain gage (via a bridge box) or a strain-gage transducer to the amplifier's input connector.
If the end of the connection cable of a strain-gage transducer is formed by a 7-pin plug (a TAJIMI MUSEN product), insert it into the input connector directly as shown at right.

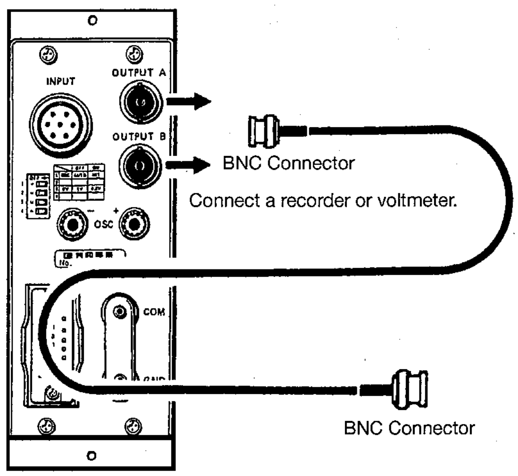


If the connection cable of a strain-gage transducer comes without a plug on its end, or if a strain gage is to be connected directly, either of the following two methods can be used.
In one method, connection is made via a bridge box.
In the other method, the leadwires of a sensor are connected to a plug in advance, then the plug is connected to the amplifier's input connector. Use a plug whose specifications conform with PRC03-12A10-7M10, a product of TAJIMI MUSEN.
For connection of a strain gage, a bridge box can be conveniently used.



3-2 Connection of output

The amplifier provides two output systems—OUTPUT A and OUTPUT B.
These systems are independent of each other. Therefore, two external instruments can be connected at a time.
The both output terminals accept a BNC plug.
Use the accessory output cable to connect an external instrument. The output impedance* is rated at about 2Ω on either terminal.
So set an external instrument that it can measure DC voltages.

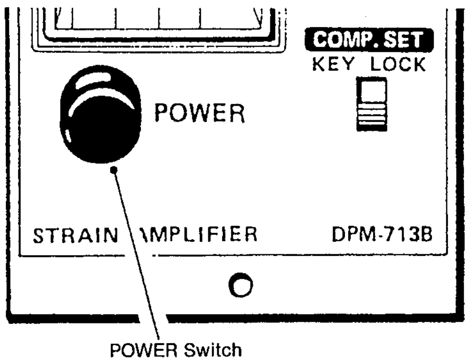


3-3 Switching power ON and OFF

Switching power ON and OFF is most important. So read the following instructions carefully.

3-3-1 Switching power ON

Prior to switching power ON, make sure of correct connection of the input connector and that of power.
About connection of these, read the following:
[2-1 Setting up input/output instruments],
[3-1 Connection of input], and
[3-2 Connection of output].
At this time, all LEDs except the LEDs on the bar-graph meter illuminate for about five seconds. Subsequently, the following conditions are effected.



Panel meter .... Illuminates in green. The indication can vary according to the actual state.
Bar-graph meter........... LEDs illuminate in an approximately same range as the indication on the panel meter.
Meter mode .... Goes to [DC] mode all the time.
Range .... Is set to the internal memory value.
Low-pass filter .... Is set to the internal memory value.

Caution

If Er- - 1 should appear after illumination of all LEDs, it is the indication of abnormality that has occurred to the control program. If such is the case, contact Kyowa or your local Kyowa representative.

3-2-2 Switching power OFF

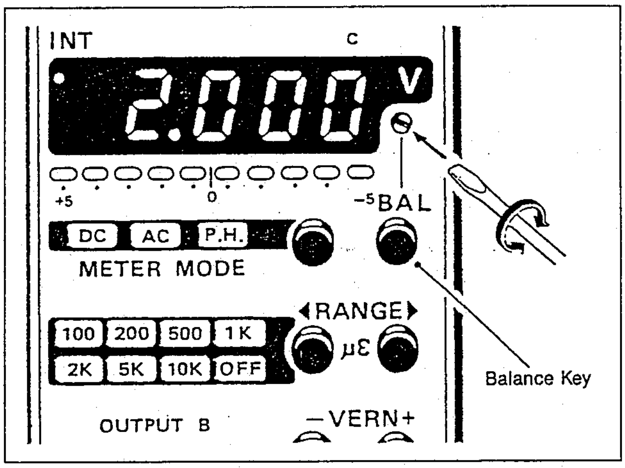
Push the power switch. All displays will then go out. At this time, the following measuring parameters are maintained by the memory.

Balancing parameter
Range parameter
Vernier parameter
Low-pass filter parameter
Comparator parameter

> ***Caution***
>
> The DPM-700B series dynamic strain amplifier maintains all measuring parameters in its internal nonvolatile memory all the time.
> However, saving of parameters can fail if the power is switched off immediately following their renewal.
> To prevent it, be sure to switch the power off more than three seconds after parameters were modified or renewed.

3-4 Basic balancing

The amplifier performs balancing completely electronically.
Make sure that incoming signals are connected, then push the balance key two times within 0.5 seconds. Balancing will then be carried out irrespective of the setting conditions of other parameters such as Range.
After balancing is executed by pushing the balance key, the panel meter will not necessarily read exactly 0 but several millivolts that remain. In this case, carry out fine balancing using the fine balance key provided immediately above the balance key.
Turn the fine balance key using the accessory small screwdriver. A clockwise turn increases the reading, and a counterclockwise turn decreases it.



3-5 Setting measuring parameters

Setting a proper range and calibration value is very important for strain measuring. When compared to the two parameters, other parameters are not important.

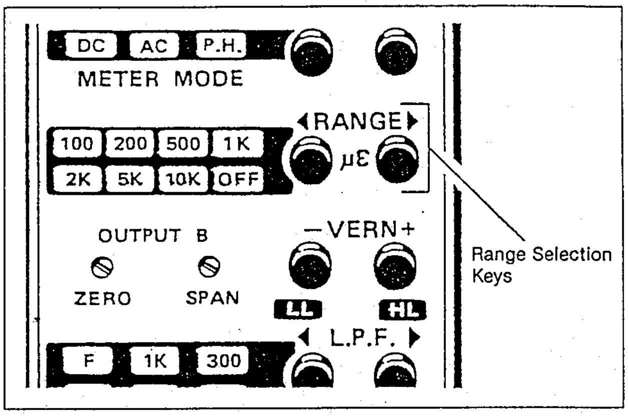
3-5-1 Setting a range

It is necessary to set a measuring range properly to assure the correct strain measuring. Introduced here is the basic method of selecting a range. For the details, refer to [4-8 Ranges].

First estimate the magnitude of a strain to be measured.

With a strain-gage transducer, devise the smallest possible range value from its rated output. The rated output of a transducer is found in its calibration sheet. When once the proper value of a range has been devised, also take a specific measuring condition into account, and thus set an optimum measuring range.

With a strain gage, estimate the magnitude of a strain with due regard to the material and construction of a measuring object. Then set a range depending on the estimate. By way of example, we select a range of <u>5k (5000) $\mu\epsilon$</u> here.

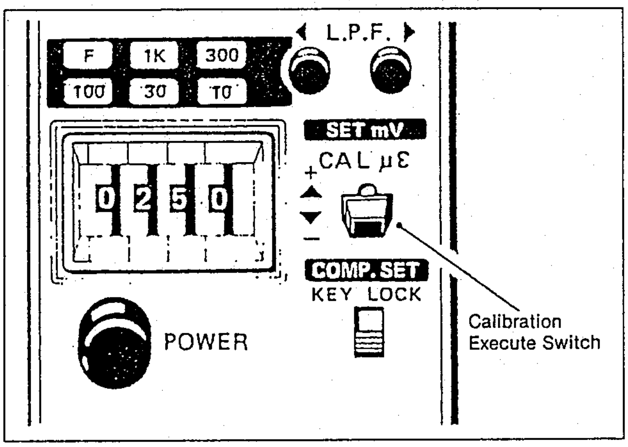


3-5-2 Setting a calibration value

When measuring signals incoming from strain-gage transducer, set a calibration value that meets its rated output.

When measuring signals incoming from a strain gage, its strain output should be grasped in advance. Where repeated loading is allowed, apply a load to it, discover its output then set a value that meets the output.

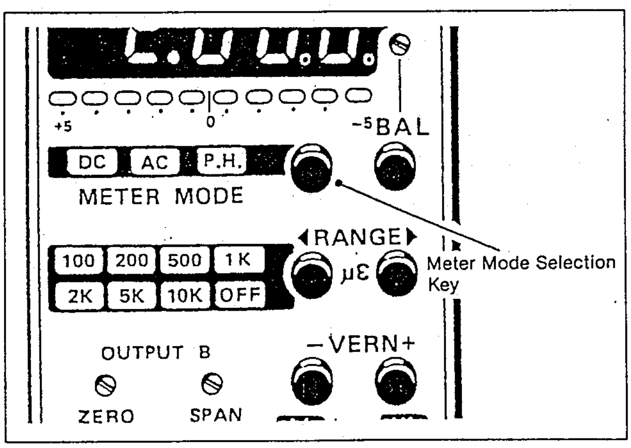
By way of example, we set <u>5k (5000) $\mu\epsilon$</u> same as the range.



3-5-3 Setting a meter mode

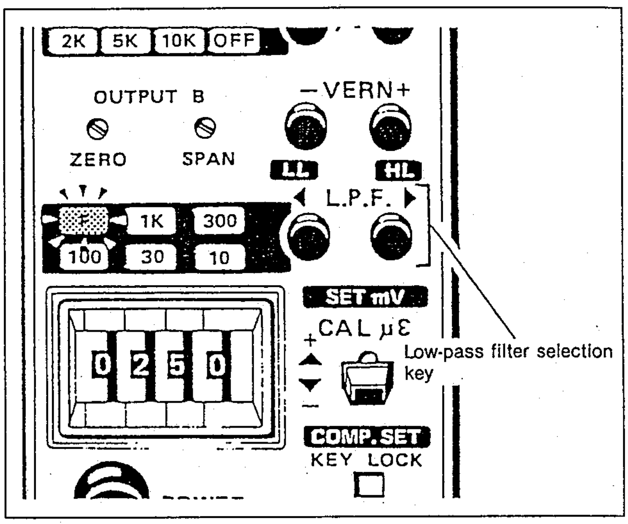
Set a meter mode to DC. This mode is automatically activated by switching the amplifier ON.

DC voltage cannot be monitored with a mode other than DC.



3-5-4 Setting the low-pass filter

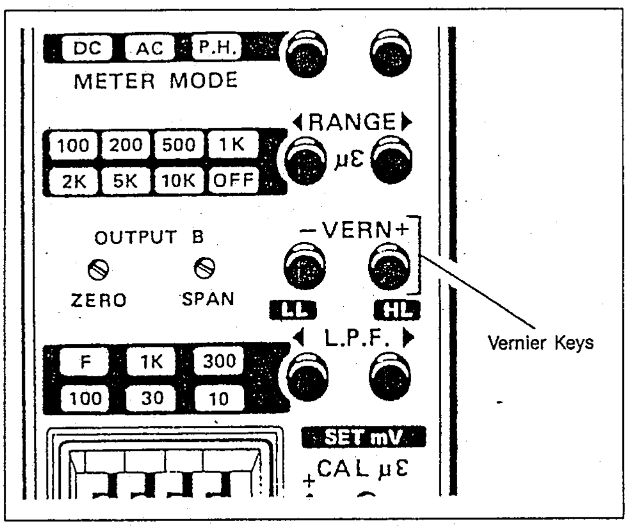
The low-pass filter is used to set limits to the frequency range of outgoing signals normally. As a routine, however, set the filter to "F" (pass), thereby inactivating the filtering function.
For the details, refer to [4-10 Low-pass filter] and [8-2 Low-pass filter characteristics].



3-5-5 Setting the vernier

Using the vernier, adjust OUTPUT A which is available when a calibration signal is entered.
By way of example, we adjust OUTPUT A to 2.000V as follows.

(1) Push the balance key two times during 0.5 seconds. The panel meter reads a voltage of OUTPUT A. This reading is approximately 0V.
(2) Using the fine balance key, obtain a reading of exactly 0.
(3) Push the balance key up and let it stay in that position.
(4) While holding the balance key in the up position, push [+] VERN key if the panel meter reads a value below 2.000V, or push [−] VERN key if the panel meter reads a larger value.
A continuous push of [+] or [−] VERN key will effect a sharp increase or decrease in the reading. To achieve fine adjustment, immediately remove the finger from either key.

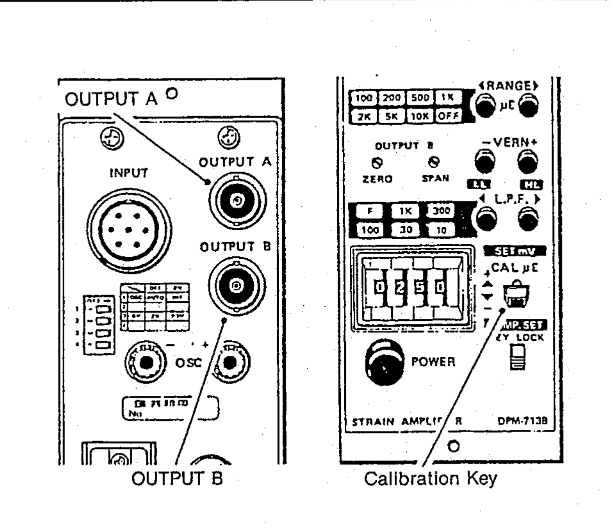


3-6 How to monitor the output

Different methods will be used to monitor OUTPUT A and OUTPUT B.

3-6-1 How to monitor OUTPUT A

Observe the reading on an external instrument connected to OUTPUT A. (We call this instrument an "output instrument hereafter.)
Approximately 0 will read where the calibration key is not operated.
Push the calibration key into the up position, then confirm a reading of approximately 2.000V on the output instrument connected to OUTPUT A.



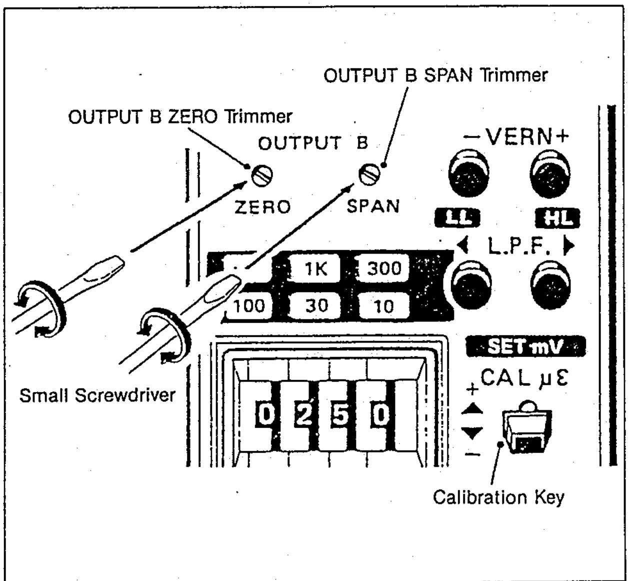
Caution

The indication on the panel meter may not necessarily agree with the reading on an output instrument connected to OUTPUT A.
This is so because the instruments have their respective reading error.

3-6-2 How to monitor OUTPUT B

OUTPUT B presents an output that comes through the span adjusting device and the zero adjusting device. Using OUTPUT B ZERO trimmer and OUTPUT B SPAN trimmer, adjust the zero point and an output voltage respectively as instructed below.

(1) Turn OUTPUT B SPAN trimmer to the clockwise turning end, using the accessory screwdriver.
(2) Turn OUTPUT B ZERO trimmer using the small screwdriver, and thereby read 0V on an output instrument while holding the calibration key in the up position.
(3) Hold the calibration key in the up position.
(4) Turn OUTPUT B SPAN trimmer, and thereby read 2.000V on an output instrument.
Remove the finger from the calibration key.
(5) If the zero point should drift after adjustment using OUTPUT B SPAN trimmer, carry out (2) and (4) processes again.
By all this, the two different instruments' respective outputs are set to an approximately same condition.



3-7 Let's actually operate the amplifier

So far, general settings have been completed. Let's now operate the amplifier actually, using different measuring parameters case by case.

(1) Vary the input to the amplifier.

If the connected sensor is a strain gage, give a force to it.

If the connected sensor is a strain-gage transducer, vary its output somehow.

While giving varied inputs to the amplifier, observe its output voltages on the amplifier's panel meter or on the connected output instrument.

Conform varied outputs from the amplifier. Also confirm varied indications on the bar-graph meter.

Roughly grasp variations in output against varied inputs.

Because the range has been set to 5k (5000) $\mu\epsilon$, variations in output might be slight.

If such is the case, renew the range to 2k$\mu\epsilon$ or 1k$\mu\epsilon$ so that the amplifier's sensitivity will grow. Set the calibration value setter to a same value as the range.

(2) Let's measure the amount of a strain.

Push the calibration key into the up position. A positive calibration value will then appear in the output.

Compare this voltage with the voltage gained against a varied input given as above.

You will then find an approximate amount of the strain that occurred, using the following equation.

$$\text{Amount of strain } [10^{-6} \text{ strain}] = \frac{\text{Voltage [V] against varied input}}{\text{Output voltage [V] when calibrated}} \times \text{CAL value}$$

Change some of the foregoing parameters, then take exercise.

4. Functions

This chapter aims to introduce all the amplifier functions in detail as well as the advanced usage.

4-1 Input

This amplifier is designed exclusively for measuring strains. The connectable sensors are as follows.

- **Strain-gage bridge box**
  It is better not to connect a strain gage alone to the input terminal normally. Purchase and use a bridge box together. For how to use a bridge box, refer to [5-1 Bridge box].
- **Strain-gage transducer**
  For how to connect a strain-gage transducer, refer to [3-1 Connection of input].

> ***Caution***
> Avoid using instruments or sensors other than the above, or else the amplifier will not function properly. Also avoid to connect one input instrument to another, or else the amplifier will get out of order.

There is no limit to a maximum strain to be input whilst the amplifier operates normally in a range up to approximately 7500×10^{-6} strain at a bridge voltage of 2V; and up to 300000×10^{-6} strain at a bridge voltage of 0.5V. (Refer to Table 4-1.)
When using a bridge box, be sure also to use shielded cables to connect strain gages to the amplifier, in order to reduce induction noise. If a parallel vinyl cable is used, the performance of the amplifier cannot be guaranteed.
Where a large amount of strain is input or a range value is too small, the indication will blink on the panel meter. If it occurred, increase the range value till the indication stops blinking.

4-2 Output

The amplifier is provided with two independent output systems. The two output terminals can be connected to two different external instruments including recorders.
Even if one output system should get out of order, it does not affect the other.

4-2-1 Voltage output

Both OUTPUT A and B enable an output of over ±5V against a load of over 5kΩ. The output levels and zero points of OUTPUT A and B can be adjusted using the vernier key and the fine balance key, respectively.
These adjusting devices increase the value when turned clockwise, and decrease the value when turned counterclockwise.

4-2-2 Current output

Both OUTPUT A and B can output ±10mA peak, minimum, against a 30Ω load. How to adjust these current outputs is same as voltage outputs.

> ***Caution***
> It is impossible to get current outputs from both OUTPUT A and B at the same time.
> Be sure to set either OUTPUT A or B to the voltage output mode.

4-3 Preheating

When once the amplifier has been switched on, it will be ready for operation immediately. Note however that the internal electrical parts and semiconductors cannot acquire the thermal stability immediately after switching the power on. Unless the carrier wave oscillation circuit, especially, reaches the thermal stability, a change in the sensitivity* or a drift of the zero point can be caused.
It is, therefore, necessary to warm the amplifier for about 10 to 15 minutes before starting operation.
Especially when microstrains of several 100×10^{-6} are to be measured or when measuring is to extend over a long time, carry out preheating for about 30 to 60 minutes.

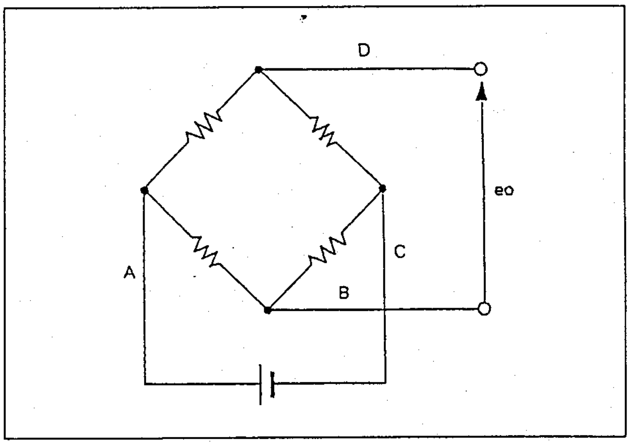
4-4 Checking the bridge

The amplifier is provided with a bridge-checking function. This function is used to check cable breaking on the whole input system, including the input cable and connector.
The results of a check is indicated on the panel meter. This indication is maintained during a push of the balance key.
If an indication other than Good appears, check and remove the cause from the input system, including the wiring to and from the sensor.
Otherwise, a correct measurement cannot be carried out.
To remove the cause, act as follows. First, switch the power [OFF], then remove the sensor cable from the input connector. After that, carry out a check on cable breaking.

Caution

Before attempting to remove the cause, be sure to switch the amplifier off.

As a matter of convenience, the wirings to the bridge are named as shown in the figure at the upper right. If error is found on Wiring A through the bridge check function, Er-a will appear on the panel meter.
Even if error exists on two wirings, the name of just one wiring will show. Therefore, proceed with checking wirings one after another as follows.
To begin with, check the wiring whose name is on the monitor meter, then remove the cause.
After that, push the balance key again, and the error indication will then disappear if there is no more error. If another or other wirings are in error, the name of a next wiring will be shown by Er-b, Er-c, or Er-d, one each at a time.



So you check the sensor and the indicated wiring to the sensor, then remove the cause of error one by one so that no error indication will appear finally.
For the relation between locations of error and error indications, refer to [8-1 Bridge check function and result indications].
The results of a bridge check is available as bridge status signals at the converging connector on the rear panel. For more details, read [4-15 Applications of the converging connector].

Caution

The indication of Er-2 appearing on the panel meter reflects a malfunction of the check circuit itself. Should it happen, contact Kyowa or your Kyowa representative.

4-5 Balancing

Both resistive and capacitive unbalance signal components* exist on a strain gage bridge. These unbalance components should be removed through balancing, in order to achieve high quality measurement.

4-5-1 Balancing range

Resistive unbalance can be reduced to ±2%, i.e. $\pm 10000 \times 10^{-6}$ strain. Capacitive unbalance can be adjusted up to 2000pF.

Resistive balancing is carried out using a single switch.

Capacitive unbalance is cancelled all the time by the internal compensation circuit.

4-5-2 Balancing

To begin with, select the DC meter mode by pushing the balance key two times within 0.5 seconds. This is all you have to do to execute balancing.

The panel meter lets you know if or not balancing has been carried out correctly. The meter indication of approximately 0 (zero) reflects correct balancing. An indicated value within a range of ±20mV can be taken as normal.

If the panel meter indication should blink or a large value should appear, it is the indication of some error. Should it happen, discover the cause by referring to [6-2 Initial balancing is impossible].

Balancing can also be carried out using an external signal. For this, refer to [4-16 Remote control].

Notes

- Selection of a meter mode other than "DC" imposes no problem for balancing.
- The CPU controls balancing to minimize remaining volts.
  If one time of balancing is not enough, repeat balancing a few times. In that case, one time of balancing may require up to 3 seconds, but this does not reflect any error.

4-6 Moving the zero point

The zero point of OUTPUT A and B can be removed. This function can be conveniently used to move the base line of an external instrument.

Different methods and moving ranges are used on OUTPUT A and B.

OUTPUT A: ±0.1V or more. Use the fine balance key.

OUTPUT B: ±0.1V or more. In addition, ±30mV or more (this only on OUTPUT B). Use the fine balance key or the OUTPUT B ZERO point adjustor.

Selection of the "DC" meter mode lets you observe the OUTPUT A ZERO point on the panel meter.

Notes

- OUTPUT B ZERO point can be removed using either fine balance key or OUTPUT B ZERO point adjustor. But, use of the fine balance key affects both OUTPUT A and B.
- Therefore, first move OUTPUT A ZERO point using the fine balance key. After that, move OUTPUT B ZERO point using OUTPUT B ZERO point adjustor.

4-7 Meter modes

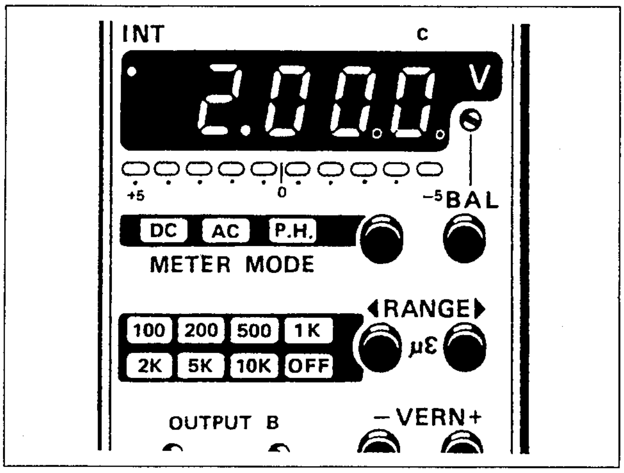
The panel meter lets you monitor OUTPUT A. Also on the panel meter, you select a suitable mode using the meter mode selection key. Three monitor modes are provided. They are DC, AC and PH modes.

- **DC mode**
  The DC mode presents all signal components including DC components.
  Use this mode for operation of the balance key or the calibration key.
- **AC mode**
  The AC mode presents only AC signal components after removal of DC components. In other words, the mode presents the variations contained in strain signals.
- **PH mode**
  The PH mode presents the absolute peak value of a signal, positive or negative. This mode always presents a peak value detected. So a peak value is held until it is replaced by a larger value.
  To cancel a value which is being held, activate the DC mode once, then switch it to the PH mode again.

4-8 Range

Selection of the largest range of 10kμε lets you cover all measuring ranges.
With this range, however, a maximum output is rated at as small as 20mV or thereabout against a strain input of 100×10^{-6}. This means poor precision of measuring.
By contrast, a small range causes saturation against a large strain input.
Accordingly, a range should be so selected as to meet the amount of a strain to be measured.
The amplifier provides eight ranges in all. They are 100, 200, 500, 1k (1000), 2k (2000), 5k (5000), 10k (10000) με, and OFF.
The smaller a range is selected, the larger a gain becomes, resulting in larger noise.
If the range is set to [OFF], neither a calibration value nor a strain signal output is available.
To select a range, use the range selection keys, ◀ and ▶.
An output voltage of approximately 2V is obtained against a strain input of the range value, provided that VERNIER is set to its maximum and the bridge is excited by 2V.
Refer to [4-9 Vernier] for its details. How to select the range suitable for a sensor in use is introduced below.
For reference, the relation between range values and strain magnitudes is shown in Table 4-9.

> **Note**
> The range is interlocked with the vernier. So you can select an optimum range using the vernier alone.



4-8-1 When using a strain gage

Select an optimum range for a strain gage as follows.

(1) Estimate the amount of a strain to be measured.
(2) Select a range which is larger but nearest to the estimated amount of a strain. The value of a range means the amount of a strain.
(3) Push up the Calibration key and continuously push [+] or [−] VERN key to have the output voltage of 2V.

4-8-2 When using a strain-gage transducer

A strain-gage transducer has a fixed rated output, which is expressed by a unit of mV/V. It then indicates an output voltage per volt of bridge excitation power against a rated capacity.
A Kyowa strain-gage transducer comes with a calibration sheet stating its strain output. Select a range which is smaller and nearest to this strain output.

Even if the calibration sheet of a strain-gage transducer does not introduce its strain output, a strain output can be calculated as follows by using a gage factor Ks.*
Convert a rated output in μV/V, then multiply it by a gage factor Ks.

Example
Here's how to select the optimum range for a strain-gage transducer, whose output is rated at 1.567mV/V and whose gage factor is 2.00.
1567μV/V is obtained by converting the rated output in μV/V.

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

So you select a range of 5k (5000) με.
When using a strain-gage transducer at a half of the rated output, it is preferable to double the sensitivity from a viewpoint of reduction in noise.

Example
How to select the optimum range for a strain-gage transducer, whose rated output is 1.567mV/V and gage factor is 2.00, when using it at 20% of its rated output. 20% of a rated output means 626.4x10^{-6} strain. So select a range of 1k (1000) με.

Reference
Where the range is set at 5k (5000) με and VERN at its maximum, a voltage of about 2V is available at OUTPUT A against an input of 5000x10^{-6} strain, equal to the range.

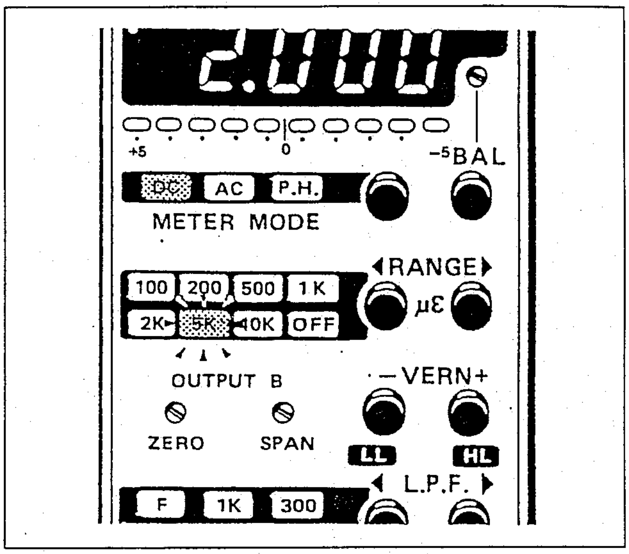


Table 4-1 Range values and strain magnitudes

Range (με)	Vernier (VERN)	Calibration values and measurable strain magnitudes			
		Bridge voltage: 2V		Bridge voltage: 0.5V	
		Measuring range (x10^{-6})	CAL (με)	Measuring range (x10^{-6})	CAL (με)
100	MAX	1 to 250	1 to 250	4 to 1000	4 to 1000
	MIN	Approx. 3 to 750	3 to 750	Approx. 12 to 3000	12 to 3000
200	MAX	2 to 500	2 to 500	8 to 2000	8 to 2000
	MIN	Approx. 6 to 1500	6 to 1500	Approx. 24 to 6000	24 to 6000
500	MAX	5 to 1250	5 to 1250	20 to 5000	20 to 5000
	MIN	Approx. 15 to 3750	15 to 3750	Approx. 60 to 15000	60 to 9999
1k	MAX	10 to 2500	10 to 2500	40 to 10000	40 to 9999
	MIN	Approx. 30 to 7500	30 to 7500	Approx. 120 to 30000	120 to 9999
2k	MAX	20 to 5000	20 to 5000	80 to 20000	80 to 9999
	MIN	Approx. 60 to 1500	60 to 9999	Approx. 240 to 60000	240 to 9999
5k	MAX	50 to 12500	50 to 9999	200 to 50000	200 to 9999
	MIN	Approx. 150 to 37500	150 to 9999	Approx. 600 to 150000	600 to 9999
10k	MAX	100 to 25000	100 to 9999	400 to 100000	400 to 9999
	MIN	Approx. 300 to 75000	300 to 9999	Approx. 1200 to 300000	1200 to 9999

NOTE: Typical calibration values are shown.

4-9 VERNIER (VERN)

The VERNIER supplements the function of a range for OUTPUT A and B. It adjusts a range by multipling it by 1 to 1/1.25. If an attempt is made to adjust a range exceedingingly, a range itself is switched to another automatically. This means that the operation of VERNIER alone enables an approximately continuous change of the sensitivity from minimum to maximum.
To increase the sensitivity, push [+] VERNIER key; and to decrease, push [–] VERNIER key.
To operate VERNIER keys, first set a certain value to the calibration value setter in advance. Subsequently, operate the keys while holding the calibration key in the up or down position, and watching panel meter indications.
VERNIER provides four working speeds according to how [+] or [–] key is pushed. An immediate removal of the finger from either key changes the sensitivity by approximately 1mV.
The longer time the key is pushed, the faster it changes the sensitivity. If VERNIER is working fast, you cannot read panel meter indications.
In order to set the sensitivity to an optimum value, remove the finger from the key for once, then push either [+] or]–] key shortly, and thus carry out fine adjustment.

Example
Where the range is set to 1k (1000) $\mu\epsilon$, and the calibration setter to 2000$\mu\epsilon$, respctively, push the calibration key, the panel meter then reads 1.260V. Here's how to set this reading to 2.000V.

(1) Push and keep the calibration key in the up position.
(2) Push [+] VERNIER key. Suppose that a continuous push for about 6 seconds has resulted in a reading of 2.2025V on the panel meter.
(3) This reading is too large. So push VERNIER [–] key to read approximately 2.000V. Lastly, push [+] and/or [–] key for a short time and thus obtain a reading of 2.000V.

> ***Caution***
>
> If VERNIER is adjusted to the full extent, the zero point may happen to move by 10mV or thereabouts.
> If it should happen and if necessary, adjust the zero point again using the fine balance key.

4-10 Low-pass filter

The amplifier incorporates a low-pass filter of the amplitude flat characteristic (i.e. 2-pole Butterworth characteristic).
Five cut-off frequencies are provided, including 10, 30, 100, 300 and 1kHz, in addition to [F], flat.
At the point of a cut-off frequency selected, the amplitude is delayed by about 70%, and the phase is delayed by 90 degrees against the flat region.
The cut-off characteristic is rated at –12dB/Oct. This means that the amplitude attenuates to one fourth when a frequency is doubled in the cut-off region in excess of a cut-off frequency.
The low-pass filter plays the following roles.

(1) Removes the unnecessary high-frequency components from a strain signal.
(2) Determines the overall characteristic of a measuring system including a strain gage or a strain-gage transducer.
(3) Unifies the characteristics of data paths for simultaneous multi-point measuring.

To select a cut-off frequency, use the low-pass filter selection keys, ◀ and ▶.
When strain signals vary in the form of sine wae (sinfunctionally), set the low-pass filter to a cut-off frequency from two to five times larger than the signal frequency of strain signals that are to be measured.
The low-pass filter's characteristic is shown in item [5-2].

> ***Caution***
>
> With a low-pass filter of the amplitude flat characteristic, the phase delay becomes unproportionate with the frequency nearby a cut-off frequency in use. Accordingly, fast rising or falling signals that pass the filter will cause an overshoot. To prevent it, set the low-pass filter to a cut-off frequency about 10 times larger than the frequency of strain signals.

4-11 Calibration value

A calibration signal (a reference strain signal) is used to measure the amount of a strain.
The value of this calibration signal is set to the calibration value setter, provided on the front panel, using a positive four-digit integer.
The calibration value is settable in a range from 1 to 9999$\mu\epsilon$ by an increment or decrement of 1$\mu\epsilon$.
You need to estimate the amount of a strain in order to find and set a proper calibration value to the amplifier.

4-11-1 When using a strain gage

When it is possible to estimate the amount of a strain that will occur, use the estimate as the calibration value also when using a strain gage.
If it is not possible, we recommend this expedient measure. Begin with an expedient value, and modify it subsequently in a manner to meet the actual amount of a strain signal.
When the amount of a strain is estimated at approximately 950x10^{-6} strain, for example, use a calibration value of 900 to 1000$\mu\epsilon$.

4-11-2 When using a strain-gage transducer

A strain-gage transducer has its own rated capacity. The calibration sheet of a strain-gage transducer shows the strain output against its rated capacity. Referring to this output, set a suitable calibration value.
For your information, we introduce a few samples below. They are just samples and do not mean that they should be followed at all times.

Example
What a measuring condition can be when using a load cell, whose capacity is 2tf (19.6133kN) and calibration coefficient is 0.0004997tf (0.0049N)/10^{-6} strain, for measuring a load within the rated capacity.
A strain output against a rated capacity of 2tf is calculated as:

$$2 \div 0.0004997 = 4002.4 \ (\text{x}10^{-6} \text{ strain})$$

Accordingly, set the range to 2k (2000) $\mu\epsilon$, and the calibration value to 4002$\mu\epsilon$.
After calibration was carried out, adjust an output voltage to 2.000V, and the relation will be then made simple between an output voltage and the amount of a load.

Example
What a calibration value can be for the combination of the amplifier and the PG-5KU pressure transducer, whose capacity is 5kgf/cm^2 (490kPa) and rated output is 3993x10^{-6} strain.
In this case, set a calibration value of 3993$\mu\epsilon$, which is the rated output of the transducer. After calibration was carried out, adjust an output voltage to 5.000V.
If so, 5.000V comes to correspond to 5kgf/cm^2.

Example
What a calibration value can be for using a strain-gage transducer at 20% of its rated capacity. This transducer's output is rated at 1.567mV/V.
Converted into μV/V, it amounts to 1567μV/V.
Accordingly, the rated strain output is calculated as:

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

The transducer is to be used at 20% of its rated output, and so its output is as small as:

$$3134 \times 0.2 = 626.8 \ (\text{x}10^{-6} \text{ strain})$$

The calibration value is then set to 626$\mu\epsilon$, and the range to 1k (1000) $\mu\epsilon$.

4-11-3 Entering a calibration value

Use the calibration key to enter a calibration value that was set using the calibration value setter.
Pushing the key into the up position from the neutral position enters a [+ (plus)] value, and pushing into the down position enters a [– (minus)] value.
A calibration value is entered during a push into the up or down position. It is also possible to enter a calibration value remotely using an external control signal.
For a remote control signal, read [4-16 Remote control].

Caution
When executing calibration, there will be a momentary pause before the panel indication changes. But this does not reflect any error.

4-12 Key-lock

A key-lock function is provided. Use this key-lock function in order to prevent the measuring parameters from changing at the time when the keys are touched by mistake.
The following functions can be locked.

- Execution of balancing
- Range
- Vernier
- Low-pass filter
- Meter mode selection
- Execution of calibration

To activate the key-lock function, set the key-lock key to the up position. It is also possible to activate the function using a remote control signal. For remote control signals, read [4-16 Remote control].

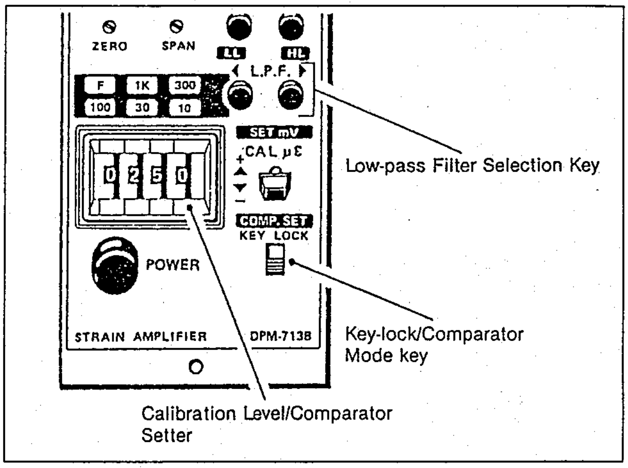
4-13 Comparator output

The DPM-7000B dynamic strain amplifier is provided with two comparators.
Their outputs respectively respond to HL (High Level) and LL (Low Level) values which have been set. Both HL and LL values can be set in a range from ±1mV to ±9999mV by an increment or decrement of 1mV.
The setting of an HL or an LL value is valid against only the value indicated on the panel meter.

4-13-1 Setting a comparator level

To set an HL or an LL value, proceed as follows.

(1) Set the key-lock/comparator mode setting key to the up position.
(2) Push the low-pass filter selection key, ◀, and the present LL value will then appear on the panel meter. By a push of the ▶ key, the present HL value will appear.
(3) Set a suitable four-digit positive integer to the calibration/comparator setter.
(4) While holding down the low-pass filter selection key, ◀, push the calibration key into the up position, and the LL value is replaced by a + (plus) value. By a push of the key into the down position, the LL value is replaced by a – (minus) value.
(5) In the same manner as above, while holding down the low-pass filter selection key, ◀, push the calibration key into the up position or down position, and the HL value will then be replaced by a + (plus) or – (minus) value. The replacements are indicated on the panel meter.

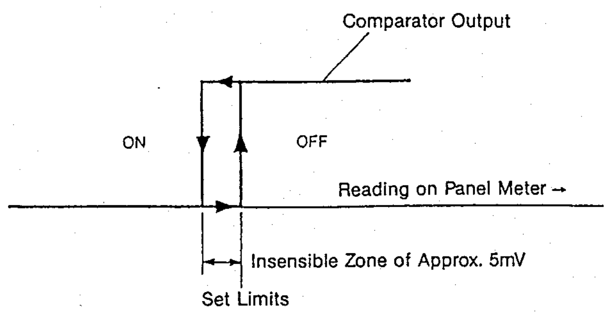


(6) Set the preceding calibration value to the calibration/comparator setting key.
Then push the calibration key into the up or down position.
The preceding calibration value will then appear on the panel meter for convenience.
(7) When once the setting has been completed, return the key-lock/comparator key to the down position. But if the key-lock function is to be maintained, you need not do it.

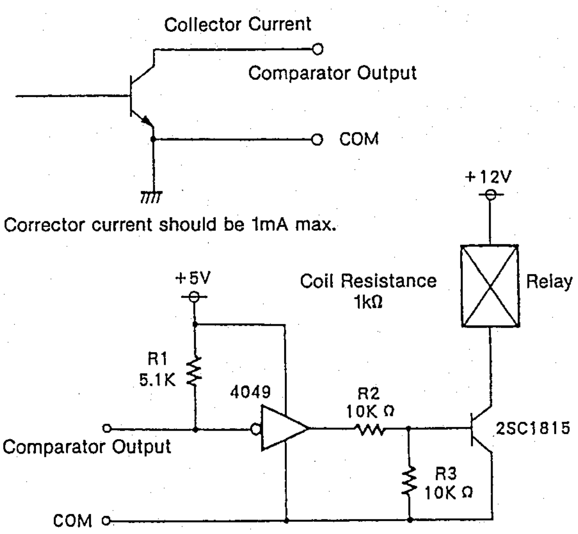
4-13-2 Comparators' output characteristics

Two types of comparator outputs are provided—HL and LL.
These are open collector outputs that turn [ON] when the following requirements are satisfied.
The relation between theses signals and the values indicated on the panel meter is shown at right.

HL: Turns [ON] when the value on the panel meter has exceeded the HL value which was set.
LL: Turns [ON] when the value on the panel meter has exceeded the LL value which was set.



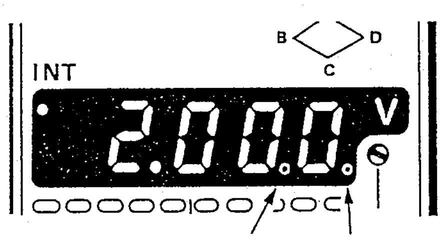
Comparator outputs, HL and LL, are connected to the converging connector provided on the rear panel. For the details, refer to [4-15 Applications of converging connector].
Shown at right are the internal circuit for comparator outputs as well as the circuit recommended for external connection.
For information, the YB-500 series exclusive carrying case is provided with internal connections with comparator outputs for all channels. For the details, refer to the instruction manual of the exclusive carrying case.



Comparator output 'L" lets the relay contact open/close.

4-13-3 Monitoring comparator operations

The monitor lamp, shown at right, is provided on the panel meter.
This lamp blinks when the comparator's output is turned [ON]. It goes out when the comparator's output is turned [OFF].



Blinks when the preset LL is exceeded.
Blinks when the preset HL is exceeded.

4-14 Carrier synchronization

Carrier synchronization is necessary when operating multiple units of the DPM-700B dynamic strain amplifier for simultaneous measurement of strains on multiple measuring points. Carrier synchronization serves prevention of beats* that are caused by the difference between carrier frequencies.

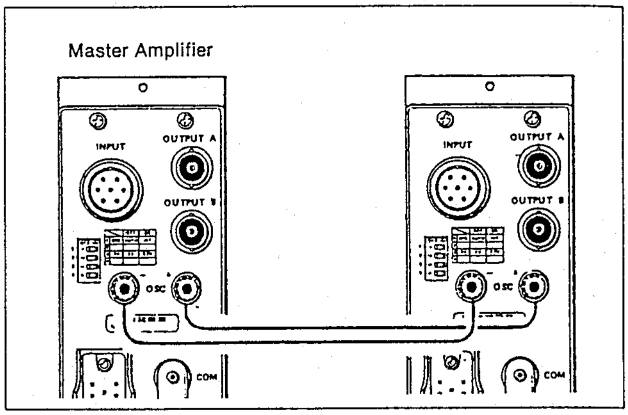
To achieve carrier synchronization, proceed as follows.

(1) Switch all channels [OFF].

(2) Connect all [OSC+] terminals and [−] terminals in parallel. Connect a [+] terminal to another [+] terminal, and connect a [−] terminal to another [−] terminal.
The YB-500 series exclusive carrying case, an option, achieves automatic connection of all [OSC+] and [−] terminals internally. So it is a great convenience.

(3) Set SW1 to [ON] (INT) on the channel which is to be the master.
The master channel acts as the source of a carrier frequency.

(4) Switch SW1 on all other channels [OFF] (AUTO).



(5) Switch all channels [ON] at the same time.
The channel, whose SW1 is at [ON] (INT), acts as the master.
The INTERNAL indicator lamp keeps illuminating on the front panel during operation of the master.

(6) When all channels cannot be switched [ON] at the same time, be sure to switch the master [ON] in the first place.

Caution

- In order to achieve carrier synchronization, all dynamic strain amplifiers need to provide a same nominal carrier frequency. Carrier synchronization is impossible unless all dynamic strain amplifiers are of the same type.
- Up to 50 units of the DPM-700B can achieve carrier synchronization with one unit acting as the master.
- Before connecting the synchronous input/output terminals, be sure to switch all units off.
- Do NOT connect units, whose respective SW1 switches are set to [ON] (INT).
- If the INT lamps illuminate on multiple units by switching units on after connection of their synchronous input/output connectors, check to be sure if or not their respective SW1's are at [ON] (INT). Switch units off for once, then perform the correct switch setting. After that, switch them on again.
- For information, where conventional Kyowa amplifiers (such as the DPM-600 series or DPM-300 series, etc.) are to be synchronized with the DPM-700B, use a conventional amplifier as the master.

4-15 Applications of the converging connector

The amplifier is provided with a converging connector on its rear panel. Generally, the connector is used to connect with an AC power supply via the accessory power cable.
The connector is provided with a pin that connects with a DC power supply, too. The connector also enables connection of input/output signals. Table 4-5 shows the names and functions of these signals. For the details of external control signals contained in the table, refer to [4-16 Remote control].

Table 4-2 Names and functions of signals connectable to the converging connector

Pin No.	Signal Name	Input/output	Function and destination
1	+12V (Note 2)	Input	Connects with the + terminal of a DC power supply.
2	REM BAL (Note 2)	Input	Valid with an external balancing signal "L."
3	OSC	Input/output	Connects with input or output synchronous signals.
4	N.C (Note 3)		
5	COM	—	Common electric potential
6	N.C (Note 3)		
7	100Vac	Input	Connects with an AC power supply.
8	N.C (Note 3)		
9	Bridge status	Output	Outputs open collector "L" against a bridge check which has proven N.G.
10	REM KEYLOCK (Note 2)	Input	Valid with "L," an external key-lock signal.
11	GND	—	Connects with the carrying case internally.
12	Comparator output HL (Note 2)	Output	Outputs open collector 'L" against a signal in excess of an HL value that has been set.
13	Comparator output LL (Note 2)	Output	Outputs open collector "L" against a signal below an LL value that has been set.
14	0V	Input	Connects with the minus polarity of a DC power supply. (Note 1)
15	OUTPUT A	Output	Connects with OUTPUT A internally.
16	OUT COM	Output	Connects with OUTPUT A COM.
17	REM +CAL (Note 2)	Input	Valid with an "L" signal that commands execution of external positive-value calibration.
18	REM −CAL (Note 2)	Input	Valid with an "L" signal that commands execution of external negative-value calibration.
19	N.C (Note 3)		
20	100Vac	Input	Connects with an AC power supply.

Connector plug: HIROSE ELECTRIC S-1620-C

Note 1: Use a heat-resisting vinyl cable of over 0.3mm^2 in diameter for wiring.
Note 2: It is a signal of the common electric potential of Pin #5 COM.
Note 3: N.C means an unused pin.

4-16 Remote control

The following functions can be controlled remotely.

- Execution of balancing
- Execution of calibration
- Execution and cancellation of key-lock

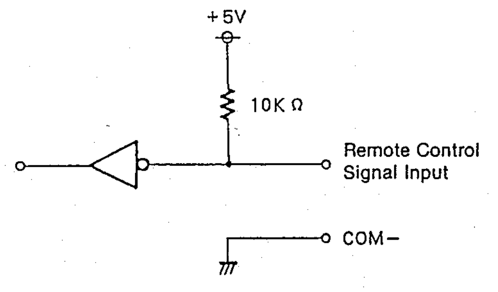
Remote control has the same significance as manual operation of the front panel switches that control the amplifier functions. The priority is given to a control switch when it is valid on the front panel.

Caution

Either a control switch or a remote control signal becomes valid when it goes on the "L" level. Here, the negative logic OR (logic sum) works.

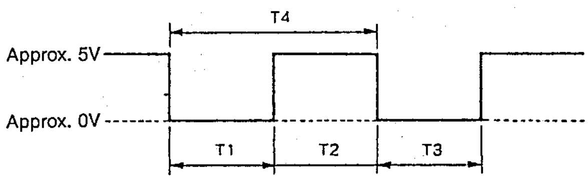
4-16-1 Remote control signals

Control signal input circuit



(2) Key-lock Control

Control signals are valid when they are on the "L" (0V) level. While this level is maintained, functions are executed.
The balancing function is, however, executed only one time in response to a signal shown at right.



Ensure 50ms minimum for T1, T2 and T3 (valid time lengths).
Repetition time T4 should be in a range of 100 to 500ms.

Note

When an external control signal is not valid, it is made to go on a level of approximately 5V by the internal circuit.

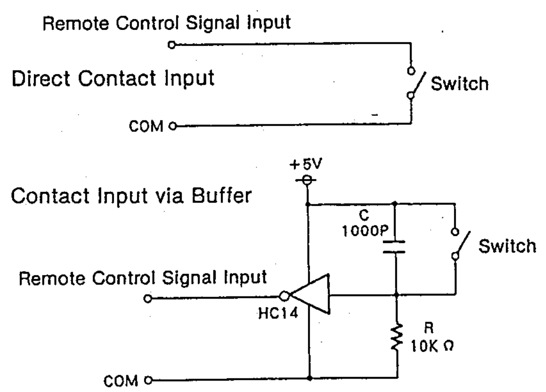
4-16-2 External connection

To carry out remote control, use the converging connector, which are introduced in item 4-15. Perform wiring after removing the housing from the converging connector.

Caution

The converging connector is also connected to an AC power supply. Therefore, be sure to remove the power plug from the AC outlet before wiring.

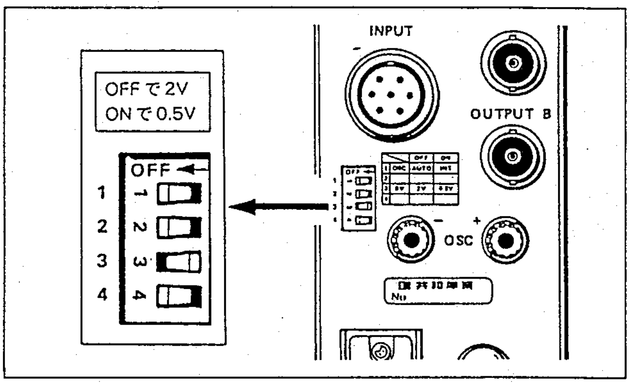
Shown at right are the recommended circuits for remote control.
If a circuit other than those shown is to be used, contact Kyowa.



Take care of chattering due to switching.

4-17 Bridge voltage

A bridge exciting voltage is switchable to 2V or 0.5V. It is set to 2V when the amplifier is shipped from the factory.
To select a bridge voltage, use SW3 provided on the rear panel.



Caution

Be sure to carry out balancing each time a bridge voltage has been switched from one to the other.

Select a bridge exciting voltage of 0.5V in the following cases.

- When strains are to be measured on a material whose heat resistance is poor, for instance, plastic or wood.
  A strain gage is heated if a large current flows on it. Precision measurment is, accordingly, impossible unless the material of a measurement object provides good heat radiation.
- When large strains are to be measured.
  A bridge excitation voltage of 0.5V guarantees a four times larger strain measuring range.
- When using a strain gage whose gage length is shorter than 1mm.

4-18 External instruments

Connectable external instruments are voltage measuring instruments or recorders that satisfy the following requirements.

(1) Voltage-signal instruments whose input impedance is rated at higher than 5kΩ.
(2) Current-signal instruments whose allowable maximum input current is rated at below 100mA.

5. Options

We introduce all options that can be used together with DPM-700B.
These options are available for separate purchasing.

5-1 Bridge box

The bridge box can be conveniently used for measuring strains with strain gages. The bridge box incorporates highly stable resistors to allow for a variety of strain-gage bridges.

5-1-1 The functions of the bridge box

The bridge box comes with three internal fixed resistors, which enable the strain-gage bridge configurations as follows.
For connections other than the 4-gage method, the internal fixed reistors are used as dummy gages.

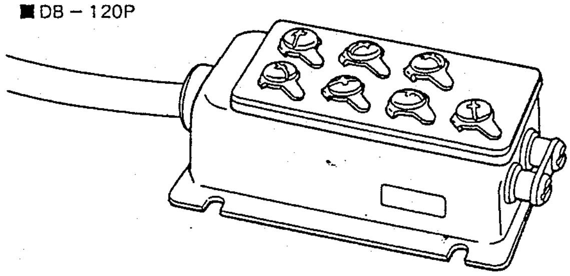
(1) One-gage method using the 2-wire or 3-wire system
(2) Two-gage method
(3) Four-gage method

5-1-2 Models of the bridge box

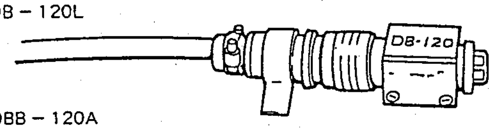
The following models are provided.

(1) DB-120P, DB-120L, DBB-120A
Use these models for 120Ω strain gages.
(2) DB-350P
Use this model for 350Ω strain gages.

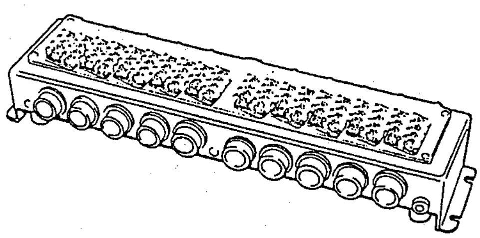
■ DB – 120P



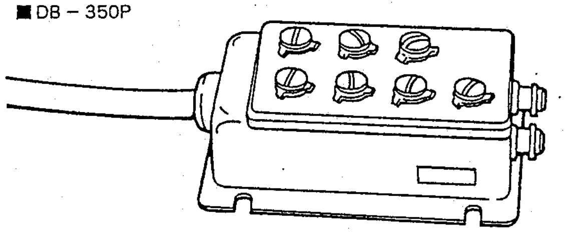
■ DB – 120L



■ DBB – 120A



■ DB – 350P

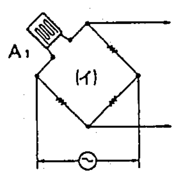
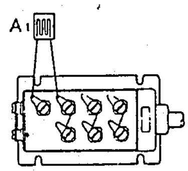
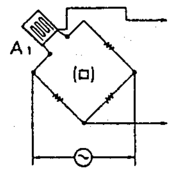
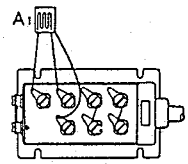
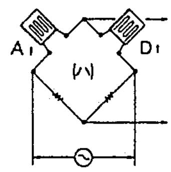
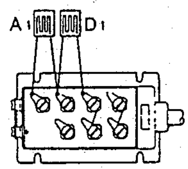
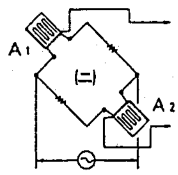
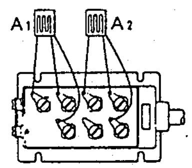
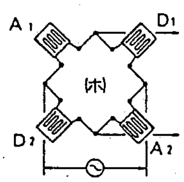
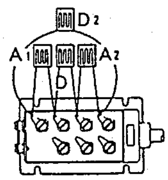


5-1-3 Wiring to the bridge box

How to configure a variety of strain gage bridges is introduced below.

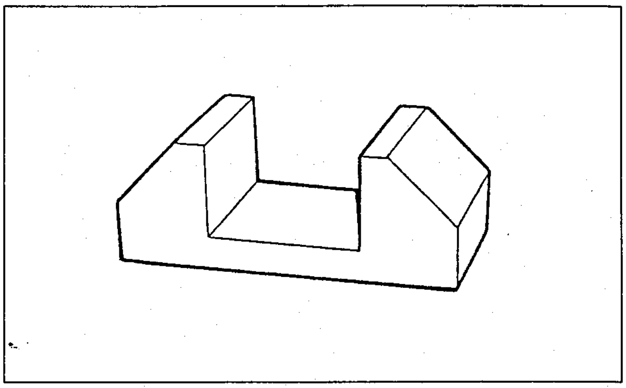
Caution

- When performing wiring to the bridge box, soldering is recommended in order to reduce contact resistance.
- Use shortest possible leadwires connecting the strain gage and the bridge box. Leadwires shorter than 1 meter are ideal.
- Use a shielded cable for dynamic strain measurement. It is advantageous in that it reduces noise.

Gage method	Bridge circuit	Wiring to the bridge box
1-gage method (2-wire system)		
1-gage method (3-wire system)		
2-gage method		
2-gage method; (3-wire active-active system)		
4-gage method		

5-2 FA-1B amplifier stand

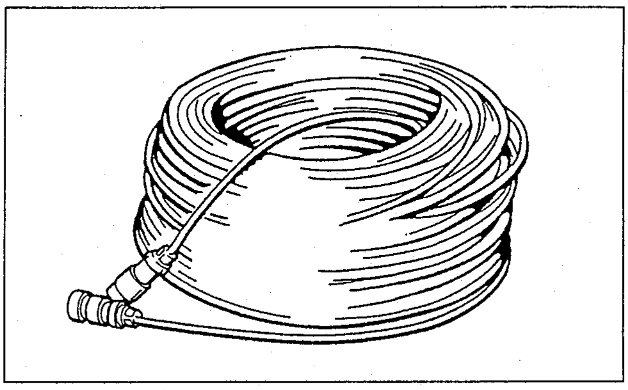
When operating a single unit of the amplifier, fix it using this rubber-made stand.



5-3 N extension cables

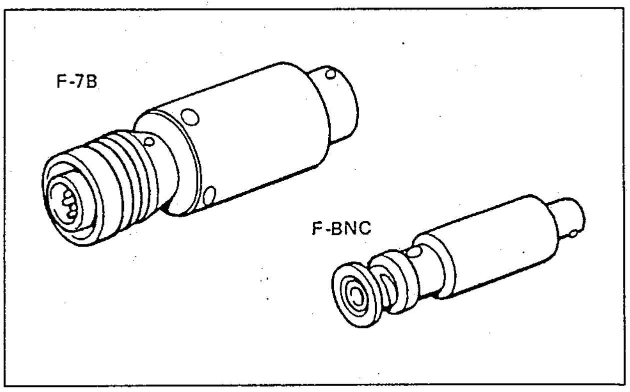
These extension cables serve connection of the bridge box or strain-gage transducers which are remote.
The cables are provided with connectors at their respective ends.
The following five models are available offering different lengths.

N81, 5m in cable length
N-82, 10m in cable length
N-83, 20m in cable length
N-84, 30m in cable length
N-85, 50m in cable length



5-4 F noise filters

They efficiently reduce external high-frequency noise. They are directly connected to the input connector and the output connector respectively.



5-5 Exclusive carrying case

The following four models are provided, respectively accommodating different numbers of units to facilitate multichannel measurements.

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

Each case comes with a converging control switch, which is operable on its front panel. What's more, each eliminates the need for interchannel connection, offering a great conveniece.

5-5-1 The functions of exclusive carrying cases

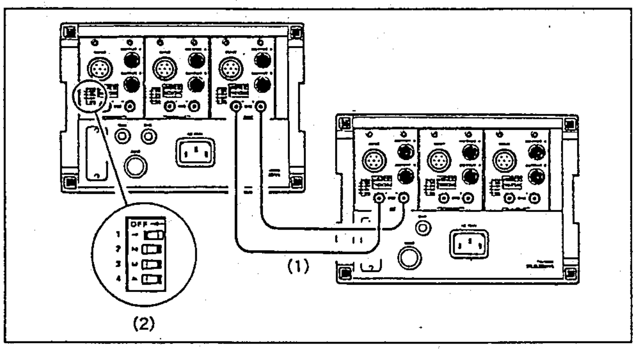
The functions the exclusive carrying cases provide:

- A converging balance key
- A converging calibration key
- A power switch that switches all housed units on or off at a time.
- Internal connections that enable carrier synchronization
- Converging connector that connects with comparator outputs and bridge status outputs
- A converging key-lock key
- Rack-mount fixtures

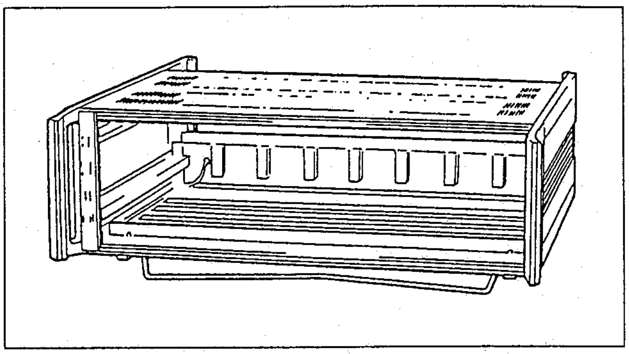
5-5-2 Carrier synchronization between exclusive carrying cases

When using multiple carrying cases, perform carrier synchronization as follows.

(1) Connect one carrying case to another as sown below.



(2) Set SW1 switch to ON (NT) on one carrying case.
(3) Set SW1 switch to OFF (AUTO) on all other carrying cases.
(4) Switch all carrying cases on at the same time. If simultaneous switching-on is impossible, be sure to switch first the case whose SW1 switch is set to ON (INT).



Caution

- Be sure to house carrier-type dynamic strain amplifier units of the same model in the exclusive carrying case.
  If dynamic strain amplifiers having different nominal carrier frequencies are housed in the carrying case, they will not operate normally.
- Set SW1 switch to ON (INT) on the rear panel on one unit only, and to OFF (AUTO) on all other units.
- It is also possible to house DC type signal conditioners and dynamic strain amplifiers together in the carrying case.
- It is also possible to house DC type signal conditioners and dynamic strain amplifiers together in the carrying case.
- Balancing, calibration or key-lock can be achieved on all channels simultaneously by operating the coverging balance key, the converging calibration key or the converging key-lock key respectively.
- Even though the key-lock function is active, converging balance or converging calibration can work. Take care to avoid accidential balancing or calibration.

6. Troubleshooting

If the amplifier does not operate as expected or if its operation is unstable, do not take it as a machine trouble right away but make sure if or not the environment is acting as the cause.
Typical troubles and remedies are introduced below. Should the introduced remedy fail, contact your Kyowa representative.
For caution's sake, the manufacturer may refuse to repair if the product has been damaged by failure to follow the instructions given by this manual or if the product has been disassembled or remodeled by the user.

6-1 The amplifier cannot be switched on.

Should the panel meter fail to illuminate after the amplifier was switched on, the cause can be the broken power cable or the melted fuse. Check the power cable first.
The fuses are inside the cabinet. Prior to replacement, be sure to disconnect the power cable from the AC outlet or the battery.

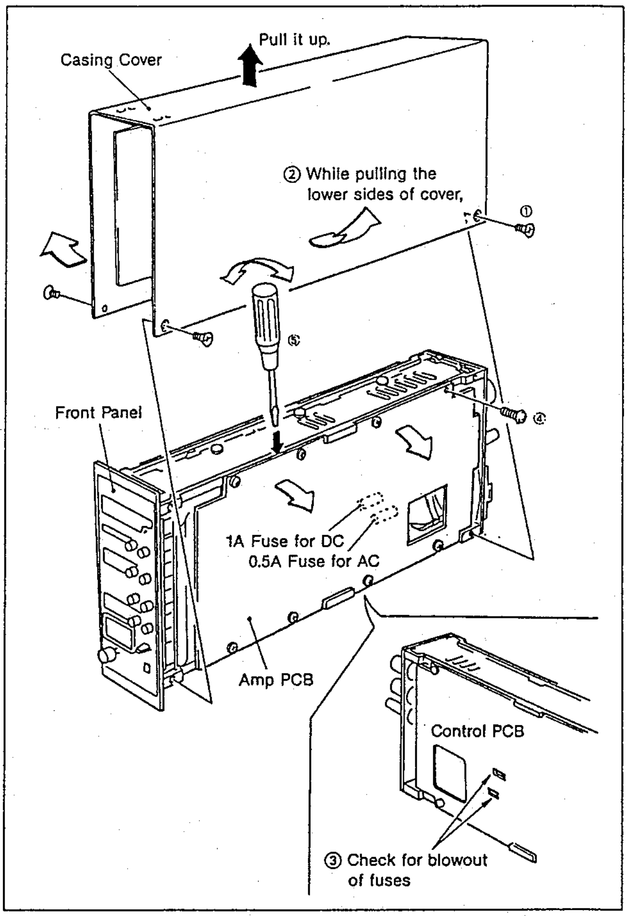
6-1-1 Replacing fuses

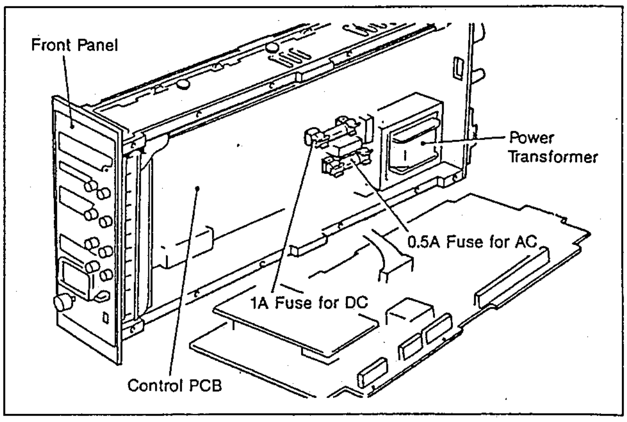
Use the following fuses for replacement.

For AC power: Midget type, 0.5A
For DC power: Midget type, 1A

Should the replacement melt again, the cause can be a trouble with the circuit. Should it happen, contact your Kyowa representative.
The fuses are on the parts side of the control PCB. Replace either one as follows.

① Remove four screws that fasten the mainframe cover.
② While opening the bottom of the cover, pull it up.
③ Look in at the two square windows on the control PCB and make sure of the melted fuse.
④ Remove eight M3 screws that fasten the amplifier PCB.
⑤ Insert a flat-blade scewdriver in between the top of the amplifier PCB and the mainframe, then remove the board from the connector.
⑥ The fuses are now accessible. Replace the melted fuse by a new one.
⑦ Insert the amplifier PCB in the connector in order reverse to the disassembly.
While assembling, take care to prevent the vinyl cable from being caught in.





6-2 Initial balancing is impossible.

- **The panel meter indication remains in excess of ±5V.**

  The cause can be the abnormal strain gage bridge connected to the input connector. So check the strain gage bridge to find if or not—
  - the sides of the bridges have been broken or shortcircuited or the insulation resistance has decreased;
  - or the leadwires from the strain gage bridge have been broken.

- **When using a bridge box**

  Check the resistance between the terminals of the bridge box and the terminals of the input connector. If the result shown at right is obtained for a 120Ω bridge, it is the indication of a normal bridge box. For a 350Ω bridge, the resistance values shown at right should read:

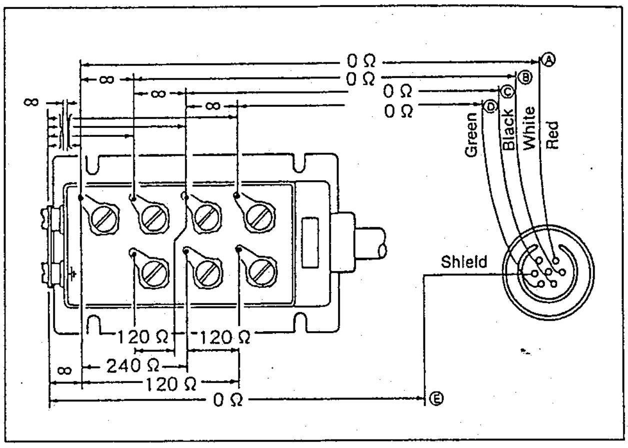
  350Ω in stead of 120Ω;
  700Ω instead of 240Ω.

- **Initial balancing is still impossible even though the bridge box has been proven normal.**

  In this case, the cause can be the abnormal strain gage connected to the bridge box or malcontact of the connector pin.
  Replace the strain gage or the bridge box, and see how it will turn out.

- **The value indicated on the panel meter is not so large, but it is blinking.**

  Balancing is disabled if the wiring is long between the bridge box terminals and the strain gage, and the capacitive unbalance is accordingly large. The cause can be as follows.



(1) The 1-gage method is in use and the leadwires are long.
(2) The 2-gage method is in use and one gage is connected by a shielded wire while the other gage is connected by a vinyl-coated wire.
(3) The extension cable to the bridge box is improper, thereby resulting in large capacitive unbalance on the cable.

- **Several tens of millivolts remains even though balancing has been repeated many times using the calibration key.**

  In this case, the cause can be the largely shifted adjusting range of the fine balance key.
  Set RANGE to OFF for once, then turn the fine balance key so as to obtain an output voltage of zero. Subsequently, push the balance key again.

Carry out the proper remedy. Should the trouble still remain, contact your Kyowa representative.

6-3 No output is available.

- **The range switch position is at [OFF].**

  Set the range switch at a position other than [OFF].

- **The OUTPUT B SPAN adjustor is at the minimum position.**

  Set the adjustor to a proper position. But this can apply to the OUTPUT B only.

- **The panel meter indication varies but no output is available.**

  The cause can be malfunction of the output cable. Check the conductivity of the output cable. The cause also be the OUTPUT B SPAN adjustor whose position is at its minimum. So check this too.

Should an output be unavailable despite the above remedies, contact your Kyowa representative.

6-4 Unstability of the zero point

Should a drift of the zero point occur despite no strain given after initial balancing was achieved, the input system could have been affected by such factors as:

- the decrease in the insulation resistance of the strain gage or of the leadwires.
- the insufficient temperature compensation achieved on the strain gage.
- the fixed resistor/s incorporated in the bridge box are no good.

Check the above. If no causative factor is found, contact your Kyowa representative.

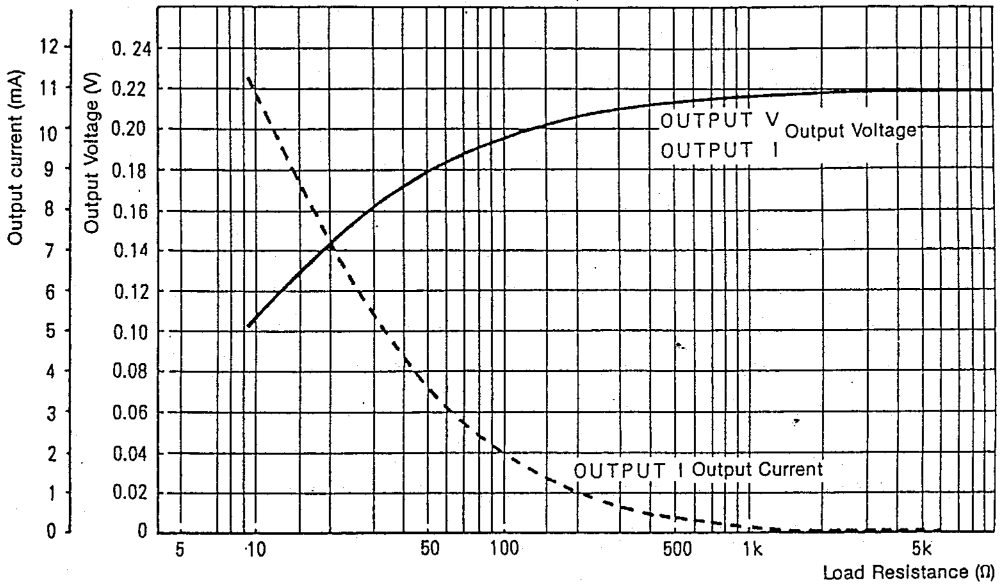
6-5 Large noise

The cause can be the following. Find the cause and carry out the proper remedy.

- **Inductive interference**
  A nearby instrument having a large leakage flux can be the cause of induction noise. A large capacity motor and an iron-resonance constant-voltage instrument are a few examples.
  Remedies are as follows.
  - Place a causative instrument apart from the amplifier.
  - To connect the strain gage to the amplifier, use a 2-conductor flat cable at least. If possible, use a 2-conductor shielded cable, which is the ideal. In this case, connect the shielding wire to the ground terminal E of the bridge box.
  - Ground a measuring object and the dynamic strain amplifier separately but at a same grounding position.
- **Interference due to a measuring object's electric potential**
  This interference occurs when a measuring object has a certain electric potential, AC or DC. In this case, grounding the amplifier does not necessarily bring about a good result, but connection of a measuring object to the amplifier can be the solution in some cases.

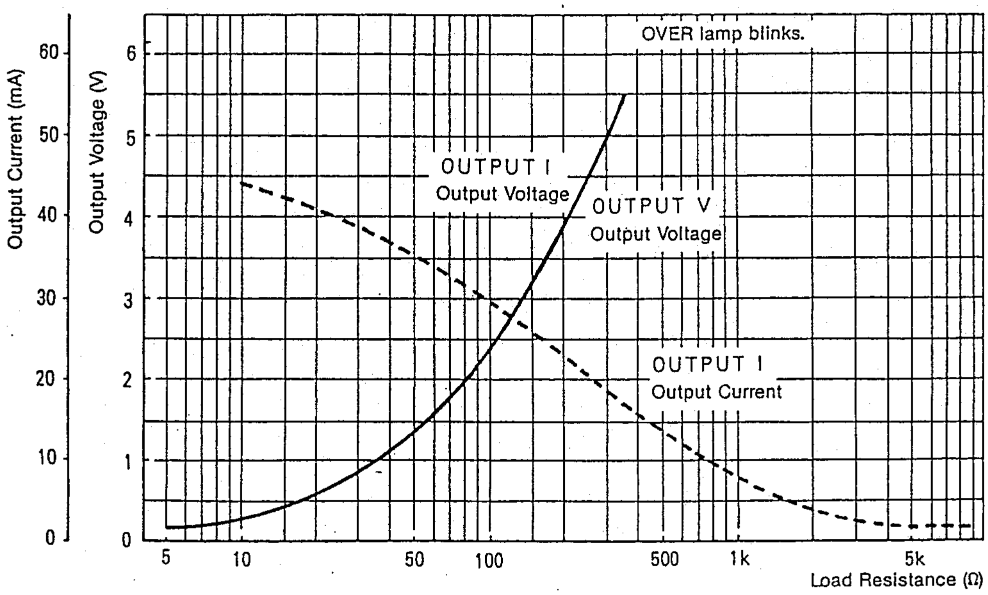
7. Characteristics

7-1 Sensitivity characteristic



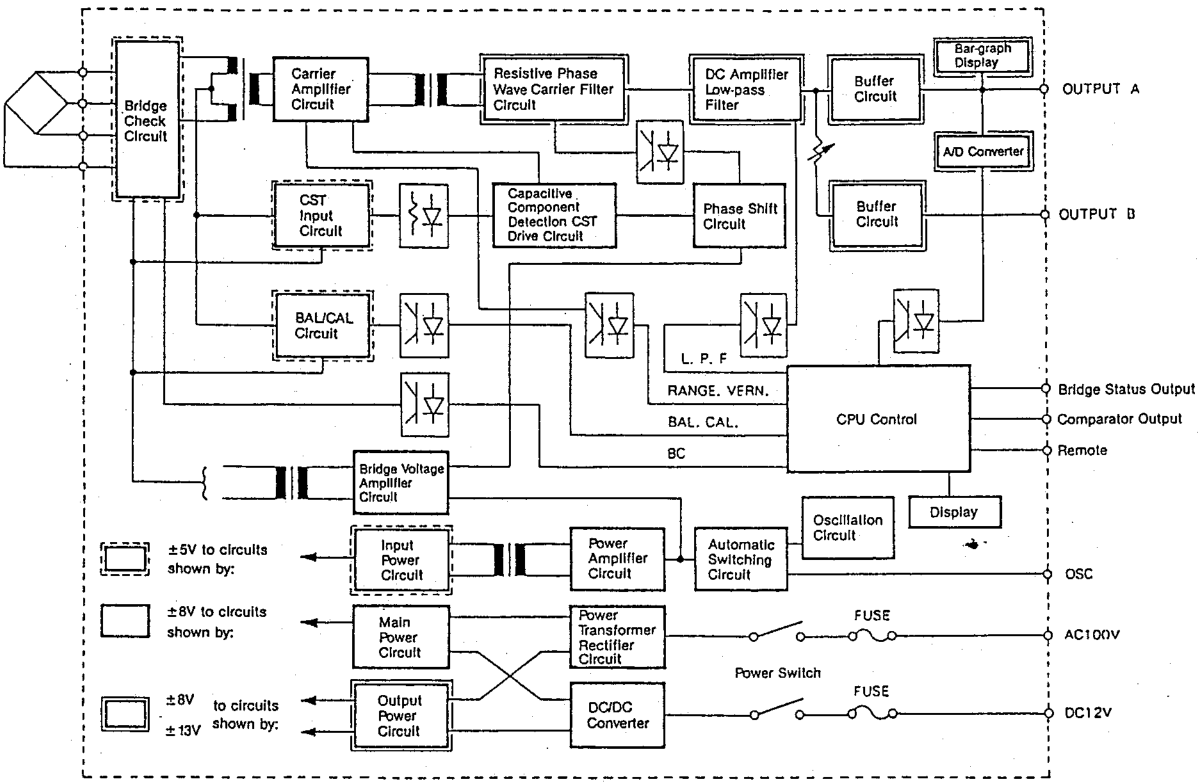
Sensitivity characteristic
(Maximum output against $10x10^{-6}$ strain input)

7-2 Output characteristic



Output characteristic
(Maximum output against non-linearity of ±0.1%)

7-3 Block diagram and operation principle



7-3-1 Operation principle

We explain it as follows depending on the above block diagram. Changes in physical quantities are detected as changes in resistance of strain gages and converted in electric signals. As the result, the strain-gage bridges output minute AC volts. They are no more than handreds of microvolts, normally. These bridge outputs are amplified up to several volts through the carrier wave amplifier circuit that provides a high AC gain.

Strain signals at up to this stage are superimposed over AC carrier signals so that they cannot be taken out separately. So they are rectified then converted in DC by the circuit that detects the phase of resistive signal components. They are further integrated through the low-pass filter, then output via the DC amplifier.

The carrier filter and the low-pass filter have similar functions but they play quite different roles. The former is indispensable in that it works to remove carrier signals, while the latter works to cut off some of signals and is not necessarily needed all time time.

The features of the system can be summarized as follows.

- **Advantageous features**
  - Signals are amplified in the AC form so that a highly sensitive strain amplifier is made possible.
  - The temperature characteristic is superbly stable at the zero point. Excellent both in temperature characteristic and long-term stability.
    This is the most important feature of a carrier type dynamic strain amplifier.
  - Carrier waves are transmitted via the input transformer so that they are hardly affected by surge noise.
    From the construction mentioned above, an AC type dynamic strain amplifier can well be an insulated amplifier.
  - Free from the effect of thermoelectric power.
  - Less power consumption when compared to a DC amplifier.

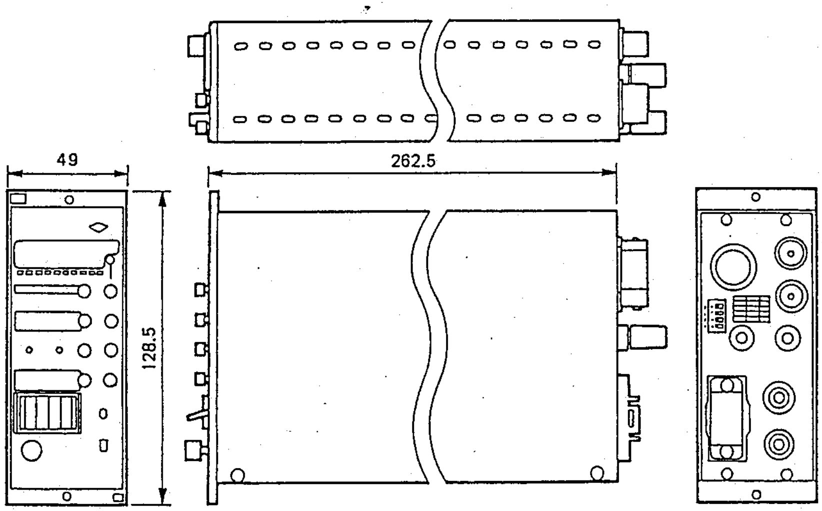
- **Disadvantages**
  - Unnecessary capacitive components generated by wiring to strain gages, etc. need to be removed. But, this is done automatically inside DPM-700B.
  - The practical frequency of carrier waves is 30kHz or thereabouts. High response is therefore unavoidable.

• Easily affected by resistance induced by wirings.

From the above, the DPM-700B series dynamic strain amplifier is optimum for such strain measurements as follows.

(1) General strain measurements using strain gages.
(2) Measurements that require high temperature stability.
(3) Measurements of small strain outputs. The yardstick will be about $500x10^{-6}$ strain or lower.

7-4 Dimensional drawings



8. Appendixes

8-1 Bridge check functions and error indications

Table 8-1 shows the relation between error indications on the panel meter and detected wire-breaking locations.
When one wire has broken, the panel meter indicates "where" exactly. But if two or four wires have broken, what shown is just one wire as shown in Table 8-1. In case three wires have broken, Er-b shows all the time. Also if a side of the bridge should break, an error indication does not necessarily agre with its location.

Table 8-1 Wire-breaking locations and error indications

Wire-breaking locations	Error indications
A	Er-a
B	Er-b
C	Er-c
D	Er-d
A B C D	Er-b
A B C	Er-b
A B D	Er-b
A C D	Er-b
B C D	Er-b
A B	Er-a
A C	Er-a
A D	Er-d
B C	Er-b
B D	Er-b
C D	Er-d
None	Good

Should Er-2 appear, it indicates a trouble with the bridge check function. In this case, contact your Kyowa representative.

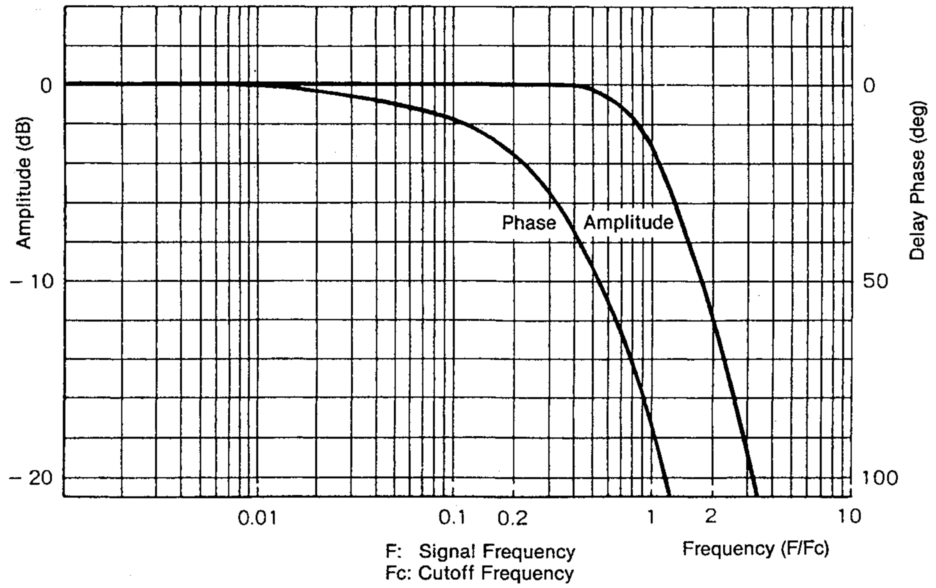
8-2 Low-pass filter characteristic

8-2-1 shows the characteristic of the low-pass filter incorporated in DPM-700B. In 8-2-1 the frequency characteristic is normalized against a cut-off frequency. About the relation between the amplitude and the phase, first obtain the ratio of F/Fc, then read it from the diagram below.

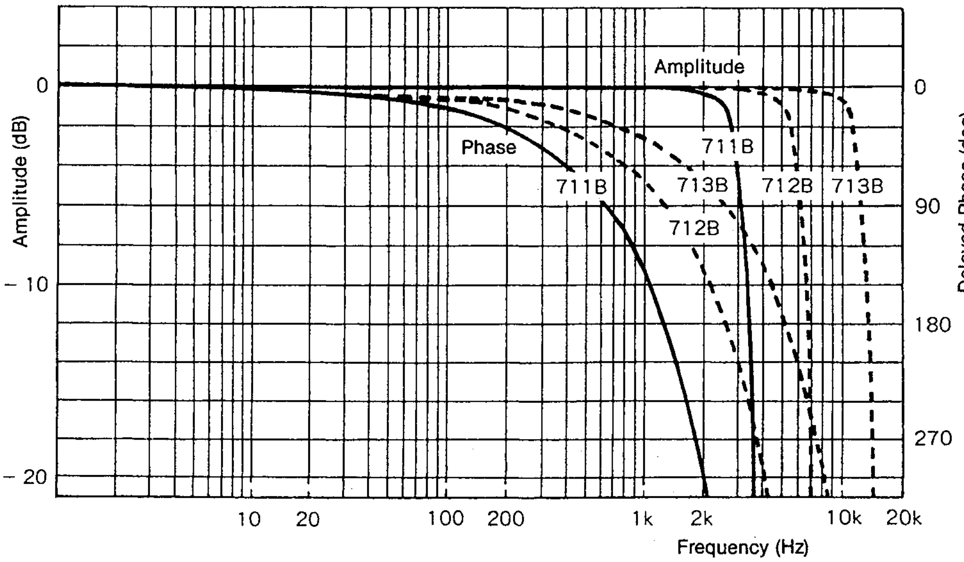
(Except when low-pass filter of the DPM-711B is set to 1 kHz.)

In addition, frequency-response characteristic when cut-off frequency is selected to F position is shown in 8-2-2.

8-2-1 Low-pass filter characteristic



8-2-2 Frequency characteristic (where the low-pass filter is set to F)

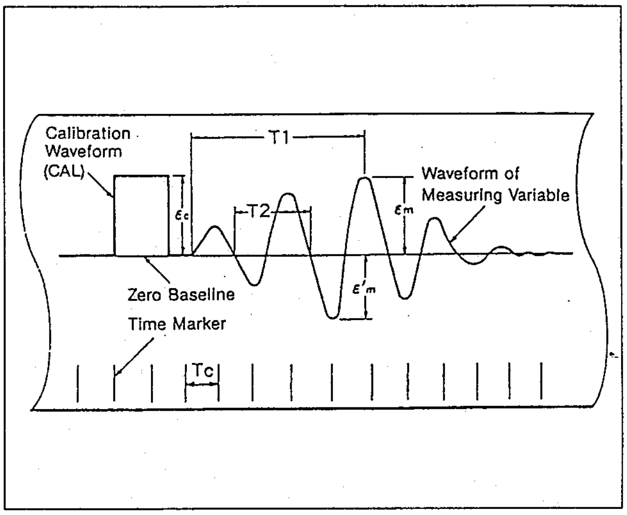


8-3 How to calculate strains

The following explains how to measure strains and stresses using DPM-700B.

8-3-1 Method of calculation applicable to a strain gage

Suppose that a strain waveform was obtained as shown at right. The diagram shows a positive (+) calibration signal value recorded at the top of the waveform. Suppose that the direction of this calibration signal waveform shows the direction of [elongation].
The time factor of the strain waveform can be obtained referring to Tc, i.e. an interval between one time-marker and another.
Various values can be obtained as follows from the figure at right.



(1) Calculating the maximum strain ϵm and the maximum stress σm.

Measure the respective heights of the calibration signal and the maximum strain from the base line of zero, using a scale.
Suppose that a measurement of ϵc is hc [mm], and that of σm is hm [mm]. The maximum strain ϵm can be calculated using the equation below.

$$\epsilon m = c \times \frac{hm}{hc}$$

ϵm is in the same direction as $+\epsilon e$. Therefore it is [elongation].
When once the strain has been obtained, stress at that point (provided that is of the monoaxial stress system) can be found using the equation below.

$$\sigma m = E \times \epsilon m$$

(2) Calculating strain $\epsilon' m$ and stress $\sigma' m$

Strain $\epsilon' m$ is in the direction opposite to $+\epsilon c$. Therefore it is [contraction].
Suppose that the height of $\epsilon' m$ is h'm [mm], the amount of $\epsilon' m$ can be found using the equation below.

$$\epsilon' m = \epsilon c \times \frac{h'm}{hc}$$

Stress $\sigma' m$ (provided that it is of the monoaxial stress system) is calculated using the equation below.

$$\sigma' m = E \times \epsilon' m$$

(3) Time from the start point of the strain waveform to the maximum strain

Calculate T1, i.e. a time from the start point to the maximum strain, using time markers. Measure 10 or so intervals between time markers, and obtain their average, then tc [mm] against time TC. Suppose that a measurement of T1 is t1 [mm]. T1 can be calculated using the equation below.

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

(4) Frequency of the strain waveform

If vibrations are cyclic, a frequency can be calculated. Measure the length of 10 or so cycles, then obtain their average t2 [mm]. Compare the computation with the marker interval, tc.

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

From T2, the frequency is calculated using the equation below.

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

(5) Analysis of a phenomenon

If a phenomenon is so simple that a measurement at a single point is enough, it is possible to disclose all about it by simply calculating the relation between the amount of a strain and a time when it occurred, depending on its waveform.
By contrast, a complex phenomenon requires simultaneous or individual measurements at

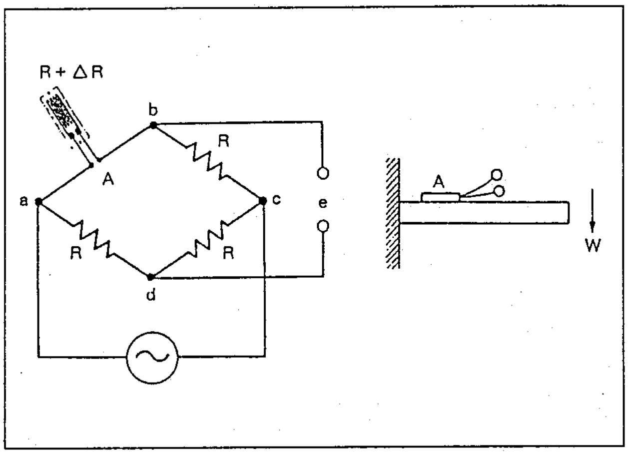
multiple points. In this case too, the relation between the amount of a strain and a time at each point can be disclosed using the calculating methods introduced above.
However, only this cannot afford thorough analysis of a complex phenomenon. In addition to analyses on respective measuring points, it is necessary to compare the results of individual analyses on the time axis.

This analyzing technique should vary widely according to different measuring purposes. There cannot be one uniform technique.
In many cases, however, it is possible to estimate the relations between measuring points. So consider these relations together with the measuring results on measuring points, in order to grasp a phenomenon totally.

8-3-2 Correction required due to the number of strain gages used

The above calculation methods are applicable to a measurement using one strain gage as an active gage as shown at right.
When using multiple strain gages, the measuring result should be corrected according to the number of strain gages in use.
For information, this correction is not necessary for a strain-gage transducer.

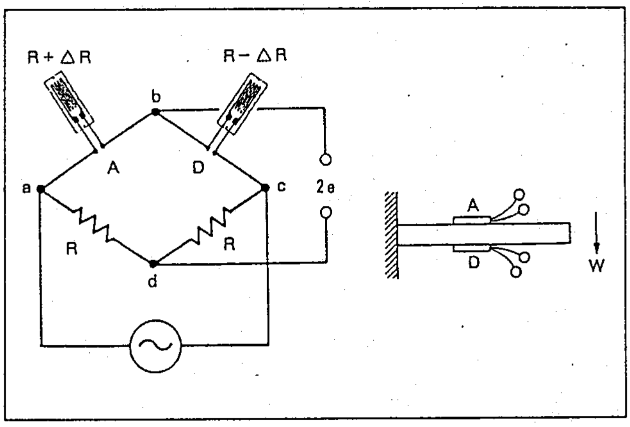
ϵ: Strain after correction
ϵ_0: Measuring result
σ: Stress
E: Young's modulus (Coefficient of vertical elasticity)



(1) When using both Active (A) and Dummy (D) gages to measure strains

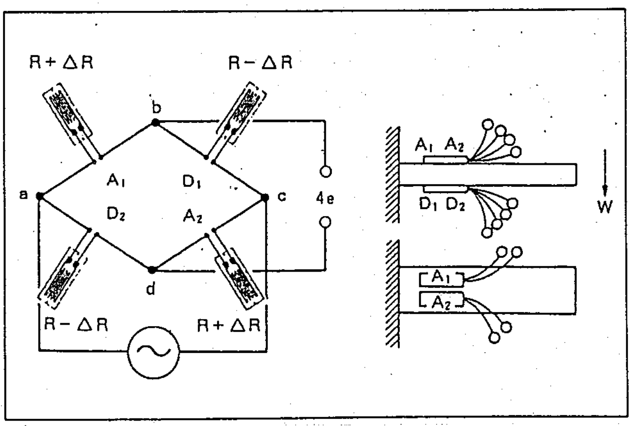
① When using two strain gages in the arrangement shown at right, multiply a measurement value ϵ_0 by 1/2.

$$\epsilon = \frac{\epsilon_0}{2} \qquad \sigma = E \times \epsilon = \frac{\epsilon_0}{2} \times E$$



② When using four strain gages in the arrangement shown at right, multiply a measurement value ϵ_0 by 1/4.

$$\epsilon = \frac{\epsilon_0}{4} \qquad \sigma = E \times \epsilon = \frac{\epsilon_0}{4} \times E$$

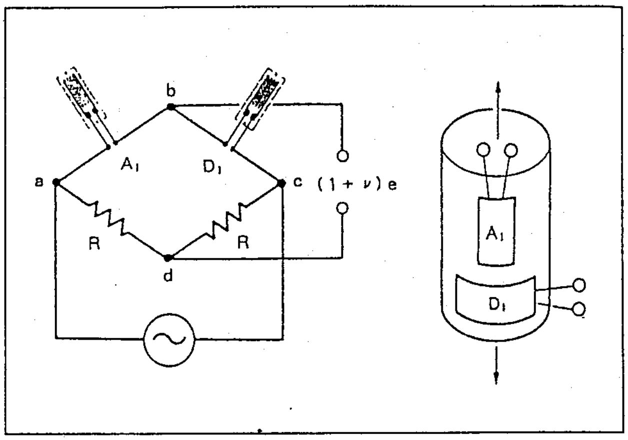


(2) When using Active (A) and Dummy (D) gage, which is at right angle to the former

① When using two strain gages in the arrangement shown at right, multiply ϵ_0 by $1/(1+\nu)$.

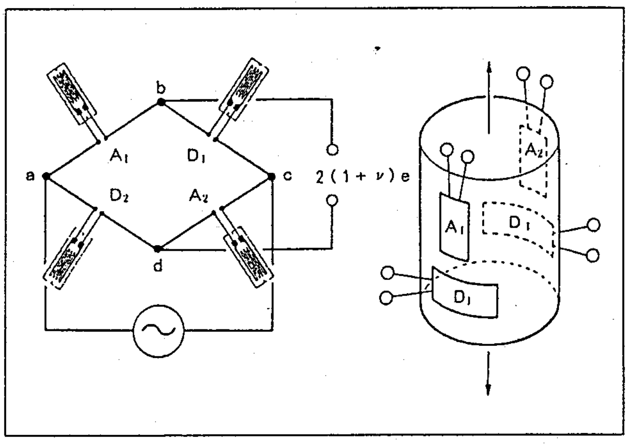
$$\epsilon = \frac{\epsilon_0}{1+\nu} \qquad \sigma = E \times \epsilon = \frac{\epsilon_0}{1+\nu} \cdot E$$

Where, ν: Poisson's ratio



② When using four strain gages in the aggrangement shown shown at right, multiply ϵ_0 by $1/2(1+\nu)$.

$$\epsilon = \frac{\epsilon_0}{2(1+\nu)} \qquad \sigma = E \times \epsilon \frac{\epsilon_0}{2(1+\nu)} \cdot E$$



8-3-3 When using a strain gage whose gage factor is other than 2.00

Correct a measurement value using the following equation.

$$\epsilon = \frac{2.00}{Ks} \times \epsilon_0 \qquad \sigma = E \times \epsilon = \frac{2.00}{Ks} \times \epsilon_0 \cdot E$$

Where, Ks: Gage factor of a strain gage used

8-3-4 Calculating methods applicable to strain-gage transducers

A strain-gage transducer measures a physical variable such as load, pressure, torque, displacement, acceleration or other after conversion into electric signals through strain gages it incorporates.
The DPM-700B series is designed to measure strains. The amount of a strain measured has to be converted into a physical quantity by using the calibration factor or the rated output stated in the calibration sheet of a strain-gage transducer used.

(1) Calculating method using a calibration factor

Multiply the discovered amount of a strain by the calibration factor stated in the calibration sheet of a strain-gage transducer, and a physical quantity will then be obtained.

Example

Suppose that a measurement of 2900×10^{-6} strain gage was obtained using a load cell whose capacity is 2tf (19.6133kN) and calibration factor is 0.0004997tf (0.0049N)/10^{-6} strain. A load given to this load cell can be calculated as follows.

$$0.0004997 \times 2900 = 1.44913\ [\text{tf}]$$

(2) Calculating method using a rated output

An output value (or a rated output or an output voltage sensitivity) against a rated load is stated in the calibration sheet or a strain-gage transducer. The following examples show how to obtain the reading of a physical quantity given to a strain-gage transducer through adjusting the stated rated output as well as the dynamic strain amplifier's calibration factor and output.

Example

Using the combination of: PG-5KU pressure transducer whose capacity is 5kgf (490kPa)/cm^2 and rated output of 3993x10^{-6}, i.e. the transducer's rated output. Adjust the RANGE and VERNIER so as to obtain an output voltage of 5.000V when the calibration key is pushed to the [+] position. Subsequently, give a pressure to the transducer. By all time, 5.000V will come to correspond to 5kgf/cm^2.

Example

Using the combination of: AS-20GA acceleration transducer whose capacity is 20G (196m/s^2) and rated output is 850x10^{-6} strain; and DPM-700B dynamic strain amplifier.

Set the amplifier's calibration value to 850$\mu\epsilon$, then carry out adjustment so that the amplifier's output reads 2.000V when the calibration key is pushed. By all this, 2.000V will come to correspond to 20G.

8-3-5 Correction required when an extension cable was used

Indoor measurement seldom requires an extension cable.

By contrast, for outdoor measurement the amplifier has to be remote from a measuring point on occasions. If such is the case, place a bridge box nearby a measuring point, then connect a bridge box to the amplifier using an extension cable.

Note, however, that a measurement thus obtained inevitably contains an error due to an extension cable. The longer an extension cable is used, the larger a measurement error grows.

In order to remove this error, multiply a measurement by a suitable correction factor stated in the following table.

For information, this correction method will not be free from a certain amount of error inducible to the kind of an extension cable and the ambient temperature.

Extension cable / Bridge resistance	5m	25m	50m	75m	100m	200
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

Shown in the above table are correction factors applicable to the Kyowa extension cable (0.5mm^2, 4-conductor shielded cabtire cable).

8-4 Common and grounding terminals

The DPM-700B series' common terminal and grounding terminal are configured as shown at the right. As shipped, these terminals are shortcircuited on the rear panel.

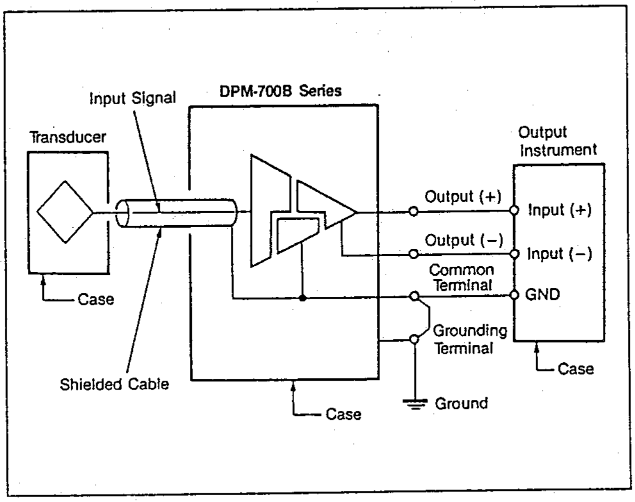
Use these terminals as instructed below in order to assure safety.

(1) Ground the grounding terminal.

(2) When using an output instrument which is not grounded, leave the common and grounding terminals shortcircuited.

(3) When using an output instrument which is grounded, remove the shortcircuiting plate from the rear panel.

(4) When installing the amplifier in the exclusive carrying case, remove the shortcircuiting plate from the rear panel in advance, then use the grounding terminal and the common terminal, respectively provided on the rear of the carrying case.



9. Glossary

- **Wheatstone bridge** .... It is a bridge whose four resistors connect in series one another; and a bridge exciting power connects to one connection, and an ammeter to another connection which is opposite.

- **1-gage method** .... It is a measuring method whereby one side of the bridge is formed by a strain gage.

- **2-gage method** .... It is a measuring method whereby two sides of the bridge are formed by one each strain gage respectively.

- **4-gage method** .... It is a measuring method whereby the four sides of the bridge are formed by one each strain gage respectively.

- **Output impedance** .... Impedance seen from the output terminal of an instrument toward that instrument.

- **Preheating time** .... A time an instrument requires to satisfy its all performance specifications after it is switched on.

- **Unbalance components** .... Volts that occur due to the resistive and capacitive deviations of a strain-gage bridge.

- **Balancing range** .... A range within which a strain-gage bridge's resistive and capacitive deviations can be corrected. The resistive balancing range is expressed by a percentage to gage resistance; and the capacitive balancing range, by a capacitive value.

- **Sensitivity** .... An output against a strain input under the specified condition.

- **Gage factor Ks** .... The ratio of a change in gage resistance to a change in the amount of a strain, which was given to a strain gage. Generally, it is 2 for metal-wire strain gages.

- **Open collector output** .... It is an output system wherein no transistor load resistance exists and a collector is connected directly to the output.

- **Beats** .... The superposition of a signal over another having a different frequency creates frequencies, one of which is the total sum of the two and the other is the remainder after subtraction of the original frequencies. Usually, beats mean the latter.

- **Carrier** .... A carrier or a carrier wave means AC signals that transmit strain signals. Generally, a carrier is more than two times larger than the frequency of strains which are to be measured.

- **Bridge voltage** .... The voltage of a power source, AC or DC, connected to a Wheatstone bridge. The higher a bridge voltage, the larger a Wheatstone bridge's output voltage grows. A bridge voltage should, therefore, be decided according to the kind of a measuring object and that of a strain gage.

- **Dummy gage** .... This type of gage acts merely as a resistor, i.e. a constituent element of a gage bridge.

- **Active gage** .... A gage which is bonded to the strain-generating area of a measuring object.

- **Vernier**... A small scale used to achieve fine range setting.

10. Index

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