KYOWA
ELECTRONIC INSTRUMENTS CO., LTD.

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DYNAMIC STRAIN AMPLIFIER

DPM-900/950 SERIES

INSTRUCTION MANUAL

Thank you for purchasing KYOWA's product DPM-900/950 series Dynamic Strain Amplifier.
Read this Instruction Manual carefully in order to make full use of the high performance capabilities of the product.
Do not use the product in methods other than described in this Manual.

CONTENTS

STANDARD ACCESSORIES

The DPM-900/950 series Dynamic Strain Amplifier (hereinafter referred to as the DPM-900/950 series) comes with the following accessories. After unpacking, check to be sure that they are included.

Instruction Manual	1
Simplified instruction manual seal	1
AC power cable (P-25)	1
3p - 2p conversion plug (CM-52)	1
BNC cable (U-59 and U-08)	1 each
Fuses, midget type (1.0 A and 0.5 A)	1 each
Product Warranty	1

SAFETY PRECAUTIONS

The DPM-900/950 series is designed in accordance with “8. SPECIFICATIONS.” Do not use the DPM-900/950 series in an environment exceeding the specifications. Or, failure of the DPM-900/950 series may result.

PRIOR TO USE

For safe use of the DPM-900/950 series, do not forget to read the “Safety Precautions” prior to use.
Kyowa Electronic Instruments Co., Ltd. assumes no liability for any damages resulting from user’s failure to comply with the safety precautions.
For safety operation of the DPM-900/950 series, the following symbol mark is used.

⏚	Indicates “PROTECTIVE GROUND TERMINAL.” Be sure to connect the GND terminal to the ground. However, excludes when grounding with a 3-prong AC power cable.

SAFETY SYMBOLS

For safety operation of the DPM-900/950 series, the following symbol marks are used in the Instruction Manual.

⚠ WARNING	Improper operation of the system may result in death or severe injury of the operator.
⚠ CAUTION	Improper operation of the system may result in injury of the operator and physical damage of the system.

⚠ WARNING

- **Power Supply**
  To prevent a fire hazard, before connecting the power cable, be sure to check the local line voltage is matched with the operating voltage specified for the DPM-900/950 series.
- **Power Cable and Power Outlet**
  To prevent an electric shock or fire hazard, use the accessory power cable, 3p - 2p conversion plug, and a power plug with protective ground terminal to the greatest possible extent.
  When using 3-prong power cable, use a 3-prong power plug with protective ground terminal.
  Operators must be cautioned that use of an extension power cable with no ground conductor disables the protective ground function.
  Read the Instruction Manual first, connect the power cable to the DPM-900/950 series with the DPM-900/950 series turned OFF and connect the power cable to the power outlet.
- **Protective Ground**
  To prevent an electric shock hazard, be sure to ensure protective ground before connecting the power cable.
  If 3p – 2p conversion plug is used, be sure to ground the DPM-900/950 series to the “GND” terminal.
  If a 2p flat vinyl power code is used, always ground with optional grounding conductor.
- **For Electrical Operator Safety**
  To prevent an electric shock hazard, operators must be cautioned not to cut the protective grounding conductor or disconnect the GND terminal.
- **Confirmation of Protective Ground**
  To prevent an electric shock hazard, if any abnormal matters are found in the protective ground function, fuse holder, etc., do not operate the DPM-900/950 series. In addition, be sure to check safe protective ground function before operating the DPM-900/950 series.
- **External Connection**
  To prevent an electric shock hazard, ensure the safe protective ground of all concerned instrument and then, connect the DPM-900/950 series to the measuring object and external devices, PC, etc.
- **Fuse**
  To prevent a fire hazard, be sure to use a fuse providing the same rating (current, voltage, type) as specified for the DPM-900/950 series.
  Do not use any fuse other than specified. Do not short-circuit the fuse holder.
  Before replacing the fuse, disconnect the power cable from the wall outlet in advance.
- **Inflammable Gaseous Environment**
  To prevent fire and explosion hazards, do not operate the DPM-900/950 series where it is exposed to inflammable gases, inflammable vapors or inflammable dust.
- **If Any Trouble Occurs**
  To prevent a fire hazard, if smoke is emitted from the DPM-900/950 series, immediately disconnect the AC adapter from the receptacle and stop using the DPM-900/950 series.
- **Maximum Input Voltage Range**
  The DPM-900/950 series is a measuring instrument specified for strain gage transducers and strain gages. Do not input high voltage. Or, deteriorated performance and damage of the product may result.

⚠ CAUTION

- **After the power OFF, wait more than 5 seconds to power ON again.**
  If the power switch is repeated turned ON and OFF within 5 seconds, fuse may blow out due to rush current generated by switching the power ON and the DPM-900/950 series' reliable function may not be guaranteed.
- **Do not use the DPM-900/950 series under excessively high/low temperature.**
  Use the DPM-900/950 series in the specified operating temperature range -10 to 50ºC.
  Use at temperatures exceeding the specified range may lower the performance and cause trouble.
  If use under direct sunlight or in a cold place is inevitable, prepare a sunscreen or take proper measures to keep it warm.
- **Do not use the DPM-900/950 series under high humidity.**
  Use in a humid place exceeding the specified range or where it is exposed to splashing water may lower the performance and cause trouble.
- **Immediately stop the DPM-900/950 series if operating environment changes abruptly.**
  Leave the DPM-900/950 series as it is until it becomes adaptable to the environment.
  Abrupt change in ambient temperature due to transportation, etc. may cause dew condensation result to deteriorate its performance and cause trouble.
- **Do not use the DPM-900/950 series under dusty environment.**
  If dust is entered into the DPM-900/950 series, performance of the DPM-900/950 series may become deteriorated. Be sure to keep away from dust not only when operating but also storage.
- **Take care when operating the DPM-900/950 series at a location with excessive vibration.**
  If excessive vibration is applied to the DPM-900/950 series, performance of the DPM-900/950 series may become deteriorated.
  Adopt vibration-proof measures such as shock absorber, etc.
- **Do not use the DPM-900/950 series under poor power condition.**
  When using the AC power cable, use the DPM-900/950 series within the specified power supply voltage.
  Use the DPM-900/950 series in an environment without instantaneous voltage drop or interfering noise.
- **When using the DC power supply, handle the DPM-900/950 series with utmost care.**
  Touch the battery terminal by the input/output cable or use the same power supply with the measuring instrument may cause unexpected trouble. Read "3-2 CONNECTION OF POWER" prior to use.
- **Do not pull cords and cables.**
  Lay cords and cables with a certain allowance so that o unreasonable force is applied to the connections.
  Pulling or applying unreasonable force may cause trouble or interrupt the measurement.
- **Preheat the DPM-900/950 series before use.**
  Preheat the DPM-900/950 series for about 30 to 60 minutes after the power ON.
- **For using a Rotary Transformer Torque Transducers or Inductance-Type Displacement Transducer, be sure to set the "Setting Switch 4" on the rear panel to ON.** Or, it may cause decreases in measurement accuracy of the DPM-900/950 series.
- **Do not install the sensor near the welding machine or measure it near the welding machine.**
  It may cause various malfunction.
- **Do not disassemble or remodel.**
  It may cause electric shock or malfunction. And this product will not be out of warranty

NOTATION USED IN THE INSTRUCTION MANUAL

Notational Words

To express strain, “10^{-6} strain”, “µm/m” or “µε” is used properly.
This Manual uses “µε” relating to the on-panel indications, and “µm/m” when referring to strain in general.
The words suffixed by “*” are explained in “10. Glossary”.
The value converted in SI (the International System units) is given in parentheses after each conventional expression of a unit.

Informational Notes

Certain notations are used as necessary to attract your attention to information that requires special care when handling the DPM-900/950 series and to information provided for reference purpose.

Examples of Notations

NOTE

Essential precautions required when handling the DPM-900/950 series.

MEMO

Reference items required when handling the DPM-900/950 series.

1. PRODUCT OUTLINE

1-1 PRODUCT OUTLINE

The DPM-900/950 series is a strain amplifier that incorporates an AC excitation voltage. When compared to a DC type strain amplifier, the DPM-900/950 series generally marks high stability, sensitivity and lower noise. In addition to these, the DPM-900/950 series provides unique features as follows.

Features

[DPM-900 series]

- Allows high accuracy measurement since the DPM-900 series has high S/N ratio.

[DPM-950 series]

- Allows high accuracy measurement by inverter noise reduction effect.

[For both DPM-900 and 950 series]

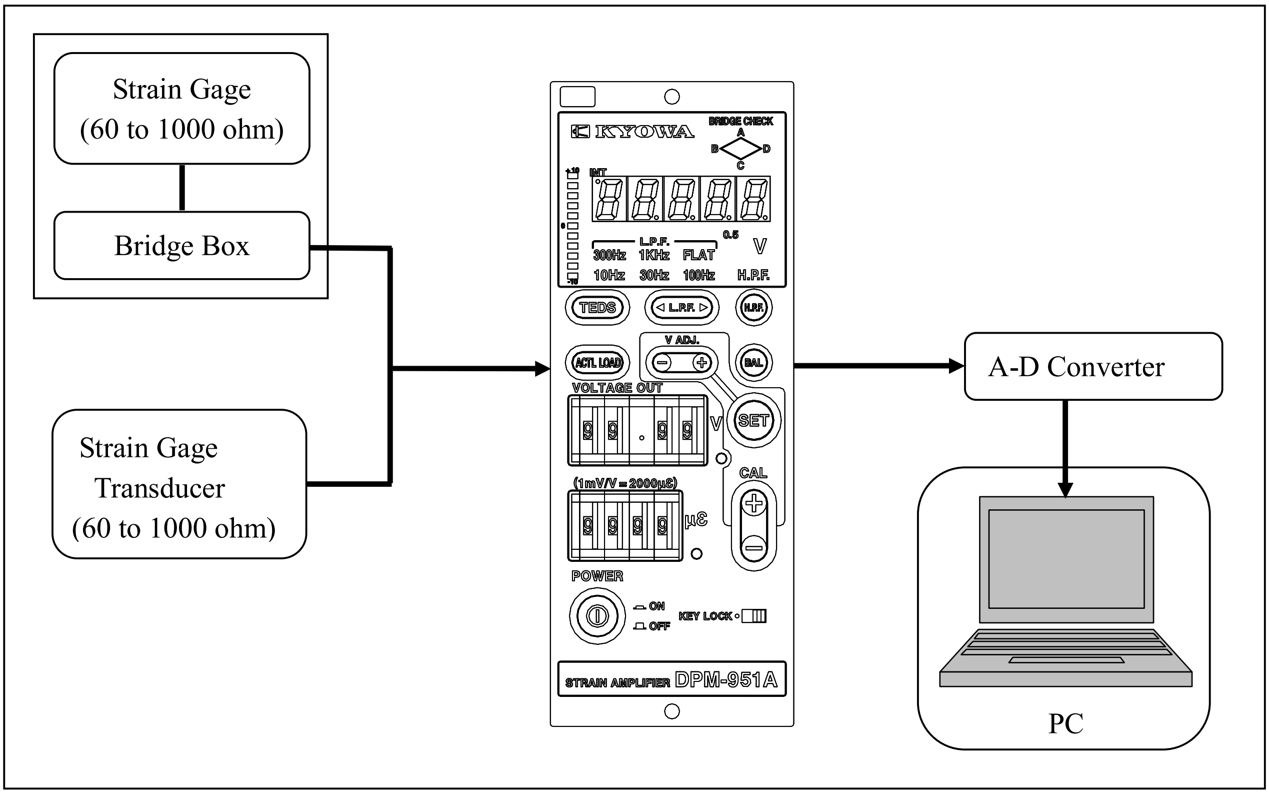
- Easy setting
  Just set input strain and output voltage at the time.
- Light weight
  Approximately 15% lighter than the conventional amplifier.
- Monitor and bar graph meter are standard provision.
  Strain signal can be monitored without connecting the output to the voltmeter.
- High output
  The rated output is ±10 V (twice of the conventional amplifier).
- High stability
  The zero point stability of the amplifier is good, it can measure with high accuracy.
- TEDS*1 function
  When using strain gage transducer with built-in TEDS circuit, the internal gain can be easily set without referring the Test Data Sheet by pressing the TEDS switch.
- ACTL LOAD function
  The internal gain can be set with the actual load or external calibrator by enabling the ACTL LOAD mode.
- Bridge check function
  This function checks breaking of wires in the strain gage bridge, and the monitor indicates which wires are broken.

MEMO

The conventional amplifier is DPM-700B series.
The words suffixed by "*" in the Instruction Manual are explained in "10. Glossary".
For TEDS function and operation method of the ACTL LOAD function, read "5-7-2 Setting Internal Gain with TEDS function" and "5-7-3 Setting Internal Gain with ACTL LOAD."

1-2 SYSTEM CONFIGURATION

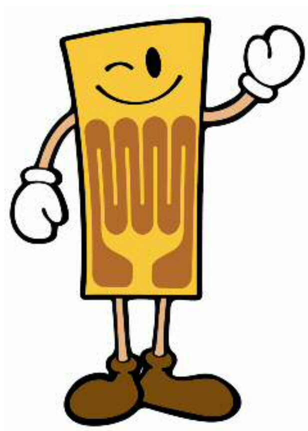
This section describes a general system configuration when using the DPM-900/950 series for measurement.



The DPM-900/950 series adopt the system configuration shown above, whereby it's input terminal connects with a strain gage transducer or a strain gage. For connection of the latter, a bride box is used generally. The DPM-900/950 series amplifies minute signals sensed by a strain gage, and provides an output of several volts after amplification in general cases. This allows connection of the DPM-900/950 series directly to a recorder or a voltmeter.

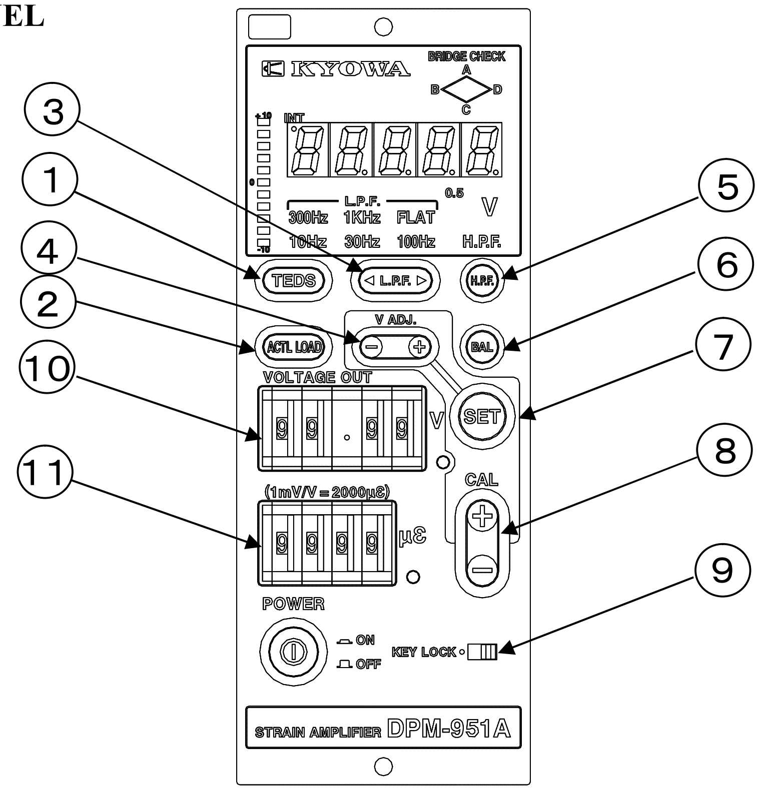
To measure a strain converted in electric signals, a calibration signal is used. The DPM-900/950 series uses a calibration signal that has been certified through a standardizing equipment KYOWA maintains.

For how to use strain gages or how to obtain the stress, read "9. Appendix."



2. PARTS AND FUNCTIONS

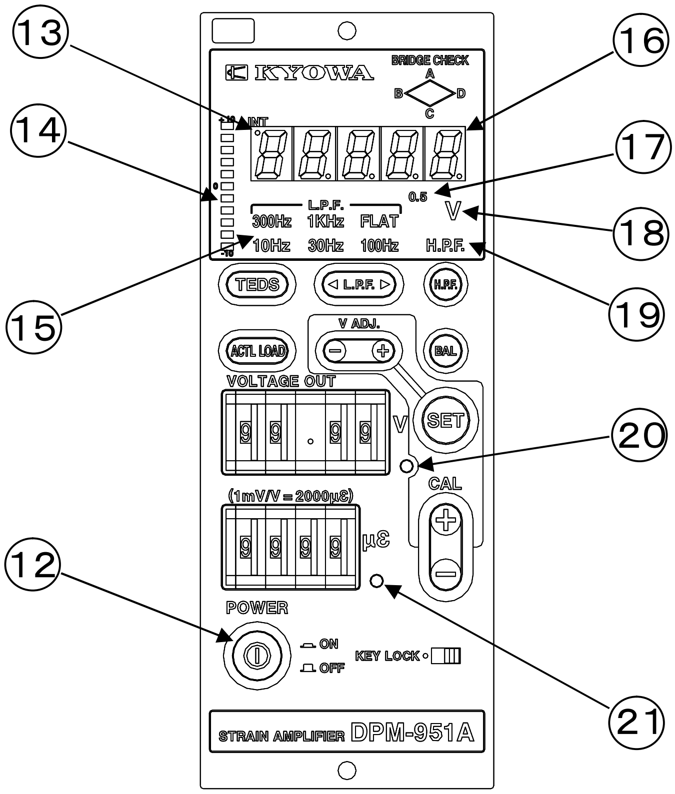
2-1 FRONT PANEL



1)	TEDS switch	Press and hold TEDS switch. The TEDS switch lights up in blue, the setting mode becomes TEDS mode.
2)	ACTL LOAD switch	Press and hold ACTL LOAD switch. The ACTL LOAD switch lights up in orange, the setting mode becomes setting mode with the input strain.
3)	L.P.F. switch	Changes a cutoff frequency of the low-pass filter. ◁ changes to a smaller one ▷ changes to a larger one (10 Hz ↔ 30 Hz ↔ 100 Hz ↔ 300 Hz ↔ 1 kHz ↔ FLAT)
4)	V ADJ. switch	Conduct zero-point fine adjustment and sensitivity fine adjustment of output voltage. +: Zero-point moves to a positive direction. −: Zero-point moves to a negative direction. With pressing the SET switch or + of the CAL ON switch, press + of the V ADJ. switch for high sensitivity, press − for low sensitivity.
5)	H.P.F. switch	Press and hold H.P.F. switch to changes valid or invalid of the H.P.F. When the H.P.F is valid, the H.P.F. lamp (item 19)) lights up.
6)	BAL switch	Press the BAL switch twice for balancing. Press and hold the BAL switch for disconnection check of the bridge.
7)	SET switch	Set the VOLTAGE OUT and CAL switches. Press the SET switch twice to set the internal gain of the DPM-900/950 series.
8)	CAL ON switch	+: Add + calibration signal that is set to the CAL switch to the output. −: Add − calibration signal that is set to the CAL switch to the output.
9)	KEY LOCK switch	Set the KEY LOCK switch to left for prohibiting operations other than POWER switch.
10)	VOLTAGE OUT switch	For setting the output voltage.
11)	CAL switch	For setting the input strain and required calibration signal value.

NOTE

Press and hold is an operation for continuously pressing the switch for 0.5 seconds or more.
Press twice is an operation to press the switch twice within 0.5 seconds.

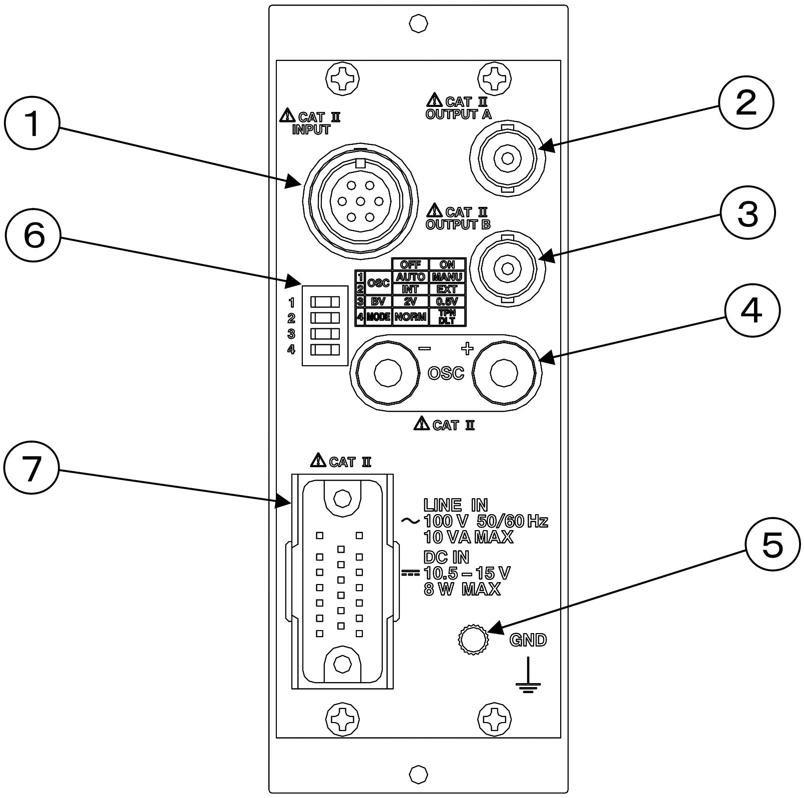


12)	POWER switch	POWER ON/OFF Press the POWER switch for turned ON and press again for turned OFF.
13)	INT lamp	Lights up when using the internal oscillator output for the excitation voltage of the DPM-900/950 series as the carrier.
14)	Bar graph meter	Indicates an output voltage by the length of the bar. One LED segment corresponds to 2 V. When the internal gain is fine adjusted to lower than ×200, 0 (orange LED) flickers. For details, read “4-6-5 Sensitivity Fine Adjustment.”
15)	L.P.F. lamp	Displays the cutoff frequency of the L.P.F.
16)	Monitor	Indicates the output voltage of the OUTPUT A and B in general. If the output voltage at the OUTPUT A or OUTPUT B exceeds ±11V, numbers or characters on the monitor flicker. In addition, indicates the physical quantity in TEDS mode and error content in error mode.
17)	BV 0.5 V lamp	When outputting 0.5 Vrms excitation voltage, the BV 0.5 V lamp lights up and when outputting 2 Vrms excitation voltage, the BV 0.5 V lamp lights out.
18)	V lamp	Lights up when displaying voltage on the monitor. Lights out only in the TEDS mode.
19)	H.P.F. lamp	Lights up when the H.P.F. switch is set to valid. When invalid, the H.P.F. lights out.
20)	VOLTAGE OUT lamp	Lights up after setting the internal gain correctly. After setting the internal gain, if the set value of the VOLTAGE OUT switch is changed, the VOLTAGE OUT lamp flickers.
21)	CAL lamp	Lights up after setting the internal gain correctly. After setting the internal gain, if the set value of the CAL switch is changed, the CAL lamp flickers. Lights out when in TEDS mode and ACTL LOAD mode.

NOTE

Internal gain: Gain from the input to the output of the DPM-900/950 series.
Capable of setting the internal gain within ×200 to ×20000.
In addition, when the internal gain is large, it means high sensitivity and when it is small, low sensitivity.

2-2 REAR PANEL



1)	INPUT connector	NDIS connector Connects with a strain gage transducer or a bridge box.
2)	OUTPUT A connector	BNC connector Outputs voltage based on the preset internal gain when the strain is input. Outputs the same voltage with the OUTPUT B connector. The rated output is 10 V.
3)	OUTPUT B connector	BNC connector Outputs voltage based on the preset internal gain when the strain is input. Outputs the same voltage with the OUTPUT A connector. The rated output is 10 V.
4)	OSC terminal	Terminal for OSC (internal oscillator) input/output Used for synchronous operation of multiple DPM-900/950 series units through parallel connection of [+] and [-].
5)	GND terminal	For grounding. It is connected internally to the common electric potential of the circuitry.
6)	Setting Switch	Used for selecting the oscillator (AUTO/MANU, INT/EXT) and excitation voltage (0.5 Vrms/2 Vrms). In addition, the “Setting Switch” is used for setting measuring mode (DPM-911/951 only) of the Rotary Transformer Torque Transducer or Inductance-Type Displacement Transducer. For details of the setting method, read “5-11 OSC SYNCHRONIZATION”, “5-14 EXCITATION VOLTAGE” and “5-15 TPN/DLT MEASURING MODE.”
7)	Centralized connector	For connecting the power cable in general. When the DPM-900/950 series are housed in the carrying case, it enables to connect them with certain control signals.

3. PREPARATION

This chapter describes necessary preparation before turning ON the power and how to use a single unit of DPM-900/950 series.
For how to use multiple units (channels) housed in the exclusive carrying cases, also read “6-5 EXCLUSIVE CARRYING CASE.”

3-1 HOW TO SET UP INPUT/OUTPUT INSTRUMENTS

When measuring strain with the DPM-900/950 series, connect input signal, output instrument and power to the DPM-900/950 series. The output instrument can be omitted in some cases.

3-1-1 Input Instrument

Prepare a strain gage transducer or strain gage configured in the Wheatstone Bridge[*2]. When using a strain gage, also prepare a bridge box by referring to “6-1 BRIDGE BOX.”

3-1-2 Output Instrument

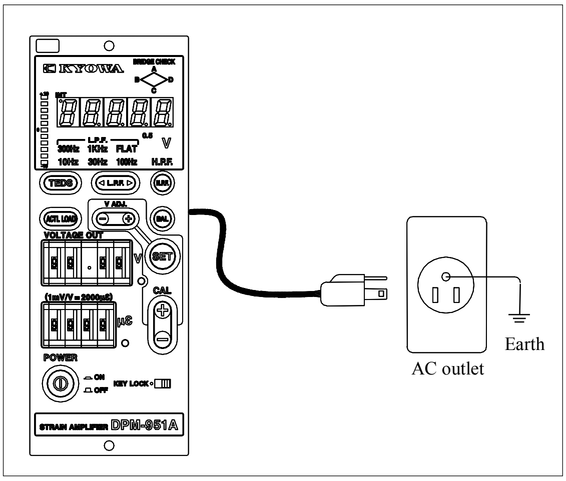
Output instrument is a voltmeter with input impedance 5 kohm or more or recorder. Requires for reading the amplified strain signal.
Since the DPM-900/950 series has a monitor, voltmeter etc. is not necessary. Connect the output instrument to the DPM-900/950 series using the output cable, and accessory.
For the connection with the output instrument, read “4-2 CONNECTION OF OUTPUT” and “5-2 OUTPUT.”

3-2 CONNECTION OF POWER

The DPM-900/950 series requires AC or DC power.
In either case, make sure of the power voltage prior to connection.

3-2-1 AC Power

Use the accessory power cable and connect the DPM-900/950 series to an AC power outlet as described right. Before connecting the DPM-900/950 series, be sure to check the power supply voltage is within the specified range.

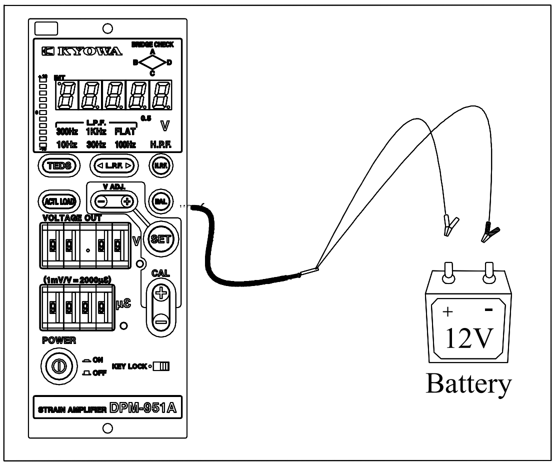


NOTE

Ground the middle prong of the 3-prong plug without fail.

3-2-2 DC Power

A DC power in a voltage range of 10.5 V to 15 V, or a battery is connectable.
A DC power cable is not attached to the DPM-900/950 series. Therefore prepare a connector plug (HIROSE ELECTRIC’s S-1620A-C or the equivalent) and use it as shown at right.
For connection to the DC power, read “5-12 APPLICATION OF CENTRALIZED CONNECTOR.”



3-2-3 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.

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

NOTE

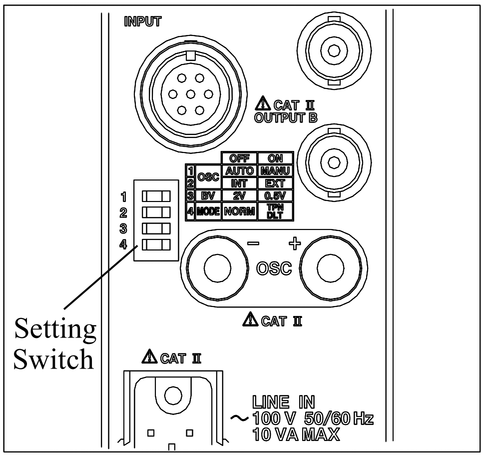
When using the accessory 3p - 2p conversion plug (CM-52), be sure to ground its earth terminal (green).

3-3 INITIAL SETTING

Set all "Setting Switches 1 to 4" to OFF.

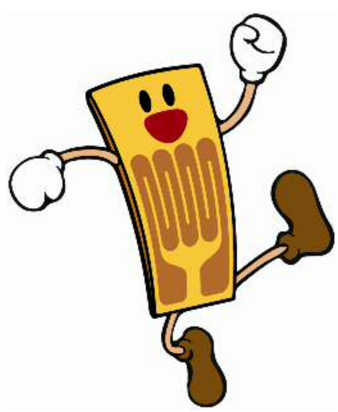
MEMO

Note that "Setting Switch 1" is not necessarily to set to OFF when operating multiple DPM-900/950 series units at a time.
Read "5-11 OSC SYNCHRONOUS."



NOTE

Although the "Setting Switch 4" is usually turned OFF, set the "Setting Switch 4" to ON only when using the Rotary Transformer Torque Transducer or Inductance-Type Displacement Transducer with the DPM-911/951.
For details, read "5-15 TPN/DLT MEASURING MODE."
No operation of the DPM-912/913/952 changes whether ON or OFF is selected.



4. BASIC OPERATION

This chapter describes the basic operation of the DPM-900/950 series.
The instructions given in this chapter is related to the usage of a single unit.

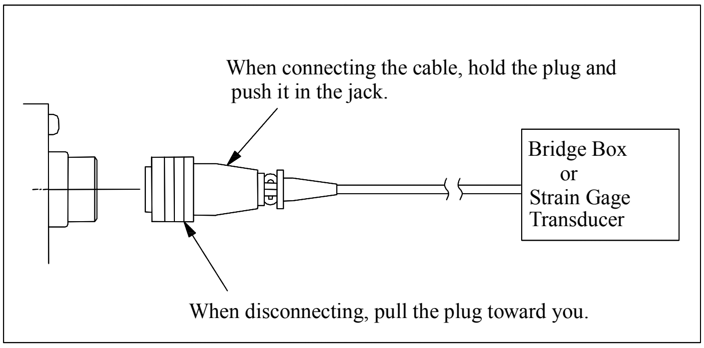
MEMO

For operation of multiple channels using the exclusive carrying case, read "6-5 EXCLUSIVE CARRYING CASE."

4-1 CONNECTION OF INPUT

Connect a strain gage (via a bridge box) or a strain gage transducer to the DPM-900/950 series' INPUT connector.
Configure a Wheatstone Bridge with the strain gage(s) and the bridge box.

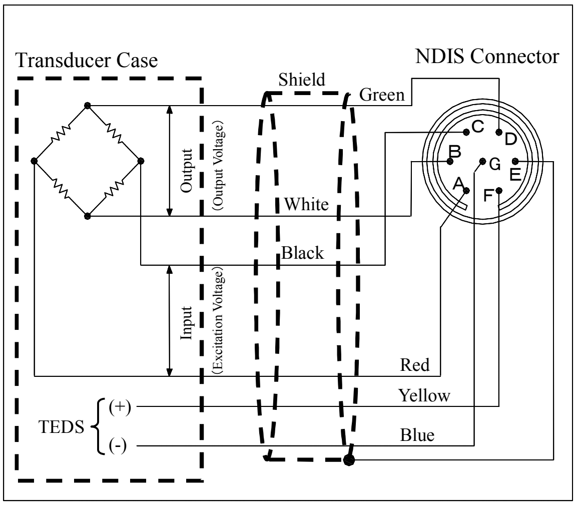
If one end of the connection cable of a strain gage transducer is formed by a NDIS connector, insert it into the INPUT connector directly as shown at right.



If the connection cable of a strain gage transducer comes without the NDIS connector on its end or if a strain gage is to be connected directly, either of the following 2 methods can be used.

1) **When using the bridge box for connection**
   Read "6-1 BRIDGE BOX."

2) **When connecting the strain gage to the plug in advance**
   A connection method is shown in the right. The plug is NDIS connector PRC03-12A10-7M10 (TAJIMI).
   For connection of a strain gage, a bridge box of full bridge method*5 can be conveniently used.



MEMO

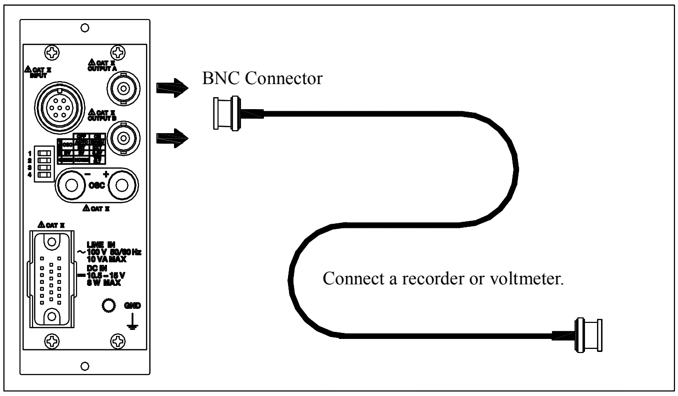
For the E terminal, read "9-5 E TERMINAL OF INPUT CONNECTOR."
Wire colors described in figures are typical colors of KYOWA strain gage transducer.

NOTE

Do not connect a remote sensing sensor to the DPM-900/950 series. The F terminal and G terminal are input terminals dedicated for the TEDS.

4-2 CONNECTION OF OUTPUT

The DPM-900/950 series provides OUTPUT A and OUTPUT B. These systems output the same voltage but are independent of each other. Therefore, 2 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*6 is rated at about 2 ohm on either terminal.

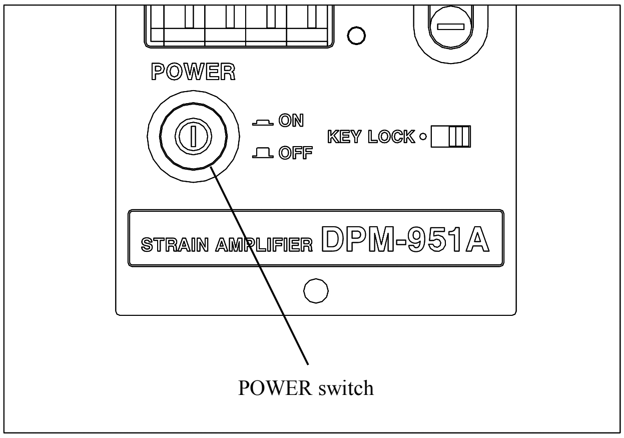


4-3 TURNING ON AND OFF THE POWER

Turning ON and OFF the power is the most important operation. Read the following instructions carefully.

4-3-1 Turning ON the Power

Prior to turning ON, make sure the input/output connector and power are correctly connected.



MEMO

For connection, read the following.
"3-1 SETTING UP INPUT/OUTPUT INSTRUMENT"
"3-2 CONNECTION OF POWER"
"4-1 CONNECTION OF INPUT"
"4-2 CONNECTION OF OUTPUT"

Press the **POWER** switch until it clicks.
At this time, all LEDs illuminate for about 3 seconds. After that, measuring conditions are set and the DPM-900/950 series become measuring state.

NOTE

After turning ON the power, be sure to bridge check the DPM-900/950 series before measurement. (However, excluding cases using Rotary Transformer Torque Transducer.)
For details, read "5-4 BRIDGE CHECK."

4-3-2 Turning OFF the Power

Press the **POWER** switch.
All indications disappear.

NOTE

The DPM-900/950 series maintains all measuring parameters in its internal nonvolatile memory all the time.
However, saving of parameters may fail if the power is turned OFF immediately after the renewal. To prevent it, after conducting the zero adjustment, sensitivity fine adjustment, changing LPF setting or HPF setting, wait 3 seconds or more and turn OFF the power. In addition, if you turned OFF the power without setting the internal gain after changing mode to the TEDS or ACTL LOAD mode, turning ON the power again changes the TEDS mode or ACTL MODE to the normal mode. (Conduct the internal gain setting to maintain the current mode.)

4-4 SELECTING MODE

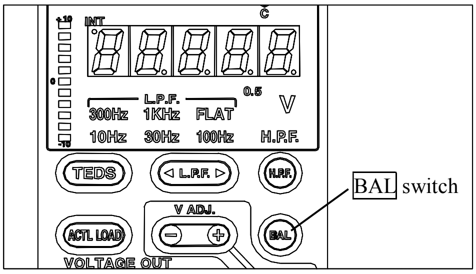
The DPM-900/950 series provides “Normal Mode”, “TEDS Mode” “ACTL LOAD Mode” and “TPN/DLT Measuring Mode.” Setting methods of the internal gain and display unit of the indication varies with every mode.

“TEDS Mode”	Setting and cancelation is possible by pressing and holding TEDS switch. While “TEDS Mode” is set, TEDS switch light up.
“ACTL LOAD Mode”	Setting and cancelation is possible by pressing and holding ACTL LOAD switch. While “ACTL LOAD Mode” is set, ACTL LOAD switch light up.
“Normal Mode”	When both TEDS switch and ACTL LOAD switch is off, “Normal Mode” is set.
“TPN/DLT Measuring Mode”	Turning on “Setting Switch 4” on the rear panel make it setting. (DPM-911/951 only)

However, “Normal Mode” and “TPN/DLT Measuring Mode” have no outward difference. For how to confirm modes, read the MEMO in “5-15 TPN/DLT MEASURING MODE.”
For the setting methods of the internal gain, read “5-7 INTERNAL GAIN.”

4-5 BASIC BALANCING

The DPM-900/950 series performs balancing completely electronically.
Make sure that input signals are connected, and then press the BAL switch twice.
Balancing will then be carried out irrespective of the setting conditions of other parameters.



MEMO

After balancing is executed, the panel meter will not necessarily read exactly 0 but several mV remains.
Carry out fine balancing by using the V ADJ. switch if necessary.

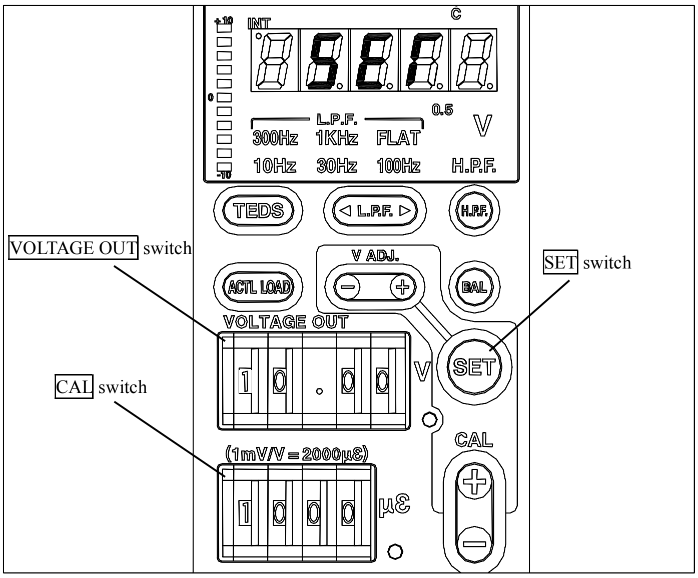
4-6 SETTING MEASURING PARAMETERS

This section describes how to set the measuring parameters of the DPM-900/950 series.

4-6-1 Setting an Basic Internal Gain

It is necessary to set an internal gain (sensitivity[*10]) properly to assure the correct strain measuring.
This section describes how to select the internal gain with the CAL switch.
For details, read “5-7 INTERNAL GAIN.”

First, estimate the strain to be measured.
When using the strain gage transducer for the input, set the internal gain from the rated output.
For example, when using the strain gage transducer with ±1000 μm/m rated output.
For setting the internal gain with 10 V of the rated input, set VOLTAGE OUT switch to 10.00 and CAL switch to 1000 and press the SET switch twice.
After the internal gain is correctly set, SEt (SET) appears on the monitor.



With a strain-gage, estimate the strain with due regard to the material and construction of a measuring object. Set the value as the standard and set the internal gain in the same way.

NOTE

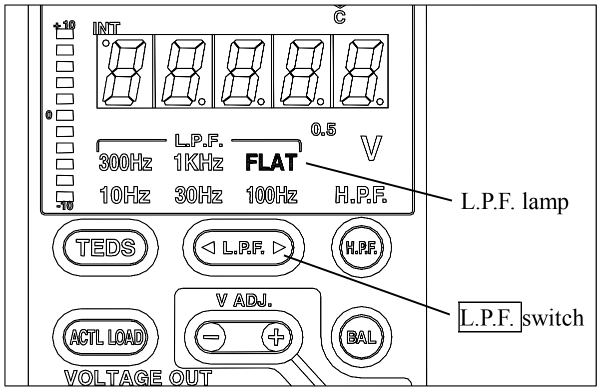
After setting the internal gain, Er-○○○ appears without appearing SEt to the monitor, read "9-4 TROUBLESHOOTING."
After connecting or changing the sensor, be sure to bridge check the DPM-900/950 series before setting the internal gain.
Set the VOLTAGE OUT switch from "1.00" to "10.00."
When the setting value is less than "1.00," it may not satisfy for specification of sensitivity adjuster accuracy.

MEMO

The rated capacity and rated output of the strain-gage transducer are found in its Test Data Sheet.
When using the TEDS installed strain gage transducer, read the TEDS information to set the internal gain. The internal gain can be easily set.
When using the actual load or external calibrator, use the ACTL LOAD to set the internal gain. The internal gain can be accurately set.
For details, read "5-7 SETTING INTERNAL GAIN."

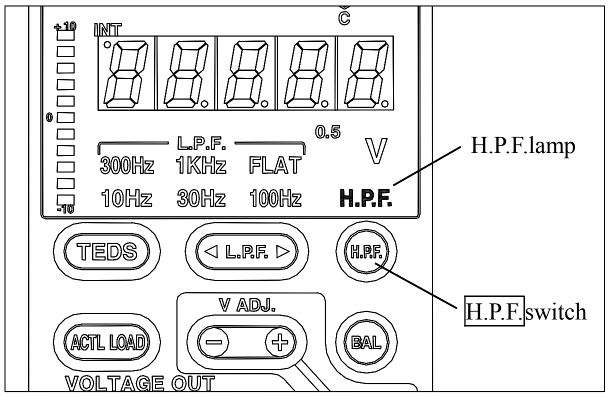
4-6-2 Setting Low-pass Filter

The low-pass filter is used for setting limits to the frequency range of outgoing signals normally.
For not limiting the frequency range, set the filter to "FLAT," thereby inactivating the filtering function.
Press the < or > of the L.P.F. switch to set a target L.P.F. lamp.
For details, read "5-8 LOW-PASS FILTER" and "9-2 LOW-PASS FILTER CHARACTERISTICS."



4-6-3 Setting High-pass Filter

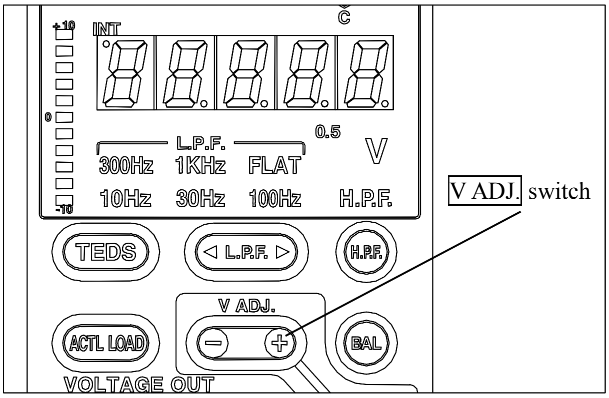
The high-pass filter is used for eliminating the DC component of outgoing signals normally.
As a routine, it is not necessary to set.
Press and hold the H.P.F. switch for valid.
Press again for invalid.
When the H.P.F. is valid, the H.P.F. lamp lights up and the cutoff frequency of that time is 0.2 Hz.
When the H.P.F. is invalid, the H.P.F. lamp lights out.



NOTE

After valid the H.P.F., be sure to conduct the balancing before the measurement. (When the input is saturated, accurate measurement cannot be conducted.) In addition when outputting the calibration signal by pressing the CAL switch with the H.P.F. lamp lights up, the calibration signal is not added to the output. Turn OFF the H.P.F. lamp and output the calibration signal. In the case where nothing is connected to the input, even if the high pass filter is enabled, the output saturates minus (Only DPM-913C.)

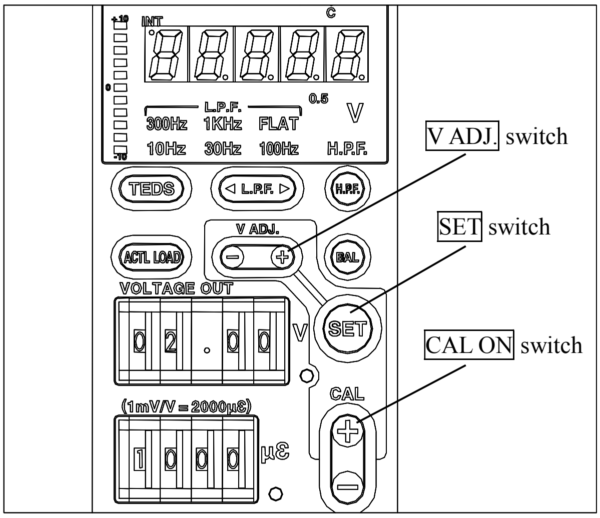
4-6-4 Zero Point Fine Adjustment



Capable of fine adjusting the output of OUTPUT A and OUTPUT B. It is convenient for moving the baseline of the external equipments, etc.
Press + or − of the V ADJ. switch to vary the output. In addition, hold down the + or − of the V ADJ. switch to faster the changing speed. The adjustment range of the zero point is approximately ±50 mV from the balance adjusted value.

4-6-5 Sensitivity Fine Adjustment

Capable of fine adjusting the preset internal gain.
Either of the following 2 methods can be used for the sensitivity fine adjustment.
Basically, use the item 1) method. It is convenient to use the item 2) method for ACTL LOAD mode.



1) Sensitivity fine adjustment by the CAL ON switch
With pressing the + or − of the CAL ON switch, press the + or − of the V ADJ. switch to change the internal gain.
+: Internal gain moves to a higher direction.
−: Internal gain moves to a lower direction.
In addition, hold down the + or − of the V ADJ. switch to faster the changing speed. The sensitivity fine adjustment range is ×1 to ×1/2.5.

2) Sensitivity fine adjustment by the SET switch
With pressing the SET switch, press the + or − of the V ADJ. switch to change the internal gain.
+: Internal gain moves to a higher direction.
−: Internal gain moves to a lower direction.
In addition, hold down the + or − of the V ADJ. switch to faster the changing speed. The sensitivity fine adjustment range is ×1 to ×1/2.5.

NOTE

The internal setting range of the DPM-900/950 series is ×200 to ×20000. For details, read “5-7 INTERNAL GAIN.”
Capable of adjusting the internal gain within the range of ×80 to ×20000 by conducting the sensitivity fine adjustment.
When the internal gain lowers ×200, 0 (orange LED) of the bar graph meter flickers.
However, when the internal gain lowers ×200, specifications related to the performance is not guarantee.

5. FUNCTIONS

This chapter describes all the DPM-900/950 series functions in detail as well as advanced usage.

5-1 INPUT

The DPM-900/950 series is designed exclusively for measuring strain. The connectable sensors are as follows.

- Strain gage bridge box
  When measuring strain by using the strain gage, use the bridge box.
  In addition, purchase the bridge box.
  For how to use the bridge box, read "6-1 BRIDGE BOX."

- Strain gage transducer
  For how to connect the strain gage transducer, read "4-1 CONNECTION OF INPUT."

NOTE

Avoid using instruments or sensors other than the above, or else the DPM-900/950 series will not function properly. Also avoid connecting one input to multiple DPM-900/950 series units, or else the DPM-900/950 series will get out of order.

When setting the minimum internal gain at excitation voltage 2 Vrms, the maximum input is approximately ±50000 μm/m. However, it is capable of inputting approximately up to ±130000 μm/m by conducting the sensitivity fine adjustment but the sensitivity at that time is not guaranteed.

The maximum output of the DPM-900/950 series is ±10 V. Where a large amount of strain is input and exceeds the allowable range of the maximum output, the indication on the panel meter blinks. If it occurred, decrease the internal gain till the indication stops blinking.

When using a bridge box, be sure also to use shielded cables to connect strain gages to the DPM-900/950 series in order to reduce induction nose. If a parallel vinyl cable is used, the performance of the amplifier cannot be guaranteed.

5-2 OUTPUT

The DPM-900/950 series is provided with 2 independent output systems. The 2 output terminals can be connected to 2 different external instruments. Even if one output system should get out of order, it does not affect the other.
OUTPUT A and OUTPUT B have the following characteristics.
Over ±10V output possible for over 5 kohm load.
The output level can be set up by the internal gain setting and conducting the sensitivity fine adjustment.
The zero point can be adjusted by the zero adjustment.
However, OUTPUT A and OUTPUT B cannot be adjusted separately about the output level and zero point.

5-3 PREHEATING

When once the DPM-900/950 series has been turned ON, it will be ready for operation after 5 seconds. Note that the internal electrical parts and semiconductors cannot acquire the thermal stability immediately after switching the power ON. Unless the OCS circuit, especially reaches the thermal stability, a change in the sensitivity or a drift of the zero point can be changed. Carry out preheating[*7] for about 30 to 60 minutes for stable measurement.

5-4 BRIDGE CHECK

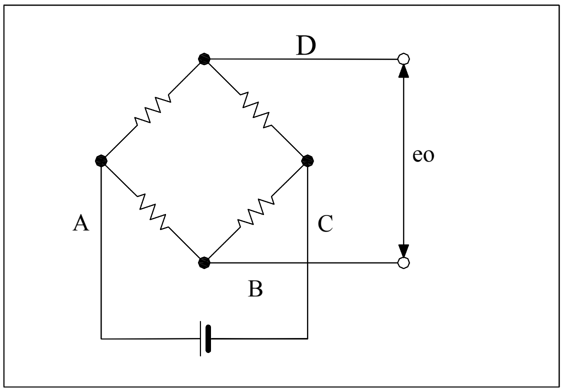
The DPM-900/950 series provides a bridge check function. This function is used to check cable breaking on the whole input system, including the input cable and connector.

Press and hold the $\boxed{\text{BAL}}$ switch to conduct the bridge check.
The result of the check is indicated on the monitor.
This indication is maintained while pressing the $\boxed{\text{BAL}}$ switch.
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, turn OFF the power, and then remove the sensor cable from the input connector. After that, carry out a check on cable breaking.

NOTE

If the breaking exists in the input cable, correct measurement cannot be conducted.
When connecting sensor to the input or changing the sensors, be sure to bridge check and set the internal gain.
Be sure to turn OFF the DPM-900/950 series before checking and mending the error.
Do not conduct the bridge check function with the Rotary Transformer Torque Transducer connected.

As a matter of convenience, the wirings to the bridge are named as shown in the figure in the right. If error is found Wiring A through the bridge check function, **Er-a** will appear on the monitor. Even if error exists on two wirings, the name of only one wiring will be shown. Therefore, check wirings one after another as follows.
To begin with, check the wiring whose name is on the monitor to remove the cause. After that, press and hold the $\boxed{\text{BAL}}$ switch 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 the next wiring will be shown by **Er-b** , **Er-c** or **Er-d** , one each at a time.
Check the sensor and the indication 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, read “9-1 BRIDGE CHECK FUNCTION AND RESULT INDICATION.”
The result of bridge check is available as bridge status signals at the converging connector on the rear panel. For details, read “5-12 CENTRALIZED CONNECTOR.”



NOTE

Be sure to turn OFF the DPM-900/950 series before mending the cause.

5-5 BALANCING

Both resistive and capacitive signal components*8 exist on a strain gage bridge. These unbalance components should be removed through balancing, in order to achieve high quality measurement.

5-5-1 Balancing Range

Resistive unbalance can be reduced to ±2 %, i.e. ±10000 μm/m.
Capacitive unbalance can be adjusted up to 2000 pF.
Resistive balancing is carried out by using the BAL switch.
Capacitive unbalance is cancelled all the time by the internal compensation circuit.

5-5-2 Balancing

Press the BAL switch on the front panel twice. This is all you have to do to execute balancing.
The monitor lets you know if or not balancing has been carries out correctly. The meter indication of approximately 0 (zero) reflects correct balancing. An indication value within a range of ±10 mV can be taken as normal. To adjust the meter indication to exactly 0 (zero), execute the zero point adjustment.
For details, read “4-6-4 Zero Point Fine Adjustment.”
After pressing the BAL switch, if a large value should appear, it is the indication of some error. Repeat balancing a few times. Should it happen after that, discover the cause by referring to “7-2 INITIAL BALANCING IS IMPOSSIBLE.”
Balancing can also be carried out by using the external control signal. For details, read “5-13 REMOTE CONTROL.”

NOTE

The CPU controls to minimize remaining V during balancing the DPM-900/950 series. If one time of balancing is not enough, repeat balancing a few times. In that case, one time of balancing may require up to 5 seconds, but this does not reflect any error.

5-6 MOVING ZERO POINT

The zero point of OUTPUT A and OUTPUT B can be removed.
This function is conveniently used to move the base line of an external instrument.
For how to move the zero point, read “4-6-4 Zero Point Fine Adjustment.”
Zero point adjustment range is <u>about ±50 mV from the balancing value.</u>

NOTE

The zero points of OUTPUT A and OUTPUT B move at the same time and same range.
The zero points of OUTPUT A and OUTPUT B cannot move independently.

5-7 INTERNAL GAIN

Setting methods for the internal gain are the following 3 methods that use CAL, TEDS, or ACTL LOAD.
In general, CAL is used.
When the measuring target is the TEDS installed strain gage transducer, set the internal gain with the TEDS for easy setting.
If you want to set the internal gain with the actual load or external calibrator, set the internal gain with the ACTL LOAD.
Selection of the smallest internal gain (× 200) lets you cover up to ±50000 μm/m measuring range.
However, with this internal gain, a maximum output is rated at as small as 20 mV or there against a strain input of 100 μm/m. This means poor precision of measuring.
By contrast, the largest internal gain (× 20000) causes saturation against a large strain input.
Accordingly, an appropriate internal gain should be selected so as to meet the amount of a strain to be measured.
The larger the internal gain is selected, the larger an amplification degree becomes, resulting in large noise.

NOTE

The internal gain setting range of the DPM-900/950 series is × 200 to × 20000.
If you want to set the internal gain with the CAL either × 200 or × 20000, set the CAL and VOLTAGE OUT switches as follows.

- Internal Gain × 200 : CAL switch "5000", VOLTAGE OUT switch "01.00"
- Internal Gain × 20000: CAL switch "0500", VOLTAGE OUT switch "10.00"

The internal gain can be calculated from the following equation.
Internal Gain = "Value of the VOLTAGE OUT switch" / "Value of the CAL switch μm/m"
*When the excitation voltage is 0.5 Vrms, multiply the internal gain calculated by the above equation by 4.

5-7-1 Setting Internal Gain with Calibration Signal

Use the calibration signal (CAL) of the DPM-900/950 series for internal gain setting.
For functions of the calibration signal, read "5-9 CALIBRATION SIGNAL."
When adjusting the sensitivity with the CAL switch "0000," neither the calibration value nor signal output is available.

- When the measuring target is strain gage

Follows are the setting procedures of the optimum internal gain.

1) Set the DPM-900/950 series to the normal mode. (When the TEDS or ACTL LOAD switch is lighting up, press and hold the either switch to light out.
2) Connect the strain gage and conduct bridge check.
3) Estimate the amount of the strain to be measured.
4) Set the CAL switch to the estimated amount strain.
5) Set the VOLTAGE OUT switch to the desire voltage value.
6) Press the SET switch twice.
7) Press the BAL switch twice. (The DPM-900/950 series becomes measuring state after balancing.)
   While correctly setting the internal gain, SEt appears on the monitor.
   When Er-ooo appears on the monitor, it indicates the setting error. Read the "9-4 TROUBLE SHOOTING.

NOTE

Set the VOLTAGE OUT switch within the range of "1.00" to "10.00" for excitation voltage 2 Vrms and "0.10" to "10.00" for excitation voltage 0.5 Vrms. Setting internal gain outside this range may not satisfy the specification.
When the internal gain is set with the CAL switch "0000," oFF appears on the monitor and the voltage out is 0 V fixed regardless of the input. (The same thing happened when the range is set to OFF with the DPM-700 series.)

- When the measuring target is strain gage transducer

The rated output (μm/m) of the KYOWA strain gage transducer is described in the Test Data Sheet.
Capable of conducting the optimum internal gain setting by using the rated output. If the strain output is not described in the rated output, the strain output can be obtained from the gage factor Ks*11.

$$\text{Rated Output } (\mu V/V) \times \frac{4}{\text{Gage Factor (Ks)}} = \text{Rated Output } (\mu m/m)$$

Suppose when using the strain gage transducer with the rated output 1567 μV/V and gage factor 2.00.
Follows are the setting procedures of the optimum internal gain.

1) Set the DPM-900/950 series to the normal mode. (When the TEDS or ACTL LOAD switch is lighting up, press and hold the either switch to light out.)
2) Connect the strain gage transducer and conduct bridge check.
3) Calculate the rated output (μm/m). The rated output at that time is 1567 × 2 = 3134 μm/m
4) Set the CAL switch to “3134.”
5) Set the VOLTAGE OUT switch to “10.00” (10 V).
6) Press the SET switch twice.
7) Press the BAL switch twice. (The DPM-900/950 series becomes measuring state after balancing.)

While correctly setting the internal gain, SEt appears on the monitor.
When Er-○○○ appears on the monitor, it is indicating the setting error. Read “9-4 TROUBLE SHOOTING.”
In addition, when using the strain gage transducer with the half or less of the rated capacity, increase the sensitivity 2 times or more to decrease the noise.
For example, when using the strain gage transducer with the 20 % of the rated capacity, the rated output can be obtained 3134 × 20% =626.8 (μm/m) only. Keep 10.00 of the VOLTAGE OUT switch, set the CAL switch to “0627” and set the internal gain for more accurate measurement.

5-7-2 Setting Internal Gain with TEDS

When the measuring target is the TEDS-installed strain gage transducer, the DPM-900/950 series can load the TEDS information and set the internal gain easily. TEDS information that is used in the DPM-900/950 series is the rated output (μm/m), rated capacity and recommended excitation voltage range.
Follows are the setting procedures of the optimum internal gain.

1) Set the DPM-900/950 series to the TEDS mode. (Press and hold the TEDS switch to lights up.)
2) Connect the TEDS-installed strain gage transducer to the input and conduct bridge check.
3) Set the VOLTAGE OUT switch to the desired voltage.
4) Press the SET switch twice.
5) Press the BAL switch twice. (The DPM-900/950 series becomes measuring state after balancing.)

While correctly setting the internal gain, tEdS-rEAd appears on the monitor.
When Er-tEdS or Er-tEdS-bu appears on the monitor, it is indicating the setting error. Read “9-4 TROUBLE SHOOTING.”

MEMO

Physical value (converted value from the voltage) is displayed on the monitor in TEDS mode.
For displaying the voltage on the monitor, press and hold the TEDS switch to become the normal mode.
(Though the TEDS switch lights out, the setting contents are maintained.)
Pressing the SET switch in TEDS mode appears ○○○○u ○○○○.d on the monitor.
Above are the rated output and rated capacity that are set to the DPM-900/950 series.
For example, when using a TEDS-installed transducer with rated output 3134 μm/m and rated capacity 4678 N. When setting the internal gain with the TEDS, press and hold the SET switch to scroll 3134u 4678.d display on the monitor.

5-7-3 Setting Internal Gain with ACTL LOAD

The DPM-900/950 series can set the internal gain with the ACTL LOAD (actual load). When using an extension cable, set the internal gain with ACTL LOAD for more accurate measurement.

Follows are the setting procedures of the optimum internal gain with the ACTL LOAD.

1) Set the DPM-900/950 series to the ACTL LOAD mode. (Press and hold the ACTL LOAD switch to lights up.)
2) Connect the strain gage, strain gage transducer, or external calibrator to the input and conduct bridge check.
3) Press the BAL switch twice. (Conduct balance adjustment in no load state.)
4) Input the actual load or strain of the external calibrator.
5) Set the VOLTAGE OUT switch to the desired voltage.
6) Press the SET switch twice.
7) Press the BAL switch twice with no load. (The DPM-900/950 series becomes measuring state after balancing.)

While correctly setting the internal gain, SEt appears on the monitor.
When the Er- ○○○ appears on the monitor, it is indicating the setting error. Read “9-4 TROUBLE SHOOTING.”

MEMO

Press and hold the SET switch in the ACTL LOAD mode. The ○○○○u scrolls on the monitor.
It is the amount of the strain that is input to the DPM-900/950 series.
When the input strain is 10000 μm/m at the time of internal gain setting, the calibration signal corresponds to the input cannot be set.
Maximum calibration signal is 9999 μm/m.
In addition, the built-in software version is scrolled horizontally on the monitor if the **SET** switch is pressed and hold in the “Normal Mode.”

5-8 LOW-PASS FILTER

The DPM-900/950 series provides a secondary Butterworth type low-pass filter.
Five cutoff frequencies are provided, including 10, 30, 100, 300 Hz and 1 kHz, in addition to “FLAT.”
At the point of a cutoff frequency selected, the amplitude is attenuated by about 70%.
The cutoff characteristic is rated at -12 dB/Oct. It means that the amplitude attenuates to 1/4 when frequency is doubled in the cutoff region in excess of a cutoff 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) Unities the characteristics of data paths for simultaneous multi-point measuring.

For the setting method of the low-pass filter, read “4-6-2 Setting Low-pass Filter.”
When strain signals vary in the form of sine wave (sin-functionally), set the low-pass filter to a cutoff frequency from 2 to 5 times larger than the signal frequency or strain signals that are to be measured.
For the characteristic of the low-pass filter, read “9-2 LOW-PASS FILTER.”

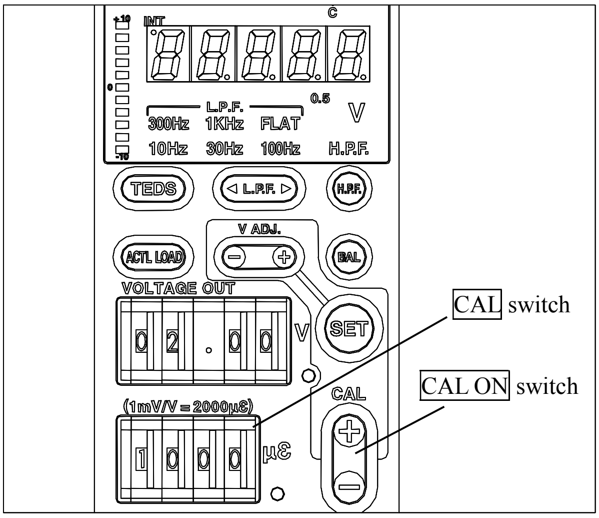
NOTE

With a low-pass filter having the Butterworth characteristic, the phase delay becomes unproportional to the frequency nearby a cutoff 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 cutoff frequency about 10 times larger than the frequency of strain signals.

5-9 CALIBRATION SIGNAL

A calibration signal (CAL) is used for measurement the amount of a strain.
The value of this calibration signal is set to the CAL switch by using a positive 4-digit integer as an amount of the strain.
The calibration value is settable in a range from 1 to 9999 με by an increment or decrement of 1με.
Capable of adding the calibration signal to the output in any mode.

Output adding method of the calibration signal is described in the following.
First, set the target calibration signal to the CAL switch. Press the CAL ON switch. Press + of the CAL ON switch for adding the positive calibration signal, press − for negative calibration signal.
The calibration signal is added to the output while the CAL ON switch is pressed.



MEMO

It is also possible to activate the function using an external control signal.
For details, read “5-13 REMOTE CONTROL.”

5-10 KEY-LOCK

The DPM-900/950 series provides key-lock function. Use the key-lock function in order to prevent the measuring parameters from changing when the keys are touched by mistake.
While the key-lock function is active, setting operation other than POWER switch become invalid. However, the setting values of the CAL and VOLTAGE OUT switches are changeable.

To activate the key-lock function, set the KEY-LOCK switch to the left position.

MEMO

It is also possible to activate the function by using an external control signal.
For details, read “5-13 REMOTE CONTROL.”

5-11 OSC SYNCHRONIZATION

OSC synchronization (carrier*13 synchronization) is necessary when operating multiple units of the DPM-900/950 series for simultaneous measurement of strain on multiple measuring points. Carrier synchronization is for prevention of beats*14 that are caused by difference between carrier frequencies.
When measuring strains with the OSC synchronization, set any one of the DPM-900/950 series as the master (use the internal OSC) and set others as slaves (use the external OSC).
Capable of setting whether to use the internal OSC or external OSC by "Setting Switch 1" and "Setting Switch 2" on the rear panel.

- When automatically determining (AUTO) the internal or external
  When "Setting Switch 1" is set to OFF (AUTO), the OSC terminal voltage is checked when turning ON the DPM-900/950 series and automatically determines the internal (INT) or external (EXT).

- When manually (MANU) setting the internal or external
  When manually setting the internal (INT) or external (EXT), set "Setting Switch 1" to ON (MANU).
  For using the internal OSC, set "Setting Switch 2" to OFF (INT).
  For using the external OSC, set "Setting Switch 2" to ON (EXT).

To achieve OSC synchronization, proceed as follows. (In the following procedure explanation, the DPM-900/950 series is referred DPM).

1) Turn OFF all DPM.
2) Connect all OSC terminals in parallel. Connect a + terminal to another + terminal, and connect a – terminal to another – terminal.
   The YC-A series exclusive carrying case (option) achieves automatic connection of all OSC terminals internally. So it is a great convenience.
3) Set "Setting Switch 1" of the DPM to ON (MANU) and "Setting Switch 2" to OFF (INT) which is to be the master.
4) Set all "Setting Switch 1" of the DPM of non-master (slave) to OFF (AUTO).
   If you previously turn ON the DPM which will be set to slave, it needs to be set "Setting Switch 1" and "Setting Switch 2" to ON (MANU-EXT).
5) Turn ON the DPM that setting to master first. The INT lamp of DPM operating as the master lights up.
   Then turn ON the DPM that setting to slave.

MEMO

To set the automatically identified DPM as the master, turn on the power before the slave.
To set up a master or slave regardless of when the power is turned ON, set it manually.

NOTE

- In order to achieve OSC synchronization, all dynamic strain amplifiers need to provide a same frequency of the excitation voltage.
- Up to 50 units of the DPM-900/950 series can achieve synchronization with one unit acting as the master.
- Before connecting the OSC terminals, be sure to turn OFF the DPM-900/950 series.
- Do not connect multiple units with “Setting Switch 1” set to ON (MANU) and “Setting Switch 2” set to OFF (INT).
- If the INT lamps illuminate on multiple units after turning ON with the OSC terminals connected, check whether multiple DPM-900/950 series units with “Setting Switch 1” set to ON and “Setting Switch 2” to OFF exist. Turn OFF the units once and correct set the setting switches. Then turn ON the units once again.
- When the master is changed, the bridge power of the slave side may vary. In such case, set the internal gain again. (When the excitation voltage is changed, the output accuracy will be approximately the same as before changing by readjusting the internal gain.)
- When the internal OSC circuit broken, Er-Carr appears on the monitor to indicate the error. (When setting as the master.)
- When the input OSC signal of the OSC input/output terminal is not specifying the specifications of the excitation voltage, Er-Carr appears on the monitor to indicate the error. (When setting as slave.)
- Where conventional KYOWA’s amplifiers (such as DPM-700 series or DPM-600 series, etc.) are to be synchronized with the DPM-900/950 series, use the DPM-900/950 series as slave. Also, read the instruction manual of each model because setting method is slightly different.

5-12 APPLICATION OF CENTRALIZED CONNECTOR

The DPM-900/950 series provides a centralized connector on its rear panel. Generally, the connector is used to connect with an AC power supply via the accessory power cable. The connector also provides a pin that connects with a DC power supply. The connector also enables connection of input/output signals.
Names and functions of these signals are shown in the following table.
For details of external control signals (with REM on the signal name) in the table, read "5-13 REMOTE CONTROL."

Pin No.	Signal Name	Signal type	Function and destination
1	+12 V	Power supply	Connects[1] with the + terminal of a DC power supply.
2	REM BAL[2]	Remote input	Valid with an external balancing signal "L."
3	OSC	Input/output	Connects with input synchronous signal.
4	N.C[3]		
5	COM	Common electric potential	Common electric potential of the remote signal, bridge status, OUTPUT A Also can be used as OCS – signal.
6	N.C[3]		
7	AC POWER INPUT	Power supply	Connects with an AC power supply.
8	N.C[3]		
9	Bridge status	Output	Outputs open collector[*12] "L" against a bridge check which has proven N.G.
10	REM KEYLOCK[2]	Remote input	Valid with an external key-lock signal "L."
11	GND	Grounding terminal	Connects with the case and COM terminals internally.
12	N.C		
13	N.C		
14	0 V	Power supply	Connects with the minus terminal of a DC power supply. [1]
15	OUTPUT A[2]	Output	Connects with OUTPUT A connector internally.
16	COM	Common electric potential	Common electric potential of the remote signal, bridge status, OUTPUT A Also can be used as OCS – signal.
17	REM +CAL[2]	Remote input	Valid with an "L" signal that commands execution of external +CAL input.
18	REM -CAL[2]	Remote input	Valid with an "L" signal that commands execution of external -CAL input.
19	N.C[3]		
20	100 VAC	Power supply	Connects with an AC power supply.

Connector plug: HIROSE ELECTRONIC S-1620A-C

[1] Use a heat-resisting vinyl cable of over 0.3 mm^2 in diameter for wiring.

[2] It is a signal with Pin #5 COM as common electric potential. (COM and GND have same electric potential)

[3] N.C: Non connection

5-13 REMOTE CONTROL

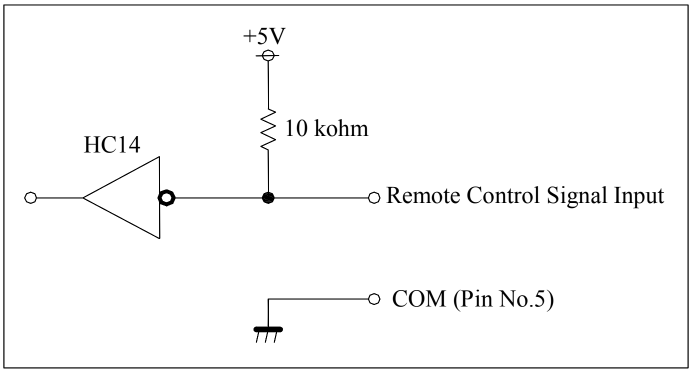
The following functions can be controlled remotely.

- Execution of balancing — REM BAL signal
- Outputting CAL — REM +CAL, REM –CAL signals
- Execution and cancellation of key-lock — REM KEYLOCK signal

Remote control has the same significance as manual operation of the front panel switches that control the DPM-900/950 series functions. The priority is given to the first operated one.

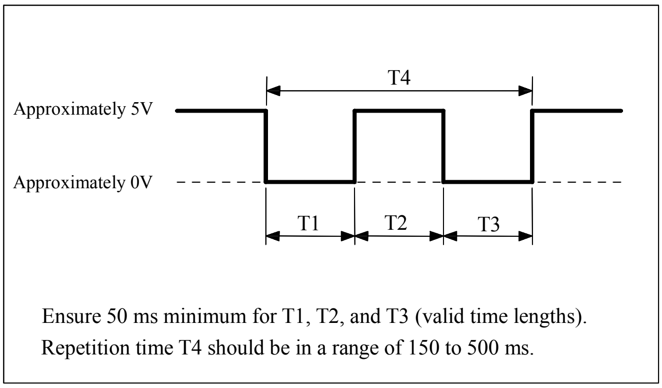
5-13-1 Remote Control Signals

Control signal input circuit is shown at the right.

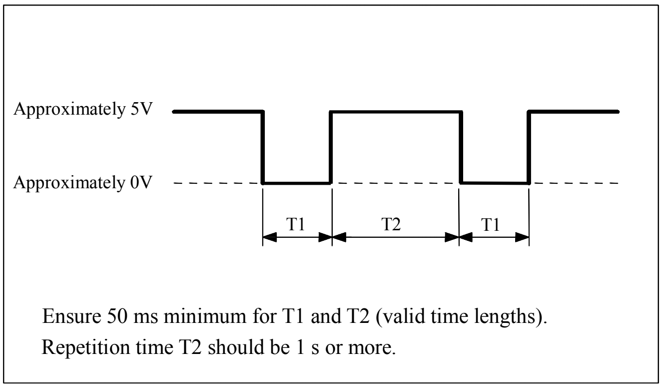


Control signals are valid when they are on the "L" (0 V) level. While this level is maintained, functions are executed.

The balancing function by the remote control is executed only one time in response to a signal shown at the right.



When executing the CAL addition on and off by the remote control, use the signal in the right.



NOTE

When an external control signal is "H," it is made to be on the level of approximately 5 V by the internal circuit.

Avoid generating chattering when rising or falling the control signal.

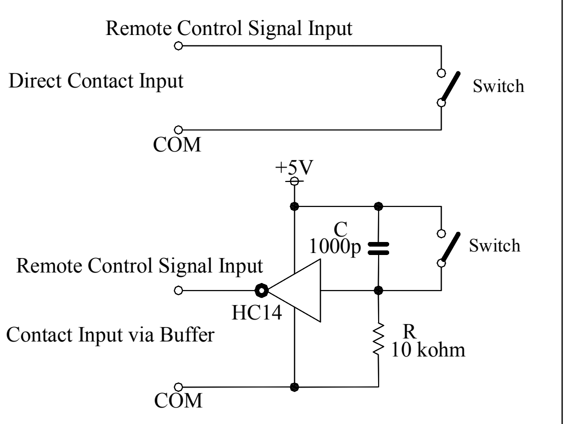
5-13-2 External Connection

When remote controlling the DPM-900/950 series, use the terminals of the centralized connector. Perform wiring after removing the housing from the centralized connector. For details of the centralized connector, read “5-12 APPLICATION OF THE CENTRALIZED CONNECTOR.”

NOTE

An AC power supply is also connected to the centralized connector. Therefore, be sure to remove the power plug from the AC outlet.

Shown at the right are the recommended circuits for remote control.
If a circuit other than shown is used, contact KYOWA or our representatives.

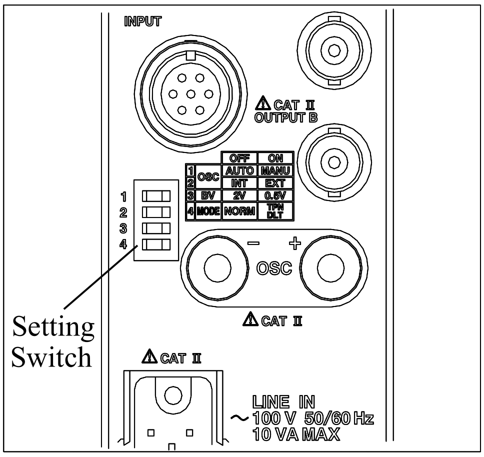


Take care of chattering due to switching.

5-14 EXCITATION VOLTAGE

An excitation voltage*15 is switched to 2 Vrms or 0.5 Vrms. It is set to 2 Vrms prior to shipment.
To select an excitation voltage, use “Setting Switch 3” provided on the rear panel. Set “Setting Switch 3” to OFF at 2 Vrms and ON at 0.5 Vrms. Be sure to turn OFF the DPM-900/950 series prior to set the “Setting Switch 3.”

When the BV 0.5 V lamp on the front panel lights up, the DPM-900/950 series is set to 0.5 Vrms, otherwise it is set to 2 Vrms.



NOTE

Be sure to balance and set internal gain every time an excitation voltage has been switched.

Select an excitation voltage of 0.5 Vrms in the following cases.

- **When strains are measured on a material with poor heat radiation such as plastic or wood.**
  A strain gage is heated if a large current flows on it. Precision measurement is, accordingly impossible unless the material of a measurement object provides good heat radiation. Therefore, the excitation voltage is decreased to suppress self-heating.

- **When large strains are to be measured.**
  An excitation voltage of 0.5 V guarantees four times larger strain measuring range.

- **When using a strain gage with gage length shorter than 1 mm.**

5-15 TPN/DLT MEASURING MODE（For the DPM-911/951 only）

In addition the strain gages or strain gage transducers, the DPM-900/950 series can measure data using Rotary Transformer Torque Transducer, and Inductance-Type Displacement Transducer.
Be sure to change modes to the TPN/DLT Measuring Mode for using the Rotary Transformer Torque Transducer or Inductance-Type Displacement Transducer.
To change modes to the TPN/DLT Measuring Mode, turn ON the “Setting Switch 4” on the rear panel. Be sure to turn OFF the DPM-900/950 series before changing the Setting Switches.
In addition, for how to set the internal gain, read “5-7 INTERNAL GAIN.”

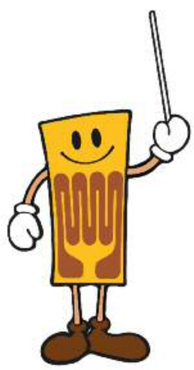
NOTE

Turn ON the “Setting Switch 4” and immediately after turning ON the power, check that the monitor display changes as follows.
All LED light up → Version of the built-in software → ‘ ΓPn_dLΓ ’（Scroll horizontally）
→ Output voltage
The ΓPn_dLΓ appears in the TPN/DLT Measuring Mode only.
Do not conduct the bridge check function with the Rotary Transformer Torque Transducer connected.
If the “Setting Switch 4” of the DPM-912/913/952 is turned ON, the DPM-912/913/952 is still in the “Normal Mode.”

MEMO

After turning ON the DPM-900/950 series, press and hold the **SET** switch for checking the TPN/DLT Measuring Mode.
The following display appears on the monitor.
● The version of the built-in software and ΓPn_dLΓ are scrolled horizontally.

Press and hold the **SET** switch if the “Setting Switch 4” is set to OFF.
The following display appears.
● The version of the built-in software is scrolled horizontally.



6. OPTIONS

This chapter describes all options that can be used together with the DPM-900/950 series.
These options are available for separate purchasing.

6-1 BRIDGE BOX

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

6-1-1 Functions of Bridge Box

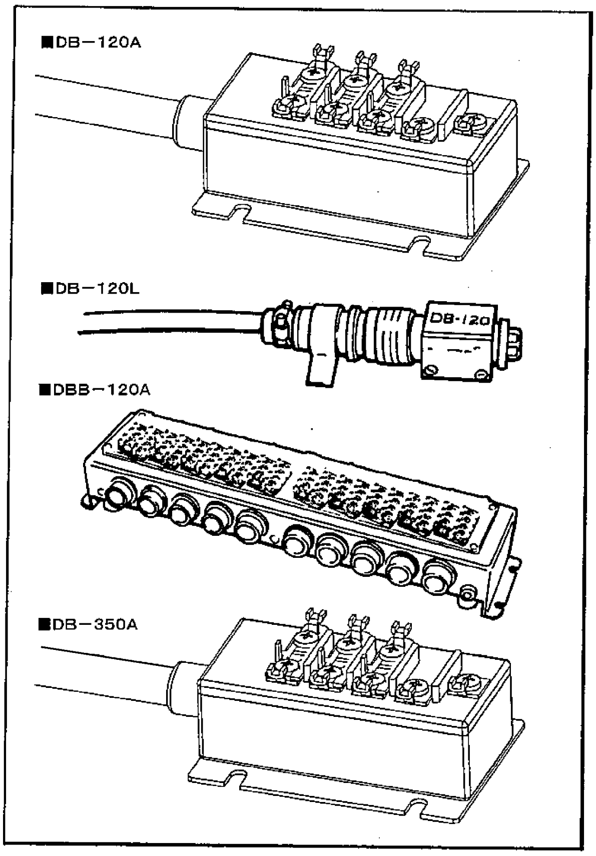
The bridge box comes with three internal fixed resistors, which enable the strain gage bridge configurations as follows.
For connections other full bridge method, the internal fixed resistors are used as dummy gages.

1) Quarter bridge system*3 using the 2-wire or 3-wire
2) Half bridge system*4
3) Full bridge system

6-1-2 Models of Bridge Box

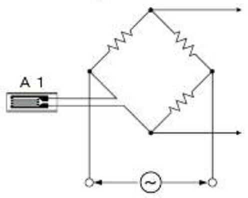
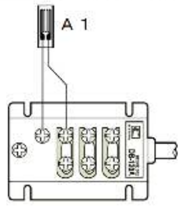
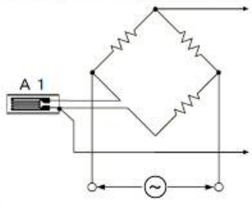
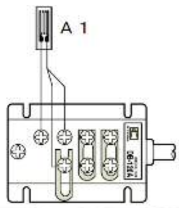
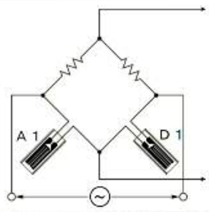
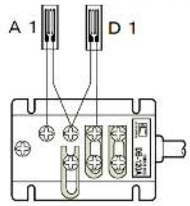
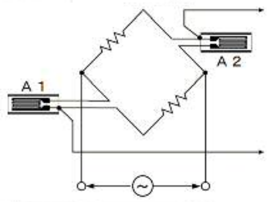
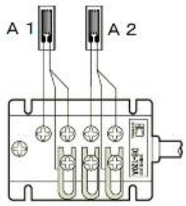
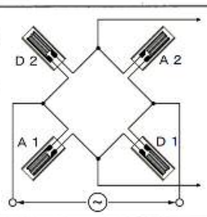
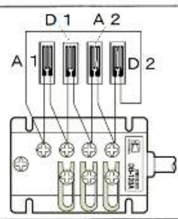
The following models are provided.

1) DB-120A, DB-120L, and DBB-120A
   For 120 ohm strain gages.
2) DB-350A
   For 350 ohm strain gages.



6-1-3 Wiring to Bridge Box

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

Gage Method	Bridge Circuit	Wiring to the bridge box
Quarter bridge system (2-wire)		
Quarter bridge system (3-wire)		
Half bridge system		
Half bridge system (3-wire active-active)		
Full bridge system		

NOTE

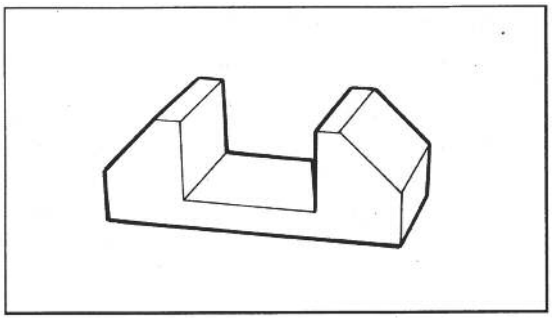
When wiring strain gage (s) to the bridge box, soldering is recommended to reduce contact resistance.
Use shortest possible leadwires for connecting the strain gage and the bridge box. Leadwires shorter than 1 m are ideal.
Use a shielded cable for dynamic strain measurement. It is advantageous to reduce noise.
For other details, refer to the bridge box's Instruction Manual.

6-1-4 Shield Conversion Cable N-117

When using a bridge box that can input multiple channels with DPM-911/912/913, please use shield conversion cable N-117 (optional).
It can be isolated for each channels.

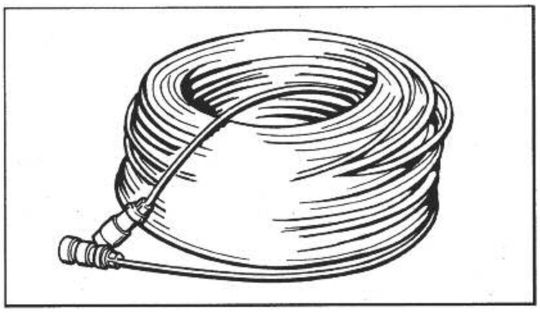
6-2 AMPLIFIER STAND FA-1B

When operating a single unit of the DPM-900/950 series, this rubber made stand is used for fixing.



6-3 EXTENSION CABLE N

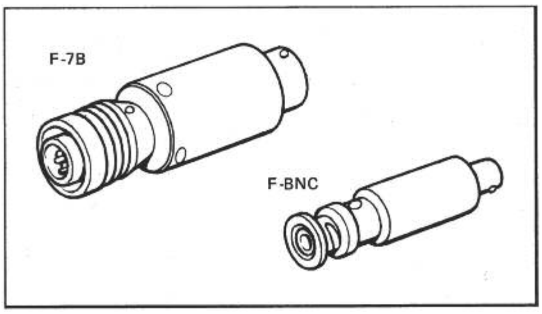
For connecting the bridge box or strain gage transducers at a remote place.
The cable ends are provided with connectors.
The following 6 models are available offering different lengths.



- N-81 Cable length: 5 m
- N-82 Cable length: 10 m
- N-83 Cable length: 20 m
- N-84 Cable length: 30 m
- N-85 Cable length: 50 m
- N-100 Cable length: 100 m

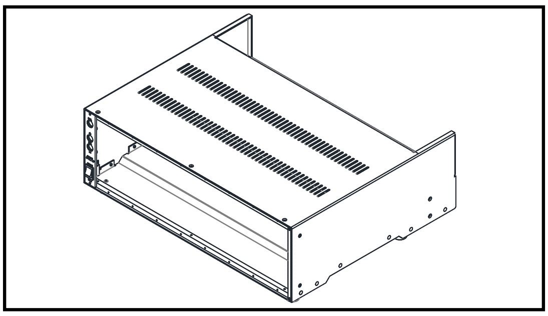
6-4 NOISE FILTER F

Efficiently reduces external high-frequency noise.
They are directly connected to the INPUT connector and OUTPUT A and B connectors, respectively.



6-5 EXCLUSIVE CARRYING CASE

The following 4 models are provided, respectively accommodating different numbers of units to facilitate multichannel measurements.



- YC-3A For 3 channels
- YC-4A For 4 channels
- YC-6A For 6 channels
- YC-8A For 8 channels

Each case provides a converging control switch that is operable on its front panel. What’s more, each eliminates the need for interchannel connection, offering a great convenience.

6-5-1 Functions of Exclusive Carrying Case

Functions of the exclusive carrying case are described as follows.

- A batch balance key.
- A batch calibration key.
- A POWER switch that switches all housed units ON or OFF at a time.
- Internal connections that enable OSC synchronization.
- Centralized connector that connects with bridge status outputs.
- A batch key-lock key.

Rack mount fixtures for JIS and DIN are also provided.

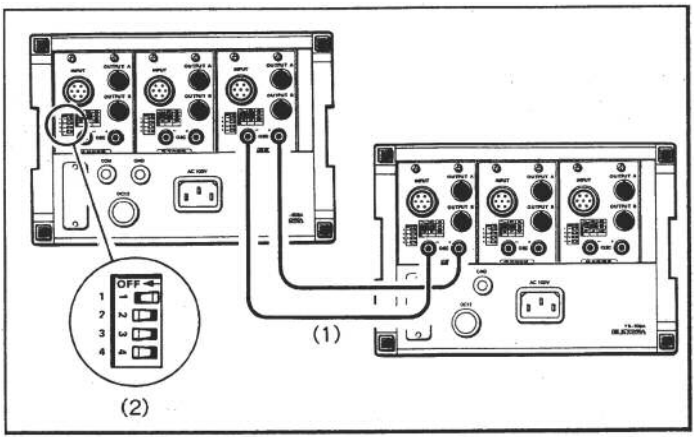
NOTE

- Be sure to house dynamic strain amplifier units of the same model in the exclusive carrying case. If dynamic strain amplifiers having different OSC frequencies are housed in the carrying case, they will not operate normally.
- Set "Setting Switch 1" to ON (MANU) and "Setting Switch 2" to OFF (INT) on the rear panel on one unit only, and "Setting Switch 1" 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.
- Balancing, calibrations or key-lock can be achieved on all channels simultaneously by operating the batch key (BAL, CAL or KEY-LOCK key respectively).
- When using the DPM-900/950 series housed in the exclusive carrying case, the DPM-900/950 series and exclusive carrying case generate heat. But there is no problem in performance.
- While turning ON (1 hour or more after turning ON the power) and immediately after the turning OFF, the main body of the DPM-900/950 series housed in the exclusive carrying case is hot.
  Do not touch the DPM-900/950 series with the bare skin to avoid low-temperature burns.
  Be sure to put gloves for touching the DPM-900/950 series.
- When using the DPM-900/950 series housed in the exclusive carrying case with continuous current for 24 hours, be sure to conduct a periodical inspection every 2 years.

6-5-2 Carrier Synchronization between Exclusive Carrying Cases

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

1) Connect one carrying case to another as shown in right.
2) Set the "Setting Switch 1" of any one of the DPM-900/950 series to ON (MANU) and "Setting Switch 2" to OFF (INT).
3) Set the "Setting Switch 1" of all other DPM-900/950 series to OFF (AUTO).
4) Turn ON the all exclusive carrying cases at the same time. If simultaneous turning ON is impossible, turn ON the power of the exclusive carrying case that housing the DPM-900/950 series with the "Setting Switch 1" to ON (MANU) and "Setting Switch 2" to OFF (INT) at the very first.



7. TROUBLE SHOOTING

If the DPM-900/950 series does not operate as expected or if its operation is unstable, do not take it as a machine trouble right away but make sure whether or not the operating environment is acting as the cause. Typical troubles and remedies are introduced below. Contact KYOWA or our representatives if the trouble still remains after carrying out the proper remedy.
KYOWA may refuse to repair if the product has been damaged by failure to follow the instructions given in this Instruction Manual or if the product has been disassembled or remodeled by the user.

7-1 DPM-900/950 SERIES CANNOT BE TURNED ON

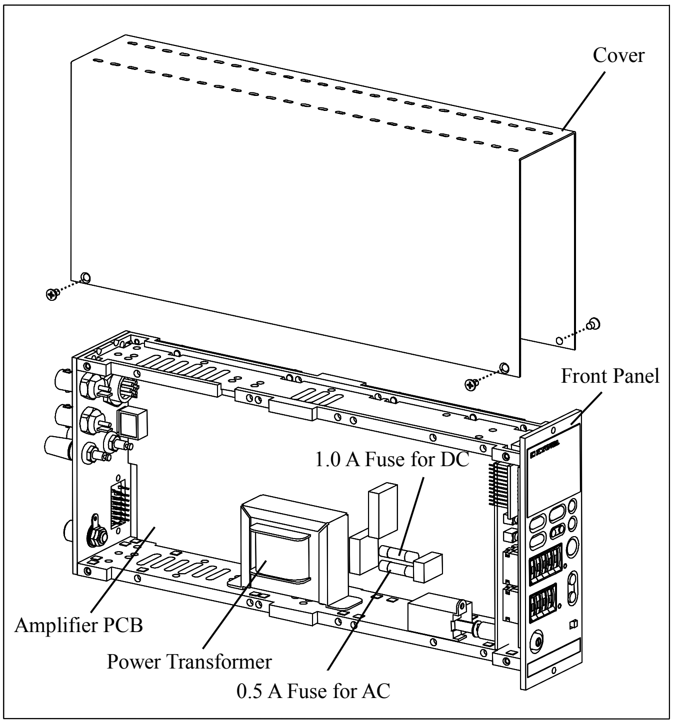
When the indicators such as monitor fail to illuminate after turning ON, the cause may be the broken power cable or the melted fuse. Check the power cable first.
The fuses are inside the case. Prior to replacement, be sure to disconnect the power cable from the AC outlet or the battery.

Check the fuses in the following procedures and replace them if necessary.
The fuses are on the parts side of the control PCB.
Use the fuses having the following rated capacity.

- For AC power: Midget type 0.5 A
- For DC power: Midget type 1.0 A

1) Remove 4 screws that fasten the mainframe cover. Use the Phillips-head screw driver for M2.6.
2) While opening the bottom of the cover, pull it up.
3) Check if the fuses on the amplifier PCB are melted. If those are melted, replace them.
4) While opening the bottom of the cover, cover it to the DPM-900/950 series.
5) Fix the cover to the DPM-900/950 series with the replaced 4 screws.

Contact KYOWA or our representatives if the trouble still remains after carrying out the proper remedy.

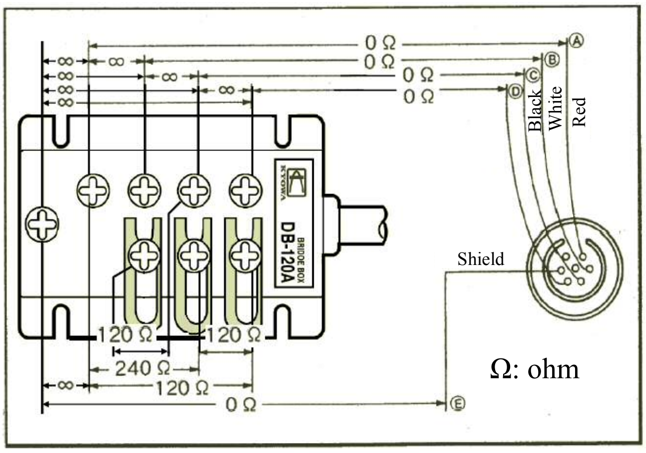


7-2 INITIAL BALANCING IS IMPOSSIBLE

♦ Er-oPEn or Er-SEnSor appears on the monitor when executing bridge check
The cause can be the abnormal strain gage bridge connected to the INPUT connector. Check the strain gage bridge.

- The sides of the bridges have been broken, short circuited or the insulation resistance has decreased.
- The leadwires from the strain gage bridge have been broken.
- The input from the strain gage bridge exceeds ±10000 μm/m.

♦ 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 120 ohm bridge, it is the indication of a normal bridge box.
For a 350 ohm bridge, the resistance values shown at right should read:
- 120 ohm → 350 ohm
- 240 ohm → 700 ohm



♦ 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 the contact failure of the connection pin.
Replace the strain gage or the bridge box.

♦ Several tens of mV remains even though balancing has been repeated many times.
Press the V ADJ. switch to execute the zero point adjustment so as to obtain an output voltage of zero.

Contact KYOWA or our representatives if the trouble still remains after carrying out the proper remedy.

MEMO

Remaining voltage after the balance adjustment may increase when the leadwire (from the bridge box to strain gage) is long.
At this time, adjust the length of leadwires as follows.
Example) Vinyl-coated flat 3-wire cable (L-10): 30 m or less
Vinyl-coated low-noise 3-wire cable (L-13): 15 m or less

7-3 NO OUTPUT IS AVAILABLE

♦ oFF is displayed on the monitor.
The internal gain is set with the CAL switch set to "0000."
Set the CAL switch at a position other than "0000."

♦ The monitor indication does not vary and no output is available.
The input cable may not correctly connected to the connector or broken.
Execute the bridge check.

♦ The monitor indication varies but no output is available.
The output cable may not correctly connected to the connector or broken.
Repair or replace the output cable.

Contact KYOWA or our representatives if the trouble still remains after carrying out the proper remedy.

7-4 INSTABILITY OF THE ZERO POINT

♦ When preheating is insufficiently
Preheat the DPM-900/950 series approximately 30 to 60 minutes. For details, read "5-3 PREHEATING."

♦ When the insulation of the strain gage or leadwires is low
Repair or replace it.

♦ When the temperature compensation is insufficient
Use the strain gage having the sufficient temperature compensation.

♦ When the fixed resistors incorporated in the bridge box are no good.
Repair or replace them.

Contact KYOWA or our representatives if the trouble still remains after carrying out the proper remedy.

7-5 LARGE NOISE

The cause can be the following.

● Inductive Interference
A nearby instrument having a large leakage flux can be the cause of induction noise. A large capacity motor and an iron-resistance constant-voltage instrument are a few examples. In addition, when the measuring point is far from the DPM-900/950 series, the induction noise may generate.
Remedies are as follows.
  • Place a causative instrument apart from the DPM-900/950 series.
  • 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.

● 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 DPM-900/950 series does not necessarily bring about a good result, but connection of a measuring object to the DPM-900/950 series can be the solution in some cases.

In addition, in case of inductive interference or if measuring object has a certain electric potential, it is to solve the problem by a simple method. Especially, the number of devices that are used in the same measuring environment is increasing resulting in interfering with each other as noise resources. The above remedies are just a few examples to solve the noise interference. Fully consider the operating environment and take an appropriate remedy to obtain the most efficient results.

8. SPECIFICATIONS

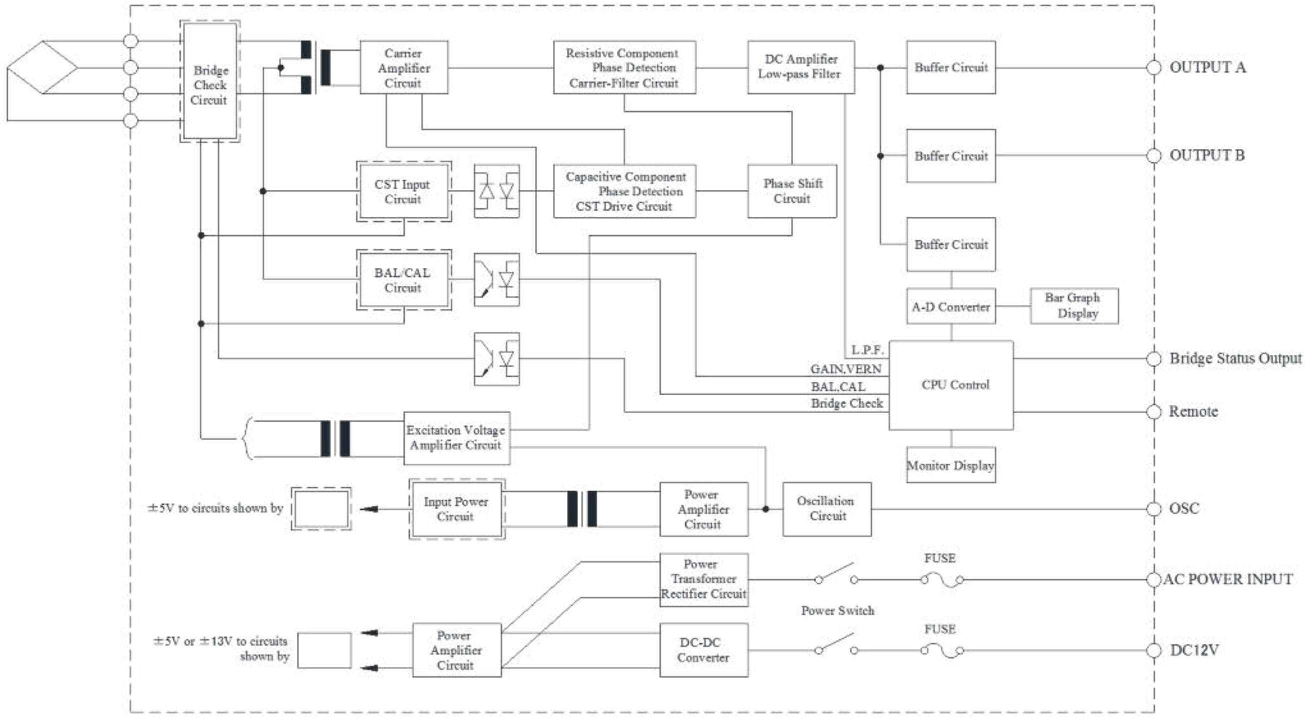
8-1 SPECIFICATIONS

	DPM-911/951	DPM-912/952	DPM-913
Measuring Target	Strain Gage, Strain Gage Transducer		
Measuring CH	1 CH/unit		
Applicable Bridge Resistance	60 ohm to 1000 ohm		
Gage Factor	2.00 fixed		
Bridge Power			
Voltage	2 Vrms, 0.5 Vrms selectable		
Frequency	5 kHz sine wave	12 kHz sine wave	28kHz sine wave
Balancing Range*9			
Resistance	Within ±2% (±10000 μm/m)		
Capacitance	Within 2000 pF		
Balancing Method			
Resistance	True electron auto-balance method		
Accuracy	Within ±0.5 μm/m (When 500 μm/m is input, outputs 10 V, excitation voltage: 2 Vrms)		
Storage	Written into nonvolatile memory		
Capacitance	CST method (Auto-tracking)		
Nonlinearity	Within ±0.1% FS		Within ±0.2% FS
Output Impedance	Approximately 2 ohm		
Calibration Signal (CAL)	1 μm/m steps within ±(1 to 9999) μm/m [Setting: CAL switch (4-digit digital switch)]		
Accuracy	Within ±(0.5% + 0.5 μm/m)		Within ±(0.5% + 1.0 μm/m)
Sensitivity Adjuster	The amplifier sensitivity is set in combined with the $\boxed{\text{CAL}}$ and $\boxed{\text{VOLTAGE OUT}}$ switches (4-digit digital switch)		
$\boxed{\text{CAL}}$ Switch Range	1 μm/m steps up to 100 to 9999 μm/m		
$\boxed{\text{VOLTAGE OUT}}$ Switch Range	0.01 V steps up to 1.00 to 10.00 V [Condition: When 500 μm/m is input, outputs 10.00 V (× 20000) to 5000 μm/m is input, outputs 1.00 V (× 200)] [Setting Example: When 500 is set to CAL, VOLTAGE OUT is 10.00 (× 20000) to 5000 is set to CAL, VOLTAGE OUT is 1.00 (× 200)		
Accuracy	Within ±0.5%		Within ±(0.5%+5mV)
Sensitivity Fine Adjustment	Range: 1 to 1/2.5		
Frequency Response Range	911 DC to 2.5 kHz Deviation: ±10% 951 DC to 2 kHz Deviation: ±10%	DC to 5 kHz Deviation: ±10%	DC to 10 kHz Deviation: ±10%
Low-Pass Filter (LPF)			
Transfer Characteristic	Secondary Butterworth Type		
Cutoff Frequency	6 steps: 10, 30, 100, 300 Hz, 1 kHz, and FLAT		
Amplitude Ratio at the cutoff point	-3 ±1 dB		
Attenuation	-12 ±1 dB/oct. (Excluding when setting 1 kHz)	-12 ± 1 dB/oct.	
High-Pass Filter(HPF)			
Cutoff Frequency	0.2 Hz or OFF		

	DPM-911/951	DPM-912/952	DPM-913
S/N Ratio			
(when 500 μm/m is input, outputs 10.00 V.)	911 54 dBp-p or more (RTI: Within 2 μm/mp-p) 951 53 dBp-p or more (RTI: Within 2.3 μm/mp-p)	912 52 dBp-p or more (RTI: Within 2.5 μm/mp-p) 952 47 dBp-p or more (RTI: Within 4.5 μm/mp-p)	48 dBp-p or more (RTI: Within 3.9 μm/mp-p)
(when 1000 μm/m is input, outputs 10.00 V.)	911 60 dBp-p or more 951 58 dBp-p or more	912 57 dBp-p or more 952 53 dBp-p or more	53 dBp-p or more
	[Common Condition] Excitation Voltage: 2 Vrms, Bridge Resistance: 120 ohm, LPF = FLAT		
Output	OUTPUT A: ±10 V (Load resistance 5 kohm or more) OUTPUT B: ±10 V (Load resistance 5 kohm or more)		
Stability			
Zero - Temperature	±0.1 μm/m/ºC		±0.2 μm/m/ºC
Zero - Time	±0.5 μm/m/24h		±1.0 μm/m/24h
Zero – Power Fluctuation	±0.05% FS/±10% fluctuation		±0.05% FS/±10% fluctuation
Sensitivity - Temperature	±0.05%/ºC		±0.05%/ºC
Sensitivity - Time	±0.3%/24 h		±0.3%/24 h
Sensitivity – Power Fluctuation	±0.05%/±10% fluctuation		±0.05%/±10% fluctuation
Withstand Voltage	Between measuring bridge – case : 1000 VAC for 1 minutes Between AC power – case : 1000 VAC for 1 minutes		
Output Voltage Display	$4^1/_2$-digit digital display (7-segment LED) 11-segment LED bar graph meter		
Excessive Input Display	Output Voltage Display flickers. ($4^1/_2$-digit digital display only)		
Check Function	Bridge Check		
Key-lock Function	Setting methods other than POWER switch become invalid (However, the setting values of the CAL and VOLTAGE OUT switches can be changed.)		
Remote Function	Capable of controlling the following functions Balance adjustment (BAL) Addition of the calibration signal (CAL) Key-lock		
Synchronization Method	Automatically determines internal (INT) or external (EXT) and manual setting		
TEDS	Read the TEDS information of the TEDS-compatible sensor and set the rated output to the output voltage of the VOLTAGE OUT switch (Condition: Within the setting range of the sensitivity adjuster)		
Actual Load Calibration	Set the actual load to the output voltage of the VOLTAGE OUT switch (Condition: Within the setting range of the sensitivity adjuster)		
Vibration Resistance	5 to 200 Hz, 29.4 m/s^2 (3G) X, Y, and Z directions: 12 cycles with 10 minutes/cycle		
Impact Resistance	15 G, 11 msec or less X, Y, and Z directions: each 3 times		
Operating Temperature & Humidity Range	-10 to 50ºC, 20 to 85 %RH (noncondensing)		
Storage Temperature Range	-30 to 70ºC		
Power Supply	90 to 110 VAC (approximately 10 VA: 100 VAC) 10.5 to 15 VDC (approximately 0.6 A: 12 VDC) The following products are also available upon request. ● A115: 108 to 132VAC ● A200: 180 to 220VAC ● A230: 207 to 253VAC		
Dimension	49 (W) mm× 128.5 (H)mm × 262.5 (D) mm (Protruded portion not included)		
Weight	Approximately 1.2 kg		

8-2 BLOCK DIAGRAM AND OPERATION PRINCIPLE

8-2-1 Block Diagram



8-2-2 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 hundreds of microvolt, normally. These bridge output 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 into 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 cutoff some of signals and is not necessarily needed all time.

The features of the system can be summarized as follows.

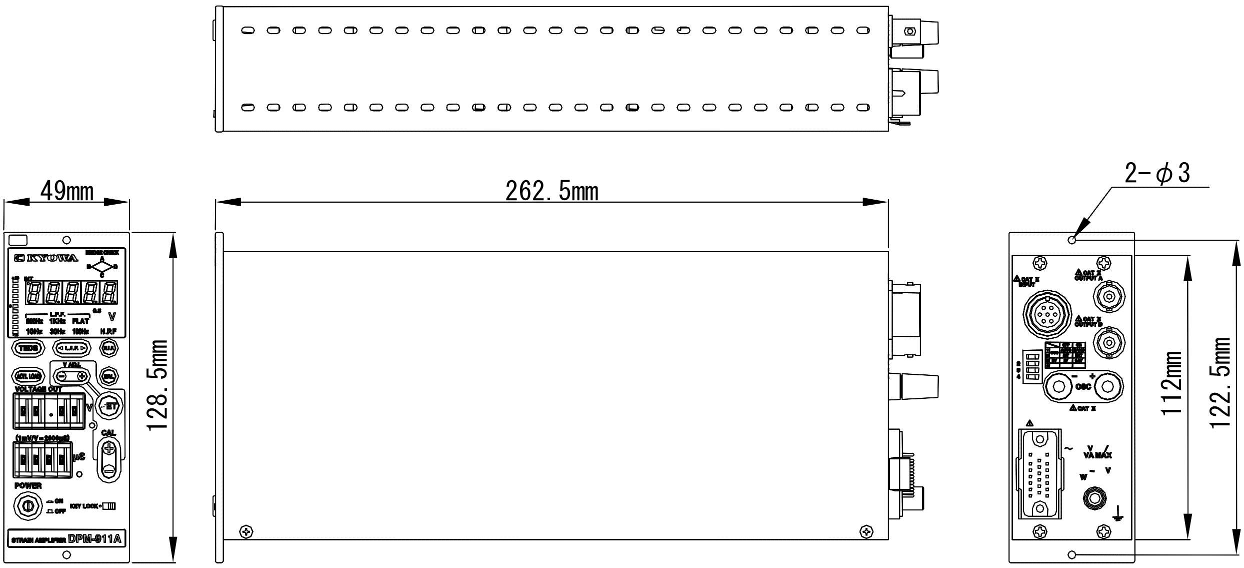
- Advantageous Features
  - Signals are amplified in the AC form so that a highly sensitive strain amplifier is made possible.
  - The temperature characteristic is superbly stable at the zero point. Excellent both in temperature characteristic and long-term stability.
    This is the most important 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, a carrier type dynamic strain amplifier can well be an isolated 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 the DPM-900/950 series.
  - The practical frequency of carrier wave is 30 kHz or thereabouts. High response is therefore unavoidable.
  - Easily affected by resistance induced by wirings.

From the above, the DPM-900/950 series is optimum for such strain measurements as follows.

1) General strain measurements using strain gages.
2) Measurements that requires high stability.
3) Measurements of small strain outputs. The yardstick will be about approximately 500 μm/m.

8-3 DIMENSIONAL DRAWING



9. APPENDIXES

9-1 BRIDGE CHECK FUNCTION AND RESULT INDICATION

The following table shows the relation between error indications on the monitor and detected wire-breaking locations.
When 1 wire is broken, the monitor indicates "wire-breaking location" exactly. But if 2 wires are broken, wire-breaking locations of only one wire are shown as described in the following table. <u>In case 3 or 4 wires are broken, Er-b appears all the time</u>.
In addition, if a side of the bridge is broken, an error indication does not necessarily agree with its location.

Wire-breaking locations	Error
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

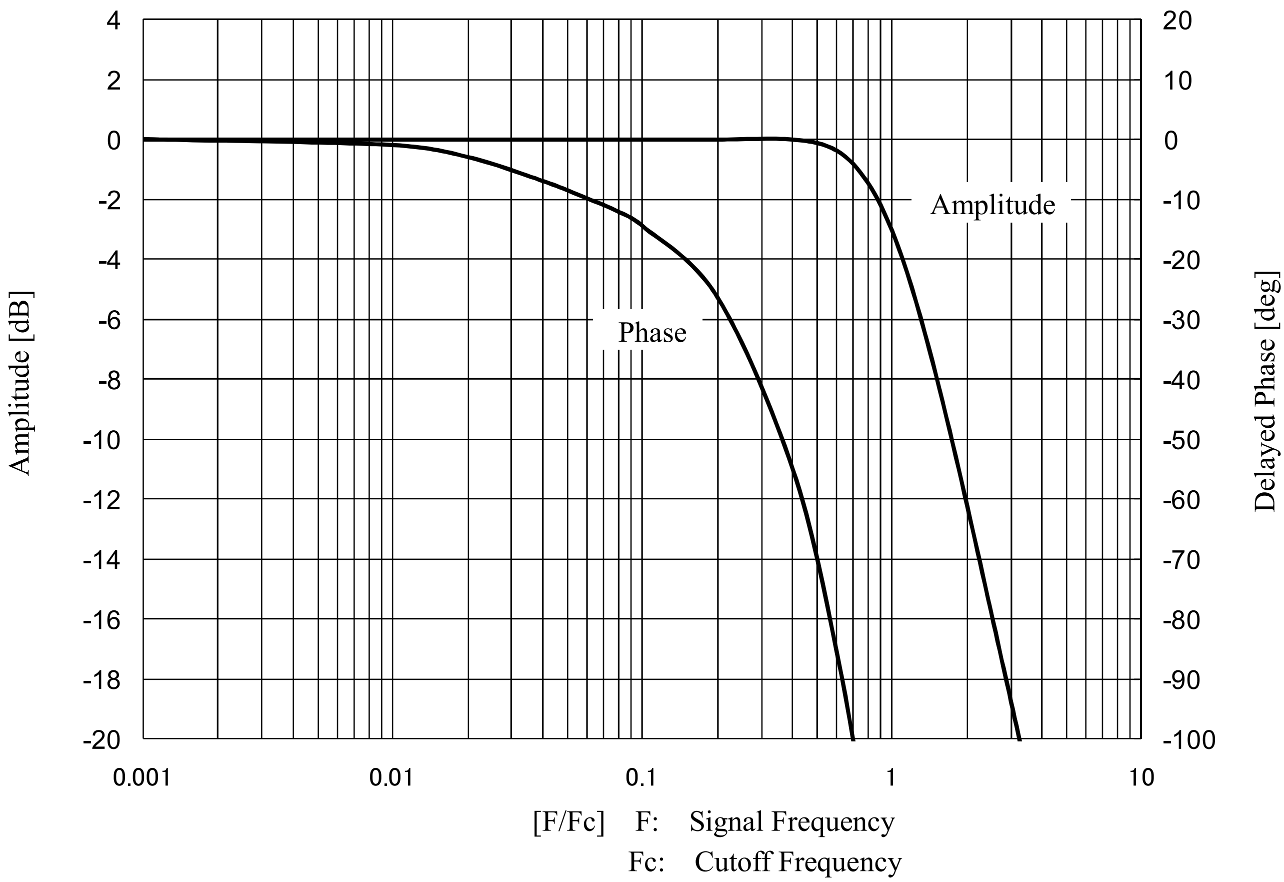
NOTE

If Er-2 appears, it indicated that the bridge check circuit is faulty. In this case, contact KYOWA or our representatives.

9-2 LOW-PASS FILTER CHARACTERISTIC

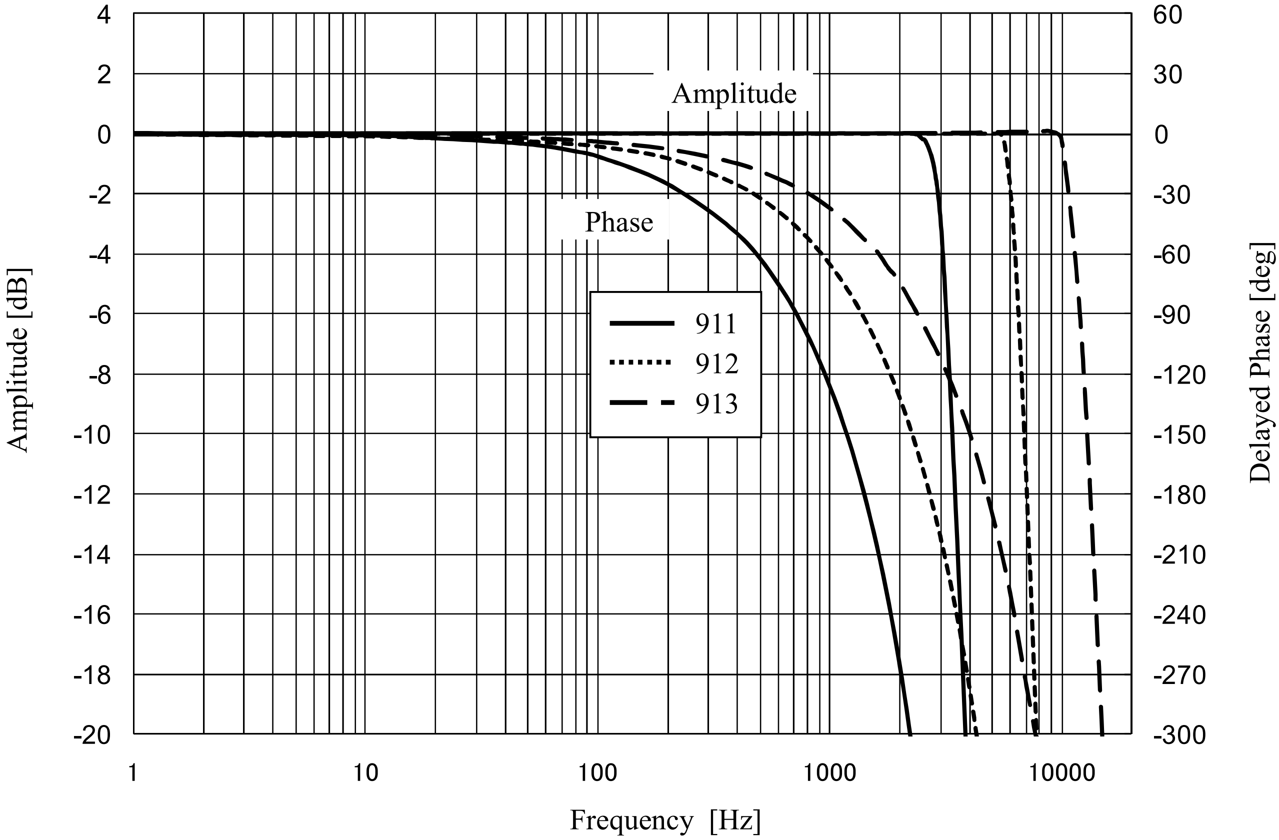
Section 9-2-1 shows the characteristic of the low-pass filter incorporated in the DPM-900/950 series. In section 9-2-1, the frequency characteristic is normalized against a cutoff frequency. About the relation between the amplitude and the phase, first obtain the ration of F/Fc, and then read it from the diagram below.
In addition, frequency-response characteristic when cutoff frequency of the DPM-911/912/913 or DPM-951/952 is set to FLAT is shown in the section 9-2-2 and 9-2-3.

9-2-1 Low-pass Filter Characteristic



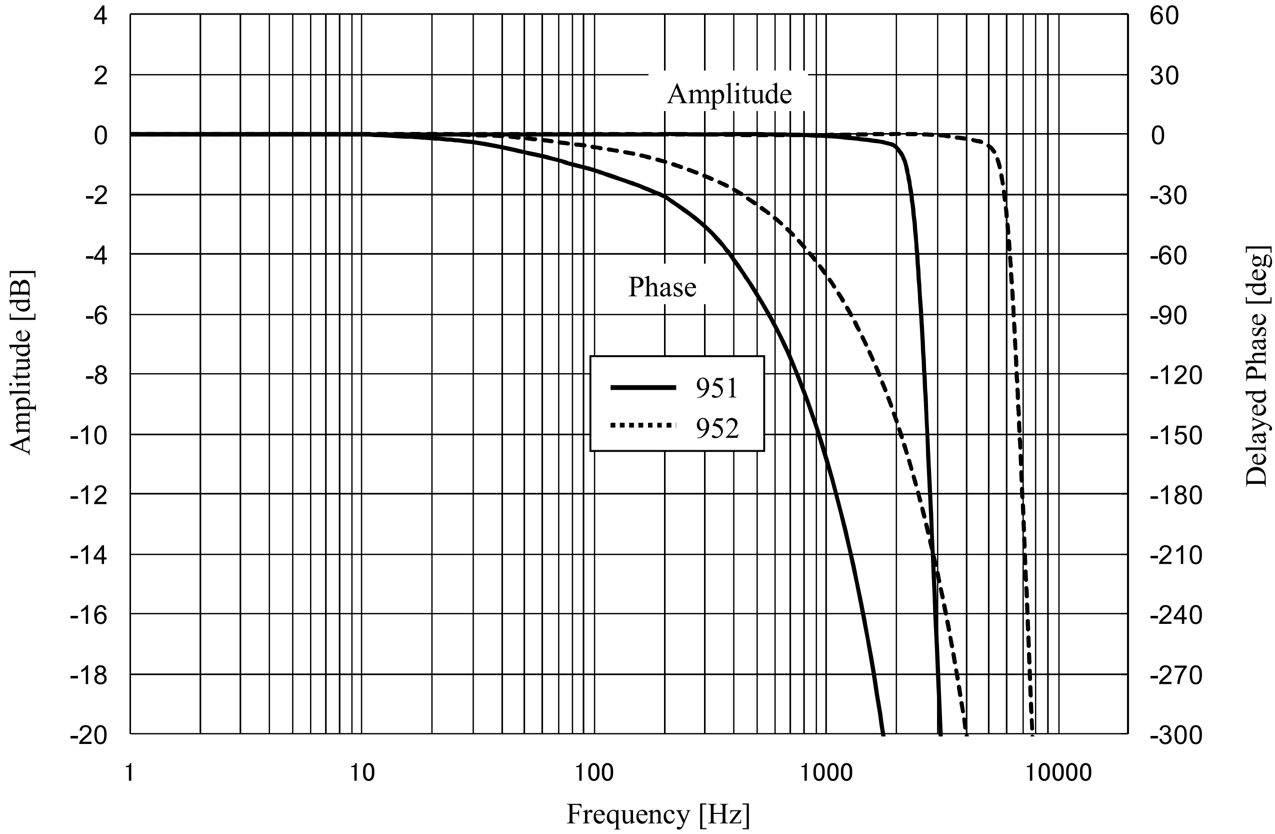
9-2-2 Response Frequency Characteristic 1 (DPM-911/912/913)

Low-pass Filter when the cutoff frequency is set to FLAT.



9-2-3 Response Frequency Characteristic 2 (DPM-951/952)

Low-pass Filter when the cutoff frequency is set to FLAT.

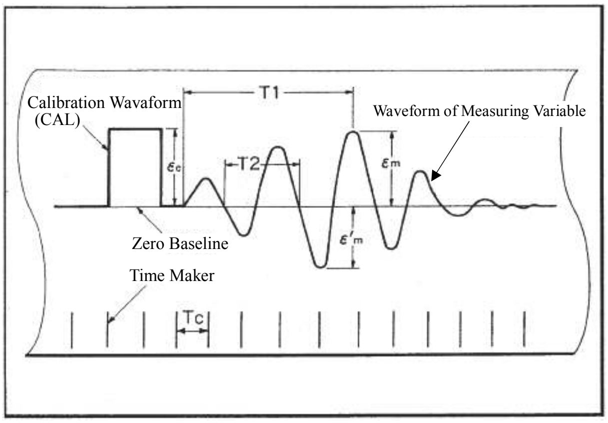


9-3 HOW TO CALCULATE STRAINS

This section describes how to measure strains and stress.

9-3-1 Method of Calculation Applicable to Strain Gage

Suppose that a strain waveform as shown at right was obtained. 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-maker and another).
Various values can be obtained as follows from the right figure.



1) Calculating the maximum strain ε_m and the maximum stress σ_m.
Measure the respective heights of the calibration signal and the maximum strain from the base line of zero by using a scale.
Suppose that a measurement of ε_c is h_c [mm], and that of ε_m is h_m [mm]. The maximum strain ε_m can be calculated using the equation below.

$$\varepsilon_m = \varepsilon_c \times \frac{h_m}{h_c}$$

ε_m is in the same direction as $+\varepsilon_c$. Therefore it is "elongation."
When once the strain ε has been obtained, stress σ at that point (provided that it is of the monoaxial stress system) can be found using the equation below.

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

However, E is Young's modulus of the measuring point and the gage axis is considered as attached according to stress axis direction.
Therefore, the maximum stress σ_m is obtained by the following equation.

$$\sigma_m = E \times \varepsilon_m$$

2) Calculating strain ε'_m and stress σ'_m
Strain ε'_m is in the direction opposite to $+\varepsilon_c$. Therefore it is "construction."
Suppose that the height of ε'_m is h'_m [mm], the amount of ε'_m can be obtained using the equation below.

$$\varepsilon'_m = \varepsilon_c \times \frac{h'_m}{h_c}$$

Stress σ'_m (provided that it is of the monoaxial stress system) is calculated using the equation below.

$$\sigma'_m = E \times \varepsilon'_m$$

3) Time from the start point of the strain waveform to the maximum strain
To calculate T_1 (i.e. time from the start point to the maximum strain), use the time maker. Measure 10 or so intervals between time makers, and obtain their average, then t_c [mm] against time T_C. Suppose that a measurement of T_1 is t_1 [mm]. T_1 can be calculated using the equation below.

$$T_1 = \frac{t_1}{t_c} \times T_c \quad \text{[sec]}$$

4) Frequency of the strain waveform

If vibrations are periodically generated, a frequency can be calculated. Measure the length of 10 or so cycles, then obtain their average t_2 [mm]. Compare the result with the marker interval, t_c.

$$T_2 = \frac{t_2}{t_c} \times T_c \qquad [\mathrm{sec}]$$

From T_2, the frequency f is obtained by using the equation below.

$$f = \frac{1}{T_2} \qquad [\mathrm{Hz}]$$

5) Analysis of phenomenon

If a phenomenon is so simple that a measurement at a single point is enough, it is possible to disclose the whole phenomenon by simple calculating the relation between the amount of a strain and a time from its recorded waveform.

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

This analyzing technique should vary widely according to different measuring purposes. There cannot be one uniform technique.

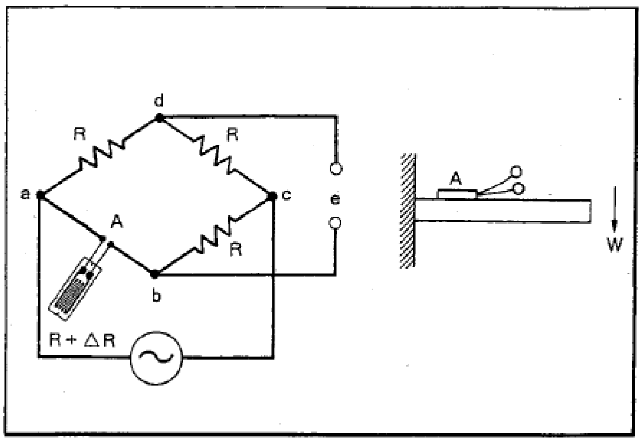
In many cases, however, it is possible to estimate the relations between measuring points, so consider these relations together with the measuring results on measuring points, in order to grasp a phenomenon totally.

9-3-2 Correction Required due to the Number of Strain Gage Used

The above calculation methods are applicable to a measurement using one strain gage as an Active gage*16 as shown in the right. When using multiple strain gages, the measuring result should be corrected according to the number of strain gages in use.

In addition, 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)

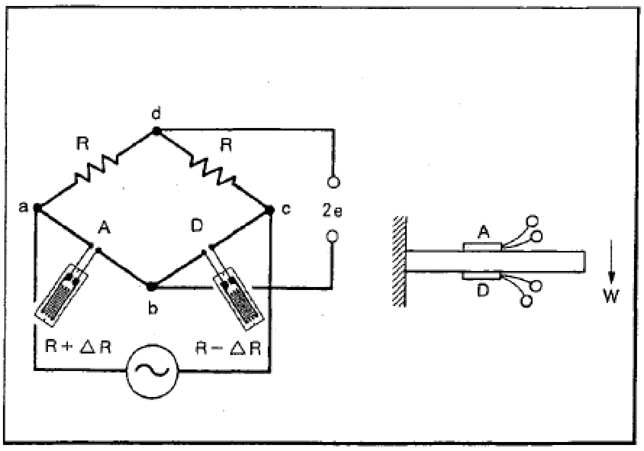


1) When using both gages to measure strains

(1) When using 2 strain gages in the arrangement shown in the right, multiply the measurement value ε_0 by 1/2.

$$\varepsilon = \frac{\varepsilon_0}{2}$$

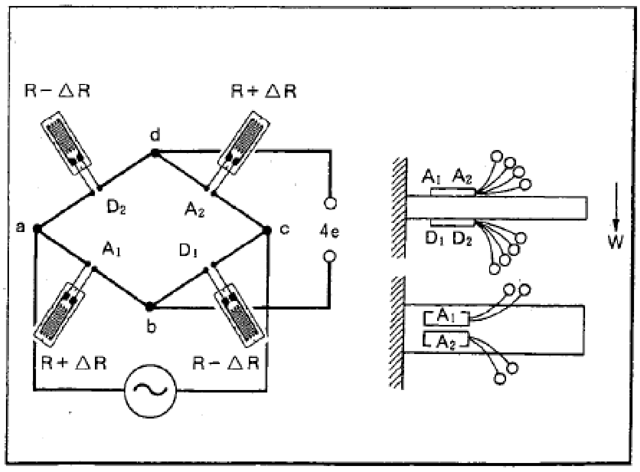
$$\sigma = E \times \varepsilon = \frac{E \times \varepsilon_0}{2}$$



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

$$\varepsilon = \frac{\varepsilon_0}{4}$$

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



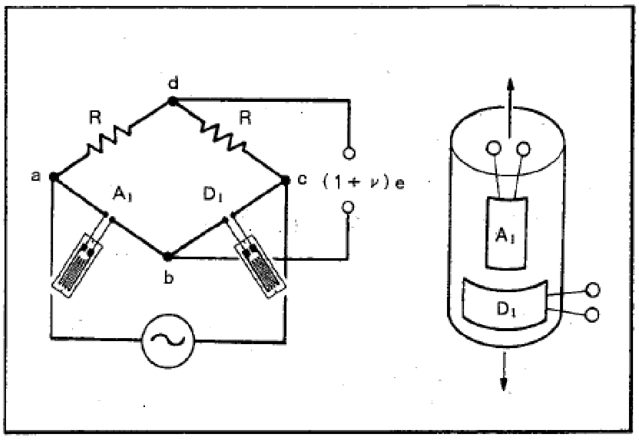
2) When using active gage and dummy gage[*17]

(1) When using 2 strain gages in the arrangement shown in the right, multiply ε_0 by $\frac{1}{(1+\nu)}$.

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

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

where, ν: Poisson's ratio

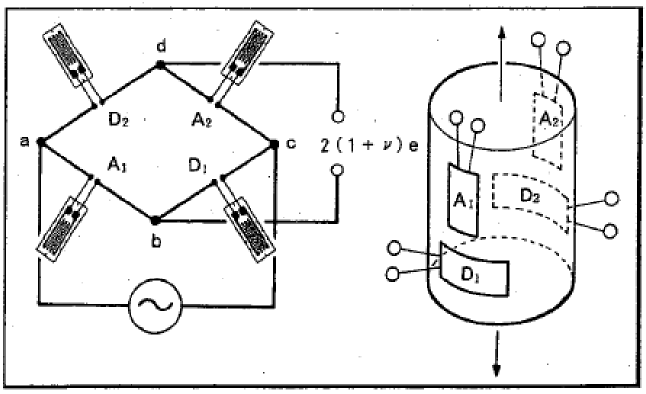


(2) When using 4 strain gages in the arrangement shown in the right, multiply ε_0 by $\frac{1}{2(1+\nu)}$.

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

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

where, ν: Poisson's ratio



9-3-3 When using strain gage having gage factor other than 2.00

Correct the measurement value using the following equation.

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

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

where, K_s : Gage factor

9-3-4 Calculating Methods Applicable to Strain Gage Transducer

A strain gage transducer measures a physical quantity such as load, pressure, torque, displacement, acceleration or other after conversion into electric signals through strain gages.
The DPM-900/950 series is designed to measure strains. The amount of a measured strain has to be converted into a physical quantity by using the calibration factor or the rated output stated in the Test Data Sheet of the strain gage transducer.

1) Calculating method using a calibration factor

Multiply the amount of strain obtained using the strain gage transducer by the calibration factor stated in the Test Data Sheet of the strain gage transducer to obtain the desired physical quantity.

<Example> Suppose that a measurement of 2900 μm/m was obtained using a load cell with capacity of 20 kN (2.0394 tf) and calibration factor of 0.004997 kN (0.00051 tf)/μm/m.
A load given to this load cell can be calculated as follows.
$0.004997 \times 2900 = 14.4913$ [kN]

2) Calculating method using a rated output

An output value (or a rated output or output voltage sensitivity) against a rated load is stated in the Test Data Sheet of 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 amplifiers' calibration factor and output.

<Example> Using the combination of: pressure transducer with capacity of 490 kPa (5 kgf/cm^2) and rated output of 3993 με.
Set the CAL switch of the DPM-900/950 series to 3993 μm/m (rated output of the transducer) or set the VOLTAGE OUT switch to output 10.00 V. Press the SET switch twice to set the internal gain. After that, apply pressure to the transducer. 10.000 V will come to correspond to 490 kPa.

<Example> Using the combination of: acceleration transducer with capacity of 196 m/s^2 (20 G) and rated output of 850 μm/m and the DPM-900/950 series
Set the CAL switch of the DPM-900/950 series to 850 μm/m (rated output), set the VOLTAGE OUT switch to 10.00 V and press the SET switch twice to set the internal gain. Then 10.000 V will come to correspond to 196 m/s^2 (20 G).
Suppose a recording meter is used. If calibration value of 850 με is entered, adjust the vibration width of the recording sheet to have 20 mm or 200 mm. Then, the amount of the vibration width will come to correspond to 196 m/s^2 (20 G).

9-3-5 Correction Required When an Extension Cable was Used

Indoor measurement seldom requires an extension cable. By contrast, for outdoor measurement the DPM-900/950 series 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 DPM-900/950 series using an extension cable. Note 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 measured value by a suitable correction factor stated in the following table.
In addition, 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.

Correction factor when using the extension cable with the DPM-911/951

Extension Cable / Bridge Resistance	5 m	25 m	50 m	75 m	100 m	200 m
120 ohm	1.003	1.015	1.030	1.046	1.060	1.120
350 ohm	1.002	1.005	1.009	1.013	1.017	1.032

Correction factor when using the extension cable with the DPM-912/952

Extension Cable / Bridge Resistance	5 m	25 m	50 m	75 m	100 m	200 m
120 ohm	1.003	1.017	1.034	1.052	1.069	1.151
350 ohm	1.002	1.009	1.015	1.023	1.031	1.070

Correction factor when using the extension cable with the DPM-913

Extension Cable / Bridge Resistance	5 m	25 m	50 m	75 m	100 m	200 m
120 ohm	1.006	1.025	1.046	1.081	1.112	1.326
350 ohm	1.007	1.033	1.067	1.103	1.138	1.309

Shown in the above tables are correction factors applicable to the KYOWA extension cable (0.5 mm^2, 4-conductor shielded cabtire cable) that is described in “6-3 EXTENSION CABLE N.”

9-4 TROUBLE SHOOTING

The DPM-900/950 series provides several error indications.
The error indication, status at that time, and remedies are described in the following table. If any error indication appears on the monitor, check the following table for remedies.

Error	Displayed Timing	Status	Remedy
Er-oPEn	After doing bridge check or After the setting the internal gain (ACTL LOAD mode)	1) The sensor is not connected. 2) The bridge box is not connected or the strain gage (s) is not connected to the bridge box. 3) Cable is broken. 4) Input strain exceeds ±10000 μm/m.	1) Connect the sensor. 2) Connect the bridge box or strain gage. 3) Repair or replace the cable. 4) Make input strain within ±10000 μm/m.
Er-SEnSor	After doing bridge check	Not applicable sensor is connected.	Connect the applicable sensor.
Er-CArr	After turning ON the power, when the input from the external OSC is not coming (slave only)	OSC frequency or voltage is faulty.	Replace the normal master.
Er-CAL-HI o-Lo	After setting the internal gain (normal mode)	Less than minimum internal gain (×200) is set.	Decrease the setting value of the CAL switch or increase the setting value of the VOLTAGE OUT switch and set the internal gain again.
Er-CAL-Lo o-HI	After setting the internal gain (normal mode)	Higher than maximum internal gain (×20000) is set.	Increase the setting value of the CAL switch or decrease the setting value of the VOLTAGE OUT switch and set the internal gain again.
Er-TEdS	After setting the internal gain (TEDS mode)	1) TEDS-installed sensor is not connected. 2) TEDS information cannot be read. (Cable is broken or the sensor is faulty.)	1) Connect the TEDS-installed sensor. 2) Repair the cable or replace the sensor.
Er-TEdS-bu	After setting the internal gain (TEDS mode)	The applied voltage is outside the range of the sensor's recommended excitation voltage.	From the rear setting switch, set the bridge voltage to the appropriate value and reboot. Or replace the sensor that the sensor's recommended excitation voltage matches the current bridge voltage.
Er-o-Lo	After setting the internal gain (TEDS mode)	Less than Minimum internal gain (×200) is set.	Increase the setting value of the VOLTAGE OUT switch and set the internal gain again.
Er-o-HI	After setting the internal gain (TEDS mode)	1) Higher than maximum internal gain (×20000) is set. 2) Setting value of VOLTAGE OUT switch exceeds 10.00 V	1) Decrease the setting value of the VOLTAGE OUT switch and set the internal gain again. 2) Setting value of VOLTAGE OUT switch set 10.00V or less.
Er-AL-HI o-Lo	After setting the internal gain (ACTL LOAD mode)	1) Less than minimum internal gain (×200) is set. 2) Input strain is too large. 3) Input strain is minus.	1) Increase the setting value of the VOLTAGE OUT switch and set the internal gain again. 2) Reduce the input strain. 3) Set the input strain to plus.
Er-AL-Lo o-HI	After setting the internal gain (ACTL LOAD mode)	Higher than maximum internal gain (×20000) is set.	Decrease the setting value of the VOLTAGE OUT switch and set the internal gain again.

Contact KYOWA or our representatives even if the error indication appears after conducting the remedies.

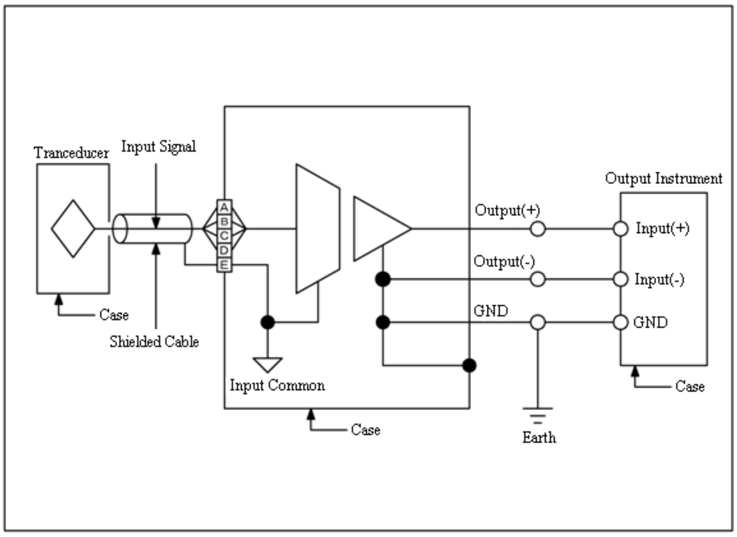
NOTE

If the output voltage of the OUTPUT A or OUTPUT B exceeds ±11V, numbers or characters on the monitor flicker.

9-5 E TERMINAL OF INPUT CONNECTOR

9-5-1 E Terminal of DPM-911/912/913

The E terminal of the input connector is connected to the input common.
The internal connection is shown in the right figure. Use these terminals as instructed below in order to assure safety.
1) Be sure to ground the grounding terminal.
2) When an output instrument is not grounded, connect the grounding terminal of the DPM-900 series.
(The output instrument is also grounded.)

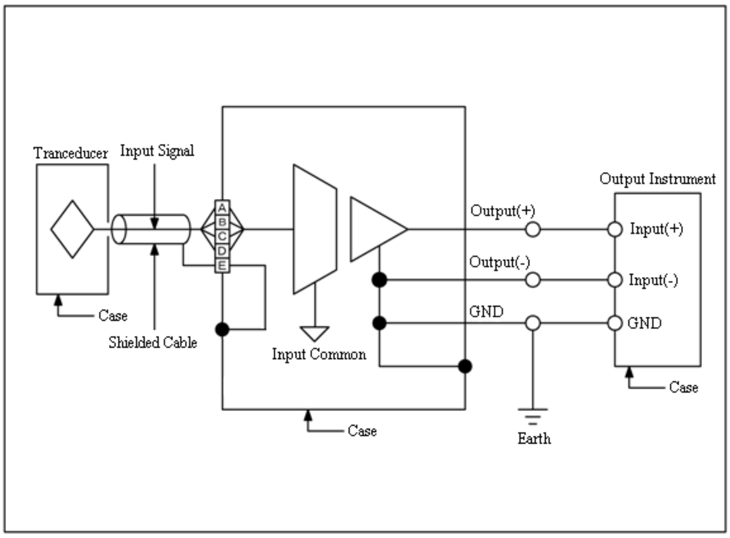


NOTE

If the E terminal is grounded with the shielded cable, isolating state between the input and output terminals becomes not insulating state. (The same thing happened when the E terminal and GND terminal are short circuited.)
When measuring strain of the target having the electrical potential with the E terminal grounded, an unexpected accident may happen.

9-5-2 E Terminal of DPM-951/952

The E terminal is connected to the case of the DPM-951/952 (same potential with the GND terminal).
The internal connection is shown in the right figure. Use these terminals as instructed below in order to assure safety.
1) Be sure to ground the grounding terminal.
2) When an output instrument is not grounded, connect the grounding terminal of the DPM-950 series.
(The output instrument is also grounded.)



NOTE

If the GND terminal is not grounded, external noise emitted from the inverter motor may not be reduced. Be sure to ground the GND terminal.

MEMO

To increase the noise reduction effect, ground the E terminal at the transducer side with the shielded cable.

9-6 INTERNAL GAIN AND INPUT STRAIN

【BV = 2 Vrms】

Internal Gain	Switch Setting		Input Range［με］		
	Input strain ［με］	Output voltage ［V］	Sensitivity fine adjustment × 1	~	Sensitivity fine adjustment × 1/2.5
× 200	5000	1.00	±50000	~	±125000
× 2000	5000	10.00	±5000	~	±12500
× 20000	500	10.00	±500	~	±1250

【BV = 0.5 Vrms】

Internal Gain	Switch Setting		Input Range ［με］		
	Input strain［με］	Output voltage ［V］	Sensitivity fine adjustment × 1	~	Sensitivity fine adjustment × 1/2.5
× 200	2000	0.10	±200000	~	±500000
× 2000	2000	1.00	±20000	~	±50000
× 20000	2000	10.00	±2000	~	±5000

NOTE

The higher the setting value of the VOLTAGE OUT switch, the greater the sensitivity adjustment accuracy. So it is recommended to set the range from “1.00” to “10.00.”
If the value of the VOLTAGE out switch is less than “1.00”, it may not satisfy the specifications for sensitivity adjuster accuracy.
In addition, setting that expanded for input strain range within ±200000 μm/m at BV=0.5 Vrms is possible. In that case, refer to table above to set the range from “00.10” to “10.00.”
For other details about sensitivity fine adjustment, refer to “4-6-5 Sensitivity Fine Adjustment.”

10. GLOSSARY

[*1] TEDS
TEDS is an acronym for Transducer Electronic Data Sheet.
It is a table of digitized sensor's information that is held in the transducer. Capable of conducting applicable measurement without manual setting by reading the information with the TEDS-compatible amplifier.

[*2] Wheatstone Bridge
A Wheatstone bridge circuit is structured by 4 resistors connecting in series to one another and connecting a power supply and ammeter to 2 opposing connection points, respectively. It is used for detecting minute resistance change except for low resistance.

[*3] Quarter bridge method
It is a measuring method whereby one side of the bridge is formed by a strain gage.

[*4] Half bridge method
It is a measuring method whereby two sides of the bridge are formed by one each strain gage respectively.

[*5] Full bridge method
It is a measuring method whereby 4 sides of the bridge are formed by one each strain gage respectively.

[*6] Output Impedance
Impedance seen from the output terminal of an instrument in opening state.

[*7] Preheating Time
A time an instrument required to satisfy its all performance specifications after it is turned ON.

[*8] Unbalance Components
Volts that are generated due to the resistive and capacitive deviations of a strain gage bridge.

[*9] 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.

[*10] Sensitivity
An output against a strain input under the specified condition.

[*11] Gage Factor Ks
The ratio of a change in gage resistance to a change in the amount of a stain applied to a strain gage. Generally, it is 2 for metal-wire strain gages.

[*12] Open Collector Output
It is an output system wherein no transistor load resistance exists and a collector is connected directly to the output.

[*13] 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.

[*14] Beat
When combining 2 signals having different frequency, frequency components of sum and difference generate. In general, beat means the difference component.

[15] Excitation Voltage
The voltage or a power source, AC or DC, connected to a Wheatstone bridge. The higher an excitation voltage, the larger a Wheatstone bridge's output voltage grows. An excitation voltage should, therefore, be decided according to the kind of a measuring object and that of a strain gage.

[16] Active Gage
A gage which is bonded to the strain generating area of a measuring object.

[17] Dummy Gage
This type of gage acts merely as a resistor, i.e. a constituent element of a gage bridge.

KYOWA

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