AS2503／AS2603

DC BRIDGE SYSTEM
DYNAMIC STRAIN AMPLIFIERS

INSTRUCTION MANUAL

A&D Company, Limited

1WMPD4003356

DC BRIDGE SYSTEM
DYNAMIC STRAIN AMPLIFIERS
AS2503／AS2603
OPERATION MANUAL

Cautions

- Read this manual carefully before using this product.
- Place this manual within reach of the AS series amplifier.

A&D Company, Limited

INTRODUCTION

▲Before Using▼

Thank you for your purchase of our product strain amplifier AS2503/AS2603. Please read this manual carefully before operating this instrument.

This manual provides the information necessary to operate the instrument safely. This manual covers basic functions and operations of the AS series amplifiers and handling precautions. Place this manual within reach of the AS series amplifier. If you encounter any problem in the manual, please contact our sales representative.

▲Examining Contents in Package▼

If opening the package in a warm room during the cold season, open the package after it has reached room temperature to avoid any operational failure due to condensation on the surface of the product.

The warranty does not apply for the case where damages or faults caused by use against instructions, warnings, or cautions.

This instrument is delivered after a thorough examination at the factory prior to shipment. However, please examine the product's condition and verify that no obvious shipping damage has occurred after opening the package. Also, examine the specifications of the input units and accessories. If there are any missing or damaged items, please contact our sales representative.

▲Cautions▼

- The contents of this manual are subject to change without notice.
- This manual is copyrighted with all rights reserved. No parts of this manual may be transcribed or reproduced without written permission.
- Please let us know if there are any points that are unclear or missing in this manual.
- We do not assume any responsibility for the outcome of the use of the AS series amplifier.

PRECAUTIONS

Observe the following warning and cautions when using amplifiers. The warranty does not apply any damage caused by the use against instructions, warnings, and cautions. To safely use the amplifiers, the following statements are used in this manual to call the readers' attention.

⚠WARNING

This indicates a condition or practice that could result in personal injury or loss of life, and measures and instructions to avoid such conditions.

⚠CAUTION

This indicates a condition or practice that could result in damage to the instrument or other property and general cautions that users must take into consideration.

⚠WARNING

• Power Supply

Make sure that the power supply is within the rating. If any voltage exceeding the rated voltage were supplied, there would be risk of damage to this amplifier, or even a fire. Also, in order to prevent electric shock and hazards such as a fire, be sure to use only the AC power cable supplied with this amplifier.

• Protective Grounding

Be sure to ground this amplifier before supplying power. Grounding is necessary to use this amplifier safely, as well as to protect the user and peripheral equipment from injury or damage. Be sure to observe the following instructions:

1) Protective grounding
   This product uses a 3-pole power cable, which is provided with grounding. Always connect to the power outlet having grounding.
2) Caution on protective function
   While the power is supplied to the amplifier, do not cut or remove the protective grounding line. Otherwise, safety of the amplifier is not guaranteed.
3) Protective function failure
   Avoid using this product when there is a failure in protective grounding or protective functions. Confirm that there is no failure in the protective function before using.

• Use in Gaseous Atmosphere

Never use this amplifier in a flammable or explosive atmosphere, or atmosphere of steam. Use in such atmosphere will result in danger to users and the amplifiers.

• Input Signal Connection

Connect the signal wire to the input terminal after connecting protective grounding terminal to the ground. When connecting the signal wire, check whether the signal wire is being properly protected from leak signals from the environment or common-mode voltage in order to avoid electrical shock or burning. Note that the AS2503 does not have isolation between the input block and output block.

• Cautions during Operation

Be careful of operations because large voltage might be applied between the input terminal (input signal wire) and ground of this amplifier or input terminal and output terminal (output signal wire).

• Installation Category and Contamination Level

The AS series amplifiers are devices with Installation Category II and Contamination Level II. Use them following the regulations defined in Installation Category II and Contamination Level II.

⚠CAUTION

• Caution in Handling

When using this amplifier, always follow the precautions below.

1) Users

Users who are not familiar with the operation of this instrument should avoid using it.

2) Use and storage environment

The storage temperature and humidity of this instrument is –20 to 70°C and 10 to 90%, respectively. Avoid storing in places where the temperature could rise over the storage temperature and where there is direct sunlight exposure such as inside an automobile.

Do not use this recorder at the following locations.

１. Locations where the temperature and humidity rise due to direct sunlight or heaters.

(The operating environment of the amplifier; temperature: -10 to 50 °C, humidity: 20 to 85%)

2. Wet locations

3. Locations where salt, oil, or corrosive gases exist

4. Damp or dusty locations

5. Locations subject to strong vibrations

3) Cautions on power supply

1. Be careful of power voltage fluctuations. Avoid using the amplifier when the voltage is likely to exceed the rated voltage.
2. If the power supply includes a lot of noise or high-voltage inductive noise, use a noise filter or other noise protection.

4) Calibration

We recommend a periodical calibration to maintain the accuracy. More reliable measurement are possible by calibrating the amplifier once a year (extra cost option).

CAUTION IN HANDLING

Read this manual carefully before using the amplifier.

1. Do not apply neither voltage nor current to the output terminal of this amplifier from external source.

2. Use this amplifier with power supply voltages from 85 VAC to 132 VAC, 180 VAC to 264 VAC, or 10 VDC to 30 VDC. The AC power supply selection switch is provided inside the chassis. To switch the AC power supply voltage, refer to Page 7-4. If the power fuse is burnt, check the cause of fuse blow-out. To replace the fuse, always disconnect the power plug and input/output signal cable first, and then replace the fuse in the fuse holder. For how to replace fuse, see Page 7-3. When replacing, examine the ratings of fuse (e.g. for AC or DC).

3. The operating temperature and humidity of the amplifiers is –10 to 50°C and 20 to 85%, respectively. If opening the package in a warm room during the cold season, open the package after it has reached room temperature to avoid any operational failure due to condensation on the surface of the product.

   Do not use this instrument at the following locations.
   - High-humidity locations
   - Locations with direct sunlight exposure
   - In the vicinity of high-temperature heat source
   - Location with vibrations
   - Locations where salt, water, oil, or corrosive gases exist

4. When using many amplifier units, install fan units.

5. When a case is used to accommodate amplifiers, the case must be grounded.

6. This product uses a flash memory for saving setup values. Replacement of battery is not needed accordingly.

7. This amplifier unit uses rotary encoders are used for knobs to control functions. However, indication position of the knob sometimes stays at the position between scale markings. In such case, the settings upon power-up may differ from those upon turning off the amplifier. To avoid such event, it is recommended to allow knob indication to be at the correct scale marking position.

WARRANTY

We ship our products after conducting quality control, which covers from design to manufacturing. It is, however, possible that failures may occur in the products. If the product does not operate correctly, please make a check of the power supply, cable connections, or other conditions before returning this product to us. For repair or calibration, contact our sales agency. Before returning, be sure to inform us of the model, serial number, and problematic points. The following is our warranty.

LIMITED WARRANTY

1. Warranty period

   Two years from our shipment.

2. Warranty limit

   We will repair the defects of our product free of charge within the warranty period; however, this warranty does not apply in the following cases.

   (1)Damage or faults caused by incorrect use.

   (2)Damage or faults caused by fire, earthquake, traffic accident, or other natural disasters.

   (3)Damage or faults caused by a repair or modification that is carried out by someone other than a service representative of us.

   (4)Damage or faults caused by use or storage in environmental conditions that should be avoided.

   (5)Periodical calibration.

   (6)Damage or faults caused during transportation.

3. Liability

   We do not assume any liabilities for equipment other than us.

Disposing of your used our product

- Disposing of your used our product -

In the European Union

EU-wide legislation as implemented in each Member State requires that used electrical and electronic products carrying the mark(left) must be disposed of separately from normal household waste. This include electrical accessories, such as chargers or AC adaptors.

The mark on the electrical and electronic products only applies to the current European Union Member States.

Outside the European Union

If you wish to dispose of used electrical and electronic products outside the European Union, please contact your local authority and ask for the correct method of disposal.

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1 . OVERVIEW

1.1. Features

The AS2503 and AS2603 are amplifiers that inherit the superior performance in conventional A&D's amplifiers. Moreover they feature new functions such as wire length adjustment and wire disconnection checking, realizing higher-accuracy and higher-quality measurement and a reduction in measurement preparation time. The AS2503 and AS2603 include an LED monitor and the auto-balancing function, thereby improving their operability. The connection status between input/output block and power supply block in AS2503 is direct connection and the structural status of those in AS2603 is isolation. Since constant voltage ranging from 2VDC to 10VDC for bridge power supply is used and high frequency responses (DC to 500 kHz in AS2503 and DC to 100 kHz in AS2603) are realized, measurement of high-speed strain like shocks is possible. Also these amplifiers can be used as a DC amplifier, featuring 10,000X in AS2503 and 5,000X in AS2603 of the maximum gain.

Another feature of the AS2503 and AS2603 amplifiers are their lead-free and battery-less product design. When several amplifier units are installed in a case, power supply, auto-balancing, calibration value input, and key-locking for all amplifier units can be made by one operation. If you encounter any problem, read the section for maintenance, and contact with A&D's sales agency if the problem is not solved.

Wide Bandwidth DC Strain Amplifier	Wide Bandwidth DC Strain Amplifier
	
AS2503	AS2603

DC Strain Amplifier

1.2 Major Features of Amplifiers

The following table lists the overview of dynamic strain amplifiers AS2503 and AS2603.

Model	BV	Configuration	Balance	Frequency response	Sensitivity (at BV = 2V)	Major application
AS2503	DCV	Unit	Auto	DC～500kHz	10V/1,000×10^{-6} strain	- Measurement of high-speed strain like a shock - Can be used for a DC amplifier.
AS2603	DCV	Unit	Auto	DC～100kHz	10V/2,000×10^{-6} strain	- Measurement of high-speed strain like a shock. Can be used for a DC amplifier. Isolation between input and output and power-supply block.

Table 1-1 Specifications of DC Strain Amplifiers

The following cases for units are provided.

Product Name	Model	Description	Remark
Bench-top case	AS16-104	4CH Bench-top case	Functions of +/-CAL, BAL, KEY-LOCK and batch power-on/off is available for all units. Linked or synchronized operation with other units is available.
	AS16-105	6CH Bench-top case	
	AS16-106	8CH Bench-top case	
Rack-mount case	AS16-107	8CH Rack-mount case	

Table 1-2 Description of Case

1.3 Accessories

・Output cord (0311-2057) x 1
・Time-lag fuse
(Fuse for AC power supply: 85 to 132VAC/180 to 264VAC, 125mA: 0334-4307 x 1)
(Fuse for DC power supply: 10V to 30VDC, 800mA: 0334-4315 x 1)
・Screw driver x 1
・AC power cord (0311-5044)
・Instruction Manual x 1

1.4 Block Diagram of Measurement

The following diagram illustrates a typical measurement system that broadly covers a variety of factors including signal amplitude, frequencies, and measuring time.

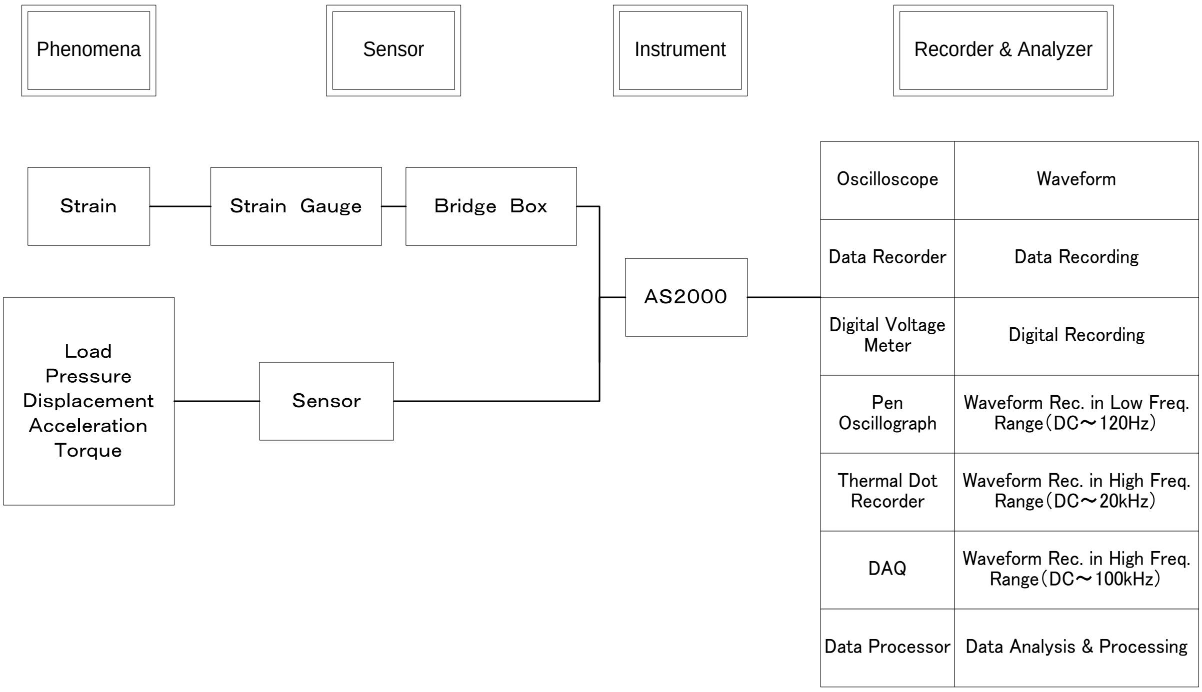


Figure 1-1 Block Diagram of Measurement

1.5 Features of Dynamic Strain Amplifiers

Bridge power voltage supply	DC bridge (DC strain amplifier)
Recommended sensors	1. Strain gauges 2. Sensors for load, displacement, acceleration, and torque (Strain gauge-type transducers)
Features	DC strain amplifiers have higher non-linearity and sensitivity than those of AC strain amplifiers. Generally, the DC strain amplifiers are used with strain gauge transducers, but they can also be used as DC amplifiers.

Table 1-3 Recommended Sensors and Features

Amplifier Type	DC Strain Amplifier	DC Strain Amplifier
Model	AS2503 (Wide-range type)	AS2603 (Wide-range type)
Voltage sensitivity	+/- 10 V output in $\pm 1{,}000\times10^{-6}$	+/- 10 V output in $\pm 2{,}000\times10^{-6}$
Non-linearity	± 0.01% /FS	± 0.05% /FS
Frequency response	DC to 500kHz	DC to 100kHz
Noise	80×10^{-6} strain p-p	50×10^{-6} strain p-p
Maximum gain	10,000X	5,000X
Bridge voltage	2, 3, 5, 9, and 10 VDC	2, 3, 5, 9, and 10 VDC
Isolation between input block and power supply	NA	+++
Measurement with strain gauge transducers	+++	+++
Measurement of strain such as shock	+++	++
Measurement with strain gauge	+	+
If the distance between measuring point and instrument	+++ Wire-length adjustment: patent protected	+++ Wire-length adjustment: patent protected
Using as DC amplifier	Possible	Possible

+++: Best suited　　++: Suited　　+: Usable but not suited　　NA: Not suited or cannot be used

Table 1-4 Functional Difference between AS2503 and AS2603

2．NAMES and FUNCTIONS OF PARTS

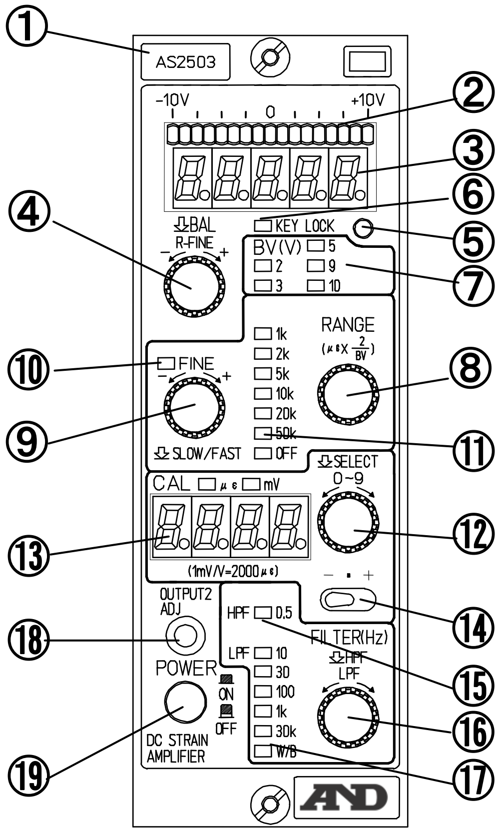


Figure 2-1

AS Amplifier Front View (AS2503)

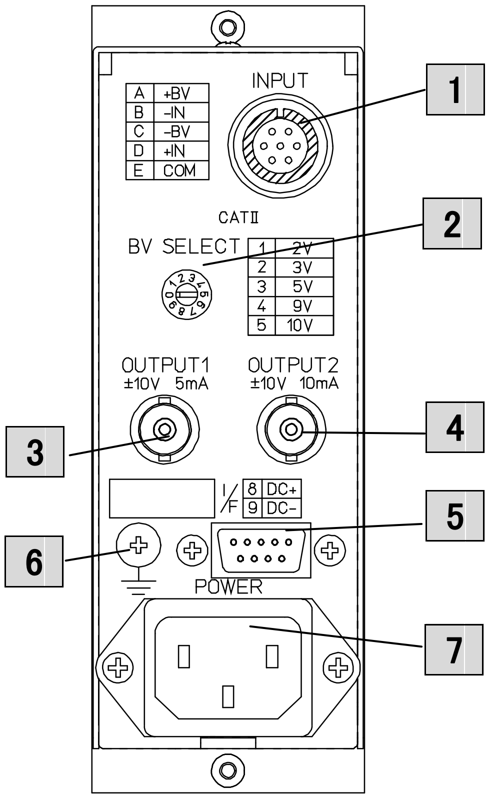


Figure 2-2

AS Amplifier Back View

2.1 Names and Functions of Parts on Front Panel (See 2-1.)

Number	Name	Function
①	Model	Model indication
②	Level meter (17-dot LED)	This level meter monitors the output voltage of OUTPUT1 $\boxed{3}$. The green LED at the middle comes on when the output voltage is within ±100 mV. When the output voltage exceeds ±10.05 V, the LED at the over-voltage side blinks.

Table 2-1 Front Panel: Names and Functions (1)

Number	Name	Function
③	Digital monitor (Four digits 1/2)	This monitor digitally displays the output voltage of OUTPUT2 $\boxed{4}$. When OUTPUT2 level adjustment volume ⑱ is turned clockwise, [10.000] is indicated in response to an output of 10 V. In combination with ⑱, 2 kN can be displayed as [2.000] when the transducer converting 2 kN to 10 V is used. For decimal point shift, refer to page 3-10.
④	Wire disconnection check/ Wire length adjustment/ Auto-balance knob (BAL) * See pages 3-4 to 3-6 for wire disconnection check and wire length adjustment	Pressing the knob performs wire disconnection check and wire length adjustment, enabling automatic balancing of resistors and capacitance. For details, see page 2-6 Indication upon Balancing. The result of wire disconnection check is indicated on digital monitor ③. If there is neither disconnection nor short, the indication of Good is made, thereby making wire length adjustment (dropout rate indication) and auto-balancing. If there is a disconnection or short, the problematic location is repeatedly indicated. After confirming the location, make repair. For more information on wire disconnection function, see pages 3-4 and 3-5. Whenever this button is pressed, the resistance balance is automatically kept accordingly. Note When the high-pass filter is used (High-pass filter LED ⑮ illuminating), even balancing is not performed, indication of good balance (0 V) is made. Therefore, do not forget to perform balancing. When the high-pass filter is turned on, a frequency element of 0.5 Hz or lower including DC is deleted, which is the state of the offset voltage cancellation.
	Resistance balance fine tuning (R-FINE)	Turning this knob clockwise moves the output to the positive side, while turning it counter-clockwise moves the output to the negative side.

Table 2-1 Front Panel: Names and Functions (2)

Number	Name	Function
⑤	KeyLock switch (KEY LOCK)	On/Off switching for keyLock can be made by pressing this knob for one second or longer. While in the lock state, keyLock LED ⑥ illuminates. In this state, BAL ④, measuring range selection ⑧, measuring range fine tuning ⑨, calibration value setting ⑫ and filter setting ⑯ cannot be used. Pressing this knob for one second or longer cancels the lock; keyLock LED ⑥ also comes off.
⑥	KeyLock LED	This LED indicates whether keyLock is effective or not, in that light-up for lock and light-out for unlock..
⑦	Bridge power voltage LED (BV (V))	This LED indicates the bridge power voltage (2 V, 3 V, 5 V, 9V or 10 V). To select, use bridge power voltage selection switch 2 on the rear panel. For more details, see 2-11 Bridge Power Selection.
⑧	Measuring range selection knob (RANGE)	This knob is used to select the measuring range. Turing this knob clockwise narrows the measuring range (i.e. increasing the sensitivity). See page 3-4 for measuring range. In this case, fine tuning is not made. [Fine tuning LED ⑩ comes off.]
⑨	Measuring range fine tuning knob (FINE)	Fine tuning is made with the knob. Turning the knob clockwise narrows measuring range (i.e. increasing sensitivity) and wides the range (i.e. decreasing sensitivity). As measuring range fine tuning knob ⑨ and measuring range selection functions together in AS2503, the range automatically shifts when signals exceed the measuring range. See measuring range LED ⑪. Fine tuning LED ⑩ comes off upon range shift. On the other hand in AS2603, as measuring range fine tuning knob ⑨ and measuring range selection does not function together. After fine tuning is made with measuring range fine turning knob and measuring range selection knob ⑧ is used to switch the range, the fine tuning of measuring range is maintained.
	Speed selection (SLOW/FAST)	Pressing this knob allows the fine tuning speed for measurement range to switch between high speed and low speed. Also, resistance balance fine tuning ④ is switched between high speed and low speed.

Table 2-1 Front Panel: Names and Functions (3)

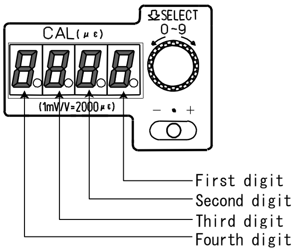
Number	Name	Function
⑩	Fine tuning LED	This LED comes on while fine tuning is made.
⑪	Measuring range LED	This LED indicates measuring range. The measuring ranges of AS2503 and AS2603 are explained in 3-4 Measuring Range and 3-5 Measuring Range.
⑫	Calibration value setup knob (CAL(με)) με=10^{-6} 	Indicated value is calculated value based on input. The value can be set from 1με to 9999με by a step of 1με. Pressing the knob changes the digit for calibration value LED ⑬ and turning the knob changes values. For further information, see page 2-6 How to Set Calibration Value. The value the equivalent voltage value based on a gauge factor of 2.0 and the one gauge configuration (1mV/V=2000με).
⑬	Calibration value LED	The LED displays calibration value and setting status (digit blinking).
⑭	Calibration value application switch	This switch is used to input the value that is set by calibration value setting knob ⑫. Pushing toward right inputs a plus value (tension) and pushing toward left inputs a minus value (compression). As a calibration value is superimposed with the input signal to generate the output voltage, return the position to OFF (middle) after inputting the calibration value.
⑮	High-pass filter LED	This LED comes on when the high-pass filter is used.
⑯	ON./OFF for high-pass filter (FILTER)	Pressing the knob allows the high-pass filter to switch between ON and OFF. High-pass filter LED ⑮ comes on for ON and it comes off for OFF. Filter type: 2-pole Bessel filter Cut-off frequency: 0.5 Hz
	Low pass filter setting knob (FILTER)	This knob is used to set the low-pass filter. Turning the knob allows the filter to be set to OFF (= W/B) or cut-off frequency. The setting information is displayed on low-pass filter LED ⑰. Filter type: 4-pole Bessel filter Cut-off frequencies: 10, 30, 100, 1k, 30kHz, W/B

Table 2-1 Front Panel: Names and Functions (4)

Number	Name	Function
⑰	Low-pass filter LED	This LED indicates the cut-off frequency for the low-pass filter. W/B (wideband) signifies OFF for the low-pass filter.
⑱	OUTPUT2 level control volume	The output voltage for OUTPUT2 4 can be controlled from the rating 10 V to 1 V. Control the voltage with the attached screw driver. The output value is indicated on the digital monitor ③. As decimal point shifting is possible through the dip switch on the bottom face of the amplifier unit, digital monitor ③ can be used for an indicator. For how to shift the decimal point, refer to page 3-10.
⑲	Power switch (POWER)	Pressing this switch supply the power to the amplifier unit. The power is turned off by pressing this button again.

Table 2-1 Front Panel: Names and Functions (5)

2.2 How to Set Calibration Value (CAL) (Entering strain)

The indicated value is calculated value based on input. The value can be set from 1με to 9999με by a step of 1με (=10^{-6}). Values should be set for each digit (Figure 2-3). Pressing calibration value setting knob ⑫ (Figure 2-3) illuminates the fourth digit of calibration value LED ⑬. Turning the switch changes the value on ⑬. Even the indication is blinking, the setting is being made.

Press the knob when your target value is indicated. In this case, blinking of ⑬ turns to illuminating (value fixed), and then the third digit starts blinking. Repeat this step up to the first digit. After the first digit comes on and then all digits illuminates, calibration value setting completes. To change the calibration value, repeat the steps above. The value is based on the equivalent value for gauge factor 2.00 and one gauge configuration. For strain gauge-type transducer, set and calculate the value based on 1mV/V=2000με.

■Calibration value setting

For strain input (μ ε)

Calibration value (CAL) setting range	Forth Digit	Third Digit	Second Digit	First Digit
1 to 9999	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9

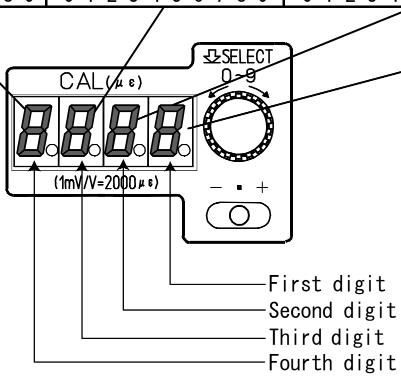


Figure 2-3
Calibration value (CAL)

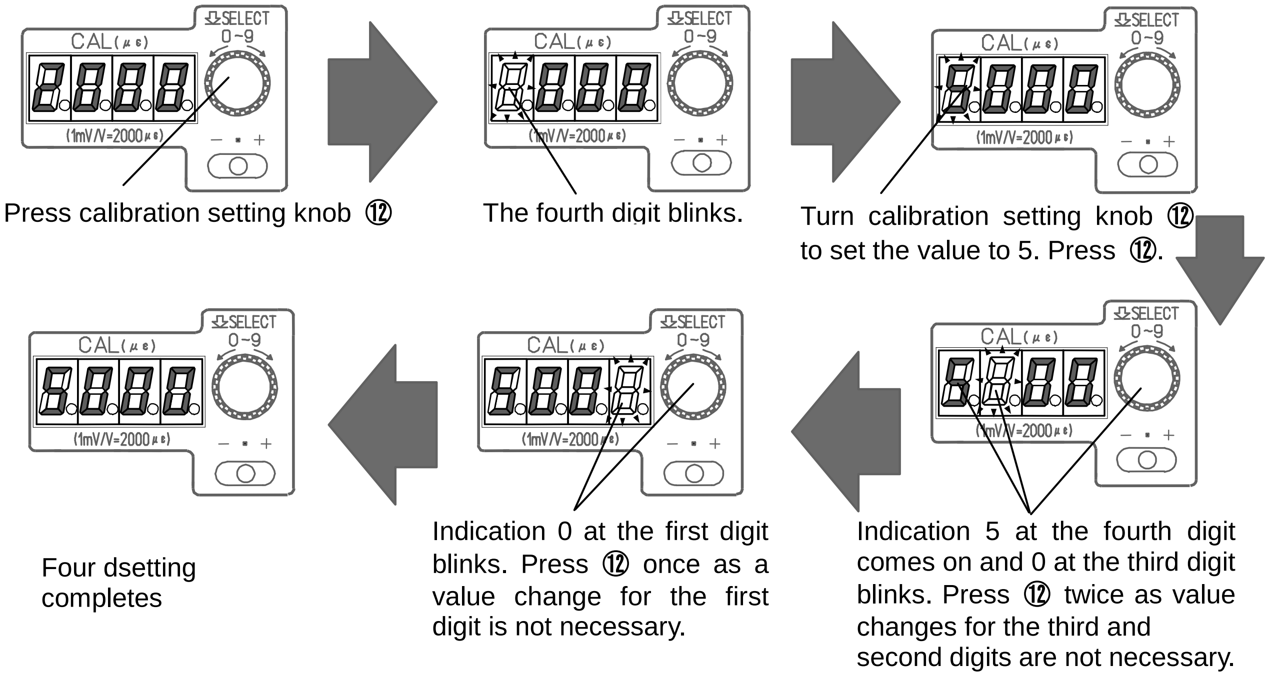


Figure 2-4

2.3 How to Set Calibration Value (CAL) (Entering voltage)

To change the unit from mV to με and με to mV, depress calibration value setting knob ⑫ (See Figure 2-5) for one second or longer. Then, the indication of LED changes (e.g., fromμε to mV). You can change the unit by depressing the calibration value setting knob ⑫ for one second or longer when setting the value of each digit. The settable values are as follows.

■Calibration value setting

For voltage input (mV)

CAL	Forth Digit	Third Digit	Second Digit	First Digit
0.01～9.99	0	0.1.2.3.4.5.6.7.8.9.	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9
10.00～99.99	1 2 3 4 5 6 7 8 9	0.1.2.3.4.5.6.7.8.9.	0 1 2 3 4 5 6 7 8 9	0 1 2 3 4 5 6 7 8 9

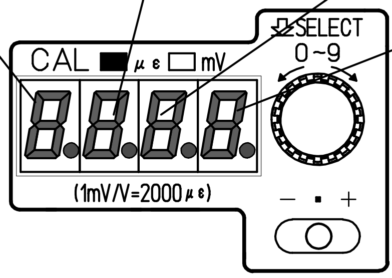
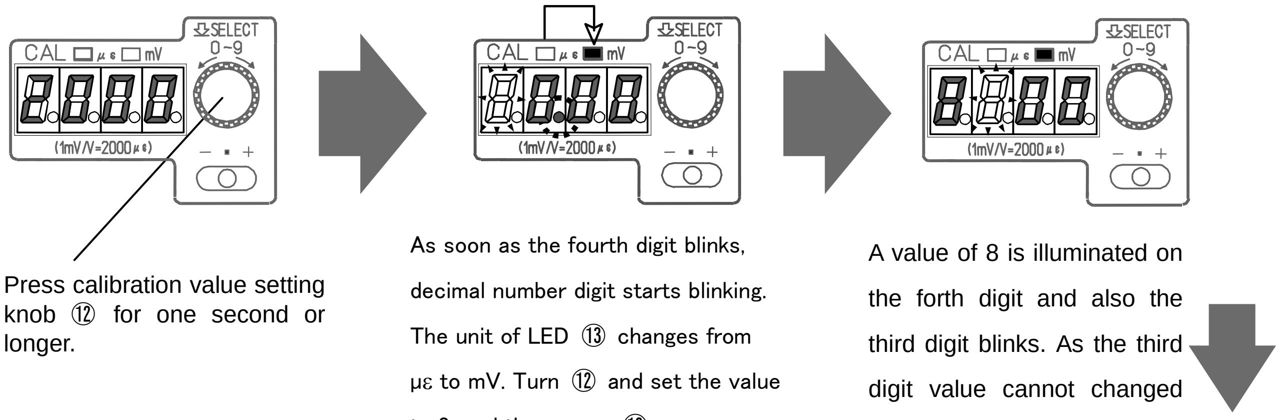


Figure 2-5

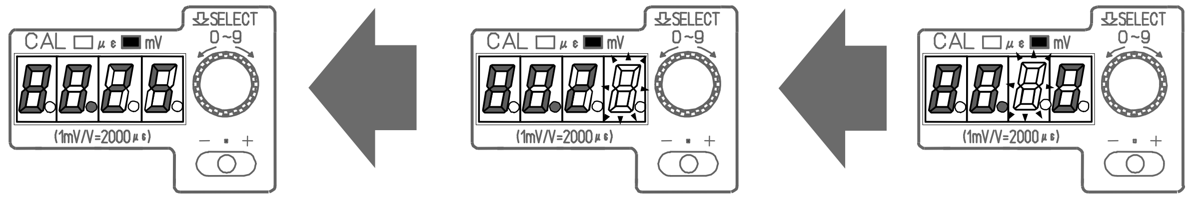
E.g. When changing the CAL value from 2000με to 80.25 mV (See Figure 2-6)



Press calibration value setting knob ⑫ for one second or longer.

As soon as the fourth digit blinks, decimal number digit starts blinking. The unit of LED ⑬ changes from με to mV. Turn ⑫ and set the value to 8, and then press ⑫.

A value of 8 is illuminated on the forth digit and also the third digit blinks. As the third digit value cannot changed (staying to be 0), press ⑫.



A value of 0 is illuminated on the third digit, and then the second digit blinks. Turn ⑫ to set 2, and after that press ⑫.

A value of 2 is illuminated on the second digit, and then the first digit blinks. Turn ⑫ to set to 5, and after that Press ⑫.

All digits illuminates, and the setting is completed after 80.05 is indicated.

Figure 2-6

2.4 Indication upon Balancing

Pressing BAL knob ④ executes wire disconnection check and wire length adjustment, thus automatically realizing both resistance balancing and capacitance balancing. While the wire disconnection check and wire length adjustment functions are effective (ON), the following indications appear. If there is wire disconnection or short, the problematic location is indicated repeatedly on digital monitor ③. The indication continues until the BAL knob is pressed for five seconds or longer or the power of amplifier is turned off. Make repair following the indication. When wire disconnection check is not effective (OFF), the portions enclosed by broken line are omitted, executing auto-balancing. For how to set these functions to ON or OFF, refer to page 3-10 How to Switch Special Function Setting.

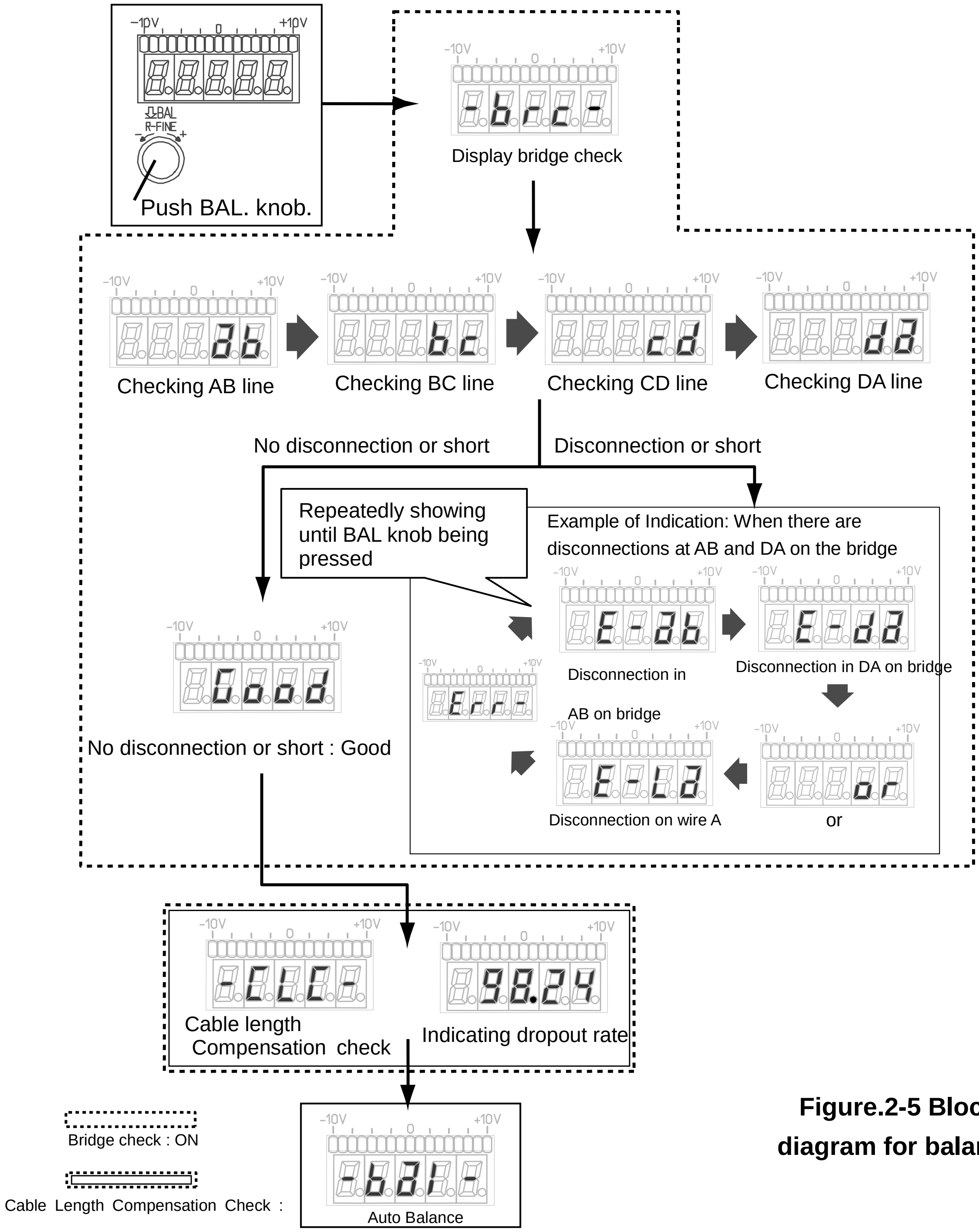


Figure.2-5 Block diagram for balance

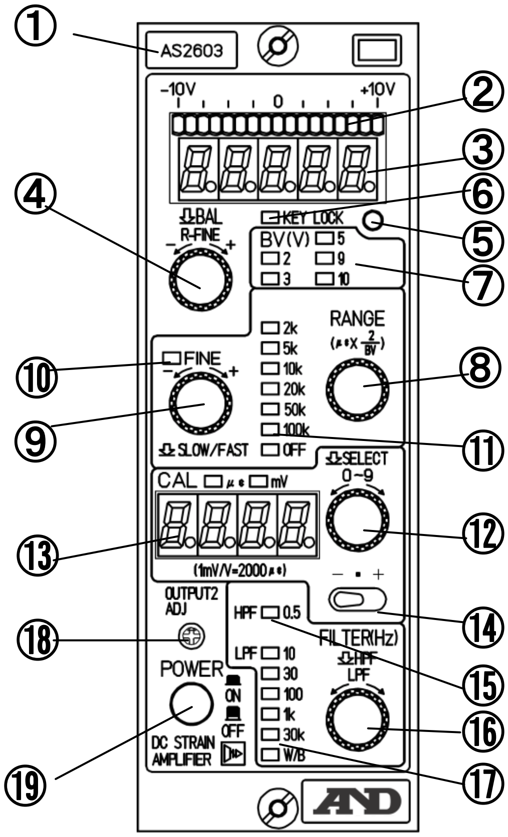


Figure 2-1 Front view of
AS amplifier unit (AS2603)

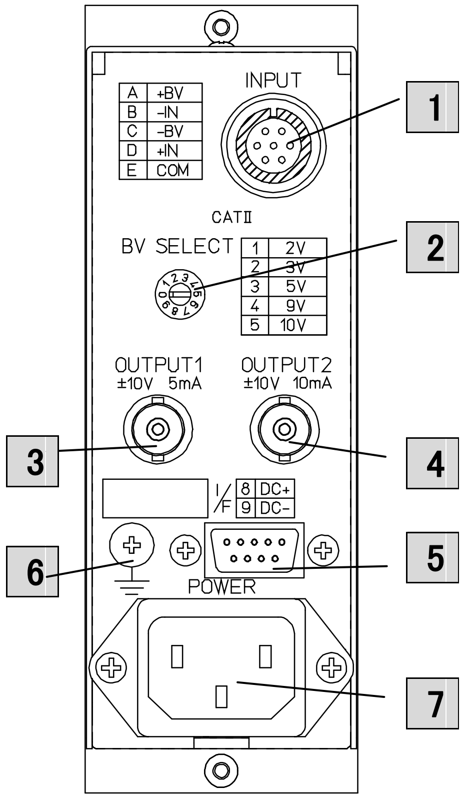
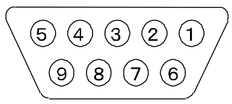


Figure 2-2 Rear view of
AS amplifier unit

2.5 Rear Panel: Names and Functions (See Table 2-2)

Number	Name	Function
1	Input connector (INPUT)	The bridge box or connector or a transducer is connected. The connector should be an input connector for strain measurement confirming the standards of The Japanese Society for Non-Destructive Inspection (NDIS4102).
2	Bridge power voltage selection switch (BV)	Selection of power voltage applied to the bridge can be switched (0.5 V or 20 V).
3	Output connector 1 (OUTPUT1)	The output voltage and current are ±10 V and ±5 mA, respectively. This connector can be connected to a recorder (e.g. thermal-dot recorder or data acquisition devices) or A/D converter, which accept voltage signals

Table 2-2 Rear Panel: Names and Functions (1)

<table>
<tr><th>Number</th><th>Name</th><th>Function</th></tr>
<tr><td>4</td><td>Output connector 2
(OUTPUT2)</td><td>The output voltage and current are ±10 V and ±10 mA, respectively. The output level can be controlled from 10 V to 1 V with OUTPUT2 level adjustment volume ⑱ on the front panel.
Note
If output of current from 4 to 20 mA is required, modification from the voltage output to the current output is available with extra costs. For details, contact with NIPPON AVIONICS’s sales agency.</td></tr>
<tr><td>5</td><td>Interface connector
(I/F)</td><td>This connector is used to connect an amplifier unit and case electrically. The pin layout is shown as follows. Other than DC power voltage supply, it is possible to perform keylock, auto-balancing, calibration value application, and synchronous signal output. A connection cable is available separately.


Amplifier, Interface connector (from rear side)
<table><tr><td>(1) +CAL</td><td>(2) -CAL</td><td>(3) BAL</td></tr><tr><td>(4) OSC</td><td>(5) GND</td><td>(6) KEYLOCK</td></tr><tr><td>(7) GND</td><td>(8) DC+</td><td>(9) DC-</td></tr></table></td></tr>
<tr><td>6</td><td>Protective grounding terminal</td><td>If 3-pin power cord cannot be used for grounding, use this terminal for grounding.</td></tr>
<tr><td>7</td><td>Power supply connector</td><td>This is the connector to be connected to the AC power cable. The AC power supply block of the amplifier unit have a withstand voltage of 1.5 kVAC/minute against input, output, and case.
Note
When using a power supply of 100VAC, use AC power supply cord 47326. When using 110VAC or higher, use optional AC power supply cord 200V (0311-5112). When using 180 to 264 VAC, also use optional AC power cord 200V (0311-5112).</td></tr>
</table>

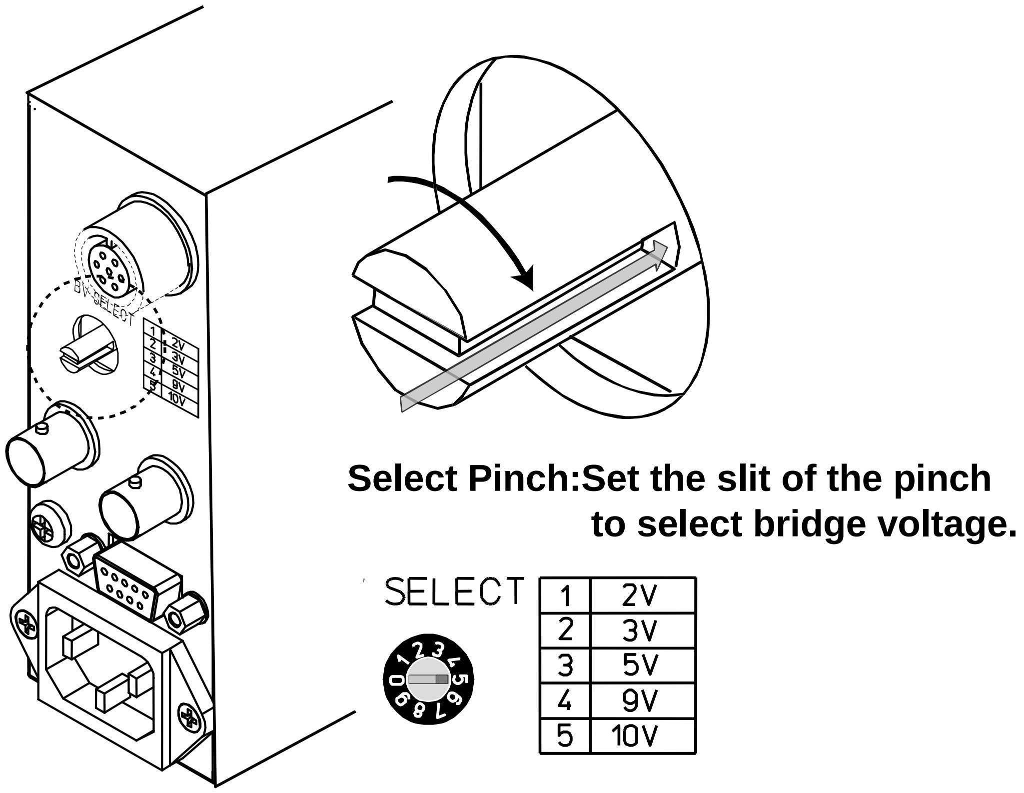
Table 2-2 Rear Panel: Names and Functions (2)

2.6 Selecting Bridge Supply

Users can change bridge voltage by the voltage pinch on the back panel.

Bridge supply: 2V, 3V, 5V, 9V and 10V

Set the slit of the pinch at the number of selected voltage.



3 .BEFORE MEASURING

3.1 Cable Connections

3.1.1 Input Cable Connections (See Figure 3-1.)

(1) Paste a strain gauge to the location where measurement is made.

(2) Connect the strain gauge to the bridge box.

(3) Adjust the power supply for strain gauge with bridge power voltage selection switch 2 . Set the supply voltage to 2 V for general 120-ohm strain gauge. When using a transducer, set to 3 V, 5 V, 9 V, or 10 V according to the input voltage. For details see page 4-7, Measurement Using Transducer.

(4) Connect the bridge box or a transducer to the input connector 2 on the rear panel. For connection information, see Cautions before Measuring on page 4-1. Since the AS2503 and AS2603 automatically adjust the voltage drop generated between the bridge and the amplifier through the wire length adjustment function, high-accuracy measurement is possible. For more information on this adjustment function, see page 3-6.

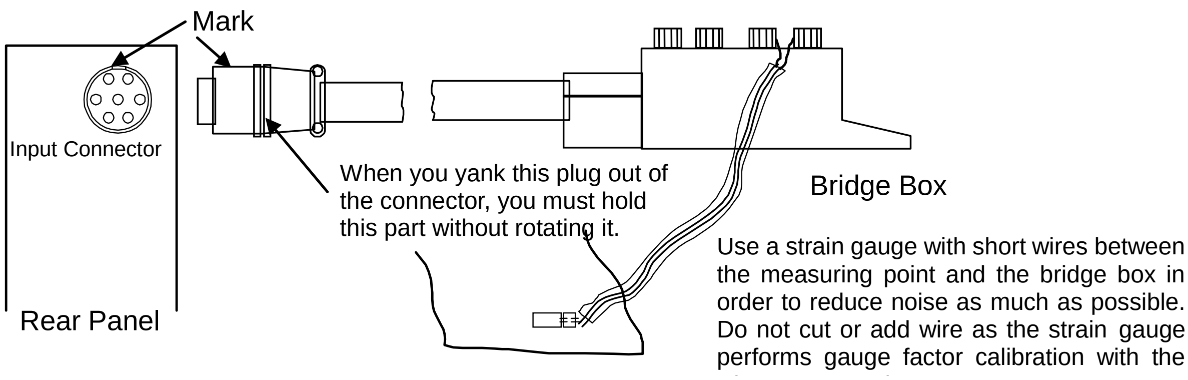


Figure 3-1 Connection with bridge box and so on

3.1.2 Power Supply Cable and Output Cable Connections (See Figure 3-2)

(1) Use the power supply cable for 100 VAC (Model 0311-5112 for 110 VAC or higher), 200 VAC, or 12 VDC depending on the voltage.

(2) Connect the output cable appropriate to the recorder to be used.

(3) For more information, refer to Connection between Output and Load on page 4-12.

(4) The chassis of this amplifier is connected to the output common lead.

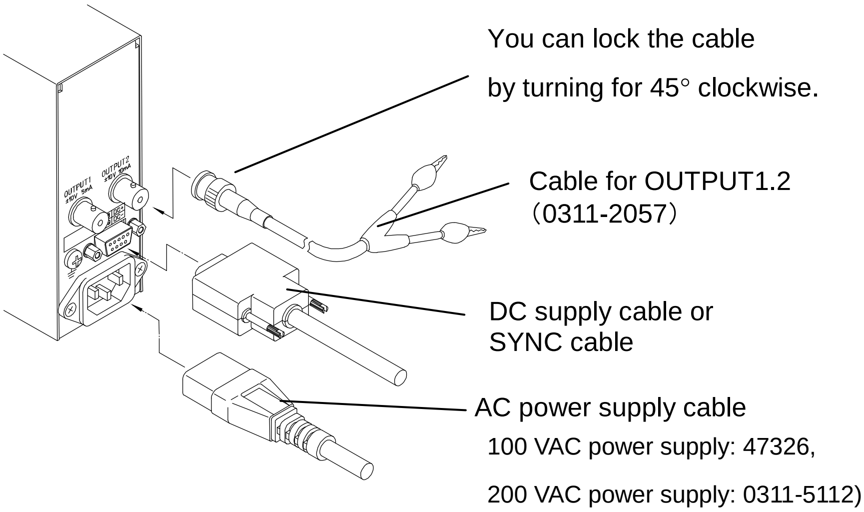


Figure 3-2 Connection of power supply code and output cable

3.2 Operation before Measuring

3.2.1 Standalone Operation

(1) Set the calibration value application switch ⑭ (+ • -) to the • (OFF) position.

(2) Pressing power switch ⑲ (POWER) supplies power to the amplifier.

(3) Set the measuring range to OFF (Measuring Range LED ⑪) using measuring range selection knob ⑧ (RANGE).

(4) Setting the measuring range to OFF using measuring range selection knob ⑧ illuminates the green LED in the middle of level meter ②. Activate for about 10 minutes.

(5) For correct strain measurement, you must conduct initial balancing for the bridge circuit. Tune to your target measuring range using measuring range selection knob ⑧ and adjust the output to zero while no load is being applied.

(6) Wire disconnection check, wire length adjustment, and automatic balancing.

Turn measuring range selection knob ⑧ clockwise up to your target measuring range, and then narrow the measuring range (i.e. increasing sensitivity). In this case, the indication of measuring range LED ⑪ changes from OFF to other values, in that the value changes toward 200. Pressing the BAL knob ④ performs the wire disconnection check, wire length adjustment (indication of the rate of damping), and auto-balancing in this order. For more information, see Indication upon Execution of BAL on page 2-7.

(These functions are available when the dip switches for the wire disconnection check and wire length adjustment are set to ON.)

When there is neither wire disconnection nor a short, and indication of Good is indicated on the digital monitor ③, and then the wire length adjustment (indication of the rate of damping) and auto-balancing are performed. If there is a wire disconnection or short, the examination results are indicated on the digital monitor ③ repeatedly. The contents to be indicated are listed on the pages from 3-6 to 3-7. Following the indicated results (page 3-7), repair the cable or bridge. After the repair, press BAL again for at least five seconds to check for failures.

The wire length adjustment automatically calculates the voltage drop occurring in the cable connecting between the AS amplifier and measurement point (bridge), saving this calculation data into the internal memory. The power supply to the bridge is provided after this adjustment. As a result, high-accuracy strain measurement is available without considering the conductor resistance generated by the cable.

After the wire length adjustment is made, the initial balance is made, and then the green LED in the middle comes on. For further fine-tuning, turn the BAL knob ④ clockwise or anti-clockwise. The adjustment range is an output of ±1 V.

* The wire length adjustment data is stored in the internal memory until the BAL switch is pressed, even if the power switch ⑲ is turned on or off. The wire length function is set to off or non-adjustment by the dip switch on the bottom face of the AS amplifier.
* For more information on wire disconnection function and wire length adjustment, see the pages 3-6 to 3-8.

(7) In response to the magnitude of the strains anticipated, apply a calibration value using the calibration setting knob ⑫ first, and then start measuring.

The measuring range can be checked after applying a calibration value using the calibration value application switch ⑭. The measuring ranges for AS amplifiers are described on page 3-4 for AS2503 and page 3-5 for AS2603.

3-2-2 Measuring Range

AS2503

Measuring Range (Measuring Range LED ⑪)	Measuring Range Fine Tuning Knob ⑨	Measurable Strain (×10^{-6} strain)	
		BV=2V	BV=3V
1k	1X to 2X continuous tuning	±1,000 to ±2,000	±666 to ±1,333
2k	1X to 2.5X continuous tuning	±2,000 to ±5,000	±1,333 to ±3,333
5k	1X to 2X continuous tuning	±5,000 to ±10,000	±3,333 to ±6,666
10k	1X to 2X continuous tuning	±10,000 to ±20,000	±6,666 to ±13,333
20k	1X to 2.5X continuous tuning	±20,000 to ±50,000	±13,333 to ±33,333
50k	1X to 2.5X continuous tuning	±50,000 to ±125,000	±33,333 to ±83,333

Measuring Range (Measuring Range LED ⑪)	Measuring Range Fine Tuning Knob ⑨	Measurable Strain (×10^{-6} strain)	
		BV=5V	BV=9V
1k	1X to 2X continuous tuning	±400 to ±800	±222 to ±444
2k	1X to 2.5X continuous tuning	±800 to ±2,000	±444 to ±1,111
5k	1X to 2X continuous tuning	±2,000 to ±4,000	±1,111 to ±2,222
10k	1X to 2X continuous tuning	±4,000 to ±8,000	±2,222 to ±4,444
20k	1X to 2.5X continuous tuning	±8,000 to ±20,000	±4,444 to ±11,111
50k	1X to 2.5X continuous tuning	±20,000 to ±50,000	±11,111 to ±27,777

Measuring Range (Measuring Range LED ⑪)	Measuring Range Fine Tuning Knob ⑨	Measurable Strain (×10^{-6} strain)
		BV=10V
1k	1X to 2X continuous tuning	±200 to ±400
2k	1X to 2.5X continuous tuning	±400 to ±1,000
5k	1X to 2X continuous tuning	±1,000 to ±2,000
10k	1X to 2X continuous tuning	±2,000 to ±4,000
20k	1X to 2.5X continuous tuning	±4,000 to ±10,000
50k	1X to 2.5X continuous tuning	±10,000 to ±25,000

Table 3-1 Measuring Range of AS2503

As measuring range fine tuning knob ⑨ of AS2503 functions in tandem to measuring range selection. Accordingly, if the signal exceeds the measuring range, the range automatically changes (See measuring range LED ⑪). Fine tuning LED ⑩ comes off upon switching.

⚠CAUTION

After taking the balance, if you change the fine adjustment or measurement range, please rebalances.

AS2603

Measuring Range (Measuring Range LED ⑪)	Measuring Range Fine Tuning Knob ⑨	Measurable Strain ($\times 10^{-6}$ strain)	
		BV=2V	BV=3V
2k	1X to 2.5X continuous tuning	±2,000 to ±5,000	±1,333 to ±3,333
5k	1X to 2X continuous tuning	±5,000 to ±10,000	±3,333 to ±6,666
10k	1X to 2X continuous tuning	±10,000 to ±20,000	±6,666 to ±13,333
20k	1X to 2.5X continuous tuning	±20,000 to ±50,000	±13,333 to ±33,333
50k	1X to 2X continuous tuning	±50,000 to ±100,000	±33,333 to ±66,666
100k	1X to 2.5X continuous tuning	±100,000 to ±250,000	±66,666 to ±166,666

Measuring Range (Measuring Range LED ⑪)	Measuring Range Fine Tuning Knob ⑨	Measurable Strain ($\times 10^{-6}$ strain)	
		BV=5V	BV=9V
2k	1X to 2.5X continuous tuning	±800 to ±2,000	±444 to ±1,111
5k	1X to 2X continuous tuning	±2,000 to ±4,000	±1,111 to ±2,222
10k	1X to 2X continuous tuning	±4,000 to ±8,000	±2,222 to ±4,444
20k	1X to 2.5X continuous tuning	±8,000 to ±20,000	±4,444 to ±11,111
50k	1X to 2X continuous tuning	±20,000 to ±40,000	±11,111 to ±22,222
100k	1X to 2.5X continuous tuning	±40,000 to ±100,000	±22,222 to ±55,555

Measuring Range (Measuring Range LED ⑪)	Measuring Range Fine Tuning Knob ⑨	Measurable Strain ($\times 10^{-6}$ strain)
		BV=10V
2k	1X to 2.5X continuous tuning	±400 to ±1,000
5k	1X to 2X continuous tuning	±1,000 to ±2,000
10k	1X to 2X continuous tuning	±2,000 to ±4,000
20k	1X to 2.5X continuous tuning	±4,000 to ±10,000
50k	1X to 2X continuous tuning	±10,000 to ±20,000
100k	1X to 2.5X continuous tuning	±20,000 to ±50,000

Table 3-2 Measuring Range of AS2603

As measuring range fine tuning knob ⑨ of AS2603 is not coupled with measuring range selection. Even the range is switched with measuring range selection knob ⑧ after fine tuning is made with measuring range fine tuning knob, the fine tuning for the measuring range is maintained.

⚠CAUTION

After taking the balance, if you change the fine adjustment or measurement range, please rebalances.

3.3 Wire Disconnection Check Function

3.3.1 Overview

The wire disconnection check function of the AS amplifiers can detect a bridge wire disconnection, short, or cable disconnection. Since disconnected portions can easily be found, testing personnel can reduce the measurement preparation time or prepare countermeasures against wire disconnections. The wire disconnection check function can be set to on or off using the dip switch on the bottom face of the AS amplifier.

(The bridge resistance should be 120 Ω or higher.)

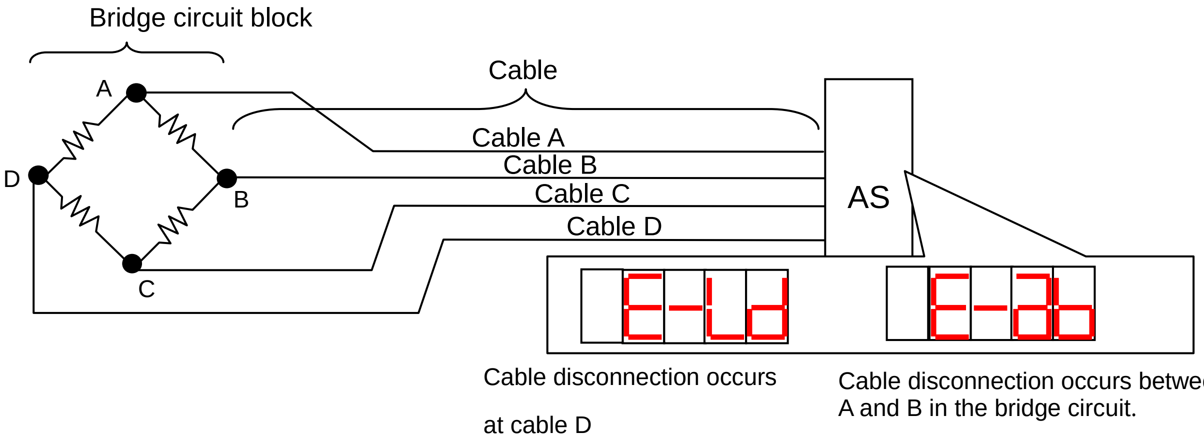


Figure 3-3 Overview of Disconnection Check

When no failure is found after the wire disconnection check, the indication Good is displayed on the digital monitor. If a failure is found, the failure information is repeatedly displayed on the digital monitor ③. The indication does not disappear until the BAL knob is pressed or the amplifier unit power supply is turned off. For error contents, refer to page 3-5. After confirming the cause of failure, take measures to repair the failure. Following repairs, press the BAL knob for longer than five seconds for disconnection checking. If there is no problem, Good is indicated.

If disconnection or a short is detected, there is always an error indication. However, the failure location may not be found depending on the number of disconnections or the disconnection conditions on the cable or at the bridge, or both.

When the wire disconnection function is turned off, switch the dip switches on the bottom face of the amplifier according to How to Switch Special Function Setting on page 3-9.

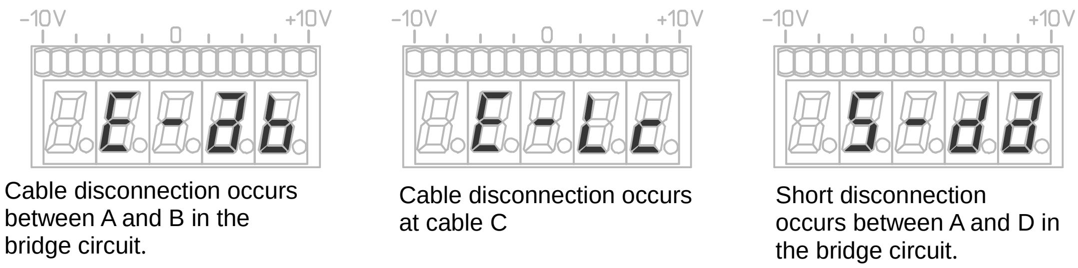


Figure 3-4 Example of error indication

3.3.2 Error Indication List upon Wire Disconnection and Short

Error indication in the case of disconnection

Disconnection on bridge circuit				Disconnection on cable				INDICATION (Digital Monitor③)
A-B	B-C	C-D	D-A	A	B	C	D	
○	○	○	○	○	○	○	○	**Good**
×	○	○	○	○	○	○	○	**E-ab**
○	×	○	○	○	○	○	○	**E-bc**
○	○	×	○	○	○	○	○	**E-cd**
○	○	○	×	○	○	○	○	**E-da**
×	×	○	○	○	○	○	○	**E-ab E-bc or E-Lb**
○	○	○	○	○	×	○	○	
○	×	×	○	○	○	○	○	**E-bc E-cd or E-Lc**
○	○	○	○	○	○	×	○	
○	○	×	×	○	○	○	○	**E-cd E-da or E-Ld**
○	○	○	○	○	○	○	×	
×	○	○	×	○	○	○	○	**E-ab E-da or E-La**
○	○	○	○	×	○	○	○	
○	×	○	×	○	○	○	○	**E-bc E-da**
×	○	×	○	○	○	○	○	**E-ab E-cd**
×	×	×	○	○	○	○	○	**E-ab E-bc E-cd or E-Lb E-Lc**
○	○	○	○	○	×	×	○	
×	×	○	×	○	○	○	○	**E-ab E-bc E-da or E-La E-Lb**
○	○	○	○	×	×	○	○	
×	○	×	×	○	○	○	○	**E-ab E-cd E-da or E-La E-Ld**
○	○	○	○	×	○	○	×	
○	×	×	×	○	○	○	○	**E-bc E-cd E-da or E-Lc E-Ld**
○	○	○	○	○	○	×	×	
○	○	○	○	×	○	×	○	**OPEn**
○	○	○	○	○	×	○	×	
○	○	○	○	×	×	×	○	
○	○	○	○	×	×	○	×	
○	○	○	○	×	○	×	×	
○	○	○	○	○	×	×	×	
○	○	○	○	×	×	×	×	
×	×	×	×	○	○	○	○	

×: Disconnection

Error Indication in the case of short

Disconnection on bridge circuit				Disconnection on cable				INDICATION (Digital Monitor③)
A-B	B-C	C-D	D-A	A	B	C	D	
○	○	○	○	○	○	○	○	**Good**
×	○	○	○	○	○	○	○	**S-ab**
○	×	○	○	○	○	○	○	**S-bc**
○	○	×	○	○	○	○	○	**S-cd**
○	○	○	×	○	○	○	○	**S-da**
×	×	○	○	○	○	○	○	**S-ab S-bc**
○	×	×	○	○	○	○	○	**S-bc S-cd**
○	○	×	×	○	○	○	○	**S-cd S-da**
×	○	○	×	○	○	○	○	**S-ab S-da**
×	○	×	○	○	○	○	○	**S-ab S-cd**
○	×	○	×	○	○	○	○	**S-bc S-da**
×	×	×	○	○	○	○	○	**S-ab S-bc S-cd S-da**
×	×	○	×	○	○	○	○	
×	○	×	×	○	○	○	○	
○	×	×	×	○	○	○	○	
×	×	×	×	○	○	○	○	

Table 3-3 Error indication upon wire disconnection and short

3.4 Wire Length Adjustment Function

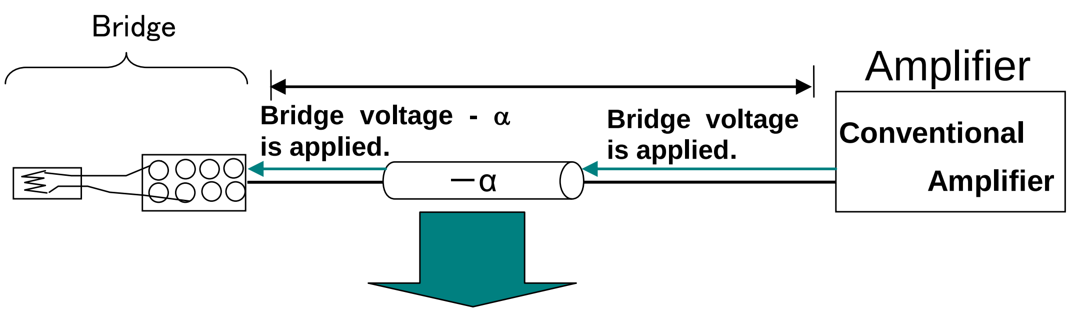
If the length of the cable connecting between the bridge and amplifier is long, the bridge resistance is lower due to the conductor resistance of the cable. For the rate of the bridge voltage drop, refer to table 3-3 below. Before this function is employed, testing personnel made remote sensing through a 6-core cable or adjustment through values for the cable length or wire diameter.

The AS series employs a unique automatic adjustment circuit in lieu of the conventional techniques above, thereby enabling supplying the bridge power that reflects conductor resistance. Since high-accuracy strain measurement is possible, testing personnel can reduce measurement time and measurement steps.

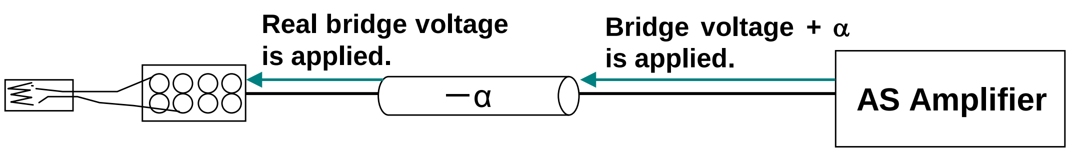
On/off for wire length adjustment can be switched using the dip switch on the bottom face of the amplifier. See page 3-10 for more details.

	Distance between amplifier and bridge box (m)			
Bridge Resistance	20m	50m	100m	200m
120Ω	−1. 2	−3. 0	−5. 8	−11. 0
350Ω	−0. 4	−1. 1	−2. 1	−4. 1
500Ω	−0. 3	−0. 7	−1. 5	−2. 9
1000Ω	−0. 1	−0. 4	−0. 7	−1. 5

Table 3-4 Rate of Voltage Drop (%) (0.5 mm^2 wire at 20°C)



1) Automatically calculating voltage drop of the bridge voltage due to cable conductor resistance.
2) Applying the bridge voltage reflecting the voltage drop



Length: 300m, Core wire: 0.5 mm^2, using our optional extension cable

Figure 3-5 Explanatory Diagram of Wire Length Adjustment Function

⚠CAUTION

The AS Series amplifiers are provided with the wire length adjustment function that corrects the voltage drop of excitation voltage supplied from the amplifier if the wire length between the amplifier and bridge circuit for strain measurement.

This functionality is based on the assumption that the transducer or bridge box is configured by the Wheatstone bridge circuit. Therefore, the wire length adjustment function does not function if a calibration value generator that does not include the Wheatstone bridge circuit.

Moreover, the wire length adjustment function may not correctly function for transducers that include a resistor for output adjustment. The reason is the amplifier regards the resistance of the resistor for output adjustment as the resistance of wire, thereby correcting the voltage drop. As a result, the voltage applied to the transducer may increase by a maximum of 130% compared to the normal voltage, which causes the transducer to output larger values. Be careful when using transducers.

Resistor for output adjustment in NIPPON AVIONICS's 9E Series transducers

Model	Resistor	Model	Resistor	Model	Resistor	Model	Resistor
9E01-L1	Provided	9E01-L21	Provided	9E02-P2	Provided	9E08-D1A	Provided
9E01-L2	Not provided	9E01-L22	Provided	9E02-P3	Not provided	9E08-D2	Provided
9E01-L3	Provided	9E01-L23	Provided	9E02-P4	Provided	9E08-D3	Provided
9E01-L4	Provided	9E01-L23W	Provided	9E02-P5	Not provided	9E08-D4	Provided
9E01-L5	Provided	9E01-L23H	Not provided	9E02-P6	Not provided	9E08-D5	Provided
9E01-L8	Provided	9E01-L31	Provided	9E02-P6G	Not provided	9E08-D6	Not provided
9E01-L9	Provided	9E01-L33	Provided	9E02-P7	Not provided	9E08-D7	Not provided
9E01-L11	Provided	9E01-L35	Provided	9E02-P11	Provided	9E05-B1	Provided
9E01-L14	Provided	9E01-L36	Provided	9E02-P13	Provided	9E05-T1	Provided
9E01-L15	Provided	9E01-L41	Not provided	9E02-P14	Not provided	9E06-S1	Not provided
9E01-L18	Provided	9E01-L42	Not provided	9E02-P15	Not provided	9E06-S2	Not provided
9E01-L18W	Provided	9E01-L43	Not provided	9E02-P16	Not provided	9E07-A1	Not provided
9E01-L19	Provided	9E01-L44	Not provided	9E02-P17	Not provided	9E07-A3	Not provided
9E01-L19W	Provided	9E01-L45	Not provided				

3.5 How to Switch Special Function Setting

By switching dip switches on the bottom face of the AS amplifier, settings for special functions can be made.

- ON/OFF for wire length adjustment
- ON/OFF for wire disconnection check function
- Decimal point shift for digital monitor ③

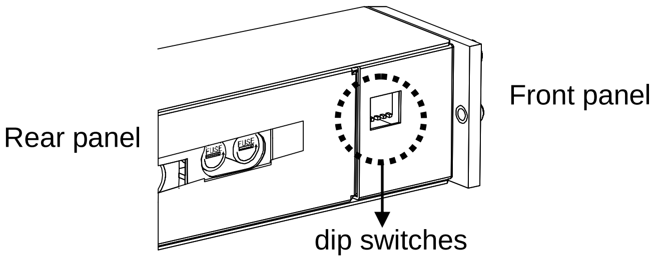


Figure 3-6 Position of dip switch

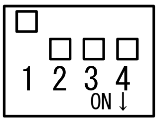
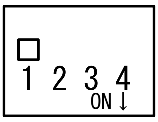
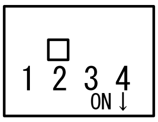
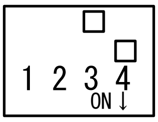
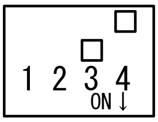
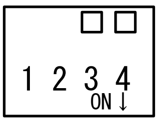
Dip switch	Function	Description
	Factory-set (Factory-set settings)	Wire length adjustment function: (Switch 1 is Off.) Wire disconnection check function: ON (Switch 2 is On.) Decimal point of digital monitor ③, displaying decimal point at the fourth place: 10.000 (Switches 3 and 4 are On.)
	Wire length adjustment function (Switch 1 changeover)	Wire length adjustment function: OFF (Switch 1 up: Off) Wire length adjustment function: ON (Switch 1 down: On)
	Wire disconnection check function (Switch 2 changeover)	Wire disconnection check function: OFF (Switch 2 up: Off) Wire disconnection check function: ON (Switch 1 down: On)
	Decimal point indication (Setup through the combinations of switches 3 and 4)	Displaying the decimal point of digital monitor ③ at the third place: 100.00
	Decimal point indication (Setup through the combinations of switches 3 and 4)	Displaying the decimal point of digital monitor ③ at the second place: 100.00
	Multipoint indication (Setup through the combinations of switches 3 and 4)	No indication of the decimal point on digital monitor ③: 10000

Table 3-5

ON/OFF switching for dip switches is possible when the amplifier is turned on.

3.6 Cases

3.6.1 Names of Case Elements

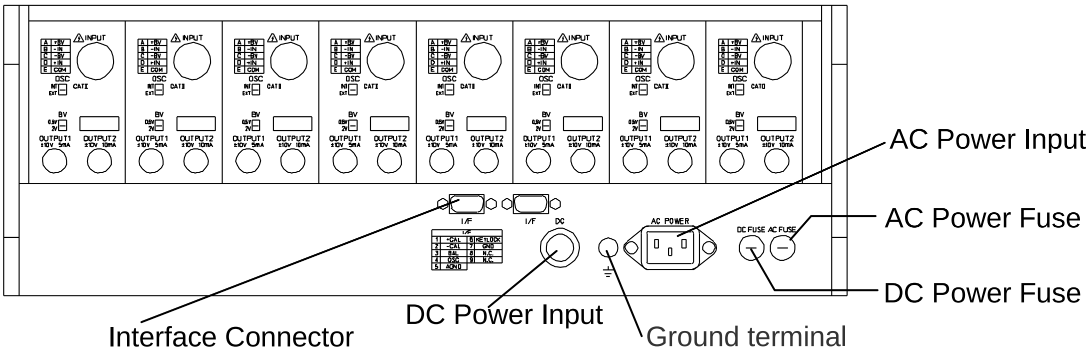


Fig.3-7

・Use standard AC power cord (47326) that is attached to the case as a standard for 100 VAC power supply.

・Use optional DC power cord (47229) for DC power supply.

3.6.2 How to Use Case

A) Power supply cable connection

When using a battery (12 VDC, or 10 to 30 VDC) for power supply with amplifier units being installed in a case, take into account the voltage drop caused by the DC power cord length and wire diameter. When using several channels or a long power supply cord, a voltage drop occurs. This voltage drop may cause the power supply voltage to be lower than the allowable power supply voltage of 10 V at DC power input connector.

For example, the DC power supply cord (47229) has a core area of 1.25 mm^2. If eight amplifiers are mounted, a current of 3.2 A (0.4 A x 8) flows, and a voltage drop of 0.5 V will occur if the cord is extended to 10 m. If a 10-m cable with 0.75 mm^2 is used, a voltage drop of 1.65 V will occur. For use under such conditions, the power supply should be provided with the voltage drop taken into account, or the wire diameter or cord length of the power cord should be modified.

B) Synchronization between units and cases

When several units are mounted in the case, wires for signals are connected inside of the case. BAL, calibration value application, or key lock can be made for all units in the case using the BAL switch, calibration application switch, or key lock switch for all channels positioned on the front panel.

Moreover, the synchronization is also available by connecting cases using the synchronization cable (Figure 3-8).

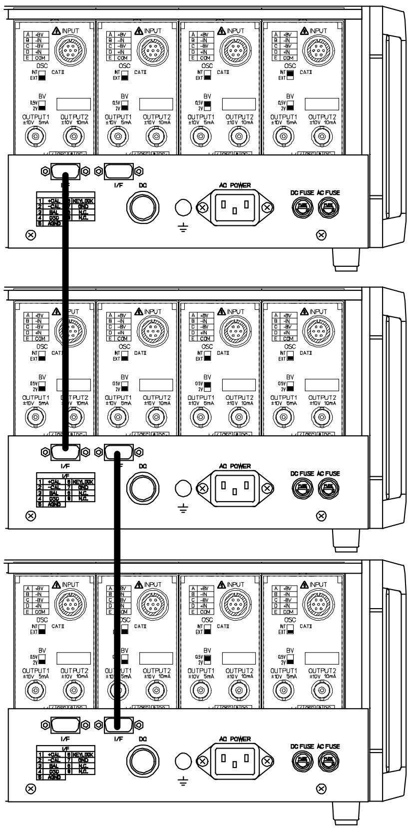


Figure 3-8 Rear Panel of case

C) Balancing for all units ①

Hold down the switch for BAL for all units ①. You can execute the wire disconnection check, wire length adjustment, and auto-balancing for all units in a case. For a wire disconnection check and wire length adjustment, ON/OFF setting (selectable with dip switches) for each unit is also effective. Auto-balancing is made for all amplifier units. This function is available for all amplifier units installed in two or more cases, which are connected to each other with a synchronization cable. To perform auto-balancing for one unit, press the BAL knob ④ for that unit.

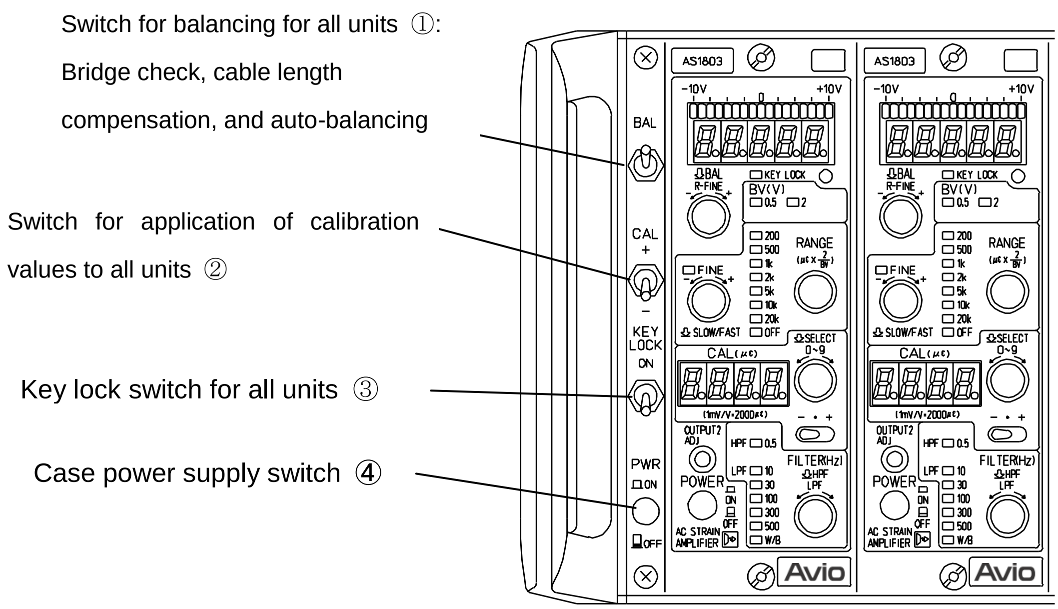


Figure 3-9 Front Panel of case

D) Switch for application of calibration values to all units ②

Hold down the switch to apply calibration value ②. A calibration value is set to all amplifier units. This switch has priority over the calibration value application switch ⑭ in each amplifier unit regardless of the position of the switch (+ • -). This function is available for all amplifier units installed in two or more cases, which are connected to each other with a synchronization cable. To apply a calibration value to only one unit, use the calibration value application switch ⑭ in each unit. Before doing so, confirm that the switch for applying the calibration value to all units is set to OFF.

E) All unit key locking switch ③

Key locking is made for all amplifier units in a case by pushing up (ON) the key locking switch for all units ③. In this case, the all units key locking LED comes on. While key locking is effective, the BAL switch for all units ① positioned in a case, BAL knob ④, measuring range selection knob ⑧, measuring range fine-tuning knob ⑨, calibration value selection knob ⑫, and filter selection ⑯ that are positioned on the front panel of each amplifier unit do not function. To cancel the key locking, hold down the key locking switch for all units ③. In this case, if key locking is set in each amplifier unit, the key locking status is maintained. This is applicable when two or more cases are being used.

F) Remote box

The same operations are available when a small control box like in Figure 3-10 is used. The BAL switch should include a locking mechanism in order to avoid erroneous operations. Use a momentary switch accordingly.

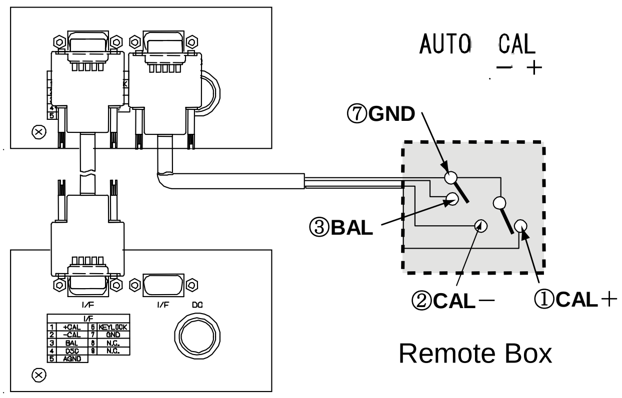
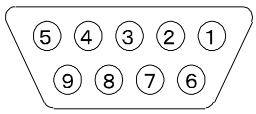


Figure 3-10 Remote Box Overview



Case/Interface Connector Pin Alignment

①+CAL	②−CAL	③BAL
④OSC	⑤GND	⑥KEYLOCK
⑦GND	⑧N. C	⑨N. C

Table 3-6 Interface Connector at Rear Face of Case

⚠CAUTION

Table 3-5: The pins #4 and #5 of the interface connector on the back case are not used for the DC strain amplifier. They are for the synchronization signal connector pin of the AC strain amplifier.

3.6.3 Heat Release for Case

A) Using standalone rack-mounting case

⚠CAUTION

As a rack-mounting case does not have legs, avoid placing it on a desk or floor. Otherwise, heat cannot be released, resulting in damages to amplifiers. It should be properly mounted.

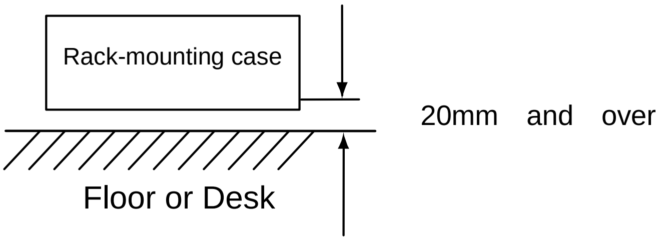


Figure 3-11 Rack-mount Case Installation

B) Using two or more rack-mounting cases

In this case, install fans following the criteria below because the temperature in the unit rises depending on the number of stacks in the rack, load, and ambient temperature.

Number of case	Number of fan unit under severe condition
1−3	1
3−6	2
6−9	3

Note

What are harsh environmental conditions?

- Power supply: 110 VAC(+10%)
- Output voltage and current: +10V, 10mA
- Ambient temperature: +50°C

Table 3-7 Number of Fan for Heat Release and Rack-mount

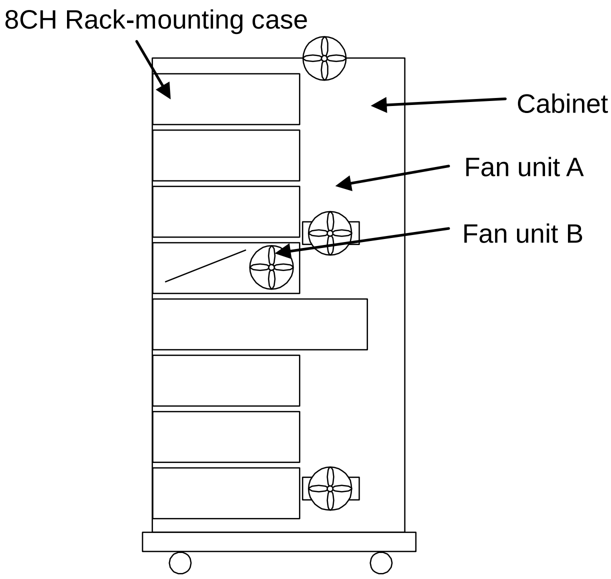


Figure 3-12 Disposition of fan

If fan unit A may prevent upward air flows (when the depth differs as shown with a slant), fan unit A should be mounted directly above this position. Through this fan layout, fan unit A ventilates, and fan unit B enhances natural convection. One fan unit B should be installed for every three cases. It should be mounted as close to a case as possible. When a user prepares fans, ask NIPPON AVIONICS in advance how to mount the fans.

4 . MEASUREMENT

4.1 Cautions before Measuring (Refer to Table 4.1)

Before starting measurement, check the following points:

Items	Cautions	Reasons
Installation environment for strain gauges and bridge box	The joints must be soldered, and the connectors must be properly connected.	Prevents poor connections, noise, and instability in operation.
	The insulation resistance of strain gauges must be equal to or greater than 60 MΩ.	Prevents instability in operation as well as noise from entering the equipment.
	Installing the bridge box and strain gauges in the presence of strong magnetic or electric fields must be avoided.	Prevents noise from entering the equipment.
	Install the bridge box and strain gauges in environments where there is as little moisture as possible and the ambient temperature is not high.	Prevents instability in operation.
	The leads that connect strain gauges to the bridge box should be as short as possible and should be shielded.	Prevents reduction in the gauge factor and deterioration in output linearity. Prevents noise from entering the equipment.
	The interconnecting cable, which connects the bridge box to the AS amplifier unit, should be as short as possible. (The AS amplifier automatically compensates for bridge voltage drops with its cable length compensation.)	Prevents a bridge voltage drop, which may result in an error between the signal and the internal calibrator.
Installation environment for dynamic strain amplifier system	The amplifier system must be used in environments where the ambient temperature ranges from -10 to +50°C and the ambient humidity ranges from 20 to 85% RH (with no condensation).	Prevents instability in operation.
	Install the amplifier system in environments where acceleration of mechanical vibrations is less than 3 G (3000 rpm, 0.6 mm_{P-P})	Prevents damage and noise from entering the equipment.
	Installing the amplifier system in the presence of strong magnetic or electric fields must be avoided.	Prevents noise from entering the equipment.

	The housing case must be properly grounded (when the system operates on AC power).	Prevents noise from entering the equipment.
Operation of dynamic strain amplifier system.	Select the bridge supply voltage in accordance with the strain gauge to be used.	Prevents measurement errors due to generation of heat in strain gauges.
	The connectors must be properly connected.	Prevents instability in operation and poor connections.
	Care must be taken not to smear the input connector with oil, dirt, or anything else.	Prevents instability in operation and poor connections.
	Verify that the power supply voltage is within the range of specifications. AC: 85 – 132 V, or 198 – 264 V DC: 10 – 30 V Check that the polarity of the battery is correct, especially when 12 VDC is used.	If the supply voltage is less than the lower limit, failures in operation may occur. If the supply voltage is higher than the specified upper limit, heat may be produced, which may result in damaging electronic components. If the polarity of the battery is not correct, the amplifier system will not operate. (However, the system and the battery will not be damaged though.)
	Do not apply pressure to strain gauges when units are in the auto balancing mode.	Applying pressure to strain gauges in auto balancing mode causes the bridge to be unbalanced.
	Do not turn the measurement range selector control ⑧or the measurement range fine adjustment control ⑨during measurement. (Use the keylock function.)	Prevents changing the amplitude of a preset calibration value.
	Before using a low-pass filter, the operator should be familiar with its characteristics.	Prevents reducing amplitude and the occurrence of phase differences.
	Prevent short-circuit in the output cable.	The power supply may be disabled, and heat will be generated in the circuitry.
Countermeasures against noise	1. Use shielded wires as leads connecting strain gauges and connect the metal shields of the wires to terminal E on the bridge box. 2. Connect the ground terminal of the bridge box to terminal E and the base metal. 3. Ground the output common. Performing all of or any of the above steps, 1, 2, and 3, may be effective for noise reduction.	

Table 4-1 Causations before Measuring

4.2 Input Connection

4.2.1 Examples of Strain Gauge Bridge Configurations

When incorporating one or more strain gauges into the four arms of a bridge, a quarter-, half- or full-bridge configuration can be used. These configurations can further be classified into same sign equivalent values, different sign equivalent values, and different sign constant proportional values according to the type of strain applied to the strain gauge(s). In addition, by effectively utilizing the characteristics of the bridge, measures can be taken to compensate for the effect of temperatures, eliminate errors, or increase the output.

This section describes examples of bridge configurations that are generally used. The following symbols are used:

R: Resistance of fixed register (Ω)
Rg: Resistance value of strain gauge (Ω)
Rd: Resistance value of dummy gauge (Ω)
r: Resistance value of lead wire (Ω)
e: Output voltage from bridge (V)
K: Gauge factor of strain gauge to be used (2.00)
ε: Amount of strain applied (μm/m)
E: Bridge excitation voltage (V)
ν: Poisson’s rate of an object to be measured

For information on how to cement strain gauges and on the characteristics of strain gauges, refer to the technical manuals provided by the strain gauge manufacturers, or “Strain Measurement I” or “Strain Measurement II” published by the Japanese Society of Non-destructive Inspection. The wiring methods of the bridge boxes shown in Table 4 are applied where bridge box 5370 is used.

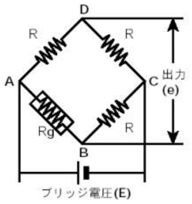
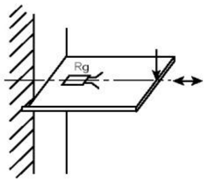
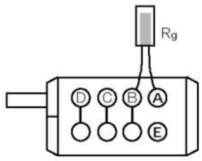
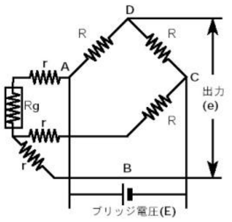
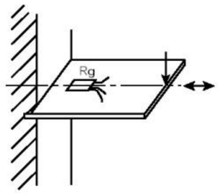
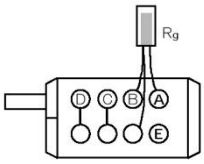
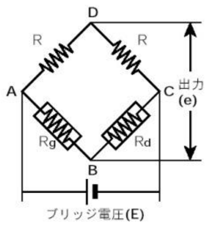
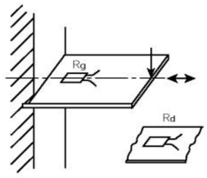
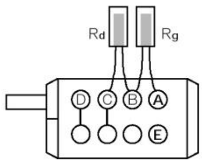
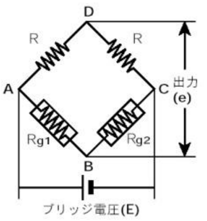
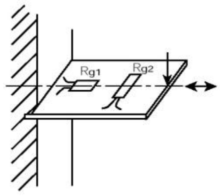
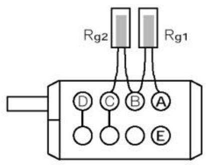
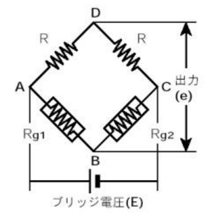
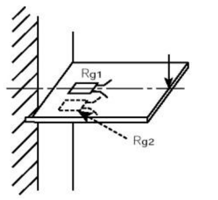
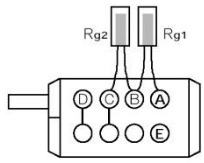
Circuits	Bridge Configurations	Examples	Bridge Box Wiring Methods	Remarks
	One-gauge configuration			-Suited for where simple tension, compression, or bending force is applied -Suited for where changes in ambient temperature are small -Calculated using the calibration value as it is
	One-gauge, three- wire configuration			-Suited for where simple tension, compression, or bending force is applied -Strain-gauge-lead wires are temperature-compensated. -Calculated using the calibration value as it is
	one-active gauge, one-dummy gauge configuration			-Suited for where simple tension, compression. or bending force is applied -Temperature compensation using a dummy gauge -Calculated using the calibration value as it is
	Two-active Gauge configuration			-Suited for where simple tension, compression, or bending force is applied -Temperature compensation -Calculated using calibrated value x 1/ (1+ν). or signal value x 1/ (1+ν)
	Two-active Gauge configuration			-Detects bending strain -Eliminates tension and compression strain -Temperature compensation -Calculated using calibration value x 1/2 or signal value x 1/2

Table 4-2 Wheatstone Bridge Connections (1)

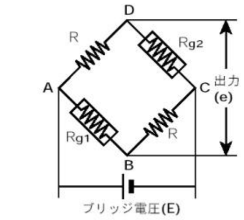
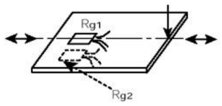
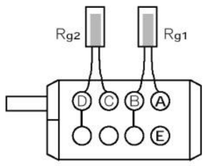
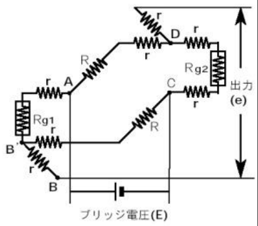
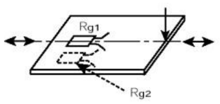
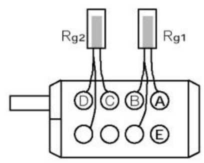
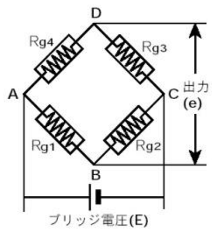
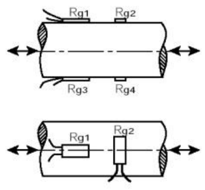
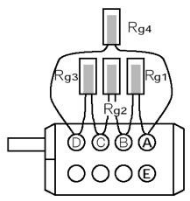
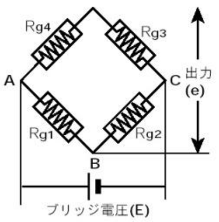
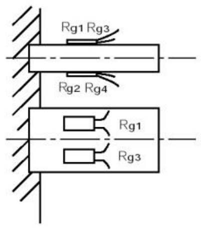
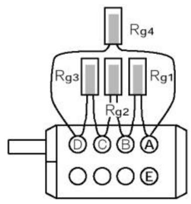
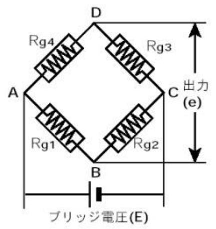
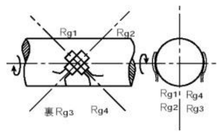
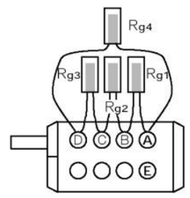
	Opposite-arm, two-active-gauge configuration			-Detects tension and compression strain -Eliminates bending strain -Effects of changes in temperature are doubled -Calculated using calibration value x 1/2 or signal value x 1/2
	Opposite-arm, two-active , three-wire configuration			-Detects tension and compression strain -Eliminates bending strain -Effects of changes in temperature are doubled -Strain-gauge-lead wires are temperature-compensated. -Calculated using calibration value x 1/2 or signal value x 1/2
	Four-active gauge configuration			-Detects tension and compression strain -Eliminates bending strain -Temperature compensation -Calculated using calibrated value x 1/ 2 (1+ν). or signal value x 1/ 2 (1+ν)
	Four-active Gauge configuration			-Detects bending strain -Eliminates tension and compression strain -Temperature compensation -Calculated using calibration value x 1/4 or signal value x 1/4
	Four-active Gauge configuration			-Detects torsional strain -Eliminates tension, compression, and bending strain -Temperature compensation -Calculated using calibration value x 1/4 or signal value x 1/4

Table 4-2 Wheatstone Bridge Connections (2)

4.2.2 Bridge Box

The bridge box comprises a terminal box, a cable, and a connector. The terminal box has terminals for connecting strain gauges and contains three high-precision resisters (e.g., 120 Ω for 5370). The bridge circuit is formed by connecting one strain gauge or more to the terminals. The following four types of bridge boxes are now available.

	General-size
For 120-	5370
For 350-	5373

Table 4-3 Type of Bridge Box

(1) Installation

a. Install the bridge box in an area as close to the measurement point as possible.

b. The bridge box may be secured with screws using the screw holes shown in Fig. 4-1, as needed.

c. Avoid installing the bridge box where it will be exposed to high humidity, excessive temperature changes, or strong electric and magnetic fields.

d. When the bridge box is installed, secure the interconnecting cable, if possible, and connect it to the amplifier unit.

(2) Connections to bridge box (5370/5373/5379/5380)

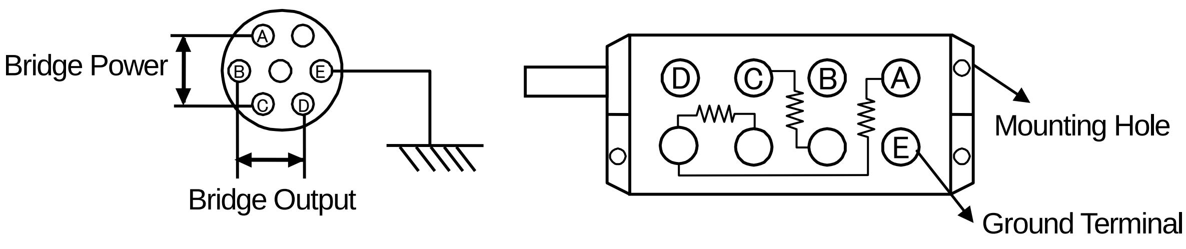


Figure 4-1 Bridge Box Overview

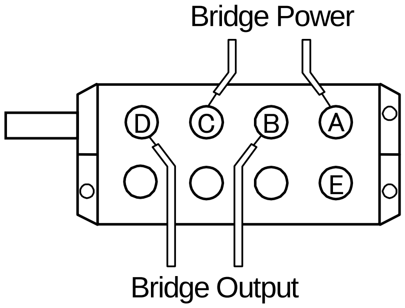


Figure 4-2 Bridge Box Connection

a. As shown in Fig. 4.1, pins A and C are provided for the bridge power supply, and pins B and D are provided for the input to the amplifier unit. Pin E is the common terminal.

b. This is a bridge for measuring strain. Various methods are used for connecting strain gauges.

For details on these connecting methods, refer to “Examples of Strain Gauge Bridge Configuration” on page 4-3. When using various types of transducers via the bridge box, make connections as shown in Fig. 4.2.

c. If the cable from the bridge box or a transducer to the amplifier unit is long, the bridge voltage will drop due to the conductor resistance of the cable as shown in Table 4.4. Because the output voltage from the bridge deviates from the calibration (CAL) value due to the bridge voltage drop, the calibration value must then be corrected. For information on how to correct it, refer to “Correction of Calibrated (CAL) Value” on page 4-10. The amplifier, however, has (standard) cable length correction that provides a proper bridge voltage taking the conductor resistance of the cable into account. This enables precision measurements without having to pay attention to the difference between the output voltage and the calibration (CAL) value. For information on how to correct the value, refer to “Correction of Calibrated (CAL) Value” on page 4-15.

As the amplifier can supply the bridge voltage in which cable conductor resistance is considered thanks to the wire length adjustment function (standard), accurate measurement can be made without regarding the error between output voltage and calibration value.

	Length from the amplifier to bridge box (m)			
Bridge resistance	20m	50m	100m	200m
60Ω	-2.4	-5.8	-11.0	-19.9
120Ω	-1.2	-3.0	-5.8	-11.0
350Ω	-0.4	-1.1	-2.1	-4.1
500Ω	-0.3	-0.7	-1.5	-2.9
1000Ω	-0.1	-0.4	-0.7	-1.5

Table 4-4 Bridge Voltage Drop Rate (%) (0.5 mm^2 wire, +20°C)

For how to adjust, see 4-15 Calibration Value (CAL) Correction

d. Make connections by screwing and soldering when Models 5370 or 5373 are used.

e. If the lead wires from strain gauges to the bridge box are long, the gauge factor will become apparently lower and the output linearity will deteriorate, even when the bridge has been initially balanced. The lead wires, therefore, should be as short as possible (2 m or less). The gauge factor of a strain gauge supplied with lead wires attached has been calibrated together with the lead wires. Do not cut them or add other lead wires.

4.2.3 Measurement with Transducer

In most strain-gauge-based transducers, the physical amount to be measured is applied to an elastic part, and the resulting deformation is converted into an electrical amount.

This elastic part is called the sensing part. The sensing part is made of material which exhibits a higher limit of proportionality and less creep and hysteresis. A strain gauge is cemented on the sensing part, connected so as to form a bridge, temperature-compensated and anti-humidity. For details on various types of transducers, refer to the technical manuals provided by manufacturers.

(1) Connection of transducer to the amplifier unit

When using various types of transducers with the amplifier unit, make connections as shown in Fig. 4.3. Fig 4.4 shows cables that are used for directly connecting various types of transducers to the amplifier unit. A&D's interconnecting cables and extension cables are manufactured in accordance with the specifications for input connectors of strain gauges specified by the Japanese Society of Non-destructive Inspection.

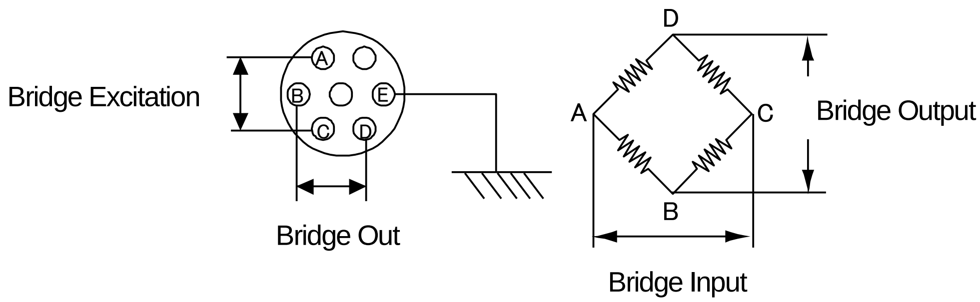


Fig. 4.3. Connection of Transducer

Fig. 4.4. Connection Cable

(2) Operating precautions on use of transducers

a. Unstable and loose attachment of a transducer may cause malfunctioning of the amplifier unit or noise. Transducers should be securely fixed after referring to manufacturer's operation manuals.

b. Although transducers and their connectors are generally moisture-proof, they should be placed to avoid water and rain so that insulation can be maintained.

c. Even though the cable from the amplifier unit to the transducer is long, precision measurements can be taken because of the cable length correction feature. (Refer to page 3.6.)

d. A transducer to be used must be a type on which the common (E) terminal of the amplifier unit will not be connected to another terminal (A, B, C or D).

e. Do not place transducers and their interconnecting cables where they will be exposed to strong electric and/or magnetic fields.

f. Table 5 lists the maximum bridge voltage that can be applied to the transducer, which is calculated based on the bridge allowable current and drift. For more details, see instruction manual.

Bridge resistor	Bridge voltage (B/V)
60Ω	Within 2V
120Ω	Within 3V
350Ω	Within 10V
500Ω	Within 12V
1000Ω	Within 12V

Table 4-5 Bridge Resistance and Bridge Voltage

4.2.4 When using AS Series amplifier as DC amplifier

The AS Series amplifiers are measuring instrument but can be used DC amplifier, too.

(1) When the amplifier is used as DC amplifier using a bridge box

In this case, CMRR drops slightly.

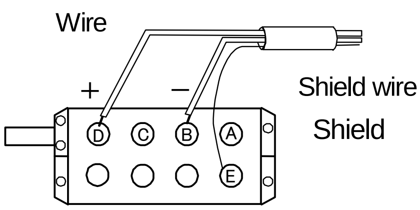


Figure 4-5

(2) When the amplifier is used as DC amplifier using a DC amplifier cable (47228)

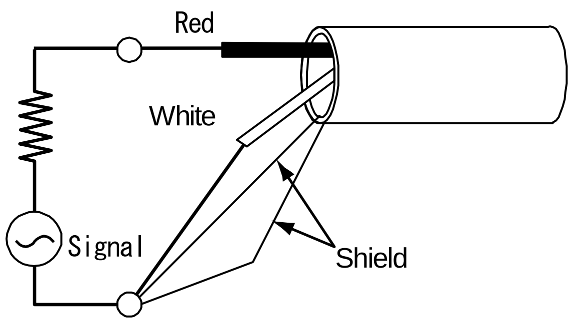


Figure 4-6

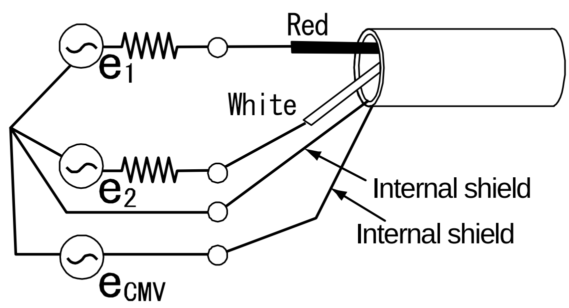


Figure 4-7

(a) When using amplifier with one-side wire grounded

The output from amplifier in Figure 4-6 is common mode output. Noises from commercial power supply (hum) may be regarded as a signal, and is amplified and output. To make inverse phase output, connect red wire and white wire inversely. If noses from power supply comes to mixed in, make the red wire as short as possible.

(b) When using amplifier for differential input

As this amplifier is an differential input amplifier, common mode voltage e_{CMV} (±5V) does not appear as an output. Only the difference between e_1 and e_2 will be amplified.

(3) Cautions when using

a) The allowable input voltage is ±8V or less

b) The common mode voltage is ±5 V or less

c) For the relation between input range and gain, refer to the following tables.

AS2503

Measuring range (Measuring range LED ⑪)	Measuring range (Gain) Fine tuning knob ⑨	Input range	Gain
1k	1-2X Continuous tuning	±1mV- ±2mV	10,000X - 5,000X
2k	1-2.5X Continuous tuning	±2mV- ±5mV	5,000X - 2,000X
5k	1-2X Continuous tuning	±5mV- ±10mV	2,000X - 1,000X
10k	1-2X Continuous tuning	±10mV- ±20mV	1,000X - 500X
20k	1-2.5X Continuous tuning	±20mV- ±50mV	500X - 200X
50k	1-2.5X Continuous tuning	±50mV-±125mV	200X - 80X

AS2603

Measuring range (Measuring range LED ⑪)	Measuring range (Gain) Fine tuning knob ⑨	Input range	Gain
2k	1-2.5X Continuous tuning	±2mV- ±5mV	5,000X - 2,000X
5k	1-2X Continuous tuning	±5mV- ±10mV	2,000X - 1,000X
10k	1-2X Continuous tuning	±10mV- ±20mV	1,000X - 500X
20k	1-2.5X Continuous tuning	±20mV- ±50mV	500X - 200X
50k	1-2X Continuous tuning	±50mV-±100mV	200X - 100X
100k	1-2.5X Continuous tuning	±100mV-±250mV	100X - 40X

Table 4-6 Input Range and Gain

The input ranges of AS2503 and AS2603 are ±125mV for the gain of 80X and ain oV for the gain of 40X. To input high voltage than those voltages, use 1/100 attenuator probe (47322). However, the frequency response will be DC to 30 kHz when the attenuator probe is used.

A calibration value can be applied when the amplifier is used as an DC amplifier. For με CAL, the amplifier can be used by reading the unit of με as μs by setting BV to 2V.

4.3 Connection of Output to Load

Two types of outputs are available; OUTPUT 1 and OUTPUT 2.

(1) OUTPUT 1 3

Delivers a voltage of +/-10 V and a current of +/-5 mA (into a load of 2 kΩ or more), allowing voltage-input type instruments such as thermal dot recorders and data acquisition devices to be connected to OUTPUT 1.

Thus output is displayed on the monitoring meter .

(2)OUTPUT 2 4

Delivers a voltage of +/-10 V and a current of +/-10 mA (into a load of 332 Ω or more).

The output voltage of OUTPUT2 can be varied from +/-10 V to approximately +/-1 V with the level adjustment control ⑱. Because this output can be displayed digitally on the digital monitor ③, it can also be displayed as a physical amount by adjusting the output voltage (scaling).

4.3.1 Connection of Output to Data Recorder

Special care must be taken with the input level of data recorders. Especially with frequency-modulated data recorders, if an input signal greater than the allowable input level of the data recorder is applied, it may be overmodulated, causing failure in recording. To avoid this, the amplifier unit is capable of displaying excessive output voltage.

As shown in Fig. 4.8, if the input signal exceeds the threshold level (approximately +/-10.5 V), an LED located on the right or left side of the reading blinks for a certain period of time. An excessive level up to a frequency of approximately 1 kHz can be checked on the monitoring meter ②.

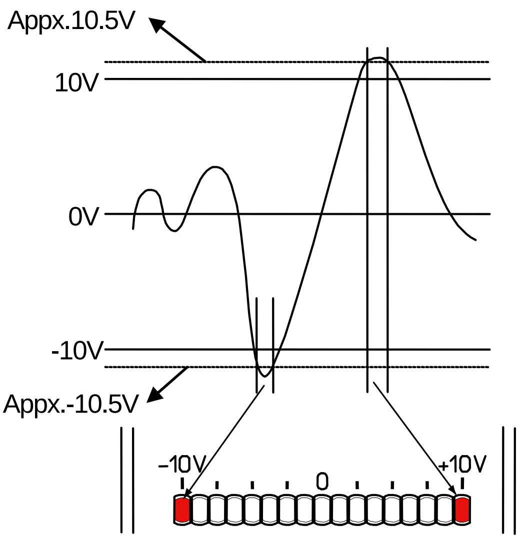


Figure 4-8

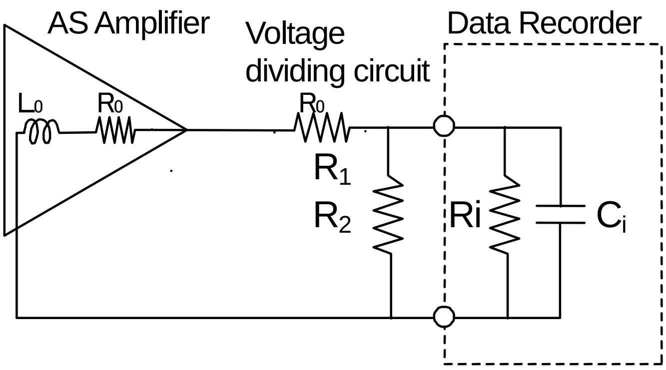


Figure 4-9

Care must be taken concerning the following points for connection to a data recorder.

(1) Where direct connections can be made

If a data recorder is capable of accepting a signal of more than 20 Vp-p (+/-10V), it can be directly connected to the amplifier unit.

(2) Where a voltage divider is required

If the input level of a data recorder is +/-1 V, a voltage divider is required. Pay due care to the impedance.

In general, since the output impedance increases as the frequency band becomes higher, it is expressed as: $R_0(\Omega)+L_0(\mu H)$.

If a voltage divider is inserted as shown in Fig. 4.7, this will cause errors, as described in the following example.

Example:

Errors will be caused as shown in Table 4.7, if the voltage dividing ratio is 1/10 under the following conditions:

Input impedance of data recorder: Ri=100 kΩ, Ci=100 pF

Output impedance of the amplifier unit: R_0=1Ω, L_0=200 μH

R_1 (kΩ)	R_2 (kΩ)	Errors caused by voltage divider (5)				
		DC	1kHz	2kHz	5kHz	10kHz
90	11.1	-0.08	-0.08	-0.09	-0.12	-0.24
9	1.01	-0.02	0.02	-0.02	-0.02	-0.02

Table 4-7 Error Caused by Voltage Divider

4.4 How to Read Measured Values

This section describes how to read the measured values of a waveform recorded on a data acquisition device or recorder.

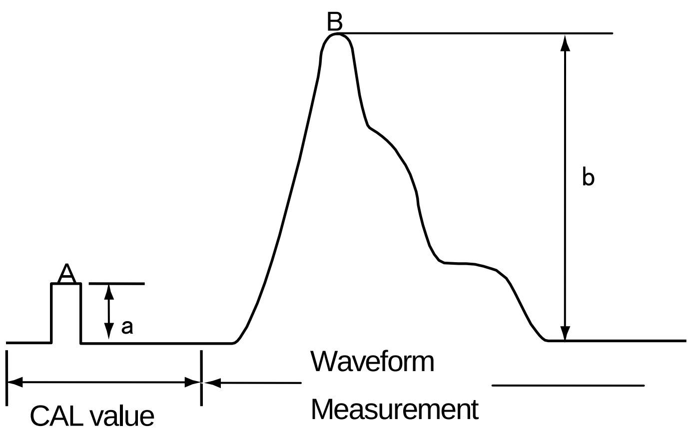


Figure 4-10

$$\text{Measured value at point B}=\left\{\frac{\text{b (Amplitude at point B)}}{\text{a (Amplitude of calibration value)}}\right\} \times \text{Set CAL value}$$

(1) Measurement with strain gauges

Set CAL value: 500 μm/m

Deflection of CAL waveform: 10 mm

Deflection at point B: 22 mm

Amount of strain at point B ={22/10} x 500 μm/m

=1100 x μm/m

Where the measurement is based on the quarter-bridge configuration with a gauge factor of 2.00.

(2) Measurement with various types of transducers

This calibration voltage value is linked with the bridge supply voltage, and the amount of calibration can always be applied with any panel-indicated value (1 μm/m to 9,999 μm/m).

Example:

If a load cell with a rated capacity and a rated output of 1 ton and 1 mV/V is used, to convert the rated output of 1 mV/V into an amount of strain, the rated output is given by:

1 mV/V x 2V = 2mV

Where the load cell is used with the bridge voltage (E) = 2V.

If the measurement is based on the quarter-bridge configuration with a gate factor (K) of 2.00, the relationship between the amount of strain (ε) to be applied to the bridge and the output voltage (e) is given by:

$$e = 1/4 \times K \times E \times \varepsilon = 1/4 \times 2 \times 2 \times \varepsilon = \varepsilon$$

That is, 1 μm/m strain corresponds to 1 μV and 1000 μm/m to 1 mV. The rated output of 2 mV corresponds to 2000 μm/m. As a result, the relationship between calibration values and the physical amount is as follows irrespective of the bridge supply voltage:

Strain calibration value	Physical value calibration value
2000×10^{-6} strain	1ton× 1 =1ton
1000×10^{-6} strain	1ton×1/2 =500kg
500×10^{-6}strain	1ton×1/4 =250kg
200×10^{-6} strain	1ton×1/10 =100kg

Table 4-8

The formula is as follows:

$$\text{Calibration value of physical amount} = \frac{\text{Calibration value for } 10^{-6} \text{ strain of the amplifier}}{\text{Rated output value } (10^{-6} \text{ strain})} \times \text{Rated capacity}$$

The physical amount can be calculated as follows:

Calibration value of physical amount: 250 kg (500 μm/m)

Deflection of CAL waveform: 10 mm

Deflection at point B: 22 mm

The physical amount can be calculated as follows:

$$\text{Load at point B} = \frac{22}{10} \times 250 \text{ kg} = 550 \text{ kg}$$

4.4.1 Correction of Calibration (CAL) Values

(1) Where gauge factors are not 2.00

In this amplifier unit, its gauge factor is set to 2.00. If strain gauges with a gauge factor other than 2.00 are to be used, the following formula must be used.

$$\text{True CAL value} = \frac{2.00}{\text{Kc (Gauge factor of strain gauge)}} \times \text{CAL value of unit}$$

(2) Where bridge configurations are not quarter-bridge configuration

The calibration (CAL) values of this amplifier unit are equivalent voltage values based on the 2.00 gauge factor and the quarter-bridge configuration. The calibration values based on half- or full-bridge configurations can thus be obtained by referring to the next table.

The relationship between the bridge supply voltage and bridge output voltage can be represented by the following formula:

$e = (K \times \varepsilon \times E \times \text{Bridge configuration})/4$

Where: K; gauge factor

ε; Amount of strain (10 μm/m)

E; bridge voltage

Gauge configuration		Real calibration value
Two-gauge	One active one dummy	Calibration value on panel ×1
	Two active	Calibration value on panel ×1/2
	Opposite arm two active	Calibration value on panel ×1/2
Four-gauge	Four active	Calibration value on panel ×1/4
Transducer	Four active	Calibration value on panel ×1(*)

Table 4-9

For details, refer to the remarks in the “Wheatstone Bridge Connections Table” on pages 4.4-4.5.

*Although transducers are generally based on the full-bridge configuration, their output is made to match the quarter-bridge configuration.

(3) Where the distance from the bridge box to the amplifier unit is long

If the cable from the bridge box or a transducer to the amplifier unit is long, the bridge supply will drop due to the conductor resistance of the cable. This causes errors between the bridge output voltage and the CAL value. For obtaining the voltage drop rate, refer to “Bridge Voltage Drop Rate” on page 4.7 or measure the voltage drop rate between terminals A and C on the bridge box, using a voltmeter.

Example:

If the cable length is 100 m and the strain gauge resistance is 120 Ω under an ambient temperature of 20°C, the bridge supply voltage will be reduced by 5.8% between terminals A and C, which can be obtained from the “Bridge Voltage Drop Rate Table” on page 4.6. The true calibration value can thus be given by:

True calibration value

$$= \frac{1}{1-0.058} \times \text{Calibration value on display}$$

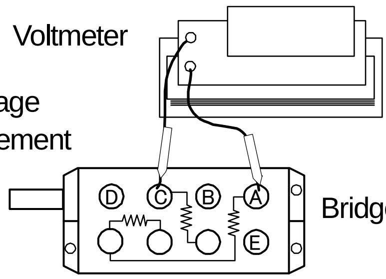


Figure.4-8 Voltage measurement on bridge box

Such measurement and adjustment are not needed in AS series amplifiers thanks to wire length adjustment (Page 3-8).

4.5 Special Applications

This section introduces examples that configure two or more bridges using a single power supply and calculate value of addition, average, and subtraction using several transducers.

4.5.1 Configuring two or more bridges using a single power supply

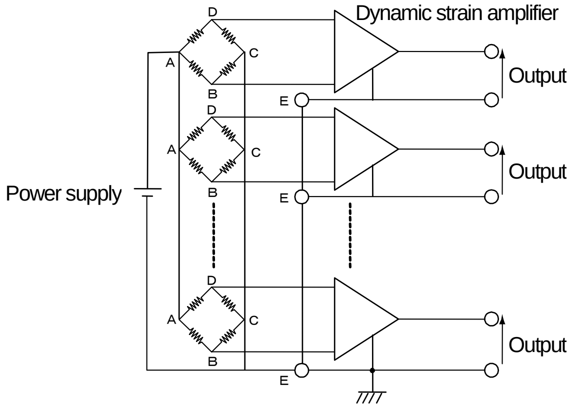


Figure 4-12

Connect the E terminal of each bridge box. If the power is supplied separately, connect either of the power to the E terminal of the bridge box. The power supply should not exceed the common mode voltage (±5V).

4. 5. 2 Special use of transducer

(1) When calculating value of addition (Figure 4-13)

Separate power supply is needed for E1, E2 and E3. In this case, 50 Hz or 60 Hz noise from commercial power supply will affect the measurement. To minimize the influence of the noise, add a capacitor.

(2) When calculating value of subtraction (Figure 4-14)

Separate power supply is needed for E1 and E2. Also, in this case, 50 Hz or 60 Hz noise from commercial power supply will affect the measurement. To minimize the influence of the noise, add a capacitor.

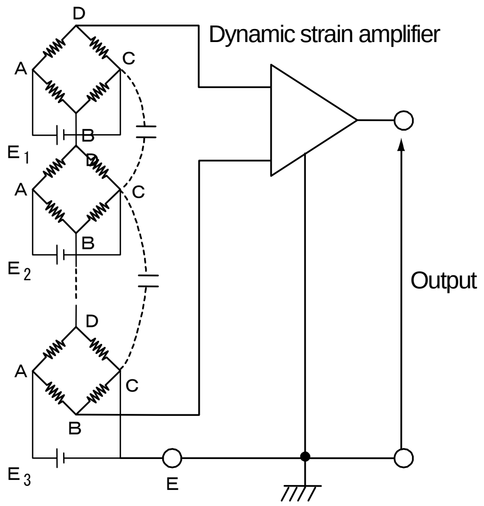


Figure 4-13

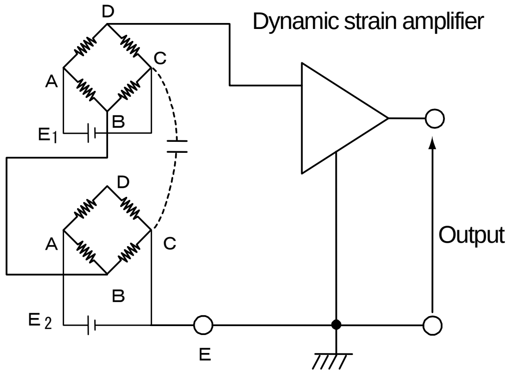


Figure 4-14

(3) When calculating value of mean (Figure 4-15)

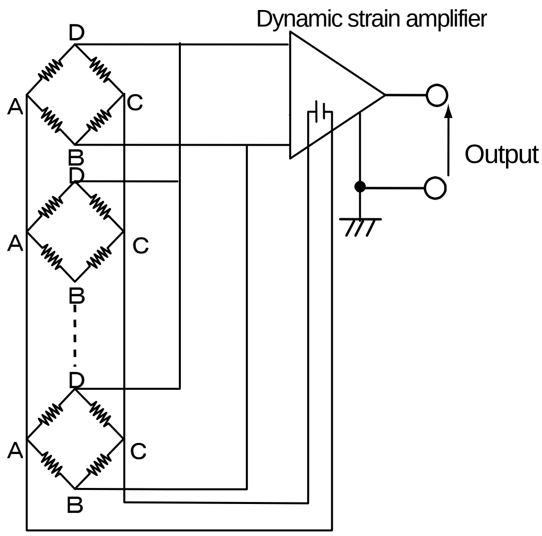


Figure 4-15

For use as above figures 4-13 to 4-15, rated capacity needs to be equal if using transducers, and special attention is required on capacity of the bridge supply if using dynamic strain measuring equipments.

5. Operation Theory

5.1 Flow of Measurement Signal (Refer to figure 5-1)

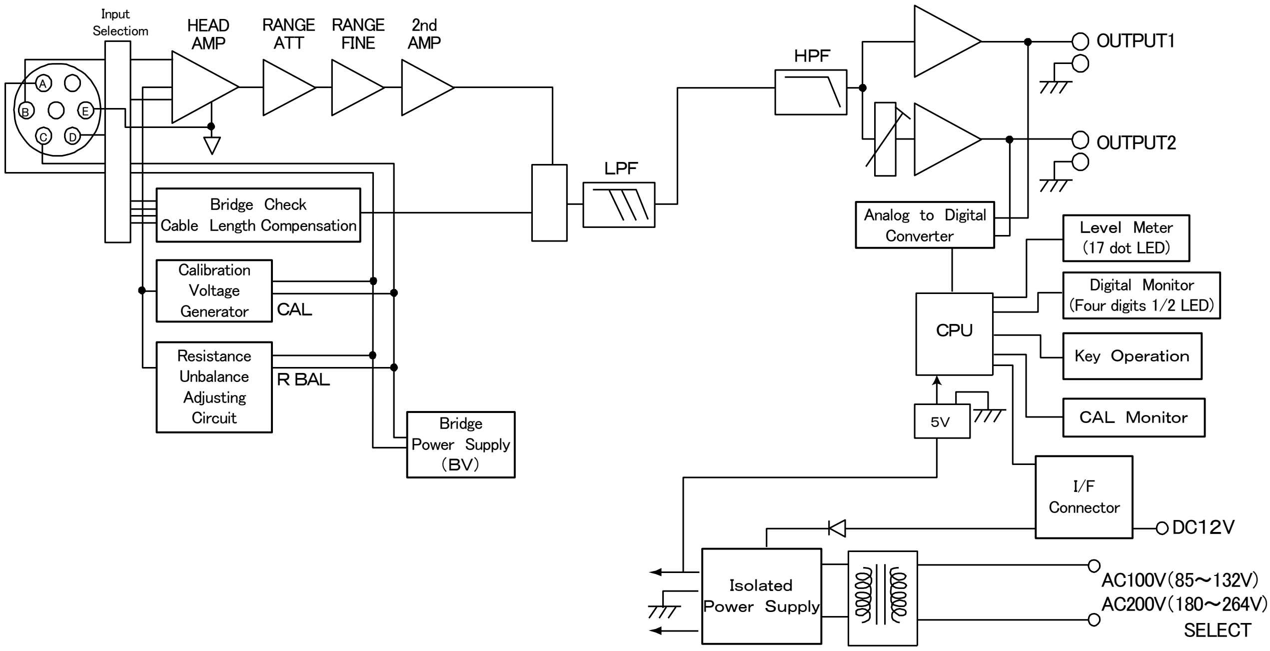


Figure 5-1 AS2503 Block Diagram

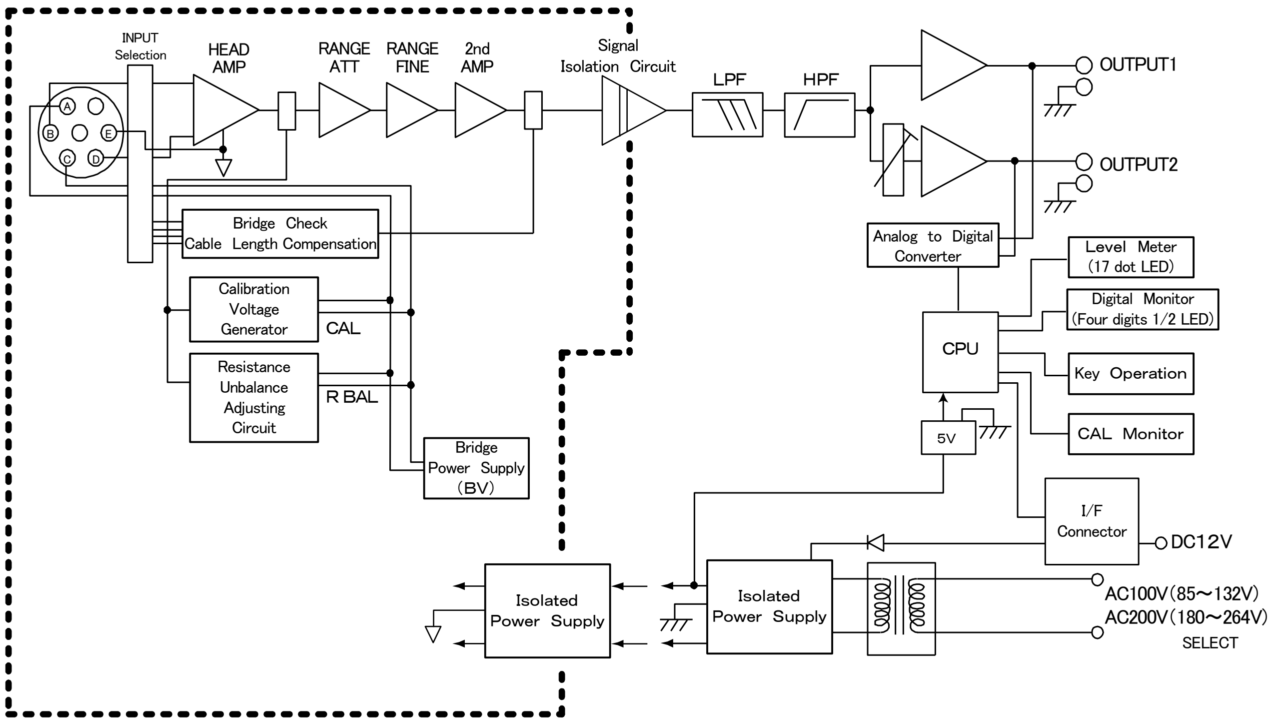


Figure 5-2 AS2603 Block Diagram

The signal fed from the bridge box or a transducer is applied to the INPUT connector $\boxed{1}$ of this product and amplified through High impedance and low zero-drift preamplifier.
To this preamplifier are added the outputs of a 4-digit digital calibration voltage generating circuit (CAL), a resistance unbalance adjusting circuit (R BAL) and a capacitance unbalance auto eliminating circuit (C BAL), only the signal of which is fed to the subsequent stage.
The signal which has been amplified through a main amplifier, and then outputted via a LPF(Low-pass Filter) and HPF(High-pass Filter) at AS2503.
The signal which has been amplified through a main amplifier, and then outputted via a signal isolation circuit and LPF and HPF at AS2603.
There are two output systems: the output of OUTPUT 1 $\boxed{3}$ is displayed on a level meter ②, while the output of OUTPUT 2 $\boxed{4}$ is displayed on a digital monitor ③.

6 . Optional Functions

6.1 Case Function and Type

	Number of CH	TYPE
Bench-top Case	4CH	AS16-104
	6CH	AS16-105
	8CH	AS16-106
Rack-mounting Case	8CH	AS16-107

Table6-1 Four Type of Case

We provide cases listed in Table 6-1. Select the case based on the number of channel to be used.

6.1.1 Accommodating Amplifier Units

When accommodating amplifier units into a case, first the slit on the bottom of the unit should be adjusted to the guide of the case. Press the amplifier unit slowly so that the power supply and interface connectors are connected securely. After installing all amplifier units, fix them with two screws at the top and bottom of the front face an amplifier unit.

6.1.2 How to Mount Blank Panel

Blank panels are used to cover the area of a case where amplifier units are not installed. To fix the panel to the case, use top and bottom screws.

6.1.3 Connecting Grounding Wire

When an amplifier unit is connected to a case, the protective grounding terminal, case protective grounding terminal, grounding terminal of batch power supply connector are connected and have the same potential.

The grounding wire should have AWG16 wire material and connected with a screw. Always connect the grounding wire to ground.

⚠WARNING

Always ground the protective grounding terminal for safety.

6.1.4 Caution on Rack-mount Case

A rack-mount case is a case that is used for accommodating a case to 19-inch rack. The rails on the left and right should be placed on the rails of the rack, and then fix the case by using four attaching holes. When using several cases, install a fan unit between cases in order to release heat and maintain amplifier accuracy.

⚠CAUTION

Avoid placing a rack-mount case on a desk or floor as the rack-mount case is no provided with rubber legs.

7 . MAINTENANCE

7.1 Items to Be Checked

We ship our products after conducting quality control, which covers from design to manufacturing. It is, however, possible that failures may occur in the products due to natural degradation, components defects, or wire disconnection.

If a failure occurs, it is necessary to find the cause. In such case, check the following items and refer to page 4-1. If the cause cannot be found, contact our sales agency. Before returning, be sure to inform us of problematic points.

⚠WARNING

- Check the power supply voltage range
  Power supply voltage range: 85 to 132VAC/180 to 264VAC
  12VDC (10 to 30VDC)
- Check input strain range
  Input voltage range: $1{,}000\times10^{-6}$ to $125{,}000\times10^{-6}$ strain (for AS2503)
  $2{,}000\times10^{-6}$ to $250{,}000\times10^{-6}$ strain (for AS2603)
- Check common-mode voltage

First check the power supply voltage.

Power supply voltagange : 10 to 30VDC
85 to 132VAC, 50Hz or 60Hz

Symptom 1　The bridge is out of balance

Set the range to OFF using measuring range selection knob ⑧. (Measuring range LED ⑪ comes on at OFF.)　Is bridge voltage 2　V?

Does the green LED of level meter ② come on?

No : Adjustment for internal components of the amplifier unit is needed.

Yes

After adding the dummy resistor to the bridge box, set the measurement range selection knob ⑧ to OFF. After that, turn to the direction of 1k to perform bridge balancing for each range sequentially.

Was the bridge balanced?

Yes : Make adjustment for a strain gauge, transducer, and input cable.

No

Check the bridge voltage and bridge circuit.

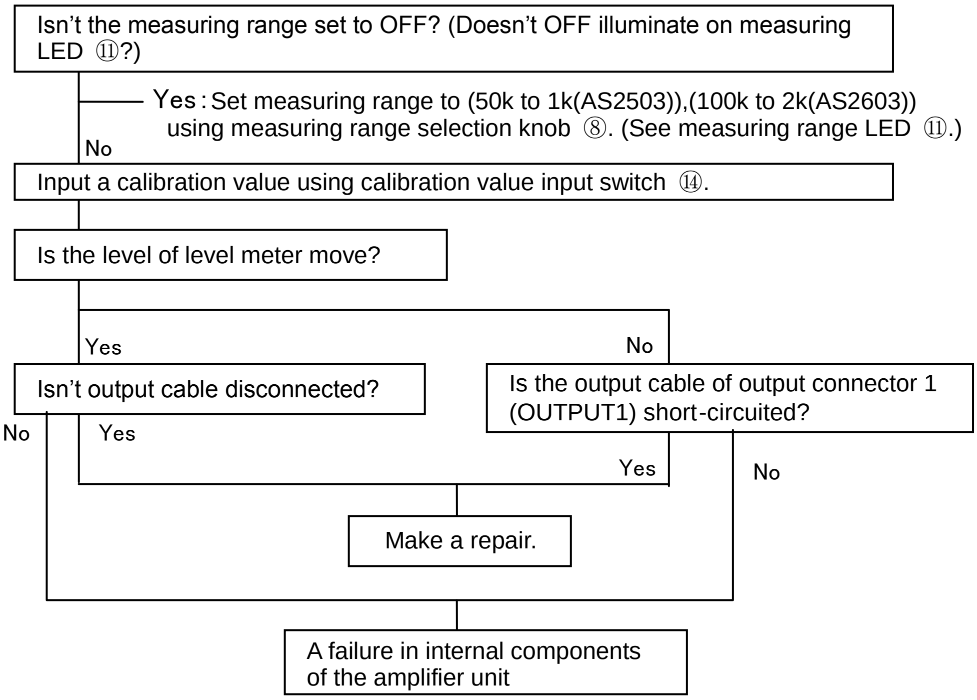
Isn’t the A or C terminal connected to the E terminal (common)?

Yes : Modify the connection.

No : Isn’t the output from the bridge, the B or D terminal, short -circuited to the E terminal (common)?

Figure 7-1 Check Item Chart (1)

Symptom 2 No signal is output.



Symptom 3　The bridge is balanced but the zero position drift with time.

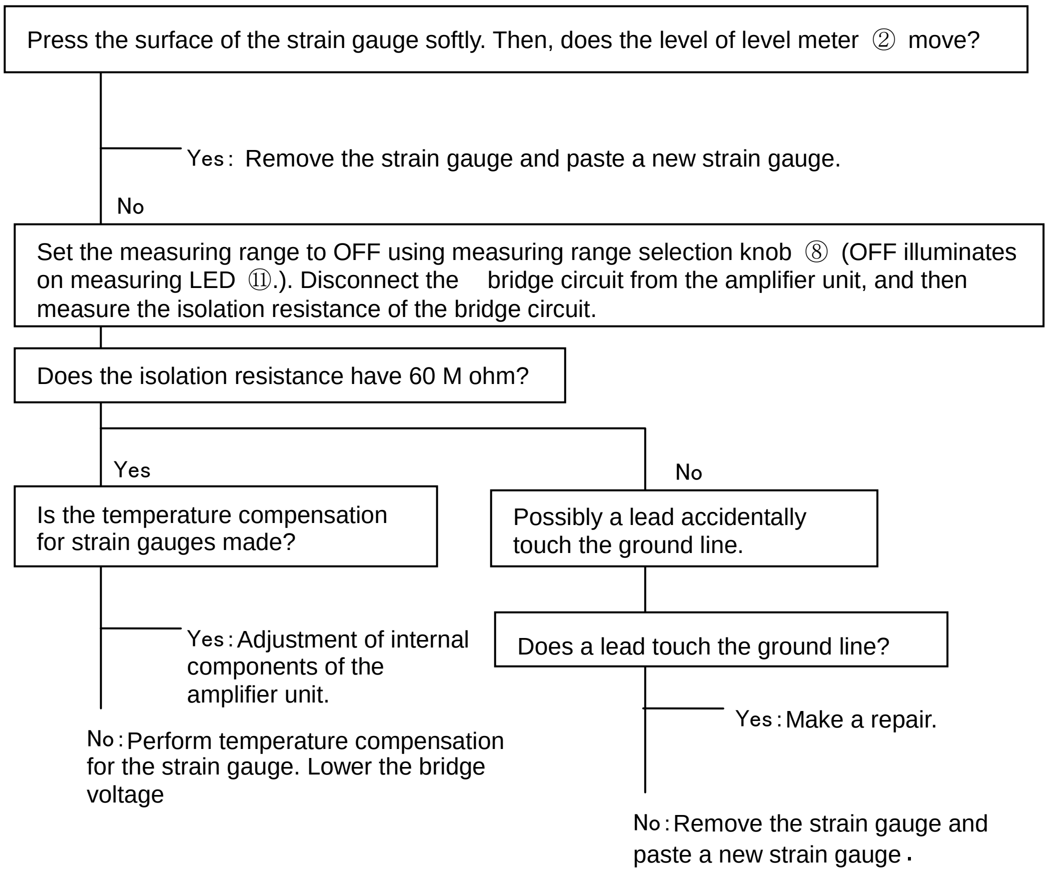


Figure 7-1 Check Item Chart (2)

7.2 How to Replace Fuse

Follow the following fuse replacement procedure.

1. Turn the power switch to off, and then disconnect input and output cables from the amplifier unit.
2. Place the amplifier unit so that the front of the unit to be left side, bottom of the unit to be in the front, and the rear of the unit to be right side.
3. Use a flat-blade screw driver and turn the fuses to the arrow directions mentioned on the fuse holders. (See Figure 7-3, counter-clockwise)

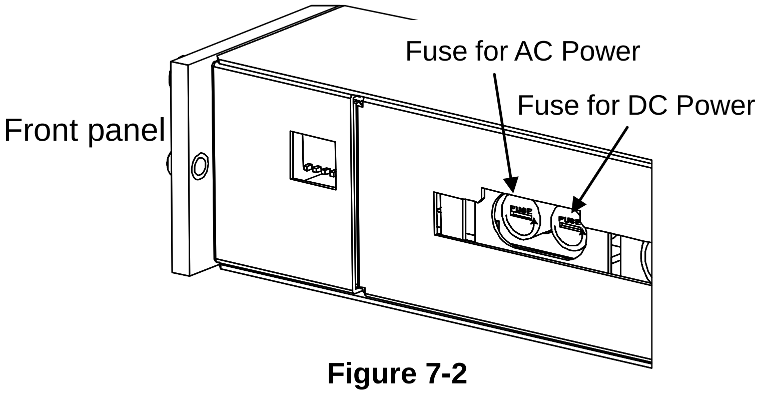


Figure 7-2

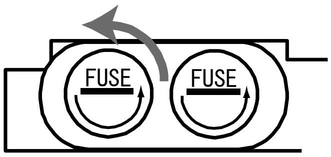


Figure 7-3

4. Replace the fuses at the front part of the fuse holders.
5. The fuse ratings are: 100 VAC and 125 mA for AC power fuse and 12 VDC and 800 mA time-lag fuse (slow blowing) for DC power supply fuse. When replacing, be careful of AC and DC.
6. When installing fuse holder, use a flat-blade screw driver. When pushing the fuse, keep the fuse holder slit to be vertical to the amplifier unit (Figure 7-2, dotted line), and then press deeply and turn clockwise by 90 degree.

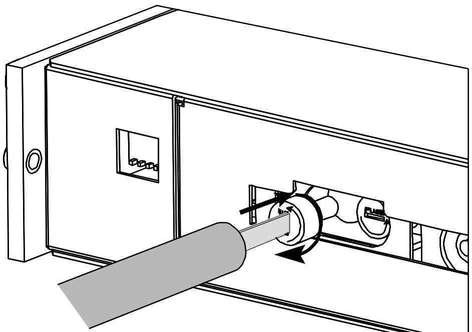


Figure 7-4

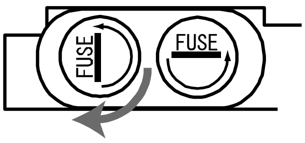


Figure 7-5

7. Confirm that the fuse holder is fully installed in the amplifier unit as Figure 7-2. Also, confirm that the fuse holder slit (flat-blade screw driver contact portion) is parallel to the amplifier unit as Figure 7-3.
8. The fuse replacement is completed. Examine why the fuse was brown. After taking measures, turn on the amplifier.

⚠WARNING

Power supply cord and input/output cable should be disconnected from the amplifier unit. Always use fuses having specified ratings.

7.3 Changing AC Power Supply Voltage

Follow the steps below to switch the AC power supply voltage.

1. Turn off and disconnect the power supply cord and input/output cable from the amplifier unit.
2. Remove the cover using two screws (M3) on the top face (Figure 7-6).
3. The AC power supply selection switch is positioned at the location shown in Figure 7-7. Selection to 200 VAC, OFF, and 100 VAC is available. Voltage switching is available by sliding the switch to the target voltage position. The fuse can support both 100 VAC and 200 VAC. The installed fuse (100 VAC/200 VAC, 100 mA: 0334-3006) can therefore be used for both supply voltages.
4. Attach the amplifier cover so that the slit of the amplifier cover matches to the frame of the amplifier unit.
5. Fasten the screws of upper face. The fuse replacement is competed.
6. When using 200 VAC power supply, use optional AC power supply cord 200 V (Figure 7-8: 0311-5112).

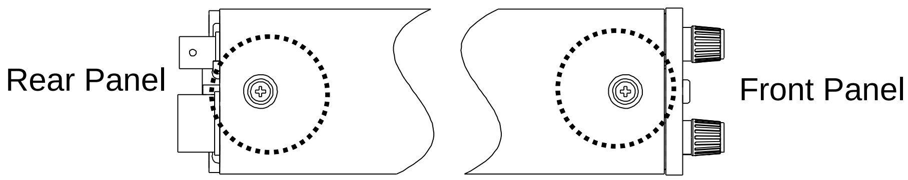


Figure.7-6

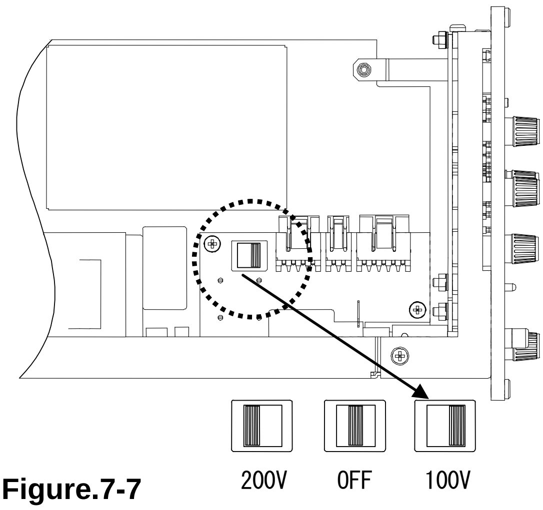


Figure.7-7

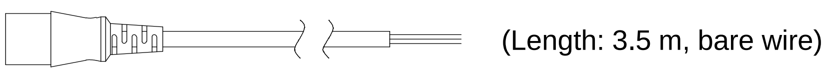


Figure.7-8 AC Power Cable for 200V

⚠WARNING

Power cord and input/output cable should be disconnected.
As the AC power supply cord 200 V (0311-5112) has bare wire at one end, processing is needed to connect to the power source.
After switching the power supply voltage, change the power supply voltage rating indicated on the plate on the amplifier cover.

8 . SPECIFICATIONS

8.1 AS2503

Item	Description
Number of Channels	1 channel/unit
Bridge resistance	60 - 1,000 Ω
Gage factor	2.00
Bridge power voltage supply	2, 3, 5, 9, 10 VDC
Disconnection check function	Detecting disconnection and short of input bridge circuit (bridge impedance of 120 Ω or larger) and displaying checked result by LED Function ON/OFF is available by using the bottom setting SW
Cable length adjusting function	Automatic adjusting of bridge power voltage drop according to a change of cable length up to bridge circuit (bridge impedance of 120 Ω or larger). Function ON/OFF is available by using the bottom setting SW
Balance adjusting range	Deviation of resistive value: ±2%(±10,000 × 10^{-6} in strain) (Both in auto-balance and fine-tuning)
Balance adjusting accuracy	Within ±1.0 × 10^{-6} in strain (RANGE = 50k, Without FINE, BV = 2V)
Maximum input range	±125,000 × 10^{-6} in strain (RANGE = 50k, FINE = ×2.5, BV = 2V)
Voltage sensitivity	±1,000 × 10^{-6} in strain (RANGE = 1k, Without FINE, BV = 2V)
Measurement range change	1k, 2k, 5k, 10k, 20k, 50k (× 10^{-6} in strain, × 2/BV in value), OFF
Fine adjustment	Continuously changeable in FINE RANGE, 2 step changing amount can be selected
Internal calibrator	Set value: ±1 - 9,999 × 10^{-6} in strain, Accuracy: ± (0.2%rdg + 0.5×10^{-6} in strain) Set value: ±0.01 – 99,99mV (±0.01 – 99,99mV at BV = 2V), Accuracy: ± (0.2%rdg + 0.5×10^{-6} in strain)
Nonlinearity	Within ±0.1%/FS
Frequency response	DC to 500 kHz, +1, -3dB
High-pass filter	0.5Hz: 2-pole Bessel (Filter descent response: – 12 dB/oct)
Low-pass filter	10, 30, 100, 500, 1k, 3kHz, 4-pole Bessel (Filter descent response: -24dB/oct)
Stability	Zero drift: Within ±0.1 × 10^{-6} in strain/°C, Within ±0.5 × 10^{-6} in strain/24h Sensitivity: Within ±0.01%/°C, within ±0.05%/24h

TABLE 8-1 Specification list for AS2503 (1)

Item	Explanation
Noise level	80×10^{-6} in strain p-p RTI (W/B, RANGE = 1k, Without FINE, BV = 2V, 120 Ω in bridge) 20×10^{-6} in strain p-p RTI (DC – 30kHz, RANGE = 1k, Without FINE, BV = 2V, 120 Ω in bridge)
Output	OUTPUT1 ±10 V ±5 mA, OUTPUT2 ±10 V ±10m A Output impedance: 0.5Ω or less, Capacitive load: Operable up to 0.1 μF (For output current of 4 - 20mA: Load impedance: 500 Ω or less, Output impedance: Approx. 5 MΩ, Voltage/current conversion accuracy: Within ±0.1%)
Output adjustment	OUTPUT2 ADJ (Can be independently varied continuously from 1 to 1/10)
Output monitor display	17-dot LED display (OUTPUT1 monitor) Green LED at center blinks when voltage is within approximately ±100 mV. LEDs at both ends blink when voltage is greater than approximately ±10.5 V.
Digital display	4 1/2 digital display (OUTPUT2 monitor), Scaling display available with OUTPUT2 ADJ Accuracy: Within ±0.05% rdg ±1 count, Displaying location of decimal point can be changed by using the bottom setting SW.
Key lock function	Turning the key lock ON/OFF by pressing the key lock button approximately for one second. (Except CAL switch and BV selection switch)
Setting value saving	Saving the value in flash memory. (Can be held without back-up battery)
Resistance to vibration	29.4m/s^2 (50Hz, X,Y,Z, 10 minutes for each) and conforming to MIL-STD-810F 514.5C-1
Withstand Voltage (Insulation resistance)	1.5 kVAC, 1 minute, between each input terminal output and housing case 1 kVAC, 1 minute, between DC power input and input 500 VAC, 1 minute, between DC power input and output or housing case
AC power supply	85 - 132 VAC/180 - 264 VAC (Internal switch must be changed) 10 VA or less
DC power supply	DC10 - 30V, 7 VA or less
Operating environmental conditions	- 10°C - + 50°C, Within 20 - 85% RH, without condensation
Storage temperature range	- 20°C to + 70°C, Within 10 - 90% RH
Outline dimension	H143 (±1.0) × W49.5 (±0.5) × D253 (±2.0) mm *Excluding protrusion
Weight	Within 1.4 (±0.1) kg

TABLE 8-1 Specification list for AS2503 (2)

Item	Explanation
Input impedance	Approx. 15 MΩ + Approx. 15 MΩ (DC)
Zero adjustment range	±10 mV (RTI) (BV = 2 V) (incl. auto-balancing and fine-tuning)
Balancing adjustment resolution	Within ±1 μV (RTI) (RANGE = 1k, without FINE, BV = 2 V)
Measuring range	.±125 mV (input equivalent value) (RANGE = 50k, FINE = 2.5X, BV = 2 V)
Gain	10,000X (RANGE = 1k), 5,000X (2k), 2,000X (5k), 1,000X (10k), 500X (20k), 200X (50k) (Without FINE)
Gain resolution	±0.1 %
Common mode rejection ratio (CMRR)	70 dB or more (50 Hz or 60 Hz) at 1 kΩ balanced input
Maximum allowable input voltage	±8 VDC or AC peak value
Common mode allowable input voltage	±5 VDC or AC peak value
Internal calibrator	Set value: ±0.01 to 99.99 mV (±0.01 to 59.99 mV at BV = 2 V) Accuracy: ± (0.2%rdg + 5 μV)
Linearity	Within ±0.01% FS
Stability	Zero point: Within ±1μV/°C, ±5μV/24 hours Sensitivity: Within ±0.01%/°C, ±5%/24 hours
Noise	80 μV p-p RTI (W/B, RANGE = 1k (1,000X), without FINE, BV = 2V) 20 μV p-p RTI (DC to 30 kHz, RANGE = 1k, without FINE, BV = 2V)

TABLE 8-2 Specification List for AS2503 as DC Amplifier

8.2 AS2603

Item	Description
Number of Channels	1 channel/unit
Bridge resistance	60 - 1,000 Ω
Gage factor	2.00
Bridge power voltage supply	2, 3, 5, 9, 10 VDC
Disconnection check function	Detecting disconnection and short of input bridge circuit (bridge impedance of 120 Ω or larger) and displaying checked result by LED Function ON/OFF is available by using the bottom setting SW
Cable length adjusting function	Automatic adjusting of bridge power voltage drop according to a change of cable length up to bridge circuit (bridge impedance of 120 Ω or larger). Function ON/OFF is available by using the bottom setting SW
Balance adjusting range	Deviation of resistive value: ±2%(±10,000 × 10^{-6} in strain) (Both in auto-balance and fine-tuning)
Balance adjusting accuracy	Within ±2.0 × 10^{-6} in strain (RANGE = 2k, Without FINE, BV = 2V)
Maximum input range	±250,000 × 10^{-6} in strain (RANGE = 100k, FINE = ×2.5, BV = 2V)
Voltage sensitivity	±1,000 × 10^{-6} in strain (RANGE = 1k, Without FINE, BV = 2V)
Measurement range change	2k, 5k, 10k, 20k, 50k, 100k (× 10^{-6} in strain, × 2/BV in value), OFF
Fine adjustment	Continuously changeable in FINE RANGE, 2 step changing amount can be selected
Internal calibrator	Set value: ±1 - 9,999 × 10^{-6} in strain, Accuracy: ± (0.2%rdg + 0.5×10^{-6} in strain) Set value: ±0.01 – 99,99mV (±0.01 – 99,99mV at BV = 2V), Accuracy: ± (0.2%rdg + 0.5×10^{-6} in strain)
Nonlinearity	Within ±0.05%/FS
Frequency response	DC to 500 kHz, +1, -3dB
High-pass filter	0.5Hz: 2-pole Bessel (Filter descent response: – 12 dB/oct)
Low-pass filter	10, 30, 100, 500, 1k, 3kHz, 4-pole Bessel (Filter descent response: -24dB/oct)
Stability	Zero drift: Within ±0.1 × 10^{-6} in strain/°C, Within ±0.5 × 10^{-6} in strain/24h Sensitivity: Within ±0.01%/°C, within ±0.05%/24h

TABLE 8-3 Specification list for AS2603 (1)

Item	Explanation
Noise level	50×10^{-6} in strain p-p RTI (W/B, RANGE = 1k, Without FINE, BV = 2V, 120 Ω in bridge) 20×10^{-6} in strain p-p RTI (DC – 30kHz, RANGE = 1k, Without FINE, BV = 2V, 120 Ω in bridge)
Output	OUTPUT1 ±10 V ±5 mA, OUTPUT2 ±10 V ±10m A Output impedance: 0.5Ω or less, Capacitive load: Operable up to 0.1 μF (For output current of 4 - 20mA: Load impedance: 500 Ω or less, Output impedance: Approx. 5 MΩ, Voltage/current conversion accuracy: Within ±0.1%)
Output adjustment	OUTPUT2 ADJ (Can be independently varied continuously from 1 to 1/10)
Output monitor display	17-dot LED display (OUTPUT1 monitor) Green LED at center blinks when voltage is within approximately ±100 mV. LEDs at both ends blink when voltage is greater than approximately ±10.5 V.
Digital display	4 1/2 digital display (OUTPUT2 monitor), Scaling display available with OUTPUT2 ADJ Accuracy: Within ±0.05% rdg ±1 count, Displaying location of decimal point can be changed by using the bottom setting SW.
Key lock function	Turning the key lock ON/OFF by pressing the key lock button approximately for one second. (Except CAL switch and BV selection switch)
Setting value saving	Saving the value in flash memory. (Can be held without back-up battery)
Resistance to vibration	29.4m/s^2 (50Hz, X,Y,Z, 10 minutes for each) and conforming to MIL-STD-810F 514.5C-1
Withstand Voltage (Insulation resistance)	1.5 kVAC, 1 minute, between each input terminal output and housing case 1 kVAC, 1 minute, between DC power input and input 500 VAC, 1 minute, between DC power input and output or housing case
AC power supply	85 - 132 VAC/180 - 264 VAC (Internal switch must be changed) 10 VA or less
DC power supply	DC10 - 30V, 7 VA or less
Operating environmental conditions	- 10°C - + 50°C, Within 20 - 85% RH, without condensation
Storage temperature range	- 20°C to + 70°C, Within 10 - 90% RH
Outline dimension	H143 (±1.0) × W49.5 (±0.5) × D253 (±2.0) mm *Excluding protrusion
Weight	Within 1.4 (±0.1) kg

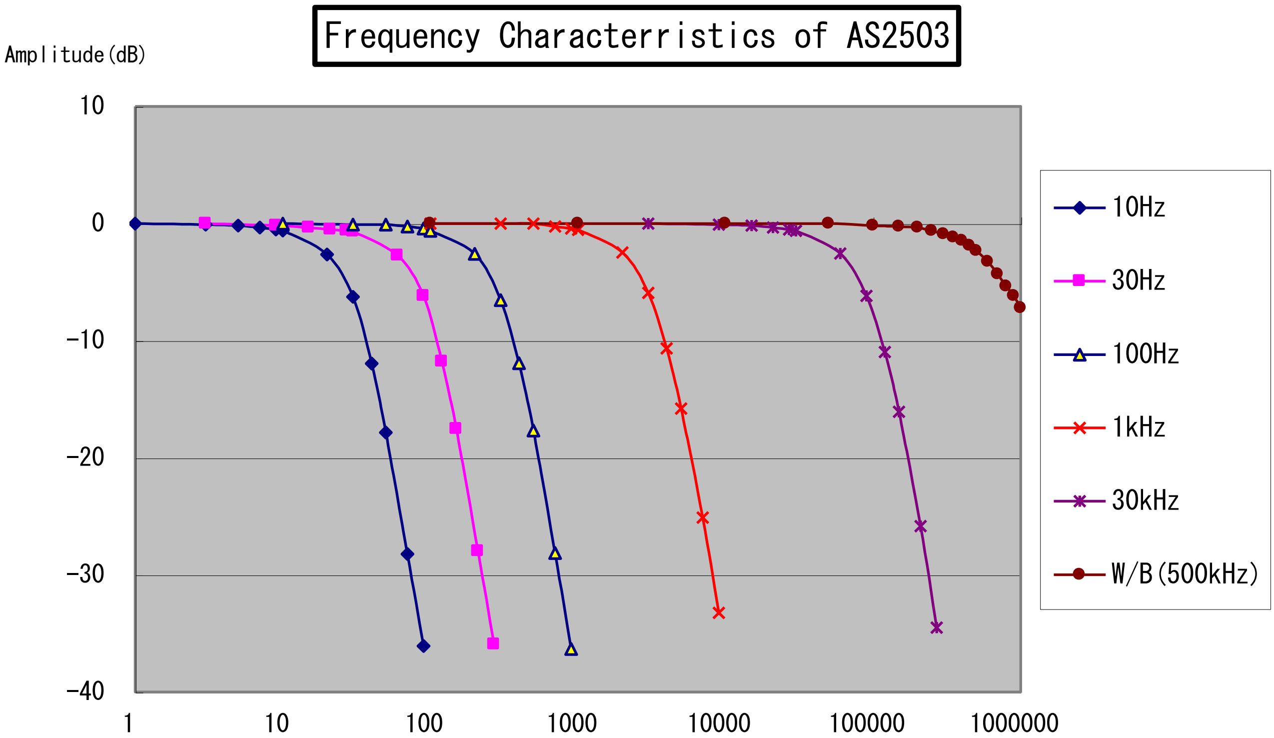
TABLE 8-3 Specification list for AS2603 (2)

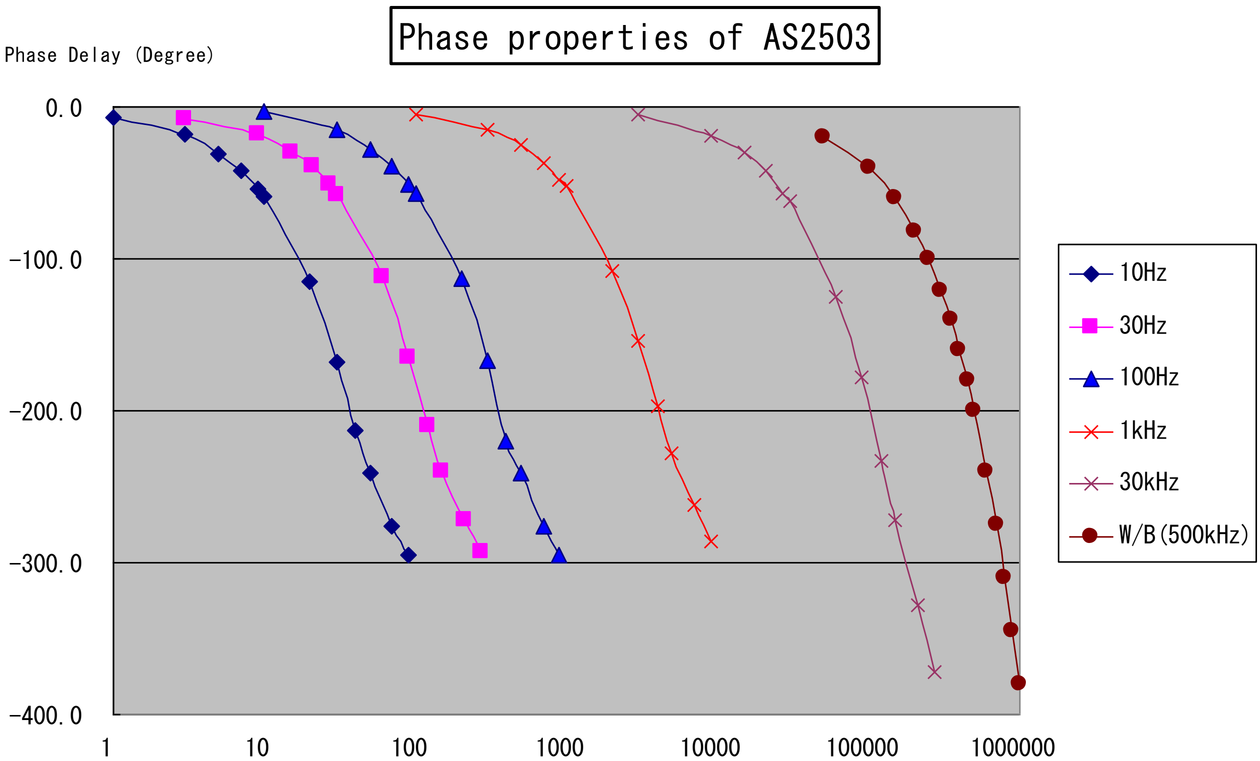
Item	Explanation
Input impedance	Approx. 15 MΩ + Approx. 15 MΩ (DC)
Zero adjustment range	±10 mV (RTI) (BV = 2 V) (incl. auto-balancing and fine-tuning)
Balancing adjustment resolution	Within ±2 μV (RTI) (RANGE = 2k, without FINE, BV = 2 V)
Measuring range	.±250 mV (input equivalent value) (RANGE = 100k, FINE = 2.5X, BV = 2 V)
Gain	5,000X (2k), 2,000X (5k), 1,000X (10k), 500X (20k), 200X (50k), 100X (RANGE = 100k) (Without FINE)
Gain resolution	±0.1 %
Common mode rejection ratio (CMRR)	70 dB or more (50 Hz or 60 Hz) at 1 kΩ balanced input
Maximum allowable input voltage	±8 VDC or AC peak value
Common mode allowable input voltage	±5 VDC or AC peak value
Internal calibrator	Set value: ±0.01 to 99.99 mV (±0.01 to 59.99 mV at BV = 2 V) Accuracy: ± (0.2%rdg + 5 μV)
Linearity	Within ±0.05% FS
Stability	Zero point: Within ±1μV/°C, ±5μV/24 hours Sensitivity: Within ±0.01%/°C, ±5%/24 hours
Noise	50 μV p-p RTI (W/B, RANGE = 2k (5,000X), without FINE, BV = 2V) 20 μV p-p RTI (DC to 30 kHz, RANGE = 2k, without FINE, BV = 2V)

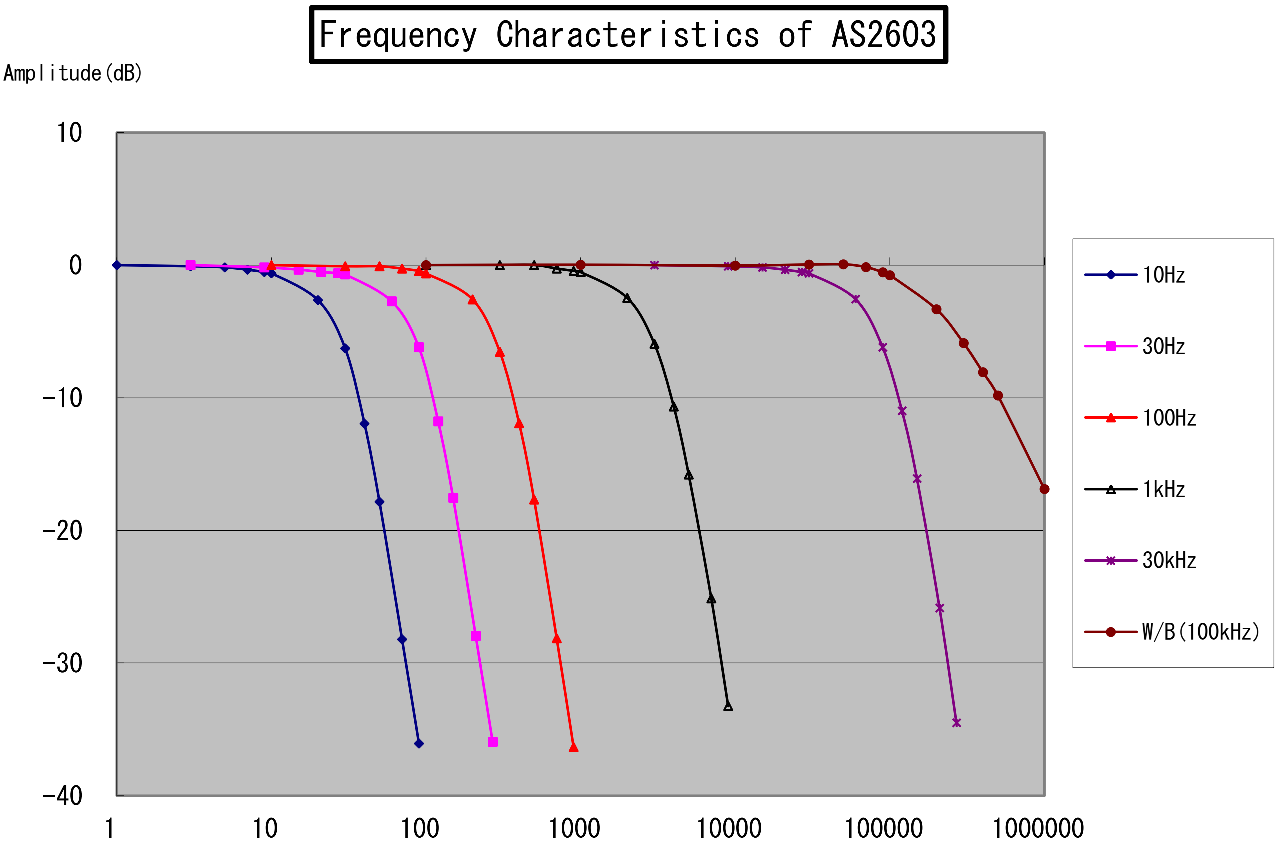
TABLE 8-4 Specification List for AS2603 as DC Amplifier

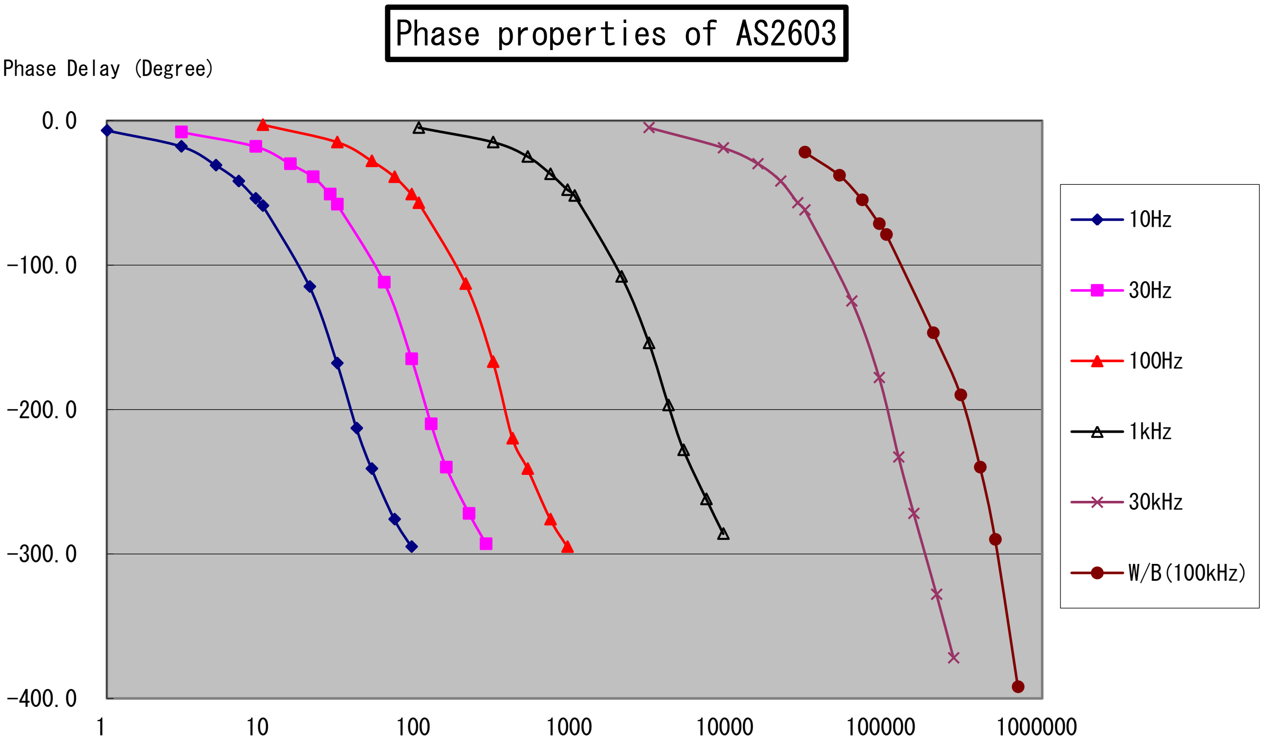
9 . REFERENCES

9.1 Frequency and Phase Characteristics






Frequency Characteristics of AS2603
Amplitude(dB)
10
0
-10
-20
-30
-40
1
10
100
1000
10000
100000
1000000
10Hz
30Hz
100Hz
1kHz
30kHz
W/B(100kHz)


Phase properties of AS2603
Phase Delay (Degree)
0.0
-100.0
-200.0
-300.0
-400.0
1
10
100
1000
10000
100000
1000000
10Hz
30Hz
100Hz
1kHz
30kHz
W/B(100kHz)

9.2 Cable List

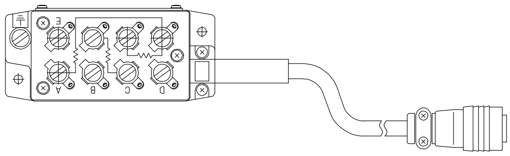
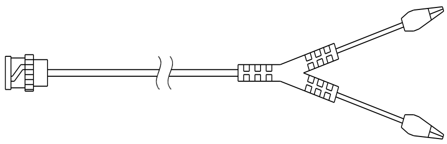
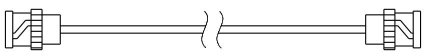
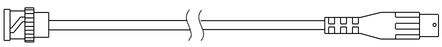
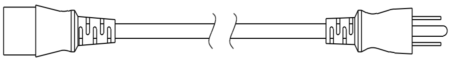
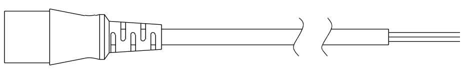
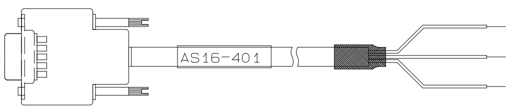
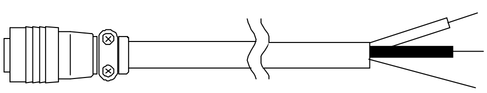
Name	Shape	Pin alignment	Remark
Bridge box TYPE 5370(120Ω) 5373(350Ω)		A…+BV B…- Input C…-BV D…+ Input E… Shield	**Length: 3m** **External diameter of cable Φ9.6** **Core wire: 0.5mm²**
Output cable TYPE: 0311-2057 (Black mold) TYPE: 0311-5084 (Red Mold)		Red …+ Output (BNC core wire) Black: common	**Length: 2m** **Metal BNC** **-alligator clip** **(+Red, - Black** **AS amplifier unit:** **Attached as standard** **(One piece)**
Output cable TYPE: 47226			**Length: 2m** **Metal BNC-Metal BNC**
Output cable TYPE: 0311-5200			**Length: 2m** **Insulated BNC** **—Metal BNC,** **For RA connection**
AC power supply cord For amplifier unit and case (100VAC) TYPE: 0311-5044			Length: 2.5m AS amplifier unit and case: attached as standard (one)
AC power supply cord For amplifier unit (200VAC) TYPE: 0311-5112			Length: 3.5m Bare wire
DC power supply cord For amplifier unit TYPE: AS16-401		Red ···DC(+) Black ···DC(-) Green ··· Shield	**Length: 2m** **D-sub9pin male – Bare wire**
DC power supply cord For case TYPE: 47229		Red ···DC(+) Black ···DC(-) Shield	**Length: 2.5m** **External diameter of cable: Φ10** **Core wire: 1.25mm²**

TABLE 9-1 Cable List (1)

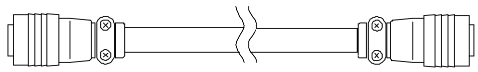
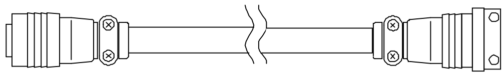
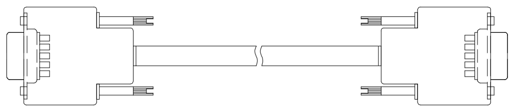
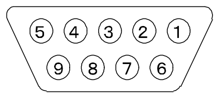
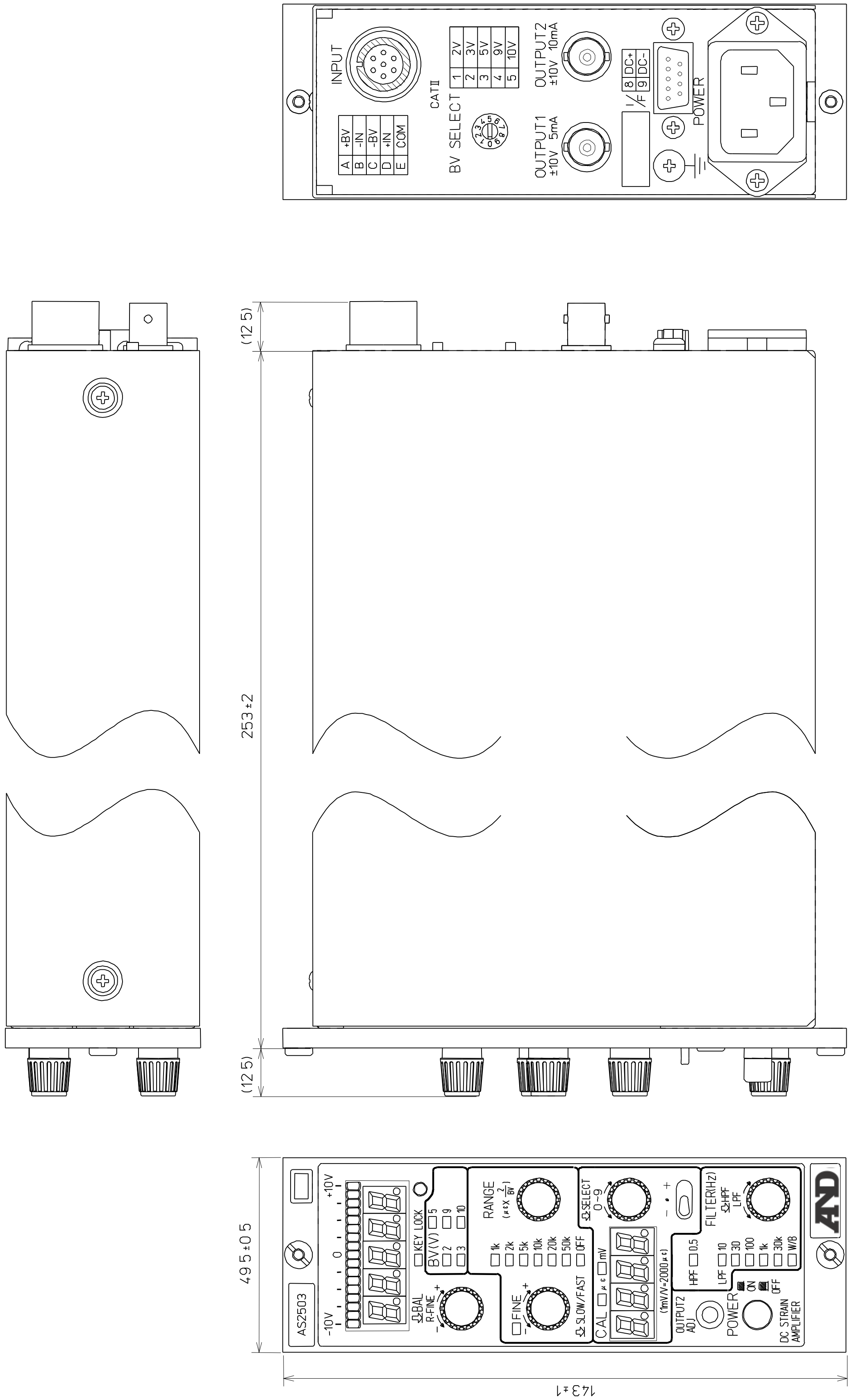
Name	Shape	Pin alignment	Remark
Junction cable TYPE: 47230		A…+BV B…- Input C…-BV D…+ Input E… Shield	**Length: 10m** **External diameter of cable: Φ9.6** **Core wire: 0.5mm^2**
Extension cable TYPE: 47231		A…+BV B…- Input C…-BV D…+ Input E… Shield	**Length: 25m** **External diameter of cable: Φ9.6** **Core wire: 0.5mm^2**
Synchronization cable Between new cases and new cases TYPE: AS16-402	  **(Case connector)**	①+CAL ②-CAL ③BAL ④[OSC] ⑤[GND] ⑥KEYLOCK ⑦GND ⑧(DC+) ⑨(DC-)	**Length: 1.8m** **D-Sub9pin male** **---D-Sub9pin male** **Straight cable** **④、⑤ : Non Conection At DC Strain Amplifier** **⑧,⑨: wiring is made for only amplifier unit**

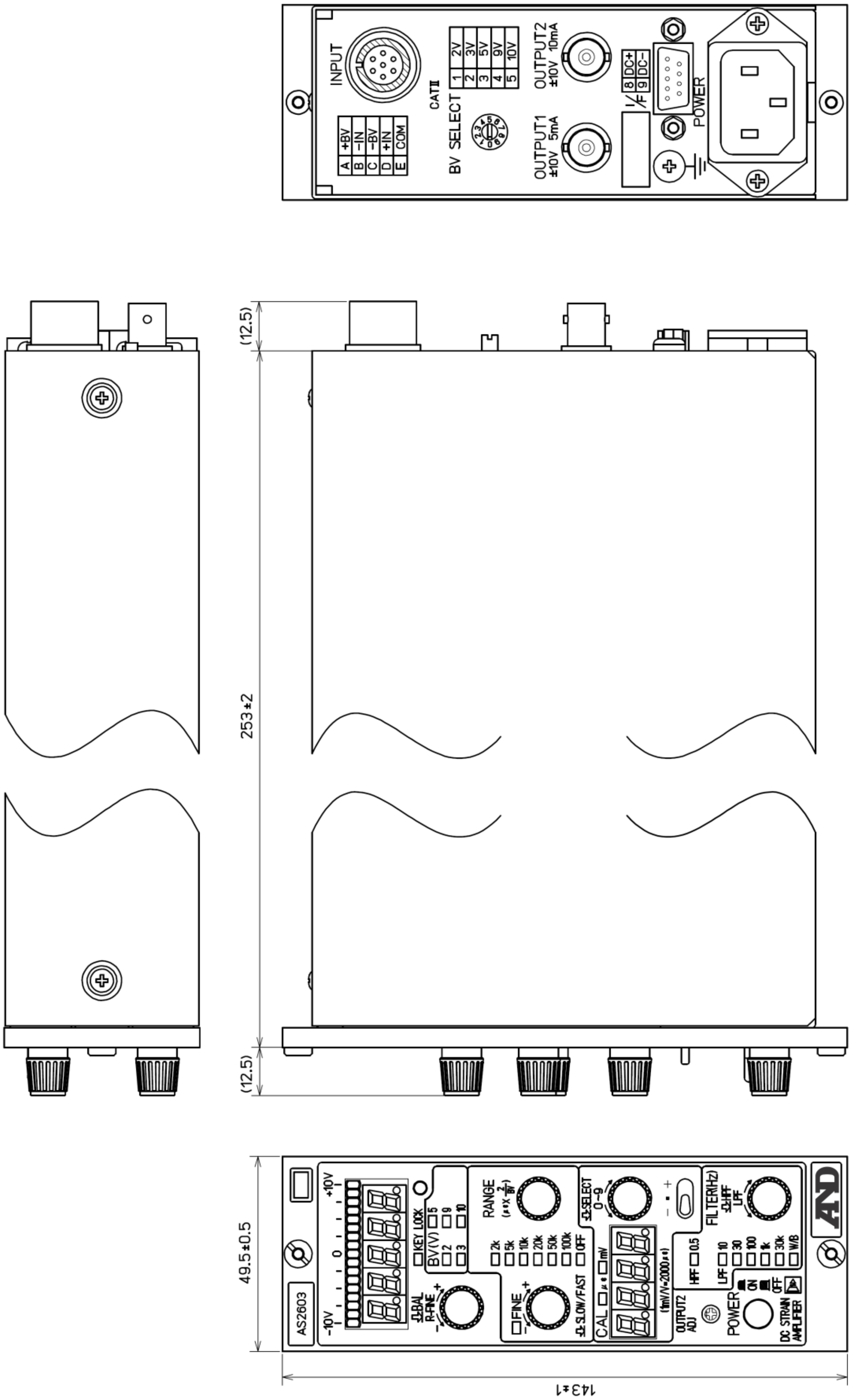
TABLE 9-1 Cable List (2)

9.3 External Dimensions

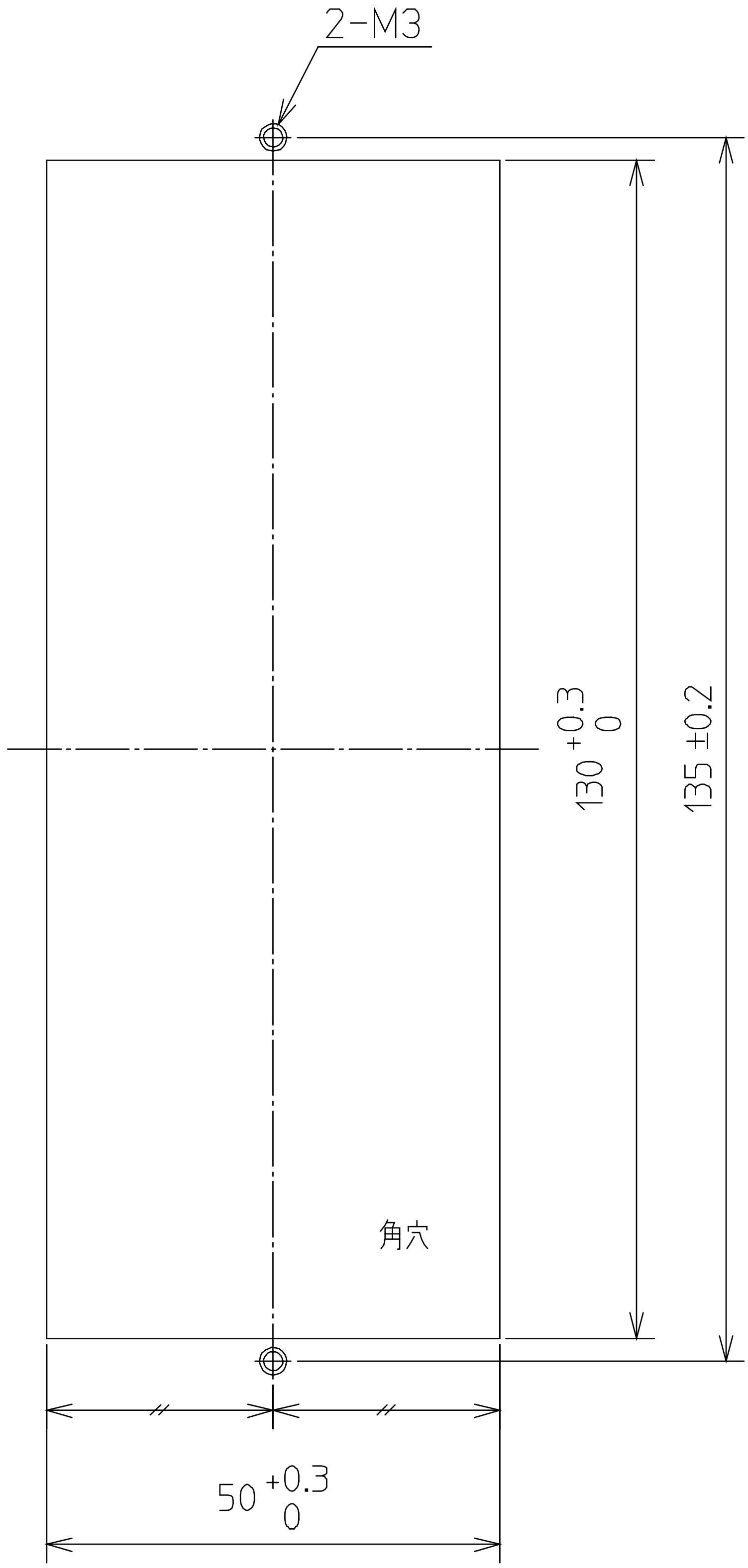
9.3.1 Amplifier Unit (AS2503)



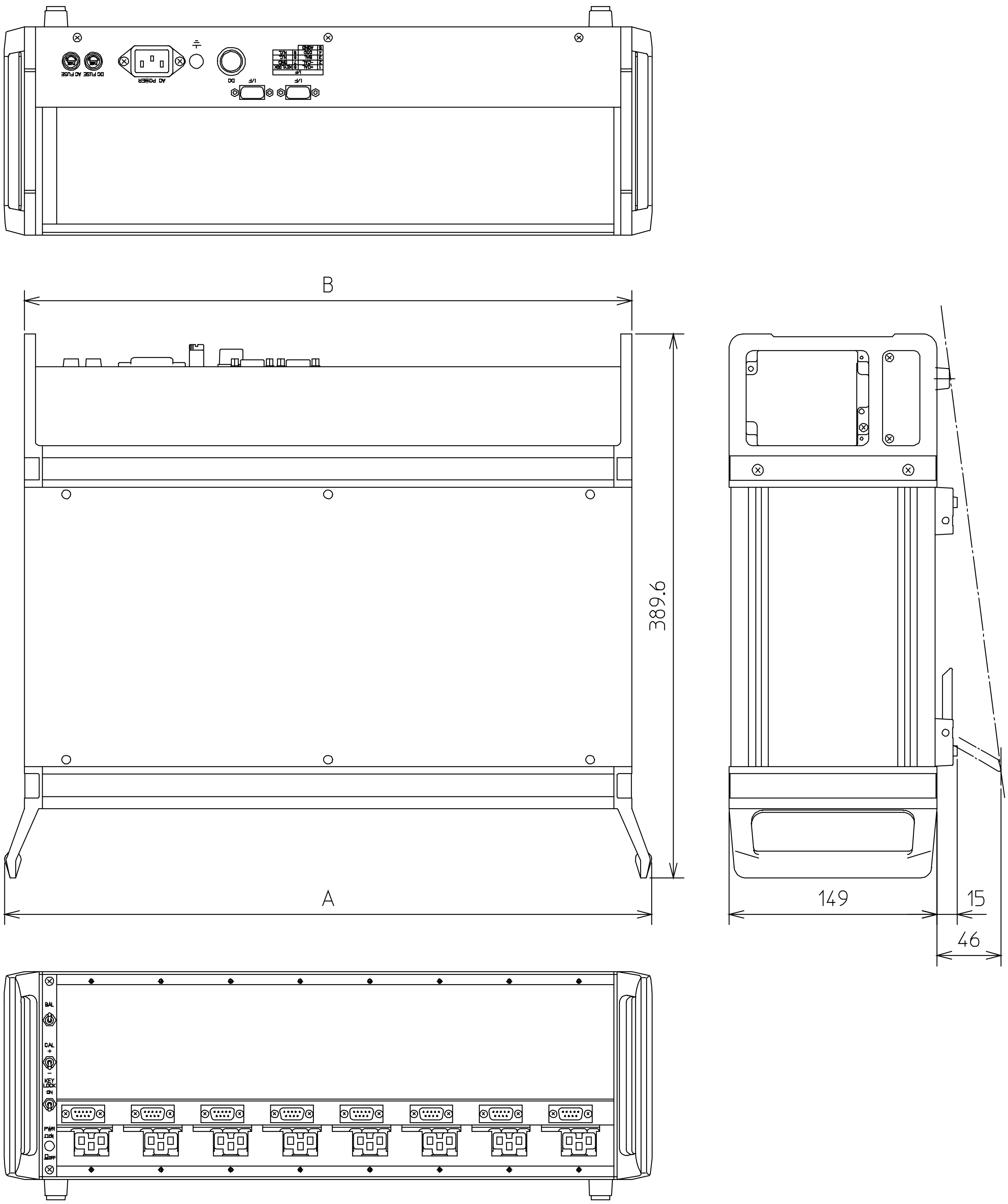
9.3.2 Amplifier Unit (AS2603)



9.3.3 Panel Cut Sizes

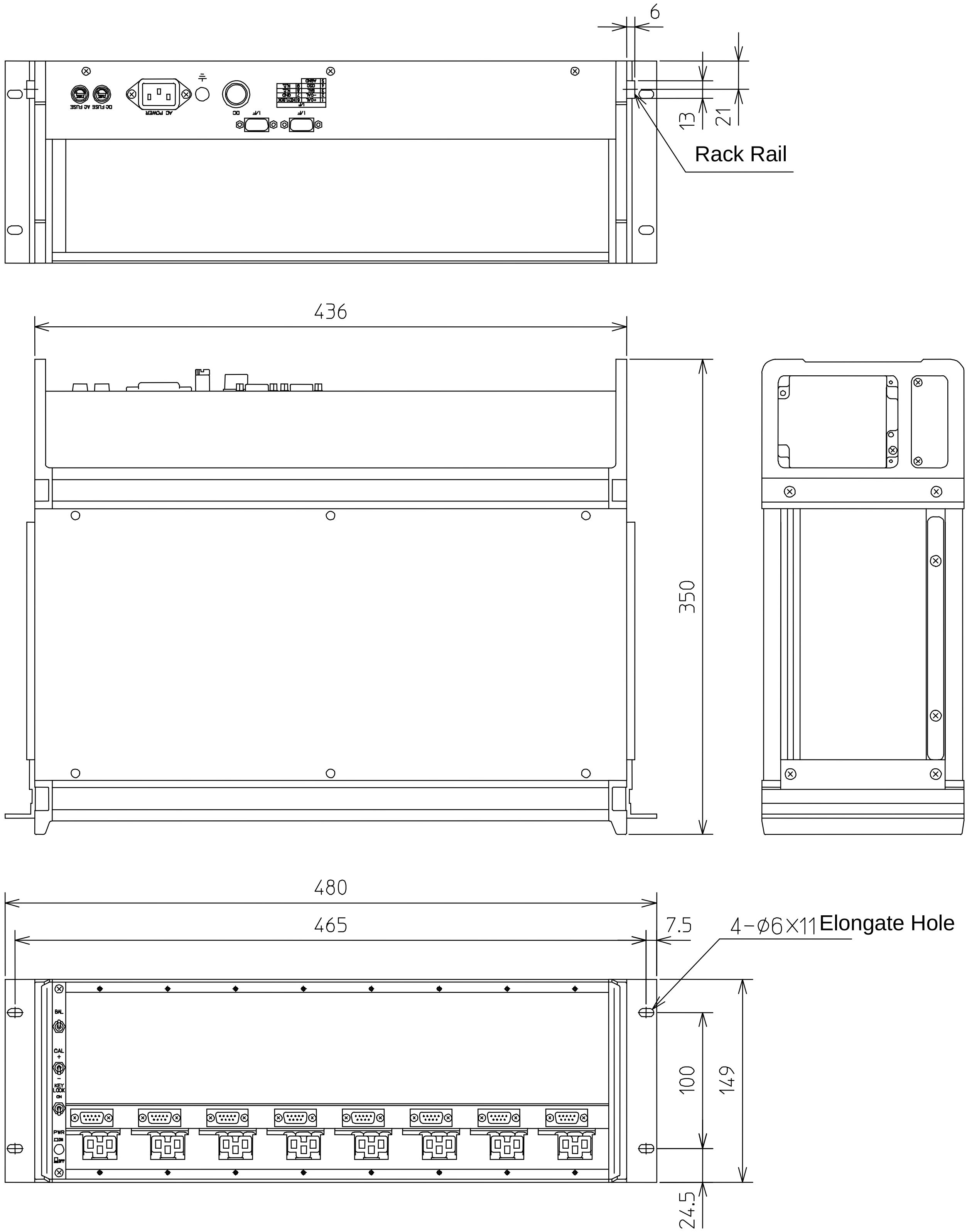


9.3.4 Bench-top Case

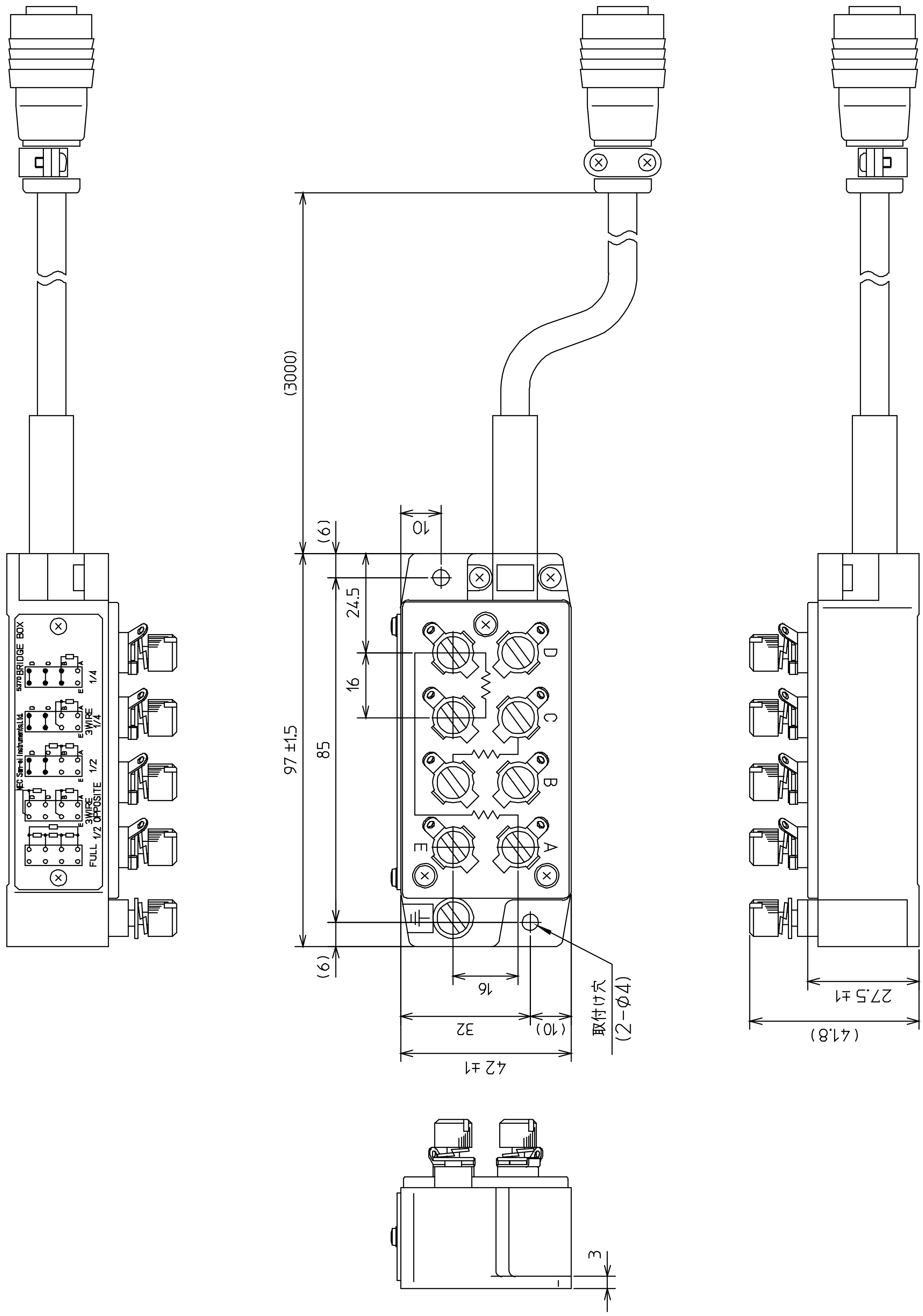


Name	Type	A	B
4CH Bench top case	AS16-104	262.6	236
6CH Bench top case	AS16-105	362.6	336
8CH Bench top case	AS16-106	462.6	436

9.3.5 Rack-mount Case



9.3.6 Bridge Box (5370 and 5373)



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The warranty period for this product is two years from the date of purchase. In case of a failure, the product will be repaired free of charge (only if the failure is ascribable to the responsibility of A&D).

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(4) Troubles which are apparently not attributable to our company or those that cannot be decided clearly whether our company is responsible for those troubles;
(5) Exhaustion of consumptions and repair parts;
(6) Troubles attributed to third pirty's conflicts;
(7) Troubles caused by a force majeure such as natural disasters

Address inquiries to:

AS2503/AS2603
Operation Manual 1WMPD4003356

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Eighth:	April	2016

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