MODEL 9B02 LOW - PASS FILTER
INSTRUCTION MANUAL

Precautions

1. The allowable input voltage range for this instrument is rated at ±30 volts.
2. Do not apply voltage or current to the output connector from outside.
3. Use the instrument on the specified AC line voltage (±10%). Use a time-lag power fuse (with the mark T).
4. Use the instrument in the appropriate operating environment --- a temperature of 0 to 40°C and a relative humidity (RH) of 20 to 85% without condensation. Pay special attention to condensation when the instrument that has been stored cold is used in a humid place.
5. Keep the instrument away from the following adverse conditions:
   - High humidity
   - Direct sunlight
   - High temperature
   - Excessive vibration
   - Dust, salt, water, oil, and corrosive gas
6. Install fan units for ventilation when the instrument is used in a multichannel arrangement.

Table of Contents

Preface

Welcome to the AVIONICS Model 9B02 Low-Pass Filter developed under the IEC standards for safety and reliability. The instrument will be a competent workhorse for your measurement. The AVIONICS Signal Conditioner Family is available for your choice from the following models.

	Model	No. of channels/ unit	Gain	Frequency Response	Remarks
DC voltage/ current standard	3K02	1	0-11V, 0-110mA		
Low-pass filter	9B02	2	Cutoff frequency: 1Hz-9kHz	For W/B: DC-100kHz	

The following unit mount and cases are available for our signal conditioner family.

	Model	Description	Remarks
Unit mount	43721	For 1 channel	
Bench top case	7774	For 3 channels	
	7775	For 6 channels	
	7776	For 8 channels	
Rack mount case	7777	For 8 channels	

1. NAMES AND FUNCTIONS OF COMPONENTS

1.1 Front Panel

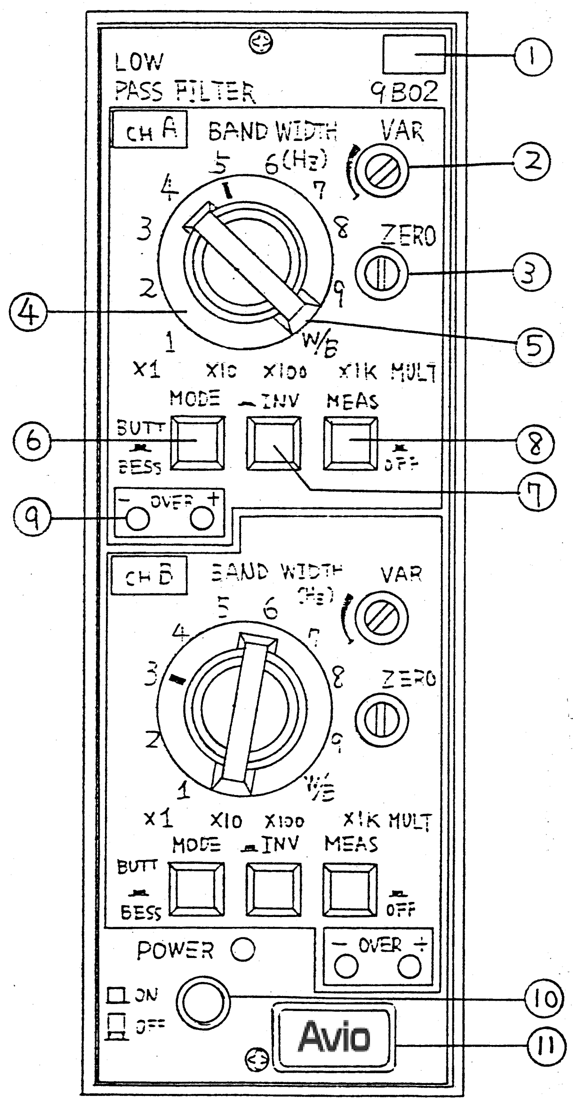


Fig. 1

① Channel Number Label

② Gain Adjustment Control (VAR)
The gain is x1 when this control is turned fully couter-

clockwise. The gain increases as this potentiometer is turned clockwise and it finally reaches about x5.

③ Zero Position Control (ZERO)
When this control is rotated fully counterclockwise, the output voltage steps down approximately -1 V; when it is turned fully clockwise, the voltage steps up approximately +1 V.

④ Cutoff Frequency Switch (BANDWIDTH)
This switch changes the cutoff frequency from 1 Hz (leftmost position) to 9 Hz in increments of 1 Hz and to W/B (righmost position).

Use this switch together with the Multiplier ⑤ for setting a specific cutoff frequency. The setting of this switch to the W/B (wide band) position, however, overrides the setting of the multiplier.

⑤ Multiplier (MULT)
This control multiplies the cutoff frequency selected by the BANDWIDTH switch ④ by a factor of x1, x10, x100, or x1K.

⑥ Filter Characteristic Switch (MODE)
This switch selects the filter characteristic. When the button is released (BUTT), the filter shows the 3-pole Butterworth characteristic (maximally flat amplitude); when it is depressed (BESS), the filter shows the 3-pole Bessel characteristic (maximally flat phase). When the button is pressed again, it pops back to the BUTT position.

⑦ Polarity Switch (INV)
This button switches I/O signal polarity. When the button is released, the input and output signals have the same polarity. When it is depressed, the signals have an opposite polarity.

⑧ Input Switch (MEAS)
Pressing this locking switch turns the input off. When pressed again, the button is released to turn on the input.

⑨ Overvoltage Output Indicator (OVER)
When the output voltage exceeds approximately ±10.5 volts, the red LED on the - or + side where the overvoltage occurred lights to alert the operator.

If the overvoltage lasts for a very short time or it occurs in non-repetitive waveforms, the LEDs do not light up.

⑩ Power Switch (POWER)
Pressing this switch turns on the instrument; pressing it again turns off power. When the switch is released, a yellow ring appears around the button.

(11) Panel Lock
Locks the instrument in a bench top case or rack mount case.
To unlock the instrument, pull the lock forcedly toward you.

1.2 Rear Panel

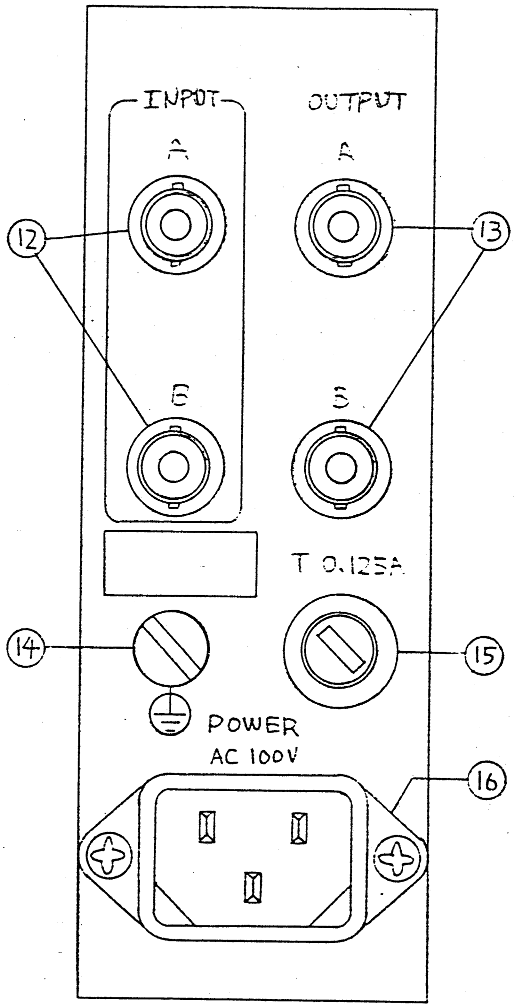


Fig. 2

⑫ Input Connector (INPUT)
Connectors A and B (NBC type) connect the input cables for channels A and B, respectively.

⑬ Output Connector (OUTPUT)
Connectors A and B (BNC type) connect the output cables for channels A and B, respectively. The output signals are ±10 V and ±50 mA. The signals can be connected to a voltage-input

recorder (data recorder, oscillograph with DC amplifier, etc.), A-D converter, or light-beam oscillograph.

⑭ Ground Terminal (GND)
This instrument comes under Class I in the IEC standard. Be sure to ground the equipment before use.

⑮ Fuse Holder (FUSE)
Contains a 5 ϕ x 20 mm, time-lag, midget-type power fuse.

⑯ Power Connector (POWER)
This 3-pin connector connects the supplied power cable. The ground pin (center) is connected to the GND terminal ⑭.

2. MEASUREMENT SETUP

Before connecting the cables to this instrument, be sure to:

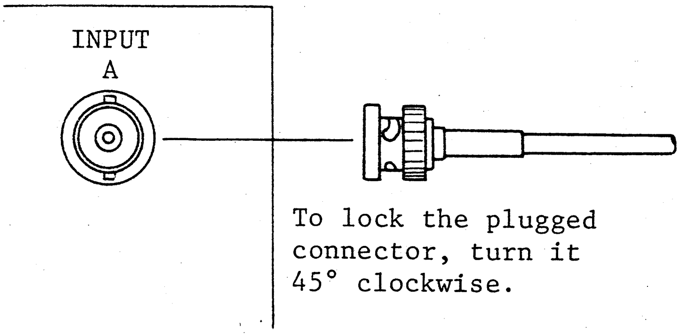
(1) Turn off the MEAS switch ⑧.

(2) Turn off the POWER switch ⑩.

(3) Ground the instrument by the GND terminal ⑭.

3. MEASURING

3.1 Connecting the Input Cable



Plug the signal input cable from an amplifier or other equipment to an appropriate INPUT connector ⑫. Since this instrument employs a single-ended input system, use sufficient care for connection.

Fig. 3

3.1.1 For Input from Amplifier or Data Recorder

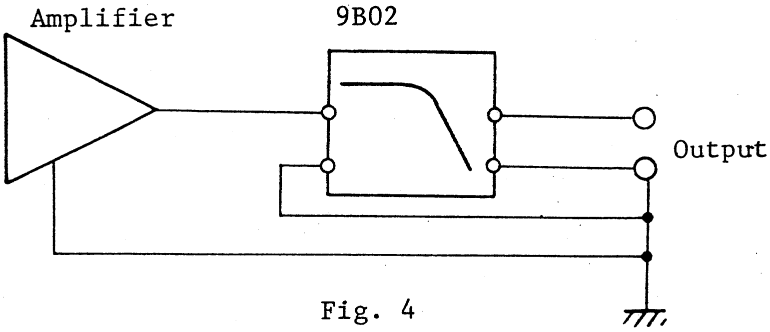


Fig. 4

Connect the input cable from an amplifier or data recorder as shown in Fig. 4. Although the potential difference between the 9B02 output point and the ground that is added to the amplifier output may develop noise or error, it does not matter when the amplifier output level is raised to the volt order.

3.1.2 For Input from Signal Source

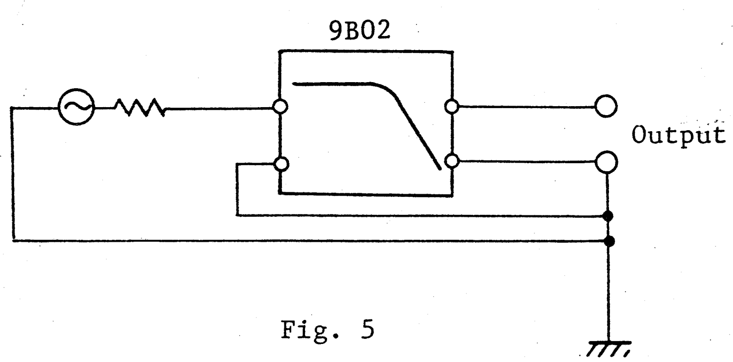


Fig. 5

In this case, the potential difference between the 9B02 output and the ground is also regarded as an input signal.
Thus it is recommended that an amplifier be connected as shown in Fig. 5 when the input signal voltage is 500 mV or less.

3.2 Connecting the Output Cable

Since the OUTPUT connectors are of the BNC type like the INPUT connectors, be careful not to take an INPUT connector for an OUTPUT connector, or vice versa.

3.2.1 Connecting an Output Load

(1) Automatic balancing recorder

Since the full scale (F.S.) output voltage of this instrument is ±10 V, arbitrary sensitivity increase of the load (for example, ±0.1 V/F.S.) will worsen the signal-to-noise ratio (SN ratio), reducing the measurement accuracy.

(2) Data recorder

a. For direct connection, use a data recorder to which more than 20 Vp-p (±10 V) can be applied.

b. When the input level of the data recorder is ±1 V, insert a voltage dividing circuit as shown in Fig. 6.

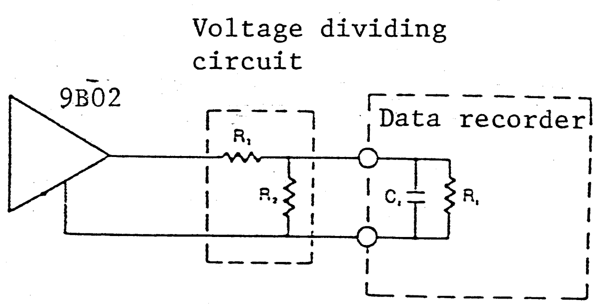
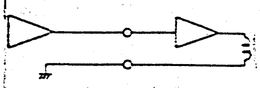
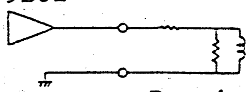
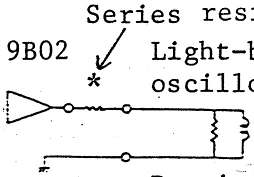


Fig. 6

However, the impedance in the above circuit must be $R_1 + R_2 // R_i \geqq 200\ \Omega$.

(3) Light-beam oscillograph

The input circuit of a light-beam oscillograph will be of any of the types shown in the table below. When the circuit contains no DC amplifier, check to see if the current is within the safe range for the galvanometer, because the maximum output current of this instrument is ±50 mA.

Input part of light-beam oscillograph	Circuit arrangement	Type of input	Applicable NEC SAN-EI's light-beam oscillograph model	Note
With DC amplifier	9B02 Light-beam oscillograph  Galva-nometer	Voltage	5L45, 5L46, 5L47, 5M28	Check the input range.
With amplitude adjusting circuit	9B02 Light-beam oscillograph  Galva-nometer Damping resistance	Current	5L41, 5L42, 5L43, 5L44, 5M27	Check the current with a galvanometer.
Without amplitude adjusting circuit	Series resistance 9B02 * Light-beam oscillograph  Galva-nometer Damping resistance	Current	5M26	

* If the input part contains no amplitude adjusting circuit, insert a series resistance into it, consulting the following table.

Galvano-meter model	Frequency response	Appropriate external damping resistance	Series resistance	Amplitude (optical length: 30 cm)	
				mm/0.5 V	mm/10 V
3311	DC to 70 Hz	80 Ω	100 kΩ	3.4	68
3312	DC to 170 Hz	14 Ω	10 kΩ	2.7	54
3313	DC to 260 Hz	12 Ω	2 kΩ	2.6	53
3308	DC to 650 Hz	∞	1 kΩ	3.8	77
3303	DC to 750 Hz	∞	1 kΩ	2.2	45
3309	DC to 1 kHz	∞	500 Ω, 1/2 W	1.5	30
3310	DC to 2 kHz	∞	200 Ω, 1 W	1.1	22
3314	DC to 4.8 kHz	∞	180 Ω, 1 W	0.6	12
3315	DC to 7 kHz	∞	180 Ω, 1 W	0.4	8

Note: The amplitude is one-third of the value shown above when the optical length is 10 cm.

3.3 Operating the Instrument

3.3.1 Preparation

(1) Cutting off the input

Before connecting the cables, turn off the MEAS switch .

(2) Power on

Press the POWER switch ⑩ to turn on the instrument. Allow approximately 10 minutes for warmup. When the equipment is housed in a cabinet, the warmup time should be about one hour.

(3) Adjusting the offset

Adjust the offset (zero position) of the instrument by rotating the ZERO position control ③ with the MEAS switch pressed (OFF). Turning the ZERO position control clockwise makes the output voltage positive; turning it counterclockwise makes the voltage negative.

To adjust input signals together with the offset, use the above procedure with the MEAS switch released (MEAS).

(4) Watching the OVER indicators

When a data recorder is connected to this instrument, note the input voltage level at the data recorder. In particular, when frequency modulated signals are input, an overvoltage will cause overmodulation that will disable the correct recording. To alert the operator before this occurs, this equipment lights up the OVER indicator ⑨ if the input voltage for each channel exceeds approximately ±10.5 volts.

However, an instantaneous overvoltage cannot be indicated.

3.3.2 After Measurement

(1) Turn off the MEAS switch ⑧.

(2) Turn off the POWER switch ⑩.

3.4 Selecting the Filter Characteristic by the MODE Switch

This instrument provides two types of filter characteristics: 3-pole Butterworth and 3-pole Bessel.

Use the Butterworth characteristic for smoother amplitude change and better SN ratio, and the Bessel characteristic for better phase characteristic and waveform response.

3.4.1 Butterworth Filter

An ideal Butterworth filter has a maximally flat amplitude pass band, in which the waveform amplitudes are flattened below 0 dB.

However, this ideal characteristic is attained at the cost of the phase characteristic; the phase delays to a large extend around the cutoff frequency, and the delay characteristic (phase characteristic differentiated by angular frequency) surges in the pass band, substantially distorting the output signal. When square waves are added to the input, for example, overshoot and ringing appear in the output. The reason is that the frequency components of the input square waves affect the output waveform because of their different delay characteristics. The overshoot in an ideal 3-pole Butterworth filter is calculated at about 8 percent.

3.4.2 Bessel Filter

A Bessel filter provides maximally flat phase and delay characteritics in the pass band, making some compromise in flat amplitude characteristic. Thus the Bessel filter shows a smoother downslope around the cutoff frequency, compared with the Butterworth filter. However, since the Bessel filter allows the delay characteristic to be flattened in the pass band, the frequency components of the input square waves show less lag time in the output, causing reduced overshoot and ringing. In other words, the Bessel filter provides the waveform with less distortion. The overshoot for input square waves is calculated at about 0.8 percent in an ideal 3-pole Bessel filter.

3.5 Housing Case

This instrument can be housed in a 3, 6, or 8 channel bench top case or an 8 channel rack mount case.

Although the instrument can be powered through the outlet on the case, the input and output cables must be connected directly to the rear panel of the instrument.

To install the instrument in the case, release the panel lock (11)
on the front panel by pulling it with force toward you, insert the unit into the case, and then push the panel lock. The unit will be locked in the case.

Before locking, remove the screws from the bottom of the case.

Tighten the screws when the entire unit is not inserted into the case. The screws are also useful to prevent vibration when the unit is moved from one place to another.

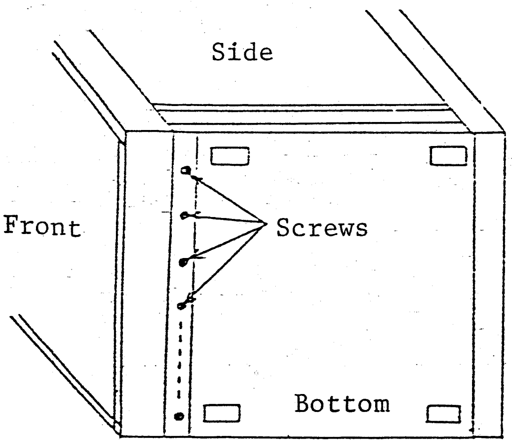


Fig. 7

3.6 Fan Units

3.6.1 When One Rack Case Is Installed

No fan unit is needed. Separate the rack case from the floor surface more than 20 mm.

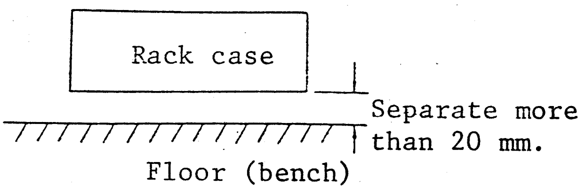


Fig. 8

3.6.2 When Several Rack Cases Are Installed

When several rack cases are to be installed in one cabinet, the temperature inside the unit may rise as high as to impare the instrument reliability. The temperature rising rate differs with the number of instruments, load conditions, and ambient temperature. So determine the necessary number of fan units, referring to the table below.

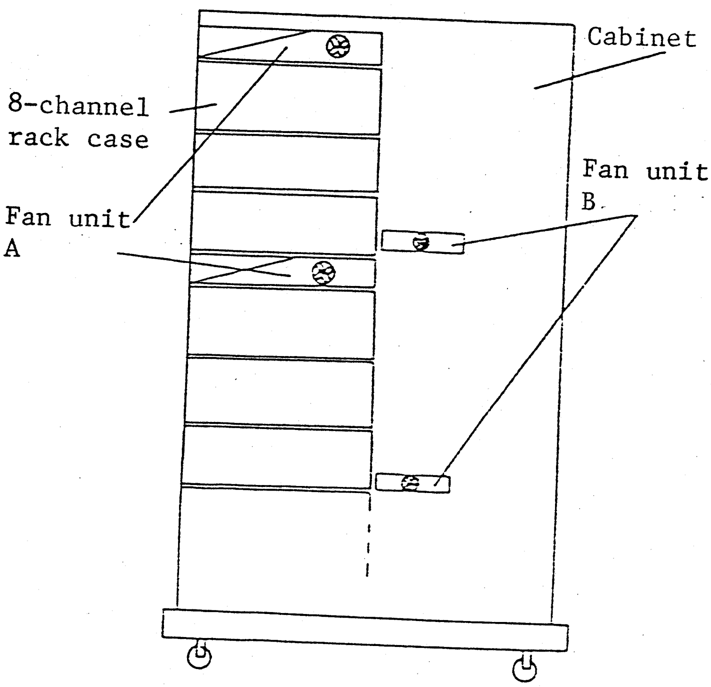


Fig. 9

Fan unit A ventilates the interior of multi-staged instruments when the load draws a large current at a high temperature, while fan unit B accelerates natural convection.

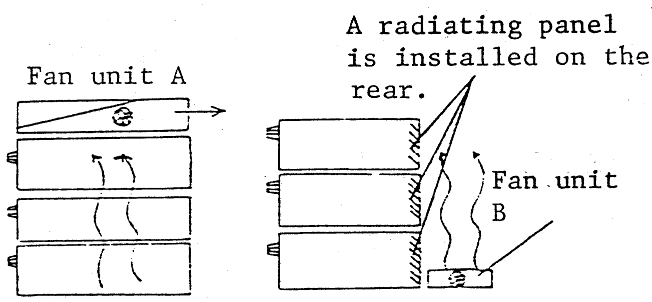


Fig. 10

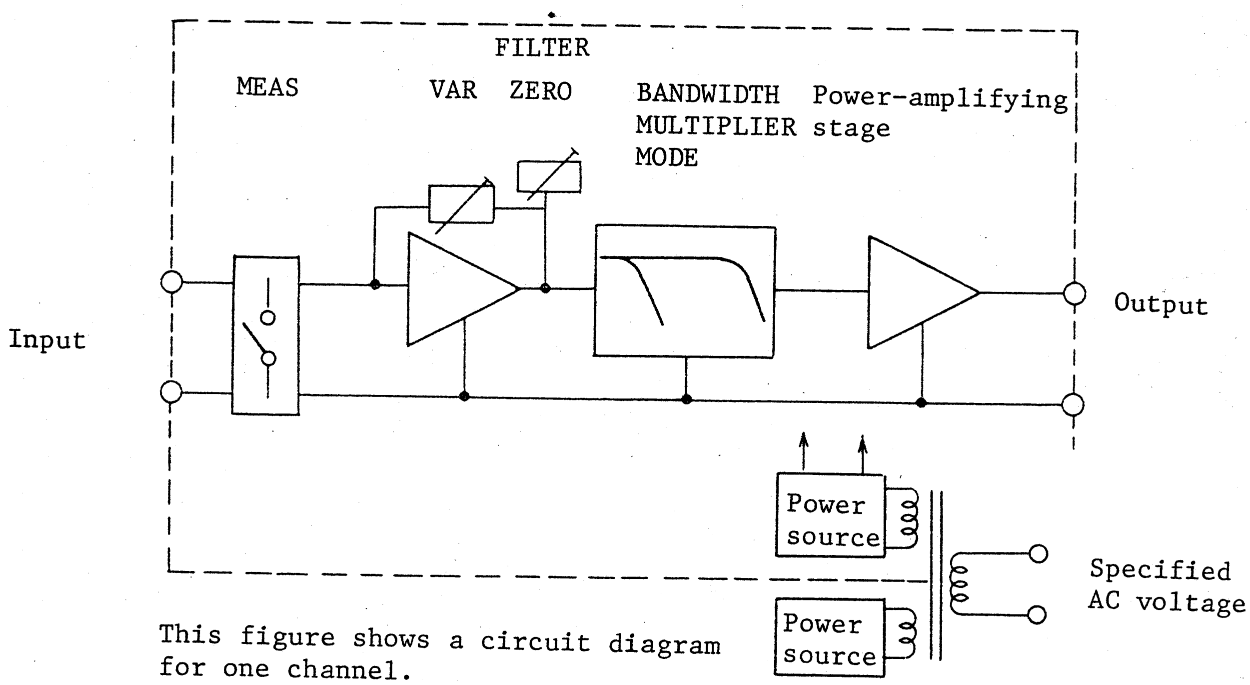
Install one fan unit B for every three instruments as close as possible to the rack cases. (A radiating panel is installed on the rear of the rack case.)

No. of rack cases	No. of fan units	
	A	B
1 to 3	1	1
3 to 6	1 to 2	2
6 to 9	1 to 2	3

Note: The number of fan units in the above table is determined under the following possible worst conditions:

- Line voltage: Specified AC voltage (+10%)
- Output voltage: +10 V; output current: 50 mA
- Ambient temperature: +40°C

4. PRINCIPLES OF OPERATION



This figure shows a circuit diagram for one channel.

Fig. 11

Figure 11 is a block diagram of the 9B02. The two channels are completely separated from each other in this model.

Signals are input to the first stage through the MEAS switch for gain control, zero adjustment, and polarity control before being filtered. Filtered signals are routed to the power-amplifying stage and then output.

5. MAINTENANCE

If your instrument shows any sign of improper operation, check the symptom and correct it using the following table.

Symptom	Possible cause and countermeasure
Unstable output	1. Connection of input cable • Turn the plugged input cable connector tight until a click is heard. • Check the cable connection with a circuit tester.
No output	1. Cable connection • An input cable is connected instead of the output cable. 2. Output cable connection • The load exceeded the rating or the cable is shorted. 3. Breakage of output cable • Check the cable connection with a circuit tester.
Excessive output voltage	1. Set the MEAS switch to OFF. • If the output voltage is normal, the input cable connection is responsible. • If the output voltage is too high, rotate the ZERO control for adjustment. • If the OVER indicator is on, the equipment interior is faulty. 2. If the input is too large, adjust the VAR control.

6. SPECIFICATIONS

1. Number of channels

   2 channels/unit

   Each channel uses a different power source.

2. Input

   - Input system: single-ended input
   - Input impedance: approx. 10 MΩ
   - I/O polarity: selectable between in- and anti-phase
   - Input switch: with MEASURE and OFF positions

3. Cutoff frequency

   - Switchable from 1 Hz to 9 Hz in increments of 1 Hz, using the BANDWIDTH switch
   - The multiplier selects a magnification factor among x1, x10, x100, and x1K for each setting of the BANDWIDTH switch.
   - 100 kHz within -3 dB at the W/B position of the BANDWIDTH switch

4. Filter characteristics

   - 3-pole Butterworth characteristic (maximally flat amplitude) at the BUTT position of the MODE switch
   - 3-pole Bessel characteristic (maximally flat phase) at the BESS position of the MODE switch

5. Gain

   - Set gain: x1 (variable up to x5 with the VAR control)
   - DC gain accuracy: ±0.1% (at x1 of VAR)

6. Linearity

   - ±0.01% of full scale (DC)

7. Maximum input voltage

   - ±10 V

8. Maximum allowable input voltage

- No burning at 30V AC/DC

9. Drift

- ±500 μV/°C 60 minutes after power on with input terminal shorted and VAR set to x1 (±200 μV/day)

10. Noise

- 5 mVp-p when the BANDWIDTH switch set to W/B, VAR to x1, and the input terminal shorted

11. Offset adjusting range

- Approx. ±1 V

12. Output

- Voltage: ±10 V
- Current: ±50 mV
- Impedance: below 1 Ω
- Capacitive load: 0.1 μF

13. Insulation resistance

- Above 100 MΩ against 500V DC between output and housing case

14. Dielectric strength

- Channel A output - channel B output } 500V AC, 1 min.
- Output - housing case } 500V AC, 1 min.

- Output - AC power source } 2000V AC, 1 min.
- Housing case - AC power source } 2000V AC, 1 min.

15. Operating conditions

- Temperature: 0°C to 40°C when a single unit is used
- Humidity: 20% to 85% RH

16. Power requirements

- 100, 117, 220 or 240V AC ±10%, 50/60 Hz, approx. 13 VA

17. External dimensions

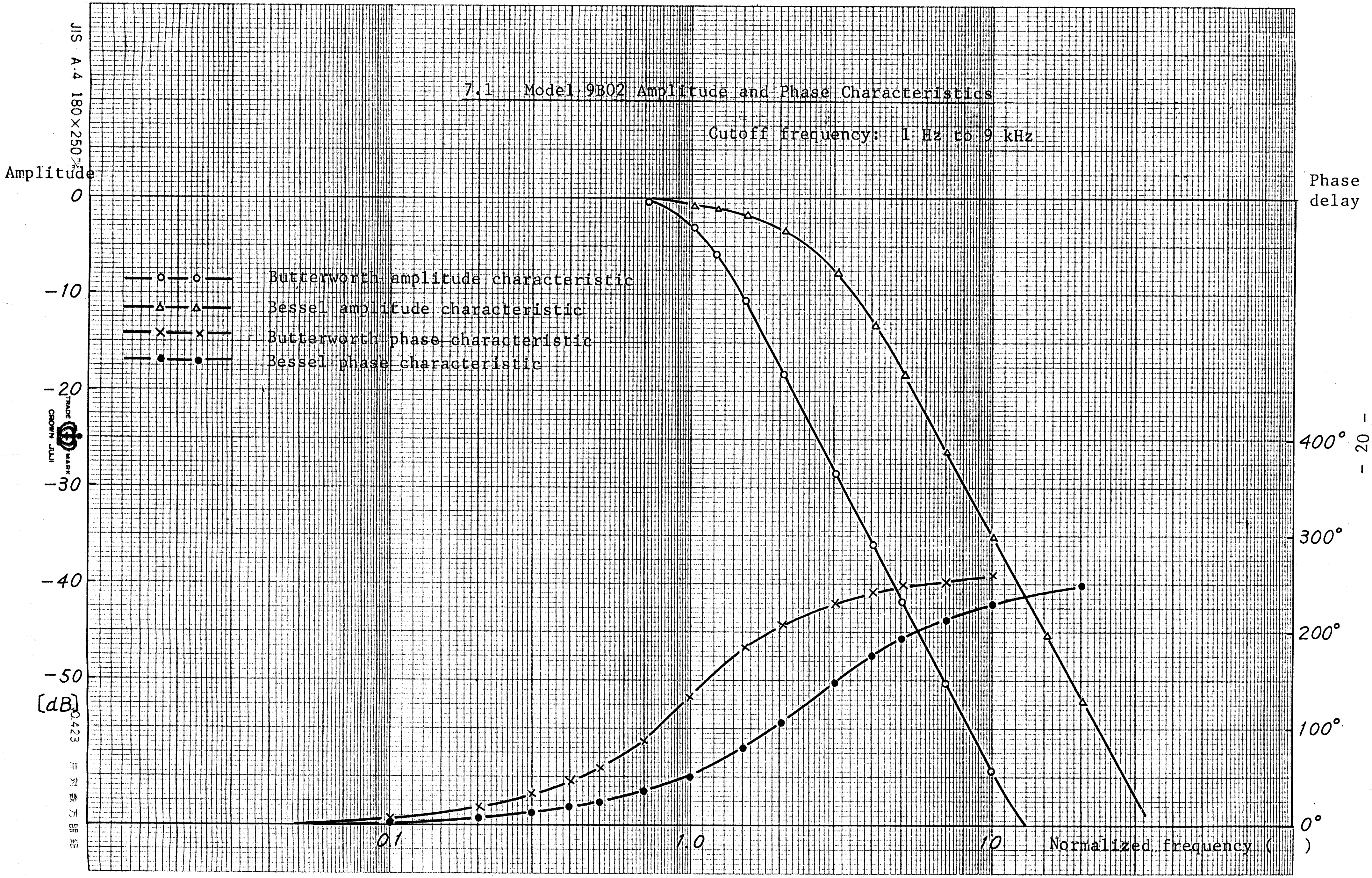
- Approx. 143 (H) x 50 (W) x 354 (D) mm

18. Weight

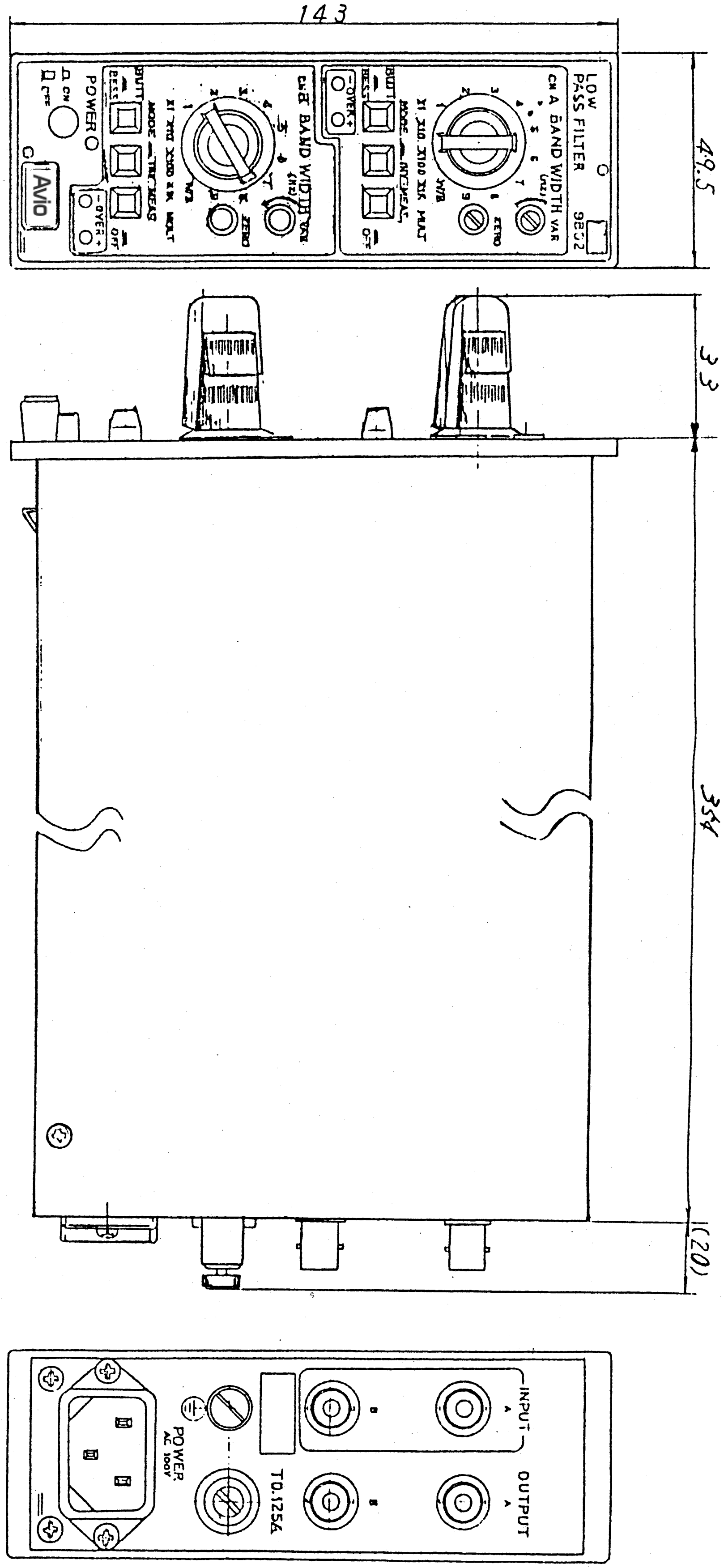
- Approx. 1.7 kg

7.1 Model 9B02 Amplitude and Phase Characteristics

Cutoff frequency: 1 Hz to 9 kHz



7.2 Model 9B02 External View and Dimensions



Dimensions are shown in mm.

LOW-PASSFILTER 9B02

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