INSTRUCTION MANUAL

WOW & FLUTTER METER

MODEL 6702

KIKUSUI ELECTRONICS CORPORATION

Power Requirements of this Product

Power requirements of this product have been changed and the relevant sections of the Operation Manual should be revised accordingly.
(Revision should be applied to items indicated by a check mark ☑.)

☐ Input voltage

The input voltage of this product is _____ VAC,
and the voltage range is _____ to _____ VAC. Use the product within this range only.

☐ Input fuse

The rating of this product's input fuse is _____A, _____VAC, and _____.

WARNING

- To avoid electrical shock, always disconnect the AC power cable or turn off the switch on the switchboard before attempting to check or replace the fuse.
- Use a fuse element having a shape, rating, and characteristics suitable for this product. The use of a fuse with a different rating or one that short circuits the fuse holder may result in fire, electric shock, or irreparable damage.

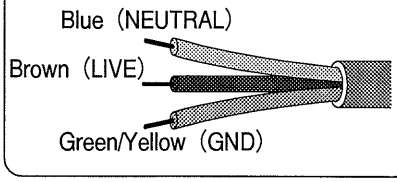
☐ AC power cable

The product is porvided with AC power cables described below. If the cable has no power plug, attach a power plug or crimp-style terminals to the cable in accordance with the wire colors specified in the drawing.

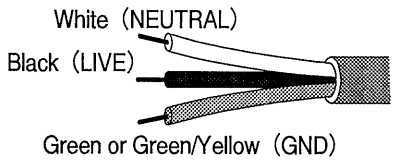
WARNING

- The attachment of a power plug or crimp-style terminals must be carried out by qualified personnel.

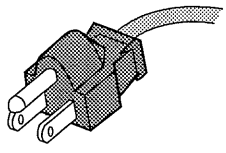
☐ Without a power plug



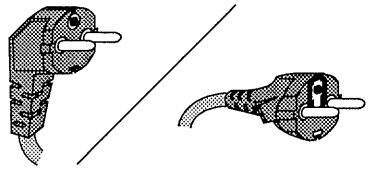
☐ Without a power plug



☐ Plugs for USA



☐ Plugs for Europe



☐ Provided by Kikusui agents

Kikusui agents can provide you with suitable AC power cable.
For further information, contact your Kikusui agent.

☐ Another Cable _____

 Kikusui Part No. Z9-000-027 IB001681

KIKUSUI

TABLE OF CONTENTS

1. GENERAL

This instrument measures wow and flutters of various recording/reproducing devices including audio tape recorders, video tape recorders, disc record players, and cine-sound recorders. The measurement complies with the following standards:

- o NAB (National Association of Broadcasters), mean-value measurement
- o JIS (Japanese Industrial Standards), rms-value measurement
- o CCIR (Comité Consulatif International des Radiocommunications), peak-value measurement
- o DIN (Deutsche Industrie Normen), peak-value measurement

Measurement can be done in a manner that the meter pointer remains stationary, by using a sample hold method (of a peak hold method in JIS of a sigma (σ) memory method in CCIR or DIN). (Sigma (σ) denotes a standard deviation used in mathematical statistics.) The measured wow and flutters can be displayed in a digital quantity. The operational time is adjustable down to 3 seconds, thereby enabling efficient measurement.

The input voltage sensitivity is as high as 100 μV (-80 dBv), allowing direct measurement of the playback head output signal of a tape recorder. The wow and flutter measuring sensitivity also is very high -- the

instrument has a 0.01% FS range with minimum measuring division of 0.002%.

The instrument employs a highly stable crystal oscillator to provide a reference signal (3000 Hz/3150 Hz). The digital display unit is capable of indicating the tape speed as well as wow and flutters by sample hold measurement (complying with JIS, CCIR, and DIN). For tape speed indication, the gate time can be referenced to the crystal oscillator output signal or to the AC line frequency (50/60 Hz). Frequency ratio measurement with respect to the reference signal (3000 Hz/3150 Hz) also is possible. The instrument can be used as an independent frequency counter for a range of 10 Hz ~ 999.9 kHz.

The instrument has output terminals for an oscilloscope and a pen recorder, and also has a DC output terminal which provides a DC signal representing wow and flutters in sample hold measurement as per JIS, CCIR, or DIN.

Having the above features, the instrument is capable of measuring and recording waveforms and periods of wow and flutters. The instrument is widely used for wow and flutter measurements in research and development, manufacturing, inspection and maintenance of various types of recording/reproducing devices.

2. SPECIFICATIONS

- o Model No.: 6702
- o Measuring center frequency range: Within 3000 Hz ±150 Hz (NAB, JIS, CCIR)
  Within 3150 Hz ±150 Hz (DIN)
- o Input terminals: 5-way type, 19 mm (3/4 in.) spacing,
  HI, LO, GND terminals
- o Input impedance:
  10 mV range ... Within 600 kΩ ±20% (between HI - LO)
  Approx. 300 kΩ (between HI - GND, LO - GND)
  (Input capacitance: approx. 30 pF at 150 kHz)
  0.1 mV range... Approx. 10 kΩ (between HI - LO)
- o Measurable input level range: 0.1 mV ~ 10 Vrms (sinusoidal signal, between HI - LO) in 2 sub-ranges of 0.1 mV ~ 30 mV rms range and 10 mV ~ 10 V rms.
- o Maximum allowable input level:
  Between HI - LO: AC (10 Hz ~ 1 MHz) ... ±15 Vp-p
  DC ..... ±50 V
  Between HI - GND, LO - GND:
  AC (10 Hz ~ 1 MHz) ... ±15 Vp-p
  DC ..... ±50 V

o Wow/flutter indication system: Mean-value indication as per NAB
Rms-value indication as per JIS
Peak-value indication as per CCIR
Peak-value indication as per DIN

o Wow/flutter measuring ranges and indication (meter) accuracies:

Top frames: Measuring range (wow/flutter %)

Bottom frames: Indication accuracy (% of full-scale value)

Conditions

Signal source impedance: Not higher than 3 kΩ

Measuring center frequency: 3000 Hz ±50 Hz (NAB, JIS, CCIR) or 3150 Hz ±50 Hz (DIN)

Wow/flutter measuring ranges		0.01%	0.03%	0.1%	0.3%	1%	3%
0.1 mV range	WEIGHTED		0.005 ±10	±5	±5	±5	3 ±5
	LINEAR				0.05 ±10	±5	3 ±5
10 mV range	WEIGHTED	0.002 ±10*	±5	±5	±5	±5	3 ±5
	LINEAR		0.005 ±10	±5	±5	±5	3 ±5

(* When sigma memory is used: $^{+20}_{-10}$)

o Wow/flutter frequency characteristics

Aural-sense compensation characteristics:

In compliance with NAB, JIS, CCIR and DIN standards

Separation characteristics:

Wow ..... 0.5 Hz ~ 6 Hz

Flutter ..... 6 Hz ~ 200 Hz

Flat response characteristics:

NAB, JIS (4 Hz reference)

Within -3 dB ±1 dB at 0.5 Hz, 200 Hz.

Attenuates with 6 dB/oct or over at frequencies lower than 0.5 Hz.

Attenuates with 15 dB/oct or over at frequencies higher than 200 Hz.

CCIR, DIN (4 Hz reference)

Within -3 dB ±1 dB at 0.3 Hz, 200 Hz.

Attenuates with 6 dB/oct or over at frequencies lower than 0.3 Hz.

Attenuates with 15 dB/oct or over at frequencies higher than 200 Hz.

Accuracy of reference level: ±5% or better of full-scale value (between WEIGHTED-LINEAR at 4 Hz)

o Tape speed

Indication system: 4-digits strage display system,
7-segment LED readout

Measuring unit: Frequency Measurement kHz
(Dimensionless number for frequency ratio measurement)

(Frequency Indication)

Indication range: 2700 Hz ~ 3500 Hz or wider

Gate time: 1 sec (nominal)

(Frequency ratio Indication)

Indication range: 0.90 ~ 1.11 or wider

Gate time: 1/3 sec, 1/3.15 sec (nominal)

o Sample hold measurement

Measuring system: JIS: Peak hold system
CCIR, DIN: Sigma memory system

Start system: Manual (single, repeat)
Auto (automatic control with input monitor)

Sigma mode: 1σ, 2σ, 3σ

Measuring time: 3 ranges of 3 sec, 5 sec, and 10 sec.
(crystal-controlled)
(When operated at 3 sec range in Sigma memory system, the flatness characteristics are such that the wow component of 0.3 Hz and lower is attenuated with 24 dB/oct or over.)

Standby time: Variable for a range of 2 sec ~ 6 sec or over.

Repeat interval: Variable for a range of 2 sec ~ 12 sec or over.

GO/NO-GO preset: Number of preset points: 3 points of I, II, III.

Preset range: 0 ~ full scale

Preset accuracy: Within $\pm$5% of full scale

Indications: Standby, operation, read, GO/NO-GO

o Frequency counter

Measuring range: 10 Hz ~ 999.9 kHz

Gate time: 1 sec, 0.1 sec, 0.01 sec (nominal);
manual selection

Measuring accuracy: $\pm$(1 count + reference frequency accuracy)

Reference frequency accuracy

Crystal oscillator: 1.26 MHz $\pm 5 \times 10^{-5}$ or better
(at 20°C $\pm$10°C (68°F $\pm$50°F))

AC line freqency: Accuracy of the commercial AC line power

Indication system: The same as the item for tape speed.

Input terminals: Terminals for wow/flutter measurement are used in common.

Input level range: 100 mV rms ~ 10 V rms (sinusoidal signal)

Measuring unit: kHz

o Wow/flutter digital indication:

Indication Method:	Full scale 0.0100%, 0.0300%:	5 digits
	Full scale 0.100%, 0.300%:	4 digits
	Full scale 1.00%, 3.00%:	3 digits

Indication accuracy: ± (1% of full scale + 1 digit)

o Internal oscillator (reference signal oscillator for recording)

Oscillating frequency: 3000 Hz or 3150 Hz (automatic selection with INDICATION switch)

3000 Hz: NAB, JIS, CCIR

3150 Hz: DIN

Frequency accuracy: $\pm 5 \times 10^{-5}$ or better (at 20°C ±10°C (68°F ±50°F))

Output voltage: 0.2 V rms or over (open-ended)

Distortion factor: 2% or less

Output impedance: 600 Ω ±20% (single-ended)

Output terminals: 5-way type, 19 mm (3/4 in.) spacing

o Wow/flutter signal outputs:

Recorder terminal:

Output voltage:	(∓) 0.75 V per (±) 1% change in relative speed. [Negative (positive) output for positive (negative) shift of frequency] ±20%
Output impedance:	Approx. 10 kΩ (single-ended)
Terminals:	5-WAY, 19 mm (3/4 in.) spacing

Oscilloscope terminal:

Output voltage:	(per full scale) NAB, JIS ..... Approx. 1.5 V rms CCIR, DIN ..... Approx. 1 V rms (When wow/flutter are sinusoidal wave)
Output impedance:	Approx. 10 kΩ (single-ended)
Terminals:	5-WAY, 19 mm (3/4 in.) spacing

DC output:

Output voltage:	1 V ±1% per full scale
Output impedance:	Approx. 10 kΩ (single-ended)
Terminals:	5-WAY, 19 mm (3/4 in.) spacing

- Ambient temperature and humidity: $5^{\circ}C \sim 35^{\circ}C$ ($41^{\circ}F \sim 95^{\circ}F$), 85% RH

- Power requirements: 100 V ±10%, 50/60 Hz AC, approx. 38 VA.
  Convertible to 110 V, 117 V, 220 V, 230 V or 240 V with internal voltage tap change.

- Dimensions: 310 W × 150 H × 420 D mm
  (12.2 W × 5.91 H × 16.5 D in.)

  (Maximum dimensions): 330 W × 165 H × 470 D mm
  (13.0 W × 6.50 H × 18.5 D in.)

- Weight (net): Approx. 8.7 kg (19.2 lb.)

- Accessories: Shorting bar 1
  Instruction manual ..... 1 copy

3. OPERATION METHOD

3.1 Explanation of Front Panel

(Refer to Fig. 3-1)

① "POWER" switch: Instrument main power switch. The upper position is for power ON and the lower position for OFF.

② "INPUT (A)" terminals: The signal reproduced by a record/playback device is applied to this input terminal block for measurement. The terminal block consists of HI, LO and GND terminals. Although the HI and LO terminals are not floated from the ground (GND), keep normally the LO terminal shorted to the GND terminal with the shorting bar (supplied).

When the measured signal level is very low, remove the shorting bar and connect the GND terminal to the ground line of the measured signal source for measurement being less affected by noise. When the measured signal level is low, note also that a shielded cable which securely guard the

signal against noise should be used for connection to the measured signal source. The GND terminal is connected to the chassis.

③ "SENSITIVITY" switch: Selects the input sensitivity when the instrument is used as a wow/flutter meter. The depressed and locked state ("0.1 mV") is for 100 μV rms and the undepressed state ("10 mV") is for 10 mV rms.

④ "COUNTER" switches: These four switches are for using the instrument as a frequency counter.

- o PUSH COUNTER ONLY: Selects the operation mode of the instrument. When this switch is depressed and locked, the instrument operates a frequency counter.
- o 0.01 (S): When the instrument is used as a frequency counter and this switch is depressed and locked, the gate time is 0.01 sec and the upper limit measuring frequency is 999.9 kHz.

o 0.1 (S): When the instrument is used as a frequency counter and this switch is depressed and locked, the gate time is 0.1 sec and the upper limit measuring frequency is 99.99 kHz.

o 1 (S): When the instrument is used as a frequency counter and this switch is depressed and locked, the gate time is 1 sec and the upper limit measuring frequency is 9.999 kHz.

When the instrument is used as wow and flutter meter, the gate time selection functions of the "0.01 (S)", "0.1 (S)" and "1 (S)" switches remain idle.

⑤ "WOW/FLUTTER RANGE (%)" switches: Select a wow/flutter measuring range from six ranges of 0.01%, 0.03%, 0.1%, 0.3%, 1% and 3%, for full-scale values of ⑧ "METER."

⑥ "MODE" switches: Select a wow/flutter measuring mode from four modes as follows:

o WEIGHTED: Wow/flutter measurement with aural-sense compensation, complying with NAB, JIS, CCIR and DIN.

- o WOW: Measurement of wow component (0.5 Hz ~ 6 Hz) alone separated from the measured signal.

- o FLUTTER: Measurement of flutter component (6 Hz ~ 200 Hz) alone separated from the measured signal.

- o LINEAR: Measurement of all wow/flutter components of the measured signal, complying with NAB, JIS, CCIR and DIN.

⑦ "INDICATION" switches: Select a wow/flutter indication system from four standards as follows:

- o NAB: For measurement in compliance with NAB
- o JIS: For measurement in compliance with JIS
- o CCIR: For measurement in compliance with CCIR
- o DIN: For measurement in compliance with DIN

⑧ "METER" (WOW/FLUTTER %): Indicates directly the wow/flutter with two scales -- top scale for "1" and bottom scale for "3" -- corresponding to setting of the ⑤ "WOW/FLUTTER RANGE (%)" switch when in real-time indication mode or corresponding to the range of which ㉗ "WOW/FLUTTER RANGE (%)" LED has lighted, when in the memory indication mode.

⑨ "TAPE SPEED/WOW & FLUTTER/FREQUENCY" LED's: 7-segment LED's which indicate the tape speed, the wow/flutter rate in the sample-hold measurement (JIS, CCIR, DIN), and the input signal frequency.

⑩ "%" LED (red): Turns ON when this instrument is used as a wow and flutter meter and ⑱ "DIGITAL DISPLAY" switch is depressed and locked ("MEMORY" state).

⑪ "kHz" LED (red): Turns ON in either of the following two cases:

(1) When this instrument is used as a wow and flutter meter, ⑱ "DIGITAL DISPLAY" switch is not depressed ("TAPE SPEED" state) and any other switch than "RATIO (A/B)" of "COUNTER MODE" switches is depressed

(2) When this instrument is used as a frequency counter (the "PUSH COUNTER ONLY" switch of ④ "COUNTER" switches is depressed and locked)

⑫ "RATIO" LED (red): Turns ON when ⑨ "TAPE SPEED/WOW & FLUTTER/FREQUENCY" LED's are indicating the frequency ratio.

⑬ "OVER" LED (red): When ⑨ "TAPE SPEED/WOW & FLUTTER/ FREQUENCY" LED's are indicating the contents of the memory (wow and flutter rate), if the value is larger than the full scale of ⑧ "METER," this light turns ON to indicate that the indicated value is not the correct one.

When the instrument is used as a frequency counter, if the input signal frequency is higher than the displayable limit (9999), this light flickers.

⑭ "STANDBY" LED (red): When the instrument is used in the automatic sample hold mode of operation, this light flickers during the period of from starting of the sample hold measuring circuit to the measuring operation. The period is adjustable for 2 ~ 6 sec with ㊶ "STANDBY TIME" potentiometer on the instrument side panel. (This light does not flicker when in the manual operation.)

⑮ "OPERATION" LED (red): This light turns ON when the circuit is in operation in the sample hold mode.

⑯ "READ" LED (red): Turns ON when the sample hold measuring operation is over and the measured value is stored.

⑰ "METER INDICATION" switch: Selects the item to be indicated by ⑧ "METER." When this switch is not depressed ("REAL TIME" state), the wow and flutter rate measured on the real time base is indicated. When this switch is depressed and locked ("MEMORY" state), if ㉜ "PRESET (ON/OFF)" switch is "OFF," the meter indicates the contents of memory; if the switch is "ON," the meter indicates the GO/NO-GO judgement criterion value selected by ㉝ "PRESET (I II III)."

⑱ "DIGITAL DISPLAY" switch: Selects the item to be indicated by ⑨ "TAPE SPEED/WOW & FLUTTER/FREQUENCY" LED's. When the switch is not depressed ("TAPE SPEED" state), the LED's indicate the tape speed in a method selected by ㉛ "COUNTER MODE" switch. When the switch is depressed and locked ("MEMORY" state), if ㉜ "PRESET (ON/OFF)" switch is "OFF," the LED's indicates the contents of memory;

if the switch is "ON," the LED's indicate the GO/NO-GO judgement criterion value selected by ㉝ "PRESET (I II III)" switch.

⑲ "INTEGRATION TIME" switches: These switches are for selection of operation time when in the sample hold mode, for a period of 3 sec, 5 sec, or 10 sec.

⑳ "SIGMA (σ) switches: These switches are for setting partitions (limits of control) when sigma memory (CCIR, DIN) mode of measurement is done under the sample hold measurement.

- o 1 σ: For partition equal to standard deviation. (Inside accuracy: 68.3%)
- o 2 σ: For partition equal to twice of standard deviation. (Inside accuracy: 95.4%)
- o 3 σ: For partition equal to trice of standard deviation. (Inside accuracy: 99.7%)

(The values measured under the "WEIGHTED" mode correspond roughly to the values measured at this range.)

㉑ "START MEMORY OPERATION" LED (green): This light turns ON if the wow and flutter rate is not stored in the memory when its contents are to be displayed by depressing ⑰ "METER INDICATION" switch or ⑱ "DIGITAL DISPLAY" switch. The light goes OFF if the sample hold measurement is started. (For the sample hold measurement, refer to Item 6 of Section 3.4).

㉒ "RESET" button: If you press this button, the memory is cleared and the circuit is reset to the initial state irrespective of the state of the sample hold measuring circuit.

㉓ "START" button: As you press this button, the circuit starts its operation irrespective of whether the sample hold measuring mode is automatic or manual (single or repeat).

㉔ "MANUAL/AUTO" switch: When this switch is depressed and locked, the sample hold measuring circuit is in the automatic operation; when this switch is not depressed, the circuit is in the manual operation.

㉕ "SINGLE/REPEAT" switch: Sample hold measurements are repeatedly done if you press this button to the locked state ("REPEAT" state), under the state that ㉔ "MANUAL/AUTO" switch is not depressed and ㉕ "START" button is depressed.

㉖ "LEVEL" LED (green): This light turns ON when the level of the signal applied to ② "INPUT (A)" terminal is sufficient for measurement as follows:

Measurement	Measurable input voltage (sinusoidal wave)
Wow and flutter	(0.1 mV range): 100 μV rms ~ 10 V rms
	(10 mV range): 10 mV rms ~ 10 V rms
Frequency counter	100 mV rms ~ 10 V rms

The light may turn ON even when the input signal level is lower than the above-mentioned nominal minimum measurable input voltages.

㉗ "WOW FLUTTER RANGE (%)" LED's (red): These LED's indicate the wow flutter range (%) which was used when storing the wow flutter rate indicated by ⑧ "METER" in the sample hold measurement must be read for the range indicated by the lighted one of these lights.

㉘ "OUTPUT (B) INT OSC" terminal: Provides the internal oscillator sine-wave signal for recording. The signal frequency is 3150 Hz when "DIN" is selected by ⑦ "INDICATION" switch or 3000 Hz when "NAB", "JIS", or "CCIR" is selected. The GND terminal is connected to the chassis. The output impedance is 600 Ω (nominal).

㉙ "GO" LED (green): This light turns ON when ㉞ "GO/NO-GO DISPLAY" switch is ON and the value of wow and flutter is smaller than the criterion value selected by ㉝ "PRESET (I II III)" switch.

㉚ "NO GO" LED (red): This light flickers when ㉞ "GO/NO-GO DISPLAY" switch is ON and the value of wow and flutter is larger than the criterion value selected by ㉝ "PRESET (I II III)" switch.

3.2 Explanation of Rear Panel

(Refer to Figure 3-2.)

(31) "COUNTER MODE" switches:	These switches select one of the four tape speed indication methods as follows:
o FREQ/50 Hz EXT (LINE):	The reference gate time is that of the line frequency (for 50 Hz area).
o FREQ/60 Hz EXT (LINE):	The reference gate time is that of the line frequency (for 60 Hz area).
o FREQ/INT (CRYSTAL):	The reference gate time is controlled by the internal crystal oscillator.
o RATIO (A/B)/INT (CRYSTAL):	The reference gate time is controlled by the internal crystal oscillator and the counter indicates the ratio (A/B) between signal frequency (A) of (2) "INPUT (A)" and output signal frequency (B) of (28) "OUTPUT (B) INT OSC."
(32) "PRESET (ON/OFF)" switch:	If this switch is set in the ON state while the instrument is used as a wow and flutter meter, (8) "METER" or (9) "TAPE

SPEED/WOW & FLUTTER/FREQUENCY" LED's indicate the GO/NO-GO judgement criterion value selected by ㉝ "PRESET (I II III)" when ⑰ "METER INDICATION" switch or ⑱ "DIGITAL DISPLAY" switch is depressed and locked ("MEMORY" state).

If this switch is set in the OFF state, the contents of the memory (wow and flutter rate) are displayed.

㉝ "PRESET (I II III)" switch: Selects the GO/NO-GO judgement criterion values set by ㊸ "I", ㊹ "II" and ㊺ "III" ("GO/NO-GO PRESET") potentiometers located inside the side panel.

㉞ "GO/NO-GO DISPLAY" switch: When this switch is set in the ON state, GO/NO-GO judgement result is displayed. When it is OFF, no judgement result is displayed.

㉟ "DC OUT" terminal: When ㉜ "PRESET (ON/OFF)" switch is OFF, this terminal delivers the wow flutter rate measured in the sample hold mode (JIS, CCIR, DIN); when the switch is ON, this terminal delivers a DC voltage signal representing the GO/NO-GO judgement

criterion value selected by ㉝ "PRESET (I II III)" switch. The output signal voltage represents the value indicated by ⑧ "METER" or ⑨ "TAPE SPEED/WOW & FLUTTER/FREQUENCY" LED's -- the voltage is 1 V for full scale indication of ⑧ "METER." By connecting a digital voltmeter to this terminal, the wow and flutter rate of GO/NO-GO judgement criterion value can be digitally displayed. The GND terminal is connected to the chassis. The output impedance is approximately 10 kΩ.

㊱ "TO RECORDER" terminal: By connecting a pen-writing recorder or other similar instrument to this terminal, drift of the tape speed and wow and flutter rate can be recorded. The GND terminal is connected to the chassis. The output impedance is approximately 10 kΩ.

㊲ "TO SCOPE" terminal: By connecting a oscilloscope to this terminal, wow and flutter waveforms and periods can be directly observed. The GND terminal is connected to the chassis. The output impedance is approximately 10 kΩ.

㊳ Power cord:

AC line power cord (100 V ±10%, 50/60 Hz).

By changing the internal transformer taps, six types of AC line voltages are available as follows:

100 V, 110 V, 117 V

220 V, 230 V, 240 V

㊴ FUSE holder:

Fuse holder of the AC power line. Use a slow-blow fuse of a glass tube type (6.4 mm dia. × 30 mm (0.252 in. dia. × 1.18 in.)). The current rating depends on the AC line voltage as follows:

100 V, 110 V, 117 V ..... 1 A

220 V, 230 V, 240 V ..... 0.5 A

㊵ GND terminal:

For grounding the chassis (casing).

3.3 Explanation of Semi-fixed Potentiometers on Side Panel

(Refer to Figure 3-3.)

㊶ "STAND-BY TIME" potentiometer: Adjusts the standby time (2 ~ 6 sec) for sample hold measurement. The standby time becomes longer as this potentiometer is turned clockwise, and vice versa.

㊷ "REPEAT INTERVAL" potentiometer: Adjusts the interval (2 ~ 12 sec) between operations when in the repeat mode in the sample hold measurement. The interval becomes longer as this potentiometer is turned clockwise, and vice versa.

㊸ "I", ㊹ "II", ㊺ "III" "GO/NO-GO PRESET" potentiometers:

These potentiometers are for setting the GO/NO-GO judgement criterion values as required. The values increase as these potentiometers are turned clockwise, and vice versa. The adjustable range covers from zero to full scale of ⑧ "METER." When ㊷ "PRESET (ON/OFF)"

switch is set in the ON state and (17) "METER INDICATION" switch or (18) "DIGITAL DISPLAY" switch is depressed and locked ("MEMORY" state), (8) "METER" or (9) "TAPE SPEED/WOW & FLUTTER/FREQUENCY" LED's indicates the value selected by (33) "PRESET (I II III)" switch. Position "I", "II" and "III" of (33) "PRESET (I II III)" switch correspond to potentiometers "I", "II" and "III" on the side panel.

The GO/NO-GO judgement criterion value is of the range indicated by (27) "WOW FLUTTER RANGE (%)" LED's.

(46) ~ (56) Calibration potentiometers: These are calibration potentiometers of the instrument. These potentiometers must not be turned except the case the instrument is calibrated.

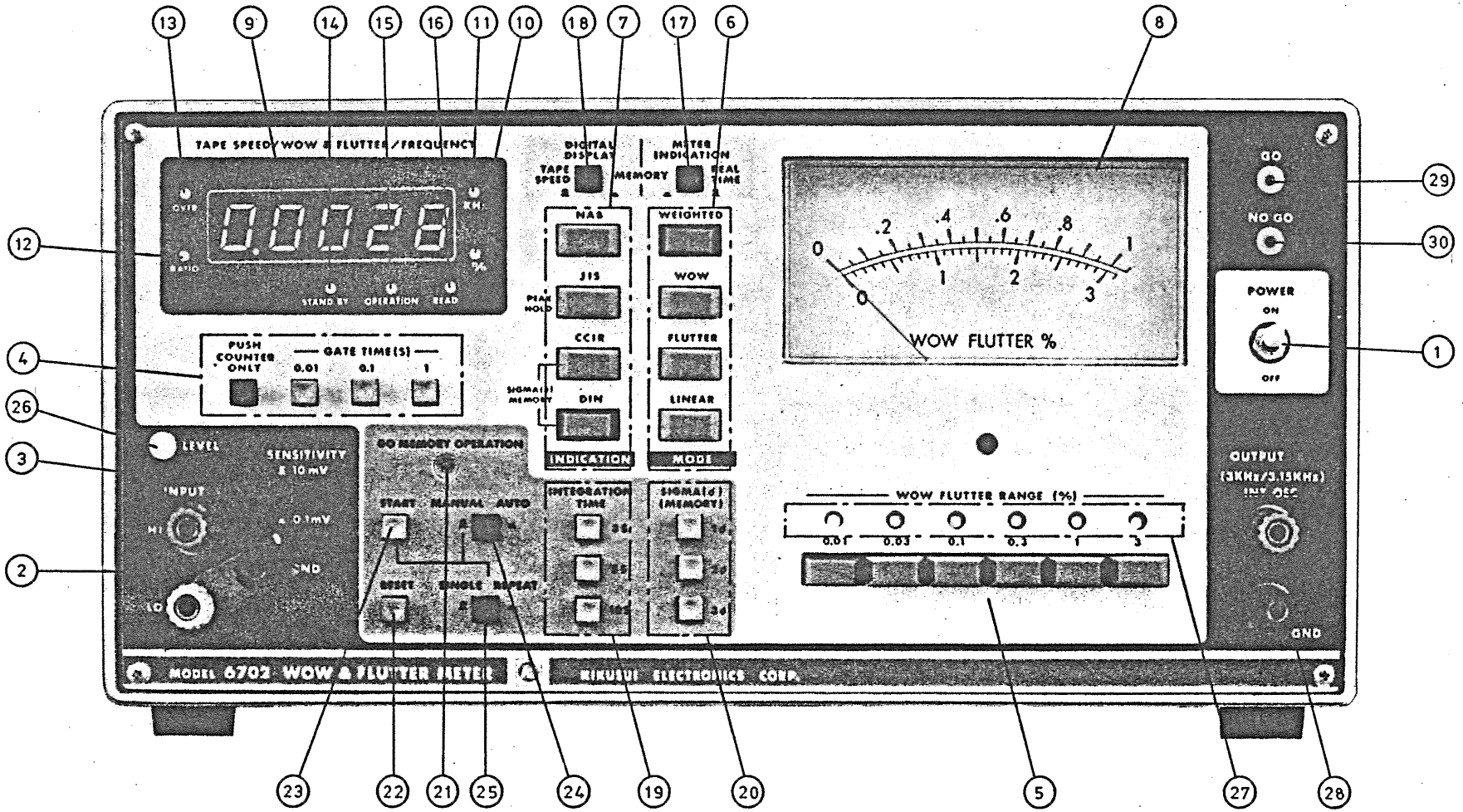


Figure 3-1 Front Panel

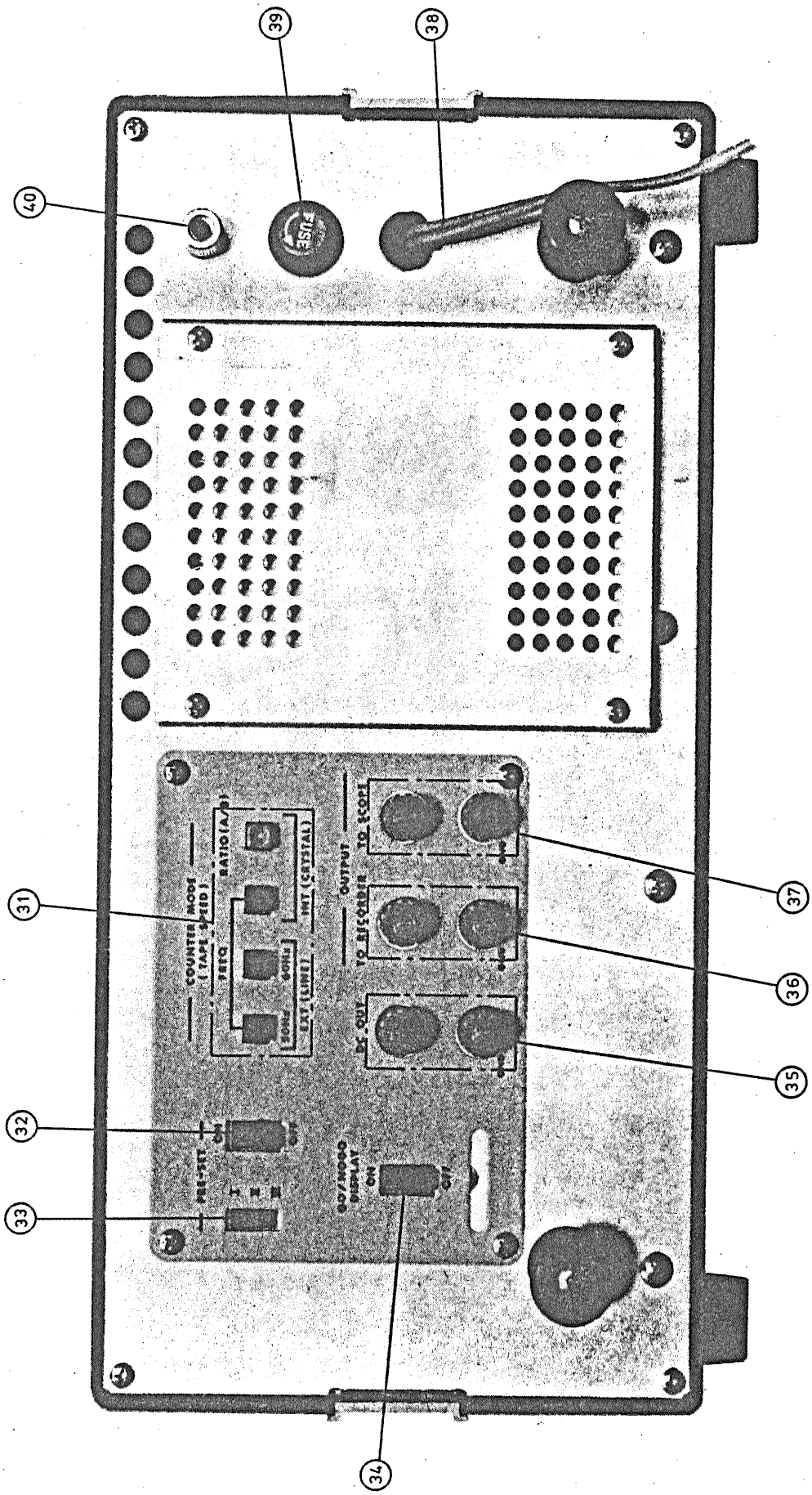


Figure 3-2 Rear Panel

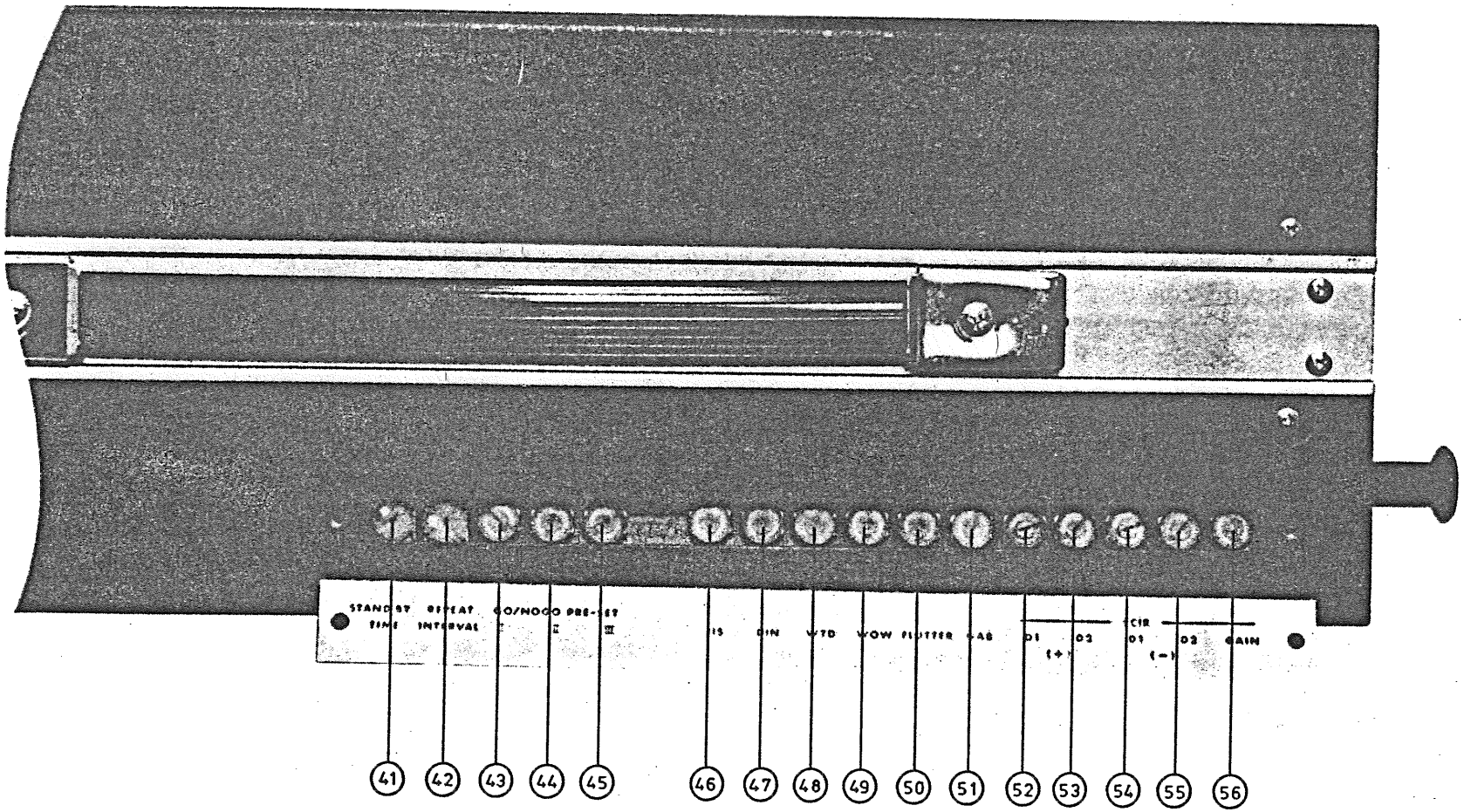


Figure 3-3 Semi-fixed Potentiometers on Side Panel

3.4 Operating Procedure

A. Wow and flutter measurement

1. Make sure that ① "POWER" switch is in the OFF state, connect ㊳ power cord to an AC line outlet, and set the panel switches as follows:

③ "SENSITIVITY" switch	"10 mV"
④ "COUNTER" switch "PUSH COUNTER ONLY".....	Not depressed
⑤ "WOW FLUTTER RANGE (%)" switch ..	"3 (%)"
⑥ "MODE" switch	Normally, "WEIGHTED" or "LINEAR"
⑦ "INDICATION" switch	NAB, JIS, CCIR or DIN as required
⑰ "METER INDICATION" switch	"REAL TIME"
⑱ "DIGITAL DISPLAY" switch	"TAPE SPEED"
㉛ "COUNTER MODE" switch	"FREQ/INT (CRYSTAL)"

2. Turn ON ① "POWER" switch.

3. Apply to ② "INPUT (A)" terminal the signal of the recording/reproducing device to be tested. If the tested device is a tape recorder or other similar device on which a signal is required to

be recorded before measurement or when measurement is to be performed by recording and reproducing at the same time, connect the input terminal of the tested device to the "OUTPUT (B) INT OSC" terminal.

(Either the 3000 Hz or 3150 Hz signal for recording can be selected by means of ⑦"INDICATION" switch on the front panel. (For frequency selection, refer to Section 3.5 "Notes in operation."))

Provided that the signal applied to ② "INPUT (A)" terminal is 10 mV rms or over, ㉖ "LEVEL" LED turns ON to indicate that the instrument is in the measuring state and ⑨ "TAPE SPEED/WOW & FLUTTER/FREQUENCY" LED's display the input signal frequency. If the input signal is less than 10 mV rms, you may set ③ "SENSITIVITY" switch in the "0.1 mV" state so that the input sensitivity increases and the required input signal level becomes 100 μV rms or over. Even when ㉖ "LEVEL" LED is ON, no correct wow and flutter rate is indicated unless the input signal frequency is 3000 Hz ±150 Hz (NAB, JIS, CCIR,) or 3150 Hz ±150 Hz (DIN). (㉖ "LEVEL" LED may turn ON even when the input signal level is lower than the rated minimum input level.)

4. Observing the point deflection of ⑧ "METER," gradually raise the instrument sensitivity by turning ⑤ "WOW FLUTTER RANGE (%)" switch from the "3(%)" position to "1(%)", "0.3(%)" and so forth

until the pointer deflection becomes maximum but not deflected overscale. Under this state, read the wow and flutter rate on the corresponding scale of the meter.

5. To measure the wow component only, press the "WOW" button of ⑥ "MODE" switch; to measure the flutter component only, press the "FLUTTER" button. These measurements are independent of ⑦ "INDICATION" switch setting for selection of Standards.

6. For the sample hold measurement, in addition to the above procedure, set the switches as follows:

(1) Measurement with peak hold system (JIS)

⑥ "MODE" switch	Press the required one of "WEIGHTED", "WOW", "FLUTTER" and "LINEAR" buttons.
⑦ "INDICATION" switch	"JIS"
⑲ "INTEGRATION TIME" switch ..	Required one of "3S", "5S" and "10S"

(2) Measurement with sigma memory (CCIR, DIN)

⑥ "MODE" switch	"WEIGHTED" or "FLUTTER"

⑦ "INDICATION" switch ..... "CCIR" or "DIN"

⑲ "INTEGRATION TIME" switch .. Required one of "3S","5S" and "10S"

The standard sigma (σ) operation time is 5S (5 seconds). The longer the operation time, the larger is the sample and the more accurately analyzed is the normal distribution. When 3S (3 seconds) is selected, note to the fact that the sigma operation for the wow component lower than 0.3 Hz is done with an attenuation rate of 24 dB/oct for the flatness characteristics.

⑳ "SIGMA (σ)" switch ..... Required one of "1 σ", "2 σ" and "3 σ"

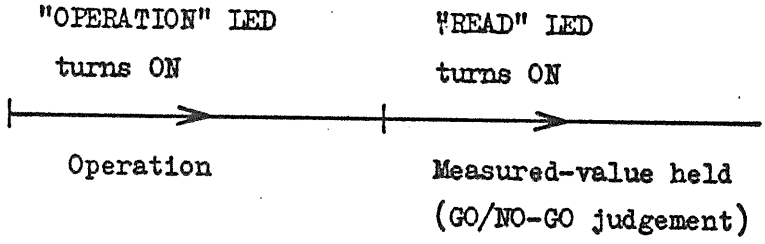
If the GO/NO-GO judgement is required, select the judgement criterion value with ㉝ "PRESET (I II III)" switch and turn ON ㉞ "GO/NO-GO DISPLAY" switch.

o Manual Operation

SINGLE

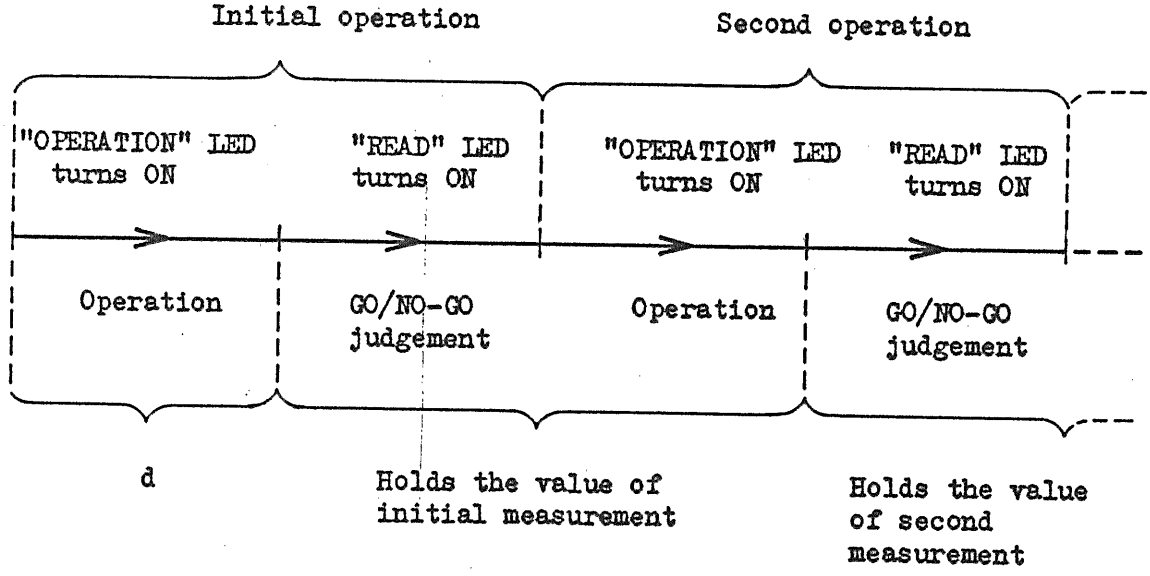
Set ㉔ "MANUAL/AUTO" switch and ㉕ "SINGLE/REPEAT" switch in the undepressed state ("MANUAL", "SINGLE") and depress ㉓ "START"

button. The circuit will clear the memory and perform a single operation.



REPEAT

Set (24) "MANUAL/AUTO" switch in the undepressed state ("MANUAL" state), depress and lock (25) "SINGLE/REPEAT" switch (set in the "REPEAT" state), and depress (23) "START" button. Measurements will be repeated as follows:

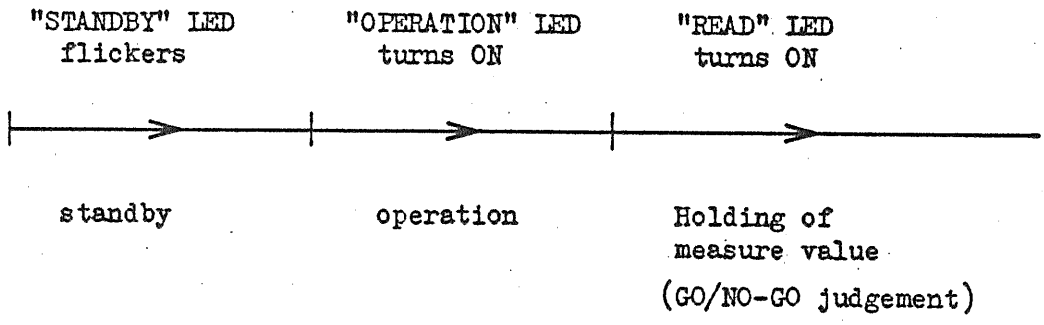


When in the REPEAT mode, the measured value of the preceding measuring cycle is held until the current operation is completed. Therefore, when wow and flutter rate is indicated by ⑧ "METER" or ⑨ "TAPE SPEED/WOW & FLUTTER/FREQUENCY" LED's, the result of measurement alone is displayed. Consequently, the difference of measured values between n-th measuring cycle and (n+1)-th measuring cycle can be read more easily.

Until the initial operation is completed (section "d" in the illustration), the data of the preceding measuring cycle is held.

o Auto Operation

Set ㉔ "MANUAL/AUTO" switch in the depressed and looked state ("AUTO" state) and ㉕ "SINGLE/REPEAT" switch in the undepressed state ("SINGLE" state). As the 3000 Hz (JIS, CCIR) or 3150 Hz (DIN) signal is received from the measured device (tape recorder, etc.) the circuit starts after clearing the memory and performs a series of operations as follows.



If (25) "SINGLE/REPEAT" switch is depressed and locked ("REPEAT" state), the measured-value indication method is the same as that in the "REPEAT" operation.

Regardless of whether in the MANUAL or AUTO operation, if you press (22) "RESET" button, the operation stops immediately and the memory is cleared.

As you depress and lock (17) "METER INDICATION" switch or (18) "DIGITAL DISPLAY" switch (set in the "MEMORY" state), the contents of the memory is indicated by (8) "METER" or (9) "TAPE SPEED/WOW & FLUTTER/FREQUENCY" LED's.

7. To observe waveforms and periods of wow and flutter components, connect an oscilloscope to (35) "TO SCOPE" terminal. A signal waveform which is corresponding setting of (6) "MODE" switch and (5) "WOW FLUTTER RANGE (%)" switch can be observed.

To record drifts (tape speed), connect a pen recorder to (36) "TO RECORDER" terminal. If you use a high speed pen recorder or similar instrument, wow and flutters can be recorded as well as drifts. The output of the terminal varies in the negative (-) direction as the tape speed shifts in the positive (+) direction (speed increases), regardless of setting of (6) "MODE" switch, (7) "INDICATION" switch and (5) "WOW FLUTTER RANGE (%)" switch.

To display externally the contents of the memory, connect a digital voltmeter to ㉟ "DC OUT" terminal. This terminal provides a DC voltage signal of 1 V for full scale of ⑧ "METER".

8. The tape speed can be directly read with ⑨ "TAPE SPEED/WOW & FLUTTER/FREQUENCY" LED's simultaneously as the wow and flutter rate is measured. The indication range is 2700 Hz ~ 3500 Hz or over (⑱ "DIGITAL DISPLAY" switch set in the "TAPE SPEED" state).

There are two other tape speed measuring methods as follows:

(1) By selecting the counter mode

Set ㉛ "COUNTER MODE (TAPE SPEED)" switch in the "RATIO (A/B)/INT (CRYSTAL)". In this case the reference gate time is controlled by the internal crystal oscillator and the tape speed is indicated in terms of ratio A/B between input signal frequency (a) and ㉘ "OUTPUT (B) INT OSC" terminal signal frequency (B). (⑫ "RATIO" LED turns ON.) The frequency of ㉘ "OUTPUT (B) INT OSC" terminal signal is automatically set to the center frequency of the Standards selected by ⑦ "INDICATION" switch. When the input signal frequency (A) is equal to the frequency of ㉘ "OUTPUT (B) INT OSC" terminal frequency, the frequency ratio (A/B) is

indicated as "1.000". Thus, tape speed variation is indicated as a dimensionless number. The indication range is 0.85 ~ 1.15 or wider.

As measuring Standards differ, indication may differ even for the same tape speed. Make sure that the correct Standards and correct Standard Test Tape are used.

(2) By selecting the reference gate time

Set (31) "COUNTER MODE (TAPE SPEED)" switch in the "FREQ/50 Hz EXT (LINE)" or "FREQ/60 Hz EXT (LINE)" state. Also the instrument operates as a regular frequency counter, the difference gate time is controlled by the AC line frequency. When the measured frequency is affected by the AC line frequency, measurement can be done eliminating the effects caused by the AC line frequency change, by using this method. Select "50 Hz" or "60 Hz" in conformity with the AC line frequency.

B. Frequency Measurement (Frequency Counter)

1. Depress and lock the "PUSH COUNTER ONLY" button of (4) "COUNTER" switches. When this is done, the instrument does not work as a wow and flutter meter and the sample hold measuring circuit also is reset.

2. Apply to ② "INPUT (A)" terminal the signal to be measured. If the signal level is 100 mV rms (sine wave) or over, ㉖ "LEVEL" LED turns ON (flickers if the input signal frequency is lower than 40 Hz) to indicate that the frequency measurement can be done. Set the gate time switch appropriately. ⑨ "TAPE SPEED/WOW & FLUTTER/FREQUENCY" LED's will directly indicate the signal frequency.

"0.01 (S)" ..... Measurable upper-limit frequency: 999.9 kHz
"0.1 (S)" ..... Measurable upper-limit frequency: 99.99 kHz
"1 (S)" ..... Measurable upper-linit frequency: 9.999 kHz

When such a signal is applied that its frequency exceeds 9999 indicated by ⑨ "TAPE SPEED/WOW & FLUTTER/FREQUENCY" LED's, ⑬ "OVER" LED flickers to indicate that the input signal frequency is higher than the measurable upper limit. (㉖ "LEVEL" LED may light even when the input signal level is lower than the specified minimum input voltage level.

3.5 Notes in Operation

o The "WOW" measurement and "FLUTTER" measurement selected by ⑥ "MODE" switches are not based on any paticular standards. These measurements may be used for analysis study.

- When the instrument is operating as a wow and flutter meter, if the level and frequency of the input signal applied to (2) "INPUT (A)" terminal are not within the specified ranges of the instrument, (26) "LEVEL" LED does not turn-on. However, if the input signal level is sufficiently high, (26) "LEVEL" LED turns-on even if the input signal frequency is not within the specified frequency range of the instrument. For wow/flutter measurement, check the center frequency specified by the Standard applied for the measurement.

- When the reproduced signal level (input signal) is sufficiently high (10 mV rms or over), set (3) "SENSITIVITY" switch in the "10 mV" position. With this setting, stable measurement can be done as the wow/flutter meter does not deflects over the full scale and the measurement is less affected by noise.

- If the input signal is not sinusoidal (if the signal includes higher orders of harmonics at large rates even when the fundamental component is a sine wave), the instrument may not operate in spite of that the signal level is within the input signal level. This is especially true when the input signal is a square wave of an abnormal duty ratio (far from 1). Measurement is successful if the effective-value level of the signal is within the operating input level range of the instrument.

- The input impedance between "HI" and "LO" of ② "INPUT (A)" terminal normally is within 600 kΩ ±20%. When ③ "INPUT SENSITIVITY" switch is set in the "0.1 mV" position, the input impedance becomes approximately 10 kΩ regardless of whether the instrument is used as a wow flutter meter or a frequency counter.

- The signal frequency of ㉘ "OUTPUT (B) INT OSC" terminal differs according to setting of the ⑦ "INDICATION" switch as follows:

  3000 Hz ..... NAB, JIS, and CCIR

  3150 Hz ..... DIN

  The output signal level also slightly differs between 3000 Hz and 3150 Hz.

- Do not press at the same time two or more buttons of ⑥ "MODE", ⑦ "INDICATION", ⑲ "INTEGRATION TIME", ⑳ "SIGMA (σ)" or "WOW FLUTTER RANGE (%)" switches. If two or more switches are depressed at the same time, no correct measurement can be expected.

- When the instrument is in the sample hold mode and the circuit is in operation, do not turn ⑥ "MODE", ⑦ "INDICATION", ⑲ "INTEGRATION TIME", ⑳ "SIGMA (σ)", (CCIR, DIN), or ⑤ "WOW FLUTTER RANGE (%)" switch. If any one of these switches is turned while in operation, no correct wow and flutter rate measured the sample hold mode is displayed.

- The memory is cleared if the power is turned OFF.

- Note that, since the wow/flutter measuring sensitivity and input sensitivity of this instrument are very high, the wow/flutter measuring range and indicating meter errors vary by setting ⑥ "MODE" and ⑤ "WOW FLUTTER RANGE (%)" switch and by the input signal level. (Refer to Section 2 "SPECIFICATIONS").

- Note that, since the oscillating frequency of the internal reference signal oscillator of this instrument is 1.26 MHz and ⑨ "TAPE SPEED/WOW & FLUTTER/FREQUENCY" LED's are driven in a time-sharing system, the instrument may radiate waves through very slightly. An MW radio receiver or an FM radio receiver placed very close (within 10 cm (3.94 in.)) to this instrument may be affected.

- The ambient temperature and humidity conditions of this instrument are 5°C ~ 35°C (41°F ~ 95°F) and 85% RH. Do not use the instrument under direct sunlight, near a source of heat, or in a highly humid atmosphere. When the instrument has been moved from a cold place to a warm place, allow a sufficient stabilization period after turning-on the instrument power. Note also that adverse environmental conditions (gases, dust, vibration, chemicals, etc.) will shorten the instrument life. The storing ambient temperature range is approximately -10°C (-14°F) to +60°C (+140°F).

- When the instrument is modified for its AC line power, also change the indications of fuse rating and AC line voltage.

4. OPERATING PRINCIPLE

4.1 Definitions of Wow and Flutter

The rate of variation in speed (ξ_u) of an object in motion can be expressed in terms of percentage as follows:

$$\xi_u = \frac{U - U_0}{U_0} \times 100\ (\%)$$

where, U_0 : Average velocity

U : Instantaneous velocity

This concept can be applied to measurement of relative speed variation of the recording medium of a record/playback device (such as the tape of a tape recorder). Since the reproduced signal frequency is a function of the tape speed, the rate of relative speed change (ξ_w) of a record/playback device can be expressed in terms of the rate of frequency change in percentage as follows:

$$\xi_w = \frac{f - f_0}{f_0} \times 100\ (\%)$$

where, f_0: Center frequency

f : Instantaneous frequency

Thus, wow and flutter can be defined as "frequency variation caused by variation in relative velocity between recording medium and detecting head of a record/playback device when in a recording or reproducing operation." Slower frequency variation is called "wow" and faster variation is called "flutter." Very slow variation (gradual variation) is called "drift" and it is not included in the categories of wow and flutter as used here.

In other words, wow and flutter are the same in effects with that center frequency f_o has been frequency-modulated with the deviation of $f - f_o$. The rate of wow and flutter denotes the degree of frequency modulation. The terms wow, flutter and drift are used to distinguish the changing speed.

4.2 Measuring Principle

Wow and Flutter Meter Circuit

The rate of wow and flutter difined in Section 4.1 can be known by demodulating the frequency-modulated signal. The basic construction of this wow and flutter meter, which employs the above principle, is as shown with a basic block diagram in Figure 4-1.

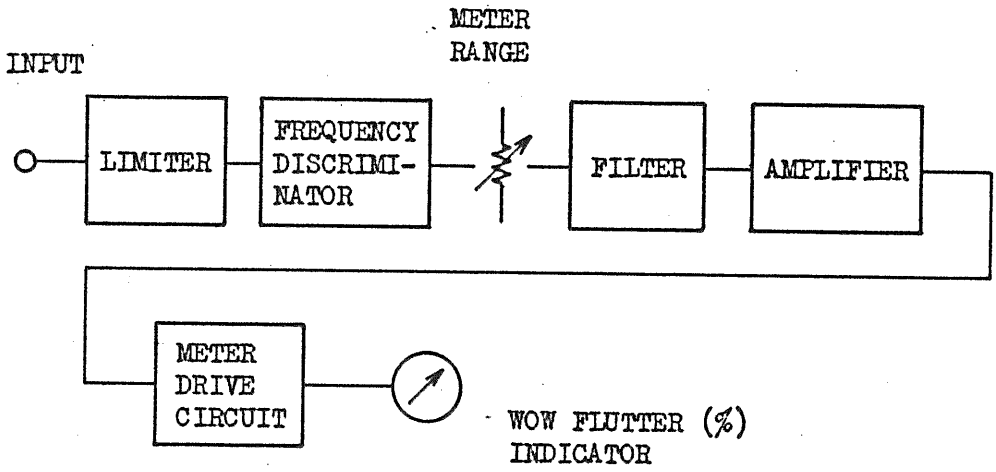


Figure 4-1 Basic block diagram of Wow and Flutter Meter

The input signal is fed through the limiter circuit to the frequency discriminator for demodulation. The demodulator output signal is fed through the meter range selector circuit to the filter circuit which conditions the signal in accordance with the speed of frequency change as defined in Section 4.1. The conditioned modes are four types of WEIGHTED, WOW, FLUTTER, and LINEAR.

The WEIGHTED mode is for aural compensation in compliance with NAB, JIS, CCIR and DIN. The signal is weighted in accordance with the effects of wow and flutter on the aural sense of human being.

The WOW and FLUTTER modes are for separating, with filters, the wow and flutter components with 6 Hz as the boundary frequency between the two components. The LINEAR mode is for passing all components of wow and flutter. The Standards are available as is the case for the WEIGHTED mode.

The signal weighted as above is amplified with the amplifier and fed to the indicating meter through the meter drive circuit (indicating meter circuit). The indicating meter circuit provides indicating systems corresponding to the applied Standard (NAB = mean value, JIS = effective value, CCIR/DIN = peak value). This circuit also controls the dynamic characteristics of the indicating meter.

Sigma Memory Circuit

If the reading of the meter which indicates the measured wow and flutter rate varies quite at random with respect to time, it can be assumed that the probability distribution of peak voltage values (V_{WF}) of the sinusoidal wave components included in the signal are of a normal distribution of a bell shape as shown in Figure 4-2. In the case of a normal distribution, approximately 99.7% of the measured values theoretically fall in span ($V_{WF} - 3\sigma$, $V_{WF} + 3\sigma$), 95.4% in span ($V_{WF} - 2\sigma$, $V_{WF} + 2\sigma$), and 68.3% in span ($V_{WF} - \sigma$, $V_{WF} + \sigma$). This instrument is designed to apply the above characteristics of the normal distribution to wow and flutter measurement. All

components which are not within the above spans are eliminated by regarding them to be caused by external factors, and the components which are inside the span are measured to determine the wow and flutter rate.

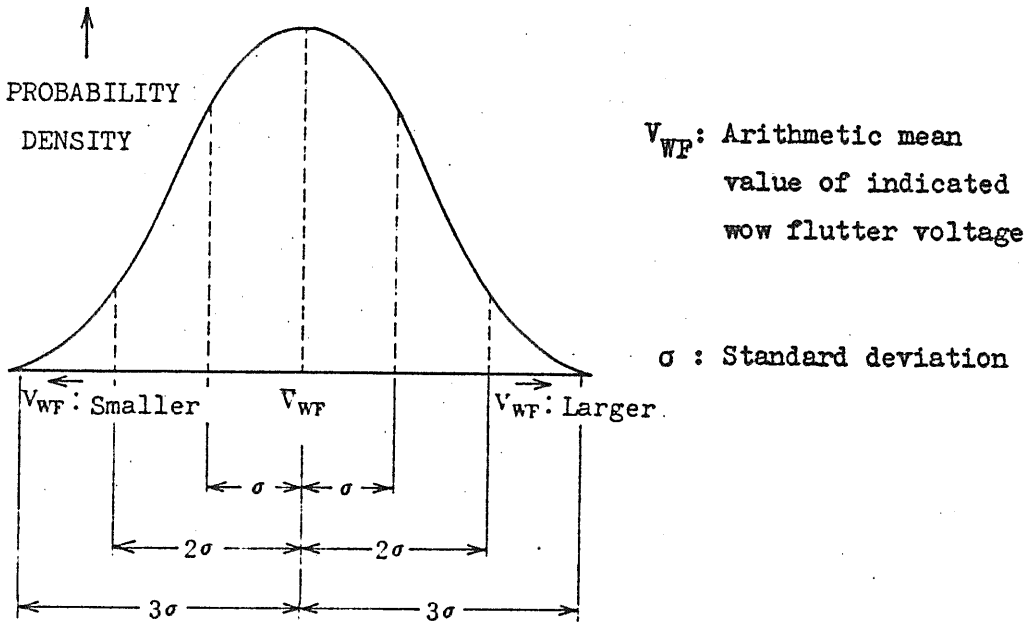


Figure 4-2

Figure 4-3 shows a basic circuit for voltage measurement (sigma operation) basing on the characteristics of the normal distribution. Integration constant (RC) is selected by (27) "SIGMA (σ)" switch in order to determine the components of wow and flutter to be eliminated and the remaining components are integrated to obtain the maximum value. Processing of the wow and flutter signal by sigma operation circuit is illustrated in Figure 4-4.

An overall block diagram of the instrument is shown in Figure 4-5.

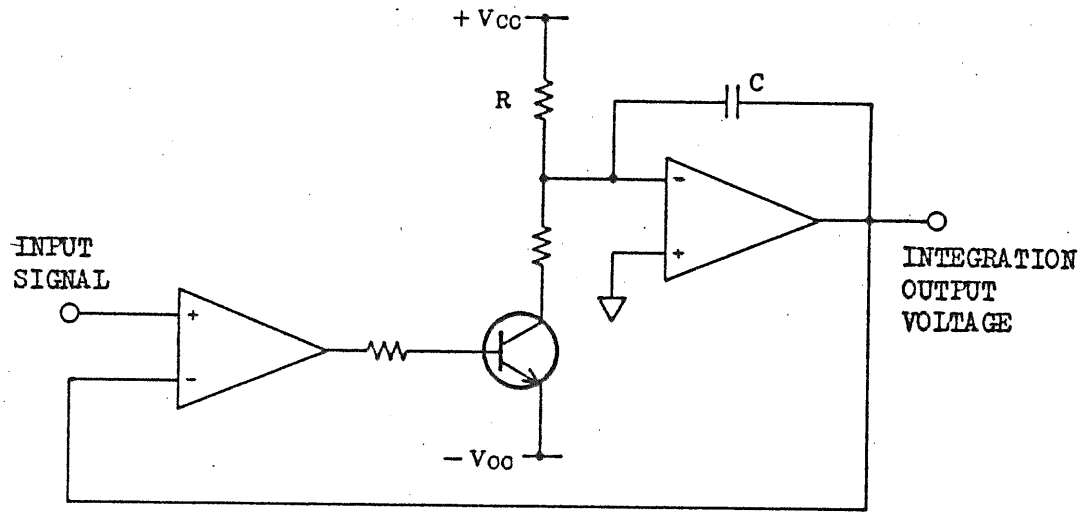


Figure 4-3 Sigma operation circuit

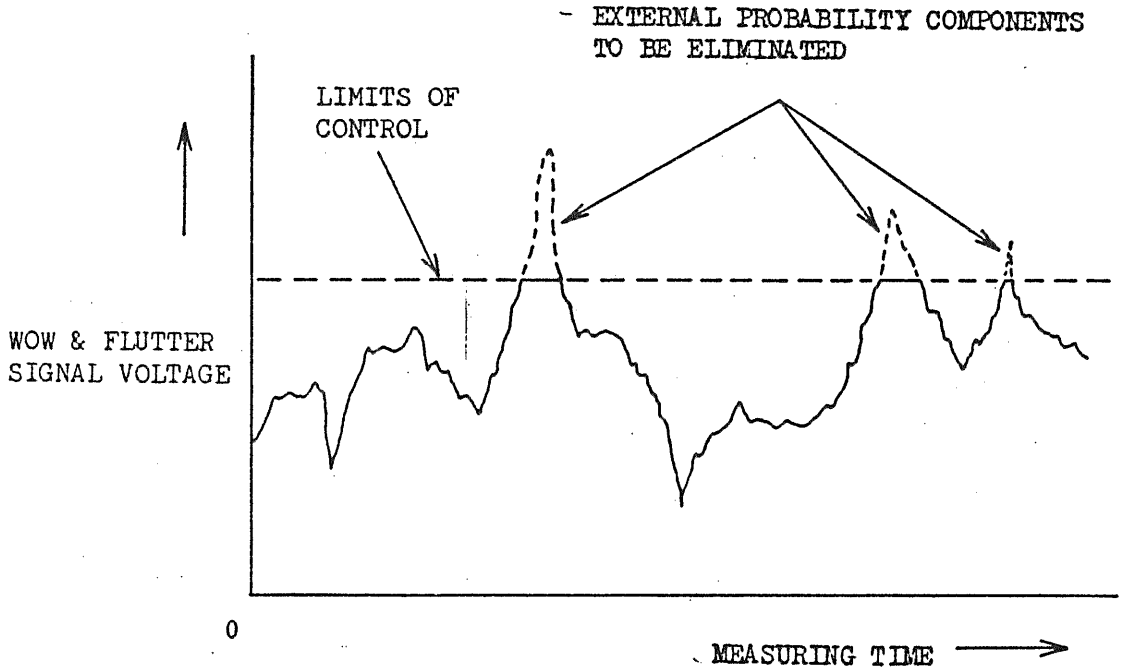


Figure 4-4

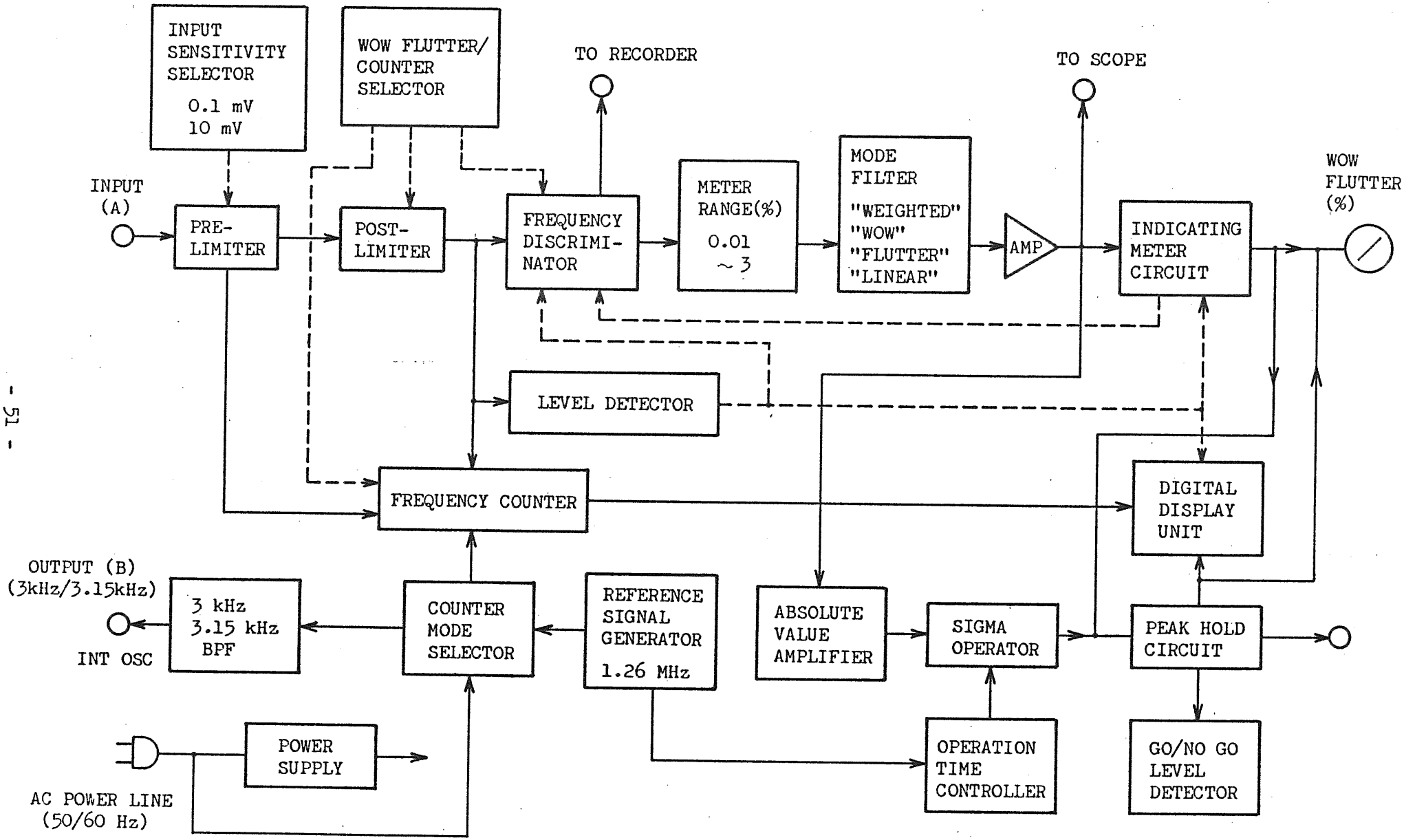


Figure 4-5 Block Diagram

5. SIGMA (σ) OPERATION

Regarding the data of measured values (x) of chemical analysis, lengths, weights or time in general, assuming that the variation factors which affect the original population from which the data have been collected are of a nature of probability, their probability density function $\phi(x)$ can be expressed as follows:

$$\phi(x) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left[-\frac{1}{2\sigma^2}(x-\mu)^2\right] \quad \ldots\ldots\ldots (5\text{-}1)$$

where, σ and μ are positive constants

This equation represents a "Gaussian error curve Figure 5-1" derived theoretically basing on the law of errors. The variation factors of the wow and flutter signal voltage (V) also is of a nature of probability and its waveform is complicated as a typical example is shown in Figure 5-2. Yet, this complicated waveform is a combination of a number of sinusoidal wave components which have respective periods and peak values. Taking the peak voltage (V_{WF}) as a probability variable, its probability density function $\phi(V_{WF})$ can be expressed by equation (5-2).

$$\phi(V_{WF}) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left[-\frac{1}{2\sigma^2}(V_{WF}-\mu)^2\right] \quad \ldots\ldots (5\text{-}2)$$

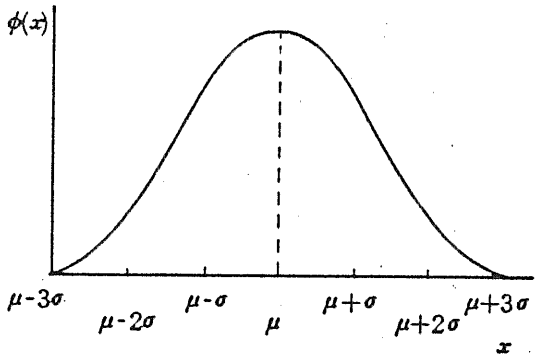


Figure 5-1

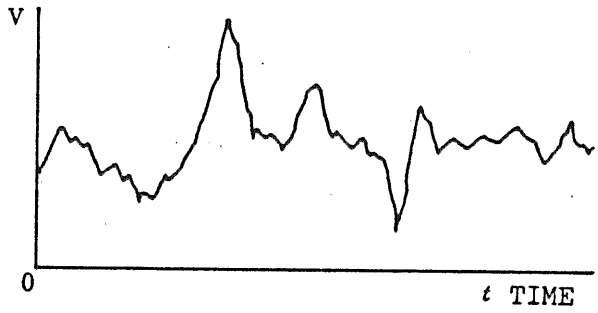


Figure 5-2 Wow flutter signal waveform (typical)

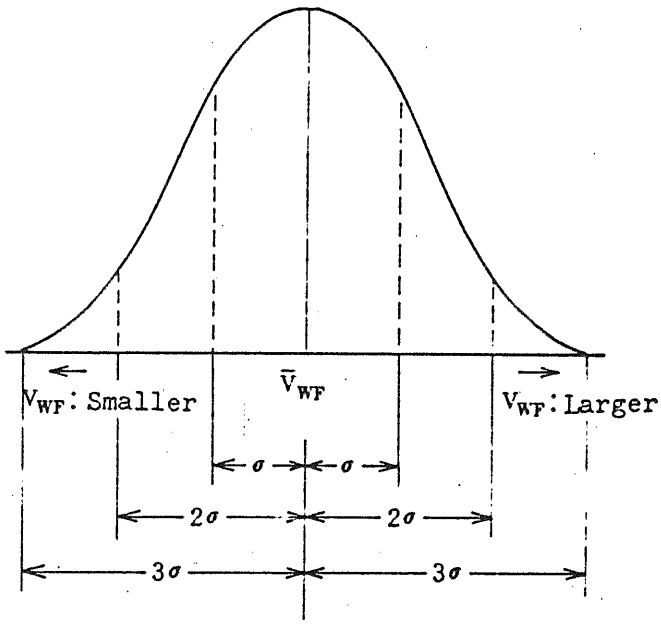


Figure 5-3

Referring to Figure 5-3, the probability of the value falling onto the span of 1 σ deviation is approximately 68.3% (probability of falling onto other than the span is approximately 31.7%), and the probabilities falling onto the spans of 2 σ and 3 σ deviations are approximately 95.4% (probability of falling onto other than the span is approximately 4.6%) and approximately 99.7% (probability of falling onto other than the span is approximately 0.3%), respectively, as calculated by the following equation:

$$P\left(\overline{V}_{WF} - \sigma \leqq \overline{V}_{WF} \leqq \overline{V}_{WF} + \sigma\right)$$

$$= \frac{1}{\sqrt{2\pi}} \int_{\overline{V}_{WF}-\sigma}^{\overline{V}_{WF}+\sigma} \exp\left[-\frac{1}{2\sigma^2}\left(V_{WF} - \overline{V}_{WF}\right)^2 d V_{WF}\right]$$

Now, assume a sine wave voltage which is expressed as follows:

$$V = g(t) = \sin t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5\text{-}3)$$

To calculate the rate of existens of each instantaneous value per unit period of time ($P\{g(t)\}$) let us derive a derivative the reciprocal function of equation (5-3). The reciprocal function of equation (5-3) is as follows:

$$t = \sin^{-1} g(t) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (5\text{-}4)$$

(Refer to Figure 5-4)

This equation signifies an infinite polyvalent function in section [-1, 1]. In order to obtain a monovalent function, let us define the range of "t" to the main value of $\sin^{-1} g(t)$, that is, to the section defined by the following equation:

$$-\frac{\pi}{2} \leqq \sin^{-1} g(t) \leqq \frac{\pi}{2} \quad \cdots\cdots\cdots\cdots\cdots\cdots \quad (5\text{-}5)$$

Now, the following equation can be written:

$$\frac{dg(t)}{dt} = \cos t$$

Therefore,

$$\frac{dt}{dg(t)} = \frac{1}{\frac{dg(t)}{dt}} = \frac{1}{\cos t} \left[-\frac{\pi}{2} \leqq \sin^{-1} g(t) \leqq \frac{\pi}{2}\right]$$

As $\cos t \geqq 0$ in equation (5-5),

$$\cos t = \sqrt{1 - \sin^2 t} = \sqrt{1 - g^2(t)}.$$

Consequently,

$$P\{g(t)\} = \frac{d}{dt} \sin^{-1} t = \frac{1}{1-g^2(t)} \quad \cdots\cdots\cdots \quad (5\text{-}6)$$

$$[-1 < g(t) < 1]$$

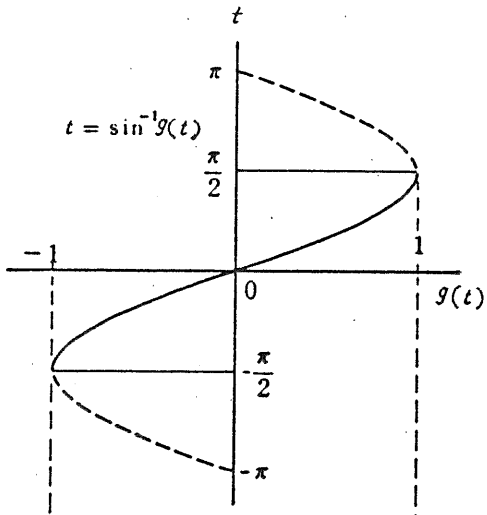


Figure 5-4

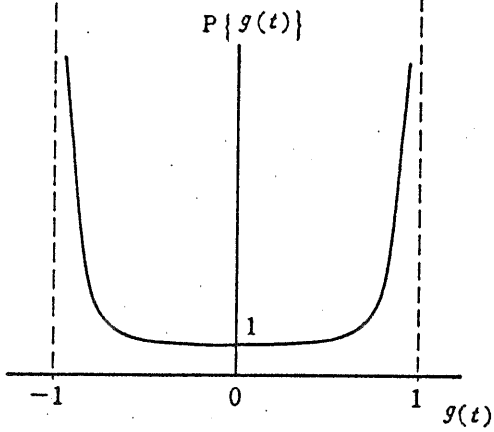


Figure 5-5

As shown in Figure 5-5, the closer the signal value to the peak value of the sine wave, the larger is $P\{g(t)\}$. The wow and flutter signal voltage actually applied to the sigma integrator is as expressed by equation (5-6). Further, as the signal is full-wave rectified, the sample of V_{WF} also becomes larger. The current which represents the outside probability in the normal distribution (31.7% for 1 σ section, 4.6% for 2 σ section and 0.3% for 3 σ section) flows in resister R and

it is not charged in capacitor C. The shorter the period of wow flutter indication voltage or the longer the operation time, the closer is the probability density of V_{WF} to the normal distribution.

6. MAINTENANCE

6.1 Calibration

The instrument has been designed for accurate and reliable operation for a long time. However, it is most recommendable to calibrate the instrument at every six (6) months in order to maintain its reliability and especially its accuracy.

6.2 Notes in Calibration

- Before turning-on the instrument power, check mechanical zero of (8) "METER" and adjust it as if required.

- Allow more than 5 minutes of stabilization period after turning-on the instrument power.

- Allow sufficient statilization periods also for instruments which are used for calibration.

- Calibrate the instrument in an ambient temperature of $20^{\circ}C \pm 10^{\circ}C$ ($68^{\circ}F \pm 50^{\circ}F$).

6.3 Calibration Procedure

Remove the calibration panel from the right-hand side of the instrument (by removing the two clamping-screws at both sides).

The semi-fixed potentiometers inside the instrument are identified with the marks on the panel. For calibration, follow in the due order the procedure mentioned in the following and set the center frequency of the wow/flutter calibrator frequency at 3000 Hz and the output voltage at approximately 1 V rms unless specified otherwise.

"INDICATION" Calibration for "JIS"

(1) Set the panel switches as follows:

㉛ "COUNTER MODE" switch: FREQ INT (CRYSTAL)
③ SENSITIVITY switch: "10 mV"
④ "PUSH COUNTER ONLY" button of "COUNTER" switch: Undepressed state
⑤ "WOW FLUTTER RANGE (%)" switch: "0.1"
⑥ "MODE" switch: "LINEAR"
⑦ "INDICATION" switch: "JIS"
⑰ "METER INDICATION" switch: "REAL TIME"

(2) From a calibrator, apply a signal frequency-modulated with a sinusoidal wow/flutter signal of 4 Hz by 0.100% rms. So adjust the "JIS" potentiometer that ⑧ "METER" pointer indicates the "1" position of the "0 ~ 1" scale.
The JIS calibration is complete by the above procedure.

(3) Varying the degree of FM (frequency modulation) of the calibrator signal in conformity with ⑤ "WOW FLUTTER RANGE (%)" switch of instrument and check the meter indication (full scale). Check that the meter indication is within ±5% FS for the 0.01% range and within ±2.5% for other ranges.

(4) Return ⑤ "WOW FLUTTER RANGE (%)" switch to the 0.1% range position.

Level Adjustment of MODE Filter

(5) Set ⑥ "MODE" switch in the "WEIGHTED" state.

(6) Set the calibrator as explained in (2) above, and so adjust the "WTD" control that ⑧ "METER" pointer indicates the "1" position of the "0 ~ 1" scale.

(7) Set ⑥ "MODE" switch in the "WOW" state.

(8) Set the wow/flutter frequency alone of the calibrator at 1 Hz.

(9) Check that ⑧ "METER" meter pointer is within 0.95 ~ 1.05 of the "0 ~ 1" scale.

(10) Set ⑥ "MODE" switch in the "FLUTTER" state.

(11) Set the wow/flutter frequency alone of the calibrator at 40 Hz.

(12) Check that ⑧ "METER" pointer is within 0.95 ~ 1.05 of the "0 ~ 1" scale.

(13) Return ⑥ "MODE" switch to the "LINEAR" state.

Indication Calibration for NAB

(14) Set ⑦ "INDICATION" switch in the "NAB" state.

(15) From a calibrator, apply a signal frequency-modulated with a sinusoidal wow/flutter signal of 40 Hz by 0.100% rms. So adjust the "NAB" control that ⑧ "METER" pointer indicates the "1" position of the "0 ~ 1" scale.

Indication Calibration for CCIR

(16) Set the panel switches as follows:

⑦ INDICATION switch: CCIR
⑥ MODE switch: LINEAR

(17) From the calibrator, apply a signal frequency-modulated with a wow flutter signal of 40 Hz by 0.100% peak. So adjust the "CCIR GAIN" control that ⑧ "METER" pointer indicates the "1" position on the "0 ~ 1" scale.

(18) Set ⑥ "MODE" switch in the "WEIGHTED" state and ⑤ "WOW FLUTTER RANGE (%)" switch in the "1" position.

(19) Set the wow flutter signal of the calibrator at frequency 1 Hz, FM degree 2% peak-peak, waveform square pulse, and pulse width 100 msec. So set that the frequency varies in the positive (+) direction as the pulse signal is applied.

(20) So adjust the "CCIR, (-) D1, D2" controls that the maximum deflection of the meter pointer becomes "1 $\pm$0.04" and the minimum deflection "0.41 $\pm$0.04" on the "0 ~ 1" scale. Adjust the maximum deflection with "D1" and the minimum deflection with "D2".

The frequency discriminator output of this instrument varies in the negative (-) direction as the frequency varies in the positive (+) direction. In the above case, therefore, adjust the (-) sides of the "D1" and "D2" controls. If the frequency variation is in the negative (-) direction, adjust the (+) sides of these controls.

(21) Varying the pulse width of the calibrator signal to 60 msec, 30 msec and 10 msec, check that the maximum meter indications on the "0 ~ 1" scale are as follows:

60 msec ..... 0.9 ±0.06

30 msec ..... 0.62 ±0.06

10 msec ..... 0.21 ±0.03

(22) If the indications are not within the above tolerances, re-adjust the instrument starting by Step (20).

(23) Set the frequency deviation of Step (19) in the negative (-) direction.

(24) Adjust the "CCIR, (+) D1, D2" controls as explained in Steps (20) ~ (22).

(25) When the above adjustment has been done, return the procedure to Step (16) and check that ⑧ "METER" pointer deflection is within "1 ±0.025" on the "0 ~ 1" scale.

(26) Repeat the procedure of (16) through (25) for 2 or 3 times.

Indication Calibration for DIN

(27) Set the panel switches as follows:

⑦ "INDICATION switch: "DIN"

⑥ "MODE switch: "LINEAR"

⑤ "WOW FLUTTER RANGE (%)" switch: "0.1"

(28) From the calibrator, apply a signal frequency-modulated with a wow flutter frequency 40 Hz (center frequency 3150 Hz) by 0.100% peak. So adjust the "DIN" control that ⑧ "METER" pointer indicates the "1" position on the "0 ~ 1" scale. Only when the center frequency of the calibrator is 3000 Hz, adjust ⑧"METER" pointer at 0.952 of the "0 ~ 1" scale.

The sample hold circuit has already been sufficiently stabilized and it is not required to be adjusted here.

When in the sigma operation, the 3 σ mode corresponds to 100% indication and the 2 σ and 1 σ mode correspond to 99.3% and 86.9%, respectively. (theoretical values)
[Wow flutter waveform: sinusoidal wave (approximately 70 Hz)]