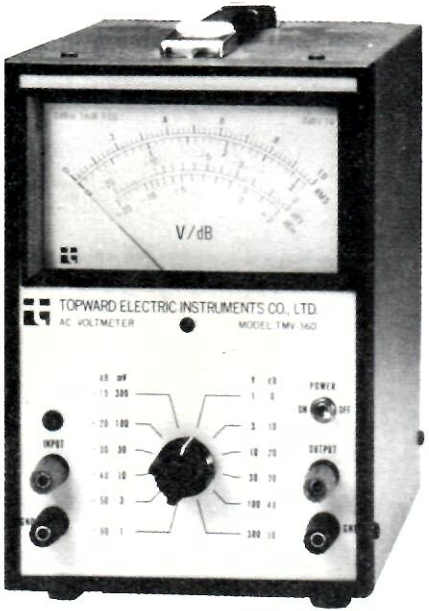
INSTRUCTION MANUAL

AC MILLIVOLT METER
MODEL: TMV-360/380/381/381R

Topward

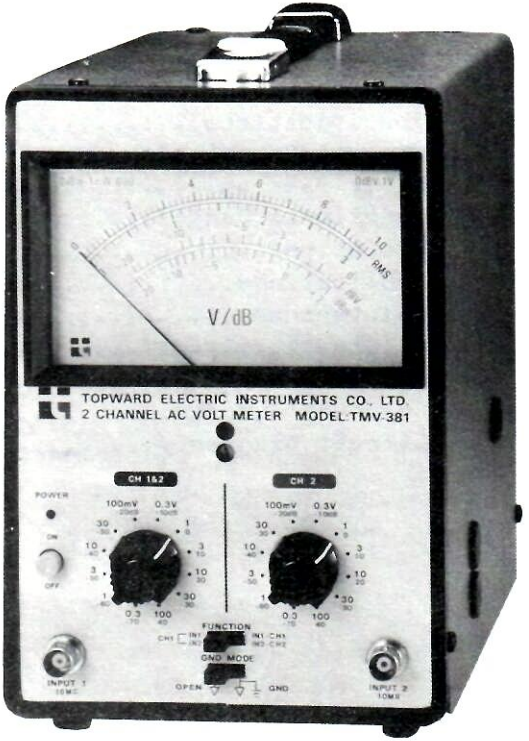
TABLE of CONTENTS

TMV-360



TMV-380

TMV-381



GENERAT

TOPWARD'S Model TMV-380, TMV-381 and TMV-381R are dual-channel electronic voltmeter sets having two independent AC voltmeters in a single cabinet. Two-pointer meter allows easy dual measurements and inter-channel comparisons. They also are wideband, super high sensitive voltmeter for use anywhere voltage measurements are made. The easy-to-use voltmeter provides frequency response as wide as 5 Hz to 1 MHz, measurable range from 0.3mV to 100V, (1 mV to 300V for TMV-380) and input impedance of 10 M . The optional remote control feature is convenient for measurement in production lines.

The Model TMV-381R range indicator lamp is prepared on the top side of dual pointer meter and remote control of range switching is availabe to check the input range.

TMV-381R is attached line decorder and the measuring range can be remotely controlled by ACS-017.

This manual was prepared in common to four versions, major differences of which are as follows.

TMV-381, TMV-381R 300uV maximum sensitivity.
TMV-380, TMV-360 1mV maximum sensitivity. (TMV-360 single channel only)

FEATURES

A. All solid state circuitries provide high stability, rather short warm-up time, and low power consumption.

B. Two power source circuits, positive and negative, are provided for very stable DC bias and recover from any overload in a very short time.

C. Small-sized compact construction is easy to carry and large-sized two-pointer meter is easy to read.

D. Two-color, four-scale dial plate and red and black pointers allow quick, and accurate voltage reading.

E. Number of adjusting trimmers are minimized with amplifiers that are precisely calculated in open loop gains and are negative feedbacked through metalfilm resistors as accurate as 1%

Amplifier characteristics therefore are free from secular change.

F. Input impedance is as high as 10 MΩ on all ranges and its parallel capacitance less than 45 pF.

G. Indirect attenuator switching by relay and FET (field-effect transistor) switch provides higher reliability,signal-to-noise ratio, and inter-channel

crosstalk than most previous direct method of rotary switch.

H. Remote range selection is possible in a simple way that optional remote control unit "ACS-017" can be connected to TMV-381R, since is attached remote function.

I. Two channel range setting can be made either individually or together (in interlocked manner).

J. A ground mode selector may float measuring circuit above ground.

SPECIFICATIONS

Values brackets [ ] are for the TMV-380, TMV-360 version

Meter Section

Measurable voltages:	0.3mV-100V in 12 ranges: 0.3mV, 1mV, 3mV, 10mV, 30mV, 100mV, 0.3V, 1V, 3V, 10V, 30V and 100V full scales. [1mV-300V in 12 ranges: 1mV, 3mV, 10mV, 30mV, 100mV, 300mV, 1V, 3V, 10V, 30V, 100V and 300V full scales.]
dB:	-90 ~ +40dB (0dB= 1V).
dBm:	-90 ~ +42dBm [-90 ~ +46dBm] (0dBm=1mW, 600Ω).
Error:	Within+- 3% of full scale at 1kHz.
Frequency response:	+- 10% at 5Hz ~ 1MHz, +- 5% at 10Hz ~ 500kHz and +- 3% at 20Hz ~ 200kHz as +- 2% at 30Hz ~ 100kHz referenceed to 1kHz response.
Input impedance:	10MΩ +-5%, with less than 45pF parallel capacitance.
Durable input voltage:	500V (DC + AC peak) 100V peak (DC+AC peak) up to -10dB.
Stability:	Within +-0.5% of full scale for +-10% line voltage fluctuation.

Temperature coefficient:	+-0.08%/°C.
Residual voltage :	Less than 30uV at shorted input on TMV-381, 100uV on TMV-360 and 380.
Operating temperature:	0～50°C.
Relative humidity:	80%.
Crosstalk, Individual:	Less than -80dB with other input terminated with 600Ω.
Interlock:	Less than -50dB with other input terminated with 600Ω.
Residual noise:	Less than 30uV with input shorted on 0.3mV range.

Amplifier Section

Gain:	Approx. 70dB.
Output voltage:	1Vrms +-10%.
Output impedance:	600Ω +-10%.
Distortion:	Less than 1% at full scale. (Rated by signal-to-noise ratio in 0.3mV. 1mV and 1V 〔 1mV , 3mV and 3 V 〕 ranges.)
Signal-to-noise ratio:	Over 40dB at full scale. (Over 30dB at 0.3mV 〔 1mV 〕 range)
Frequency response:	Wethin +-3dB at 5Hz～500kHz.

Power Supply Section

Line voltage:	115V,230V AC +-10%, 50/60Hz.
Power consumption:	Approx. 10W
Accessory	TMV-360 ACS-001x1, TMV-380 ACS-003x2, TMV-381 ACS-003x2.

Dlimensions:	128(138)W x 190(212)H x 238(268)Dmm. Values in ( ) include protrusions.
Net weight:	3kg.

Accessories

Power cable:	1pc.
Input cable:	BNC cord, 2 pcs.
Instruction manual:	1 copy.

CIRCUIT DESCRIPTION

In studying the operation of each circuit in voltmeter please refer to Figure 1, the "Block Diagram ", and the Schematic Diagram on the back.

Outline of Operation

A signal voltage to be measured, which is input from the INPUT connector, is passed through the First Attenuator and is converted to a low impedance by the Impedance Converter. The impedance-converted signal is normalized, or further attenuated in proportion to 1 Vrms fullscale value through the Second and Third Attenuator. The normalized signal is magnified 20-fold by the Main Amplifier and is fed to the Output Amplifier and the Absolute-Mean Value Detctor.

The Output Amplifier magnifies the signal 50-fold and feeds to the OUTPUT connector. The Absolute-Mean Value Detector converts the signal from the Main Amplifier to DC current in proportion to the absolutemean value. The converted signal activates the Meter.

The Attenuator Control encodes the signal led from the RANGE selector to generate an Attenuator Control signal. This signal controls the First, Second, and Third Attenuators to set the sensitivity corresponding to each range.

The Power Supply feeds to the functional circuits +-5 V DC voltages stabilized by its IC regulator.

escription of Functional Circuits

1. First Attenuator

A resistance divider attenuator. The amount of attenuation is switched in two steps by relay contacts: 0dB and -60dB.

2. Impedance Converter

A three-fold no-phase-inverison amplifier having a FET differential input. This converts the First Attenuator output signal to a sufficiently low impedance and feeds to the Second Attenuator.

3. Second Attenuator

A resistance divider attenuator. The amount of attenuation is switched in two steps by relay contacts:0 dB and -30 dB.

4. Third Attenuator

A resistance divider attenuator. The amount of attenuation is switched in four steps by a FET switch: 0 dB, -10 dB, -20 dB, and -30 dB.

5. Main Amplifier

A wideband, non-phase-inversion amplifier having a differential input. This has high input impedance, low output impedance, and 20-fold gain. This output signal level is 20 mVrms for the fullscale read on the Meter.

6. Output Amplifier

A wideband, non-phase-inversion amplifier with a differential input. This works stably even for capacitive loads. The gain is 50-fold and the output impedance 600Ω . The output signal level is 1 Vrms for the fullscale read on the Meter.

7. Absolute-Mean Value Detector

An absolute-mean value detector comprised of a high through-rate, high gain amplifier with a differential input. This has a very good linearity as negative feed back by the voltage detected from the current flowing through the Meter load. In switching, this provides a sufficiently wide frequency band so that the high frequency pahse compensation circuit is reset.

8. Attenuator Control

A logic control circuit comprised of a diode matrix and output buffer transistors. This encodes a 12-bit signal from the RANGE selector switch to 6-bit signals, which control the First, Second, and Third Attenuators. The remote control connector is connected to this circuit.

9. Power Supply

A power source of converting the AC input to +-5V DC outputs to supply. This has a silicon diode bridge for full-wave rectification, high-capacitance electrolytic capacitors for smoothing, and an IC regulator stabilization.

10. RANGE-CH1 & 2 Selector

A 12-contact rotary switch for setting a desired channel 1 and 2 measurable voltage range. This feeds a signal corresponding to the range into the Attenuator Control.

11. RANGE-CH 2 Selector (Below description are in TMV-380, TMV-381 only)

A 12-contact rotary switch for setting a desired channel 2 measurable voltage range. This feeds a signal corresponding to the range into the Attenuator Control.

12. CH2 SELECTOR Switch

A selector which is used to select either individual or interlocked range setting of channels 1 and 2. This selector, when set on the individual side (right position), allows the RANGE-CH2 selector 11 to set a channel 2 range independently. At the left position (interlock side), the RANGE-CH1 & 2 selector 10 can set both channel 1 and 2 ranges at a time.

13. GND MODE Switch

A switch which is used to disconnect the input negative circuits from the casing ground. The switch, when in the GND position, connects both channel 1 and 2 negative leads to the grounding post (casing). At the OPEN position, the input negative connectors are floated off ground. This allows grounding on the signal source side.

BLOCK DIAGRAM

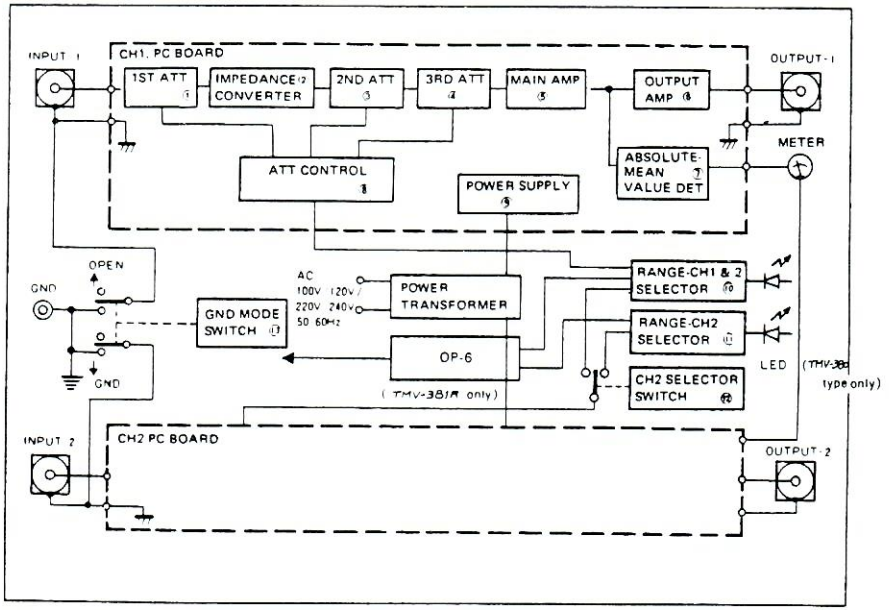


Figure 1 - Block Diagram

FUNCTIONAL CONTROLS

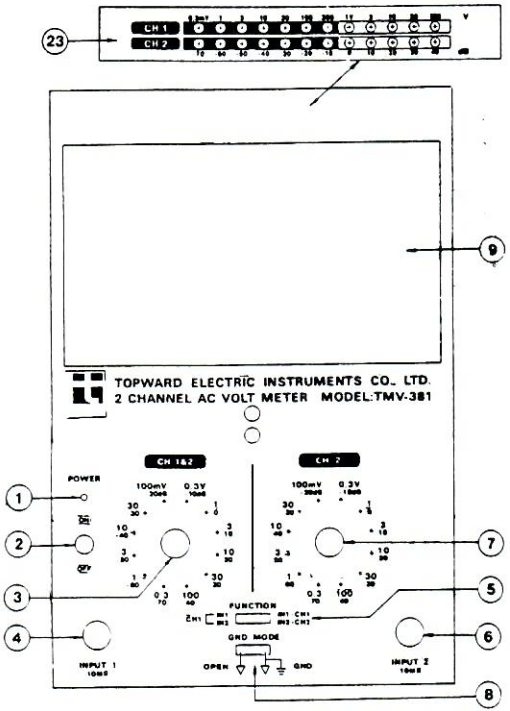


Figure 2 - Front Panel View

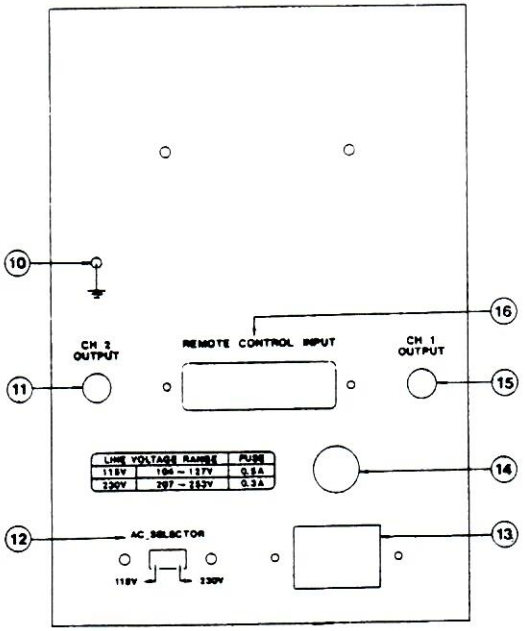


Figure 3 - Rear Panel View

Front panel (see Figure 2)

1. Power on indicator (LED).

2. **POWER** - Power on-off switch.

3. **RANGE-CH1 & 2** - Channel 1 and 2 attenuator selector.

4. **INPUT 1** - Channel 1 input connector.

5. **CH2 SELECTOR** - Individual-interlock range setting selector.

6. **INPUT 2** - Channel 2 input connector.

7. **RANGE-CH2** - Channel 2 attenuator selector.

8. **GND MODE** - Negative input floating switch.

9. Dual-pointer meter.

Rear panel (see Figure 3)

10. **GND** - Casing grounding post.

11. **OUTPUT-2** - Channel 2 monitor output connector.

12. Line voltage selector.

13. Power cable connector.

14. Fuse holder.

15. OUTPUT-1 - Channel 1 monitor output connector.

16. CONT-INPUT - TMV-380, TMV-381 type: Remote control mounting hole.
TMV-380R type: connector for Remote control.

23. Range indicator lamp (TMV-381R only).

OPERATION

Set-up

Values in brackets [ ] are for the TMV-380, TMV-360 version.

1. Press the **POWER** pushswitch 2 in. The Power-on indicator 1, a light-emitting diode, will light, indicating that power has been applied.

2. Plug the signal calbes into the **INPUT** 1 and 2 connectors 4 and 6.

3. Set the **CH2 SELECTOR** switch 5 to the individual side (right position).

4. Set the **RANGE-CH 1 & 2** selector 3 and the **RANGE-CH2** selector 7 to "100V [300V]". To measure an AC voltage superimposed on a DC voltage, be sure to set the selectors to the positions before connecting the cables to points to be measured. Otherwise, the DC voltage causes a high surge, which could burn voltmeter.

5. Set the **GND MODE** selector 8 to "GND" (right position).

6. Connect the cables to points to be measure.

7. Turn the selectors 3 and 7 for proper ranges until each Meter pointer switngs over one third of the fullscale.

8. Read the Meter.

(1). Voltage Scales

There are two black voltage scales: a scale A graduated 0 to 10 and a scale B 0 to 3. When the RANGE selector 3 is at "1 V", for example, the division 10 on the scale A indicates 1 V. At the "300mV" position, the division 3 on the scale B indicates 300mV. Similarly, the other RANGE selector positions show their full scale values.

(2). dB Scale

In general, the dB values are expressed in dBV which is a unit referenced by 0 dB equal to 1 V. (Note that the TMV-380, TMV-360 version has no dB scale.) The division 10 at the scale A corresponds to 0 dB on the red dB scale, which is a voltage ratio scale. Since the RANGE selector has 12 range positions in steps of 10 dB, the voltage ratio of 0.3mV to 100 V is 110 dB attenuation. Assume a reference voltage level on the scale A be 1 V with the RANGE selector at "1 V", a given voltage can be read as low as -70 dB (0.3mV) by turning the selector downward. Further, as the scale A allows reading to -20 dB (0.03mV), you can continuously measure the voltage ratio as high as -90 dB (0.03mV to 1 V). The read of -90 dB means a signal-to-noise ratio of around 10 dB. Also, the dB scale allows continuous measuring up to +40 dB (1 to 100 V) by turing the selector upward.

(3). dBm Scale

In general, voltmeters have a reference level division of 0 dBm equal to

0.775 V (1mW power) induced across a 600Ω resistance load, Therefore, the red dBm scale is available to measure a power level referenced to 0 dBm, with the impedance of the given power circuit being 600Ω pure resistance. Where measured across specific resistance loads, for example, 10kΩ , other than the 600Ω load, the levels are sometimes expressed in dBs.

How to Use Remote Control

Availability of the optional Remote Control is one of outstanding features of Voltmeters.

TMV-381R : To attach the Remote Control, remove the blind plate at the rear of voltmeter. Install and plug the optional connector into the 16-pin connector on the PC board. Wire it to the multi-pin connector (plug) supplied with the option. Also, wire its pins to a RANGE pushswitch or rotary switch and to a **PANEL-REMOTE** switch and individual-interlock switch (toggle switch, pushswitch or slide switch). These switches allows you to change the measuring voltage range on your voltmeter from a distance place.

TMV-381R type: The measuring range of TMV-381R can be remetely coutrolled by ACS-017(option). The outputs of remote controll connector 16 are as table 1 and the input and output or each range are as tabel 2.

Connector P16		Connector P16	
1	A	6	G
2	B	10	REMOTE-PANEL change over
3	C	11	GROUND
4	D	12	−5V
5	G		

Table 1

	Connector(16)					
	1	2	3	4	5	6
	A	B	C	D	G	G
	L	H	H	H	L	L
	H	L	H	H	L	L
	L	L	H	H	L	L
	H	H	L	H	L	L
1mV	L	H	L	H	L	L
3mV	H	L	L	H	L	L
10mV	L	L	L	H	L	L
330mV	H	H	H	L	L	L
100mV	L	H	H	L	L	L
300mV	H	L	H	L	L	L

Table 2

	1	2	3	4	5	6
	A	B	C	D	G	G
1 V	L	L	H	L	L	L
3 V	H	H	L	L	L	L
10 V	L	H	L	L	L	L
30 V	H	L	L	L	L	L
100 V	L	L	L	L	L	L
300 V	H	H	H	H	L	L
	×	×	×	×	H	L
	×	×	×	×	L	H
	×	×	×	×	H	H

(TTL Level)

REMOTE : L PANEL : H
The "H" indicates the open collector of more than 5V.

APPLICATIONS

The basic use of your voltmeter is to measure sinusoidal wave voltages as an AC voltmeter. In addition, it provides a wide variety of applications as described below.

Amplifier Gain Measurement

Voltmeter is capable of measuring an amplifier gain, which is a signal magnification from point A to B in Figure 6 with a signal generator connected to the amplifier input. If the measured signal levels at points A and B are a and b dB, respectively, then the gain is (b - a) dB.

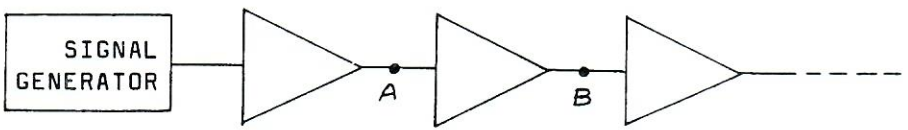


Figure 6 - Amplifier Gain Measurement

Also the method is applicable for measuring an open loop gain of each amplifier circuit with the negative-feedback signal leaves applied. Further, the method can be used for measuring the frequency responses of given circuits by changing the signal generator frequency. Voltmeter is capable of directly reading a gain between two points as having two independent voltmeters. As an

example, let us calculate the open loop gain (from point A to B) of the negative-feedback amplifier shown in Figure 8. Assume that the measured level at point A be +1.5 dB on the -60 dB range of the channel 1 and that of point B -4 dB on the +10 dB range of the channel 2. The gain from point A to B is then (+10 dB -4 dB) - (-60 dB + 1.5 dB) = 64.5 dB.

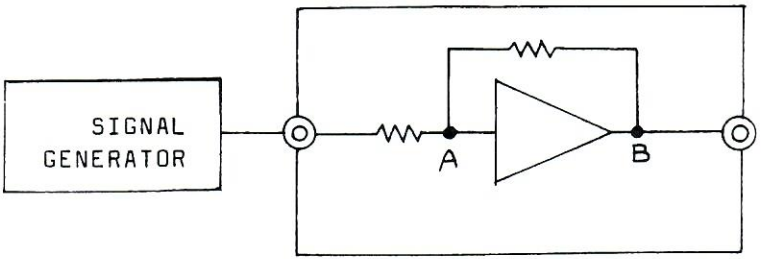


Figure 7 - Negative Feedback Amplifier Gain Measurement

Voltage Calculations of Some Special Waveforms

An voltmeter of absolute-mean value indication type, reads root-mean-square values of sinusoidal wave inputs. Also it deflects the pointers in proportion to the absolutemean value of a given input wave.

If the form factor (=root-mean-square value/absolutemean value) of the input wave and the crest factor (=peak value/root-mean-square value) are known; then the root-mean-square value and peak value can be calculated as follows.

Assume the Meter read V.

Absolute-mean value = $\frac{2\sqrt{2}}{\pi}$ V ≒ 0.9 V.

Root-mean-square value =(Absolute-mean value) x (Form factor).

Peak value = (Root-mean-square value) x (Crest factor).

For rectangular wanes, their form factor and crest factor are unity (1).

Absolute-mean value = $\frac{2\sqrt{2}}{\pi}$ V ≒ 0.9 V.

Root-mean-square value = 0.9 V.

Peak value = 0.9 V.

For sawtooth waves, their form factor is $2/\sqrt{3}$ and the crest factor $\sqrt{3}$.

Absolute-mean value = $\frac{2\sqrt{2}}{\pi}$ V ≒ 0.9 V.

Root-mean-square value= $\frac{2\sqrt{2}}{\pi} \times \frac{2}{\sqrt{3}}$ V = $\frac{4\sqrt{2}}{\pi\sqrt{3}}$ V ≒ 1.04 v.

Peak value = $\frac{4\sqrt{2}}{\pi\sqrt{3}} \times \sqrt{3}$ V = $\frac{4\sqrt{2}}{\pi}$ V ≒ 1.8 V.

Ways To Better Dual-Channel Voltmeter Operation

The two input channels and two meter pointers arranged specifically in Voltmeter are most useful for measuring an electronic equipment having two signal sources.

For example, Voltmeter is far more convenient for measuring stereo left and

right channel characteristics than using two units of usual single-channel voltmeter.

(1)Frequency response

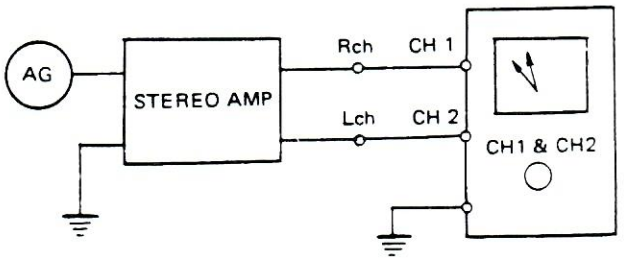


Figure 8 - Stereo Amplifier Frequency Response Measurement

Set the **CH2 SELECTOR** switch to the lift side (interlock position) as most stereo amplifiers are not deviated vertually in the left and right channel levels. Set the **GND MODE** switch to "GND". If the given stereo amplifier output has no connector common to the left and right channels, then turnt he switch to "OPEN" and connect the GND post on the rear panel of voltmeter to that of the stereo amplifier.

(2)Crosstalk characteristic

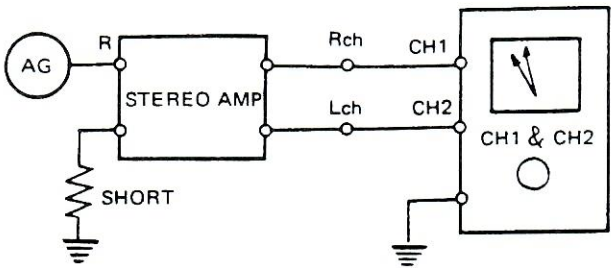


Figure 9 - Stereo Amplifier Crosstalk Measurement

Crosstalk measurement is needed if there is a large difference between the left and right channel output levels. Slide the **CH2 SELECTOR** switch to right side (individual position). Set the **RANGE-CH1 & 2** selector and **RANGE-CH2** selector to proper positions for ease of read. Set the **GND MODE** switch for no adverse effect by hum as explained in above Example (1), the "Frequency response".

MAINTENANCE

Removing the casing

1. Remove the six screws holding the casing on the both sides and top using a Phillips screw driver.

2. Widen the bottom of the 7-shaped casing a little and pull it up for removal.

Mounting the casing

1.Widen the bottom of the casing a little when covering it over the main body.

2. Fit the casing PC board retianer to the PC board.

3. Alternately tighten the six screws for uniform torque.
CAUTION: Excessive tightening could cause damaging the screw or breaking the vinyl leather. Be careful.

Replacing the fuse

1. Open the fuse holder using a Phillips screw driver.

2. Replace the fuse.
   CAUTION: Be sure to select the fuse of rated capacity. For a 100 to 120 V AC lines, use a 0.5 A fuse; for a 200 to 240 V AC lines, a 0.3 A fuse.

ALIGNMENT

Voltmeter was presicely aligned at the factory. However it can be aligned through the adjust holes located on the side with leaving is housed in the casing, if required. In realignment, first adjust the line to the rated voltage, use a precisely calibrated measuring instruments, and proceed as follows.

Values in brackets [ ] are in the TMV-380, TMV-360 version.

Presert Controls on Side Panel (see Figure 4)

The foolowing controls, placed on the Main PC boad (600041001), are to be preset on the right-hand side panel.

IDENTIFICATION	DESCRIPTION
TC101	First Attenuator preset trimmer capacitor
VR101	First Attenuator preset variable resistor
VR102	Meter Amplifier gain preset variable resistor

1. Before turning the **POWER** switch "ON", adjust the Meter zero-adjust screws (right for channel 1 and left for channel 2) on the front panel until the pointers correctly indicate "0".

2. Set the CH2 **SELECTOR** switch to the right side (individual position).

3. Connect a voltmeter calibrator 1 KHz (or 400 Hz) output to the INPUT connector 4.

4. Set the **RANGE-CH1 & 2** selector 3 on your TMV-380 to the 30mV 100mV range and set the voltmeter calibrator output voltage to 30 mV (100mV).

5. Adjust VR102 until the pointer swings to the fullscale.

6. In turn, set the **RANGE-CH1 & 2** selector 3 to the 10V (30V) range and set the voltmeter calibrator output voltage to 10V (30V).

7. Adjust VR101 until the pointer swings to the fullscale.

8. Disconnect the voltmeter calibrator and connect a wideband signal generator to the **INPUT** 1 connector 4.

9. Set the signal generator frequency to 1 KHz and set the **RANGE -CH1 & 2** selector 3 on voltmeter to the "1 V" range.

10. Adjust the signal generator output level until the pointer swings to the fullscale.

11. Change the signal generator frequency from 1 kHz to 50 kHz.

12. Adjust TC101 until the pointer swings to the fullscale.

13. Repeat Steps 3 through 10.

14. For channel 2 alignment, similarly proceed with Steps 3 through 13.

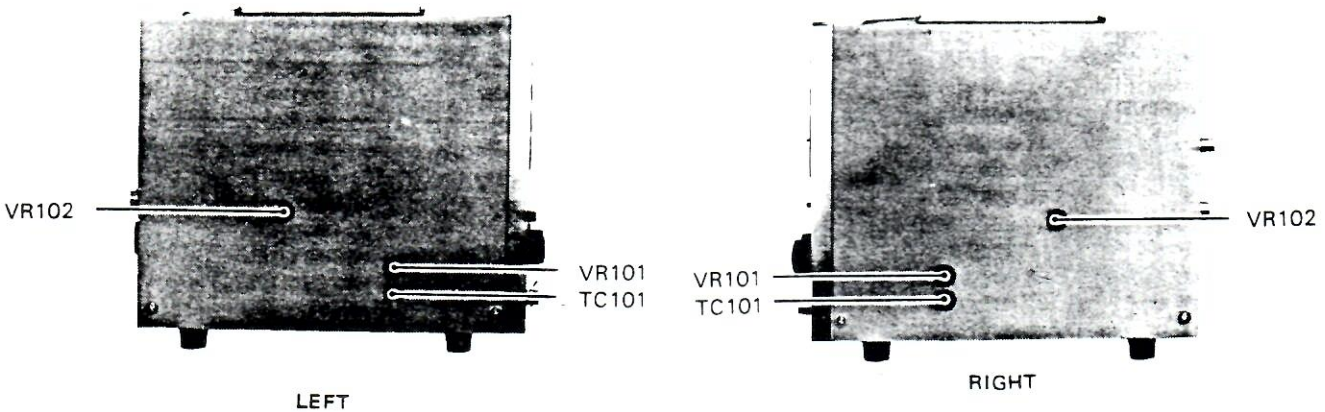


Figure 4 - Preset Controls on Side Panel

CAUTIONS FOR USE

1. Your voltmeter will work just when the POWER switch is pressed in. For accurate measurements, wait around five minutes for warm-up.

2. Avoid placing your voltmeter where magnetic field and electric field are too strong.

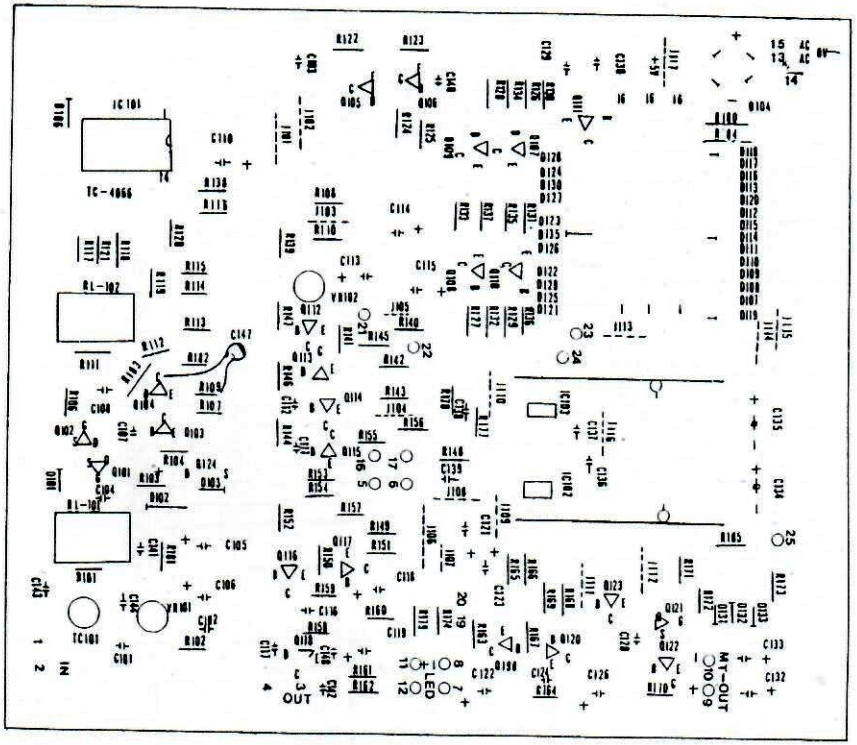
3. The input signal cable other than supplied should be low-capacitance shielded cable, or coaxial cable. For measurements at higher than audio frequencies, terminate the input connetors with 50Ω or 600Ω , resistor.

4. The continuous maximum input voltage allowable for your voltmeter is 80 Vrms with the **RANGE** selector at "-70dB" to "-10dB". Full care should be observed in measuring high voltages.

5. Be careful of a line noise and similar small noises as your voltmeter is a highly sensitive voltmeter.

6. Do not leave your meter at any of high temperature and humidity places for a long period of time.

7. As having two channel independent voltmeter, your voltmeter is involved in selection of grounding point on some equipment udner measurement. Set the **GND MODE** switch to "OPEN" and connect the GND post of your voltmeter to a point where noise effect is minimized.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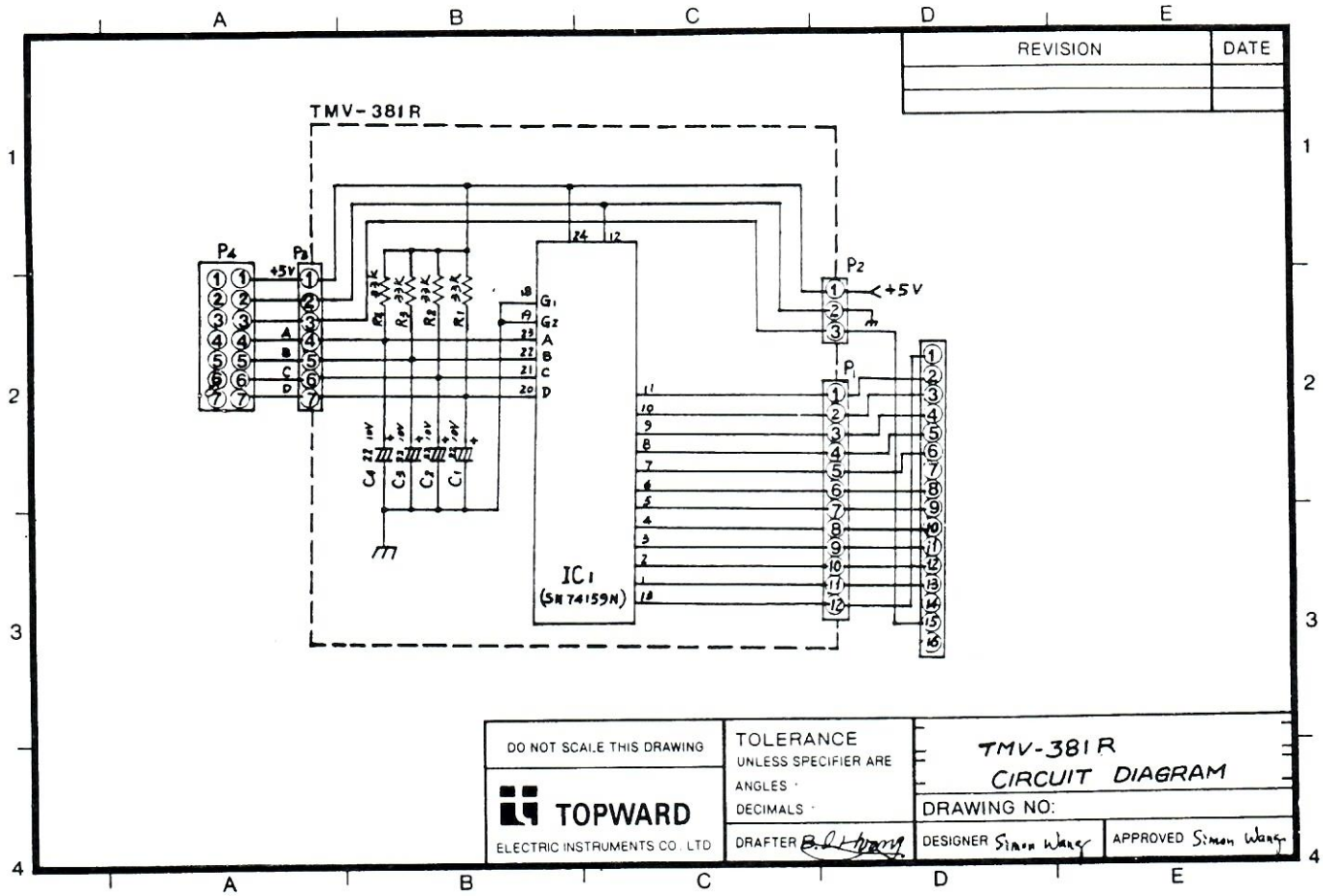
RL-102
RL-101
TC101
YR102
YR101
IN
OUT
MT-OUT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TMV-381R
P4
P3
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A
B
C
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R3 33K
R2 33K
R1 33K
C4 22 10V
C3 22 10V
C2 22 10V
C1 22 10V
24
12
16
15
23
22
21
20
G1
G2
A
B
C
D
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8
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TOPWARD
ELECTRIC INSTRUMENTS CO. LTD
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DESIGNER Simon Wang
APPROVED Simon Wang
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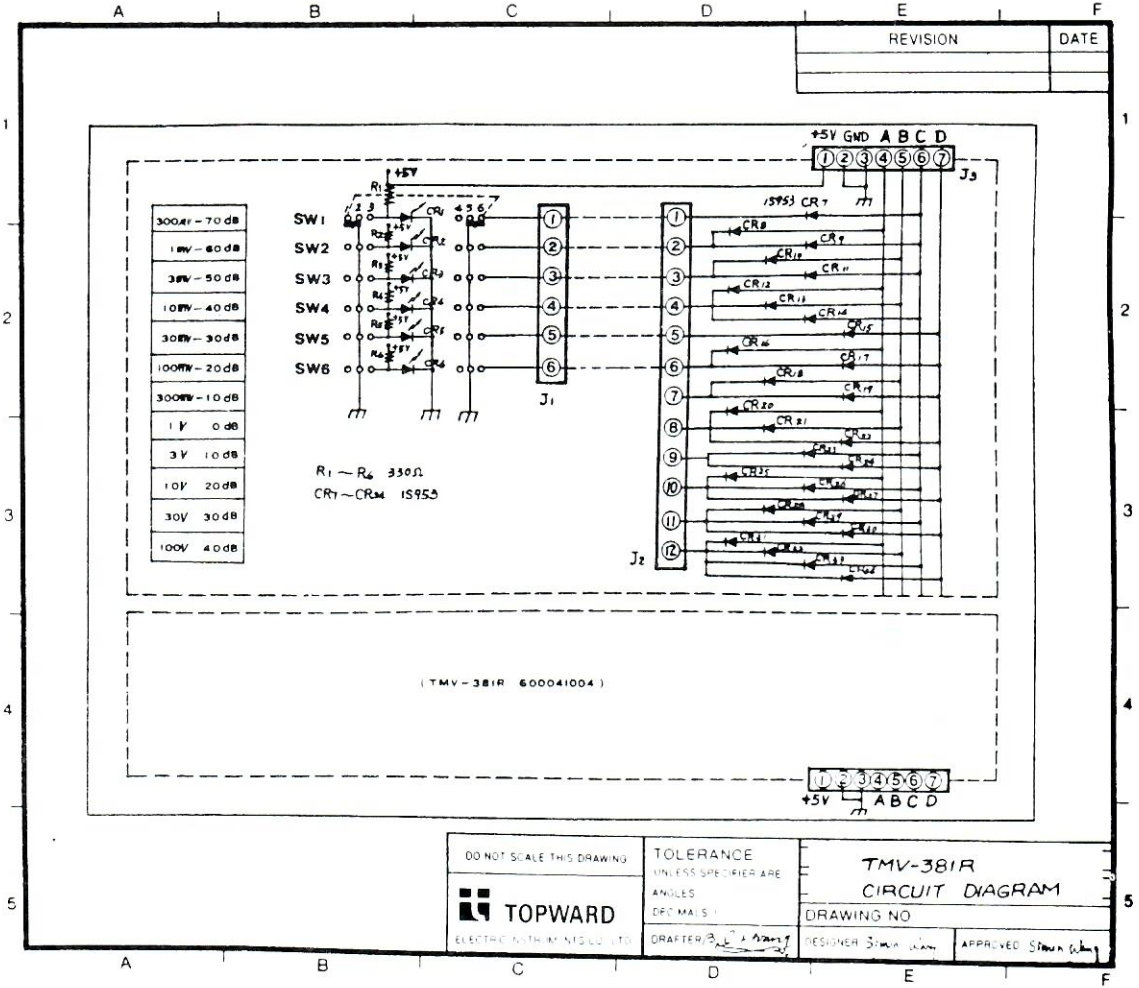
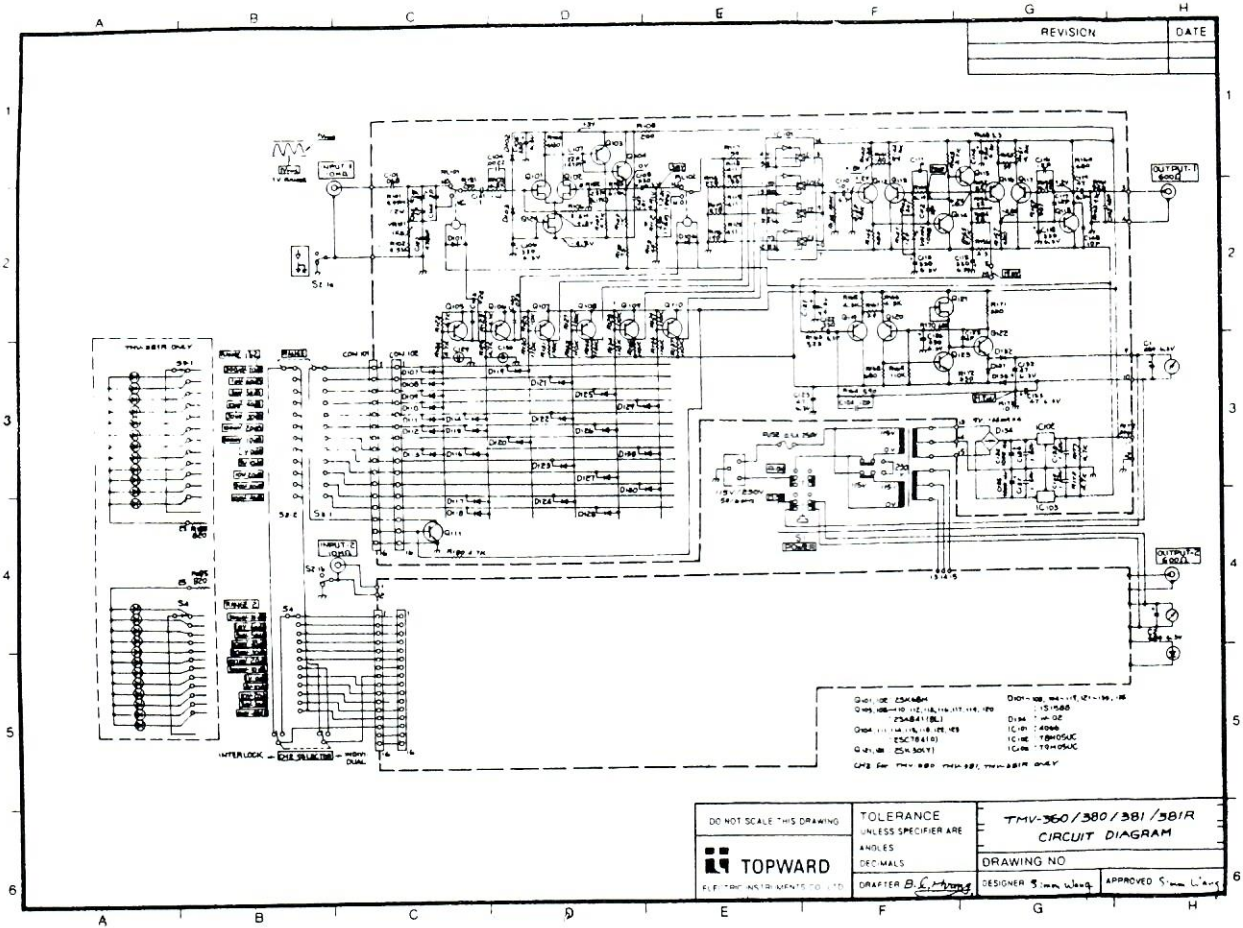
CIRCUIT DIAGRAM
DRAWING NO:


REVISION
DATE
+5V GND A B C D
J3
+5V
R1
SW1
SW2
SW3
SW4
SW5
SW6
J1
J2
CR7
CR8
CR9
CR10
CR11
CR12
CR13
CR14
CR15
CR16
CR17
CR18
CR19
CR20
CR21
CR22
CR23
CR24
CR25
CR26
CR27
CR28
CR29
CR30
CR31
CR32
CR33
CR34
300μV – 70dB
1mV – 60dB
3mV – 50dB
10mV – 40dB
30mV – 30dB
100mV – 20dB
300mV – 10dB
1V 0dB
3V 10dB
10V 20dB
30V 30dB
100V 40dB
R1 – R6 330Ω
CR7 – CR34 1S953
(TMV-381R 600041004)
+5V A B C D
DO NOT SCALE THIS DRAWING
TOLERANCE
UNLESS SPECIFIED ARE
ANGLES
DECIMALS
TOPWARD
ELECTRONIC INSTRUMENTS CO., LTD.
DRAFTER
DESIGNER
APPROVED
TMV-381R
CIRCUIT DIAGRAM
DRAWING NO


REVISION
DATE
DO NOT SCALE THIS DRAWING
TOLERANCE
UNLESS SPECIFIER ARE
ANGLES
DECIMALS
TOPWARD
TMV-360/380/381/381R
CIRCUIT DIAGRAM
DRAWING NO
DRAFTER B.C. Hung
DESIGNER Simon Wang
APPROVED Simon Lam