MODEL VG-4420

FUNCTION GENERATOR

OPERATION MANUAL

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(3) When testing speaker, if there is a peak volt value, when in low-freq. this must be the resonant freq. (fo) of this speaker, see Figure 11. Whether installation may cause any effect to this frequency or not? The proper design of case-installation will cause two small ramp on both sides of this sharp ramp.

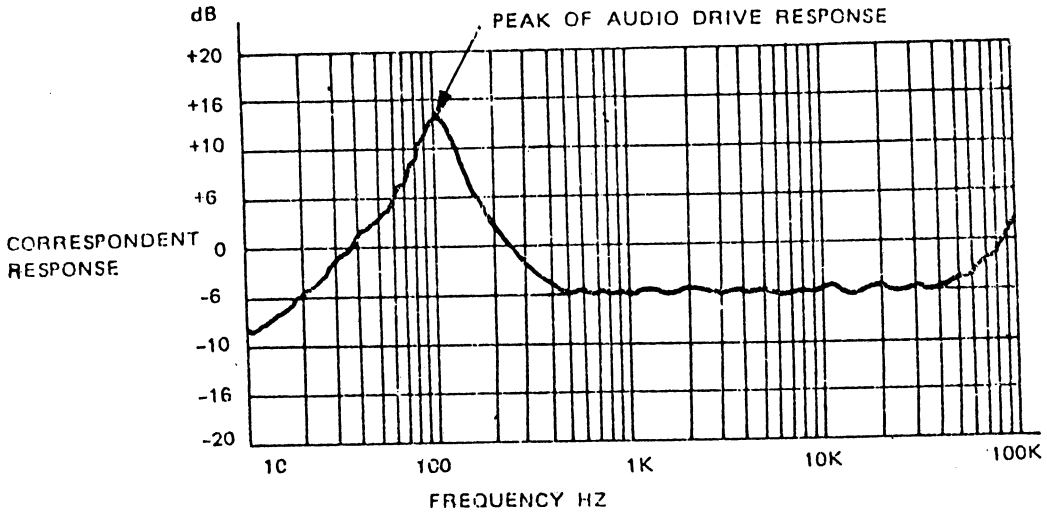


Figure 11

5-6 Testing of speaker and impedance network:
This equipment can be used to test the frequency characteristics of speaker or any impedance network. Also can get the resonant frequency of network.

(1) Connect the device under test as in Figure 9, can use oscilloscope in stead of voltmeter.

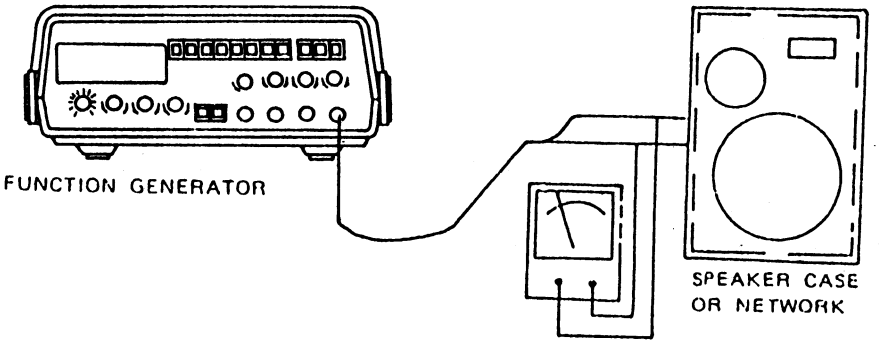


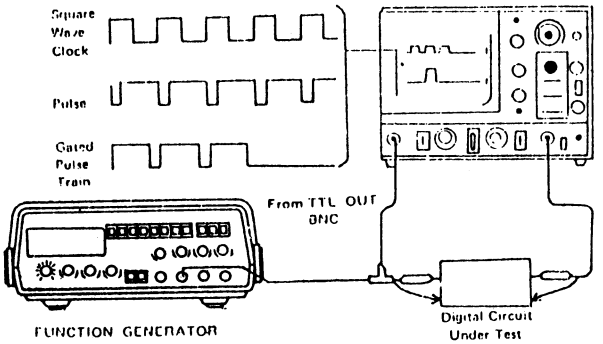
Figure 9

(2) When use voltmeter, adjust the frequency of instrument record down voltage relative to frequency.

5-5 Testing of logic circuit:
This equipment is suitable for logic circuit test, use square or pulse wave can analyzer or watch the frequency waveform of a designed testing circuit. Also the DC Offset effect, drive the plug-in model board or logic circuit troubls-shooting etc.
Used as signal tracing and signal replacing operation.

(1) Connected the lines as Figure 8.

Figure 8.



(2) According to the operation guide in this manual, set square wave or pulse wave output.

(3) Use the label TTL, CMOS output terminal in testing TTL logic circuit.

(4) If test CMOS circuit, must pull-up the switch of TTL/CMOS, adjust CMOS level by twist the switch use when the proper level set.

(5) Can use dual-trace scope to show the input-output timing relationship judged by the two waves showed.

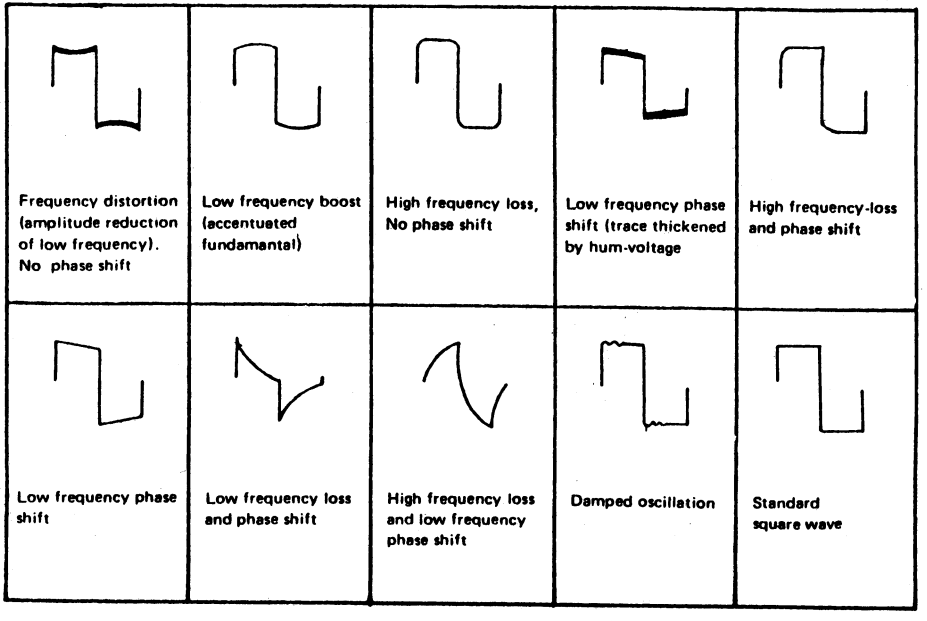
(2) Use the output of triangle wave, adjust the amplitude until there are no clipping happened in the applied frequency.

(3) Select square wave, adjust frequency, choose to watch the wave-form of middle of amplifier pass band, like 20Hz, 1KHz, 10KHz etc.

(4) The output waveform of (3), must get something with frequency Figure 7 shows come possible condition.

Caution: The composed poly-wave frequency of square wave is quite large, so Square wave is not suitable for testing the narrow band amplifier.

Figure 7

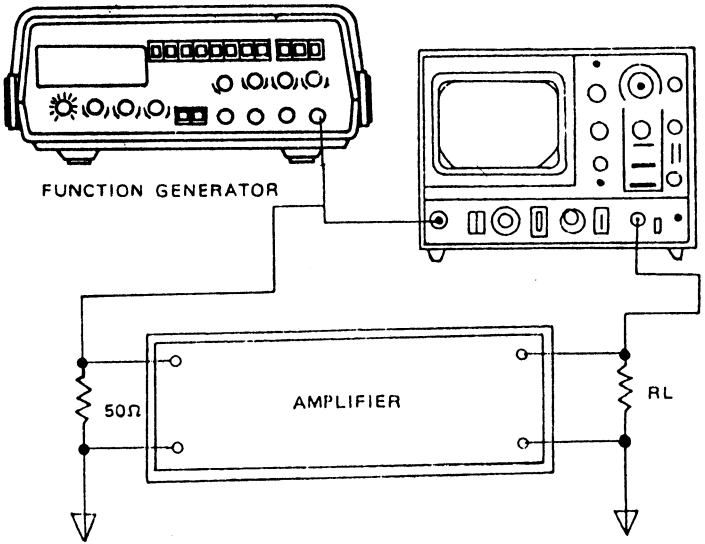


5-3 Amplifier over-load characteristics:
With sine wave input, will be different to output the overload point. Using triangle wave will easily observe the display for scilloscope. It can decide the linear range of output waveform. And the largest nodistortion output amplitude.

5-4 Using the square wave test the characteristics of amplified circuit: The ferquency response curve get using sine wave, can't actually realize the transient response of amplifier. Using the high oder poly wave-square wave and the oscilloscope can get many characteristics of amplifier.

(1) Using the circuit of Figure 6 the 50Ω connector trim the oscillation effect of square wave.

Figure 6



5. APPLICATION NOTE

This section describes the application of the model Function Generator in detail as well as a brief description relating to the block diagram. Only for the essential application method.

5-1 Trouble-shooting using signal-tracing method:
This method is similar to signal replacing way. The signal of model with be fixedly send to input terminal. With oscilloscope from front stage to rear stage, orderly observe signal wave. Stage by stage until find the one that with normal input but unnormal output.

5-2 Use as bias source and signal source circuit:
Utilized to Figure 5 of connecting type, can be provided bias of a transistor and signal input. From oscilloscope can observe the output waveform. Adjust to the best condition, will be output max. amplitude and no distortion. Adjust DC OFF-SET, will see the different effect of different bias condition.

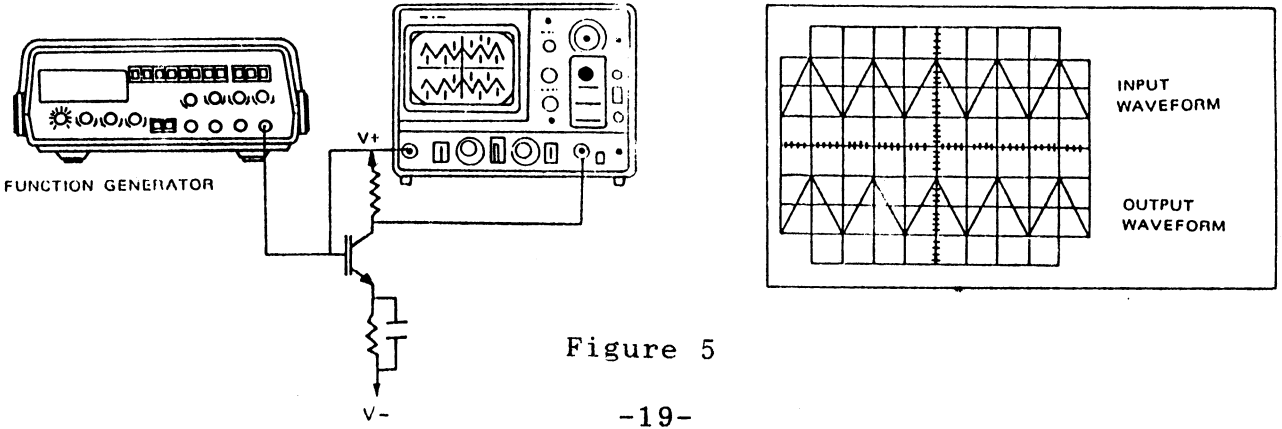


Figure 5

A TTL GATE is also driven by the square wave from the LEVEL DETECTOR. The output of the TTL GATE provides a TTL pulse at the PULSE output connector.

A diode shaping bridge network uses the log curve of silicon diodes to simulate a sinusoidal curve. Figure 3-3. Sine amplifier U401,boosts the amplitude of the sine wave to the proper level for the OUTPUT AMPLIFIER.

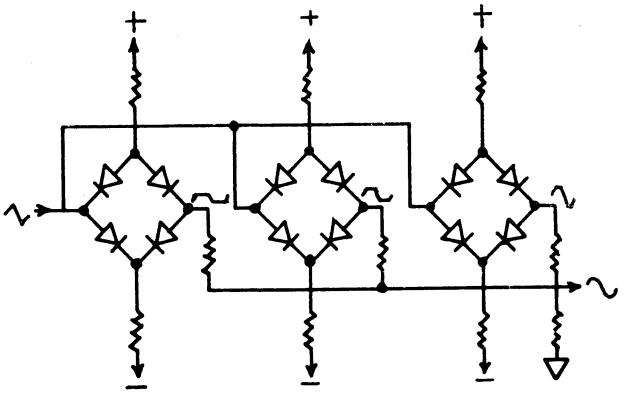


Fig.3-3. Diode Shaping Bridge

A square, triangle or sine wave may be selected by the FUNCTION switch. The desired waveform is connected to the AMPLITUDE potentiometer. OUTPUT AMPLIFIER Q501 thru Q506 is a non inverting amplifier which supplies the necessary output amplitudes of the desired waveforms as selected by the FUNCTION switch and AMPLITUDE control.

By varying the current from one current source and not the other, the timing capacitor will charge and discharge at different rates causing an unsymmetrical triangle waveform (Ramp) Figure 3-2.

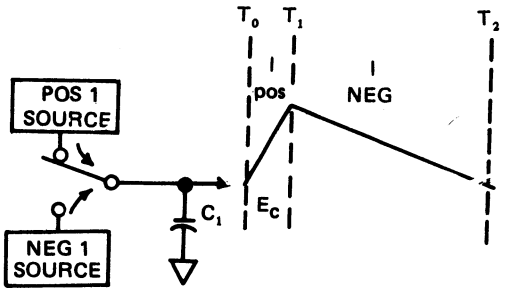


Fig.3-2 Unsymmetrical Triangle (Ramp) Waveform

The RANGE switch selects different timing resistors and timing capacitors which determine the frequency of the generator.A high input impedance BUFFER Q301, U301A, U301B is necessary to prevent loading of the timing capacitor at small timing currents. The triangle waveform is connected to the LEVEL DETECTOR U301C, U301D, U301E, Q302 and Q303. The LEVEL DETECTOR switches when the voltage at its input reaches a pre-determined level. The output from the LEVEL DETECTOR causes the CURRENT SOURCE Diode Bridge to switch, disconnecting one current source and connecting the other. By connecting and disconnecting and current sources at the proper level of voltage on the timing capacitor the triangle waveform is produced. The square wavefrom the LEVEL DETECTOR drives another diode switch producing a symmetrical square wave for use at the OUTPUT AMPLIFIER.

Two constant current sources of opposite polarity charge and discharge a timing capacitor producing the triangle waveform figure 3-1.

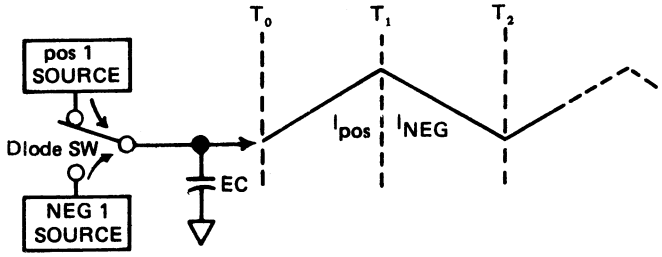


Fig. 3-1 Triangle Waveform

The Positive Current Source charges the timing capacitor during the time period T_0 - T_1 causing the voltage on the timing capacitor to increase from T_0 to T_1 linearty. At time T_1 the Diode Switch disconnects the Positive Current Source from the timing capacitor and connects the Negative Current Source at time T_1. The voltage on the timing capacitor will now discharge or decrease linearty until time T_2 when the Diode Switch will disconnect the Negative Current Source and connect the Positive Current Source, etc.
Rt1 and Rt2, Figure 4 are equal in value and determine the positive and negative voltage at the Positive and Negative Current Source. The DUTY potentiometer varies the voltage and thus the current of the Positive or Negative Current Source depending upon the position of the INVERT switch.

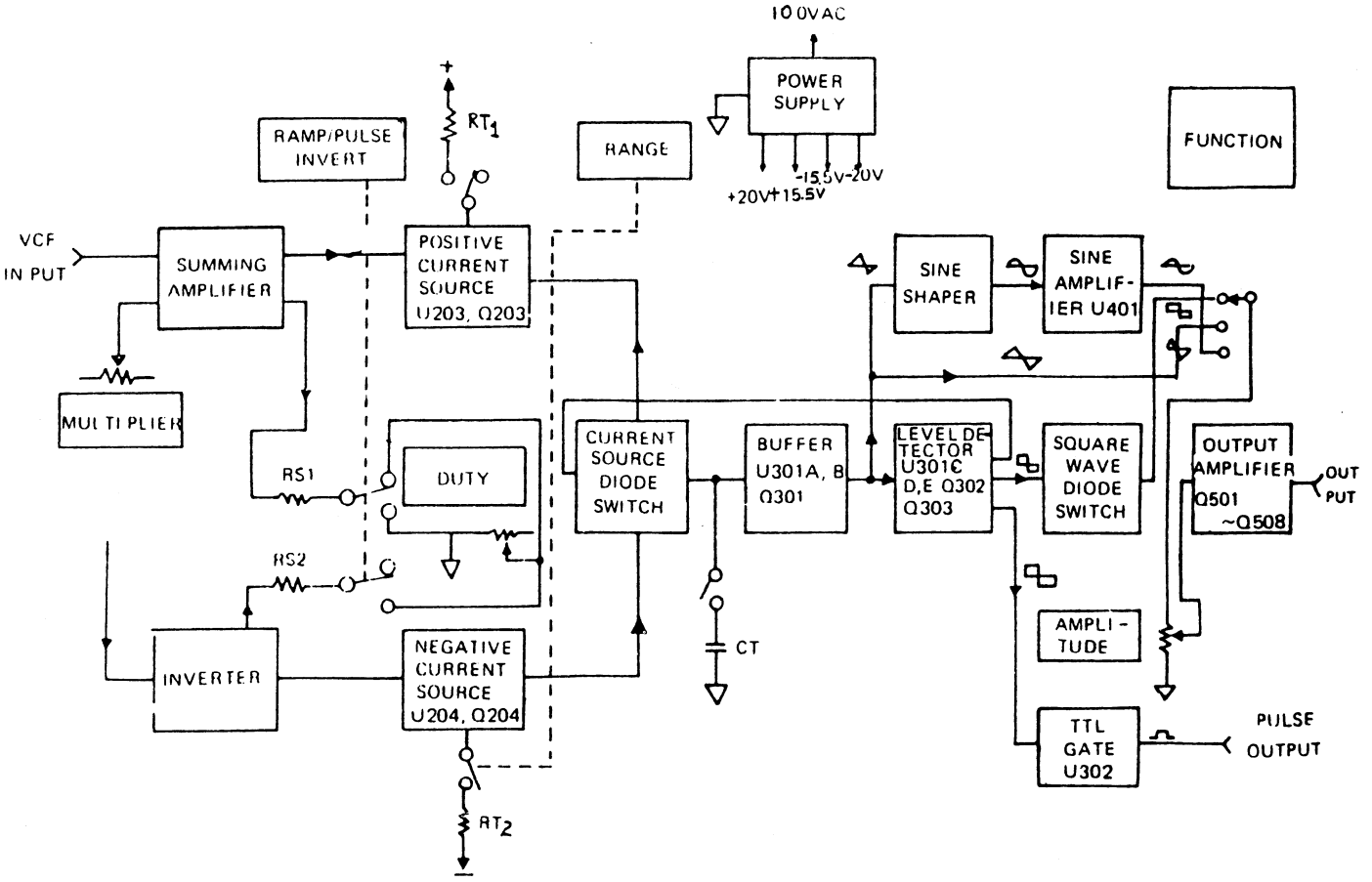


Figure 4 Block Diagram

(9) PULSE OUTPUT:
Connect the oscilloscope to the PULSE output.
By adjusting the generator frequency, the DUTY control and the INVERT switch, the high-speed TTL pulse or CMOS pulse may be utilized as a very versatile pulse generator, With the INVERT switch in the NORM position, the pulse width "on time" is determined by the RANGE and MULTIPLIER setting and the repetition rate "off time" is set by the DUTY control.
NOTE: When the INVERT switch is set to INVERT, the pulse "off time" is determined by the RANGE and MULTIPLIER setting and the pulse "on time" is set with the DUTY control.

3. THEORY OF OPERATION

3-1 GENERAL:

This section describes the operation of this DIGITAL FUNCTION GENERATOR in detail as well as a brief description relating to the Block Diagram (Fig. 4).

3-2 MAIN GENERATOR:

A DC Voltage from the MULTIPLIER potentiometer is connected to the Summing Amplifier U201 and Q201. The output of the Summing Amplifier drives the Positive Current Source U203, Q203 and the inverter U202, Q202. The Invert in turn drives the Negative Current Source U204 and Q204.

(6) DC OFFSET:
Reconnect the oscilloscope to the OUTPUT and select the triangle waveform, Rotate the DC OFFSET control potentiometer (pull position) and observe the peaks of the triangle waveform will "clip" when the DC OFFSET plus the peak amplitude exceeds ±10V. Reduce the output amplitude and observe the amount of DC OFFSET may be increased by the same amount the peak amplitude has been decreaseed. Return the potentiometer to "PUSH" position and the AMPLITUDE to maximum.

(7) DUTY CONTROL:
While observing the triangle waveform on the oscilloscope, rotate the DUTY control CW from the CAL position.Observe one slope of the triangle remains constant while the other slope is varibale over typically a 20:1 range, producing a ramp waveform.

(8) INVERT SWITCH:
Depress the INVERT potentiometer (pull position) and observe the positive and negative slopes of the ramp waveform reverse (invert).
By selecting the Square wave and repeating the same procedure, this model DIGITAL FUNCTION GENERATOR become very versatile pulse generators.
The pulse width may be determined by the following formula:
PULSE WIDTH = the reciprocal of 2 X freq. setting.
In other words, the pulse width equals one-half the time period of the frequency set by the RANGE and MULTIPLIER controls.
The time symmetry of the Sine wave may be set in the same manner, providing additional versatility.
NOTE: The DUTY control and INVERT switch provide the same flexibility for the PULSE output.

2-5 FIRST TIME OPERATION PROCEDURE:
NOTE: Before applying power to the Digital FUNCTION GENERATOR, be sure the proper line voltage is available.

(1) Set the digital function generator controls as follows:

RANGE	10k
MULTIPLIER	2.0
FUNCTION	∿
DUTY	CAL
AMPLITUDE	MAX
OFFSET	PUSH
ATTENUATOR	0dB

(2) MAIN OUTPUT:
Connect an oscilloscope to output.
Observe a 20Vp-p 20KHz triangle wave.

(3) FUNCTION SWITCH:
Select and observe a 20Vp-p square wave and sine wave.

(4) AMPLITUDE CONTROL:
Rotate the AMPLITUDE vernier from maximum to minimum and observe greater than 30dB of attenuation.

(5) ATTENUATION:
Connect the oscilloscope to the OUTPUT and push the ATT pushbutton switch and the signal will be attenuated by a factor of 20dB.

(11) CMOS LEVEL CONTROL WITH TTL/CMOS OUTPUT SELECTED
The CMOS LEVEL CONTROL potentiometer (pull position) provides CMOS LEVEL OUPUT from 5V to 15V continuously variable. Depress the potentiometer switch and observe the TTL and CMOS output, push is TTL, pull is CMOS.

(12) FREQUENCY COUNTER:
1. -20dB SELECTED SWITCH:
Select the frequency counter input sensitivity, push on is 200mVrms (-20dB). Push off is 20mVrms (1/1).

② EXT, INT SELECTED SWITCH:
Select the frequency counter is INT or EXT, push on is EXT, push off is INT.

③ EXT INPUT CONNECTOR:
For EXT frequency counter, BNC type connector.

④ COUNTER DISPLAY:
LED indicator display measured INT or EXT input frequency.

⑤ Hz,KHz LED:
Hz, KHz and the position of the decimal point are indicated when the gate time switch is pressed to the 10Sec, 1Sec, 0.1Sec, 10mSec.

⑥ GATE LED:
Gate signal indicates when the gate time switch, is pushed.

⑦ OVER LED:
Lamp which indicates that the counter display value is an overflow.

(7) AMPLITUDE WITH ATT:
The AMPLITUDE control provides 20dB of attenuation of the output waveform selected by the FUNCTION switch. When the switch is pulled, in addition to 20dB provided by amplitude control, a maximum of 40dB of attenuation, at the output.

(8) OUTPUT:
Square, triangle, sine, ramp and pulse waveforms are provided at up to 20Vp-p amplitude (open circuit) at the OUTPUT. (When ATT pushbutton switch is pushed). The VCF input and PULSE outputs, utilize BNC connectors.

(9) VCF INPUT:
A VCF (voltage-controlled frequency) input is provided for externally sweeping the frequency. Approximately +10V applied at the VCF input will sweep the generator frequency down three decades or 1000:1.
The generator may also be swept up in frequency by applying a negative voltage at the VCF input.

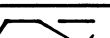
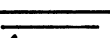
(10) PULSE OUTPUT:
The PULSE OUTPUT is a TTL or CMOS output signal suitable for driving TTL or CMOS logic. The rise and fall time of the PULSE output is typically 15nS. The pulse width and repetition rate may be set as desired, utilizing the RANGE and MULTIPLIER and DUTTY control. The symmetry of the PULSE output is controlled in the same manner as the output waveforms described in Table 2-1.

(6) DC OFFSET WITH LEVEL CONTROL:
A DC OFFSET control (DC offset control potentiometer in pull position) is provided to allow the DC level of the OUTPUT waeforms to be set as desired.

NOTE: The amount of offset plus the amplitude setting can't exceed the maximum p-p amplitude or dipping will occur.

Table 2-2 below illustrates the effect of the DC OFFSET control. The clipped waveform is caused by too much amplitude and too much offset.

Table 2-2 DC Offset Control

Offset	Amplitude	Output
0	Max	 +10V -10V
Max CW	Max	 +10V 0V
Max CCW	Max	0V -10V
Mid CW	Max	 +10V -10V
Mid CCW	Max	 +10V -10V

(5) DUTY CONTROL WITH INVERT:
Time symmetry of the OUTPUT waveforms, as well as the TTL or CMOS PULSE output, is controlled by the DUTY potentiometer.
When this control is set to the CAL position, the time symmetry of the output waveforms is 50/50 or approximately 100% symmetrical.
The variable symmetry allows the time period of onehalf the waveform to be changed while the other half remains fixed as determined by RANGE and MULTIPLIER settings. This unique feature provides ramp waveforms, variable pulse width and variable duty cycle pulses, and skewed sine waves. The duty control potentiometer with INVERT switch when pull position is provided, inverts the time symmetry set by the Duty control.

NOTE: The time symmetry as illustrated below is for reference only. Any desired time symmetry ratio may be set as desired within the limits.

Table 2-1 Duty Control

Ramp/Pulse Invert Switch	Duty Control	MAIN OUTPUT			Pulse Output
		Square	Triangle	Sine	
pull	Cal				
push	Cal				
push	Max CW				
pull	Max CW				

2-4 CONTROLS AND INDICATORS:

(1) POWER SWITCH:
The power switch applies power to the function generator.

(2) RANGE SWITCH:
Seven fixed decades of frequency are provided by the RANGE pushbutton switch. Each of the seven pushbutton RANGE switches is interlocked. Depressing one pushbutton will release all others.

(3) FUNCTION SWITCH:
Three interlocking pushbutton switches provide selection of the desired output waveform. Depressing one switch will release the switch previously depressed. Square, triangle, and sine waveforms are provided, satisfying most applications.

(4) MULTIPLIER:
The MULTIPLIER is a variable potentiometer allowing frequency settings between fixed ranges. Although the dial skirt is calibrated from .2 to 2.0, the dynamic range of the MULTIPLIER dial is 1000:1 (three decades). For example, this allows frequecny settings between 200KHz and 200Hz without changing ranges.

NOTE: This is necessary when sweeping up in frequency over a three decade range 1000:1 (Voltage Control Frequency Applications)

f. Frequency Range : 0.2Hz ~ 2MHz (INT), 5Hz ~ 10MHz (EXT)
g. Sensitivity : ≤ 20mVrms.
h. Max. Input Voltage: 150Vrms.
i. Input Impedance : 1MΩ//600PF.

2. INSTALLATION AND OPERATION

2-1 UNPACKING AND INSPECTION:

THE DIGITAL FUNCTION GENERATOR is packaged to absorb any reasonable shock encountered during shipping.
Carefully remove the instrument from the shipping container and inspect for shipping damage. If damage is found, notify the carrier immediately.

2-2 AC POWER REQUIREMENTS:

This instrument operate on line voltages of 100V, 120V, 220V, 240V, AC ± 10% 50/60Hz, power dissipation approx.11.2 VA
(Internally selectable).

2-3 FUSE REPLACEMENT:

If for some reason the fuse blows, first try to determine the cause of the failure and remedy if possible.

NOTE:Replace with the proper size fuse ONLY to prevent damage to the instrument.

Pulse Ouput	:
Rise time	: < 25nS will sink 5 TTL Loads
Level	: Amplitude Fixed, > +3V open circuit
CMOS Level	: 4V ± 1V ~ 14.5V ± 0.5V adjustable Rise & Fall time < 120nS
Frequency Counter	: Built - in
Power Source	: AC 100, 120, 220, 240V (internally changeable) ± 10% 50/60Hz Power consumption approx. 11.2VA
Accessories	: Test lead BNC to alligator.....2
	: Instruction manual X 1.....1
	: Fuse 0.5A (100V,120V).....1 0.3A (220V,240V)
	: AC cord.....1
Dimension	: 230(W) X 95(H) X 280(D) mm
Weight	: Approx. 2.1Kg
Operating temp.& humidity	: 0°C ~ 40°C , 10% ~ 80% RH

(2)Frequency counter:

a. INT,EXT Switch Selectable.
b. Accuracy : ± Time Base accuracy ±1 count.
c. Time Base : Oscillation frequency 10MHz.
temp. Stability 0°C ~ 40°C ± 2 X 10^{-5} .
d. Counting Capacity : 6 digits (0.3" LED display).
e. Resolution : 0.1Hz, 1Hz, 10Hz, 100Hz.

(1)Main Generator

Frequency Range	: 0.2Hz to 2MHz (7 Ranges) 6 digits counter display
Frequency Accuracy	: ±5% of length scale
V.C.F (Voltage Controlled Frequency)	: Approx. 0 to 10V (±1V) input for 1000:1 (3 decades) frequency ratio Input impedance approx. 10KΩ
Main Output Waveforms	: Sine, triangle, square, pulse, CMOS and ramp
Amplitude	: >20Vp-p open circuit, >10Vp-p into 50Ω
Output Impedance	: 50Ω ± 6%
Attenuation	: -20dB ± 1dB with continuously Variable
DC offset	: Variable +10 to -10V open circuit, +5 to -5V into 50Ω
Sine Wave	: Distortion 0.2Hz ~ 200KHz ≤ 1% (100K range) Response 0.2Hz ~ 100KHz ≤ 0.1dB 100KHz ~ 2MHz ≤ 0.5dB
Square wave	: Rise Time < 120nS Symmetry < 2% (0.2Hz ~ 100KHz)
Triangle wave	: Linearity > 98% (0.2Hz ~ 100KHz)
Duty control	: 1:1 ~ 10:1 continuously variable

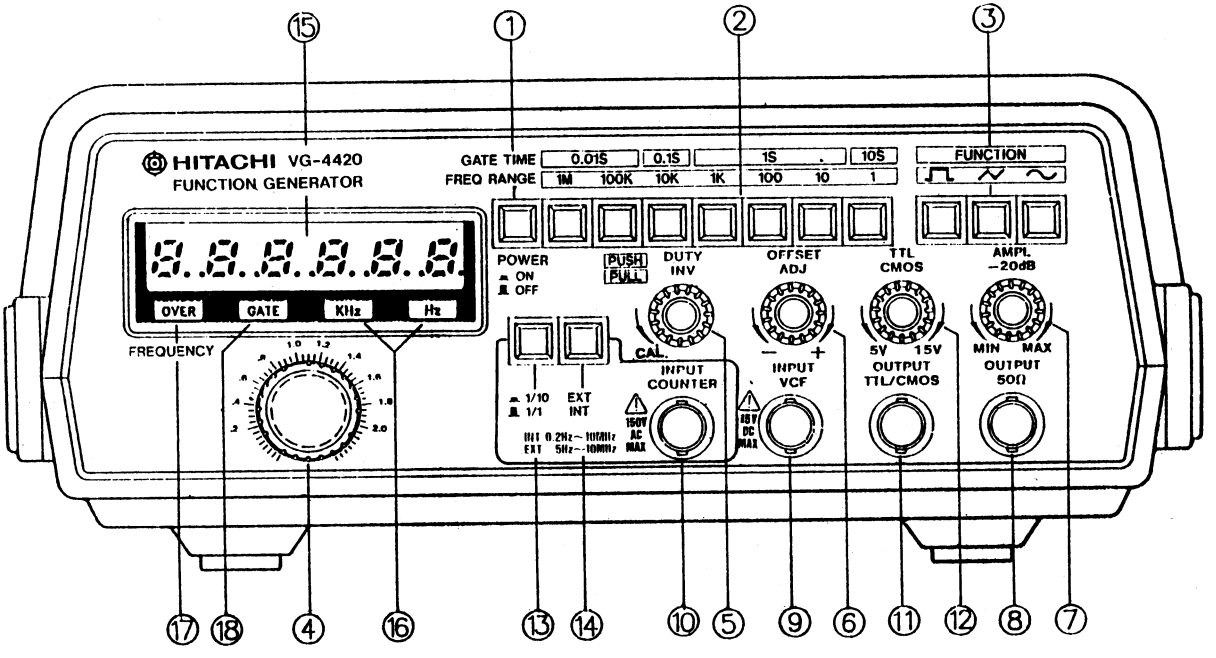
1-4 PRINTED CIRCUIT BOARDS:
Main Generator: All circuitry and the power supply are contained on the main P.C. board. All controls and the POWER switch are also contained on the main P.C. board.

FREQUENCY COUNTER: The frequency counter is contained on the main P.C. board.

1-5 ELECTRICAL DESCRIPTION:
The DIGITAL Function Generator utilizes two constant current sources of opposite polarity for charging and discharging a timing capacitor to produce the triangular waveform.
A diode shaping bridge network shapes the triangle to produce the low-distortion sine wave. The level detector senses the voltage on the timing capacitor and connects and disconnects the current sources alternately. The square wave produced by the level detector is utillized to produce the output square wave.

1-6 SPECIFICATIONS: (All specifications apply with frequency dial between 0.2 ~ 2 times range and operated at 18°C ~ 28°C)

Specifications are listed below:


⑮
①
②
③
HITACHI VG-4420
FUNCTION GENERATOR
GATE TIME
FREQ RANGE
0.01S
0.1S
1S
10S
1M
100K
10K
1K
100
10
1
FUNCTION
POWER
ON
OFF
PUSH
PULL
DUTY
INV
OFFSET
ADJ
TTL
CMOS
AMPL
-20dB
OVER
GATE
KHz
Hz
FREQUENCY
CAL.
INPUT
COUNTER
INPUT
VCF
5V
15V
OUTPUT
TTL/CMOS
MIN
MAX
OUTPUT
50Ω
1/10
1/1
EXT
INT
150V
AC
MAX
45V
DC
MAX
⑰
⑱
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1. GENERAL DESCRIPTION

(1)INTRODUCTION:

1-1 The DIGITAL FUNCTION GENERATOR provides square, triangle, sine, ramp and pulse waveforms over a frequency range from 0.2 Hz to 2 MHz, plus a VCF input,variable DC offset and TTL or CMOS pulse output.
The frequency counter measurement range from 5 Hz to 10 MHz (EXT). High input sensitivity of 20mVrms.

1-2 FRONT PANEL:
The main output and all controls are located on the front panel. They are ① the push button POWER switch, ② seven frequency RANGE push button switches, ③ three push button FUNCTION switches, ④ frequency MULTIPLIER (variable), ⑤ DUTY potentiometer with invert switch, ⑥ DC OFFSET control with level control, ⑦ output AMPLITUDE control with output attenuation, ⑧ OUTPUT, ⑨ VCF(voltage controlled frequency) input, ⑩ COUNTER input, ⑪ TTL or CMOS pulse output, ⑫ CMOS level control with CMOS/TTL selector SW, ⑬ input sensitivity ATT, ⑭ EXT/INT selector SW, ⑮ counter display, ⑯ Hz and KHz indicator, ⑰ overflow indicator, ⑱ Gate signal indicator.

1-3 REAR PANEL:
On the rear panel are located the power cord receptacle and fuse holder.

(4) In testing other impedance network, the resonant may not occur in low frequency. But in approaching the resonant frequecy, there are still increasing in voltage,then the impedance can be tested as following:

a. Series connected a R1 to the network under test as in Figure 10.

b. Get voltage read out in E1, E2, adjust R1 until E2 is equal to one half of E1.

c. Under this frequency, the impedance network is the same as the R1.

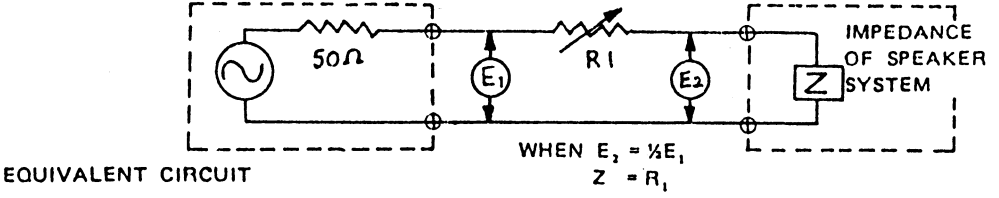

Figure 10