SECTION 8

WHITE NOISE TEST GENERATOR GE4/501P

Introduction

The White Noise Generator GE4/501P was designed as a standard source for use with special equipment for measuring noise in the presence of a television signal. The measuring equipment has now been superseded but the GE4/501P may be used for test purposes; precautions to be observed in such tests are included in the following description.

Mechanical Details

The apparatus is contained in a light-alloy case, with removable panels and built-in carrying handles, which has the dimensions 17 in. by 9½ in. by 10½ in. high. On the bottom of the case are rubber feet and fixed to the top panel are seatings to receive the feet of a similar unit.

The unit is constructed in two parts, a generator chassis which is mounted vertically behind a side panel and a power supply chassis fixed to the bottom of the case. The weight is 20 lb.

Circuit Description Figs. 17 and 18

Figs. 17 and 18 provide circuit details of the complete equipment, one referring to the operational stages and the other to the mains-derived supplies.

Noise Generator Fig. 17

Noise is generated in a photo-multiplier cell excited by a pea lamp, amplified by a wide-band amplifier and filtered. Provision is made for metering the noise output power.

The pea lamp used to illuminate the photo-multiplier is connected in the cathode circuit of a pentode valve V10. The screen and control grids of this valve are fed from a stabilised 200-volt h.t. line so that the current through the lamp is maintained at a constant value. The brightness of the lamp may be varied by means of RV2, the *Photo-multiplier Illumination* control, which adjusts the voltage of V10 control grid.

Control of the generated noise power is provided by the *Output Level* control RV1, adjustment of which determines the current through the photo-multiplier; see under Power Supplies.

The wide-band negative-feedback amplifier V4, V5 and V6 amplifies the photo-multiplier output The amplifier has a large overload margin and its output is auto-transformer coupled to a low-pass filter from which the signal is fed to the output plug PLC.

The output power is nominally 1 mW into 75 ohms resistance but this figure applies only over the band of frequencies from 100 kc/s to 5 Mc/s. Below 100 kc/s the output impedance of the unit falls with frequency and theoretically is zero at zero frequency. If the generator is used as a source of noise to be mixed with a television signal the mixing pad must have sufficient attenuation to isolate the generator output impedance.

The output power can be continuously varied over a range of about 6 dB by use of the *Output Level* control. By adjustment of the *Photo-multiplier Illumination* control a range of output up to several milliwatts can be obtained. This increased output may suffer some limiting on peaks of noise, a visual check for which should be made as described in the penultimate part of the Test Specification. If limiting occurs, the illumination should be increased. The noise generated by the tube is proportional to the square root of the photo-current and increasing the illumination while decreasing the gain of the multiplier gives a greater ratio of d.c. current to noise current for the same noise output power.

The noise output has a uniform distribution of energy (to within 1 dB) over the range of frequencies from 250 kc/s to 5 Mc/s. Below 250 kc/s the response of a particular photo-multiplier may accentuate the noise output at the lower frequencies, by about 2 dB at 100 kc/s.

Meter M1 is used in conjunction with MR5, MR6, C25 and C26 to monitor the power level at the output plug and switch S1 enables this meter to be used also for measuring the photo-multiplier current. The meter scale has marks that represent an output level of 1 mW and differences of ± 1dB. The gain of the photo-multiplier tube may vary with time and frequent checks should be made of the output power if it is necessary to maintain an accurate output level.

Power Supplies Fig. 18

The power supply unit utilises two mains transformers T1 and T3, the input-voltage tappings of which are paralleled at the voltage selector panel.

The output from a secondary h.t. winding of T1 is full-wave rectified and smoothed by a conventional filter to produce an 800-volt supply for the photo-multiplier. The two valves V1 and V2 are connected as a cascode stage which, by virtue of its high impedance, produces a constant-current characteristic. The control grid of V1 is connected to the final anode of the photo-multiplier so that the current at which the circuit stabilises depends on the photo-multiplier current and on the value of the load resistor R24 plus RV1. The adjustment of this *Output Level* control determines the current through the resistor chain R15—R22 and thereby controls the voltages on all intermediate electrodes of the photo-multiplier.

T3 has two secondary windings. The output from a 275-volt winding is full-wave rectified, smoothed in a conventional filter and applied to the anode of the series stabiliser-valve V9. V7 is a shunt amplifier which uses as a reference the voltage developed across the stabiliser V8; see Instruction V.4.

The output from a 100-volt winding is fed to a full-wave rectifier V12 which is mounted on the generator chassis. The output from V12 cathode is smoothed by an RC filter to produce a 150-volt auxiliary supply for the control circuit of the photo-multiplier illumination lamp.

Operating Instructions

1. Terminate the output of the generator with a 75-ohm resistive load.
2. Set the meter switch to *Meter Output Level.*
3. Set the *Photo-multiplier Illumination* control to about two-thirds of full scale.
4. Switch on and allow the generator to warm up. Adjust the *Output Level* control to give an output of 1 mW as measured by either the meter on the unit or a suitable external measuring device.
5. Set the meter switch to *Multiplier Current* and check that the meter reading is between 1 and 1·5. Adjust the two controls in turn to obtain an output power of 1 mW with a photo-multiplier current between 100 and 150 μA (1 and 1·5 on the meter).

The output from the generator will gradually fall because of fatiguing effects in the photo-multiplier, especially with a new tube. The drift is greatest when the unit is first switched on, and after a period of storage.

Test Specification

The following equipment is required :

Avometer Model 8.
Wide-band oscilloscope, such as Tektronix 524AD.
Wayne Kerr Video Oscillator type 022B.
P.O. Decibelmeter type E3233.
S.T. and C. Milliwatt Test Set 74608A.

Power Supplies

Check that the voltage selector is appropriately set. Remove all valves in the generator chassis except V12.

1. Connect the Avometer between h.t. and earth (across C18). The h.t. should be 200 volts ± 5 per cent.
2. Connect the Avometer between e.h.t. and earth (pin 6 of PLA and earth). The voltage should be 800 volts ± 50 volts.
3. Connect the Avometer to measure the auxiliary h.t. (across C29). The voltage should be 150 volts ± 10 volts.
4. Connect the oscilloscope across the h.t. as in item 1. The level of hum and noise should be less than 10 mV p-p.
5. Measure with the oscilloscope across the e.h.t. as in item 2. The hum level should be less than 200 mV p-p.
6. Return the valves of the generator to the appropriate sockets.

Noise Generator

A comparison method should be used to make amplitude/frequency measurements as outlined in (a) to (d) below; a typical arrangement for the purpose is shown in Fig. 8.1. The amplitude of the

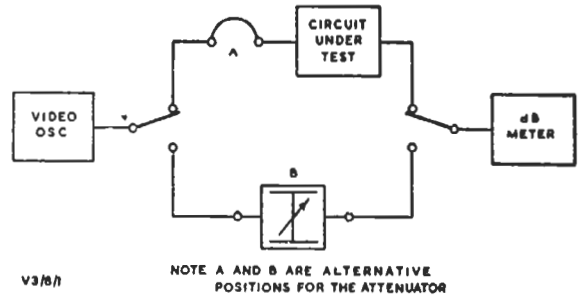

Fig. 8.1 Layout of Equipment for Measuring Frequency/Amplitude Characteristics

video-oscillator output is kept constant as frequency is varied and a characteristic is obtained by noting the attenuator alterations necessary to maintain a

predetermined reading on the Decibelmeter. Note that tests (a) and (b) are detailed for use in the event of test (c) giving an unsatisfactory result.

(*a*) *Measurement of Transformer Frequency-response Characteristic*

1. Disconnect the lead joining R39 to the junction of R40 and C16. This removes the negative feedback from the amplifier.
2. Remove V4 and V5.
3. Connect a 75-ohm resistor across R36 and apply the output of the video oscillator across this combination.
4. Disconnect transformer T2 from the filter and connect the Decibelmeter, set to *Term Level*, across the transformer output. The following table gives typical results on which a tolerance of ± 0·2 dB is allowed.

f	*Relative Output* (*dB*)
100 kc/s	−0·1
300 kc/s	0
1 Mc/s	0
2 Mc/s	0
3 Mc/s	0
4 Mc/s	0
5 Mc/s	−0·1

5. Restore the circuit to normal and return V4 and V5 to their sockets.

(*b*) *Measurement of Filter Frequency Response*

1. With transformer T2 disconnected from the filter, apply the video-oscillator output to the junction of L3 and C21.
2. Connect the Decibelmeter to the generator output and check the frequency response. The response in the pass-band should be within ± 0·2 dB of the following :

f	*Relative Output* (*dB*)
100 kc/s	0
300 kc/s	0
1 Mc/s	0
2 Mc/s	0
3 Mc/s	−0·1
4 Mc/s	−0·25
5 Mc/s	−0·3

The loss in the stop-band should be at least 10 dB at 5·9 Mc/s and 20 dB from 6·3 Mc/s up to at least 10 Mc/s.

3. Restore the circuit to normal.

(*c*) *Measurement of Frequency Response of Filter and Transformer*

For an overall check of filter and transformer, proceed as follows :

1. Provide an input to the transformer, following the procedure of items 1, 2 and 3 under (a).
2. Set RV3 to its mid-position and measure the output from the filter on the Decibelmeter connected to the output plug. The loss is 4 dB and the response should be within ± 0·3 dB of the following figures :

f	*Relative Output* (*dB*)
100 kc/s	0
300 kc/s	+0·1
1 Mc/s	0
2 Mc/s	0
3 Mc/s	−0·1
4 Mc/s	−0·2
4·5 Mc/s	0
5 Mc/s	−0·5

3. Restore the circuit to normal and V4 and V5 to their sockets.

(*d*) *Overall Frequency-response Test* (*Amplifier and Output Circuit*)

1. Disconnect R25 from the junction of R24 and C31. Connect a 75-ohm resistor between the free end of R25 and earth. Apply the output of the video oscillator across the 75-ohm resistor at a level of about −34 dB.
2. Remove V1 and V2.
3. Measure with the Decibelmeter across output plug PLC and adjust C16 to give the same gain at 1 Mc/s as at 4 Mc/s.
4. Measure the frequency response. It should be flat to within 0·5 dB from 100 kc/s to 4·8 Mc/s, and within 1 dB up to 5 Mc/s. The gain should be 34 dB ± 1 dB at 1 Mc/s.
5. Restore the circuit to normal and V1 and V2 to their sockets, unless test (e) is to be carried out.

(*e*) *Overload Test*

1. As for items 1 and 2 of test (d); but see item (5) of same test.
2. Connect the oscilloscope in place of the Decibelmeter and terminate the output of the

noise generator in 75 ohms.

3. Set the output frequency of the oscillator to 1 Mc/s and increase the output level of the oscillator until the displayed sine wave gives evidence of limiting. This should occur at a voltage not less than 8-volts p-p as measured on the oscilloscope.
4. Restore the circuit to normal and return V1 and V2 to their sockets.

(*f*) *Selection of R25*

1. Set the front-panel controls to their mid-positions and switch the internal meter to measure the photo-multiplier current.
2. Measuring output power with the Decibel-meter, adjust the two front-panel controls to give a 1-mW output with photo-multiplier current between 100 and 150 μA. With some photo-multiplier tubes there may be difficulty in obtaining this setting, in which event the value for R25 should be selected within the range 220 to 560 ohms.

(*g*) *Adjustment of Output Indicator*

Allow the unit at least 30 minutes to warm up.

1. Switch the output meter to read the output level and connect the Milliwatt Test Set to the output plug.
2. Set the output level to 1 mW and adjust RV3 to bring the output-meter pointer to the 1-mW mark.

Visual Check of Output Waveform

Monitor the noise-generator output with the oscilloscope to check that, with the output set at 1 mW, there are no repetitive components such as hum, continuous waves or impulsive interference. Check also that any asymmetry about the zero datum does not exceed a ratio of 4 : 3.

Mains-voltage Variations

The output should not change by more than 1 dB for a change of ± 10 per cent in mains-input voltage.

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