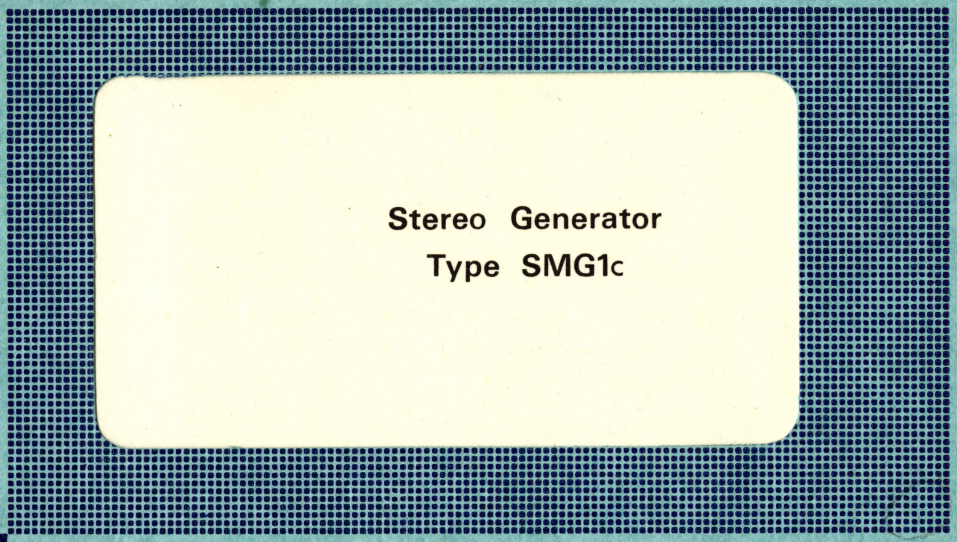
INSTRUCTION MANUAL



RADIOMETER

ELECTRONIC MEASURING INSTRUMENTS
FOR SCIENTIFIC AND INDUSTRIAL USE

Instruction Manual
for

Stereo Generator
Type SMG1c

1st edition

Table of Contents

	page
SECTION A - INTRODUCTION	A1
1. Principles for Generating a Multiplex Stereo Signal according to the FCC system	A1
2. The Stereo Generator, type SMG1	A3
SECTION B - SPECIFICATIONS	B1
SECTION C - ACCESSORIES	C1
SECTION D - GENERAL DESCRIPTION	D1
1. Operating Principle	D1
2. Control, Meter and Terminals	D2
SECTION E - OPERATING INSTRUCTIONS	E1
1. Connection	E1
2. Operating Modes	E2
SECTION F - CIRCUIT DESCRIPTION	F1
1. Input Circuits, Function Selector and Input Amplifiers	F1
2. Modulating Oscillator	F2
3. Switch Modulator	F2
4. 38 kHz Carrier and 19 kHz Pilot Signal Exciter	F2
5. Phase-Linear Low-Pass Filter	F2
6. Output Amplifier	F3
7. Meter Circuit	F3
8. RF-Unit	F3
9. Regulated Power Supply	F3
SECTION G - MAINTENANCE	G1
1. General	G1
2. Removing the Generator from its Cabinet	G1
3. Replacement of Components	G1
4. Adjustments	G1

SECTION H - APPLICATIONS H1

1. General H1

2. Initial Connections and Settings H1

3. LR Separation (LR-Separation is equal to MS-Identity) H2

4. LR Balance expressed by means of the Identity Factor (LR-Identity is equal to MS-Separation) H3

5. Fidelity H3

6. Distortion H4

7. Measuring Intermodulation between the Harmonics of the L or R Signal and Signals at 19 kHz and 38 kHz (The Pilot Signal and the Regenerated Carrier Signal) H4

8. M and S Channel Identity of Tuner, IF Amplifier and Discriminator in a Receiver (MS-Identity is equal to LR-Separation) H4

9. M and S Channel Separation of Tuner, IF Amplifier and Discriminator of a Receiver (MS-Separation is equal to LR-Identity) H6

10 Pilot Reserve H6

11. Measuring FM Discriminator Characteristics H7

12. Listening Tests H7

Stereo Generator
Type SMG1

Section A. Introduction

PRINCIPLES FOR GENERATING A MULTIPLEX STEREO-SIGNAL ACCORDING TO THE FCC SYSTEM

The frequency spectrum for a multiplex stereo-signal of the approved FCC system is shown in Fig.1.

The M-channel (Main or Monophonic Channel) occupies the frequency range 50 Hz to 15 kHz. The M-signal is made up of the sum of the left and right signals (L + R). This enables a stereophonic broadcasting station to be received on a monophonic receiver (compatibility).

The difference between the left and right signals (L - R) is transmitted as a double sideband signal, amplitude-modulated on a suppressed sub-carrier of 38 kHz

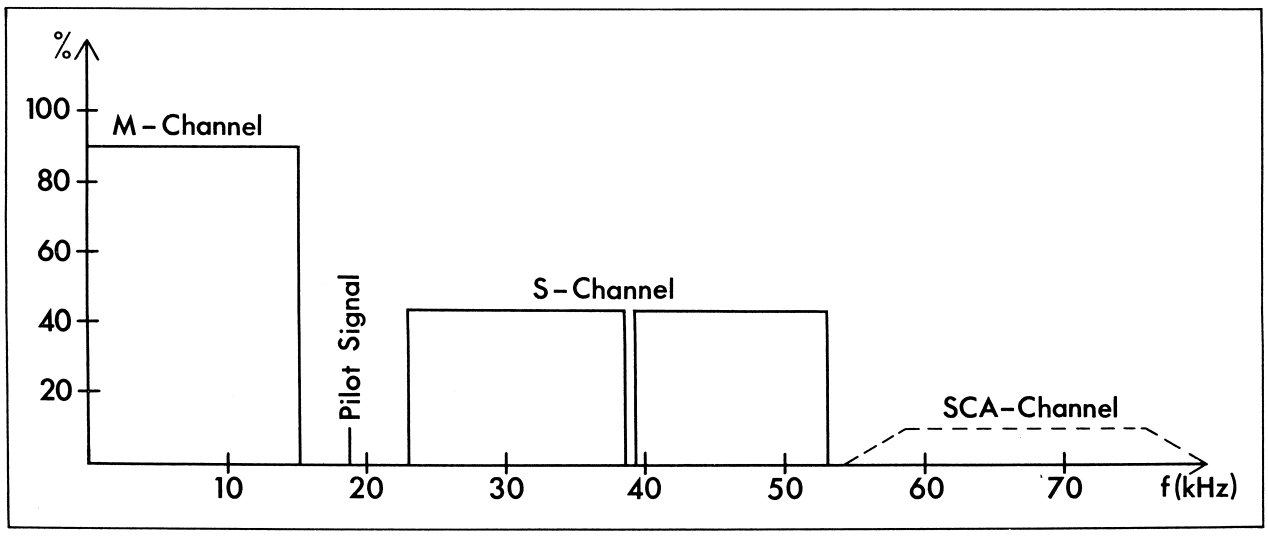


Fig.1. Frequency Spectrum for a Multiplex Stereo Signal

(S-channel or stereophonic sub-channel, covering the frequency range 23 - 53 kHz).

In he receiver, the difference signal (L - R) is obtained by regenerating the 38 kHz carrier and demodulating the S-channel. However, this carrier must be in exact phase with the suppressed 38 kHz carrier on the transmitter side, and to accomplish this, a pilot signal of 19 kHz (half of the suppressed carrier frequency) is transmitted with a normalized amplitude and with a stated phase relationship to the suppressed carrier.

The FCC allows a third channel, the SCA-channel (Subsidiary Communications Authorization) to be transmitted as a frequency-modulated sub-carrier on 67 kHz. This channel is used for background music in department stores, etc. It must not occupy more than 10% of the maximum peak-deviation of the FM broadcast transmitter.

The multiplex stereo signal can be generated in the two ways described in the following:

Fig.2 shows the Matrix Principle. In a matrix circuit the um (L + R) and the difference (L - R) of the left (L) and right (R) signals are obta ned. The sum-signal is passed onwards to an adder network, and the difference-signal is modulated into a 38 kHz carrier. Using a balanced modulator, the carrier is suppressed, so that the modulating process results in two sidebands, which pass on to the adder network.

The 38 kHz carrier is obtained by frequency-doubling a 19 kHz signal from a crystal-controlled oscillator. The 19 kHz signal is also fed to the adder network as a pilot signal.

The output signal from the adder network is the composite multiplex stereo-signal, which is used to frequency-modulate the transmitter.

Fig.3 shows the Time-Multiplex or Time-Division Principle. Here an electronic switch alternates between the left (L) and right (R) signal at a frequency of 38 kHz. The 38 kHz carrier and the 19 kHz pilot signal are formed in the same way as in the Matrix Principle.

By the switching process, sidebands to the odd harmonics of the carrier frequency will be produced. They are, however, eliminated by a filter with a 53 kHz cut-off frequency.

Mathematically it can be proved that the output-signal from the filter has the frequency spectrum shown in Fig.1, except that some unbalance between the main-channel and the stereophonic sub-channel

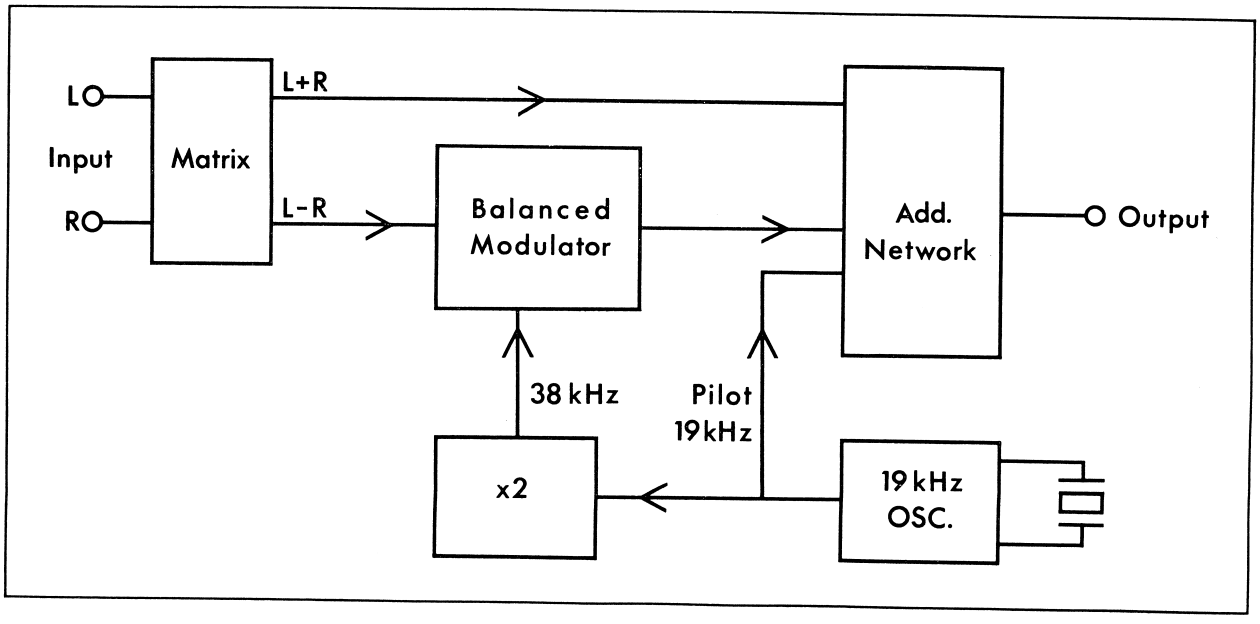


Fig.2. The Matrix Principle

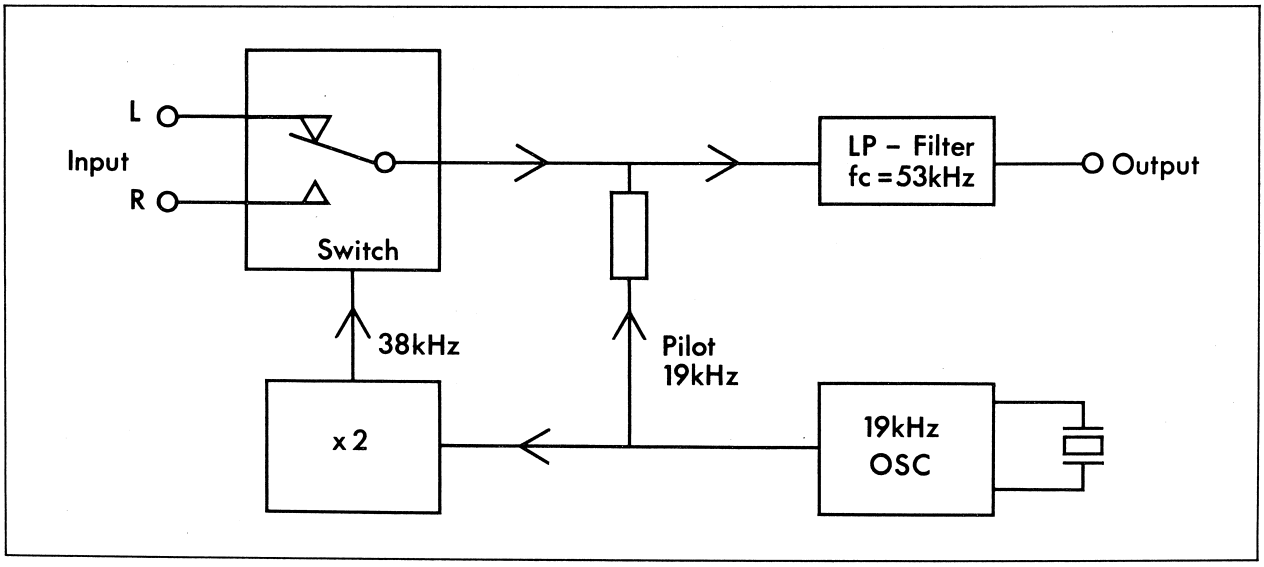


Fig.3. The Time - Multiplex Principle

is present. This unbalance would result in LR cross-talk after decoding; however, the unbalance can be compensated for either in the switching modulator or in the filter.

THE STEREO GENERATOR, TYPE SMG1

In the Stereo Generator, type SMG1, the time-multiplex principle has been adopted, because of its obvious advantages, of which one of the most significant is the completely uniform handling of the left and right signals, which implies that minor amplitude- and phase-differences become less probable.

The Stereo Generator, type SMG1, is a transistorized, line-operated instrument that complies with the standards for stereophonic broadcasting approved by the American FCC and recommended by the European Broadcasting Union (EBU).

The composite signal may be used for testing stereo adapters or driving FM generators to a full 75 kHz deviation. A built-in 100 MHz oscillator, frequency-modulated by the composite signal and provided with a step attenuator, makes the instrument self-contained by generating an FM multiplex signal for tests on receivers and tuners.

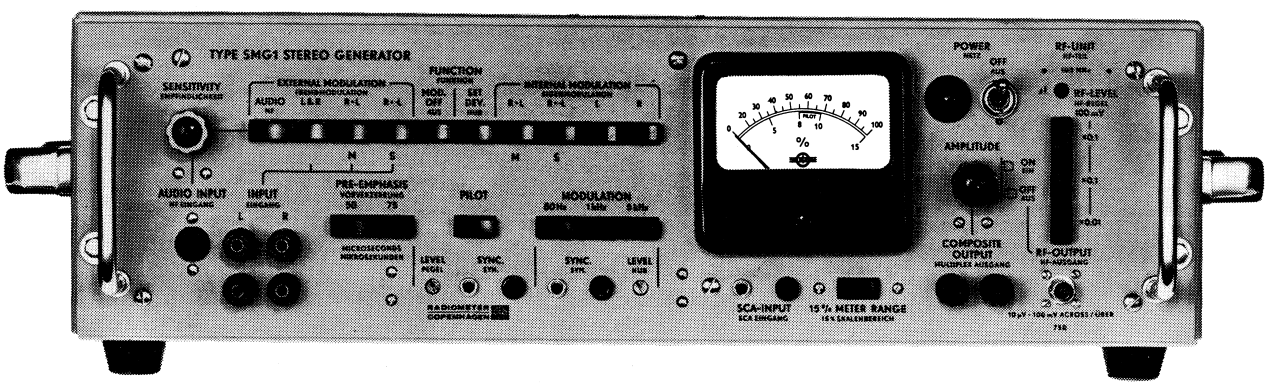


Fig.4. The Stereo Generator, type SMG1

The Stereo Generator, type SMG1, can be modulated internally by a built-in oscillator with choice of 80 Hz, 1 kHz, and 5 kHz (80 Hz, 1 kHz, and 10 kHz for SMG1S2) and externally from an AF oscillator or other program source.

The following operating modes are provided:

Stereophonic modulation of right or left channels. Both channels simultaneous with external modulation.

Mono- or stereophonic sub-channel output.

Stereophonic modulation with stereophonic input from tapes or records.

SCA modulation with FM sub-carriers.

The 19 kHz pilot and the composite signal are monitored by a peak-reading meter calibrated in % of system deviation. The pilot and the oscillator synchronizing signals are available from two terminals on the front panel. 50 and 75 µsec. standard pre-emphases are switchable in or out of circuit.

Section B. Specifications

INPUTS

Left (L) and Right (R) Inputs

Frequency range:	40 Hz to 15 kHz.
Fidelity:	±0.2 dB.
Input Voltage:	Approx. 250 millivolts rms for 100% modulation (inclusive of 10% pilot signal). Maximum input voltage is 10 volts.
Input Impedance:	10 to 15 kΩ depending on FUNCTION SELECTOR setting.

Audio Input — (Provides for stereo inputs from tapes and records. An input filter suppresses 19 kHz spurious signals).

Frequency Range:	40 Hz to 15 kHz.
Fidelity:	Approx. ±1 dB up to 12 kHz.
Input Voltage:	Approx. 250 millivolts to 10 volts rms for 100% modulation (inclusive of 10% pilot signal), depending on SENSITIVITY setting.
Input Impedance:	Approx. 15 kΩ.

SCA Input — (Subsidiary Communications Authorization).

Frequency Range:	10 to 75 kHz.
Fidelity:	±0.5 dB.
Input Voltage:	Approx. 250 millivolts rms for 10% modulation.

Input Impedance:	22 kΩ.

MODULATING OSCILLATOR

Frequencies	80 Hz, 1 kHz and 5 kHz.
Accuracy	±5%.
Distortion	Less than 0.1%.
PRE-EMPHASIS	Standard 50 μsec pre-emphasis ±1 dB. Standard 75 μsec pre-emphasis ±2 dB. Switchable in or out of circuit.

OPERATING MODES

External Modulation

AUDIO	Provides for stereo inputs from tapes and records for listening tests.
L & R	Normal two-channel multiplex signal output (also left only or right only signals).
R = L	Monophonic channel output.
R = -L	Stereophonic sub-channel output.

Internal Modulation

R = L	Monophonic channel output.
R = -L	Stereophonic sub-channel output.
L	Left channel multiplex signal output.
R	Right channel multiplex signal output.
Modulation OFF	No modulating signal supplied, only 19 kHz pilot supplied by pressing PILOT push-button.
Set Deviation	Pure sine-wave output supplied from COMPOSITE OUTPUT for setting deviation of external RF FM signal generator, if used.

OUTPUTS

Composite Output

Level:	0 to 7 volts peak.
Load Impedance:	Minimum 1500 Ω shunted by maximum 300 pF.

Overdrive Limit:	Approx. 10 volts peak for load impedances greater than 10 kΩ.
Output Impedance.	40 to 250 Ω, depending on AMPLITUDE setting.
Distortion:	Less than 0.2%.
Residual Hum and Noise:	Less than 0.03%.
Residual 38 kHz Carrier:	less than 1%, typically 0.5%.
Residual Spurious Signals above 53 kHz:	Approx. 1%.
Pilot Signal	Switchable in and out.
Pilot Frequency:	19 kHz ±2 Hz.
Pilot Level:	Adjustable from 0 to 20%.
LR Separation:	Better than 40 dB. Typically 45 dB for modulation frequencies below 10 kHz.
MS Separation: (Except AUDIO INPUT)	Pre-emphasis out: better than 45 dB. Pre-emphasis in: better than 40 dB.

Modulating Oscillator Sync. Output

Frequencies:	80 Hz, 1 kHz and 5 kHz. (80 Hz, 1 kHz and 10 kHz for SMG1S2).
Level:	Approx. 2 volts rms.
Source Impedance:	Approx. 22 kΩ.

Pilot Sync. Output

Frequency:	19 kHz.
Level:	Approx. 0.4 volts rms.
Source Impedance.	Approx. 22 kΩ.

RF FM Output

Frequency:	100 MHz, adjustable within ±0.5 MHz.
Output Voltage:	10 µvolts to 100 millivolts across a 75 Ω load. The voltage is adjustable in steps of 20 dB by means of a 20 + 20 + 40 dB attenuator.
Accuracy of Output Voltage:	From 100 µvolts to 100 millivolts: ±2 dB. At 10 µvolts: ±6 dB.
Peak Deviation:	±75 kHz for 100% deflection on meter.
Accuracy of Deviation:	±5% at ±75 kHz deviation.
Nominal Output Impedance.	75 Ω (60 Ω for SMG1S4), unbalanced. VSWR: 1.2 to 1.6.
Distortion:	Less than 1% at 75 kHz deviation, typically 0.5%.

LR Separation:	Better than 40 dB. Typically 45 dB for modulation frequencies below 10 kHz.
MS Separation:	Pre-emphasis out: better than 45 dB. Pre-emphasis in: better than 40 dB.

METER

Ranges	0 to 100% with peak value indication. 0 to 15% for pilot only.
Accuracy	±3% of full scale deflection.

TERMINALS

L and R Input and Composite Output	Binding posts that accept 4 mm banana plugs. Spacing 19 mm (3/4").
SCA Input, Pilot Sync. and Modulating Oscillator Sync.	Standard 4 mm banana jacks.
Audio Input	5-pole sockets, type Preh 8-7505 (5 DIN 41524 M).
RF - Output	Coaxial BNC socket, type UG 290/U.

POWER SUPPLY

Voltages:	110, 115, 127, 200, 220 or 240 volts.
Line Frequencies:	50 to 60 Hz.
Consumption:	11 watts.

SEMICONDUCTORS COMPLEMENT	26 transistors and 10 diodes.
MOUNTING AND FINISH	Steel cabinet finished in grey enamel.

DIMENSIONS AND WEIGHT

Height:	160 mm (6 1/4 inches).
Width:	565 mm (22 1/2 inches).
Depth:	235 mm (9 1/4 inches).
Weight:	9.1 kilos net (20 lbs.).

ACCESSORIES SUPPLIED	1 Coaxial Cable (75 Ω), type 6D6, with BNC plugs, type UG-88/U. 1 Power Cord, type 12G19-1.5. 1 Plug, type Preh 8-7506, for Audio Input.
ACCESSORIES AVAILABLE	20 dB Pad, type FDL2, 75 Ω (Small 20 dB attenuator terminated in male and female type BNC connectors). Balancing Transformer, type UBT3 (Provides for balanced output voltages from 40 MHz to 250 MHz. Impedance Ratio 75 to 300 Ω. Voltage ratio 1 to 1. Input socket BNC type UG-290/U).

Section C. Accessories

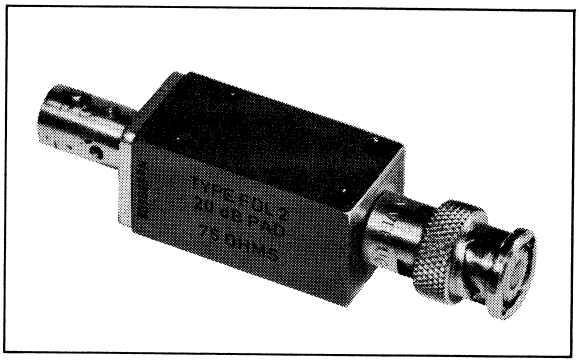


Fig.5. The Attenuator, type FDL2

20 dB PAD, TYPE FDL2

General

The Attenuator, type FDL2, is an attenuator to be used from dc to about 300 MHz, with 75 Ω nominal impedance.

The attenuator is constructed as a single-section pi-type resistive network. It contains high-stability carbon resistors of the film-type, selected to close tolerances.

The attenuator is completely shielded by a metal casing; no undesired electrical coupling to the internal elements is possible.

Specifications

Attenuation:	20 dB
Impedance:	75 Ω
Accuracy:	Within ±0.2 dB at dc. Within ± 0.5 dB to 250 MHz.
Maximum Power Input:	0.1 watt.

Dimensions:

Height:	18 mm (3/4 inch)
Width:	18 mm (3/4 inch)
Depth:	76 mm (3 inches)
Weight:	70 grams (2 1/2 oz)

Terminals:

BNC-type coaxial connectors, male and female.

BALANCING TRANSFORMER, TYPE UBT3

General

The Balancing Transformer, type UBT3, has been designed to produce a balanced output voltage from a signal generator. It has a voltage ratio of 1:1; i.e. the calibration of the signal generator can be used directly.

When the Balancing Transformer is connected to a 75 Ω source the output impedance is 300 Ω. The balance of the output voltage is within a few per cent up to 200 MHz and within 5% to 250 MHz.

The unit contains a specially designed

transformer and a resistive matching network. It has a BNC input socket and output from a socket which matches a commercially available 2-pin plug for twin-lead cable. One plug is supplied with the type UBT3.

Specifications

Frequency Response:

Within 1 dB from 40 MHz to 250 MHz with 300 Ω load.

Voltage Ratio:

1:1.

Accuracy of Output Voltage:

Within ±1 dB of nominal value.

Output Impedance:

300 Ω when connected to a 75 Ω source.

Terminals:

Input: BNC socket, type UG290/U.

Output: Socket for 2-pin plug. The correct pin diameter is 3.2 mm (1/8 inch) and the spacing is 7.9 mm (5/16 inch).

Dimensions:

Height: 25 mm (1 inch)
Width: 18 mm (3/4 inch)
Depth: 100 mm (4 inches)
Weight: 150 grams (5 1/2 oz)

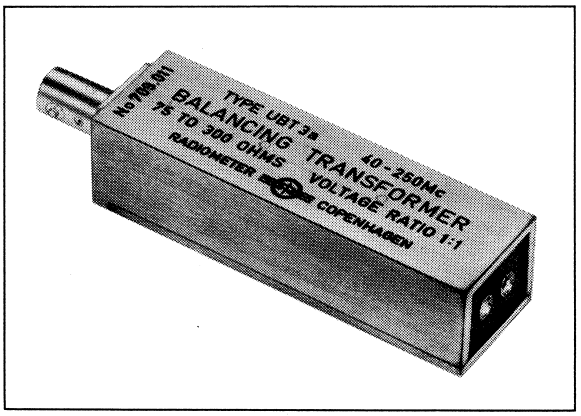


Fig.6. The Balancing Transformer, type UBT3

Section D. General Description

OPERATING PRINCIPLE

I princ'p e as shown on the block diagram in F g 7, the FUNCTION SELECTOR witches the inputs of the LEFT and R GHT AMPLIFIER between the external modulat'on terminals and the MODULATNG OSCIL ATOR to obtain the follow-.ng ope atin modes:

Externa Modulation

AUD O:

Lef and right amplif'er connected to AUDIO INPUT.

Ste eophonic music from tapes and records.

L & R:

Left amplif'er connected to L INPUT and rig t ampl fier to R INPUT.
Normal wo-channel multiplex output signal.

R = L:

Bo h ampl'fiers parallel-connected to L INPUT.
Monophonic or Main-Channel output signa .

R = -L:

Left amplifier connected to L INPUT.
Right amp'ifier input signal a fraction (equal to the reciprocal amplification) of the left amplifier output voltage.
Both amplifiers giving a 180 degrees' phase shift, the output voltages of the left and right amplifier will be equal, but in opposite phase.
Stereophonic sub-channel output signal.

MOD. OFF:

Modulating circuits disconnected.

SET. DEV.:

The modulating oscillator connected directly to the output amplifier.

Internal Modulation

R = L:

Both amplifiers parallel-connected to the modulating oscillator.
Monophonic or Main-Channel output signal.

R = -L:

Left amplifier connected to the modulating oscillator. Right amplifier input signal a fraction of the left amplifier output voltage.
Stereophonic sub-channel output.

L

Left amplifier connected to the modulating oscillator.
Left channel multiplex signal output.

R

Right amplifier connected to the modulating oscillator.
Right channel multiplex signal output.

The switch modulator alternates between the left and right amplifier outputs at a frequency of 38 kHz. The switching voltage is a 38 kHz square wave signal obtained from a flip-flop. This flip-flop is triggered by a crystal-controlled 76 kHz oscillator and feeds another flip-flop, which divides the frequency into 19 kHz (square wave). A filter smoothens this signal into a sine wave, which serves as the pilot signal and is added to the output of the switch modulator.

The switch output signal and the pilot signal pass through a phase-linear low-pass filter to the output amplifier. The amplified signal is then measured with a peak-reading meter and fed to the RF-UNIT and to the Composite Output terminals via a potentiometer. The RF-UNIT is a frequency-modulated oscillator operating on 100 MHz and is modulated by the composite output signal from the output amplifier. Before the RF signal reaches the RF-OUTPUT terminal it may be attenuated as much as 80 dB in steps of 20 dB.

CONTROL, METER and TERMINALS

As can be seen on Fig.8, all controls are located on the front panel.

(1) Power Switch and Pilot Lamp

Located near the upper right-hand corner of the meter.
Pilot lamp: Neon, 220 volts.

(2) FUNCTION SELECTOR

Selects the wanted operating mode as explained above.

(3) SENSITIVITY and AUDIO INPUT socket

The knob controls the modulation level, when an external modulation source (gramophone or tape recorder) is connected to the AUDIO INPUT five-pole socket.

(4) PRE-EMPHASIS

With both push-buttons out, the audio frequency response is straight from 40 Hz to 15 kHz (no pre-emphasis). With one

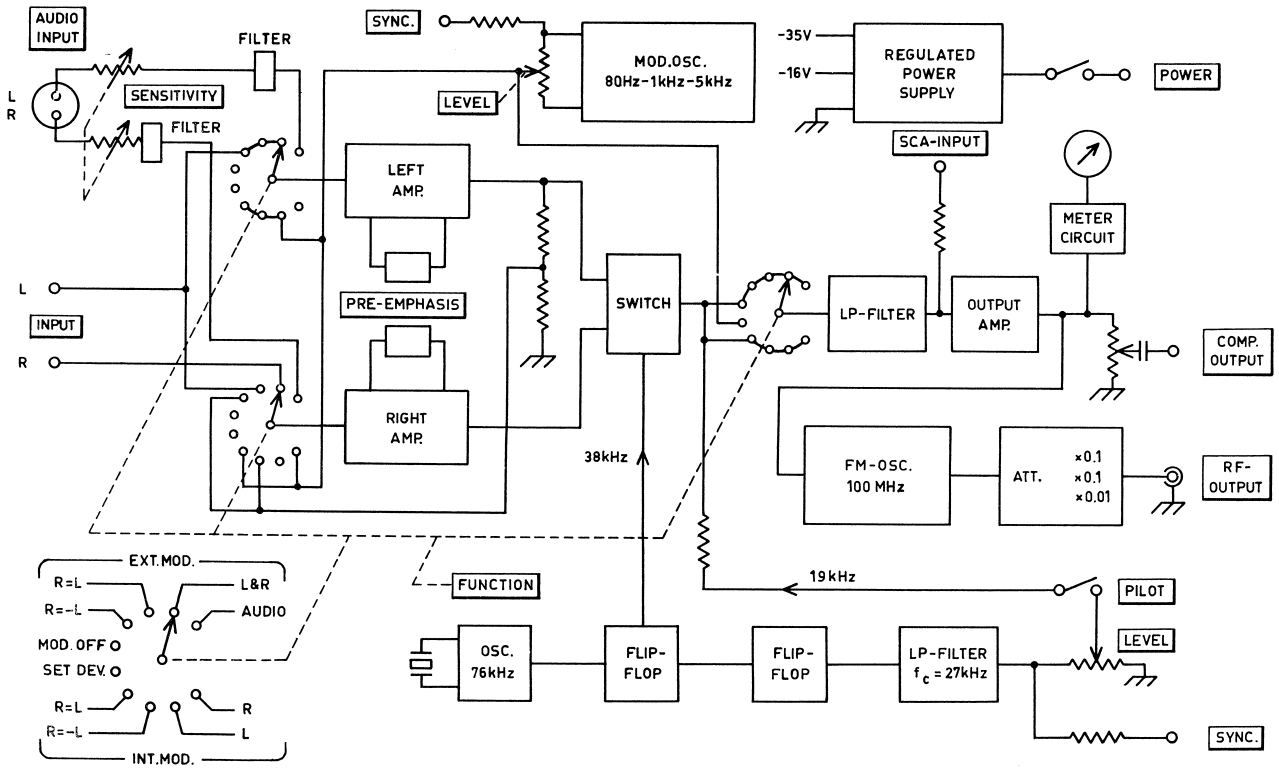


Fig.7. Simplified Block Diagram

of the buttons pushed in, the pre-emphasis is 50 µsec (European standard) or 75 µsec (American standard) respectively.

(5) PILOT, pilot LEVEL and SYNC

Pushing the pilot button switches on the 19 kHz pilot signal. The level is set with the screw-driver adjustment marked LEVEL and can be indicated on the meter (see under METER). The pilot signal is available at the SYNC. banana-plug-type terminals for synchronization purposes (approx. 0.4 volts rms), both with the button in and out.

(6) MODULATION FREQUENCY, LEVEL and SYNC.

Selects the desired modulation frequency when internal modulation is used. The screw-driver adjustment marked LEVEL sets the modulation level for internal modulation (see under METER).

The modulation signal is available from the SYNC banana-plug-type terminals (approx. 2 volts).

7) L and R INPUT terminals

When other than the built-in modulation frequencies are required, or when different left and right signals are wanted, external audio signal generators have to be connected to the left (L) and right (R) INPUT banana-plug-type terminals. The lower binding posts are grounded.

(8) METER and METER switch

The meter indicates the peak value of the composite signal. Normally, the upper scale, graduated from 0-100% of the system deviation, is used. By pressing the METER push-button below the meter, the range is changed to 0-15%. This range is mainly intended for setting the pilot signal level (normalized level being 8-10%). If, however, it is used to measure a complex signal - when a weak modulation signal is applied - the accuracy is approx. 5% only.

(9) SCA-INPUT terminals

To these banana-plug-type terminals an SCA (Subsidiary Communications Authorization) signal generator can be connected.

(10) COMPOSITE OUTPUT and AMPLITUDE control

The composite signal is available at the two binding posts marked COMPOSITE OUTPUT, of which the left one is grounded. The output level is set with the AMPLITUDE control, being approx.7

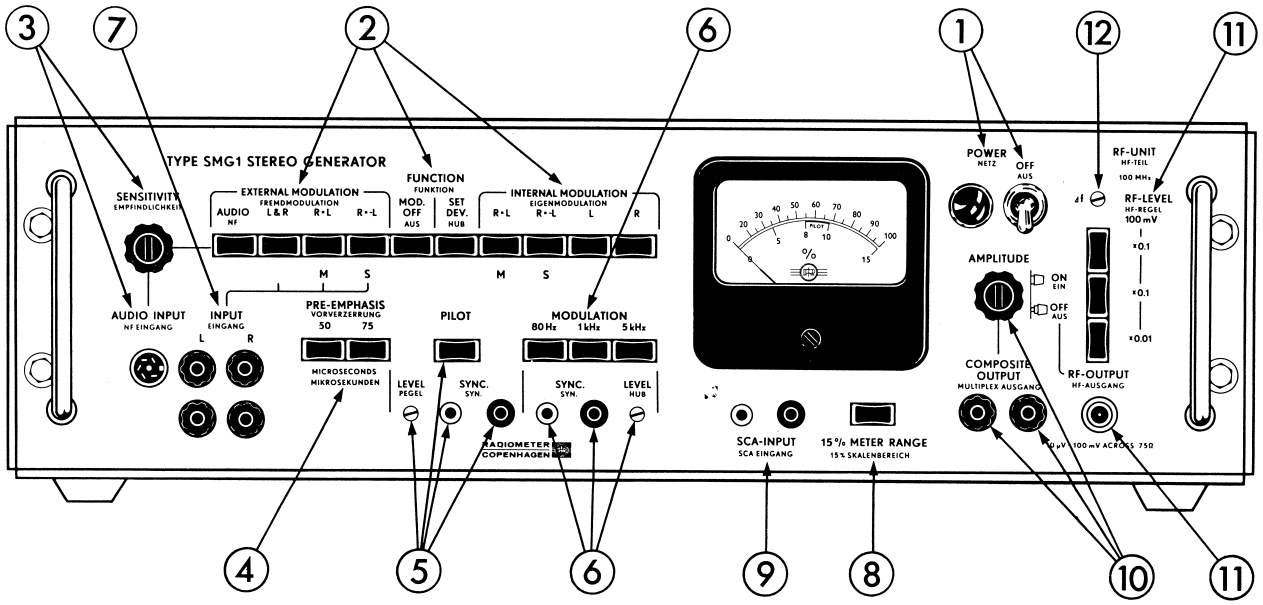


Fig.8. Front Plate of the Stereo Generator, type SMG1

volts peak when the control is turned fully clockwise, and the meter reads 100%.

(11) RF-LEVEL and RF-OUTPUT terminal and RF-oscillator switch

A 100 MHz signal modulated with the signal on the COMPOSITE OUTPUT terminal is available on the BNC connector RF-OUTPUT. By means of the RF-LEVEL push-button switch, the level of the FM-signal can be changed from 100 mV to 10 μV in steps of 20 dB.

The peak-deviation is 75 kHz when the meter reads 100%.

The RF-oscillator can be switched off by pulling the knob of the AMPLITUDE control.

(12) Δf

To avoid interference from a local broadcasting station operating on a frequency close to 100 MHz, the carrier frequency of the FM-signal can be changed approximately ± 0.5 MHz with this screw-driver adjustment.

Line Voltage Receptacle, Fuse, and Voltage Selector

Are all located on the rear of the cabinet.

Section E. Operating Instructions

CONNECTION

Power

Before connecting the instrument to the power line, make sure that the line voltage selector is set to the voltage of the power line. The voltage selector is always set to 220 volts when the instrument leaves the factory.

To change to another voltage, loosen the centre screw on the voltage selector, and set the selector to the desired voltage. The selector is accessible from the back of the cabinet. If the voltage is changed, it may also be necessary to exchange the fuse located in the selector.

The fuse type should be 80 mA, slow-blow, for 200, 220 and 240 volts, and 160 mA, slow-blow, for 110, 115 and 127 volts.

The generator is ready for use a few seconds after being connected to the power line. The first time some of the push-buttons are operated after connecting up, the meter-pointer will jump to full deflection, because the electrolytic capacitors are being charged. However, this will not damage the instrument.

External Modulating Sources

Gramophone or Tape Recorder.

The gramophone or tape recorder should be provided with amplifiers able to give at least 350 millivolts peak. The amplifiers should give the de-emphasis required for the employed playback system.

A plug, type Preh 8-7506, or the like should be used to connect the gramophone or tape recorder to the AUDIO INPUT. The order of the connections, which complies with the DIN 41524 recommendations, appears from the circuit diagram appended to this manual.

The B & O types 610 VF, 41 VF and 42 VF stereo gramophones with built-in amplifiers can be used direct (Manufacturer: Bang and Olufsen, Struer, Denmark).

External Audio Signal Generators.

External modulation sources used for measurements should always be connected to the L and R terminals (binding posts). Normally, unshielded leads will suffice, but in case of hum, shielded cables should be used.

When an M (R = L) output signal or an S (R = -L) output signal is wanted, the audio signal generator must be connected to the L-terminal. In other cases, the generator is connected to the L- or R-terminal, as required.

If different left and right signals are wanted, use either two external generators connected to the L and R terminals, or

connect the L terminal to an external audio generator, and the R terminal (or vice versa) to the MODULATION FREQUENCY SYNC. terminal with a variable resistor shunting the terminals to ground. Then choose the R signal modulation frequency with the MODULATION FREQUENCY switch, and set the level with the variable resistor.

SCA Sub-Carrier.

To add a normalized SCA sub-channel signal to the composite stereo signal, a frequency-modulated oscillator should be connected to the SCA INPUT terminals. The carrier frequency should be approx. 67 kHz, the peak-deviation 7 kHz, and the output voltage approx. 250 millivolts.

COMPOSITE OUTPUT to a stereo adapter

Connect COMPOSITE OUTPUT to the adapter. To avoid distortion, make sure that the load impedance is at least 1500 Ω. If a shielded cable is used, check also that the capacitive load does not exceed 300 pF.

RF-OUTPUT to Antenna Input of a receiver

For approx. 75 Ω input impedance of the receiver antenna terminals, connect a 75 Ω coaxial cable from the RF-OUTPUT terminal direct to the receiver antenna terminals. If the input impedance is 300 Ω, use a 75/300 Ω Balancing Transformer, type UBT3, in front of the receiver.

If other output voltages or a better standing wave ratio than those specified for the Stereo Generator are required, insert an appropriate 75 Ω pad between the Stereo Generator and the cable.

Modulating an external FM Signal Generator

When making measurements on other frequencies than 100 MHz or with continuously variable output voltages, an external FM signal generator should be used.

This signal generator should be able to handle modulation frequencies up to 75 kHz with negligible amplitude- and phase-distortion.

Proceed as follows:

1) Connect COMPOSITE OUTPUT terminals to the External Modulation terminals of the signal generator. If necessary, use a shielded cable. Make sure that the load does not exceed the limiting values (see above).

2) Set the signal generator to External FM and to the required carrier frequency.

3) Push MODULATION FREQUENCY button 1 kHz and FUNCTION SELECTOR button SET. DEV. of the Stereo Generator. With the modulation LEVEL adjustment in correct setting, the meter will now read 100%.

4) Turn AMPLITUDE knob of the Stereo Generator and/or the modulation level knob of the signal generator, until the modulation meter of the signal generator reads 75 kHz peak-deviation.

5) When now modulating with the complex stereo signal, the peak-deviation will be 75 kHz, when the meter of the Stereo Generator reads 100%, and of proportional values for lower readings. For a complex stereo signal, the modulation meter of the signal generator will not always read the peak deviation of the stereo FM-signal, as the Stereo Generator meter does.

OPERATING MODES

Modulation from gramophone or tape recorder for listening tests

1) Connect the gramophone or tape recorder as described above.

2) Push buttons AUDIO, PRE-EMPHASIS (50 µsec European standard, or 75 µsec American standard) and PILOT.

3) Turn SENSITIVITY knob, so that the meter reads 50-70% during loud passages in the music.

Internal Modulation

1) Push buttons PILOT and PRE-EMPHASIS (50 µsec or 75 µsec, European and American standard, respectively), if pilot signal or pre-emphasis is desired for the measurements in progress.

2) Push the desired MODULATION FREQUENCY button: 80 Hz, 1 kHz or 5 kHz. 80 Hz, 1kHz or 10 kHz for SMG1S2.

3) For the following operating modes, push the appropriate FUNCTION SELECTOR buttons located below the inscription INTERNAL MODULATION:

Monophonic channel output:
R = L (M)

Stereophonic sub-channel output:
R = - L (S)

Left channel multiplex signal output:
L

Right channel multiplex signal output:
R

Note:
If a modulation level different from the preset level is desired, turn the screwdriver adjustment marked LEVEL, use external modulation below, or use the arrangement described above.

When pre-emphasis is enserted, the modulation level obtained for a 5 kHz (10 kHz for SMG1S2) modulation frequency is almost normal, whereas the modulation levels obtained for modulation frequencies of 1 kHz and 80 Hz are lower.

External Modulation

1) Push buttons PILOT and PRE-EMPHASIS (50 µ sec or 75 µ sec, European and American standard, respectively), if pilot signal or pre-emphasis is wanted for the measurements in progress.

2) For the following operating modes, connect the external audio signal generator(s) (see also above), and push the appropriate FUNCTION SELECTOR buttons, located under the inscription EXTERNAL MODULATION, as described below:

a) Monophonic channel output:

Connect the external generator to L INPUT terminals. Push button R = L (M).

b) Stereophonic sub-channel output:

Connect the external generator to L INPUT terminals. Push button R = -L (S).

c) Left channel multiplex signal output:

Connect the external generator to L INPUT terminals. Push button L & R.

d) Right channel multiplex signal output:

Connect the external generator to R INPUT terminals. Push button L & R.

e) Simultaneous left and right channel multiplex output:

Connect the external generators to L and R INPUT terminals. Push button L & R.

3) Set the external generators(s) to the desired frequency (frequencies) and to the appropriate output level(s) - read the meter of the Stereo Generator.

Note:

If different left and right signals are wanted, but only one audio signal generator is available, use the built-in modulating oscillator as the second one.

Special Operating Modes

1) Non-standard pilot amplitude or phase.

The standard pilot amplitude gives a frequency deviation that is 8-10% of the maximum deviation (75 kHz). To obtain a non-standard value, push buttons PILOT, MOD. OFF and METER, and turn the screw-driver adjustment marked LEVEL, until the meter reads the desired pilot signal amplitude. Although not specified, a pilot amplitude giving more than 20% deviation can be obtained. To measure amplitudes that correspond to deviations larger than 15%, release the METER button and read the upper scale.

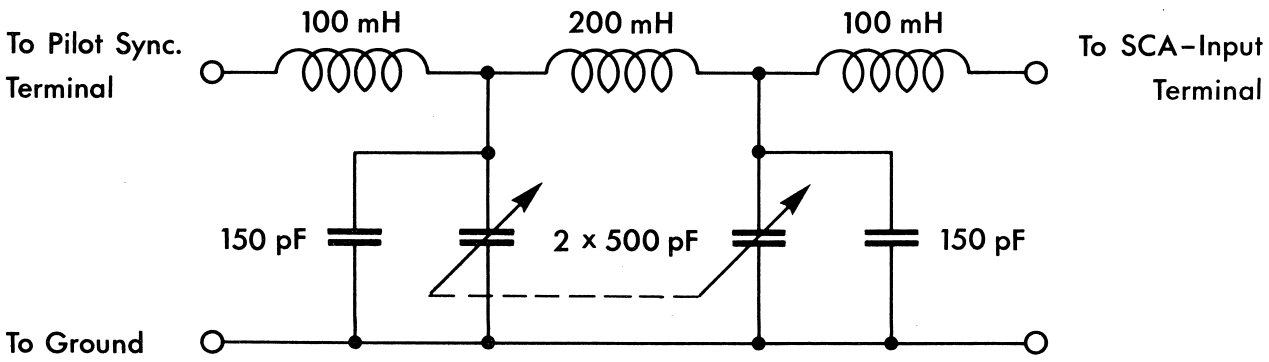


Fig.9. Pilot Phase Shifting Network

At the plant, the pilot signal phase has been internally adjusted to the standard value. If a non-standard pilot phase is required, connect the variable low-pass filter as shown in Fig.9 between the PILOT SYNC. and SCA INPUT terminals, and release the PILOT button. The pilot amplitude will have the standardized value simply by turning the variable double-capacitor of the filter. See MAINTENANCE as regards finding the setting of the capacitor which gives the correct pilot phase.

If, moreover, a smaller non-standard pilot amplitude is wanted, shunt the PILOT SYNC. terminal (to which the input of the filter still is connected) with a variable resistor to ground, and then set the amplitude with this resistor.

2) Using the Stereo Generator as a low-distortion audio signal generator.

Push FUNCTION SELECTOR button SET DEV. and one of the MODULATION FREQUENCY buttons. 80 Hz, 1 kHz or 5 kHz . (80 Hz, 1 kHz or 10 kHz for SMG1S2.) The signal at the COMPOSITE OUTPUT terminals will now be a pure sine-wave of the chosen frequency. Voltage: 0-5 volts rms, depending on the setting of AMPLITUDE and LEVEL. Distortion: Less than 0.2%. Load impedance: minimum 1500 Ω.

3) FM-Modulating the RF-UNIT with an external modulation signal.

a) Modulation frequencies approx. 40 Hz - 15 kHz.

Push FUNCTION SELECTOR button marked EXTERNAL MODULATION R = L (M).

Connect the external audio signal generator to L INPUT terminals.

Set the output voltage of the audio signal generator to full deflection (100%) on the meter, if 75 kHz peak deviation is wanted, and proportionally lower for smaller peak deviations.

b) Modulation frequencies approx. 10 kHz - 75 kHz.

Push FUNCTION SELECTOR button marked MOD. OFF.

Connect the external signal generator terminals.

Set the output voltage of the signal generator to full deflection (100%) on the meter, if 75 kHz peak deviation is wanted, and proportionally lower for smaller peak deviations.

Section F. Circuit Description

INPUT CIRCUITS, FUNCTION SELECTOR and INPUT AMPLIFIERS

The input circuits are connected to the input amplifiers so as to provide the required operating modes.

Input Amplifiers

The left and right input amplifiers are two identical amplifiers equipped with three transistors each. Heavy negative feedback is used to obtain constant amplification and small phase error. 50 µsec (European standard) or 75 µsec (American standard) pre-emphasis can be switched into the feedback loop.

The outputs from these amplifiers feed the switch modulator.

Audio Input

The Audio Input provides for stereo inputs from tapes and records. A two-gang potentiometer provides for sensitivity control, and two low-pass filters with a cut-off frequency of 15 kHz suppress spurious signals, particularly at 19 kHz.

In position AUDIO, the Function Selector connects the Audio Input to the input amplifiers.

L and R Input

This input circuit is intended for measurements where external audio signal generators are used.

With Function Selector in position L & R, the L Input and R Input terminals are coupled to the left and right input amplifier respectively.

In position R = L, the L Input terminals are coupled to the parallel-connected left and right input amplifiers.

In position R = -L, the L Input terminals are connected to the left input amplifier. The input signal to the right input amplifier is nearly half the sum of the output signals from the two input amplifiers. The summation is a bit skewed to obtain exactly balanced driving signals to the switch modulator.

Operating Modes MOD. OFF and SET DEV.

With Function Selector in position MOD. OFF, the connection between the switch modulator and the low-pass filter in front of the output amplifier is open. Therefore, there is either no input signal to the output amplifier, or, if the PILOT button is pushed, the input signal is the pilot signal only.

In position SET. DEV., the Modulating Oscillator supplies a pure sine-wave signal to the output amplifier.

Internal Modulation

With Function Selector in position R = L, the left and right input amplifiers are parallel-fed from the built-in modulating oscillator.

In position R = -L, the left input amplifier is fed from the modulating oscillator, and the input signal to the right input amplifier is nearly half the sum of the output signals from the two input amplifiers. In this way balanced driving signals to the switch modulator are obtained.

In position L ONLY, the left input amplifier is fed from the modulating oscillator, and the right input amplifier is short-circuited to ground. Vice versa in position R ONLY.

MODULATING OSCILLATOR

The modulating oscillator is a 3-transistors' Wien-bridge RC-oscillator with a thermistor for amplitude stabilization. Three modulation frequencies can be chosen by switching the capacitors in the Wien-bridge circuit.

The modulation level is set by means of a screw-driver adjustment. The oscillator signal is accessible from the Sync. terminals.

SWITCH MODULATOR

Two transistors, Q9 and Q10, are used in the switch modulator. The collectors are grounded, the bases are fed with balanced 38 kHz square-wave signals (the carrier signal), and the emitters are connected to the outputs of the input amplifiers via a resistive network. During one half-period Q9 is saturated and Q10 is cut off, whereas Q9 is cut off and Q10 is saturated during the other half-period. The saturated transistor leads the output signal from the corresponding input amplifier to ground via a 200 Ω resistor, producing a multiplex signal at the centre of the resistive network (the arm of potentiometer R35). The multiplex signal from the modulator passes through a low-pass filter, which suppresses unwanted modulation products above 53 kHz.

The resistors R33 and R37 are necessary for obtaining a correct multiplex signal from the low-pass filter. A mathematical analysis shows that without R33 and R37 an MS-unbalance is present, which will cause LR crosstalk.

38 kHz CARRIER and 19 kHz PILOT SIGNAL EXCITER

76 kHz Crystal Controlled Oscillator

The 76 kHz frequency, which is basis for both the carrier and pilot signal frequencies, is crystal-controlled to secure a frequency stability better than 10^{-4}. The crystal operates as a series resonance circuit. The exact oscillating frequency is adjusted with an inductance, L5.

38 kHz Flip-Flop

The differentiated 76 kHz signal triggers a flip-flop, whose 38 kHz square-wave output is used as carrier signal to the switch modulator. Exactly equal half-periods of the carrier signal have been ensured by using a flip-flop triggered from a 76 kHz source.

19 kHz Flip-Flop and Low-Pass Filter

The differentiated 38 kHz square-wave triggers another flip-flop, whose output, after being filtered in a phase-stable low-pass filter, is used as the 19 kHz pilot signal. The pilot signal can be switched on or off with S101, and its level is set with a screw-driver-adjusted potentiometer R128. For synchronizing purposes it is accessible from the Sync. terminals.

PHASE-LINEAR LOW-PASS FILTER

The combined pilot and switched left/right signal passes through a 76 kHz rejector circuit to an emitter-follower Q101. The emitter-follower feeds a low-pass filter with extremely low phase- and ampli-

tude-distortion up to 53 kHz to avoid MS unbalance and consequential LR-cross-talk after decoding.

OUTPUT AMPLIFIER

The filtered signal is fed to the output amplifier which is a 3-stage transistor amplifier with heavy feed-back in order to obtain high stability, low phase shift, low distortion and low output impedance in the frequency range 30 Hz to 75 kHz.

The SCA-Input is connected to the input of the output-amplifier through a capacitor and a resistor.

The amplifier output signal is fed to the Composite Output via a potentiometer R216 and a blocking capacitor C214. Further, the output signal is fed to the RF-unit and to the meter circuit.

METER CIRCUIT

The meter must be peak-reading to ensure that the reading is a measure of the system peak-deviation, when the modulation signal is a complex signal.

The meter circuit consists of the transistor Q204, the peak-rectifier CR201-C212, the dc amplifier Q205, and the meter.

With the meter range switch S201 in its normal position (range 0-100%), the transistor Q204 will operate as an emitter-follower, supplying a very low feeding impedance to the peak-rectifier. Within the meter range 0-15%, Q204 is coupled as a common emitter with the output feeding the peak-rectifier. In this case the feeding impedance is too high to secure true peak-rectification of complex signals, so that this range should be used for measurement of the pilot signal only. If, however, this range is used for measuring a complex signal, the accuracy will be only about 5%.

The dc amplifier employs a silicon transistor Q205 with a very high current gain at small collector currents, which is necessary for true peak-rectification.

RF-UNIT

Oscillator

The 100 MHz oscillator employs transistor Q401 in a common base configuration. It has a tapped collector inductance and feed-back through capacitor C410. Small frequency changes may be made with trimmer C407, which is part of the tuning capacity.

The output is taken from a loop, coupled to the tuning inductance.

The RF-oscillator can be switched off by pulling the knob of the AMPLITUDE control.

FM Modulator

The frequency modulator is a reactance switch modulator, CR402-C406. The part of an oscillation period during which the capacitor C406 is connected across the tuned circuit is varied in accordance with the modulation signal fed to the diode CR402. In this way a truly linear frequency modulation is produced.

Oscillator and FM modulator are housed in a shielding box.

RF Attenuator

The RF-signal passes an attenuator having three sections of 20, 20 and 40 dB attenuation. Each section can be switched in or out, so that the output voltages from 10 μV to 100 mV are obtainable in steps of 20 dB.

The impedance level is 75 Ω. The attenuator is protected against burn-out by a dc blocking capacitor C301. The RF-Output terminal is a type BNC connector.

REGULATED POWER SUPPLY

The generator can operate on the following nominal line voltages:

110, 115, 127, 200, 220, 240 volts.
S502 is the line switch. The slow-blow

fuse F501 protects the line transformer in case of a short-circuit.

The rectified voltage is regulated by a circuit employing three transistors and one zener diode. The regulated output voltage is set to -35 volts by the resistor R505. Some of the circuits operate on -16 volts, which are supplied via another zener diode, CR501, fed from the -35 volts supply.

The electronic regulation permits the instrument to be operated on line voltages deviating ±10% from the nominal value.

Section G. Maintenance

GENERAL

The Stereo Gene·ator, type SM'G1, has been des'gne to withstand rough treatment, but careful handling and proper use assure a long l fe and h'gh re.iabil-ity.

Necessa y repair should be carried out on y by skilled e sonnel, provided with the proper equ pmen to ensure that the repairs are correctly made.

REMOVING THE GENERATOR FROM ITS CABINET

Detach the power cord and remove the four fixing screws at t e sides of he front panel. The generator can now be pulled out of its abinet.

REPLACEMENT OF COMPONENTS

General

Print boards with the transistors soldered directly in have been used th oughout in the Stereo Generator. When servicing these ci cuits some precautions must be taken. Use a low-power soldering iron (65 watts maximum) to avoid damaging the print boards and transistors.

Most components are directly accessible. When this is no. the case, loosen the frame carrying the print board of interest by removing a few screws, and then remove the print board.

Selected Components

The transistors Q9, Q10,and Q205 have been selected. If these transistors are to be replaced, the generator should be returned to the factory, or selected duplicates should be ordered from the factory.

All other components may be replaced by components of equal type and tolerance.

ADJUSTMENTS

External adjustment (accessible from the front panel

1) Meter, mechanical zero.
With the power switched off, adjust the screw on the meter to meter-reading 0.
Switch on the power.

2) Modulating oscillator level.
Push button SET DEV.
Set the screw-driver adjustment marked LEVEL below the MODULATION FREQUENCY buttons to full scale deflection (100%) on the meter.

3) Pilot signal level.
Push buttons MOD.OFF and PILOT.
Press button METER.

Set the screw-driver adjustment marked LEVEL below the PILOT button, so that the meter (0-15% scale) reads the required pilot level. The normalized value, 8-10%, is marked on the scale. If a pilot level greater than 15% is required, merely release the METER button and read the upper scale (0-100%).

4) RF-Unit. Frequency adjustment.
In cases where a local broadcasting transmitter interferes with the built-in 100 MHz FM-oscillator, the frequency of the latter can be shifted approx. ±0.5 MHz from the preset value by turning the screw-driver adjustment FREQ. ADJ.

Complete Adjustment Scheme (External and Internal Adjustment)

Do not change the internal adjustments unless repairs or wear and tear make it necessary.

Before starting the adjustments, check that buttons PILOT and PRE-EMPHASIS are released.

1) Meter, mechanical zero.
With the power switched off, adjust the screw on the meter to meter-reading 0. Switch on the power.

2) Regulated power supply. ADJ. -35 V.
Connect a dc voltmeter to the -35 volts lead. Adjust the resistor R505, marked "ADJ. -35 V", so that the voltmeter reads -35 volts.

3) 76 kHz oscillator.
Connect an electronic counter to PILOT SYNC. terminals. Turn the inductance adjuster of the inductance L5, until the counter reads 19 kHz.

4) 76 kHz rejector circuit. "76 kHz TRAP"
Connect an oscilloscope to COMPOSITE OUTPUT terminals and synchronize from PILOT SYNC.
Push EXTERNAL MODULATION button R = L. No external modulation must be supplied.
Adjust L106 (marked "76 kHz TRAP") to minimum vertical deflection on the scope.

5) SET R = L and SET R = -L.
Push MODULATION FREQUENCY button 1 kHz.
Connect a wave analyzer, covering the frequency range up to approx. 40 kHz, to COMPOSITE OUTPUT terminals.
Push INTERNAL MODULATION button marked R = -L.
Find a residual signal close to 1 kHz with the wave analyzer.
Adjust the resistor R28 marked SET R=-L to minimum residual signal on the wave analyzer.
Push INTERNAL MODULATION button marked R = L.
Find a residual signal close to 37 or 39 kHz with the wave analyzer.
Adjust the resistor R35 marked SET R = L to minimum residual signal on the wave analyzer.
Again, push button R = -L, and repeat the procedure once or twice.

Note:
If no wave analyzer is available, the adjustment can be made in nearly the same way (but less accurately) by using an oscilloscope connected to COMPOSITE OUTPUT terminals and synchronized from MODULATION FREQUENCY SYNC.

With R = -L button pushed, the scope will show a double side-band-signal with suppressed carrier. The presence of a 1 kHz residual signal is characterized by the fact that the tops are not situated on a horizontal line. Set R28 (marked SET R = -L) to minimum residual signal.

With R = L button pushed, the scope will show a 1 kHz sine wave with the 37 and 39 kHz residual signals superposed as a "ripple". Set R35 (marked SET R = L) to minimum "ripple".
Repeat this procedure once or twice.

6) ADJ.METER and ADJ. 15%.

Connect a vacuum-tube voltmeter to COMPOSITE OUTPUT terminals.

Turn AMPLITUDE control fully clockwise.
Push MODULATION FREQUENCY button 1 kHz.
Push button SET.DEV.
Turn the potentiometer R126, Modulation LEVEL (accessible from the front panel), until the VTVM reads 5 volts rms.
Adjust the resistor R227, ADJ. METER, so that the built-in meter reads 100%.
Turn the potentiometer R126, Modulation LEVEL (accessible from the front panel), until the VTVM reads 0.5 volt rms.
Press METER button, and adjust the resistor R224, ADJ.15%, until the built-in meter reads 10%.

7) MODULATION LEVEL and SET. DEV.
Push INTERNAL MODULATION button R = L.
Push MODULATION FREQUENCY button 1 kHz.
Turn the potentiometer R126, Modulation LEVEL (accessible from the front panel), until the built-in meter reads 90%.
Push button SET.DEV.
Adjust the resistor R8, ADJ. SET. DEV., so that the meter reads 100%.
Repeat the adjustment of R126 and R8 once or twice.

8) PILOT LEVEL
Push buttons MOD.OFF and PILOT.
Depress button METER.

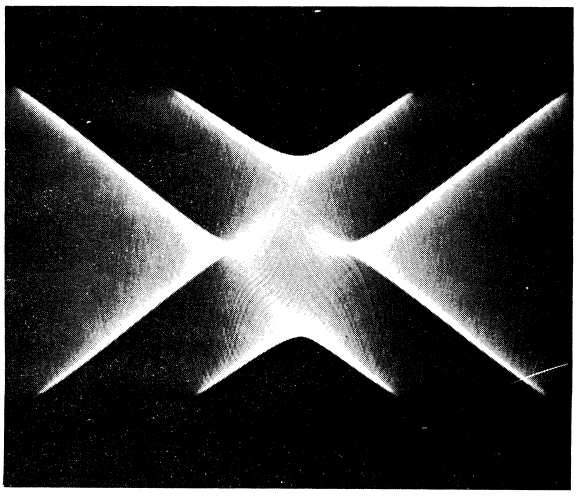


Fig.10. Pilot Phase adjustment

Adjust the potentiometer R128, PILOT LEVEL (accessible from the front panel), until the meter reads 8-10% (marked on the 0-15% scale).

9) PILOT PHASE
Connect an oscilloscope to COMPOSITE OUTPUT terminals, and synchronize from MODULATION FREQUENCY SYNC. terminals.

Push buttons PILOT and INTERNAL MODULATION R =-L.

Push MODULATION FREQUENCY button 1 kHz. (If the modulation frequency by chance turns out to be a sub-harmonic of the pilot frequency, push both the 1 kHz and the 5 kHz (10 kHz for SMG1S2) buttons). Vertical as well as horizontal expansion will then produce a picture on the scope as seen in Fig.10. Turn the inductance adjuster of the inductor L3, until the two arrow points are on the same horizontal line.

The following three items relate to the RF-UNIT. The RF-oscillator and the FM modulator are housed in a shielding box. They are mounted on a small print board, which becomes accessible by removing four nuts and pulling away half of the box.

10) Output voltage
With all RF-LEVEL buttons out, set the output voltage to 100 millivolts by moving the loop coil L404 in relation to the tuning coil L403. Make sure that the output voltage is correct when the cover is replaced.
Check the RF-attenuator by measuring the output voltages when the RF-LEVEL buttons are pushed in different combinations.

11) Modulation linearity and peak-deviation.
Connect an FM modulation meter (deviation meter) to the RF-OUTPUT terminal and tune it to the frequency of the RF-Unit. Connect a distortion meter or a wave analyzer to the AF-output of the modulation meter.

Push buttons SET DEV. and MODULATION FREQUENCY 1 kHz.
The meter should now read 100%.

Note:
During the following adjustments, it is important that the RF-oscillator box is assembled. Adjust with an insulated screw-driver through the holes marked ADJ.1 and ADJ.2.

Set the resistor R402 "MOD.BIAS"(ADJ.1) to minimum modulation distortion, measured on the distortion meter or the wave analyzer

Set the resistor R405 "FM DEV."(ADJ.2) to 75 kHz peak-deviation, measured on the modulation meter.
Repeat the adjustment of R402 and R405, until both potentiometers are in optimum position.

12) FREQ.ADJ. Fine-adjustment of the RF-frequency.
A fine-adjustment of the RF-frequency is made with the screw-driver adjustment FREQ.ADJ., accessible from the front panel.
The frequency change is so small that the accompanying peak-deviation change as a rule is insignificant.
If accurate peak-deviation is essential, make the adjustments outlined in 11).

DC Potentials

The potentials listed on the following pages can be used to locate faults.
The potentials are referred to ground and measured with a vacuum-tube voltmeter with a 2 MΩ probe to avoid capacitive loading.

Section H. Applications

GENERAL

This chapter does not purport to provide a complete exposition on ways and means of testing and aligning a stereo multiplex receiver or adapter. The proper procedure will to a great extent depend on what the user wants to test and which auxiliary instruments are available. In the following are sketched some measurements which can be made with the Stereo Generator and some commonly used auxiliary instruments are mentioned. With this as a guide, the user should be able to plan the measuring procedure needed for his requirements.

For use in the greater part of the measurements mentioned below, the following instruments are to be recommended:

Wave Analyzer:	Radiometer, FRA3
Audio Frequency VTVM:	Radiometer, RV24
Distortion Meter:	Radiometer, BKF6
Low Distortion Audio Oscillator:	Radiometer, HO32
Oscilloscope (without phase- or amplitude distortion for the frequency range 50 Hz -53 kHz):	Tektronix, 515

To avoid damage to your stereo generator, never apply voltages above 10 volts rms to the terminals.

INITIAL CONNECTIONS AND SETTINGS

(See also OPERATING INSTRUCTIONS).

In most cases internal modulation is adequate. Therefore, in the following, internal modulation will normally be assumed. If, however, external modulation is required, the measurements can be carried out in a similar way (see OPERATING INSTRUCTIONS).

Pre-emphasis can be used, if desired. When measuring on an adapter (or tuner + IF amplifier + discriminator + adapter) without de-emphasis circuit (de-emphasis circuit being placed in the succeeding AF-amplifier), it is more convenient not to use pre-emphasis. In other cases it may prove more convenient to use pre-emphasis.

Note, however, that when using internal modulation and pre-emphasis, full driving signals (i.e. 100% meter deflection, 7 volts peak at COMPOSITE OUTPUT terminals with AMPLITUDE knob turned fully clockwise, and 75 kHz peak-deviation of the RF-signal) are obtained only for 5 kHz (10 kHz for SMG1S2) modulation frequency, while lower signals are obtained for 80 Hz and 1 kHz. Full driving signals include the pilot signal.

When using external modulation and pre-emphasis, the modulating voltage should be set either to a fixed value, giving

full deflection for the highest modulation frequency to be used, or it should be reduced as the modulation frequency is increased, to avoid overdriving the Stereo Generator and thus exceeding the standard deviation.

It is assumed that the standardized pilot signal is to be used. Refer to OPERATING INSTRUCTIONS under "Special Operating Modes 2' for setting up a non-standard pilot amplitude or phase.

Some of the following measurements are not exclusively applicable to stereophonic investigations, but can also be used in work on monophonic FM receivers (or stereophonic receivers operated as monophonic receivers). In such cases, always push R = L (M) button (INTERNAL or EXTERNAL MODULATION), and release PILOT button. Except for this, proceed as described in the following.

The initial connections and settings depend on which output signal is to be used - i.e. the composite output for adapters or the RF-output for receivers.

Initial connections and settings for measurements on adapters

1) Connect the adapter to COMPOSITE OUTPUT terminals.

2) Push button PILOT.

3) Push the appropriate PRE-EMPHASIS button (European standard: 50 µsec, American standard: 75 µsec), if desired.

4) Push 1 kHz MODULATION FREQUENCY button.

5) Set AMPLITUDE KNOB to the level suitable for the adapter. This can be accomplished in several ways:

Push one of the INTERNAL MODULATION BUTTONS. With an oscilloscope connected across COMPOSITE OUTPUT terminals, the peak-to-peak value can be measured on the screen.

Using a normal rms-calibrated vacuum voltmeter, the signal used for setting the level must be a pure sine-wave. This can be obtained by pushing SET DEV. button.

A conventional VTVM (rms-calibrated, mean-value or rms-measuring) should be used only for purposes of comparing. When the built-in meter reads 100% and AMPLITUDE control is turned fully clockwise, the peak-voltage on COMPOSITE OUTPUT terminals will be close to 7 volts. By now comparing the readings of a VTVM connected across COMPOSITE OUTPUT terminals, when AMPLITUDE knob is turned fully clockwise, with the readings when it is turned partly up, it is possible to calculate the peak output voltage for any AMPLITUDE setting.

The stereo generator is now ready for the measurements on adapters described in the following paragraphs.

Initial connections and settings for measurements on receivers

1) Push the RF-oscillator switch (knob of the AMPLITUDE control).

2) Set RF-LEVEL to an appropriate value.

3) Push PILOT button.

4) Push appropriate PRE-EMPHASIS button (European standard: 50 µsec, American standard: 75 µsec), if desired.

5) Push 1 kHz MODULATION FREQUENCY button.

6) Connect RF-OUTPUT terminals to the antenna terminals of the receiver, and tune the receiver to the output frequency of the stereo generator (approx. 100 MHz).

The stereo generator is now ready for the measurements on receivers described in the following paragraphs.

LR SEPARATION (LR-SEPARATION IS EQUAL TO MS-IDENTITY)

1) Push button L.

2) Measure the voltages at the left and right output terminals of the adapter or receiver. The ratio of these voltages is the L to R separation (L to R crosstalk).

3) Push button R.

4) Measure the voltages at the right and left output terminals of the adapter or receiver. The ratio of these voltages is the R to L separation (R to L crosstalk).

5) If desired, repeat the measurements for other modulation frequencies.

Note:
In case the output signal of the adapter or receiver contains hum, or 19 or 38 kHz residual signals, make sure that these signals do not compromise the measurements. Use a selective vacuum tube voltmeter (wave analyzer), appropriate filters in front of a VTVM, or an oscilloscope synchronized from the MODULATION FREQUENCY SYNC.

LR BALANCE EXPRESSED BY MEANS OF THE IDENTITY FACTOR (LR-IDENTITY IS EQUAL TO MS-SEPARATION)

The identity factor is an expression of the differences in amplification of L- and R-channels.
Let the ratio of the amplification of L-channel to that of R-channel be denoted by "f", then the Identity Factor is equal to

$$20 \log_{10} \frac{1 + f}{1 - f} \text{ dB.}$$

Measuring the Identity Factor

1) Connect the ungrounded side of the L and R output terminals of your adapter or receiver through two identical resistors in series. The value of the resistors must be high as compared with the output impedance of your adapter or receiver.

2) Press button R = L (M).

3) Measure the voltage between the point of junction of the two resistors and ground (V_1) by means of a frequency analyzer (or a VTVM and a low-pass filter which removes any residual signals that may be present at 19 kHz and 38 kHz).

4) Press button R = -L (S).

5) Measure the resultant voltage (V_2).

The LR identity factor can now be determined as

$$20 \log \frac{V_1}{V_2} \text{ dB.}$$

FIDELITY

If a check of the fidelity at the three built-in modulation frequencies is sufficient:

1) Push button L.

2) Measure the voltage on the left output terminals of the adapter or receiver for modulation frequencies 1 kHz, 80 Hz and 5 kHz. (80 Hz, 1 kHz or 10 kHz for SMG1S2.)

If the de-emphasis of the adapter or receiver agrees with the pre-emphasis of the Stereo Generator, the voltage will be the same for all three modulation frequencies, when the tone controls are in neutral position.

3) Repeat the measurement for the right channel by pushing R ONLY button and measuring on the right output terminals of the adapter or receiver.

If a detailed frequency response is to be measured:

1) Push L & R button (EXTERNAL MODULATION).

2) Connect an external audio signal generator to L INPUT terminals, and adjust its output voltage to full deflection on the meter for the highest modulation frequency to be used.

3) Measure the voltage on the left output terminals of the adapter or receiver as a function of frequency. If the de-emphasis of the adapter agrees with the pre-emphasis of the Stereo Generator, the voltage will be frequency-independent in the audio frequency range, when the tone controls are in neutral position.

4) Connect the audio signal generator to R INPUT terminals and repeat the measurement of the right channel.

Measuring the frequency response for the monophonic (M) channel and the stereophonic (S) sub-channel

1) Push button R = L (M) (INTERNAL or EXTERNAL MODULATION, as required).

2) Measure the voltage on the left or right output terminals of the adapter or receiver as a function of frequency.

3) Push button R = -L (S), and repeat the measurement.

DISTORTION

In most practical cases it is sufficient to check the distortion at a low, a medium and a high modulation frequency. The built-in modulating oscillator is designed with due regard to this particular application. Its distortion is very low, its low modulation frequency has been chosen so as not to interfere with the line frequency, and its high modulation frequency has been selected as the maximum frequency, whose second and third harmonics will pass through the AF amplifier of the receiver under test.

If other test-frequencies are required, a low-distortion, audio frequency signal generator should be used.

Measuring the distortion

1) Push one of the modulation buttons of FUNCTION SELECTOR, depending on the type of multiplex-signal for which the distortion is to be measured.

2) Measure the distortion with a wave analyzer or a distortion meter connected to that adapter- or receiver- output that corresponds to the type of multiplex-signal under measurement.

3) If desired, repeat the measurement for modulation frequencies of 80 Hz and 5 kHz, (10 kHz for SMG1S2), and for other types of multiplex-signals.

Note.
If a distortion meter is used, make sure that the measurements are not disturbed by 19 or 38 kHz spurious signals. If that is the case, insert a low-pass filter with a cut-off frequency of 15 kHz (and, perhaps, traps at 19 and 38 kHz) in front of the distortion meter.

MEASURING INTERMODULATION BETWEEN THE HARMONICS OF THE L OR R SIGNAL AND SIGNALS AT 19 kHz AND 38 kHz (THE PILOT SIGNAL AND THE REGENERATED CARRIER SIGNAL)

Components produced by intermodulation of this kind in the stereo generator are typically 90-100 dB below the level of the L or R signal.

Measuring intermodulation with an R or L signal frequency, f_A:

1) Connect a low-distortion generator to the L or R input (the built-in modulation generator can be used, too).

2) Push button R & L.

3) Set the frequency of the signal generator to f_A, and adjust the amplitude, so that the built-in meter reads 100%.

4) Measure the intermodulation components at the output of either channel by means of a frequency analyzer. The frequency of the intermodulation components will be

$$\pm n_1 \times f_A \pm n_2 \times 19 \text{ kHz},$$

where n_1 and n_2 are integers.

M AND S CHANNEL IDENTITY OF TUNER, IF AMPLIFIER AND DISCRIMINATOR IN A RECEIVER (MS-IDENTITY IS EQUAL TO LR-SEPARATION)

Measured with an oscilloscope

1) Connect an oscilloscope to the discriminator output. Make sure that the capacitive load gives a cut-off frequency that is larger than 500 kHz. Do not use a probe, as this will cause amplitude- and phase-distortion, if not adjusted very carefully.

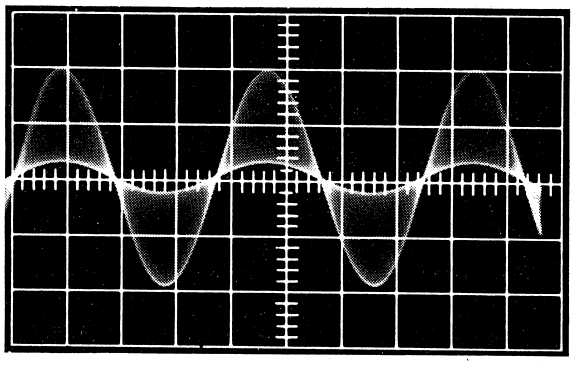


Fig.11. Scope view shows MS amplitude unbalance. (Measured on discriminator output).

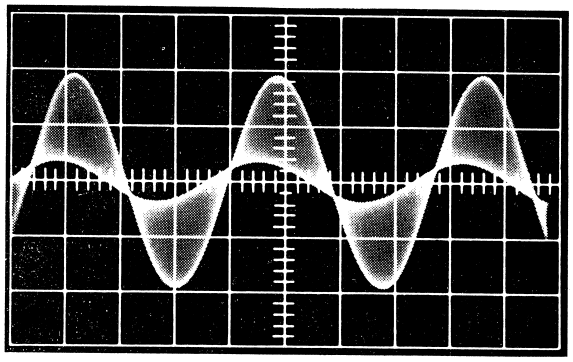


Fig.12. Scope view shows a phase distortion in addition to MS unbalance. (Measured on discriminator output).

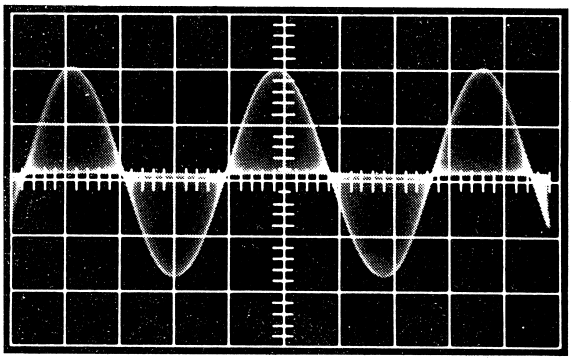


Fig.13. Waveform for an L or R signal as viewed on COMPOSITE OUTPUT, without pilot signal.

Trigger the oscilloscope from MODULATION FREQUENCY SYNC. terminal. Use an oscilloscope with a flat amplitude and a linear phase characteristic from 30 Hz to at least 75 kHz.

2) Push L or R button.

3) Release PILOT button.

4) The scope will now show a picture as in Fig.11 or 12.

Fig.13 shows the ideal case with perfect M and S channel identity. In practice, however, scope views as in Fig.11 and 12 will be obtained.

Fig.11 shows MS amplitude unbalance (the S channel amplitude is too low). From this picture the MS Identity Factor equal to the LR Separation (after demodulation in an ideal multiplex decoder) can be calculated as shown in Fig.14.

Fig.12 shows a phase distortion in addition to MS amplitude unbalance (indicated by a non-coincidence of corresponding tops of the two sinusoidal envelopes).

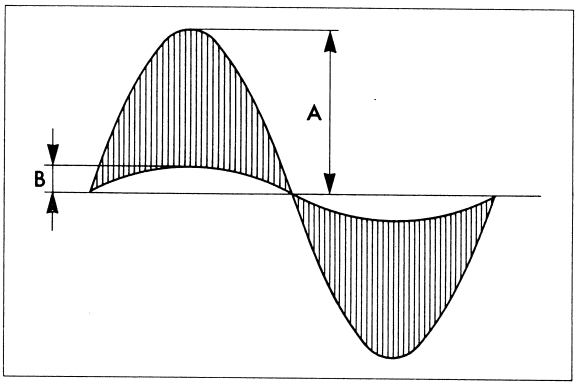


Fig.14. Calculation of MS Identity Factor equal to LR Separation (after decoding).

5) Repeat the measurement for other modulation frequencies; if convenient, also for a very high frequency (10 to 15 kHz, using external modulation), where MS unbalance and especially phase distortion often are very pronounced.

Measured with a wave analyzer (for frequencies up to 53 kHz)

(This method gives no information about phase distortion).

1) Connect a wave analyzer to the discriminator output. Make sure that the capacitive load gives a cut-off frequency that is larger than 500 kHz.

2) Push L or R button.

3) Measure the discriminator output signal components at the modulation frequency (monophonic channel), and at 38 kHz plus and minus the modulation frequency (stereophonic sub-channel sidebands).

For perfect MS identity the amplitude of the two sidebands should be equal, and either should be equal to half the amplitude of the monophonic channel signal.

If phase distortion is disregarded, the MS Identity Factor will be:

$$20 \log_{10} \frac{1 + f}{1 - f} \text{ dB},$$

$$f = m/(s_1 + s_2)$$

where m is the monophonic channel signal voltage, and s_1 and s_2 are the voltages of the stereophonic sub-channel sidebands.

M AND S CHANNEL SEPARATION OF TUNER, IF AMPLIFIER AND DISCRIMINATOR OF A RECEIVER (MS-SEPARATION IS EQUAL TO LR-IDENTITY)

M to S Separation (Crosstalk)

1) Connect a wave analyzer (frequency range: 40 Hz to 53 kHz) to the discriminator output.

2) Push button R = L (M).

3) Measure the discriminator output signal components at the modulation frequency (monophonic channel), and at 38 kHz plus and minus the modulation frequency (stereophonic sub-channel sidebands).

The M to S separation is:

$$20 \log_{10} m/(s_1 + s_2) \text{ dB},$$

where m is the monophonic channel signal voltage, and s_1 and s_2 are the voltages of the (unwanted) stereophonic sub-channel sidebands.

S to M Separation (Crosstalk)

1) Connect a wave analyzer (frequency range: 40 Hz to 53 kHz) to the discriminator output.

2) Push button R = -L (S).

3) Measure the discriminator output signal components at the modulation frequency (monophonic channel), and at 38 kHz plus and minus the modulation frequency (stereophonic sub-channel sidebands).

The S to M separation is:

$$20 \log_{10} (s_1 + s_2)/m \text{ dB},$$

where m is the voltage of the (unwanted) monophonic channel signal, and s_1 and s_2 are the voltages of the stereophonic sub-channel sidebands.

PILOT RESERVE

A stereophonic FM-receiver should in all circumstances be able to function correctly, even if the pilot sub-carrier were to depart from its normal level.

A deviation from the optimal value of amplification in tuners, etc., may very likely be caused by aging.

Measuring Pilot Reserve

1) Push button L (the R-channel could be used as well).

2) Reduce the level of the pilot signal until minimum allowable L to R separation, or maximum allowable distortion of the L channel, is reached.

Measuring the separation and measuring the distortion are described above.

The level of the pilot signal is changed by turning screwdriver adjustment LEVEL below button PILOT.

3) Push button MOD. OFF.

4) Read the level of the pilot signal on the meter. Press button METER to get an accurate reading.

5) Push button L.

6) Increase the level of the pilot signal until minimum allowable L to R separation or maximum allowable distortion is reached. However, the pilot signal should not exceed the level corresponding to 20% modulation.

7) Push button MOD. OFF.

8) Read the level of the pilot signal on the meter.

9) The readings in (4) and (8) give the allowable range of the pilot signal amplitude.

Note:
The measurements at increased pilot signal level assume that the FM-receiver has a bandwidth large enough not to cause distortion for a 10% increase of the frequency deviation.

MEASURING FM DISCRIMINATOR CHARACTERISTICS

In multiplex stereo development work it often may be necessary to measure the harmonic distortion of the FM discriminator versus the modulation frequency. The modulation frequency range is 40 Hz to 53 kHz. If an FM signal generator capable of handling this modulation frequency range is not available, the Stereo Generator can be used.

See OPERATING INSTRUCTIONS for further instructions.

For the distortion measurements use a wave analyzer, accepting high frequencies (up to third harmonic of the highest modulation frequency), or use a VLF receiver (20 - 200 kHz) or appropriate filters together with a wide-band VTVM.

LISTENING TESTS

1) Connect a gramophone or tape recorder to the AUDIO INPUT.

2) Push buttons AUDIO, PILOT and PRE-EMPHASIS (European Standard: 50 µsec, American Standard: 75 µsec).

3) Turn SENSITIVITY knob, so that the meter reads 50-70% during loud passages in the music.

Note:
During interruptions or soft passages in the sound, the tone of the built-in oscillator may be heard. To eliminate this tone, the oscillations of the built-in oscillator should be stopped by releasing all three frequency buttons of the oscillator. All three buttons are released by gently pushing one of the buttons just so far that the other two buttons are released, and then letting go of the button.

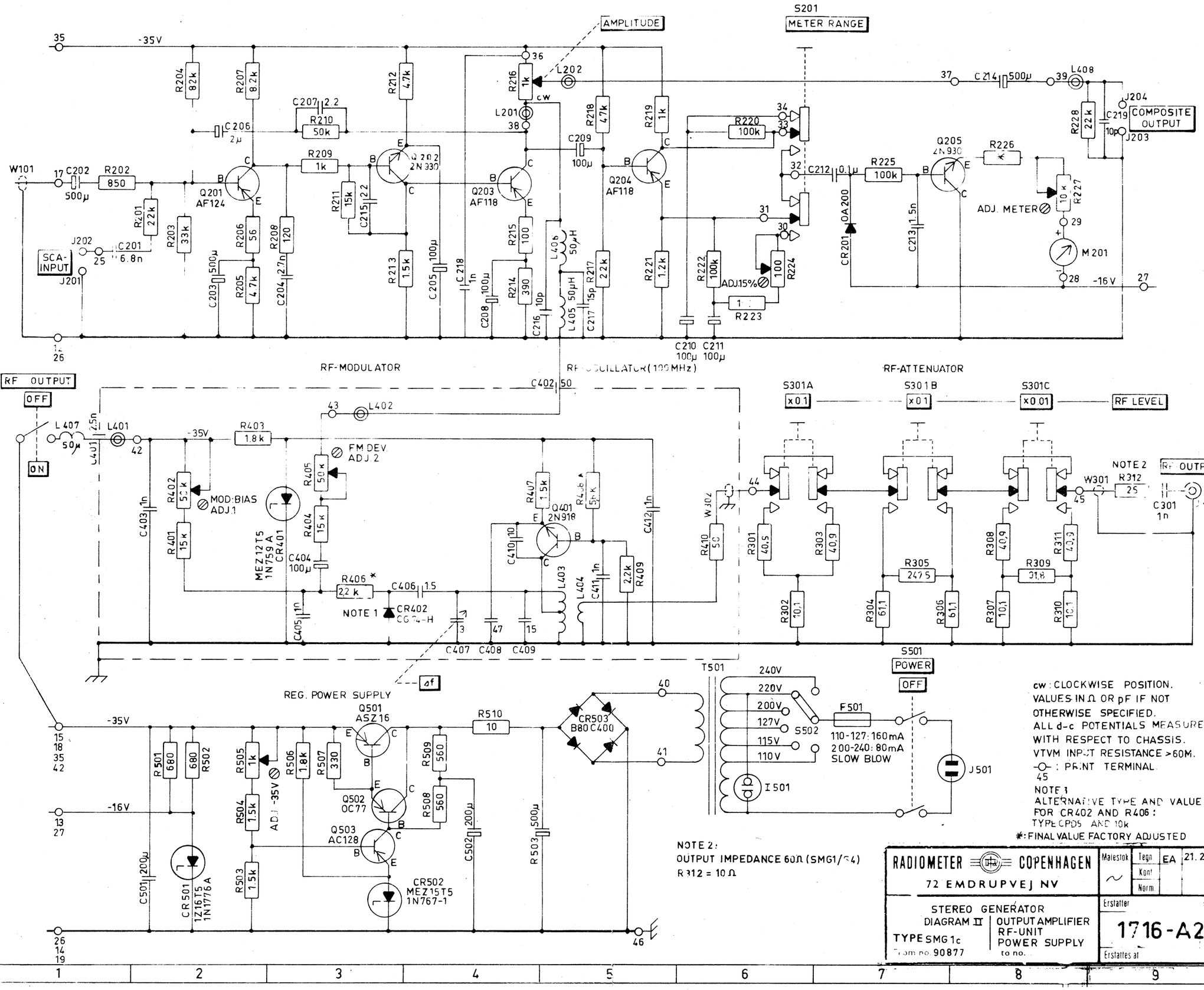
DC POTENTIALS

		minimum	typical	maximum
Q1	-Vc	9.7 V	13 V	15 V
	-Vb	5 V	5.3 V	5.8 V
Q2	-Vc	7.1 V	8 V	8.8 V
	-Vb		12.5 V	
Q3	-Vc	14 V	16 V	20 V
Q4	-Vc	14 V	16 V	20 V
Q5	-Vc	7.1 V	8 V	8.8 V
	-Vb		12.5 V	
Q6	-Vc	9.7 V	13 V	15 V
	-Vb	5 V	5.3 V	5.8 V
Q7	-Vc		6.3 V	
	+Vb		3.6 V	
Q8	-Vc		7.5 V	
	+Vb		3 V	
Q9	+Vb		2.2 V	
Q10	+Vb		2.2 V	
Q11	-Vc		7.3 V	
	+Vb		2.5 V	
Q12	-Vc		7.3 V	
	+Vb		2.5 V	
Q13	-Vc		13.5 V	
	-Ve		7 V	
	-Vb		7 V	
Q101	-Vc		15.5 V	
	-Vb		7.3 V	
Q102	-Vc	11 V	16 V	20 V
	-Ve		4.2 V	
Q103	-Vc		24.1 V	
	-Ve		4.5 V	
Q104	-Vc	4 V	4.7 V	
	-Ve	1.4 V	1.6 V	1.8 V
Q201	-Vc	12 V	15 V	17 V
	-Vb	8.5 V	9.5 V	11 V

		minimum	typical	maximum
Q202	-Vc	6.5 V	7.2 V	8 V
	-Ve		15.5 V	
Q203	-Vc	19 V	22 V	24 V
	-Ve		7 V	
Q204	-Vc	24 V	26 V	27 V
	-Ve	9.5 V	10.5 V	13.2 V
	-Vb	9.8 V	10.7 V	13.5 V
Q401	-Vc		0 V	
	-Ve		5.8 V	
	-Vb		5.6 V	
CR401	-Vc		12 V	
Q501	-Vc	At nominal line voltages	41 V	
		" " " " -10% 36 V		
	-Ve	34.5 V	35 V	35.5 V
Q502	-Vb		36 V	
Q503	-Ve	13.5 V	15 V	16.5 V
CR501	-Vc	14.5 V	16 V	17.5 V

Hum on the supply voltage (-35 V) from the power supply should be less than 1 mV rms.

The power consumption of the generator is approximately 10 VA.



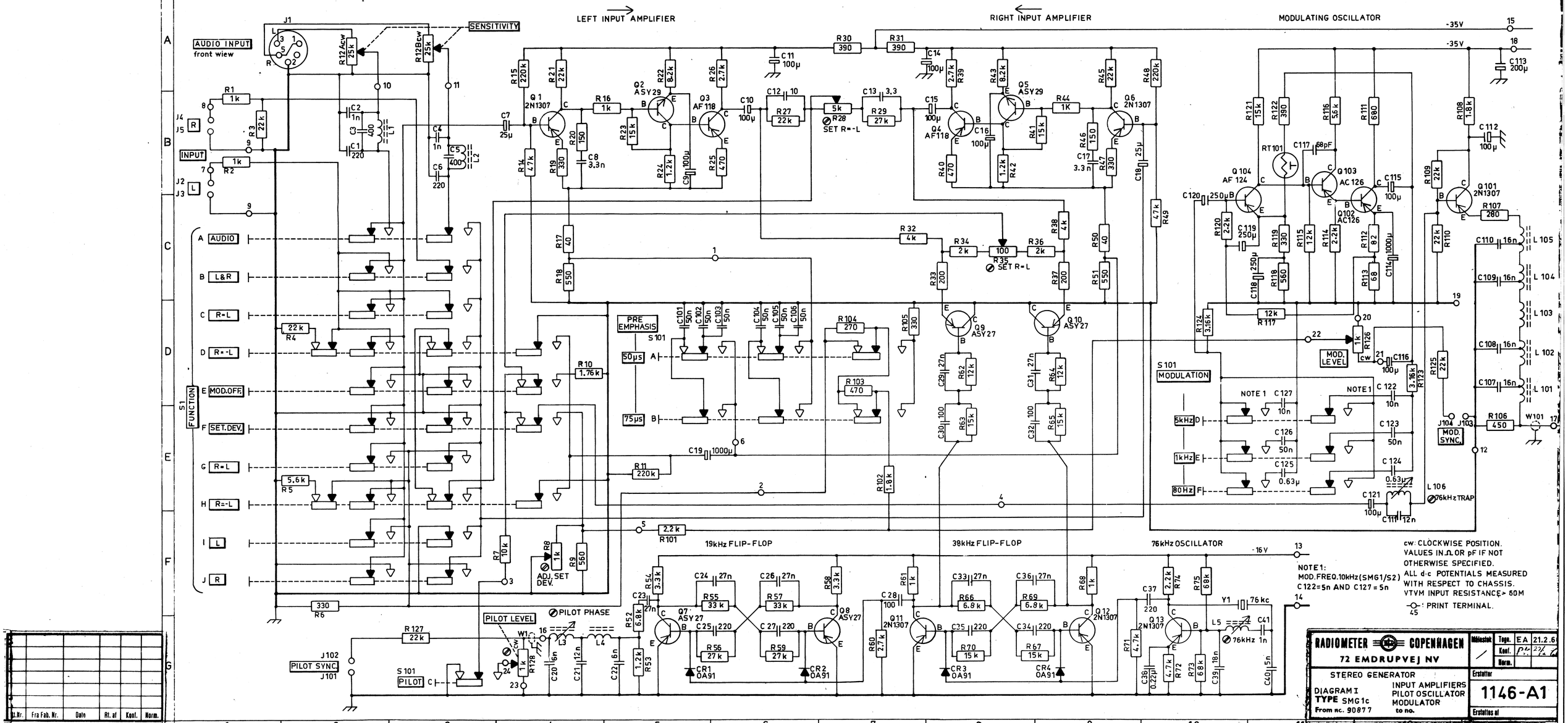
5	119343	10-5-67	LTJ	PK	
4	106995	24-1-67	KHK	sla.	
3	105935	12-12-66		sla	
2	103419	26-10-66	BS.		
1	90877	14-6-66	HK		35
Rev.	Engineering No.	Date	Revised	Kont	Norm

RADIOMETER COPENHAGEN
72 EMDRUPVEJ NV

Malestok: Tegn EA 21.2.66; Kont; Norm

STEREO GENERATOR
DIAGRAM II | OUTPUT AMPLIFIER RF-UNIT POWER SUPPLY
TYPE SMG 1c
from no. 90877 to no.

Erstatter
1716-A2
Erstattes af


LEFT INPUT AMPLIFIER
RIGHT INPUT AMPLIFIER
MODULATING OSCILLATOR
AUDIO INPUT
front wiew
SENSITIVITY
INPUT
S1 FUNCTION
A AUDIO
B L&R
C R-L
D R=-L
E MOD.OFF.
F SET.DEV.
G R=L
H R=-L
I L
J R
PRE EMPHASIS
S101
50µs
75µs
MODULATION
MOD. LEVEL
MOD. SYNC.
19kHz FLIP-FLOP
38kHz FLIP-FLOP
76kHz OSCILLATOR
PILOT LEVEL
PILOT PHASE
ADJ. SET DEV.
PILOT SYNC.
J102
J101
S101 PILOT
SET R=-L
SET R=L
L106 76kHz TRAP
-35V
-16V
NOTE 1:
MOD.FREQ.10kHz(SMG1/S2)
C122=5n AND C127=5n
cw: CLOCKWISE POSITION.
VALUES IN Ω OR pF IF NOT
OTHERWISE SPECIFIED.
ALL d-c POTENTIALS MEASURED
WITH RESPECT TO CHASSIS.
VTVM INPUT RESISTANCE> 50M
: PRINT TERMINAL.
RADIOMETER COPENHAGEN
72 EMDRUPVEJ NV
STEREO GENERATOR
DIAGRAM I
TYPE SMG 1c
From no. 90877
INPUT AMPLIFIERS
PILOT OSCILLATOR
MODULATOR
to no.
Tegn. EA 21.2.6
Konf.
Norm.
Erstatter
1146-A1
Erstattes af
Ill.Nr. Fra Fab. Nr. Dato Rt. af Konf. Norm.