Function generator 10 mHz-2MHz

PM 5133

9445 051 33001

Instruction manual

9499 453 00302
8502 01/3/01-09

S&I
Scientific & Industrial Equipment Division

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Industrial Equipment

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Gerätehandbuch
Mode d'emploi et d'entretien

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PHILIPS

Please note

In correspondence concerning this instrument, please quote the type number and serial number as given on the type plate.

Bitte beachten

Bei Schriftwechsel über dieses Gerät wird gebeten, die Typennummer und die Gerätenummer anzugeben. Diese befinden sich auf dem Typenschild an der Rückseite des Gerätes.

Noter s. v. p.

Dans votre correspondance et dans vos réclamations se rapportant à cet appareil, veuillez toujours indiquer le numéro de type et le numéro de série qui sont marqués sur la plaquette de caractéristiques.

Important

As the instrument is an electrical apparatus, it may be operated only by trained personnel. Maintenance and repairs may also be carried out only by qualified personnel.

Wichtig

Da das Gerät ein elektrisches Betriebsmittel ist, darf die Bedienung nur durch eingewiesenes Personal erfolgen. Wartung und Reparatur dürfen nur von geschultem, fach- und sachkundigem Personal durchgeführt werden.

Important

Comme l'instrument est un équipement électrique, le service doit être assuré par du personnel qualifié. De même, l'entretien et les réparations sont à confier aux personnes suffisement qualifiées.

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CONTENTS

INHALTSVERZEICHNIS

TABLE DES MATIERES

1. GENERAL

1.1. INTRODUCTION

The **PM 5133 function generator** is designed for research, industrial and educational applications and the spezialized audio service workshop.

The instrument provides both **linear and logarithmic sweep facilities,** plus a wide range of other useful facilities in one self-contained instrument. For example, it offers **sine, square and triangular waveforms, positive or negative pulses and DC**, a variable duty cycle (10 % to 90 %) and a 10 mHz – 2 MHz frequency range selectable via a 7-position rotary switch having an overriding coarse/fine control. Combined with the **3 1/2 digit LED display**, the fine adjustment provides an immediate and very accurate readout of sweep frequency and other setting conditions. Thus setting-up compared with the usual dialsetting procedure is simplified, whilst parallax is eliminated.

A maximum **output of 20 Vpp** (10 Vpp for pulses) is available at the frontpanel mounted socket. A pushbutton gives choice of 600 or 50 Ohm output impedance. Output attenuation of more than 60 dB is selectable in 3–10–20–30 dB calibrated steps with a continuous 20 dB overriding control. The 3 1/2-digit display can be used to monitor the open circuit output voltage.

Sweep facilities include **single shot** and **continuous operation,** with the choice between linear and logarithmic mode. Frequency ranges are divided into **seven linear and five logarithmic subranges** with continuous coarse and fine adjustment. The logarithmic sweep ranges cover more than four decades, which makes the instrument useful for sweeping in the audio frequency range.
The single sweep can be triggered either manually, or electronically from an external source. The sweep period is continuously adjustable between 5 ms and 100 s. The START and STOP frequencies can be set independent of each other.

A HOLD facility allows a sweep to be stopped at any desired frequency, useful for checking phenomena which may appear during a sweep. An interrupted sweep is continued by releasing the HOLD button. If required, a sweep can be reset to the start frequency by means of the RESET button. When the instrument is used in the sweep mode, the start, stop and run frequencies are all indicated on separate LED's.

An error-warning lamp automatically lights up, if the operator selects any incompatible setting.

The generator also offers an internally or externally controlled **burst** and **single-cycle** signal with a continuously adjustable start/stop phase between -90° and $+90^{\circ}$.

The input/output facilities include a **TTL output,** a pen-lift control, an internal modulation voltage and a frequency control voltage.

The ergonomic design of the instrument ensures ease of use. It's rugged construction and compact size provides maximum electrical and mechanical protection.

1.2. TECHNICAL DATA

Safety characteristics

This apparatus has been designed and tested in accordance with Safety Class I requirements of IEC Publication 348, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. This manual contains some information and warnings which must be followed by the user to ensure safe operation and to retain the apparatus in a safe condition.

Performance characteristics, specifications

Properties expressed in numerical values with stated tolerance are guaranteed by the manufacturer. Specified non-tolerance numerical values indicate those that could be nominally expected from the mean of a range of identical instruments.

This specification is valid after the instrument has warmed up for 30 minutes (reference temperature 23 °C).

If not stated otherwise, relative or absolute tolerances relate to the set value.

1.2.1. Frequency

frequency range	LIN (linear)	0.1 Hz – 2 MHz
	LOG (logarithmic)	10 mHz – 2 MHz
LIN sub-ranges	I	0.1 Hz – 2 Hz
	II	1 Hz – 20 Hz
	III	10 Hz – 200 Hz
	IV	100 Hz – 2 kHz
	V	1 kHz – 20 kHz
	VI	10 kHz – 200 kHz
	VII	100 kHz – 2 MHz
LOG sub-ranges	I	10 mHz – 200 Hz
	II	0.1 Hz – 2 kHz
	III	1 Hz – 20 kHz
	IV	10 Hz – 200 kHz
	V	100 Hz – 2 MHz
characteristic		linear or logarithmic, selectable
adjustments		– range switch FREQ RANGE – FREQUENCY knobs for coarse and fine setting
vernier frequency adjustment		±5 % of end of range for LIN ±25 % for LOG
display		3 1/2 digit 7-segment LED display 3 decimal points 4 LEDs for dimensions mHz, Hz, kHz, MHz
setting error		range LIN I to VII, LOG I ot IV: ±2 % ±1 digit range LOG V: ±3 % ±1 digit
temperature coefficient		< 0.1 %/K for LIN mode < 0.25 %/K for LOG mode

short-term drift	range LIN I to VI < 0.1 %; LIN VII < 0,3 %; LOG < 0,5 % } within 15 min
long-term drift	LIN < 0.3 %; LOG < 0.5 % } within 7 h

1.2.2. Output

connection	BNC socket
impedance	50 Ω/600 Ω, selected by pushbutton
load capability	short-circuit proof
wave forms	sine wave triangular wave square wave positive pulse negative pulse all with or without DC offset; DC d.c. voltage without a.c.
duty cycle	continuously adjustable from 10 % to 90 %, when pushbutton DUTY CYCLE is pressed
amplitude, open circuit	2 Vpp . . . 20 Vpp for sine, triangle, square wave 1 Vpp . . . 10 Vpp for pulses
– limit	±10 V (for details see chapter 3.2.3.)
– display	3 1/2 digit 7-segment LED display, alternative to frequency display, selected by pushbutton AMPL/FREQ, step attenuation ignored
– display error	±3 % of end of range, at 1 kHz sine and square wave
DC (offset) voltage, open circuit	continuously adjustable from –5 V to +5 V, when pushbutton DC OFFSET is pulled
attenuation	
– continuous	0 . . . 20 dB (see open circuit voltage 2 Vpp . . . 20 Vpp)
– fixed	0,3,10, 20, 30 dB, selectable in any combination
amplitude response (sine wave; reference value 2 kHz)	< 0.1 dB in ranges LIN I to VI, LOG I to IV < 0.3 dB for frequencies < 1 MHz < 1.0 dB for frequencies up to 2 MHz (output voltage 20 Vpp, attenuator 0 dB, output impedance 50 Ω, load 50 Ω)
distortion (sine wave)	< 0.5 % in ranges LIN I to VI, LOG II to IV < 2.0 % in ranges LIN VII, LOG I and V

linearity (triangular wave)	better than 99 % up to 100 kHz
rise time, fall time (square wave)	< 60 ns at max. amplitude, into 50 Ω
overshoot and ringing (square wave)	< 2 % at max. amplitude, into 50 Ω

1.2.3. TTL OUTPUT

frequency, duty cycle	as main output
fan out	20 TTL inputs
level	standard TTL level: high > 2.4 V low < 0.8 V
external voltage	short-circuit proof against 0 V and 5 V

1.2.4. Sweep, internal

operating modes	– single sweep, manually started by pushbutton TRIG – single sweep, electronically started via TRIG & BURST input – continuous sweep
characteristic	linear and logarithmic
max. sweep range	2 1/2 decades for LIN 4 1/2 decades for LOG
start frequency	continuously coarse and fine adjustable within the selected sweep range; displayed when pushbutton STD BY is pressed
stop frequency	identical to the frequency setting in normal mode both frequencies are independently adjustable; the start frequency may be set higher or lower than the stop frequency
display	as for normal mode (start or stop frequency); 3 LEDs for STOP, RUN, START in addition
sweep period range	5 ms to 100 s, adjustable in 4 sub-ranges
– sub-ranges	0.005 – 0.1 s 0.05 – 1 s 0.5 – 10 s 5 – 100 s
sweep control elements	– pushbutton TRIG to start a single sweep – pushbutton HOLD to stop the running sweep immediately – pushbutton RESET for resetting during the sweep to the start frequency

sweep indication	LED 'RUN'
sweep voltage at INT MODULATION OUTPUT	BNC socket at the rear side
– output voltage	0 V . . . +5 V (≙ f_{START} . . . f_{STOP})
– impedance	10 kΩ
frequency-analogue voltage at FREQ CONTROL VOLTAGE OUTPUT	BNC socket at the rear side, see chapter 1.2.9.
PEN LIFT OUTPUT	BNC socket at the rear side; electronic switch, closed during the sweep, open during fly-back
	max. current: 200 mA, output voltage: < 0.7 V } electronic switch closed
	output voltage: +20 V, internal resistance: 100 kΩ } electronic switch open

1.2.5. Frequency control, external

SWEEP/FM INPUT	BNC socket at the rear side for external control signal for normal mode
voltage vs. frequency characteristic	**linear:** 1 V/0.2 f_{max}, where f_{max} represents the upper limit of the corresponding sub-range **logarithmic:** 1 V/decade
max. sweep range	2 1/2 decades for LIN 4 1/2 decades for LOG
max. sweep frequency	4 kHz for a sweep of 1 1/2 decades for LIN 20 kHz for a sweep of 1 1/2 decades for LOG; sweep voltage: sawtooth, duty cycle 90 %
modulation frequency range	DC to 20 kHz, for frequency deviation ⩽ 10 %; adjustable as MOD/PERIOD > 0.05 ms
input impedance	5 kΩ
TRIG & BURST INPUT	BNC socket at the rear side for external trigger signal for single sweep
– trigger signal	negative going edge from ⩾ +2.2 V to ⩽ 0.8 V, e.g. H/L transition of a TTL signal
– max. input voltage	±15 V
– input impedance	1 TTL input

1.2.6. Burst control, internal

operating modes	repetitive or single triggering
duty cycle, repetitive operation	≈ 50 %; each burst is terminated at the start/stop level
repetition time, repetitive operation	5 ms to 100 s, continuously adjustable within 4 sub-ranges MOD/SWEEP PERIOD
– sub-ranges	5 ms – 0.1 s 0.05 – 1 s 0.5 – 10 s 5 – 100 s
burst duration for single operation	half modulation period MOD/SWEEP PERIOD
single triggering	manually (internal) or electronically via TRIG & BURST INPUT as for internal sweep
start and stop phase	continuously adjustable between $-\pi/2$ and $+\pi/2$, (-90^{o} to $+90^{o}$)
voltage at INT MODULATION OUTPUT	TTL-high level: during burst period TTL-low level: during off period
– impedance	250 Ω (pull-up)

1.2.7. Burst control, external

TRIG & BURST INPUT	for external TTL signal; at L/H transition the burst starts; after H/L transition the last cycle is terminated at the start/stop level on the positive slope
max. control frequency	2 MHz
max. input voltage	±15 V
input load	1 TTL input
start and stop level	continuously adjustable between $-\pi/2$ and $+\pi/2$, (-90^{o} to $+90^{o}$)

1.2.8 SINGLE MODE

triggering	
– manually	with pushbutton TRIG
– electronically	via TRIG & BURST INPUT or internal repetitive
repetition period for internal triggering	5 ms to 100 s; continuously adjustable within 4 sub-ranges MOD/SWEEP PERIOD
– sub-ranges	5 ms – 0.1 s 0.05 – 1 s 0.5 – 10 s 5 – 100 s
start and stop phase	continuously adjustable between $-\pi/2$ and $+\pi/2$, (-90^{o} to $+90^{o}$)
control voltage at INT MODULATION OUTPUT	TTL-high level: during single period TTL-low level: during off period
output impedance	250 Ω (pull-up)
max. trigger frequency	2 MHz for external triggering
external trigger voltage	TTL level
max. input voltage	±15 V
max. input load	1 TTL input

1.2.9. Frequency-analogue control voltage

Control voltage at FREQ CONTROL VOLTAGE OUTPUT	0 . . . +5 V; 1 V/0.2 f_{max} for LIN 1 V/decade for LOG
– impedance	1 kΩ

1.2.10. Error indication for unallowed operating modes

LED 'ERROR' indicates unallowed settings, see chapter 3.2.7.

1.2.11. Power supply

Power supply	ac mains
reference value	220 V
nominal values	110 V/128 V/220 V/238 V, selectable by solder links
nominal operating range	±10 % of selected nominal value
operating limits	±10 % of selected nominal value
nominal frequency range	50 – 60 Hz
limit range of operation	47.5 – 63 Hz
power consumption	38 W

1.2.12. Environmental conditions

Ambient temperature:	
reference value	+23° C ±1 K
nominal working range	+ 5° . . . +40° C
limits for storage and transport	-40° C . . . +70° C
Relative humidity:	
reference range	45 . . . 75 %
nominal working range	20 . . . 80 %
limit range of operation	10 . . . 90 %
limits for storage and transport	0 . . . 90 %
Air pressure:	
reference value	1013 mbar (≙ 760 mm Hg)
nominal working range	800 . . . 1066 mbar (up to 2200 m height)
Air speed:	
reference value	0 . . . 0.2 m/s
nominal working range	0 . . . 0.5 m/s
Operating position	normally upright on feet or with handle fold down
Warm-up time	30 min.

1.2.13. Cabinet

protection type (see DIN 40 050)	IP 20
protection class (see IEC 348)	class I, protective conductor
overall dimensions	
– height	140 mm
– width	310 mm
– depth	390 mm
weight	approx. 5.8 kg

1.3. ACCESSORIES

1.3.1. Standard

instruction manual
fuse 500 mA delayed
labels for power supply

1.3.2. Optional

PM 9585: 50 Ω termination 1 W
PM 9581: 50 Ω termination 3 W
PM 9075: Coaxial connection cable BNC-BNC 75 Ω
PM 9051: Adapter BNC (male) – Banana (female)

1.4. OPERATING PRINCIPLE (Fig. 30)

The functional block modulation oscillator control controls the integrator and the modulation sine shaper according to the actual operating mode.

When the switch MODE is set to SWEEP and the button STD BY/CONT is pressed, the start frequency of the main oscillator can be adjusted. When the button TRIG is operated or triggered by an appropriate pulse at the socket TRIG & BURST, the integrator begins one cycle of a saw-tooth voltage. Analogous to this, the frequency of the main oscillator continuously runs to the adjusted STOP-frequency and quickly flies back to the START frequency.

This process can also be initiated by locking out the STD BY/CONT button; but then the integrator generates a sawtooth voltage periodically repeated. The integrator can be stopped at any value by the button HOLD respectively can be set back to the start-condition with the button RESET. The duration of the period of the sawtooth voltage can be adjusted by the switch MOD/SWEEP PERIOD and the potentiometer PERIOD.

During the forward ramp of the sawtooth voltage, an electronic contact in the modulation oscillator control is "closed" which connects the socket PEN LIFT to ground. During fly-back the connection is open.

In the positions BURST and SINGLE, the main oscillator can be controlled with the TTL-signal of the integrator via the burst control.

According to the operating mode the applied control voltage (saw-tooth or square wave) of the modul. oscillator is fed to the socket INT MOD OUTPUT.

All values controlling the frequency of the main oscillator are combined by the control section to one internal control voltage.
According to the operating mode, this voltage is dependent on the position of the potentiometer STOP FREQ or START FREQ, on the sweep voltage of the modulation oscillator, and on the external voltage at the socket SWEEP/FM. The control section provides two charging currents for the main oscillator, being proportional to the driving voltage in the LIN mode. In the LOG mode the current sources are switched over. The relation between the charging currents and the control voltage is now exponential. When the DUTY CYCLE button is pressed the ratio of the two charging currents can be varied by means of the potentiometer DUTY CYCLE. So the duty cycle of the signal generated by the main oscillator is varied.

When the pushbutton AMPL/FREQ is unlocked and the LIN mode is chosen, the controlling voltage is digitized by the analog to digital converter ADC and displayed as a frequency. In the LOG mode the negative charging current is directly measured, digitized by the ADC and displayed as a frequency. Via LED control the ADC controls the range resistors in the measuring control and the dimension indication, the decimal point and the mode indicators of the display.

The integration capacitors comprises the frequency-determining capacities of the main oscillator. They are selected by the FREQ RANGE switch.

The triangular voltage of the main oscillator is lead directly via the switching stages to the output channel. The square-wave voltage must be processed for further use in the signal conditioner. The outputs of this functional block are routed to the output TTL, to the square wave generator and the burst control.

By means of the burst control the SINGLE and BURST functions of the main oscillator are controlled. If the trigger input of the BURST control has switched over to TTL-high level, the main oscillator is able to run free; if the trigger input is set to TTL-low level, the main oscillator is blocked after reaching the chosen Start/Stop phase. The signals are generated by the modulation generator; the signals may also be applied to the input TRIG & BURST.

The square-wave generator forms –dependent upon the adjusted WAVE FORM– a zero-symmetrical square-wave voltage or positive or negative square-wave pulses out of the square-wave voltage of the signal conditioner.

The triangular voltage is directly switched via the WAVE FORM switch either to the AMPLITUDE control or to the sine shaper. The resulting sine voltage is fed as well to the WAVE FORM switch as to the AMPLITUDE control.

The voltage adjusted at the regulator AMPLITUDE is amplified by the power amplifier to a maximum of 20 Vpp. This alternating voltage can be superimposed with a direct current by the potentiometer DC OFFSET.

The attenuator operated by the switches ATTENUATION allows an exact reduction at choice within the combinable stages 3, 10, 20 and 30 dB. The inner resistance of the OUTPUT can be switched over via the button 600 Ω/50 Ω in the 600 Ω/50 Ω selector.

Tandem potentiometer AMPLITUDE causes the ampl display conditioner to produce a d.c. voltage being proportional to the amplitude. When the AMPL/FREQ button is pushed this voltage is indicated as open-circuit voltage of the generator. The indicated values of the voltage for pulse signals are half as big as for zero-symmetrical signal wave forms. This is organized by the WAFE FORM switch in the ampl display conditioner.

The power supply provides the d.c. voltages for the circuitries.

The instrument is switched on and off with the switch POWER.

2. INSTALLATION INSTRUCTIONS

2.1. INITIAL INSPECTION

Check the contents of the shipment for completeness and note whether any damage has occurred during transport. If the contents are incomplete, or there is damage, a claim should be filed with the carrier immediately, and the Philips Sales or Service organisation should be notified in order to facilitate the repair or replacement of the instrument.

2.2. SAFETY INSTRUCTIONS

Upon delivery from the factory the instrument complies with the required safety regulations, see para. 1.2. To maintain this condition and to ensure safe operation, the instructions below must carefully be followed.

2.2.1. Maintenance and repair

Failure and excessive stress:
If the instrument is suspected of being unsafe, take it out of operation permanently.
This is the case when the instrument

- shows physical damage
- does not function anymore
- is stressed beyond the tolerable limits (e.g. during storage and transportation)

Dismantling the instrument: When removing covers or other parts by means of tools, live parts or terminals could be exposed. Before opening the instrument, disconnect it from all power sources.

If the **open live instrument needs calibration, maintenance or repair,** it must be performed only by trained personnel being aware of the risks. After disconnection from all power sources, the capacitors in the instrument may remain charged for some seconds.

2.2.2. Earthing (grounding)

Before any other connection is made the instrument shall be connected to a protective earth conductor via the three-core mains cable. The mains plug shall be inserted only into a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension cord without protective conductor.
The external contacts of the BNC sockets must not be used to connect a protective conductor.

WARNING:	Any interruption of the protective conductor inside or outside the instrument, or disconnection of the protective earth terminal, is likely to make the instrument dangerous. Intentional interruption is prohibited.

The circuit earth potential applied to the external contacts of the BNC sockets is connected to the cabinet. The external contacts of the BNC sockets must not be used to connect a protective conductor.

2.2.3. Connections

The circuit earth potential is applied to the external contacts of the BNC sockets and is connected to the cabinet by means of parallel-connected capacitor and resistor. By this means hum loops are avoided and a clear HF earthing is obtained.
If the circuit earth potential in a measurement set-up is different from the protective earth potential, it must be noticed,

- that the BNC sockets can be touched and that it must not be live, see the safety regulations on the subject (VDE 0411),
- that all sockets marked with the sign ⊥ are internally interconnected.

2.2.4. Mains voltage setting and fuses

Before inserting the mains plug into the mains socket, make sure that the instrument is set to the local mains voltage.
The instrument shall be set to the local mains voltage only by a qualified person who is aware of the hazard involved.

> WARNING: If the mains plug has to be adapted to the local situation, such adaption should be done by a qualified person only.

Make sure that only fuses of the required current rating, and of the specified type, are used for renewal. The use of repaired fuses, and/or the short-circuiting of fuse holders, are prohibited.
The fuse shall be renewed only by a qualified person who is aware of the hazard involved.

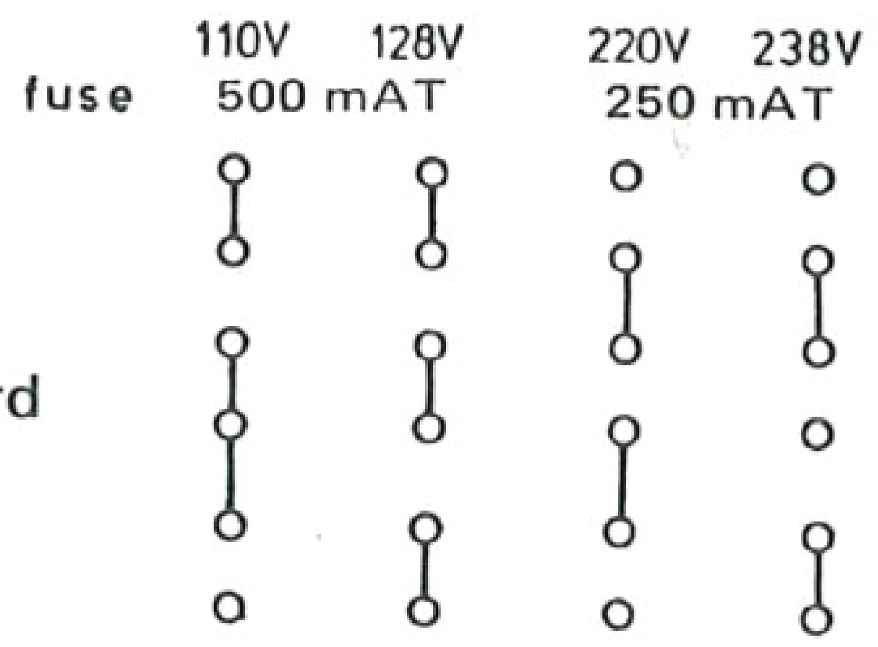
> WARNING: The instrument shall be disconnected from all voltage sources when a fuse is to be renewed, or when the instrument is to be adapted to a different mains voltage.

2.3. MAINS VOLTAGE SETTING AND FUSES

The safety instructions in chapter 2.2.4. must be followed.

On delivery from the factory the instrument is set to 220 V.
If the instrument is to be used on a different supply voltage proceed as follows:

- Unplug the mains connector
- Fold up the handle to the top.
  For this push the buttons of the handle.
- Loosen the central screw at the rear
- Dismantle the cabinet
- Change the solder links on the printed circuit board according to the connection diagram on the bottom side of the instrument



- If necessary, insert the supplied fuse 500 mA delayed into the fuse holder instead of the fuse built-in
- Change the mains voltage plate at the rear of the instrument in accordance with the mains voltage selected. The plates for the other supply voltages are inserted into a plastic cover, as the fuse just mentioned.
- Close the instrument

2.4. OPERATING POSITION OF THE INSTRUMENT

The instrument may be used in the positions indicated in clause1.2.12.With the handle folded down, the instrument may be used in a sloping position; for this push the buttons of the handle. The characteristics mentioned in Section 1.2. are guaranteed for the specified positions.
Ensure that the ventilation holes in the cover are free of obstruction.
Do not position the instrument on any surface which produces or radiates heat, or in direct sunlight.

2.5. DISMANTLING THE INSTRUMENT

- Unplug the mains connector
- Fold up the handle to the top. For this push the buttons of the handle
- Loosen the central screw at the rear
- Dismantle the cabinet

3. OPERATING INSTRUCTIONS

3.1. CONTROLS AND SOCKETS (Fig. 31, 32, 37)

Legend	Position	Function
POWER	83	mains switch:
○ ON		white dot for ON position
● OFF		
WAVE FORM	84	signal wave form, rotary switch
FREQ RANGE Hz	87	frequency ranges, rotary switch
FREQUENCY START	610/1-2	start frequency } for SWEEP mode; double potentiometer
FREQUENCY STOP	630/1-2	stop frequency } for SWEEP mode; double potentiometer
FREQUENCY	630/1-2	frequency adjustment for the other operating modes (MODE)
	409, 411 412, 413	7-segment LED display
AMPL/FREQ	81/U2	measuring mode for the digital display, pushbutton
mHz, Hz, kHz, MHz	357-360	indication of the frequency range, LEDs
Vpp	361	indication of amplitude measurement, LED
ERROR	362	indication of wrong operating mode, LED
STOP, RUN, START	354-356	state of internal sweep, LEDs
DUTY CYCLE	82/3	duty cycle switch, pushbutton
DUTY CYCLE	650	duty cycle control, potentiometer
ATTENUATION	82/U2	fixed attenuation, pushbutton array
AMPLITUDE	760	variable attenuation, tandem potentiometer
DC OFFSET PUSH FOR ZERO	660	DC offset, if pulled; push-pull-switch with potentiometer
50 Ω/600 Ω	82/4	output impedance, pushbutton
OUTPUT	807	output connection, BNC connector at the front side
MODE	86	operating mode, rotary switch
LIN, LOG	82/1-2	linear or logarithmic operation, pushbuttons
MOD/SWEEP PERIOD s	85	period range for modulation or sweep mode, rotary switch
PERIOD	780	variable period, potentiometer
HOLD	81/1	sweep hold, pushbutton
RESET	81/2	sweep reset, pushbutton
STD BY/CONT	81/3	stand by/continuous operation, pushbutton
TRIG	81/4	trigger, pushbutton
START PHASE	700	phase control for burst trigger or single pulse trigger, potentiometer

Legend		Position	Function	
INT MOD	OUTPUT	804	output modulation signals	BNC
TTL	OUTPUT	805	output TTL signal	BNC
PEN LIFT	OUTPUT	806	pen lift control signal	BNC
FREQ CONTROL VOLTAGE	OUTPUT	802	output control voltage	BNC
SWEEP/FM	INPUT	801	external sweep or FM signal	BNC
TRIG & BURST	INPUT	803	external trigger	BNC

BNC connectors: at the rear side

3.2. OPERATION

3.2.1. Setting the wave form

The required wave form, sine, triangular, square wave, positive or negative pulses is selected by the WAVE FORM switch. If the duty cycle of the output signal shall be set to a value different to 50 %, the pushbutton DUTY CYCLE must be pressed allowing the required value to be set by the DUTY CYCLE control.

At the socket TTL OUTPUT a TTL signal is available, corresponding to the signal at the OUTPUT socket.

3.2.2. Setting the frequency, see also short-form instruction 3.2.6.1.

The following elements serve for frequency adjustment:

- the FREQ RANGE switch, decadal stepped
- the choice of LIN or LOG mode
- the continuously and independently operating STOP and START controls; double potmeters with different sensitivities for convenient operation
- the digital frequency and automatic dimension display
- the ERROR indicator for unallowed combinations of frequency and duty cycle settings

The stop frequency is adjusted in NORMAL mode by means of the STOP control with pre-set frequency range. In the same range with chosen SWEEP mode, the START control serves for adjusting the start frequency. The start frequency may be higher or lower than the stop frequency.

3.2.3. Setting the OUTPUT voltage, see also short-form instruction 3.2.6.2.

The amplitude of the output signal is continuously adjustable by means of the AMPLITUDE control. With AMPL/FREQ button pressed, this value, p-p, is digitally displayed.

Pulled button DC OFFSET enables a continuously adjustable positive or negative d.c. voltage to be added to the output signal.

With WAVE FORM switch in position DC, the a.c. part of the output signal is switched off and the d.c. voltage only is fed to the output.

With step attenuator ATTENUATION, the output signal including the DC offset can be attenuated in any combinable steps of 3 dB, 10 dB, 20 dB and 30 dB.

With the 600 Ω/50 Ω pushbutton the required output impedance can be selected.

Note: The output amplifier could be overdriven due to adding signal and DC offset voltage. To avoid limiting, the peak value of the open-circuit output voltage must not exceed ±10 V (step attenuator set to 0 dB).

3.2.4. Setting the internal sweep, see also short-form instruction 3.2.6.3.

During the SWEEP PERIOD when using LIN mode a sweep within one frequency sub-range is linearly performed from the START to the STOP frequency. In position LOG mode the sweep has a logarithmic characteristic.

The sweep period can be selected in sub-ranges and is fine adjustable.

Starting a single sweep is done by pressing the pushbutton TRIG or by a trigger pulse (H/L edge e.g. of a TTL signal) at the TRIG & BURST INPUT. Continuous sweep is realized by unlocking the pushbutton STD BY/CONT.

The MODULATION OUTPUT socket at the rear side provides the momentary sweep voltage corresponding to a distinct signal frequency for controlling an oscilloscope or x - y plotter. The voltage to frequency relationship is linear; a sweep voltage of 0 V represents f_{START}, a sweep voltage of +5 V f_{STOP}.

Further elements for manual control are

– the HOLD pushbutton to stop the sweep immediately

– the RESET pushbutton for resetting to f_{START} during the sweep.

Note: Before executing an internal sweep, disconnect all cables from the SWEEP/FM INPUT socket. This input is not switched off during an internal sweep.

3.2.5. External sweep and frequency modulation, see also short-form instruction 3.2.6.5.

A voltage at the SWEEP/FM INPUT socket modulates the frequency of the generator. The required basic frequency is adjusted by means of the FREQ RANGE switch and the STOP control. The frequency varies linearly or logarithmically corresponding to the chosen LIN or LOG mode; at this socket d.c. or a.c. voltages may be applied.

The maximum frequency variation may not exceed 2 1/2 decades in LIN mode and 5 decades in LOG mode, whereby the actual upper frequency limit is also valid as sweep limit, which should not be overdriven because of signal distortion due to overdriving the current source.

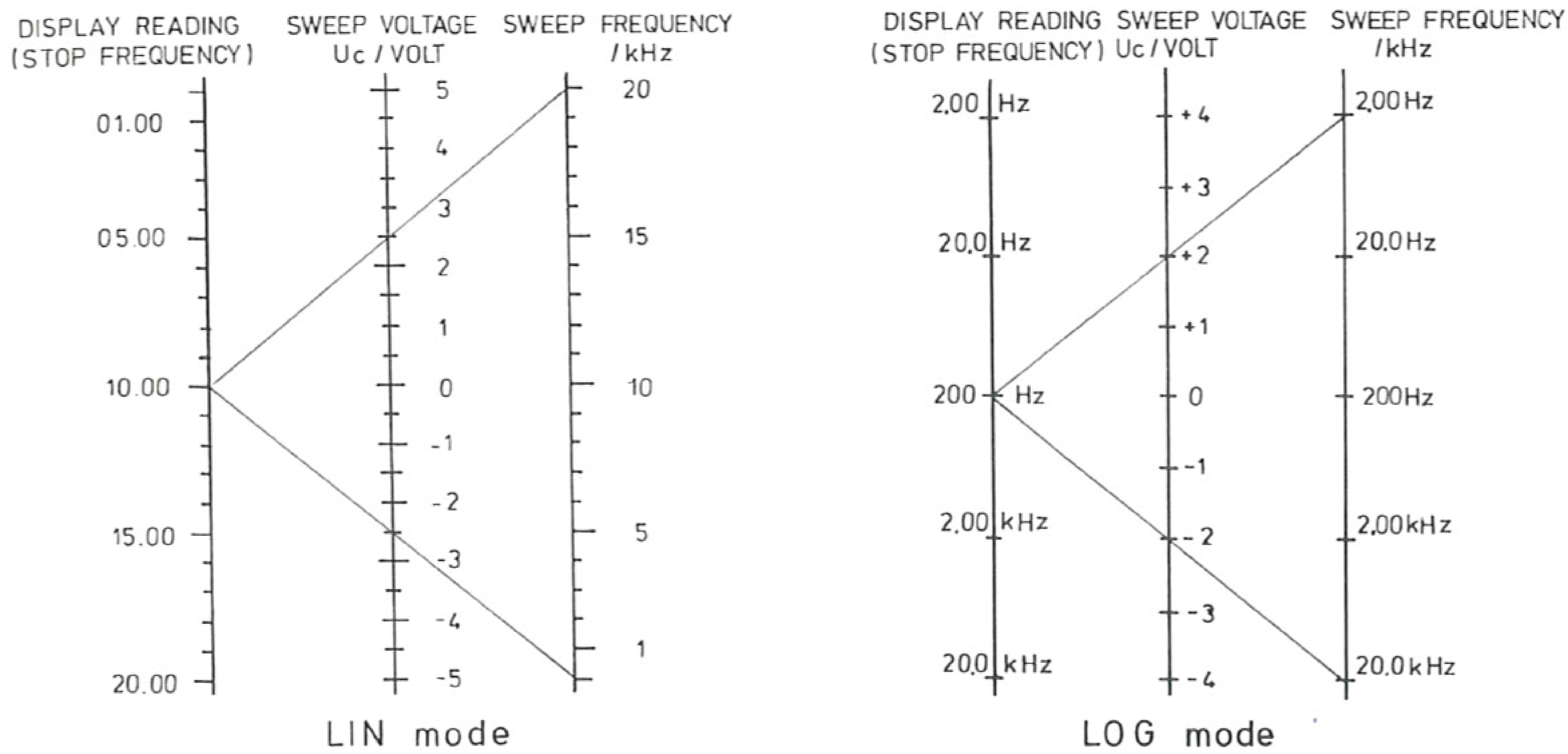


Fig. 1 External sweep; sweep range vs. sweep control voltage Uc; example for ranges LIN V (1 kHz – 20 kHz) and LOG III (1 Hz – 20 kHz)

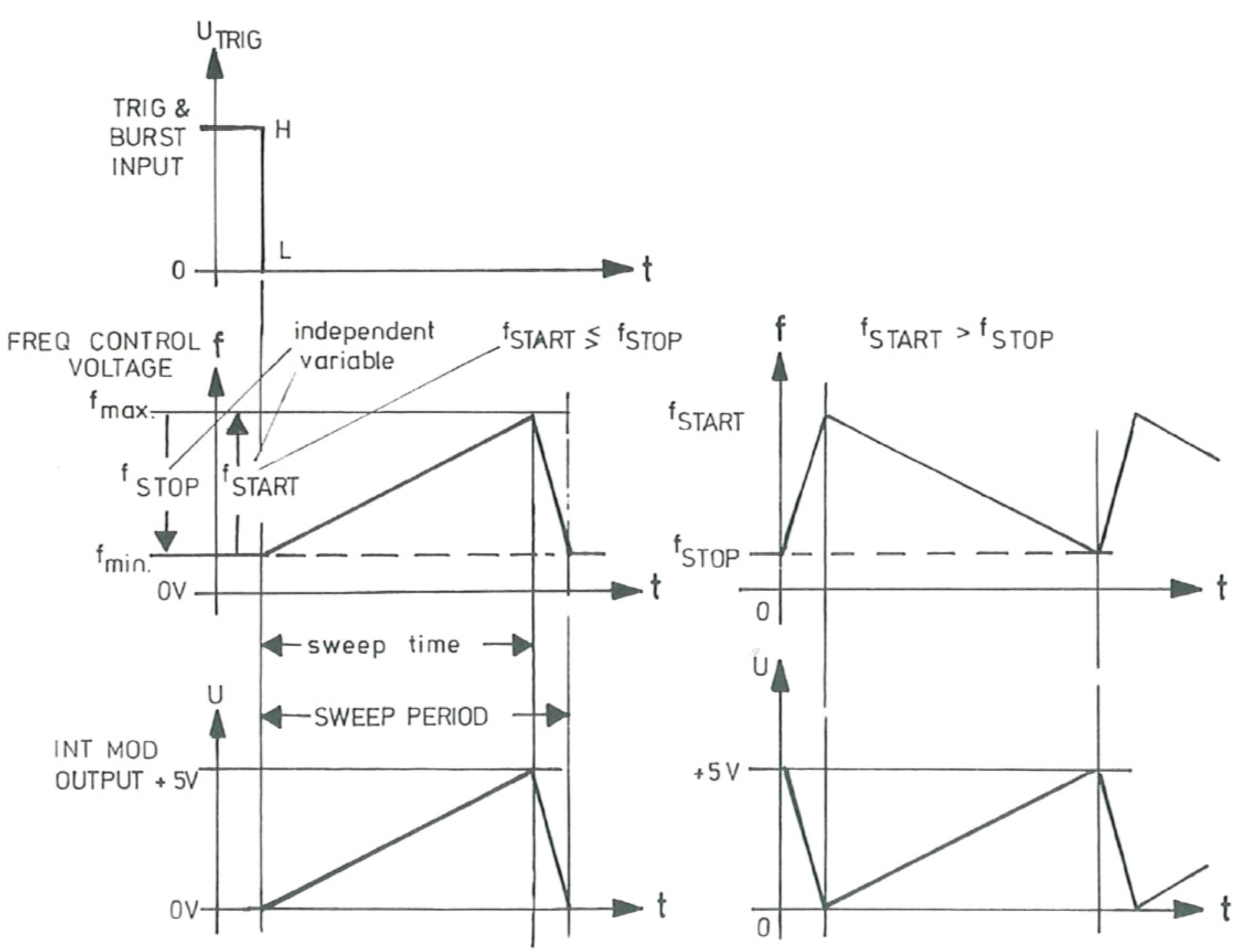
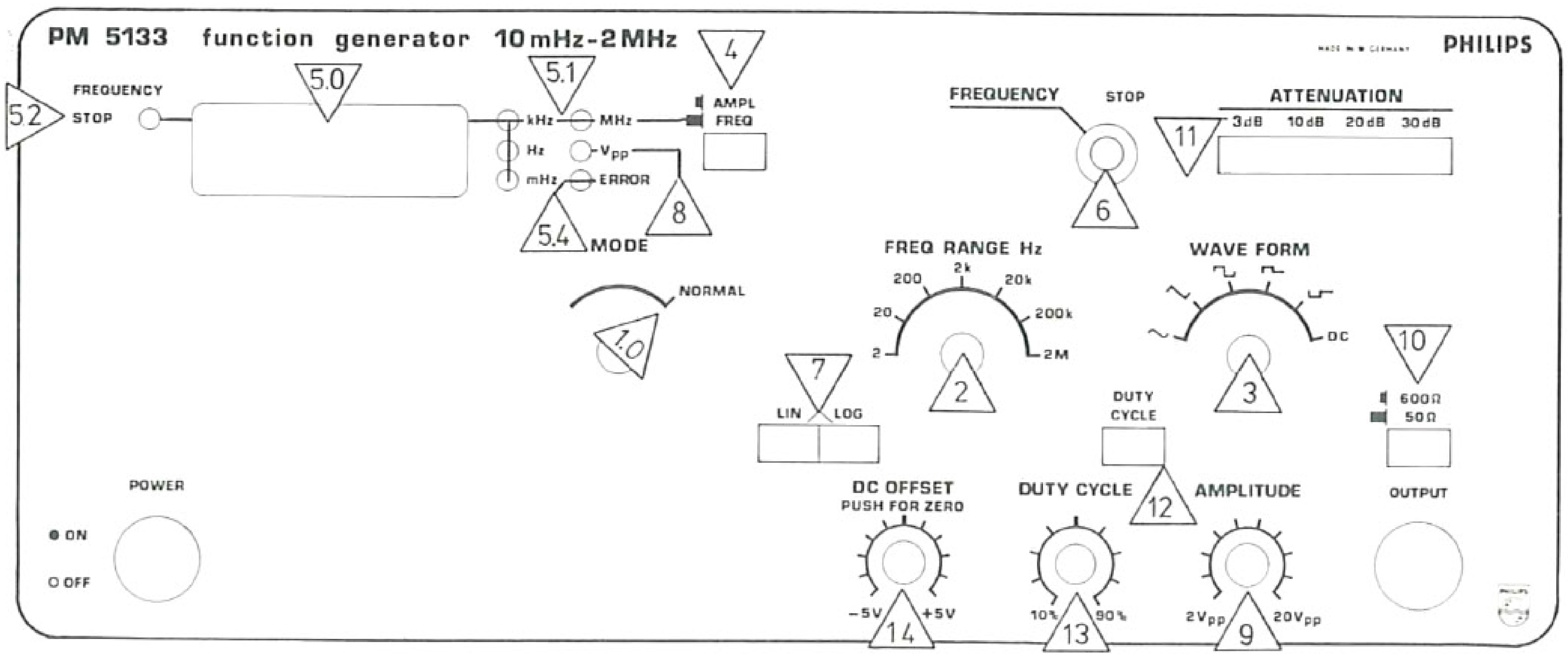
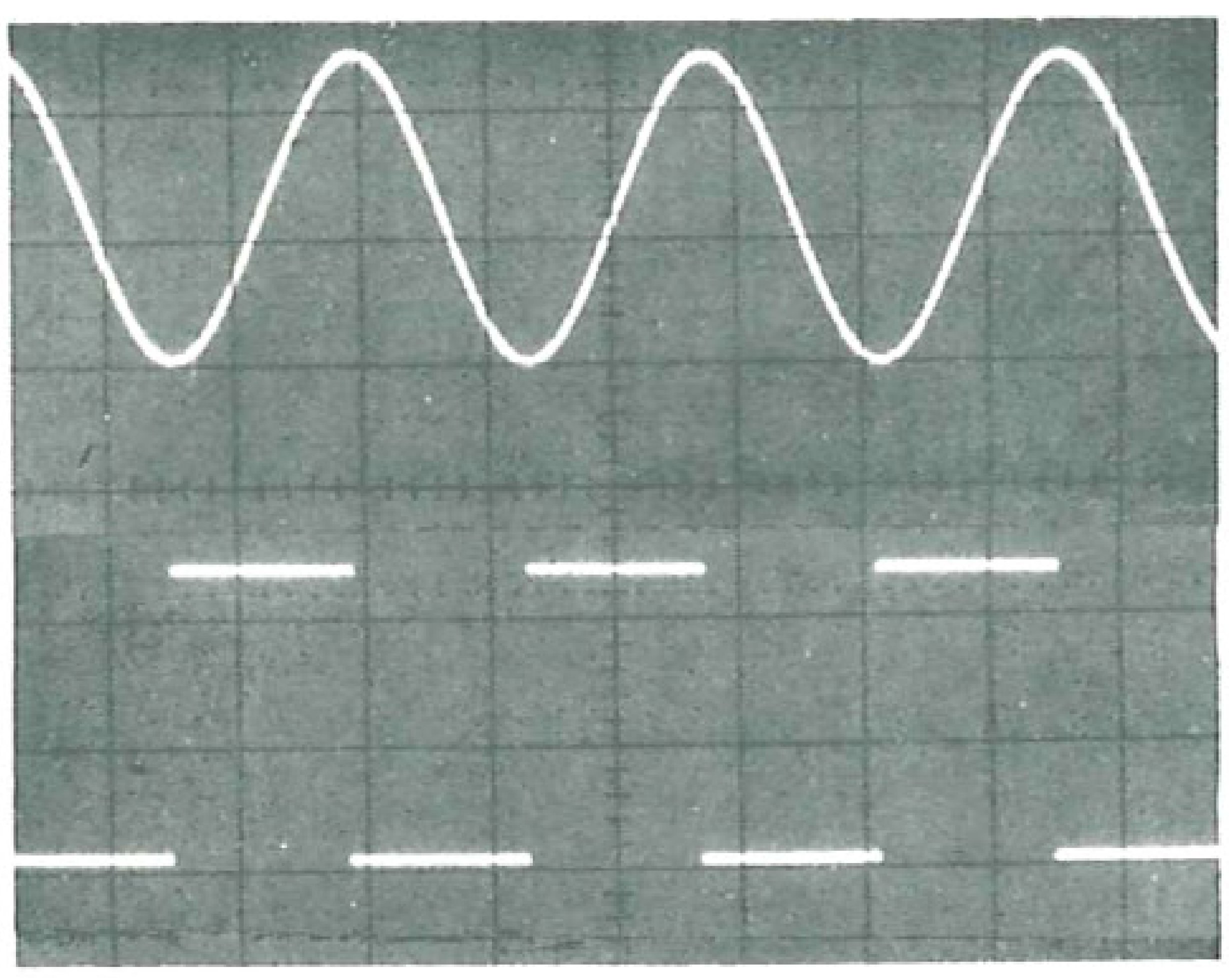
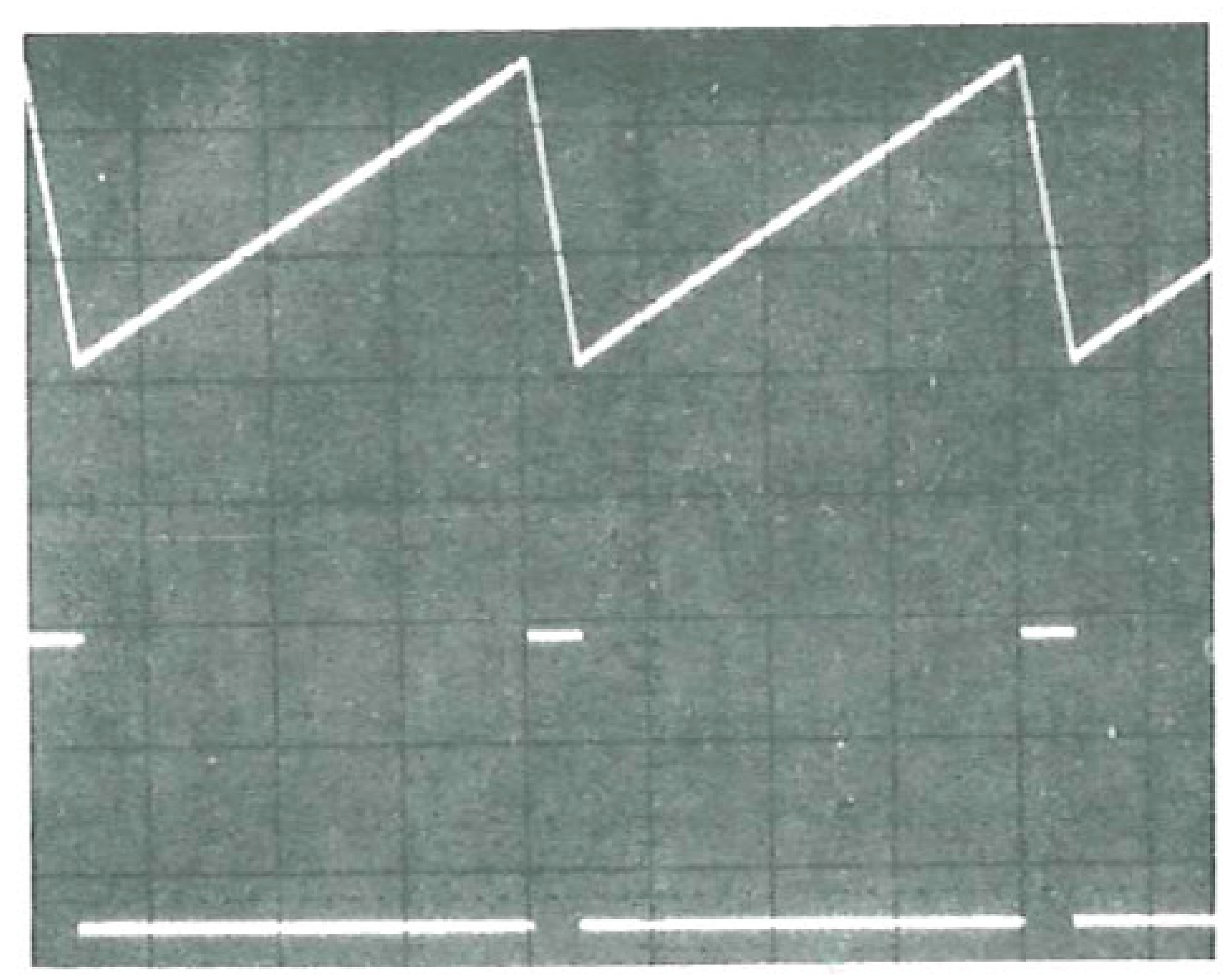


Fig. 2 Sweep mode





Sine wave output signal and corresponding TTL signal.



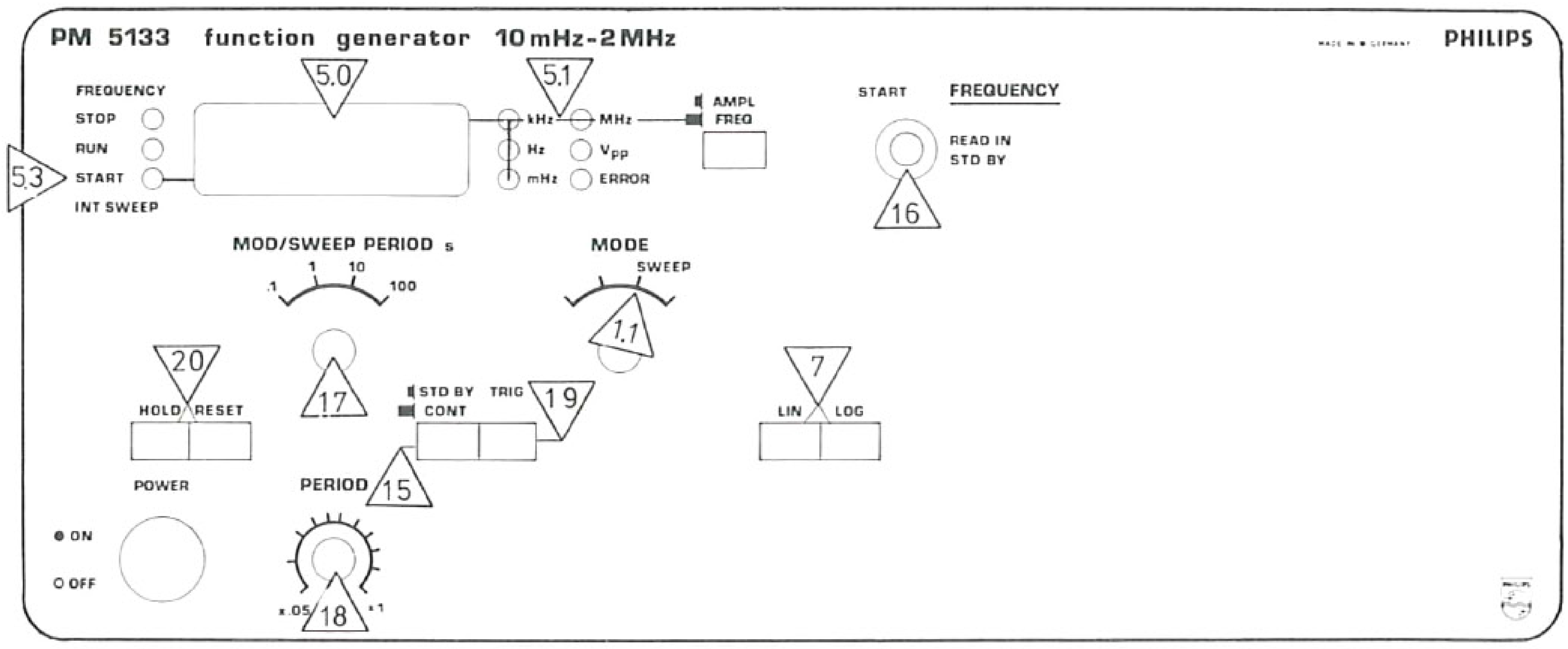
Variable duty cycle shown in triangular and square wave signal.

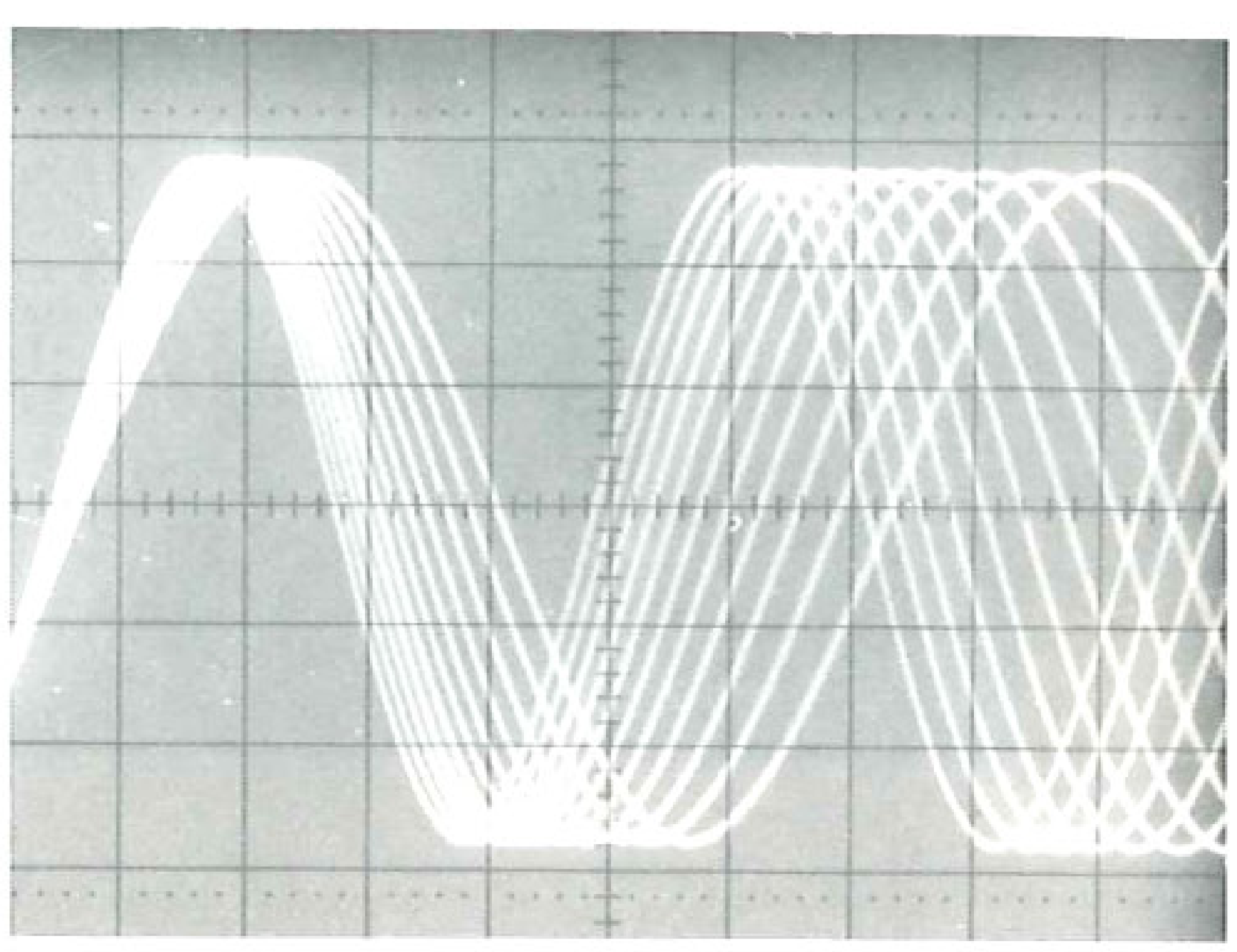
3.2.6.1. NORMAL mode

1.0	Set to NORMAL
2	select frequency range
3	choose signal wave form
4	if necessary, unlock AMPL/FREQ button
7	set to LIN or LOG mode
5.0 5.1	displayed frequency lies within the chosen frequency range with respect to the indicated dimension
5.2	indication STOP lights
6	set (coarse/fine) the required frequency by means of the double control STOP

3.2.6.2.

4	push AMPL/FREQ button
8 5.0	Vpp indicates voltage measurement; the display indicates the open circuit amplitude at theinput of the attenuator
9	set AMPLITUDE to the required value
10	select output impedance
11	choose ATTENUATION
12	if required, push DUTY CYCLE button (only in LIN mode; in LOG mode indicator ERROR flashes)
13	adjust the duty cycle by means of the DUTY CYCLE control
14	if required, pull switch DC OFFSET for adding a d.c. offset to the a.c. signal and adjust the OFFSET by means of the control





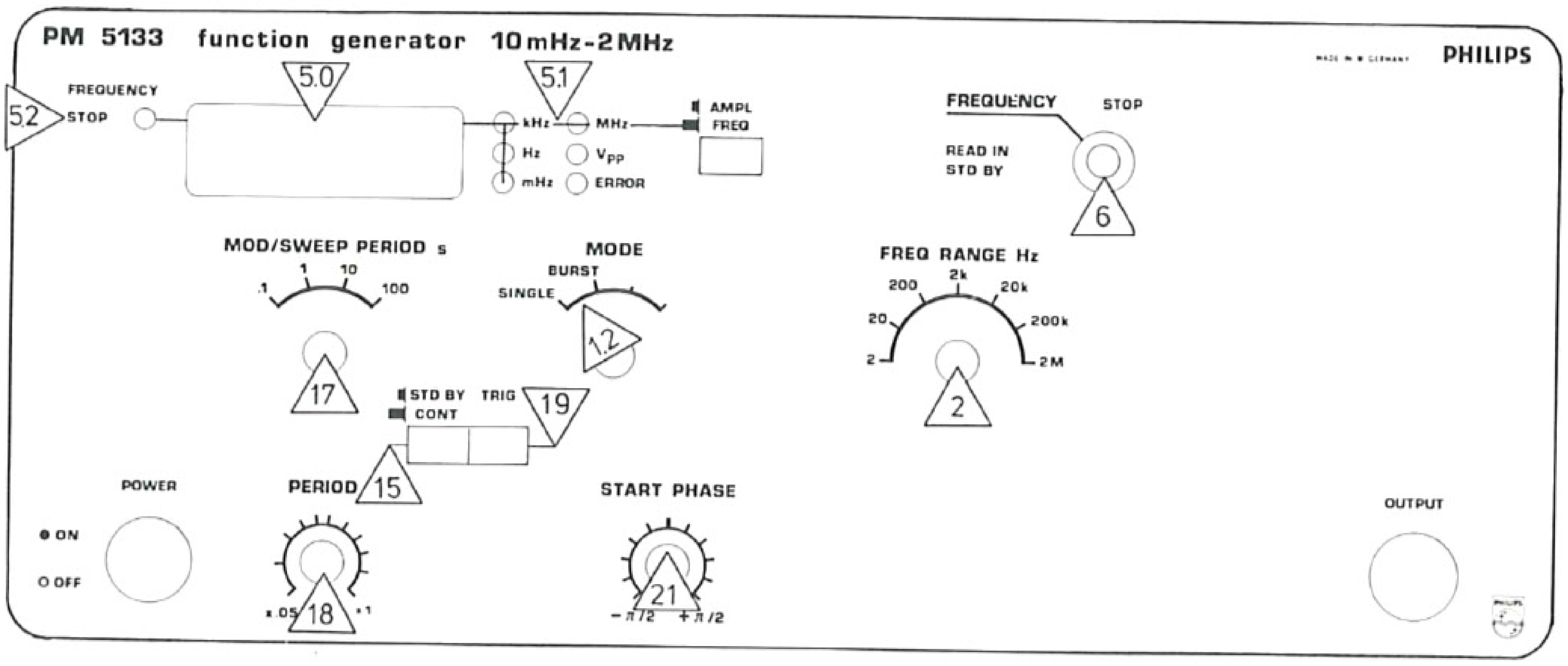
Oscillogram showing frequency sweep.

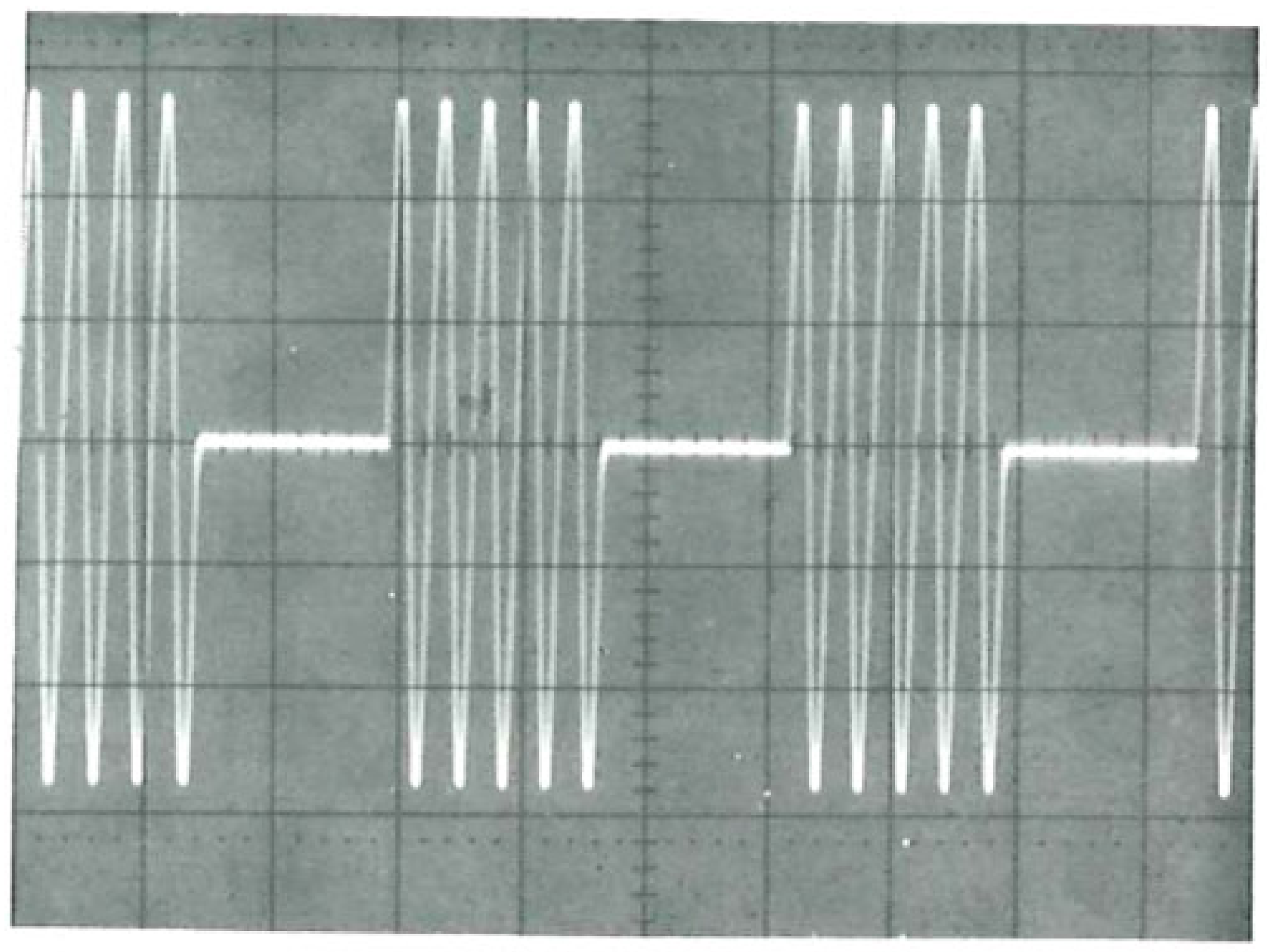
3.2.6.3. SWEEP mode

Adjust STOP frequency in NORMAL mode, see 3.2.6.1.

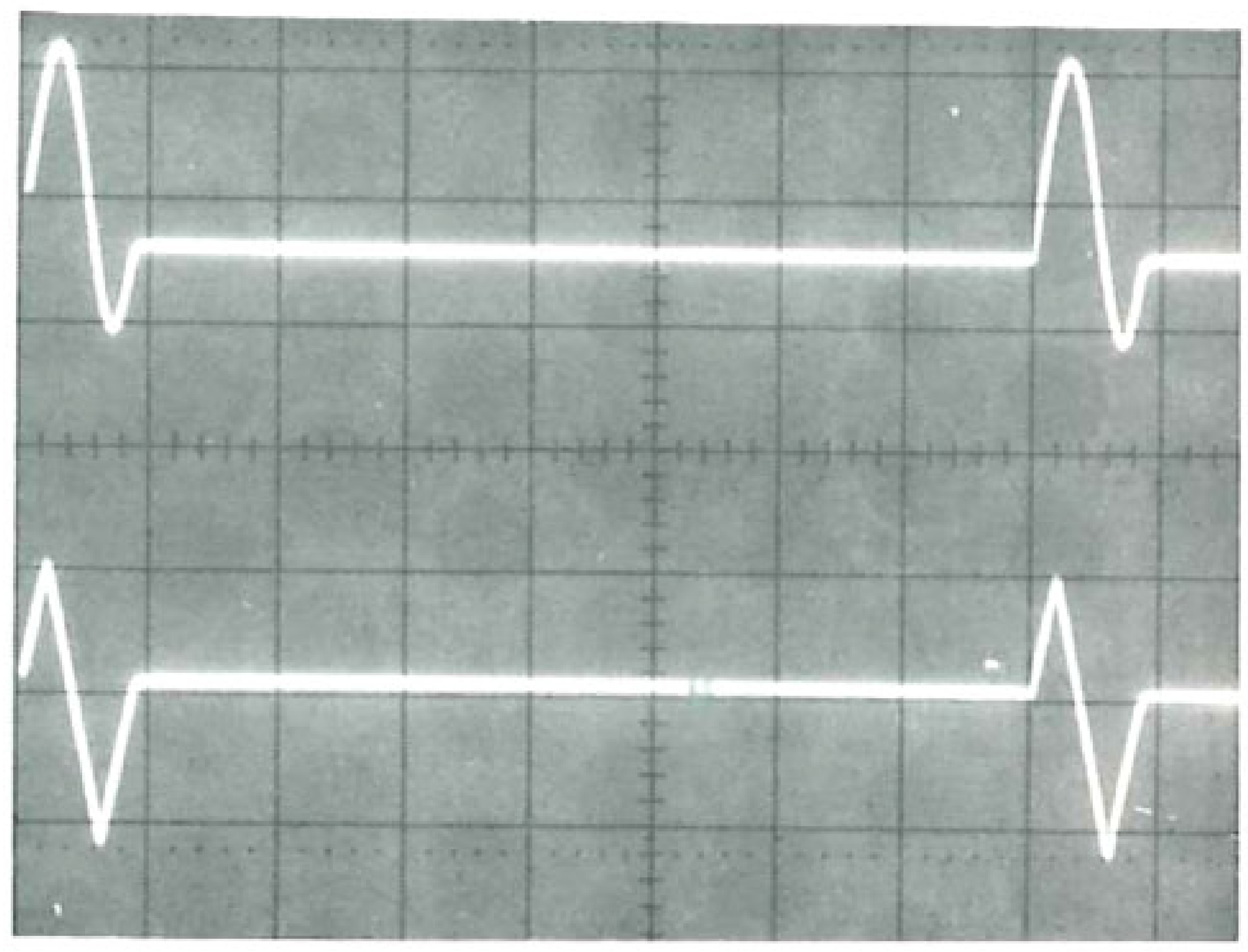
1.1	set to SWEEP
7	set to LIN or LOG mode
15	set sweep generator to STD BY
5.3	START frequency indication lights
16	adjust required start frequency by coarse/fine START control
17	choose SWEEP PERIOD range
18	adjust required period time with PERIOD control
15	start the sweep by unlocking the pushbutton or:
19	start by pushing the button or by external trigger signal
20	if required, HOLD or RESET the sweep

If necessary, check and correct the settings of the output signal according to 3.2.6.2.





Burst signal.



Single facility shown with different start phase between sine wave and triangular wave.

3.2.6.4. BURST or SINGLE mode

Adjust frequency (STOP frequency) as in NORMAL mode, see 3.2.6.1.

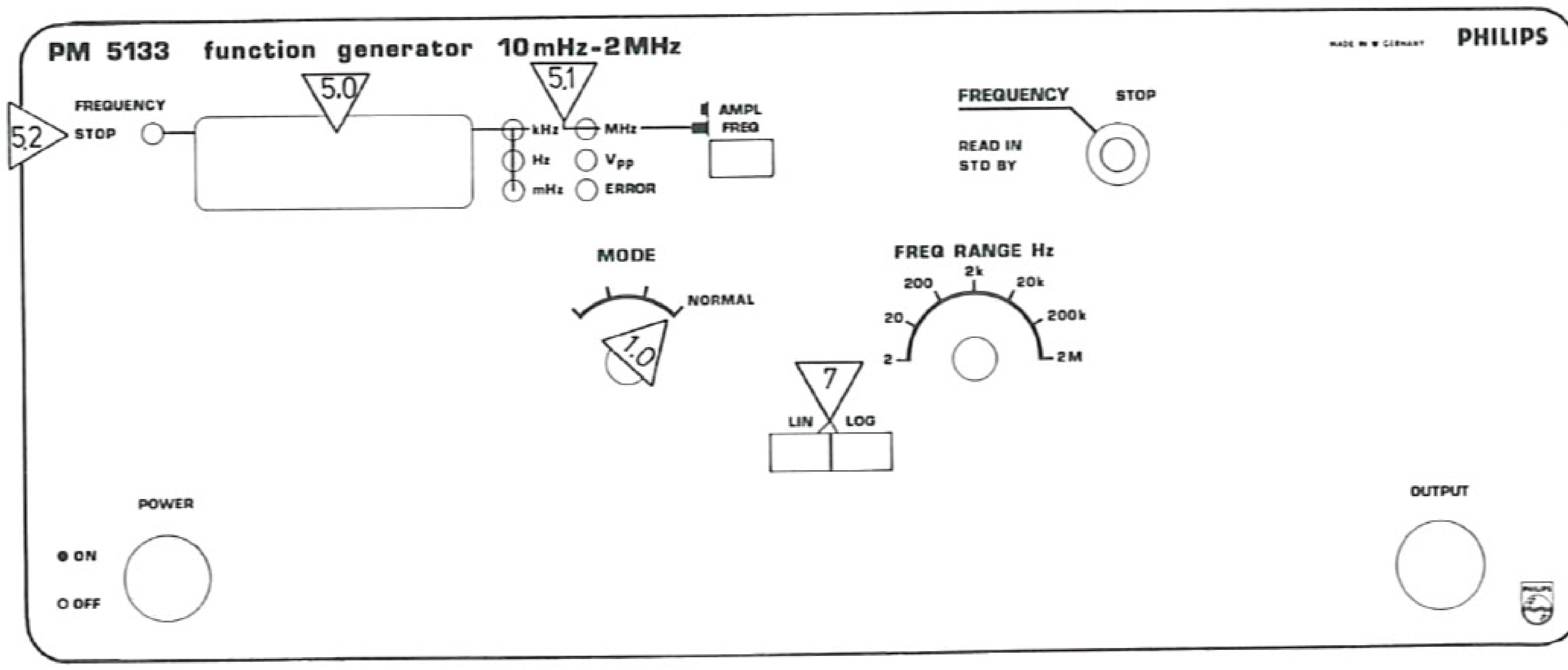
1.2	set to SINGLE or BURST
5.2	STOP frequency is indicated
17	choose range of repetition period or burst duration
18	adjust repetition period or burst duration
21	adjust start phase
15.2	start periodical operation by unlocking the pushbutton or:
19.1	start single operation by pushing the TRIG button or by external trigger signal

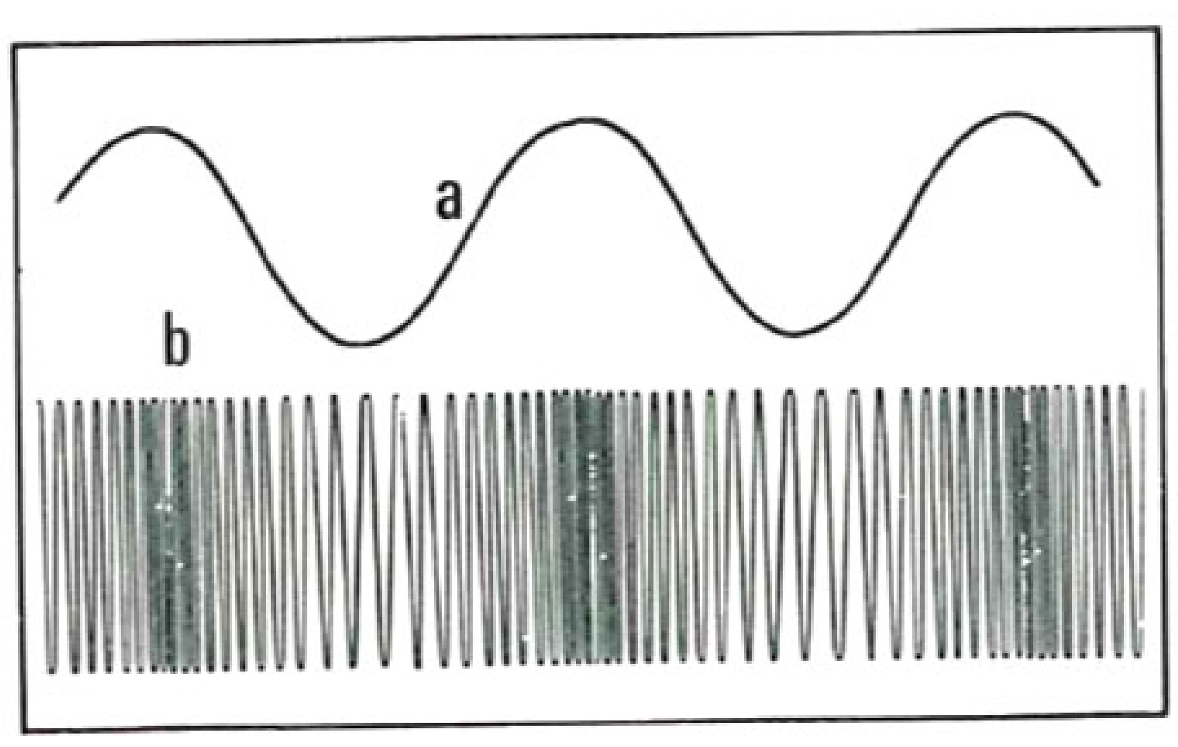
If necessary, check and correct the settings of the output signal according to 3.2.6.2.

3.2.6.4.1. External BURST

Adjust frequency (STOP frequency) as in NORMAL mode, see 3.2.6.1.

1.0	set to NORMAL
2	apply external square wave signal (TTL level) to socket TRIG & BURST (see 1.2.7.)
21	adjust start/stop phase





(a) sine wave signal applied to the SWEEP/FM input

(b) frequency-modulated signal at the PM 5133 output.

3.2.6.5. External sweep/FM

Adjust STOP-frequency in NORMAL mode, see 3.2.6.1.

1.0	set to NORMAL
7	set to LIN or LOG mode
5	displayed frequency lies within the chosen frequency range
5.1	with respect to the indicated dimension
5.2	indication STOP lights
6	adjust sweep adv. frequency deviation by feeding a d.c. or a.c. voltage to socket SWEEP/FM.

If necessary, check and correct the settings of the output signal according to 3.2.6.2.
In order to avoid error functions, it is necessary to disconnect all cables from the SWEEP/FM socket for other modes.

3.2.7. Error indication

In order to have a quick indication of unallowed setting of frequencies, frequency ranges and duty cycle the LED indicator ERROR flashes. The unallowed combinations of settings are shown in the following table:

MODE	FREQ RANGE Hz
LOG	x 2 Hz x 20 Hz
both buttons LOG and DUTY CYCLE pressed	
if none of buttons LIN or LOG pressed	

3.2.8. Frequency indication at the upper range limits

The normal upper limit of the frequency ranges is indicated by 2000 on the display. Actually the display range is limited to 2048 due to the digital voltmeter component in the display circuitry.
Turning the frequency potmeters above 2048 does not effect the display.

4.1. CIRCUIT DESCRIPTION PM 5133

4.1.1. Modulation generator, see figs. 4.1 - 1 and 38

The modulation generator generates input voltages for the control section. In SWEEP mode sawtooth voltages(10 Vpp) and in BURST and SINGLE CYCLE mode square wave signals (10 Vpp) are generated. The modulation generator mainly consists of the integrator 402 with charging capacitors 503 to 506, comparator 308/309, current switch 305/306, regulator 301/302 and square wave switch 401/1. The square wave output voltage of 401/1 can be devided by the potmeter PERIOD. This voltage is halved by 603/604 and sensed by voltage follower 401/2. This voltage and the connected MOD PERIOD resistors 614/615 determine the input current of the following integrator.

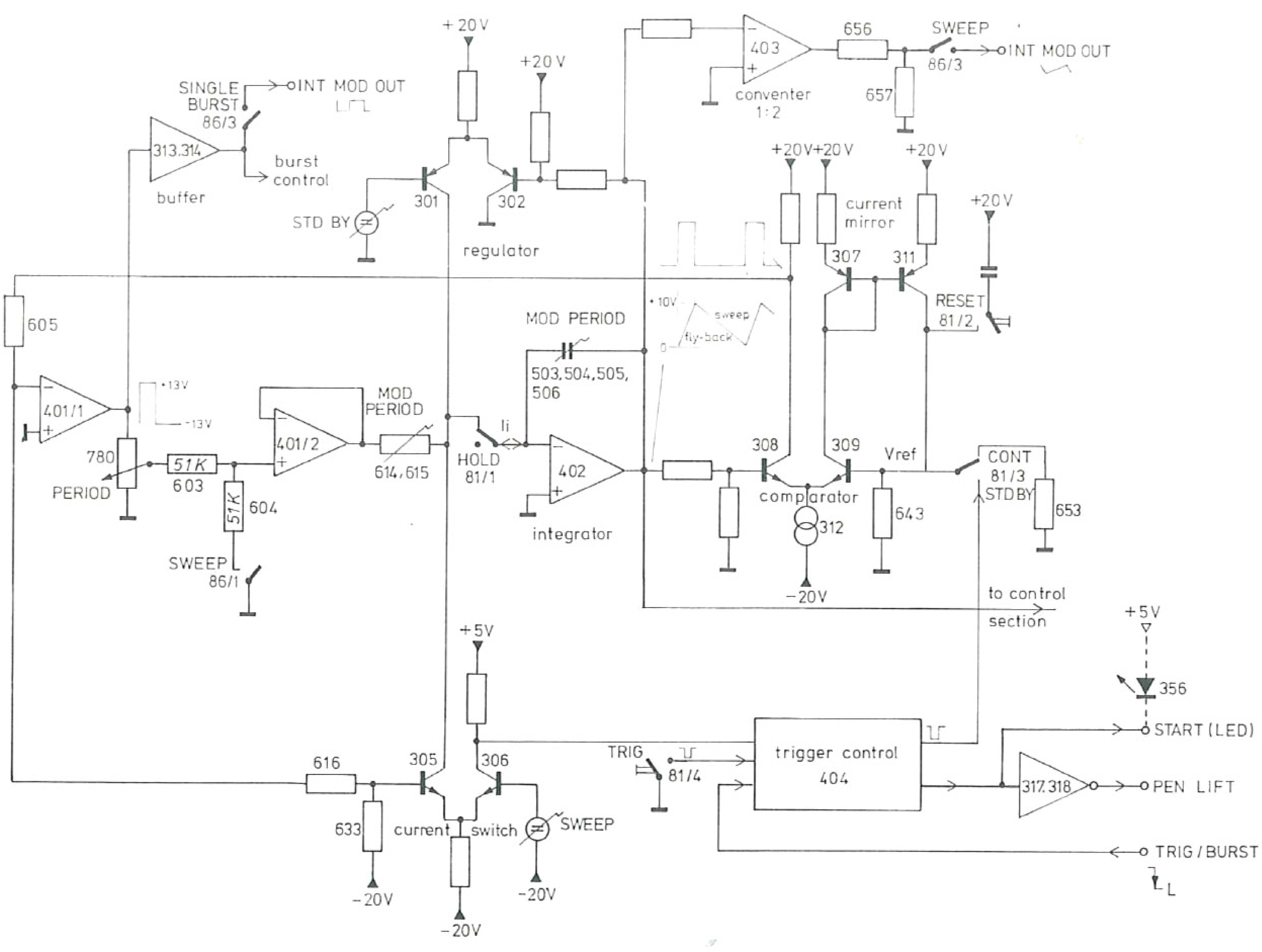


Fig. 4.1 - 1 Modulation generator

In continuous **SWEEP mode** a positive voltage is applied to the input resistors of the integrator, resulting in a negative going ramp from 10 V to 0 V at the output of the integrator. The reference level Vref of the comparator at the base of transistor 309 is set to 0 V. When the integrator output voltage reaches 0 V, transistor 308 is turned off and transistor 305 is turned on. Simultaneously the collector current of transistor 312 is routed via transistor 309 and the current mirror 307/311 to resistors 643/653 establishing a reference voltage of about 4.8 V. In consequence of the high collector current of transistor 305 the integrator now quickly flies back to +10 V. At this level the comparator turns over to the initial state and a new cycle starts.

In **STAND BY** mode the positive reference level of comparator 308/309 during fly-back phase of the integrator is increased to 6 V by switching off resistor 653. Hence the comparator 308/309 can't switch over, when the integrator output voltage arrives at 10 V. This integrator output level is now fixed by a regulator circuitry comprising 301/302. By switch 81/3 the -13 V output voltage of 401/1 is connected to 606, lowering the base voltage of 301 to about 15 V. When the integrator output voltage reaches 10 V the base voltage of 302 approaches 15 V too; so transistor 301 becomes conducting. The collector output current thus will balance the integrator 402 input current. By this way the integrator output voltage is stabilized to 10V .

When pressing pushbutton **TRIG** only one integrator sawtooth cycle is initiated. A negative pulse is applied to the reference input of comparator 308/309 via trigger control 404 and the comparator is switched over from its STAND BY position. Furthermore triggering is possible by an external TTL signal on the falling edge via input TRIG & BURST.

When pressing pushbutton **RESET** a positive pulse is fed to the reference input of the comparator, switching over the comparator and initiating fly-back.

In **HOLD** mode current to the integrator is switched off by SK 81/1 and the integrator remains at its instantaneous output voltage.

Indication of the sweep status is done by the LEDs RUN and START.
In **STAND BY** mode transistor 306 is switched off. Hence collector voltage is high. This high level is inverted to low by 404.2.3 and fed to the LED control circuitry 411 and 414 (U2). Additionally, high level from mode switch 86/1 is applied to the LED control circuitry. Hence during stand-by and sweep the corresponding LEDs are activated. The output of gate 404.3 is additionally applied to inverting circuitry transistors 317/318 for PEN LIFT OUTPUT.

In SWEEP mode the integrator output voltage slope is inverted by amplifier 403. The voltage is attenuated by resistor 656/657 to 5 Vpp and fed to the INT MODULATION OUTPUT socket.

In BURST and SINGLE mode the integrator generates symmetrical triangular wave forms. The output voltage of square wave switch 401/1 is not halved by resistors 603/604. The reference voltage of the current switch 305/306 is set to positive by transistor 304. Thus transistor 305 is turned off and fly-back is inhibited. Square wave signal from the output of 401/1 is fed via buffer 313/314 to the burst control. The same signal is applied to the INT MOD OUTPUT via SK 86/3.

4.1.2. **Control section,** see figs. 4.1 - 2 and 38

The **general task** of the control section is to generate charging currents for the main oscillator. Inputs of this circuitry are the wiper voltages of the start and stop frequency potmeter, the output voltage of the modulation generator and the external sweep or modulation signal. These voltages are converted to the output currents Ip and In. The conversion characteristic is linear or logarithmical.

In **NORMAL mode** the input of the amplifier 403 is set to ground; so the start potentiometer is not active. As the output of the amplifier is $V_{in} = 2V_{ref} - V_{sweep}$, where V_{ref} = +5 V, +10 V are applied to the potmeter 630 for the (stop) frequency setting. The voltages at the wipers are converted into currents via resistors 661 to 666 and summed up at the input of amplifier 405/1. This current is transferred by transistor 315 to 697/698 for LIN mode establishing the control voltage Vc for the following voltages to current converters.

Additionally the proportional voltage at emitter 315 is routed by 405/2 and 405/3 to the FRE-QUENCY CONTROL VOLTAGE output socket. The voltage at this terminal ranges from 0 to +5 V.

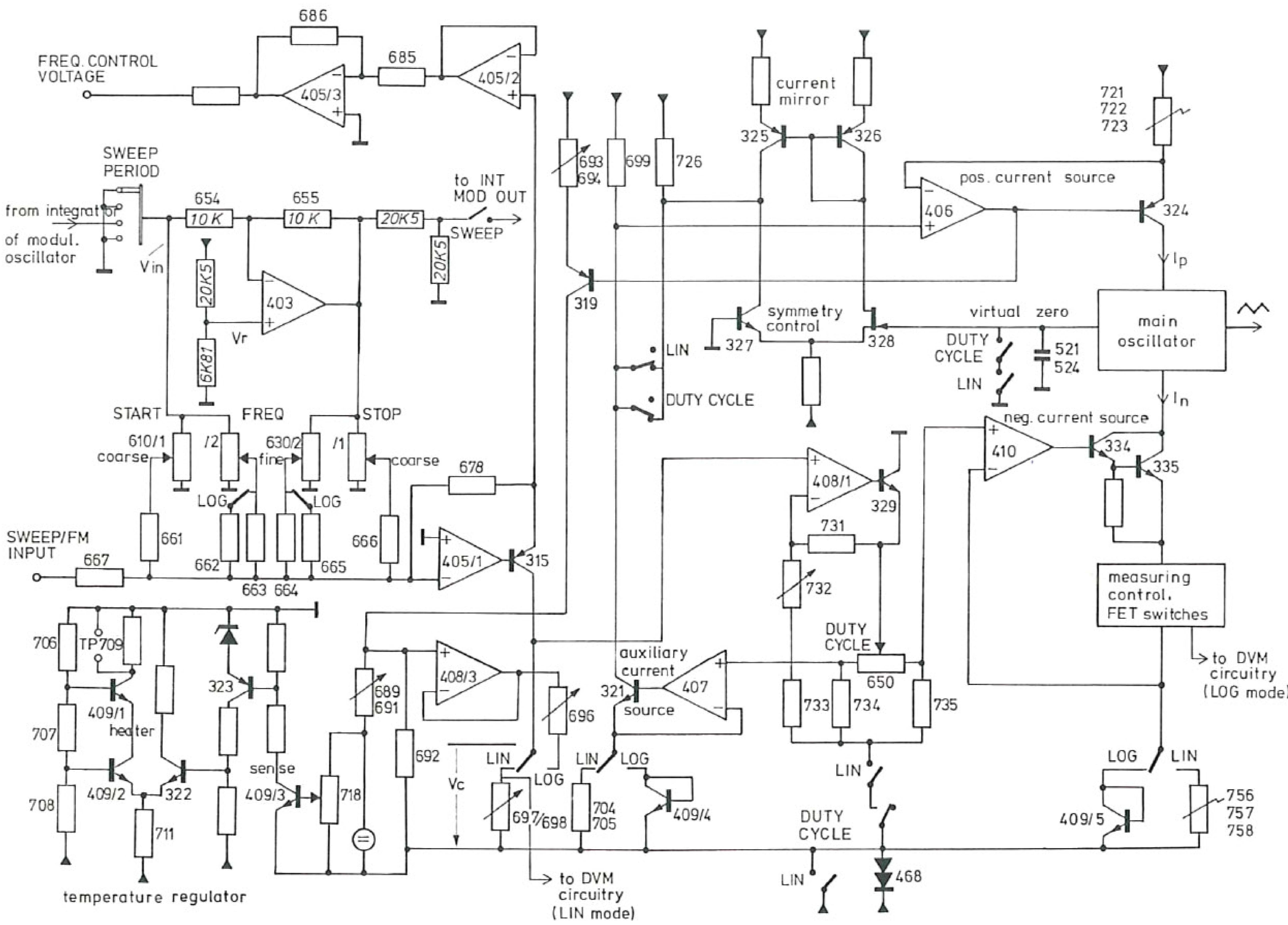


Fig. 4.1 - 2 Control section

When DUTY CYCLE is not pressed potmeter 650 is not active. Control voltage Vc is passed 1 : 1 via impedance converter OP 408/1, transistor 329 to the **negative current source**, comprising amplifier 410, darlington transistor 334/335 and the current determining resistors 756, 757, 758. For the upper five frequency ranges resistor 756 is switched on resulting in a current range of 0.5 mA - 10 mA. In the 20 Hz and 2 Hz ranges the current ranges are reduced by resistors 757 and 758 by a factor of 1/10 or 1/100 respec. Additionally Vc is passed via 408/1, transistor 329 to the auxiliary current source 407/321. The output current of 407/321 is fed to resistor 699/726, establishing a control voltage for the **positive current source**, comprising amplifier 406/transistor 324 and the current determining resistors 721 to 723. The output current Ip is identical with In.

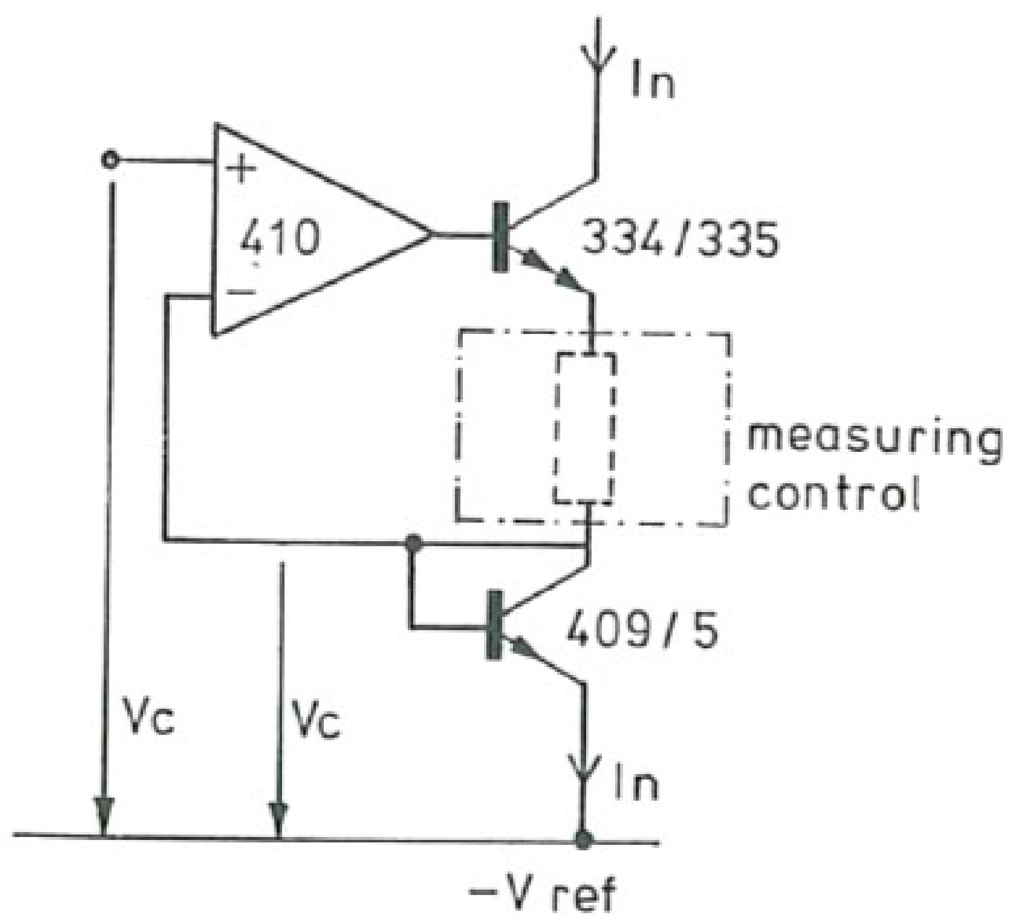
In order to vary the **duty cycle** of the main oscillator signal the ratio Ip/In must be altered. Additionally the condition 1/Ip + 1/In = constant must be satisfied to get no frequency change. For the total setting range of the duty cycle each current (Ip, In respec.) is varied from 0.56 I to 5 I where I = Ip = In for normal mode or 50% duty cycle respectively.
Variation of Ip/In is controlled by potmeter 650 when the DUTY CYCLE button is pressed. In this situation Vc is amplified by the amplifier 408/1 and divider 731 - 733. The output voltage 5 Vc is applied to potmeter wiper 650. In central position of 650 this voltage is decreased to Vc again by divider 650, 734 or 650, 735 respectively and applied to the current converter 410, 334/335 and 407/321 resulting in Ip = In = I. In the end positions of 650 the resulting control voltages of the current converters are 0.56 Vc and 5 Vc, vice versa. The corresponding output currents are Ip = 0.56 I and In = 5 I, vice versa.

In **SWEEP mode,** stand-by state, +10 V output from the modulation oscillator is applied to amplifier 403 and to start potentiometer 610. Hence 0 V at the amplifier output and stop potmeter 630 is resulting. Thus 630 is inactive. During the sweep the modulation oscillator voltage represents a negative going ramp. Hence the voltages at the potmeters 610/630 are mutually decreasing and increasing until at the end of the sweep 630 is active only as in normal mode, thus defining the stop frequency.

The **symmetry control** circuitry 325 to 328 is provided to equalize Ip and In and by this establishing a highly symmetrical oscillator wave form. This is one of the main conditions to obtain low sine wave distortion. Unbalances of Ip and In would effect a d.c.-level change at capacitors 521, 524. This voltage difference is converted to collector output current 325/327, correcting the control voltage at 699/627 of the positive current source for cancelling the Ip matching error.

In duty cycle mode the symmetry control circuitry has to be switched off which is done by connecting the virtual ground of the quadruple switch to real ground and by separating the output of the symmetry control circuitry from the positive current source.

In **LOG mode** the current determining resistors 756 and 704 in the current sources 410/334/335 and 407/321 are substituted by the emitter diodes of the array transistors 409/4 and 409/5.
The input control voltage of 410 is applied as forward voltage Vc to diode 409/5. The resulting diode current In, routed to the main oscillator, is exponentially related to Vc:



$$In = Io \cdot e^{Vc/Vt}$$

Fig. 4.1 – 3 Principle of logarithmic converter

Io and Vt are sensitive to transistor junction temperature and hence to ambient temperature variations. These variations are avoided by a regulator circuitry establishing a constant chip temperature of the array 409.
In this regulator circuitry transistor 409/3 represents the temperature sensing element. If the chip temperature would rise, the collector current of this transistor would increase, hence steering up transistor 223. By this action transistor 322 base voltage is lifted thus decreasing the emitter collector currents of the chip heating transistors 409/2 and 409/1. Consequently, the chip temperature decreases until the collector current of 409/3 is reduced to its initial value. This means, that the chip temperature is stabilized on a fixed level and gets insensitive to ambient temperature variations.

Maximum frequency variation per subrange in LOG mode is $2 \cdot 10^4$. The corresponding range of Ip and In is from 0.5 μA to 10 mA. For 0.5 μA a basic diode forward voltage of about 270 mV is required, which is established by the circuitry comprising 464, 688, 689 – 692 and 408/3. The sum of this voltage and the voltage drop at resistors 695/696 represent the control voltage Vc. The variable term of this voltage at resistors 695/696 is about 75 mV per current or frequency decade.

At higher currents about $>$ 1 mA the voltage drop Rb $\cdot$ In at the bulk resistance Rb of the logarithming diode is diminishing the internal forward voltage. This voltage drop is compensated by an additional control voltage portion, established by the collector current of transistor 319 at resistors 691/692.

4.1.3. **Main generator,** see figs. 4.1 - 3 and 39

The main oscillator generates a symmetrical triangular voltage of 10 Vpp. This is performed by d.c. charging a capacitor alternatingly in positive and negative direction. The frequency is determined by the selected range capacitor and the charging current, generated by the control section.

Switchover of the charging current is achieved by a transistor switching circuit controlled by a two-level detector or comparator at two predetermined voltage levels of the integrating capacitors.

The circuit operates as follows:
Assume that point 'a' is positive. The integration capacitor will charge via transistor 356 and 357 (355 and 358 are switched off). At a predetermined level, transistor 423.1 of the comparator will switch on. So transistors 371, 423.2 and 352 are cut off, resulting in a negative reference voltage of the comparator at resistor 828. Hence, 352 is turned off, Ia becomes null and the quadruple switch circuit will switch over. The capacitor will now be charged in the reverse direction via transistors 355 and 358. At a negative predetermined level, transistor 423.1 will switch off and open transistors 371, 423.2 and 352 again. So point 'a' is positive again and a new cycle starts. In this way, a triangular wave is generated, the frequency of which depends on the charging capacitor, the charging current and the signal amplitude.

The basic part of the oscillator is the **quadruple switch** with the frequency determining capacitors, selected by the front-panel pushbuttons FREQ RANGE Hz. Under the control of the square wave signal at point 'a', at each half-cycle two diagonal opposite transistors open while the other two close (i.e. 356, 357 open, 355, 358 close, vice versa). In this way the direction of the charging current is alternating.

The **main oscillator** generates a time-symmetrical output voltage. For 50 % duty cycle signals of the generator the charging currents Ip and In must be equal. Asymmetrical wave forms are generated, if these charging currents are differing. This is dependant from the duty cycle settings. The symmetry of the triangular output voltage with respect to zero is resulting from switch over voltages of the comparator 423.1/423.3.
In LIN mode the loading currents Ip/In vary between 0.5 mA and 10 mA for the 5 upper frequency ranges and are reduced by a factor of 1/10 or 1/100 for the 20 Hz and 2 Hz range respectively.

A high impedance FET **buffer** 362 avoids charging current leakage at the charging capacitor. Emitter follower 365 then connects the signal to the comparator 423.1/423.2.

To compensate for non-linearity in the frequency response in the higher ranges due to delays in the oscillator loop a **lead circuit** is inserted between oscillator and comparator, comprising components 817, 547, 548.

The **comparator** 423.1/423.2 compares the divided instantaneous integration voltage with the reference level at the base 423.2 which is Vr = ±2.0 V. When the base 423.1 attains one of the reference levels, the comparator switches over and actuates the quadruple switch. At the same time, the comparator reference level is switched to the opposite polarity.
On the reference side of the comparator two currents sources Irp and Irn generate voltages at resistor 828. Irp has twice the value of Irn. According to the state of transistor 371 either the difference of the two sources results in a +2.0 V reference level or the second source alone generates a -2.0V reference level.

The triangular signal of the oscillator is fed via WAVE FORM switch to the **sine shaper** circuit 431. Associated preset controls for distortion (offset and amplitude of the input signal) are potentiometers 863 and 868. The output is routed through a low-pass filter which serves to reduce sine wave distortion and to flatten amplitude response at the upper frequency end. By 866 the amplitude at 2 MHz is adjusted. The output d.c. offset is set to zero by 873. The emitter-follower 381/382 is used for impedance matching. The output is fed via the wave form selector switch and front-panel AMPLITUDE control 760 to the power amplifier.

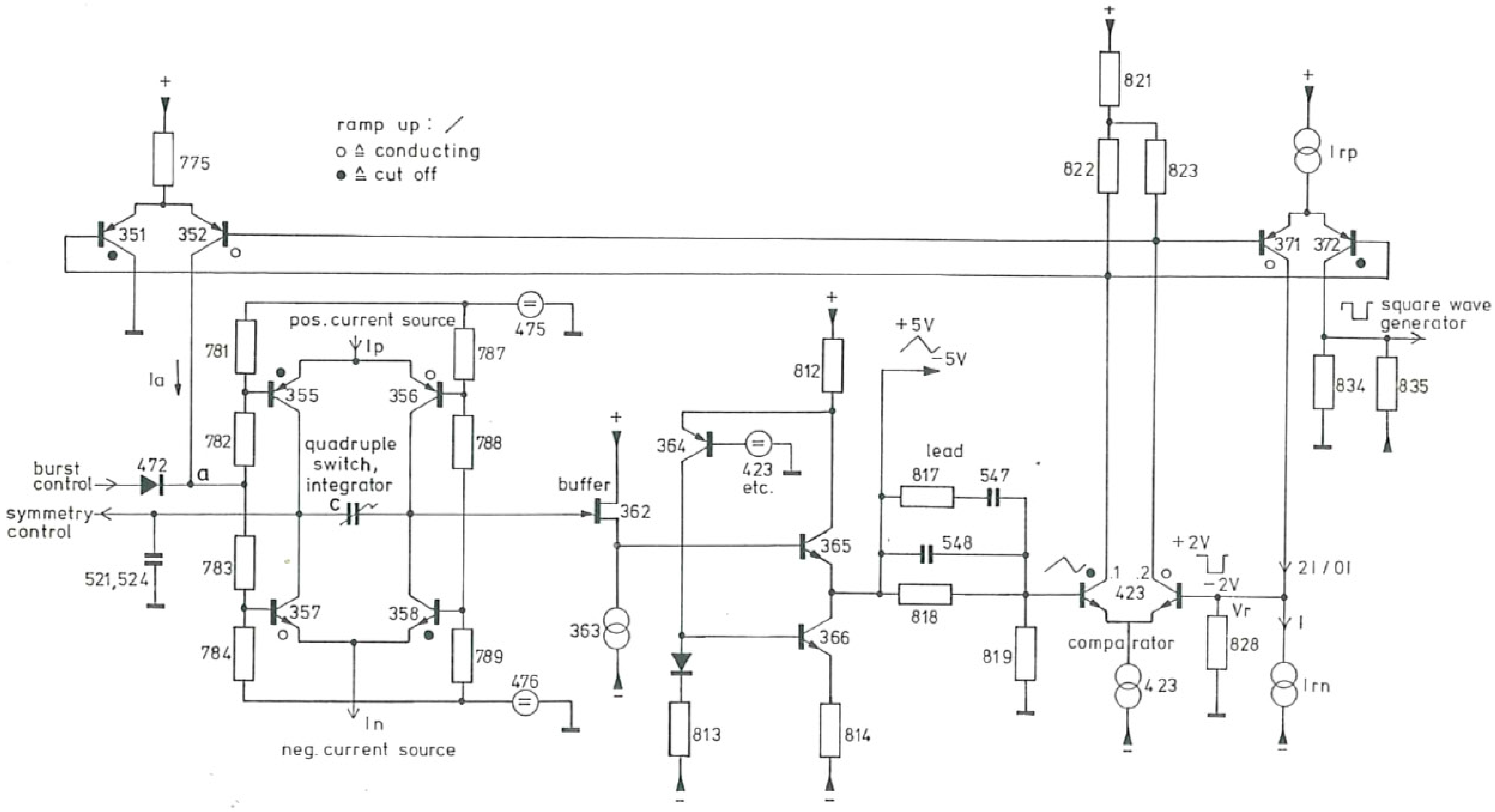


Fig. 4.1 - 4 Main oscillator

The **square wave generator** provides three wave forms, i.e. square wave, positive and negative pulse. The square wave signal at the collector of transistor 372 in the signal conditioner controls the square wave generator which comprises two complementary current switches 373/375 and 374/376. Positive or negative pulses are performed by activating one of the two switches. In sine wave, triangle and DC mode the square wave generator is switched off via SK 84/2.

4.1.4. **Burst control,** see figs. 4.1 - 4, 4.1 - 5, 39

The burst function of the main oscillator is controlled by the TTL signal on the line 'C' (see fig. 39). In NORMAL mode without external TRIG & BURST input the line 'C' is set to TTL high level by resistor 791. The oscillator is running free. If the line 'C' is pulled to low, effected by an external TRIG & BURST input signal or by the internal modulation generator in BURST mode, the main oscillator is stopped on the next negative going ramp of the triangular wave (emitter 365) at a level determined by the position of the START PHASE potmeter 700. By a following low-to-high transistion on the line 'C' the oscillator is unlocked and is free running again.

More details are shown by fig. 4.1 - 5: in the oscillator free-running mode with the line 'C' on TTL high level the flip-flop built up with gates 421.8 and 421.11 is set to high at 421.8 resp. to low at 421.11. Diode 473 is pulled low resulting in a reverse voltage at diode 472: collector currents of 354 are inhibited from the oscillator switching input 'a' and conducted by 473 to emitter 359.

By a high-to-low transition of the line 'C' gate input 421.5 is set to high. At the next switching over point of the differential stage 351/352 at the positive peak of the internal triangular oscillator voltage gate input 422.5 and hence gate output 422.4 are going high: a short low-going trigger pulse is generated at 421.3 resulting from the propagation time difference between 422.4 – 421.2 and 422.4 – 422.10 – 421.6 – 422.12. This trigger pulse is switching over the flip-flop into the other stable state. Diode 473

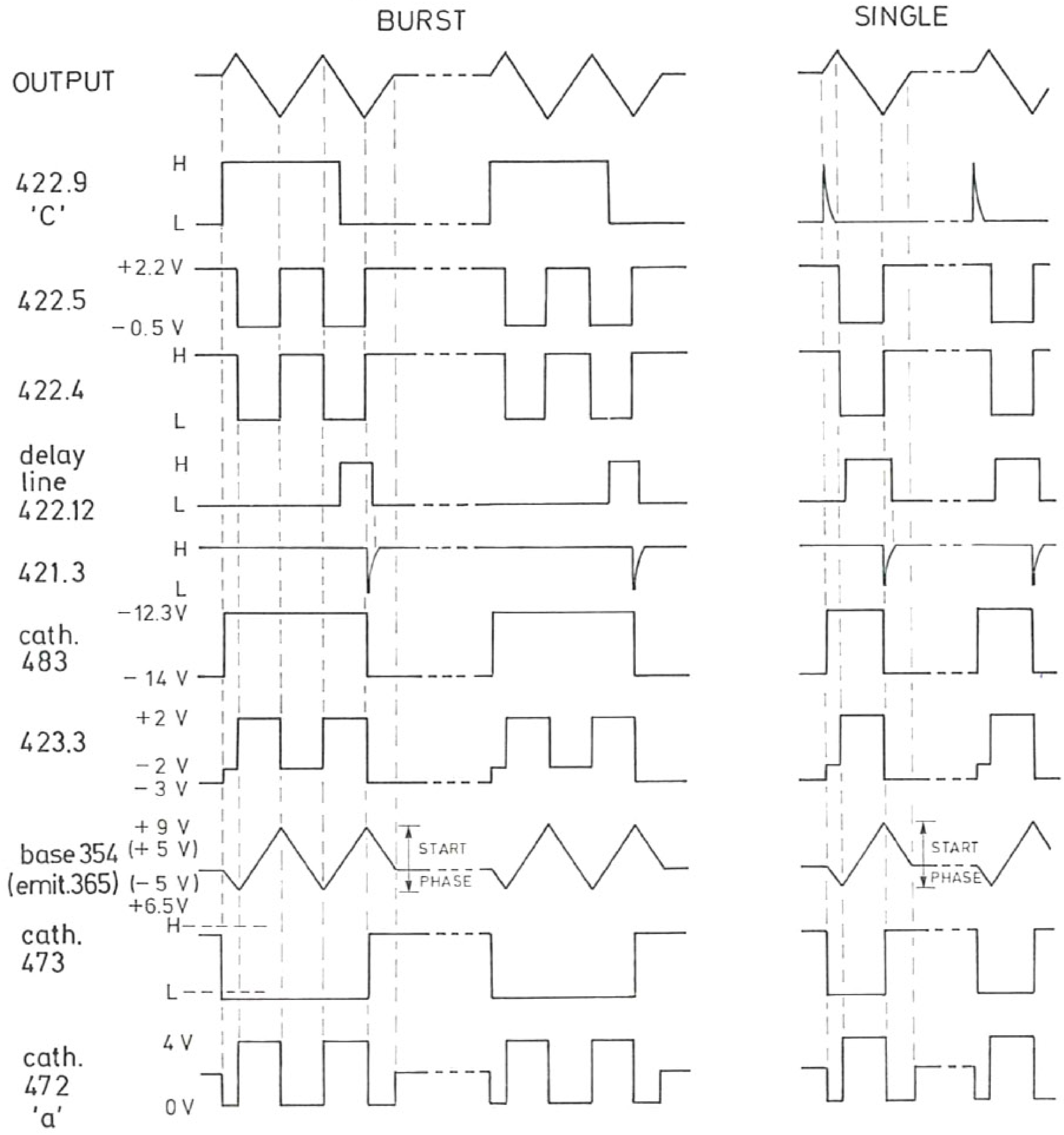


Fig. 4.1 - 5 Timing diagrams for BURST and SINGLE

cathode is pulled high. When the ramp voltage at the base of transistor 354 is approaching the base voltage of transistor 353, which is determined by the position of the START PHASE potmeter 700, transistor 354 starts turning on. The rising collector current (starting at zero) is conducted by diode 472 to point 'a'. Starting at 0V the point 'a' level is increasing in positive direction. Arriving at about 2V the collector currents 356 and 358 are balancing each other, so the integrating capacitor voltage at the collectors stops to change: the coresponding oscillator output voltage at emitter 365 is fixed to a d.c. level between -5V and +5V determined by START PHASE potmeter 700. By the low-level state of gate output 421.8 diode 483 has become conductive effecting an increase of the collector 423.7 current. Hence the base 423.3 voltage is lowered to about -3V. By this action transistor 423.2 –3–4 certainly is turned off. Therefore switching over of the comparator (423.1/423.2) at the negative peak of the triangular oscillator voltage is avoided, when the START PHASE potmeter 700 yields a -5V stop level.

By a low-to-high transistion of the line 'C' input the 421.8 - 11 flip-flop is reset to the high level at 421.8 resp. to the low level at 421.11. Diode 483 is reversed. Diode 473 takes over the collector current of 354. Diode 472 is turned off. The oscillator starts from the stop level in free-running mode.

Whilst in BURST mode a TTL pulse train with a 1:1 mark/space ratio duty-cycle 50%, is inputted to the line 'C' only short low-going trigger pulses are generated in **SINGLE mode** and routed to the line 'C', each pulse having a width below one half period of the oscillator signal. Hence each burst initiated by a trigger pulse is formed by only one oscillator wave cycle.

4.1.5 Measuring control, range resistor logic

By the measuring control section a d.c. voltage is generated which is proportional to the momentary generator frequency. In LOG mode this voltage is derived from the output current In of the control section which determines the main oscillator frequency. In LIN mode the internal control voltage Vc of the control section is picked up as frequency analog voltage.

In **LOG mode** current In is led to the range resistors 747, 748, 751, 752 and 753, see figs. 4.1-6 and 38. Only one at a time of the FET-switches 338-342 conducts permitting the current to flow either through 1R, 10R, 100R or 1000R with R = 187.7 Ω. These resistors are switched by the measuring range (MR) control lines from the DVM 405 via OR-gate 408, inverting transistors 331, 332 and 1-of-4 decoder 411.
The positive supply voltage of the 1-of-4 decoder is carried along by OP 408/2 with the input voltage of OP 410 and hence the voltage at the sources of the FETs 337 – 342. By this the high output level of the decoder representing the gate level of the switched on FET is equal to the FET source level, thus avoiding gate leakage currents. Care has been taken that the negative current source cannot be overdriven during fast frequency sweeps at the switch-over points of the range resistor logic. If in the course of a sweep In is increasing rapidly the voltage picked up from the range resistors may shortly become too large caused by the 200 ms delay time of the range resistor control logic including the DVM. This excess voltage is avoided by the clamping circuitry including FETs 336 and 337. The clamping voltage is about 3 V. The nominal maximum input voltage of the DVM picked up from the range resistors is about 10 mA · 188 Ω ≅ 1.9 V.

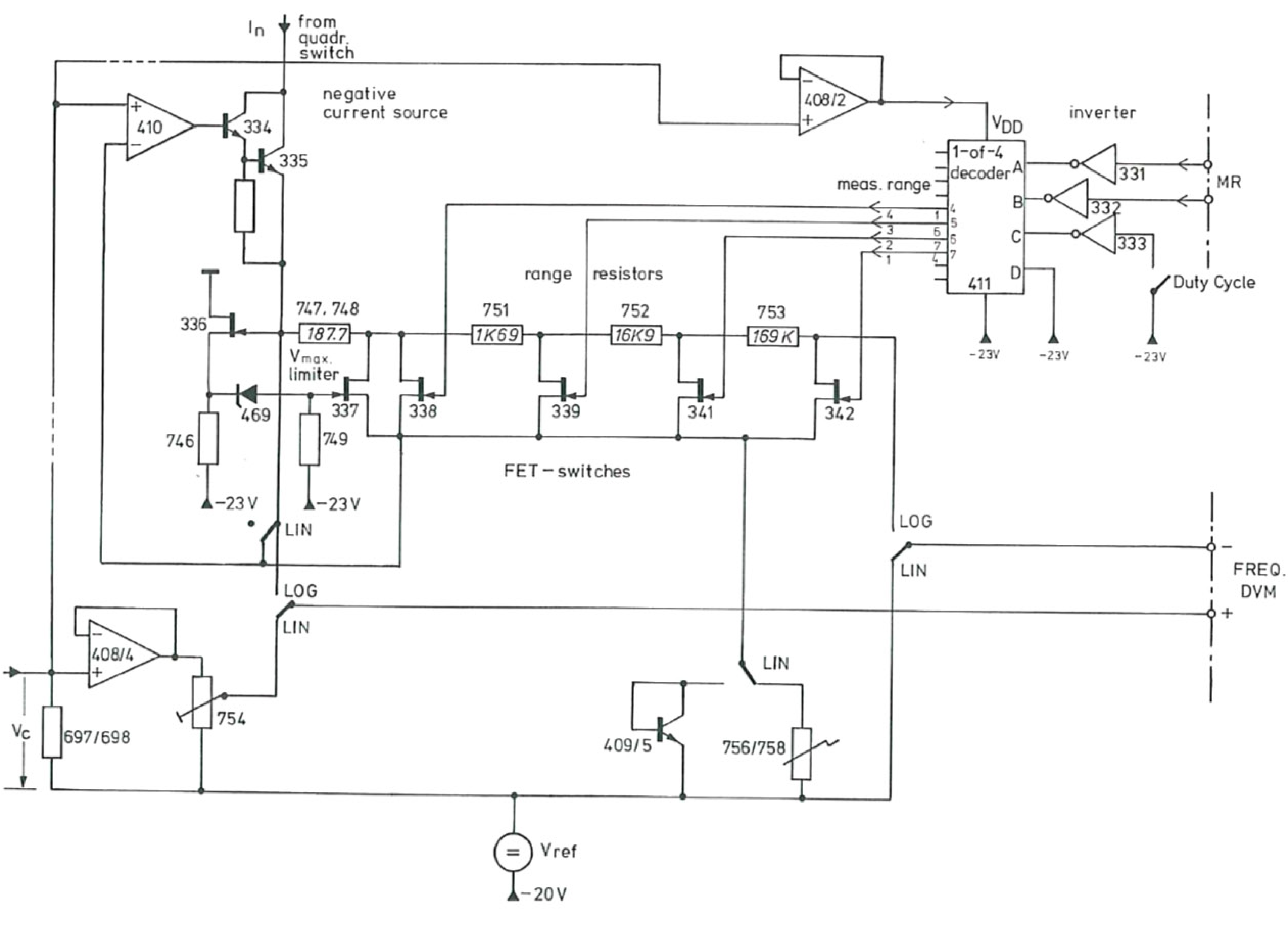


Fig. 4.1-6 Measuring control

In **LIN mode** internal control voltage Vc is picked up by the voltage follower 408/4. The range resistor control logic is fixed to range 4, hence only resistors 747, 748 are switched on by FET 338 (see table below: LIN mode). Automatic range control of DVM is disabled by a high level input from SK 82/1 to OR gate 408.9.

In **DUTY CYCLE mode** all FET switches 338 - 342 are turned off by decoder 411. This is necessary to prevent FETs 338 - 342 from break down by high gate currents.

States of range resistor logic

LOG mode SK 87 in pos. 200 Hz

range	display range	IC405 .5.6.7	IC408 .3.4	IC411 .1.4.6.7
1	0 1 0,0 – 1 9 9,9 mHz	L L L	L L	L H L L
2	0,2 0 0 – 1,9 9 9 Hz	L L H	H L	L L L H
3	0 2,0 0 – 1 9,9 9 Hz	L H L	L H	L L H L
4	0 2 0,0 – 2 0 4,8 Hz	L H H	H H	H L L L

LIN mode

	IC405 .5.6.7	IC408 .3.4	IC411 .1.4.6.7
all frequency ranges	X X X	H H	H L L L

FET 338 active

DUTY CYCLE (LIN mode only)

	IC411 .1.4.6.7.12
all frequency ranges	L L L L H *

* all FETs 338-342 switched off

4.1.6 Frequency and amplitude display

For frequency indication the d.c. voltage conditioned in the measuring control circuitry (see chapter 4.1.5.) is converted to digital by the DVM circuitry and transfered to the LED display.

For amplitude display purposes the output d.c. voltage of the **amplitude display conditioner** is picked up by the digital voltmeter (DVM) circuitry and displayed.
The voltage of the amplitude conditioner is derived from the tandem section 760/1 of the amplitude potmeter and is following proportionally the a.c. output amplitude of section 760/2. The frequency analog voltage of the measuring control circuitry or the amplitude analog voltage of the amplitude display conditioner are selected by the AMPL/FREQ switch 81 and routed to the DVM circuitry.

The differential input amplifier of the DVM circuitry including OP401 and OP403 eliminates the common negative portions of the d.c. input voltage. The voltage at OP403 output ranges from 0 to -4V.

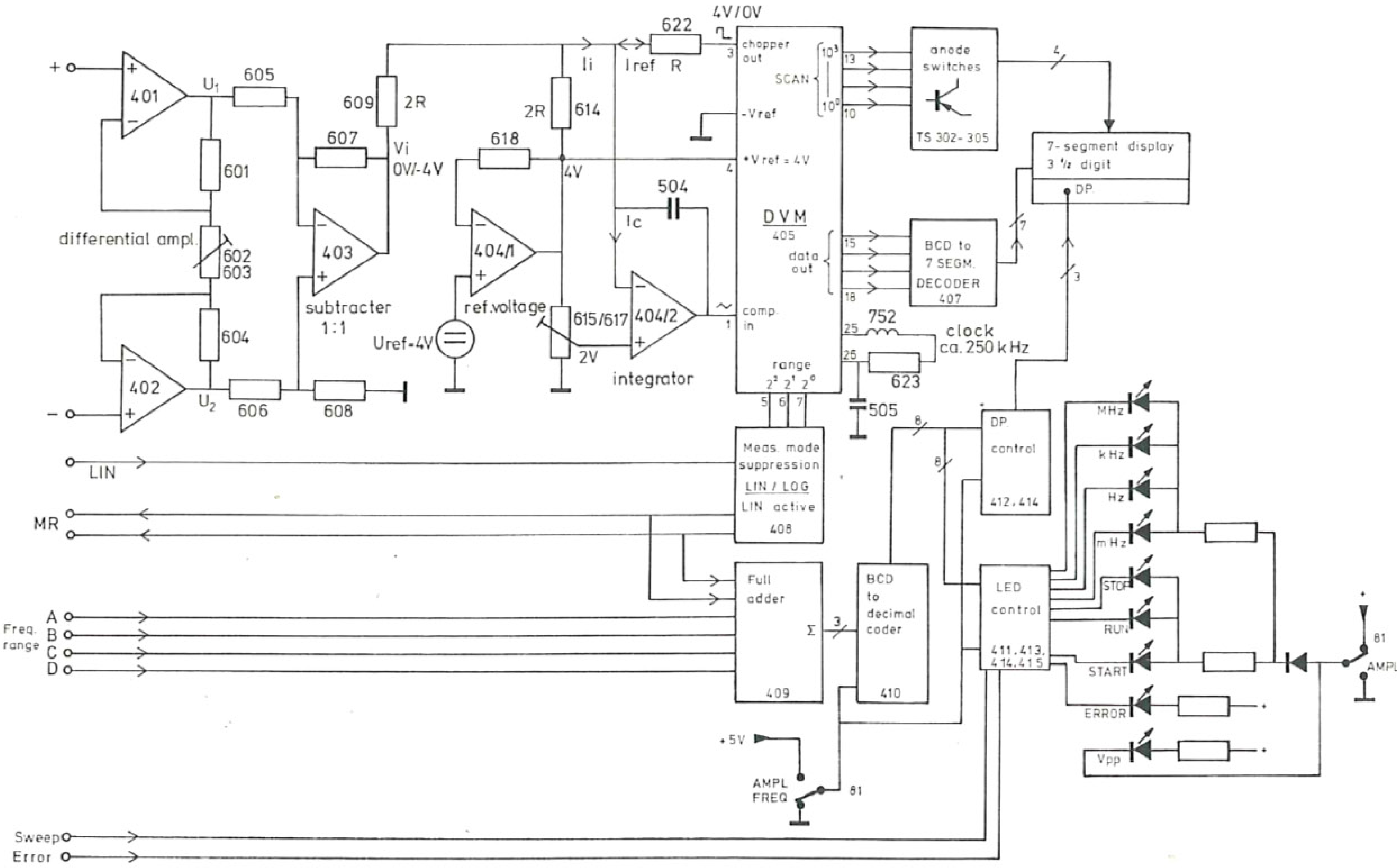


Fig. 4.1 - 7 DVM circuitry, display

This voltage is converted to digital by the DVM circuitry and transfered to the 7-segment display. In this circuitry OP404/1 generates a stable reference voltage of Vref = +4.0 V. OP404/2 with capacitor 504 are representing an integrator. This integrator is fed by current Ii from the differential input amplifier and Iref from the chopper out of DVM405.3.

The chopper output of 405 is switching between +Vref and 0 V. This switching function is controlled internally by the DVM 405 depending on the momentary integrator output voltage at pin 1. The resulting integrator output voltage generally is a sawtooth voltage. For small input voltages Vi (frequency or amplitude resp.) Ii becomes small and the integrator output voltage nearly is a symmetrical triangular wave.

In the **DVM** the sample frequency fs is derived from the clock frequency divided by 16. The sample pulses are counted by an internal up/down counter during fixed periods controlled by an internal timer. The up/down counting function depends on the momentary positive or negative going slope of the integrator output voltage. After the up/down counting period the counter state represents the digitalized input voltage. The contents of the counter is transfered to a buffer memory and multiplexed to the display via decoder driver 407. The counter of the DVM 405 is reset and a new conversion cycle is started again.

4.1.7. Digital voltmeter circuit

Details

The ADC HEF 4739 P is based on the principle of delta-pulse modulation. This integrating system ensures good linearity and series mode rejection. In addition, the circuit contains a minimum of critical elements, the accuracy of the ADC being dependent only on the accuracy of the reference voltages. The output of flip-flop FF operates a chopper switch to connect the negative input of the integrator via R to either a positive or a negative reference voltage. The state of the flip-flop depends on the level of the D input at the time of a sample pulse fs. In turn, the level of the D input depends on the state of charge of capacitor C. See fig. 4.1 - 8.

Assume that, at the instant of a pulse fs, the voltage level at D is below the flip-flop working point. This results in a low output from the chopper and a negative reference voltage is connected to R. The input voltage Vi and the reference Vref are both applied to the integrator. Because Vref is greater than Vi within the scale range, the integrator output voltage increases according to:

$$V_{DC} = \frac{1}{RC} (|Vref| - Vi)\ t + Vo \qquad (1)$$

where t is the time and Vo is the initial level

At each succeeding sample pulse fs, VD is sampled and when VD exceeds the flip-flop working point the flip-flop changes its state.

The integrator is then connected to the +Vref, its output is going in negative direction according to:

$$V_{Dd} = -\frac{1}{RC}(|Vref|+Vi)\ t + V_1 \qquad (2)$$

where V_1 is the initial level

After V_D falls under the flip-flop working point the next fs pulse will reverse the chopper output etc. Therefore a sawtooth like integrator output voltage according to fig. 4.1 - 8 will result.

During one measuring period tm of the DVM a large number of sawtooth periods proceed. Because the average of the integrator output is fixed to the D flip-flop input threshold the sum of all positive and negative ramps are zero.

Hence: $(|Vref| - Vi)\ tc - (\ Vref\ + Vi)\ td = 0 \qquad (3)$

where tc resp. td is the sum of all positive resp. negative going ramp periods.

Consequently:

$$Vi = \frac{tc - td}{tc + td}\ Vref \qquad (4)$$

where tc + td = tm (measuring time).

Assuming:

N = total number of pulses fs during tm
n = total number of pulses fs during tc

Then equation (4) can be written as:

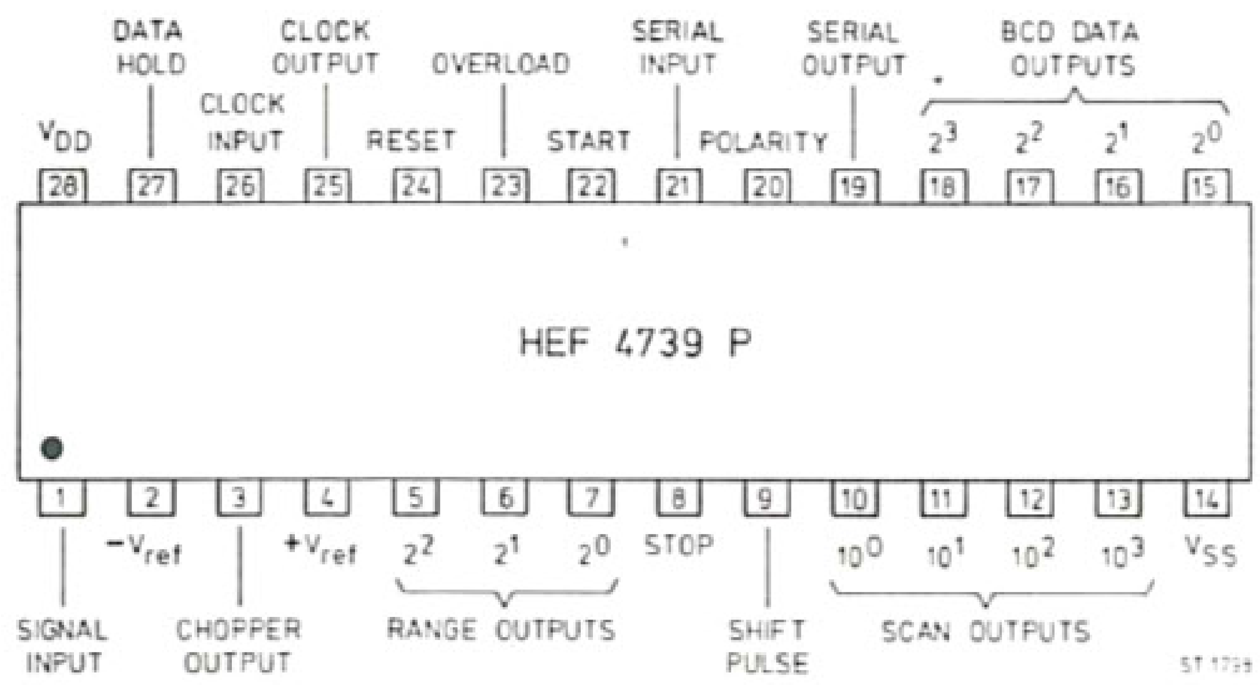
$$Vi = \frac{n - (N - n)}{N}\ Vref \qquad\qquad Vi = \frac{2n - N}{N}\ Vref \qquad (5)$$

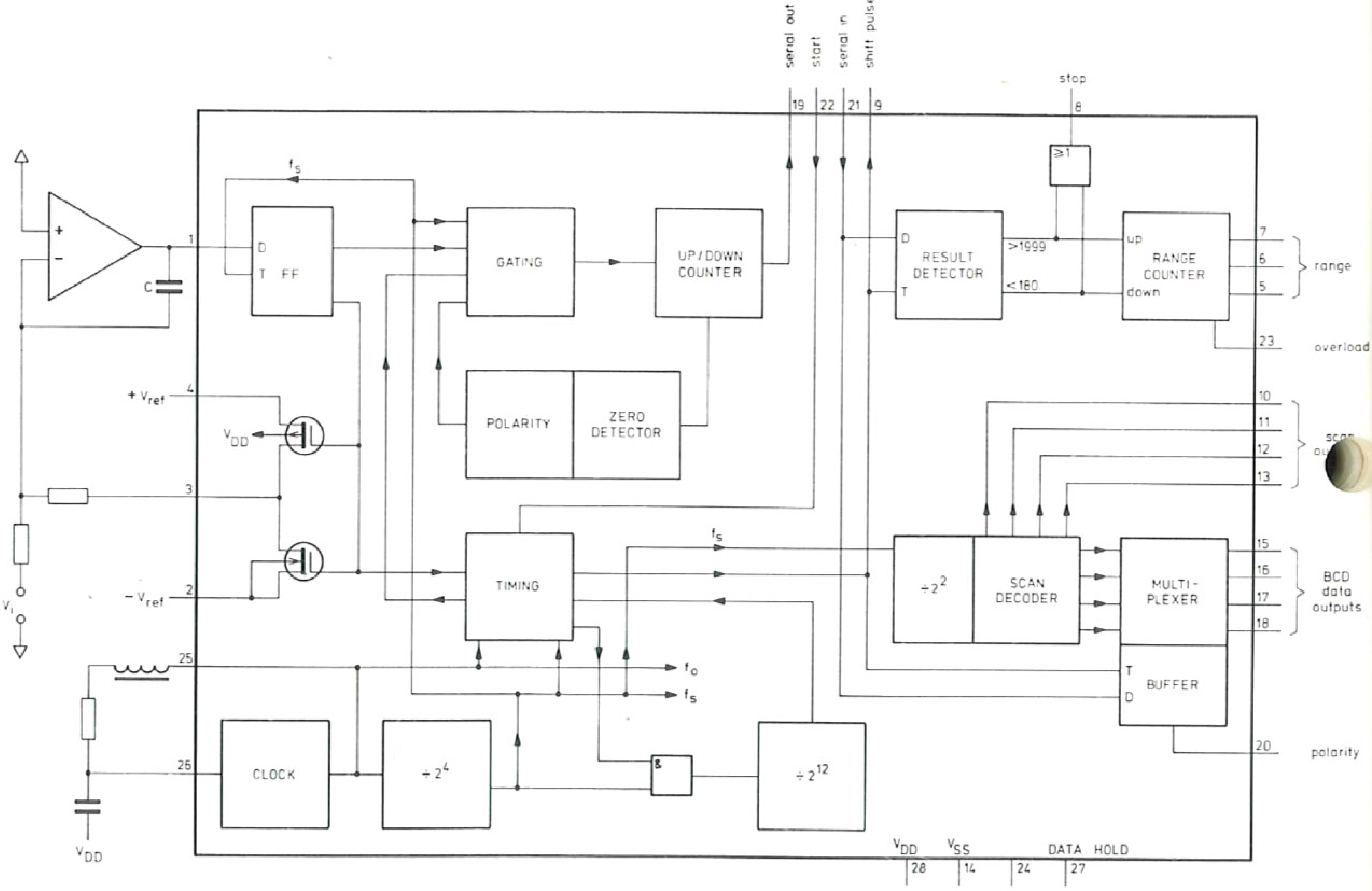
Since an up/down counter is used to count up when +Vref is connected to the integrator, after N sample times the contents of the counter will be 2n - N.

This counter includes polarity and zero detecting sections and counts the absolute value of 2n – N by shifting the counter contents at clock rate through an adder circuit that adds one binary up or down according to the state of Q and the polarity. At the end of the measuring period, the counter content (together with polarity) is serial-shifted out, at clock rate fo, at pin 19 in synchronism with the shift pulses at pin 9. The serial data is organized as follows in NBCD code.

most significant bit = last bit out least significant bit = first bit out

bit no.	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
data	POL	2^1	2^0	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	2^3	2^2	2^1	2^0	X
	10^3			10^2				10				1				





In the integrated circuit is N = 4096. The reference voltage +Vref = +4 V, -Vref = 0 V. The figure shows the internal functions of the block. To obtain a stable display, the contents are divided by two and transfered into a memory, after which the counter is reset. A new measurement can start. Within the circuit block a multiplexer alternately connects each decade of the memory to the decoder driver. At the same time, a pulse is generated to drive the anode switch of the associated 7-segment "LED". The decoded information is then transfered via the decoder driver to the indicator "LED's", the cathodes of which are connected in parallel.

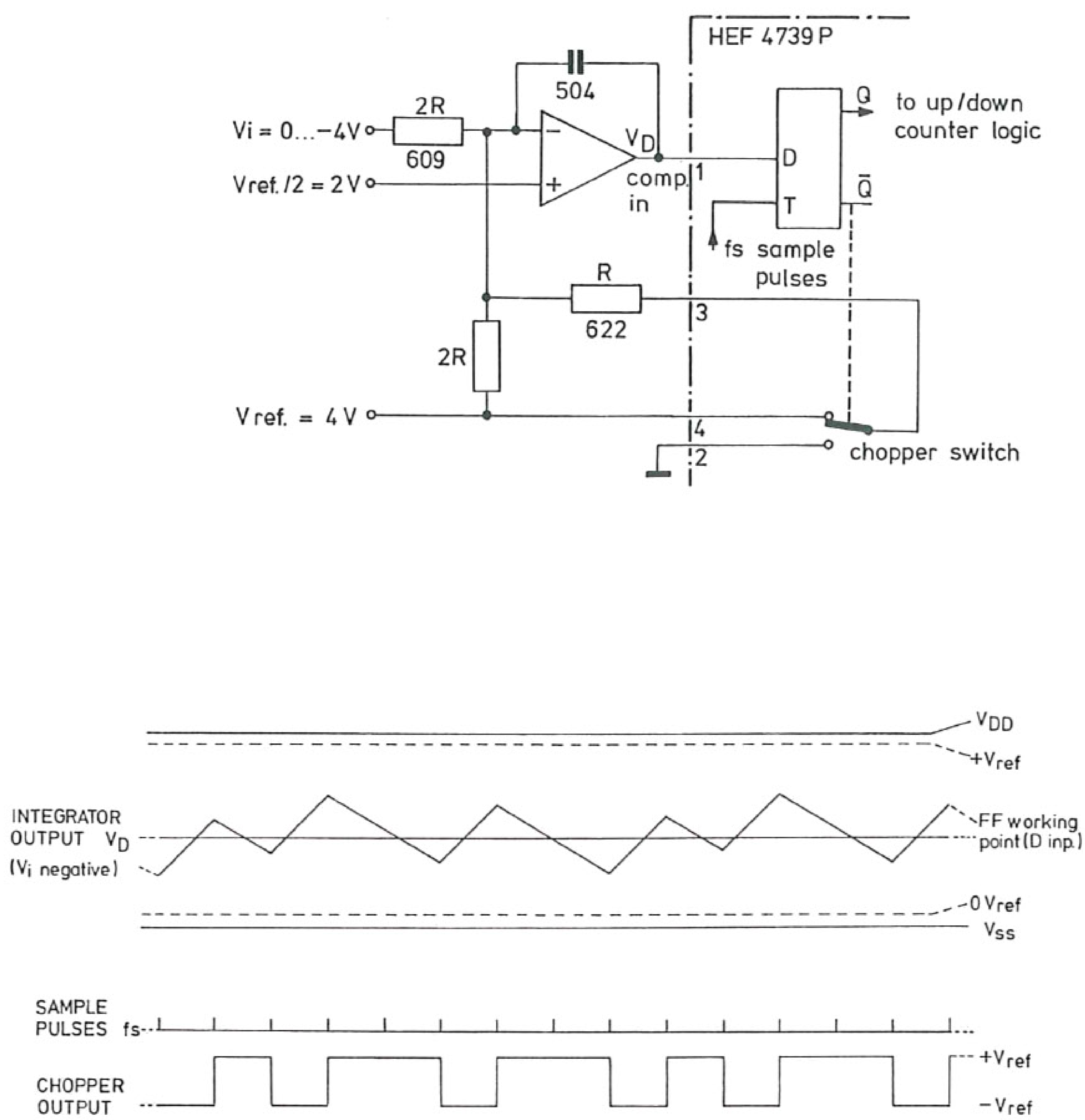


Fig. 4.1 - 8 Integrator operational principle

Trigger point : scan IC 405/13, IC 406/11 ≙ 10^3

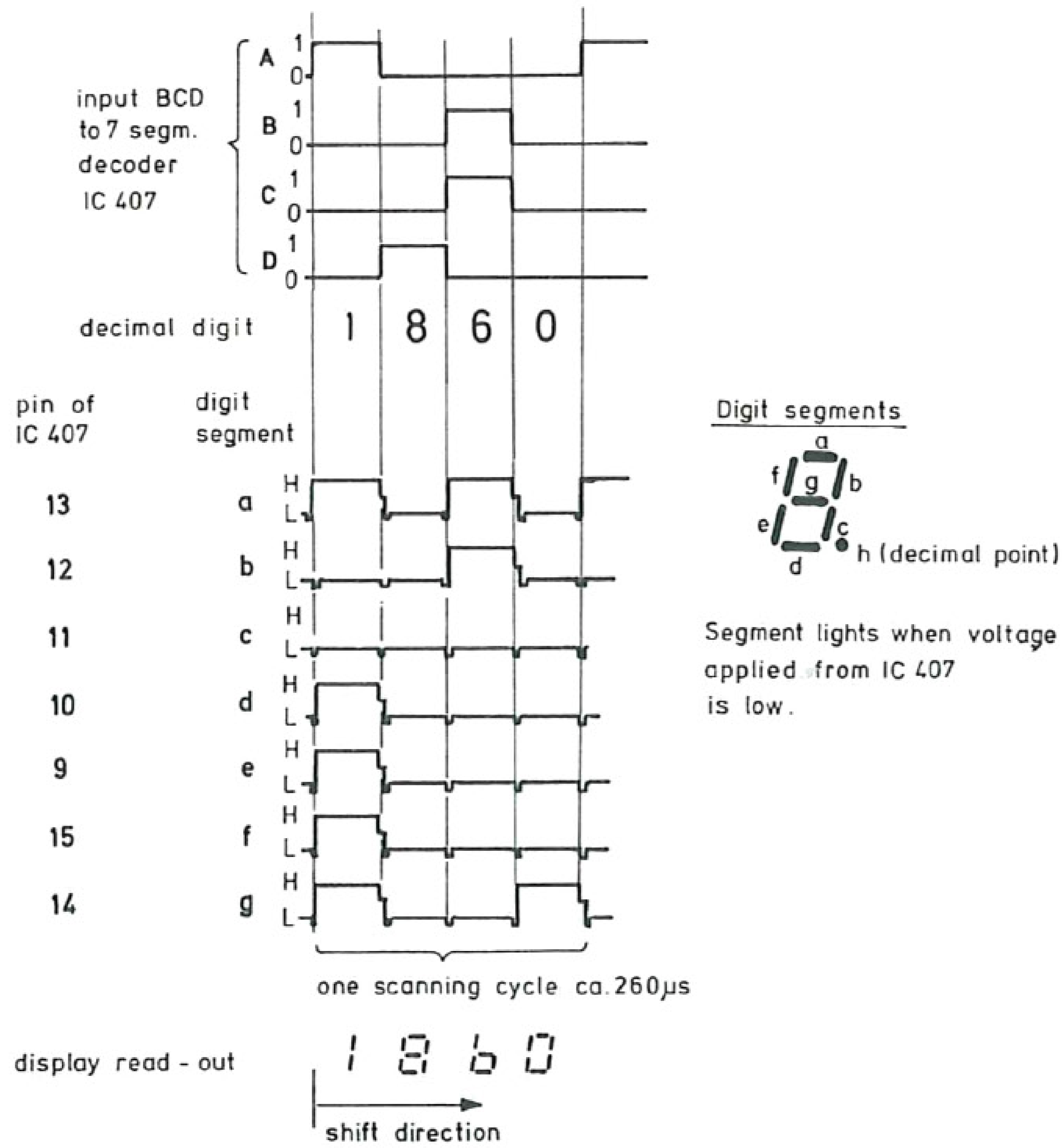


Fig. 4.1 - 9 Timing diagram of display presentation

4.1.8. LED and decimal point control

In frequency measuring mode of the DVM in LIN mode 7 and in LOG mode 8 combinations of dimension and decimal point (DP) indications are possible (see table fig. 4.1 - 10).
In **LIN mode** frequency range is switched by SK 82/3 and coded by IC 412 - 413. This binary dimension pattern controls data input B of full adder IC 409. A permanent logic 3 is applied via OR gate 408.3/4 to the A input. Range out of DVM 405 is inefficient because 408.9 is set to high level.

In **LOG mode** OR gate 408 is switched off (408.9 L). Automatic range changing capability of DVM is used via BCD range out. Outputs DVM 405.7/6/5 are controlling 408 to give additional 2 bit information for ranging the LED and DP control at full adder 409.7/5 and simultaneously for measuring control via inverter TS 331/332 and coder 411 to switch one of the range FETs 338 - 342.

LIN mode	Freq. range	Decim. point	IC 409 input B	IC 409 input A	IC 410 output
–		200.0	– –	–	–
I	2 Hz	2.000	1110 ≙ 14	3	1 (17)*
II	20 Hz	20.00	1111 ≙ 15	3	2 (18)*
III	200 Hz	200.0	0000 ≙ 0	3	3
IV	2 kHz	2.000	0001 ≙ 1	3	4
V	20 kHz	20.00	0010 ≙ 2	3	5
VI	200 kHz	200.0	0011 ≙ 3	3	6
VII	2 MHz	2.000	0100 ≙ 4	3	7

LOG mode	Freq. range	Decim. point	IC 409 input B	IC 409 input	IC 410 output	
–		200.0	–			0
–	2 Hz	2.000	–		↑	1
–	20 Hz	20.00	–			2
I	200 Hz	200.0	0000 ≙ 0	0-3	0-3	3
II	2 kHz	2.000	0001 ≙ 1	0-3	1-4	4
III	20 kHz	20.00	0010 ≙ 2	0-3	2-5	5
IV	200 kHz	200.0	0011 ≙ 3	0-3	3-6	6
V	2 MHz	2.000	0100 ≙ 4	0-3	4-7	7

* Carry bit (value 16) unused

Fig. 4.1 - 10 Table LED and decimal point control

Error indication for unallowed combinations of settings (see 3.2.7) is done by LED 362. The error control logic 415, 416 releases multivibrator 416 and LED 362 starts flashing at a rate of ca. 5 Hz.

Examples for RANGE– and DP–logic

Freq. range VII, 2.000 MHz, LIN mode (see fig. 4.1 - 10):

U1/IC 413.1 H→U2/IC 409.7/5/2 H IC 410.4 H (output 7);
a) IC 413.6 H IC 415.6 L LED 360 (MHz) active
b) IC 412.6 H IC 414.6 L DP display U3/411 active.

Freq. range V, 2.000 MHz, LOG mode (see fig. 4.1 - 10):

U1/IC 413.1 H →U1/IC 409.2 H, inputs A1, A2 adding binary value 0 - 3 from DVM,
IC 410.1/6/7/4 (outputs 4 - 7) H.

Examples for ERROR–logic

MODE	TERMINAL/LEVEL			
	IC 415 .1.2.9.10.11.12.13	IC 416 .1.2.3.4.5.8.9.10.11.12.13	415/U2 .12.13	LED 362
LOG 2 Hz	L H H H L H L	H⎍⎍L H L H ⎍ L H H	⎍ ⎍	flash
LOG 20 Hz	L H H H H L L	H⎍⎍H L H ⎍ L H H	⎍ ⎍	flash
LOG/DUTY CYCLE	L H H H L L H	H⎍⎍H L H ⎍ L H H	⎍ ⎍	flash
LIN nor LOG	H L H L L L L	H⎍⎍L H H ⎍ H L L	⎍ ⎍	flash

4.1.9 Power amplifier

The power amplifier mainly consists of a 0 dB gain buffer stage, a voltage amplifier and an output stage.

Via AMPLITUDE potmeter 760 the selected signal is applied to the complementary input buffer 311, 312 followed by a voltage amplifier operating as a complementary cascode stage in push-pull arrangement. The following output stage consists of two darlington arrangements 317/319 and 318/320 which are complementary to each other. Feedback is performed by resistor 679 with parallel capacitor 521 to the inverting input of the voltage amplifier, resulting in an overall voltage gain of about 10 dB.

Output DC OFFSET is controlled by potmeter 660 via resistor 658 connected to the input of the voltage amplifier and can be set up to ±5 V. Resistors 648 and 685 are representing the 50 Ω impedance through which the power amplifier is driving the step attenuator which maintains this impedance for the different attenuation steps. For 600 Ω output impedance the attenuator output is serialised by resistor 879.

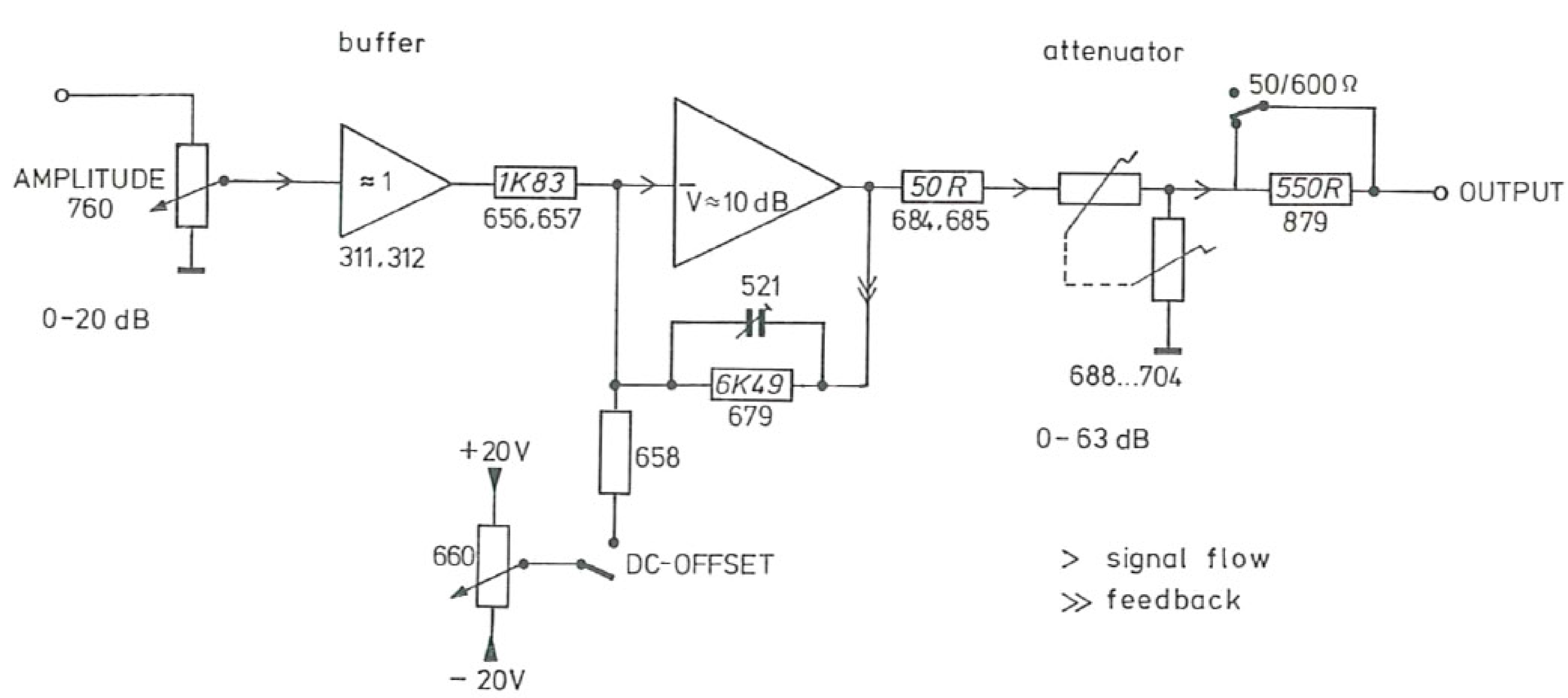


Fig. 4.1 - 11 Power amplifier and attenuator

4.1.10 Power supply

Three of the required five supply voltages are generated by voltage regulators: these are a fixed +5 V supply and two bipolar ±20 V supplies. The 20 V regulators are by-passed with resistors 888 and 889 reducing the regulator power dissipation. If solder joints +20A, +20B, +20C or -20A, -20B, -20C are opened for fault finding a 1 kΩ dummy load must be connected to the regulator output to avoid reverse output current fed from the by-pass resistors damaging the regulators.

Two additional voltages of ±23 V, only slightly stabilized are generated, used for the extended voltage range of the operational amplifiers in the control and measuring section and for the FET switches in the range control.

4.2. ACCESS TO PARTS

Before dismantling the instrument, the safety regulations in accordance with para. 2.1. must be strictly observed.

4.2.1. Cabinet, see 2.4.

4.2.2. Knobs

- Remove the cap from the knob.
- Unscrew the nut and remove the knob.
- When replacing the knob, ensure that the white mark is correctly aligned with the text plate markings.

4.2.3. Text plate

- Remove the cabinet, see 2.4.
- Remove the turn-knobs, see 4.2.2.
- Remove the plastic cover of the mains switch.
- The text plate can now be removed.
  Be careful:
  The textplate is fitted to the frontplate by double sided adhesive tape.

4.2.4. Pushbutton unit
Replacing a pushbutton lever.

The single pushbutton lever can be replaced from the front.

- Push the spring towards the pushbuttons.
- Remove the wire strap and/or lift the plastic reed between the contacts.
- Carefully tear the pushbutton lever out of the pushbutton.

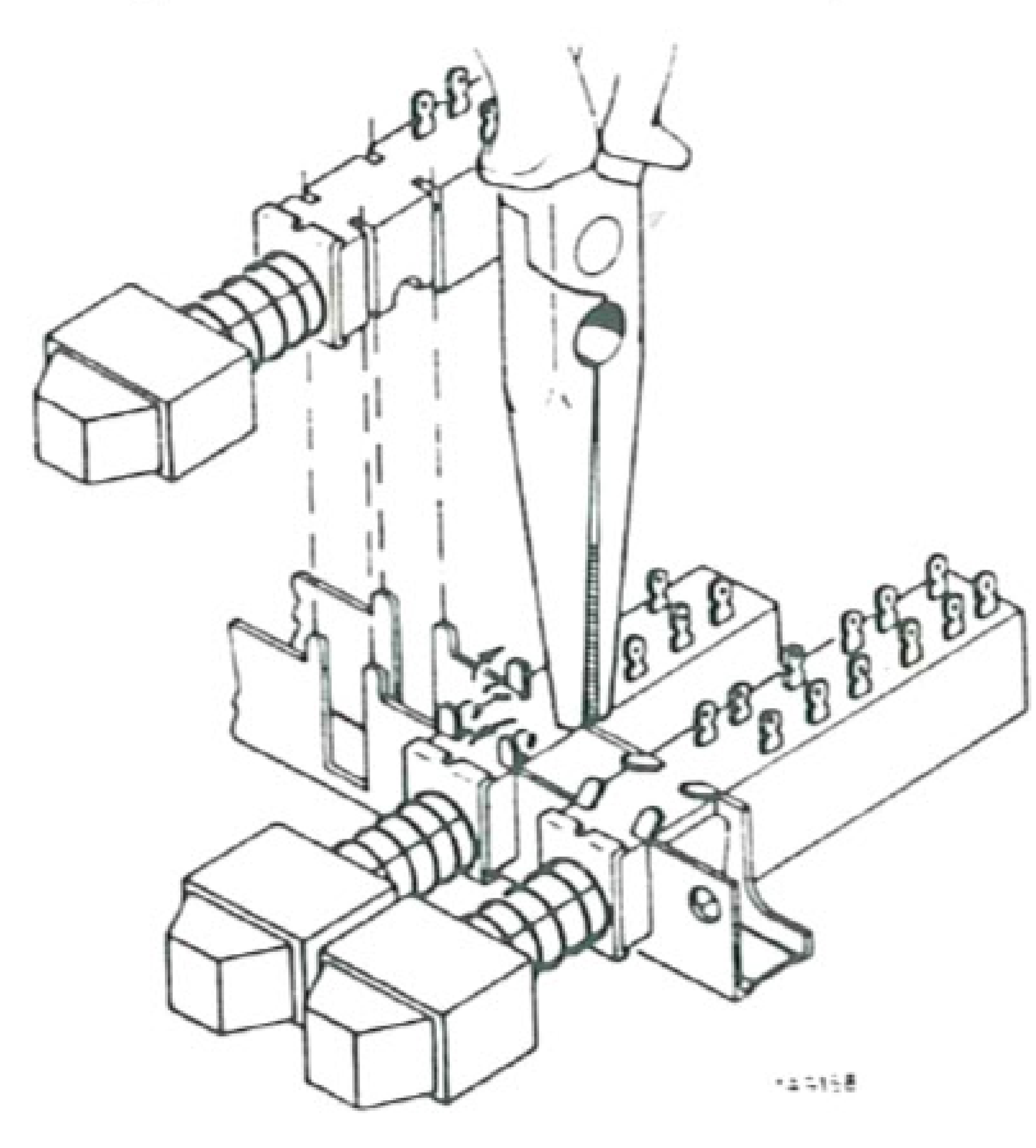
Replacing a switch of the pushbutton unit (see figure below)

- Straigten the 4 retaining lugs of the relevant switches as shown in the figure below.
- Break the body of the relevant switch by means of a pair of pliers and remove the pieces. The soldering pins are then accessible.
- Remove the soldering pins and clean the holes in the printed circuit board (e.g. with a suction soldering iron).
- Bend the 4 retaining lugs back to their original positions.
- Solder the new switch on to the printed circuit board.

Note: The pushbutton array for the attenuator 82/U2 must completely be desoldered before you can demount a single pushbutton.

4.2.5. Replacing a rotary switch

For the repair of defective rotary switches on Unit 1 complete switches must be replaced. Single switch-wafers are not available.



4.3. CHECK AND ADJUSTMENT

4.3.1. General

- The limits mentioned in this paragraph are valid only for a newly adjusted instrument and therefore might deviate from the values as stated in paragraph 1.2. "Technical Data".

- Adjustment of the instrument is only permitted after a warm-up time of at least 30 minutes at an ambient temperature of (+23 ±3)^{o} C and when connected to a mains voltage of 220 V ±5 %. The cabinet must be closed, i.e. a **special cover for adjustment** must be used with convenient access to the adjusting elements.

- If not explicitely stated otherwise, the voltage potentials refer to the relevant contact measured against circuit earth (⊥).

- The following abbreviations are used for setting and measuring instruments:

X	≙ Button pressed	
—	≙ Button not pressed/unlocked	
o	≙ Button only tipped	
rh	≙ extreme right-hand position	
lh	≙ extreme left-hand position	
m	≙ mid-position	
ml	≙ position in the middle between m and lh	
+	≙ LED, lighting	
*	≙ LED, flashing	
o—	≙ outputs, unloaded	
●—	≙ OUTPUT, terminated with 50 Ω, e.g. PM 9585; pushbutton 50 Ω/600 Ω unlocked	
◎	≙ double (coarse/fine) control	
⊤↓	≙ keep setting concerned	
Vac, Vdc	≙ Digital multimeter for a.c. and d.c. measurements, e.g. PM 2517	
OSC	≙ Oscilloscope	e.g. PM 3240, PM 3260
C	≙ Counter	e.g. PM 6622/02
Fg	≙ Function generator	e.g. PM 5132
DA	≙ Distortion analyzer	e.g. HP 334A
SA	≙ Spectrum analyzer	
50 Ω	≙ 50 Ω terminating resistor	e.g. PM 9585

4.3.2. Preparations

- All trimming potentiometers and capacitors in mid-position; (only for complete new adjustment).

- Solder joints A to K must be closed. To be opened for failure detection only.

- Terminate the OUTPUT by a 50 Ω resistor, if not stated otherwise.

4.3.3. General functional test

- Set the instrument to POWER ON

- Adjust power supply according to seq. 1.1 to 1.5 of the following table

- Actuate all controls for rough functional test of the generator and check all input and output sockets.

4.3.4. Table of checks and adjustments

Seq.	MODE	FREQ RANGE Hz	FREQUENCY START	FREQUENCY STOP	LIN	LOG	MOD/SWEEP PERIOD s	MOD/SWEEP PERIOD PERIOD	sweep control HOLD	sweep control RESET	sweep control CONT STDBY	sweep control TRIG	S P
	86	87	610	630	82/1	82/2	85	780	81/1	81/2	81/3	81/4	7
1.													
1.1.													
1.2.													
1.3.													
1.4.													
2.1.	NORMAL	2 kHz		rh	×								
2.2.	NORMAL	20 kHz		rh	×								
2.3.													
2.4.													
2.5.					—	—							
3.1.	NORMAL	20 kHz		rh	×								
3.2.													
3.3.	NORMAL	20 kHz			—	—							
3.4.		20 kHz		rh	×								
3.5.		20 kHz		1 kHz	×								
3.6.		20 kHz											
3.7.		2 MHz / 200		rh / lh		×							
3.8.		20 kHz		lh (lh)		×							
3.9.		20 kHz		2.00 Hz		×							
3.10.		20 kHz		20.00 kHz		×							
4.1.		200		200.0 Hz	×								
4.2.		2 kHz		2.000 kHz	×								
4.3.		200 kHz		200.0 kHz	×								
4.4.		2 MHz		1.000 MHz	×								
4.5.		20 kHz		1 kHz 2 kHz 5 kHz 10 kHz 15 kHz	× × × × ×								
4.6.		2 MHz		200 kHz 500 kHz 1.0 MHz 1.5 MHz	× × × ×								
4.7.		200 kHz		20 kHz 2 kHz 200 Hz 20 Hz		× × × ×							
4.8.		20 kHz		10.00 kHz		×							
4.9.		20 kHz		10.00 kHz	×								
4.10.		20 kHz		10.0 kHz	×								
4.11.		20 kHz		10.0 kHz	×								

weep control				WAVE FORM			outputs							inputs		internal measurement		LED indicators					measured via: output; point	measuring instrument (see 4.3.1.)	measured value	adjustment, control pos.	remarks
OLD	RESET	CONT STDBY	TRIG	START PHASE	DC OFFSET		DUTY CYCLE 650 / DUTY CYCLE	AMPLI-TUDE 760 / ATTE-NUAT.	OUT-PUT 807 / 50 Ω 600 Ω	TTL	PEN LIFT	INT MOD OUTPUT	FREQ.CONT VOLT	SWEEP/FM	TRIG & BURST	FREQ AMPL	display	STOP	RUN	START	Vpp	ERROR					
1/1	81/2	81/3	81/4	700	660	84	82/3	82/1-4 U2	82/4	805	806	804	802	801	803	81 U2		354	355	356	361	362					
																							+20 A	Vdc	20,0 ±0.05 V	882	power supply
																							-20 A	Vdc	-20.0 ±0,05 V	885	opened solder joints
																							+5 A	Vdc	5 V ±0,25 V		must be loaded with
																							+23	Vdc	23,6 ±0.4 V		1 kΩ
																							-23	Vdc	-23.6 ±0.4 V		
																							R817/818	Vac	2,89 Vrms/±1 digit	837	~ amplitude RMS measurement
																							R817/818	Vdc	±0,5 mV	830	~ offset
																							TP406/U1	Vdc	0 ±1 mV	701	offset OP 406
																							TP407/U1	Vdc	0 ±1 mV	703	offset OP 407
																							TP709/U1	Vdc	136 mV/±2 mV	718	thermostat ϑ_u= 23° C, $\Delta V / \vartheta_u$ = 2.7 mV/K
										o													TTL OUT	C	20 kHz/±0.2 kHz	697	int. control voltage; STOP FREQ. fine in mid pos.
						DC										x	00.00				x				00.00	616/U2	display offset; adjust display to zero
										o							20.00 kHz	x				x	TTL OUT	C	20 kHz/±20 Hz	603/U2	display final value, adjust to 2000
										o							20.00 kHz	x						C	20 kHz/±20 Hz	754	LIN final value, adjust to 2000
										o							1.00 kHz	x						C	1 kHz/±1 Hz	744	LIN initial value
							50 %			o							20.00 kHz	x						C	20 kHz/±20 Hz	732	duty cycle; final value
																	2.000 MHz	x					display				control of dimensions
																	/						display				and d.p. ranging
																	200.0 Hz	x									
																	00.20 Hz	x							00.20 Hz	689	basic LOG value
																	200 Hz	x							200 Hz	696	LOG slope; apply DC +2,0 V at SWEEP Input
																	20.00 kHz	x							20.00 kHz	693	final LOG value; tune STOP FREQ with
																											unlocked button LOG, then adjust in position LOG
										o							200.0 Hz	x					TTL OUT	C	5,00 ms/±10 µs	526	FREQ. RANGE I/III fixed adjustm.
										o							2.000 kHz	x						C	500 µs/±1 µs	529	FREQ. RANGE IV fixed adjustm.
										o							200.0 kHz	x						C	200 kHz/±200 Hz	535	FREQ. RANGE VI
										o							1.000 MHz	x						C	1,00 MHz/±1kHz	537	FREQ. RANGE VII
																	01.00 kHz	x						C	Tol.		display control:
																	2.00 kHz	x							±1 % ±1 digit		1; 2; 5; 10; 15 kHz
										o							5.00 kHz	x									
																	10.00 kHz	x									
																	15.00 kHz	x									
																	0.200 MHz	x									
										o							0.500 MHz	x						C	Tol.		display control:
																	1.000 MHz	x							< 2 % ±1 digit		0,2; 0,5; 1,0; 1,5 MHz
																	1.500 MHz	x									
																	20.00 kHz	x						C	Tol.		display control:
										o							2.000 kHz	x							< 1 % ±1 digit		20 K, 2 K, 200 Hz, 20 Hz
																	200.0 Hz	x									
																	20.00 Hz	x									
										o							10.00 kHz	x						C	Δ f/f ±9 ... 11 %		fine tuning
										o							10.00 kHz	x							Δ f/f +20 ... 30 %		fine tuning (only pos. direction)
							x			o							10.00 kHz	x						C	10 kHz ±0.5 kHz		duty cycle
							10 %																		9 ... 11 %		
							x			o							10.00 kHz							C	10 kHz ±0.5 kHz		duty cycle
							90 %																		89 ... 91 %		

red via: ; point	measuring instrument (see 4.3.1.)	measured value	adjustment, control pos.	remarks
START 610/E	OSC	0 ±20 mV	646	SWEEP CONT adjustment of neg. peak value
STOP 630/E	OSC	0 ±20 mV	649	(limit scope input by diode AAZ)
STOP 630/E	Vdc	0 ±20 mV	608	sweep stand by
OD OUT	C	50 ms ±0.5 ms	612	sweep period
↓	C	1,00 s ±0,200 s		
	C	5 ms ±50 µs		
	C	500 ms ±50 ms		
	C	5 s ±0.5 s		
/LED				when switching from NORMAL to SWEEP control START/STOP FREQ of display and LED indicators STOP and START TRIG button → RUN LED HOLD button → Sweep stops RESET button → return to START LIN nor LOG → ERROR LED
		f < 120 Hz > 1980 Hz		START FREQ
		Δf/f ±9 . . . 11 %		START FREQ fine
T	OSC		777	symmetry of START PHASE range
	OSC			start single BURST by button TRIG
	OSC			start single cycle by button TRIG
	OSC			ext. BURST } apply TTL-signal f=50Hz
	OSC			BURST, ext. tiggered } to input TRIG&BURST
	OSC	overshoot <10%		ext. BURST fmax; apply TTL signal 100 kHz
T OUT	OSC	+0,3 ±0,2 V/> +15V		sweep/fly-back
D OUT	OSC	o		INT. MOD OUTPUT
		∿ 5 Vpp		
		⊓ 5 Vpp		
ONT VOLT	Vdc	5 V ±0,15 V		FREQ. CONTROL VOLTAGE OUTPUT
	OSC	∿ 5 Vpp		
		2.000 kHz/±40 Hz		SWEEP/FM INPUT, apply 4.75 Vdc
T	OSC	High > 2.8 V Low < 0.4 V		TTL OUTPUT
	Vdc	< 30 mV	654	power amplifier, offset adj.
	DA	k < 0.25 %	863/868	distortion
	Vdc	< 30 mV	873	sine shaper, offset adj.
	Vac	>7,07 Vrms		sine wave, RMS measurement
	Vac	5 Vrms/±0.05Vrms *	846	square wave, neg. half wave *(RMS-measurement, sine wave 7.07 Vrms)
	Vac	5 Vrms/±0.05Vrms *	841	square wave, pos. half wave *(RMS-measurement at sine wave 7,07 Vrms)
TPUT	OSC		521	power ampl., optimize adjust rise time/less overshoot
	OSC	< 50 ns		rise time
	Vac	7.07 Vrms *		control waveform
		5,77 ±0.2 V		(* RMS-measurement at sine wave 7.07 Vrms)
		10 V ±0.2 V		
TPUT	Vac	< 2 % < 1 MHz *3	866	amplitude response sine wave / *3 < 6 % < 2 MHz
	Vdc	-5 V ±0.5 V		DC-offset tuning
		+5 V ±0.5 V		
nd	Vac	Vrms	853	display Vpp; lower basic value } adj. DVM to measured open-circuit voltage 1 Vrms = 2,83 Vpp
	Vac	Vrms	852	display Vpp; upper basic value
UTPUT	Vac	3.54±0.06Vrms		output impedance 600 Ω, load 600 Ω
	Vac	3 ±0.2 dB		control ATTENUATOR
		10 ±0.2 dB		
		20 ±0.2 dB		
		30 ±0.2 dB		

4.4. SAFETY INSPECTION AND TESTS AFTER REPAIR AND MAINTENANCE IN THE PRIMARY CIRCUIT

4.4.1. General directives

- Take care that creepage distance and clearances have not been reduced
- Before soldering, wires:
  should be bent through the holes of solder tags, or wrapped round the tag in the form of an open U, or, wiring ridigity shall be maintained by cable clamps or cable lacing.
- Replace all insulating guards and -plates.

4.4.2. Safety components

Components in the primary circuit may only be renewed by components selected by Philips, see also chapter 4.5.1.

4.4.3. Checking the protective earth connection

The correct connection and condition is checked by visual control and by measuring the resistance between the protective-lead connection at the plug and the cabinet/frame. The resistance shall not be more than 0.5 Ω. During measurement the mains cable should be moved. Resistance variations indicate a defect.

4.4.4. Checking the insulation resistance

Measure the insulation resistance at U = 500 Vdc between the mains connections and the protective lead connections. For this purpose set the mains switch to ON. The insulation resistance shall not be less than 2 MΩ.

Note:
2 MΩ is a minimum requirement at 40 ^{o}C and 95 % relative humidity. Under normal conditions the insulation resistance should be much higher (10 to 20 MΩ).

4.5. SPARE PARTS

4.5.1. General

Standard Parts
Electrical and mechanical parts replacement can be obtained through your local Philips organisation or representative. However, many of the standard electronic components can be obtained from other local suppliers. Before purchasing or ordering replacement parts, check the parts list for value, tolerance, rating and description.

NOTE:
Physical size and shape of a component may affect instrument performance, particularly at high frequencies. Always use direct-replacement components, unless it is known that a substitute will not degrade instrument performance.

Special Parts
In addition to the standard electronic components, some special components are used:

- Components, manufactured or selected by Philips to meet specific performance requirements.
- Components which are important for the safety of the instrument, marked with 'S' in the parts list.

ATTENTION:
Both type of components may only be replaced by components obtained through your local Philips organisation.

Seq.	MODE	FREQ RANGE Hz	FREQUENCY START	FREQUENCY STOP	LIN	LOG	MOD/SWEEP PERIOD s	PERIOD	sweep control HOLD	RESET	CONT STD BY	TRIG	START PHASE	DC OFFSET	WAVE FORM	outputs DUTY CYCLE 650 / DUTY CYCLE	AMPLI-TUDE 760 / ATTE-NUAT.	OUT-PUT 807 / 50 Ω 600 Ω	TTL	PEN LIFT	INT. MOD OUTP	FREQ CONT. VOLT	inputs SWEEP/FM	TRIG & BURST	internal measurement	FREQ display AMPL	LED indicators STOP	RUN	START	Vpp	ERROR	measured v output; po
	86	87	610	630	82/1	82/2	85	780	81/1	81/2	81/3	81/4	700	660	84	82/3	82/1-4 U2	82/4	805	806	804	802	801	803	81 U2		354	355	356	361	362	
5.1.	SWEEP						1 s	0.05																								potm. STA
5.2.	↓						1 s	0.05																								potm. STO
5.3.	↓						1 s	0.05			x																					potm. STO
5.4.	↓						1 s	0.05													o—											INT MOD
5.5.	↓						1 s	1													o—											↓
5.6.	↓						0.1 s	0.05													o—											↓
5.7.	↓						10 s	0.05													o—											↓
5.8.	↓						100 s	0.05													o—											↓
6.1.	NORMAL	2 kHz			x		10 s	1			x																x					display/LE
	SWEEP		lh	rh																												
																													x			
												x																x				
									x																							
										x																						
					—	—																										
																															x	
6.2.	SWEEP	2 kHz	lh								x															<0.120kHz						
			rh		x																					>1.980kHz						display
6.3.	SWEEP	2 kHz	1.000		x																					1.000 kHz						display
			kHz																													
7.1.	BURST	2 kHz		2.000 kHz	x		0.1 s	0.05					±π/2		∧∨		m	o—								2.000 kHz	x					OUTPUT
7.2.	BURST	2 kHz		2.000 kHz	x		10 s	0.05			x	x	o		↓		m	o—								2.000 kHz	x					↓
7.3.	SINGLE	200		200.0 Hz	x		0.1 s	0.05			x	x	o		↓		m	o—								200.0 Hz	x					↓
7.4.	NORMAL	2 kHz		2.000 kHz	x								o		↓		m	o—								2.000 kHz	x					↓
7.5.	BURST	2 kHz		2.000 kHz	x		0.1 s	0.05			x		o		↓		m	o—								2.000 kHz	x					↓
7.6.	NORMAL	2 MHz		2.000 MHz	x								o		↓		m	o—								2.000 MHz	x					↓
8.1.	SWEEP						0.1 s	0.05												o—								x				PEN LIFT
8.2.	NORMAL						0.1 s	0.05																			x					INT MOD
	SWEEP																											x				↓
	BURST																										x					↓
	SINGLE																										x					↓
8.3.	NORMAL		lh	rh	x		0.1 s	0.05														o—					x					FREQ CON
	SWEEP																											x				
8.4.	NORMAL	2 kHz		100 Hz	x																					2.000 kHz	x					display
8.5.	↓	2 kHz		rh	x														o—								x					TTL OUT
9.1.	↓														DC		rh	o—									x					OUTPUT
9.2.	↓	20 kHz		rh	x										∼		m	o—									x					↓
9.3.	↓	20 kHz		rh	x										∼		rh	o—									x					↓
9.4.	↓	20 kHz		rh	x										∼		rh	o—									x					↓
9.5.	↓	20 kHz		rh	x										⊓⊔			o—									x					↓
9.6.	↓	20 kHz		rh	x										⎍			o—									x					↓
9.7.	↓	200 kHz		rh	x										⊓⊔		m	●—									x					50 Ω OUTP
9.10.	↓	200 kHz		rh	x										⊓⊔		rh	●—									x					↓
9.11.	↓	20 kHz		rh	x										∼			o—									x					OUTPUT
	↓														∧∨																	
	↓														⊓⊔																	
9.12.	↓	2 MHz		lh/rh	x										∼		m	●—									x					50 Ω OUTPU
9.13.	↓													x	DC		rh	o--									x					OUTPUT
	↓													lh/rh																		
10.1.	↓	2 kHz		rh	x										∼		lh	o—							x					x		display and
10.2.	↓	2 kHz		rh	x										∼		rh	o—							x					x		OUTPUT
10.3.	↓	2 kHz		rh	x										∼		20.00	●—							x	20.00 Vpp				x		600 Ω OUTP
	↓																	x														
10.4.	↓	2 kHz		rh	x										∼		20.00	o—							x	20.00 Vpp				x		OUTPUT

4.5.2. Static sensitive components

This instrument contains electrical components that are susceptible to damage from static discharge. Servicing static-sensitive assemblies or components should be performed only at a static-free work station by qualified service personnel.

4.5.3. Handling MOS devices

Though all our MOS integrated circuits incorporate protection against electrostatic discharges, they can nevertheless be damaged by accidental over-voltages. In storing and handling them, the folowing precautions are recommended.

CAUTION:
Testing or handling and mounting call for special attention to personal safety. Personnel handling MOS devices should normally be connected to ground via a resistor.

4.5.4. Mechanical parts, miscellaneous, electrical parts not on units

Item	Fig.	Quantity	Order number	Description	
1	31	1	5322 447 44009	cover, grey	
1	31	1	5322 447 40049	cover, brown	
2	32	4	5322 462 40488	foot (bottom side), grey	
2	32	4	5322 462 10222	foot (bottm side), brown	
3	33	2	5322 520 34164	bearing bush	
4	33	2	5322 530 84075	spring	
5	33	2	5322 528 34101	rachet	
6	33	2	5322 532 54425	ring for handle, grey	
6	33	2	5322 532 51481	ring for handle, brown	
7	33	2	5322 498 54048	arm for handle	
8		1	5322 498 54051	carrying handle	
9	33	2	5322 414 64053	knob, grey	
9	33	2	5322 414 30043	knob, brown	
10		4	5322 462 44176	foot (rear side)	
11		1	5322 502 14164	coin-slot crew (rear side)	
12		1	4822 530 70124	locking washer (rear side)	
13		7	5322 532 51309	insulating bush for BNC socket	
14		1	5322 455 71005	textplate, grey	
15	34	1	5322 321 14048	mains cable 1850	*S
16	34	1	5322 401 14048	cable clamp	*S
17	34	1	5322 325 54067	lead through	*S
18	34	1	5322 325 60119	pull relief	
19		4	5322 462 34125	print holder/U1	
20		2	5322 462 34115	print holder/U2	
100		1	4822 253 30013	fuse 250 mAT	*S
-		1	4822 253 30017	fuse 500 mAT	*S
21	31	7	5322 414 74015	cap for knob, small, grey	
21	31	7	5322 414 70016	cap for knob small, brown	
22	31	4	5322 414 74019	cap for knob big, grey	
22	31	4	5322 414 70015	cap for knob big, brown	

*S = Safety component

Item	Fig.	Quantity	Order number	Description
23		13	5322 414 25851	knob for pushbutton, grey
23		13	5322 414 20033	knob for pushbutton, brown
24		5	5322 414 34075	knob pos. 650, grey
24		5	5322 414 30053	knob pos. 650, brown
25		2	5322 414 34096	knob pos. 610, 10 mmØ ,grey
25		2	5322 414 30041	knob pos. 610, 10 mmØ ,brown
26		4	5322 414 34239	knob pos. 84-87, grey
26		4	5322 414 30071	knob pos. 84-87, brown
27		2	5322 414 34136	knob pos. 610/630, 14 mmØ , grey
27		2	5322 414 30037	knob pos. 610/630, 14 mmØ , brown
28		7	5322 267 10004	BNC connector
29		-	5322 390 24013	silicon paste DC 340
80		1	5322 146 20672	mains transformer *S
83		1	5322 276 14433	mains switch *S
590		1	5322 121 44028	capacitor XY 0.01MU 2x2N5 *S
30		1	5322 450 60217	window
31		1	5322 255 40263	heat sink, unit 1
32		4	5322 255 40286	heat sink, unit 1
33		6	5322 255 40264	heat sink, unit 2
34		2	5322 526 10015	damping bead 3.5 x 3 mm
35		1	5322 526 10212	damping bead 3.5 x 7.5 mm
36		1	5322 255 44047	IC-socket, 28 pole, U2
37		2	5322 255 44107	IC-socket, 16 pole, U1
81/1/2		2	5322 276 10959	pushbutton switch U1
81/3		1	5322 276 10961	pushbutton switch U1
81/4		1	5322 276 10959	pushbutton switch U1
82/1		1	5322 276 11001	pushbutton switch U1
82/2		1	5322 276 10999	pushbutton switch U1
82/3		1	5322 276 10961	pushbutton switch U1
82/4		1	5322 276 14221	pushbutton switch U1
81		1	5322 276 10962	pushbutton switch U2
82		1	5322 276 40292	pushbutton switch U2
84		1	5322 273 60127	rotary switch
85		1	5322 273 64059	rotary switch
86		1	5322 273 60128	rotary switch
87		1	5322 273 60129	rotary switch
500	36	1	5322 121 41554	capacitor 100N/50 V
501	36	1	4822 122 31316	capacitor 100P/100 V
610, 630	36	2	5322 102 10182	carbon potm. 1k0+4k7, ≤ series/03
610, 630	36	2	5322 101 20669	carbon potm. 4k7+4k7, > series/03
620, 640	36	2	5322 116 54059	resistor 11 Ohm MR25, ≤ series/03
620, 640	36	2	5322 116 50511	resistor 48.7 Ohm, > series/03
650	36	1	5322 103 64043	potmeter 5k0/5
660	36	1	5322 101 64012	potmeter 47 kOhm/lin.+ switch
700	36	1	4822 101 20441	carbon potm. 10 kOhm lin.
750	36	1	5322 116 54459	resistor 75 Ohm MR25
760	36	1	5322 102 10183	carbon potm. 1k0+1k0
770	36	1	5322 116 54448	resistor 59 Ohm MR25
780	36	1	4822 101 20416	carbon potm. 4k7/lin.
880	36	1	5322 116 51268	resistor 100 kOhm MR25
890	36	1	5322 116 50511	resistor 48.7 Ohm MR25
892	40	1	5322 116 51279	resistor 1 MOhm MR30

*S = Safety component

4.5.5. Electrical parts

UNIT 1

Some parts are listed in chapter 4.5.4.
All metal film resistors not listed are of type MR25+ 1% 0,4 W
(ordering code see end of this list)

TRANSISTORS/U1

301,302,304	4822 130 44568	BC557B
303,305,306	4822 130 40959	BC547B
307,311,313	4822 130 44197	BC558B
308,309,312	4822 130 40937	BC548B
314,316,317	4822 130 40937	BC548B
315,319	4822 130 44568	BC557B
318	4822 130 41095	BC337-16
321	4822 130 40959	BC547B
322,327,329	4822 130 40937	BC548B
323-326	4822 130 44197	BC558B
328,336,337	5322 130 44499	BF245A
331-333	4822 130 44568	BC557B
334,335	4822 130 40937	BC548B
338-342	5322 130 34044	BSV80
351-353	4822 130 44197	BC558
354,375	4822 130 44237	BF450
355,356	5322 130 44322	BCY78/X
357,358	5322 130 44453	BCY59/X
359	4822 130 40959	BC547B
361,364	4822 130 44568	BC557B
362	5322 130 44499	BF245A
363,367,391	4822 130 40937	BC548B
365,366	5322 130 44034	2N2219A
368,369,392	4822 130 44197	BC558B
371,372,381	4822 130 44568	BC557B
373	4822 130 41705	BSX20
374	5322 130 44127	2N2894A
376	4822 130 40902	BF240
382	4822 130 40959	BC547B

INTEGRATED CIRCUITS/U1

224	5322 209 85565	UA78GCU1
225	5322 209 86349	UA79GCU1
401	5322 209 85512	MC1458N
402	5322 209 86355	LF355N
403,424	4822 209 80617	MUA741CN
404	5322 209 85201	N74LS132A
405	4822 209 80587	LM324N
406,407,410	5322 209 84688	MC1456N
408	4822 209 80587	LM324N
409	5322 209 85461	CA3183E
411	5322 209 14056	HEF4028BP
412	5322 209 14054	HEF4081BP
413,414	5322 209 14074	HEF4072BP
415	5322 209 14067	HEF4075BP
416	5322 209 14046	HEF4011BP
421	5322 209 84823	N74LS00N
422	4822 209 80783	N74LS04N
423	5322 209 85461	CA3183E
431	5322 209 84778	OQ0011
441	5322 209 84841	UA7805CU

DIODES/U1

451,453	4822 130 34233	BZX79-B5V1
452	4822 130 30229	AAZ15
454,455	5322 130 34321	IN4151
456,463,471	4822 130 34297	BZX79-C10
457,459-462	5322 130 34321	1N4151
458	4822 130 34173	BZX79-C5V6
464,478	5322 130 34294	BZV11
465,466	5322 130 34321	1N4151
467	4822 130 31111	BZX79-C6V2
468,484	4822 130 34047	BZX75-C1V4
469	4822 130 34382	BZX79-B8V2
472-474,477	5322 130 34321	1N4151
475,476	4822 130 34197	BZX79-B12
479	4822 130 34281	BZX59-B15
481-483	5322 130 34321	1N4151
485,486	4822 130 34379	BZX79-B10
487	4822 130 34047	BZX75-C1V4
488	4822 130 30229	AAZ15
491,492	4822 130 34328	BZX79-B11
495,496	4822 130 31346	BZX79-C4V3
497-499	5322 130 32031	SKB2/08L5A,RECTIFIER

CAPACITORS/U1

ITEM	ORDERING NUMBER	FARAD	TOL %/VAL	VOLTS	REMARKS
501	4822 122 30103	22N	-20+80	63V	CERAMIC PLATE
502,503	4822 122 30027	1NO	10	100V	CERAMIC PLATE
504	5322 121 54108	47N	1	63V	POLYESTER FOIL
505	5322 121 41533	470N	5	100V	" "
506	5322 121 50829	4MU7	5	100V	" "
507,518	4822 122 30034	470P	10	100V	CERAMIC PLATE
508,509	4822 122 30027	1NO	10	100V	" "
511-513	4822 122 31413	150P	2	100V	" "
514,520	4822 122 30103	22N	-20+80	63V	" "
515,522	4822 124 20698	22MU		25V	ELECTROLYTIC
516	4822 124 20671	68MU		6.3V	"
517	4822 121 40232	220N	10	100V	POLYESTER FOIL
519	4822 122 30114	2N2	10	100V	CERAMIC PLATE
521,524	4822 122 30128	4N7	10	100V	" "
523,525	4822 122 30034	470P	10	100V	" "
527	5322 121 44246	2MU2	5	100V	POLYESTER FOIL
528	4822 121 40231	150N	10	100V	POLYESTER FOIL
531	5322 121 50848	140N	1	63V	" "
532	5322 121 54124	100N	1	63V	" "
533	5322 121 50846	24N9	1	63V	" "
534	5322 121 50847	2N37	1	125V	" "
535	5322 125 50183	11-120P		250V	TRIMMER
536	4822 122 31413	150P	2	100V	CERAMIC PLATE
537	5322 125 54038	5.5-40P		100V	TRIMMER
538	4822 122 31069	39P	2	100V	CERAMIC PLATE
539,541	4822 122 31316	100P	2	100V	" "
542	4822 124 20678	47MU		10V	ELECTROLYTIC
543,545	4822 122 30103	22N	-20+80	63V	CERAMIC PLATE
544	4822 122 31054	10P	2	100V	" "
546	4822 122 31063	22P	2	100V	" "
547	4822 122 31058	15P	2	100V	" "
548	4822 122 31521	56P	2	100V	" "
549	5322 122 32053	4P7	0,25	100V	" "

ITEM	ORDERING NUMBER	FARAD	TOL %/VAL	VOLTS	REMARKS
551,556	4822 122 30103	22N	-20+80	63V	CERAMIC PLATE
552	4822 122 30034	470P	10	100V	" "
553	4822 122 30043	10N	-20+80	63V	" "
554,555	4822 122 30128	4N7	10	100V	" "
561	5322 121 40323	100N	10	100V	POLYESTER FOIL
562,563	4822 122 30103	22N	-20+80	63V	CERAMIC PLATE
564	4822 122 31054	10P	2	100V	" "
581	4822 124 20697	10MU		25V	ELECTROLYTIC
582	4822 121 40232	220N	10	100V	POLYESTER FOIL
583	4822 124 20722	1MU		63V	ELECTROLYTIC
584,585	4822 124 20678	47MU		10V	"
586-588	4822 121 40232	220N	10	100V	POLYESTER FOIL
591	4822 124 20779	2200MU		16V	ELECTROLYTIC
592,593	4822 124 20798	3300MU		40V	"
594-596	4822 121 40232	220N	10	100V	POLYESTER FOIL

RESISTORS/U1

All metal film resistors not listed are of type MR25 ±1% 0.4W (ordering code see page 4-29)

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
608,649	4822 100 10037	1K0		LIN	POTM.TRIMMING
612	4822 100 10029	2K2		LIN	" "
625	4822 100 10051	22K		LIN	" "
646,701,703	4822 100 10079	47K		LIN	" "
654,655	5322 116 50748	10K	0.1	MR25	METAL FILM
658	5322 116 55183	20K5	0.1	MR25	" "
659	5322 116 54165	6K81	0.1	MR25	" "
661,666	5322 116 55034	10K5	0.1	MR25	" "
689	5322 101 14008	2K2		LIN	POTM.TRIMMING
693	5322 101 10372	10K		LIN	" "
696,718	5322 101 14051	220E		LIN	" "
697,732	5322 101 14047	470E		LIN	" "
698	5322 116 55146	1K87	0.1	MR25	METAL FILM
705,726	5322 116 54995	237E	0.1	MR25	" "
721,758	5322 116 54888	20K	0.1	MR25	" "
722,757	5322 116 54064	2K0	0.1	MR25	" "
723, 756	5322 116 51496	200E	0.1	MR54	" "
740	4822 110 72214	10MA	5	VR25	HIGH VOLT.RESISTOR
744	4822 100 10079	47K		LIN	POTM.TRIMMING
748	5322 116 54169	191E	0.1	MR25	METAL FILM
751	5322 116 54292	1K69	0.1	MR25	" "
752	5322 116 54833	16K9	0.1	MR25	" "
753	5322 116 51495	169K	0.1	MR25	" "
754,830	5322 101 14011	100E		LIN	POTM.TRIMMING
759	5322 111 90137	10K			RESISTOR-NETW.
777	4822 100 10075	100E		LIN	POTM.TRIMMING
803	4822 116 51105	470E	5	PR37	HIGH VOLT.RESISTOR
818	5322 116 54286	1K21	0.1	MR25	METAL FILM
819	5322 116 51494	806E	0.1	MR25	" "
828	5322 116 50267	200E	0.1	MR25	" "
829,836	5322 116 54288	590E	0.1	MR25	" "
831	5322 116 54755	287E	0.1	MR25	" "
832	5322 116 50956	562E	0.1	MR25	" "

ITEM	ORDERING NUMBER	OHM	TOL (%)	TYPE	REMARKS
837,853	5322 101 14011	100E		LIN	POTM.TRIMMING
841,846	4822 100 10038	470E		LIN	" "
852	4822 100 10254	1K0		LIN	" "
856,857	5322 116 50748	10K	0.1	MR25	METAL FILM
863,868,882	4822 100 10038	470E		LIN	POTM.TRIMMING
866	4822 100 10035	10K		LIN	" "
873	4822 100 10075	100E		LIN	" "
885	4822 100 10019	220E		LIN	" "
888,889	4822 112 21076	68E	5	WR0617	W.-W.RESISTOR

COILS/U1

894	5322 158 10276	COIL,4.7MUH
895	5322 158 10283	COIL,150MUH
896	5322 158 10132	COIL,FXC-BROADBAND

U N I T 2

TRANSISTORS/U2

301	5322 130 44452	BFQ11,FET
302-305	4822 130 40988	BC328-25
311,314,318	4822 130 44568	BC557B
312,313,317	4822 130 40959	BC547B
315,320	5322 130 40468	2N2905A
316,319	5322 130 44034	2N2219A

DIODES/U2

351,352	4822 130 34297	BZX79-C10
353	5322 130 34397	BZX93
361	4822 130 34048	BZX79-C2V8
362,363	5322 130 34321	1N4151

INTEGRATED CIRCUITS/U2

401,402	5322 209 86355	LF355N
403	4822 209 80617	MUA741CN
404	5322 209 85512	MC1458N
405	5322 209 10212	HEF4739VP/RI
406,414,415	5322 209 84994	N74LS05N
407	5322 209 86282	N7447AN
408	5322 209 14053	HEF4071BP
409	5322 209 14214	HEF4008BP
410	5322 209 14056	HEF4028BP
411	5322 209 85312	N74LS02N
412,413	5322 209 14067	HEF4075BP

CAPACITORS/U2

ITEM	ORDERING NUMBER	FARAD	TOL %/VAL	VOLTS	REMARKS
501,502	4822 124 20679	100MU		10V	ELECTROLYTIC
503,506	4822 122 30103	22N	-20+80	63	CERAMIC PLATE
504	4822 121 50566	1N0	1	250V	POLYESTER FOIL
505	4822 122 30034	470P	10	100V	CERAMIC PLATE
507	4822 124 40167	220MU		6.3V	ELECTROLYTIC

ITEM	ORDERING NUMBER	FARAD	TOL %/VAL	VOLTS	REMARKS
511,513	4822 124 20704	220MU		25V	ELECTROLYTIC
512,514	4822 122 30103	22N	-20+80	63V	CERAMIC PLATE
515,516	4822 122 31045	4P7	0.25	100V	" "
517,518	4822 122 30103	22N	-20+80	63V	" "
519,520	4822 122 30128	4N7	10	100V	" "
521	4822 125 50077	1.4-5.5P		100V	TRIMMER
522,523	4822 122 30103	22N	-20+80	63V	CERAMIC PLATE
524	4822 122 30104	1P0	0.25	100V	" "

RESISTORS/U2

ITEM	ORDERING NUMBER	OHM	TOL(%)	TYPE	REMARKS
601,604-608	5322 116 54285	19K6	0.1	MR25	METAL FILM
602	5332 116 51392	30K1	0.1	MR25	" "
603	5322 101 14069	22K		LIN	POTM.TRIMMING
609,614	5322 116 54892	200K	0.1	MR30	METAL FILM
612	5322 116 55033	1K05	0.1	MR25	" "
613	5322 116 54292	1K69	0.1	MR25	" "
615,617	5322 116 55036	12K1	0.1	MR25	" "
616	4822 100 10037	1K0		LIN	POTM.TRIMMING
622	5322 116 54227	100K	0.1	MR25	METAL FILM
654	5322 101 14048	47K		LIN	POTM.TRIMMING
663	5322 116 51497	649E	1	MR25	METAL FILM
682,687	5322 116 54396	68R	5	PR52	POWER METAL FILM
684,685	5322 116 50286	100E	1	MR54C	METAL FILM

COILS/U2

751	5322 158 10271	COIL, FXC-BROADBAND
752	5322 158 10276	COIL,4.7MUH

U N I T 3

DIODES/U3

354-362	4822 130 30914	CQY54,LED
366	5322 130 34321	1N4151

DISPLAY/U3

409-413	5322 130 34389	HP5082-7730,DISPLAY

LACQUERED METAL FILM RESISTORS MR25

style	resistance range	tol. ±%	series	temperature coefficient ±ppm/°C	limiting voltage (r.m.s.) V	service code no. 5322 116 5.... followed by
MR 25	4,99 Ω – 301 kΩ	1	E96	50 *	250	

* For resistance values lower than 49,9 Ω: 100 ppm/°C.

4,99	0568	16,5	4109	54,9	4445	182	4493	604	4528
5,11	4192	16,9	0627	56,2	4446	187	4494	619	4529
5,23	4113	17,4	4432	57,6	4447	191	4495	634	4531
5,36	4239	17,8	0418	59	4448	196	0676	649	4532
5,49	4102	18,2	4083	60,4	4449	200	4496	665	4533
5,62	4128	18,7	0895	61,9	4451	205	0669	681	4534
5,76	4413	19,1	4104	63,4	4375	210	4036	698	4037
5,90	1064	19,6	0473	64,9	4453	215	0457	715	0571
6,04	4114	20	1048	66,5	4454	221	4002	732	4535
6,19	1049	20,5	0678	68,1	4455	226	4497	750	4536
6,34	0862	21	4433	69,8	4456	232	4498	768	4537
6,49	4112	21,5	0677	71,5	4457	237	0679	787	4538
6,65	4414	22,1	0983	73,2	4458	243	0437	806	4539
6,81	4013	22,6	0491	75	4459	249	4499	825	4541
6,98	4103	23,2	4434	76,8	0494	255	4501	845	4542
7,15	4415	23,7	4014	78,7	0578	261	4502	866	4543
7,32	4416	24,3	4435	80,6	4461	267	4503	887	4544
7,50	4417	24,9	0903	82,5	4462	274	4504	909	4545
7,68	4418	25,5	4436	84,5	4463	280	4505	931	4546
7,87	4046	26,1	0876	86,6	4464	287	4506	953	4547
8,06	4419	26,7	4067	88,7	4465	294	4507	976	4548
8,25	4099	27,4	0493	90,9	4466	301	4508	1K	4549
8,45	4421	28	0623	93,1	4467	309	4509	1K02	4551
8,66	1051	28,7	4068	95,3	0569	316	4511	1K05	4552
8,87	4101	29,4	4084	97,6	4468	324	4512	1K07	4553
9,09	0863	30,1	0904	100	4469	332	4513	1K1	4554
9,31	4422	30,9	4437	102	4471	340	4514	1K13	4555
9,53	4258	31,6	4034	105	4472	348	4515	1K15	0415
9,76	4423	32,4	4105	107	4473	357	0603	1K18	4556
10	0452	33,2	0527	110	4474	365	4516	1K21	4557
10,2	4111	34	4438	113	4475	374	4517	1K24	4559
10,5	4071	34,8	4027	115	4476	383	4518	1K27	0555
10,7	4424	35,7	4439	118	4477	392	4006	1K3	0526
11	4059	36,5	0409	121	4426	402	4519	1K33	4561
11,3	4425	37,4	4158	124	4478	412	4521	1K37	0628
11,5	0838	38,3	0954	127	4479	422	0459	1K4	4562
11,8	0738	39,2	4087	130	4481	432	4522	1K43	4563
12,1	4069	40,2	0926	133	4482	442	0592	1K47	0635
12,4	4427	41,2	4108	137	4483	453	4523	1K5	4564
12,7	4261	42,2	1052	140	4484	464	0536	1K54	0586
13	4082	43,2	0519	143	4485	475	4007	1K58	0622
13,3	1047	44,2	0818	147	0766	487	0508	1K62	4565
13,7	4428	45,3	0795	150	4486	499	4524	1K65	4566
14	0839	46,4	0492	154	0506	511	4525	1K69	4567
14,3	4429	47,5	0952	158	4487	523	4526	1K74	0629
14,7	0412	48,7	0511	162	0417	536	0621	1K78	5015
15	0902	49,9	4441	165	4488	549	0732	1K82	4568
15,4	0925	51,1	4442	169	4489	562	4009	1K87	0728
15,8	0861	52,3	4443	174	4491	576	4527	1K91	4569
16,2	4431	53,6	4444	178	4492	590	0561	1K96	4571

2K	4572	6K65	4604	22K1	4003	73K2	0666	243K	4733
2K05	0664	6K81	4012	22K6	0481	75K	4686	249K	4734
2K1	4573	6K98	4605	23K2	4645	76K8	4687	255K	4735
2K15	0767	7K15	4606	23K7	4646	78K7	0533	261K	4736
2K21	4574	7K32	4607	24K3	4647	80K6	4688	267K	4737
2K26	0675	7K5	4608	24K9	4648	82K5	4689	274K	4738
2K32	4575	7K68	4609	25K5	4649	84K5	4691	280K	4739
2K37	4576	7K87	0458	26K1	4651	86K6	4692	287K	4741
2K43	4004	8K06	4611	26K1	4652	88K7	4693	294K	4742
2K49	0581	8K25	4558	27K4	0559	90K9	4694	301K	4743
2K55	4577	8K45	4612	28K	0667	93K1	4297	316 K	5268
2K61	0671	8K66	4613	28K7	4653	95K3	0567	332 K	1184*
2K67	4578	8K87	4614	29K4	4654	97K6	4695	348 K	5499
2K74	0636	9K09	4615	30K1	4655	100K	4696	365 K	5641
2K8	4579	9K31	4616	30K9	4656	102K	4697	374 K	5457
2K87	0414	9K53	4617	31K6	4657	105K	4698	383 K	5335
2K94	4581	9K76	4618	32K4	4658	107K	4699	402 K	5283
3K01	0524	10K	4619	33K2	0482	110K	4701	412 K	5424
3K09	4582	10K2	4621	34K	4659	113K	4702	422 K	5247
3K16	0579	10K5	0731	34K8	4661	115K	4279	442 K	5458
3K24	4583	10K7	4622	35K7	4662	118K	4703	464 K	5207
3K32	4005	11K	4623	36K5	0726	121K	4704	475 K	1275
3K4	4584	11K3	0668	37K4	4663	124K	4705	499 K	5468
3K48	4585	11K5	4624	38K3	0483	127K	4706	511 K	5258
3K57	4586	11K8	4625	39K2	4664	130K	4707	536 K	4758
3K65	4587	12K1	0572	40K2	4665	133K	4708	562 K	1169
3K74	4588	12K4	4626	41K2	4666	137K	4709	590 K	5567
3K83	4589	12K7	0443	42K2	0474	140K	4259	619 K	5315
3K92	4591	13K	0522	43K2	4667	143K	4711	649 K	5331
4K02	4592	13K3	4627	44K2	4668	147K	4712	681 K	5284
4K12	4593	13K7	4628	45K3	4669	150K	4713	750 K	5532
4K22	0729	14K	4629	46K4	0557	154K	4714	806 K	1369
4K32	4594	14K3	4631	47K5	4671	158K	4715	825 K	1398
4K42	0556	14K7	4632	48K7	0442	162K	4716	866 K	1395
4K53	0631	15K	4001	49K9	0674	165K	4717	909 K	5533
4K64	0484	15K4	0479	51K1	0672	169K	4718	953 K	1368
4K75	4008	15K8	4633	52K3	4673	174K	4719	1MAO	5535
4K87	0509	16K2	0593	53K6	4674	178K	4721		
4K99	0523	16K5	4634	54K9	4675	182K	4722		
5K11	4595	16K9	4635	56K2	4676	187K	4723		
5K23	4596	17K4	4636	57K6	4677	191K	4724		
5K36	4597	17K8	4637	59K	4678	196K	4725		
5K49	4598	18K2	4638	60K4	4679	200K	4726		
5K62	4011	18K7	0558	61K9	0872	205K	4727		
5K76	4599	19K1	4639	63K4	4681	210K	4208		
5K9	0583	19K6	4641	64K9	0514	215K	4728		
6K04	4601	20K	4642	66K5	4682	221K	4038		
6K19	0608	20K5	4643	68K1	4683	226K	4729		
6K34	4602	21K	4644	69K8	4684	232K	4731		
6K49	4603	21K5	0451	71K5	4685	237K	4732		

* 4822 116 5 . . . .

Fig. 30 Block diagram PM 5133

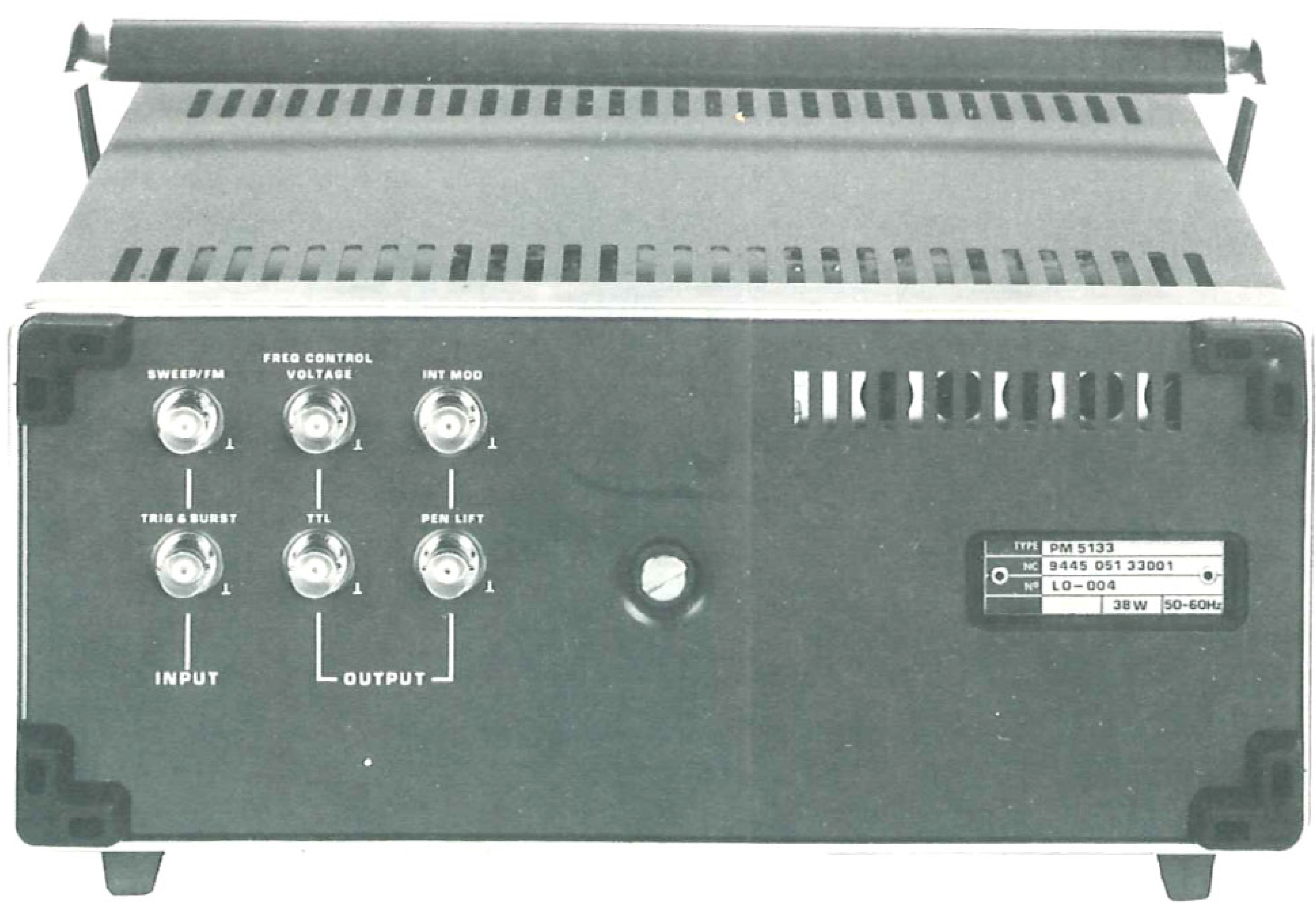


Fig. 32 Back view

Fig. 31 Front view

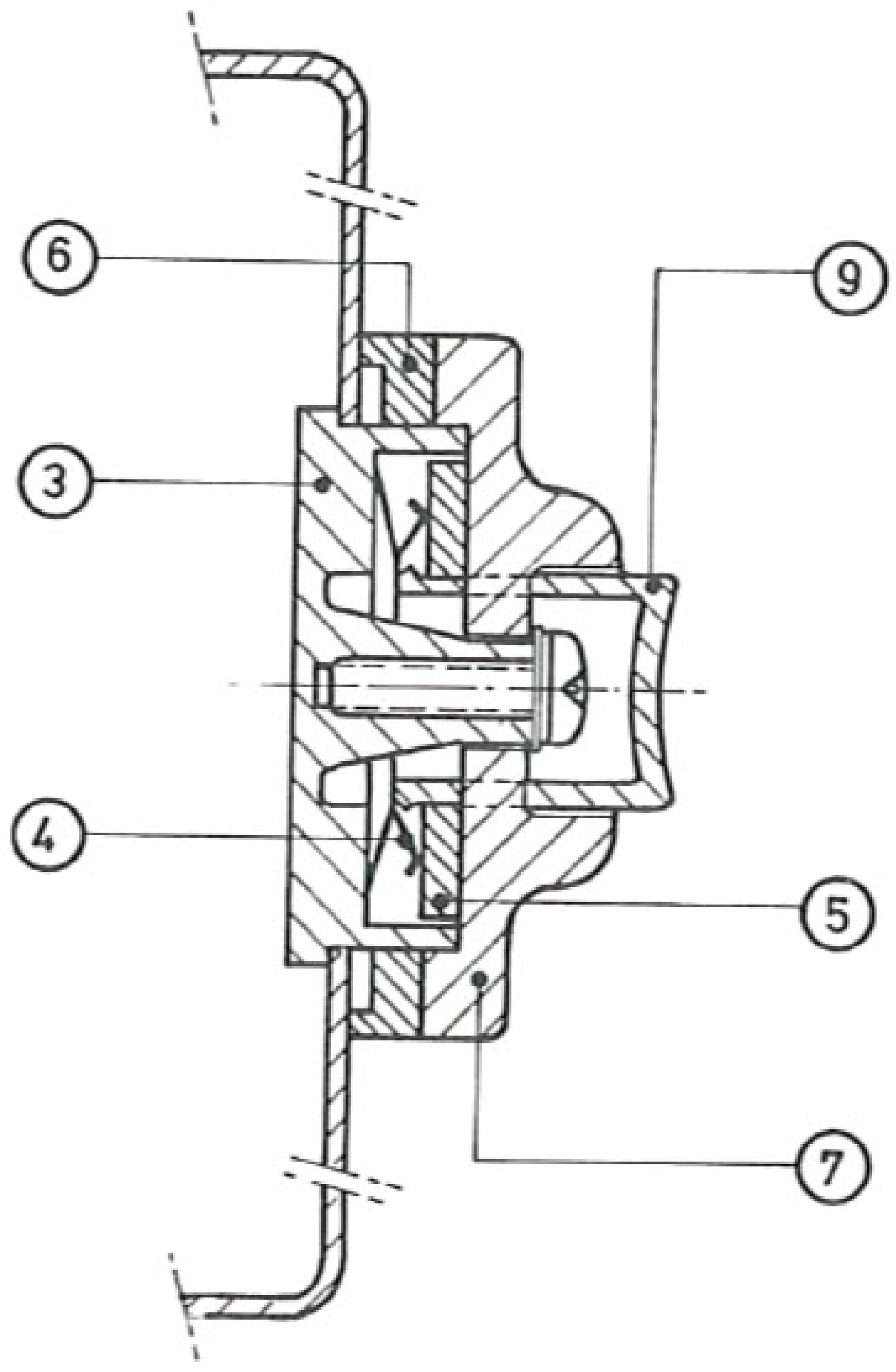


Fig. 33 Handle: spare parts

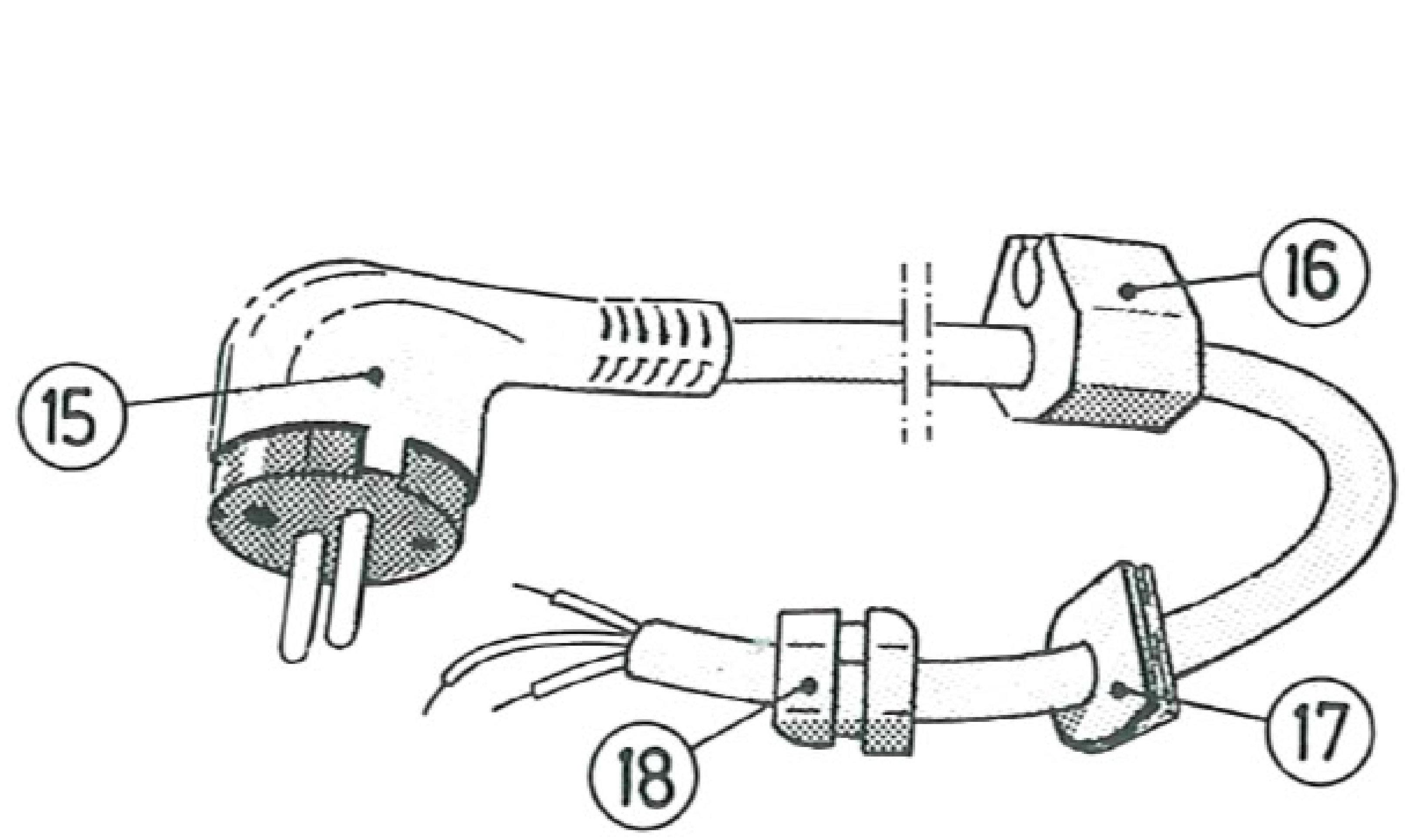


Fig. 34 Mains cable: spare parts

Fig. 36 Overall circuit diagram

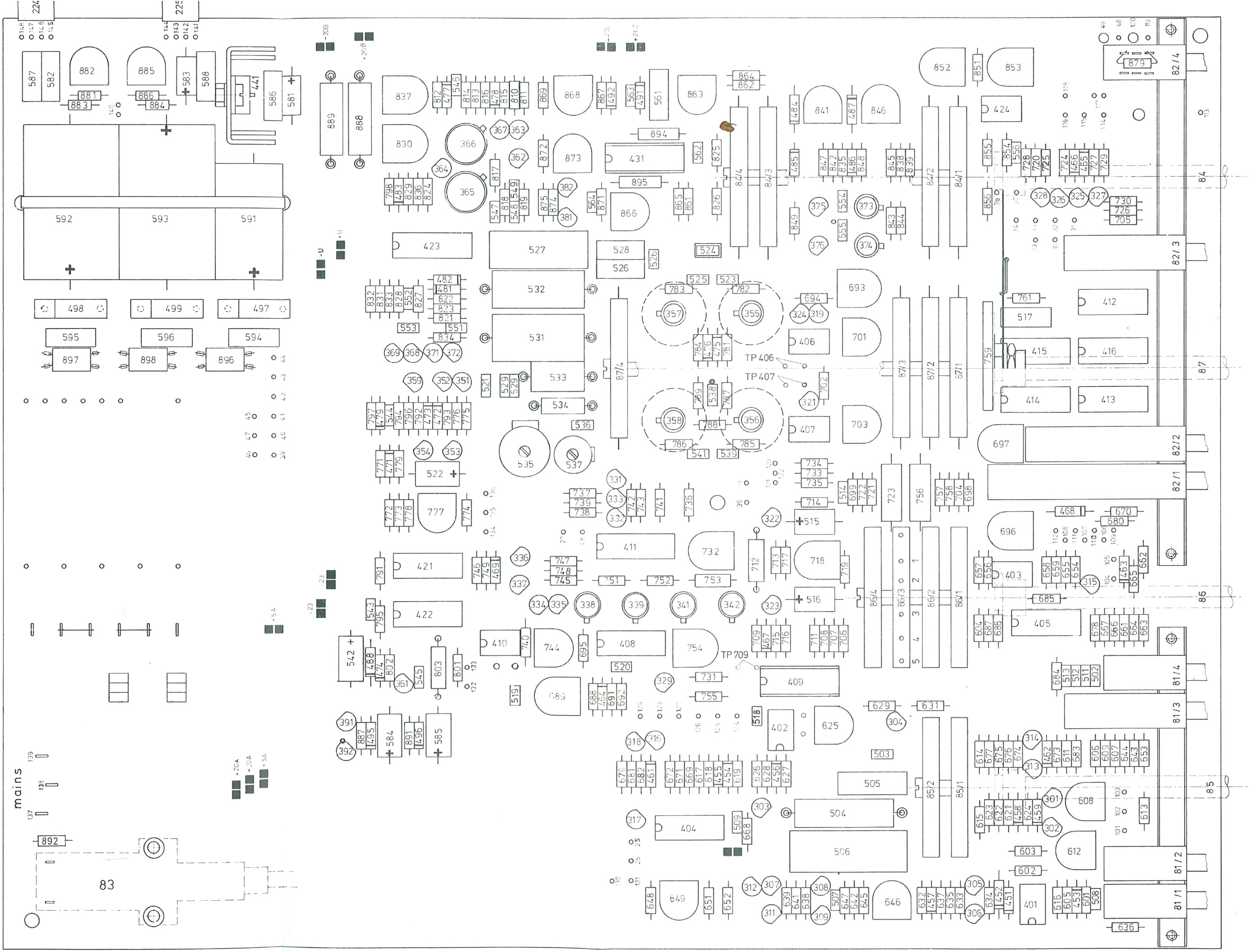


Fig. 37 Unit 1, component lay-out

Fig. 38 Unit 1, part 1; frequency control

INT. MOD OUT
CONTROL VOLTAGE
Modulation oscillator control
control section
Integrator
PERIOD
FREQUENCY
Symmetry control
DUTY CYCLE
SINGLE
BURST
SWEEP
NORMAL
RESET
STD BY
HOLD
TRIG
LOG
LIN
to Fig. 39
TRIG&BURST INPUT
Connections 1-10 for version PM 5133 S only
SWEEP (LEDs)
SWEEP/FM INPUT
START (LED)
PEN LIFT
FREQ / DVM+

Fig. 38

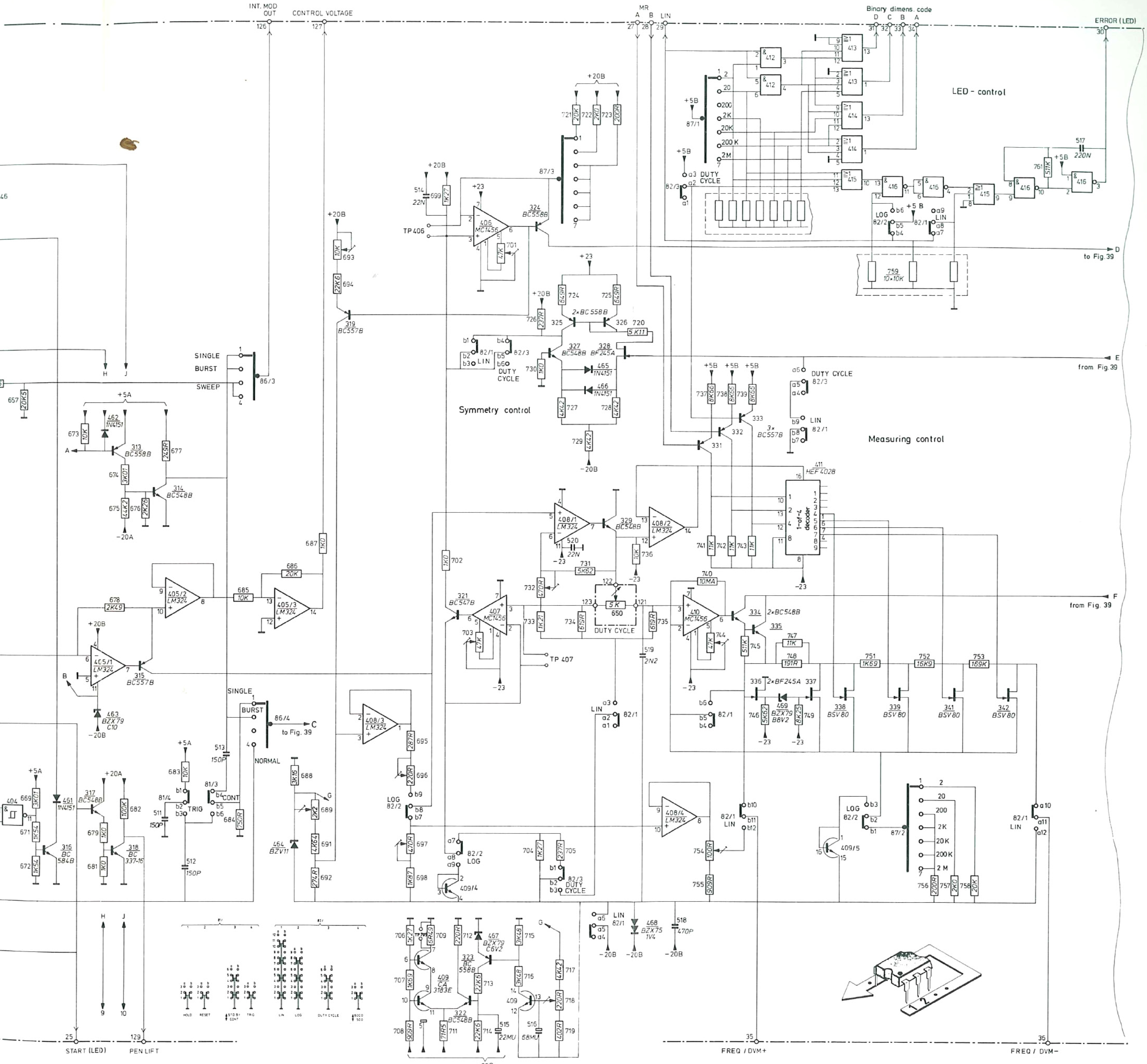
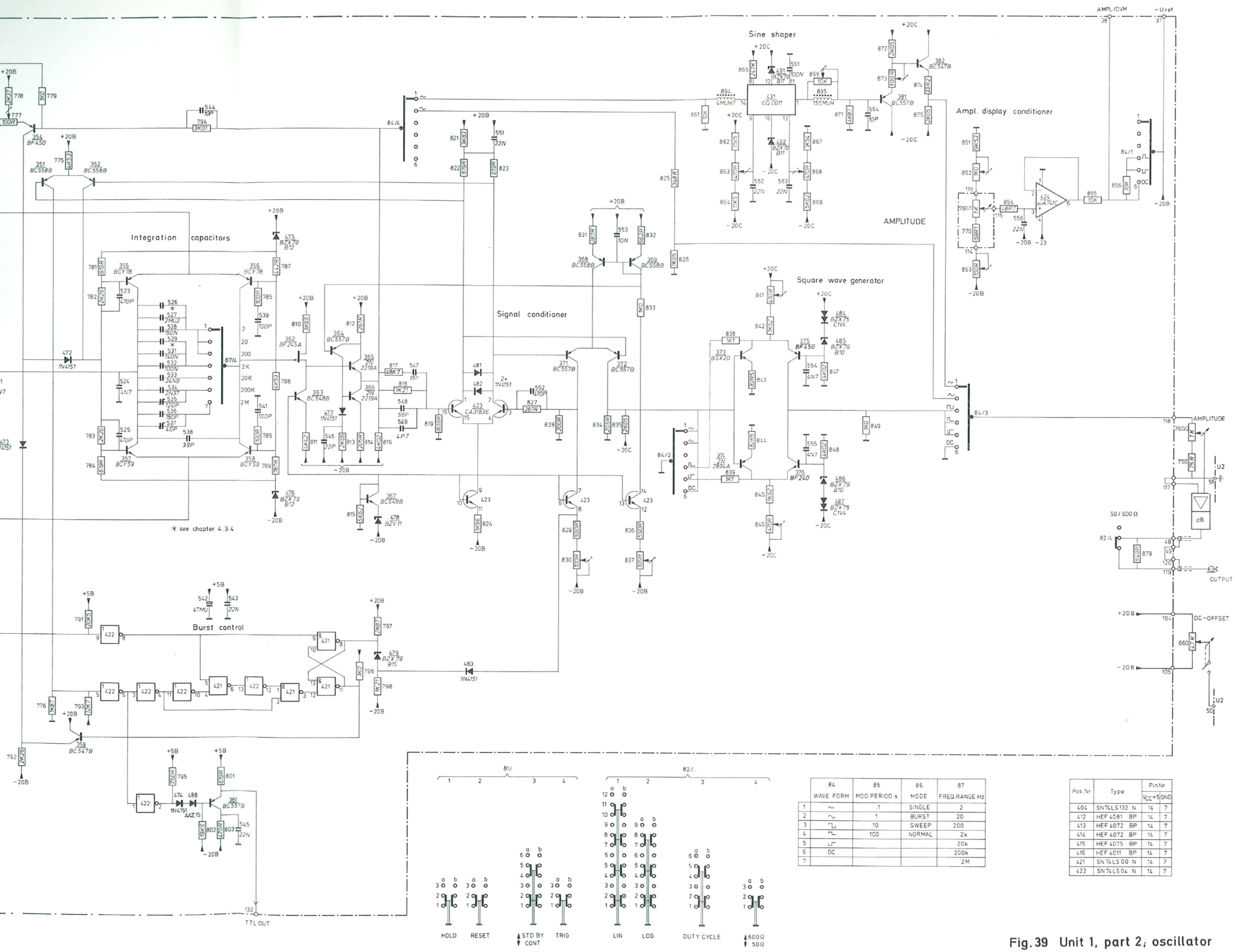


Fig. 38 Unit 1, part 1; frequency control

	84 WAVE FORM	85 MOD PERIOD s	86 MODE	87 FREQ RANGE Hz
1	∼	.1	SINGLE	2
2	∼	1	BURST	20
3	⊓⊔	10	SWEEP	200
4	⊓_	100	NORMAL	2k
5	⊔‾			20k
6	DC			200k
7				2M

Pos. Nr	Type	Pin Nr Vcc+5	Pin Nr GND
404	SN 74 LS 132 N	14	7
412	HEF 4081 BP	14	7
413	HEF 4072 BP	14	7
414	HEF 4072 BP	14	7
415	HEF 4075 BP	14	7
416	HEF 4011 BP	14	7
421	SN 74 LS 00 N	14	7
422	SN 74 LS 04 N	14	7

Fig. 39 Unit 1, part 2; oscillator



	84 WAVE FORM	85 MOD PERIOD s	86 MODE	87 FREQ RANGE Hz
1	∼	.1	SINGLE	2
2	∿	1	BURST	20
3	⊓⊔	10	SWEEP	200
4	⊓_	100	NORMAL	2k
5	⊔⊓			20k
6	DC			200k
7				2M

Pos.Nr.	Type	Pin Nr.	
		Vcc+5	GND
404	SN74LS132 N	14	7
412	HEF 4081 BP	14	7
413	HEF 4072 BP	14	7
414	HEF 4072 BP	14	7
415	HEF 4075 BP	14	7
416	HEF 4011 BP	14	7
421	SN74LS00 N	14	7
422	SN74LS04 N	14	7

Fig. 39 Unit 1, part 2; oscillator

Fig. 40 Unit 1, power supply

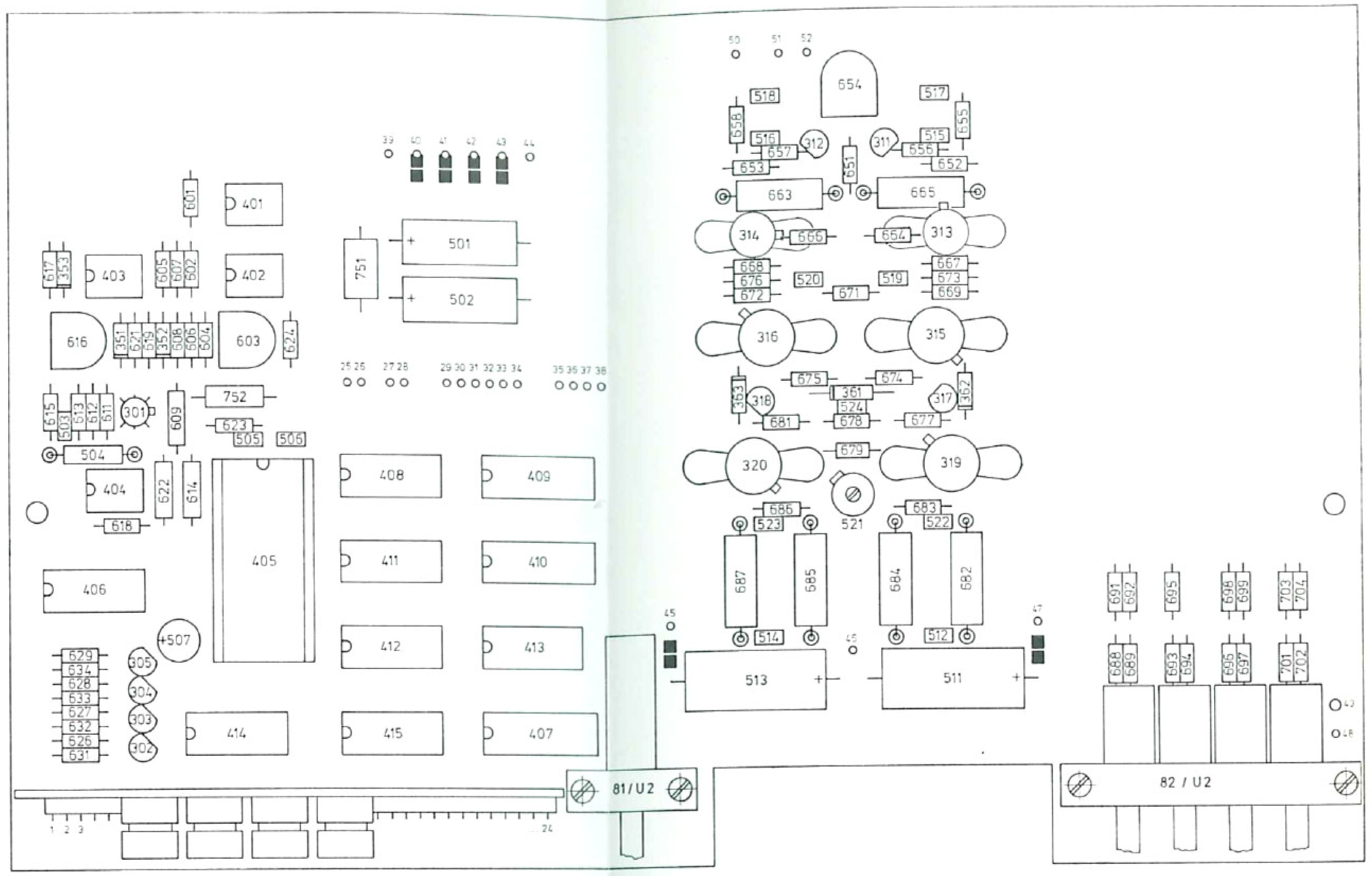


Fig. 41 Unit 2, component lay-out

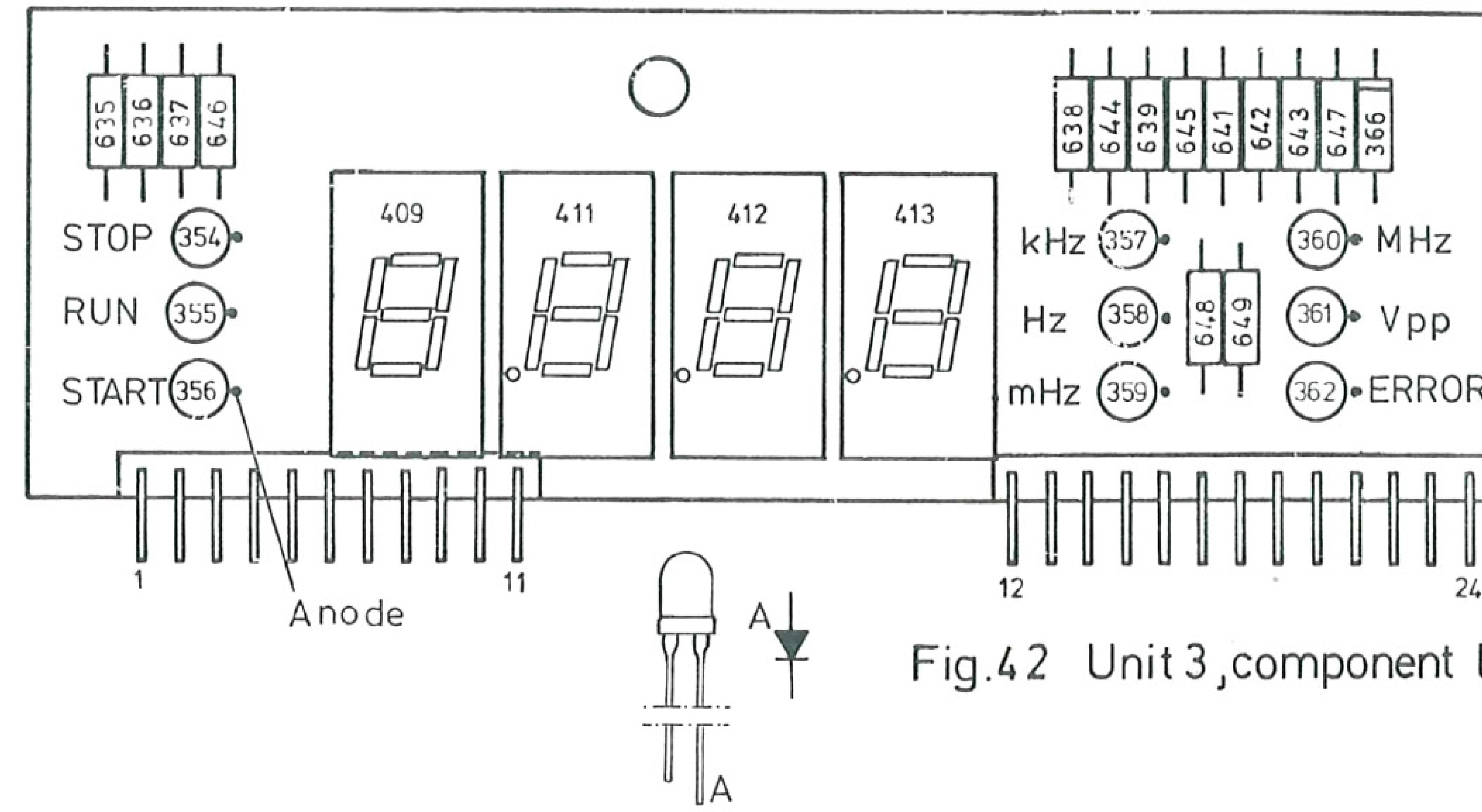


Fig.42 Unit 3, component lay-out

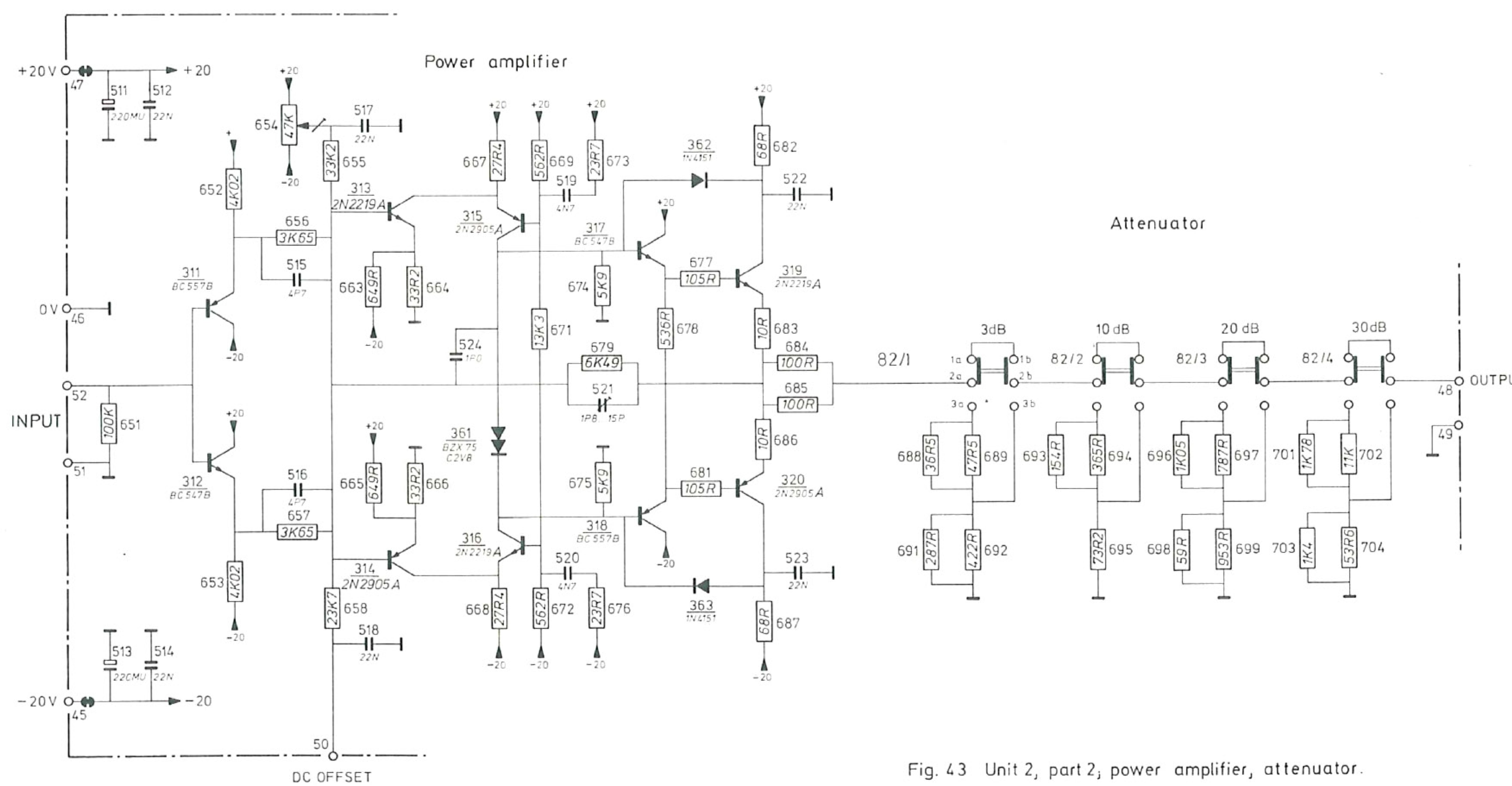
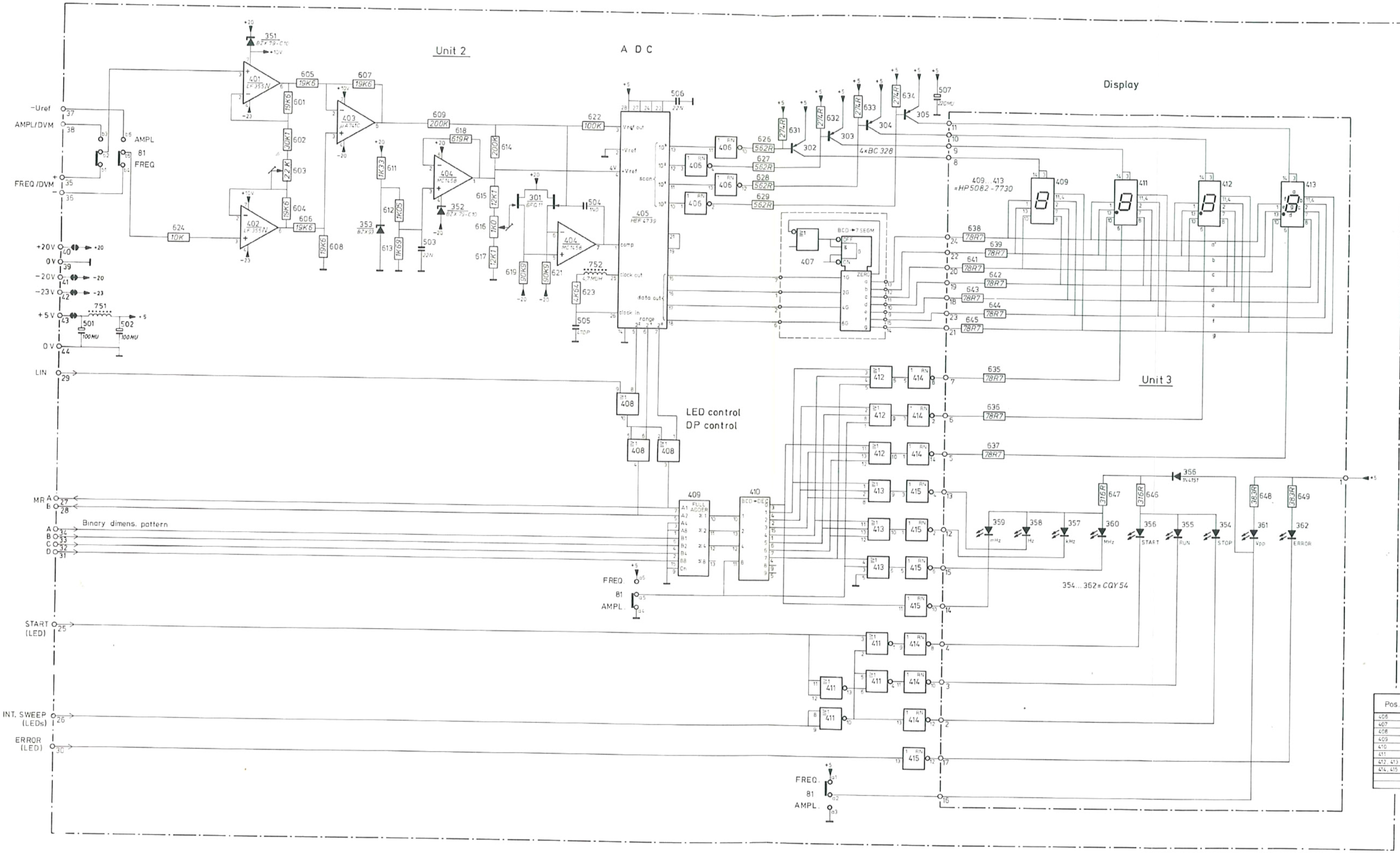


Fig. 43 Unit 2, part 2, power amplifier, attenuator.



Pos. Nr.	Type	Pin Nr.	
		VCC = 5V	GND
406	N74LS05 N	14	7
407	N7447 AN	16	8
408	HEF 4071 BP	14	7
409	HEF 4008 BP	16	8
410	HEF 4028 BP	16	8
411	N74LS02 N	14	7
412, 413	HEF 4075 BP	14	7
414, 415	N74LS05 N	14	7

Fig. 44 Unit 2, part 1; Unit 3; DVM, display

CODING SYSTEM OF FAILURE REPORTING FOR QUALITY ASSESSMENT OF T & M INSTRUMENTS

(excl. potentiometric recorders)

The information contents of the coded failure description is necessary for our computerized processing of quality data.

Since the reporting of repair and maintenance routines must be complete and exact, we give you an example of a correctly filled-out PHILIPS SERVICE Job sheet.

① Country	② Day Month Year	③ Typenumber /Version	④ Factory/Serial no.
3 2	1 5 0 4 7 5	O P M 3 2 6 0 0 2	D O 0 0 7 8 3

CODED FAILURE DESCRIPTION ⑥

⑤ *Nature of call*	*Location*	*Component/sequence no.*	*Category*
[ ] Installation		T S 0 6 0 7	5
[ ] Pre sale repair		R 0 0 6 3 1	2
[ ] Preventive maintenance	0 0 2 1	9 9 0 0 0 1	4
[X] Corrective maintenance			
[ ] Other			

⑦ *Job completed* [X]

Working time ⑧ 1 2 Hrs

Detailed description of the information to be entered in the various boxes:

①Country: 3 2 = Switzerland

②Day Month Year 1 5 0 4 7 5 = 15 April 1975

③Type number/Version O P M 3 2 6 0 0 2 = Oscilloscope PM 3260, version 02 (in later oscilloscopes this number is placed in front of the serial no)

④Factory/Serial number D O 0 0 7 8 3 = DO 783 These data are mentioned on the type plate of the instrument

⑤Nature of call: Enter a cross in the relevant box

⑥Coded failure description

Location

These four boxes are used to isolate the problem area. Write the code of the part in which the fault occurs, e.g. unit no or mechanical item no of this part (refer to 'PARTS LISTS' in the manual).

Example: 0001 for Unit 1
000A for Unit A
0075 for item 75

If units are not numbered, do not fill in the four boxes; see Example Job sheet.

Component/sequence no.

These six boxes are intended to pinpoint the faulty component.

A. Enter the component designation as used in the circuit diagram. If the designation is alfa-numeric,the letters must be written (starting from the left) in the two left-hand boxes and the figures must be written (in such a way that the last digit occupies the right-most box) in the four right-hand boxes.

B. Parts not identified in the circuit diagram:

990000 Unknown/Not applicable
990001 Cabinet or rack (text plate, emblem, grip, rail, graticule, etc.)
990002 Knob (incl. dial knob, cap, etc.)
990003 Probe (only if attached to instrument)
990004 Leads and associated plugs
990005 Holder (valve,transistor, fuse, board, etc.)
990006 Complete unit (p.w. board, h.t. unit, etc.)
990007 Accessory (only those without type number)
990008 Documentation (manual, supplement, etc.)
990009 Foreign object
990099 Miscellaneous

Category

0 Unknown, not applicable (fault not present, intermittent or disappeared)
1 Software error
2 Readjustment
3 Electrical repair (wiring, solder joint, etc.)
4 Mechanical repair (polishing, filing, remachining, etc.)
5 Replacement (of transistor, resistor, etc.)
6 Cleaning and/or lubrication
7 Operator error
8 Missing items (on pre-sale test)
9 Environmental requirements are not met

⑦Job completed: Enter a cross when the job has been completed.

⑧Working time: Enter the total number of working hours spent in connection with the job (excluding travelling, waiting time, etc.), using the last box for tenths of hours.

1 2 = 1,2 working hours (1 h 12 min.)