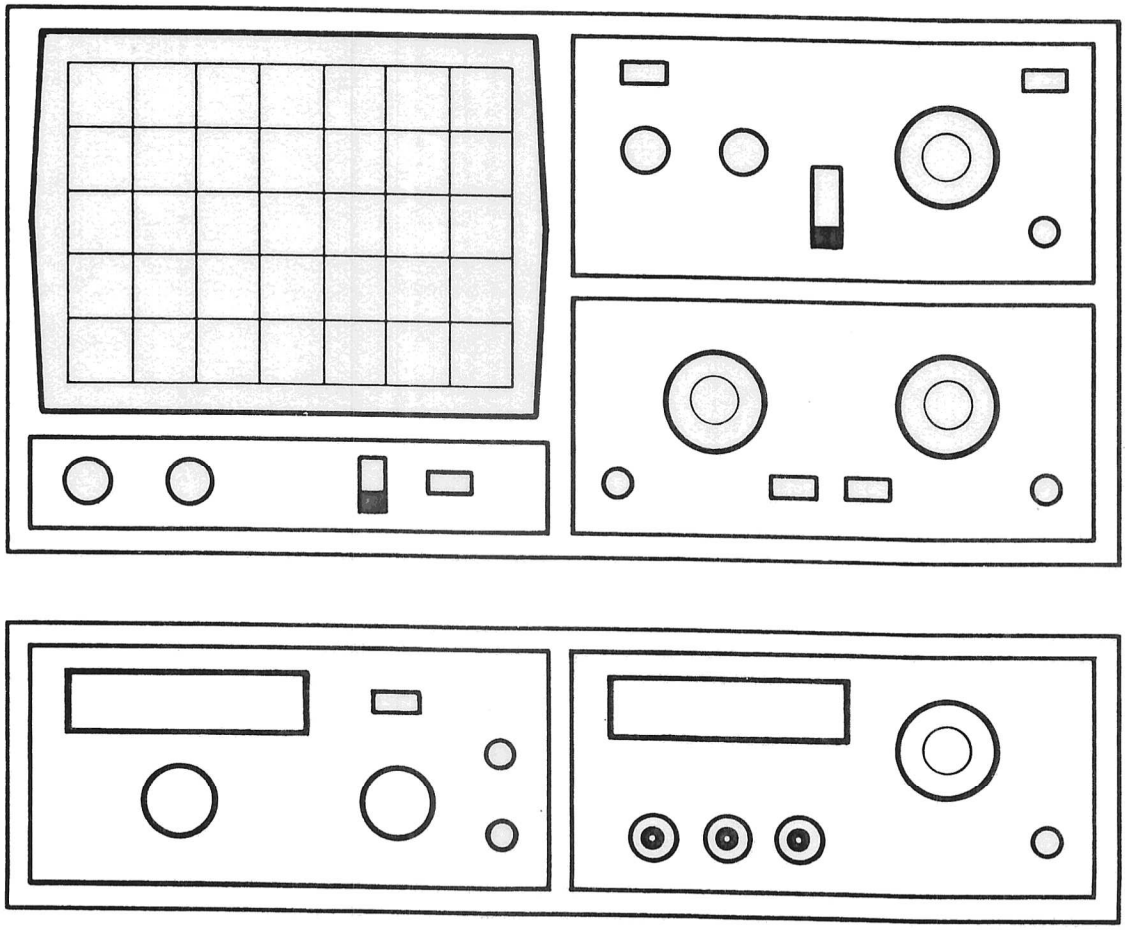
HAMEG
Instruments

MANUAL

Funktionsgenerator HM8030-3



Specification

(Reference Temperature: 23°C ± 1°C)

Operating Modes

Sine-Square-Triangle-DC
free running or ext. frequency modulated, with or without DC offset

Frequency Ranges

0.02 Hz to 2 MHz in 8 decade steps
variable control: x0.09 to x1.1 (12:1)
Frequency Stability: < 0.1%/h or 0.4%/24 h at constant ambient temperature (medium position of frequency control)

Waveform Characteristics

Sine Wave Distortion:
0.1 Hz to 100 kHz: max. 0.5%
0.1 MHz to 0.5 MHz: max. 1.5%
0.5 MHz to 2 MHz: max. 3%
Square Wave Risetime: max. 30 ns (10 to 90%)
Overshoot: < 5%
(when output is terminated with 50 Ω)
Triangle Non-Linearity: < 1% (up to 100 kHz)

Display

Frequency: 4 digit 7 Segm. LED, 8 x 5 mm each
Accuracy up to 100 kHz: 1% ± LSD[1)]
up to 2 MHz: 3% ± 4 digit
(valid up to 1998 digits)
LED-indicator for mHz, Hz and kHz

Outputs (short circuit proof)

Signal output:
Impedance: 50 Ω
Output voltage: 20 V_{pp} open circuit
max. 10 V_{pp} into 50 Ω
Attenuation: approx. − 60 dB
2 steps: − 20 dB ± 0.2 dB each
Variable attenuation: 0 to − 20 dB
Amplitude Flatness: (sine/triangle)
0.02 Hz up to 0.2 MHz: max. 0.2 dB
0.2 MHz up to 2 MHz: max. 0.5 dB
DC Offset: continuously variable (disconnectible)
Offset range: max. ± 2.5 V into 50 Ω
max. ± 5 V open circuit
Trigger Output: square wave synchronous to signal output; approx. +5V (TTL).

FM Input (VCF)

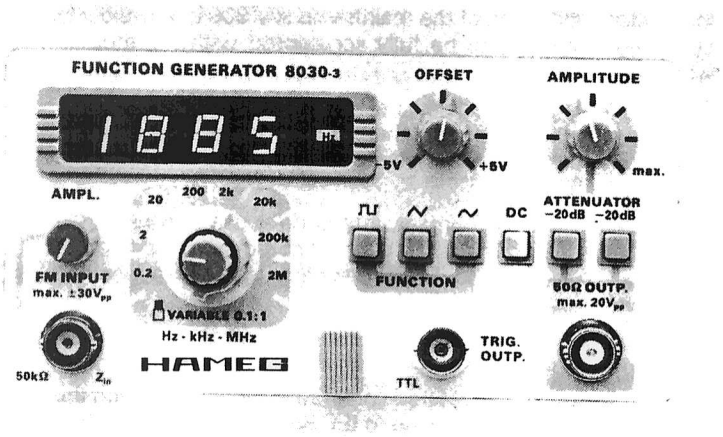
Frequency change: max. 1:100
Input impedance: 50 kΩ ‖ 25 pF
Input voltage: ± 30 V max.

General Information

Operating conditions: + 10°C to + 40°C
max. relative humidity: 80%
Supply (from HM 8001): + 5V/100 mA
+ 16V/280 mA, − 16V/280 mA (∑ 9.5 W).
Dimensions (mm): (without multipoint conn.)
W 135, **H** 68, **D** 228 mm
Weight: approx. 0.80 kg

[1)] Least Significant Digit

Values without tolerances are intended as guide lines and represent characteristics of the average instrument.
Subject to change without notice



Function Generator HM 8030-3

- **Frequency Range 0.02 Hz to 2 MHz**
- **Operating Modes: Sine, Square, Triangle, DC**
- **Digital Frequency Readout**
- **DC-Offset Adjustment**
- **FM-Input; Trigger Output**
- **Square Wave Risetime typ. < 30 ns**

The **various signals** available from the **HM 8030-3** function generator module make it a versatile signal source useful for most measurement and test applications. Its **low frequency ranges** are particularly well suited for simulating mechanical and servo techniques.
Frequencies are read out on a **3½ digit LED display** with a maximum resolution of 0.1 mHz. A variable frequency control with a gear ratio of 4.6:1 facilitates accurate frequency adjustments. Additional quality features include the relatively **low distortion factor** of the generated signals and **constant amplitude flatness** throughout the entire frequency range of the instrument.
All outputs are **short-circuit-proof** and protected against external DC-voltages up to ± 45 V.
With an external signal source, the **HM 8030-3** can also be used in the **sweep mode**.

Optional Accessories

HZ 33, HZ 34: 50 Ω test cable BNC-BNC.
HZ 22: 50 Ω through-termination.

General information

The operator should not neglect to carefully read the following instructions and those of the mainframe HM8001, to avoid any operating errors and to be fully acquainted with the module when later in use.

After unpacking the module, check for any mechanical damage or loose parts inside. Should there be any transportation damage, inform the supplier immediately and do not put the module into operation.

This plug-in module is primarily intented for use in conjunction with the Mainframe HM8001. When incorporating it into other systems, the module should only be operated with the specified supply voltages.

Safety

Every module is manufactured and tested for use only with the mainframe HM8001 according to IEC 348 Part 1 and 1a (Safety requirements for electronic test and measurement equipment). All case and chassis parts are connected to the safety earth conductor. Corresponding to Safety Class 1 regulations (three-conductor AC power cable). Without an isolating transformer, the instrument's power cable must be plugged into an approved three-contact electrical outlet, which meets International Electrotechnical Commission (IEC) safety standards.

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 istrument must be disconnected and secured against unintentional operation if there is any suggestion that safe operation is not possible. This may occur:
- if the instrument has visible damage,
- if the instrument has loose parts.
- if the instrument does not function,
- after long storage under unfavourable circumstances (e.g. outdoors or in moist environments),
- after excessive transportation stress (e.g. in poor packaging).

When removing or replacing the metal case, the instrument must be completely disconnected from the mains supply. If any measurement or calibration procedures are unavoidable on the opened-up instrument, these must only be carried out by qualified personnel acquainted with the danger involved.

Symbos As Marked on Equipment

DANGER – High voltage

Protective ground (earth) terminal.

ATTENTION – refer to manual.

Operating conditions

The ambient temperature range during operation should be between +10°C and +40°C and should not exceed −40°C or +70°C during transport or storage. The operational position is optional, however, the ventilation holes on the HM8001 and on the plug-in modules must not be obstructed.

Warranty

Before being shipped, each plug-in module must pass a 24 hour quality control test.

Provided the instrument has not undergone any modifications Hameg warrants that all products of its own manufacture conform to Hameg specifications and are free from defects in material and workmanship when used under normal operating conditions and with the service conditions for wich they were furnished.

The obligation of HAMEG hereunder shall expire two (2) years after delivery and is limited to repairing, or at its option, replacing without charge, any such product which in Hameg's sole opinion proves to be defective with the scope of this warranty.

This is Hameg's sole warranty with respect to the products delivered hereunder. No statement, representation, agreement or understanding, oral or written, made by an agent, distributor, representative or employee of, which is not contained in thiss warranty will be binding upon Hameg, unless made in writing and executed by an authorized Hameg employee. Hameg makes no other warranty of any kind whatsoever, expressed or implied, and all implied warranties of merchantibility and fitness for a particular use which exceed the aforestated obligation are hereby disclaimed by Hameg be liable to buyer, in contract or in tort, for any special, indirect, incidental or consequential damages, espresses, losses or delays however caused.

In case of any complaint, attach a tag to the instrument with a description of the fault observed. Please supply name and department, address and telephone number to ensure rapid service.

The instrument should be returned in its original packaging for maximum protection. We regret that transportation damage due to poor packaging is not covered by this warranty.

Maintenance

The most important characteristics of the instruments should be periodically checked according th the instructions provided in the sections "Operational check" and "Alignment procedcure". To obtain the normal operating temperature, the mainframe with inserted module should be turned on at least 60 minutes before starting the test. The specified alignment procedure should be strictly observed.

When removing the case detach mains/line cord and any other connected cables from case of the mainframe HM8001. Remove both screws on rear panel and, holding case firmly in place, pull chassis forward out of case. When later replacing the case, care should be taken to ensure that it properly fits under the edges of the front and rear frames.

After removal of the two screws at the rear of the module, both chassis covers can be lifted. When reclosing the module, care should be taken that the guides engage correctly with the front chassis.

Operation of the module

Provided that all hints given in the operating instructions of the HM8001 Mainframe were followed – especially for the selection of the correct mains voltage – start of operation consists practically of inserting the module into the right or left opening of the mainframe. The following precautions should be observed:

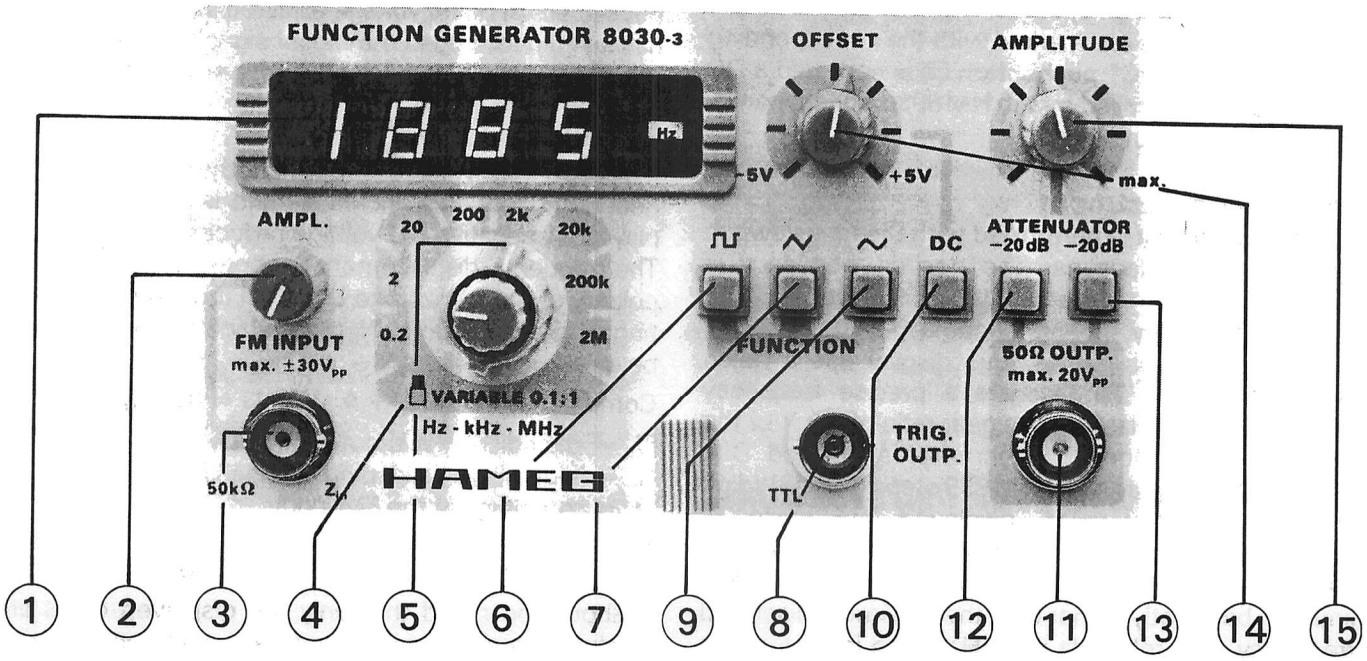
Before exchanging the module, the mainframe must be switched off. A small circle (o) is now revealed on the red power button in the front centre of the mainframe.

If the BNC sockets at the rear panel of the HM8001 unit were in use before, the BNC cables should be disconnected from the basic unit for safety reasons. Slide in the new module until the end position is reached.

Before being locked in place, the cabinet of the instrument is not connected to the protective earth terminal (banana plug above the mainframe multipoint connector). In this case, no test signal must be applied to the input terminals of the module.

Generally, the HM8001 set must be turned on and in full operating condition, before applying any test signal. If a failure of the measuring equipment is detected, no further measurements should be performed. Before switching off the unit or exchanging a module, the instrument must be disconnected from the test circuit.

Control elements of HM8030-3



① **DISPLAY** (7-segment LED)
3½-digit frequency meter with a max. indication of 1999 digits. LED indicators for mHz, Hz and kHz.

② **AMPLITUDE** (adjusting knob)
Attenuation of input voltage for FM-input. This permits the user to change the sweep width.

③ **FM INPUT** (BNC connector)
Applying a DC voltage to this input will vary the oscillator frequency linearly to max. 1:100. The max. allowable input voltage is ±30V.

④ **VARIABLE** (adjusting knob)
Continuous and linear frequency fine adjustment, overlapping the ranges selected with ⑤. Setting range from x0.09 to x1.1 of selected range. Gear ratio is 4.6:1. Adjustable frequency range 20mHz – 2MHz.

⑤ **FREQUENCY** (7-position rotary switch)
Frequency coarse adjustment from 0.2Hz to 2MHz in 8 decade steps.

⑥/⑦/⑨/⑩ **FUNCTION** (pushbutton)
Mode selection: Triangle – Sine – Square – DC.

⑧ **TRIGGER OUTPUT** (BNC connector)
This short-circuit-proof output supplies a square signal in synchronism with the output signal. It is TTL compatible and has a duty-factor of approx. 50%.

⑪ **50 Ω OUTPUT** (BNC connector)
Short-circuit-proof signal output of the generator. The output impedance is 50Ω, and the max. output amplitude is 20Vpp (o.c.) or 10Vpp respectively when terminated with 50Ω.

Attention! The output is protected against external DC voltages up to max. ±45V.

⑫/⑬ **–20dB, –20dB** (pushbutton)
Two fixed attenuators, –20dB each. They can be used separately. When both pushbuttons are activated, a total attenuation of –40dB results. Including the amplitude control ⑮, the max. attenuation amounts to –60dB (factor 1000).

⑭ **OFFSET** (adjusting knob)
Adjustment of the positive or negative offset voltage. This DC voltage can be superimposed on the output signal. The max. offset voltage is ±5V (o.c.) or ±2.5V respectively when terminated with 50Ω.

⑮ **AMPLITUDE** (adjusting knob)
Continuous adjustment of the output amplitude from 0 to –20dB.

Function selection

The type of output signal is selected with the function selection switches ⑥/⑦/⑨/⑩. A total number of 3 different waveforms – sine, square and triangle – are available. The functions are marked with the corresponding symbols. If the "DC" pushbutton ⑩ is activated a DC voltage level is supplied by the HM8030-3 or supperimposed on the output signal.

Frequency adjustment

Coarse adjustment is performed with the range switch ⑤ divided into decades. The desired frequency is selected by turning the VARIABLE control ④. The selected frequency appears on the 3½-digit display ①. Compared to knob scales, this display has a much higher resolution. To facilitate a precise frequency adjustment of the last digit, a gear ratio of 4.6:1 of the frequency adjustment potentiometer is provided. Due to the limited display range of 1999 steps of the 3½digit display, the maximum displayed frequency is 199.9mHz or a multiple of this frequency in decade steps. Therefore the set frequency at the upper range limit can be slightly higher than the maximum displayed frequency. The mHz, Hz and kHz range indicators are integrated into the display panel.

Output amplitude and signal connection

Adaptation in decade steps to the desired amplitude range is performed by the use of two attenuators with −20dB each, which are activated by pushbuttons.
Including the continuously adjustable AMPLITUDE control ⑮, the maximum attenuation amounts to −60dB. With the maximum amplitude of $10V_{pp}$, the minimum signal voltage to be supplied is about 10mV. These values are obtained when the generator output is terminated with 50Ω. In the open-circuit condition, the available signal amplitude is about twice as high. Therefore the maximum output voltage of the output socket is specified with $20V_{pp}$. If exact square-shaped signals are required, care should be taken that only 50Ω coaxial cables (e.g. HZ34) are used. Furthermore, this cable must be terminated with a 50Ω through-termination (e.g. HZ22). If these precautions are not observed, overshoot may occur, especially when high frequencies are selected. If test circuits having a 50Ω input impedance are connected, this termination is not required. In high signal voltage ranges, it should be noted that the used terminating resistor must dissipate the corresponding effective power.
The output terminal of the HM8030-3 is short circuit proof. However, if an external DC voltage exceeding ±45V is applied to the output, the output stage is likely to destruction.
If the output of the HM8030-3 unit comes into contact with components of the circuit under test, which are carrying DC voltage, an isolationg capacitor of appropriate dielectric strength should be connected in series with the output of the generator. The capacitance of this isolating capacitor should be selected in that way that the frequency response of the output signal is not affected over the whole frequency range of the HM8030-3 unit.

Trigger output

In the sine, square and triangle modes, the trigger output ⑧ supplies a square signal in synchronism with the output signal. An offset voltage adjusted at the 50Ω output has no influence upon the trigger signal. The trigger output is short-circuit-proof and can drive several TTL inputs.

FM input

If a positive DC voltage is applied to the FM input ③, the generator frequency increases and is accordingly displayed. A negative DC voltage reduces the frequency. The frequency displacement depends on the value and polarity of the DC voltage **U** and on the **VARIABLE** setting. The set frequency $\mathbf{N_0}$ (DC voltage not included) can be selected at will.

Computation: $\mathbf{N = N_0 + A \cdot U}$ or $\mathbf{U = (N - N_0) : A}$

$\mathbf{N_0}$ = digit display without voltage **U**,
N = digit display including voltage **U**,
U = ± voltage at the FM input.
A = 0-680 (digits per volt),
("A" depends on Amplitude ② setting.)

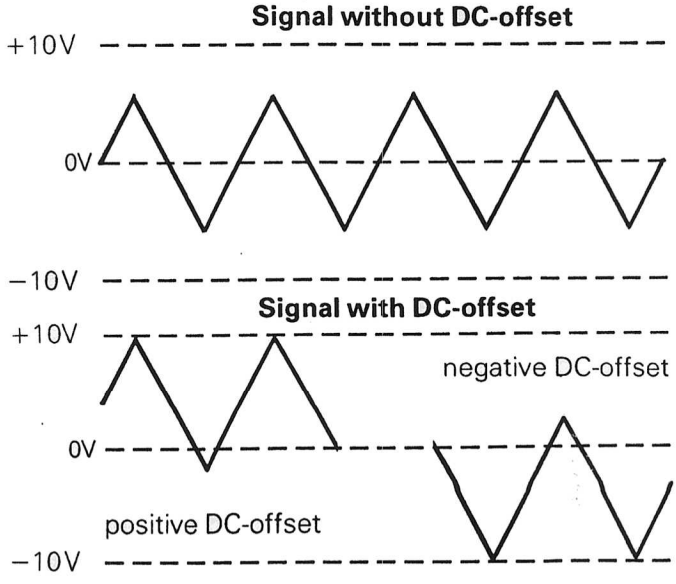
It should be noted that only the displayed digits are valid; the decimal point is not taken into consideration (e.g. 100.0 ≙ 1000 digit). The display "1999" cannot and "000" should not be exceeded. Any zeroes preceding the decimal point are dropped.

Limits: if the highest displayed number is **N** = 1998 and the smallest $\mathbf{N_0}$ = 090, then **U** will be + 2.8V max. The frequency increases by a factor of 22.2. If the smallest displayed number is **N** = 011 (lower numbers are possible, but inaccurate) and the highest $\mathbf{N_0}$ = 1100, then **U** will be −1.6V max. The frequency changes by a factor of 100.

The frequency change is ***linear*** as a function of the voltage **U** and has the same value in all ranges.
The specified values are only obtained if the amplitude control knob ② is turned fully clockwise.

DC offset

When the switch ⑩ DC is depressed, a DC voltage can be superimposed on the output signal. The maximum offset voltage with open output is ±5V.



Operational check

Measuring equipment required

20 MHz Oscilloscope: HM 203 or HM 204
HZ 22 50 Ω Through-Termination
HM 8011-3 Digital Multimeter or similar
Adjustable DC voltage source (max. 30 V) e.g. HM 8040
HM 8021-2 Frequency Counter

Frequency variation

The adjustment range of the **VARIABLE** knob ④ must in any case overlap the selected decade on both sides by min. 5%.

Amplitude stability

Setting:	⑦	⑤	④	⑮
	∿	1 k	max	max

Connect oscilloscope to output ⑪. Use a 50 Ω through-termination. Set oscilloscope to DC coupling. Adjust signal height to 6 div. Check all frequency ranges with ⑤ and ④. The signal height should not vary by more than 0.12 Div. or 0.3 Div. respectively.

Maximum output amplitude

Setting:	⑦	⑤	④	⑮	⑫/⑬
	∿	1 k	max.	max.	released

Connect oscilloscope to output ⑪. The signal amplitude should be 20 V_{pp} ± 500 mV_{pp}. With a 50 Ω load at the output ⑪, the signal amplitude should still be 10 V_{pp} ± 250 mV_{pp}.

Output attenuator function

Setting:	⑨	⑤	④	⑮	⑫/⑬
	∼	100	50 Hz	max.	released

Connect digital multimeter (V_{AC}) to output ⑮. Set knob ⑮ for 5 V display. Firstly depress button ⑫ (– 20 dB) only, then both buttons ⑫/⑬ (– 40 dB) simultaneously. The DVM should display 0.5 V or 0.05 V ± 2% respectively.

Adjustment range of the offset voltage

Setting:	⑩	⑭	⑮	⑫/⑬
	depressed	max	max	released

Connect DVM to the output ⑪. Use a 50 Ω through-termination. The DC potential should vary between about + 2.5 V and – 2.5 V by use of control ⑭.

Frequency variation by FM input

Setting: optional; ② fully cw.

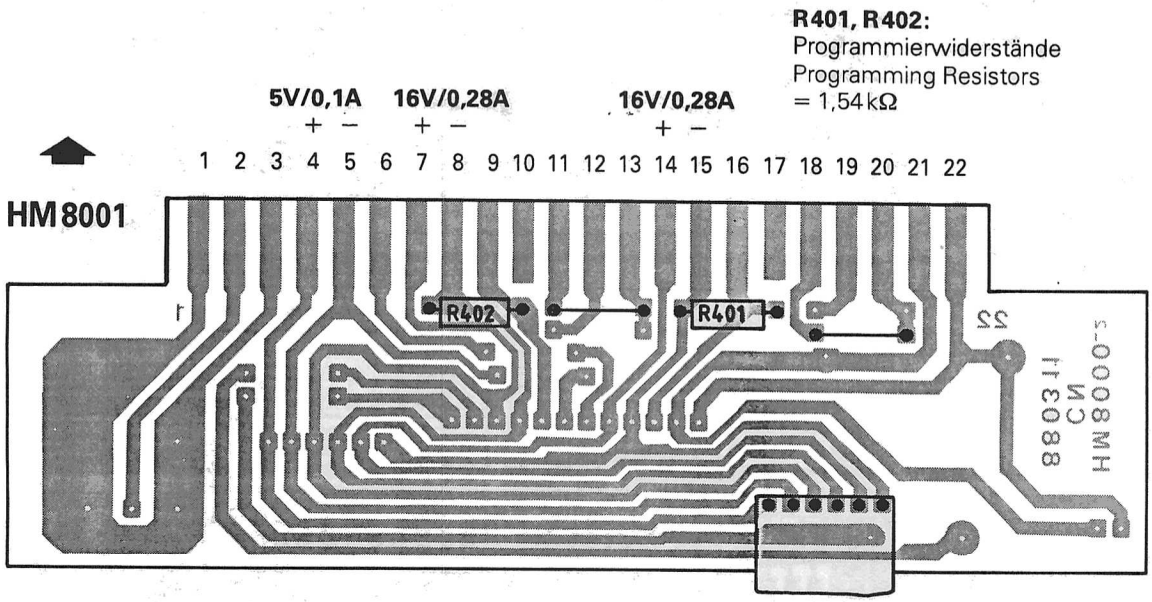
Apply an adjustable DC voltage (± 30 V max.) to the input ③. Display indication ① will vary as a function of the applied DC voltage. The obtained results can be examined by use of the formulas specified in the **"FM input"** section of the operating instructions.

Trigger signal waveform

Connect the oscilloscope to output ⑪. A square wave signal with TTL level and a 50% duty factor will be shown on the screen ("Low": about 0.4 V; "High": about 5 V).

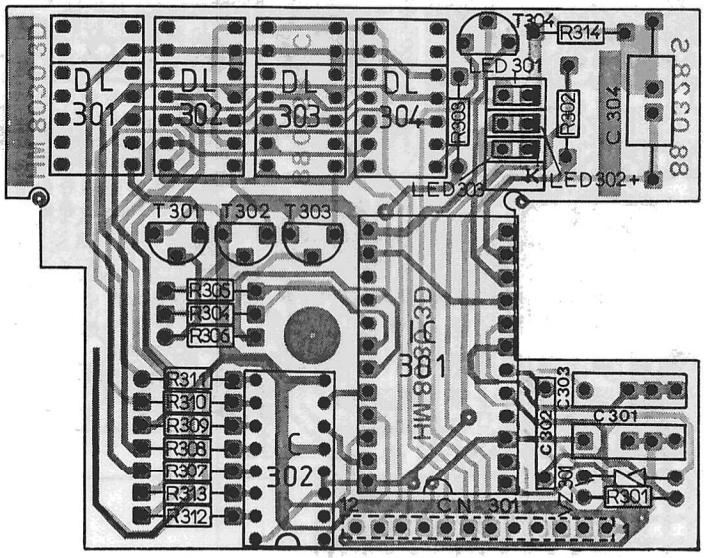
Steckerleiste; Versorgungsspannungen
Carte connecteur

Multipoint Connector; Supply Voltages
Placa conector de alimentacion



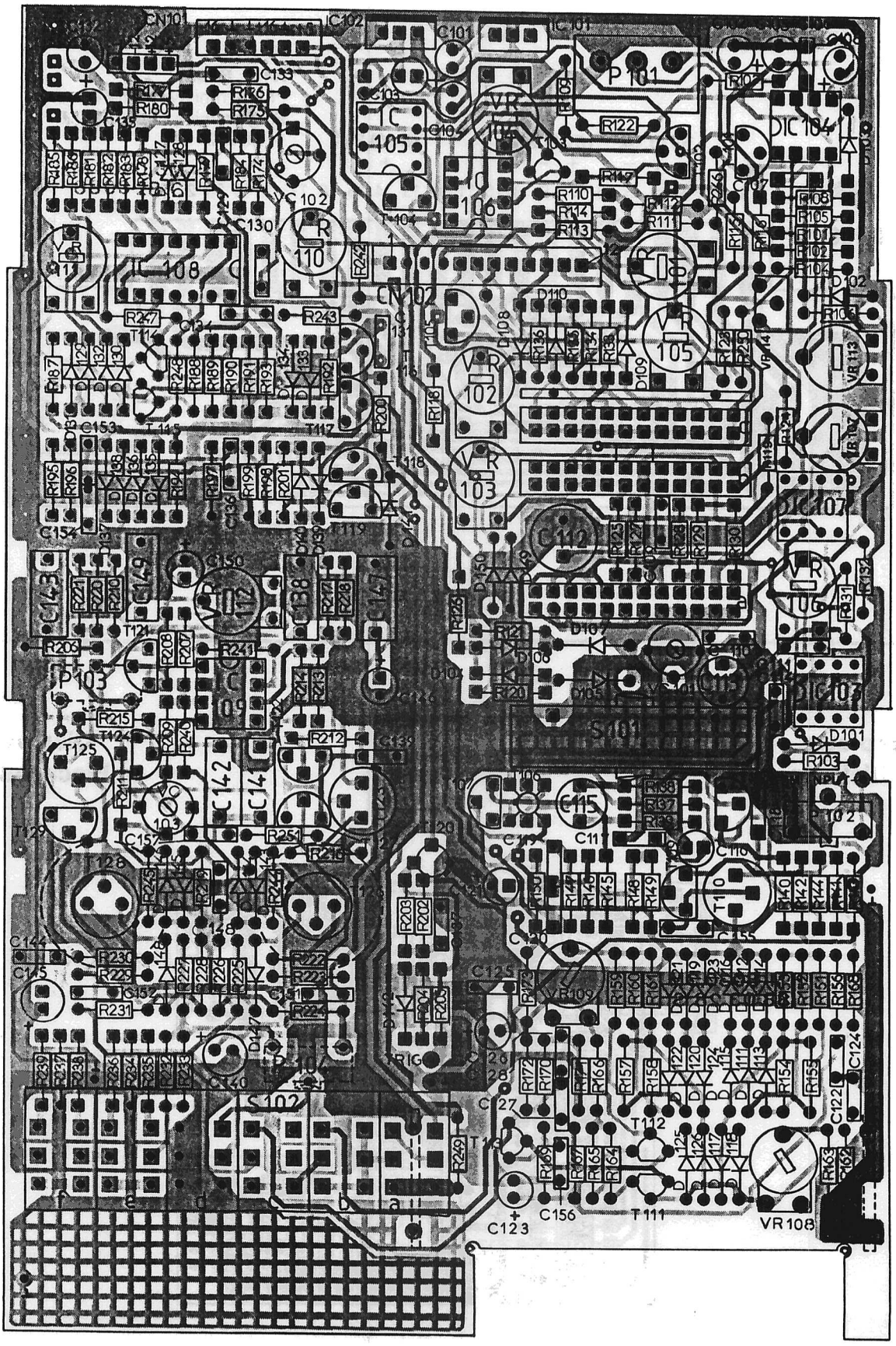
Anzeigeplatte
Carte affichage

Display Board
Placa indicador



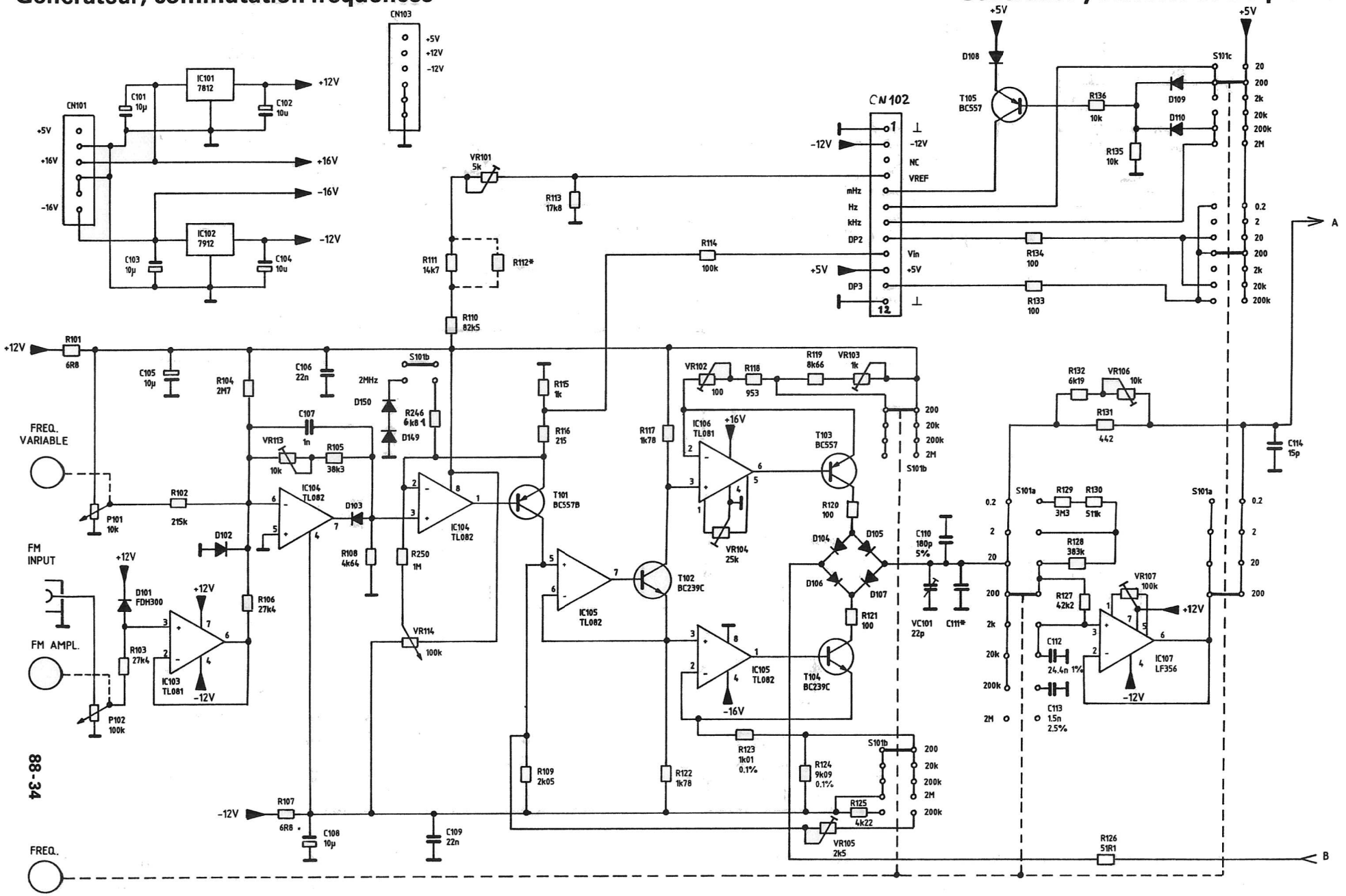
Bestückungsplan
Implantation de composants

Component Locations, Main Board
Localizacion de componentes; placa base



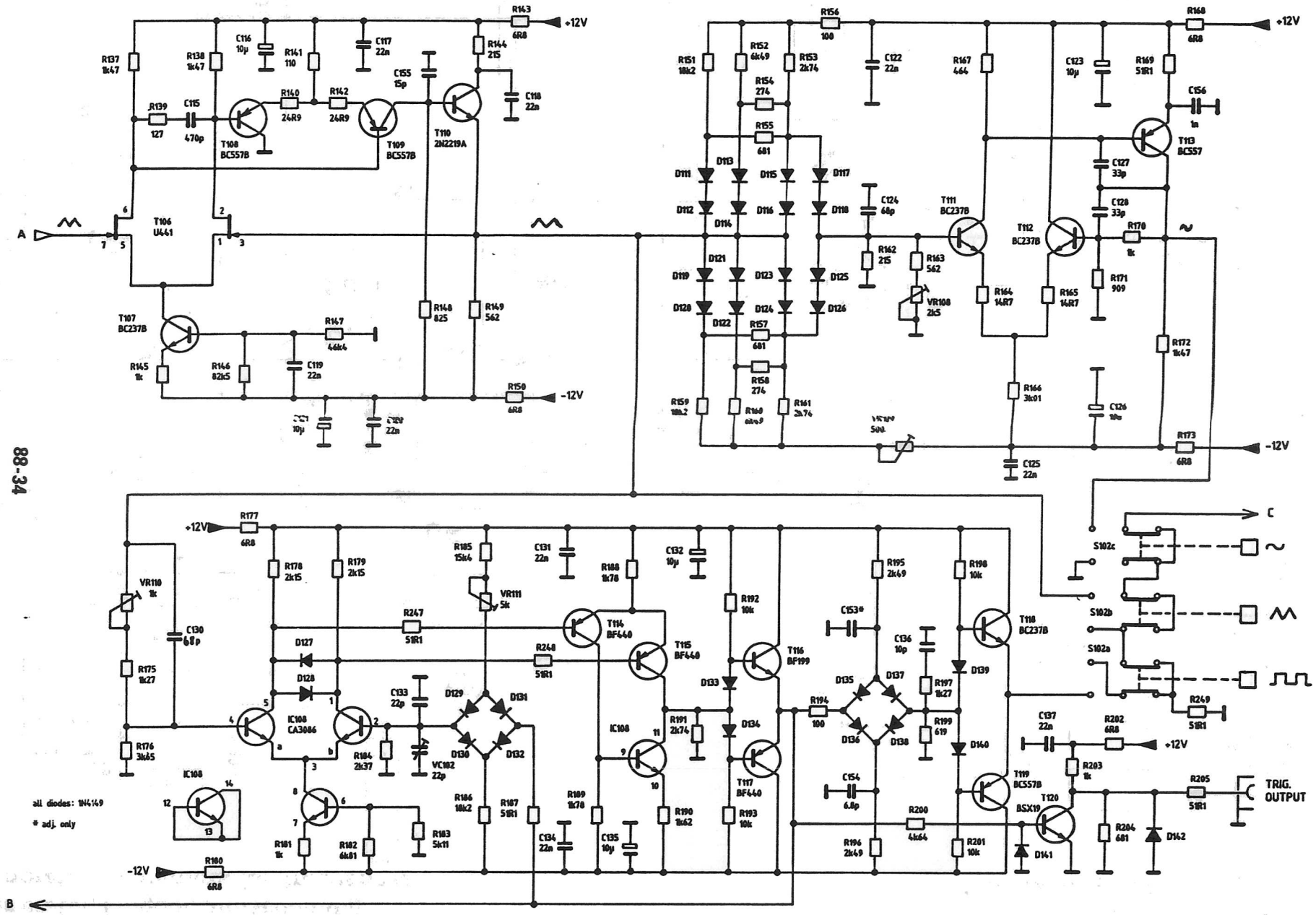
Generator, Frequenzumschaltung
Generateur; commutation frequences

Generator, Range Selection
Generador y selector de frequencia



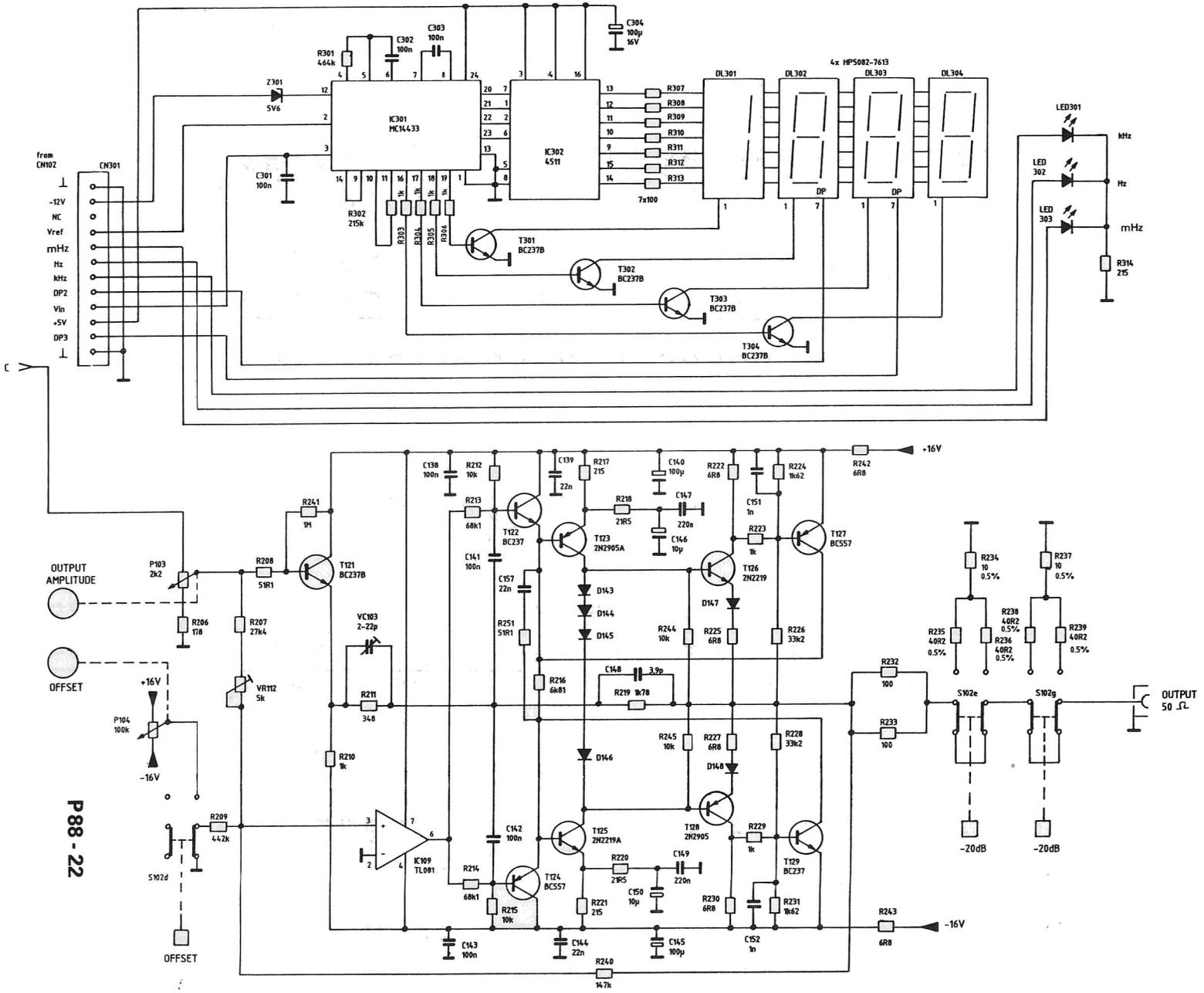
Vorverstärker, Signalformung
Preamplificateur; mise en forme signaux

Buffer Amplifier, Signal Shaping
Amplificador separador y formación de la señal



Endverstärker, digitale Anzeige
Amplificateur final; affichage numerique

Output Amplifier; Digital Display
Amplificador de salida; Indicador digital



Liste elektronischer Teile

Electronic Parts List

Ref. No.	Description		
R 101	6.8 Ω	1%	TK 50
R 102	215 kΩ	1%	TK 50
R 103	27.4 kΩ	1%	TK 50
R 104	2.7 MΩ	1%	TK 50
R 105	38.3 kΩ	1%	TK 50
R 106	27.4 kΩ	1%	TK 50
R 107	6.8 Ω	1%	TK 50
R 108	4.64 kΩ	1%	TK 50
R 109	2.05 kΩ	1%	TK 50
R 110	82.5 kΩ	1%	TK 50
R 111	14.7 kΩ	1%	TK 50
R 112	adj. only		
R 113	17.8 kΩ	1%	TK 50
R 114	100 kΩ	1%	TK 50
R 115	1 kΩ	1%	TK 50
R 116	215 Ω	1%	TK 50
R 117	1.78 kΩ	1%	TK 50
R 118	953 Ω	1%	TK 50
R 119	8.66 kΩ	1%	TK 50
R 120	100 Ω	1%	TK 50
R 121	100 Ω	1%	TK 50
R 122	1.78 kΩ	1%	TK 50
R 123	1.01 kΩ	0.1%	TK 25
R 124	9.09 kΩ	0.1%	TK 25
R 125	4.22 kΩ	1%	TK 50
R 126	51.1 Ω	1%	TK 50
R 127	42.2 kΩ	1%	TK 50
R 128	383 kΩ	1%	TK 50
R 129	3.3 MΩ	1%	TK 50
R 130	511 kΩ	1%	TK 50
R 131	442 Ω	1%	TK 50
R 132	6.19 kΩ	1%	TK 50
R 133	100 Ω	1%	TK 50
R 134	100 Ω	1%	TK 50
R 135	10 kΩ	1%	TK 50
R 136	10 kΩ	1%	TK 50
R 137	1.47 kΩ	1%	TK 50
R 138	1.47 kΩ	1%	TK 50
R 139	127 kΩ	1%	TK 50
R 140	24.9 Ω	1%	TK 50
R 141	110 Ω	1%	TK 50
R 142	24.9 Ω	1%	TK 50
R 143	6.8 Ω	5%	TK 100
R 144	215 Ω	1%	TK 50
R 145	1 kΩ	1%	TK 50
R 146	82.5 kΩ	1%	TK 50
R 147	46.4 kΩ	1%	TK 50
R 148	825 Ω	1%	TK 50
R 149	562 Ω	1%	TK 50
R 150	6.8 Ω	5%	TK 100
R 151	18.2 kΩ	1%	TK 50
R 152	6.49 kΩ	1%	TK 50
R 153	2.74 kΩ	1%	TK 50
R 154	274 Ω	1%	TK 50
R 155	681 Ω	1%	TK 50
R 156	100 kΩ	1%	TK 50
R 157	681 Ω	1%	TK 50
R 158	274 Ω	1%	TK 50
R 159	18.2 kΩ	1%	TK 50
R 160	6.49 kΩ	1%	TK 50
R 161	2.74 kΩ	1%	TK 50
R 162	215 Ω	1%	TK 50
R 163	562 Ω	1%	TK 50
R 164	14.7 Ω	1%	TK 50
R 165	14.7 Ω	1%	TK 50
R 166	3.01 kΩ	1%	TK 50
R 167	464 Ω	1%	TK 50
R 168	6.8 Ω	5%	TK 100
R 169	51.1 Ω	1%	TK 50
R 170	1 kΩ	1%	TK 50
R 171	909 Ω	1%	TK 50
R 172	1.47 kΩ	1%	TK 50
R 173	6.8 Ω	5%	TK 100
R 175	1.27 kΩ	1%	TK 50
R 176	3.65 kΩ	1%	TK 50
R 177	6.8 Ω	5%	TK 100
R 178	2.15 kΩ	1%	TK 50
R 179	2.15 kΩ	1%	TK 50
R 180	6.8 Ω	5%	TK 100
R 181	1 kΩ	1%	TK 50
R 182	6.81 kΩ	1%	TK 50
R 183	5.11 kΩ	1%	TK 50
R 184	2.37 kΩ	1%	TK 50
R 185	15.4 kΩ	1%	TK 50
R 186	18.2 kΩ	1%	TK 50
R 187	51.1 Ω	1%	TK 50
R 188	1.78 kΩ	1%	TK 50
R 189	1.78 kΩ	1%	TK 50
R 190	1.62 kΩ	1%	TK 50
R 191	2.74 kΩ	1%	TK 50
R 192	10 kΩ	1%	TK 50
R 193	10 kΩ	1%	TK 50
R 194	100 Ω	1%	TK 50
R 195	2.49 kΩ	1%	TK 50
R 196	2.49 kΩ	1%	TK 50
R 197	1.27 kΩ	1%	TK 50
R 198	10 kΩ	1%	TK 50
R 199	619 Ω	1%	TK 50
R 200	4.64 kΩ	1%	TK 50
R 201	10 kΩ	1%	TK 50
R 202	6.8 Ω	5%	TK 100
R 203	1 kΩ	1%	TK 50
R 204	681 Ω	1%	TK 50
R 205	51.1 Ω	1%	TK 50
R 206	178 Ω	1%	TK 50
R 207	27.4 kΩ	1%	TK 50
R 208	51.1 Ω	1%	TK 50
R 209	442 kΩ	1%	TK 50
R 210	1 kΩ	1%	TK 50
R 211	348 Ω	1%	TK 50
R 212	10 kΩ	1%	TK 50
R 213	68.1 kΩ	1%	TK 50
R 214	68.1 kΩ	1%	TK 50
R 215	10 kΩ	1%	TK 50
R 216	6.81 kΩ	1%	TK 50
R 217	215 Ω	1%	TK 50
R 218	21.5 Ω	1%	TK 50
R 219	1.78 kΩ	1%	TK 50
R 220	21.5 Ω	1%	TK 50
R 221	215 Ω	1%	TK 50
R 222	6.8 Ω	5%	TK 100
R 223	1 kΩ	1%	TK 50
R 224	1.62 kΩ	1%	TK 50
R 225	6.8 Ω	5%	TK 100
R 226	33.2 kΩ	1%	TK 50
R 227	6.8 Ω	5%	TK 100
R 228	33.2 kΩ	1%	TK 50
R 229	1 k	1%	TK 50
R 230	6.8 Ω	5%	TK 50
R 231	1.62 kΩ	1%	TK 50
R 232	100 Ω	1%	TK 50
R 233	100 Ω	1%	TK 50
R 234	10 Ω	0.5%	TK 50
R 235	40.2 Ω	0.5%	TK 50
R 236	40.2 Ω	0.5%	TK 50
R 237	10 Ω	0.5%	TK 50
R 238	40.2 Ω	0.5%	TK 50
R 239	40.2 Ω	0.5%	TK 50
R 240	147 kΩ	1%	TK 50
R 241	1 MΩ	1%	TK 50
R 242	6.8 Ω	5%	TK 100
R 243	6.8 Ω	5%	TK 100
R 244	10 kΩ	1%	TK 50
R 245	10 kΩ	1%	TK 50
R 246	6.81 kΩ	1%	TK 50
R 247	51.1 Ω	1%	TK 50
R 248	51.1 Ω	1%	TK 50
R 249	51.1 Ω	1%	TK 50
R 250	1 MΩ	1%	TK 50
R 251	51.1 Ω	1%	TK 50
R 301	464 kΩ	1%	TK 50
R 302	215 kΩ	1%	TK 50
R 303	1 kΩ	1%	TK 50
R 304	1 kΩ	1%	TK 50
R 305	1 kΩ	1%	TK 50
R 306	1 kΩ	1%	TK 50
R 307	100 Ω	1%	TK 50
R 308	100 Ω	1%	TK 50
R 309	100 Ω	1%	TK 50
R 310	100 Ω	1%	TK 50
R 311	100 Ω	1%	TK 50
R 312	100 Ω	1%	TK 50
R 313	100 Ω	1%	TK 50
R 314	215 Ω	1%	TK 50
C 101	10 µF	35 V	
C 102	10 µF	35 V	
C 103	10 µF	35 V	
C 104	10 µF	35 V	
C 105	10 µF	35 V	
C 106	22 nF	63 V	10%
C 107	1 nF	63 V	10%
C 108	10 µF	35 V	
C 109	22 nF	63 V	20%

Liste elektronischer Teile

Electronic Parts List

Ref. No.	Description		
C 110	180 pF	63 V	5%
C 111	adj. only		
C 112	24.4 nF	63 V	1%
C 113	1.5 nF	160 V	2.5%
C 114	15 pF	63 V	10%
C 115	470 pF	160 V	
C 116	10 µF	35 V	
C 117	22 nF	63 V	20%
C 118	22 nF	63 V	20%
C 119	22 nF	63 V	20%
C 120	22 nF	63 V	20%
C 121	10 µF	35 V	
C 122	22 nF	63 V	20%
C 123	10 µF	35 V	
C 124	68 pF	63 V	10%
C 125	22 nF	63 V	20%
C 126	10 µF	35 V	
C 127	33 pF	500 V	5%
C 128	33 pF	500 V	5%
C 130	68 pF	63 V	10%
C 131	22 nF	63 V	20%
C 132	10 µF	35 V	
C 133	22 pF	63 V	10%
C 134	22 nF	63 V	20%
C 135	10 µF	35 V	
C 136	10 pF	63 V	10%
C 137	22 nF	63 V	20%
C 138	100 nF	100 V	20%
C 139	22 nF	63 V	20%
C 140	100 µF	35 V	
C 141	100 nF	100 V	20%
C 142	100 nF	100 V	20%
C 143	100 nF	100 V	20%
C 144	22 nF	63 V	20%
C 145	100 µF	35 V	
C 146	10 µF	35 V	
C 147	220 nF	100 V	20%
C 148	3.9 pF	63 V	10%
C 149	220 nF	100 V	20%
C 150	10 µF	35 V	
C 151	1 nF	63 V	10%
C 152	1 nF	63 V	10%
C 153	adj. only		
C 154	6.8 pF	400 V	5%
C 155	15 pF	63 V	10%
C 156	1 nF	63 V	10%
C 157	22 nF	63 V	20%
C 301	100 nF	100 V	20%
C 302	100 nF	100 V	20%
C 303	100 nF	100 V	20%
C 304	100 µF	16 V	
D 101		FDH300	
D 102 - D 150		1N4149	
IC 101	7812		
IC 102	7912		

Ref. No.	Description
IC 103	TL 081
IC 104	TL 082
IC 105	TL 082
IC 106	TL 081
IC 107	LF 356
IC 108	CA 3086
IC 109	TL 081
IC 301	MC 14433
IC 302	4511
LED 301	TLSO 5101
LED 302	TLSO 5101
LED 303	TLSO 5101
DL 301	HP 5082-7613
DL 302	HP 5082-7613
DL 303	HP 5082-7613
DL 304	HP 5082-7613
T 101	BC557B
T 102	BC239C
T 103	BC557
T 104	BC239C
T 105	BC557
T 106	U441
T 107	BC237B
T 108	BC557B
T 109	BC557B
T 110	2N2219A
T 111	BC237B
T 112	BC237B
T 113	BC557
T 114	BF440
T 115	BF440
T 116	BF199
T 117	BF440
T 118	BC237B
T 119	BC557B
T 120	BSX19
T 121	BC237B
T 122	BC237
T 123	2N2905A
T 124	BC557
T 125	2N2219A
T 126	2N2219
T 127	BC557
T 128	2N2905
T 129	BC237
T 301	BC237B
T 302	BC237B
T 303	BC237B
T 304	BC237B
VR 101	5k
VR 102	100Ω
VR 103	1k
VR 104	25k

Ref. No.	Description	
VR 105	2.50 kΩ	
VR 106	10 kΩ	
VR 107	100 kΩ	
VR 108	2.5 kΩ	
VR 109	500 Ω	
VR 110	1 kΩ	
VR 111	5 kΩ	
VR 112	5 kΩ	
VR 113	10 kΩ	
VR 114	100 kΩ	
P 101	10 kΩ	lin., 1:4.6
P 102	100 kΩ	
P 103	2.2 kΩ	
P 104	100 kΩ	
VC 101	2-22 pF	
VC 102	2-22 pF	
VC 103	2-22 pF	
Z 301	5V6	