

**TG8**

**Bang&Olufsen**

## CONTENTS

	Page
Technical specifications .....	2
Function .....	4
Oscillator .....	4
AGC .....	4
Sync amplifier .....	4
Sine output amplifier .....	5
Sine/square conversion, output amplifier .....	5
600 ohm attenuator .....	5
Voltmeter .....	5
Power supply .....	5
Frequency counter .....	6
Adjustments .....	7
Parts list .....	12
Block diagram .....	21
Diagrams .....	22
Oscillator and sync amplifier .....	22
Output amplifier - 600 ohm attenuator .....	23
Voltmeter and power supply .....	24
Frequency counter .....	25

## TECHNICAL SPECIFICATIONS

### "OUTPUT 600 OHM"

#### Frequency

Frequency range: 1Hz - 100kHz in 5 ranges.  
Frequency display: 4-digit frequency counter.  
Accuracy:  $\pm 1$  digit.

#### Output

Waveform: Sine, square.  
Attenuator, push-button: 3.16mV - 10V EMF in 8 ranges.  
Accuracy:  $\pm 0.2$ dB.  
Attenuator, variable: -10dB to 0dB.  
Frequency characteristics, sine:  $\pm 0.1$ dB, 1Hz - 100kHz.  
Output impedance: 600 ohm  $\pm 1\%$ .  
Rise time, square:  $< 200$ nS.  
Distortion, sine:  
10Hz - 20Hz  $< 0.001\%$  (-100dB)  
20Hz - 20kHz  $< 0.0005\%$  (-106dB)  
typ. 0.00015%  
20kHz - 50kHz  $< 0.001\%$  (-100dB)  
50kHz - 100kHz  $< 0.003\%$  (-90dB).

### "SYNC OUTPUT "

Waveform: Sine.  
Output voltage: 1V EMF.  
Output impedance: 1K ohm.  
Temperature range: 10°C - 40°C

Specifications reached after 5 minutes.

"COMM": Chassis of "OUTPUT 600 OHM" is galvanically connected with the cabinet and "SYNC 1V" chassis.

"FLOAT": Chassis of "OUTPUT 600 OHM" is galvanically separated from the cabinet and "SYNC 1V" chassis. The capacitance between the two chassis is approx. 20nF.

Power supply: 110/220V, 50-60Hz.

Consumption: Approx. 16W.

Dimensions, cabinet: 325 x 219 x 80 mm.

Weight: 3.9 kilo.

Subject to modifications without prior notice.

## FUNCTION

### Oscillator

The operational amplifiers IC8-IC9 operate as integrators, each with  $90^\circ$  phase angle and, together with the summation amplifier IC7, they constitute a state-variable oscillator.

Together with R15 and R20 the capacitors C20 → C29 constitute the fixed frequency determining links of the oscillator in the five frequency ranges.

As volume controller the potentiometers 2PA-B are coupled to the integrators IC8 and IC9 whereby the frequency of the oscillator becomes variable.

Together with P2A-B the resistors R14 and R18 determine the bottom frequency limit in the five frequency ranges.

The transistor TR3, TR4 and their associated components ensure that the output signal of the oscillator on frequency shifting and in similar situations will increase to approx. 3.5dB above the nominal signal level.

### AGC

The output voltage of the oscillator is kept at constant level via an AGC circuit made up of the integrator IC10, a downstream low-pass filter designed around IC11 and the regulator device TR5.

The signal voltage from IC7 and IC9 which, mutually, are  $180^\circ$  phase-shifted is input via R23-R24 to the rectifier diodes D16-D17 where the rectification of the two signals takes place. Due to the mutual phase characteristics of the two signals a DC current with a ripple frequency of two times the signal frequency of the oscillator is applied to the integrator IC10.

The reference voltage of the AGC circuit is formed across the diode D15.

The signal level of the oscillator is adjusted with P3.

The time constants of the integrator are altered via the frequency shift device and from the integrator IC10 an AGC voltage, overlaid with a ripple, is output.

Since an AGC voltage with a considerable ripple voltage will cause distortion in the oscillator, the AGC voltage will be filtered in a 3rd order low-pass filter prior to applying the AGC voltage to the regulator device TR5.

The low-pass filter is made up of IC11 and its associated components. Via the frequency shift device the cutoff frequency of the low-pass filter is aligned with the five frequency ranges of the oscillator.

The AGC regulator device consists of a field-effect transistor incorporated as variable resistor in the feedback branch R11, R53.

In the frequency range 1 → 10Hz the regulating time of the AGC is reduced by increasing the oscillating frequency at the instant of shifting. When the x1 frequency range is activated IC13 is preset, the relay RL1 will pull via TR6 whereby R13, R17 are coupled in the oscillator and this will increase the oscillating frequency of the oscillator. The signal of the oscillator is detected via D12, D13 and input to the comparator IC11.

At sufficient signal level the comparator IC11 will go high (+15V) and will clear IC13. The relay will drop out and the oscillator will continue to oscillate at its correct oscillating frequency.

### Sync Amplifier

The Sync amplifier consists of TR7, IC14, TR8 and associated components.

The output of the "SYNC" is permanently connected to the chassis.

A galvanic separation between the "SYNC" output to chassis and the oscillator output to chassis ("OUTPUT 600 OHM") is obtained by passing the oscillator signal to the "SYNC" output via an optocoupler. When "COMM" is activated, the oscillator and the "SYNC" output to the chassis are galvanically connected; when "FLOAT" is activated, the oscillator and the "SYNC" output are galvanically separated, i.e. only capacitively connected by 20nF. With P4 the signal level of the "SYNC" output is adjusted to 1V.

### Sine Output Amplifier

The oscillator signal is passed via the "OFF" and "v" switches to the sine output amplifier. The sine output amplifier functions as an inverting amplifier and by means of component selection, compensation etc. it is optimized for sine reproduction with low distortion. The output stage operates in class A with a crossover current of 27mA in the output stage, adjustable with P7.

### Sine/square-wave Conversion, Output Amplifier

The sine signal from the oscillator is output and converted to a square-wave signal in a Schmitt trigger consisting of TR25, TR26. A symmetrical adjustment of the square-wave signal is made with P9.

Via D31, TR27 the square-wave signal is passed to an amplifier stage designed around TR28...TR31 in which the rise/fall times of the square signal are reduced and the signal level is clamped symmetrically around zero volt. Via the volume control a complementary-symmetrical push-pull output stage TR32, TR33 is input to the square wave.

### 600 Ohm Attenuator

The attenuator is designed as a  $\pi$ -link attenuator with 10dB attenuation per link.

The output impedance is constantly 600 ohm.

### Voltmeter

The measuring signal for the voltmeter is output across R214 in the 600 ohm attenuator and passed to the input amplifier TR35-TR36 of the voltmeter in which the signal after an amplification of approx. 3.5dB is input to a mean value detector designed around TR37-TR38. The rectified signal is output from the detector across R133 and input to the differential amplifier IC17.

On the output of IC17 a potential is output which is an expression of the current through R133. In order to remove the AC component from the pulsing

DC voltage which IC17 is outputting, the DC voltage in the frequency range 1 → 10Hz is passed through a 3rd order low-pass filter IC18.

In the remaining frequency ranges the 3rd order low-pass filter is cut out via the x1 frequency switch.

From IC18 the DC voltage, via the sensitivity adjustment P13/P14 is passed to meter instrument of the voltmeter.

#### Power Supply

The power supply  $\pm 24V$  for the sine and square wave output amplifier is stabilized with IC1-IC2 while the power  $\pm 15V$  for the oscillator and the AGC amplifier is supplied by IC3-IC4.

The supply voltage  $\pm 14V$  is stabilized and filtered by D6, D7 and TR1.

The voltage +5V for the frequency counter is stabilized with IC5, the chassis of which, furthermore, is identical with the cabinet chassis irrespective of the position of the "COMM" - "FLOAT" switch.

In the +5V transformer winding a +14V (A) voltage is generated by voltage doubling, with C15-D9-D10, for the supply of the sync amplifier of the oscillator.

#### Frequency Counter

The frequency counter is designed around IC28, a 4-digit counter with multiplexed 7-segment driver. The multiplex frequency triggers at approx. 1000Hz.

The timebase oscillator oscillates at the crystal frequency of 3,2768MHz.

The crystal frequency is sub-divided into 20Hz and 2Hz (B4-B3) with IC20-IC21.

One of the two timebase frequencies is selected via IC26 and is further sub-divided into 10Hz and 1Hz with IC22 prior to being input, via IC23, to the LATCH input of the counter. In the oscillator frequency ranges x1, x10 and x100 the timebase frequency 1Hz is used, in the frequency ranges x1k, x10k the timebase frequency 10Hz is used.

In order to avoid "flickering" of the least significant digit (DP4), each timebase startup is synchronized with the counter frequency - this synchronization is implemented via IC22-IC23.

The counter frequency is output from the "SYNC" output of the oscillator and input to TR49-TR45 in which the sine signal is converted to a square signal.

In the frequency range x10K the counter frequency is sub-divided by 10 in IC24, while in the remaining frequency ranges the counter frequency is diverted around IC24.

In the frequency range x100 and x1K the counter frequency is passed unchanged to the CLK input on IC28.

In the lower frequency ranges x10 and x1 a phase-locked oscillator IC29 is inserted in the signal path of the counter frequency whereby gate times of 10 and 100 seconds in the lower frequency ranges are avoided.

As mentioned, the gate time in the two lowest frequency ranges is 1 second. IC29 is phase-locked on an oscillator frequency 10, respectively 100 times higher than the counter frequency, and this oscillator frequency is input as counter frequency to IC28 instead.

## ADJUSTMENT

1. The meter instrument is automatically zeroing.
2. Connect an ohmmeter between chassis on "SYNC. 1V" and the BNC socket on "OUTPUT 600 OHM".

Check: "FLOAT" activated  $\rightarrow \infty \Omega$

"COMM." activated  $\rightarrow 0 \Omega$

### 3. Check Frequency Range

Switch on the TG8 (activate "ON")

ATTENUATOR: 10V

MODE:  $\sim$

FREQUENCY (var.): min.

1. Check FREQUENCY: 1  $\rightarrow f < 1\text{Hz}$   
10  $\rightarrow f < 10\text{Hz}$   
100  $\rightarrow f < 0.1\text{kHz}$   
1K  $\rightarrow f < 1.0\text{kHz}$   
10K  $\rightarrow f < 10.0\text{kHz}$

FREQUENCY (var.): max.

2. Check FREQUENCY: 1  $\rightarrow f > 10\text{Hz}$   
10  $\rightarrow f > 100\text{Hz}$   
100  $\rightarrow f > 1.0\text{kHz}$   
1K  $\rightarrow f > 10.0\text{kHz}$   
10K  $\rightarrow f > 100.0\text{kHz}$

### 4. No-load Current

MODE: OFF

Adjust P7 until a reading of 900mV is obtained across R76.

#### Offset

MODE: Set the three MODE buttons in their released positions.

Adjust P6 until a reading of  $< \pm 30\text{V DC}$  is obtained on OUTPUT 600 OHM.



5. Square Symmetry

MODE: 

FREQUENCY: 1K ( $f \sim 10\text{kHz}$ ).

VOLTAGE: max.

Connect an oscilloscope to OUTPUT 600 OHM.

Adjust P9 until a symmetrical square is obtained.

Check that  $t_r$  &  $t_f < 150\text{nS}$ .

6. AC Signal Level, AGC

FREQUENCY: 100 ( $f \sim 1\text{kHz}$ ).

Adjust P1 until a reading of 25mV is obtained across TR5.

7. Output Voltage

Connect a mean value reading digital voltmeter (e.g. FLUKE 8600A) to OUTPUT 600 OHM.

Adjust the square with P10 to 11.17V AC.  
(10.05V sine  $\times 1.111$ ).

MODE:  $\sim$

Adjust the sine with P3 to 10.05V AC.

Turn the VOLTAGE potentiometer to 10.00V AC.

Check the attenuator over 10V  $\rightarrow$  3 mV.  
(tolerance  $\pm 0.2\text{dB}$ ).

8. Voltmeter

MODE: OFF

Attenuator: 10V

Adjust the meter instrument to zero with P12.

MODE:  $\sim$

Attenuator: 3V


Adjust P14 ( $\sim$ ) to 10 on the meter instrument.

MODE: 

Attenuator: 10V

Turn the VOLTAGE potentiometer to 11.11V AC.

Attenuator. 3V

Adjust P13 () to 10 on the meter instrument.

9. Check VOLTAGE potentiometer

VOLTAGE: min.

Check that the meter instrument is at  $< -10\text{dB}$ .

MODE:  $\sim$

Check that the meter instrument is at  $< -10\text{dB}$ .

10. SYNC. 1V

Adjust with P4 the output from the SYNC. 1V to 1.03V AC.

Check the sine signal from the SYNC. 1V with an oscilloscope.

MODE: 10K ( $f \sim 100\text{kHz}$ )

Check that  $U_{\text{O SYNC. 1V}} = 1\text{V AC} \pm 3\text{dB}$ .

11. Adjust the 2nd Harmonic of THD at 100kHz



MODE:  $\sim$

Attenuator: 10V

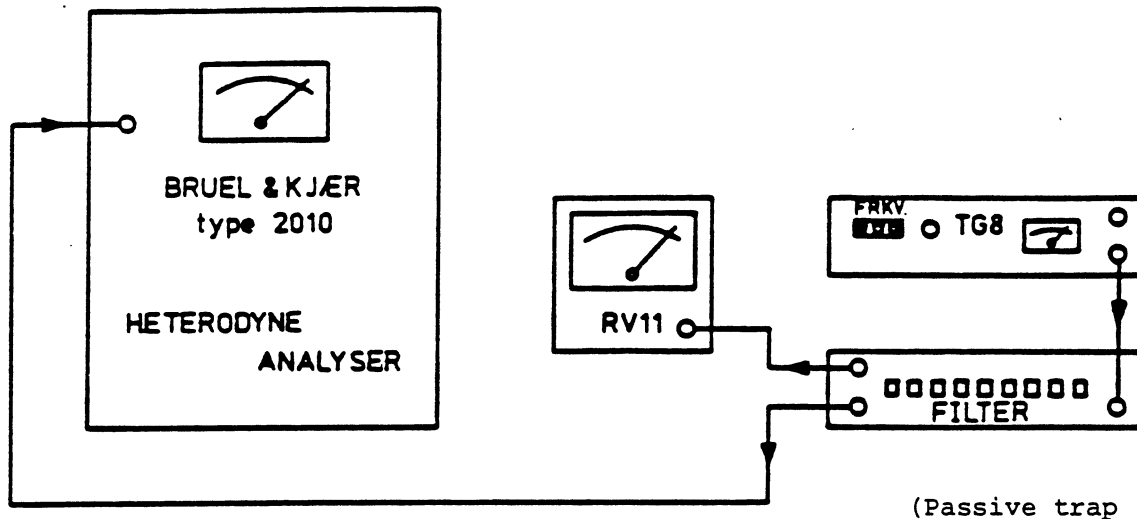
VOLTAGE: max.

Adjust P5 to minimum 2nd harmonic at 100kHz.  
(Test rig: see appendix 1).

12. Check THD with the test rig (appendix 1) in the following ranges:

<u>Range</u>	<u>Frequency</u>	<u>MAX. THD</u>
x 1	10Hz	< -100dB (0.001%)
x 10	10Hz	< -100dB (0.001%)
x 10	20Hz	< -106dB (0.0005%)
x 10	100Hz	
x 100	100Hz	
x 100	1kHz	
x 1K	1kHz	
x 1K	10kHz	
x 10K	10kHz	
x 10K	20kHz	
x 10K	50kHz	
x 10K	100kHz	

## APPENDIX 1



### Principle

- 1) Select the frequency to be THD metered on the FILTER BOX.
- 2) Adjust the frequency on TG8 until the 1st harmonic (the fundamental frequency) has been attenuated by 50dB - to be metered with RV11.
- 3) Input the fundamental frequency, now attenuated by 50dB, to B&K 2010 - search and measure the 2nd and 3rd harmonics.

### Typical metering result, 2nd harmonic

2nd harmonic, measured with B&K 2010 =	- 75.0dB
fund. frequency - 2nd harm. filter attenuated $-(50-9.5)$ dB =	- 40.5dB
→ 2nd harmonic distortion:	- 115.5dB

### Typical metering result, 3rd harmonic

3rd harmonic, measured with B&K 2010 =	- 78,0dB
fund. frequency - 3rd harm. filter attenuated $-(50-4.5)$ dB =	- 45.5dB
→ 3rd harmonic distortion:	- 123.5dB

For frequencies  $\leq f = 50$ kHz the HP spectrum analyzer 3580A is recommended.

# STYKLISTE/PARTS LIST

## 1. Modstande/Resistors

R1	4,02K $\Omega$	1%	0,25W	5020212
R2	220 $\Omega$	5%	0,25W	5010092
R3	4,02K $\Omega$	1%	0,25W	5020212
R4	220 $\Omega$	5%	0,25W	5010092
R5	220 $\Omega$	5%	0,25W	5010092
R6	22K $\Omega$	5%	0,25W	5010079
R7	220 $\Omega$	5%	0,25W	5010092
R8	100 $\Omega$	5%	0,25W	5010065
R9	22K $\Omega$	5%	0,25W	5010079
R10	1K $\Omega$	5%	0,25W	5010040
R11	10,0K $\Omega$	1%	0,25W	5020110
R12	2,00K $\Omega$	1%	0,25W	5020199
R13	330 $\Omega$	5%	0,25W	5010044
R14	536 $\Omega$	1%	0,25W	5020594
R15	3,16K $\Omega$	1%	0,25W	5020207
R16	20,0K $\Omega$	1%	0,25W	5020236
R17	330 $\Omega$	5%	0,25W	5010044
R18	536 $\Omega$	1%	0,25W	5020594
R19	2,00K $\Omega$	1%	0,25W	5020199
R20	3,16K $\Omega$	1%	0,25W	5020207
R21	82 $\Omega$	5%	0,25W	5010056
R22	100 $\Omega$	5%	0,25W	5010065
R23	10,0K $\Omega$	1%	0,25W	5020110
R24	10,0K $\Omega$	1%	0,25W	5020110
R25	10,0K $\Omega$	1%	0,25W	5020110
R26	1K $\Omega$	5%	0,25W	5010040
R27	22K $\Omega$	5%	0,25W	5010079
R28	6,8K $\Omega$	5%	0,25W	5010052
R29	5,6K $\Omega$	5%	0,25W	5010041
R30	1,5K $\Omega$	5%	0,25W	5010247
R31	100 $\Omega$	5%	0,25W	5010065
R32	100 $\Omega$	5%	0,25W	5010065
R33	2,2M $\Omega$	10%	0,25W	5010245
R34	820K $\Omega$	5%	0,25W	5010505
R35	120K $\Omega$	5%	0,25W	5010047
R36	12K $\Omega$	5%	0,25W	5010046
R37	680 $\Omega$	5%	0,25W	5010144
R38	3,3M $\Omega$	5%	0,25W	5010848
R39	1M $\Omega$	5%	0,25W	5010054
R40	150K $\Omega$	5%	0,25W	5010063
R41	15K $\Omega$	5%	0,25W	5010053
R42	680 $\Omega$	5%	0,25W	5010144
R43	2,2M $\Omega$	10%	0,25W	5010245
R44	820K $\Omega$	5%	0,25W	5010505
R45	120K $\Omega$	5%	0,25W	5010047
R46	12K $\Omega$	5%	0,25W	5010046
R47	680 $\Omega$	5%	0,25W	5010144
R48	10K $\Omega$	5%	0,25W	5010059
R49	100K $\Omega$	1%	0,25W	5020263
R50	100K $\Omega$	1%	0,25W	5020263
R51	383K $\Omega$	1%	0,25W	5020624
R52	100K $\Omega$	1%	0,25W	5020263
R53	270 $\Omega$	5%	0,25W	5010000
R54	4,7K $\Omega$	5%	0,25W	5010048
R55	4,7K $\Omega$	5%	0,25W	5010048
R56	10K $\Omega$	5%	0,25W	5010059
R57	33K $\Omega$	5%	0,25W	5010075
R58	10K $\Omega$	5%	0,25W	5010059

R59	1K $\Omega$	5%	0,25W	5010040
R60	12K $\Omega$	5%	0,25W	5010046
R61	1,5K $\Omega$	5%	0,25W	5010247
R62	1K $\Omega$	5%	0,25W	5010040
R63	10K $\Omega$	5%	0,25W	5010059
R64	150 $\Omega$	5%	0,25W	5010057
R65	100 $\Omega$	5%	0,25W	5010065
R66	100 $\Omega$	5%	0,25W	5010065
R67	1,00K $\Omega$	1%	0,25W	5020188
R68	1,69K $\Omega$	1%	0,25W	5020197
R69	22 $\Omega$	5%	0,25W	5010448
R70	1,2K $\Omega$	5%	0,25W	5010153
R71	27 $\Omega$	5%	0,25W	5010403
R72	18K $\Omega$	5%	0,25W	5010135
R73	22K $\Omega$	5%	0,25W	5010079
R74	6,8K $\Omega$	5%	0,25W	5010052
R75	120 $\Omega$	5%	0,25W	5010128
R76	33 $\Omega$	5%	0,25W	5010253
R77	33 $\Omega$	5%	0,25W	5010253
R78	536 $\Omega$	1%	0,25W	5020594
R79	120 $\Omega$	5%	0,25W	5010128
R80	220 $\Omega$	5%	0,25W	5010092
R81	18K $\Omega$	5%	0,25W	5010135
R82	8,25K $\Omega$	1%	0,25W	5020565
R83	3,24K $\Omega$	1%	0,25W	5020208
R84	14,7 $\Omega$	1%	0,25W	5020168
R85	10K $\Omega$	5%	0,25W	5010059
R86	14,7 $\Omega$	1%	0,25W	5020168
R87	1,69K $\Omega$	1%	0,25W	5020197
R88	1,69K $\Omega$	1%	0,25W	5020197

R91	22K $\Omega$	5%	0,25W	5010079
R92	22K $\Omega$	5%	0,25W	5010079
R93	5,6K $\Omega$	5%	0,25W	5010041
R94	2,2K $\Omega$	5%	0,25W	5010064
R95	470 $\Omega$	5%	0,25W	5010058
R96	2,2K $\Omega$	5%	0,25W	5010064
R97	1,2K $\Omega$	5%	0,25W	5010153
R98	5,6K $\Omega$	5%	0,25W	5010041
R99	4,7K $\Omega$	5%	0,25W	5010048
R100	4,7K $\Omega$	5%	0,25W	5010048
R101	560 $\Omega$	5%	0,25W	5010067
R102	22K $\Omega$	5%	0,25W	5010079
R103	4,7K $\Omega$	5%	0,25W	5010048
R104	470 $\Omega$	5%	0,25W	5010058
R105	470 $\Omega$	5%	0,25W	5010058
R106	2,7K $\Omega$	5%	0,25W	5010298
R107	470 $\Omega$	5%	0,25W	5010058
R108	470 $\Omega$	5%	0,25W	5010058
R109	470 $\Omega$	5%	0,25W	5010058
R110	2,7K $\Omega$	5%	0,25W	5010298
R111	330 $\Omega$	5%	0,25W	5010044
R112	4,7K $\Omega$	5%	0,25W	5010048
R113	4,7K $\Omega$	5%	0,25W	5010048
R114	270 $\Omega$	5%	0,25W	5010000
R115	270 $\Omega$	5%	0,25W	5010000
R116	22 $\Omega$	5%	0,25W	5010448
R117	22 $\Omega$	5%	0,25W	5010448

R122	1,00M $\Omega$	1%	0,25W	5020288
R123	1K $\Omega$	5%	0,25W	5010040

R124	1K $\Omega$	5%	0,25W	5010040
R125	1,5K $\Omega$	5%	0,25W	5010247
R126	1K $\Omega$	5%	0,25W	5010040
R127	4,7K $\Omega$	5%	0,25W	5010048
R128	1K $\Omega$	5%	0,25W	5010040
R129	2,7K $\Omega$	5%	0,25W	5010298
R130	22K $\Omega$	5%	0,25W	5010079
R131	31,6 $\Omega$	1%	0,25W	5020170
R132	4,7K $\Omega$	5%	0,25W	5010048
R133	3,16 $\Omega$	1%	0,25W	5020207
R134	634K $\Omega$	1%	0,25W	5020359
R135	634K $\Omega$	1%	0,25W	5020359
R136	1,00M $\Omega$	1%	0,25W	5020288
R137	1,00M $\Omega$	1%	0,25W	5020288
R138	10K $\Omega$	5%	0,25W	5010059
R139	120K $\Omega$	5%	0,25W	5010047
R140	120K $\Omega$	5%	0,25W	5010047
R141	120K $\Omega$	5%	0,25W	5010047
R142	330K $\Omega$	5%	0,25W	5010117
R143	330K $\Omega$	5%	0,25W	5010117
R144	931 $\Omega$	1%	0,25W	5020314
R145	820 $\Omega$	5%	0,25W	5010068

R150	18K $\Omega$	5%	0,25W	5010135
R151	330K $\Omega$	5%	0,25W	5010117
R152	2,2K $\Omega$	5%	0,25W	5010064
R153	10K $\Omega$	5%	0,25W	5010059
R154	10K $\Omega$	5%	0,25W	5010059
R155	120 $\Omega$	5%	0,25W	5010128
R156	47K $\Omega$	5%	0,25W	5010045
R157	180K $\Omega$	5%	0,25W	5010072
R158	2,2K $\Omega$	5%	0,25W	5010064
R159	10K $\Omega$	5%	0,25W	5010059
R160	10K $\Omega$	5%	0,25W	5010059
R161	10K $\Omega$	5%	0,25W	5010059
R162	10K $\Omega$	5%	0,25W	5010059
R163	10K $\Omega$	5%	0,25W	5010059
R164	2,2K $\Omega$	5%	0,25W	5010064
R165	10K $\Omega$	5%	0,25W	5010059
R166	2,2K $\Omega$	5%	0,25W	5010064
R167	2,2K $\Omega$	5%	0,25W	5010064
R168	2,2K $\Omega$	5%	0,25W	5010064
R169	2,2K $\Omega$	5%	0,25W	5010064
R170	1M $\Omega$	5%	0,25W	5010054
R171	10K $\Omega$	5%	0,25W	5010059
R172	10K $\Omega$	5%	0,25W	5010059
R173	4,7K $\Omega$	5%	0,25W	5010048
R174	4,7K $\Omega$	5%	0,25W	5010048
R175	4,7K $\Omega$	5%	0,25W	5010048
R176	4,7K $\Omega$	5%	0,25W	5010048
R177	68 $\Omega$	5%	0,25W	5010039
R178	68 $\Omega$	5%	0,25W	5010039
R179	68 $\Omega$	5%	0,25W	5010039
R180	68 $\Omega$	5%	0,25W	5010039
R181	68 $\Omega$	5%	0,25W	5010039
R182	68 $\Omega$	5%	0,25W	5010039
R183	68 $\Omega$	5%	0,25W	5010039
R184	68 $\Omega$	5%	0,25W	5010039
R185	4,7K $\Omega$	5%	0,25W	5010048
R186	2,2K $\Omega$	5%	0,25W	5010064
R187	10K $\Omega$	5%	0,25W	5010059
R188	1K $\Omega$	5%	0,25W	5010040

R189	4,7K $\Omega$	5%	0,25W	5010048
R201	1,30K $\Omega$	1%	0,25W	5020569
R202	2,21K $\Omega$	1%	0,25W	5020568
R203	2,21K $\Omega$	1%	0,25W	5020568
R204	2,21K $\Omega$	1%	0,25W	5020568
R205	2,21K $\Omega$	1%	0,25W	5020568
R206	2,21K $\Omega$	1%	0,25W	5020568
R207	2,21K $\Omega$	1%	0,25W	5020568
R208	2,21K $\Omega$	1%	0,25W	5020568
R209	2,21K $\Omega$	1%	0,25W	5020568
R210	2,21K $\Omega$	1%	0,25W	5020568
R211	2,21K $\Omega$	1%	0,25W	5020568
R212	2,21K $\Omega$	1%	0,25W	5020568
R213	2,21K $\Omega$	1%	0,25W	5020568
R214	787 $\Omega$	1%	0,25W	5020567
R215	2,43K $\Omega$	1%	0,25W	5020578
R216	2,43K $\Omega$	1%	0,25W	5020578
R217	2,43K $\Omega$	1%	0,25W	5020578
R218	2,43K $\Omega$	1%	0,25W	5020578
R219	2,43K $\Omega$	1%	0,25W	5020578
R220	3,48K $\Omega$	1%	0,25W	5020209
R221	1,30K $\Omega$	1%	0,25W	5020569
R222	1,07K $\Omega$	1%	0,25W	5020189
R223	187K $\Omega$	1%	0,25W	5020483
R224	7,50K $\Omega$	1%	0,25W	5020226
R225	7,50K $\Omega$	1%	0,25W	5020226
R226	7,50K $\Omega$	1%	0,25W	5020226
R227	7,50K $\Omega$	1%	0,25W	5020226
R228	7,50K $\Omega$	1%	0,25W	5020226
R229	7,50K $\Omega$	1%	0,25W	5020226
R230	2,21K $\Omega$	1%	0,25W	5020568

## 2. Potentiometre/Potentiometers

~P1	250 $\Omega$	20%	0,1W	5370059
P2	2x5K $\Omega$	5%		5310114
~P3	100 $\Omega$	20%	0,1W	5370208
✓P4	22K $\Omega$	20%	0,1W	5370068
P5	100 $\Omega$	20%	0,1W	5370208
~P6	250 $\Omega$	20%	0,1W	5370059
~P7	2,2K $\Omega$	20%	0,1W	5370006
P8A+B	4,7K $\Omega$ +1K $\Omega$	10%		5310111
~P9	5K $\Omega$	20%	0,1W	5370058
-P10	250 $\Omega$	20%	0,1W	5370059
~P12	10K $\Omega$	20%	0,1W	5370074
~P13	250 $\Omega$	20%	0,1W	5370059
~P14	250 $\Omega$	20%	0,1W	5370059

## 3. Kondensatorer/Capacitors

C1	1000 $\mu$ F	-10+50%	35V	4200388
C2	1000 $\mu$ F	-10+50%	35V	4200388
C3	22 $\mu$ F	-10+100%	40V	4200121
C4	22 $\mu$ F	-10+100%	40V	4200121
C5	22 $\mu$ F	-10+100%	40V	4200121
C6	22 $\mu$ F	-10+100%	40V	4200121



C7	22μF	-10+100%	40V	4200121
C8	22μF	-10+100%	40V	4200121
C9	100μF	-10+100%	25V	4200403
C10	100μF	-10+100%	25V	4200403
C11	220μF	-10+100%	25V	4200184
C12	22μF	-10+100%	40V	4200121
C13	1nF	10%	100V	4010027
C14	1000μF	-10+100%	16V	4200312
C15	47μF	-10+100%	40V	4200415
C16	470μF	-10+100%	25V	4200174
C17	100μF	-10+100%	16V	4200129
C18	100μF	-10+100%	16V	4200129
C20	4,7μF	5%	100V	4130188
C21	4,7μF	5%	100V	4130188
C22	470nF	1%	160V	4130273
C23	470nF	1%	160V	4130273
C24	47nF	1%	160V	4130260
C25	47nF	1%	160V	4130260
C26	4,7nF	1%	63V	4100031
C27	4,7nF	1%	63V	4100031
C28	470pF	1%	630V	4100217
C29	470pF	1%	630V	4100217
C30	22pF	-10+100%	63V	4000183
C31	22pF	-10+100%	63V	4000183
C32	47pF	5%	63V	4000191
C33	47pF	5%	63V	4000191
C34	5,6pF		63V	4000086
C35	100nF	20%	63V	4130179
C36	100nF	20%	63V	4130179
C37	100nF	5%	63V	4130261
C38	4,7μF	20%	25V	4200477
C39	100μF	20%	10V	4200478
C40	3,3μF	10%	25V	4200485
C41	100μF	20%	10V	4200478
C42	1μF	10%	50V	4200426
C43	22μF	20%	10V	4200480
C44	4,7μF	20%	25V	4200477
C45	68nF	5%	63V	4130270
C46	100nF	5%	63V	4130261
C47	18nF	5%	63V	4130221
C48	1μF	20%	50V	4200426
C49	220μF	-10+100%	16V	4200126
C50	4,7nF	5%	50V	4010127
C51	100nF	20%	63V	4130179
C52	100nF	20%	63V	4130179
C53	100nF	20%	63V	4130179
C54	100nF	20%	63V	4130179
C55	100nF	20%	63V	4130179
C56	100pF	5%	63V	4000176
C58	10nF	5%	63V	4130220
C59	10pF	5%	63V	4000175
C60	1nF	10%	100V	4010027
C61	10pF	5%	63V	4000175
C62	22nF	-20+100%	40V	4010068
C63	22μF	-10+100%	40V	4200121
C64	22μF	-10+100%	40V	4200121
C65	1μF	5%	100V	4130182
C66	2,2pF		63V	4000073

C72	100pF	5%	63V	4000176
C73	1nF	10%	100V	4010027
C77	1,5nF	10%	100V	4010067
C78	1000µF	-10+50%	6,3V	4200547
C79	470µF	-10+100%	40V	4200304
C80	10pF	5%	63V	4000175
C81	4700µF	-10+50%	6V	4200558
C82	10µF	20%	16V	4200431
C83	15µF	20%	16V	4200562
C84	2,2µF	20%	50V	4200423
C85	0,47µF	20%	35V	4201058
C86	22µF	-10+100%	40V	4200121
C90	33pF	5%	63V	4000186
C91	33pF	5%	63V	4000186
C92	100µF	-10+100%	16V	4200129
C93	100pF	2%	63V	4000176
C94	10µF	20%	16V	4200431
C95	10µF	20%	16V	4200431
C96	10µF	20%	16V	4200431
C98	10nF	5%	63V	4130220

#### 4. Dioder/Diodes

D1	B80C1500	80V	1-1,5A	8300303
D2	1N4148	75V	80mA	8300131
D3	1N4148	75V	80mA	8300131
D4	1N4148	75V	80mA	8300131
D5	1N4148	75V	80mA	8300131
D6	ZPD15	15V		8300053
D7	ZPD15	15V		8300053
D8	B80C1500	80V	1-1,5A	8300303
D9	1N4148	75V	80mA	8300131
D10	1N4148	75V	80mA	8300131
D12	1N4148	75V	80mA	8300131
D13	1N4148	75V	80mA	8300131
D14	1N4148	75V	80mA	8300131
D15	BZV38	6,4V		8300283
D16	1N4148	75V	80mA	8300131
D17	1N4148	75V	80mA	8300131
D18	1N4148	75V	80mA	8300131
D19	1N4148	75V	80mA	8300131
D20	1N4148	75V	80mA	8300131
D21	1N4148	75V	80mA	8300131
D22	1N4148	75V	80mA	8300131
D23	1N4148	75V	80mA	8300131
D24	1N4148	75V	80mA	8300131
D25	1N4148	75V	80mA	8300131
D28	1N4148	75V	80mA	8300131
D29	1N4148	75V	80mA	8300131
D30	1N4148	75V	80mA	8300131
D31	ZPD10	10V		8300310
D32	1N4148	75V	80mA	8300131
D33	1N4148	75V	80mA	8300131
D34	ZPD4,7	4,7V		8300309

D35	ZPD4,7	4,7V		8300309
D36	ZPD5,6	5,6V		8300296
D37	ZPD5,6	5,6V		8300296
D38	1N4148	75V	80mA	8300131
D39	1N4148	75V	80mA	8300131
D40	AA143	25V	50mA	8300142
D41	AA143	25V	50mA	8300142
D42	AA143	25V	50mA	8300142
D43	AA143	25V	50mA	8300142

D50	1N4148	75V	80mA	8300131
D51	1N4148	75V	80mA	8300131
D52	1N4148	75V	80mA	8300131
D53	1N4148	75V	80mA	8300131
D54	1N4148	75V	80mA	8300131
D55	1N4148	75V	80mA	8300131
D56	1N4148	75V	80mA	8300131
D57	1N4148	75V	80mA	8300131
D58	1N4148	75V	80mA	8300131
D59	1N4148	75V	80mA	8300131
D60	1N4148	75V	80mA	8300131
D61	1N4148	75V	80mA	8300131
D62	1N4148	75V	80mA	8300131
D63	1N4148	75V	80mA	8300131
D64	LT-9000D			8330096
D65	LT-9000D			8330096

#### 5. Transistorer/Transistors

TR1	BC547B	NPN	8320097
TR2	BC547B	NPN	8320097
TR3	BC547B	NPN	8320097
TR4	BC557B	PNP	8320152
TR5	U1898E	FET	8320420
TR6	BC547B	NPN	8320097
TR7	BC547B	NPN	8320097
TR8	BC547B	NPN	8320097

TR10	BC550B	NPN	8320344
TR11	BC550B	NPN	8320344
TR12	BC557B	PNP	8320152
TR13	MPSH54	PNP	8320365
TR14	BC547B	NPN	8320097
TR15	MPSH04	NPN	8320549
TR16	BD137	NPN	8320292
TR17	BD138	PNP	8320241
TR18	MPSH54	PNP	8320365
TR19	MPSH04	NPN	8320549
TR20	BC547B	NPN	8320097
TR21	BC547B	NPN	8320097

TR25	BC557B	PNP	8320152
TR26	BC557B	PNP	8320152
TR27	BC557B	PNP	8320152
TR28	BC557B	PNP	8320152
TR29	BC547B	NPN	8320097

TR30	BC557B	PNP	8320152
TR31	BC547B	NPN	8320097
TR32	BC547B	NPN	8320097
TR33	BC557B	PNP	8320152
TR35	U1899E	FET	8320412
TR36	BC557B	PNP	8320152
TR37	BC547C	NPN	8320377
TR38	BC547C	NPN	8320377
TR40	MPSA13	NPN	8340054
TR41	MPSA13	NPN	8340054
TR42	MPSA13	NPN	8340054
TR43	MPSA13	NPN	8340054
TR44	BC557B	PNP	8320152
TR45	BC547B	NPN	8320097
TR46	BC547B	NPN	8320097
TR47	BC547B	NPN	8320097
TR48	U1899E	FET	8320412
TR49	U1899E	FET	8320412

#### 6. Integrerede kredse/Integrated Circuits

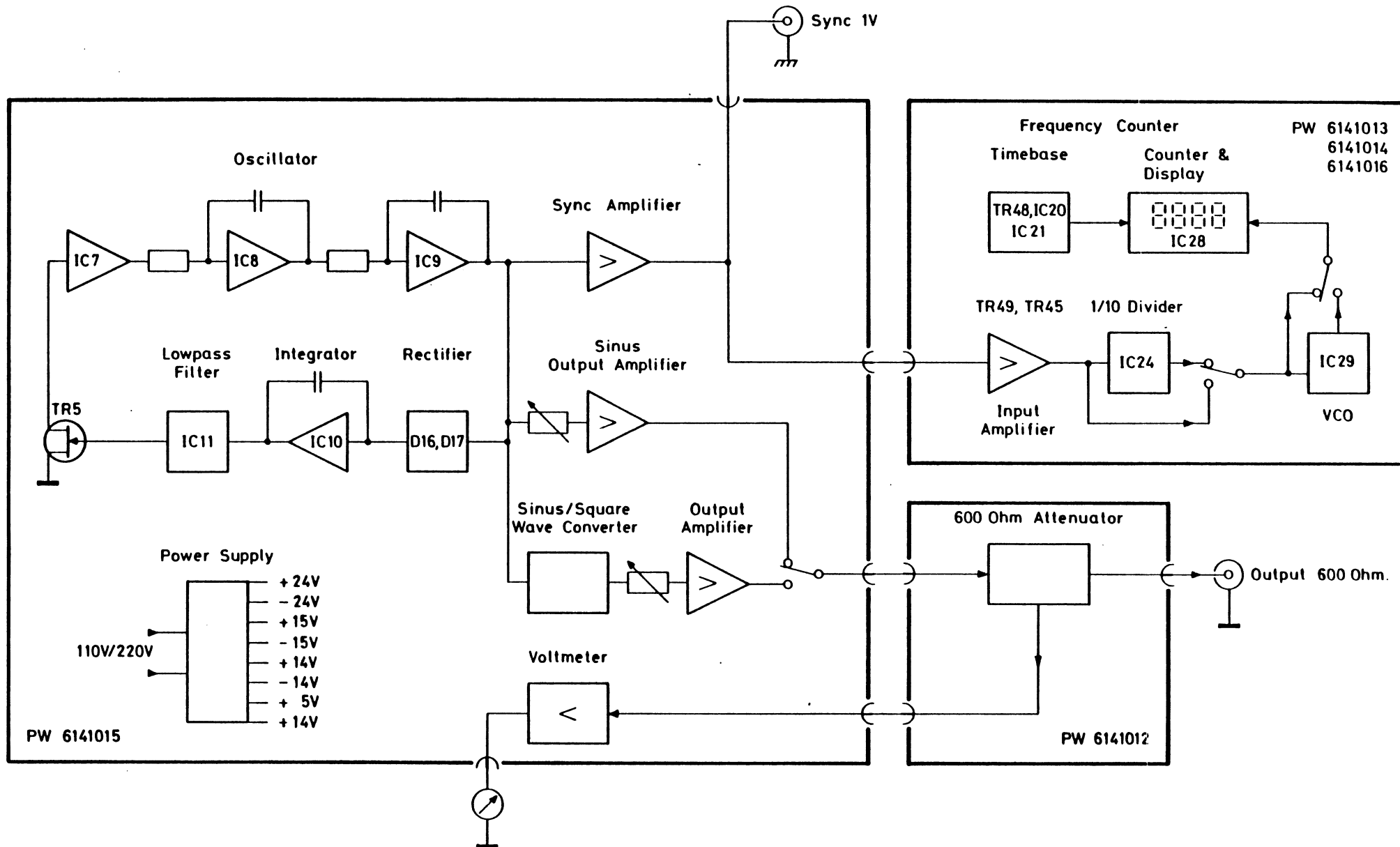
IC1	LM317	Regulator, positiv	8340244
IC2	LM337	Regulator, negativ	8340547
IC3	LM340-15	Regulator, +15V/1A	8340064
IC4	LM320-15	Regulator, -15V/1A	8340098
IC5	LM340-05	Regulator, +5V/0,5A	8340212
IC7	NE5534	Op.amp.	8340210
IC8	NE5534	Op.amp.	8340210
IC9	NE5534	Op.amp.	8340210
IC10	µA741C	Op.amp.	8340141
IC11	TL072	Dual FET Op.amp.	8340195
IC13	MM74C74N	Dual Flip-Flop	8340298
IC14	CNY17-1	Opto-kobler	8330086
IC17	TL071	FET Op.amp.	8340168
IC18	TL071	FET Op.amp.	8340168
IC20	HEF4020B	Counter/Divider	8340548
IC21	CD4518BC	Dual Counter	8340549
IC22	MM74C74N	Dual Flip-Flop	8340298
IC23	MM74C73N	Dual Flip-Flop	8340550
IC24	CD4017BNC	Counter/Divider	8340378
IC25	DM74C14	Hex Schmitt Trigger	8340221
	CD40106C		
IC26	CD4066BCN	Quad Switch	8340202
IC27	CD4066BCN	Quad Switch	8340202
IC28	MM74C925	4-Digit Counter	8340551
IC29	MC14046BCP	Phase-Locked Loop	8340552
IC30	CD4518BC	Dual Counter	8340549
IC31	SN74LS03N	4xNand Gate	8340332

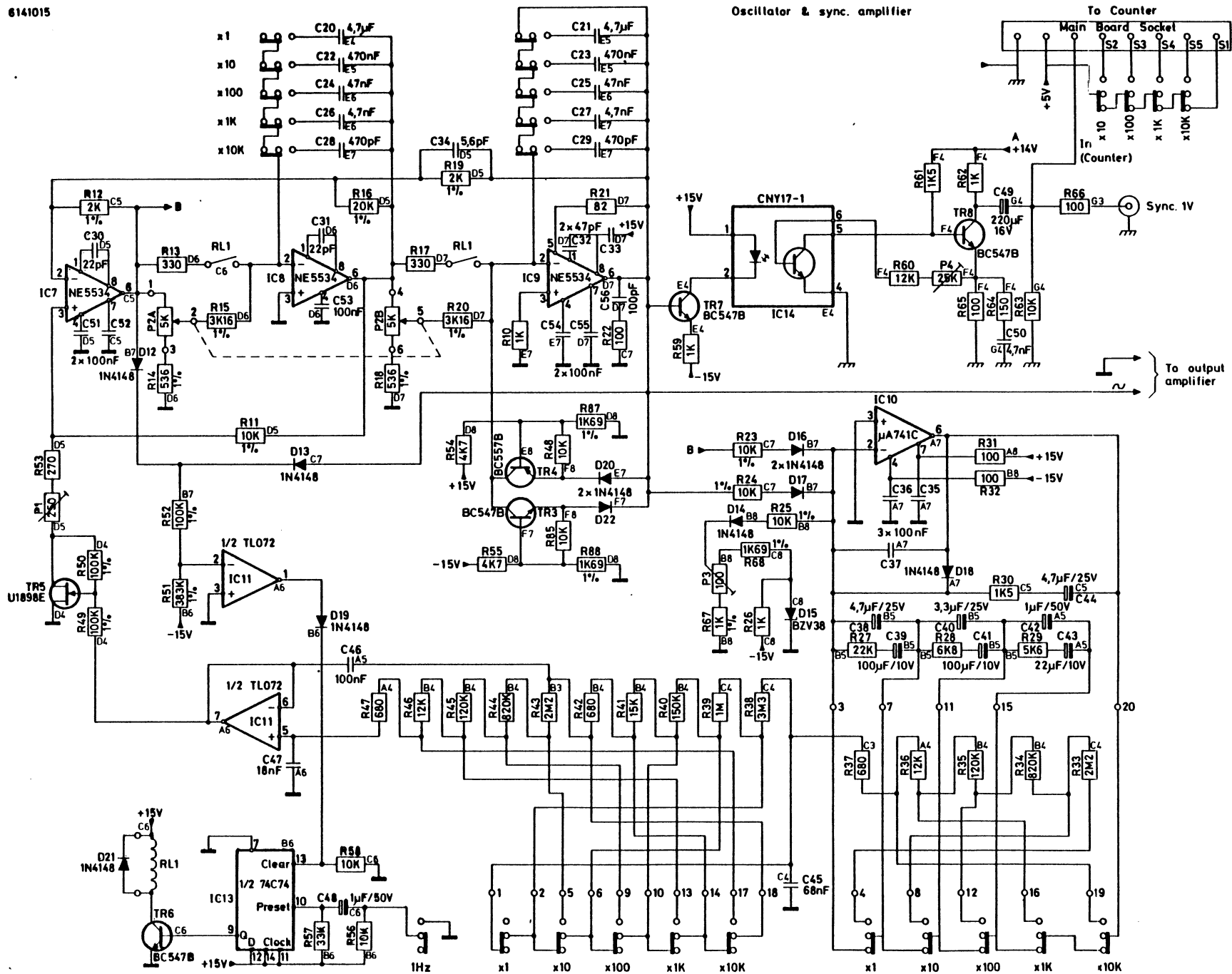
## 7. 7-Segment Display

DP1	HD1107R	8330085
DP2	HD1107R	8330085
DP3	HD1107R	8330085
DP4	HD1107R	8330085

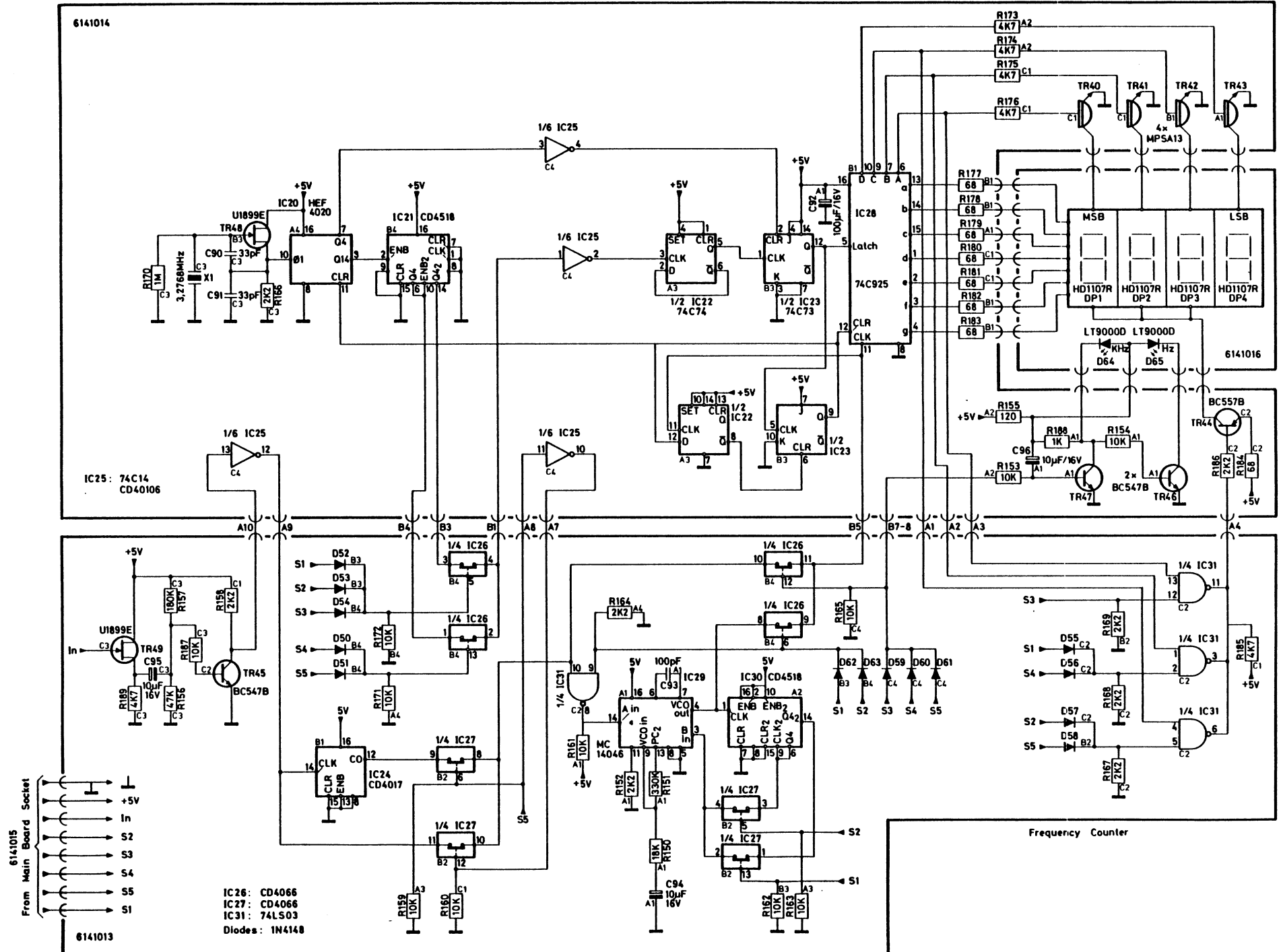
## 8. Diverse/Miscellaneous

Viserinstrument/Meter 1mA		8450051
Nettransformer/Power Transformer		8013315
Relæ/Relay 12V 2A-125V		7600059
Omskifter/Switch "POWER"		7400264
Omskifter/Switch "FREQUENCY"		7400265
Omskifter/Switch "ATTENUATOR"		7400266
Krystal/Crystal 3,2768MHz		8090024
Sikring/Fuse 125mA-T (220V)		6600025
Sikring/Fuse 250mA-T (110V)		6600000
Sikringsholder/Fuse Socket		7201014
Drev/Gear 1:5		2755016
Netledning/Power Cable		6271086
BNC-fatning/BNC Socket	2622278+2622320+7210184	
Knap/Knob "VOLTAGE"	2627019+3164435+2770096	
Knap/Knob "FREQUENCY"	2627019+3164435+2770097	
Aksel/Shaft "FREQUENCY"		2830001
Fatning/Socket 8-pol.		7210233
IC-sokkel/IC Socket		7200046
Displayglas/Display Glas		3370122
Køleplade/Heatsink		3358137
Gummifod/Rubber Foot		0585027

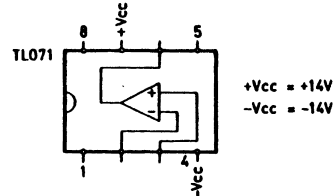
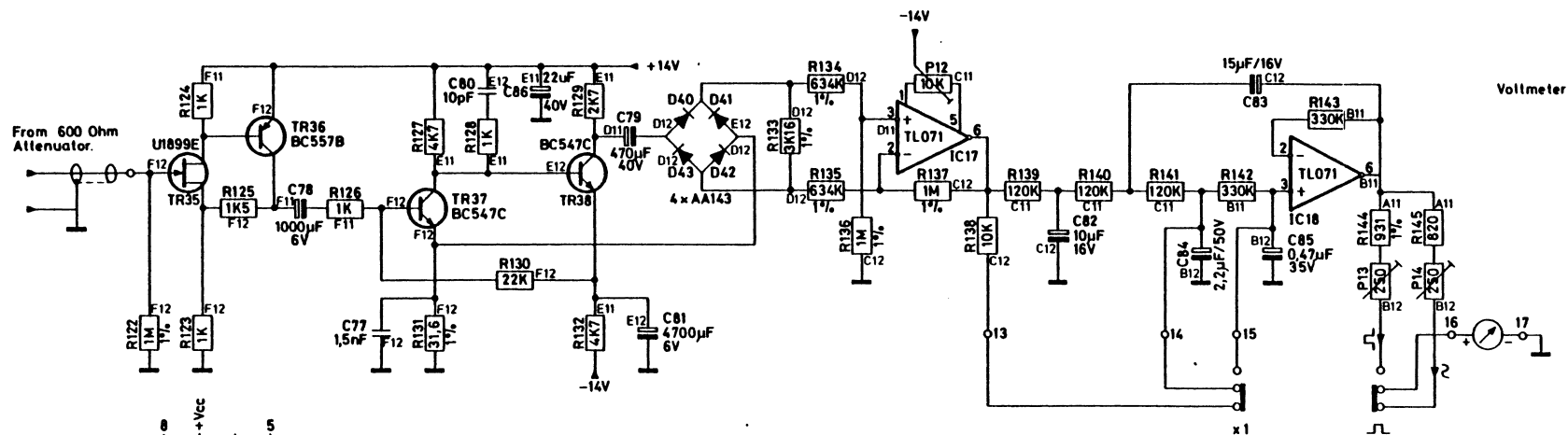




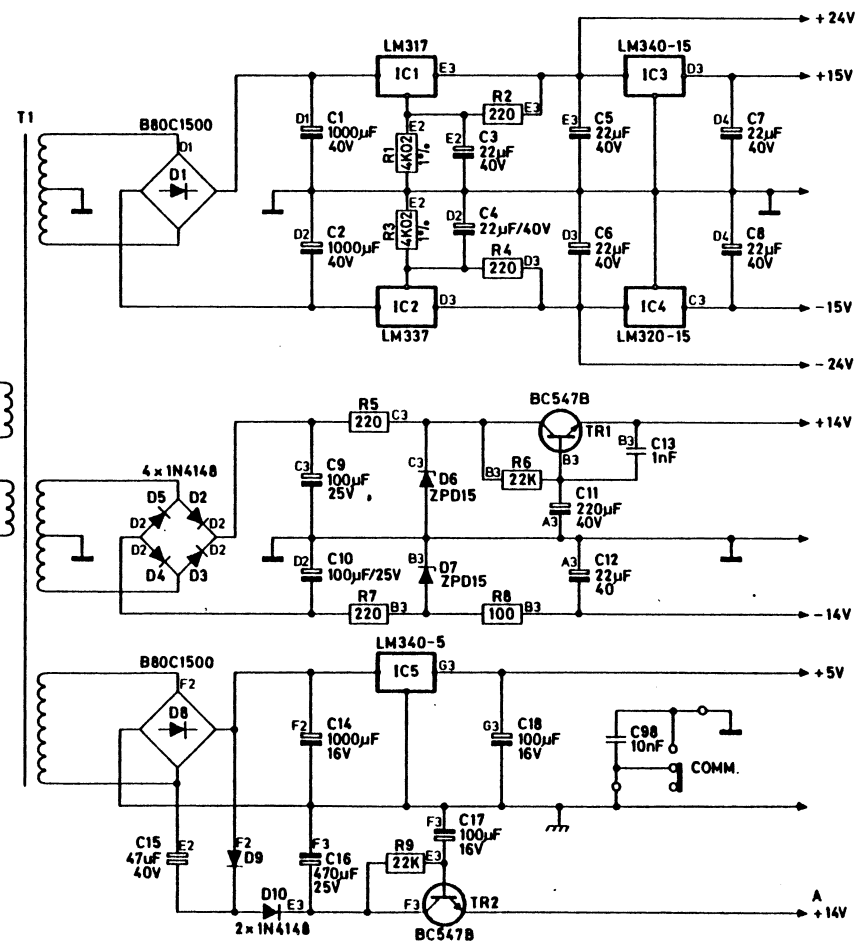
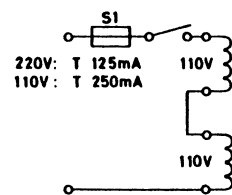
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Power Supply







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