Frequency Analysing

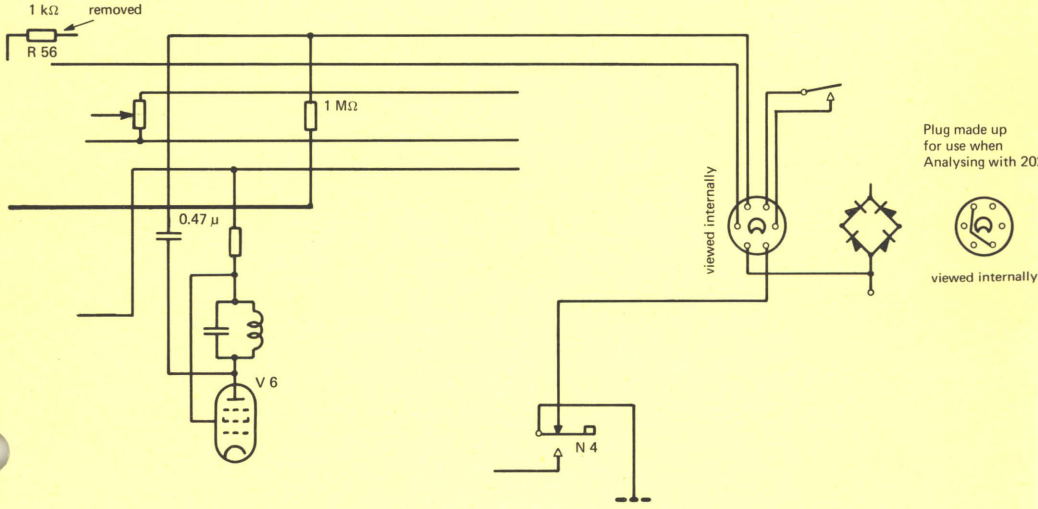
When the Heterodyne Slave Filter type 2020 is coupled together with a Beat Frequency Oscillator type 1022 with serial numbers earlier than 268295 (valve types) the following troubles might occur.

If 2020 is used as a Frequency Analyser the band pass frequency is determined by the Frequency Tuning of 1022, and when this is tuned to a certain frequency, 2020 will give an output voltage if the double frequency is applied to the input of 2020.

This happens because the Variable Oscillator output of 1022 valve types contains a mixing of the variable oscillar frequency and the low frequency, and this will tune 2020 to accept a passing of two different frequencies.

To avoid this a change should be made in 1022 so that there will not be any mixing at all in 1022 when using 2020 as a Frequency Analyser.

The interruption of the mixing is practically done by stopping the fixed oscillator signal from arriving to the mixer circuit like shown on the sketch below.



Parts to be ordered:

1 pcs of Plug	JP 4705
1 pcs of Capacitor 0.47 µ/250 V	CS 0021
1 pcs of Carbon Resistor 1 MΩ – 1/3 W	

Service Instructions

2020

Heterodyne Slave Filter

Consisting of:

Trouble Shooting:

If some sort of trouble occurs with this instrument then first check the D.C. working voltages from the Power Supply.

Then use the Checking Procedure with Block Diagram in order to localize a trouble to be in one certain circuit.

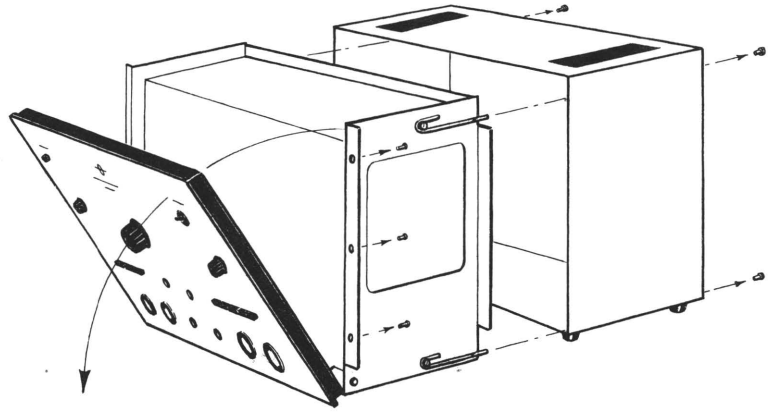
When a fault has been found and remedied the voltages and adjustments which are influenced by the remedy must be rechecked and the Checking Procedure can be used again to tell if all basic functions of the instrument are fulfilled.

The tolerance stated in the instructions can only be used as a guide for adjustment and control, but any deviations must not be corrected without being sure that the tolerances of the instrument used for making the adjustment are so small as to have no influence on the measurements.

The instructions in this Manual are given purely as a guide to the service of equipment. Some faults, as f.inst. small deviations in tolerances require for their correction special control equipment and extensive experience, and in these cases it is necessary to send the instrument to the factory.

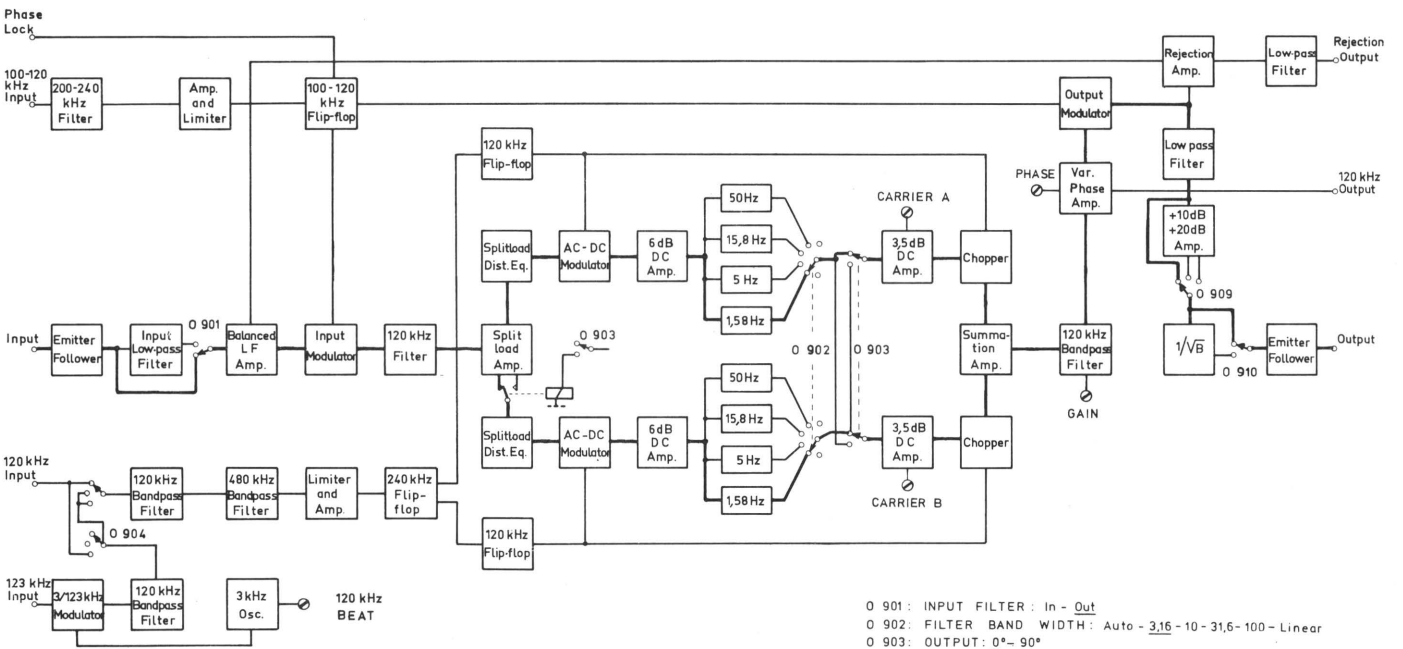
Spare Parts:

Please state type and serial number of apparatus when spare parts are ordered.



Instruments Necessary for Service and repair:

Beat Frequency Oscillator Type 1022 (or Sine Random Generator Type 1024)
Electronic Voltmeter (frequency response to 200 kHz - f.s.d. for 1 mV)
LF Oscillator (any type with a 2 V output facility)
Double Beam Oscilloscope
Multimeter (50 uA)
Frequency Counter

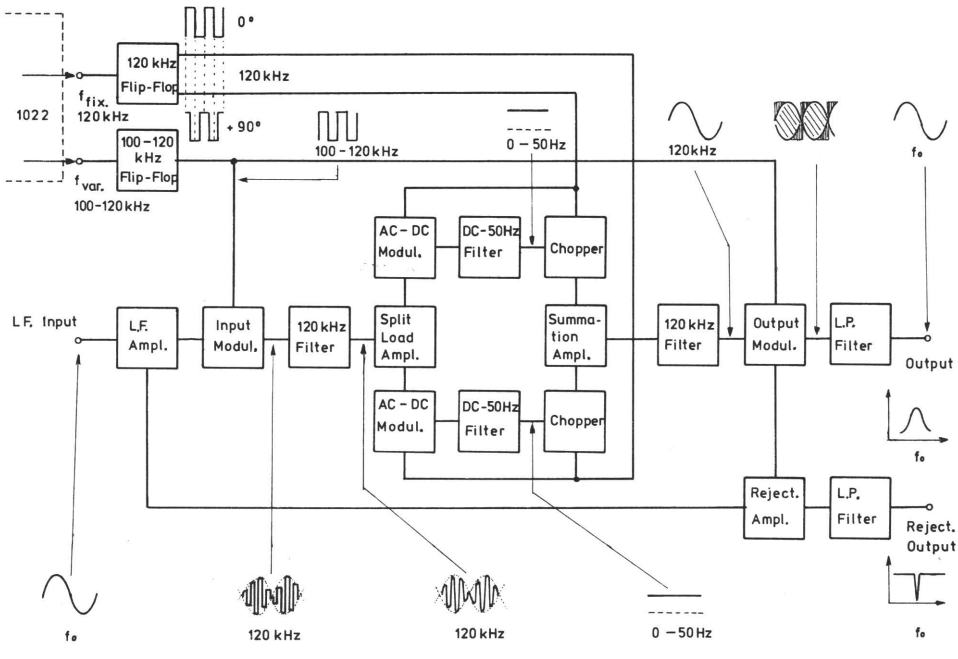


0 901: INPUT FILTER: In - Out
0 902: FILTER BAND WIDTH: Auto - 3,16 - 10 - 31,6 - 100 - Linear
0 903: OUTPUT: 0° - 90°
0 904: BFO MODE: Sine - Noise - 120kHz Beat
0 909: GAIN: 0 - 10 - 20 dB
0 910: BAND WIDTH COMPENSATION: Off - $1/\sqrt{B}$

Principle of the Instrument

2020.1

Valid from serial no. 253966



The Heterodyne Slave Filter Type 2020 is intended to be used together with a Beat Frequency Oscillator Type 1022 or 1024. The 1022 is a Heterodyne Oscillator having a fixed oscillator section of 120 kHz and a variable oscillator section of 100–120 kHz. A mixing of these two frequencies will give the low frequency output signal from 20 to 20000 Hz. Now if 1022 is tuned to a low frequency signal of 1 kHz the variable oscillator will have a frequency of 119 kHz.

The operation principle of 2020 is mixing the low frequency signal (1 kHz) with a variable high frequency signal (119 kHz) to make up a fixed frequency (120 kHz) at which we can do the filtering. As being the same frequencies used for 1022 to give the low frequency output signal the center frequency of 2020 will be exactly the same as the oscillator frequency.

In the Input Modulator of 2020 the 1 kHz signal is mixed with a 119 kHz variable oscillator signal. The sum of this will give a signal of 120 kHz, which is splitted up into two signals in the Split Load Amplifier. The output of the Split Load Amplifier is fed to an AC to DC Modulator where 120 kHz is mixed with 120 kHz from the fixed oscillator to 0 Hz which is equal to DC. Due to phase sensitivity of a multiplicative mixer it is necessary to have two AC to DC Modulators controlled by two fixed frequency signals (120 kHz) 90° out of phase. The output will be a DC voltage which is analog to the level of the 1kHz Input Signal. The two DC voltages are now filtered in two narrow band, Low Pass Filters giving the band width of the entire system. The Cut–off frequency of each filter corresponds to half of the selected band width.

The DC voltages are chopped back to 120 kHz by means of the two 90° out of phase signals as used for the AC to DC Modulators. After chopping the signals are added in the Summation Amplifier the output of which has correct phase and amplitude.

In the Output Modulator the 120 kHz is mixed with the variable oscillator frequency 119 kHz and the difference is 1 kHz exactly as the fundamental of the input signal.

Another facility at the instrument is the Rejection Mode where the Input Signal is fed to the Rejection Amplifier together with the filtered fundamental frequency of the Input Signal. The difference between these two signals will be any frequency except the fundamental.

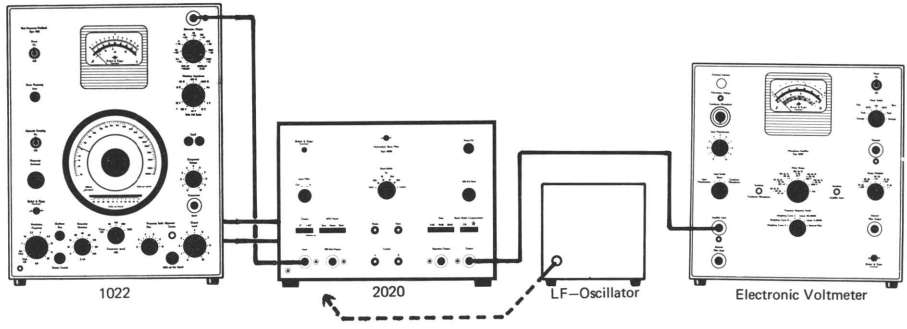
Checking Procedure

2020.2

Valid from serial no. 253966

This Section is meant to be used as a guide for a quick check carried out to examinate if the instrument is within the specifications, or to localize a suspected fault to be in a certain circuit. A further examination of the respective circuits can be carried out according to the adjustment procedure at the single circuits.

Furthermore the checking procedure should be used after a repair of the instruments as a final check before the Service of the instrument can be regarded as completed.



Allow a warm-up time of 15 minutes.

2.1. Signal to Noise

OUTPUT: "0"
BFO MODE: "Sine"
BAND WIDTH: "31,6 Hz"
GAIN: "0 dB"
BAND WIDTH COMP.: "Off"

Connections like shown above (1 V on the Electronic Voltmeter).

Adjust a 1 kHz output signal from 1022 to give 1 V on "Output".

Disconnect the "Input" to 2020.

Max voltage on "Output": 300 μV corresponding to -70 dB re 1 V.

For furhter checks "Carrier A and B" should be adjusted to min. deflection: approx 100 μV.

On the "120 kHz Output" the voltage should be less than 300 μV as well.

2.2. Gain

a. OUTPUT: "0"
BFO MODE: "Sine"
BAND WIDTH: "Linear"
GAIN: "0 dB"
BAND WIDTH COMP.: "Off"

Connections like shown above.

Adjust a 1 kHz output signal from 1022 to give 1 V deflection on "Output"

b. BAND WIDTH to: "31,6 Hz"

Check the voltage on "Rejection Output" and if necessary adjust "Phase" and "Gain" to min. output voltage: <3 mV.

The voltage on "Rejection Output" should be <5.5 mV at any other frequency.

The voltages on "120 kHz Output" and "Output" should both be 1 V ± 1%.

2.3. Frequency Response

a. OUTPUT: "0"
BFO MODE: "Sine"
BAND WIDTH: "Linear"
GAIN: "0 dB"
BAND WIDTH COMP.: "Off"

Connections like shown above.

Adjust a 1 kHz output signal from 1022 to give 1 V deflection on "Output". Check the frequency response of 1022 together with the electronic voltmeter.

b. BAND WIDTH to "31,6 Hz"

Check the frequency response and compare to the response from a.

The difference should be max 1%.

The voltage on "120 kHz Output" should be 1 V ± 1% during the frequency sweep as well.

continued

2.4. Unwanted Signal Attenuation

OUTPUT: "0"
BFO MODE: "Sine"
BAND WIDTH: "31,6 Hz"
GAIN: "0 dB"
BAND WIDTH COMP.: "Off"

Connections like shown except the "Input" connection to 2020.

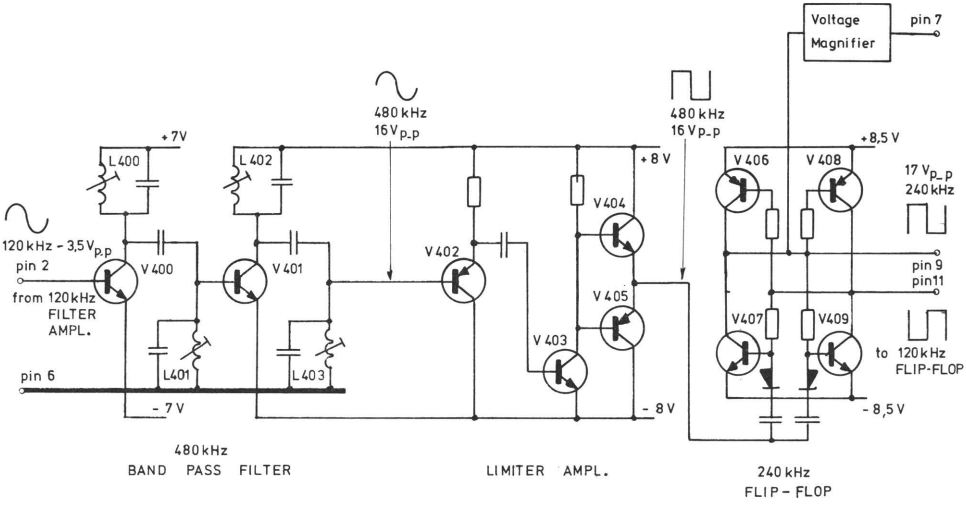
Tune 1022 to 1 kHz and apply a 4 kHz signal from LF-oscillator to 2020 "Input".

When the 4 kHz "Input" voltage to 2020 is varied from 0–1 V the voltage on "Output" should be less than 250 µV.

When the 4 kHz "Input" voltage is between 1 and 2 V the "Output" voltage should be at least 70 dB below the "Input" voltage.

240 kHz Square Wave Generator ZI 0003

Valid from serial no. 253966



The purpose of this circuit is to create a 240 kHz square formed puls with a 180° phase difference for the two 120 kHz Flip-Flops which are used in the AC-DC Modulators to "beat" the 120 kHz Input Modulator signal down to a DC analog to the Input Level, and again to "Chop" the filtered DC back to 120 kHz as before.

The coils L 400–403 are tuned to 480 kHz (fourth harmonic of 120 kHz) so the input to V 402 is 480 kHz sine wave which is amplified in V 403 and clipped to square pulses in V 404 and 405.

These pulses are fed to a 240 kHz Flip-Flop which triggers on the negativ going pulseform.

The resulting output of the Flip-Flop are two 240 kHz squareforms with a phase difference of 180°.

Signal voltages and curveforms are for an "Input" signal of 1 V, 1 kHz.

3.1. 480 kHz Filter Adjustment

BFO MODE: "Sine"

Connect the "120 kHz" output of 1022 to the "120 kHz" input of 2020.

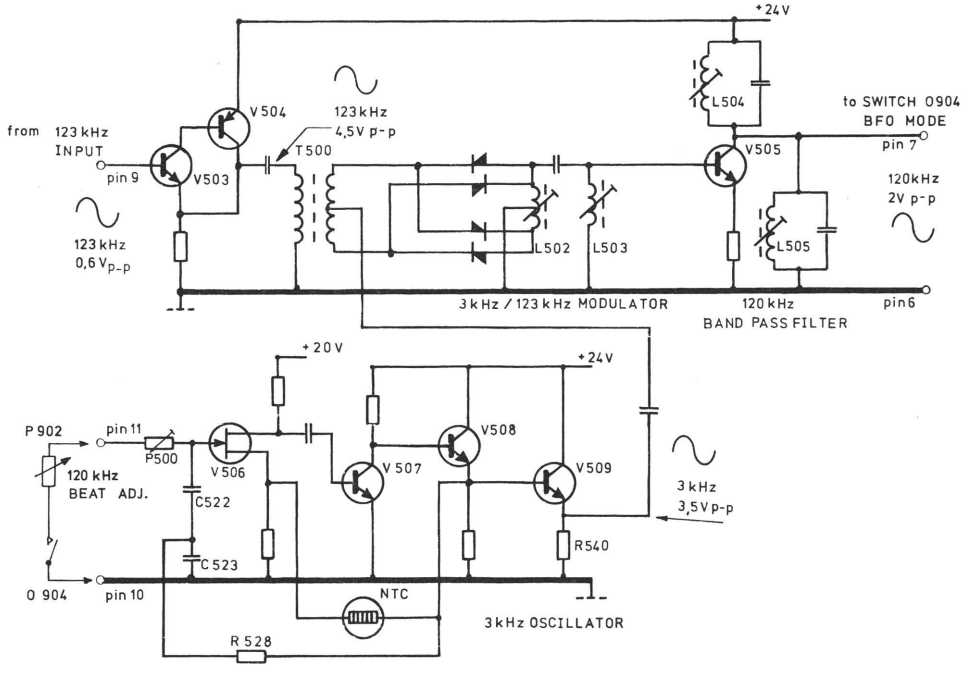
Adjust L 400–403 to max. voltage on V 402 base, which can be measured with an oscilloscope or an electronic voltmeter (freq. response to 500 kHz).

(Make sure that the "120 kHz" output from 1022 is 120 kHz ± 5 Hz).

120 kHz Fixed Frequency Conditioning ZS 0169

2020.4

Valid from serial no.253966



If a Sine Random Generator Type 1024 is used in the Noise Mode, the "120 kHz Output" will not be a sine but a band of noise, which cannot be used to drive the Flip-Flops in 2020.

Therefore, the "123 kHz Output" of 1024 is used instead. This 123 kHz is a sine wave and if it is mixed with a 3 kHz signal the result will be 120 kHz which is independent of the noise band in 1024.

4.1. 120 kHz Beat

BFO MODE: "Beat"
BAND WIDTH: "31,6 Hz"
BAND WIDTH COMP.: "Off"
OUTPUT: "0"
GAIN: "0 dB"

Connect the Fixed Oscillator "123 kHz", the variable oscillator "100–120 kHz" and the 120 kHz Output to 2020.

"Input" signal from 1024 to 2020: 1 kHz sine, app. 0.5 V.

Adjust "120 kHz Beat" until a slow beat shows up on 1024 meter (Meter Time Const.: 0.3 sec.).

If necessary set "120 kHz Beat" to mid position and adjust P 500 until the beat shows up.

4.2. Band Pass Filter Adj.

BFO MODE: "Noise"

Connect the fixed oscillator "123 kHz" from 1024 to "123 kHz" on 2020.

Adjust "120 kHz Beat" to 120 kHz measured with a Frequency Counter connected across pin 6 and 7.

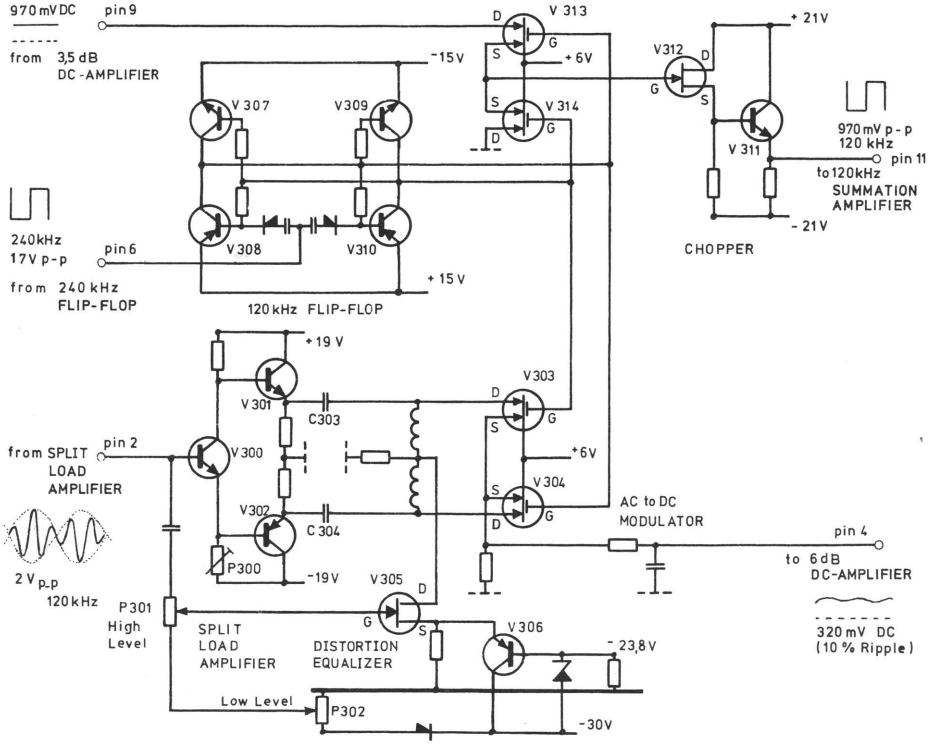
Adjust L 503–L 505 to max output voltage on pin 7.

BFO MODE to "Sine"

Connect 120 kHz ± 2 Hz to "120 kHz Input" and adjust L 500 and L 501 to max voltage between pin 3 and 4.

AC to DC Modulators and Choppers ZM 0006/7

Valid from serila no. 253966



The AC to DC Modulators and Choppers ZM 0006 and ZM 007 are indentical except for the Phase Lock arrangement, so only ZM 0007 will be mentioned.

The Distortion Equalizer circuit is creating a DC voltage depending on the input level. The MOS FET's have a DC voltage output on high input levels which we compensate with the Distortion Equalizer.

The 120 kHz input signal to ZM 0006/7 was created by mixing the "Input" signal (1 kHz) with the variable oscillator signal (119 kHz).

When the output of the 120 kHz Flip-Flop, which is triggered by the 240 kHz Flip-Flop, is mixed with the 120 kHz Modulator Input, the resulting output will be a DC voltage analog to the 1 kHz input signal.

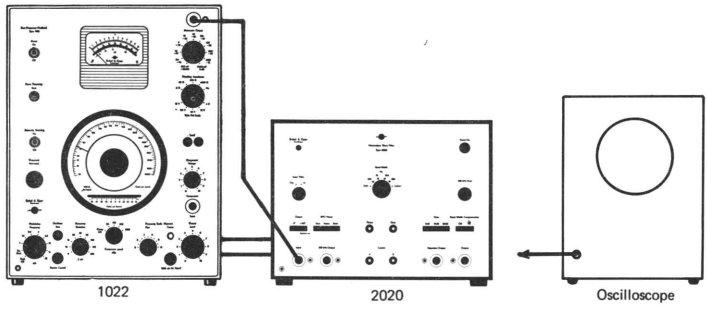
If the input signal (1 kHz) is distorted the 0–500 Hz output from the AC to DC Modulator will contain some low frequency components as well representing the distortion.

The 0–500 Hz output will be filtered and fed to the Chopper input where it is modulated back to 120 kHz, but now the 120 kHz has a certain band width corresponding to the selected filter characteristic.

Signal voltages and curve forms are for an "Input" signal of 1 V, 1 kHz.

ATTENTION: Do not ever dismount ZM 0006 and ZM 0007 with POWER "On" because this will cause a breakdown of the DC Amplifier ZE 0031.

continued



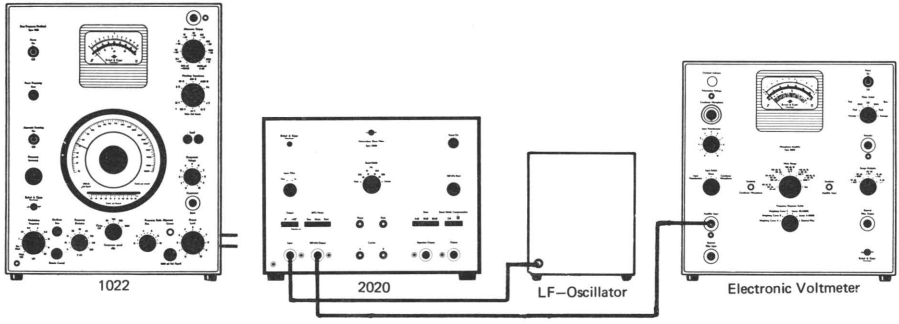
5.1. Symmetry

OUTPUT: "0"
BFO MODE: ,"Sine"
BAND WIDTH: "31,6 Hz"

Signal input from 1022: 1 V at 1 kHz.

Check with the oscilloscope that the voltages on the emittersides of C 203 (303) and C 204 (304) are of the same height.

If not adjust P 200 (300)



5.2. Unwanted Signal Attenuation

OUTPUT: "0"
BFO MODE: "Sine"
BAND WIDTH: "31,6 Hz"

Connect "120 kHz" and "100–120 kHz" from 1022 to 2020 and adjust "Carrier A" and "Carrier B" to min. "120 kHz Output" voltage measured with an electronic Voltmeter.

Turn P 202 and P 302 fully counterclockwise and then clockwise until a situation where the "120 kHz Output" voltage suddenly increases. Then adjust P 202 and P 302 one turn counterclockwise.

Set the 1022 (or 1024) Frequency Scale to 1.5 kHz and apply a 4 kHz signal of 2 V from the LF. Oscillator to the "Input" of 2020.

Adjust P 201 and P 301 to min. "120 kHz Output" voltage.

If the 4 kHz input signal is lowered to 0–1 V the "120 kHz Output" voltage should be less than 250 μV.

If necessary find the 4 kHz input voltage (between 0–1 V) where the "120 kHz Output" voltage has the highest value and adjust P 202 and P 302 to min.

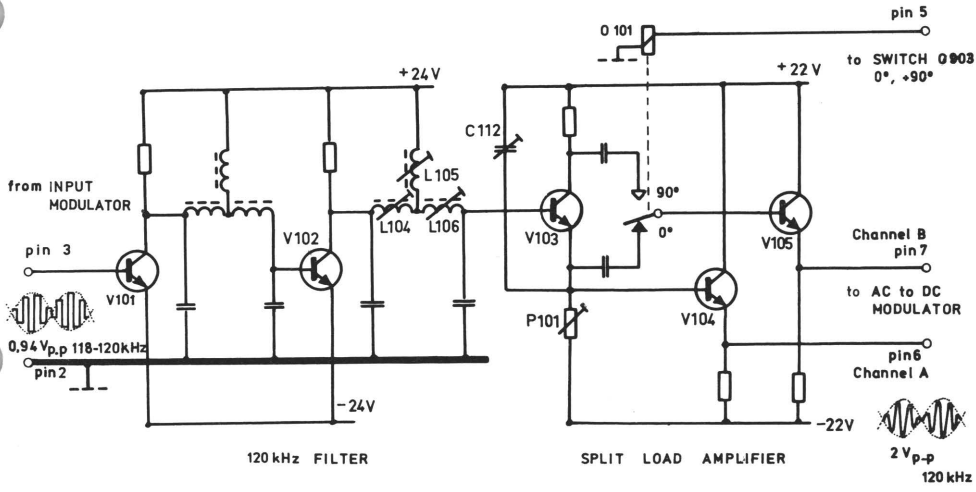
At a 4 kHz input signal between 1 and 2 V the "120 kHz Output" should be at least 70 dB below the Input level.

If necessary readjust P 201 and P 301 at high levels.

After any adjustment recheck the "120 kHz Output" voltage without 4 kHz Input signal: this voltage should not change more than 2 dB during adjustment of the potentiometers mentioned above.

120 kHz Filter and Split Load Amp. ZS 0168

Valid from serial no. 253966



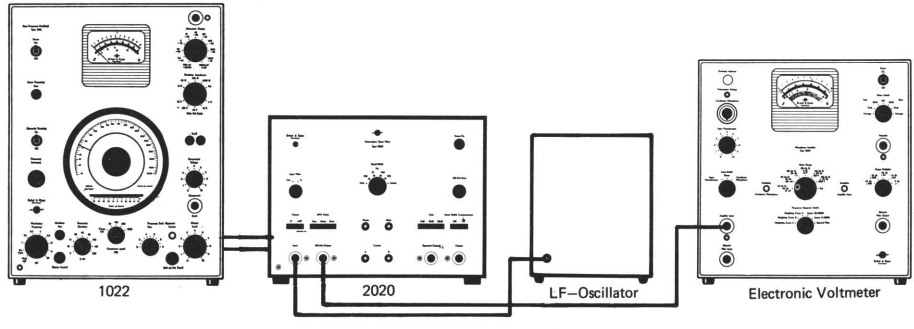
When INPUT FILTER is "In" the Input Low Pass Filter (0–20 kHz) is connected between the Input Emitter Follower and the Input Modulator.

The Low Frequency Input Signal which is modulated with the Variable Oscillator-signal is applied to the 120 kHz Filter Amplifier ZS 0168 having two outputs, one at which has an invertible output facility when OUTPUT is switched to +90°. Signal voltages and curveforms are for an "Input" signal at 1 V, 1 kHz.

6.1. 120 kHz Filter Adj.

The 120 kHz Band Pass Filter should not be adjusted unless it is found strictly necessary.

If adjustment is found necessary it can be carried out according to the same procedure as shown under item 7.4. except that L 105 should be adjusted to give 0° phase shift between pin 3 (input) and pin 6 (output).



6.2. Ripple

Connections like shown above.

a. OUTPUT: "0"
BFO MODE: "Sine"
BAND WIDTH: "31,6 Hz"

1022 tuned to 4 kHz.

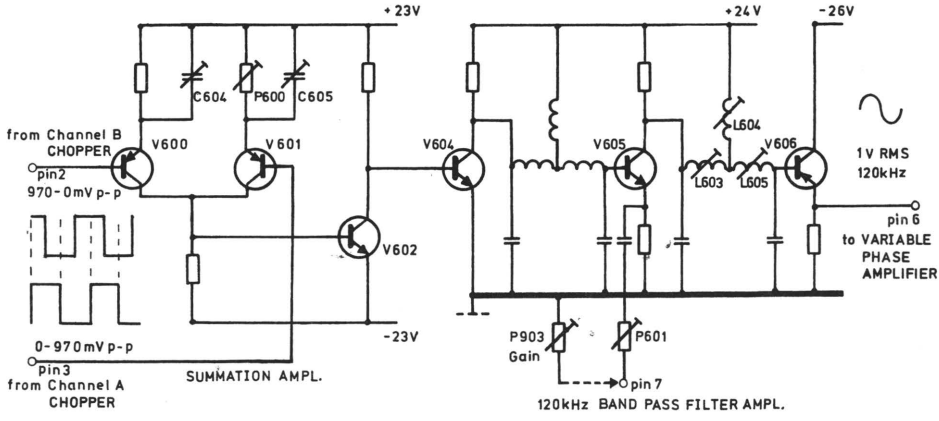
Adjust the frequency from the LF Oscillator (at 1 V) to max.voltage on "120 kHz Output".

b. OUTPUT to "90°"

Adjust C 112 and P 101 to min. beat. Tolerance ±1%.

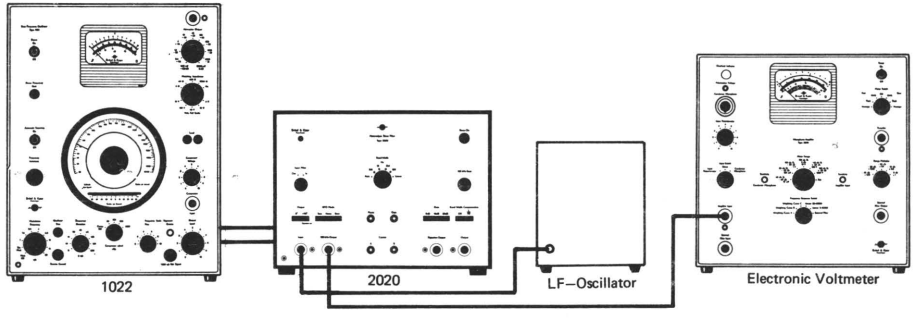
Summation Amplifier ZS 0170

Valid from serial no. 253966



In this circuit the two chopped signals A and B are added together and fed through a 120 kHz Band Pass Filter.
Here it is very important to have the correct voltage and phase applied to the base of V 602 and the adjustment is carried out as follows:

Signal voltages and curveforms are for an "Input" signal of 1 V, 1 kHz.



7.1. Sensitivity

OUTPUT: "00"
INPUT FILTER: "Out"
BFO MODE: "Sine"
BAND WIDTH: "31,6 Hz"
GAIN: "0 dB"
BAND WIDTH COMP.: "Off"

Apply an input signal from 1022 of 1 V, 4 kHz to "Input" of 2020.

"Gain" and "Phase" to mid. position.

The electronic voltmeter connected to "120 kHz Output" should read 1 V.

If necessary adjust P 601 (coarse adjustment of "Gain").

7.2. Ripple

OUTPUT: "00"
INPUT FILTER: "Out"
BFO MODE: "Sine"
BAND WIDTH: "31,6 Hz"
GAIN: "0 dB"
BAND WIDTH COMP.: "Off"

Connect the instruments like shown and tune the frequency until a slow beat of 1 Hz is obtained on the electronic voltmeter (if there is any beat).

The ripple should be max 1 %.

If necessary adjust C 604, C 605 and P 600 to min. ripple.

Check the ripple in all "BAND WIDTH" positions, as a defective Main Filter could cause too much ripple.

continued

7.3. Summation

OUTPUT: "0°"
INPUT FILTER: "In"
BFO MODE: "Sine"
BAND WIDTH: "31,6 Hz"
GAIN: "0 dB"
BAND WIDTH COMP.: "Off"

Apply an input signal of 1 V from 1022 to "Input" of 2020.

a. Check of channel "A".
Connect an oscilloscope to channel "B" (pin 2) and tune the frequency from 1022 to min. signal.

b. Then check: input signal to channel "A" (pin 3) 120 kHz
970 mV pp.
signal on V 602, c. 120 kHz
905 mV p.p.

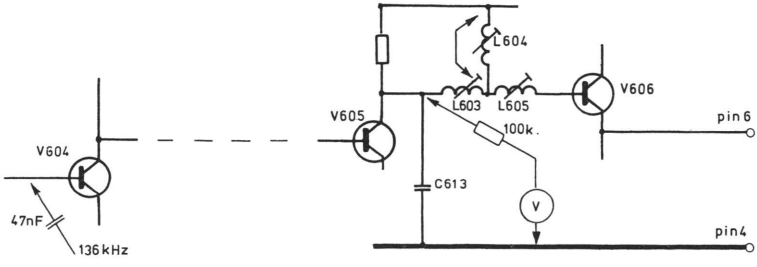
Repeat item a but for channel "B".

c. Adjust the frequency from 1022 for the same amplitude of the two signals channel A and channel B. (Pin 2 and pin 3).

signal on V 602,c 120 kHz
1260 mV p.p.

7.4. Filter Adjustment

The 120 kHz Band Pass Filter should not be adjusted unless it is strictly necessary.



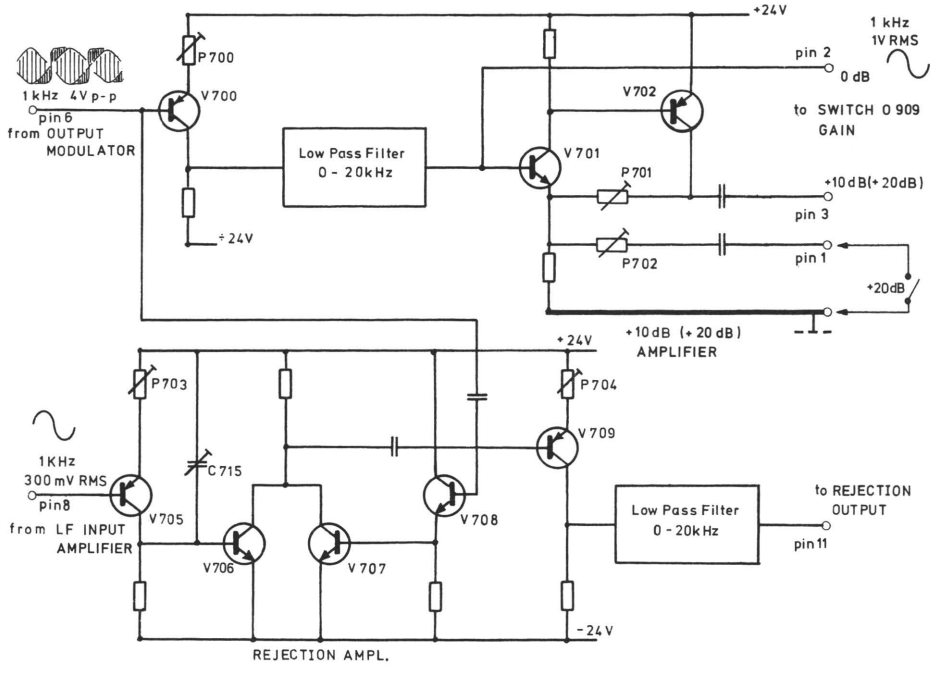
If adjustment is found necessary connect 136 kHz through a capacitor of 47 nF to the base of V 604, short connect L 604 and adjust L 603 to max voltage measured across C 613 with an electronic voltmeter with a series resistor of 100 kΩ.

Remove the short connection across L 604, apply 136 kHz ±2 Hz across it and adjust L 605 to max voltage between pin 6 and 4.

Connect 120 kHz ±2 Hz to the base of V 604 and adjust L 604 to 180° phase shift between V 604 base and V 606 emitter.

The 180° phase shift can be measured with a double beam oscilloscope with one channel connected to V 604 base, the other to V 606 emitter. If the sensitivities are adjusted to indicate a voltage of exactly the same height and the two channels are added together, a 180° phase shift would correspond a minimum deflection on the oscilloscope.

Rejection and Output Amplifiers ZE 0029

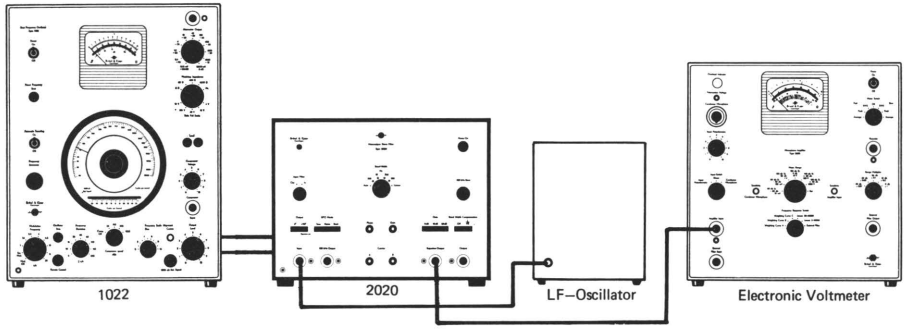


The input to V 700 is the filtered low frequency signal, which is applied to a 0 + 10 and +20 dB output through a Low Pass Filter.

The same signal is fed to V 708 and if the non-filtered LF is applied to V 705 the difference between the two will appear on the collectors of V 706, 707.

This means that the Rejection Output will consist of all frequencies in the range 0–20 kHz except the fundamental,which is supressed.

Signal voltages and curve forms are for an "Input" signal of 1 V, 1 kHz,



continued

8.1. Rejection Sensitivity

OUTPUT: "00"
BFO MODE: "Sine"
BAND WIDTH: "10 Hz"
GAIN: "0 dB"
BAND WIDTH COMP.: "Off"

Connections like shown above; 1022 adjusted to 1 kHz.

Connect 4 kHz exactly 1 V from the LF-oscillator to the "Input" of 2020.

Check the voltage on "Rejection Output": 1V ±1%.

If necessary adjust P 704.

8.2. Rejection

OUTPUT: "00"
BFO MODE: "Sine"
BAND WIDTH: "10 Hz"
GAIN: "0 dB"
BAND WIDTH COMP.: "Off"

Apply 1 kHz, 1 V from 1022 to "Input" of 2020.

Adjust "Gain" to 1 V ±1% measured on the "120 kHz Output".

Adjust "Phase" to min. "Rejection Output".

The two potentiometers influence each others, so that "Gain" and "Phase" adjustments should be continued until 1 V ±1% is obtained on the "120 kHz Output" at the same as min. "Rejection Output" voltage: $<$2,5 mV.

If necessary adjust P 703.

When this adjustment has been made at f.inst. 1 kHz the "Rejection Output" voltage should be $<$5 mV through the whole range.

At 20 kHz the "Rejection Output" voltage can be adjusted to min. by C 715.

8.3. Sensitivity

a. OUTPUT: "00"
BAND WIDTH: "Linear"
BFO MODE: "Sine"
GAIN: "0 dB"
BAND WIDTH COMP.: "Off"

Adjust the "Input" voltage from 1022 at 1000 Hz to give a 1 V indication on an electronic voltmeter connected to "Output" of 2020.

b. BAND WIDTH to "31,6 Hz"

Check that "120 kHz Output" voltage is 1 V ±1%.

If necessary adjust "Gain".

The "Output" voltage should be 1 V ±1%.

If necessary adjust P 700.

c. GAIN to "10 dB"

With an "Input" voltage of 1 V −10 dB the "Output" voltage should be 1 V ±1%.

If necessary adjust P 701.

d. GAIN to "20 dB"

With an "Input" voltage of 1 V−20 dB the "Output" voltage should be 1 V ±1%.

If necessary adjust P 702.

8.4. Frequency Response

OUTPUT: "00"
BAND WIDTH: "31,6 Hz"
BFO MODE: "Sine"
BAND WIDTH COMP.: "Off"
GAIN to required positions

Adjust the "Input" voltage from 1022 at 1000 Hz to give a 1 V indication on an electronic voltmeter connected to "Output" of 2020.

Check the frequency response in all "Gain" positions.

Tolerance: 20–20.000 Hz ±2%.

8.5. Overload

OUTPUT: "00"
BAND WIDTH: "31,6 Hz"
BFO MODE: "Sine"
BAND WIDTH COMP.: "Off"
GAIN to required positions

Check with an oscilloscope that it is possible to obtain 1 V +10 dB $\sim$ 3.16 V on the "Output" of 2020 without limitation of the sinewave.

continued

8.6. Band Width compersation

a. OUTPUT: "0"
BAND WIDTH: "Lin."
BFO MODE: "Sine"
BAND WIDTH COMP.: "Off"
GAIN: "0 dB"

Adjust the "Input" signal from 1022 at 1000 Hz to give a 1 V indication on an electronic voltmeter connected to the "Output" of 2020.

b. BAND WIDTH COMP. to "$\frac{1}{\sqrt{8}}$"
BAND WIDTH to "31,6 Hz"

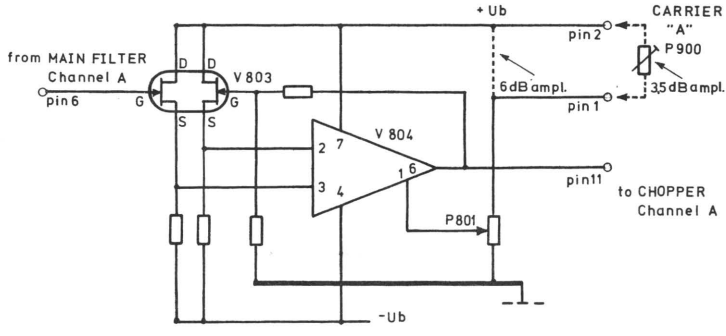
The output voltage from 2020 should be 1 V −5 dB.

c. BAND WIDTH to "10–31,6 and 100 Hz"

The output voltage from 2020 should decrease 5 dB for every bandwidth increase.

DC Amplifiers in Oven ZE 0031

Valid from serial no. 253966



A simplified diagram of one D.C. amplifier is shown above (3.5 dB DC Ampl. channel A). The amplifier is designed as a differential amplifier with a positive and a negative supply voltage thus having O V DC on input and output in the balance condition without input signal.

A part of the circuit is mounted in an oven where a constant temperature is obtained by feeding the heating element from a supply unit where a germanium transistor is used as a temperature detector.

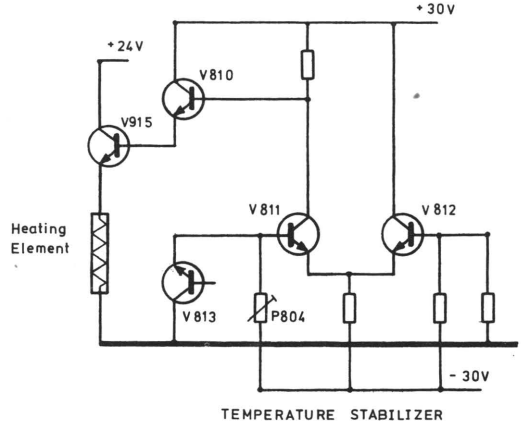
9.1. Oven Temperatur

POWER: "On"

Bear in mind that the oven should be left for 10–15 minutes after switching on or adjustment before the voltage is checked.

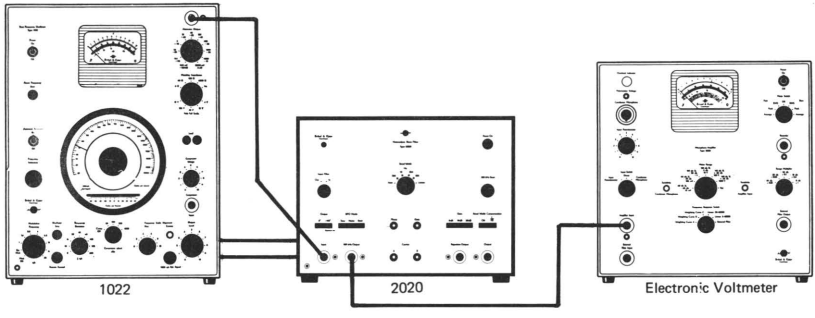
The oven temperatur is not very critical as long as it is stable, but should normally be around 55°C.

The adjustment of P 804 will vary the temperatur app. ±5°C, but it should not be touched if the voltage across the heating element is approx. 10 V (for room temperature of 20–25°C) and remaining constant.



TEMPERATURE STABILIZER

continued



9.2. Balance

a. OUTPUT: "0°"
BFO MODE: "Sine"
INPUT FILTER: "Out"
BAND WIDTH: "31,6 Hz"
CARRIER A & B: "Mid.Pos."

ATTENTION:

Very much care should be taken with this circuit to avoid connecting of the output terminals pin 5, 11, 18 or 22 to ground or to a supply voltage as this would cause a break down of V 801, 804, 806 or 809.

ZM 0006 and ZM 0007 must not be removed with POWER "On".

Before any adjustment of P 800–804 adjust "Carrier A" and "Carrier B" to mid. position.

The DC voltages across R 802 and R 821 should be O V $\pm$1 mV.

If necessary adjust P 800 for O V across R 802 and P 802 for O V across R 821.

Adjust P 801 and 803 to min. "120 kHz Output".

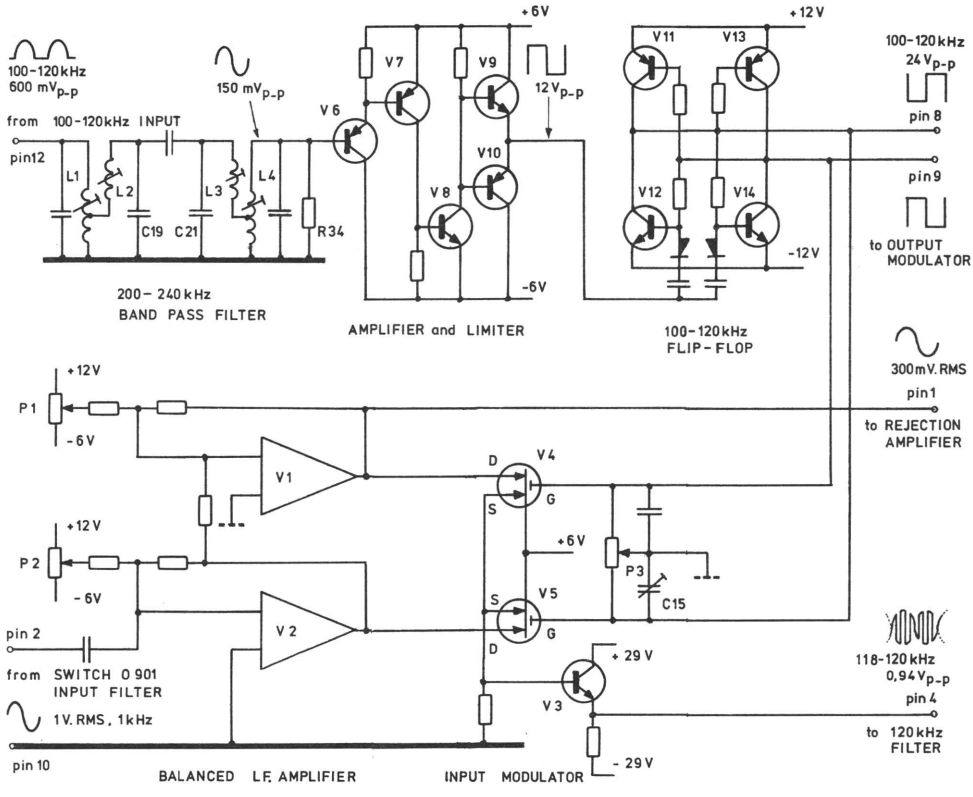
b. OUTPUT: "90°"

Readjust P 802 or 804 until "0°" and " 90°" will give the same "120 kHz Output" within 10 dB.

"120 kHz Output" in one of the positions should be below 200 uV.

Input Modulator ZM 0003

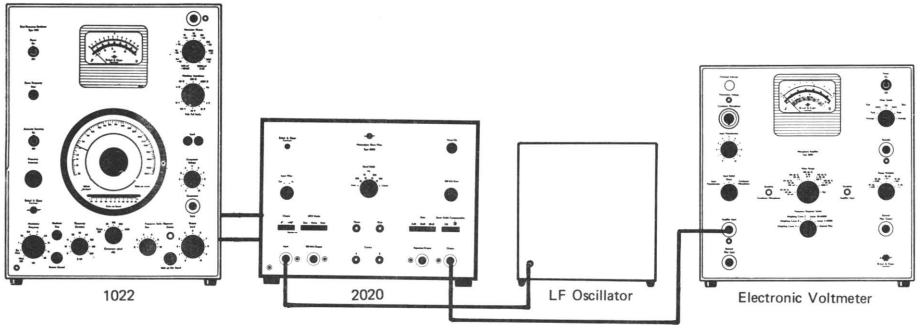
Valid from serial no. 253966



The Input Modulator consists of a 200—240 kHz Band Pass Filter with a succeeding pulseshaper which supplies squareformed pulses for a Flip-Flop circuit the output of which will have exactly the same frequency as the variable oscillator in the BFO 1022 (100—120 kHz).

Furthermore there is a Balanced LF Amplifier with two inverted stages (V 1 and V 2). The input to this amplifier is the low frequency signal (f.inst. 1 kHz), and if this frequency is modulated with the signal from the Flip-Flop circuit the resulting output through V 3 will be exactly 120 kHz.

continued



10.1. Distortion

a. OUTPUT: "0o"
BAND WIDTH: "31,6 Hz"
BFO MODE: "Sine"
BAND WIDTH COMP.: "Off"
GAIN: "0 dB"

Connect the "120 kHz" and "100–120 kHz" outputs of 1022 to the respective inputs, of 2020 and apply a signal 1 V, 1 kHz from a low distortion oscillator (–76 dB) to the "Input".

Tune 1022 to max deflection on an electronic voltmeter connected to the "Output" of 2020 and readjust the input voltage to give exactly 1 V on "Output".

Tune 1022 to app. 2 kHz and 3 kHz in order to find the 2nd and 3rd harmonics from the modulator. Voltage on "Output": Max 250 μV corresponding 72.5 dB below 1 V.

If necessary adjust P 3 and C 15 to min. (corresponding to 2nd and 3rd harmonics)

If this method does not give a sufficient low distortion adjust P 1 and P 2 for O V DC between ground and the output of V 1 and V 2.

b. BAND WIDTH to "100 Hz"

Then adjust P1, P3 and C 15 to min. distortion: $< 1mV \sim 60$ dB.

c. BAND WIDTH to "31,6 Hz"

Distortion max 250μV ~72.5 dB below 1 V.

The 200–240 kHz Band Pass Filter should not be adjusted unless it is strictly necessary.

A check of the filter curve can be carried out without having the ZM 0003 circuit in the 2020 according to following procedure:

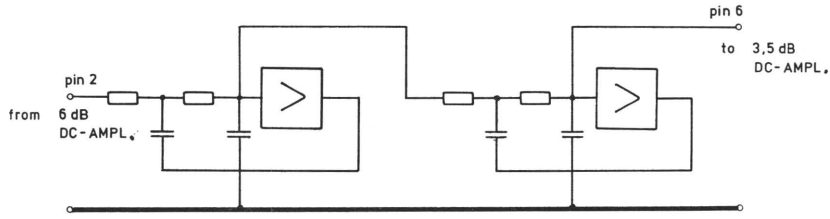
1 Connect the Variable Oscillator Output (100–120 kHz) from 1022 to pin 12 and 10 on ZM 0003 and an electronic voltmeter across R 34.
By varying the BFO 1022 from 20–20000 Hz the signal across R 34 should vary from 200–240 kHz which are the 3 dB points. The level in the filter range should be within ± 0.5 dB.

If necessary adjust the coils according to following procedure:

2 The Variable Oscillator Output (100–120 kHz) from 1022 connected to pin 12 and 10. 1022 tuned to 10 kHz (var. osc. freq. = 110 kHz).
Short connect C 21 and adjust L 1 to max. voltage measured from the midpoint tap oL1 to ground.
3 Connect the voltmeter across C 19 and adjust L 2 to min. voltage.

4 Short connection across C 19 instead. 110 kHz oscillator signal connected across R 34. Adjust L 4 to max voltage measured from the midpoint tap of L 4 to ground.
5 Connect the voltmeter across C 21 and adjust L 3 to min. voltage.

Recheck the filter curve according to item 1.



LOW PASS FILTER

ATTENTION:

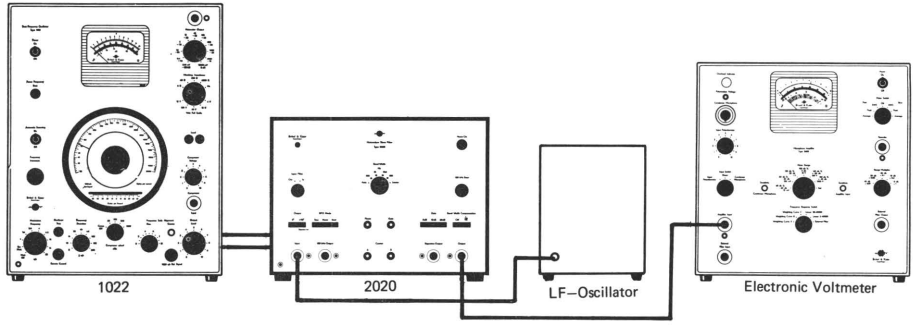
Do not adjust any of the Main Filters, as it is extremely difficult to do this without having the special test equipment which is used at the factory.

If a Main Filter is found defective it should be sent to the factory for repair and adjustment unless the trouble is found to be in a relay.

One of the troubles which could occur with a filter is that it is impossible to adjust the ripple (item 6.2.) down to 1%.

Another trouble which would be caused by the filter alone is a Band Width out of specification.

This could be checked according to following procedure:



11.1. Band Widths

a. OUTPUT: "00"
BFO MODE: "Sine"
BAND WIDTH: "Linear"
GAIN: "0 dB"
BAND WIDTH COMP.: "Off"

Adjust the output voltage from the LF generator to give an 18 dB deflection on the voltmeter connected to 2020 "Output" (on 1 V range).

b. BAND WIDTH to "100 Hz"

Tune to the max output by fine adjustment of 1022's frequency adjustment where the deflection should be 18 dB ±1%.

Tune the L.F. generator to one side until the voltmeter reads 15 dB and note the frequency.

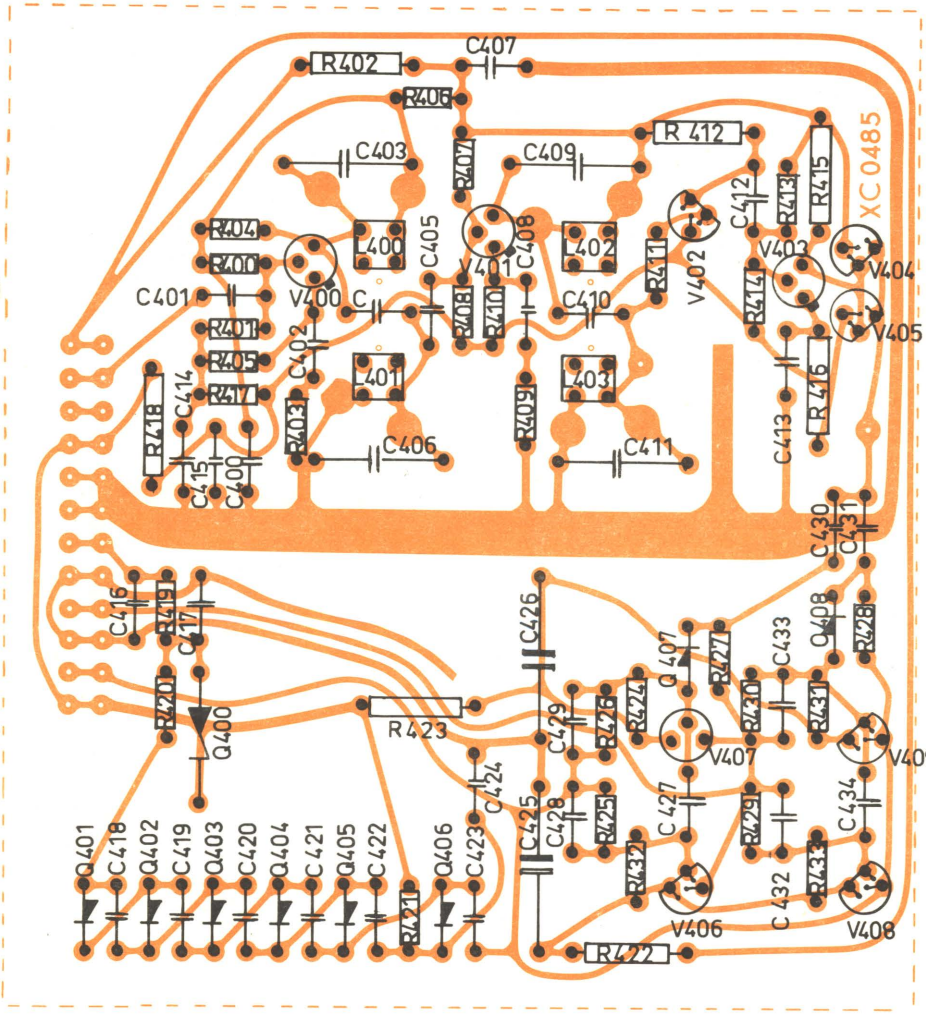
Tune the generator to the other side until 15 dB on the voltmeter and note the frequency.

The difference between the two noted frequencies is the band width.

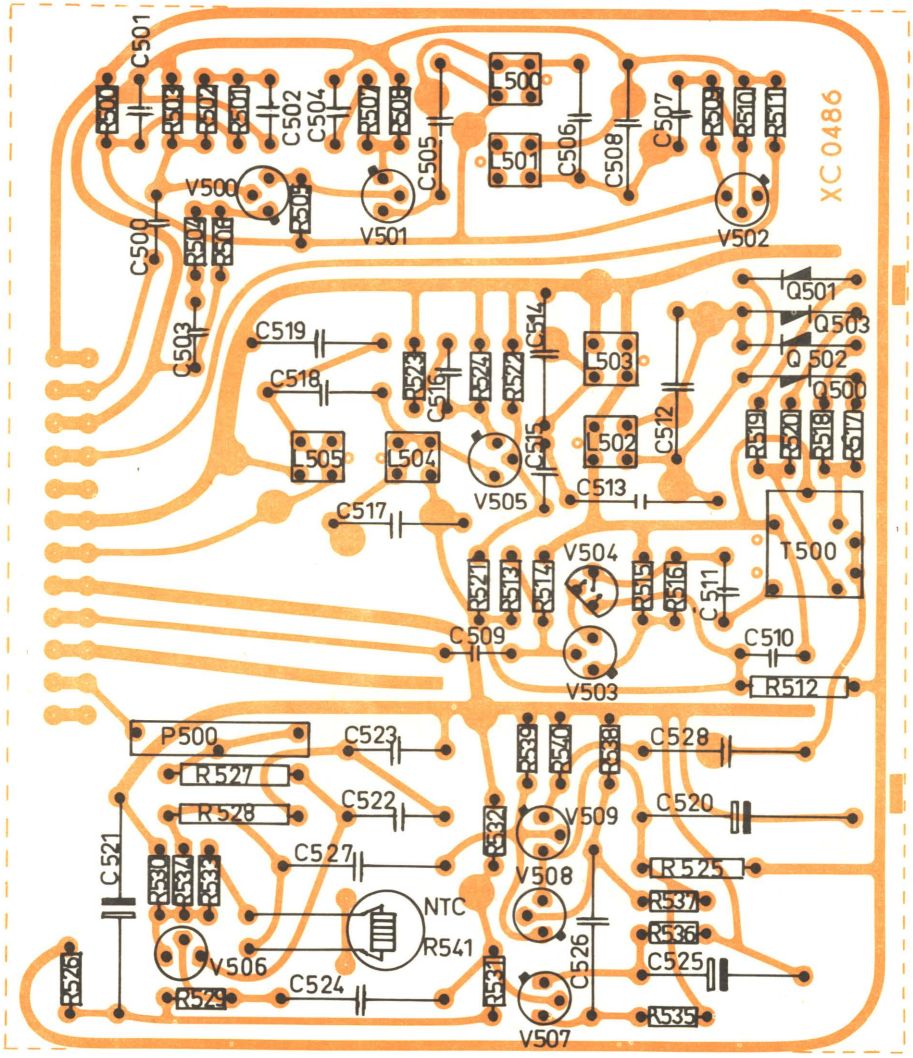
Tolerance: 5% of the selected band width.

c. BAND WIDTH to required positions

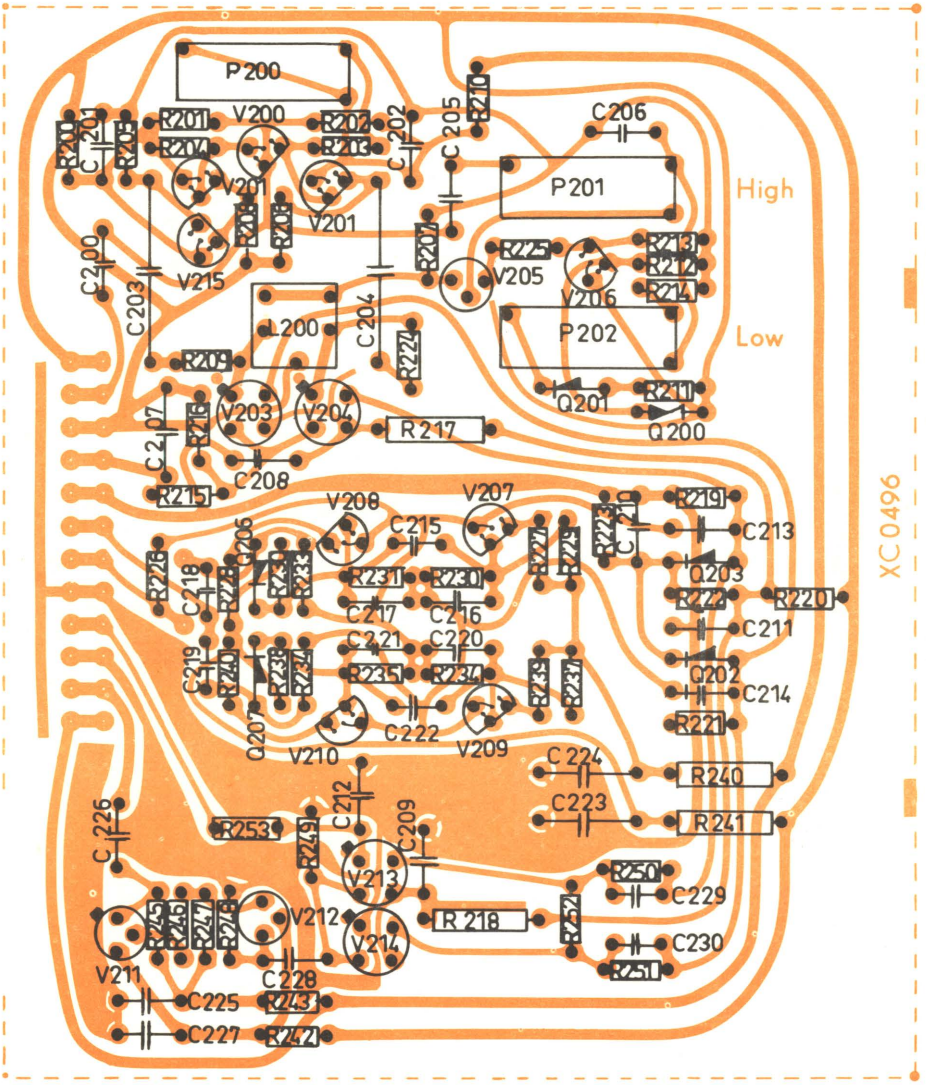
Check the other 3 dB Bandwidths according to the same method.



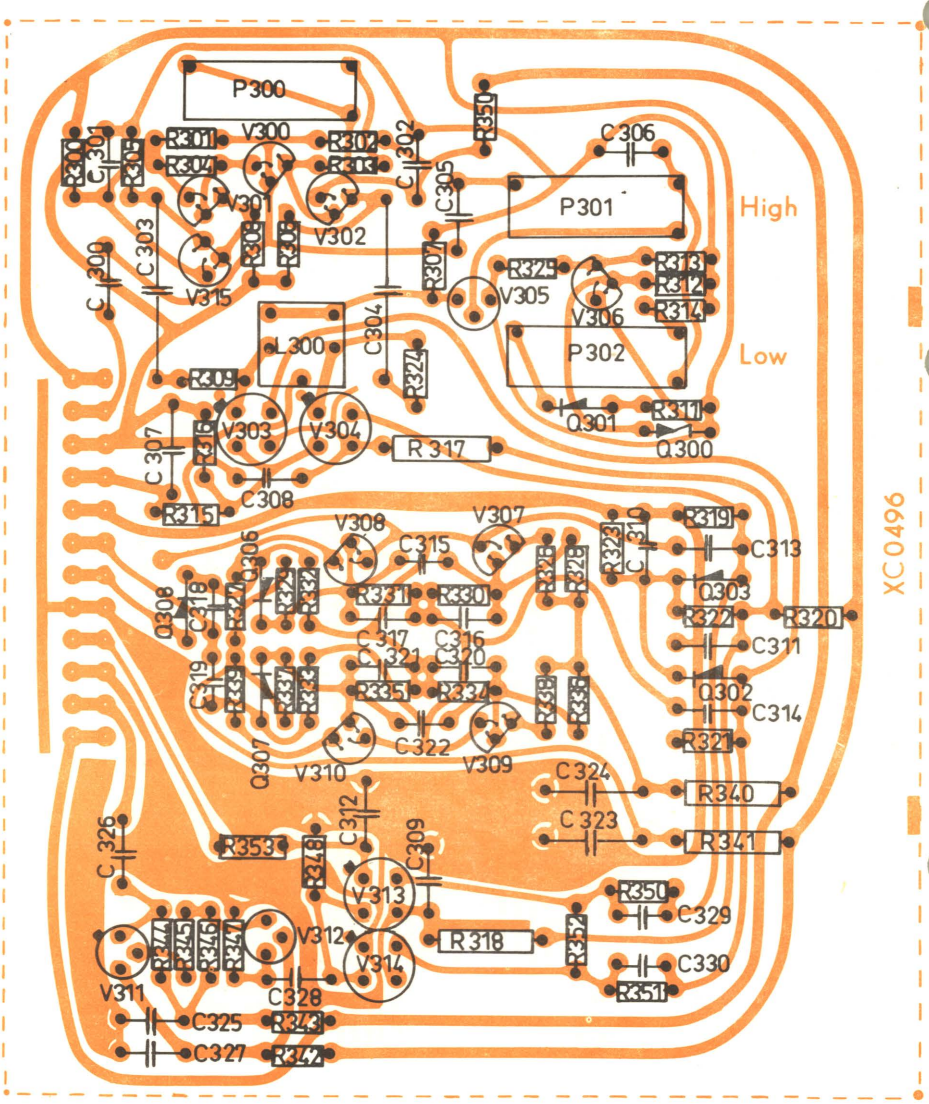
240 kHz square Wave Generator ZI 0003 – printed circuit XC 0485.



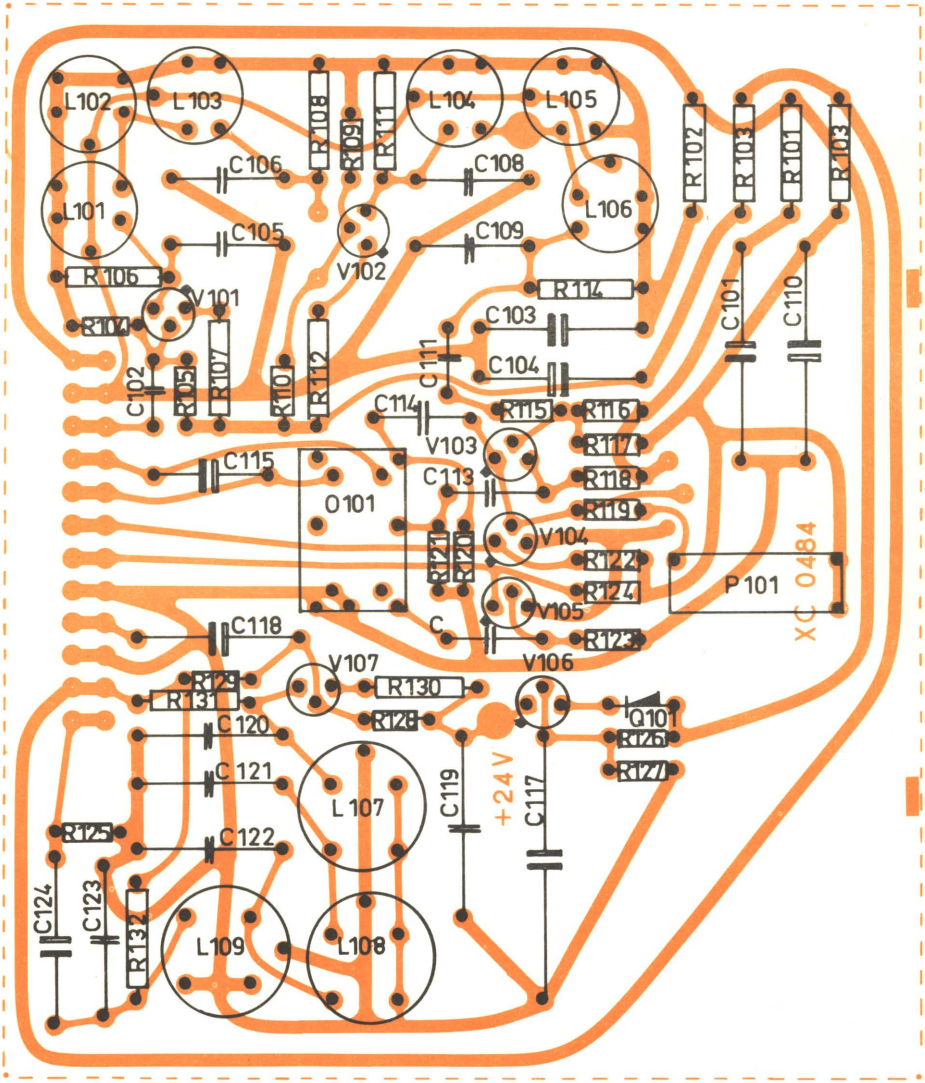
120 kHz Fixed Frequency conditioning ZS 0169 – printed circuit XC0486.



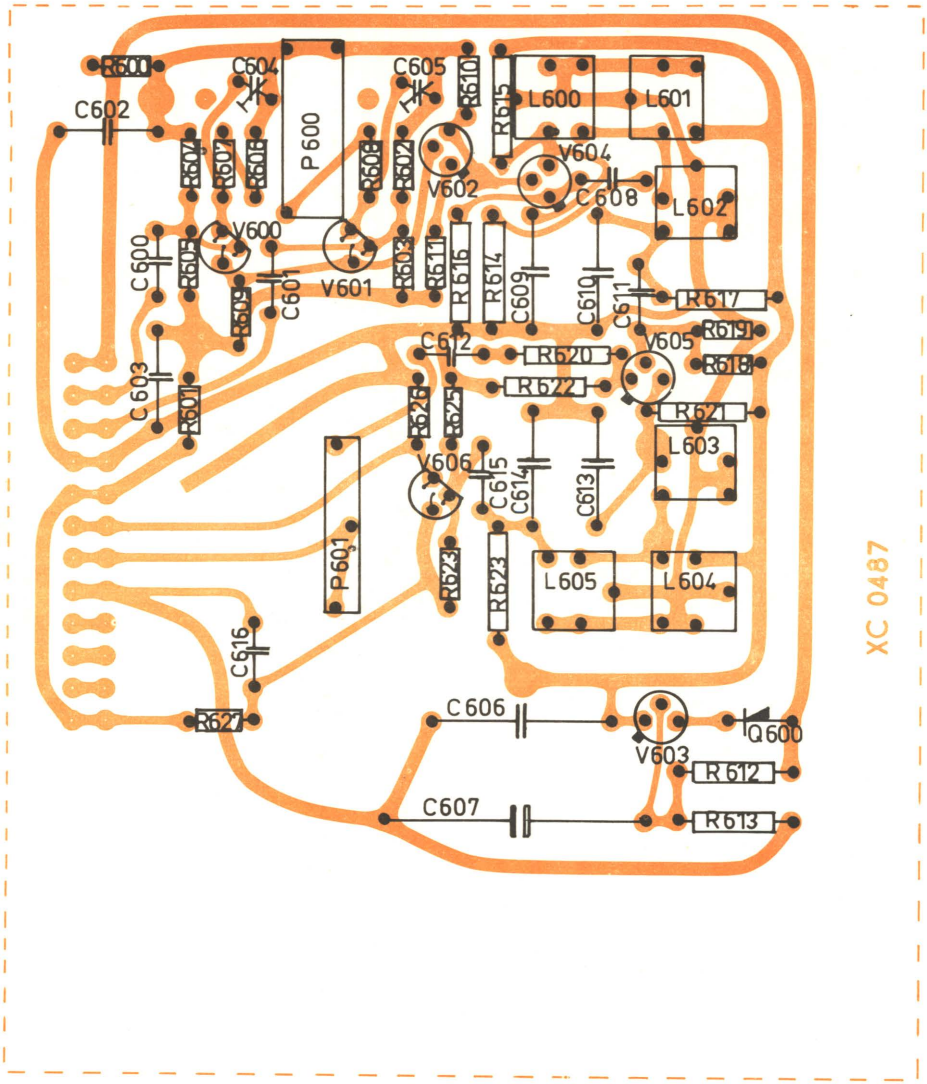
AC to DC Modulator and chopper ZM 0006 – printed circuit XC 0496.



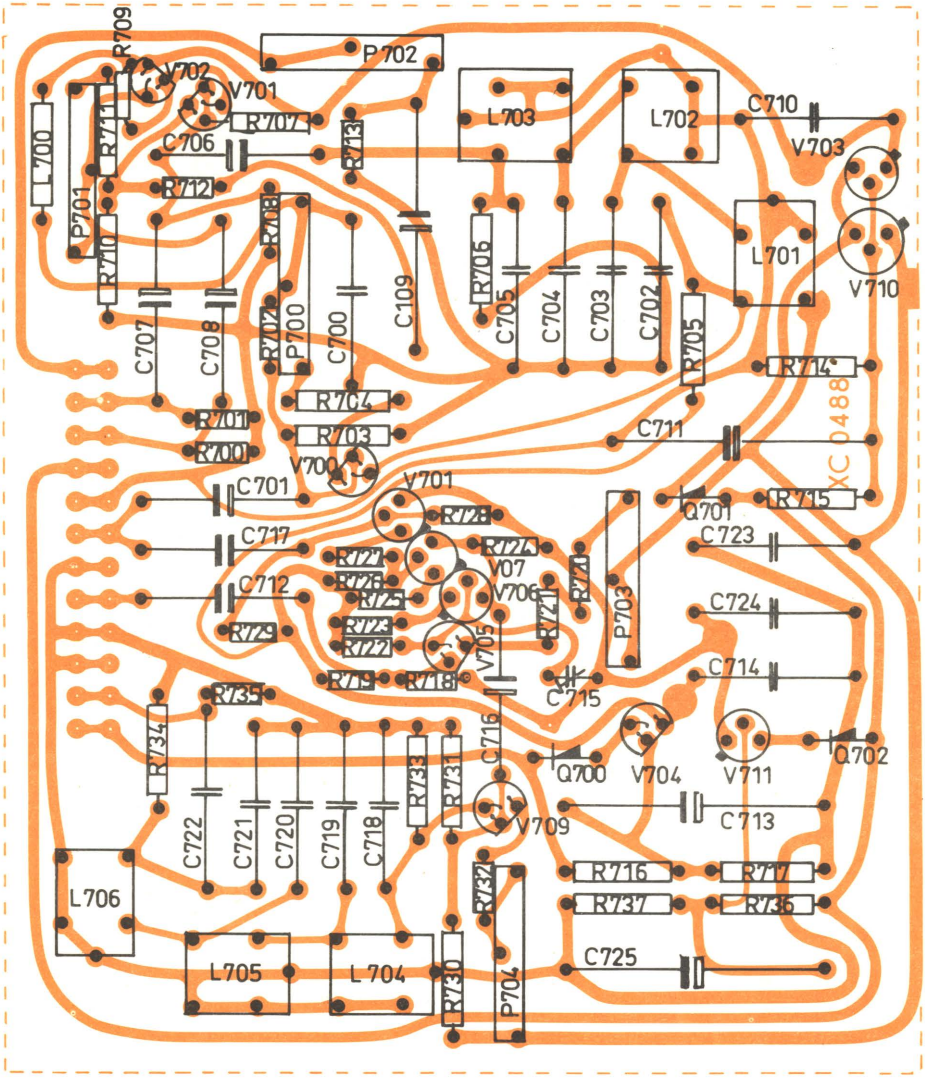
AC to DC Modulator and chopper ZM 0007 – printed circuit XC 0496.



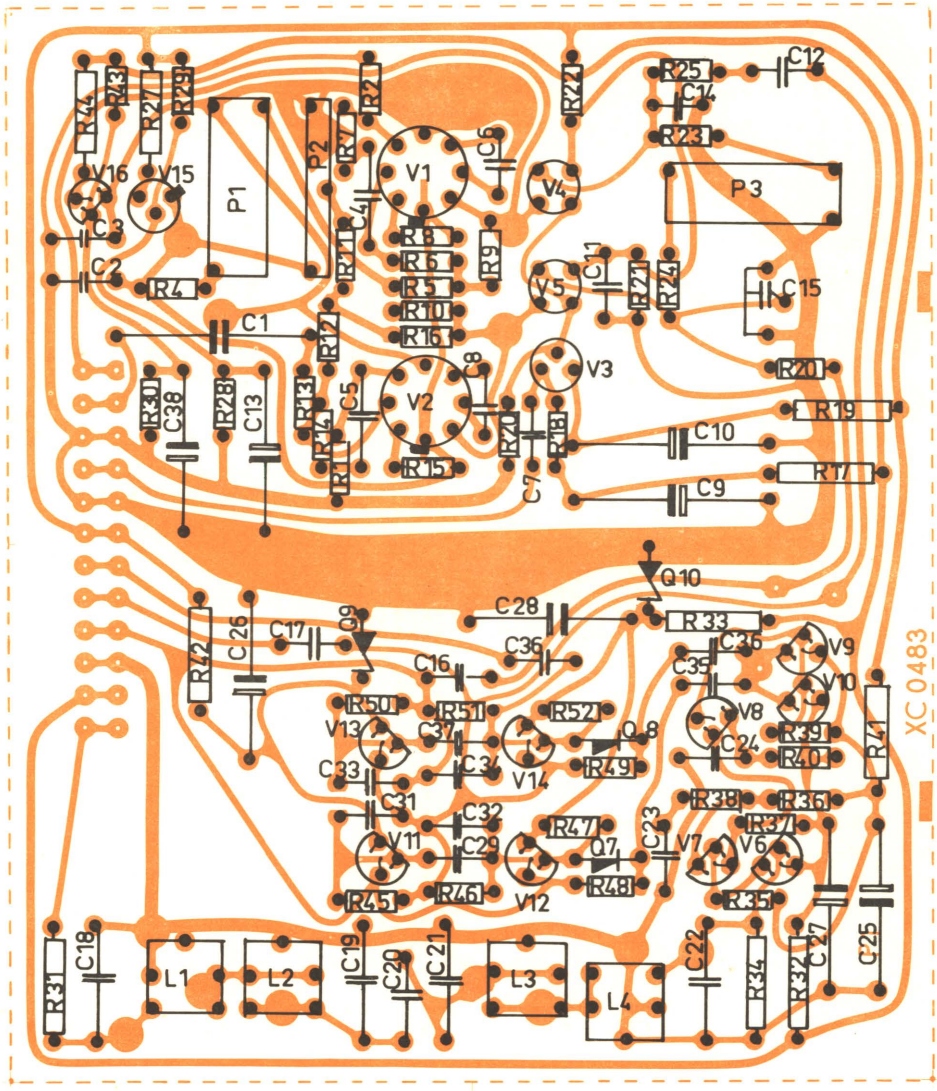
Input and 120 kHz Filter ZS 0168 – printed circuit XC 0484.



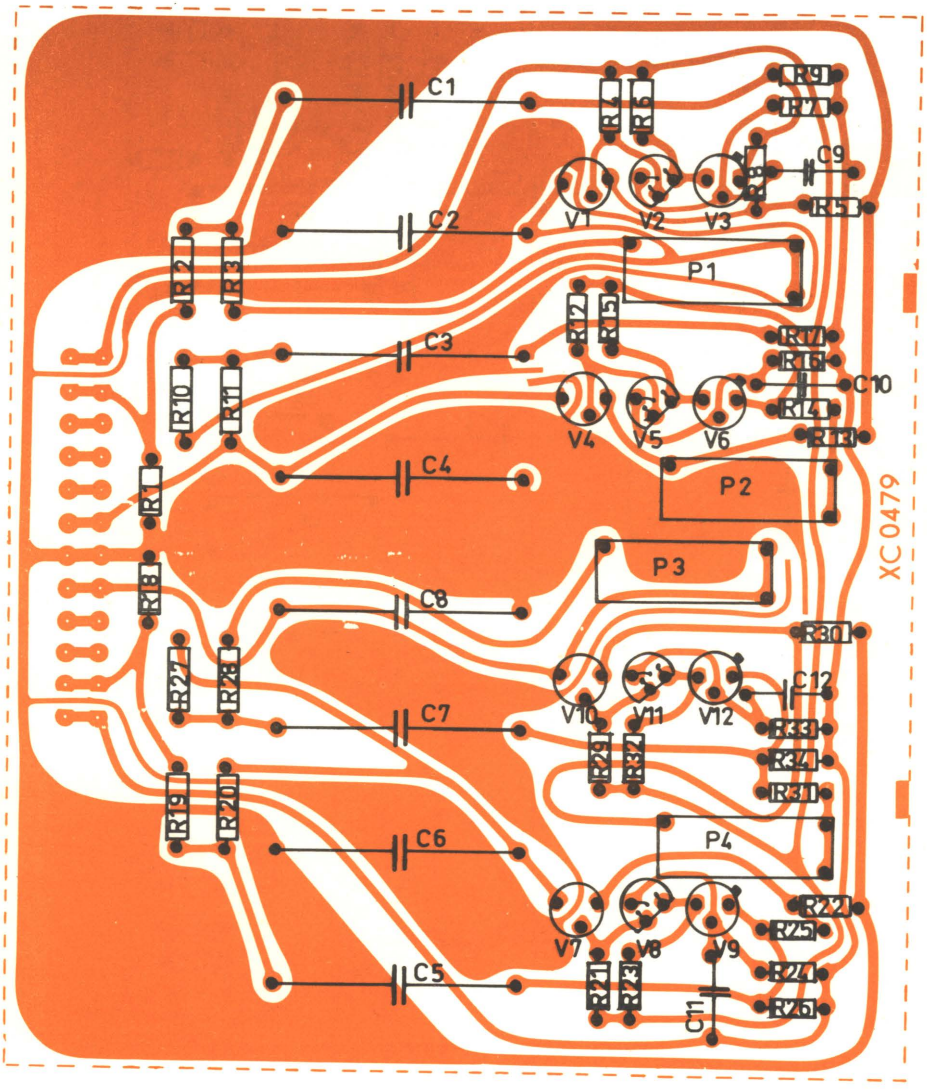
Summation and 120 kHz Filter Amplifier ZS 0170 – printed circuit XC 0487.



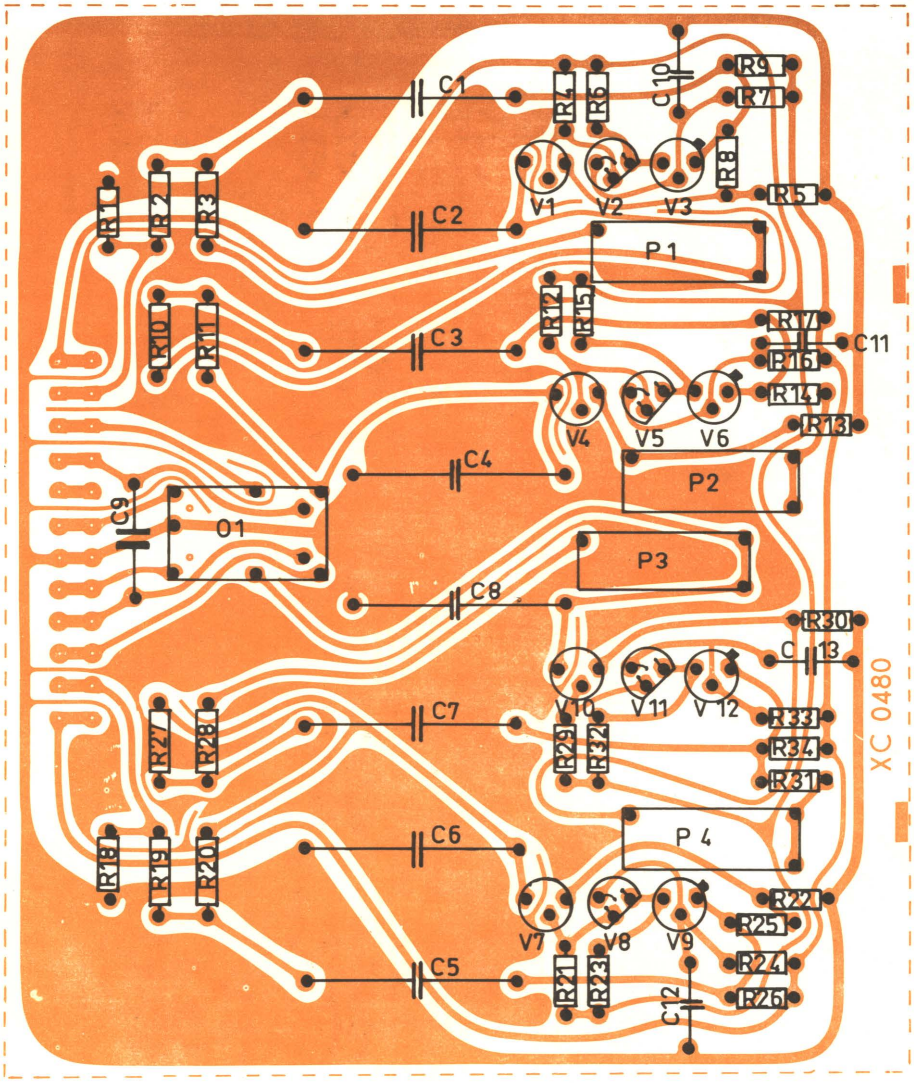
Rejection Ampl. LP Filter and Output Ampl. ZE 0029 – printed circuit XC 0488.



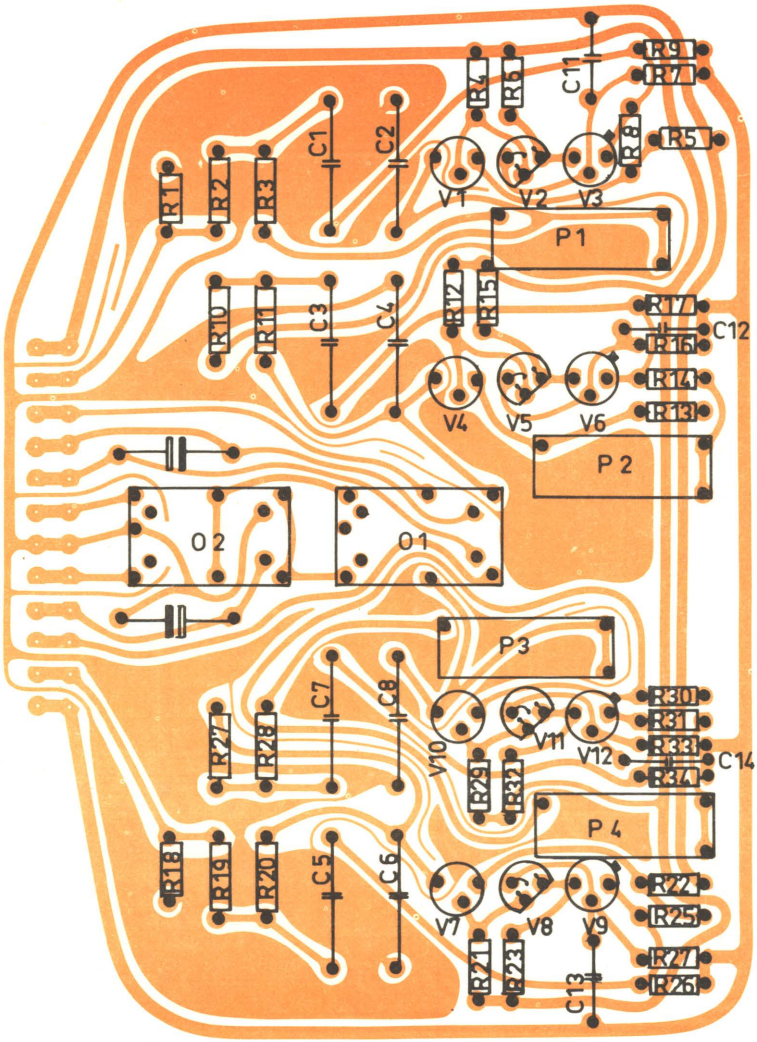
Input Modulator ZM 0003 – printed circuit XC 0483.



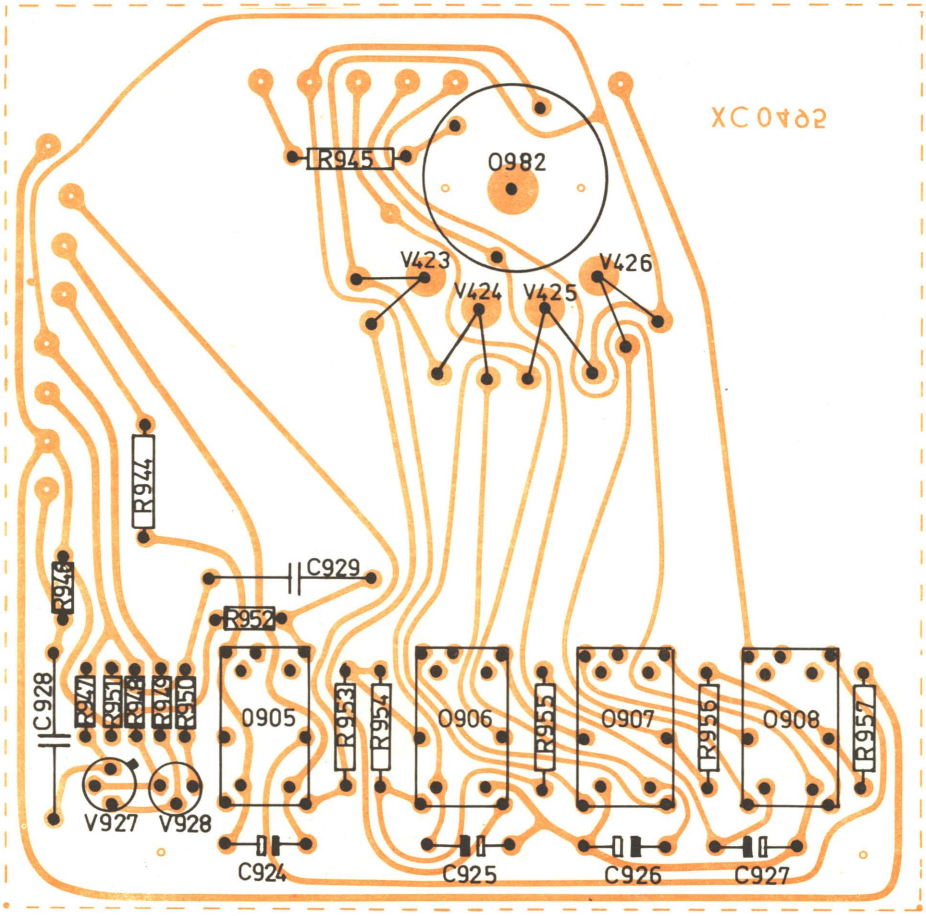
Main Filter – 3.16 Hz ZT 0030 – printed circuit XC 0479.



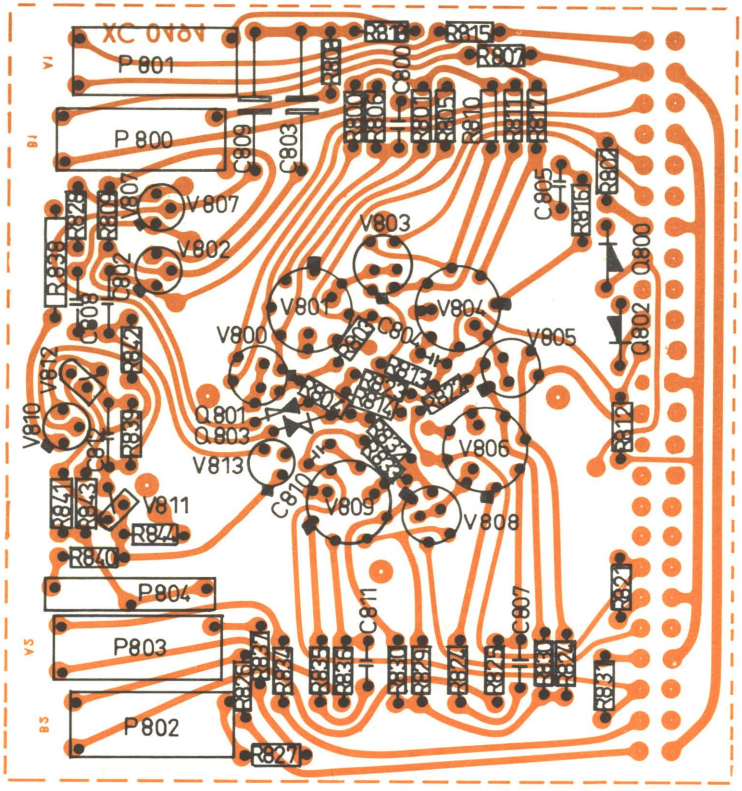
Main Filter 10 Hz ZT 0031 – 31.6 Hz ZT 0032 – printed circuit XC 0480.



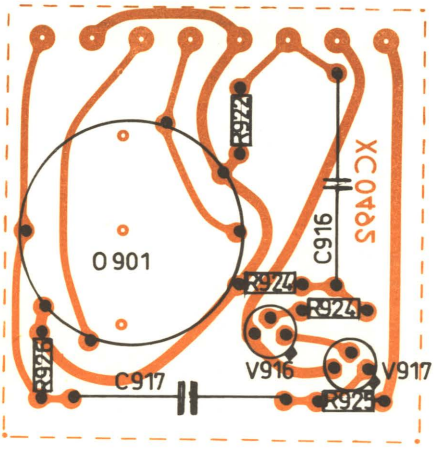
Main Filter 100 Hz ZT 0033 – printed circuit XC 0481



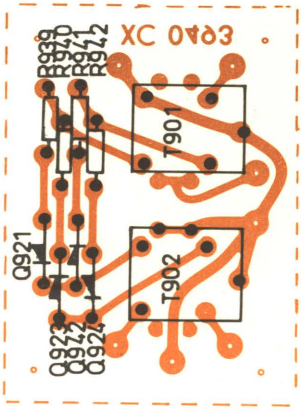
Filter Band Width OE 0006 – printed circuit XC 0495



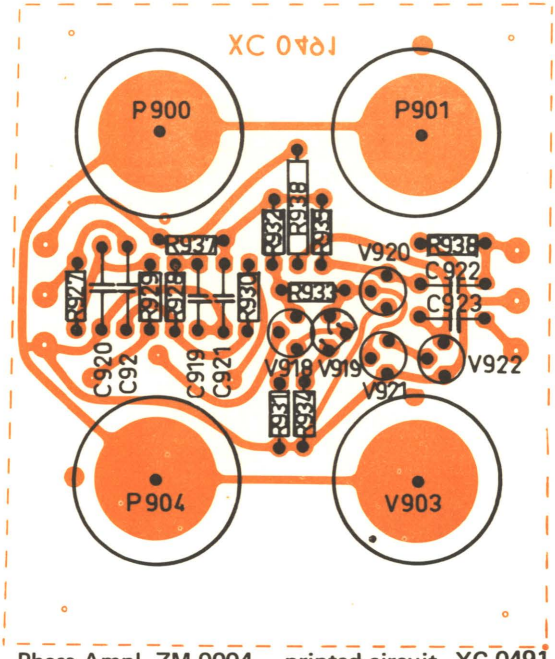
DC Amplifier ZC 0031 — printed circuit XC 0494



Emitter Follower ZE 0030
printed circuit XC 0492

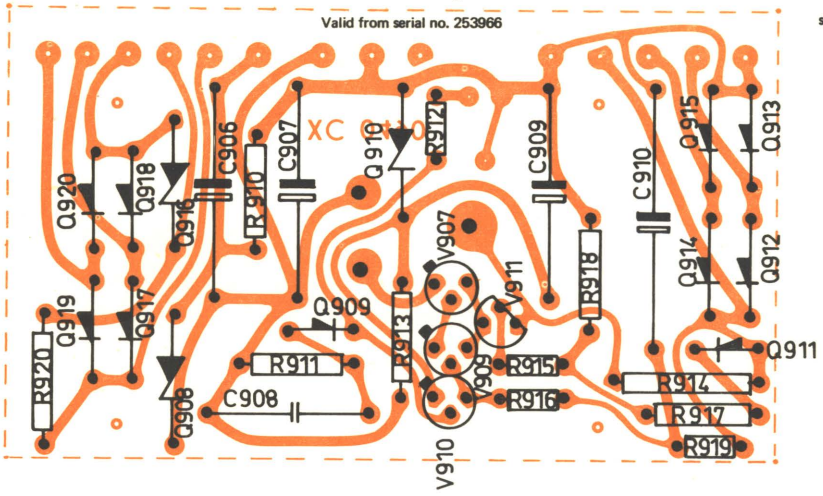


Output Amplifier ZM 0005
printed circuit XC 0493

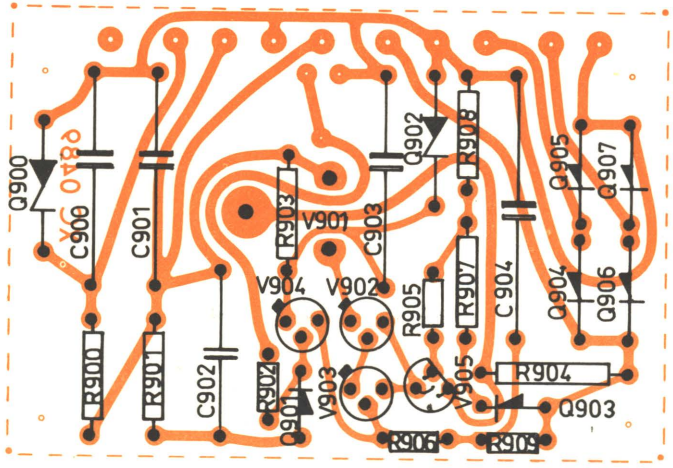


Phase Ampl. ZM 0004 – printed circuit XC 0491

Valid from serial no. 253966



Negative Voltage Supply ZG 0017 - printed circuit XC 0490



Positive Voltage Supply ZG 0016 - printed circuit XC 0489

CIRCUIT DIAGRAM REF.	COMPONENT TYPE			STOCK REF.
CAPACITORS:				
C 1	Electrolytic	(safco)	16µF/ 63 V	CE 0504
C 2,3	Polyester		0,1µF/250 V	CS 0402
C 4,5	Ceramic	1%	0,62nF/125 V	CT 1109
C 6	Polystyrene		50µF/ 63 V	CT 1530
C 7	Polyester		0,1µF/250 V	CS 0402
C 8	Polystyrene		50pF/ 63 V	CT 1530
C 9,10	Electrolytic	(safco)	16µF/ 63 V	CE 0504
C 11	-		0,1µF/250 V	CE 0402
C 12	Polyester		47nF/250 V	CS 0401
C 13	Electrolytic		100µF/ 15 V	CE 0310
C 14	Ceramic		3,3pF/400 V	CK 0330
C 15	Trimmer		2-6pF/	CV 0029
C 16,17	Polyester		47nF/250 V	CS 0401
C 18,19	Polystyrene		1,6nF/400 V	CT 3232
C 20	-	1%	180pF/ 63 V	CT 1310
C 21,22	-		1,6nF/400 V	CT 3232
C 23,24	Polyester		0,1µF/250 V	CS 0402
C 25-28	Electrolytic	(safco)	5µF/ 63 V	CE 0502
C 29	Ceramic		390pF/400 V	CK 2390
C 30	Polyester		10nF/250 V	CS 0403
C 31-34	Ceramic		47pF/400 V	CK 1471
C 35,36	-		100pF/400 V	CK 2100
C 37	-		390pF/400 V	CK 2390
C 38	Electrolytic		100µF/ 15 V	CE 0310
C 101	Electrolytic	(safco)	16µF/ 63 V	CE 0504
C 102	Polyester		0,1µF/250 V	CS 0402
C 103,104	Electrolytic	(safco)	5µF/ 63 V	CE 0502
C 105,106	Polystyrene	2%	1nF/500 V	CT 3218
C 107	Polyester		0,1µF/250 V	CS 0402
C 108,109	Polystyrene	2%	1nF/500 V	CT 3218
C 110	Electrolytic	(safco)	16µF/ 63 V	CE 0504
C 111	Polyester		0,1µF/250 V	CS 0402
C 112	Trimmer		3-10pF	CV 0030
C 113,114	Polyester		0,22µF/250 V	CS 0405
C 115	Electrolytic		8µF/ 40 V	CE 0414
C 116	Polyester		0,22µF/250 V	CS 0405
C 117	Electrolytic		100µF/ 70 V	CE 0520
C 118	-	(safco)	5µF/ 63 V	CE 0502
C 119	Polycarbonat		1µF/100 V	CS 0336
C 120	Polystyrene		500pF/500 V	CT 0213
C 121,122	-		2nF/500 V	CT 0122
C 123	-		500pF/500 V	CT 0213
C 124	Electrolytic	(safco)	5µF/ 63 V	CE 0502
C 200-202	Polyester		0,1µF/250 V	CS 0402
C 203,204	Polycarbonat		1µF/100 V	CS 0336
C 205,206	Polyester		0,1µF/250 V	CS 0402
C 207	Polystyrene	1%	3,3nF/ 63 V	CT 1544
C 208,209	Polyster		0,1µF/250 V	CS 0402
C 210-212	-		o,1µF/250 V	CS 0402
C 213,214	-		47 nF/250 V	CS 0401
C 215	Ceramic		390pF/400 V	CK 2390
C 216,217	-		47pF/400 V	CK 1471
C 218,219	-		100pF/400 V	CK 2100
C 220,221	-		47pF/400 V	CK 1471
C 222	-		390pF/400 V	CK 2390
C 223,224	Polyester		0,22µF/250 V	CS 0405
C 225-227	-		0,1µF/250 V	CS 0402
C 228	-		47nF/250 V	CS 0401
C 229,230	Ceramic	5%	10pF/400 V	CK 1100
C 300-302	Polyester		0,1µF/250 V	CS 0402
C 303,304	Polycarbonat		1µF/100 V	CS 0336
C 305,306	Polyester		0,1µF/250 V	CS 0402
C 307	Polystyrene	1%	3,3nF/ 63 V	CT 1544
C 308,309	Polyester		0,1µF/250 V	CS 0402
C 310-312	-		0,1µF/250 V	CS 0402
C 313,314	-		47nF/250 V	CS 0401
C 315	Ceramic		390pF/400 V	CK 2390
C 316,317	-		47pF/400 V	CK 1471
C 318,319	-		100pF/400 V	CK 2100
C 320,321	-		47pF/400 V	CK 1471
C 322	-		390pF/400 V	CK 2390
C 323,324	Polyester		0,22µF/250 V	CS 0405
C 325-327	-		0,1µF/250 V	CS 0402
C 328	-		47nF/250 V	CS 0401
C 329	Ceramic	5%	10pF/400 V	CK 1100
C 330	-	5%	10pF/400 V	CK 1100
C 400	-		47nF/250 V	CS 0401
C 401	-		4,7nF/400 V	CK 3470
C 402	Polyester		47nF/250 V	CS 0401
C 403	Polystyrene	1%	5nF/250 V	CT 1202
C 404	-	1%	49,9pF/ 63 V	CT 1530
C 405	Ceramic		4,7nF/400 V	CK 3470
C 406	Polystyrene	1%	5nF/250 V	CT 1202
C 407	Polyester		0,1µF/250 V	CS 0402

CIRCUIT DIAGRAM REF.	COMPONENT TYPE			STOCK REF.
CAPACITORS:				
C 408	Polyester		47nF/250 V	CS 0401
C 409	Polystyrene	1%	5nF/250 V	CT 1202
C 410	-	1%	49,9pF/ 63 V	CT 1530
C 411	-	1%	5nF/250 V	CT 1202
C 412	Ceramic		4,7nF/400 V	CK 3470
C 413,414	Polyester		47nF/250 V	CS 0401
C 415-423	-		0,1µF/250 V	CS 0402
C 424	-		47nF/250 V	CS 0401
C 425,526	Electrolytic	(safco)	5µF/ 63 V	CE 0502
C 427	Ceramic		390pF/400 V	CK 2390
C 428,429	-		22pF/400 V	CK 1220
C 430,431	-		100pF/400 V	CK 2100
C 432,433	-		22pF/400 V	CK 1220
C 434	-		390pF/400 V	CK 2390
C 500	Polyester		22nF/250 V	CS 0400
C 501-504	-		0,1µF/250 V	CS 0402
C 505	Polystyrene	1%	6,26nF/250 V	CT 1203
C 506	Ceramic		39pF/400 V	CK 1390
C 507	Polyester		22nF/250 V	CS 0400
C 508	Polystyrene	1%	6,26nF/250 V	CT 1203
C 509	Polyester		47nF/250 V	CS 0401
C 510	-		0,1µF/250 V	CS 0402
C 511	-		47nF/250 V	CS 0401
C 512	Polystyrene	1%	31,8nF/100 V	CT 1600
C 513	-		450pF/500 V	CT 0112
C 514	-	1%	31,8nF/100 V	CT 1600
C 515,516	Polyester		37nF/250 V	CS 0401
C 517	Polystyrene	1%	31,8nF/100 V	CT 1600
C 518	-		200pF/500 V	CT 0107
C 519	-	1%	31,8nF/100 V	CT 1600
C 520,521	Electrolytic	(safco)	16µF/ 63 V	CE 0504
C 522,523	Mica		4nF/350 V	CM 0066
C 524	Polycarbonat		1µF/100 V	CS 0336
C 525	Electrolytic	(safco)	5µF/ 63 V	CE 0502
C 526-528	Polycarbonat		1µF/100 V	CS 0336
C 600,601	Polyester		0,1µF/250 V	CS 0402
C 602,603	-		0,22µF/250 V	CS 0405
C 604,605	Trimmer		10-40pF/	CV 0026
C 606	Polycarbonat		1µF/100 V	CS 0336
C 607	Electrolytic		100µF/ 70 V	CE 0520
C 608	Polyester		0,1µF/250 V	CS 0402
C 609,610	Polystyrene	2%	1nF/500 V	CT 3218
C 611,612	Polyester		0,1µF/250 V	CS 0402
C 613,614	Polystyrene	2%	1nF/500 V	CT 3218
C 615,616	Polyester		0,1µF/250 V	CS 0402
C 700	Polycarbonat		1µF/100 V	CS 0336
C 701	Electrolytic	(safco)	5µF/ 63 V	CE 0502
C 702	Polystyrene	5%	500pF/500 V	CT 0213
C 703,704	-	5%	2nF/500 V	CT 0122
C 705	-	2,5%	500pF/500 V	CT 0213
C 706-708	Electrolytic	(safco)	5µF/ 63 V	CE 0502
C 709	-		400µF/ 10 V	CE 0305
C 710	Polycarbonat		1µF/100 V	CS 0336
C 711	Electrolytic		100µF/ 70 V	CE 0520
C 712	-	(safco)	5µF/ 63 V	CE 0502
C 713	-		100µF/ 70 V	CE 0520
C 714	-		100µF/25-35 V	CE 0415
C 715	Trimmer		2-6pF/250 V	CV 0022
C 716,717	Electrolytic	(safco)	5µF/ 63 V	CE 0502
C 718	Polystyrene	2,5%	500pF/500 V	CT 0213
C 719,720	-	5%	2nF/500 V	CT 0122
C 721	-	2,5%	500pF/500 V	CT 0213
C 722-724	Polycarbonat		1µF/100 V	CS 0336
C 725	Electrolytic		100µF/ 70 V	CE 0520
C 800	Ceramic		2,2nF/100 V	CK 0082
C 801	-		1nF/500 V	CK 3100
C 802	Polyester		0,1µF/250 V	CS 0402
C 803	Electrolytic	(safco)	5µF/ 63 V	CE 0502
C 804	Ceramic		1nF/500 V	CK 3100
C 805	-		47nF/100 V	CK 0096
C 806	-		2,2nF/100 V	CK 0082
C 807	-		1nF/500 V	CK 3100
C 808	Polyester		0,1µF/250 V	CS 0402
C 809	Electrolytic	(safco)	5µF/ 63 V	CE 0502
C 810	Ceramic		1nF/500 V	CK 3100
C 811	-		4,7nF/100 V	CK 0096
C 812	Polyester		10nF/250 V	CS 0403
C 900,901	Electrolytic	(safco)	16µF/ 63 V	CE 0504
C 902	Polycarbonat		1µF/100 V	CS 0336
C 903	Electrolytic	(safco)	16µF/ 63 V	CE 0504
C 904	-		100µF/ 70 V	CE 0520
C 905	-		800µF/ 64 V	CE 0516
C 906,907	-	(safco)	16µF/ 63 V	CE 0504
C 908	Polycarbonat		1µF/100 V	CS 0336

continued

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
CAPACITORS:					
C 909	Electrolytic	(safco)		16µF/ 63 V	CE 0504
C 910	-			100µF/ 70 V	CE 0520
C 911,912	-			800µF/ 64 V	CE 0516
C 913	-	(safco)		16µF/ 63 V	CE 0504
C 914,915	-			5µF/ 63 V	CE 0502
C 916	Polyester			2µF/250 V	CS 0028
C 917	Electrolytic	(safco)		16µF/ 63 V	CE 0504
C 918	Polystyrene	1%		100pF/125 V	CT 1133
C 919	Polyester			22nF/250 V	CS 0400
C 920	Polystyrene	1%		100pF/125 V	CT 1133
C 921-923	Polyester			0,1µF/250 V	CS 0402
C 924-927	Electrolytic			8µF/ 40 V	CE 0414
C 928,929	Polycarbonat			1µF/100 V	CS 0336
C 930	Polyester			0,22µF/250 V	CS 0405
RESISTORS:					
R 1,2	Carbon	1/4 W	5%	10kΩ	RB 4100
R 4	-	-	-	4,7kΩ	RB 3470
R 5	-	-	-	270kΩ	RB 5270
R 6	Metal		1%	20kΩ	RF 4200
R 7	-		-	316 Ω	RF 2316
R 8	Carbon	1/4 W	5%	10kΩ	RB 4100
R 9	Metal		1%	2,21kΩ	RF 3221
R 10	-		-	20kΩ	RF 4200
R 11	Carbon	1/4 W	5%	1MΩ	RB 6100
R 12	Metal		1%	12,1kΩ	RF 4121
R 13	-		-	43,2kΩ	RF 4432
R 14	-		-	316 Ω	RF 2316
R 15	Carbon	1/4 W	5%	10kΩ	RB 4100
R 16	Metal		1%	62kΩ	RF 3162
R 17	Carbon	1/3 W	5%	300 Ω	
R 18	-	1/4 W	-	22kΩ	RB 4220
R 19	-	1/3 W	-	300 Ω	
R 20	-	1/4 W	-	100kΩ	RB 5100
R 21	-	-	-	10kΩ	RB 4100
R 22	-	-	-	47kΩ	RB 4470
R 23,24	-	-	-	2,2kΩ	RB 3220
R 25,26	-	-	-	1kΩ	RB 3100
R 27	-	1/3 W	-	750 Ω	
R 28	-	1/4 W	-	10kΩ	RB 4100
R 29	-	-	-	15kΩ	RB 4150
R 30	-	-	-	5,6kΩ	RB 3560
R 31	-	1/3 W	0,5%	3,56kΩ	
R 32	-	-	5%	3kΩ	
R 33	-	-	-	1,8kΩ	
R 34	-	-	0,5%	3,56kΩ	
R 35	-	1/4 W	5%	2,2kΩ	RB 3220
R 36	-	-	-	5,6kΩ	RB 3560
R 37	-	-	-	2,7kΩ	RB 3270
R 38	-	-	-	33 Ω	RB 1330
R 39	-	-	-	4,7kΩ	RB 3470
R 40	-	-	-	2,7kΩ	RB 3270
R 41	-	1/3 W	-	3kΩ	
R 42	-	-	-	1,8kΩ	
R 43	-	1/4 W	-	22kΩ	RB 4220
R 44	-	1/3 W	-	1,2kΩ	
R 45,46	-	1/4 W	-	47kΩ	RB 4470
R 47	-	-	-	8,2kΩ	RB 3820
R 48,49	-	-	-	12kΩ	RB 4120
R 50,51	-	-	-	47kΩ	RB 4470
R 52	-	-	-	8,2kΩ	RB 3820
R 101	-	1/3 W	-	800 Ω	
R 102,103	-	-	-	500 Ω	
R 104	-	1/4 W	-	100kΩ	RB 5100
R 105	-	-	-	47kΩ	RB 4470
R 106	-	1/3 W	0,5%	7,5kΩ	
R 107	-	-	-	2,2kΩ	
R 108	-	-	-	9,7kΩ	
R 109	-	1/4 W	5%	100kΩ	RB 5100
R 110	-	-	-	47kΩ	RB 4470
R 111	-	1/3 W	0,5%	7,5kΩ	
R 112	-	-	-	2,2kΩ	
R 113	-	-	5%	800 Ω	
R 114	-	-	0,5%	9,6kΩ	
R 115	-	1/4 W	5%	1kΩ	RB 3100
R 116	-	-	-	100kΩ	RB 5100
R 117	-	-	-	47k Ω	RB 4470
R 118	Metal		1%	2,15kΩ	RF 3215
R 119	-		-	1,78kΩ	RF 3178
R 120,121	Carbon	1/4 W	5%	1MΩ	RB 6100
R 122	-	-	-	8,2kΩ	RB 3820
R 123	-	-	-	100kΩ	RB 5100
R 124	-	-	-	8,2kΩ	RB 3820

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
RESISTORS:					
R 125	Carbon	1/4 W	5%	1MΩ	RB 6100
R 126	-	-	-	2,2kΩ	RB 3220
R 127	-	-	-	10kΩ	RB 4100
R 128	-	-	-	180kΩ	RB 5180
R 129	-	1/3 W	0,5%	220kΩ	RB 5220
R 130	-	-	-	2,35kΩ	
R 131	-	-	-	4,8kΩ	
R 132	-	-	-	5,34kΩ	
R 200	-	1/4 W	5%	1,5kΩ	RB 3150
R 201	-	-	-	150kΩ	RB 5150
R 202	-	-	-	68kΩ	RB 4680
R 203	Metal		1%	4,99kΩ	RF 3499
R 204	-		-	5,49kΩ	RF 3549
R 205,206	-		-	2,15kΩ	RF 3215
R 207	Carbon	1/4 W	5%	22 Ω	RB 1220
R 208	-	-	-	8,2kΩ	RB 3820
R 209	Metal	-	1%	280kΩ	RF 2280
R 210	Carbon	-	5%	1,8kΩ	RB 3180
R 211	Metal	1/3 W	1%	2,15kΩ	RF 3215
R 212	Carbon	1/4 W	5%	33kΩ	RB 4330
R 213	-	-	-	15kΩ	RB 4150
R 214	Metal	1/3 W	1%	22,1kΩ	RF 4221
R 215	-	-	-	82,5kΩ	RF 4825
R 216	Carbon	1/4 W	5%	82kΩ	RB 4820
R 217,218	-	1/3 W	-	500 Ω	
R 219	-	1/4 W	1%	24,9kΩ	RF 4248
R 220	Metal		1%	24,9kΩ	RF 4249
R 221	Carbon	1/4 W	5%	1MΩ	RB 6100
R 222	Metal		1%	2,74kΩ	RF 3274
R 223	-		-	3,92kΩ	RF 3392
R 224	-		-	280kΩ	RF 2280
R 225	Carbon	1/4 W	5%	1,5kΩ	RB 3150
R 226	-	-	-	10kΩ	RB 4100
R 227,228	-	-	-	39 Ω	RB 1390
R 229,230	-	-	-	8,2kΩ	RB 3820
R 231,232	-	-	-	47kΩ	RB 4470
R 233,234	-	-	-	10kΩ	RB 4100
R 235,236	-	-	-	47kΩ	RB 4470
R 237,238	-	-	-	8,2kΩ	RB 3820
R 239,240	-	-	-	39kΩ	RB 1390
R 241,242	-	1/3 W	1%	4,7kΩ	
R 243,244	-	1/4 W	5%	3,9kΩ	RB 3390
R 245	-	-	-	10kΩ	RB 4100
R 246	-	-	-	1kΩ	RB 3100
R 247	-	-	-	47kΩ	RB 4470
R 248	Miniresistor			10MΩ	RA 0025
R 249	Carbon	-	-	100kΩ	RB 5100
R 250	Metal		1%	3,92kΩ	RF 3392
R 251	-		-	3,92kΩ	RF 3392
R 252	-		-	15kΩ	RF 4150
R 253	Carbon	1/4 W	5%	33 Ω	RB 1330
R 300	-	-	-	1,5kΩ	RB 3150
R 301	-	-	-	150kΩ	RB 5150
R 302	-	-	-	68kΩ	RB 4680
R 303	Metal		1%	4,99kΩ	RF 3499
R 304	-		-	5,49kΩ	RF 3549
R 305,306	-		-	2,15kΩ	RF 3215
R 307	Carbon	1/4 W	5%	22 Ω	RB 1220
R 308	-	-	-	8,2kΩ	RB 3820
R 309	Metal		1%	280kΩ	RB 3180
R 310	Carbon	-	5%	1,8kΩ	RB 3180
R 311	Metal		1%	2,15kΩ	RF 3215
R 312	Carbon	-	5%	33kΩ	RB 4330
R 313	-	-	-	15kΩ	RB 4150
R 314	Metal		1%	22,1kΩ	RF 4221
R 315	-		-	82,5kΩ	RF 4825
R 316	Carbon	1/4 W	5%	82kΩ	RB 4820
R 317,318	-	1/3 W	-	500 Ω	
R 319	-	1/4 W	-	1MΩ	RB 6100
R 320	Metal		1%	24,9kΩ	RF 4249
R 321	Carbon	-	5%	1MΩ	RB 6100
R 322	Metal		1%	2,74kΩ	RF 3274
R 323	-		-	3,92kΩ	RF 3392
R 324	-		-	2,80kΩ	RF 2280
R 325	Carbon	1/4 W	5%	1,5kΩ	RB 3150
R 326,327	-	-	-	39 Ω	RB 1390
R 328,329	-	-	-	8,2kΩ	RB 3820
R 330,331	-	-	-	47kΩ	RB 4470
R 332,333	-	-	-	10kΩ	RB 4100
R 334,335	-	-	-	47kΩ	RB 4470
R 336,337	-	-	-	8,2kΩ	RB 3820
R 338,339	-	-	-	39 Ω	RB 1390
R 340,341	-	1/3 W	1%	4,7kΩ	
R 342,343	-	1/4 W	5%	3,9kΩ	RB 3390
R 344	-	-	-	10kΩ	RB 4100
R 345	-	-	-	1kΩ	RB 3100

continued

RESISTORS:

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 346	Carbon	1/4 W	5%	47kΩ	RB 4470
R 347	Miniresistor			10MΩ	RA 0025
R 348	Carbon	1/4 W	5%	100kΩ	RB 5100
R 350	Metal		1%	3,92kΩ	RF 3392
R 351	-		1%	3,92kΩ	RF 3392
R 352	-		-	15kΩ	RF 4150
R 353	Carbon	1/4 W	5%	33 Ω	RB 1330
R 400	-	-	-	180kΩ	RB 5180
R 401	-	-	-	47kΩ	RB 4470
R 402	-	1/3 W	-	1,5kΩ	
R 403	-	1/8 W	-	6,8 Ω	RA 0204
R 404	Metal		1%	12,1kΩ	RF 4121
R 405	Carbon	1/4 W	5%	4,7kΩ	RB 3470
R 406	-	-	-	470 Ω	RB 2470
R 407	-	-	-	82kΩ	RB 4820
R 408	-	-	-	22kΩ	RB 4220
R 409	-	-	-	330 Ω	RB 2330
R 410	-	-	-	1kΩ	RB 3100
R 411	-	-	-	18kΩ	RB 4180
R 412	-	1/3 W	-	2kΩ	
R 413	-	1/4 W	-	27kΩ	RB 4270
R 414	-	-	-	2,2kΩ	RB 3220
R 415	-	1/3 W	-	1,5kΩ	
R 416	-	-	-	160 Ω	
R 417	-	1/4 W	-	470 Ω	RB 2470
R 418	-	1/3 W	-	1,5kΩ	
R 419	-	1/4 W	-	47kΩ	RB 4470
R 420	-	-	-	8,2kΩ	RB 3820
R 421	-	-	-	1kΩ	RB 3100
R 422,423	-	1/3 W	-	3kΩ	
R 424	-	1/4 W	-	3,3kΩ	RB 3330
R 425,426	-	-	-	47kΩ	RB 4470
R 427,428	-	-	-	10kΩ	RB 4100
R 429,430	-	-	-	47kΩ	RB 4470
R 431	-	-	-	3,3kΩ	RB 3330
R 432,433	-	-	-	8,2kΩ	RB 3820
R 500	-	-	-	5,6kΩ	RB 3560
R 501	-	-	-	180kΩ	RB 5180
R 502,503	-	-	-	180kΩ	RB 5180
R 504	-	-	-	330 Ω	RB 2330
R 505,506	-	-	-	10kΩ	RB 4100
R 507	-	-	-	3,9kΩ	RB 3390
R 508	-	-	-	10kΩ	RB 4100
R 509,510	-	-	-	820kΩ	RB 5820
R 511	-	-	-	10kΩ	RB 4100
R 512	-	1/3 W	-	500 Ω	
R 513	-	1/4 W	-	220kΩ	RB 5220
R 514	-	-	-	22kΩ	RB 4220
R 515	-	-	-	150 Ω	RB 2150
R 516	-	-	-	1,2kΩ	RB 3120
R 517,518	Metal		1%	1kΩ	RF 3100
R 519,520	-		-	1kΩ	RF 3100
R 521	Carbon	1/4 W	5%	39kΩ	RB 4390
R 522	-	-	-	12kΩ	RB 4120
R 523	-	-	-	330 Ω	RB 2330
R 524	-	-	-	4,7kΩ	RB 3470
R 525	-	1/3 W	-	300 Ω	
R 526	-	1/4 W	-	82kΩ	RB 3820
R 527	Metal		1%	12,7kΩ	RF 0012
R 528	-		-	13,3kΩ	RF 0011
R 529	Carbon	-	5%	3,9kΩ	RB 3390
R 530	Metal		1%	316 Ω	RF 2316
R 531	Carbon	1/4 W	5%	470kΩ	RB 5470
R 532	-	-	-	47kΩ	RB 4470
R 533	Metal		1%	200 Ω	RF 2200
R 534	-	-	-	1kΩ	RF 3100
R 535	Carbon	-	5%	6,8kΩ	RB 3680
R 536	-	-	-	1kΩ	RB 3100
R 537,538	-	-	-	100kΩ	RB 5100
R 539,540	-	-	-	1kΩ	RB 3100
R 541	NTC resistor			5kΩ	RN 0002
R 600,601	Carbon	1/4 W	5%	680 Ω	RB 2680
R 602	-	-	-	56kΩ	RB 4560
R 603	-	-	-	270kΩ	RB 5270
R 604	-	-	-	56kΩ	RB 4560
R 605	-	-	-	270kΩ	RB 5270
R 606	Metal		1%	3,32kΩ	RF 3332
R 607	-		-	100 Ω	RF 2100
R 608	-		-	3,16kΩ	RF 3316
R 609	-		-	2,74kΩ	RF 3274
R 610	-		-	3,32kΩ	RF 3332
R 611	-		-	2,49kΩ	RF 3249
R 612	Carbon	1/3 W	5%	1kΩ	
R 613	-	-	-	5kΩ	

RESISTORS:

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 614	Carbon	1/3 W	0,5%	12kΩ	
R 615	-	-	0,5%	75kΩ	
R 616	Carbon	1/3 W	0,5%	2,8kΩ	
R 617	-	-	-	9,7kΩ	
R 618,619	-	1/4 W	5%	68kΩ	RB 4680
R 620	-	1/3 W	0,5%	3,2kΩ	
R 621	-	-	-	7,5kΩ	
R 622	-	-	-	6kΩ	
R 623	-	-	-	9,7kΩ	
R 624	-	1/4 W	5%	68kΩ	RB 4680
R 625	-	-	-	150kΩ	RB 5150
R 626	-	-	-	6,8kΩ	RB 3680
R 627	-	-	-	1,8kΩ	RB 3180
R 700,701	-	-	-	1MΩ	RB 6100
R 702	-	-	-	150kΩ	RB 5150
R 703	-	1/3 W	-	120kΩ	
R 704	-	-	-	1,5kΩ	
R 705	-	-	0,5%	4,8kΩ	
R 706	-	-	-	5kΩ	
R 707	-	-	5%	1,15MΩ	
R 708	-	1/4 W	-	220kΩ	RB 5220
R 709	-	-	-	22kΩ	RB 4220
R 710	-	1/3 W	-	1kΩ	
R 711	-	-	-	1,6kΩ	
R 712	-	1/4 W	-	100 Ω	RB 2100
R 713	-	-	-	1MΩ	RB 6100
R 714	-	1/3 W	-	5kΩ	
R 715,716	-	-	-	1kΩ	
R 717	-	-	-	5kΩ	
R 718	-	1/4 W	-	100kΩ	RB 5100
R 719	-	-	-	270kΩ	RB 5270
R 720	Metal		1%	1,5kΩ	RF 3150
R 721	-		-	7,5kΩ	RF 3750
R 722-726	-		-	10kΩ	RF 4100
R 727	-		-	20kΩ	RF 4200
R 728	Carbon	1/4 W	5%	100kΩ	RB 5100
R 729	-	-	-	270kΩ	RB 5270
R 730	-	1/3 W	-	50kΩ	
R 731	-	-	-	200kΩ	
R 732	-	1/4 W	-	220 Ω	RB 2220
R 733,734	-	1/3 W	0,5%	4,8kΩ	
R 735	-	1/4 W	5%	1MΩ	RB 6100
R 736	-	1/3 W	-	1kΩ	
R 737	-	-	-	5kΩ	
R 800,801	Metal		1%	63,4kΩ	RF 4634
R 802	Carbon	1/4 W	5%	4,7kΩ	RB 3470
R 803,804	Metal		1%	100kΩ	RF 5100
R 805	Carbon	1/4 W	5%	1,5kΩ	RB 3150
R 806	-	-	-	100kΩ	RB 5100
R 807	Metal		1%	5,49kΩ	RF 3549
R 808	-		-	14kΩ	RF 4140
R 809	Carbon	1/4 W	5%	3,3kΩ	RB 3330
R 810,811	Metal		1%	63,4kΩ	RF 4634
R 812	Carbon	1/4 W	5%	4,7kΩ	RB 3470
R 813	Metal		1%	49,9kΩ	RF 4499
R 814	-		-	100kΩ	RF 5100
R 815	-		-	6,81kΩ	RF 3681
R 816	Carbon	1/4 W	5%	1,5kΩ	RB 3150
R 817	-	-	-	100kΩ	RB 5100
R 818	Metal		1%	14kΩ	RF 4140
R 819,820	-		-	63,4kΩ	RF 4634
R 821	Carbon	1/4 W	5%	4,7kΩ	RB 3470
R 822,823	Metal		1%	100kΩ	RF 5100
R 824	Carbon	1/4 W	5%	1,5kΩ	RB 3150
R 825	-	-	-	100kΩ	RB 5100
R 826	Metal		1%	5,49kΩ	RF 3549
R 827	-		-	14kΩ	RF 4140
R 828	Carbon	1/4 W	5%	4,7kΩ	RB 3470
R 829,830	Metal		1%	63,4kΩ	RF 4634
R 831	Carbon	1/4 W	5%	4,7kΩ	RB 3470
R 832	Metal		1%	100kΩ	RF 5100
R 833	-		-	49,9kΩ	RF 4499
R 834	-		-	6,81kΩ	RF 3681
R 835	Carbon	1/4 W	5%	1,5kΩ	RB 3150
R 836	-	-	-	100kΩ	RB 5100
R 837	Metal		1%	14kΩ	RF 4140
R 838	Carbon	1/3 W	5%	220 Ω	
R 839	-	1/4 W	-	5,6kΩ	RB 3560
R 840,841	Metal		1%	3,92kΩ	RF 3392
R 842	-		-	2,05kΩ	RF 3205
R 843	-		-	5,49kΩ	RF 3549
R 900	Carbon	1/3 W	5%	620 Ω	
R 901	-	-	0,5%	57kΩ	

continued

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
RESISTORS:					
R 902	Carbon	1/4 W	5%	33kΩ	RB 4330
R 903	-	1/3 W	-	2kΩ	
R 904	Wire	1 W	-	1,3 Ω	RO 0005
R 905	Carbon	1/4 W	-	1kΩ	RB 3100
R 906	-	-	-	5,5kΩ	RB 4560
R 907	-	1/3 W	0,5%	100 Ω	
R 908	-	-	-	5kΩ	
R 909	-	1/4 W	5%	56kΩ	RB 4560
R 910	-	1/3 W	-	620 Ω	
R 911	-	-	0,5%	57kΩ	
R 912	-	1/4 W	5%	33kΩ	RB 4330
R 913	-	1/3 W	-	2kΩ	
R 914	Wire	1 W	-	1,3 Ω	RO 0005
R 915	Carbon	1/4 W	-	1kΩ	RB 3100
R 916	-	-	-	56kΩ	RB 4560
R 917	-	1/3 W	0,5%	100 Ω	
R 918	-	-	-	5kΩ	
R 919	-	1/4 W	5%	56kΩ	RB 4560
R 920	Wire	5,5 W		330 Ω	RX 0300
R 921	Carbon	1/4 W	5%	1kΩ	RB 3100
R 922,923	-	-	-	1MΩ	RB 6100
R 924	-	-	-	1kΩ	RB 3100
R 925	-	-	-	10kΩ	RB 4100
R 926	-	-	-	1MΩ	RB 6100
R 927,928	Metal	-	1%	121kΩ	RF 2141
R 929	-		-	18,2kΩ	RF 4182
R 930	-		-	6,21kΩ	RF 3181
R 931	Carbon	1/4 W	5%	12kΩ	RB 4120
R 932	-	-	-	8,2kΩ	RB 3820
R 933	-	-	-	12kΩ	RB 4120
R 934	-	-	-	100 Ω	RB 2100
R 935	-	-	-	6,8kΩ	RB 3680
R 936	-	-	-	1MΩ	RB 6100
R 937	-	-	-	1,8kΩ	RB 3180
R 938	-	1/3 W	-	2kΩ	
R 939,940	Metal		1%	2,15kΩ	RF 3215
R 941,942	-		-	2,15kΩ	RF 3215
R 943	Carbon	1/4 W	5%	33kΩ	RB 4330
R 944,945	-	1/3 W	-	100 Ω	
R 946	-	1/4 W	-	1MΩ	RB 6100
R 947	-	-	-	10kΩ	RB 4100
R 948	-	-	-	68kΩ	RB 4680
R 949,950	-	-	-	1kΩ	RB 3100
R 951	-	-	-	1MΩ	RB 6100
R 952	Miniresistor			10MΩ	RA 0025
R 953	Carbon	1/3 W	0,5%	60,3kΩ	
R 954	-	-	-	37,1kΩ	
R 955	-	-	-	21kΩ	
R 956	-	-	-	11,7kΩ	
R 957	-	-	-	14,7kΩ	
R 958	-	1/4 W	5%	1MΩ	RB 6100

COILS – TRANSFORMERS:

L 1	330 µH	LB	0653
L 2,3	295 µH	LB	0652
L 4	330 µH	LB	0653
L 101	1378 µH	LB	0657
L 102	562 µH	LB	0655
L 103	1378 µH	LB	0657
L 104	1378 µH	LB	0656
L 105	562 µH	LB	0654
L 106	1378 µH	LB	0656
L 107	31,1 mH	LB	0647
L 108	50,4 mH	LB	0648
L 109	31,1 mH	LB	0647
L 200	2x4 mH	LB	0645
L 300	2x4 mH	LB	0645
L 400-403	21 µH	LB	0646
L 500,501	280 µH	LB	0651
L 502	56 µH	LB	0650
L 503-505	56 µH	LB	0649
L 600	1378 µH	LB	0657
L 601	562 µH	LB	0655
L 602	1378 µH	LB	0657
L 603	1378 µH	LB	0656
L 604	562 µH	LB	0654
L 605	1378 µH	LB	0656
L 700	30 µH	LJ	0008
L 701	31,1 mH	LB	0647
L 702	50,4 mH	LB	0648
L 703,704	31,1 mH	LB	0647
L 705	50,4 mH	LB	0648
L 706	31,1 mH	LB	0647

CIRCUIT DIAGRAM REF.	COMPONENT TYPE		STOCK REF.
COILS - TRANSFORMERS:			
L 900-903		30 µH	LJ 0008
T 500	Transformer		LB 2000
T 900	Power		TN 0029
T 901	Transformer		LB 2001
T 902	-		LB 2002

DIODES:

Q 7,8	Silicon	150V/300 mA	QV	0217
Q 9,10	Zener	10,8-13,2V/ 19 mA	QV	1117
Q 101	Silicon	150V/300 mA	QV	0217
Q 200	Zener	5,9-6,5V/ 34 mA	QV	1322
Q 201-203	Silicon	150V/300 mA	QV	0217
Q 206,207	-	150V/300 mA	QV	0217
Q 300	Zener	5,9-6,5V/ 34 mA	QV	1322
Q 301-303	Silicon	150V/300 mA	QV	0217
Q 306-308	-	150V/300 mA	QV	0217
Q 400	Zener	35,2-37,8V/ 30 mA	QV	1321
Q 401-408	Silicon	150V/300 mA	QV	0217
Q 500-503	Germanium	115V/150 mA	QV	0085
Q 600	Silicon	15oV/300 mA	QV	0217
Q 700-702	-	150V/300 mA	QV	0217
Q 800	-	150V/300 mA	QV	0217
Q 801	Zener	15,3-17V/ 17 mA	QV	1118
Q 802	Silicon	150V/300 mA	QV	0217
Q 803	Zener	15,3-17V/ 17 mA	QV	1118
Q 900	Zener	22,8-25,2V/ 40 mA	QV	0218
Q 901	Silicon	150V/300 mA	QV	0217
Q 902	Zener	10,7-11,5V/ 80 mA	QV	1315
Q 903	Silicon	150V/300 mA	QV	0217
Q 904-907	-	200V/600 mA	QV	0502
Q 908	Zener	22,8-25,4V/ 40 mA	QV	0218
Q 909	Silicon	150V/300 mA	QV	0217
Q 910	Zener	10,7-11,5V/ 80 mA	QV	1315
Q 911	Silicon	150V/300 mA	QV	0217
Q 912-915	-	200V/600 mA	QV	0502
Q 916	Zener	22,8-25,2V/ 40 mA	QV	0218
Q 917-920	Silicon	200V/600 mA	QV	0502
Q 921-924	-	150V/300 mA	QV	0217

TRANSISTORS:

V 1,2	Integr.circuit		PA7712 C	VE	0005
V 3	Silicon	NPN	BC107	VB	1032
V 4,5	MOS	FET	M511	VB	4001
V 6,7	Silicon	PNP	2N3702	VB	0038
V 8,9	-	NPN	2N3704	VB	0028
V 10,11	-	PNP	2N3702	VB	0038
V 12	-	NPN	2N3704	VB	0028
V 13	-	PNP	2N3702	VB	0038
V 14	-	NPN	2N3704	VB	0028
V 15	-	NPN	BC107	VB	1032
V 16	-	PNP	2N3702	VB	0038
V 101-106	-	NPN	BC107	VB	1032
V 107	-	PNP	2N3702	VB	0038
V 200,201	-	NPN	2N3704	VB	0028
V 202	-	PNP	2N3702	VB	0038
V 203,204	MOS	FET	M511	VB	4001
V 205		FET	P1069	VB	1500
V 206	Silicon	NPN	2N3704	VB	0028
V 207	-	NPN	2N3704	VB	0028
V 208	-	PNP	2N3702	VB	0038
V 209	-	NPN	2N3704	VB	0028
V 210	-	PNP	2N3702	VB	0038
V 211	-	NPN	BC107	VB	1032
V 212		FET	2N4302	VB	0045
V 213,214	MOS	FET	M511	VB	4001
V 215		NPN	2N3704	VB	0028
V 300,301	Silicon	NPN	2N3704	VB	0028
V 302	-	PNP	2N3702	VB	0038
V 303,304	MOS	FET	M511	VB	4001
V 305		FET	P1069	VB	1500
V 306	Silicon	NPN	2N3704	VB	0028
V 307	-	NPN	2N3704	VB	0028
V 308	-	PNP	2N3702	VB	0038
V 309	-	NPN	2N3704	VB	0028
V 310	-	PNP	2N3702	VB	0038
V 311	-	NPN	BC107	VB	1032
V 312		FET	2N4302	VB	0045
V 313,314	MOS	FET	M511	VB	4001
V 315	Silicon	NPN	2N3704	VB	0028

continued

TRANSISTORS:

CIRCUIT DIAGRAM REF.	COMPONENT TYPE			STOCK REF.
V 400,401	Silicon	NPN	BC107	VB 1032
V 402	-	PNP	2N3702	VB 0038
V 403	-	NPN	BC107	VB 1032
V 404	-	NPN	2N3704	VB 0028
V 405,406	-	PNP	2N3702	VB 0038
V 407	-	NPN	2N3704	VB 0028
V 408	-	PNP	2N3702	VB 0038
V 409	-	NPN	2N3704	VB 0028
V 500-503	-	NPN	BC107	VB 1032
V 504	-	PNP	2N3702	VB 0038
V 505	-	NPN	BC107	VB 1032
V 506		FET	2N4302	VB 0045
V 507-509	Silicon	NPN	BC107	VB 1032
V 600,601	-	PNP	2N3702	VB 0038
V 602-605	-	NPN	BC107	VB 1032
V 606	-	PNP	2N3702	VB 0038
V 700	-	PNP	2N3702	VB 0038
V 701	-	NPN	2N3704	VB 0028
V 702	-	PNP	2N3702	VB 0038
V 703	-	NPN	BC107	VB 1032
V 704,705	-	PNP	2N3702	VB 0038
V 706-708	-	NPN	BC107	VB 1032
V 709	-	PNP	2N3702	VB 0038
V 710	-	NPN	2N3053	VB 0251
V 711	-	NPN	BC107	VB 1032
V 800	(dobb)	FET	U232	VB 1002
V 801	Integr.circuit		PA7709	VE 0003
V 802	Silicon	NPN	2N3053	VB 0251
V 803	(dobb)	FET	U232	VB 1002
V 804	Integr.circuit		PA7709	VE 0003
V 805	(dobb)	FET	U232	VB 1002
V 806	Integr.circuit		PA7709	VE 0003
V 807	Silicon	PNP	2N4037	VB 0067
V 808	(dobb)	FET	U232	VB 1002
V 809	Integr.circuit		PA7709	VE 0003
V 810	Silicon	NPN	2N3053	VB 0251
V 811,812	-	NPN	2N4287	VB 0055
V 813	Germanium	NPN	ASY29	VB 0506
V 900	Silicon	NPN	2N4922	VB 0063
V 901	Silicon	NPN	40363	VB 0255
V 902-904	Silicon	NPN	BC107	VB 1032
V 905	-	PNP	2N3702	VB 0038
V 906	-	PNP	2N4919	VB 0061
V 907	-	NPN	40363	VB 0255
V 908-910	-	NPN	BC107	VB 1032
V 911	-	PNP	2N3702	VB 0038
V 912	-	NPN	2N4922	VB 0063
V 915	-	NPN	2N4922	VB 0063
V 916-918	-	NPN	BC107	VB 1032
V 919	-	PNP	2N3702	VB 0038
V 920-922	-	NPN	BC107	VB 1032
V 927	-	NPN	BC107	VB 1032
V 928		FET	2N4302	VB 0045

POTENTIOMETERS:

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
P 1	Carbon	0,5W	lin.	10 kΩ	PG 3109
P 2	Wire	-	-	10 kΩ	PG 3107
P 3	-	-	-	5 kΩ	PG 2504
P 101	-	-	-	500 Ω	PG 1501
P 200	-	-	-	1 kΩ	PG 2103
P 201	-	-	-	50 kΩ	PG 3506
P 202	-	-	-	5 kΩ	PG 2504
P 300	-	-	-	1 kΩ	PG 2102
P 301	-	-	-	50 kΩ	PG 3506
P 302	-	-	-	5 kΩ	PG 2504
P 500	-	-	-	1 kΩ	PG 2103
P 600	-	-	-	500 Ω	PG 1501
P 601	-	-	-	1 kΩ	PG 2103
P 700-704	-	-	-	1 kΩ	PG 2103
P 800-803	-	-	-	5 kΩ	PG 2504
P 804	-	-	-	10 kΩ	PG 3107
P 900-903	-	2W	-	500 Ω	PQ 1509
P 904	-	-	-	5 kΩ	PQ 2509

PRINTED CIRCUIT:

	Rejection Ampl.	ZE	0029	XC	0488
	Emitter follower	ZE	0030	XC	0492

PRINTED CIRCUITS:

	DC ampl. (in Oven)	ZE	0031	XC	0494
	240 kHz squarewave	ZI	0003	XC	0485
	Input Modulator	ZM	0003	XC	0483
	Var. Phase Ampl.	ZM	0004	XC	0491
	Output Ampl.	ZM	0005	XC	0493
	AC to DC modulator	ZM	0006	XC	0496
	AC to DC modulator	ZM	0007	XC	0496
	Input filter 120 kHz	ZS	0168	XC	0484
	120 kHz Fixed Freq. Conditioning	ZS	0169	XC	0486
	Summation ampl.	ZS	0170	XC	0487
	3,16 kHz Filter	ZT	0030		
	10 Hz Filter	ZT	0031		
	31,6 Hz Filter	ZT	0032		
	100 Hz Filter	ZT	0033		
	Voltage Supply	ZG	0016	XC	0489
	−Voltage Supply	ZG	0017	XC	0490
	Filter Bandwidth	OE	0006	XC	0495
	Gain Switch	OE	0008	XC	0511
	BFO Mode Switch	OR	0104	XC	0482

MISCELLANEOUS:

O 101	Relay 24 V	OC	0024
O 900	"On–Off" switch	NN	0014
O 901	"Input Filter"	OH	2000
O 902	"Bandwidth" switch	OH	3000
O 903	"Output" switch	NN	0022
O 904	"BFO Mode" switch	NN	0021
O 905-908	Relay 24 V	OC	0024
O 909	"Gain" switch	NN	0021
O 910	"Bandwidth Comp." switch	NN	0022
	Transistor Socket	JY	0005
	Coax -	JJ	0108
	Ground -	JT	6204
	6 pin - (Remote Band width)	JJ	4704
	12 pin -	JP	1201
	24 pin -	JP	2403
	6 pin plug	JP	4705
V 913	Neon Lamp (red)	VS	0014
V 914	Fuse 1 A	VF	0008
V 923-926	Neon Lamp	VS	0015
	Cover plastic	KF	2600
	Safety cover for "on-off" switch	DD	0088
	Bakelite knob large SN 3222 + DB 0674 + YQ		2083
	Bakelite knob small SN 2522 + DB 0674 + YQ		2083
	Power cord EUR	AN	0005
	Power cord USA	AN	0006

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Circuit Diagram

valid from serial no. 253966

2020.14

Consisting of:

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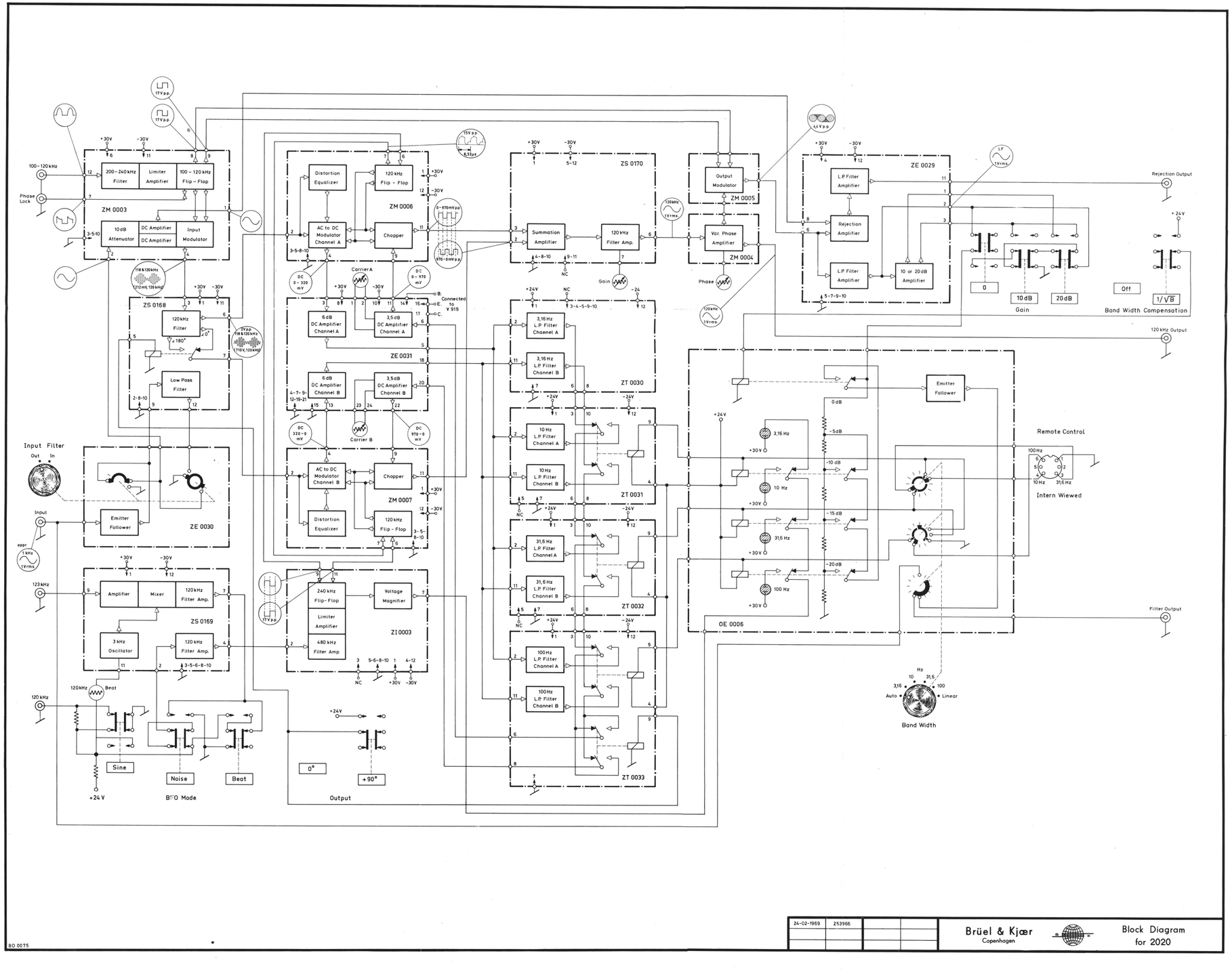
Circuit Diagram
valid from serial no. 253966

2020.14
sheet 2a

Block Diagram



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Block Diagram for 2020

BD 0075

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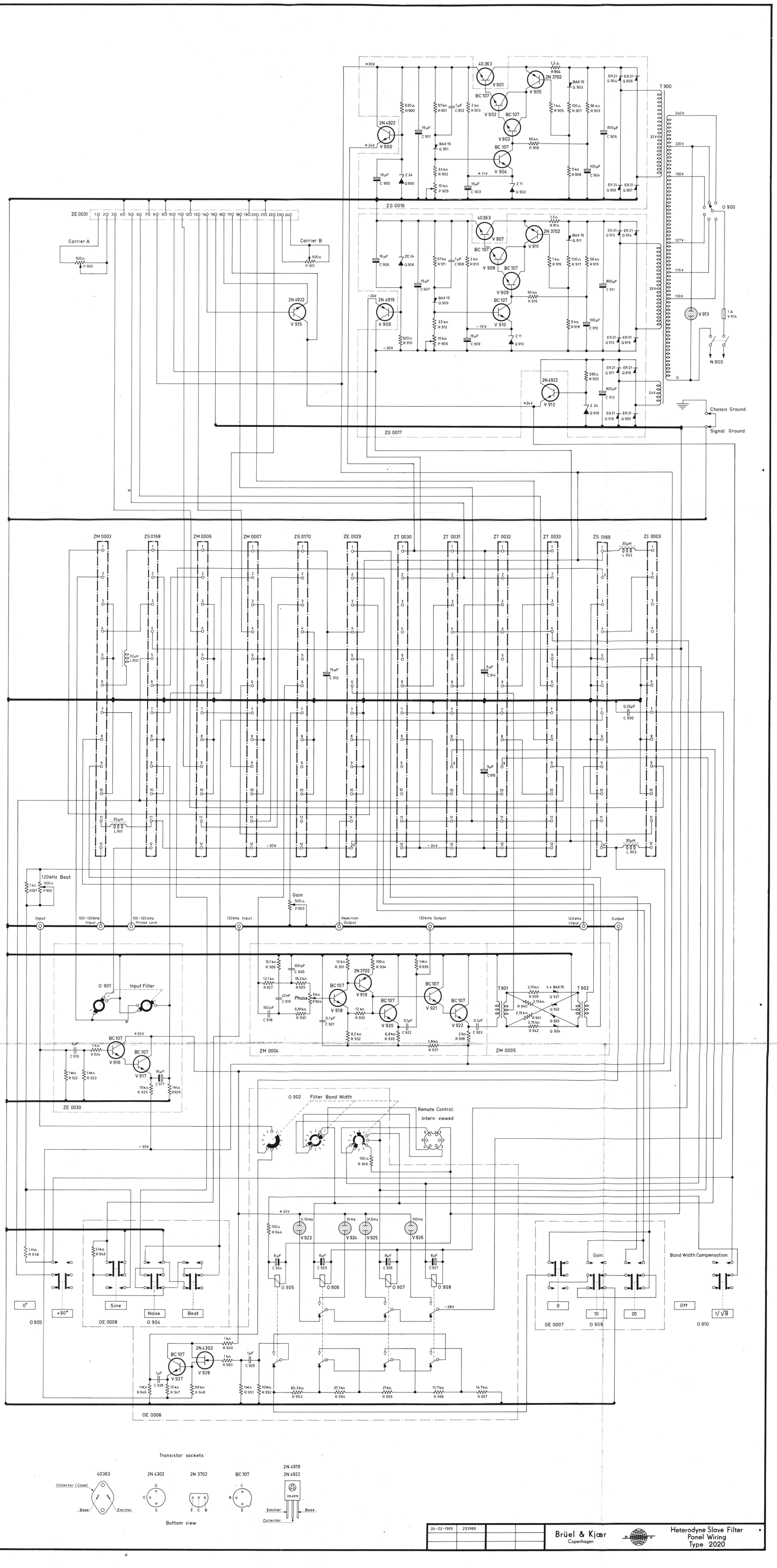
Circuit Diagram
valid from serial no. 253966

2020.14
sheet 2b

Panel Wiring



Transistor sockets

Bottom view

BD 0073

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Heterodyne Slave Filter
Panel Wiring
Type 2020

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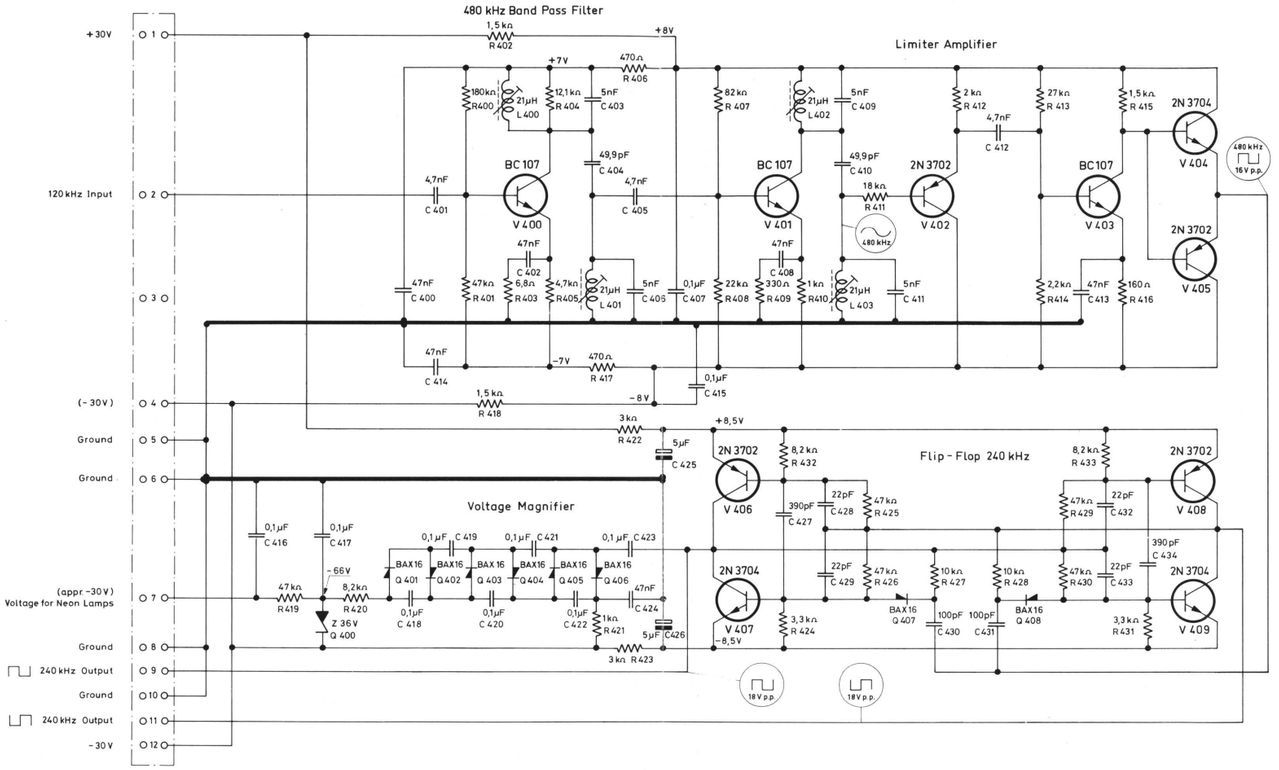
Circuit Diagram

valid from serial no. 253966

2020.14

sheet 3

240 kHz Square Wave Generator ZI 0003



Transistor sockets

2N 3702
2N 3704

E C B

BC 107

C
B
E

Bottom view

BD 0062

20-02-1969	253966		

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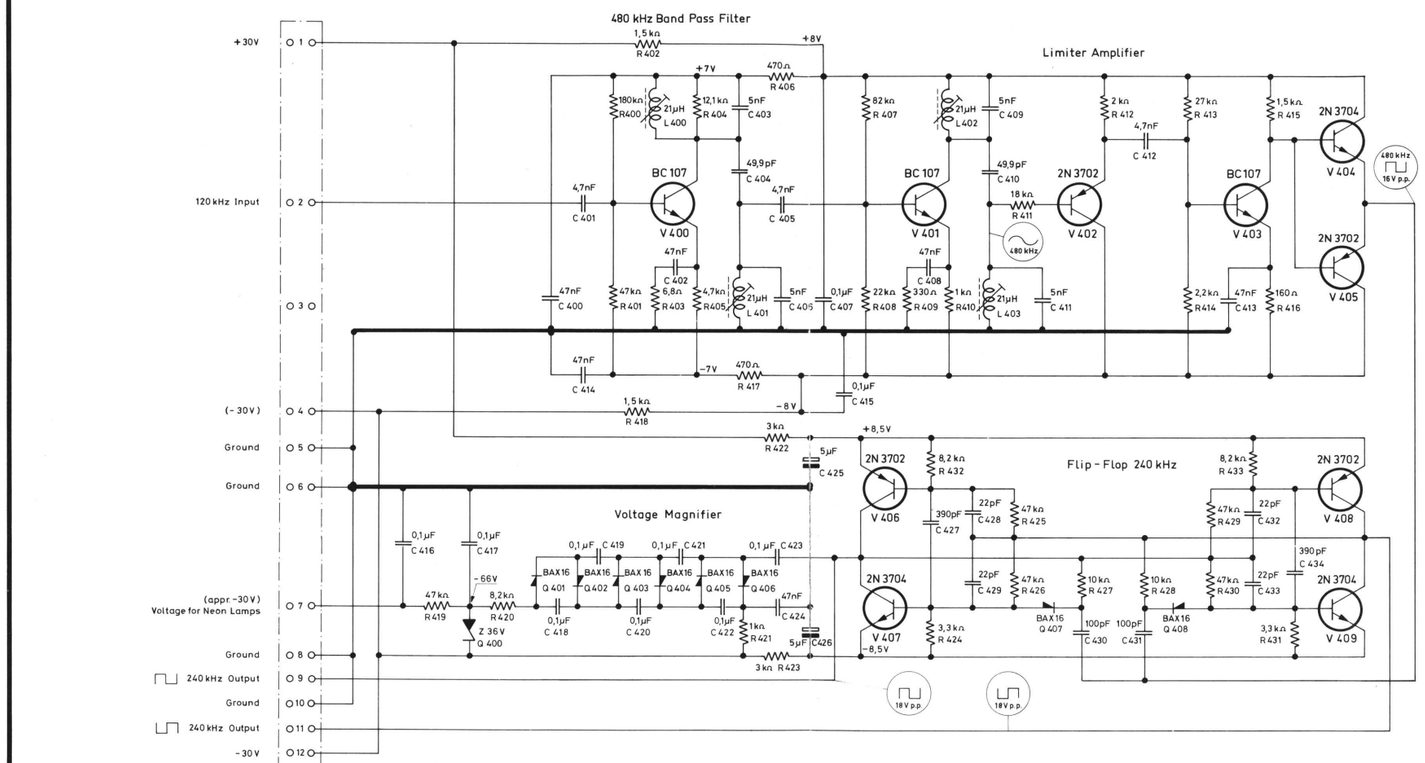
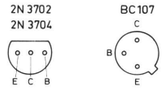
ZI 0003
240kHz Square Wave Generator
for 2020

240 kHz Square Wave Generator ZI 0003



Transistor sockets



Bottom view

20-02-1969	253966		

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ZI 0003
240kHz Square Wave Generator
for 2020

BD 0062

BRÜEL & KJÆR
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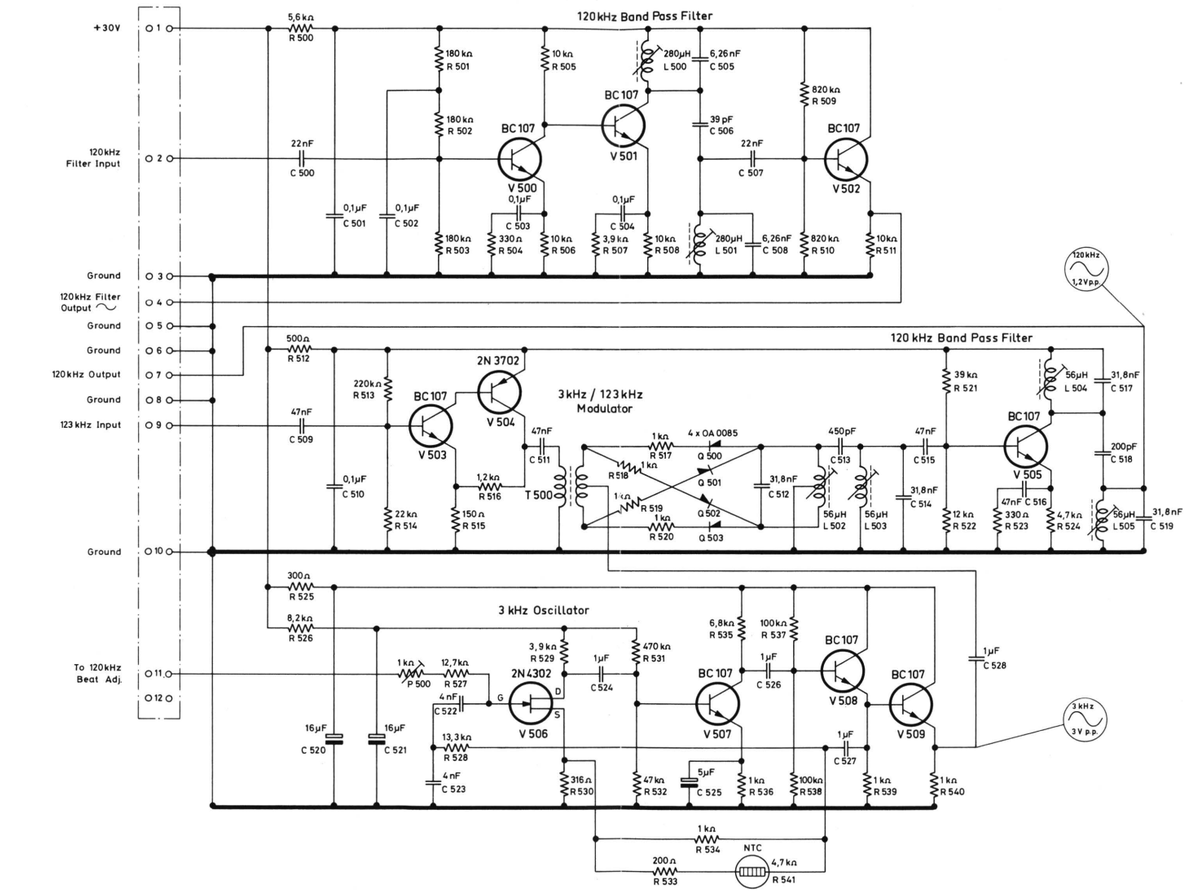
Circuit Diagram

valid from serial no. 253966

2020.14

sheet 4

120 kHz Fixed Frequency Conditioning ZS 0169



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ZS 0169
120kHz Fixed Frequency Conditioning for 2020

BD 0067

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Circuit Diagram

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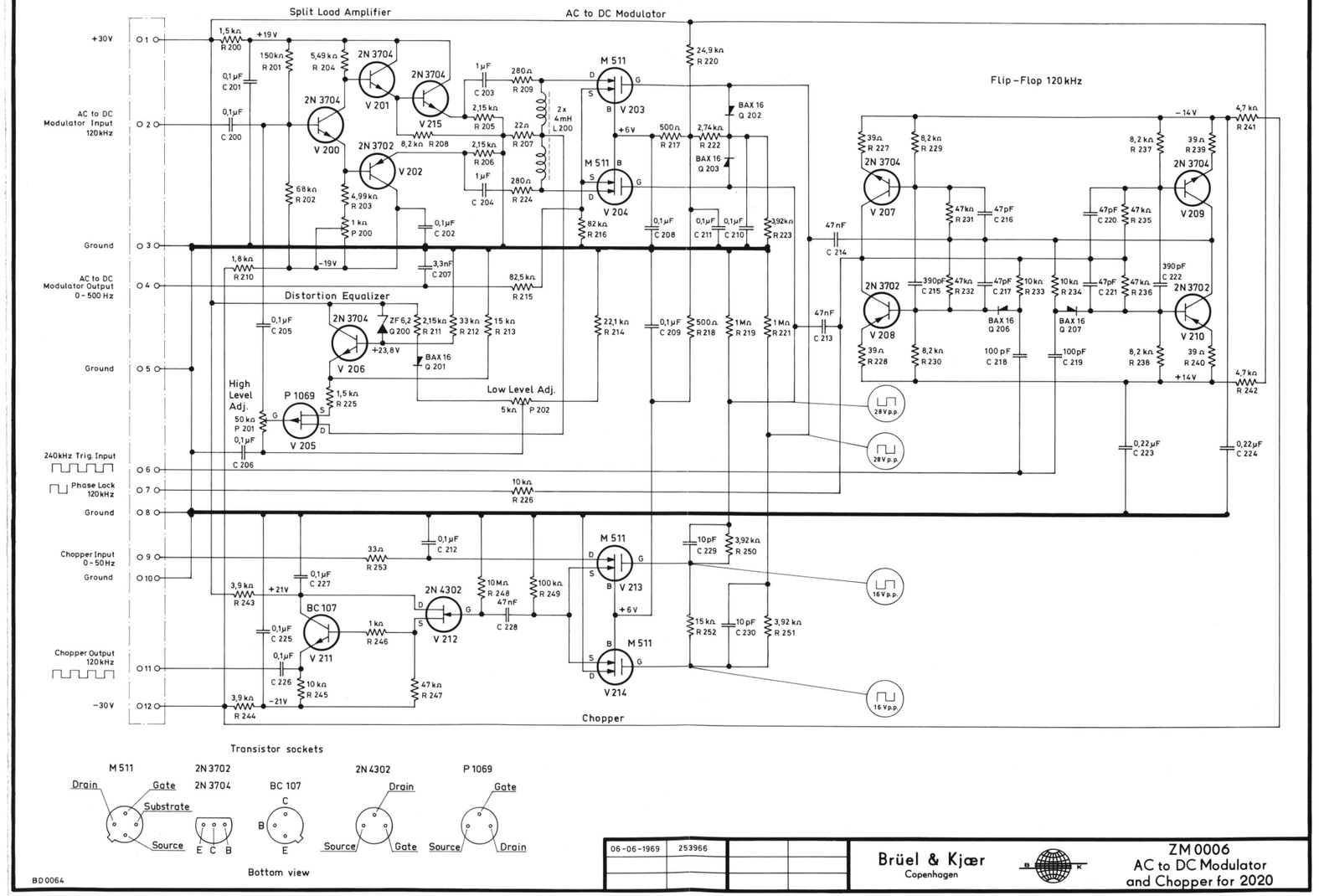
2020.14

sheet 5a

AC to DC Modulator and Chopper ZM 0006



Transistor sockets

BD 0064

06-06-1969	253966		

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ZM 0006
AC to DC Modulator and Chopper for 2020

2020.14-9.69

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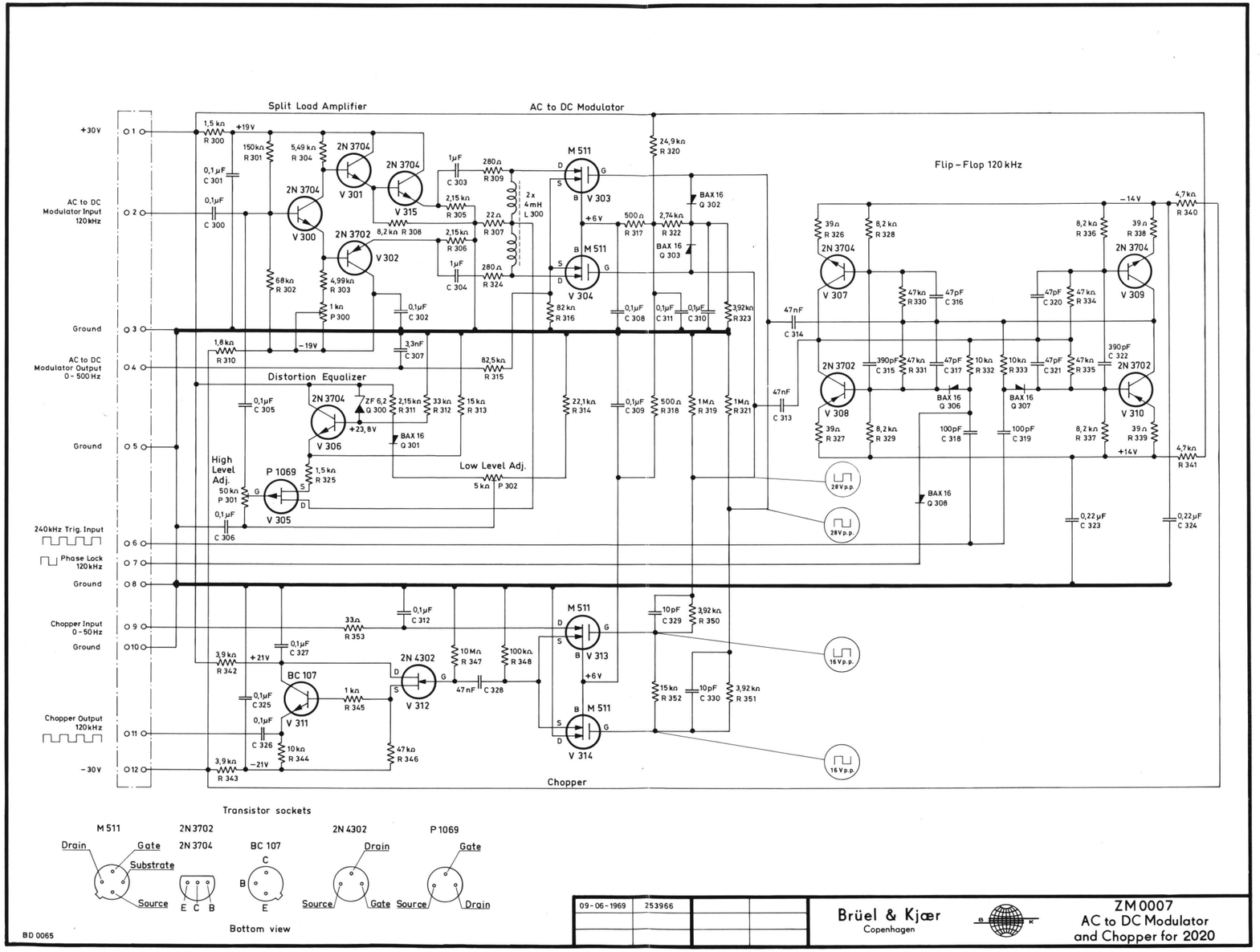
Circuit Diagram
valid from serial no. 253966

2020.14
sheet 5b

AC to DC Modulator and Chopper ZM 0007



2020.14-9.69

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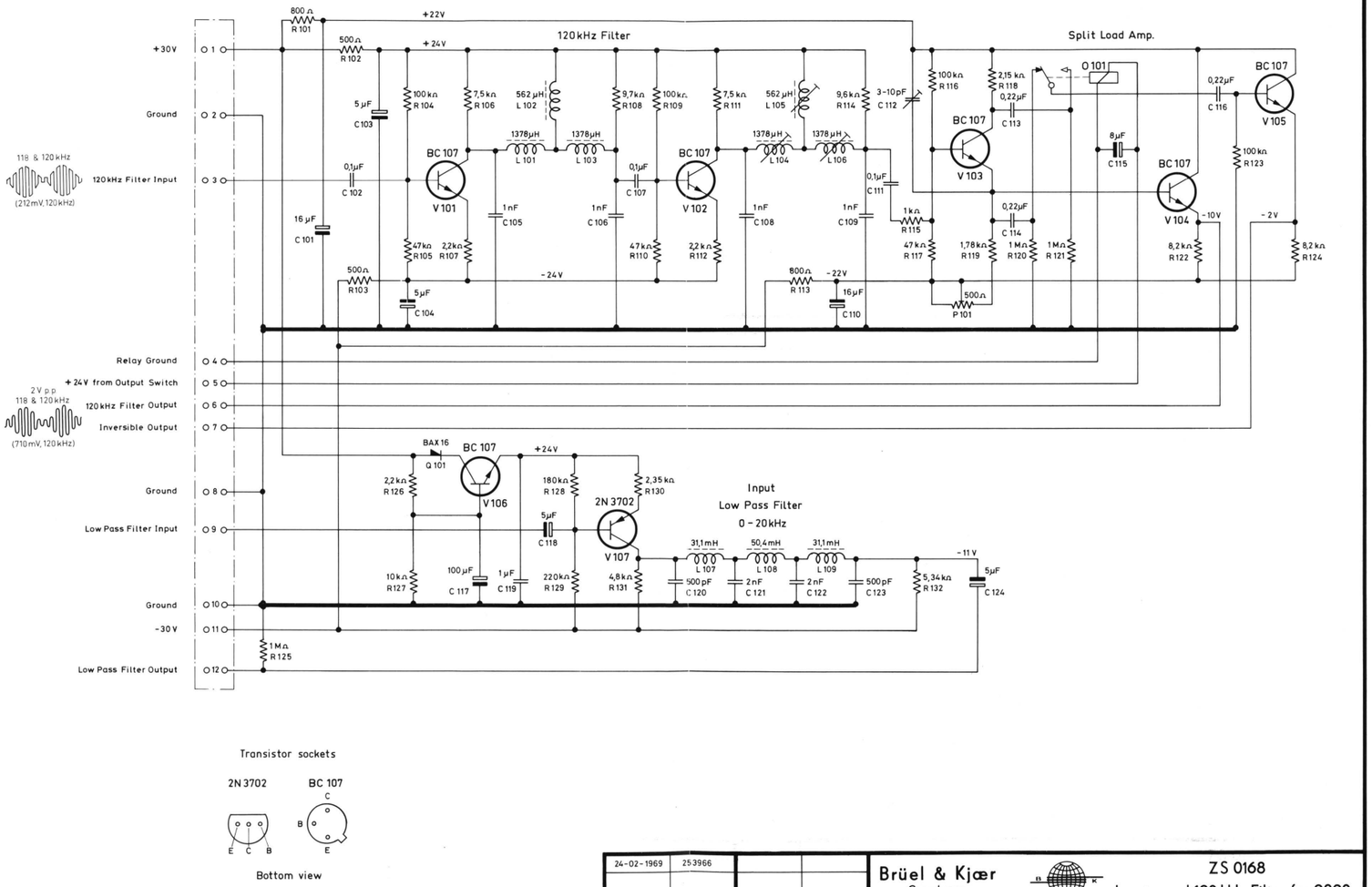
Circuit Diagram

valid from serial no. 253966

2020.14

sheet 6

Input and 120 kHz Filter ZS 0168



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ZS 0168
Input - and 120 kHz Filter for 2020

BD 0068

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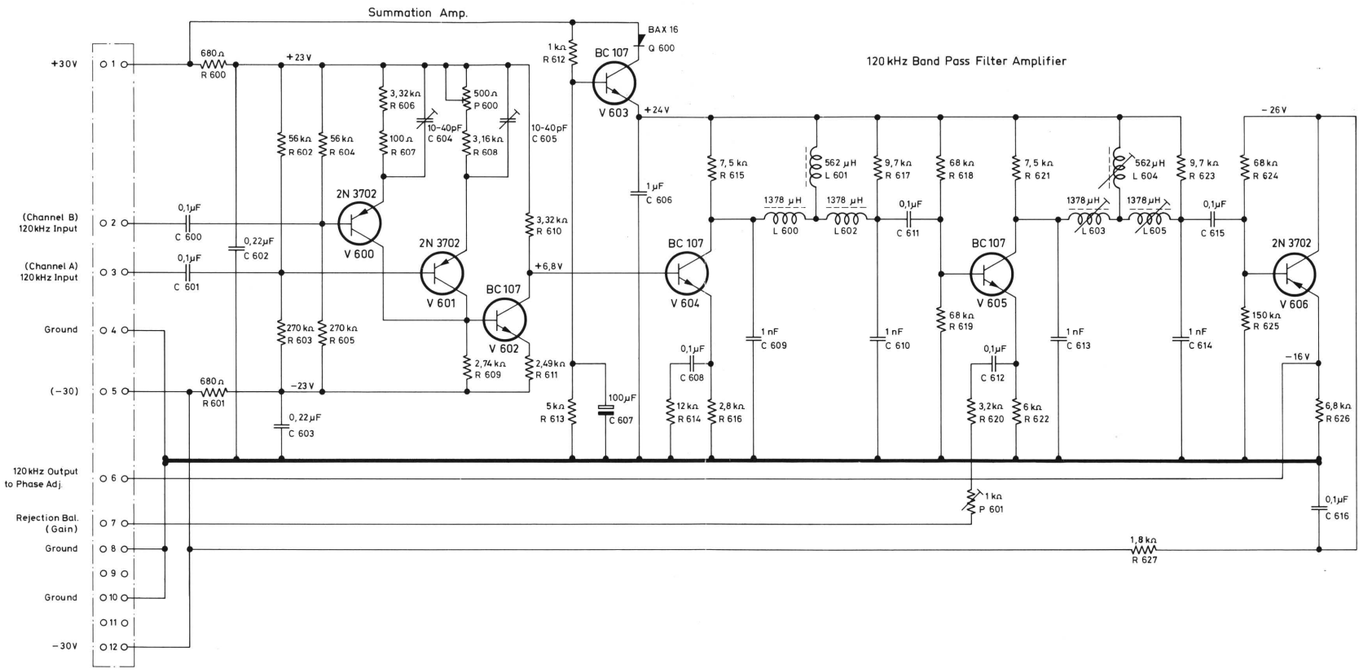
Circuit Diagram

valid from serial no. 253966

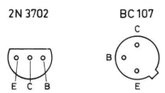
2020.14

sheet 7

Summation – and 120 kHz Filter Amp. ZS 0170



Transistor sockets



Bottom view

BD 0068

24-02-1969	253966		

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ZS 0170
Summation – and 120kHz Filter Amp. for 2020

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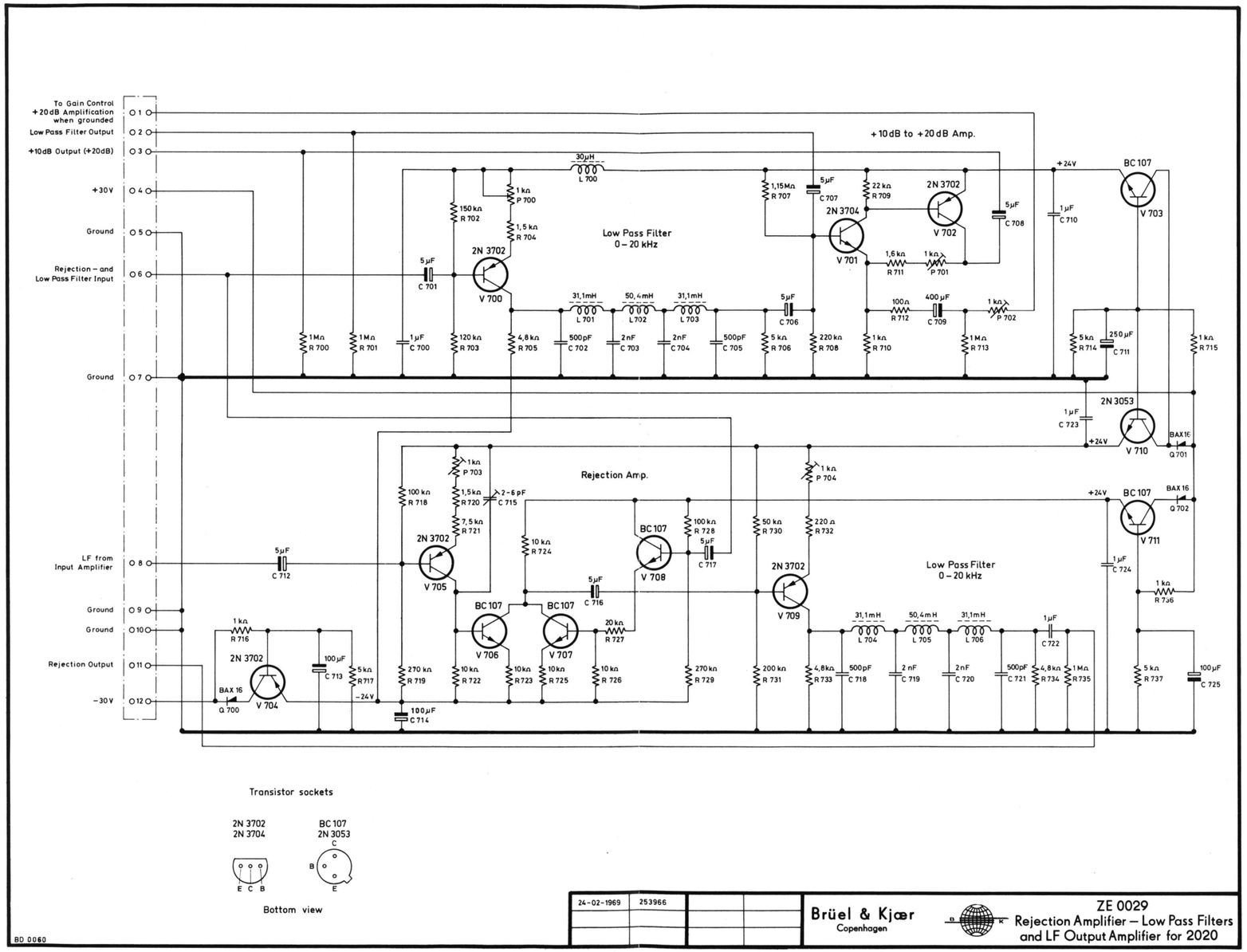
Circuit Diagram

valid from serial no. 253966

2020.14

sheet 8

Rej. Amp. — LP. Filter and Output Amp. ZE 0029



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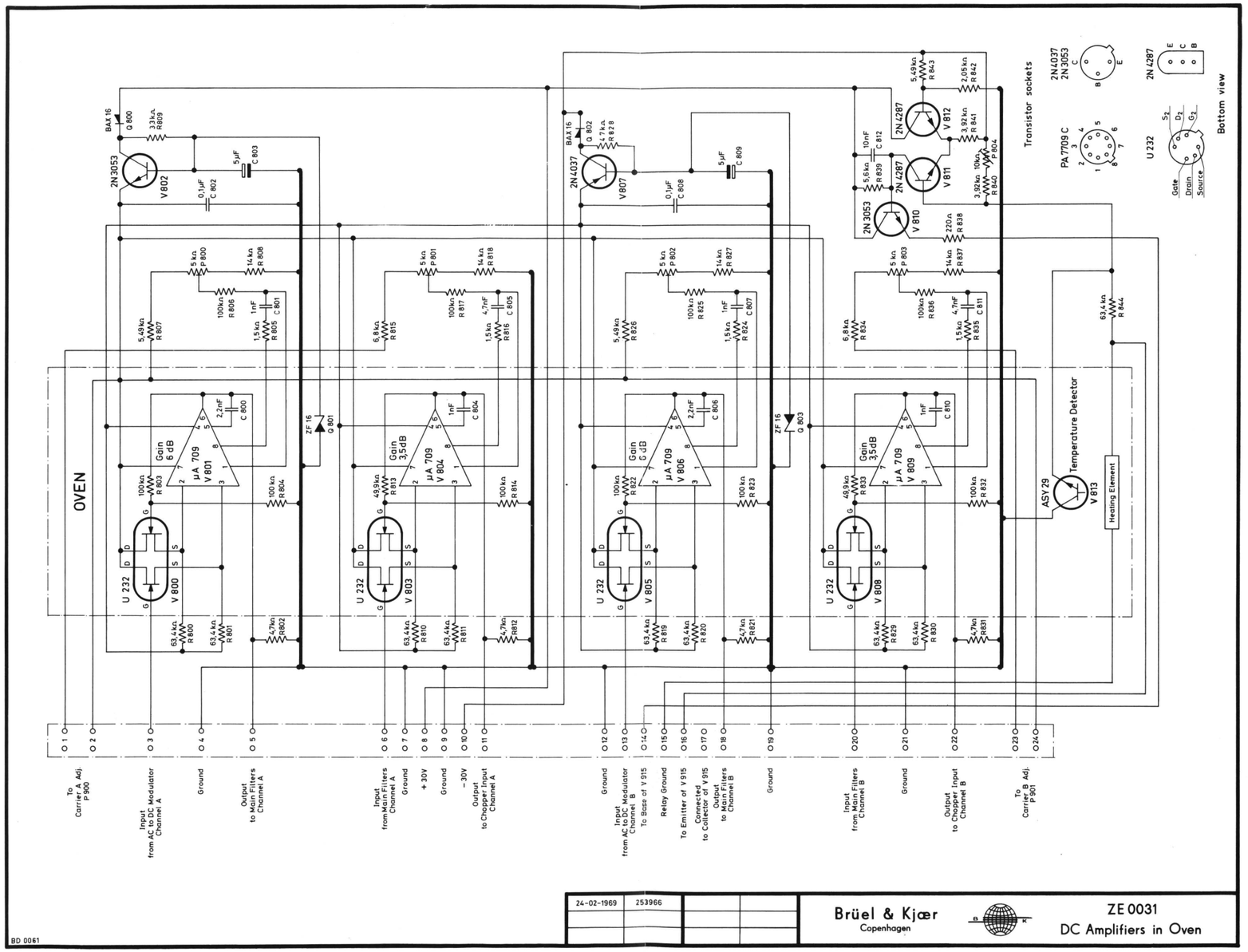
Circuit Diagram
valid from serial no. 253966

2020.14
sheet 9

DC Amplifiers in Oven ZE 0031



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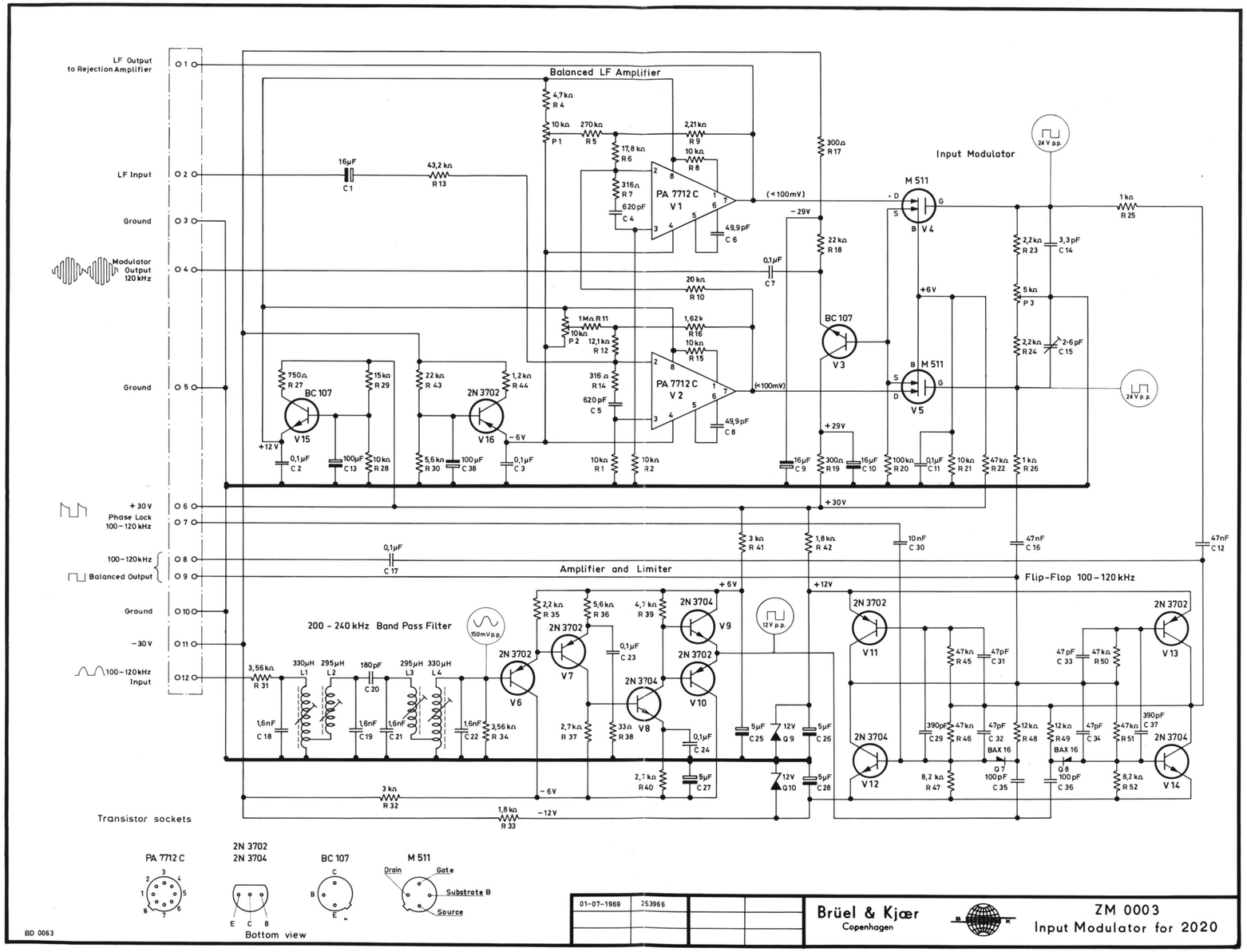
Circuit Diagram

valid from serial no. 253966

2020.14

sheet 10

Input Modulator ZM 0003



BRÜEL & KJÆR
Nærum - Denmark

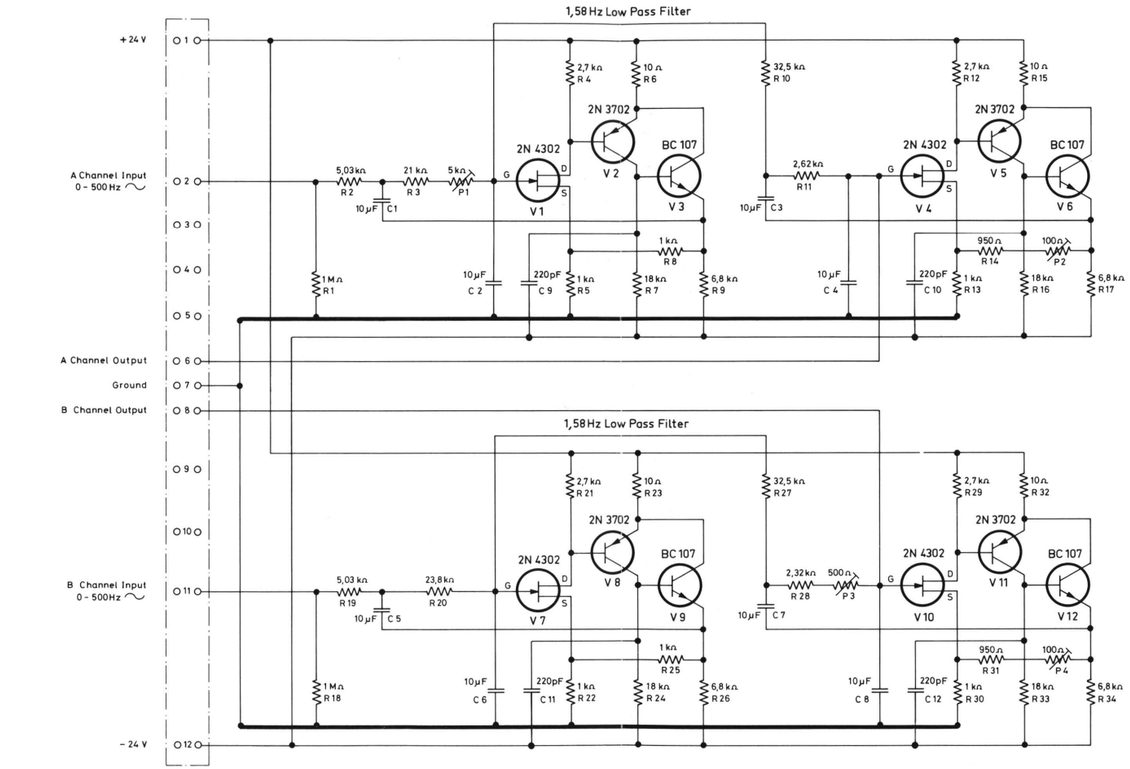
Circuit Diagram

valid from serial no. 253966

2020.14

sheet 11a

Main Filter 3.16 Hz ZT 0030



Transistor sockets

Bottom view

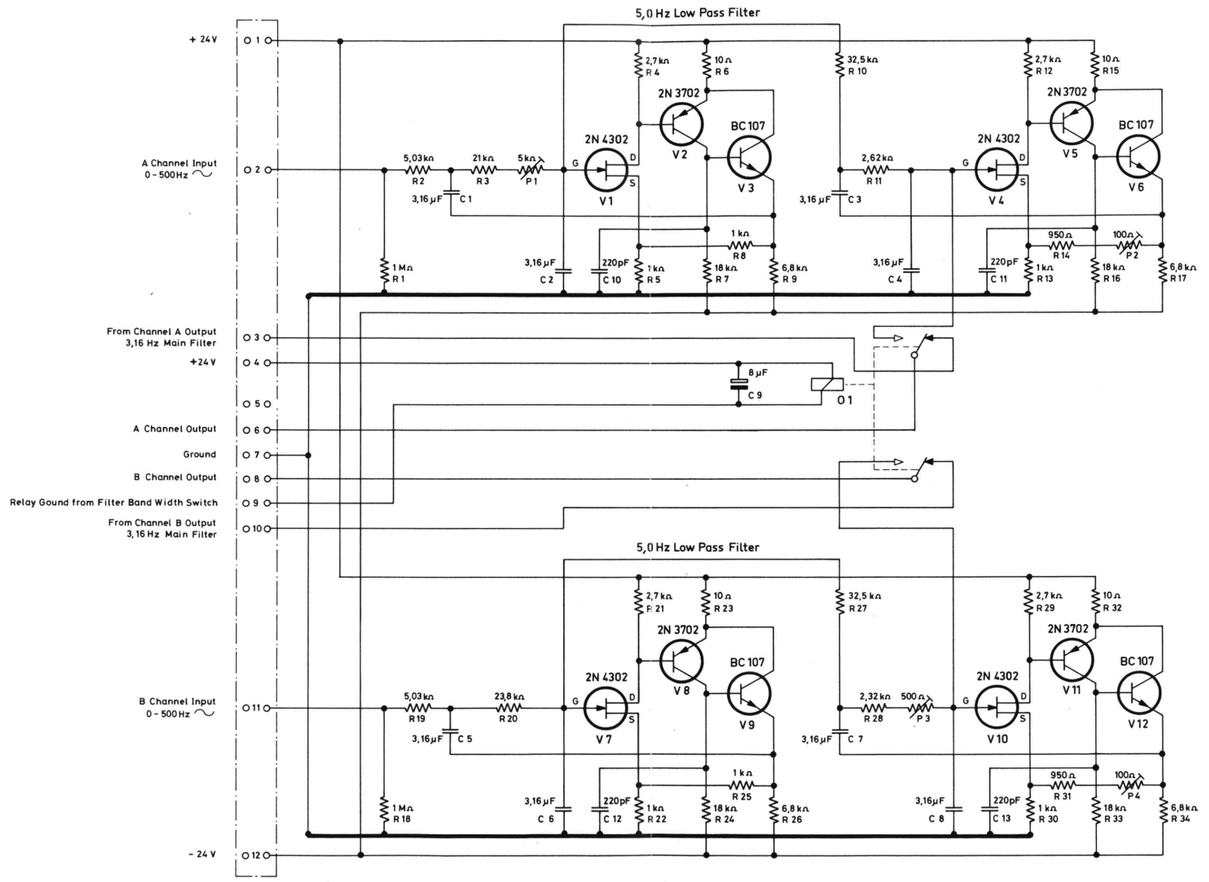
BD 0069

20-02-1969	253966		

Brüel & Kjær
Copenhagen

ZT 0030
3,16 Hz Main Filter for 2020

Main Filter 10 Hz ZT 0031



Transistor sockets

Bottom view

BD 0070

20-02-1969	253966		

Brüel & Kjær
Copenhagen

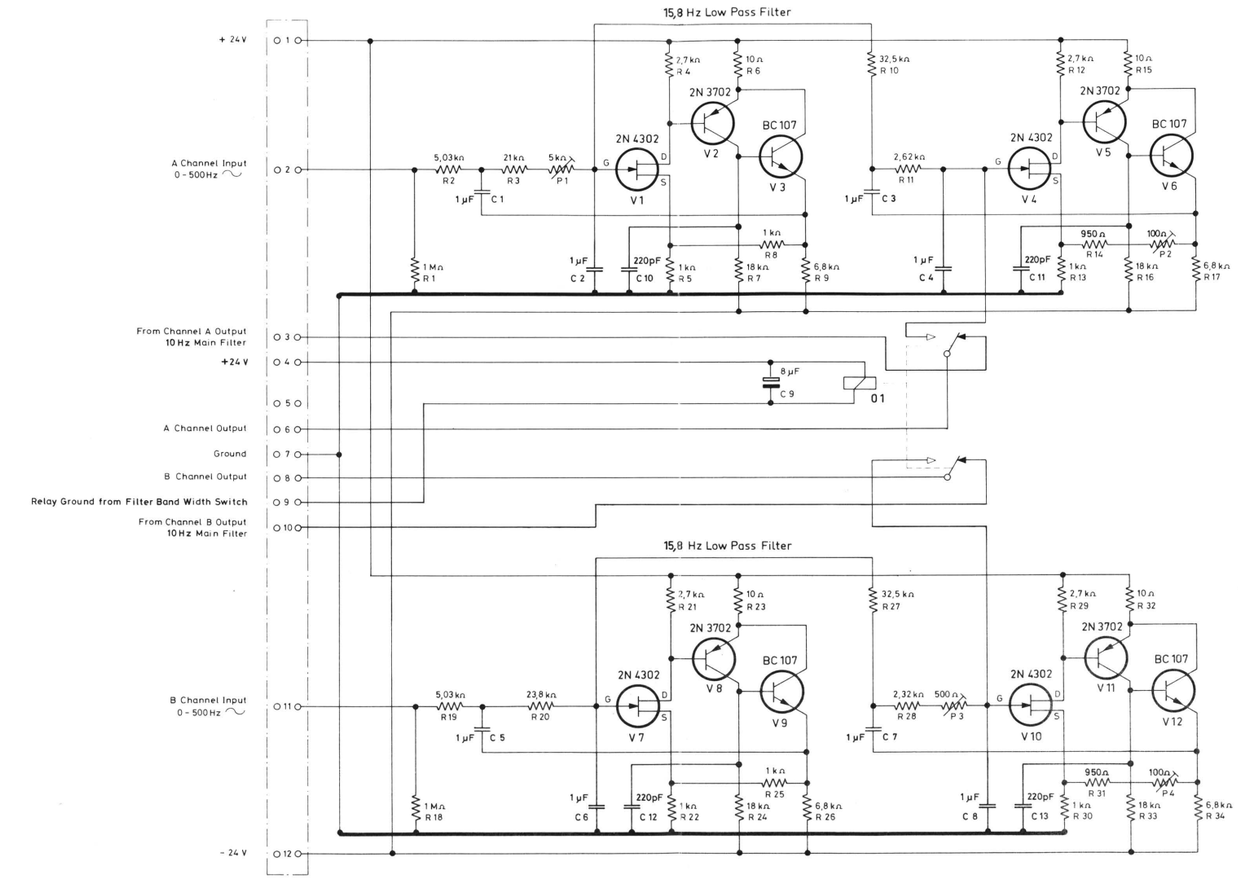
ZT 0031
10 Hz Main Filter for 2020

BRÜEL & KJÆR
Nærum - Denmark

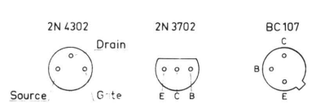
Circuit Diagram
valid from serial no. 253966

2020.14
sheet 11c

Main Filter 31.6 Hz ZT 0032



Transistor sockets



Bottom view

BD 0071

24-02-1969	253966		

Brüel & Kjær
Copenhagen

ZT 0032
31,6 Hz Main Filter for 2020

BRÜEL & KJÆR
Nærum - Denmark

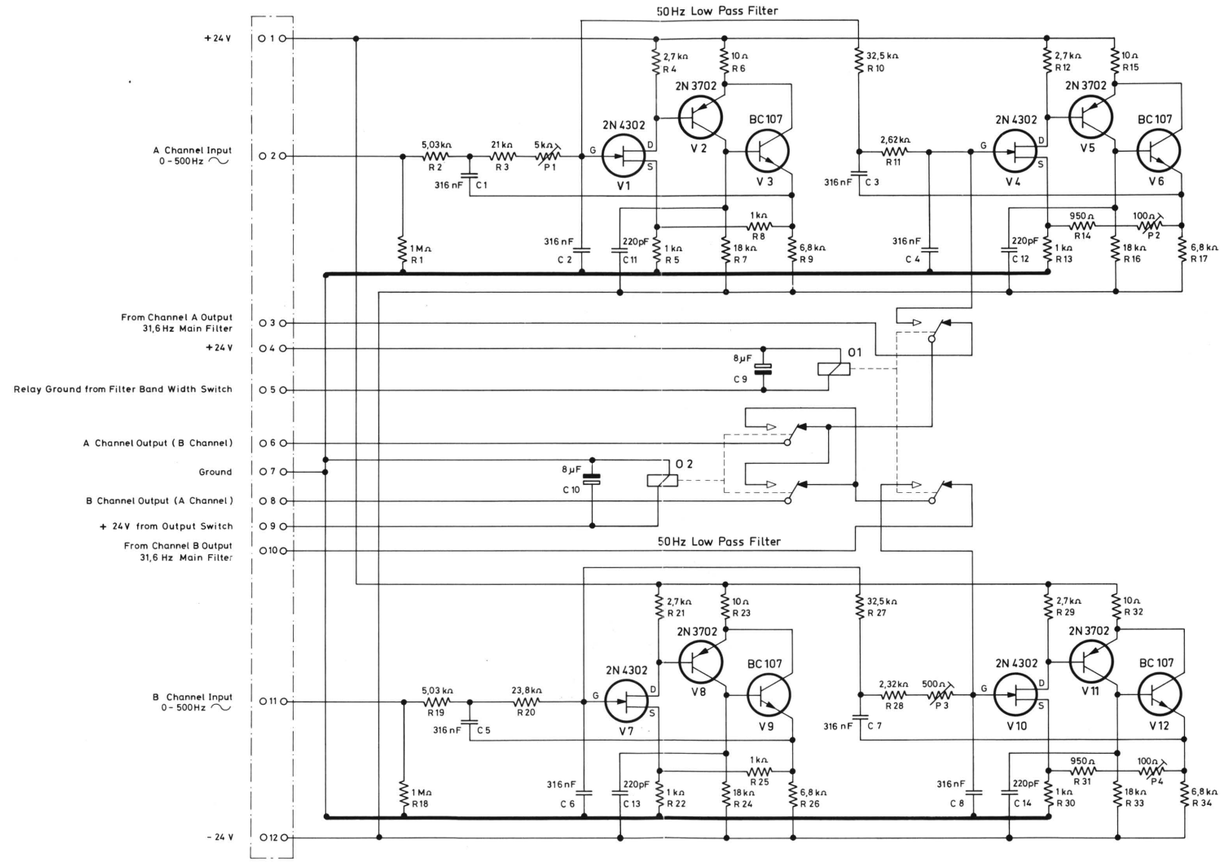
Circuit Diagram

valid from serial no. 253966

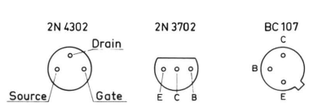
2020.14

sheet 11d

Main Filter 100 Hz ZT 0033



Transistor sockets



20-02-1969	253966		

Brüel & Kjær
Copenhagen

ZT 0033
100 Hz Main Filter for 2020

BD 0072

BRÜEL & KJÆR
Nærum - Denmark

Service Instructions

2020

Heterodyne Slave Filter

Consisting of:

Trouble Shooting:

If some sort of trouble occurs with this instrument then first check the D.C. working voltages from the Power Supply.

Then use the Checking Procedure with Block Diagram in order to localize a trouble to be in one certain circuit.

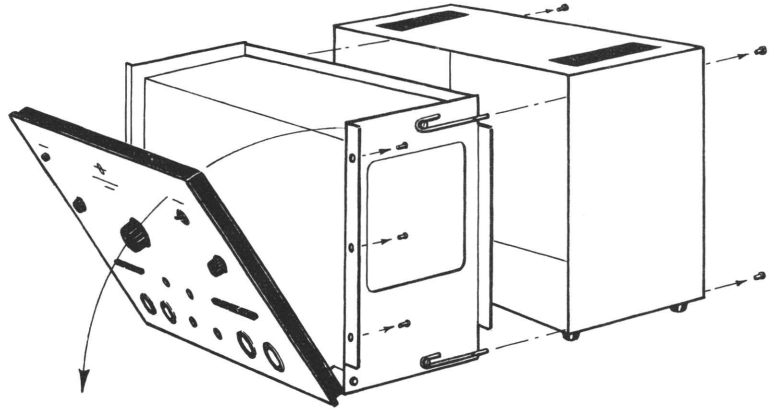
When a fault has been found and remedied the voltages and adjustments which are influenced by the remedy must be rechecked and the Checking Procedure can be used again to tell if all basic functions of the instrument are fulfilled.

The tolerance stated in the instructions can only be used as a guide for adjustment and control, but any deviations must not be corrected without being sure that the tolerances of the instrument used for making the adjustment are so small as to have no influence on the measurements.

The instructions in this Manual are given purely as a guide to the service of equipment. Some faults as f.inst. small deviations in tolerances require for their correction special control equipment and extensive experience, and in these cases it is necessary to send the instrument to the factory.

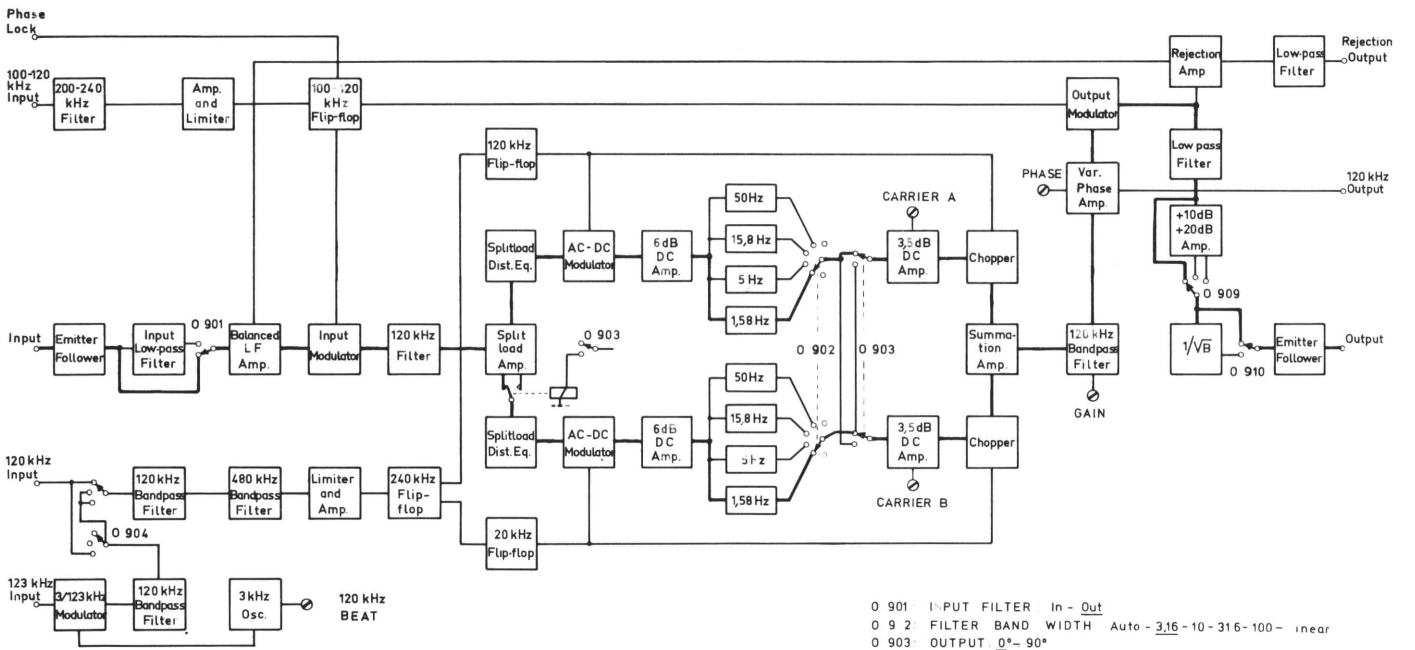
Spare Parts:

Please state type and serial number of apparatus when spare parts are ordered.



Instruments Necessary for Service and repair:

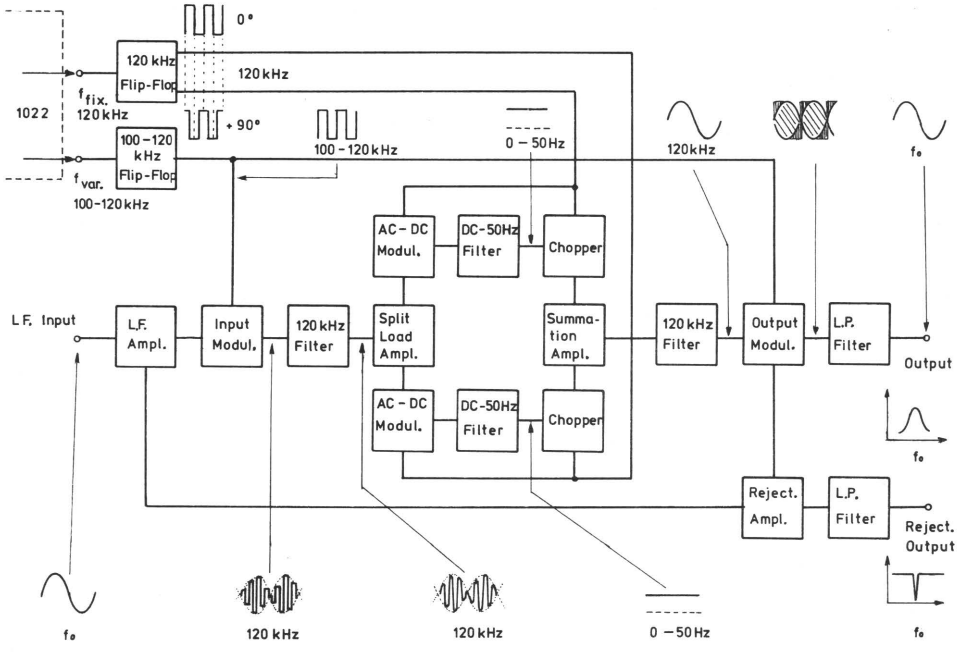
Beat Frequency Oscillator Type 1022 (or Sine Random Generator Type 1024)
Electronic Voltmeter (frequency response to 200 kHz - f.s.d. for 1 mV)
LF Oscillator (any type with a 2 V output facility)
Double Beam Oscilloscope
Multimeter (50 uA)
Frequency Counter



0 901 INPUT FILTER In - Out
0 902 FILTER BAND WIDTH Auto - 3,16 - 10 - 31 6 - 100 - linear
0 903 OUTPUT 0° - 90°
0 90 BFO MODE Sine - Noise 120kHz Beat
0 909 GAIN: 0 - 10 - 20 dB
0 910 BAND WIDTH COMPENSATION. Off - $1/\sqrt{B}$

Principle of the Instrument

Valid from serial no. 253966



The Heterodyne Slave Filter Type 2020 is intended to be used together with a Beat Frequency Oscillator Type 1022 or 1024. The 1022 is a Heterodyne Oscillator having a fixed oscillator section of 120 kHz and a variable oscillator section of 100–120 kHz. A mixing of these two frequencies will give the low frequency output signal from 20 to 20000 Hz. Now if 1022 is tuned to a low frequency signal of 1 kHz the variable oscillator will have a frequency of 119 kHz.

The operation principle of 2020 is mixing the low frequency signal (1 kHz) with a variable high frequency signal (119 kHz) to make up a fixed frequency (120 kHz) at which we can do the filtering. As being the same frequencies used for 1022 to give the low frequency output signal the center frequency of 2020 will be exactly the same as the oscillator frequency.

In the Input Modulator of 2020 the 1 kHz signal is mixed with a 119 kHz variable oscillator signal. The sum of this will give a signal of 120 kHz, which is splitted up into two signals in the Split Load Amplifier. The output of the Split Load Amplifier is fed to an AC to DC Modulator where 120 kHz is mixed with 120 kHz from the fixed oscillator to 0 Hz which is equal to DC. Due to phase sensitivity of a multiplicative mixer it is necessary to have two AC to DC Modulators controlled by two fixed frequency signals (120 kHz) 90° out of phase. The output will be a DC voltage which is analog to the level of the 1kHz Input Signal. The two DC voltages are now filtered in two narrow band, Low Pass Filters giving the band width of the entire system. The Cut–off frequency of each filter corresponds to half of the selected band width.

The DC voltages are chopped back to 120 kHz by means of the two 90° out of phase signals as used for the AC to DC Modulators. After chopping the signals are added in the Summation Amplifier the output of which has correct phase and amplitude.

In the Output Modulator the 120 kHz is mixed with the variable oscillator frequency 119 kHz and the difference is 1 kHz exactly as the fundamental of the input signal.

Another facility at the instrument is the Rejection Mode where the Input Signal is fed to the Rejection Amplifier together with the filtered fundamental frequency of the Input Signal. The difference between these two signals will be any freqaency except the fundamental.

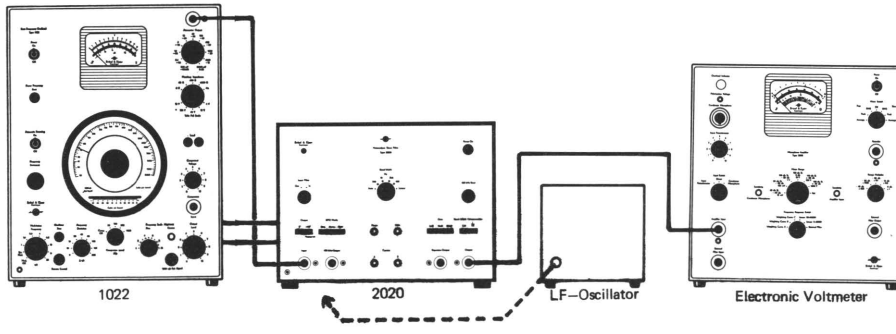
Checking Procedure

2020.2

Valid from serial no. 253966

This Section is meant to be used as a guide for a quick check carried out to examinate if the instrument is within the specifications, or to localize a suspected fault to be in a certain circuit. A further examination of the respective circuits can be carried out according to the adjustment procedure at the single circuits.

Furthermore the checking procedure should be used after a repair of the instruments as a final check before the Service of the instrument can be regarded as completed.



Allow a warm-up time of 15 minutes.

2.1. Signal to Noise

OUTPUT: "0"
BFO MODE: "Sine"
BAND WIDTH: "31,6 Hz"
GAIN: "0 dB"
BAND WIDTH COMP.: "Off"

Connections like shown above (1 V on the Electronic Voltmeter).

Adjust a 1 kHz output signal from 1022 to give 1 V on "Output".

Disconnect the "Input" to 2020.

Max voltage on "Output": 300 μV corresponding to -70 dB re 1 V.

For furhter checks "Carrier A and B" should be adjusted to min. deflection: approx 100 μV.

On the "120 kHz Output" the voltage should be less than 300 μV as well.

2.2. Gain

a. OUTPUT: "0"
BFO MODE: "Sine"
BAND WIDTH: "Linear"
GAIN: "0 dB"
BAND WIDTH COMP.: "Off"

Connections like shown above.

Adjust a 1 kHz output signal from 1022 to give 1 V deflection on "Output"

b. BAND WIDTH to: "31,6 Hz"

Check the voltage on "Rejection Output" and if necessary adjust "Phase" and "Gain" to min. output voltage: <3 mV.

The voltage on "Rejection Output" should be <5.5 mV at any other frequency.

The voltages on "120 kHz Output" and "Output" should both be 1 V ±1%.

2.3. Frequency Response

a. OUTPUT: "0"
BFO MODE: "Sine"
BAND WIDTH: "Linear"
GAIN: "0 dB"
BAND WIDTH COMP.: "Off"

Connections like shown above.

Adjust a 1 kHz output signal from 1022 to give 1 V deflection on "Output". Check the frequency response of 1022 together with the electronic voltmeter.

b. BAND WIDTH to "31,6 Hz"

Check the frequency response and compare to the response from a.

The difference should be max 1%.

The voltage on "120 kHz Output" should be 1 V ± 1% during the frequency sweep as well.

continued

2.4. Unwanted Signal Attenuation

OUTPUT: "0"
BFO MODE: "Sine"
BAND WIDTH: "31,6 Hz"
GAIN: "0 dB"
BAND WIDTH COMP.: "Off"

Connections like shown except the "Input" connection to 2020.

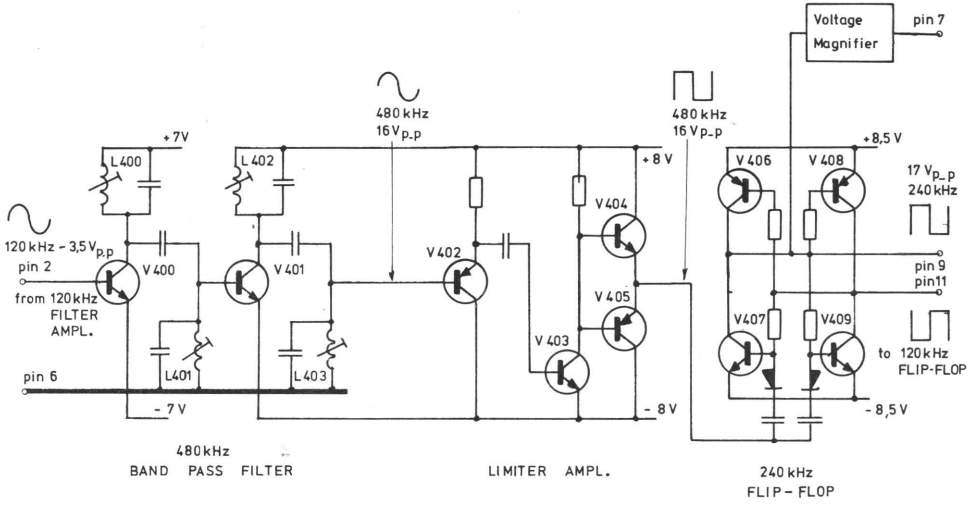
Tune 1022 to 1 kHz and apply a 4 kHz signal from LF-oscillator to 2020 "Input".

When the 4 kHz "Input" voltage to 2020 is varied from 0—1 V the voltage on "Output" should be less than 250 µV.

When the 4 kHz "Input" voltage is between 1 and 2 V the "Output" voltage should be at least 70 dB below the "Input" voltage.

240 kHz Square Wave Generator ZI 0003

Valid from serial no. 253966



The purpose of this circuit is to create a 240 kHz square formed puls with a 180° phase difference for the two 120 kHz Flip-Flops which are used in the AC-DC Modulators to "beat" the 120 kHz Input Modulator signal down to a DC analog to the Input Level, and again to "Chop" the filtered DC back to 120 kHz as before.

The coils L 400–403 are tuned to 480 kHz (fourth harmonic of 120 kHz) so the input to V 402 is 480 kHz sine wave which is amplified in V 403 and clipped to square pulses in V 404 and 405.

These pulses are fed to a 240 kHz Flip-Flop which triggers on the negativ going pulseform.

The resulting output of the Flip-Flop are two 240 kHz squareforms with a phase difference of 180°.

Signal voltages and curveforms are for an "Input" signal of 1 V, 1 kHz.

3.1. 480 kHz Filter Adjustment

BFO MODE: "Sine"

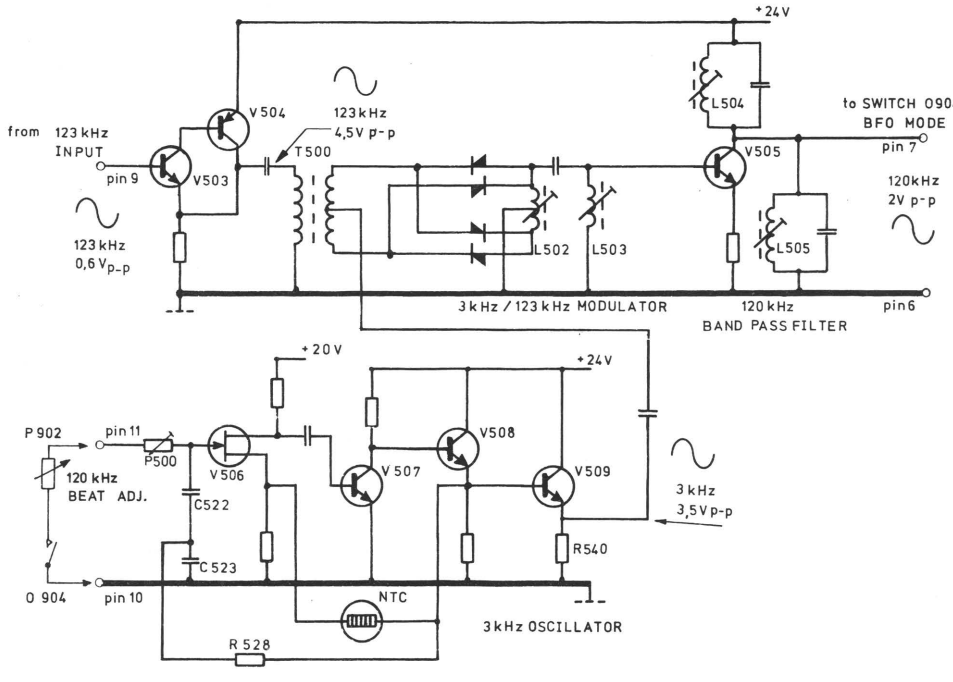
Connect the "120 kHz" output of 1022 to the "120 kHz" input of 2020.

Adjust L 400–403 to max. voltage on V 402 base, which can be measured with an oscilloscope or an electronic voltmeter (freq. response to 500 kHz).

(Make sure that the "120 kHz" output from 1022 is 120 kHz ±5 Hz).

120 kHz Fixed Frequency Conditioning ZS 0169

Valid from serial no.253966



If a Sine Random Generator Type 1024 is used in the Noise Mode, the "120 kHz Output" will not be a sine but a band of noise, which cannot be used to drive the Flip-Flops in 2020.

Therefore, the "123 kHz Output" of 1024 is used instead. This 123 kHz is a sine wave and if it is mixed with a 3 kHz signal the result will be 120 kHz which is independent of the noise band in 1024.

4.1. 120 kHz Beat

BFO MODE: "Beat"
BAND WIDTH: "31,6 Hz"
BAND WIDTH COMP.: "Off"
OUTPUT: "0"
GAIN: "0 dB"

Connect the Fixed Oscillator "123 kHz", the variable oscillator "100–120 kHz" and the 120 kHz Output to 2020.

"Input" signal from 1024 to 2020: 1 kHz sine, app. 0.5 V.

Adjust "120 kHz Beat" until a slow beat shows up on 1024 meter (Meter Time Const.: 0.3 sec.).

If necessary set "120 kHz Beat" to mid position and adjust P 500 until the beat shows up.

4.2. Band Pass Filter Adj.

BFO MODE: "Noise"

Connect the fixed oscillator "123 kHz" from 1024 to "123 kHz" on 2020.

Adjust "120 kHz Beat" to 120 kHz measured with a Frequency Counter connected across pin 6 and 7.

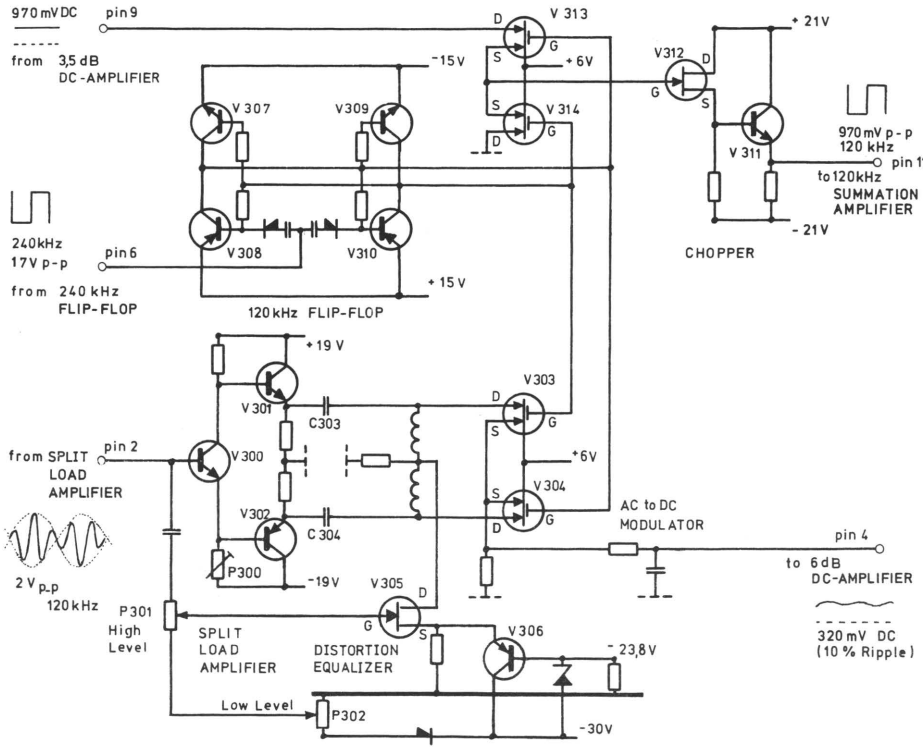
Adjust L 503–L 505 to max output voltage on pin 7.

BFO MODE to "Sine"

Connect 120 kHz ± 2 Hz to "120 kHz Input" and adjust L 500 and L 501 to max voltage between pin 3 and 4.

AC to DC Modulators and Choppers ZM 0006/7

Valid from serila no. 253966



The AC to DC Modulators and Choppers ZM 0006 and ZM 007 are indentical except for the Phase Lock arrangement, so only ZM 0007 will be mentioned.

The Distortion Equalizer circuit is creating a DC voltage depending on the input level. The MOS FET's have a DC voltage output on high input levels which we compensate with the Distortion Equalizer.

The 120 kHz input signal to ZM 0006/7 was created by mixing the "Input" signal (1 kHz) with the variable oscillator signal (119 kHz).

When the output of the 120 kHz Flip-Flop, which is triggered by the 240 kHz Flip-Flop, is mixed with the 120 kHz Modulator Input, the resulting output will be a DC voltage analog to the 1 kHz input signal.

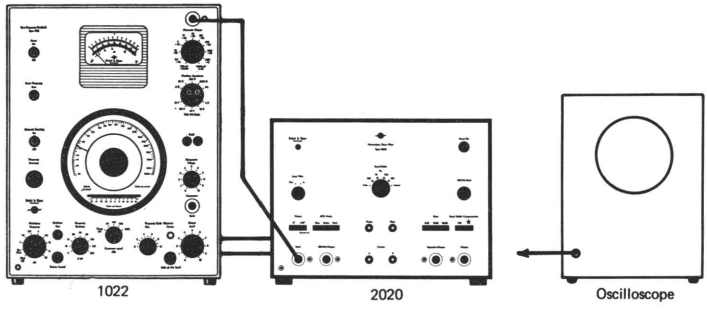
If the input signal (1 kHz) is distorted the 0–500 Hz output from the AC to DC Modulator will contain some low frequency components as well representing the distortion.

The 0–500 Hz output will be filtered and fed to the Chopper input where it is modulated back to 120 kHz, but now the 120 kHz has a certain band width corresponding to the selected filter characteristic.

Signal voltages and curve forms are for an "Input" signal of 1 V, 1 kHz.

ATTENTION: Do not ever dismount ZM 0006 and ZM 0007 with POWER "On" because this will cause a breakdown of the DC Amplifier ZE 0031.

continued



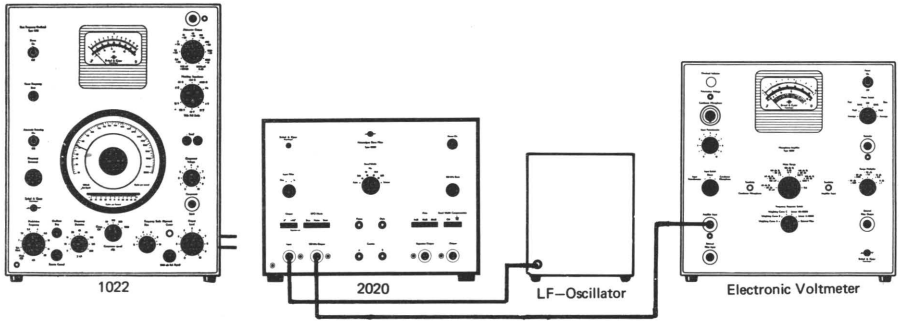
5.1. Symmetry

OUTPUT: "0"
BFO MODE: „"Sine"
BAND WIDTH: "31,6 Hz"

Signal input from 1022: 1 V at 1 kHz.

Check with the oscilloscope that the voltages on the emittersides of C 203 (303) and C 204 (304) are of the same height.

If not adjust P 200 (300)



5.2. Unwanted Signal Attenuation

OUTPUT: "0"
BFO MODE: "Sine"
BAND WIDTH: "31,6 Hz"

Connect "120 kHz" and "100–120 kHz" from 1022 to 2020 and adjust "Carrier A" and "Carrier B" to min. "120 kHz Output" voltage measured with an electronic Voltmeter.

Turn P 202 and P 302 fully counterclockwise and then clockwise until a situation where the "120 kHz Output" voltage suddenly increases. Then adjust P 202 and P 302 one turn counterclockwise.

Set the 1022 (or 1024) Frequency Scale to 1.5 kHz and apply a 4 kHz signal of 2 V from the LF. Oscillator to the "Input" of 2020.

Adjust P 201 and P 301 to min. "120 kHz Output" voltage.

If the 4 kHz input signal is lowered to 0–1 V the "120 kHz Output" voltage should be less than 250 μV.

If necessary find the 4 kHz input voltage (between 0–1 V) where the "120 kHz Output" voltage has the highest value and adjust P 202 and P 302 to min.

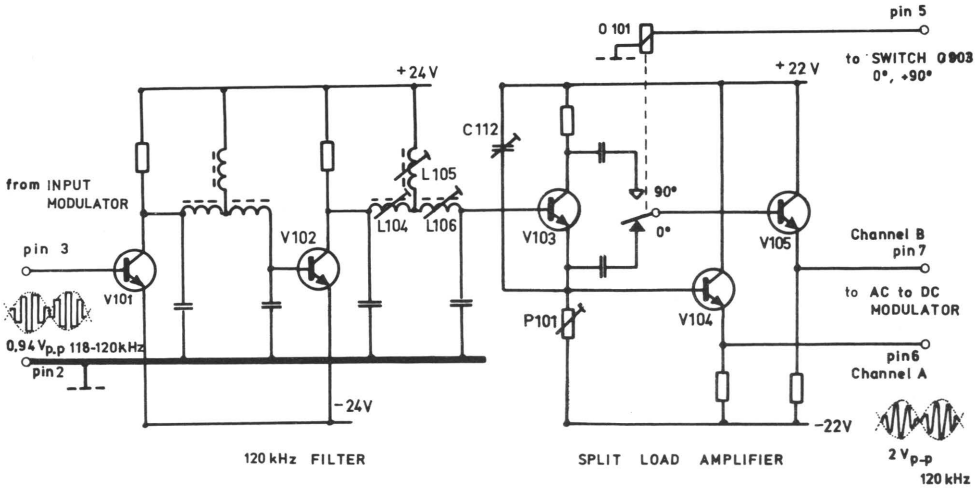
At a 4 kHz input signal between 1 and 2 V the "120 kHz Output" should be at least 70 dB below the Input level.

If necessary readjust P 201 and P 301 at high levels.

After any adjustment recheck the "120 kHz Output" voltage without 4 kHz Input signal: this voltage should not change more than 2 dB during adjustment of the potentiometers mentioned above.

120 kHz Filter and Split Load Amp. ZS 0168

Valid from serial no. 253966



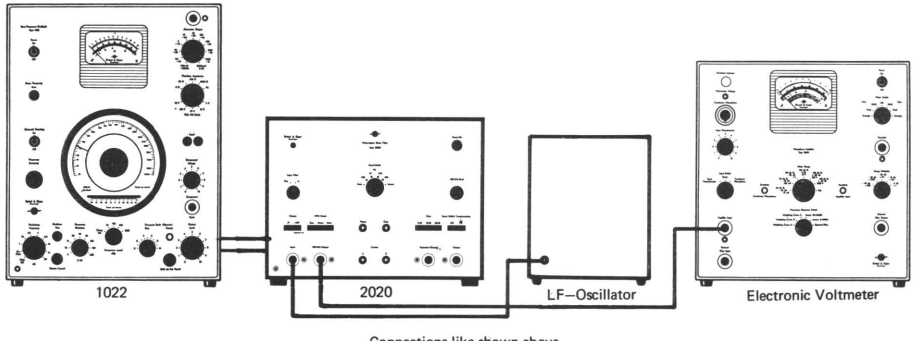
When INPUT FILTER is "In" the Input Low Pass Filter (0–20 kHz) is connected between the Input Emitter Follower and the Input Modulator.

The Low Frequency Input Signal which is modulated with the Variable Oscillator-signal is applied to the 120 kHz Filter Amplifier ZS 0168 having two outputs, one at which has an invertible output facility when OUTPUT is switched to +90°. Signal voltages and curveforms are for an "Input" signal at 1 V, 1 kHz.

6.1. 120 kHz Filter Adj.

The 120 kHz Band Pass Filter should not be adjusted unless it is found strictly necessary.

If adjustment is found necessary it can be carried out according to the same procedure as shown under item 7.4. except that L 105 should be adjusted to give 0° phase shift between pin 3 (input) and pin 6 (output).



6.2. Ripple

Connections like shown above.

a. OUTPUT: "0"
BFO MODE: "Sine"
BAND WIDTH: "31,6 Hz"

1022 tuned to 4 kHz.

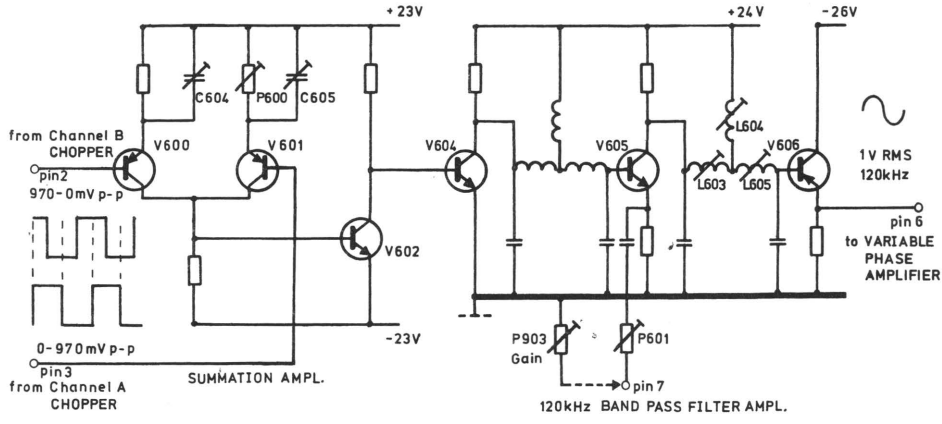
Adjust the frequency from the LF Oscillator (at 1 V) to max. voltage on "120 kHz Output".

b. OUTPUT to "90°"

Adjust C 112 and P 101 to min. beat. Tolerance ±1%.

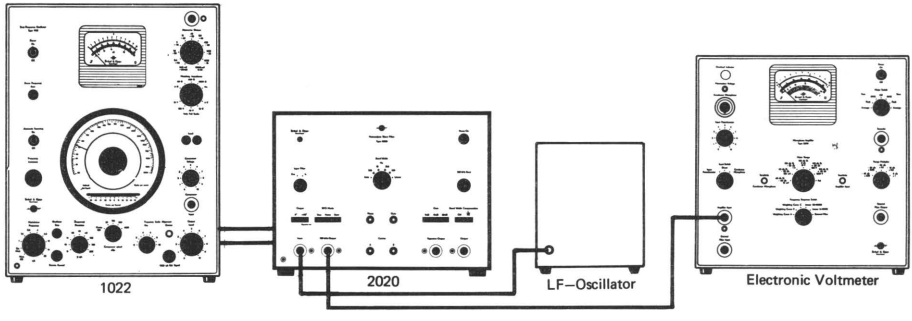
Summation Amplifier ZS 0170

Valid from serial no. 253966



In this circuit the two chopped signals A and B are added together and fed through a 120 kHz Band Pass Filter.
Here it is very important to have the correct voltage and phase applied to the base of V 602 and the adjustment is carried out as follows:

Signal voltages and curveforms are for an "Input" signal of 1 V, 1 kHz.



7.1. Sensitivity

OUTPUT: "0o"
INPUT FILTER: "Out"
BFO MODE: "Sine"
BAND WIDTH: "31,6 Hz"
GAIN: "0 dB"
BAND WIDTH COMP.: "Off"

Apply an input signal from 1022 of 1 V, 4 kHz to "Input" of 2020.

"Gain" and "Phase" to mid. position.

The electronic voltmeter connected to "120 kHz Output" should read 1 V.

If necessary adjust P 601 (coarse adjustment of "Gain").

7.2. Ripple

OUTPUT: "0o"
INPUT FILTER: "Out"
BFO MODE: "Sine"
BAND WIDTH: "31,6 Hz"
GAIN: "0 dB"
BAND WIDTH COMP.: "Off"

Connect the instruments like shown and tune the frequency until a slow beat of 1 Hz is obtained on the electronic voltmeter (if there is any beat).

The ripple should be max 1 %.

If necessary adjust C 604, C 605 and P 600 to min. ripple.

Check the ripple in all "BAND WIDTH" positions, as a defective Main Filter could cause too much ripple.

continued

7.3. Summation

OUTPUT: "0o"
INPUT FILTER: "In"
BFO MODE: "Sine"
BAND WIDTH: "31,6 Hz"
GAIN: "0 dB"
BAND WIDTH COMP.: "Off"

Apply an input signal of 1 V from 1022 to "Input" of 2020.

a. Check of channel "A".
Connect an oscilloscope to channel "B" (pin 2) and tune the frequency from 1022 to min. signal.

b. Then check: input signal to channel "A" (pin 3) 120 kHz
970 mV pp.
signal on V 602, c. 120 kHz
905 mV p.p.

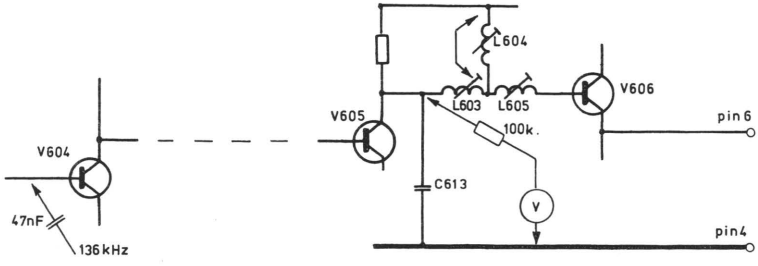
Repeat item a but for channel "B".

c. Adjust the frequency from 1022 for the same amplitude of the two signals channel A and channel B. (Pin 2 and pin 3).

signal on V 602,c 120 kHz
1260 mV p.p.

7.4. Filter Adjustment

The 120 kHz Band Pass Filter should not be adjusted unless it is strictly necessary.



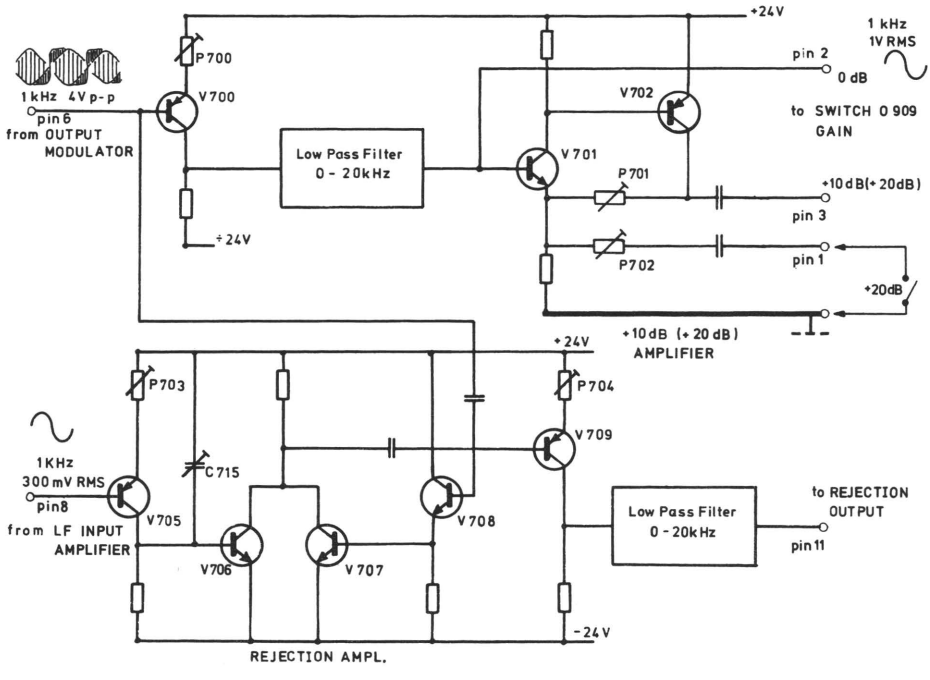
If adjustment is found necessary connect 136 kHz through a capacitor of 47 nF to the base of V 604, short connect L 604 and adjust L 603 to max voltage measured across C 613 with an electronic voltmeter with a series resistor of 100 kΩ.

Remove the short connection across L 604, apply 136 kHz ±2 Hz across it and adjust L 605 to max voltage between pin 6 and 4.

Connect 120 kHz ±2 Hz to the base of V 604 and adjust L 604 to 180° phase shift between V 604 base and V 606 emitter.

The 180° phase shift can be measured with a double beam oscilloscope with one channel connected to V 604 base, the other to V 606 emitter. If the sensitivities are adjusted to indicate a voltage of exactly the same height and the two channels are added together, a 180° phase shift would correspond a minimum deflection on the oscilloscope.

Rejection and Output Amplifiers

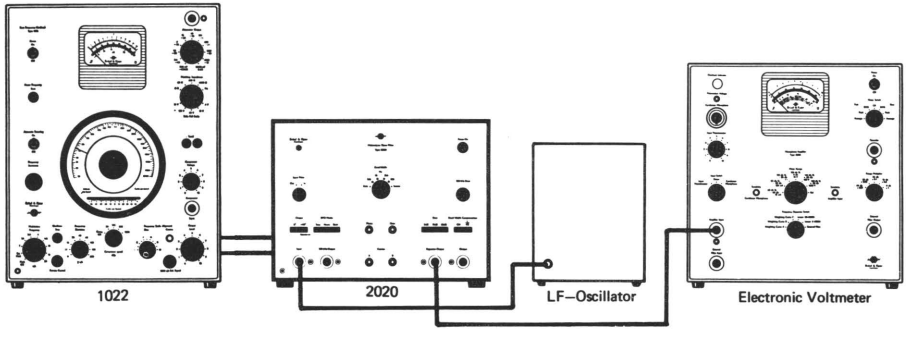


The input to V 700 is the filtered low frequency signal, which is applied to a 0 + 10 and +20 dB output through a Low Pass Filter.

The same signal is fed to V 708 and if the non-filtered LF is applied to V 705 the difference between the two will appear on the collectors of V 706, 707.

This means that the Rejection Output will consist of all frequencies in the range 0–20 kHz except the fundamental, which is supressed.

Signal voltages and curve forms are for an "Input" signal of 1 V, 1 kHz,



continued

8.1 Rejection Sensitivity

OUTPUT: "0o"
BFO MODE: "Sine"
BAND WIDTH: "10 Hz"
GAIN· "0 dB"
BAND WIDTH COMP · "Off"

Connections like shown above; 1022 adjusted to 1 kHz.

Connect 4 kHz exactly 1 V from the LF-oscillator to the "Input" of 2020.

Check the voltage on "Rejection Output": 1V ±1%.

If necessary adjust P 704.

8.2 Rejection

OUTPUT. "0o"
BFO MODE. "Sine"
BAND WIDTH· "10 Hz"
GAIN: "0 dB"
BAND WIDTH COMP.. "Off"

Apply 1 kHz, 1 V from 1022 to "Input" of 2020.

Adjust "Gain" to 1 V ±1% measured on the "120 kHz Output".

Adjust "Phase" to min. "Rejection Output".

The two potentiometers influence each others, so that "Gain" and "Phase" adjustments should be continued until 1 V +1% is obtained on the "120 kHz Output" at the same as min. 'Rejection Output" voltage: $<2{,}5$ mV.

If necessary adjust P 703.

When this adjustment has been made at f.inst. 1 kHz the "Rejection Output" voltage should be <5 mV through the whole range.

At 20 kHz the "Rejection Output" voltage can be adjusted to min. by C 715.

8 3 Sensitivity

a. OUTPUT· "0o"
BAND WIDTH: "Linear"
BFO MODE. "Sine"
GAIN: "0 dB"
BAND WIDTH COMP.· "Off"

Adjust the "Input" voltage from 1022 at 1000 Hz to give a 1 V indication on an electronic voltmeter connected to "Output" of 2020.

b. BAND WIDTH to "31,6 Hz"

Check that "120 kHz Output" voltage is 1 V ±1%.

If necessary adjust "Gain".

The "Output" voltage should be 1 V ±1%.

If necessary adjust P 700.

c. GAIN to "10 dB"

With an "Input" voltage of 1 V −10 dB the "Output" voltage should be 1 V ±1%.

If necessary adjust P 701

d. GAIN to "20 dB"

With an "Input" voltage of 1 V−20 dB the "Output" voltage should be 1 V ±1%.

If necessary adjust P 702.

8.4. Frequency Response

OUTPUT. "0o"
BAND WIDTH· "31,6 Hz"
BFO MODE: "Sine"
BAND WIDTH COMP.. "Off"
GAIN to required positions

Adjust the "Input" voltage from 1022 at 1000 Hz to give a 1 V indication on an electronic voltmeter connected to "Output" of 2020.

Check the frequency response in all "Gain" positions.

Tolerance: 20–20.000 Hz ±2%.

8.5. Overload

OUTPUT: "0o"
BAND WIDTH: "31,6 Hz"
BFO MODE: "Sine"
BAND WIDTH COMP.: "Off"
GAIN to required positions

Check with an oscilloscope that it is possible to obtain 1 V +10 dB ∼ 3 16 V on the "Output" of 2020 without limitation of the sinewave.

continued

8.6. Band Width compersation

a. OUTPUT: "0o"
BAND WIDTH: "Lin."
BFO MODE: "Sine"
BAND WIDTH COMP.: "Off"
GAIN: "0 dB"

Adjust the "Input" signal from 1022 at 1000 Hz to give a 1 V indication on an electronic voltmeter connected to the "Output" of 2020.

b. BAND WIDTH COMP. to "$\frac{1}{\sqrt{B}}$"
BAND WIDTH to "3,16 Hz"

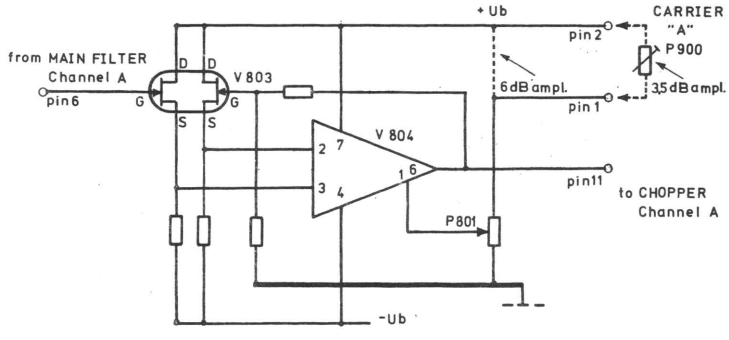
The output voltage from 2020 should be 1 V –5 dB.

c. BAND WIDTH to "10–31,6 and 100 Hz"

The output voltage from 2020 should decrease 5 dB for every bandwidth increase.

DC Amplifiers in Oven ZE 0031 2020.9

Valid from serial no. 253966



A simplified diagram of one D.C. amplifier is shown above (3.5 dB DC Ampl. channel A). The amplifier is designed as a differential amplifier with a positive and a negative supply voltage thus having O V DC on input and output in the balance condition without input signal.

A part of the circuit is mounted in an oven where a constant temperature is obtained by feeding the heating element from a supply unit where a germanium transistor is used as a temperature detector.

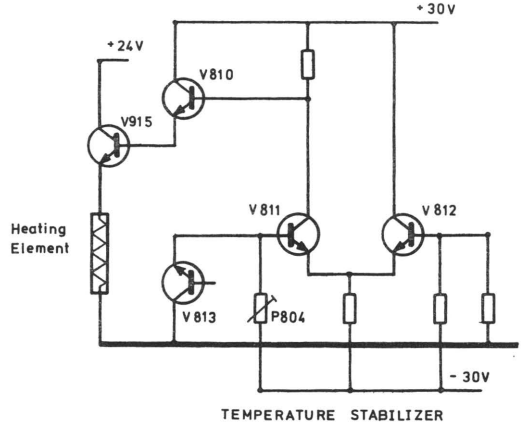
9.1. Oven Temperatur

POWER: "On"

Bear in mind that the oven should be left for 10–15 minutes after switching on or adjustment before the voltage is checked.

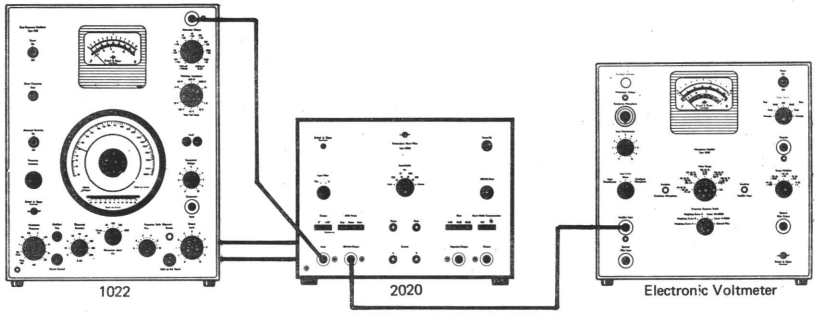
The oven temperatur is not very critical as long as it is stable, but should normally be around 55°C.

The adjustment of P 804 will vary the temperatur app. ±5°C, but it should not be touched if the voltage across the heating element is approx. 10 V (for room temperature of 20–25°C) and remaining constant.



TEMPERATURE STABILIZER

continued



9.2. Balance

a. OUTPUT: "0°"
BFO MODE: "Sine"
INPUT FILTER: "Out"
BAND WIDTH: "31,6 Hz"
CARRIER A & B: "Mid.Pos."

ATTENTION:

Very much care should be taken with this circuit to avoid connecting of the output terminals pin 5, 11, 18 or 22 to ground or to a supply voltage as this would cause a break down of V 801, 804, 806 or 809.

ZM 0006 and ZM 0007 must not be removed with POWER "On".

Before any adjustment of P 800–804 adjust "Carrier A" and "Carrier B" to mid. position.

The DC voltages across R 802 and R 821 should be O V $\pm$1 mV.

If necessary adjust P 800 for O V across R 802 and P 802 for O V across R 821.

Adjust P 801 and 803 to min. "120 kHz Output".

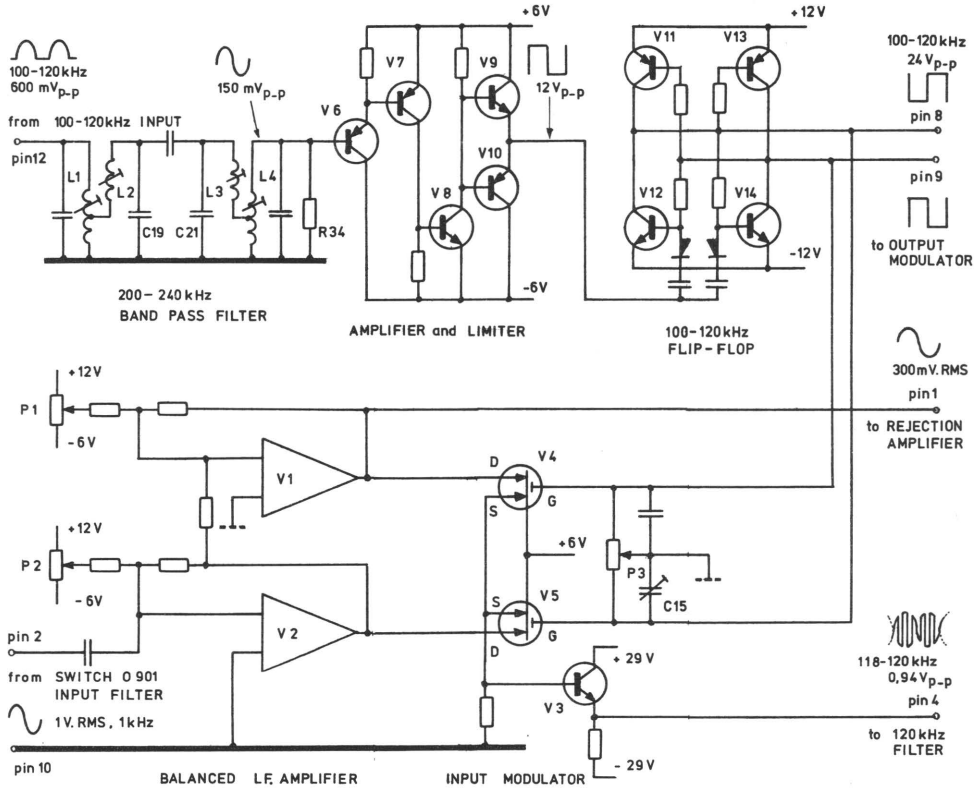
b. OUTPUT: "90°"

Readjust P 802 or 804 until "0°" and " 90°" will give the same "120 kHz Output" within 10 dB.

"120 kHz Output" in one of the positions should be below 200 uV.

Input Modulator ZM 0003

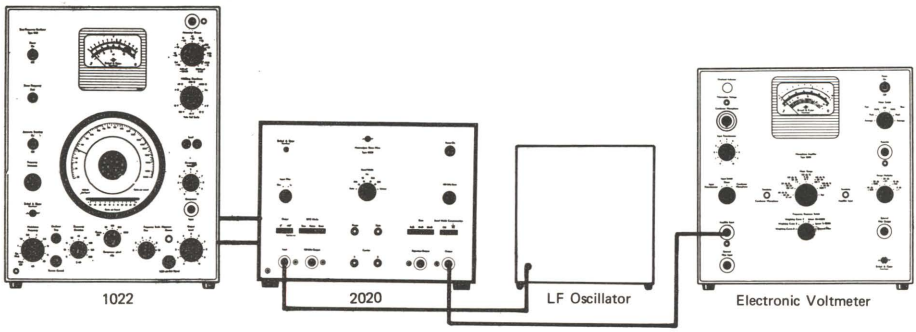
Valid from serial no. 253966



The Input Modulator consists of a 200–240 kHz Band Pass Filter with a succeeding pulseshaper which supplies squareformed pulses for a Flip-Flop circuit the output of which will have exactly the same frequency as the variable oscillator in the BFO 1022 (100–120 kHz).

Furthermore there is a Balanced LF Amplifier with two inverted stages (V 1 and V 2). The input to this amplifier is the low frequency signal (f.inst. 1 kHz), and if this frequency is modulated with the signal from the Flip-Flop circuit the resulting output through V 3 will be exactly 120 kHz.

continued



10.1. Distortion

a. OUTPUT: "0o"
BAND WIDTH: "31,6 Hz"
BFO MODE: "Sine"
BAND WIDTH COMP.: "Off"
GAIN: "0 dB"

Connect the "120 kHz" and "100–120 kHz" outputs of 1022 to the respective inputs, of 2020 and apply a signal 1 V, 1 kHz from a low distortion oscillator (–76 dB) to the "Input".

Tune 1022 to max deflection on an electronic voltmeter connected to the "Output" of 2020 and readjust the input voltage to give exactly 1 V on "Output".

Tune 1022 to app. 2 kHz and 3 kHz in order to find the 2nd and 3rd harmonics from the modulator. Voltage on "Output": Max 250 μV corresponding 72.5 dB below 1 V.

If necessary adjust P 3 and C 15 to min. (corresponding to 2nd and 3rd harmonics)

If this method does not give a sufficient low distortion adjust P 1 and P 2 for O V DC between ground and the output of V 1 and V 2.

b. BAND WIDTH to "100 Hz"

Then adjust P1, P3 and C 15 to min. distortion: < 1mV $\sim$ 60 dB.

c. BAND WIDTH to "31,6 Hz"

Distortion max 250μV $\sim$ 72.5 dB below 1 V.

The 200–240 kHz Band Pass Filter should not be adjusted unless it is strictly necessary.

A check of the filter curve can be carried out without having the ZM 0003 circuit in the 2020 according to following procedure:

1 Connect the Variable Oscillator Output (100–120 kHz) from 1022 to pin 12 and 10 on ZM 0003 and an electronic voltmeter across R 34.
By varying the BFO 1022 from 20–20000 Hz the signal across R 34 should vary from 200–240 kHz which are the 3 dB points. The level in the filter range should be within $\pm$ 0.5 dB.

If necessary adjust the coils according to following procedure:

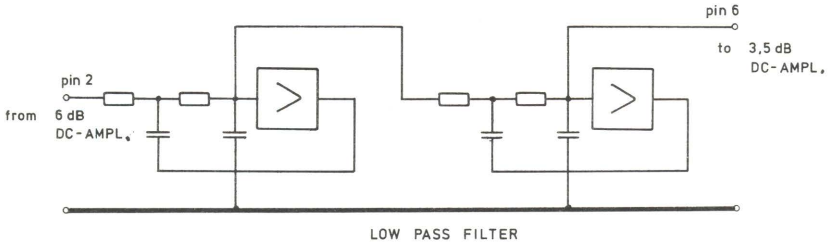
2 The Variable Oscillator Output (100–120 kHz) from 1022 connected to pin 12 and 10. 1022 tuned to 10 kHz (var. osc. freq. = 110 kHz).
Short connect C 21 and adjust L 1 to max. voltage measured from the midpoint tap oL1 to ground.
3 Connect the voltmeter across C 19 and adjust L 2 to min. voltage.

4 Short connection across C 19 instead. 110 kHz oscillator signal connected across R 34. Adjust L 4 to max voltage measured from the midpoint tap of L 4 to ground.
5 Connect the voltmeter across C 21 and adjust L 3 to min. voltage.

Recheck the filter curve according to item 1.

Main Filters ZT 0030 - 0033

Valid from serial no. 253966



LOW PASS FILTER

ATTENTION:

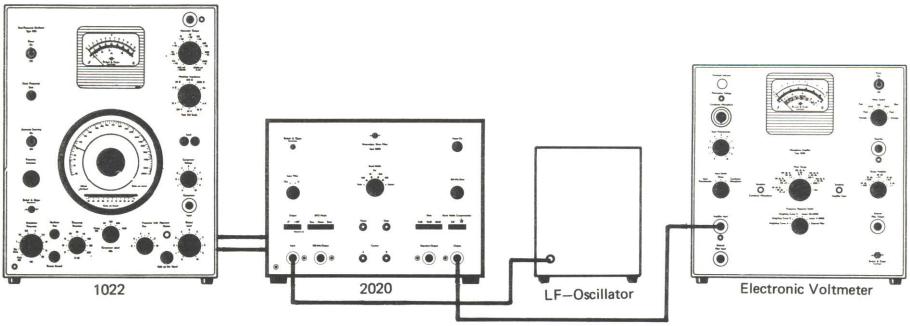
Do not adjust any of the Main Filters, as it is extremely difficult to do this without having the special test equipment which is used at the factory.

If a Main Filter is found defective it should be sent to the factory for repair and adjustment unless the trouble is found to be in a relay.

One of the troubles which could occur with a filter is that it is impossible to adjust the ripple (item 6.2.) down to 1%.

Another trouble which would be caused by the filter alone is a Band Width out of specification.

This could be checked according to following procedure:



11.1. Band Widths

a. OUTPUT: "0o"
BFO MODE: "Sine"
BAND WIDTH: "Linear"
GAIN: "0 dB"
BAND WIDTH COMP.: "Off"

Adjust the output voltage from the LF generator to give an 18 dB deflection on the voltmeter connected to 2020 "Output" (on 1 V range).

b. BAND WIDTH to "100 Hz"

Tune to the max output by fine adjustment of 1022's frequency adjustment where the deflection should be 18 dB ±1%.

Tune the L.F. generator to one side until the voltmeter reads 15 dB and note the frequency.

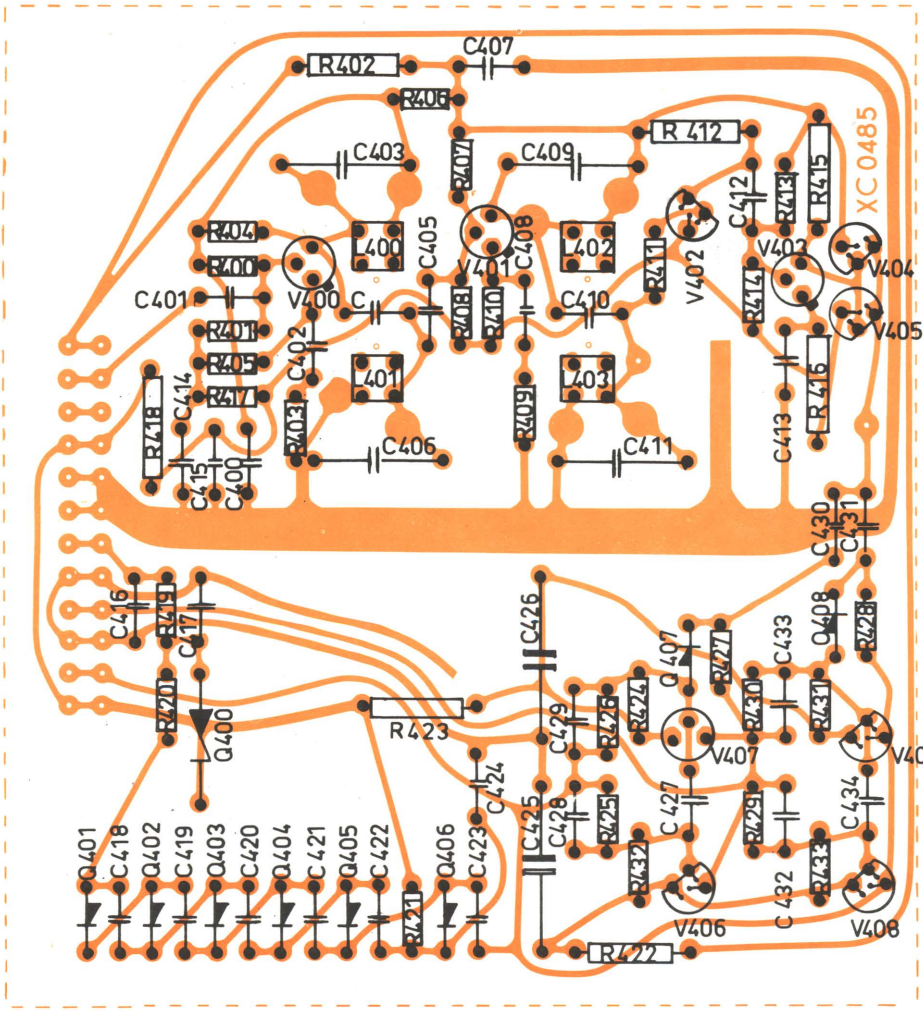
Tune the generator to the other side until 15 dB on the voltmeter and note the frequency.

The difference between the two noted frequencies is the band width.

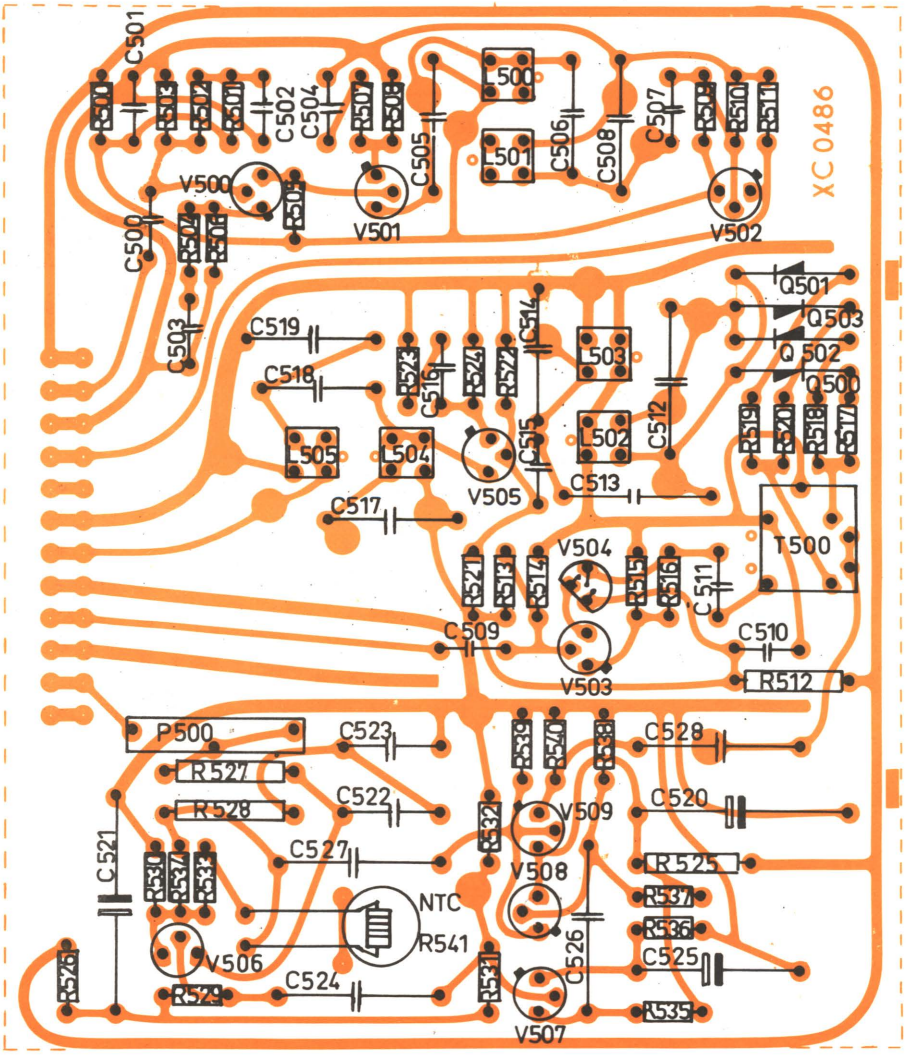
Tolerance: 5% of the selected band width.

c. BAND WIDTH to required positions

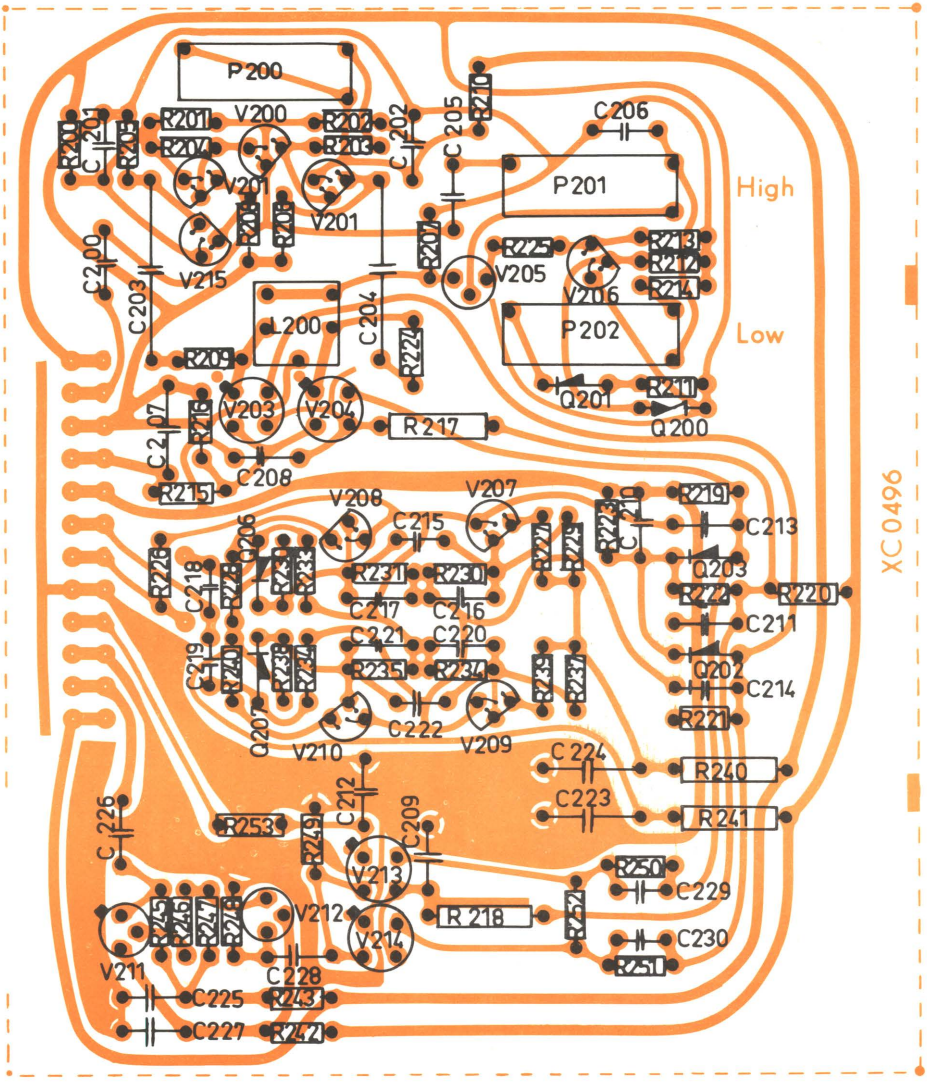
Check the other 3 dB Bandwidths according to the same method.



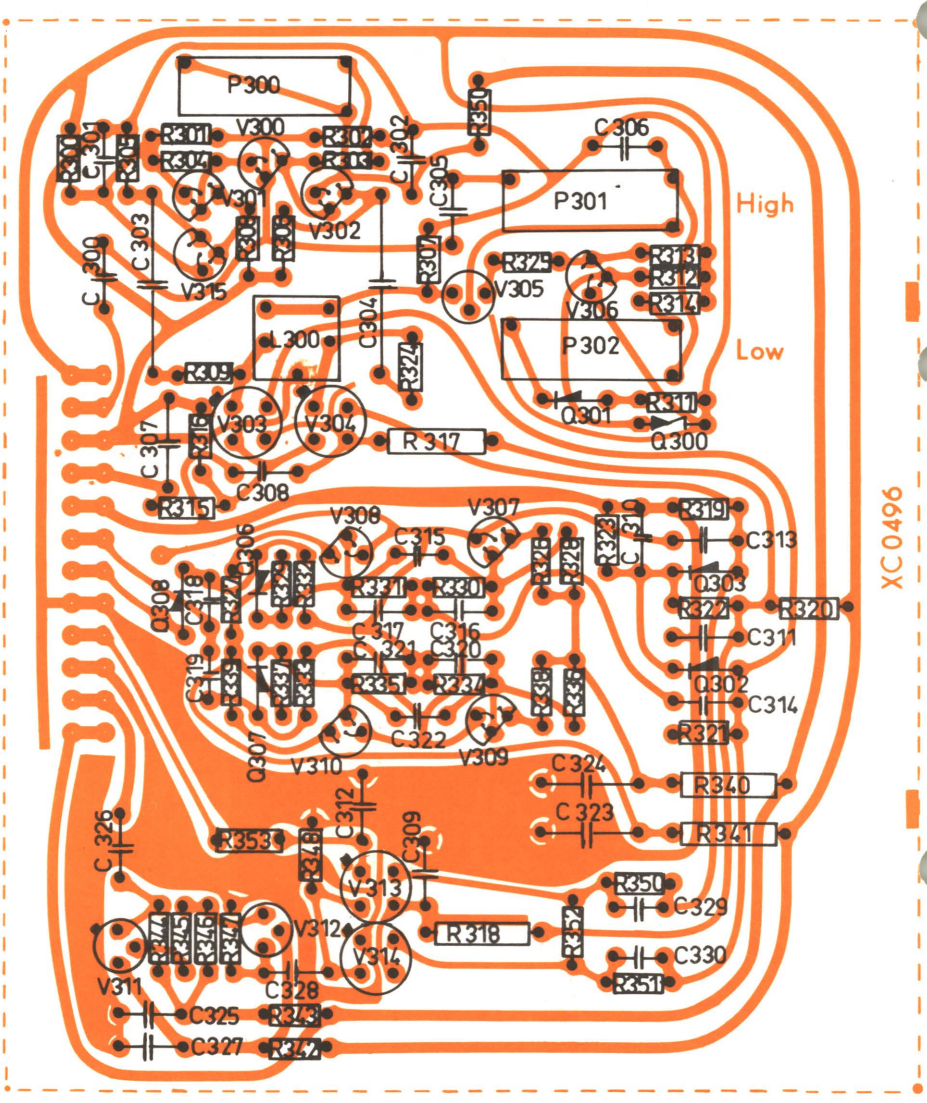
240 kHz square Wave Generator ZI 0003 – printed circuit XC 0485.



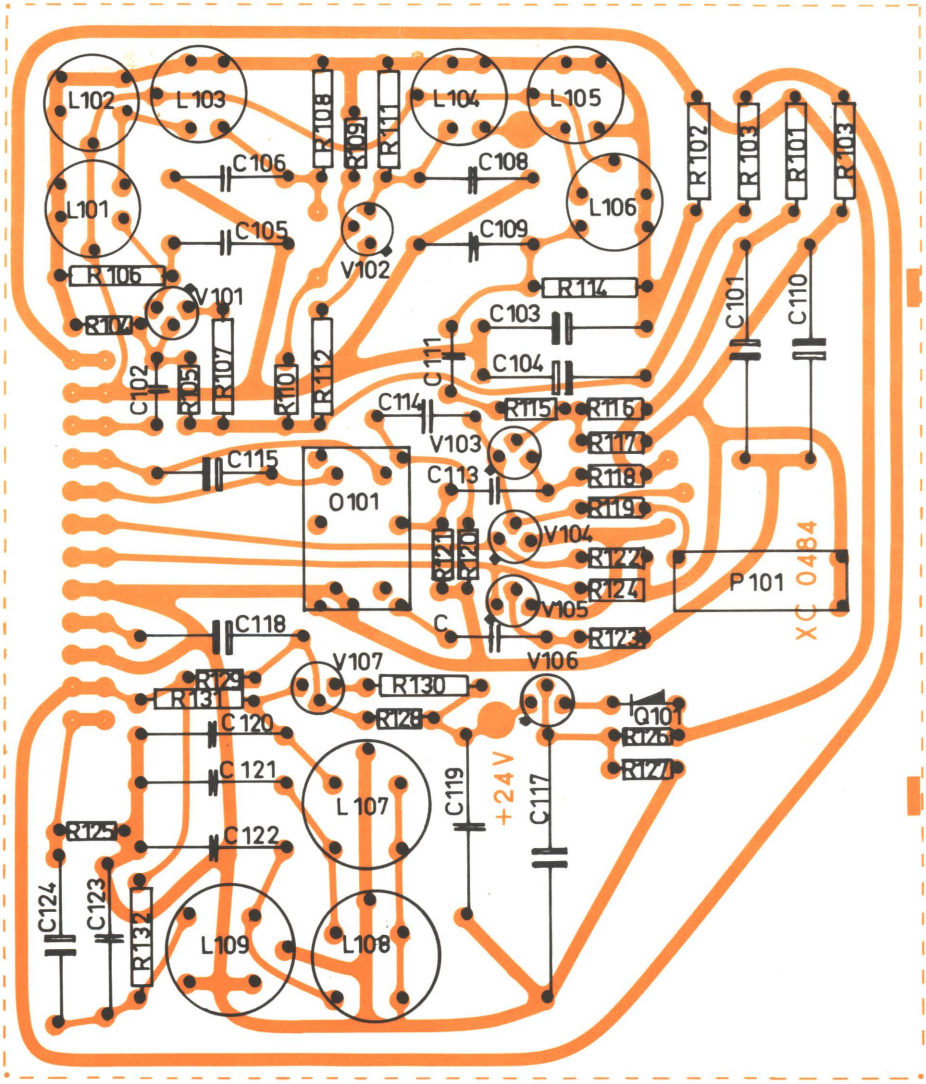
120 kHz Fixed Frequency conditioning ZS 0169 – printed circuit XC0486.



AC to DC Modulator and chopper ZM 0006 — printed circuit XC 0496.



AC to DC Modulator and chopper ZM 0007 – printed circuit XC 0496.



Input and 120 kHz Filter ZS 0168 – printed circuit XC 0484.

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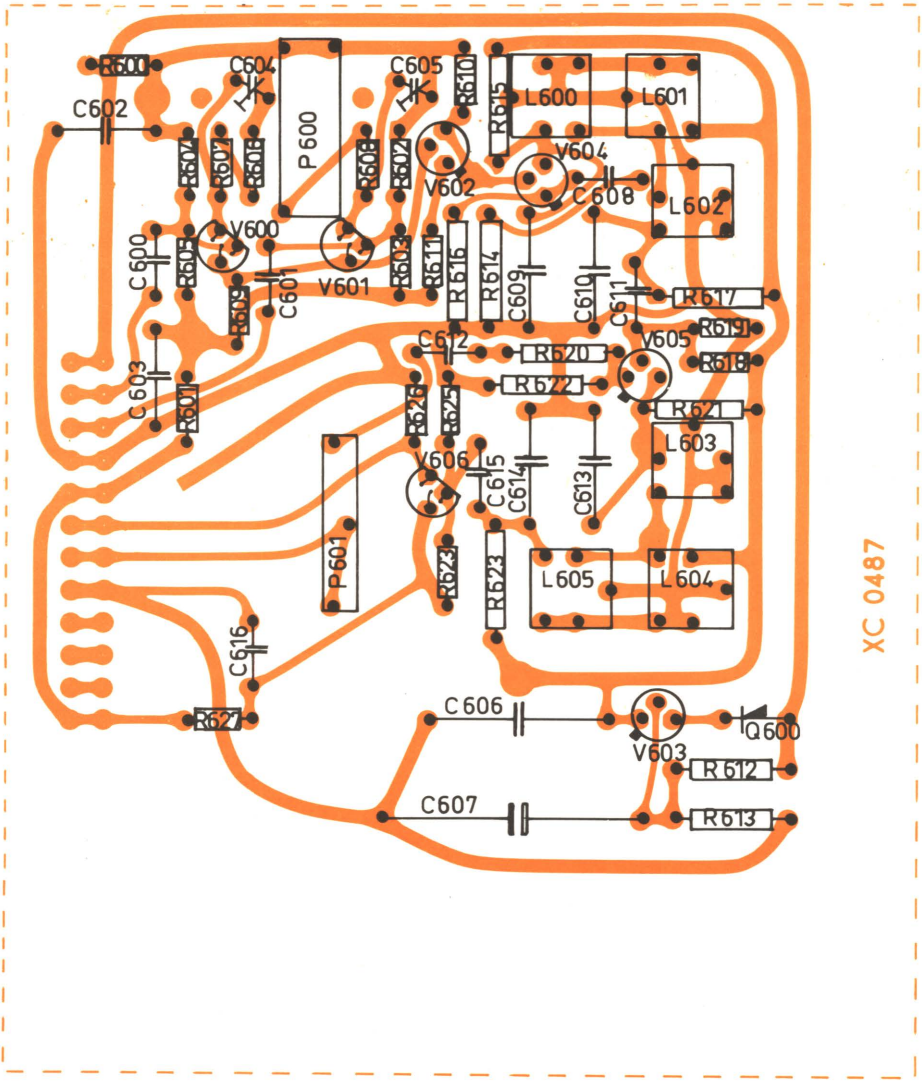
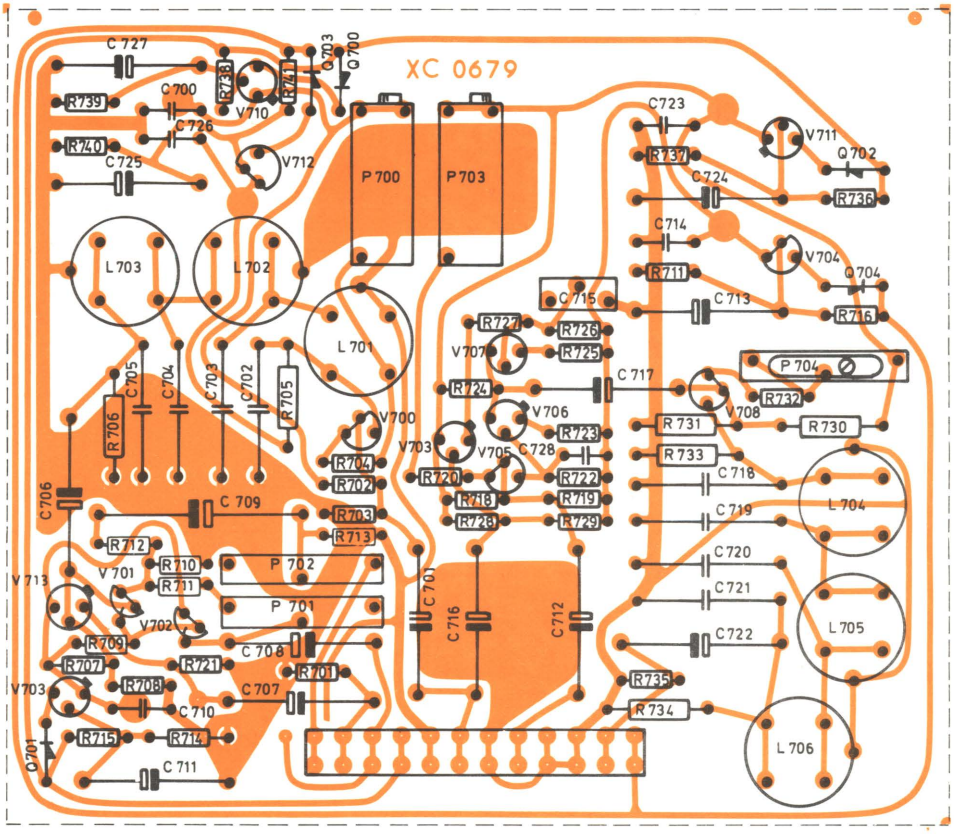
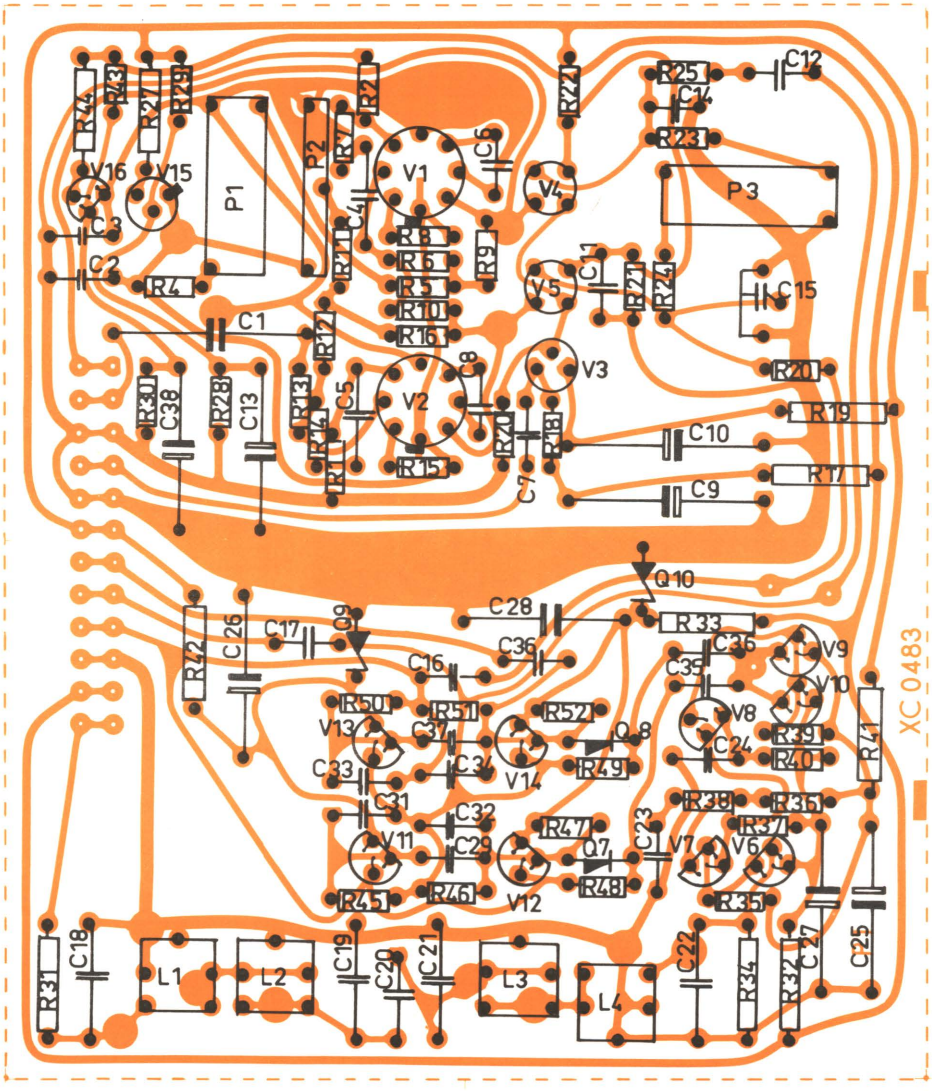


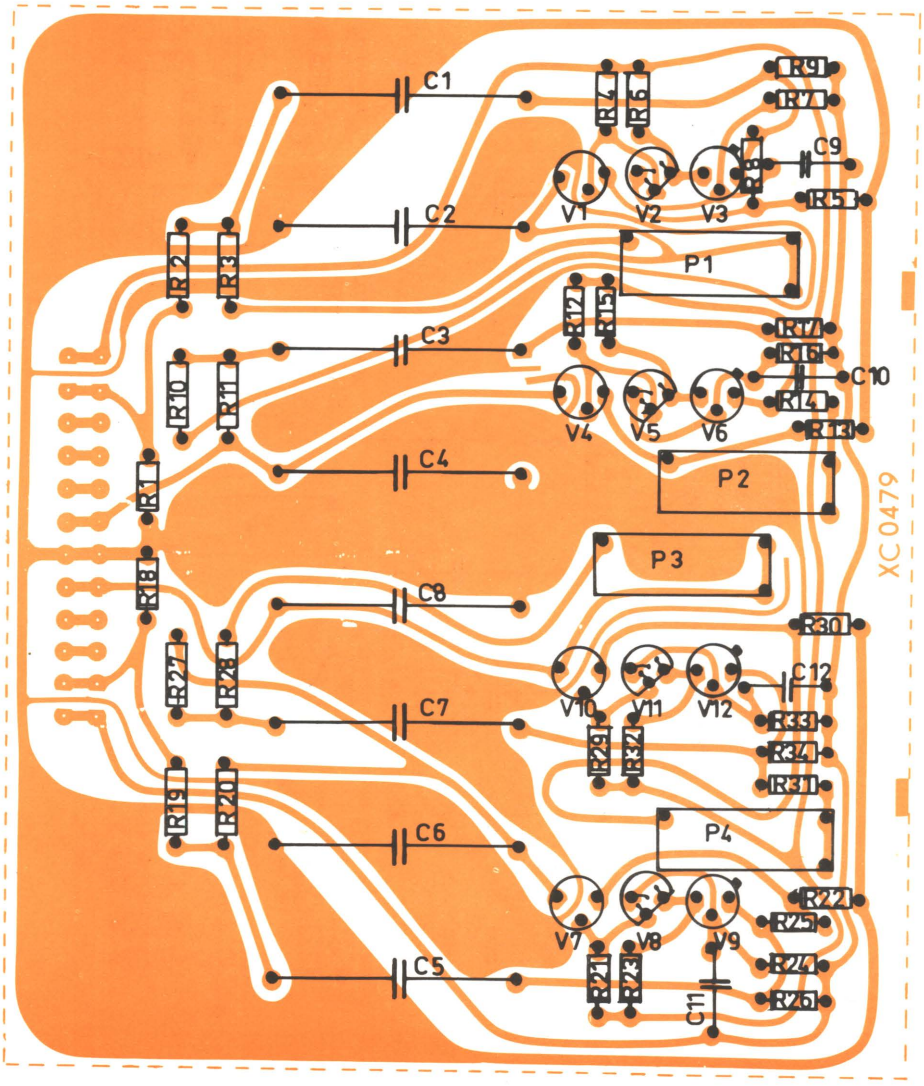
Summation and 120 kHz Filter Amplifier ZS 0170 – printed circuit XC 0487.



Rejection Ampl. LP Filter and Output Ampl. ZE 0086 – printed circuit XC 0679



Input Modulator ZM 0003 – printed circuit XC 0483.



Main Filter — 3.16 Hz ZT 0030 — printed circuit XC 0479.

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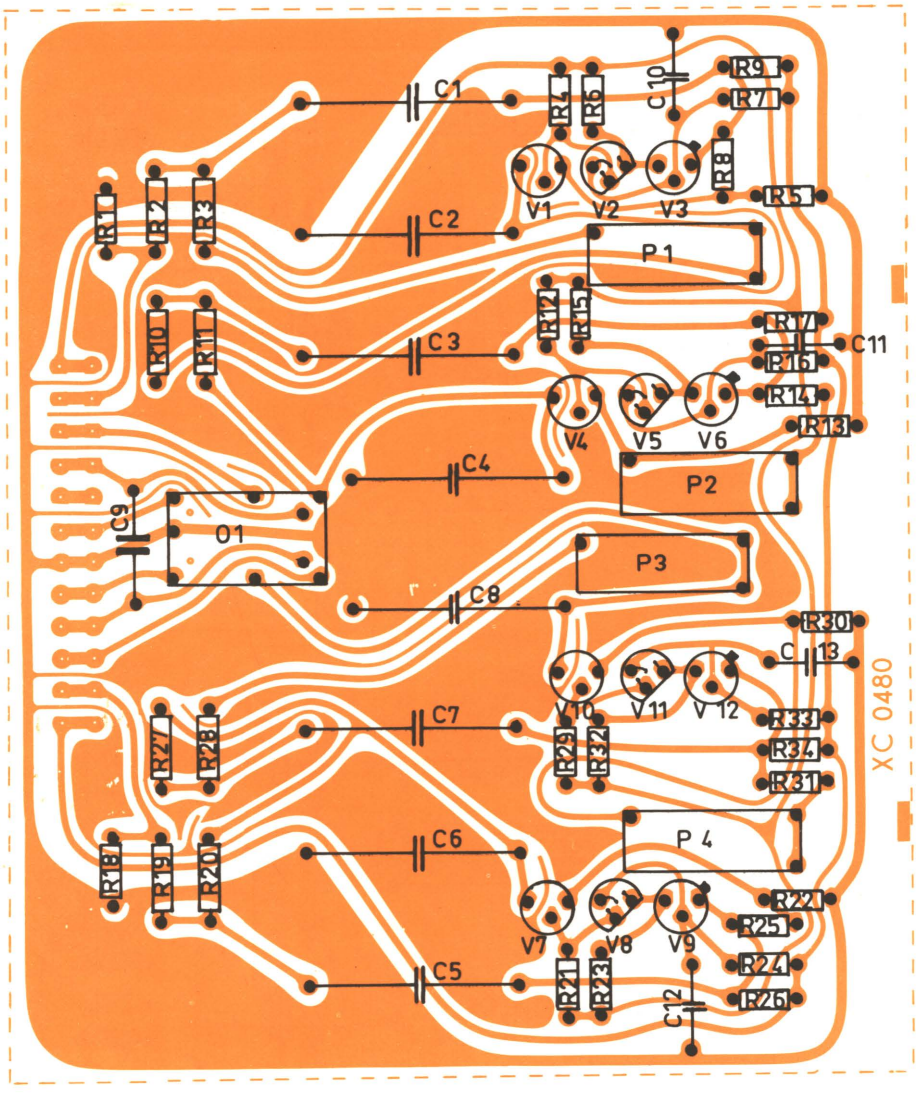
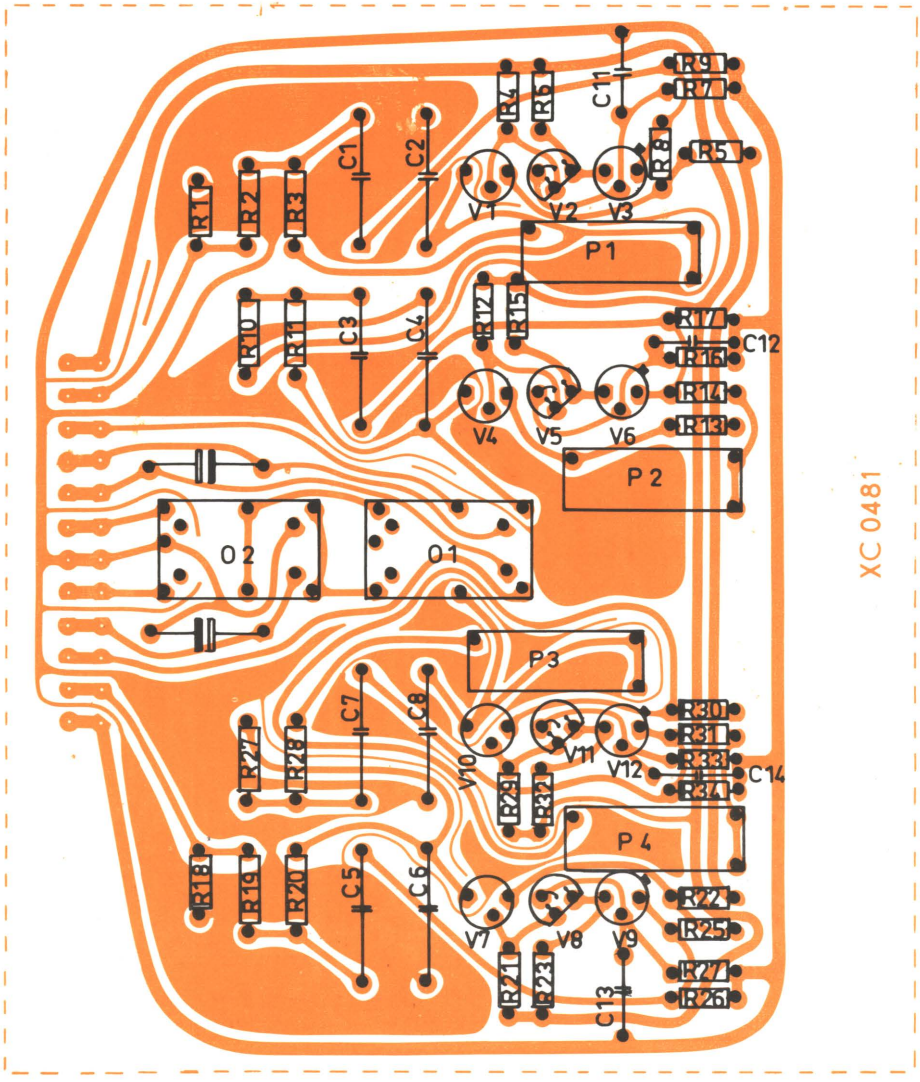
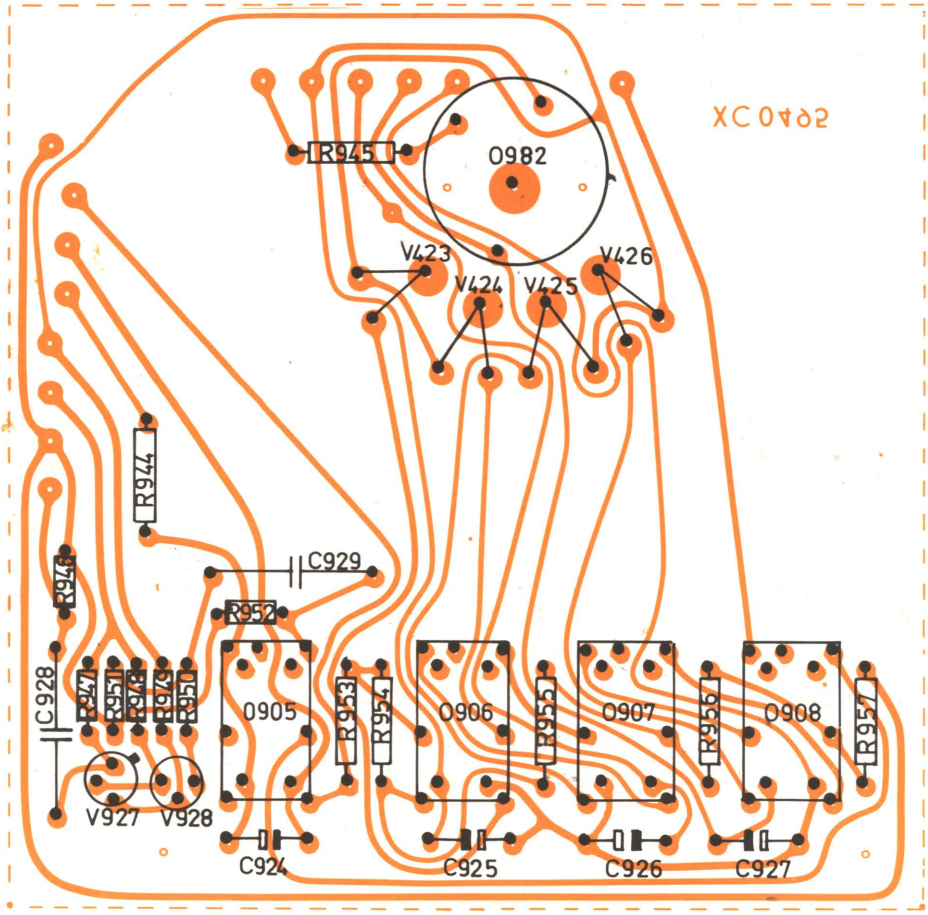


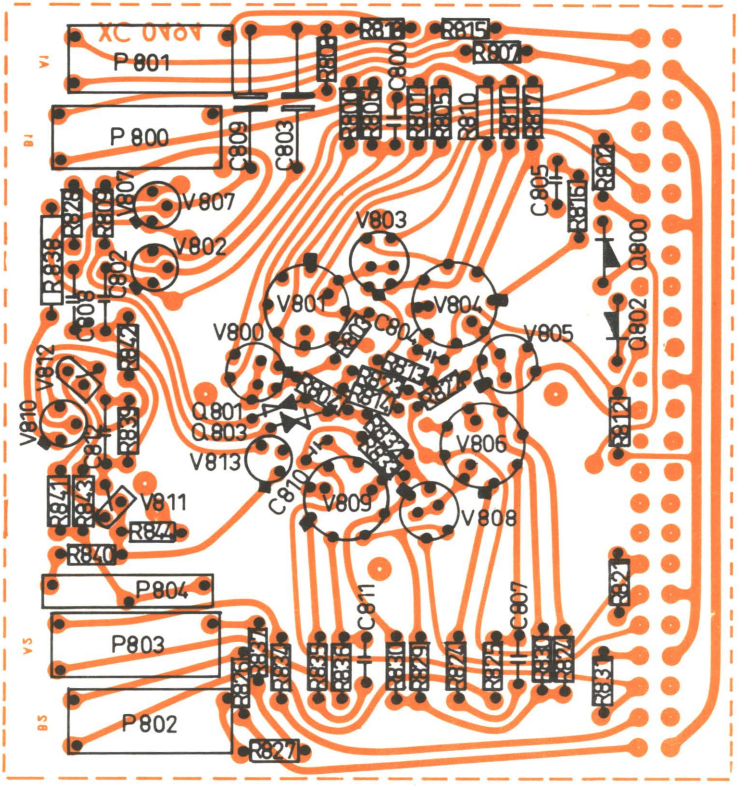
Main Filter 10 Hz ZT 0031 – 31.6 Hz ZT 0032 – printed circuit XC 0480.



Main Filter 100 Hz ZT 0033 — printed circuit XC 0481



Filter Band Width OE 0006 – printed circuit XC 0495



DC Amplifier ZC 0031 — printed circuit XC 0494

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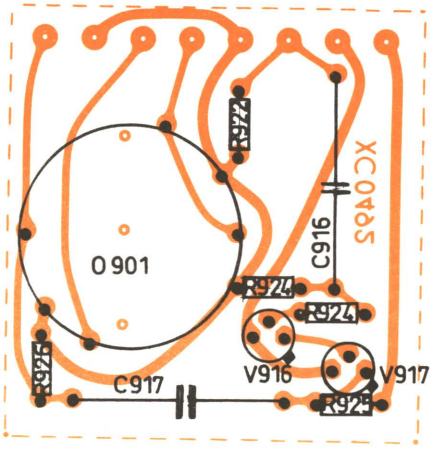
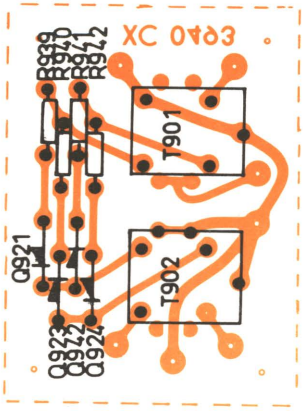
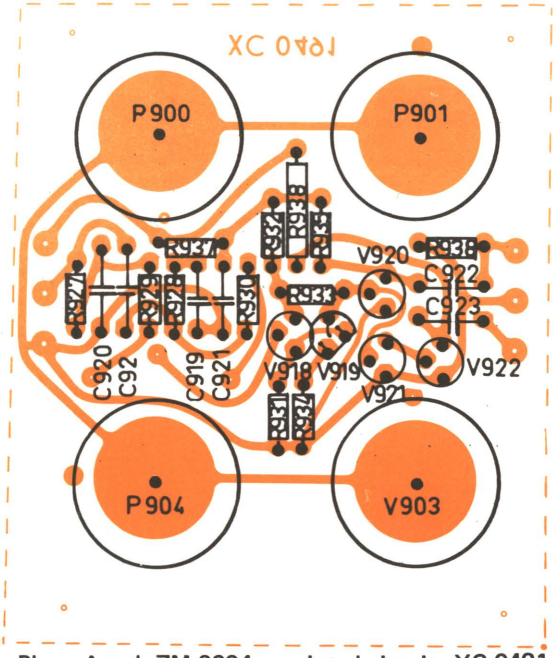


Emitter Follower ZE 0030
printed circuit XC 0492

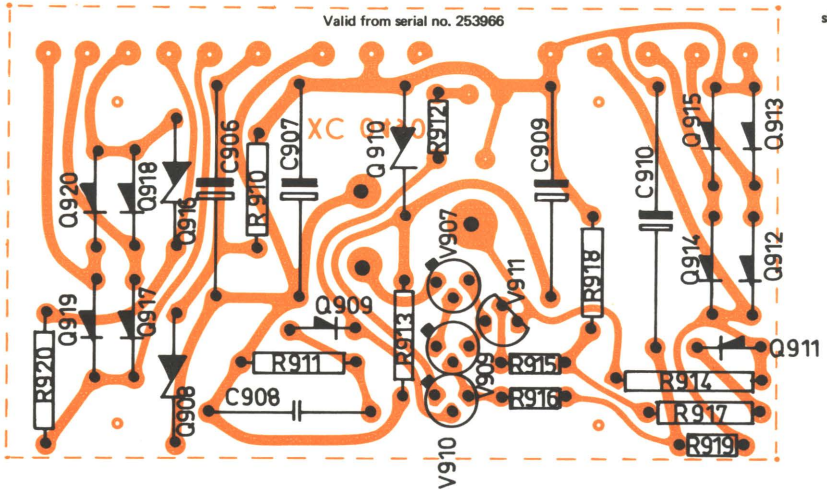


Output Amplifier ZM 0005
printed circuit XC 0493

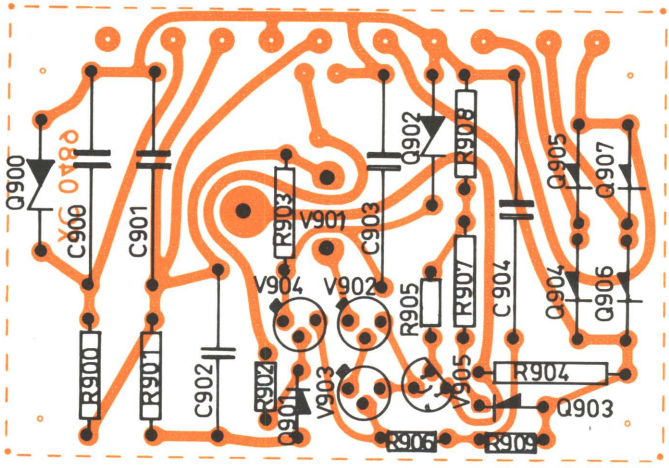


Phase Ampl. ZM 0004 – printed circuit XC 0491

Valid from serial no. 253966



Negative Voltage Supply ZG 0017 - printed circuit XC 0490



Positive Voltage Supply ZG 0016 - printed circuit XC 0489

CIRCUIT DIAGRAM REF	COMPONENT TYPE			STOCK REF.
CAPACITORS:				
C	Electrolytic	(safco)	16 µF/ 63 V	CE 0504
C 2,3	Polyester		0.1 µF/250 V	CS 0402
C 4,5	Ceramic	1%	0.62 nF/125 V	CT 109
C 6	Polystyrene		50 pF/ 63 V	CT 1530
C 7	Polyester		0 µF/250 V	CS 0402
C 8	Polystyrene		50 pF/ 63 V	CT 1530
C 9,10	Electrolytic	(safco)	16 µF/ 63 V	CE 0504
C 11			0.1 µF/250 V	CE 0402
C 12	Polyester		47 nF/250 V	CS 0401
C 13	Electrolytic		100 µF/ 15 V	CE 0310
C 14	Ceramic		3.3 pF/400 V	CK 0330
C 15	Trimmer		2-6 pF	CV 0029
C 16,17	Polyester		47 nF/250 V	CS 0401
C 18,19	Polystyrene		1.6 nF/400 V	CT 3232
C 20	-	1%	180 pF/ 63 V	CT 1310
C 21,22	-		1.6 nF/400 V	CT 3232
C 23,24	Polyester		0.1 µF/250 V	CS 0402
C 25-28	Electrolytic		5 µF/ 70 V	CE 0200
C 29	Ceramic		390 pF/400 V	CK 2390
C 30	Polyester		10 nF/250 V	CS 0403
C 31-34	Ceramic		47 F/400 V	CK 1471
C 35,36			100 pF/400 V	CK 2100
C 37	-		390 pF/400 V	CK 2390
C 38	Electro ytic		100 µF/ 15 V	CE 0310
C 101	Electrolytic	(safco)	16 µF/ 63 V	CE 0504
C 102	Polyester		0.1 µF/250 V	CS 0402
C 103,104	Electrolytic		5 µF/ 70 V	CE 0200
C 105,106	Polystyrene	2%	1 nF/500 V	CT 3218
C 107	Polyester		0.1 µF/250 V	CS 0402
C 108,109	Polystyrene	2%	1 nF/500 V	CT 3218
C 110	Electrolytic	(safco)	16 µF/ 63 V	CE 0504
C 111	Polyester		0.1 µF/250 V	CS 0402
C 112	Trimmer		6-25 pF	CV 0037
C 113,114	Polyester		0.22 µF/250 V	CS 0405
C 115	Electrolytic		8 µF/ 40 V	CE 0414
C 116	Polyester		0.22 µF/250 V	CS 0405
C 17	Electrolytic		100 µF/100 V	CE 0612
C 118	-		5 µF/ 70 V	CE 0200
C 119	Polycarbonat		1 µF/100 V	CS 0336
C 120	Polystyrene		500 pF/500 V	CT 0213
C 121,122	-		2 nF/500 V	CT 0122
C 123	-		500 pF/500 V	CT 0213
C 124	Electrolytic		5 µF/ 70 V	CE 0200
C 200-202	Polyester		0.1 µF/250 V	CS 0402
C 203,204	Polycarbonat		1 µF/100 V	CS 0336
C 205,206	Polyester		0.1 µF/250 V	CS 0402
C 207	Polystyrene	1%	3.3 nF/ 63 V	CT 1544
C 208,209	Polyester		0.1 µF/250 V	CS 0402
C 210-212	-		0.1 µF/250 V	CS 0402
C 213,214	-		47 nF/250 V	CS 0401
C 215	Ceramic		390 pF/400 V	CK 2390
C 216,217	-		47 pF/400 V	CK 1471
C 218,219	-		100 pF/400 V	CK 2100
C 220,221	-		47 pF/400 V	CK 1471
C 222	-		390 pF/400 V	CK 2390
C 223,224	Polyester		0.22 µF/250 V	CS 0405
C 225-227	-		0.1 µF/250 V	CS 0402
C 228	-		47 nF/250 V	CS 0401
C 229,230	Ceramic	5%	10 pF/400 V	CK 1100
C 300-302	Polyester		0.1 µF/250 V	CS 0402
C 303,304	Polycarbonat		1 µF/100 V	CS 0336
C 305,306	Polyester		0.1 µF/250 V	CS 0402
C 307	Polystyrene	1%	3.3 nF/ 63 V	CT 1544
C 308,309	Polyester		0.1 µF/250 V	CS 0402
C 310-312	Polyester		0.1 µF/250 V	CS 0402
C 313,314	-		47 nF/250 V	CS 0401
C 315	Ceramic		390 pF/400 V	CK 2390
C 316,317	-		47 pF/400 V	CK 1471
C 318,319	-		100 pF/400 V	CK 2100
C 320,321	-		47 pF/400 V	CK 1471
C 322	-		390 pF/400 V	CK 2390
C 323,324	Polyester		0.22 µF/250 V	CS 0405
C 325-327	-		0.1 µF/250 V	CS 0402
C 328	-		47 nF/250 V	CS 0401
C 329	Ceramic	5%	10 pF/400 V	CK 1100
C 330	-	5%	10 pF/400 V	CK 1100
C 400	-		47 nF/250 V	CS 0401
C 401	-		4.7 nF/400 V	CK 3470
C 402	Polyester		47 nF/250 V	CS 0401
C 403	Polystyrene	1%	5 nF/250 V	CT 1202
C 404		1%	49.9 pF/ 63 V	CT 1530
C 405	Ceramic		4.7 nF/400 V	CK 3470
C 406	Polystyrene	1%	5 nF/250 V	CT 1202
C 407	Polyester		0.1 µF/250 V	CS 0402
C 408	-		47 nF/250 V	CS 0401
C 409	Polystyrene	1%	5 nF/250 V	CT 1202
C 410		1%	49.9 pF/ 63 V	CT 1530
C 411		1%	5 nF/250 V	CT 1202
C 412	Ceramic		4.7 nF/400 V	CK 3470
C 413,414	Polyester		47 nF/250 V	CS 0401
C 415-423			0. µF/250 V	CS 0402
C 424	-		47 nF/250 V	CS 0401
C 425,426	Electrolytic		5 µF/ 70 V	CE 0200
C 427	Ceramic		390 pF/400 V	CK 2390
C 428,429	-		22 pF/400 V	CK 1220
C 430,431	-		100 pF/400 V	CK 2100
C 432,433	-		22 pF/400 V	CK 1220
C 434	-		390 pF 400 V	CK 2390
C 500	Polyester		22 nF/250 V	CS 0400
C 501-504	-		0 1 µF/250 V	CS 0402
C 505	Polystyrene	1%	6.26 nF/250 V	CT 203
C 506	Ceramic		39 pF 400 V	CK 1390
C 507	Polyester		22 nF/250 V	CS 0400
C 508	Polystyrene	1%	6.26 nF/250 V	CT 203
C 509	Polyester		47 nF/250 V	CS 0401
C 510	-		0.1 µF/250 V	CS 0402
C 511	-		47 nF/250 V	CS 0401
C 512	Polystyrene	1%	3 .8 nF/100 V	CT 1600
C 513	-		450 pF/500 V	CT 0112
C 514		1%	31.8 nF/100 V	CT 1600
C 515,516	Polyester		37 nF/250 V	CS 0401
C 517	Polystyrene	1%	31.8 nF/100 V	CT 1600
C 518	-		200 pF/500 V	CT 0 07
C 519	-	1%	31.8 nF/100 V	CT 1600
C 520,521	Electro ytic	(safco)	16 µF 63 V	CE 0504
C 522,523	Mica		4 nF/350 V	CM 0066
C 524	Polycarbonat		1 µF/100 V	CS 0336
C 525	Electr lytic		5 µF/ 70 V	CE 0200
C 526-528	Polycarbonat		1 µF/100 V	CS 0336
C 600,601	Polyester		0.1 µF/250 V	CS 0402
C 602,603	-		0.22 µF/250 V	CS 0405
C 604,605	Trimmer		10-40 pF/	CV 0026
C 607	Polycarbonat		1 µF/100 V	CS 0336
C 607	Elect olytic		100 µF/100 V	CE 0612
C 608	Polyester		0.1 µF/250 V	CS 0402
C 609,610	Polystyrene	2%	1 nF/500 V	CT 3218
C 611,612	Polyester		0.1 µF/250 V	CS 0402
C 613,614	Polystyrene	2%	1 nF/500 V	CT 3218

continued

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
CAPACITORS:					
C 615,616	Polyester			0.1 µF/250 V	CS 0402
C 700	Electrolytic			32 µF/ 64 V	CE 0509
C 701	-			5 µF/ 70 V	CE 0200
C 702	Polystyrene		5%	500 pF/500 V	CT 0213
C 703,704	-		5%	2 nF/500 V	CT 0122
C 705	-		2,5%	500 pF/500 V	CT 0213
C 706-708	Electrolytic			5 µF/ 70 V	CE 0200
C 709				400 µF/ 10 V	CE 0305
C 710	Polycarbonat			0.1 µF/250 V	CS 0402
C 711	Electrolytic			50 µF/ 40 V	CE 0418
C 712	-			100 µF/ 15 V	CE 0310
C 713	-			50 µF/ 40 V	CE 0418
C 714	Polyester			0.1 µF/250 V	CS 0402
C 715	Trimmer			3-10 pF/250 V	CV 0030
C 716	Electrolytic			5 µF/ 70 V	CE 0200
C 717	-			100 µF/ 15 V	CE 0310
C 718	Polystyrene		2.5%	500 pF/500 V	CT 0213
C 719,720			1%	1.1 nF/ 63 V	CT 1148
C 721	-		2.5%	500 pF/500 V	CT 0213
C 722	Polycarbonat			1 µF/100 V	CS 0336
C 723	-			0.1 µF/250 V	CS 0402
C 724,725	Elect olytic			50 µF/ 40 V	CE 0418
C 726	Polyester			0.1 µF/250 V	CS 0402
C 727	Electrolytic			50 µF/ 40 V	CE 0418
C 800	Ceramic			2.2 nF/100 V	CK 0082
C 801	-			1 nF/500 V	CK 3100
C 802	Polyester			0.1 µF/250 V	CS 0402
C 803	Electrolytic			5 µF/ 70 V	CE 0200
C 804	Ceramic			1 nF/500 V	CK 3100
C 805	-			47 nF/100 V	CK 0096
C 806	-			2.2 nF/100 V	CK 0082
C 807	-			1 nF/500 V	CK 3100
C 808	Polyester			0.1 µF/250 V	CS 0402
C 809	Electrolytic			5 µF/ 70 V	CE 0200
C 810	Ceramic			1 nF/500 V	CK 3100
C 811	-			4.7 nF/100 V	CK 0096
C 812	Polyester			10 nF/250 V	CS 0403
C 900,901	Electrolytic	(safco)		16 µF/ 63 V	CE 0504
C 902	Polycarbonat			1 µF/100 V	CS 0336
C 903	Electrolytic	(safco)		16 µF/ 63 V	CE 0504
C 904	-			100 µF/100 V	CE 0612
C 905	-			800 µF/ 64 V	CE 0516
C 906,907	-	(safco)		16 µF/ 63 V	CE 0504
C 908	Polycarbonat			1 µF/100 V	CS 0336
C 909	Electrolytic	(safco)		16 µF/ 63 V	CE 0504
C 910	-			100 µF/100 V	CE 0612
C 911,912	-			800 µF/ 64 V	CE 0516
C 913	-	(safco)		16 µF/ 63 V	CE 0504
C 914,915	-			5 µF/ 70 V	CE 0200
C 916	Polyester			2 µF/250 V	CS 0028
C 917	Electrolytic	(safco)		16 µF/ 63 V	CE 0504
C 918	Polystyrene		1%	100 pF/125 V	CT 1133
C 919	Polyester			22 nF/250 V	CS 0400
C 920	Polystyrene		1%	100 pF/125 V	CT 1133
C 921-923	Polyester			0.1 µF/250 V	CS 0402
C 924-927	Electrolytic			8 µF/ 40 V	CE 0414
C 928,929	Polycarbonat			1 µF/100 V	CS 0336
C 930	Polyester			0.22 µF/250 V	CS 0405
C 931	-			0.1 µF/250 V	CS 0402
RESISTORS:					
R 1,2	Carbon	1/4 W	5%	10 kΩ	RB 4100
R 4	-	-	-	4.7 kΩ	RB 3470
R 5	-	-	-	270 kΩ	RB 5270
R 6	Metal		1%	20 kΩ	RF 4200
R 7	-		-	316 Ω	RF 2316
R 8	Carbon	1/4 W	5%	10 kΩ	RB 4100

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
RESISTORS:					
R 9	Metal		1%	2.21 kΩ	RF 3221
R 10	-		-	20 kΩ	RF 4200
R 11	Carbon	1/4 W	5%	1MΩ	RB 6100
R 12	Metal		1%	12.1 kΩ	RF 4121
R 13	-		-	43.2 kΩ	RF 4432
R 14	-		-	316 Ω	RF 2316
R 15	Carbon	1/4 W	5%	10 kΩ	RB 4100
R 16	Metal		1%	62 kΩ	RF 3162
R 17	Carbon	1/3 W	5%	300 Ω	
R 18	-	1/4 W	-	22 kΩ	RB 4220
R 19	-	1/3 W	-	300 Ω	
R 20	-	1/4 W	-	100 kΩ	RB 5100
R 21	-	-	-	10 kΩ	RB 4100
R 22	-	-	-	47 kΩ	RB 4470
R 23,24	-	-	-	2.2 kΩ	RB 3220
R 25,26	-	-	-	1 kΩ	RB 3100
R 27	-	1/3 W	-	750 Ω	
R 28	-	1/4 W	-	10 kΩ	RB 4100
R 29	-	-	-	15 kΩ	RB 4150
R 30	-	-	-	5.6 kΩ	RB 3560
R 31	-	1/3 W	0.5%	3.56 kΩ	
R 32	-	-	5%	3 kΩ	
R 33	-	-	-	1.8 kΩ	
R 34	-	-	0.5%	3.56 kΩ	
R 35	-	1/4 W	5%	2.2 kΩ	RB 3220
R 36	-	-		5.6 kΩ	RB 3560
R 37	-	-	-	2.7 kΩ	RB 3270
R 38	-	-	-	33 Ω	RB 1330
R 39	-	-		4.7 kΩ	RB 3470
R 40	-	-	-	2.7 kΩ	RB 3270
R 41	-	1/3 W	-	3 kΩ	
R 42	-	-	-	1.8 kΩ	
R 43	-	1/4 W	-	22 kΩ	RB 4220
R 44	-	1/3 W	-	1.2 kΩ	
R 45,46	-	1/4 W	-	47 kΩ	RB 4470
R 47	-	-	-	8.2 kΩ	RB 3820
R 48,49	-	-	-	12 kΩ	RB 4120
R 50,51	-	-	-	47 kΩ	RB 4470
R 52	-	-	-	8.2 kΩ	RB 3820
R 101	-	1/3 W	-	800 Ω	
R 102,103		-	-	500 Ω	
R 104	-	1/4 W	-	100 kΩ	RB 5100
R 105	-	-	-	47 kΩ	RB 4470
R 106	-	1/3 W	0.5%	7.5 kΩ	
R 107	-	-	-	2.2 kΩ	
R 108		-	-	9.7 kΩ	
R 109		1/4 W	5%	100 kΩ	RB 5100
R 110	-	-	-	47 kΩ	RB 4470
R 111	-	1/3 W	0.5%	7.5 kΩ	
R 112	-	-	-	2.2 kΩ	
R 113	-	-	5%	800 Ω	
R 114	-	-	0.5%	9.6 kΩ	
R 115	-	1/4 W	5%	1 kΩ	RB 3100
R 116	-	-	-	100 kΩ	RB 5100
R 117	-	-	-	47 kΩ	RB 4470
R 118	Metal		1%	2.15 kΩ	RF 3215
R 119	-		-	1.78 kΩ	RF 3178
R 120,121	Carbon	1/4 W	5%	1MΩ	RB 6100
R 122	-	-	-	8.2 kΩ	RB 3820
R 123	-	-	-	100 kΩ	RB 5100
R 124	-	-	-	8.2 kΩ	RB 3820
R 125	-	-	-	1MΩ	RB 6100
R 126	-	-	-	2.2 kΩ	RB 3220
R 127	-	-	-	10 kΩ	RB 4100
R 128	-	-	-	180 kΩ	RB 5180
R 129	-	1/3 W	0.5%	220 kΩ	RB 5220
R 130	-	-	-	2.35 kΩ	
R 131	-	-	-	4.8 kΩ	
R 132	-	-	-	5.34 kΩ	

continued

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
RESISTORS:					
R 200	Carbon	1/4 W	5%	1 5 kΩ	RB 3150
R 201	-	-	-	150 kΩ	RB 5150
R 202	-	-	-	68 kΩ	RB 4680
R 203	Metal		1%	4.99 kΩ	RF 3499
R 204	-		-	5.49 kΩ	RF 3549
R 205,206		-	-	2.15 kΩ	RF 3215
R 207	Carbon	1/4 W	5%	22 Ω	RB 1220
R 208	-	-	-	8.2 kΩ	RB 3820
R 209	Metal	-	1%	280 kΩ	RF 2280
R 210	Carbon	-	5%	1.8 kΩ	RB 3180
R 211	Metal	1/3 W	1%	2.15 kΩ	RF 3215
R 212	Carbon	1/4 W	5%	33 kΩ	RB 4330
R 213	-	-	-	15 kΩ	RB 4150
R 214	Metal	1/3 W	1%	22.1 kΩ	RF 4221
R 215	-			82.5 kΩ	RF 4825
R 216	Carbon	1/4 W	5%	82 kΩ	RB 4820
R 217,218	-	1/3 W	-	500 Ω	
R 219	-	1/4 W	1%	24.9 kΩ	RF 4248
R 220	Metal		1%	24.9 kΩ	RF 4249
R 221	Carbon	1/4 W	5%	1MΩ	RB 6100
R 222	Metal		1%	2.74 kΩ	RF 3274
R 223	-		-	3.92 kΩ	RF 3392
R 224	-		-	280 kΩ	RF 2280
R 225	Carbon	1/4 W	5%	1.5 kΩ	RB 3150
R 226	-	-	-	10 kΩ	RB 4100
R 227,228	-	-	-	39 Ω	RB 1390
R 229 230		-		8.2 kΩ	RB 3820
R 231,232	-	-	-	47 kΩ	RB 4470
R 233,234	-	-	-	10 kΩ	RB 4100
R 235,236	-	-		47 kΩ	RB 4470
R 237,238	-	-		8 2 kΩ	RB 3820
R 239,240	-	-	-	39 kΩ	RB 1390
R 241,242	-	1/3 W	1%	4 7 kΩ	
R 243,244	-	1/4 W	5%	3.9 kΩ	RB 3390
R 245	-	-	-	10 kΩ	RB 4100
R 246	-	-	-	1 kΩ	RB 3100
R 247	-	-	-	47 kΩ	RB 4470
R 248	Miniresistor			10MΩ	RA 0025
R 249	Carbon	-	-	100 kΩ	RB 5100
R 250	Metal		1%	3.92 kΩ	RF 3392
R 251	-		-	3.92 kΩ	RF 3392
R 252	-		-	15 kΩ	RF 4150
R 253	Carbon	1/4 W	5%	33 Ω	RB 1330
R 300	-	-	-	1.5 kΩ	RB 3150
R 301	-	-	-	150 kΩ	RB 5150
R 302	-	-	-	68 kΩ	RB 4680
R 303	Metal		1%	4.99 kΩ	RF 3499
R 304	-		-	5.49 kΩ	RF 3549
R 305,306	-		-	2.15 kΩ	RF 3215
R 307	Carbon	1/4 W	5%	22 Ω	RB 1220
R 308	-	-	-	8.2 kΩ	RB 3820
R 309	Metal		1%	280 kΩ	RB 3180
R 310	Carbon	-	5%	1.8 kΩ	RB 3180
R 311	Metal		1%	2.15 kΩ	RF 3215
R 312	Carbon	-	5%	33 kΩ	RB 4330
R 313	-	-	-	15 kΩ	RB 4150
R 314	Metal		1%	22.1 kΩ	RF 4221
R 315	-		-	82.5 kΩ	RF 4825
R 316	Carbon	1/4 W	5%	82 kΩ	RB 4820
R 317,318	-	1/3 W	-	500 Ω	
R 319	-	1/4 W	-	1MΩ	RB 6100
R 320	Metal		1%	24.9 kΩ	RF 4249
R 321	Carbon	-	5%	1MΩ	RB 6100
R 322	Metal		1%	2.74 kΩ	RF 3274

CIRCUIT DIAGRAM REF	COMPONENT TYPE				STOCK REF.
RESISTORS:					
R 323	Metal		-	3.92 kΩ	RF 3392
R 324	-		-	2.80 kΩ	RF 2280
R 325	Carbon	1/4 W	5%	1.5 kΩ	RB 3150
R 326,327	-	-	-	39 Ω	RB 1390
R 328,329	-	-	-	8.2 kΩ	RB 3820
R 330,331	-	-	-	47 kΩ	RB 4470
R 332,333	-	-	-	10 kΩ	RB 4100
R 334,335	-	-	-	47 kΩ	RB 4470
R 336,337	-	-	-	8.2 kΩ	RB 3820
R 338,339	-	-	-	39 Ω	RB 1390
R 340,341	-	1/3 W	1%	4.7 kΩ	
R 342,343	-	1/4 W	5%	3.9 kΩ	RB 3390
R 344	-	-	-	10 kΩ	RB 4100
R 345	-	-	-	1 kΩ	RB 3100
R 346	-	-	-	47 kΩ	RB 4470
R 347	Miniresistor			10MΩ	RA 0025
R 348	Carbon	1/4 W	5%	100 kΩ	RB 5100
R 350	Metal		1%	3.92 kΩ	RF 3392
R 351	-		-	3.92 kΩ	RF 3392
R 352	-		-	15 kΩ	RF 4150
R 353	Carbon	1/4 W	5%	33 Ω	RB 1330
R 400	-	-	-	180 kΩ	RB 5180
R 401	-	-	-	47 kΩ	RB 4470
R 402	-	1/3 W	-	1.5 kΩ	
R 403		1/8 W		33 Ω	RB 1330
R 404	Metal		1%	12.1 kΩ	RF 4121
R 405	Carbon	1/4 W	5%	4.7 kΩ	RB 3470
R 406	-	-	-	470 Ω	RB 2470
R 407	-	-	-	82 kΩ	RB 4820
R 408	-	-	-	22 kΩ	RB 4220
R 409	-	-	-	330 Ω	RB 2330
R 410	-	-	-	1 kΩ	RB 3100
R 411	-	-		18 kΩ	RB 4180
R 412	-	1/3 W	-	2 kΩ	
R 413	-	1/4 W	-	27 kΩ	RB 4270
R 414	-	-		2.2 kΩ	RB 3220
R 415	-	1/3 W		1.5 kΩ	
R 416	-	-	-	160 Ω	
R 417	-	1/4 W	-	470 Ω	RB 2470
R 418	-	1/3 W	-	1.5 kΩ	
R 419	-	1/4 W	-	47 kΩ	RB 4470
R 420	-	-	-	8.2 kΩ	RB 3820
R 421	-	-	-	1 kΩ	RB 3100
R 422,423	-	1/3 W	-	3 kΩ	
R 424	-	1/4 W	-	8.2 kΩ	RB 3820
R 425,426	-	-	-	47 kΩ	RB 4470
R 427,428	-	-	-	10 kΩ	RB 4100
R 429,430	-	-	-	47 kΩ	RB 4470
R 431	-	-	-	8.2 kΩ	RB 3820
R 432,433	-	-	-	8.2 kΩ	RB 3820
R 500	-	-	-	5.6 kΩ	RB 3560
R 501	-	-	-	180 kΩ	RB 5180
R 502,503	-	-	-	180 kΩ	RB 5180
R 504	-	-	-	330 Ω	RB 2330
R 505,506	-	-	-	10 kΩ	RB 4100
R 507	-	-	-	3.9 kΩ	RB 3390
R 508		-	-	10 kΩ	RB 4100
R 509,510	-	-	-	820 kΩ	RB 5820
R 511	-	-	-	10 kΩ	RB 4100
R 512	-	1/3 W	-	500 Ω	
R 513	-	1/4 W	-	220 kΩ	RB 5220
R 514	-	-	-	22 kΩ	RB 4220
R 515	-	-	-	150 Ω	RB 2150
R 516	-	-	-	1.2 kΩ	RB 3120

continued

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
RESISTORS:					
R 517,518	Metal		1%	1 kΩ	RF 3100
R 519,520	-		-	1 kΩ	RF 3100
R 521	Carbon	1/4 W	5%	39 kΩ	RB 4380
R 522	-	-	-	12 kΩ	RB 4120
R 523	-	-	-	330 Ω	RB 2330
R 524	-	-	-	4.7 kΩ	RB 3470
R 525	-	1/3 W	-	300 Ω	
R 526	-	1/4 W	-	82 kΩ	RB 3820
R 527	Metal		1%	12.7 kΩ	RF 0012
R 528	-		-	13.3 kΩ	RF 0011
R 529	Carbon	-	5%	3.9 kΩ	RB 3390
R 530	Metal		1%	316 Ω	RF 2316
R 531	Carbon	1/4 W	5%	470 kΩ	RB 5470
R 532	-	-	-	47 kΩ	RB 4470
R 533	Metal		1%	200 Ω	RF 2200
R 534	-	-		1 kΩ	RF 3100
R 535	Carbon	-	5%	6.8 kΩ	RB 3680
R 536	-	-	-	1 kΩ	RB 3100
R 537,538	-	-	-	100 kΩ	RB 5100
R 539,540	-	-	-	1 kΩ	RB 3100
R 541	NTC resistor			5 kΩ	RN 0002
R 600,601	Carbon	1/4 W	5%	680 Ω	RB 2680
R 602	-	-	-	56 kΩ	RB 4560
R 603	-	-	-	270 kΩ	RB 5270
R 604	-	-	-	56 kΩ	RB 4560
R 605	-	-	-	270 kΩ	RB 5270
R 606	Metal		1%	3.32 kΩ	RF 3332
R 607	-		-	100 Ω	RF 2100
R 608	-		-	3.16 kΩ	RF 3316
R 609	-		-	2.74 kΩ	RF 3274
R 610	-		-	3.32 kΩ	RF 3332
R 611	-		-	2.49 kΩ	RF 3249
R 612	Carbon	1/3 W	5%	1 kΩ	
R 613	-	-	-	5 kΩ	
R 614	-	-	0.5%	12 kΩ	
R 615	-	-	-	75 kΩ	
R 616	-	-	-	2.8 kΩ	
R 617	-	-	-	9.7 kΩ	
R 618,619	-	1/4 W	5%	68 kΩ	RB 4680
R 620	-	1/3 W	0.5%	3.2 kΩ	
R 621	-	-	-	7.5 kΩ	
R 622	-	-	-	6 kΩ	
R 623	-	-	-	9.7 kΩ	
R 624	-	1/4 W	5%	68 kΩ	RB 4680
R 625	-	-	-	150 kΩ	RB 5150
R 626	-	-	-	6.8 kΩ	RB 3680
R 627	-	-	-	1.8 kΩ	RB 3180
R 700,701	-	-	-	1MΩ	RB 6100
R 702	-	-	-	150 kΩ	RB 5150
R 703	-	-	-	120 kΩ	RB 5120
R 704	-	-	-	1.5 kΩ	RB 3150
R 705	-	1/3 W	0.5%	4.8 kΩ	
R 706	-	-	-	5 kΩ	
R 707	-	1/4 W	5%	820 kΩ	RB 5820
R 708	-	-	-	390 kΩ	RB 5390
R 709	-	-	-	22 kΩ	RB 4220
R 710	-	-	-	1 kΩ	RB 3100
R 711	-	-	-	1.6 kΩ	RB 3162
R 712	-	-	-	100 Ω	RB 2100
R 713	-	-	-	1MΩ	RB 6100
R 714	-	-	-	10 kΩ	RB 4100
R 715,716	-	-	-	2.2 kΩ	RB 3220
R 717	-	-	-	10 kΩ	RB 4100
R 718	-	1/4 W	-	180 kΩ	RB 5180
R 719	-	-	-	470 kΩ	RB 5470
R 720	Metal	-	1%	9.09 kΩ	RF 3909
R 721	-		-	27 kΩ	RF 3270
R 722-726	-		-	10 kΩ	RF 4100
R 727	-		-	20 kΩ	RF 4200
R 728	Carbon	1/4 W	5%	180 kΩ	RB 5180
R 729	-	-	-	470 kΩ	RB 5470
R 730	-	1/3 W		50 kΩ	
R 731	-	-	-	200 kΩ	
R 732	-	1/4 W	-	220 Ω	RB 2220
R 733,734	-	1/3 W	0.5%	4.3 kΩ	
R 735	-	1/4 W	5%	1MΩ	RB 6100
R 736	-	-	-	2.2 kΩ	RB 3220
R 737	-	-	-	10 kΩ	RB 4100
R 738	-	-	-	2.2 kΩ	RB 3220
R 739 740	-	-	-	10 kΩ	RB 4100
R 741	-	-	-	2 2 kΩ	RB 3220
R 800,801	Metal		1%	63.4 kΩ	RF 4634
R 802	Carbon	1/4 W	5%	4.7 kΩ	RB 3470
R 803,804	Metal		1%	100 kΩ	RF 5100
R 805	Carbon	1/4 W	5%	1.5 kΩ	RB 3150
R 806	-	-	-	100 kΩ	RB 5100
R 807	Metal		1%	5.49 kΩ	RF 3549
R 808	-		-	14 kΩ	RF 4140
R 809	Carbon	1/4 W	5%	3.3 kΩ	RB 3330
R 810,811	Metal		1%	63.4 kΩ	RF 4634
R 812	Carbon	1/4 W	5%	4.7 kΩ	RB 3470
R 813	Metal		1%	49.9 kΩ	RF 4499
R 814	-		-	100 kΩ	RF 5100
R 815	-		-	6.81 kΩ	RF 3681
R 816	Carbon	1/4 W	5%	1.5 kΩ	RB 3150
R 817	-	-	-	100 kΩ	RB 5100
R 818	Metal		1%	14 kΩ	RF 4140
R 819,820	-		-	63.4 kΩ	RF 4634
R 821	Carbon	1/4 W	5%	4.7 kΩ	RB 3470
R 822,823	Metal		1%	100 kΩ	RF 5100
R 824	Carbon	1/4 W	5%	1.5 kΩ	RB 3150
R 825	-	-		100 kΩ	RB 5100
R 826	Metal		1%	5.49 kΩ	RF 3549
R 827	-			14 kΩ	RF 4140
R 828	Carbon	1/4 W	5%	4.7 kΩ	RB 3470
R 829,830	Metal		1%	63.4 kΩ	RF 4634
R 831	Carbon	1/4 W	5%	4 7 kΩ	RB 3470
R 832	Metal		1%	100 kΩ	RF 5100
R 833	-		-	49 9 kΩ	RF 4499
R 834	-		-	6.81 kΩ	RF 3681
R 835	Carbon	1/4 W	5%	1.5 kΩ	RB 3150
R 836	-	-	-	100 kΩ	RB 5100
R 837	Metal		1%	14 kΩ	RF 4140
R 838	Carbon	1/3 W	5%	220 Ω	
R 839	-	1/4 W	-	5.6 kΩ	RB 3560
R 840,841	Metal		1%	3.92 kΩ	RF 3392
R 842	-			2.05 kΩ	RF 3205
R 843	-		-	5.49 kΩ	RF 3549
R 900	Carbon	1/3 W	5%	620 Ω	
R 901	-	-	0.5%	57 kΩ	
R 902	-	1/4 W	5%	33 kΩ	RB 4330
R 903	-	1/3 W	-	2 kΩ	
R 904	Wire	1 W	-	1.3 Ω	RO 1105
R 905	Carbon	1/4 W	-	10 Ω	RB 1100
R 906	-	-	-	5.5 kΩ	RB 4560
R 907	-	1/3 W	0.5%	100 Ω	
R 908	-		-	5 kΩ	
R 909	-	1/4 W	5%	56 kΩ	RB 4560
R 910	-	1/3 W	-	620 Ω	
R 911	-	-	0.5%	57 kΩ	
R 912	-	1/4 W	5%	33 kΩ	RB 4330
R 913	-	1/3 W	-	2 kΩ	
R 914	Wire	1 W	-	1.3 Ω	RO 0005
R 915	Carbon	1/4 W	-	10 Ω	RB 1100
R 916	-	-	-	56 kΩ	RB 4560
R 917	-	1/3 W	0.5%	100 Ω	
R 918	-	-	-	5 kΩ	
R 919	-	1/4 W	5%	56 kΩ	RB 4560

continued

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
RESISTORS:					
R 920	Wire	5.5 W		330 Ω	RX 0300
R 921	Carbon	1/4 W	5%	1 kΩ	RB 3100
R 922,923	-	-	-	1MΩ	RB 6100
R 924	-	-	-	1 kΩ	RB 3100
R 925	-	-	-	10 kΩ	RB 4100
R 926	-	-	-	1MΩ	RB 6100
R 927,928	Metal	-	1%	121 kΩ	RF 2141
R 929	-		-	18.2 kΩ	RF 4182
R 930	-		-	6.21 kΩ	RF 3181
R 931	Carbon	1/4 W	5%	12 kΩ	RB 4120
R 932	-	-	-	8.2 kΩ	RB 3820
R 933	-	-	-	12 kΩ	RB 4120
R 934		-	-	100 Ω	RB 2100
R 935	-	-	-	6.8 kΩ	RB 3680
R 936	-	-	-	1MΩ	RB 6100
R 937	-	-	-	1.8 kΩ	RB 3180
R 938	-	1/3 W	-	2 kΩ	
R 939,940	Metal		1%	2.15 kΩ	RF 3215
R 941,942	-		-	2.15 kΩ	RF 3215
R 943	Carbon	1/4 W	5%	33 kΩ	RB 4330
R 944,945	-	1/3 W	-	100 Ω	
R 946	-	1/4 W		1MΩ	RB 6100
R 947	-	-	-	10 kΩ	RB 4100
R 948	-		-	68 kΩ	RB 4680
R 949,950	-	-	-	1 kΩ	RB 3100
R 951	-	-	-	1MΩ	RB 6100
R 952	Miniresistor			10MΩ	RA 0025
R 953	Carbon	1/3 W	0.5%	60.3 kΩ	
R 954	-	-	-	37.1 kΩ	
R 955			-	21 kΩ	
R 956	-	-	-	11.7 kΩ	
R 957	-	-	-	14.7 kΩ	
R 958	-	1/4 W	5%	1MΩ	RB 6100
COILS – TRANSFORMERS:					
L 1				330 μH	LB 0653
L 2,3				295 μH	LB 0652
L 4				330 μH	LB 0653
L 101				1378 μH	LB 0657
L 102				562 μH	LB 0655
L 103				1378 μH	LB 9657
L 104				1378 μH	LB 0656
L 105				562 μH	LB 0654
L 106				1378 μH	LB 0656
L 107				31,1mH	LB 0647
L 108				50.4mH	LB 0648
L 109				31.1mH	LB 0647
L 200				2x4mH	LB 0645
L 300				2x4mH	LB 0645
L 400-403				21 μH	LB 0646
L 500,501				280 μH	LB 0651
L 502				56 μH	LB 0650
L 503-505				56 μH	LB 0649
L 600				1378 μH	LB 0657
L 601				562 μH	LB 0655
L 602				1378 μH	LB 0657
L 603				1378 μH	LB 0656
L 604				562 μH	LB 0654
L 605				1378 μH	LB 0656
L 701				31.1mH	LB 0647
L 702				50.4mH	LB 0648
L 703				31.1mH	LB 0647
L 704				15.9mH	LB 0781

CIRCUIT DIAGRAM REF.	COMPONENT TYPE			STOCK REF.
COILS – TRANSFORMERS:				
L 705			18.5mH	LB 0782
L 706			15.9mH	LB 0781
L 900-903			30 μH	LJ 0008
T 500	Transformer			LB 2000
T 900	Power			TN 0029
T 901	Transformer			LB 2001
T 902	-			LB 2002
DIODES:				
Q 7,8	Silicon		150 V/300 mA QV 0217	
Q 9,10	Zener		10.8-13.2 V/ 19 mA QV 1117	
Q 101	Silicon		150 V/300 mA QV 0217	
Q 200	Zener		5.9-6.5 V/ 34 mA QV 1322	
Q 201-203	Silicon		150 V/300 mA QV 0217	
Q 206,207	-		150 V/300 mA QV 0217	
Q 300	Zener		5.9-6.5 V/ 34 mA QV 1322	
Q 301-303	Silicon		150 V/300 mA QV 0217	
Q 306-308	-		150 V/300 mA QV 0217	
Q 400	Zener		35.2-37.8 V/ 30 mA QV 1321	
Q 401-408	Silicon		150 V/300 mA QV 0217	
Q 500-503	Germanium		115 V/150 mA QV 0085	
Q 600	Silicon		150 V/300 mA QV 0217	
Q 700-704	-		150 V/300 mA QV 0217	
Q 800	-		150 V/300 mA QV 0217	
Q 801	Zener		15.3-17 V/ 17 mA QV 1118	
Q 802	Silicon		150 V/300 mA QV 0217	
Q 803	Zener		15.3-17 V/ 17 mA QV 1118	
Q 900	Zener		22.8-25.2 V/ 40 mA QV 0218	
Q 901	Silicon		150 V/300 mA QV 0217	
Q 902	Zener		10.7-11.5 V/ 80 mA QV 1315	
Q 903	Silicon		150 V/300 mA QV 0217	
Q 904-907	-		400 V/ 1 A QV 0237	
Q 908	Zener		22.8-25.4 V/ 40 mA QV 0218	
Q 909	Silicon		150 V/300 mA QV 0217	
Q 910	Zener		10.7-11.5 V/ 80 mA QV 1315	
Q 911	Silicon		150 V/300 mA QV 0217	
Q 912-915	-		400 V/ 1 A QV 0237	
Q 916	Zener		22.8-25.2 V/ 40 mA QV 0218	
Q 917-920	Silicon		400 V/ 1 A QV 0237	
Q 921-924	-		150 V/300 mA QV 0217	

CIRCUIT DIAGRAM REF.	COMPONENT TYPE			STOCK REF.
TRANSISTORS:				
V 1,2	Integr.circuit		PA 7712 C	VE 0005
V 3	Silicon	NPN	BC 107	VB 1032
V 4,5	MOS	FET	M 511	VB 4001
V 6,7	Silicon	PNP	2 N 3702	VB 0038
V 8,9	-	NPN	2 N 3704	VB 0028
V 10,11	-	PNP	2 N 3702	VB 0038
V 12	-	NPN	2 N 3704	VB 0028
V 13	-	PNP	2 N 3702	VB 0038
V 14	-	NPN	2 N 3704	VB 0028
V 15	-	NPN	BC 107	VB 1032
V 16	-	PNP	2 N 3702	VB 0038
V 101-106	-	NPN	BC 107	VB 1032
V 107	-	PNP	2 N 3702	VB 0038
V 200,201	-	NPN	2 N 3704	VB 0028
V 202	-	PNP	2 N 3702	VB 0038
V 203,204	MOS	FET	M 511	VB 4001
V 205		FET	P 1069	VB 1500
V 206	Silicon	NPN	2 N 3704	VB 0028
V 207	-	NPN	2 N 3704	VB 0028
V 208	-	PNP	2 N 3702	VB 0038

continued

CIRCUIT DIAGRAM REF.	COMPONENT TYPE			STOCK REF.
TRANSISTORS:				
V 209	Silicon	NPN	2 N 3704	VB 0029
V 210	-	PNP	2 N 3702	VB 0038
V 211	-	NPN	BC 107	VB 1032
V 212		FET	2 N 5391	VB 1023
V 213,214	MOS	FET	M 511	VB 4001
V 215		NPN	2 N 3704	VB 0028
V 300,301	Silicon	NPN	2 N 3704	VB 0028
V 302	-	PNP	2 N 3702	VB 0038
V 303,304	MOS	FET	M 511	VB 4001
V 305		FET	P 1069	VB 1500
V 306	Silicon	NPN	2 N 3704	VB 0028
V 307	-	NPN	2 N 3704	VB 0028
V 308	-	PNP	2 N 3702	VB 0038
V 309	-	NPN	2 N 3704	VB 0028
V 310	-	PNP	2 N 3702	VB 0038
V 311	-	NPN	BC 107	VB 1032
V 312		FET	2 N 5391	VB 1023
V 313,314	MOS	FET	M 511	VB 4001
V 315	Silicon	NPN	2 N 3704	VB 0028
V 400,401	-	NPN	BC 107	VB 1032
V 402	-	PNP	2 N 3702	VB 0038
V 403	-	NPN	BC 107	VB 1032
V 404	-	NPN	2 N 3704	VB 0028
V 405,406	-	PNP	2 N 3702	VB 0038
V 407	-	NPN	2 N 3704	VB 0028
V 408	-	PNP	2 N 3702	VB 0038
V 409	-	NPN	2 N 3704	VB 0028
V 500-503	-	NPN	BC 107	VB 1032
V 504	-	PNP	2 N 3702	VB 0038
V 505	-	NPN	BC 107	VB 1032
V 506		FET	2 N 4302	VB 1026
V 507-509	Silicon	NPN	BC 107	VB 1032
V 600,601	-	PNP	2 N 3702	VB 0038
V 602-605	-	NPN	BC 107	VB 1032
V 606	-	PNP	2 N 3702	VB 0038
V 700	-	PNP	2 N 3702	VB 0038
V 701	-	NPN	2 N 3704	VB 0028
V 702	-	PNP	2 N 3702	VB 0038
V 703	-	NPN	BC 107	VB 1032
V 704,705	-	PNP	2 N 3702	VB 0038
V 706-708	-	NPN	BC 107	VB 1032
V 709	-	PNP	2 N 3702	VB 0038
V 710,711	-	NPN	BC 107	VB 1032
V 712	-	PNP	2 N 3702	VB 0038
V 713	-	NPN	BC 107	VB 1032
V 800	(dobb)	FET	U 232	VB 1002
V 801	Integr.circuit		PA 7709	VE 0003
V 802	Silicon	NPN	2 N 3053	VB 0251
V 803	(dobb)	FET	U 232	VB 1002
V 804	Integr.circuit		PA 7709	VE 0003
V 805	(dobb)	FET	U 232	VB 1002
V 806	Integr.circuit		PA 7709	VE 0003
V 807	Silicon	PNP	2 N 4037	VB 0067
V 808	(dobb)	FET	U 232	VB 1002
V 809	Integr.circuit		PA 7709	VE 0003
V 810	Silicon	NPN	2 N 3053	VB 0251
V 811,812	-	NPN	2 N 4287	VB 0055
V 813	Germanium	NPN	ASY 29	VB 0506
V 900	Silicon	NPN	2 N 4922	VB 0063
V 901	-	NPN	40363	VB 0255
V 902-904	-	NPN	BC 107	VB 1032
V 905	-	PNP	2 N 3702	VB 0038
V 906	-	PNP	2 N 4919	VB 0061
V 907	-	NPN	40363	VB 0255
V 908-910	-	NPN	BC 107	VB 1032
V 911	-	PNP	2 N 3702	VB 0038
V 912	-	NPN	2 N 4922	VB 0063
V 915	-	NPN	2 N 4922	VB 0063
V 916-918	-	NPN	BC 107	VB 1032
V 919	Silicon	PNP	2 N 3702	VB 0038
V 920-922	-	NPN	BC 107	VB 1032
V 927	-	NPN	BC 107	VB 1032
V 928		FET	2 N 4302	VB 0045

CIRCUIT DIAGRAM REF	COMPONENT TYPE				STOCK REF.
POTENTIOMETERS:					
P 1	Carbon	0.5 W	lin.	10 kΩ	PG 3109
P 2	Wire	-	-	10 kΩ	PG 3107
P 3	-	-	-	5 kΩ	PG 2504
P 101		-	-	500 Ω	PG 1501
P 200	-	-	-	1 kΩ	PG 2103
P 201	-	-	-	50 kΩ	PG 3506
P 202	-	-	-	5 kΩ	PG 2504
P 300	-	-	-	1 kΩ	PG 2102
P 301	-	-	-	50 kΩ	PG 3506
P 302	-	-	-	5 kΩ	PG 2504
P 500	-	-	-	1 kΩ	PG 2103
P 600	-	-	-	500 Ω	PG 1501
P 601	-	-	-	1 kΩ	PG 2103
P 700-703		-	-	1 kΩ	PG 2102
P 704	-	-	-	1 kΩ	PG 2103
P 800-803	-	-	-	5 kΩ	PG 2504
P 804	-	-	-	10 kΩ	PG 3107
P 900-903	-	2 W	-	500 Ω	PQ 1509
P 904	-	-	-	5 kΩ	PQ 2509

PRINTED CIRCUIT:		
Rejection Ampl.	ZE 0086	XC 0679
Emitter follower	ZE 0030	XC 0492
DC ampl. (in Oven)	ZE 0031	XC 0494
240 kHz squarewave	ZI 0003	XC 0485
Input Modulator	ZM 0003	XC 0483
Var. Phase Ampl.	ZM 0004	XC 0491
Output Ampl.	ZM 0005	XC 0493
AC to DC modulator	ZM 0006	XC 0496
AC to DC modulator	ZM 0007	XC 0496
Input filter 120 kHz	ZS 0168	XC 0484
120 kHz Fixed Freq. Conditioning	ZS 0169	XC 0486
Summation ampl.	ZS 0170	XC 0487
3.16 kHz Filter	ZT 0030	
10 Hz Filter	ZT 0031	
31.6 Hz Filter	ZT 0032	
100 Hz Filter	ZT 0033	
Voltage Supply	ZG 0016	XC 0489
—Voltage Supply	ZG 0017	XC 0490
Filter Bandwidth	OE 0006	XC 0495
Gain Switch	OE 0008	XC 0511
BFO Mode Switch	OR 0104	XC 0482

MISCELLANEOUS:		
O 101	Relay 24 V	OC 0024
O 900	"On—Off" switch	NN 0014
O 901	"Input Filter"	OH 2000
O 902	"Bandwidth" switch	OH 3000
O 903	"Output" switch	NN 0022
O 904	"BFO Mode" switch	NN 0021
O 905-908	Relay 24 V	OC 0024
O 909	"Gain" switch	NN 0021
O 910	"Bandwidth Comp" switch	NN 0022
V 913	Neon Lamp (red)	VS 0024
V 914	Fuse 1 A	VF 0008
V 923-926	Neon Lamp	VS 0015
	Bakelite knob large	SN 3222 + DB 0674 + YQ 2083
	Bakelite knob small	SN 2522 + DB 0674 + YQ 2083

Circuit Diagram

Valid from serial no. 338619

2020.14

Consisting of:

Circuit Diagram

Valid from serial no. 338619

2020.14

sheet 2b

Panel Wiring

ZE 0031 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24

Carrier A — 500Ω P 900

Carrier B — 500Ω P 901

2N 4922 V 915

ZG 0016

+30V — 620Ω R 900 — 57kΩ R 901 — 1µF C 902 — 2kΩ R 903

40363 V 901 — BC 107 V 902 — BC 107 V 903 — BC 107 V 904

2N 4922 V 900 — +24V — 16µF C 901 — BAX 16 Q 901 — 33kΩ R 902 — 10kΩ P 905 — 16µF C 900 — Z 24 Q 900 — 16µF C 903 — +11V — Z 11 Q 902

1,3Ω R 904 — 2N 3702 V 905 — 10Ω R 905 — BAX 16 Q 903 — 100Ω R 907 — 56kΩ R 909 — 56kΩ R 906 — 800µF C 905 — 5kΩ R 908 — 100µF C 904

1N 4004 Q 904 — 1N 4004 Q 906 — 1N 4004 Q 905 — 1N 4004 Q 907

T 900 — 32V — 240V — 220V — 150V — 127V — 115V — 110V — O 900 — V 913 — 1A V 914 — N 900 — 0 — 24V

ZE 0030

−24V — 2N 4919 V 906 — 16µF C 906 — ZE 24 Q 908 — 620Ω R 910 — −30V

40363 V 907 — BC 107 V 908 — BC 107 V 909 — BC 107 V 910

2N 3702 V 911 — 1,3Ω R 914 — BAX 16 Q 911 — 10Ω R 915 — 100Ω R 917 — 56kΩ R 919 — 56kΩ R 916 — 800µF C 911 — 5kΩ R 918 — 100µF C 910

16µF C 907 — 57kΩ R 911 — 1µF C 908 — 2kΩ R 913 — 33kΩ R 912 — 10kΩ P 906 — 16µF C 909 — −19V — Z 11 Q 910

1N 4004 Q 912 — 1N 4004 Q 914 — 1N 4004 Q 913 — 1N 4004 Q 915

2N 4922 V 912 — +24V — 330Ω R 920 — 800µF C 912 — Z 24 Q 916

1N 4004 Q 917 — 1N 4004 Q 919 — 1N 4004 Q 918 — 1N 4004 Q 920

ZG 0017

Chassis Ground

Signal Ground

ZM 0003 ZS 0168 ZM 0006 ZM 0007 ZS 0170 ZE 0086 ZT 0030 ZT 0031 ZT 0032 ZT 0033 ZS 0169 ZI 0003

30µH L 902 — 30µH L 900 — 16µF C 913 — 5µF C 914 — 5µF C 915 — 0,22µF C 930 — 30µH L 901 — 30µH L 903 — −30V — −24V

120kHz Beat — 1kΩ R 921 — 500Ω P 902

Gain — 500Ω P 903

Input — 100–120kHz Input — 100–120 kHz Phase Lock — 120kHz Input — Rejection Output — 120kHz Output — 123 kHz Input — Output

O 901 Input Filter

ZM 0004

12,1kΩ R 928 — 100pF C 920 — 12,1kΩ R 927 — 18,2kΩ R 929 — 22nF C 919 — Phase 5kΩ P 904 — 100pF C 918 — 6,81kΩ R 930 — 0,1µF C 921 — 12kΩ R 931 — 2N 3702 V 919 — 100Ω R 934 — 12kΩ R 933 — 8,2kΩ R 932 — 6,8kΩ R 935 — 0,1µF C 922 — 1MΩ R 936 — BC 107 V 918 — BC 107 V 920 — BC 107 V 921 — BC 107 V 922 — 0,1µF C 923 — 2kΩ R 938 — 1,8kΩ R 937

ZM 0005

T 901 — 2,15kΩ R 939 — 4 x BAX16 Q 921 Q 922 Q 923 Q 924 — 2,15kΩ R 940 — 2,15kΩ R 941 — 2,15kΩ R 942 — T 902

2µF C 916 — 1kΩ R 924 — BC 107 V 916 — BC 107 V 917 — 16µF C 917 — 1MΩ R 922 — 1MΩ R 923 — 10kΩ R 925 — 1MΩ R926

O 902 Filter Band Width

Remote Control: Intern viewed

100Ω R 945

+30V — 100Ω R 944 — 3,16Hz V 923 — 10Hz V 924 — 31,6Hz V 925 — 100Hz V 926

8µF C 924 — O 905 — 8µF C 925 — O 906 — 8µF C 926 — O 907 — 8µF C 927 — O 908 — −28V

1MΩ R 958 — 0° — +90° — O 903

3,3kΩ R 943 — Sine — Noise — Beat — OE 0008 — O 904

Gain: — 0 — 10 — 20 — OE 0007 — O 909

Band Width Compensation: — Off — 1/√B — O 910

1kΩ R 949 — 2N 4302 V 928 — BC 107 V 927 — 1µF C 929 — 1µF C 928 — 1MΩ R 946 — 10kΩ R 947 — 68kΩ R 948 — 1kΩ R 950 — 1MΩ R 951 — 10MΩ R 952 — 60,3kΩ R 953 — 37,1kΩ R 954 — 21kΩ R 955 — 11,7kΩ R 956 — 14,7kΩ R 957

OE 0006

Transistor sockets

40363 — Collector (Case) — Base — Emitter

2N 4302 — G — D — S

2N 3702 — E C B

BC 107 — C — B — E

2N 4919 2N 4922 — 2N 4919 — Emitter — Base — Collector

Bottom view

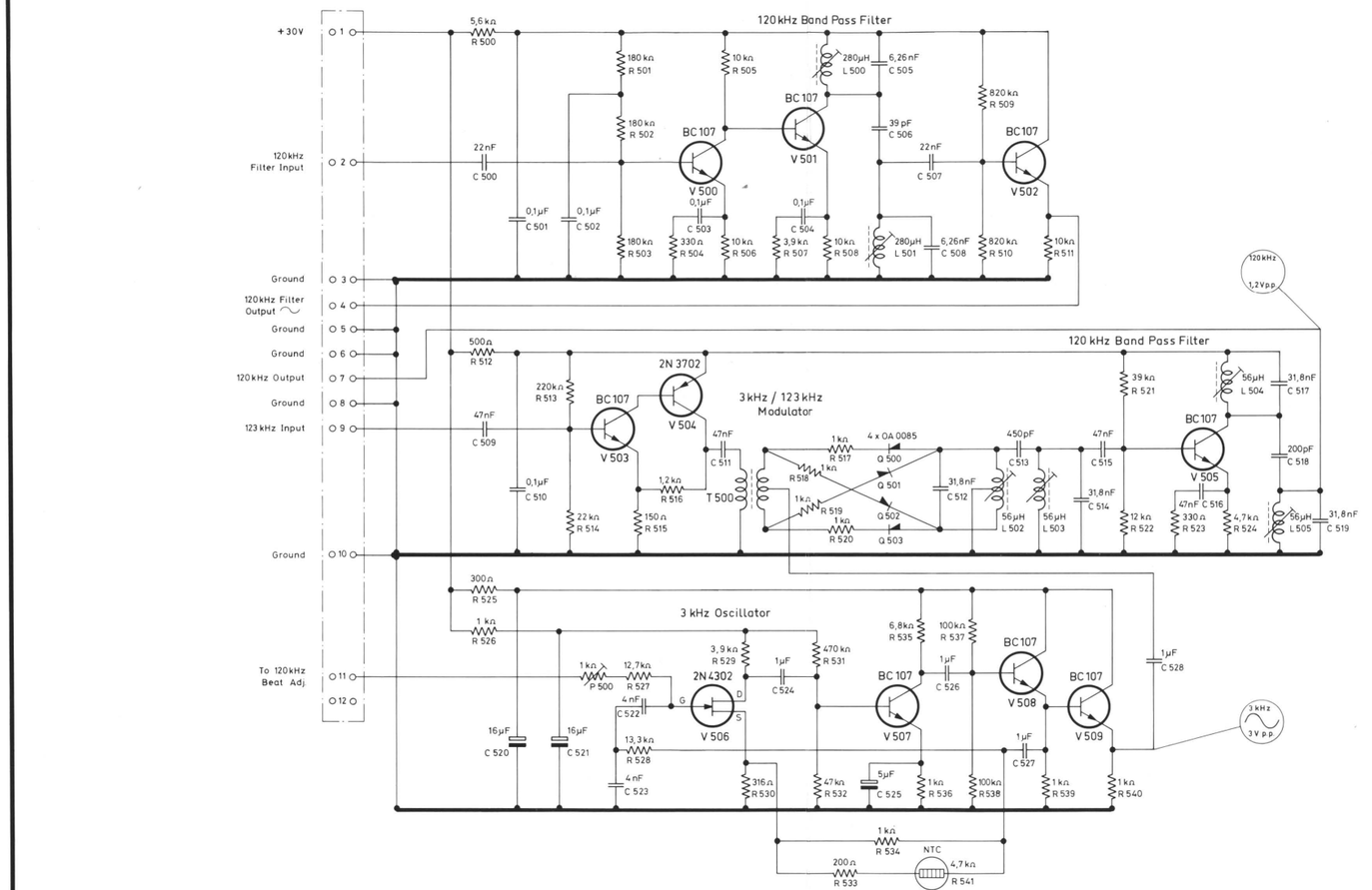
24-02-1969	253966		
13-03-1972	253966		
17-03-1972	338619		

Brüel & Kjær Copenhagen

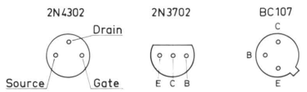
Heterodyne Slave Filter
Panel Wiring
Type 2020

BD 0073

120 kHz Fixed Frequency Conditioning ZS 0169



Transistor sockets

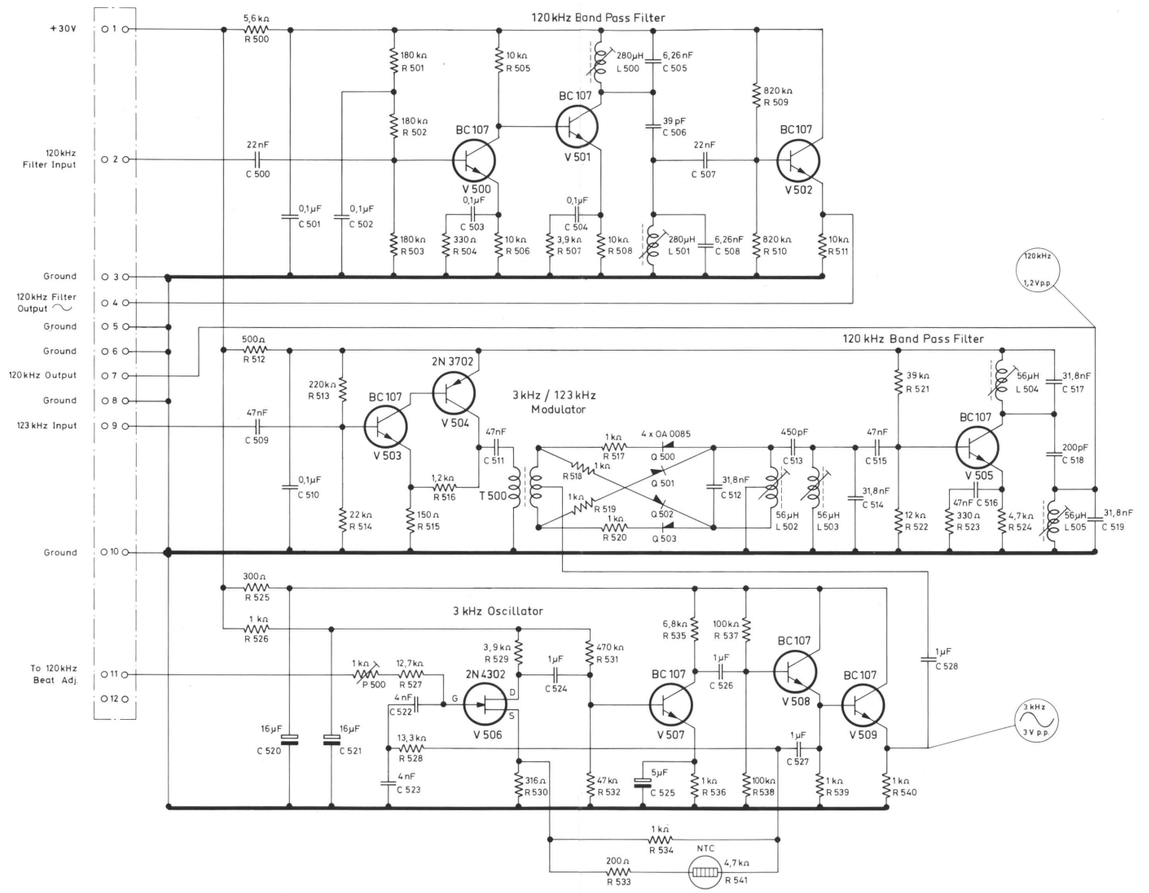


Bottom view

24-02-1969	253966			Brüel & Kjær Copenhagen
17-03-1972	338619			ZS 0169 120kHz Fixed Frequency Conditioning for 2020

BD 0067

120 kHz Fixed Frequency Conditioning ZS 0169



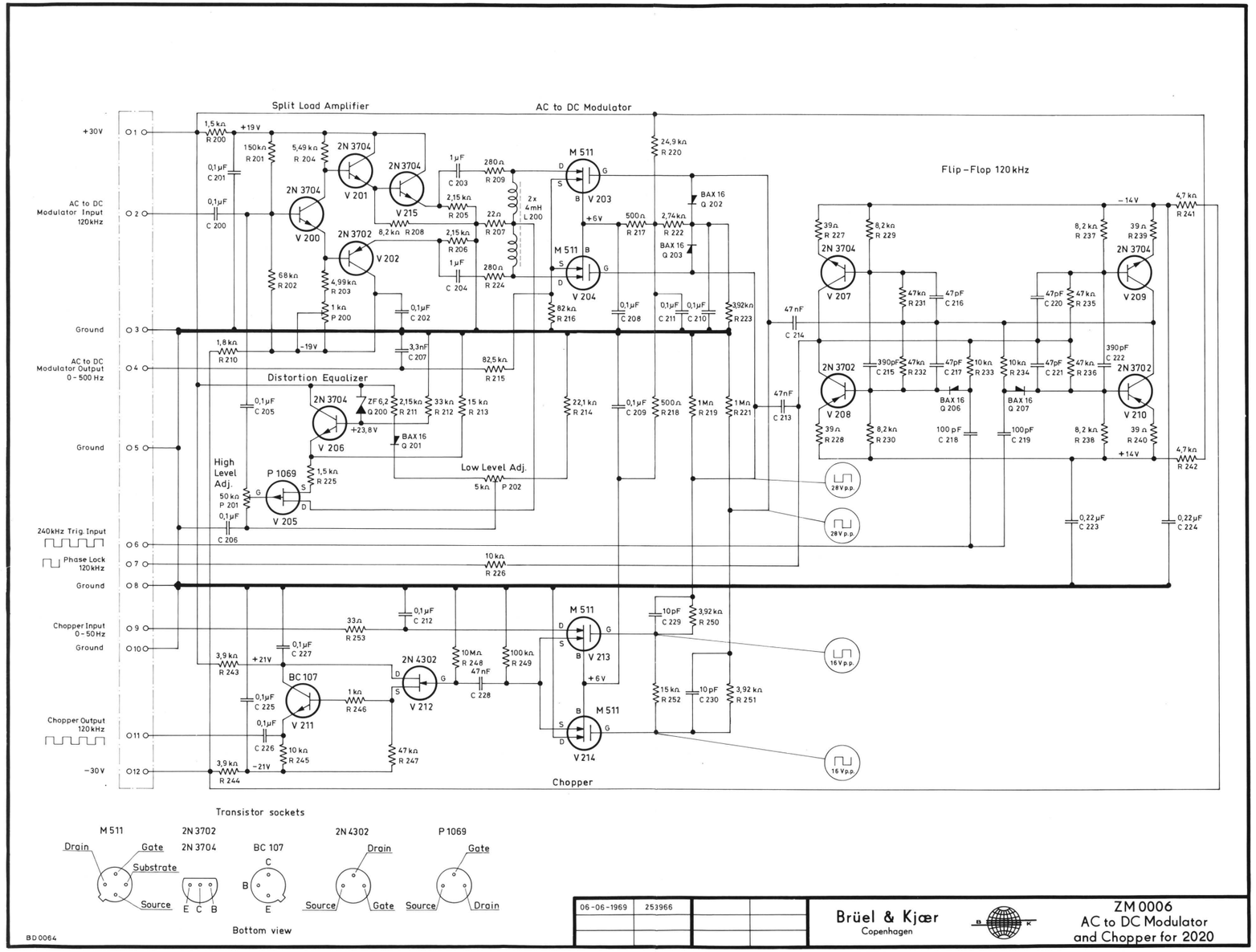
Transistor sockets

Bottom view

24-02-1969	253966			Brüel & Kjær Copenhagen
17-03-1972	338619			ZS 0169 120kHz Fixed Frequency Conditioning for 2020

BD 0067

AC to DC Modulator and Chopper ZM 0006



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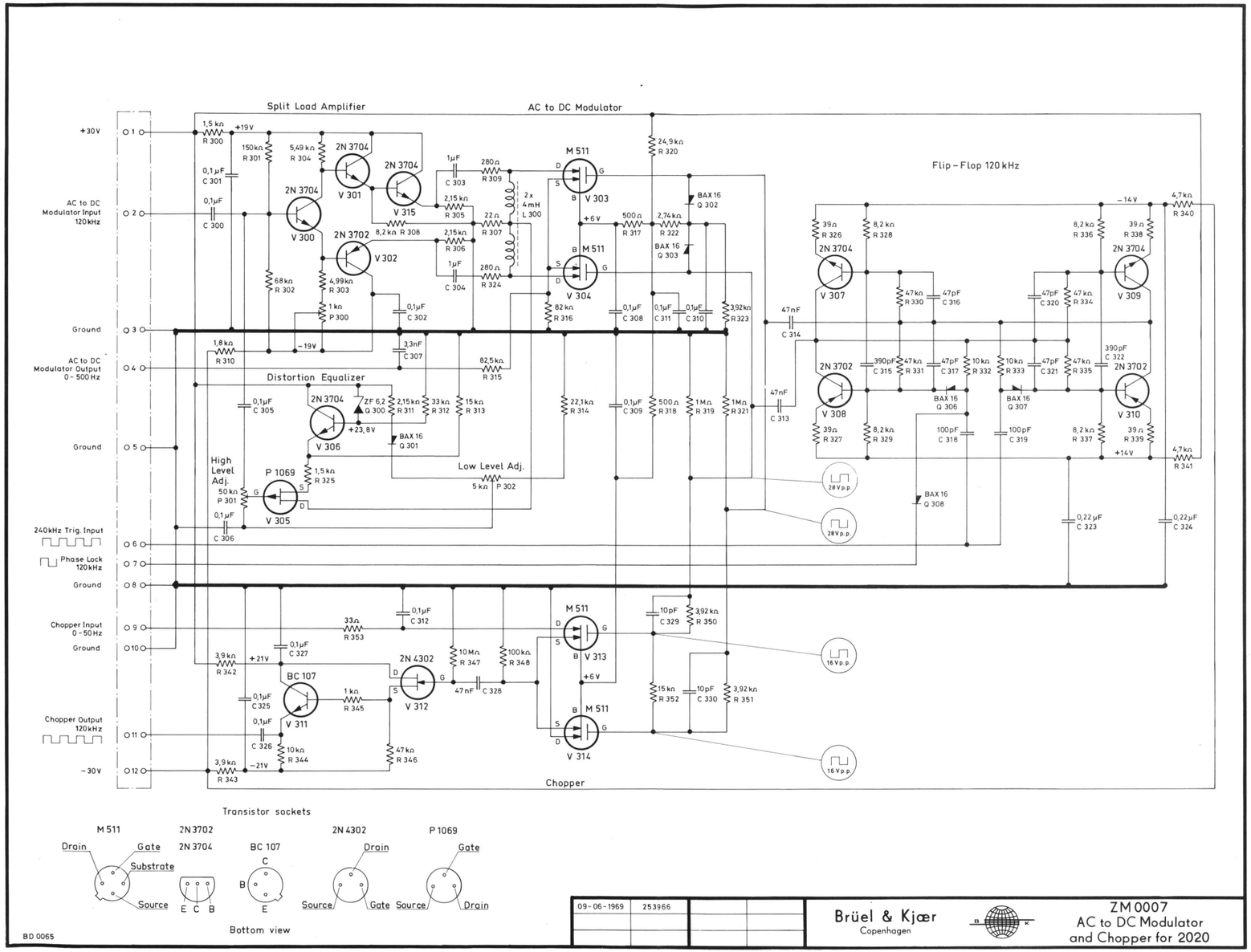
Circuit Diagram

valid from serial no. 253966

2020.14

sheet 5b

AC to DC Modulator and Chopper ZM 0007



09-06-1969	253966		

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ZM 0007
AC to DC Modulator
and Chopper for 2020

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Circuit Diagram

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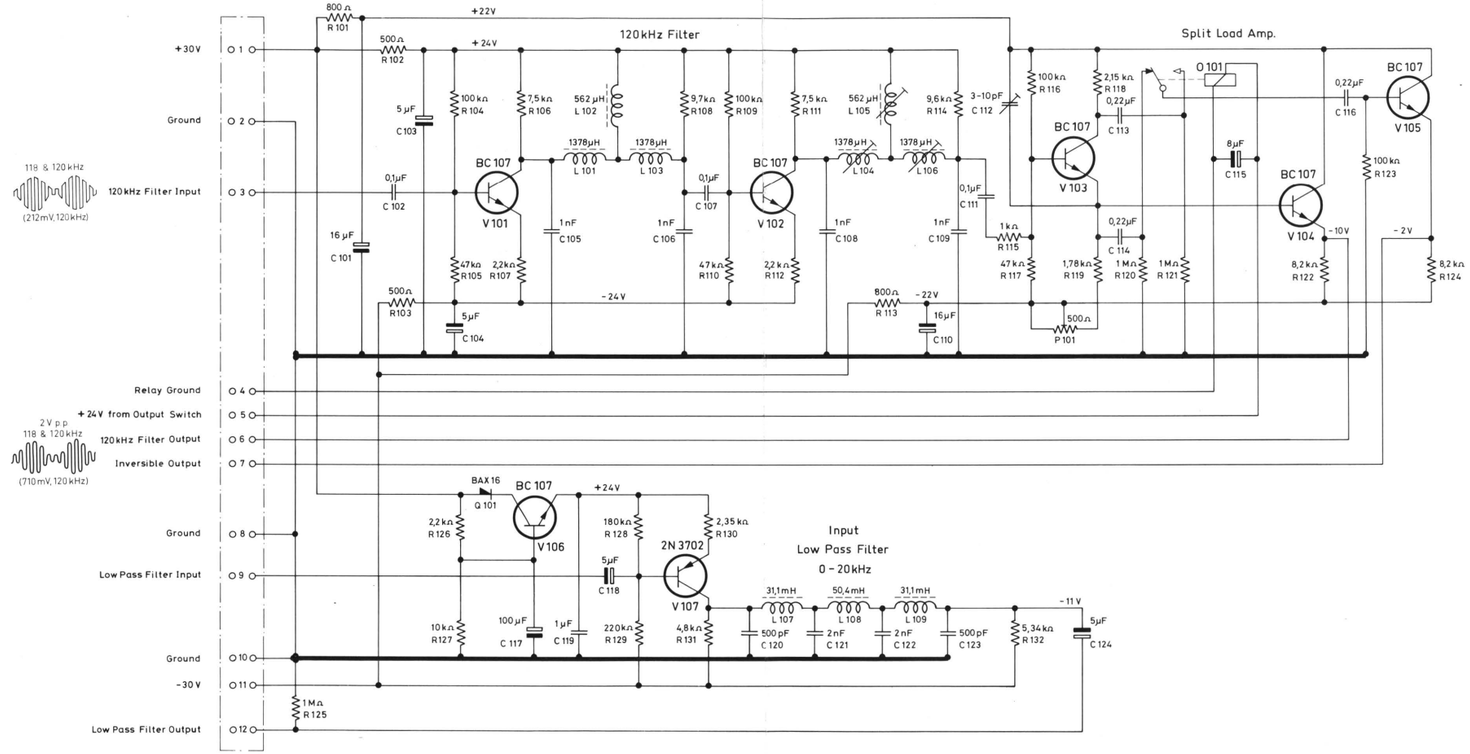
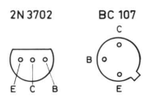
2020.14

sheet 6

Input and 120 kHz Filter ZS 0168



Transistor sockets



Bottom view

BD 0066

24-02-1969	253966		

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ZS 0168
Input – and 120 kHz Filter for 2020

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Circuit Diagram

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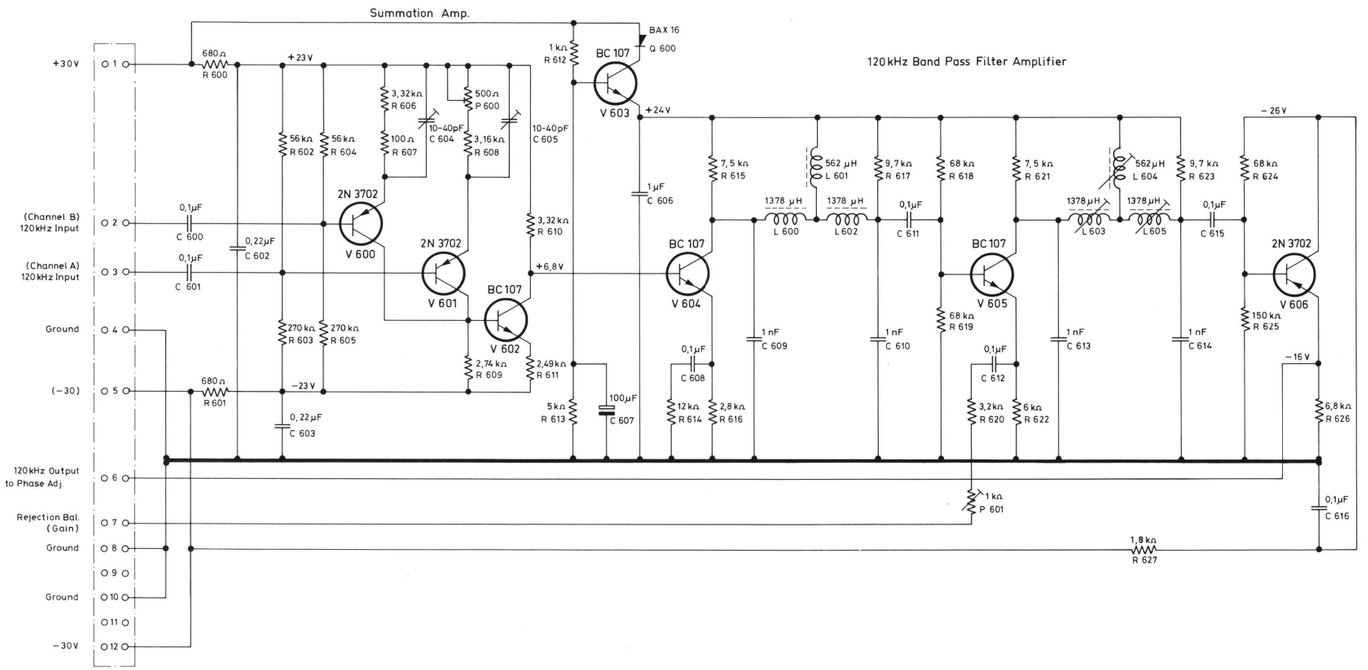
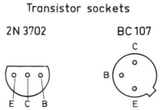
2020.14

sheet 7

Summation – and 120 kHz Filter Amp. ZS 0170



Transistor sockets



BD 0068

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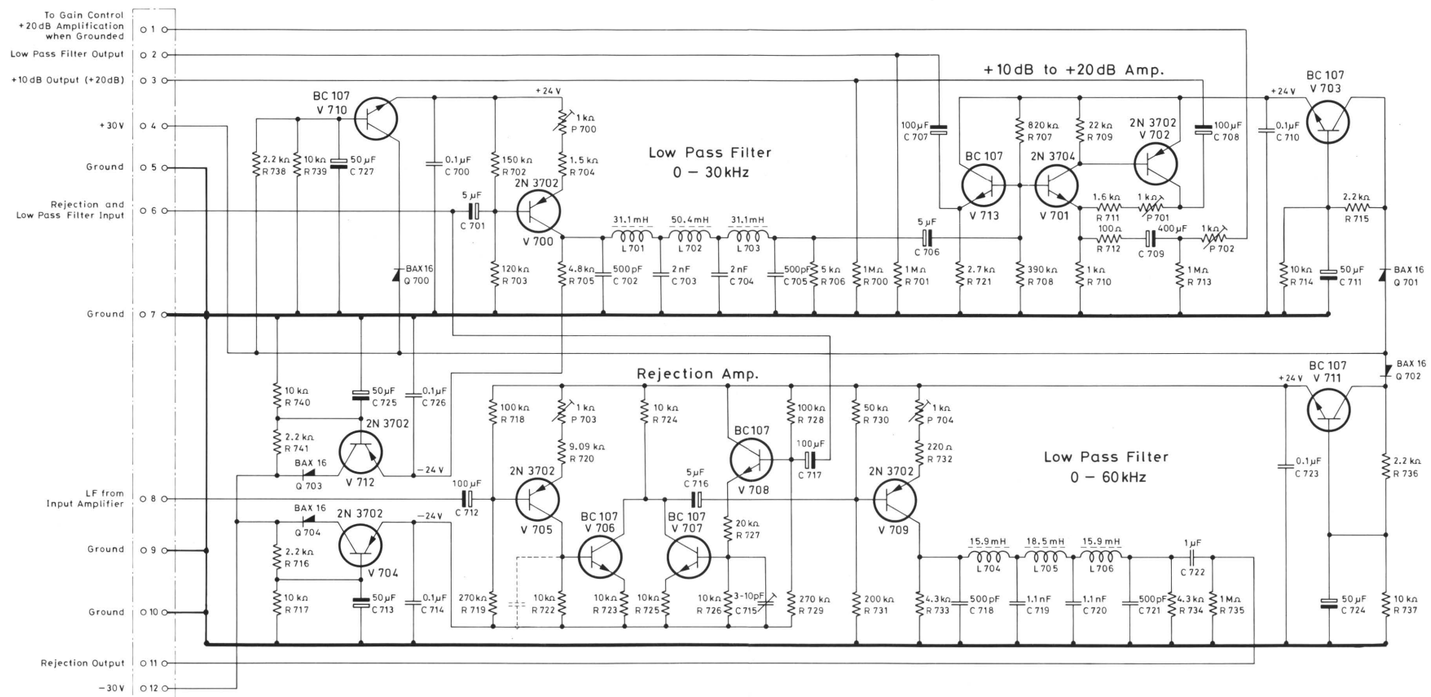
ZS 0170
Summation – and 120kHz Filter Amp. for 2020

Rej. Amp. – LP Filter and Output Amp. ZE 0086



Type no:	2N 3702 2N 3704	BC 107
Bottom view:	B C E	B E C
Remarks:	TO – 92	TO – 18

17-03-1972	338619			Brüel & Kjær Copenhagen	ZE 0086 Rejection Amplifier – Low Pass Filters and LF Output Amplifier for 2020

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Circuit Diagram

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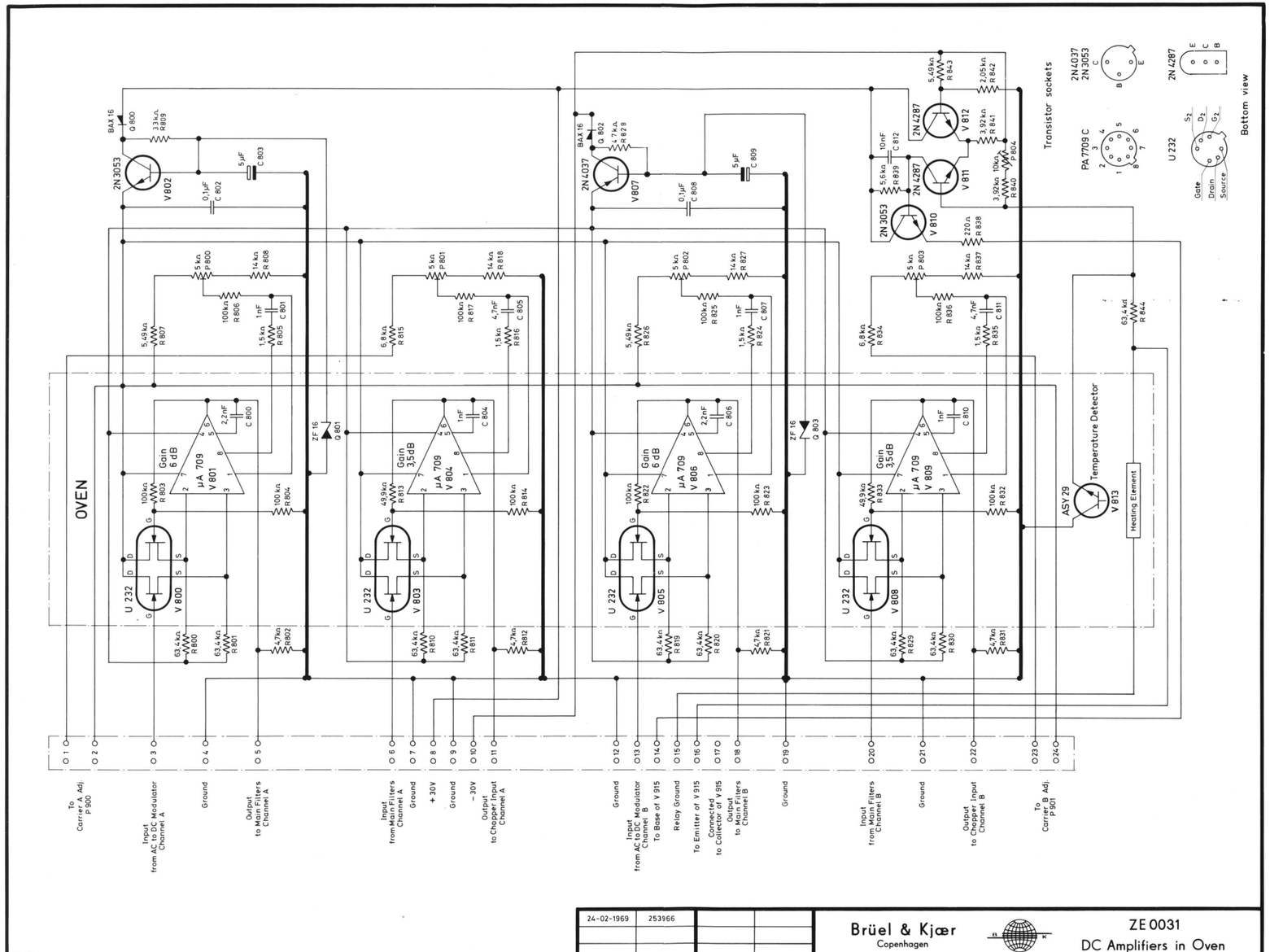
2020.14

sheet 9

DC Amplifiers in Oven ZE 0031



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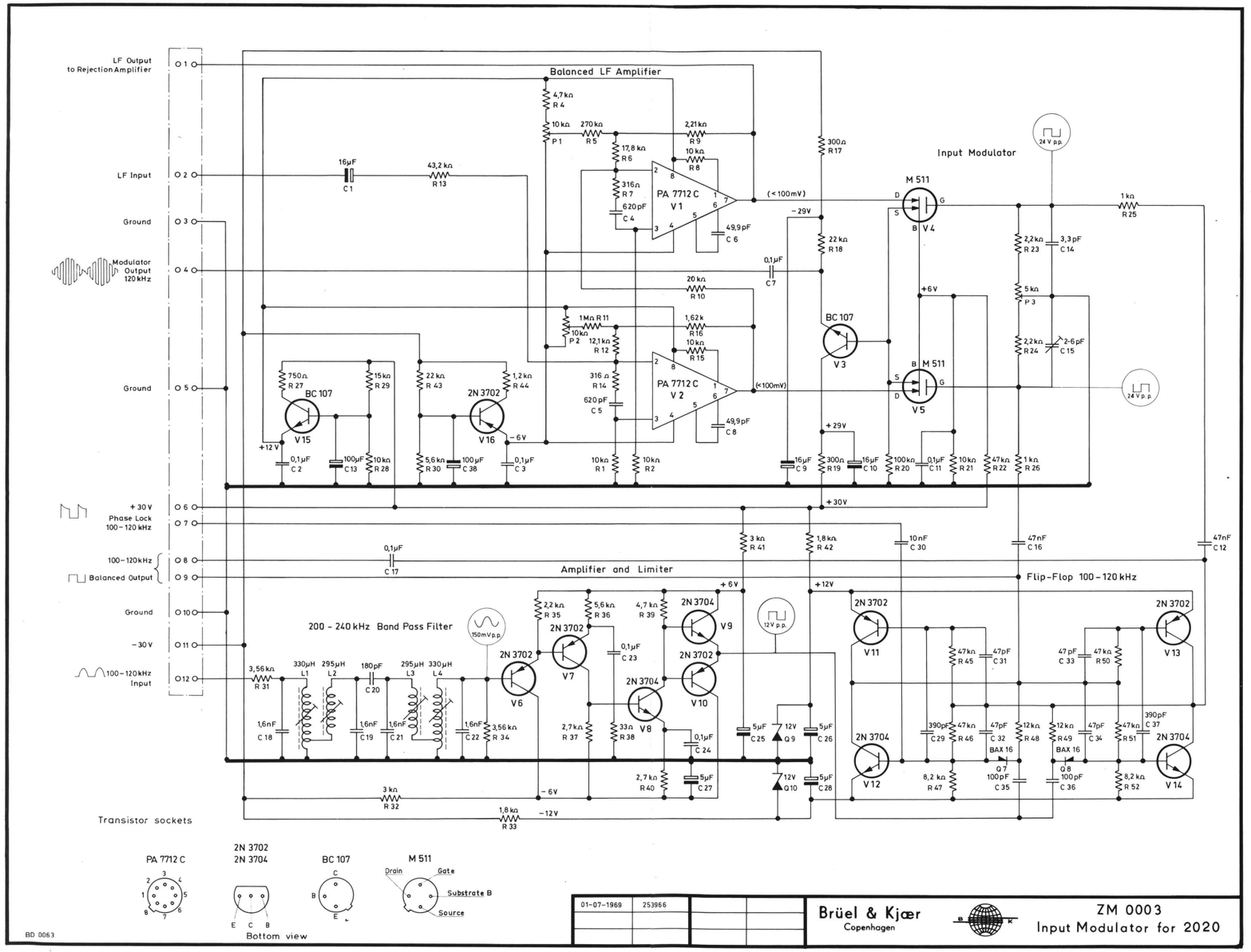
ZE 0031
DC Amplifiers in Oven

BD 0061

Input Modulator ZM 0003



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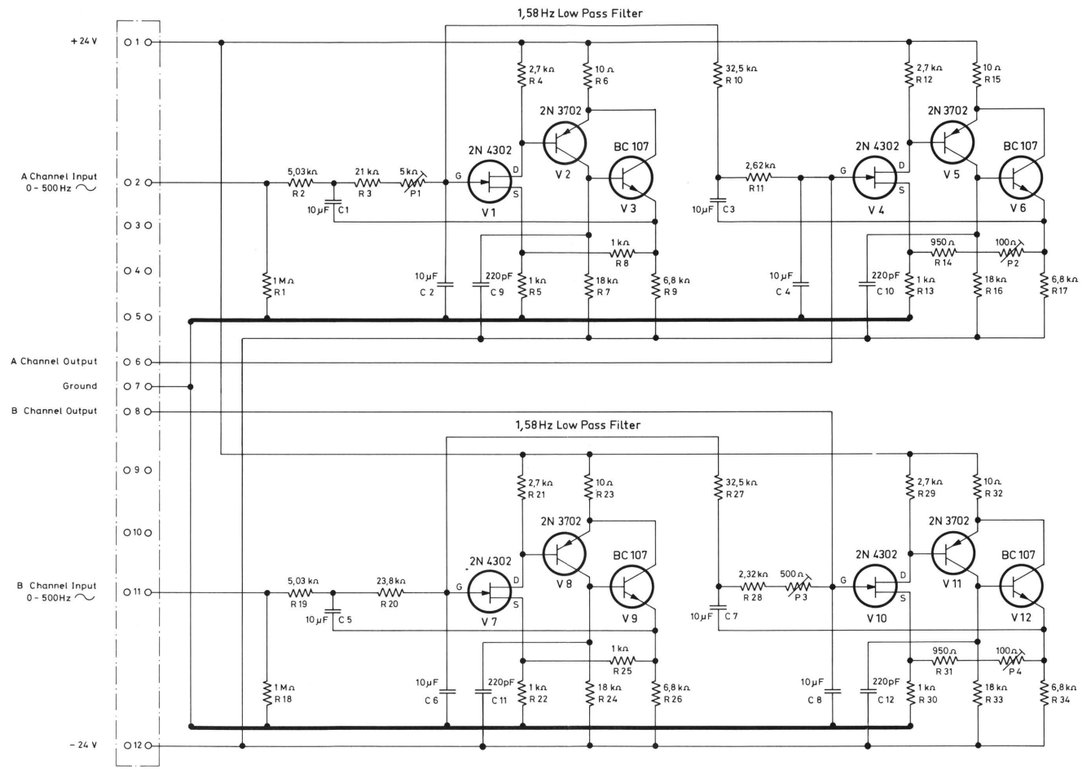
Circuit Diagram

valid from serial no. 253966

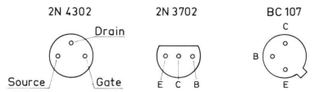
2020.14

sheet 11a

Main Filter 3.16 Hz ZT 0030



Transistor sockets



BD 0069

20-02-1969	253966		

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ZT 0030
3,16 Hz Main Filter for 2020

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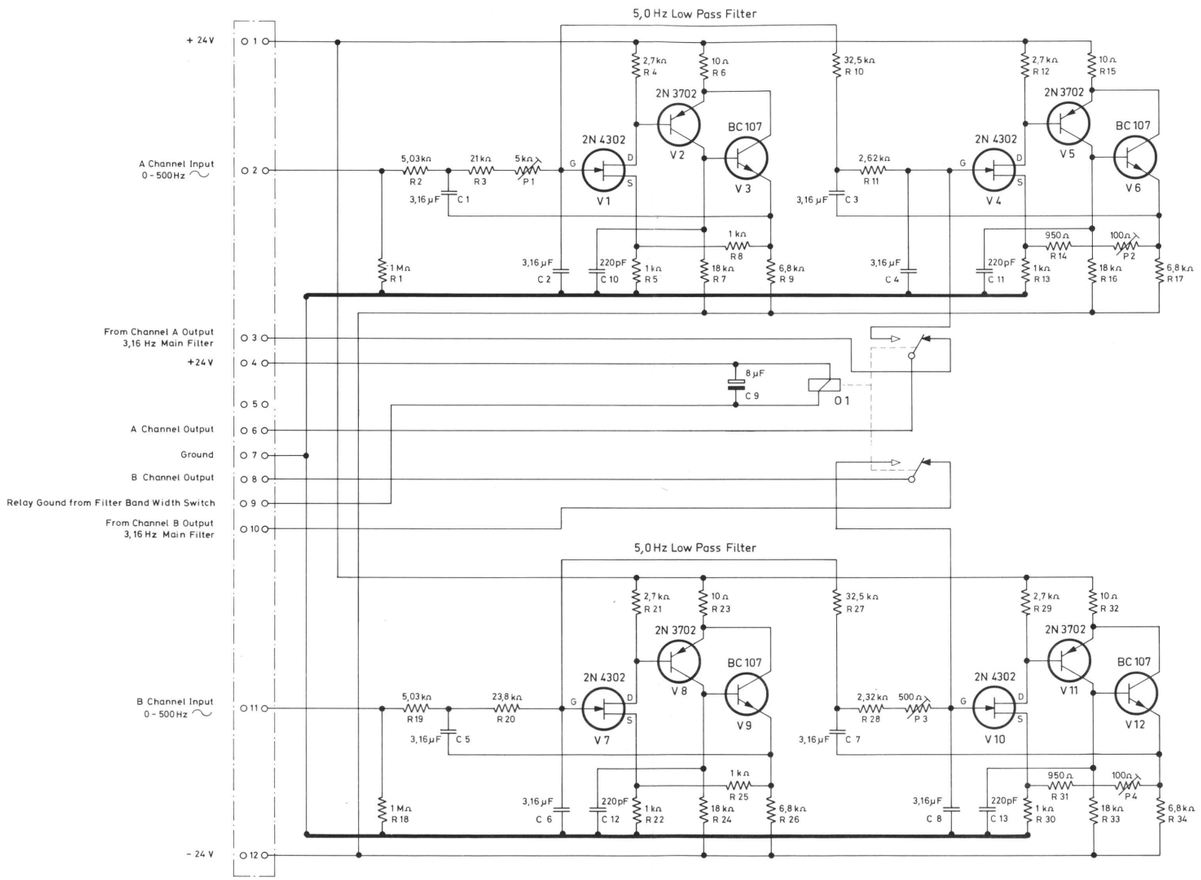
Circuit Diagram

valid from serial no. 253966

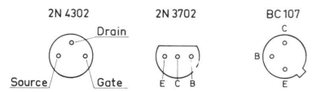
2020.14

sheet 11b

Main Filter 10 Hz ZT 0031



Transistor sockets



Bottom view

BD 0070

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ZT 0031
10 Hz Main Filter for 2020

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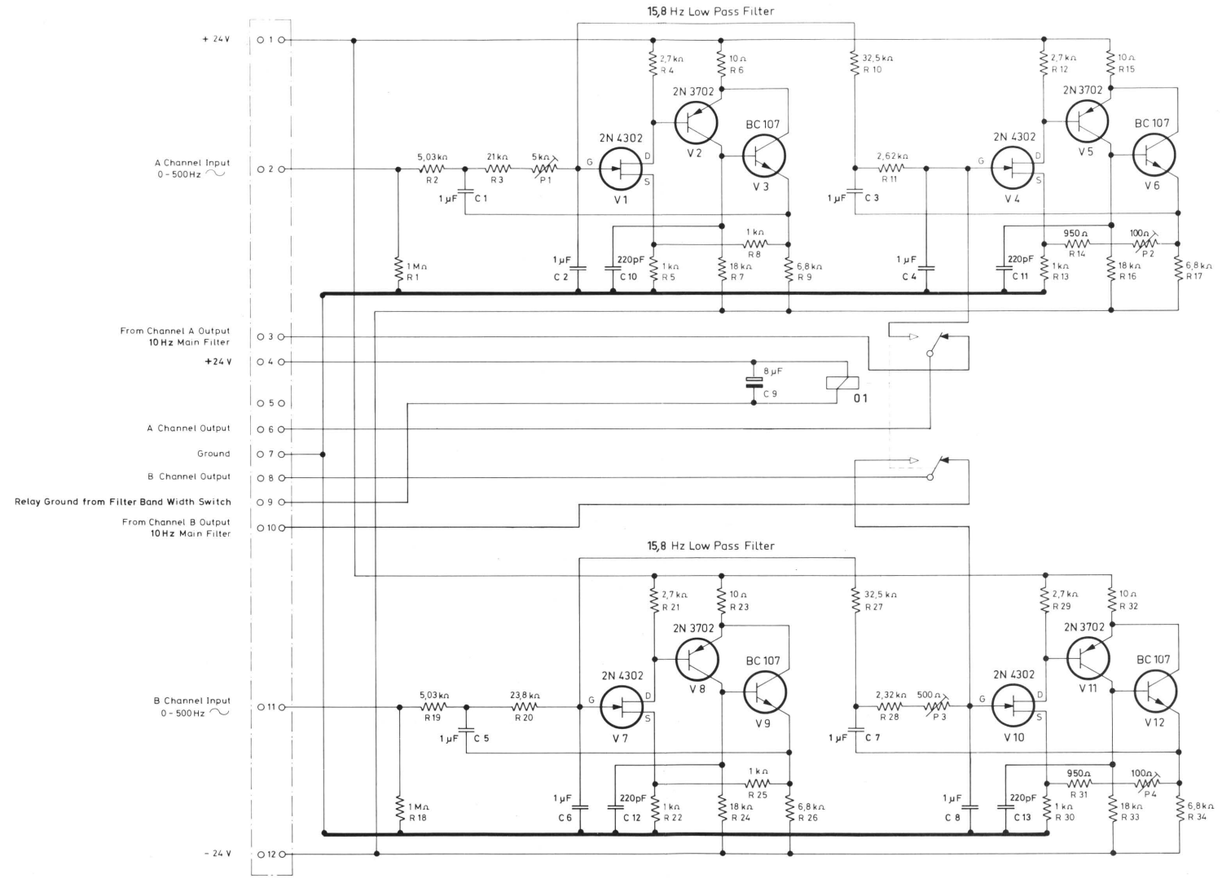
Circuit Diagram

valid from serial no. 253966

2020.14

sheet 11c

Main Filter 31.6 Hz ZT 0032



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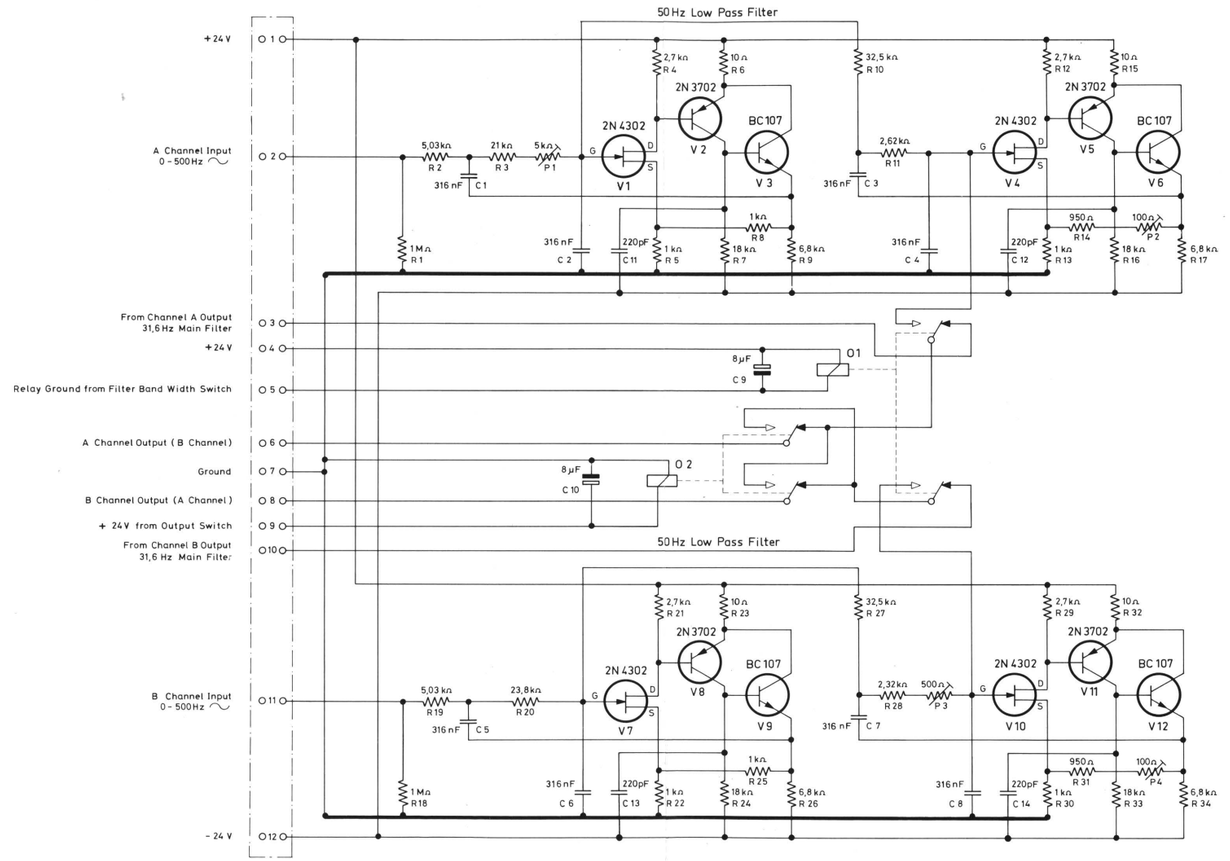
Circuit Diagram

valid from serial no. 253966

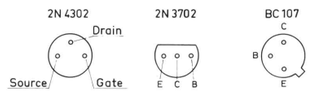
2020.14

sheet 11d

Main Filter 100 Hz ZT 0033



Transistor sockets



Bottom view

BD 0072

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Copenhagen

ZT 0033
100 Hz Main Filter for 2020