Brüel & Kjær

2010

Heterodyne Analyzer

valid from serial no. 795325

037–0108

Service

2010

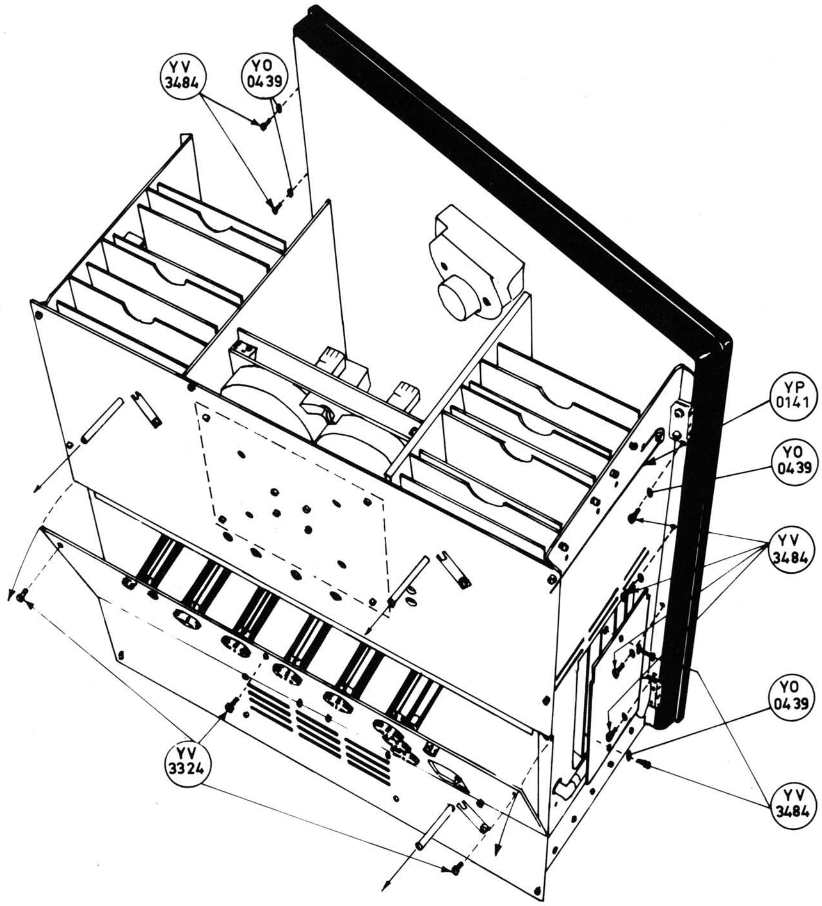
Heterodyne Analyzer

valid from serial no. 795325

037–0108

consisting of:

2010



Introduction

The Heterodyne Analyzer Type 2010 is a constant bandwidth narrow bandwidth analyzer covering the frequency range 2 Hz to 200 kHz in three logarithmic or linear ranges with bandwidths selectable from 3.16 to 1000 Hz. The analyzer also contains a beat frequency oscillator (BFO), the frequency of which is synchronized with the tuning frequency of the analyzer. The entire filter section can be switched out of the circuit thus allowing the instrument to be used as a voltmeter and wideband amplifier as well as allowing external filters to be connected. The tuned-in frequency can be read off the large main frequency scale (lin and log calibration) and on a 6 digit Nixie display.

Trouble Shooting:

Confirmation of trouble.

Improper control settings may, at times, give indications of trouble.

Therefore, if trouble is encountered in the Heterodyne Analyzer Type 2010, be sure that it is not caused by improper front or rear panel control settings.

Check the 2010 according to the Checking Procedure given in the next chapter.

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 instruction in this Manual are given purely as a guide to the service of equipment. Some faults, as f.inst. small deviations in tolerances requires 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.

Principle of the Heterodyne Analyzer Type 2010

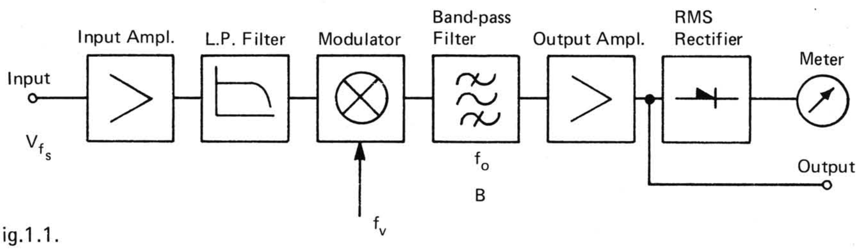
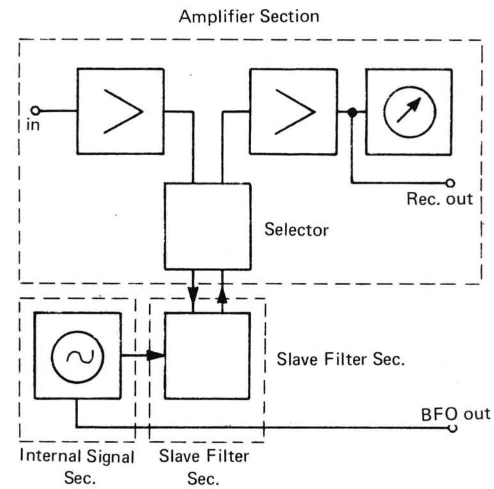


Fig.1.1.

The signal to be analyzed (frequency = f_s, amplitude = V_{fs}) enters the analyzer at the input and is fed to the low-pass filter via the input attenuator and amplifier. The signal then passes through the low-pass filter and is fed to the modulator. In the modulator the input signal is mixed with the signal from the V.C.O. = f_V. The signal f_V is rejected in the modulator and the output from the modulator consists only of the signals f_s, $f_V + f_s$ and $f_V - f_s$. This signal is filtered in the band-pass filter with the centre frequency = f_o and the bandwidth B, and thus B is the bandwidth of the analyzer. When f_V is varied maximum deflection on the meter is obtained for $f_V + f_s = f_o$ and the deflection is controlled by the amplitude V_{fs}.

The reason for the low-pass filter at the input is to avoid signals with a frequency $f_s = f_o$ or $f_s - f_V = f_o$ which will pass right through the band-pass filter.



The Heterodyne Analyzer Type 2010 can basicly be divided into three Main Sections:

1. The Measuring Amplifier Section.
2. Internal Signal Section.
3. The Slave Filter Section.

Measuring Amplifier Section

Figure 1.2 shows a simplified Block Diagram of the Measuring Amplifier in the 2010.

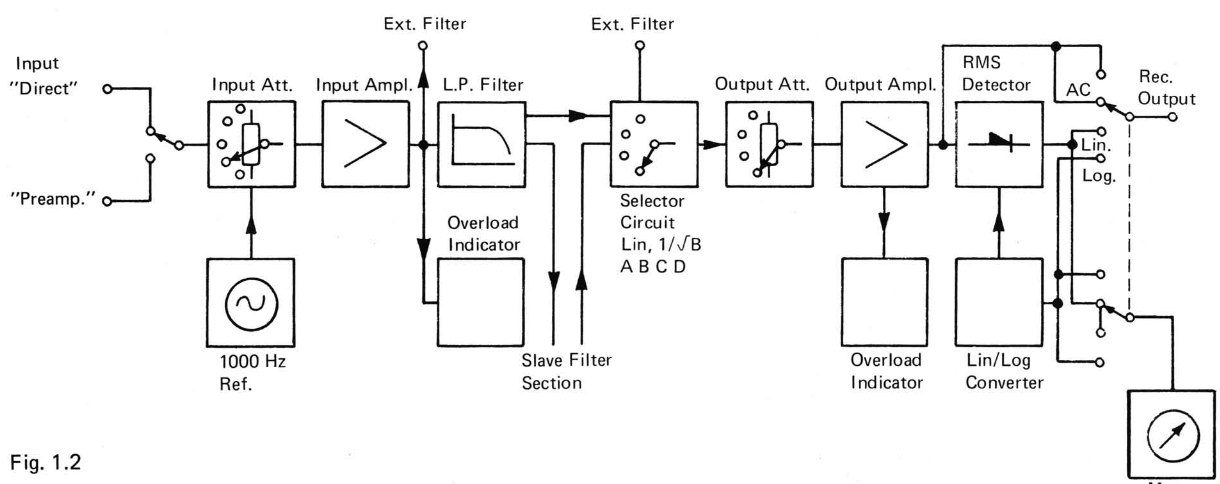


Fig. 1.2

The signal to be measured enters the Measuring Amplifier at the input (either "Direct" og "Preamp."). The signal is then fed to the input attenuator and amplifier. An overload detection circuit is placed immediately after the input amplifier.

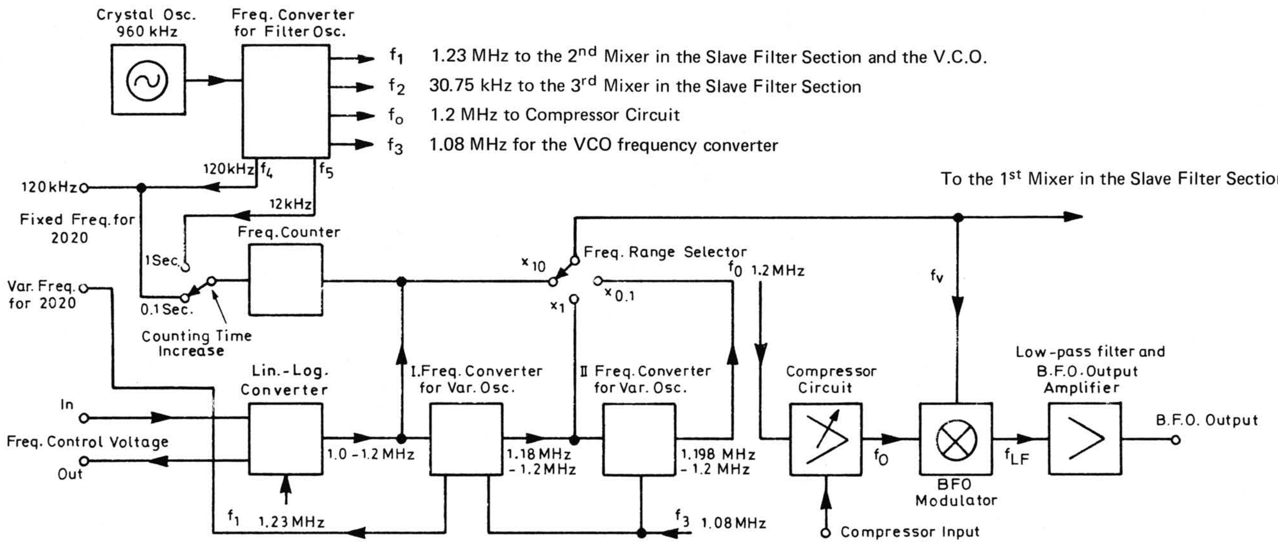
A reference oscillator is built into the 2010 for calibration purposes. The oscillator produces a stabilized sinusoidal voltage of 50 mV at 1000 Hz. The signal is selected by the push-button REF and enters the amplifier right at the input terminal. After the input amplifier the signal is fed to either the Slave Filter Section of if desired direct to the Linear and A, B, C, D Weighting Network.

An External Filter may be connected between the input and output amplifier.

The input to the output amplifier is taken via the output attenuator from either the output of the weighting networks, Lin or from a 30 kHz or 750 Hz band-pass filter in the Slave Filter Section. An overload detection circuit is placed immediately after the output amplifier. From the output amplifier the signal is fed to the RMS detector circuit and from there to the indicating meter. The output signal is also available on the Recorder Output either direct from the output amplifier as an AC voltage or from the RMS detector circuit, giving a linear or logarithmic DC signal

Internal Signal Section

Figure 1.3 shows a simplified Block Diagram of the Internal Signal Section.



The internal signal section provides the necessary signals at correct frequencies which are needed for the various circuits of the instrument.

In order to obtain maximum frequency stability the section is based on a crystal parallel resonance type oscillator which generates a signal of 960 kHz.

The 960 kHz signal is fed to a frequency converter which produces the following frequency outputs:

f_o = 1.20 MHz for the compressor circuit (B.F.O.) and an external output.

f_1 = 1.23 MHz for the 2nd mixer in the slave filter section and the V.C.O. stabilization circuit.

f_2 = 30.75 kHz for the 3rd mixer in the slave filter section.

f_3 = 1.08 MHz for the V.C.O. frequency converter.

f_4 = 120 kHz for the frequency counter and the fixed frequency output for the 2020.

f_5 = 12 kHz for the frequency counter.

The variable oscillator is a voltage controlled oscillator (V.C.O.). The controlling DC voltage is supplied either from a potentiometer connected to the shaft in the centre of the main frequency scale or from an external source for remote control of the frequency sweep. The DC signal is either fed directly to the oscillator circuit giving a linear sweep or via a linear/logarithmic converter resulting in a logarithmic sweep.

In order to provide a good resolution and low frequency stability the output signal from the V.C.O. which covers the range from 1.2 MHz to 1 MHz (output range 0 to 200 kHz) is fed to two converters which each decreases the range by one decade. The first converter having a range of 1.2 MHz to 1.18 MHz (output range 0 to 20 kHz) and the second having a range of 1.2 Mhz to 1.198 MHz (output range of 0 to 2 kHz). In this way the same relative frequency stability is obtained in all three ranges.

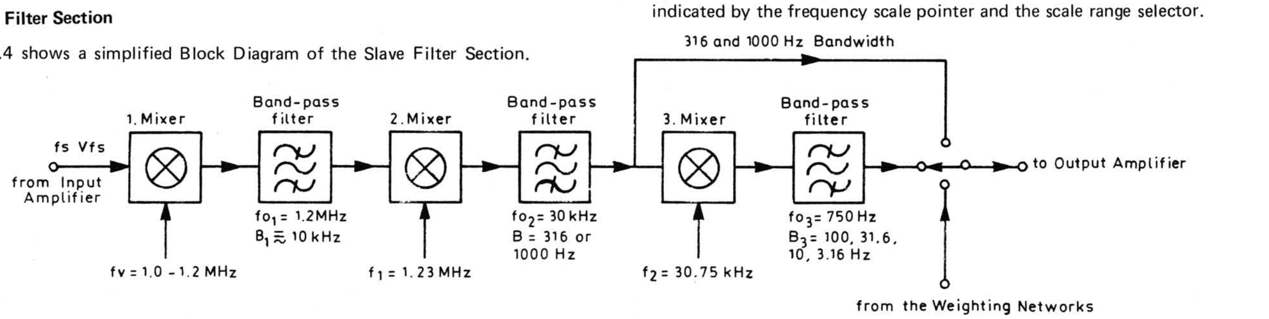
The signal f_o = 1.2 MHz is passed through a variable gain amplifier. The gain is controlled by a DC voltage coming from the compressor amplifier and rectifier circuit. From the output of the variable gain amplifier the 1.2 MHz signal is fed to the B.F.O. modulator. The 1.2 MHz signal is here mixed with the signal f_v from the V.C.O.

The resulting frequency $f_o - f_v = f_{LF}$ is passed through a low pass filter and to the B.F.O. output amplifier.

The B.F.O. signal is available on the B.F.O. output socket and can also be indicated on the meter for the measuring amplifier. The frequency generated by the V.C.O. is displayed on the built in six digit Nixie display and also indicated by the frequency scale pointer and the scale range selector.

The Slave Filter Section

Figure 1.4 shows a simplified Block Diagram of the Slave Filter Section.



To obtain the wide frequency range of the Heterodyne Analyzer (2 Hz – 200 kHz) the centre frequency of the first band-pass filter f_{o1} must be fairly high f_{o1} = 1.2 MHz.

The bandwidths from 3.16 Hz to 1000 Hz can not be obtained in one 1.2 MHz band-pass filter. To obtain the bandwidth's 3.16 Hz, 10 Hz, 31.6 Hz, 100 Hz, 316 Hz and 1000 Hz three intermediate-frequency stages (I.F.$_s$) with the following centre frequencies are used.

f_{o1} = 1.2 MHz
f_{o2} = 30 kHz where the bandwidths 316 and 1000 Hz are obtained.
f_{o3} = 750 Hz and the bandwidths 100, 31.6, 10, 3.16 Hz are obtained in this stage.

If the input signal f_s + the frequency from the V.C.O. f_v (output from the 1st mixer) = f_{o1} = 1.2 MHz + Δf the signal will pass through the first band-pass filter if $\Delta f = \frac{B_1}{2} \leqslant$ approx. 4 kHz.

The 1.2 MHz + Δf is fed to the second mixer stage and mixed with the signal f_1 = 1.23 MHz. The output signal 1.23 MHz – (1.2 MHz + Δf) = 30 kHz – Δf will pass through the second band-pass filter f_{o2} = 30 kHz if $\Delta_f \leqslant \frac{B_2}{2}$ = 158 or 500 Hz.

If the output signal from the 30 kHz band-pass filter is fed to the output section and the meter a signal can be analyzed with a bandwidth of either 316 Hz or 1000 Hz.

If narrower bandwidths are desired the output signal from the 30 kHz band-pass filter (30 kHz – Δf) is fed to the third mixer stage and is mixed with the signal f_2 = 30.75 kHz.

The output signal 30.75 kHz – (30 kHz – Δf) = 750 Hz + Δf will pass through the third band-passfilter f_o = 750 Hz if $\Delta f \leqslant \frac{B_3}{2}$. B_3 to be 100, 31.6, 10, 3.16 Hz respectively.

If the output signal from the 750 Hz band-pass filter is fed to the output amplifier and the meter, signals can be analyzed with the bandwidths mentioned above.

A further detailed explanation of the different stages will follow.

The Measuring Amplifier

The signal chosen by the input selector is applied to the input amplifier via the input attenuator.

The input attenuator is divided into three sections with an amplifier between the 2nd and the 3rd section. The 1st and 2nd section are located on the P.C. board ZE 0037 together with the variable gain amplifier and the 1 kHz ref. oscillator.

The 3rd section of the attenuator is located on the P.C. board ZE 0038 together with a 17 dB fixed gain amplifier, a 200 kHz L.P. filter and the overload circuit.

The Variable Gain Amplifier (ZE 0037)

The signal enters the amplifier via the source follower V 1 and is then amplified in the two differential stages V 3, V 4 and V 5, V 6. The gain can be varied from 3—23 dB by the gain control potentiometer and the sensitivity potentiometers located on the front panel.

1000 Hz Ref. Oscillator

The 1000 Hz ref. oscillator is also located on the ZE 0037. The oscillator is of the L-C type with a positive feedback to a center tap on the coil.

A 6.8 V zener diode Q 3 keeps the amplitude constant. The frequency is adjustable by the iron-core in the coil and the output voltage can be adjusted by P 1.

The oscillator is activated by the push-button marked 50 mV REF on the front panel.

3rd Attenuator Sec. and the 17 dB Amplifier (ZE 0038)

From the output of the variable gain amplifier the signal is applied to the 3rd attenuator section and from there to the 17 dB fixed gain amplifier. The attenuator and the amplifier are both located on the ZE 0038. The signal is applied to the amplifier via the source follower V 51 and amplified in the two differential stages V 52, V 53 and V 54, V 55.

Via the emitter follower V 56 the signal is fed to the phase splitter V 70, to the "Ext. Filter In" socket and to the 200 kHz lowpass filter.

The Overload Indicator Circuit

From the phase splitter V 70 the signal is applied to a full wave rectifier Q 70—Q 73. The rectifier circuit is followed by a monostable multivibrator (V 71 and V 72). V 71 will normally be in the on position. If the negative voltage across R 75 exceeds the bias on the emitter of V 71 the multivibrator will switch over and the neon lamp will light up. Is the overload of short durations the lamp will be on for approx. 0.5 sec. The delay is controlled by C 73 and R 83.

With a constant high overload the lamp will be on continuously. A constant overload just on the limit will cause the lamp to flicker. V 73 can activate a relay S 16 located on the ZK 0004. The sensitivity of the overload circuit can be adjusted by P 51.

When the 2010 is used as a measuring amplifier the signal from the output of the 200 kHz LP filter on the ZE 0038 is selected by the selector circuit ZS 0173 and passed on to the output amplifier.

The Selector Circuit ZS 0173

The selector circuit feeds the output section with one of the following four signals.

1. The signal from the output of the 200 kHz LP filter (ZE 0038)
2. The filtered signal from the 30 kHz BP filter (ZS 0175)
3. The filtered signal from the 750 Hz BP filter (ZS 0177)
4. The Ext. Filter.

The signal can be applied either directly or via the ABCD and Ext. filter or via the selective section to the output section. In the selective mode the signal can also be applied to the output section via the bandwidth compensation attenuator (BWC).

When the push button marked FREQUENCY RESP. LINEAR is pushed in the relay S 6 on the ZS 0173 is activated. The signal passes then directly and unweighted through the ZS 0173 to the input of the output amplifier ZE 0039.

Output Attenuator and Amplifier ZE 0039

The output amplifier is divided into four sections. Two 20 dB amplifiers, one 30 dB amplifier and one 10 dB amplifier which also inverts the signal.

The output attenuator is divided into three sections, controlled by the switch "Output Section Att.". The first attenuator section is placed right at the input. The second section between 1st and 2nd 20 dB amplifier, and the third section after the second 20 dB amplifier. The signal is then fed to the 30 dB amplifier. From the output of the 30 dB amplifier the signal is applied to one side of the bridge rectifier in the overload circuit, to the input of the 10 dB amplifier and to the output III (pin V). The output from the 10 dB amplifier is applied to the other side of the bridge rectifier in the overload circuit and to the outputs I and II (pin R and U).

Output II is fed to the switch O 15 ANALYZER (ZH 0037) and also together with output III to the AFC circuit ZK 0003.

The output I is also fed to the O 15 and from there to the O 3 READ OUT SELECTOR

The 1st 20 dB Amplifier

The first 20 dB amplifier consists of a F.E.T. differential input stage V 301 and an output stage V 302. The feedback is controlled by R 311 and R 308. C 314 coarse a drop in the gain of approx. 0.2 dB at 200 kHz. By P 301 the amplifier is adjusted for symmetrically clipping on the output.

The 2nd 20 dB Amplifier

The second 20 dB amplifier is identically to the first amplifier and consists of the transistors V 303 and V 304. The feedback resistors are R 320 and R 317.

The 30 dB Amplifier

The 30 dB amplifier consists of a F.E.T. differential input stage V 305 and two amplifier stages V 306 and V 307. The collector resistor for the output transistor V 307 is divided into two and connected to + 20 V and + 80 V respectively. The feedback is controlled by the resistors R 330 and R 328. C 316 causes an increase in the gain at 2 Hz. C 306 will decrease the open loop gain at high frequencies.

The 10 dB Amplifier

The 10 dB amplifier consists of an amplifier stage V 308 and a class B output stage V 309 and V 310. The feedback is controlled by R 335 and R 333. R 335 and R 334 controls the DC level on the output.

The Overload Circuit

The overload circuit for the output amplifier is identically to the circuit described in the section for the ZE 0038.

From the output amplifier ZE 0039 the signal is applied to the RMS rectifier circuit ZL 0015 and ZL 0016 and from there to the meter.

Meter Circuit ZL 0015 and ZL 0016

From the output II on the ZE 0039 the signal is applied to the meter circuit via the push button marked ANALYZER (Part of the switch O 15).

The switch O 15 is located on the P.C. board ZH 0037 which also is the interconnection board for the output section. O 15 consists of 6 push buttons marked from the left to the right as follows.
AFC – LIN FREQ. RESP. – SEL. FREQ. RESP. – BANDWIDTH COMP. – ANALYZER – BFO

With ANALYZER in the inner position the signal from the output III of ZE 0039 is fed to the meter circuit.

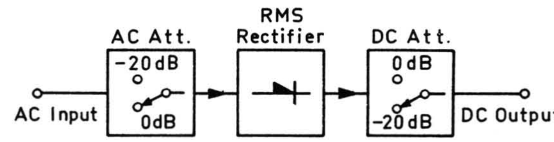
With ANALYZER in the outer position the output signal from the BFO is fed to the meter circuit.

With BFO in the inner position the + 190 V for the indicator lamps in the meter is disconnected.

The meter circuit consists basicly of a RMS detector and a Lin/Log converter. The meter circuit is located on the P.C. boards ZL 0015, ZL 0016, ZH 0036 and ZK 0003.

The "Recorder output" can be AC or DC dependent of the setting of the switch O 3 READ OUT SELECTOR . The DC output will follow the meter function to an ordinary linear mode or a logarithmic mode chosen by the O 3.

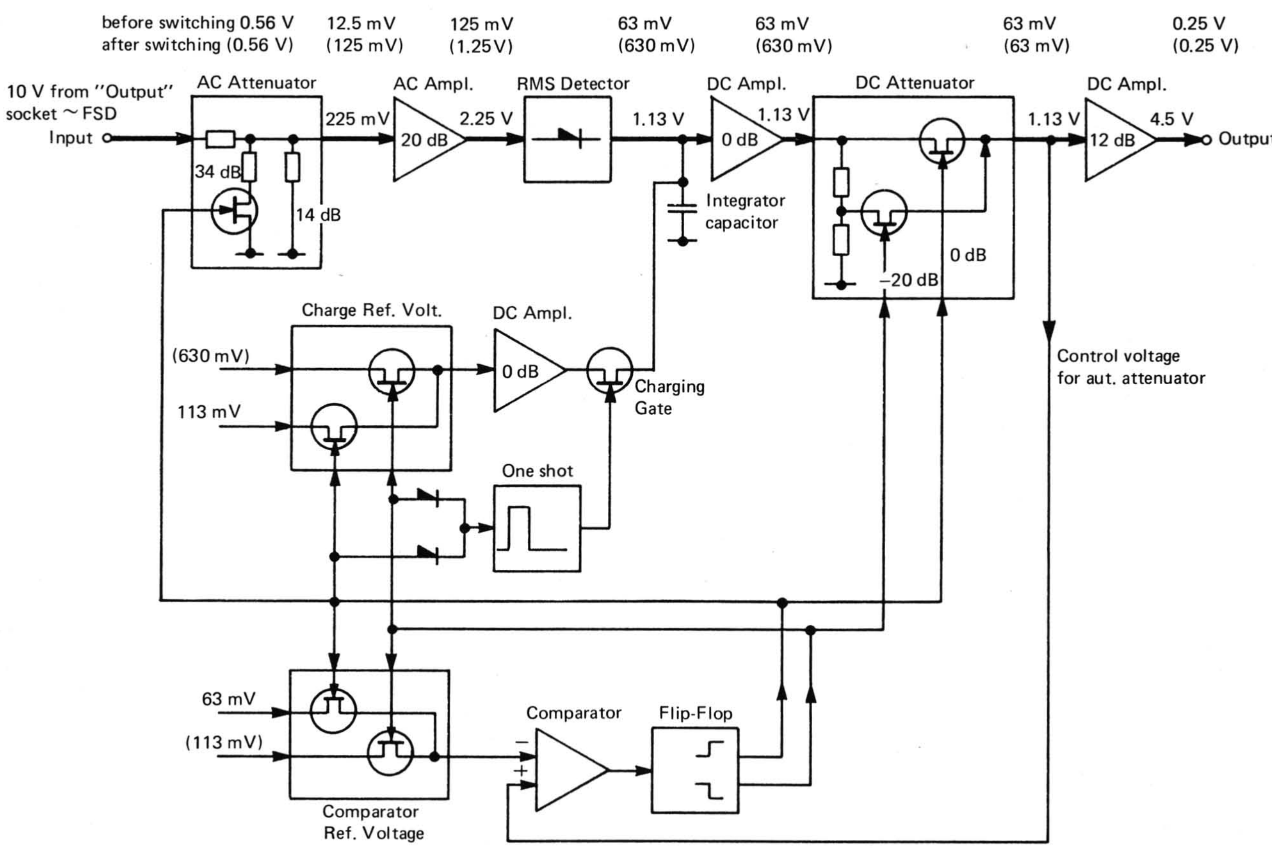
The wide dynamic range of the RMS circuit is achieved by means of an AC attenuator on the input of the signal rectifier and a DC attenuator on the output of the rectifier.



On low input levels there is a low attenuation before the signal rectifier and a high attenuation of the DC voltage.

On high input levels the AC attenuator is 20 dB more and the DC attenuation 20 dB less than on low input levels.

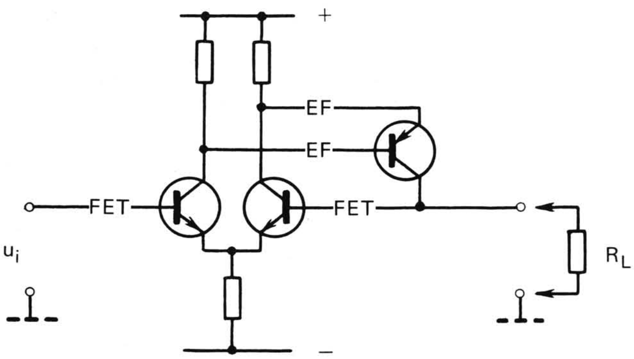
At the cross-over level an electronic switch circuit sets the attenuators to the correct positions.



With 10 V AC input to the RMS circuit the AC attenuator has chosen the low output (225 mV) which is applied through a 20 dB symmetric amplifier to the signal rectifier. To the rectifier output (1130 mV) is connected an integrator and a 0 dB DC amplifier in an oven the output of which is led to the DC attenuator. This attenuator is in the high output position and the DC output amplifier will have 1130 mV on the input and 4.5 V on the output. In this position the comparator reference is 63 mV and the comparator output is negative. A negative input to the flip-flop gives the output situations indicated, and these situations set the attenuators, the comp. ref. and the charge ref.

When the 10 V AC input signal is decreased the output voltage from the DC attenuator will decrease as well and when this voltage is approx. 63 mV the comparator will cause a change of the flip-flop situation and the attenuators will make a level change as shown on the block diagram above. At the same time the comp. ref. will change to 113 mV. Thus the level change when decreasing will happen at 63 mV, but when increasing it will happen at 113 mV. When a level change is made the charge of the capacitors in the integrator must change value by a factor of 10, this must be done very fast to avoid unstability of the deflection. The charge ref. is controlled from the flip-flop and when the level is changed from f.inst. 63 mV to 630 mV on the integrator the charge ref. will change from 113 mV to 630 mV. Each level change gives a signal to a one shot multivibrator and this opens the charging gate. Thus 630 mV will be applied to the capacitors in the integrator while the gate is open. The pulse duration of the one shot multivibrator is controlled by the "Average Time" switch and so the charging time always corresponds to the value of the capacitors in the integrator.

Simplified "Ideal Diode" circuit.



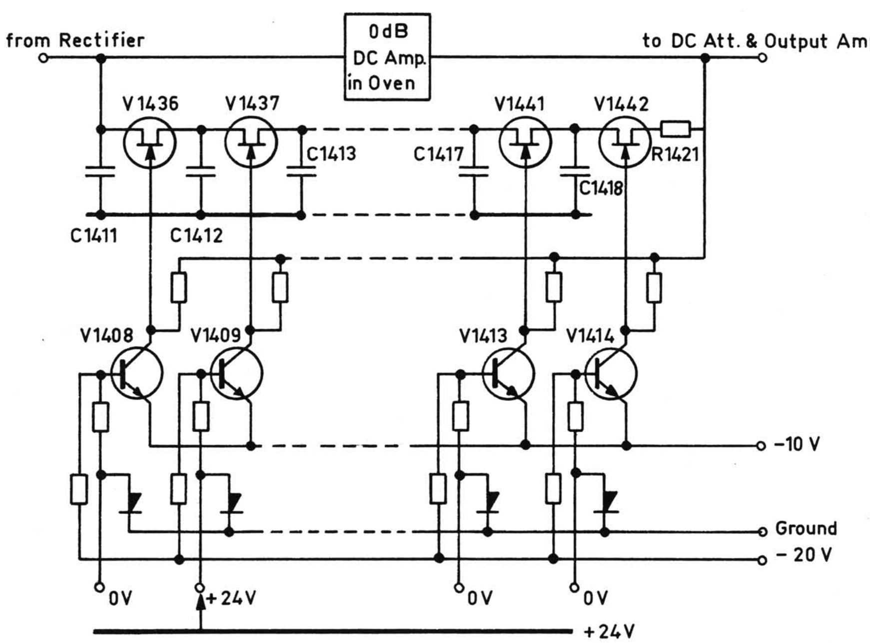
The RMS detector consists of five ideal diodes.

The principle of one diode is shown on the sketch above. When the input base is more positive than the feedback base the output transistor will apply a positive current to R_L. The voltage across R_L will be exactly the same as the input voltage because of a 100% feedback. A negative input will cause an open circuit output transistor and the voltage across R_L will be 0 V.

In the practical circuit there are two F.E.T.'s and two emitter followers connected as shown.

The advantage of this circuit compared to an ordinary diode is that this does not load the signal source at all, and any positive input voltage from a few mV to 10 V will generate an output signal of exactly the same value, i.e. a very linear diode.

Simplified Diagram of the Integrator on the ZL 0015

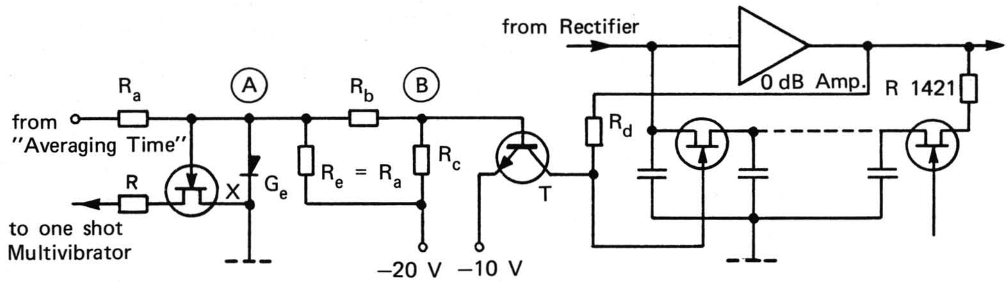


Averaging Time Selector

From the signal rectifier a positive current is applied to the integrator which is formed by a number of capacitors in parallel. A smaller or larger number of capacitors will be connected dependent on the position of the AVERAGE TIME Selector.

As shown on the simplified diagram above F.E.T.'s are used as gates to connect the capacitors across the output from the rectifier. All F.E.T.'s except one will be shortcircuited at any time and if V 1437 is the one which is opencircuit the C 1411 and C 1412 will be acting as integrating capacitors. At the same time the capacitors C 1413 – C 1418 will have the same voltage due to R 1421 and when selecting another average time there will not be any change in the deflection at all.

The actual gate functions is as follows: All the drains and sources of the F.E.T.'s will always be 0 V or positive. The emitter of the switch driver transistors is connected to a fixed −10 V. (The centerpoint of the voltage divider R 1425 and R 1426.) A + 24 V is supplied to the switch driver selected by the AVERAGE TIME selector. All other switch drivers will have 0 V in.



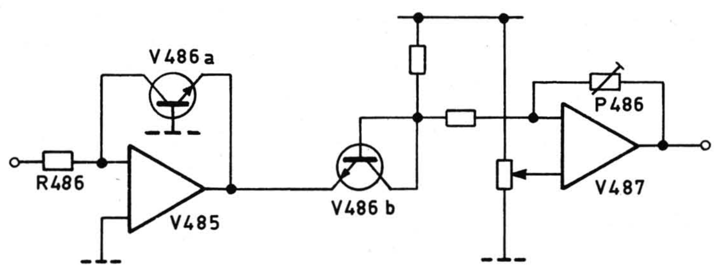
R_b = 1.5 MΩ, R_c = 3.3 MΩ, R_a = R_e = 220 kΩ, R_d = 100 kΩ

The simplified diagram above shows one section of the Integrator

The + 24 V applied will give a voltage drop across R_a and the voltage in Ⓐ will be approx. 0.2 V. This will coarse the F.E.T. marked X to conduct and the resistor R is connected to ground. Due to the voltage divider R_b and R_c the voltage in Ⓑ will be less negative than the emitter of the transistor T and the transistor will conduct. There is now −10 V on the collector, which is connected to the gate of the F.E.T., and the F.E.T. will be open circuited.

If there is 0 V in the −20 V will be divided by R_e = R_a and R_a and there will be −10 V at Ⓐ. The voltage in Ⓑ will now be more negative than −10 V and T will not conduct. There will now be the same voltage on the gate, source and drain of the F.E.T. which then will be shortcircuited.

The F.E.T.'s V 1422 − 1428 shown on the original diagram do not influence the integrator but connect different resistor values giving the time constant for the one shot multivibrator which opens the charging gate.



The Lin/Log converter utilizes the fact that the relationship between collector current and emitter-base voltage of a transistor is logarithmic for currents in the range of 1 nA to 1 mA.

The operational amplifier V 485 gives a logarithmic output voltage for a linear current because V 486a ia used as a logarithmic feedback element. A feedback applied to the emitter causes the collector current to be equal to the input current through R 486. The linear feedback current through V 486a forces the base emitter voltage and thus the output voltage of V 485 to have a logarithmic function.

V 486b is a temperature and level compensation for V 486a both being in the same housing.

V 487 inverts the output signal to have the same polarity as the input and amplifies the signal to the desired scale factor, which is 90 mV per dB.

From the 12 dB output amplifier located on the ZL 0016 the lin. DC output signal is fed to READ OUT SELECTOR O 3, and to the input of the Lin./Log. converter. From READ OUT SELECTOR the lin. or the log. DC voltage is connected to the meter and to the "Recorder" socket.

The Internal Signal Section

To perform different functions in the 2010 Heterodyne Analyzer a number of signals with specific frequencies are needed.

The internal signal section supplies these signals at the correct frequency and the correct level.

The internal signal section consists of a fixed oscillator section and a variable oscillator section each followed by a number of frequency dividers and converters.

Crystal Controlled Oscillator and Frequency Dividers ZI 0008

The oscillator is a crystal controlled parallel resonance type. The frequency is 960 kHz. Fine adjustment of the frequency can be done by C 622. The Q for the crystals can vary and by P 602 the signal amplitude on the collector of V 605 can be adjusted.

The output is approx. 1 V p-p and is via an emitter follower V 609 fed to the frequency dividers.

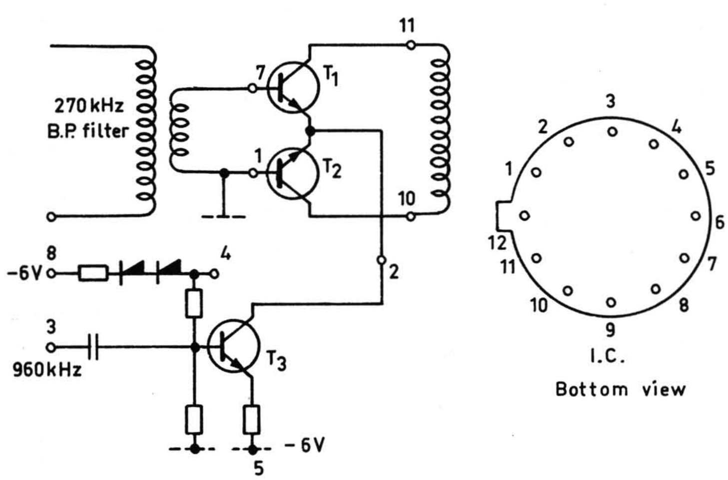
The input to the frequency divider consists of a trigger circuit V 601 giving a square wave signal on the collector of V 601. The signal from V 601 is fed to a divider 1: 4 V 607.

The fifth harmonic of the resulting 240 kHz sq.wave signal is extracted in the 1.2 MHz bandpass filter. The 240 kHz signal is fed to a divider 1: 2 V 606. The resulting 120 kHz signal is passed through a 120 kHz L.P. filter to an output. To obtain the 12 kHz for the counter circuit the 120 kHz signal is divided by 10.

The ninth harmonic of the 120 kHz signal is extracted in the 1.08 MHz bandpass filter.

The 1.08 MHz filter is a 3 pole filter where L 601 and L 602 is critically coupled. The third section consists of L 603 and C 611.

To avoid loading the filter the signal is taken out via an emitter follower V 603.



Pin 4-5-8 is short circuited

Fig. 1.20

The Modulator

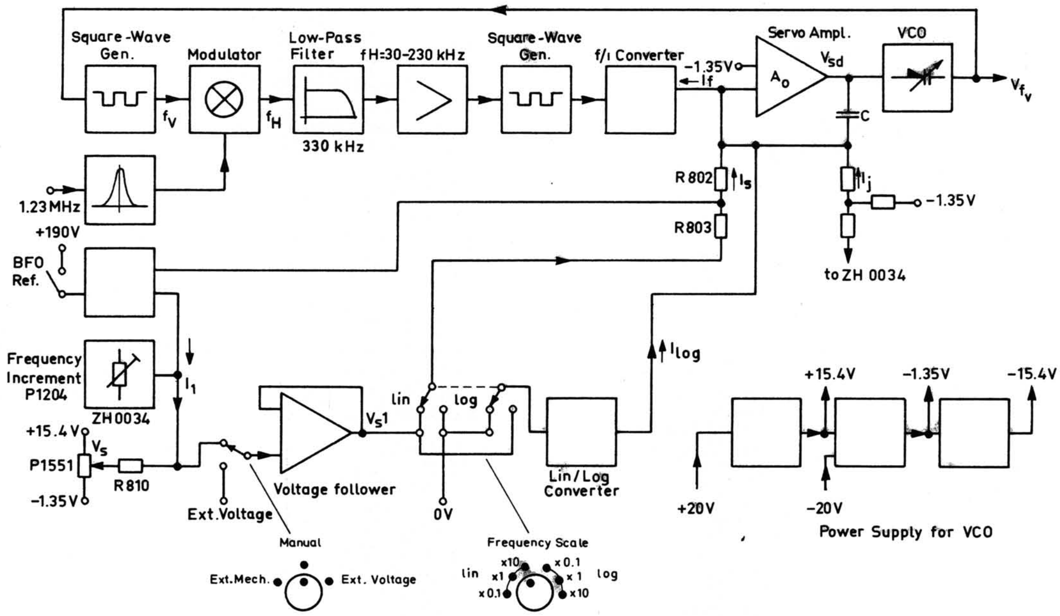
The modulator V 651 is an integrated circuit. Fig.1.20 shows a simplified schematic of the modulator and the pin connections on the I.C. The 270 kHz signal is applied to the base of a balanced amplifier T_1 and T_2, pin 1 and 7. The 960 kHz is applied to pin 3 and via T_3 to the emitter of T_1 and T_2. The output is taken from pin 10 and 11.

The Frequency Converter ZM 0010

The 1.08 MHz signal is fed to a divider 1: 4 via a trigger circuit V 660.

The resulting frequency (270 kHz) is passed through a 270 kHz bandpass filter to a modulator V 651. The 270 kHz signal is modulated with the 960 kHz signal from the fixed oscillator. The sum of the frequencies (960 + 270) kHz is extracted in the 1.23 MHz bandpass filter. The filtered signal is fed to a square wave generator V 652 and V 653 and to an emitter follower V 654.

A 1.23 MHz sq.wave signal is available on the emitter of V 654. The 1.23 MHz signal is fed to a divider 1: 40 via the trigger circuit V 650. The resulting frequency 30.75 kHz is fed to a trigger circuit V 651 and V 658 and a sq.wave with an amplitude of ±6 V is available on the collectors of V 657 and V 658.



The Voltage Controlled Oscillator. VCO

The control voltage V_s for the VCO is normally supplied from P 1551 which is the main tuning potentiometer for the frequency. V_s is via the voltage follower applied to the Lin/Log selector. In pos. "Lin" the output of the voltage follower is fed to the servo amplifier and the input of the Lin/Log converter is connected to 0 V.

The current I_{log} from the Lin/Log converter applied to the servo amplifier will in pos. "Lin" have a fixed value of approx. 1 μA. In pos. "Log." V_s is applied to the Lin/Log converter via the voltage follower and the output current I_{log} will be proportional to the exponential value of V_s. In pos. "Log" the input of the servo amplifier is connected to 0 V via the resistors R 802 and R 803.

The output of the servo amplifier V_{sd} is applied to the VCO and the generated frequency is controlled by the voltage V_{sd}.

Fine adjustment of the frequency is done by P 1204 "Frequency Increment". A small voltage $V_1 = I_1 \times R\,810$ is added to V_s and the position of P 1204 is indicated by lamps on the front panel (ZH 0034).

When the push button "BFO Ref" is activated a reference circuit will change the f_H to 40 kHz independent of V_s.

Oscillator and Modulator ZI 0009

The oscillator consists of a parallel resonance circuit Q 961 (VDC = voltage dependent capacitor) //L 981 and the amplifier stage V 961.

The two diodes Q 964 and Q 965 keep the amplitude constant independent of the frequency. The output is taken from the emitter of V 961 and fed to a 26 dB amplifier V 962, V 963. From the output of the amplifier the signal is fed to an emitter follower V 964 and to a class B output stage V 965, V 966. Via the emitter follower V 964 the signal is fed to a modulator circuit.

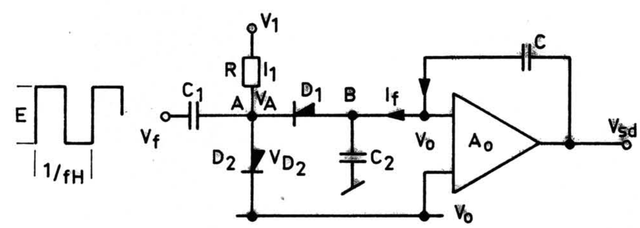
In the modulator the signal f_v is modulated with the 1.23 MHz signal and the resulting signal = f_H = 1.23 MHz − f_v is taken out via the 330 kHz lowpass filter.

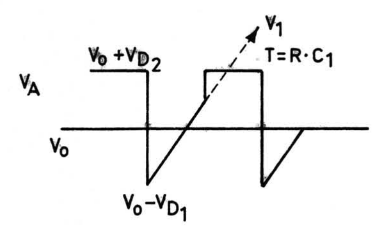
Via C 981 the signal V_{fv} is applied to the square wave generator V 981, V 982.

The signal V_c 981 and V_c 982 will be square wave signals with the frequency f_V and in opposite phase. The 1.23 MHz signal is applied to the tuned circuit L 985//C 986. From L 985 the 1.23 MHz signal $\angle 0^o$ and $\angle 180^o$ is applied to the ring-modulator V 983-V 986.

The output from the modulator is fed through a 330 kHz lowpass filter and the signal f_H is then amplified 24 dB before it is applied to the frequency/current = f/I converter.

The Frequency/Current Converter ZZ 0014





The function of the frequency/current converter is to give a current I_f proportional to the frequency f_H. The converter consists of a square wave generator for f_H and the f/I converter itself.

When V_f is high the Diode D_2 will conduct due to a small bias current through the resistor R. The voltage in the point A will then be $V_o + V_{D2}$.

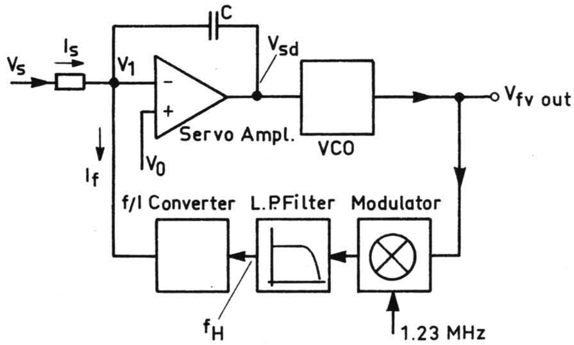
The voltage in the point B will remain constant at the level V_o due to the capacitor C_2 and the emitter-capacity $A_o \cdot C$. (A_o = gain of the amplifier), and the diode D_1 will not conduct.

When V_f is going low D_2 will stop conducting right away. Now both D_1 and D_2 are not conducting and V_1 will follow V_f. When $\Delta V_f = V_{D1} + V_{D2}$ the voltage $V_A = V_o - V_{D1}$ and the diode D_1 will conduct.

The miller-capacity $A_o \cdot C \gg C_1$ and the voltage V_B will not change. Therefore the rest of V_f will as a charge be fed to $C_2 + A_o \cdot C$. The charge Q is negative. After a certain time controlled by R_1 and C_1 D_2 will start to conduct. When V_f is going high, that through C_1 applied charge will be fed to V_o through D_2. D_1 is not conducting and no signal will go to B.

The charge which is fed to the servo amplifier per second is $-Q \cdot f = I_f$.

VCO with Servo Amplifier

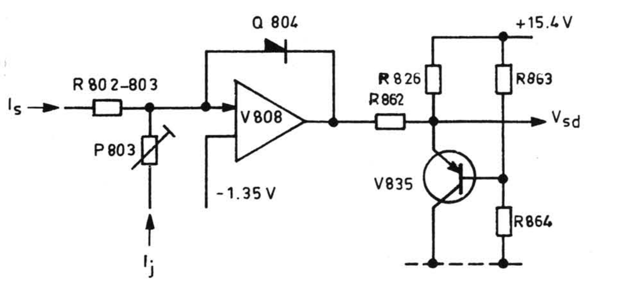


The output voltage of the servo amplifier V_{sd} = control voltage for the VCO will regulate itself until the current I_s and I_f are equal.

Example: $V_1 = V_o$.

If I_f is less than I_s the voltage V_1 will increase. The amplifier will invert the signal and V_{sd} will decrease, f_V will decrease and $f_H = 1.23$ MHz $- f_v$ will increase causing I_f to increase until balance is reached $I_f = I_s$.

The capacitor C will give the circuit a certain time constant and thus a better stability.



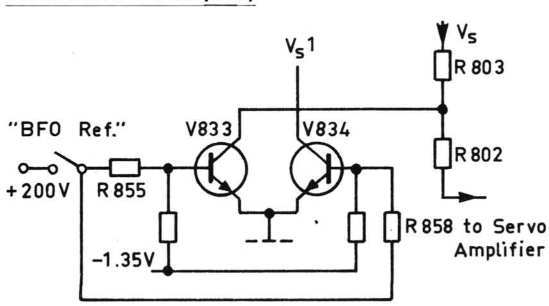
The servo amplifier consists of an integrated amplifier and an emitter follower.

In pos. "Lin" R 802 and R 803 will control the current I_s. The output voltage V_{sd} is limited of the low end V_{sd}min = 1.2 V = $f_v \cong 900$ kHz.

V_{sd}max = 9 V = $f_v \cong 1215$ kHz. The voltage is limited by V 835 which is controlled by R 863 and R 864.

The frequency adjustment is done by changing the current I_J through R 801. I_j can be adjusted by P 803 (internal adjustment) or by P 1381 "Frequency adjustment" available from the front panel.

The BFO Reference Frequency



$f_{ref} = 10$ kHz ($f_H = 40$ kHz) is made by the circuit consisting of V 833 and V 834.

Normally the transistors V 833 and V 834 will be off. When the BFO Ref. contact is activated a current will flow through the resistors R 855 and R 858 to the base of the two transistors and the two transistors will be fully on. $V_{C833} = V_{C834} = 0$ V. The current I_{log} will then be 1 μA in both the "Lin" and the "Log" position.

V 833 connects R 803 to 0 V and having R 802 = 7.32 kΩ $I_{R832} \cong$ 185 μA and $I_s = I_{R802} + I_J + I_{log} = 200\ \mu$A which will give a $f_H = 40$ kHz and this $f_{LF} = 10$ kHz.

To avoid loading the main tuning potentiometer the voltage V_S is passed through a voltage-follower consisting of two balanced amplifier stages and an output emitter follower.

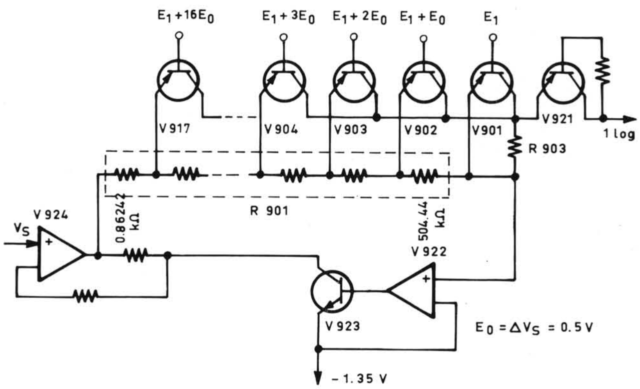
By a potentiometer (P 804) the output of the amplifier is adjusted to 0 V for 0 V input. (Unity gain)

Power Supply for VCO ZZ 0041

Due to the high requirement to the stability of the VCO, the oscillator has its own Power Supply. A special selected zener diode Q 801 is used as reference for the + 15.4 supply. The + 15.4 V is then used as reference for the −1.35 V and −15.4 V supply.

The Lin/Log Converter for the VCO ZM 0043

The purpose of the Lin/Log converter is to convert the linear control voltage V_S to an exponential varying current I_{log} in that way that I_{log} (0 V) = 1 μA and I_{log} (10 V) = 1000 μA.



The simplified schematic shows the principle of the converter. When V_S is less than E_1 the transistors V 901 — V 917 will all be "Off" and $I_{log} = 0$.

As V_S increases and exceeds E_1 the V 901 will start to conduct and as long as the V 902 is "Off"

$$I_{log} = I_{V1} = \frac{V_s - E_1}{(318,27\ k + 200,82\ k \ldots + 0,86242\ k)\ \Omega}$$

As the voltage across the resistor between the emitters of V 901 and V 902 approaching E_0 the V 902 will start to conduct and the voltage across the resistor between the emitters of V 901 and V 902 will

$$I_{log} = \frac{(V_s - (E_1 + E_o))}{(504,44\ k + 318,27\ k \ldots + 0,86242\ k)\ \Omega}$$

e.i. I_{log} is now increasing faster because the 504, 44 kΩ is coupled out. By the correct choice of E_1, E_o and the value of the resistors 504, 44 kΩ– 0,86242 kΩ it is possible to get the wanted exponential relation between V_S and I_{log}.

The Frequency Converter for the VCO ZZ 0013

The variable oscillator will in the linear range cover the frequencies 1—1.2 MHz giving the frequency range from 0—200 kHz. To obtain the frequency ranges 0—20 kHz and 0—2 kHz and keep the same relative stability and resolution two frequency converters are used.

The 1—1.2 MHz signal from the VCO is applied to a trigger circuit V 501 and then divided by 10 in the V 502. The resulting frequency 100—120 kHz is passed through a bandpass filter with a center frequency of 109.5 kHz. The filtered signal is modulated with the 1.08 MHz signal in the balanced modulator V 507 — V 510.

The sum of the two frequencies is extracted via a bandpass filter with a center frequency of 1.190 MHz. The filtered signal (1.18 — 1.2 MHz) is via the FREQUENCY SCALE selector O 8 applied to the BFO section and to the first modulator in the slave filter section.

If the frequency range 0—2 kHz is selected the signal 1.18—1.2 MHz is fed to a frequency converter similar to the one described in the above text. The resulting frequency 1.198 — 1.2 MHz is then applied to the BFO and the slave filter section.

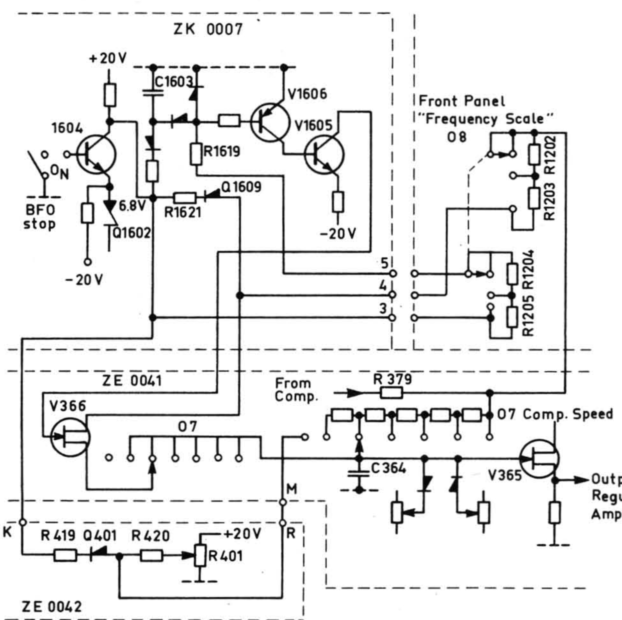
BFO Comparator and Marking Circuit ZK 0007

The purpose of the comparator is to control a number of functions within a specific interval of the frequency range. The sweeping range of the frequency scale is adjusted by the potentiometers P 1603 and P 1604. ("Frequency Range Adjustment") on the rear panel.

When the selected frequency range is exceeded the following will happen:
1. The BFO output will decrease to zero.
2. Blanking of the display read-out
3. The signal way through the amplifier is disconnected except if the FREQUENCY RESPONSE is in position "Lin".

The control voltage for the VCO is applied to the comparators V 1601 and V 1602. The output of the comparators is connected together via the diodes Q 1604 and Q 1605. When the frequency is out of range the output will be positive and V 1603 will conduct. V 1603, V 1614 and V 1616 are controlling the voltage for the relays in the control circuit ZH 0030. V 1604 is switched "On" when the output of the comparators goes positive. Note that the V 1614 can be switched "On" by the BFO stop pushbutton too. V 1604 will switch V 1606 "On" which again will switch V 1605 "On".

When the frequency is back in the active range the V 1604 will be switched "Off". C 1603 will then be charged through the resistor R 1619 and when the voltage across C 1603 is at the right level V 1606 and V 1605 will be switched "Off".



The simplified diagram above shows the BFO stop function.

When the BFO stop push button is depressed, the variable gain amplifier receives a maximum compression signal which reduces the output of the amplifier to zero. When the push button is released the output signal will appear with a speed dependent of the setting of the COMPRESSOR SPEED selector O 7 and the FREQUENCY SCALE selector O 8.

With COMPRESSOR SPEED selector O 7 in the position "Comp. Off" the O 7 will be in its outer left position. When the BFO stop is activated the V 1604 is switched "On". V_{CV1604} is then −6.8 V controlled by the zener diode Q 1602. C 364 on ZE 0041 will then discharge through Q 401 and R 419 and reduce the output of the var. gain amplifier to zero.

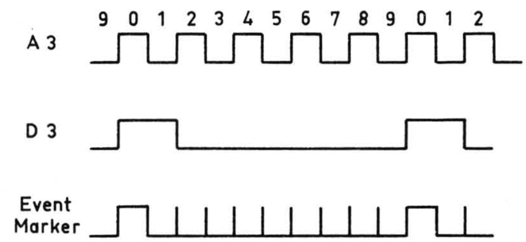
When the BFO stop is released V_C1604 will be + 20 V and Q 401 will be reverse biased. C 364 will then be charged via R 420 and the output voltage will appear with a speed controlled by R 420 and C 364.

If one of the compressor speeds is selected and the BFO stop is activated the V 1604 will be switched "On". V 1604 will switch V 1606 and V 1605 "On". V_{CV1605} is then −20 V and will switch the MOSFET V 366 "On". C 364 will discharge through V 366 and Q 1609 and R 1621. When the BFO stop is released V 1604 will be switched "Off". V 1605 will still be "On" in a time controlled by C 1603 and R 1619 + the resistor selected by FREQUENCY SCALE selector O 8 (R 1204, R 1205). C 384 will be charged through R 379 + the resistors in the compressor speed selector in parallel with V 366 + the resistors selected by the FREQUENCY SCALE selector O 8 (R 1202, R 1203).

The output voltage will appear with a speed dependent on the selected compressor speed and the position of FREQUENCY SCALE selector.

The screwdriver operated switch O 17 OVERLOAD and FREQ MARKING. enables a change in either the 3rd, 4th or 5th digit from the left on the Nixie display to be recorded. The circuit consists of a monostable multivibrator V 1610 and V 1611 and the transistor V 1612.

If the 4th digit is selected the signals A 3 and D 3 from the counter will control the marker circuit. In the following V 1612 will be assumed in the "Off" position.



A 3 shows the signal for the 4th digit

The signal A 3 is differentiated (C 1611, C 1612) and for each level change of A 3 there will be either a positive or a negative impulse on the input of V 1610 and V 1611. This pulse will switch on one of the inputs of the monostable multivibrator.

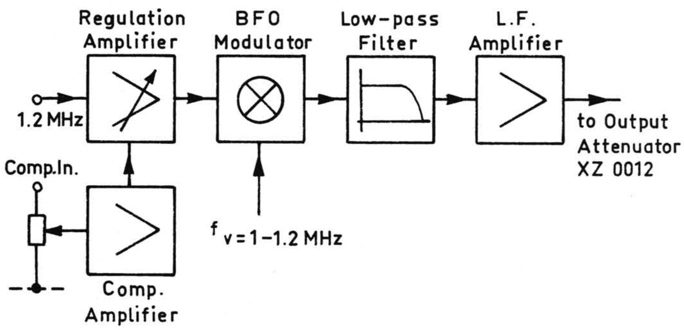
When V 1610 is "On" the relay S 16 will activate and shortcircuit two terminals at the output socket marked "Overload and Frequency Marking". V 1610 will be "On" in 20 msec controlled by the capacitor C 1610. If both A 3 and B 3 is "high" the relay S 16 will remain activated as long as A 3 is "high", e.i. the marker will give a larger pulse each time the 4th digit shows a zero.

When the push button COUNTING TIME INCR. is in its outer position the signal B 5 will be "low" within the frequency range and "high" when the frequency range is exceeded.

The V 1612 will then be "On" when the frequency is out of range and the multivibrator can not be switched "On". If the frequency is 20 kHz (2 kHz, 20 kHz or 200 kHz respectively) the fourth digit will show a zero and V 1610 should be on as long as A 3 is "high", but at the same time B 5 will go "high" and V 1612 will be switched "On" after a time controlled by C 1621 and R 1638 (20 msec). V 1610 will then go "Off".

When COUNTING TIME INCREASE is pushed in the signal Ÿ is "high" and the frequency marking is working when the frequency is out of range.

The BFO Section and Automatic Gain Control



The BFO section and the automatic gain control is located on the following P.C. boards:

The compressor amplifier ZE 0041
The regulation amplifier ZE 0042
The BFO modulator LP filter ZM 0012
LP filter and LF amplifier ZE 0040

The 1.2 MHz signal is applied to the regulation amplifier ZE 0042. The gain of this amplifier is controlled by a DC voltage from the compressor amplifier ZE 0041.

The Compressor Amplifier ZE 0041

A control signal is applied to the compressor input and is via the compr. potm. fed to the compressor amplifier. The amplifier consists of a FET differential input stage V 361 and an output stage V 362.

The gain is 16 dB and controlled by the resistors R 368 and R 366. By P 361 the DC level on the output is adjusted for symmetrically clipping. Via C 361 the signal is fed to the phase-splitter V 363. The two signals from the phase-splitter are rectified and via the emitter follower V 364 fed to a RC circuit.

The regulation speed is dependable of the setting of the COMPRESSOR SPEED

The schematic diagram for ZE 0041 shows the COMPRESSOR SPEED O 7 in the position "Compressor Off".

In this position the compressor amplifier is not in use. A portion of the 1.2 MHz signal is rectified in the regulation amplifier and applied to the RC circuit via O 7 and then via the source follower V 365 to the output.

In the following text one of the compressor speeds are selected.

By a nearly constant current through R 379 controlled by R 378 and P 364 a DC voltage is added to the rectified signal. The resulting DC voltage across C 364 is fed to the output via the source follower V 365. Q 366 and Q 367 limits the voltage on the gate of V 365 to a level controlled by the potentiometers P 362 and P 363.

The MOSFET V 366 and the other section of O 7 is used with the BFO stop and will be described under the ZK 0004.

The Regulation Amplifier ZE 0042

The 1.2 MHz signal is attenuated by the voltage divider R 402 and R 403 and applied to the variable gain amplifier via the emitter follower V 401. The gain of the amplifier is controlled by a DC voltage coming from the compressor amplifier. The amplifier is followed by a 1.2 MHz bandpass filter. The output signal to the BFO modulator is taken via the emitter follower V 405. Via C 409 the signal is fed to the rectifier Q 402. The DC level on the output of the rectifier can be varied by P 401. In the position "Compr. Off" the signal is applied to the RC circuit in the compressor amplifier ZE 0041 and then used to control the gain of the regulation amplifier in compressor off mode.

The BFO Modulator ZM 0012

In the BFO modulator the variable frequency f_v = (1—1.2 MHz) is mixed with the fixed frequency 1.2 MHz.

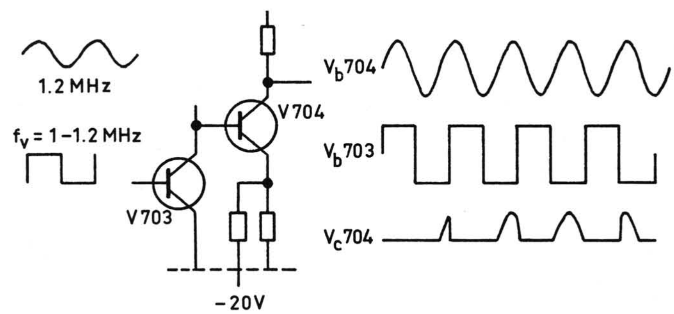
The variable frequency f_v is applied to the square wave generator V 701 and V 702. The V 701 and V 702 are coupled as a differential stage where $V_b701 = V_{fv}$ and $V_b702 = 0$ V. When V_{fv} is going high the V 702 will be "Off" and when V_{fv} is going low and passes 0 the V 701 acts as an emitter follower for the common base amplifier V 702.

The resulting square wave signal on the collector of V 702 will trigger V 703 and V 707 "On" and "Off" at the same time.

The fixed frequency 1.2 MHz (from the regulation amplifier) is applied to the 1.2 MHz bandpass filter L 701//C 707. The two signals $V_f \angle 0^o$ and $V_f \angle 180^o$ from the secondary winding on the L 701 is fed to the base of the transistors V 704 and V 706.

When V 702 is "Off" the V 703 and V 707 will be "On" and the base on V 704 and V 706 will be shortcircuited to ground through V 703 and V 707.

When V 702 is "On" the V 703 and V 707 will be "Off" and the signals $V_f \angle 0^o$ and $V_f \angle 180^o$ is applied to the base of V 704 and V 706.



The wanted frequency is 1.2 MHz — f_v = L F e.i. the difference between the two signals.

The difference is achieved in the following way:

The two signals are amplified in V 704 and V 706.

The phase of the signal on the collector of V 704 is turned 180° and the signal is added to the signal on the collector of V 706.

From the collector of V 705 and V 706 the signal is fed via the emitter follower V 708 to the input of the 200 kHz lowpass filter.

After the filtering the signal is amplified 20 dB. The amplifier consists of two differential stages V 709, V 710 and V 711, V 712.

The BFO Amplifier ZE 0040

The input to the BFO amplifier is taken from the output of the 20 dB amplifier and enters the BFO amplifier via a 200 kHz LP filter.

The input amplifier consists of two differential amplifier stages V 751, V 752 and V 753, V 754 and an emitter follower V 755. By P 751 the DC level on the output is adjusted to 0.

The second amplifier consists of two differential amplifier stages similar to the circuits mentioned above. A small difference is the constant current source V 756 in the emitter of the first stage.

From the collector of V 759 the signal is fed to a class B output amplifier. V 761 and V 762 are coupled as diodes and used to minimize the cross-over distortion in the class B stage. V 765 and 766 protects the output transistors in case of a shortcircuiting of the output. The output is taken either direct (output impedance approx. 5 Ω) or via the output attenuator. The output impedance is 600 Ω in all of the positions of the attenuator.

The 2010 Heterodyne Analyzer

The signal to be analyzed passes through the input amplifier ZE 0037 and ZE 0038. Via the 200 kHz lowpass filter on ZE 0038 the signal is applied to the first modulator ZS 0174.

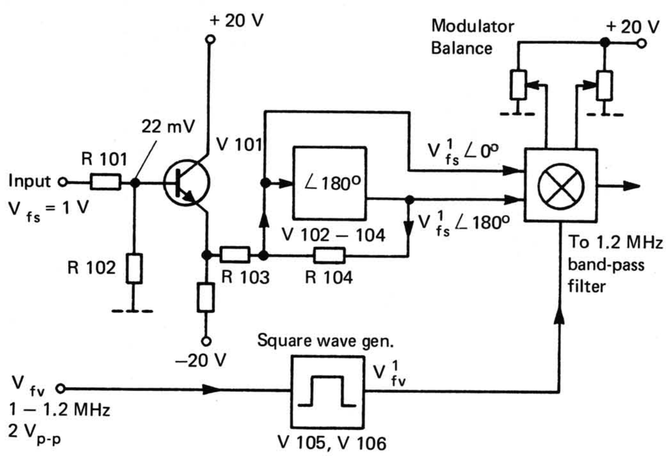
1st Modulator and 1.2 MHz Filter ZS 0174

The signal levels given in the text and the diagram is for full deflection on the meter for $f_v + f_s = 1.2$ MHz.

To get a minimum of distortion in the modulator the input signal $V_{fs} = 1$ V is attenuated by the voltage divider R 101 and R 102 to 22 mV = V_{fs}'.

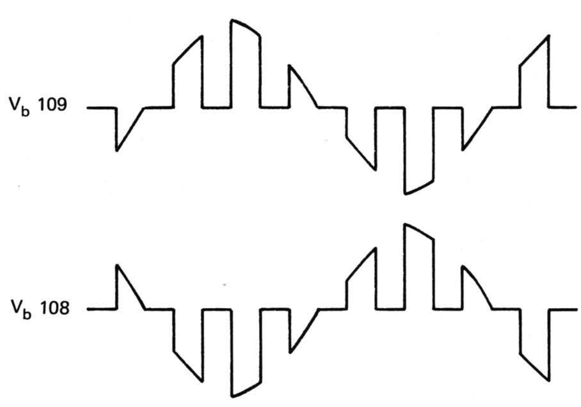
V_{fs}' is fed via the emitter follower V 101 to the modulator V 110 and to a phase inverter. The phase inverter consists of a balanced input stage V 102 and V 103 and an output stage V 104. A feedback is provided over R 104 and R 103. V_{fs}' — = the output from the phase inverter is fed to the modulator V 107.

The modulator transistors V 107 and V 110 are triggered "On" and "Off" at the same time by the signal from the square wave generator V 105, V 106. The s.q. generator is controlled by the signal V_{fv} (approx. 2 V p-p from the VCO or the frequency converters for the VCO).



When V 106 is "Off" V 107 and V 110 will be "On". When V 106 is "On" V_C106 will be approx. –0.6 V and V 107 and V 110 will be "Off". When V 107 and V 110 is "Off" V_{fs}' $\angle 0^\circ$ is fed to the base of V 109 via R 119 and V_{fs}' $\angle 180^\circ$ to the base of V 108 via R 120.

Is V 107 and V 110 "On" the base of V 108 and V 109 is shortcircuited to ground.



The signal V_{fv} on the base of V 108 and V 109 will be in phase and therefore practically rejected in the primary winding of L 101. Due to leakage- and base current an external adjustment is necessary. For fine adjustment of the balance there is two potentiometers MODULATOR BALANCE available on the front panel.

The frequency $f_s + f_v = 1.2$ MHz is then extracted via the 1.2 MHz band-pass filter.

The first section of the filter consists of L 101, C 116 and R 129. By R 129 the Q is adjusted.

The signal is fed to the second section via V 111. The gain of V 111 has a positive temp. coefficient due to the NTC resistor R 148.

The second sec. (L 102, C 119) is critically coupled to the third sec. (L 103, C 121) via C 120.

The Q is adjusted by P 101 and R 133.

The signal is then fed to the fourth section via V 112. The fourth sec. (L 104, C 122) is critically coupled to the fifth sec. (L 105, C 124) via C 123.

The Q is adjusted by P 102 and R 136.

The output from the fifth sec. is fed to a 6 dB amplifier (V 113 and V 114).

On the output of the 6 dB amplifier is now a 1.2 MHz signal with an amplitude direct proportional to the amplitude of the input signal.

The Second Modulator ZS 0175

The 1.2 MHz signal from ZS 0174 is then applied to the second modulator ZS 0175 in which the 1.2 MHz signal is mixed with the 1.23 MHz signal from the internal signal section. The modulator consists of the transistors V 151 — V 154. The 1.2 MHz signal is applied to the base of V 151 and V 154. The 1.23 MHz signal is applied to the base of V 152 and V 153. When the 1.23 MHz signal is "high" V 153 will be "On" and V 152 will be "Off".

The current through V 151 will then be zero. The current through V 154 and thus the current through V 153 will be proportional to but in opposite phase of the 1.2 MHz signal ($f_s + f_v$). When the 1.23 MHz is "low" V 153 will be "Off" and V 152 will be "On". The current through V 151 will be proportional to, and in phase with the 1.2 MHz signal. The difference between the two signals = 30 kHz is extracted in a bandpass filter with a center frequency of 30 kHz. The bandpass filter consists of two 2-poled butterworth filters separated by an amplifier.

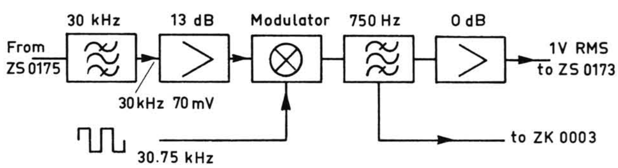
The bandwidth of the filter can be selected to either 316 Hz or 1000 Hz by the SELECTIVITY CONTROL selector O 5. The SELECTIVITY CONTROL activates the relay S 9 and controls the transistors V 161 and V 162.

In the position "1000 Hz" S 9 is activated and V 161 and V 162 will be "On". With the filter in the "316 Hz" bandwidth position the sensitivity is adjusted by P 155. In the "1000 Hz" bandwidth the sensitivity is adjusted by P 157. (Rear Panel).

The filtered signal is then applied to a 23 dB amplifier. The output of the 23 dB is passed through a 30 kHz lowpass filter and the signal is then via the selector circuit ZS 0173 applied to the output section of the measuring amplifier.

The second output from the 23 dB amplifier is attenuated 23 dB and the signal is fed to the third modulator ZS 0177.

The Third Modulator and the 750 Hz Filter ZS 0177



The voltages given is for full scale deflection.

The signal from the second modulator ZS 0175 is applied to an extra 30 kHz bandpass filter to attenuate the image another 20 dB to a total of 90 dB.

The image (31.5 kHz) is attenuated 70 dB on ZS 0175. The image will occur when $f_s + f_v = 1198.5$ kHz.

Output from 2nd modulator $f_1 - (f_s + f_v) = 31.5$ kHz would in the 3rd modulator give the difference frequency of 750 Hz which would pass through the 750 Hz bandpass filter.

The filtered signal is then amplified 13 dB (V 202 and V 210) and applied to the modulator.

The modulator consists of the transistors V 203, V 204, V 207 and V 208 and is similar to the modulator described under the ZS 0175. The 30 kHz signal is here mixed with the 30.75 kHz from the internal signal section.

The difference frequency 750 Hz is extracted via a 750 Hz bandpass filter.

The 750 Hz bandpass filter consists of two sections separated by an amplifier V 201 and V 205.

The bandwidth of the filter is selected by the SELECTIVITY CONTROL O 5 on ZH 0030.

The Relays S 10 – S 13 are controlled by the SELECTIVITY CONTROL

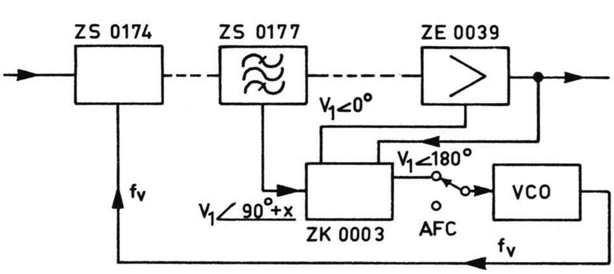
In the position "100 Hz" S 10 is activated
In the position "31.6 Hz" S 11 is activated
In the position "10 Hz" S 12 is activated
In the position "3.16 Hz" S 13 is activated

The sensitivity in the 100 Hz bandwidth is adjusted by P 208. (Rear Panel "Filter Sensitivity Adjustment"). The sensitivity for the bandwidths 3.16 Hz, 10 Hz and 31.6 Hz is adjusted by P 209, P 203 and P 202. (Rear Panel).

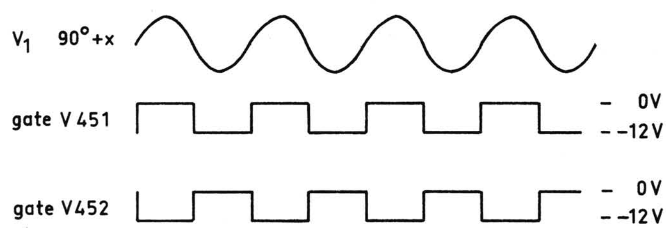
L 207 is a hum compensation coil placed around L 204. By P 211 the hum on the output is adjusted to min. The bandpass filter is followed by a 0 dB amplifier V 206 and V 209. The filtered signal is then applied to the selector circuit ZS 0173.

After the first section in the filter an output is taken via V 211 to the AFC circuit ZK 0003.

Automatic Frequency Control (AFC) Circuit ZK 0003



The signal $V_1 \angle 90° + x$ from the first section of the 750 Hz filter is applied to V 458. From the output amplifier ZE 0039 a signal $V_1 \angle 0°$ and a signal $V_1 \angle 180°$ are applied to the phase detector V 451 and V 452. When the 750 Hz filter is in resonance x = 0 and the signal $V_1 \angle 90° + x = V_1 \angle 90°$ and the output from the phase detector is 0 V DC. At small deviations from resonance in the 750 Hz filter the phase detector will give a DC voltage out which is added to the control voltage for the VCO.



The signal $V_1 \angle 90° + x$ is converted to a square wave signal in V 458.

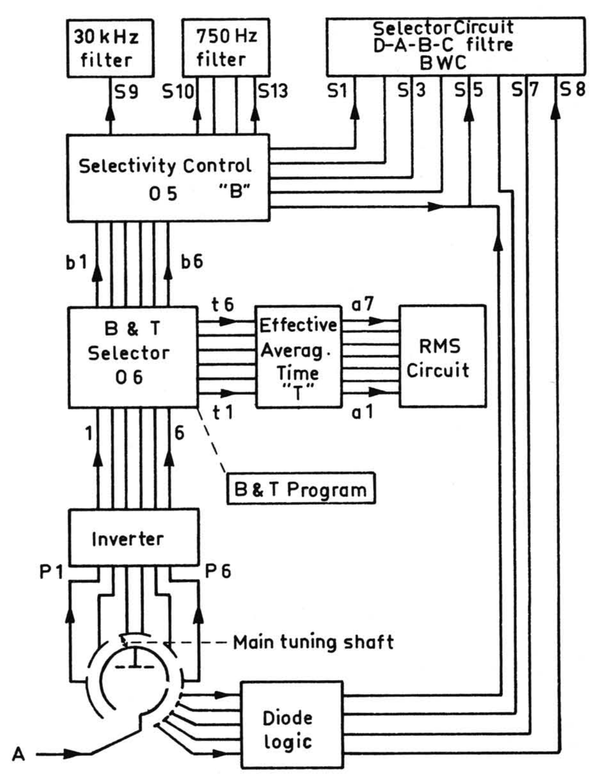
V 451 and V 452 will be switched "On" and "Off" respectively by the signal $V_1 \angle 90° + x$ and part of the signals $V_1 \angle 0°$ and $V_1 \angle 180°$ will be passed on to the capacitor C 459.

The DC voltage across C 459 is amplified 14 dB and the resulting voltage is applied to an attenuator. The purpose of the attenuator is to give the correct DC voltage to the VCO dependent of the bandwidth and the frequency scale selector.

The Control Circuits ZH 0030 – ZH 0031 – ZH 0036

The control circuits permit the selection of the following:

a. The bandwidth "B" in the filters.
b. The bandwidth compensation "BWC".
c. The time constant "T" in the meter circuit.
d. The weighted networks A, B, C, D, Lin. and Ext. filter.



The selector, mounted on the PZ 0003 (Main Frequency tuning section), will connect one or at the cross-over point two of the leads P 1 – 6 to ground. The inverter will connect the corresponding lead (and only one lead) to + 24 V.

1 – 6 is applied to B & T PROGRAM selector and the information on 1 – 6 is distributed to t 1 – 6 and b 1 – 6 dependent on the position of the selector.

The control circuits can be operated in three ways.

1. Manually.
2. Internally by the selector board ZH 0031.
3. Externally.

The control circuits activates the relays in the 30 kHz filter,the 750 Hz filter ZS 0177, the selector circuit ZS 0173 and the FET switches in the meter circuit.

The table shows the combination of the realys in different modes of the analyzes.

Combination of Relays

	ZS . . .	0173	0173	0173	0173	0173	0173	0173	0173	1075	0177	0177	0177	0177
		Relay number												
Bandwidth	BWC	S 1	S 2	S 3	S 4	S 5	S 6	S 7	S 8	S 9	S 10	S 11	S 12	S 13
3.16 Hz	Off	0	1	0	0	0	1	0	0	0	0	0	0	1
10 Hz	Off	0	1	1	0	0	1	0	0	0	0	0	1	0
31.6 Hz	Off	0	1	0	1	0	1	0	0	0	0	1	0	0
100 Hz	Off	0	1	0	0	1	1	0	0	0	1	0	0	0
316 Hz	Off	1	1	1	0	1	1	0	0	0	0	0	0	1
1000 Hz	Off	1	1	0	1	1	1	0	0	1	0	0	0	1
3.16 Hz	On	0	1	0	0	0	0	0	0	0	0	0	0	1
10 Hz	On	0	1	1	0	0	0	0	0	0	0	0	1	0
31.6 Hz	On	0	1	0	1	0	0	0	0	0	0	1	0	0
100 Hz	On	0	1	0	0	1	0	0	0	0	1	0	0	0
316 Hz	On	1	1	1	0	1	0	0	0	0	0	0	0	1
1000 Hz	On	1	1	0	1	1	0	0	0	1	0	0	0	1
Curve D		0	0	0	0	1	1	1	1	0	0	0	0	1
Curve A		0	0	0	0	1	1	0	1	0	0	0	0	1
Curve B		0	0	0	0	0	1	0	1	0	0	0	0	1
Curve C		0	0	0	0	0	1	1	0	0	0	0	0	1
Lin		0	0	0	0	0	1	0	0	0	0	0	0	1
Ext. Filter		1	0	0	0	0	1	0	0	0	0	0	0	1
Off *C		0	0	0	0	0	0	0	0	0	0	0	0	1

Off *C = The passive range of the frequency scale.
(1 = the relay is activated.)

Manual Control of the Bandwidth and "BWC"

The B & T PROGRAM selector should be in position "Manual", and the push button markedSELECTIVEshould be "In". The bandwidth is selected by the switchSELECTIVITY CONTROL. A relay S 15 located on the comparator ZK 0004 will disconnect the voltage to all the relays except S 13 when the frequency pointer is turned to the passive range of the frequency scale (the button line in the relay combination table).

If the push button "BWC" is pushed in the relay S 6 will disengage and the bandwidth compensation is controlled by S 3, S 4 and S 5. The bandwidth selected is indicated by a light in the cluster surrounding the switch.

Manual Control of the "Effective Averaging Time T"

The B & T PROGRAM selector should be in position "Manual". The time constant is selected by the switch O 4 marked EFF. AVERAGING TIME T (See schematic diagram for ZH 0036). The voltage is applied to the pin t_6 either through Q 1304 or V 1313 (ZH 0030) and the voltage is zero on $t_1 - t_5$.

The switch O 4 distributes the voltage through the leads a 1 – a 7 to the meter circuit. The transistors V 1361 – 1367 controls the indicator lamp for the time constant selected.

In position "Fast" 24 V is applied to a 1 via the switch O 4. Due to the diode Q 1361 the indicator lamp will not light up. The switch O 4 also connects a capacitor C 1361 across the meter. In position "Slow" 24 V is applied to a 3 and the capacitor C 1362 is connected across the meter. Also here is a diode Q 1362 to prevent light in the indicator lamp.

Manual Control of A, B, C, D, Lin. and Ext. Filter

The push button marked "Selective" should be "In" and the "Selectivity Control" may not be in "Ext. Filter".

The frequency pointer is set to the desired position and the diode logic on ZH 0031 activates the relays S 5 – S 8 according to the relay combination table.

When the push button marked "Linear" is "In" the relay S 6 is activated. All other relays except S 13 is disengaged independent of the setting of the controls.

In the position "Ext. Filter" the push button "Linear" must be out. In the "Ext. Filter" position the relays S 1, S 6 and S 13 should be activated.

Internal Control of Bandwidth, Time Constant and B & T Program

The B & T PROGRAM permits the selection of the most suitable bandwidth and effective averaging for given frequencies or frequency ranges.

The B & T program selector has five positions.

1. B. variable T. constant
2. B. constant T. variable
3. B. variable T. variable
4. B. variable T. variable
5. Manual

On the Frequency scale there is 5 black marks dividing the frequency scale into six equal sections. Each sec. = 1/2 decade. These marks indicate the cross-over frequencies.

Position 1. "B." variable "T." constant

SELECTIVITY CONTROL	Bandwidth (Hz)					
1000 Hz	3.16	10	31.6	100	316	1000
316 Hz	3.16	3.16	10	31.6	100	316
100 Hz	3.16	3.16	3.16	10	31.6	100
31.6 Hz	3.16	3.16	3.16	3.16	10	31.6
10 Hz	3.16	3.16	3.16	3.16	3.16	10
3.16 Hz	3.16	3.16	3.16	3.16	3.16	3.16

Cross-over frequency: 20 Hz 63 Hz 200 Hz 630 Hz 2 kHz 6.3 kHz 20 kHz

All positions of the SELECTIVITY CONTROL may be used and the bandwidth compensation "BWC" may also be used. As seen from the table the bandwidth of the highest frequency is equal to position of SELECTIVITY CONTROL selector.

Position 2. "B." constant "T." variable

EFF. AVERAGING TIME	Time constant (sec.)					
0.1 sec.	30	10	3	1	0.3	0.1
0.3 sec.	100	30	10	3	1	0.3
1 sec.	100	100	30	10	3	1
3 sec.	100	100	100	30	10	3
10 sec.	100	100	100	100	30	10
30 sec.	100	100	100	100	100	30
100 sec.	100	100	100	100	100	100

Cross-over frequency: 20 Hz 63 Hz 200 Hz 630 Hz 2 kHz 6.3 kHz 20 kHz

All positions of SELECTIVITY CONTROL and FREQUENCY RANGE can be used.

As seen from the table the time constant at the highest frequency is equal to the position of EFF. AVERAGING TIME.

Position 3. "B." variable "T." variable B & T = constant

SELECTIVITY CONTROL	Bandwidth (Hz)			
1000 Hz	31.6	100	316	1000
316 Hz	10	31.6	100	316
100 Hz	3.16	10	31.6	100
31.6 Hz	3.16	3.16	10	31.6
10 Hz	3.16	3.16	3.16	10
3.16 Hz	3.16	3.16	3.16	3.16

EFF. AVERAGING TIME	Time constant (sec.)			
0.1 sec.	3	1	0.3	0.1
0.3 sec.	10	3	1	0.3
1 sec.	30	10	3	1
3 sec.	100	30	10	3
10 sec.	100	100	30	10
30 sec.	100	100	100	30
100 sec.	100	100	100	100

Cross-over frequency: 20 Hz 63 Hz 630 Hz 6.3 kHz 20 kHz

Example: B. is chosen to 100 Hz and T. to 3 sec. In the frequency range 20 – 63 Hz is B = 3.16 Hz and T = 100 sec. At 63 Hz B will change to 10 Hz and T to 30 sec. B · T = constant = 300.

Position 4. "B." variable "T." variable B & T = constant

SELECTIVITY CONTROL	Bandwidth (Hz)		
1000 Hz	100	316	1000
316 Hz	31.6	100	316
100 Hz	10	31.6	100
31.6 Hz	3.16	10	31.6
10 Hz	3.16	3.16	10
3.16 Hz	3.16	3.16	3.16

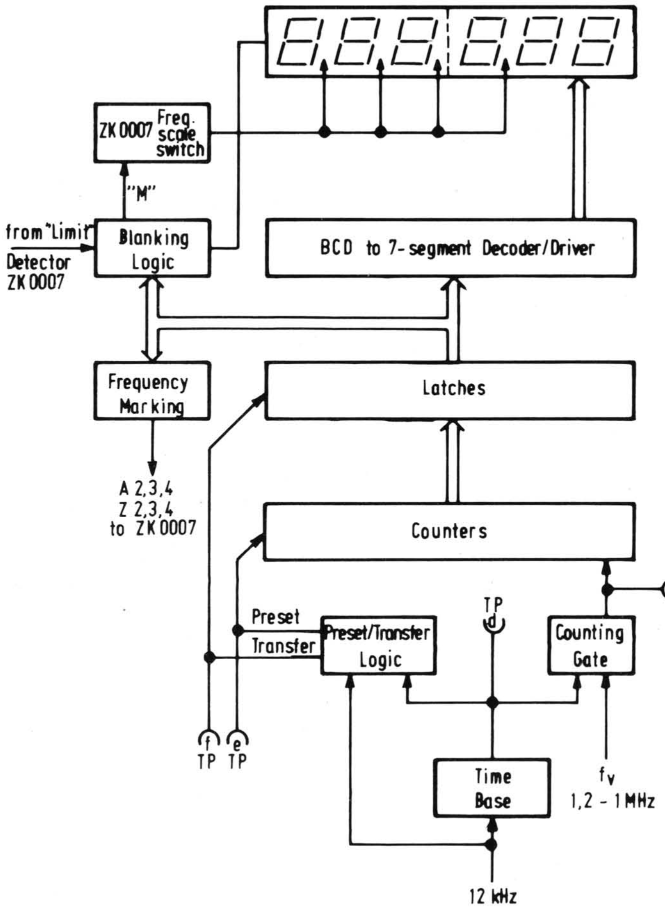
EFF. AVERAGING TIME	Time constant (sec.)		
0.1 sec.	1	0.3	0.1
0.3 sec.	3	1	0.3
1 sec.	10	3	1
3 sec.	30	10	3
10 sec.	100	30	10
30 sec.	100	100	30
100 sec.	100	100	100

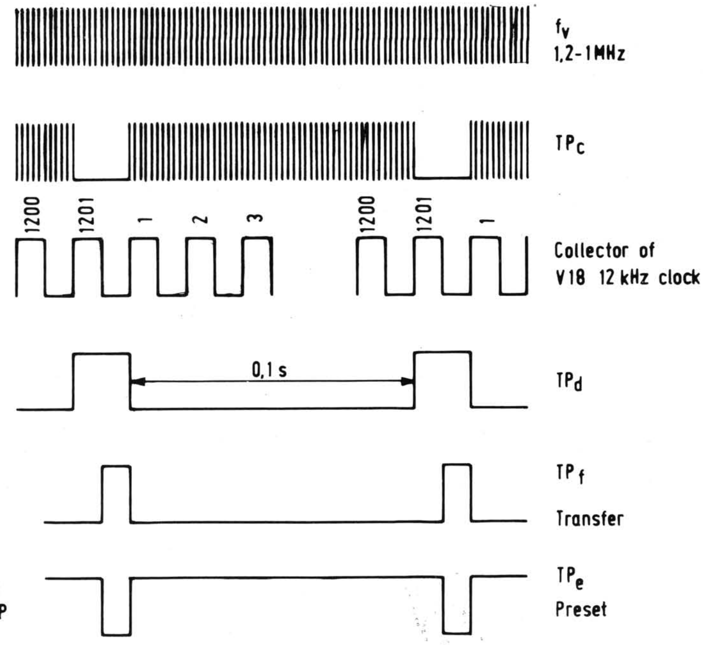
Cross-over frequency: 20 Hz 200 Hz 2 kHz 20 kHz

Position 4 is similar to position 3 with the exception of the cross-over frequencies.

External Control of the Bandwidth and the Time Constant

A socket (Ext. B & T Program) on the rear panel of the 2010 enables the B & T program switch-over frequencies to be remote controlled. The leads p 1 – 6 is available at this socket.





Frequency Counter

With Counting Time positioned in 0,1 s the function of the frequency counter is as follows:

When a counting periode is started the counter has been preset to 120000 and the Counting Gate V12 pin 6 is now enabled (controlled from the Time Base, V17).
Since V17 is a 1201 divider and the clock pulses are 120 kHz the Counting Gate is enabled for 0,1 s and the "fv" signal is lead to the Counter.

On the positive going edge of pulse no 1201 the Counting Gate is disabled which stops for "fv" and the counting. On the trailing edge of pulse no 1201 a transfer pulse is produced which leads the result from the counter through the latch to the 7-segment Decoder/Driver.

A preset pulse is produced at the same time as the transfer pulse, this will preset the counter to 120000, and the whole procedure is repeated.

Blanking Logic

The Blanking Logik is controlled by the signals from the 12 pm socket pin 1, 2 and 3, according to the below table. Pin 7 on the 9 pin socket is connected to the Limit Detector on the P. C. board ZK 0007 which will blank the whole display if the frequency exceed the selected frequency range. Furthermore, the IQ output from V 1710 control the Blanking Logik in this way that if this output is "1" the whole display will be burned off, which will happen if the frequency is below 0 Hz. The scheme below shows the combinations which will turn off the single ciffer.

Frequency Scale		x0,1s	x1s	x10s	x0,1s	x1s	x10s	x0,1s	x1s	x10
Counting Time		0,1s			1s			1s Ext.		
Levels at pin no. on the 12 pin socket	1	1	1	0	1	1	0	1	1	1
	2	1	0	0	1	1	0	0	0	0
	3	1	1	1	0	1	1	1	1	1

A "1" on pin no. 1 prevents that ciffer no. 3 will be turned off.
A "1" on pin no. 2 prevents that ciffer no. 2 will be turned off.
A "0" on pin no. 3 prevents that ciffer no. 1 will be turned off.

Frequency Marking

By means of a "Frequency Marking" selector on the rear it is possible to chose marking intervals controlled by ciffer no. 3, 4 and 5.

Output from the respective latch is applied to the Frequency Marking Circuit on ZK 0007. Every time the chosen ciffer change the A × ouput will activate the Frequency Marking relay. The Z × output will change to "1" when the ciffer change to "0" and stay on to hold the Frequency Marking relay energized until the ciffer change again.

Checking Procedure

The Heterodyne Analyzer 2010 can be divided into three sections.

1. The measuring amplifier section.
2. The BFO section.
3. The analyzer section.

The reference for the check-out is the built in 50 mV reference signal. The controls are set to the following positions, which will be refered to as "the Standard position" in the proceeding text.

front panel
DIRECT INPUT: "In"
REF. 50 mV: "In"
GAIN CONTROL: "Cal."
INPUT SECTION ATTENUATOR: "100 mV"
OUTPUT SECTION ATTENUATOR: "x 1"
READ-OUT SELECTOR (METER): "Lin"
READ-OUT SELECTOR (RECORDER): "AC"
EFF. AVERAGING TIME: "0.1 sec."
AFC: "Out"
FREQUENCY RESPONSE: "Linear"
BWC: "Out"
METER AND RECORDER: "Analyzer"
SWEEP CONTROL: "Manual"
COMPRESSOR SPEED: "Off"
B & T PROGRAM: "Manual"
FREQUENCY POINTER: "Within the active range"
METER SCALE: "Lin" SA 0051

rear panel
OVERLOAD AND FREQUENCY MARKING: "Off"

FREQUENCY RANGE ADJUSTMENT
SET LOWER LIMIT: Fully counterclockwise
SET UPPER LIMIT: Fully clockwise

MEASURING AMPLIFIER

50 mV Ref.

Controls are set to "Standard".

Check the meter indication, approx. 50 mV. In case of no meter indication check:

1. Meter Circuit:

Switch from "Analyzer" to "BFO" and turn up the BFO output voltage. Check the meter indication. In case of no indication the meter circuit may be defective. Check the AC voltage on the "Recorder" output

2. Output Amplifier:

OUTPUT ATTENUATOR: "x 1"
BFO ATTENUATOR: "1 V"
CAL. OFF: "In"
FREQUENCY RESPONSE: "Selective"
SELECTIVITY CONTROL: "Ext. Filter"

Is there a meter indication for the BFO voltage the meter circuit is working.
Switch to "Analyzer" and connect the "BFO Output" to "Ext. Filter" output
Check the meter indication.
Is there a meter indication the output amplifier section is working. Check the input amplifier

3. Input Amplifier:

INPUT ATTENUATOR: "1 V"
OUTPUT ATTENUATOR: "x 1"
CAL. OFF: "In"
FREQUENCY RESPONSE: "Lin"
SELECTIVITY CONTROL: "1000 Hz"

Connect the "BFO Output" to "Direct Input"
Is there a meter indication the malfunction must be in the 50 mV reference generator.

When nothing else is mentioned the setting of controls = "Standard".

Sensitivity:

a. INPUT: "Direct"
Range of "Sensitivity" adjustment –9 to + 4 dB re 50 mV.
Set "Sensitivity" to Ref. deflection.

b. INPUT: "Preamp"
Range of "Sensitivity" adjustment –9 to + 4 dB re 50 mV.
Set "Sensitivity" to Ref. deflection.

Gain Control:

a. INPUT: "Direct"
Range of "Gain Control" approx. 11 dB.
Set GAIN CONTROL to "Cal."

b. READ OUT SELETOR (meter): "Log"
Indication on the meter approx. 68 mV.

Overload Indicators:

INPUT ATTENUATOR: "10 mV"
The overload indicators should light up.

Effective Averaging Time T:

INPUT ATTENUATOR: "30 mV"
Adjust "Gain Control" to full deflection on the meter.
Set EFFECTIVE AVERAGING TIME to "100 sec"
Push the Cal. off and check that the speed of the meter movement increases as the Effective Averaging Time is decreased.

Weighted Network A, B, C, D and Lin:

INPUT ATTENUATOR: "100 mV"
GAIN CONTROL: "Cal"
FREQUENCY RESPONSE: "Selective"
SELECTIVITY CONTROL: "1000 Hz"
50 mV REF.: "In"

Turn the frequency pointer to the weighted network positions and check the meter indication, approx. 50 mV.

Output Attenuator:

CAL. OFF: "In"
INPUT ATTENUATOR: "10 V"
OUTPUT ATTENUATOR: "x 1"
BFO ATTENUATOR: "10 V"
FREQUENCY SCALE: "x 1"
FREQUENCY: "1000 Hz"

Connect the "BFO Output" to "Direct Input" and adjust the BFO output voltage to a 18 dB deflection on the meter.
Check the steps of the OUTPUT ATTENUATOR
Tolerance: ± 0.1 dB (+ ± 0.1 dB from the BFO attenuator)

Input Attenuator:

Same control settings as for the Output Attenuator

Check the steps of the INPUT ATTENUATOR.
Tolerance: ± 0.1 dB (+ ± 0.1 dB from the BFO attenuator.)

Frequency Response:

CAL. OFF: "In"
INPUT SECTION ATTENUATOR: "10 V"
OUTPUT SECTION ATTENUATOR: "x 1"
BFO ATTENUATOR: "10 V"
FREQUENCY SCALE: "x 0.1"
FREQUENCY: "1000 Hz"
EFFECTIVE AVERAGING TIME: "0.1 sec."

Connect the "BFO Output" to "Direct Input"
Adjust the BFO output voltage for a 18 dB deflection.
Adjust the frequency to 2 Hz and check the meter deflection: 18 dB ± 0.5 dB.

FREQUENCY SCALE: "Log x 10"
EFFECTIVE AVERAGING TIME: "0.1 sec"

Adjust the frequency to 200 kHz and check the meter deflection: 18 dB ± 0.5 dB.

BFO SECTION:

Frequency Scale and Nixie Read-out:

CAL. OFF: "In"
FREQUENCY SCALE: "Log x 1"
FREQUENCY INCREMENT: "0"
COUNTING TIME INCREASE: "In"

Set the frequency pointer at 20 Hz and adjust the "Frequency Adjustment" to 20 Hz on the Nixie-read-out.

FREQUENCY SCALE: "Lin. x 1"

The Nixie read-out should indicate zero.
Due to the difference in tolerance between the Lin and the Log function it may be necessary to move the frequency pointer a pointer width to get zero.

FREQUENCY SCALE: "Log x 1"

Check that the Nixie read-out corresponds to the indication on the frequency scale.
Set frequency to 1 kHz.
Check "Frequency Increment". Approx. ± 7% of the indicated frequency.

Gain Reserve:

BFO ATTENUATOR: "10 V"
INPUT SECTION ATTENUATOR: "10 V"
OUTPUT SECTION ATTENUATOR: "x 1"

Connect the "BFO Output" to "Direct Input"
Adjust the BFO output voltage to a 5 dB deflection on the meter.
Set COMPRESSOR SPEED to "100 dB/sec"
The BFO output should increase approx. 10 dB.

BFO Ref. signal:

FREQUENCY SCALE: "Lin x 1"

Activate the BFO Ref. signal push button.
Nixie read-out: 1000 Hz ± 2%.

FREQUENCY SCALE: "Log x 1"

Activate the BFO Ref. signal push button.
Nixie read-out: 1000 Hz ± 2%.

Signal/Noise:

BFO ATTENUATOR: "10 V"
INPUT SECTION ATTENUATOR: "10 V"
OUTPUT SECTION ATTENUATOR: "x 1"
COMPRESSOR SPEED: "Off"

Connect the "BFO Output" to "Direct Input"
Adjust the BFO output voltage for full deflection on the meter.
Activate the BFO stop push button.
Indication on the meter $<$ 3 mV.

ANALYZER SECTION:

Filter Sensitivity:

CONTROL SETTING: "Standard" FREQUENCY RESPONSE: "Selective" SELECTIVITY CONTROL: "1000 Hz" FREQUENCY SCALE: "Log x 1"	Set the frequency dial at 1000 Hz. Deflection on the meter: approx. 50 mV. Switch SELECTIVITY CONTROL to "316 Hz" Check the deflection on the meter: approx. 50 mV. Switch SELECTIVITY CONTROL to "100 Hz" Check the deflection on the meter: approx. 50 mV. Switch SELECTIVITY CONTROL to "10 Hz" Deflection on the meter: approx. 50 mV. It may be necessary to fine adjust the frequency. Switch SELECTIVITY CONTROL to "3.16 Hz" Deflection on the meter: approx. 50 mV.
AFC: "In"	Offset the frequency approx. 1 Hz by means of the "Frequency Increment". Push in the AFC push button. Check that the AFC pull in the frequency so the deflection on the meter is within 0.5 dB of 50 mV. It may be necessary to adjust the levels in the filters so that all the filters have the same relative attenuation of the centre frequency. The procedure for the filter sensitivity adjustment is described in the Instruction Manual section 3.1.4.

Bandwidth Compensation (BWC):

SELECTIVITY CONTROL: "3.16 Hz"	Release the AFC push button and readjust the frequency to resonance in the 3.16 Hz filter. Push in the BANDWIDTH COMPENS. push button. The deflection on the meter should drop 5 dB. Check that the signal is attenuated 5 dB each time the bandwidth is increased. Release the BWC push button.

B & T Program:

CAL. OFF: "In" SELECTIVITY CONTROL: "1000 Hz" EFF. AVERAGING TIME T: "0.1 sec"	
B & T PROGRAM: "B. var. 1"	Vary the frequency from 20 kHz to 20 Hz. Check that BANDWIDTH is changed each time the frequency pointer passes one of the black spots on the frequency scale.
B & T PROGRAM: "T var. 2"	Vary the frequency from 20 kHz to 20 Hz. Check that EFFECTIVE AVERAGING TIME T is changed each time the frequency pointer passes one of the black spots on the frequency scale.
B & T PROGRAM: "B & T var. 3"	Vary the frequency from 20 kHz to 20 Hz. Check that BANDWIDTH and EFFECTIVE AVERAGING TIME are changed in accordance with the table given in the Technical Description: B & T Program.
B & T PROGRAM: "B & T var. 4"	Vary the frequency from 20 kHz to 20 Hz. Check that BANDWIDTH and EFFECTIVE AVERAGING TIME are changed in accordance with the table given in the Technical Description: B & T Program.

Compressor Function:

CONTROL SETTING: "Standard" CAL. OFF INPUT SEC. ATTENUATOR: "10 V" BFO ATTENUATOR: "10 V" BFO OUTPUT VOLTAGE: Fully clockwise	Connect the "BFO Output" to "Direct Input". Connect "Recorder" output to "Compressor Input".
COMPRESSOR SPEED: "1000"	Adjust the COMPRESSOR VOLTAGE to a 15 dB deflection on the meter. Turn the OUTPUT SEC. ATTENUATOR to "x 0.003". Check the meter deflection: 15 dB ± 1 dB.

3.1 POWER SUPPLY

ZG 0029

−80 V	Connect a DC voltmeter between pin A and pin C. Adjust P 1051 to −80 V ± 1 V.
+ 80 V	Connect the DC voltmeter between pin B and pin C. Check that the voltage is + 80 V ± 3 V.

ZG 0028

+ 20 V	Connect the DC voltmeter between pin M and ground. Adjust P 1001 to + 20 V ± 0.1 V.
−20 V	Connect the DC voltmeter between pin N and ground. Check the voltage: −20 V ± 0.2 V.
+ 5 V	Connect the DC voltmeter between pin V and ground. Check the voltage: + 5 V ± 0.2 V.

ZG 0172

200 V polarization voltage

Check the 200 V polarization voltage at the socket marked "Pol. Voltage" (Rear Panel).
200 V ± 1 V. If necessary adjust P 1101.

3.2. BFO SECTION

a. The Fixed Oscillator

1.2 MHz frequency

Connect a frequency counter to the socket "Fixed Freq. 1.2 MHz" on the rear panel.
Adjust C 622 on ZI 0008 for 1.2 MHz ± 1 Hz.

1.2 MHz amplitude

Check the amplitude of the 1.2 MHz signal: 130 – 170 mV p-p.

b. The Variable Oscillator (VCO)

Variable frequency 1 – 1.2 MHz

Connect a frequency counter to the socket "Var. Freq. 1 – 1.2 MHz" on the rear panel.
Check the variable frequency in the three frequency ranges.

FREQ. SCALE	Frequency
x 0.1	1198 – 1200 kHz
x 1	1180 – 1200 kHz
x 10	1000 – 1200 kHz

Amplitude

Check the amplitude of the variable frequency signal at the socket "Var. Freq. 1 – 1.2 MHz": 1.5 – 2.3 V p-p.

15.4 V and −1.35 V power supply.

It should be noted that adjustment of the 15.4 V and 1.35 V will affect the frequency adjustment.

Check the voltage at pin "T" on ZZ 0041: 15.4 V ± 10 mV (P 801).
Check the voltage at pin "S": −1.35 V ± 3 mV (P 802).
Check the voltage at pin "F": 8 V ± 0.2 V at 0 Hz.

c. Frequency Adjustment

FREQ. SCALE: "Lin x 10"
FREQUENCY: "Approx. 1 kHz"
COUNTING TIME: "Pushed in"

Check the range of the "Frequency Adjustment": 200 Hz ± 15 Hz.
Set "Frequency Adjustment" to the middle position.

d. Frequency Increment

Set "Frequency Increment" to 0. (Light in zero lamp only).
When turning the "Frequency Increment" 45° left or right, the – or + lamp should be "On" a
the zero lamp "Off".
Adjustable by P 1382 (ZH 0034).

FREQUENCY: "Approx. 10 kHz"

Check the range of "Frequency Increment" 2 kHz ± 200 Hz.
Set "Frequency Increment" to zero.

e. Voltage Follower and Frequency Adjustment (Lin)

SWEEP CONTROL: "Ext. Voltage"
FREQ. SCALE: "Lin x 10"
FREQ. ADJ.: "Middle pos."

Connect a jumper lead from pin "P" on ZZ 0041 to pin 7 in the socket "Frequency Control Voltage In".

* Connect a Digital Voltmeter between pin 7 in the socket "Freq. Control Voltage In" and pin 8 in the socket "Control Voltage Out".

Check the voltage: 0 V ± 1 mV. If necessary adjust P 804 (ZZ 0041).

* **Note:** Some Countries require the use of 3 core power cord on electrical equipment. This may course problems in some tests. In this case great care must be taken to assure that none of the test leads are grounded and there is no common ground between the voltmeter and the test object.

Connect the Digital Voltmeter between pin "P" on ZZ 0041 and ground.

By turning the frequency pointer the voltage at pin "P" is set to 10 V ± 1 mV.
Check the output frequency: 200 kHz ± 10 Hz. If necessary adjust C 809 (ZZ 0041).
Set the voltage at pin "P" to 0 V ± 1 mV.

Check the output frequency: 0 Hz ± 10 Hz. If necessary adjust P803 (ZZ 0041)

Repeat item e until the frequencies are within ±10 Hz at 0V and 10V.

f. BFO Ref. Signal

Push in the BFO REF. SIGNAL.
Check the frequency: 10 kHz ± 200 Hz.

g. Adjustment of Frequency Scale

Linearity of Main Tuning Potentiometer

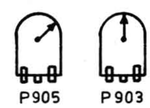
If by any change the main tuning potentiometer has to be changed the new potentiometer must be corrected for linearity. This is done by the factory. When ordering a spare tuning potentiometer please give the serial number of the 2010.

Adjustment of Lin. scale

FREQ. SCALE: "Lin x 10"
FREQ. INCREMENT: "0"

Set P 905 (ZM 0043) as shown.

Set P 903 (ZM 0043) as shown.



Set the frequency pointer to 0 Hz.
Check the frequency on the Display read out.
Loosen and turn the main tuning potentiometer to a 0 Hz ± 100 Hz reading on the Nixie read out.
Set the frequency pointer to 200 kHz.
Check the frequency on the Display read out: 200 kHz ± 100 Hz.
If necessary adjust P 903 (ZM 0043).

Set the frequency pointer to 0 Hz.
Check the frequency on the Display read out: 0 Hz.
If necessary adjust P 905 (ZM 0043).

Make sure the main tuning potentiometer is securely tightened.
Check the frequency at 0 Hz and 200 kHz and readjust if necessary.

Check the frequency scale in intervals of 20 kHz
Tolerance: 0.3% of Scale range.

If the main tuning potentiometer has been changed then check the B & T program according to the tables given in the Technical Description (sec. B & T Program).

Adjustment of Logarithmic scale

FREQ. SCALE: "Lin x 10"

Set the frequency pointer at 0 Hz on Display.
Switch FREQUENCY SCALE to "Log × 10" and adjust P904 to 200 Hz on Display
Check the frequency scale according to the table.

Log. scale	f_{min}	f_{max}
0.02	0.0198	0.0202
0.03	0.0290	0.0310
0.05	0.0485	0.0515
0.07	0.0680	0.0720
0.10	0.0980	0.1020
0.14	0.137	0.143
0.2	0.196	0.204
0.3	0.294	0.306
0.5	0.490	0.510
0.7	0.686	0.714
1	0.98	1.02
1.4	1.37	1.43
2	1.96	2.04
3	2.94	3.06
5	4.90	5.10
7	6.86	7.14
10	9.80	10.20
14	13.7	14.3
20	19.6	20.4

If the logarithmic scale does not track the fault might be in the Lin/Log Converter

A way to find a faulty transistor in Lin/Log converter is to set the frequency pointer to 200 kHz and measure the DC voltage drop across the resistor between the emitters of V901 - V916.
Voltage drop from one transistor to the following transistor: 500mV

Lin/Log converter

FREQ. SCALE: "Log x 10"

SWEEP CONTROL: "Manual"

Should a separate control of the Lin/Log Converter be desired a coarse check can be carried out in the following way.
Set the frequency pointer within f_{min} and f_{max} taken from the table below. Check the DC voltage on pin 8 at the socket "Frequency Control Voltage Out".
The DC voltage is given in the column "Input Voltage".

Due to the very narrow tolerance of the Lin/Log Converter no major adjustments should be carried out without having the proper test equipment.
If appropriate test equipment is available the adjustments are carried out in the following way:

Adjust the potentiometer P904 - P901 - P902 in the mentioned order according to the table below.

Check all the frequencies and readjust if necessary

Input Voltage	f_{min} kHz	f_{max} kHz	Adjust
0	0.198	0.202	P 904
0.5	0.278	0.286	
* 1	0.394	0.404	
1.5	0.558	0.570	
* 2	0.789	0.803	
2.5	1.116	1.134	
* 3	1.578	1.600	
3.5	2.230	2.258	
* 4	3.150	3.188	
4.5	4.452	4.502	
* 5	6.289	6.359	P 901
5.5	8.88	8.98	
* 6	12.55	12.69	
6.5	17.73	17.91	
* 7	25.05	25.31	
7.5	35.38	35.74	
* 8	49.99	50.49	
8.5	70.60	71.30	
* 9.0	99.70	100.7	
9.5	140.9	142.3	
* 10.0	199.0	201.0	P 902

h. Long Term Stability

FREQ. SCALE: "Log x 10"

The 2010 should have been switched off for at least 8 hour

Switch on the 2010. Set the frequency pointer at 200 Hz and adjust for a 200 Hz Nixie read out by "Frequency Adjustment".
After one hour reset the frequency to 200 Hz.
Check the frequency after 7 hours: 200 Hz ± 15 Hz

i. Frequency Range

UPPER LIMIT: "Fully clockwise"
LOWER LIMIT: "Fully CCW"
FREQ. SCALE: "Lin x 10"

Set the frequency pointer somewhere in the passive part of the frequency scale.
The Nixie read out should be "Off".

Turn the frequency pointer towards 0 Hz.
Check that the Nixie read out is "On" before the frequency pointer reach 0 Hz.

Turn the frequency pointer from the passive range towards 200 kHz.
Check that the Nixie read out is "On" when the frequency pointer reach approx. 203–205 kHz.
If necessary adjust P 1601 (ZK 0004).

"Upper Limit" range

Set the frequency pointer at 0 Hz.
Turn "Upper Limit" fully counterclockwise.

Check that the Nixie read out is "Off".
Turn "Upper Limit" fully clockwise.

"Lower Limit" range	Set the frequency pointer at 200 kHz. Turn the "Lower Limit" fully clockwise. Check that the Nixie read out is "Off". Turn the "Lower Limit" fully counterclockwise.

k. BFO Output Amplifier

DC voltage on the BFO output BFO OUTPUT VOLTAGE: "Fully CCW" BFO ATTENUATOR: "10 V Source Imp. 5 Ω" FREQUENCY: 1000 Hz	Check the DC voltage on the "BFO Output" socket:0 V ±50 mV. If necessary adjust P 752 (ZE 0040).
Max. BFO output signal BFO OUTPUT VOLTAGE: "Fully clockwise"	Connect an electronic voltmeter to the "BFO Output" socket. Adjust P 401 for an output voltage of: 11.5 V RMS ±0.5 V. Connect an oscilloscope to the "BFO Output". Load "BFO Output" with a 5 Ω resistor . Check the output voltage: 1.3 – 1.7 V p-p. (square wave) Connect an electronic voltmeter to the "BFO Output". Turn up the BFO OUTPUT VOLTAGE to a 300 mV reading on the voltmeter. Load "BFO Output" with a 5 Ω resistor. Check the output voltage: 6 dB ±1 dB below 300 mV (approx. 150 mV).
BFO ATTENUATOR to "10 V Source Imp. 600 Ω"	Turn up the BFO OUTPUT VOLTAGE for a 10 V reading on the voltmeter. Load "BFO Output" with a 600 Ω, 3 W resistor. Check the output voltage: It should drop 6 dB ±0.2 dB.
BFO Attenuator FREQUENCY: "1000 Hz"	Check all positions of the BFO ATTENUATOR (Source Imp. 600 Ω). Tolerance: ±0.1 dB. Same as above at 200 kHz.
Frequency response BFO ATTENUATOR: "10 V Source Imp. 5 Ω"	Check the frequency response at an output of 10 V. Tolerance: 5 Hz – 200 kHz: 0.1 dB 2 Hz – 5 Hz: 0.15 dB
Noise BFO ATTENUATOR: "10 V Source Imp. 5 Ω" BFO OUTPUT VOLTAGE: "Fully CW"	Connect an electronic voltmeter (2 – 200 000 Hz) to the "BFO Output" Push in BFO STOP and check the output voltage: max. 3 mV.
Noise + HF above 200 kHz FREQUENCY: "100 Hz" BFO ATTENUATOR: "10 V Source Imp. 5 Ω" BFO OUTPUT VOLTAGE: "Fully CCW"	Connect an oscilloscope to the "BFO Output" Max. signal on "BFO Output.": 100 mV RMS. Check the noise in "x 0.1", "x 1" and "x 10" position of FREQUENCY SCALE.
Distortion BFO ATTENUATOR: "10 V Source Imp. 600 Ω" BFO OUTPUT: "10 V" FREQUENCY: "1000 Hz"	Check the distortion at 1000 Hz. 2nd harm. <0.01% 3rd harm. <0.01% Check the distortion in "x 0.1", "x 1" and "x 10" position of FREQUENCY SCALE. Connect a 2 nF capacitor across the "BFO Output." Check the distortion at 1000 Hz. Tolerance: same as above.
BFO ATTENUATOR: "10 V Source Imp. 5 Ω"	Replace the 2 nF capacitor with a 130 Ω resistor. Connect an oscilloscope to the "BFO Output" Check that there is no visible distortion.

I. Signals for 2020

"Fixed Freq. 120 kHz"

Connect a frequency counter to the socket "Fixed Freq. 120 kHz".
Check the frequency: 120 kHz.
Check the amplitude of the 120 kHz signal;1–5 V p-p.

"Var. Freq."

Connect a frequency counter to the socket "Var. Freq.".
Check the frequency: 200 – 240 kHz.
Check the amplitude of the 200 – 240 kHz signal: 160 – 1000 mV p-p.

The BFO section is now adjusted and can be used as signal source for the adjustment of the measuring amplifier.

Throughout the next chapters the control setting marked "Standard" refers to the standard set up of the 2010 given in the Checking Procedure.

Connect "BFO Output" to "Direct Input".

3.3. METER CIRCUIT

a. Mechanical Zero

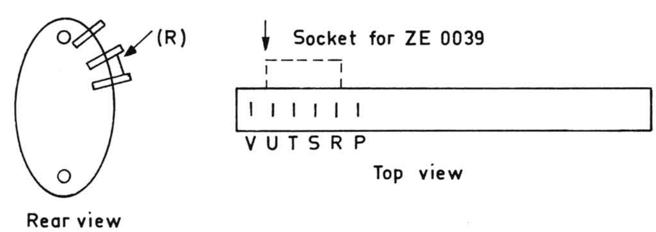
POWER: "Off"

Check the mechanical zero point of the meter.

b. Meter Sensitivity

POWER: "On"
CONTROL SETTING: "Standard"
INPUT ATTENUATOR: "30 mV"
READ OUT SELECTOR: "DC Lin"

Connect a DC voltmeter to "Recorder" output
Adjust "Gain Control" to 4.5 V ± 10 mV on the "Recorder" output
Adjust P 1361 (ZH 0036) for full scale deflection (10 V) on the 2010 meter.



c. Balance Adjustement

POWER: "Off"

Remove the output amplifier ZE 0039.
Shortcircuit the pin "R" and the pin "U" in the socket for ZE 0039.
It can be done by connecting a jumper wire directly between pin "R" and pin "U" in the socket for ZE 0039 or by connecting the jumper wire from pin "U" to the corresponding terminal (R) on the READ OUT SELECTOR. See figure above.

Shortcircuit the "Recorder" output

DC balance of 20 dB amplifier (ZL 0016)

POWER: "On"

Measure the DC voltage at the junction of R 1807 and R 1808 (output of amplifier): 0 V ±0.1 mV
If necessary adjust P 1804.

DC balance of 0 dB amplifier and inverter (ZL 0016)

Measure the DC voltage at the junction of R 1805 and R 1806: 0 V ±1 mV.
If necessary adjust P 1803.

DC balance of 0 dB amplifier (ZL 0015)

Measure the DC voltage at pin A on ZL 0016: 0 V ±0.1 mV.
If necessary adjust P 1403 and P 1405 (ZL 0015).

DC balance of 12 dB amplifier (ZL 0016)

Measure the DC voltage at pin P on ZL 0016: 0 V ±1 mV.
If necessary adjust P 1801.
(Use only an insulated screwdriver).

d. Linearity Adjustment I

POWER: "Off"

Remove the shortcircuits between pin R and U.
Place the ZE 0039 in the unit again.

POWER: "On"
FREQUENCY: "1000 Hz"
BFO ATTENUATOR: "100 mV"
CAL. OFF: "In"

Measure the DC voltage at pin A (ZL 0015).
Adjust the BFO OUTPUT VOLTAGE for exactly 900 mV reading at pin A.

BFO ATTENUATOR: "10 mV"

Check the voltage at pin A: 90 mV ±0.3 mV.
If necessary adjust P 1403.
Recheck the 900 mV reading and repeat the adjustment until the linearity is within the tolerance.

e. Attenuator Adjustment

BFO ATTENUATOR: "10 mV"
BFO OUTPUT VOLTAGE: "CW"

Measure the DC voltage at pin B (ZL 0015).
Switch the BFO ATTENUATOR to "30 mV" and back to "10 mV".
Check the voltage at pin B.
Switch the BFO ATTENUATOR to "3 mV" and back to "10 mV".
Check the voltage at pin B:
Same reading as above. If necessary adjust P 1404.

f. Meter Circuit Sensitivity

BFO ATTENUATOR: "100 mV"

Connect an electronic voltmeter to the "Recorder" output
Adjust BFO OUTPUT VOLTAGE to 10 V ±20 mV on "Recorder" output.

READ OUT SELECTOR: "DC Lin"

Check the DC voltage at the "Recorder" output: 4.5 V ±10 mV.
If necessary adjust P 1802 (ZL 0016).

g. Linearity adjustment II

Check the DC voltage at the "Recorder" output according to the table below.

DC voltage	BFO ATTENUATOR							
	300 mV	100 mV	30 mV	10 mV	3 mV	1 mV	0.3 mV	0.1 mV
max.	14.4		1.44	460	144	46	14.7	
nom.	14.23	4.50	1.423	450	142.3	45	14.2	4–7
min.	14.0		1.40	440	140	44	13.7	
	V			mV				

If not all the values are within the tolerance adjust P 1801 at 45 mV.
Check at 14.2 mV. If necessary fine adjust P 1801.

h. Cross-over Adjustment

BFO ATTENUATOR: "30 mV"
READ OUT SELECTOR: "DC Log"
BFO OUTPUT VOLTAGE: "Fully CCW"

Turn BFO OUTPUT VOLTAGE all the way up and then slowly back.
Watch the meter indication.
At 3 on the 10 V scale a little jump will be seen.

Max. jump ±0.06 V.
If necessary adjust P 1401.
To repeat the check the meter deflection must be above 4 V.

Turn BFO OUTPUT VOLTAGE slowly upwards.
Watch the meter deflection.
At 4 a second jump will be seen.
To minimize the jump adjust P 1402, max. jump ±0.06 V.
To repeat the check the meter must be below 3 V before the voltage is turned up again.

EFFECTIVE AVERAGING TIME: "3 sec."

Check the jumps: same tolerance as above.

There is no interaction between the two adjustments.

i. Lin/Log Converter

FREQUENCY: "1000 Hz"
BFO ATTENUATOR: "100 mV"
READ OUT SELECTOR: "DC Lin"

Connect a DC voltmeter to the "Recorder" output
Adjust BFO OUTPUT VOLTAGE to 4.5 V ±10 mV on "Recorder" output.

READ OUT SELECTOR: "DC Log"
BFO ATTENUATOR: "1 mV"

Check the DC voltage on "Recorder" output: 0 V ±40 mV.
If necessary adjust P 485 (ZK 0003).

BFO ATTENUATOR: "100 mV"

Check the DC voltage on "Recorder" output: 3.6 V ±40 mV.
If necessary adjust P 486 (ZK 0003).
Recheck and if necessary readjust at the two points.

k. Linearity of Meter and Lin/Log Converter

BFO ATTENUATOR: "100 mV"
READ OUT SELECTOR: "DC Lin"

Connect a DC voltmeter to "Recorder" output and adjust BFO OUTPUT VOLTAGE to 4.5 V ±10 mV.

READ OUT SELECTOR: "DC Log"

Check the meter and Lin/Log converter according to the table below.

BFO ATTENUAT.	Meter deflection nominal	max/min	DC voltage nominal	max/min
0.3 V	10 V	10.1 V 9.9 V	4.50 V	4.54 V 4.46 V
0.1 V	8 V	8.1 V 7.9 V	3.60 V	3.64 V 3.56 V
30 mV	6 V	6.1 V 5.9 V	2.70 V	2.74 V 2.66 V
10 mV	4 V	4.1 V 3.9 V	1.80 V	1.84 V 1.76 V
3 mV	2 V	2.1 V 1.9 V	900 mV	940 mV 860 mV
1 mV	0 V	+ 0.1 V − 0.1 V	0 mV	+40 mV −40 mV

l. Frequency Response of Meter Circuit

Logarithmic reading

FREQUENCY: "2 kHz"
READ OUT SELECTOR: "Log AC"
BFO ATTENUATOR: "30 mV"

Adjust BFO OUTPUT VOLTAGE for a 16 dB deflection on the 2010 meter.
Change the frequency to 200 kHz and check the reading: ±0.5 dB
If necessary adjust C 421 (ZL 0015).
Before any adjustment readjust BFO OUTPUT VOLTAGE for the same voltage on "Recorder" output for both 2 and 200 kHz.

Linear reading

READ OUT SELECTOR: "Lin AC"
FREQUENCY: "2 kHz"
BFO ATTENUATOR: "1 V"

As above but adjust C 1422 (ZL 0015) at 200 kHz.

3.4. MEASURING AMPLIFIER

a. Output Amplifier

DC balance

CONTROL SETTING: "Standard"
FREQUENCY RESPONSE: "Selective"
SELECTIVITY CONTROL: "Ext. Filter"

Check the DC voltage on pin "U" of ZE 0039: 0 V ±3 V.
If necessary adjust P 305 (ZE 0039).

b. Frequency Response of Output Amplifier

FREQUENCY: "2 kHz"

Connect the "BFO Output" to the "Ext. Filter Out".
Adjust BFO OUTPUT VOLTAGE for 10 V deflection.

Load "Recorder" output with a 10 kΩ resistor.
Check the frequency response: 2 Hz – 10 Hz ±0.3 dB re 2 kHz
10 Hz – 200 kHz ±0.1 dB re 2 kHz. If necessary adjust C 308 (ZE 0039) at 200 kHz.

Remove the load

Output Section Attenuator

FREQUENCY: "1 kHz"

Connect the "BFO Output" to "Ext. Filter Out".
Adjust BFO OUTPUT VOLTAGE for 19.5 dB deflection.

Check the steps of OUTPUT ATTENUATOR against BFO ATTENUATOR or a special attenuator box.
Tolerance: ±0.1 dB (+ ±0.1 dB from the BFO attenuator).

At 200 kHz the tolerance is ±0.2 dB.

c. Overload Indicator

FREQUENCY RESPONSE: "Selective"
SELECTIVITY CONTROL: "Ext. Filter"

Input signal to "Ext. Filter Out": 1 kHz adjusted to give exactly 56 V peak on "Recorder" output

The "Output Section Overload" should indicate overload within ± 0.5 dB of this condition.

Check at 200 kHz if the indication is still correct and with an oscilloscope that the output voltage has not yet been limited.
If necessary adjust P 304 (ZE 0039).

Check that the relay S 16 (ZK 0004) is activated when the overload indicator comes on.

d. Output Impedance

FREQUENCY RESPONSE: "Selective"
SELECTIVITY CONTROL: "Ext. Filter"

Input signal: 1 kHz adjusted to give exactly 10 V RMS on "Recorder" output

Load the "Recorder" output with a resistor of 1 kΩ.

The "Recorder" output voltage should drop max. 0.5 dB corresponding to an output impedance of 50 Ω.

The above mentioned check should be made at 200 kHz as well.

e. Noise and Hum

READ OUT SELECTOR: "AC"

Short circuit the "Ext. Filter Out" socket.
Check the noise and hum on the recorder output according to the following scheme.

OUTPUT ATTENUAT.	Hum 50 Hz	Hum 100 Hz	Hum 150 Hz	Noise
x 0.001	30 mV	20 mV	30 mV	150 mV
x 1				2.2 mV

f. Distortion

OUTPUT ATTENUATOR: "x 1"

Adjust a 1 kHz input signal to give 10 V RMS on "Output".

Set the Frequency Analyzer (2107) to Rejection Mode at 1 kHz and check the distortion which can be measured down to 0.25% only with these instruments.

However, the tolerance for 2010 is 0.1% at 1 kHz and 0.3% at 50 kHz but to measure this a more complex set up is necessary.

Input Amplifier

g. Sensitivity and Reference

CONTROL SETTING: "Standard"
CAL. OFF: "In"

Connect the "BFO Output" to "Direct Input"

Apply exactly 100 mV – 1 kHz to the "Direct Input".
Adjust the "Direct Sens." for full deflection on the meter (10 V).
AC voltage on the "Recorder" output: 10 V ± 0.1 dB

Push in 50 mV REF.
Adjust P 1 (ZE 0037) for a meter deflection to the "Ref." mark.

Check the range of the "Sens." adjustment in both "Direct" and "Preamp.": + 4 to –10 dB.

Check the range of the "Gain Control" > 10 dB.
Check that the "Uncal." indicator lamp is working.

h. Input Section Attenuator

Control setting as for item Sensitivity and Reference.

FREQUENCY: "200 Hz"

Adjust BFO OUTPUT VOLTAGE for a 19.5 dB reading on the 2010 meter.
Check the steps of INPUT ATTENUATOR against the BFO ATTENUATOR or a special attenuator box.
Tolerance: ± 0.1 dB (+ ± 0.1 dB from the BFO attenuator)

At 200 kHz the tolerance is ± 0.3 dB.
If necessary adjust C 3, C 6, C 8 and C 10 (ZE 0037).

i. Overload Indicator for the Input Amplifier

INPUT ATTENUATOR: "1 V"
FREQUENCY RESPONSE: "Selective"
SELECTIVITY CONTROL: "Ext. Filter"

Input signal: 1 kHz adjusted to give exactly 5.6 V peak on "Ext. Filter In" socket.

The "Input Section Overload" should indicate overload within ±0.5 dB of this condition.

Check at 200 kHz if the indication is still correct and with an oscilloscope that the output has not yet been limited.
If necessary adjust P 51 (ZE 0038).

Check that the relay S 16 (ZK 0004) is activated when the overload indicator comes on.

k. Output Impedance (Input Amplifier)

INPUT ATTENUATOR: "1 V"
FREQUENCY RESPONSE: "Selective"
SELECTIVITY CONTROL: "Ext. Filter"

Input signal: 1 kHz adjusted to give 1 V RMS on "Ext. Filter In" socket.

Load the socket with a resistor of 200 Ω.

The "Ext. Filter In" output voltage should drop max. 1 dB corresponding to an output impedance of <25 Ω.

The above mentioned check should be made at 200 kHz as well.

l. Hum (Input Amplifier)

Shortcircuit the "Direct Input".
Measure the hum on the "Ext. Filter Input".

INPUT ATTENUAT.	50 Hz	100 Hz	150 Hz
10 mV	280 μV	200 μV	280 μV
300 mV 300 V	90 μV	90 μV	90 μV

m. Distortion

INPUT ATTENUATOR: "0.1 V"

Adjust a 1 kHz input signal to give 1 V RMS on "Ext. Filter In" socket.

Set the Frequency Analyzer (2107) to Rejection Mode at 1 kHz and check the distortion, which can only be measured down to 0.25% with these instruments.

The tolerance for Type 2110 is 0.01% at 1 kHz and 0.03% at 50 kHz, but to measure this a much more complex set up is necessary.

n. Noise

CONTROL SETTING: "Standard"
INPUT ATTENUATOR: "10 mV"
OUTPUT ATTENUATOR: "x 0.003"
CAL. OFF: "In"

Shortcircuit the "Direct Input".
Check the noise by reading the meter indication on the 2010.

	Lin	D	A	B	C
μV	7.0	5.0	2.0	2.0	2.0

3.5. COMPRESSOR

a. Compressor Adjustment

FREQUENCY: "1000 Hz"
BFO ATTENUATOR: "1 V"
BFO OUTPUT VOLTAGE: " Fully CW"
METER AND RECORDER: "BFO"
COMPRESSOR SPEED: "1000 dB/sec."

Connect the "BFO Output" to the "Compressor Input".
Adjust "Compressor Voltage" for a 20 dB reading on the 2010 meter.

Measure the AC Voltage at pin A on ZE 0041: 0.5 V RMS.
If necessary adjust P 364.

Adjust "Compressor Voltage" for a 18 dB reading on the 2010 meter.
Change COMPRESSOR SPEED to "3 dB/sec" and check the meter deflection.
Max. deviation: ±0.1 dB.

Connect a DC voltmeter (input impedance > 1 MΩ) to arm of P 362.
Turn P 362 slowly clockwise and watch the 2010 meter. At 0.2 dB increase in the meter reading note the DC voltage. Turn P 632 back to a DC reading of 450–500 mV less than the first reading.

Connect the voltmeter to the arm of P 363.
Turn P 363 slowly till the deflection on the 2010 meter has decreased 0.2 dB. Note the DC voltage and turn P 363 back to 150–200 mV difference from the first reading.

Check the compression according to the Checking Procedure.

b. Frequency Response of the Compressor

BFO ATTENUATOR: "10 V Source Imp. 5 Ω"

Adjust "Compressor Voltage" to 10 V at the "BFO Output".
Check the frequency response: 1 kHz – 200 kHz
Tolerance: ±0.2 dB.

Check the frequency response: 2 Hz - 1000 Hz
Tolerance : ±0.2 dB.

COMPRESSOR SPEED: "3 dB/sec."

Adjust "Compressor Voltage" to 1 V at the "BFO Output".
Check the frequency response: 1 kHz – 200 kHz
Tolerance : ±0.2 dB.

3.6. WEIGHTING NETWORK

a. INPUT SEC. ATTENUATOR: "1 V"
OUTPUT SEC. ATTENUATOR: "x 1"
FREQUENCY RESPONSE: "Selective"
SELECTIVITY CONTROL: "1000 Hz"
EFF. AVERAGING TIME: "0.3 sec."
DIRECT INPUT: "In"
CAL. OFF: "In"
FREQUENCY DIAL: "Lin."

Connect an external oscillator to "Direct Input"
Adjust the input voltage at 1000 Hz to a 19.5 dB deflection on 2010.
Check the meter deflection in position A-B-C-D
Tolerance: ±0.1 dB re lin.
If necessary adjust: Curve A: P 251
Curve B: P 252
Curve C: P 253
Curve D: P 254.

Adjustment of Curve A will affect the adjustment of Curve B-C-D
Check the frequency response of the weighting networks according to the table.

Frequency	C	B	A	D
10 Hz	–12.3 –14.3 –16.3	–36.2 –38.2 –40.2	–68.4 –70.4 –74.0	–25.6 –27.6 –29.6
100 Hz	+ 0.7 – 0.3 – 1.3	– 4.6 – 5.6 – 6.6	–18.1 –19.1 –20.1	– 7.3 – 7.8 – 8.3
1 kHz ref	+ 0.1 0 – 0.1	+ 0.1 0 – 0.1	+ 0.1 0 – 0.1	+ 0.1 0 – 0.1
1.6 kHz	+ 0.4 – 0.1 – 0.6	+ 0.5 0 – 0.5	+ 0.5 + 1.0 + 1.5	+ 4.9 + 5.4 + 5.9
4 kHz	– 0.3 – 0.8 – 1.3	– 0.2 – 0.7 – 1.2	+ 0.5 + 1.0 + 1.5	+ 10.4 + 10.9 + 11.4
8 kHz	– 2.5 – 3.0 – 3.5	– 2.4 – 2.9 – 3.4	– 0.6 – 1.1 – 1.6	+ 5.5 + 6.0 + 6.5
20 kHz	–10.2 –11.2 –12.2	–10.1 –11.1 –12.1	– 8.3 – 9.3 –10.3	– 7.1 – 8.1 – 9.1

3.7. FILTER ADJUSTMENT

a. 1.2 MHz Filter ZS 0174

Test Equipment

1.2 MHz variable oscillator. Resolution < 100 Hz
Frequency Counter
Electronic Voltmeter (Frequency Range > 1.2 MHz)
and x 10 probe.
Multimeter (20000 Ω/V)

Due to the requirement of high stability the filters are artificial aged.
Only minor repair and adjustment should be carried out. (Example: replacement of a transistor).
If a major repair and adjustment is necessary it is recommended to have it done by the factory.

Check of DC voltages.

C 101 (+): +6.8 V	Tolerance: ±0.5 V
C 102 (−): −12 V	Tolerance: ±1 V
C 104 (+): +0.6 V	Tolerance: ±0.1 V
C 105 (+): +8 V	Tolerance: ±0,5 V
C 106 (−): −9 V	Tolerance: ±0.5 V

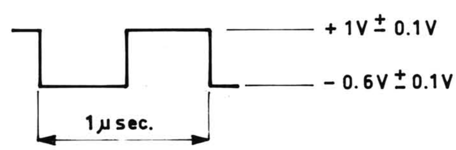
Check of square wave generator V 105 and V 106.

FREQUENCY SCALE: "Log. x 10"

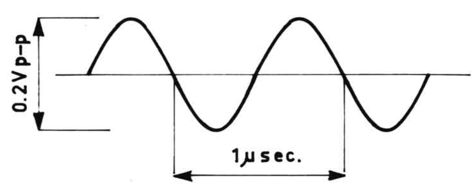
Remove ZE 0038.

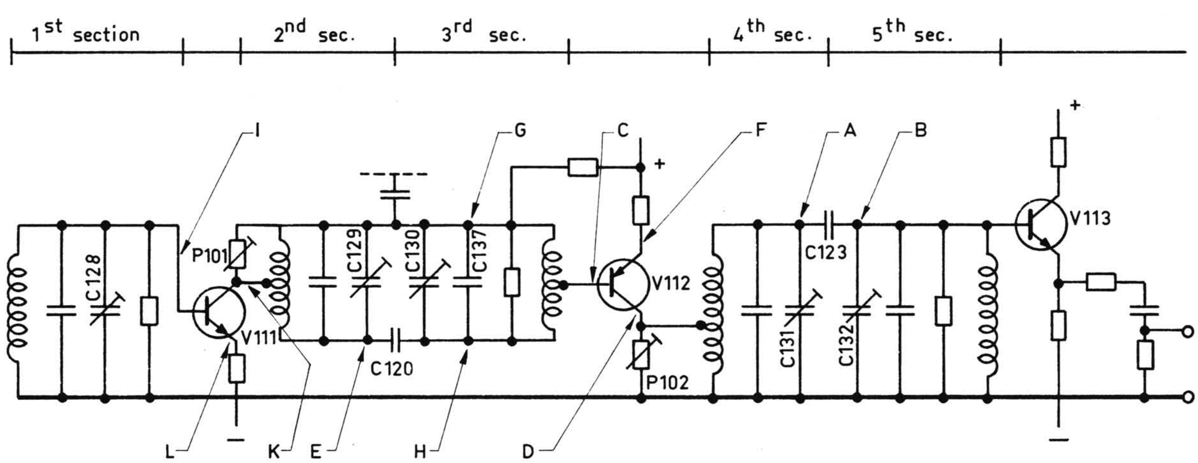
Set the frequency at 200 kHz.

Check the signal on the collector of V 106.

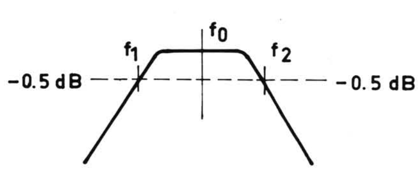


Check the signal on the emitter of V 108 and V 109.





5 th filter section.



Stop the 1–1.2 MHz to the modulator by unsoldering C 107. (1–1.2 MHz input pin V).

Apply a 100 mV – 1200 kHz signal through a 0.1 µF capacitor to point A.
Connect the electronic voltmeter to pin E.
Adjust C 132 for max. peak.
Check the resonance frequency. f_o = 1200 kHz ±0.4 kHz.
To get the best accuracy the resonance frequency is checked in the following way.
Adjust the signal generator for a max. reading on the voltmeter.
Then offset the frequency ± until the meter deflection has decreased 0.5 dB.
Note the frequencies and calculate the resonance frequency f_o after the formular

$$f_o = 0.5\,(f_1 + f_2)$$

4th filter section	Shortcircuit point B to ground. Apply a 100 mV – 1200 kHz signal through a 0.1 μF capacitor to point C. Connect the voltmeter to point D. Check the resonance frequency f_o = 1200 kHz ±0.4 kHz. Remove the shortcircuit from point B.
3rd filter section	Apply a 100 mV – 1200 kHz signal through a 0.1 μF capacitor to point E. Connect the voltmeter to point F. Adjust C 130 for a max. peak. Check the resonance frequency f_o = 1200 kHz ±0.4 kHz.
2nd filter section	Shortcircuit point G and H. Apply a 100 mV – 1200 kHz signal through a 0.1 μF capacitor to point I. Connect the voltmeter to point K. Adjust C 129 for max. peak. Check the resonance frequency f_o = 1200 kHz ±0.4 kHz. Remove the shortcircuit from point G and H.
1st filter section.	Shortcircuit the collector of V 106 to ground (soldering tag). Apply a 1200 kHz approx. 100 mV signal, through a 0.1 μF capacitor to the base of V 109 (Soldering tag). Connect the voltmeter to point L. Adjust the input signal for a 100 mV reading at point L. Adjust C 128 for max. peak. Check the resonance frequency f_o = 1200 kHz ±1 kHz. Remove the shortcircuit.
Adjustment of amplitude	Apply a 1200 kHz ±100 Hz signal to point I. Adjust the input voltage for a 100 mV ±1 mV reading at point L. Check the voltage at point F: 55 mV ±1 mV. If necessary adjust P 101. Check the voltage at pin E: 226 mV ±2 mV. If necessary adjust P 102.
Check of bandwidth	Connect the signal generator through a 0.1 μF capacitor to the base of V 109. (Soldering tag). Shortcircuit the collector of V 106 to ground. Connect the voltmeter to pin E. Input signal = 1200 kHz. Adjust the amplitude for a suitable reading on the voltmeter: approx. 300 mV. Check the 3 dB bandwidth: 10.5 kHz ±0.5 kHz. Check the centre frequency of the filter: 1200 kHz ±1 kHz. Connect C 107 again.
Modulator Balance. INPUT ATTENUATOR: "1 V" OUTPUT ATTENUATOR: "x 0.3" CAL. OFF: "In" FREQUENCY RESPONSE: "Selective" METER AND RECORDER: "Analyzer" SELECTIVITY CONTROL: "316 Hz" FREQUENCY SCALE: "Log. x 0.1" FREQUENCY: "2 Hz"	Adjust "Modulator Balance" to min. deflection on the 2010 meter. Check the range of the upper knob of "Modulator Balance: ±13 dB re min. If necessary adjust P 103 (ZS 0174). Check the range of the lower knob: ±11 dB re. min. If necessary adjust C 115 (ZS 0174). After some warm up time check again "Modulator Balance". Tolerance: as above ±3 dB

b. 30 kHz Bandpass Filter

For adjustment of the 30 kHz bandpass filter the BFO section and the Measuring amplifier of the 2010 is well suited.

SELECTIVITY CONTROL: "316 Hz"

Remove the ZS 0174.
Shortcircuit the base and the collector on V 152.
Unsolder C 155 (Pin B).

1st section

Shortcircuit C 152.
Connect the BFO output signal to pin A.
Input signal: 50 mV – 30 kHz.
Connect "Direct Input" to the emitter of V 156.
Adjust L 151 for max. peak at 30 kHz.
Remove the shortcircuit from C 152.

2nd section

Connect the BFO signal to the top of L 151.
Adjust L 152 for max. peak of 30 kHz.

3rd section

Shortcircuit C 154.
Connect the BFO signal to the junction of L 152/C 152.
Connect "Direct Input" to pin L.
Adjust L 153 for max. peak at 30 kHz.
Remove the shortcircuit from C 154.

4th section

Connect the BFO signal to the top of L 153.
Adjust L 154 for max. peak at 30 kHz.

Adjustment of amplitude

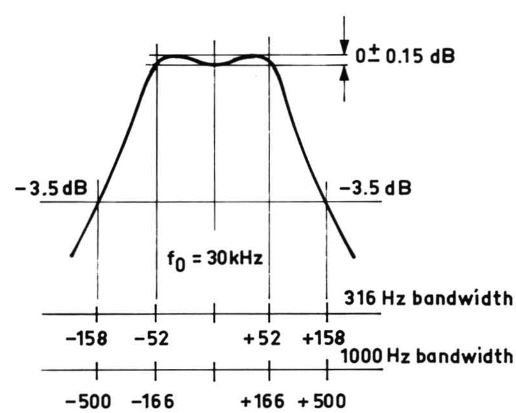
Apply a signal 44 mV, 30 kHz (±0.1 dB, ±10 Hz) to pin A.
Turn P 157 fully CCW.
Check the signal at the emitter of V 156: 58 mV ±0.5 mV.
If necessary adjust P 155.

Check the signal at pin L: 1.15 V ±0.1 dB.
If necessary adjust P 154.

Change SELECTIVITY CONTROL to "1000 Hz"
Check the voltage at pin L: 1.15 V ±0.1 dB.
If necessary adjust P 152.

Change SELECTIVITY CONTROL to "316 Hz"
Adjust P 157 to 1 V ±0.1 dB at pin L.

Check of Bandwidth



SELECTIVITY CONTROL: "316 Hz"

Check the –3.5 dB bandwidth: 316 Hz ±9 Hz.
Check the centre frequency: 30 kHz ±10 Hz.

SELECTIVITY CONTROL: "1000 Hz"

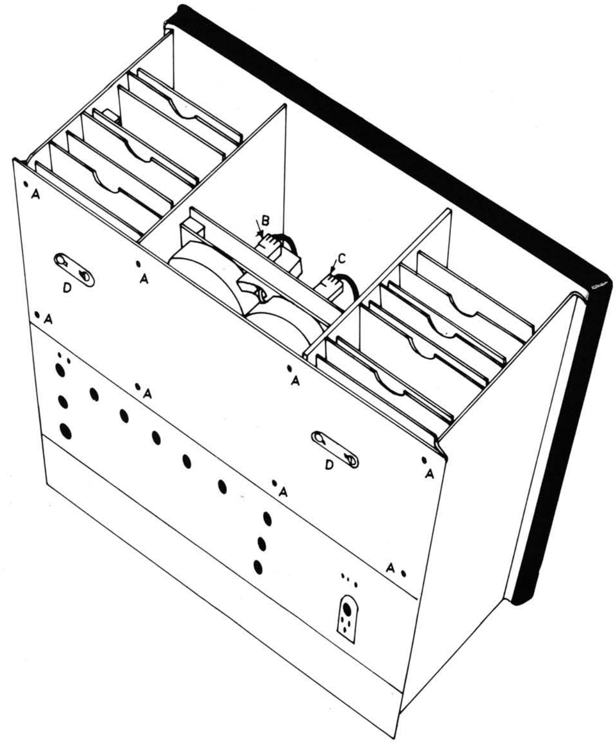
Check the –3.5 dB bandwidth: 1000 Hz ±30 Hz.
Check the centre frequency: 30 kHz ±30 Hz.

Ripple

Check the ripple on the filter top.
Tolerance: ±0.15 dB.

Remove the shortcircuit from V 152.
Replace C 155.
Place the ZS 0175 in the 2010.

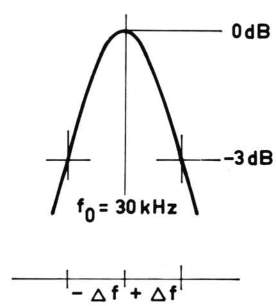
c. 750 Hz Bandpass Filter ZS 0177



To ease the adjustments the filter section can be removed from the 2010.
Disconnect the plugs "B" and "C".
Loosen and disengage the locks "D" for the shaft to the Input and Output attenuator.
Remove the eight screws marked "A".
The filter section can now be removed from the unit.

Connect the ZS 0177 to the 2010 via the plugs "B" and "C"

Remember ground connection between the 2010 and the chassis for the filter section.



30 kHz filter section

Disconnect R 235 at the input (30 kHz signal from ZS 0175).
Apply the BFO signal through R 235.
Input signal: 30000 Hz, 70.7 mV (−3 dB of full scale deflection).

Short circuit L 206 **(not to ground).**
Connect an electronic voltmeter to point A–B.
Adjust L 205 for max. peak at 30 kHz (30 mV range).
Check the −3 dB frequencies $\pm\Delta f$ and adjust L 205 to $+\Delta f = -\Delta f$.

Remove the shortcircuit from L 206.
Connect the BFO signal to the top of C 215.
Adjust L 206 for max. peak at 30 kHz (316 mV range).

Apply the BFO signal to R 235 again.
Check the voltage at R 235: 70.7 mV.
If necessary readjust BFO OUTPUT VOLTAGE.
Measure the signal at point A: 316 mV ±0.1 dB.
If necessary adjust P 207.

Check the −3 dB bandwidth of the filter: approx. 965 Hz.

750 Hz filter section

METER AND RECORDER: "BFO"
FREQUENCY RESPONSE: "Selective"
SELECTIVITY CONTROL: "3.16 Hz"

Connect the BFO signal to C 205 through a 56 kΩ resistor.
Input voltage: approx. 3 V.
Connect an electronic voltmeter to C 207.
Shortcircuit the top of L 202 point "D" to ground.
Adjust L 201 for max. peak at 649.70 Hz.
Amplitude approx. 20 mV.
Check the −3 dB frequencies and adjust L 201 to $+\Delta f = -\Delta f$.
Remove the shortcircuit from L 202.

Connect the BFO signal direct to C 207.
Input voltage: 30 mV.
Connect the voltmeter to the junction of R 210 and the emitter of V 211.
Adjust L 202 to max. peak at 749.7 Hz.
Amplitude approx. 240 mV.
Check the −3 dB frequencies and adjust L 202 to $+\Delta f = -\Delta f$.

Connect the BFO signal to the top of L 202.
Input voltage: 100 mV.
Shortcircuit the top of L 204 to ground.
Connect the voltmeter to the 3rd tap of L 203 (point F).
Adjust L 203 for max. peak at 749.7 Hz.
Amplitude approx. 24 mV.
Check the −3 dB frequencies and adjust L 203 to $+\Delta f = -\Delta f$.
Remove the shortcircuit from L 204.

Connect the BFO signal to C 209.
Input voltage: 70 mV.
Connect the voltmeter to the output (C 206).
Adjust L 204 for max. peak at 749.7 Hz.
Amplitude approx. 0.5 V.
Check the −3 dB frequencies and adjust L 204 to $+\Delta f = -\Delta f$.

Sensitivity adjustment.

SELECTIVITY CONTROL: "100 Hz"

Connect the BFO signal to C 205 through a 56 kΩ resistor.
Input signal: 5 V, 750 Hz.
Connect the voltmeter to the junction of R 210 and the emitter of V 211.
If P 201 has been replaced set P 201 to the middle position. Else leave P 201 in the preadjusted position.
Adjust BFO OUTPUT VOLTAGE for a 140 mV reading on the voltmeter.

SELECTIVITY CONTROL: "3.16 Hz"

Set the BFO frequency for max. peak.
Adjust P 209 to 140 mV deflection on the voltmeter.

SELECTIVITY CONTROL: "10 Hz"

Adjust P 203 to 140 mV deflection on the voltmeter.

SELECTIVITY CONTROL: "31.6 Hz"

Adjust P 202 to 140 mV deflection on the voltmeter.

SELECTIVITY CONTROL: "100 Hz"

Connect the voltmeter to C 206.
Adjust P 208 to 0.5 V deflection on the voltmeter.

SELECTIVITY CONTROL: "3.16 Hz"

Adjust P 210 to 0.5 V deflection on the voltmeter.

SELECTIVITY CONTROL: "10 Hz"

Check the voltage: 0.5 V. If necessary adjust P 203.

SELECTIVITY CONTROL: "31.6 Hz"

Check the voltage: 0.5 V. If necessary adjust P 202.

Check of bandwidth

SELECTIVITY CONTROL: "3.16 Hz"

Measure the −3.5 dB bandwidth: 3.16 Hz ±8 Hz.

Calculate the centre frequency: 749.7 Hz ±0.1 Hz.

If the bandwidth exceeds the tolerance change P 201 to another position and repeat the sensitivity adjustment.

Check the −3.5 dB in "10 Hz", "31.6 Hz" and "200 Hz" positions of SELECTIVITY CONTROL.
Tolerance: ±3%.

AFC adjustment

GAIN CONTROL: "Cal." INPUT SEC. ATTENUATOR: "100 mV" INPUT: "Direct" CAL. OFF: "In" FREQUENCY SCALE: "Lin. x 1" BFO ATTENUATOR: "0.1 V" SELECTIVITY CONTROL: "100 Hz" FREQUENCY RESPONSE: "Selective" METER AND RECORDER: "Analyzer" OUTPUT SEC. ATTENUATOR: "x 1" READ OUT SELECTOR: "Lin. AC" B & T PROGRAM: "Manual" FREQUENCY: "10 kHz" AFC: "Out"	Connect "BFO Output" to "Direct Input". Adjust BFO OUTPUT VOLTAGE for full scale deflection on the 2010 meter. Connect an oscilloscope to pin 6 of V 458. Check the signal: 750 Hz, 20 $V_{p\text{-}p}$ (square wave). Turn INPUT ATTENUATOR to "30 V". Check the signal: symmetrical clipped sine wave. If necessary adjust P 452. Check the signal of the collector of V 452, approx. 22 V p-p symmetrically. Remove the connection between "BFO Output" and "Direct Input". Note the frequency of the Nixie read-out. Push-in the "AFC" button. Adjust P 451 to the same read-out on the Nixie tubes. Release the "AFC" button.
SELECTIVITY CONTROL: "3.16 Hz" 50 mV REF.: "In" INPUT SEC. ATTENUATOR: "100 mV"	Adjust the frequency tuning for max. reading on the 2010 meter. Push-in the "AFC" button. Turn frequency tuning clockwise until the meter reading has decreased 0.5 dB. Release the "AFC" button and read the frequency. (Δf') Push-in the "AFC" button and turn the frequency counter clockwise until the meter reading has decreased 0.5 dB. Release the "AFC" button and read the frequency (Δf') The range of the AFC circuit = $\frac{\Delta f' + \Delta f''}{3.16\ \text{(Bandwidth)}}$ = min. 10.
Pull-in range of AFC	The AFC operates in the four lower bandwidths only.

	SELECTIVITY CONTROL			
	3.16	10	31.6	100
FREQ. SCALE "x 0.1"	10	–	–	–
FREQ. SCALE "x 1"	10	100	100	–
FREQ. SCALE "x 10"	10	100	1000	1000

Capacitors:

C 1201	Polycarbonate	1.5 µF/100 V	CS 0343
C 1202	Ceramic	390 pF/400 V	CK2391
C 1220	Electrolytic	6800 µF/ 25 V	CE 0450
C 1221,1222	-	1250 µF/ 40 V	CE 0434

Coils:

L 1231,1232	Filter coil	LJ 0008

Selectors and Relays:

O 1	Input Attenuator	OH 2036
O 2	Output Attenuator	OH 2037
O 3	Read Out Selector	OH 2038
O 4	Effective Averaging Time	OH 3007
O 5	Selectivity Control	OH 3006
O 6	B & T Program	OH 3005
O 7	Compressor Speed	OH 2034
O 8	Frequency Scale	OG 3000
O 9	BFO Attenuator	OG 3001
O 10,11	BFO Ref., BFO Stop	NT 0023
O 12	Counting Time Increase	OH 3047
O 13	Sweep Control	OH 2035
O 14	Push button Selector	OJ 0010
O 15	- -	OJ 0011
O 16	Power Switch	NN 0014
O 17	Overload and Frequency marking	OH 3024
S 1-8	Relay	OC 0024
S 9	-	OC 0028
S 10,11,12	-	OC 0029
S 13	-	OC 0028
S 15,16	-	OC 0021

Potentiometers:

P 1201	"Gain Control"	10 kΩ	PP3116
P 1202,1203	"Modulator Balance"	20 kΩ	PP 3200
P 1204	"Frequency Increment"	5 kΩ	PX 2516
P 1205	"BFO Output Voltage"	5 kΩ	PQ 2505
P 1206	"Compressor Voltage"	25 kΩ	PP 3254
P 1551	Frequency Scale Potm.	2.2 kΩ	PD 2200

Diodes:

Q 1201-1203	Si. diode.	150 V/300 mA	BAX 16	QV 0217
Q 1236	-	150 V/300 mA	BAX 16	QV 0217

Resistors:

R 1202	Carbon	0.25 W	5%	2.2MΩ	RB 6220
R 1203	-	-	-	330 kΩ	RB 5330
R 1204	-	-	-	8.2MΩ	RB 6820
R 1205	-	-	-	1.5MΩ	RB 6150
R 1206	-	-	-	220 kΩ	RB 5220
R 1207,1208	-	-	-	10 kΩ	RB 4100
R 1209	-	-	-	330 kΩ	RB 5330
R 1218	Metal	-	1%	511 Ω	RF 2511
R 1232	Carbon	-	5%	560 Ω	RB 2560

Scales:

Supplied with the Instrument

Voltage and dB scale	SA 00
dB and voltage scale (Lin.)	SA 00
dB and voltage scale (Log. 50 dB)	SA 00
P.S.D. scale	SA 00
Scale for 1" microphone	SA 00
Scale for 1/2" microphone	SA 00
Scale for 6–17 mV/g accelerometer	SA 0058
Log/Lin scale	SA 0059
Uncalibrated scale (0 – 100)	SA 0087

Scales

Accessories

Absorption Coefficient scale	SA 0054
0.8 - 2.6 mV per N/m² microphone scale	SA 0060
0.4 - 1.06 mV per N/m² microphone scale	SA 0083
dB/dB m scale	SA 0084
1.7 - 6 mV/g accelerometer scale	SA 0142
17 - 60 mV/g accelerometer scale	SA 0143
60 - 170 mV/g accelerometer scale	SA 0144

Miscellaneous:

Power cord		AN 0010
Rubber feet		DF 7010
Guides for PC boards	89.6 mm	DZ 9013
Guides for PC boards (large)	130 mm	DZ 9037
Guides for PC boards	8 mm	DZ 9076
Moving Coil Instrument		IM 0028
Metal Cabinet		KQ 0084
Knob 50 mm		SN 5018
Retaining ring for do.		DB 0849
Screw for do.		YQ 2087
2 mm Allen key for above		QA 0043
Knob 31.5 mm		SN 3222
Knob 25 mm		SN 2527
Knob 25 mm		SN 2522
Knob 10 mm		SN 1022
Retaining ring for 25 and 31.5 mm Knob		DB 0674
M 4 Allen screw for do.		YQ 2083
2 mm Allen key for above		QA 0043
7 pin socket Overload and F. marking		JJ 0709
8 pin socket B & T Program		JJ 0802
10 pin socket		JJ 1001
18 pin socket		JJ 18
18 pin socket		JJ 18
Multi socket 2 x 10 pin		JJ 20
Socket for neon lamp		JO 00
Socket for scale lamp		JO 00
Socket for dial lamp		JO 00
Bezel for Frequency scale		SO 01
Frequency pointer		SV 00
Power transformer		TN 0039

Lamps and Fuses:

Scale Lamps	VS 1273
Neom Lamp	VS 0015
Neon Lamp (decimal point)	VS 0016
Fuse 0.5 Amp.	VF 0023

Printed Circuit Boards with Components:

Frequency Counter	ZD 0188 ZY 0029
Input Att. and 1st Input Amplifier	ZE 0037
2nd Input Amplifier	ZE 0038
Output Att. and Amplifier	ZE 0039
BFO Amplifier	ZE 0040
Compressor Amplifier	ZE 0041
Regulation Amplifier	ZE 0042
Power Supply ± 20 V and + 5 V	ZG 0028
Power Supply ± 80 V and + 24 V	ZG 0029
Power Supply for Preamplifier	ZG 0172
Interconnecting Circuit (Input Sec.)	ZH 0029
Control Circuit	ZH 0030
Contact Circuit	ZH 0031
Interconnecting Circuit for V.C.O.	ZH 0032
Interconnecting Circuit for Power Supply	ZH 0033
Frequency Adjustment Circuit	ZH 0034
Sensitivity Control	ZH 0035
Averaging Time Circuit	ZH 0036
Interconnecting Circuit (Output sec.)	ZH 0037
Interconnecting Circuit (BFO)	ZH 0038
Interconnecting Circuit (Comp.)	ZH 0039
Push button circuit	ZH 0040
Fixed Oscillator and Frequency Converter	ZI 0008
Oscillator and Modulator for V.C.O.	ZI 0009
AFC Circuit and Lin/Log Converter	ZK 0003
BFO Comparator and Marking Circuit	ZK 0007
Integrator and Range Selector	ZL 0015
Active Diodes and Amplifiers	ZL 0016
Frequency Converter	ZM 0010
Lin/Log Converter for V.C.O.	ZM 0043
BFO Modulator	ZM 0012
DABC Filter and Selector Circuit	ZS 0173
1.2 MHz Bandpass Filter	ZS 0174
30 kHz Bandpass Filter	ZS 0175
750 Hz Bandpass Filter	ZS 0177
Frequency Converter for Var. Osc.	ZZ 0013
Control Circuit for V.C.O.	ZZ 0041
BFO Attenuator	ZX 0012

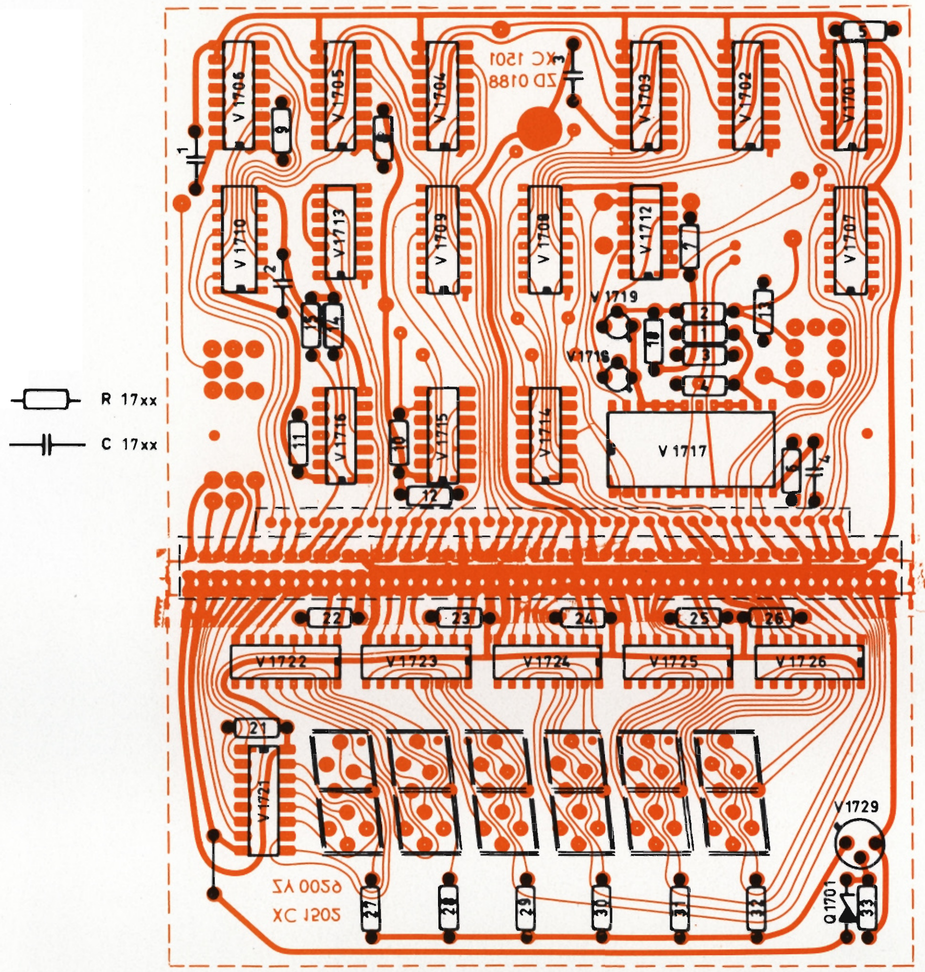

Direct Input
Pol. Voltage
Insert Voltage
Preamp. Input
Gain Control
ZE 0037
ZE 0038
ZS 0174
ZS 0175
ZS 0177
ZS 0173
ZE 0039
ZL 0016
ZL 0015
Ext. Filter to Input
Ext. Filter from Output
Recorder
DC Out
AC In
Overload
ZI 0009
ZZ 0041
ZM 0043
ZK 0003
ZM 0010
B & T Program
ZH 0030
ZH 0036
Averaging Time
ZH 0034
ZH 0031
Freq. Increment
Sweep Control
Clutch
BFO Ref. Signal
Ext. Var. Freq 1.0 – 1.2 MHz
Read Out Selector
AFC
Linear Freq. Resp.
Selective Freq. Resp.
Bandwidth Compens.
Analyzer
BFO
Compressor Input
Frequency Control Voltage In
Frequency Control Voltage Out
Var. Freq.
Fixed Freq. 120 kHz
Overload and Frequency Marking
ZZ 0013
ZI 0008
ZE 0042
ZE 0041
BFO Stop
ZK 0007
ZG 0029
ZG 0028
ZG 0172
Frequency Display
Latch
Decode Counters
Time Base
Counter Gate
ZD 0188
Counting Time
Frequency Scale
Fixed Freq. 1.2 MHz
Var. Freq. 1.0 – 1.2 MHz
ZM 0012
ZE 0040
BFO - Output Voltage
XZ 0012
BFO Attenuator
Output Section Attenuator
Input Section Attenuator
BFO Output
Power

BRÜEL & KJÆR
Nærum - Denmark

Circuit and Layout Diagrams with Parts List

ZD 0188
ZY 0029

Frequency Counter



Viewed from the component side

Remarks to position numbers: Add. 1700 to all numbers

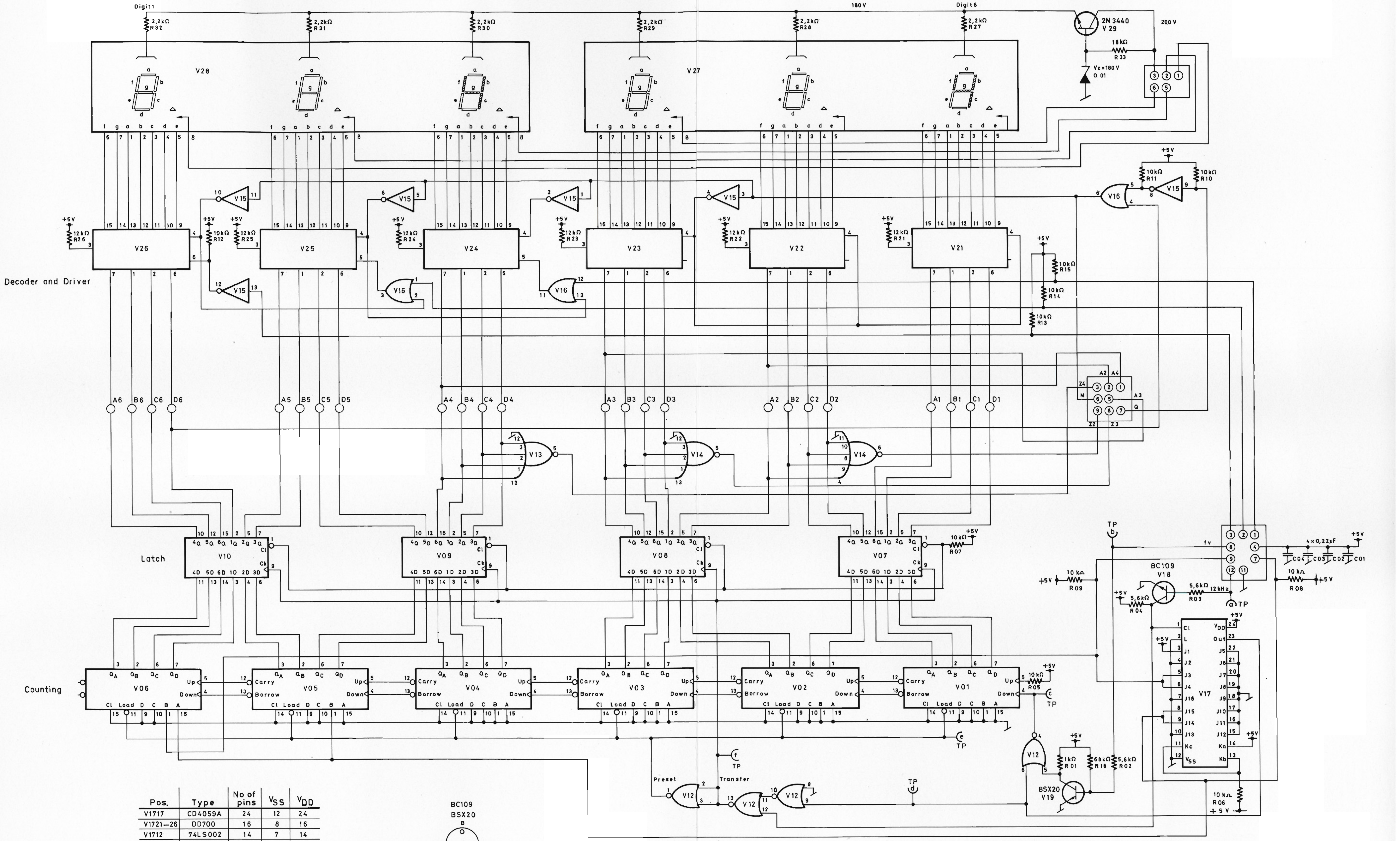
ZD 0188

C 1-4	Ceramic			0,22 μF/ 30 V	CK 5220
R 1	Carbon	1/4 W	5%	1 kΩ	RB 3100
R 2-4	-	-	-	5,6 kΩ	RB 3560
R 5-12	-	-	-	10 kΩ	RB 4100
R 13	-	-	-	68 kΩ	RB 4680
R 14,15	-	-	-	10 kΩ	RB 4100
V 1-6	U/D Decade Counter			74LS192	VD 1009
V 7-10	6 × D Flip-Flop			74LS174	VD 1006
V 12	4 × 2 Input NOR			74LS02	VD 1000
V 13,14	2 × 5 Input NOR			74LS260	VD 1036
V 15	6 × INV			74LS05	VD 1035
V 16	4 × 2 Input OR			74LS32	VD 1034
V 17	Programmable Counter			CD4059A	VD 2067
V 18	Silicon	NPN		BC109	VB 0047
V 19	-	-		BSX20	VB 0513
	Printed Circuit Board				XC 1501
	14-pin Socket for dual-in-line				JJ 1408
	16-pin Socket for dual-in-line				JJ 1622
	20-pin Socket for dual-in-line				JJ 2012
	24-pin Socket for dual-in-line				JJ 2406

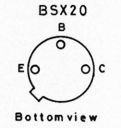
ZD 0188
ZY 0029

ZY 0029

Q 1	Ze.			IN5279	174,5-183,6 V/0,4 W	QV 1373
R 21-26	Carbon	1/4 W	5%		12 kΩ	RB 4120
R 27-32	-	-	-		2,2 kΩ	RB 3220
R 33	-	-	-		18 kΩ	RB 4180
V 21-26	Display Driver			DD700		VD 0060
V 27,28	Display					VU 0002
V 29	Silicon		NPN	2N3440		VB 0250
	Printed Circuit Board					XC 1502
	Socket for diaplsy					JV 0009
	16-pin Socket for dual-in-line					JJ 1622
	10-pin Plug					JP 1007
	20-pin Plug					JP 2006
	Single Pole Pin					JL 0050



Pos.	Type	No of pins	V_{SS}	V_{DD}
V1717	CD4059A	24	12	24
V1721—26	DD700	16	8	16
V1712	74LS002	14	7	14
V1715	74LS005	"	"	"
V1716	74LS032	"	"	"
V1707–10	74LS174	16	8	16
V1713–14	74LS260	14	7	14
V1701–06	74LS192	16	8	16



Divid by 1201 (Counting Time 0,1 S.)
—"— " 12001 (Counting Time 1 S.)

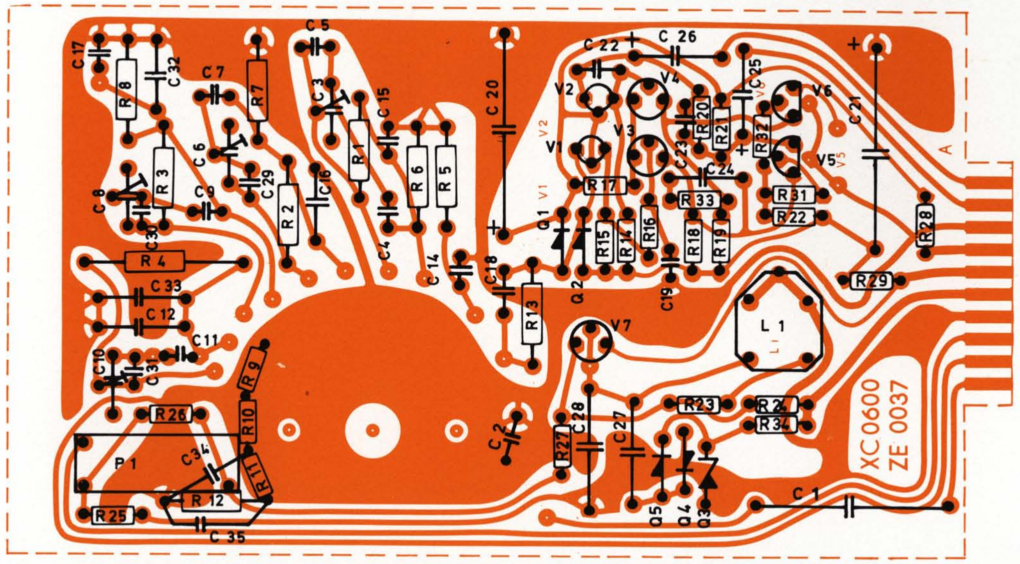
Add. 1700 To all Position Numbers

2010 from serial no. 669811

669811 - 28.4.77 - ZD0188 - 2010

Circuit and Layout Diagram with Parts List

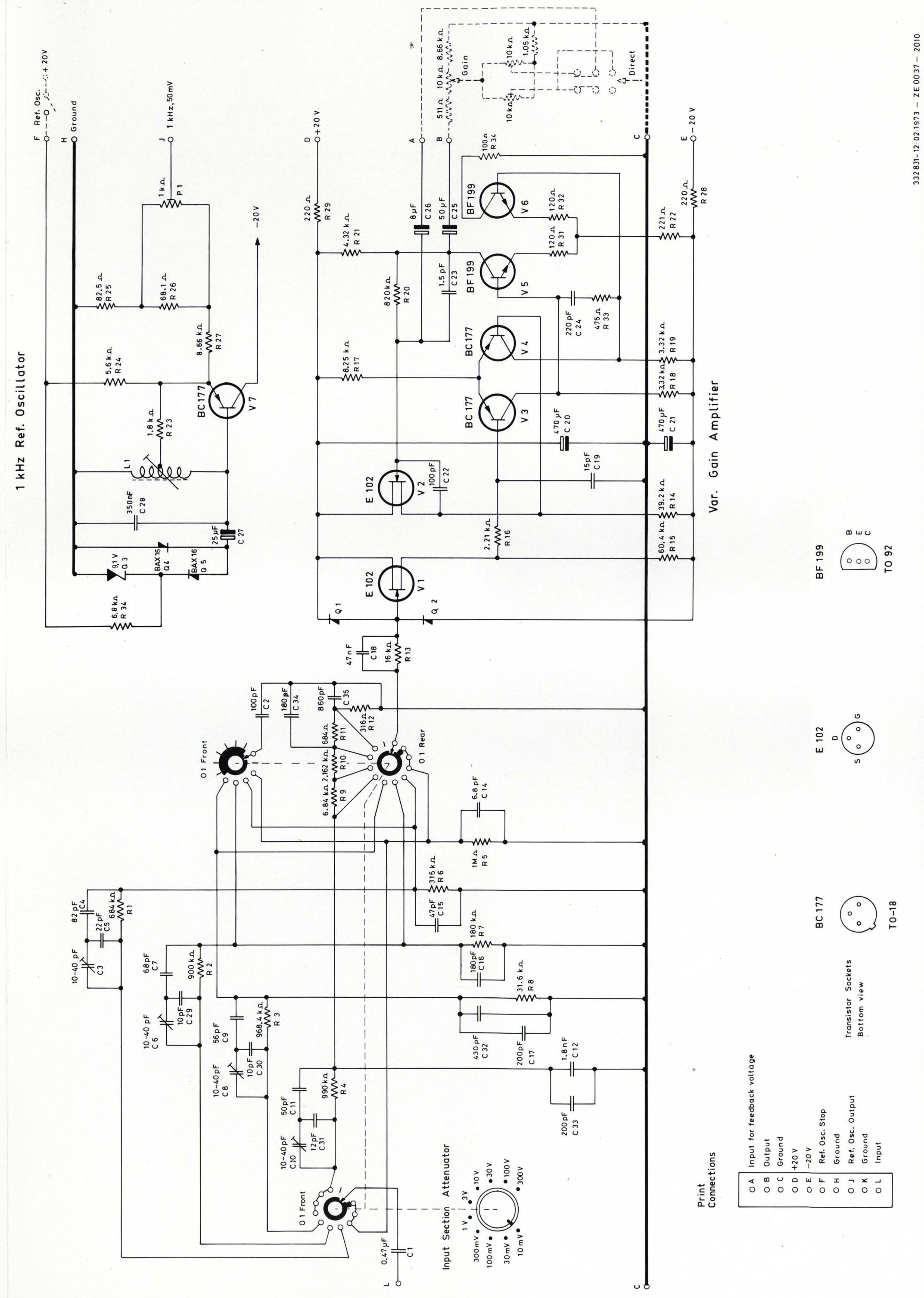
ZE 0037
Input Attenuator and Amplifier



A. Feed back
B. Out
C. Ground
D. + 20 V
E. –20 V
F. Ref. Osc. Stop
H. Ground
J. Out
K. Ground
L. In

CIRCUIT DIAGRAM REF.	COMPONENT TYPE		STOCK REF.
C 1	Polycarbonate	0.47 μF/250 V	CS 0021
C 3	Trimmer	10-40 pF/160 V	CV 0026
C 4	Ceramic	82 pF/ 63 V	CK 1820
C 5	-	22 pF/400 V	CK 1220
C 6	Trimmer	10-40 pF/160 V	CV 0026
C 7	Ceramic	68 pF/400 V	CK 1680
C 8	Trimmer	10-40 pF/160 V	CV 0026
C 9	Ceramic	56 pF/400 V	CK 1560
C 10	Trimmer	10-40 pF/160 V	CV 0026
C 11	Ceramic	50 pF/400 V	CK 0058
C 12	Polystyrene	1.8 nF/ 63 V	CT 1153
C 14	Ceramic	6.8 pF/400 V	CK 0680
C 15	-	47 pF/400 V	CK 1470
C 16	-	180 pF/400 V	CK 2180
C 17	-	200 pF/400 V	CK 0078
C 18	-	4.7 nF/500 V	CK 3470
C 19	-	15 pF/400 V	CK 1150
C 20,21	Electrolytic	640 μF/ 16 V	CE 0209
C 23	Ceramic	1.5 pF/250 V	CK 0151
C 24	Polystyrene	220 pF/125 V	CT 1141
C 25	Electrolytic	50 μF/ 6.4 V	CE 0204
C 26	-	8 μF/ 40 V	CE 0414
C 27	-	25 μF/ 6.4 V	CE 0203
C 28	Polycarbonate	330 nF/250 V	CS 0035
C 29,30	Ceramic	10 pF/400 V	CK 1100
C 31	-	12 pF/400 V	CK 0095
C 32	Polystyrene	430 pF/125 V	CT 1145
C 33	Ceramic	200 pF/400 V	CK 0078
C 34	Polystyrene	180 pF/125 V	CT 1140
C 35	-	860 pF/125 V	CT 1163
L 1	Coil	75 mH	LB 0694
O 1E	Selector wafer		OD 1009
O 1F	-		OD 1010
P 1	Potm. Wire w.0.5 W lin.	1 kΩ	PG 2102
Q 1,2	Si. Diode 100 V/225 mA	EC 401	QV 0213
Q 3	Zener Diode 9.1 V/0.4 W	ZF 9.1	QV 1109
Q 4,5	Si. Diode 150 V/0.3 A	BAX 16	QV 0217

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 1	Metal	1/2 W	5%	684 kΩ	RF 6009
R 2	-	-	-	900 kΩ	RF 6014
R 3	-	-	-	968.4 kΩ	RF 6015
R 4	-	-	-	990 kΩ	RF 6016
R 5	-	-	-	1MΩ	RF 6010
R 6	-	1/4 W	-	316 kΩ	RF 6008
R 7	-	-	-	100 kΩ	RF 6013
R 8	-	-	-	31.6 kΩ	RF 6012
R 9	-	-	-	6.84 kΩ	RF 6007
R 10	-	-	-	2.162 kΩ	RF 6005
R 11	-	-	-	684 Ω	RF 6002
R 12	-	-	-	316 Ω	RF 6000
R 13	-	1/2 W	2%	16 kΩ	RF 0106
R 14	-	1/4 W	1%	39.2 kΩ	RF 4392
R 15	-	-	-	60.4 kΩ	RF 4604
R 16	-	-	-	2.21 kΩ	RF 3221
R 17	-	-	-	8.25 kΩ	RF 3825
R 18,19	-	-	-	3.32 kΩ	RF 3332
R 20	Carbon	-	5%	820 kΩ	RB 5820
R 21	Metal	-	1%	4.32 kΩ	RF 3432
R 22	-	-	-	221 Ω	RF 2221
R 23	Carbon	-	5%	1.8 kΩ	RB 3180
R 24	-	-	-	5.6 kΩ	RB 3560
R 25	Metal	-	1%	82.5 Ω	RF 1825
R 26	-	-	-	68.1 Ω	RF 1681
R 27	-	-	-	8.66 kΩ	RF 3866
R 28,29	Carbon	-	5%	220 Ω	RB 2220
R 31,32	-	-	-	120 Ω	RB 2120
R 33	Metal	-	1%	475 Ω	RF 2475
R 34	Carbon	-	5%	6.8 kΩ	RB 3680
V 1,2	FET	N spec.		E 102	VB 1010
V 3,4		PNP		BC 177	VB 0071
V 5,6		NPN		BF 173	VB 0065
V 7		PNP		BD 177	VB 0071
	Printed Circuit Board				XC 0600



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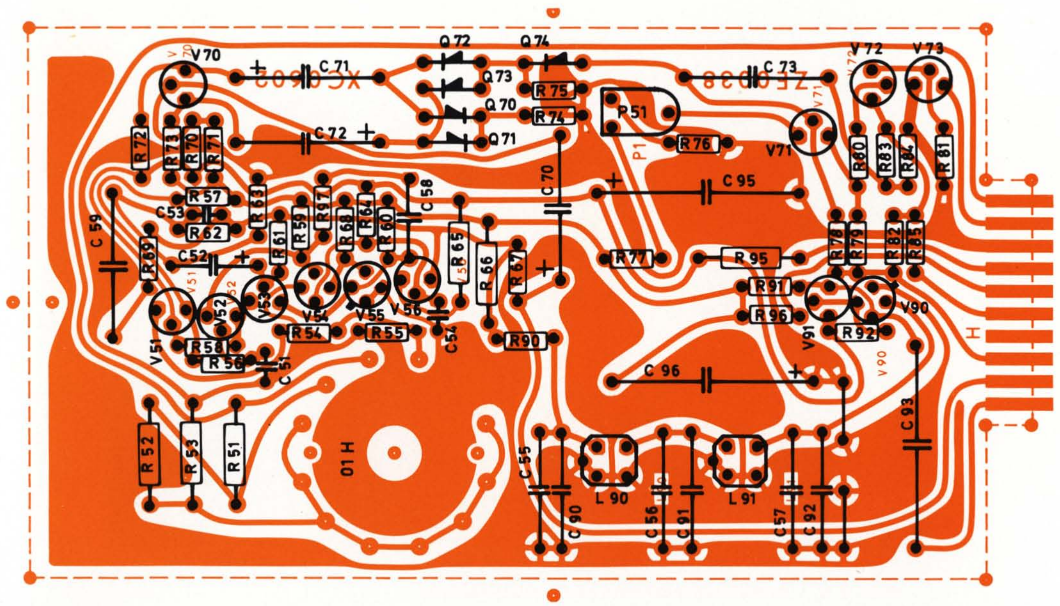
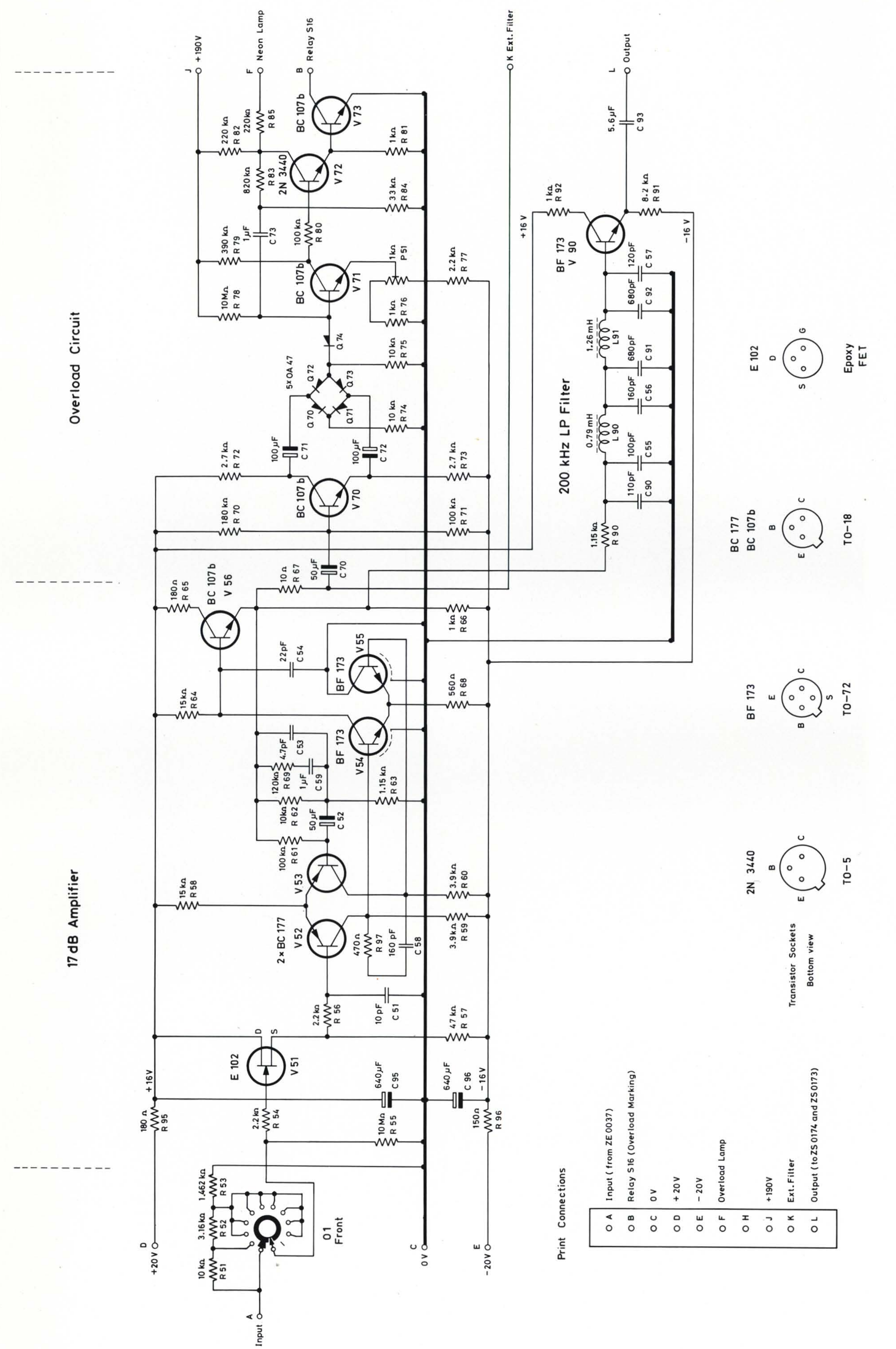
Circuit and Layout Diagram with Parts List ZE 0038

Second Input Amplifier



CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
C 51	Ceramic			10 pF/400 V	CK 1100
C 52	Electrolytic			50 µF/ 6.4 V	CE 0204
C 53	Ceramic			4.7 pF/400 V	CK 0470
C 54	-			22 pF/400 V	CK 1220
C 55	Polystyrene	1%		100 pF/125 V	CT 1133
C 56	-	1%		160 pF/125 V	CT 1130
C 57	-	1%		120 pF/125 V	CT 1137
C 58	-	1%		160 pF/125 V	CT 1130
C 59	Polycarbonate			1 µF/100 V	CS 0336
C 70	Electrolytic			50 µF/ 25 V	CE 8965
C 71,72	-			100 µF/ 15 V	CE 0310
C 73	Polycarbonate			1 µF/100 V	CS 0336
C 90	Polystyrene	1%		110 pF/125 V	CT 1136
C 91,92	-	1%		680 pF/125 V	CT 1134
C 93	Polycarbonate			5.6 µF/100 V	CS 0346
C 95,96	Electrolytic			640 µF/ 16 V	CE 0209
L 90	Coil			0.79 mH	LB 0698
L 91	-			1.26 mH	LB 0699
O 1H	Selector wafer				OD 1008
P 51	Potm. Carbon	0.1 W	lin.	1 kΩ	PG 2101
Q 70-74	Ge. Diode	25 V/110 mA		OA 47	QV 0094
R 51	Metal	0.25 W	0.5%	10 kΩ	RF 6011
R 52	-	-	-	3.16 kΩ	RF 6006
R 53	-	-	-	1.462 kΩ	RF 6004
R 54	Carbon	-	5%	2.2 kΩ	RB 3220
R 55	-	0.3 W	10%	10MΩ	RA 0025
R 56	-	0.25 W	5%	2.2 kΩ	RB 3220
R 57	-	-	-	47 kΩ	RB 4470
R 58	-	-	-	15 kΩ	RB 4150
R 59,60	-	-	-	3.9 kΩ	RB 3390
R 61	-	-	-	100 kΩ	RB 5100
R 62	Metal	-	1%	9.31 kΩ	RF 3931
R 63	-	-	-	1.15 kΩ	RF 3115

CIRCUIT DIAGRAM REF.	COMPONENT TYPE					STOCK REF.
R 64	Carbon		-	5%	15 kΩ	RB 4150
R 65	-		0.3 W	10%	180 Ω	
R 66	-		-	-	1 kΩ	
R 67	-		0.25 W	5%	10 Ω	RB 1100
R 68	-		-	-	560 Ω	RB 2560
R 69	Metal		-	1%	80.6 kΩ	RF 4806
R 70	Carbon		-	5%	180 kΩ	RB 5180
R 71	-		-	-	100 kΩ	RB 5100
R 72,73	-		-	-	2.7 kΩ	RB 3270
R 74,75	-		-	-	10 kΩ	RB 4100
R 76	-		-	-	1 kΩ	RB 3100
R 77	-		-	-	2.2 kΩ	RB 3220
R 78	-		0.3 W	10%	10MΩ	RA 0025
R 79	-		0.25 W	5%	390 kΩ	RB 5390
R 80	-		-	-	100 kΩ	RB 5100
R 81	-		-	-	1 kΩ	RB 3100
R 82	-		-	-	220 kΩ	RB 5220
R 83	-		-	-	820 kΩ	RB 5820
R 84	-		-	-	33 kΩ	RB 4330
R 85	-		-	-	220 kΩ	RB 5220
R 90	Metal		-	1%	1.15 kΩ	RF 3115
R 91	Carbon		-	-	8.2 kΩ	RF 3820
R 92	-		-	5%	2.7 kΩ	RB 3270
R 95	-		0.3 W	10%	180 Ω	
R 96	-		0.25 W	5%	150 Ω	RB 2150
R 97	-		-	-	470 Ω	RB 2470
V 51	FET		N		E 102	VB 2045
V 52,53	Si.		PNP		BF 177	VB 0071
V 54,55	-		NPN		BF 173	VB 0065
V 56	-		NPN		BC 107	VB 0257
V 70,71	-		NPN		BC 107	VB 0257
V 72	-		NPN		2 N 3440	VB 0250
V 73	-		NPN		BC 107	VB 0257
V 90	-		NPN		BF 173	VB 0065
V 91	-		PNP		BC 177	VB 0071
	Printed Circuit Board					XC 0602



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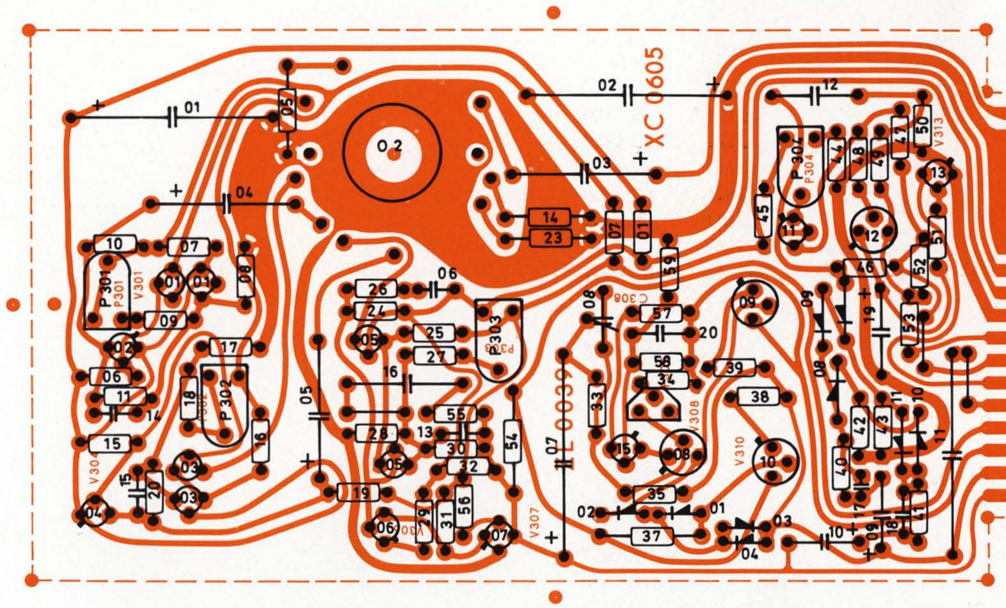
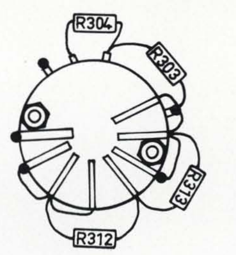
Circuit and Layout Diagrams with Parts List

ZE 0039

Output Amplifier





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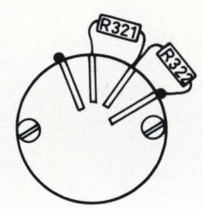

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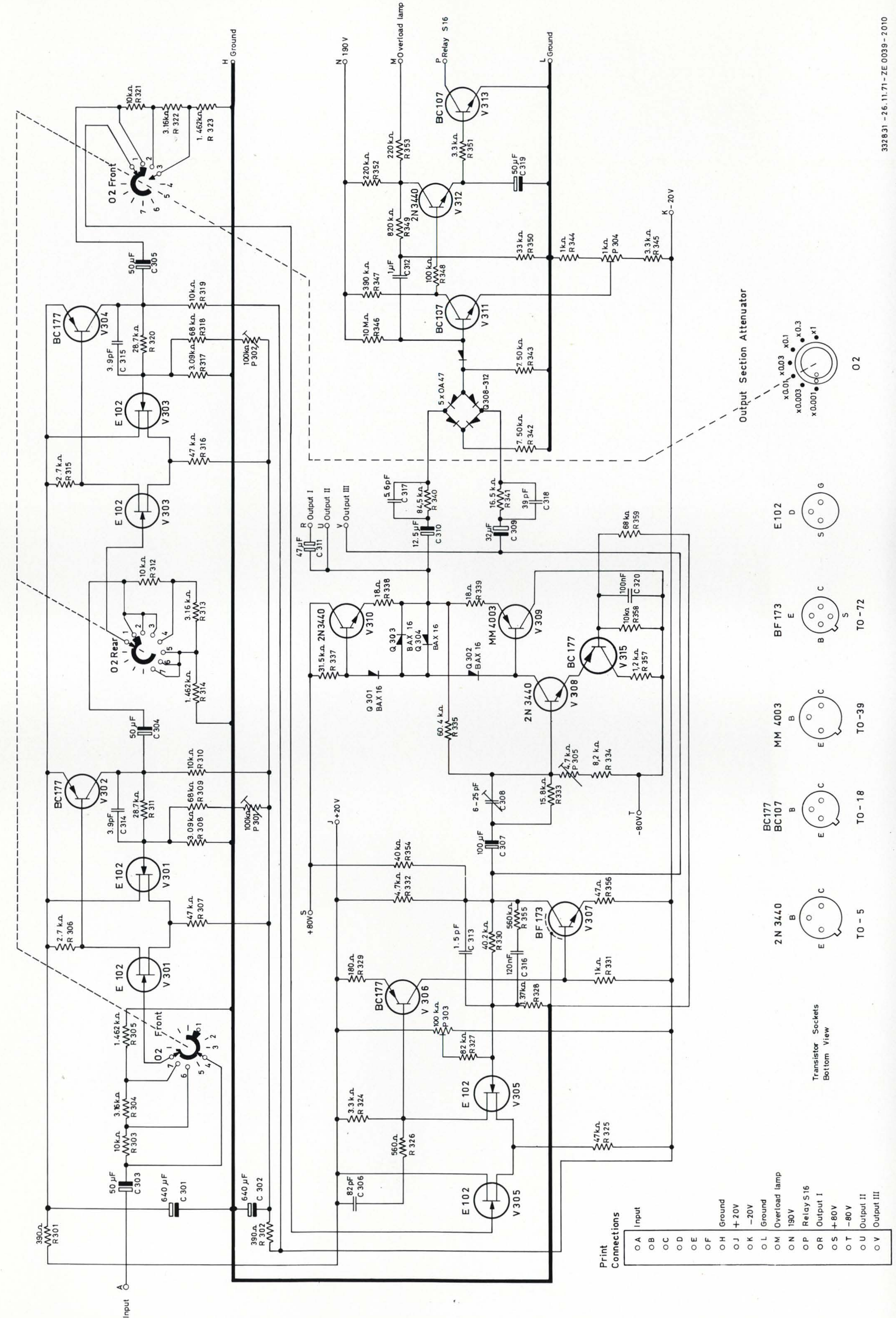
CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
C 301,302	Electrolytic			640 µF/ 25 V	CE 0419
C 303-305	-			50 µF/ 25 V	CE 8965
C 306	Ceramic			82 pF/ 63 V	CK 1820
C 307	Electrolytic			100 µF/100 V	CE 0612
C 308	Trimmer			6–25 pF/250 V	CV 0037
C 309	Electrolytic			32 µF/ 4 V	CE 0100
C 310	-			12.5 µF/ 25 V	CE 0416
C 311	-			25 µF/ 35 V	CE 0412
C 312	Polycarbonate			1 µF/100 V	CS 0384
C 313	Ceramic			1.5 pF/400 V	CK 0150
C 314,315	-			3.9 pF/400 V	CK 0390
C 316	Polycarbonate			0.12 µF/250 V	CS 0050
C 317	Ceramic			5.6 pF/250 V	CK 0561
C 318	-			39 pF/400 V	CK 1391
C 320	Polycarbonate			100 nF/250 V	CS 0402
O 2C	Selector wafer				OD 1005
O 2B	-				OD 1006
P 301-303	Potm. Cermet0.5 W.		lin.	100 kΩ	PG 4108
P 304	-	-	-	1 kΩ	PG 2108
P 305	-	-	-	4.7 kΩ	PG 2471
Q 301-304	Si. Diode	150 V/300 mA		BAX 16	QV 0217
Q 308	Ge. Diode	25 V/110 mA		OA 47	QV 0094
R 301-302	Carbon	0.25 W	5%	390 Ω	RB 2390
R 303	Metal	-	0.5%	10 kΩ	RF 6011
R 304	-	-	-	3.16 kΩ	RF 6006
R 305	-	-	-	1.462 kΩ	RF 6004
R 306	Carbon	-	5%	2.7 kΩ	RB 3270
R 307	-	-	-	47 kΩ	RB 4470
R 308	Metal	-	1%	3.09 kΩ	RF 3309
R 309	Carbon	-	5%	68 kΩ	RB 4680
R 310	-	-	-	10 kΩ	RB 4100

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 311	Metal	-	1%	28.7 kΩ	RF 4287
R 312	-	-	0.5%	10 kΩ	RF 6011
R 313	-	-	-	3.16 kΩ	RF 6006
R 314	-	-	-	1.462 kΩ	RF 6004
R 315	Carbon	-	5%	2.7 kΩ	RB 3270
R 316	-	-	-	47 kΩ	RB 4470
R 317	Metal	-	1%	3.09 kΩ	RF 3309
R 318	Carbon	-	5%	68 kΩ	RB 4680
R 319	-	-	-	10 kΩ	RB 4100
R 320	Metal	-	1%	28.7 kΩ	RF 4287
R 321	-	-	0.5%	10 kΩ	RF 6011
R 322	-	-	-	3.16 kΩ	RF 6006
R 323	-	-	-	1.462 kΩ	RF 6004
R 324	Carbon	-	5%	3.3 kΩ	RB 3330
R 325	-	-	-	47 kΩ	RB 4470
R 326	-	-	-	560 Ω	RB 2560
R 327	-	-	-	82 kΩ	RB 4820
R 328	Metal	-	1%	1.37 kΩ	RF 3137
R 329	Carbon	-	5%	180 Ω	RB 2180
R 330	Metal	-	1%	40.2 kΩ	RF 4402
R 331	Carbon	-	5%	1 kΩ	RB 3100
R 332	-	-	-	4.7 kΩ	RB 3470
R 333	Metal	-	1%	15.8 kΩ	RF 4158
R 334	-	-	-	8.2 kΩ	RF 3820
R 335	-	-	-	60.4 kΩ	RF 4604
R 337	-	0.3 W	10%	31.5 kΩ	
R 338,339	-	0.25 W	5%	18 Ω	RB 1180
R 340	Metal	-	1%	84.5 kΩ	RF 4845
R 341	-	-	-	16.5 kΩ	RF 4165
R 342,343	-	-	-	7.50 kΩ	RF 3750
R 344	Carbon	-	5%	1 kΩ	RB 3100
R 345	-	-	-	3.3 kΩ	RB 3330
R 346	-	0.3 W	10%	10MΩ	RA 0025
R 347	-	0.25 W	5%	390 kΩ	RB 5390



ZE 0039

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 348	-	-	-	100 kΩ	RB 5100
R 349	-	-	-	820 kΩ	RB 5820
R 350	-	-	-	33 kΩ	RB 4330
R 351	-	-	-	3.3 kΩ	RB 3330
R 352,353	-	-	-	220 kΩ	RB 5220
R 354	-	0.3 W	10%	40 kΩ	
R 355	-	0.25 W	5%	560 kΩ	RB 5560
R 356	-	-	-	47 Ω	RB 1470
R 357	-	-	-	1.2 kΩ	RB 3120
R 358	-	-	-	10 kΩ	RB 4100
R 359	-	-	-	68 kΩ	RB 4680

V 301	FET	N spec.	E 102	VB 1010
V 302	Si. Transistor	PNP	BC 177	VB 0071
V 303	FET	N spec.	E 102	VB 1046
V 304	Si. Transistor	PNP	BC 177	VB 0071
V 305	FET	N spec.	E 102	VB 1046
V 306	Si. Transistor	PNP	BC 177	VB 0071
V 307	-	NPN	BF 173	VB 0065
V 308	-	NPN	2 N 3440	VB 0250
V 309	-	PNP	MM 4003	VB 0068
V 310	-	NPN	2 N 3440	VB 0250
V 311	-	NPN	BC 0107	VB 0032
V 312	-	NPN	2 N 3440	VB 0250
V 313	-	NPN	BC 107	VB 0032
V 315		PNP	BC 177	VB 0071
	Heat Sink			DT 0036
	Printed Circuit Board			XC 0605

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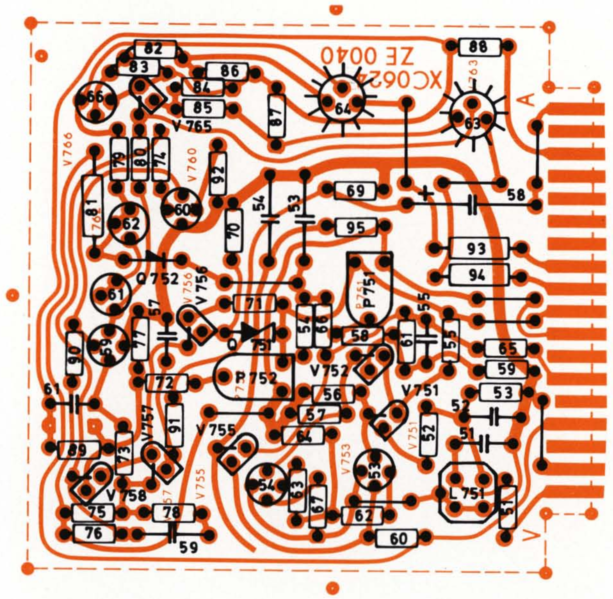
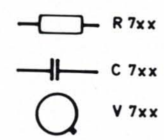
Circuit and Layout Diagram with Parts List

ZE 0040

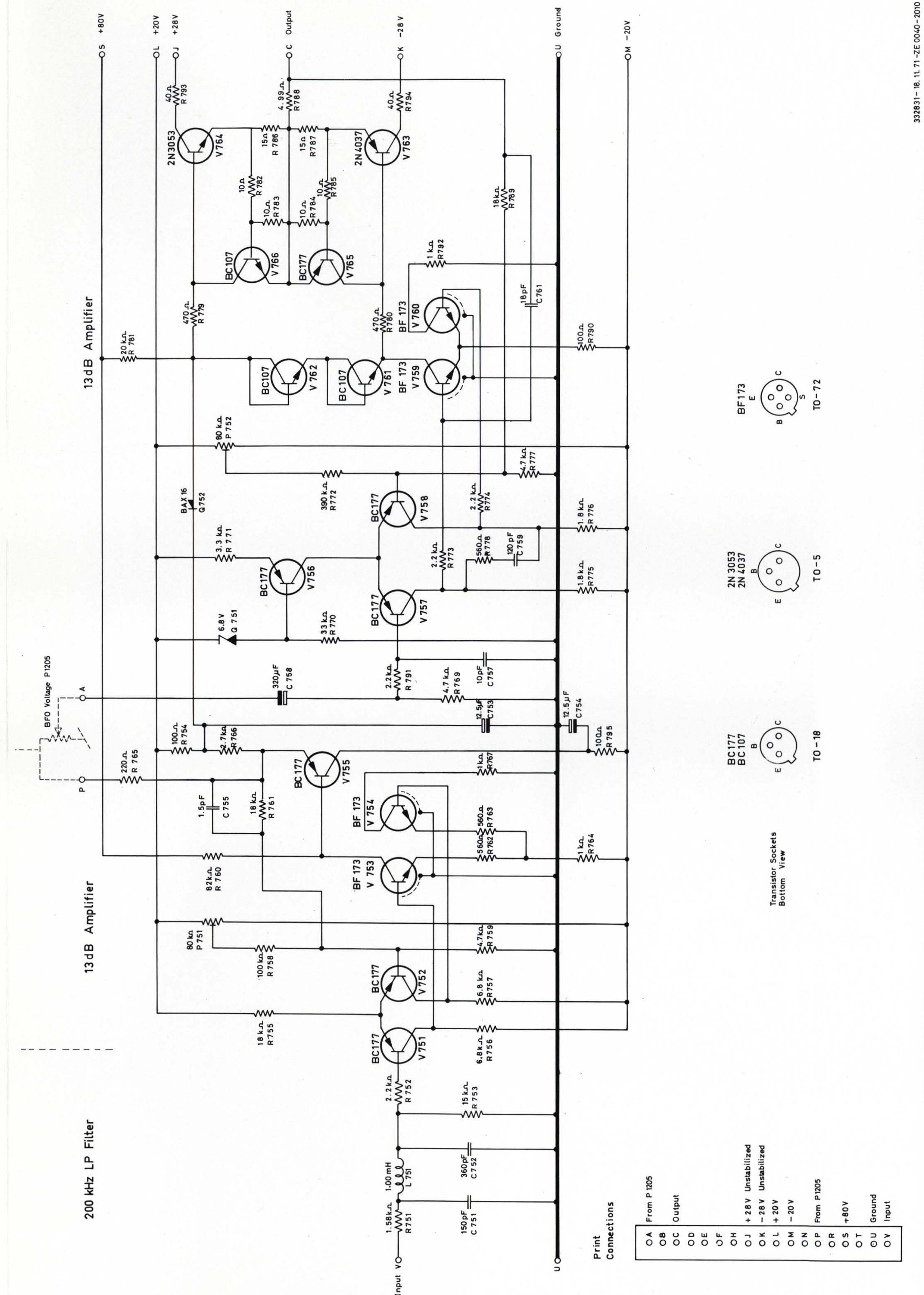
B.F.O. Amplifier





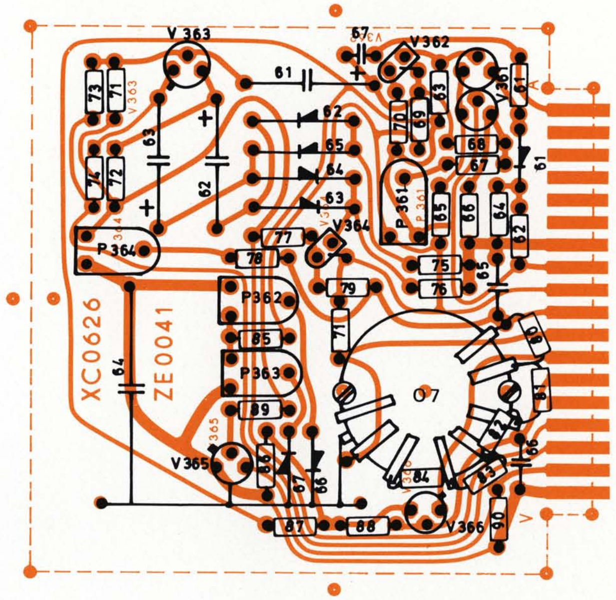
CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
C 751	Polystyrene	1%		150 pF/125 V	CT 1139
C 752	-	1%		360 pF/100 V	CT 1113
C 753,754	Electrolytic			12.5 µF/ 25 V	CE 0416
C 755	Ceramic			1.5 pF/400 V	CK 0150
C 757	-			10 pF/400 V	CK 1100
C 758	Electrolytic			320 µF/ 6.4 V	CE 0211
C 759	Polystyrene	1%		120 pF/125 V	CT 1137
C 761	Ceramic			18 pF/400 V	CK 1180
L 751	Coil			1 mHy	LB 0693
P 751,752	Potm.Carbon 0.1 W		lin.	80 kΩ	PG 3800
Q 751	Ze. Diode	6-7.5 V/	5 mA	ZG 6.8	QV 1106
Q 752	Si. Diode	150 V/300 mA		BAX 16	QV 0217
R 751	Metal	0.25 W	1%	1.58 kΩ	RF 3158
R 752	Carbon	-	5%	2.2 kΩ	RB 3220
R 753	-	-	-	15 kΩ	RB 4150
R 754	-	-	-	100 Ω	RB 2100
R 755	-	-	-	18 kΩ	RB 4180
R 756,757	-	-	-	6.8 kΩ	RB 3680
R 758	-	-	-	100 kΩ	RB 5100
R 759	-	-	-	4.7 kΩ	RB 3470
R 760	-	-	-	82 kΩ	RB 4820
R 761	-	-	-	18 kΩ	RB 4180
R 762,763	-	-	-	560 Ω	RB 2560
R 764	-	-	-	1 kΩ	RB 3100
R 765	-	-	-	220 Ω	RB 2220
R 766	-	-	-	2.7 kΩ	RB 3270
R 767	-	-	-	1 kΩ	RB 3100
R 769	-	-	-	4.7 kΩ	RB 3470

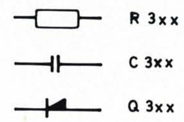
CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 770	-	-	-	33 kΩ	RB 4330
R 771	-	-	-	3.3 kΩ	RB 3330
R 772	-	-	-	390 kΩ	RB 5390
R 773,774	-	-	-	2.2 kΩ	RB 3220
R 775,776	-	-	-	1.8 kΩ	RB 3180
R 777	-	-	-	4.7 kΩ	RB 3470
R 778	-	-	-	560 Ω	RB 2560
R 779,780	-	-	-	470 Ω	RB 2470
R 781	-	0.3 W	10%	20 kΩ	
R 782-785	-	0.25 W	5%	10 Ω	RB 1100
R 786,787	-	-	-	15 Ω	RB 1150
R 788	Metal	-	1%	4.99 Ω	RF 0499
R 789	Carbon	-	5%	18 kΩ	RB 4180
R 790	-	-	-	100 Ω	RB 2100
R 791	-	-	-	2.2 kΩ	RB 3220
R 792	-	-	-	1 kΩ	RB 3100
R 793,794	-	0.3 W	10%	40 Ω	
R 795	-	0.25 W	5%	100 Ω	RB 2100
V 751,752	Si. Transistor	PNP		BC 177	VB 0071
V 753,754	-	NPN		BF 173	VB 0065
V 755-758	-	PNP		BC 177	VB 0071
V 759,760	-	NPN		BF 173	VB 0065
V 761,762	-	NPN		BC 107	VB 0032
V 763	-	PNP		2 N 4037	VB 0067
V 764	-	NPN		2 N 3053	VB 0251
V 765	-	PNP		BC 177	VB 0071
V 766	-	NPN		BC 107	VB 0032
	Heat Sink				DT 0036
	Locking Arm for P.C. Board				DZ 9015
	Retaining pin				YN 0063
	Printed Circuit Board				XC 0624



Circuit and Layout Diagrams with Parts List ZE 0041

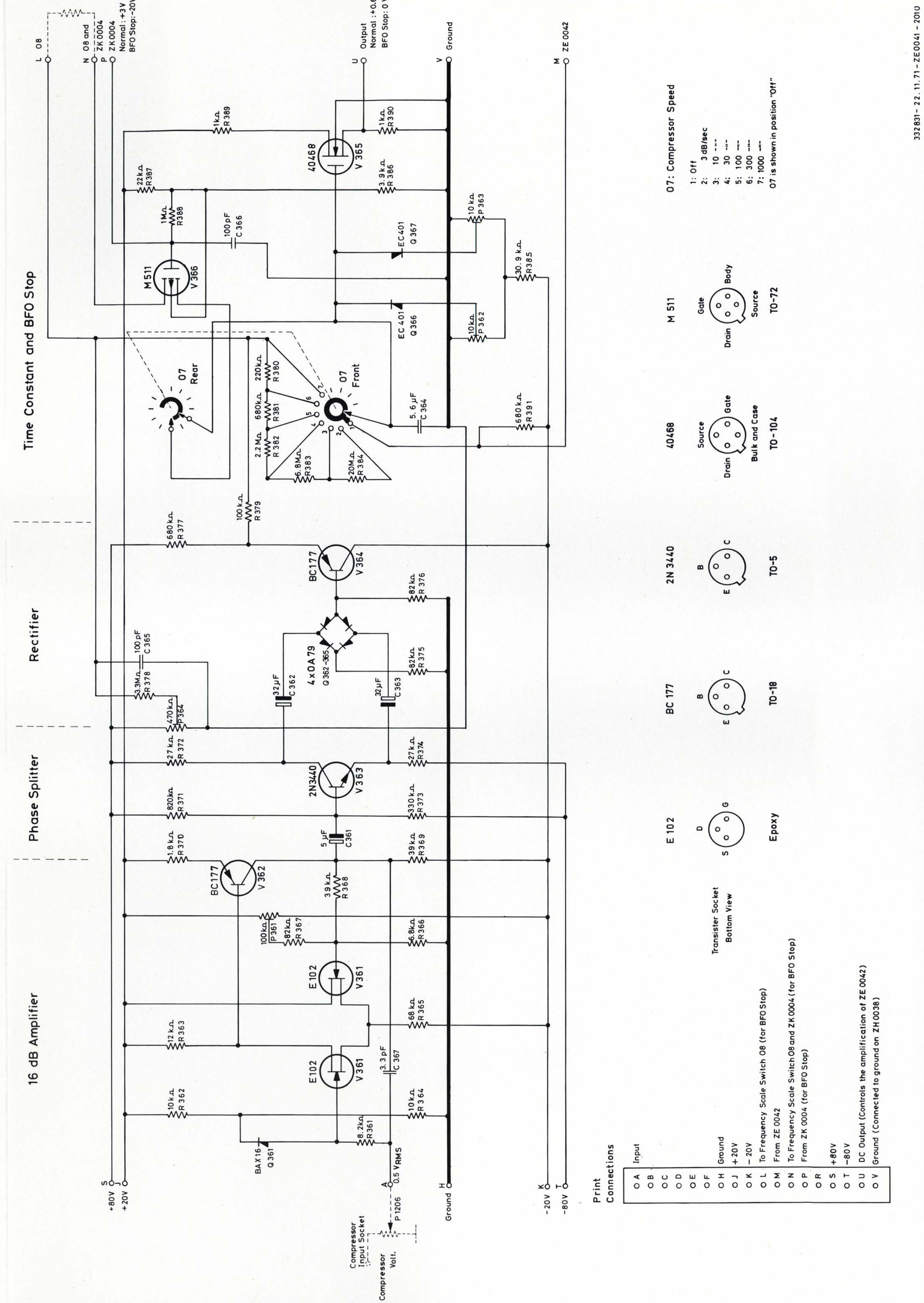
Compression Amplifier





CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
C 361	Electrolytic			5 µF/ 70 V	CE 0200
C 362,363	-			32 µF/ 64 V	CE 0509
C 364	Polycarbonate			5.6 µF/100 V	CS 0346
C 365,366	Ceramic			100 pF/500 V	CK 2101
C 367	-			3.3 pF/400 V	CK 0330
O 7	Selector				OD 1007
P 361	Potm. Cermet	0.5 W.	lin.	100 kΩ	PG 4108
P 362,363	-	-	-	10 kΩ	PG 3109
P 364	-	-	-	470 kΩ	PG 4509
Q 361	Si. Diode	150 V/300 mA		BAX 16	QV 0217
Q 362-365	Ge. Diode	45 V/100 mA		OA 79	QV 0079
Q 366,367	Si. Diode	100 V/225 mA		EC 401	QV 0213
R 361	Carbon	0.25 W	5%	8.2 kΩ	RB 3820
R 362	-	-	-	10 kΩ	RB 4100
R 363	-	-	-	12 kΩ	RB 4120
R 364	-	-	-	10 kΩ	RB 4100
R 365	-	-	-	68 kΩ	RB 4680
R 366	-	-	-	6.8 kΩ	RB 3680
R 367	-	-	-	82 kΩ	RB 4820
R 368,369	-	-	-	39 kΩ	RB 4390
R 370	-	-	-	1.8 kΩ	RB 3180
R 371	-	-	-	820 kΩ	RB 5820

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 372	-	-	-	27 kΩ	RB 4270
R 373	-	-	-	330 kΩ	RB 5330
R 374	-	-	-	27 kΩ	RB 4270
R 375,376	-	-	-	82 kΩ	RB 4820
R 377	-	-	-	680 kΩ	RB 5680
R 378	-	0.3 W	10%	3.3MΩ	RA 0022
R 379	-	0.25 W	5%	100 kΩ	RB 5100
R 380	-	-	-	220 kΩ	RB 5220
R 381	-	-	-	680 kΩ	RB 5680
R 382	-	-	10%	2.2MΩ	RA 0015
R 383	-	-	-	6.8MΩ	RA 0023
R 384	Metal	-	-	20MΩ	RH 0002
R 385	-	-	1%	30.9 kΩ	RF 4309
R 386	Carbon	-	5%	3.9 kΩ	RB 3390
R 387	-	-	-	22 kΩ	RB 4220
R 388	-	-	-	1MΩ	RB 6100
R 389,390	-	-	-	1 kΩ	RB 3100
R 391	-	-	-	680 kΩ	RB 5680
V 361	FET	N spec.		E 102	VB 1013
V 362	Si. Transistor	PNP		BC 177	VB 0071
V 363	-	NPN		2 N 3440	VB 0250
V 364	-	PNP		BC 177	VB 0071
V 365	MOS FET	N		40468	VB 4002
V 366	MOS FET	P		M 511	VB 4001
Printed Circuit Board					XC 0626



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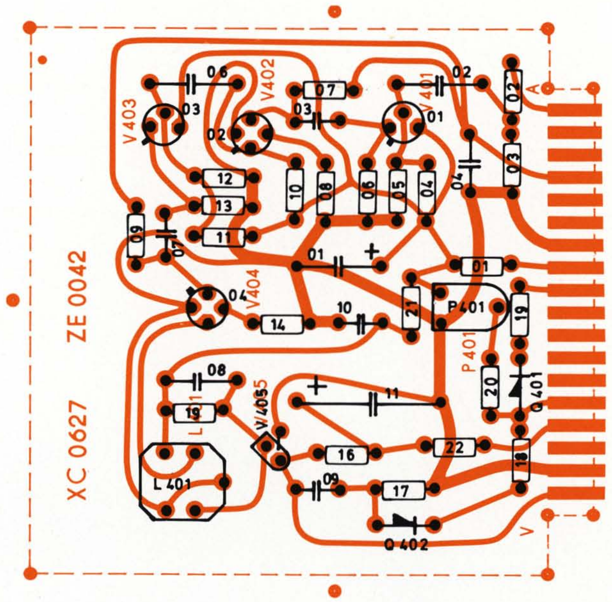
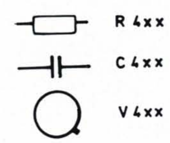
Circuit and Layout Diagram with Parts List ZE 0042

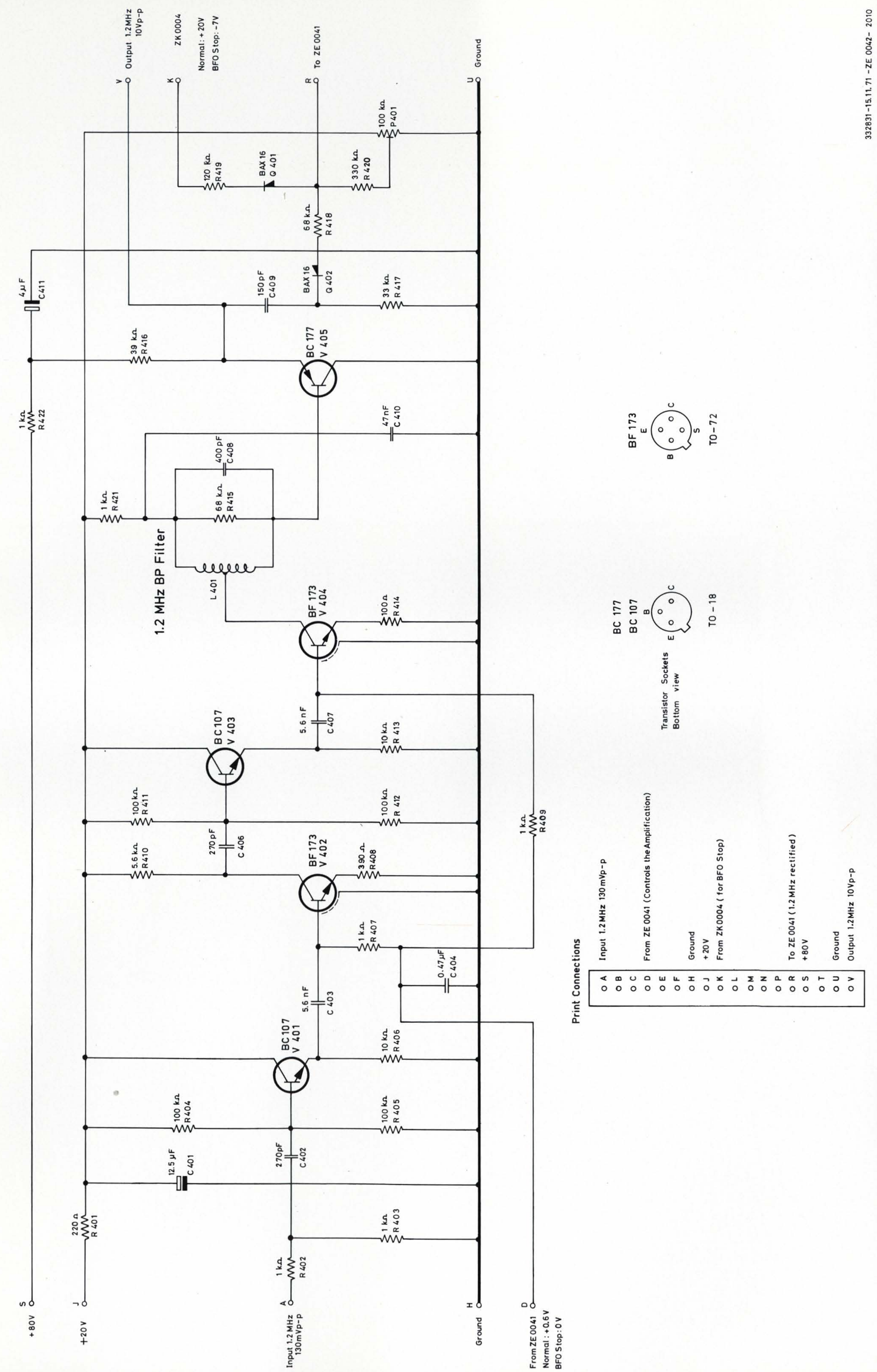
Regulation Amplifier





CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
C 401	Electrolytic			12.5 µF/ 25 V	CE 0416
C 402	Ceramic			270 pF/400 V	CK 2270
C 403	-			5.6 nF/400 V	CK 3560
C 404	-			0.47 µF/ 12 V	CK 5470
C 406	-			270 pF/400 V	CK 2270
C 407	-			5.6 nF/400 V	CK 3560
C 408	Polystyrene			400 pF/500 V	CT 0111
C 409	Ceramic			150 pF/400 V	CK 2150
C 410	-			47 nF/ 30 V	CK 4470
C 411	Electrolytic			4 µF/250 V	CE 2034
L 401	Coil		44 µH		LB 0685
P 401	Potm. Cermet 0.5 W		lin.	100 kΩ	PG 4108
Q 401,402	Si. Diode	150 V/300 mA		BAX 16	QV 0217
R 401	Carbon	0.25 W	5%	220 Ω	RB 2220
R 402,403	-	-	-	1 kΩ	RB 3100
R 404,405	-	-	-	100 kΩ	RB 5100
R 406	-	-	-	10 kΩ	RB 4100
R 407	-	-	-	1 kΩ	RB 3100
R 408	-	-	-	390 Ω	RB 2390

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 409	-	-	-	1 kΩ	RB 3100
R 410	-	-	-	5.6 kΩ	RB 3560
R 411,412	-	-	-	100 kΩ	RB 5100
R 413	-	-	-	10 kΩ	RB 4100
R 414	-	-	-	100 Ω	RB 2100
R 415	-	-	-	68 kΩ	RB 4680
R 416	-	-	-	39 kΩ	RB 4390
R 417	-	-	-	33 kΩ	RB 4330
R 418	-	-	-	68 kΩ	RB 4680
R 419	-	-	-	120 kΩ	RB 5120
R 420	-	-	-	330 kΩ	RB 5330
R 421,422	-	-	-	1 kΩ	RB 3100
V 401	Si. Transistor	NPN	BC 107		VB 0032
V 402	-	NPN	BF 173		VB 0065
V 403	-	NPN	BC 107		VB 0032
V 404	-	NPN	BF 173		VB 0065
V 405	-	PNP	BC 177		VB 0071
	Locking Arm for P.C. Board				DZ 9015
	Retaining pin				YN 0063
	Printed Circuit Board				XC 0627



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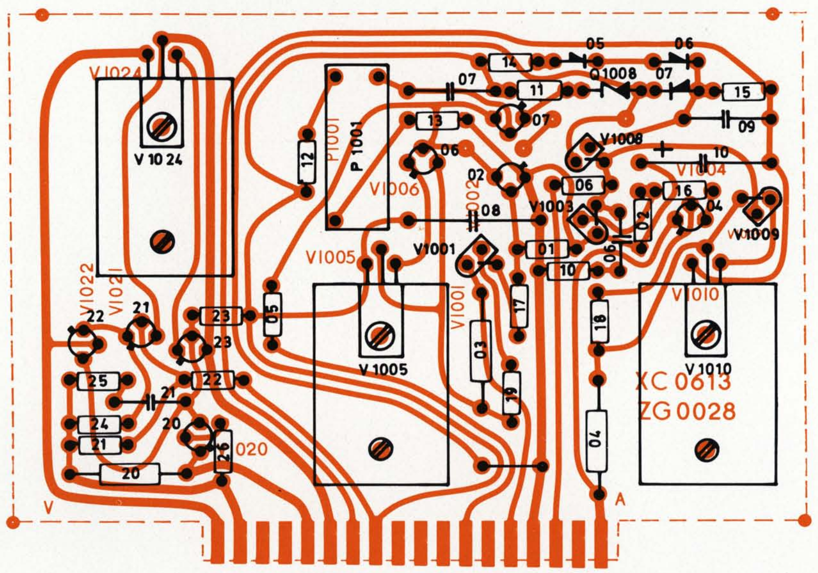
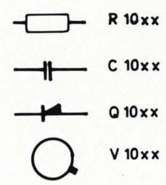
Circuit and Layout Diagram with Parts List

ZG 0028

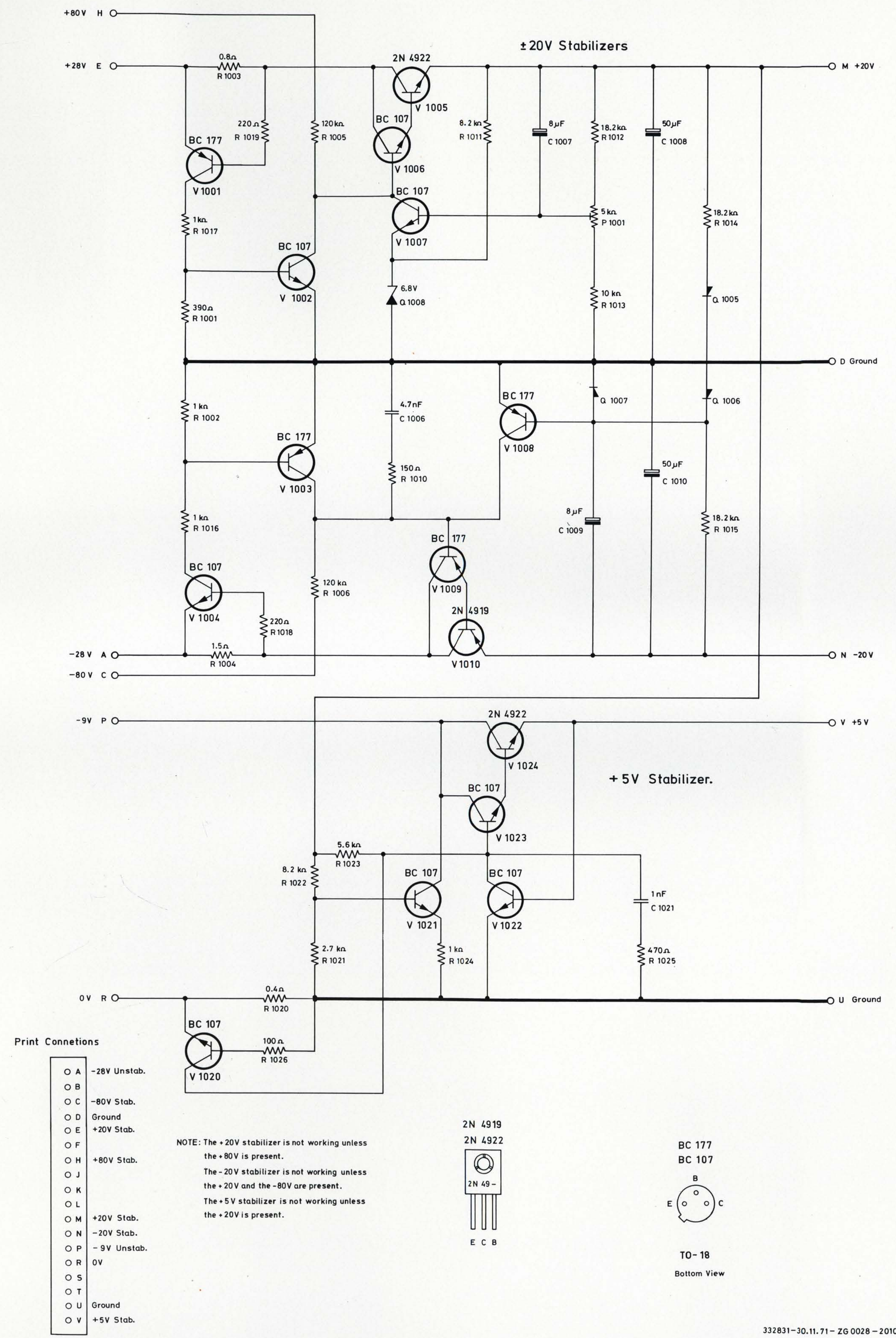
Power Supply
± 20 V
+ 5 V





CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
C 1006	Ceramic			4.7 nF/100 V	CK 0096
C 1007	Electrolytic			8 µF/ 40 V	CE 0414
C 1008	-			50 µF/ 25 V	CE 8965
C 1009	-			8 µF/ 40 V	CE 0414
C 1010	-			50 µF/ 25 V	CE 8965
C 1021	Ceramic			1 nF/500 V	CK 3100
P 1001	Potm. wire w.0.5 W	lin.		5 kΩ	PG 2504
Q 1005-1007	Si. Diode	150 V/300 mA		BAX 16	QV 0217
Q 1008	Zener Diode	6.6-7.0 V Selected		ZG 6.8	QV 1106
R 1001	Carbon	0.25 W	5%	390 Ω	RB 2390
R 1001	-	-	-	1 kΩ	RB 3100
R 1003	Wire w.	1 W	-	0.8 Ω	RO 1103
R 1004	-	-	-	1.5 Ω	RO 1104
R 1005,1006	Carbon	0.25 W	-	120 kΩ	RB 5120
R 1010	-	-	-	150 Ω	RB 2150
R 1011	-	-	-	8.2 kΩ	RB 3820
R 1012	Metal	-	1%	18.2 kΩ	RF 4182
R 1013	-	-	-	10 kΩ	RF 4100
R 1014,1015	-	-	-	18.2 kΩ	RF 4182
R 1016,1017	Carbon	-	5%	1 kΩ	RB 3100
R 1018,1019	-	-	-	220 Ω	RB 2220

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 1020	Wire w.	1 W	-	0.4 Ω	RO 1102
R 1021	Carbon	0.25 W	-	2.7 kΩ	RB 3270
R 1022	-	-	-	8.2 kΩ	RB 3820
R 1023	-	-	-	5.6 kΩ	RB 3560
R 1024	-	-	-	1 kΩ	RB 3100
R 1025	-	-	-	470 Ω	RB 2470
R 1026	-	-	-	100 Ω	RB 2100
V 1001	Si. Transistor	PNP		BC 177	VB 0071
V 1002	-	NPN		BC 107	VB 0032
V 1003	-	PNP		BC 177	VB 0071
V 1004	-	NPN		BC 107	VB 0032
V 1005	-	NPN		2 N 4922	VB 0063
V 1006,1007	-	NPN		BC 107	VB 0032
V 1008,1009	-	PNP		BC 177	VB 0071
V 1010	-	PNP		2 N 4919	VB 0061
V 1020-1023	-	NPN		BC 107	VB 0032
V 1024	-	NPN		2 N 4922	VB 0063
	Heat Sink				DK 0178
	Locking arm for P.C. Board				DZ 9015
	Retaining pin				YN 0063
	Printed Circuit Board				XC 0613



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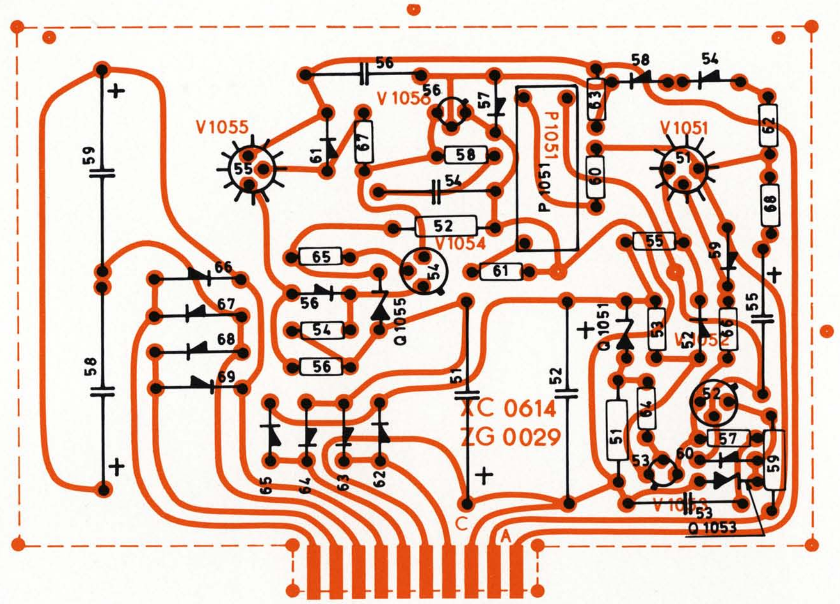
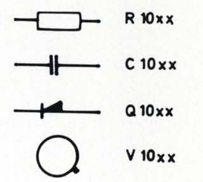
Circuit and Layout Diagram with Parts List

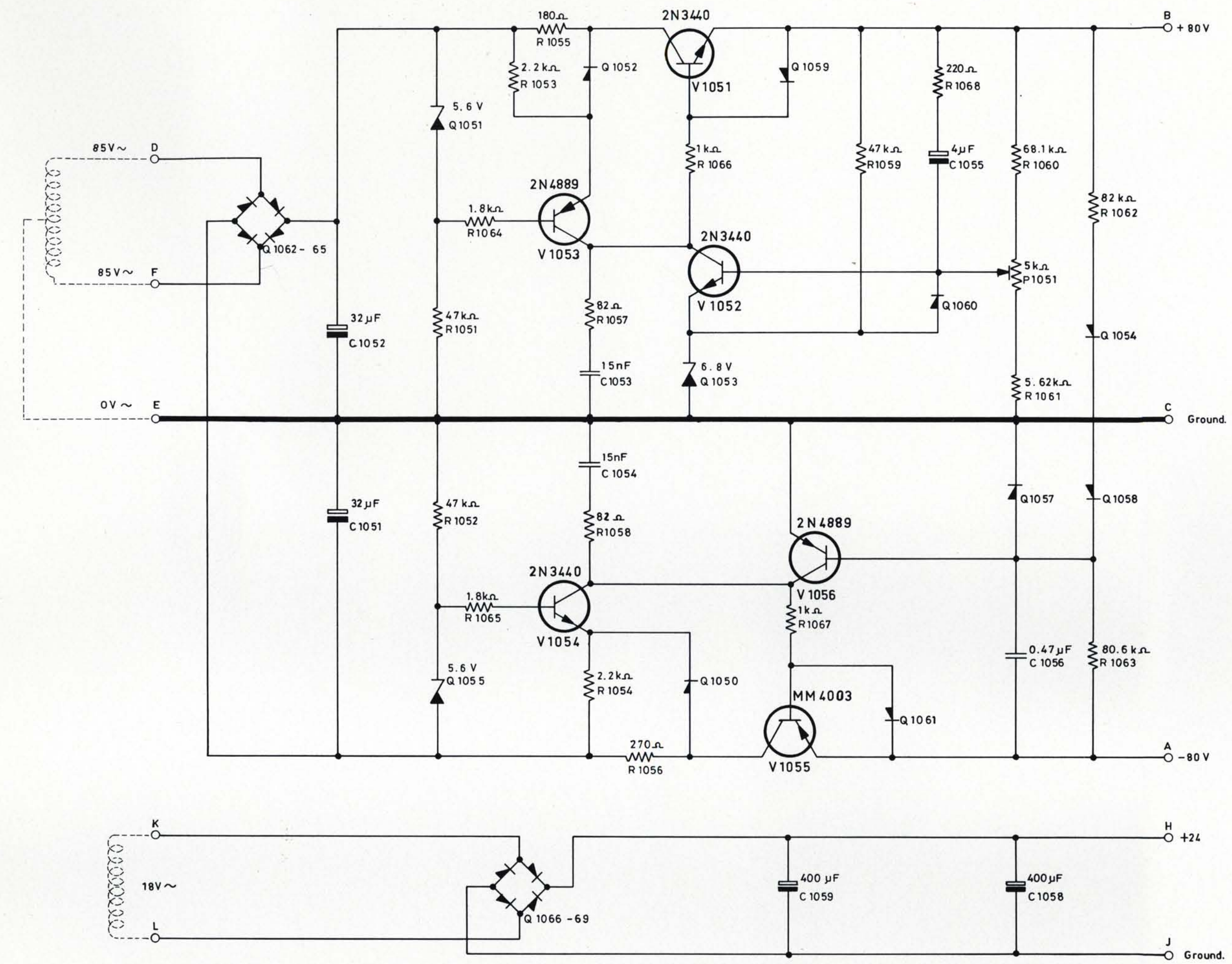
ZG 0029
Power Supply
± 80 V
+ 24 V



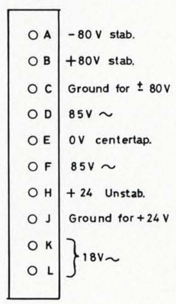


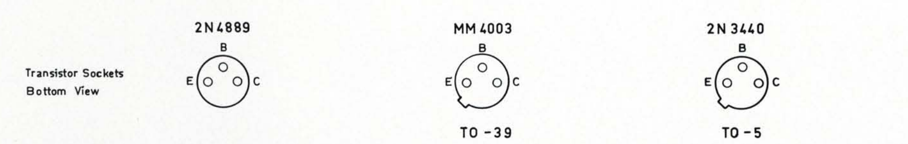
CIRCUIT DIAGRAM REF.	COMPONENT TYPE					STOCK REF.
C 1051,1052	Electrolytic				32 µF/250 V	CE 0711
C 1053,1054	Ceramic				15 nF/400 V	CK 4150
C 1055	Electrolytic				4 µF/250 V	CE 2034
C 1056	Polycarbonate 2%				0.47 µF/160 V	CS 0234
C 1058,1059	Electrolytic				400 µF/ 40 V	CE 0417
P 1051	Potm. Wire W.0.5 W		lin.		5 kΩ	PG 2504
Q 1051	Ze. Diode	5.0-6.2 V/	5 mA	ZG 5.6		QV 1105
Q 1052	Si. Diode	150 V/	300 mA	BAX 16		QV 0217
Q 1053	Ze. Diode	6.0-7.5 V/	5 mA	ZG 6.8		QV 1106
Q 1054	Si. Diode	150 V/	300 mA	BAX 16		QV 0217
Q 1055	Ze. diode	5.0-6.2 V/	5 mA	ZG 5.6		QV 1105
Q 1056-1061	Si. Diode	150 V/	300 mA	BAX 16		QV 0217
Q 1062-1065	-	1200 V/	150 mA	BYX 10		QV 0025
Q 1066-1069	-	400 V/	1 A	1 N 4004		QV 0237
R 1051,1052	Carbon	0.33 W	10%		47 kΩ	
R 1053,1054	-	0.25 W	5%		2.2 kΩ	RB 3220
R 1055	-	-	-		180 Ω	RB 2180
R 1056	-	-	-		270 Ω	RB 2270

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 1057,1058	-	-	-	82 Ω	RB 1820
R 1059	-	0.33 W	10%	47 kΩ	
R 1060	Metal	0.25 W	1%	68.1 kΩ	RF 4681
R 1061	-	-	-	5.62 kΩ	RF 3562
R 1062	-	-	-	82.5 kΩ	RF 4825
R 1063	-	-	-	80.6 kΩ	RF 4806
R 1064,1065	Carbon	-	5%	1.8 kΩ	RB 3180
R 1066,1067	-	-	-	1 kΩ	RB 3100
R 1068	-	-	-	220 Ω	RB 2220
V 1051,1052	Si. Transistor	NPN		2 N 3440	VB 0250
V 1053	-	PNP		2 N 4889	VB 0058
V 1054	-	NPN		2 N 3440	VB 0250
V 1055	-	PNP		MM 4003	VB 0068
V 1056	-	PNP		2 N 4889	VB 0058
	Heat Sink				DT 0040
	Locking arm for P.C. Boards				DZ 9015
	Retaining pin				YN 0063
	Printed Circuit Board				XC 0614



Print
Connections

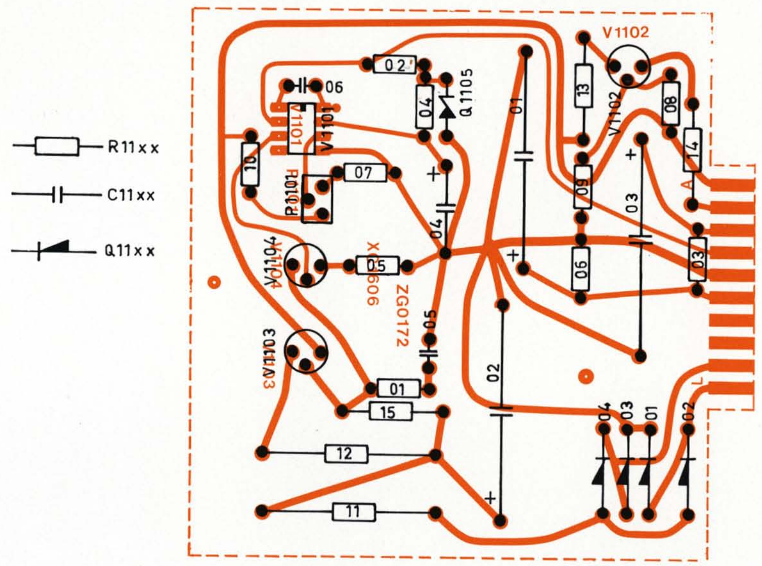




332831-7. 12. 71-ZG 0029-2010

Circuit and Layout Diagrams with Parts List

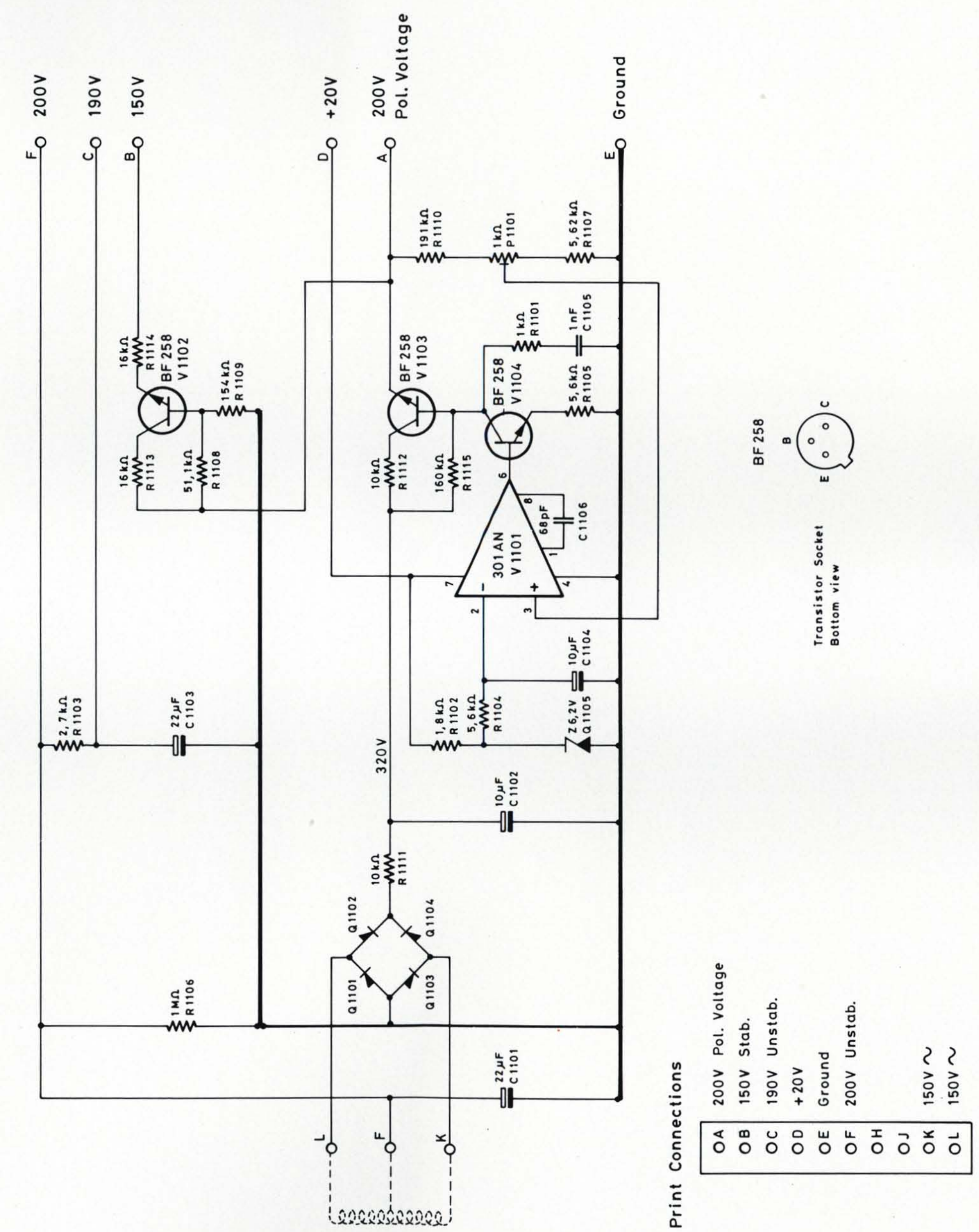
ZG 0172



Viewed from the printed circuit side

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
C 1101	Electrolytic			22 µF/250 V	CE 0805
C 1102	-			10 µF/450 V	CE 0919
C 1103	-			22 µF/250 V	CE 0805
C 1104	-			10 µF/ 25 V	CE 0416
C 1105	Ceramic			1 nF/400 V	CK 3101
C 1106	-			68 pF/400 V	CK 1683
P 1101	Cermet	1/2 W	lin	1 kΩ	PG 2114
Q 1101-04	Si.	BYX10		800 V/150 mA	QV 0025
Q 1105	Ze.	1N825		5,9-6,5 V/0,24 W	QV 1346
R 1101	Carbon	1/4 W	5%	1 kΩ	RB 3100
R 1102	-	-	-	1,8 kΩ	RB 3180
R 1103	-	-	-	2,7 kΩ	RB 3270
R 1104,05	-	-	-	5,6 kΩ	RB 3560

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 1106	Carbon	1/4 W	5%	1 MΩ	RB 6100
R 1107	Metal	-	1%	5,62 kΩ	RF 3562
R 1108	-	-	-	51,1 kΩ	RF 4511
R 1109	-	-	-	154 kΩ	RF 5154
R 1110	-	-	-	191 kΩ	RF 5191
R 1111,12	Wire	7 W	5%	10 kΩ	RX 0403
R 1113,14	Carbon	1/3 W	-	16 kΩ	
R 1115	-	-	-	160 kΩ	
V 1101	Op. Ampl.			LM301	VE 0017
V 1102-04	Silicon NPN			BF258	VB 0552
	Printed Circuit Board				XC 1606
	Heat Sink				DT 0036



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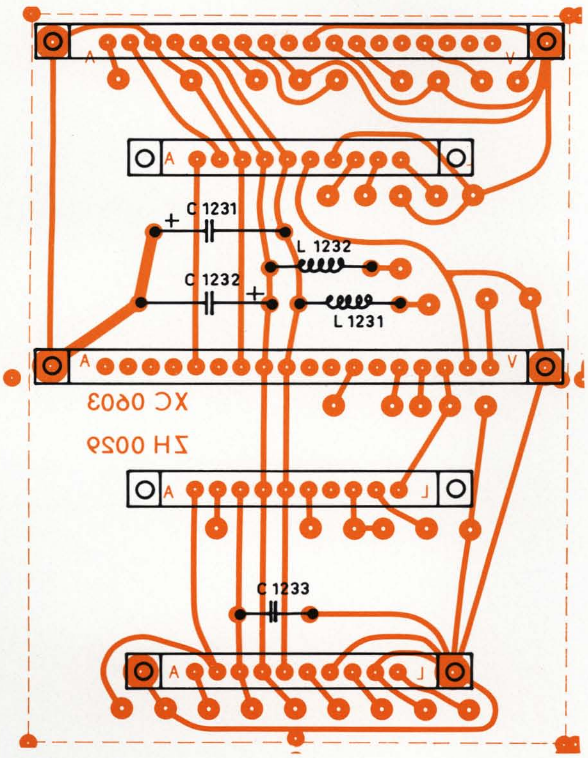
Layout Diagrams with Parts List

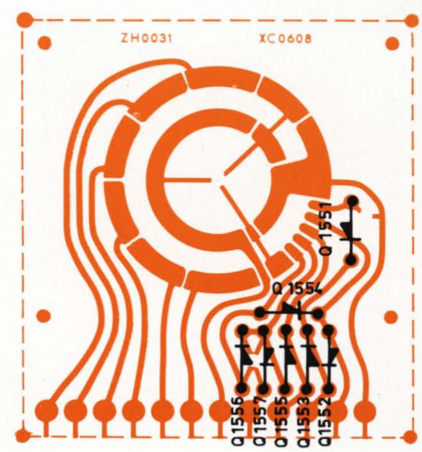
ZH 0029
Interconnection Circuit for Input Section

ZH 0031
Contact Circuit

ZH 0029



ZH 0031



CIRCUIT DIAGRAM REF.	COMPONENT TYPE		STOCK REF.
C 1231,1232	Electrolytic	25 μF/ 25 V	CE 2002
C 1233	Ceramic	0.47 μF/ 12 V	CK 5470
L 1231,1232	Coil	30 μH	LJ 0008
	Printed Circuit Board		XC 0603

CIRCUIT DIAGRAM REF.	COMPONENT TYPE			STOCK REF.
Q 1551-1557	Si. Diode	150 V/300 mA	BAX 16	QV 0217
	Printed Circuit Board			XC 0608

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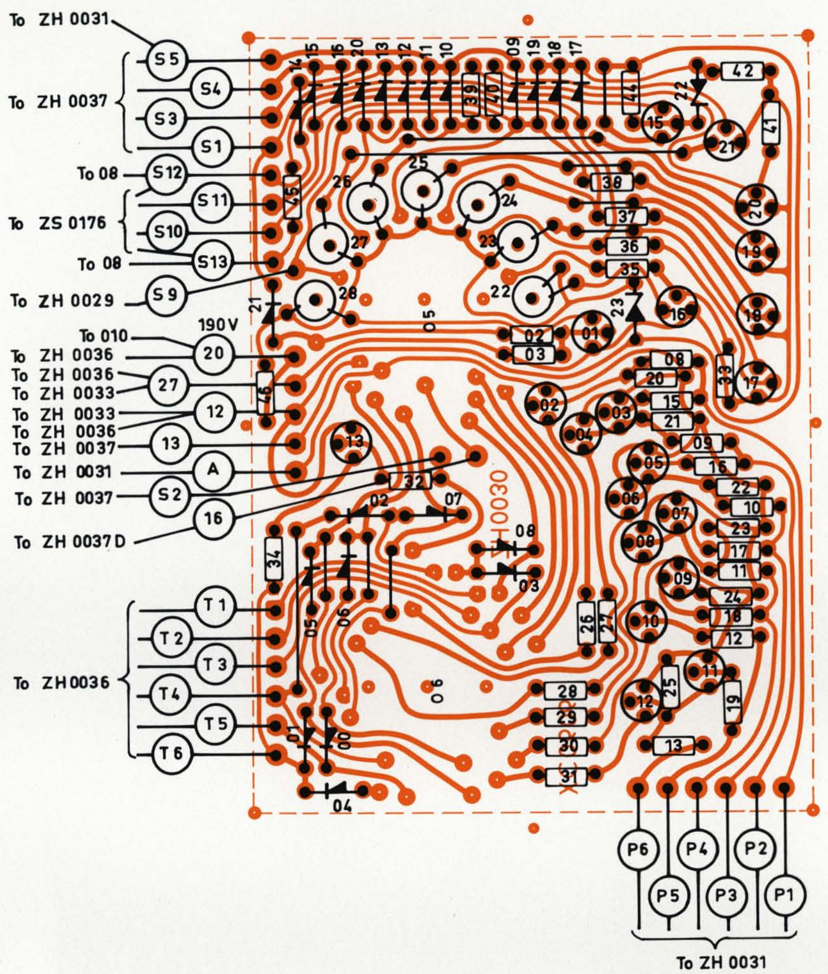
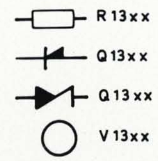
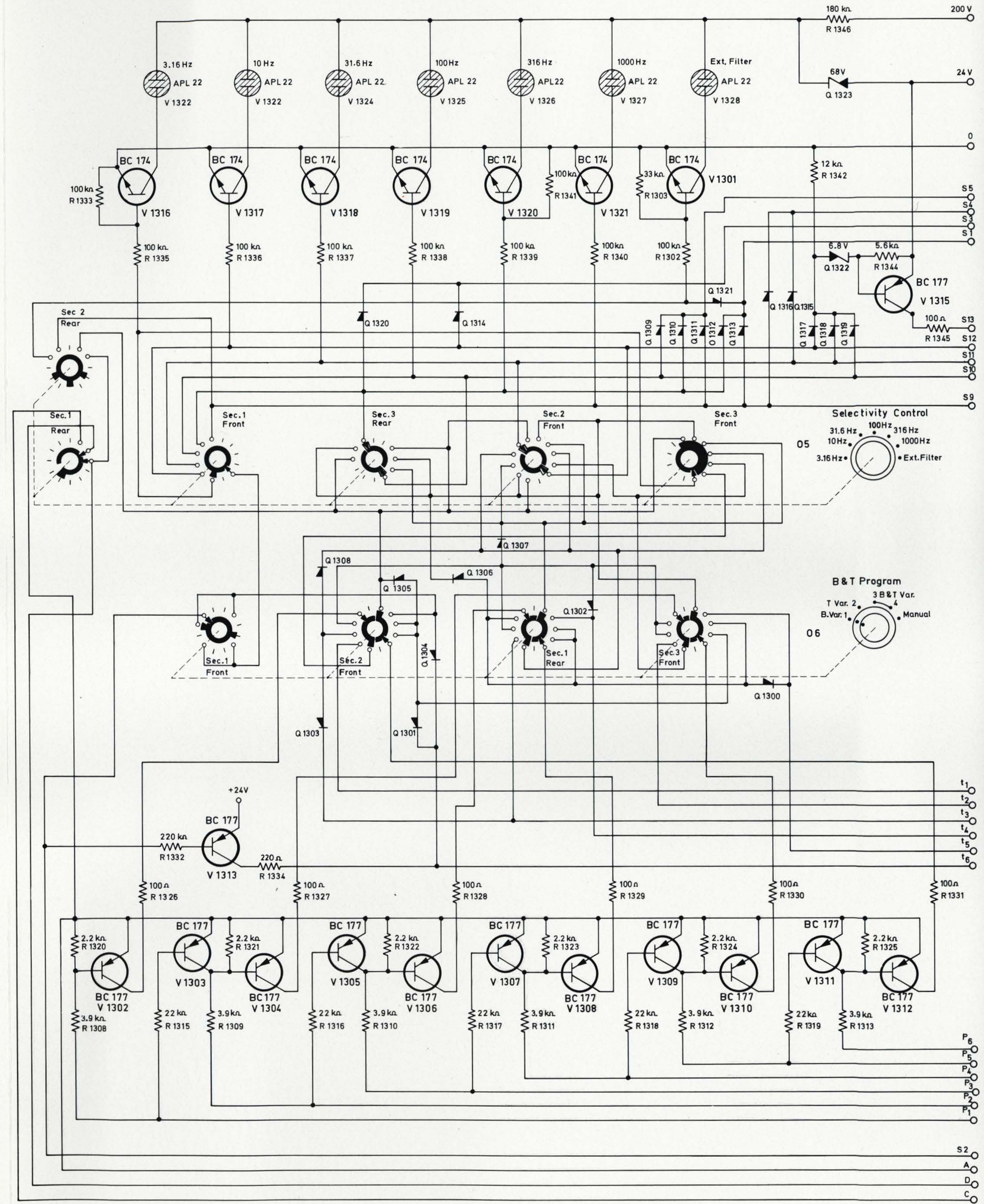
Circuit and Layout Diagrams with Parts List

ZH 0030

Control Circuit







CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
O 5	Selector wafer				OH 3006
O 6	-				OH 3005
Q 1300-1321	Si. Diode	150 V/300 mA		BAX 16	QV 0217
Q 1322	Zener Diode	6-7.5 V/ 5 mA		ZG 6.8	QV 1106
Q 1323	-	65-71 V/ 2 mA		1 N 734 A	QV 1336
R 1302	Carbon	0.25 W	5%	100 kΩ	RB 5100
R 1303	-	-	-	33 kΩ	RB 4330
R 1308-1313	-	-	-	3.9 kΩ	RB 3390
R 1315-1319	-	-	-	22 kΩ	RB 4220
R 1320-1325	-	-	-	2.2 kΩ	RB 3220
R 1326-1331	-	-	-	100 Ω	RB 2100
R 1332	-	-	-	220 kΩ	RB 5220

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 1333	-	-	-	100 kΩ	RB 5100
R 1334	-	-	-	220 Ω	RB 2220
R 1335-1341	-	-	-	100 kΩ	RB 5100
R 1342	-	-	-	12 kΩ	RB 4120
R 1344	-	-	-	5.6 kΩ	RB 3560
R 1345	-	-	-	100 Ω	RB 2100
R 1346	-	-	-	150 kΩ	RB 5150
V 1301	Si. Transistor	NPN		BC 174	VB 0537
V 1302-1313	-	PNP		BC 177	VB 0071
V 1315	-	PNP		BC 177	VB 0071
V 1316-1321	-	NPN		BC 174	VB 0537
V 1322-1328	Neon Lamp				VS 0015
	Printed Circuit Board				XC 0606

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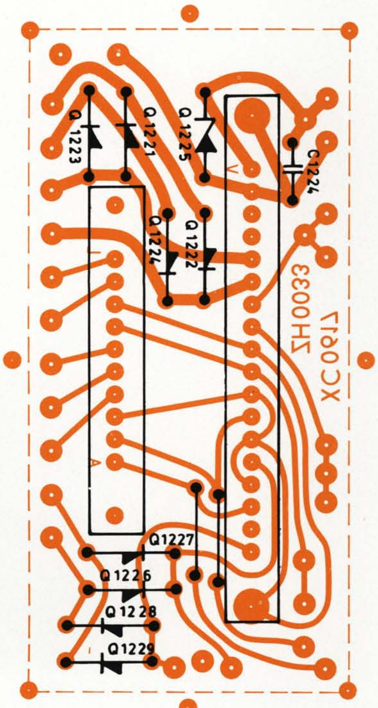
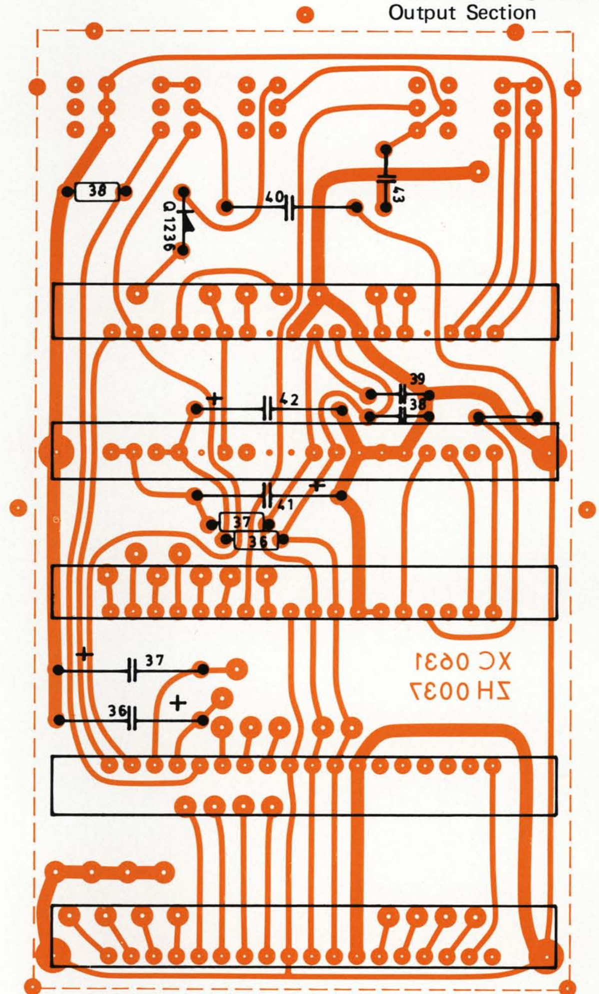
Layout Diagram with Parts List

ZH 0033
Interconnecting Circuit for V.C.O.

ZH 0037
Interconnecting Circuit for Output Section



ZH 0033



ZH 0037

CIRCUIT DIAGRAM REF.	COMPONENT TYPE			STOCK REF.
C 1224	Ceramic	0.47 μF/ 12 V		CK 5470
Q 1221-1224	Si. Diode	400 V/ 1 A	1 N 4004	QV 0237
Q 1225	Zener Diode	6-7.5 V/30 mA		QV 1306
Q 1226-1229	Si. Diode	400 V/ 1 A	1 N 4004	QV 0237
	Printed Circuit Board			XC 0617

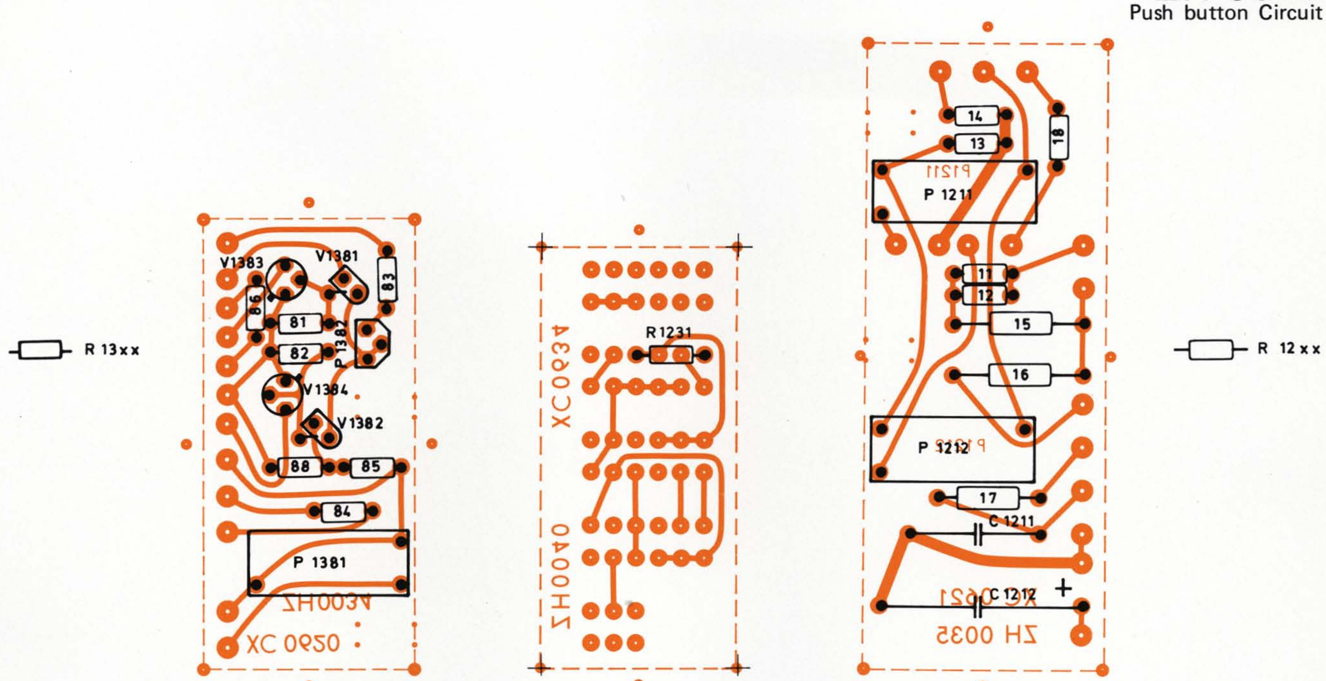
CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
C 1236,1237	Electrolytic			2.5 μF/ 64 V	CE 0401
C 1238,1239	Ceramic			47 nF/ 30 V	CK 4470
C 1240	Polycarbonate			3.3 μF/100 V	CS 0347
C 1241,1242	Electrolytic			5 μF/ 70 V	CE 0200
C 1243	Ceramic			47 nF/ 30 V	CK 4470
Q 1236	Si. Diode	150 V/300 mA		BAX 16	QV 0217
R 1236,1237	Carbon	0.25 W	5%	100 Ω	RB 2100
R 1238	-	-	-	100 kΩ	RB 5100
	Printed Circuit Board				XC 0631

Layout Diagram with Parts List

ZH 0034
Frequency adj. Circuit

ZH 0035
Sensitivity Control

ZH 0040
Push button Circuit



ZH 0034 ZH 0040 ZH 0035

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
P 1381	Potm. Wire w.0.5 W		lin.	10 kΩ	PG 3111
P 1382	Potm. Carbon0.15 W		-	25 kΩ	PG 3250
R 1381,1382	Carbon	0.25 W	5%	3.9 kΩ	RB 3390
R 1383	-	-	-	27 kΩ	RB 4270
R 1384	-	-	-	180 kΩ	RB 5180
R 1385	Metal	-	1%	11.5 kΩ	RF 4115
R 1386	-	-	-	15.4 kΩ	RF 4154
R 1388	-	-	-	75 kΩ	RF 4750
V 1381,1382	Si. Transistor	PNP		BC 177	VB 0071
V 1383,1384	-	NPN		BC 107	VB 0032
	Printed Circuit Board				XC 0620

ZH 0040

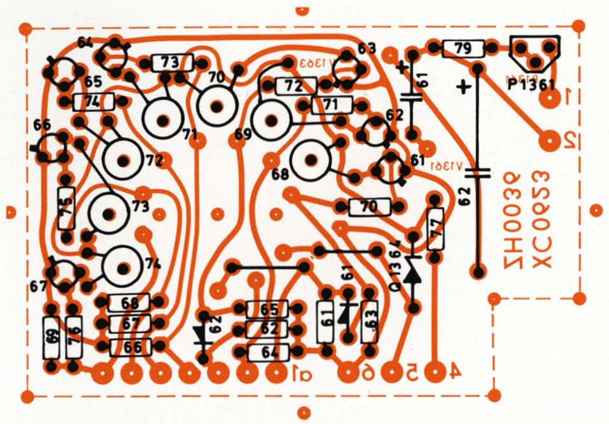
R 1231	Carbon	0.12 W	10%	10MΩ	RA 0025
	Printed Circuit Board				XC 0634

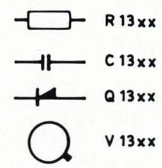
CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
C 1211	Polycarbonate			0.22 μF/250 V	CS 0017
C 1212	Electrolytic			32 μF/250 V	CE 0711
P 1211,1212	Potm. Wire w.0.5 W		lin.	10 kΩ	PG 3111
R 1211,1212	Carbon	0.25 W	5%	12 Ω	RB 1120
R 1213	Metal	-	1%	1.05 kΩ	RF 3105
R 1214	-	-	-	8.66 kΩ	RF 3866
R 1215,1216	Wire w.	5.5 W	10%	30 Ω	RX 0309
R 1217	Carbon	0.25 W	-	20MΩ	RH 0002
	Printed Circuit Board				XC 0621

Layout Diagram with Parts List

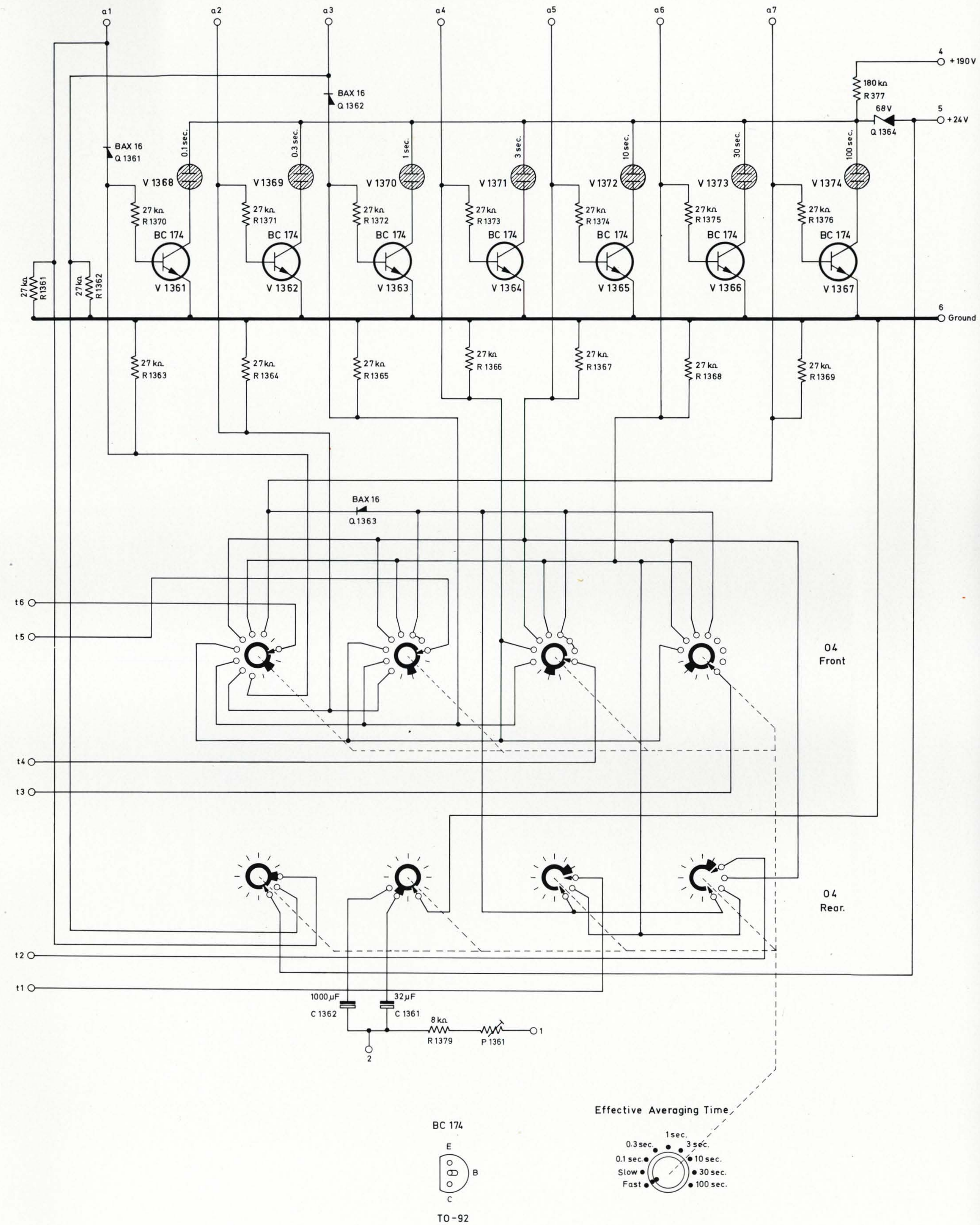
ZH 0036

Averaging Time Circuit





CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
C 1361	Electrolytic	32 µF/	4 V		CE 0100
C 1362	-	1000 µF/	6 V		CE 0210
P 1361	Potm. Cermet0.5 W	lin.	4.7 kΩ		PG 2471
Q 1361,1362	Si. Diode	150 V/300 mA	BAX 16		QV 0217
Q 1364	Zener Dioce	65-71 V/ 2 mA	1 N 734 A		QV 1336
R 1361-1376	Carbon	0.25 W	5%	27 kΩ	RB 4270
R 1377	-	-	-	180 kΩ	RB 5180
R 1379	Metal	-	1%	8.06 kΩ	RF 3806
V 1361-1367	Si. Transistor	NPN	BC 174		VB 0537
V 1368-1375	Neon Lamp	VS 0015			
	Printed Circuit Board				XC 0623



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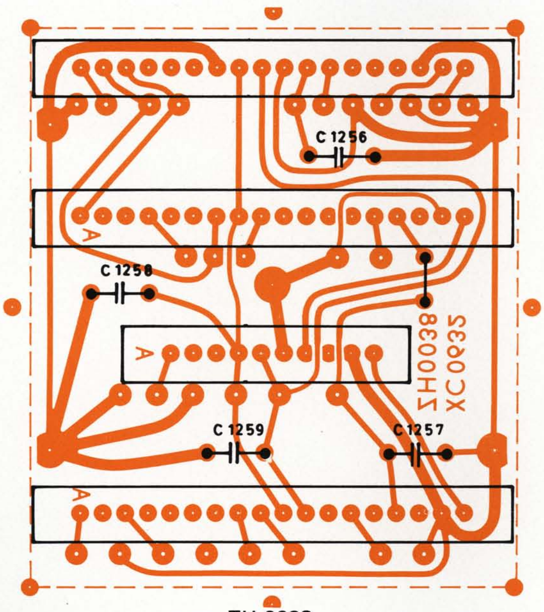
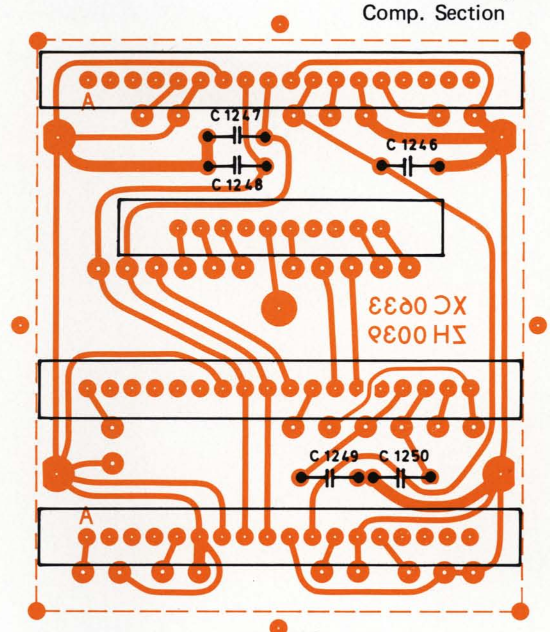
Layout Diagram with Parts List

ZH 0038
Interconnecting Circuit for B.F.O. Section

ZH 0039
Interconnecting Circuit for Comp. Section



ZH 0038



ZH 0039

CIRCUIT DIAGRAM REF.	COMPONENT TYPE		STOCK REF.
C 1256	Ceramic	0.47 μF/ 12 V	CK 5470
C 1257-1259	Polycarbonate	47 nF/250 V	CS 0401
	Printed Circuit Board		XC 0635

CIRCUIT DIAGRAM REF.	COMPONENT TYPE		STOCK REF.
C 1246	Ceramic	0.47 μF/ 12 V	CK 5470
C 1247-1250	Polycarbonate	47 nF/250 V	CS 0401
	Printed Circuit Board		XC 0633

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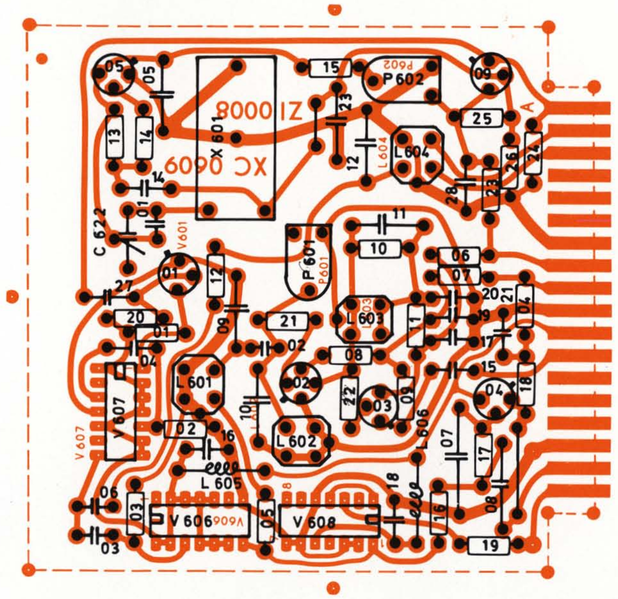
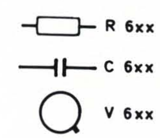
Circuit and Layout Diagram with Parts List

ZI 0008

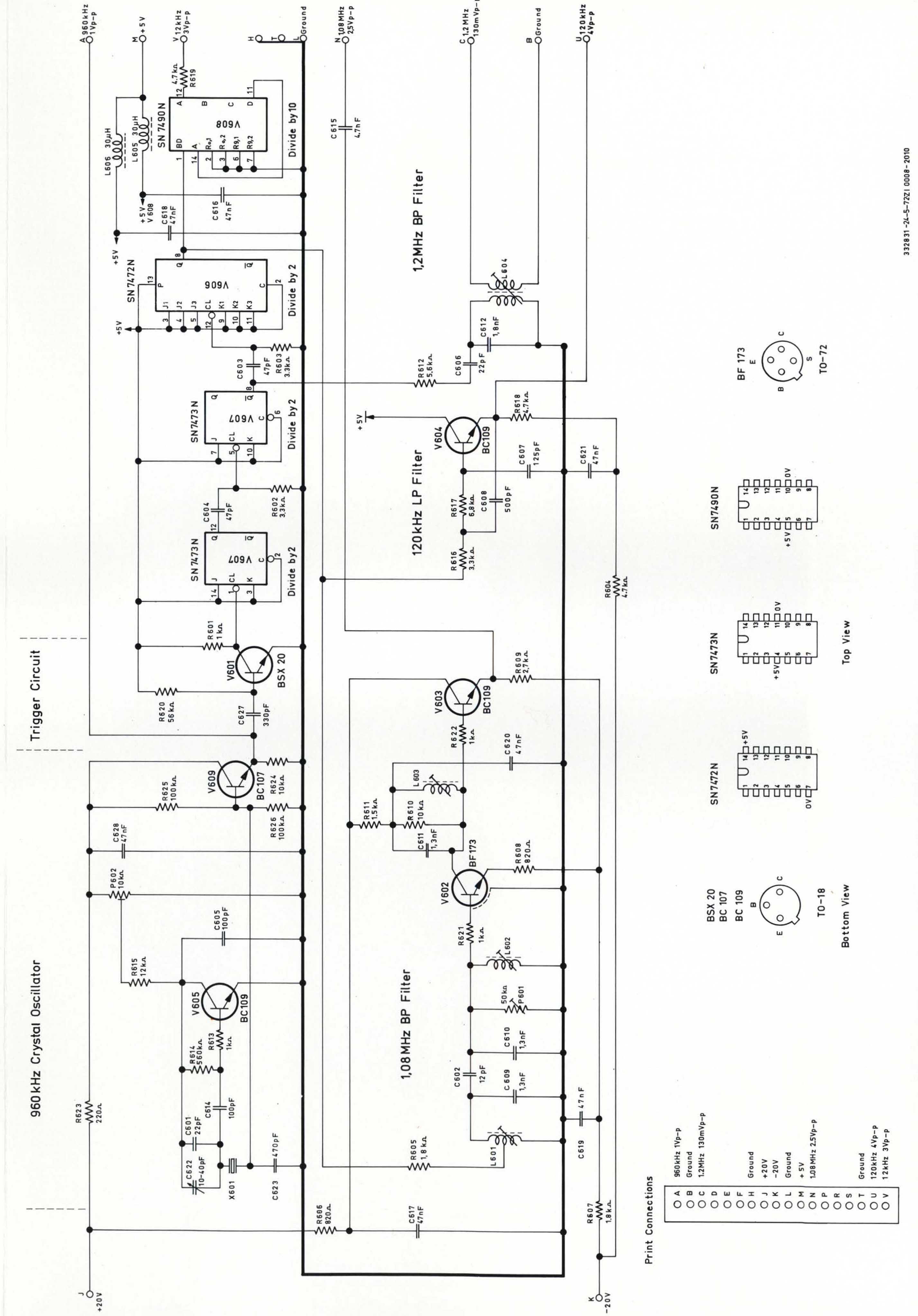
Fixed Oscillator and Frequency Converters





CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
C 601	Ceramic			22 pF/400 V	CK 1220
C 602	-			12 pF/400 V	CK 1120
C 603,604	-			47 pF/400 V	CK 1470
C 605	Polystyrene		1%	100 pF/125 V	CT 1133
C 606	Ceramic			22 pF/400 V	CK 1220
C 607	Polystyrene			125 pF/500 V	CT 0104
C 608	-			500 pF/125 V	CT 1131
C 609-611	-		1%	1.3 nF/ 63 V	CT 1150
C 612	-		1%	1.8 nF/ 63 V	CT 1153
C 614	Ceramic			100 pF/400 V	CK 2100
C 615	-			4.7 nF/500 V	CK 3470
C 616-621	-			47 nF/ 30 V	CK 4470
C 622	Trim. cop.			10-40 pF/160 V	CV 0026
C 623	Polystyrene		1%	470 pF/100 V	CT 1111
C 627	Ceramic			330 pF/400 V	CK 2330
C 628	-			47 nF/ 30 V	CK 4470
L 601	Coil			22 µH	LB 0707
L 602,603	-			21 µH	LB 0706
L 604	-			8.5 µH	LB 0820
L 605,606	-			30 µH	LJ 0008
X 601	Crystal			960 kHz	MB 0008
P 601	Potm. Carbon	0.1 W	lin.	50 kΩ	PG 3502
P 602	Potm. Cermet	0.5 W	-	10 kΩ	PG 3109
R 601	Carbon	0.25 W	5%	1 kΩ	RB 3100
R 602-603	-	-	-	3.3 kΩ	RB 3330
R 604	-	-	-	4.7 kΩ	RB 3470
R 605	-	-	-	1.8 kΩ	RB 3180
R 606	-	-	-	820 Ω	RB 2820
R 607	-	-	-	1.8 kΩ	RB 3180

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 608	-	-	-	820 Ω	RB 2820
R 609	-	-	-	2.7 kΩ	RB 3270
R 610	-	-	-	10 kΩ	RB 4100
R 611	-	-	-	1.5 kΩ	RB 3150
R 612	-	-	-	5.6 kΩ	RB 3560
R 613	-	-	-	1 kΩ	RB 3100
R 614	-	-	-	560 kΩ	RB 5560
R 615	-	-	-	12 kΩ	RB 4120
R 616	-	-	-	3.3 kΩ	RB 3330
R 617	-	-	-	6.8 kΩ	RB 3680
R 618,619	-	-	-	4.7 kΩ	RB 3470
R 620	-	-	-	56 kΩ	RB 4560
R 621,622	-	-	-	1 kΩ	RB 3100
R 623	-	-	-	220 Ω	RB 2220
R 624	-	-	-	10 kΩ	RB 4100
R 625	-	-	-	100 kΩ	RB 5100
V 601	Si. Transistor	NPN		BSX 20	VB 0513
V 602	-	NPN		BF 173	VB 0065
V 603-605	-	NPN		BC 109	VB 0047
V 606	J-K Master-slave fl. fl.			SN 7472 N	VD 0011
V 607	Dual Master-slave J-K fl. fl.			SN 7473 N	VD 0017
V 608	Decade Counter			SN 7490 N	VD 0013
V 609	Si. Transistor	NPN		BC 107	VB 0032
	Locking arm for P.C. Board				DZ 9015
	Retaining pin				YN 0063
	Socket for Crystal				JV 0005
	Printed Circuit Board				XC 0609



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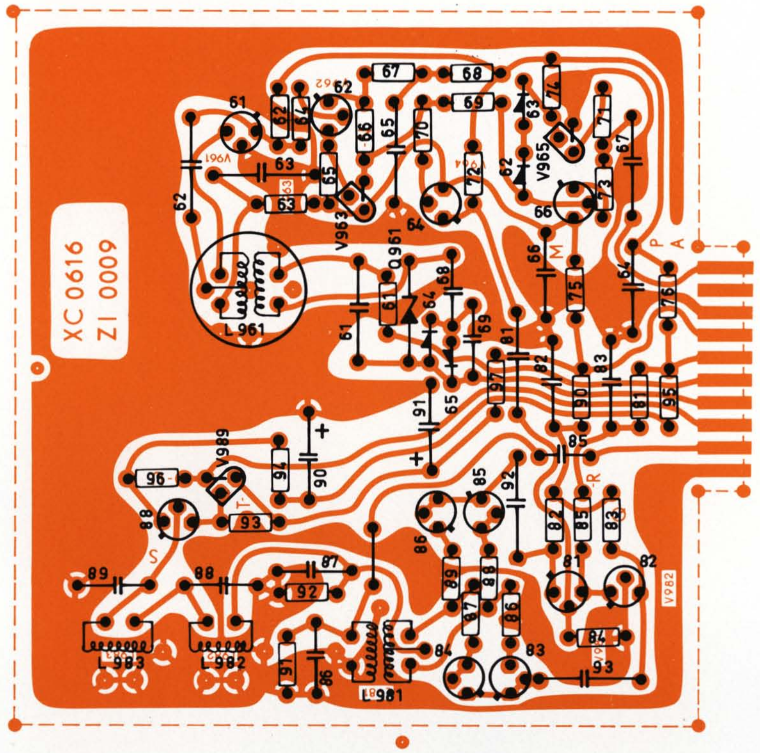
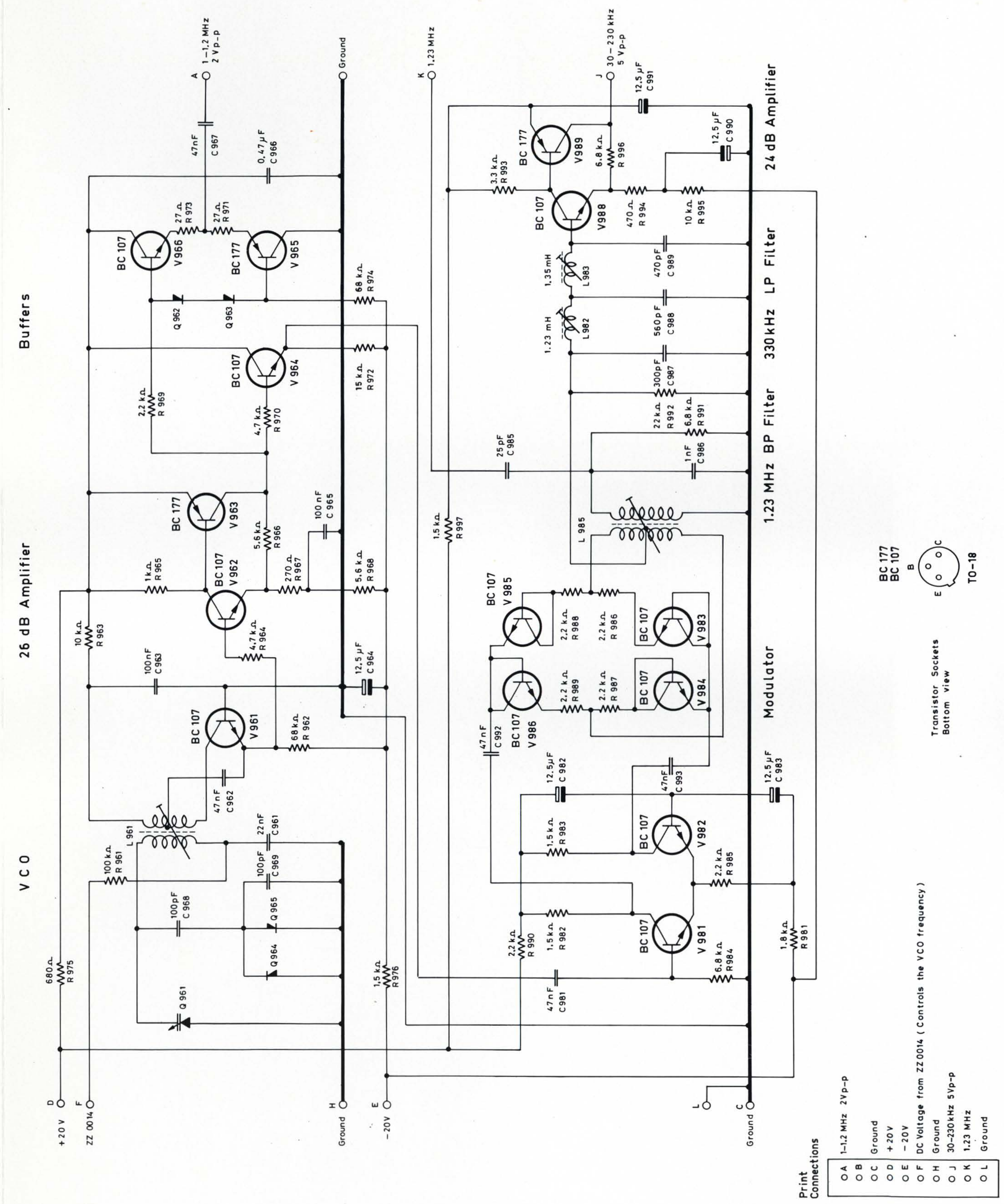
Circuit and Layout Diagram with Parts List ZI 0009

Oscillator and Modulator for V.C.O.



CIRCUIT DIAGRAM REF.	COMPONENT TYPE			STOCK REF.
C 961	Polystyrene	1%	22 nF/ 63 V	CT 1517
C 962	Polycarbonate		47 nF/250 V	CS 0009
C 963	-		100 nF/250 V	CS 0013
C 964	Electrolytic		12.5 µF/ 25 V	CE 0416
C 965	Polycarbonate		100 nF/250 V	CS 0013
C 966	-		0.47 µF/100 V	CS 0383
C 967	-		47 nF/250 V	CS 0009
C 968,969	Polystyrene		100 pF/125 V	CT 0500
C 981	Polycarbonate		47 nF/250 V	CS 0009
C 982,983	Electrolytic		12.5 µF/ 25 V	CE 0416
C 985	Ceramic		25 pF/400 V	CK 0091
C 986	Polystyrene	1%	1 nF/ 63 V	CT 1132
C 987	-	1%	300 pF/100 V	CT 1112
C 988	-	1%	560 pF/100 V	CT 1122
C 989	-	1%	460 pF/100 V	CT 1111
C 990,991	Electrolytic		12.5 µF/ 25 V	CE 0416
C 992,993	Polycarbonate		47 nF/250 V	CS 0009
L 961	Coil		21 µH	LB 0710
L 981	-		17.5 µH	LB 0686
L 982	-		1.23mH	LB 0691
L 983	-	-	1.35mH	LB 0762
Q961	Zener Diode	12.3-13.6 V/ 19 mA 1 N 4165 B		QV 1332
Q962-965	Si. Diode	150 V/300 mA BAX 16		QV 0217
R 961	Carbon	0.25 W 5%	100 kΩ	RB 5100
R 962	-	- -	68 kΩ	RB 4680
R 963	-	- -	10 kΩ	RB 4100
R 964	-	- -	4.7 kΩ	RB 3470
R 965	-	- -	1 kΩ	RB 3100
R 966	-	- -	5.6 kΩ	RB 3560

CIRCUIT DIAGRAM REF.	COMPONENT TYPE			STOCK REF.
R 967	- - -		270 Ω	RB 2270
R 968	- - -		5.6 kΩ	RB 3560
R 969	- - -		2.2 kΩ	RB 3220
R 970	- - -		4.7 kΩ	RB 3470
R 971	- - -		27 Ω	RB 1270
R 972	- - -		15 kΩ	RB 4150
R 973	- - -		27 Ω	RB 1270
R 974	- - -		68 kΩ	RB 4680
R 975	- - -		680 Ω	RB 2680
R 976	- - -		1.5 kΩ	RB 3150
R 981	- - -		1.8 kΩ	RB 3180
R 982,983	- - -		1.5 kΩ	RB 3150
R 984	- - -		6.8 kΩ	RB 3680
R 985-990	- - -		2.2 kΩ	RB 3220
R 991	- - -		6.8 kΩ	RB 3680
R 992	- - -		22 kΩ	RB 4220
R 993	- - -		3.3 kΩ	RB 3330
R 994	- - -		470 Ω	RB 2470
R 995	- - -		10 kΩ	RB 4100
R 996	- - -		6.8 kΩ	RB 3680
R 997	- - -		1.5 kΩ	RB 3150
V 961,962	Si. Transistor	NPN	BC 107	VB 0032
V 963	-	PNP	BC 177	VB 0071
V 964	-	NPN	BC 107	VB 0032
V 965	-	PNP	BC 177	VB 0071
V 966	-	NPN	BC 107	VB 0032
V 981-986	-	NPN	BC 107	VB 0032
V 988	-	NPN	BC 107	VB 0032
V 989	-	PNP	BC 177	VB 0071
	Housing for Coil			GS 0245
	Printed Circuit Board			XC 0616



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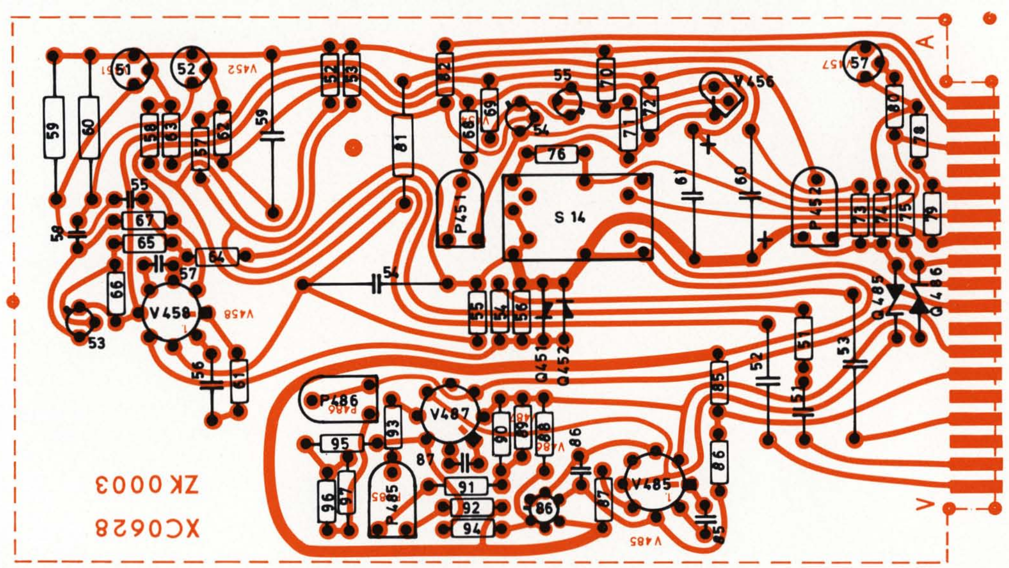
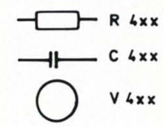
Circuit and Layout Diagram with Parts List

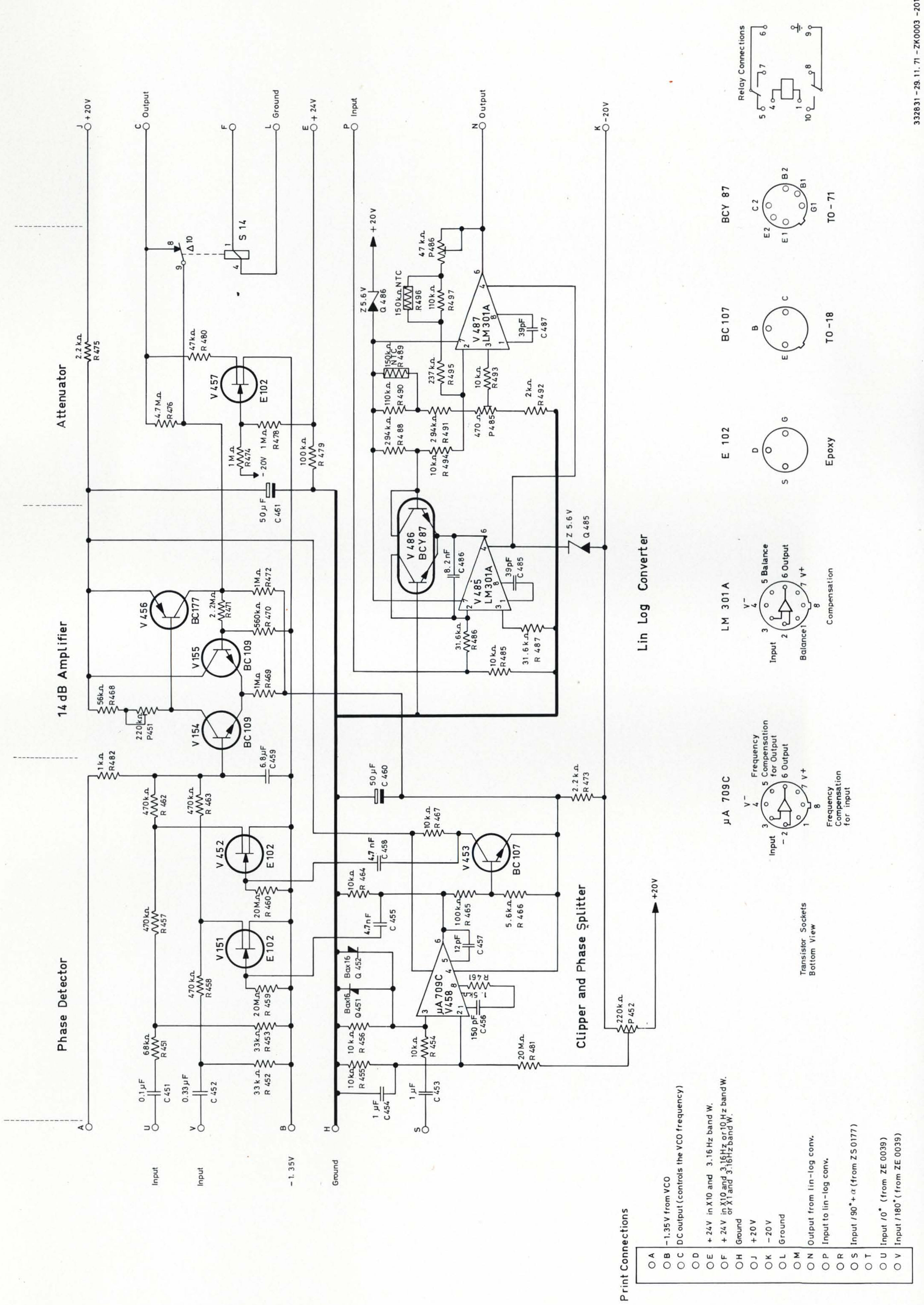
ZK 0003
Lin/log Converter
and AFC Circuit





CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
C 451	Polycarbonate			0.1 µF/100 V	CS 0402
C 452	-			0.33 µF/100 V	CS 0340
C 453,454	-			1 µF/100 V	CS 0336
C 455	Ceramic			4.7 nF/100 V	CK 0096
C 456	-			150 pF/400 V	CK 2150
C 457	-			12 pF/400 V	CK 1120
C 458	-			4.7 nF/100 V	CK 0096
C 459	Polycarbonate			6.8 µF/100 V	CS 0385
C 460,461	Electrolytic			50 µF/ 40 V	CE 0418
C 485	Ceramic			39 pF/400 V	CK 1391
C 486	-			8.2 nF/ 40 V	CK 3820
C 487	-			39 pF/400 V	CK 1391
P 451,452	Potm. Cermet	0.5 W	lin.	220 kΩ	PG 4204
P 485	-	-	-	470 Ω	PG 1504
P 486	-	-	-	47 kΩ	PG 3471
Q 451,452	Si. Diode	150 V/300 mA		BAX 16	QV 0217
Q 485,486	Zener Diode	5-6.2 V/	5 mA		QV 1105
R 451	Carbon	0.25 W	5%	68 kΩ	RB 4680
R 452,453	-	-	-	33 kΩ	RB 4330
R 454-456	-	-	-	10 kΩ	RB 4100
R 457,458	-	-	-	470 kΩ	RB 5470
R 459,460	-	0.5 W	10%	20MΩ	
R 461	-	0.25 W	5%	1.5 kΩ	RB 3150
R 462,463	-	-	-	470 kΩ	RB 5470
R 464	-	-	-	10 kΩ	RB 4100
R 465	-	-	-	100 kΩ	RB 5100
R 466	-	-	-	5.6 kΩ	RB 3560
R 467	-	-	-	10 kΩ	RB 4100
R 468	-	-	-	56 kΩ	RB 4560
R 469	-	-	-	1MΩ	RB 6100
R 470	-	-	-	560 kΩ	RB 5560
R 471	-	0.12 W	-	2.2MΩ	RA 0015
R 472	-	0.25 W	-	1MΩ	RB 6100
R 473	-	-	-	2.2 kΩ	RB 3220

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 474	-	-	-	1MΩ	RB 6100
R 475	-	-	-	2.2 kΩ	RB 3220
R 476	-	0.12 W	-	10MΩ	RA 0025
R 478	-	0.25 W	-	1MΩ	RB 6100
R 479	-	-	-	100 kΩ	RB 5100
R 480	-	-	-	47 kΩ	RB 4470
R 481	-	1/2 W	10%	50MΩ	
R 482	-	0.25W	5%	1 kΩ	RB 3100
R 485	Metal	-	-	10 kΩ	RF 4100
R 486,487	-	-	-	31.6 kΩ	RF 4316
R 488	-	-	-	294 kΩ	RF 5294
R 489	NTC			150 kΩ	RN 0005
R 490	Metal	0.25 W	1%	110 kΩ	RF 5110
R 491	-	-	-	294 kΩ	RF 5294
R 492	-	-	-	2 kΩ	RF 3200
R 493,494	-	-	-	10 kΩ	RF 4100
R 495	-	-	-	237 kΩ	RF 5237
R 496	NTC			150 kΩ	RN 0005
R 497	Metal	0.25 W	1%	110 kΩ	RF 5110
O 14	Relay				OC 0024
V 451,452	FET	N		E 102	VB 0045
V 453	Si. Transistor	NPN		BC 107	VB 0032
V 454,455	-	NPN		BC 109	VB 0047
V 456	-	PNP		BC 177	VB 0071
V 457	FET	N		E 102	VB 0045
V 458	Integr. Circuit			µA 709 C	VE 0003
V 485	Integr. Circuit			LM 301 A	VE 0028
V 486	Si. Transistor	NPN		BC 187	VB 5302
V 487	Integr. Circuit			LM 301 A	VE 0006
	Printed Circuit Board				XC 0628



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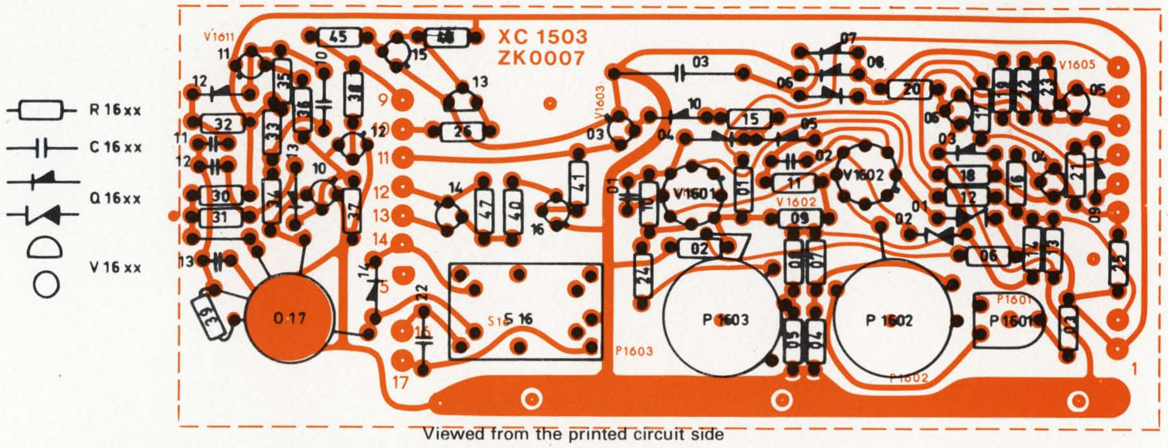
Circuit and Layout Diagrams with Parts List

ZK 0007

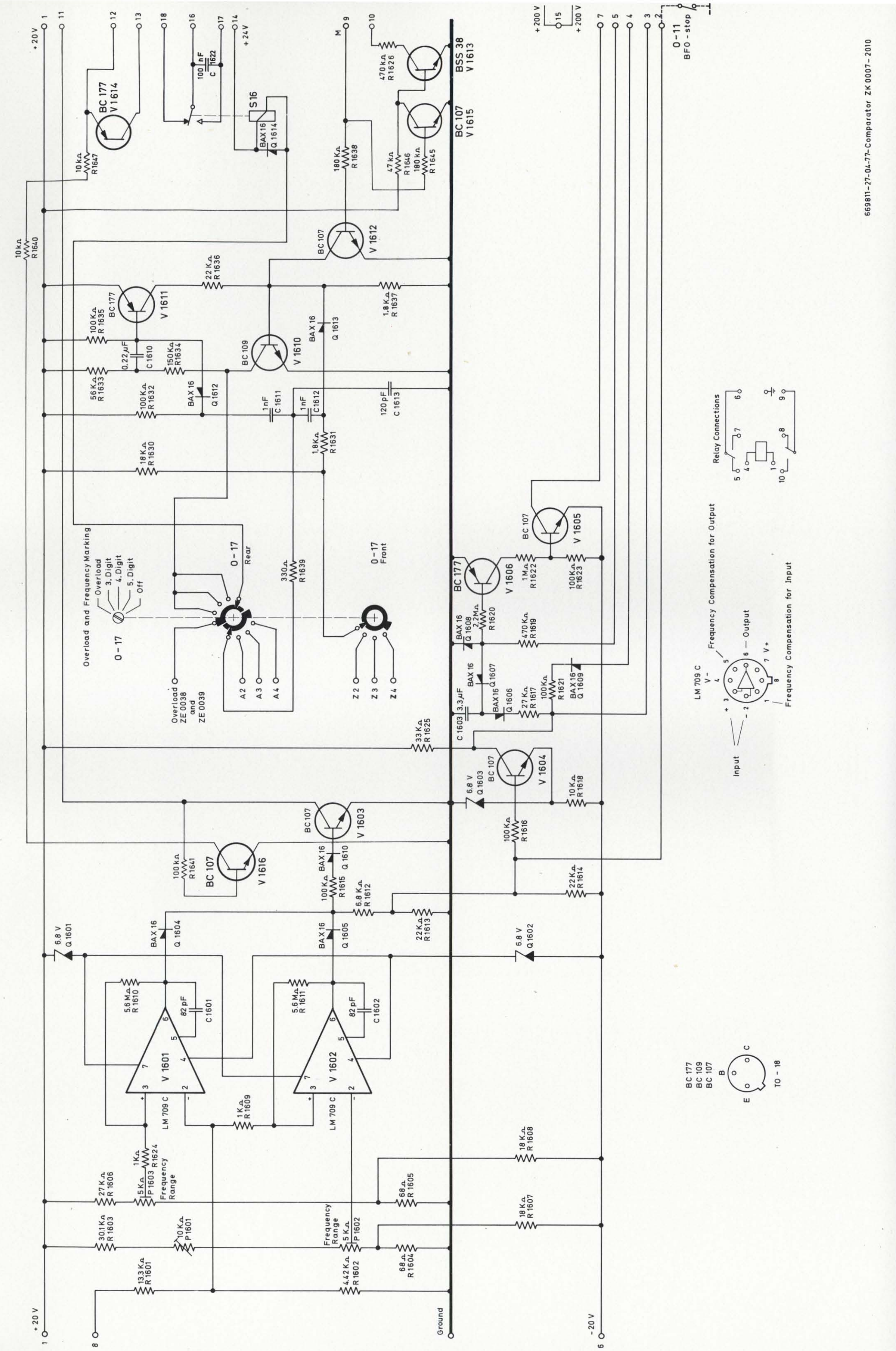
B.F.O. Comparator and Marking Circuit



Viewed from the printed circuit side

C 1601,02	Ceramic			82 pF/ 63 V	CK 1820
C 1603	Polycarbonate			3,3 μF/ 63 V	CS 0900
C 1610	-			0,22 μF/100 V	CS 0389
C 1611,12	Ceramic			1 nF/400 V	CK 3101
C 1613	-			120 pF/400 V	CK 2122
C 1622	Polycarbonate			100 nF/250 V	CS 0402
O 17	Selector Wafer				OH 3024
P 1601	Cermet	1/2 W	lin	10 kΩ	PG 3109
P 1602,03	Wire	3 W	-	5 kΩ	PC 2500
Q 1601-03	Ze.	ZG6,8		6,0-7,5 V/0,25 W	QV 1106
Q 1604-14	Si.	BAX16		150 V/300 mA	QV 0217
R 1601	Metal	1/4 W	1%	13,3 kΩ	RF 4133
R 1602	-	-	-	4,42 kΩ	RF 3442
R 1603	-	-	-	30,1 kΩ	RF 4301
R 1604,05	Carbon	-	5%	68 Ω	RB 1680
R 1606	-	-	-	27 kΩ	RB 4270
R 1607,08	-	-	-	18 kΩ	RB 4180
R 1609	-	-	-	1 kΩ	RB 3100
R 1610,11	-	-	-	5,6 MΩ	RB 6560
R 1612	-	-	-	6,8 kΩ	RB 3680
R 1613,14	-	-	-	22 kΩ	RB 4220
R 1615,16	-	-	-	100 kΩ	RB 5100
R 1617	-	-	-	27 kΩ	RB 4270
R 1618	-	-	-	10 kΩ	RB 4100
R 1619	-	-	-	470 kΩ	RB 5470
R 1620	-	-	-	2,2 MΩ	RB 6220
R 1621	-	-	-	100 kΩ	RB 5100
R 1622	-	-	-	1 MΩ	RB 6100

R 1623	Carbon	1/4 W	5%	100 kΩ	RB 5100
R 1624	-	-	-	1 kΩ	RB 3100
R 1625	-	-	-	33 kΩ	RB 4330
R 1626	-	-	-	470 kΩ	RB 5470
R 1630	-	-	-	18 kΩ	RB 4180
R 1631	-	-	-	1,8 kΩ	RB 3180
R 1632	-	-	-	100 kΩ	RB 5100
R 1633	-	-	-	56 kΩ	RB 4560
R 1634	-	-	-	150 kΩ	RB 5150
R 1635	-	-	-	100 kΩ	RB 5100
R 1636	-	-	-	22 kΩ	RB 4220
R 1637	-	-	-	1,8 kΩ	RB 3180
R 1638	-	-	-	180 kΩ	RB 5180
R 1639	-	-	-	330 Ω	RB 2330
R 1640	-	-	-	10 kΩ	RB 4100
R 1641	-	-	-	100 kΩ	RB 5100
R 1645	-	-	-	180 kΩ	RB 5180
R 1646	-	-	-	47 kΩ	RB 4470
R 1647	-	-	-	10 kΩ	RB 4100
S 16	Relay				OC 0021
V 1601,02	Op. Ampl.			709C	VE 0003
V 1603-05	Silicon		NPN	BC107	VB 0032
V 1606	-		PNP	BC177	VB 0071
V 1610	-		NPN	BC109	VB 0047
V 1611	-		PNP	BC177	VB 0071
V 1612	-		NPN	BC107	VB 0032
V 1613	-		-	BSS38	VB 0549
V 1614	-		PNP	BC177	VB 0071
V 1615,16	-		NPN	BC107	VB 0032
Printed Circuit Board					XC 1503
Cover for potentiometer					PD 0079



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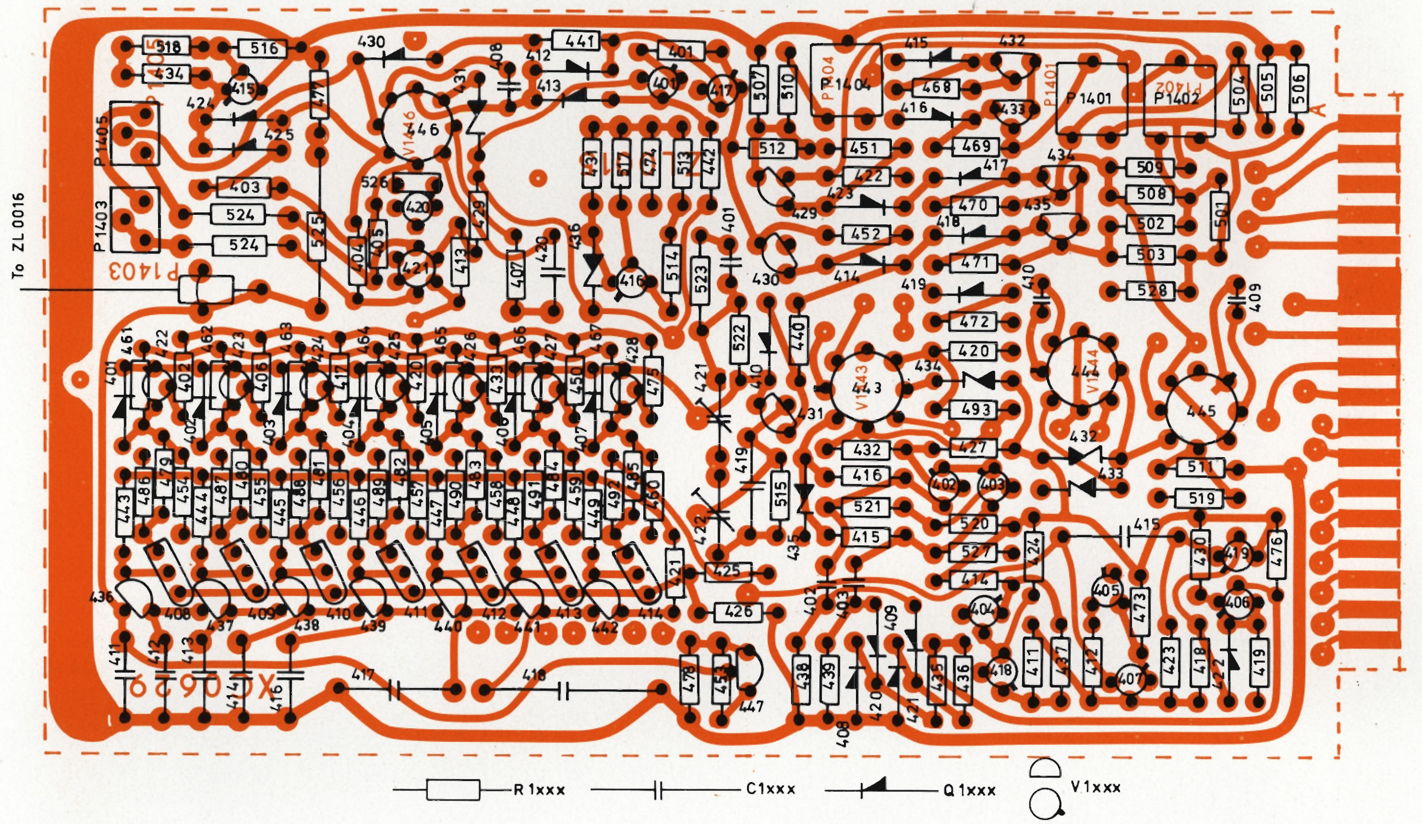
Circuit and Layout Diagrams with Parts List

ZL 0015

Integrator and Range Selector



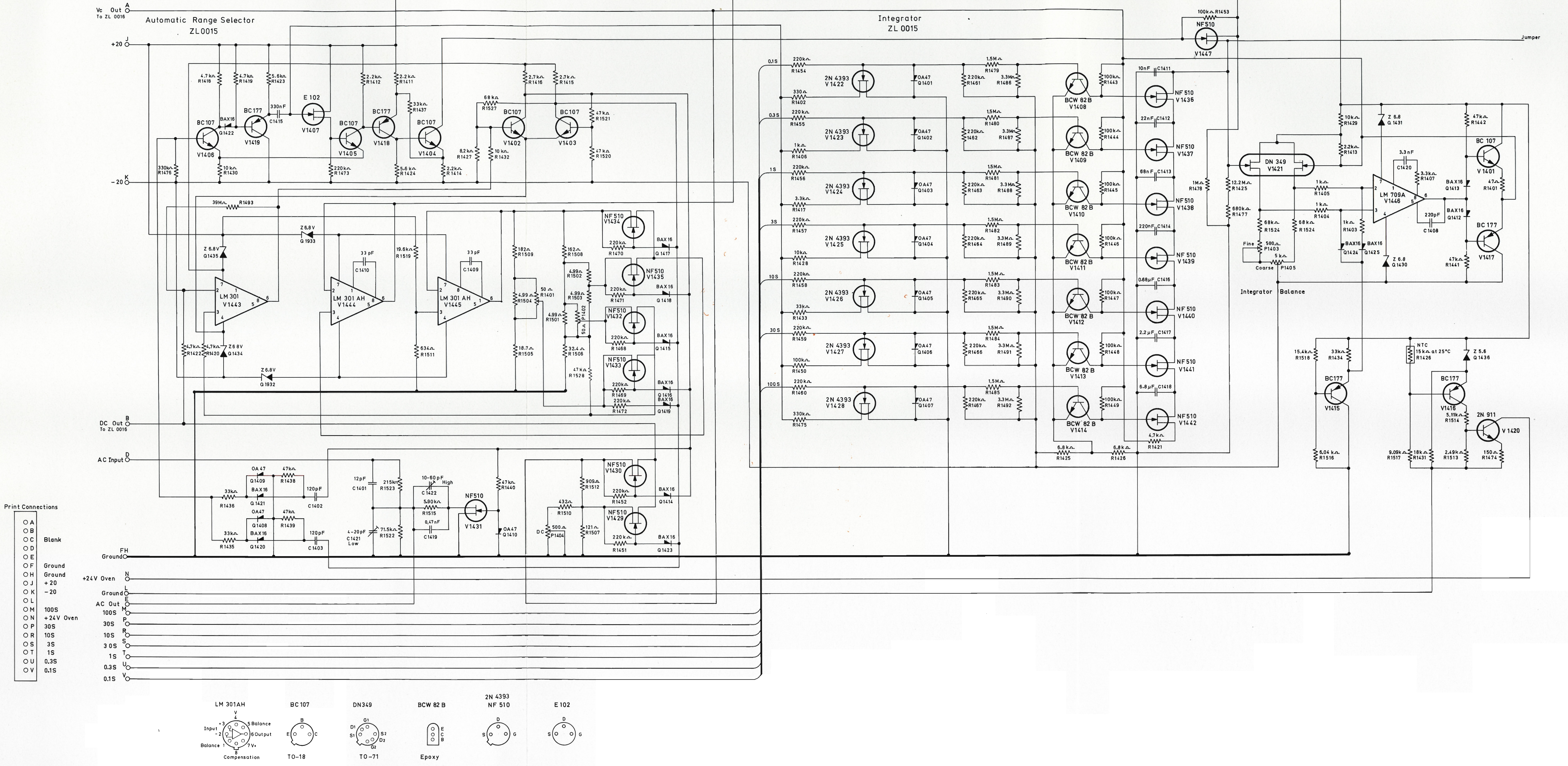
C 1401	Ceramic			12 pF/400 V	CK 1120
C 1402,1403	-			120 pF/400 V	CK 2122
C 1408	-			220 pF/400 V	CK 2222
C 1409,1410	-			33 pF/400 V	CK 1330
C 1411	Polycarbonate			10 nF/250 V	CS 0394
C 1412	-			22 nF/250 V	CS 0393
C 1413	-			68 nF/100 V	CS 0392
C 1414	-			220 nF/100 V	CS 0389
C 1415	-			330 nf/100 V	CS 0350
C 1416	-			680 nF/ 63 V	CS 0348
C 1417	-			2,2 μF/ 63 V	CS 0349
C 1418	-			6,8 μF/ 63 V	CS 0397
C 1419	Polystyrene			470 pF/125 V	CT 1111
C 1420	Ceramic			3,3 nF/400 V	CK 3330
C 1421	Trimmer			4-20 pF/250 V	CV 0040
C 1422	-			10-60 pF/160 V	CV 0032

P 1401,1402	Cermet	1/2 W		50 Ω	PG 0505
P 1403	-	-		500 Ω	PG 1509
P 1404	-	-		500 Ω	PG 1512
P 1405	-	-		5 kΩ	PG 2520

Q 1401-1410	Ge.Diode	OA44	25 V/110 mA	QV 0094
Q 1412-1425	Si. Diode	BAX16	150 V/300 mA	QV 0217
Q 1430-1435	Ze. Diode	ZG6,8	6-7,5 V/5 mA	QV 1106
Q 1436	-	ZG5,6	5,6-6 V/10 mA	QV 1107

R 1401	Carbon	1/4 W	5%	47 Ω	RB 1470
R 1402	-	-	-	330 Ω	RB 2330
R 1403-1406	-	-	-	1 kΩ	RB 3100
R 1407	-	-	-	3,3 kΩ	RB 3330
R 1411-1414	-	-	-	2,2 kΩ	RB 3220
R 1415-1416	-	-	-	2,7 kΩ	RB 3270
R 1417	-	-	-	3,3 kΩ	RB 3330
R 1418-1422	-	-	-	4,7 kΩ	RB 3470
R 1423,1424	Carbon	1/4 W	5%	5,6 kΩ	RB 3560
R 1425,1426	-	-	-	6,8 kΩ	RB 3680
R 1427	-	-	-	8,2 kΩ	RB 3820
R 1428-1430	-	-	-	10 kΩ	RB 4100
R 1431	-	-	-	18 kΩ	RB 4180
R 1432	-	-	-	10 kΩ	RB 4100
R 1433-1437	-	-	-	33 kΩ	RB 4330
R 1438-1442	-	-	-	47 kΩ	RB 4470
R 1443-1450	-	-	-	100 kΩ	RB 5100
R 1451,1452	-	-	-	220 kΩ	RB 5220
R 1453	-	-	-	100 kΩ	RB 5100
R 1454-1473	-	-	-	220 kΩ	RB 5220
R 1474	-	-	-	150 Ω	RB 2150
R 1475,1476	-	-	-	330 kΩ	RB 5330
R 1477	-	-	-	680 kΩ	RB 5680
R 1478	-	-	-	1 MΩ	RB 6100
R 1479-1485	-	-	-	1,5 MΩ	RB 6150
R 1486-1492	-	-	-	3,3 MΩ	RB 6330
R 1493	-	-	10%	39 MΩ	RH 0003
R 1501-1504	Metal	-	1%	4,99 Ω	RF 0499
R 1505	-	-	-	18,7 Ω	RF 1187
R 1506	-	-	-	32,4 Ω	RF 1324
R 1507	-	-	-	121 Ω	RF 2121
R 1508	-	-	-	162 Ω	RF 2162
R 1509	-	-	-	182 Ω	RF 2182
R 1510	-	-	-	432 Ω	RF 2432
R 1511	-	-	-	634 Ω	RF 2634
R 1512	-	-	-	909 Ω	RF 2909
R 1513	-	-	-	2,49 kΩ	RF 3249
R 1514	-	-	-	5,11 kΩ	RF 3511
R 1515	-	-	-	5,90 kΩ	RF 3590
R 1516	-	-	-	6,04 kΩ	RF 3604
R 1517	-	-	-	9,09 kΩ	RF 3909
R 1518	-	-	-	15,4 kΩ	RF 4154
R 1519	-	-	-	19,6 kΩ	RF 4196
R 1520,1521	Carbon	-	5%	47 kΩ	RB 4470

ZL 0015



ZL 0015

R 1522	Metal	1/4 W	1%		71,5 kΩ	RF 4715
R 1523	-	-	-		215 kΩ	RF 5215
R 1524	Matched pair	-	-		68 kΩ	RF 9003
R 1525	Carbon	1 W	2%		12,2 MΩ	RH 0012
R 1526	NTC				15 kΩ	RN 0010
R 1527	Carbon	1/4 W	5%		68 kΩ	RB 4680
R 1528	-	-	-		47 kΩ	RB 4470
V 1401-1406	Si. Trans.		NPN	BC107		VB 0032
V 1407	FET		N	E102		VB 1016
V 1408-1414	Si. Trans.		NPN	BCW82B		VB 0578
V 1415-1419	-		PNP	BC177		VB 0071
V 1420	-		NPN	2N911		VB 0521
V 1421	FET		N.Spec.	DN349		VB 1005
V 1422-1428	-		N	2N4393		VB 1056
V 1429-1435	-		N. Spec.	NF510		VB 1021
V 1436-1442	-		-	NF510		VB 1034
V 1443-1445	Op. Amp.			LM709A		VE 0006
V 1446	-			LM709A		VE 0010
V 1447	FET		N.Spec.	NF510		VB 1034

Heat Sink	DZ 2105
Cover for Oven	DS 0171
Socket	JJ 0043
Printed Circuit Board	XC 0629

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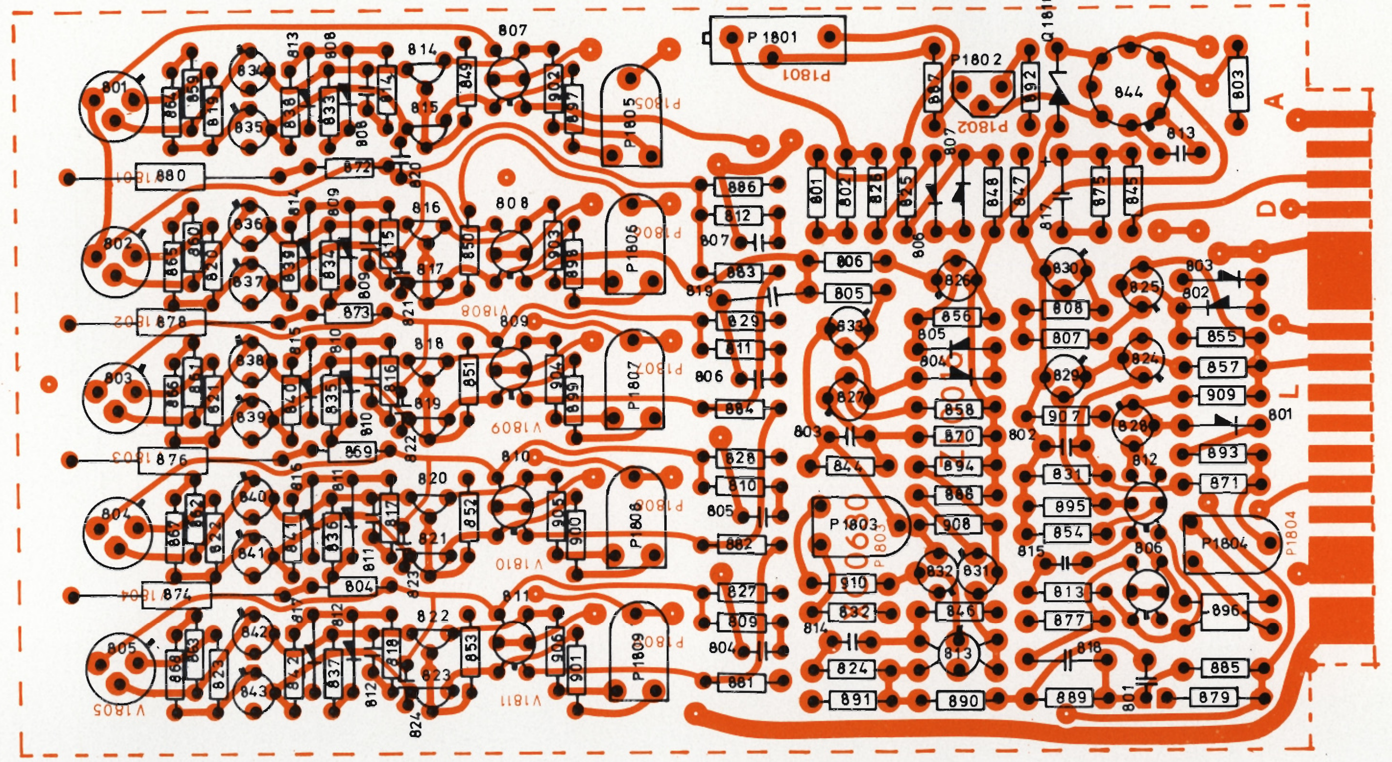
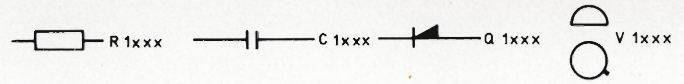
Circuit and Layout Diagrams with Parts List

ZL 0016

Active Diodes and Amplifiers

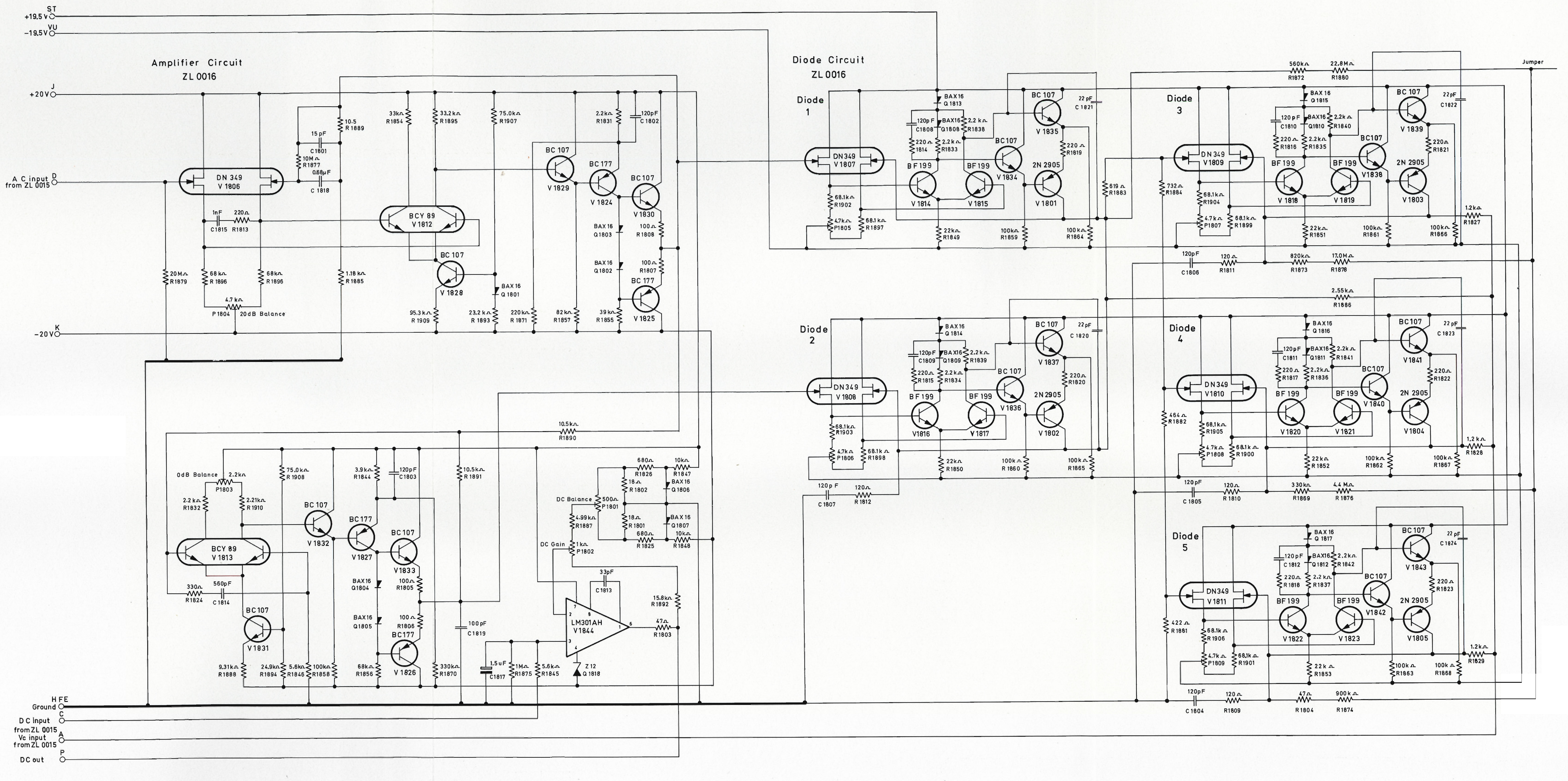


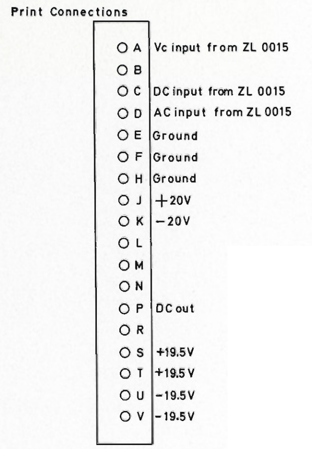


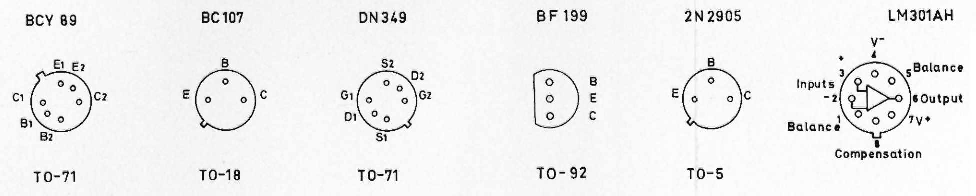
C 1801	Ceramic				15 pF/400 V	CK 1150
C 1802-1812	-				120 pF/400 V	CK 2122
C 1813	-				33 pF/400 V	CK 1330
C 1814	-				560 pF/400 V	CK 2561
C 1815	-				1 nF/400 V	CK 3101
C 1817	Tantalum				1,5 µF/ 35 V	CF 0008
C 1818	Polycarbonate				680 nF/100 V	CS 0348
C 1819	Ceramic				100 pF/500 V	CK 2101
C 1820-1824	-				22 pF/100 V	CK 1220
P 1801	Potm. Wire w.		1/2 W		500 Ω	PG 1511
P 1802	Potm. Cermet		-		1 kΩ	PG 2109
P 1803	-		-		2,2 kΩ	PG 2207
P 1804-1809	-		-		4,7 kΩ	PG 2470
Q 1801-1817	Si.	BAX16			150 V/300 mA	QV 0217
Q 1818	Ze.	1N716			11-13 V/10 mA	QV 1117
R 1801,1802	Carbon		1/4 W	5%	18 Ω	RB 1180
R 1803,1804	-		-	-	47 Ω	RB 1470
R 1805-1808	-		-	-	100 Ω	RB 2100
R 1809-1812	-		-	-	120 Ω	RB 2120
R 1813-1823	-		-	-	220 Ω	RB 2220
R 1824	-		-	-	330 Ω	RB 2330
R 1825,1826	-		-	-	680 Ω	RB 2680
R 1827-1829	-		-	-	1,2 kΩ	RB 3120
R 1831-1842	-		-	-	2,2 kΩ	RB 3220
R 1844	-		-	-	3,9 kΩ	RB 3390
R 1845,1846	-		-	-	5,6 kΩ	RB 3560
R 1847,1848	-		-	-	10 kΩ	RB 4100
R 1849-1853	-		-	-	22 kΩ	RB 4220
R 1854	-		-	-	33 kΩ	RB 4330
R 1855	-		-	-	39 kΩ	RB 4390
R 1856	-		-	-	68 kΩ	RB 4680
R 1857	-		-	-	82 kΩ	RB 4820
R 1858-1868	-		-	-	100 kΩ	RB 5100
R 1869-1871	-		-	-	330 kΩ	RB 5330
R 1872	Carbon		1/4 W	5%	560 kΩ	RB 5560
R 1873	-		-	-	820 kΩ	RB 5820
R 1874	-		-	-	900 kΩ	RH 0010
R 1875	-		-	-	1 MΩ	RB 6100
R 1876	-		-	-	4,4 MΩ	RH 0011
R 1877	-		1/4 W	10%	10 MΩ	RB 7100
R 1878	-		1 W	2%	17 MΩ	RH 0013
R 1879	-		1/4 W	10%	20 MΩ	RH 0002
R 1880	-		1 W	2%	22,8 MΩ	RH 0015
R 1881	Metal		1/4 W	1%	422 Ω	RF 2422
R 1882	-		-	-	464 Ω	RF 2464
R 1883	-		-	-	619 Ω	RF 2619
R 1884	-		-	-	732 Ω	RF 2732
R 1885	-		-	-	1,18 kΩ	RF 3118
R 1886	-		-	-	2,55 kΩ	RF 3255
R 1887	-		-	-	4,99 kΩ	RF 3499
R 1888	-		-	-	9,31 kΩ	RF 3931
R 1889-1891	-		-	-	10,5 kΩ	RF 4105
R 1892	-		-	-	15,8 kΩ	RF 4158
R 1893	-		-	-	23,2 kΩ	RF 4232
R 1894	-		-	-	24,9 kΩ	RF 4249
R 1895	-		-	-	33,2 kΩ	RF 4332
R 1896	Matched pair		-	-	68 kΩ	RF 9003
R 1897-1906	Metal		-	-	68,1 kΩ	RF 4681
R 1907,1908	-		-	-	75 kΩ	RF 4750
R 1909	-		-	-	93,3 kΩ	RF 4953
R 1910	-		-	-	2,21 kΩ	RF 3221
V 1801-1805	Si. Trans.		PNP		2N2905	VB 0059
V 1806-1811	FET		Nspecial		DN349	VB 1005
V 1812,1813	Si. Trans.		NPN		BCY89	VB 5304
V 1814-1823	-		NPN		BF173	VB 0515
V 1824-1827	-		PNP		BF177	VB 0071
V 1828-1843	-		NPN		BC107	VB 0032
V 1844	Op. Amp.				LM301AH	VE 0006
	Plug					JP 0043
	Printed Circuit Board					XC 0630

ZL 0016

2010 from serial no. 795325







795325 - 21.3.79 - ZL 0016 - 2010

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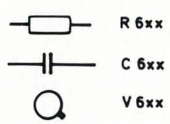
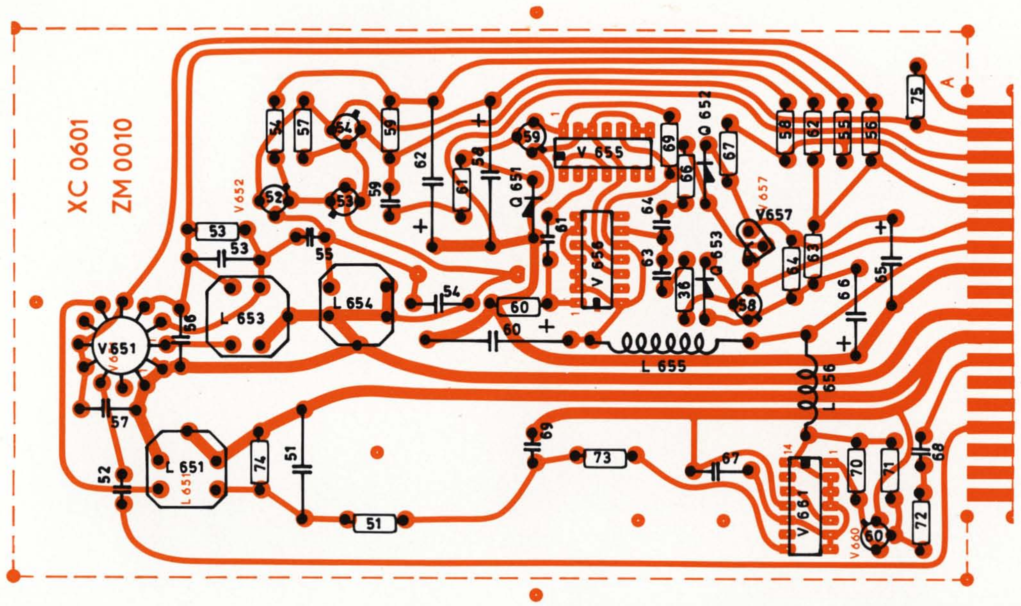
Circuit and Layout Diagram with Parts List ZM 0010

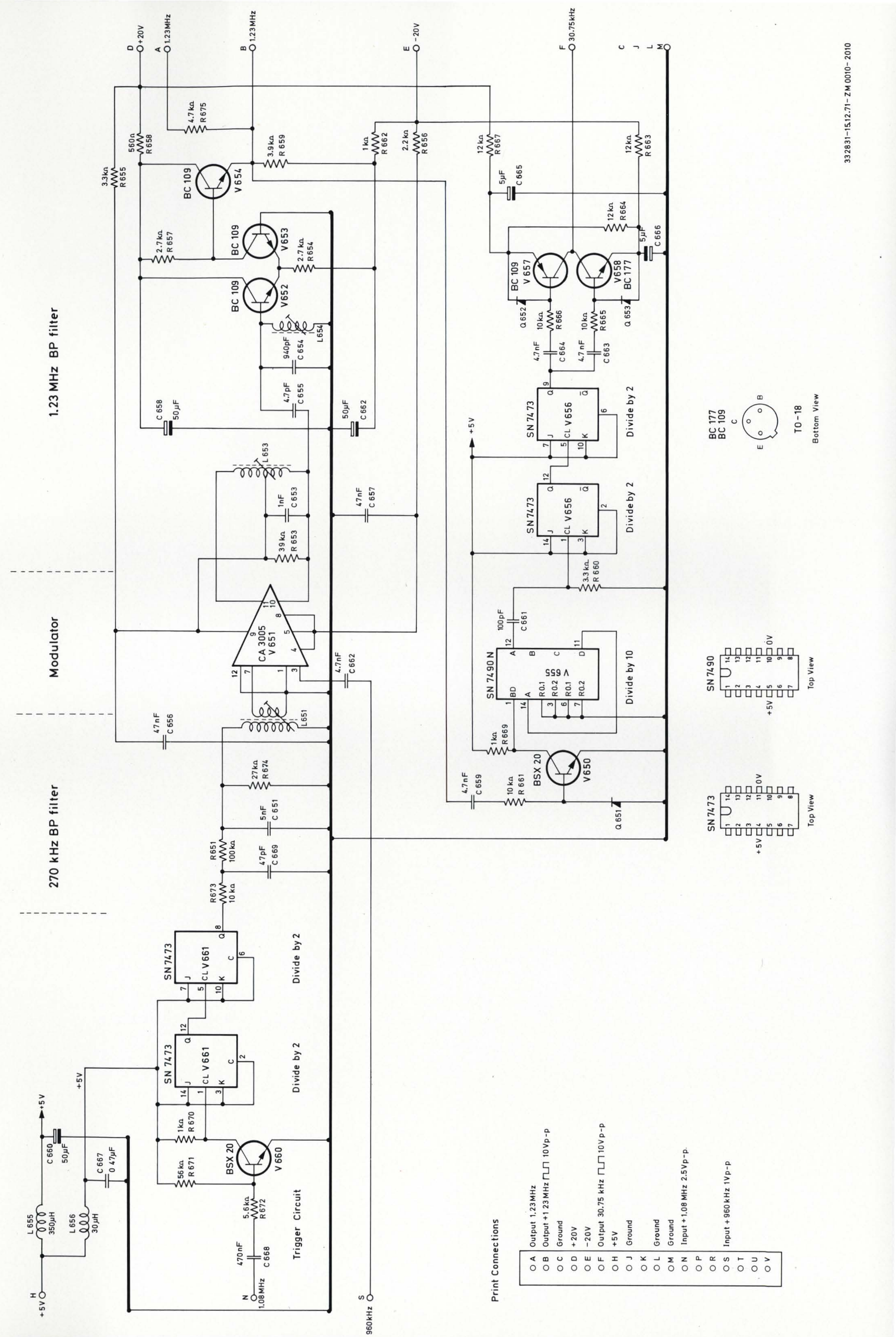
Frequency Converter





CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
C 651	Polystyrene	1%		5 nF/250 V	CT 1202
C 652	Ceramic			4.7 nF/500 V	CK 3470
C 653	Polystyrene	5%		1 nF/125 V	CT 1018
C 654	-	1%		940 pF/500 V	CT 1300
C 655	Ceramic			4.7 pF/400 V	CK 0470
C 656,657	-			47 nF/ 30 V	CK 4470
C 658	Electrolytic			50 µF/ 25 V	CE 8965
C 659	Ceramic			4.7 nF/500 V	CK 3470
C 660	Electrolytic			50 µF/ 25 V	CE 8965
C 661	Ceramic	5%		100 pF/400 V	CK 2100
C 662	Electrolytic			50 µF/ 25 V	CE 8965
C 663,664	Ceramic			4.7 nF/500 V	CK 3470
C 665,666	Electrolytic			5 µF/ 70 V	CE 0200
C 667	Ceramic			0.47 µF/ 12 V	CK 5470
C 668	-			470 pF/400 V	CK 2470
C 669	-			47 pF/400 V	CK 1470
L 651	Coil			70 µH	LB 0695
L 653	-			16 µH	LB 0696
L 654	-			16 µH	LB 0706
L 655	-			350 µH	LJ 0012
L 656	-			30 µH	LJ 0008
Q 651-653	Ge. Diode	25 V/110 mA	OA 47		QV 0094
R 651	Carbon	1/4 W	5%	100 kΩ	RB 5100
R 652	-	-	-	27 kΩ	RB 4270
R 653	-	-	-	39 kΩ	RB 4390
R 654	-	-	-	2.7 kΩ	RB 3270
R 655	-	-	-	3.3 kΩ	RB 3330

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 656	-	-	-	2.2 kΩ	RB 3220
R 657	-	-	-	2.7 kΩ	RB 3270
R 658	-	-	-	560 Ω	RB 2560
R 659	-	-	-	3.9 kΩ	RB 3390
R 660	-	-	-	3.3 kΩ	RB 3330
R 661	-	-	-	10 kΩ	RB 4100
R 662	-	-	-	1 kΩ	RB 3100
R 663,664	-	-	-	12 kΩ	RB 4120
R 665,666	-	-	-	10 kΩ	RB 4100
R 667	-	-	-	12 kΩ	RB 4120
R 668	-	-	-	4.7 kΩ	RB 3470
R 669,670	-	-	-	1 kΩ	RB 3100
R 671	-	-	-	56 kΩ	RB 4560
R 672	-	-	-	5.6 kΩ	RB 3560
R 673	-	-	-	10 kΩ	RB 4100
R 674	-	-	-	27 kΩ	RB 4270
R 675	-	-	-	4.7 kΩ	RB 3470
V 651	H.F.-Ampl.			CA 3005	VE 0007
V 652-654	Silicon	NPN		BC 109	VB 0047
V 655	Decade Counter			SN 7490 N	VD 0013
V 656	J.K. Flip-flop			SN 7473 N	VD 0017
V 657	Silicon	PNP		BC 177	VB 0071
V 658	-	NPN		BC 109	VB 0047
V 659,660	-	NPN		BSX 20	VB 0513
V 661	J.K. Flip-flop			SN 7473 N	VD 0017
	Printed Circuit Board				XC 0601



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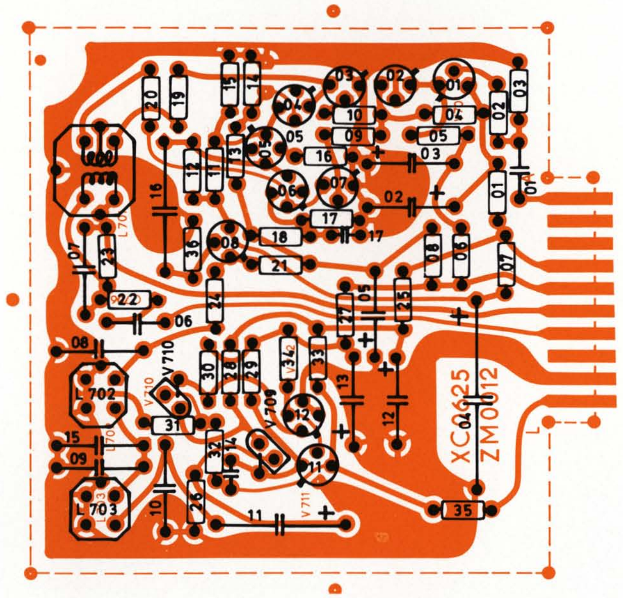
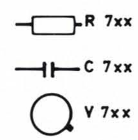
Circuit and Layout Diagram with Parts List

ZM 0012

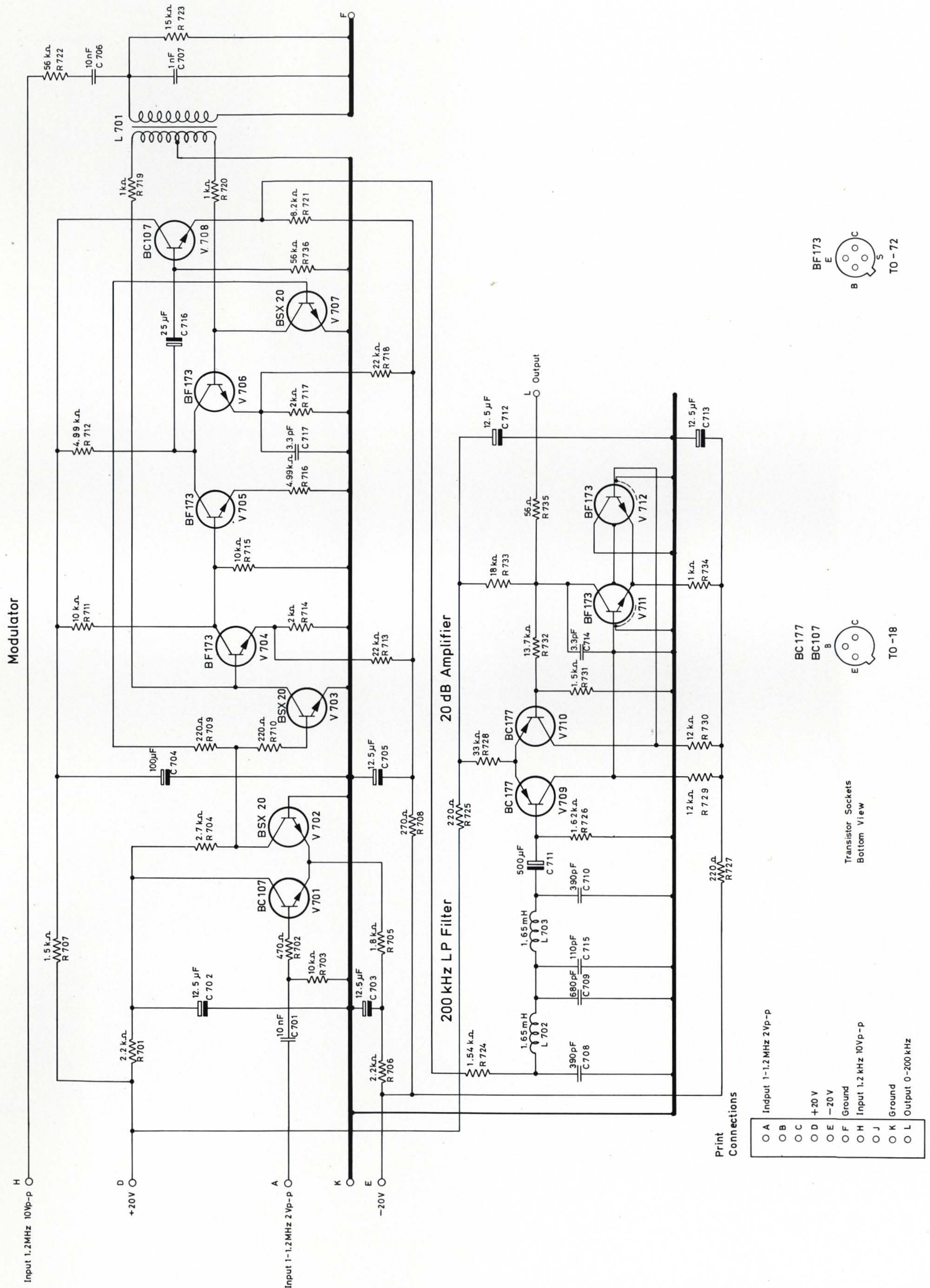
B.F.O. Modulator





CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
C 701	Polycarbonate			10 nF/250 V	CS 0403
C 702,703	Electrolytic			12.5 µF/ 25 V	CE 0416
C 704	-			1000 µF/ 16 V	CE 0309
C 705	-			12.5 µF/ 25 V	CE 0416
C 706	Polycarbonate			10 nF/250 V	CS 0403
C 707	Polystyrene	1%		1000 pF/ 63 V	CT 1132
C 708	-	1%		390 pF/100 V	CT 1120
C 709	-	1%		680 pF/125 V	CT 1134
C 710	-	1%		390 pF/100 V	CT 1120
C 711	Eletrolytic			500 µF/ 2.5 V	CE 0101
C 712,713	-			12.5 µF/ 25 V	CE 0416
C 714	Ceramic			3.3 pF/400 V	CK 0330
C 715	Polystyrene	1%		110 pF/125 V	CT 1136
C 716	Electrolytic			25 µF/ 25 V	CE 2002
C 717	Ceramic			3.3 pF/400 V	CK 0330
L 701	Coil			17 µH	LB 0686
L 702,703	-			1.65 mH	LB 0692
R 701	Carbon	0.25 W	5%	2.2 kΩ	RB 3220
R 702	-	-	-	470 Ω	RB 2470
R 703	-	-	-	10 kΩ	RB 4100
R 704	-	-	-	2.7 kΩ	RB 3270
R 705	-	-	-	1.8 kΩ	RB 3180
R 706	-	-	-	2.2 kΩ	RB 3220
R 707	-	-	-	1.5 kΩ	RB 3150
R 708	-	-	-	270 Ω	RB 2270
R 709,710	-	-	-	220 Ω	RB 2220
R 711	Metal	-	1%	10 kΩ	RF 4100
R 712	-	-	-	4.99 kΩ	RF 3499
R 713	Carbon	-	5%	22 kΩ	RB 4220
R 714	Metal	-	1%	2 kΩ	RF 3200
R 715	-	-	-	10 kΩ	RF 4100

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 716	-	-	-	4.99 kΩ	RF 3499
R 717	-	-	-	2 kΩ	RF 3200
R 718	Carbon	-	5%	22 kΩ	RB 4220
R 719,720	-	-	-	1 kΩ	RB 3100
R 721	-	-	-	8.2 kΩ	RB 3820
R 722	-	-	-	56 kΩ	RB 4560
R 723	-	-	-	15 kΩ	RB 4150
R 724	Metal	-	1%	1.54 kΩ	RF 3154
R 725	Carbon	-	5%	220 Ω	RB 2220
R 726	Metal	-	1%	1.62 kΩ	RF 3162
R 727	Carbon	-	5%	220 Ω	RB 2220
R 728	-	-	-	33 kΩ	RB 4330
R 729,730	-	-	-	12 kΩ	RB 4120
R 731	Metal	-	1%	1.5 kΩ	RF 3150
R 732	-	-	-	13.7 kΩ	RF 4137
R 733	Carbon	-	5%	18 kΩ	RB 4180
R 734	-	-	-	1 kΩ	RB 3100
R 735	-	-	-	56 Ω	RB 1560
R 736	-	-	-	56 kΩ	RB 4560
V 701	Si. Transistor	NPN		BC 107	VB 0032
V 702,703	-	NPN		BSX 20	VB 0513
V 704-706	-	NPN		BF 173	VB 0065
V 707	-	NPN		BSX 20	VB 0513
V 708	-	NPN		BC 107	VB 0032
V 709,710	-	PNP		BC 177	VB 0071
V 711,712	-	NPN		BF 173	VB 0065
	Locking arm for P.C. Board				DZ 9015
	Retaining pin				YN 0063
	Printed Circuit Board				XC 0625



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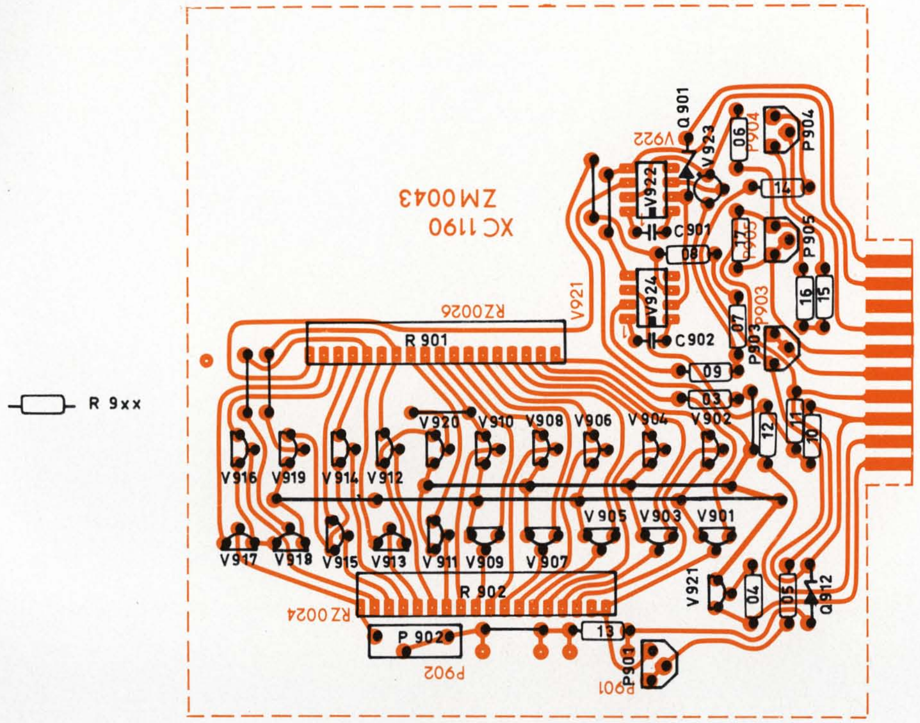
Circuit and Layout Diagrams with Parts List

ZM 0043

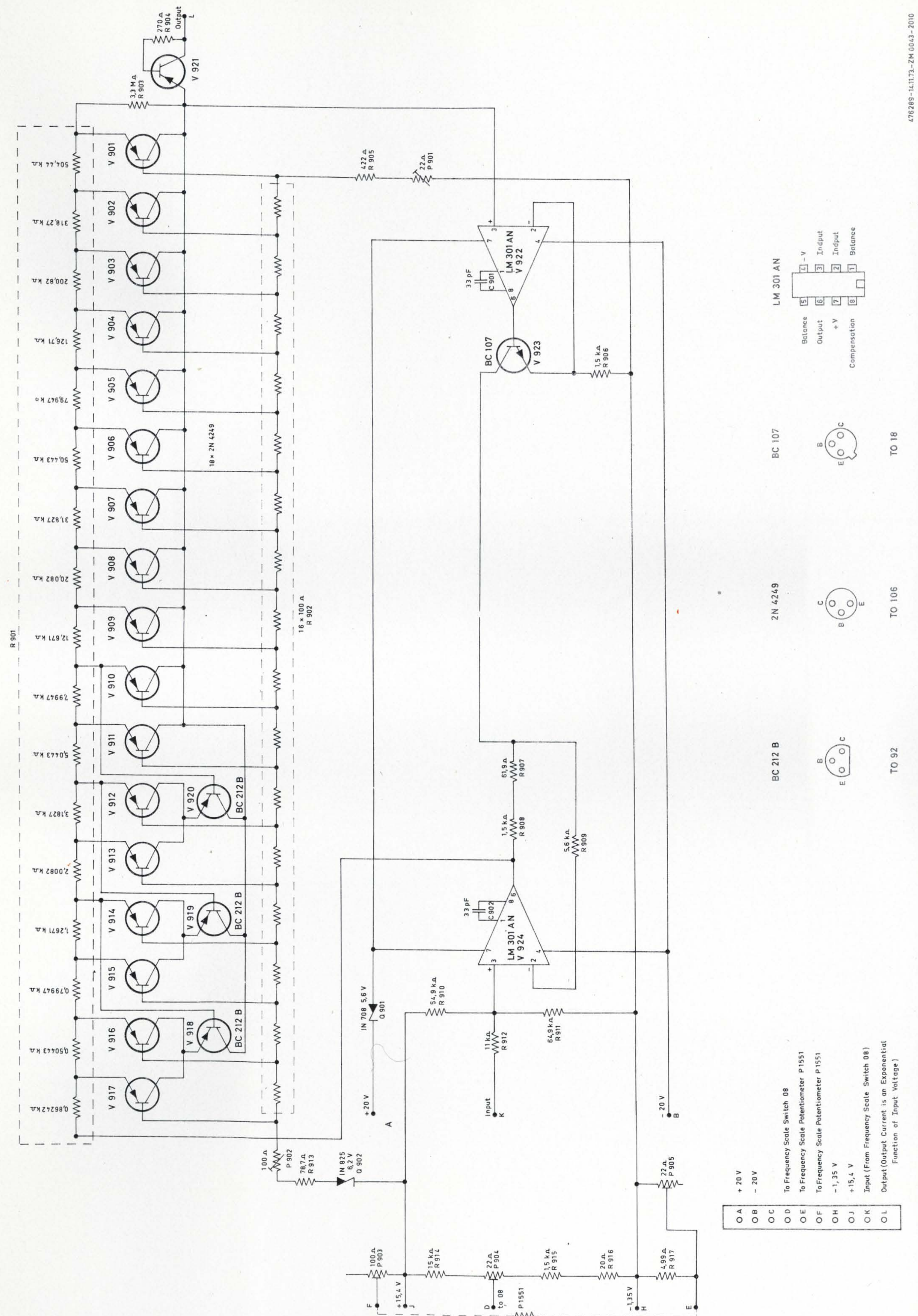
Lin/log Converter for VCO



Viewed from the printed circuit side

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
C 901,902	Ceramic			33 pF/ 400 V	CK 1330
	Supply Rail			55,8 mm	OD 0245
	- -			91,4 mm	OD 0246
P 901	Trim. potm.	0,5 W	lin.	22 Ω	PG 0222
P 902	- -	Multiturn	-	100 Ω	PG 1107
P 903	- -	0,5 W	-	100 Ω	PG 1106
P 904,905	- -	-	-	22 Ω	PG 0222
Q 901	Zener ZG 5,6			5,6 V/ 46 mA	QV 1105
Q 902	- 1 N 825			6,2 V/ 50 mA	QV 1346
R 901	Thick film Resistor		1%		RZ 0026
R 902	- - -		-		RZ 0024
R 903	Mini-Resistor	0,3 W	10%	3,3 MΩ	RA 0022
R 904	Carbon	0,25 W	5%	270 Ω	RB 2270
R 905	Metal	-	1%	422 Ω	RF 2422
R 906	-	-	-	1,5 kΩ	RF 3150
R 907	-	-	-	61,9 Ω	RF 1619
R 908	-	-	-	1,5 kΩ	RF 3150

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 909	Carbon	0,25 W	5%	5,6 kΩ	RB 3560
R 910	Metal	-	1%	54,9 kΩ	RF 4549
R 911	-	-	-	64,9 kΩ	RF 4649
R 912	-	-	-	11 kΩ	RF 4110
R 913	-	-	-	78,7 kΩ	RF 4787
R 914	-	-	-	15 kΩ	RF 0014
R 915	-	-	-	1,5 kΩ	RF 0015
R 916	-	-	-	20 Ω	RF 1200
R 917	-	-	-	4,99	RF 0499
V 901-917	Si. Transistor	NPN		Matched	VB 0112
V 918-920	- -	PNP		2 N 4249	VB 0081
V 921	- -	NPN			VB 0112
V 922	Op. Amp.			LM 301	VE 0017
V 923	Si. Transistor	NPN		BC 107	VB 0032
V 924	Op. Amp.			LM 301	VE 0017
	Printed circuit				XC 1190



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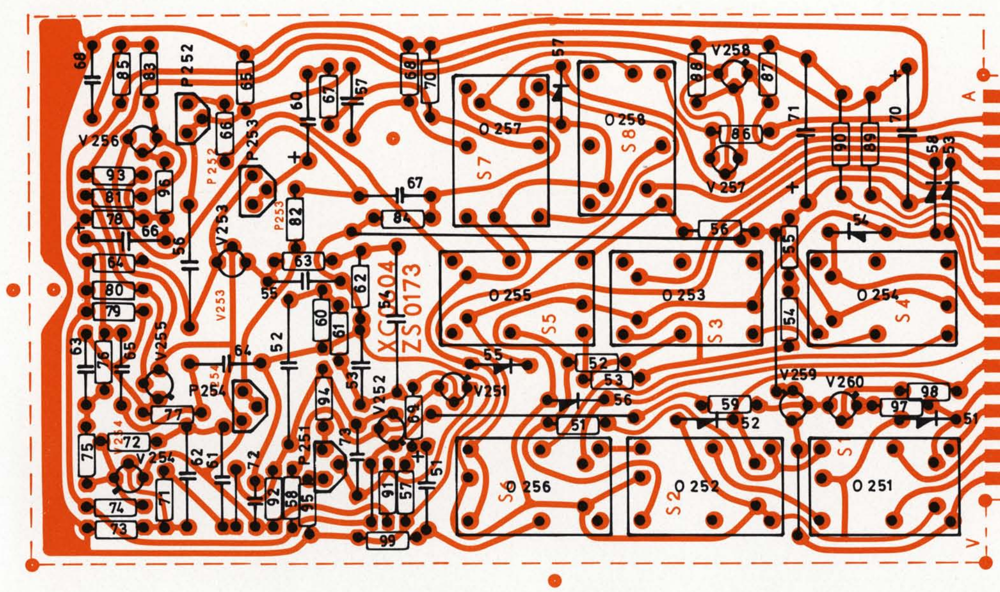
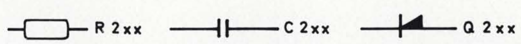
Circuit and Layout Diagram with Parts List

ZS 0173

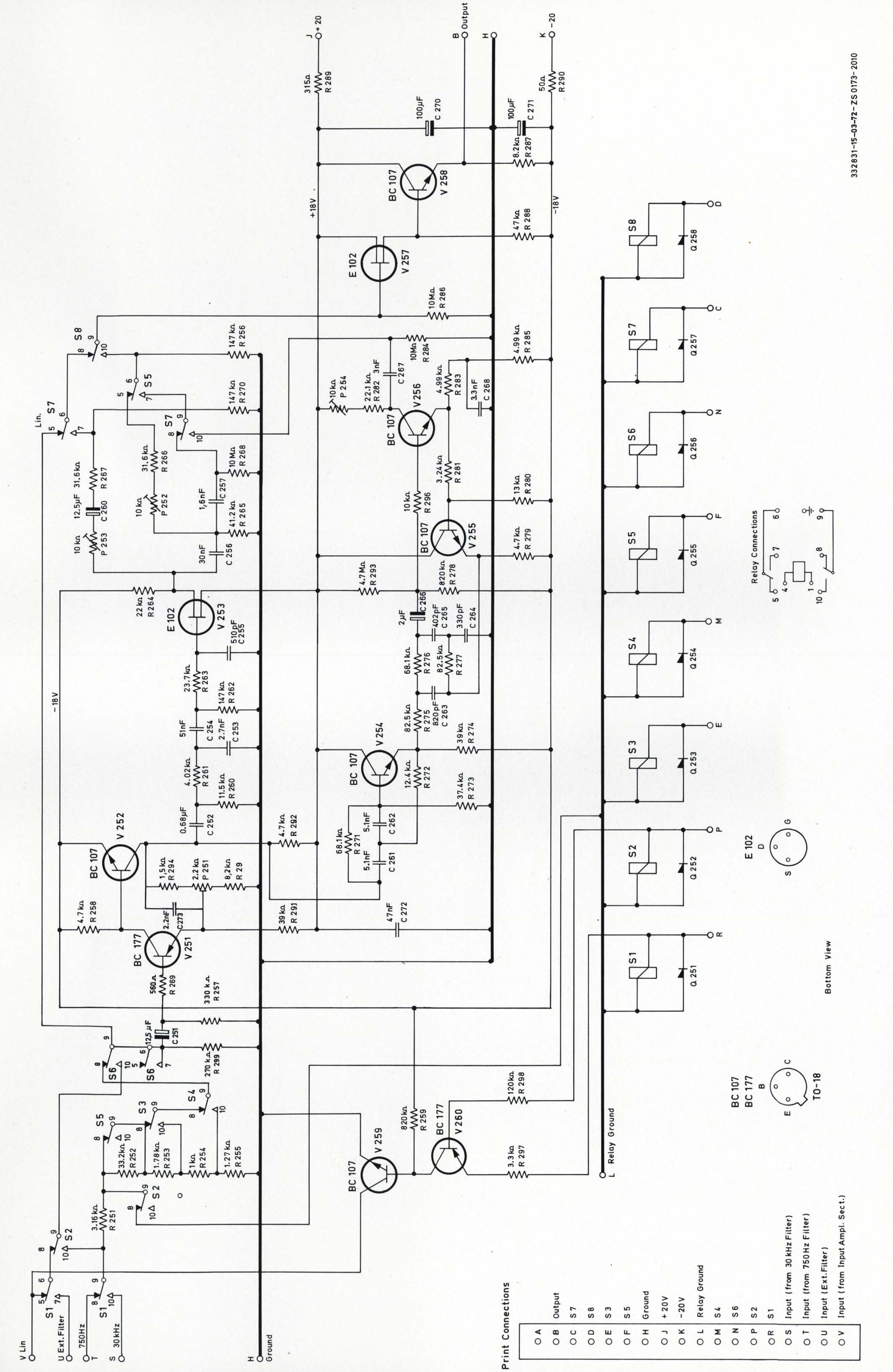
D-A-B-C Filter and Selector Circuit





CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
C 251	Electrolytic			12.5 µF/ 25 V	CE 0416
C 252	Polycarbonate			0.68 µF/100 V	CS 0342
C 253	Polystyrene		1%	2.7 nF/ 63 V	CT 1158
C 254	-		1%	51 nF/ 63 V	CT 1542
C 255	-		1%	510 pF/125 V	CT 1135
C 256	-		1%	30 nF/ 63 V	CT 1519
C 257	-		1%	1.6 nF/ 63 V	CT 1152
C 260	Electrolytic			12.5 µF/ 25 V	CE 0416
C 261,262	Polystyrene		1%	5.1 nF/ 63 V	CT 1124
C 263	-		1%	820 pF/ 63 V	CT 1121
C 264	-		1%	330 pF/125 V	CT 1144
C 265	-		1%	402 pF/100 V	CT 1115
C 266	Electrolytic			2 µF/ 70 V	CE 0401
C 267	Polystyrene		1%	3 nF/ 63 V	CT 1157
C 268	-		1%	3.3 nF/ 63 V	CT 1544
C 270,271	Electrolytic			100 µF/ 35 V	CE 0443
C 272	Ceramic			47 nF/ 30 V	CK 4470
C 273	Polystyrene		1%	2.2 µF/ 63 V	CT 1126
O 251-258	Relay				OC 0024
P 251	Potm. Cermet	0.5 W	lin.	2.2 kΩ	PG 2220
P 252-254	Potm. wire w.	-	-	10 kΩ	PG 3110
Q 251-258	Si. Diode	150 V/300 V		BAX 16	QV 0217
R 251	Metal	0.25 W	1%	3.16 kΩ	RF 3316
R 252	-	-	-	33.2 kΩ	RF 4332
R 253	-	-	-	1.78 kΩ	RF 3178
R 254	-	-	-	1 kΩ	RF 3100
R 255	-	-	-	1.27 kΩ	RF 3127
R 256	-	-	-	147 kΩ	RF 5147
R 257	Carbon	-	5%	330 kΩ	RB 5330
R 258	-	-	-	4.7 kΩ	RB 3470
R 259	-	-	-	820 kΩ	RB 5820
R 260	Metal	-	1%	11.5 kΩ	RF 4115
R 261	-	-	-	4.02 kΩ	RF 3402
R 262	-	-	-	147 kΩ	RF 5147
R 263	-	-	-	23.7 kΩ	RF 4237
R 264	Carbon	-	5%	22 kΩ	RB 4220
R 265	Metal	-	1%	41.2 kΩ	RF 4412
R 266,267	-	-	-	31.6 kΩ	RF 4316

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 268	Carbon	0.3 W	10%	10MΩ	RA 0025
R 269	-	0.25 W	5%	560 Ω	RB 2560
R 270	Metal	0.25 W	1%	147 kΩ	RF 5147
R 271	-	-	-	68.1 kΩ	RF 4681
R 272	-	-	-	12.4 kΩ	RF 4124
R 273	-	-	-	37.4 kΩ	RF 4374
R 274	Carbon	-	5%	39 kΩ	RB 4390
R 275	Metal	-	1%	82.5 kΩ	RF 4825
R 276	-	-	-	68.1 kΩ	RF 4681
R 277	-	-	-	82.5 kΩ	RF 4825
R 278	Carbon	-	5%	820 kΩ	RB 5820
R 279	-	-	-	4.7 kΩ	RB 3470
R 280	Metal	-	1%	13 kΩ	RF 4130
R 281	-	-	-	3.24 kΩ	RF 3324
R 282	-	-	-	22.1 kΩ	RF 4221
R 283	-	-	-	4.99 kΩ	RF 3499
R 284	Carbon	0.3 W	10%	10MΩ	RA 0025
R 285	Metal	0.25 W	1%	4.99 kΩ	RF 3499
R 286	Carbon	0.3 W	10%	10MΩ	RA 0025
R 287	-	0.25 W	5%	8.2 kΩ	RB 3820
R 288	-	-	-	47 kΩ	RB 4470
R 289	-	0.3 W	-	315 Ω	
R 290	-	-	-	50 Ω	
R 291	-	0.25 W	-	39 kΩ	RB 4390
R 292	-	-	-	4.7 kΩ	RB 3470
R 293	-	-	-	4.7MΩ	RB 6470
R 294	-	-	-	1.5 kΩ	RB 3150
R 295	-	-	-	8.2 kΩ	RB 3820
R 296	-	-	-	10 kΩ	RB 4100
R 297	-	-	-	3.3 kΩ	RB 3330
R 298	-	-	-	120 kΩ	RB 5120
R 299	-	-	-	270 kΩ	RB 5270
V 215	Si. Transistor	PNP		BC 177	VB 0071
V 252	-	NPN		BC 107	VB 0032
V 253	FET	N		E 102	VB 1002
V 254-256	Si. Transistor	NPN		BC 107	VB 0257
V 257	FET	N		E 102	VB 1025
V 258	Si. Transistor	NPN		BC 107	VB 0257
V 259	-	NPN		BC 107	VB 0032
V 260	-	PNP		BC 177	VB 0071
	Printed Circuit Board				XC 0604



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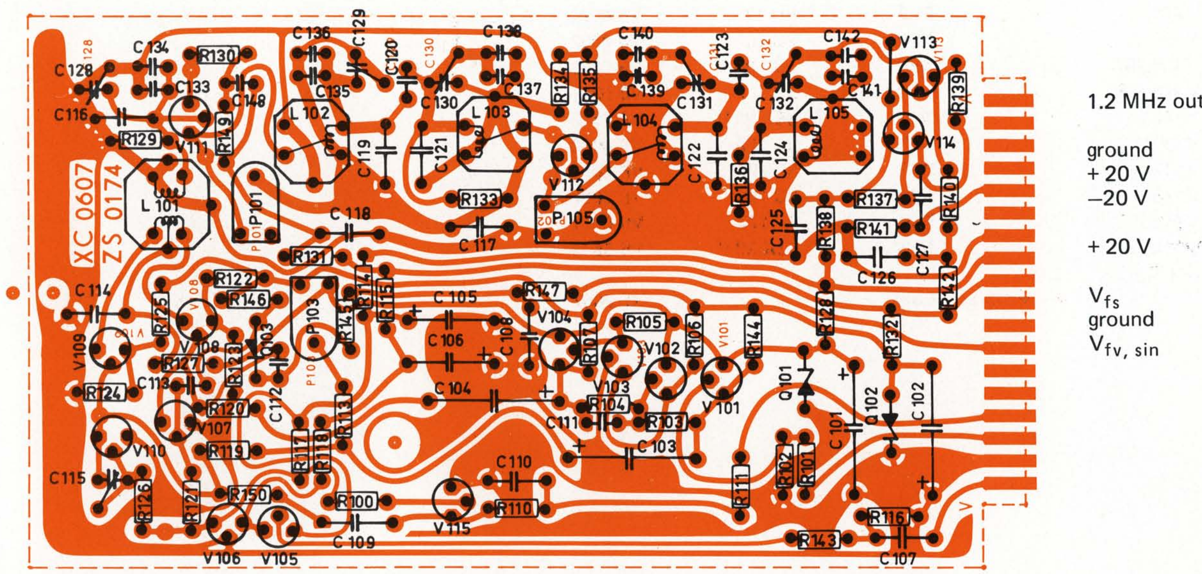
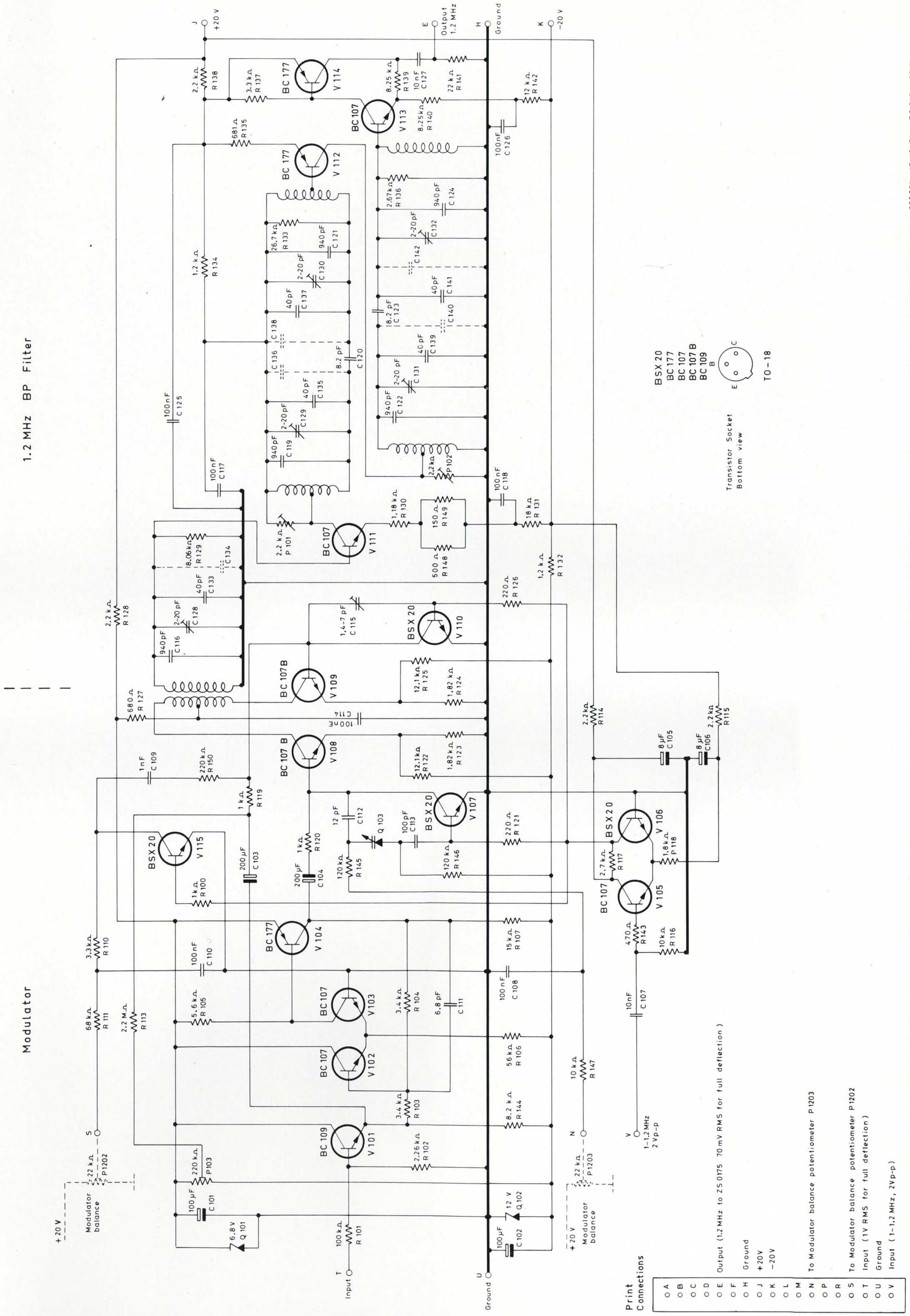
Circuit and Layout Diagrams with Parts List ZS 0174

1.2 MHz Bandpass Filter



CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
C 101,102	Electrolytic			100 µF/ 15 V	CE 0310
C 103,104	-			200 µF/ 10 V	CE 0306
C 105,106	-			8 µF/ 40 V	CE 0414
C 107	Polycarbonate			10 nF/250 V	CS 0403
C 108	-			100 nF/250 V	CS 0402
C 109	Polystyrene			1 nF/ 63 V	CT 1132
C 110	Polycarbonate			100 nF/250 V	CS 0402
C 111	Ceramic			6.8 pF/400 V	CK 0680
C 112	-			12 pF/400 V	CK 0095
C 113	-			100 pF/400 V	CK 2100
C 114	Polycarbonate			100 nF/250 V	CS 0402
C 115	Trim.			1.4-7 pF/ 50 V	CV 0028
C 116	Mica			940 pF/350 V	CM 0011
C 117,118	Polycarbonate			100 nF/250 V	CS 0402
C 119	Mica			980 pF/350 V	CM 0011
C 120	Ceramic			8.2 pF/400 V	CK 0820
C 121,122	Mica			940 pF/350 V	CM 0011
C 123	Ceramic			8.2 pF/400 V	CK 0820
C 124	Mica			940 pF/350 V	CM 0011
C 125,126	Polycarbonate			100 nF/250 V	CS 0402
C 127	-			10 nF/250 V	CS 0403
C 128-132	Trim.			2-20 pF/ 50 V	CV 0025
C 133	Ceramic			40 pF/400 V	CK 1400
C 135	-			40 pF/400 V	CK 1400
C 137	-			40 pF/400 V	CK 1400
C 139	-			40 pF/400 V	CK 1400
C 141	-			40 pF/400 V	CK 1400
L 101	Filter Coil			17 µH	LB 0688
L 102	-			17 µH	LB 0690
L 103	-			17 µH	LB 0689
L 104	-			17 µH	LB 0690
L 105	-			17 µH	LB 0687
P 101,102	Potm. Cermet 0.5 W		lin.	2.2 kΩ	PG 2207
P 103	-	-	-	220 Ω	PG 4204
Q 101	Zener Diode	6-7.5 V/ 5 mA		ZG 6.8	QV 1106
Q 102	-	11-13 V/19mA		MZ 716 A	QV 1117
Q 103	Si. Diode	400 V/ 1 A		1 N 4004	QV 0236
R 100	Carbon	0.25 W	5%	1 kΩ	RB 3100
R 101	Metal	-	1%	100 kΩ	RF 5100

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOČK REF.
R 102	-	-	-	2.26 kΩ	RF 3226
R 103,104	-	-	-	3.40 kΩ	RF 3340
R 105	Carbon	-	5%	5.6 kΩ	RB 3560
R 106	-	-	-	56 kΩ	RB 4560
R 107	-	-	-	15 kΩ	RB 4150
R 110	-	-	-	3.3 kΩ	RB 3330
R 111	-	-	-	68 kΩ	RB 4680
R 113	-	-	-	2.2MΩ	RA 0015
R 114,115	-	-	-	2.2 kΩ	RB 3220
R 116	-	-	-	10 kΩ	RB 4100
R 117	-	-	-	2.7 kΩ	RB 3270
R 118	-	-	-	1.8 kΩ	RB 3180
R 119,120	-	-	-	1 kΩ	RB 3100
R 121	-	-	-	220 Ω	RB 2220
R 122	Metal	-	1%	12.1 kΩ	RF 4121
R 123,124	-	-	-	1.82 kΩ	RF 3182
R 125	-	-	-	12.1 kΩ	RF 4121
R 126	Carbon	-	5%	220 Ω	RB 2220
R 127	-	-	-	680 Ω	RB 2680
R 128	-	-	-	2.2 kΩ	RB 3220
R 129	Metal	-	1%	8.06 kΩ	RF 3806
R 130	-	-	-	1.18 kΩ	RF 3118
R 131	Carbon	-	5%	18 kΩ	RB 4180
R 132	-	-	-	1.2 kΩ	RB 3120
R 133	Metal	-	1%	26.7 kΩ	RF 4267
R 134	Carbon	-	5%	1.2 kΩ	RB 3120
R 135	Metal	-	1%	681 Ω	RF 2681
R 136	-	-	-	26.7 kΩ	RF 4267
R 137	Carbon	-	5%	3.3 kΩ	RB 3330
R 138	-	-	-	2.2 kΩ	RB 3220
R 139,140	Metal	-	1%	8.25 kΩ	RF 3825
R 141	Carbon	-	5%	22 kΩ	RB 4220
R 142	-	-	-	12 kΩ	RB 4120
R 143	-	-	-	470 Ω	RB 2470
R 144	-	-	-	8.2 kΩ	RB 3820
R 145,146	-	-	-	120 kΩ	RB 5120
R 147	-	-	-	10 kΩ	RB 4100
R 148	NTC			500 Ω	RN 0006
R 149	Metal	0.25 W	1%	150 Ω	RF 2150
R 150	Carbon	-	5%	220 kΩ	RB 5220
V 101	Si. Transistor	NPN		BC 109	VB 0047
V 102,103	-	NPN		BC 107	VB 0032



CIRCUIT DIAGRAM REF.	COMPONENT TYPE			STOCK REF.
V 104	-	PNP	BD 177	VB 0071
V 105	-	NPN	BC 107	VB 0032
V 106,107	-	NPN	BSX 20 V	VB 0513
V 108,109	-	NPN	BC 107	VB 0257
V 110	-	NPN	BSX 20 V	VB 0513
V 111	-	NPN	BC 107	VB 0032
V 112	-	PNP	BC 177	VB 0071
V 113	-	NPN	BC 107	VB 0032
V 114	-	PNP	BC 177	VB 0071
V 115	-	NPN	BSX 20 V	VB 0513
	Printed Circuit Board			XC 0607

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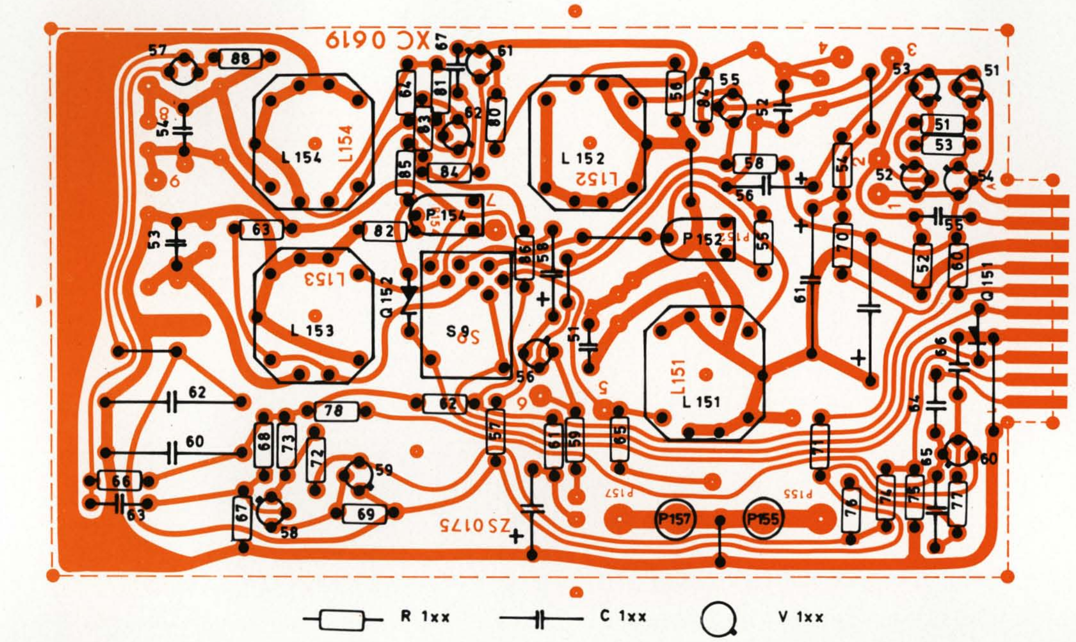
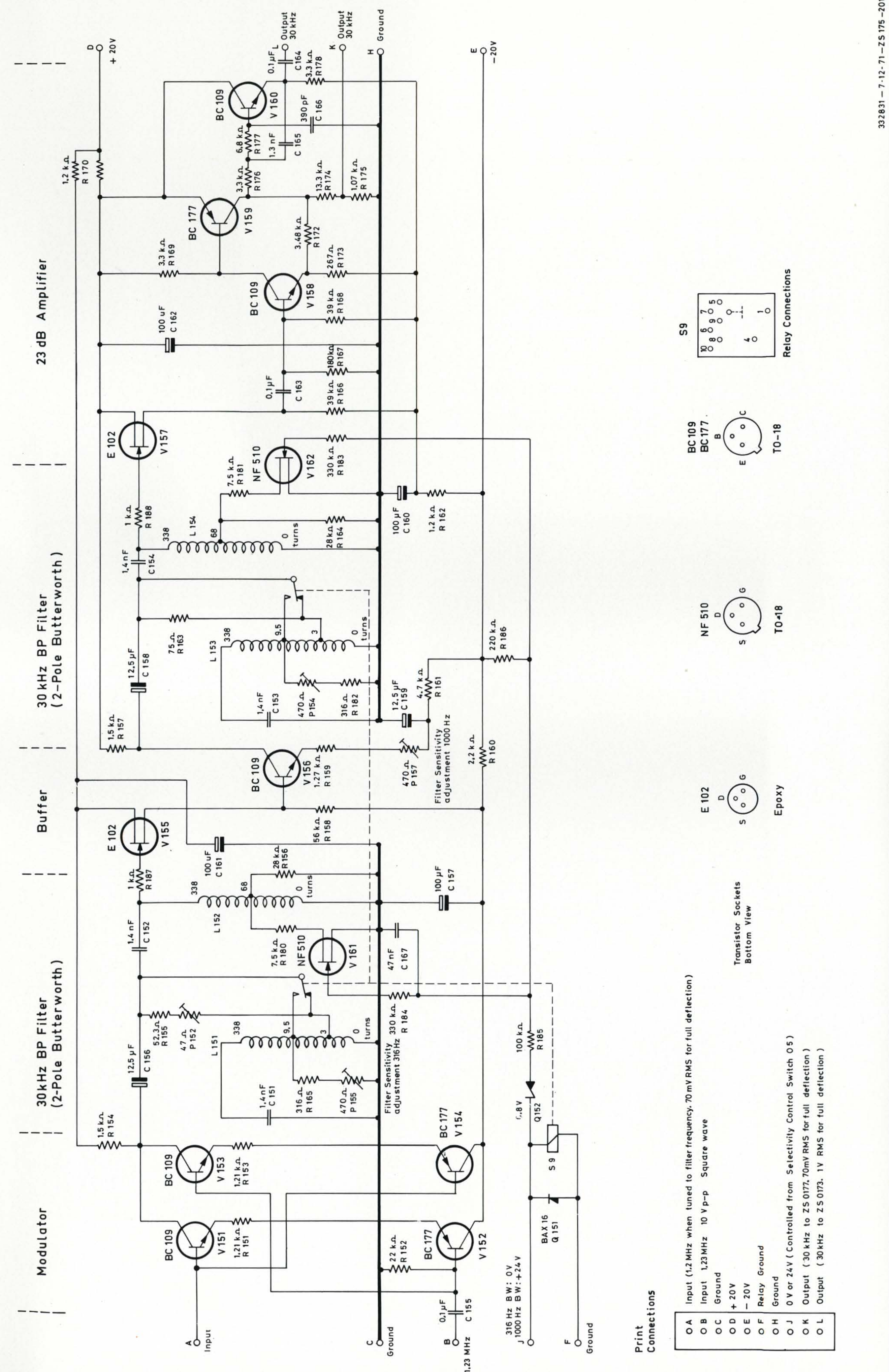
Circuit and Layout Diagram with Parts List ZS 0175

30 kHz Bandpass Filter



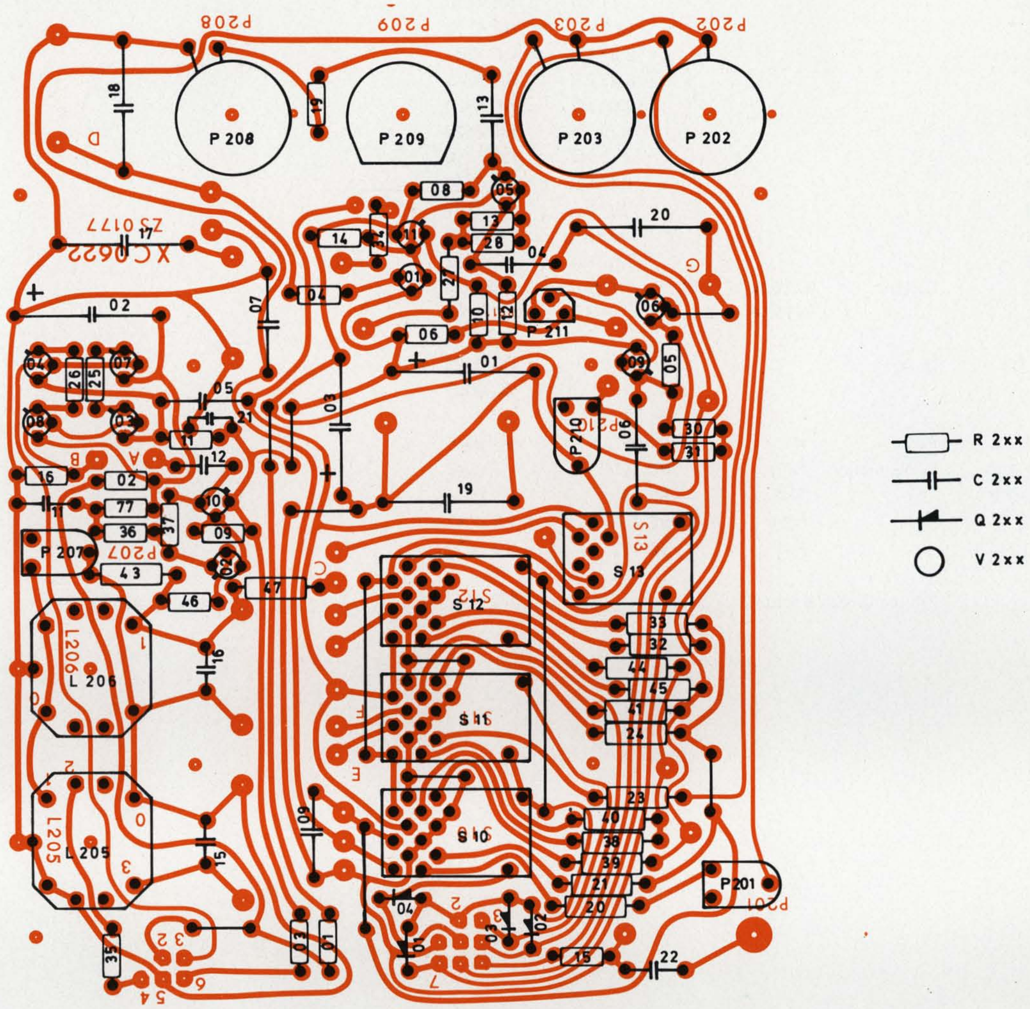
CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
C 151-154	Polystyrene	2%		1.4 nF/ 30 V	CT 0031
C 155	Polycarbonate			0.1 µF/250 V	CS 0402
C 157	Electrolytic			100 µF/ 16 V	CE 0310
C 160-162	-			100 µF/ 16 V	CE 0310
C 163,164	Polycarbonate			0.1 µF/250 V	CS 0402
C 165	Polystyrene	1%		1.3 nF/ 63 V	CT 1150
C 166	-	1%		390 pF/ 63 V	CT 1531
L 151	Filter Coil			18.4 mH	LB 0708
L 152	-			18.4 mH	LB 0709
L 153	-			18.4 mH	LB 0708
L 154	-			18.4 mH	LB 0709
S 9	Relay				OC 0028
P 152	Potm.Cermet 0.5 W		lin.	47 Ω	PG 0470
P 154	-	-	-	470 Ω	PG 1504
P 155	Potm.Wire w. 1 W		-	470 Ω	PT 1470
P 157	—	-	-	470 Ω	RP 1470
Q 151	Si. Diode	150 V/300 mA		BAX 16	QV 0217
Q 152	Zener Diode	6.0-7.5 V/5 mA		ZG 6.8	QV 1106
R 151	Metal	0.25 W	1%	1.21 kΩ	RF 3121
R 152	Carbon	-	5%	22 kΩ	RB 4220
R 153	Metal	-	1%	1.21 kΩ	RF 3121
R 154	Carbon	-	5%	1.5 kΩ	RB 3150
R 155	Metal	-	1%	52.3 Ω	RF 1523
R 156	-	-	-	28 kΩ	RF 4280
R 157	Carbon	-	5%	1.5 kΩ	RB 3150
R 158	-	-	-	56 kΩ	RB 4560
R 159	Metal	-	1%	1.27 kΩ	RF 3127
R 160	Carbon	-	5%	2.2 kΩ	RB 3220
R 161	-	-	-	4.7 kΩ	RB 3470
R 162	-	-	-	1.2 kΩ	RB 3120
R 163	Metal	-	1%	75 Ω	RF 1750
R 164	-	-	-	28 kΩ	RF 4280

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 165	-	-	-	316 Ω	RF 2316
R 166	Carbon	-	5%	39 kΩ	RB 4390
R 167	-	-	-	180 kΩ	RB 5180
R 168	-	-	-	39 kΩ	RB 4390
R 169	-	-	-	3.3 kΩ	RB 3330
R 170	-	-	-	1.2 kΩ	RB 3120
R 171	-	-	-	390 Ω	RB 2390
R 172	Metal	-	1%	3.48 kΩ	RF 3348
R 173	-	-	-	267 Ω	RF 2267
R 174	-	-	-	13.3 kΩ	RF 4133
R 175	-	-	-	1.07 kΩ	RF 3107
R 176	Carbon	-	5%	3.3 kΩ	RB 3330
R 177	-	-	-	6.8 kΩ	RB 3680
R 178	-	-	-	3.3 kΩ	RB 3330
R 180,181	Metal	-	1%	7.5 kΩ	RF 3750
R 182	-	-	-	316 Ω	RF 2316
R 183,184	Carbon	-	5%	330 kΩ	RB 5330
R 186	-	-	-	220 kΩ	RB 5220
R 187,188	-	-	-	1 kΩ	RB 3100
V 151	Si. Transistor	NPN		BC 109	VB 0047
V 152	-	PNP		BC 177	VB 0071
V 153	-	NPN		BC 109	VB 0047
V 154	-	PNP		BC 177	VB 0071
V 155	FET	N		E 102	VB 1025
V 156	Si. Transistor	NPN		BC 109	VB 0047
V 157	FET	N		E 102	VB 1025
V 158	Si. Transistor	NPN		BC 109	VB 0047
V 159	-	PNP		BC 177	VB 0071
V 160	-	NPN		BC 109	VB 0047
V 161,162	FET	N		NF 510	VB 1021
	Printed Circuit Board				XC 0619



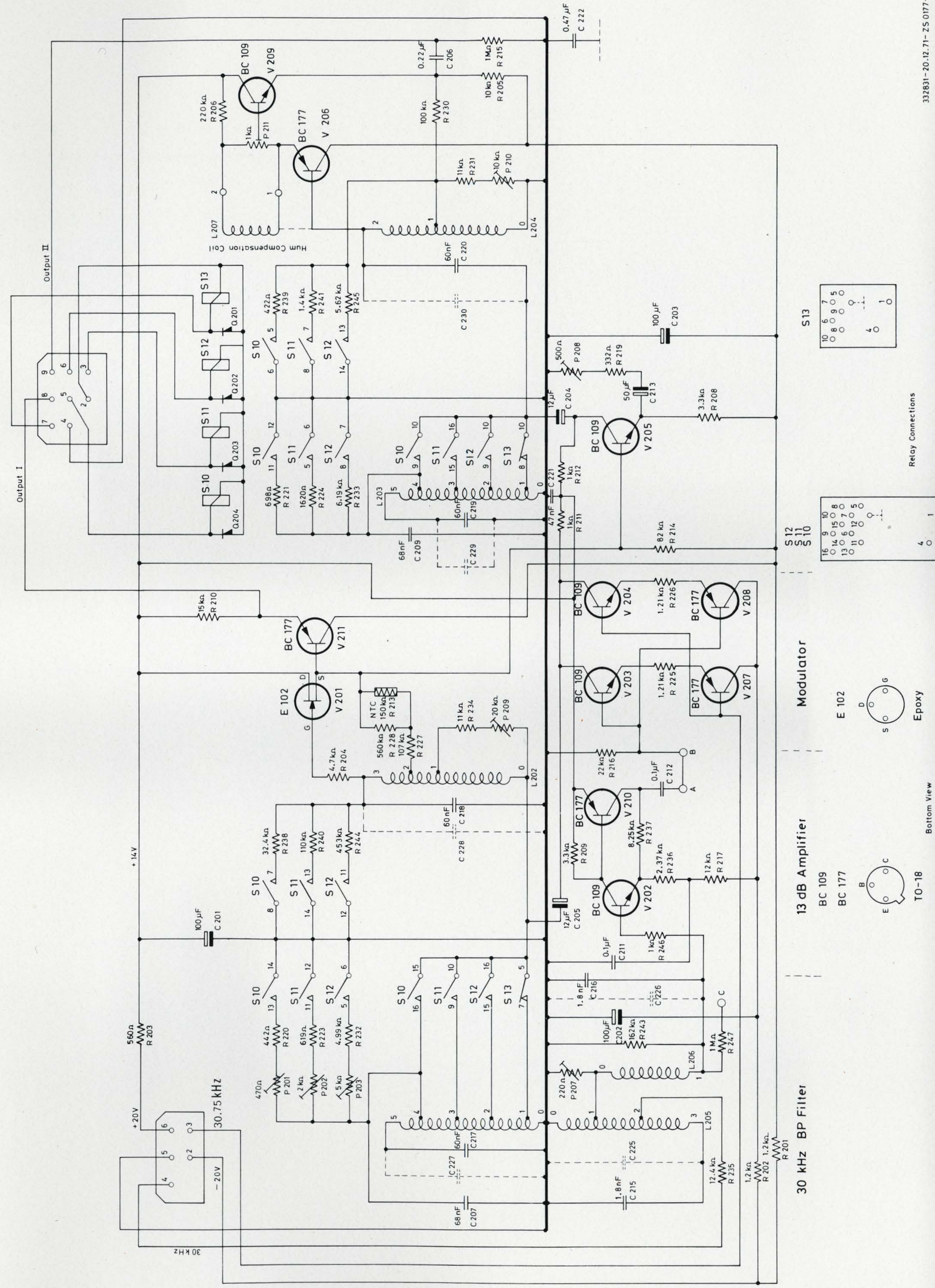
Circuit and Layout Diagram with Parts List ZS 0177

750 Hz Bandpass Filter



CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
C 201-203	Electrolytic	100 µF/ 16 V			CE 0310
C 204,205	-	12 µF/ 25 V			CE 0416
C 206	Polycarbonate	0.22 µF/100 V			CS 0339
C 207	-	68 nF/250 V			CS 0011
C 209	-	68 nF/250 V			CS 0011
C 211,212	-	0.1 µF/250 V			CS 0044
C 213	Electrolytic	50 µF/ 6.4 V			CE 0204
C 215,216	Polystyrene	1.8 nF/ 30 V			CT 0029
C 217-220	-	60 nF/ 63 V			CT 0030
C 221	Ceramic	47 nF/ 30 V			CK 4470
C 222	-	0.47 µF/ 12 V			CK 5470
L 201	Filter Coil	0.74 H			LB 0680
L 202	-	0.74 H			LB 0681
L 203	-	0.74 H			LB 0680
L 204	-	0.74 H			LB 0682
L 205	-	15.2 mH			LB 0683
L 206	-	15.2 mH			LB 0684
P 201	Potm. Cermet	0.5 W	lin.	470 Ω	PG 1504
P 202	Potm. Wire w.	-	-	2 kΩ	PC 2200
P 203	-	-	-	5 kΩ	PC 2501
P 207	-	-	-	220 Ω	PG 1221
P 208	-	3 W	-	500 Ω	PC 1500
P 209	-	1 W	-	20 kΩ	PC 3200
P 210	Potm. Cermet	0.5 W	-	10 kΩ	PG 3109
P 211	-	-	-	1 kΩ	PG 2109

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
Q 201-204	Si. Diode	150 V/300 mA		BAX 16	QV 0217
R 201,202	Carbon	0.25 W	5%	1.2 kΩ	RB 3120
R 203	-	-	-	560 Ω	RB 2560
R 204	-	-	-	4.7 kΩ	RB 3470
R 205	-	-	-	10 kΩ	RB 4100
R 206	-	-	-	220 kΩ	RB 5220
R 208,209	-	-	-	3.3 kΩ	RB 3330
R 210	-	-	-	15 kΩ	RB 4150
R 211,212	-	-	-	1 kΩ	RB 3100
R 213	NTC			150 Ω	RN 0005
R 214	Carbon	0.25 W	5%	82 kΩ	RB 4820
R 215	-	-	-	1MΩ	RB 6100
R 216	-	-	-	22 kΩ	RB 4220
R 217	-	-	-	12 kΩ	RB 4120
R 219	Metal	-	1%	332 Ω	RF 2332
R 220	-	-	-	442 Ω	RF 2442
R 221	-	-	-	698 Ω	RF 2698
R 223	-	-	-	619 Ω	RF 2619
R 224	-	-	-	1.62 kΩ	RF 3162
R 225,226	-	-	-	1.21 kΩ	RF 3121
R 227	-	-	-	107 kΩ	RF 5107
R 228	Carbon	-	5%	560 kΩ	RB 5560
R 230	Metal	-	1%	100 kΩ	RF 5100
R 231	-	-	-	11 kΩ	RF 4110
R 232	-	-	-	4.99 kΩ	RF 3499
R 233	-	-	-	6.19 kΩ	RF 3619



CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 234	-	-	-	11 kΩ	RF 4110
R 235	-	-	-	13.3 kΩ	RF 4133
R 236	-	-	-	2.37 kΩ	RF 3237
R 237	-	-	-	8.25 kΩ	RF 3825
R 238	-	-	-	32.4 kΩ	RF 4324
R 239	-	-	-	422 Ω	RF 2422
R 240	-	-	-	110 kΩ	RF 5110
R 241	-	-	-	1.40 kΩ	RF 3140
R 243	-	-	-	162 kΩ	RF 5162
R 244	-	-	-	453 kΩ	RF 0272
R 245	-	-	-	5.62 kΩ	RF 3562
R 246	Carbon	0.15 W	10%	10MΩ	RA 0025
R 247	-	0.25 W	5%	1MΩ	RB 6100
S 10-12	Relay				OC 0029
S 13					OC 0028
V 201	FET	N		E 102	VB 0045
V 202-205	Si. Transistor	NPN		BC 109	VB 0047
V 206-208	-	PNP		BC 177	VB 0071
V 209	-	NPN		BC 109	VB 0047
V 210,211	-	PNP		BC 177	VB 0071
	Printed Circuit Board				XC 0622

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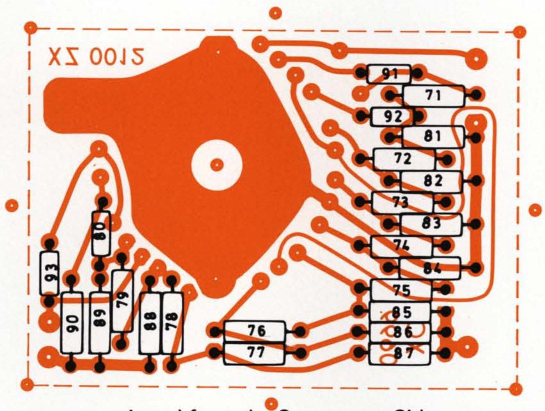
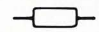
Layout Diagram with Parts List

ZX 0012

BFO Attenuator



viewed from the Component Side



R 12xx

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 1271-1280	Metal	0.25 W	0.5%	295.7 Ω	RF 6019
R 1281-1289	-	-	-	200 Ω	RF 6018
R 1290	-	-	-	136.7 kΩ	RF 6017
R 1291	-	-	1%	100 Ω	RF 2100
R 1292	Carbon	-	5%	10 Ω	RB 1100
R 1293	Metal	-	1%	499 Ω	RF 2499
	Printed Circuit Board				XC 0699

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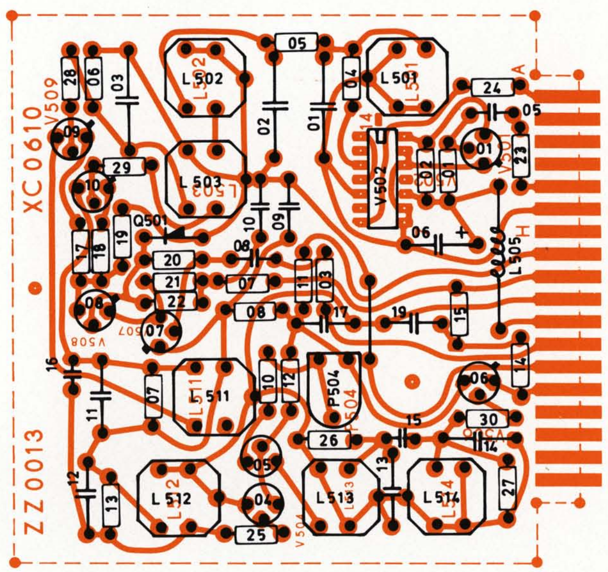
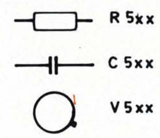
Circuit and Layout Diagram with Parts List

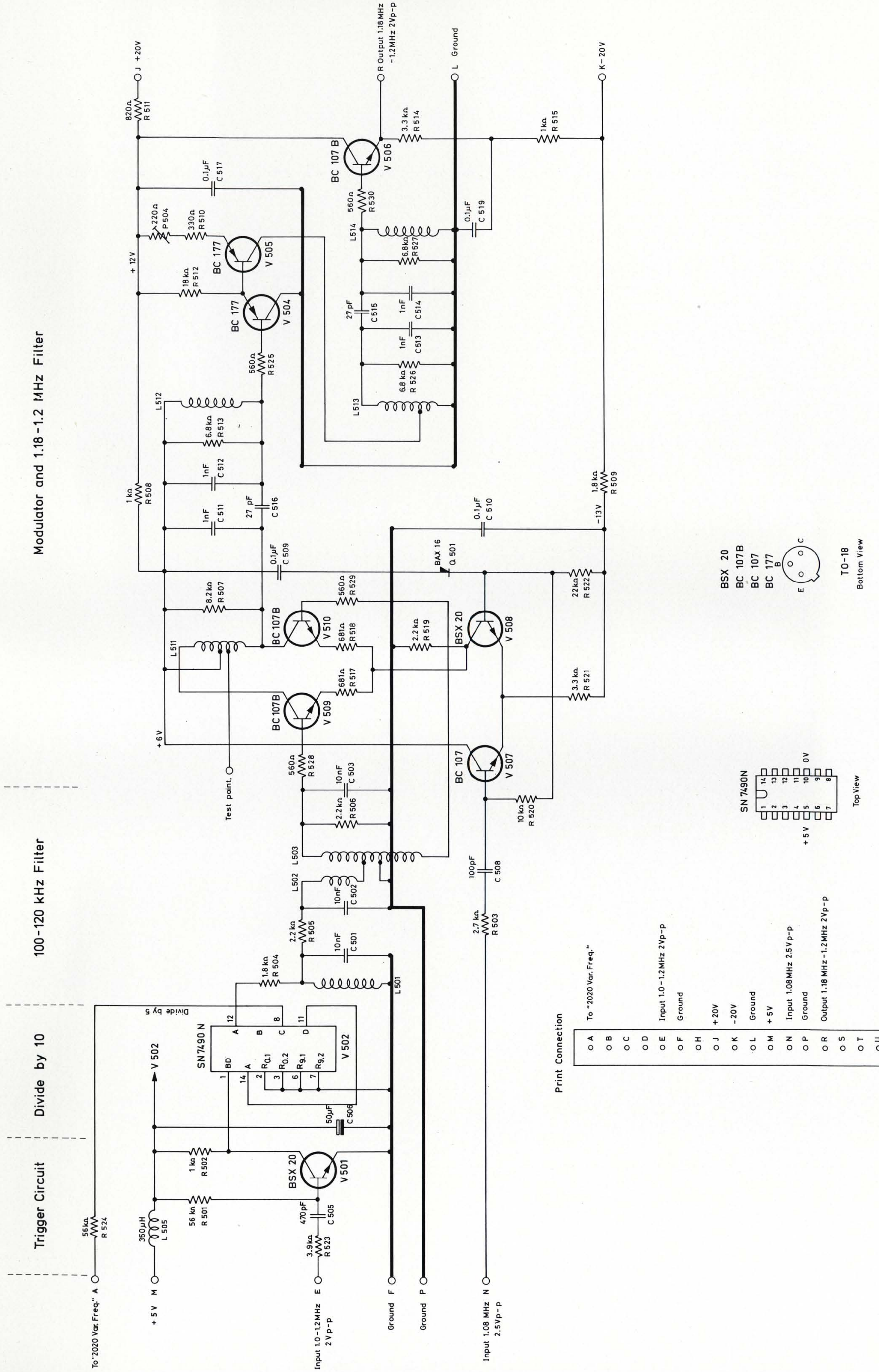
ZZ 0013
Frequency Converter
for Variable Osc.





CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
C 501-502	Polystyrene			10 nF/ 63 V	CT 1545
C 505	Ceramic			470 pF/400 V	CK 2470
C 506	Eletrolytic			50 µF/ 6.4 V	CE 0204
C 508	Ceramic			100 pF/400 V	CK 2100
C 509,510	Polycarbonate			100 nF/250 V	CS 0402
C 511-514	Polystyrene			1 nF/ 63 V	CT 1132
C 515,516	Ceramic			27 pF/400 V	CK 1270
C 517	Polycarbonate			100 nF/250 V	CS 0402
C 519	-			100 nF/250 V	CS 0402
L 501,502	Coil			210 µH	LB 0703
L 503	-			210 µH	LB 0704
L 505	-			350 µH	LJ 0012
L 511	-			67 µH	LB 0705
L 512	-			17.4 µH	LB 0706
L 513	-			17.4 µH	LB 0707
L 514	-			17.4 µH	LB 0706
P 504	Potm. Cermet	0.5 W	lin.	220 Ω	PG 1221
Q 501	Si. Diode	150 V/300 mA		BAX 16	QV 0217
R 501	Carbon	0.25 W	5%	56 kΩ	RB 4560
R 502	-	-	-	1 kΩ	RB 3100
R 503	-	-	-	2.7 kΩ	RB 3270
R 504	-	-	-	1.8 kΩ	RB 3180
R 505,506	-	-	-	2.2 kΩ	RB 3220
R 507	-	-	-	8.2 kΩ	RB 3820
R 508	-	-	-	1 kΩ	RB 3100

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 509	-	-	-	1.8 kΩ	RB 3180
R 510	-	-	-	330 Ω	RB 2330
R 511	-	-	-	820 Ω	RB 2820
R 512	-	-	-	18 kΩ	RB 4180
R 513	-	-	-	6.8 kΩ	RB 3680
R 514	-	-	-	3.3 kΩ	RB 3330
R 515	-	-	-	1 kΩ	RB 3100
R 517,518	Metal	-	1%	681 Ω	RF 2681
R 519	Carbon	-	5%	2.2 kΩ	RB 3220
R 520	-	-	-	10 kΩ	RB 4100
R 521	-	-	-	3.3 kΩ	RB 3330
R 522	-	-	-	22 kΩ	RB 4220
R 523	-	-	-	3.9 kΩ	RB 3390
R 524	-	-	-	56 kΩ	RB 4560
R 525	-	-	-	560 Ω	RB 2560
R 526,527	-	-	-	6.8 kΩ	RB 3680
R 528-530	-	-	-	560 Ω	RB 2560
V 501	Si. Transistor	NPN		BSX 20	VB 0513
V 502	Decade Counter			SN 7490 N	VD 0013
V 504,505	Si. Transistor	PNP		BC 177	VB 0071
V 506	-	NPN		BC 107	VB 0257
V 507	-	NPN		BC 107	VB 0032
V 508	-	NPN		BSX 20	VB 0513
V 509,510	-	NPN		BC 107	VB 0257
	Printed Circuit Board				XC 0610



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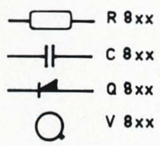
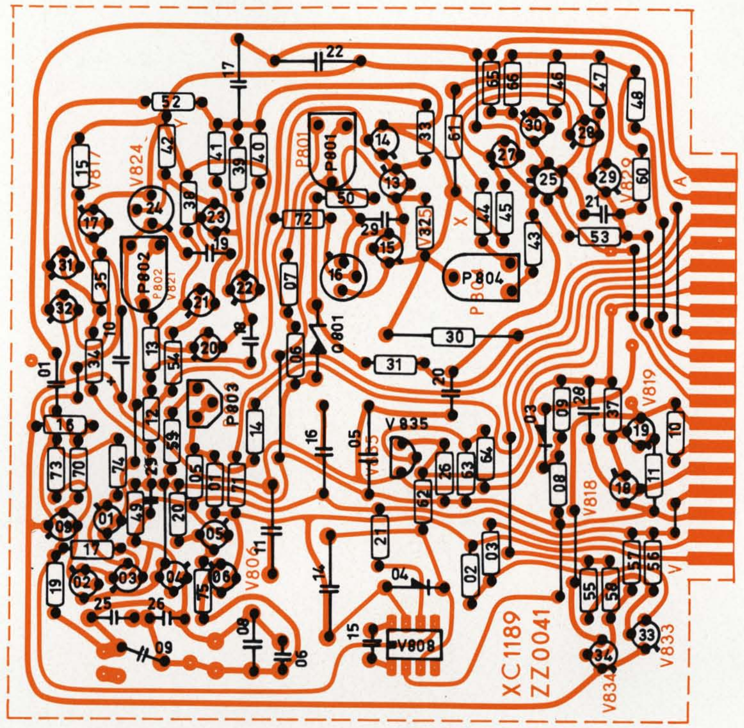
Nærum - Denmark

Circuit and Layout Diagram with Parts List

ZZ 0041

Control Circuit for VCO



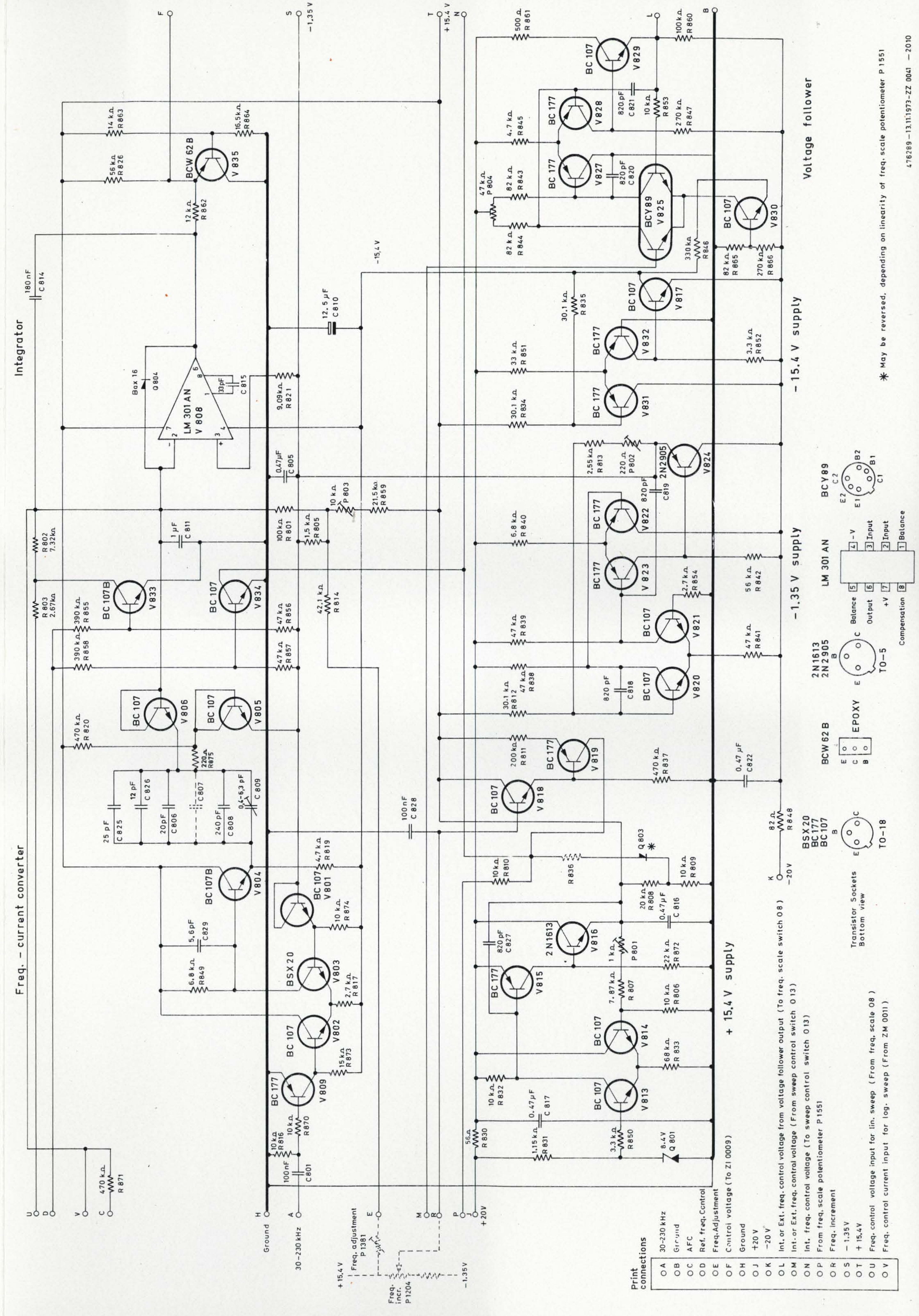


Viewed from the printed circuit side

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
C 801	Polycarbonate			100 nF/250 V	CS 0402
C 805	-			0,47 μF/100 V	CS 0383
C 806	Ceramic			20 pF/400 V	CK 0093
C 808	Mica			240 pF/350 V	CM 0001
C 809	Trim. Cond.			0,4-6,3 pF	CV 0034
C 810	Electrolytic			12,5 μF/ 25 V	CE 0416
C 811	Polycarbonate			1 μF/100 V	CS 0384
C 814	-			180 nF/100 V	CS 0338
C 815	Ceramic			33 pF/400 V	CK 1330
C 816,817	Polycarbonate			0,47 μF/100 V	CS 0383
C 818,821	Ceramic			820 pF/400 V	CK 2820
C 822	Polycarbonate			0,47 μF/100 V	CS 0383
C 825	Ceramic			25 pF/400 V	CK 0091
C 826	-			12 pF/400 V	CK 0095
C 827	-			820 pF/400 V	CK 2820
C 828	Polycarbonate			100 nF/250 V	CS 0402
C 829	Ceramic			5,6 pF/400 V	CK 0560
P 801	Potm. Cermet	0,5 W	lin.	1 kΩ	PG 2108
P 802	-	-	-	220 Ω	PG 1221
P 803	-	-	-	10 kΩ	PG 3110
P 804	-	-	-	47 kΩ	PG 3471
Q 801	Zener	1 N 3155		8,0-8,8 V/ 10 mA	QV 1329
Q 803,804	Si.	BAX 16		150 V/300 mA	QV 0217
R 801	Metal	0,25 W	1%	100 kΩ	RF 5100
R 802	-	-	-	7,32 kΩ	RF 3732
R 803	-	-	-	2,67 kΩ	RF 3267
R 805	-	-	-	1,50 kΩ	RF 3150
R 806	-	-	-	10 kΩ	RF 4100
R 807	-	-	-	7,87 kΩ	RF 3787
R 808	-	-	-	20 kΩ	RF 4200
R 809,810	-	-	-	10 kΩ	RF 4100

CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 811	Metal	0,25 W	1%	200 kΩ	RF 5200
R 812	-	-	-	30,1 kΩ	RF 4301
R 813	-	-	-	2,55 kΩ	RF 3255
R 814	-	-	-	41,2 kΩ	RF 4412
R 816	Carbon	-	5%	10 kΩ	RB 4100
R 817	-	-	-	2,7 kΩ	RB 3270
R 819	-	-	-	4,7 kΩ	RB 3470
R 820	-	-	-	470 kΩ	RB 5470
R 821	Metal	-	1%	9,09 kΩ	RF 3909
R 826	Carbon	0,25 W	5%	56 kΩ	RB 4560
R 830	Wire	4,2 W	-	56 Ω	RX 0319
R 831	Metal	0,25 W	1%	1,15 kΩ	RF 3115
R 832	Carbon	-	5%	10 kΩ	RB 4100
R 833	-	-	-	6,8 kΩ	RB 4680
R 834,835	Metal	-	1%	30,1 kΩ	RF 4301
R 837	Carbon	-	5%	470 kΩ	RB 5470
R 838,839				47 kΩ	RB 4470
R 840	-	-	-	6,8 kΩ	RB 3680
R 841	-	-	-	47 kΩ	RB 4470
R 842	-	-	-	56 kΩ	RB 4560
R 843,844	-	-	-	82 kΩ	RB 4820
R 845	-	-	-	47 kΩ	RB 3470
R 846	-	-	-	330 kΩ	RB 5330
R 847	-	-	-	270 kΩ	RB 5270
R 848	-	-	-	82 Ω	RB 1820
R 849	-	-	-	6,8 kΩ	RB 3680
R 850	-	-	-	3,3 kΩ	RB 3330
R 851	-	-	-	33 kΩ	RB 4330
R 852	-	-	-	3,3 kΩ	RB 3330
R 853	-	-	-	10 kΩ	RB 4100
R 854	-	-	-	2,7 kΩ	RB 3270
R 855	-	-	-	390 kΩ	RB 5390
R 856,857	-	-	-	47 kΩ	RB 4470

ZZ 0041
2010 from serial no. 476289



CIRCUIT DIAGRAM REF.	COMPONENT TYPE				STOCK REF.
R 858	Carbon	0,25 W	5%	390 kΩ	RB 5390
R 859	Metal	-	1%	21,5 kΩ	RF 4215
R 860	Carbon	-	5%	100 kΩ	RB 5100
R 861	-	0,3 W	10%	500 Ω	
R 862	-	0,25 W	5%	12 kΩ	RB 4120
R 863	Metal	-	1%	14 kΩ	RF 4140
R 864	-	-	-	16,5 kΩ	RF 4165
R 865	Carbon	-	5%	82 kΩ	RB 4820
R 866	-	-	-	270 kΩ	RB 5250
R 870	-	-	-	10 kΩ	RB 4100
R 871	-	-	-	470 kΩ	RB 5470
R 872	-	-	-	22 kΩ	RB 4220
R 873	-	-	-	15 kΩ	RB 4150
R 874	-	-	-	10 kΩ	RB 4100
R 875	-	-	-	220 Ω	RB 2220
V 801,802	Si. Transistor		NPN	BC 107	VB 0032
V 803	-		-	BSX 20	VB 0513
V 804	-		-	BC 107	VB 0252
V 805,806	-		-	-	VB 0032

CIRCUIT DIAGRAM REF.	COMPONENT TYPE			STOCK REF.
V 808	Op. Amp.		LM 301	VE 0017
V 809	Si. Transistor	PNP	BC 177	VB 0071
V 814	-	NPN	BC 017	VB 0032
V 815	-	PNP	BC 177	VB 0071
V 816	-	NPN	2 N 1613	VB 0026
V 817,818	-	-	BC 107	VB 0032
V 819	-	PNP	BC 177	VB 0071
V 820,821	-	NPN	BC 107	VB 0032
V 822,823	-	PNP	BC 177	VB 0071
V 824	-	-	2 N 2905	VB 0059
V 825	-	NPN	BC 489	VB 5304
V 827,828	-	PNP	BC 177	VB 0071
V 829,830	-	NPN	BC 107	VB 0032
V 831,832	-	PNP	BC 177	VB 0071
V 833	-	-	BC 107	VB 0257
V 834	-	-	-	VB 0032
V 835	-	PNP	2 N 4249	VB 0081
	Printed Circuit Board			XC 1189