Bang & Olufsen

(1) Manual tune for pretty stations, use auto otherwise.

(2) Only monitor Tape 1 line level.

(3) Tape 1 line to data stream DIN.

But press it

(4) Over vol 2-8 = no loudness.

(5) Press standby & monitor together

= if shows TP

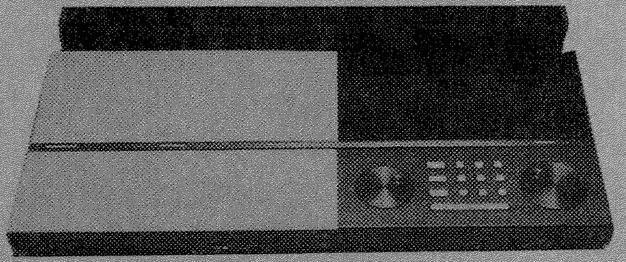
= test pass

if TE = test error & see page 7-1 for errors.

~~(6) [illegible]~~

(6) CMOS memory = 3 years!

(7) [illegible] pulled [illegible] for [illegible]



BEOMASTER 8000 AND BEOLAB TERMINAL

TECHNICAL PRODUCT INFORMATION

INTRODUCTION

Beomaster 8000 is a completely newly developed receiver with top specifications. The apparatus is microcomputer controlled and can, with the aid of the remote control unit BEOLAB TERMINAL, be employed to remote control the complete BEOLAB 8000 system.
The apparatus's AF section is constructed upon the same principles as those of the AF section in the Beomaster 4400, for which reason the technical description of the Beomaster 8000's AF section is based upon the technical product information for the Beomaster 4400.

CONTENTS

	Section Page
INTRODUCTION	0
RF SIGNAL CIRCUIT	1
Tuner, front end	1 - 1
IF circuit	1 - 3
AGC	1 - 4
Stereo decoder	1 - 4
Signal/Multipath meter	1 - 6
Silent Tuning (Signal condition)	1 - 7
AF SIGNAL PROCESSING CIRCUIT	2
Preamplifier and switch	2 - 1
RIAA	2 - 2
Volume Control	2 - 3
Loudness	2 - 4
Tone Control and Filters	2 - 5
Supression of Noise Spikes from the Volume Control	2 - 6
Output Amplifier	2 - 8
Safety Circuits	2 - 9
Clipping	2 - 11
CONTROL UNIT	3
Microcomputers	3 - 1
FM Tuning System	3 - 2
AFT	3 - 5
Frequency Counter	3 - 6
FM and Volume Memory	3 - 7
Digital Control of Volume Regulation	3 - 8
Keyboard and Display	3 - 9
Reset	3 - 11
Remote Control Transmitter	3 - 12
Remote Control Receiver	3 - 13
Beolab Remote Control	3 - 14
POWER SUPPLY	4
Turning on and off	4 - 1
ST-BY Circuit	4 - 2
Relay Circuit	4 - 3
Delayed Relay Circuit	4 - 3
ADJUSTMENT	5
BLOCKDIAGRAMS	6

Glossary

* Double beat = interference signals which are generated by an interplay between two other transmitters or harmonics of these. May occur on a receiver frequency or directly in the IF.

* Repeat spot = interference signals which are generated due to the harmonic of the osciallator frequency of the set having a separation of 10.7 mHz from the harmonics of another transmitter.

* Continuous beat = interference in the IF due to two other transmitters with 10 .7 mHz separation.

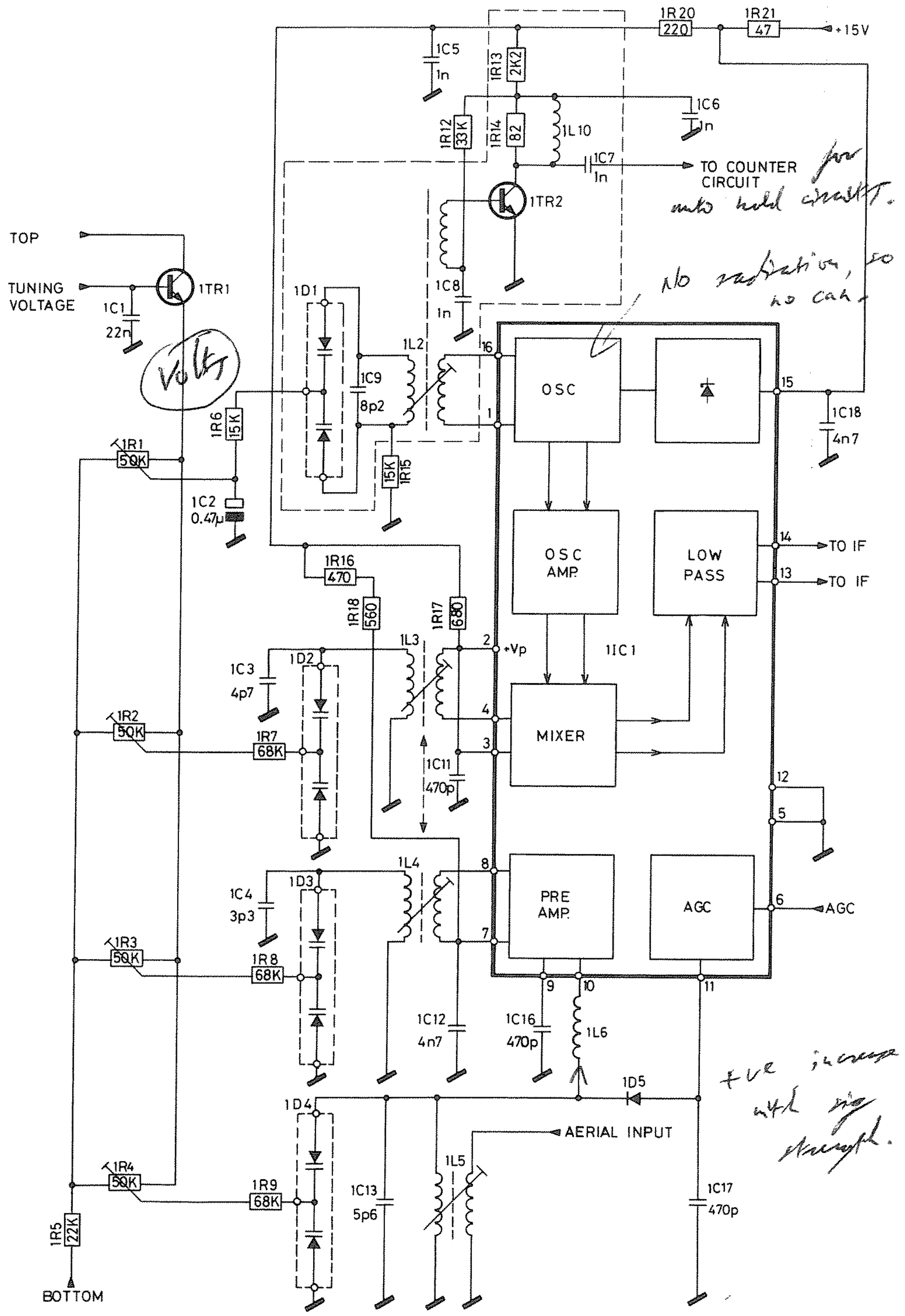
* Image frequency = interference generated by another transmitter being 10.7 mHz above the oscillator frequency of the receiver.

RF SIGNAL CIRCUIT

Tuner, front end

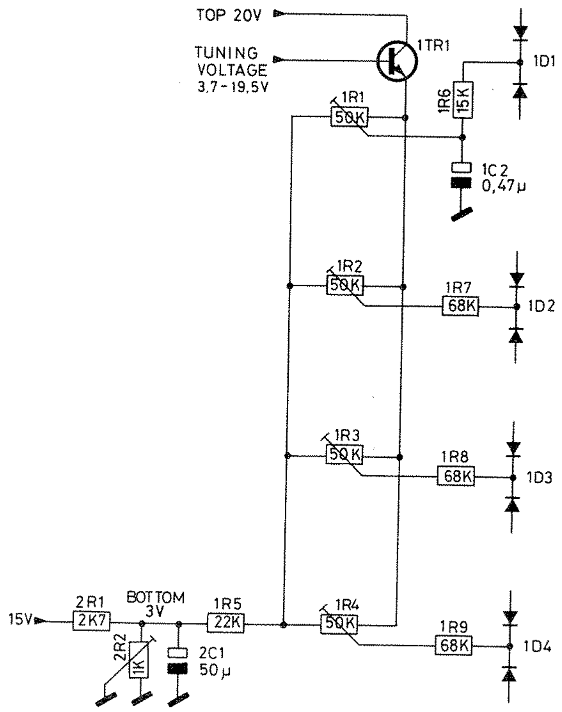
The tuner is a unit of new design and is built up around the IC TDA 1062. This IC contains a dual-balanced mixer with oscillator, an RF amplifier (with higher amplification than in previously used tuners) and an AGC circuit.
These circuits ensure high sensitivity and high frequency stability. The TDA 1062 and the employment of double capacitor diodes mean a high signal processing capability and a good spurious rejection, such as double beat*, repeat spot*, continous beat* and image frequency*.

from integrator.



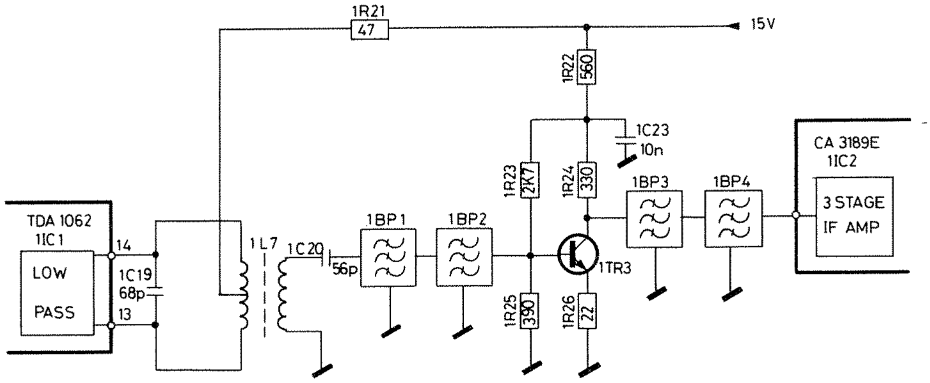
From the aerial input the signal is fed to the aerial circuit 1L5 and from here further on to the RF amplifier of 1IC1 in which an amplification of approx. 24 dB is obtained. From the amplifier the signal is fed to 1L4 from where it is transmitted inductively to 1L3 and into the mixer stage. The mixer stage has an amplification of approx. 16 dB and is dual balanced, which means that the input to the mixer stage from the RF stage and the oscillator respectively are designed symmetrically and balanced.
Consequently, the aerial and oscillator signals will be balanced out in the mixer stage, and thus only the IF signal required will be present at in that output.

Harmonics from either the aerial or the oscillator frequencies, if any, will be absorbed in th low pass filter (cuts off at approx. 100 MHz) through which the mixer signal is carried to the IF circuit. A situation in which errant signals could contribute to the mixing with resulting interference is thus practically non-existing.
Like the mixer stage, the oscillator is a balanced and symmetrical set-up. Compared to earlier tuners this means a marked improvement of the frequency stability, especially against temperature fluctuations.
The oscillator is designed with a separate stage between mixer and osciallator, and it oscilliates at such a very low amplitude that the radiation is so low that a complete tuner section shielding is unnecessary.
From a winding (printed on the PC board) on the oscillator coil, the oscillator frequency is fed to 1TR2 for amplification, and from here to a frequency counter in connection with the microcomputer (see separate paragraph).

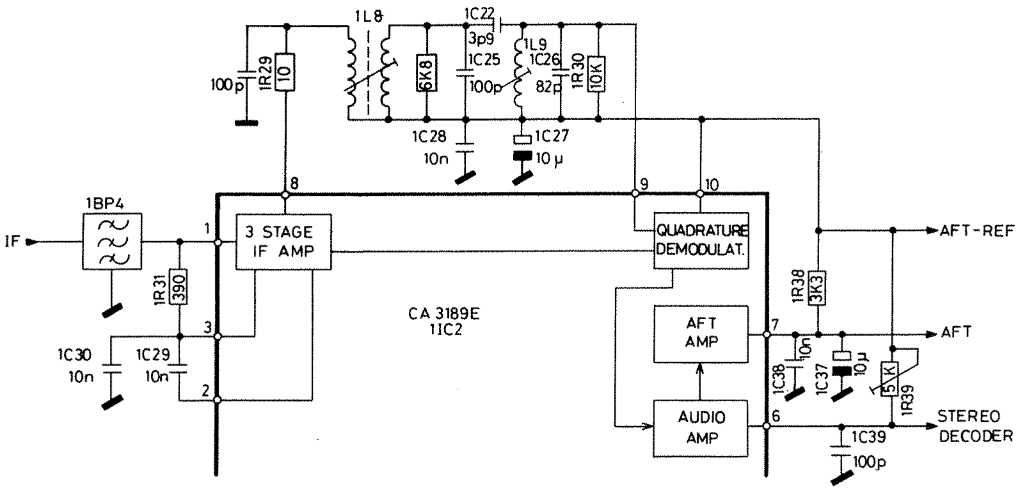


The tuning circuit has been designed with double diodes and the conventional trimming capacitors have been replaced by trimming potentiometers.
The double diodes are more linear than single diodes as the two diodes signalwise are in series and reversed. The curvad characteristics of the diodes will then cancel each other and thus prevent undesired mixing on the diodes (improved cross modulation data).
The transistor 1TR1 is an emitter follower which ensures that the tuning voltage is of low impedance relative to the tuning circuit, and at the same time it functions as part of the temperature compensation. The temperature curve of the transistor corresponds to the temperature curve of the diodes and as the latter are determined by natural constants, the resulting temperature compensation approaches the ideal situation.
Top voltage (≧20 V) is applied to the collector of 1TR1. Bottom voltage (3.0 V) is applied to the bottom of the trimming potentiometers 1R1, 1R2, 1R3 and 1R4. The tuning voltage (3.7-19.5 V) is fed to the base of 1TR1 and it has been set in such a way that with the dial completely bottomed the base emitter voltage on 1TR1 is 0.4 V (1TR1 = OFF).
This means that the voltage both sides of 1R1, 1R2, 1R3 and 1R4 will be equal (= bottom voltage). Consequently, the setting of the trimming potentiometer levers has no signifieance, and the coils 1L2, 1L3, 1L4 and 1L5 (bottom settings) can be adjusted without influencing the top setting. This results in a simplified adjustment procedure as bottom and top have to be positioned once only, and it will thus be unnecessary to repeat the adjustment as with earlier designs.

IF circuit

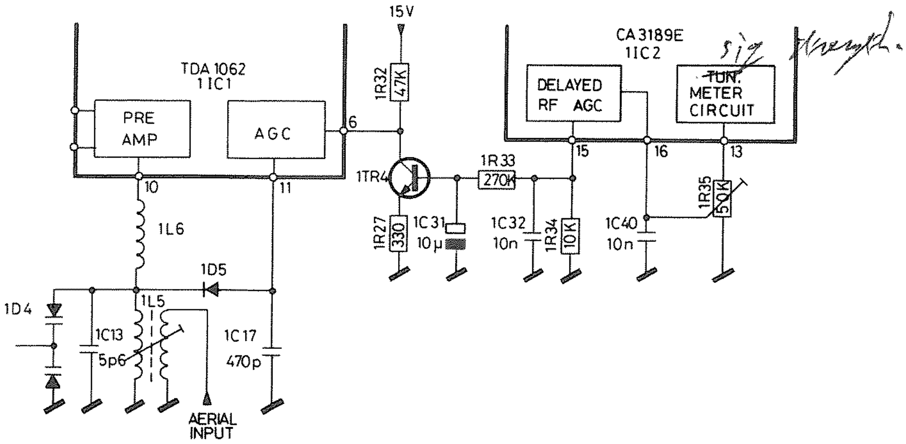


From the tuner IC the IF signal is fed to 1L7 which is furnished with a screen to avoid interference from the RF coils and feedback from the detector coils. Now the signal passes on through the 2 band-pass filters 1BP1, 1BP2 and into 1TR3 which amplifies it by approx. 16 dB corresponding to the attenuation in the two preceeding band-pass filters.
From the collector of 1TR3 the signal is fed through 1BP3, 1BP4 and into 1IC2.
The ceramic band-pass filters have an accuracy of ±30 kHz and the Beomaster 8000 is equipped with 4 such to ensure an extra high neighbour channel selectivity.



In 1IC2 the signal passes through a three stage IF amplifier with limiter and further on to the quadrature detector.
Functionwise these three stages are similar to earlier designs, but from a practical angle there is the difference that the detector is connected a-symmetrically in that pin 10 of 1IC2 is internally zener-stabilized (approx. 5.6 V) and – as far as the signal goes – is »cold« (decoupled with iC27 and 1C28). The AFT voltage on pin 7 will therefore have a positive or negative tendency relative to the DC level on pin 10. Pin 6 provides AF output (adjustable with 1R39).

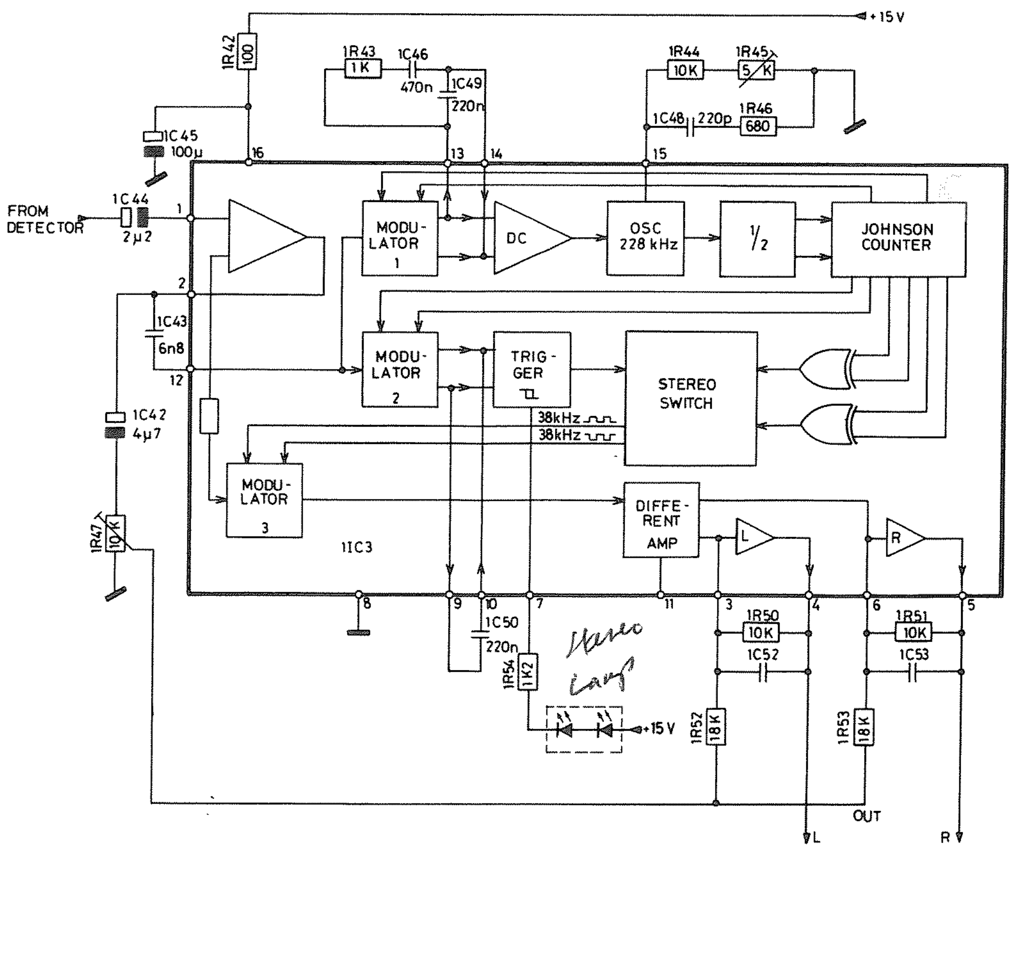
AGC



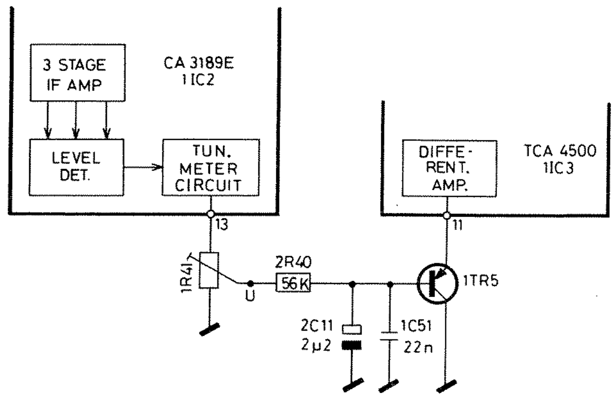
To avoid overloading with resultant distortion when receiving powerful aerial signals the RF section has been equipped with an AGC circuit. The DC level on pin 13 of 1IC2 is a function of the signal level and is intended for the tuning meter. Moreover, this voltage is used for the AGC and is, via trimming potentiometer 1R35, fed to the AGC circuit of 1IC2. On the output of this AGC circuit (pin 15) 8-9 V will be present in a no-signal situation, 1TR4 will be ON, and the DC voltage on pin 6 of 1IC1 will be 0 V. When the signal strength exceeds 1 mV EMF, the voltage on pin 15 of 1IC2 will drop, 1TR4 will start opening and the voltage on pin 6 of 1IC1 will start to increase. Now the voltage on pin 11 on 1IC1 will also increase, 1D5 will start to conduct, and 1IC17 will be laid parallel to the tuned circuit 1L5/1IC13, whereby the circuit will be dampened and thus the RF signal will be attenuated.
1D5 is a PIN diode which means it is a diode with a special linear resistance.

Stereo decoder

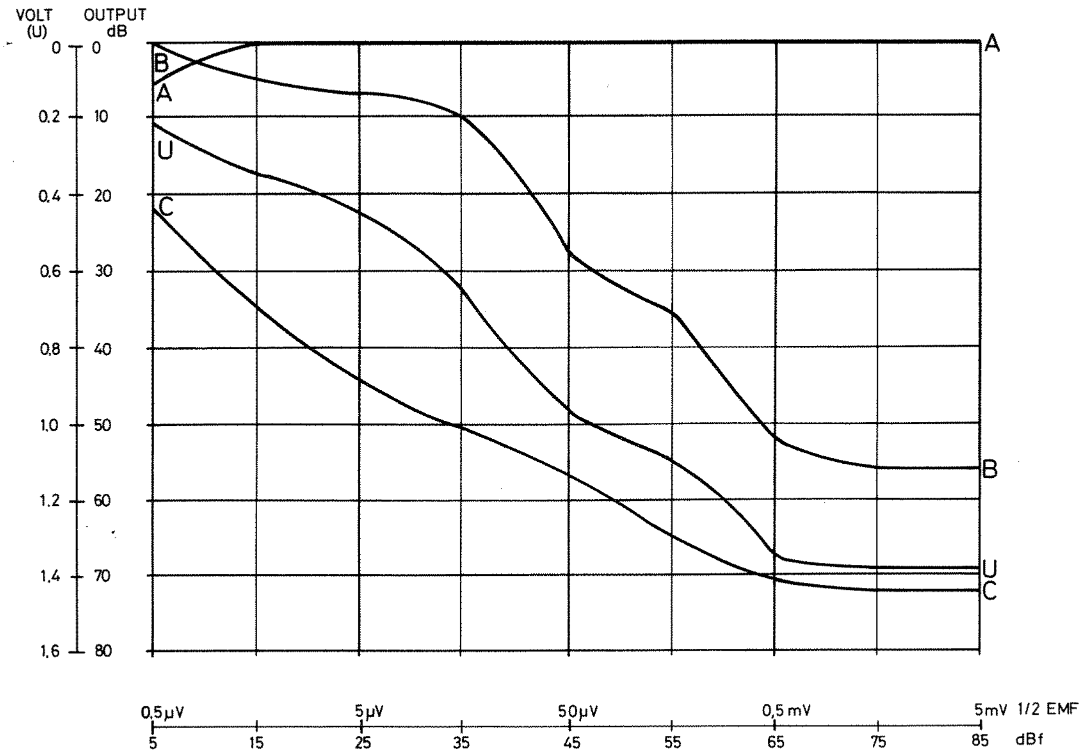
The stereo decoder is designed with an IC, type TCA 4500. This IC contains an internal digital counterbalancing of the 2nd and 3rd harmonics of the 38 Hz signal, thereby making external filters on the output superfluous.



The MXP signal form the FM detector is applied to pin 1 of 1IC3. Through a preamplifier the signal is fed to modulator No. 1 where it is compared with a 19 khz signal from the internal oscillator (228 kHz). The internal oscillator is DC controlled and externally adjustable with 1R45.
The correction voltage from modulator No. 1 (dependent on the phase relations between external and internal 19 kHz) is filtered in a low-pass filter and is via a DC amplifier fed to the internal osciallator whereby the latter is locked to the pilot frequency. To activate the stereo switch both the 19 khz from the MPX signal and the 19 kHz from the internal oscillator must be present. When this is the case, a trigger circuit will be activated from modulator No. 2, and this trigger circuit will – via the stereo switch – feed the 38 kHz to modulator No. 3, from where the signal passes to a differential amplifier.
The L and R signals are taken off this differential amplifier and passed through two separate AF amplifiers to pins 4 and 5. The AF amplifiers ensure high output voltage and low output impedance combined with low distortion. The de-emphasis is determined by 1C52 and 1C53 (4.7 nF = 50 μs – 7.5 nF = 75 μs).
From 1IC3 the AF signal is fed through a 19 kHz and a 38 kHz filter and further on through an operational amplifier, 2IC6, to the switching circuit.

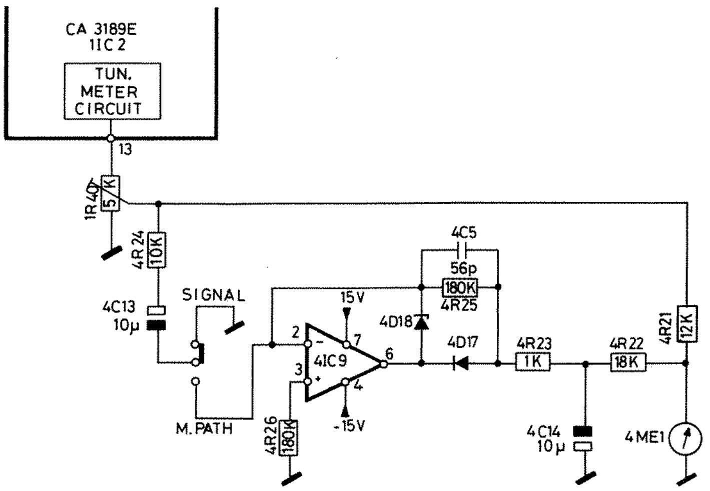


Due to the reduced signal-to-noise ratio on stereo when the aerial signals are weak, an automatic switching to mono is desireable when the signal drops below a given level.
To achieve this function, the voltage from pin 13 of 1IC2 (otherwise intended for the tuning meter) is utilized as it is increasing with more powerful signals. Thereby 1TR5 will gradually go ON and 1TR5 will thus open a path from pin 11 of 1IC3 to the chassis potential. This results in an internal switching in the IC whereby the stereo effect slowly increases simultaneous with the signal strength increase.
This form of stereo/mono switching (smooth takeover) eliminates the »jump« in signal-to-noise separation that existed in previously used decoders.



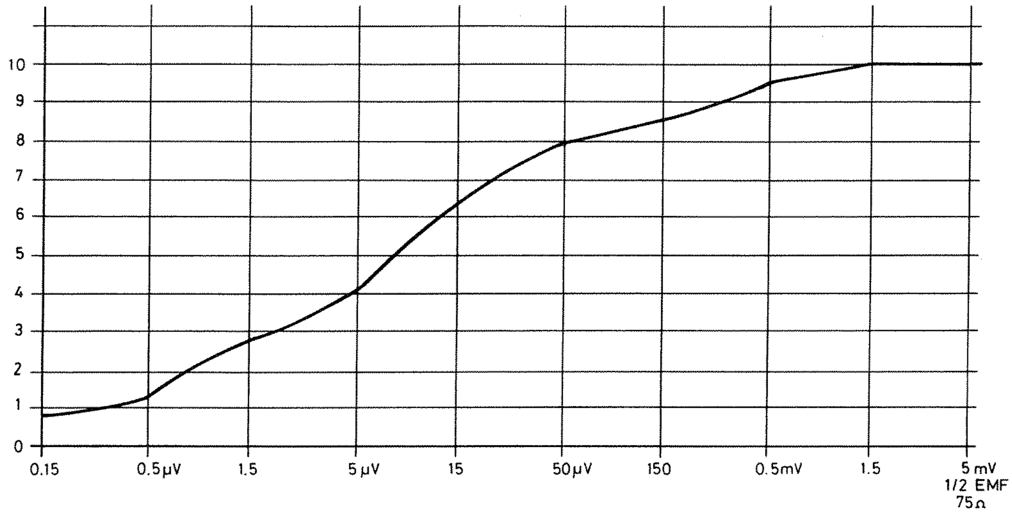
Graph showing stereo/mono switching in Beomaster 8000.
A = Signal
B = Separation
C = Noise
U = Pilot voltage on the base of 1TR5
As it will be seen, the pilot voltage is not a fully linear curve since it is a function of the level detecting of the 3 stages of the IF amplifier.
The MPX indicator will light up when tuning to a station which is transmitting a 19 kHz carrier wave.

Signal/Multipath meter



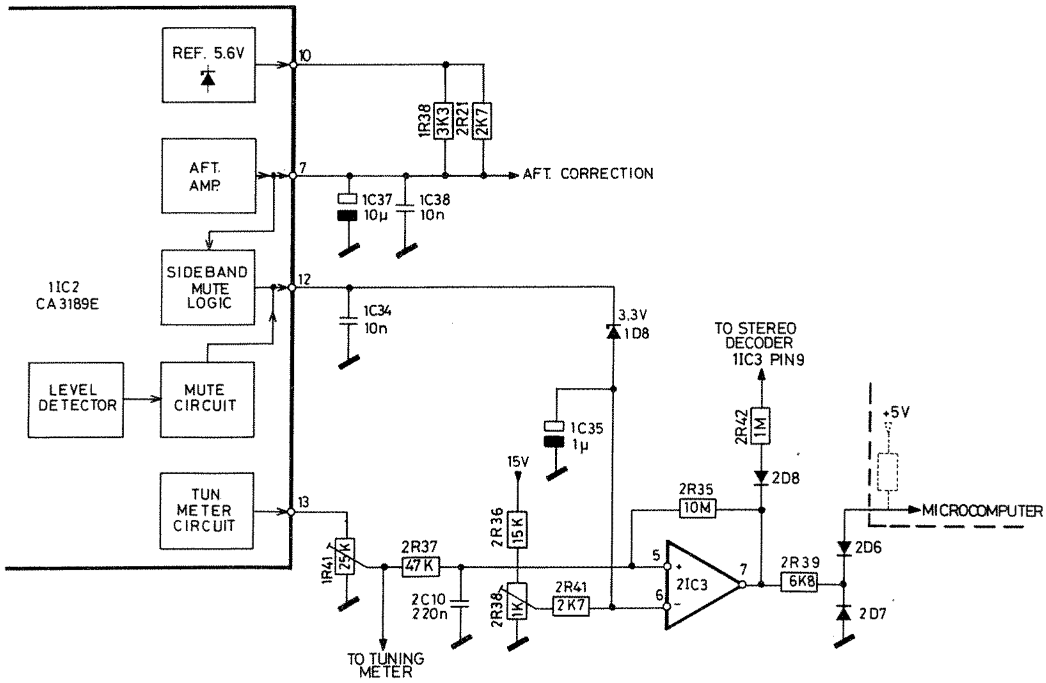
The Beomaster 8000 is equipped with a circuit to check the multipath conditions. By multipath is understood the reception of one station simultaneously from several directions which means that the main signal is mixed with reflections from highrise buildings or similar obstacles (resembles »ghosting« on a TV screen). Such phase-shifted signals will result in a distortion of the AF signal, and they appear as an AM modulation in the IF amplifier.

Such an AM modulation will also be present on pin 13 of 1IC2 together with a DC voltage which is independent of the signal level. When the meter switch is set in position SIGNAL, this DC voltage will result in a meter deflection which indicates the strength of the station tuned in to. The AM modulation will be grounded through 4R24, 4C13 and the switch. In the position M. PATH the DC voltage will be fed to the meter, but now the AM modulation will be input to the negative pin of the operational amplifier 4IC9. On the output of 4IC9 the positive side of the signal will be shorted back to the negative input by 4D18 while the negative side will be rectified in 4D17, filtered through 4R23, 4C14, 4R22 and fed to the meter. This will result in a smaller meter deflection, and the difference between the two meter readings in the two switch settings is a measurement of the multipath conditions on the aerial.



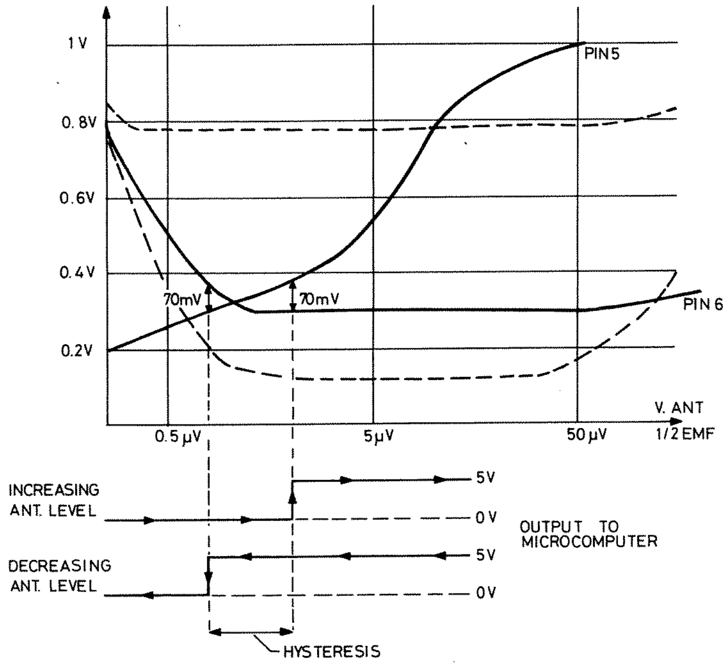
The above graph shows the meter deflection (position SIGNAL) relative to the aerial signal.

Silent Tuning (Signal condition)



When tuning out approx. ±100 kHz from an FM station, pin 12 of 1IC2 will be going towards high. This will result in a voltage rise on pin 6 of 2IC3 and when this voltage exceeds that on pin 5, 2IC3 – which has the function of a Schmitt trigger – will switch to low on the output. This low level is fed to the microcomputer which mutes the receiver by regulating down the volume control, if the receiver is an AUT. TUNE mode.

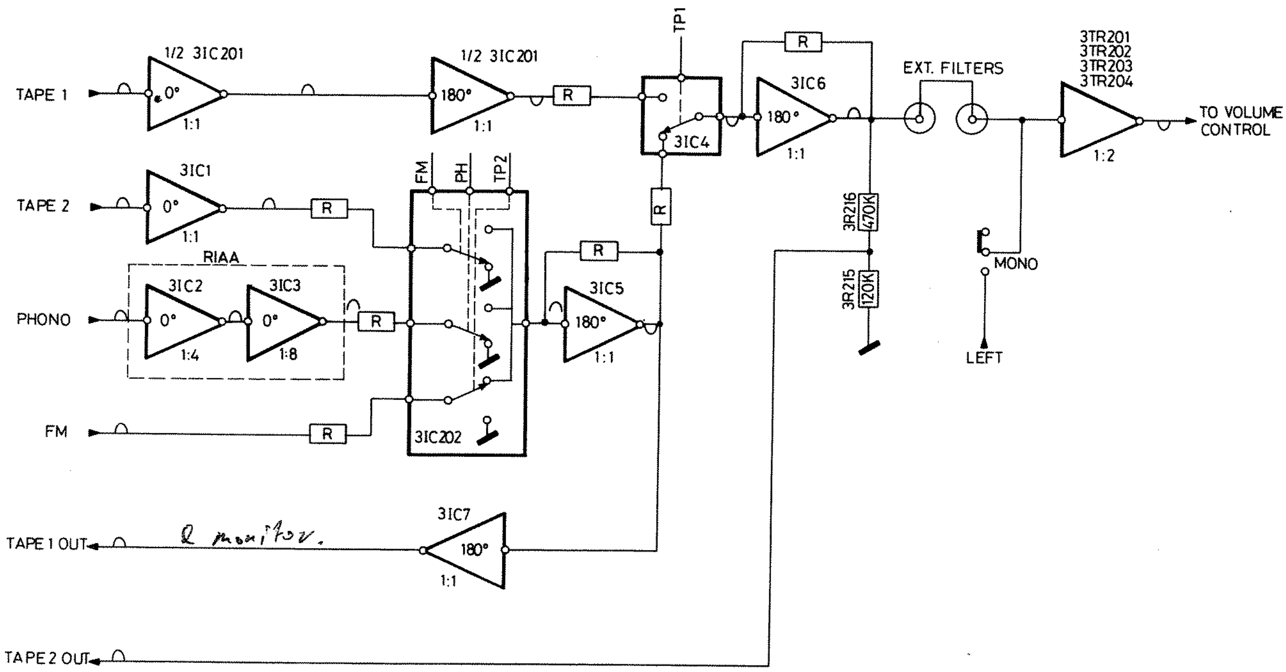
As 2IC3 has a ±15 V supply, the output will be changing between these two levels which cannot directly be fed to the microcomputer. Therefore the diodes 2D6 and 2D7 have been mounted, so that a low level only (0 V) can be fed to the microcomputer. When the microcomputer is not receiving a low pulse from 2IC3 its input will go high due to an integral pull-up resistor. The ±100 kHz for muting the sidebands is determined by the resistors 1R38 and 2R21.
Pin 12 of 1IC2 will also rise to approx. 3 V when receiving a weak signal <2μV. To prevent this level from being lead to 2IC3, the zenerdiode 1D8 is inserted. The voltage on 1IC2 pin 12 must therefore be more than 3.3 V to be supplied to 2IC3.
Furthermore, a signal-dependent DC voltage from the tuning meter circuit (falling at weak aerial signals) is applied to pin 5 of 2IC3. This voltage is utilized to order the microcomputer when to mute.



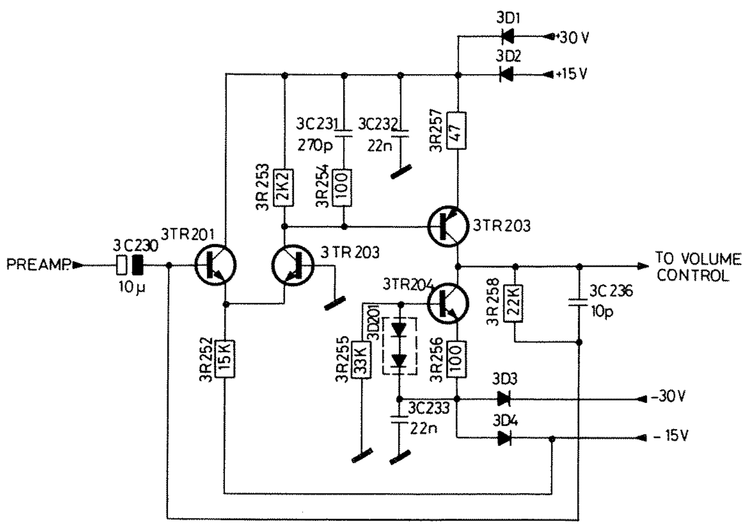
The diagram shows the muting coupling-in and coupling-out levels as a function of the voltage on pins 5 and 6 of 2IC3.
The level is adjustable with 2R38, which is accessible through the bottom. The broken lines indicate the outer limits of the adjustment range (approx. 1μV – 50μV). 2R38 is factory-adjusted to cancel out muting at signals >5μV ±2.5μV and to couple-in the muting at signals <2.5 uV ±1μV.
2R35 ensures that the muting is coupled-in at a lower signal level than the coupling out thus avoiding repeated coupling in and out, when the set is tuned to a weak and fading station.
Apart from using the above information as indications of when to mute, they are also being used to inform the microcomputer whether the set is tuned to a station, which it must know in connection with the Automatic Fine Tuning (AFT). Furthermore, via 2D8, the low pulse is to the stereo decoder and the microcomputer, and this ensures that the stereo indicator will light up only when the receiver is tuned to a station.

AF SIGNAL PROCESSING CIRCUIT
Preamplifier and switch

The preamplifier circuits are based upon operational amplifiers which are supplied from ±15 V. Due to the symmetrical supply design, the utilization will be optimum because the voltage swing will be around zero.
In an amplifier with simple positive supply such as an emitter follower, the operating point will lie above half the supply voltage for maximum signal processing and consequently such a supply voltage cannot be fully utilized.

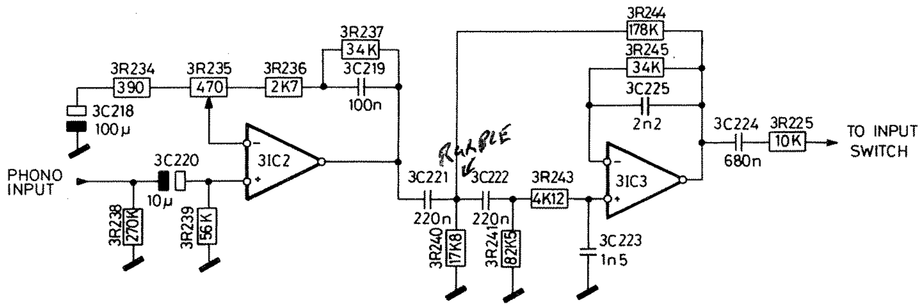


The principle of the amplifier is shown in the above block diagram. The FM, TAPE 2 and PHONO signals are fed to the switch 3IC202 which switches with digital levels from the microcomputer (the input, to which a high level is applied to the controlling pin, will be connected to the input of the inverting amplifier 3IC5). This amplifier is designed, by means of its feedback, to ensure 0 V signal voltage across the switch (3IC202) due to the fact that any signal voltage at the switch might cause distortion. From the output of 3IC5 a signal is tapped for the TAPE 1 OUT (3IC7) and for the TAPE 1 switch (3IC6). The TAPE 1 switch is made separate because it must be switchable independently of the other switches due to the monitoring function.
The TAPE 1 input differs from the other inputs, with an inverting amplifier (1/2 of 3IC201) inserted between the input amplifier and the switch. The inversion is necessary because both signals to the switch (3IC4) must have the same phase and because it would be inexpedient to make the input stage inverting due to noise risk. From the TAPE 1 switch the signal is fed through the necessary amplifier, the signal now having resumed its original phase, and the signal level will be approx. 225 mV on the putput to the external filters.
The signal for TAPE 2 OUT is tapped via a voltage divider 3R215/3R216 to adapt it to the DIN level.

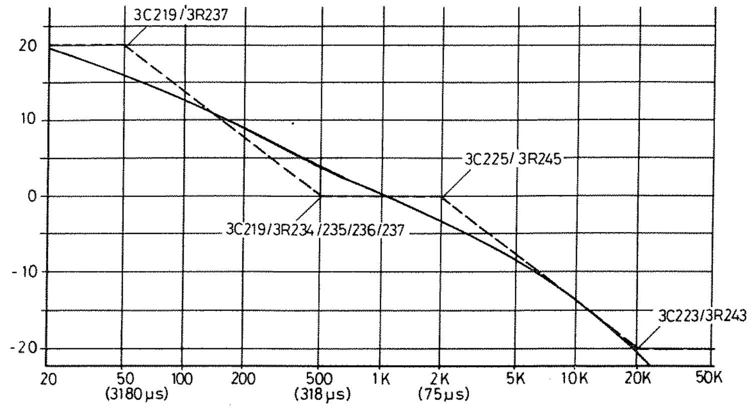


The last amplifier is made up of discrete components with ±30 V supply. This design has been chosen to ensure a high signal voltage to the volume control and at the same time to retain the full overload margin of the other preamplifier components. In order to avoid »blobs« when switching on and off, the amplifier is supplied by ±15 V until ±30 V is present (the ±30 V is taken from ±55 V which is delayed in order to obtain a smooth start up. (See section on power supply).

RIAA

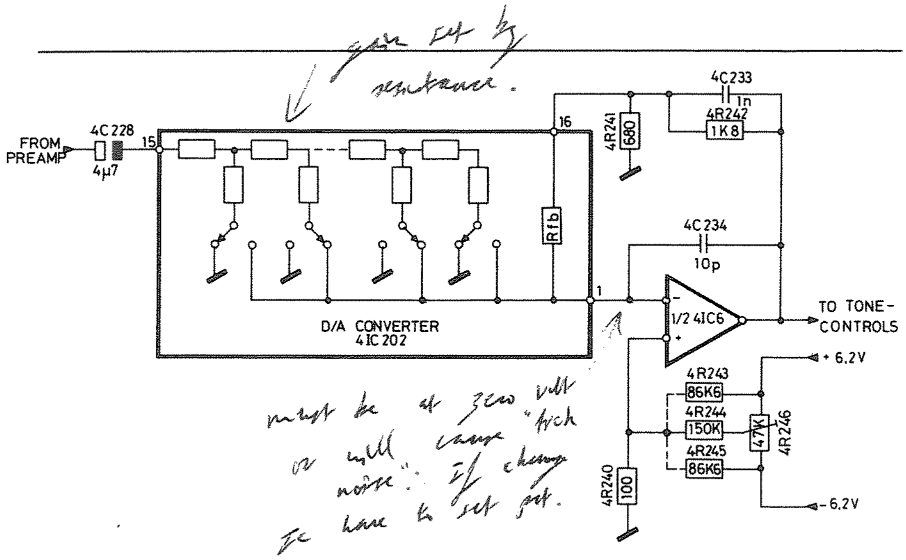


The RIAA amplifier is designed with two operational amplifiers and incorporates a sensitivity adjustment which is accommodated in the feedback of the first amplifier. This type of coupling offers the advantage that the amplification is regulated according to the pick-up output, thus resulting in an overload margin which remains the same irrespective of the output voltage of the pick-up. Furthermore, the RIAA amplifier has an integral LO filter cutting off 18 dB/octave below 20 Hz. The LO filter is made up of the following 3 R-C links: 3C221/3R240, 3C222/3R241 and 3C224/3R225.



The above graph shows the RIAA curve. The R-C link 3C225/3R245 will begin to flatten out at approx. 20 kHz. In order to prevent this, 3C223/3R243 maintains a downgoing curve at frequencies above 20 kHz.

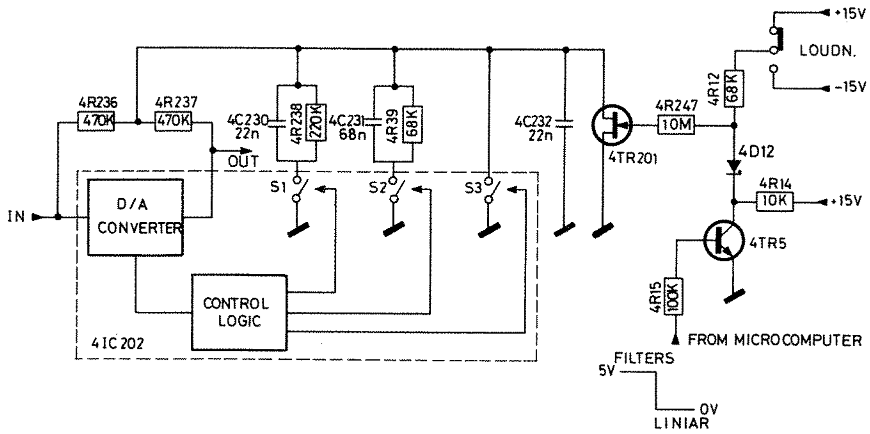
Volume Control



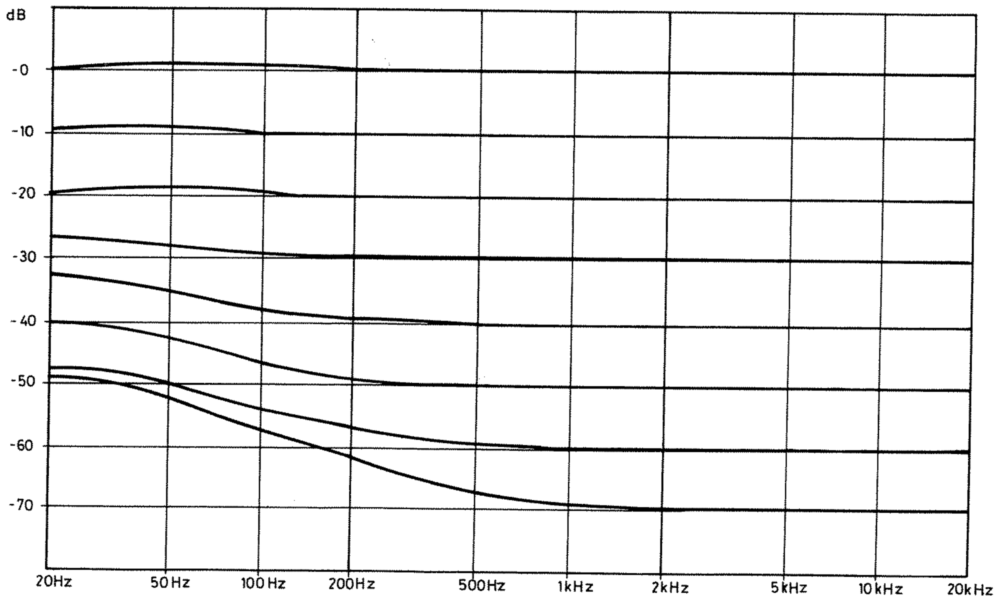
From the preamplifier, the signal is fed via 4C228 to the volume control IC (4IC202) which is controlled by the microcomputer (see section on digital control of volume regulation).
In principle, the digital/analog converter of 4IC202 is made up as a resistor network with some switches and it is controlled by the CONTROL LOGIC circuit. The CONTROL LOGIC converts the linear counting sequence from the microcomputer into a logarithmic counting sequence so the loudness becomes controllable in 60 steps with 1.5 dB spacing between steps.
There must be no signal voltage on the output of 4IC202, as any such signal voltage would be present in several locations in the resistor network with the consequence that the volume control setting would become undefined. For this reason an operaional amplifier with negative feedback follows the output of 4IC202 to ensure zero signal voltage at this location. Part of the feedback, the resistor Rfb, is integral with the 4IC202 and it will therefore be in accordance with the manufacturing tolerances present in the resistor network.
4IC6 is fitted with an off-set adjustment by means of which the output of 4IC6 is adjusted to 0 V (±200 µV). This is to prevent noise, due to the fact that the output impedance of 4IC202 at low volumes will vary up to 30/40%. A DC voltage on the output of 4IC6 will be voltage divided across the feedback 4R242/Rfb and the output impedance of 4IC202 with the effect that any output impedance fluctuations will result in a corresponding DC voltage fluctuation, and the latter DC »jumps« will cause some audible clicks in the loudspeakers.
We have opted for the use of a 47 kohm potentiometer for the off-set adjustment and then to shunt the series resistor 4R244 with two resistors 4R243 and 4R245.

These two resistors can be clipped, should the adjustment range become too small at either side. The reason for this facility is to avoid an over-sensitive adjustment and in order to ensure a good long-term stability because a smaller series resistor would result in a greater voltage change on the + input of 4IC6 with the same potentiometer change.
Metallic film resistors have been used to ensure temperature stability and long-term stability.

Loudness

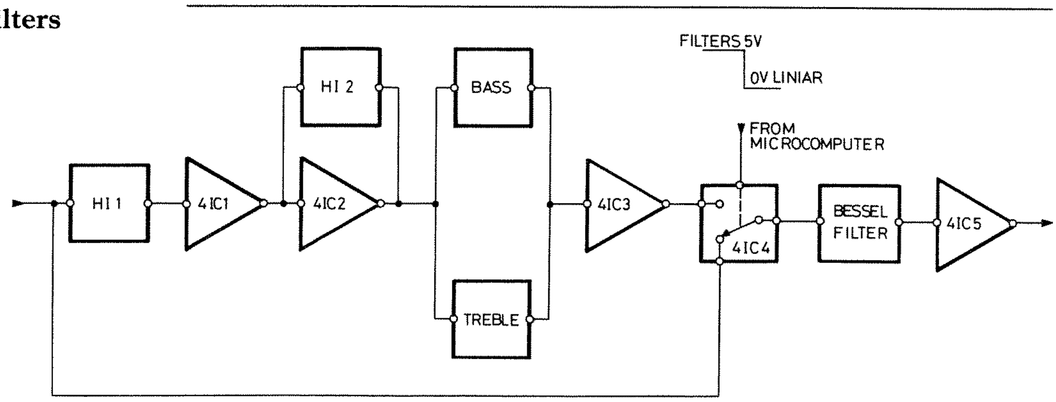


The loudness regulation, which acts in the bass range, is achieved by letting part of the signal bypass the D/A converter, through 4R236 and 4R237.
By means of the electronic switches S1, S2 and S3 built into 4IC202 the magnitude of the bass boost is controlable.
At full volume the three switches will be open and there will be no boost because 4R236 and 4R237 have no bearing on an »open« D/A converter. The resistors 4R236, 4R237 and the capacitor 4C232 will now become increasingly important, down to a volume of 2.8 (on the display) when S1 closes and the R-C network 4C230/4R238 becomes concurrent. At volume 2.0 the S1 will re-open and S2 closes whereby 4C231/4R239 becomes concurrent to the bass boost. S2 remains closed all the way down to 0 volume, when S3 closes with the result that in this mode no signal is bypassing the D/A converter.

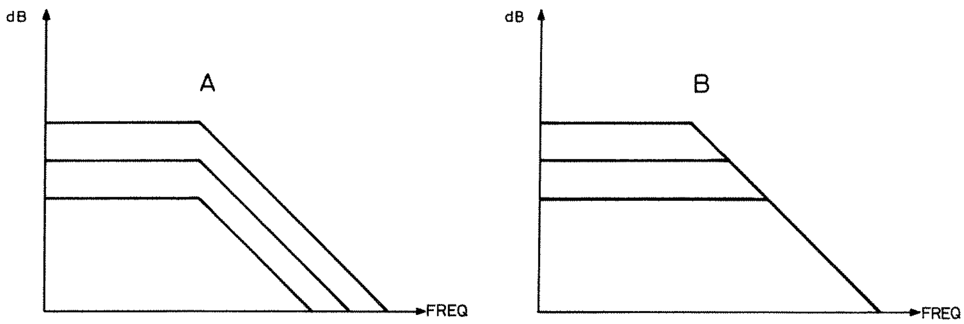


The above graph shows the loudness regulation curves.
The loudness function is controlled by the LOUDN button by means of 4TR201 and is disengaged together with filters and tone controles in the FILTERS OFF mode (controlled by the microcomputer).

Tone Controls and Filters



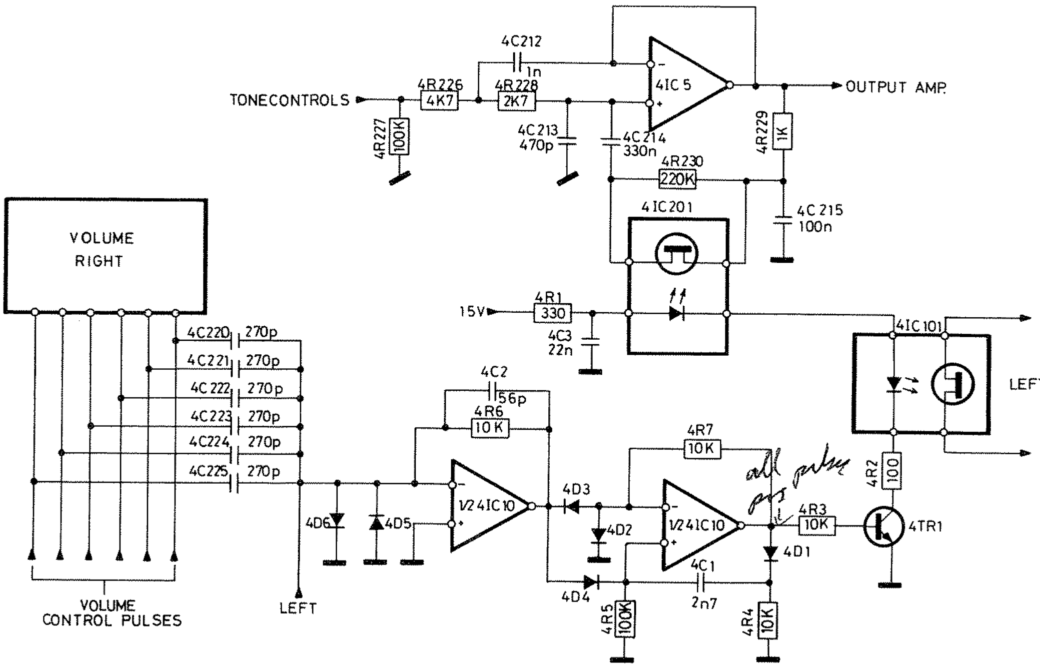
The above bloc diagram shows the principal arrangement. The HI 1 filter cuts-off with 12 dB/octave from 7 kHz and the HI 2 filter with 6 dB/octave from 10 kHz. In principle, the function of the tone controls is the same as in earlier receivers, however, with the difference that the bass control has a tapping with the facility that the cut off frequency will vary according to the amount of bass boost (Fig. A), whereas, in earlier receivers, the cut off frequency was fixed irrespective of the amount of bass boost (Fig. B).



A bessel filter with a cut-off frequency at approx. 50 khz is incorporated ahead of 4IC5. The function of the filter is to prevent frequencies above 50 kHz from reaching the output amplifier and thus cause transient intermodulation distortion (TID).

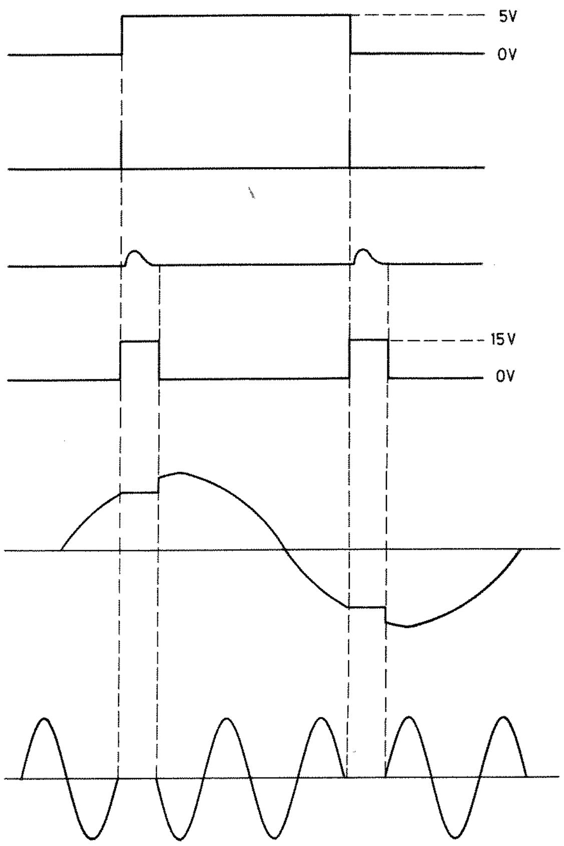
Supression of Noise Spikes from the Volume Control

When the volume control is regulated, the digital control pulses will cross over to the AF signal inside 4IC202, and appear as an audible cracking in the loudspeakers.



The above circuit has been introduced in order to avoid that.
The control pulses for the volume control are via 12 capacitors (6 in each channel) carried to a junction where two opposed diodes (4D5 and 4D6) have been fitted which limit the pulses in order to prevent interaction between the control inputs to the volume IC.
From this junction the pulses travel through an amplifier stage (the first half of 4IC10) and enter a mono-stable multivibrator (second half of 4IC10) which can be triggered positively (via 4D4) as well as negatively (via 4D3).
By way of example, a negative pulse at the output of the amplifier will be fed to the – input via 4D3 which causes the output to go positive. 4C1 will be charged through 4D1 and may, during the charging, be considered a short-circuiting so that a positive voltage (positive feedback) will be fed to the +input and the multivibrator will hold its position.
When the charging of 4IC1 is finished the voltage on the + input will drop, and the multivibrator will change its position when the voltage has dropped below the level on the – input (0.7 V).

The output is now negative going, 4D1 will block and 4C1 will become reverse charged by 4R4. The feedback 4R7 will now keep the multivibrator stable and ensure that the output remains at approx. 0 V (it must not become negative, due to 4TR1). 4D2 ensures that the feedback to the – input is of no consequence when the multivibrator is ON.
The multivibrator will be ON for approx. 100 µsec. at each pulse applied. Each time it goes ON 4TR1 will be forward biased, 4TR1 goes ON and the LEDs in 4IC101/201 will light up.
4C3 provides for a high starting current caursing the diode to turn on fast.
The FET transistors in 4IC101/201 will short-circuit when illuminated with the consequence that the output signal on 4IC5 will be clamped to the input during the span of time (approx. 100 µsec.) in which the noise pulse was to pass. The noise pulse is delayed and flattened out in the bessel filter which is fitted in the input of 4IC5, thus compensating for the inertia (approx. 5 µsec.) of the optocouplers.
4IC5 will maintain the level that was on the input for as long as the FET transistors are short-circuited, and the noise pulses will be conducted to chassis via 4C214, 4IC201 and 4C215.



Control pulse from the microcomputer to the volume IC

Noise pulse after volume control (in the signal path)

Noise pulse after bessel filter (in the signal path)

Output from multivibrator

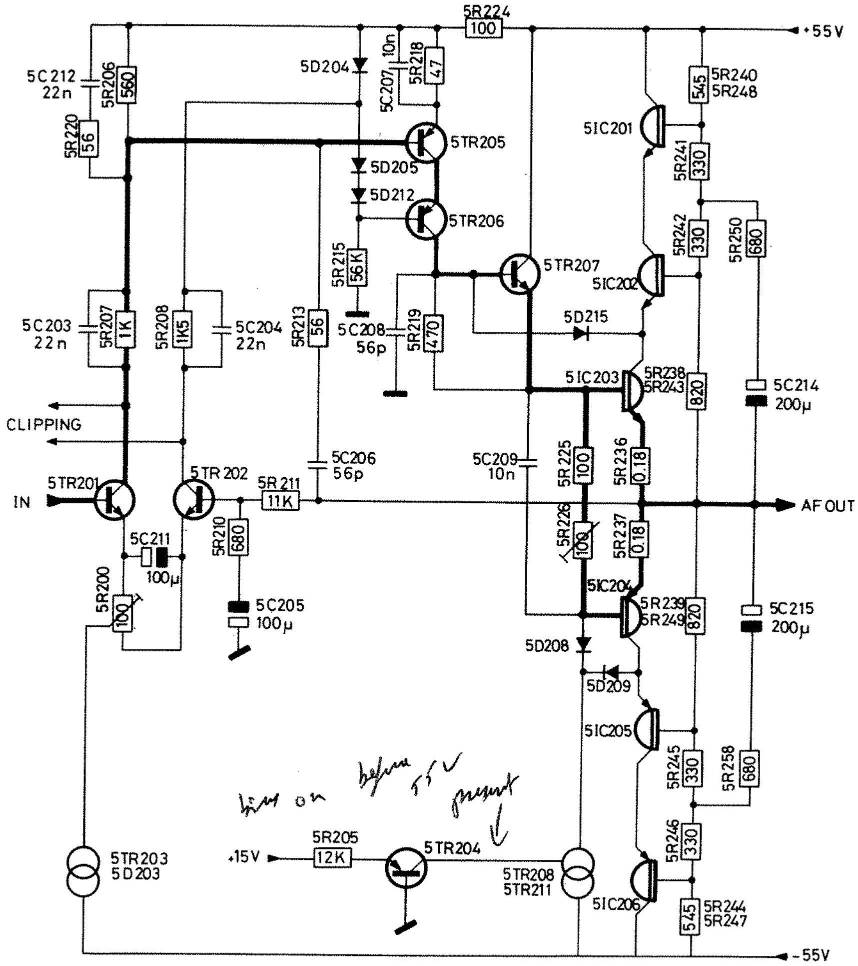
Low signal frequency after 4IC5 when the suppression circuit is activated

High signal frequency after 4IC5 when the suppression circuit is activated

The resistor 4R230 ensures the charging of 4C214 when 4IC201 is OFF thus preventing DC jumps when 4IC201 goes ON.

Output amplifier

The output amplifier is designed according to the same basic principles as were used in the Beomaster 4400.
The basic diagram of the amplifier is shown below.

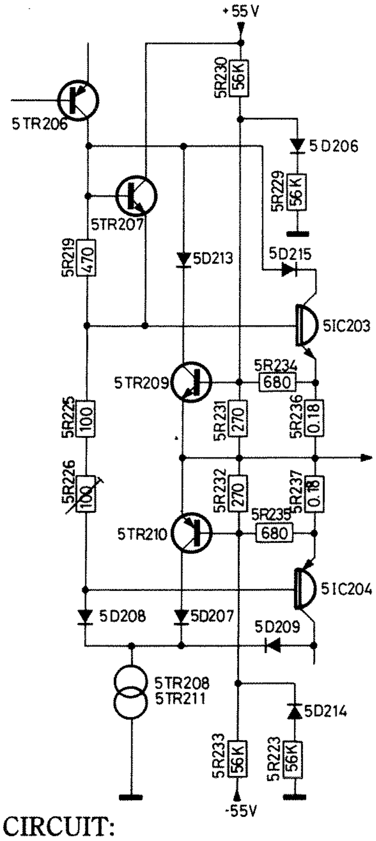


The AF signal is applied to the differential amplifier 5TR201/5TR202 which is off-set adjustable with 5R200. This off-set adjustment – and the PA-KEY circuit (see section on Power Supply), which ensures that no current is applied to the constant-current generator 5TR208/5TR211 until there is full supply voltage on the output amplifier – provides an ON/OFF function without clicks in the loudspeakers.
From the collector of 5TR201 the signal is fed through an R-C network, from which the voltage for the CLIPPING indicator is tapped, and on to 5TR205/5TR206. Two transistors are used here in order to handle the great voltage swing and at the same time to avoid the effect of B-C capacitance.
The transistors are coupled in cascade and 5TR206 may be considered grounded base coupled as it is diode biased from +55 V. The voltage swing will be across 5TR206 and the B-C capacitance of 5TR206 is insignificant because the base is very low-impedant. The B-C capacitance in 5TR205 will have very little influence since there is very small voltage amplification in this transistor and consequently the feedback will also be very small.
The internal feedback is made up of 5R213/5C206 and the external one of 5R210, 5R211 and 5C205.
The signal is now applied to the driver transistor 5TR207 and further on to the two signal processing output transistors 5IC203/5IC204.
Compared with the Beomaster 4400 one additional transistor is used in this network for the positive and negative sides respectively, but the coupling principle is identical.
Thus, on the positive side, 5IC201 will first become fully conducting, then 5IC202 and finally the signal processing 5IC203.

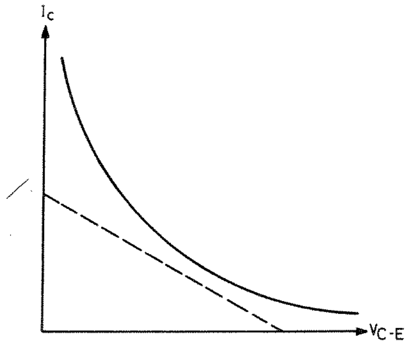
The diode 5D215 will – if 5IC203 is fully driven – bypass part of the base current around 5TR207 and in this way protect the driver transistor. Furthermore, it prevents 5IC203 from becoming fully driven far into saturation which would increase the turn-off time of 5IC203.
The diode 5D208 supplies the base current for 5IC204 and corresponds to the B-E function of 5TR207. The diode 5D209 corresponds to 5D215 but has no safety function inasmuch as the current in this instance is being limited by the constant-current generator 5TR208/5TR211.

Safety circuits

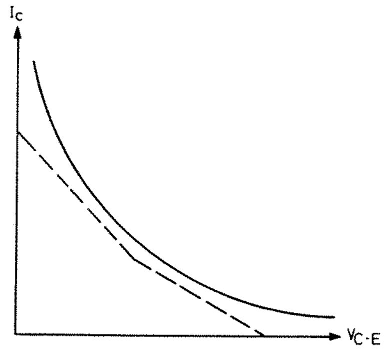
The output amplifier features two different safety circuits:
1. Current limiter circuit.
2. Loudspeaker and temperature safety circuits (Fault Switch).



CURRENT LIMITER CIRCUIT:
The function of this circuit is to protect the output transistors against too high collector currents with respect to the instantaneous collector/emitter (C-E) voltage in such a way that at high C-E voltage only a low collector current is permissible and vice versa. In principle the safety circuits are indentical for the positive and the negative sections, hence only the positive one will be described below.
5TR209 measures the voltage across the emitter resistor 5R236 and thus the current through the output transistors. The base voltage divider 5R231/5R234 ensures that the safety circuit is activated at the correct level. The voltage divider 5R234/5R230 which is parallel to the output transistors, ensures that the safety circuit becomes activated when a high voltage across the output transistors is present. This will result in a safety circuit curve of the following configuration:



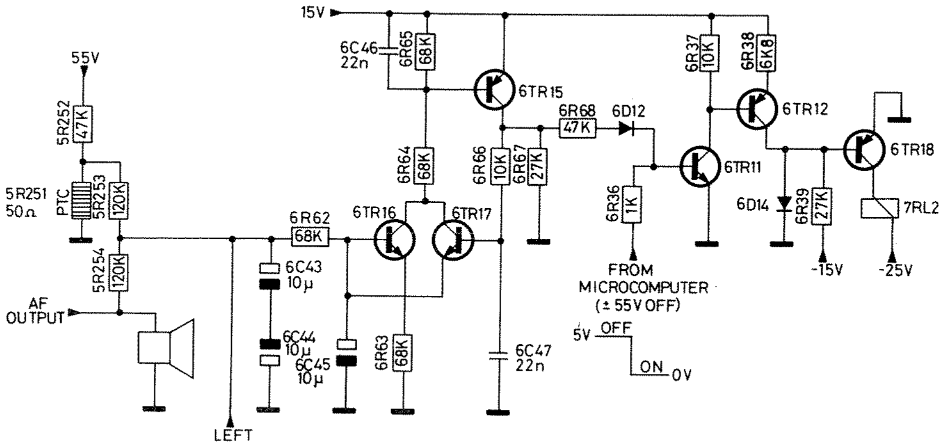
However, the above curve is not optimized in that it takes a course far away from maximum power at high collector current. Hence the network 5D206/5R229. During positive drive this network will draw some base current away from 5TR209. This will result in the following safety circuit curve:



When the safety circuit is activated, 5TR209 will conduct and thus reduce the base current in 5TR207, and similarly 5TR210 in the negative section will reduce the base current in 5IC204. The diodes 5D207/5D213 prevent 5TR209/5TR210 from getting reverse biased whereby they would remove part of the base current for 5TR207 (during the negative half cycle) and to 5IC204 (during the positive half cycle).

LOUDSPEAKER AND TEMPERATURE SAFETY CIRCUITS (FAULT SWITCH)

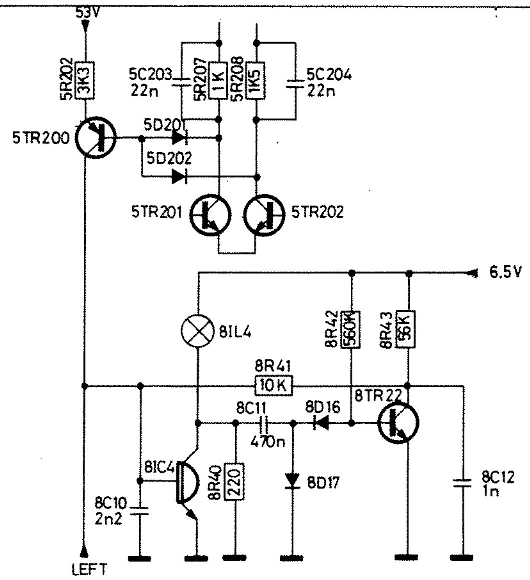
The function of the circuit is to switch off the supply voltage in case a fault should lead to the occurance of a DC voltage on the loudspeaker output. Furthermore the circuit will switch off the supply voltage to the output amplifier in case of excessive heat sink temperture due to overloading.



During normal operation 0 V will be present between 5R254 and 5R253. If a DC voltage should appear on the loudspeaker output, the voltage (either positive or negative) will cause 6TR16 or 6TR17 respectively to go ON which would forward bias 6TR15 and turn it ON. 6TR15 will now forward bias 6TR17 and the state will remain constant. 6TR15 will also conduct a positive voltage to the base of 6TR11 which corresponds to an OFF pulse from the microcomputer, and the relay circuit will disconnect the mains voltage from the ±55 V transformer.

At too high heat sink temperature the resistance in 5R251 will increase and a DC voltage will occur across it, which will be applied to the base of 6TR16 via 5R253/6R62, and the safety circuit will become activated as described above.

Clipping



When clipping of the output signal occurs, the differential amplifier will attempt to compensate for it. If the clipping occurs in the positive half-period, 5TR201 draws maximum current whereby the collector voltage drops towards zero and 5TR200 becomes forward biased via 5D201. In the same way 5TR202 draws maximum current if the clipping occurs in the negative half-period, and 5TR200 becomes forward biased via 5D202.

When the indicator circuit is not activated 8IC4 is OFF while 8TR22 is ON. When clipping occurs on the output, 5TR200 becomes forward biased and goes ON. This results in a positive voltage on the base of 8IC4 which goes ON, and 8IL4 lights up. The voltage on the left side of 8C11 jumps from +15 V to 0 V when 8IL4 lights up. The voltage on the right side of 8C11 then becomes negative which discharges 8C11 through 8D16/8R42 and 8TR22 goes OFF. The collector voltage increases towards 6.5 V whereby base current is applied to 8IC4 via 8R41, and 8IL4 remains illuminated until 8C11 is fully discharged. This is the safeguard that 8IL4 – even during a very short duration clipping – will remain illuminated for as long as it takes the eye to perceive it.

CONTROL UNIT
Microcomputers

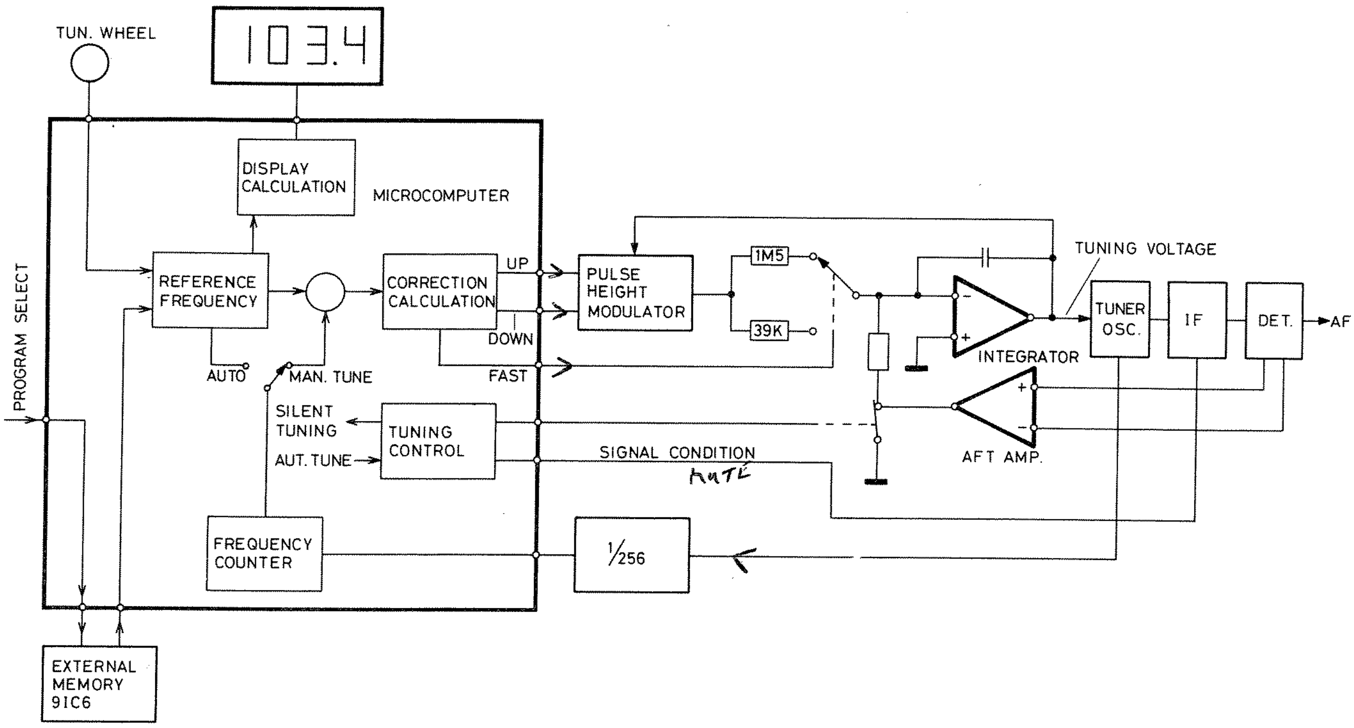
The Beomaster 8000 employs two microcomputers, each with its own crystal-controlled oscillator (2 MHz). The microcomputers operate as a unit, and they will be discussed as a unit. 9IC3 is the superior one (MASTER) which receives all inputs, controls the display and forwards orders to 9IC4 (SLAVE), which controls volume/balance, input/programme selection, power supply, FM frequency measuring and frequency correction.
A number of benefits are obtained by the employment of two microcomputers, among these that the counter in 9IC4 (SLAVE) may be constantly used as fequency counter for the tuning system. The other section of 9IC4 is controlled by Interrupt pulses from 9IC3 (MASTER) and handles the non-timecritical functions. Each 1.52 µsec. 9IC3 – via the Interrupt and the four leads in the Data Bus – will send an order to 9IC4 for what tasks are to be performed. Once every approx. 25 µsec 9IC3 and 9IC4 exchange data, likewise per Interrupt and Data Bus.
The microcomputer has an internal Testprogram enabling it to test itself. The Testprogram tests most of the microcomputer functions, and when the program reports OK, it is most likely that the microcomputer is functionally in order. Further the test checks any shortening to chassis of such pin connections which normally cannot be connected to chassis level.
The Testprogram can be activated by short-circuiting the two points marked TEST PGR. in the diagram (A screwdriver is pressed against the PC board and tilted briefly against the pin) or by setting the receiver in the ST-BY mode and then simultaneously activating the MONITOR and ST-BY keys. If the microcomputer is OK, TP (TEST PASSED) will light up on the display. If, on the other hand, an error is present the display will light up with the letters TE (TEST ERROR) followed by a number which indicates the error code. It should, however, be noted that the error indication cannot be 100% reliable because an error in the microcomputer or the connections to the latter might prevent the error from being correctly displayed.

TE	Defect IC	or short pin to chassis
1	9IC3 (RAM)	
2	9IC3 (ROM)	3*
3	9IC3	31
4	9IC3	4*-25-27-28-29
5	9IC3	19-(17-18-20)* - (15-16)*2
6	9IC3	6-7-8-9 - (2-5)*
7	9IC4 (RAM)	
8	9IC4 (RAM)	10-11
9	9IC4 (RAM)	
10	9IC4	31-32-33-34-35-36-37-38
11	9IC4	22-23-24-25-26-27-28-29
12	9IC4	14-15-16-17-18-19-20
13	9IC4	6-8-9

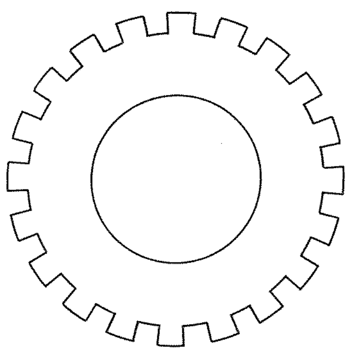
* Due to these pins being controlling leads to the display, it will mis-display if errors are present here.
*2 Can only be tested by shortning the TEST PGR. points on the PC board.

FM Tuning System

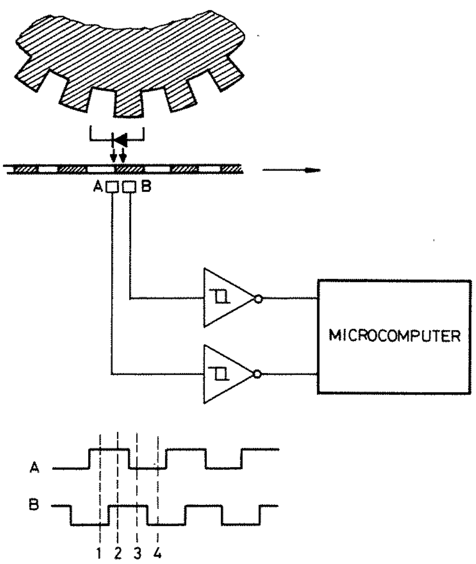
The main part of the tuning system functions are integrated in the microcomputer program and operate with the crystal-controlled oscillator (2 MHz) of the microcomputer as reference. The resolution, i. e. the increments with which the frequency correction is made, is 12.5 kHz hereby ensuring a correct tuning to any FM station. Due to display readability considerations, the frequency readout has one decimal only.



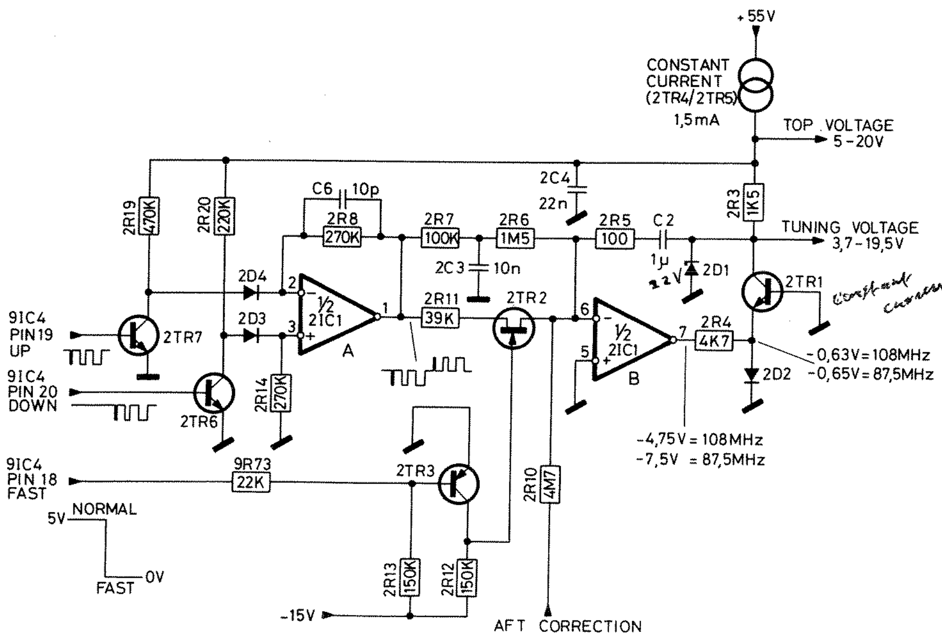
The functional principle of the tuning system is shown above. When a programme is keyed, a reference frequency will be retrieved from the RAM. This reference frequency will appear in the display and via CORRECTION CALCULATION, PULS HEIGHT MODULATOR and INTEGRATOR it will be converted into tuning voltage which corresponds to the programme selected. The oscillator frequency will now be read by a frequency counter circuit in the microcomputer and compared with the reference frequency. If the two frequencies are different, the CORRECTION CALCULATION will make a correction of the tuning voltage. Such controls and corrections are made 40 times per second thus ensuring a very accurate tuning at any time. If a different dial setting is required, the reference frequency may be changed by means of the tuning wheel.



Below the wheel is a toothed disk with 20 teeth. Around the toothed disk an infra-red optocuopler is fitted in such a way that there is an LED at one side and two photo-sensitive transistors at the other side. When turning the tuning wheel, the two transistors will emit some pulses which are applied to the microcomputer (9IC3) through two Schmitt triggers (1/3 of 9IC7) providing for well defined pulses.



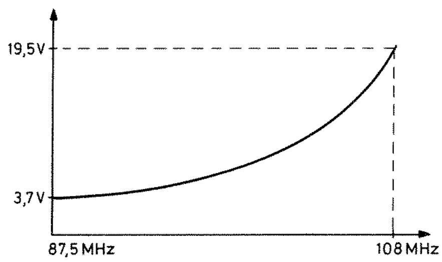
The two photo-sensitive transistors are positioned in such a way as to enable 4 different conditions for each of the 20 notches. This results in 80 steps per wheel rotation, and as each step amounts to a 12.5 kHz reference frequency change, a full rotation will correspond to a 1 MHz change of the received frequency.
Dependent on the rotational direction of the wheel, either A or B will be 90° ahead of the other one. The microcomputer uses this fact to decide wheter the reference frequency is to be lowered or raised.



The tuning voltage is based on a pulse width modulation from the micro-computer. When setting to a higher dial frequency some low pulses will emit from pin 19 of 9IC4, the width of which is a function of the wheel turning speed. The faster the wheel turning, the wider the pulses.
In the same way low pulses will be emitted from pin 20 of 9IC4 when the wheel is turned towards a lower dial frequency.
These low pulses will be inverted by 2TR6/2TR7 and applied to the + and - inputs respectively of 2IC1 (A) where they will be amplified. 2D3 and 2D4 will be blocking when no corrective pulses are emitted (2TR6/2TR7 = ON).
Without the diodes both the inputs of 2IC1 (A) would be grounded to the chasis with an undefined output voltage as the result.
On the output of 2IC1 (A) the UP pulses will be present as negative-going pulses and the DOWN pulses as positive-going ones.

The correction pulses are applied to pin 6 of the integrator 2IC1 (B) across 2R7/2R8.
The input impedance of the integrator may be considered indefinitely high and consequently equal amounts of current will flow through 2R6, 2R5 and 2C2.
If positive-going correction pulses are applied to the integrator, 2C2 will become charged and this will result in a negative going voltage on the output, because the integrator will maintain 0 V on the minus input. For this reason the voltage across 2R6 is constant and so is the charging current to 2C2. In this way a linear charging of 2C2 is achieved and thus a linearily decreasing output voltage.

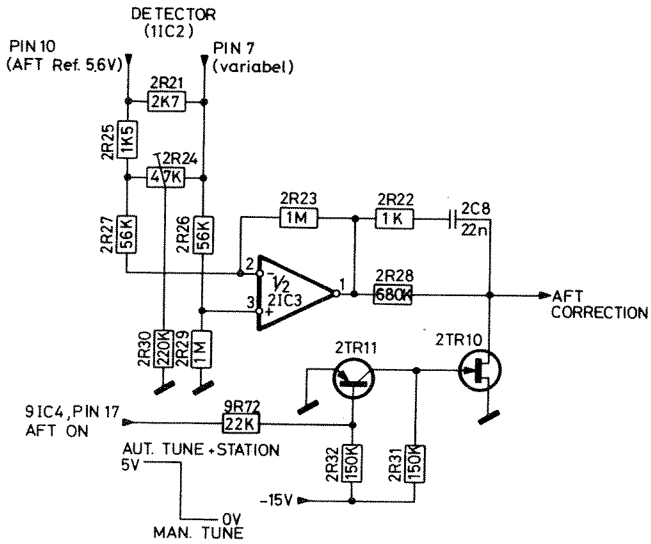
In the same way the negative-going correction pulses will cause a linearily increasing output voltage.
Due to the fact that the output voltage on the operational amplifier is insufficient for the tuning voltage, the output voltage from 2IC1 (B) will be applied to the emitter of 2TR1, which on account of the constant current will function as a variable resistor and be part of a voltage divider with 2R3. The tuning voltage is taken from the collector of 2TR1.
The diode 2D1 ensures that the tuning voltage will not exceed 22 V in case the constant-current generator should become faulty.
The diode 2D2 safeguards 2TR1 if – on account of a fault – a positive voltage should become present on pin 7 of 2IC1.
In order to obtain that one full rotation of the tuning wheel changes the received frequency by 1 MHz – across the entire FM band – it is not desirable to have the tuning voltage as a linear regulation, but as shown in the diagram.



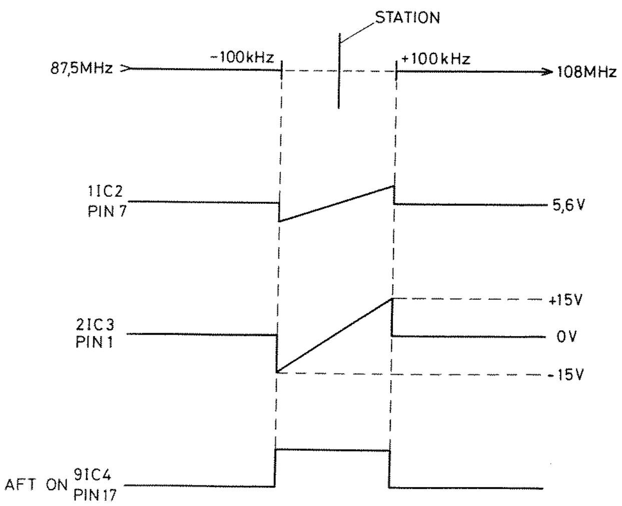
This is achieved by having the collector resistance of 2TR6/2TR7 connected to the top voltage which changes with the tuning voltage. When the dial voltage increases, the tuning voltage increases and thus the collector voltage of 2TR6/2TR7. Consequently the correction pulses will be higher and the tuning voltage will be regulated faster at higher dial frequency.
At a programme selection, pin 18 (FAST) of 9IC4 will go low, 2TR3 will go ON and 2TR2 will go ON. The correction pulses are now fed to the input of the integrator through 39 kohm (2R11) instead of 1.6 Mohm (2R7/2R8) when using the tuning wheel. The tuning voltage will therefore quickly be adjusted to the programme selected.

AFT
(Automatic Fine Tuning)

This circuit is different from an AFC regulation in that AFT ensures a fully correct tuning to the transmitter frequency, where AFC only reduces the mis-tuning, dependent on the accuracy of the manual dial setting.
The functioning of the AFT circuit could be compared with having a servo motor fitted on the tuning potentiometer of an ordinary diode-tuned tuner, and having this motor governed by the detector.
The AFt regulation can only be activated in the AUT. TUNE mode.



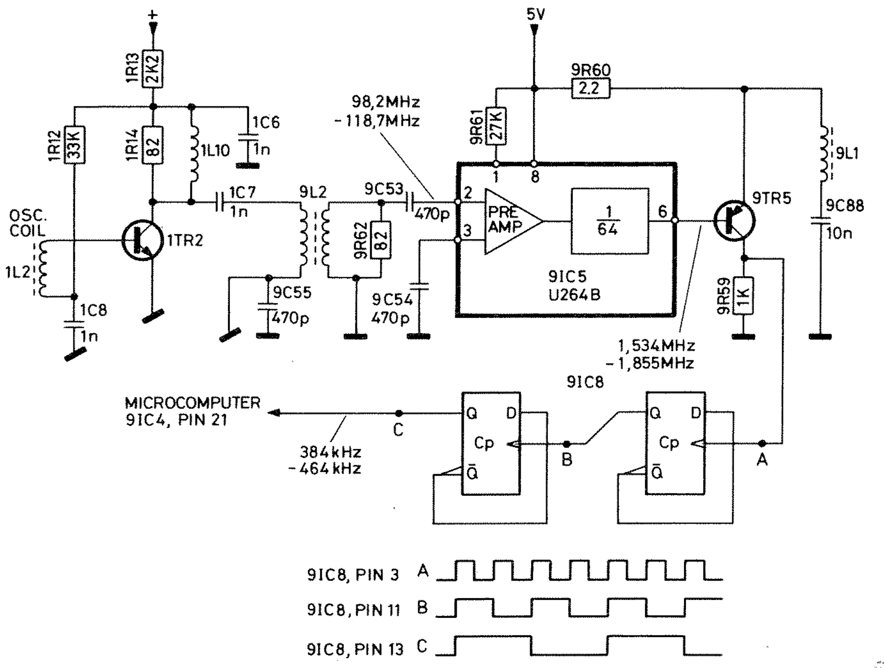
The correction voltage from the detector is applied to pin 3 of 2IC3 and the reference voltage (approx. 5.6 V) is applied to pin 2. The voltage on pin 3 of 2IC3 will vary either positively or negatively in relation to the voltage on pin 2, and consequently there will be a voltage between +15 V and -15 V on the output (pin 1), with 0 V at correct tuning to a station.
The AFT voltage is applied to the integrator when 2TR10 is OFF.



When tuning with the tuning wheel (AUT. TUNE activated) the volume will be regulated down in any off-station position (Silent Tuning). At tuning to a ±100 kHz station the microcomputer will activate the volume, light-up a P on the programme display (if the station is pre-programmed, the programme number will also be displayed), stop the correction pulses UP/DOWN and put pin 17 of 9IC4 high (AFT ON). This high pulse will make 2TR11/2TR10 go OFF, and the correction voltage of AFT will be applied to the integrator which will change the tuning voltage until the detector and thus the correction voltage of AFT is 0 V. You are now tuned correctly to the station (<±1 kHz).

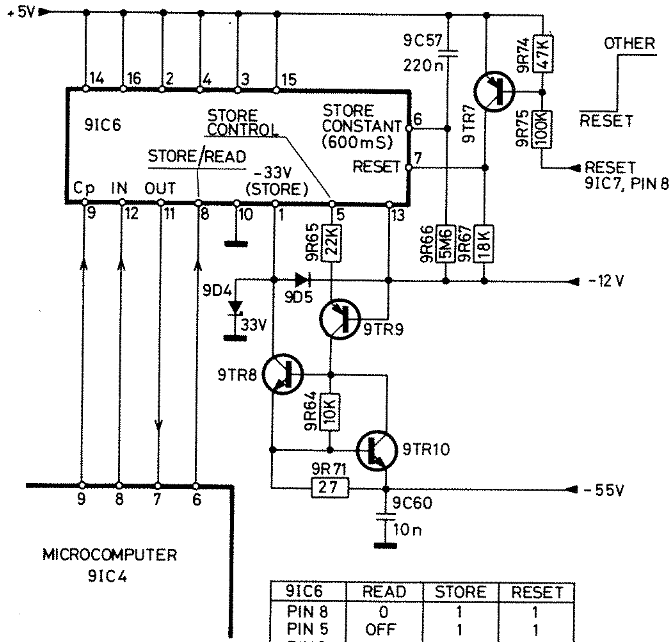
Any drift in the receiver will result in the detector immediately producing a positive or negative voltage with the effect that the AFT circuit and the integrator will correct the tuning voltage until the detector produces 0 V. This means that when tuning with the tuning wheel until a P lights up on the programme display, the AFT circuit will immediately provide a correct tuning. This makes a tuning meter unnecessary, and the usual AFC on/offs are avoided, to obtain a correct FM station tuning.
When the receiver is in AUTO TUNE mode and tuned to a station (±100 kHz), so that the AFT is ON, the microcomputer will function as a frequency counter. This way the received frequency will be applied directly to the display.

Frequency Counter



Input to the frequency counter is taken from a winding on the oscillator coil (1L2), amplified in 1TR2, and conveyed via 9L2 (this ensures galvanic separation between the tuner and the counter), to 9IC5. The signal is additionally amplified in 9IC5 and divided with 64. From 9IC5, the signal is amplified through 9TR5 and divided with 4 through the two front edge triggered Flip-Flop units in 9IC8. The frequencies between 384 kHz and 464 khz will now be fed to the counter circuit in the microcomputer. The division is necessary, as the microcomputer is incapable of counting frequencies over 500 kHz. 9C55 ensures that no RF or IF are transferred via chassis to the counter circuit (by very strong antenna signals). 9L1 and 9C88 form a noise filter which prevents noise from dividing circuits in causing inteference on +5 V supply voltages.

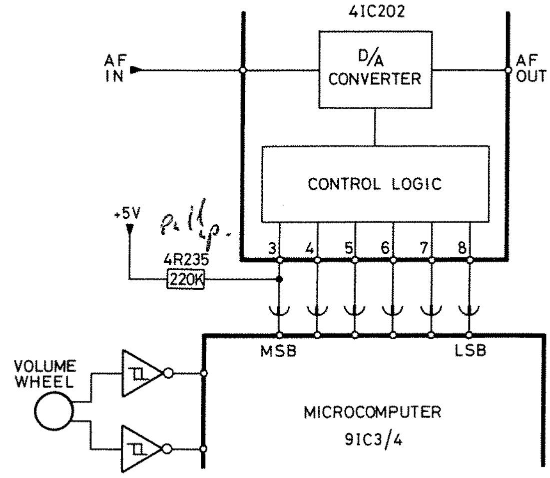
FM and Volume Memory



9IC6	READ	STORE	RESET
PIN 8	0	1	1
PIN 5	OFF	1	1
PIN 9	⎍⎍⎍	⎍⎍⎍	1
PIN 1	-12 V	- 33V	1
PIN 7	0	0	1
PIN 6	0	⎍	1

To store FM programmes and volume/balance levels from the start, a Non Volatile Memory (9IC6) is employed, which has the capability of storing the recorded information for a number of years, also without supply voltage, but may be altered at any time by electronic means.
When »STORING« in 9IC6, a high level is transmitted from the microcomputer to 9IC6, pin 8, and 29 clock pulses are dispatched from the microcomputer to 9IC6, pin 9, which is applied in order to control the data transfer from the microcomputer to 9IC6, pin 12. This transferring of data lasts approx. 1 msec, after which 9IC6, pin 6, is high for a short moment. This discharges 9C57, and until it is again recharged, programming will take place (approx. 600 msec).
Pin 5 will go high simultaneously with pin 6, which results in 9TR9 going ON and starts the current generator 9TR8/9TR10. -33 V will now be applied to 9IC6, pin 1, until 9C57 is charged and pin 5 therefore goes low again.
When »READING« in 9IC6, the microcomputer will put 9IC6, pin 8, low, and the 29 clock pulses will once more be sent out to 9IC6, pin 6, which is now employed for the controlling of data transfer from 9IC6, pin 11, to the microcomputer. During »Start Up«, or Mains drop out, a low pulse from the reset circuit is fed to 9TR7 basis. This causes 9TR7 to go ON, and a high pulse is applied to 9IC6, pin 7, which makes 9IC6 reset its auxillary circuits, but the memory remains intact.
After replacement of 9IC6 ought all of the 9 programmes be defined with an arbitrary frequency (e.g. 87.5 MHz), as there is a possibility of stored information which does not correspond to stations between 87.5-108 MHz. This will be seen on the apparatus as follows: When tuned to a station »P« will appear in programme display in the normal way, but will switch off after a short while, even though the receiver is still tuned in on that particular station.

Digital Control of Volume Regulation



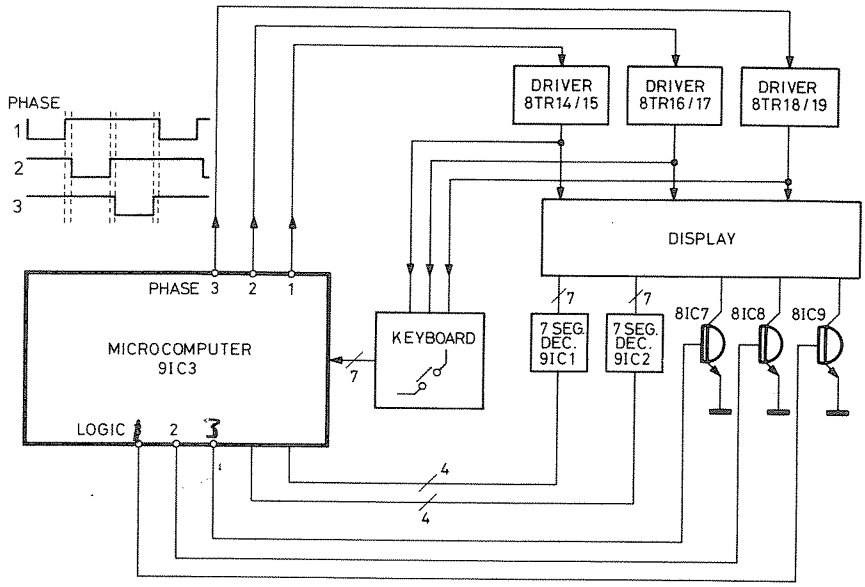
The volume is controlled by means of the volume wheel which as far as the functioning goes is identical to the tuning wheel (see section on tuning system). The microcomputer will convert the pulses from the volume wheel into a digital counting sequence which is then fed to the CONTROL LOGIC circuits of the IC (4IC202). In the latter the counting sequence is converted into a logarithmic sequence so that the volume regulation is effected in steps of 1.5 dB. The resistor 4R235 ensures that the volume will be lowered 48 dB if the plug with the control leads is removed.

MSB					LSB	
0	0	0	0	0	0	= 6.0
0	0	0	0	0	1	= 5.9
0	0	0	0	1	0	= 5.8
0	0	0	0	1	1	= 5.7
0	0	0	1	0	0	= 5.6
⋮					⋮	⋮
1	1	1	0	0	0	= 0.4
1	1	1	0	0	1	= 0.3
1	1	1	0	1	0	= 0.2
1	1	1	0	1	1	= 0.1
1	1	1	1	0	0	= 0.0
1	1	1	1	0	1	= 0.0
1	1	1	1	1	0	= 0.0
1	1	1	1	1	1	= 0.0

Due to the fact that 6 control leads are used there are 64 steps available for the regulation, but only 60 of these are employed. Thus each step corresponds to 0.1 on the display.
The volume circuit is also utilized for Muting and Silent Tuning. These regulations are made in small jumps with the effect of a sort of fast Fade-in/Fade-out function, which is very pleasant to the ear. The balance regulation is also performed by means of the volume circuits, and the up and down channel regulations are made as shown in below diagram.

<		>		
L	R	L	R	
	-1.5dB	-1.5dB		1
+1.5dB	-1.5dB	-1.5dB	+1.5dB	2
+1.5dB	-3dB	-3dB	+1.5dB	3
+3dB	-3dB	-3dB	+3dB	4
+3dB	-4.5dB	-4.5dB	+3dB	5
+4.5dB	-4.5dB	-4.5dB	+4.5dB	6
+4.5dB	-90dB	-90dB	+4.5dB	

Keyboard and Display



Keyboard must be "ducked" or will get no button action.

Control of keyboard and display is achieved via three pins from the microcomputer, upon which an alternating low level (PHASE 1-2-3) is constantly transmitted whilst the apparatus is connected to the mains.
Pulses from the microcomputer feed 3 driver circuits, which will alternately go ON and deliver +5 V (high) to the display digits, which anodes are commonly connected in 3 groups, enabling the groups, one by one, to receive anode voltage (Multiplexing).
Simultaneously with being applied to the display, the high pulses are used for polling the keyboard, e.g. the keyboard is scanned with an alternating high pulse (Strobe). The duration of a pulse is approx. 1.6 msec, and it takes approx. 5 msec to scan the complete keyboard. If a button is activated, a high pulse will be applied to the microcomputer on one of the 7 leads from the keyboard, and as the microcomputer knows which code is transmitted to the multiplexer, it also knows which lead (Strobe) to the keyboard is high. The microcomputer in this way locates which button is activated.
As previously stated, the anode groups will alternately be supplied with +5 V. The microcomputer will, simultaneously with a group receiving a supply voltage, transmit codes to the two 7-segment decoders (9IC1/9IC2), each of which will turn on a digit, by setting those segments to be turned on, to 0. The microcomputer will, at the same time, transmit codes to the 3 logic drivers controlling those segments not included with the 7-segment units, which must by able to write all the numerals.
It can be seen from the table below which code is transmitted from the microcomputer, to enable the 7-segment unit to write a given numeral.

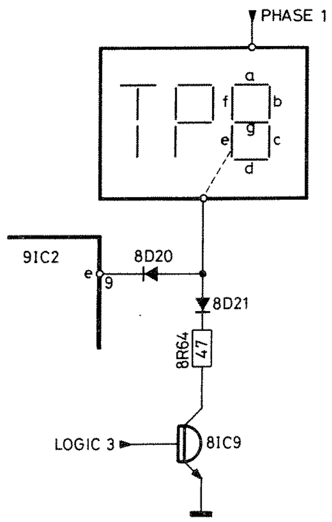
FUNCTION TABLE 9IC1-2 (SN74247)

DECIMAL ON DISPLAY	INPUTS D	C	B	A	OUTPUTS a	b	c	d	e	f	g
0	0	0	0	0	0	0	0	0	0	0	1
1	0	0	0	1	1	0	0	1	1	1	1
2	0	0	1	0	0	0	1	0	0	1	0
3	0	0	1	1	0	0	0	0	1	1	0
4	0	1	0	0	1	0	0	1	1	0	0
5	0	1	0	1	0	1	0	0	1	0	0
6	0	1	1	0	0	1	0	0	0	0	0
7	0	1	1	1	0	0	0	1	1	1	1
8	1	0	0	0	0	0	0	0	0	0	0
9	1	0	0	1	0	0	0	0	1	0	0
OFF	1	1	1	1	1	1	1	1	1	1	1

The table shows which digits/segments are supplied, from which phase, and which 7-segment decoder/logic driver activates the unit.

FUNCTION TABLE DISPLAY									
	9IC3				9IC3				
PIN	15	16	17		18	19	20		
	PHASE 3	PHASE 2	PHASE 1		LOGIC 3	LOGIC 2	LOGIC 1	9IC1	9IC2
			0	9DP3 H			1		
			0	9DP3 P		1			
			0	9DP3 T	1				
		0		FM 10MHz 8			1		
		0		FM 10MHz 8		1			
		0		FM 10MHz 8	1				
		0		9DP4, decimal point	1				
	0			9DP1 <			1		
	0			9DP1 >		1			
	0			FM 100MHz 1	1				
			0	VOL. LS 0.1 8				*	
		0		VOL. MS 1.0 8				*	
	0			BALANCE 8				*	
			0	PGR. No. 8					*
		0		FM 0.1MHz 8					*
	0			FM 1.0 MHz 8					*
* SEE FUNCTION TABLE FOR 9IC1-2									

The programme number digit is normally driven by PHASE 1, together with the 7-segment decoder 9IC2, but when in the PHONO position an H has to be written, which the 7-segment unit is unable to do. Therefore, a 4 is written by means of 9IC2, and e-segment is turned on by LOGIC 3 (8IC9) via 8D21. 8D20 prevents the low level from 8IC9 on entering pin 9 of 9IC2.

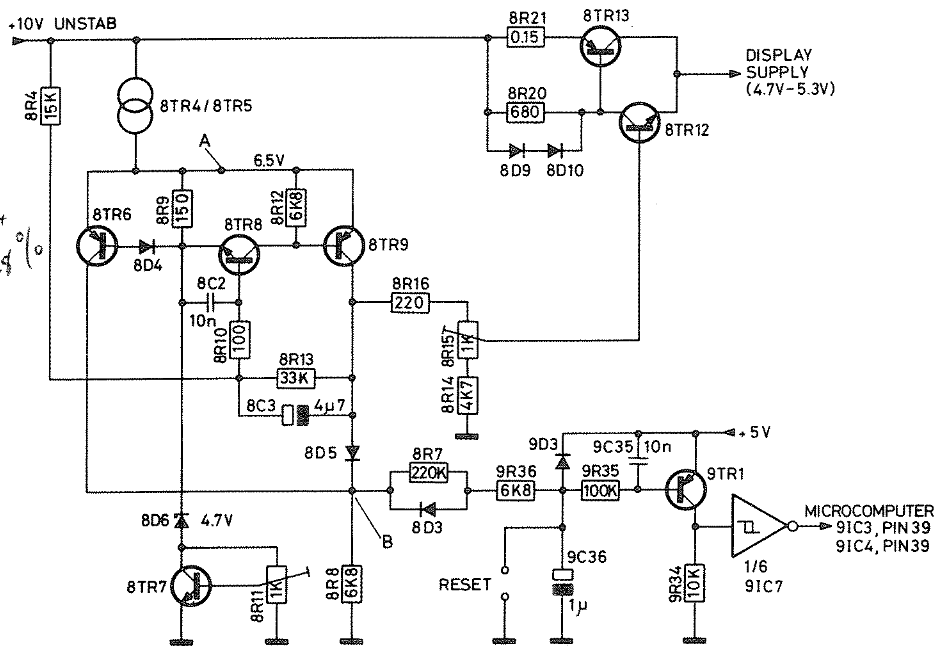


By shorting the points marked TEST DIGIT in the diagram, the six 7-segment units controlled from the 7-segment decoders, will light all segments.

Reset

With brief mains voltage dropouts, where +5 V supply voltage has fallen, the microcomputer will switch itself to a random mode. This will possibily be a »locked« position, from which it cannot be moved until the apparatus has been disconnected from the mains.

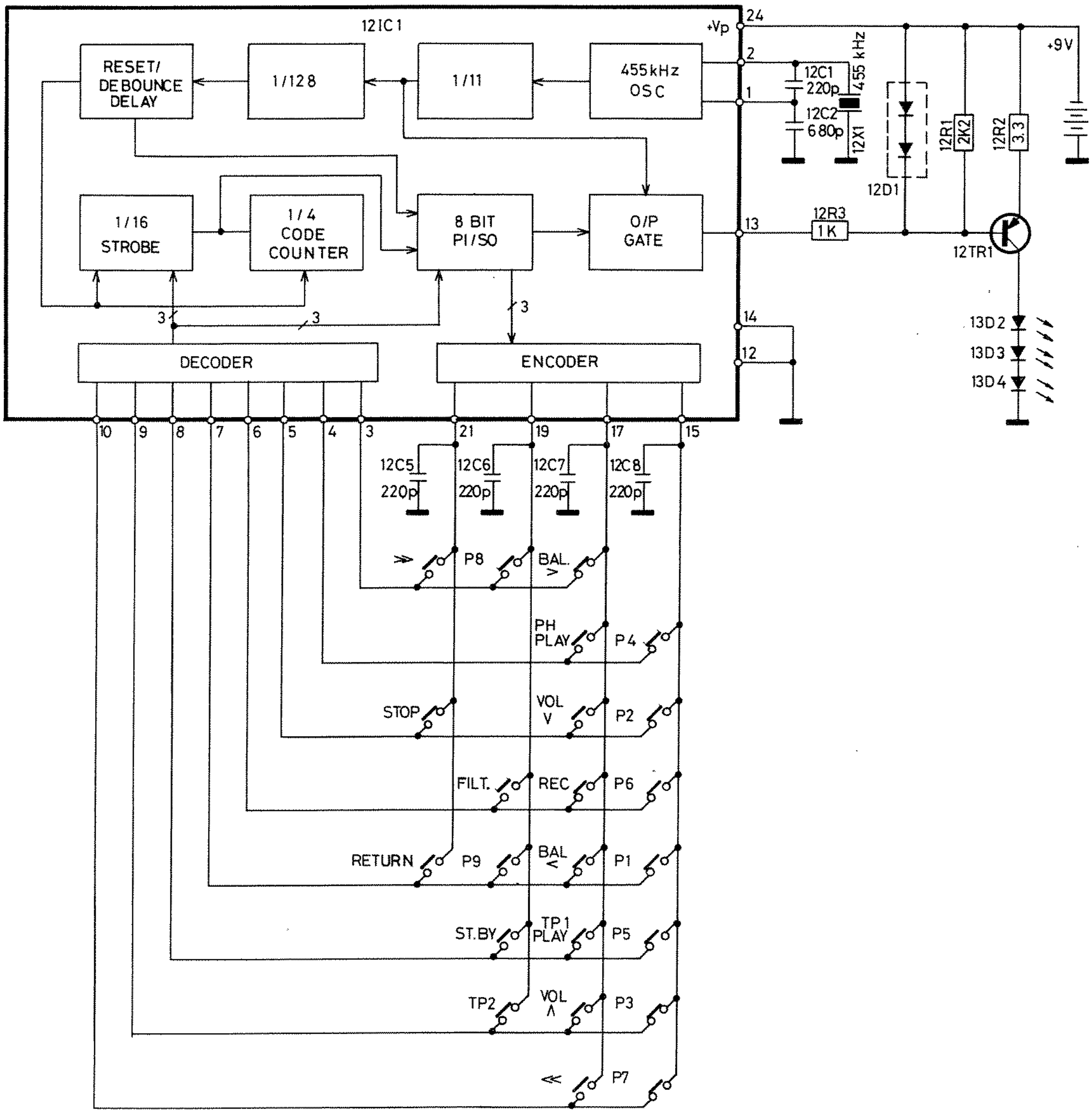
If 18% mains drop = display off. & computer re-set + to stand-by at 28%



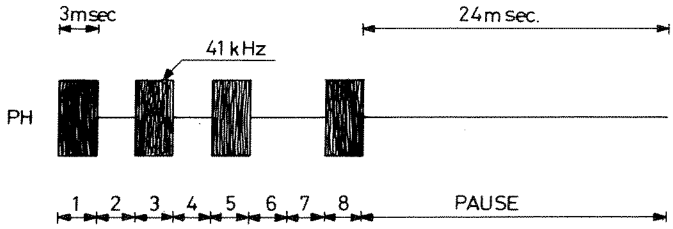
In order to prevent this, the circuit, as shown above, has been designed. During normal operation, the voltage at point A is 6.5 V (to be adjusted within ±100 mV with 8R11). 8TR8 and 8TR9 will be ON and point B will be high. With a mains dropout, the supply voltage +10 V UNSTAB will drop, and the voltage at point A will go below 6.5 V. 8TR9 will hereby draw less current and 8TR8 will subsequently draw less current, and 8TR9 will go OFF. The voltage to the base of 8TR12 will be cut off, and the display switched off.
This means a lessening of the load on the +10 V UNSTAB (which is also used for +5 V), and the voltage will therefore rise. The voltage at point A will rise to over 6.5 V, 8TR6 goes ON, and point B will continue to be high.
8D5 ensures that the high level at point B is not transferred to the base of 8TR12, thus avoiding switching the display on again. The display switches off and 8TR6 goes ON when the mains voltage drops approx. 18%, and if the mains voltage drops right down to 25-27% under nominal mains voltage, will 8TR6 go OFF, and the voltage at point B be low.
This low level is transferred via 8D3 to the base of 9TR1, which goes ON and feeds a high level to the inverting Schmitt Trigger. The two microcomputers (9IC3/9IC4) are fed with a low level and become reset.
When the apparatus is connected to the mains, the time constant 8R7/9C36 ensures that the base of 9TR1 is kept low, ensuring a reset during the entire starting up process. The time constant 8R13/8C3 prevents the display »flickering« when the apparatus is connected to the mains, and that the display remains switched off for approx. 1 second in the event of mains drop out. (Due to the rising voltage as a result of the display switch off, 8TR8/8TR9 could go ON).
With the rising mains voltage the display will switch on at approx. minus 13% mains voltage. 9D3 makes sure that the microcomputers are reset, if +5 V is briefly shorted to chassis.
When +5 V goes to 0 V as a result of short circuiting, 9C36 is discharged through 9D3. When +5 V reoccurs, the voltage across 9C36 will momentarily be 0V, while 9C36 charges. This, very briefly, holds 9TR1 ON, and reset is hereby achieved. Manual reset of the microcomputer can be carried out by briefly short circuiting the two points marked »Reset« on the diagram.

Remote Control Transmitter (Beolab Terminal)

Remote control is accomplished by employing infrared light modulated with 41 kHz. The infrared light has a wavelength of 950 nm, which corresponds to a frequency of approx. 316000 Giga Hz. Frequency-wise, it lies just below the visible light.



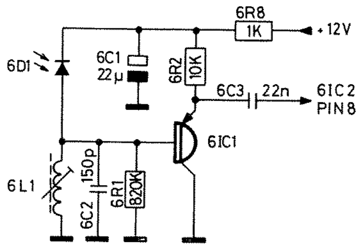
12IC1 performs internally all the transmitter functions. The only external circuit is a 455 kHz crystal (12X1) to the reference oscillator and a constant-current generator 12TR1, 12D1, 12R7 and 12R2, which ensures a constant current of 200 mA through the infrared light diodes (13D2, 13D3 and 13D4), when transmitting. The constant current ensures an unaltered range by battery charges down to 5-6 volts.



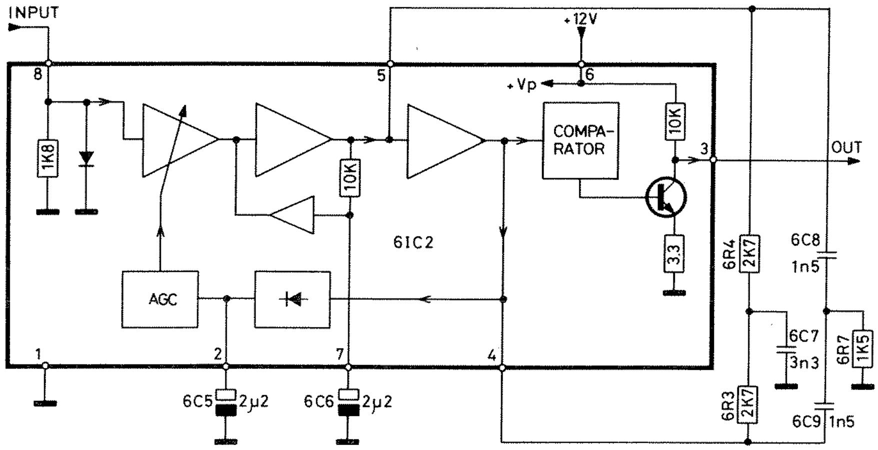
Each time a button is activated, 12IC1 will produce a pulse train which consists of 8 bits, each of which has a duration of 3 msec, followed by a pause of 24 msec. The first and last hit will always be high (start and finish bit), whereas the others can assume both positions, all according to which function has been selected.

The transmitter only delivers infrared light each time a high bit is transmitted, and accordingly there will only be current consumed each time a high bit is transmitted. The transmitter will transmit a code just as long as the button is activated. If the button is activated only briefly, then 12IC1 will ensure that a minimum of 4 pulse trains are transmitted.

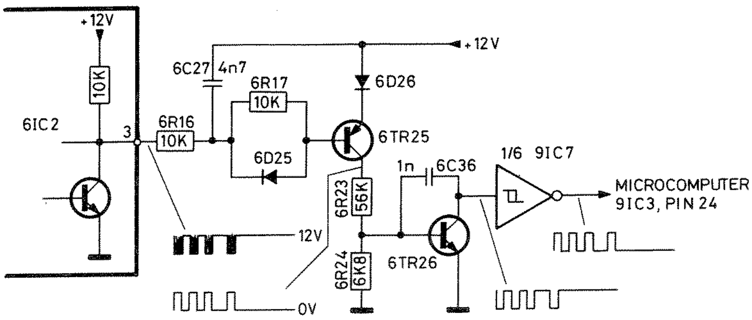
Remote Control Receiver



The infrared light waves from the Beolab Terminal are received by a light sensitive diode 6D1, which possesses the property that its leakage current increases when exposed to infrared light.
Because the infrared light waves are modulated with 41 kHz from the Beolab Terminal, the leakage current in 6D1 will vary by 41 kHz, and a pulse train will be formed across the circuit 6L1/6C2, which is tuned to 41 kHz, and is similar to that transmitted from the Beolab Terminal.
6R1's function is to stabilise the Q of 6L1, in order to achieve the proper relation between bandwidth and sensitivity. The emitter follower 6IC1 provides an impedance match between the input circuit and 6IC2. Because it must have sufficiently high impedance to have no influence on the Q of 6L1, a Darlington transistor is used.



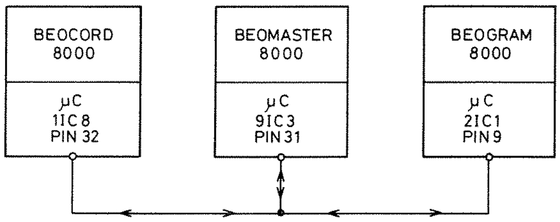
From the input stage, the signal is fed into 6IC2, where it passes through an amplifier, which internally is AGC controlled, and continues through an amplifier with internal feedback.
The third amplifier stage, through which the signal is routed, has external feedback using a double T filter, 6R3, 6R4, 6C7 and 6C8, 6C9, 6R7. This filter has the quality that a relatively weak signal is fed back to pin 5 at 41 kHz, thereby resulting in maximum gain at 41 kHz, and noise being reduced.
Ths signal is now fed via a comparator and a transistor, to pin 3, which will be 12 V when not receiving, and swing between 0-12 V when receiving a modulated signal (41 kHz), from the Beolab Terminal.



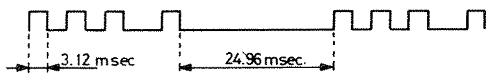
When 6IC2, pin 3, goes low (transistor in 6IC2 = ON) 6C27 will become charged via 6R16 however, charging will be limited to approx. 1.8 V, due to 6D25, 6TR25 and 6D26. 6TR25 will go ON, and when pin 3 again reaches +12 V discharging of 6C27 will occurr via 6R16 and the 10 kohm in 6IC2. This discharging will therefore occurr relatively slower then charging, and 6TR25 will thus be kept ON, as long as there is modulation with 41 kHz. 6D26 is applied as a noise preventative, as there is now a demand of 1.2 V below supply voltage for biasing 6TR25.
A bit pattern is formed on the collector of 6TR25, which corresponds to that as sent from the Beolab Terminal. This bit pattern is fed through 6TR26 where it is phase inverted, and conveyed to an inverting Schmitt Trigger (1/6 9IC7), which operates as a pulse shaper.
The same bit pattern, which was originally sent out from the Beolab Terminal, is now fed to the microcomputer. The microcomputer will now carry out the function which corresponds to the button which is activated on the Beolab Terminal.

Beolab Remote Control

The complete Beolab 8000 system can be operated as one unit, as the microcomputers of Beocord 8000, Beogram 8000 and Beomaster 8000 respectively, are connected together with an extra lead in the connecting cable (Datalink).



On this Datalink, information can be transmitted from Beomaster to Beocord/Beogram, and from Beocord to Beomaster or Beogram to Beomaster. The information consists of an 8 bit code, built up in the same way as the codes from the Beolab Terminal, to the microcomputer in the Beomaster 8000. Only two pulse trains are transmitted each time a function is to be carried out, and as the length of a pulse train is approx. 25 msec, it is difficult to check the bit pattern in a pulse train, unles a storage oscilliscope is available.



The bit pattern for the different functions are shown in the table below.

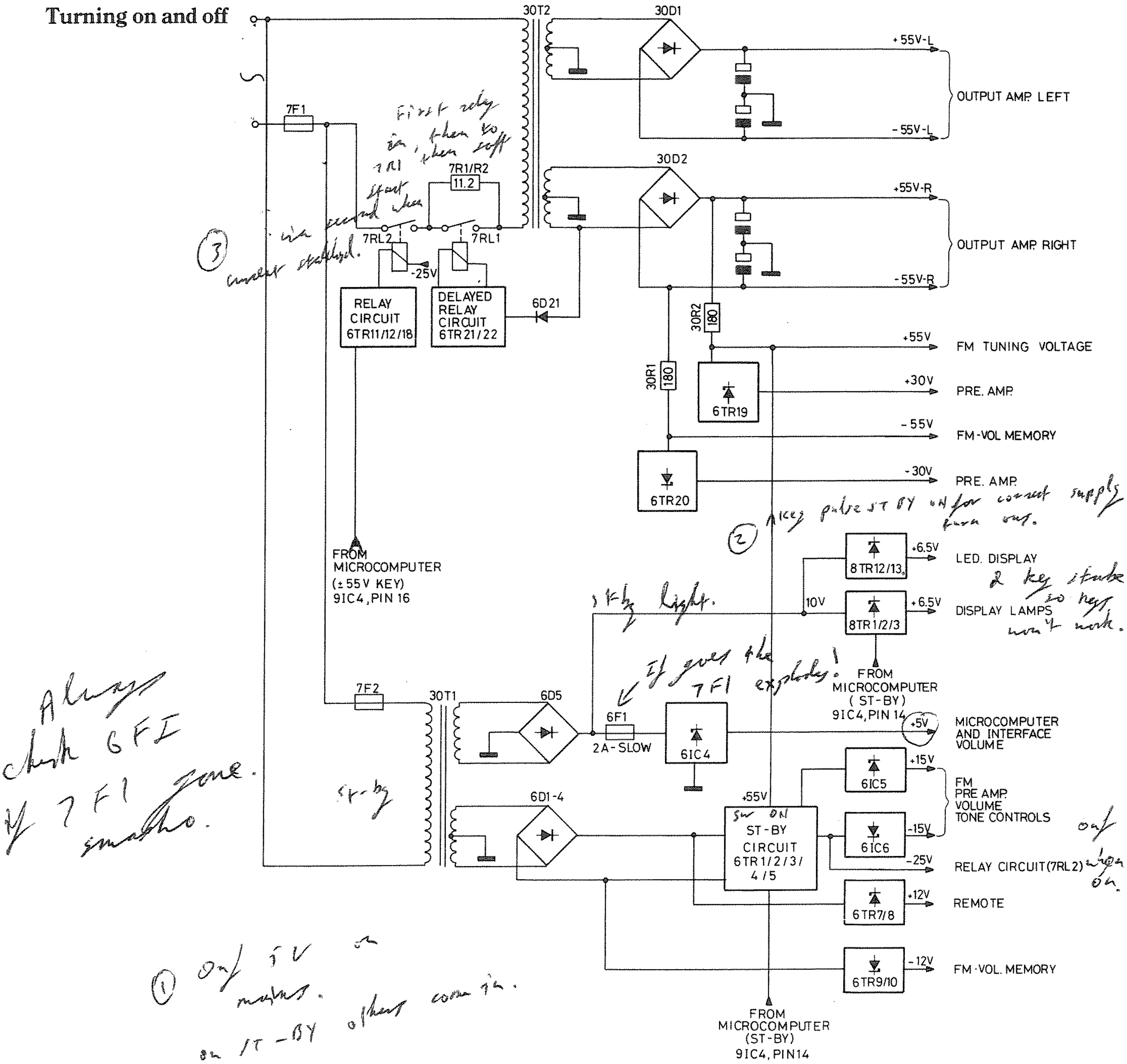
BEOLAB DATALINK FUNCTION TABLE 1																
TERMINAL-BEOMASTER FUNCTION	CODE TO BEOCORD START								CODE TO BEOGRAM START							
PH / play									1	0	1	0	1	0	0	1
TP1 / play	1	0	1	0	1	0	1	1								
REC	1	0	1	0	1	1	0	1								
<<	1	0	1	0	1	1	1	1								
>>	1	0	1	1	0	0	0	1								
RETURN	1	0	1	1	0	0	1	1								
STOP	1	0	1	1	0	1	0	1								
SYSTEM OFF (ST-BY)	1	1	0	0	1	0	1	1	1	1	0	0	1	0	1	1
TP1 END	1	1	0	0	0	1	1	1								
PH END									1	1	0	0	1	0	0	1

BEOLAB DATALINK FUNCTION TABLE 2								
BEOCORD FUNCTION	CODE TO BEOMASTER START							
TAPE ON	1	0	1	1	0	1	1	1
REC. START	1	0	1	1	1	0	0	1
REC. STOP	1	0	1	1	1	0	1	1
TIMER START	1	0	1	1	1	1	0	1
TIMER STOP	1	0	1	1	1	1	1	1
TAPE OFF	1	1	0	0	0	0	0	1

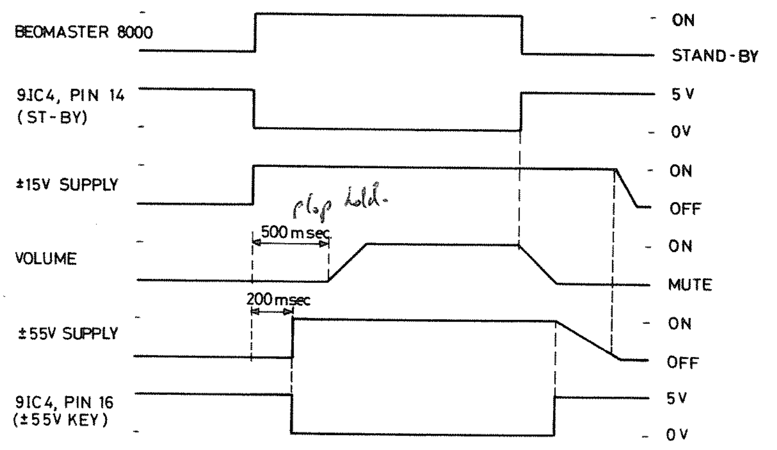
BEOLAB DATALINK FUNCTION TABLE 3								
BEOGRAM FUNCTION	CODE TO BEOMASTER START							
PHONO ON	1	1	0	0	0	0	1	1
PHONO OFF	1	1	0	0	0	1	0	1
PHONO START (MEMORY)	1	1	0	1	0	1	0	1

240 V

POWER SUPPLY
Turning on and off

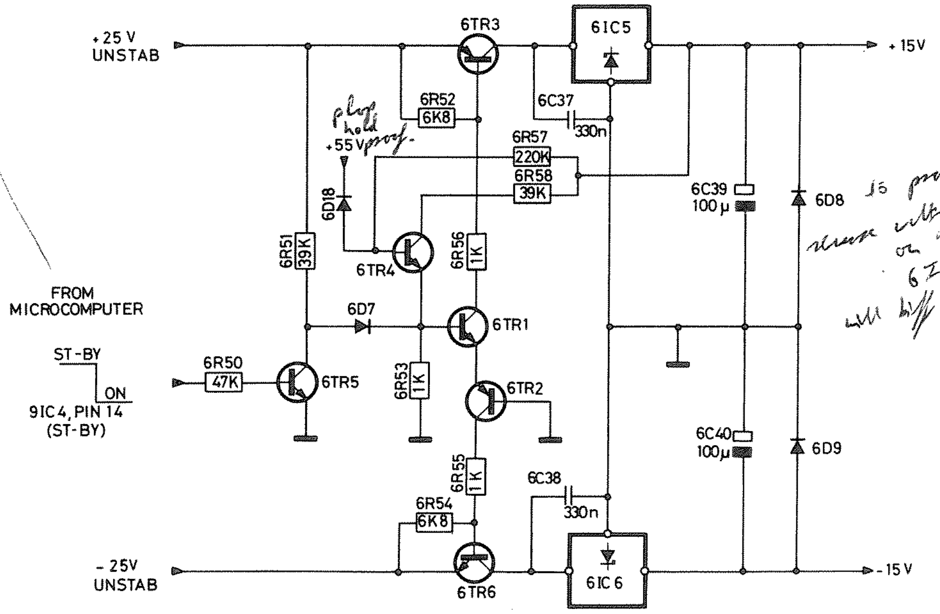


The turning on and off of the power supply is performed in microcomputer controlled stages.
When the receiver is turned on, pin 14 (ST-BY) of 9IC4 will go low, and this will activate the ±15 V power supply and the power supply for the display lamps (8IL1-4). Immediately after, pin 16 (±55 V KEY) of 9IC4 will go low. This low level is applied to the relay circuit (6TR11, 6TR12 and 6TR18) and will activate 7RL2. A current which is limited by 7R1/R2 will now be fed to the large mains transformer 30T2, and a voltage will be present on the secondary side. This voltage is rectified in 6D21 and applied to the delayed relay circuit, which activates 7RL1 after which there will be full supply voltage on the output amplifier. By this »soft« start-up the strong starting current which 30T2 would otherwise draw, is avoided.
Finally the microcomputer will open the volume control. This takes place approx. 1/2 second after the activation of the receiver, and then the set will be functioning normally.



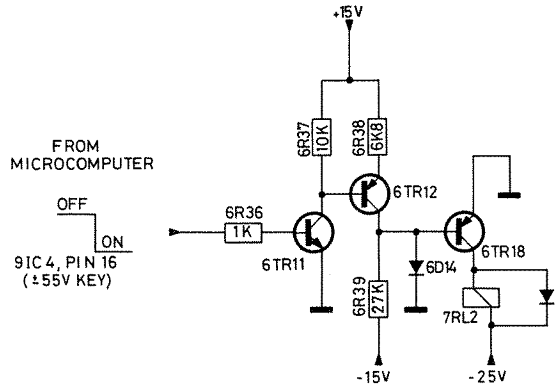
The above diagram shown the turning on and off sequences.
By activation of STAND-BY, pin 14 (ST-BY) of 9IC4 will go high, the display will go off and the microcomputer will start regulating down on the volume control (MUTE).
When the volume has been regulated all the way down, pin 16 ±55 V KEY) of 9IC4 will go high and the AC voltage to the ±55 V power supply will become interrupted. Due to the large-capacity condensers it will take a moment until the voltage is fallen completely. In order to avoid a blob by ±15 V falling while there is still a voltage on the output amplifier, ±15 V has been keyed to ±55 V (Right) during the turning off operation.
This is why the ±15 V will only be switched off when ±55 V has fallen to below approx. 1 V.

ST-BY Circuit

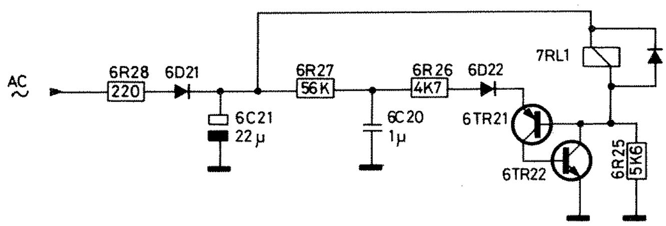


At start-up of the receiver from ST-BY, pin 14 of 9IC4 will go low and 6TR5 will go OFF. Now 6TR1 becomes biased via 6R51/6D7 from the unstabilized voltage (+25 V UNSTAB) which is always present when the receiver is connected to the mains. 6TR1/6TR2 go ON and connect the base of 6TR3/6TR6 to the chassis so that also these go ON. 6IC5/6IC6 are now being supplied with current and ±15 V is ON.
When the receiver is set in ST-BY, pin 14 of 9IC4 will go high, and 6TR5 goes ON, but due to 6D7 the low level, which is now present on the collector of 6TR5 cannot be conducted to 6TR1. 6TR4 is biased from +15 V and supplies the base current to 6TR1. Thus the circuit will keep itself ON until the +55 V voltage has dropped so much that the base of 6TR4 is grounded to 0 V via 6D18 and the +55 V supply.
6TR4 goes OFF, 6TR1/6TR2/6TR3/6TR6 go OFF and ±15 V is disconnected.

Relay Circuit



When pin 16 of 9IC4 goes low, 6TR11/6TR12 will go OFF, 6TR18 will become base biased from -15 V via 6R39, and 7RL2 will be drawn.
6D14 safeguards 6TR18 against excessive reverse voltage.



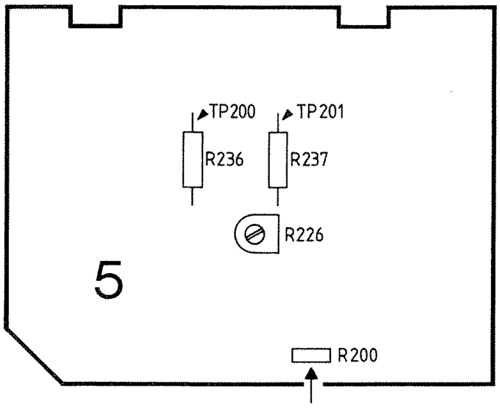
Delayed Relay Circuit

The AC voltage is rectified by 6D21 and smoothed by 6C21. The DC voltage is now conducted through a delay circuit, 6R27/6C20, and via 6R26/6D22 forward biasing 6TR21. 6TR21 will start drawing current, forward biasing 6TR22. 6TR21/6TR22 will now go fully ON, and 7RL1 will be drawn.
6D22 safeguards 6TR21 against reverse current during the charging of 6C20.

Adjustments

Component specifications without paranthesis specifies the right channel.
Component specifications with paranthesis specifies the left channel.

No-signal Current

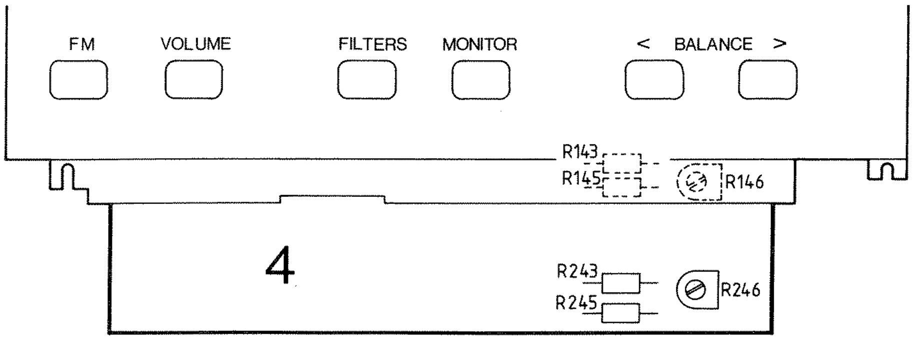


No-signal current is adjusted while the receiver is cold and with the volume control turned down.
Speakers must not be connected.
Connect DC millivoltmeter across the two emitter resistors 5R236/5R237 (TP200 and TP201).
With 5R226 adjust to 18 mV.
The adjustment may also be carried out by inserting an mA meter in series with the collector of 5IC203 and adjust 5R226 to 50 mA.

Offset output amplifier

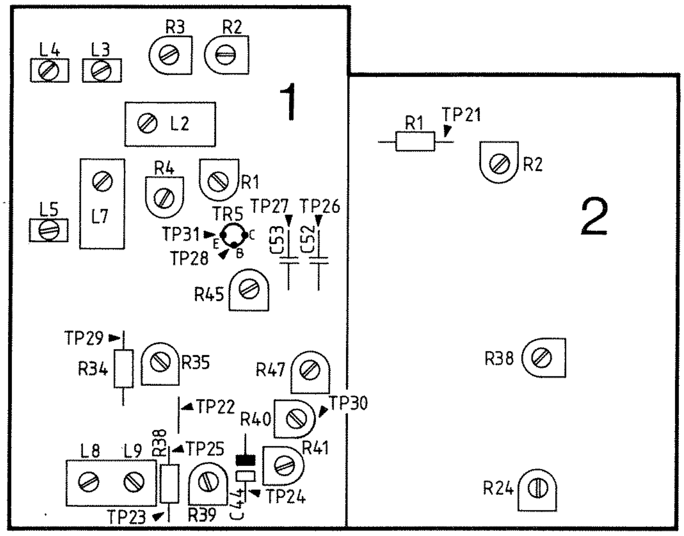
Adjustment is carried out with the volume control turned down and after the apparatus has been switched on at least half a minute.
5R200 is adjusted to 0V (±5 mV) on the speaker output.

Offset volume control



Switch on the apparatus and turn the volume control to 0.0. Connect the oscilloscope to the right (left) speaker output and set in DC position. Switch off X deflection on the oscilloscope. (Ext. X position). Set sensitivity at 5 mV/cm. (If the trimmer potentiometer is out of balance it will be necessary to use a lower sensitivity at the start of the adjustment).
Regulate the volume control forward and backwards between 0.0. and 0.1. The oscilloscope will show some DC springs, and if they are sufficiently strong, it will be possible to hear them as crackling in the speakers.
With 4R246 (4R146) the DC spring on the oscilloscope can be minimized (<3 mV).
If the potentiometers adjusting area is too small, this may be extended by cutting off resistor 4R243 (4R143) or 4R245 (4R145).
Should the potentiometer be turned more to the right than is possible, cut off 4R245 (4R145).
Should the potentiometer be turned more to the left than is possible, cut off 4R243 (4R143).
With regard to possible later adjustment, the resistor should not be removed, but cut in one of the ends and positioned in such a way that there is no risk of contact with the other components.

Tuning voltage



Connect DC voltmeter to 2TP21. With 2R2 adjust to 3,0 V.

Tuner

Set FM receiver to 87,5 MHz (Manual Tune).
Connect sweep generator to aerial input and set to 87,5 MHz.
Connect oscilloscope to 1TP22 via an RC probe.
Adjust 1L2, 1L3, 1L4, 1L5 and 1L7 for maximum and symmetrical IF curve.
(It may be necessary to repeat the procedure).
Set the FM receiver and the sweep generator to 108 MHz.
Adjust 1R1, 1R2, 1R3, and 1R4 to maximum and symmetrical IF curve.

Detector

1. Connect RF generator and distortion meter to the apparatus. Set test generator to 1 mV EMF Δ±75 kHz. Adjust 1L8 to minimum distortion and adjust 1L9 to 0V DC between 1TP23 and 1TP25. Repeat both adjustments until both are in order.

2. Should there not be a distortion meter accessible for the purpose of adjusting, then adjusting can be carried out on the S-curve. However, there will be some uncertainty as to whether the apparatus will comply with its distortion data:
   Set FM receiver to, for example, 94 MHz.
   Connect sweep generator to the aerial input, and set to the same frequency as the receiver.
   Connect oscilloscope to 1TP24.
   Adjust 1L8 and 1L9 to maximum and symmetrical S-curve.
   Adjust 1L9 to 0 V DC between 1TP23 and 1TP25.

FM-AF output

Connect RF generator to the aerial input, and set to, for example, 94 MHz and to send 1 mV EMF, Δ±75 kHz.
Set the receiver to the same frequency as the RF generator and adjust 1R39 to 0,7 V AC in 1TP26 or 1TP27.

AGC

Connect RF generator to the aerial input, set to, for example, 94 MHz, and to 1 mV EMF, Δ±75 kHz. Set the receiver to the same frequency as the RF generator and adjust 1R35 to 3,5 V (±0.2 V), measured in 1TP29.

Signal strength meter

Connect RF generator to the aerial input and set to, for example, 94 MHz, and to send 1 mV EMF, Δ±75 kHz.
Set the receiver to the same frequency as the RF generator and adjust 1R40 to 2 V DC, measured in 1TP30.

Opening of stereo decoder

Connect RF generator to the aerial input, set to, for example, 94 MHz, and to 25 µV EMF, Δ±75 kHz. Set the receiver to the same frequency as the RF generator, and adjust 1R41 to 0,6 V DC, measured in 1TP28.
Channel separation will then be 10 dB (±2 dB).

Stereo decoder

Set the receiver to a mono station.
Mount a 220 k ohm resistor from the base of 1TR5 to +15 V.
Connect frequency counter to 1TP31.
Adjust 1R45 to 19 kHz ±50 Hz.
(1R45 may also be adjusted by connecting 19 kHz from 1TP31 to the y-input on an oscilloscope, and 19 kHz from a stereo coder to the oscilloscopes x-input.
When the lissajoux figure is at rest, the adjustment is correct.
A third adjustment possibility is to set the receiver to a stereo signal. Turn 1R45 one way until the stereo effect ceases, then to the other side until the stereo effect ceases.
Setting, in the middle between these two positions, is approximately the correct adjustment.) Remove 220 k ohm resistor again.
Connect stereo coder to the aerial input.
Connect watt meter or the AC volt meter to the AF output. Adjust 1R47 for minimum signal in the unmodulated channel.

AFT

Before this adjustment can be carried out, IF and detector adjustments have to be absolutely exact.
Connect RF generator to the aerial input, and set to, for example, 94 MHz, and to 1 mV EMF, Δ±75 kHz. Set the receiver to the same frequency as the RF generator and set to AUT. TUNE position.
Connect oscilloscope to 1TP22.
Adjust 2R24 for minimum 2. harmonic of signal as shown in the diagram below.

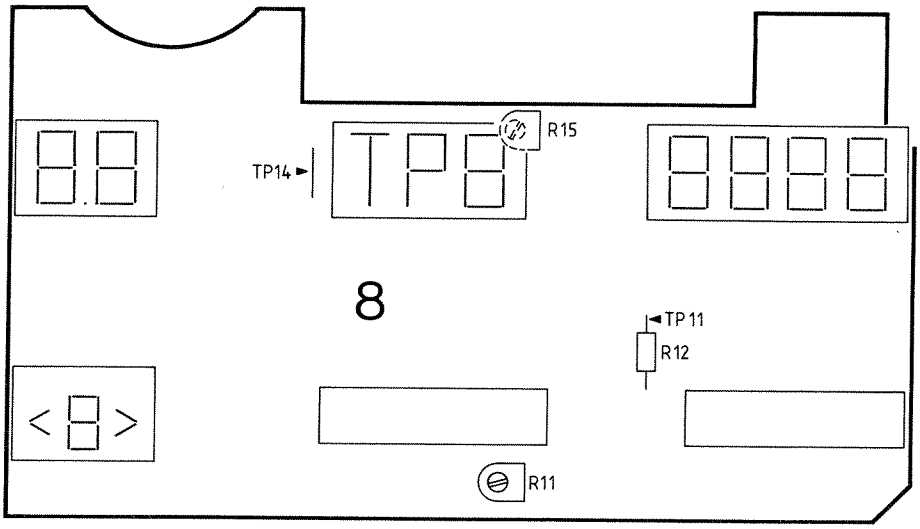
Correct

Wrong

FM signal condition

Connect RF generator to the aerial input, and set to, for example, 94 MHz, and to 10 µV EMF, Δ±75 kHz.
Set receiver to the same frequency as the RF generator, and set to AUT. TUNE position.
Adjust 2R38 in such a way that the receiver just opens for the signal. 2R38 is accessible from the bottom of the apparatus, and may therefore easily be readjusted should the local conditions, or customer, so desire.

Reset circuit

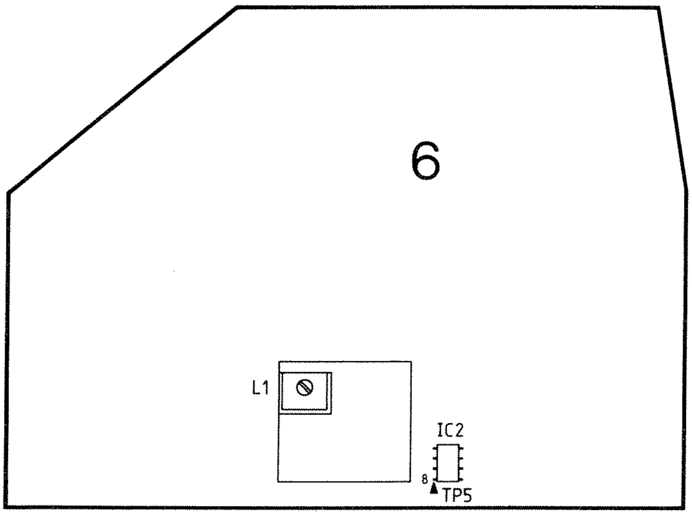


Start the apparatus in an arbitrary programme.
Adjust 8R11 to 6,5 V DC (±100 mV) measured in 8TP11.

Display light

Start the apparatus in an arbitrary programme.
Adjust 8R15 to 5 V DC, measured in 8TP14.

Remote control receiver

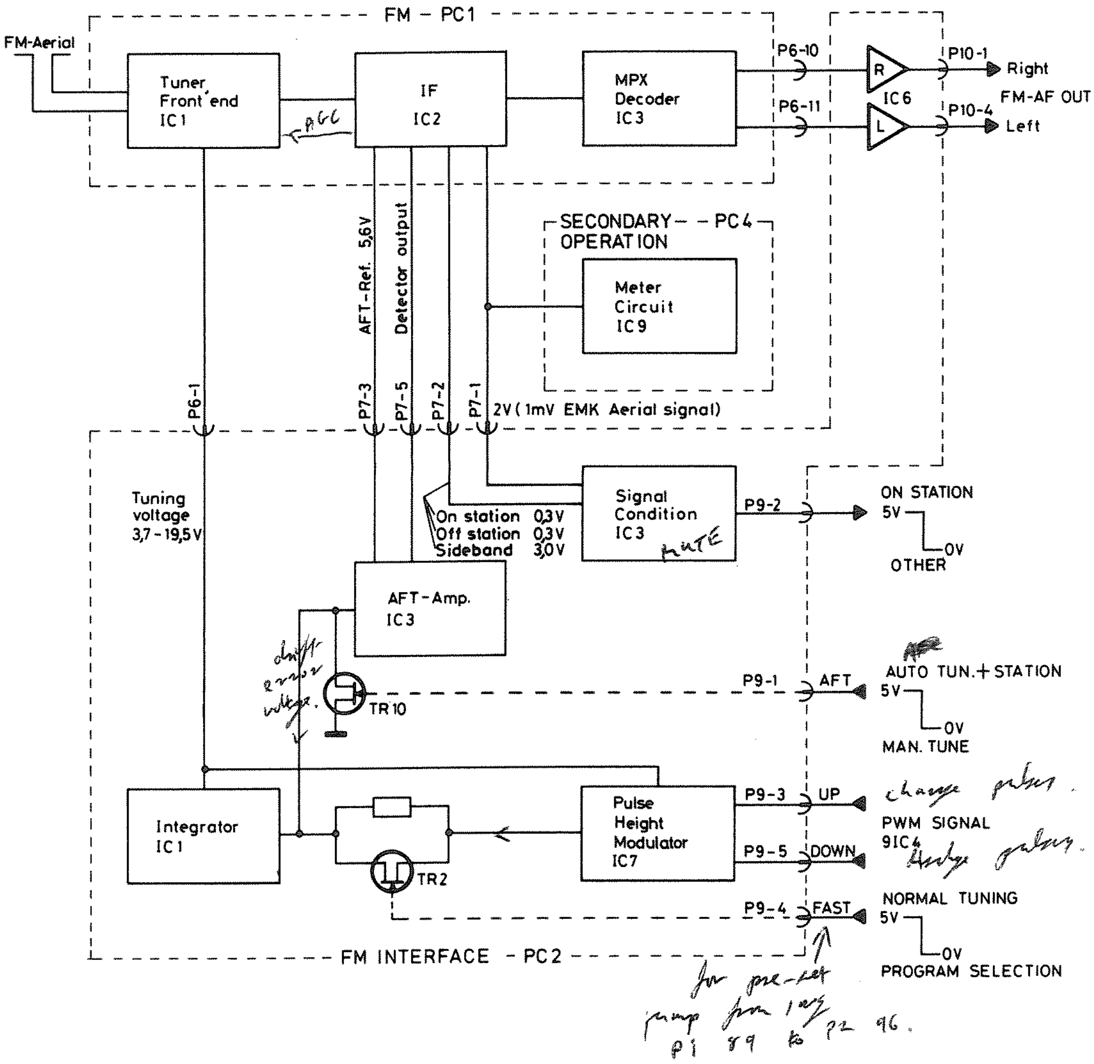


Connect the oscilloscope at 6TP5.
With the Beolab Terminal transmit a weak signal.
(Holding the Beolab Terminal indirectly or at some distance, so that 6IC1 will not be overdriven).
Adjust 6L1 for maximum signal at 6TP5.

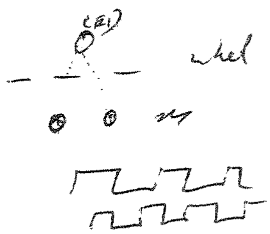
HF Blokdiagram Kredsløbene er alle vist på diagram 1.

RF Block Diagram All the circuits are shown on diagram 1.

HF-Blockschaltbild Die Schaltkreise sind sämtlich auf Diagramm 1 gezeigt.



vol & Tuning wheels = led. lamp and gapped wheel & two photo sensors beneath. Dependent on wheel direction changes phase of square wave out of sensors.



nearly ± 100 kHz each side of station.

manual position = for pretty stations only.