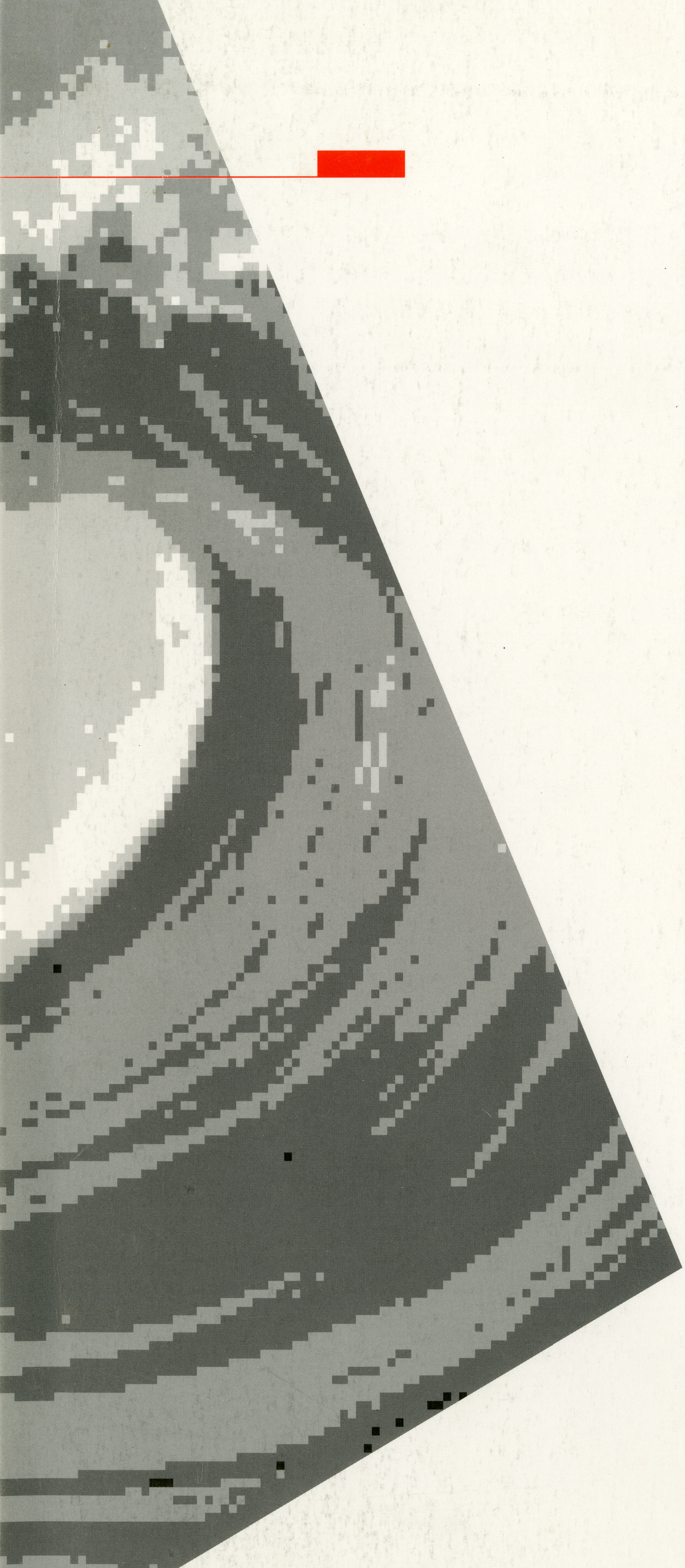

RE 201
Dual Channel Audio Analyzer
Service Manual

Volume II

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LIST OF FIGURES

1 GENERAL INFORMATION

This manual provides technical information and maintenance instructions for the RE201 Filter Option Board. The circuit board description, theory of operation and adjustment instructions are included to provide the information necessary to service the Board.

1.1 Introduction

The Filter Option for the RE201 Dual Channel Audio Analyzer is designed to extend the dynamic range of the THD and IM measurements and the frequency range of the RMS measurement. Furthermore, measurements of SINAD (Signal, Noise and Distortion) to 25 kHz fundamental frequency are added to the capabilities of the RE201.

When using the Filter Option, THD below -100 dB from 20 to 25 kHz (harmonics included) and RMS voltage up to 75 kHz can be measured. Measurements on a standard IM signal can be improved by using the Filter Option. The dynamic range is extended to approx. -70 dB for each intermodulation product.

The increased dynamic range is obtained by means of a programmable notch filter, which attenuates the fundamental signal component but not the harmonics. The notch frequency and attenuation are set automatically by the RE201. To enable measurements of RMS voltage up to 75 kHz possible, the Filter Option also includes an analog RMS detector.

The Filter Option circuitry is located on a separate Printed Circuit Board which plugs into the RE201 Analog Motherboard. A PROM containing all software for handling of the notch filters and attenuators is located on the Filter Option Board. Thus, no changes have to be made to the software located elsewhere in the instrument.

1.2 Installation

When unpacking the Option Board the packing material should be visually inspected for physical damage. If damaged notify the carrier and your local RE INSTRUMENTS representative or the factory. The packing material should be retained for inspection by the carrier in case of complaint.

For a description of the installation refer to the RE201 Basic Unit Technical Manual section 1.2.2.

1.3 Equipment and Accessories

Description	Code No.
RE201 Filter Option	901-525
Technical Manual for the RE201 Filter Option	983-259

1.4 Specifications

True-rms

Frequency range	20 Hz to 75 kHz
Cut-off frequencies	75 kHz, -0.2 dB; 240 kHz, -3 dB
Flatness (1 kHz reference)	+/- 0.1 dB, 20 Hz to 50 kHz +/- 0.2 dB, 50 kHz to 75 kHz
Accuracy	+/- 2 % + flatness
Display modes	Volt, Watt, dBm, dB or % relative to stored reference or previously measured value

Harmonic Distortion (THD)

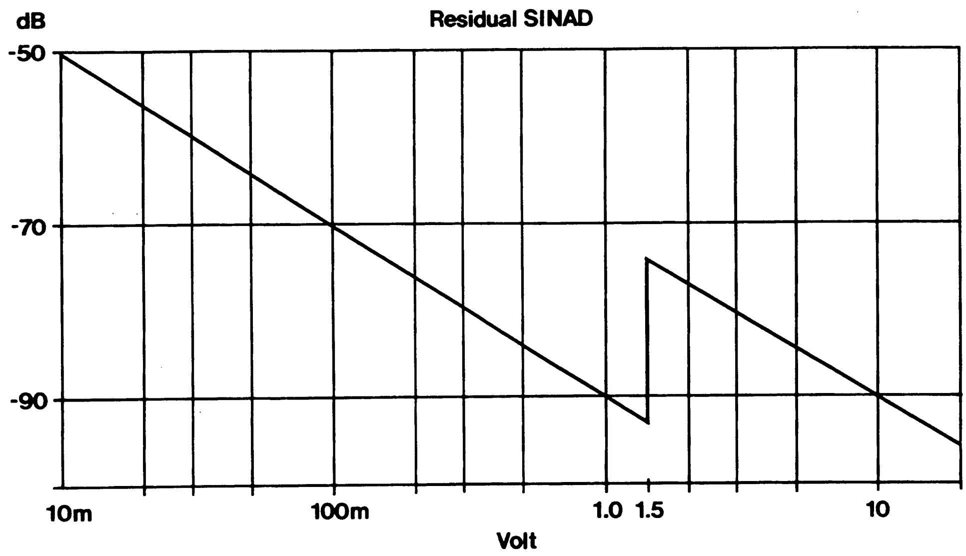
Sensitivity (0.5 Vrms to 1.5 Vrms)	< -100 dB (0.001 %), typical -105 dB 50 Hz, 150 Hz and 15.625 kHz components below -87 dB, -90 dB and -95 dB respectively
Sensitivity (5 mVrms to 15 Vrms)	As specified above
Sensitivity as a function of input level	Increases approx. 1 dB when the input level is increased by 1 dB from 5 mVrms to 0.5 Vrms and from 1.5 Vrms to 5 Vrms
Accuracy	+/- 2.5 dB, THD < -70 dB; +/- 1.5 dB, THD > -70 dB

Intermodulation (IM)

Sensitivity	< -67 dB (0.04%), typical -72 dB, any intermodulation product
Accuracy	+/- 2.5 dB, IM < -50 dB +/- 1.5 dB, IM > -50 dB

Distortion and Noise (SINAD)

Fundamental frequency range	20 Hz to 25 kHz
Noise bandwidth	125 kHz
Residual SINAD at 1 V rms	< -90 dB, typical -93 dB, 40 Hz to 25 kHz < -86 dB, typical -89 dB, 20 Hz to 40 Hz
Residual SINAD at 10 V rms	As specified above
Residual SINAD as a function of input level	Refer to graph below



Residual SINAD as a function of input level

Accuracy	+/- 1.5 dB
Display modes	%, dB

The environmental requirements for the Filter Option are identical to those of the RE201 Basic Unit.

2 PRINCIPLES OF OPERATION

As the main signal processing in the RE201 is performed digitally, the dynamic range is limited by the resolution of the A/D converter. The RE201 employs a 12 bit converter which limits the dynamic range to approx. 75 to 80 dB. Distortion measurements of 80 dB dynamic range may be a serious limitation so the Filter Option is designed to overcome this constraint. The Filter Option, which is fully transparent, uses a programmable notch filter to filter out the main component so that the full dynamic range of the A/D converter can be used for the harmonics.

Hereby, the measurement range of the RE201 may be extended by more than 20 dB for THD measurements and 10 dB for IM measurements.

Furthermore, the Filter Option is provided with an RMS detector which enables broadband RMS measurements at fundamental frequencies up to 75 kHz. By using this detector, measurements of noise and distortion for fundamental frequencies up to 25 kHz are possible.

To fully understand the operation of the Filter Option please refer to the simplified block diagram in fig. 2.1, which presents the Filter Option and the Frontend of the the RE201 Dual Channel Audio Analyzer.

The notch filter, which consists of two identical sections, is inserted just after the input amplifier, whereas the RMS detector is inserted just before the S/H amplifier and A/D converter.

The measurements which use the Filter option are detailed in the following sections.

A detailed block diagram of the entire Filter Option is shown in fig. 3.1.

2.1 Measuring RMS

The RMS detector on the Filter Option Board can be used to measure RMS voltage levels up to 75 kHz. During this measurement the 25 kHz antialiasing filter in the RE201 Frontend is circumvented - switches S5 and S7 are in closed position. The fluctuating DC voltage output from the RMS detector is digitized by means of the A/D converter of the Analog Frontend. Following this, a software lowpass filter is employed. The result is calibrated according to the actual gain setting and the result is displayed.

When the RE201 is equipped with the Filter Option, one of the eight softkeys under the LEARN LEVEL menu becomes the RMS75 key.

The accuracy of the RMS75 measurement is +/- 3 % - crest factor <= 7.

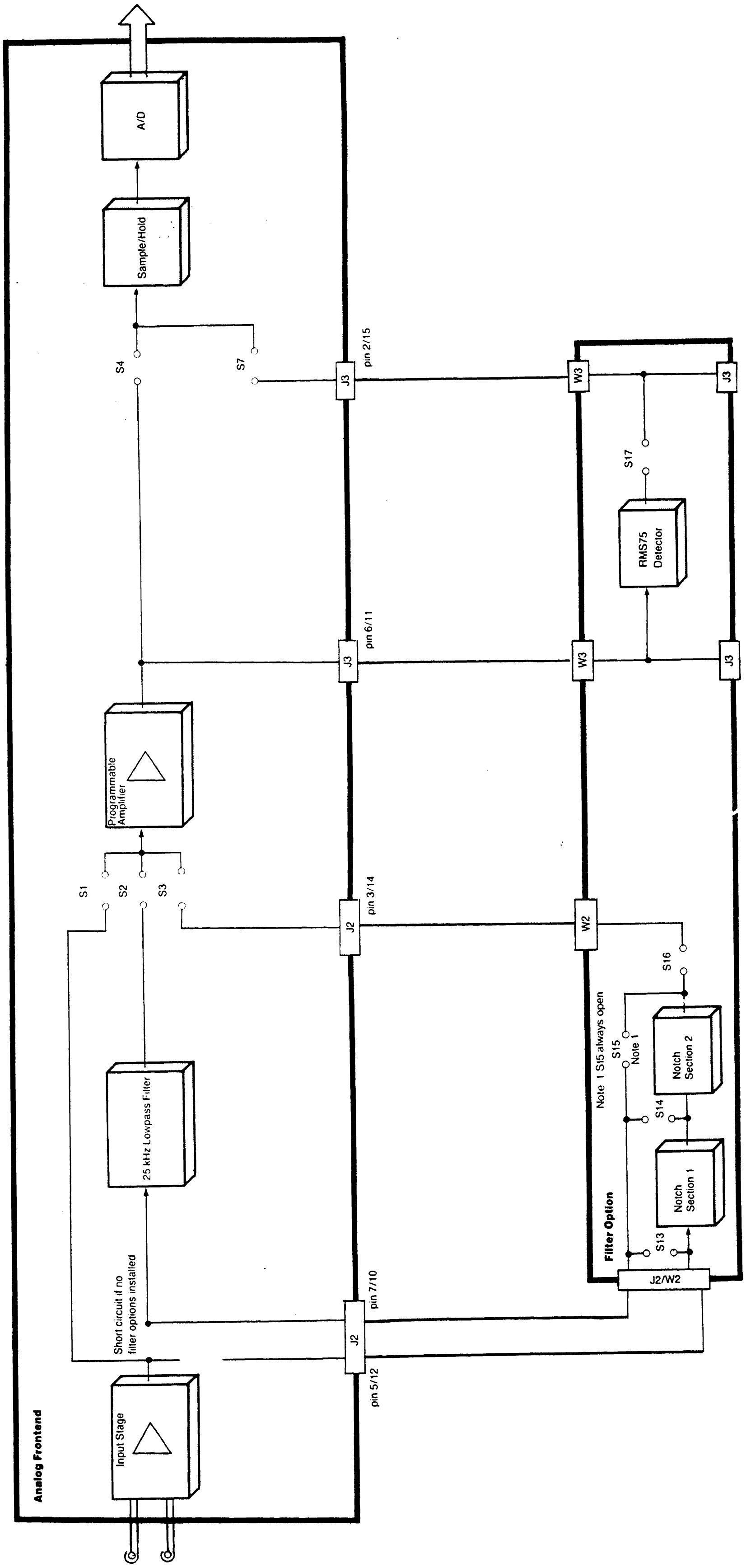


Fig. 2.1 - Filter Option & Frontend Block Diagram

2.2 Measuring THD

When a THD measurement is activated, the RMS level of the signal and the frequency of the fundamental signal component are obtained with switches S2, S13 and S4 in the closed position. It is then checked that each harmonic component is more than -64 dB below the fundamental signal component.

If one of the harmonic components is less than 64 dB below the fundamental signal component, the THD measurement will progress without using the Filter option, i.e. THD will be measured by the RE201 as if the Filter Option were not installed.

If, however, all the harmonic components are more than -64 dB below the fundamental signal component, the first section of the notch filter is automatically inserted between the input amplifier and the 25 kHz antialiasing filter in the RE201 Frontend. In order to accomplish this - switches S14, S2 and S4 are in the closed position. The notch frequency of the filter is then set in accordance with the frequency of the fundamental signal component.

The response of the filter section is shown in fig. 2.2. The harmonic components are amplified by 40 dB whereas the fundamental signal component is attenuated by more than 60 dB compared to the harmonic components. In this way, the harmonics may utilize the entire input range of the Analog to Digital converter. This method of increasing the dynamic range and reducing the noise floor is illustrated in fig. 2.3.

Now, the levels of the harmonic components are measured, the THD calculated and the results displayed on the RE201 CRT. The results will appear exactly as the results for the THD measurements without the Filter Option.

At 1 kHz and an input level of 1 Vrms, THD below -100 dB (0.001 %) can be measured by the RE201 equipped with the Filter Option.

The THD measurement can only be performed in the frequency range from 20 Hz to 12.5 kHz, as the maximum frequency component, which by means of an FFT analysis can be measured by the RE201, is 25 kHz.

With fundamental components having a frequency of 12.5 kHz, only the 2nd harmonic can be included in the measured THD. Where the 3rd harmonic component is important, the THD measurement can only be performed at a fundamental frequency up to 8.3 kHz.

At higher frequencies the THD measurement must be performed as a SINAD measurement which uses the entire notch filter and the RMS detector located on the Filter Option Board. This is described in the following section.

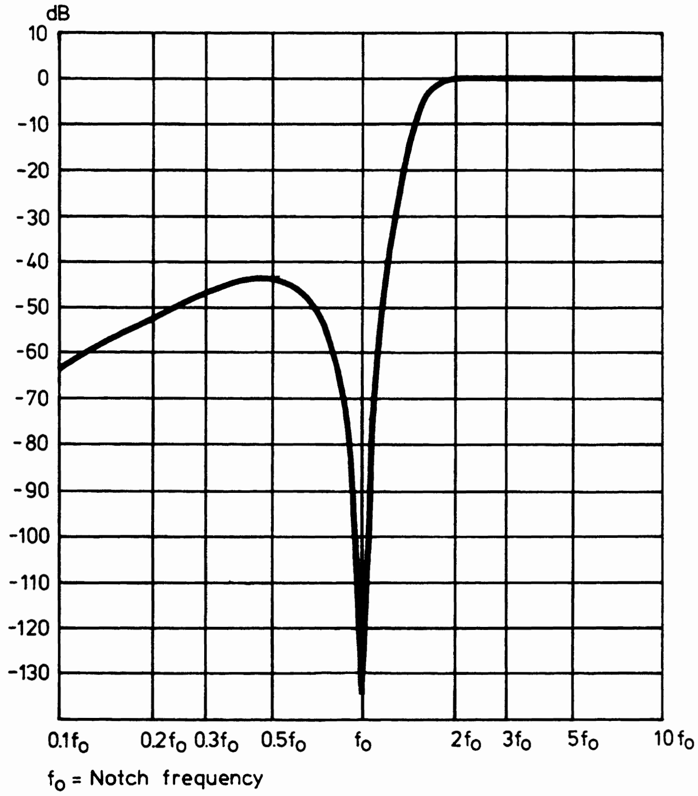


Fig. 2.2 - Notch Filter for THD Measurement

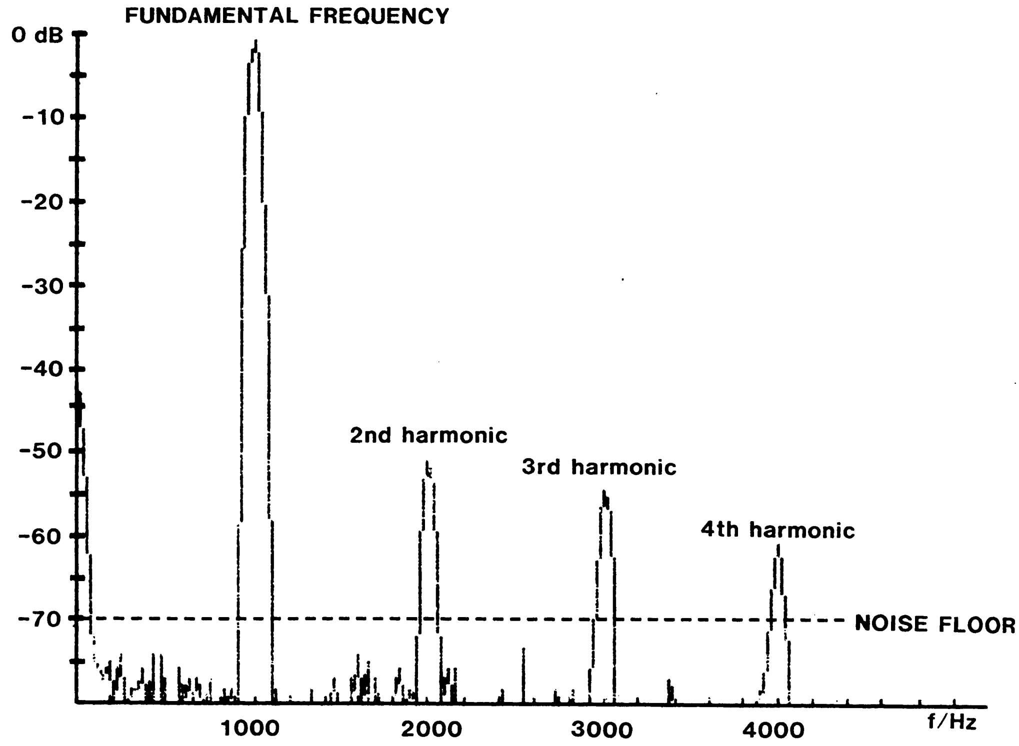
2.3 Measuring SINAD

When the RE201 is equipped with the Filter Option, one of the eight softkeys in the EXECUTE menu becomes the SINAD key.

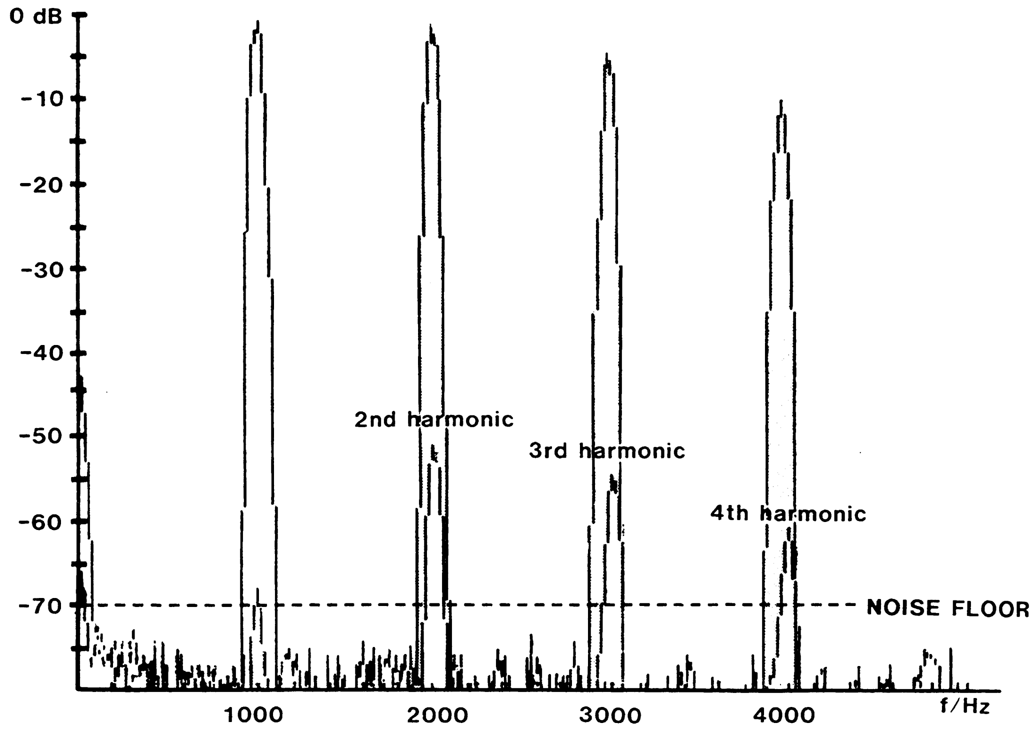
The SINAD measurement starts with a measurement of the frequency of the fundamental signal component. This measurement is performed with switches S2, S13 and S4 in the closed position, refer to fig. 2.1. The 25 kHz antialiasing filter is bypassed and the RMS level of the fundamental and the noise is measured using the 75 kHz detector - switches S1, S17 and S7 in the closed position.

The notch frequency of the filter is automatically set in accordance with the measured frequency of the fundamental signal component, and the two identical sections of the notch filter, each comprising more than 60 dB rejection of the fundamental, are inserted between the input stage and the main amplifier in the RE201 Frontend, i.e. the amplifier following the 25 kHz antialiasing filter, by opening switch S1 and closing S16 and S3.

The gain is adjusted according to the level of the noise and distortion by performing an autoranging procedure employing the amplifiers of the Filter Option and the main amplifier of the Analog Frontend. The gain of the Frontend input stage is maintained in order



(a) Spectrum of applied signal



(b) Spectrum after notching and amplification

Fig. 2.3 - Measuring THD

not to overdrive the input of the notch filters. Thus, the noise and distortion may be amplified from 0 to 98 dB in steps of 2 dB (0 - 60 dB in the Filter Option and 0 - 38 dB in the Frontend).

The frequency response of the total notch filter is shown in fig. 2.4. The fundamental signal component is attenuated by more than 100 dB compared to the harmonic components and the noise. A lowpass filter with a cut-off frequency of 130 kHz ensures a well-defined noise bandwidth.

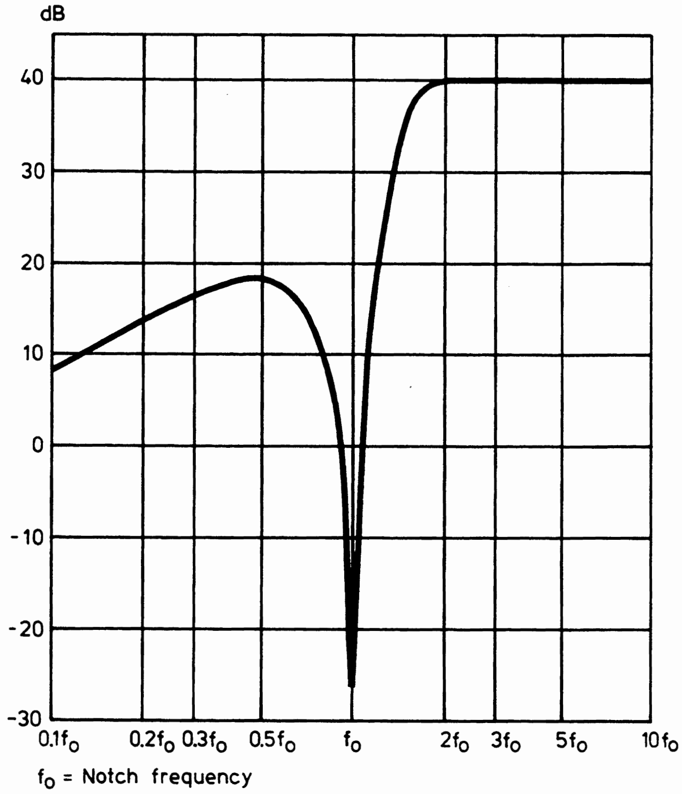


Fig. 2.4 - Notch Filter for SINAD Measurement

The RMS value of the filtered signal is then measured by the RMS detector located on the Filter Option Board. The RMS detector is inserted between the main attenuator and the S/H amplifier in the RE201 Frontend. During this operation switches S7 and S17 are closed.

The output from the RMS detector for this set-up is the RMS value of the distortion and noise.

The inverse SINAD is calculated by the RE201 as the ratio between the RMS level of the distortion and noise, and the RMS level of the fundamental signal component, with due corrections for the different gain settings. The result is then displayed on the RE201 CRT in either % or dB.

2.4 Measuring IM

The dynamic range of the IM measurement is extended by using the Filter Option Board. For this purpose, the signal is routed through the first section of the notch filter on the Filter Option - as in the case of a THD measurement - switches S14, S2 and S4 are closed.

The notch filter will be set for attenuation of the low frequency component, the amplitude of which is four times that of the high frequency component for a standard IM signal. The amplification of the high frequency components, including the intermodulation products, will be 10 dB, i.e. the dynamic range of the IM measurement is increased from -60 dB to -70 dB. This principle is illustrated in fig. 2.5. The notch filter frequency response is as fig. 2.2, with the exception that the amplification is only +10 dB instead of +40 dB.

In order to obtain the above mentioned increase in dynamic range, the input signal must fulfil the following conditions:

* the IM signal must be a standard IM signal.

* the lower frequency of the intermodulation products to be included must be at least twice the frequency of the low frequency component in the IM signal.

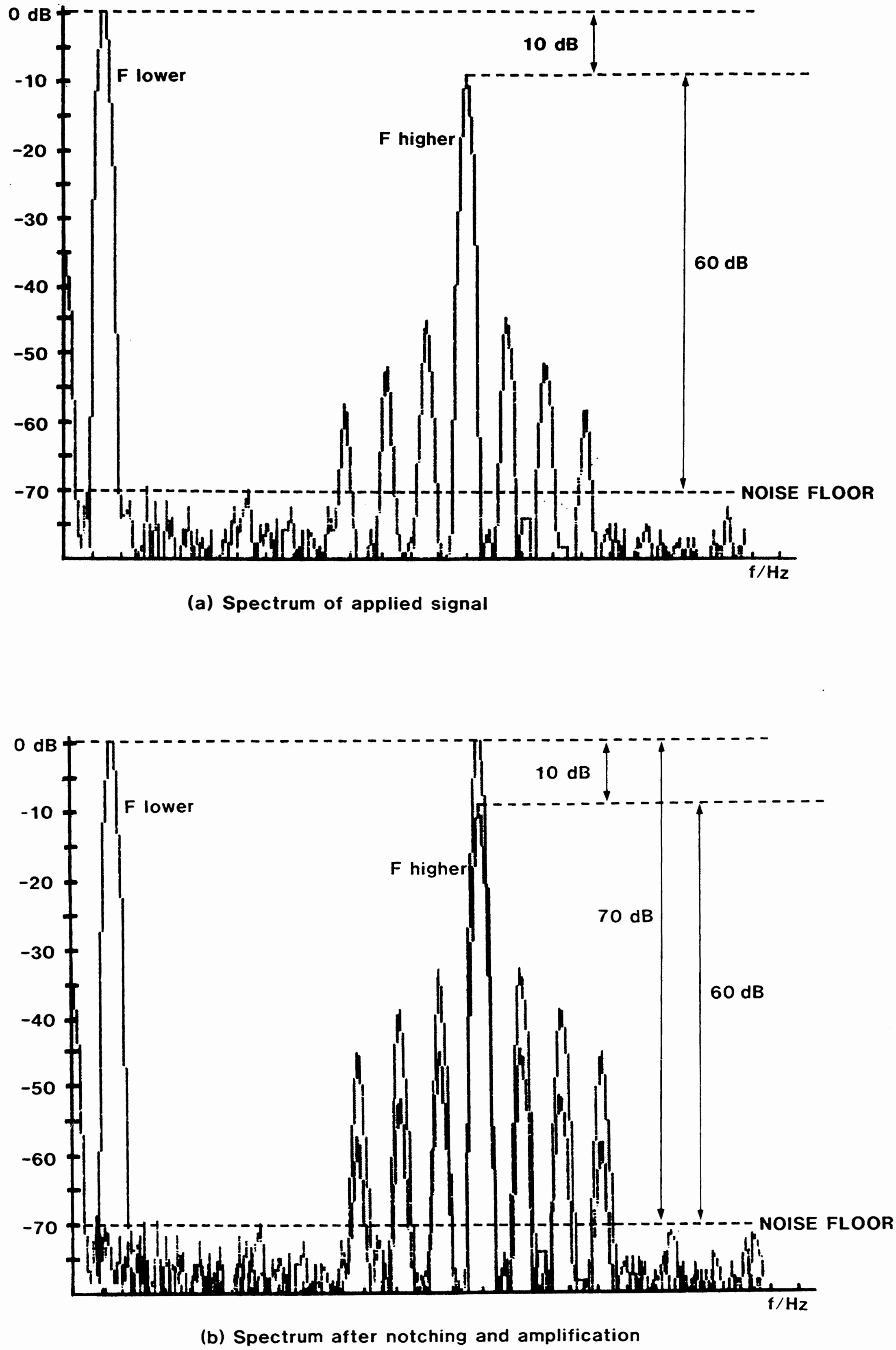


Fig. 2.5 - Measuring IM

3 CIRCUIT DESCRIPTIONS

Referring to the Block Diagram in fig. 3.1 and the schematic diagram 985-203 the Filter Option may be divided into two analog constituents: the notch filters and the RMS detector. Furthermore, the Board comprises digital circuitry for the interface to the Static CPU and program memory.

3.1 Notch Filters

As described in section 2, Notch Filter Section 1 is used solely for THD and IM measurements and together with Notch Filter Section 2 for SINAD measurements.

Each Notch Filter Section comprises two notch filters and a highpass filter coupled in cascade, as shown in the Block Diagram in fig. 3.1.

Each notch filter is implemented as a Bandpass Filter in the feedback path of an amplifier. The Bandpass Filters are implemented as 'State Variable' filters containing two integrators. The frequency response for one notch filter set to 0 dB gain, is shown in fig. 3.2.

The programmability is obtained through a 10-bit programmable resistor network, which selects between approx. 1000 different resistor configurations in the notch filter sections to obtain a variation in the notch frequency over a limited frequency range. In order to extend the programmable frequency range, the entire range of interest has been divided into three subranges, where each subrange is selected by alteration of the feedback capacitors. Table 3.1 shows the three different ranges and the frequency resolution obtained within each range.

Frequency Range	Resolution
20 - 400 Hz	0.4 Hz
400 - 3200 Hz	3.2 Hz
3200 - 25000 Hz	25.6 Hz

Table 3.1 - Programmable Notch Frequency

In order to ensure flat response from one octave above the center frequency (for correct measurement of the second harmonic), the notch filter response is sharpened by means of an additional highpass filter section. These highpass filters are also implemented as 'State Variable' filters. The frequency response for the highpass filters is shown in fig. 3.3.

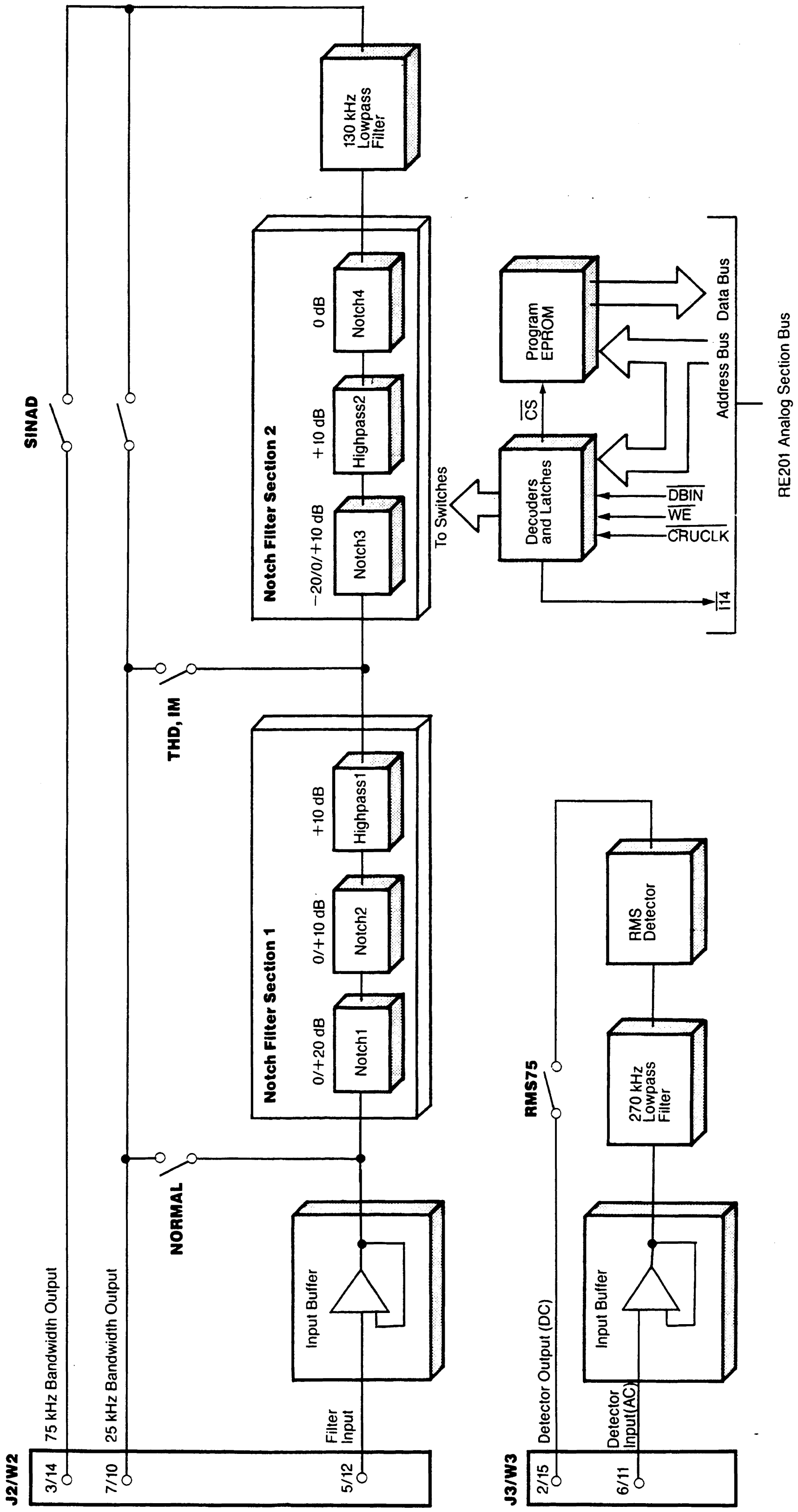


Fig. 3.1 - Filter Option Block Diagram

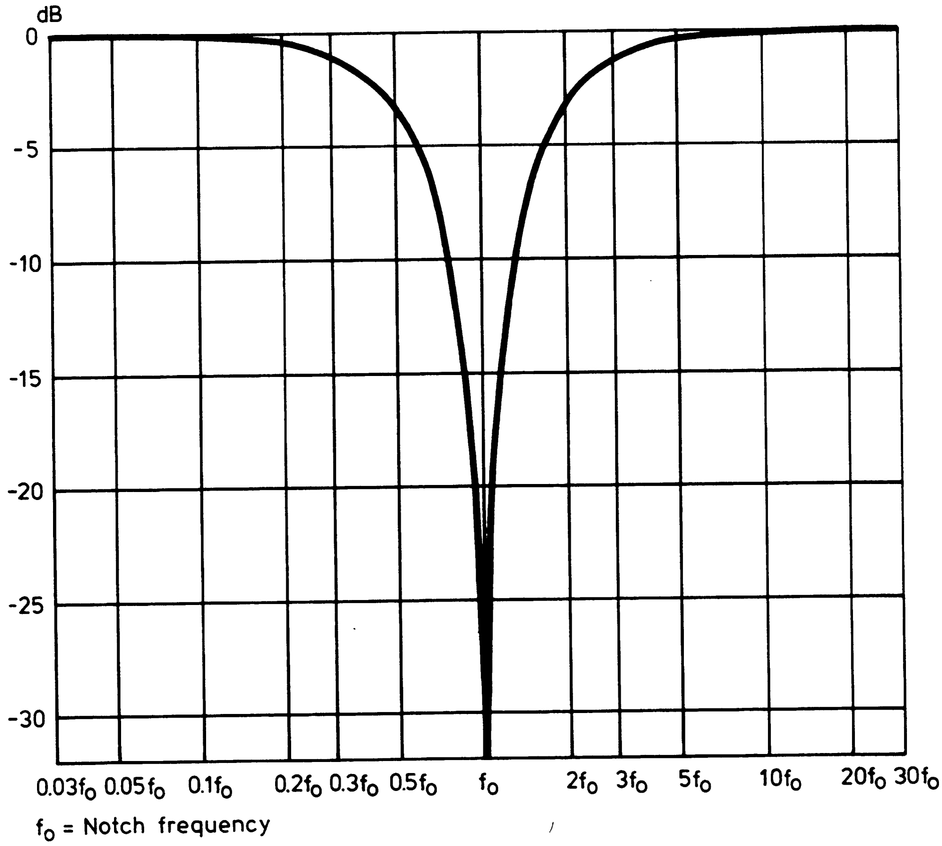


Fig. 3.2 - Notch Filter Frequency Response

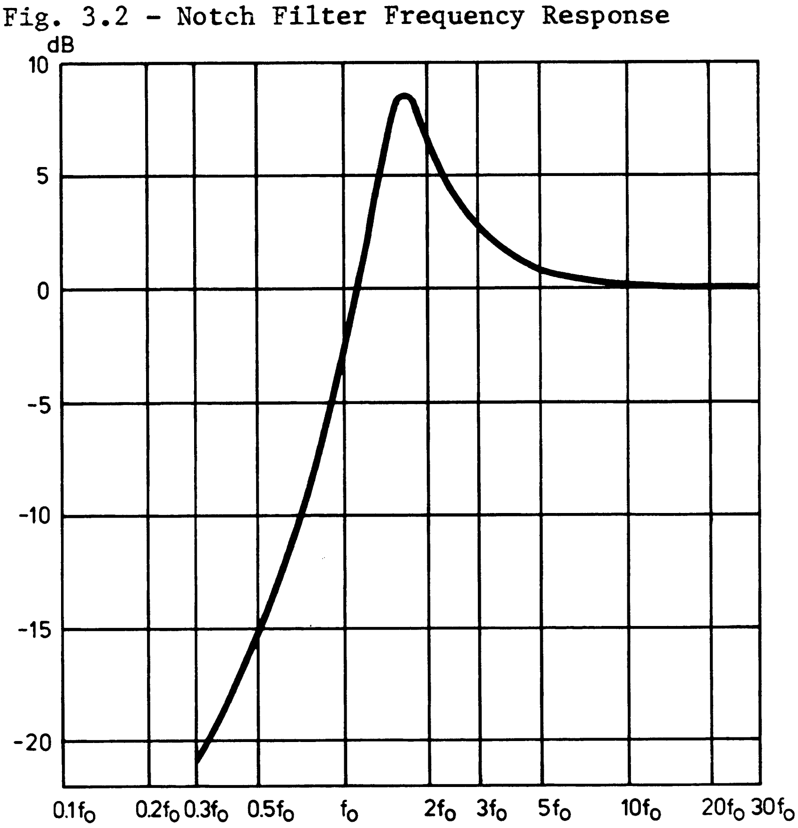


Fig. 3.3 - Highpass Filter Frequency Response

The highpass filters have a fixed gain of 10 dB each, while the gain of each of the notch filters is programmable. The gain of each filter block is shown in the Block Diagram in fig. 3.1. Notch3 includes a -20 dB gain setting facility, in order to be able to select a total gain of 0 dB during SINAD measurements in spite of the gain of the two highpass filters.

In section 2, fig. 2.2, the frequency response for Notch Filter Section 1 is shown, i.e. the combination of two notch filters and one highpass filter, with the gain set to a total of 40 dB. This gain is always used for the THD measurement. For IM measurements, the programmable gain is set to 0 dB, leaving only the 10 dB amplification of the highpass filter.

For SINAD measurements, Notch Filter Sections 1 and 2 are used together. The gain is programmed in accordance with the actual level of the noise and distortion. The frequency response for both Notch Filter Sections is shown in fig. 2.4 in section 2.

Key figures are given in table 3.2 for the accumulated attenuation, relative to input level, following each of the filter blocks shown in fig. 3.1, for the notch frequency as well as for some of the harmonic frequencies.

The filter is set to a total gain of 0 dB, i.e. Notch3 is programmed for -20 dB in order to compensate for the gain in the two highpass filters.

Frequency	Notch1 0 dB	Notch2 0 dB	HP1 +10 dB	Notch3 -20 dB	HP2 +10 dB	Notch4 0 dB
Notch	-32 dB	-64 dB	-57 dB	-109 dB	-102 dB	-134 dB
2nd harmonic	-3.3 dB	-6.6 dB	+10 dB	-13.3 dB	+3.3 dB	0 dB
3rd harmonic	-1.3 dB	-2.6 dB	+10 dB	-11.3 dB	+1.3 dB	0 dB
4th harmonic	-0.14 dB	-0.3 dB	+10 dB	-10.15 dB	+0.15 dB	0 dB

Table 3.2 - Attenuation at 0 dB total gain

3.2 RMS Detector

For RMS detection an integrated circuit, AD637, is used, which offers true RMS-to-DC conversion with an error of less than 1% for crest factors up to 7. The RMS value is computed directly from the input signal by the AD637. The output is 1 V DC for 1 V RMS. A noise limiting filter with a cut-off frequency of 270 kHz is included, placed in front of the RMS detector.

The output of the detector may be connected to the detector bus of the RE201 via an FET switch. The voltage from the detector is digitized by means of the Analog-to-Digital Converter of the Analog Frontend and then lowpass filtered by software.

3.3 Program Memory and Switch Control

The Filter Option is operated by the Static CPU located in the Analog Section. The notch frequency as well as the gain is fully programmable by means of the Communication Register Interface of the Static CPU. Refer to the RE201 Technical Manual, section 3.2.2.

The Filter Option Board comprises additional program memory for the Static CPU, containing the software for performing the actual set-ups (QD12). Decoding of the control signals from the Static CPU to select the option being addressed is implemented by means of a Schottky PROM (QD7).

As the Filter Option shares address space with the Audio Generator, a means is provided for the Static CPU to select the option being addressed. The Filter Option is selected when the CPU has written a '1' to QD1, pin 9. This action at the same time disables the other options. When the Filter Option is selected, $\overline{I14}$ is pulled low by QD9, pin 3. This feature allows the Static CPU to detect the presence of the option during the power-up initialization procedure.

The HEF4724, an 8 bit programmable latch, is generally used as a latch for set-up information from the Static CPU. Level transformation from TTL levels to levels usable for control of the FET switches is implemented using LM324 opamps as comparators. Due to the diode connected to the gate of each FET switch, the FET will only go off, if -15 V is supplied to the cathode of the diode. As the inverting input of the LM324 comparator is held at 2.5 V, a TTL '0' at the non-inverting input implies an output voltage of -15 V, while a TTL '1' forces the output to +15 V.

4 MAINTENANCE

This section describes maintenance and adjustment procedures for the Filter option. The reader is expected to be acquainted with the operation of the RE201.

It is recommended that section 2, Principles of Operation, and section 3, Circuit Description, are studied before adjustments are commenced.

4.1 Recommended Test Equipment

Table 4.1 lists the test equipment necessary to carry out a qualifying performance test and to adjust the Filter Option if necessary.

Instrument	Critical Specifications	Recommended Model
1) LF Signal Generator	THD < -110 dB, SINAD < -100 dB, Frequency range 20 Hz to 75 kHz	B&O, Model TG8
2) RMS/DC Voltmeter	Accuracy of reading 0.2% at 20 Hz to 75 kHz and at DC	Fluke RMS differential Voltmeter, Model 8506A
3) Multitone Generator	3 sine waves simultaneously, THD < -75 dB	RE201 Audio Generator (901-500)

Table 4.1 - Recommended Test Equipment

4.2 Performance Tests

All tests outlined in this section may be performed using measurements in either channel of the RE201, as the performance of the Filter Option is independent of the selected channel.

It is recommended to carry out all programming of the RE201 before the test is initiated. The following is a survey of the definitions necessary to carry out the entire performance test.

RMS75 Measurement: Duration 500 ms, display VOLT
Duration 500 ms, display DB REF

THD Measurements: TRACK, 2nd to 9th harmonic included, dB display
TRACK, 2nd to 7th harmonic included, dB display

TRACK, 2nd to 3rd harmonic included, dB display
TRACK, 2nd harmonic only included, dB display

SINAD Measurement: TRACK, duration 500 ms, display dB

RMS Detector

Adjust the LF generator (1) to a frequency of 1 kHz and an output level of 1.000 Vrms +/- 5 mV by means of the RMS voltmeter (2). Instigate an RMS75 measurement in volts and check that the result is 0.99 V - 1.01 V. Press <STO REF>. With the 1 kHz measurement as reference, check the frequency response of the RMS detector in accordance with table 4.2 by performing an RMS75 measurement with the display in dBr.

Frequency	**Tolerance = reading of RE201 display**
1 kHz	0.0 dB
10 kHz	+/- 0.1 dB
50 kHz	+/- 0.1 dB
75 kHz	+0.1 dB/-0.2 dB

Table 4.2 - RMS Detector Frequency Response

Notch Filters

Adjust the LF generator (1) to an output level of 1.000 Vrms +/- 10 mV. Check that the distortion fulfils the requirements set out in table 4.3 by performing THD measurements with the pertinent number of harmonics included.

Frequency	Harmonics Included	THD	Single Harmonic
25 Hz	2nd to 9th	< - 83 dB	* 2nd < - 87 dB
			* 6th < - 90 dB
			Others < -105 dB
300 Hz	2nd to 9th	< -100 dB	< -105 dB
1.0 kHz	2nd to 9th	< -100 dB	< -105 dB
3.125 kHz	2nd to 7th	< - 89 dB	* 5th < - 90 dB
			Others < -105 dB
7.0 kHz	2nd to 3rd	< -100 dB	< -103 dB
12.0 kHz	2nd	< -100 dB	

Table 4.3 - Distortion

Note: Should any of the requirements marked with an asterisk (*) be exceeded, the fault is due to excessive 50 Hz/150 Hz/15.625 kHz components in the RE201 and not due to the Filter Option.

With the same output level as above, verify the SINAD measurements to be in accordance with the requirements set out in table 4.4.

Frequency	SINAD
20 Hz	< -86 dB
300 Hz	< -90 dB
3.0 kHz	< -90 dB
10.0 kHz	< -90 dB
24.9 kHz	< -90 dB

Table 4.4 - SINAD

Verification of the gain in the Filter Option may, if necessary, be done by measuring SINAD for signals with a well-defined SINAD, e.g. multitone signals. As the gain of each amplifier on the Filter Option is a multiple of 10 dB, it is recommended to utilize multitones yielding SINADs of -10 dB, -20 dB etc.

4.3 Adjustments

Should any of the performance tests above fail, some adjustments can be performed, assuming the failures are out by a small margin.

The RMS detector has a total of three adjustment possibilities (for offset and gain).

The cut-off frequencies for the highpass filters, contributing to the total filter frequency response for the THD and SINAD notch filters (refer to section 3) have one adjustment each. The adjustment corrects the value measured for the second harmonic.

The locations of the test points and the potentiometers used for adjustments are shown in fig. 4.1.

Note that the RMS detector is used for the SINAD measurement, and consequently, the performance of the detector should be verified prior to adjustments of Notch Filter Section 2.

RMS Detector

When adjusting offset for the RMS75 detector, R306 must be shortcircuited. The location of R306 and the potentiometers mentioned

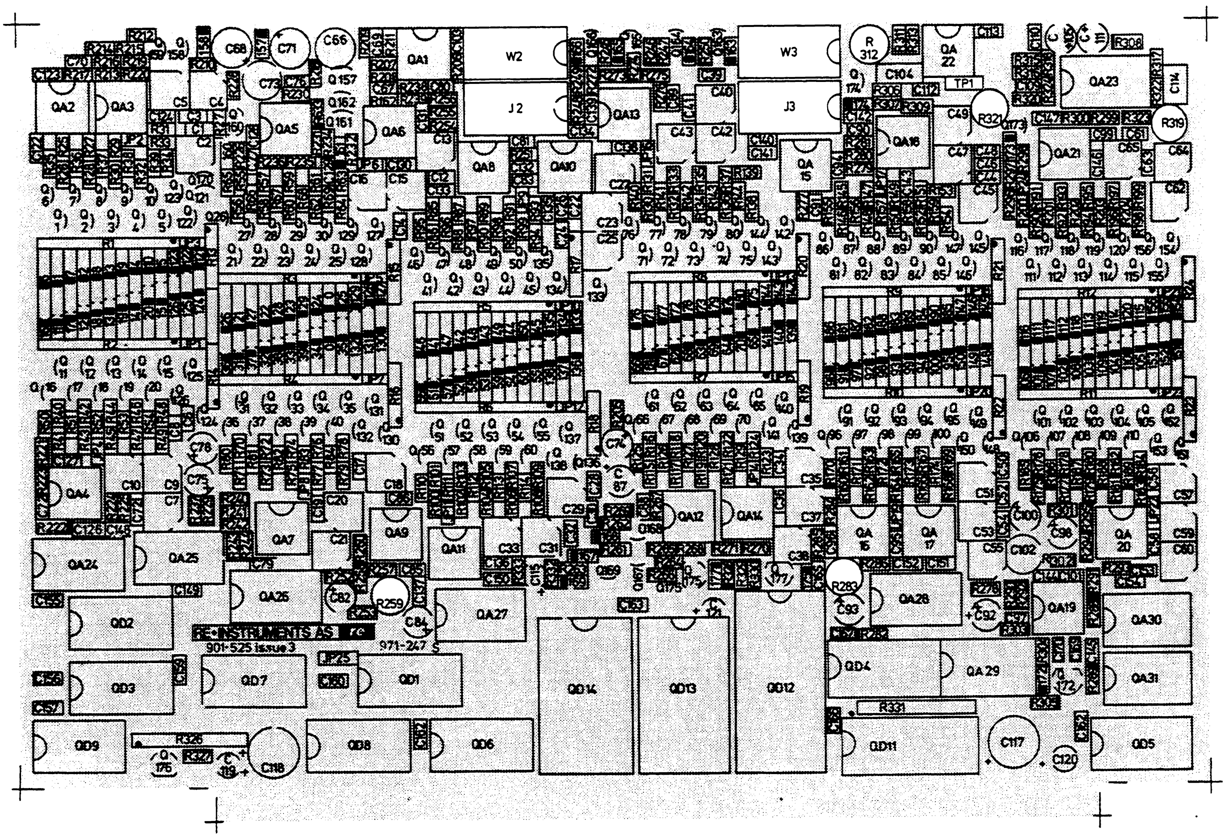


Fig. 4.1 - Filter Option Component Layout

below is shown in fig. 4.1. Using the voltmeter (2), proceed as follows:

a. Adjust R312 to obtain 0.000 mV (DC) +/- 0.5 mV in TP1.

b. Activate an RMS75 measurement and adjust R321 to obtain 0.000 mV (DC) +/- 0.5 mV on the output (J3/W3, pins 2/15).

c. Remove the shortcircuit of R306 and connect the LF generator (1) to the RE201. Adjust frequency to 1 kHz and output level to 1.000 V +/- 1 mV and activate an RMS75 measurement.

d. Adjust R319 to obtain 1.000 V (DC) +/- 1 mV on the output (J3/W3, pins 2/15, ground e.g. at pin 16).

e. Verify the frequency response of the RMS detector in accordance with table 4.2.

Notch Filter Section 1 (THD)

For adjustment of Notch Filter Section 1, used for THD measurements, a multitone is used with a fundamental component of 1 kHz and two 'harmonic' components of 2 kHz and 9 kHz, each -65 dB below the fundamental signal component. The THD of the 1 kHz component must be insignificant compared to the two artificial harmonic components. This multitone may be generated by the RE201 Audio Generator (3) set up as follows:

RIGHT CHANNEL - Multitone with 2 kHz and 9 kHz components, relative levels 1:1, signal level 0.80 mVrms.

LEFT CHANNEL - 1 kHz reference tone, signal level 1.00 Vrms.

Connect the two outputs together and feed the resulting multitone into the RE201. Activate a THD measurement in dB, including the 2nd to 9th harmonics, with 5 averaging loops. Observe the levels at the 2nd and 9th harmonic components, and adjust R259 to obtain equal levels at the 2nd and the 9th harmonics. The location of R259 is shown in fig. 4.1.

Notch Filter Section 2 (SINAD)

Before any adjustments of this section are initiated, be sure that Notch Filter Section 1 is correctly adjusted, as Section 1 is used in conjunction with Section 2 for SINAD measurements.

Two multitones are used for the adjustment. The multitone generator (3) should be set as follows:

MULTITONE 1 - 1 kHz and 9 kHz, relative levels 500:1, signal level 1.00 Vrms

MULTITONE 2 - 1 kHz and 2 kHz, relative levels 500:1, signal level 1.00 Vrms.

a. Feed Multitone 1 to the RE201 and measure SINAD for a fundamental of 1 kHz. Note the value of SINAD.

b. Feed Multitone 2 to the RE201 and repeat the SINAD measurement. Adjust R283 to obtain the same SINAD result as for a.

5 TROUBLESHOOTING

The scope of this section is to provide some troubleshooting hints, which may help to identify whether an observed error is originating from the Filter Option board. Before this conclusion is drawn, various types of other measurements should be performed and verified, in order to make sure that the error is not generated by the RE201 Basic Unit. For instance, the Performance Test described in section 4.2 of the RE201 Basic Unit Technical Manual could be carried out.

It is recommended that section 2, Principles of Operation, and section 3, Circuit Description, of the present manual are carefully studied before troubleshooting is commenced.

Faults originating from the Filter Option board during measurements are most often easily detected, as the Filter Option is used exclusively during the following measurements:

* RMS75
* SINAD
* THD, if the level of each harmonic component is at least -64 dB below the fundamental
* IM, if a standard IM test signal is used (refer to section 2.4)

Whenever the notch filter is actually inserted in the signal path, CR7 of the Static CPU (901-411) is lit. CR7 is the 3rd LED from the left when viewing the PCB from the component side. Thus, during measurements utilizing the notch filter, e.g. a THD measurement, CR7 will be OFF during estimation of frequency and level for the fundamental, and ON during measurement of the level of the harmonics.

The first step, if any errors are detected, is to check that the flat cables W2 and W3 connecting the Filter Option to the Analog Frontend are properly inserted and not defective. W2 is used for input/output to the filters, whereas W3 is used for input/output to the RMS detector. When bypassing the notch filters, e.g. for RMS25 or frequency measurements, Q166 of the Filter Option is activated. Improper operation of this switch will jeopardize all measurements - similarly, if W2 is defective. Further information may be found in section 2.5, Actual Measurements Set-up, in the RE201 Basic Unit Technical Manual.

The troubleshooting will depend on whether the error is observed during a selftest or during a performance test.

5.1 Selftest Errors

If the Analog Section fails during a selftest, the first step to perform is to obtain more information about which part of the Analog Section has caused the error. This is done by reading the error code displayed on the Light Emitting Diodes (LEDs), CR1-CR8, on the top edge of the Static CPU board. The error code for errors on the Filter Option is as shown (facing the component side of the Static CPU):

11ØØØ11Ø

where '1' designates LED on, 0 LED off. The leftmost diode on the board is not part of the error code display.

During the selftest procedure performed by the RE201, the program EPROM QD12 is tested, using a Cyclic Redundancy Code Check (CRCC). When testing this device, the CARD ON circuit (QD6-QD9) and the functioning of the data/address lines are also verified.

If the error is due to a fault in the CARD ON circuit, the Static CPU will be unable to gain access to the Filter Option (refer to section 3.3 for further information). Check that JP25 is mounted correctly, i.e. in position 1-2.

5.2 Performance Test Errors

Even if the Filter Option has passed the selftest procedure on power-on, the board might be defective, as the notch filters and the RMS detector are not tested.

RMS75 Errors

If RMS75 measurements yield results different from RMS25 measurements and/or peak measurements, it is very likely that the RMS detector of the Filter Option is faulty. A fault relating to the RMS detector will also affect SINAD measurements.

If RMS75 measurement results are very small, independent of the input voltage, the error is probably due to faulty FET switches, either in the discharge circuitry of the Filter Option board, in the output of the RMS75 detector (Q173), or in the input to the Analog Frontend (901-421, Q45). If the error is due to the latter, other measurements involving analog detectors, except from the peak detectors,(i.e. Phase, Quasi-peak, Wow & Flutter), will also produce erroneous results. The error may be caused by faults in the decoding and control circuit for the pertinent FET switch.

THD Errors

When troubleshooting faulty THD measurements, a signal with a well-defined THD (below -64 dB for each harmonic) may be of use. Such a signal may be generated by using the 1 kHz reference tone of the Audio Generator as the fundamental component and a multitone as synthesized harmonics (an example is given in section 4.3 for adjustment of the Notch Filter Section 1). An external resistive divider/summation circuit makes it possible to obtain well-defined, very small THD values.

If the filters are working properly for some frequencies, but not for all, emphasis should be put on the fact that the frequency range is subdivided according to table 3.1 in three subranges, which are selected by change of capacitors in the feedback circuitries. Thus, a notch frequency of 200 Hz is programmed by selecting the lowest frequency subrange and programming the resistor value for 200 Hz/0.4 Hz = 500. The same resistor configuration is used for 1600 Hz = 500*3.2 Hz in the middle range and for 12.8 kHz = 500*25.6 Hz in the highest range.

SINAD Errors

If the THD and RMS75 measurements are operating properly, but the SINAD measurements are not, the error is related to Notch Filter Section 2 and/or related signal coupling switches, e.g. the switch in the output, Q163 (refer to the Block Diagram, fig. 3.1.).

Programming of notch frequencies is done as described for the THD measurements.

6 PARTS LIST AND SCHEMATIC DIAGRAM

6.1 Parts List

All electronic components are included in the parts list. Parts marked with a * are manufactured by RE INSTRUMENTS AS.

When ordering spare parts it is important that you give the following information.

* Code No. and description of the part.
* Circuit reference from the schematic diagram.
* Complete type designation of RE product.

Filter (901-525)

CAPACITORS

C 1	C Ceramic 56p0 2% 100V NPO	213-210
C 2	C Polystyrene 1n5 1% 63V	243-312
C 3	C Ceramic 100p 2% 100V NPO	213-211
C 4	C Polystyrene 12n4 1% 63V	243-311
C 5	C Polypropylen 100n 1% 63V 150PPM	242-302
C 6	C Ceramic 56p0 2% 100V NPO	213-210
C 7	C Polystyrene 1n5 1% 63V	243-312
C 8	C Ceramic 100p 2% 100V NPO	213-211
C 9	C Polystyrene 12n4 1% 63V	243-311
C 10	C Polypropylen 100n 1% 63V 150PPM	242-302
C 12	C Ceramic 56p0 2% 100V NPO	213-210
C 13	C Polystyrene 1n5 1% 63V	243-312
C 14	C Ceramic 100p 2% 100V NPO	213-211
C 15	C Polystyrene 12n4 1% 63V	243-311
C 16	C Polypropylen 100n 1% 63V 150PPM	242-302
C 17	C Ceramic 56p0 2% 100V NPO	213-210
C 18	C Polystyrene 1n5 1% 63V	243-312
C 19	C Ceramic 100p 2% 100V NPO	213-211
C 20	C Polystyrene 12n4 1% 63V	243-311
C 21	C Polypropylen 100n 1% 63V 150PPM	242-302
C 23	C Polystyrene 787p 1% 63V	243-313
C 24	C Ceramic 100p 2% 100V NPO	213-211
C 25	C Polystyrene 6n34 1% 63V	243-314
C 26	C Ceramic 390p 10% 100V	213-021
C 27	C Polypropylen 51n1 1% 63V 150PPM	242-301
C 29	C Polystyrene 787p 1% 63V	243-313
C 30	C Ceramic 100p 2% 100V NPO	213-211
C 31	C Polystyrene 6n34 1% 63V	243-314
C 32	C Ceramic 390p 10% 100V	213-021
C 33	C Polypropylen 51n1 1% 63V 150PPM	242-301
C 34	C Ceramic 56p0 2% 100V NPO	213-210
C 35	C Polystyrene 1n5 1% 63V	243-312
C 36	C Ceramic 100p 2% 100V NPO	213-211
C 37	C Polystyrene 12n4 1% 63V	243-311
C 38	C Polypropylen 100n 1% 63V 150PPM	242-302
C 39	C Ceramic 56p0 2% 100V NPO	213-210
C 40	C Polystyrene 1n5 1% 63V	243-312
C 41	C Ceramic 100p 2% 100V NPO	213-211
C 42	C Polystyrene 12n4 1% 63V	243-311
C 43	C Polypropylen 100n 1% 63V 150PPM	242-302
C 45	C Polystyrene 787p 1% 63V	243-313
C 46	C Ceramic 100p 2% 100V NPO	213-211
C 47	C Polystyrene 6n34 1% 63V	243-314
C 48	C Ceramic 390p 10% 100V	213-021
C 49	C Polypropylen 51n1 1% 63V 150PPM	242-301
C 51	C Polystyrene 787p 1% 63V	243-313
C 52	C Ceramic 100p 2% 100V NPO	213-211
C 53	C Polystyrene 6n34 1% 63V	243-314
C 54	C Ceramic 390p 10% 100V	213-021
C 55	C Polypropylen 51n1 1% 63V 150PPM	242-301

C 56	C Ceramic 56p0 2% 100V NP0	213-210
C 57	C Polystyrene 1n5 1% 63V	243-312
C 58	C Ceramic 100p 2% 100V NP0	213-211
C 59	C Polystyrene 12n4 1% 63V	243-311
C 60	C Polypropylen 100n 1% 63V 150PPM	242-302
C 61	C Ceramic 56p0 2% 100V NP0	213-210
C 62	C Polystyrene 1n5 1% 63V	243-312
C 63	C Ceramic 100p 2% 100V NP0	213-211
C 64	C Polystyrene 12n4 1% 63V	243-311
C 65	C Polypropylen 100n 1% 63V 150PPM	242-302
C 66	Electrolytic Bipolar 4u7 25V	261-301
C 67	C Ceramic 100n 20% 50V	213-401
C 68	Electrolytic 100/25, 2000h/85°, R:6.3*11, RM2	261-073
C 69	C Ceramic 22n0 -20+80% 63V	213-011
C 70	C Ceramic 2p70 p25 100V NPO	213-201
C 71	Electrolytic 100/25, 2000h/85°, R:6.3*11, RM2	261-073
C 72	C Ceramic 1p80 p25 100V NP0	213-219
C 73	Electrolytic Bipolar 4u7 25V	261-301
C 74	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 75	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 76	C Ceramic 22n0 -20+80% 63V	213-011
C 77	C Ceramic 2p70 p25 100V NPO	213-201
C 78	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 79	C Ceramic 3p90 p25 100V NP0	213-223
C 81	C Ceramic 2p70 p25 100V NPO	213-201
C 82	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 83	C Ceramic 10p0 2% 100V NP0	213-205
C 84	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 85	C Ceramic 10p0 2% 100V NP0	213-205
C 86	C Ceramic 15p0 2% 100V NP0	213-216
C 87	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 88	C Ceramic 2p70 p25 100V NPO	213-201
C 89	C Ceramic 6p80 p25 100V NP0	213-204
C 91	C Ceramic 2p70 p25 100V NPO	213-201
C 92	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 93	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 94	C Ceramic 15p0 2% 100V NP0	213-216
C 95	C Ceramic 15p0 2% 100V NP0	213-216
C 96	C Ceramic 10p0 2% 100V NP0	213-205
C 97	C Ceramic 2p70 p25 100V NPO	213-201
C 98	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 99	C Ceramic 6p80 p25 100V NP0	213-204
C 100	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 101	C Ceramic 22n0 -20+80% 63V	213-011
C 102	Electrolytic Bipolar 4u7 25V	261-301
C 103	C Ceramic 100n 20% 50V	213-401
C 104	MKT, 1/63/10, R:6*11.5*7.2, RM2	241-064
C 105	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 109	C Ceramic 330p 2% 100V N750	213-214
C 110	C Ceramic 150p 2% 100V N750	213-212
C 111	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 112	C Ceramic 100n 20% 50V	213-401
C 113	C Ceramic 100n 20% 50V	213-401
C 114	MKT, 1/63/10, R:6*11.5*7.2, RM2	241-064

C	115	C solid AL 10u 20% 16V	265-008
C	117	Electrolytic 100/25, 2000h/85°, R:6.3*11, RM2	261-073
C	118	Electrolytic 100/25, 2000h/85°, R:6.3*11, RM2	261-073
C	119	C solid AL 10u 20% 16V	265-008
C	120	C solid AL 10u 20% 16V	265-008
C	121	C solid AL 10u 20% 16V	265-008
C	122	C Ceramic 100n 20% 50V	213-401
C	123	C Ceramic 100n 20% 50V	213-401
C	124	C Ceramic 100n 20% 50V	213-401
C	126	C Ceramic 100n 20% 50V	213-401
C	127	C Ceramic 100n 20% 50V	213-401
C	128	C Ceramic 100n 20% 50V	213-401
C	129	C Ceramic 100n 20% 50V	213-401
C	130	C Ceramic 100n 20% 50V	213-401
C	131	C Ceramic 100n 20% 50V	213-401
C	132	C Ceramic 100n 20% 50V	213-401
C	133	C Ceramic 100n 20% 50V	213-401
C	134	C Ceramic 100n 20% 50V	213-401
C	135	C Ceramic 100n 20% 50V	213-401
C	136	C Ceramic 100n 20% 50V	213-401
C	137	C Ceramic 100n 20% 50V	213-401
C	138	C Ceramic 100n 20% 50V	213-401
C	139	C Ceramic 100n 20% 50V	213-401
C	140	C Ceramic 100n 20% 50V	213-401
C	141	C Ceramic 100n 20% 50V	213-401
C	142	C Ceramic 100n 20% 50V	213-401
C	143	C Ceramic 100n 20% 50V	213-401
C	144	C Ceramic 100n 20% 50V	213-401
C	145	C Ceramic 100n 20% 50V	213-401
C	146	C Ceramic 100n 20% 50V	213-401
C	147	C Ceramic 100n 20% 50V	213-401
C	148	C Ceramic 100n 20% 50V	213-401
C	149	C Ceramic 100n 20% 50V	213-401
C	150	C Ceramic 100n 20% 50V	213-401
C	151	C Ceramic 100n 20% 50V	213-401
C	152	C Ceramic 100n 20% 50V	213-401
C	153	C Ceramic 100n 20% 50V	213-401
C	154	C Ceramic 100n 20% 50V	213-401
C	155	C Ceramic 100n 20% 50V	213-401
C	156	C Ceramic 100n 20% 50V	213-401
C	157	C Ceramic 100n 20% 50V	213-401
C	158	C Ceramic 100n 20% 50V	213-401
C	159	C Ceramic 100n 20% 50V	213-401
C	160	C Ceramic 100n 20% 50V	213-401
C	162	C Ceramic 100n 20% 50V	213-401
C	163	C Ceramic 100n 20% 50V	213-401
C	165	C Ceramic 100n 20% 50V	213-401
C	166	C Ceramic 100n 20% 50V	213-401
C	167	C Ceramic 100n 20% 50V	213-401
C	169	C Ceramic 150p 2% 100V N750	213-212
C	170	C Ceramic 330p 2% 100V N750	213-214

DIODES

CR 1	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 2	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 3	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 4	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 5	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 6	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 7	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 8	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 9	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 10	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 11	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 12	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 13	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 14	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 15	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 16	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 17	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 18	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 19	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 20	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 21	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 22	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 23	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 24	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 25	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 26	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 27	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 28	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 29	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 30	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 31	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 32	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 33	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 34	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 35	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 36	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 37	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 38	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 39	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 40	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 41	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 42	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 43	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 44	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 45	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 46	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 47	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 48	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 49	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 50	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 51	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 52	Diode BAV10 Si Vr-60V If-600mA	350-022

CR 53	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 54	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 55	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 56	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 57	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 58	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 59	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 60	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 61	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 62	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 63	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 64	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 65	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 66	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 67	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 68	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 69	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 70	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 71	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 72	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 73	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 74	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 75	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 76	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 77	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 78	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 79	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 80	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 81	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 82	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 83	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 84	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 85	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 86	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 87	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 88	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 89	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 90	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 91	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 92	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 93	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 94	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 95	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 96	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 97	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 98	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 99	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 100	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 101	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 102	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 103	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 104	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 105	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 106	Diode BAV10 Si Vr-60V If-600mA	350-022

CR 107	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 108	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 109	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 110	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 111	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 112	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 113	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 114	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 115	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 116	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 117	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 118	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 119	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 120	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 121	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 122	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 123	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 124	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 125	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 126	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 127	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 128	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 129	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 130	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 131	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 132	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 133	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 134	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 135	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 136	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 137	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 138	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 139	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 140	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 141	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 142	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 143	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 144	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 145	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 146	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 147	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 148	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 149	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 150	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 151	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 152	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 153	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 154	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 155	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 156	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 157	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 158	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 160	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 161	Diode BAV10 Si Vr-60V If-600mA	350-022

CR 162	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 163	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 164	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 165	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 166	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 167	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 168	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 169	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 172	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 173	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 174	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 175	Diode Schottky BAT41 S 150V 250mA	350-061
CR 177	Diode zener BZX79-C3V6 0.4W	350-626

CONNECTORS

J 2	Connector Socket for 16-Pin	816-217
J 3	Connector Socket for 16-Pin	816-217

TRANSISTORS

Q 1	Transistor J109-18 n Fet	360-188
Q 2	Transistor J109-18 n Fet	360-188
Q 3	Transistor J109-18 n Fet	360-188
Q 4	Transistor J109-18 n Fet	360-188
Q 5	Transistor J109-18 n Fet	360-188
Q 6	Transistor JFet-N J112, TO92	360-114
Q 7	Transistor JFet-N J112, TO92	360-114
Q 8	Transistor JFet-N J112, TO92	360-114
Q 9	Transistor JFet-N J112, TO92	360-114
Q 10	Transistor JFet-N J112, TO92	360-114
Q 11	Transistor J109-18 n Fet	360-188
Q 12	Transistor J109-18 n Fet	360-188
Q 13	Transistor J109-18 n Fet	360-188
Q 14	Transistor J109-18 n Fet	360-188
Q 15	Transistor J109-18 n Fet	360-188
Q 16	Transistor JFet-N J112, TO92	360-114
Q 17	Transistor JFet-N J112, TO92	360-114
Q 18	Transistor JFet-N J112, TO92	360-114
Q 19	Transistor JFet-N J112, TO92	360-114
Q 20	Transistor JFet-N J112, TO92	360-114
Q 21	Transistor J109-18 n Fet	360-188
Q 22	Transistor J109-18 n Fet	360-188
Q 23	Transistor J109-18 n Fet	360-188
Q 24	Transistor J109-18 n Fet	360-188
Q 25	Transistor J109-18 n Fet	360-188
Q 26	Transistor JFet-N J112, TO92	360-114
Q 27	Transistor JFet-N J112, TO92	360-114
Q 28	Transistor JFet-N J112, TO92	360-114
Q 29	Transistor JFet-N J112, TO92	360-114
Q 30	Transistor JFet-N J112, TO92	360-114
Q 31	Transistor J109-18 n Fet	360-188
Q 32	Transistor J109-18 n Fet	360-188
Q 33	Transistor J109-18 n Fet	360-188

Q 34	Transistor J109-18 n Fet	360-188
Q 35	Transistor J109-18 n Fet	360-188
Q 36	Transistor JFet-N J112, TO92	360-114
Q 37	Transistor JFet-N J112, TO92	360-114
Q 38	Transistor JFet-N J112, TO92	360-114
Q 39	Transistor JFet-N J112, TO92	360-114
Q 40	Transistor JFet-N J112, TO92	360-114
Q 41	Transistor J109-18 n Fet	360-188
Q 42	Transistor J109-18 n Fet	360-188
Q 43	Transistor J109-18 n Fet	360-188
Q 44	Transistor J109-18 n Fet	360-188
Q 45	Transistor J109-18 n Fet	360-188
Q 46	Transistor JFet-N J112, TO92	360-114
Q 47	Transistor JFet-N J112, TO92	360-114
Q 48	Transistor JFet-N J112, TO92	360-114
Q 49	Transistor JFet-N J112, TO92	360-114
Q 50	Transistor JFet-N J112, TO92	360-114
Q 51	Transistor J109-18 n Fet	360-188
Q 52	Transistor J109-18 n Fet	360-188
Q 53	Transistor J109-18 n Fet	360-188
Q 54	Transistor J109-18 n Fet	360-188
Q 55	Transistor J109-18 n Fet	360-188
Q 56	Transistor JFet-N J112, TO92	360-114
Q 57	Transistor JFet-N J112, TO92	360-114
Q 58	Transistor JFet-N J112, TO92	360-114
Q 59	Transistor JFet-N J112, TO92	360-114
Q 60	Transistor JFet-N J112, TO92	360-114
Q 61	Transistor J109-18 n Fet	360-188
Q 62	Transistor J109-18 n Fet	360-188
Q 63	Transistor J109-18 n Fet	360-188
Q 64	Transistor J109-18 n Fet	360-188
Q 65	Transistor J109-18 n Fet	360-188
Q 66	Transistor JFet-N J112, TO92	360-114
Q 67	Transistor JFet-N J112, TO92	360-114
Q 68	Transistor JFet-N J112, TO92	360-114
Q 69	Transistor JFet-N J112, TO92	360-114
Q 70	Transistor JFet-N J112, TO92	360-114
Q 71	Transistor J109-18 n Fet	360-188
Q 72	Transistor J109-18 n Fet	360-188
Q 73	Transistor J109-18 n Fet	360-188
Q 74	Transistor J109-18 n Fet	360-188
Q 75	Transistor J109-18 n Fet	360-188
Q 76	Transistor JFet-N J112, TO92	360-114
Q 77	Transistor JFet-N J112, TO92	360-114
Q 78	Transistor JFet-N J112, TO92	360-114
Q 79	Transistor JFet-N J112, TO92	360-114
Q 80	Transistor JFet-N J112, TO92	360-114
Q 81	Transistor J109-18 n Fet	360-188
Q 82	Transistor J109-18 n Fet	360-188
Q 83	Transistor J109-18 n Fet	360-188
Q 84	Transistor J109-18 n Fet	360-188
Q 85	Transistor J109-18 n Fet	360-188
Q 86	Transistor JFet-N J112, TO92	360-114
Q 87	Transistor JFet-N J112, TO92	360-114

Q 88	Transistor JFet-N J112, TO92	360-114
Q 89	Transistor JFet-N J112, TO92	360-114
Q 90	Transistor JFet-N J112, TO92	360-114
Q 91	Transistor J109-18 n Fet	360-188
Q 92	Transistor J109-18 n Fet	360-188
Q 93	Transistor J109-18 n Fet	360-188
Q 94	Transistor J109-18 n Fet	360-188
Q 95	Transistor J109-18 n Fet	360-188
Q 96	Transistor JFet-N J112, TO92	360-114
Q 97	Transistor JFet-N J112, TO92	360-114
Q 98	Transistor JFet-N J112, TO92	360-114
Q 99	Transistor JFet-N J112, TO92	360-114
Q 100	Transistor JFet-N J112, TO92	360-114
Q 101	Transistor J109-18 n Fet	360-188
Q 102	Transistor J109-18 n Fet	360-188
Q 102	Transistor J109-18 n Fet	360-188
Q 104	Transistor J109-18 n Fet	360-188
Q 105	Transistor J109-18 n Fet	360-188
Q 106	Transistor JFet-N J112, TO92	360-114
Q 107	Transistor JFet-N J112, TO92	360-114
Q 108	Transistor JFet-N J112, TO92	360-114
Q 109	Transistor JFet-N J112, TO92	360-114
Q 110	Transistor JFet-N J112, TO92	360-114
Q 111	Transistor J109-18 n Fet	360-188
Q 112	Transistor J109-18 n Fet	360-188
Q 113	Transistor J109-18 n Fet	360-188
Q 114	Transistor J109-18 n Fet	360-188
Q 115	Transistor J109-18 n Fet	360-188
Q 116	Transistor JFet-N J112, TO92	360-114
Q 117	Transistor JFet-N J112, TO92	360-114
Q 118	Transistor JFet-N J112, TO92	360-114
Q 119	Transistor JFet-N J112, TO92	360-114
Q 120	Transistor JFet-N J112, TO92	360-114
Q 121	Transistor FET J106 N 25V	360-261
Q 122	Transistor FET J106 N 25V	360-261
Q 123	Transistor FET J106 N 25V	360-261
Q 124	Transistor FET J106 N 25V	360-261
Q 125	Transistor FET J106 N 25V	360-261
Q 126	Transistor FET J106 N 25V	360-261
Q 127	Transistor J109-18 n Fet	360-188
Q 128	Transistor J109-18 n Fet	360-188
Q 129	Transistor J109-18 n Fet	360-188
Q 130	Transistor J109-18 n Fet	360-188
Q 131	Transistor J109-18 n Fet	360-188
Q 132	Transistor J109-18 n Fet	360-188
Q 133	Transistor J109-18 n Fet	360-188
Q 134	Transistor J109-18 n Fet	360-188
Q 135	Transistor J109-18 n Fet	360-188
Q 136	Transistor J109-18 n Fet	360-188
Q 137	Transistor J109-18 n Fet	360-188
Q 138	Transistor J109-18 n Fet	360-188
Q 139	Transistor J109-18 n Fet	360-188
Q 140	Transistor J109-18 n Fet	360-188
Q 141	Transistor J109-18 n Fet	360-188

Q 142	Transistor J109-18 n Fet	360-188
Q 143	Transistor J109-18 n Fet	360-188
Q 144	Transistor J109-18 n Fet	360-188
Q 145	Transistor J109-18 n Fet	360-188
Q 146	Transistor J109-18 n Fet	360-188
Q 147	Transistor J109-18 n Fet	360-188
Q 148	Transistor J109-18 n Fet	360-188
Q 149	Transistor J109-18 n Fet	360-188
Q 150	Transistor J109-18 n Fet	360-188
Q 151	Transistor J109-18 n Fet	360-188
Q 152	Transistor J109-18 n Fet	360-188
Q 153	Transistor J109-18 n Fet	360-188
Q 154	Transistor J109-18 n Fet	360-188
Q 155	Transistor J109-18 n Fet	360-188
Q 156	Transistor J109-18 n Fet	360-188
Q 157	Transistor JFet-N J112, TO92	360-114
Q 158	Transistor FET J106 N 25V	360-261
Q 159	Transistor FET J106 N 25V	360-261
Q 160	Transistor J109-18 n Fet	360-188
Q 161	Transistor J109-18 n Fet	360-188
Q 162	Transistor J109-18 n Fet	360-188
Q 163	Transistor J109-18 n Fet	360-188
Q 164	Transistor J109-18 n Fet	360-188
Q 165	Transistor J109-18 n Fet	360-188
Q 166	Transistor J109-18 n Fet	360-188
Q 167	Transistor J109-18 n Fet	360-188
Q 168	Transistor J109-18 n Fet	360-188
Q 169	Transistor J109-18 n Fet	360-188
Q 170	Transistor FET J106 N 25V	360-261
Q 172	Transistor JFet-N J112, TO92	360-114
Q 173	Transistor J109-18 n Fet	360-188
Q 174	Transistor J109-18 n Fet	360-188
Q 175	Transistor 2N3904 pnp	360-064
Q 176	Transistor BC547B npn	360-159
Q 177	Transistor BC327-25 SI PNP 45V 1A 800mW TO-92	360-224

INTEGRATED ANALOG CIRCUITS

QA 1	IC NE5532A Dual OP-Amp low noise	364-640
QA 2	IC 5534A OP-Amp low noice	364-518
QA 3	IC NE5532A Dual OP-Amp low noise	364-640
QA 4	IC NE5532A Dual OP-Amp low noise	364-640
QA 5	IC NE5532A Dual OP-Amp low noise	364-640
QA 6	IC NE5532A Dual OP-Amp low noise	364-640
QA 7	IC NE5532A Dual OP-Amp low noise	364-640
QA 8	IC 5534A OP-Amp low noice	364-518
QA 9	IC 5534A OP-Amp low noice	364-518
QA 10	IC LF356 op amp	364-203
QA 11	IC LF356 op amp	364-203
QA 12	IC 5534A OP-Amp low noice	364-518
QA 13	IC NE5532A Dual OP-Amp low noise	364-640
QA 14	IC NE5532A Dual OP-Amp low noise	364-640
QA 15	IC 5534A OP-Amp low noice	364-518
QA 16	IC 5534A OP-Amp low noice	364-518

QA 17	IC LF356 op amp	364-203
QA 18	IC LF356 op amp	364-203
QA 19	IC NE5532A Dual OP-Amp low noise	364-640
QA 20	IC NE5532A Dual OP-Amp low noise	364-640
QA 21	IC NE5532A Dual OP-Amp low noise	364-640
QA 22	IC TL082 dual op amp	364-619
QA 23	IC AD637J RMS to DC converter	364-618
QA 24	IC LM324N Quad OP-Amp	364-176
QA 25	IC LM324N Quad OP-Amp	364-176
QA 26	IC LM324N Quad OP-Amp	364-176
QA 27	IC LM324N Quad OP-Amp	364-176
QA 28	IC LM324N Quad OP-Amp	364-176
QA 29	IC LM324N Quad OP-Amp	364-176
QA 30	IC LM324N Quad OP-Amp	364-176
QA 31	IC LM324N Quad OP-Amp	364-176

INTEGRATED DIGITAL CIRCUITS

QD 1	IC HEF4724BP 8-bit adessable latch	364-412
QD 2	IC HEF4724BP 8-bit adessable latch	364-412
QD 3	IC HEF4724BP 8-bit adessable latch	364-412
QD 4	IC HEF4724BP 8-bit adessable latch	364-412
QD 5	IC HEF4724BP 8-bit adessable latch	364-412
QD 6	IC CD74HCT138 3-to-8 line dec.	364-570
QD 8	IC CD74HCT138 3-to-8 line dec.	364-570
QD 9	IC SN74LS03 Quad 2-input Nand gate open collector	364-329
QD 11	IC SN74LS245 Octal bus transceiver	364-332

RESISTORS

R 1	R Thick Film 10*100K 5% 0.1W	146-015
R 2	R Thick Film 10*100K 5% 0.1W	146-015
R 3	R Thick Film 10*100K 5% 0.1W	146-015
R 4	R Thick Film 10*100K 5% 0.1W	146-015
R 5	R Thick Film 10*100K 5% 0.1W	146-015
R 6	R Thick Film 10*100K 5% 0.1W	146-015
R 7	R Thick Film 10*100K 5% 0.1W	146-015
R 8	R Thick Film 10*100K 5% 0.1W	146-015
R 9	R Thick Film 10*100K 5% 0.1W	146-015
R 10	R Thick Film 10*100K 5% 0.1W	146-015
R 11	R Thick Film 10*100K 5% 0.1W	146-015
R 12	R Thick Film 10*100K 5% 0.1W	146-015
R 13	R Thick Film 4*100K 5% 0.1W	146-014
R 14	R Thick Film 4*100K 5% 0.1W	146-014
R 15	R Thick Film 4*100K 5% 0.1W	146-014
R 16	R Thick Film 4*100K 5% 0.1W	146-014
R 17	R Thick Film 4*100K 5% 0.1W	146-014
R 18	R Thick Film 4*100K 5% 0.1W	146-014
R 19	R Thick Film 4*100K 5% 0.1W	146-014
R 20	R Thick Film 4*100K 5% 0.1W	146-014
R 21	R Thick Film 4*100K 5% 0.1W	146-014
R 22	R Thick Film 4*100K 5% 0.1W	146-014
R 23	R Thick Film 4*100K 5% 0.1W	146-014
R 24	R Thick Film 4*100K 5% 0.1W	146-014

R 25	R Metal Film 7K68 0.5% 0.4W TC50	141-145
R 26	R Metal Film 82E5 1% 0.5W TC50	112-825
R 27	R Metal Film 15K4 0.5% 0.4W TC50	141-146
R 28	R Metal Film 137E 1% 0.5W TC50	113-137
R 29	R Metal Film 30K9 0.5% 0.4W TC50	141-147
R 30	R Metal Film 178E 1% 0.5W TC50	113-178
R 31	R Metal Film 61K9 0.5% 0.4W TC50	141-149
R 32	R Metal Film 261E 1% 0.5W TC50	113-261
R 33	R Metal Film 124K 0.5% 0.4W TC50	141-064
R 34	R Metal Film 332E 1% 0.5W TC50	113-332
R 35	R Metal Film 249K 0.5% 0.4W TC50	141-063
R 36	R Metal Film 499K 0.5% 0.4W TC50	141-142
R 37	R Metal Film 1M00 1% 0.5W TC50	117-100
R 38	R Carbon Film 2M 5% 0.2W	106-720
R 39	R Carbon Film 3M9 5% 0.2W	106-739
R 40	R Metal Film 82E5 1% 0.5W TC50	112-825
R 41	R Metal Film 7K68 0.5% 0.4W TC50	141-145
R 42	R Metal Film 137E 1% 0.5W TC50	113-137
R 43	R Metal Film 15K4 0.5% 0.4W TC50	141-146
R 44	R Metal Film 178E 1% 0.5W TC50	113-178
R 45	R Metal Film 30K9 0.5% 0.4W TC50	141-147
R 46	R Metal Film 261E 1% 0.5W TC50	113-261
R 47	R Metal Film 61K9 0.5% 0.4W TC50	141-149
R 48	R Metal Film 332E 1% 0.5W TC50	113-332
R 49	R Metal Film 124K 0.5% 0.4W TC50	141-064
R 50	R Metal Film 249K 0.5% 0.4W TC50	141-063
R 51	R Metal Film 499K 0.5% 0.4W TC50	141-142
R 52	R Metal Film 1M00 1% 0.5W TC50	117-100
R 53	R Carbon Film 2M 5% 0.2W	106-720
R 54	R Carbon Film 3M9 5% 0.2W	106-739
R 55	R Metal Film 7K68 0.5% 0.4W TC50	141-145
R 56	R Metal Film 82E5 1% 0.5W TC50	112-825
R 57	R Metal Film 15K4 0.5% 0.4W TC50	141-146
R 58	R Metal Film 137E 1% 0.5W TC50	113-137
R 59	R Metal Film 30K9 0.5% 0.4W TC50	141-147
R 60	R Metal Film 178E 1% 0.5W TC50	113-178
R 61	R Metal Film 61K9 0.5% 0.4W TC50	141-149
R 62	R Metal Film 261E 1% 0.5W TC50	113-261
R 63	R Metal Film 124K 0.5% 0.4W TC50	141-064
R 64	R Metal Film 332E 1% 0.5W TC50	113-332
R 65	R Metal Film 249K 0.5% 0.4W TC50	141-063
R 66	R Metal Film 499K 0.5% 0.4W TC50	141-142
R 67	R Metal Film 1M00 1% 0.5W TC50	117-100
R 68	R Carbon Film 2M 5% 0.2W	106-720
R 69	R Carbon Film 3M9 5% 0.2W	106-739
R 70	R Metal Film 82E5 1% 0.5W TC50	112-825
R 71	R Metal Film 7K68 0.5% 0.4W TC50	141-145
R 72	R Metal Film 137E 1% 0.5W TC50	113-137
R 73	R Metal Film 15K4 0.5% 0.4W TC50	141-146
R 74	R Metal Film 178E 1% 0.5W TC50	113-178
R 75	R Metal Film 30K9 0.5% 0.4W TC50	141-147
R 76	R Metal Film 261E 1% 0.5W TC50	113-261
R 77	R Metal Film 61K9 0.5% 0.4W TC50	141-149
R 78	R Metal Film 332E 1% 0.5W TC50	113-332

R	79	R Metal Film 124K 0.5% 0.4W TC50	141-064
R	80	R Metal Film 249K 0.5% 0.4W TC50	141-063
R	81	R Metal Film 499K 0.5% 0.4W TC50	141-142
R	82	R Metal Film 1M00 1% 0.5W TC50	117-100
R	83	R Carbon Film 2M 5% 0.2W	106-720
R	84	R Carbon Film 3M9 5% 0.2W	106-739
R	85	R Metal Film 7K68 0.5% 0.4W TC50	141-145
R	86	R Metal Film 82E5 1% 0.5W TC50	112-825
R	87	R Metal Film 15K4 0.5% 0.4W TC50	141-146
R	88	R Metal Film 137E 1% 0.5W TC50	113-137
R	89	R Metal Film 30K9 0.5% 0.4W TC50	141-147
R	90	R Metal Film 178E 1% 0.5W TC50	113-178
R	91	R Metal Film 61K9 0.5% 0.4W TC50	141-149
R	92	R Metal Film 261E 1% 0.5W TC50	113-261
R	93	R Metal Film 124K 0.5% 0.4W TC50	141-064
R	94	R Metal Film 332E 1% 0.5W TC50	113-332
R	95	R Metal Film 249K 0.5% 0.4W TC50	141-063
R	96	R Metal Film 499K 0.5% 0.4W TC50	141-142
R	97	R Metal Film 1M00 1% 0.5W TC50	117-100
R	98	R Carbon Film 2M 5% 0.2W	106-720
R	99	R Carbon Film 3M9 5% 0.2W	106-739
R	100	R Metal Film 7K68 0.5% 0.4W TC50	141-145
R	101	R Metal Film 82E5 1% 0.5W TC50	112-825
R	102	R Metal Film 15K4 0.5% 0.4W TC50	141-146
R	103	R Metal Film 137E 1% 0.5W TC50	113-137
R	104	R Metal Film 30K9 0.5% 0.4W TC50	141-147
R	105	R Metal Film 178E 1% 0.5W TC50	113-178
R	106	R Metal Film 61K9 0.5% 0.4W TC50	141-149
R	107	R Metal Film 261E 1% 0.5W TC50	113-261
R	108	R Metal Film 124K 0.5% 0.4W TC50	141-064
R	109	R Metal Film 332E 1% 0.5W TC50	113-332
R	110	R Metal Film 249K 0.5% 0.4W TC50	141-063
R	111	R Metal Film 499K 0.5% 0.4W TC50	141-142
R	112	R Metal Film 1M00 1% 0.5W TC50	117-100
R	113	R Carbon Film 2M 5% 0.2W	106-720
R	114	R Carbon Film 3M9 5% 0.2W	106-739
R	115	R Metal Film 7K68 0.5% 0.4W TC50	141-145
R	116	R Metal Film 82E5 1% 0.5W TC50	112-825
R	117	R Metal Film 15K4 0.5% 0.4W TC50	141-146
R	118	R Metal Film 137E 1% 0.5W TC50	113-137
R	119	R Metal Film 30K9 0.5% 0.4W TC50	141-147
R	120	R Metal Film 178E 1% 0.5W TC50	113-178
R	121	R Metal Film 61K9 0.5% 0.4W TC50	141-149
R	122	R Metal Film 261E 1% 0.5W TC50	113-261
R	123	R Metal Film 124K 0.5% 0.4W TC50	141-064
R	124	R Metal Film 332E 1% 0.5W TC50	113-332
R	125	R Metal Film 249K 0.5% 0.4W TC50	141-063
R	126	R Metal Film 499K 0.5% 0.4W TC50	141-142
R	127	R Metal Film 1M00 1% 0.5W TC50	117-100
R	128	R Carbon Film 2M 5% 0.2W	106-720
R	129	R Carbon Film 3M9 5% 0.2W	106-739
R	130	R Metal Film 82E5 1% 0.5W TC50	112-825
R	131	R Metal Film 7K68 0.5% 0.4W TC50	141-145
R	132	R Metal Film 137E 1% 0.5W TC50	113-137

R	133	R Metal Film 15K4 0.5% 0.4W TC50	141-146
R	134	R Metal Film 178E 1% 0.5W TC50	113-178
R	135	R Metal Film 30K9 0.5% 0.4W TC50	141-147
R	136	R Metal Film 261E 1% 0.5W TC50	113-261
R	137	R Metal Film 61K9 0.5% 0.4W TC50	141-149
R	138	R Metal Film 332E 1% 0.5W TC50	113-332
R	139	R Metal Film 124K 0.5% 0.4W TC50	141-064
R	140	R Metal Film 249K 0.5% 0.4W TC50	141-063
R	141	R Metal Film 499K 0.5% 0.4W TC50	141-142
R	142	R Metal Film 1M00 1% 0.5W TC50	117-100
R	143	R Carbon Film 2M 5% 0.2W	106-720
R	144	R Carbon Film 3M9 5% 0.2W	106-739
R	145	R Metal Film 7K68 0.5% 0.4W TC50	141-145
R	146	R Metal Film 82E5 1% 0.5W TC50	112-825
R	147	R Metal Film 15K4 0.5% 0.4W TC50	141-146
R	148	R Metal Film 137E 1% 0.5W TC50	113-137
R	149	R Metal Film 30K9 0.5% 0.4W TC50	141-147
R	150	R Metal Film 178E 1% 0.5W TC50	113-178
R	151	R Metal Film 61K9 0.5% 0.4W TC50	141-149
R	152	R Metal Film 261E 1% 0.5W TC50	113-261
R	153	R Metal Film 124K 0.5% 0.4W TC50	141-064
R	154	R Metal Film 332E 1% 0.5W TC50	113-332
R	155	R Metal Film 249K 0.5% 0.4W TC50	141-063
R	156	R Metal Film 499K 0.5% 0.4W TC50	141-142
R	157	R Metal Film 1M00 1% 0.5W TC50	117-100
R	158	R Carbon Film 2M 5% 0.2W	106-720
R	159	R Carbon Film 3M9 5% 0.2W	106-739
R	160	R Metal Film 7K68 0.5% 0.4W TC50	141-145
R	161	R Metal Film 82E5 1% 0.5W TC50	112-825
R	162	R Metal Film 15K4 0.5% 0.4W TC50	141-146
R	163	R Metal Film 137E 1% 0.5W TC50	113-137
R	164	R Metal Film 30K9 0.5% 0.4W TC50	141-147
R	165	R Metal Film 178E 1% 0.5W TC50	113-178
R	166	R Metal Film 61K9 0.5% 0.4W TC50	141-149
R	167	R Metal Film 261E 1% 0.5W TC50	113-261
R	168	R Metal Film 124K 0.5% 0.4W TC50	141-064
R	169	R Metal Film 332E 1% 0.5W TC50	113-332
R	170	R Metal Film 249K 0.5% 0.4W TC50	141-063
R	171	R Metal Film 499K 0.5% 0.4W TC50	141-142
R	172	R Metal Film 1M00 1% 0.5W TC50	117-100
R	173	R Carbon Film 2M 5% 0.2W	106-720
R	174	R Carbon Film 3M9 5% 0.2W	106-739
R	175	R Metal Film 7K68 0.5% 0.4W TC50	141-145
R	176	R Metal Film 82E5 1% 0.5W TC50	112-825
R	177	R Metal Film 15K4 0.5% 0.4W TC50	141-146
R	178	R Metal Film 137E 1% 0.5W TC50	113-137
R	179	R Metal Film 30K9 0.5% 0.4W TC50	141-147
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R	181	R Metal Film 61K9 0.5% 0.4W TC50	141-149
R	182	R Metal Film 261E 1% 0.5W TC50	113-261
R	183	R Metal Film 124K 0.5% 0.4W TC50	141-064
R	184	R Metal Film 332E 1% 0.5W TC50	113-332
R	185	R Metal Film 249K 0.5% 0.4W TC50	141-063
R	186	R Metal Film 499K 0.5% 0.4W TC50	141-142

R	187	R Metal Film 1M00 1% 0.5W TC50	117-100
R	188	R Carbon Film 2M 5% 0.2W	106-720
R	189	R Carbon Film 3M9 5% 0.2W	106-739
R	190	R Metal Film 82E5 1% 0.5W TC50	112-825
R	191	R Metal Film 7K68 0.5% 0.4W TC50	141-145
R	192	R Metal Film 137E 1% 0.5W TC50	113-137
R	193	R Metal Film 15K4 0.5% 0.4W TC50	141-146
R	194	R Metal Film 178E 1% 0.5W TC50	113-178
R	195	R Metal Film 30K9 0.5% 0.4W TC50	141-147
R	196	R Metal Film 261E 1% 0.5W TC50	113-261
R	197	R Metal Film 61K9 0.5% 0.4W TC50	141-149
R	198	R Metal Film 332E 1% 0.5W TC50	113-332
R	199	R Metal Film 124K 0.5% 0.4W TC50	141-064
R	200	R Metal Film 249K 0.5% 0.4W TC50	141-063
R	201	R Metal Film 499K 0.5% 0.4W TC50	141-142
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R	203	R Carbon Film 2M 5% 0.2W	106-720
R	204	R Carbon Film 3M9 5% 0.2W	106-739
R	205	R Carbon Film 22E 5% 0.2W	106-222
R	206	R Carbon Film 1K 5% 0.2W	106-410
R	207	R Carbon Film 33K 5% 0.2W	106-533
R	208	R Carbon Film 470E 5% 0.2W	106-347
R	209	R Carbon 10K 5% 0.2w	106-510
R	210	R Carbon Film 22E 5% 0.2W	106-222
R	211	R Carbon 10K 5% 0.2w	106-510
R	212	R Carbon Film 100K 5% 0.2W	106-610
R	213	R Metal Film 549E 1% 0.5W TC50	113-549
R	214	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	215	R Metal Film 49K9 0.1% 0.4W TC50	141-138
R	216	R Metal Film 2K49 0.5% 0.4W TC50	141-174
R	217	R Metal Film 49K9 0.1% 0.4W TC50	141-138
R	218	R Carbon Film 22E 5% 0.2W	106-222
R	219	R Metal Film 24K9 0.5% 0.4W TC50	140-697
R	220	R Metal Film 1K 0.5% 0.4W TC50	141-144
R	221	R Metal Film 4K99 0.5% 0.4W TC50	140-734
R	222	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	223	R Metal Film 63K4 0.5% 0.4W TC50	141-175
R	224	R Carbon 10K 5% 0.2w	106-510
R	225	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	226	R Carbon Film 27K 5% 0.2W	106-527
R	227	R Carbon Film 470E 5% 0.2W	106-347
R	228	R Carbon 10K 5% 0.2w	106-510
R	229	R Carbon Film 22E 5% 0.2W	106-222
R	230	R Carbon 10K 5% 0.2w	106-510
R	231	R Carbon Film 100K 5% 0.2W	106-610
R	232	R Carbon Film 100K 5% 0.2W	106-610
R	233	R Metal Film 15K8 0.1% 0.4W TC50	141-195
R	234	R Metal Film 49K9 0.1% 0.4W TC50	141-138
R	235	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	236	R Metal Film 49K9 0.1% 0.4W TC50	141-138
R	237	R Carbon Film 22E 5% 0.2W	106-222
R	238	R Metal Film 24K9 0.5% 0.4W TC50	140-697
R	239	R Metal Film 1K 0.5% 0.4W TC50	141-144
R	240	R Metal Film 4K99 0.5% 0.4W TC50	140-734

R 241	R Metal Film 32K 0.5% 0.4W TC50	141-148
R 242	R Metal film 4k99 0.1% 0.25w TC25	140-981
R 243	R Carbon Film 4K7 5% 0.2W	106-447
R 244	R Metal film 4k99 0.1% 0.25w TC25	140-981
R 245	R Carbon Film 33K 5% 0.2W	106-533
R 246	R Carbon Film 33K 5% 0.2W	106-533
R 247	R Carbon Film 33K 5% 0.2W	106-533
R 248	R Carbon Film 100K 5% 0.2W	106-610
R 249	R Carbon Film 100K 5% 0.2W	106-610
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R 253	R Carbon Film 22E 5% 0.2W	106-222
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R 255	R Metal Film 10K 0.5% 0.4W TC50	140-750
R 256	R Carbon Film 2K2 5% 0.2W	106-422
R 257	R Carbon Film 470E 5% 0.2W	106-347
R 258	R Metal Film 3K65 1% 0.5W TC50	114-365
R 259	R Cermet Trimpot 1K 10% 0.5W TC70	182-310
R 260	R Metal Film 2K00 1% 0.5W TC50	114-200
R 261	R Carbon Film 100K 5% 0.2W	106-610
R 262	R Carbon Film 100K 5% 0.2W	106-610
R 263	R Carbon Film 100K 5% 0.2W	106-610
R 264	R Metal Film 499K 0.5% 0.4W TC50	141-062
R 265	R Metal Film 15K8 0.1% 0.4W TC50	141-195
R 266	R Metal Film 49K9 0.1% 0.4W TC50	141-138
R 267	R Metal Film 49K9 0.1% 0.4W TC50	141-138
R 268	R Metal Film 4K99 0.5% 0.4W TC50	140-734
R 269	R Carbon Film 22E 5% 0.2W	106-222
R 270	R Metal Film 24K9 0.5% 0.4W TC50	140-697
R 271	R Metal Film 1K 0.5% 0.4W TC50	141-144
R 272	R Metal Film 32K 0.5% 0.4W TC50	141-148
R 273	R Metal Film 4K99 0.5% 0.4W TC50	140-734
R 274	R Metal film 4k99 0.1% 0.25w TC25	140-981
R 275	R Carbon Film 4K7 5% 0.2W	106-447
R 276	R Metal film 4k99 0.1% 0.25w TC25	140-981
R 277	R Metal Film 10K 0.1% 0.4W TC50	141-139
R 278	R Carbon Film 22E 5% 0.2W	106-222
R 279	R Metal Film 3K16 0.1% 0.1W TC50	141-109
R 280	R Metal Film 10K 0.5% 0.4W TC50	140-750
R 281	R Carbon Film 2K2 5% 0.2W	106-422
R 282	R Carbon Film 22E 5% 0.2W	106-222
R 283	R Cermet Trimpot 1K 10% 0.5W TC70	182-310
R 284	R Carbon Film 470E 5% 0.2W	106-347
R 285	R Metal Film 3K65 1% 0.5W TC50	114-365
R 286	R Metal Film 2K00 1% 0.5W TC50	114-200
R 288	R Metal Film 5K76 1% 0.5W TC50	114-576
R 289	R Metal Film 5K23 1% 0.5W TC50	114-523
R 290	R Metal Film 49K9 0.1% 0.4W TC50	141-138
R 291	R Metal Film 4K99 0.5% 0.4W TC50	140-734
R 292	R Metal Film 49K9 0.1% 0.4W TC50	141-138
R 293	R Carbon Film 22E 5% 0.2W	106-222
R 294	R Metal Film 24K9 0.5% 0.4W TC50	140-697
R 295	R Metal Film 1K 0.5% 0.4W TC50	141-144

R	296	R Metal Film 32K 0.5% 0.4W TC50	141-148
R	297	R Metal Film 4K99 0.5% 0.4W TC50	140-734
R	298	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	299	R Carbon Film 4K7 5% 0.2W	106-447
R	300	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	301	R Carbon Film 22E 5% 0.2W	106-222
R	302	R Carbon Film 12K 5% 0.2W	106-512
R	303	R Carbon Film 4K7 5% 0.2W	106-447
R	304	R Carbon Film 470E 5% 0.2W	106-347
R	305	R Carbon Film 33K 5% 0.2W	106-533
R	306	R Carbon Film 100K 5% 0.2W	106-610
R	307	R Carbon Film 15K 5% 0.2W	106-515
R	308	R Carbon Film 47E 5% 0.2W	106-247
R	309	R Carbon Film 33K 5% 0.2W	106-533
R	311	R Carbon Film 390K 5% 0.2W	106-639
R	312	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	313	R Carbon Film 1K 5% 0.2W	106-410
R	315	R Metal Film 2K21 1% 0.5W TC50	114-221
R	316	R Metal Film 2K21 1% 0.5W TC50	114-221
R	317	R Carbon Film 47E 5% 0.2W	106-247
R	318	R Carbon 150E 5% 0.2W	106-315
R	319	R var 2K2 20% 0.5W	182-313
R	320	R Carbon 1M 5% 0.2w	106-710
R	321	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	322	R Carbon Film 1K 5% 0.2W	106-410
R	323	R Carbon Film 390K 5% 0.2W	106-639
R	324	R Carbon Film 100K 5% 0.2W	106-610
R	326	R trick film Sil 8x2K2	146-013
R	327	R Carbon Film 330E 5% 0.2W	106-333
R	328	R Carbon Film 270E 5% 0.2W	106-327
R	329	R Carbon 150E 5% 0.2W	106-315
R	330	R Carbon Film 3K3 5% 0.2W	106-433
R	331	R thick film Sil 8x10K	146-003
R	332	R Metal Film 4K99 0.5% 0.4W TC50	140-734
R	333	R Metal Film 4K99 0.5% 0.4W TC50	140-734

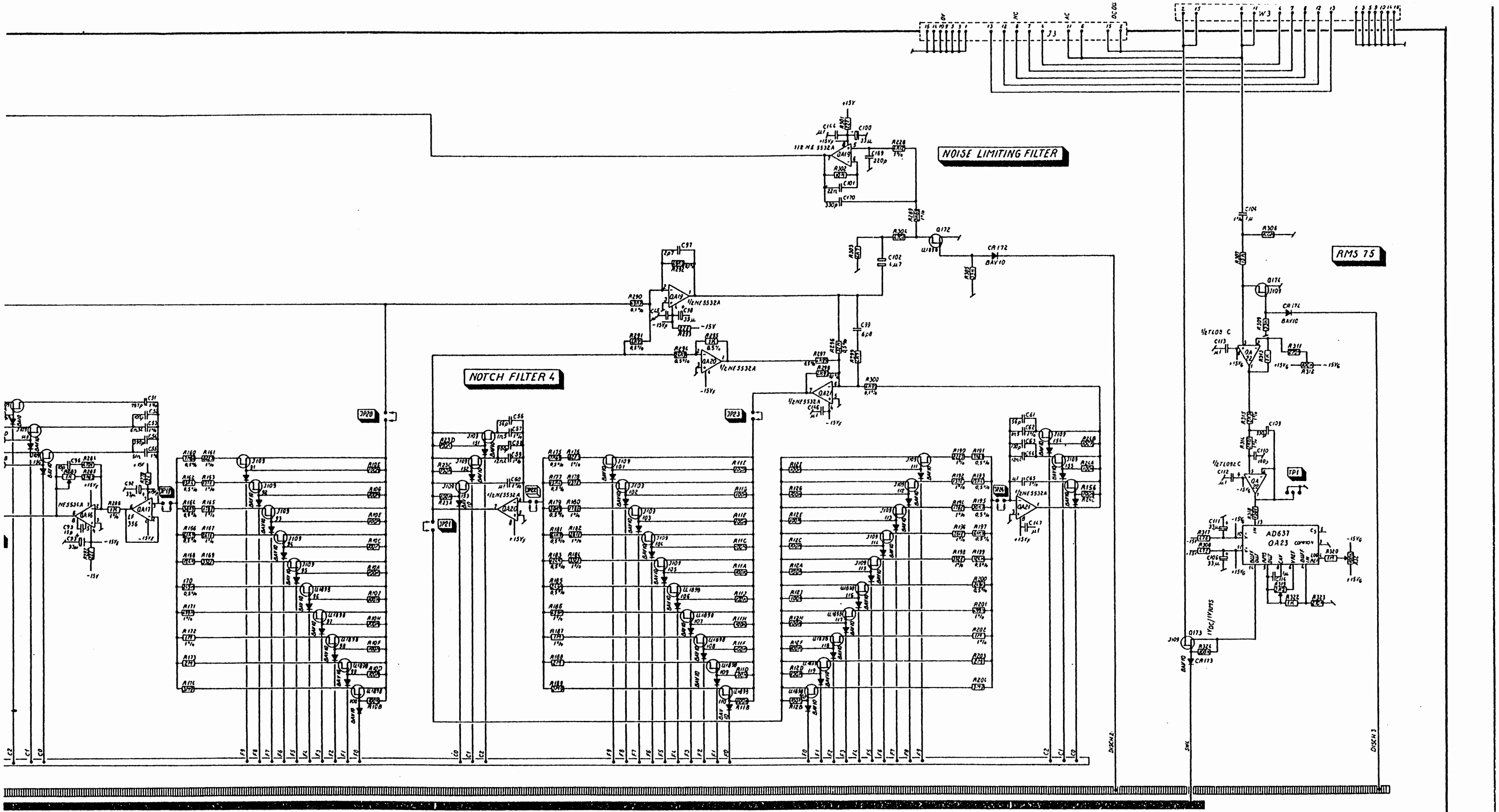
CABLES

W	2	16 Leads Flat Cable with DIP-Plug	617-843
W	3	16 Leads Flat Cable with DIP-Plug	617-843

MISCELLANEOUS

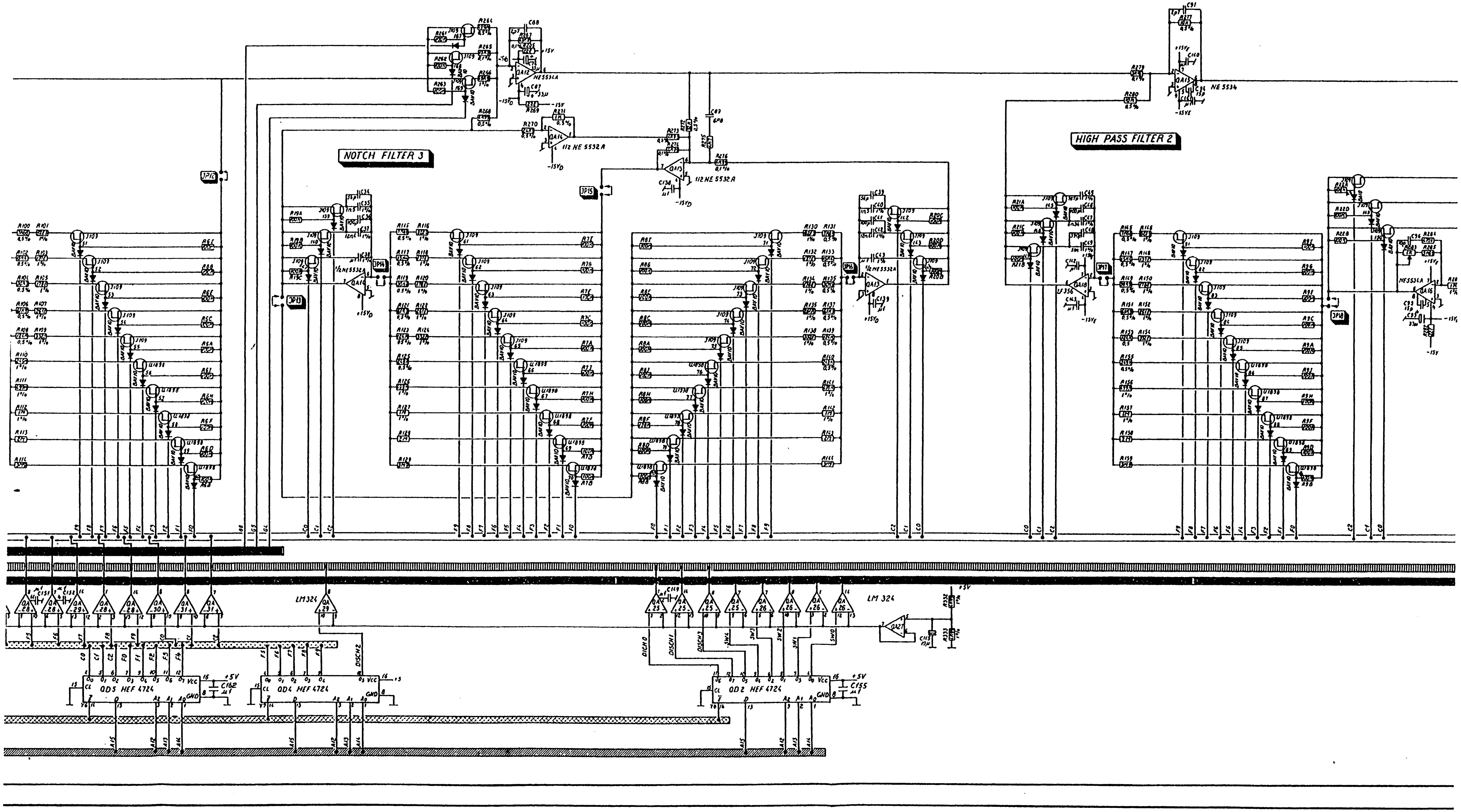
tubular rivet 02.5x0.25x7	060-270
RE201 901-527 QD7 Select PROM	368-237
RE201 Filter Option QD12 Program PROM	368-317
Female Plug	805-718
Wire Wrap Terminal	805-727
14 Pin Dil Socket	816-131
8 Pin Dil Socket	816-132
16 Pin Dil Socket	816-133
24 Pin Dil Socket	816-134
20 Pin DIL Socket	816-184
28 Pin DIL Socket	816-251

Board Extractor	857-017
Conducter Rail C1	931-036
Filter Option PCB	971-247
***** Unknown text *****	983-702



NOTE: NUMBERS 1-156 AND 161-169 DESIGNATE BOTH FET-TRANSISTOR AND DIODE

Subject: Filter Option used in RE 201			RE INSTRUMENTS AS Emdrupvej 26 DK 2100 Copenhagen Ø Denmark +45 (01) 18 44 22 Telefax +45 1 184401 Telex 22211 redk			Sheet of	
						Scale	
Issue/Rev no	1/	2/	3/	4/	5/	PCB	971-247
Date	850710	850904	860521			PCB Assy	901-525
Drawn	TH	BD	BD			Schematic Drawing	985-203
App		NE					



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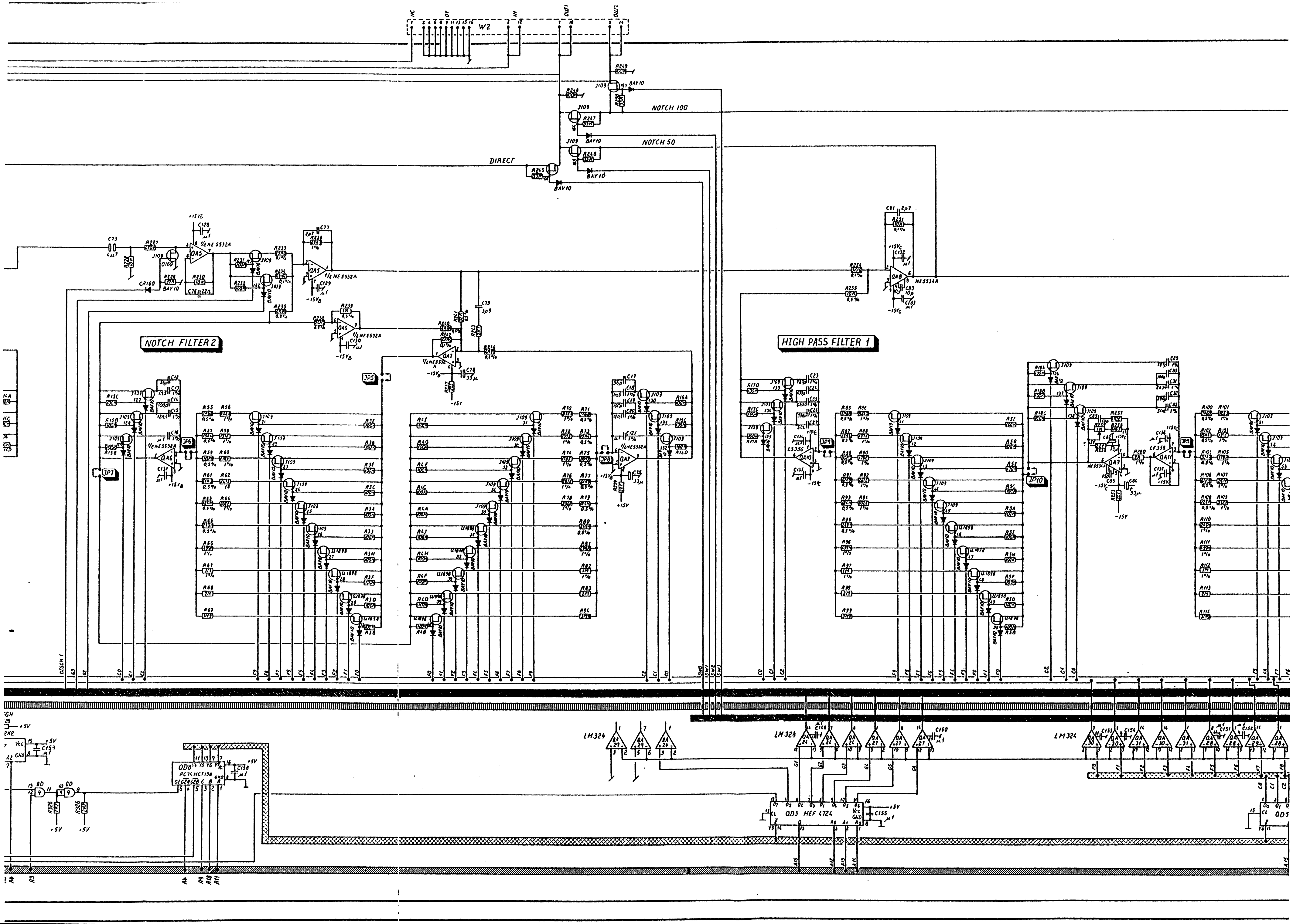
HIGH PASS FILTER 2
NE 5534
LM 324
QD5 HEF 4724
QD4 HEF 4724
QD2 HEF 4724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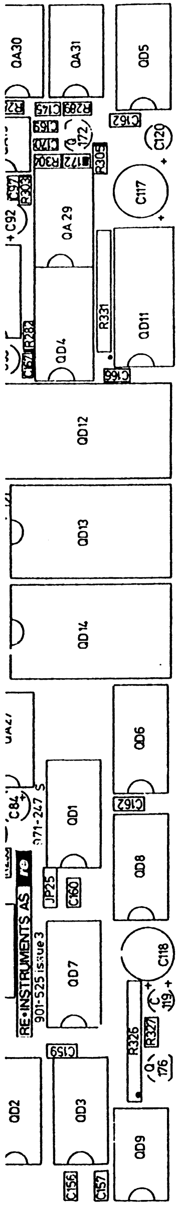
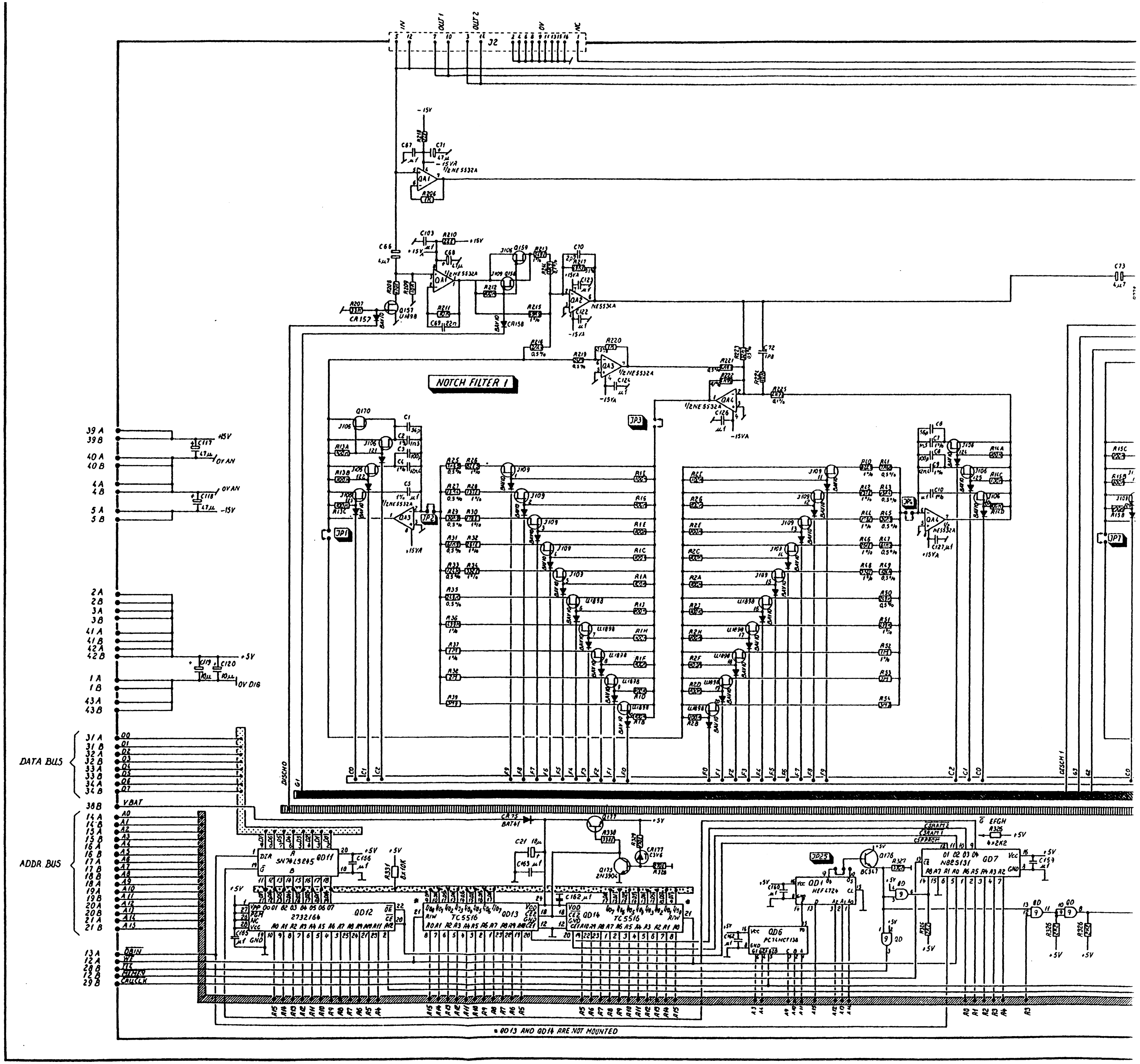
NOTCH 50
DIRECT
NOTCH FILTER 2
HIGH PASS FILTER 1
LM324
QD3 HEF 4724


RE-INSTRUMENTS AS
901-525 issue 3
QA29
QA30
QA31
QD1
QD2
QD3
QD4
QD5
QD6
QD7
QD8
QD9
QD11
QD12
QD13
QD14
C117
C118
JP25


J2
NOTCH FILTER I
DATA BUS
ADDR BUS
VBAT
JP1
JP2
JP3
JP7
JP25
SN74LS245
2732164
TC5516
HEF4724
PC74HCT138
N82S131
1/2NE5532A
NE5532A
+5V
-15V
+15V
* QD13 AND QD14 ARE NOT MOUNTED

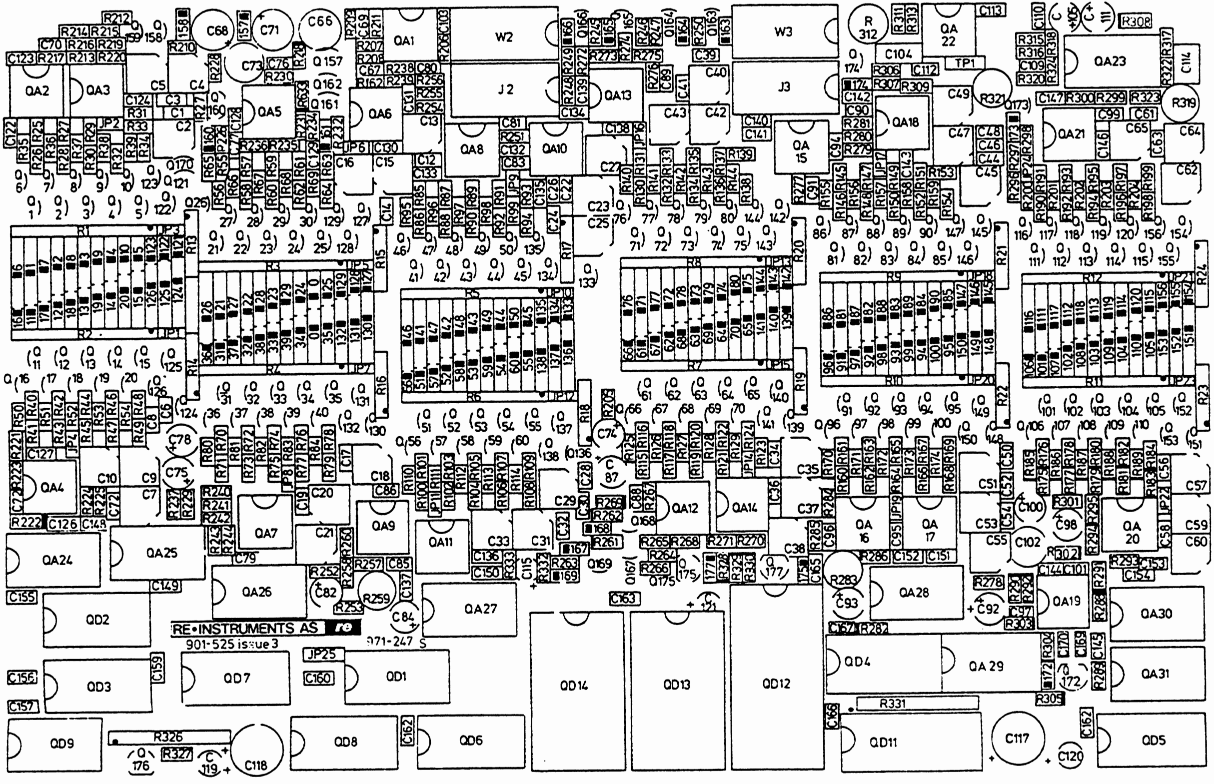

RE•INSTRUMENTS AS
re
901-525 issue 3
971-247 S

TABLE OF CONTENTS

LIST OF FIGURES

1 GENERAL INFORMATION

This manual provides technical and maintenance instructions for the RE201 FSK Option. The circuit board description and adjustment instructions are included to provide the information necessary to service the board.

1.1 Introduction

The FSK facility enables transmission of ASCII strings using the signal path. This is used to remote control the RE201, e.g. while testing a radio link. Transmission of ASCII strings is only available under remote control and is transparent to what is going on.

1.2 Installation

When buying the FSK mod. kit (906-072), an installation instruction (983-289) is supplied. When the FSK board is mounted into the RE201 from the factory, no extra installation is needed.

1.3 Specifications

Mark frequency	1650 Hz
Space frequency	1850 Hz
Tracking range:	
Mark frequency	1585 Hz/1790 Hz
Space frequency	1715 Hz/1925 Hz
Recommended input voltage	-12 dBm

2 PRINCIPLES OF OPERATION

The coded ASCII strings are sent serially using the signal path. The mark/space is represented by 2 frequencies, 1650 Hz/1850 Hz, respectively. The encoded ASCII strings are sent into the RE201 via the RS232 input.

2.1 FSK System

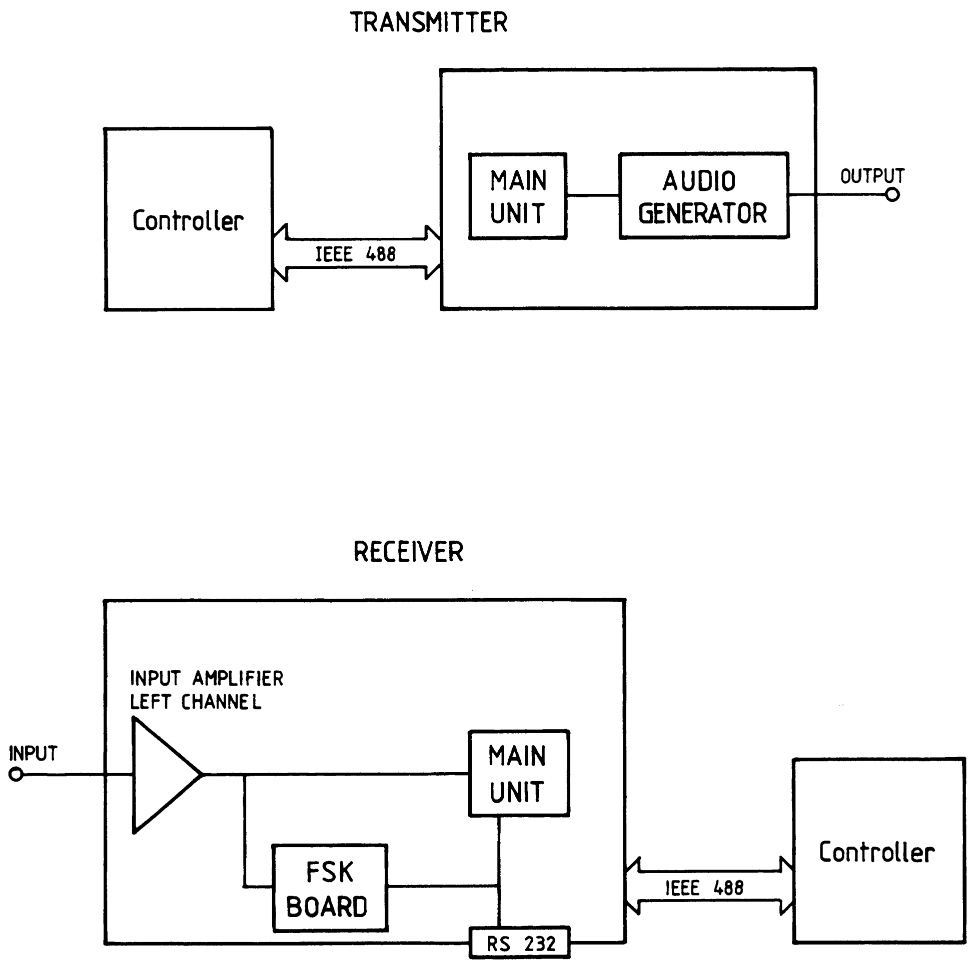


Fig. 2.1 - FSK System Block Diagram

As seen in fig. 2.1, a computer is used in the transmitter to control the Audio Generator in the RE201. The output will consist of the desired test signals as well as the FSK signals.

In the receiver, the input signal is amplified to get a proper level. The FSK input signal, containing both test signals and FSK frequencies, is taken from the left channel. The FSK board searches for FSK frequencies and outputs corresponding logic levels to the RS232 input port. This may cause the RE201 to change function.

2.2 FSK Board

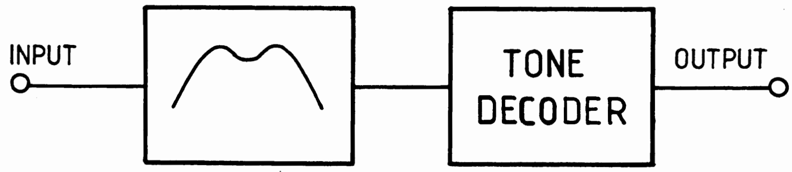


Fig. 2.2 - FSK Board Block Diagram

The FSK board consists of an input filter and a tone decoder.

The input filter is designed to damp most test signals to ease the tone decoding. The FSK frequencies are bypassed, and the input filter is designed to damp 1020 Hz (according to CCITT) at least 30 dB. The tone decoder is built around the IC XR2211, which searches for the 2 FSK frequencies. If the mark frequency is found, and the level is above the lower limit, the output is raised high.

2.3 FSK Commands in the RE201

The ASCII string to be transmitted must be initiated by a start delimiter and completed by an end delimiter. The string may comprise all ASCII characters (except of course the end delimiter).

<SOH>string<EXT>

The default delimiters are, as shown, SOH (decimal 01) as start delimiter and EXT (decimal 03) as stop delimiter. The delimiters may be changed using the FSKDEL command. The syntax for this command is similar to the syntax for CRTDEL. In the actual transmission, the string will always be enclosed by SOH and EXT.

Transmission of FSK strings is transparent to what is going on.

It should be noted, that the Audio Generator output level must be set prior to using the link, and single tone must be selected as source.

When an FSK string is received, the RE201 is put in IDLE and an SRQ code 108 is issued. As regards enabling of SRQ's, the FSK SRQ follows error SRQ's.

3 CIRCUIT DESCRIPTION

Referring to the block diagram in fig. 2.2 and the schematic diagram 985-234, the FSK Option may be divided into two parts; the input filter and the tone decoding.

3.1 Input Filter

The input signal to the input filter as well as the +15V supply, is supplied to the FSK board via the flat cable.

As the filter is built around op-amps, a double power supply is needed. This is supplied by making a 7.5 V DC supply, and this DC difference is removed from the input and output of the filter by condensators (C1, C9).

The filter is a 4th order Chebychev bandpass filter and is realized by 2 SAB blocks.

3.2 Tone Decoding

The tone decoder IC XR2211 is a monolithic phase-locked loop system, especially designed for data communication. By adding passive components, the various frequencies and time constants may be determined. The FSK frequencies are 1650Hz/1850Hz as mark/space and the baud rate is 110.

The data output is connected to the lock detect output, so that the FSK output is only raised high, when the mark frequency is detected at a level above 2 mV. 2 LED's, red and green, are added to inspect the outputs from the tone decoder.

LED's ON:	Indicating:
none	no FSK frequency detected
green	space frequency detected
red	impossible
both	mark frequency detected

The data output from the tone decoder is buffered and connected to the data in pin at the RS-232 connector.

4 MAINTENANCE

This section describes maintenance and adjustment procedures for the FSK Option. The reader is expected to be acquainted with the operation of the RE201.

It is recommended that section 2, Principles of Operation, and section 3, Circuit Description, are studied, before adjustments are commenced.

4.1 Recommended Test Equipment

Table 4.1 lists the test equipment necessary to carry out a qualifying performance test and to adjust the FSK Option if necessary.

Instrument	Critical Specifications	Recommended Model
LF generator	Frequency range 1 kHz-4 kHz	RE201 Audio Generator 901-500
IEEE/IEC bus controller		HP85A w/IEEE interface or Fluke 1720A
DC voltmeter		

4.2 Performance Tests

FSK test signals are supplied to the left channel, and the FSK detection may be monitored at the RS-232 connector pin 2 by a DC voltmeter. A high level (+15V) indicates a mark frequency. The FSK detection may also be inspected visually by the 2 LED's on the FSK board. An overview of the condition indicated by the LED's is listed in section 3.2. It is necessary to remove the bottom plate to see the LED's.

The tracking frequencies may be checked according to the specifications mentioned in section 1.3.

Removal of the pumper JP1 disables the frequency hysteresis, and the tracking ranges will be 1585 Hz/1750 Hz and 1750 Hz/1925 Hz. This is used to frequency adjust the FSK board.

4.3 Adjustment

If the tracking frequency ranges have moved significantly, it is necessary to adjust the FSK board as follows:

1. Remove the jumper JP1.

2. Apply 1750 Hz to the left channel input.

3. Adjust R5 until the green LED is on and the red LED is altering.

4. Replace the jumper.

5 TROUBLESHOOTING

The scope of this section is to provide some troubleshooting hints, which may help to identify an observed error. The FSK output may be monitored at the RS-232 connector pin 2 by a DC voltmeter or at the 2 LED's on the FSK board. A test point, TP1, is included on the FSK board to monitor the signal between the input filter and the tone decoder.

If the FSK detection fails, please check that the right frequencies at a proper level are supplied to the left channel input. Next step is to check that the flat cable connecting the FSK board at the Analog Frontend is properly inserted and not defective. Similarly, check the coax cables connected to the FSK board.

The supply voltage may be monitored at QA1 pin 11 (0V), pin 14 (7.5V) and pin 4 (+15V). The input signal to the FSK board may be monitored at R12; the end closest to the flat cable.

5.1 Performance Test Errors

If proper test signals and supply voltages are supplied to the FSK board, and no signal is present at the test point TP1, there must be an error in the input filter.

If a proper signal is present at the test point TP1, but the LED's are not turned on according to the list in section 3.2, the error must be the tone decoder IC or a bad connection to the connected components.

If the tracking frequency ranges are not adjusted properly, one of the passive components connected to the tone decoder IC must be malfunctioning.

6 PARTS LIST AND SCHEMATIC DIAGRAMS

6.1 Parts List

All electronic components are included in the parts list. Parts marked with a * are manufactured by RE INSTRUMENTS AS.

When ordering spare parts it is important that the following information is included:

* Code No. and description of the part.
* Circuit reference from the schematic diagram.
* Complete type designation of RE product.

FSK Board (901-777)

CAPACITORS

C 1	MKT, 0.1/100/10, R:4*9*13, RM4	241-025
C 2	C Polystyrene 23n7 1% 63V	243-309
C 3	C Polystyrene 23n7 1% 63V	243-309
C 4	C Polystyrene 23n7 1% 63V	243-309
C 5	C Polystyrene 23n7 1% 63V	243-309
C 6	MKT, 0.1/100/10, R:4*9*13, RM4	241-025
C 7	MKT, 0.1/100/10, R:4*9*13, RM4	241-025
C 8	Electrolytic 100/25, 2000h/85°, R:6.3*11, RM2	261-073
C 9	MKT, 0.1/100/10, R:4*9*13, RM4	241-025
C 10	C Ceramic u1 -20+80% 30V	213-009
C 11	MKT, 0.068/250/10, R:4*9*13, RM4	241-054
C 12	C Polyester 27n 10% 400V	240-527
C 13	MKT, 1/63/10, R:6*12*18, RM6	241-027
C 14	C Polystyrene 6n34 1% 63V	243-314
C 15	C Polyester 27n 10% 400V	240-527

DIODES

CR 1	LED 3mm green	350-060
CR 2	LED 3mm red	350-043

RELAYS & JUMPERS

JP 1	2-pol amp connector	805-951

TRANSISTORS

Q 1	Transistor BC547B npn	360-159

INTEGRATED ANALOG CIRCUITS

QA 1	IC TL084 quad op amp	364-276
QA 2	IC XR2211 FSK Demodulator	364-777

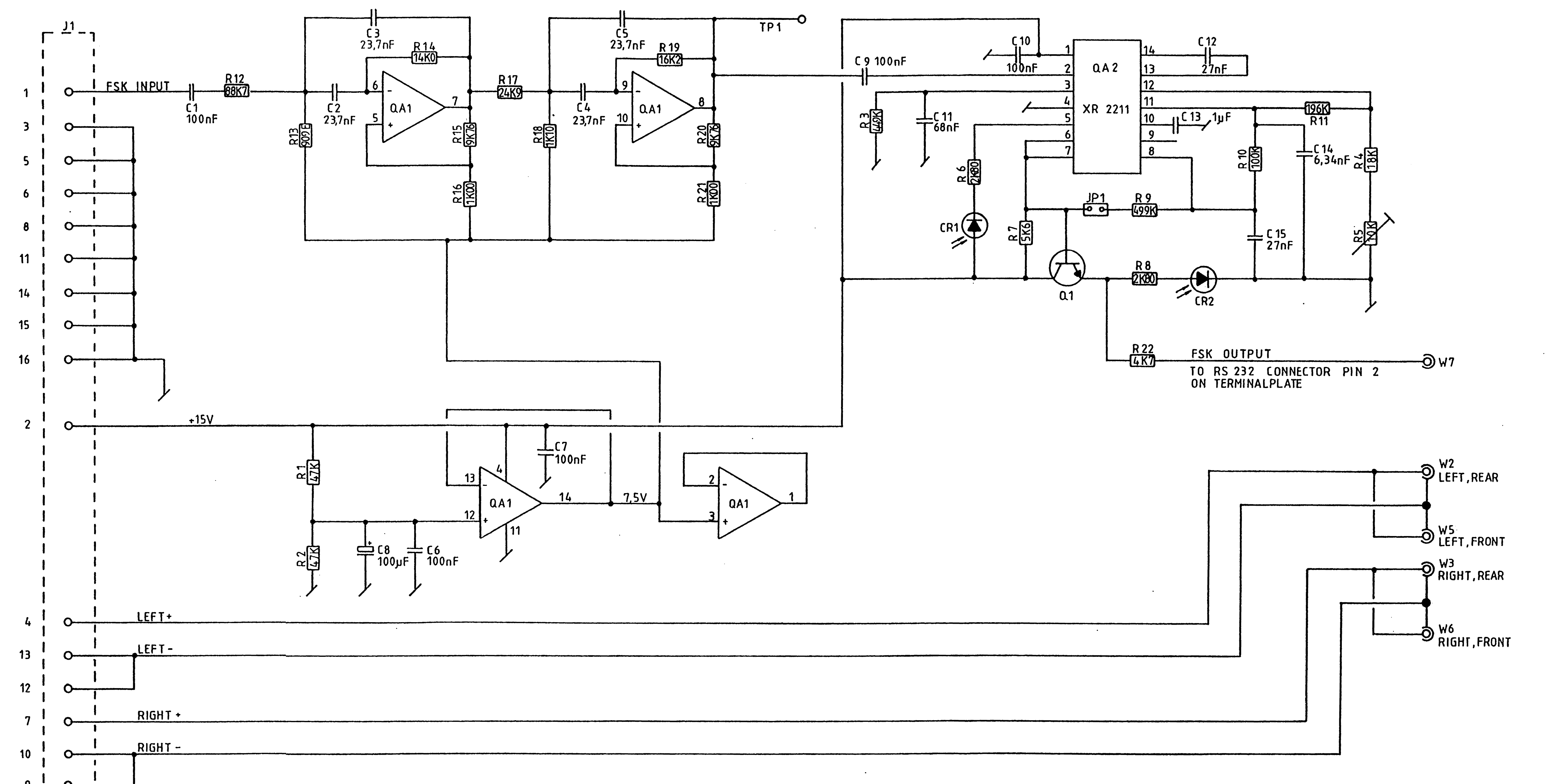
RESISTORS

R 1	R Carbon 47K 5% 0.2w	106-547
R 2	R Carbon 47K 5% 0.2w	106-547
R 3	R Metal Film 499K 1% 0.5W TC50	116-499
R 4	R Carbon Film 18K 5% 0.2W	106-518
R 5	R Cermet Trimpot 10K 20% 0.5W TC70	182-301
R 6	R Metal Film 2K80 1% 0.5W TC50	114-280
R 7	R Carbon Film 5K6 5% 0.2W	106-456
R 8	R Metal Film 2K80 1% 0.5W TC50	114-280
R 9	R Metal Film 499K 1% 0.5W TC50	116-499
R 10	R Carbon Film 100K 5% 0.2W	106-610
R 11	R Metal Film 196K 1% 0.5W TC50	116-196
R 12	R Metal Film 88K7 1% 0.5W TC50	115-887
R 13	R Metal Film 909E 1% 0.5W TC50	113-909
R 14	R Metal Film 14K0 1% 0.5W TC50	115-140

R 15	R Metal Film 9K76 1% 0.5W TC50	114-976
R 16	R Metal Film 1K 0.5% 0.4W TC50	140-444
R 17	R Metal Film 24K9 1% 0.5W TC50	115-249
R 18	R Metal Film 1K10 1% 0.5W TC50	114-110
R 19	R Metal Film 16K2 1% 0.5W TC50	115-162
R 20	R Metal Film 9K76 1% 0.5W TC50	114-976
R 21	R Metal Film 1K 0.5% 0.4W TC50	140-444
R 22	R Carbon Film 4K7 5% 0.2W	106-447

MISCELLANEOUS

Solder sleeve	062-625
Spacer 3.5/6-1.5	065-672
Coax Cable for FSK Output	616-199
Flat Cable with DIP Plug Connector 300mm	617-818
Female Plug	805-718
PCB For FSK	971-338



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Drawn	KMA					Schematic Drawing 985-234
App.	JMA					

TABLE OF CONTENTS

LIST OF FIGURES

1 GENERAL INFORMATION

This manual provides technical information and maintenance instructions for the RE201 Weighting Filters Option Board. Circuit Board description, theory of operation and maintenance instructions are included to provide the information necessary to service the board. All operating instructions are included in the RE201 Operation Manual.

1.1 Introduction

The Weighting Filters Option for the RE201 Dual Channel Audio Analyzer is designed for measurement of noise according to the various procedures recommended in standards for broadcasting, audio equipment and telephone systems.

The Weighting Filters Option incorporates the individual filters needed to perform the required weighting of the signal.

To meet the requirements for special types of detection, a quasi-peak detector is incorporated. When the noise level has to be detected by an RMS or average responding meter, the meter function is provided digitally by the RE201.

Finally, the Weighting Filters Option contains filters for measurement of rumble and weighted crosstalk.

1.2 Installation

When unpacking the Option Board the packing material should be visually inspected for physical damage. If damaged notify the carrier and your local RE INSTRUMENTS representative or the factory. The packing material should be retained for inspection by the carrier in case of complaint.

For installation instructions refer to the RE201 Basic Unit Technical Manual, section 1.2.2.

1.3 Equipment and Accessories

Description	Code No.
Weighting Filters	901-526
Technical Manual for RE201 Weighting Filters	983-260

1.4 Specifications

The responses of the Weighting Filters and the quasi-peak detector are specified by the respective standards:

Standards:

CCIR 468-2, weighted and unweighted
CCIR/ARM
DIN 45633 (IEC 651 A, B, C)
DIN 45300 Bandpass (300 Hz to 15 kHz with 19 kHz notch)
CCITT P53
AT&T C-message
DIN 45539, A and B weighted (IEC 98A, weighted and unweighted)

Detectors:

Quasi-peak (CCIR 468)
RE201 Basic Unit detectors: RMS (Broadband or Selective), Peak and Average

When measuring noise with the RE201 the dynamic range is limited by the noise voltage of the input amplifier in the Frontend. The noise voltage is less than 50 nV/ $\sqrt{Hz}$, i.e. at a noise bandwidth of 22.4 kHz the limit of the noise measurement will be -100 dBm (7 µV).

The environmental requirements for the Weighting Filters Option are identical to those of the RE201 Basic Unit.

2 PRINCIPLES OF OPERATION

For an introduction to the operation of the Weighting Filters Option refer to the simplified Block Diagram in fig. 2.1, which presents the Weighting Filters Option and the Analog Frontend of the RE201 Dual Channel Audio Analyzer.

The Weighting Filters Option comprises a bank of filters, which are inserted in the signal path just after the input amplifier on the Frontend. The quasi-peak detector is inserted just before the S/H amplifier and A/D converter.

During the execution of a weighted measurement the following steps are performed:

An autoranging sequence is performed, utilizing the input amplifiers on the Analog Frontend and the Weighting Filters Option to establish an input level which will not cause internal overload in the selected filter. This is done with switches S19, S20 and S2 closed. After having determined the input level the pertinent filter is inserted and the gain finally adjusted. This is done by opening switch S19, closing the input/output switches of the selected filter, and depending on the selected level measurement, closing switch S4 (measuring RMS or Average), or closing switches S21 and S7 (measuring quasi-peak).

In the following subsections the responses of the individual filters included in the filter bank are shown and their applications discussed.

The following filters are included:

2.1 CCITT P53 and C-message filter for measurement of noise in telephone systems. (CCITT P53 and US standard)

2.2 CCIR 468 and 31.5 Hz to 16 kHz (-0.5 dB) band pass filter for measurement of noise in broadcasting systems and equipment. (CCIR 468 standard)

2.3 300 Hz to 15 kHz (-3 dB) band pass filter for measurement of noise in FM radios. (DIN 45300 standard)

2.4 Sound level filters A, B and C weighting for measurement of noise. (DIN 45633 and IEC 651 standard)

2.5 Rumble filters for measurement of weighted and unweighted rumble in disc record playing equipment (DIN 45539 standard)

2.6 User recommended filters: the IBA filter for measurement of weighted crosstalk and Dolby Lab's filter (CCIR/ARM) for measurement of noise in professional as well as consumer audio equipment.

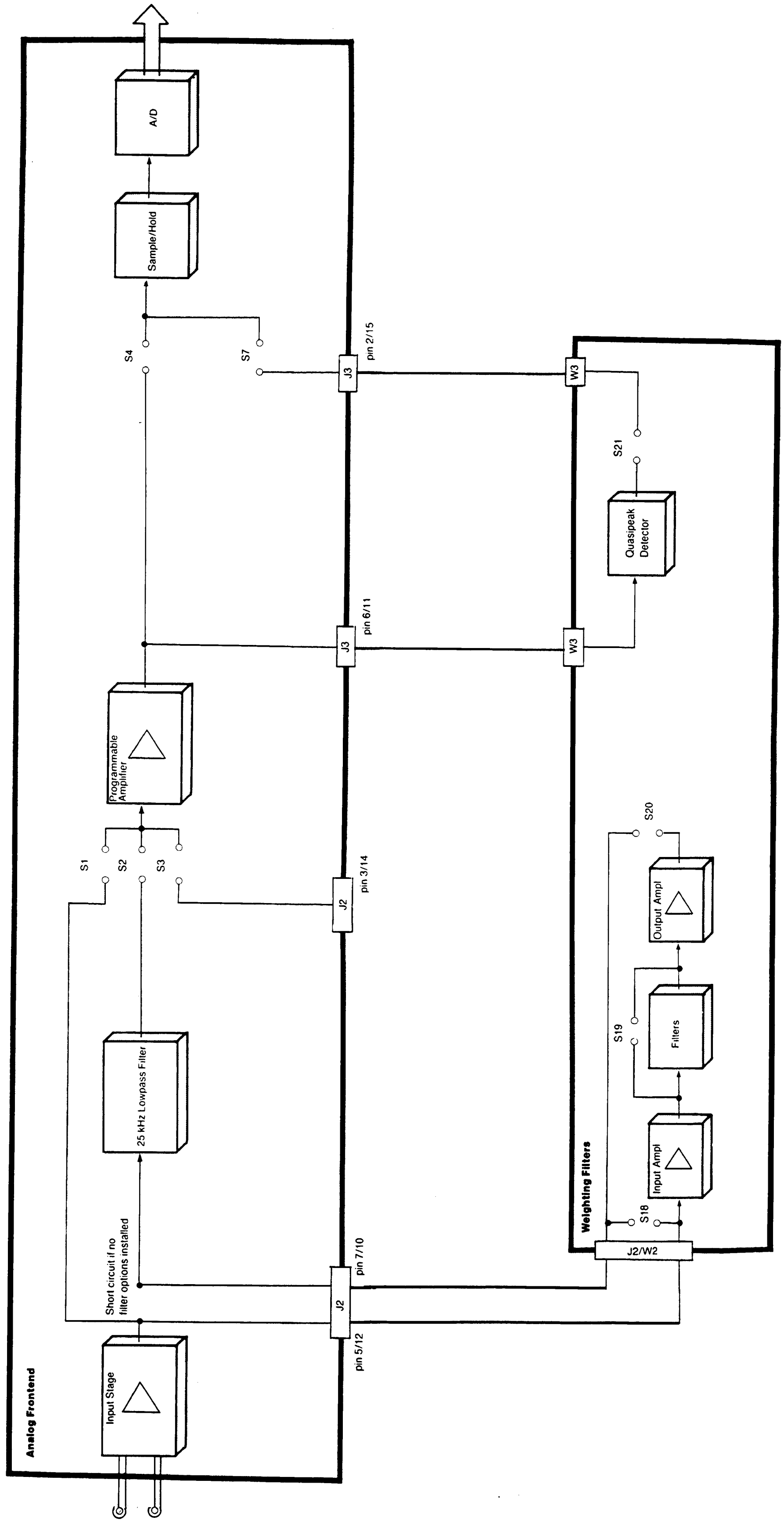

Fig. 2.1 - Weighting Filters and Frontend Block Diagram

2.1 CCITT P53 and C-Message Filters

The transfer characteristics for the CCITT P53 and for the C-Message filter are shown in figs. 2.2 and 2.3.

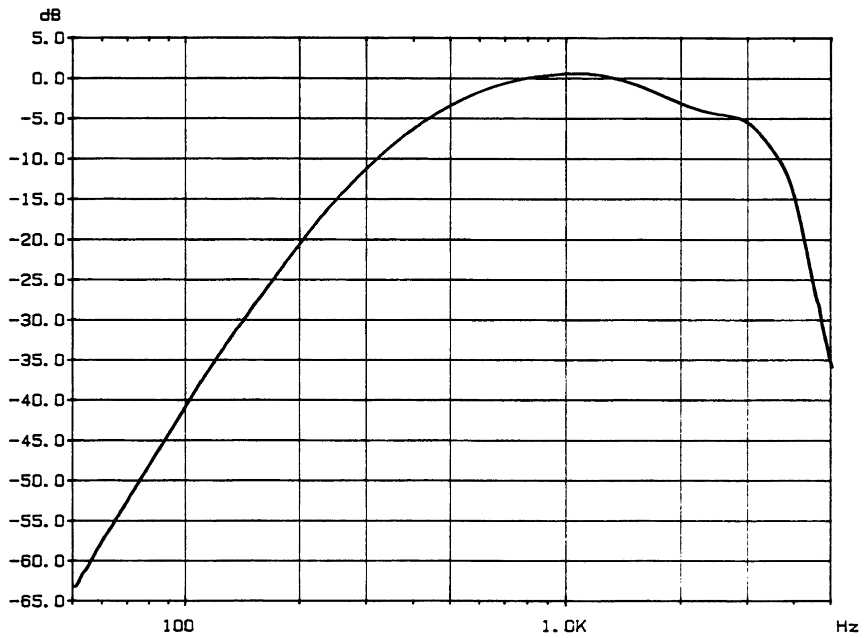

Fig. 2.2 - CCITT P53 Psophometric Filter

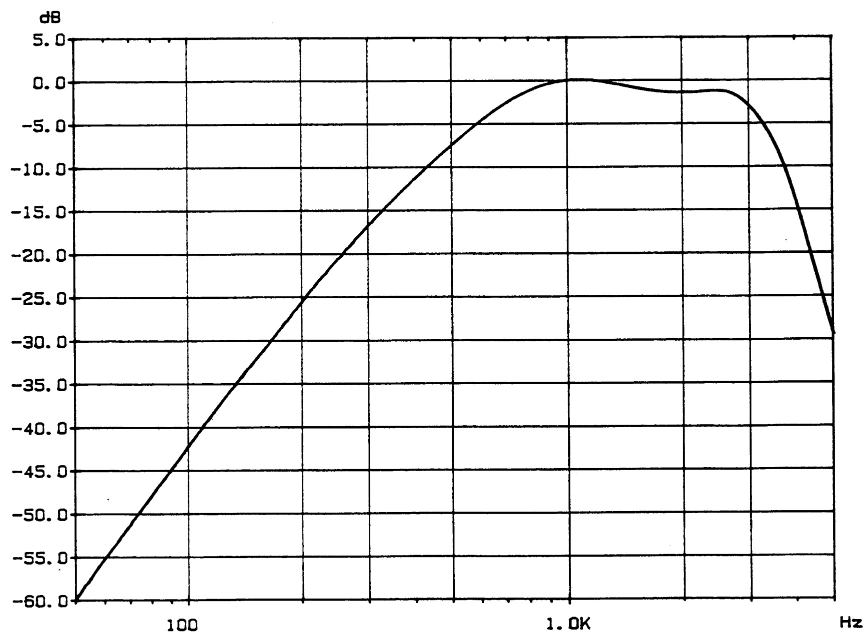

Fig. 2.3 - C-Message Psophometric Filter

Both filters are used for measurement of noise in telephone systems.

The CCITT P53 filter is recommended by the CCITT - the International Telegraph and Telephone Consultative Committee and commonly used in Europe.

The C-Message filter is recommended by the American Telephone and Telegraph Company and therefore used in the United States.

As specified in the standards the weighted signal is RMS detected using an integration time of approx. 250 ms.

2.2 CCIR 468 and 31.5 Hz to 16 kHz Band Pass Filters

The two filters (response shown in figs. 2.4 and 2.5) are recommended by the CCIR - the International Radio Consultative Committee - for measurement of noise in broadcast systems.

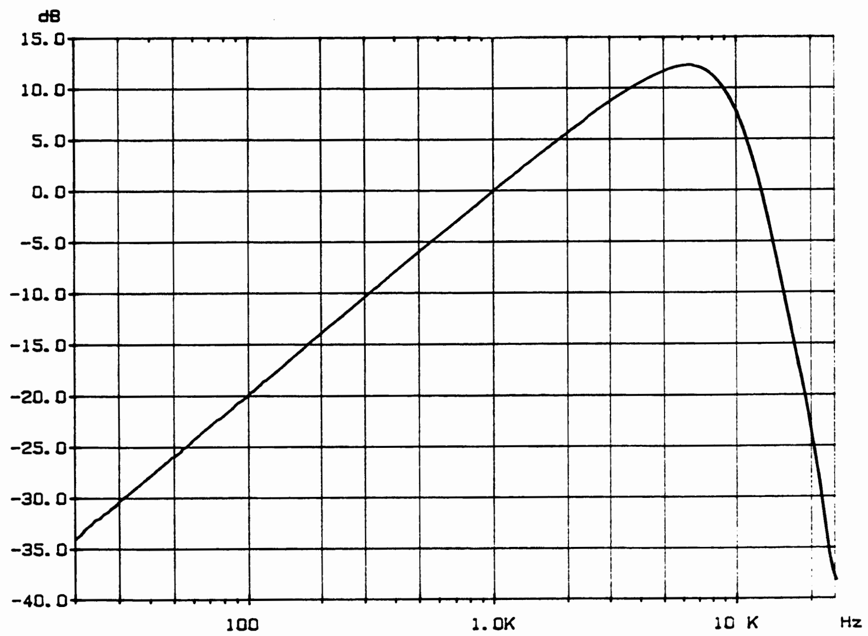

Fig. 2.4 - CCIR 468 Noise Weighting Filter

The CCIR 468 filter is used for measurement of weighted noise, while the 31.5 Hz to 16 kHz band pass filter is used for measurement of unweighted noise. However, the noise bandwidths of the two filters are approximately the same.

When using the CCIR 468 filter, it is specified that the signal must be quasi-peak detected. The detector is a peak to peak detector with a charge time constant of approx. 1.2 ms and a discharge time constant of approx. 300 ms.

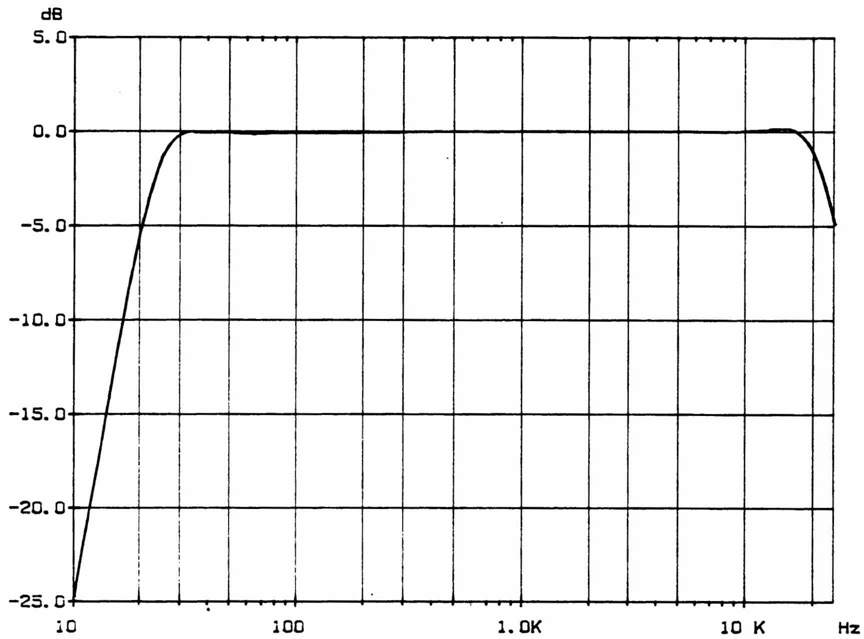

Fig. 2.5 - CCIR Band Pass Filter (31.5 Hz - 16 kHz)

In addition to the transfer characteristics, the CCIR 468 standard specifies the dynamic response of the filter and the detector: when a signal sequence configured of 10 ms bursts of a 5 kHz tone per sec. is applied, the signal reading must be between 72% and 82% of the full scale deflection of a steady 5 kHz signal.

When using the 31.5 Hz to 16 kHz band pass filter for unweighted measurements the noise level is measured by means of the quasi-peak detector. Alternatively, a standard RMS measurement can be performed.

By nature the level of a noise signal is fluctuating with time. Thus, to obtain a steady reading of the quasi-peak detector, the RE201 displays the mean quasi-peak value as well as the maximum quasi-peak value.

When an RMS detector is used it is possible to set the integration time sufficiently long to obtain a steady reading.

2.3 300 Hz to 15 kHz Band Pass Filter

This filter (transfer characteristics shown in fig. 2.6) is recommended in the standard DIN 45300 for measurement of noise in FM radios.

The RMS level of the noise is measured. Usually, the noise level is measured in dB relative to the output level which corresponds to +/-75 kHz deviation of the FM carrier.

To avoid that the measurement is influenced by an insufficiently suppressed 19 kHz pilot tone signal, the filter incorporates a notch at 19 kHz.

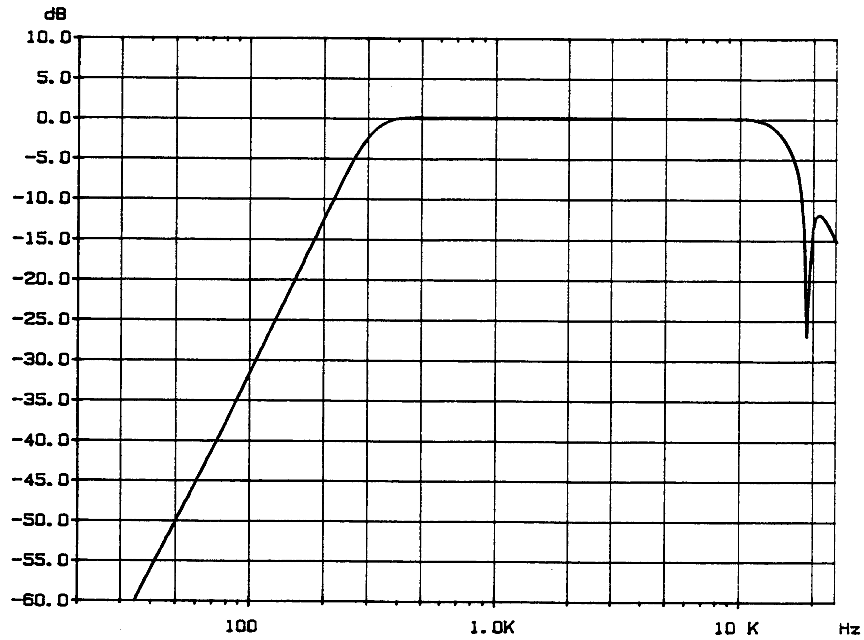

Fig. 2.6 - DIN 45300 Band Pass Filter (300 Hz - 15 kHz)

2.4 A, B and C Weighting Filters

These filters (fig. 2.7, 2.8 and 2.9) are recommended in DIN 45633 and IEC 651 for measurement of sound level, especially noise.

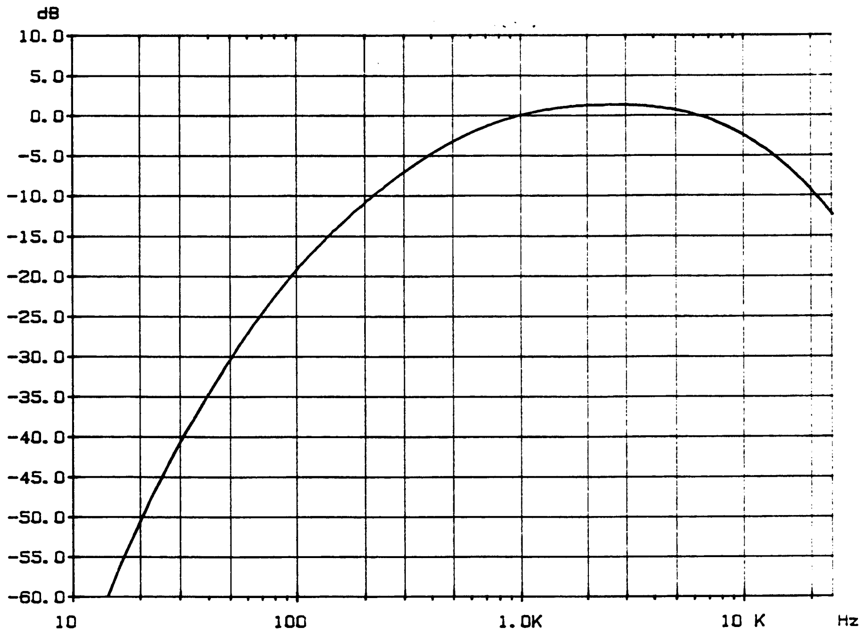

Fig. 2.7 - DIN 45633/IEC 651 A Weighting Filter

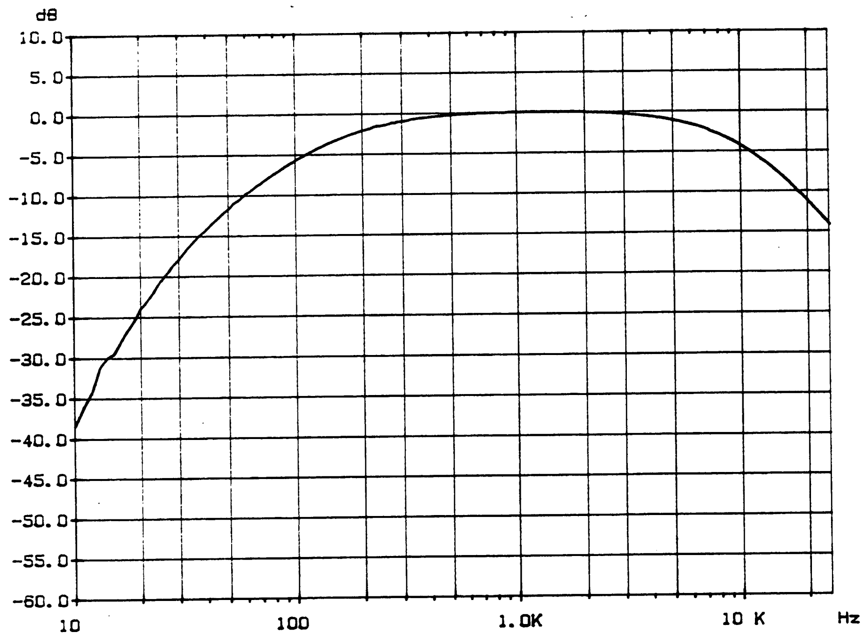

Fig. 2.8 - DIN 45633/IEC 651 B Weighting Filter

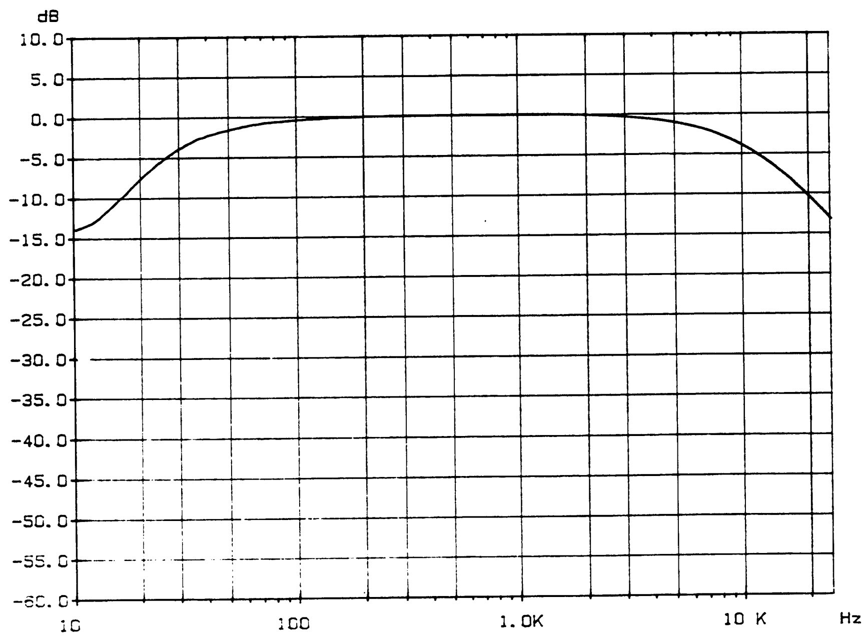

Fig. 2.9 - DIN 45633/IEC 651 C Weighting Filter

The RMS level of the noise is measured relatively to a reference signal level, i.e. the result is displayed in DBR on the RE201 CRT.

These filters (especially the A weighting filter) are commonly used for measurement of noise in any kind of audio equipment.

2.5 Rumble Filters

When measuring rumble from a disc record playing equipment the filters recommended in the DIN 45539 standard (figs. 2.10 and 2.11) must be used. This test is commonly performed by replaying a test record with unmodulated grooves as well as reference signals for the left, right, lateral and vertical planes. The rumble (weighted as well as unweighted) is the average output voltage obtained from the unmodulated grooves relative to the average reference signal corresponding to the plane of measurement.

2.6 Weighted Crosstalk Filter

This filter (fig. 2.12) is recommended by IBA - Independent Broadcast Authority - in the United Kingdom to be used during measurements of crosstalk between two transmission channels.

The channel which should be inspected for cross-coupled noise must be in the same state as if a signal-to-noise measurement were being performed. The interfering channel is operated as under "normal" working condition.

Then the RMS level of the interfering signals is measured. To be able to separate the interfering signals from background noise, the RMS measurement has to be selective.

The measurement result is quoted as a signal/interference ratio in dB, i.e. on the RE201 CRT as DBR.

2.7 CCIR/ARM Filter

The CCIR/ARM filter (see fig. 2.13) is identical to the CCIR 468 filter except that the 0 dB reference point is at 2 kHz instead of 1 kHz. The filter response of the CCIR/ARM is obtained from the CCIR 468 filter by software correction of the gain. The filter is used for measurement of noise in professional and consumer audio equipment. The noise level is measured relative to a reference level by an average responding meter (ARM), i.e. the RE201 performs an average measurement and the result is displayed in DBR.

This noise measurement method is recommended by Dolby Laboratories, Inc., San Francisco, USA. The method is a result of an investigation of techniques for measuring noise, carried out in 1972. Dolby Labs found that existing methods were unsatisfactory and that the CCIR/ARM method gave more applicable results when comparison of noise levels from product to product was made.

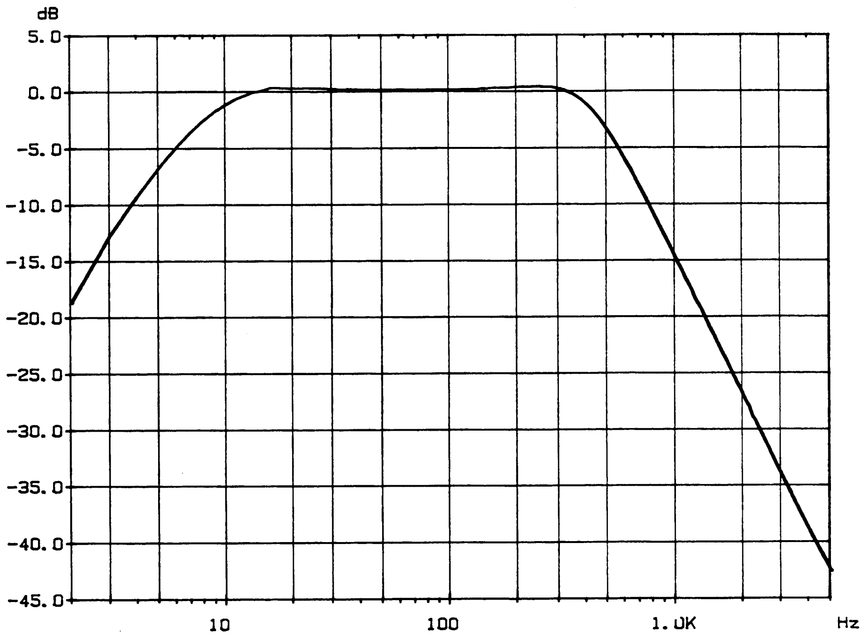

Fig. 2.10 - DIN 45539 Rumble Unweighted Filter

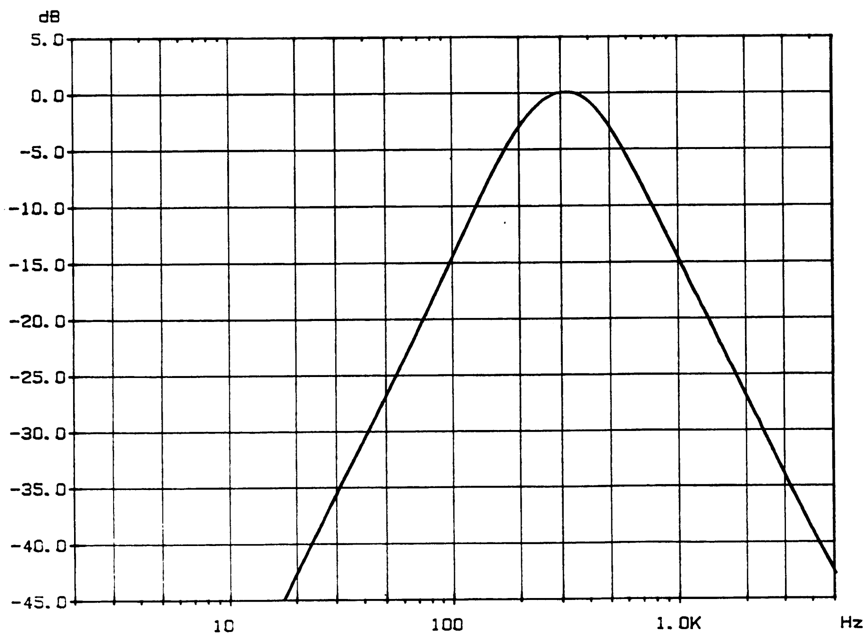

Fig. 2.11 - DIN 45539 Rumble Weighted Filter

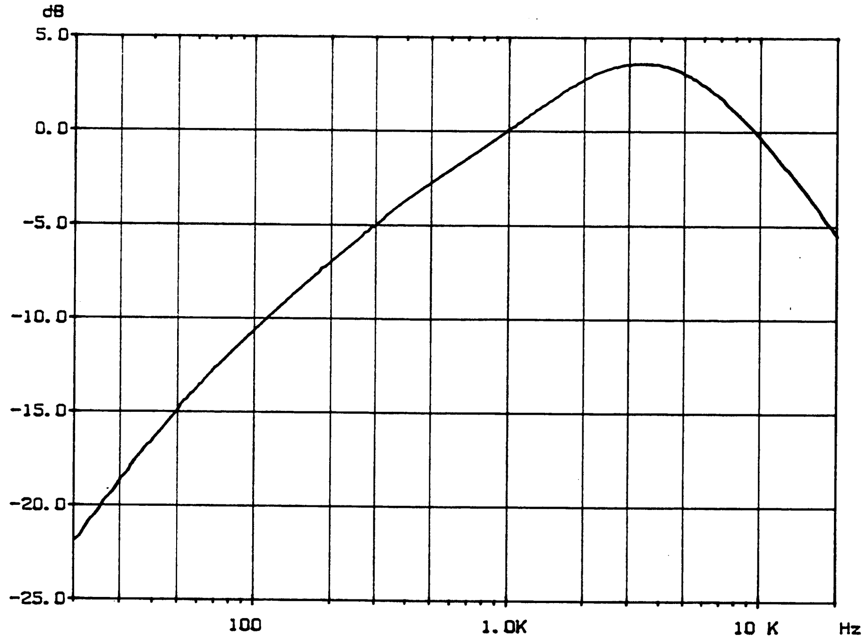

Fig. 2.12 - IBA Crosstalk Weighting Filter

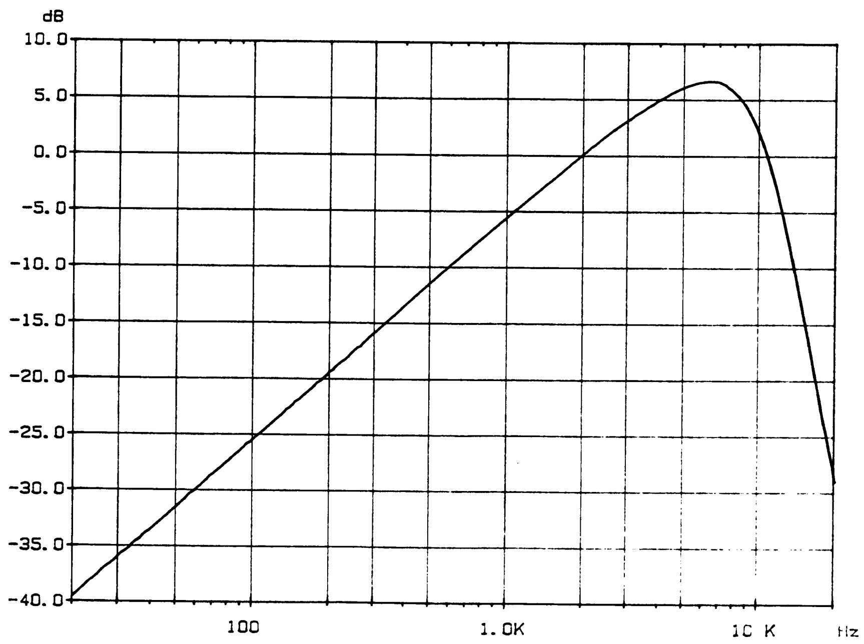

Fig. 2.13 - CCIR/ARM Noise Weighting Filter (Dolby)

3 CIRCUIT DESCRIPTION

Referring to the more detailed Block Diagram in fig. 3.1 and the schematic diagram No. 985-204, the Weighting Filters Option consists of the following main parts as described below:

* Input Stage
* Filter Bank
* 25 kHz Output Filter
* Quasi-peak Detector
* Program Memory and Switch Control

All set-up operations for the board are controlled by one of the microprocessors in the RE201, the Static CPU. Refer to the description of the Analog Section in the RE201 Basic Unit Technical Manual (section 3.2).

3.1 Input Stage

The signal path in the input stage may either be through QA1 with Q14 "on" (used in case Filter Option (901-525) is not installed and the Weighting Filters Option is not in use) or through the input amplifier QA2. QA2 is a dual amplifier and for each stage it is possible to select gain 0 dB or 10 dB. The gain depends on the "switch position" of Q2, Q4 and Q3, Q5.

Whenever abrupt signal changes occur in the analog circuitry, e.g. due to signal switching, capacitors will be charged/discharged and glitches may be generated. Before such transients have decayed, sensitive measurements can not take place. Further, unintended overload interrupts might be generated, disturbing the execution of the measurement. In order to minimize the probability of occurrence of glitches and to shorten the settling time for the signal after switching, all AC coupling capacitors are discharged during signal switching. The discharging is accomplished by means of FET switches, clamping one end of the capacitor to ground. Prior to any signal switching or change of gain, the Static CPU first closes these switches, hereby clamping the signal to ground while switching takes place.

Discharging switches are included for every AC coupling capacitor. The input discharge switch DISCH0 is Q1. The output from the input amplifier is connected to all input switches (Q6 - Q14) of the various filters included in the filter bank.

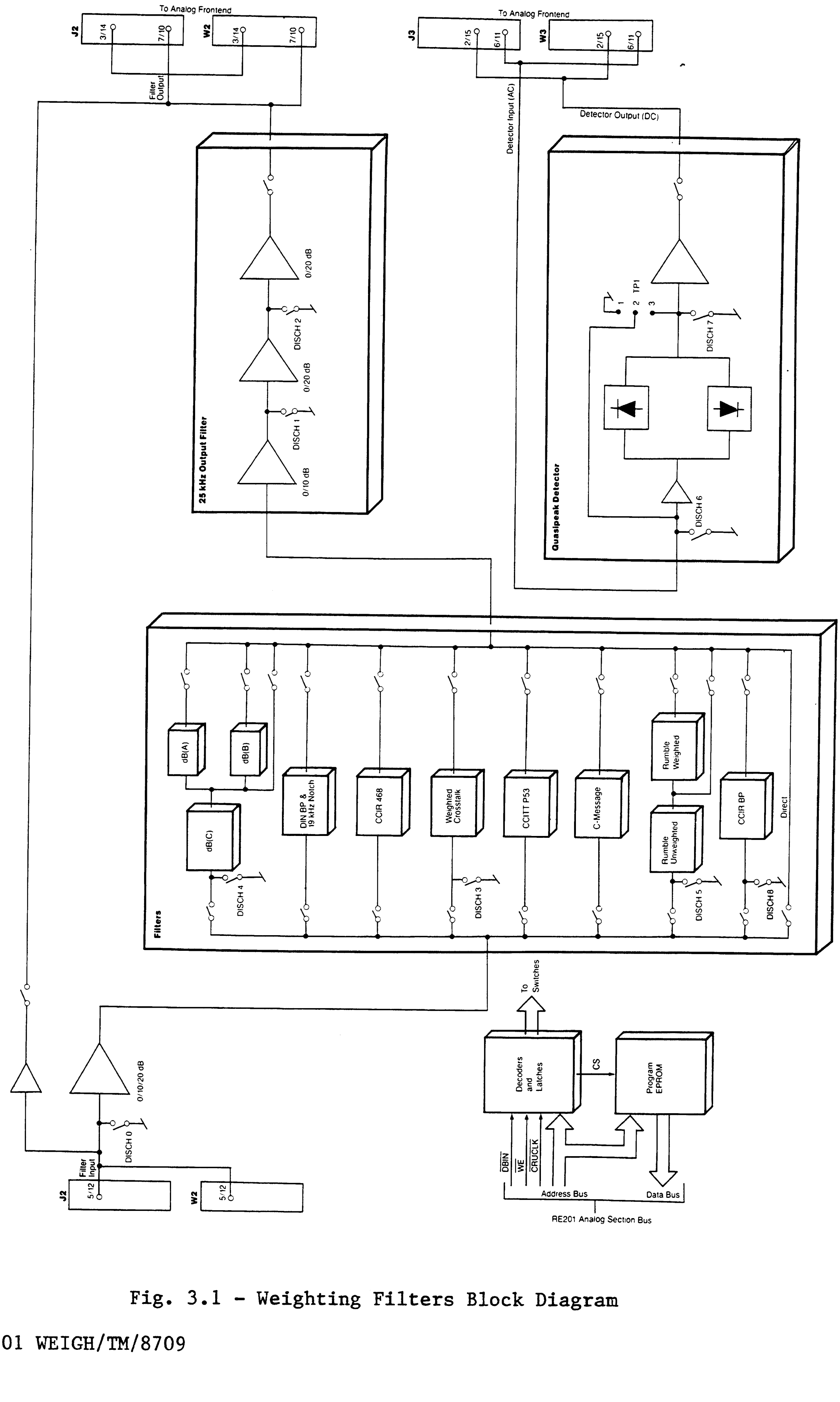

Fig. 3.1 - Weighting Filters Block Diagram

3.2 Filter Bank

The filters in the filter bank all utilize the same basic structure, namely an input switch followed by cascade coupled filters and finally an output switch. All output switches are connected to the input of the 25 kHz output filter. A description of each of the filter blocks shown in fig. 3.1 is provided in the following.

dB(A), dB(B), dB(C)

The switch Q7 routes the signal to these filters. The dB(C) filter (built around QA3) is common to all the filters in this block. (Q15 is one of the above mentioned discharge switches (DISCH4)). The output from the dB(C) filter is routed to the dB(A) input (one half of QA5), the dB(B) input (second half of QA5) and to the dB(C) output switch. Depending on the state of the three output switches - dB(C)/Q21, dB(B)/Q22 and dB(A)/Q23 - the output will be (A), (B) or (C) weighted. In order to adjust the 0 dB level at the centre frequency (1 kHz) three potentiometers are inserted. Since dB(C) is common, this filter is always adjusted before dB(B) and dB(A). R25, R34 and R40 is used for adjustment of dB(C), dB(B) and dB(A), respectively.

DIN BP - 300 Hz - 15 kHz

Input/output switches to these filters are Q8/Q24. The filter consists of a 300 Hz - 15 kHz bandpass filter and a 19 kHz notch filter connected in cascade. The bandpass filter is built around QA4, and the 19 kHz notch filter is the one half of QA17. R52 is used to tune the notch frequency and R57 to adjust the level at the centre frequency (1 kHz).

CCIR BP

This bandpass filter is configured around QA6. Input/output switches are Q9 and Q25. Q48 is a discharge switch. No adjustment facilities are included in this filter.

CCIR 468

This filter is implemented by means of QA7 and QA14. Input/output switches are QA10 and QA26.

R76 is used to adjust the attenuation at 1 kHz. During this adjustment it is necessary to mount jumper JP2. Afterwards, JP2 must be removed, and the level at 6.3 kHz is adjusted by means of R79.

Crosstalk Weighting Filter

This filter comprises only one dual opamp - QA8. Q17 serves as discharge and Q11 and Q27 are input/output switches. The output level at the center frequency may be adjusted by means of R96.

CCITT P53

The CCITT P53 filter consists of 5 cascade coupled filters (QA9, QA10 and QA13). Input/output switches are Q12 and Q28. Output level at the center frequency is adjustable via R113.

C-Message Filter

The C-Message filter is, except for component values, identical to the CCITT P53 filter, i.e. five cascade coupled filters: QA11, QA12 and QA13. Q13 and Q29 are input/output switches. By means of R152 it is possible to adjust the output level at the center frequency.

Rumble Weighted & Unweighted

The switch Q14 routes the signal to the common part of the filter (QA15). If Q30 is on, the "Rumble Unweighted" filter is selected, i.e. the output of the common part is routed through an inverting amplifier (one half of QA16), the gain of which is adjustable by means of R147. If "Rumble Weighted" is selected, the output of QA15 is routed through another filter/amplifier (QA14 and second half of QA16). The gain is fine-adjusted with R148. Q18 and Q47 are discharge switches.

Direct

The last signal path through the filter bank comprises no filtering ("Direct"), and it is used to autorange the unweighted input signal. Furthermore, it may be used as a 25 kHz lowpass filter with more gain and thus better noise performance than the RE201 Basic Unit provides by itself. Q6 is the switch "Direct".

25 kHz Output Filter

The output filter consists of a 25 kHz filter, a 0/10 dB amplifier and two identical 0/20 dB amplifiers, all built around two dual operational amplifiers, QA20 and QA21. Two discharges are included in the output filter (Q34 and Q39).

The output from the filter bank is always routed through this output stage.

3.3 Quasi-peak Detector

Quasi-peak detection is a special way of measuring peak values of a signal. Short transients will not be detected and are ignored in the measurement result.

The quasi-peak detector included in the Weighting Filters Option consists of a full-wave rectifier, a "peak value memory" capacitor and a reset facility to discharge this capacitor.

If Q43 is "on", the charge capacitor will be discharged.

The output from the quasi-peak detector is always a negative voltage.

Applying different DC voltages on TP1-2 enables adjustment of the full-wave rectifier (refer to section 4).

3.4 Program Memory and Switch Control

The Weighting Filters Option is operated by the Static CPU, located in the Analog Section. Selection of filter as well as gain is programmed by means of the Communication Register Interface of the Static CPU - refer to the RE201 Basic Unit Technical Manual section 3.2.2.

The Weighting Filters Option board comprises additional program memory for the Static CPU, containing the software for performing the actual set-ups (QD1). Decoding of the control signals from the Static CPU for the memory is implemented by means of a Schottky PROM (QD5).

As the Weighting Filters Option shares address space with the Audio Generator Option and the Filter Option, a means is provided for the Static CPU to select the option being addressed. The Weighting Filters Option is selected when the CPU has written a "1" to QD7, pin 6. This action at the same time disables the other options. When the Weighting Filters Option is selected, $\overline{\text{I14}}$ is pulled low by QD8, pin 3. This feature allows the Static CPU to detect the presence of the option during the power-up initialization procedure.

The digital control circuit comprising QD6-QD19 is used to select gain, filter and discharge. These parameters are selected by means of FET switches Q1 - Q44 controlled by the computer interface.

For set-up information from the Static CPU, eight-bit programmable latches (HEF4724) are used. Level transformation from TTL levels to levels used for control of the FET switches is implemented using LM324 operational amplifiers as comparators. Due to the diode connected to the gate of each FET switch, an N-channel FET will only be off, if -15 V is supplied to the anode of the diode, and a P-channel FET, if +15 V is supplied. As the inverting inputs of the LM324 comparators are held at +2.5 V, a TTL "0" at the non-inverting input implies an output voltage of -15 V, while a TTL "1" forces the output to +15 V.

Jumpers and Test Points

The following two jumpers are included:

JP1: Selects between two different CARD ON addresses

- 1-2: Address 100C (normal position).
- 2-3: Address 100E (for future use).

JP2: Used during adjustment of the CCIR 468 filter (normally not mounted).

Only one test point is incorporated:

TP1:
- Pin 1: GROUND.
- Pin 2: Input to quasi-peak detector.
- Pin 3: Quasi-peak detector integrator.

4 MAINTENANCE

This section describes the maintenance and adjustment procedures for the Weighting Filters Option. The reader is expected to be acquainted with the operation of the RE201.

It is recommended that section 2, Principles of Operation, and section 3, Circuit Description, are studied before adjustments are commenced.

4.1 Recommended Test Equipment

Table 4.1 lists the test equipment necessary to carry out a qualifying performance test and to adjust the Weighting Filters Option if necessary.

Instrument	Critical Specifications	Recommended Model
1) LF Signal Generator	THD < -90 dB, Frequency range 5 Hz to 50 kHz	B&O, Model TG8
2) RMS/DC Voltmeter	Accuracy of reading 0.2% at 5 Hz to 50 kHz and at DC	Fluke RMS differential Voltmeter, Model 8506A

Table 4.1 - Recommended Test Equipment

4.2 Performance Tests

All tests outlined in this section may be performed using measurements in either channel of the RE201. The performance of the Weighting Filter Option is independent of the selected channel.

It is recommended to carry out all programming of the RE201 before the test is initiated. Weighted measurements involving each filter that is going to be tested or adjusted must be defined. In addition to this, a quasi-peak and an RMS25 measurement are used. The following is a survey of the definitions:

BASIC PARAMETERS:	Voltage reference 0.5 V
WEIGHTED MEASUREMENTS:	One for each of the filters listed in table 4.2. The level measurement RMS25, display DB REF.

Filters

The filter test is basically a check of the filter output level at certain frequencies. Since the 25 kHz output filter is common to all filters, it is important to check this filter first. Apart from this, the test of the remaining filters can be carried out in casual order. The CCIR/ARM filter is not tested, as it - except for a software correction of the absolute level - equals the CCIR 468 filter.

Test of the 25 kHz filter is done as follows:

a. Adjust the LF generator (1) to frequency 1 kHz, output level 500 mV +/- 5 mV, measured with the voltmeter (2), and connect the generator to the input of RE201.

b. Execute the weighted measurement including the 25 kHz filter.

c. Verify that the reading of the RE201 is 0.0 dBr +/- 0.1 dB and then press <STO REF>.

d. Adjust the frequency to 25 kHz, and verify that the result displayed is 0.0 dBr +/- 0.2 dB.

All frequency response tests for the remaining filters included in table 4.2 are accomplished in the following way:

a. Adjust the LF generator (1) to a frequency corresponding to Fref (refer to table 4.2) for the filter being tested.

b. Execute the weighted measurement including the filter in question.

c. Press <RCL REF> on the RE201, and verify that the reading is within the limits for the output listed in table 4.2.

d. Press <STO REF>, adjust the frequency of the generator (1) to the remaining frequencies in the table and check the output levels.

Filter	Frequency	Output	Tolerance
25 kHz	Fref 1 kHz	0.0 dBr	+/- 0.1 dB <STO REF>
	25 kHz	0.0 dBr	+/- 0.2 dB
dB(C)	Fref 1 kHz	0.0 dBr	+/- 1 dB <STO REF>
	20 Hz	-6.2 dBr	+/- 5 dB
	20 kHz	<-11.2 dBr	+ 3 dB
dB(B)	Fref 1 kHz	0.0 dBr	+/- 1 dB <STO REF>
	50 Hz	-11.6 dBr	+/- 3 dB
	20 kHz	<-11.1 dBr	+ 3 dB
dB(A)	Fref 1 kHz	0.0 dBr	+/- 1 dB <STO REF>
	200 Hz	-10.9 dBr	+/- 1 dB
	20 kHz	<-9.3 dBr	+ 3 dB
DIN BP	Fref 1 kHz	0.0 dBr	+/- 0.1 dB <STO REF>
	300 Hz	-2.2 dBr	+/- 0.5 dB
	19 kHz	<-25 dBr	
CCIR BP	Fref 1 kHz	0.0 dBr	+/- 0.1 dB <STO REF>
	22 Hz	-3.0 dBr	+3.5/-3.0 dB
	22.4 kHz	-3.0 dBr	+3.5/-3.0 dB
CCIR 468	Fref 6.3 kHz	0.0 dBr	+/- 0.1 dB <STO REF>
	1 kHz	-12.2 dBr	+/- 0.5 dB
	12.5 kHz	-12.2 dBr	+/- 1.2 dB
Crosstalk	Fref 1 kHz	0.0 dBr	+/- 0.1 dB <STO REF>
	200 Hz	-7.0 dBr	+/- 1 dB
	10 kHz	-0.8 dBr	+/- 1 dB
CCITT P53	Fref 800 Hz	0.0 dBr	+/- 0.1 dB <STO REF>
	200 Hz	-21 dBr	+/- 1.8 dB
	4 kHz	-15 dBr	+/- 2.8 dB
C-Message	Fref 1 kHz	0.0 dBr	+/- 0.1 dB <STO REF>
	200 Hz	-25 dBr	+/- 2 dB
	4 kHz	-14.5 dBr	+/- 3 dB
Rumble, Unweighted	Fref 315 Hz	0.0 dBr	+/- 0.1 dB <STO REF>
	5 Hz	-6 dBr	+/- 3 dB
	630 Hz	-7 dBr	+/- 1 dB
Rumble, Weighted	Fref 315 Hz	0.0 dBr	+/- 0.1 dB <STO REF>
	160 Hz	-6.7 dBr	+/- 1 dB
	630 Hz	-7 dBr	+/- 1 dB

Table 4.2 - Frequency Response Test

Quasi-peak Detector

To check the quasi-peak detector, the LF generator (1) is adjusted to 1.000 Vrms +/- 5 mV, measured with the voltmeter (2). Connect the generator to the RE201 input and start a quasi-peak measurement. Verify that the accuracy is better than +/- 10 mV. Repeat the test for an input level of 100 mV (accuracy better than +/- 1 mV). Finally, perform the two tests for a frequency of 20 kHz.

4.3 Adjustments

Should any of the performance tests mentioned above fail, some adjustments can be performed, provided the failures are of a minor nature.

Filters

Most of the filters are provided with adjustment possibilities for level adjustment. Since the dB(C) filter is common to the dB(A) and dB(B) filters, it is necessary to adjust dB(C) before dB(A) and dB(B).

Use an RMS voltmeter (2) connected to J2/W2, pin 7/10 and ground (e.g. pin 2) to verify the output level. Adjust the LF generator (1) to 1.000 Vrms +/- 1 mV and connect it to the RE201. Adjust the frequency of the generator as outlined in table 4.3 and adjust the output level of each filter by means of the potentiometer listed in the table. The locations of the potentiometers are shown in fig. 4.1.

Filter	Frequency	Adjust
dB(C)	1 kHz	R25
dB(B)	1 kHz	R34
dB(A)	1 kHz	R40
DIN BP	1 kHz	R57
	19 kHz	R52 adjusted to output level < 56 mV
CCIR 468	1 kHz	R76 adjusted to output level 157 mVrms +/- 0.2 mV with JP2 shortcircuited
	6.3 kHz	R79 (with JP2 open)
Crosstalk	1 kHz	R96
CCITT P53	800 Hz	R113
C-Message	1 kHz	R132
Rumble, Unweighted	315 Hz	R147
Rumble, Weighted	315 Hz	R148

Table 4.3 - Output Level Adjustments

Quasi-peak Detector

The adjustment procedure for the quasi-peak detector is normally accomplished as outlined below.

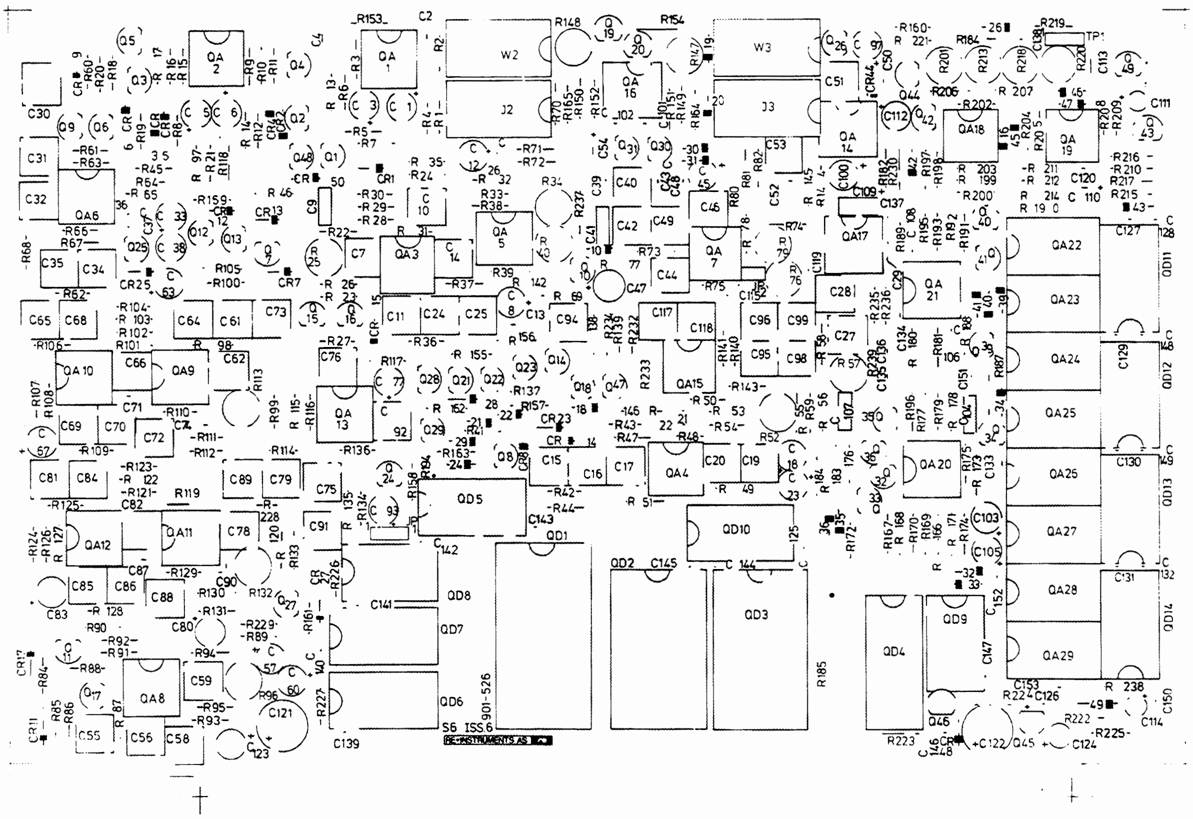

Fig. 4.1 - Weighting Filters Component Layout

a. Shortcircuit the input of the integrator of the quasi-peak detector by connecting TP1, pins 1 and 3. Connect the voltmeter (2) to QA19, pin 7 and ground.

b. Adjust the quasi-peak output offset level to 0 Vdc +/- 0.5 mV by means of R218.

c. Remove the shortcircuit and adjust the LF generator (1) to 500 mVrms +/- 0.5 mV, measured with the voltmeter (2). Use this signal as input to the RE201. Perform a quasi-peak measurement and adjust R220 to obtain a reading on the RE201 of 500 mV +/- 1 mV.

If any component of the two rectifiers, e.g. QA18, QA19, CR16, CR45, CR46 or CR47 has been replaced, the adjustment procedure must be extended. In order to circumvent the influence on the quasi-peak result caused by the voltage drop across the diodes in the rectifiers, it is necessary to bias them. If any components are changed, the bias must be adjusted.

A low voltage, low drift (approx. 25 mVdc +/- 0.5 mV) reference voltage source is required.

d. Shortcircuit the input of the quasi-peak detector (J3/W3, pins 6/11) to ground (e.g. pin 2). The cable may be disconnected during this adjustment. Connect the reference voltage source to TP1, pin 1-2 (negative on pin 2). Adjust the output of the quasi-peak detector (measured as during a. above) to equal the reference source within +/- 1.5 mV by means of R213.

e. Change the polarity of the reference voltage and adjust the output to -Vref +/- 1.5 mV by means of R201.

f. Repeat d-e until Vout = |Vref| for both polarities of the input voltage.

g. Remove the shortcircuit at the input and the reference voltage source. Complete the adjustment by performing c above.

5 TROUBLESHOOTING

The scope of this section is to provide some hints on troubleshooting involving the Weighting Filters Option board, mainly in order to make certain that the error observed is originating from the Weighting Filters Option. Before this conclusion is drawn, a number of other measurements should be performed and verified, in order to make sure that the error is not a general one. For instance, the Performance Test, described in section 4.2 of the RE201 Basic Unit Technical Manual, could be carried out.

It is recommended that section 2, Principles of Operation, and section 3, Circuit Description, of the present manual are studied carefully before commencing any troubleshooting.

Faults originating from the Weighting Filters Option during measurements are most often easily detected, as the Weighting Filters Option board is only used during weighted measurements and quasi-peak measurements. When bypassing the Weighting Filters Option e.g. for distortion measurements, however, Q19 of the Weighting Filters Option is activated. Improper operation of this switch will jeopardize all measurements, except the weighted ones. If the Filter Option is installed, Q166 of this option is used instead of Q19 on the Weighting Filters Option board. Further information may be found in section 2.5, Actual Measurements Set-up, of the RE201 Basic Unit Technical Manual.

As the first step, if errors are detected, check that the flat cables W2 and W3 connecting the Weighting Filters Option to the Analog Frontend or to the Filter Option, if installed, are properly inserted and not defective. W2 is used for input/output to the filters - pins 5/12 for input, pins 7/10 for output - whereas W3 is used for input/output to the quasi-peak detector - pins 6/11 for input, pins 2/15 for output.

The troubleshooting will depend on whether the error is observed during selftest or during performance tests.

5.1 Selftest Errors

If the Analog Section fails during a selftest, the first step to perform is to obtain more information about which part of the Analog Section has caused the error. This is done by reading the error code displayed on the Light Emitting Diodes (LEDs), CR1-CR8, on the top edge of the Static CPU board. The error code for errors on the Weighting Filters Option is as shown (facing the component side of the Static CPU):

    1100 0111

where '1' designates LED on, '0' LED off. The ninth (leftmost) of the diodes is not part of the error code display.

During the selftest procedure performed by the RE201, the program EPROM QD1 is tested, using a Cyclic Redundancy Code Check (CRCC). When testing this device, the CARD ON circuit (QD6-QD9) and the functioning of the data/address lines are also verified.

If the error is due to a fault in the CARD ON circuit, the Static CPU will be unable to gain access to the Weighting Filters Option (refer to section 3.4 for further information). Check that JP1 is mounted correctly, i.e. in position 1-2. The location of JP1 may be found in fig. 4.1.

5.2 Performance Test Errors

Even if the Weighting Filters Option has passed the selftest procedure on power-on, the board might be defective, as the filters are not tested.

Faults originating from the Weighting Filters Option will influence the weighted measurements and/or the quasi-peak measurements.

Weighted Measurement Errors

If the output level from one of the filters is very low, independent of frequency and level of the input signal, the error is probably due to faulty FET switches in the input/output of the selected filter or faults in the decoding and control circuitry. If the error is present, irrespective of the filter selected, faults in the output switch (Q20) are most likely. If for instance all output levels at the reference frequencies for the different filters are erroneous, the fault may originate from the input amplifiers (QA2) or the 25 kHz output filter, configured around QA20 and QA21.

Quasi-peak Errors

If a quasi-peak measurement yields results different from e.g. RMS25 measurements for sine wave inputs, the quasi-peak detector of the Weighting Filters Option is very likely to be defective. If the results are very low, faults may originate from failing FET switches in the output stage (Q44), in the discharge circuit (Q42), or in the RESET circuit (Q43,Q49). Alternatively the input switch Q45 at the Analog Frontend could possibly be malfunctioning.

6 PARTS LIST AND SCHEMATIC DIAGRAM

6.1 Parts List

All electronic components are included in the parts list. Parts marked with a * are manufactured by RE INSTRUMENTS AS.

When ordering spare parts it is important that you give the following information.

- * Code No. and description of the part.
- * Circuit reference from the schematic diagram.
- * Complete type designation of RE product.

Weighting Filter (901-526)

CAPACITORS

C 1	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 2	C Ceramic 22p0 2% 100V NP0	213-206
C 3	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 4	Electrolytic Bipolar 4u7 25V	261-301
C 5	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 6	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 7	C Polypropylen 100n 1% 63V 150PPM	242-302
C 8	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 9	MKT, 1/63/10, R:6*11.5*7.2, RM2	241-064
C 10	C Polyst 2n00 1% 63V	243-305
C 11	C Polyst 2n00 1% 63V	243-305
C 12	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 13	C Ceramic 100n 20% 50V	213-401
C 14	C Polypropylen 100n 1% 63V 150PPM	242-302
C 15	C Polypropylen 51n1 1% 63V 150PPM	242-301
C 16	C Polypropylen 51n1 1% 63V 150PPM	242-301
C 17	C Polypropylen 51n1 1% 63V 150PPM	242-301
C 18	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 19	C Polystyrene 2n74 1% 63V	243-318
C 20	C Polyst 10n0 1% 63V	243-302
C 21	C Ceramic 180p 2% 100V N750	213-228
C 22	C Ceramic 22p0 2% 100V NP0	213-206
C 23	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 24	C Polypropylen 100n 1% 63V 150PPM	242-302
C 25	C Polypropylen 100n 1% 63V 150PPM	242-302
C 26	C Ceramic 100n 20% 50V	213-401
C 27	C Polyst 2n00 1% 63V	243-305
C 28	C Polyst 2n00 1% 63V	243-305
C 29	C Ceramic 100n 20% 50V	213-401
C 30	C Polypropylen 100n 1% 63V 150PPM	242-302
C 31	C Polypropylen 100n 1% 63V 150PPM	242-302
C 32	C Polypropylen 100n 1% 63V 150PPM	242-302
C 33	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 34	C Polystyrene 2n74 1% 63V	243-318
C 35	C Polyst 10n0 1% 63V	243-302
C 36	C Ceramic 180p 2% 100V N750	213-228
C 37	C Ceramic 22p0 2% 100V NP0	213-206
C 38	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 39	C Ceramic 330p 2% 100V N750	213-214
C 40	C Polystyrene 20n 1% 63V	243-316
C 41	C Ceramic 680p 10% 100V	213-234
C 42	C Polypropylen 51n1 1% 63V 150PPM	242-301
C 43	C Ceramic 220p 2% 100V N750	213-218
C 44	C Polystyrene 2n74 1% 63V	243-318
C 45	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 46	C Polyst 10n0 1% 63V	243-302
C 47	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 48	C Ceramic 68p0 2% 100V NP0	213-215
C 49	C Polystyrene 14n 1% 63V	243-322
C 50	C Ceramic 180p 2% 100V N750	213-228

C 51	C Polypropylen 51n1 1% 63V 150PPM	242-301
C 52	C Ceramic 33p0 2% 100V NPO	213-208
C 53	C Polystyrene 1n 1% 63V	243-320
C 54	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 55	C Polypropylen 100n 1% 63V 150PPM	242-302
C 56	C Polystyrene 3n32 1% 63V	243-323
C 57	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 58	C Polystyrene 22n1 1% 63V	243-315
C 59	C Polystyrene 22n1 1% 63V	243-315
C 60	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 61	C Polypropylen 51n1 1% 63V 150PPM	242-301
C 62	C Polypropylen 34n 1% 63V 150PPM	242-303
C 63	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 64	C Polypropylen 51n1 1% 63V 150PPM	242-301
C 65	C Polypropylen 51n1 1% 63V 150PPM	242-301
C 66	C Polystyrene 1n 1% 63V	243-320
C 67	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 68	C Polypropylen 51n1 1% 63V 150PPM	242-301
C 69	C Polypropylen 100n 1% 63V 150PPM	242-302
C 70	C Polystyrene 499p 1% 63V	243-319
C 71	C Ceramic 100n 20% 50V	213-401
C 72	C Polypropylen 100n 1% 63V 150PPM	242-302
C 73	C Polypropylen 51n1 1% 63V 150PPM	242-301
C 74	C Ceramic 100n 20% 50V	213-401
C 75	C Polypropylen 51n1 1% 63V 150PPM	242-301
C 76	C Polystyrene 6n34 1% 63V	243-314
C 77	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 78	C Polyst 2n00 1% 63V	243-305
C 79	C Polystyrene 20n 1% 63V	243-316
C 80	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 81	C Polypropylen 34n 1% 63V 150PPM	242-303
C 82	C Polyst 4n64 1% 63V	243-301
C 83	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 84	C Polypropylen 100n 1% 63V 150PPM	242-302
C 85	C Polypropylen 51n1 1% 63V 150PPM	242-301
C 86	C Polystyrene 1n 1% 63V	243-320
C 87	C Ceramic 100n 20% 50V	213-401
C 88	C Polypropylen 100n 1% 63V 150PPM	242-302
C 89	C Polypropylen 34n 1% 63V 150PPM	242-303
C 90	C Ceramic 100n 20% 50V	213-401
C 91	C Polypropylen 100n 1% 63V 150PPM	242-302
C 92	C Polystyrene 2n74 1% 63V	243-318
C 93	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 94	C Polypropylen 100n 1% 63V 150PPM	242-302
C 95	C Polyst 10n0 1% 63V	243-302
C 96	C Polystyrene 3n57 1% 63V	243-321
C 97	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 98	C Polypropylen 100n 1% 63V 150PPM	242-302
C 99	C Polypropylen 100n 1% 63V 150PPM	242-302
C 100	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 101	C Ceramic 100n 20% 50V	213-401
C 102	C Ceramic 100n 20% 50V	213-401
C 103	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C 104	MKT, 1/63/10, R:6*11.5*7.2, RM2	241-064

C	105	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C	106	C Ceramic 100n 20% 50V	213-401
C	107	MKT, 1/63/10, R:6*11.5*7.2, RM2	241-064
C	108	C Ceramic 100n 20% 50V	213-401
C	109	MKT, 1/63/10, R:6*11.5*7.2, RM2	241-064
C	110	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C	111	C Tantalum 10u 10% 10V	267-017
C	112	Electrolytic 33/16, 2000h/85°, Low Il, R:5*11, RM2	261-086
C	113	MKT, 1/63/10, R:6*11.5*7.2, RM2	241-064
C	114	C Tantalum 10u 10% 10V	267-017
C	115	C Ceramic 100n 20% 50V	213-401
C	117	C Polypropylen 100n 1% 63V 150PPM	242-302
C	118	C Polypropylen 100n 1% 63V 150PPM	242-302
C	119	C Ceramic 100n 20% 50V	213-401
C	120	C Ceramic 100n 20% 50V	213-401
C	121	Electrolytic 47/25, 2000h/85°, R:5*11, RM2	261-085
C	122	Electrolytic 47/25, 2000h/85°, R:5*11, RM2	261-085
C	123	C solid AL 10u 20% 16V	265-008
C	124	C solid AL 10u 20% 16V	265-008
C	127	C Ceramic 100n 20% 50V	213-401
C	128	C Ceramic 100n 20% 50V	213-401
C	129	C Ceramic 100n 20% 50V	213-401
C	130	C Ceramic 100n 20% 50V	213-401
C	131	C Ceramic 100n 20% 50V	213-401
C	132	C Ceramic 100n 20% 50V	213-401
C	133	C Ceramic 100n 20% 50V	213-401
C	134	C Ceramic 330p 2% 100V N750	213-214
C	135	C Ceramic 150p 2% 100V N750	213-212
C	136	C Ceramic 18p0 2% 100V NP0	213-222
C	137	C Ceramic 39p0 2% 100V NP0	213-232
C	138	C Ceramic 82p0 2% 100V NPO	213-229
C	139	C Ceramic 100n 20% 50V	213-401
C	140	C Ceramic 100n 20% 50V	213-401
C	141	C Ceramic 100n 20% 50V	213-401
C	142	C Ceramic 100n 20% 50V	213-401
C	143	C Ceramic 100n 20% 50V	213-401
C	145	C Ceramic 100n 20% 50V	213-401
C	146	C Ceramic 100n 20% 50V	213-401
C	147	C Ceramic 100n 20% 50V	213-401
C	148	C Ceramic 100n 20% 50V	213-401
C	149	C Ceramic 100n 20% 50V	213-401
C	150	C Ceramic 100n 20% 50V	213-401
C	151	C Ceramic 100n 20% 50V	213-401
C	152	C Ceramic 100n 20% 50V	213-401
C	153	C Ceramic 100n 20% 50V	213-401

DIODES

CR 1	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 2	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 3	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 4	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 5	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 6	Diode BAV10 Si Vr-60V If-600mA	350-022

CR 7	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 8	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 9	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 10	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 11	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 12	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 13	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 14	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 15	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 16	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 17	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 18	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 19	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 20	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 21	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 22	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 23	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 24	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 25	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 26	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 27	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 28	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 29	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 30	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 31	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 32	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 33	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 34	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 35	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 36	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 39	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 40	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 41	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 42	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 43	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 44	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 45	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 46	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 47	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 50	Diode BAV10 Si Vr-60V If-600mA	350-022

CONNECTORS

J 2	Connector Socket for 16-Pin	816-217
J 3	Connector Socket for 16-Pin	816-217

RELAYS & JUMPERS

JP 1	Wire Wrap Terminal	805-727
JP 2	Wire Wrap Terminal	805-727

TRANSISTORS

Q 1	Transistor J109-18 n Fet	360-188
Q 2	Transistor J109-18 n Fet	360-188
Q 3	Transistor J109-18 n Fet	360-188
Q 4	Transistor J175-18 p jfet	360-252
Q 5	Transistor J175-18 p jfet	360-252
Q 6	Transistor J109-18 n Fet	360-188
Q 7	Transistor J109-18 n Fet	360-188
Q 8	Transistor J109-18 n Fet	360-188
Q 9	Transistor J109-18 n Fet	360-188
Q 10	Transistor J109-18 n Fet	360-188
Q 11	Transistor J109-18 n Fet	360-188
Q 12	Transistor J109-18 n Fet	360-188
Q 13	Transistor J109-18 n Fet	360-188
Q 14	Transistor J109-18 n Fet	360-188
Q 15	Transistor J109-18 n Fet	360-188
Q 16	Transistor J109-18 n Fet	360-188
Q 17	Transistor J109-18 n Fet	360-188
Q 18	Transistor J109-18 n Fet	360-188
Q 19	Transistor J109-18 n Fet	360-188
Q 20	Transistor J109-18 n Fet	360-188
Q 21	Transistor J109-18 n Fet	360-188
Q 22	Transistor J109-18 n Fet	360-188
Q 23	Transistor J109-18 n Fet	360-188
Q 24	Transistor J109-18 n Fet	360-188
Q 25	Transistor J109-18 n Fet	360-188
Q 26	Transistor J109-18 n Fet	360-188
Q 27	Transistor J109-18 n Fet	360-188
Q 28	Transistor J109-18 n Fet	360-188
Q 29	Transistor J109-18 n Fet	360-188
Q 30	Transistor J109-18 n Fet	360-188
Q 31	Transistor J109-18 n Fet	360-188
Q 32	Transistor J109-18 n Fet	360-188
Q 33	Transistor J175-18 p jfet	360-252
Q 34	Transistor J109-18 n Fet	360-188
Q 35	Transistor J109-18 n Fet	360-188
Q 36	Transistor J175-18 p jfet	360-252
Q 39	Transistor J109-18 n Fet	360-188
Q 40	Transistor J109-18 n Fet	360-188
Q 41	Transistor J175-18 p jfet	360-252
Q 42	Transistor J109-18 n Fet	360-188
Q 43	Transistor J109-18 n Fet	360-188
Q 44	Transistor J109-18 n Fet	360-188
Q 47	Transistor J109-18 n Fet	360-188
Q 48	Transistor J109-18 n Fet	360-188
Q 49	Transistor J109-18 n Fet	360-188

INTEGRATED ANALOG CIRCUITS

QA 1	IC 5534A OP-Amp low noice	364-518
QA 2	IC NE5532A Dual OP-Amp low noise	364-640
QA 3	IC TL082 dual op amp	364-619
QA 4	IC NE5532A Dual OP-Amp low noise	364-640
QA 5	IC TL082 dual op amp	364-619
QA 6	IC TL082 dual op amp	364-619
QA 7	IC NE5532A Dual OP-Amp low noise	364-640
QA 8	IC TL082 dual op amp	364-619
QA 9	IC NE5532A Dual OP-Amp low noise	364-640
QA 10	IC NE5532A Dual OP-Amp low noise	364-640
QA 11	IC NE5532A Dual OP-Amp low noise	364-640
QA 12	IC NE5532A Dual OP-Amp low noise	364-640
QA 13	IC NE5532A Dual OP-Amp low noise	364-640
QA 14	IC TL082 dual op amp	364-619
QA 15	IC TL082 dual op amp	364-619
QA 16	IC NE5532A Dual OP-Amp low noise	364-640
QA 17	IC NE5532A Dual OP-Amp low noise	364-640
QA 18	IC TL082 dual op amp	364-619
QA 19	IC TL082 dual op amp	364-619
QA 20	IC TL082 dual op amp	364-619
QA 21	IC TL082 dual op amp	364-619
QA 22	IC LM324N Quad OP-Amp	364-176
QA 23	IC LM324N Quad OP-Amp	364-176
QA 24	IC LM324N Quad OP-Amp	364-176
QA 25	IC LM324N Quad OP-Amp	364-176
QA 26	IC LM324N Quad OP-Amp	364-176
QA 27	IC LM324N Quad OP-Amp	364-176
QA 28	IC LM324N Quad OP-Amp	364-176
QA 29	IC LM324N Quad OP-Amp	364-176

INTEGRATED DIGITAL CIRCUITS

QD 1	RE201 Weighting Filters QD1 Program PROM	368-278
QD 4	IC SN74LS245 Octal bus transceiver	364-332
QD 5	RE201 901-527 QD7 Select PROM	368-237
QD 6	IC CD74HCT138 3-to-8 line dec.	364-570
QD 7	IC HEF4724BP 8-bit adessable latch	364-412
QD 8	IC SN74LS03 Quad 2-input Nand gate open collector	364-329
QD 9	IC HEF4075BP Tripple 3-input OR gate	364-362
QD 10	IC CD74HCT138 3-to-8 line dec.	364-570
QD 11	IC HEF4724BP 8-bit adessable latch	364-412
QD 12	IC HEF4724BP 8-bit adessable latch	364-412
QD 13	IC HEF4724BP 8-bit adessable latch	364-412
QD 14	IC HEF4724BP 8-bit adessable latch	364-412

RESISTORS

R 1	R Carbon Film 33E 5% 0.2W	106-233
R 2	R Carbon Film 100K 5% 0.2W	106-610
R 3	R Carbon Film 1K 5% 0.2W	106-410
R 4	R Carbon Film 33E 5% 0.2W	106-233
R 5	R Carbon Film 22K 5% 0.2W	106-522

R 6	R Carbon Film 470E 5% 0.2W	106-347
R 7	R Carbon Film 33K 5% 0.2W	106-533
R 8	R Carbon Film 33E 5% 0.2W	106-233
R 9	R Metal Film 8K66 0.1% 0.2W TC25	140-982
R 10	R Metal film 3K92 0.1% 0.25w TC25	141-004
R 11	R Metal Film 75E0 1% 0.5W TC50	112-750
R 12	R Carbon Film 33K 5% 0.2W	106-533
R 13	R Carbon Film 33K 5% 0.2W	106-533
R 14	R Carbon Film 33E 5% 0.2W	106-233
R 15	R Metal Film 8K66 0.1% 0.2W TC25	140-982
R 16	R Metal film 3K92 0.1% 0.25w TC25	141-004
R 17	R Metal Film 75E0 1% 0.5W TC50	112-750
R 18	R Carbon Film 33K 5% 0.2W	106-533
R 19	R Carbon Film 33K 5% 0.2W	106-533
R 20	R Carbon Film 33K 5% 0.2W	106-533
R 21	R Carbon Film 33K 5% 0.2W	106-533
R 22	R Carbon Film 2K2 5% 0.2W	106-422
R 23	R Metal Film 75K0 1% 0.5W TC50	115-750
R 24	R Carbon Film 33E 5% 0.2W	106-233
R 25	R Cermet Trimpot 100E 20% 0.5W TC70	182-317
R 26	R Metal Film 3K32 1% 0.5W TC50	114-332
R 27	R Carbon Film 33K 5% 0.2W	106-533
R 28	R Metal Film 7K50 1% 0.5W TC50	114-750
R 29	R Carbon Film 220E 5% 0.2W	106-322
R 30	R Metal Film 6K49 1% 0.5W TC50	114-649
R 31	R Metal Film 6K49 1% 0.5W TC50	114-649
R 32	R Metal Film 10K0 1% 0.5W TC50	115-100
R 33	R Metal Film 3K92 1% 0.5W TC50	114-392
R 34	R Cermet Trimpot 100E 20% 0.5W TC70	182-317
R 35	R Carbon Film 33E 5% 0.2W	106-233
R 36	R Metal Film 5K62 1% 0.5W TC50	114-562
R 37	R Metal Film 5K62 1% 0.5W TC50	114-562
R 38	R Metal Film 4K99 1% 0.5W TC50	114-499
R 39	R Metal Film 1K00 1% 0.5W TC50	114-100
R 40	R Cermet Trimpot 470E 20% 0.5W TC70	182-302
R 41	R Carbon Film 33K 5% 0.2W	106-533
R 42	R Metal Film 5K90 1% 0.5W TC50	114-590
R 43	R Metal Film 1K62 1% 0.5W TC50	114-162
R 44	R Metal Film 78K7 1% 0.5W TC50	115-787
R 45	R Carbon Film 2K2 5% 0.2W	106-422
R 46	R Carbon Film 33K 5% 0.2W	106-533
R 47	R Metal Film 6K65 1% 0.5W TC50	114-665
R 48	R Metal Film 6K65 1% 0.5W TC50	114-665
R 49	R Metal Film 6K65 1% 0.5W TC50	114-665
R 50	R Carbon Film 33E 5% 0.2W	106-233
R 51	R Carbon Film 33E 5% 0.2W	106-233
R 52	R Cermet Trimpot 470E 20% 0.5W TC70	182-302
R 53	R Metal Film 2K0 0.5% 0.4W TC50	141-186
R 54	R Metal Film 68K0 1% 0.5W TC50	115-680
R 55	R Metal Film 33K2 1% 0.5W TC50	115-332
R 56	R Metal Film 4K02 1% 0.5W TC50	114-402
R 57	R Cermet Trimpot 470E 20% 0.5W TC70	182-302
R 58	R Metal Film 4K22 1% 0.5W TC50	114-422
R 59	R Metal Film 1K 0.5% 0.4W TC50	141-144

R 60	R Carbon Film 33K 5% 0.2W	106-533
R 61	R Metal Film 39K2 1% 0.5W TC50	115-392
R 62	R Metal Film 10K7 1% 0.5W TC50	115-107
R 63	R Metal Film 523K 1% 0.5W TC50	116-523
R 64	R Carbon Film 33E 5% 0.2W	106-233
R 65	R Carbon Film 33E 5% 0.2W	106-233
R 66	R Metal Film 4K75 1% 0.5W TC50	114-475
R 67	R Metal Film 4K75 1% 0.5W TC50	114-475
R 68	R Metal Film 4K75 1% 0.5W TC50	114-475
R 69	R Carbon Film 33K 5% 0.2W	106-533
R 70	R Carbon 10K 5% 0.2w	106-510
R 71	R Metal Film 1K33 1% 0.5W TC50	114-133
R 72	R Metal Film 1K33 1% 0.5W TC50	114-133
R 73	R Metal Film 1K33 1% 0.5W TC50	114-133
R 74	R Carbon Film 33E 5% 0.2W	106-233
R 75	R Metal Film 2K43 1% 0.5W TC50	114-243
R 76	R Cermet Trimpot 200E 20% 0.5W TC70	182-315
R 77	R Carbon Film 33E 5% 0.2W	106-233
R 78	R Metal Film 511E 1% 0.5W TC50	113-511
R 79	R Cermet Trimpot 100E 20% 0.5W TC70	182-317
R 80	R Metal Film 1K69 1% 0.5W TC50	114-169
R 81	R Metal Film 1K69 1% 0.5W TC50	114-169
R 82	R Metal Film 1K69 1% 0.5W TC50	114-169
R 84	R Carbon Film 33K 5% 0.2W	106-533
R 85	R Carbon Film 33K 5% 0.2W	106-533
R 86	R Carbon Film 2K2 5% 0.2W	106-422
R 87	R Metal Film 22K1 1% 0.5W TC50	115-221
R 88	R Metal Film 10K0 1% 0.5W TC50	115-100
R 89	R Carbon Film 33E 5% 0.2W	106-233
R 90	R Carbon Film 33E 5% 0.2W	106-233
R 91	R Metal Film 33K2 1% 0.5W TC50	115-332
R 92	R Metal Film 22K1 1% 0.5W TC50	115-221
R 93	R Metal Film 2K67 1% 0.5W TC50	114-267
R 94	R Metal Film 11K0 1% 0.5W TC50	115-110
R 95	R Metal Film 10K5 1% 0.5W TC50	115-105
R 96	R Cermet Trimpot 1K 10% 0.5W TC70	182-310
R 97	R Carbon Film 33K 5% 0.2W	106-533
R 98	R Metal Film 1K82 1% 0.5W TC50	114-182
R 99	R Metal Film 8K06 1% 0.5W TC50	114-806
R 100	R Carbon Film 33E 5% 0.2W	106-233
R 101	R Metal Film 68K0 1% 0.5W TC50	115-680
R 102	R Metal Film 13K7 1% 0.5W TC50	115-137
R 103	R Metal Film 3K92 1% 0.5W TC50	114-392
R 104	R Metal Film 13K7 1% 0.5W TC50	115-137
R 105	R Carbon Film 33E 5% 0.2W	106-233
R 106	R Metal Film 46K4 1% 0.5W TC50	115-464
R 107	R Metal Film 14K7 1% 0.5W TC50	115-147
R 108	R Metal Film 2K21 1% 0.5W TC50	114-221
R 109	R Metal Film 14K7 1% 0.5W TC50	115-147
R 110	R Metal Film 4K12 1% 0.5W TC50	114-412
R 111	R Metal Film 3K65 1% 0.5W TC50	114-365
R 112	R Metal Film 1K58 1% 0.5W TC50	114-158
R 113	R Cermet Trimpot 1K 10% 0.5W TC70	182-310
R 114	R Metal Film 14K0 1% 0.5W TC50	115-140

R	115	R Metal Film 2K43 1% 0.5W TC50	114-243
R	116	R Metal Film 14K3 1% 0.5W TC50	115-143
R	117	R Carbon Film 33E 5% 0.2W	106-233
R	118	R Carbon Film 33K 5% 0.2W	106-533
R	119	R Metal Film 2K61 1% 0.5W TC50	114-261
R	120	R Metal Film 4K87 1% 0.5W TC50	114-487
R	121	R Metal Film 21K0 1% 0.5W TC50	115-210
R	122	R Metal Film 8K66 1% 0.5W TC50	114-866
R	123	R Metal Film 21K0 1% 0.5W TC50	115-210
R	124	R Carbon Film 33E 5% 0.2W	106-233
R	125	R Metal Film 14K3 1% 0.5W TC50	115-143
R	126	R Metal Film 7K15 1% 0.5W TC50	114-715
R	127	R Metal Film 4K87 1% 0.5W TC50	114-487
R	128	R Metal Film 7K15 1% 0.5W TC50	114-715
R	129	R Metal Film 3K57 1% 0.5W TC50	114-357
R	130	R Metal Film 2K61 1% 0.5W TC50	114-261
R	131	R Metal Film 4K53 1% 0.5W TC50	114-453
R	132	R Cermet Trimpot 470E 20% 0.5W TC70	182-302
R	133	R Metal Film 2K91 1% 0.5W TC50	114-291
R	134	R Metal Film 3K74 1% 0.5W TC50	114-374
R	135	R Metal Film 3K16 1% 0.5W TC50	114-316
R	136	R Carbon Film 33E 5% 0.2W	106-233
R	137	R Carbon Film 33K 5% 0.2W	106-533
R	138	R Carbon Film 2K2 5% 0.2W	106-422
R	139	R Metal Film 48K7 1% 0.5W TC50	115-487
R	140	R Metal Film 63K4 1% 0.5W TC50	115-634
R	141	R Metal Film 63K4 1% 0.5W TC50	115-634
R	142	R Carbon Film 33K 5% 0.2W	106-533
R	143	R Carbon Film 33E 5% 0.2W	106-233
R	144	R Metal Film 4K02 1% 0.5W TC50	114-402
R	145	R Metal Film 11K3 1% 0.5W TC50	115-113
R	146	R Carbon Film 33E 5% 0.2W	106-233
R	147	R Cermet Trimpot 470E 20% 0.5W TC70	182-302
R	148	R Cermet Trimpot 470E 20% 0.5W TC70	182-302
R	149	R Metal Film 4K75 1% 0.5W TC50	114-475
R	150	R Metal Film 4K75 1% 0.5W TC50	114-475
R	151	R Metal Film 4K99 1% 0.5W TC50	114-499
R	152	R Metal Film 4K99 1% 0.5W TC50	114-499
R	153	R Carbon Film 33K 5% 0.2W	106-533
R	154	R Carbon Film 33K 5% 0.2W	106-533
R	155	R Carbon Film 33K 5% 0.2W	106-533
R	156	R Carbon Film 33K 5% 0.2W	106-533
R	157	R Carbon Film 33K 5% 0.2W	106-533
R	158	R Carbon Film 33K 5% 0.2W	106-533
R	159	R Carbon Film 33K 5% 0.2W	106-533
R	160	R Carbon Film 33K 5% 0.2W	106-533
R	161	R Carbon Film 33K 5% 0.2W	106-533
R	162	R Carbon Film 33K 5% 0.2W	106-533
R	163	R Carbon Film 33K 5% 0.2W	106-533
R	164	R Carbon Film 33K 5% 0.2W	106-533
R	165	R Carbon Film 33K 5% 0.2W	106-533
R	166	R Carbon Film 100K 5% 0.2W	106-610
R	167	R Carbon Film 33K 5% 0.2W	106-533
R	168	R Metal Film 75E0 1% 0.5W TC50	112-750

R	169	R Metal film 3K92 0.1% 0.25w TC25	141-004
R	170	R Metal Film 8K66 0.1% 0.2W TC25	140-982
R	171	R Carbon Film 33E 5% 0.2W	106-233
R	172	R Carbon Film 33K 5% 0.2W	106-533
R	173	R Carbon Film 33K 5% 0.2W	106-533
R	174	R Carbon Film 15K 5% 0.2W	106-515
R	175	R Carbon Film 100K 5% 0.2W	106-610
R	176	R Carbon Film 33K 5% 0.2W	106-533
R	177	R Metal Film 113E 1% 0.5W TC50	113-113
R	178	R Metal Film 2K00 1% 0.5W TC50	114-200
R	179	R Metal Film 19K1 0.1% 0.2W TC25	140-983
R	180	R Metal Film 8K25 1% 0.5W TC50	114-825
R	181	R Metal Film 8K25 1% 0.5W TC50	114-825
R	182	R Metal film 330K 5% 0.2W TC250	107-633
R	183	R Carbon Film 33K 5% 0.2W	106-533
R	184	R Metal film 150K 5% 0.2W TC250	107-615
R	185	R thick film Sil 8x10K	146-003
R	187	R Carbon Film 33K 5% 0.2W	106-533
R	188	R Carbon Film 15K 5% 0.2W	106-515
R	189	R Carbon Film 100K 5% 0.2W	106-610
R	190	R Carbon Film 33K 5% 0.2W	106-533
R	191	R Metal Film 113E 1% 0.5W TC50	113-113
R	192	R Metal Film 2K00 1% 0.5W TC50	114-200
R	193	R Metal Film 19K1 0.1% 0.2W TC25	140-983
R	194	R Thick Film 4*10K 5% 0.1W	146-017
R	195	R Carbon Film 33K 5% 0.2W	106-533
R	196	R Carbon Film 33E 5% 0.2W	106-233
R	197	R Carbon Film 100K 5% 0.2W	106-610
R	198	R Carbon Film 15K 5% 0.2W	106-515
R	199	R Carbon Film 1K 5% 0.2W	106-410
R	200	R Metal Film 1M00 1% 0.5W TC50	117-100
R	201	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	202	R Metal Film 10K 0.1% 0.1W TC25	141-010
R	203	R Metal Film 10K 0.1% 0.1W TC25	141-010
R	204	R Carbon Film 47E 5% 0.2W	106-247
R	205	R Metal Film 24K9 1% 0.5W TC50	115-249
R	206	R Metal Film 49K9 0.1% 0.4W TC50	141-138
R	207	R Metal Film 49K9 0.1% 0.4W TC50	141-138
R	208	R Metal Film 121E 1% 0.5W TC50	113-121
R	209	R Metal Film 121K 1% 0.5W TC50	116-121
R	210	R Metal Film 121K 1% 0.5W TC50	116-121
R	211	R Carbon Film 1K 5% 0.2W	106-410
R	212	R Metal Film 1M00 1% 0.5W TC50	117-100
R	213	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	214	R Carbon Film 33E 5% 0.2W	106-233
R	215	R Carbon Film 33K 5% 0.2W	106-533
R	216	R Carbon Film 1K 5% 0.2W	106-410
R	217	R Metal Film 1M00 1% 0.5W TC50	117-100
R	218	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	219	R Carbon Film 33E 5% 0.2W	106-233
R	220	R Cermet Trimpot 10K 20% 0.5W TC70	182-301
R	221	R Carbon Film 33K 5% 0.2W	106-533
R	225	R Carbon Film 2K2 5% 0.2W	106-422
R	226	R Carbon Film 1K 5% 0.2W	106-410

R 227	R Carbon Film 1K 5% 0.2W	106-410
R 228	R Carbon Film 1K 5% 0.2W	106-410
R 229	R Carbon Film 33E 5% 0.2W	106-233
R 230	R Carbon Film 33K 5% 0.2W	106-533
R 232	R Metal Film 39K2 1% 0.5W TC50	115-392
R 233	R Metal Film 113K 1% 0.5W TC50	116-113
R 234	R Carbon Film 1K 5% 0.2W	106-410
R 235	R Metal Film 4K53 1% 0.5W TC50	114-453
R 236	R Metal Film 4K99 1% 0.5W TC50	114-499
R 237	R Metal Film 1K00 1% 0.5W TC50	114-100
R 238	R Carbon Film 2K2 5% 0.2W	106-422

TESTPOINTS

TP 1	Wire Wrap Terminal	805-727

CABLES

W 2	16 Leads Flat Cable with DIP-Plug	617-843
W 3	16 Leads Flat Cable with DIP-Plug	617-843

MISCELLANEOUS

	tubular rivet 02.5x0.25x7	060-270
	Female Plug	805-718
	DIN 41651 dip plug connector 16-pol male	805-754
	Connector Socket for 16-Pin	816-217
	28 Pin DIL Socket	816-251
	Board Extractor	857-017
	Conducter Rail C1	931-036
	Weighting Filter Option PCB ISS 5	971-269
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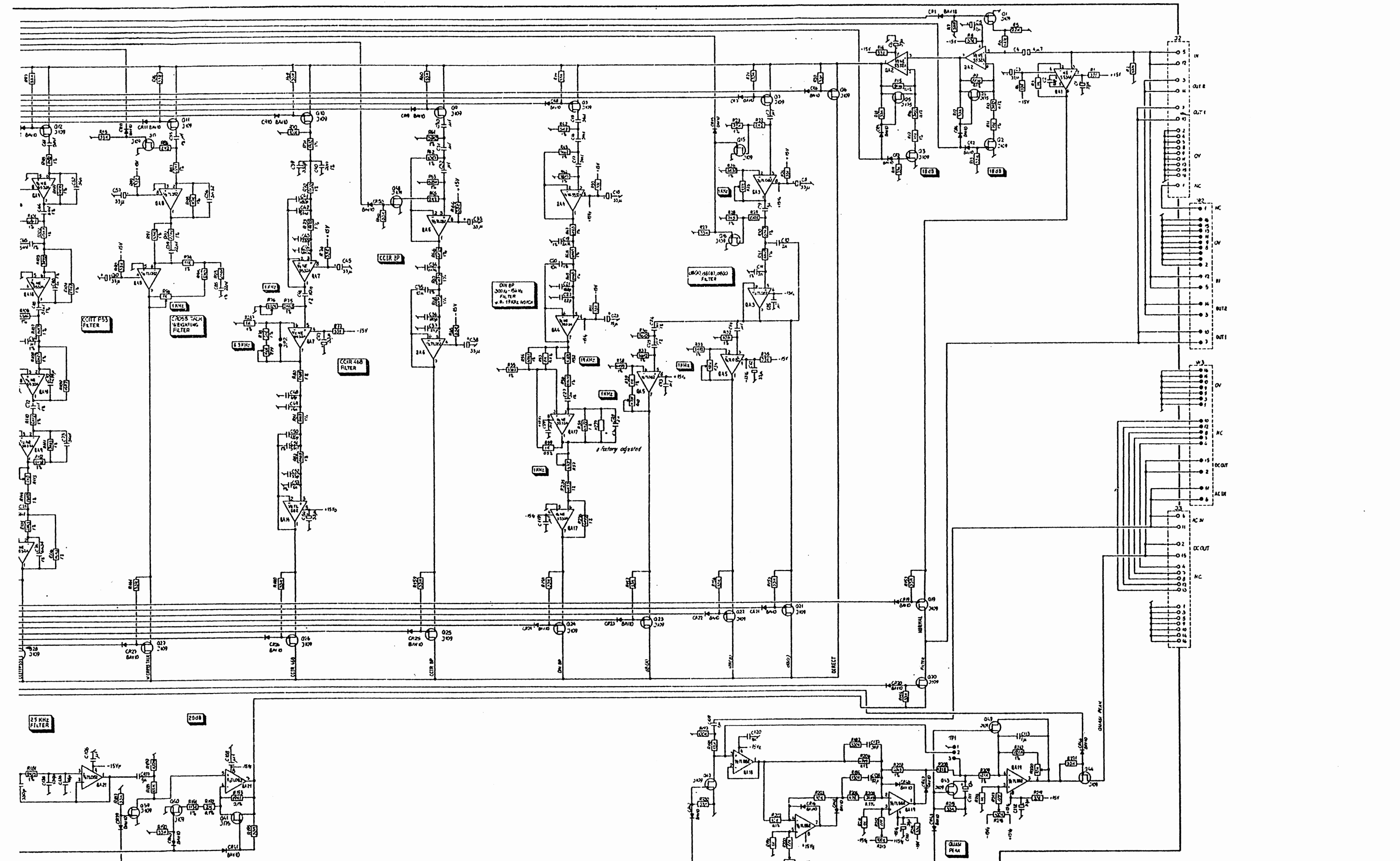

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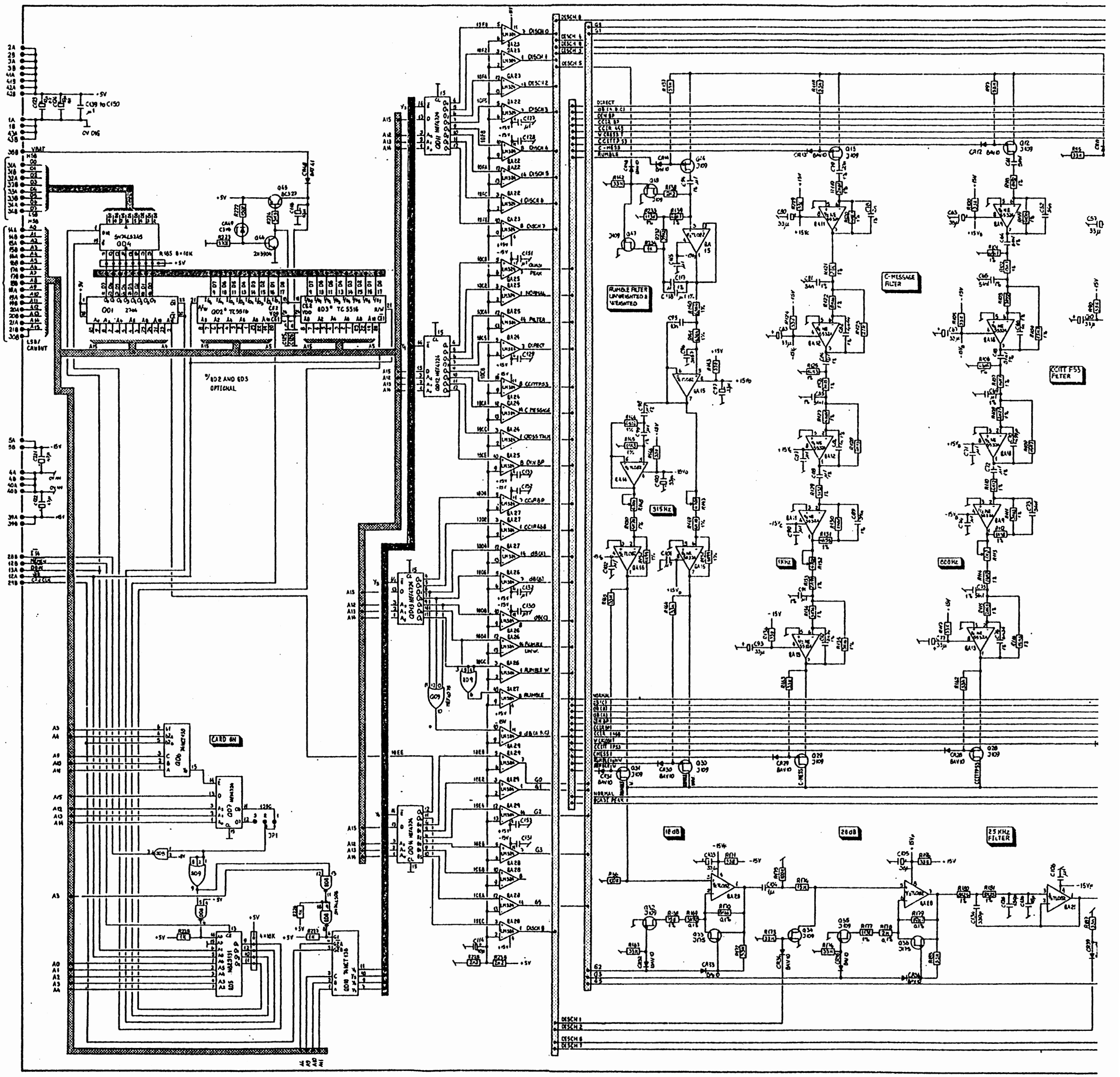
used in RE201						Scale :
Issue/Rev.no	1/	2/	3/ 3397/3481	4/	5/	PCB 971-269
Date	850702	850904	870806			PCB Assy 901-526
Drawn	TD	BD	KMA			Schematic Drawing 985-204
App.		NE				



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TC5516
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DISCH 3
DISCH 4
DISCH 5
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DISCH 8
QUASI PEAK
NORMAL
FILTER
DIRECT
CCITT P53
C MESSAGE
CROSS TALK
DIN BP
CCIR BP
CCIR 468
RUMBLE
CARD ON
RUMBLE FILTER UNWEIGHTED & WEIGHTED
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1kHz
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CCITT P53 FILTER
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20dB
25 KHz FILTER
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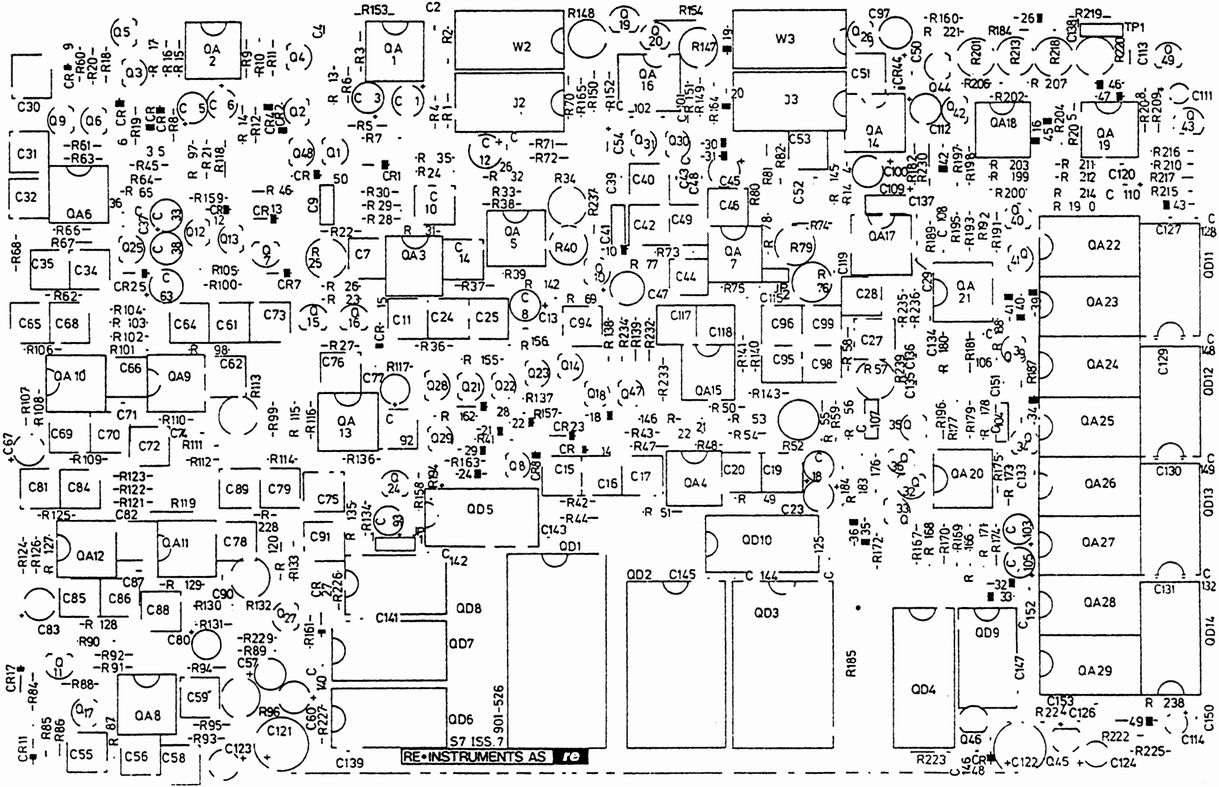
G1
G2
G3
JP1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901-526
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TABLE OF CONTENTS

LIST OF FIGURES

1 GENERAL INFORMATION

The present Technical Manual for the RE201 Wow & Flutter Option provides technical information and maintenance instructions. The circuit board description, theory of operation and adjustment procedures are included as well as some troubleshooting hints. All information on operation, however, is found in the RE201 Operation Manual.

1.1 Introduction

The RE201 Wow & Flutter Option (code No. 901-456) mounted in an RE201 Dual Channel Audio Analyzer enables the latter to measure Wow & Flutter, i.e. frequency modulation caused by mechanical irregularities in tape recorders and turntables. This frequency modulation is detected according to the DIN45507, NAB1965 or JIS C 5551 standards.

Wow & Flutter may be measured in the following ranges: 10 %, 1 % and 0.1 % as either unweighted - (500 Hz bandwidth) or weighted (200 Hz bandpass or according to DIN45507) Wow & Flutter.

Wow & Flutter is often measured together with the 'DRIFT', which is the average frequency in the played-back signal measured as % deviation from the reference frequency (3.15 kHz or 3 kHz). This is a standard facility of the basic RE201 and as such not dependent on the presence of the Wow & Flutter Option. The DRIFT represents a fixed offset from nominal of the tape velocity.

As the Wow & Flutter Option is designed to be used in a microprocessor controlled test instrument, the conventional analog meter has been replaced by a software LP filter in the RE201 which can simulate the dynamic response of a meter. A sigma detector is used to make it possible to deliver a single result during Wow & Flutter measurements.

1.2 Installation

When unpacking the plug-in unit, the packing material should be visually inspected for any physical damage.

If the option card is damaged, please notify the carrier and your local RE representative or the factory. The packing material should be retained for inspection by the carrier.

For a description of the installation refer to the RE201 Basic Unit Technical Manual section 1.2.2.

1.3 Equipment and Accessories

Description	Code No.
RE201 Wow & Flutter Option	901-456
Technical Manual for the RE201 Wow & Flutter Option	983-258

1.4 Specifications

Input

Frequency range	2.4 kHz - 3.8 kHz
Ranges	0.1%, 1%, 10% FSD
Accuracy	+/- 3% of range

Filter Modes

Filter one	0.2 - 500 Hz (-3 dB)
Filter two	0.5 - 200 Hz (-3 dB)
Weighted	according to DIN 45507

Standards

DIN	quasi-peak detection
NAB	average detection, RMS calibrated
JIS	RMS detection

Residual FM at 500 Hz bandwidth	<0.01%
Sigma detector	2 sigma (4.5%) programmable measuring time

The environmental requirements for the Wow & Flutter Option are identical to those of the RE201 Basic Unit.

2 PRINCIPLES OF OPERATION

2.1 Principles of Operation

When a perfectly recorded single tone signal is played back on a tape recorder or a turntable, the quality of the reproduced signal will inevitably be reduced. Noise will be added from electrical circuitry, the signal will be distorted, and velocity changes due to mechanical imperfections (CPS for turntables, tape speed for tape recorders) will cause FM modulation of the signal. A Wow & Flutter meter is basically an FM detector which has been optimized at standardized frequencies (3 kHz as specified by NAB1965/JIS C 5551 and 3.15 kHz as specified by DIN45507 standards). The RMS or peak frequency deviation measured in percentage of the reference frequency is the Wow & Flutter measurement.

The signal from the reproducing equipment is first bandpass filtered (2.4 - 3.8 kHz) to eliminate influence of possible low or high frequency components, which may be present in the signal.

The filtered signal is then FM demodulated in a demodulator specifically designed to deliver an output voltage which is proportional to the relative variation from the center frequency.

The demodulated signal is amplified in the range amplifier and bandpass filtered according to the operator requirements (500 Hz bandpass, 200 Hz bandpass or DIN weighting).

Finally, the signal is detected as specified by the chosen standard (RMS for JIS C 5551, average/RMS calibrated for NAB1965 and quasi-peak for DIN45507) and fed to the programmable sigma detector.

The output from the sigma detector is converted into digital representation and displayed on the RE201 CRT.

In section 3 a more detailed description of the individual circuit blocks is given.

3 CIRCUIT DESCRIPTION

3.1 Circuit Description

A simplified block diagram of the RE201 Wow & Flutter Option is shown in fig. 3.1 while the schematic diagram is shown in drawing No. 985-137.

The option card contains the following main units:

* 2.4 - 3.8 kHz bandpass (BP filter)
* Limiter
* FM Detector
* Range Amplifier and Saturation Limiter
* Filters
* Detector Amplifier
* Sigma Detector

2.4 - 3.8 kHz Filter

This circuit rejects frequency components in the input signal (e.g. hum) outside the actual frequency band, which may affect the measurements due to AM to FM conversion in the limiter. The cut-off frequency of the filter has been determined by the worst case condition in the input signal which is:

a. 3 kHz - 10% drift - a 300 Hz wow and flutter component. This equals 2.4 kHz.

b. 3.15 kHz + 10% drift + a 300 Hz wow and flutter component. This equals 3765 Hz.

The actual active filter consists of two separate sections built around QA1: a 0.3 dB ripple three-pole Chebyschev lowpass section with a cut-off frequency of 3800 Hz and a 0.3 dB ripple three-pole Chebyschev highpass section having a cut-off frequency of 2400 Hz. The resulting transfer characteristic is shown in fig. 3.2.

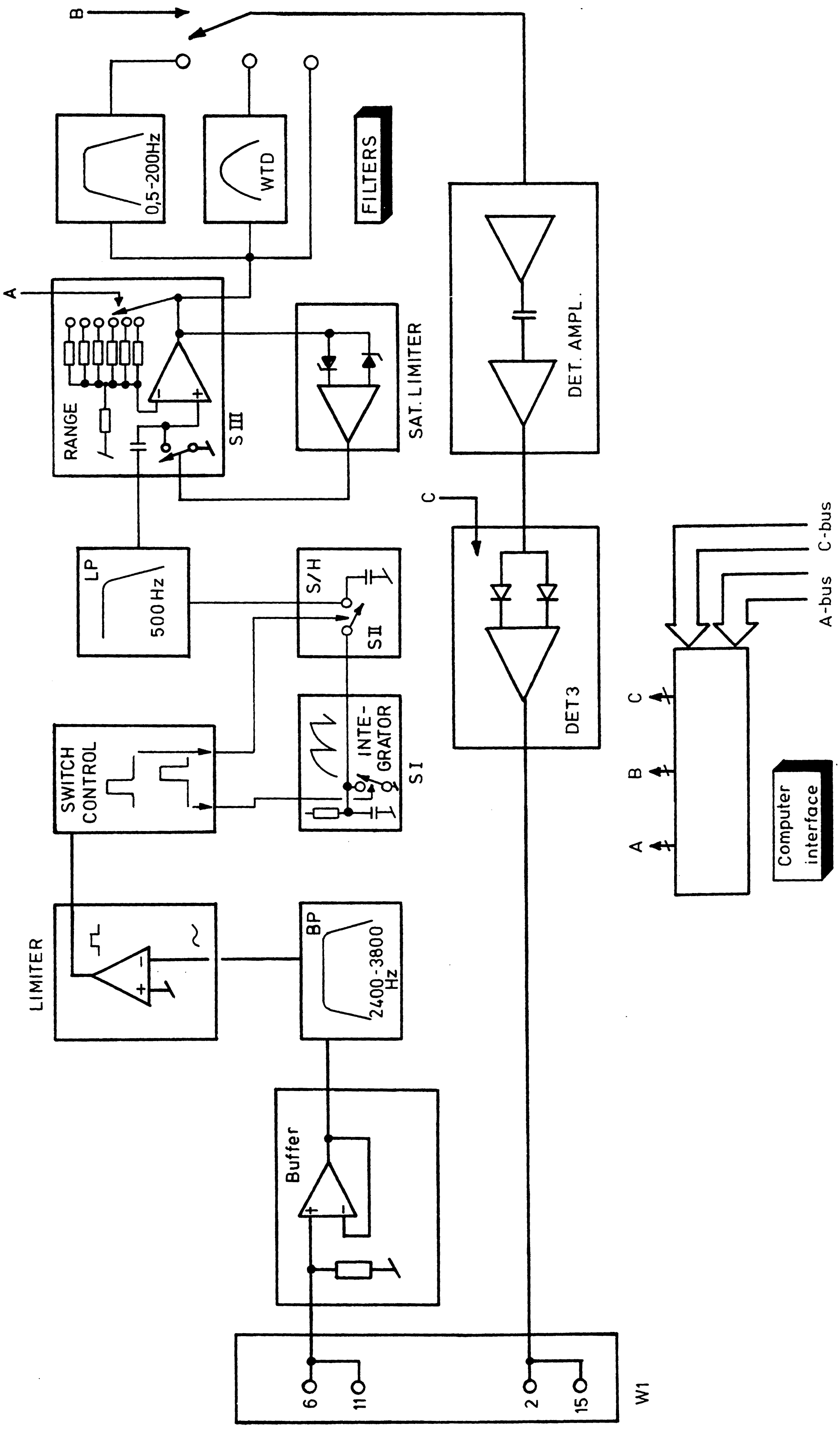

Fig. 3.1 - Wow & Flutter Block Diagram

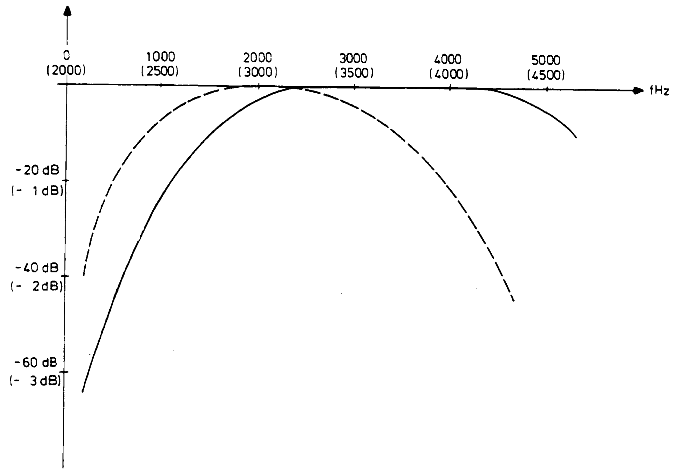

Fig. 3.2 - Transfer Characteristics of the 3 kHz Bandpass Filter

The dotted line and the numbers in parentheses show a magnification of the transfer function within the frequency range 2.4 kHz - 3.8 kHz (passband).

Limiter

This stage is a hard limiting high gain amplifier which shapes the sinusoidal input signal into a TTL compatible square wave used as input to the FM detector.

FM Detector

This circuit block comprises switch control, integrator, sample and hold, and 500 Hz filter.

The signal from the limiter is fed to the switch control section which consists of a dual monostable oneshot. (QD1). The leading edge of the signal from the limiter triggers the first monostab to fire a 10 microsecs pulse.

This pulse is used in the sample-and-hold (SH) circuit, but it is also guided to the second monostable via a delay circuit (2 microsecs delay by means of R19, C16). The output from the second monostable is again a 10 microsec wide pulse used in the integrator.

The logic levels from the monostable oneshot are converted to levels appropriate for the analog switches (S1 and S2) in the circuits based on Q2 and Q3. The actual pulses found at the gates of Q4 (S1) and Q5 (S2) are shown in fig. 3.3.

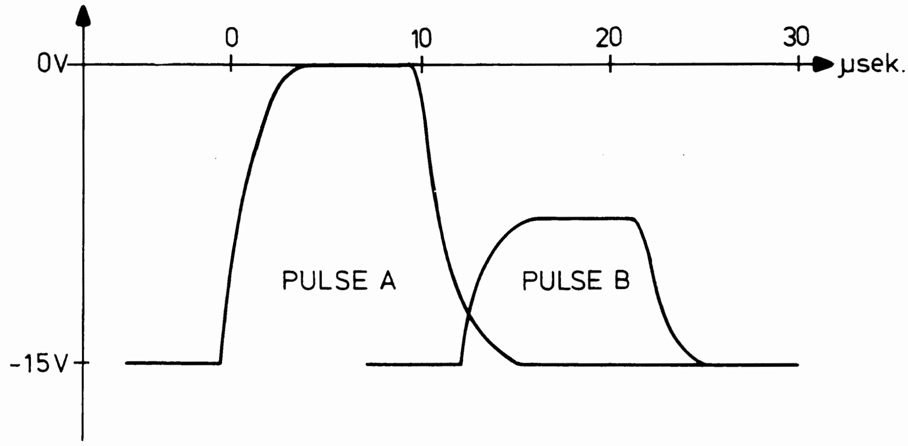

Fig. 3.3 - Control Pulses for S1 and S2

Pulse A controls the SH switch so that the voltage at the output of the integrator is sampled at the beginning of each square wave period.

Pulse B controls the discharge switch in the integrator. This circuit basically consists of an RC integrator and the analog switch S1 used to discharge the capacitor (C22). The voltage measured at the node between R and C (R38 and C22) is shown in fig. 3.4.

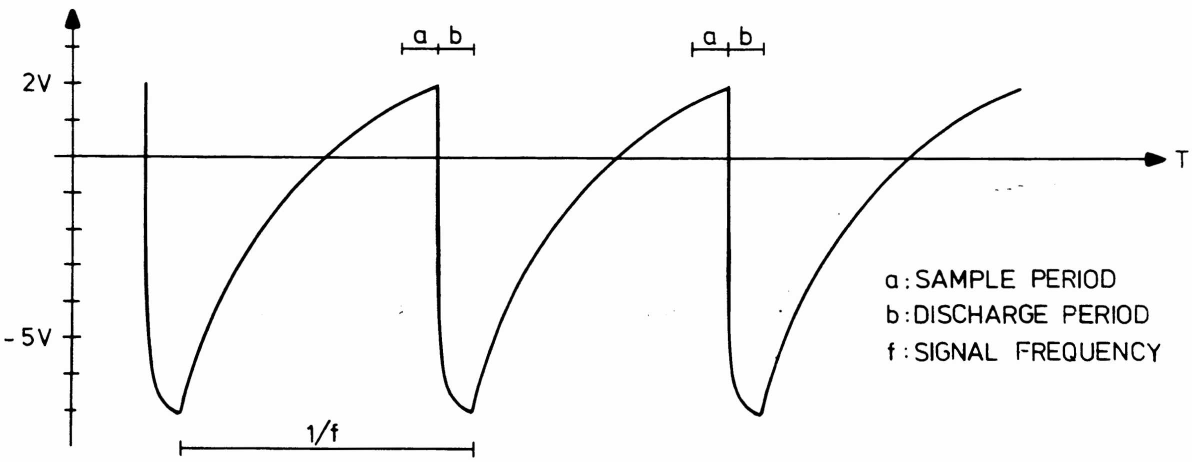

Fig. 3.4 - Voltage at the Output of the Integrator

It should be noted that the signal period (1/f) will normally be >300 microsecs so that the pulse width of A and B will be much smaller compared to 1/f than indicated in the figure.

The voltage fed to the sample and hold circuit can be written as

$$V = VO\ (1 - e^{\frac{-1}{RCf}})$$

If it is FM modulated with a peak frequency deviation of Δf, V can be separated into a DC component and an AC component; if the time constant is carefully chosen, the AC component will be proportional to $\Delta f/f$.

If RC is chosen as 1/3075 Hz, the AC component is proportional to $\Delta f/f$ (2700 Hz < f < 3465 Hz; Δf < 500 Hz) with an accuracy better than 1%.

At the output of the SH circuit the signal is filtered in a 500 Hz second order Butterworth lowpass filter (QA6). This filter establishes the noise bandwidth and removes the sampling frequency from the demodulated signal.

Range Amplifier and Saturation Limiter

The AC component of the demodulated signal is amplified in this stage. The gain is selectable in 4 steps of 20 dB. The input and output are AC coupled which creates a problem common for many instruments measuring at very low frequencies:

The cut-off frequency for the AC coupling at the input is approx. 0.01 Hz; consequently, a spike in the output from the FM detector will cause a (time consuming) saturation in the range amplifier. If this saturation was to disappear by discharge, the instrument could be blocked for several seconds - this is to a large extent circumvented by means of the saturation limiter (QA7, Q6).

This limiter simply detects if the signal at the output of the range amplifier is greater than 5 volts. Then it switches on the analog switch Q6 forcing the input of the range amplifier to discharge nearly instantaneously. The range amplifier also stays discharged when the option card is not being used by means of Q11, Q12.

Filters

By means of the computer interface it is possible to select between 3 different modes of operation:

a. 0.2 - 500 Hz: The signal measured directly at the output of the range amplifier (the filtering is provided by the 500 Hz filter and the AC coupling of the detector amplifier).

b. 0.5 - 200 Hz: A passive filter with skirts falling 6 dB/octave below 0.5 Hz and above 200 Hz. At midband frequencies the filter causes a measurement error of -0.8%.

c. Weighted: An active filter (QA8) weighting according to DIN 45507.

All filters are selected by means of FET switches (Q17 - Q19) driven by the computer interface (QD2, QD3 and QD4).

Detector Amplifier

Depending upon the standard selected, the detector is coupled as either a peak-peak detector (DIN 45507), full wave RMS calibrated average detector (NAB1965), or as a full wave RMS detector (JIS C 5551).

The detector circuit consists of four identical diodes, two of which (CR8, CR9) are placed in the feedback of QA10. This eliminates the effect of the diode drop, and provides a linear detection down to small signal levels. The selection of detector circuitry is done via the computer interface using FET switches.

Sigma Detector

The output from the detector amplifier is fed back into the Analog Frontend of the RE201 and digitized by means of the A/D converter.

The 12 bit samples from the A/D converter are used as input to a digital LP filter used to simulate the dynamic response of an analog meter. The output from this filter is then fed into a sigma detector that delivers a readout indicating the 95.5% level, i.e. the output from the "meter" has been above this value 4.5% of the time during which the measurement was performed (refer to fig. 3.5). Use of the sigma detector fully automatizes the Wow & Flutter measurement so that objective unambiguous results can be obtained.

Jumpers and Test Points

The locations of the jumpers, test points and potentiometers are shown in fig. 3.6.

Jumpers

P1: Selects different output routing possibilities.
Normal position 5-6.

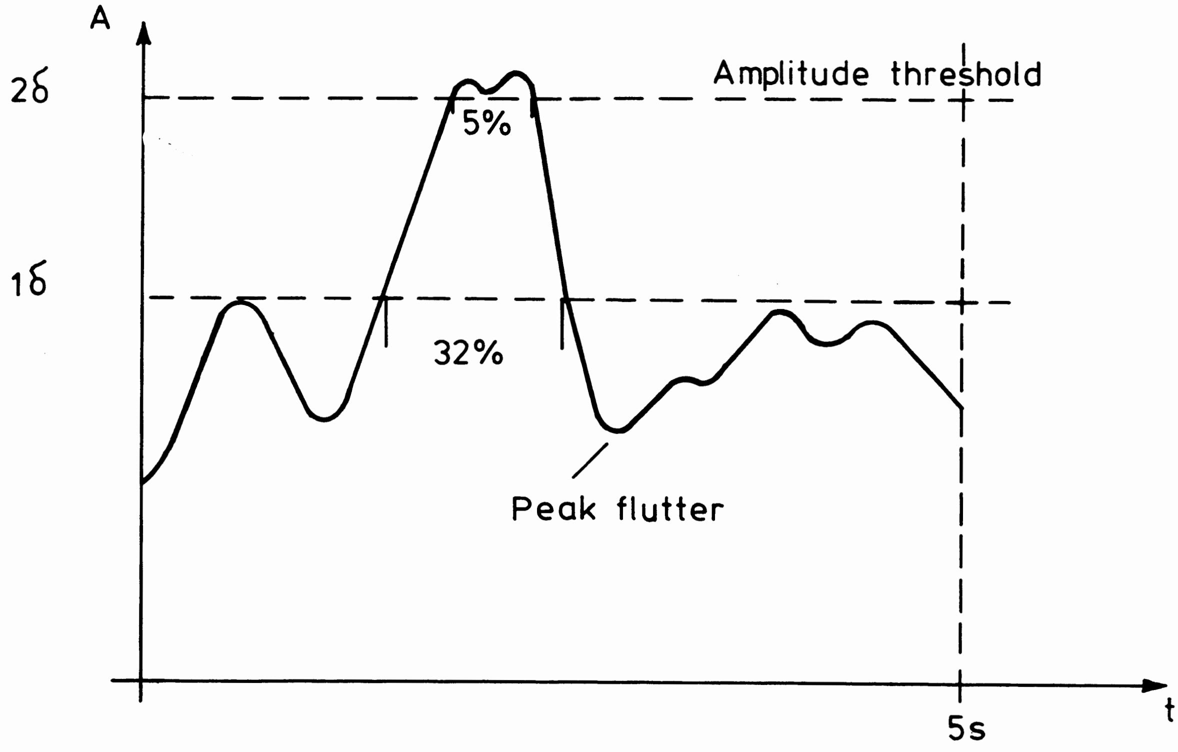

Fig. 3.5 - Sigma Detector Principle

Test Points

TPA: Not used during adjustments. May be used for check of 2.4 - 3.8 kHz filter.

TPB: Used for monitoring purposes during adjustments of limiter threshold for 50% duty cycle.

TPC: Pin Nos. 1-2 used for adjustment of 7.5 V in the FM demodulator (R39).

Pin Nos. 2-4 used for adjustment of -7.5 V in the FM demodulator (R36).

TPD: Used during adjustment of DC offset in the range amplifier and filters.

TPE: Used during adjustment of DC offset in the input stage to the detector.

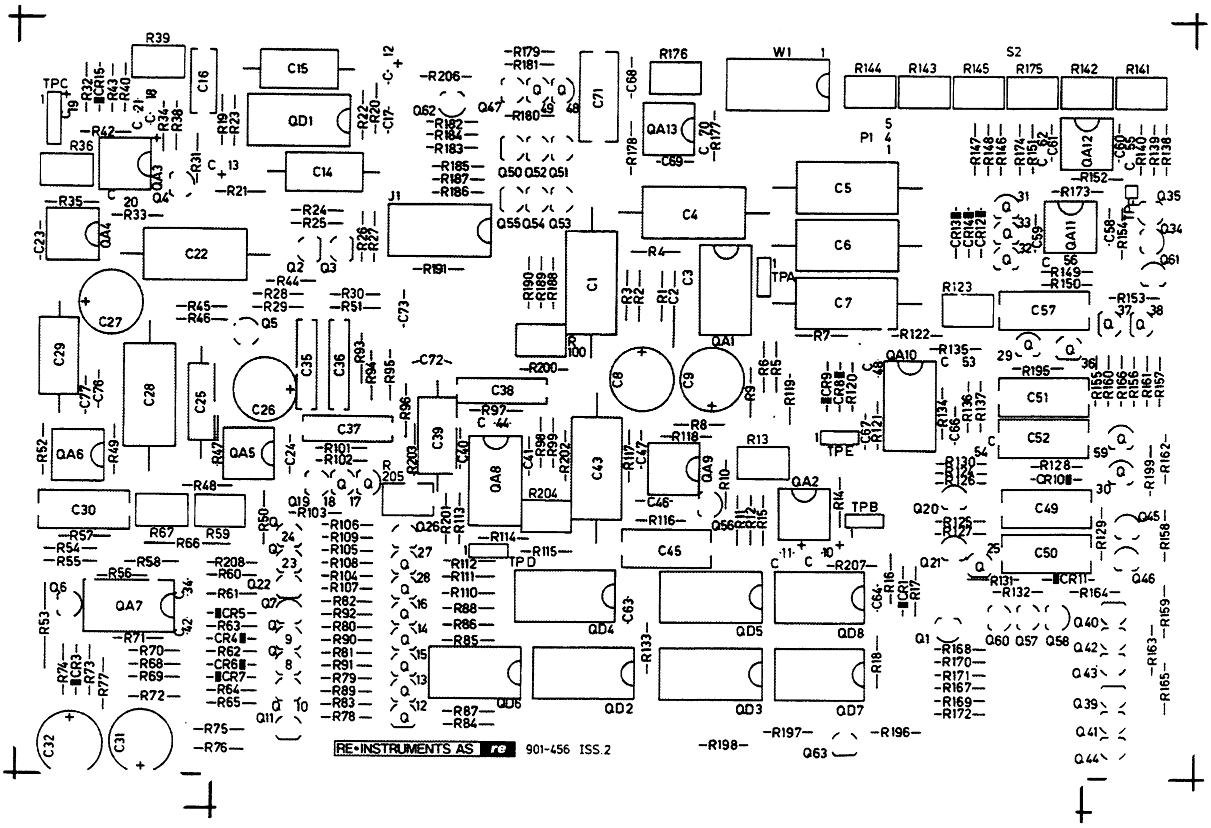

Fig. 3.6 - Wow & Flutter Component Layout

4 MAINTENANCE

The performance test given in this section verifies the operation of the Wow & Flutter Option for the RE201. If the tolerances given during the performance tests are not met, reference should be made to section 5, Troubleshooting, which gives some troubleshooting hints.

4.1 Recommended Test Equipment

Instrument	Critical Specifications	Recommended Model
Oscilloscope	None	
Signal generator	Frequency range 10 Hz - 10 kHz level adjustable to 3 mV RMS	Audio Generator for the RE201 901-500

Table 4.1 - Recommended Test Equipment

In order to check the Wow & Flutter Option, an FM modulated signal must be provided. This test signal may be generated by using a stable VCO (Voltage Controlled Oscillator) and a signal generator used as modulation source.

Specification of FM Test Signal

Carrier Frequency:	2700 - 3450 Hz
Drift of carrier:	<1% during measurement period
Signal level:	5 mV - 17 V RMS
Frequency of mod. signal:	0.2 - 500 Hz
Amplitude of modulation signal:	Must be controlled to give peak frequency deviations in the range 0.03% to 10%
Modulation waveform:	0.5 - 500 Hz sine wave and 1 Hz square wave
Accuracy of peak frequency deviation:	<1%

4.2 Performance Test

Fig. 4.1 shows the test set-up for the Wow & Flutter Option:

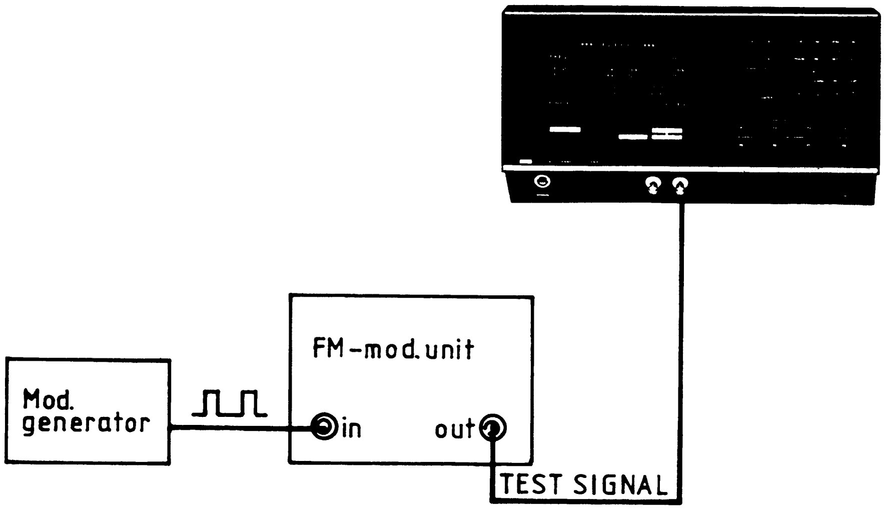

Fig. 4.1 - Test Set-up

Refer to fig. 4.1.

a. Adjust the FM mod. unit and the modulation signal generator to obtain the following test signal:

Carrier frequency	2700 Hz to 3450 Hz
Modulation signal	30 Hz sine wave
Peak frequency deviation	0.7%
Level of test signal	5 mV - 17 V RMS

b. Instruct the RE201 to measure Wow & Flutter using the following parameters:

* Appropriate channel
* DIN Standard
* 0.2 - 500 Hz Filter
* 1% range
* 5 sec. integration time

The result should be 0.7% +/- 0.03%.

Now change standard to NAB and then JIS and check that the measured result is 0.5% +/- 0.03% in either case.

c. Change the modulation frequency to 4 Hz maintaining the same peak frequency deviation (0.7%).

d. Instruct the RE201 to measure Wow & Flutter using the following parameters:

* Appropriate channels
* DIN Standard
* 0.2 - 500 Hz Filter
* 1% range

The result should be 0.7% +/- 0.03%.

Change the filter to the DIN45507 Weighting Filter and check that the reading is still 0.7% within 0.03%.

e. Change the peak frequency deviation in a sequence 10%, 1%, 0.1% and check by selecting the corresponding ranges that the range selector is accurate to within +/- 3% of full scale reading.

If the tolerances are not met, refer to section 4.3 for adjustments.

Filters

Refer to fig. 4.1.

a. Instruct the RE201 to measure Wow & Flutter using the following parameters:

* Appropriate channel
* DIN Standard
* 0.2 - 500 Hz Filter
* 1% range
* 5 sec. integration time

b. Adjust the peak deviation of the FM modulated test signal to achieve a 1% reading.

By turning the modulation frequency, check that the upper cut off frequency (-3 dB) is within 430 - 570 Hz.

c. Change to 0.5 - 200 Hz filter and verify that the cut off frequency is within 185 - 215 Hz.

d. For check of Filter Weighted, refer to the following section.

Check of Standard

The static measurements that must be carried out in order to verify that the RE201 with the Wow & Flutter Option installed conforms to the requirements of the DIN standard 45507, the NAB1965 standard and the JIS standard are described below:

Refer to fig. 4.1.

a. Instruct the RE201 to measure Wow & Flutter using the following parameters:

- * Appropriate channel
- * DIN Standard
- * Weighting according to DIN45507
- * 1% range
- * 5 secs. integration time

With a 4 Hz modulation frequency (sine wave) adjust the frequency deviation of the test signal to obtain a 1% reading.

b. By turning the modulation frequency between 0.2 and 200 Hz, keeping the peak deviation constant, check that the response of the filter follows fig 4.2.

c. Repeat step 2 when JIS and NAB standards are selected.

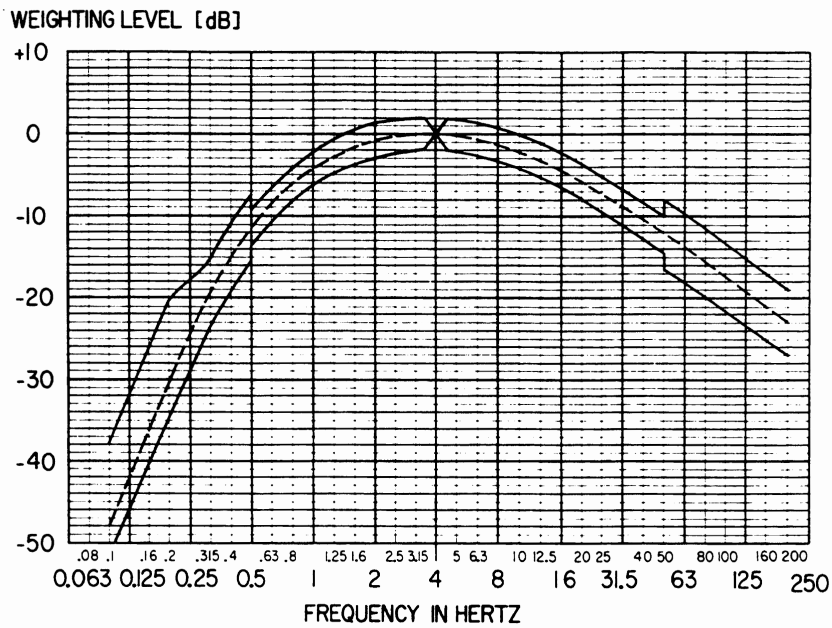

Fig. 4.2 - Standard W&F Weighting Function

4.3 Adjustments

This section describes adjustment procedures to be employed during regular service and in case of discrepancies encountered during performance tests.

Whenever reference is made to specific circuit blocks, refer to the schematic drawing No. 985-137.

The locations of test points and adjustment potentiometers are shown in fig. 3.6.

Noise

In order to minimize the internal noise level in the RE201 Wow & Flutter Option it may be necessary to adjust the threshold level of the limiter (QA2):

a. Connect the output from the RE201 Audio Generator to Ch. A of the RE201 and adjust the level to 1 V RMS and the frequency to 3 kHz.

b. Instruct the RE201 to measure Wow & Flutter using the following parameters:

   * Appropriate channel
   * DIN Standard
   * 0.2 - 500 Hz filter
   * 1% range
   * 5 secs. integration time

c. Connect an oscilloscope to test point TPB pin 2.

d. Adjust R13 until the square wave displayed on the oscilloscope has a 50% duty cycle.

If the noise level is still high, refer to section 5 (Trouble-shooting).

Discriminator Adjustment

Connect the DVM to TPC1 and adjust output to 7.5 V +/- 10 mV by means of R39.

Connect the DVM to TPC4 and adjust voltage to -7.5 V +/- 10 mV by means of R36.

Calibration

Refer to the description of the FM mod. unit (Section 4.1, Recommended Test Equipment) and fig. 4.1.

a. Adjust the FM mod. unit and the modulation signal generator to obtain the following signal:

Carrier frequency	3100 Hz
Modulation signal	30 Hz
Peak frequency deviation	1.0 %
Level of test signal	1 V RMS

b. Instruct the RE201 to measure Wow & Flutter using the following parameters:

* Appropriate channel
* DIN Standard
* 0.2-500 Hz filter
* 1% range

c. Connect the DVM to TPD2.

d. Set modulation off on the FM mod. unit.

e. Adjust voltage to 0 V +/- 0.3 mV by means of R59.

f. Instruct the RE201 to use 0.1% range.

g. Adjust voltage to 0 V +/- 20 mV by means of R67.

h. Change to 0.5 - 200 Hz filter and 1% range.

i. Adjust output to 0 V +/- 0.3 mV by means of R205.

j. Change to DIN45507 Weighting Filter.

k. Adjust voltage to 0 V +/- 0.3 mV by means of R204.

l. Connect node between R197 and R198 to gnd (0 V) and connect the DVM to W1 pin 2 or 15.

m. Change to 0.2 - 500 Hz filter.

n. Adjust to 0 V +/- 0.3 mV by means of R175 and remove the connection to the node mentioned above.

o. Connect the DVM to TPE 2.

p. Adjust to 0 V +/- 0.3 mV by means of R123.

Sensitivity

Input signal:

Frequency	3150 Hz
Level	1 V RMS
Modulation	32 Hz
Peak frequency deviation	10 %

a. Instruct the RE201 to measure Wow & Flutter using the the following parameters:

* Appropriate channel
* DIN Standard
* 0.2 - 500 Hz filter
* 1% range

b. Connect DVM to W1 pin 2 or 15.

c. Adjust output to 2518 mV +/- 5 mV by means of R145.

d. Change filter to 0.5 - 200 Hz.

e. Check that output level is 2482 mV +/- 14 mV.

f. Change standard to NAB and filter to 0.2 - 500 Hz.

g. Adjust output to 1780 mV +/- 3 mV by means of R143.

h. Change filter to 0.5 - 200 Hz.

i. Check that output level at W1 pin 2 or 15 is 1756 mV +/- 9 mV.

j. Change standard to JIS and filter to 0.2 - 500 Hz.

k. Adjust level to 1780 mV +/- 3 mV using R144.

l. Change filter to 0.5 - 200 Hz.

m. Check that output level is 1756 mV +/- 9 mV.

5 TROUBLESHOOTING

This section provides some troubleshooting hints, should the Wow & Flutter Board be defective.

As the Wow & Flutter Option board adds one specific measurement capability to the RE201, it is easy to detect when errors originate from this board. Before troubleshooting the Wow & Flutter Board, however, the following should be checked:

* Is the board installed in accordance with section 1.2.2 of the RE201 Basic Unit Technical Manual?

* Are other types of measurement performing correctly?

The description of the set-ups during different measurements included in section 2 (Principles of Operation) of the RE201 Technical Manual may prove helpful. Whenever reference is made to specific circuit blocks, refer to the schematic diagram drawing No. 985-137.

Decoding Circuit

If the Wow & Flutter Option is not recognized during the initialization procedure, i.e. it is not listed when the 'options installed' are displayed, and the <W&F> softkey does not appear in EXECUTE MODE, it is because the line W&F PRESENT ($\overline{I13}$) is not pulled low by the Option Board when requested by the Static CPU. Check the decoding circuit (QD3 - QD3 - QD5), or try to move the option to another slot in the Analog Section, as the error may be due to a bad connection in the Analog Motherboard, either in the $\overline{I13}$ line or in the Address/Control Bus (the Data Bus is not used by the Wow & Flutter Option). Eventually, the error may possibly be due to a bad input circuit for detection of $\overline{I13}$ in the static CPU.

Noise

If the internal noise level is too high, even after performing the adjustments outlined in section 4.3, it is recommended to check the drive pulses for the sample and hold circuit and the discharging switch (Q4). These pulses are found at the nodes between R28 and R29, and R44 and R30, respectively.

Alternatively, an increased noise level may originate from a hum component in the demodulated signal. This may be verified by connecting the oscilloscope to TPD pin 2 and specifying DIN45507 weighting. Then the influence from HUM should be reduced by approx. 12 dB.

This type of error may be caused by a bad tantalum capacitor (C18 or C19), a defective operational amplifier in the discriminator or Range

Selector circuitry or an error in the +/- 15 V power supply in the RE201.

Range Amplifier

If an error appears in some - but not in all - ranges, the error will most probably be due to a defective FET switch (Q7- Q10) or an error in the associated drive circuits (Q13 - Q16 or QD2 - QD4).

Filters

When troubleshooting the filters, it should be noted that input to the filters 0.5 - 200 Hz and weighted is the output from the 0.2 - 500 Hz filter. (Consequently, an error in this circuitry may affect the output from all filters.)

Standards

First of all, check the FET switches (Q31 - Q33) and the associated drive circuits (Q40 - Q42 and QD2, QD3, QD5). Since the static and dynamic performance depends on several parameters, such as actual transfer characteristics for the WTD filter and the rise and drop time for the peak detectors, it is not simple to give other troubleshooting hints. In cases where it is not possible to relate the error to a defective component, the factory should be consulted.

6 PARTS LIST AND SCHEMATIC DIAGRAM

6.1 Parts List

All electronic components are included in the parts list. Parts marked with an * are manufactured by RE INSTRUMENTS AS.

When ordering spare parts it is important that you give the following information:

- Code No. and description of the part.
- Circuit reference from the schematic diagram.
- Complete type designation of RE product.

Wow & Flutter (901-456)

CAPACITORS

C 1	C Polystyrol 10n55 1% 63V		243-104
C 2	C Polyst 499p 1% 63V	NND	243-140
C 3	C Ceramic 33p 2% 100V NP0		213-119
C 4	C Polystyrol 46p7 1% 63V	N	243-156
C 5	C Polyst 10n0 2% 63V		243-020
C 6	C Polyst 10n0 2% 63V		243-020
C 7	C Polyst 10n0 2% 63V		243-020
C 8	Electrolytic 47/25, 2000h/85°, R:5*11, RM2		261-085
C 9	Electrolytic 47/25, 2000h/85°, R:5*11, RM2		261-085
C 10	C solid AL 10u 20% 16V		265-008
C 11	C solid AL 10u 20% 16V		265-008
C 12	C solid AL 10u 20% 16V		265-008
C 13	C solid AL 10u 20% 16V		265-008
C 14	C Polyst 1n00 2% 63V		243-014
C 15	C Polyst 1n00 2% 63V		243-014
C 16	MKT, 0.01/400/10, R:4*9*13, RM4		241-020
C 17	C Ceramic u1 -20%+80% 12V		213-017
C 18	C solid AL 10u 20% 16V		265-008
C 19	C solid AL 10u 20% 16V		265-008
C 20	C Ceramic 33p 2% 100V NP0		213-119
C 21	C Ceramic 33p 2% 100V NP0		213-119
C 22	C Polyst 10n0 2% 63V		243-020
C 23	C Ceramic 100n 20% 50V		213-400
C 24	C Ceramic 100n 20% 50V		213-400
C 25	C Polysterol 1n5 5% 63V	NND	243-151
C 26	Electrolytic 47/25, 2000h/85°, R:5*11, RM2		261-085
C 27	Electrolytic 47/25, 2000h/85°, R:5*11, RM2		261-085
C 28	C Polysterol 12n 2% 63V		243-017
C 29	C Polystyrol 6n 2% 63V		243-016
C 30	MKT, 2.2/63/10, R:8.5*15*18, RM6		241-031
C 31	Electrolytic 47/25, 2000h/85°, R:5*11, RM2		261-085
C 32	Electrolytic 47/25, 2000h/85°, R:5*11, RM2		261-085
C 34	C Ceramic 100p 2% 100V NP0		213-125
C 35	MKT, 1/63/2.5, R:5.5*10.5*18,	Special	241-040
C 36	MKT, 1/63/2.5, R:5.5*10.5*18,	Special	241-040
C 37	MKT, 1/63/2.5, R:5.5*10.5*18,	Special	241-040
C 38	MKT, 1/63/2.5, R:5.5*10.5*18,	Special	241-040
C 39	C Polyst 2n00 1% 63V		243-106
C 40	C Ceramic 100n 20% 50V		213-400
C 41	C Ceramic 100n 20% 50V		213-400
C 42	C Ceramic 10n -20+80% 63V		213-027
C 43	C Polystyrol 16n 1% 63V		243-018
C 44	C Ceramic 1n -20+80% 63V		213-024
C 45	MKT, 2.2/63/10, R:8.5*15*18, RM6		241-031
C 46	C Ceramic 100n 20% 50V		213-400
C 47	C Ceramic 100n 20% 50V		213-400
C 48	C Ceramic 10p 2% 100V NP0		213-113
C 49	MKT, 2.2/63/10, R:8.5*15*18, RM6		241-031
C 50	MKT, 2.2/63/10, R:8.5*15*18, RM6		241-031
C 51	MKT, 2.2/63/10, R:8.5*15*18, RM6		241-031

C 52	MKT, 2.2/63/10, R:8.5*15*18, RM6	241-031
C 53	C Ceramic 10p 2% 100V NP0	213-113
C 54	C Ceramic 10p 2% 100V NP0	213-113
C 56	C Ceramic 100p 2% 100V NP0	213-125
C 57	C Polycarbonate u68 1% 63V 150PPM	242-024
C 58	C Ceramic 100n 20% 50V	213-400
C 59	C Ceramic 100n 20% 50V	213-400
C 63	C Ceramic u1 -20%+80% 12V	213-017
C 64	C Ceramic u1 -20%+80% 12V	213-017
C 66	C Ceramic 100n 20% 50V	213-400
C 67	C Ceramic 100n 20% 50V	213-400
C 76	C Ceramic 100n 20% 50V	213-400
C 77	C Ceramic 100n 20% 50V	213-400

DIODES

CR 1	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 3	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 4	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 5	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 6	Diode zener BZX79-C4V3 0.4W	350-639
CR 7	Diode zener BZX79-C4V3 0.4W	350-639
CR 8	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 9	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 10	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 11	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 12	Diode BAV20 Si Vr-150V If-250mA	350-023
CR 13	Diode BAV20 Si Vr-150V If-250mA	350-023
CR 14	Diode BAV20 Si Vr-150V If-250mA	350-023
CR 15	Diode zener 1N825 C6V2 0.4W	350-637

TRANSISTORS

Q 1	Transistor 2N3904 pnp	360-064
Q 2	Transistor BC557B pnp	360-160
Q 3	Transistor BC557B pnp	360-160
Q 4	Transistor J109-18 n Fet	360-188
Q 5	Transistor JFet-N J112, TO92	360-114
Q 6	Transistor J109-18 n Fet	360-188
Q 7	Transistor J109-18 n Fet	360-188
Q 8	Transistor J109-18 n Fet	360-188
Q 9	Transistor J109-18 n Fet	360-188
Q 10	Transistor J109-18 n Fet	360-188
Q 11	Transistor BC547B npn	360-159
Q 12	Transistor BC557B pnp	360-160
Q 13	Transistor BC557B pnp	360-160
Q 14	Transistor BC557B pnp	360-160
Q 15	Transistor BC557B pnp	360-160
Q 16	Transistor BC557B pnp	360-160
Q 17	Transistor J109-18 n Fet	360-188
Q 18	Transistor J109-18 n Fet	360-188
Q 19	Transistor J109-18 n Fet	360-188
Q 20	Transistor J109-18 n Fet	360-188
Q 21	Transistor J109-18 n Fet	360-188

Q 22	Transistor BC547B npn	360-159
Q 23	Transistor BC547B npn	360-159
Q 24	Transistor BC547B npn	360-159
Q 25	Transistor BC547B npn	360-159
Q 26	Transistor BC557B pnp	360-160
Q 27	Transistor BC557B pnp	360-160
Q 28	Transistor BC557B pnp	360-160
Q 29	Transistor J109-18 n Fet	360-188
Q 30	Transistor J109-18 n Fet	360-188
Q 31	Transistor J109-18 n Fet	360-188
Q 32	Transistor J109-18 n Fet	360-188
Q 33	Transistor J109-18 n Fet	360-188
Q 36	Transistor BC547B npn	360-159
Q 39	Transistor BC557B pnp	360-160
Q 40	Transistor BC557B pnp	360-160
Q 41	Transistor BC557B pnp	360-160
Q 42	Transistor BC557B pnp	360-160
Q 45	Transistor J109-18 n Fet	360-188
Q 46	Transistor J109-18 n Fet	360-188
Q 47	Transistor J109-18 n Fet	360-188
Q 49	Transistor J109-18 n Fet	360-188
Q 50	Transistor BC547B npn	360-159
Q 52	Transistor BC547B npn	360-159
Q 53	Transistor BC557B pnp	360-160
Q 55	Transistor BC557B pnp	360-160
Q 56	Transistor J109-18 n Fet	360-188
Q 57	Transistor J109-18 n Fet	360-188
Q 58	Transistor J109-18 n Fet	360-188
Q 59	Transistor J109-18 n Fet	360-188
Q 60	Transistor J109-18 n Fet	360-188
Q 61	Transistor J109-18 n Fet	360-188
Q 63	Transistor BC557B pnp	360-160

INTEGRATED ANALOG CIRCUITS

QA 1	IC TL084 quad op amp	364-276
QA 2	IC LM318N OP-Amp	364-216
QA 3	IC LF353 dual op amp	364-350
QA 4	IC LF356 op amp	364-203
QA 5	IC LF356 op amp	364-203
QA 6	IC LF356 op amp	364-203
QA 7	IC TL084 quad op amp	364-276
QA 8	IC TL084 quad op amp	364-276
QA 9	IC LF356 op amp	364-203
QA 10	IC TL084 quad op amp	364-276
QA 11	IC LF356 op amp	364-203

INTEGRATED DIGITAL CIRCUITS

QD 1	IC 74LS221 dual monostab	364-272
QD 2	IC SN74LS138N 1-of-8 decoder/demultiplexer	364-308
QD 3	IC HEF4724BP 8-bit adessable latch	364-412
QD 4	IC SN74LS139N Dual 1 of-4 decoder/demultiplexer	364-376
QD 5	IC SN74LS139N Dual 1 of-4 decoder/demultiplexer	364-376

QD 6	IC 74LS04 hex inverters	364-219
QD 7	IC 74LS04 hex inverters	364-219

RESISTORS

R 1	R Carbon Film 100K 5% 0.2W	106-610
R 2	R Metal Film 6K65 1% 0.5W TC50	114-665
R 3	R Metal Film 6K65 1% 0.5W TC50	114-665
R 4	R Metal Film 6K65 1% 0.5W TC50	114-665
R 5	R Metal Film 3K92 1% 0.5W TC50	114-392
R 6	R Metal Film 76K8 0.5% 0.4W TC50	140-947
R 7	R Metal Film 909E 1% 0.5W TC50	113-909
R 8	R Carbon Film 33E 5% 0.2W	106-233
R 9	R Carbon Film 33E 5% 0.2W	106-233
R 10	R Carbon Film 1K 5% 0.2W	106-410
R 11	R Carbon Film 1K 5% 0.2W	106-410
R 12	R Carbon Film 390K 5% 0.2W	106-639
R 13	R Cermet Trimpot 100K 20% 0.5W TC150	182-035
R 14	R Carbon Film 56E 5% 0.2W	106-256
R 15	R Carbon Film 56E 5% 0.2W	106-256
R 16	R Carbon 10K 5% 0.2w	106-510
R 17	R Carbon Film 4K7 5% 0.2W	106-447
R 18	R Carbon Film 2K2 5% 0.2W	106-422
R 19	R Carbon Film 220E 5% 0.2W	106-322
R 20	R Carbon Film 10E 5% 0,2W	106-210
R 21	R Carbon Film 10E 5% 0,2W	106-210
R 22	R Metal Film 14K0 1% 0.5W TC50	115-140
R 23	R Metal Film 14K0 1% 0.5W TC50	115-140
R 24	R Carbon Film 2K2 5% 0.2W	106-422
R 25	R Carbon Film 2K2 5% 0.2W	106-422
R 26	R Carbon 10K 5% 0.2w	106-510
R 27	R Carbon 10K 5% 0.2w	106-510
R 28	R Carbon Film 1K 5% 0.2W	106-410
R 29	R Carbon Film 22K 5% 0.2W	106-522
R 30	R Metal Film 10K0 1% 0.5W TC50	115-100
R 31	R Carbon Film 100E 5% 0.2W	106-310
R 32	R Carbon Film 100E 5% 0.2W	106-310
R 33	R Carbon Film 100E 5% 0.2W	106-310
R 34	R Metal Film 4K99 1% 0.5W TC50	114-499
R 35	R Metal Film 4K75 1% 0.5W TC50	114-475
R 36	R Cermet Trimpot 470E 20% 0.5W TC150	182-038
R 38	R Metal Film 32K4 0.5% 0.5W TC50	140-856
R 39	R.var 2K2 20% 0.5w	182-031
R 40	R Metal Film 1K21 1% 0.5W TC50	114-121
R 42	R Metal Film 1K10 1% 0.5W TC50	114-110
R 43	R Metal Film 10K0 1% 0.5W TC50	115-100
R 44	R Metal Film 10K7 1% 0.5W TC50	115-107
R 45	R Metal Film 4K42 1% 0.5W TC50	114-442
R 46	R Metal Film 1K00 1% 0.5W TC50	114-100
R 47	R Metal Film 1K00 1% 0.5W TC50	114-100
R 48	R Metal Film 38K3 1% 0.5W TC50	115-383
R 49	R Metal Film 38K3 1% 0.5W TC50	115-383
R 50	R Carbon Film 22E 5% 0.2W	106-222
R 51	R Carbon Film 22E 5% 0.2W	106-222

R 52	R Carbon Film 1K 5% 0.2W	106-410
R 53	R Carbon Film 1M2 5% 0.5W	100-712
R 54	R Metal Film 21K5 1% 0.5W TC50	115-215
R 55	R Metal Film 10K0 1% 0.5W TC50	115-100
R 56	R Metal Film 18K2 1% 0.5W TC50	115-182
R 57	R Carbon Film 680E 5% 0.2W	106-368
R 58	R Carbon 1M 5% 0.2w	106-710
R 59	R Cermet Trimpot 100K 20% 0.5W TC150	182-035
R 60	R Carbon Film 180E 5% 0.2W	106-318
R 61	R Metal Film 1M 0.5% 0.25W TC50	140-949
R 62	R Metal Film 100K 0.5% 0.4W TC50	140-553
R 63	R Metal Film 10K 0.5% 0.4W TC50	140-450
R 64	R Metal Film 1K 0.5% 0.4W TC50	140-444
R 65	R Carbon Film 100K 5% 0.2W	106-610
R 66	R Carbon Film 4M7 5% 0.5W	100-747
R 67	R Cermet Trimpot 100K 20% 0.5W TC150	182-035
R 68	R Carbon Film 4K7 5% 0.2W	106-447
R 69	R Carbon Film 4K7 5% 0.2W	106-447
R 70	R Carbon Film 4K7 5% 0.2W	106-447
R 71	R Carbon Film 4K7 5% 0.2W	106-447
R 72	R Carbon Film 68K 5% 0.2W	106-568
R 73	R Carbon 47K 5% 0.2w	106-547
R 74	R Carbon 47K 5% 0.2w	106-547
R 75	R Carbon Film 33E 5% 0.2W	106-233
R 76	R Carbon Film 33E 5% 0.2W	106-233
R 77	R Carbon Film 56K 5% 0.2W	106-556
R 78	R Carbon Film 56K 5% 0.2W	106-556
R 79	R Carbon Film 56K 5% 0.2W	106-556
R 80	R Carbon Film 56K 5% 0.2W	106-556
R 81	R Carbon Film 56K 5% 0.2W	106-556
R 82	R Carbon Film 56K 5% 0.2W	106-556
R 83	R Carbon Film 15K 5% 0.2W	106-515
R 84	R Carbon Film 5K6 5% 0.2W	106-456
R 85	R Carbon Film 5K6 5% 0.2W	106-456
R 86	R Carbon Film 5K6 5% 0.2W	106-456
R 87	R Carbon Film 5K6 5% 0.2W	106-456
R 88	R Carbon Film 5K6 5% 0.2W	106-456
R 89	R Carbon Film 2K2 5% 0.2W	106-422
R 90	R Carbon Film 2K2 5% 0.2W	106-422
R 91	R Carbon Film 2K2 5% 0.2W	106-422
R 92	R Carbon Film 2K2 5% 0.2W	106-422
R 93	R Metal Film 825K 1% 0.5W TC50	116-825
R 94	R Metal Film 825K 1% 0.5W TC50	116-825
R 95	R Metal Film 332K 1% 0.5W TC50	116-332
R 96	R Metal Film 374K 1% 0.5W TC50	116-374
R 97	R Metal Film 162K 1% 0.5W TC50	116-162
R 98	R Metal Film 1M00 1% 0.5W TC50	117-100
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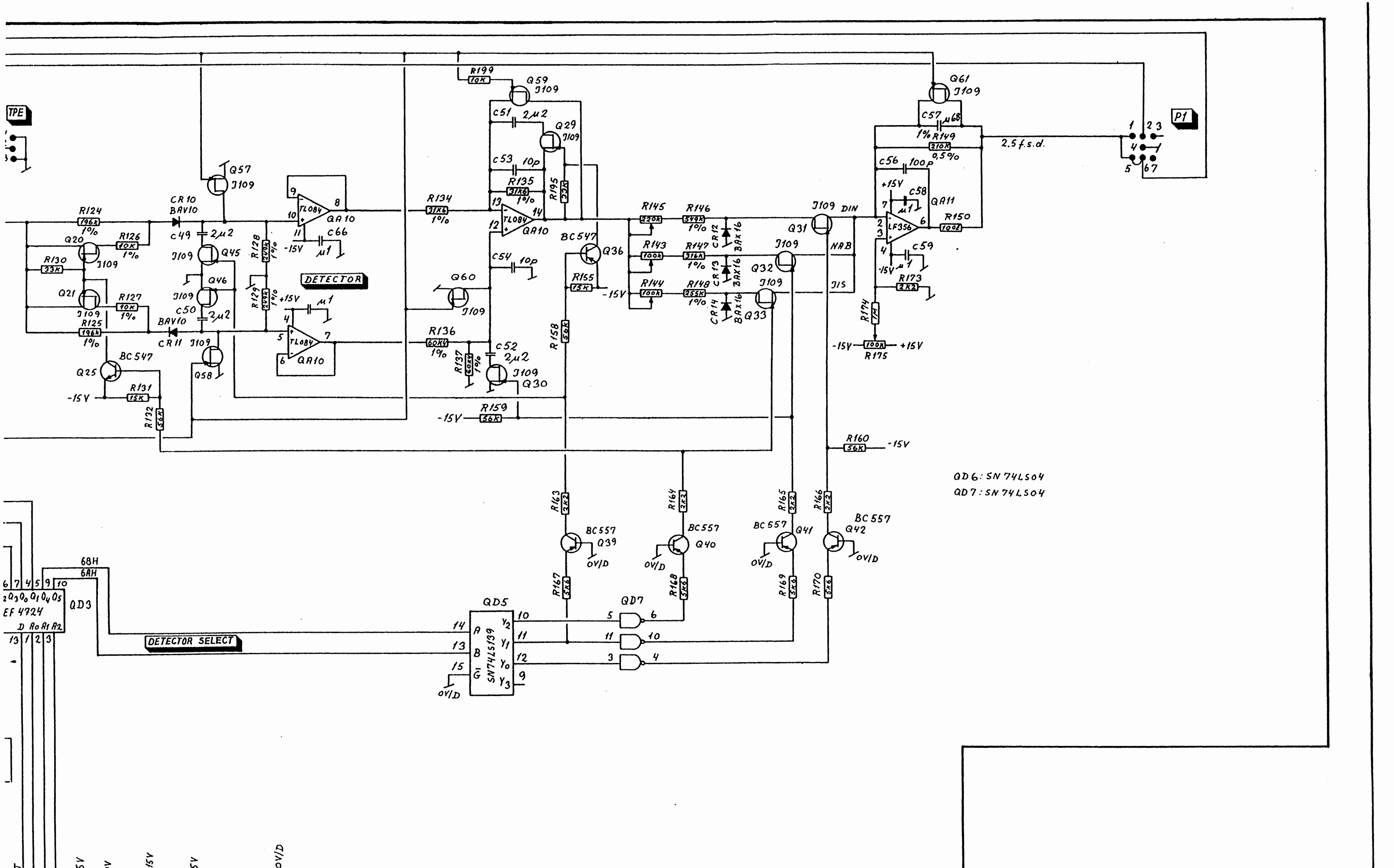
R 102	R Carbon Film 33K 5% 0.2W	106-533
R 103	R Carbon Film 33K 5% 0.2W	106-533
R 104	R Carbon Film 15K 5% 0.2W	106-515
R 105	R Carbon Film 15K 5% 0.2W	106-515

R	106	R Carbon Film 15K 5% 0.2W	106-515
R	107	R Carbon Film 56K 5% 0.2W	106-556
R	108	R Carbon Film 56K 5% 0.2W	106-556
R	109	R Carbon Film 56K 5% 0.2W	106-556
R	110	R Carbon Film 5K6 5% 0.2W	106-456
R	111	R Carbon Film 5K6 5% 0.2W	106-456
R	112	R Carbon Film 5K6 5% 0.2W	106-456
R	113	R Carbon 10K 5% 0.2w	106-510
R	114	R Metal Film 1K00 1% 0.5W TC50	114-100
R	115	R Metal Film 9K09 1% 0.5W TC50	114-909
R	116	R Metal Film 374K 1% 0.5W TC50	116-374
R	117	R Metal Film 4K42 1% 0.5W TC50	114-442
R	118	R Metal Film 18K2 1% 0.5W TC50	115-182
R	119	R Metal Film 100K 1% 0.5W TC50	116-100
R	120	R Metal Film 100K 1% 0.5W TC50	116-100
R	121	R Carbon Film 3K3 5% 0.2W	106-433
R	122	R Carbon 1M 5% 0.2w	106-710
R	123	R Cermet Trimpot 100K 20% 0.5W TC150	182-035
R	124	R Metal Film 196K 1% 0.5W TC50	116-196
R	125	R Metal Film 196K 1% 0.5W TC50	116-196
R	126	R Metal Film 10K0 1% 0.5W TC50	115-100
R	127	R Metal Film 10K0 1% 0.5W TC50	115-100
R	128	R Metal Film 249K 1% 0.5W TC50	116-249
R	129	R Metal Film 249K 1% 0.5W TC50	116-249
R	130	R Carbon Film 33K 5% 0.2W	106-533
R	131	R Carbon Film 15K 5% 0.2W	106-515
R	132	R Carbon Film 56K 5% 0.2W	106-556
R	133	R Carbon 10K 5% 0.2w	106-510
R	134	R Metal Film 31K6 1% 0.5W TC50	115-316
R	135	R Metal Film 31K6 1% 0.5W TC50	115-316
R	136	R Metal Film 60K4 0.5% 0.4W TC50	140-946
R	137	R Metal Film 60K4 0.5% 0.4W TC50	140-946
R	143	R Cermet Trimpot 100K 20% 0.5W TC150	182-035
R	144	R Cermet Trimpot 100K 20% 0.5W TC150	182-035
R	145	R Cermet Trimpot 220K 20% 0.5W TC150	182-044
R	146	R Metal Film 549K 1% 0.5W TC50	116-549
R	147	R Metal Film 316K 1% 0.5W TC50	116-316
R	148	R Metal Film 255K 1% 0.5W TC50	116-255
R	149	R Metal Film 210K 0.5% 0.4W TC50	140-871
R	150	R Carbon Film 100E 5% 0.2W	106-310
R	155	R Carbon Film 15K 5% 0.2W	106-515
R	158	R Carbon Film 56K 5% 0.2W	106-556
R	159	R Carbon Film 56K 5% 0.2W	106-556
R	160	R Carbon Film 56K 5% 0.2W	106-556
R	163	R Carbon Film 2K2 5% 0.2W	106-422
R	164	R Carbon Film 2K2 5% 0.2W	106-422
R	165	R Carbon Film 2K2 5% 0.2W	106-422
R	166	R Carbon Film 2K2 5% 0.2W	106-422
R	167	R Carbon Film 5K6 5% 0.2W	106-456
R	168	R Carbon Film 5K6 5% 0.2W	106-456
R	169	R Carbon Film 5K6 5% 0.2W	106-456
R	170	R Carbon 10K 5% 0.2w	106-510
R	173	R Carbon Film 2K2 5% 0.2W	106-422
R	174	R Carbon 1M 5% 0.2w	106-710

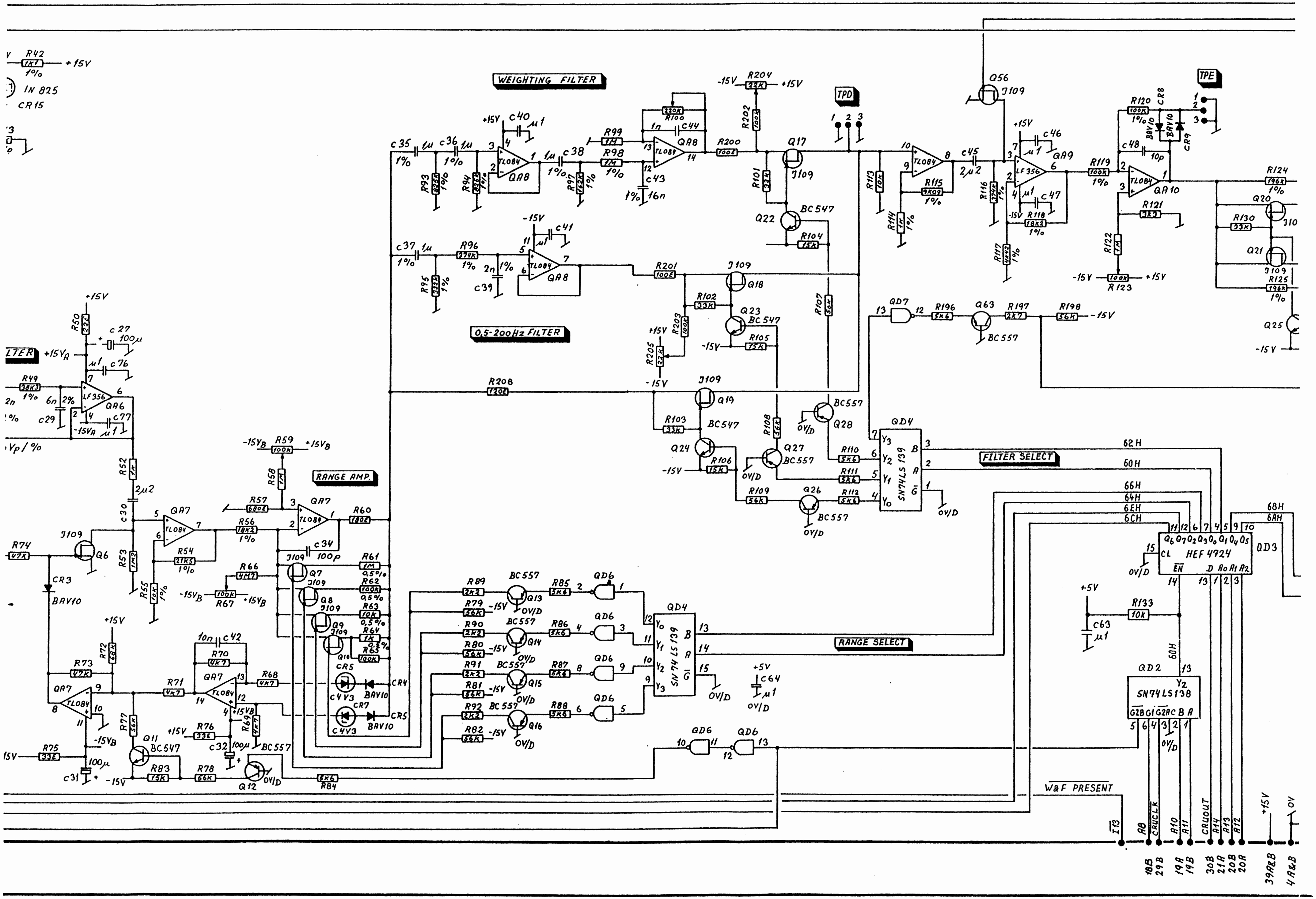
R	175	R Cermet Trimpot 100K 20% 0.5W TC150	182-035
R	178	R Carbon Film 220K 5% 0.2W	106-622
R	179	R Carbon Film 33K 5% 0.2W	106-533
R	181	R Carbon Film 33K 5% 0.2W	106-533
R	182	R Carbon Film 15K 5% 0.2W	106-515
R	184	R Carbon Film 15K 5% 0.2W	106-515
R	185	R Carbon Film 56K 5% 0.2W	106-556
R	187	R Carbon Film 56K 5% 0.2W	106-556
R	188	R Carbon 10K 5% 0.2w	106-510
R	190	R Carbon Film 5K6 5% 0.2W	106-456
R	195	R Carbon Film 33K 5% 0.2W	106-533
R	196	R Carbon Film 5K6 5% 0.2W	106-456
R	197	R Carbon Film 2K7 5% 0.2W	106-427
R	198	R Carbon Film 56K 5% 0.2W	106-556
R	199	R Carbon 10K 5% 0.2w	106-510
R	200	R Carbon Film 100E 5% 0.2W	106-310
R	201	R Carbon Film 100E 5% 0.2W	106-310
R	202	R Carbon Film 100K 5% 0.2W	106-610
R	203	R Carbon Film 100K 5% 0.2W	106-610
R	204	R var 22K 20% 0.5W	182-034
R	205	R var 22K 20% 0.5W	182-034
R	208	R Carbon Film 120E 5% 0.2W	106-312

MISCELLANEOUS

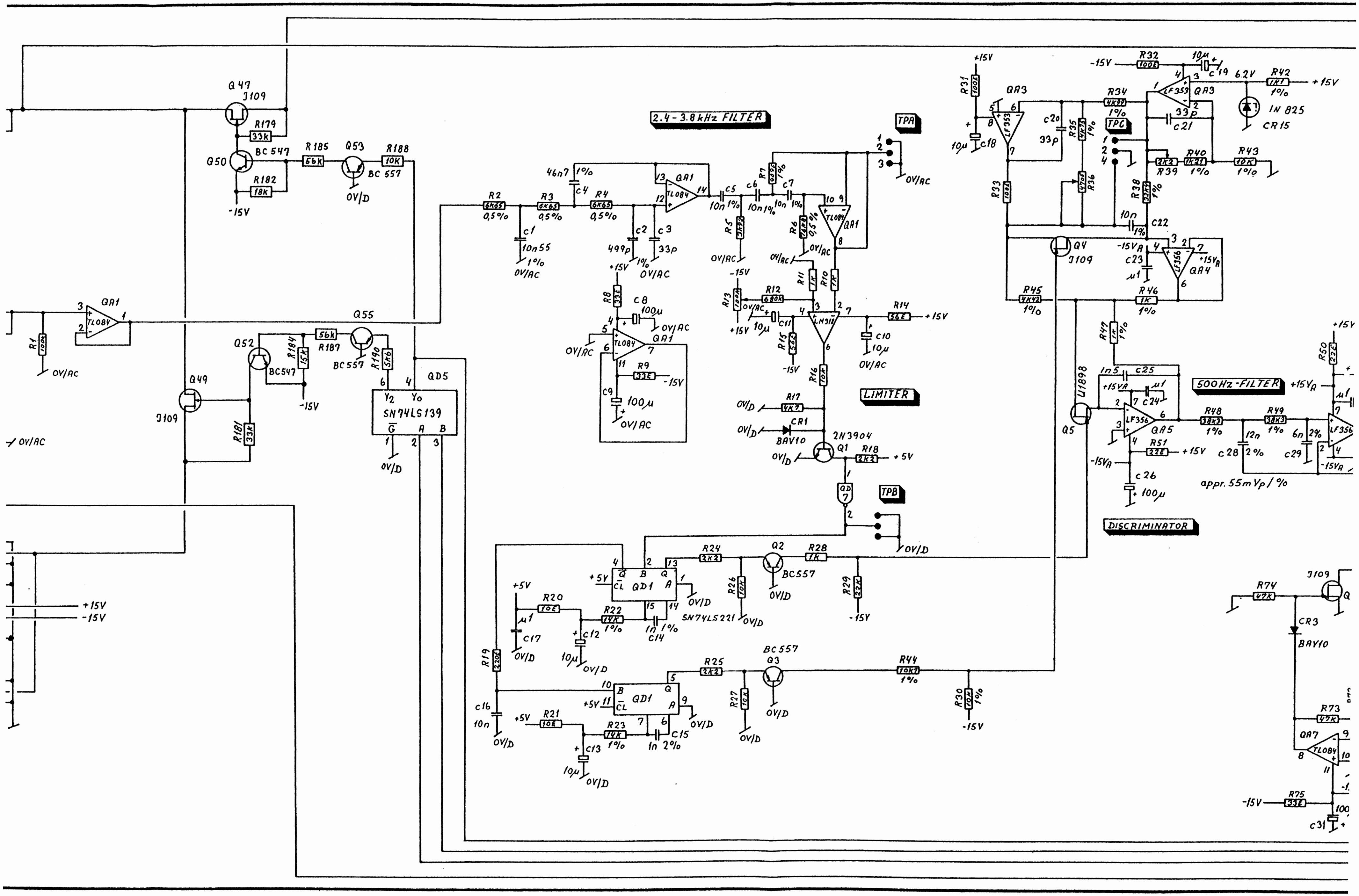
tubular rivet 02.5x0.25x7	060-270
16 Lead Flat Cable 135mm	644-002
Female Plug	805-718
Wire Wrap Terminal	805-727
DIN 41651 dip plug connector 16-pol male	805-754
16 Pin Dil Socket	816-133
Board Extractor	857-017
Wow & Flutter PCB	971-175
***** Unknown text *****	983-702



Subject		RE INSTRUMENTS AS				Sheet of
Wow and Flutter Option		Emdrupvej 26 DK 2100 Copenhagen Ø Denmark +45 01 18 44 22 Telefax +45 1 184401 Telex 22211 redk				Scale :
used in RE 201						
Issue/Rev no	1/	2/	3/	4/	5/	PCB 971-175
Date	831221	850904	860404			PCB Assy 901-456
Drawn	UP	BD	BD			Schematic Drawing 985-137
App	WR	NE	NE			



WEIGHTING FILTER
0,5-200Hz FILTER
RANGE AMP.
FILTER SELECT
RANGE SELECT
W&F PRESENT
TPD
TPE
SN 74 LS 139
SN74LS138
HEF 4724



2.4 - 3.8 kHz FILTER
TPA
TPB
TPC
LIMITER
DISCRIMINATOR
500Hz-FILTER
Q47
J109
R179
33k
Q50
BC 547
R182
18K
-15V
R185
56k
Q53
BC 557
R188
10K
OV/D
QA1
TL084
R1
100K
OV/AC
Q55
Q52
BC547
R184
15K
R187
BC557
R190
5K6
Q49
R181
33k
QD5
SN74LS139
R2
6K65
0,5%
R3
R4
C1
10n55
1%
46n7
C4
C2
499p
C3
33p
R8
33E
C8
100µ
R9
C9
C5
C6
C7
10n 1%
R7
R5
R6
R11
R10
1K
R13
R12
680K
C11
R15
R14
56E
+15V
C10
10µ
LM311
R16
10K
R17
4K7
CR1
BAV10
2N3904
Q1
R18
2K2
+5V
QD
R24
Q2
R28
R26
R29
22K
QD1
SN74LS221
R20
10E
R22
14K
C14
C17
C12
R19
220K
C16
10n
R21
R23
C13
C15
1n 2%
R25
BC 557
Q3
R27
R44
10K7
R30
R31
QA3
LF353
C18
C20
R32
100E
C19
R34
4K82
R35
R36
R33
R38
R39
2K2
R40
1K21
R43
R42
1K1
6.2V
IN 825
CR15
C21
C22
Q4
QA4
LF356
C23
R45
4K42
R46
R47
U1898
Q5
C25
1n5
C24
QA5
R48
38K3
R49
R51
22E
C26
C28
12n
C29
6n
R50
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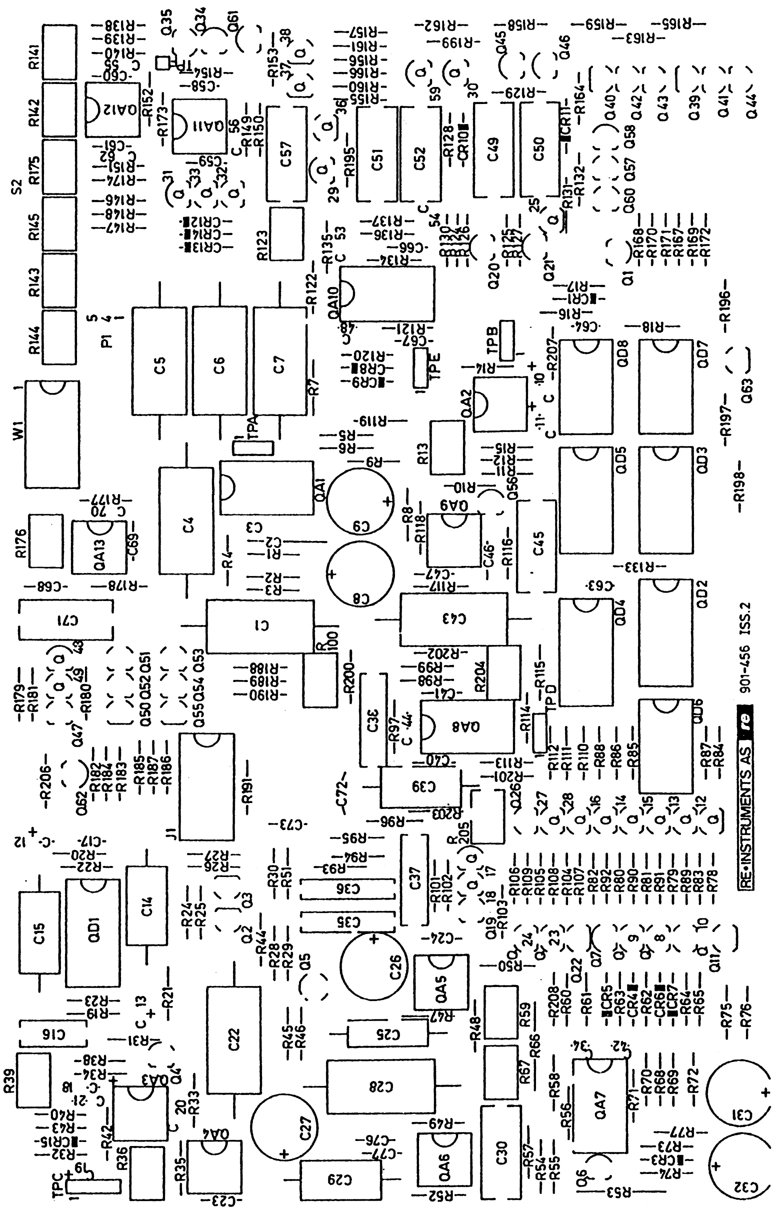
47K
CR3
R73
QA7
R75
C31
+15V
-15V


901-456 ISS.2
RE·INSTRUMENTS AS

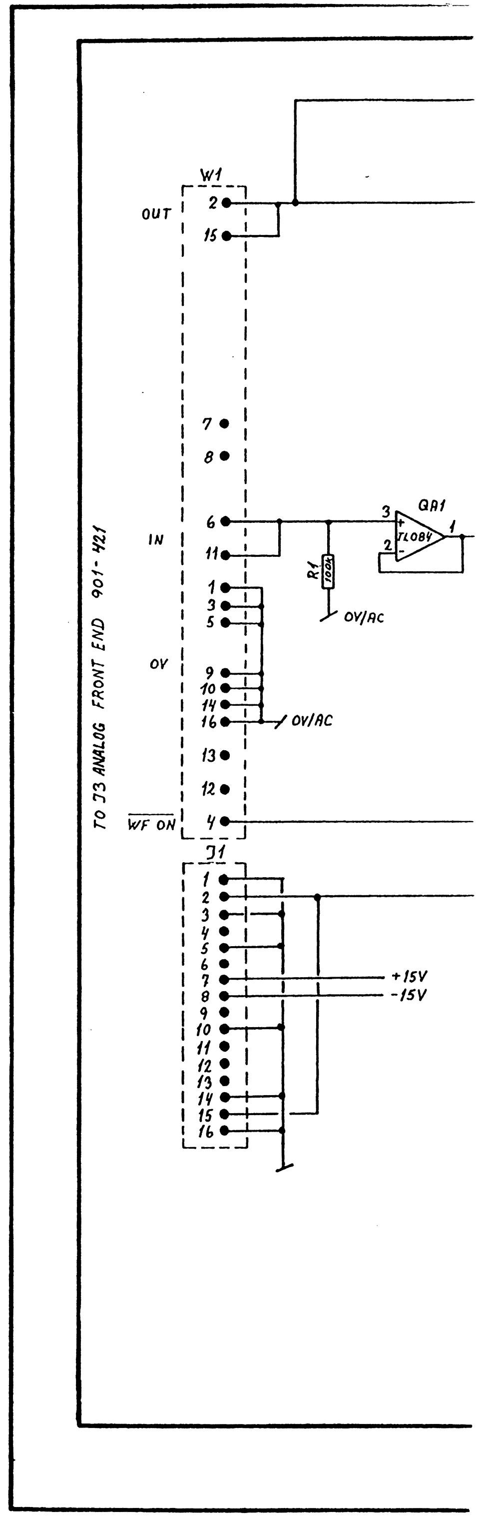

W1
OUT
IN
OV
WF ON
QA1
TL084
R1
100k
OV/AC
J1
+15V
-15V
TO J3 ANALOG FRONT END 901-421

TABLE OF CONTENTS

LIST OF FIGURES

1 GENERAL INFORMATION

This manual provides the technical information necessary to install and verify the operation of the ZOOM Board. Furthermore, the function of the electrical circuitry is described together with information which allows troubleshooting to board level. A parts list and a schematic diagram are found at the rear of this manual.

1.1 Introduction

The ZOOM Board (901-393) provides, when installed, the RE201 with increased frequency resolution. This is required to measure THD at frequencies lower than 475 Hz (the limit for the basic RE201), and IM and Difference Frequency Intermodulation if the distortion products are close to the test tones. Furthermore, the ZOOM Board provides selective measurements with 80 dB selectivity at 4 Hz in the entire frequency range 20 Hz to 25 kHz. The ZOOM Board comprises one single printed circuit board and a ribbon cable used for installation.

The ZOOM Board is transparent and requires no special actions from the operator.

1.2 Installation

The ZOOM Board must be mounted in the Digital Section of the RE201. To get access to this section refer to the RE201 Technical Manual section 4.3.

When the Digital Section has been opened the following installation procedure should be followed:

1. Disconnect the ribbon cable which connects the Arithmetical Unit Board (901-527 placed at slot No. 2, slot No. 7 being the rearmost) from the socket J2.

2. Remove the Arithmetical Unit PCB and the ribbon cable from socket J4 on the Digital Motherboard (901-409).

3. Mount the ribbon cable which is delivered with the ZOOM PCB in socket J4 on the digital Motherboard.

4. Mount the Arithmetical Unit PCB in slot No. 2 (components facing the rear part of the RE201).

5. Mount the connector placed at the middle of the ribbon cable to the socket J2 on the Arithmetical Unit Board.

6. Mount the ZOOM Board in slot No. 4 (components facing the rear part of the RE201).

7. Mount the third connector of the ribbon cable in socket J2 on the ZOOM Board.

Now, the RE201 may be reassembled. Switch the power on and check that the following text appears on the CRT as a part of the selftest routine:

ZOOM >901-393< PASSED

This ensures that the ZOOM Board has been correctly installed and that it is ready for operation.

1.3 Equipment and Accessories

Description	Code No.
ZOOM Board	901-393
Technical Manual for the ZOOM Board	983-227
Ribbon Cable	617-844

1.4 Specifications

As the ZOOM Board is fully transparent, no special operation is required by the user. The following extensions of the RE201 facilities will be available as extensions of allowed parameter limits (e.g. THD frequency, DFIM test signal frequency separation, bandwidth of selective measurements etc.).

Frequency range	20 Hz - 25 kHz (frequency measurement down to 4 Hz).
Frequency measuring accuracy	+/- 0.1 Hz, 4 Hz to 60 Hz +/- 0.2 Hz, 60 Hz to 125 Hz +/- 0.8 Hz, 125 Hz to 200 Hz +/- 1.5 Hz, 200 Hz to 25 kHz
Frequency measuring resolution	0.1 Hz below 200 Hz 1 Hz above 200 Hz
Frequency selectivity	237.5 Hz, 59.4 Hz, 14.8 Hz or 3.7 Hz to -80 dB depending upon resampling

The environmental requirements for the ZOOM Board are identical to those of the RE201 Basic Unit.

2 PRINCIPLES OF OPERATION

2.1 Principles of Operation

The following section describes the principal function of the ZOOM Option. In this section references are made to fig. 2.1 - Block Diagram, ZOOM Board, and the schematic diagram (985-134) found at the rear of this manual. For a more detailed description of individual circuit blocks refer to section 3.

The ZOOM Board basically provides increased frequency resolution within a limited bandwidth. In an FFT analyzing instrument as the RE201 the number of samples in the FFT is usually fixed, and as frequency resolution is proportional to fs/N (where fs is the sampling frequency and N the number of time samples in the FFT), the only means to increase selectivity is to reduce the sampling rate (i.e. observe the signal for a longer period). This must, however, be done in a way which ensures that the sampling theorem (i.e. sampling frequency is at least twice as high as the highest frequency component in the signal) is always obeyed.

To understand the function of the ZOOM Board it is necessary to regard some basic properties of Fourier transformation. Fig. 2.2A shows a signal comprising frequency components in a band around a center frequency fo. For convenience, negative frequency components or the effect of sampling will not be considered in the following as these factors do not influence the principal function.

If the signal in fig. 2.2A is multiplied by $\exp(-i\omega_0 t)$ (where ω_0 is the angular frequency corresponding to fo), then the frequency spectrum will be shifted from center frequency fo to center frequency zero (fig. 2.2B). In conventional mixers the multiplication factor is $\sin(\omega_0 t)$ and not a complex function. Using a complex function requires more circuitry, but the advantage is that the spectrum will not be convoluted around zero as would be the case in a conventional mixer. Furthermore, multiplication with a complex number can be implemented with any required accuracy in a digital environment working on digital samples rather than on analog time functions.

In the ZOOM Board each time sample (64 kHz sampling rate) is multiplied by samples of the time functions $\cos(\omega_0 t)$ and $-\sin(\omega_0 t)$ and the two numbers are processed in a "real" and an "imaginary" channel.

Following the translation of the frequency spectrum the signal is lowpass filtered in a digital filter which removes frequency components outside the pass band and allows resampling (fig. 2.2C). Resampling by a factor N means that only every N'th sample is used. This corresponds to a reduction in sampling frequency, which again can

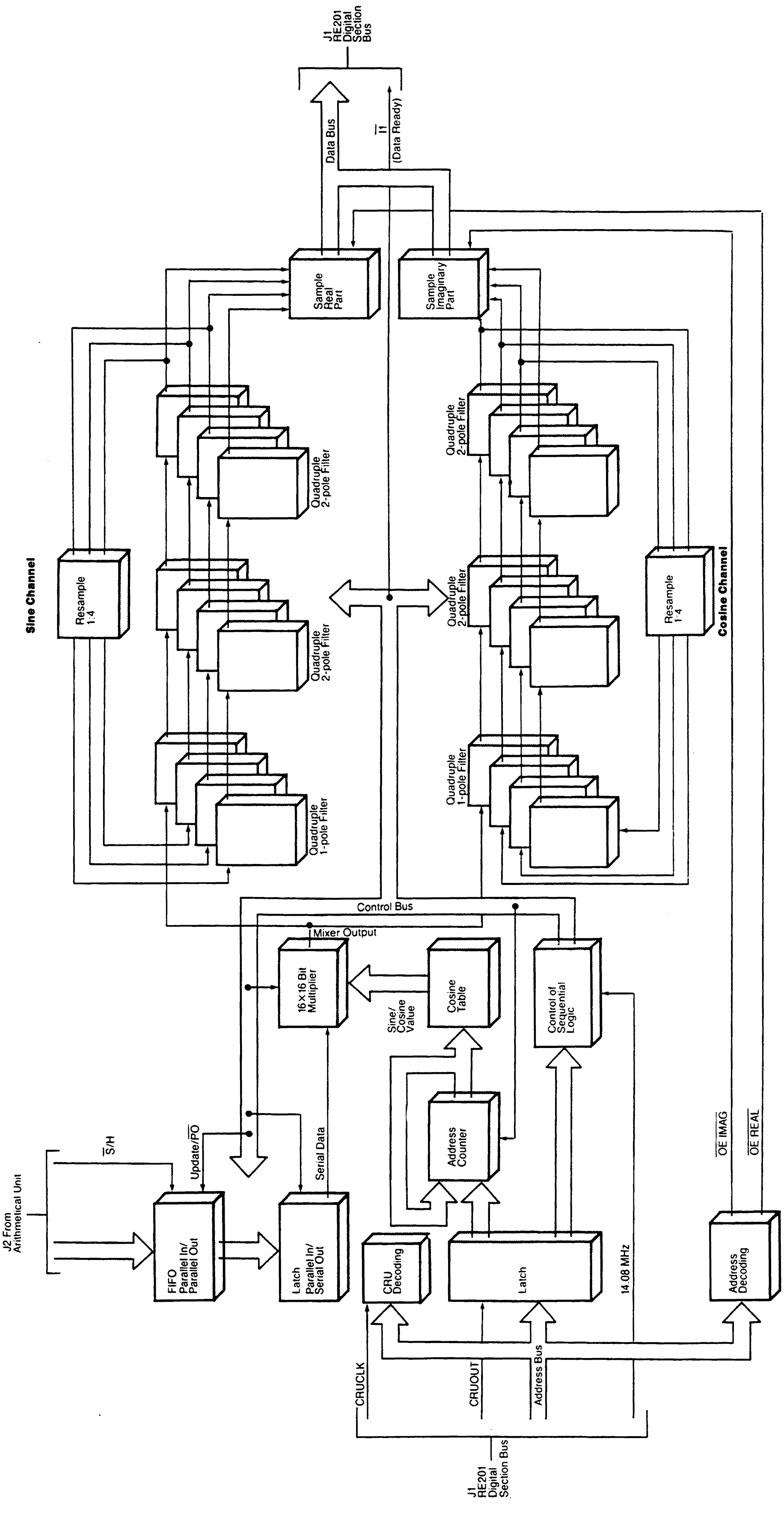
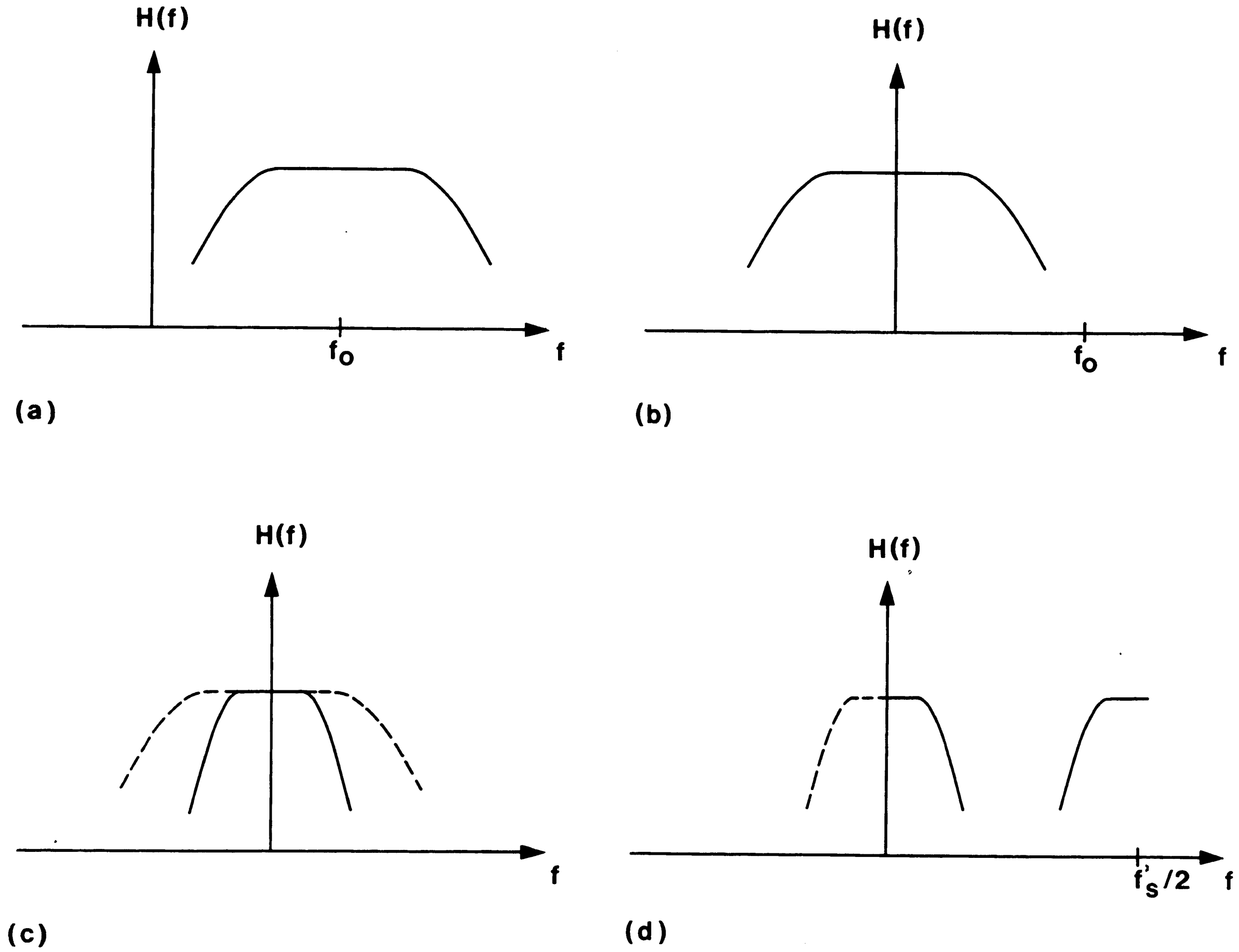


Fig. 2.1 - ZOOM Block Diagram



(a) Example of Frequency Spectrum

(b) Frequency Spectrum After Mixing
(Multiplication with $\exp(j\omega_o t)$) fs > fo

(c) Lowpass Filtering and Resampling

(d) Spectrum After FFT Processing

Fig. 2.2 - ZOOM Principles of Operation

be used to provide increased frequency resolution in a reduced frequency band (refer to description of basic properties of FFT transformation in section 2.2 of the RE201 Basic Unit Technical Manual). Following the filtering and resampling the RE201 performs a 256 point complex FFT on the resampled signal. As a part of the FFT routine the "negative frequency information" will appear from fs and down as shown in fig. 2.2D, and consequently the information about the frequency band around fo is now available with an increased frequency resolution. The RE201 uses lookup tables to compensate for loss and ripple in the digital filters, and information about mixing frequency and resample rate to convert the spectral information back to the original frequency band.

The digital lowpass filter is a five pole filter configured as one single pole and two double pole filters in cascade. The filter is designed to allow a reduction in sample rate (resampling) of four times as the cut-off frequency is below fs/8. To be an ideal antialiasing filter, max. attenuation (more than 80 dB) should have been obtained at fs/8, however, as the difficulties in realization of digital filters increase rapidly when the bandwidth becomes small compared to fs, some aliasing has been allowed. This does not cause any problems as only 60% of the pass band is used in the RE201 for measuring purposes.

The process involved in mixing and first sample reduction can be summarized as follows:

1. Samples of the time function are at a rate of 64 kHz transferred to the ZOOM Board.

2. Each sample is multiplied by 16 bit samples of -sin($\omega_0 t$) and cos($\omega_0 t$), respectively.

3. The two new samples generated by means of the multiplication process are filtered in identical digital lowpass filters (SINE CHANNEL and COSINE CHANNEL) working at 64 kHz sample rate.

4. The first 266 output samples from the filters are not used, to allow ripple in the filters to extinguish.

5. Every fourth sample from the SINE- and COSINE CHANNELS is used and stored by the Main CPU in RAM memory until 256 complex pairs have been saved.

6. The appropriate window function is multiplied on all the samples by the Main CPU.

7. A 256 point complex FFT is performed.

The frequency samples calculated via this FFT are separated by 64 kHz/ 256*4 or 62.5 Hz (which is half the frequency separation obtained in the RE201 basic unit).

As approx. 60% (155 frequency samples) of the bandwidth (256*62.5 Hz or 16000 Hz) is used for further computations the RE201 is now able to analyze any frequency range of 9687.5 Hz with 62.5 Hz separation of frequency samples.

To obtain even better frequency selectivity a fundamental feature of digital filters is used: if the sampling frequency is scaled by a factor N, then the transfer function F(f) will transform to F(f/N).

Thus, the digital bandpass filters will, if the resampled data is recycled through the same hardware configuration at the reduced sample rate, allow a new resampling by a factor of four and so on.

In the RE201, data may be resampled and recycled through the filters three times providing the reduced sampling rates 4 kHz, 1 kHz and 250 Hz, and hereby a separation of frequency samples of approx. 15.6 Hz, 3.9 Hz and 0.98 Hz, respectively.

Using the highest degree of resampling (128 times) it is possible to analyze any 151 Hz frequency band between 20 Hz and 25 kHz with a frequency resolution of 0.98 Hz corresponding to a selectivity of better than 4 Hz to 80 dB.

3 CIRCUIT DESCRIPTION

This section provides a more detailed description of the function and individual circuit blocks of the ZOOM Board.

The circuitry may be divided into the following main blocks:

1. Interface to the Arithmetical Unit (901-527) and RE201 system

2. Address counter, COSINE table and mixer

3. Digital filters

4. Circuitry for control of sequential logic.

3.1 Interface to the Arithmetical Unit and RE201 System

The interface to the Arithmetical Unit is provided by QD64, QD65 and QD66. These three IC's configure a 12 bit wide, 16 bit deep FIFO. This FIFO is used as a buffer between the A/D converter (64 kHz sample rate) and the sequential logic in the ZOOM Board to ensure that no samples are lost due to timing discrepancies between the fixed 64 kHz clock rate and the data processing in the sequential logic. The number of samples stored in the FIFO will vary during a total data collection, however, space for more than 8 samples is not required at any point of time. The FIFO is loaded by the S/H signal from the Arithmetical Unit (J2 pin 7); samples are shifted to the output by the signal UPDATE/PO. Before a data collection is started, the FIFO is reset by Master Reset, MR, controlled by the CPU. By means of the signal TEST, the CPU may disable the outputs, forcing all output lines high (except pin 13 on QD64), a facility used during the selftest procedure.

The interface to the RE201 system i.e. the Main CPU, comprises the following individual lines and circuit blocks.

1. Address lines used for selection of output buffers QD33, QD34, QD35 and QD36 containing processed samples. Configured of QD42, QD46, QD47, QD52 which control the lines OE REAL and OE IMAG (Output Enable, real part and Output Enable, Imaginary part).

2. Decoder QD43 used to select between QD68 or QD69, which by means of the CRU facility of the TMS 9900 are loaded with the mixer frequency. Furthermore, the output pins 6, 7, 9 and 10 of QD68 (control lines F0, F1, F2 and FIL1) are set by the CPU to define the mode of operation for the ZOOM Option as follows:

	$\overline{FIL1}$	$\overline{F2}$	$\overline{F1}$	$\overline{F0}$
2 times resampling	Ø	Ø	Ø	Ø
1 time recycling 8 times resampling	1	1	1	1
2 times recycling 32 times resampling	1	1	Ø	1
3 times recycling 128 times resampling	1	Ø	1	1

3. Bus drivers QD33, QD34, QD35 and QD36, which load the processed samples to the RE201 Data Bus.

4. 14.08 MHz clock used in the sequential network and $\overline{SC}$ (64 kHz System Clock, Start Conversion) used to synchronize the Master Reset signal (via QD54).

5. Interrupt lines:

   $\overline{I1}$: Informs the CPU that a sample pair (real, imag) is ready.
   $\overline{I15}$: Informs the CPU that the ZOOM Board is installed.
   $\overline{I12}$: When K5 pins 1 and 2 are connected at power up, the CPU will initiate a special test sequence used for signature analysis.

3.2 COSINE Table, Address Counter and Mixer

The COSINE table contains 1024 16 bit samples of one period of a COSINE. When samples from this table are read out at a 64 kHz rate and with address increment N, the sample sequence will represent a sinewave ("cosinewave") with frequency N*64000/1024 Hz or N*62.5 Hz. The address increment (N) is by the CPU loaded into QD68 and QD69. The address COUNTER QD70, QD71 and QD72 will then at the outputs present the sum of the old address (found at the input of latches QD74 and QD75) and the address increment. The sum is latched through QD74 and QD75 by "UPDATE/$\overline{PO}$", and the new address will appear at the outputs of QD70, QD71 and QD72 and so on.

As explained in section 2 each sample from the A/D converter should be multiplied by $\cos(\omega_o t)$ and $-\sin(\omega_o t)$, respectively. The samples of $-\sin(\omega_o t)$ are obtained by means of the address QD73 and the line SINE/COSINE the following way:

As the COSINE table contains 1024 samples of one cosine period, the -sine value corresponding to a given cosine value is found by adding 256 to the address (adding 90 degrees to the angle). This is controlled by the control circuit by either setting SINE/COSINE high (adding 256 to the address for sine values) or by setting the SINE/COSINE low (adding 0 for cosine values).

The mixing process is provided by the 16 bit serial multiplier QD7, QD8. The two samples to be multiplied are read from the COSINE table (16 bit parallel) out from QD37, QD67 (16 bit serial). The information read from the COSINE table is as earlier described a sample of $\cos(\omega_o t)$, $\sin(\omega_o t)$, respectively, and the information from QD37, QD67 is a 16 bit word containing the 12 bit sample from the A/D converter as the least significant bits and zeros as the four most significant bits.

The same sample is read twice from the FIFO into QD37, QD67, once for the cosine and once for the -sine multiplication.

The outputs from the multiplier are fed to the filter section in bit serial form.

3.3 Digital Filters

The digital filter, which occupies the upper right half of the schematic diagram (985-134), is configured as shown in fig. 3.1.

The corresponding transfer function is:

$$H(z) = K_1\ K_2\ K_3 \frac{(z+1)(z^2+Bz+1)(z^2+Ez+1)}{(z+A)(z^2+Cz+D)(z^2+Fz+G)}$$

where

A	=	-0.859375	(55/64)
B	=	0.015625	(1/64)
C	=	-1.703125	(109/64)
D	=	0.796875	(51/64)
E	=	-0.84375	(54/64)
F	=	-1.71875	(110/64)
G	=	0.921875	(59/64)
K1	=	0.0625	(1/16)
K2	=	0.0625	(1/16)
K3	=	0.125	(1/ 8)

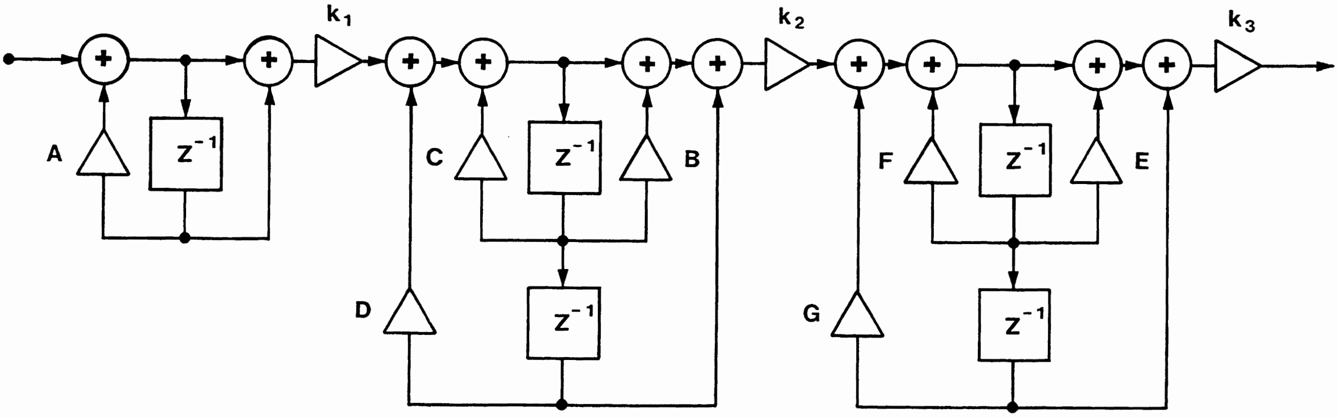


Fig. 3.1 - Digital 5-pole Lowpass Filter Block Diagram

The coefficients are hard-wired at the multipliers QD1, QD2, QD3, QD4, QD5 and QD6 (A, D, C, G, F and E, respectively), whereas B is implemented as a shift register (delay). K1, K2 and K3 are scaling factors used to avoid overflow in the registers in the filter due to high filter gain.

The circuit may in fact be considered as configured of 8 filters (4 for the COSINE- and 4 for the SINE channel). All filters are identical from a hardware point of view, i.e. adders, multiplicators and shift registers are common. The main difference is that each filter in the two sets runs at different sample frequencies. The operation of the individual filters is interleaved and data created during the filter processes is saved in RAM memory (QD9, QD10, QD11, QD12, QD13 and QD14). As the word size used during filtering is 20 bits, each RAM memory (256 x 1 bit) can store the required 8 samples.

The filters operate with 20 bits to reduce the effect of digital noise coming from the arithmetical operations. Furthermore, whenever it is necessary to limit the length of a result (e.g. after multiplication of a 20 bit word with an 8 bit coefficient) this is performed using rounding and not simple truncation.

3.4 Control Circuitry

The control of the entire sequence machine (i.e. mixing and filtering) is performed by QD63, which is a 512x4 bit low power Schottky PROM. The counter QD41 is advanced by the signal FIRST, each step recalling a four bit word, which together with the least significant bit from the counter (SINE/$\overline{\text{COSINE}}$) is used to control every single step in the entire process. The signals on the four control lines are synchronized by means of the register QD29.

As a part of the mixing/filtering process the interrupt line $\overline{\text{I1}}$ is forced low when a result is ready for the computer. As $\overline{\text{I1}}$ is the interrupt which has the highest priority, the CPU will immediately fetch the imaginary part and then the real part of the result. When the real part is read ($\overline{\text{OE}}$ REAL low) the flip-flop QD44 is preset and the interrupt line released (high).

All jumpers and test points on the ZOOM Board are included to enable signature analysis troubleshooting, using special test equipment to force the board into different modes of set-up. Thus, they are only of value for the factory.

4 MAINTENANCE

The following section describes the test required to ensure that the ZOOM Board is working correctly. For troubleshooting hints refer to section 5 of this manual.

4.1 Performance Test

As a part of the selftest routine carried out by the RE201 after power up the following information must appear on the CRT:

ZOOM >901-393< PASSED

This ensures that the interface to the CPU, control circuitry, mixer and filters are working properly as the comprehensive selftest applied to the ZOOM Board is successfully completed. To check the interface to the Arithmetical Unit the following test is recommended:

1. Define a selective RMS measurement with a center frequency between 25 Hz and 24995 Hz and a bandwidth of 10 Hz (right or left channel).

2. Apply a signal with the required center frequency to the specified channel. Level approx. 1 V RMS.

3. The reading from the selective measurement should be within 0.1 dB of the reading obtained by an RMS25 measurement.

5 TROUBLESHOOTING

This section provides some troubleshooting information which may be useful in pinpointing specific errors. Troubleshooting to component level, however, is extremely difficult and it is recommended that defective boards are returned to the factory for repair.

5.1 Troubleshooting

RE201 Does Not Switch on the CRT at Power Up

This may be caused by a short between pins 1 and 2 at jumper K5. A short between these two pins will force the RE201 into a special test routine used for signature analysis of the ZOOM Board.

ZOOM >901-393< PASSED Does Not Appear

This might be caused by an insufficient grounding of interrupt 15 (line 29A on the edge connector).

ZOOM >901-393< FAILED

During the selftest routine several individual tests are performed. The result of these tests is displayed on the diode array placed at the top edge of the CPU board (901-789). In the following a description of the error codes is provided. The LED's should be viewed from the component side of the CPU board, 1 indicating that the diode is switched on and 0 that it is switched off.

0001 1000 - a sequence with the parameters: Mixer frequency 62.5 Hz, no recycling and TEST high fails to set $\overline{\text{I5}}$ low after a defined period or, alternatively, if $\overline{\text{I1}}$ does not go high when the real part of the result is read.

0001 1001
or
0001 1010 - a sequence with the parameters: Mixer frequency 62.5 Hz, no recycling and TEST high delivers an erroneous result.

0001 1011 - a sequence with the parameters: Mixer frequency 0 Hz, no recycling and TEST high or a sequence with the parameters: Mixer frequency 4 kHz, one recycle and TEST high produced incorrect results.

0001 1100 - a sequence with the parameters: Mixer frequency 1 kHz, two recycles and TEST high or a sequence with the parameters: Mixer frequency 250 Hz, three recycles and TEST high produced incorrect results.

0001 1101 - a sequence with the parameters: Mixer frequency 62.5 Hz, four recycles and TEST high produced incorrect results.

6 PARTS LIST AND SCHEMATIC DIAGRAM

6.1 Parts List

All electronic components are included in the parts list. Parts marked with a * are manufactured by RE INSTRUMENTS AS.

When ordering spare parts it is important that you give the following information.

- * Code No. and description of the part.
- * Circuit reference from the schematic diagram.
- * Complete type designation of RE product.

Zoom (901-393)

CAPACITORS

C 1	C solid AL 10u 20% 16V	265-008
C 2	C solid AL 10u 20% 16V	265-008
C 3	C solid AL 10u 20% 16V	265-008
C 4	C solid AL 10u 20% 16V	265-008
C 5	C solid AL 10u 20% 16V	265-008
C 6	C solid AL 10u 20% 16V	265-008
C 7	C solid AL 10u 20% 16V	265-008
C 8	C solid AL 10u 20% 16V	265-008
C 9	C Ceramic 100n 20% 50V	213-400
C 10	C Ceramic 100n 20% 50V	213-400
C 11	C Ceramic 100n 20% 50V	213-400
C 12	C Ceramic 100n 20% 50V	213-400
C 13	C Ceramic 100n 20% 50V	213-400
C 14	C Ceramic 100n 20% 50V	213-400
C 15	C Ceramic 100n 20% 50V	213-400
C 16	C Ceramic 100n 20% 50V	213-400
C 17	C Ceramic 100n 20% 50V	213-400
C 18	C Ceramic 100n 20% 50V	213-400
C 19	C Ceramic 100n 20% 50V	213-400
C 20	C Ceramic 100n 20% 50V	213-400
C 21	C Ceramic 100n 20% 50V	213-400
C 22	C Ceramic 100n 20% 50V	213-400
C 23	C Ceramic 100n 20% 50V	213-400
C 24	C Ceramic 100n 20% 50V	213-400
C 25	C Ceramic 100n 20% 50V	213-400
C 26	C Ceramic 100n 20% 50V	213-400
C 27	C Ceramic 100n 20% 50V	213-400
C 28	C Ceramic 100n 20% 50V	213-400
C 29	C Ceramic 100n 20% 50V	213-400
C 30	C Ceramic 100n 20% 50V	213-400
C 31	C Ceramic 100n 20% 50V	213-400
C 32	C Ceramic 100n 20% 50V	213-400
C 33	C Ceramic 100n 20% 50V	213-400
C 34	C Ceramic 100n 20% 50V	213-400
C 35	C Ceramic 100n 20% 50V	213-400
C 36	C Ceramic 100n 20% 50V	213-400
C 37	C Ceramic 100n 20% 50V	213-400
C 38	C Ceramic 100n 20% 50V	213-400
C 39	C Ceramic 100n 20% 50V	213-400
C 40	C Ceramic 100n 20% 50V	213-400
C 41	C Ceramic 100n 20% 50V	213-400
C 42	C Ceramic 100n 20% 50V	213-400
C 43	C Ceramic 100n 20% 50V	213-400
C 44	C Ceramic 100n 20% 50V	213-400
C 45	C Ceramic 100n 20% 50V	213-400
C 46	C Ceramic 100n 20% 50V	213-400
C 47	C Ceramic 100n 20% 50V	213-400

CONNECTORS

J 2	Connector Socket for 14-Pin	816-218

RELAYS & JUMPERS

K 1	Wire Wrap Terminal	805-727
K 2	Wire Wrap Terminal	805-727
K 3	Wire Wrap Terminal	805-727
K 4	Wire Wrap Terminal	805-727
K 5	Wire Wrap Terminal	805-727

CHOKES

L 1	COIL 15MHz	731-203
L 2	COIL 15MHz	731-203

INTEGRATED DIGITAL CIRCUITS

QD 1	IC SN74LS384N 8-bit two's-complement multipliers	367-008
QD 2	IC SN74LS384N 8-bit two's-complement multipliers	367-008
QD 3	IC SN74LS384N 8-bit two's-complement multipliers	367-008
QD 4	IC SN74LS384N 8-bit two's-complement multipliers	367-008
QD 5	IC SN74LS384N 8-bit two's-complement multipliers	367-008
QD 6	IC SN74LS384N 8-bit two's-complement multipliers	367-008
QD 7	IC SN74LS384N 8-bit two's-complement multipliers	367-008
QD 8	IC SN74LS384N 8-bit two's-complement multipliers	367-008
QD 9	IC 82LS16N 256x1 RAM	364-523
QD 10	IC 82LS16N 256x1 RAM	364-523
QD 11	IC 82LS16N 256x1 RAM	364-523
QD 12	IC 82LS16N 256x1 RAM	364-523
QD 13	IC 82LS16N 256x1 RAM	364-523
QD 14	IC 82LS16N 256x1 RAM	364-523
QD 15	IC AM25LS15 Quad serial adder/subtractor	364-417
QD 16	IC AM25LS15 Quad serial adder/subtractor	364-417
QD 17	IC AM25LS15 Quad serial adder/subtractor	364-417
QD 18	IC AM25LS15 Quad serial adder/subtractor	364-417
QD 19	IC 74LS164 shift register	364-306
QD 20	IC 74LS164 shift register	364-306
QD 21	IC 74LS164 shift register	364-306
QD 22	IC 74LS273 oct D ff	364-304
QD 23	IC 74LS273 oct D ff	364-304
QD 24	IC 74LS273 oct D ff	364-304
QD 25	IC 74LS273 oct D ff	364-304
QD 26	IC 74LS273 oct D ff	364-304
QD 27	IC 74LS174 hex D ff	364-271
QD 28	IC 74LS174 hex D ff	364-271
QD 29	IC 74LS174 hex D ff	364-271
QD 30	IC 74LS04 hex inverters	364-219
QD 31	IC SN74LS03 Quad 2-input Nand gate open collector	364-329
QD 32	IC 74LS157 quad 2-1 MUX	364-407
QD 33	IC AM25LS22N 8-bit shift register	364-413
QD 34	IC AM25LS22N 8-bit shift register	364-413
QD 35	IC AM25LS22N 8-bit shift register	364-413

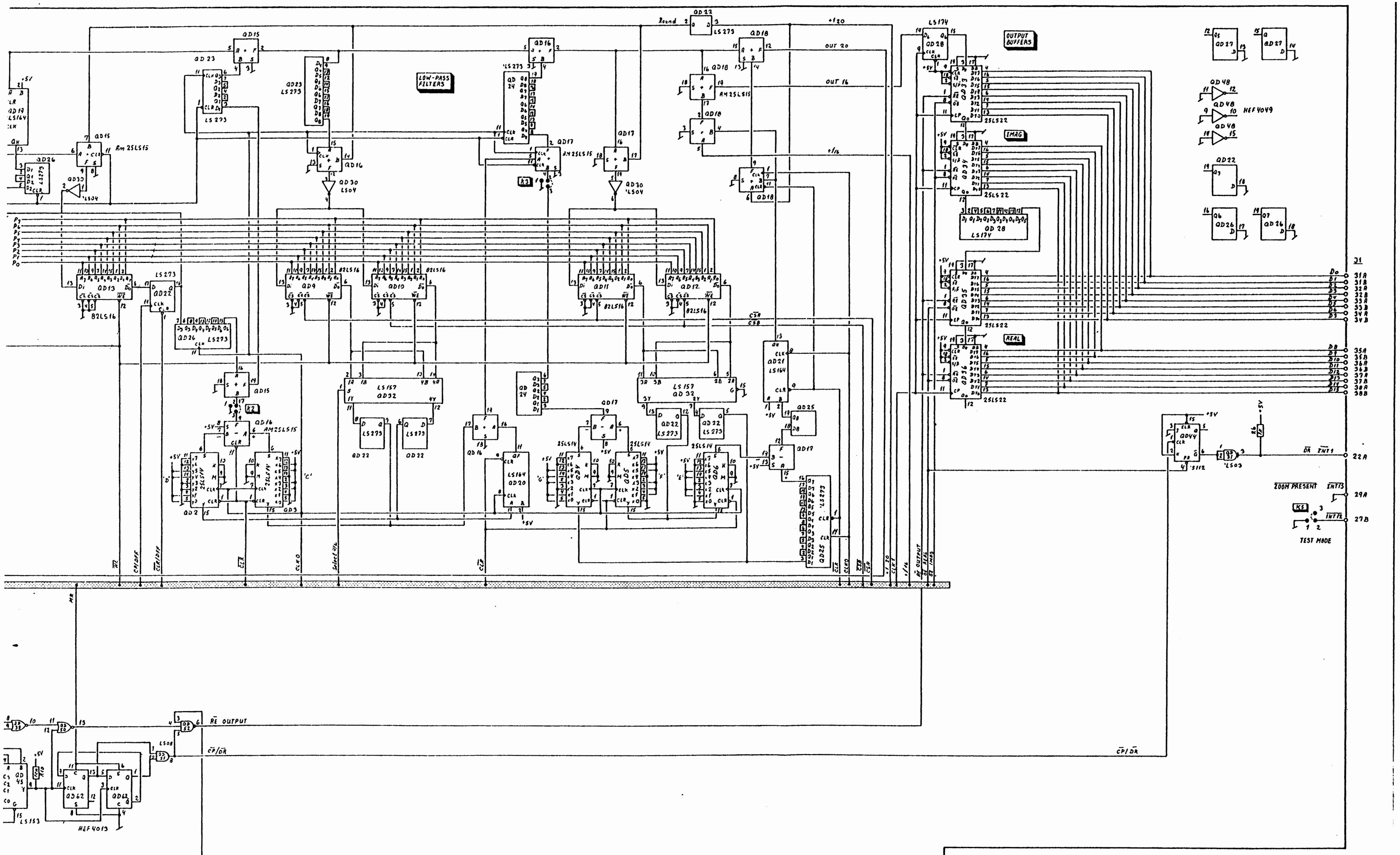
QD 36	IC AM25LS22N 8-bit shift register	364-413
QD 37	IC AM25LS22N 8-bit shift register	364-413
QD 38	IC 74LS02 quad NOR gate	364-298
QD 41	IC HEF4040BP 12-stage binary counter	364-260
QD 42	IC SN74LS138N 1-of-8 decoder/demultiplexer	364-308
QD 43	IC SN74LS138N 1-of-8 decoder/demultiplexer	364-308
QD 44	IC 74S112 dual JK ff	364-541
QD 45	IC SN74LS153N Dual 4-line to 1-line Multiplexer	364-137
QD 46	IC SN74LS27N Triple 3-input NOR gate	364-299
QD 47	IC 74LS00 quad NAND gate	364-213
QD 48	IC 4049 hex inv buffer	364-224
QD 49	IC SN74S00N Quadruple 2-Input Nand Gates	364-082
QD 50	IC 74LS02 quad NOR gate	364-298
QD 51	IC 74LS08 quad AND gate	364-270
QD 52	IC 74LS10 tripl NAND gate	364-300
QD 53	IC 74LS20 dual NAND gate	364-402
QD 54	IC 74LS74 dual D ff	364-185
QD 55	IC 74LS74 dual D ff	364-185
QD 56	IC 74LS74 dual D ff	364-185
QD 57	IC 74LS163 bin counter	364-408
QD 58	IC 74LS163 bin counter	364-408
QD 59	IC 74LS163 bin counter	364-408
QD 60	IC 74S260 dual NOR gate	364-498
QD 61	IC 74LS283 4bit bin adder	364-562
QD 62	IC HEF4013BP Dual D-type Flip-Flop	364-222
QD 64	IC CD40105BE FIFO register 16x4 bits	364-410
QD 65	IC CD40105BE FIFO register 16x4 bits	364-410
QD 66	IC CD40105BE FIFO register 16x4 bits	364-410
QD 67	IC SN74LS165N 8-bit parallel-in serial out shift reg	364-307
QD 68	IC HEF4724BP 8-bit adessable latch	364-412
QD 69	IC HEF4724BP 8-bit adessable latch	364-412
QD 70	IC HEF4008BP 4-bit binary full adder	364-411
QD 71	IC HEF4008BP 4-bit binary full adder	364-411
QD 72	IC HEF4008BP 4-bit binary full adder	364-411
QD 73	IC HEF4008BP 4-bit binary full adder	364-411
QD 74	IC 40174 hex D ff	364-266
QD 75	IC 40174 hex D ff	364-266

RESISTORS

R 1	R thick film Sil 8x47K	146-005
R 2	R thick film Sil 8x47K	146-005
R 3	R Metal film 1K00 5% 0.2W TC250	107-410
R 4	R Metal film 1K00 5% 0.2W TC250	107-410
R 5	R Metal film 1K00 5% 0.2W TC250	107-410
R 6	R Metal film 1K00 5% 0.2W TC250	107-410
R 7	R Metal film 47K0 5% 0.2W TC250	107-547
R 8	R Metal film 10K0 5% 0.2W TC250	107-510
R 9	R Metal film 10K0 5% 0.2W TC250	107-510
R 10	R Metal film 10K0 5% 0.2W TC250	107-510
R 11	R Metal film 10K0 5% 0.2W TC250	107-510

MISCELLANEOUS

tubular rivet 02.5x0.25x7	060-270
RE201 Zoom QD39 Ver. 1.0	368-198
RE201 Zoom QD40 Ver. 1.0	368-199
RE201 Zoom QD63 Ver. 1.0	368-200
Female Plug	805-718
Wire Wrap Terminal	805-727
16 Pin Dil Socket	816-133
24 Pin Dil Socket	816-134
Solder Terminal 0.1 O2	823-303
Board Extractor	857-017
Conducter Rail C1	931-036
PCB for ZOOM Option	971-143



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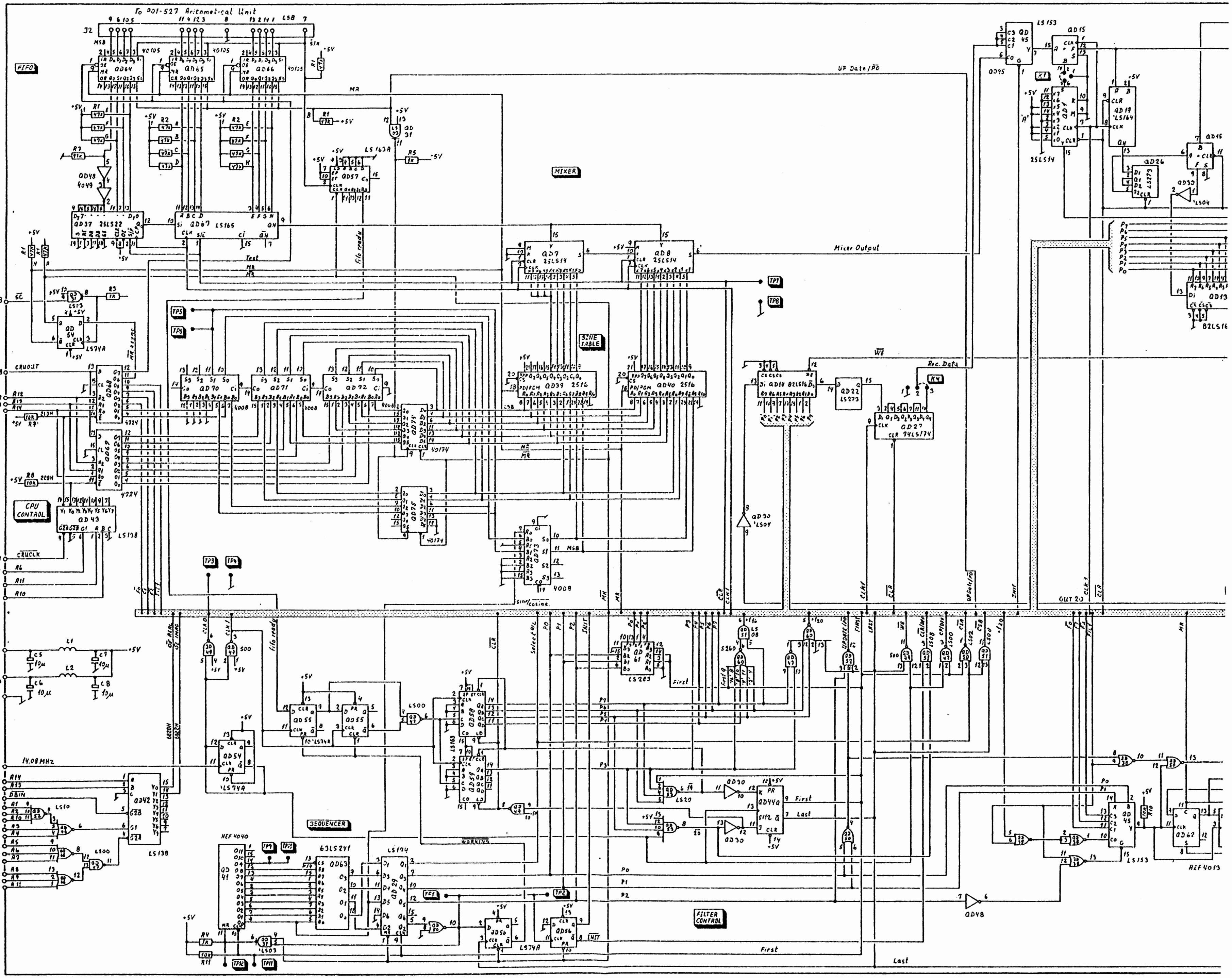
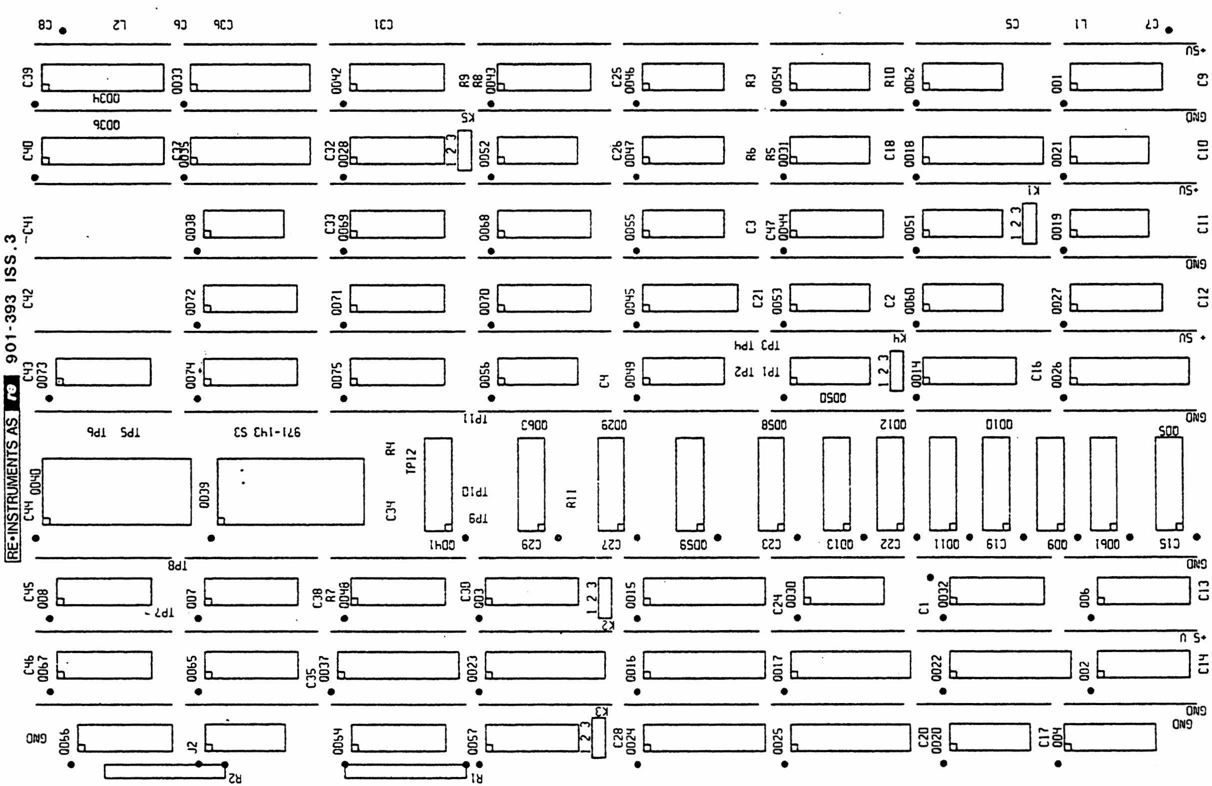
used in: RE201						Scale	
Issue/Rev.no	1/	2/	3/	4/	5/	PCB	971-143
Date	840306	850904				PCB Assy	901-393
Drawn	UP	BD				Schematic Drawing	985-134
App.		NE					



To 901-527 Aritmetical Unit
FIFO
MIXER
SINE TABLE
CPU CONTROL
SEQUENCER
FILTER CONTROL
UP Date/PO
Mixer Output
Rec. Data
14.08 MHz
sine/cosine
Working
First
Last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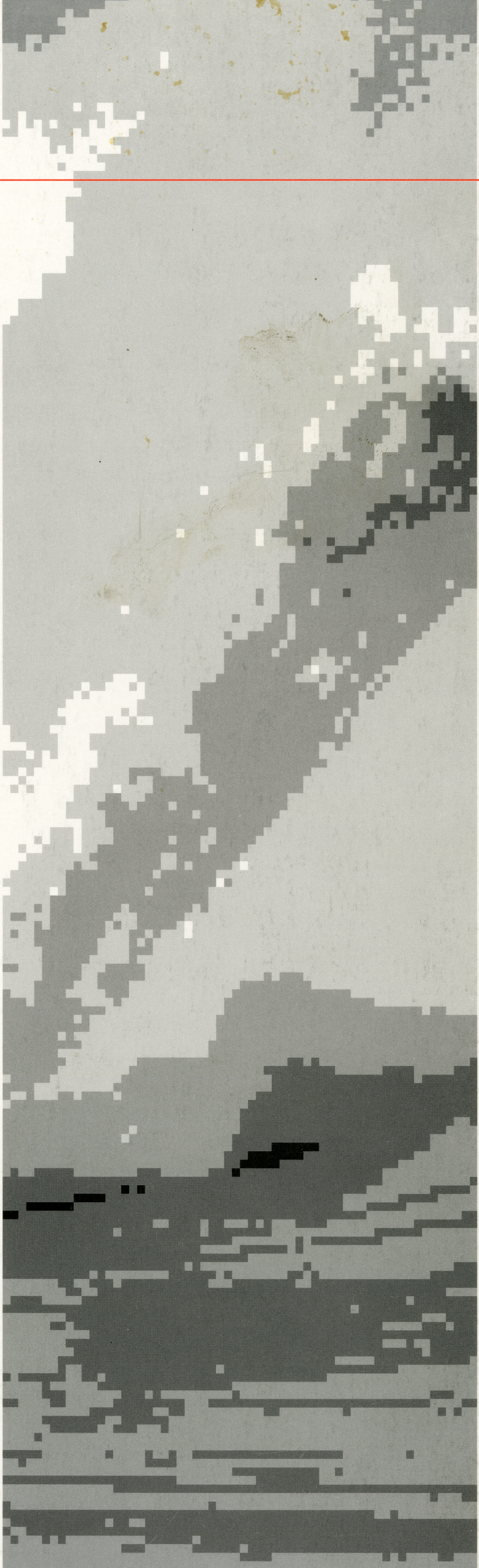

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