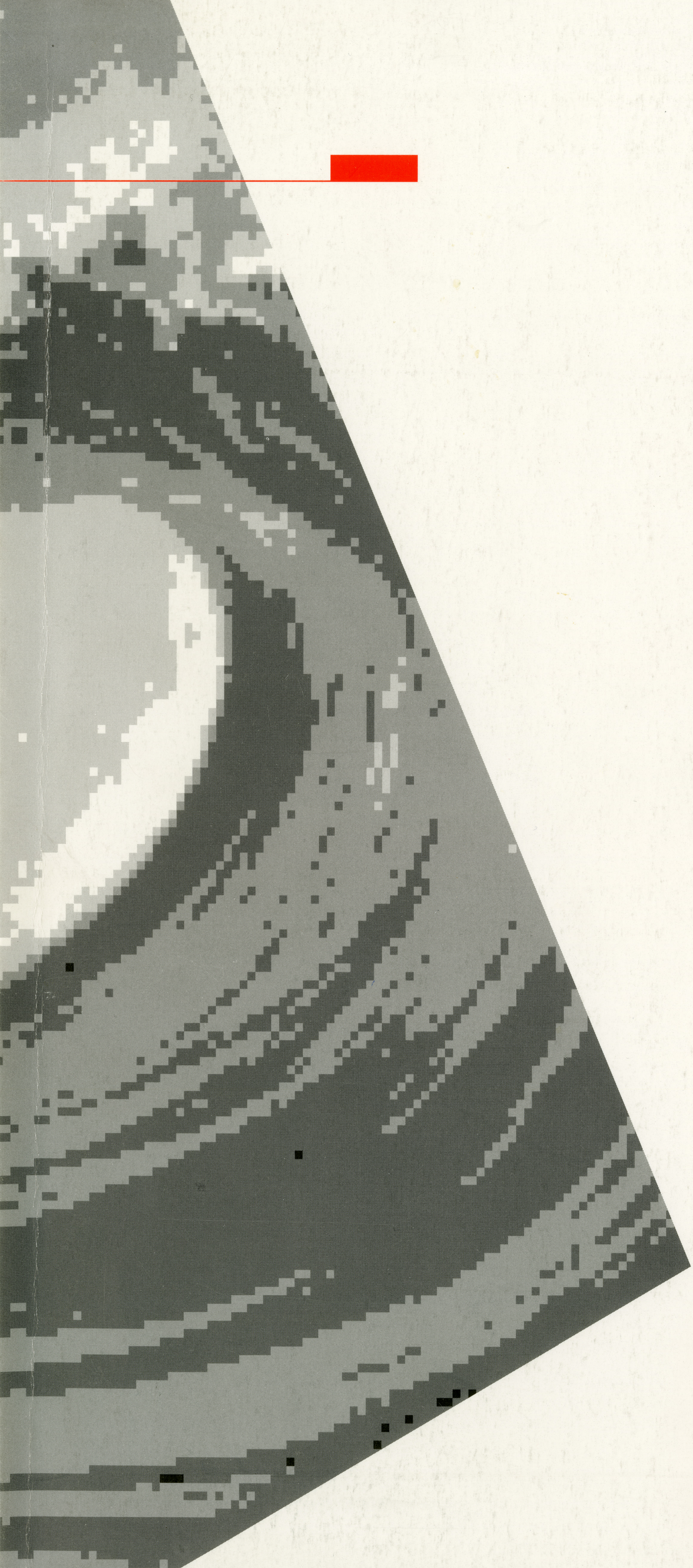

RE 201
Dual Channel Audio Analyzer
Service Manual

Volume I

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RE 201
Dual Channel Audio Analyzer
Service Manual

SAFETY PRECAUTIONS FOR LINE-POWERED EQUIPMENT

All line-powered equipment can be dangerous. Therefore, certain basic rules and precautions must be observed to ensure the best possible safety for users, service personnel, as well as third parties. At RE TECHNOLOGY AS we have taken great care during the design and production of our equipment. However, safety may be impaired by incorrect installation, handling, or intervention.

WARNING

Ensure that the line cable, connectors, and power outlet all have the correct configuration, to establish a protective earth. Disconnecting the protective earth conductor, inside or outside the equipment, may potentially be hazardous to the operator. Removing the covers may expose parts carrying potentially dangerous voltages.

INSTALLATION

This is a Safety Class I unit which requires protective earthing via the IEC power inlet. Before switching on, the unit must be connected via the third wire in the power cable to a protective earth contact in the line socket. The protective action must not be negated by using an extension cord (power cable) without a protective conductor (protective earth). Grounding one conductor of a two-conductor outlet is not sufficient protection. Ensure that the line fuse has the correct value according to the voltage and power consumption. If the unit requires separate signal grounding, through external connections to the unit chassis, do not disconnect the protective earth.

SERVICE

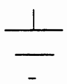
Only trained service personnel should attempt to dismantle and repair the unit. Take great care during the installation and service of the unit, especially when adjusting or measuring an open unit under voltage. Before removing any covers, switch off the unit and remove the line cable from the power outlet.
Capacitors inside the unit may hold dangerous charges for a considerable time after the unit has been switched off. If it is necessary to replace components in the line connected partition or area, use only new parts of the correct and approved type. Take special care to maintain or re-establish the protective earthing. The conductivity must be measured after the service or repair is finished. Do not remove any warning labels. Replace any damaged or illegible labels with new labels.

BACK-UP BATTERIES

For units with lithium back-up batteries, ensure, when replacing them, that they are of the same type and are correctly installed before you switch the power on to the unit. Do not recharge the batteries or expose them to temperatures above 100 °C (212 °F). Dispose of used batteries responsibly, according to your national/local guidelines. The batteries contain chemicals which are harmful to the environment. When you dispose of the unit itself, first remove the batteries and dispose of them separately.

SAFETY SYMBOLS

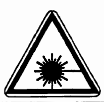
Warning. The unit will be marked with this symbol when it is necessary for the user to refer to the manual.



Ground terminal (sometimes used in the manual to indicate circuit common connected to the chassis).

Attention. Observe precautions for handling Electrostatic Sensitive Devices.

Danger. Live voltage exceeding 1000 V.



Warning label for laser radiation. The product is marked with this symbol if it is necessary to protect against laser radiation which is invisible and can cause permanent damage to the eye.

Use of Product Names. The product names mentioned herein are used for identification purposes only, and may be trademarks and/or registered trademarks of their respective companies.

TABLE OF CONTENTS

LIST OF FIGURES

1 GENERAL INFORMATION

This manual provides technical information on the RE201 Audio Generator Option. For operation of this option, reference is made to the description of the Audio Generator in the RE201 Operation Manual.

1.1 Introduction

The RE201 Dual Channel Audio Analyzer provides the design and test engineer with powerful facilities for carrying out complicated audio measurements. Distortion measurements, such as

* Intermodulation Distortion - IM
* Difference Frequency Distortion - DFIM
* Transient Intermodulation Distortion - TIM

have mainly been performed in the laboratory on a sample basis, as the test equipment has been complicated to use and expensive. Now, these intricate measurements may easily be performed by operators using the RE201 with the Audio Generator Option (901-500) installed.

The Audio Generator Option offers a wide variety of test signals:

* Single-tone sine wave from 1 Hz to 25 kHz with 1 Hz resolution. This can be used to measure e.g. frequency response and Total Harmonic Distortion (THD).
* Two-tone sine waves suitable for use during Intermodulation and Difference Frequency Distortion measurements.
* TIM signal consisting of a band limited 3.2 kHz square wave and a 15 kHz sine wave. The square wave may be substituted by a triangle wave to indicate slew rate limitations.
* Multi-tone signal consisting of up to 8 single frequency components, the amplitude and frequency of which are freely selectable by the operator. This signal may be used for fast frequency response measurements, e.g. on filters, amplifiers and tape recorders.

The following sections give information about the principles of operation and a description of the circuit blocks. For operating instructions refer to the RE201 Operation Manual (983-298).

1.2 Installation

When unpacking the option boards, the packing material should be visually inspected for physical damage. If it is 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.

The two boards of the Audio Generator Option must be mounted in the Analog Section of the RE201. It is only necessary to remove the top plate of the RE201 and the clamp bar securing the PCB's in the print magazine to get access to this area.

* Remove the screws securing the top plate (refer to fig. 1.1) using a Pozidriv No. 1 screwdriver.

* Dismount the top plate by sliding it backwards approx. 2 cm until it disengages along the front and rear edges. The plate may then be lifted and removed.

* Remove the clamp bar securing the PCB's (refer to fig. 1.2).

The print magazine comprises six slots. No. 0 is the first slot on the left (viewed from the front of the RE201), and No. 5 is the last slot on the right.

If the Static CPU (901-788) is not positioned in slot No. 5 it must be moved to this position. The flat cable connected to the Static CPU has to be dismounted before the Audio Generator Option is installed.

Insert the Digital Board (901-499) in slot No. 4 and the Analog Board (901-498) in slot No. 3 and connect the two boards by means of the ribbon cable.

Release the two coaxial cables from the clip on the left wall of the Analog PCB Compartment and connect the two cables to the two coaxial connectors placed on the top edge of the Analog Board (901-498). Due to different cable lengths it is not possible to interchange the cables.

Secure the coaxial connectors by using a 6 mm (15/64 in.) torque wrench adjusted to 0.7 Nm (100 oz. in.) max. torque.

*** Note ***

The connectors may be damaged if this torque is exceeded.

Remount the flat cable to the Static CPU.

Fig. 1.2 shows the RE201 Analog Section with the Audio Generator Option properly installed.

Following reassembly, on switch on the RE201 should automatically recognize that the Audio Generator has been installed. Check

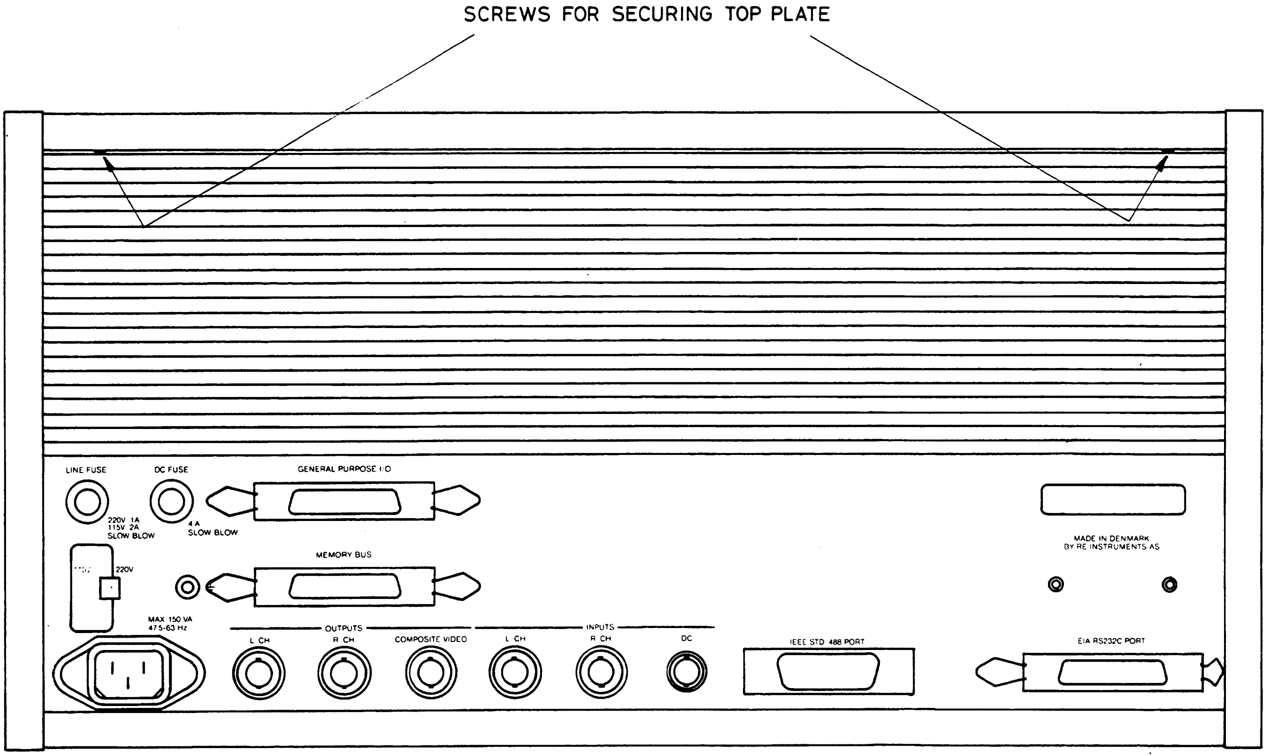


Fig. 1.1 - Top Plate Screws

following the selftest routine that the RE201 as part of "OPTIONS INSTALLED" displays:

AUDIO GENERATOR X.X

This verifies that the Audio Generator Option has been accepted by the system and is ready for use. X.X is the software revision installed on the Digital Board of the Audio Generator.

1.3 Equipment and Accessories

Description	Code No.
Audio Generator Option for the RE201 (configured of Analog Board 901-498 and Digital Board 901-499)	901-500
Technical Manual for the Audio Generator Option for the RE201	983-229

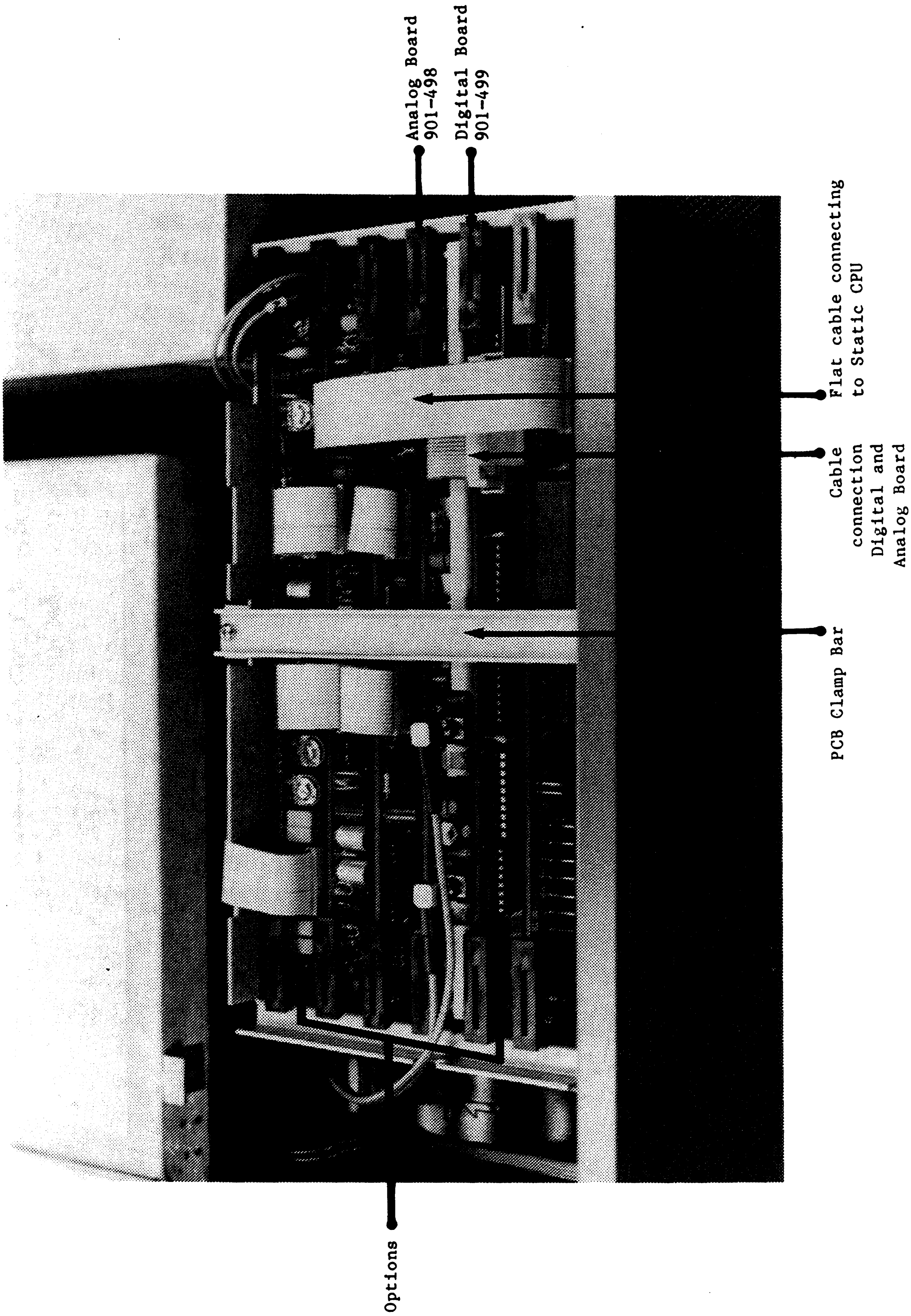


Fig. 1.2 - Audio Generator Option Installed

1.4 Specifications

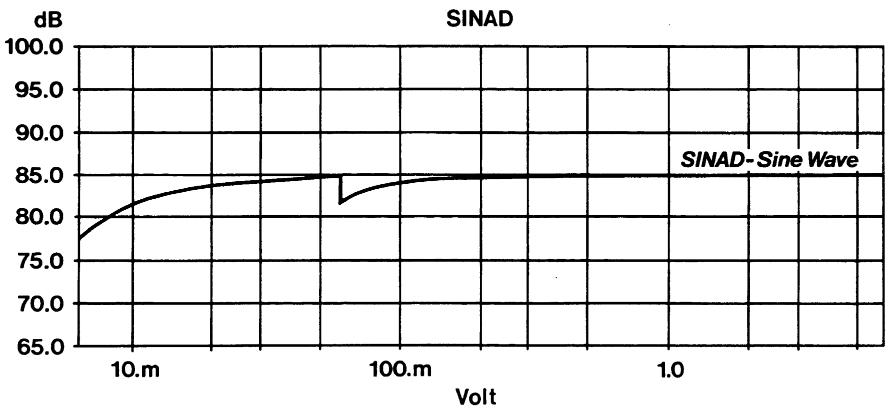
General

Signal modes	Sine wave, 1 kHz reference tone, SMPTE/DIN intermodulation, Difference Frequency Distortion, Multi-tone, TIM test signals, OFF
Frequency accuracy	+/- 20 ppm
Output level range	0.8 mV peak to 8.87 V peak (-62.7 dBu to 18.2 dBu) open circuit
Output level resolution	0.1 dB
Flatness (1 kHz reference)	+/- 0.1 dB
Level accuracy	+/- 0.1 dB + flatness
Output circuit	2 balanced floating outputs, transformerless, short circuit protected
Output impedance	600 Ohms +/- 1 %

Signal Modes

Sine Wave

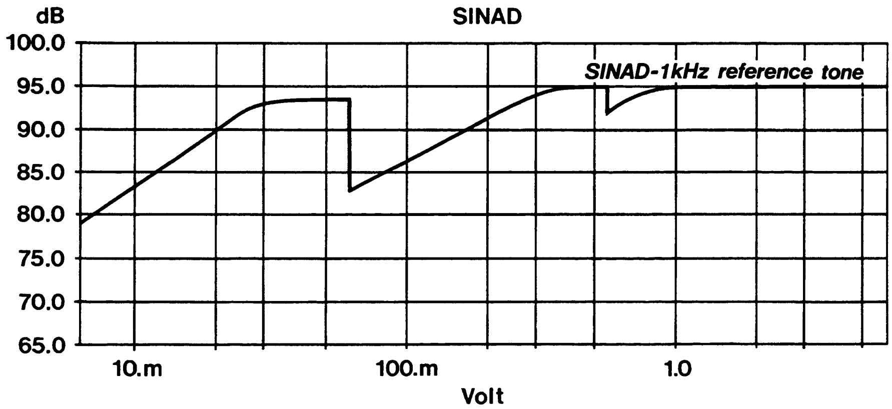
Frequency range	1 Hz to 25 kHz
Frequency resolution	1 Hz
Total Harmonic Distortion	< -88 dB, typical -91 dB, 1 Hz to 1 kHz
	< -87 dB, typical -90 dB, 1 kHz to 9 kHz
	< -90 dB, typical -92 dB, 9 kHz to 25 kHz
Distortion and Noise (SINAD)	< -82 dB, typical -85 dB, 1 Hz to 4 kHz
(125 kHz bandwidth)	< -81 dB, typical -84 dB, 4 kHz to 12.5 kHz
	< -83 dB, typical -86 dB, 12.5 kHz to 25 kHz



SINAD as a Function of Level - Sine Wave (Typical Values)

1 kHz Reference Tone

Total Harmonic Distortion	< -97 dB (0.0015 %)
Distortion and Noise (SINAD) (22.4 kHz bandwidth)	< -95 dB (0.002 %)



SINAD as a Function of Level - 1 kHz Reference Tone (Typical Values)

SMPTE/DIN Intermodulation Signal

Level ratio	4:1
Frequency range	10 Hz to 25 kHz
Frequency resolution	10 Hz
SMPTE/DIN intermodulation	< -76 dB (0.02 %) 300 Hz/7 kHz, 2nd to 4th order products included

DIN Difference Frequency Distortion Signal

Level ratio	1:1
Frequency range	10 Hz to 25 kHz
Frequency resolution	10 Hz
Difference frequency distortion	< -86 dB (0.005 %), 14 kHz/15 kHz, 2nd to 6th order products individually

Transient Intermodulation Signal

Description	3.2 kHz square or triangle wave plus 15 kHz sine wave, peak level ratio 4:1
Cut-off frequency	30 kHz or 100 kHz selectable, (-3 dB)
Transient intermodulation	< -75 dB (0.02 %)

Multi-tone

Maximum number of tones	8 simultaneously
Relative level	1 to 999

Frequency range	10 Hz to 25 kHz
Frequency resolution	10 Hz

OFF

Description	0 V, 600 Ohms output impedance

<u>Manual Sweep</u>

Functions controlled	Level and frequency
Level step	0.1 to 79.9 dB, 0.1 dB resolution
Frequency step	Linear: 1 Hz to 24999 Hz, 1 Hz resolution Logarithmic: 1/3 octave, 1/1 octave or 0.01 decade to 1.99 decade, 0.01 decade resolution

The environmental requirements for the Audio Generator are identical to those of the RE201 Basic Unit.

2 PRINCIPLES OF OPERATION

2.1 Principles of Operation

This section describes the basic function of the Audio Generator Option. For a more detailed description of the electrical circuits refer to section 3 in this manual.

Whenever a reference is given to specific circuit blocks refer to fig. 2.1 - Audio Generator, Block Diagram. Further details are given in section 3 (fig. 3.1 - Digital Board, Block Diagram and fig. 3.2 - Analog Board, Block Diagram).

The Audio Generator Option is composed of 2 printed circuit boards (fig. 2.1):

- A Digital Board (901-499) mainly comprising:

  * A Programmable Read Only Memory (PROM) containing 32,000 samples of a 1 Hz sine wave sampled with a 64 kHz sample rate. This Sine Table thus contains half a period of the 1 Hz signal.

  * An Address Counter which calculates the address of the next sample to be read.

  * A RAM - used for storing of samples. This is used to generate all types of complex signals containing more than one spectral component.

  * A Read Only Memory used to store the program code used by the static computer in the Analog Section to operate the Audio Generator Option.

- An Analog Board (901-498) comprising:

  * A 3.2 kHz square/triangle wave generator for TIM signals.

  * A 1 kHz very pure reference signal.

  * A 16 bit Digital-to-Analog Converter (DAC) which converts the digital samples from the digital part of the Audio Generator to an analog staircase signal.

  * A 25 kHz low-pass filter which removes high frequency components from the staircase signal.

  * Two input selectors used to select signal sources.

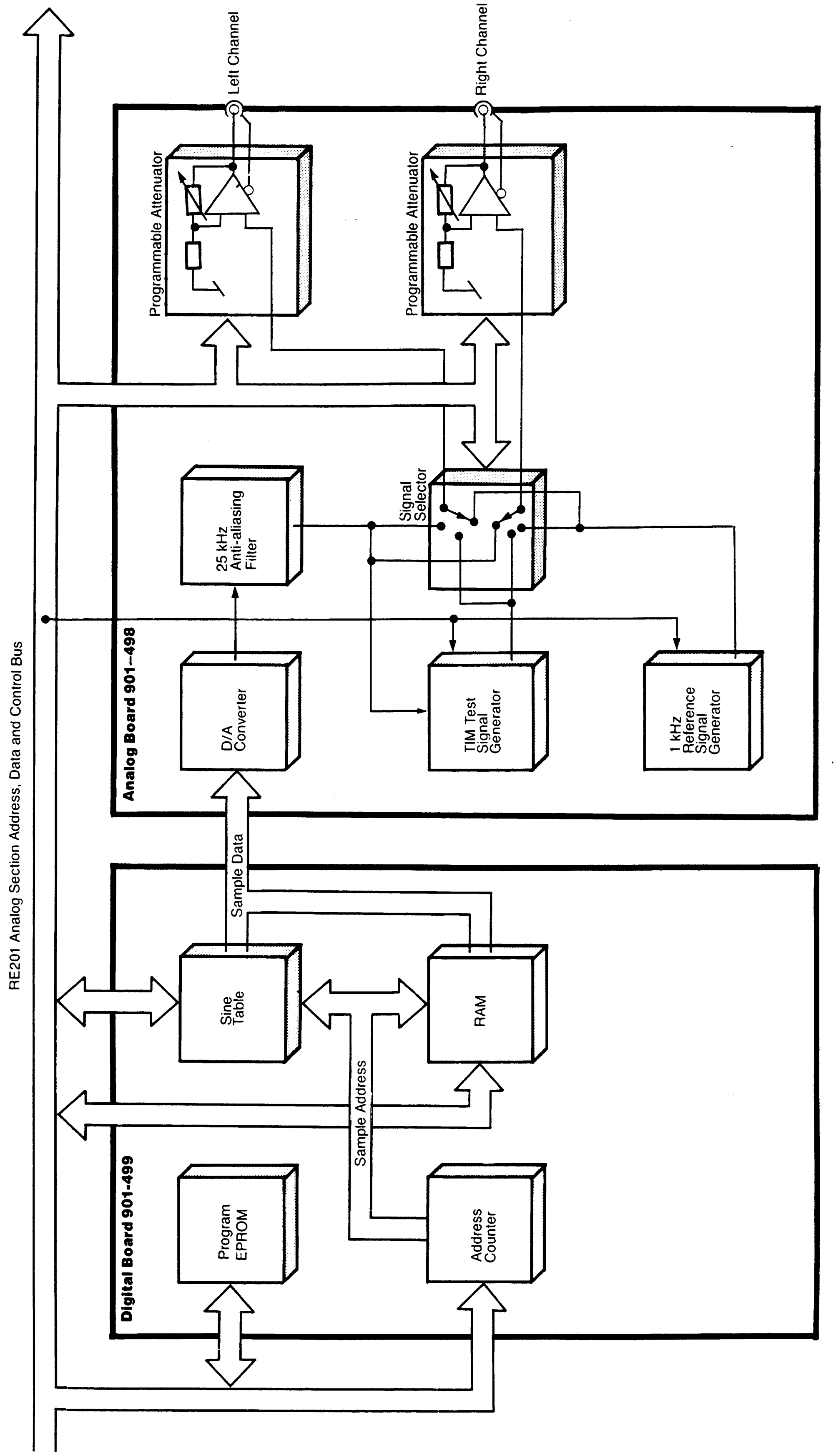


Fig. 2.1 - Audio Generator Block Diagram

* Two attenuators with buffers which allow the output level to be varied between 0.8 mV peak and 8.87 V peak in 0.1 dB steps.

Generating a Single Sine Wave

A single sine wave is generated by reading out samples from the Sine Table to the D/A converter.

The sampling (or Read-Out) frequency is 64 kHz +/- 20 ppm. Thus, if the address from the address counter is changed by one between each sample, i.e. if each sample in the Sine Table is used consecutively, thus the frequency of the sine wave at the output of the 25 kHz filter is 1 Hz, as it will take half a second to run through the Sine Table (a half period). Due to the symmetry of the sine wave the samples of the negative half period can be generated simply by negating the numbers from the positive half period.

To change the frequency only requires the address increment to be changed. Thus, if the address increment is n, it will take 1/2n seconds to run through a half period, and consequently the frequency will be n Hz. In this way it is possible to generate signals with frequencies in the interval 1 Hz to 25 kHz without changing the sampling frequency. 25 kHz is chosen as the upper limit to ease the requirements of the 25 kHz antialiasing filter, which, in order to ensure a signal free of aliased frequency components, has to reject the stop-band (39 kHz and up) by more than 90 dB.

Aliasing occurs when the sampling theorem is not obeyed. The spectrum of a wave form sampled at sampling frequency fs is the original spectrum repeated at fs Hz frequency interval (theoretically, ad infinitum if the sampling function is a delta function). Thus, if the original spectrum contains a frequency component above fs/2 then a corresponding component below fs/2 will be found in the sampled signal. This so called aliased frequency component will interfere with the original low frequency spectrum and may cause measurement errors. It is therefore very important that the antialiasing filter effectively removes all frequency components which may cause aliasing problems, i.e. from 39 kHz and up when the 25 kHz bandwidth is used.

Changing Frequency

As the Audio Generator Option is based on digital synthesis it is capable of changing a frequency instantaneously. In many test situations this will cause transients which will have to decay before measurements may commence. The transients may be minimized if the frequency is allowed to change only where derivatives of the time function are minimum. This will be obtained if the frequency is changed when the current time function (sine wave) is a maximum or a minimum.

For this purpose a so called 'window detector' is incorporated on the Digital Board. This unit is programmable and ensures that the frequency (i.e. size of address counter increment) is changed when the value of the samples read from the Sine Table is close to maximum (+1 or -1). This happens when the address is close to 16,000. Refer to fig. 2.2.

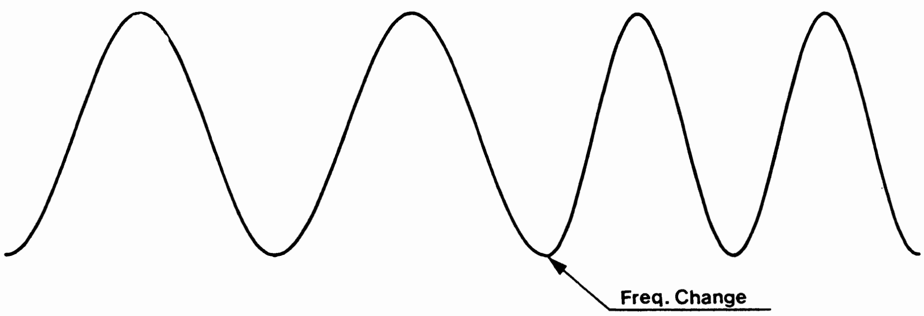


Fig. 2.2 - Change of Frequency

It can be shown that for some frequencies the address 16,000, which corresponds to the exact maximum, is never used (e.g. 6,400 Hz). Thus, the window detector is programmed to enable frequency changes in an interval around address 16,000. The size of the interval is frequency dependent.

Multi-tones

In the RE201 multi-tones are signals configured of more than one frequency component. This can be either two-tone signals for IM or DFIM test purposes or signals comprising up to 8 sine waves used for e.g. frequency response testing. A multi-tone is defined by

* Amplitude of resulting signal (RMS, PEAK, mW, dBm)
* Relative amplitude of individual components (0 - 999)
* Frequency of individual components (resolution 10 Hz)

The information about a multi-tone is used by the Static CPU to calculate samples of the composite signal. This calculation is performed by using the numbers in the Sine Table and the values are stored in the RAM memory. The number of calculated samples depends on the required frequency resolution as follows:

10 Hz resolution	6,400 samples
100 Hz resolution	640 samples
1000 Hz resolution	64 samples

As a consequence of this it takes the Static CPU 2.4 secs. to calculate a multi-tone signal with 8 components and 10 Hz resolution, whereas it only takes 0.1 sec. to set up a multi-tone signal with 8 components and 1 kHz resolution. The CPU calculates the samples of the multi-tone so that the plus-peak values of the individual frequency components are added in the first sample in the multi-tone table. Hereby the peak value of the multi-tone will always be equal to the sum of the peak values of the individual frequency components.

TIM Signal

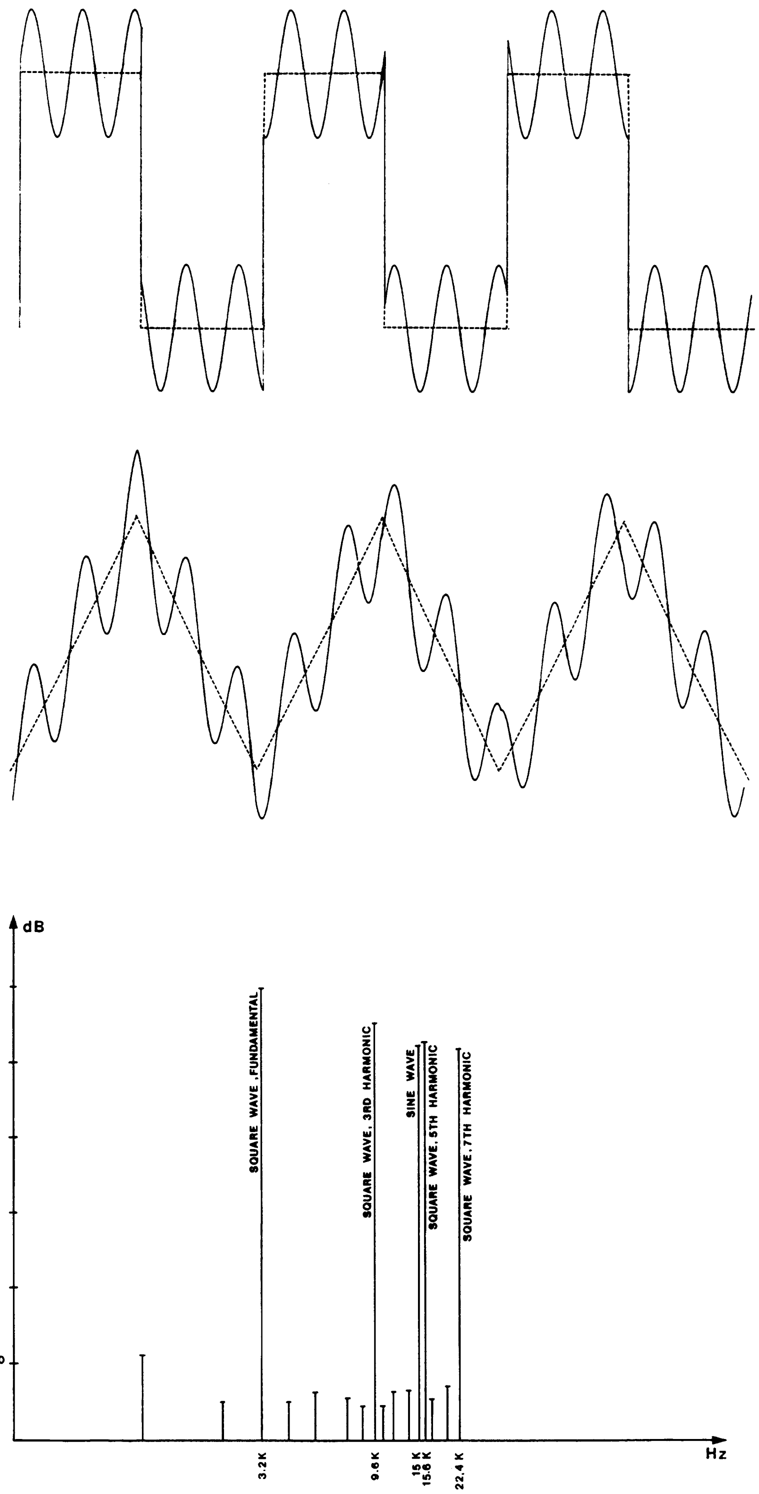
The TIM test signal is generated by adding a 3.2 kHz square wave and a 15 kHz sine wave. The square wave is generated by simple division of the 64 kHz main clock, and the 15 kHz is generated using the D/A converter. A special circuit integrates the square wave to a triangle wave form which, combined with the 15 kHz sine wave, constitutes an alternative test signal recommended for TIM testing. Fig. 2.3 shows the time function for the two signals together with the spectrum for the square wave and 15 kHz configuration.

The square and triangle waves are low-pass filtered (30 kHz or 100 kHz selectable) to reduce the high frequency content in the test signal.

1 kHz Reference Signal

The 1 kHz reference signal is provided as an alternative to the D/A generated signal as in some test situations it is necessary to have different signals in the left and right channels.

The 1 kHz reference signal is generated from the 64 kHz main clock, divided by 64 and bandpass filtered.



(a) Square Wave and 15 kHz Sine Wave

(b) Triangle Wave and 15 kHz Sine Wave

(c) Spectrum of Square Wave and 15 kHz Sine Wave

Fig. 2.3 - TIM Signals

3 CIRCUIT DESCRIPTIONS

3.1 Digital Board

A Block Diagram for the Digital Board (901-499) is found in fig. 3.1 while the schematic diagram is found in drawing 985-159 at the back of this manual.

The circuitry may be divided into the following main blocks:

* Address decoding and board identification
* Program memory, sample memory (Sine Table, RAM)
* Frequency latch and address counter
* Reset detector and latch
* Window detector and latch

In the following the function of the above listed circuit blocks is described.

Address Decoding and Board Identification

During the selftest routine - by means of the CRU interface (serial data communication to or from a specifically selected address using the lines CRUCLK, CRUIN and A15/CRUOUT) the Static CPU writes a logic 1 to QD33, pin 1. If the Analog Board is inserted correctly and connected to the Digital Board, the line ANALOG BOARD MOUNTED (J2, pin 5) will also be high. This will cause $\overline{I14}$ to go low, which informs the Static CPU that the two boards are installed.

Further, the CPU is informed that the CARD ON signal (QD23, pin 1) is high and that the decoding circuits QD58 and QD60 consequently are enabled so that the CPU can communicate with the memory and latches on the board. As the Audio Generator shares address space with other options in the Analog Section, the CARD ON signal is used to select this board to be addressed, while other boards are deselected, and vice versa.

QD58 is a Schottky PROM used for address decoding and selection of the different EPROM and RAM memories when the CPU requires to read or write to these. QD36 buffers the address bus towards the internal bus on the board in order to enable the internal bus to be separated from the Static CPU address bus and to minimize the load on the bus drivers on the CPU board.

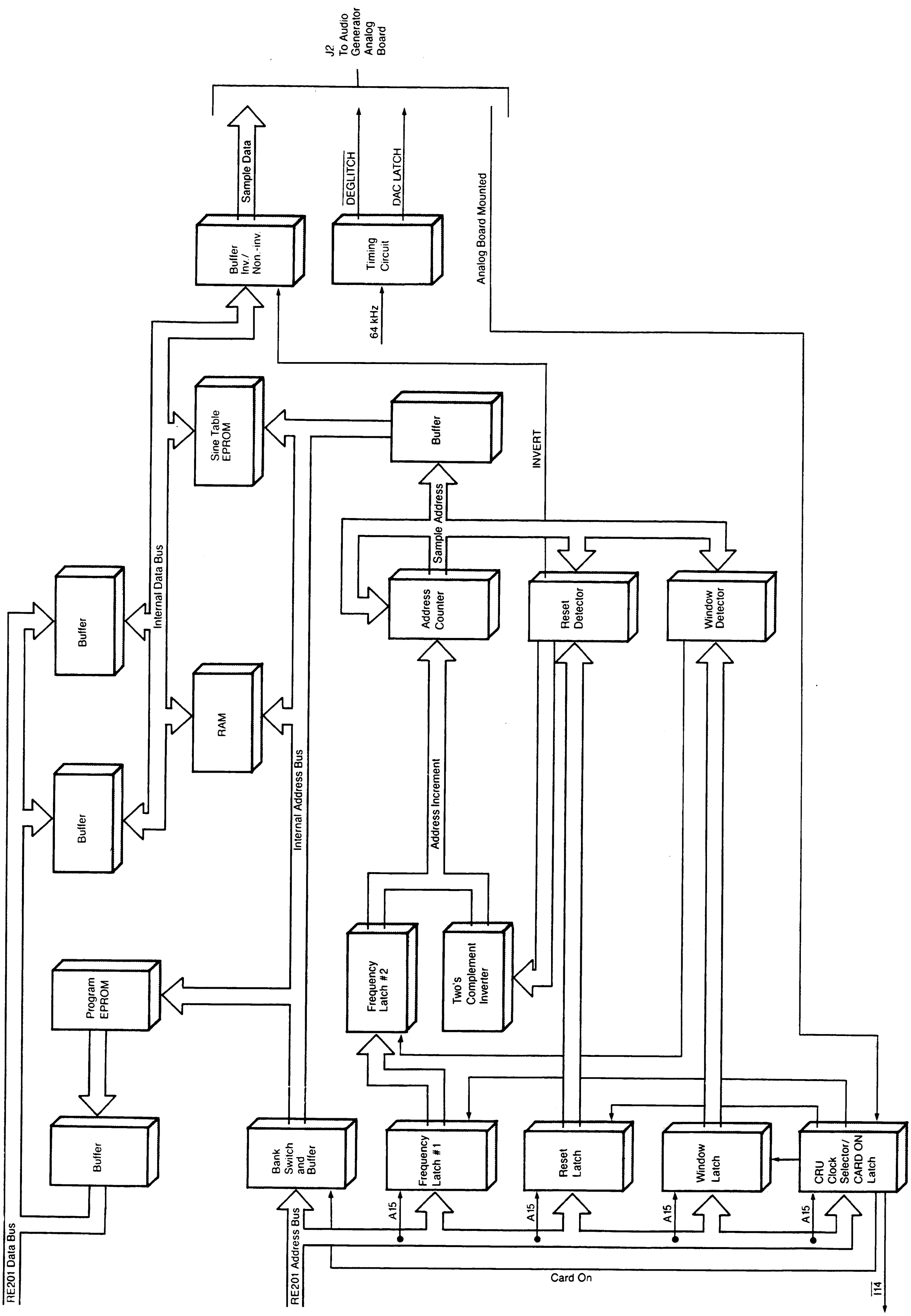


Fig. 3.1 - Digital Board Block Diagram

QD31 and QD32 are used for bank switching, i.e. extensions of the address space accessible by the CPU. By means of its 16 address lines (A0 - A15) the TMS9995 on the Static CPU board can select 64 kbytes equivalent to 32 k words of 16 bits. As the Sine Table alone contains 32 k words it would occupy the entire address space leaving nothing for program and RAM memories etc. To overcome this problem the circuitry composed of QD31, QD32 and QD37 has been employed. The bank switching works as follows. The Static CPU may require to read from the Sine Table (QD1, QD2, QD3 and QD4) to calculate multi-tone samples to be placed in RAM memory (QD7 and QD8). To address the Sine Table the CPU first selects pin 15 to be $\overline{\text{CRUCLK}}$ output by means of the CRU CLOCK SELECTOR QD60. Pin 15 is connected to pin 14 on QD32. It is now possible by means of the three least significant CRU address bits (A12, A13 and A14) and A15/CRUOUT to set the four most significant address bits on the internal address lines (buffered by QD37). This procedure allows the CPU to let a specific address space for the Static CPU correspond to banks of address space on the internal address bus on the board. Hereby the CPU is able to read the entire Sine Table by using only a limited part of its available address area.

This bank switching concept is applied to the Program EPROM and the RAM as well.

The address space on the Digital Board is divided as follows:

Sine Table	32 banks of 2 kbytes
RAM	8 banks of 2 kbytes
Program EPROM	4 banks of 4 kbytes

The mode of operation of the Digital Board (i.e. single tone, multi-tone) is determined by the state of QD31 (pins 10 and 11). Pin 9, MODE SHIFT, is used partly to grant access to the internal address bus to the Static CPU, partly to accomplish different tasks while changing between single-tone and multi-tone. This state is also set by the Static CPU by means of the CRU CLOCK SELECTOR QD60.

Program Memory and Sample Memory

The program memory on the Digital Board consists of three individual circuit blocks.

* Program EPROM (16 kbytes) with a unidirectional data bus buffer (QD5 and QD53).

  This holds the program code which is required by the Static CPU to operate the Audio Generator Option.

* 8 k words (16 bits) of CMOS RAM with bidirectional buffer arrangement: QD7, QD8, QD56 and QD57.

  Used to store the calculated multi-tone time samples. Direction of the two buffers is determined by $\overline{\text{DBIN}}$ (Data Bus IN) whereas selection between the most significant and least significant bytes depends on the state of A15.

* Sine Table (QD1, QD2, QD3 and QD4) EPROM containing 32,000 16 bit samples of one period of a sinusoid. Used to generate single sine waves and as a table for the CPU for calculation of multi-tones.

Frequency Latch and Address Counter

Single Sine Waves

The frequency of single sine waves is, as described earlier, defined by the size of the address increment used in the address counter. The address increment (equal to the frequency in Hz when a single sine wave is used) is loaded into QD29 and QD30 by means of the CRU facility via the CRU CLOCK SELECTOR.

If the frequency is set up for the first time, the contents of QD29 and QD30 are allowed to enter QD40 and QD41, because the CPU keeps the line "MODE SHIFT" high. The address increment is then routed from QD40 and QD41 to the 16 bit address QD11, QD12, QD13 and QD14.

The address which is of the ripple-through type will present the sum of the current address and the address increment at the outputs. This value is by means of a derivative of the 64 kHz main clock entered into the registers QD23 and QD24 and used as next address.

The buffers QD34 and QD35 are used to disconnect the address counter from the internal address bus when the CPU requires access to EPROM and RAM. The outputs of QD34 and QD35 are disabled when INT.MODE SHIFT is high, which is the case when the CPU has set "MODE SHIFT" to high.

Multi-tones

When the Audio Generator Option is required to generate a multi-tone, the CPU, as previously described, calculates the required samples and places them in the RAM memory. Then the CPU sets the control lines as follows:

* MODE SHIFT is set high and then low to set INT.MODE SHIFT high (enabling address buffers QD34 and QD35 and disabling QD48 and QD49).

* $\overline{\text{SFREQ}}$ is set high enabling the RAM memory.

* MULTITONE is set high. This disables the Sine Table, QD40 and QD41 and enters a logic one on the CARRY input on QD14.

Due to R10 and R11 the input to the adders will now be zero on all lines and a one on the CARRY input. This will result in an address increment of one on the output of the adders.

Reset Selector and Latch

The reset detector is a 15 bit comparator, which detects when the address on the bus reaches a precalculated value stored by the CPU via CRU in the latches QD27 and QD28. The following values are used:

32,000	Sine wave	
6,400	Multi-tone	10 Hz resolution
640	Multi-tone	100 Hz resolution
64	Multi-tone	1000 Hz resolution

When the address counter reaches the value stored in the latches, QD22, pin 12 goes low. This signal propagates to the outputs of QD44 in order to disable QD40 and QD41 and enable QD48 and QD49, which invert the address value stored in QD27 and QD28. At the same time, QD69, pin 3, which serves as a CARRY input to the address goes high. The result of this will be that the two's complement value of the address value stored in QD27 and QD28 is added to the current address. Consequently, the next address will be the previous address minus 32,000, 6,400, 640 or 64, respectively.

If the signal is a sine wave the gates QD38, QD39, QD46 and QD47 will now be configured to invert the number read from the Sine Table. This routine will be repeated each time the address counter exceeds 32,000 ensuring that the positive as well as the negative half wave period is generated.

If a multi-tone is being generated the state of the inverters QD38, QD39, QD46 and QD47 is not changed as samples of a whole period of the multi-tone are calculated and stored.

Window detector and latch

The window detector controls the timing of frequency changes for single tone signals. As previously explained, this circuitry is employed in order to ensure a minimum of transients during frequency change. This is the case if the change happens when the output sine value is close to a maximum value (+1 or -1) corresponding to a Sine Table address close to 16,000.

As the address 16,000 may never be used for some frequencies and only with long time intervals for others, it is necessary for each frequency to define a range of addresses in which the change is allowed to happen.

This address space around address 16,000 is called the window, and the window is defined by:

$$16{,}000-256-f/2 \text{ to } 16{,}000+256+f/2$$

where f is the frequency in Hz.

Thus, the width of the window is as a minimum +/- 256 address locations, because the comparator only monitors the 8 most significant address lines.

The window detector is configured of a comparator monitoring the lower limit of the interval 16,000-256-f/2 and another comparator monitoring the upper limit of the interval 16,000+256+f/2.

A change of frequency is performed as follows:

* The CPU loads the new frequency into the frequency latch. MODE SHIFT is low and QD45, pin 1 is low disabling the input of the latches in QD40 and QD41. The CPU also resets the D flip-flop QD45 by means of the line FREQUENCY CHANGE.

* When the address is within the window, QD63, pin 10 will go high causing the data input on QD45 (pin 5) to be high.

* When QD51, pin 15 (generated from the 64 kHz main clock) goes high the data input is latched onto pin 1 - causing the latches in QD40 and QD41 to be enabled. The new address increment will now be routed to the address counter. At the same time pin 13 on QD45 will go high (TP1). This is used to inform the CPU that the change of frequency has been completed.

<u>Test Points and Jumpers</u>

The following is a list of the individual test points and jumpers.

JP1 Used by the Static CPU to detect that the card is installed correctly. At the factory the jumper is installed between 1 and 5. Other positions are for future use.

JP2 Not installed. For future use if it should be required to provide the RAM memory with power back-up.

TP1-TP9 For troubleshooting at the factory.

3.2 Analog Board (901-498)

The following subsection gives a description of the individual circuit blocks of which this part of the Audio Generator Option is configured. The description makes reference to fig. 3.2 - Analog Board, Block Diagram and to the schematic diagram, drawing No. 985-158 at the back of this manual.

The circuitry on the Analog Board may be divided into the following main blocks:

* D/A converter, deglitch and filtering
* TIM test signal generator
* 1 kHz reference signal generator
* Control circuitry
* Left channel output stage
* Right channel output stage

These blocks are described in the following subsection. As the left and right channel stages are identical, however, only the left channel output stage is discussed.

D/A Converter, Deglitch and Filtering

The 16 bit DAC QD1 receives the digital samples from the Sine Table or the RAM memory on the Digital Board (901-499) via the ribbon cable W1 and the latches QD2 and QD3. The timing is controlled by the signal DAC LATCH. DAC LATCH, which is a 64 kHz square wave signal, is also used as input signal to the TIM and 1 kHz generators. The DAC now converts the 16 bit digital number (two's complement form) into an analog signal (voltage) at pin 17 (JP1, pin 2). If an oscilloscope is connected to JP1 the typical picture shown in fig. 3.3 will be seen. The sinusoid is approximated by a staircase function where the duration of each "step" is 15.625 microseconds (64 kHz). As shown in the enlargement of three steps the change from one level to another will cause ringing. These transients are later removed by the deglitch circuit.

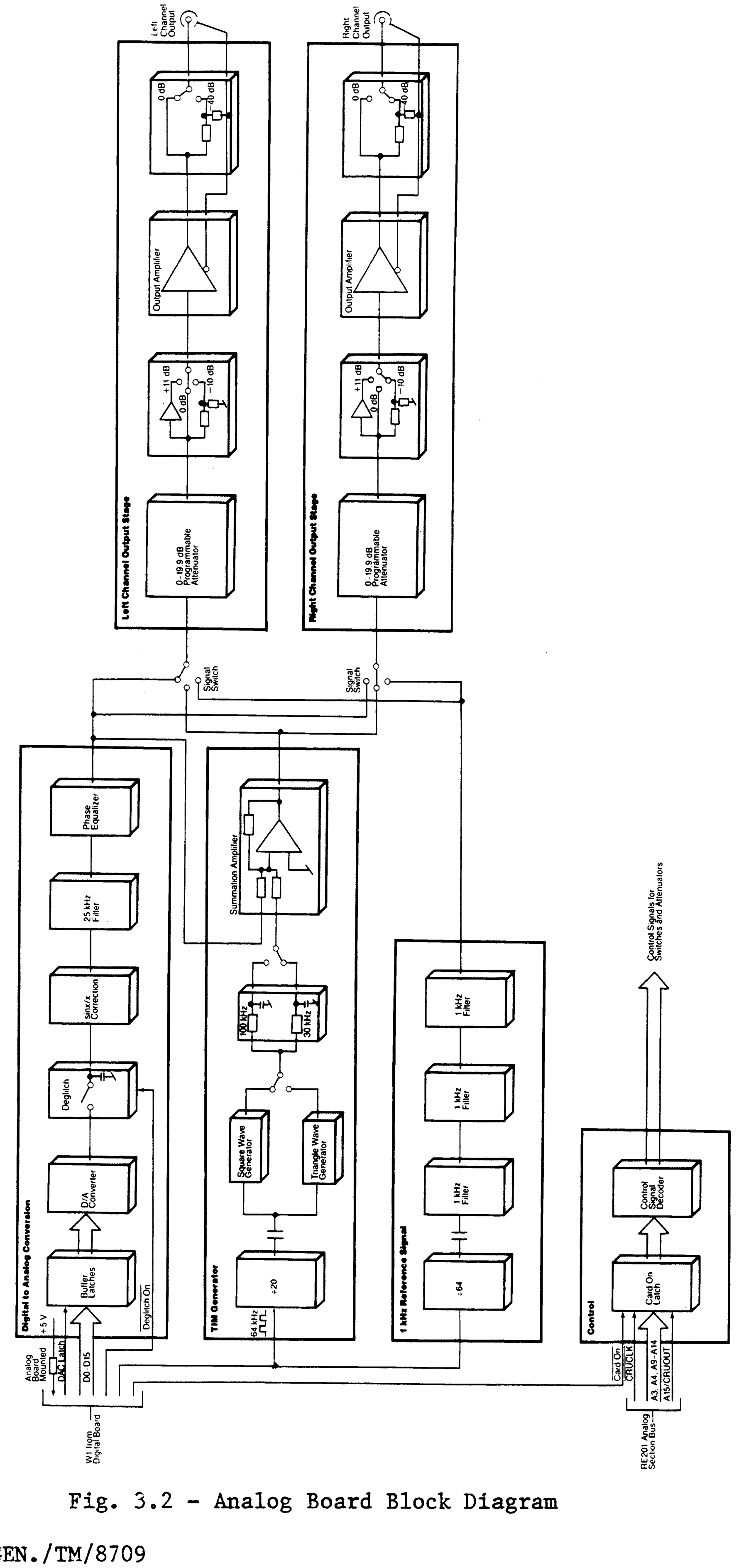


Fig. 3.2 - Analog Board Block Diagram

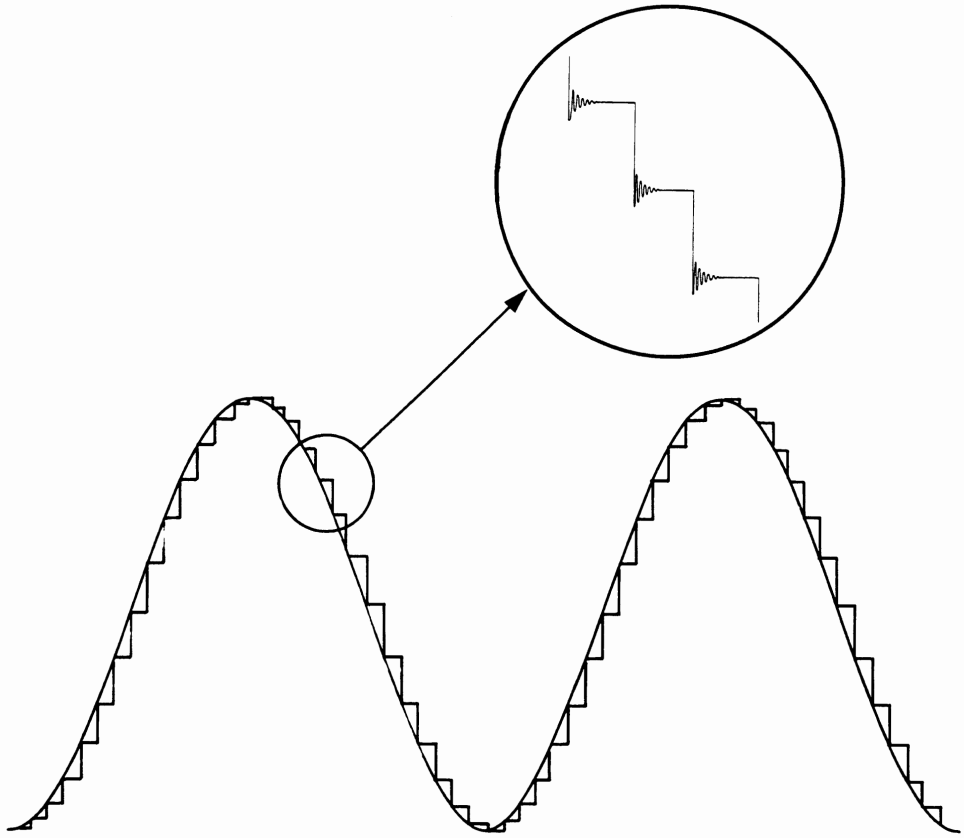


Fig. 3.3 - Typical DAC Output Waveform

Having a resolution of 16 bits the quantization noise (1/2 LSB) will be approximately 96 dB below the peak output voltage. The RMS value of the quantization noise can be shown to be $1/\sqrt{12}$ of LSB and consequently, the S/N ratio obtainable by means of an ideal 16 bit D/A converter should be:

$$20 \log \frac{\frac{1}{2} \cdot 2^{16}}{\sqrt{2} \cdot \frac{1}{\sqrt{12}}} = 98\,\text{dB}$$

This should also be the SINAD value obtainable when the ideal 16 bit DAC is used to generate sine waves. However, this is only true if the sampled signal is stocastic. As this is not the case, and as the inherent distortion in the internal networks in the DAC is also a limiting factor, the SINAD is in practice limited to approx. 90 dB and the THD to approx. 95 dB.

As mentioned above the fast transients present when changing from one level of the staircase wave form to the next unavoidably generates ringing. As this will raise the overall noise floor, it has to be removed, and this is done by means of the deglitch network. The deglitch is a sample and hold unit where the sample point is delayed from the DAC LATCH (conversion). The timing and principal function are shown in fig. 3.4. When the deglitch switch QA1 is on, the capacitor C174 is charged by the DAC output voltage. When the switch goes off, the capacitor is capable of maintaining the voltage for many sample

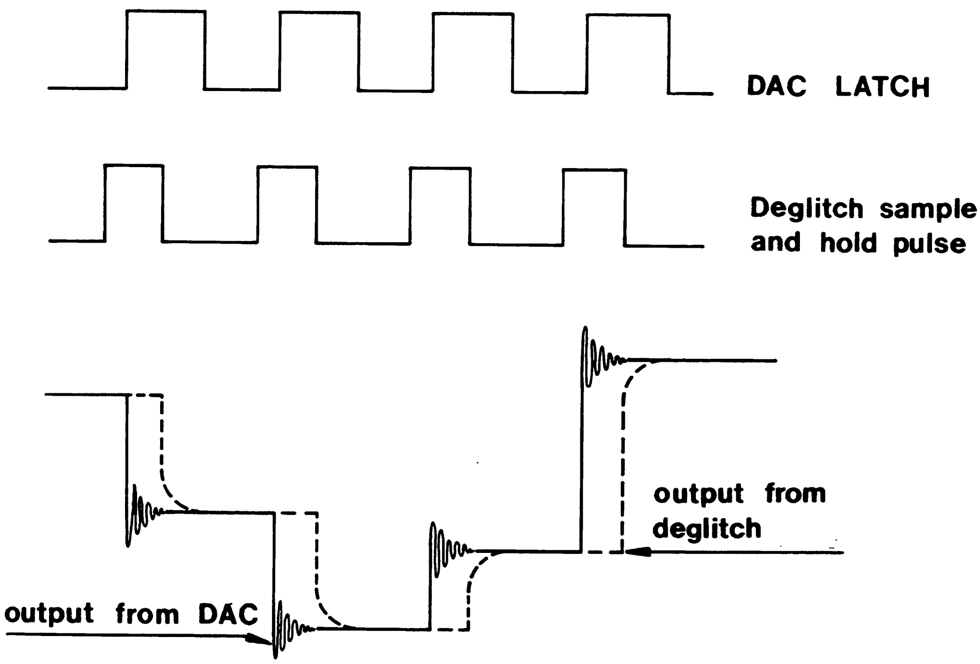


Fig. 3.4 - Function and Timing of Deglitch Network

periods due to the high input impedance of QA2. Hereby the ringing (noise) found at the DAC output is removed.

It is well known from the sampling theory that low-pass filtering of a time function sampled by means of delta functions will give a perfect recovery of the original wave form provided the sampling theorem is fulfilled, i.e. the sampled signal must contain no frequency component above half the sampling frequency. In the present case, however, the time function is sampled by means of rectangular pulses with a pulse width of 15.625 microseconds. This implies that some correction is required, as explained in the following.

The staircase signal can be represented as the convolution in the time domain of a 15.625 microsecond rectangular pulse and a train of delta functions representing ideal samples of the sine wave. As convolution in the time domain corresponds to multiplication in the frequency domain the resulting spectrum will be composed of sets of delta functions multiplied by the Fourier transform of a single 15 microsecond pulse. The delta functions are placed at fs, 2fs, 3fs etc., where fs is the sampling frequency.

The spectrum of one single pulse is

$$F(f) = k \sin(x)/x$$

where $x = 2\pi fT/2$ and T = 15.625 microseconds. *

As F(0) equals k we can write

$$F(f)/F(0) = \sin(x)/x$$

Table 3.1 shows calculated values of F(f)/F(0) for T = 15.625 micro-seconds.

Frequency	F(f)/F(0)
0 Hz	1.000
1000 Hz	1.000
10000 Hz	0.960
25000 Hz	0.767

Table 3.1 - F(f)/F(0) values

Thus, after proper low-pass filtering the staircase representation of a 1 kHz sine wave will give a perfect sine wave with an amplitude correction factor of 1.000. A 25 kHz sine wave, however, will have an amplitude which will be 0.767 times lower than if sampled by means of delta functions (ideal sampling). The x/sinx filter corrects this to ensure that the output level from the Audio Generator is independent of the frequency in the specified frequency range.

The antialiasing filter, which is an active ninth order elliptical filter designed to have minimum ripple (0.05 dB) in the pass band (DC to 25 kHz) and maximum attenuation in the stop band (39 kHz and upwards), removes all high frequency components (sampling frequency, higher order spectra etc.) from the signal. The filter is built around high quality operational amplifiers, QA14, QA15, QA16 and QA17.

Finally, the phase equalizer corrects the nonlinear phase characteristics of the antialiasing filter. This is done to ensure that the frequency shifting routine implemented via the window detector on the Digital Board will provide a smooth shift at one of the maxima of the time function.

<u>TIM Generator</u>

The 64 kHz square wave signal is divided by 20 (QD7 and QD9), AC coupled and low-pass filtered to create the TIM100 and TIM30 square and triangle wave forms. The final square wave or triangle is in QA7 added to a 15 kHz sine wave generated by the digital frequency synthesizer to give the resulting TIM test signals.

To ensure the required high accuracy of the resulting levels, the C-MOS dividers are supplied from a highly accurate 5V supply (QA25).

1 kHz Reference Signal Generator

The DAC LATCH 64 kHz square wave signal is divided by 64 in QD8 and QD10. Then the signal is AC coupled and fed through 3 identical bandpass filters. These filters remove all harmonics from the signal and generate a pure sine wave with SINAD and THD specifications close to -100 dB.

Control Circuitry

The Static CPU is informed via the Digital Board that the Audio Generator Option has been mounted correctly. For this purpose the 5V connected to pin 5 in W1 indicates to the Digital Board that the Analog Board and W1 are mounted correctly. The Digital Board responds by keeping CARD ON low, which enables the CPU to operate the control circuitry on the Analog Board. This is done by means of the CRU CLOCK selector, QD11, latches QD12, QD13, QD14, QD15 and operational amplifiers, QA28, QA29 and QA30. The operational amplifiers operate as comparators with 2.5V switch voltage. When the voltage of the non-inverting input is at logic level Ø (0 Volt) the output voltage is approx. -15V and consequently, the connected FET transistor is off. When the input level is logical 1 the output level is approx. +15V. As the diode in the gate will be reversed, gate and drain will be at the same voltage level (through 33 kOhms) and the FET transistor will be on.

Q8 and Q17 are used to change the non-inverting input to ground as a part of the set-up, when the Audio Generator Option is in the "GND" mode.

Left Channel Output Stage

The output stage consists of the following individual blocks:

* 0-19.9 dB programmable attenuator with 0.1 dB resolution
* -10 dB, 0 dB or +11 dB programmable attenuator
* Floating output stage QA10, QA11
* 0 dB or -40 dB programmable attenuator. The switching element is a relay as opposed to the FET transistors used elsewhere.

As the input level to the output stage is 2.5V peak, it is possible by means of the above listed attenuators to regulate to output voltage between 0.8 mV peak and 8.87V peak with 0.1 dB resolution.

The output stage contains a number of facilities for adjustment of DC offset, level and common mode rejection. These facilities together with other adjustment facilities in the Audio Generator Option are described in more detail in section 4 (Maintenance) of this manual.

Test Points and Jumpers

In the following the function of the test points and jumpers on the Analog Board is described. Fig. 3.5 shows the component layout and the following table provides a short description:

JP1 Disconnects the DAC from the analog circuitry. At the factory the jumper is placed in position 2-3. When removed, pins 1 and 3 can be used to feed an analog signal to the filter-output section for test purposes.

JP2 Not connected at the factory. A short placed between these two pins (e.g. the one from JP1) will switch on the deglitch switch permanently.

JP3-JP4 Disconnects the output stages from filters and attenuator stages if the factory positioned jumpers are removed. Signals applied between pins 2 and 3, 2 and 1, respectively, may be used to test the output stages.

JP5-JP6 Connected at the factory. A 22 kOhm resistor in parallel with a 470 pF capacitor define the DC potential and prevent oscillations which may occur at certain load impedances.

TP1 May be used for monitoring the DAC, the TIM and the 1 kHz reference signal.

TP2 May be used together with JP1 and JP2 to check the performance of the antialiasing filter.

TP3 Used to check the 5V reference voltage used to generate TIM square wave, TIM triangle and 1 kHz square wave signals. Adjustable by means of R61.

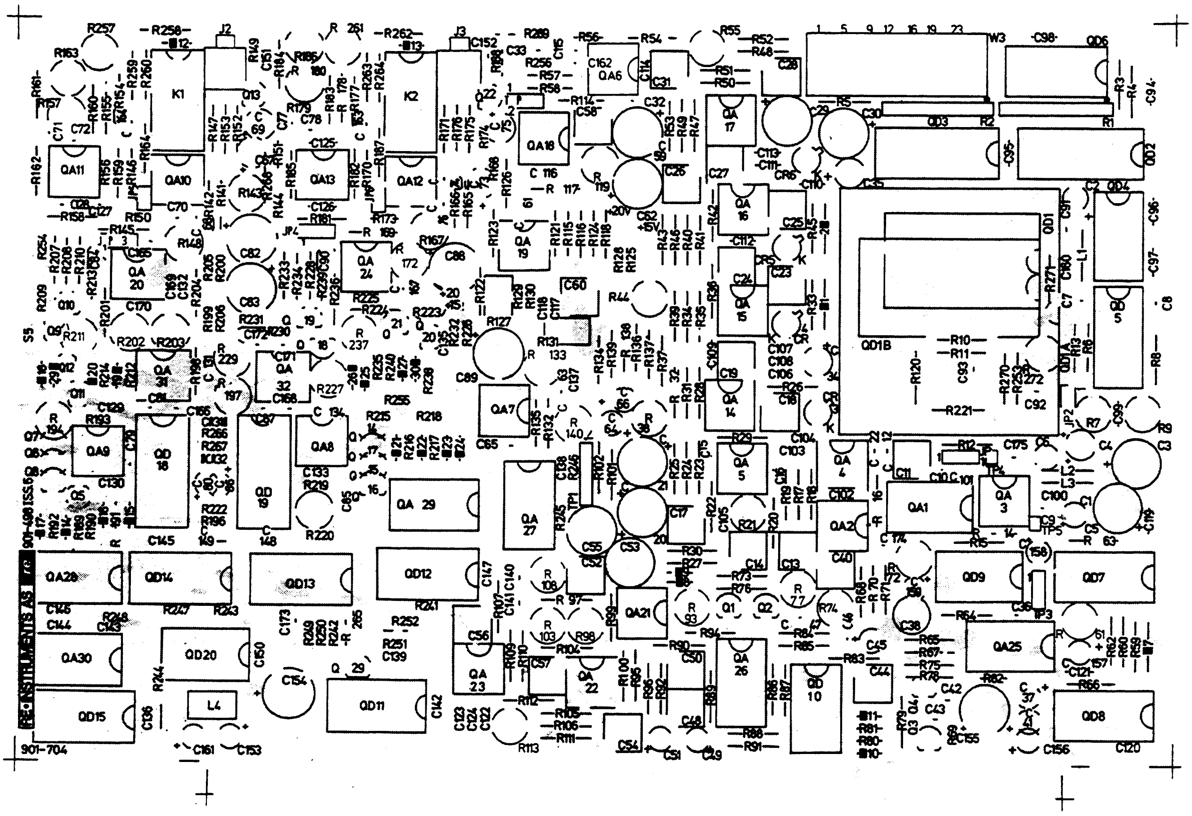


Fig. 3.5 - Analog Board Component Layout

4 MAINTENANCE

This section describes maintenance and adjustment procedures for the RE201 Audio Generator Option.

4.1 Recommended Test Equipment

Table 4.1 lists the test equipment necessary to carry out a performance test and to adjust the Audio Generator Option, if necessary.

Instrument	Critical Specifications	Recommended Model
1) RMS/DC Voltmeter	Accuracy of reading 0.02 %, at 20 Hz-25 kHz and at DC	Fluke RMS differential Voltmeter, Model 8506A
2) Oscillo-scope	None	
3) Distortion Analyzer	THD measurements -100 dB 20 Hz-12.5 kHz SINAD measurements - 90 dB	RE201 with Filter Option (901-525)
4) Frequency Counter	Resolution better than 0.1 Hz	Fluke Model 1911A

Table 4.1 - Recommended Test Equipment

4.2 Performance Test

As all the tests outlined in this section are performed on both channels of the Audio Generator Option, it will be convenient to perform measurements with the right and left outputs connected to the right and left inputs of the RE201.

The performance test includes:

* Frequency check
* Frequency response tests
* Test of the different attenuators
* THD and SINAD measurements

RE201 Programming

It is recommended to carry out all programming of the RE201 (defining signals and measurements) before the test is initiated.

The following gives a survey of the definitions necessary to carry out the entire performance test. It is implied that all the definitions are identical for both channels. All levels are EMF values.

Signal Definitions

SIGNAL 00	1000 Hz	1.77 Vrms
SIGNAL 01	20 Hz	1.77 Vrms
SIGNAL 02	1000 Hz	6.27 Vrms
SIGNAL 03	TIM30 SQR	1.77 Vrms
SIGNAL 04	TIM30 TRI	1.77 Vrms
SIGNAL 05	TIM100 SQR	1.77 Vrms
SIGNAL 06	MFREQ0	1.00 Vrms
SIGNAL 07	100 Hz	1.00 Vrms
SIGNAL 08	5000 Hz	1.00 Vrms
SIGNAL 09	1 kHz, Ref.	1.77 Vrms

MFREQ0	3200 Hz	Relative level 1
	15000 Hz	Relative level 1

Measurement Definitions

Level Definitions

LEV1	Channel BOTH, Mode SEL, Center frequency 3200 Hz, Bandwidth 100 Hz, Representation DBR
LEV2	Channel BOTH, Mode SEL, Center frequency 15000 Hz, Bandwidth 100 Hz, Representation DBR

Distortion Definitions

THD0	Channel RIGHT, Frequency TRACK, 2nd to 9th Harmonic included, Representation DB, Averaging LIN, No. of Loops 5
THD1	Channel RIGHT, Frequency TRACK, 2nd Harmonic only included, Representation DB, Averaging LIN, No. of Loops 5
SINAD0	Channel RIGHT, Frequency TRACK, Duration 250 ms, Representation DB

Sequences

S0	LEV1, LEV2

Frequency Accuracy

a. Connect the frequency counter (4) to one of the outputs of the Audio Generator. The RE201 cannot be used for this test, as the Audio Generator utilizes the same main clock as the frequency measurement.

b. Activate a 5000 Hz Single Tone signal (SIGNAL 08) and check that the frequency accuracy is +/-0.1 Hz.

c. Activate a 1 kHz Reference Tone (SIGNAL 09) and check that the frequency accuracy is +/-0.02 Hz.

d. Activate a TIM SQR signal (SIGNAL 03) and check that the frequency measured is 3200 Hz +/-0.07 Hz.

Frequency Response, Single Tone

a. Connect the RMS voltmeter (1) to the right channel output. Activate a 20 Hz, 1.77 Vrms signal (SIGNAL 01).

b. Verify, that the output level is 1.768 Vrms +/-12 mV (1.756 V - 1.780 V).

c. Using the GENCTRL frequency change facility, verify the frequency response in accordance with table 4.2.

d. Repeat the test for the left channel output.

Frequency	Result
20 Hz	1.756 - 1.780 V
1000 Hz	1.756 - 1.780 V
5000 Hz	1.756 - 1.780 V
10000 Hz	1.756 - 1.780 V
16000 Hz	1.756 - 1.780 V
20000 Hz	1.747 - 1.789 V
25000 Hz	1.747 - 1.789 V

Table 4.2 - Frequency Response

1 kHz Reference Tone Output Level

a. Connect the RMS voltmeter to the right channel output and activate the 1 kHz Reference Tone, level 1.77 Vrms (SIGNAL 09).

b. Verify, that the output level is 1.768 Vrms +/-12 mV (1.756 V - 1.780 V).

TIM Output Level

a. Activate a TIM30 SQR signal (SIGNAL 03), and initiate a sequence including two selective RMS measurements, center frequencies 3.2 kHz and 15 kHz (SO).

b. Verify, that the 3.2 kHz level is 14.1 dB +/-0.2 dB above the 15 kHz level.

c. Activate a TIM30 TRI signal (SIGNAL 04) and verify that the 3.2 kHz level is 10.2 dB +/-0.1 dB above the 15 kHz level.

TIM Filter

a. Connect the oscilloscope (2) to the right channel output. Activate a TIM100 SQR signal (SIGNAL 05).

b. Observe the sharpness of the edges on the square wave. Then activate a TIM30 SQR signal and note that the edges are rounded compared to the TIM100 SQR signal.

Multi-tone

a. With the right channel output connected to the RE201 right channel input, select the multi-tone outlined in the programming section above.

b. Execute the sequence including the 3.2 kHz and the 15 kHz selective measurements (SO) and verify, that the two level measurement results are identical.

Attenuator Test

The attenuator chain in the Audio Generator consists of three individual attenuators in each channel. To fully check these attenuators, several different settings must be verified. Table 4.3 lists the signals to be defined, the levels to be tested, the tolerances allowed, and, for reference, the actual set-up of each attenuator section.

The measurements are performed in the left as well as in the right channel, using the RMS voltmeter (1) connected to the channel being tested. Activate SIGNAL 02 and use the GENCTRL facility to change the output level according to table 4.3.

Output level	Tolerance	Attenuator Setting 0/-40 dB	0- -19.9 dB	-10/0/+11 dB
6.27 Vrms	+/-60 mV	0 dB	0 dB	+11 dB
562 mVrms	+/-5.6 mV	0 dB	0 dB	-10 dB
298 mVrms	+/-3.0 mV	0 dB	-15.5 dB	0 dB
261 mVrms	+/-2.6 mV	0 dB	-16.6 dB	0 dB
642 mVrms	+/-6.4 mV	0 dB	-8.8 dB	0 dB
17.8 mVrms	+/-0.2 mV	-40 dB	0 dB	0 dB

Table 4.3 - Attenuator Test

THD and SINAD

Single-tone

a. Connect the outputs of the Audio Generator to the inputs of the RE201. The RE201 must be equipped with Filter Option (901-525); alternatively, a separate distortion analyzer with the specifications outlined in table 4.1 may be used.

b. Measure THD including 2nd to 9th harmonics (THD) and SINAD (result in dB, SINAD 0) for a 100 Hz, 1.00 Vrms signal (SIGNAL 07). Verify that the total harmonic distortion is below -88 dB and that SINAD is below -85 dB.

c. Change the frequency to 1000 Hz and repeat.

d. Change the frequency to 10000 Hz and measure THD, 2nd harmonic (THD 1) and SINAD. Verify that THD is below -90 dB and that SINAD is below -82 dB.

1 kHz Reference Signal

a. With a 1 kHz, 1.00 Vrms signal, activate a THD measurement including 2nd to 9th harmonics (THD 0). Check that THD is below -97 dB.

4.3 Adjustments

Should any of the performance tests described in section 4.2 fail, some adjustments may be performed if the excesses are minor. Adjustments should only be performed, if a voltmeter with the specifications given in table 4.1 is available. Some of the adjustments, which require special measuring equipment, are not described. This includes adjustment of the antialiasing filter, of the Deglitch circuit, and the Common Mode Rejection adjustments.

All adjustments are performed on the Analog Board (901-498) of the Audio Generator. In order to gain access to the board, the Service Kit (906-032) must be used. The Analog Board is mounted on the Extender Board and connected to the Digital Board by means of the 26-way extender cable supplied with the Service Kit. When measurements are performed on the output signal, the SMC-to BNC cable also supplied may be used.

The adjustments outlined below are divided into six independent groups. If it is not obvious which adjustments are required, it is recommended to perform an adjustment of the Audio Generator in the same order as described below. Whenever an adjustment has to be carried out in both channels, test pins, resistors etc. belonging to the right channel are mentioned in brackets. The locations of test points and adjustment potentiometers are shown in fig. 3.5. Signal definitions are outlined in the beginning of section 4.2.

All adjustments except of output amplifiers are independent of level and channel.

Frequency Response

a. Connect the RMS voltmeter (1) to TP2 (2-1) on the Audio Generator. Select a 1000 Hz Single Tone on the RE201 (SIGNAL 00). Use the measured voltage (Vo) as the reference for the following three adjustments.

b. Change the frequency to 20 Hz. Adjust the measured voltage to Vo +/- 0.03 % by means of R55.

c. Change the frequency to 16000 Hz. Adjust the measured voltage to Vo +/- 0.03 % by means of R21.

d. Repeat b. and c.

Phase Equalizer

a. Remove the jumper at JP1 and connect JP1, pins 1-3. Connect the voltmeter (1) to TP1, pins 1-2 and adjust to 0 V DC +/- 0.5 mV by means of R131.

b. Reinstall the jumper at JP1, connecting pins 2 and 3, and select a 1000 Hz Single Tone signal (SIGNAL 00).

c. Adjust by means of R127 to 1.7678 Vrms +/- 0.03%.

d. Change the frequency to 16000 Hz and adjust by means of R119 to 1.7678 Vrms +/- 0.03%.

e. Change the frequency to 1000 Hz and repeat c. and d.

+5 V Reference

a. Connect the voltmeter (1) to TP3 (2-1) and adjust to +5 V DC +/- 5 mV by means of R61.

1 kHz Reference Oscillator

a. Connect the RMS voltmeter to TP1, pins 5-2. Adjust the voltage to maximum by means of R93, R98 and R108.

b. Adjust to 1.7678 Vrms +/- 0.9 mV by means of R103.

c. Adjust to 0 V DC +/- 0.5 mV by means of R113.

TIM Oscillator

a. With no TIM signal selected, remove the jumper at JP1 and connect JP1, pins 1 and 3. Connect the voltmeter (1) to TP1, pins 3-2 and adjust to 0 V DC +/- 0.5 mV by means of R140.

b. Select a TIM triangle signal (SIGNAL 04) and adjust to 0 V DC +/- 0.5 mV by means of R72.

c. Adjust the RMS voltage in TP1 (3-2) of the TIM triangle to 1.1547 Vrms +/- 0.6 mV by means of R77.

d. Select a TIM square signal. Adjust the RMS voltage of the TIM square to 2.000 Vrms +/- 1 mV by means of R74.

e. Select a 15 kHz single-tone. Remount the jumper at JP1, connecting pins 2 and 3, and adjust the RMS voltage in TP1 (3-2) to 0.3535 Vrms +/- 0.2 mV by means of R133.

Output Amplifiers

a. Select a 1000 Hz, 1.77 Vrms Single Tone (SIGNAL 00). Connect to JP3 pins 2-3 JP4. pins 1-2. Remove JP5 (JP6).

b. Shortcircuit the outer conductor of the output cable to 0 V (circuit ground). Connect the voltmeter (1) to the inner conductor and 0 V and adjust the voltage to 0 V DC +/- 0.5 mV by means of R148 (R172).

c. Shortcircuit the inner conductor of the output cable to 0 V. Connect the voltmeter (1) to the shield and 0 V and adjust to 0 V DC +/- 0.5 mV by means of R157 (R180).

d. Repeat b. and c. once.

e. Remount JP5 (JP6) and connect JP3, pins 1-2 (JP4, pins 3-2).

Output Level

a. Connect the RMS voltmeter (1) to the output of the Audio Generator. Select a 1000 Hz, 1.77 Vrms Single Tone (SIGNAL 00).

b. Adjust level to 1.7678 Vrms +/- 0.9 mV by means of R202 (R227).

c. Change level to 6.27 Vrms, using the GENCTRL facility, and adjust the output level to 6.2723 Vrms +/- 3 mV by means of R211 (R237).

d. Change the level to 17.7 mVrms. Adjust the output level to 17.678 mVrms +/- 9 uV by means of R257 (R261).

5 TROUBLESHOOTING

This section provides information on how to troubleshoot the Audio Generator Option, mainly to distinguish between errors from the Analog Board and the Digital Board.

The errors may be divided into selftest errors and errors found during the performance test (refer to section 4.2). It is recommended that section 2, Principles of Operation, and section 3, Circuit Descriptions, are carefully studied before troubleshooting is commenced.

5.1 Selftest Errors

The selftest routine performed by the RE201 mainly concentrates on the digital circuitry. During a selftest, the Static CPU verifies that the Analog and Digital Boards are both mounted correctly. If this is not the case, information about the Audio Generator Option will not appear on the CRT after power-up or a selftest. This type of error may be caused by a faulty CARD ON circuit (built around QD33, QD59, QD51 and QD61 on the Digital Board), a bad or missing connection between the Analog and Digital Boards (flat cable) or by one of the Audio Generator boards being mounted incorrectly in the Analog Motherboard.

If the RE201 recognizes the Audio Generator, the selftest routine proceeds with a test of the digital part. This test includes a test of the program PROM, the sine wave table and the multi-tone RAM. During the test, the address/data lines and the decoding circuit are also checked. If any error occurs during this part of the selftest, the selftest result will be represented as an error code on the LEDs (CR1-CR8) placed at the upper edge of the Static CPU board. CR1 is the rightmost of the diodes when viewing the PCB from the component side.

CR5-CR8 display the QD-designation of the failing IC, while CR1-CR4 display an error code specific for the Audio Generator, as detailed in table 5.1.

5.2 Performance Test Errors

On the basis of the tests performed during the performance test, it should be possible to determine from which part of the Audio Generator Option the fault originates.

Analog Board Errors

Errors on the analog part will primarily be detected as erroneous output levels. If the deviation of the output level is considerable compared to the selected output level, and regardless of which signal is selected, the error is most likely due to faulty FET switches

Error Code	QD No.	Function
0001 0101	QD1	Sine Table PROM, MSB
0010 0101	QD2	Sine Table PROM, LSB
0011 0101	QD3	Sine Table PROM, MSB
0010 0101	QD4	Sine Table PROM, LSB
0101 0101	QD5	Program PROM
0111 0101	QD7	Multi-tone RAM, LSB
1000 0101	QD8	Multi-tone RAM, MSB

Table 5.1 - Audio Generator Error Codes

(Q1-Q21), or to a faulty control circuit. The control circuit consists of a number of addressable latches (QD12-QD15) and voltage comparators (QA27-QA29).

To aid the troubleshooting of the output attenuator chain, table 5.2 lists the actual set-up of each of the attenuator sections for different specified levels of a Single Tone. It should be noted, that the output amplifiers may be isolated, e.g. for input of a test signal by means of the jumpers JP3 and JP4.

If the problems are only present when using single-/multi-tone signals, the error probably stems from the D/A-conversion circuit (including the Deglitch circuit), from the sinx/x correction, the antialiasing filter or the phase equalizer, or the error may be caused a fault on the Digital Board.

Digital Board Errors

Errors on the Digital Board will normally be observed as erroneous single-tone signals (peculiarities in the time function) or as incorrect frequency shifts.

Incorrect frequency measurements found during the performance test indicate errors in the frequency latches (QD40, QD41) or in the address counter circuit (QD11-QD13, QD23 and QD24).

If only one half of the sine wave is generated, the error probably stems from a faulty output buffer circuit (QD67, QD38, QD39, QD46 and

QD47), or from the reset detector circuit.

Level	0/-40 dB	-10/0/+11 dB	0 to -19.9 dB
0.566 mV	-40 dB	-10 dB	-19.9 dB
.	.	.	.
5.59 mV	-40 dB	-10 dB	0 dB
5.66 mV	-40 dB	0 dB	-9.9 dB
.	.	.	.
17.7 mV	-40 dB	0 dB	0 dB
17.9 mV	-40 dB	+11 dB	-10.9 dB
.	.	.	.
62.7 mV	-40 dB	+11 dB	0 dB
63.4 mV	0 dB	-10 dB	-18.9 dB
.	.	.	.
559 mV	0 dB	-10 dB	0 dB
566 mV	0 dB	0 dB	-9.9 dB
.	.	.	.
1.77 V	0 dB	0 dB	0 dB
1.79 V	0 dB	+11 dB	-10.9 dB
.	.	.	.
6.27 V	0 dB	+11 dB	0 dB

Table 5.2 - Attenuator Settings

In the case of an incorrect or no frequency shift when pressing 'cursor left/right', the error is most likely caused by a defective window latch/ window detector circuit (QD25, QD15-QD18). Errors in this circuitry may also cause the RE201 to completely stop the execution when the cursor key is activated.

If a single-tone generated on the Digital Board is not a sinusoid, the error may be due to a faulty reset latch/reset detector circuit (QD19-QD22, QD27 and QD28).

6 PARTS LISTS AND SCHEMATIC DIAGRAMS

6.1 Parts Lists

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.

Main Parts List

Assembled Units

* Audio Generator Analog Board	901-498
* Audio Generator Digital Board	901-499

Audio Generator Analog Board (901-498)

CAPACITORS

C 1	C solid AL 10u 20% 16V	265-008
C 2	C Tantal 68u 20% 16V	267-015
C 3	Electrolytic Capacitor 47U 25V	261-O85
C 4	C Tantalum 22u 20% 16V	267-019
C 5	Electrolytic Capacitor 47U 25V	261-O85
C 6	C Tantalum 22u 20% 16V	267-019
C 7	C Ceramic 33p0 2% 100V NP0	213-208
C 8	C Ceramic 100p 2% 100V NP0	213-211
C 9	C Ceramic 22p0 2% 100V NP0	213-206
C 10	C Ceramic 12p0 p25 100V NPO	213-227
C 11	C Polyst 1n00 1% 63V	243-304
C 12	C Ceramic 18p0 2% 100V NP0	213-222
C 13	C Polyst 1n00 1% 63V	243-304
C 14	C Polyst 2n00 1% 63V	243-305
C 15	C Ceramic 100p 2% 100V NP0	213-211
C 16	C Ceramic 22p0 2% 100V NP0	213-206
C 17	C Polyst 10n0 1% 63V	243-302
C 18	C Polyst 10n0 1% 63V	243-302
C 19	C Polyst 10n0 1% 63V	243-302
C 20	Electrolytic Capacitor 47U 25V	261-O85
C 21	Electrolytic Capacitor 47U 25V	261-O85
C 22	C Ceramic 10p0 2% 100V NP0	213-205
C 23	C Polyst 10n0 1% 63V	243-302
C 24	C Polyst 10n0 1% 63V	243-302
C 25	C Polyst 10n0 1% 63V	243-302
C 26	C Polyst 10n0 1% 63V	243-302
C 27	C Polyst 10n0 1% 63V	243-302
C 28	C Polyst 10n0 1% 63V	243-302
C 29	Electrolytic Capacitor 47U 25V	261-O85
C 30	Electrolytic Capacitor 47U 25V	261-O85
C 31	C Polyst 10n0 1% 63V	243-302
C 32	C Ceramic 10p0 2% 100V NP0	213-205
C 33	C Ceramic 22n0 -20+80% 63V	213-011
C 34	C Tantalum 22u 20% 16V	267-019
C 35	C Tantalum 22u 20% 16V	267-019
C 36	C Ceramic 2p70 p25 100V NPO	213-201
C 37	C solid AL 10u 20% 16V	265-008
C 38	Electrolytic Bipolar 4u7 25V	261-301
C 40	C Polyst 10n0 1% 63V	243-302
C 41	C solid AL 10u 20% 16V	265-008
C 42	C Ceramic 270p 2% 100V N750	213-213
C 43	C Ceramic 27p0 2% 100V NP0	213-207
C 44	C Polyst 1n00 1% 63V	243-304
C 45	C solid AL 10u 20% 16V	265-008
C 46	C Ceramic 22n0 -20+80% 63V	213-011
C 47	C Ceramic 330p 2% 100V N750	213-214
C 48	C Polyst 10n0 1% 63V	243-302
C 49	C solid AL 10u 20% 16V	265-008
C 50	C Polyst 10n0 1% 63V	243-302
C 51	C solid AL 10u 20% 16V	265-008

C 52	C Polyst 10n0 1% 63V	243-302
C 53	Electrolytic Capacitor 47U 25V	261-O85
C 54	C Polyst 10n0 1% 63V	243-302
C 55	Electrolytic Capacitor 47U 25V	261-O85
C 56	C Polyst 10n0 1% 63V	243-302
C 57	C Polyst 10n0 1% 63V	243-302
C 58	C Polyst 2n00 1% 63V	243-305
C 59	Electrolytic Capacitor 47U 25V	261-O85
C 60	C Polyst 2n00 1% 63V	243-305
C 61	C Ceramic 4p70 p25 100V p100	213-203
C 62	Electrolytic Capacitor 47U 25V	261-O85
C 63	C Ceramic 4p70 p25 100V p100	213-203
C 64	C solid AL 10u 20% 16V	265-008
C 65	C Ceramic 10p0 2% 100V NP0	213-205
C 66	C solid AL 10u 20% 16V	265-008
C 67	C Tantal 15u 20% 35V	267-008
C 68	C Ceramic 22p0 2% 100V NP0	213-206
C 69	C Tantal 15u 20% 35V	267-008
C 70	C Ceramic 10p0 2% 100V NP0	213-205
C 71	C Ceramic 10p0 2% 100V NP0	213-205
C 72	C Ceramic 22p0 2% 100V NP0	213-206
C 73	C Tantal 15u 20% 35V	267-008
C 74	C Ceramic 22p0 2% 100V NP0	213-206
C 75	C Tantal 15u 20% 35V	267-008
C 76	C Ceramic 10p0 2% 100V NP0	213-205
C 77	C Ceramic 10p0 2% 100V NP0	213-205
C 78	C Ceramic 22p0 2% 100V NP0	213-206
C 79	C Ceramic 22p0 2% 100V NP0	213-206
C 80	C solid AL 10u 20% 16V	265-008
C 81	C Ceramic 22p0 2% 100V NP0	213-206
C 82	Electrolytic Capacitor 47U 25V	261-O85
C 83	Electrolytic Capacitor 47U 25V	261-O85
C 84	C Ceramic 4p70 p25 100V p100	213-203
C 85	C Ceramic 22p0 2% 100V NP0	213-206
C 86	C solid AL 10u 20% 16V	265-008
C 87	C Ceramic 22p0 2% 100V NP0	213-206
C 88	Electrolytic Capacitor 47U 25V	261-O85
C 89	Electrolytic Capacitor 47U 25V	261-O85
C 90	C Ceramic 4p70 p25 100V p100	213-203
C 91	C Ceramic 100n 20% 50V	213-401
C 92	C Ceramic 100n 20% 50V	213-401
C 93	C Ceramic 100n 20% 50V	213-401
C 94	C Ceramic 100n 20% 50V	213-400
C 95	C Ceramic 100n 20% 50V	213-400
C 96	C Ceramic 100n 20% 50V	213-400
C 97	C Ceramic 100n 20% 50V	213-400
C 98	C Ceramic 100n 20% 50V	213-400
C 99	C Ceramic 100n 20% 50V	213-400
C 100	C Ceramic 100n 20% 50V	213-400
C 101	C Ceramic 100n 20% 50V	213-401
C 102	C Ceramic 100n 20% 50V	213-400
C 103	C Ceramic 100n 20% 50V	213-400
C 104	C Ceramic 100n 20% 50V	213-400
C 105	C Ceramic 100n 20% 50V	213-400

C	106	C Ceramic 100n 20% 50V	213-400
C	107	C Ceramic 100n 20% 50V	213-400
C	108	C Ceramic 100n 20% 50V	213-400
C	109	C Ceramic 100n 20% 50V	213-400
C	110	C Ceramic 100n 20% 50V	213-400
C	111	C Ceramic 100n 20% 50V	213-400
C	112	C Ceramic 100n 20% 50V	213-400
C	113	C Ceramic 100n 20% 50V	213-400
C	114	C Ceramic 100n 20% 50V	213-400
C	115	C Ceramic 100n 20% 50V	213-401
C	116	C Ceramic 100n 20% 50V	213-400
C	117	C Ceramic 100n 20% 50V	213-401
C	118	C Ceramic 100n 20% 50V	213-401
C	119	C Ceramic 100n 20% 50V	213-400
C	120	C Ceramic 100n 20% 50V	213-400
C	121	C Ceramic 100n 20% 50V	213-400
C	122	C Ceramic 100n 20% 50V	213-400
C	123	C Ceramic 100n 20% 50V	213-400
C	124	C Ceramic 100n 20% 50V	213-400
C	125	C Ceramic 100n 20% 50V	213-400
C	126	C Ceramic 100n 20% 50V	213-400
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	213-400
C	130	C Ceramic 100n 20% 50V	213-400
C	131	C Ceramic 100n 20% 50V	213-400
C	132	C Ceramic 100n 20% 50V	213-400
C	133	C Ceramic 100n 20% 50V	213-400
C	134	C Ceramic 100n 20% 50V	213-400
C	135	C Ceramic 100n 20% 50V	213-400
C	136	C Ceramic 100n 20% 50V	213-400
C	137	C Ceramic 100n 20% 50V	213-400
C	138	C Ceramic 100n 20% 50V	213-400
C	139	C Ceramic 100n 20% 50V	213-400
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	213-400
C	143	C Ceramic 100n 20% 50V	213-400
C	144	C Ceramic 100n 20% 50V	213-400
C	145	C Ceramic 100n 20% 50V	213-400
C	146	C Ceramic 100n 20% 50V	213-400
C	147	C Ceramic 100n 20% 50V	213-400
C	148	C Ceramic 100n 20% 50V	213-400
C	149	C Ceramic 100n 20% 50V	213-400
C	150	C Ceramic 100n 20% 50V	213-400
C	151	C Ceramic 100n 20% 50V	213-400
C	152	C Ceramic 100n 20% 50V	213-401
C	153	C solid AL 10u 20% 16V	265-008
C	154	Electrolytic 47/25, 2000h/85°, R:5*11, RM2	261-085
C	155	Electrolytic 47/25, 2000h/85°, R:5*11, RM2	261-085
C	156	C solid AL 10u 20% 16V	265-008
C	157	C solid AL 10u 20% 16V	265-008
C	158	C solid AL 10u 20% 16V	265-008
C	159	C solid AL 1u0 20% 25V	265-001

C 160	C Ceramic 100n 20% 50V	213-400
C 161	C solid AL 10u 20% 16V	265-008
C 162	C Ceramic 100p 2% 100V NP0	213-211
C 163	C Ceramic 470p 20% 100V	213-014
C 164	C Ceramic 470p 20% 100V	213-014
C 165	C Ceramic 10p0 2% 100V NP0	213-205
C 166	C Ceramic 10p0 2% 100V NP0	213-205
C 167	C Ceramic 10p0 2% 100V NP0	213-205
C 168	C Ceramic 10p0 2% 100V NP0	213-205
C 169	C Ceramic 100n 20% 50V	213-400
C 170	C Ceramic 100n 20% 50V	213-400
C 171	C Ceramic 100n 20% 50V	213-401
C 172	C Ceramic 100n 20% 50V	213-401
C 173	C Ceramic 100p 2% 100V NP0	213-211
C 174	C Ceramic 22p0 2% 100V NP0	213-206
C 175	C Ceramic 33p0 2% 100V NP0	213-208

DIODES

CR 1	Diode zener BZX79-C5V6 0.4W	350-629
CR 2	Diode zener BZX79-C5V6 0.4W	350-629
CR 3	Diode BAV45 Si Vr-20V If-50mA	350-432
CR 4	Diode BAV45 Si Vr-20V If-50mA	350-432
CR 5	Diode BAV45 Si Vr-20V If-50mA	350-432
CR 6	Diode BAV45 Si Vr-20V If-50mA	350-432
CR 7	Diode zener 1N825 C6V2 0.4W	350-637
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 29	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 30	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 31	Diode zener BZX79-C5V6 0.4W	350-629
CR 32	Diode zener BZX79-C5V6 0.4W	350-629

CONNECTORS

J 2	Conn Coax Jack 50E F/PCB/Angled	800-308
J 3	Conn Coax Jack 50E F/PCB/Angled	800-308

RELAYS & JUMPERS

K 1	Relay Double Throw 4,5V	570-082
K 2	Relay Double Throw 4,5V	570-082

CHOKES

L 1	Choke HF Mini 470uH 10% 124MA	703-014
L 2	Choke HF Mini 470uH 10% 124MA	703-014
L 3	Choke HF Mini 470uH 10% 124MA	703-014
L 4	COIL 15MHz	731-203

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 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 J175-18 p jfet	360-252
Q 11	Transistor J175-18 p jfet	360-252
Q 12	Transistor J109-18 n Fet	360-188
Q 13	Transistor BSR50 npn	360-201
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 J175-18 p jfet	360-252
Q 20	Transistor J175-18 p jfet	360-252
Q 21	Transistor J109-18 n Fet	360-188
Q 22	Transistor BSR50 npn	360-201
Q 29	Transistor 2N3904 pnp	360-064

INTEGRATED ANALOG CIRCUITS

QA 1	IC AD7512DI dual switch	364-547
QA 2	IC LF356 op amp	364-203
QA 3	IC 5534A op amp	364-639
QA 4	IC 5534A op amp	364-639
QA 5	IC 5534A op amp	364-639
QA 6	IC 5534A op amp	364-639
QA 7	IC 5534A op amp	364-639
QA 8	IC 5534A op amp	364-639
QA 9	IC 5534A op amp	364-639

QA 10	IC 5534A op amp	364-639
QA 11	IC 5534A op amp	364-639
QA 12	IC 5534A op amp	364-639
QA 13	IC 5534A op amp	364-639
QA 14	IC NE5532A Dual OP-Amp low noise	364-640
QA 15	IC NE5532A Dual OP-Amp low noise	364-640
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 NE5532A Dual OP-Amp low noise	364-640
QA 19	IC NE5532A Dual OP-Amp low noise	364-640
QA 20	IC 5534A op amp	364-639
QA 21	IC NE5532A Dual OP-Amp low noise	364-640
QA 22	IC NE5532A Dual OP-Amp low noise	364-640
QA 23	IC NE5532A Dual OP-Amp low noise	364-640
QA 24	IC 5534A op amp	364-639
QA 25	IC TL084 quad op amp	364-276
QA 26	IC TL084 quad op amp	364-276
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 5534A op amp	364-639
QA 32	IC 5534A op amp	364-639

INTEGRATED DIGITAL CIRCUITS

QD 1	IC PCM53KPV 16 bit DAC	367-010
QD 2	IC 74HC273 Octal D-FF.	364-574
QD 3	IC 74HC273 Octal D-FF.	364-574
QD 5	IC HEF4528B Dual monostable multivibrator	364-249
QD 6	IC 74HC4049 HEX inverter	364-638
QD 7	IC HEF4029BP Synchronous up/down counter	364-269
QD 8	IC HEF4029BP Synchronous up/down counter	364-269
QD 9	IC HEF4013BP Dual D-type Flip-Flop	364-222
QD 10	IC HEF4013BP Dual D-type Flip-Flop	364-222
QD 11	IC CD74HCT138 3-to-8 line dec.	364-570
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
QD 15	IC HEF4724BP 8-bit adessable latch	364-412
QD 18	IC AD7115KN LOGDAC 0.1 dB step	364-567
QD 19	IC AD7115KN LOGDAC 0.1 dB step	364-567
QD 20	IC HEF4025BP Tripple 3-input Nor gate	364-355

RESISTORS

R 1	R thick film Sil 8x10K	146-003
R 2	R thick film Sil 8x10K	146-003
R 3	R Metal Film 10K5 1% 0.5W TC50	115-105
R 4	R Metal Film 10K5 1% 0.5W TC50	115-105
R 5	R Carbon Film 100E 5% 0.2W	106-310
R 6	R Metal Film 10K5 1% 0.5W TC50	115-105
R 7	R Cermet Trimpot 10K 20% 0.5W TC70	182-301
R 8	R Metal Film 10K5 1% 0.5W TC50	115-105

R 9	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R 10	R Metal Film 12K1 1% 0.5W TC50	115-121
R 11	R Metal Film 36K5 1% 0.5W TC50	115-365
R 13	R Carbon Film 1K 5% 0.2W	106-410
R 14	R Metal film 1K00 5% 0.2W TC250	107-410
R 15	R Metal Film 2K00 1% 0.5W TC50	114-200
R 16	R Metal Film 2K00 1% 0.5W TC50	114-200
R 17	R Carbon Film 2K2 5% 0.2W	106-422
R 18	R Carbon Film 2K2 5% 0.2W	106-422
R 19	R Metal Film 1K10 1% 0.5W TC50	114-110
R 20	R Metal Film 9K09 1% 0.5W TC50	114-909
R 21	R var 2K2 20% 0.5W	182-313
R 22	R Metal Film 7K15 1% 0.5W TC50	114-715
R 23	R Metal Film 10K2 1% 0.5W TC50	115-102
R 24	R Metal Film 49K9 1% 0.5W TC50	115-499
R 25	R Metal Film 576E 1% 0.5W TC50	113-576
R 26	R Metal Film 28E7 1% 0.5W TC50	112-287
R 27	R Carbon Film 47E 5% 0.2W	106-247
R 28	R Metal Film 1K00 1% 0.5W TC50	114-100
R 29	R Metal Film 1K00 1% 0.5W TC50	114-100
R 30	R Carbon Film 22E 5% 0.2W	106-222
R 31	R Metal Film 1K15 1% 0.5W TC50	114-115
R 32	R Metal Film 1K05 1% 0.5W TC50	114-105
R 33	R Carbon Film 1K 5% 0.2W	106-410
R 34	R Metal Film 162E 1% 0.5W TC50	113-162
R 35	R Metal Film 1K00 1% 0.5W TC50	114-100
R 36	R Metal Film 1K00 1% 0.5W TC50	114-100
R 37	R Metal film 1K13 1% 0.5W TC50	114-113
R 38	R Cermet Trimpot 200E 20% 0.5W TC70	182-315
R 39	R Metal Film 976E 1% 0.5W TC50	113-976
R 40	R Metal Film 210K 1% 0.5W TC50	116-210
R 41	R Metal Film 1K00 1% 0.5W TC50	114-100
R 42	R Metal Film 1K00 1% 0.5W TC50	114-100
R 43	R Metal Film 1K21 1% 0.5W TC50	114-121
R 44	R Cermet Trimpot 200E 20% 0.5W TC70	182-315
R 45	R Carbon Film 1K 5% 0.2W	106-410
R 46	R Metal Film 976E 1% 0.5W TC50	113-976
R 47	R Metal Film 105E 1% 0.5W TC50	113-105
R 48	R Carbon Film 47E 5% 0.2W	106-247
R 49	R Metal Film 1K00 1% 0.5W TC50	114-100
R 50	R Metal Film 1K00 1% 0.5W TC50	114-100
R 51	R Metal Film 1K30 1% 0.5W TC50	114-130
R 52	R Carbon Film 22E 5% 0.2W	106-222
R 53	R Metal Film 499E 1% 0.5W TC50	113-499
R 54	R Metal Film 52K3 1% 0.5W TC50	115-523
R 55	R Cermet Trimpot 4K7 20% 0.5W TC70	182-312
R 56	R Metal film 27K0 5% 0.2W TC250	107-527
R 57	R Metal Film 4K99 1% 0.5W TC50	114-499
R 58	R Metal Film 4K99 1% 0.5W TC50	114-499
R 59	R Metal Film 1K10 1% 0.5W TC50	114-110
R 60	R Metal Film 2K21 1% 0.5W TC50	114-221
R 61	R var 2K2 20% 0.5W	182-313
R 62	R Metal Film 12K1 1% 0.5W TC50	115-121
R 63	R Carbon Film 100E 5% 0.2W	106-310

R 64	R Metal Film 100K 1% 0.5W TC50	116-100
R 65	R Metal Film 100K 1% 0.5W TC50	116-100
R 66	R Carbon Film 100E 5% 0.2W	106-310
R 67	R Metal Film 7K68 1% 0.5W TC50	114-768
R 68	R Carbon Film 2M2 5% 0.2W	106-722
R 69	R Metal film 100E 5% 0.2W TC250	107-310
R 70	R Carbon Film 2K2 5% 0.2W	106-422
R 71	R Carbon Film 820K 5% 0.2W	106-682
R 72	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R 73	R Carbon Film 33K 5% 0.2W	106-533
R 74	R Cermet Trimpot 1K 10% 0.5W TC70	182-310
R 75	R Metal Film 4K87 1% 0.5W TC50	114-487
R 76	R Carbon Film 33K 5% 0.2W	106-533
R 77	R Cermet Trimpot 1K 10% 0.5W TC70	182-310
R 78	R Metal Film 4K87 1% 0.5W TC50	114-487
R 79	R Metal Film 5K36 1% 0.5W TC50	114-536
R 80	R Metal film 33K0 5% 0.2W TC250	107-533
R 81	R Metal film 33K0 5% 0.2W TC250	107-533
R 82	R Metal film 100E 5% 0.2W TC250	107-310
R 83	R Metal Film 100K 1% 0.5W TC50	116-100
R 84	R Metal Film 100K 1% 0.5W TC50	116-100
R 85	R Metal Film 34K0 1% 0.5W TC50	115-340
R 86	R Metal Film 2K00 1% 0.5W TC50	114-200
R 87	R Metal Film 2K00 1% 0.5W TC50	114-200
R 88	R Carbon Film 100E 5% 0.2W	106-310
R 89	R Metal Film 15K8 1% 0.5W TC50	115-158
R 90	R Metal Film 267K 1% 0.5W TC50	116-267
R 91	R Carbon Film 100E 5% 0.2W	106-310
R 92	R Metal Film 15K0 1% 0.5W TC50	115-150
R 93	R var 2K2 20% 0.5W	182-313
R 94	R Metal Film 34K0 1% 0.5W TC50	115-340
R 95	R Metal Film 2K00 1% 0.5W TC50	114-200
R 96	R Metal Film 2K00 1% 0.5W TC50	114-200
R 97	R Metal Film 15K0 1% 0.5W TC50	115-150
R 98	R var 2K2 20% 0.5W	182-313
R 99	R Metal Film 267K 1% 0.5W TC50	116-267
R 100	R Metal Film 15K8 1% 0.5W TC50	115-158
R 101	R Carbon Film 33E 5% 0.2W	106-233
R 102	R Carbon Film 33E 5% 0.2W	106-233
R 103	R Cermet Trimpot 10K 20% 0.5W TC70	182-301
R 104	R Metal Film 37K4 1% 0.5W TC50	115-374
R 105	R Metal Film 2K00 1% 0.5W TC50	114-200
R 106	R Metal Film 2K00 1% 0.5W TC50	114-200
R 107	R Metal Film 15K0 1% 0.5W TC50	115-150
R 108	R var 2K2 20% 0.5W	182-313
R 109	R Metal Film 267K 1% 0.5W TC50	116-267
R 110	R Metal Film 15K8 1% 0.5W TC50	115-158
R 111	R Carbon Film 2K2 5% 0.2W	106-422
R 112	R Carbon 1M 5% 0.2w	106-710
R 113	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R 114	R Metal Film 6K04 0.1% 0.5W TC25	141-158
R 115	R Metal Film 6K04 0.1% 0.5W TC25	141-158
R 116	R Metal Film 6K04 0.1% 0.5W TC25	141-158
R 117	R Metal Film 3K40 1% 0.5W TC50	114-340

R	118	R Metal Film 6K04 0.1% 0.5W TC25	141-158
R	119	R Cermet Trimpot 200E 20% 0.5W TC70	182-315
R	120	R Metal Film 4K99 1% 0.5W TC50	114-499
R	121	R Metal Film 6K04 0.1% 0.5W TC25	141-158
R	122	R Metal Film 100K 1% 0.5W TC50	116-100
R	123	R Metal Film 22K6 1% 0.5W TC50	115-226
R	124	R Metal Film 6K04 0.1% 0.5W TC25	141-158
R	125	R Metal film 33E0 5% 0.2W TC250	107-233
R	126	R Metal Film 20K5 1% 0.5W TC50	115-205
R	127	R Cermet Trimpot 10K 10% 0.5W TC100	182-407
R	128	R Metal film 33E0 5% 0.2W TC250	107-233
R	129	R Metal film 3K30 5% 0.2W TC250	107-433
R	130	R Metal film 470K 5% 0.2W TC250	107-647
R	131	R Cermet Trimpot 100K 20% 0.5W TC100	182-409
R	132	R Metal Film 6K19 1% 0.5W TC50	114-619
R	133	R var 2K2 20% 0.5W	182-313
R	134	R Metal Film 23K7 1% 0.5W TC50	115-237
R	135	R Metal Film 4K99 1% 0.5W TC50	114-499
R	136	R Carbon Film 100E 5% 0.2W	106-310
R	137	R Carbon Film 100E 5% 0.2W	106-310
R	138	R Carbon Film 2K2 5% 0.2W	106-422
R	139	R Carbon Film 820K 5% 0.2W	106-682
R	140	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	141	R Metal Film 40K2 1% 0.5W TC50	115-402
R	142	R Metal film 3K92 0.1% 0.25w TC25	141-004
R	143	R Cermet Trimpot 100E 20% 0.5W TC70	182-317
R	144	R Metal film 22E0 5% 0.2W TC250	107-222
R	145	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	146	R Metal film 3K92 0.1% 0.25w TC25	141-004
R	147	R Metal Film 340E 0.5% 0.4W TC50	141-103
R	148	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	149	R Metal film 22K0 5% 0.2W TC250	107-522
R	150	R Metal film 22K0 5% 0.2W TC250	107-522
R	151	R Metal film 22E0 5% 0.2W TC250	107-222
R	152	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	153	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	154	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	155	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	156	R Metal film 22K0 5% 0.2W TC250	107-522
R	157	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	158	R Metal film 3K92 0.1% 0.25w TC25	141-004
R	159	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	160	R Metal Film 340E 0.5% 0.4W TC50	141-103
R	161	R Metal film 3K92 0.1% 0.25w TC25	141-004
R	162	R Metal Film 40K2 1% 0.5W TC50	115-402
R	163	R Cermet Trimpot 100E 20% 0.5W TC70	182-317
R	164	R Metal Film 22K1 1% 0.5W TC50	115-221
R	165	R Metal Film 40K2 1% 0.5W TC50	115-402
R	166	R Metal film 3K92 0.1% 0.25w TC25	141-004
R	167	R Cermet Trimpot 100E 20% 0.5W TC70	182-317
R	168	R Metal film 22E0 5% 0.2W TC250	107-222
R	169	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	170	R Metal film 3K92 0.1% 0.25w TC25	141-004
R	171	R Metal Film 340E 0.5% 0.4W TC50	141-103

R	172	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	173	R Metal film 22K0 5% 0.2W TC250	107-522
R	174	R Metal film 22E0 5% 0.2W TC250	107-222
R	175	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	176	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	177	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	178	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	179	R Metal film 22K0 5% 0.2W TC250	107-522
R	180	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	181	R Metal film 3K92 0.1% 0.25w TC25	141-004
R	182	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	183	R Metal Film 340E 0.5% 0.4W TC50	141-103
R	184	R Metal film 3K92 0.1% 0.25w TC25	141-004
R	185	R Metal Film 40K2 1% 0.5W TC50	115-402
R	186	R Cermet Trimpot 100E 20% 0.5W TC70	182-317
R	187	R Metal Film 22K1 1% 0.5W TC50	115-221
R	188	R Metal film 22K0 5% 0.2W TC250	107-522
R	189	R Metal film 33K0 5% 0.2W TC250	107-533
R	190	R Metal film 33K0 5% 0.2W TC250	107-533
R	191	R Metal film 33K0 5% 0.2W TC250	107-533
R	192	R Metal film 33K0 5% 0.2W TC250	107-533
R	193	R Metal film 22K0 5% 0.2W TC250	107-522
R	194	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	196	R Metal film 1K00 5% 0.2W TC250	107-410
R	197	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	198	R Carbon Film 4M7 5% 0.2W	106-747
R	199	R Metal film 4K70 5% 0.2W TC250	107-447
R	200	R Metal film 33E0 5% 0.2W TC250	107-233
R	201	R Metal Film 11K5 1% 0.5W TC50	115-115
R	202	R var 2K2 20% 0.5W	182-313
R	203	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	204	R Carbon Film 3M9 5% 0.2W	106-739
R	205	R Metal film 1K80 5% 0.2W TC250	107-418
R	206	R Metal film 33E0 5% 0.2W TC250	107-233
R	207	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	208	R Metal Film 61K9 1% 0.5W TC50	115-619
R	209	R Metal film 33K0 5% 0.2W TC250	107-533
R	210	R Metal Film 4K42 1% 0.5W TC50	114-442
R	211	R Cermet Trimpot 1K 10% 0.5W TC70	182-310
R	212	R Metal film 33K0 5% 0.2W TC250	107-533
R	213	R Metal Film 10K 0.1% 0.4W TC50	141-139
R	214	R Metal film 33K0 5% 0.2W TC250	107-533
R	215	R Metal film 33K0 5% 0.2W TC250	107-533
R	216	R Metal film 33K0 5% 0.2W TC250	107-533
R	217	R Metal film 33K0 5% 0.2W TC250	107-533
R	218	R Metal film 33K0 5% 0.2W TC250	107-533
R	219	R Metal film 22K0 5% 0.2W TC250	107-522
R	220	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	221	R Metal Film 4K99 1% 0.5W TC50	114-499
R	222	R Metal film 1K00 5% 0.2W TC250	107-410
R	223	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	224	R Carbon Film 3M9 5% 0.2W	106-739
R	225	R Metal film 1K80 5% 0.2W TC250	107-418
R	226	R Metal film 33E0 5% 0.2W TC250	107-233

R	227	R var 2K2 20% 0.5W	182-313
R	228	R Metal Film 11K5 1% 0.5W TC50	115-115
R	229	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	230	R Carbon Film 4M7 5% 0.2W	106-747
R	231	R Metal film 4K70 5% 0.2W TC250	107-447
R	232	R Metal film 33E0 5% 0.2W TC250	107-233
R	233	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	234	R Metal Film 61K9 1% 0.5W TC50	115-619
R	235	R Metal film 33K0 5% 0.2W TC250	107-533
R	236	R Metal Film 4K42 1% 0.5W TC50	114-442
R	237	R Cermet Trimpot 1K 10% 0.5W TC70	182-310
R	238	R Metal film 33K0 5% 0.2W TC250	107-533
R	239	R Metal Film 10K 0.1% 0.4W TC50	141-139
R	240	R Metal film 33K0 5% 0.2W TC250	107-533
R	241	R Metal film 10K0 5% 0.2W TC250	107-510
R	242	R Metal film 10K0 5% 0.2W TC250	107-510
R	243	R Metal film 10K0 5% 0.2W TC250	107-510
R	244	R Metal film 10K0 5% 0.2W TC250	107-510
R	245	R Metal film 4K70 5% 0.2W TC250	107-447
R	246	R Metal film 4K70 5% 0.2W TC250	107-447
R	247	R Metal film 4K70 5% 0.2W TC250	107-447
R	248	R Metal film 4K70 5% 0.2W TC250	107-447
R	249	R Metal film 4K70 5% 0.2W TC250	107-447
R	250	R Metal film 4K70 5% 0.2W TC250	107-447
R	251	R Metal film 4K70 5% 0.2W TC250	107-447
R	252	R Metal film 4K70 5% 0.2W TC250	107-447
R	254	R Metal film 33K0 5% 0.2W TC250	107-533
R	255	R Metal film 33K0 5% 0.2W TC250	107-533
R	256	R Metal film 330K 5% 0.2W TC250	107-633
R	257	R Cermet Trimpot 1K 10% 0.5W TC70	182-310
R	258	R Metal Film 9K09 1% 0.5W TC50	114-909
R	259	R Metal Film 499E 0.5% 0.1W TC50	141-159
R	260	R Metal Film 102E 0.5% 0.1W TC50	141-160
R	261	R Cermet Trimpot 1K 10% 0.5W TC70	182-310
R	262	R Metal Film 9K09 1% 0.5W TC50	114-909
R	263	R Metal Film 499E 0.5% 0.1W TC50	141-159
R	264	R Metal Film 102E 0.5% 0.1W TC50	141-160
R	265	R Metal film 1K00 5% 0.2W TC250	107-410
R	266	R Metal film 100E 5% 0.2W TC250	107-310
R	267	R Metal film 100E 5% 0.2W TC250	107-310

CABLES

W	3	26 Leads Flatcable W. Connector	617-847

MISCELLANEOUS

Slot Screw M1.6X4	002-044
Slot Screw M1.6X4	005-044
Stay Bolt Issue 2	039-751
Stay Bolt	039-752
Washer |1.7/4X0.3	042-004
Female Plug	805-718
Wire Wrap Terminal	805-727

14 Pin Dil Socket	816-131
24 Pin Dil Socket	816-134
18 Pin DIL Socket	816-183
Board Extractor	857-017
Common Parts for Analog Board	901-819
Sk+rm Plade	952-859
Audio Generator Analog Part PCB	971-201

Digital Board (901-499)

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 solid AL 10u 20% 16V	265-008
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 solid AL 10u 20% 16V	265-008
C 47	C Ceramic 39p0 2% 100V NP0	213-232
C 48	C Ceramic 180p 2% 100V N750	213-228
C 49	C solid AL 10u 20% 16V	265-008

DIODES

CR 1	Diode zener BZX79-C3V6 0.4W	350-626
CR 2	Diode Schottky BAT41 S 150V 250mA	350-061

CHOKES

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

TRANSISTORS

Q 1	Transistor 2N3904 pnp	360-064
Q 2	Transistor BC327-25 SI PNP 45V 1A 800mW TO-92	360-224

INTEGRATED DIGITAL CIRCUITS

QD 7	IC TC5565PL-15 8KX8 CMOS RAM	364-612
QD 8	IC TC5565PL-15 8KX8 CMOS RAM	364-612
QD 11	IC HEF4008BP 4-bit binary full adder	364-411
QD 12	IC HEF4008BP 4-bit binary full adder	364-411
QD 13	IC HEF4008BP 4-bit binary full adder	364-411
QD 14	IC HEF4008BP 4-bit binary full adder	364-411
QD 15	IC HEF4585 4-bit comparator	364-504
QD 16	IC HEF4585 4-bit comparator	364-504
QD 17	IC HEF4585 4-bit comparator	364-504
QD 18	IC HEF4585 4-bit comparator	364-504
QD 19	IC HEF4585 4-bit comparator	364-504
QD 20	IC HEF4585 4-bit comparator	364-504
QD 21	IC HEF4585 4-bit comparator	364-504
QD 22	IC HEF4585 4-bit comparator	364-504
QD 23	IC 74HC273 Octal D-FF.	364-574
QD 24	IC 74HC273 Octal D-FF.	364-574
QD 25	IC HEF4724BP 8-bit adessable latch	364-412
QD 26	IC HEF4724BP 8-bit adessable latch	364-412
QD 27	IC HEF4724BP 8-bit adessable latch	364-412
QD 28	IC HEF4724BP 8-bit adessable latch	364-412
QD 29	IC HEF4724BP 8-bit adessable latch	364-412
QD 30	IC HEF4724BP 8-bit adessable latch	364-412
QD 31	IC HEF4724BP 8-bit adessable latch	364-412
QD 32	IC HEF4724BP 8-bit adessable latch	364-412
QD 33	IC HEF4724BP 8-bit adessable latch	364-412
QD 34	IC HEF40244 Octal buffer with 3-state	364-497
QD 35	IC HEF40244 Octal buffer with 3-state	364-497
QD 36	IC 74LS244 oct buffer	364-321
QD 37	IC 74LS244 oct buffer	364-321
QD 38	IC HEF40244 Octal buffer with 3-state	364-497
QD 39	IC HEF40244 Octal buffer with 3-state	364-497
QD 40	IC HEF40373BP Octal latch 3-state	364-572
QD 41	IC HEF40373BP Octal latch 3-state	364-572
QD 43	IC HEF4013BP Dual D-type Flip-Flop	364-222
QD 44	IC HEF4013BP Dual D-type Flip-Flop	364-222
QD 45	IC HEF4013BP Dual D-type Flip-Flop	364-222
QD 46	IC HEF40240 3-state buffer	364-573

QD 47	IC HEF40240 3-state buffer	364-573
QD 48	IC HEF40240 3-state buffer	364-573
QD 49	IC HEF40240 3-state buffer	364-573
QD 51	IC 4049 hex inv buffer	364-224
QD 52	IC 74LS04 hex inverters	364-219
QD 53	IC 74LS244 oct buffer	364-321
QD 55	IC 74LS244 oct buffer	364-321
QD 56	IC SN74LS245 Octal bus transceiver	364-332
QD 57	IC SN74LS245 Octal bus transceiver	364-332
QD 58	RE201 901-499 QD58 Select PROM	368-238
QD 59	IC CD74HCT138 3-to-8 line dec.	364-570
QD 60	IC CD74HCT138 3-to-8 line dec.	364-570
QD 61	IC SN74LS03 Quad 2-input Nand gate open collector	364-329
QD 62	IC HEF40106HEX Inverting Schmitt trigger	364-390
QD 63	IC HEF4073BP Tripple 3-input AND gate	364-385
QD 65	IC 74LS08 quad AND gate	364-270
QD 66	IC HEF4075BP Tripple 3-input OR gate	364-362
QD 67	IC HEF4071BP Quad 2-input OR gate	364-263
QD 68	IC 74LS32 quad OR gate	364-301
QD 69	IC HEF4071BP Quad 2-input OR gate	364-263

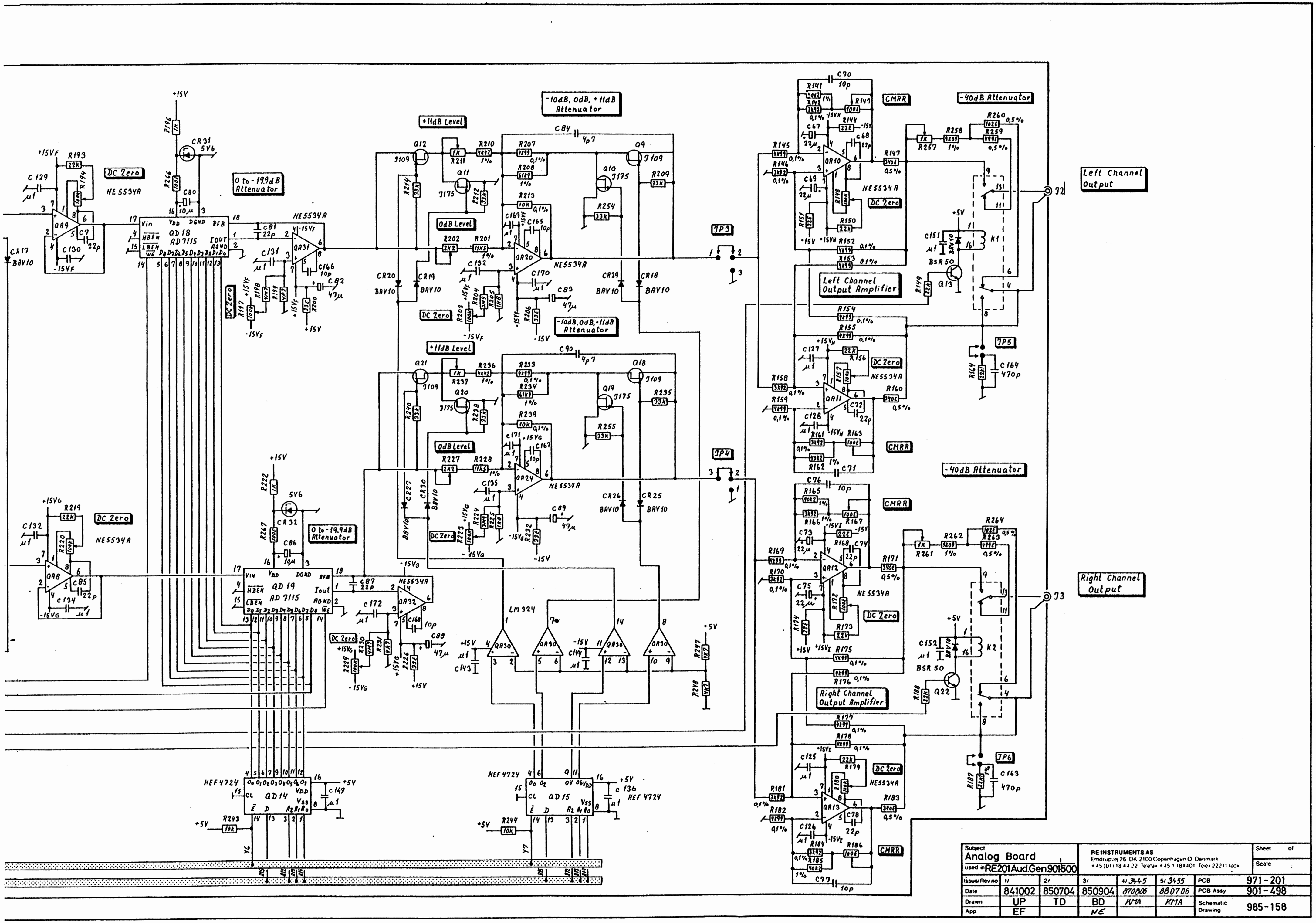
RESISTORS

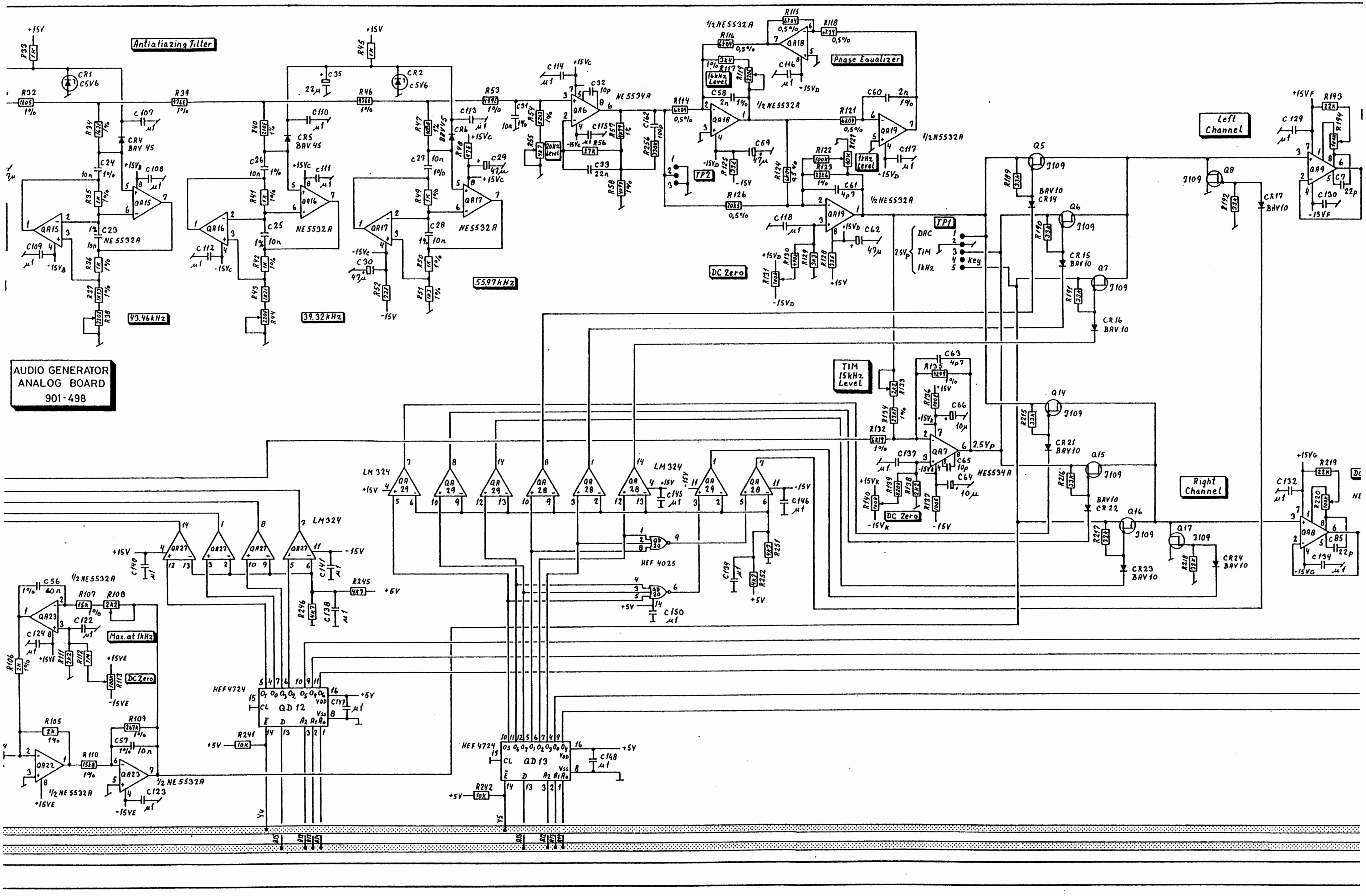
R 1	R thick film Sil 8x10K	146-003
R 2	R thick film Sil 8x10K	146-003
R 4	R thick film Sil 8x10K	146-003
R 5	R thick film Sil 8x10K	146-003
R 6	R thick film Sil 8x10K	146-003
R 7	R thick film Sil 8x10K	146-003
R 8	R thick film Sil 8x10K	146-003
R 9	R thick film Sil 8x10K	146-003
R 10	R thick film Sil 8x10K	146-003
R 11	R thick film Sil 8x10K	146-003
R 13	R Metal film 1K00 5% 0.2W TC250	107-410
R 14	R Metal film 270E 5% 0.2W TC250	107-327
R 15	R Metal film 3K30 5% 0.2W TC250	107-433
R 16	R Metal film 22K0 5% 0.2W TC250	107-522
R 17	R Metal film 22K0 5% 0.2W TC250	107-522
R 18	R thick film Sil 8x10K	146-003
R 19	R thick film Sil 8x10K	146-003
R 20	R Metal film 1K00 5% 0.2W TC250	107-410
R 21	R Metal film 1K00 5% 0.2W TC250	107-410
R 22	R Metal film 150E 5% 0.2W TC250	107-315

MISCELLANEOUS

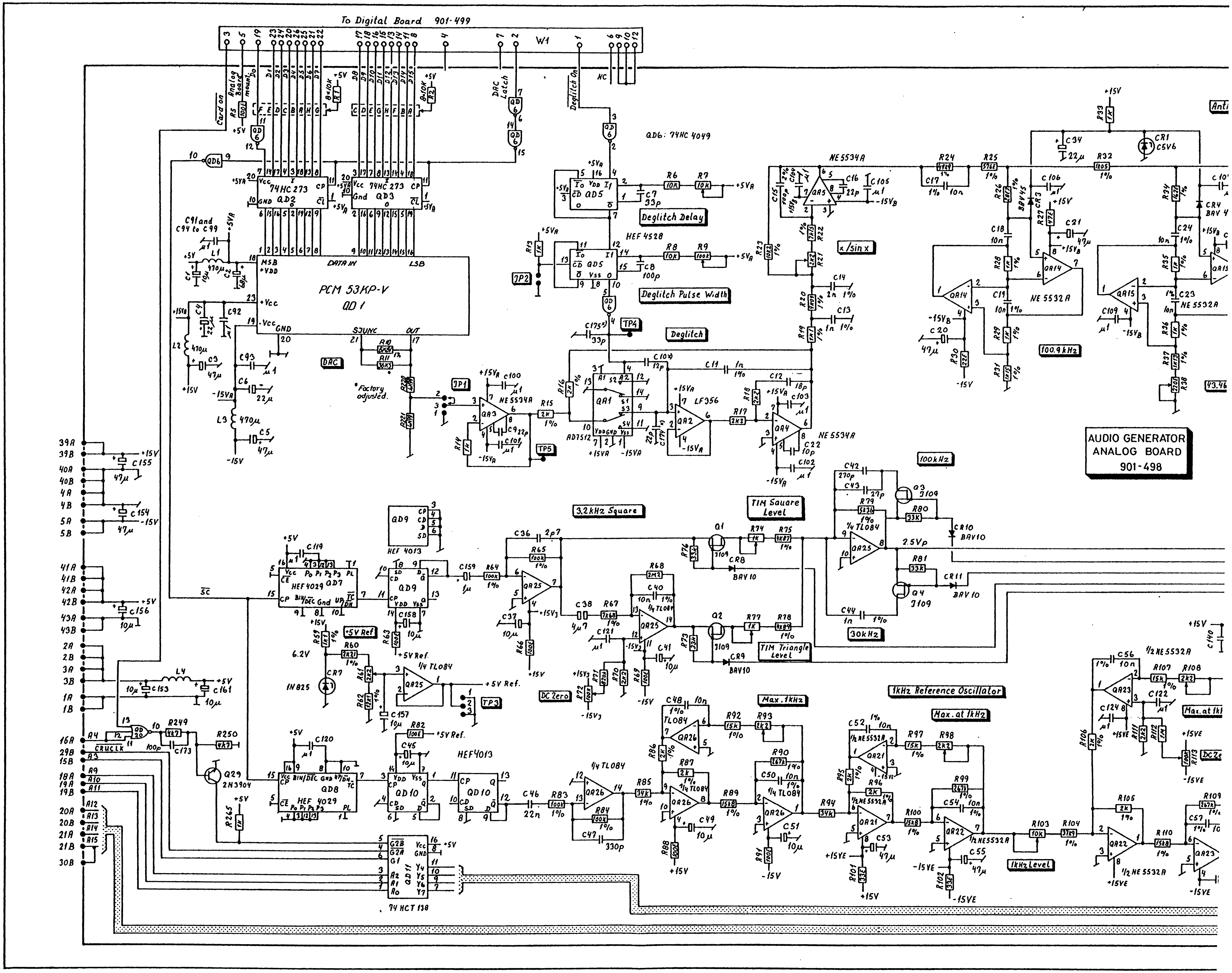
	tubular rivet 02.5x0.25x7	060-270
	Female Plug	805-718
	Wire Wrap Terminal	805-727
	DIN 41651 26-POL PCB Mounted	805-918
	20 Pin DIL Socket	816-184
	28 Pin DIL Socket	816-251
	Solder Terminal 0.1 O2	823-303
	Board Extractor	857-017

	Conducter Rail C1	931-036
	Conducter Rail C1	931-036
	Audio Generator Digital Part PCB	971-202
QD 1*	RE201 Audio Generator QD1 Ver. 1.0	368-243
QD 2*	RE201 Audio Generator QD2 Ver. 1.0	368-242
QD 3*	RE201 Audio Generator QD3 Ver. 1.0	368-241
QD 4*	RE201 Audio Generator QD4 Ver. 1.0	368-240
QD 5*	Audio Source Prom QD5 REV 1.5 F. FSK-Mod	368-349

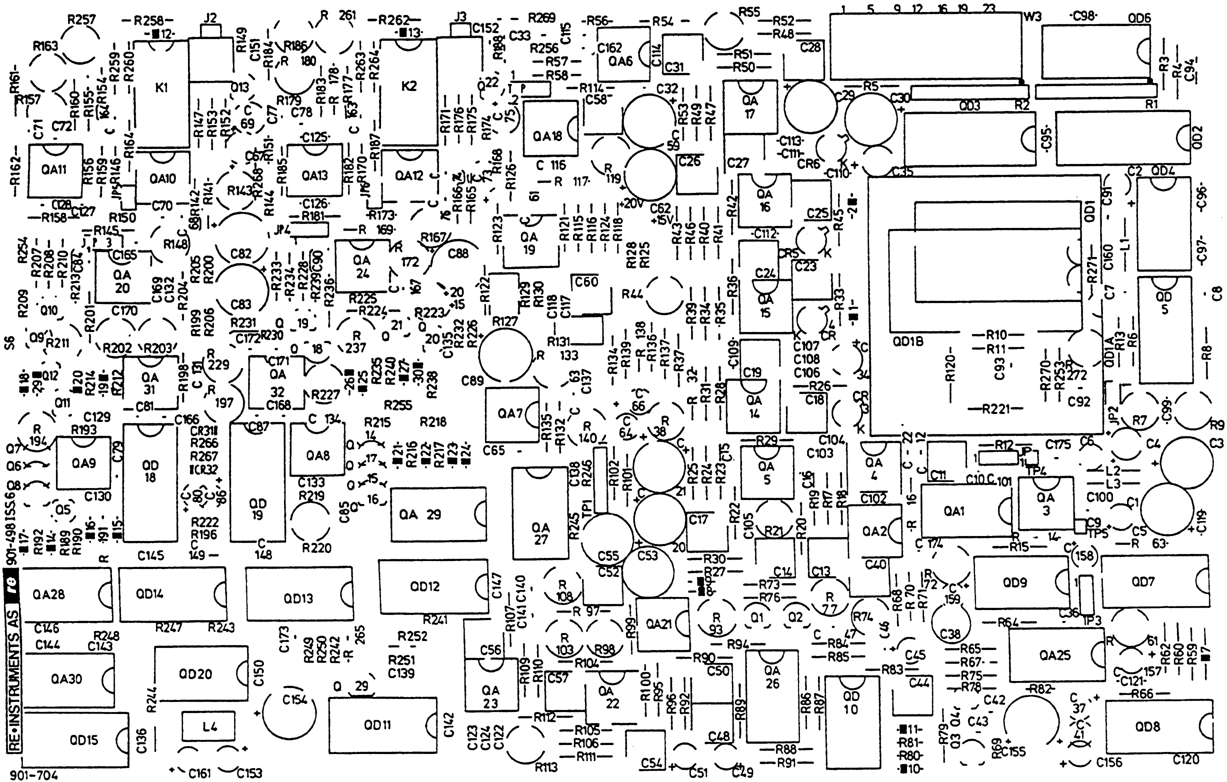

DC Zero
NE5534A
0 to -19.9dB Attenuator
AD7115
+11dB Level
-10dB, 0dB, +11dB Attenuator
0dB Level
JP3
JP4
JP5
JP6
CMRR
-40dB Attenuator
Left Channel Output
Left Channel Output Amplifier
Right Channel Output
Right Channel Output Amplifier
LM324
HEF4724
Subject
Analog Board
used in RE201 Aud.Gen. 901500
RE INSTRUMENTS AS
Emdrupvej 26 DK 2100 Copenhagen O Denmark
Issue/Rev no 1/ 2/ 3/ 4/3445 5/3455
Date 841002 850704 850904 870808 880706
Drawn UP TD BD KMA KMA
App EF NE
PCB 971-201
PCB Assy 901-498
Schematic Drawing 985-158



AUDIO GENERATOR
ANALOG BOARD
901-498
Antialiazing Filter
43.46kHz
39.32kHz
55.97kHz
Phase Equalizer
1kHz Level
1kHz Level
DC Zero
TP1
TP2
DAC
TIM
1kHz
Key
TIM 15kHz Level
Left Channel
Right Channel
Max. at 1kHz
DC Zero
DC Zero
LM324
LM324
LM324
HEF 4025
HEF 4724
HEF 4724
QD 12
QD 13
NE5532A
NE5534A



AUDIO GENERATOR
ANALOG BOARD
901-498
To Digital Board 901-499
W1
PCM 53KP-V
QD 1
74HC 273
QD2
QD3
MSB
DATA IN
LSB
DAC
Factory adjusted.
QD6: 74HC 4049
HEF 4528
Deglitch Delay
Deglitch Pulse Width
Deglitch
Deglitch On
DAC Latch
Card on
NC
AD7512
LF356
NE 5534A
x/sin x
NE 5532A
100.9 kHz
43.46
3.2 kHz Square
HEF 4029
QD7
QD8
QD9
HEF 4013
QD10
HEF4013
+5V Ref
DC Zero
TIM Square Level
TIM Triangle Level
100kHz
30kHz
1kHz Reference Oscillator
Max. 1kHz
Max. at 1kHz
1kHz Level
74 HCT 138
QD 11
1/4 TL084
1/2 NE 5532A
1N825
2N3904
Q29
CRUCLK
JP1
JP2
JP3
TP3
TP4
TP5


RE•INSTRUMENTS AS
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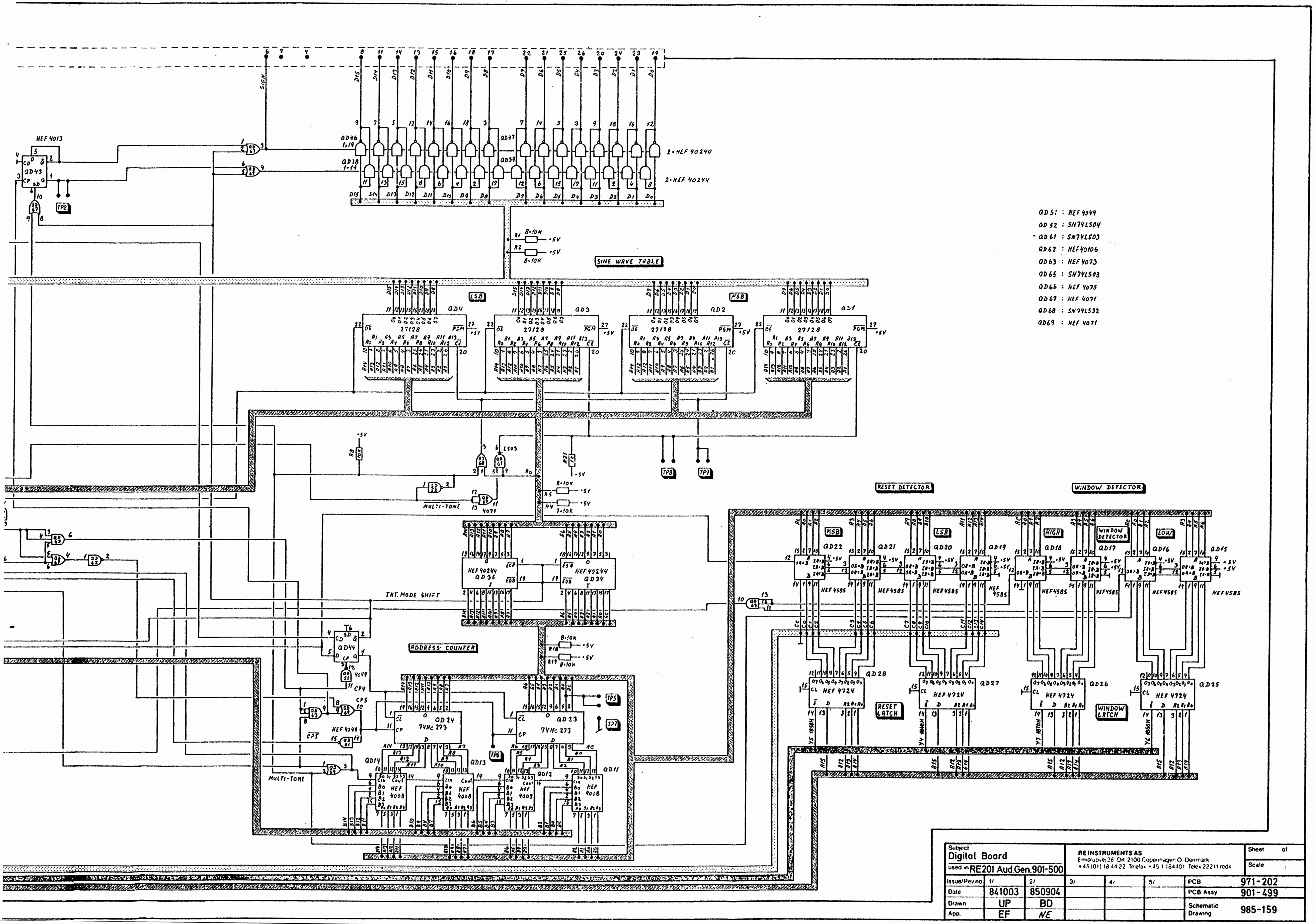
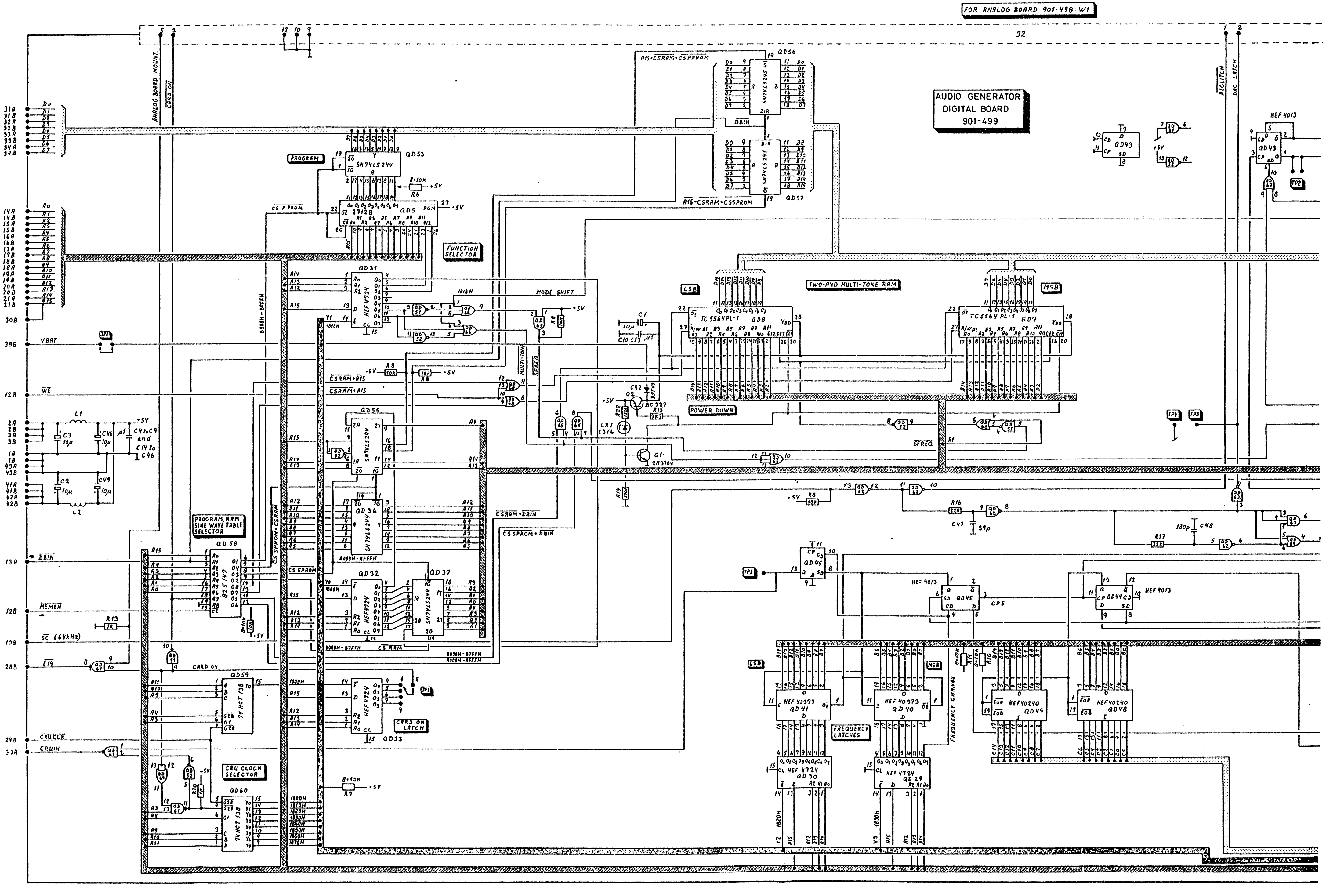
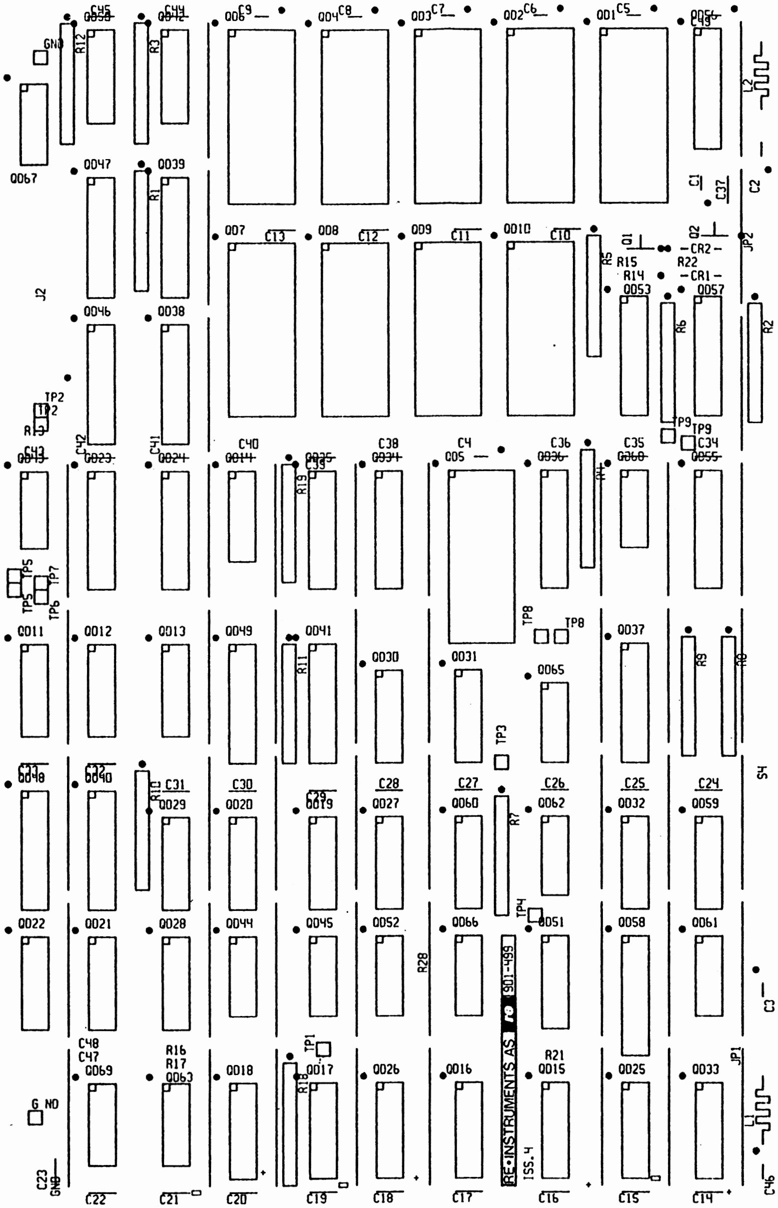
901-498 ISS.6
901-704

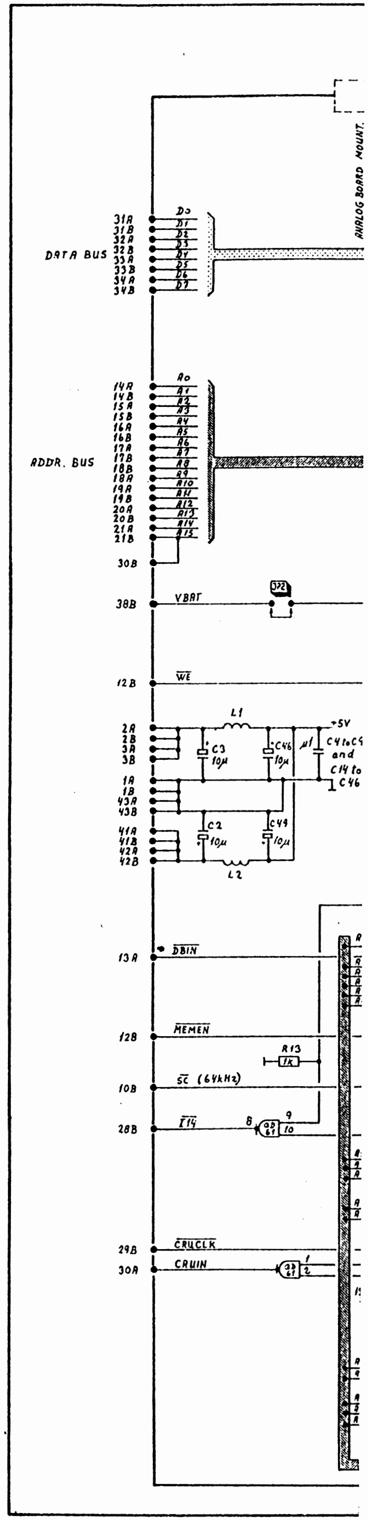


HEF 4013
QD43
TP2
SIGN
QD46
QD38
QD47
QD39
2×HEF 40240
2×HEF 40244
8×10K
+5V
SINE WAVE TABLE
LSB
MSB
QD4
QD3
QD2
QD1
27128
QD51 : HEF 4049
QD52 : SN74LS04
QD61 : SN74LS03
QD62 : HEF40106
QD63 : HEF 4073
QD65 : SN74LS08
QD66 : HEF 4075
QD67 : HEF 4071
QD68 : SN74LS32
QD69 : HEF 4071
TP8
TP7
MULTI-TONE
4071
7×10K
RESET DETECTOR
WINDOW DETECTOR
HEF 40244
QD35
QD34
INT. MODE SHIFT
HIGH
LOW
QD22
QD21
QD20
QD19
QD18
QD17
QD16
QD15
HEF 4585
QD44
ADDRESS COUNTER
HEF 4049
QD24
QD23
74HC 273
TP5
TP6
QD14
QD13
QD12
QD11
HEF 4008
QD28
QD27
QD26
QD25
HEF 4724
RESET LATCH
WINDOW LATCH
Subject
Digital Board
used in RE201 Aud.Gen. 901-500
RE INSTRUMENTS AS
Emdrupvej 26 DK 2100 Copenhagen O Denmark
+45 (01) 18 44 22 Telefax +45 1 184401 Telex 22211 redk
Sheet of
Scale
Issue/Rev no 1/ 2/ 3/ 4/ 5/
Date 841003 850904
Drawn UP BD
App. EF NE
PCB 971-202
PCB Assy 901-499
Schematic Drawing 985-159



FOR ANALOG BOARD 901-498-W1
AUDIO GENERATOR
DIGITAL BOARD
901-499
J2
ANALOG BOARD MOUNT.
CARD ON
PROGRAM
FUNCTION SELECTOR
MODE SHIFT
TWO-AND MULTI-TONE RAM
LSB
MSB
POWER DOWN
PROGRAM, RAM, SINE WAVE TABLE SELECTOR
CARD ON LATCH
CRU CLOCK SELECTOR
FREQUENCY LATCHES
FREQUENCY CHANGE
DEGLITCH
DAC LATCH
SN74LS244
27128
HEF4724
TC5564PL-1
SN74LS245
HEF4013
HEF40373
HEF40240
74HCT138
VBAT
WE
DBIN
MEMEN
SC (64kHz)
CRUCLK
CRUIN
CPS
SFREQ


RE•INSTRUMENTS AS
901-499
ISS.4
J1B
J1A


ANALOG BOARD MOUNT.
DATA BUS
ADDR. BUS
VBAT
WE
+5V
DBIN
MEMEN
SC (64kHz)
CRUCLK
CRUIN

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LIST OF FIGURES

1 GENERAL INFORMATION

This manual provides technical information on the RE201 Audio Generator Option. For operation of this option, reference is made to the description of the Audio Generator in the RE201 Operation Manual.

1.1 Introduction

The RE201 Dual Channel Audio Analyzer provides the design and test engineer with powerful facilities for carrying out complicated audio measurements. Distortion measurements, such as

* Intermodulation Distortion - IM
* Difference Frequency Distortion - DFIM
* Transient Intermodulation Distortion - TIM

have mainly been performed in the laboratory on a sample basis, as the test equipment has been complicated to use and expensive. Now, these intricate measurements may easily be performed by operators using the RE201 with the Audio Generator Option (901-705) installed.

The Audio Generator Option offers a wide variety of test signals:

* Single-tone sine wave from 1 Hz to 25 kHz with 1 Hz resolution. This can be used to measure e.g. frequency response and Total Harmonic Distortion (THD).
* Two-tone sine waves suitable for use during Intermodulation and Difference Frequency Distortion measurements.
* TIM signal consisting of a band limited 3.2 kHz square wave and a 15 kHz sine wave. The square wave may be substituted by a triangle wave to indicate slew rate limitations.
* Multi-tone signal consisting of up to 8 single frequency components, the amplitude and frequency of which are freely selectable by the operator. This signal may be used for fast frequency response measurements, e.g. on filters, amplifiers and tape recorders.

The following sections give information about the principles of operation and a description of the circuit blocks. For operating instructions refer to the RE201 Operation Manual (983-298).

1.2 Installation

When unpacking the option boards, the packing material should be visually inspected for physical damage. If it is 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.

The two boards of the Audio Generator Option must be mounted in the Analog Section of the RE201. It is only necessary to remove the top plate of the RE201 and the clamp bar securing the PCB's in the print magazine to get access to this area.

* Remove the screws securing the top plate (refer to fig. 1.1) using a Pozidriv No. 1 screwdriver.

* Dismount the top plate by sliding it backwards approx. 2 cm until it disengages along the front and rear edges. The plate may then be lifted and removed.

* Remove the clamp bar securing the PCB's (refer to fig. 1.2).

The print magazine comprises six slots. No. 0 is the first slot on the left (viewed from the front of the RE201), and No. 5 is the last slot on the right.

If the Static CPU (901-411) is not positioned in slot No. 5 it must be moved to this position. The flat cable connected to the Static CPU has to be dismounted before the Audio Generator Option is installed.

Insert the Digital Board (901-499) in slot No. 4 and the Analog Board (901-704) in slot No. 3 and connect the two boards by means of the ribbon cable.

Release the two coaxial cables from the clip on the left wall of the Analog PCB Compartment and connect the two cables to the two coaxial connectors placed on the top edge of the Analog Board (901-498). Due to different cable lengths it is not possible to interchange the cables.

Secure the coaxial connectors by using a 6 mm (15/64 in.) torque wrench adjusted to 0.7 Nm (100 oz. in.) max. torque.

*** Note ***

The connectors may be damaged if this torque is exceeded.

Remount the flat cable to the Static CPU.

Fig. 1.2 shows the RE201 Analog Section with the Audio Generator Option properly installed (note that the 901-498 here is substituted by the Analog Board 901-704).

Following reassembly, on switch on the RE201 should automatically recognize that the Audio Generator has been installed. Check

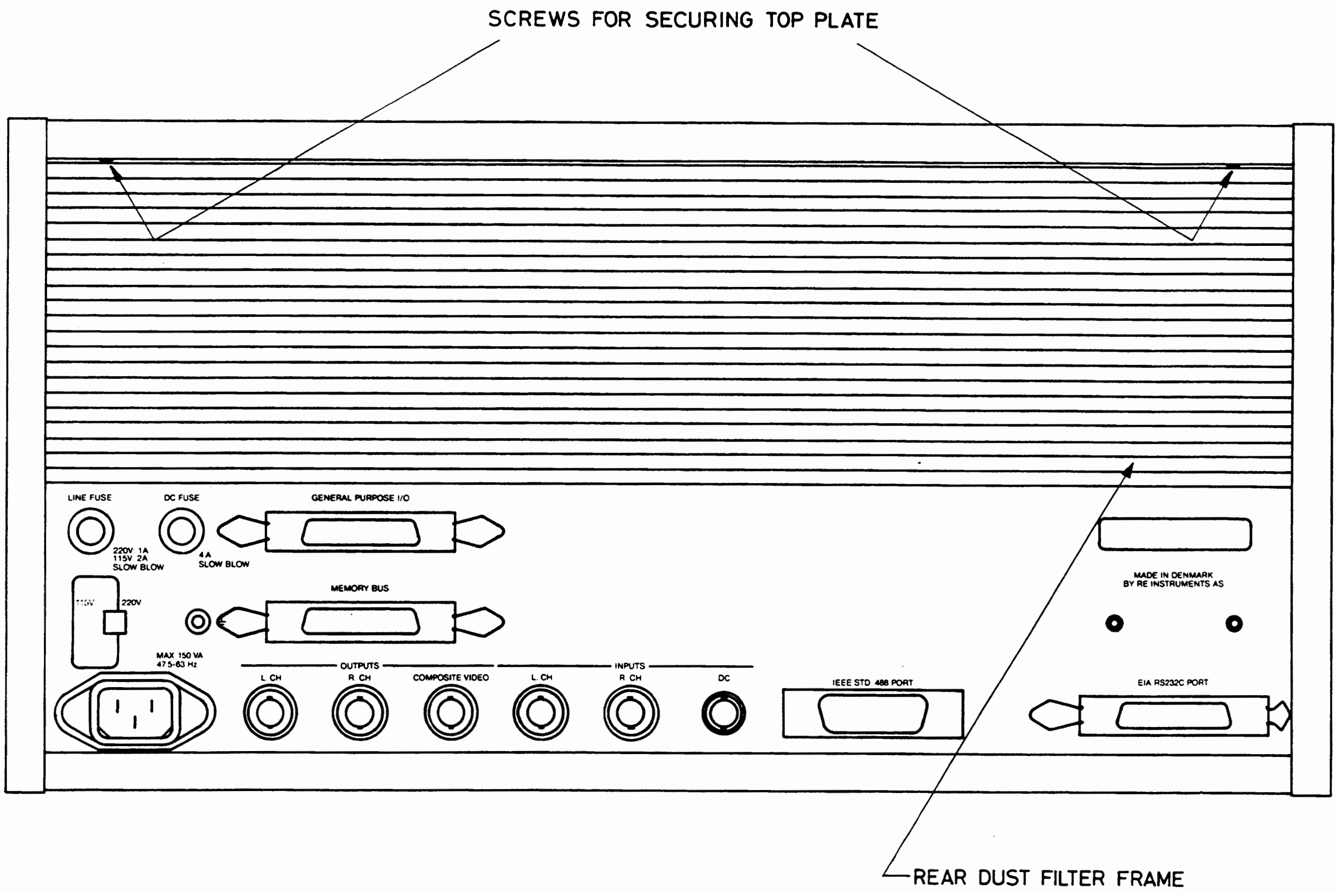


Fig. 1.1 - Top Plate Screws

following the selftest routine that the RE201 as part of "OPTIONS INSTALLED" displays:

AUDIO GENERATOR X.X

This verifies that the Audio Generator Option has been accepted by the system and is ready for use. X.X is the software revision installed on the Digital Board of the Audio Generator.

1.3 Equipment and Accessories

Description	Code No.
Audio Generator Option for the RE201 (configured of Analog Board 901-704 and Digital Board 901-499)	901-705
Manual for the Audio Generator Option for the RE201 (24.2 dBu, 20 Ohm version) operating and technical sections	983-284

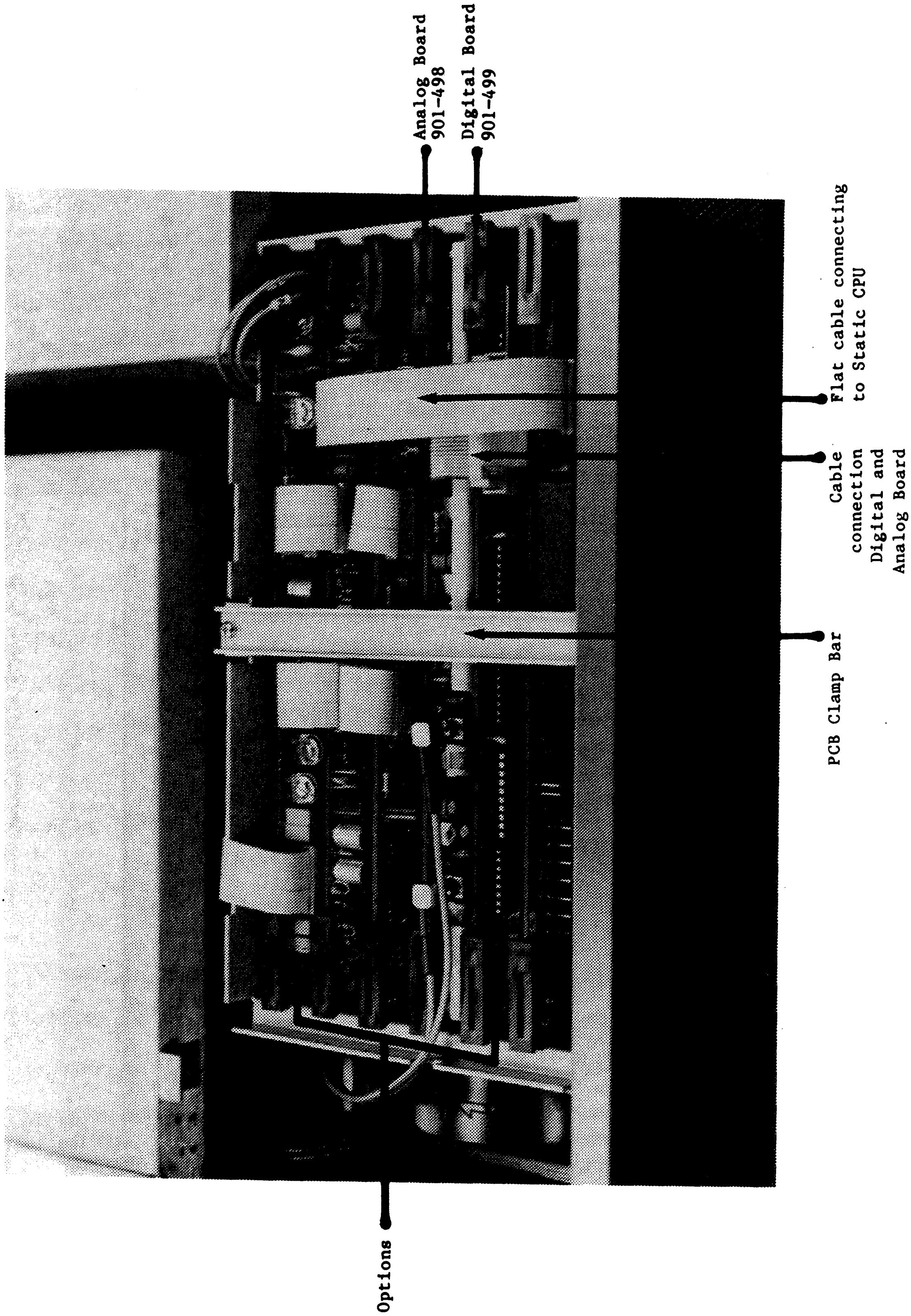


Fig. 1.2 - Audio Generator Option Installed

1.4 Specifications

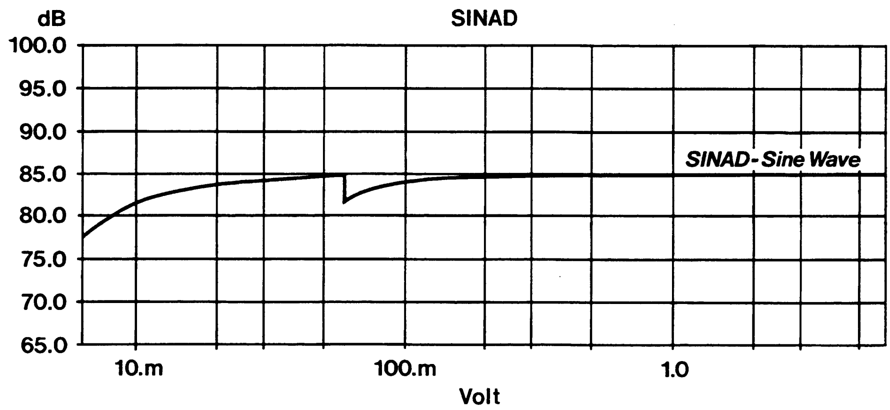
General

Signal modes	Sine wave, 1 kHz reference tone, SMPTE/DIN intermodulation, Difference Frequency Distortion, Multi-tone, TIM test signals, OFF
Frequency accuracy	+/- 20 ppm
Output level range	1.6 mV peak to 17.70 V peak (-56.7 dBu to 24.2 dBu) open circuit
Output level resolution	0.1 dB
Flatness (1 kHz reference)	+/- 0.1 dB
Level accuracy	+/- 0.1 dB + flatness
Output circuit	2 balanced floating outputs, transformerless, short circuit protected
Output impedance	20 Ohms

Signal Modes

Sine Wave

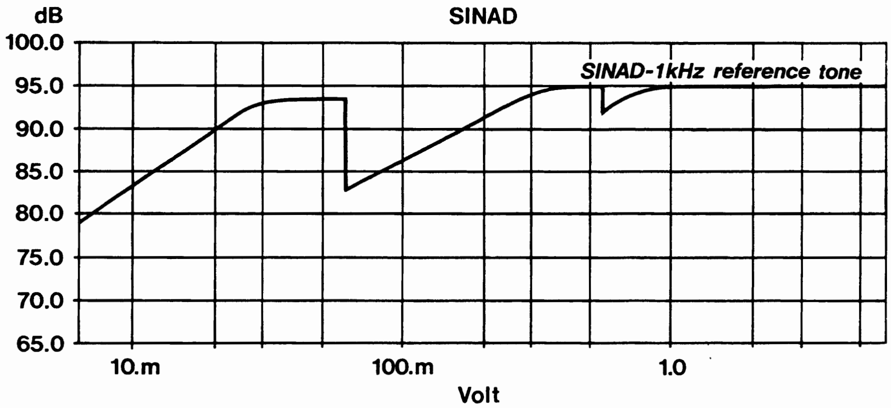
Frequency range	1 Hz to 25 kHz
Frequency resolution	1 Hz
Total Harmonic Distortion	< -88 dB, typical -91 dB, 1 Hz to 1 kHz
	< -87 dB, typical -90 dB, 1 kHz to 9 kHz
	< -90 dB, typical -92 dB, 9 kHz to 25 kHz
Distortion and Noise (SINAD)	< -82 dB, typical -85 dB, 1 Hz to 4 kHz
(125 kHz bandwidth)	< -81 dB, typical -84 dB, 4 kHz to 12.5 kHz
	< -83 dB, typical -86 dB, 12.5 kHz to 25 kHz



SINAD as a Function of Level - Sine Wave (Typical Values)

1 kHz Reference Tone

Total Harmonic Distortion	< -97 dB (0.0015 %)
Distortion and Noise (SINAD) (22.4 kHz bandwidth)	< -95 dB (0.002 %)



SINAD as a Function of Level - 1 kHz Reference Tone (Typical Values)

SMPTE/DIN Intermodulation Signal

Level ratio	4:1
Frequency range	10 Hz to 25 kHz
Frequency resolution	10 Hz
SMPTE/DIN intermodulation	< -76 dB (0.02 %) 300 Hz/7 kHz, 2nd to 4th order products included

DIN Difference Frequency Distortion Signal

Level ratio	1:1
Frequency range	10 Hz to 25 kHz
Frequency resolution	10 Hz
Difference frequency distortion	< -86 dB (0.005 %), 14 kHz/15 kHz, 2nd to 6th order products individually

Transient Intermodulation Signal

Description	3.2 kHz square or triangle wave plus 15 kHz sine wave, peak level ratio 4:1
Cut-off frequency	30 kHz or 100 kHz selectable, (-3 dB)
Transient intermodulation	< -75 dB (0.02 %)

Multi-tone

Maximum number of tones	8 simultaneously
Relative level	1 to 999

Frequency range	10 Hz to 25 kHz
Frequency resolution	10 Hz

OFF

Description	0 V, 20 Ohms output impedance

Manual Sweep

Functions controlled	Level and frequency
Level step	0.1 to 79.9 dB, 0.1 dB resolution
Frequency step	Linear: 1 Hz to 24999 Hz, 1 Hz resolution Logarithmic: 1/3 octave, 1/1 octave or 0.01 decade to 1.99 decade, 0.01 decade resolution

The environmental requirements for the Audio Generator are identical to those of the RE201 Basic Unit.

2 PRINCIPLES OF OPERATION

2.1 Principles of Operation

This section describes the basic function of the Audio Generator Option. For a more detailed description of the electrical circuits refer to section 3 in this manual.

Whenever a reference is given to specific circuit blocks refer to fig. 2.1 - Audio Generator, Block Diagram. Further details are given in section 3 (fig. 3.1 - Digital Board, Block Diagram and fig. 3.2 - Analog Board, Block Diagram).

The Audio Generator Option is composed of 2 printed circuit boards (fig. 2.1):

- A Digital Board (901-499) mainly comprising:

    * A Programmable Read Only Memory (PROM) containing 32,000 samples of a 1 Hz sine wave sampled with a 64 kHz sample rate. This Sine Table thus contains half a period of the 1 Hz signal.

    * An Address Counter which calculates the address of the next sample to be read.

    * A RAM - used for storing of samples. This is used to generate all types of complex signals containing more than one spectral component.

    * A Read Only Memory used to store the program code used by the static computer in the Analog Section to operate the Audio Generator Option.

- An Analog Board (901-704) comprising:

    * A 3.2 kHz square/triangle wave generator for TIM signals.

    * A 1 kHz very pure reference signal.

    * A 16 bit Digital-to-Analog Converter (DAC) which converts the digital samples from the digital part of the Audio Generator to an analog staircase signal.

    * A 25 kHz low-pass filter which removes high frequency components from the staircase signal.

    * Two input selectors used to select signal sources.

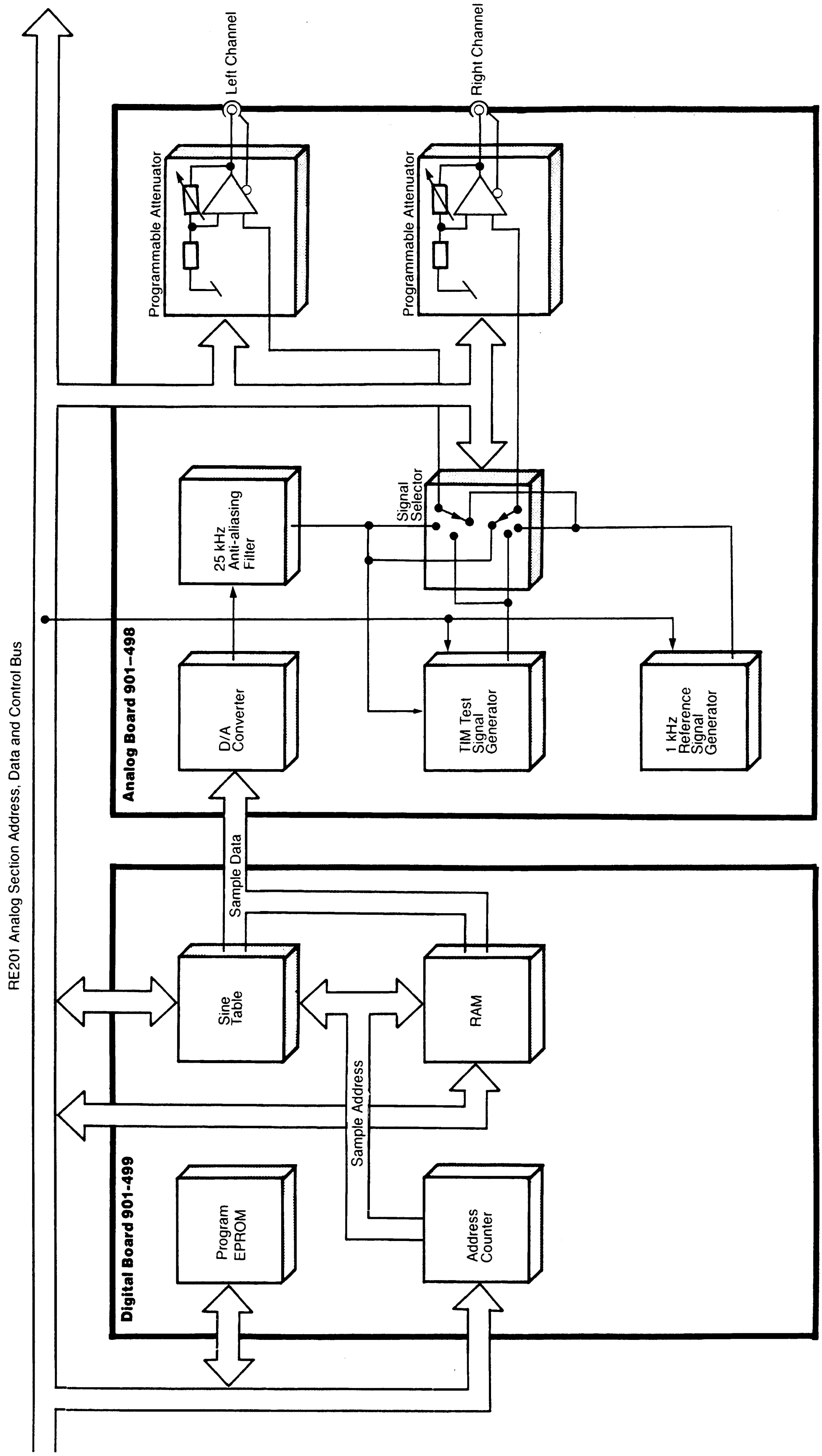


Fig. 2.1 - Audio Generator Block Diagram

* Two attenuators with buffers which allow the output level to be varied between 1.6 mV peak and 17.70 V peak in 0.1 dB steps.

Generating a Single Sine Wave

A single sine wave is generated by reading out samples from the Sine Table to the D/A converter.

The sampling (or Read-Out) frequency is 64 kHz +/- 20 ppm. Thus, if the address from the address counter is changed by one between each sample, i.e. if each sample in the Sine Table is used consecutively, thus the frequency of the sine wave at the output of the 25 kHz filter is 1 Hz, as it will take half a second to run through the Sine Table (a half period). Due to the symmetry of the sine wave the samples of the negative half period can be generated simply by negating the numbers from the positive half period.

To change the frequency only requires the address increment to be changed. Thus, if the address increment is n, it will take 1/2n seconds to run through a half period, and consequently the frequency will be n Hz. In this way it is possible to generate signals with frequencies in the interval 1 Hz to 25 kHz without changing the sampling frequency. 25 kHz is chosen as the upper limit to ease the requirements of the 25 kHz antialiasing filter, which, in order to ensure a signal free of aliased frequency components, has to reject the stop-band (39 kHz and up) by more than 90 dB.

Aliasing occurs when the sampling theorem is not obeyed. The spectrum of a wave form sampled at sampling frequency fs is the original spectrum repeated at fs Hz frequency interval (theoretically, ad infinitum if the sampling function is a delta function). Thus, if the original spectrum contains a frequency component above fs/2 then a corresponding component below fs/2 will be found in the sampled signal. This so called aliased frequency component will interfere with the original low frequency spectrum and may cause measurement errors. It is therefore very important that the antialiasing filter effectively removes all frequency components which may cause aliasing problems, i.e. from 39 kHz and up when the 25 kHz bandwidth is used.

Changing Frequency

As the Audio Generator Option is based on digital synthesis it is capable of changing a frequency instantaneously. In many test situations this will cause transients which will have to decay before measurements may commence. The transients may be minimized if the frequency is allowed to change only where derivatives of the time function are minimum. This will be obtained if the frequency is changed when the current time function (sine wave) is a maximum or a minimum.

For this purpose a so called 'window detector' is incorporated on the Digital Board. This unit is programmable and ensures that the frequency (i.e. size of address counter increment) is changed when the value of the samples read from the Sine Table is close to maximum (+1 or -1). This happens when the address is close to 16,000. Refer to fig. 2.2.

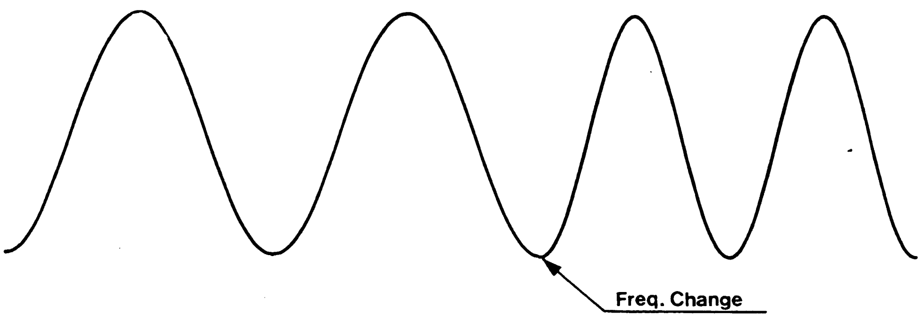


Fig. 2.2 - Change of Frequency

It can be shown that for some frequencies the address 16,000, which corresponds to the exact maximum, is never used (e.g. 6,400 Hz). Thus, the window detector is programmed to enable frequency changes in an interval around address 16,000. The size of the interval is frequency dependent.

Multi-tones

In the RE201 multi-tones are signals configured of more than one frequency component. This can be either two-tone signals for IM or DFIM test purposes or signals comprising up to 8 sine waves used for e.g. frequency response testing. A multi-tone is defined by

* Amplitude of resulting signal (RMS, PEAK, dBm)
* Relative amplitude of individual components (0 - 999)
* Frequency of individual components (resolution 10 Hz)

The information about a multi-tone is used by the Static CPU to calculate samples of the composite signal. This calculation is performed by using the numbers in the Sine Table and the values are stored in the RAM memory. The number of calculated samples depends on the required frequency resolution as follows:

10 Hz resolution	6,400 samples
100 Hz resolution	640 samples
1000 Hz resolution	64 samples

As a consequence of this it takes the Static CPU 2.4 secs. to calculate a multi-tone signal with 8 components and 10 Hz resolution, whereas it only takes 0.1 sec. to set up a multi-tone signal with 8 components and 1 kHz resolution. The CPU calculates the samples of the multi-tone so that the plus-peak values of the individual frequency components are added in the first sample in the multi-tone table. Hereby the peak value of the multi-tone will always be equal to the sum of the peak values of the individual frequency components.

TIM Signal

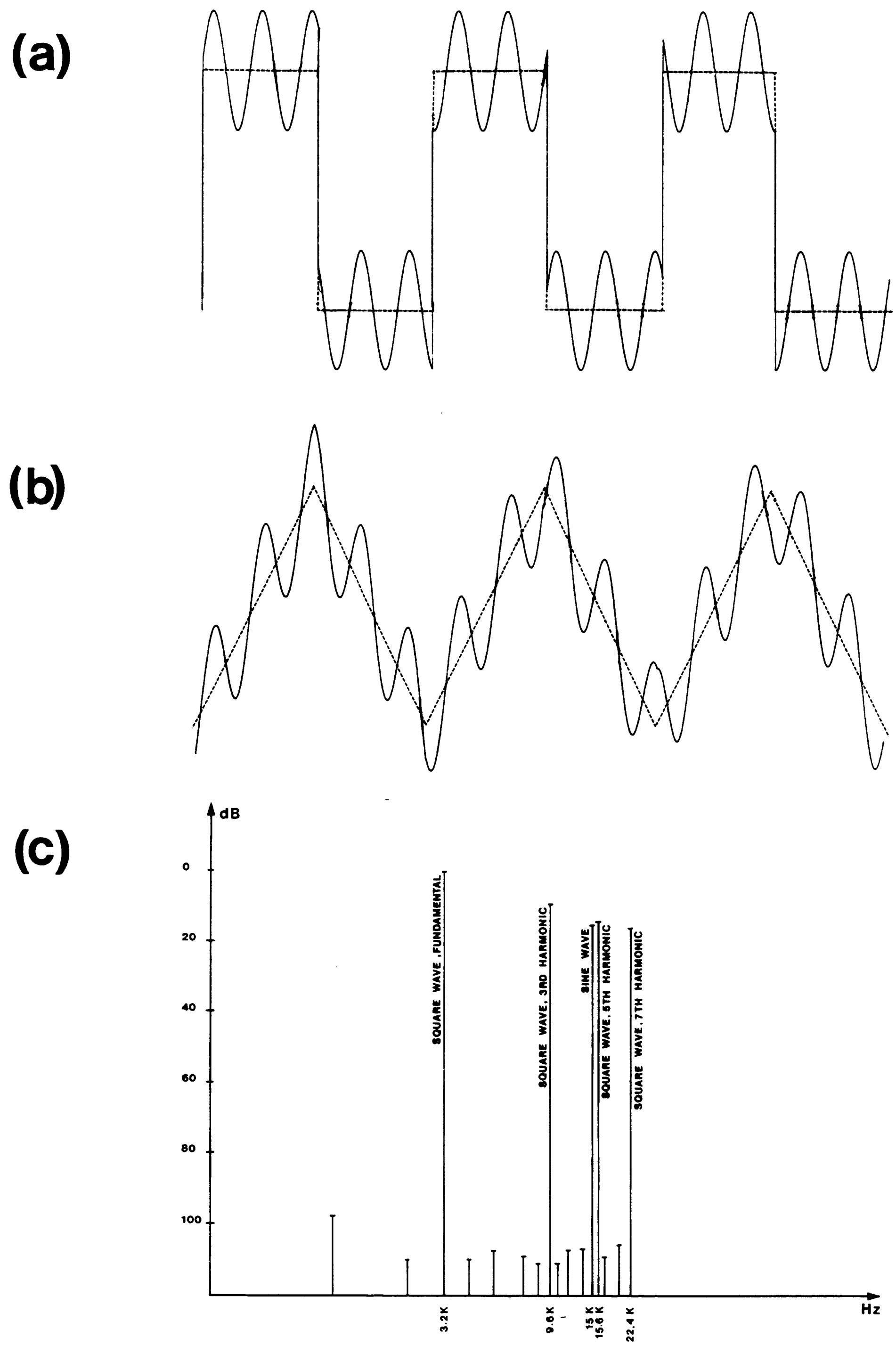
The TIM test signal is generated by adding a 3.2 kHz square wave and a 15 kHz sine wave. The square wave is generated by simple division of the 64 kHz main clock, and the 15 kHz is generated using the D/A converter. A special circuit integrates the square wave to a triangle wave form which, combined with the 15 kHz sine wave, constitutes an alternative test signal recommended for TIM testing. Fig. 2.3 shows the time function for the two signals together with the spectrum for the square wave and 15 kHz configuration.

The square and triangle waves are low-pass filtered (30 kHz or 100 kHz selectable) to reduce the high frequency content in the test signal.

1 kHz Reference Signal

The 1 kHz reference signal is provided as an alternative to the D/A generated signal as in some test situations it is necessary to have different signals in the left and right channels.

The 1 kHz reference signal is generated from the 64 kHz main clock, divided by 64 and bandpass filtered.



(a) Square Wave and 15 kHz Sine Wave

(b) Triangle Wave and 15 kHz Sine Wave

(c) Spectrum of Square Wave and 15 kHz Sine Wave

Fig. 2.3 - TIM Signals

3 CIRCUIT DESCRIPTIONS

3.1 Digital Board

A Block Diagram for the Digital Board (901-499) is found in fig. 3.1 while the schematic diagram is found in drawing 985-159 at the back of this manual.

The circuitry may be divided into the following main blocks:

* Address decoding and board identification
* Program memory, sample memory (Sine Table, RAM)
* Frequency latch and address counter
* Reset detector and latch
* Window detector and latch

In the following the function of the above listed circuit blocks is described.

Address Decoding and Board Identification

During the selftest routine - by means of the CRU interface (serial data communication to or from a specifically selected address using the lines $\overline{\text{CRUCLK}}$, CRUIN and A15/CRUOUT) the Static CPU writes a logic 1 to QD33, pin 5. If the Analog Board is inserted correctly and connected to the Digital Board, the line ANALOG BOARD MOUNTED (J2, pin 5) will also be high. This will cause $\overline{\text{I14}}$ to go low, which informs the Static CPU that the two boards are installed.

Further, the CPU is informed that the CARD ON signal is high and that the decoding circuits QD58 and QD60 consequently are enabled so that the CPU can communicate with the memory and latches on the board. As the Audio Generator shares address space with other options in the Analog Section, the CARD ON signal is used to select this board to be addressed, while other boards are deselected, and vice versa.

QD58 is a Schottky PROM used for address decoding and selection of the different EPROM and RAM memories when the CPU requires to read or write to these. QD36 buffers the address bus towards the internal bus on the board in order to enable the internal bus to be separated from the Static CPU address bus and to minimize the load on the bus drivers on the CPU board.

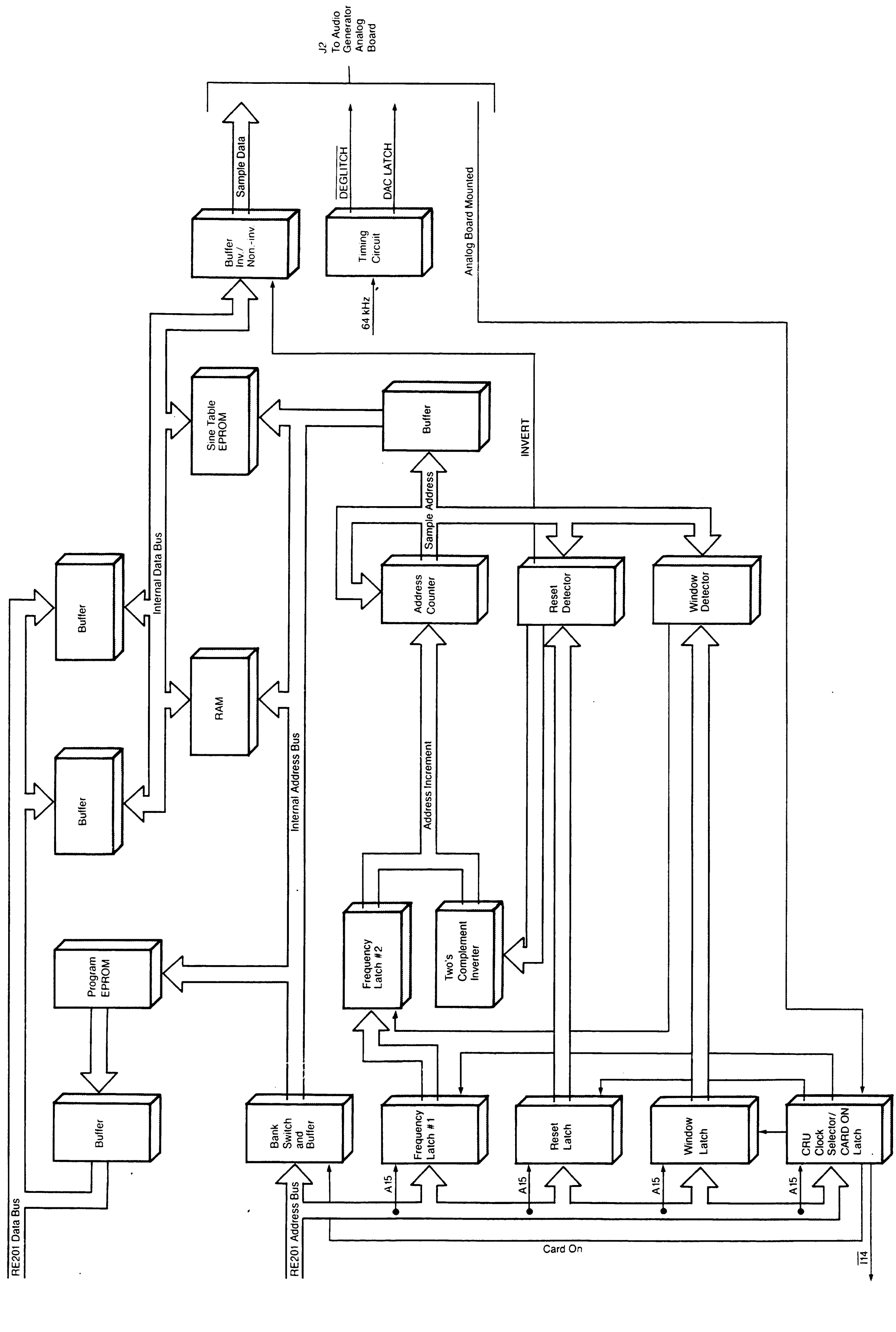


Fig. 3.1 - Digital Board Block Diagram

QD31 and QD32 are used for bank switching, i.e. extensions of the address space accessible by the CPU. By means of its 16 address lines (A0 - A15) the TMS9995 on the Static CPU board can select 64 kbytes equivalent to 32 k words of 16 bits. As the Sine Table alone contains 32 k words it would occupy the entire address space leaving nothing for program and RAM memories etc. To overcome this problem the circuitry composed of QD31, QD32 and QD37 has been employed. The bank switching works as follows. The Static CPU may require to read from the Sine Table (QD1, QD2, QD3 and QD4) to calculate multi-tone samples to be placed in RAM memory (QD7 and QD8). To address the Sine Table the CPU first selects pin 15 to be CRUCLK output by means of the CRU CLOCK SELECTOR QD60. Pin 15 is connected to pin 14 on QD32. It is now possible by means of the three least significant CRU address bits (A12, A13 and A14) and A15/CRUOUT to set the four most significant address bits on the internal address lines (buffered by QD37). This procedure allows the CPU to let a specific address space for the Static CPU correspond to banks of address space on the internal address bus on the board. Hereby the CPU is able to read the entire Sine Table by using only a limited part of its available address area.

This bank switching concept is applied to the Program EPROM and the RAM as well.

The address space on the Digital Board is divided as follows:

Sine Table	32 banks of 2 kbytes
RAM	8 banks of 2 kbytes
Program EPROM	4 banks of 4 kbytes

The mode of operation of the Digital Board (i.e. single tone, multi-tone) is determined by the state of QD31 (pins 10 and 11). Pin 9, MODE SHIFT, is used partly to grant access to the internal address bus to the Static CPU, partly to accomplish different tasks while changing between single-tone and multi-tone. This state is also set by the Static CPU by means of the CRU CLOCK SELECTOR QD60.

<u>Program Memory and Sample Memory</u>

The program memory on the Digital Board consists of three individual circuit blocks.

* Program EPROM (16 kbytes) with a unidirectional data bus buffer (QD5 and QD53).

  This holds the program code which is required by the Static CPU to operate the Audio Generator Option.

* 8 k words (16 bits) of CMOS RAM with bidirectional buffer arrangement: QD7, QD8, QD56 and QD57.

  Used to store the calculated multi-tone time samples. Direction of the two buffers is determined by $\overline{DBIN}$ (Data Bus IN) whereas selection between the most significant and least significant bytes depends on the state of A15.

* Sine Table (QD1, QD2, QD3 and QD4) EPROM containing 32,000 16 bit samples of one period of a sinusoid. Used to generate single sine waves and as a table for the CPU for calculation of multi-tones.

Frequency Latch and Address Counter

Single Sine Waves

The frequency of single sine waves is, as described earlier, defined by the size of the address increment used in the address counter. The address increment (equal to the frequency in Hz when a single sine wave is used) is loaded into QD29 and QD30 by means of the CRU facility via the CRU CLOCK SELECTOR.

If the frequency is set up for the first time, the contents of QD29 and QD30 are allowed to enter QD40 and QD41, because the CPU keeps the line "MODE SHIFT" high. The address increment is then routed from QD40 and QD41 to the 16 bit address QD11, QD12, QD13 and QD14.

The address which is of the ripple-through type will present the sum of the current address and the address increment at the outputs. This value is by means of a derivative of the 64 kHz main clock entered into the registers QD23 and QD24 and used as next address.

The buffers QD34 and QD35 are used to disconnect the address counter from the internal address bus when the CPU requires access to EPROM and RAM. The outputs of QD34 and QD35 are disabled when INT.MODE SHIFT is high, which is the case when the CPU has set "MODE SHIFT" to high.

Multi-tones

When the Audio Generator Option is required to generate a multi-tone, the CPU, as previously described, calculates the required samples and places them in the RAM memory. Then the CPU sets the control lines as follows:

* MODE SHIFT is set high and then low to set INT.MODE SHIFT high (enabling address buffers QD34 and QD35 and disabling QD48 and QD49).

* $\overline{SFREQ}$ is set high enabling the RAM memory.

* MULTITONE is set high. This disables the Sine Table, QD40 and QD41 and enters a logic one on the CARRY input on QD14.

Due to R10 and R11 the input to the adders will now be zero on all lines and a one on the CARRY input. This will result in an address increment of one on the output of the adders.

Reset Selector and Latch

The reset detector is a 15 bit comparator, which detects when the address on the bus reaches a precalculated value stored by the CPU via CRU in the latches QD27 and QD28. The following values are used:

32,000	Sine wave	
6,400	Multi-tone	10 Hz resolution
640	Multi-tone	100 Hz resolution
64	Multi-tone	1000 Hz resolution

When the address counter reaches the value stored in the latches, QD22, pin 12 goes low. This signal propagates to the outputs of QD44 in order to disable QD40 and QD41 and enable QD48 and QD49, which invert the address value stored in QD27 and QD28. At the same time, QD69, pin 3, which serves as a CARRY input to the address goes high. The result of this will be that the two's complement value of the address value stored in QD27 and QD28 is added to the current address. Consequently, the next address will be the previous address minus 32,000, 6,400, 640 or 64, respectively.

If the signal is a sine wave the gates QD38, QD39, QD46 and QD47 will now be configured to invert the number read from the Sine Table. This routine will be repeated each time the address counter exceeds 32,000 ensuring that the positive as well as the negative half wave period is generated.

If a multi-tone is being generated the state of the inverters QD38, QD39, QD46 and QD47 is not changed as samples of a whole period of the multi-tone are calculated and stored.

Window detector and latch

The window detector controls the timing of frequency changes for single tone signals. As previously explained, this circuitry is employed in order to ensure a minimum of transients during frequency change. This is the case if the change happens when the output sine value is close to a maximum value (+1 or -1) corresponding to a Sine Table address close to 16,000.

As the address 16,000 may never be used for some frequencies and only with long time intervals for others, it is necessary for each frequency to define a range of addresses in which the change is allowed to happen.

This address space around address 16,000 is called the window, and the window is defined by:

16,000-256-f/2 to 16,000+256+f/2

where f is the frequency in Hz.

Thus, the width of the window is as a minimum +/- 256 address locations, because the comparator only monitors the 8 most significant address lines.

The window detector is configured of a comparator monitoring the lower limit of the interval 16,000-256-f/2 and another comparator monitoring the upper limit of the interval 16,000+256+f/2.

A change of frequency is performed as follows:

* The CPU loads the new frequency into the frequency latch. MODE SHIFT is low and QD45, pin 1 is low disabling the input of the latches in QD40 and QD41. The CPU also resets the D flip-flop QD45 by means of the line FREQUENCY CHANGE.

* When the address is within the window, QD63, pin 10 will go high causing the data input on QD45 (pin 5) to be high.

* When QD51, pin 15 (generated from the 64 kHz main clock) goes high the data input is latched onto pin 1 - causing the latches in QD40 and QD41 to be enabled. The new address increment will now be routed to the address counter. At the same time pin 13 on QD45 will go high (TP1). This is used to inform the CPU that the change of frequency has been completed.

Test Points and Jumpers

The following is a list of the individual test points and jumpers.

JP1 Used by the Static CPU to detect that the card is installed correctly. At the factory the jumper is installed between 2 and 5. Positions 1 to 5 are used for the Audio Generator 901-500; other positions are for future use.

JP2 Not installed. For future use if it should be required to provide the RAM memory with power back-up.

TP1- For troubleshooting at the factory.
TP9

3.2 Analog Board (901-704)

The following subsection gives a description of the individual circuit blocks of which this part of the Audio Generator Option is configured. The description makes reference to fig. 3.2 - Analog Board, Block Diagram and to the schematic diagram, drawing No. 985-224 at the back of this manual.

The circuitry on the Analog Board may be divided into the following main blocks:

* D/A converter, deglitch and filtering
* TIM test signal generator
* 1 kHz reference signal generator
* Control circuitry
* Left channel output stage
* Right channel output stage

These blocks are described in the following subsection. As the left and right channel stages are identical, however, only the left channel output stage is discussed.

D/A Converter, Deglitch and Filtering

The 16 bit DAC QD1 receives the digital samples from the Sine Table or the RAM memory on the Digital Board (901-499) via the ribbon cable W1 and the latches QD2 and QD3. The timing is controlled by the signal DAC LATCH. DAC LATCH, which is a 64 kHz square wave signal, is also used as input signal to the TIM and 1 kHz generators. The DAC now converts the 16 bit digital number (two's complement form) into an analog signal (voltage) at pin 17 (JP1, pin 2). If an oscilloscope is connected to JP1 the typical picture shown in fig. 3.3 will be seen. The sinusoid is approximated by a staircase function where the duration of each "step" is 15.625 microseconds (64 kHz). As shown in the enlargement of three steps the change from one level to another will cause ringing. These transients are later removed by the deglitch circuit.

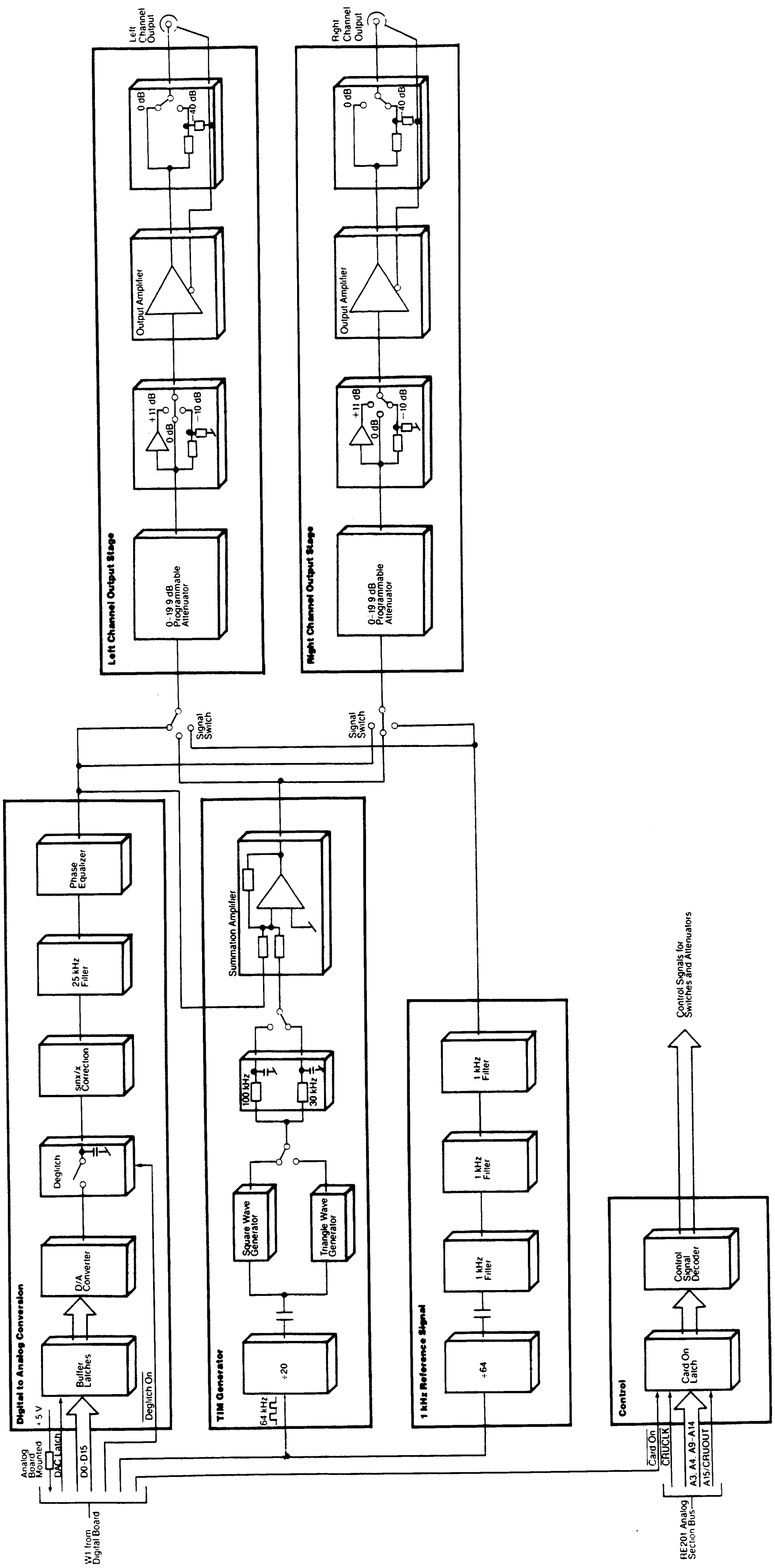


Fig. 3.2 - Analog Board Block Diagram

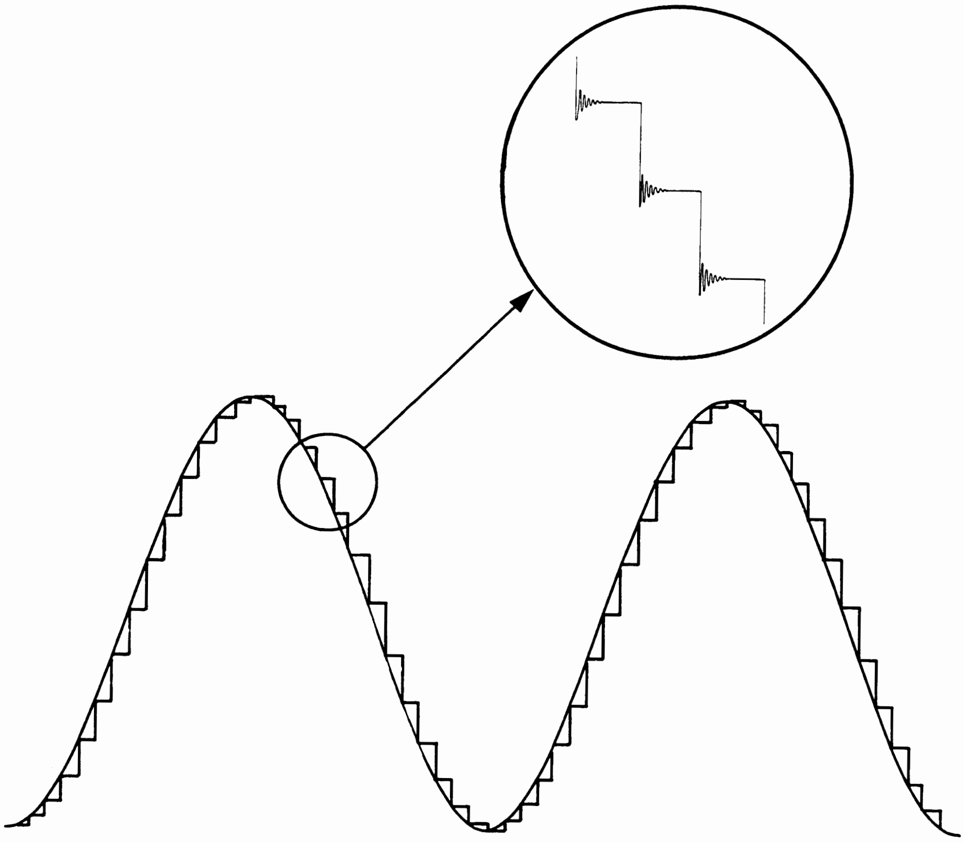


Fig. 3.3 - Typical DAC Output Waveform

Having a resolution of 16 bits the quantization noise (1/2 LSB) will be approximately 96 dB below the peak output voltage. The RMS value of the quantization noise can be shown to be 1/ $\sqrt{12}$ of LSB and consequently, the S/N ratio obtainable by means of an ideal 16 bit D/A converter should be:

$$20 \log \frac{\frac{1}{2} \cdot 2^{16}}{\sqrt{2} \cdot \frac{1}{\sqrt{12}}} = 98\,\mathrm{dB}$$

This should also be the SINAD value obtainable when the ideal 16 bit DAC is used to generate sine waves. However, this is only true if the sampled signal is stocastic. As this is not the case, and as the inherent distortion in the internal networks in the DAC is also a limiting factor, the SINAD is in practice limited to approx. 90 dB and the THD to approx. 95 dB.

As mentioned above the fast transients present when changing from one level of the staircase wave form to the next unavoidably generates ringing. As this will raise the overall noise floor, it has to be removed, and this is done by means of the deglitch network. The deglitch is a sample and hold unit where the sample point is delayed from the DAC LATCH (conversion). The timing and principal function are shown in fig. 3.4. When the deglitch switch QA1 is on, the capacitor C174 is charged by the DAC output voltage. When the switch goes off, the capacitor is capable of maintaining the voltage for many sample

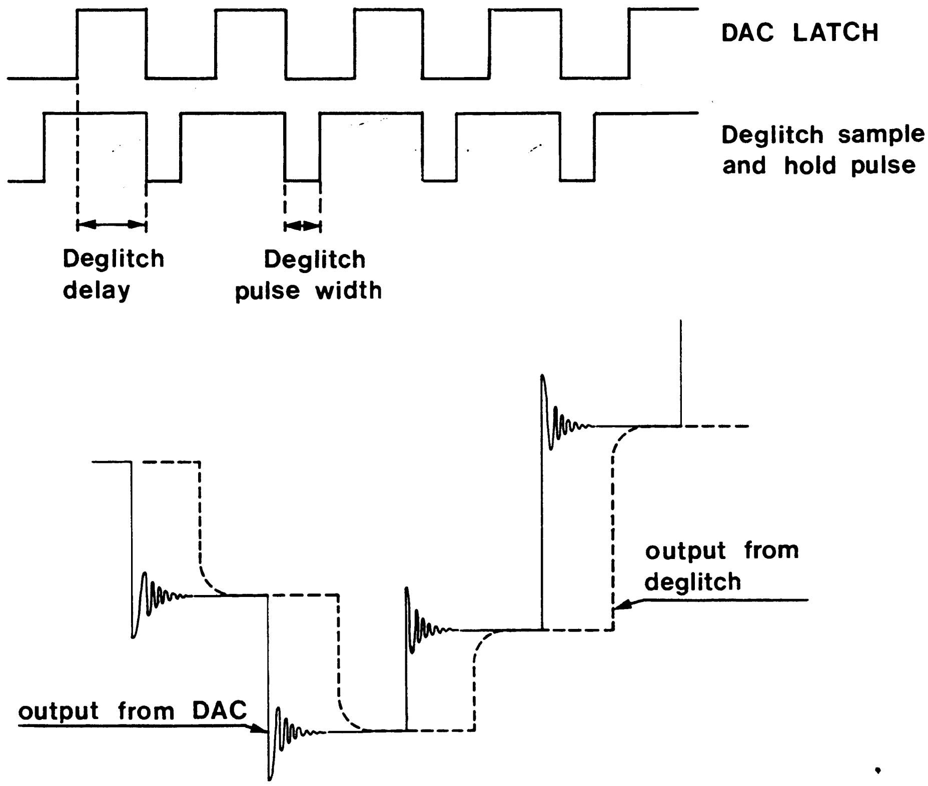


Fig. 3.4 - Function and Timing of Deglitch Network

periods due to the high input impedance of QA2. Hereby the ringing (noise) found at the DAC output is removed.

It is well known from the sampling theory that low-pass filtering of a time function sampled by means of delta functions will give a perfect recovery of the original wave form provided the sampling theorem is fulfilled, i.e. the sampled signal must contain no frequency component above half the sampling frequency. In the present case, however, the time function is sampled by means of rectangular pulses with a pulse width of 15.625 microseconds. This implies that some correction is required, as explained in the following.

The staircase signal can be represented as the convolution in the time domain of a 15.625 microsecond rectangular pulse and a train of delta functions representing ideal samples of the sine wave. As convolution in the time domain corresponds to multiplication in the frequency domain the resulting spectrum will be composed of sets of delta functions multiplied by the Fourier transform of a single 15 microsecond pulse. The delta functions are placed at fs, 2fs, 3fs etc., where fs is the sampling frequency.

The spectrum of one single pulse is

$$F(f) = k \sin(x)/x$$

where $x = 2\pi fT/2$ and $T = 15.625$ microseconds.

As F(0) equals k we can write

$$F(f)/F(0) = \sin(x)/x$$

Table 3.1 shows calculated values of F(f)/F(0) for T = 15.625 micro-seconds.

Frequency	F(f)/F(0)
0 Hz	1.000
1000 Hz	1.000
10000 Hz	0.960
25000 Hz	0.767

Table 3.1 - F(f)/F(0) values

Thus, after proper low-pass filtering the staircase representation of a 1 kHz sine wave will give a perfect sine wave with an amplitude correction factor of 1.000. A 25 kHz sine wave, however, will have an amplitude which will be 0.767 times lower than if sampled by means of delta functions (ideal sampling). The x/sinx filter corrects this to ensure that the output level from the Audio Generator is independent of the frequency in the specified frequency range.

The antialiasing filter, which is an active ninth order elliptical filter designed to have minimum ripple (0.05 dB) in the pass band (DC to 25 kHz) and maximum attenuation in the stop band (39 kHz and upwards), removes all high frequency components (sampling frequency, higher order spectra etc.) from the signal. The filter is built around high quality operational amplifiers, QA14, QA15, QA16 and QA17.

Finally, the phase equalizer corrects the nonlinear phase characteristics of the antialiasing filter. This is done to ensure that the frequency shifting routine implemented via the window detector on the Digital Board will provide a smooth shift at one of the maxima of the time function.

<u>TIM Generator</u>

The 64 kHz square wave signal is divided by 20 (QD7 and QD9), AC coupled and low-pass filtered to create the TIM100 and TIM30 square and triangle wave forms. The final square wave or triangle is in QA7 added to a 15 kHz sine wave generated by the digital frequency synthesizer to give the resulting TIM test signals.

To ensure the required high accuracy of the resulting levels, the C-MOS dividers are supplied from a highly accurate 5V supply (QA25).

1 kHz Reference Signal Generator

The DAC LATCH 64 kHz square wave signal is divided by 64 in QD8 and QD10. Then the signal is AC coupled and fed through 3 identical bandpass filters. These filters remove all harmonics from the signal and generate a pure sine wave with SINAD and THD specifications close to -100 dB.

Control Circuitry

The Static CPU is informed via the Digital Board that the Audio Generator Option has been mounted correctly. For this purpose the 5V connected to pin 5 in W1 indicates to the Digital Board that the Analog Board and W1 are mounted correctly. The Digital Board responds by keeping CARD ON low, which enables the CPU to operate the control circuitry on the Analog Board. This is done by means of the CRU CLOCK selector, QD11, latches QD12, QD13, QD14, QD15 and operational amplifiers, QA28, QA29 and QA30. The operational amplifiers operate as comparators with 2.5V switch voltage. When the voltage of the non-inverting input is at logic level Ø (0 Volt) the output voltage is approx. -15V and consequently, the connected FET transistor is off. When the input level is logical 1 the output level is approx. +15V. As the diode in the gate will be reversed, gate and drain will be at the same voltage level (through 33 kOhms) and the FET transistor will be on.

Q8 and Q17 are used to change the non-inverting input to ground as a part of the set-up, when the Audio Generator Option is in the "GND" mode.

Left Channel Output Stage

The output stage consists of the following individual blocks:

* 0-19.9 dB programmable attenuator with 0.1 dB resolution
* -10 dB, 0 dB or +11 dB programmable attenuator
* Floating output stage QA10, QA11 with 6 dB gain
* 0 dB or -40 dB programmable attenuator. The switching element is a relay as opposed to the FET transistors used elsewhere.

As the input level to the output stage is 2.5V peak, it is possible by means of the above listed attenuators to regulate to output voltage between 1.6 mV peak and 17.70 V peak with 0.1 dB resolution.

The output stage contains a number of facilities for adjustment of DC offset, level and common mode rejection. These facilities together with other adjustment facilities in the Audio Generator Option are described in more detail in section 4 (Maintenance) of this manual.

Test Points and Jumpers

In the following the function of the test points and jumpers on the Analog Board is described. Fig. 3.5 shows the component layout and the following table provides a short description:

JP1	Disconnects the DAC from the analog circuitry. At the factory the jumper is placed in position 2-3. When removed, pins 1 and 3 can be used to feed an analog signal to the filter-output section for test purposes.
JP2	Not connected at the factory. A short placed between these two pins (e.g. the one from JP1) will switch on the deglitch switch permanently.
JP3-JP4	Disconnects the output stages from filters and attenuator stages if the factory positioned jumpers are removed. Signals applied between pins 2 and 3, 2 and 1, respectively, may be used to test the output stages.
JP5-JP6	Connected at the factory. A 22 kOhm resistor in parallel with a 470 pF capacitor define the DC potential and prevent oscillations which may occur at certain load impedances.
TP1	May be used for monitoring the DAC, the TIM and the 1 kHz reference signal.
TP2	May be used together with JP1 and JP2 to check the performance of the antialiasing filter.
TP3	Used to check the 5V reference voltage used to generate TIM square wave, TIM triangle and 1 kHz square wave signals. Adjustable by means of R61.

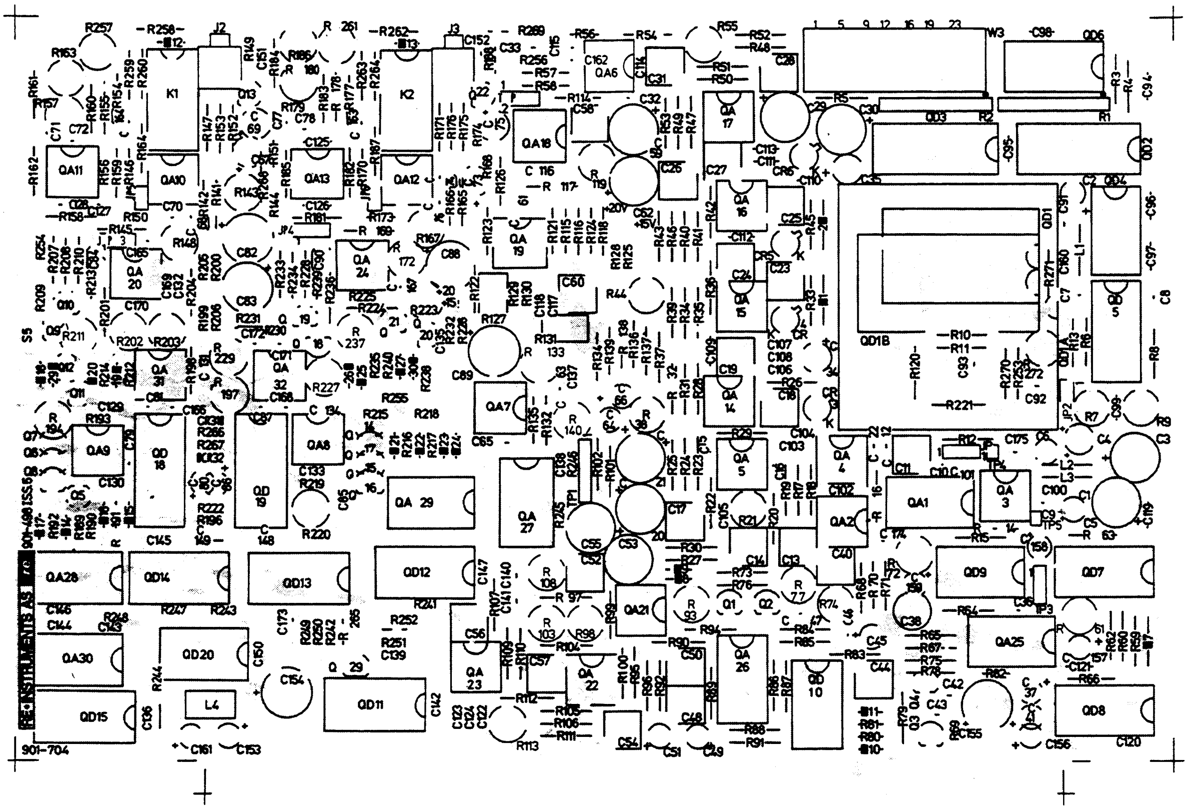


Fig. 3.5 - Analog Board Component Layout

4 MAINTENANCE

This section describes maintenance and adjustment procedures for the RE201 Audio Generator Option.

4.1 Recommended Test Equipment

Table 4.1 lists the test equipment necessary to carry out a performance test and to adjust the Audio Generator Option, if necessary.

Instrument	Critical Specifications	Recommended Model
1) RMS/DC Voltmeter	Accuracy of reading 0.02 %, at 20 Hz-25 kHz and at DC	Fluke RMS differential Voltmeter, Model 8506A
2) Oscilloscope	None	
3) Distortion Analyzer	THD measurements -100 dB 20 Hz-12.5 kHz SINAD measurements - 90 dB	RE201 with Filter Option (901-525)
4) Frequency Counter	Resolution better than 0.1 Hz	Fluke Model 1911A

Table 4.1 - Recommended Test Equipment

4.2 Performance Test

As all the tests outlined in this section are performed on both channels of the Audio Generator Option, it will be convenient to perform measurements with the right and left outputs connected to the right and left inputs of the RE201.

The performance test includes:

* Frequency check
* Frequency response tests
* Test of the different attenuators
* THD and SINAD measurements

RE201 Programming

It is recommended to carry out all programming of the RE201 (defining signals and measurements) before the test is initiated.

The following gives a survey of the definitions necessary to carry out the entire performance test. It is implied that all the definitions are identical for both channels. All levels are EMF values.

Signal Definitions

SIGNAL 00	1000 Hz	1.77 Vrms
SIGNAL 01	20 Hz	1.77 Vrms
SIGNAL 02	1000 Hz	6.27 Vrms
SIGNAL 03	TIM30 SQR	1.77 Vrms
SIGNAL 04	TIM30 TRI	1.77 Vrms
SIGNAL 05	TIM100 SQR	1.77 Vrms
SIGNAL 06	MFREQ0	1.00 Vrms
SIGNAL 07	100 Hz	1.00 Vrms
SIGNAL 08	5000 Hz	1.00 Vrms
SIGNAL 09	1 kHz, Ref.	1.77 Vrms
MFREQ0	3200 Hz	Relative level 1
	15000 Hz	Relative level 1

Measurement Definitions

Level Definitions

LEV1	Channel BOTH, Mode SEL, Center frequency 3200 Hz, Bandwidth 100 Hz, Representation DBR
LEV2	Channel BOTH, Mode SEL, Center frequency 15000 Hz, Bandwidth 100 Hz, Representation DBR

Distortion Definitions

THD0	Channel RIGHT, Frequency TRACK, 2nd to 9th Harmonic included, Representation DB, Averaging LIN, No. of Loops 5
THD1	Channel RIGHT, Frequency TRACK, 2nd Harmonic only included, Representation DB, Averaging LIN, No. of Loops 5
SINAD0	Channel RIGHT, Frequency TRACK, Duration 250 ms, Representation DB

Sequences

S0	LEV1, LEV2

Frequency Accuracy

a. Connect the frequency counter (4) to one of the outputs of the Audio Generator. The RE201 cannot be used for this test, as the Audio Generator utilizes the same main clock as the frequency measurement.

b. Activate a 5000 Hz Single Tone signal (SIGNAL 08) and check that the frequency accuracy is +/-0.1 Hz.

c. Activate a 1 kHz Reference Tone (SIGNAL 09) and check that the frequency accuracy is +/-0.02 Hz.

d. Activate a TIM SQR signal (SIGNAL 03) and check that the frequency measured is 3200 Hz +/-0.07 Hz.

Frequency Response, Single Tone

a. Connect the RMS voltmeter (1) to the right channel output. Activate a 20 Hz, 1.77 Vrms signal (SIGNAL 01).

b. Verify, that the output level is 1.768 Vrms +/-12 mV (1.756 V - 1.780 V).

c. Using the GENCTRL frequency change facility, verify the frequency response in accordance with table 4.2.

d. Repeat the test for the left channel output.

Frequency	Result
20 Hz	1.756 - 1.780 V
1000 Hz	1.756 - 1.780 V
5000 Hz	1.756 - 1.780 V
10000 Hz	1.756 - 1.780 V
16000 Hz	1.756 - 1.780 V
20000 Hz	1.747 - 1.789 V
25000 Hz	1.747 - 1.789 V

Table 4.2 - Frequency Response

1 kHz Reference Tone Output Level

a. Connect the RMS voltmeter to the right channel output and activate the 1 kHz Reference Tone, level 1.77 Vrms (SIGNAL 09).

b. Verify, that the output level is 1.768 Vrms +/-12 mV (1.756 V - 1.780 V).

TIM Output Level

a. Activate a TIM30 SQR signal (SIGNAL 03), and initiate a sequence including two selective RMS measurements, center frequencies 3.2 kHz and 15 kHz (S0).

b. Verify, that the 3.2 kHz level is 14.1 dB +/-0.2 dB above the 15 kHz level.

c. Activate a TIM30 TRI signal (SIGNAL 04) and verify that the 3.2 kHz level is 10.2 dB +/-0.1 dB above the 15 kHz level.

TIM Filter

a. Connect the oscilloscope (2) to the right channel output. Activate a TIM100 SQR signal (SIGNAL 05).

b. Observe the sharpness of the edges on the square wave. Then activate a TIM30 SQR signal and note that the edges are rounded compared to the TIM100 SQR signal.

Multi-tone

a. With the right channel output connected to the RE201 right channel input, select the multi-tone outlined in the programming section above.

b. Execute the sequence including the 3.2 kHz and the 15 kHz selective measurements (S0) and verify, that the two level measurement results are identical.

Attenuator Test

The attenuator chain in the Audio Generator consists of three individual attenuators in each channel. To fully check these attenuators, several different settings must be verified. Table 4.3 lists the signals to be defined, the levels to be tested, the tolerances allowed, and, for reference, the actual set-up of each attenuator section.

The measurements are performed in the left as well as in the right channel, using the RMS voltmeter (1) connected to the channel being tested. Activate SIGNAL 02 and use the GENCTRL facility to change the output level according to table 4.3.

Output level	Tolerance	Attenuator Setting 0/-40 dB	0- -19.9 dB	-10/0/+11 dB
12.51 Vrms	+/-120 mV	0 dB	0 dB	+11 dB
1.115 mVrms	+/-11.2 mV	0 dB	0 dB	-10 dB
592 mVrms	+/-6.0 mV	0 dB	-15.5 dB	0 dB
522 mVrms	+/-5.2 mV	0 dB	-16.6 dB	0 dB
1.281 mVrms	+/-12.8 mV	0 dB	-8.8 dB	0 dB
35.3 mVrms	+/-0.4 mV	-40 dB	0 dB	0 dB

Table 4.3 - Attenuator Test

THD and SINAD

Single-tone

a. Connect the outputs of the Audio Generator to the inputs of the RE201. The RE201 must be equipped with Filter Option (901-525); alternatively, a separate distortion analyzer with the specifications outlined in table 4.1 may be used.

b. Measure THD including 2nd to 9th harmonics (THD) and SINAD (result in dB, SINAD 0) for a 100 Hz, 1.00 Vrms signal (SIGNAL 07). Verify that the total harmonic distortion is below -88 dB and that SINAD is below -85 dB.

c. Change the frequency to 1000 Hz and repeat.

d. Change the frequency to 10000 Hz and measure THD, 2nd harmonic (THD 1) and SINAD. Verify that THD is below -90 dB and that SINAD is below -82 dB.

1 kHz Reference Signal

a. With a 1 kHz, 1.00 Vrms signal, activate a THD measurement including 2nd to 9th harmonics (THD 0). Check that THD is below -97 dB.

4.3 Adjustments

Should any of the performance tests described in section 4.2 fail, some adjustments may be performed if the excesses are minor. Adjustments should only be performed, if a voltmeter with the specifications given in table 4.1 is available. Some of the adjustments, which require special measuring equipment, are not described. This includes adjustment of the antialiasing filter, of the Deglitch circuit, and the Common Mode Rejection adjustments.

All adjustments are performed on the Analog Board (901-704) of the Audio Generator. In order to gain access to the board, the Service Kit (906-032) must be used. The Analog Board is mounted on the Extender Board and connected to the Digital Board by means of the 26-way extender cable supplied with the Service Kit. When measurements are performed on the output signal, the SMC-to BNC cable also supplied may be used.

The adjustments outlined below are divided into six independent groups. If it is not obvious which adjustments are required, it is recommended to perform an adjustment of the Audio Generator in the same order as described below. Whenever an adjustment has to be carried out in both channels, test pins, resistors etc. belonging to the right channel are mentioned in brackets. The locations of test points and adjustment potentiometers are shown in fig. 3.5. Signal definitions are outlined in the beginning of section 4.2.

All adjustments except of output amplifiers are independent of level and channel.

Frequency Response

a. Connect the RMS voltmeter (1) to TP2 (2-1) on the Audio Generator. Select a 1000 Hz Single Tone on the RE201 (SIGNAL 00). Use the measured voltage (Vo) as the reference for the following three adjustments.

b. Change the frequency to 20 Hz. Adjust the measured voltage to Vo +/- 0.03 % by means of R55.

c. Change the frequency to 16000 Hz. Adjust the measured voltage to Vo +/- 0.03 % by means of R21.

d. Repeat b. and c.

Phase Equalizer

a. Remove the jumper at JP1 and connect JP1, pins 1-3. Connect the voltmeter (1) to TP1, pins 1-2 and adjust to 0 V DC +/- 0.5 mV by means of R131.

b. Reinstall the jumper at JP1, connecting pins 2 and 3, and select a 1000 Hz Single Tone signal (SIGNAL 00).

c. Adjust by means of R127 to 1.7678 Vrms +/- 0.03%.

d. Change the frequency to 16000 Hz and adjust by means of R119 to 1.7678 Vrms +/- 0.03%.

e. Change the frequency to 1000 Hz and repeat c. and d.

+5 V Reference

a. Connect the voltmeter (1) to TP3 (2-1) and adjust to +5 V DC +/- 5 mV by means of R61.

1 kHz Reference Oscillator

a. Connect the RMS voltmeter to TP1, pins 5-2. Adjust the voltage to maximum by means of R93, R98 and R108.

b. Adjust to 1.7678 Vrms +/- 0.9 mV by means of R103.

c. Adjust to 0 V DC +/- 0.5 mV by means of R113.

TIM Oscillator

a. With no TIM signal selected, remove the jumper at JP1 and connect JP1, pins 1 and 3. Connect the voltmeter (1) to TP1, pins 3-2 and adjust to 0 V DC +/- 0.5 mV by means of R140.

b. Select a TIM triangle signal (SIGNAL 04) and adjust to 0 V DC +/- 0.5 mV by means of R72.

c. Adjust the RMS voltage in TP1 (3-2) of the TIM triangle to 1.1547 Vrms +/- 0.6 mV by means of R77.

d. Select a TIM square signal. Adjust the RMS voltage of the TIM square to 2.000 Vrms +/- 1 mV by means of R74.

e. Select a 15 kHz single-tone. Remount the jumper at JP1, connecting pins 2 and 3, and adjust the RMS voltage in TP1 (3-2) to 0.3535 Vrms +/- 0.2 mV by means of R133.

Output Amplifiers

a. Select a 1000 Hz, 3.53 Vrms Single Tone (SIGNAL 00). Connect to JP3 pins 2-3 JP4. pins 1-2. Remove JP5 (JP6).

b. Shortcircuit the outer conductor of the output cable to 0 V (circuit ground). Connect the voltmeter (1) to the inner conductor and 0 V and adjust the voltage to 0 V DC +/- 0.5 mV by means of R148 (R172).

c. Shortcircuit the inner conductor of the output cable to 0 V. Connect the voltmeter (1) to the shield and 0 V and adjust to 0 V DC +/- 0.5 mV by means of R157 (R180).

d. Repeat b. and c. once.

e. Remount JP5 (JP6) and connect JP3, pins 1-2 (JP4, pins 3-2).

Output Level

a. Connect the RMS voltmeter (1) to the output of the Audio Generator. Select a 1000 Hz, 3.53 Vrms Single Tone (SIGNAL 00).

b. Adjust level to 3.5272 Vrms +/- 1.8 mV by means of R202 (R227).

c. Change level to 12.51 Vrms, using the GENCTRL facility, and adjust the output level to 12.515 Vrms +/- 6 mV by means of R211 (R237).

d. Change the level to 35.3 mVrms. Adjust the output level to 35.272 mVrms +/- 18 uV by means of R257 (R261).

5 TROUBLESHOOTING

This section provides information on how to troubleshoot the Audio Generator Option, mainly to distinguish between errors from the Analog Board and the Digital Board.

The errors may be divided into selftest errors and errors found during the performance test (refer to section 4.2). It is recommended that section 2, Principles of Operation, and section 3, Circuit Descriptions, are carefully studied before troubleshooting is commenced.

5.1 Selftest Errors

The selftest routine performed by the RE201 mainly concentrates on the digital circuitry. During a selftest, the Static CPU verifies that the Analog and Digital Boards are both mounted correctly. If this is not the case, information about the Audio Generator Option will not appear on the CRT after power-up or a selftest. This type of error may be caused by a faulty CARD ON circuit (built around QD33, QD59, QD51 and QD61 on the Digital Board), a mal-positioned jumper JP1 on the Digital Board, a bad or missing connection between the Analog and Digital Boards (flat cable) or by one of the Audio Generator boards being mounted incorrectly in the Analog Motherboard.

If the RE201 recognizes the Audio Generator, the selftest routine proceeds with a test of the digital part. This test includes a test of the program PROM, the sine wave table and the multi-tone RAM. During the test, the address/data lines and the decoding circuit are also checked. If any error occurs during this part of the selftest, the selftest result will be represented as an error code on the LEDs (CR1-CR8) placed at the upper edge of the Static CPU board. CR1 is the rightmost of the diodes when viewing the PCB from the component side.

CR5-CR8 display the QD-designation of the failing IC, while CR1-CR4 display an error code specific for the Audio Generator, as detailed in table 5.1.

5.2 Performance Test Errors

On the basis of the tests performed during the performance test, it should be possible to determine from which part of the Audio Generator Option the fault originates.

Analog Board Errors

Errors on the analog part will primarily be detected as erroneous output levels. If the deviation of the output level is considerable compared to the selected output level, and regardless of which signal is selected, the error is most likely due to faulty FET switches

Error Code	QD No.	Function
0001 0101	QD1	Sine Table PROM, MSB
0010 0101	QD2	Sine Table PROM, LSB
0011 0101	QD3	Sine Table PROM, MSB
0010 0101	QD4	Sine Table PROM, LSB
0101 0101	QD5	Program PROM
0111 0101	QD7	Multi-tone RAM, LSB
1000 0101	QD8	Multi-tone RAM, MSB

Table 5.1 - Audio Generator Error Codes

(Q1-Q21), or to a faulty control circuit. The control circuit consists of a number of addressable latches (QD12-QD15) and voltage comparators (QA27-QA29).

To aid the troubleshooting of the output attenuator chain, table 5.2 lists the actual set-up of each of the attenuator sections for different specified levels of a Single Tone. It should be noted, that the output amplifiers may be isolated, e.g. for input of a test signal by means of the jumpers JP3 and JP4.

If the problems are only present when using single-/multi-tone signals, the error probably stems from the D/A-conversion circuit (including the Deglitch circuit), from the sinx/x correction, the antialiasing filter or the phase equalizer, or the error may be caused a fault on the Digital Board.

Digital Board Errors

Errors on the Digital Board will normally be observed as erroneous single-tone signals (peculiarities in the time function) or as incorrect frequency shifts.

Incorrect frequency measurements found during the performance test indicate errors in the frequency latches (QD40, QD41) or in the address counter circuit (QD11-QD13, QD23 and QD24).

If only one half of the sine wave is generated, the error probably stems from a faulty output buffer circuit (QD67, QD38, QD39, QD46 and

QD47), or from the reset detector circuit.

Level	0/-40 dB	-10/0/+11 dB	0 to -19.9 dB
1.13 mV	-40 dB	-10 dB	-19.9 dB
.	.	.	.
11.2 mV	-40 dB	-10 dB	0 dB
11.3 mV	-40 dB	0 dB	-9.9 dB
.	.	.	.
35.3 mV	-40 dB	0 dB	0 dB
35.7 mV	-40 dB	+11 dB	-10.9 dB
.	.	.	.
125.1 mV	-40 dB	+11 dB	0 dB
126.5 mV	0 dB	-10 dB	-18.9 dB
.	.	.	.
1115 mV	0 dB	-10 dB	0 dB
1129 mV	0 dB	0 dB	-9.9 dB
.	.	.	.
3.53 V	0 dB	0 dB	0 dB
3.57 V	0 dB	+11 dB	-10.9 dB
.	.	.	.
12.51 V	0 dB	+11 dB	0 dB

Table 5.2 - Attenuator Settings

In the case of an incorrect or no frequency shift when pressing 'cursor left/right', the error is most likely caused by a defective window latch/ window detector circuit (QD25, QD15-QD18). Errors in this circuitry may also cause the RE201 to completely stop the execution when the cursor key is activated.

If a single-tone generated on the Digital Board is not a sinusoid, the error may be due to a faulty reset latch/reset detector circuit (QD19-QD22, QD27 and QD28).

6 PARTS LISTS AND SCHEMATIC DIAGRAMS

6.1 Parts Lists

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 the following information is included:

* Code No. and description of the part.

* Circuit reference from the schematic diagram.

* Complete type designation of RE product.

Main Parts List

Assembled Units

* Audio Generator Analog Board	901-704
* Audio Generator Digital Board	901-499

Audio Generator Analog Board (901-704)

CAPACITORS

C 1	C solid AL 10u 20% 16V	265-008
C 2	C Tantal 68u 20% 16V	267-015
C 3	Electrolytic 47/25, 2000h/85°, R:5*11, RM2	261-085
C 4	C Tantalum 22u 20% 16V	267-019
C 5	Electrolytic 47/25, 2000h/85°, R:5*11, RM2	261-085
C 6	C Tantalum 22u 20% 16V	267-019
C 7	C Ceramic 33p0 2% 100V NP0	213-208
C 8	C Ceramic 100p 2% 100V NP0	213-211
C 9	C Ceramic 22p0 2% 100V NP0	213-206
C 10	C Ceramic 12p0 p25 100V NPO	213-227
C 11	C Polyst 1n00 1% 63V	243-304
C 12	C Ceramic 18p0 2% 100V NP0	213-222
C 13	C Polyst 1n00 1% 63V	243-304
C 14	C Polyst 2n00 1% 63V	243-305
C 15	C Ceramic 100p 2% 100V NP0	213-211
C 16	C Ceramic 22p0 2% 100V NP0	213-206
C 17	C Polyst 10n0 1% 63V	243-302
C 18	C Polyst 10n0 1% 63V	243-302
C 19	C Polyst 10n0 1% 63V	243-302
C 20	Electrolytic 47/25, 2000h/85°, R:5*11, RM2	261-085
C 21	Electrolytic 47/25, 2000h/85°, R:5*11, RM2	261-085
C 22	C Ceramic 10p0 2% 100V NP0	213-205
C 23	C Polyst 10n0 1% 63V	243-302
C 24	C Polyst 10n0 1% 63V	243-302
C 25	C Polyst 10n0 1% 63V	243-302
C 26	C Polyst 10n0 1% 63V	243-302
C 27	C Polyst 10n0 1% 63V	243-302
C 28	C Polyst 10n0 1% 63V	243-302
C 29	Electrolytic 47/25, 2000h/85°, R:5*11, RM2	261-085
C 30	Electrolytic 47/25, 2000h/85°, R:5*11, RM2	261-085
C 31	C Polyst 10n0 1% 63V	243-302
C 32	C Ceramic 10p0 2% 100V NP0	213-205
C 33	C Ceramic 22n0 -20+80% 63V	213-011
C 34	C Tantalum 22u 20% 16V	267-019
C 35	C Tantalum 22u 20% 16V	267-019
C 36	C Ceramic 2p70 p25 100V NPO	213-201
C 37	C solid AL 10u 20% 16V	265-008
C 38	Electrolytic Bipolar 4u7 25V	261-301
C 40	C Polyst 10n0 1% 63V	243-302
C 41	C solid AL 10u 20% 16V	265-008
C 42	C Ceramic 270p 2% 100V N750	213-213
C 43	C Ceramic 27p0 2% 100V NP0	213-207
C 44	C Polyst 1n00 1% 63V	243-304
C 45	C solid AL 10u 20% 16V	265-008
C 46	C Ceramic 22n0 -20+80% 63V	213-011
C 47	C Ceramic 330p 2% 100V N750	213-214
C 48	C Polyst 10n0 1% 63V	243-302
C 49	C solid AL 10u 20% 16V	265-008
C 50	C Polyst 10n0 1% 63V	243-302
C 51	C solid AL 10u 20% 16V	265-008

C 52	C Polyst 10n0 1% 63V	243-302
C 53	Electrolytic 47/25, 2000h/85°, R:5*11, RM2	261-085
C 54	C Polyst 10n0 1% 63V	243-302
C 55	Electrolytic 47/25, 2000h/85°, R:5*11, RM2	261-085
C 56	C Polyst 10n0 1% 63V	243-302
C 57	C Polyst 10n0 1% 63V	243-302
C 58	C Polyst 2n00 1% 63V	243-305
C 59	Electrolytic 47/25, 2000h/85°, R:5*11, RM2	261-085
C 60	C Polyst 2n00 1% 63V	243-305
C 61	C Ceramic 4p70 p25 100V p100	213-203
C 62	Electrolytic 47/25, 2000h/85°, R:5*11, RM2	261-085
C 63	C Ceramic 4p70 p25 100V p100	213-203
C 64	C solid AL 10u 20% 16V	265-008
C 65	C Ceramic 10p0 2% 100V NP0	213-205
C 66	C solid AL 10u 20% 16V	265-008
C 67	C Tantal 15u 20% 35V	267-008
C 68	C Ceramic 10p0 2% 100V NP0	213-205
C 69	C Tantal 15u 20% 35V	267-008
C 70	C Ceramic 10p0 2% 100V NP0	213-205
C 71	C Ceramic 10p0 2% 100V NP0	213-205
C 72	C Ceramic 10p0 2% 100V NP0	213-205
C 73	C Tantal 15u 20% 35V	267-008
C 74	C Ceramic 10p0 2% 100V NP0	213-205
C 75	C Tantal 15u 20% 35V	267-008
C 76	C Ceramic 10p0 2% 100V NP0	213-205
C 77	C Ceramic 10p0 2% 100V NP0	213-205
C 78	C Ceramic 10p0 2% 100V NP0	213-205
C 79	C Ceramic 22p0 2% 100V NP0	213-206
C 80	C solid AL 10u 20% 16V	265-008
C 81	C Ceramic 22p0 2% 100V NP0	213-206
C 82	Electrolytic 47/25, 2000h/85°, R:5*11, RM2	261-085
C 83	Electrolytic 47/25, 2000h/85°, R:5*11, RM2	261-085
C 84	C Ceramic 4p70 p25 100V p100	213-203
C 85	C Ceramic 22p0 2% 100V NP0	213-206
C 86	C solid AL 10u 20% 16V	265-008
C 87	C Ceramic 22p0 2% 100V NP0	213-206
C 88	Electrolytic 47/25, 2000h/85°, R:5*11, RM2	261-085
C 89	Electrolytic 47/25, 2000h/85°, R:5*11, RM2	261-085
C 90	C Ceramic 4p70 p25 100V p100	213-203
C 91	C Ceramic 100n 20% 50V	213-401
C 92	C Ceramic 100n 20% 50V	213-401
C 93	C Ceramic 100n 20% 50V	213-401
C 94	C Ceramic 100n 20% 50V	213-400
C 95	C Ceramic 100n 20% 50V	213-400
C 96	C Ceramic 100n 20% 50V	213-400
C 97	C Ceramic 100n 20% 50V	213-400
C 98	C Ceramic 100n 20% 50V	213-400
C 99	C Ceramic 100n 20% 50V	213-400
C 100	C Ceramic 100n 20% 50V	213-400
C 101	C Ceramic 100n 20% 50V	213-401
C 102	C Ceramic 100n 20% 50V	213-400
C 103	C Ceramic 100n 20% 50V	213-400
C 104	C Ceramic 100n 20% 50V	213-400
C 105	C Ceramic 100n 20% 50V	213-400

C	106	C Ceramic 100n 20% 50V	213-400
C	107	C Ceramic 100n 20% 50V	213-400
C	108	C Ceramic 100n 20% 50V	213-400
C	109	C Ceramic 100n 20% 50V	213-400
C	110	C Ceramic 100n 20% 50V	213-400
C	111	C Ceramic 100n 20% 50V	213-400
C	112	C Ceramic 100n 20% 50V	213-400
C	113	C Ceramic 100n 20% 50V	213-400
C	114	C Ceramic 100n 20% 50V	213-400
C	115	C Ceramic 100n 20% 50V	213-401
C	116	C Ceramic 100n 20% 50V	213-400
C	117	C Ceramic 100n 20% 50V	213-401
C	118	C Ceramic 100n 20% 50V	213-401
C	119	C Ceramic 100n 20% 50V	213-400
C	120	C Ceramic 100n 20% 50V	213-400
C	121	C Ceramic 100n 20% 50V	213-400
C	122	C Ceramic 100n 20% 50V	213-400
C	123	C Ceramic 100n 20% 50V	213-400
C	124	C Ceramic 100n 20% 50V	213-400
C	125	C Ceramic 100n 20% 50V	213-400
C	126	C Ceramic 100n 20% 50V	213-400
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	213-400
C	130	C Ceramic 100n 20% 50V	213-400
C	131	C Ceramic 100n 20% 50V	213-400
C	132	C Ceramic 100n 20% 50V	213-400
C	133	C Ceramic 100n 20% 50V	213-400
C	134	C Ceramic 100n 20% 50V	213-400
C	135	C Ceramic 100n 20% 50V	213-400
C	136	C Ceramic 100n 20% 50V	213-400
C	137	C Ceramic 100n 20% 50V	213-400
C	138	C Ceramic 100n 20% 50V	213-400
C	139	C Ceramic 100n 20% 50V	213-400
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	213-400
C	143	C Ceramic 100n 20% 50V	213-400
C	144	C Ceramic 100n 20% 50V	213-400
C	145	C Ceramic 100n 20% 50V	213-400
C	146	C Ceramic 100n 20% 50V	213-400
C	147	C Ceramic 100n 20% 50V	213-400
C	148	C Ceramic 100n 20% 50V	213-400
C	149	C Ceramic 100n 20% 50V	213-400
C	150	C Ceramic 100n 20% 50V	213-400
C	151	C Ceramic 100n 20% 50V	213-400
C	152	C Ceramic 100n 20% 50V	213-401
C	153	C solid AL 10u 20% 16V	265-008
C	154	Electrolytic 47/25, 2000h/85°, R:5*11, RM2	261-085
C	155	Electrolytic 47/25, 2000h/85°, R:5*11, RM2	261-085
C	156	C solid AL 10u 20% 16V	265-008
C	157	C solid AL 10u 20% 16V	265-008
C	158	C solid AL 10u 20% 16V	265-008
C	159	C solid AL 1u0 20% 25V	265-001

C 160	C Ceramic 100n 20% 50V	213-400
C 161	C solid AL 10u 20% 16V	265-008
C 162	C Ceramic 100p 2% 100V NP0	213-211
C 163	C Ceramic 470p 20% 100V	213-014
C 164	C Ceramic 470p 20% 100V	213-014
C 165	C Ceramic 10p0 2% 100V NP0	213-205
C 166	C Ceramic 10p0 2% 100V NP0	213-205
C 167	C Ceramic 10p0 2% 100V NP0	213-205
C 168	C Ceramic 10p0 2% 100V NP0	213-205
C 169	C Ceramic 100n 20% 50V	213-400
C 170	C Ceramic 100n 20% 50V	213-400
C 171	C Ceramic 100n 20% 50V	213-401
C 172	C Ceramic 100n 20% 50V	213-401
C 173	C Ceramic 100p 2% 100V NP0	213-211
C 174	C Ceramic 22p0 2% 100V NP0	213-206
C 175	C Ceramic 33p0 2% 100V NP0	213-208

DIODES

CR 1	Diode zener BZX79-C5V6 0.4W	350-629
CR 2	Diode zener BZX79-C5V6 0.4W	350-629
CR 3	Diode BAV45 Si Vr-20V If-50mA	350-432
CR 4	Diode BAV45 Si Vr-20V If-50mA	350-432
CR 5	Diode BAV45 Si Vr-20V If-50mA	350-432
CR 6	Diode BAV45 Si Vr-20V If-50mA	350-432
CR 7	Diode zener 1N825 C6V2 0.4W	350-637
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 29	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 30	Diode BAV10 Si Vr-60V If-600mA	350-022
CR 31	Diode zener BZX79-C5V6 0.4W	350-629
CR 32	Diode zener BZX79-C5V6 0.4W	350-629

CONNECTORS

J 2	Conn Coax Jack 50E F/PCB/Angled	800-308
J 3	Conn Coax Jack 50E F/PCB/Angled	800-308

RELAYS & JUMPERS

K 1	Relay Double Throw 4,5V	570-082
K 2	Relay Double Throw 4,5V	570-082

CHOKES

L 1	Choke HF Mini 470uH 10% 124MA	703-014
L 2	Choke HF Mini 470uH 10% 124MA	703-014
L 3	Choke HF Mini 470uH 10% 124MA	703-014
L 4	COIL 15MHz	731-203

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 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 J175-18 p jfet	360-252
Q 11	Transistor J175-18 p jfet	360-252
Q 12	Transistor J109-18 n Fet	360-188
Q 13	Transistor BSR50 npn	360-201
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 J175-18 p jfet	360-252
Q 20	Transistor J175-18 p jfet	360-252
Q 21	Transistor J109-18 n Fet	360-188
Q 22	Transistor BSR50 npn	360-201
Q 29	Transistor 2N3904 pnp	360-064

INTEGRATED ANALOG CIRCUITS

QA 1	IC AD7512DI dual switch	364-547
QA 2	IC LF356 op amp	364-203
QA 3	IC 5534A op amp	364-639
QA 4	IC 5534A op amp	364-639
QA 5	IC 5534A op amp	364-639
QA 6	IC 5534A op amp	364-639
QA 7	IC 5534A op amp	364-639
QA 8	IC 5534A op amp	364-639
QA 9	IC 5534A op amp	364-639

QA 10	IC 5534A op amp	364-639
QA 11	IC 5534A op amp	364-639
QA 12	IC 5534A op amp	364-639
QA 13	IC 5534A op amp	364-639
QA 14	IC NE5532A Dual OP-Amp low noise	364-640
QA 15	IC NE5532A Dual OP-Amp low noise	364-640
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 NE5532A Dual OP-Amp low noise	364-640
QA 19	IC NE5532A Dual OP-Amp low noise	364-640
QA 20	IC 5534A op amp	364-639
QA 21	IC NE5532A Dual OP-Amp low noise	364-640
QA 22	IC NE5532A Dual OP-Amp low noise	364-640
QA 23	IC NE5532A Dual OP-Amp low noise	364-640
QA 24	IC 5534A op amp	364-639
QA 25	IC TL084 quad op amp	364-276
QA 26	IC TL084 quad op amp	364-276
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 5534A op amp	364-639
QA 32	IC 5534A op amp	364-639

INTEGRATED DIGITAL CIRCUITS

QD 1	IC PCM53KPV 16 bit DAC	367-010
QD 2	IC 74HC273 Octal D-FF.	364-574
QD 3	IC 74HC273 Octal D-FF.	364-574
QD 5	IC HEF4528B Dual monostable multivibrator	364-249
QD 6	IC 74HC4049 HEX inverter	364-638
QD 7	IC HEF4029BP Synchronous up/down counter	364-269
QD 8	IC HEF4029BP Synchronous up/down counter	364-269
QD 9	IC HEF4013BP Dual D-type Flip-Flop	364-222
QD 10	IC HEF4013BP Dual D-type Flip-Flop	364-222
QD 11	IC CD74HCT138 3-to-8 line dec.	364-570
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
QD 15	IC HEF4724BP 8-bit adessable latch	364-412
QD 18	IC AD7115KN LOGDAC 0.1 dB step	364-567
QD 19	IC AD7115KN LOGDAC 0.1 dB step	364-567
QD 20	IC HEF4025BP Tripple 3-input Nor gate	364-355

RESISTORS

R 1	R thick film Sil 8x10K	146-003
R 2	R thick film Sil 8x10K	146-003
R 3	R Metal Film 10K5 1% 0.5W TC50	115-105
R 4	R Metal Film 10K5 1% 0.5W TC50	115-105
R 5	R Carbon Film 100E 5% 0.2W	106-310
R 6	R Metal Film 10K5 1% 0.5W TC50	115-105
R 7	R Cermet Trimpot 10K 20% 0.5W TC70	182-301
R 8	R Metal Film 10K5 1% 0.5W TC50	115-105

R 9	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R 10	R Metal Film 12K1 1% 0.5W TC50	115-121
R 11	R Metal Film 36K5 1% 0.5W TC50	115-365
R 13	R Carbon Film 1K 5% 0.2W	106-410
R 14	R Metal film 1K00 5% 0.2W TC250	107-410
R 15	R Metal Film 2K00 1% 0.5W TC50	114-200
R 16	R Metal Film 2K00 1% 0.5W TC50	114-200
R 17	R Carbon Film 2K2 5% 0.2W	106-422
R 18	R Carbon Film 2K2 5% 0.2W	106-422
R 19	R Metal Film 1K10 1% 0.5W TC50	114-110
R 20	R Metal Film 9K09 1% 0.5W TC50	114-909
R 21	R var 2K2 20% 0.5W	182-313
R 22	R Metal Film 7K15 1% 0.5W TC50	114-715
R 23	R Metal Film 10K2 1% 0.5W TC50	115-102
R 24	R Metal Film 49K9 1% 0.5W TC50	115-499
R 25	R Metal Film 576E 1% 0.5W TC50	113-576
R 26	R Metal Film 28E7 1% 0.5W TC50	112-287
R 27	R Carbon Film 47E 5% 0.2W	106-247
R 28	R Metal Film 1K00 1% 0.5W TC50	114-100
R 29	R Metal Film 1K00 1% 0.5W TC50	114-100
R 30	R Carbon Film 22E 5% 0.2W	106-222
R 31	R Metal Film 1K15 1% 0.5W TC50	114-115
R 32	R Metal Film 1K05 1% 0.5W TC50	114-105
R 33	R Carbon Film 1K 5% 0.2W	106-410
R 34	R Metal Film 162E 1% 0.5W TC50	113-162
R 35	R Metal Film 1K00 1% 0.5W TC50	114-100
R 36	R Metal Film 1K00 1% 0.5W TC50	114-100
R 37	R Metal film 1K13 1% 0.5W TC50	114-113
R 38	R Cermet Trimpot 200E 20% 0.5W TC70	182-315
R 39	R Metal Film 976E 1% 0.5W TC50	113-976
R 40	R Metal Film 210K 1% 0.5W TC50	116-210
R 41	R Metal Film 1K00 1% 0.5W TC50	114-100
R 42	R Metal Film 1K00 1% 0.5W TC50	114-100
R 43	R Metal Film 1K21 1% 0.5W TC50	114-121
R 44	R Cermet Trimpot 200E 20% 0.5W TC70	182-315
R 45	R Carbon Film 1K 5% 0.2W	106-410
R 46	R Metal Film 976E 1% 0.5W TC50	113-976
R 47	R Metal Film 105E 1% 0.5W TC50	113-105
R 48	R Carbon Film 47E 5% 0.2W	106-247
R 49	R Metal Film 1K00 1% 0.5W TC50	114-100
R 50	R Metal Film 1K00 1% 0.5W TC50	114-100
R 51	R Metal Film 1K30 1% 0.5W TC50	114-130
R 52	R Carbon Film 22E 5% 0.2W	106-222
R 53	R Metal Film 499E 1% 0.5W TC50	113-499
R 54	R Metal Film 52K3 1% 0.5W TC50	115-523
R 55	R Cermet Trimpot 4K7 20% 0.5W TC70	182-312
R 56	R Metal film 27K0 5% 0.2W TC250	107-527
R 57	R Metal Film 4K99 1% 0.5W TC50	114-499
R 58	R Metal Film 4K99 1% 0.5W TC50	114-499
R 59	R Metal Film 1K10 1% 0.5W TC50	114-110
R 60	R Metal Film 2K21 1% 0.5W TC50	114-221
R 61	R var 2K2 20% 0.5W	182-313
R 62	R Metal Film 12K1 1% 0.5W TC50	115-121
R 63	R Carbon Film 100E 5% 0.2W	106-310

R 64	R Metal Film 100K 1% 0.5W TC50	116-100
R 65	R Metal Film 100K 1% 0.5W TC50	116-100
R 66	R Carbon Film 100E 5% 0.2W	106-310
R 67	R Metal Film 7K68 1% 0.5W TC50	114-768
R 68	R Carbon Film 2M2 5% 0.2W	106-722
R 69	R Metal film 100E 5% 0.2W TC250	107-310
R 70	R Carbon Film 2K2 5% 0.2W	106-422
R 71	R Carbon Film 820K 5% 0.2W	106-682
R 72	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R 73	R Carbon Film 33K 5% 0.2W	106-533
R 74	R Cermet Trimpot 1K 10% 0.5W TC70	182-310
R 75	R Metal Film 4K87 1% 0.5W TC50	114-487
R 76	R Carbon Film 33K 5% 0.2W	106-533
R 77	R Cermet Trimpot 1K 10% 0.5W TC70	182-310
R 78	R Metal Film 4K87 1% 0.5W TC50	114-487
R 79	R Metal Film 5K36 1% 0.5W TC50	114-536
R 80	R Metal film 33K0 5% 0.2W TC250	107-533
R 81	R Metal film 33K0 5% 0.2W TC250	107-533
R 82	R Metal film 100E 5% 0.2W TC250	107-310
R 83	R Metal Film 100K 1% 0.5W TC50	116-100
R 84	R Metal Film 100K 1% 0.5W TC50	116-100
R 85	R Metal Film 34K0 1% 0.5W TC50	115-340
R 86	R Metal Film 2K00 1% 0.5W TC50	114-200
R 87	R Metal Film 2K00 1% 0.5W TC50	114-200
R 88	R Carbon Film 100E 5% 0.2W	106-310
R 89	R Metal Film 15K8 1% 0.5W TC50	115-158
R 90	R Metal Film 267K 1% 0.5W TC50	116-267
R 91	R Carbon Film 100E 5% 0.2W	106-310
R 92	R Metal Film 15K0 1% 0.5W TC50	115-150
R 93	R var 2K2 20% 0.5W	182-313
R 94	R Metal Film 34K0 1% 0.5W TC50	115-340
R 95	R Metal Film 2K00 1% 0.5W TC50	114-200
R 96	R Metal Film 2K00 1% 0.5W TC50	114-200
R 97	R Metal Film 15K0 1% 0.5W TC50	115-150
R 98	R var 2K2 20% 0.5W	182-313
R 99	R Metal Film 267K 1% 0.5W TC50	116-267
R 100	R Metal Film 15K8 1% 0.5W TC50	115-158
R 101	R Carbon Film 33E 5% 0.2W	106-233
R 102	R Carbon Film 33E 5% 0.2W	106-233
R 103	R Cermet Trimpot 10K 20% 0.5W TC70	182-301
R 104	R Metal Film 37K4 1% 0.5W TC50	115-374
R 105	R Metal Film 2K00 1% 0.5W TC50	114-200
R 106	R Metal Film 2K00 1% 0.5W TC50	114-200
R 107	R Metal Film 15K0 1% 0.5W TC50	115-150
R 108	R var 2K2 20% 0.5W	182-313
R 109	R Metal Film 267K 1% 0.5W TC50	116-267
R 110	R Metal Film 15K8 1% 0.5W TC50	115-158
R 111	R Carbon Film 2K2 5% 0.2W	106-422
R 112	R Carbon 1M 5% 0.2w	106-710
R 113	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R 114	R Metal Film 6K04 0.1% 0.5W TC25	141-158
R 115	R Metal Film 6K04 0.1% 0.5W TC25	141-158
R 116	R Metal Film 6K04 0.1% 0.5W TC25	141-158
R 117	R Metal Film 3K40 1% 0.5W TC50	114-340

R	118	R Metal Film 6K04 0.1% 0.5W TC25	141-158
R	119	R Cermet Trimpot 200E 20% 0.5W TC70	182-315
R	120	R Metal Film 4K99 1% 0.5W TC50	114-499
R	121	R Metal Film 6K04 0.1% 0.5W TC25	141-158
R	122	R Metal Film 100K 1% 0.5W TC50	116-100
R	123	R Metal Film 22K6 1% 0.5W TC50	115-226
R	124	R Metal Film 6K04 0.1% 0.5W TC25	141-158
R	125	R Metal film 33E0 5% 0.2W TC250	107-233
R	126	R Metal Film 20K5 1% 0.5W TC50	115-205
R	127	R Cermet Trimpot 10K 10% 0.5W TC100	182-407
R	128	R Metal film 33E0 5% 0.2W TC250	107-233
R	129	R Metal film 3K30 5% 0.2W TC250	107-433
R	130	R Metal film 470K 5% 0.2W TC250	107-647
R	131	R Cermet Trimpot 100K 20% 0.5W TC100	182-409
R	132	R Metal Film 6K19 1% 0.5W TC50	114-619
R	133	R var 2K2 20% 0.5W	182-313
R	134	R Metal Film 23K7 1% 0.5W TC50	115-237
R	135	R Metal Film 4K99 1% 0.5W TC50	114-499
R	136	R Carbon Film 100E 5% 0.2W	106-310
R	137	R Carbon Film 100E 5% 0.2W	106-310
R	138	R Carbon Film 2K2 5% 0.2W	106-422
R	139	R Carbon Film 820K 5% 0.2W	106-682
R	140	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	141	R Metal Film 34K8 1% 0.5W TC50	115-348
R	142	R Metal film 3K92 0.1% 0.25w TC25	141-004
R	143	R Cermet Trimpot 100E 20% 0.5W TC70	182-317
R	144	R Metal film 22E0 5% 0.2W TC250	107-222
R	145	R Metal Film 2K94 1% 0.5W TC50	114-294
R	146	R Metal film 2K05 0.1% 0.25w TC25	140-400
R	147	R Metal film 10E0 0.1% 0.25w TC25	140-478
R	148	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	149	R Metal film 22K0 5% 0.2W TC250	107-522
R	150	R Metal film 22K0 5% 0.2W TC250	107-522
R	151	R Metal film 22E0 5% 0.2W TC250	107-222
R	152	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	153	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	154	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	155	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	156	R Metal film 22K0 5% 0.2W TC250	107-522
R	157	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	158	R Metal film 2K05 0.1% 0.25w TC25	140-400
R	159	R Metal Film 2K94 1% 0.5W TC50	114-294
R	160	R Metal film 10E0 0.1% 0.25w TC25	140-478
R	161	R Metal film 3K92 0.1% 0.25w TC25	141-004
R	162	R Metal Film 34K8 1% 0.5W TC50	115-348
R	163	R Cermet Trimpot 100E 20% 0.5W TC70	182-317
R	164	R Metal Film 4K99 1% 0.5W TC50	114-499
R	165	R Metal Film 34K8 1% 0.5W TC50	115-348
R	166	R Metal film 3K92 0.1% 0.25w TC25	141-004
R	167	R Cermet Trimpot 100E 20% 0.5W TC70	182-317
R	168	R Metal film 22E0 5% 0.2W TC250	107-222
R	169	R Metal Film 2K94 1% 0.5W TC50	114-294
R	170	R Metal film 2K05 0.1% 0.25w TC25	140-400
R	171	R Metal film 10E0 0.1% 0.25w TC25	140-478

R	172	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	173	R Metal film 22K0 5% 0.2W TC250	107-522
R	174	R Metal film 22E0 5% 0.2W TC250	107-222
R	175	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	176	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	177	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	178	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	179	R Metal film 22K0 5% 0.2W TC250	107-522
R	180	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	181	R Metal film 2K05 0.1% 0.25w TC25	140-400
R	182	R Metal Film 2K94 1% 0.5W TC50	114-294
R	183	R Metal film 10E0 0.1% 0.25w TC25	140-478
R	184	R Metal film 3K92 0.1% 0.25w TC25	141-004
R	185	R Metal Film 34K8 1% 0.5W TC50	115-348
R	186	R Cermet Trimpot 100E 20% 0.5W TC70	182-317
R	187	R Metal Film 4K99 1% 0.5W TC50	114-499
R	188	R Metal film 22K0 5% 0.2W TC250	107-522
R	189	R Metal film 33K0 5% 0.2W TC250	107-533
R	190	R Metal film 33K0 5% 0.2W TC250	107-533
R	191	R Metal film 33K0 5% 0.2W TC250	107-533
R	192	R Metal film 33K0 5% 0.2W TC250	107-533
R	193	R Metal film 22K0 5% 0.2W TC250	107-522
R	194	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	196	R Metal film 1K00 5% 0.2W TC250	107-410
R	197	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	198	R Carbon Film 4M7 5% 0.2W	106-747
R	199	R Metal film 4K70 5% 0.2W TC250	107-447
R	200	R Metal film 33E0 5% 0.2W TC250	107-233
R	201	R Metal Film 11K5 1% 0.5W TC50	115-115
R	202	R var 2K2 20% 0.5W	182-313
R	203	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	204	R Carbon Film 3M9 5% 0.2W	106-739
R	205	R Metal film 1K80 5% 0.2W TC250	107-418
R	206	R Metal film 33E0 5% 0.2W TC250	107-233
R	207	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	208	R Metal Film 61K9 1% 0.5W TC50	115-619
R	209	R Metal film 33K0 5% 0.2W TC250	107-533
R	210	R Metal Film 4K42 1% 0.5W TC50	114-442
R	211	R Cermet Trimpot 1K 10% 0.5W TC70	182-310
R	212	R Metal film 33K0 5% 0.2W TC250	107-533
R	213	R Metal Film 10K 0.1% 0.4W TC50	141-139
R	214	R Metal film 33K0 5% 0.2W TC250	107-533
R	215	R Metal film 33K0 5% 0.2W TC250	107-533
R	216	R Metal film 33K0 5% 0.2W TC250	107-533
R	217	R Metal film 33K0 5% 0.2W TC250	107-533
R	218	R Metal film 33K0 5% 0.2W TC250	107-533
R	219	R Metal film 22K0 5% 0.2W TC250	107-522
R	220	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	221	R Metal Film 4K99 1% 0.5W TC50	114-499
R	222	R Metal film 1K00 5% 0.2W TC250	107-410
R	223	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	224	R Carbon Film 3M9 5% 0.2W	106-739
R	225	R Metal film 1K80 5% 0.2W TC250	107-418
R	226	R Metal film 33E0 5% 0.2W TC250	107-233

R	227	R var 2K2 20% 0.5W	182-313
R	228	R Metal Film 11K5 1% 0.5W TC50	115-115
R	229	R Cermet Trimpot 100K 20% 0.5W TC70	182-311
R	230	R Carbon Film 4M7 5% 0.2W	106-747
R	231	R Metal film 4K70 5% 0.2W TC250	107-447
R	232	R Metal film 33E0 5% 0.2W TC250	107-233
R	233	R Metal film 4k99 0.1% 0.25w TC25	140-981
R	234	R Metal Film 61K9 1% 0.5W TC50	115-619
R	235	R Metal film 33K0 5% 0.2W TC250	107-533
R	236	R Metal Film 4K42 1% 0.5W TC50	114-442
R	237	R Cermet Trimpot 1K 10% 0.5W TC70	182-310
R	238	R Metal film 33K0 5% 0.2W TC250	107-533
R	239	R Metal Film 10K 0.1% 0.4W TC50	141-139
R	240	R Metal film 33K0 5% 0.2W TC250	107-533
R	241	R Metal film 10K0 5% 0.2W TC250	107-510
R	242	R Metal film 10K0 5% 0.2W TC250	107-510
R	243	R Metal film 10K0 5% 0.2W TC250	107-510
R	244	R Metal film 10K0 5% 0.2W TC250	107-510
R	245	R Metal film 4K70 5% 0.2W TC250	107-447
R	246	R Metal film 4K70 5% 0.2W TC250	107-447
R	247	R Metal film 4K70 5% 0.2W TC250	107-447
R	248	R Metal film 4K70 5% 0.2W TC250	107-447
R	249	R Metal film 4K70 5% 0.2W TC250	107-447
R	250	R Metal film 4K70 5% 0.2W TC250	107-447
R	251	R Metal film 4K70 5% 0.2W TC250	107-447
R	252	R Metal film 4K70 5% 0.2W TC250	107-447
R	254	R Metal film 33K0 5% 0.2W TC250	107-533
R	255	R Metal film 33K0 5% 0.2W TC250	107-533
R	256	R Metal film 330K 5% 0.2W TC250	107-633
R	257	R Cermet Trimpot 200E 20% 0.5W TC70	182-315
R	258	R Metal Film 1K82 1% 0.5W TC50	114-182
R	260	R Metal Film 19E1 1% 0.5W TC50	112-191
R	261	R Cermet Trimpot 200E 20% 0.5W TC70	182-315
R	262	R Metal Film 1K82 1% 0.5W TC50	114-182
R	264	R Metal Film 19E1 1% 0.5W TC50	112-191
R	265	R Metal film 1K00 5% 0.2W TC250	107-410
R	266	R Metal film 100E 5% 0.2W TC250	107-310
R	267	R Metal film 100E 5% 0.2W TC250	107-310
R	268	R Metal Film 4K99 1% 0.5W TC50	114-499
R	269	R Metal Film 4K99 1% 0.5W TC50	114-499

CABLES

W	3	26 Leads Flatcable W. Connector	617-847

MISCELLANEOUS

Slot Screw M1.6X4	002-044
Slot Screw M1.6X4	005-044
Stay Bolt Issue 2	039-751
Stay Bolt	039-752
Washer |1.7/4X0.3	042-004
Female Plug	805-718
Wire Wrap Terminal	805-727

14 Pin Dil Socket	816-131
24 Pin Dil Socket	816-134
18 Pin DIL Socket	816-183
Board Extractor	857-017
Common Parts for Analog Board	901-819
Sk+rm Plade	952-859
Audio Generator Analog Part PCB	971-201

Audio Generator Digital Board (901-499)

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 solid AL 10u 20% 16V	265-008
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 solid AL 10u 20% 16V	265-008
C 47	C Ceramic 39p0 2% 100V NP0	213-232
C 48	C Ceramic 180p 2% 100V N750	213-228
C 49	C solid AL 10u 20% 16V	265-008

DIODES

CR 1	Diode zener BZX79-C3V6 0.4W	350-626
CR 2	Diode Schottky BAT41 S 150V 250mA	350-061

CHOKES

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

TRANSISTORS

Q 1	Transistor 2N3904 pnp	360-064
Q 2	Transistor BC327-25 SI PNP 45V 1A 800mW TO-92	360-224

INTEGRATED DIGITAL CIRCUITS

QD 7	IC TC5565PL-15 8KX8 CMOS RAM	364-612
QD 8	IC TC5565PL-15 8KX8 CMOS RAM	364-612
QD 11	IC HEF4008BP 4-bit binary full adder	364-411
QD 12	IC HEF4008BP 4-bit binary full adder	364-411
QD 13	IC HEF4008BP 4-bit binary full adder	364-411
QD 14	IC HEF4008BP 4-bit binary full adder	364-411
QD 15	IC HEF4585 4-bit comparator	364-504
QD 16	IC HEF4585 4-bit comparator	364-504
QD 17	IC HEF4585 4-bit comparator	364-504
QD 18	IC HEF4585 4-bit comparator	364-504
QD 19	IC HEF4585 4-bit comparator	364-504
QD 20	IC HEF4585 4-bit comparator	364-504
QD 21	IC HEF4585 4-bit comparator	364-504
QD 22	IC HEF4585 4-bit comparator	364-504
QD 23	IC 74HC273 Octal D-FF.	364-574
QD 24	IC 74HC273 Octal D-FF.	364-574
QD 25	IC HEF4724BP 8-bit adessable latch	364-412
QD 26	IC HEF4724BP 8-bit adessable latch	364-412
QD 27	IC HEF4724BP 8-bit adessable latch	364-412
QD 28	IC HEF4724BP 8-bit adessable latch	364-412
QD 29	IC HEF4724BP 8-bit adessable latch	364-412
QD 30	IC HEF4724BP 8-bit adessable latch	364-412
QD 31	IC HEF4724BP 8-bit adessable latch	364-412
QD 32	IC HEF4724BP 8-bit adessable latch	364-412
QD 33	IC HEF4724BP 8-bit adessable latch	364-412
QD 34	IC HEF40244 Octal buffer with 3-state	364-497
QD 35	IC HEF40244 Octal buffer with 3-state	364-497
QD 36	IC 74LS244 oct buffer	364-321
QD 37	IC 74LS244 oct buffer	364-321
QD 38	IC HEF40244 Octal buffer with 3-state	364-497
QD 39	IC HEF40244 Octal buffer with 3-state	364-497
QD 40	IC HEF40373BP Octal latch 3-state	364-572
QD 41	IC HEF40373BP Octal latch 3-state	364-572
QD 43	IC HEF4013BP Dual D-type Flip-Flop	364-222
QD 44	IC HEF4013BP Dual D-type Flip-Flop	364-222
QD 45	IC HEF4013BP Dual D-type Flip-Flop	364-222
QD 46	IC HEF40240 3-state buffer	364-573

QD 47	IC HEF40240 3-state buffer	364-573
QD 48	IC HEF40240 3-state buffer	364-573
QD 49	IC HEF40240 3-state buffer	364-573
QD 51	IC 4049 hex inv buffer	364-224
QD 52	IC 74LS04 hex inverters	364-219
QD 53	IC 74LS244 oct buffer	364-321
QD 55	IC 74LS244 oct buffer	364-321
QD 56	IC SN74LS245 Octal bus transceiver	364-332
QD 57	IC SN74LS245 Octal bus transceiver	364-332
QD 58	RE201 901-499 QD58 Select PROM	368-238
QD 59	IC CD74HCT138 3-to-8 line dec.	364-570
QD 60	IC CD74HCT138 3-to-8 line dec.	364-570
QD 61	IC SN74LS03 Quad 2-input Nand gate open collector	364-329
QD 62	IC HEF40106HEX Inverting Schmitt trigger	364-390
QD 63	IC HEF4073BP Tripple 3-input AND gate	364-385
QD 65	IC 74LS08 quad AND gate	364-270
QD 66	IC HEF4075BP Tripple 3-input OR gate	364-362
QD 67	IC HEF4071BP Quad 2-input OR gate	364-263
QD 68	IC 74LS32 quad OR gate	364-301
QD 69	IC HEF4071BP Quad 2-input OR gate	364-263

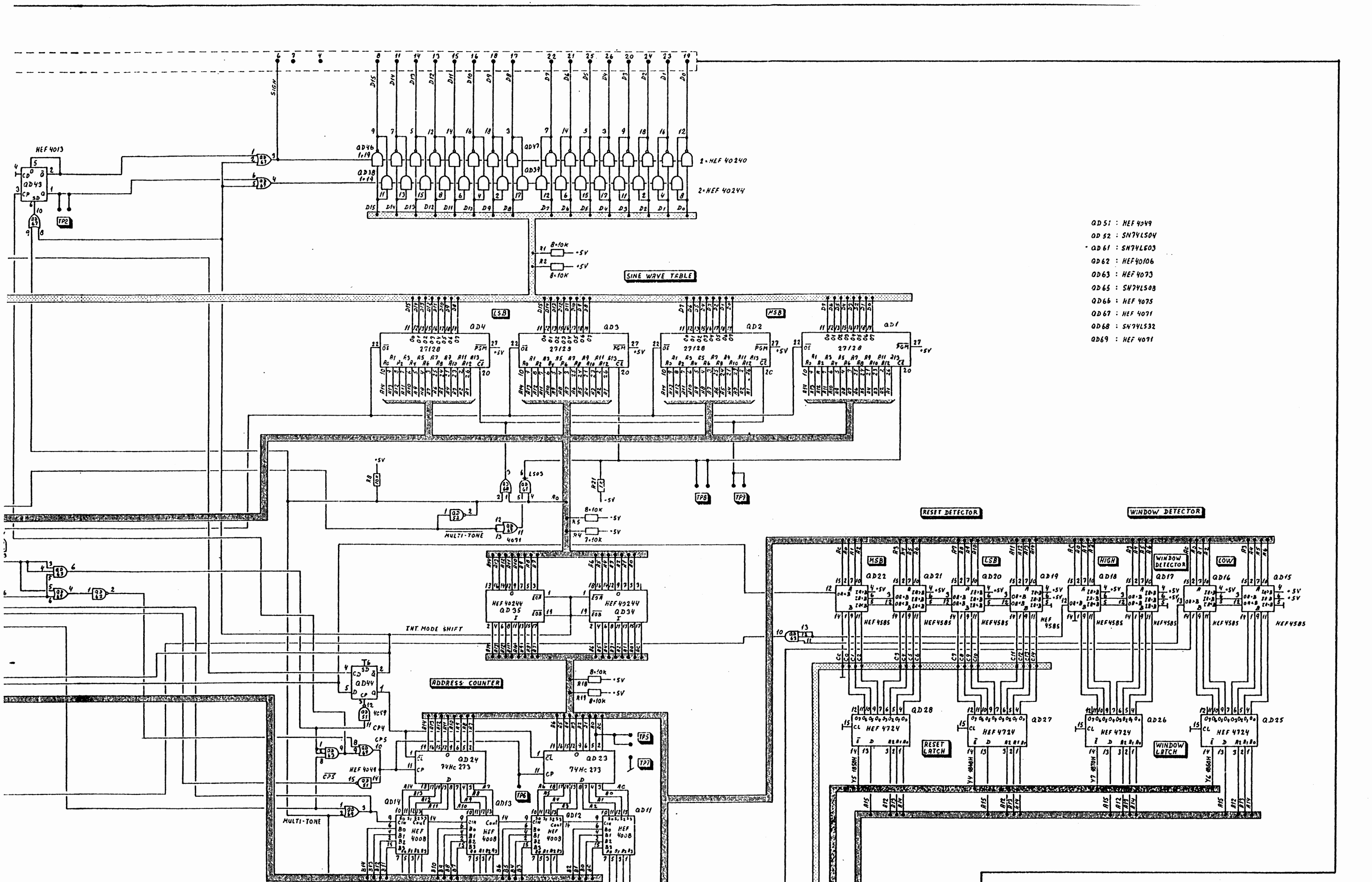
RESISTORS

R 1	R thick film Sil 8x10K	146-003
R 2	R thick film Sil 8x10K	146-003
R 4	R thick film Sil 8x10K	146-003
R 5	R thick film Sil 8x10K	146-003
R 6	R thick film Sil 8x10K	146-003
R 7	R thick film Sil 8x10K	146-003
R 8	R thick film Sil 8x10K	146-003
R 9	R thick film Sil 8x10K	146-003
R 10	R thick film Sil 8x10K	146-003
R 11	R thick film Sil 8x10K	146-003
R 13	R Metal film 1K00 5% 0.2W TC250	107-410
R 14	R Metal film 270E 5% 0.2W TC250	107-327
R 15	R Metal film 3K30 5% 0.2W TC250	107-433
R 16	R Metal film 22K0 5% 0.2W TC250	107-522
R 17	R Metal film 22K0 5% 0.2W TC250	107-522
R 18	R thick film Sil 8x10K	146-003
R 19	R thick film Sil 8x10K	146-003
R 20	R Metal film 1K00 5% 0.2W TC250	107-410
R 21	R Metal film 1K00 5% 0.2W TC250	107-410
R 22	R Metal film 150E 5% 0.2W TC250	107-315

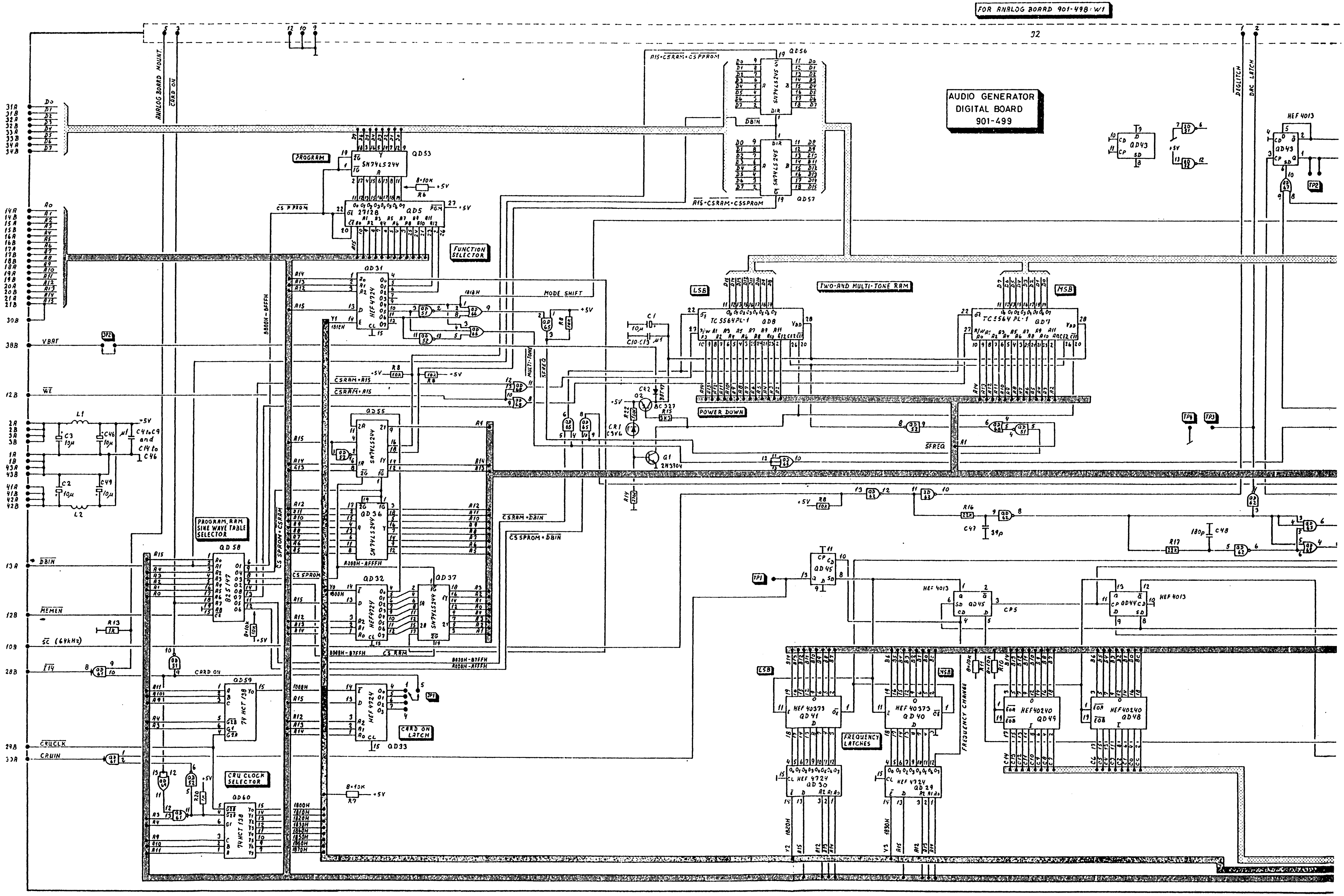
MISCELLANEOUS

	tubular rivet 02.5x0.25x7	060-270
	Female Plug	805-718
	Wire Wrap Terminal	805-727
	DIN 41651 26-POL PCB Mounted	805-918
	20 Pin DIL Socket	816-184
	28 Pin DIL Socket	816-251
	Solder Terminal 0.1 O2	823-303
	Board Extractor	857-017

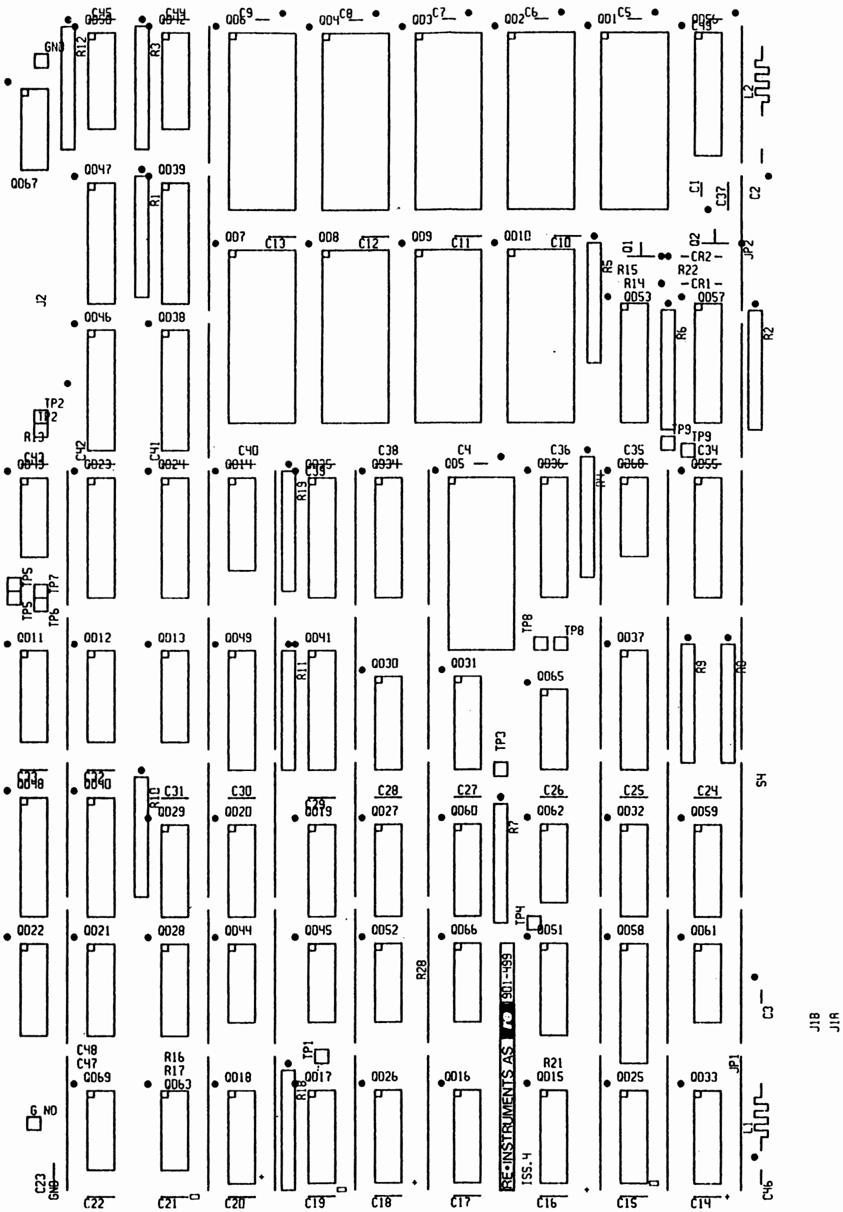
	Conducter Rail C1	931-036
	Conducter Rail C1	931-036
	Audio Generator Digital Part PCB	971-202
QD 1*	RE201 Audio Generator QD1 Ver. 1.0	368-243
QD 2*	RE201 Audio Generator QD2 Ver. 1.0	368-242
QD 3*	RE201 Audio Generator QD3 Ver. 1.0	368-241
QD 4*	RE201 Audio Generator QD4 Ver. 1.0	368-240
QD 5*	Audio Source Prom QD5 REV 1.5 F. FSK-Mod	368-349

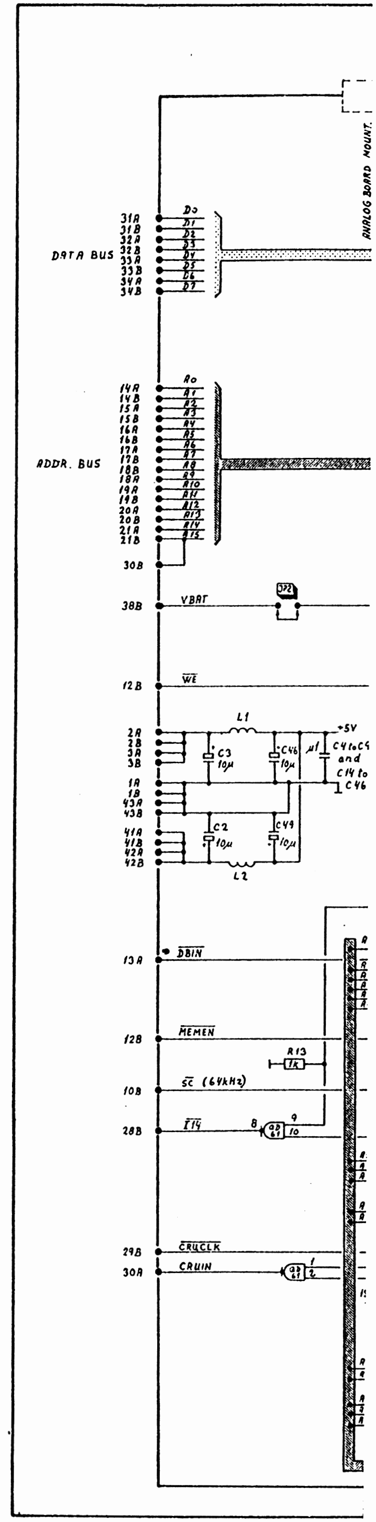


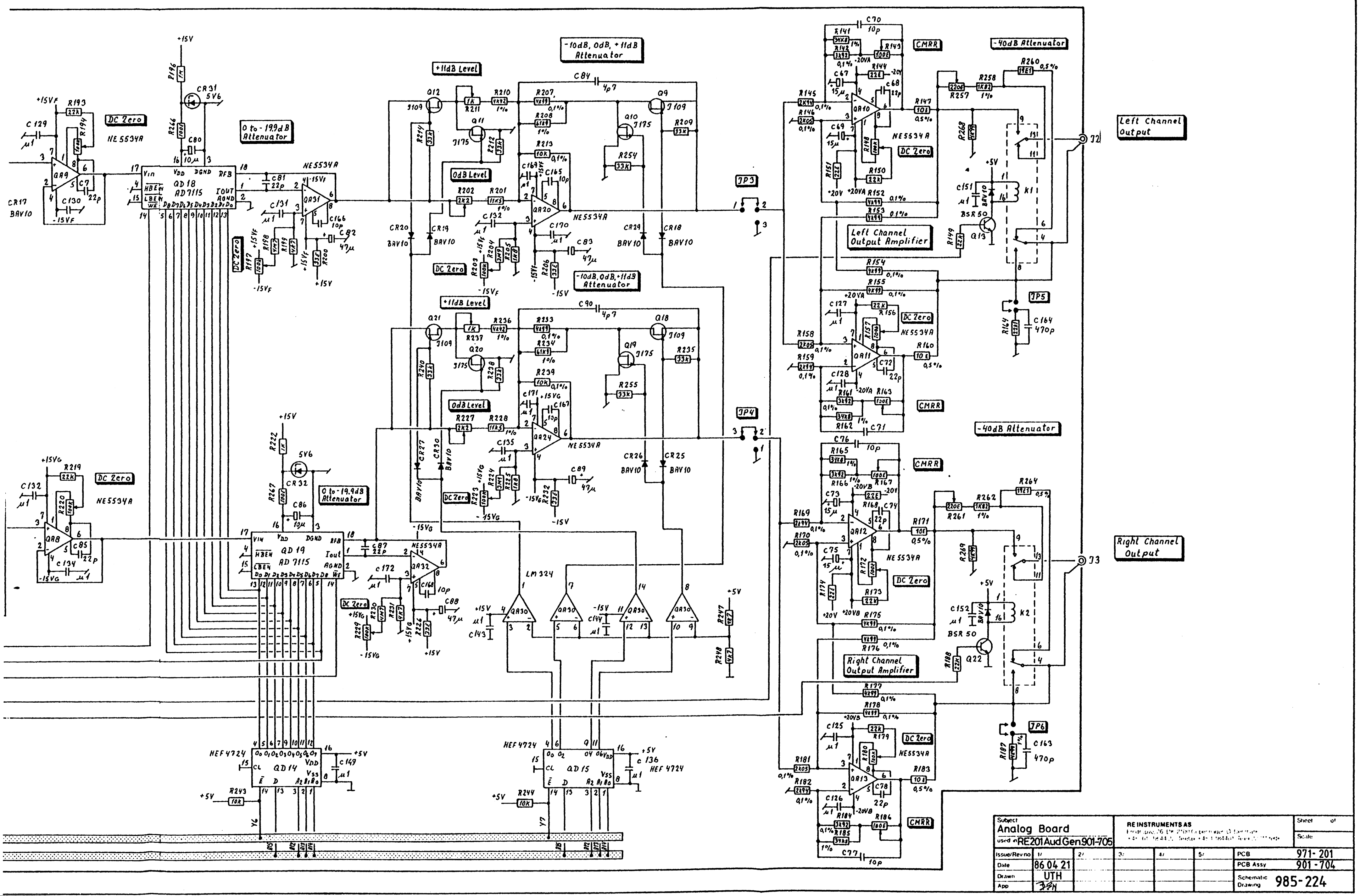
Subject: Digital Board used in RE201 Aud.Gen.901-500			RE INSTRUMENTS AS Emdrupvej 26 DK 2100 Copenhagen O Denmark +45 (01) 18 44 22 Telefax +45 1 184401 Telex 22211 redk			Sheet of Scale :
Issue/Rev.no	1/	2/	3/	4/	5/	PCB 971-202
Date	841003	850904				PCB Assy 901-499
Drawn	UP	BD				Schematic Drawing 985-159
App.	EF	NE				

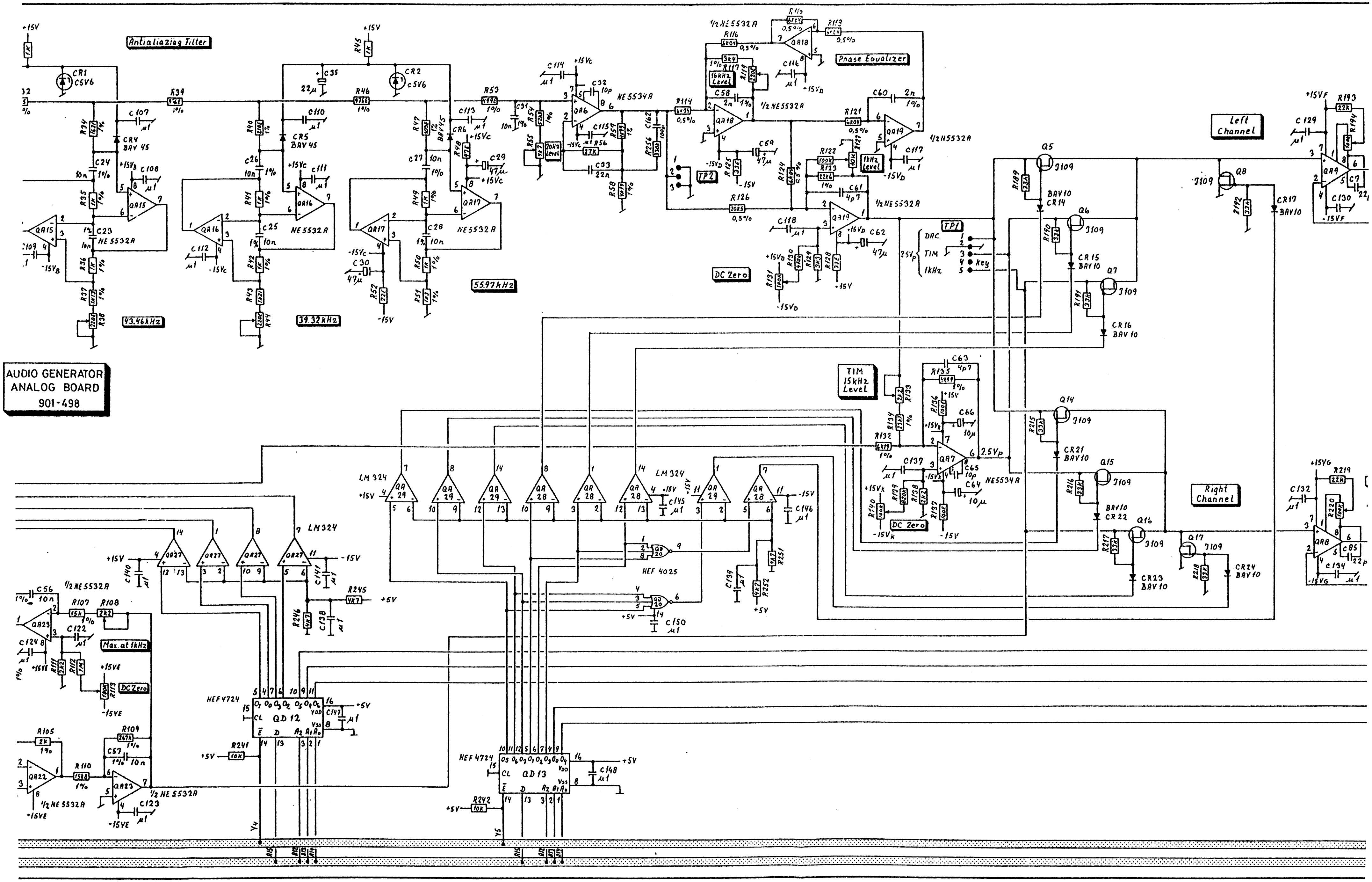


FOR ANALOG BOARD 901-498: W1
AUDIO GENERATOR
DIGITAL BOARD
901-499
PROGRAM
FUNCTION SELECTOR
MODE SHIFT
TWO-AND MULTI-TONE RAM
LSB
MSB
POWER DOWN
PROGRAM, RAM SINE WAVE TABLE SELECTOR
CRU CLOCK SELECTOR
CARD ON LATCH
FREQUENCY LATCHES
FREQUENCY CHANGE
ANALOG BOARD MOUNT
CARD ON
DEGLITCH
DAC LATCH
VBAT
WE
DBIN
MEMEN
SC (64kHz)
I14
CRUCLK
CRUIN
SN74LS244
2712B
HEF 4724
SN74LS245
TC5564PL-1
82S147
74HCT138
HEF 40373
HEF 40240
HEF 4013
2N3904
BC327


RE•INSTRUMENTS AS
901-499
ISS.4


DATA BUS
ADDR. BUS
ANALOG BOARD MOUNT.
VBAT
WE
DBIN
MEMEN
SC (64kHz)
CRUCLK
CRUIN
+5V
L1
L2


DC Zero
NE5534A
0 to -19,9dB Attenuator
+11dB Level
0dB Level
-10dB, 0dB, +11dB Attenuator
CMRR
-40dB Attenuator
Left Channel Output
Left Channel Output Amplifier
Right Channel Output
Right Channel Output Amplifier
AD7115
LM324
HEF 4724
Subject
Analog Board
used in RE201 Aud Gen 901-705
RE INSTRUMENTS AS
Issue/Revno
Date 86 04 21
Drawn UTH
PCB 971-201
PCB Assy 901-704
Schematic Drawing 985-224



Antialiazing Filter
Phase Equalizer
Left Channel
Right Channel
AUDIO GENERATOR
ANALOG BOARD
901-498
43.46kHz
39.32kHz
55.97kHz
DC Zero
TP1
TP2
TIM 15kHz Level
Max. at 1kHz
16kHz Level
1kHz Level
20kHz Level
DAC
TIM
1kHz
key
HEF 4724
HEF 4025
LM324
NE5532A
NE5534A
QD 12
QD 13

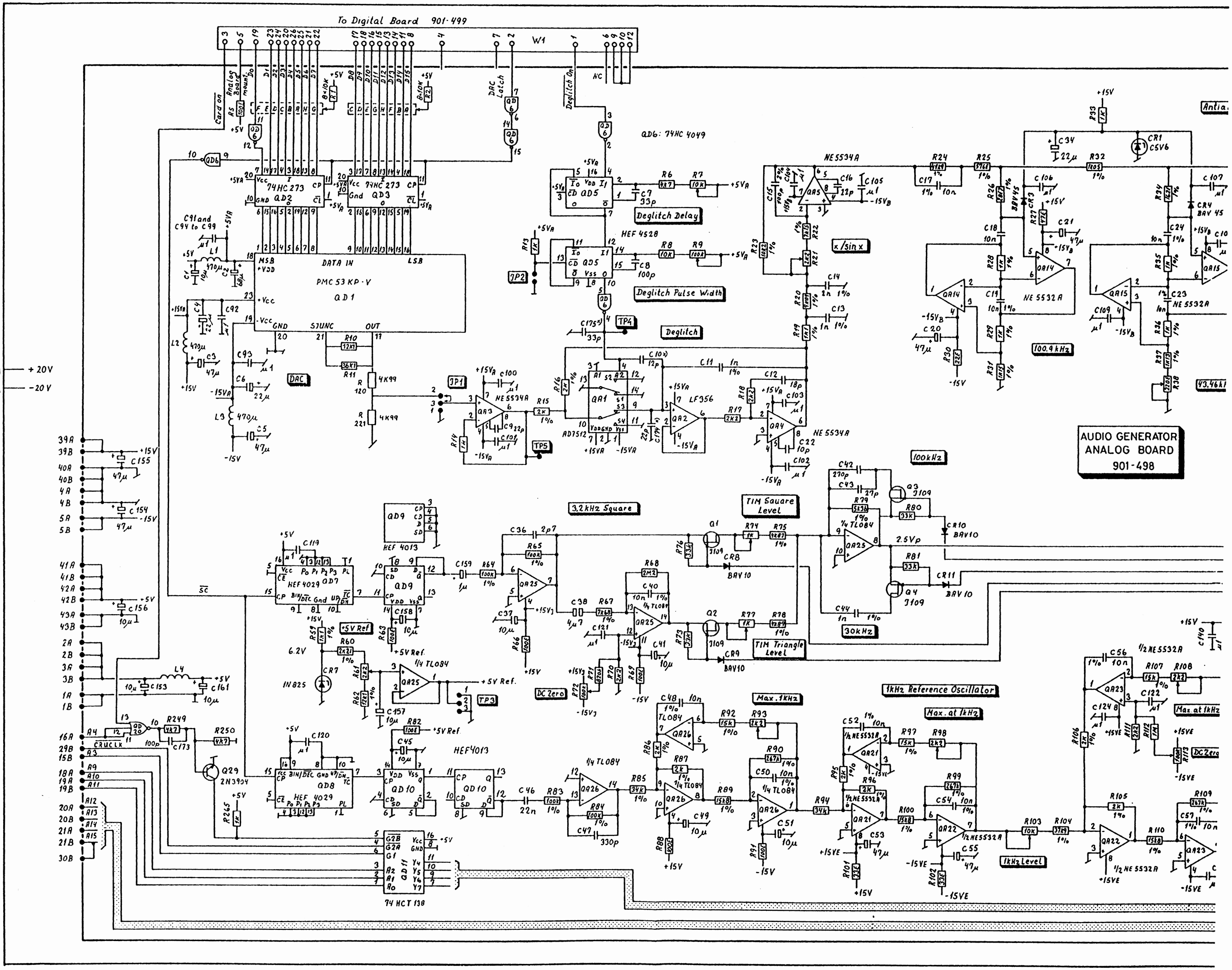

To Digital Board 901-499
W1
AUDIO GENERATOR
ANALOG BOARD
901-498
PMC 53 KP-V
QD1
DATA IN
MSB
LSB
74HC273
QD2
QD3
QD6: 74HC 4049
HEF 4528
Deglitch Delay
Deglitch Pulse Width
Deglitch
DAC
NE5534A
LF356
AD7512
x/sin x
NE 5532 A
100.9 kHz
100kHz
30kHz
3,2 kHz Square
TIM Square Level
TIM Triangle Level
HEF 4029
HEF 4013
+5V Ref
DC Zero
1/4 TL084
Max. 1kHz
1kHz Reference Oscillator
Max. at 1kHz
1kHz Level
74 HCT 138
2N3904
IN825
Card on
Analog Board mount
DAC Latch
Deglitch On
+ 20V
- 20V
6A
7A
TP1
TP2
TP3
TP4
TP5
JP1
JP2
2.5Vp
BAV10
J109
BAV 45
C5V6

TABLE OF CONTENTS

LIST OF FIGURES

1 GENERAL INFORMATION

This manual provides technical information for the RE905 Keyboard, which is to be used together with the RE201 Dual Channel Audio Analyzer.

1.1 Introduction

In many test situations it might be convenient to place the RE201 some distance away from the device under test in order to provide space for test jigs, power supplies, cables etc. The RE905 External Keyboard makes it possible to operate the RE201 from a distance of up to 2.5 m.

The RE905 Keyboard is an exact duplicate of the RE201 internal keyboard and the two keyboards can be operated in parallel.

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.

The RE905 Keyboard is connected to the RE201 Dual Channel Audio Analyzer by inserting the 14 pin connector into the equivalent found at the lower left corner of the RE201. Observe that the RE201 must be switched off during connection and disconnection in order to avoid damage of the electrical circuitry.

1.3 Equipment and Accessories

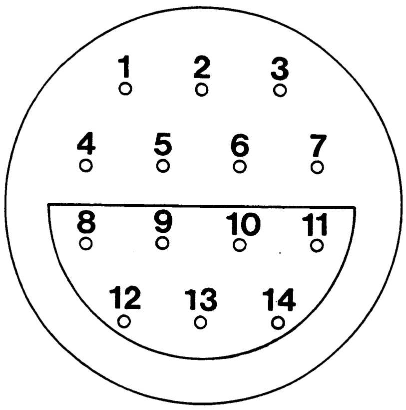
Description	Code No.
RE905 External Keyboard	906-032
Technical Manual	983-283

2 PRINCIPLES OF OPERATION

2.1 Principles of Operation

The RE905 Keyboard is provided with a 1.56 m coiled cable, which can be extended to approx. 2.5 m. The pin-out of the 14-pin connector of the cable, which matches the connector placed in the lower left corner of the front panel of the RE201, is shown in fig. 2.1.

When the RE905 Keyboard is connected to the RE201 the two keyboards may be used in parallel, the only difference being that the external keyboard uses interrupt line I12, whereas the built-in keyboard uses interrupt line I11.



1. A13 (white)
2. A12 (violet)
3. CRUOUT (black)
4. A10 (brown)
5. +5 V (brown/green)
6. A6 (grey)
7. A14 (red)
8. A11 (green)
9. $\overline{\text{CRUCLK}}$ (white/green)
10. $\overline{\text{STATIC}}$ (red/blue)
11. $\overline{\text{I12}}$ (blue)
12. A9 (yellow)
13. GROUND (grey/pink)
14. CRUIN (pink)

Fig. 2.1 - RE905 Keyboard Connector Pin-out

3 CIRCUIT DESCRIPTION

3.1 Circuit Description

The RE905 Internal PC Board (Code No. 901-610) is electrically almost identical to the RE201 internal keyboard (code No. 901-410 - refer to section 3.2.7 of the RE201 Basic Unit Technical Manual). A diagram of the RE905 Keyboard is enclosed (drawing 985-177) and a Block Diagram is found in fig. 3.1.

To prevent electrical damage to the internal C-MOS circuits when the RE905 is connected and disconnected the inputs are - when necessary - provided with TTL buffers (QD9 and QD10).

When you depress one of the 36 push buttons on the RE905 Keyboard an interrupt of the Static CPU, governing the keyboards, is generated by forcing line No. 10 (interrupt line 11) to logic zero. The Static CPU responds by writing a logic 1 to QD8 pin 6. As the address space is common for the internal keyboard and the RE905 Keyboard, a logic 1 is also written to pin 6 on QD8 on the internal keyboard, thus enabling the RE905 Keyboard to transmit data on CRUIN and disabling the internal keyboard. This is used during keyboard scan. A logic zero on QD8 pin 6 will disable the RE905 Keyboard and allow the static CPU to scan the internal keyboard.

When the RE905 Keyboard has been selected the static computer performs a scan of the 36 push buttons (QD1, QD2) and when the depressed button is detected (indicated by a logic 1 on CRUIN) the computer resets the interrupt by toggling pin No. 7 on QD8.

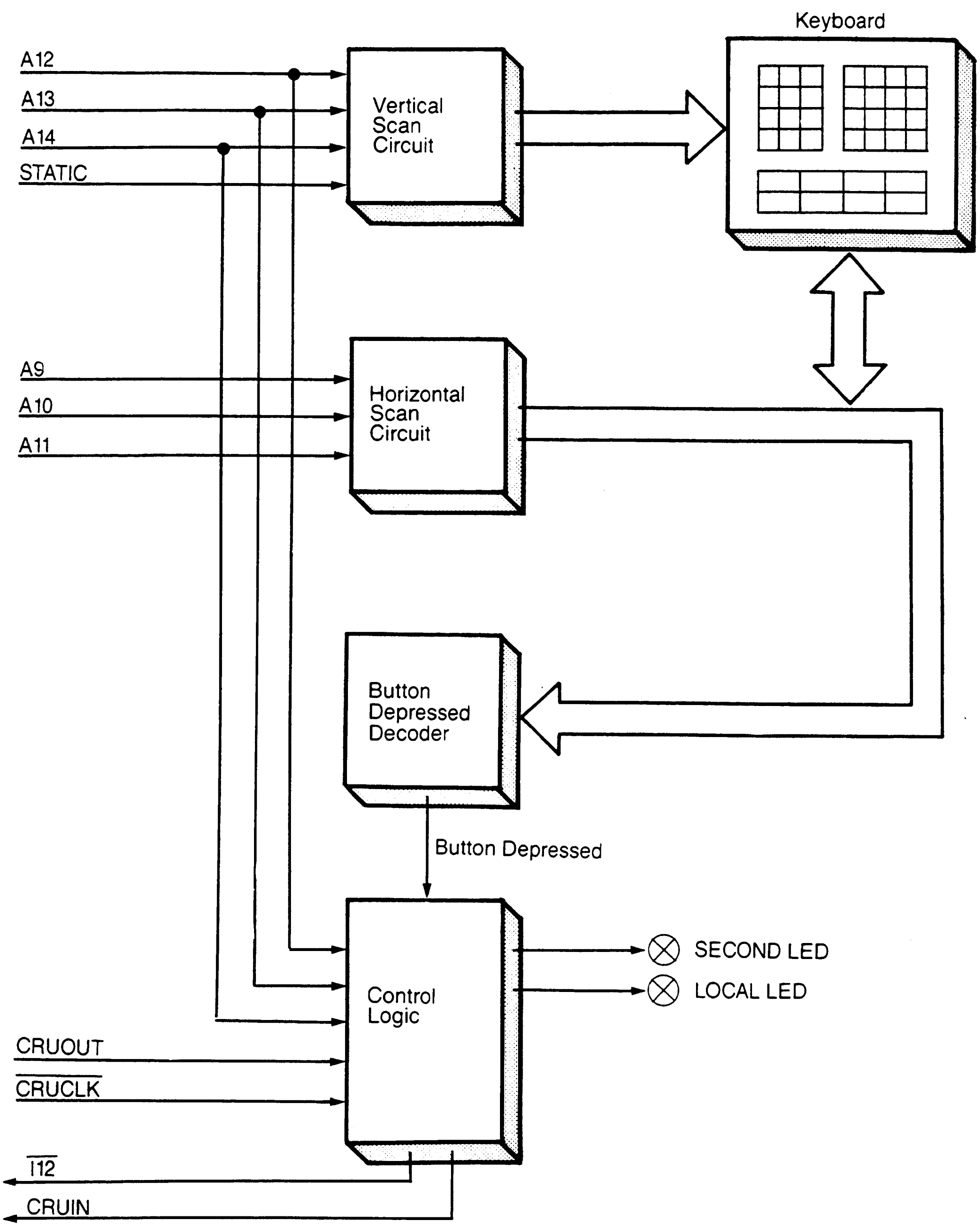


Fig. 3.1 - RE905 Block Diagram

4 PERFORMANCE TEST

4.1 Performance Test

Before the performance test is carried out please observe that:

* The RE201 should be turned off when the RE905 Keyboard is connected or disconnected to the RE201.
* Press buttons until the RE201 reacts (may be 1-2 sec.).
* Only buttons on the RE905 Keyboard are used during this test.

The performance test is now carried out as follows:

a. Connect the RE905 Keyboard to the RE201 and power up the RE201.

b. Press 'LEARN' and check that the green LED on the RE905 is turned on.

c. Press function key F1, <SYSTEM>, and check that the RE201 displays 'SYSTEM PARAMS'.

d. Press the 'cursor down' and 'cursor up' buttons one after another, and check that the cursor (>) moves down and up.

e. Press '2nd' and 'EXIT' and check that the red LED is lit when '2nd' is pressed and extinguishes when 'EXIT' is activated.

f. Press function key F5, <BASIC>, and check that the RE201 displays 'BASIC PARAMS'.

g. Press 'cursor right' and 'cursor left' and check that the cursor moves right and left.

h. Press 0 - 9 and check that all the digits, when activated, are displayed in the right-handed character field in the brackets.

i. Press '2nd' and 'EXIT'.

j. Press function key F2, <FUNCT>, and check that the RE201 displays 'ENTER FUNCTION'.

k. Press '2nd' and 'EXIT'.

l. Press function key F6, <DEFLT>, and check that the RE201 displays 'ENTER FUNCTION'.

m. Press '2nd' and 'EXIT'.

n. Press function key F3, <SEQUEN>, and check that the RE201 displays 'ENTER SEQUENCE NUMBER'.

o. Press '2nd' and 'EXIT'.

p. Press function key F7, <SETUP>, and check that the RE201 displays 'ENTER SETUP NUMBER'.

q. Press '2nd' and 'EXIT'.

r. Press function key F4, <PROGRAM>, and check that the RE201 displays 'SELECT USING SOFTKEY'.

s. Press '2nd' and 'EXIT' and '2nd' and 'EXIT'.

t. Press one by one: THD, IM, DFIM, TIM, PHASE, FREQ, SEP, LEV. Check that the RE201 starts executing each measurement when the appropriate key is activated.

u. Press '2nd' and 'TEST' and check that the RE201 performs a selftest.

v. Press 'COPY' and check that the RE201 displays 'PRINTER NOT READY' or 'PRINTING IN PROGRESS PLEASE WAIT' depending on whether a printer is connected to the RE201.

x. Press 'LEARN', 'PHASE' and function key F8, <DEFLT>, and check that the RE201 displays 'SELECT USING SOFTKEY'.

y. Press '2nd' and 'EXIT'.

When all steps are performed successfully the RE905 Keyboard should work perfectly.

If one or more keys do not work properly, disassemble the cable connector housing by unscrewing the rear part of the connector and check bad connections. If no error is found the fault is to be found either in the RE905 Keyboard or in the RE201.

4.2 Dismantling

To gain access to the RE905 PC Board the following steps should be carried out:

a. Disconnect the RE905 from the RE201.

b. Unscrew the two screws on each side panel and remove panels.

c. Move the top panel a few centimetres to the right, as shown in fig. 4.1.

d. Unscrew the screw securing the cable and remove the cable from the keyboard profile.

e. Remove the top panel by moving it to the left until it leaves the keyboard profile.

f. Unscrew the four nuts in each corner of the PC Board and remove the board from the top panel.

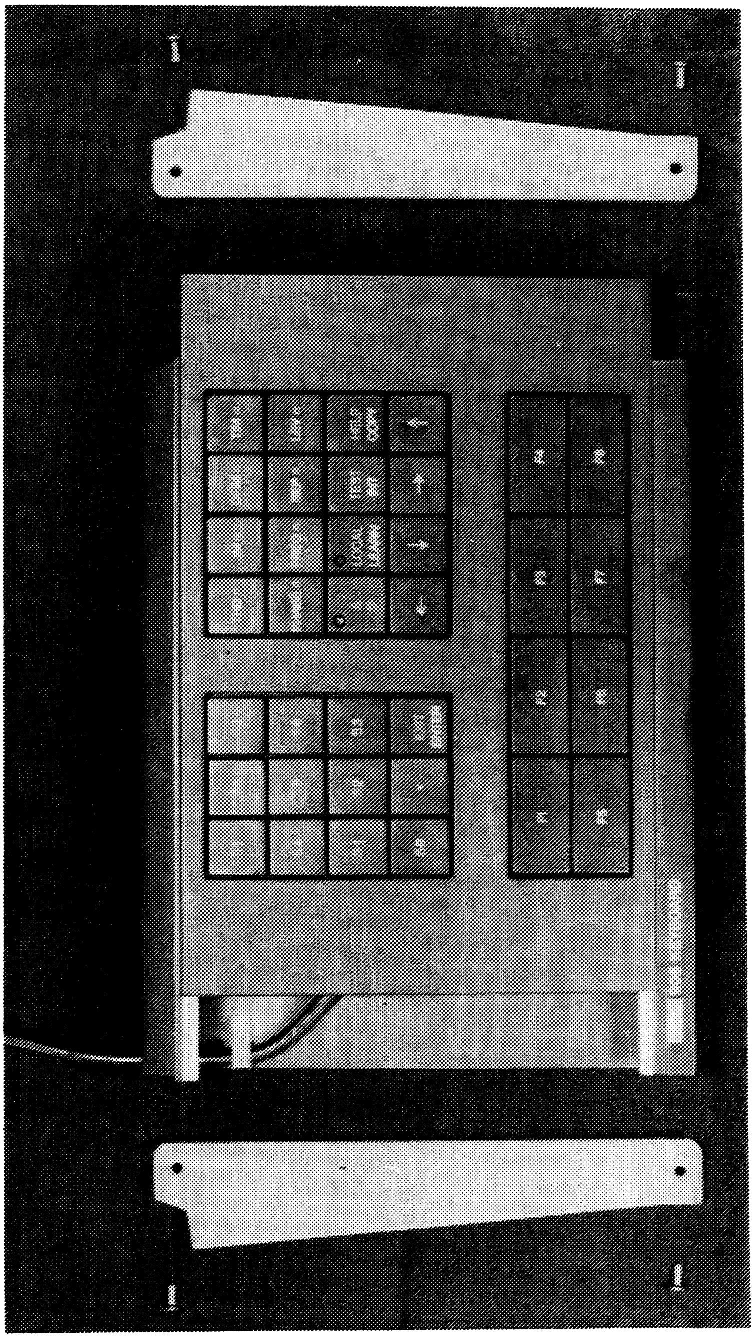


Fig. 4.1 - Dismantling the RE905

5 PARTS LIST AND SCHEMATIC DIAGRAM

5.1 Parts List

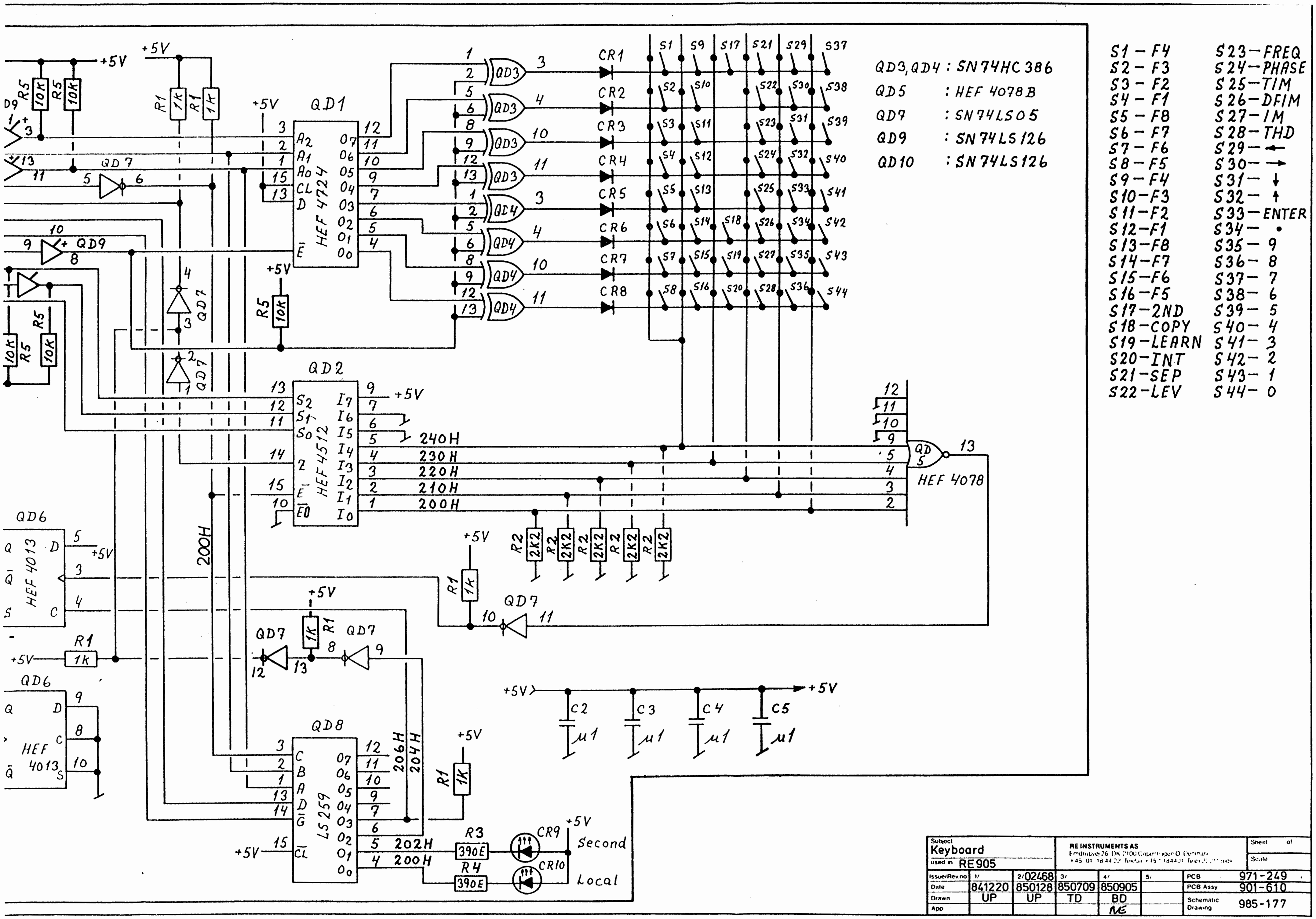
All electronic components are included in the parts list. Parts marked with a * are manufactured by RE INSTRUMENTS AS.

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

* Code No. and description of the part.

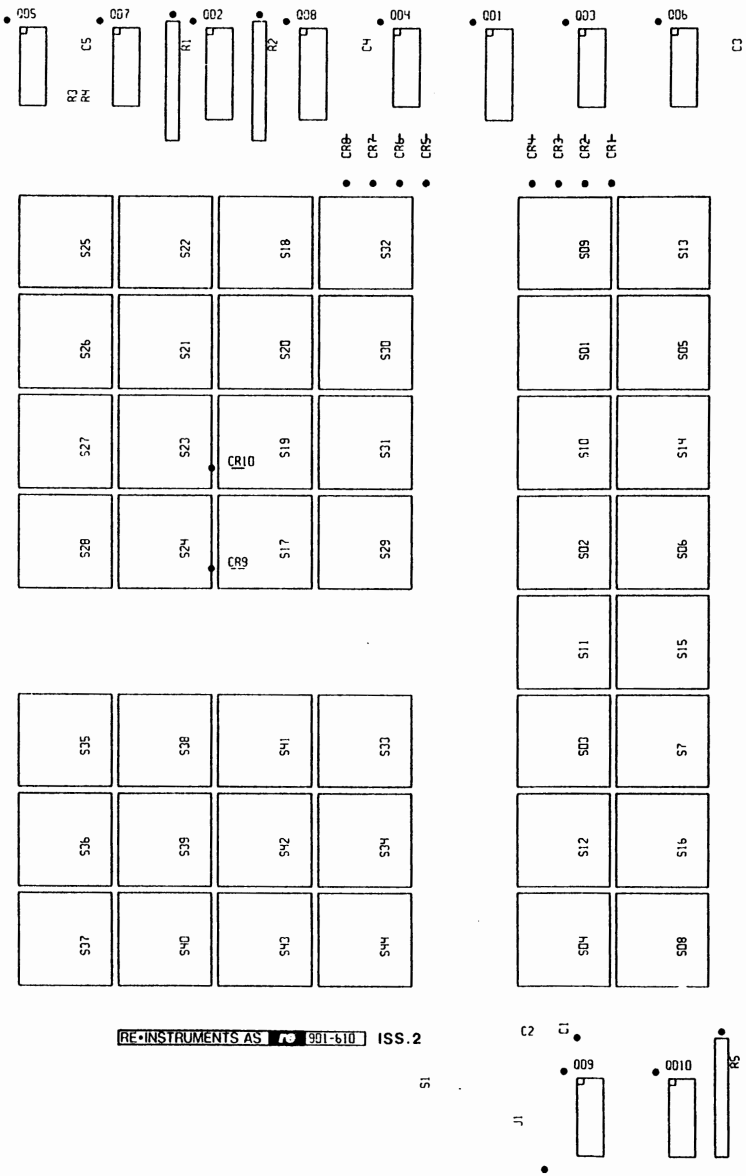
* Circuit reference from the schematic diagram.

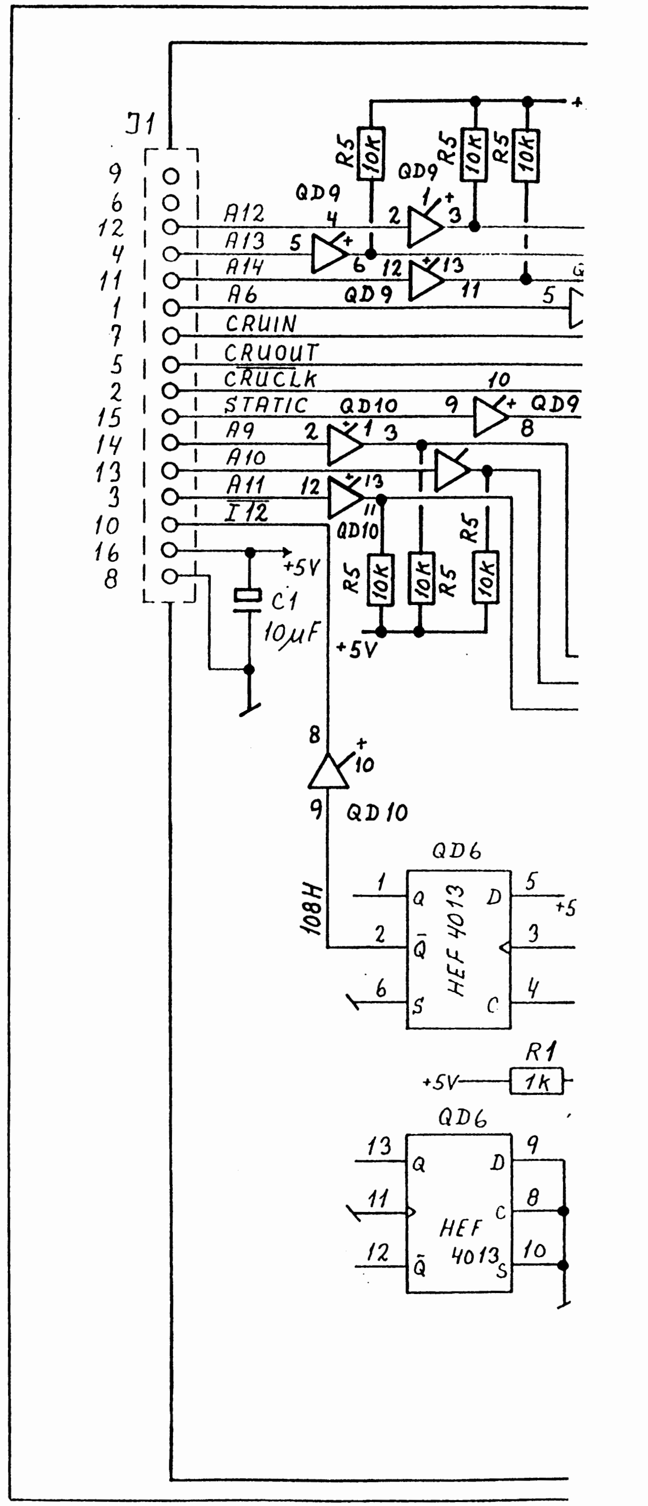
* Complete type designation of RE product.



Subject: Keyboard	RE INSTRUMENTS AS				Sheet of
used in: RE905					Scale
Issue/Rev.no	1/	2/ 02468	3/	4/	5/
Date	841220	850128	850709	850905	
Drawn	UP	UP	TD	BD	
App					

PCB: 971-249
PCB Assy: 901-610
Schematic Drawing: 985-177


RE•INSTRUMENTS AS 901-610
ISS.2


J1
A12
A13
A14
A6
CRUIN
CRUOUT
CRUCLK
STATIC
A9
A10
A11
I12
QD9
QD10
R5
10K
C1
10µF
+5V
108H
QD6
HEF 4013
R1
1k

Keyboard (901-610)

CAPACITORS

C 1	C Tantalum 10u 20% 16V	267-000
C 2	C Ceramic 100n 20% 50V	213-401
C 3	C Ceramic 100n 20% 50V	213-401
C 4	C Ceramic 100n 20% 50V	213-401
C 5	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

CONNECTORS

J 1	Connector Socket for 16-Pin	816-217

INTEGRATED DIGITAL CIRCUITS

QD 1	IC HEF4724BP 8-bit adessable latch	364-412
QD 2	IC HEF4512BP 8-input multiplexer	364-279
QD 3	IC SN74HC386N Exclusive OR-gates	364-642
QD 4	IC SN74HC386N Exclusive OR-gates	364-642
QD 5	IC 4078 8-input NOR gate	364-268
QD 6	IC HEF4013BP Dual D-type Flip-Flop	364-222
QD 7	IC SN74LS05N HEX inverters (open collector)	364-214
QD 8	IC SN74LS259 8-bit adressable latch	364-397
QD 9	IC 74LS126 quad 3-state buffer	364-273
QD 10	IC 74LS126 quad 3-state buffer	364-273

RESISTORS

R 1	R trick film Sil 8x1K	146-010
R 2	R trick film Sil 8x2K2	146-013
R 3	R Metal film 390E 5% 0.2W TC250	107-339
R 4	R Metal film 390E 5% 0.2W TC250	107-339
R 5	R thick film Sil 8x10K	146-003

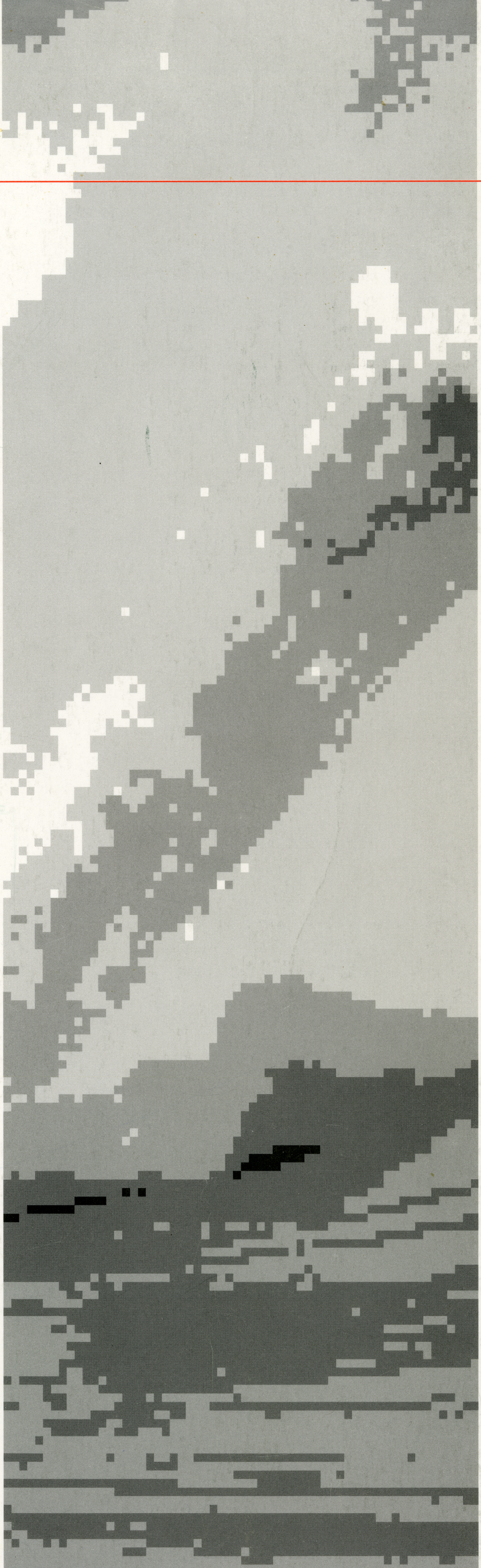
SWITCHES

S 1	Marquardt Keyboard Switch	520-209
S 2	Marquardt Keyboard Switch	520-209
S 3	Marquardt Keyboard Switch	520-209
S 4	Marquardt Keyboard Switch	520-209
S 5	Marquardt Keyboard Switch	520-209
S 6	Marquardt Keyboard Switch	520-209

S 7	Marquardt Keyboard Switch	520-209
S 8	Marquardt Keyboard Switch	520-209
S 9	Marquardt Keyboard Switch	520-209
S 10	Marquardt Keyboard Switch	520-209
S 11	Marquardt Keyboard Switch	520-209
S 12	Marquardt Keyboard Switch	520-209
S 13	Marquardt Keyboard Switch	520-209
S 14	Marquardt Keyboard Switch	520-209
S 15	Marquardt Keyboard Switch	520-209
S 16	Marquardt Keyboard Switch	520-209
S 17	Marquardt Keyboard Switch with Red LED	520-210
S 18	Marquardt Keyboard Switch	520-209
S 19	Marquardt Keyboard Switch with Green LED	520-211
S 20	Marquardt Keyboard Switch	520-209
S 21	Marquardt Keyboard Switch	520-209
S 22	Marquardt Keyboard Switch	520-209
S 23	Marquardt Keyboard Switch	520-209
S 24	Marquardt Keyboard Switch	520-209
S 25	Marquardt Keyboard Switch	520-209
S 26	Marquardt Keyboard Switch	520-209
S 27	Marquardt Keyboard Switch	520-209
S 28	Marquardt Keyboard Switch	520-209
S 29	Marquardt Keyboard Switch	520-209
S 30	Marquardt Keyboard Switch	520-209
S 31	Marquardt Keyboard Switch	520-209
S 32	Marquardt Keyboard Switch	520-209
S 33	Marquardt Keyboard Switch	520-209
S 34	Marquardt Keyboard Switch	520-209
S 35	Marquardt Keyboard Switch	520-209
S 36	Marquardt Keyboard Switch	520-209
S 37	Marquardt Keyboard Switch	520-209
S 38	Marquardt Keyboard Switch	520-209
S 39	Marquardt Keyboard Switch	520-209
S 40	Marquardt Keyboard Switch	520-209
S 41	Marquardt Keyboard Switch	520-209
S 42	Marquardt Keyboard Switch	520-209
S 43	Marquardt Keyboard Switch	520-209
S 44	Marquardt Keyboard Switch	520-209

MISCELLANEOUS

Screw pozidriv panhead M2x8	008-108
Nut hexagon M2	031-200
Washer 1.6/5*0.5	042-105
KeyBoard Plate	932-678
RE905 Keyboard PCB	971-249



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