PRECISION WATTMETER
MODEL 304B

MAINTENANCE MANUAL

INFRATEK

4. THEORY OF OPERATION

4.1. Introduction

This section presents an overall functional description of the 304B, followed by detailed circuit description. The description is supported by the schematic diagrams in section 7.

4.2. Overall Functional Description

A functional block diagram of the 304B is shown in Figure 4.1. The input section for phase 2 and phase 3 is not shown. It is identical to the input section of phase 1.
The basic signal path flows from left to right. The inputs are sensed at the input terminals, scaled, converted, directed to the A/D-Converter circuit, the digital representation transmitted via optocouplers to latches, processed by the digital controller, and sent to the display.
The current amplifier and the voltage amplifier constitute the "front end" of the power analyzer. The current amplifier senses the current in the plug-in and produces a proportional AC-or DC voltage for all functions. Its output is applied to the RMS converter, the AC-Converter, the DC-Converter, which all produce an equivalent DC voltage. The multiplexer selects one out of four signals and presents it via a sample and hold circuit to the A/D-Converter.
The voltage amplifier senses the voltage in the devider circuit. Its function, the converter function, the function of the multiplexer and A/D-Converter are the same as for the current amplifier section.
The microprocessor (digital controller) controls the operation of virtually every part of the 304B. It reads the front panel controls, configures the instrument for each function and range, triggers the A/D-Converters, controls the multiplexers, reads the appropriate latch, performs averaging, calculates the results, controls the display, and communicates with the IEEE-488 interface.
The main power supply provides supply voltages to all parts of the instrument including the DC/DC-Converters, which provide isolated supply voltage to the input section of the current and voltage amplifiers.

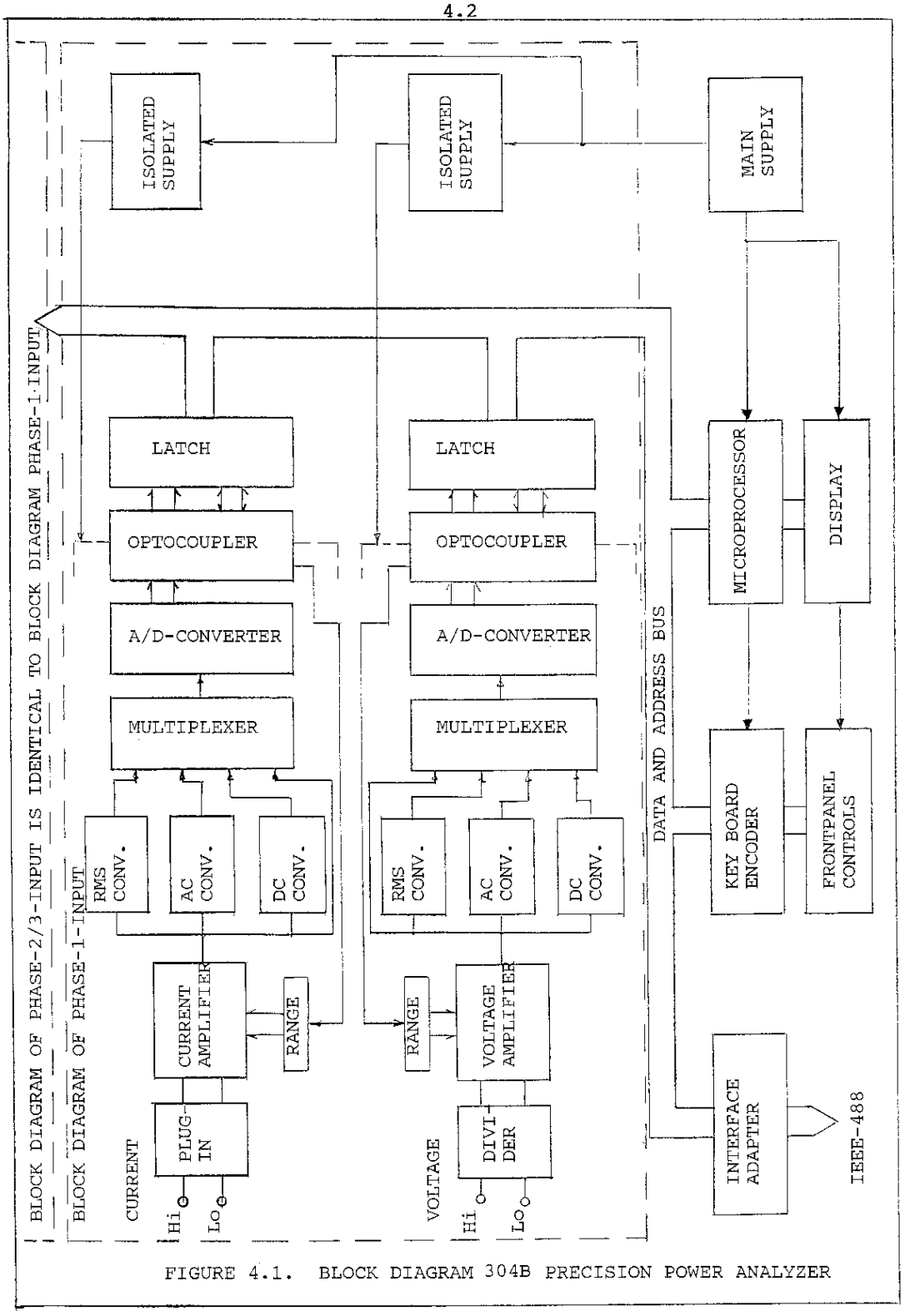


FIGURE 4.1. BLOCK DIAGRAM 304B PRECISION POWER ANALYZER

4.3. Detailed Circuit Description

The following parapraphs give a detailed circuit description of the functional blocks in Figure 4.1. The descriptions follow the part designations of the schematic diagrams of section 7. Pins are designated by the respective integrated circuit (e.g. U 202-7 for U 202 pin 7).

4.4. Current Amplifier

The current amplifier of phase 1, phase 2, and phase 3 are identical. The voltage drop across the current sensing resistor in the plug-in is amplified by amplifiers U201, U202, (max. gain = 11.18), and U203 (max. gain 11.18) to yield a full scale level of 2.5V dc or rms. The gain (step 10:1) of the first amplifier stage U201, U202 is switched by Q201. The gain of the second amplifier stage U203 is switched by Q203 (step 10:3) and by Q205 (step 10:1). The following amplifier U204 provides AC- or DC Coupling controlled by Q204.
The control signals for the gain switching transistors are produced by optocouplers U222 and U223. The table below gives the state of the gain switching transistors for the 5 current ranges.

10A plug-in

RANGE / TRANSISTOR	200mA I=1	600mA I=2	2A I=3	6A I=4	20A I=5	AC	DC+AC
Q201	OFF	OFF	ON	ON	ON		
Q203	OFF	ON	OFF	ON	OFF		
Q205	OFF	OFF	OFF	OFF	ON		
Q207						OFF	ON

The output of U204 is directly applied to the RMS converter U207, the AC-Converter U205, the DC-Converter U206-1, 2, 3, and the voltage devider R232, R233, P206. The converters produce an equivalent DC output signal with a gain of 1. The output of the AC- Converter U205-12, 13, 14 is a rectified signal which is averaged in U206-5, 6, 7. The output of the voltage devider R232, R233, P206 is used for power computation.

The three converter outputs and the voltage devider output are applied to the analog multiplexer U208. U214 selects 1 of the 4 multiplexer signals. U214 in turn is controlled by the optocoupler outputs U223-14, 16.
U211 samples the multiplexer output and presents the value to the A/D-Converter U210. The A/D-Converter performs a 12 bit conversion in approximately 30us. The digital output is buffered in U217 and U218 and applied to the optocouplers U219, U220, and U221. The reference voltage of 5.12V for the A/D-Converter is provided by Q210. The reference is established in VR203. U209 and Q210 decouple VR203 from any current variations caused by the A/D-Converter. The sample and hold and the A/D-trigger signal is initiated by the optocoupler U222 pin 11. The optocoupler output is delayed and shaped in U213-8, 9, 10. The signal at U213-10 triggers the timer U216 which produces a 6us pulse at U216-3. This pulse activates the sample and hold U211 via the devider network R253, R250. It also starts the A/D-conversion 6us later via network R245, C228, U213, and U212. Clamp transistor Q211 increases the conversion speed by forcing a reduced settling time for each conversion nibble. The dual amplifier U215 generates the over- and under range signals.
The supplies A and B are for the analog signal processing circuits. The supplies C and D are for the digital section on the amplifier board.

4.5. Voltage Amplifier

The voltage amplifier performs basically the same functions as the current amplifier. The description, therefore, is limited to the circuit parts which are different from the current amplifier.
The voltage from the input devider R111 (placed on mother board), R301, R406 is amplified in U301, U302, U303. DE305 and DE306 provide input protection. The input amplifiers U301, U302 contain two gain switching stages. Q312 switches the highest voltage range (1000V). The following table show the state of the voltage range-setting transistors.

RANGE TRANSISTOR	2V U=1	6V U=2	20V U=3	60V U=4	200V U=5	600V U=6	1000V U=7	AC	DC+AC
Q301	OFF	OFF	ON	ON	ON	ON	OFF		
Q303	OFF	ON	OFF	ON	OFF	ON	OFF		
Q305	OFF	OFF	OFF	OFF	ON	ON	ON		
Q312	OFF	OFF	OFF	OFF	OFF	OFF	ON		
Q307								OFF	ON

The output of the AC-Converter U305-7 produces on R405 a zero crossing signal which detects the zero crossing of the applied input voltage. Pin 7 of U305 drives pin 5 of optocoupler U324.
The remaining functions are identical to the current amplifier.

4.6. Latches (Decoder PCA)

The latches for the data transfer are located on the encoder PCA. Measurement data is transfered by the latches U401 through U412. They are grouped as follows: U401 and U402 transfer the 12 bit measurement data from the current amplifier phase 1. U403 and U404 transfer the 12 bit measurement data from the voltage amplifier phase 1. Similarly, U405-U408 transfer the data from phase 2, and U409-U412 transfer the data from phase 3.
U413 drives the gain setting transistors of the voltage- and current amplifiers phase 1, phase 2, and phase 3. The output U413-5 sets the AC- or AC+DC-Coupling of all current- and voltage amplifiers. U414 provides signals for the analog multiplexers U214, U314 of the current amplifiers and the voltage amplifiers.
U415 and U416 read control signals from the input amplifiers. They read the over- and under range signals, the zero crossing signals from the voltage amplifiers, the external trigger input, and the codes for the options installed and the type of plug-in in use.
U417 reads random numbers generated by counter U418, which, in turn, is driven by a random noise generator.

4.7. Address Decoder

The address decoding is performed by U420, U421 and U422. U419 serves as address pulse inverter. The address decoder addresses all latches on the Decoder PCA and starts the A/D-Converters. The decoder also generates address pulses for part of the circuitry on the encoder PCA, the IEEE-interface, and the recorder output.

4.8. Key Board Encoder (Encoder PCA)

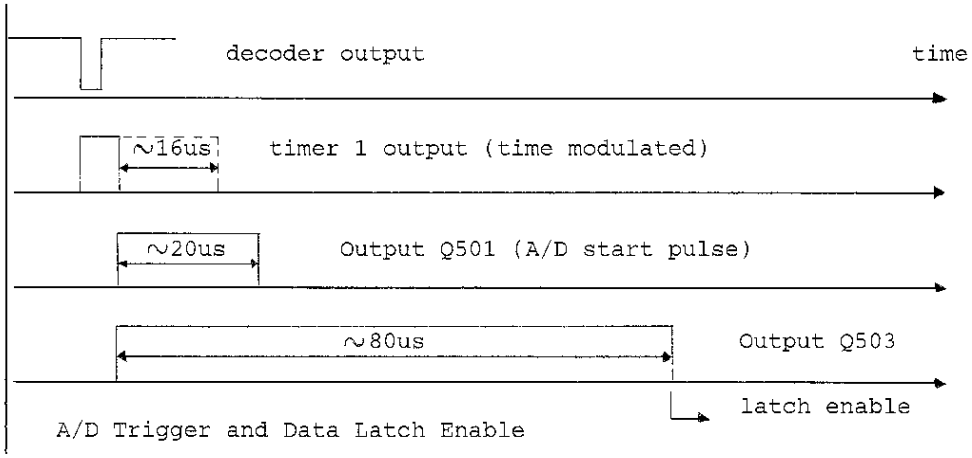
The key board encoder U501 communicates with the microprocessor over the internal bus. The microprocessor sends annunciator data (front panel Led) to the key board encoder and receives front panel control signals from the keyboard encoder. The annunciator data is buffered by U507/U508.
The key board encoder scans the keyboard (front panel controls), sensing pressed buttons on lines RLO-RL7. It sends a status flag to the microprocessor via line IRQ and U408 (on decoder PCA) whenever a front panel control is depressed. The microprocessor then reads the code from the key board encoder register.

4.9. Wh-Time Increment

U511 and U512 generate the time increment for the Wh-measurement. U511 and U512 devide the 1MHz system clock. The output state of U512 is proportional to the time increment. The microprocessor reads the time increment via latch U513 and then resets U512.

4.10. A/D Trigger and Data Latch Enable

When the A/D-Converter is addressed the decoder sends out a pulse to the dual timer U509-6. The noise generator modulates its pulse width via transistor Q502.
The second timer is started on the falling edge and starts the A/D-Converters on the current- and voltage amplifier. Q501 serves as driver.
The first timer U509 also starts U510 which generates a latch enable pulse to read in the data latches U401-U412. The timing is shown below.



4.11. Microprocessor

The 6809 Microprocessor is located on the Microprocessor PCA. Its program is stored in three 8k EPROMS'S. For variable management a 2k RAM is used and a VIA controlles the vacuum fluorescent display module. The microprocessor communicates with the reset of the instrument via the internal bus and dedicated I/0 lines.
On start-up the microprocessor is first reset. Then all peripheral circuits are initialized to operate in the desired mode. Each component that sends or receives data on the bus has a unique address or range of addresses.
The microprocessor performs the following functions: range and function control, A/D control, keyboard and display control, computation, recorder output control, and IEEE-488 interface communication.

4.12. Display

The communication with the display module is performed by the VIA U2. Display data is stored in the display module. The display module generates the display characters and scans the grids. It also contains the converters for the cathode- and anode voltage of the VFD.

4.13. Power Supply

The power supply provides the outputs +12V and +5V. The AC for the +5V supply is rectified by DE601 and regulated by U601. The +5V output supplies mostly logic circuits.
The AC voltage for the +12V supply is rectified in DE602 and regulated by U602 and U603. The +12V output supply digital and a analog circuits. The +12V output also supply the DC/DC-Converters which, in turn, supply the input circuitry of the three current- and the three voltage amplifiers.

4.14. Isolated Supply

The input section of the three current input amplifiers and the three voltage input amplifiers are each supplied by a separate DC/DC-Converter. The six DC/DC-Converters are located on the DC/DC-Converter PCA. The PCA also holds the noise generator.

4.15. Random Noise Generator

The random noise produced by R601 is amplified in Q601-Q604 and applied to Q502 and U409. The outputs of Q502 and U409 are used to produce random time increments.

4.16. IEEE-488 Interface

The main part of the interface is the interface controller U701. This circuit manages and controls the signal- and data transfer between external system controller and 304B microprocessor. The microprocessor reads data from and loads data in the U701 interface controller memory. U702 and U703 are bus transceivers to communicate with the external interface controller. U704 is the address latch. It is read when the 304B is turned on and loads memory of U701.

4.17. Recorder Output

The recorder output DA converter U705 receives a 10 bit data word and converts it to an equivalent current which is amplified in U706. The symmetrical +1V output is achieved by the offsetting resistor R716.

4.18. Multifunction Recorder Output

The 8 bit DIA-converters U750 through 752 generate 10 analog output signals. U753 contains the address of the DIA to be loaded. The address is latched into U753 with the DAL-pulse. Once the address is applied to the appropriate DIA converter, its data is loaded with the DAH-pulse.
Each of the circuits U750, U751, and 752 contain 4 DIA-converters, three of which are used to output the analog signals.
U750 outputs Arms 1, Arms 2, and Arms 3. U751 outputs Vrms 1, Vrms 2, and Vrms 3. Finally, U752 outputs W1, W2, and W3. ΣW is formed in U754-1, 2, 3. The 2V-DIA-reference is generated by U754-5, 6, 7 and U755.

5. MAINTENANCE

WARNING: These service instructions are for use by qualified personnel only. To avoid electric shock, do not perform any procedures in this section unless you are qualified to do so.

5.1. Introduction

This section presents maintenance information for the 304B. The section includes an alignment procedure, a calibration procedure, troubleshooting information, and other general service information.

5.2. Disassembly Procedure

WARNING: To avoid electric shock, remove the power cord and test leads before disassembling the instrument.

5.3. Top Cover Removal

1. Pull out the current plug-in on rear.
2. Remove the rear panel- and front panel screws along the top edge.
3. Remove the two top screws on each side panel
4. Lift the top cover from the case.

All parts of the 304B are now accessible.

5.4. Circuit Board Location

Figure 5.1. shows the location of the printed circuit board assemblies including the interconnecting cables.
The DC/DC Converter PCA, the three current amplifier PCA, the three voltage amplifier PCA, the decoder PCA, the microprocessor PCA, and the encoder PCA are all pluged into the mother board PCA placed along the rear side of the 304B.

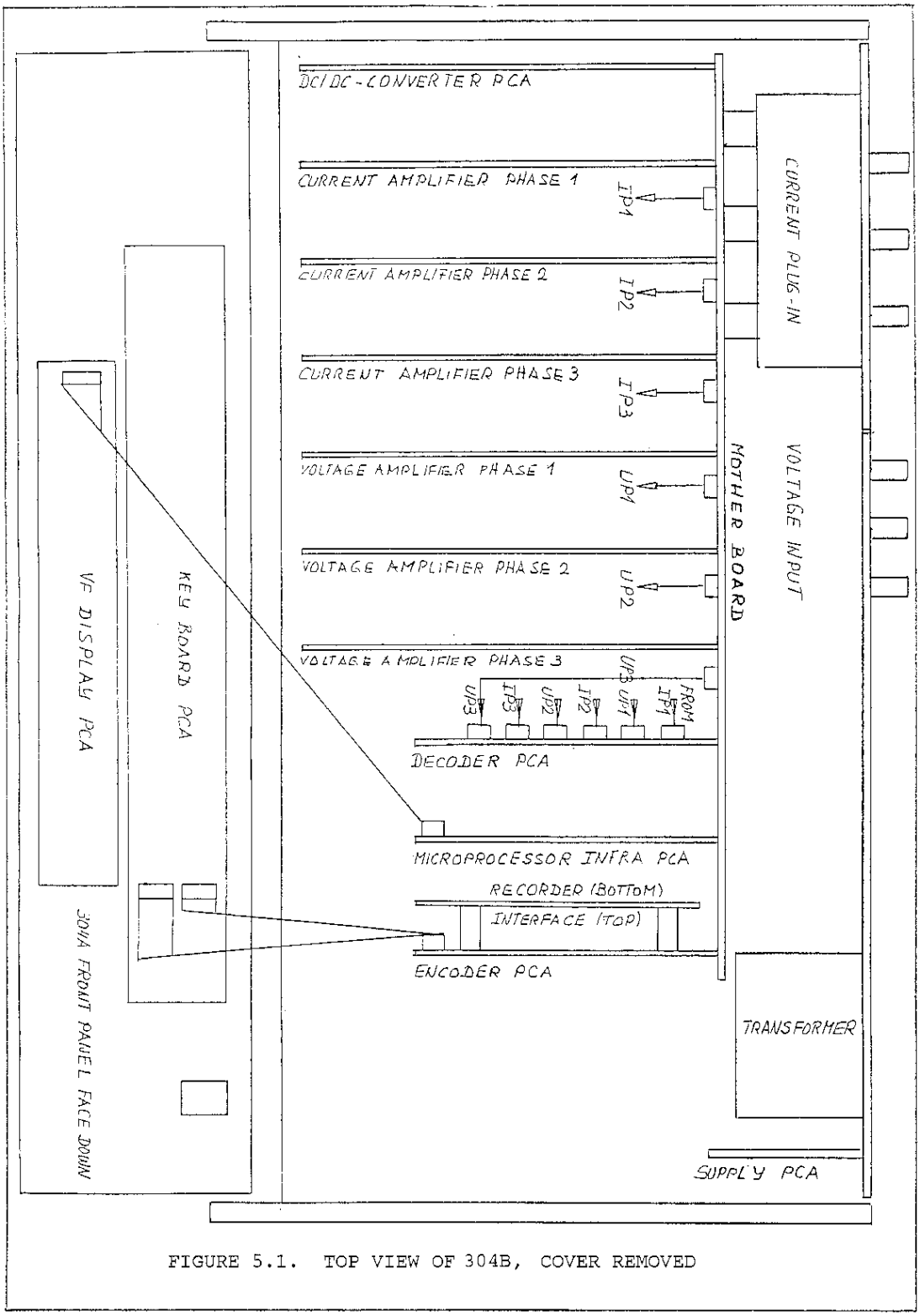


FIGURE 5.1. TOP VIEW OF 304B, COVER REMOVED

The front panel assembly carries the display module, the keyboard switches, and the front panel Led.
The rear panel assembly carries the power transformer and the main power supply PCA.
The recorder output option and the IEEE-488 interface option are mounted with spacers on the encoder PCA.

5.5. Front Panel Disassembly

1. Disconnect the connecting cable to the microprocessor PCA.
2. Disconnect the two connecting cables to the encoder PCA
3. Remove the three screws along the front panel bottom edge.
4. Unscrew the four nuts on the display module corners. Lift out the display module.
5. Unscrew the six nuts on the key board PCA and remove the print.

5.6. IEEE-488 Interface PCA Removal

1. Remove the two screws from the rear panel IEEE-488 connector.
2. Remove the two screws from the rear panel IEEE-488 address switch assembly.
3. Unplug the encoder PCA.
4. Unplug the connector to the encoder PCA and remove the three screws holding the interface PCA.

5.7. Recorder Output Removal

1. Unplug the encoder PCA.
2. Unplug the connector to the encoder PCA and remove the two screws holding the recorder output PCA.

5.8. Main Power Supply PCA Removal

When removing the main power supply PCA the rear panel must be taken off first.

1. Disconnect all leads to the rear panel. Unsolder the leads to the front panel power switch.
2. Remove the three screws along the rear panel bottom edge.
3. Take out the three isolated screws holding the voltage regulators to the rear panel.
4. Remove the screws holding the metal angles attached to the main power supply PCA.

5.9. Mother Board PCA Removal

1. Remove all boards from the mother board PCA.
2. Disconnect all leads from the mother board PCA.
3. Take off the rear panel.
4. Remove the four screws along the bottom edge of the mother board and lift it out.

5.10. Alignment and Calibration Procedure

To attain full accuracy, the current amplifiers and voltage amplifiers have to be properly aligned before calibration. The procedures are described for current- and voltage amplifiers. To eliminate offset errors measure all signals with respect to ground potential on P206 and R333.

5.11. Preliminary steps

1. Remove the three current amplifier PCA and adjust with P205 the input impedance (R201 + P205) to exactly 1.7000kOhm. Plug in the current amplifiers and turn on the power switch.

2. Adjust the ±9.5V supply voltage for the current- and voltage amplifiers using potentiometers P101-P112.

Allow 15 minutes warm-up time before proceeding to the next steps.

5.12. Clock Frequency Adjustment (Phase 1-3)

Adjust the A/D-Converter U210/U310 clock frequency on pin 24 to 290kHz by adjusting potentiometers P216 and P316.

5.13. Amplifier DC Offset Adjustment (Phase 1-3)

Select the lowest current- and voltage range.

1. Adjust P207/P307 for OmV on pin 6 of U202/U302.
2. Adjust P208/P308 for OmV on pin 6 of U203/U303.
3. Select AC-Coupling. Adjust P209/P309 for 0mV on pin 6 of U204/U304.

5.14. Converter DC Offset Adjustment (Phase 1-3)

Select AC-Coupling.

1. Adjust P210/P211 to produce 0mV on the mean output on U206/U306 pin 1.

2. Apply a current- and voltage input to yield 125mV (100Hz sinewave) on the amplifier U204/U304-6 output.
   a. Adjust P215/P315 to 125mV dc on pin 14 of RMS converter U207/U307.
   b. Adjust P211/P311 to 112.6mV dc on pin 7 of U206/ U306 (AD converter output).

Disconnect the input signals.

5.15. Preliminary A/D-Reference Adjustment (Phase 1-3)

Adjust with P219/P319 the A/D-reference on pin 21 (U210/U310) to 5.120V.

5.16. Preliminary A/D-Symmetry Adjustment (Phase 1-3)

Select AC-Coupling. Select A= and V=. Short U211/U311-5 to ground. Adjust P214/P314 for zero A= and V= display.

5.17. Adjustment for Symmetrical DC Power Reading (Phase 1-3)

Select AC+DC-Coupling. Select W display. Apply approx. 100mA/10V (20A plug-in) dc input. Select input polarity for positive W display.

1. Select 2A/20V ranges. Vary P214 slowly to give equal W readings when reversing the input signal polarity (always positive W readings).

2. Select 200mA/200V. Vary P314 slowly to give equal W readings when reversing the input signal polarity (always positive W readings).

3. Select 200mA/20V ranges. Note W reading. Reverse the signal polarity. The two readings should not differ more than +2 digits from each other. If they do, make final symmetry adjustment (200mA/20V-ranges) with P214 and P314.

5.18. RMS Converter Gain Adjustment (Phase 1-3)

Apply 200mA/20V (130Hz). Vary input to obtain 2.500Vrms at the output of U204/U304-14. Adjust P212/P312 for exactly 2.500Vdc at pin 14 of U207 and U307.

5.19. Final A/D-Converter Reference Adjustment (Phase 1-3)

Select Arms and Vrms display. With 2.500Vdc at the RMS converter output (U204/U304-14) adjust P219 for an RMS current display of 200.0mA and adjust P319 for an RMS voltage display of 20.00V.

The steps described in 5.10. through 5.19. conclude the alignment procedures.

5.20. Current Plug-in Adjustment (Phase 1-3)

The potentiometers on the connector side of the plug-in is used to correct resistance deviation in the current sensing resistor. Connect a 1.7000kOhm load between pin 1 and pin 8 of the 14 pin Amphenol connector. Apply a current input depending on the plug-in current range and adjust the voltage across the 1.7000kOhm resistor as shown in the following table:

Plug-in	Current Sensing Res.	Current Input	Voltage on 1.700k
0-2A	1 Ohm	1.900 Adc	1.8065 V
0-10A	0.1 Ohm	1.900 Adc	180.65 mV
0-30A	10mOhm	19.00 Adc	180.65 mV
0-100A	1mOhm	19.00 Adc	18.065 mV

5.21. Current Amplifier Calibration at 130Hz (Phase 1-3)

Install the current plug-in. Allow 15 minutes warm-up time.
Use AC-Coupling, select Arms. Select the 200mA range.

1. Apply 200mArms. Adjust P201 for a reading of 200.0mArms.
2. Apply 600mArms. Select the 600mA current range. Adjust P202 for a reading of 600.0mArms.

3. Apply 2.000Arms. Select the 2A current range. Adjust P203 for a reading of 2.000Arms.
4. Apply 10.00Arms. Select the 20A current range. Adjust P204 for a reading of 10.00Arms.

This procedure sets the proper gain for all current ranges.

5.22. Voltage Amplifier Calibration at 130Hz (Phase 1-3)

Allow 15 minutes warm-up time. Use AC-coupling, select Vrms.

1 Apply 2.000Vrms to the voltage input. Select the 2V range. Adjust P301 for a reading of 2.000Vrms.
2. Apply 6.000Vrms. Select the 6V range. Adjust P302 for a reading of 6.000Vrms.
3. Apply 20.00Vrms. Select 20V range. Adjust P303 for a reading of 20.00Vrms.
4. Apply 200Vrms. Select 200V range. Adjust P304 for a reading of 200.0Vrms.
5. Apply 600Vrms. Select 1000V range. Adjust P305 for a reading of 600.0Vrms.

NOTE: Prolonged exposure of the voltage amplifier input resistor R111 to voltages larger than 600V will heat it up and may result in erreneous calibration of the highest voltage range.

This procedure sets the proper gain for each voltage range.

5.23. Power Calibration

Procedures 5.21. and 5.22. set the gains for every current- and voltage range. Power can now be calibrated at one current- and one voltage range. All power ranges are then calibrated.
Set the 304B as follows: Sampling CONT, AC-Coupling, display W, 200mA/20V range. Apply 200mArms/20Vrms 130Hz sinewave. Adjust the W reading to 4.000W using potentiometer P206 on the current amplifier PCA. When performing this adjustment the current and the voltage must be exactly in-phase.
This concludes the calibration procedure. The mean values and the rectified mean values are preset by the appropriate integrated circuits. All other quantities are computed.

5.24. Delay Equalization

Potentiometers P218 and P318 equalize time differences between current- and voltage amplifier sample and Hold trigger pulses (different delays caused by the trigger-pulse-optocoupler). This adjustment normally is not required.
To equalize the trigger pulse delay proceed as follows: Set W, 200mA/20V-ranges, random sampling, and apply 150mA/15V/100kHz. Vary P218 or P318 to obtain a power reading of 2.250W.

5.25. Troubleshooting

The 304B is designed to be efficiently maintained and repaired. Many integrated circuits are socketed. To find the source of trouble complete printed circuit board assemblies can be exchanged. Once the defective PCA has been determined most circuits allow troubleshooting and repair with basic electronic troubleshooting equipment such as a multimeter and oscilloscope.
The troubleshooting of some digital sections is probably most efficiently done by exchanging the socketed integrated circuits.

5.26. Initial Troubleshooting Procedure

When a problem occures in the 304B, first verify the problem is actually in the instrument. If the problem occures when the instrument is in a system, check to see if the same problem exists when under local control. If the malfunction does not involve the IEEE-488 option or the recorder output option, remove the options from the instrument before proceeding.
A failure in the instrument may cause the 304B to display random patterns or nothing at all. If in addition none of the front panel Led's are lighted, start troubleshooting by checking the power supply for proper levels and for oscillations. If all of the supplies are working correctly, check the 1MHz clock on the microprocessor PCA (pin denoted by E on mother board connector J4). If a problem occures in the encoder PCA, the instrument may not respond to keyboard inputs and none of the front panel Led's may be lighted.
If a problem occures in the decoder PCA most likely one of the latches 74HC373 will be defective. In this case measurement data may be wrong (e.g. 1 bit is not transmitted), or gain setting, function selection (RMS, AC, Mean, and P), or under- and over range indication may not work properly.
A failure in the analog section (current- and voltage amplifier) may result in zero display for current or voltage. In this case check first the DC/DC-Converter output - it should be approximately ±12V dc.

5.27. Microprocessor Troubleshooting

In most cases the microprocessor troubleshooting will be limited to replacing socketed integrated circuits or replacing the microprocessor PCA.
If the microprocessor appears to be operative but not the display, the trouble could be caused by the VIA U2 on the microprocessor PCA.

5.28. The Encoder PCA Troubleshooting

Whenever the instrument is not properly initialized and there is a failure in the keyboard inputs or the front panel Led's, the problem is most likely caused by U501. If none of the Led's are lighted, check drivers U507, U508. If in addition to the above problems the IEEE-488 interface is not operative, check bus inverter U502.
If one of the four integrated circuits U503, U504, U505, or U506 is defective, then U501 and U701 (interface PCA) will not receive proper control signals and similar malfunctions as described above will result.
When the Wh summation does not work, check U511, U512, and U513.
When incorrect current- and voltage values (most likely constant values independent of input) are displayed, check U509 and Q501. A 20us/4V pulse should be present on the emitter of Q501.

5.29. The Decoder PCA Troubleshooting

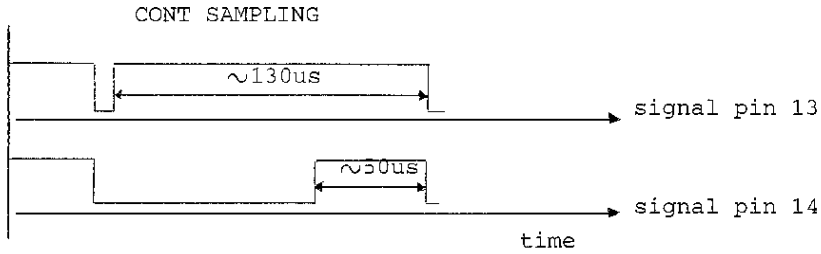
If a problem occures with measurement data transmission, check U401 through U406 (current data), U407 through U412 (voltage data). If the range selection does not work, check U413.
If one or more of the functions A_r, A_t, A=, V_r, V_t, V=, or W shows zero value with nonzero input, check U414.
If the up-range indicators, the down-range indicators, or the incorrect current plug-in (current range) is displayed, check U415 and U416.
Finally, if the instrument is properly initialized, but does not respond to keyboard inputs, the keyboard encoder interrupt on pin 7 of U415 is not transmitted to the bus, replace U415. When the IEEE-488 interface option is installed and the 304B operates normally but does not serve the Interface, the signal on U415-8 indicating "option installed" may not be transmitted to the bus; replace U415. Similarly, the signal on U415-14 indicates "recorder output installed", and if not transmitted the recorder output will not be served by the microprocessor.
If the address decoders U420/ U421/ U422 are defective, then none or only part of the peripheral latches and programmable integrated circuits will be addressed. The 304B may not initialize the key board encoder U501, the VIA U2, or the interface adapter U701.

5.30. Current- and Voltage Amplifier Troubleshooting

Whenever there is a failure in the current- or voltage amplifier, first check the power supply voltages (A, B=+9.5V, C, D=+5V). If the voltages are not present, proceed by checking the DC/DC-Converter- and regulator outputs on the mother board PCA. Malfunctions in the current- and voltage amplifier can be caused by amplifier failure, rms-, ac-, or mean converter failure, or A/D-Converter failure.
The amplifiers U201-U204, and U301-U304 can best be checked by applying an input signal. Full range input corresponds to 2.500Vrms on U204/U304-6. Check range switching. Faulty range switching may be caused by the range switching transistors Q201-Q208/ Q301-Q308, Q312, Q313 or by the optocouplers Q222, Q223, Q323.
To check the rms-, ac-, and mean converter, apply an input. The gain of the converters is 1 (use a dc signal for the mean converter).

Comparision of Converter Outputs			
Signal on U204/U304-6	RMS	Rect. Mean	Mean
2.500 Vdc 2.500 V sinewave	2.500 Vdc 2.500 Vdc	2.500 Vdc 2.252 Vdc	2.500 Vdc 0 Vdc

When one of the displayed quantities rms, rectified mean, or mean does not correspond with the converter output the fault may be in the multiplexer U208/U308, or the decoder U214/U314, or the optocoupler U223/U323.
When no current- or voltage data are transmitted (zero or constant display) the fault may be in the A/D converter or associated circuits.
Check the following: the reference voltage on U210/U310-22 (5.12V), the 290kHz clock on pin 24, the A/D-start signal on pin 13, and the clamp signal on pin 14. The signals on pin 13 and 14 are shown below.



The A/D reference is derived from the voltage reference VR203/VR303, amplifier U209/U309, and transistor Q210/Q310. The clock frequency is generated in U212/U312. The A/D-start pulse takes the following path: Decoder U411 is addressed and sends a pulse to U509 which forms a 20us pulse. Q501 drives optocouplers U222/U322 which transmits the pulse to pin 11. U213/U313-8, 9, 10 performs pulse delaying and shaping. Finally, timer U216/U316 triggers the sample and hold and the A/D-Converter. If the four described signals are in order, the fault may be in the digital section. Check the digital outputs of the A/D-Converter (pins 1-12), the inverters U218, U219, U318, U319, and the associated data optocouplers.
If the up- and down-range Led's are not operative comparator U215/U315, peak detector U206/U306-12, 13, 14, or optocoupler U224/U324 may be defective.

5.31. Random Noise Generator Troubleshooting

The proper output noise level is approximately 4Vptp (0.5V-4.5V). When this circuit needs troubleshooting make sure that the shield is connected to the noise generator ground.

5.32. Power Supply Troubleshooting

If the rear panel fuse is blown, replace it with a 250V fuse of the proper rating for the line voltage selected. Use 0.5A fast-blo for 110V power-line voltage and 0.25A slo-blo for 220V powerline voltage. Make sure the line selector switch is set to the correct line voltage.
If the fuse keeps blowing, remove all prints from the mother board. If the problem still persists the transformer or one of the 4700uF capacitors may be defective.

5.33. IEEE-488 Interface Troubleshooting

Check the voltage levels on the address selector resistors R701 through 708 and make sure levels correspond with the address selector switches. If the voltage levels are correct, proceed by replacing integrated circuits U701 through U704.

5.34. Recorder Output Troubleshooting

If the recorder output voltage is stuck at its negative maximum output (-1V), check the reference voltage on U706-14.

If the reference is **o.k.** and the address decoder U411 addresses the DAC U705, then U705 is defective.
If the recorder output voltage is close to +12V supply level, then replace U706.

5.35. Multifunction Recorder Output Troubleshooting

If none of the recorder outputs are present, check its supply voltages -5V, +12V, +5V. If they are present, the trouble lies most likely in the defective latch U753. Replace U753.
If just one output signal is missing the problem could be in the appropriate DIA-converter or in the address latch U753.
If the range of the output signals is deviating from the 0-2V range, the problem lies in the DIA-reference signal.

6. LIST OF REPLACEABLE PARTS

Microprocessor PCA INFRA

P 2	Connector to VF-Display
U 1	MC 6809P, Microprocessor
U 2	6522A, Interface Adapter (VIA)
U 5	2764 EPROM, Adr. E000-FFFF
U 6	2764 EPROM, Adr. C000-DFFF
U 7	2764 EPROM, Adr. A000-BFFF
U 8	8416, RAM
U 11, 13	74LS244N
U 12	DP8303N
U 15	UA555TC
U 17	UA75451
U 18	74LS28N
U 19	74LS08N
U 20	8K PAL, MS-INFRA
U 21	74LS138N

Mother Board PCA

C 101-124, 131-133	Cap., Tant., 1.5uF, 35V
C 125-130	Cap., Polypr., 100nF, 100V
J 1-1, ..., 2-3, J4, J5, J6	Connector female, 2x32pin, DIN 41612
J 14f, ..., 19f	2-row-connector 14 pin
J 20f, 21f, 22f	Connector Amphenol 57-10140
P 101-112	Pot., 2k, Bourns 3386W
R 101-112, 116-148	M.F. Resistor, 1 %, 0.4W, 250V
R 113, 114, 115	Resistor, Philips VR68, 1M, 5 %, 1W, 7000V
VR 101-106	Regulator LM78L05
VR 107-112	Regulator LM79L05

Current- and Voltage Amplifier PCA

C 201	Cap., Cer., 39pF, 5 %, 100V
C 301	Cap., Cer., 47pF, 5 %, 100V
C 202, 225, 228	
C 302, 325, 328	Cap., Cer., 100pF, 5 %, 100V
C 203	Cap., Cer., 22pF, 5 %, 100V
C 204	Cap., Cer., 82pF, 5 %, 100V
C 205, 206, 207, 208, 209	
C 305, 306, 307, 308, 309	Cap., Polypr., 220nF, 5 %, 100V
C 210, 211, 223, 224	
C 310, 311, 323, 324	Cap., Polypr., 220nF, 5 %, 100V
C 212, 213	
C 312, 313	Cap., Polypr., 100nF, 5 %, 100V
C 214, 215, 216, 218, 219	
C 314, 315, 316, 318, 319	Cap., Tantal, 1.5uF, 35V

C 220, 222, 226	
C 320, 322, 326	Cap., Tantal, 1.5uF, 35V
C 217, 317	Cap., Tantal, 10uF, 35V
C 221, 321	Cap., Polyst., 1000pF, 1 %, 100V
C 227, 327	Cap., Cer., 150pF, 5 %, 100V
C 229, 329	Cap., Cer., 270pF, 5 %, 100V
C 230, 330	Cap., Polyst., 560pF, 1 %, 100V
C 231, 331	Cap., Poypr., 10nF, 5 %, 400V
DE201, 202, 203, 204	
301, 302, 303, 304, 305	1N 4148, Si Diode
P 201, 202, 203, 204, 205	
301, 302, 303, 304, 305	Pot., 200, Bourns 3296X
P 206, 212, 312	Pot., 200, Bourns 3296X
P 207, 218, 307, 318	Pot., 20k, Bourns 3296X
P 208, 209, 210, 211, 215	
308, 309, 310, 311, 315	Pot., 100k, Bourns 3296X
P 213, 214, 313, 314	Pot., 1k, Bourns 3296X
P 216, 217, 219	
316, 317, 319	Pot., 2k, Bourns 3296X
Q 201, 203, 205, 207	
301, 303, 305, 307, 312	J106, J-FET
Q 202, 204, 206, 208, 209	
302, 304, 306, 308, 309	2N3904, Npn
210, 211, 310, 311, 313	
R 201, ..., 299	
301, ..., 405	M.F. Resistor, 1 %, 0.4W, 250V
U 201, 301	OP 07CP, Op. Amplifier
U 202, 203, 302, 303	OP 17GZ, Op. Amplifier
U 204, 304	LF 355BN, Op. Amplifier
U 205, 305	AD 630AD, AC Converter
U 206, 306	TL 064ACP, Quad. Amplifier
U 207, 307	AD 637JD, RMS Converter
U 208, 308	CD 4066, Analog Switch
U 209, 309	TL 061CP, Op. Amplifier
U 210, 310	ADC 1210HCD, A/D Converter
U 211, 311	LF 398AN, Sample and Hold
U 212, 217, 218	
312, 317, 318	CD 4069UBE, Hex Inverter
U 213, 313	CD 4011BE
U 214, 314	CD 4555BE, Counter
U 215, 315	TL 062CP, Dual Amplifier
U 216, 316	ICM 7555, CMOS Timer
U 219, 220, 221, 222, 223	
319, 320, 321, 322, 323	2x PC 827, Optocoupler
U 224, 324	PC 837, Triple Optocoupler

Decoder PCA

C 401	Cap., Tant., 1.5uF, 35V
C 402, 403	Cap., Polypr., 100nF, 100V
DE401, ..., 406	1N4148, Si-Diode
J 3m	Connector male, 2x32 pin, DIN 41612
J 14, ..., 19	2-row-connector 14 pin

R 401, ..., 415	M.F. Resistor, 1 %, 0.4W, 250V
U 401, ..., 417	74HC373BI, Latch
U 418	CD 4040BE, Counter
U 419	74HC04, Inverter
U 420, 421	DM74LS154N, Decoder
U 422	74LS42N, Decoder

Encoder PCA

C 501, 504	Cap., Polypr., 10nF, 5 %, 400V
C 502, 503, 505	Cap., Polystyr., 1000pF, 1 %
C 506	Cap., Cer., 1000pF, 10 %, 100V
C 507	Cap., Cer., 390pF, 10 % 100V
DE501	1N 4148, Si Diode
DE502, ..., 516	LED Green, GL-3NG5
J 5m	Connector male, 2x32 pin, DIN 41612
J 9, 10	2-row Connector 20 pin
J 11, 12	2-row Connector 14 pin
J 11f, 12f	Cable Assembly to Frontpanel
R 501, ..., 517	M.F. Resistor, 1 % 0.4W, 250V
R 518, ..., 533	M.F. Resistor, 150, 1 % 0.4W, 250V
SW 501, ..., 524	Frontpanel Switches, MPD 40892
U 501	8279 Intel Key Board Encoder
U 502	74HC640
U 503, 506	74LS02
U 504, 505	SN 4929
U 507, 508	74LS642
U 509	ICM556IPD, CMOS Dual Timer
U 510	ICM 7555, CMOS Timer
U 511	74HC4020
U 512	CD 4040BE
U 513	74HC373

Noise Generator

C 601, 602, 603	Capr., Cer., 1000pF, 10 %, 100V
C 604, 605	Capr., Tantal, 1.5uF, 35V
L 601	Choke, 10uH, 400mA
P 601	Pot., 10k, Bourns 3386P
Q 601	2N3904
Q 602, 603, 604	BC 107B
R 601, 603, 605	M.F. Resistor, 5 %, 0.4W, 250V
R 602, 604, 606, 607 608, 609, 610, 611	M.F. Resistor, 1 %, 0.4W, 250V

Main Power Supply

C 606, 607, 608	Cap., Electrol, 4700uF, 25V, 20 %
C 609, 610	Cap., Polypr., 100nF, 100V
DE601	Rectifier, W02, 1.5A

DE602	Rectifier, KBL02, 4A
J 601	Line Receptacle, 8843.FSM.40.60
J 602	Fuse Holder, FEP 031.1001
SW601	Power Switch, 1 pol 2036.78
SW602	Line Selector Switch, SQ4-2-09P
T 601	Power Transformer SE60-30.5
U 601	LM 340T5, Voltage Regulator 5V
U 602	LM 340T12, Voltage Regulator +12V
U 603	LM 7912CT, Voltage Regulator-12V

Interface

J 9f	Cable Assembly, IEEE-Encoder PCA
J 11f	Cable Assembly, IEEE-24 pol Amphenol
J 12	Cable Assembly, IEEE-Address Switch
R 701, ..., 708	M.F. Resistor, 4.75k, 1 %, 250V, 0.4W
SW701	DIP Switch, 8 pol
U 701	MC68488, Interface Adapter
U 702, 703	MC3447L, Line Driver
U 704	74HC373, Octal Latch

Recorder

C 701	Cap., Polypr., 330nF, 5 %, 100V
DE701, 702	1N 4148, Si Diode
J 10f	Cable Assembly, Recorder-Encoder PCA
P 701	Pot., 100k, Bourns 3296X
R 709, ..., 717	M.F. Resistor, 1 %, 0.4W, 250V
R 718	M.F. Resistor, 5 %, 0.4W, 250V

Multifunction Recorder

C 750, ..., 753	Cap., Cer., 1000pF, 10 %, 100V
C 754, 755	Cap., Polypr., 100nF, 5 %, 100V
C 756, 757	Cap., Tantal, 1.5uF, 35V
J 13	20 pol. 2 row connector
J 14	14 pol. 2 row connector
DE 750	7.1 Zener, 0.5W
P 750	Pot., 1k , Bourns 3386P
U 750, ..., 752	PM-7226HP, Quad DIA-converter
U 753	74HC373, octal latch
U 754	OP 200, PMI Dual Op. Amp.
U 755	LM 229CZ, 7V reference
R 750, ..., 765	M.F. Resistor, 1 %, 0.4W, 250V

DC/DC Converter PCA

DC 801, ..., 806	DC/DC Converter, 12V, +12V, 100mA, 3000V
J 6m	Connector male, 2x32 pin, DIN 41612
NG801	Noise Generator Assembly, shielded
R 801, ..., 812	M.F. Resistor, 1 %, 0.4W, 250V

Various Parts

MP 01	Rear Panel
MP 02	Front Panel
MP 03	Power Switch 10A/250V
MP 04	VF-Display Module 40-SD-027
MP 05	Front Panel Switch Assembly PCA
MP 06	Case 304B, KM7

304BT: Line-to-Line RMS Voltage PCA (parts for 1 section)

R900, ..., R917	M.F. Resistor, 1 %, 0.4W, 250V
D900	Si-Diode, 1N4148
U900	OP 400, Quad. Op. Amp.
U901	AD637JD, RMS Converter
U902	AD630AD, AC-Converter
P900, P902	Pot., 100k, Bourns 3296X
P901, P903	Pot., 20k, Bourns 3296X
C900	Cap., Tantal, 1.5uF
Q900, Q901	ZTX109C, Npn-Transistor E-Line
DC 900	DC/DC Converter +12V
DCI 900, DCI 901	DC-Current Isolator

304BM: DC-Voltage Input PCA (parts for 1 section)

R950, ..., R960	M.F. Resistor, 1 %, 0.4W, 250V
U950	OP 400, Quad. Op. Amp.
U951	AD637JD, RMS Converter
P950	Pot., 100k, Bourns 3296X
P951	Pot., 20k, Bourns 3296X
C950	Cap., Polypr., 100nF, 100V
C951	Cap., Tantal., 1.58F, 35V
Q950	ZTX109C, Npn-Transistor E-Line
DC 900	DC/DC Converter +12V
DCI 900	DC-Current Isolator

7. SCHEMATIC DIAGRAMS

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7.21.	Multifunction Recorder Output	7.22

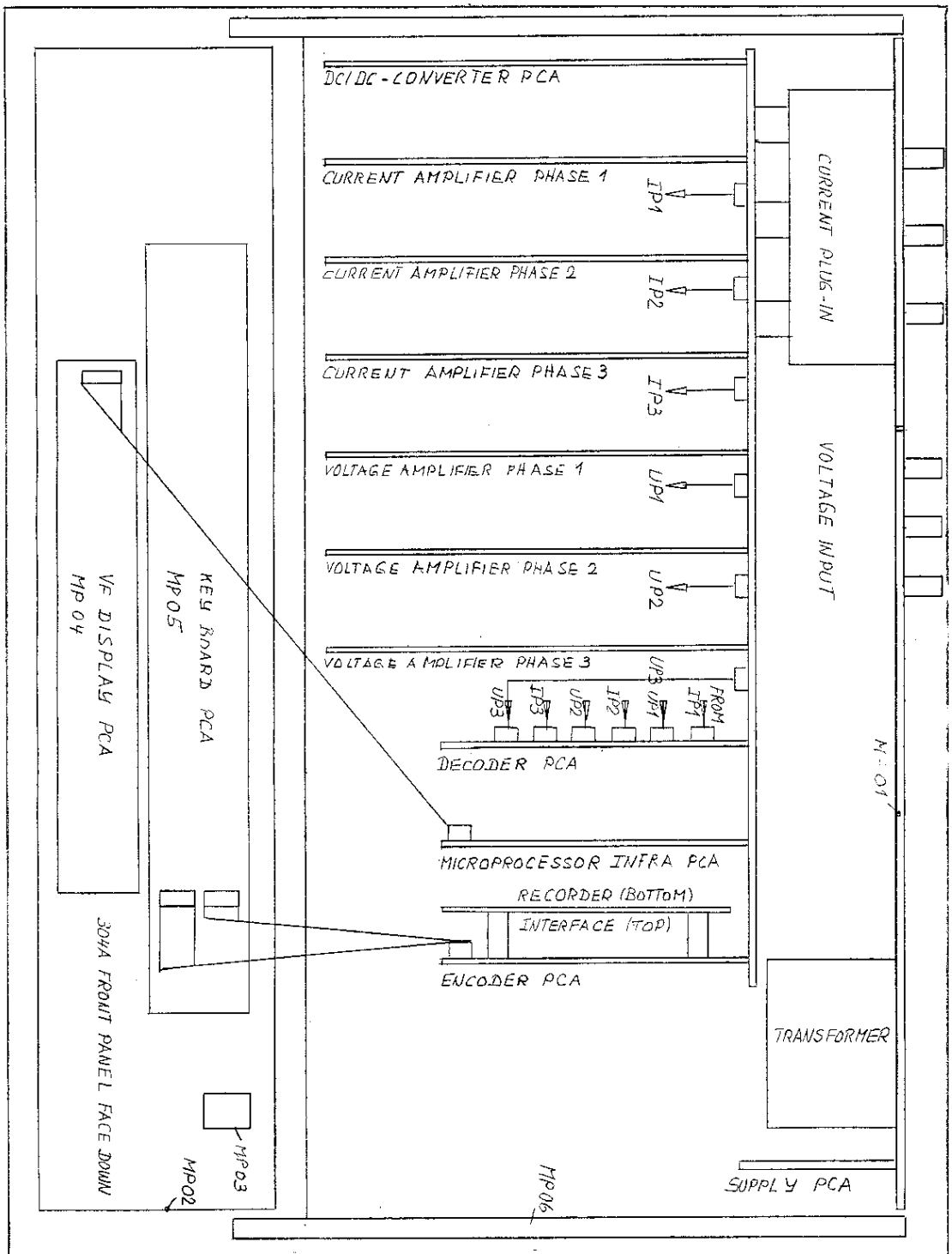


FIGURE 7.1. ASSEMBLY LOCATION

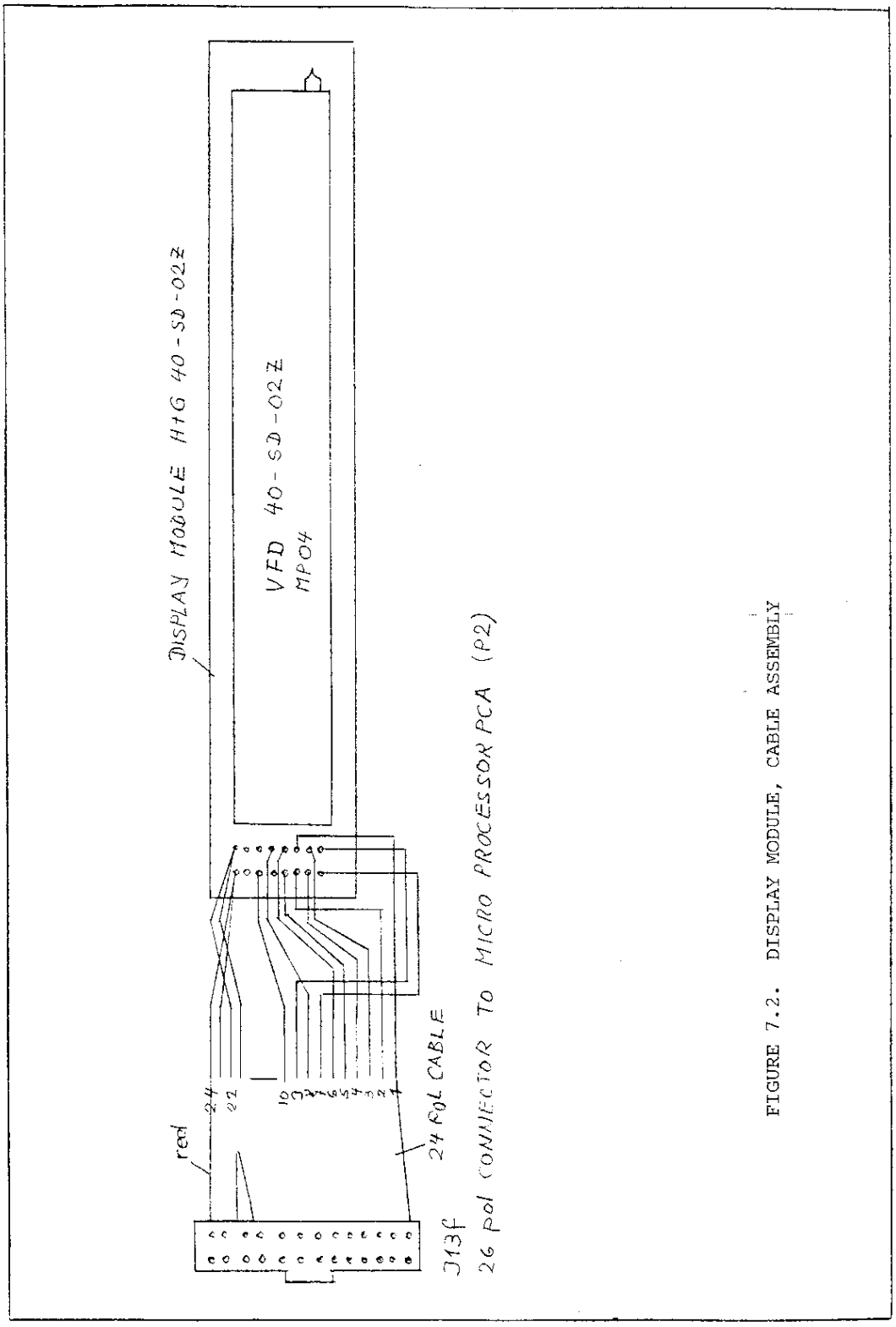
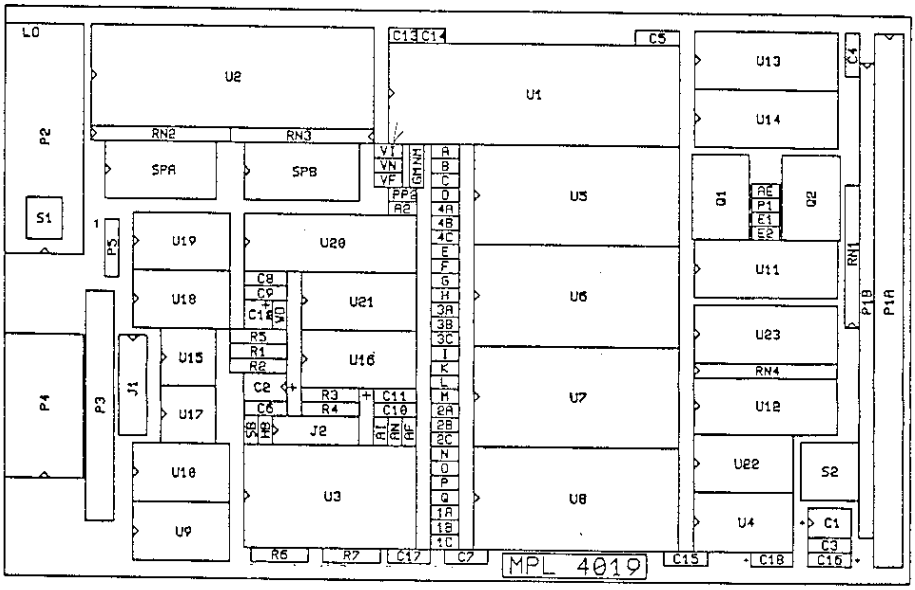


FIGURE 7.2. DISPLAY MODULE, CABLE ASSEMBLY



MICROPROCESSOR PCA

FIGURE 7.3/4. MICROPROCESSOR PCA

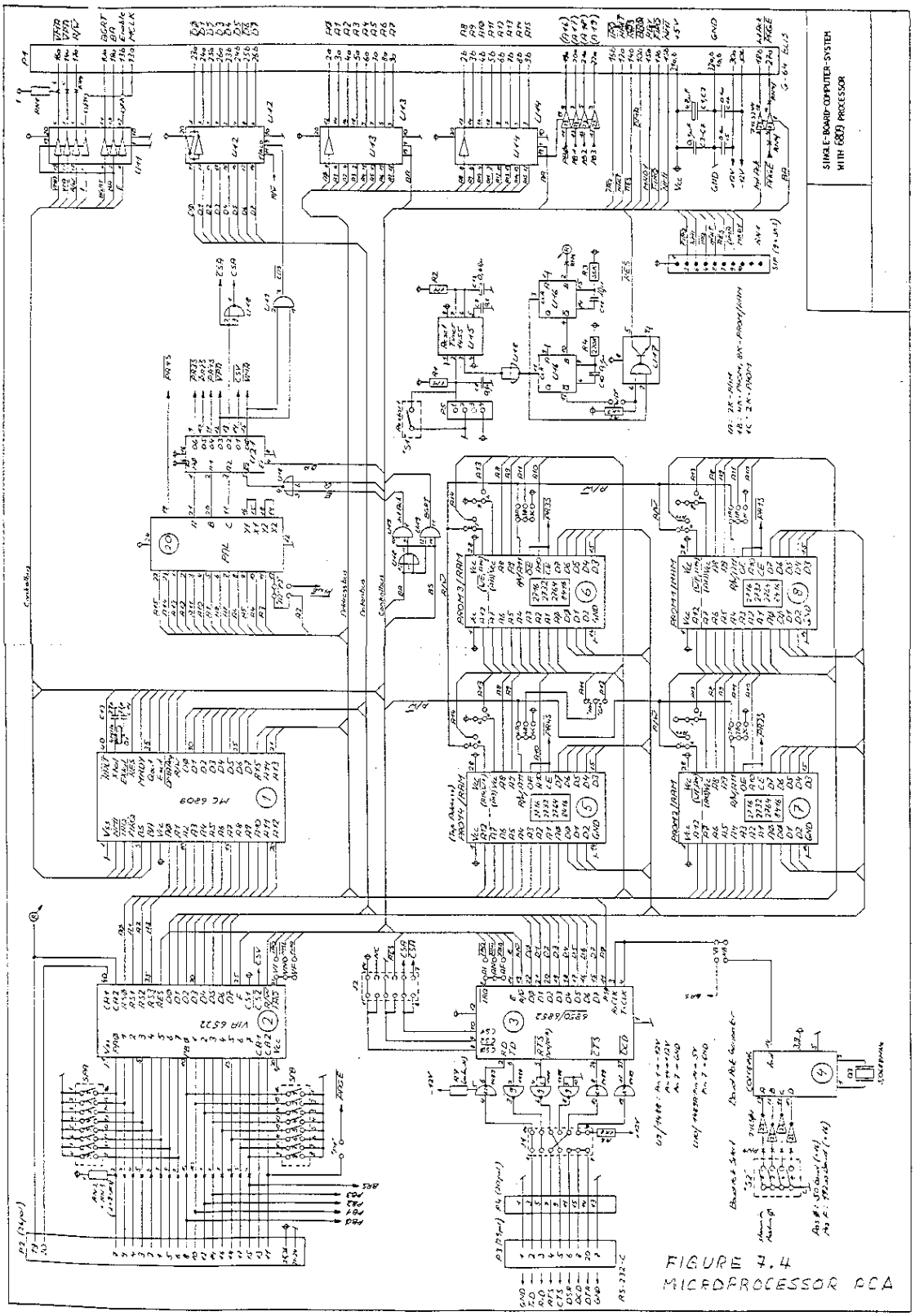
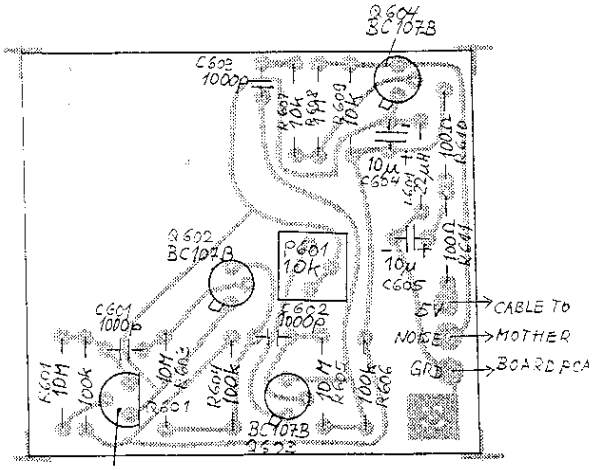
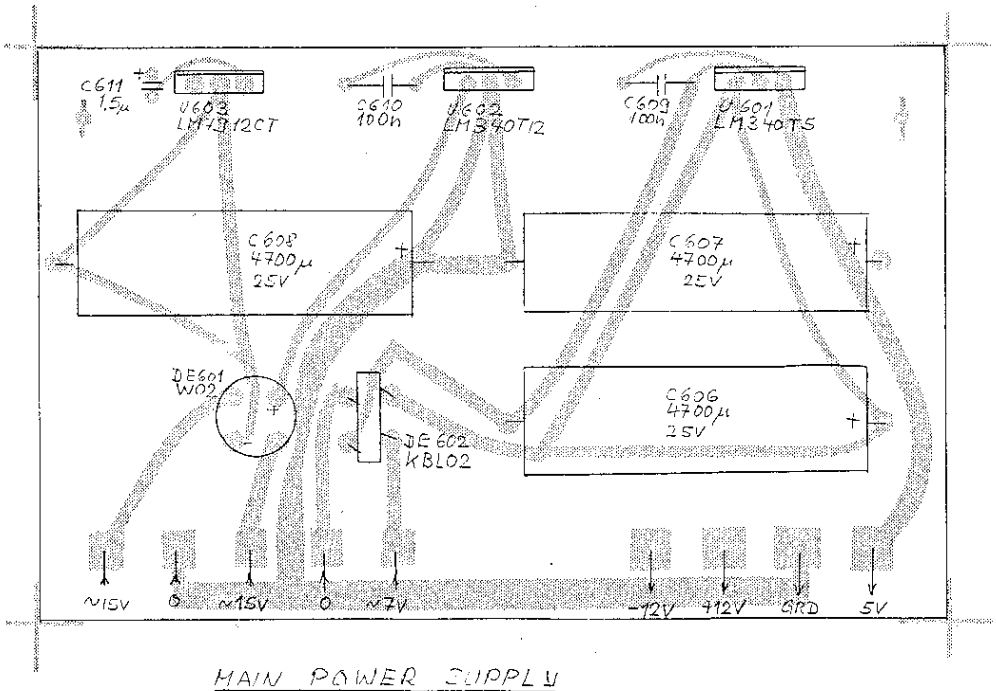


FIGURE 7.4
MICROPROCESSOR PCA



2N3904 ausgelesen

RANDOM NOISE GENERATOR



MAIN POWER SUPPLY

FIGURE 7.15 MAIN POWER SUPPLY

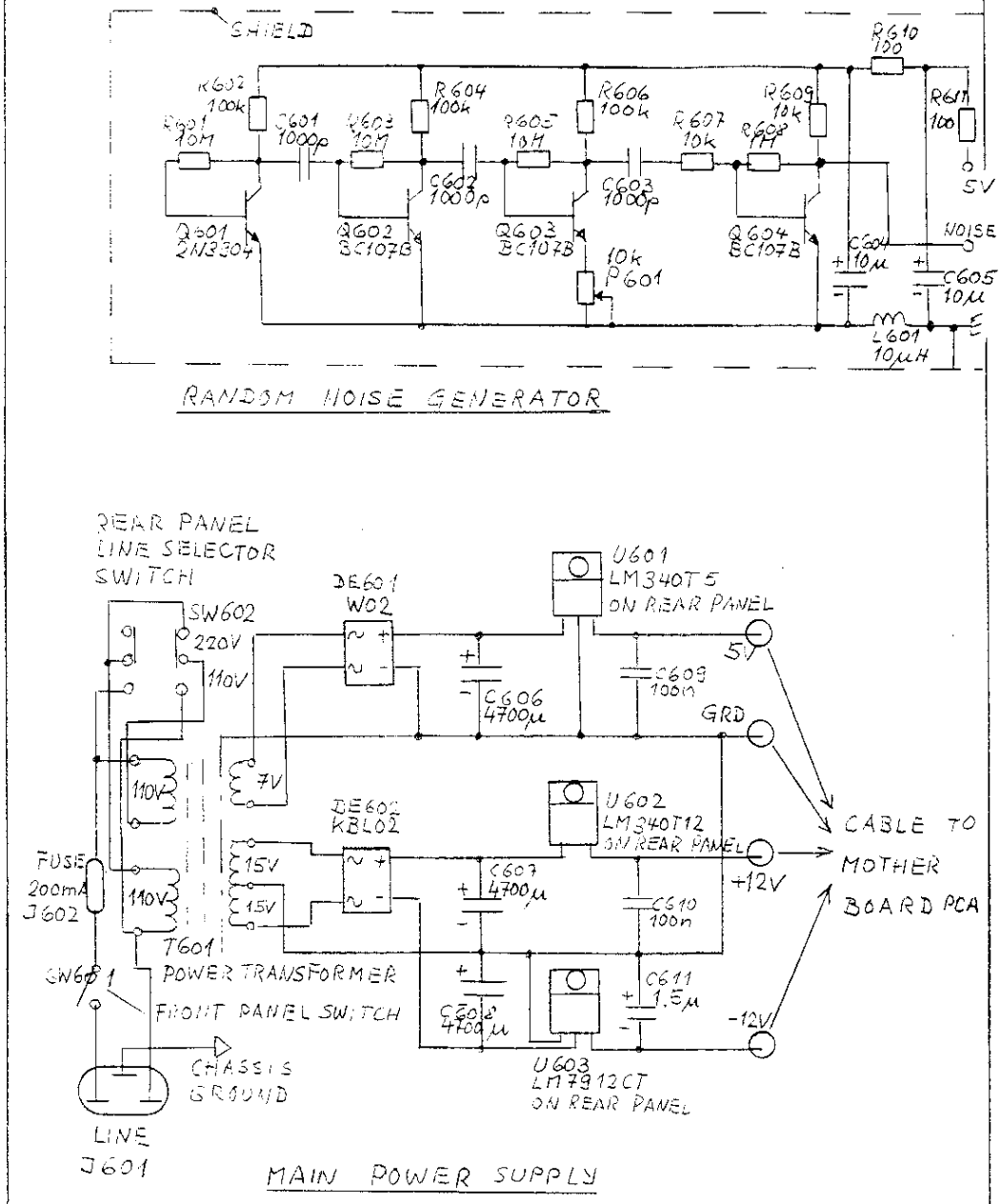
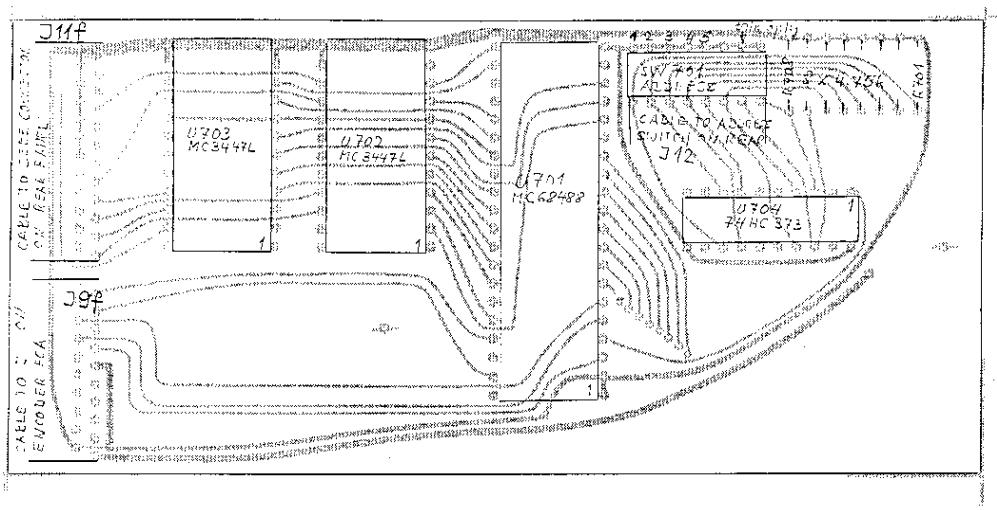
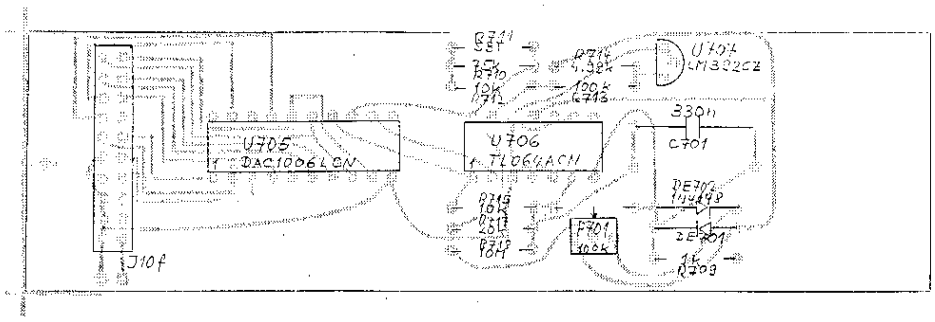


FIGURE 7.16. MAIN POWER SUPPLY



IEEE-488 INTERFACE PCA



RECORDER OUTPUT PCA

FIGURE 7.17 INTERFACE AND RECORDER

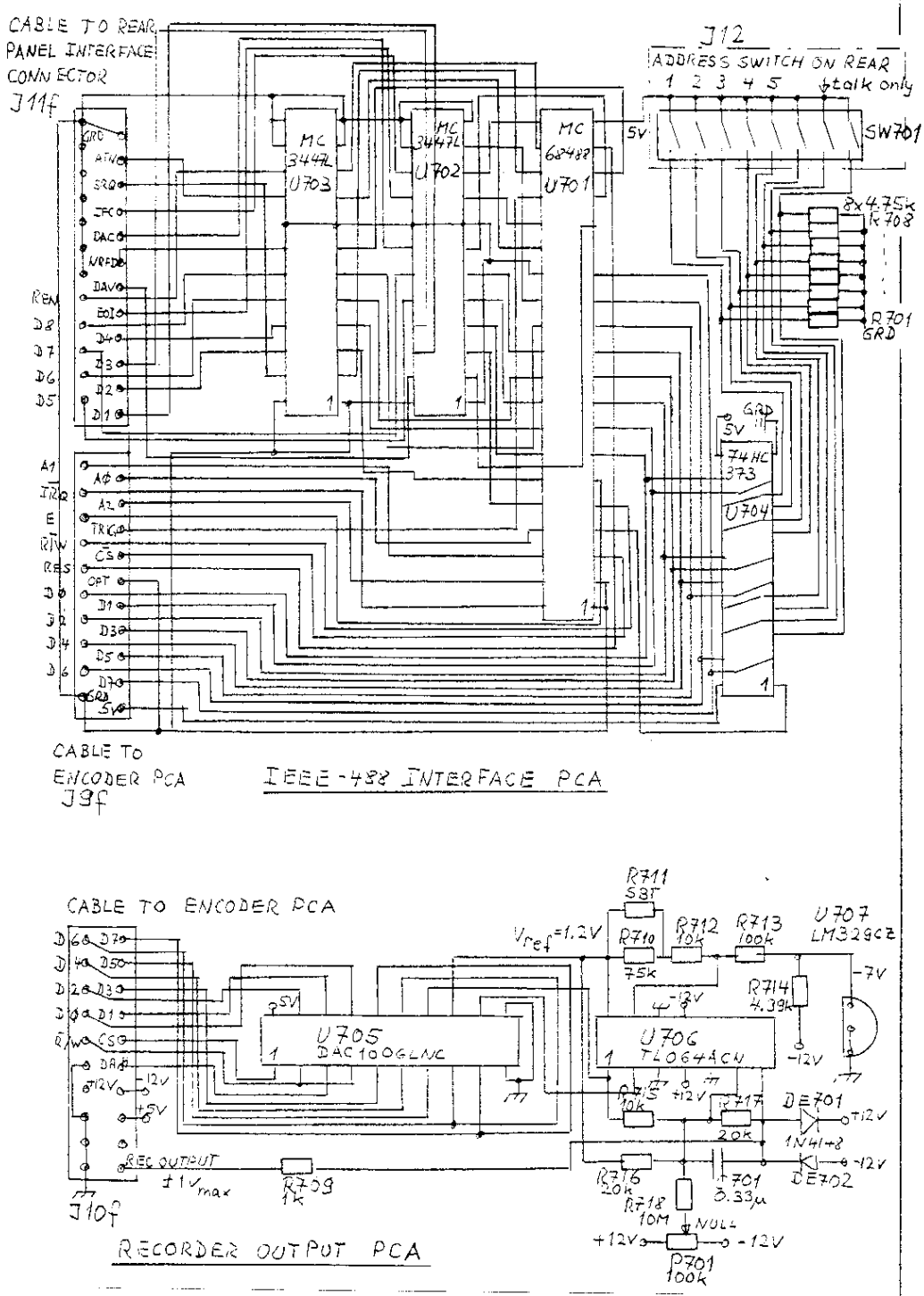
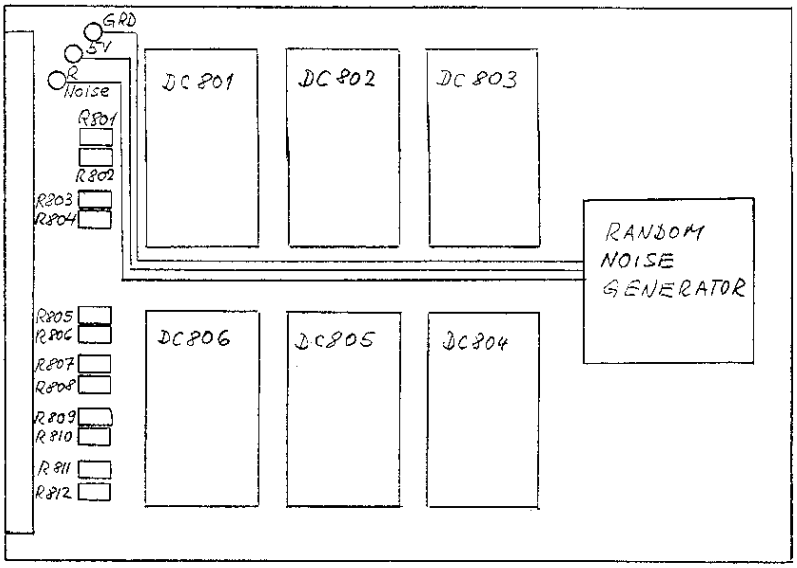
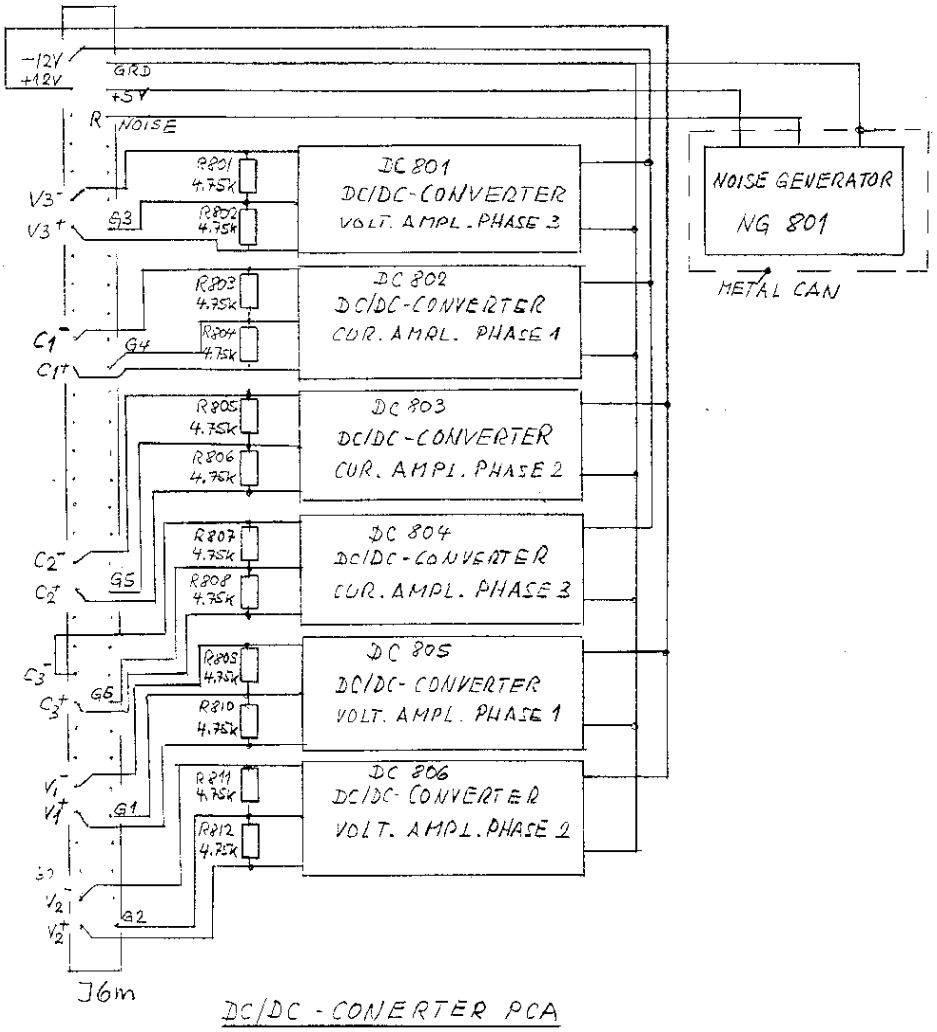


FIGURE 7.18. INTERFACE AND RECORDER OUTPUT



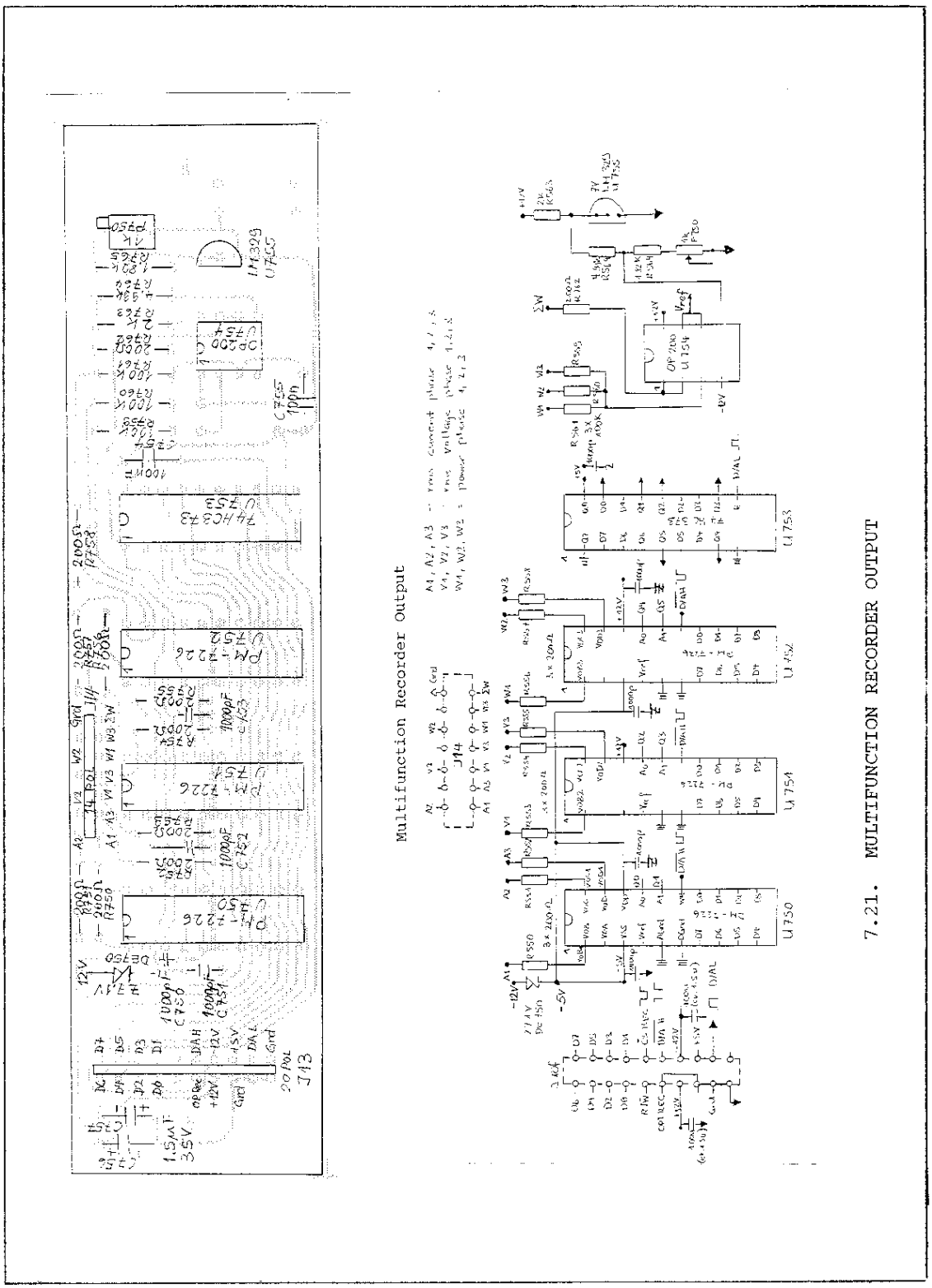
DC/DC-CONVERTER PCA

FIGURE 7.19 DC/DC-CONVERTER PCA

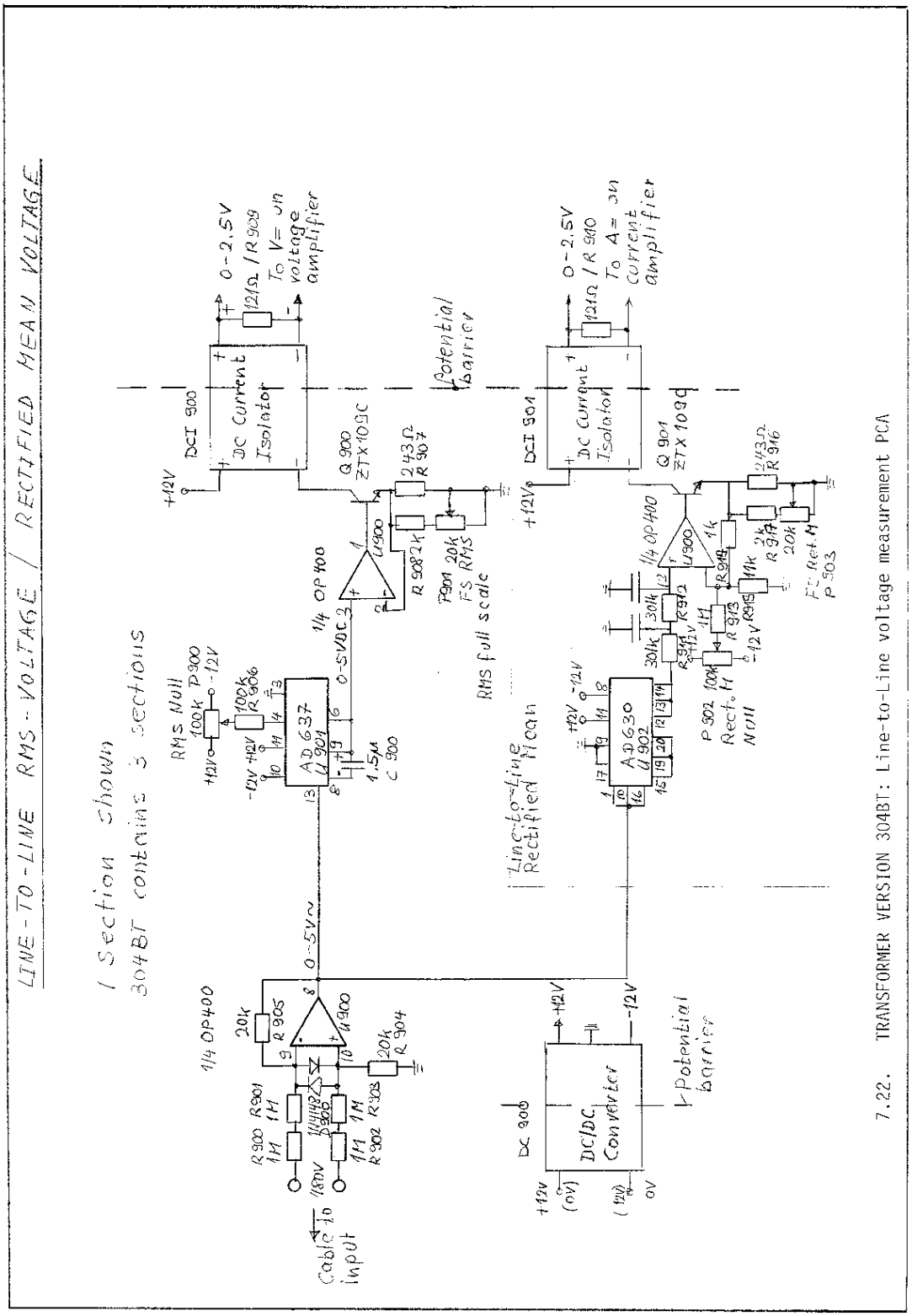


DC/DC - CONERTER PCA

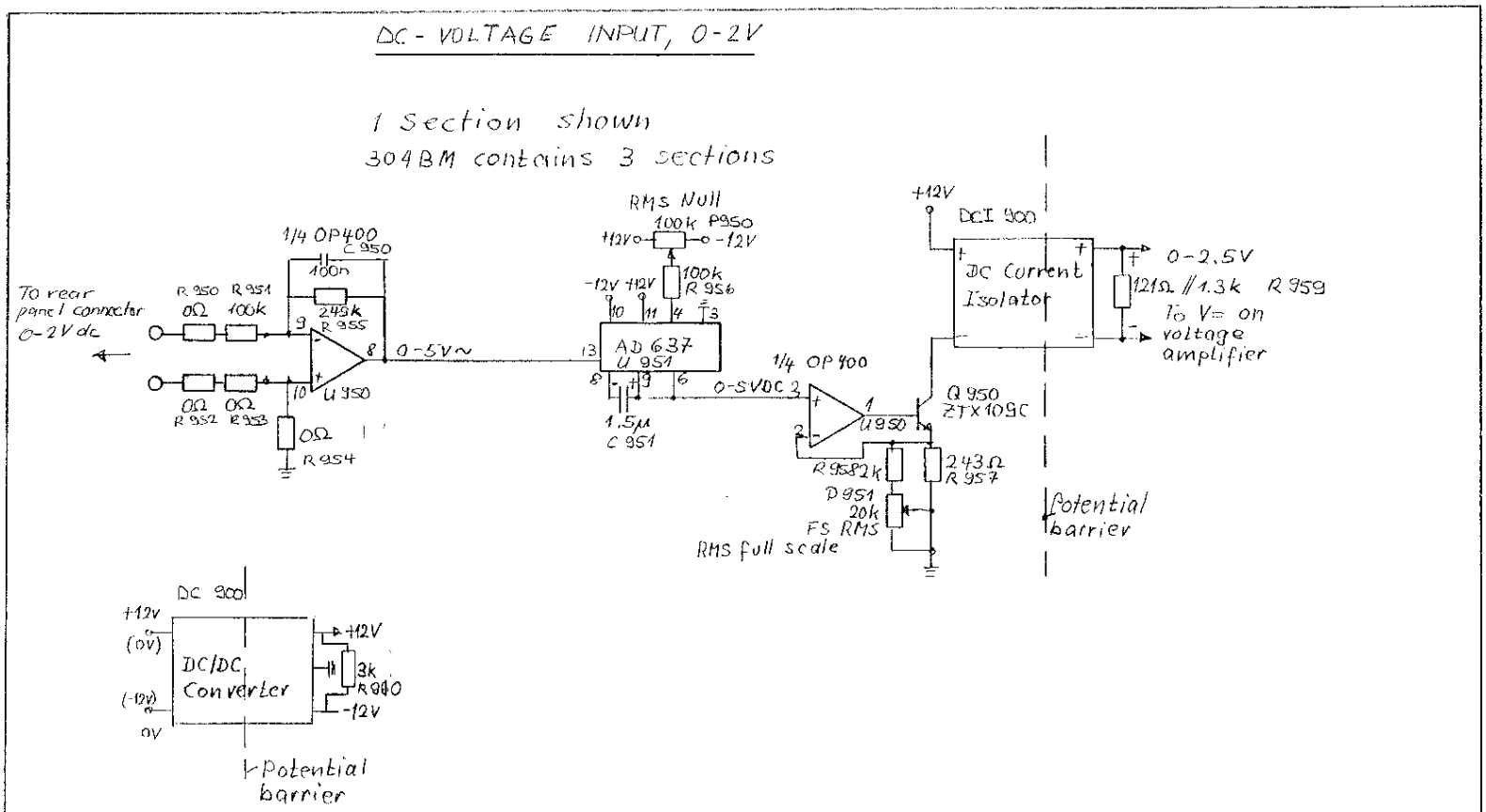
FIGURE 7.20. DC/DC CONVERTER PCA



7.21. MULTIFUNCTION RECORDER OUTPUT



7.22. TRANSFORMER VERSION 304BT: Line-to-Line voltage measurement PCA



7.23. MOTORTEST VERSION 304BM: 3-DC input PCA