Service Instructions

for the

thermatur m250

(Issue: 01. 12. 93)

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1 Construction

The microwave therapy unit "*thermatur m250*" is a portable stand-type unit on guide rollers, two of them can be blocked.

Fig. 1 and 2 show the principle of design of the unit.

1.1 Casing

After loosening the three clamping screws (4) (hexagon socket head screws, 3 mm) and screwing out the face screws (13) the face wall can be retracted and the earthing contact (12) disconnected. Then, the face wall can be completely removed, and the main sub-assemblies are accessible.

When the face is removed the rear screws (14) for fastening the rear wall are accessible. For taking off the rear wall these screws are to be unscrewed and the plug connectors of earthing conductor and mains cord disconnected.

1.2 Frame

By means of additional welded holders the frame carries the individual sub-assemblies of the unit.

1.3 Control desk

The control desk is fastened at the upper brackets of the frame by means of the four desk screws (15). Through the openings in the face wall, which are closed by the caps (7), the screws (15) can be tightened after the alignment of the desk. For dismounting the desk disconnect the plug connections to the control computer X401, X402 and X403, to the mains switch and earthing contact.

The plug connections to the main switch are easily accessible when the complete rocker switch (11) is pressed out of the desk.

For dismounting the Control computer PCB (printed circuit board) unscrew the fastening nuts and take off the knob (lift the cover by means of a small screwdriver and loosen the screw).

ATTENTION: The spacers are loosely inserted between PCB and desk!

1.4 Cable connections

The unit is to be connected to the mains via a removable power cord equipped with a non-fused earthing contact.

The mains connection element of the unit (combined element A001) contains the fuse elements in accordance with the voltage version (cf. name plate); the fuse elements are accommodated in the drawer.

The primary cable harnesses contain the interconnections between mains connection element (A001), mains filter (A002), Relay PCB (A200), mains switch (S001), primary terminals of power supply (A100) and transformers (T001 and T002). The primary harnesses also contain the earthing lines connecting the casing parts to the centralized earthing terminal X001 at the bottom of the frame.

Three secondary cable harnesses connect the individual electronic sub-assemblies among each other. The DC supply power is lead from the A100 sub-assembly to the amplifier A300 and from there separately to interface (A500) and control computer (A400).

The plug connections are self-interlocking and can only be separated by drawing at the socket case.

2 Electrical and functional descriptions

The microwave therapy unit ***thermatur m250*** consists of different electronic sub-assemblies which fulfil sophisticated functions. For repairing as well as exact testing and tuning these sub-assemblies special measuring instruments and testing devices are necessary which are not or not completely available to the service man or which cannot be operated at the customer due to technical or economical reasons.

Therefore, the work of the service man at the customer is mainly restricted to the localization of the defective sub-assembly, its replacement and, if required, re-adjustment of parameters. Then, the defective sub-assembly is to be sent to the manufacturer and, after the repair, it is tested there on the same measuring equipment used for the production. After this, the PCB is again available as replacement sub-assembly.

By the description of functions and possible error sources these Service Instructions shall be a help for the service man to quickly and safely eliminate any error.

The overall view is given in the block diagram and shows the electrical interconnections and signal flows.

2.1 Power supply (A100), high-voltage transformer (T001), rectifier (A600) and Relay PCB (A200)

For decreasing the RF interference radiation into the mains network the mains filter (A200) is arranged next to the mains input. A switching power supply of the company FARNELL ADVANCED ELECTRONIC (type NA 075 P403) is used to supply all electronic sub-assemblies. It delivers the required +5-V and ±15-V voltages. The minimum load current required for the correct function is realised by the resistor R28 = 4.7 Ω for the +5-V and resistor R27 = 150 Ω for the ±15-V circuits. Both resistors are accommodated on the Amplifier PCB.

After switching on the mains voltage the supply voltage applies to the switching power supply, the fan motor for cooling the magnetron (M001) and the heater transformer for the magnetron (T002; 3.4 V/11.5 A). Fan and heater transformer are separately protected by the slow-acting fuse F2 = 1.0 A arranged on the Relay PCB.

In dependence on the operation conditions, i. e. if RF-power output is desired, the high-voltage transformer is switched on by the relay mounted on the Relay PCB. There, it is electrically protected at the primary side by the slow-acting fuse F1 = 3.15 A.

At first K3 is switching and then K2, approximately 100 ms later. Due to this time delay and R1 on the Relay PCB the inrush current of the high-voltage transformer is reduced.

At the rest condition and when the mains voltage exceeds the nominal voltage adjusted K1 is dropped and, therefore, the transformation ratio of the high-voltage transformer small. With a smaller mains voltage K1 attracts and increases the transformation ratio by about 10 %. The accurate voltage of the switching point depends on the power range selected and is defined by the software.

Thus, the mains voltage fluctuations decreasingly extend to the high-voltage side. The fluctuation percentage of the high voltage and, therefore, that of the working range of the magnetron is decreased.

For magnetron operation the voltage of the high-voltage transformer is rectified on the Rectifier PCB. Due to the full-wave rectification the voltage is not smoothed.

The high-voltage divider (R2 to R3) and current measurement resistors (R5 to R10) for the magnetron current, accommodated on the Rectifier PCB, are used for the preparation of the corresponding measuring signals for the computer. D13 is an overvoltage preventer for the inputs of the Interface PCB.

2.2 Control computer (A400)

The Control PCB contains the micro-controller (INTEL 87C196), the 8-K EPROM with A/D and D/A converters and peripheral circuits, time and power indicators, LEDs for operation condition messages as well as all controls.

The analogous multiplexer and A/D converter integrated in the micro-controller realise 8 channels the resolution of which is 10 bit in the input voltage range between 0 and +5 V. Five channels of them are used for measuring the high-voltage (S), magnetron current in pulsed (AD2) or CW (continuous-wave) mode (AD1), mains frequency (SYNCH) and additional characteristic impedance of the radiators (RK2). The measuring voltages required are provided on the Interface PCB.

A D/A converter is realised by the pulse-length modulator integrated in the processor and an integration circuit (N1A). By means of the Amplifier PCB the output signal (A01) of the D/A converter controls the current in the magnetron coil and, thus, the magnetron current.

D3 and D6 are used as drivers for the digital signals required to control the unit [relays (D01, D05), current-divider switch (D03, D04), magnetron blocking (OFF)].

In accordance with the mode of operation, time and output power selected by the user and the process conditions (high-voltage, magnetron current, mains frequency, additional characteristic impedance of the radiator) the control, regulation and monitoring of all parameters required are realised by the micro-controller.

For unit diagnosis as well as program monitoring by means of the "watch-dog" (D1) method, program routines are integrated which, in case of error, give information to the user or service man with respect to error elimination. (Cf. also clause 5. Hints for trouble shooting).

2.3 Interface (A500)

The Interface PCB interconnects the process and computer signals. The adaptation of levels and the calculation of analogous values are performed on this PCB.

Magnetron current:

In the stand-by mode, IC1 operates as 50-mA constant-current source. In this process a magnetron current is simulated on the Rectifier PCB through the probe resistances. The voltage drop generated is led to the input of the analogous multiplexer (AD1) of the processor on the Control computer PCB via R48, R6 and TP2 in the CW-mode and via the resistors R23, R9 and TP3 (AD2) in the pulsed mode. In service operations it is used to check the magnetron-current measuring channels prior to switching on the high voltage.

After switching on the high voltage the constant-current source is switched off. Then, the real magnetron current flows through the current-divider resistors on the Rectifier PCB and can be measured and evaluated by the analogous inputs of the processor.

Switching over the magnetron-current measuring ranges:

In the smallest power range of the ***thermatur m250*** all probe resistors arranged on the Rectifier PCB (R5, R6 and R7 to R10) are included in the current path.

In the medium power range VT4 is switched on by the processor. Only R6 and R7 to R10 of the Rectifier PCB are in the current path.

In the largest power range VT5 is switched on by the processor. Then, only R7 to R10 are used as probe resistors (cf. Table 1, X402/5, X403/7).

This switching-over realises that, despite the different magnetron currents in the individual power ranges, approximately the maximum resolution of the A/D converter is always used.

Magnetron overcurrent:

With magnetron overcurrents (I = 900 mA ± 5 %) and independent of the computer function IC3 and U2 provide a high-voltage switching-off signal that is stored in the IC6 flip-flop and indicated by D5. Resetting is only possible by switching off and on again the mains voltage or by the service staff by means of S1.

Relay triggering:

Independent of the position of the magnetron overcurrent flip-flop, the watch-dog output on the Control computer PCB and a computer-port bit, VT1 is triggered by IC5 and switches the mains-voltage relay arranged on the Relay PCB and, thus, the high voltage. To keep the inrush current of the high-voltage transformer low, the high-voltage transformer is switched on at first via a series resistor (R1 on the Relay PCB). IC6 and VT2 are switched on with a time delay of about 100 ms with respect to VT1. The assigned relay K2, accommodated on the relay PCB, then bridges the series resistor and the high-voltage transformer is directly connected to the mains. Switching off the high-voltage transformer is not delayed.

IC4, VT3 and K1, provided on the relay PCB, are used for switching over the primary winding of the high-voltage transformer in case of overvoltage or undervoltage of the mains.

Determination of the additional characteristic impedance of the radiator:

Together with R37 the additional characteristic impedance of the radiator forms a voltage divider the output voltage of which is measured by the computer via the A/D converter.

By means of the output voltage the additional characteristic impedance and, thus, the radiator connected can be determined. On this basis the admissible power range is automatically selected.

High-voltage measurement:

Through R2 to R4, arranged on the Rectifier PCB, and R16, TP6 the high voltage (U_H), divided by about 333, arrives the impedance converter OP2/1 so that exactly one thousandth of the high voltage applies at measurement point 6 (MP6). A reference voltage generated in IC2 is subtracted in the OP2/2 amplifier to provide a measurement voltage U_S to the A/D converter of:

$$U_S = 4.1818 \times \left(\frac{U}{1000} - 2.2\ V \right)$$

Mains frequency synchronization:

On the Rectifier PCB the high voltage is generated by full-wave rectification of the voltage tapped at the high-voltage transformer. A part of this pulsating DC voltage applying at measurement point 6 (MP6) is differentiated and forms the basis of the square-wave pulse sequence, produced by OP1 and IC4, which corresponds to the double of the mains frequency. This pulse sequence is used by the computer to control the measurement-value generation of high-voltage and current as well as to control the magnetron coil current.

2.4 Amplifier (A300)

From the output signal of the D/A converter (U = 0 to 5 V) provided on the Computer PCB the amplifier delivers a voltage across the magnetron control coil in the range between +15 V (magnetron blocked) to -15 V (maximum magnetic current) by means of the bridge circuit consisting of IC1 and IC2.

By R7, R10 to R13, R17, R18, T1 and T2 the digital input D02 additionally enables the blocking of the magnetic current independent of the voltage applying at the analogous output (open D02 input or high-level result in magnetron blocking; low-level enables the coil control by the analogous input).

With low-level at D02 the control voltage applying at A01 arrives the inverting amplifier OP1 and then the power amplifier of IC1 operating as summing amplifier. As a power amplifier, IC2 reverses the output signal of IC1 so that a bridge amplifier becomes reality. This enables a sufficient voltage travel.

The magnetron used in the **thermatur m250** is provided with an earth-freely controllable coil. R27 and R28 are pre-loading resistors required for the switching power supply.

2.5 Magnetron and decoupling unit (A003, A004)

The magnetron (Richardson Electronics Company) type YJ 1530 SP including decoupling unit is a compact sub-assembly for generating a microwave radiation (f = 2.45 GHz) of suitable power for medical therapeutic purposes.

For operation it requires a high voltage of $\hat{u} \approx 2.6$ kV to 3.1 kV ($\hat{i} \approx 20$ mA to 800 mA), a heater voltage of 3.4 V (11.5 A) and for the power control through the magnetic field of the coil a current of approximately +1.5 A to -1.5 A.

The decoupling unit contains a filter for separating the high-frequency energy from the DC voltage for determining the additional characteristic impedance of the radiator as well as filters for harmonic and scattering energy suppression.

A thermo-switch (S002) is screwed on the sheet-metal frame of the magnetron. Through the lines th1 and th2 this switch interrupts the primary circuit of the high-voltage transformer and, therefore, protects the magnetron from damage by overheating, e. g. in case of fan failure.

3 Test of the unit

Testing devices and measuring instruments:

- High-voltage measuring instrument (up to 4 kV)
- Leakage current measuring device
- Earthing-conductor testing device
- Line-voltage regulator 25 A, 260 V
- Moving-iron instrument (1 A, 10 A)
- Digital multimeter
- Two-channel oscilloscope
- GHz-frequency meter
- Load resistor 50 Ω, 0 to 3 GHz; 250 W; S < 1.15
  with 40-dB attenuating output (calibrated)
- Additional attenuators (calibrated) 6 dB, 10 dB
- Microwave power meter (e. g. NRV by Rhode & Schwarz Comp.) including probe
- Load resistor for continuous operation 50 Ω, 0 to 3 GHz, 250 W to 500 W, S < 1.5
- DC voltage source 600 V to 3000 V
- Adapter cable 50 Ω, RG 213/U, Lemosa connector/N connector
- Laboratory power supply unit 2 x 30 V, 2 A
- Measuring lines and parts

3.1 Test of the power supply

- Remove the fuse F1 (3.15 A) on A200 or interrupt the primary connection at the high-voltage transformer.
- Separate:
  X402 (on A400),
  X504 (on A500),
  X305 (on A300).
- Switch on the mains voltage, the fan starts running.
- Voltage check at X305 (nominal voltage):

Pin 1/pin 5	+5 V	± 0.25 V
Pin 3/pin 5	+15 V	+2 V/-1.5 V
Pin 4/pin 6	-15 V	+1.5 V/-2 V.

- Plug X503 on A300.
- Voltage check at X504 in the range of U_N ± 10 %:

Pin 1/pin 5	+5 V	± 0.25 V
Pin 3/pin 5	+15 V	+2 V/-1.5 V
Pin 4/pin 6	-15 V	+1.5 V/-2 V.

- Voltage check at X403:

Pin 2/pin 1	+5 V	± 0.25 V
Pin 4/pin 1	+15 V	+2 V/-1.5 V
Pin 3/pin 1	-15 V	+1.5 V/-2 V.

- Switch of the mains voltage, plug on the connector.

3.2 Test of the magnetron coil control

- Disconnect X306.
- Switch off the mains voltage.
- Measure the 18 Vd.c. to 21 Vd.c. at the magnetron coil
  (positive pole at the red marking).
- Connect X306/3 to earth (MP1 on A500).
  Measure at MP2 on A300: about -9 V.
  Measure at X307/4: about +9 V.
- Connect X306/4 to +5 V via an 8.2-kΩ resistor (MP2 on A500).
  Measure at MP2 on A300: about +8 V.
  Measure at X307/4: about -8 V.
- Switch off the mains voltage.
- Re-connect X306.
- Switch on the mains voltage.
- Check at the magnetron coil: 18 Vd.c. to 21 Vd.c.
  (positive pole at the red marking).
- Check the mains current: $I_N \leq 0.9\ A_{RMS}$.

3.3 Test and calibration of the high-voltage measurement (A500)

- Disconnect X21/1 on A600.
- Draw off the plug-connector St on A600.
- Feed a smoothed DC voltage U_G = (600 to 3000) V $\pm$ 1 % between X21/1 (negative pole) and St (positive pole, connecting side of R9, R10).
- Switch on the unit.
- By means of TP6 at MP6 on sub-assembly A500 adjust to

  $$-\frac{U_G}{1000} \pm 0.6\ \%-$$

- Switch off U_G.
- Switch off the unit, re-connect the lines.

By way of substitution, U_G can be obtained as follows:

- Disconnect X21/1.
- Connect a high-voltage smoothing capacitor (about 1 µF, 4 kV to 5 kV) between X21/1 and St on A600.
- Bridge X12/1-4 and X12/1-7 on A500.
- Switch on the mains switch.
  ATTENTION: The high voltage is immediately at the capacitor!
- Measure the high voltage across the capacitor by means of a suitable measuring device.
- Adjust to one thousandth of the high voltage by TP6 at MP6.
- Switch off the mains switch and discharge the high-voltage capacitor (e. g. wire-wound resistor of 100 Ω and suitably insulated connecting lines).
- Disconnect the high-voltage capacitor.
- Remove the bridge at X21/1.
- Plug on X21/1 on A600.

3.4 Test and adjustment of the RF power

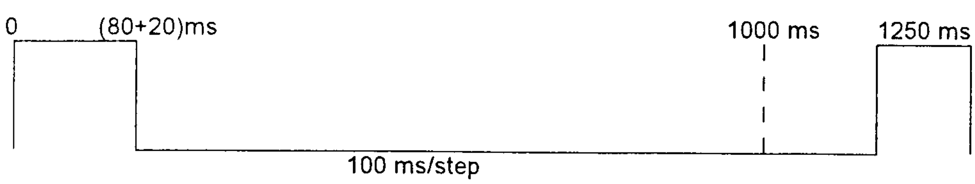
- Connect the measurement resistor 50 Ω, 250 W, 0 to 3 GHz, to the output socket of the unit via the adapter cable (Lemosa --- N).
- Connect the power meter (Rhode & Schwarz) with the probe but via an additional attenuator (-16 dB) to the measurement output (-40 dB) of the measurement resistor.
- Simultaneously press the "+" and "-" keys of the treatment timer and switch on the unit; release the keys when the signal sounds. Now, the unit performs the self-test and after termination the control sets an operation time of 150 minutes (hexadecimal display: 96).
  Independent of the load resistance (applicator) connected the power ranges can be selected one after the other by means of one of the treatment time keys (+ or -). However, short-circuit or no-load condition at the output sockets are always recognized and signalled as error condition.
- Select the 250-W power range.

- Select the CW mode; slowly increase the output power to 250 W; the actual output power is to be continuously checked; adjust the setpoint of 250 W with an allowance of maximum $\pm$ 12.5 W by means of TP2 on the Interface PCB.
- Check the mains current. I < 3.2 A_{RMS}.
- After an operation time of about 10 min re-adjustment by TP2, if required.
- Check the output power of 250 W in the CW operation at $U_N \pm$ 10 %; power allowance $\pm$ 12.5 W of the value measured at nominal voltage.
  Change the mains voltage in the stand-by mode!
- Select the pulsed mode; slowly increase the output power to 250 W; the actual output power is to be continuously checked; adjust the setpoint of 250 W with an allowance of maximum $\pm$ 12.5 W by means of TP3 on the Interface PCB.
- Check the mains current. I < 4.2 A_{RMS}.
- Check the output power of 250 W in the pulsed mode at $U_N \pm$ 10 %; power allowance $\pm$ 12.5 W of the value measured at nominal voltage.
  Change the mains voltage in the stand-by mode!
- Check the output power values at nominal voltage; switch over the power ranges by actuating the "+" key.

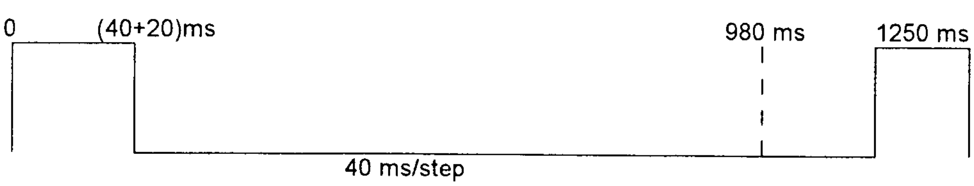
	Power range [W]	Output power selected [W]	Maximum deviation of the measurement value in W
CW mode of operation	10	1	+1/-0.5
	10	10	+2/-2
	50	4	+1/-2
	50	50	+5/-5
	250	20	+4/-4
Pulsed mode of operation	10	5	+1/-1
	10	10	+2/-2
	50	26	+5/-5
	50	50	+5/-5
	150	20	+30/-30

- Pulse parameters (envelope curve of pulse groups):

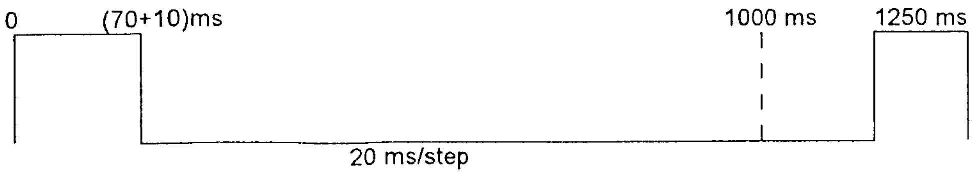
  10-W power range:



  50-W power range:



250-W power range:



Peak values (measured at MP10): 7.8 V ± 0.5 V.

3.5 Test of the high-voltage switching-off behaviour

- Select the 10-W power range, pulsed mode, 5 W output power and the nominal voltage minus 10 %.
- Vary the mains voltage so that a peak value of 2.45 V (high-voltage peak value = 2.45 kV) can be measured at MP6 on the Interface PCB.
- Check the switch-off behaviour of the high-frequency circuit (FE4).
- Select the 10-W power range, pulsed mode, 5 W output power and the nominal voltage plus 10 %.
- Vary the mains voltage so that a peak value of 3.2 V (high-voltage peak value = 3.2 kV) can be measured at MP6 on the Interface PCB.
- Check the switch-off behaviour of the high-frequency circuit (FE4).

3.6 Test of the magnetron current

- Mains voltage = nominal voltage.
- Measurement of the peak voltage at MP10:
  CW mode: 250 W RF-power: U = +6.8 V ± 0.5 V,
  Pulsed mode: 250 W RF-power: U = +6.8 V ± 0.5 V,
  +7.8 V ± 0.5 V.

3.7 Frequency measurement

- Use a frequency meter the accuracy of which is of at least 10^{-4}.
- Connect the frequency meter input to the measurement output of the terminating resistor or directional coupler via an attenuator of 16 dB to 20 dB.
- Select the CW mode and the RF output power of 250 W.
  Frequency f = 2450 MHz ± 20 MHz.

4 Test instructions for printed circuit boards (PCBs)

These test instructions are provided for the correct testing and adjustment, if required, of the PCB sub-assemblies.

By way of substitution, testing within the unit is also possible; the corresponding additional information is given in the text. For such a test remove the fuse provided for the high-voltage transformer F1 (3.15 A) on the Relay PCB A200 and disconnect the plug-connections to the control computer.

4.1 Interface (A500)

Visual inspection:

- Soldering joints,
- Soldering-tin bridges,
- Correct components on PCBs.

Re-setting to the initial condition:

- Connect X1/4 and X1/5 to +15 V supply voltage via a resistor of 1 kΩ each.
- Connect X10/1 and X10/5 to earth potential.
- Connect X2/4 and X2/5 to +5 V supply voltage via a resistor of 100 Ω each.

Connection of the supply voltages:

- Connect AMP X4/6 to GND X4/5.
- Connect +5 V $\pm$ 0.25 V to X4/1 and X4/6 to earth.
- Connect +15 V +2 V/-1.5 V to X4/3 and X4/6 to earth.
- Connect -15 V +1.5 V/-2 V to X4/4 and X4/6 to earth.

Test of the constant-current source (IC1, IC5, U1, IC6):

- Connect the ammeter between X2/6 and X4/6.
- Disconnect the earth potential from X10/1.
- Measure the current I = 50 mA +7mA/-2 mA.
- Connect the earth potential to X10/1.
- Measure the current I < 0.5 mA.
- Replace the ammeter by a 10-Ω resistor.

Test of the overcurrent comparator (IC3, U2, IC6):

- Apply a voltage of +8.6 V at X2/6.
- Check whether D5 is dark.
- Apply a voltage of +9.4 V at X2/6.
- Check whether D5 is bright.
- Switch off the voltage at X2/6.
- Actuate S1.
- Check whether D5 is dark.
- Remove the 10-Ω resistor.

Test of the current-divider resistances:

- Apply a voltage of +5 V $\pm$ 0.01 V at X2/6. By way of substitution, connect MP2, +5 V, to X2/6.
- Adjust the voltage range at X9/3 by TP2 U = 3.2 V to 4 V.
- Adjust the voltage range at X9/7 by TP3 U = 2.3 V to 2.9 V.

- Adjust TP2 and TP3 to central position.
- Switch off the voltage.

Test of MOSFET switch (VT4, VT5):

- Measure the voltage at X2/4 and X2/5 U < 0.03 V.
- Connect X10/6 and X10/4 to earth potential.
- Measure the voltage at X2/4 and X2/5 U = 5 V supply voltage.

Test of the relay driving circuits (VT1, VT2, VT3, IC5, IC6):

- Connect a 10-Ω resistor between X2/6 and X4/6.
- Measure the voltage at X1/5 U = +15 V supply voltage.
- Connect X10/7 to earth potential.
- Measure the voltage at X1/5 U < 0.5 V.
- Measure the voltage at X1/3 and X1/4 U < 0.5 V.
- Remove the earth potential from X10/5.
- Simultaneously measure the voltages at X1/3 and X1/4: U = +15 V supply voltage; X1/4 must change to supply-voltage potential with a small delay (t > 50 ms) with respect to X1/3.
- Remove the 10-Ω resistor.

Test the determination of the additional characteristic impedance:

- Connect X9/5 to earth potential.
- Measure the voltage at X2/7: U = 1.9 V ± 0.3 V.

Test of the series resistance for the amplifier:

- Measure the resistance between X9/6 and X6/4: R = 8.66 kΩ ± 0.09 kΩ.

Test of the high-voltage measurement accuracy:

- Connect X2/3 to earth potential.
- Adjust the voltage at X9/4 by TP4 to: U = -9.2 V ± 0.01 V.
- Apply a variable negative voltage (about -10.2 V) to X2/3 so that U = -3.395 V ± 0.005 V is obtained at measurement point MP6.
- Adjust the voltage at X9/4 by TP5 to: U = 5.0 V ± 0.01 V.

Test of the 100-Hz pulse generation:

- Connect the negative pole of the pulsating DC voltage (full-wave rectification); (100 Hz) U = 5 V to 10 V.
- Check the 100-Hz square-wave pulses at X9/1, X12/1/1 and MP7 by means of an oscilloscope.
- Temporarily disconnect T001 from X20/1 and X20/2 on A600 in the unit and connect the terminals of the heater transformer T002 there (remove Si1 on A200!).
- Switch off the pulsating DC voltage.

Test of the high-voltage divider:

- Apply a DC voltage U = -5 V to -10 V to X2/3 via a series resistor R = 210 kΩ ± 5 kΩ.
- Adjust the voltage at X2/3 to U/2 by means of TP6.

4.2 Amplifier (A300)

Visual inspection:

- Soldering joints.
- Soldering-tin bridges.
- Correct arrangement of components.

Re-setting to the initial condition:

- Connect the load resistor of 10 Ω, 25 W, between X7/3 and X7/4.
- Connect the series resistor of 8.66 kΩ to X6/4.

Test of the pre-amplifier:

- Connect the +15-V supply voltage to X4/3 and earth potential to X4/6.
- Connect the -15-V supply voltage to X4/4 and earth potential to X4/6.
- Apply the +2.5 V ± 0.01 V of X6/4 to the series resistor.
- Check the voltage at MP1; U_Z = -6.3 V to -7.2 V; record the voltage value.
- Connect X6/3 to earth potential.
- Apply the +5.5 V ± 0.02 V to the series resistor at X6/4.
- Adjust U = 0.875 × U_Z ± 0.05 V at MP1 by means of TP4.

Test of the power amplifier:

- Apply no voltage to the series resistor at X6/4.
- Adjust U1 = -9.2 V ± 0.05 V at MP2 by means of TP2.
- Check the voltage at X7/4; U2 = +9.2 V ± 0.25 V.
- Apply the +5.5 V ± 0.02 V to the series resistor at X6/4.
- Adjust U3 = +9.1 V ± 0.05 V at MP2 by means of TP1.
- Check the voltage at X7/4; U4 = -9.1 V ± 0.25 V.

4.3 Rectifier (A600)

Visual inspection:

- Soldering joints.
- Soldering-tin bridges.
- Correct arrangement of components (particularly insulating beats, creeping and clearing distances).

Test of the high-voltage divider:

- Connect a DC voltage of U = 4.0 V ± 0.01 V between X21/1 and X21/2 (positive pole to X21/1).
- Check the voltage at X2/3 and X2/1; U = 25 mV ± 3 mV.
- By way of substitution, use the +5 V (MP2 on A500); U = 30.5 mV to 33.5 mV between X2/3 and X21.

Test of the current divider/built-in position of the suppresser diode:

- Connect a DC voltage of U = 4.0 V ± 0.01 V between X21/2 and X2/6 (positive pole to X2/6!).
- Check the voltage between X2/5 and X2/6; U = 0.590 V ± 0.015 V.
- Check the voltage between X2/4 and X2/6; U = 1.84 V ± 0.04 V.
- Check the voltage between X2/4 and X2/1; U = 2.16 V ± 0.05 V.
- By way of substitution, feed the +5 V (MP2 on A500) and at X2/6.
- Check the voltage between X2/5 and X2/6; U = 1 V to 1.2 V.
- Check the voltage between X2/4 and X2/6; U = 1.6 V to 1.8 V.
- Check the voltage between X2/4 and X2/1; U = 3.1 V to 3.5 V.

Test of the rectifier:

- Apply an alternating voltage U_{RMS} = 10 V to 20 V, 50 Hz, between X20/1 and X20/2.
- Check the pulsating DC voltage (full-wave rectification, 100 Hz) between X21/1 and X2/6 by means of an oscilloscope.
- By way of substitution, feed the voltage (about 3.7 V_{RMS}) of the heater winding (T002) between X20/1 and X20/2.

4.4 Relay PCB (A200)

Visual inspection:

- Soldering joints.
- Soldering-tin bridges.
- Correct arrangement of components.

Test of the relay/fuses:

- Connect X1/3, 4, 5 to earth potential.
- Connect the +15-V supply voltage to X1/1.
- Check the through connection between X17/1 and X19/2; R ≈ 0 Ω.
- Disconnect the earth connection at X1/5.
- Check the through connection between X17/1 and X19/1; R ≈ 0 Ω.
- Disconnect the earth connection at X1/4.
- Check the through connection between X17/1 and X19/1; R = 33 Ω ± 5 Ω.
- Disconnect the earth connection at X1/3.
- Check the through connection between X17/1 and X19/1; R ≈ ∞.

4.5 Control computer

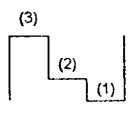
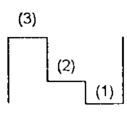
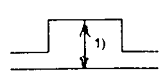
The control program comprehensively monitors the operation of the PCB itself and the input and output signals of the interface (A500).

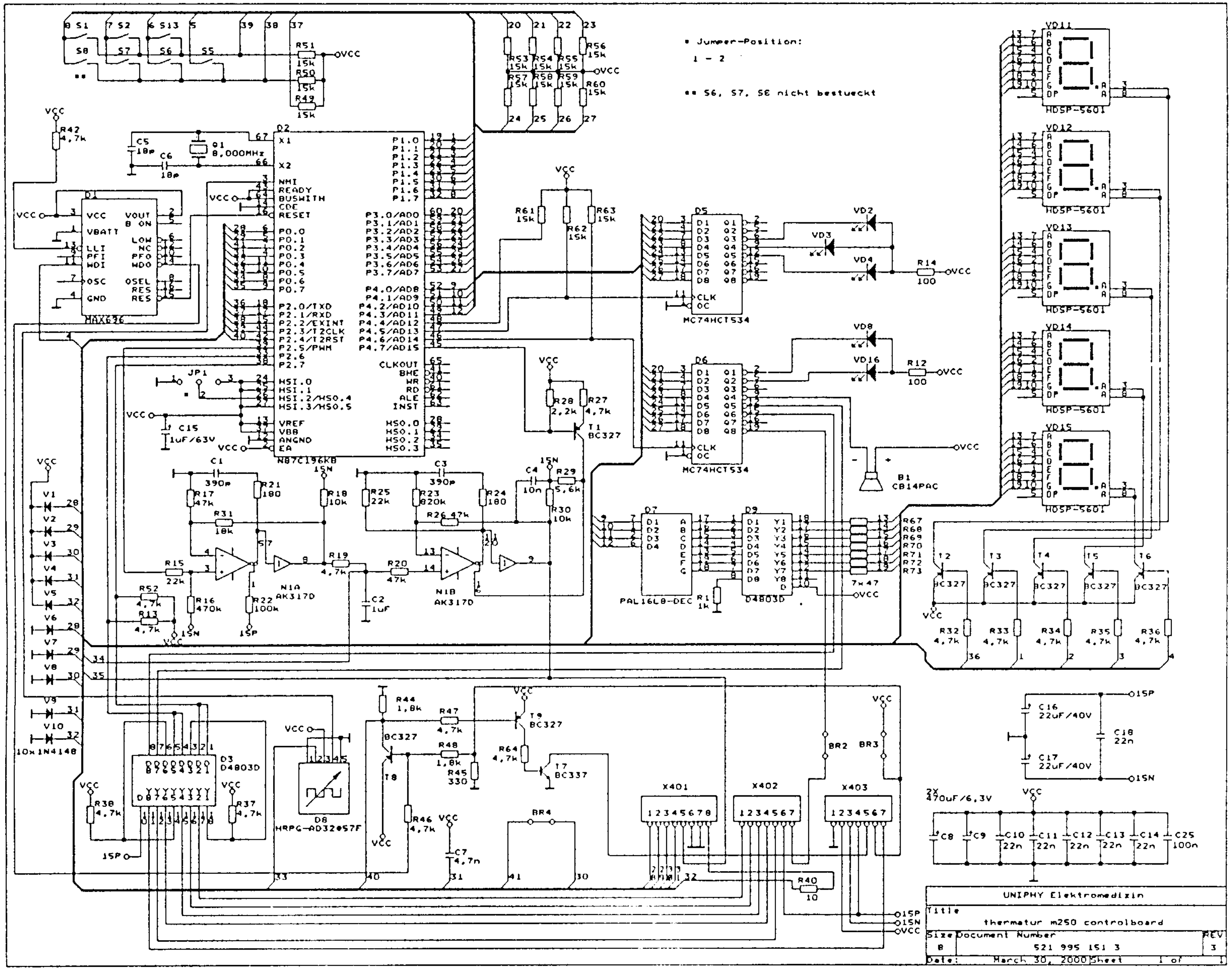
Error messages of the computer are explained in clause 5 (Table 2). Table 1 contains a survey of the signals between control computer and interface.

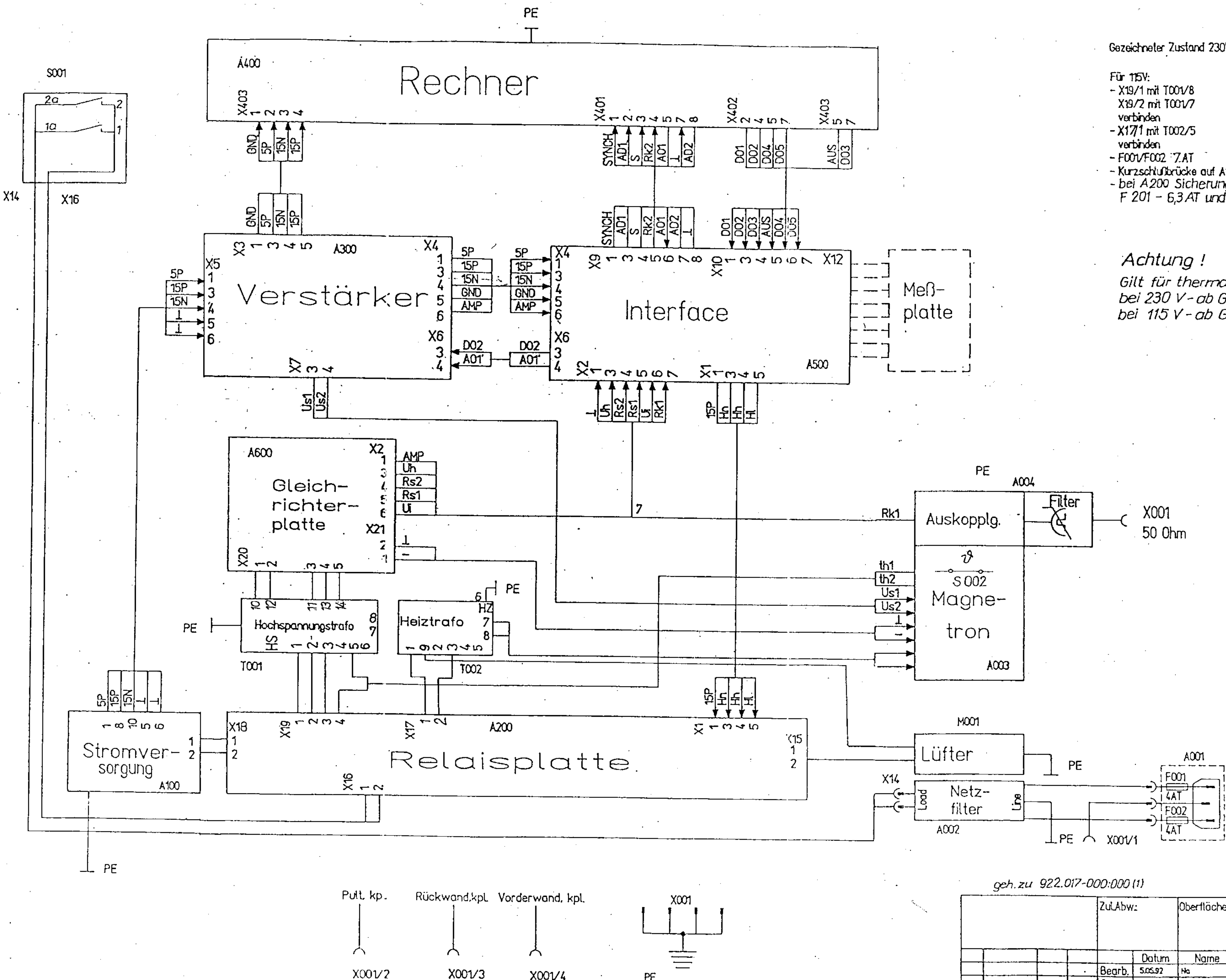
5 Hints for trouble shooting (Table 2)

	Faults or error messages	Possible cause
1	Displays are dark, fan does not run.	Mains voltage does not apply, F001 or F002 are defective.
2	Displays are bright, fan does not run.	F2 on the Relay PCB (A200) is defective.
3	No RF power display, FE4 is indicated.	F1 on the Relay PCB (A200) is defective.
4	Displays are dark, fan runs.	Error on the power supply sub-assembly (A100).
5	RF power is suddenly switched off, transition to the "stand-by" mode, FE4 is indicated after re-start, normal operation after switching off and on the mains.	The maximum magnetron current was exceeded; D5 on A500 is lit.
6	Indication of FE0	The operation parameters (mode of operation, time) were not completely entered prior to the output power adjustment.
7	Indication of FE1 FE1/6 FE1/3 FE1/1 FE1/A.	Keyboard error (key actuated, e. g. by clamping): key "cont" key "puls" key "-" key "+".
8	Indication of FE2.	Magnetron current is too heavy, cannot be controlled within the operating range of the control coil, timer display "FF".
9	Indication of FE3.	- Error at the voltage divider for current measurement (probe). - Constant-current source is defective (IC1 on A500) or not correctly triggered (IC5, IC6 on A500). - Trigger signals for VT4, VT5 (D04, D03) are missing.
10	Indication of FE4.	The high voltage is outside of the working range; mains voltage is too large - timer display: "03", too small - timer display: "00".
11	Indication of FE5.	The additional characteristic impedance of the applicator cannot be determined (not connected, no contact, measuring circuit is interrupted in the unit): short-circuit: timer display "FF", sound signal: long intervals; no-load: timer display "FF", sound signal short intervals.
12	Indication of FE6.	The quotient of actual value/setpoint is outside of the operation parameters (power) required.
13	Indication of FE7.	Checksum error in the control program.

Table 1: Signals between control computer and interface

Connection Pin	Line	Stand-by mode	Operation CW	Operation Pulsed	Remarks
X401/1	Synch	Square-wave signal 5 V_{PP}, different pulse duration and interval.	Square-wave signal 5 V_{PP}, 100 Hz, about 5 ms durat.	According to CW.	
X401/2	AD1	Staircase signal 	Sinusoidal pulses, power-dependent amplitude, 100 Hz (250 W) 50 Hz (50 W, 10 W)	Sinusoidal pulse groups, group interval 1.25 ms.	(1) 0.33 V to 0.45 V (2) 0.5 V to 0.78 V (3) 1.48 V to 2.00 V
X401/8	AD2	Staircase signal 	Sinusoidal pulses, power-dependent amplitude, 100 Hz (250 W) 50 Hz (50 W, 10 W)	Sinusoidal pulse groups, group interval 1.25 ms.	(1) 0.23 V to 0.31 V (2) 0.5 V to 0.47 V (3) 1.02 V to 1.38 V
X401/3	S	About -0.5 V (1)	Sinusoidal pulses, 100 Hz (2).	According to CW (2)	(1) Forward voltage V408 (2) Loaded pulse recognized at its cap
X401/4	RK2	250 W: 2.6 V to 3.2 V 50 W: 1.8 V to 2.2 V 10 W: 0.85V to 1.2 V	According to "Stand-by".	According to "Stand-by".	
X401/5	A01	About 5.5 V	Up > 1 V (mains voltage depend.!) 50 Hz superimposed. 	250 W: about 1.6 to 2 V (mains voltage depend.!) 10 W, 50 W: 50-Hz signal (half-wave suppression)	1) About 5.5 V (suppression of 2nd half-wave in the 10-W and 50-W ranges.
X402/2	D01	H (15 V)	L	L	
X402/4	D02	H (12 V)	L	Modulation clock L $\hat{=}$ pulse	
X402/7	D05	H (5 V)	H	H	L with undervoltage
X403/5	OFF	L	L	L	
X402/5	D04	Square-wave signal [1)]	10 W: L 50 W: H 250 W: L	According to CW	[1)] Amplitude ca. 15 V Period ca. 10 ms Pulse length ≈ 2 ms
X403/7	D03	Square-wave signal [1)]	10 W: L 50 W: L 250 W: H	According to CW	[1)] Amplitude ca. 15 V Period ca. 10 ms Pulse length ≈ 4 ms


* Jumper-Position:
1 - 2
** S6, S7, S8 nicht bestueckt
UNIPHY Elektromedizin
Title
thermatur m250 controlboard
Size B
Document Number 521 995 151 3
REV 3
Date: March 30, 2000
Sheet 1 of 1



Gezeichneter Zustand 230V

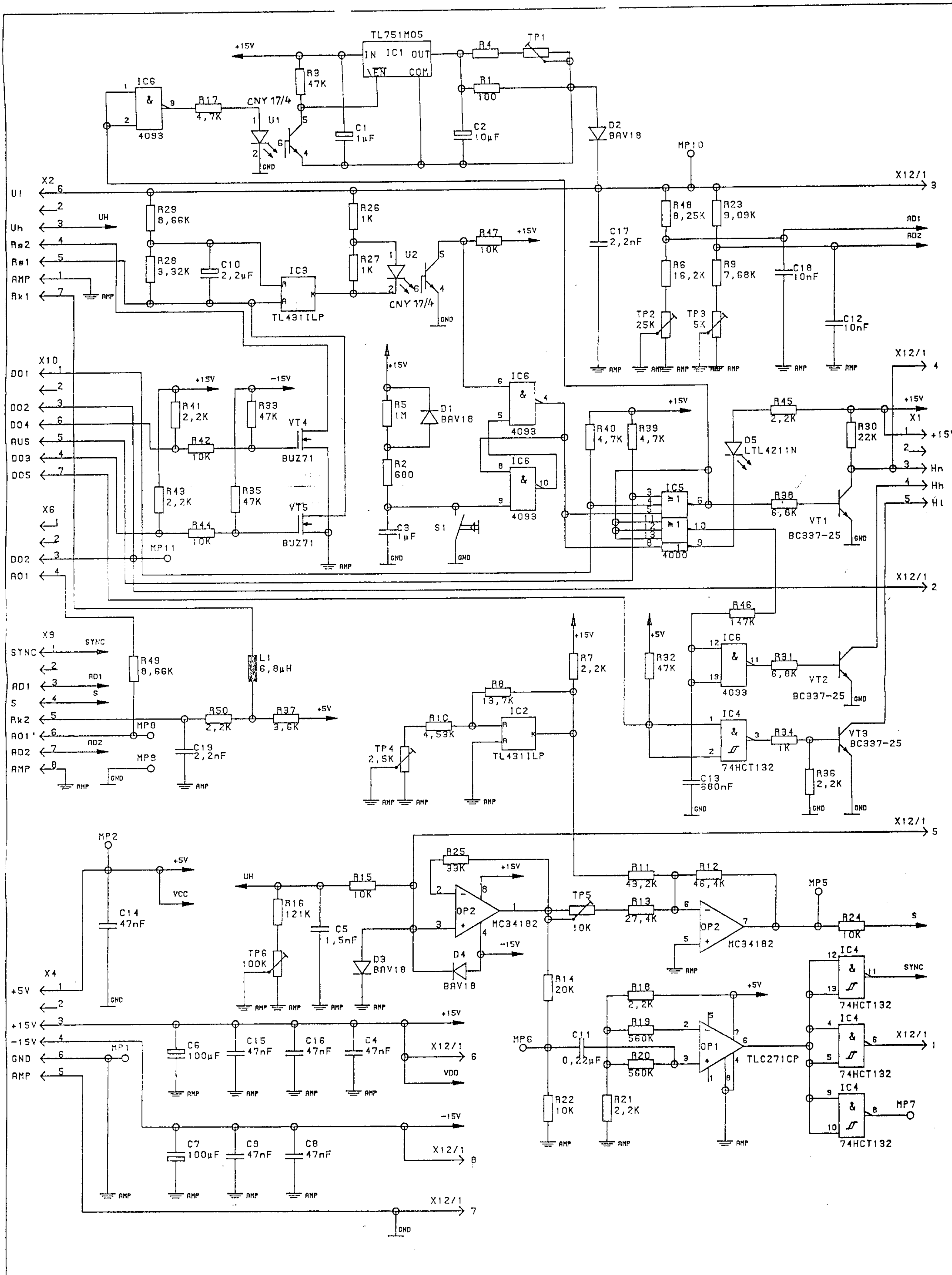
Für 115V:
- X19/1 mit T001/8
  X19/2 mit T001/7
  verbinden
- X17/1 mit T002/5
  verbinden
- F001/F002 ⌀7 AT
- Kurzschlußbrücke auf A100 auf 115V-Betrieb stecken
- bei A200 Sicherungen auswechseln:
  F 201 - 6,3 AT und F 202 - 2 AT

Achtung !

Gilt für thermatur m 250
bei 230 V - ab Geräte-Nr.: 0087
bei 115 V - ab Geräte-Nr.: 5010

geh. zu 922.017-000:000 (1)

Zul.Abw.:	Oberfläche	Maßstab:	Gewicht	
		Werkstoff:		
	Datum	Name	Benennung	
Bearb.	5.05.92	Ha	Geräteeinbau (Blockschaltbild)	
Gepr.				
Norm.				
MLE GmbH Dresden			Zeichnungs-Nr. 922.017-010:000(2) Bl.5	Blatt
AZ	Änderung	Datum	Name	Ersf.:	Ersd.: 22-713



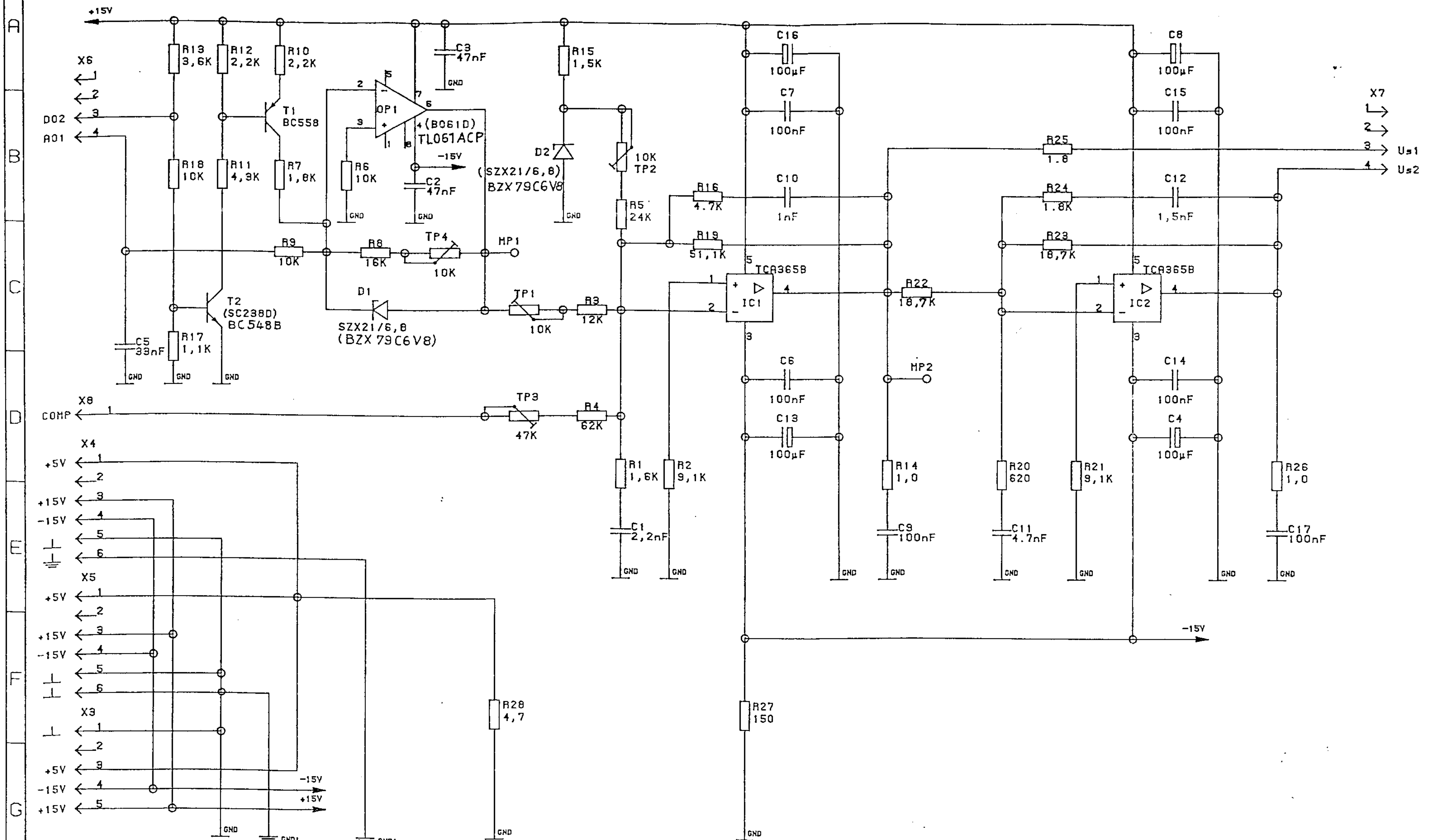
IBE KREISCHA	Bearb.		Lehmann	MLE Engineering GmbH Dresden
	Konstr	06.05.92	Leuchte	
	Techn.			
	Stand.			Auftrags Nr. 90-237

922.017-190:000 SP

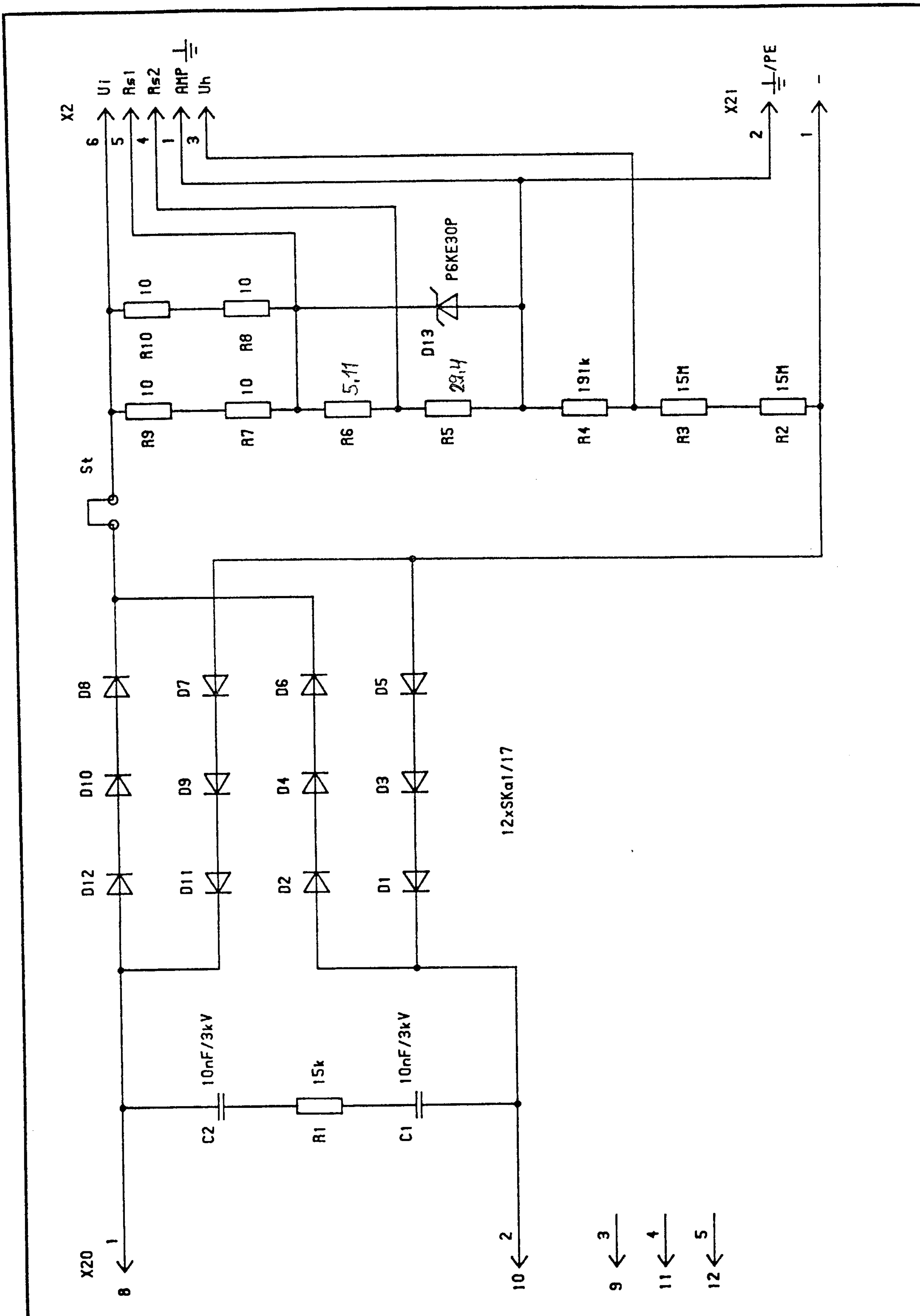
Stromlaufplan

Interfaceplatte

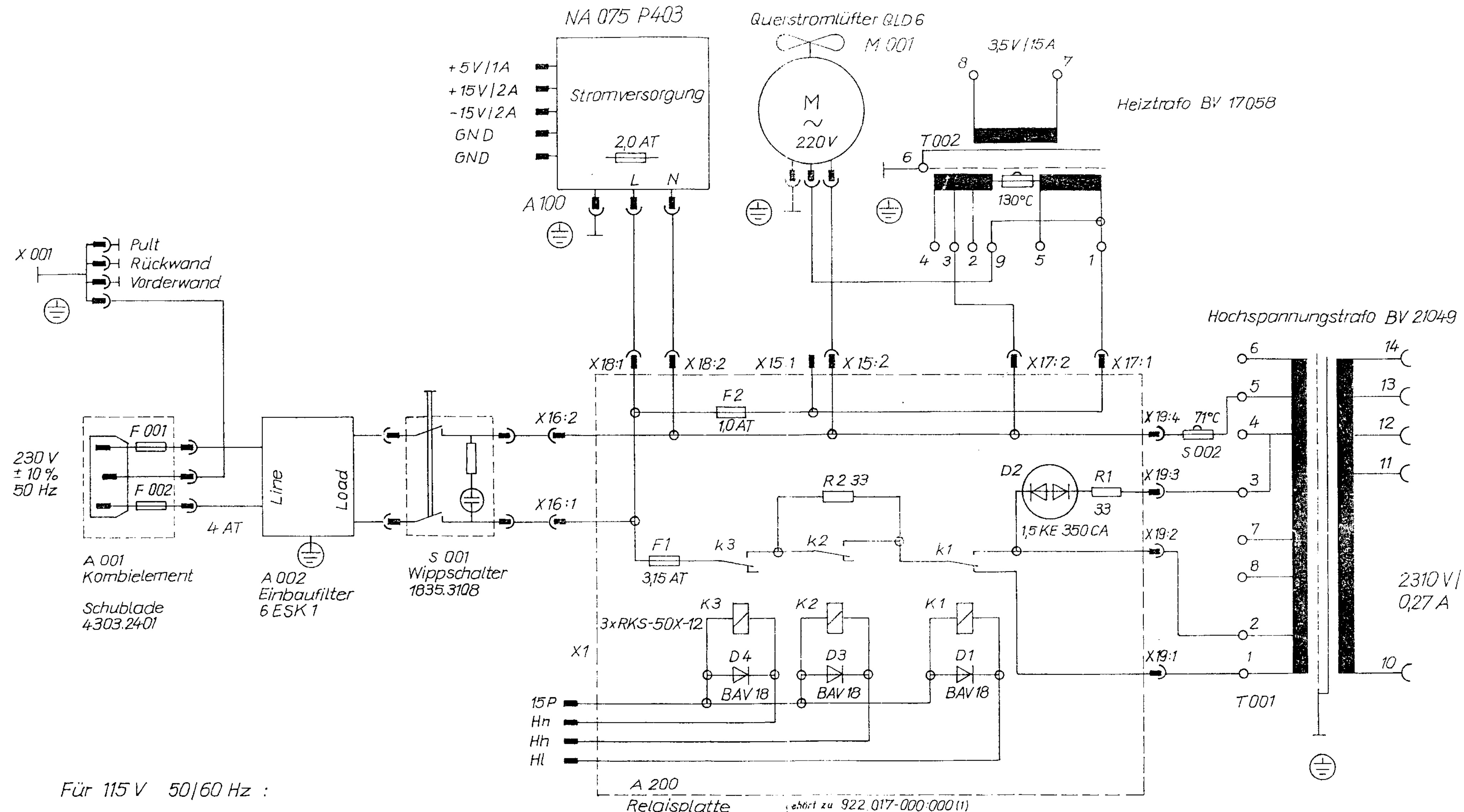
Blätter 1 Blatt: 1



		Datum		Medizin- und Labortechnik MLE Engineering GmbH Dresden	922.017-180.000 SP		Stromlaufplan
	18.12.91	Bearb.	Leuchte				
		gepr.	Nagel		Auftrags Nr. 90-213	Verstärker	Blätter 1 Blatt: 1
Mitteilung	Datum	Norm					



Bearb	06.05.92	Wandel	Benennung			
Stand	8.5.	Wandel	LP-Gleichrichter		1:1	
	Datum	Name				
MLE GmbH			Dok.-Nr. 922.017-170.000 SP		Anz.Bl.Nr.	
MZ	Mitteilung	Datum	Name	Ers.für	Ers.durch	



Für 115 V 50/60 Hz :

- Schublade 4303.2903 mit 2x 7 AT
- T001 X 19:1 an T001.8
  X 19:2 an T001.7
- T002 X 17:1 an T002.5
- F 201 6,3 AT
- F 202 2 AT
- Kurzschlußbrücke auf A100 stecken

Achtung!

Gültig für thermatur m 250

bei 230 V-ab Geräte-Nr.: 0087

bei 115 V-ab Geräte-Nr.: 5010

Maßangaben in ( ) gelten nicht für die Bearbeitung
Die ( ) Maße werden vom Besteller (Empfänger) besonders geprüft

gehört zu 922.017-000:000(1)

ÄZ	Mitteilung	Datum	Name
1993	Datum	Name	
Bearb.	2.9.	Engelh.	
Konstr.			
Technol.			
Stand			

Halbzeug/Werkstoff

Material-Nr.

Oberfläche

Benennung

Geräteeinbau (Netzkreis)

Paßmaß Abmaße

Zeichnungs-Nr.

922.017-010:000(3) Bl. 6

Ers. für

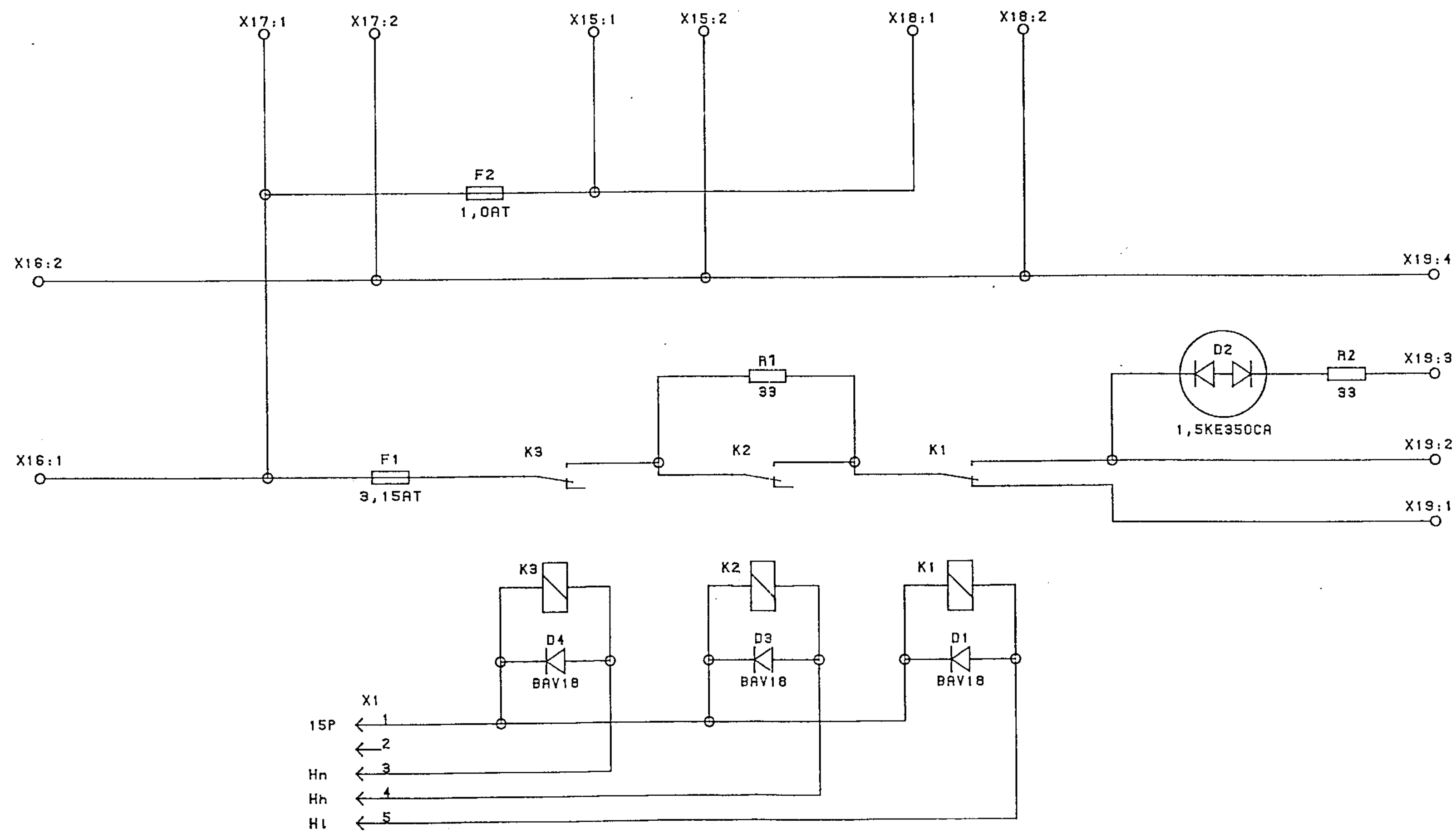
Ers. durch

zul. Abw. für Maße ohne Toleranzang.

Maßstab

Masse

Bl.Anz.Bl.Nr.



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Mitteilung	Datum	Norm			Auftrags Nr. 90-226 / Relaisplatte	Blätter 1 Blatt: 1