PREMA

INTEGRATING

DIGITAL MULTIMETER

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DESCRIPTION

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PREMA TYPE 6040 DIGITAL MULTIMETER

Operating Instructions

1. Introduction

The PREMA Type 6040 digital multimeter is suitable for measurement of DC, AC and resistance. DC voltages and AC voltages are measured to a maximum resolution of 100 nV and 10 µV, respectively. The maximum permissible voltage in each case is 1000 V. A computing RMS-value converter converts the AC voltage-signal to a DC voltage level. Depending on the range, resistance measurements can be made from a maximum displayed value of 20 M ohms to a resolution of 10 µ-ohms. Constant current sources, which are brought out separately, allow four-terminal measurements* to avoid errors due to lead resistances. All measurements can be made as relative (ratio) measurements, using an external reference.

The Digital Multimeter operates with a microprocessor which controls, on the one hand, the internal configuration and also offers, on the other hand, a wide variety of data processing capabilities by means of the "mathematical program set" option.

Data input and output provisions permit computer-controlled operation and make the digital multimeter full system-compatible. The technology of the fully integrating multi-range process, along with the shielded measurement circuitry, offers excellent suppresion of interference due to serial and common-mode voltages. Since no pauses are required between individual measurements, the entire time from the beginning of one measurement to the start of the next is used for the generation of the average value (integration).

High-impedance input stages provide a problem-free interface to the item to be tested and are protected extensively against incorrect operation (incorrect use).

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*Two terminal pair measurements.

2. Technical Data

DC Voltage (V=)

RANGES	±0.1 V, ±1 V, ±10 V, ±100 V, ±1,000 V			
MEASURING TIMES (~~ms~~ SEC)	0.02 + 0.04	0.1 + 0.2 + 0.4	1 + 2 + 4	10 + 20
MAXIMUM READOUT RANGE	19,999	199,999	1,999,999	19,999,999
RESOLUTION	10 μV	1 μV	100 nV	100 nV
RANGE SELECTION	manual, automatic or remotely controlled			
ACCURACY	±[% of the indication (% Ind) + % of maximum indication (% m Ind)]			

	24 Hrs ±1°C		90 Days		1 Year	
	% Ind	% M Ind	% Ind	% M Ind	% Ind	% M Ind
±0.1 V Range	0.001	0.0005	0.002	0.002	0.004	0.002
±1 V Range	0.0008	0.0001	~~0.001~~ 0.002	0.0003	0.003	0.0003
±10 V Range	0.0004	0.0001	~~0.001~~ 0.002	0.0001	0.003	0.0002
±100 V Range	0.001	0.0001	0.002	0.0005	0.004	0.0005
±1000 V Range	0.001	0.0001	0.002	0.0003	0.004	0.0003

The given values assume that the measurement-time dependent indicating range has been set high enough to be able to display the corresponding accuracy. The natural roundoff error of ±1 digit must be added to the percentage error of the maximum indication (% m. Ind.).

LINEARITY DEVIATION $\leq 10^{-6}$ ±1 digit

TEMPERATURE COEFFICIENTS (10°C to 40°C)

	± [% Ind	+ % m. Ind]/°C
±0.1 V Range	0.0003	0.0001
±0.1 V Range	~~0.0001~~ 0.0002	0.00003
±10 V Range	~~0.0001~~ 0.0002	0.00002
±100 V Range	0.0003	0.00003
±1,000 V Range	0.0003	0.00003

TEMPERATURE COEFFICIENTS (0°C to 50°C) Values for 10°C to 40°C) x 2

NULL POINT

Offset voltage (after 1 hr warmup time)	Temperature coefficient	better than 0.2 μV/°C
	Long term stability at 23° ±1°C	better than 4 μV over 90 days
Offset current		less than 5 pA
	Temperature coefficient	better than 1 pA/°C

INPUT IMPEDANCE

±0.1 V, ±1 V, ±10 V Range	100 G Ω (up to ±0.2 V, ±2 V, or ±20V input voltage, respectively)
±100 V, ±1,000 V Range	10 M Ω

INTERFERENCE SUPPRESSION (Measured by increasing of the interference peak value until a one digit error is indicated with a measuring period of 400 msec, without filter.)

Series Noise Suppression

50 Hz power supply	better than 100 dB
46 Hz to 56 Hz	better than 50 dB

Common-Mode Rejection (shield connected with low resistance to one of the two inputs, with 1 K Ω in one of the two input leads)

DC voltage	160 dB
50 Hz power supply	160 dB

MEASUREMENT PAUSES None, except when a computer program is selected whose processing time exceeds the measuring limit.

MEASUREMENT TECHNIQUE Fully integrating PREMA multi-ramp process (German Pat. No. 2114141, US-Pat. No. 3765012).

POLARITY CHANGE Automatic, 50 msec max.

OVERLOAD LIMITS

Between "+" and "-" input

±0.1 V, ±1 V, ±10 V range for 60 sec	±1,000 V
continuous	±700 V
±100 V, ±1,000 V range continuous	±1,000 V
Between "-" input and shield	500 V DC voltage or peak-to-peak AC voltage
Between shield and enclosure	500 V DC voltage or peak-to-peak AC voltage

OVERFLOW INDICATION Display of a "2" in the first digit and blanking of all other digits.

Resistance Ω/k Ω

Option 02

MEASUREMENT PROCEDURE — True 4-terminal (2 terminal pair)

RANGES — 10 Ω, 100 Ω, 1 k Ω, 10 k Ω, 100 k Ω, 1 M Ω, 10 M Ω

MEASURING TIMES	0.02 + 0.04	0.1 + 0.2 + 0.4	1 + 2 + 4	10 + 20
MAXIMUM INDICATOR RANGE	19,999	199,999	1,999,999	19,999,999
RESOLUTION	1 m Ω	100 µ Ω	10 µ Ω	10 µ Ω

RANGE SELECTION — Manual, automatic or remotely controlled

ACCURACY ±[% of the indication (% Ind) + % of the maximum indication (% m. Ind)]

	24 hrs ±1°V		90 days		1 Year	
	% Ind.	% m. Ind.	% Ind.	% m. Ind.	% Ind.	% m. Ind.
10 Ω Range	0.003	0.0005	0.004	0.002	0.005	0.003
100 Ω Range	0.002	0.0005	0.003	0.002	0.004	0.003
1 k Ω Range	0.001	0.0001	0.002	0.0007	0.003	0.0007
10 k Ω Range	0.001	0.00005	0.002	0.0005	0.003	0.0005
100 k Ω Range	0.002	0.0002	0.003	0.0007	0.004	0.0007
1 M Ω Range	0.003	0.0002	~~0.004~~ 0.007	0.0007	~~0.0005~~ 0.007	0.0007
10 M Ω Range	0.01	0.001	0.02	0.001	0.02	0.001

The given values assume that the measurement-time dependent indication range is high enough to allow presentation of the corresponding accuracy. The natural roundoff error of ±1 digit must be added to the % error of the maximum indication (% m. Ind.).

TEMPERATURE COEFFICIENTS (10°C to 40°C)

	±[% Ind	+ % m. Ind.]/°C
10 Ω Range	~~0.0004~~ 0.001	0.0001
100 Ω Range	~~0.0001~~ 0.0001	0.0001
1 k Ω, 10 k Ω Ranges	~~0.0001~~ 0.0002	0.00003
100 k Ω, 1 M Ω Ranges	~~0.0004~~ 0.0006	0.00004
10 M Ω Range	~~0.0012~~ 0.002	0.0001

TEMPERATURE COEFFICIENTS (0°C to 50°C)	Values at (10°C to 40°C) x 2
CURRENT THROUGH RESISTANCE MEASURED	
10 Ω Range	10 mA
100 Ω, 1 k Ω, 10 k Ω Ranges	1 mA
100 k Ω, 1 M Ω Ranges	10 μA
10 M Ω Range	1 μA
VOLTAGE AT OPEN TERMINALS	Approx. 22 V max
OVERLOAD LIMIT	±400 V peak
OVERFLOW INDICATION	
Resistance to be measured too large	Display of a "2" in the first digit and blanking of the remaining digits
Excessive input lead resistance	Display of a "3" in the first digit and blanking of the remaining digits

Ratio Measurement

Option 05

MEASURING TECHNIQUE	True 4-terminal for all ranges and functions
INPUT RESISTANCE	>3 G Ω
REFERENCE VOLTAGE	2.5 V to 20 V
INDICATED VALUE	$\frac{10\ V}{Ref\ V} \times \frac{Input\ Value}{nom.\ Range\ Value}$ or 10 x Ratio
ACCURACY	Same value as in the selected function V =, V ~, Ω/k Ω multiplied by (20 V)/(Ref V)

COMMON-MODE RANGE referenced to the "-" signal input

"+" reference input	-1 V to +21 V
"-" reference input	-11 V to +11 V

OVERLOAD LIMIT FOR RATIO INPUT

Referenced to "-" signal input	±400 V peak
Between "+" and "-" ratio input	±400 V peak

AC Voltage "V ~" (AC)

Option 03

CONVERSION METHOD — True RMS value, selectable for pure AC voltage or the sum of DC and AC voltage.

RANGES	1V	10 V	100 V	1,000 V
MAXIMUM INDICATION	1.99999 V	19.9999 V	199.999 V	1000.00 V
MEASUREMENT TIMES (sec)	0.4 to 20			

RANGE SELECTION — Manual, automatic or remotely controlled

ACCURACY ±[% of indication (% Ind) + % of maximum indication (% m. Ind)]*

	24 hrs ±1°C		90 days		1 year	
	% Ind	% m. Ind	% Ind	% m. Ind	% Ind	% m. Ind
DC	0.07	0.002	0.1	0.03	0.15	0.04
10 Hz - 20 Hz	0.3	0.04	0.4	0.06	0.5	0.07
20 Hz - 50 Hz	0.2	0.01	0.3	0.02	0.4	0.04
50 Hz - 10 k Hz	0.07	0.002	0.1	0.03	0.15	0.04
10 k Hz - 60 k Hz	0.3	0.17	0.3	0.3	0.4	0.5
60 k Hz - 300 k Hz**	2.0	0.45	3.0	0.6	4.0	0.7
300 k Hz - 1 M Hz**	4.5	1.0	5.0	1.5	6.0	2.0

COMPLETELY DIFFERENT SEE BELOW

*Shield connected to black jack of V~ (AC) input

**Frequencies higher than 100 k Hz specified in the 1 V and 10 V range only.

TEMPERATURE COEFFICIENT (10°C to 40°C)

0 TO 10 KHZ — ±(0.003% OF INDICATION + 0.002% OF MAX INDICATION)/°C

~~All ranges — ±(0.015% of indication +0.001% of maximum indication)/°C~~

10KHZ TO 1.0MHZ — ±(0.04% OF INDICATION + 0.005% OF MAX. INDICATION)/°C

2HZ TO 4HZ	0.6	0.01	0.6	0.01	0.6	0.01
4HZ TO 10HZ	0.2	0.01	0.2 ~~0.07~~	0.01	0.2	0.01
DC + 10HZ TO 1KHZ	0.05	0.01	0.07	0.01	0.1	0.01
1KHZ TO 10KHZ	0.05	0.05	0.07	0.05	0.1	0.05
10KHZ TO 100KHZ	0.2	0.5	0.3	0.5	0.4	0.7
100KHZ TO 1.0MHZ	5.0	1.3	5.5	1.5	6.0	2.0

TEMPERATURE COEFFICIENT (0^oC to 50^oC)	Values at (10^oC to 40^oC) x 2
CREST FACTOR	
At indication of 100.000	7:1
INPUT RESISTANCE	1 M Ω/<50 pf
OVERLOAD LIMITS	
V~ (AC) Input	±1414 V peak with a limit of 10^7 V x Hz
Shield to Chassis	±500 V peak
Shield to Black Input jack V~ (AC)	±200 V peak
TRANSIENT TIME	First readout to 0.2 % of an input voltage step when triggered after the step with 400 msec measuring time.
OVERFLOW INDICATION	Display of a "2" in the first digit and blanking of the remaining digits

Digital-to-Analog Converter

Option 08

DECOUPLING FROM THE INPUT	Galvanically separated from the input stage
CONVERSION RANGE	2 BCD Digits of the Indicator
SELECTION OF THE DIGITS	Via keyboard or IEC-Bus Option 06
OUTPUT VOLTAGE RANGE	±10 V

IEC BUS Interface

Option 06

DECOUPLING FROM INPUT	Galvanically separated from the input stage
OUTPUT INFORMATION	Numerical readout of measurement result, computed result and constants, function, range, measuring time, and computer program number
INPUT INFORMATION	Function, range, measuring time, start command, computer program number, and values of constants
ADDRESS	Selectable from 0 to 30, can be set up via switch on the rear of the enclosure
KEYBOARD	Can be switched off via REN, can be switched in via GTL
END CHARACTERS	EOI, CR, LF
COMPATIBILITY	IEEE Standard 488
BUS CONNECTOR	24 pin Amphenol No. 57-40240
HANDSHAKE TIME	For data output <2.2 msec (typ. 1.2 msec) for 30 characters + EOS.

BCD-Output/Remote Control Input

Option 07

DATA OUTPUT

Decoupling from Input	Galvanically separated from the input stage

Plug-in Connector on Rear of Enclosure	50 pin Amphenol-Strip No. 57-40500, suitable for the 50 pin Amphenol cable connector No. 50-30500
Available Data	a) Digits, polarity, decimal point and end-of-measurement continuously b) Ranges, functions, ratio, and filter only when not in the remote control mode of operation
Coding of the Digits	8421 BCD-code, bit-parallel and digit-parallel
Logic Level	TTL-level, 1 = high, 0 = low, may be loaded with a TTL input load factor of 1

REMOTE CONTROL INPUT

Decoupling from Input	Galvanically separated from the input stage, the same ground as data output
Plug-in Connector on Rear of Enclosure (Chassis)	Same strip as for BCD data output
Remote Control Capabilities	Ranges, functions, ratio, filter, triggering
Trigger Accuracy	5 msec after release of the trigger contact

General

WARMUP TIME	20 min. for 1 year accuracy, 1 hr for full accuracy
HUMIDITY	
Up to 25°C	Up to 75% rel. Hum.
Above 25°C	Up to 65% rel. Hum.
POWER SUPPLY	220 V AC, 15 VA to 22VA depending on configuration
WEIGHT	Approx. 6 kg
ENCLOSURE	Aluminum, 19 inch flat enclosure
DIMENSIONS	
Bench Enclosure	
Height without feet	Approx. 88 mm
Height with feet	Approx. 105 mm
Width	Approx. 444 mm
Depth without handles and operator controls	Approx. 356 mm
Depth with handles	Approx. 396 mm
Mounting brackets for reconfiguration to a drawer enclosure (option)	
Width of mounting brackets	Approx. 484 mm
From each mounting holes per mounting bracket	7.5 mm diameter
Arrangement of the four mounting holes in a rectangle	76 x 466 mm

ADDITIONAL OPTIONS

TYP 5020 G	Accessories for frame mounting
TYP AD-BNC	Adapter plug to BNC jack
TYP 57-30500	Mating plug for BCD output strip in the rear
TYP 6040-01	Added card, needed for options 02 and 03
TYP 5023K	Adapter cable for IEC BUS, 24 pin piggy-back plug, 4 mm

Changes Reserved

3. Start-Up (Turn-On)

Each PREMA measurement instrument was tested carefully and thoroughly for compliance with all specified data prior to shipment. Therefore the instrument should be in electrically perfect condition when it is received. In order to make sure of this, the instrument should be inspected for shipping damage immediately after it is received. In case of complaints, a damage report should be prepared jointly with the deliverer.

Power Connection

This PREMA measuring instrument has been configured for connection to 220 V, 50 Hz power. Voltage changes of ±10% and frequency variations of ±4% are permissible. Depending on the configuration, the power consumption is 15 to 22 volt-amperes. A cold (i.e., not hot) equipment plug connection (per DIN) with a safety contact is located on the rear for connection to the power. The equipment is protected by a 0.3 amp slow fuse. The measuring instrument is separated from power by a two-pole pushbutton switch "Netz" ("Power"), located on the front panel.

Grounding

The equipment enclosure is grounded for the user's safety by connection of the power supply cable through a suitable safety contact plug. The chassis is galvanically isolated from the shield and from both input terminals.

4.0 Operating Instructions for V = (VDC)

Measurement Voltage Input

The voltage to be measured is brought in on the front panel through the two "Eingang V=" (VDC input) jacks, where a positive voltage at the red jack relative to the black jack results in a positive readout (display). Care must be taken that the maximum values of 500 VDC or peak-to-peak AC between the "-" input and the shield (see shielding section) and between the shield and enclosure are not exceeded. This must be considered in the polarity selection for high voltage instruments which are not isolated in voltage from power.

Input Resistance "V=" (VDC)

In order to exploit the high linearity of the measuring technique, the input impedance for voltage measurements is in some cases extremely high. For example, with a 100 k ohm internal resistance of the device being tested, the instrument still permits relatively accurate measurements, up to ±20 volts. In the 100 V and 1,000 V ranges, 100 ohms internal resistance at a resolution of 10^{-5} already cause an error of one digital step. Input impedance, indicator range, and resolution are given in the following table:

Range	Maximum Indicator Range	Input Resistance	Maximum Resolution
0.1 V	0.2000000 V	≥100 G ohm	100 nV
1 V	2.0000000 V	≥100 G ohm	100 nV
10 V	20.000000 V	≥100 G ohm	1 μV
100 V	200.00000 V	10 M ohm	10 μV
1,000 V	1000.0000 V	10 M ohm	100 μV

Input Offset Current

In addition to the impedance, the input offset current represents an important input quantity which affects the accuracy. If measurements in the mV range are to be performed on very high-impedance sources, then it is desirable to compensate this current up to its noise component by means of the internal potentiometer R6 (see alignment instructions within the instrument). Thus, for example 1 pA offset current already causes an error of 100 nV corresponding to a one digit step in the 0.1 V range with a 100 k ohm internal impedance of the device being tested.

Null Point

Shifting of the null point represents a possibility for error. It is, however, easily detected by a readout differing from zero when the input is short-circuited. This error, which can appear in the lower ranges inspite of the regulated null point due to thermal EMI at the input terminals, is corrected using a rotary potentiometer on the front panel. Due to stress in shipment or because of component aging, a null shift in the 10 V range could occur under especially unfavorable conditions.

Automatic Stability Control

The Digital Multimeter performs an automatic stability control sequence five minutes after it is turned on. Subsequently it automatically performs a stability control sequence every twenty minutes and, if necessary, implements a correction. This is shown by blinking of the numbers in the "Messzeit" (measuring time) indicator field. The duration of this stability control process is 40 seconds. The stability control can be disabled by selection of program numbers 50 to 98. If the input signal exceeds 10% of the maximum indication, then stability control is also not performed. If necessary, a stability control sequence can be performed directly by selection of program 49 if the input signal does not exceed 10% of the maximum indication. Should the Digital Multimeter be turned on again only after several days and the last-stored RAM data no longer be available, then a stability control procedure is carried out without use of the program numbers 50 to 98.

Overload Protection

All ranges are protected to a high degree against damage due to overvoltages. In this case the overload is as follows:

±0.1 V, ±1 V, ±10 V ranges for 60 sec.	±1,000 V
or continuously	±700 V
±100 V, ±1,000 V ranges, continuously	±1,000 V

It must be noted, however, that by strong overloading of the lower ranges a heat up of the protection resistors and diodes cannot be avoided and that subsequently thermal voltages can cause a null point shift until internal thermal equilibrium is reached.

Serial Interference Voltage Suppression

One of the major advantages of the integrating measurement technique is its high suppression of the serial AC component of the voltage to be measured. For 50 Hz with a 400 ms measurement time, averaging of more than 100 dB is obtained. Frequencies higher than 47 Hz are always averaged out to better than 50 dB (measured by raising the input AC voltage until a one digit error indication results). These outstanding values are achieved by synchronization of the internal clock oscillator with the power supply (see alignment instructions within the equipment).

Common Mode Rejection

Common mode rejection is defined as the ability of a measuring instrument to indicate (display) only the desired differential signal between the "+" and "-" input but, on the other hand, to maximally suppress a voltage equal for both terminals with respect to ground. No error would result in an ideal system; however, in reality, a part of the DC voltage is converted to a series voltage by stray capacitances, isolation resistors and resistive imbalances. The common-mode rejection is higher than 160 dB without filter with a one-sided imbalance of 1 k ohm in the input leads.

Shielding

If no difficulties resulting from common-mode voltages are expected in the measurement, then the protective shield input (blue jack) should be connected to the negative input (black jack).

Using the protection shield input, it is possible to achieve a high DC and AC common-mode rejection in critical cases. Common-mode voltages are voltages which exist between the low point of the voltage to be measured and the power ground as well as between the power ground of the voltage source and the power ground of the measuring instrument. Common mode voltages have a tendency to permit currents to flow in the same direction into both input jacks. In order to achieve optimal shielding, the protective shield input should be connected to a DC voltage at the same level as the negative input in such a manner that the shield currents do not flow through such resistances of the voltage source and voltage lead-in cables which can affect the measurement voltage.

Keyboard Fields

The front panel keyboard is divided into the following fields:

a) Automatic and range keys: The capability of rapid, automatic range selection simplifies measurement by the Type 6040 Digital Multimeter. For longer measurement periods, the Type 6040 Digital Multimeter makes a pre-decision within 50 msec as to whether the right range has been set up. In order to achieve a high reliability, mechanical switches are avoided as much as is possible within the state of technology (i.e., except for the relay to switch in the lines carrying 1000 V). If range selection is accomplished through the rear input (see Chapters: BCD-Data Output/Remote Control Input and IEC Bus Interface), then the functions of the range keys on the front panel are disabled (interrupted). The control is galvanically isolated from the input.

b) Function Keys.

c) Data Entry Field, which is used to enter data according to the instructions under d).

d) Programming Field with the following keys:

"MESSERGEBNIS" (measurement result): When this key is activated, the direct measurement value appears in all cases.

"MESSZEIT" (Measurement time): With this key, the Data Entry Field is prepared for entry of measurement times.

"RECHENERGEBNIS" (computed result): This key causes the result of the just-selected program to be displayed.

"PROGRAMM/CONSTANTE" (program/constant): With this key, the Data Entry Field is prepared (initialized) for selection of a program or the number of a constant.

"EINGABE" (entry): Following prior call-up of a constant and activation of the entry key, the measured value ("Measurement Result" key) or any desired combination of numbers ("Data Entry" field) can be loaded into the memory of the corresponding constant (see description of the programs).

e) "Filter": After depressing this key, an average-value determination over ten measurements is performed. The most recent measured value is included in the average-value determination and the oldest measured value is discarded.

Easy-to-Read Display

For the Type 6040 Digital Multimeter, emphasis was placed on an easy-to-read presentation of the values important to the user. For this purpose the display was divided into three functionally related groups:

a) The display field for measurements and computed values was configured such that the locations of the digits for V, mV, µV and nV remain the same, independent of the range and measurement time. In addition, the readouts for V, mV, µV and nV are always combined in groups of three.

c) The display field for the measurement time shows the inserted measurement time to the user at a glance. For times greater than 4 seconds, the remaining residual integration time of the entire measurement cycle is displayed by this indication decrementing its value at one second intervals starting from the entered value and ending at zero at the end of the measurement, e.g.: 20, 19, 18 .... Thus, for long measurement times, the important point in time when a new measurement result is accepted, is recognized.

d) The program/constant display field shows the number of a selected computer program, e.g., 12, or the numberof one of the predefinable constants C_0 to C_9 of the computer programs. The value of this constant also appears simultaneously in the main display field.

e) Light emitting diodes above the corresponding pushbutton keys indicate the selected range and function.

4.1 Operating Instructions for "Ω/KΩ"

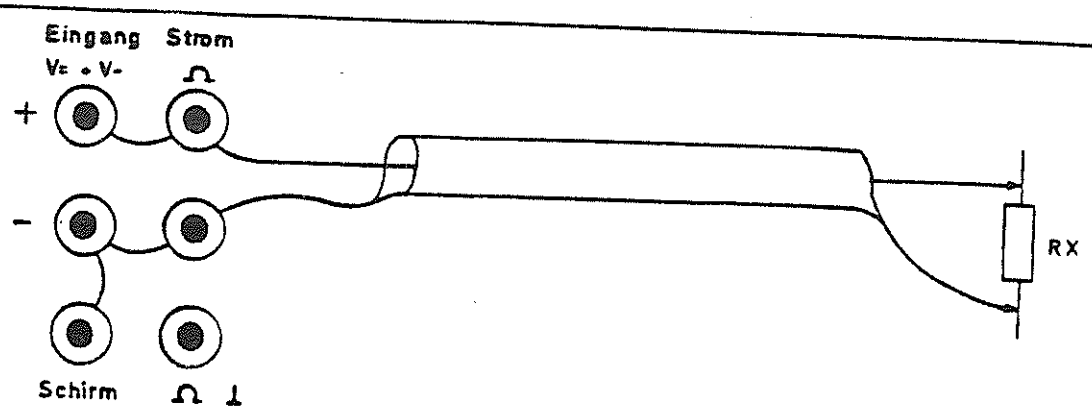
A resistance measurement using the Type 6040 Digital Multimeter is conducted in the following manner: a current (I), which simultaneously flows through a known internal range-resistor is impressed on the resistance to be measured (R_x). The voltage drop across R_x is measured across the ± input jacks by means of V = (DC) and the ratio to the voltage drop at the internal range-resistor is formed. Thus, aging or drifting of a reference voltage source does not enter into the resistance measurement.

Two-Wire Measurements

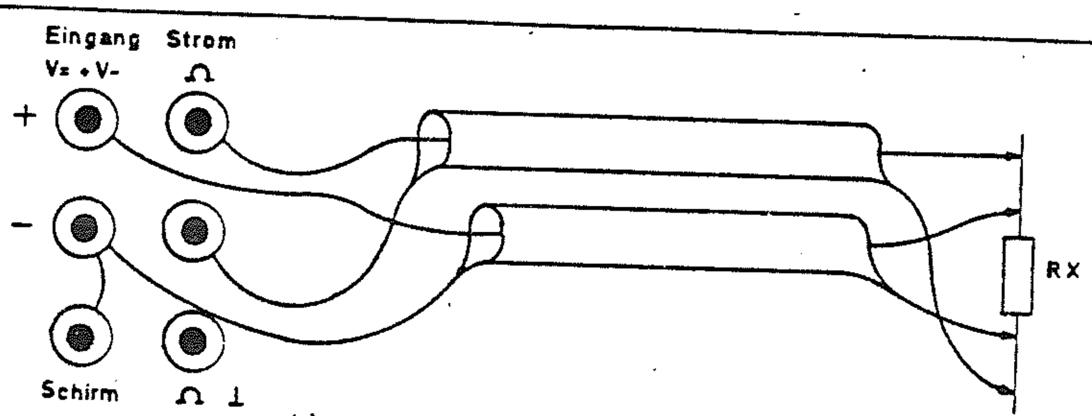
The hookups for a simple two-wire resistance measurement is presented in Figure a). In such a measurement just one shielded cable is used, where the inner conductor is connected to the "+V = Eingang" (+DC voltage input) and the "+ Strom" (+ current) output, while the cable shield serves as the return lead for the "-V = Eingang" (-DC voltage input) and "- Strom" (- current) output. This measurement setup provides acceptable measurement results; however, only in a resistance region limited at the top and bottom ends. For high resistance values, leakage current problems appear which arise from the parallel circuit of R_x and the cable insulation resistance. For low resistor values, especially in the 10 ohm and 100 ohm range, the input lead resistance comes into play. A four-wire measurement is recommended for these ranges.

Four-Wire Measurements

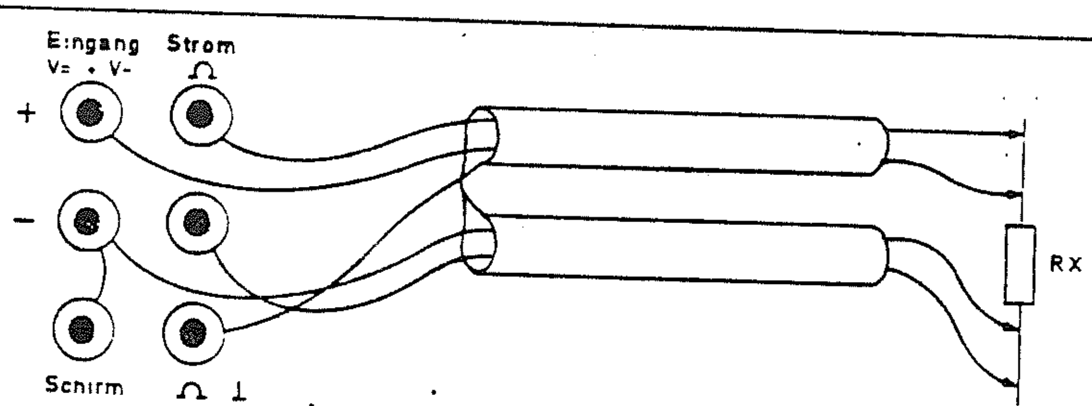
The first measurement configuration for a four-conductor measurement is presented in Figure b). The appropriate inner conductor in each case is connected to the "+" terminal of the "V = Eingang" (DC input) or to the "Strom Ω" (current-ohms) output, while the shield is connected to the corresponding "-" terminals.



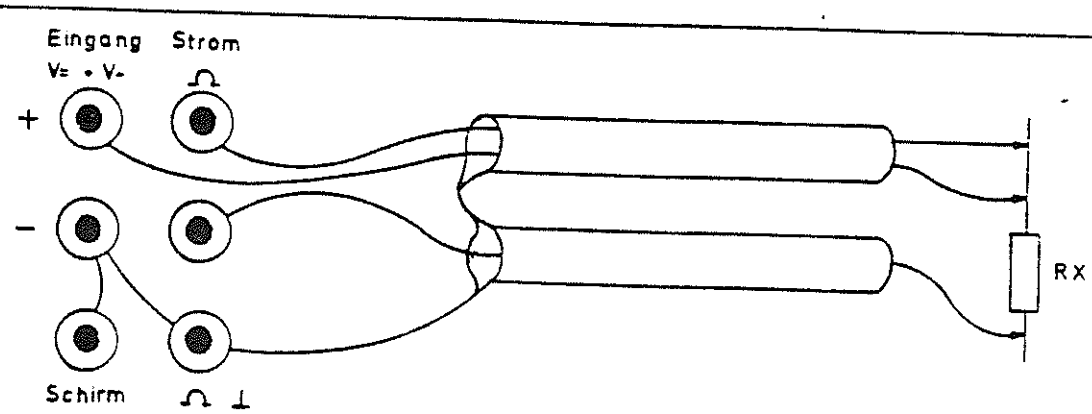
a) MOST SIMPLE MEASURMENT HOOKUP



b) NORMAL MEASUREMENT HOOKUP



c) MEASUREMENT HOOKUP FOR HIGH RESISTANCE RANGES
ESPECIALLY WITH CABLE LEAKAGE CURRENTS



d) MEASUREMENT HOOKUP FOR 10 MOHM RANGE (3 TERMINALS)
WITH CABLE LEAKAGE CURRENTS AND HIGH INTERFERENCE (NOISE)

Eingang = INPUT
Strom = CURRENT
Schirm = SHIELD

In this, and also in the following measurement configuration (Figure c), the effect of the input lead resistance is eliminated. However, for high resistance measurements, a cable with teflon insulation should be used in Figure b). Simpler insulating materials can be used even in the M-ohms range with a measurement configuration as shown in Figure c. The shield of the two-conductor cable, which is used in this configuration, is connected to the black jack of the "V∿" input (AC input). This jack simultaneously serves as ohm ground.

Three-Wire Measurements

When there is strong external interference (noise) in the 10 Mohm range, the arrangement of Figure d) may also be used. It serves to minimize AC voltage pickup and is provided only for the 10 Mohm range.

General Remarks:

The currents through the resistance to be measured are:

10 ohm range	10 mA
100 ohm, 1 kohm, 10kohm ranges	1 mA
100 kohm, 1 Mohm ranges	10 µA
10 Mohm range	1 µA

With four-wire measurements, a voltage drop in the wires from the "Strom Ω" (current Ω) outputs of up to about 2 V per wire is permissible. An excessively high lead-in resistance is indicated by a 3 in the first readout digit and blanking of the remaining digits. An overflow due to an excessive R_x is presented by a 2 in the first digit and blanking of the remaining digits.

The polarity of current to be carried through R_x is defined such that the end of R_x connected to the red jack has a negative potential relative to the other end of R_x. Care should always be taken (see also Figure a) to d)) that the resistor end of R_x, which is connected to the red (+) jack of the "Strom Ω" (current-ohms) output, is also connected to the red (+) jack of the "V=Eingang" (DC input). The same also applies to the black (-) jacks.

In an incorrect measurement configuration, a 3 appears in the first readout digit, and the remaining digits are blanked.

4.2 Operating Instructions for V∿ (AC voltage)

When equipped with option 03, the Digital Multimeter measures the true rms value of the applied voltage, that is the rms value of the sum of the applied AC and DC voltages. Using the switch below the AC terminals on the front panel, it is possible to separate the DC voltage out and to display only the pure AC voltage.

A measurement hookup recommended for AC voltage measurements consists of a two-conductor cable with a shield, with the shield being connected to the "Schirm" (shield) input. In all measurements the "Schirm" (shield) and the black "V∿" (AC) input should be connected to the test point which is closest to ground potential.

Somewhat lower shielding is achieved if a simple coaxial cable is used with a connection (jumper) between the "Schirm" (shield) and the black "V∿" (VAC) input. This frequently used measurement setup is adequate for most measurements except for high ambient noise or very low voltages.

Care must be taken with higher frequencies in the 100 V and 1,000 V ranges (above 50 kHz in the 100 V range, and over 10 kHz in the 1,000 V range) that the applied AC voltage does not exceed the rms value product of 10^7 volt · Hz. The shortest selectable measurement time is 400 msec.

4.3 Operating Instructions for Relative Measurement (Ratio)

In order to conduct a ratio measurement, a positive DC voltage is applied to the "Ratio" input jacks on the rear of the instrument, and an input signal having any desired polarity or function is applied to the inputs on the front panel. The reference voltage must be in the +2.5 V to +20 V range. The indicator then presents the ratio multiplied by 10:

$$(V_{input}/V_{ref}) \times 10.$$

A ratio measurement is a true four-terminal-measurement, i.e., the SIGNAL INPUT is not internally connected to the - REFERENCE INPUT in order to avoid grounding problems in extremely precise measurements. However, referenced to the - SIGNAL INPUT, the following common-mode voltages, are permissible:

+ REFERENCE INPUT -1 V to +21 V

- REFERENCE INPUT -11 V to +11 V

If however the reference voltage source is floating, e.g., when a standard battery is used, then the -SIGNAL INPUT and the -REFERENCE INPUT should be connected such that the common-mode range is not exceeded by static charges. The reference input itself has high impedance (>3 G ohm), and thus permits also hook-up of sources with higher internal impedance. Averaging of the reference voltage takes place simultaneously with integration of the signal voltage; this is a characteristic important for bridge measurements.

4.4 Operating Instructions for the Computer Program Set

The 6040 Digital Multimeter with its Option 09 "Computer Program Set" offers a multitude of programs, which free the user from annoying conversion computations. In addition to these standard programs, there exists the possibility of adding customer-specific programs in case they are needed. Each of these programs must be selected under two program numbers, with automatic stability control operational for the numbers 0 to 4. Under the numbers 50 to 99, the measurement process is not interrupted for automatic stability control. The constants C0 to C9 that are used are freely selectable over the range of ±0.000 000 000 to ±9 999 999 999.

PROGRAM 00/50

In this program, the last computed result is presented, independent of the next measurement result or of the start. Thus a computed result can be protected against incorrect operation.

PROGRAMS 10/60

The use of these programs is described in an easy-to-understand way by the mathematical formulas in Table 1. Program 06/56 "Polynomial" is especially useful due to its broad range of applications. With four freely selectable constants, this program is good for linearization and curve-fitting, e.g. for non-linear measurement pick-ups (sensors).

PROGRAMS 11/61 to 13/63 Grenzwert (Limit Value)

In these programs an upper limit can be specified by constant C7, a lower limit can be specified by constant C6, or both limits can be specified simultaneously.

The measured value is indicated if it is within the permitted range. If it is outside, then a blinking indication appears with the correctly signed difference to the exceeded limit.

PROGRAMS 14/64 to 16/66 MAX-MIN

From a series of measurements, the maximum value and the minimum value, as well as the difference of the two, can be presented. The number of measurement cycles to be considered can be specified through constant C8 (see table).

PROGRAMS 17/67 to 20/70 STATISTIK (Statistics)

These programs were developed for statistical evaluation of measured values of the Digital Multimeter. These are the algebraic mean, the variance, the standard deviation and the mean square value. The various statistical functions are obtained timewise in parallel and are available on request. For these programs, the number of measurement cycles to be observed can also be specified through constant C8.

PROGRAM 21/71 INTEGRATION TIME EXTENSION

This program performs a continuous average-value determination routine over a specified number of measurements. The 0.15 measurement time should be selected on the Digital Multimeter. The number of measurements between 1 and 999 999 must be specified in constant C8, and the second digit after the print must contain a one. The Digital Multimeter displays the convergence of the average value from the start to the end of the measurement, i.e., not the previous measurement result. CAUTION: The program is re-started when the polarity is changed!

PROGRAM 30/80 PROGRAM COMBINATION

Up to five different programs (see computer program set) can be combined in any desired sequence to form a new program. In doing this, each subsequent program is applied to the last (previously) computed result.

The sequence of the programs is entered in groups of two into constant C9. The first program number is the ones and tens digit, the second number is the hundreds and thousands digit, etc. For example, for program sequence 01, 02, 03, 08, 04

$$C9\ \pm 0.408030201$$

<u>Meaning of Constant C8</u>

Constant C8 allows optimal utilization of the individual computer programs. It is used to specify the number of measurements to be evaluated, whether each measurement should be newly started and the selection of digits (places) for the D/A converter (see description of the D/A Converter). The following table shows the meanings of the individual digits of constant C8:

C8:	$\pm X_1$	$X_2\ X_3\ X_4\ \ X_5\ X_6\ X_7 \cdot$	X_8	X_9	X_{10} X_{11}
	see description of D/A converter	Number of measurements to be evaluated in conjunction with X_9	Start	Number of Mea-sure-ments	No significance

Digits X_3 to X_7 specify the number of measurements between 1 and 999 999. Without the D/A converter it is not necessary to fill the digits between X_1 and the value with zeros (Ø).

Example: 100 measurements

Without D/A converter	±D 100.$X_8$1D DDD D
With D/A converter	±X_1 000100. $X_8$1D D
D = blank (dark)	

Digit X_8, i.e. the first digit after the decimal point, defines the starting mode. With a Ø, the Digital Multimeter processes the measurements continuously; with a 1, the instruments waits for a start command. If a number of measurements is defined via X_2 to X_7 and X_9, the Digital Multimeter processes the entire number of measurements after it is started and only then does it wait for the next start command. If no number of measurements is specified (X_9), the Digital Multimeter processes only one (single) measurement after the start command.

Starting is accomplished via the IEC-Bus Interface (S), via the BCD-Output/ Remote Control Input, or via repeated activation of the computed result key.

Digit X_9, the second digit after the decimal point, specifies whether a specific number of measurements is selected. With a Ø, the number of measurements is unlimited; with a 1, the number of measurements is defined by the value of digits X_2 to X_7.

COMPUTER PROGRAM SET
PROGRAMS OF OPTION 09

Program No. with/without Stability Control	Math. Function	Equation	Computation Time* (msec.)
01 / 51	Offset	$R = X - C_0$	3 – 8
02 / 52	Multiplication	$R = X \cdot C_5$	4 – 14
03 / 53	Ratio	$R = \frac{X}{C_4}$	7 – 18
04 / 54	Power	$R = \frac{X^2}{C_4}$	12 – 40
05 / 55	Percent Deviation	$R = 100 \cdot \frac{X - C_4}{C_4}$	13 – 55
06 / 56	Polynomial	$R = C_0 + C_1 \cdot X + C_2 \cdot X^2 + C_3 \cdot X^3$	18 – 65
07 / 57	Logarithms	$R = C_5 \cdot \log \frac{X}{C_4}$	190 – 300
08 / 58	Root	$R = C_5 \cdot \sqrt{\frac{X}{C_4}}$	170 – 350
09 / 59	Tangent	$R = C_5 \cdot \tan \frac{X}{C_4}$	270 – 390
10 / 60	Arctangents	$R = C_5 \cdot \arctan \frac{X}{C_4}$	220 – 450
11 / 61	Limit	$C_7 > X > C_6$	5 – 10
12 / 62	Limit greater than	$X < C_7$	4.5 – 6
13 / 63	Limit smaller than	$X > C_6$	4.5 – 6
14 / 64	Maximum Measured Value	$R = X_{max}$	11 – 15
15 / 65	Minimum Measured Value	$R = X_{min}$	11 – 15
16 / 66	Speed (range) of Measured Values	$R = X_{max} - X_{min}$	11 – 15
17 / 67	Mean (Average Value)	$R = \frac{1}{i} \cdot \sum_{k=1}^{i} X_k = \bar{X}$	28 – 55
18 / 68	Variance	$R = \frac{1}{i} \cdot \sum_{k=1}^{i} (X_k - \bar{X})^2$	75 – 150
19 / 69	Standard Deviation	$R = \frac{1}{i} \sqrt{\sum_{k=1}^{i} (X_k - \bar{X})^2}$	230 – 400
20 / 70	Root-Mean-Square Value	$R = \frac{1}{i} \sqrt{\sum_{k=1}^{i} X_k^2}$	190 – 380
21 / 71	Integration Time Extension	$R = \frac{1}{C_8} \cdot \sum_{k=1}^{C_8} X_k$	28 – 55
30 / 80	Program Combination		

*The shorter computation times apply to measurement times with 4-1/2-digit readouts, the larger times apply to 7-1/2-digit readouts.

Selection of Program Numbers for the Computer Programs of Option 09

The programs can be changed during a measurement and also during a computing process, but not during automatic calibration.

Activation of the "Programm/Constant" (program/constant) key clear the state of the measurement result or computed result, measurement time and constants; the display is blanked. The program numbers appear on the lower readout in the keyboard and they change during entry from right to left.

1) Depress "Programm/Constante" (program/constant) key
2) Enter the program numbers on the right-hand keyboard field - data entry - between 0 and 9 in any desired length and sequence.
3) Complete entry of the program numbers: Select measurement result, computed result, measurement time on constant.

Entry of the Constants for the Computer Programs of Option 09

Ten (10) constants, whose values are freely programmable, are available for the individual computer programs. The numbers of the constants, which are assigned to the individual computer programs, should be taken from:

"Programs of Option 09 (Mathematics Program Set)".

The number of the selected constant appears with "cX" on the lower readout in the keyboard; the associated value appears on the large readout. It is possible to enter the last measurement result or the last computed result as the value of a constant.

Selection* and display of the desired constant:

1) Depress the "Programm/Constante" (program/constant) key

2) Depress the "Constante/•" (constant/•) key (the constant number and constant value appear)

3) Enter the desired constant number (0 to 9) on the "Dateneingabe" (data entry) field of the keyboard.

4) Complete the selection* of the constant number: depress measurement result, computed result, measurement time, program, or entry.

Entry of the last measurement result as a constant:

1) Depress "Programm/Constante" key (program/constant key)

2) Depress "Constante/•".

3) Select constant number.

4) Depress "Eingabe" key (entry key)

5) Depress "Messergebnis" key ("measurement result" key)

6) Complete the entry by activation of the measurement result, computed result, measurement time or program/constant key.

Entry of the last computed result as a constant:

1) Depress program/constant key.

2) Depress constant/• key.

3) Select constant number.

4) Depress entry key.

5) Depress computed result key.

---

*Addressing

6) Complete the entry by activation of the measurement result, computed result, measurement time or program/constant key.

Entry of an arbitrary value as a constant:

1) Depress program/constant key.
2) Depress constant/• key.
3) Select constant number.
4) Depress entry key.
5) Using the keys in the data entry area, enter the value of the constant; a maximum of 10 digits are available.
6) Complete the entry by activation of the measurement result, computed result, measurement time or program/constant key.

5.1 Alignment Instructions for "V=" (DC)

("V=" is depressed for all alignment tasks)
For the locations of the trimming potentiometers see page 5-1-2

Step	Procedure	Trimming Potentiometers/ Board	Range Setting	Measurement Time Setting	Measurement Instrument	Measured Point	Value to be Set Up	Input Voltage Calibration Voltage Source
1	Oscillator Synchronization	R20 D - Board	-	-	Any Oscillograph R_{in} 1 MΩ, 2 V/cm	Test probe at Borehole in the front corner of the digital section. Ground at Test Point 1 in the Top Front Corner of the Integrator Board.	4 VDC ±0.5 VDC, AC Voltage below 0.5 V35	-
2 / 3	Stability Control / Input current compensation	- / R6 V-Board	10 V / 10 V	- / 0.4 sec	- / Own Display	- / -	Select Program 49 / Minimal Change of the Readout (about 0.002 V per measurement)	Short circuit / Input Open
4	Preamplifier Zero setting	Front Panel V= (DC)	0.1 V	1 sec	Own Display	-	0.0000000	Short Circuit
5	Input Current compensation	R6 V-board	100 V	1 sec	Own Display	-	000.0000	Short circuit
6	Repeat Step 4	Front Panel V= (DC)	0.1 V	1 sec	Own Display	-	0.0000000	Short Circuit
7	Calibration of 1 V-Range	R44 I-Board	1 V	2 sec	Own Display	-	1.01... V	1.01...V from an unsaturated, temperature regulated standard
8	Calibration of 10 V-Range	R30 AB-Board	10 V	2 sec	Own Display	-	10,00000 V	1.00000 V from the Calibrator with self-calibration capability
9	Calibration 0.1 V-Range	R34 AB-Board	0.1 V	2 sec	Own Display	-	0.1000000 V	0.1000000 V from the calibrator with self-calibration capability
10	Calibration 100 V-, 1000 V-Range	R18 AB-Board	100 V	2 sec	Own Display	-	100.0000 V	100.0000 V from the calibrator with self-calibration capability

The 1 second measurement time and the measurement result shall be selected in steps 1 and 3 to 8. In step 2, the 0.4 second measurement time and the measurement result shall be selected.

5.2 Alignment Instructions for V∿ (AC)

Step	Procedure	Trimming Pot. - Capacitor	Range Setting	Measurement Instrument	Measured Point	Value to Be Set Up	Input Voltage at the "V" Input Terminal
1	Offset AC Voltage Amplifier	Front Panel Zero V∿ (AC)	V= (DC) 1 V	Built-in DC Voltmeter	TP1 G-Board	±0.00000V	Short Circuit
2	Offset RMS Module	R2 G-Board	V= (DC) 1 V	Built-in DC Voltmeter	TP2 G-Board	±0.00000V	Short Circuit
3	Operating Point RMS Module	R3 G-Board	V= (DC) 1 V	Built-in DC Voltmeter	TP3 G-Board	+0.12 V ±0.02 V	Short circuit
4	Offset RMS Module	R4 G-Board	V= (DC) 1 V	Built-in DC Voltmeter	TP4 G-Board	±0.00000V	Short Circuit
5	Operating Point RMS Module	R5 G-Board	V= (DC) 1 V	Built-in DC Voltmeter	TP5 G-Board	-1.0 V ±0.1 V	Short Circuit
6	Repeat Steps 1 to 5						
7	Offset U-I Converter	R6 G-Board	V∿ (AC) 1 V	Own Display	-	0.0000 V	Short Circuit
8	1 V-Calibration	R7 VW-Board	V∿ (AC) 1 V	Own Display	-	1.0000 V	1 V rms 1 kHz sinusoidal
9	10 V-Calibration	R10 VW-Board	V∿ (AC) 10 V	Own Display	-	10.000 V	10 V rms 1 kHz sinusoidal
10	100 V-Calibration	R13 VW-Board	V∿ (AC) 100 V	Own Display	-	100.00 V	100 V rms 1 kHz sinusoidal
11	1000 V-Calibration	R15 VW-Board	V∿ 1000 V	Own Display	-	1000.0 V	1000 V rms 100 Hz sinusoidal
12	1 V-Calibration	C5 VW-Board	V∿ (AC) 1 V	Own Display	-	1.0000 V	1 V rms 100 kHz sinusoidal
13	10 V-Calibration	C7 VW-Board	V∿ (AC) 10 V	Own Display	-	10.000 V	10 V rms 100 kHz sinusoidal
14	100 V-Calibration	C9 VW-Board	V∿ (AC) 100 V	Own Display	-	100.00 V	100 V rms 100 kHz sinusoidal
15	1000 V-Calibration	C11 VW-Board	V∿ (AC) 1000 V	Own Display	-	1000.0 V	1000 V rms 10 kHz sinusoidal

The measurement time should be 1 second and the measurement result should be selected during all alignment tasks.

5.3 Alignment Instructions for Ω/kΩ (Resistance)

Step	Procedure	Trimming Potentiometer	Range Setting	Measurement Instrument	Measured Point	Value to Be Set Up	Input Calibration Resistance
1	Common Mode	R41 O-Board	a) 0.1 k b) 10 Ω c) Same as a) d) Same as b)	Second DVM, 100 µV Resolution at 6 V	Test Point A against Test Point I O-Board	a) Note Readout in the 0.1 k-Range b) Set for same Readout as in the 0.1 k-Range	Short Circuit
2	Amplification	R45 O-Board	10 kΩ	Own Display	-	10.0000	10 kΩ
3	10 Ω-Range Calibration	R42 O-Board	10 Ω	Own Display	-	10.0000	10 Ω
4	100 kΩ-Range Calibration	R43 O-Board	100 kΩ	Own Display	-	100.000	100 kΩ
5	10,000 kΩ-Range Calibration	R44 O-Board	10,000 kΩ	Own Display	-	10,000.0	10 MΩ

During all alignment tasks, the measurement time should be 1 second and "measurement result" should be selected.

5.4 Alignment Instructions for "Ratio"

Depress the following keys for all steps: 10 V, V= (DC), "Ratio" (see Item 3 for exception)

Step	Procedure	Trimming Potentiometer	Measurement Instrument	Measured Point	Value to Be Set Up	Input V= (DC)	Ratio-Input	Comments
1	Common Mode	R32 R-Board	Own Display	-	a) Note Readout at 0 V	About 6...12 V Constant	Approx. 10 V	a) Connect the Minus V= (DC) and Ratio Terminals
					b) Set in the same value at 6 V	About 6...12 V Constant	Approx. 10 V	b) Voltage source about 6 V + to "Ratio" Minus Terminal - to "V=" (DC) Minus Terminal
					c) Same as a)			
					d) Same as b)			
2	Coarse Ratio Null	R31 R-Board	Voltmeter (R_i >1kΩ)	Test Point A R-Board against Test Point ⊥ I-Board	Null ±5 mV	Short Circuit	Short Circuit	Connect "Ratio" Input with ⊥ Board I
3	Readout Null	a) R46 I-Board	Own Display	-	About 000005	Short Circuit		Release "Ratio" Key
		b)	Own Display	-	Note Readout at 17 V	Short Circuit	Approx. 17 V	Press "Ratio" Key, Connect "V=" (DC) to "Ratio" minus terminal
		c) R33 R-Board	Own Display	-	Set in the same readout at 2.5 V	Short Circuit	Approx. 2.5 V	Press "Ratio" Key, Connect to "V=" (DC) "Ratio" Minus Terminal
		d) Same as b)						
		e) Same as c)						
		f) R46 I-Board	Own Display	-	±0	Short Circuit		Release "Ratio" Key
		g)	Own Display	-	Check if ±0	Short Circuit	Approx. 10 V	Press "Ratio" Key, Connect "V=" (DC) to "Ratio" Minus Terminal
4	Ratio Null	R31 R-Board	Own Display	-	a) Note Readout at 17 V	Approx. 17 V	Approx. 17 V	
					b) Set in the same readout at 2.5 V	Approx. 2.5 V	Approx. 2.5 V	
					c) Same as a)			
					c) Same as b)			
5	Amplification	R30 R-Board	Own Display	-	10.0000	10 V	10 V	Connect Plus Terminals of "V=" (DC) and "Ratio", as well as Minus Terminals of "V=" (DC) and "Ratio"

During all alignment tasks the measurement time should be 1 second and "Measurement result" should be selected.

6.1 Measurement Principle

The PREMA multi-ramp process for analog-to-digital conversion (German Patent, Disclosure No. 2114,141) is used in the 6040 model. It provides the basis for a reliable digital voltmeter with outstanding linearity and long term accuracy with continuous integration of the measurement signal to average out noise (interference) without error-generating pauses (waiting periods).

An amplifier, combined with capacitor C to form an integrator circuit (see Figure 1), continuously integrates a current I_c, which is proportional to the voltage to be measured. This process has a high linearity because the input voltage does not have to be switched off; otherwise the capacitances of transistors, which are commonly used as switches at this time, cause an error due to the different switching transient. The error changes with the input voltage. The capacitor (Figure 2) is discharged (discharge times t_1 to t_n) at periodic intervals by a current I_{ref} from a comparison DC voltage source with opposite polarity U_{ref}. Prior to the start of the down-integration, the comparator determines the sign of the input voltage and establishes thereby the polarity of the reference voltage. For both polarities, the same reference voltage and the same down-integration resistor are used so that the readout is precisely constant to within one digit when reversing the input voltage polarity. The end of down-integration is established by coincidence of the comparator output with a pulse edge of the clock oscillator. Since the total charge-change of the capacitor during a measurement period is zero, it follows that

$$\frac{1}{R_e}\int_0^T U_e\,dt + \frac{1}{R_0} U_{ref} \sum t_i = 0$$

or

$$\frac{1}{T}\int_0^T U_e\,dt = -\frac{R_e}{R_0\,T} U_{ref} \sum t_i$$

This means that the sum of the discharge times t_i is proportional to the average value of the input voltage and is displayed as the measurement result.

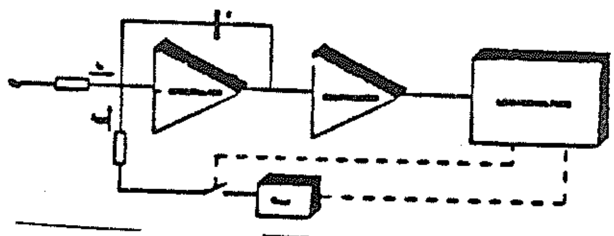


Figure 1. Simplified Conceptual Schematic

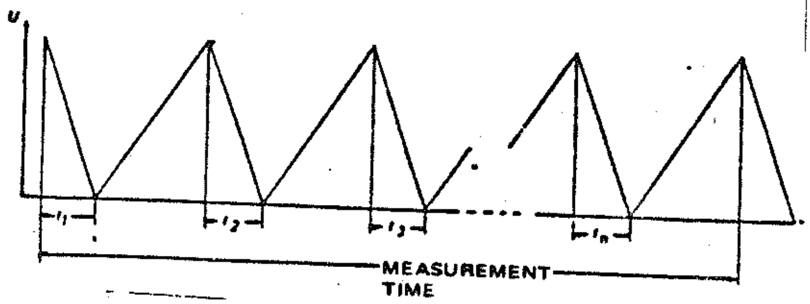
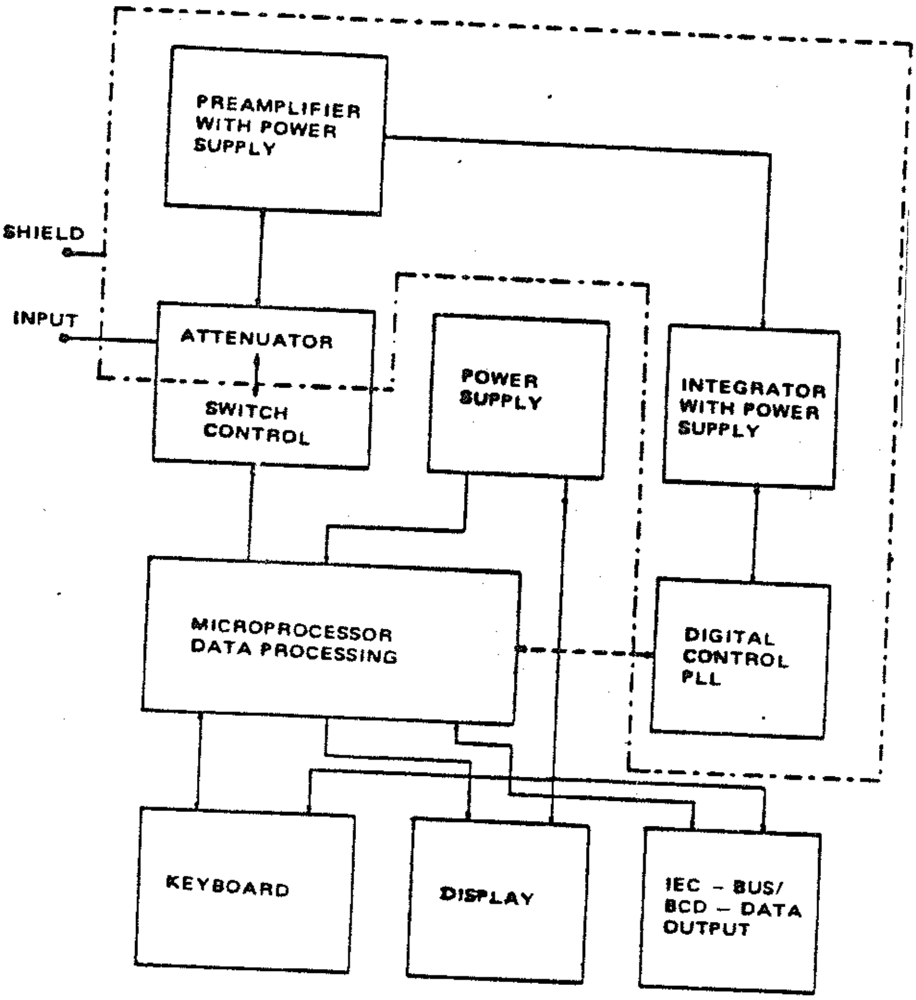


Figure 2. Integrator Output Voltage.

In this type of voltage-to-time conversion, the result is distorted neither by the loss factor (leakage) of the capacitor nor by drifting of the capacitance C. It is furthermore independent of the frequency of the clock oscillator used for the time measurement since the determination of T and of all t_i is accomplished at the same frequency. Only modest drift and speed requirements are imposed on the comparator in the PREMA Multi-Ramp Process, so that a cost effective instrument concept is possible in spite of the excellent DVM properties.



6040 - BLOCK DIAGRAM

ANALOG OUTPUT OPTION 08

a) Applications for Analog Output

By means of the analog output (digital-to-analog converter-DAC), Option 08, an analog voltage is obtained, which is derived from the digital measurement result of the Digital Multimeter. Here a one digit step corresponds to an output voltage change of 100 mV. Thus, for the specified DA conversion of two decimal digits, the output voltage range is ±9.9V. The permissible current load is 0.1mA. The output is protected against voltages of up to ±100V.

Application Examples:

1) Observation of small changes in the measured voltage, e.g. with a recorder. For this, the DAC is set up so that it converts the two most-right decimal digits of the measurement or computer result (least significant digits).

2) Observation of coarser changes of a measured voltage with a recorder. Then the DAC is controlled so that it converts the decimal digits which are of interest.

b) Connection of the Analog Output

The analog output voltage can be taken from the "Analogausgang" (analog output) terminals located on the rear of the instrument. Two decimal digits are used for conversion to an analog voltage.

The decimal digits of interest are selected through constant C8 (Const. 8).

c) Selection of the Decimal Digits to be Converted

Digit X_1 of constant C8 specifies the decimal digits for conversion to an analog voltage. The display range of the Digital Multimeter allows 10 digits in front of and behind the decimal point. The numeral in X_1 specifies the first of the two decimal digits ahead of or after the decimal point. The sign defines whether the decimal digits are in front of or after the decimal point. The "+" sign defines the digits in front of the decimal point and the "-" sign defines the digits after the decimal point. If no value is given to X_1 (display remains blank), then it has the same meaning as 0. The two digits adjacent to the decimal point are converted. The decimal digits to be converted, with the corresponding value in X_1, are presented in the table on the following page.

d) Balancing of the Analog Output

The output voltage to be set up to balance the analog output must be measured with an instrument having an accuracy better than 0.3% and an input resistance greater than 100 K ohms.

Step	Selected Constant	Value to be written into the constant	Potentiometer to be aligned	Output voltage to be set up
1	C8	±0		
2	C9	+9.9	R22 (TAW)	+9.9V±10%
3	C7	±0.0	R23 (TAW)	±10mV
4	C9	+9.9	R22	+9.9V±10mV

Examples for the selection of decimal digits to be converted to analog form

Digits for DA Converter

XXX XXX. XXX X

(X_2–X_{11} see description of the computer program set)

D = blank

C8 ±	X_1	Display
±	D≙0	± Y.Z *)
+	1	± YZ.
+	2	± YZØ.
+	3	± Y ZØØ.
+	4	± YZ ØØØ.
+	5	± YZØ ØØØ.
+	6	± Y ZØØ ØØØ.
+	7	± YZ ØØØ ØØØ.
+	8	± YZØ ØØØ ØØØ.
+	9	± Y ZØØ ØØØ ØØØ.
–	1	± Ø. YZ
–	2	± Ø. ØYZ
–	3	± Ø. ØØY Z
–	4	± Ø. ØØØ YZ
–	5	± Ø. ØØØ ØYZ
–	6	± Ø. ØØØ ØØY Z
–	7	± Ø. ØØØ ØØØ YZ
–	8	± Ø. ØØØ ØØØ ØYZ
–	9	± Ø. ØØØ ØØØ ØØY Z

*) Y, Z are the decimal digits to be converted to analog form.

IEC ~~IES~~ Bus Interface Option 06

Programming the Digital Multimeter 6070 via the IEC-Bus Interface

If the Digital Multimeter is to be programmed via the IEC bus, it must be assured that the "REN" bus management line is active. If the control unit does not output an active signal or outputs it only temporarily, the data transfer to the Digital Multimeter is interfered with. For such cases, the switch No. 6 is installed on the rear of the Digital Multimeter. In position ON, this switch bypasses the non-standard (unusual) state of the control unit in the Digital Multimeter.

Programming the Digtial Multimeter is performed according to the following description or table. Data input is possible with a character string (e.g., "MT3B4V1F1P5Ø") or in individual logic blocks (e.g., "M", "PØ1", "PC5", "PC5E123.5", "VØ" or "T4").

Once the Digital Multimeter has been addressed via the IEC-bus interface, the keyboard on the front is inoperative. The keyboard is reconnected when the "REN" line is inactivated or the control line transmits GTL (go to local).

Connection of the keyboard with GTL can only be done in conjunction with the bus state "Listener Active" and "ATN". The character GTL has the ASCII value Ø1 and is listed in the associated table as "SOH" (Start of Heading).

Explanation of Symbols for Programming the Digital Multimeter, Type 6040, via the IEC-Bus Interface

"L" With "L", the talker is placed into the function "slow". This character need be entered only with the first programming and is stored, as the keyboard, over a long time period when the unit is turned off.

"H" "H" places the talker in the "fast" state. This character need be entered only with the first programming and is stored, as the keyboard, over a long time period when the unit is turned off.

"M" The Measurement result is addressed. It appears on the display of the Digital Multimeter and in the character string of the talker function.

"R" The computation result (Rechenergebnis) of the selected program appears on the display of the Digital Multimeter and in the character string of the talker function.

"P" The Digital Multimeter is prepared that the next values are the program numbers. The program numbers are changed from the least significant digit towards the most significant digit. If the program number was "Ø1" and "P2" is entered as next program number, then "12" results as program number. By entering "P", the Digital Multimeter display is darkened, and in the character string of the speaker function "   " appears then as 3rd to 14th character. "P" must be entered also prior to the addressing (selection) of the constant.

"J" If AC voltage is selected (see "A"), the rms value of the AC voltage with superimposed DC component is measured.

"K" As for "J", but without superimposed DC component.

"C" "C" is the character for calling the individual constants. However, it is recognized only if previously "P", even without number, is entered. The values after "C" specify the constant numbers. For example, if "PC5" is entered, the value of the Constant 5 appears in the large display of the Digital Multimeter, "C5" appears in the small display, and in the character string of the talker function the value of the constant appears as 2nd to 14th character, and "C5" (the number of the constant) appears as 15th and 16th character.

"E" "E" is used to change the individual constants. If a constant has been addressed, then — after inputting "E" — the last measurement value can be entered with "M", the last computation result can be entered with "R", and individual number combinations, e.g., "+123.456" can also be entered.

Value of a constant — If a certain number combination is to be written into a constant, then this number combination must be entered in a sequence beginning with the sign, followed by the most significant decimal digit, the next most significant decimal digit, etc. The point separates the digits with positive exponent from those with negative exponent.

"B" "B" (Bereich = Range) prepares the Digital Multimeter for a measurement range change. The values after "B" give the individual ranges. It is to be noted that some ranges can be selected only with the associated measurement function:

BØ = 1Ø ohm only with Ohm,

B1 = 0.1 V/kOhm only with VDC and Ohm,

B6 = 1Ø ØØØ only with Ohm,

B7 = automatic range selection, can be selected with all measurement functions and is cancelled again only with the selection of a definite range.

"D" "D" selects in the Digital Multimeter the measurement function "DC Voltage".

"A" "A" selects in the Digital Multimeter the measurement function "AC Voltage". If the unit is not equipped with this option, this command is ignored.

"V" "V" prepares the Digital Multimeter for a change of the function "Ratio".

"VØ" turns Ratio off.

"V1" turns Ratio on.

If the unit is not equipped with this option, this command is ignored.

"F" "F" prepares the Digital Multimeter for a change of the filter.
"FØ" bypasses the additional filter,
"F1" inserts the additional filter.

"T" "T" prepares the Digital Multimeter for a change of the measurement time. The subsequent digits within the range Ø thru 9 specify the measurement time. If several digits are inputted, always the last digit is valid: e.g., "TØ12" yields the measurement time "T2" = 100 msec.

"S" With "S", the Digital Multimeter can be started. The interval between the individual triggers shall be larger than the specified measurement and computation time.

Table of Commands in "Listener" State

L	Talker Slow
H	Talker Fast
M	Measurement Result
R	Computation Result
PXX	Program Number
CX	Number of Constant
E	Input
BØ	Range 1Ø Ohm
B1	Range Ø.1 VDC, kOhm
B2	Range 1 VDC, VAC, kOhm
B3	Range 1Ø VDC, VAC, kOhm
B4	Range 1ØØ, VDC, VAC, kOhm
B5	Range 1ØØØ, VDC, VAC, kOhm
B6	Range 1ØØØØ kOhm
B7	Automatic Range Selection
D	DC Voltage
A	AC Voltage
O	Ohm
J	AC Voltage with DC Component
K	AC Voltage without DC Component
VØ	Ratio off
V1	Ratio on
FØ	Filter off
F1	Filter on
TØ	Measurement Time 2Ø ms
T1	Measurement Time 4Ø ms
T2	Measurement Time 1ØØ ms
T3	Measurement Time 2ØØ ms
T4	Measurement Time 4ØØ ms
T5	Measurement Time 1 s
T6	Measurement Time 2 s
T7	Measurement Time 4 s

Table of Commands in "Listener" State (Continued)

T8 Measurement Time 1∅ s

T9 Measurement Time 2∅ s

S Start

Explanation of the Individual Symbols in the "Talker" State

The character string in the "Talker" state consists of 30 characters indicating the state of the Digital Multimeter, including the numerical value of the display indication, the name of the display indication (Measurement Result, Computation Result, Constant), the selected program number, the measurement range, the measurement function (DC Voltage, AC Voltage, Ohm), Ratio, Filter and Measurement Time.

In addition, with the 30th character, the EOI bus management line is activated in order to indicate the end of the transmission.

For the control units which do not respond to "EOI", two additional "EOS" (End of String) characters are outputted. These two characters, "LF" and "CR", are only additional information and need not be read.

If the "Talker" state of the Digital Multimeter is terminated during the transmission, the character string — after the Digital Multimeter is called again as Talker — begins again with the first character.

The IEC bus interface in the Digital Multimeter has two Talker modes: "Talker Fast" and "Talker Slow". In "Talker Fast", the Digital Multimeter operates with the normal sequence. When a value is read at the IEC bus output, a short program interruption occurs internally during which a new value is supplied to the output. Thereafter, the Digital Multimeter continues to operate normally. No measurement pauses occur.

If the Digital Multimeter is addressed as Talker in the "fast" state, a value is sent to the output, after which the internal program remains in a waiting loop in order to make the next value immediately available. The advantage of this output mode, in conjunction with a fast controller, is that the bus is used (tied up) only for a short time. With slow devices, this output mode is not recommended because the Digital Multimeter would be disabled up to the end of the transmission. The time required by the controller to accept 30 characters should be less than 8 msec.

Explanation of the Outputted Characters in the "Talker" State

Character 1

"L,H": Talker Function Slow/Fast

L = Talker Slow

H = Talker Fast

Character 2

"Ø-3": Designates decimal point of display indication

Ø = X XXX XXX XXX. X

1 = X XXX XXX. XXX X

2 = X XXX. XXX XXX X

3 = X. XXX XXX XXX X

In Measurement Result, the decimal point is always in Position 2!

Character 3

"+, -, *": Indicates the sign of the reading

+ = positive sign

- = negative sign

* = no sign (at VAC and Ohm)

Characters 4 thru 14

"Ø-9, *": The value of the reading

Ø - 9 is the numerical value

* = this position has no meaning (display is dark)

Characters 15 and 16

"M,R,CX": Name of value indicated

M = Display shows Measurement Result

R = Display shows Computation Result

CX = Display shows Constant "X"

Characters 17 and 19 "PXX":	Program number of selected program P49 = Zero-point correction P0X = Programs with zero-point correction P5X = Programs without zero-point correction
Characters 20 and 21 "BX":	Selected measurement range, shown also with automatic range selection. BØ = Range 1ØΩ B1 = Range Ø.1 VDC, kΩ B2 = Range 1 VDC, VAC, kΩ B3 = Range 1Ø VDC, VAC, kΩ B4 = Range 1ØØ VDC, VAC, kΩ B5 = Range 1ØØØ VDC, VAC, kΩ B6 = Range 1ØØØØ kΩ
Characters 22 and 23 "BX":	Automatic range selection BØ = without automatic range selection B1 = with automatic range selection
Character 24 "D,A,O":	Indicates measurement function D = DC Voltage A = AC Voltage O = Ohm
Character 25	J = AC Voltage with DC component K = AC Voltage without DC component

Characters 26 and 27 "VX": Indicates whether Ratio is selected

VØ = Ratio off

V1 = Ratio on

Characters 28 and 29 "FX": Indicates whether Filter is inserted

FØ = Filter off

F1 = Filter on

Characters 30 and 31 "TX": Indicates Integration Time

TØ = 2Ø ms

T1 = 4Ø ms

T2 = 1ØØ ms

T3 = 2ØØ ms

T4 = 4ØØ ms

T5 = 1 s

T6 = 2 s

T7 = 4 s

T8 = 1Ø s

T9 = 2Ø s

The measurement time indication is counted with T7 thru T9 with 1 second timing toward zero. The intermediate times, e.g., 19, 18, 17 ... etc. are not taken into account with (at?) the IEC bus interface, i.e., only T9 for 2Ø sec is indicated.

Together with character 20, the EOI line (bus management) is activated.

Character String Outputted in "Talker" State - Summary

```
L2-XXXXXXXXXXXM PXXBXBXBJ VXFXT(X+EOI)
               CX       OK
H              R        A
```

H,L	Talker Function Fast/Slow
0-3	Decimal Point
+-	Sign
11	Position Indication
M,R,CX	Type of Indication (Measurement Result, Computation Result, Constant)
PXX	Program Number
BØ-6	Range 1Ø - 1ØØØØ k
BØ/1	Automatic Range Selection (Ø = without, 1 = with)
D,A,O	Measurement Function (DC, AC, Ohm)
J/K	J = AC Voltage with DC Component K = AC Voltage without DC Component
VØ/1	Ratio (Ø = without, 1 = with)
FØ/1	Filter (Ø = without, 1 = with)
TØ-9	Measurement Time 2Ø ms - 2Ø s
EOI	END

Service Request, SRQ

The IEC bus interface for the Digital Multimeter, Type 6040, is equipped with a service request function (SRQ). Sensing (interrogation) of the SRQ must be done serially. The meaning of the individual state bits transmitted when an SRQ is made are listed in the following table.

- Bit Ø: End of Measurement
- Bit 1: Computation Overrun (Option Ø9)
- Bit 2: Measurement Overrun
- Bit 3: Ohm in Error (Option Ø2)
- Bit 4: Outside of Limit (Option Ø9)
- Bit 5: Reset
- Bit 6: SRQ
- Bit 7: Selected Option not available

Bit Ø, End of Measurement, can appear together with the other state bits in order not to falsify (affect) the SRQ in fast measurement sequence.

Simple Programming Examples for IEC Bus Interface

The device address of the Digital Multimeter 6040 can be set between Ø and 3Ø with the switches Ø thru 5 at the rear of the unit.

Pet 2ØØ1:

With the Pet, the "EOI" line must be opened (separated)!

Operating the 6040 Digital Multimeter from the Pet:

The Pet 2ØØ1 is Controller, the Digital Multimeter is Listener.

```
Pet:  1ØØ Print "Input"
      11Ø Input A$
      12Ø OPEN 1, 7 ("7" is the device address of the DMM)
      13Ø Print #1, A$
      14Ø Close 1
      15Ø End
```

Reading the Character String of the 6040 Digital Multimeter by the Pet 2ØØ1.

The Pet 2ØØ1 is Controller, the DMM 6040 is Talker.

```
Pet: 2ØØ Open 2, 7 ("7" is the device address of the DMM)
     21Ø Input #2, B$
     22Ø Close 2
     23Ø Print B$
     24Ø End
```

Tektronik 5Ø41:

Operating the Digital Multimeter 6040 from the Tektronik 5Ø41:

Set switch "6" on the rear of the Digital Multimeter 6040 (REN) to "on".

The Tektronik is Controller, the DMM 6040 is Listener.

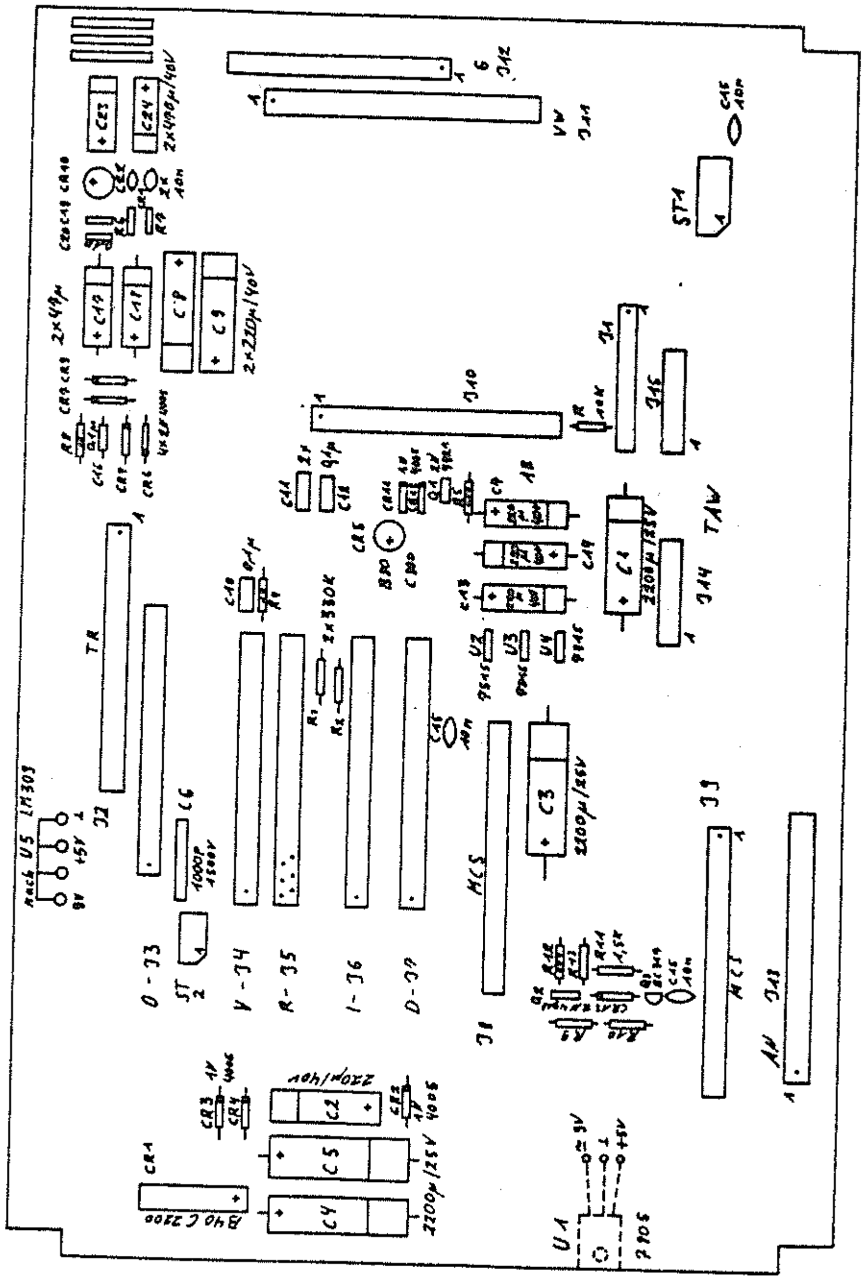
```
5Ø41:  1ØØ PRI "Input"
       11Ø INP A8
       12Ø WRI @ 7:A8 ("7" is the device address of the DMM)
       13Ø END
```

Reading the Character String of the Digital Multimeter 6040 by the Tektronik 5Ø41:

The Tektronik is Controller, the DMM 6040 is Listener.

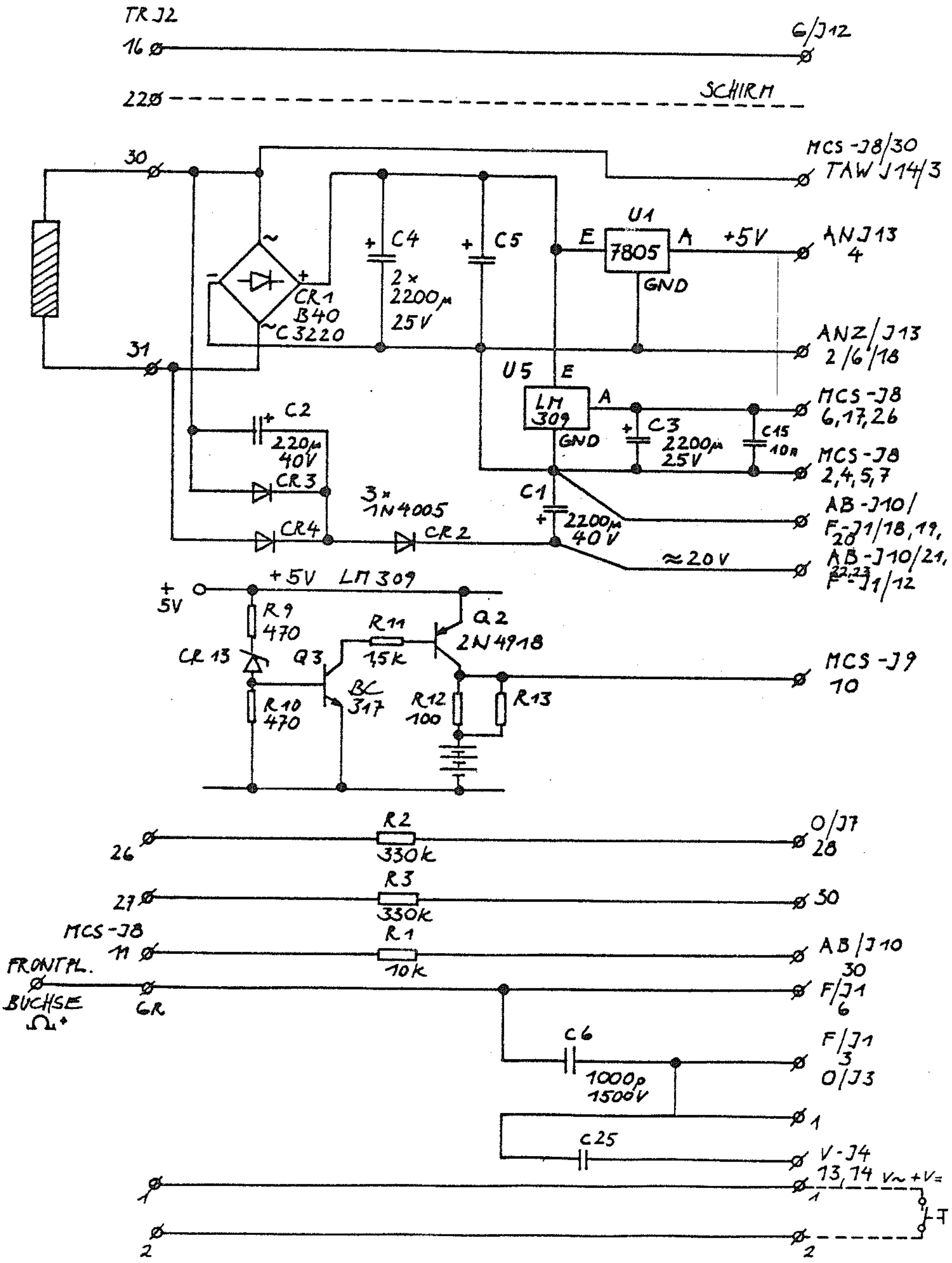
```
5Ø41:  14Ø INP 7:B8 ("7" is the device address of the DMM)
       15Ø PRI @ B8
       16Ø END
```

6040-S-GR-2

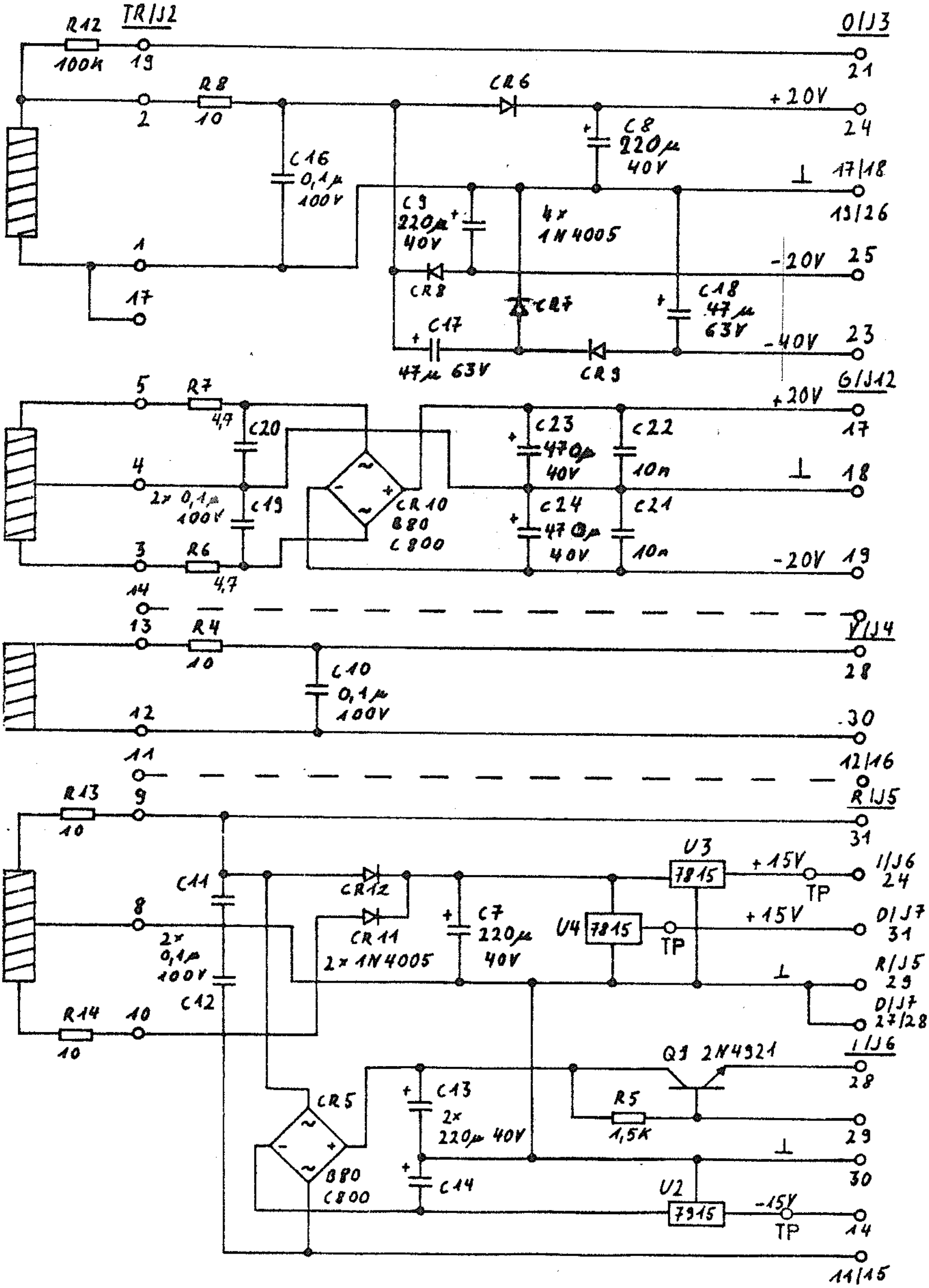


(Änderungen vorbehalten)

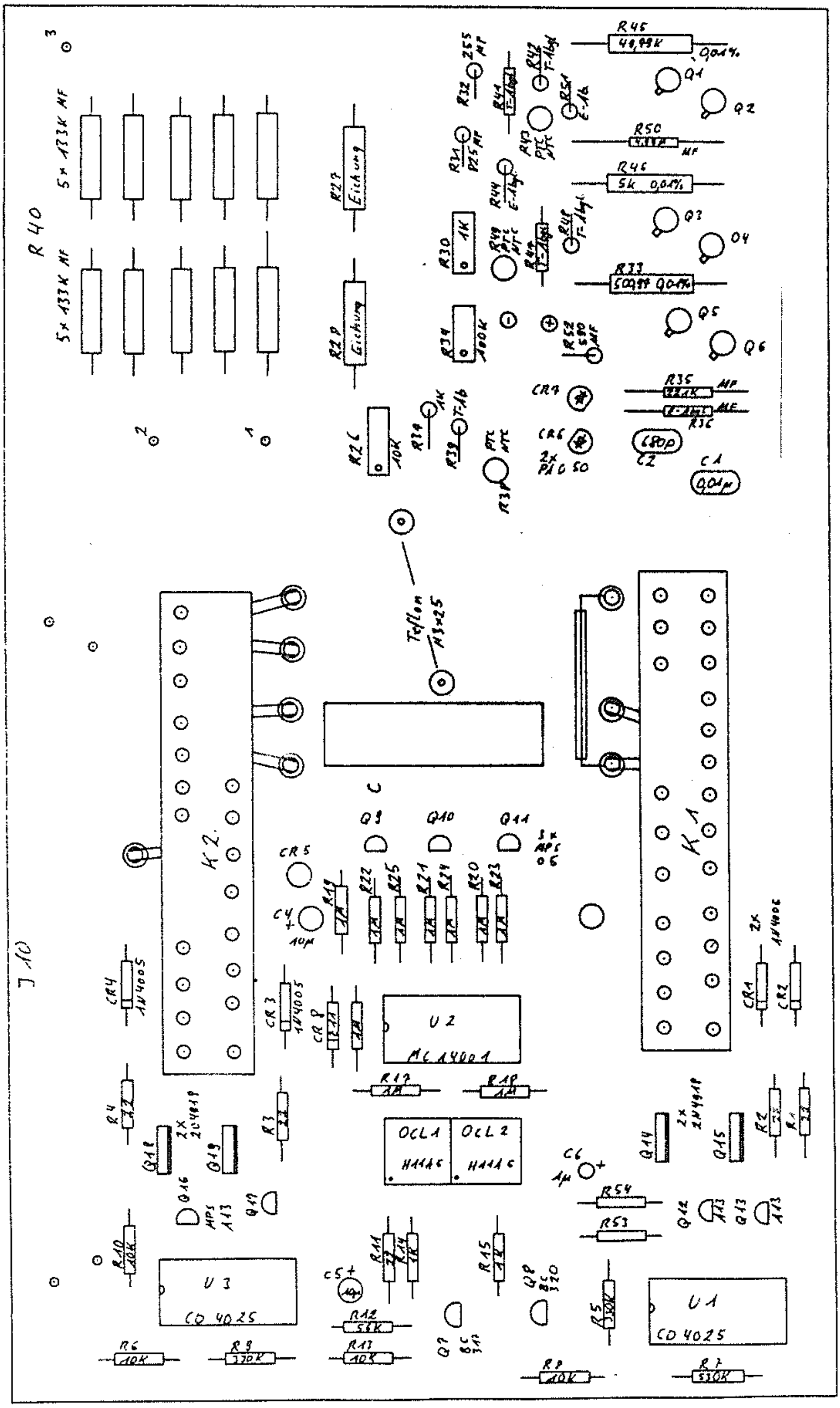
6040-S-GR-2



(Änderungen vorbehalten)

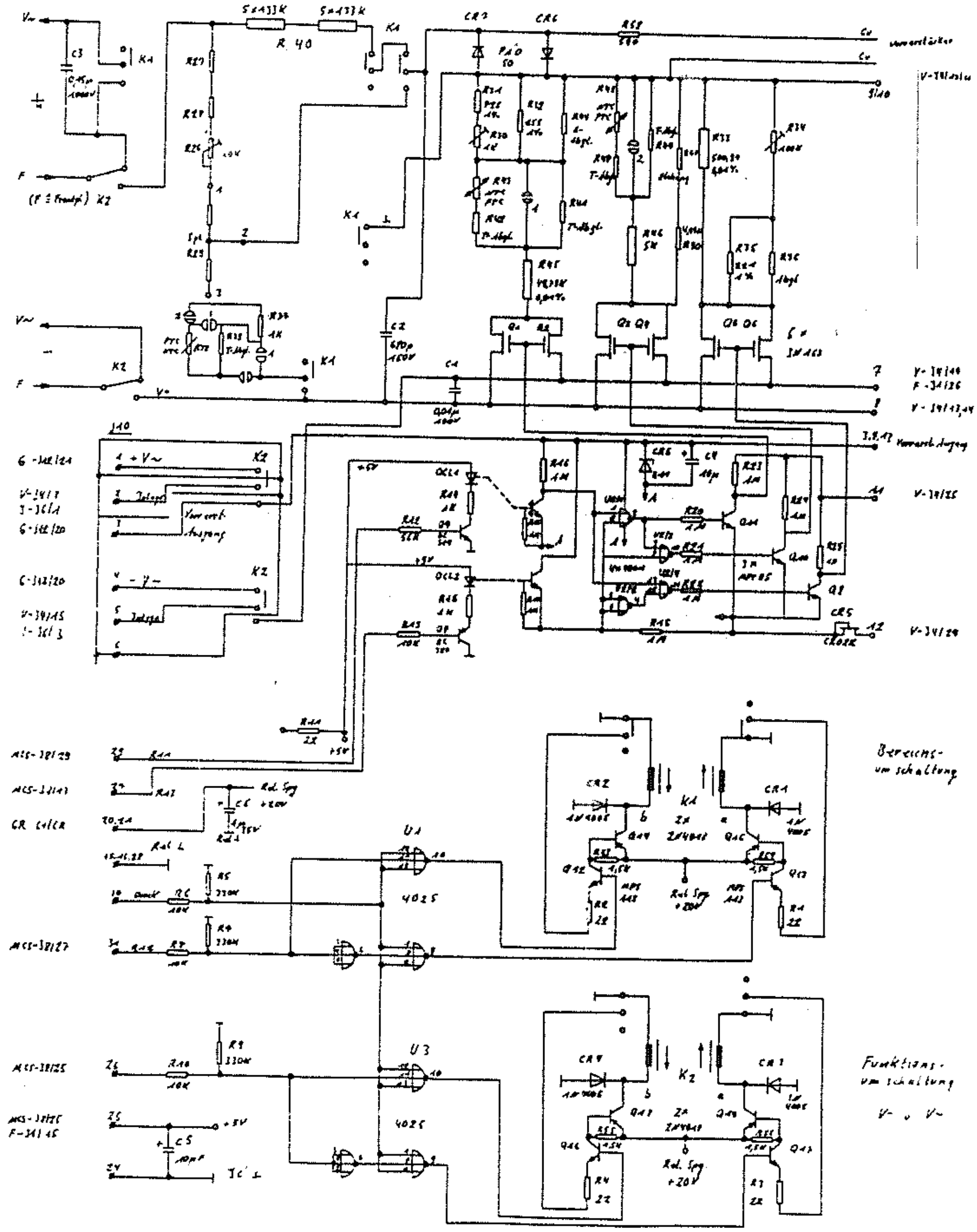

R12
100k
TR/J2
19
O/J3
21
R8
10
2
CR6
+20V
24
C8
220µ
40V
C16
0,1µ
100V
17/18
19/26
C9
220µ
40V
4x
1N4005
1
-20V
25
CR8
17
CR7
C18
47µ
63V
C17
47µ 63V
CR9
-40V
23
5
R7
4,7
G/J12
+20V
17
C20
C23
470µ
40V
C22
10n
4
18
2x 0,1µ
100V
C19
CR10
B80
C800
C24
470µ
40V
C21
10n
3
R6
4,7
-20V
19
14
13
R4
10
V/J4
C10
0,1µ
100V
28
12
30
11
12/16
R13
10
9
R/J5
31
U3
7815
+15V
TP
I/J6
24
C11
CR12
C7
220µ
40V
8
CR11
2x 1N4005
U4
7815
TP
+15V
D/J7
31
2x
0,1µ
100V
C12
R/J5
29
D/J7
27/28
R14
10
10
Q1 2N4921
I/J6
28
C13
CR5
R5
1,5K
29
2x
220µ 40V
B80
C800
30
C14
U2
7915
-15V
TP
14
11/15

Abschwächer 6040-5-AB-2



(Änderungen vorbehalten)

Abschwacher 6040-S-AB-2



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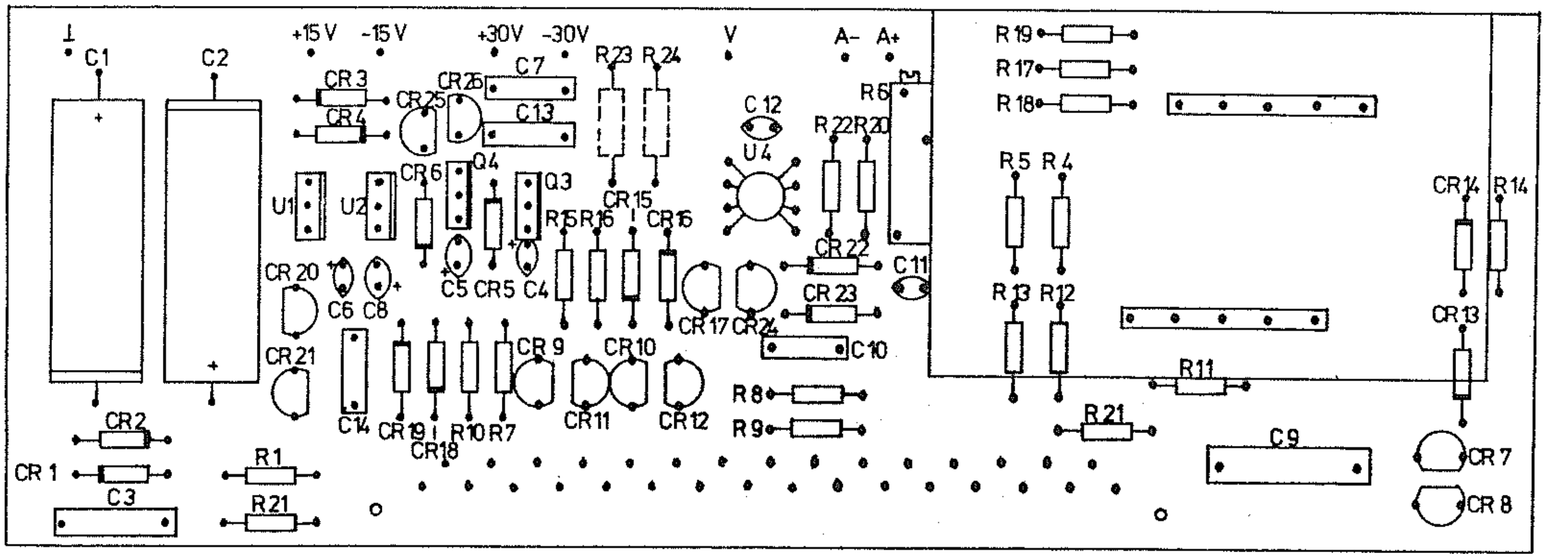


Maßstab

1981	Datum	Name
Bearb.	06.08	Mauer
Gepr.		
Norm		

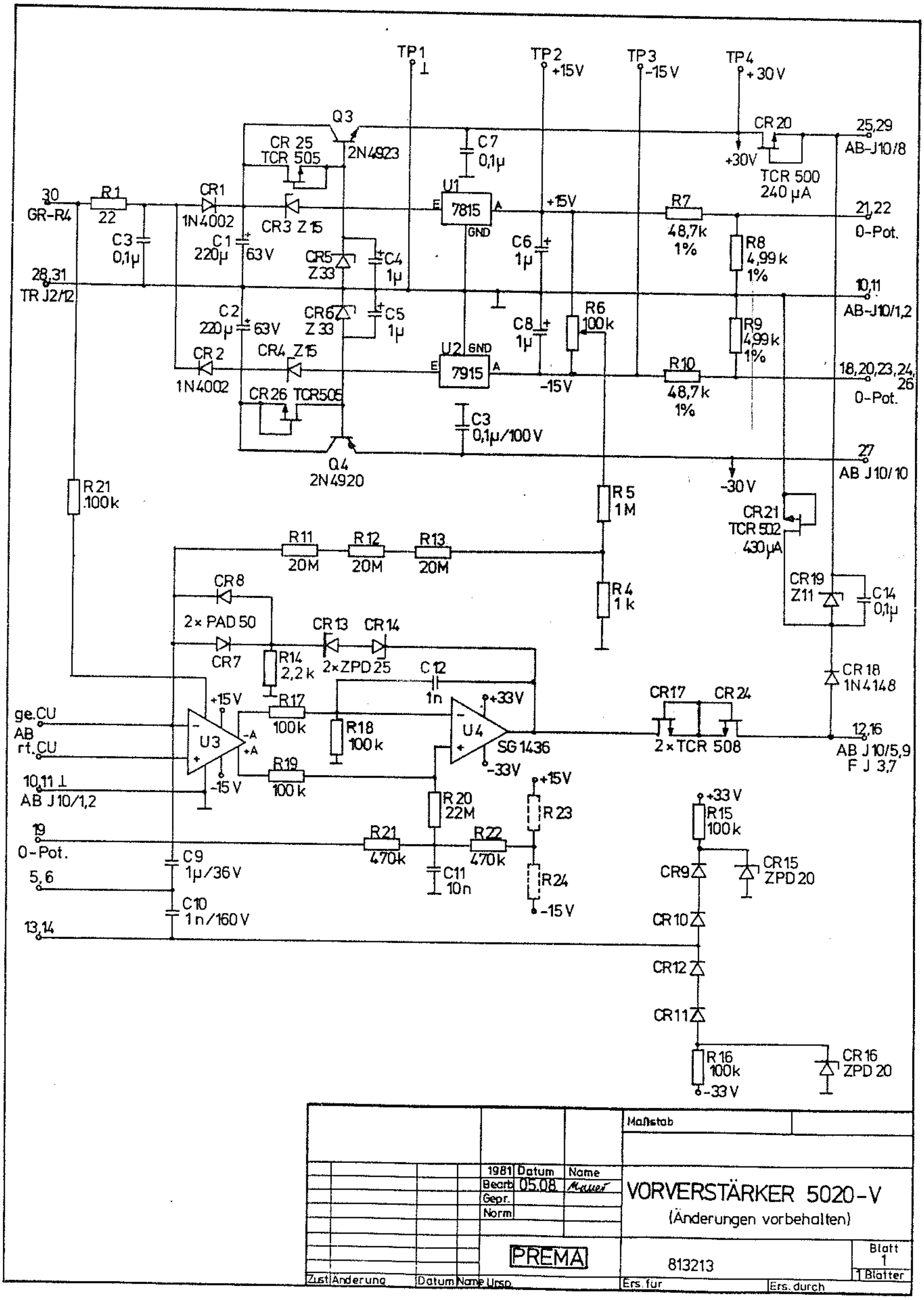
LAGEPLAN
VORVERSTÄRKER 5020-V
(Änderungen vorbehalten)

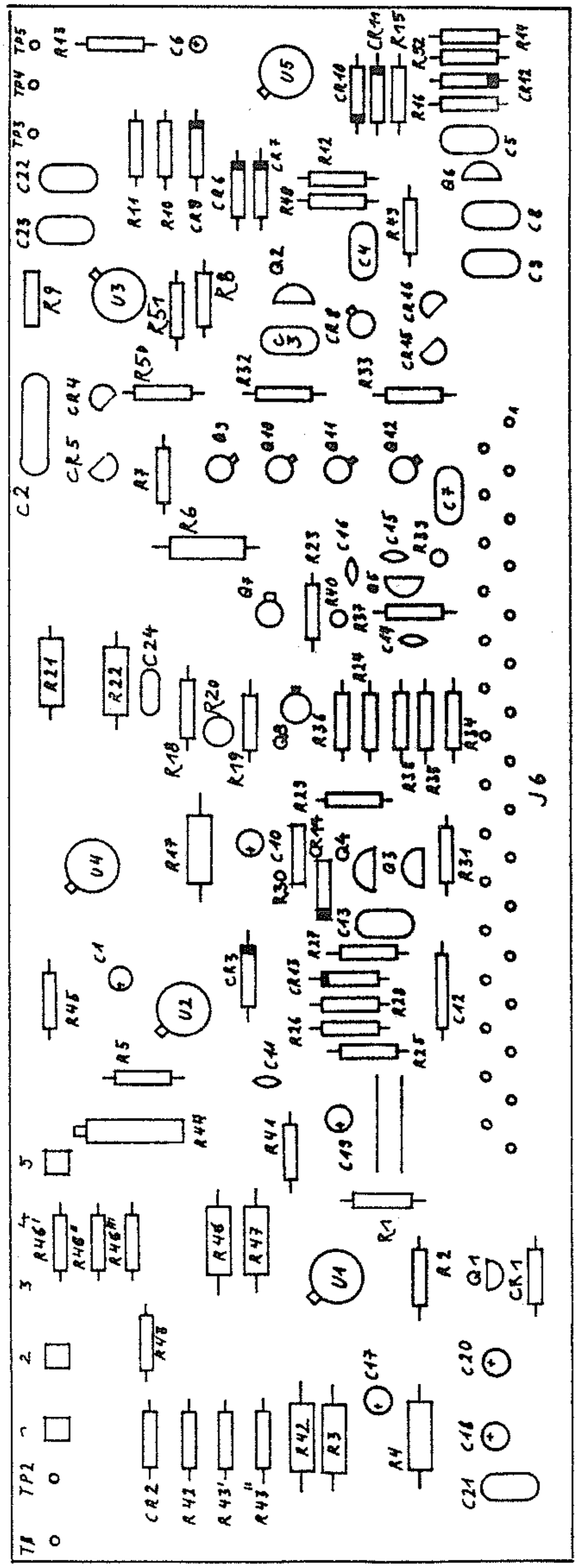
PREMA

813214

Blatt 1
1 Blätter

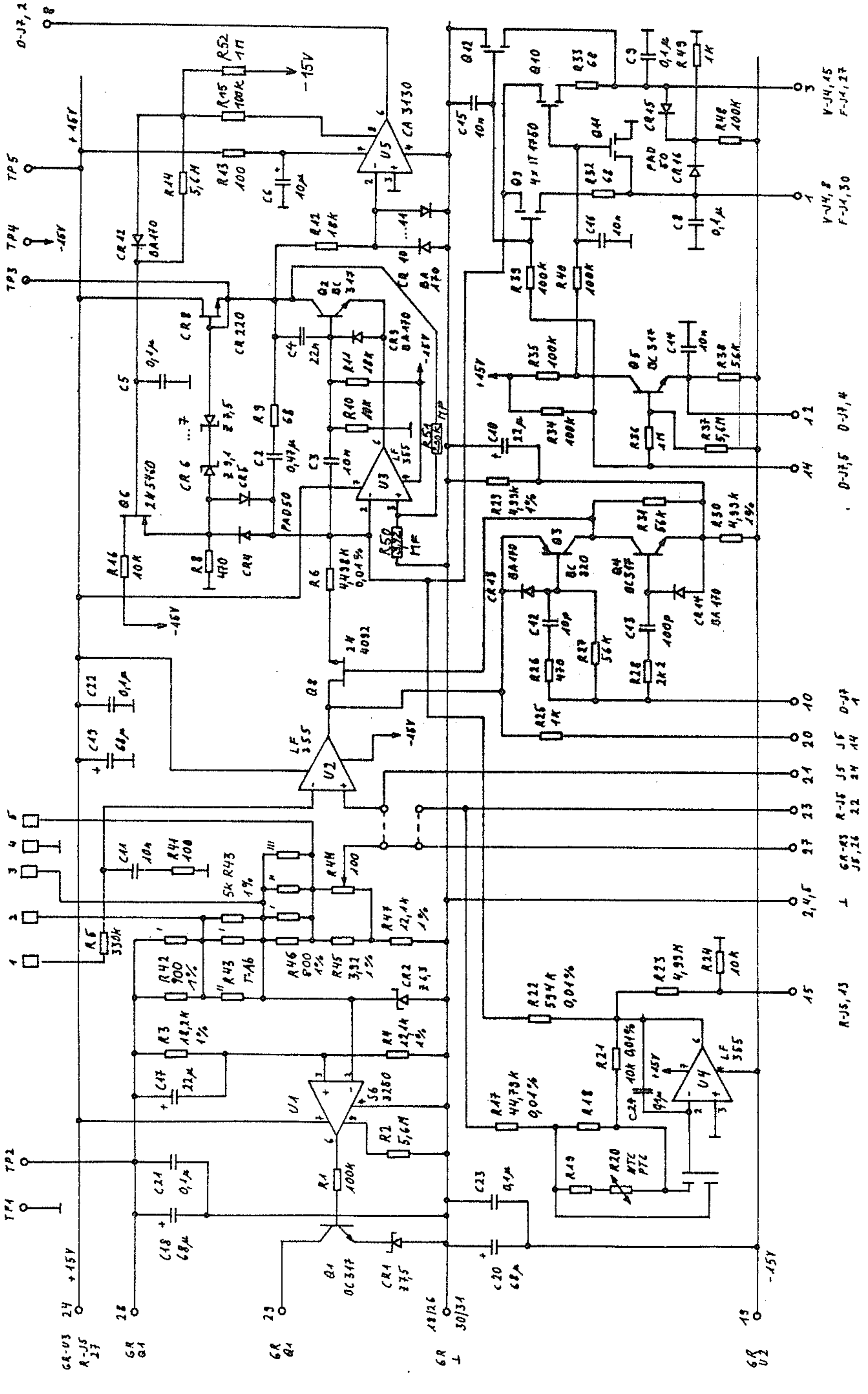
Zust. | Änderung | Datum | Name | Ursp. | Ers. für | Ers. durch


TP1
TP2 +15V
TP3 -15V
TP4 +30V
Q3 2N4923
CR 25 TCR 505
C7 0,1µ
CR 20
+30V
TCR 500 240 µA
25,29 AB-J10/8
30 GR-R4
R1 22
CR1 1N4002
CR3 Z15
U1 7815
+15V
R7 48,7k 1%
21,22 0-Pot.
C3 0,1µ
C1 220µ 63V
CR5 Z33
C4 1µ
C6 1µ
R8 4,99 k 1%
28,31 TR J2/12
10,11 AB-J10/1,2
C2 220µ 63V
CR6 Z33
C5 1µ
C8 1µ
R6 100k
R9 4,99k 1%
CR 2 1N4002
CR4 Z15
U2 7915
-15V
R10 48,7k 1%
18,20,23,24,26 0-Pot.
CR 26 TCR505
C3 0,1µ/100V
Q4 2N4920
27 AB J10/10
-30V
R21 100k
R5 1M
CR21 TCR 502 430µA
R11 20M
R12 20M
R13 20M
CR19 Z11
C14 0,1µ
CR8
2× PAD 50
CR7
R4 1k
CR13
CR14
2×ZPD 25
R14 2,2 k
CR 18 1N4148
C12 1n
ge.CU
AB
rt.CU
+15V
U3
-15V
R17 100k
R18 100 k
+33V
U4 SG 1436
-33V
R19 100 k
CR17
CR 24
2×TCR 508
12,16 AB J10/5,9 F J 3,7
10,11 ⊥ AB J10/1,2
19 0-Pot.
R 20 22M
+15V
R 23
+33V
R15 100k
R21 470k
R22 470k
C9 1µ/36V
C11 10n
R24
-15V
CR9
CR15 ZPD 20
5,6
C10 1n/160V
13,14
CR10
CR12
CR11
R 16 100k
-33V
CR 16 ZPD 20
Maßstab
1981 Datum Name
Bearb. 05.08 Mauer
Gepr.
Norm
VORVERSTÄRKER 5020-V
(Änderungen vorbehalten)
PREMA
813213
Blatt 1
1 Blätter
Zust. Änderung Datum Name Ursp.
Ers. für
Ers. durch



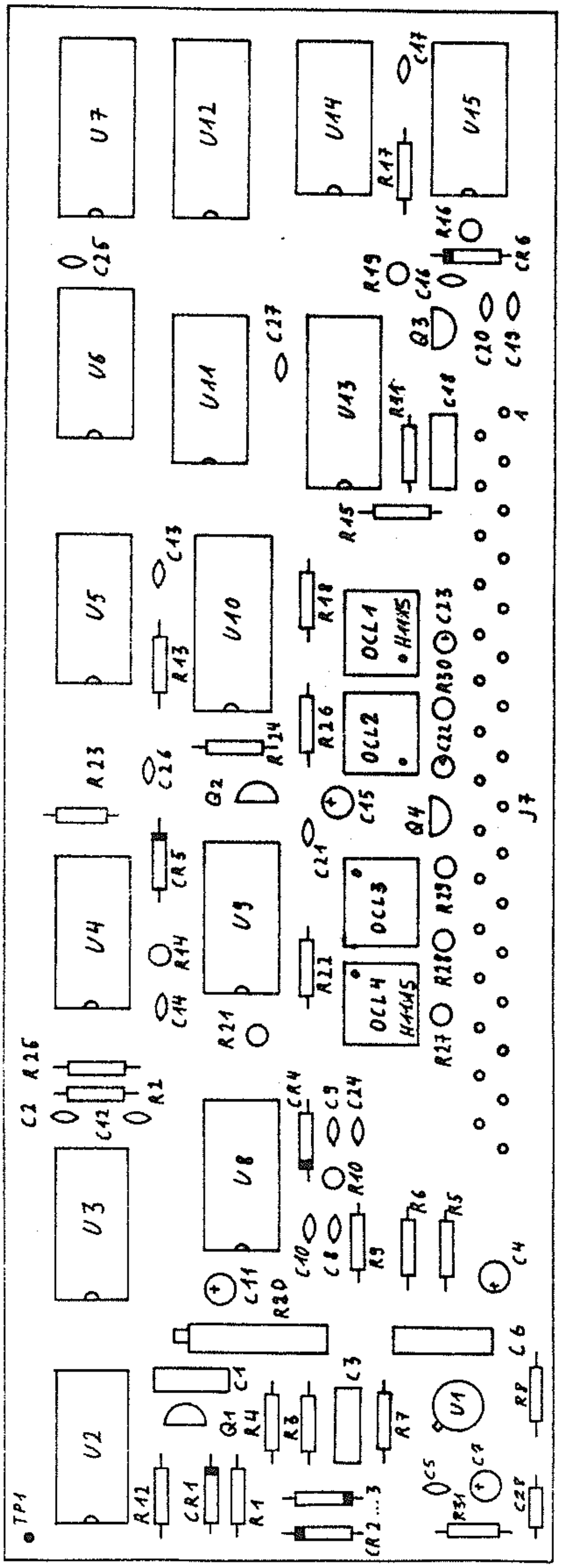
Integratorplatine 6040-1-4

(Änderungen vorbehalten)



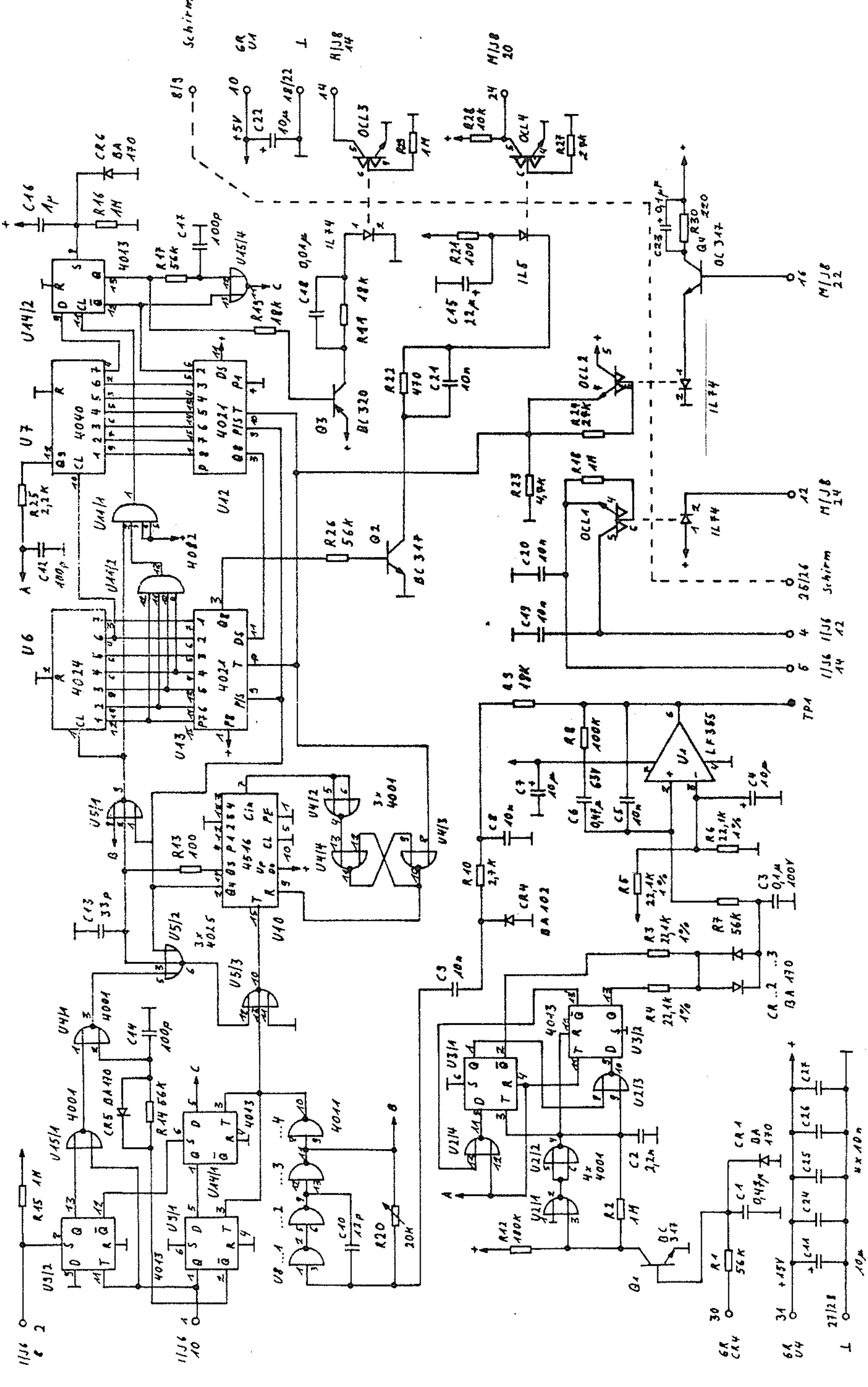
Integratorplatine 6040-1-4

(Änderungen vorbehalten)



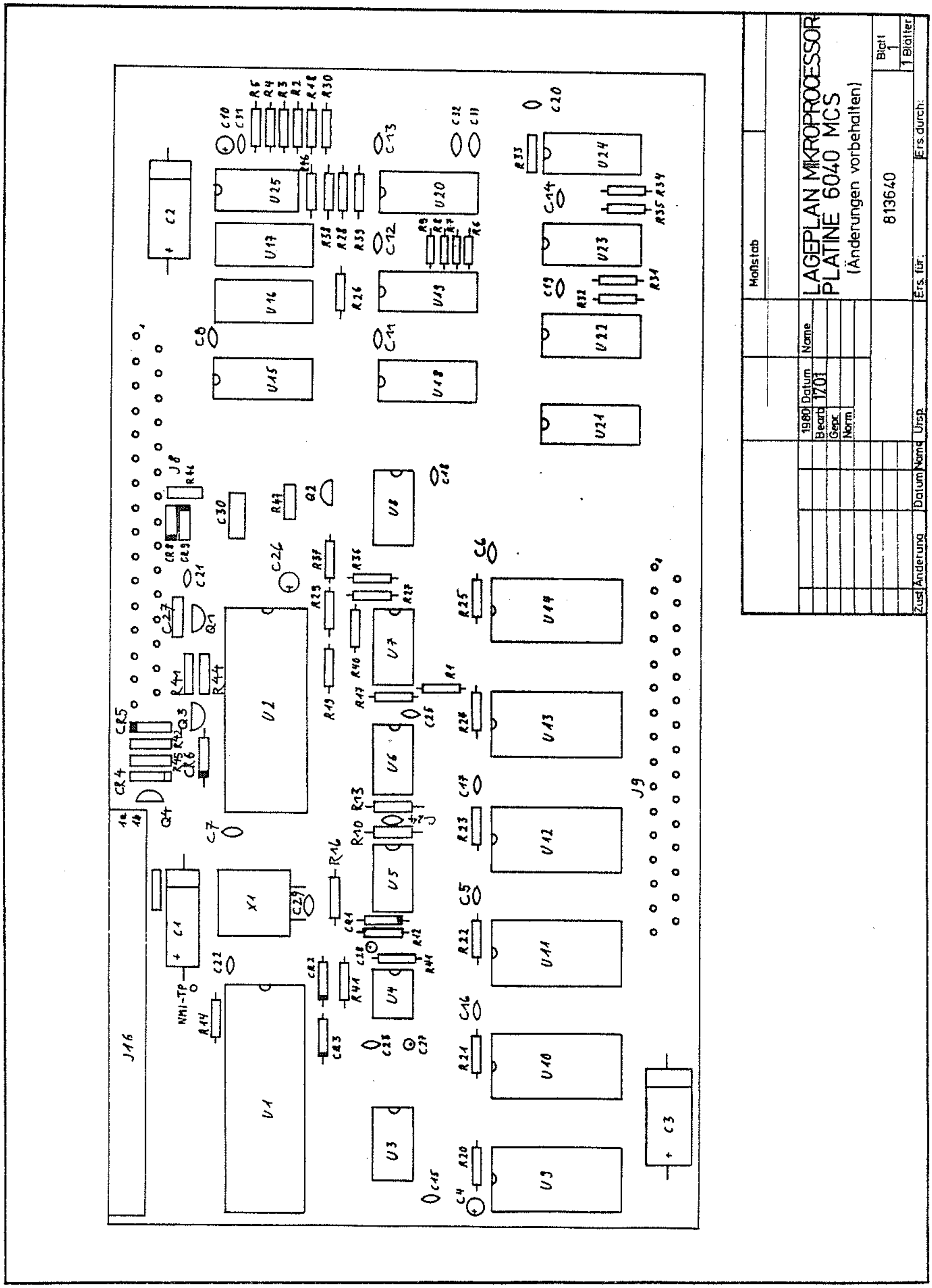
6040-D-3 Digitalplatine (schwebend)

(Änderungen vorbehalten)



6040-D-3 Digitalplatine (schwebend)

(Änderungen vorbehalten)


LAGEPLAN MIKROPROCESSOR
PLATINE 6040 MCS
(Änderungen vorbehalten)
813640
Maßstab
Blatt 1
1 Blätter
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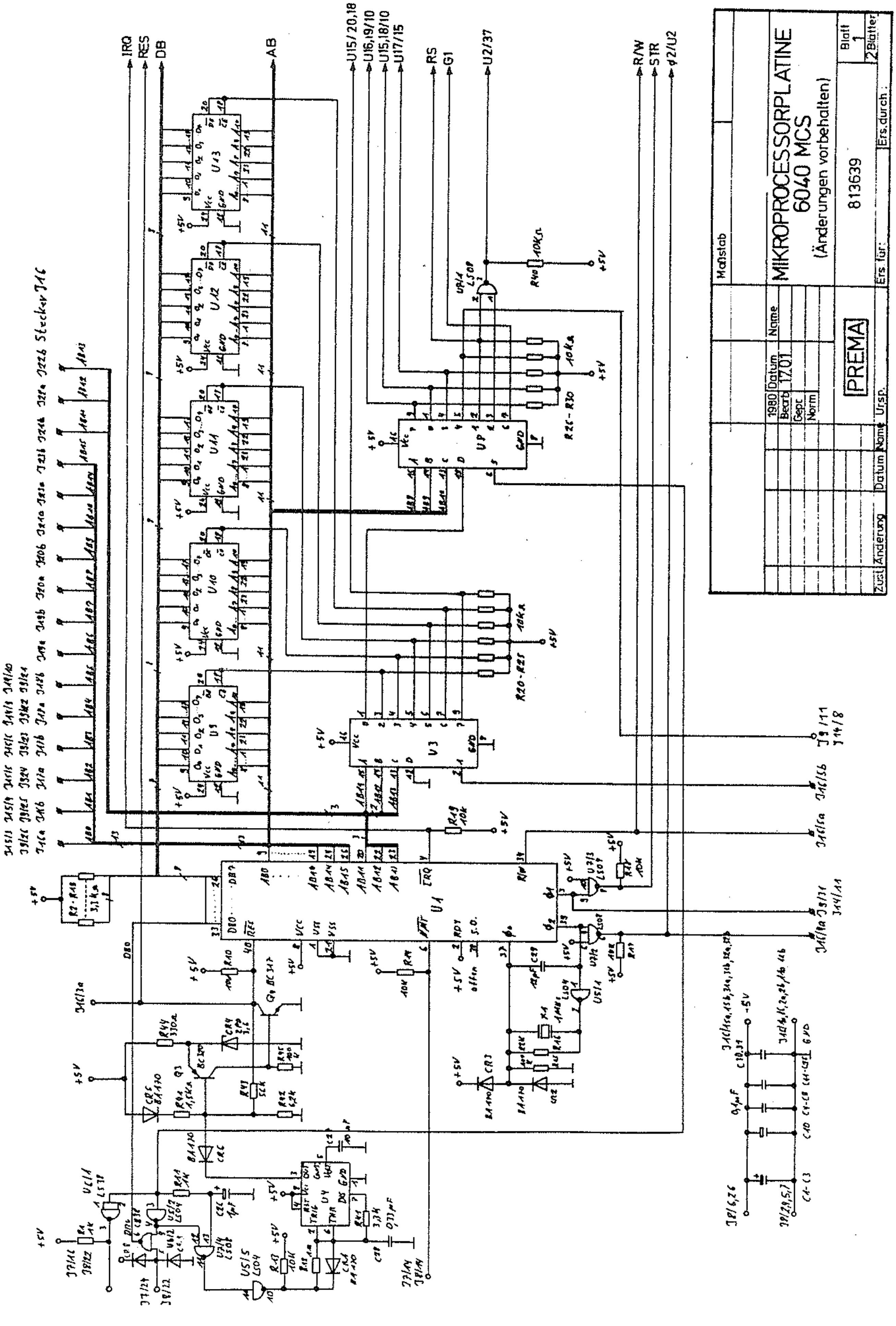
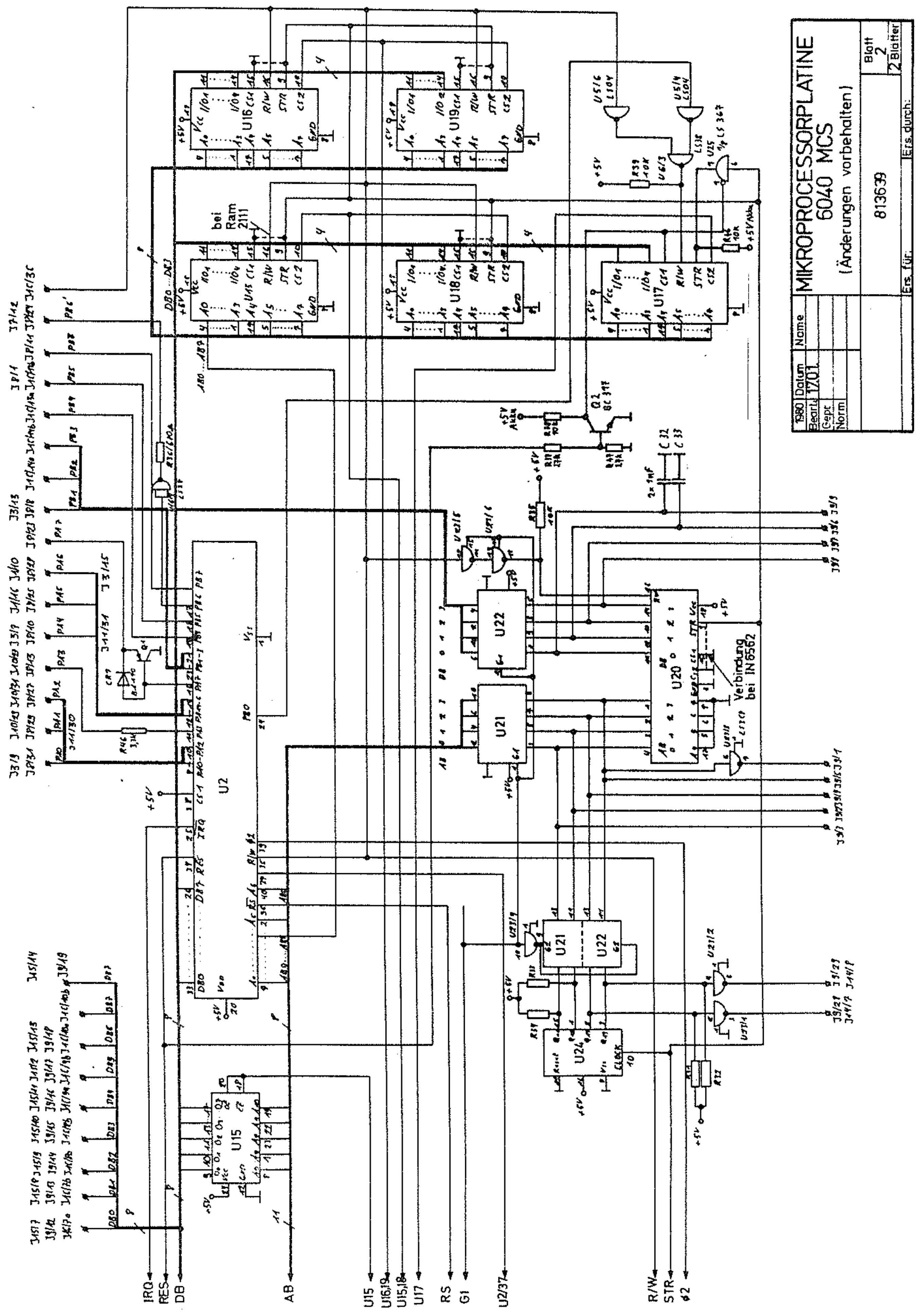
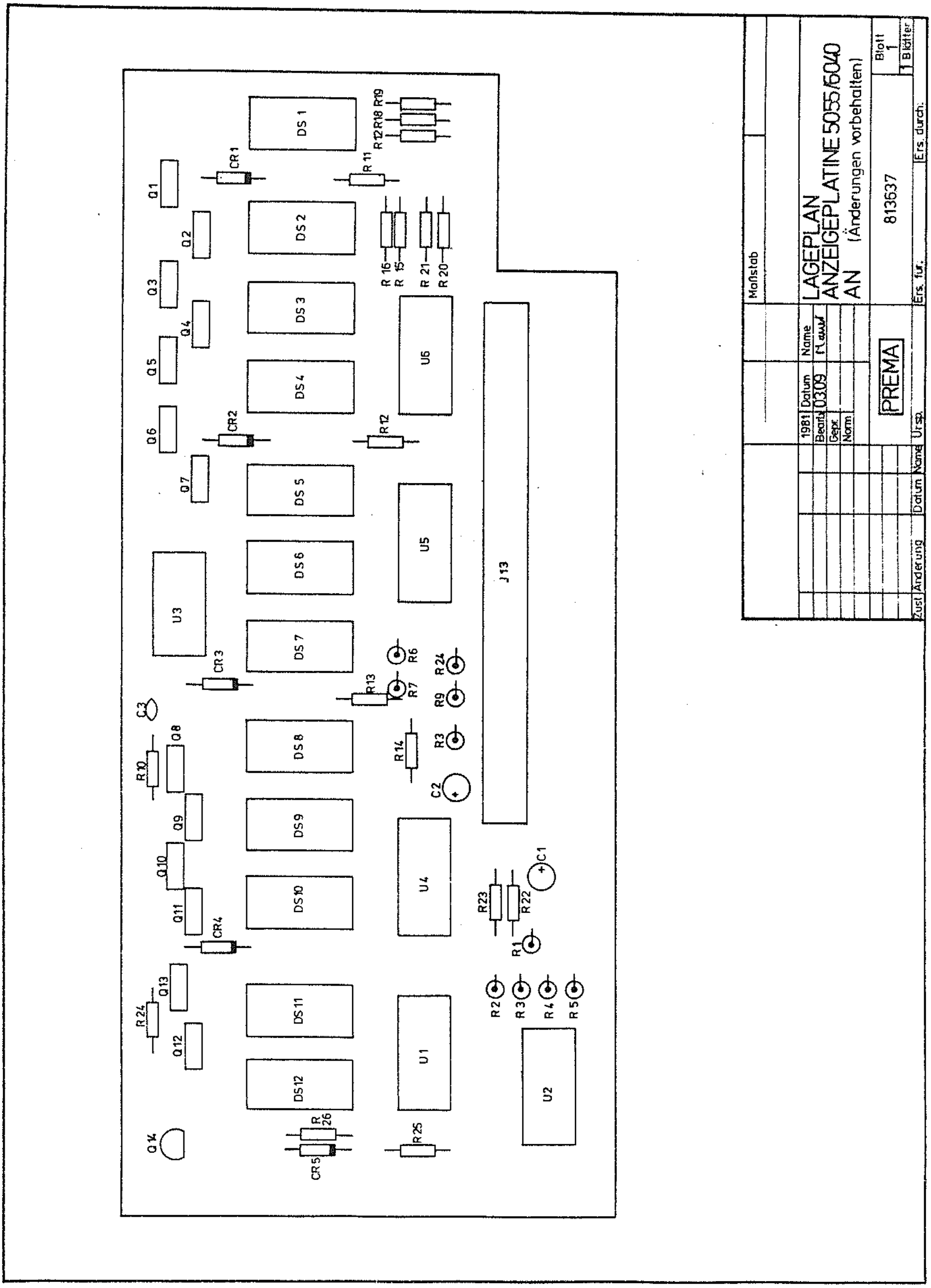
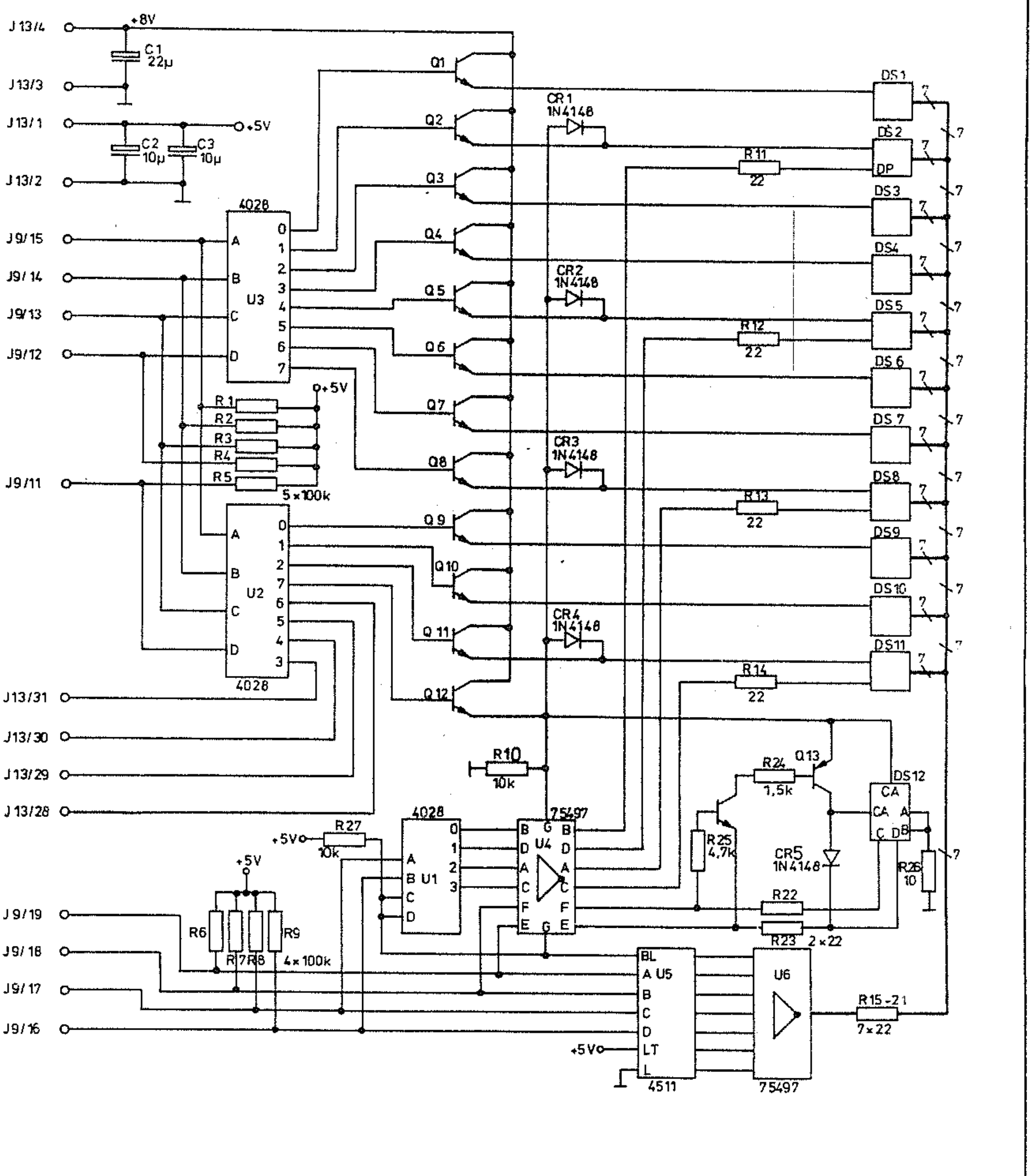
Bearb. 17.01
Gepr.
Norm
Zust. Änderung Datum Name Ursp.
Ers. für:
Ers. durch:


MIKROPROCESSORPLATINE
6040 MCS
(Änderungen vorbehalten)
813639
PREMA
Maßstab
1980 Datum Name
Bearb. 17.01
Gepr.
Norm
Blatt 1
2 Blätter
Ers. für:
Ers. durch:
Zust. Änderung Datum Name Ursp.
IRQ
RES
DB
AB
U15/20,18
U16,19/10
U15,18/10
U17/15
RS
G1
U2/37
R/W
STR
φ2/U2
Stecker J16
R20-R25
R26-R30
U1
U3
U4
U9
U10
U11
U12
U13
UP


MIKROPROCESSORPLATINE
6040 MCS
(Änderungen vorbehalten)
813639
Blatt 2
2 Blätter
1980 Datum
Bearb. 17.01
Gepr.
Norm
Name
Ers. für:
Ers. durch:
U2
U15
U16
U17
U18
U19
U20
U21
U22
U24
bei Ram 2111
Verbindung bei IN6562
IRQ
RES
DB
AB
U15
U16,19
U15,18
U17
RS
G1
U2/37
R/W
STR
ϕ2



LAGEPLAN
ANZEIGEPLATINE 5055/6040
AN
(Änderungen vorbehalten)
813637
PREMA
Maßstab
Blatt 1
1 Blätter
1981
Datum
Name
Bearb.
03.09
Gepr.
Norm
Zust.
Änderung
Datum
Name
Ursp.
Ers. für:
Ers. durch:
DS 1
DS 2
DS 3
DS 4
DS 5
DS 6
DS 7
DS 8
DS9
DS10
DS11
DS12
U1
U2
U3
U4
U5
U6
J13
Q1
Q2
Q3
Q4
Q5
Q6
Q7
Q8
Q9
Q10
Q11
Q12
Q13
Q14
CR1
CR2
CR3
CR4
CR5
C1
C2
C3
R1
R2
R3
R4
R5
R6
R7
R9
R10
R11
R12
R13
R14
R15
R16
R17
R18
R19
R20
R21
R22
R23
R24
R25
R26



1981	Datum	Name
Bearb.	02.09	Mauer
Gepr.		
Norm		

Maßstab

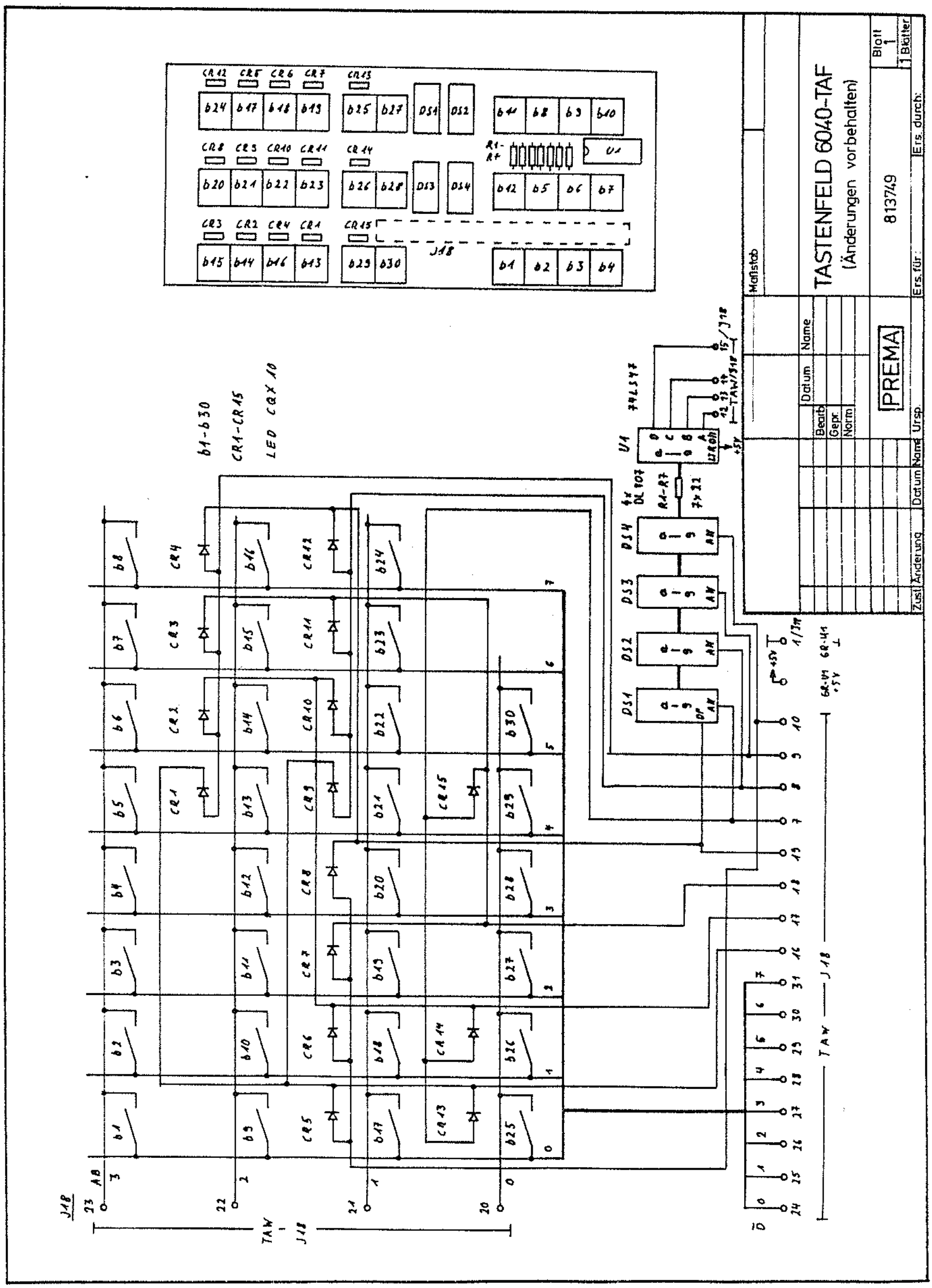
ANZEIGEPLATINE
5055/6040-AN
(Änderungen vorbehalten)

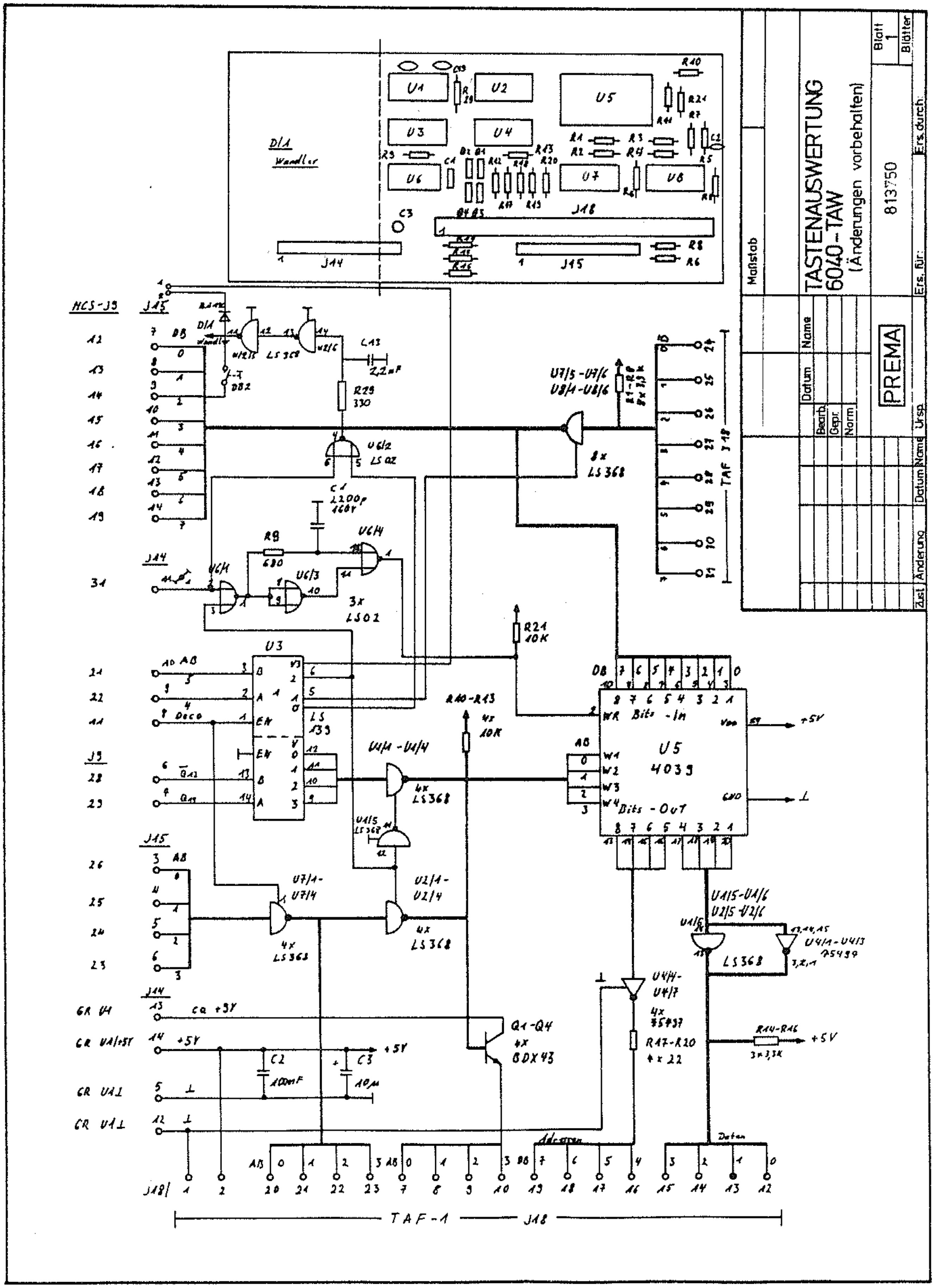
PREMA

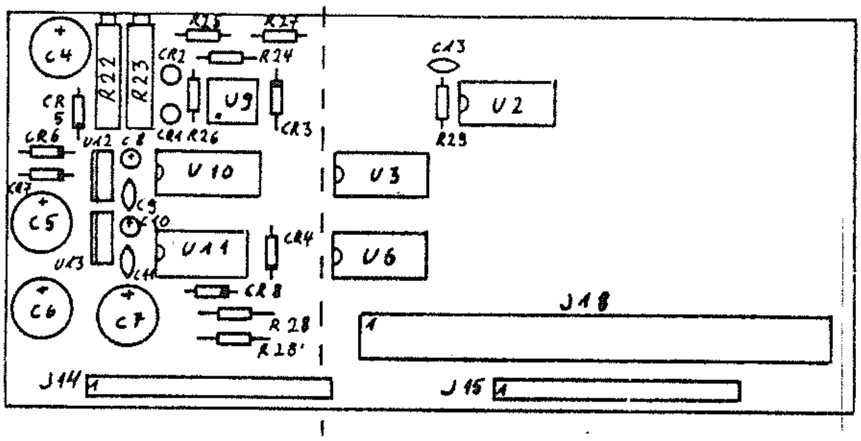
813636

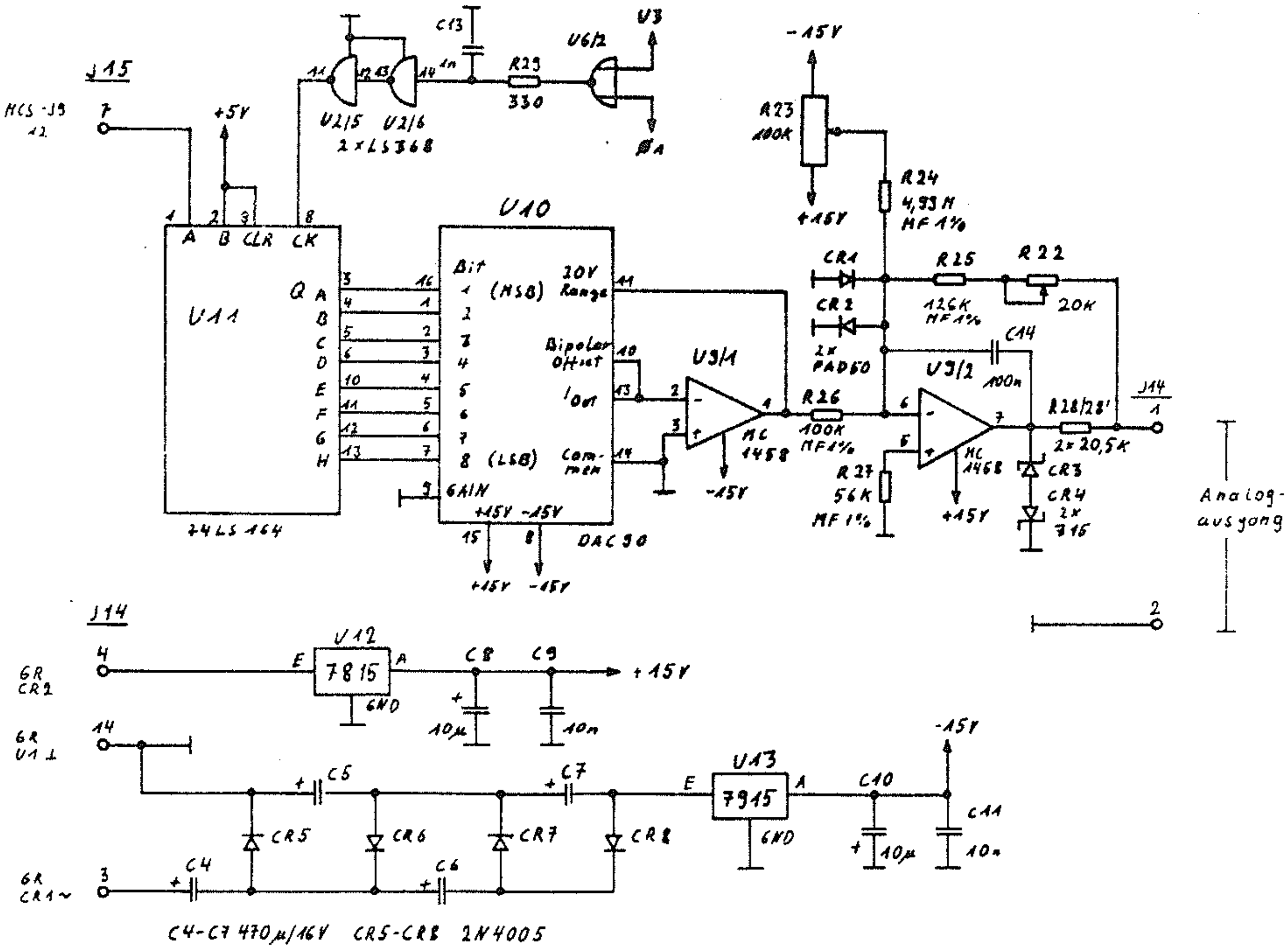
Blatt 1
1 Blätter

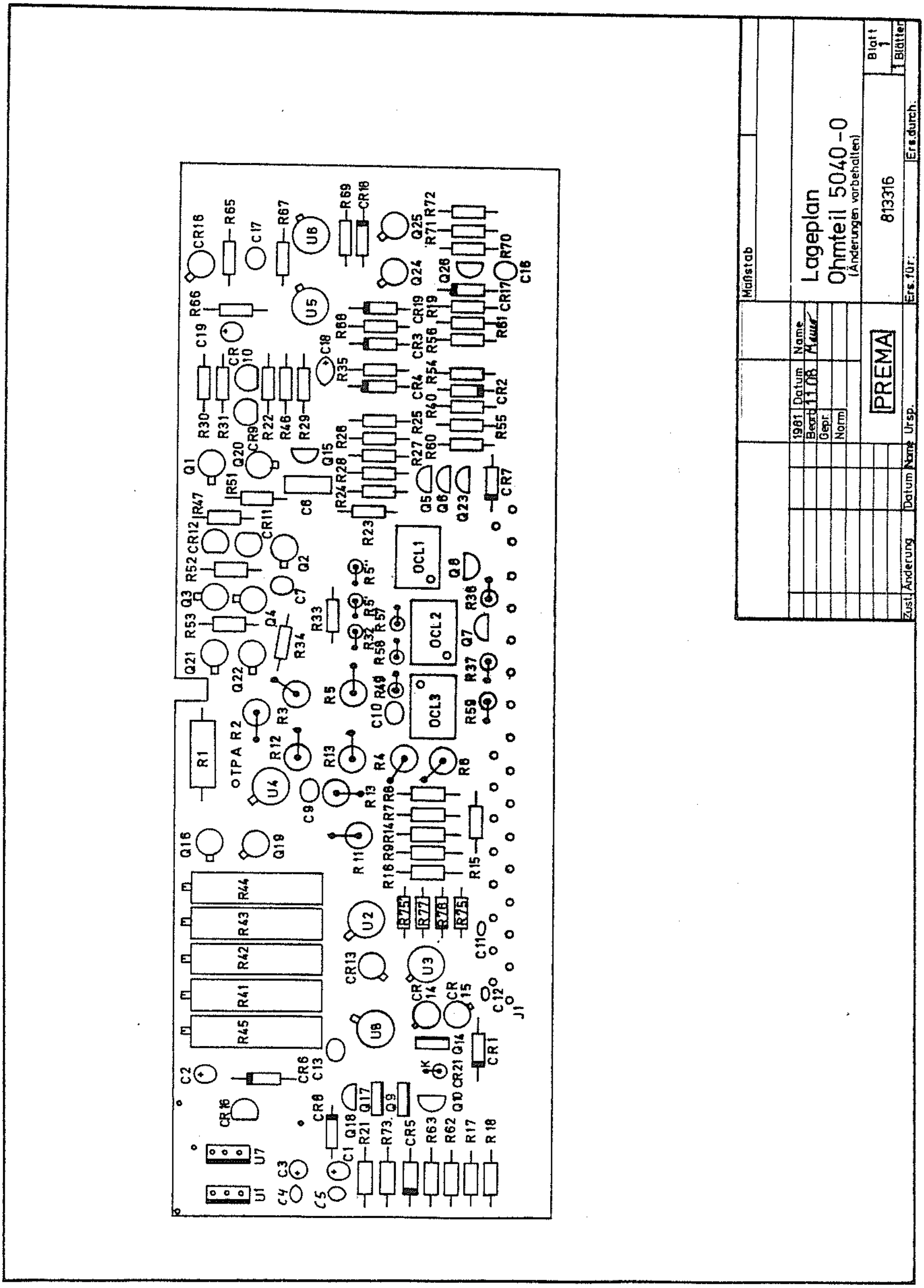
Zust. | Änderung | Datum | Name | Ursp | Ers. für: | Ers. durch

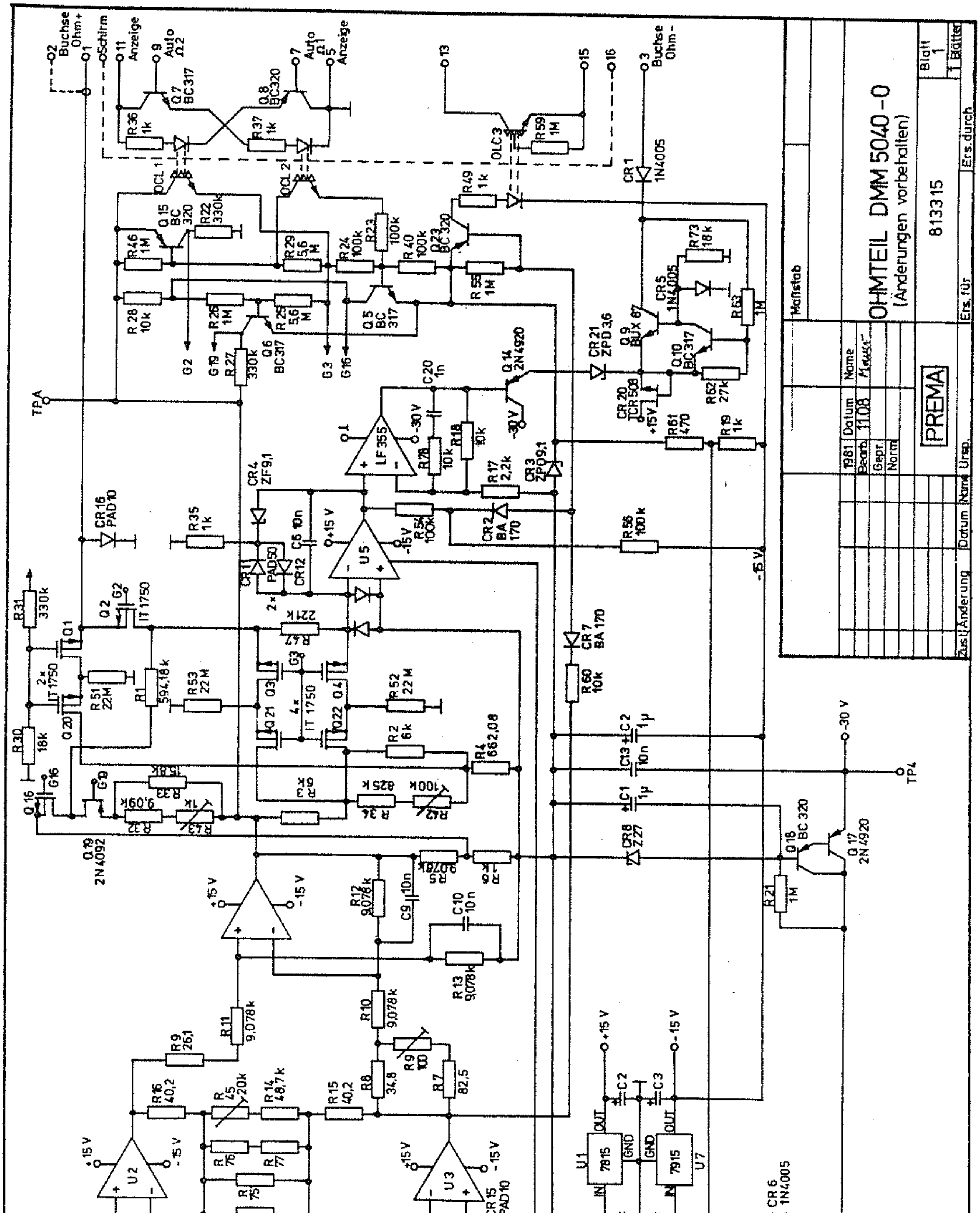

TASTENFELD 6040-TAF
(Änderungen vorbehalten)
813749
PREMA
Blatt 1
1 Blätter
Maßstab
Datum
Name
Bearb.
Gepr.
Norm
Zust.
Änderung
Ursp.
Ers. für:
Ers. durch:
b1-b30
CR1-CR15
LED CQX 10
U1
74LS47
DS1
DS2
DS3
DS4
4x DL 707
R1-R7
7x 22
+5V
TAW
J18

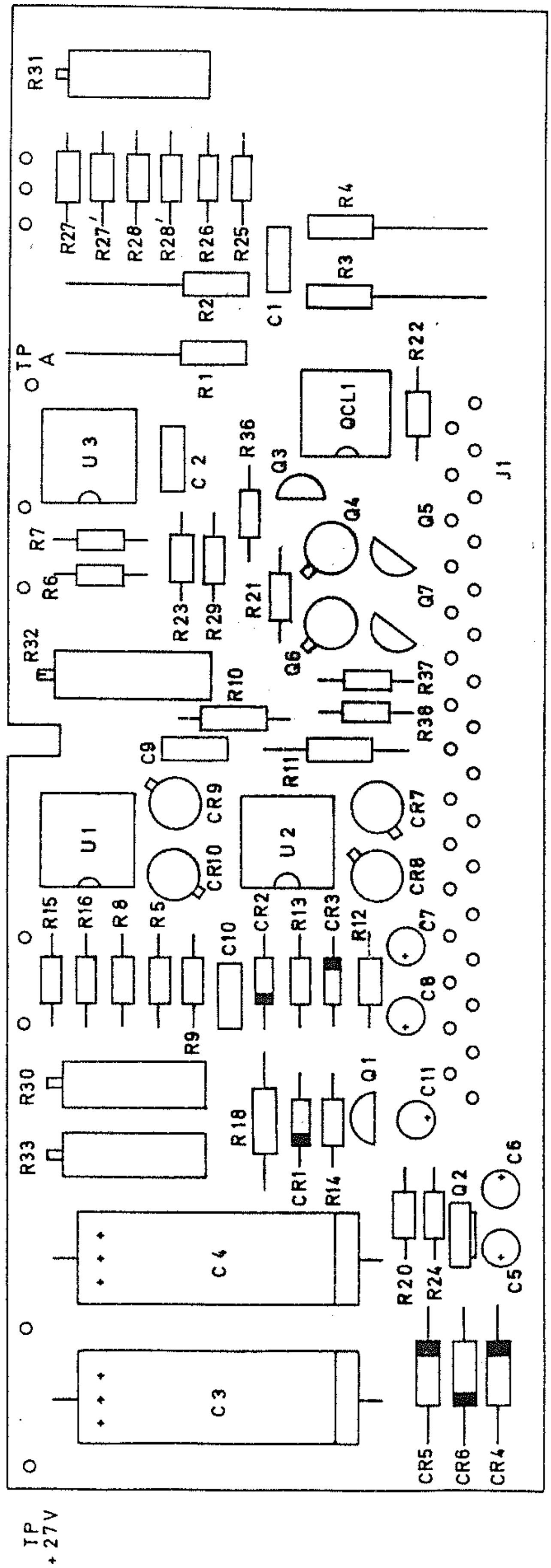

TASTENAUSWERTUNG
6040-TAW
(Änderungen vorbehalten)
813750
PREMA
Maßstab
Blatt 1
Blätter
Ers. durch:
Ers. für:
Datum
Name
Bearb.
Gepr.
Norm
Urspr.
Zust
Änderung
D/A Wandler
U1
U2
U3
U4
U5
U6
U7
U8
J14
J15
J18
HCS-J3
U7/5 - U7/6
U8/1 - U8/6
8x LS368
U3 LS 139
U5 4039
Bits - In
Bits - Out
U4/1 - U4/4
4x LS368
U7/1 - U7/4
U2/1 - U2/4
Q1 - Q4
4x BDX43
R17 - R20
4 x 22
R14 - R16
R40 - R43
4x 10K
R24 10K
R23 330
R8 680
C1 2200p 160V
C13 2,2nF
C2 100nF
C3 10µ
3x LS02
U4/5 - U4/6
U2/5 - U2/6
LS368
U4/1 - U4/3
75439
4x 75437
+5V
TAF 1 J18
TAF - 1
J18
Adressen
Daten


C4
C5
C6
C7
R22
R23
U9
U2
U10
U3
U11
U6
J18
J14
J15


J15
J14
U2/5
U2/6
2×LS368
R23
330
U6/2
U10
U11
74LS164
DAC 90
U3/1
MC 1458
U3/2
R24
4,99 M
MF 1%
R25
R22
20K
R26
100K
R27
56K
R28/28'
2×20,5K
Analog-
ausgang
U12
7815
U13
7915
+15V
-15V
C4-C7 470µ/16V CR5-CR8 2N4005

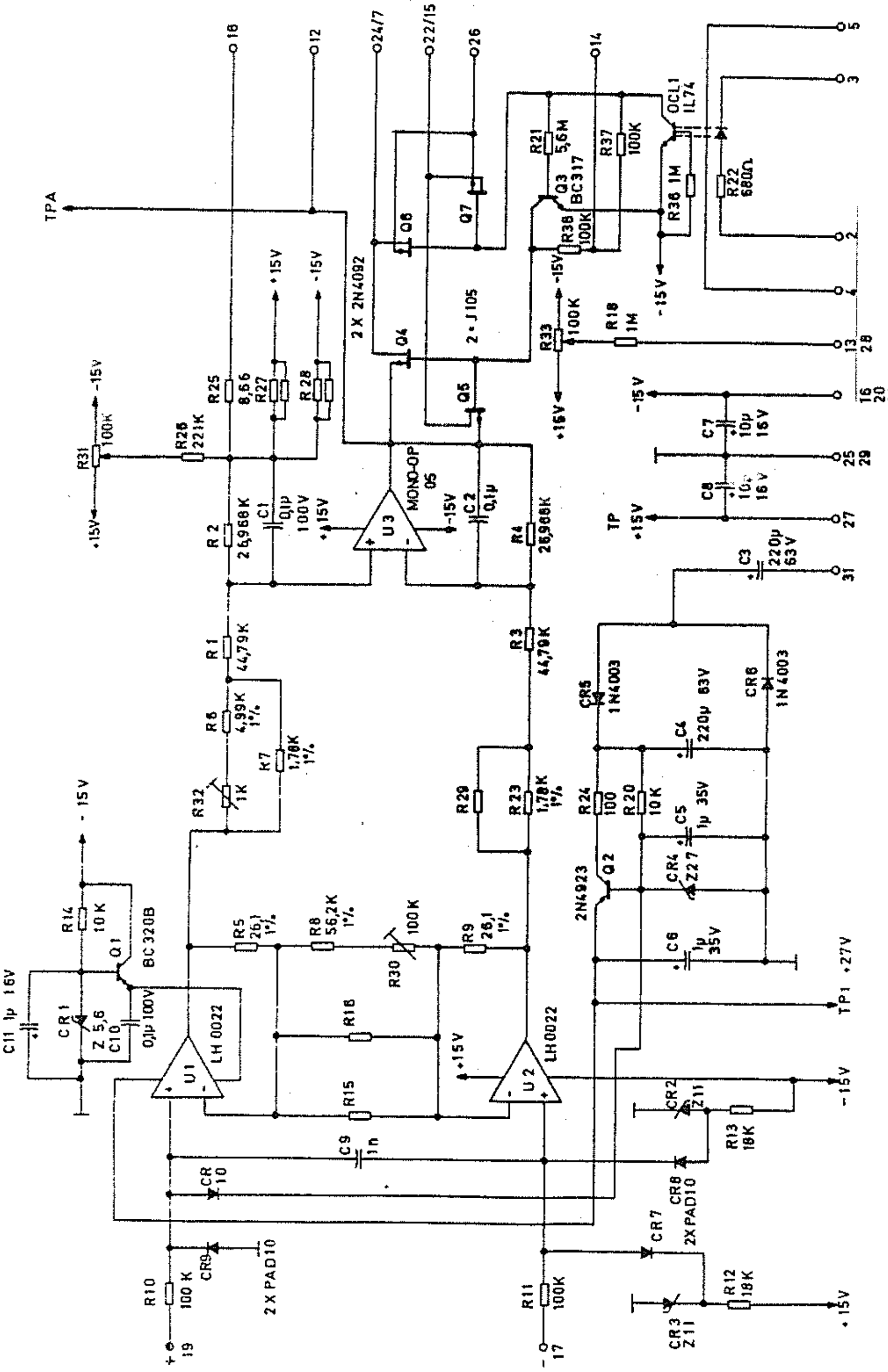

Lageplan
Ohmteil 5040-0
(Änderungen vorbehalten)
813316
PREMA
Maßstab
Blatt 1
1 Blätter
1981
Datum
Name
Bearb. 11.08.
Gepr.
Norm
Zust.
Änderung
Datum
Name
Ursp.
Ers. für:
Ers. durch:


OHMTEIL DMM 5040-0
(Änderungen vorbehalten)
813315
PREMA
Maßstab
1981
Bearb. 11.08
Gepr.
Norm
Datum
Name
Blatt 1
1 Blätter
Ers. durch
Ers. für
Urspr.
Zust. Änderung
Buchse Ohm+
Buchse Ohm-
Schirm
Anzeige
Auto
U2
U3
U5
LF 355
U1 7815
U7 7915
+15 V
-15 V
-30 V
+25 V
-25 V
-40 V
TP A
TP4



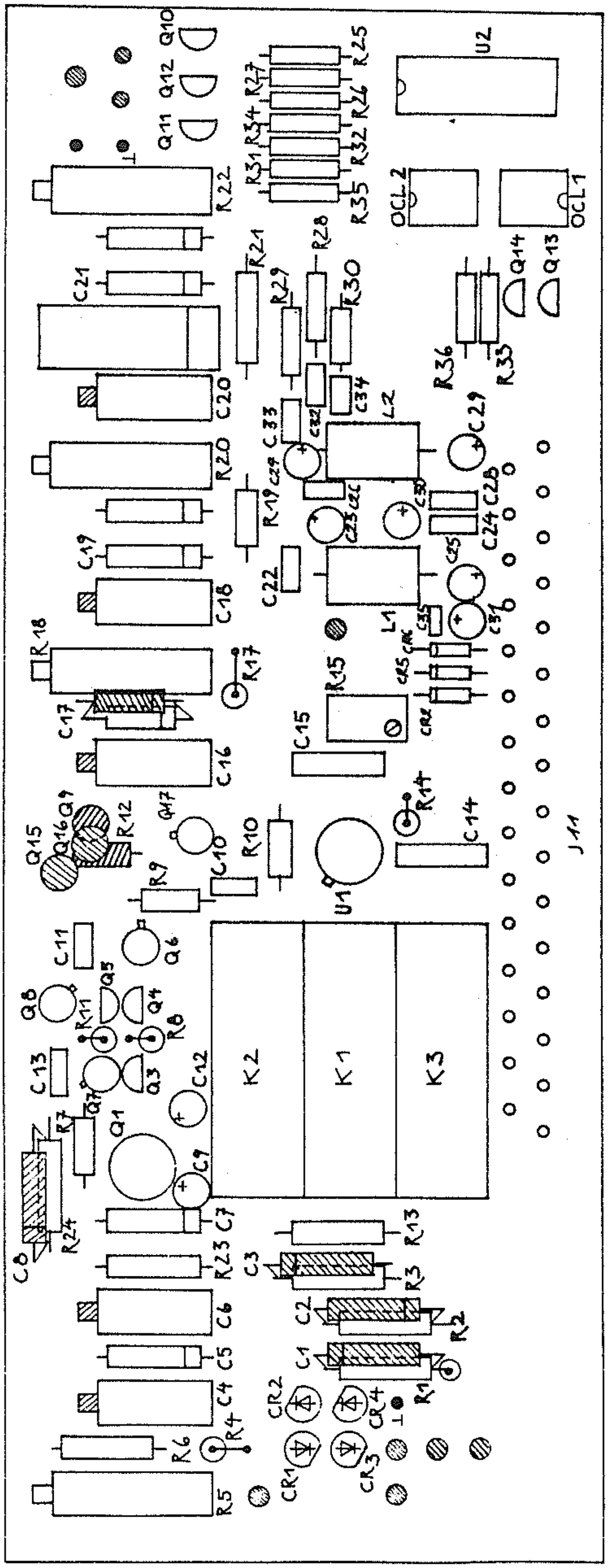
Ratioplatine DMM 5040 - R5

(Änderungen vorbehalten)



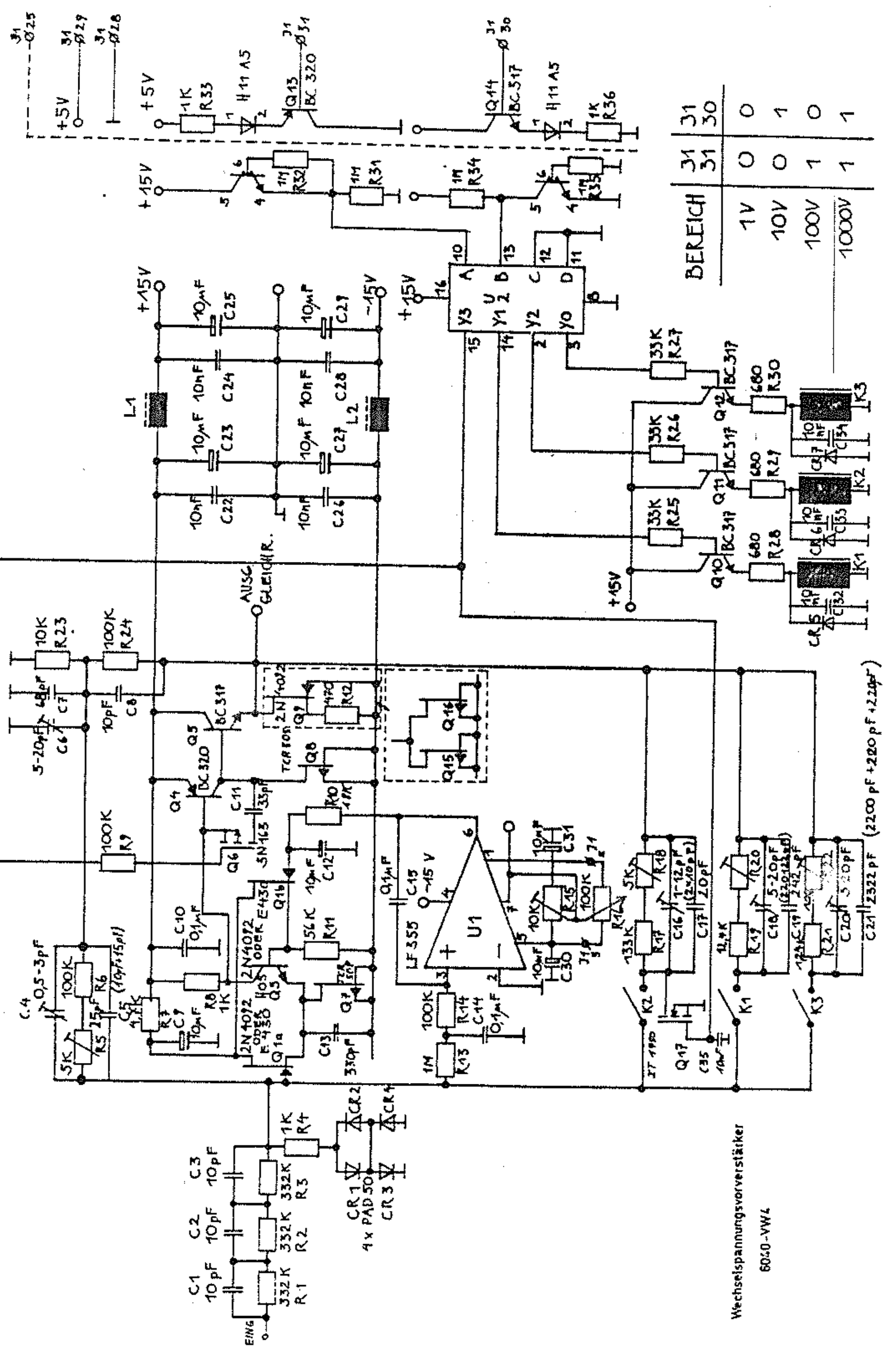
Ratioplatine 5040-R-5

(Änderungen vorbehalten)



Wechselspannungsvorverstärker
6040-VW4

(Änderungen vorbehalten)

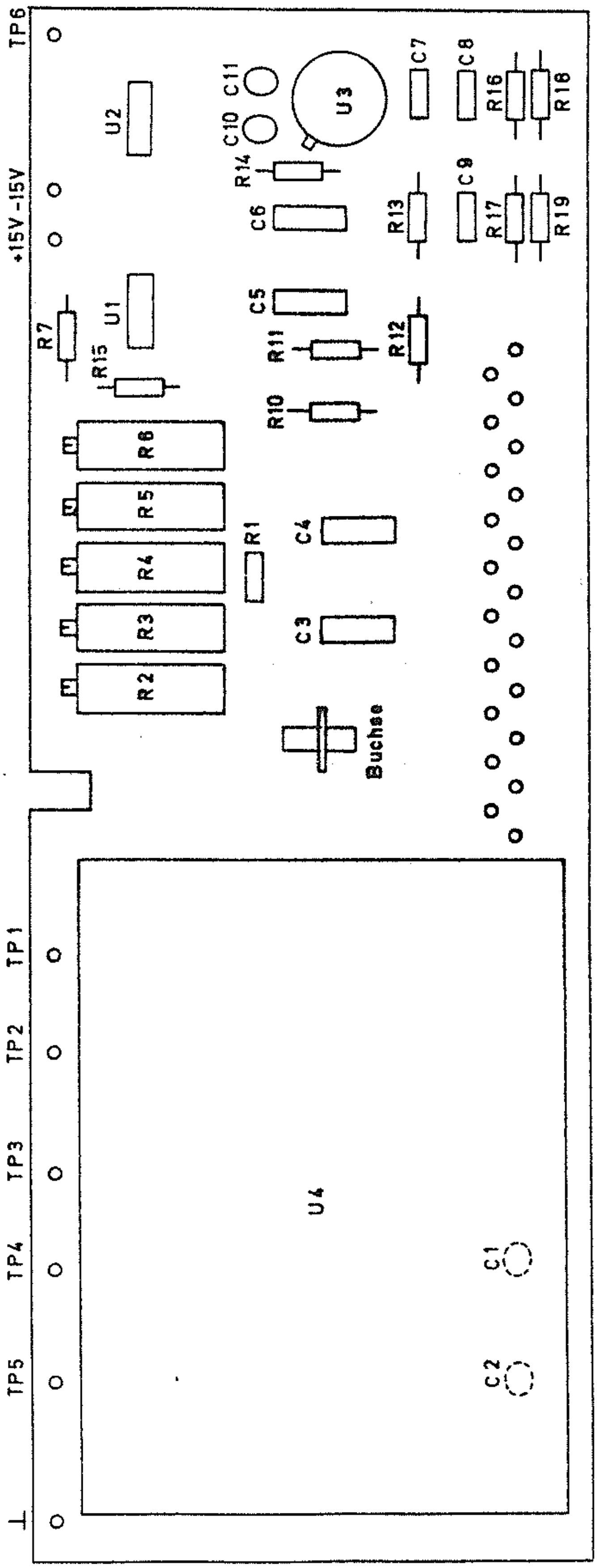


BEREICH	31 31	31 30
1V	0	0
10V	0	1
100V	1	0
1000V	1	1

Wechselspannungsvorverstärker

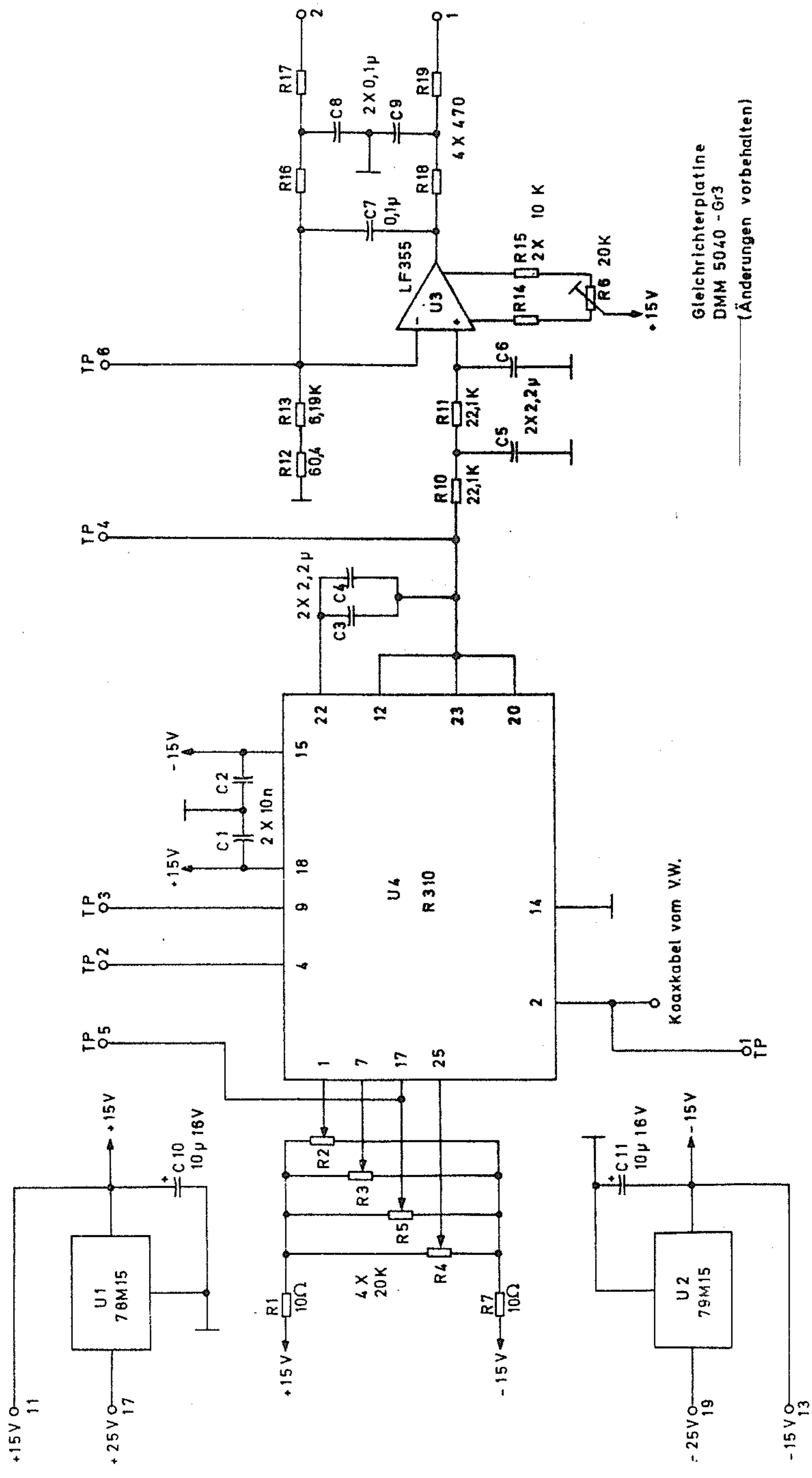
6040-VW4

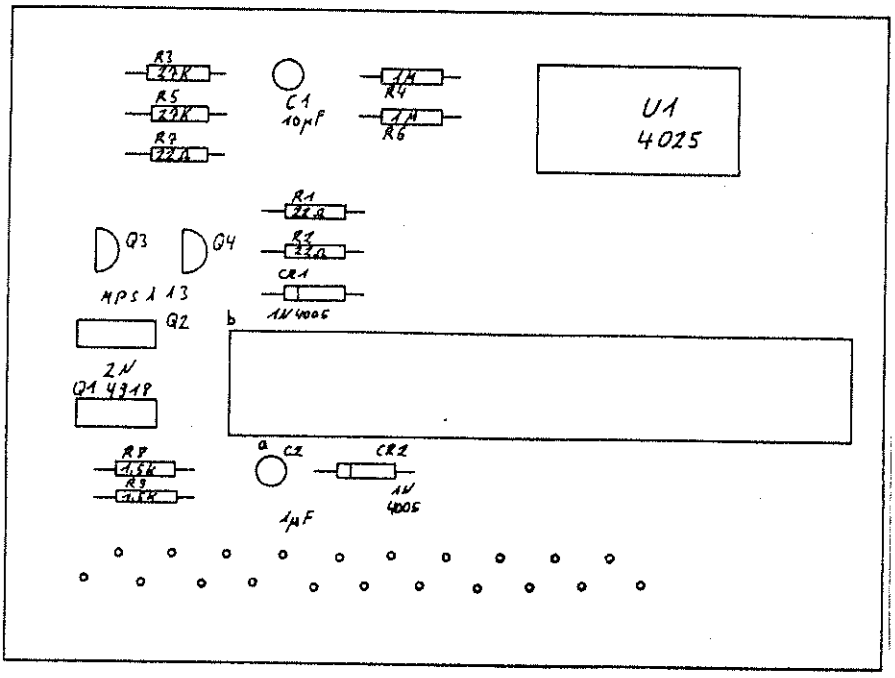
(Änderungen vorbehalten)

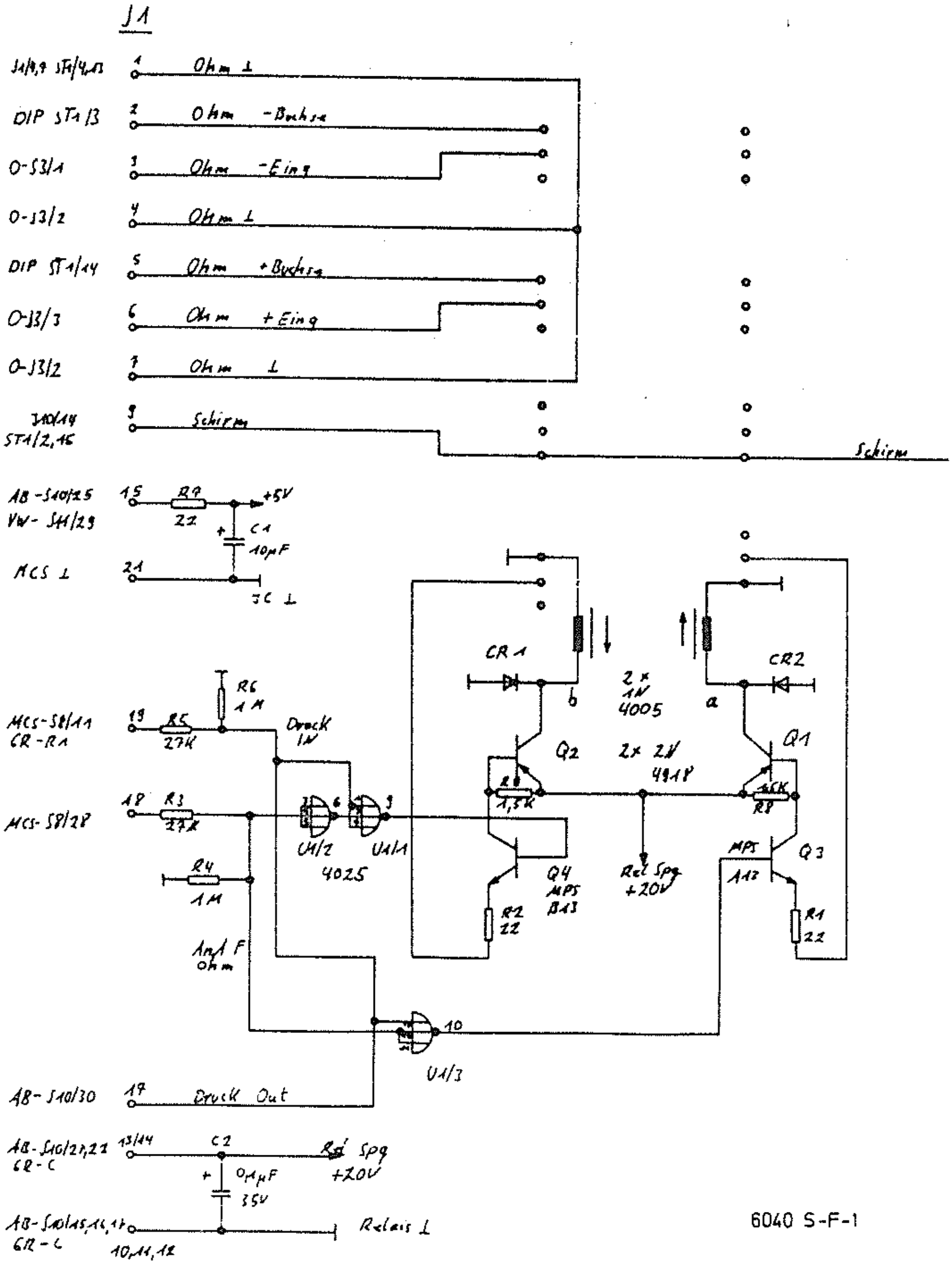


Gleichrichterplatine
DMM 5040 - Gr3

(Änderungen vorbehalten)

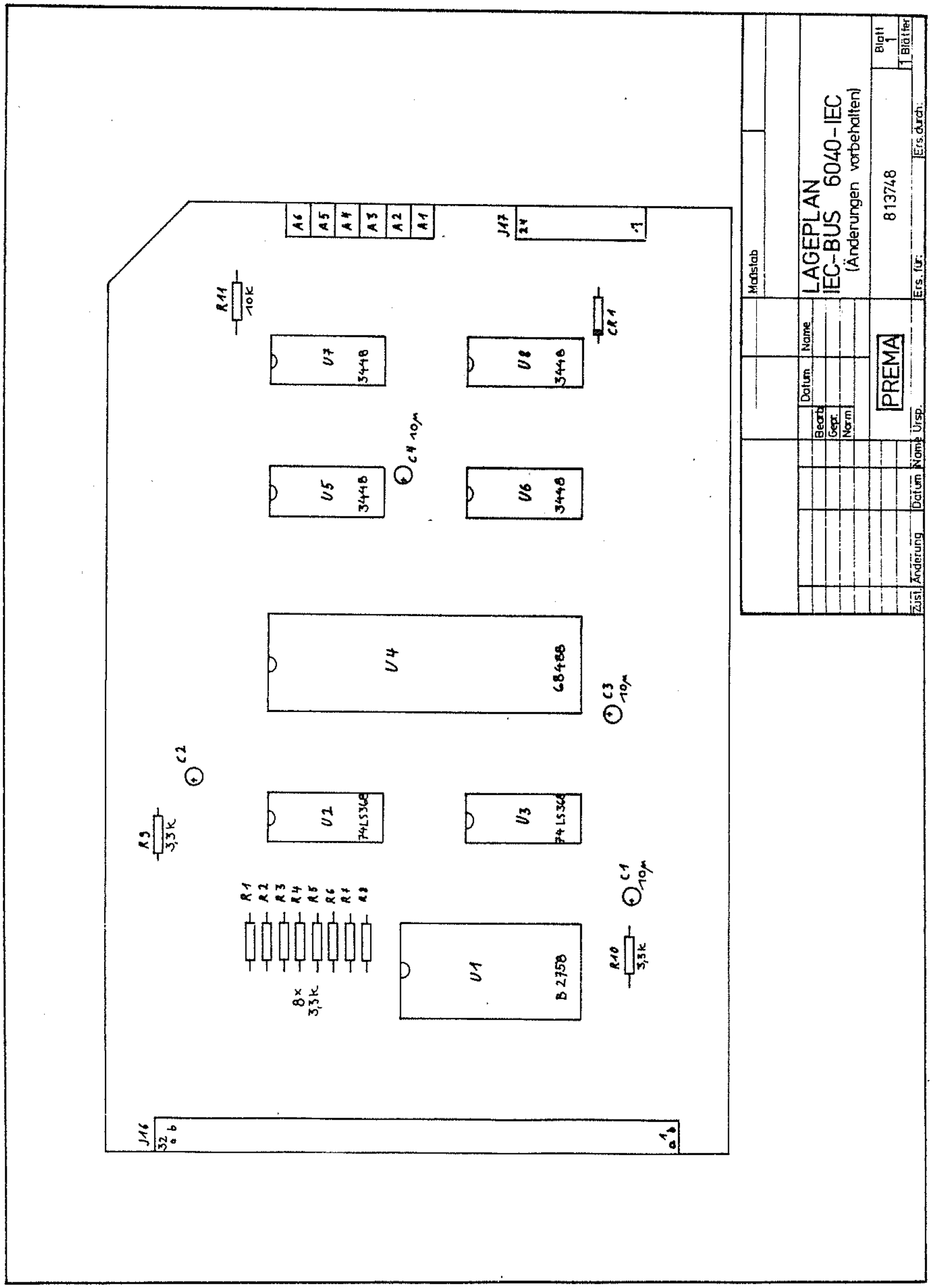

Gleichrichterplatine
DMM 5040 - Gr3
(Änderungen vorbehalten)
U4
R310
U3
LF355
U1
78M15
U2
79M15
R17
R16
R19
R18
C8
C9
2 X 0,1µ
4 X 470
C7
0,1µ
R15
2X 10 K
R14
R6 20K
+15V
C6
2X2,2µ
C5
R11
22,1K
R10
22,1K
R13
6,19K
R12
60,4
2X 2,2µ
C3
C4
C1
C2
2 X 10n
-15V
+15V
Koaxkabel vom V.W.
R2
R3
R5
R4
4 X
20K
R1
10Ω
R7
10Ω
C10
10µ 16V
C11
10µ 16V
+25V
-25V
-15V

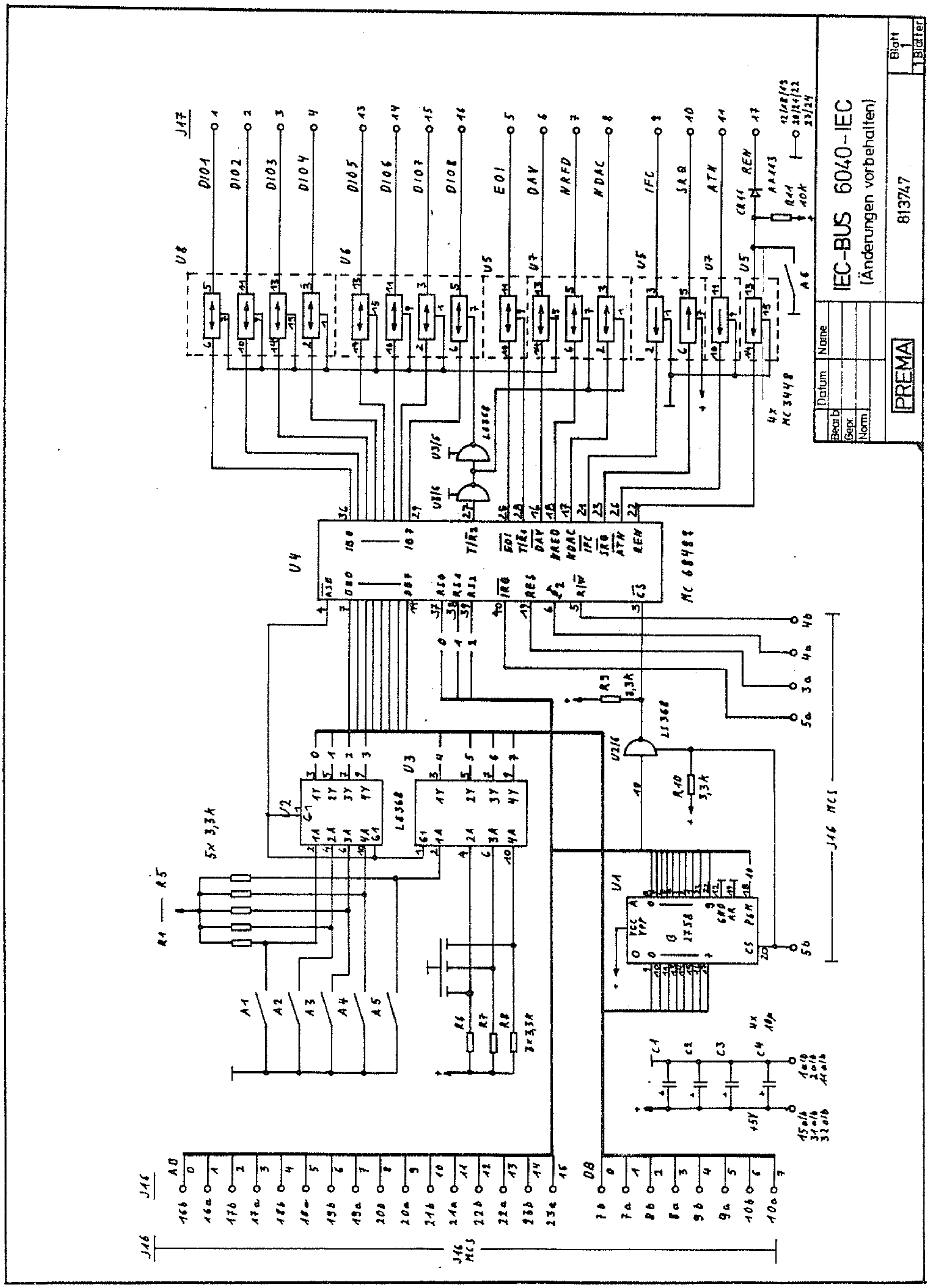


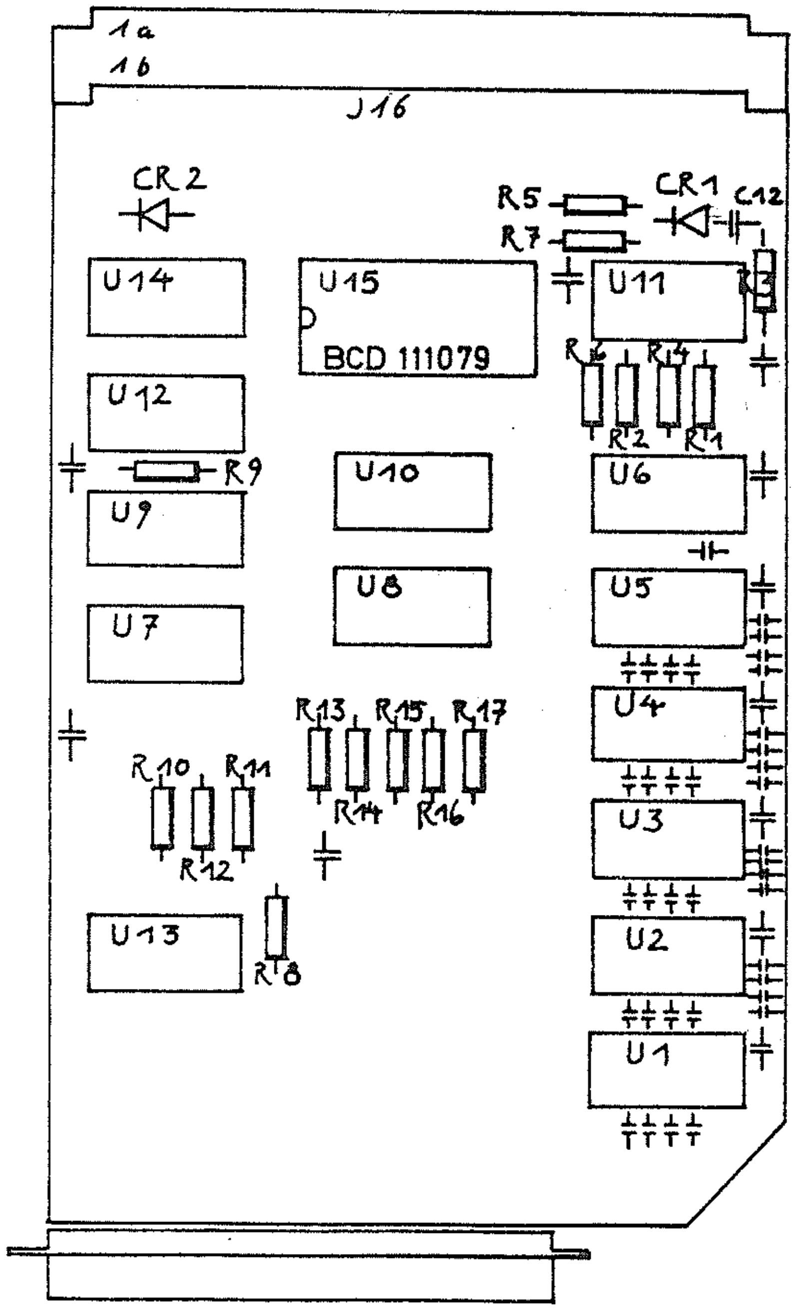


6040 S-F-1

(Änderungen vorbehalten)

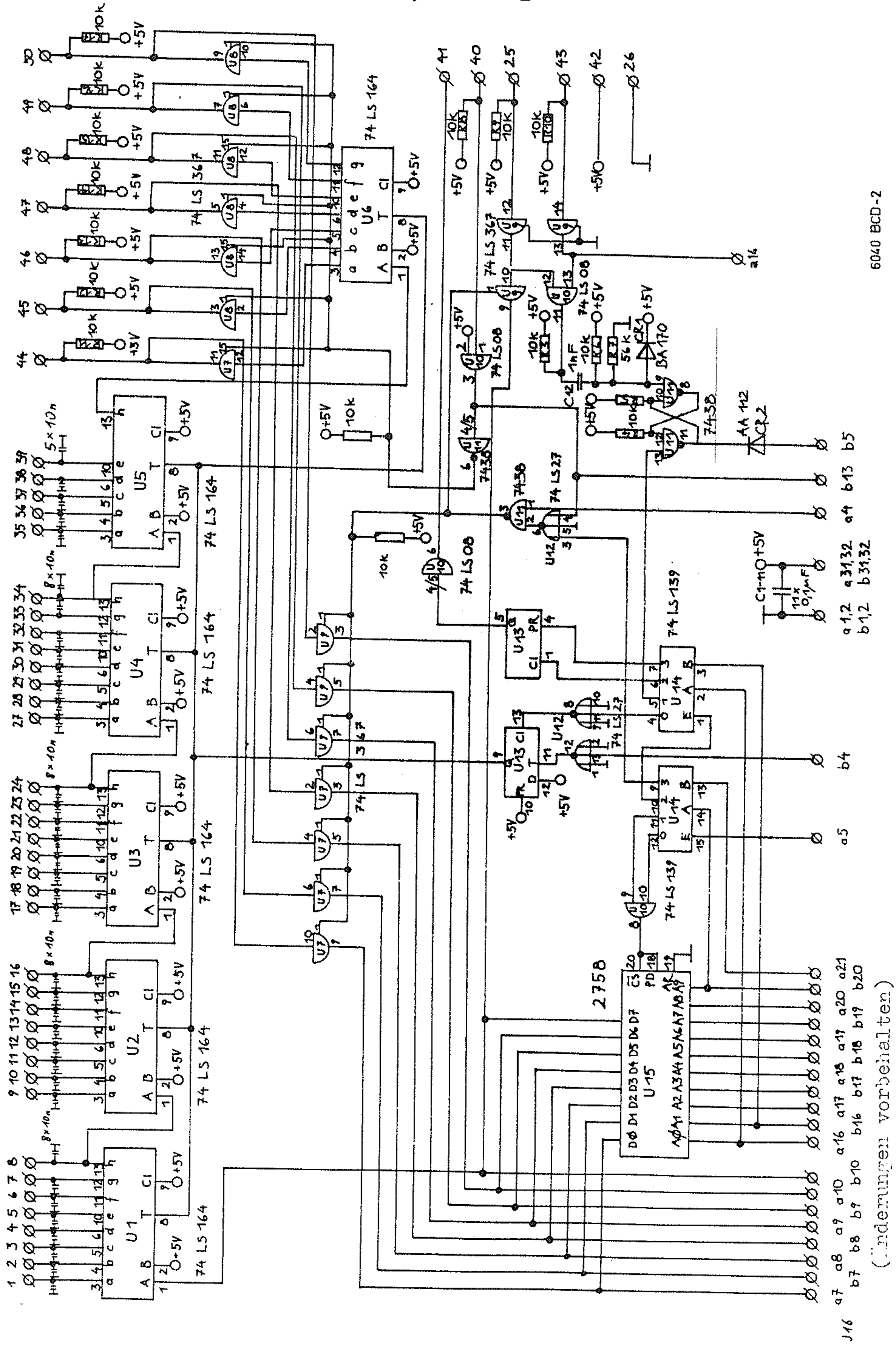

LAGEPLAN
IEC-BUS 6040-IEC
(Änderungen vorbehalten)
813748
PREMA
Blatt 1
1 Blätter
Maßstab
Datum
Name
Bearb.
Gepr.
Norm
Zust.
Änderung
Datum
Name
Urspr.
Ers. für:
Ers. durch:
U1 B 2758
U2 74LS368
U3 74LS368
U4 68488
U5 3448
U6 3448
U7 3448
U8 3448
R1 R2 R3 R4 R5 R6 R7 R8
8× 3,3k
R9 3,3k
R10 3,3k
R11 10k
C1 10µ
C2
C3 10µ
C4 10µ
CR1
J16
J17
A1 A2 A3 A4 A5 A6


IEC-BUS 6040-IEC
(Änderungen vorbehalten)
813747
PREMA
Blatt
Bearb.
Gepr.
Norm
Datum
Name
MC 68488
J17
J16

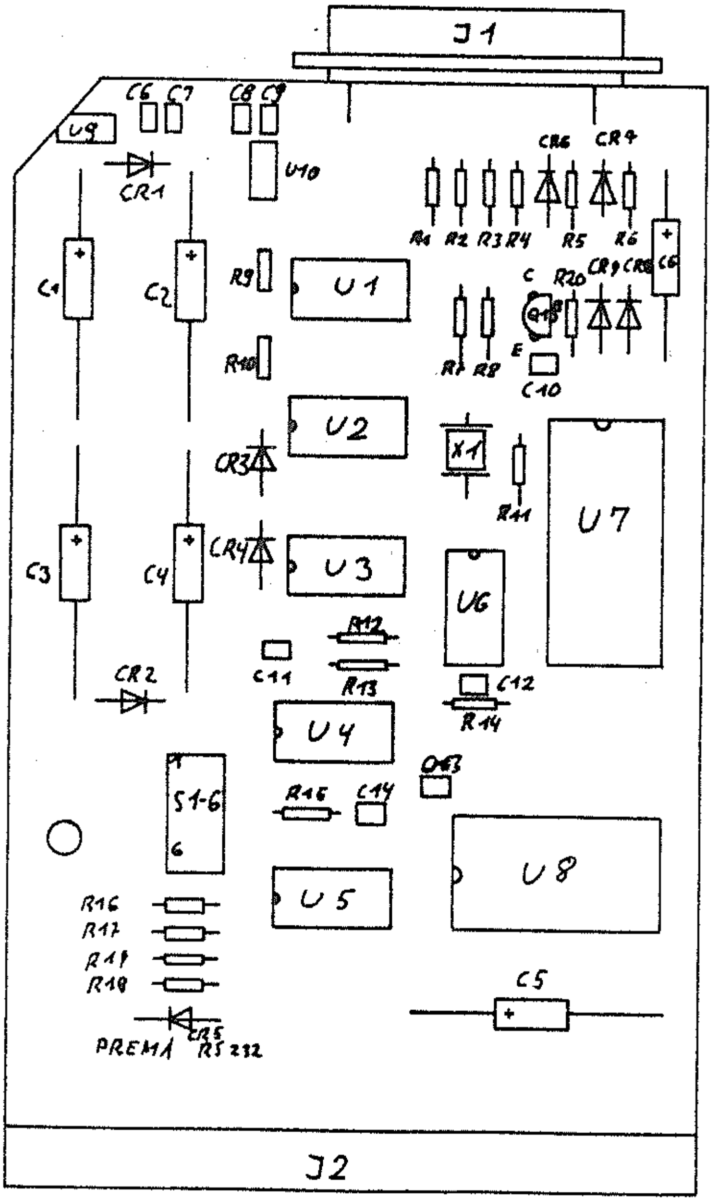


6040 BCD-2

(Änderungen vorbehalten)

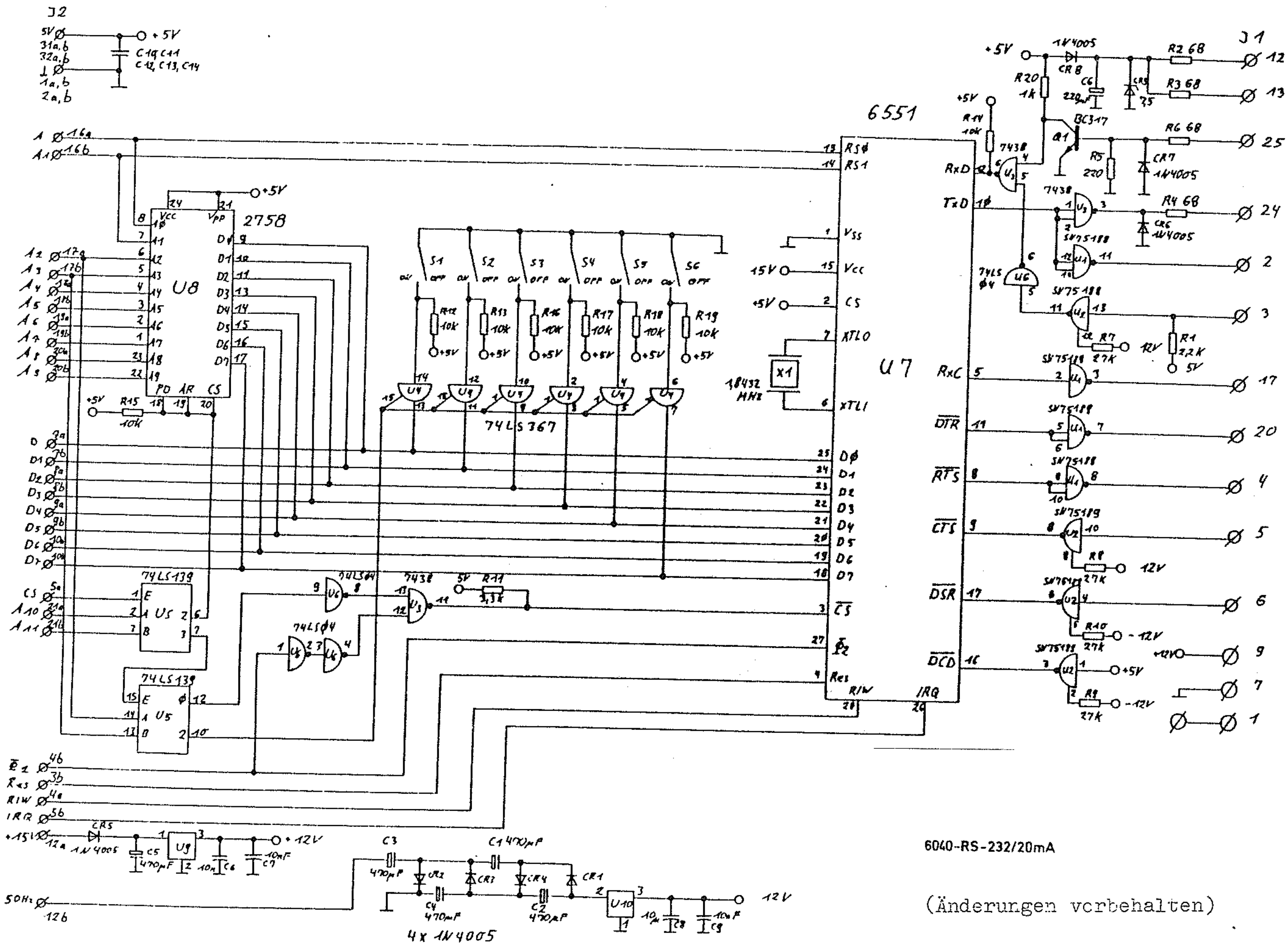


74 LS 164
U1
U2
U3
U4
U5
U6
74 LS 367
74 LS 08
74 LS 27
74 LS 139
7438
2758
U-15
BA 170
AA 112
10k
+5V
8 x 10n
5 x 10n
a1,2 b1,2
a31,32 b31,32
J16
6040 BCD-2
(Änderungen vorbehalten)



6040-RS-232/20 mA

(Änderungen vorbehalten)



6040-RS-232/20mA

(Änderungen vorbehalten)