



**ROHDE & SCHWARZ**

# Manual

## POWER SUPPLY

### Type NGSM

#### Order designations:

Power Supply	NGSM32/10	192.0810.31
IEC-625 / IEEE-488 Interface	NGSM B2	192.0810.02
RS 232 Interface	NGSM B1	192.0810.01
19" Adapter (3HU)	NGSM B0	192.0810.00

**In case of inquiries please mention type, order designation  
and serial no. (F.-Nr.) of the instrument.**

Revision:H



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## EC Certificate of Conformity



Certificate No.: 96/05/01

This is to certify that:

Power Supply

NGSM 32/10 + Option IEC625 + Option RS232

Identification No. 192.0810.31 + 192.0810.01 + 192.0810.02

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electrical equipment for use within defined voltage limits  
(73/23/EEC revised by 93/68/EEC)
- relating to electromagnetic compatibility (89/336/EEC revised by 91/263/EEC)

Conformity is proven by compliance with the following standards:

EN61010-1:1991  
EN50081-1:1992  
EN50082-1:1992

Affixing the EC conformity mark as from May 1996

## Specifications

<b>Voltage range</b>	<b>0...18V</b>	<b>0...32V</b>
<b>Constant-voltage source</b>		
Voltage setting	0...18.00 V	0...32.00 V
Resolution	10 mV	10 mV
Deviation from full scale	<0.4 %	<0.2 %
with $\pm 10$ % AC supply var.	<0.01 %	<0.01 %
between 0 and 45°C	<0.02 % / °C	<0.02 % / °C
from 10 to 90 % load current	0.01 %	0.01 %
Transient recovery time	0.1 ms	0.1 ms
PARD, voltage rms	1 mV	1 mV
<b>Constant-current source</b>		
Current setting	0...20.0 A	0...10.0 A
Resolution in Range 0 ... 9.99 A	10 mA	10 mA
Resolution in Range 10.0 ... 20.0 A	100 mA	100 mA
Deviation from full scale	<0.5 %	<1.5 %
with $\pm 10$ % AC supply var.	<0.02 %	<0.02 %
between 0 and 45°C	<0.05 % / °C	<0.05 % / °C
from 10 to 90 % load voltage	0.2 %	0.2 %
PARD, current rms	20 mA	20 mA
Continuous load	0 ... 10 A	0 ... 5 A
Load for max. 5 minutes	0 ... 20 A	0 ... 10 A
Load max. 1 ms	0 ... 30 A	0 ... 15 A
<b>Display</b>		
Voltage measurement	0... 40.00 V	0... 40.00 V
Resolution	10 mV	10 mV
Deviation from full scale	<0.2 %	<0.1 %
between 0 and 45°C	<0.02 % / °C	<0.02 % / °C
Measurement rate	approx. 6/s	approx. 6/s
Current measurement in mA range	0... 199 mA	0... 199 mA
Resolution in Range 0 ... 99.9 mA	0.1 mA	0.1 mA
Resolution in Range 100 ... 199 mA	1 mA	1 mA
Deviation in Range 0...99.9 mA	< $\pm 0.5$ % $\pm 0.1$ mA	< $\pm 0.5$ % $\pm 0.1$ mA
Deviation in Range 100...199 mA	< $\pm 0.5$ % $\pm 1$ mA	< $\pm 0.5$ % $\pm 1$ mA
between 0 and 45°C	<0.1 % / °C	<0.1 % / °C
Current measurement in A range	0... 40.0 A	0... 40.0 A
Resolution in Range 0...9.99 A	10 mA	10 mA
Resolution in Range 10.0...40.0 A	100 mA	100 mA
Deviation in Range 0...9.99 A	< $\pm 0.5$ % $\pm 10$ mA	< $\pm 0.5$ % $\pm 10$ mA
Deviation in Range 10.0...40.0 A	< $\pm 0.5$ % $\pm 100$ mA	< $\pm 0.5$ % $\pm 100$ mA
between 0 and 45°C	<0.1 % / °C	<0.1 % / °C
Peak current measurement	0... 40.0 A	0... 40.0 A
Resolution	100 mA	100 mA
Deviation from full scale	<2 %	<2 %
between 0 and 45°C	<0.2 % / °C	<0.2 % / °C
<b>General data</b>		
Voltage compensation	0.5 V per lead (remote sensing)	
Rated temperature range	0 ... +45°C	
Storage temperature range	-40 ... +60°C	
AC supply	100/ 120/ 220/ 240 V $\pm 10$ %	
	50 to 60 Hz, 690 VA	
RFI suppression	EN 55 022 class B	
Electrical safety	VDE 0411; class 1 (safety ground)	
Outputs	max.120 V DC, floating	
Dimensions ( W x H x D )	211 x 150 x 350 mm	
Dimensions 19" Adapter (Option)	19" 3HU 350 mm	
Weight	8 Kg	
<b>Option</b>		
IEC-625 / IEEE-488 Interface	Listener / Talker	
RS 232 Interface	eg for use with CMD	
19" Adapter	3HU 2.8 Kg	

## 1. Introduction

The NGSM32 has been designed with the special needs in testing of automotive systems in mind. However it is also useful for all fields of testing or maintenance of battery-operated systems. The main features are:

- Range switching 18V/32V for applications in 12V or 24V onboard supplies.
- High pulse current capability of up to 30A for 1ms.
- A high-resolution current measurement range (100uA/step) for standby-measurements in battery-operated devices such as mobile telephones or laptop P.C.'s.
- A peakmeter with hold-mode for current peaks up to 40A .
- Trend indication for visual evaluation of current flow variations, e.g. when a mobile phone registers.
- An arbitrary waveform generator with a time-resolution of 1ms for simulation of reproducible voltage variations.
- Nonvolatile memory for the storage of up to six individual setups per voltage range

### 1.1 Mains Connection

The NGSM32 is designed for mains connections to 100V, 120V , 220V or 240V line voltage (nominal value +/-10%). Please ensure that the correct line voltage is set before the NGSM32 is connected to the mains voltage by the power cable. The actual line voltage setting can be read in the window of the power line filter at the rear panel of the NGSM32. The NGSM32 is designed according to safety-class I of the VDE 0411 specification, for that reason it has to be connected only to earthed sockets!

#### 1.1.1 Conversion of the Line Voltage Setting

To convert the line voltage, perform the following steps:

- Remove the power cable at the rear of the NGSM32
- Open the lid of the power-filter enclosure with a suitable tool, by hooking into the slit at the upper edge and pull it outwards.
- Remove the coding-cylinder with the printed line voltage values and fit it to the right position, so that the desired line voltage value will appear in the window, if the lid is closed.
- If necessary, remove the line fuses by unplugging the fuse-holders, marked by a white arrow.
- If necessary, replace the line fuses according to the following table:

Line Voltages	Fuses
100V or 120V	IEC 127 T 6.3H / 250V
220V or 240V	IEC 127 T 3.15H / 250V

- After correct positioning of the coding-cylinder and correct selection and installation of the line fuses, close the lid and plug in the power cable.

### 1.2 Load Connection

The sockets for the load connection are located at the front panel of the NGSM32. The positive pole terminal is a red-coloured panel socket and signed with the symbol "+" and the negative pole terminal is a black-coloured panel socket and signed with the symbol "-". By connecting a load, take notice that the wire gauge is heavy enough to avoid unnecessary warming and voltage dropping.

#### 1.2.1 Load Connection with Remote Voltage Sensing

If it is necessary to compensate the voltage drop due to the load leads, the sense leads must be connected to the load. The sense terminals are grey-coloured panel sockets, labeled as "+ SENSE" and "SENSE -". It should be noted that every sense lead will provide voltage sensing up to 0.5V drop in each load lead. If the load leads resistance are too high, the voltage at the load cannot be regulated correctly (if the voltage drop exceeds 0.5V)!



### 1.2.2 Mass Connection

The grey-coloured panel socket in the middle of the jack panel is connected to protective earth. Because the power outputs are electrically isolated from earth, either the positive or the negative terminal may be connected to earth. If none of the power outputs are grounded, the voltage difference between ground and any power output should not exceed 120V DC!

## 1.3 Built in Protection of the NGSM32

### 1.3.1 Protective Precautions in Remote Sensing

In remote sensing, the following errors can be made:

- The "+ SENSE" and "SENSE -" jacks can be short-circuited.
- One or both sense terminals can be connected to the load with wrong polarity (e.g. "+" with "SENSE -" and "-" with "+ SENSE").

In these cases, the output voltage may exceed the nominal value voltage level by up to 3V!

### 1.3.2 Protection of the Power Output

There is a fuse (F3) in the "+" power output current path, which is accessible at the rear panel of the NGSM32. This fuse must be of the type M 20 E UL 198G.

### 1.3.3 Overheating Protection of the Power Unit

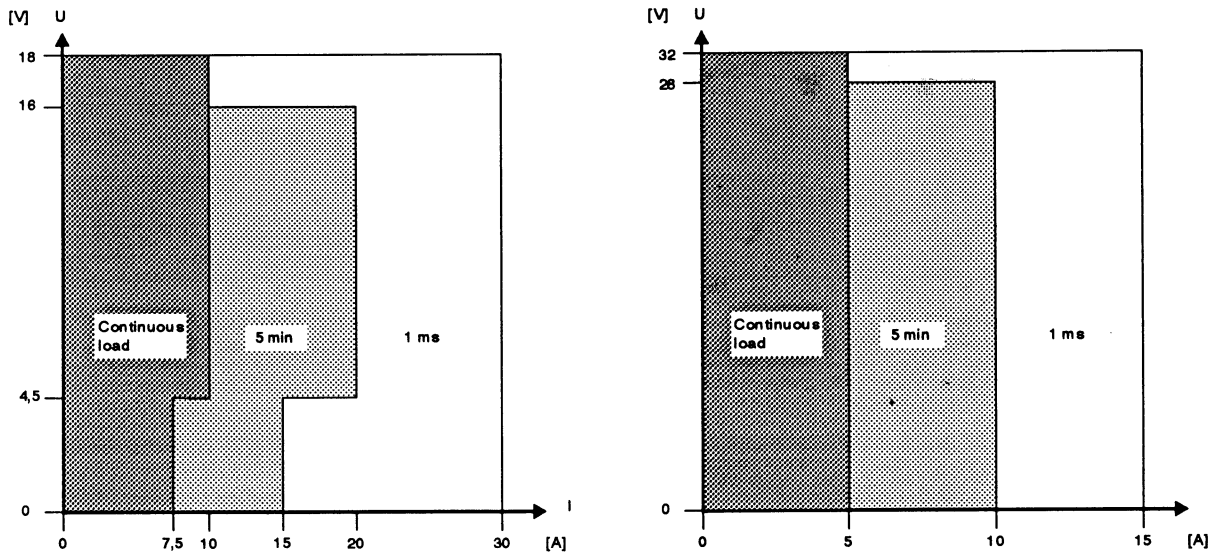
A temperature sensing circuit is located on the power unit of the NGSM32 which controls the speed of the fan and switches off the power output if the upper temperature limit of the power unit is reached. In the case of switching-off the LED "OVERLOAD" at the front panel of the NGSM32 turns on. The power output can be switched on again after sufficient cooling time, if the LED has turned off or flashes. If the NGSM32 detects an error in the temperature sensing circuit (e.g. shorting or cable break of the temperature sensor), the power output will be switched off and the error message "FAIL 005" will appear at the front panel.

### 1.3.4 Overtemperature Protection of the Line Transformer

The NGSM32 monitors the output power over time. If the output power exceeds the continuous power dissipation limit, the NGSM32 calculates the allowable time period over which the actual output power can be handled without overloading the line transformer. Before the critical temperature will be reached, the power output will be switched off automatically and this operation will be announced acoustically. The "OVERLOAD" LED on the front panel will flash. The flashing rate of this LED is proportional to the temperature increase of the line transformer. The flashing rate will slow down while the transformer cools down. After the LED has turned to the off-state completely, the line transformer has cooled down sufficiently to provide the maximum output power again. The nominal continuous output power can be taken unlimited, during the flashing phase of the LED..

### 1.3.4 The Current Load Capacity

The current load capacity within the respective voltage range will be presented in the following diagrams. The restrictions will be monitored by the NGSM32 independently, as explained in the following.



Current loadability in the 18V- and 32V-range

### 1.3.5 Monitoring the 15A-Level in 18V-Range

If the nominal voltage value is less than or equal to 4.5V, no nominal current value greater than 15A can be set. If a current value of greater than 15A was set on a voltage value greater 4.5V and the voltage value will be reduced to less or equal 4.5V, then the nominal current value will be set to 15A automatically. The NGSM32 stores the preset current value and restores it, if the voltage value exceeds 4.5V again.

### 1.3.6 Monitoring the 10A-Level in 18V-Range

If the output voltage is greater than 16V, only an output current of less or equal than 10A can be taken. There is no monitoring of the value settings, the NGSM32 switches over to current regulation automatically.

### 1.3.7 Monitoring the 5A-Level in 32V-Range

If the output voltage is greater than 28V, only an output current of less than or equal to 5A can be taken. There is no monitoring of the value settings, the NGSM32 switches over to current regulation automatically.

### 1.3.8 Monitoring the Output Voltage

To reduce the power loss of the NGSM32 power unit, the output voltage of the line transformer is adapted to the output voltage of the power output by automatic voltage ranging. The correspondence between the temporary output voltage and the transformer output voltage range is controlled by a monitor logic. If the output voltage is too high, a failure in the automatic voltage ranging or in the power unit is assumed. In this case, the NGSM32 produces the error message "FAIL 003" and tries to switch off the power output.

### 1.3.9 Protection of connected Voltage Sources

If the NGSM32 is used to charge car batteries or any rechargeable battery, the following points should be noted. The NGSM32 contains an internal, electronic current sink, to enable the regulator to hold a stable operating point and to get a fast decay of the output voltage, if the arbitrary waveform generator is running. This dynamic regulated current sink can take current peaks of up to 3 amps! As a matter of fact, the NGSM32 can take current of an external voltage source, if the output voltage of the NGSM32 is lower than the voltage of the external source. The current is measured by the NGSM32 and is displayed with a negative sign on the digital display. If the NGSM32 is dissipating current for longer than 2 seconds, the output is switched off. The current sink is switched off simultaneously. The reason for this function is to prevent discharging of a battery if after a charge it is not disconnected from the NGSM32. If a battery is not designed to source currents of up to 3 amps for 2 seconds, please note that no current can flow into the NGSM32. This is provided as long as the output voltage of the NGSM32 is greater than or equal to the voltage of the external source. As safety precaution it is recommended, to install a diode in the load lead between the battery and the NGSM32. In this way a current reflow is prevented even if the output voltage of the NGSM32 is less than the voltage of the external source. The same effect will appear, if several NGSM32 are connected in parallel, to get higher output currents. In this case it is also recommended, to connect the power outputs via diodes.

### 1.3.10 Prevention against User Errors

The functions "VSET" and "ISET" are automatically deselected, if nearly 30 seconds of no manipulation of the knob is made and the "SETOFF" bit in the option register is set (see section 2.2.7). After this time any manipulation of the knob causes no variation of value-settings, until an explicit selection of a function is made. The power output is switched off if the "RANGE" toggle switch is moved, so that no undesired voltage value may damage the load by accident. Additionally, if a stored setting is selected by the "RECALL" function. The NGSM32 checks, whether there is any voltage level within the curve shape which is higher than the actually selected voltage setting. If this occurs, the user is warned acoustically and visually, and the corresponding value is displayed but not made available until start-pushbutton is depressed again.

## 2. Manual Operation of the NGSM32

### 2.1.1 Mains Switch "POWER ON"

The NGSM32 is set to operation with the mains switch at the front panel. After switching on, the digital displays show the voltage and current values, which were set at the last switch off. The power output is off. By switching off the NGSM32 a data safeguarding program is started and the actual voltage and current settings are stored in a nonvolatile memory. If a transient voltage dip starts the data safeguarding program and the line voltage returns before the execution is finished, a protection circuit provides a restart of the NGSM32. The error message "FAIL 000" appears on the digital display. Switching off and on the NGSM32 removes the message.

### 2.1.2 Reprogramming the Test Pulses 4 of DIN 40 839

The free programmable waveform memory contains two waveforms for simulation of voltage dipping in car onboard supplies (see sections 3, 3.6 and 3.7). If these waveforms were modified and should be reprogrammed, this can be done while powering on the NGSM32. For reprogramming, the pushbuttons "RECALL" (section 2.1.10) and "WAVEFORM" (section 2.1.15) both must be pressed and hold while the mains switch is set to "on". The NGSM32 quits the reprogramming by an acoustic signal, if the "BEEPER" bit in the option register is set to 1. The content of memory locations P11 to P60 remains unchanged.

### 2.1.3 Pushbutton "OUTPUT ON"

This pushbutton switches on or off the power output of the NGSM32. If the LED "OUTPUT ON" glows, the power output is switched on. Pushing the key once again, switches off the power output. Please note that the output terminals are not potential free, but the output voltage is set to zero value by programming!

#### 2.1.4 Pushbutton "VSET"

The desired voltage value can be varied by the knob, if the "VSET" button is pushed and the LED "VSET" is glowing. Pushing the "VSET" key once again deselects the function. If no value variation is made within one minute, the function will be deselected automatically if the "SETOFF" bit in the option register is set to 1 (see section 2.2.7). While in this operating mode, the digital display "VOLTAGE" shows the desired voltage value, indicated by the "SET" LED.

#### 2.1.5 Switch "RANGE"

With the "RANGE" switch, the operating ranges 18V/10A(20A) or 32V/5A(10A) of the NGSM32 can be selected. Every actuation of the "RANGE" switch will lead to a switching off of the power output.

#### 2.1.6 Pushbutton "ISET"

The desired current value can be varied by the knob, if the "ISET" button is pushed and the LED "ISET" is glowing. Pushing the "ISET" key once again deselects the function. If no value variation is made for about one minute, the function will be deselected automatically, if the "SETOFF" bit in the option register is set to 1 (see section 2.2.7). While in this operating mode, the digital display "CURRENT" shows the desired current value, indicated by the "SET" LED.

#### 2.1.7 Switch "MODE"

With the "MODE" switch, two different modes of current regulation can be selected. In switch position "CC" (Constant Current) the current regulator of the NGSM32 operates as a constant current regulator. In switch position "FB" (Foldback) the current regulator of the NGSM32 switches off the power output, if the measured current reaches the desired current value.

#### 2.1.8 Pushbutton "PEAK"

The ammeter of the NGSM32 is switched to peak measurement mode if the pushbutton "PEAK" is pressed and the LED "PEAK" is glowing. After a response time of about 15 seconds the successive highest current value is displayed on the digital display "CURRENT". Pushing the button once again deactivates the peak mode and clears the peak memory.

#### 2.1.9 Pushbutton "A/mA"

The ammeter of the NGSM32 is switched from the measuring range "A" to "mA" with this pushbutton. The selected measuring range is labeled by the corresponding LED "A" and "mA" respectively. Activating the "PEAK" operation mode switches the instrument to measurement range "A" automatically. If the "PEAK" mode is active, a change over from the range "A" to "mA" switches off the peak measurement mode. If the power output is off, the measurement range "mA" cannot be selected. If the measurement range "mA" was selected and the power output is switched to off, the range "A" is set automatically. In junction with the "RECALL" pushbutton the programming mode for the option register of the NGSM32 is selected if the pushbutton "A/mA" is pushed instead of a numerical key (see section 2.2.7).

#### 2.1.10 LED-bar "di/dt"

With the LED-bar "di/dt" a dynamic variation of the current, measured by the NGSM32 can be determined. If the current flow over time varies very slowly or not at all, the LED in the middle of the bar is glowing. The position of that LED is marked by the numeral "0". Quick variations of current flow are indicated by the light spot moving from position "0". Movement to the left indicates a loss of current flow, movement to the right a gain of current flow. The amount of the movement is a measure for the speed, and not for the value of the current flow variation.

#### **2.1.11 Pushbutton "RECALL"**

Pushing this button displays the text "rcl\_" at the "VOLTAGE" display. The NGSM32 now expects entry of a memory location number in the range "1" to "6" by the numerical keypad. If no recall of a memory location is desired, pushing the "RECALL" button once more cancels the operation. If a numerical key is pressed, the content of the desired memory location is read out. Every memory location holds one voltage and one current value for every voltage range of 18V or 32V. So twelve pairs of voltage and current values can be recalled. The recalled values are displayed in the digital displays. If the pushbutton "A/mA" is pressed instead of a numerical key, the programming mode of the option register will be selected (see section 2.2.7).

If the pushbutton "RECALL" is pressed with the pushbutton "WAVEFORM" while power on simultaneously, the test pulses 4 of DIN 40 839 are reprogrammed (see section 2.1.1).

#### **2.1.12 Pushbutton "STORE"**

In waveform programming mode, this pushbutton is used to store a node or the configuration register or the starting point of a waveform. These functions are explained in sections 2.2.2.1 to 2.2.4. If the waveform programming mode is inactive, the "STORE" pushbutton starts the storing of a voltage and current value pair. At the "VOLTAGE" display the text "Sto\_" appears. The NGSM32 is waiting for the entry of a memory location number in the range "1" to "6" by the numerical keypad. If no storage is desired, pushing the "STORE" button once again cancels the operation. Otherwise, if a numerical key is pressed the actual values of voltage and current are stored. Six memory locations in the voltage ranges 18V or 32V are available.

In the option register programming mode, the pushbutton "STORE" is used to store the actual content of the option register (see section 2.2.7).

#### **2.1.13 Numerical Keypad "1" to "6"**

The memory locations for voltage and current values are selected with this keypad as described above, or waveform programming functions are activated as described in section 2.2.

#### **2.1.14 LED "OVERLOAD"**

If the permissible output power is exceeded, the "OVERLOAD" LED flashes. The NGSM32 can be operated with reduced output power until the LED's flashing rate slows down and the LED turns off at least. After that, the maximum output power is available again.

If the LED "OVERLOAD" glows continuously, the maximum temperature of the power unit is exceeded. The power output is switched off and the blower accelerates to maximum speed. After an adequate cooling-off period, the LED "OVERLOAD" turns off or starts flashing. The power output then can be switched on again by pressing the "POWER ON" pushbutton.

#### **2.1.15 Pushbutton "WAVEFORM"**

If the power output is switched on, a programmed waveform can be started by pressing this button. If the power output is off, this pushbutton activates the waveform programming mode.

If the pushbutton "WAVEFORM" is pressed with the pushbutton "RECALL" while power on simultaneously, the test pulses 4 of DIN 40 839 are reprogrammed (see section 2.1.1).

### 2.1.16 Digital Display "VOLTAGE"

Different informations according to the operating modes of the NGSM32 can be shown on this four-digit display, as described in the following.

Desired voltage value:	If the mode "VSET" is active and the LED "SET" upon the display is glowing. The displayed unit is in volts.
Measured voltage value:	If the mode "VSET" is inactive and the power output of the NGSM32 is switched on. Negative voltage values are displayed with a negative sign. By increasing the maximum measurement value, the maximum possible value will be shown and the display will flash. The displayed unit is in volts.
Voltage values of the waveform generator:	see section 2.2.1.1
Time values of the waveform generator:	see section 2.2.1.2
Content of the configuration register:	see section 2.2.3
Content of the option register:	see section 2.2.7
Text "rcl_":	see section 2.1.11
Text "Sto_":	see section 2.1.12
Text "FAIL":	see section 2.3
Text "LLO":	see section 4.3.10

### 2.1.17 Digital Display "CURRENT"

Different informations according to the operating modes of the NGSM32 can be shown on this three-digit display, as described in the following.

Desired current value:	If the mode "ISET" is active and the LED "SET" upon the display is glowing.
Measured current value:	If the mode "ISET" is inactive and the power output of the NGSM32 is switched on. Negative current values are displayed with a negative sign. By increasing the maximum measurement value, the maximum possible value will be shown and the display will flash.
Nodes of the waveform memory:	see sections 2.2.1.1 to 2.2.2.2
Error codes:	see section 2.3
Text "Arb":	see section 2.2
Text "OPr":	see section 2.2.7

## 2.2 Programming Waveforms

A waveform, executable by the NGSM32 is programmable by nodes. In both voltage ranges (18V or 32V) 60 nodes can be programmed respectively. A node consists of a voltage and a time value. The voltage value may be any value which is valid in the actual selected voltage range. A time value must be in the limits between 0 and 4095ms and can be programmed with the resolution of 1 ms. The waveform programming mode can be activated by pressing the "WAVEFORM" button when the power output is switched off. The "VOLTAGE" display turns to off and the "CURRENT" display shows the text "Arb".

### 2.2.1 Regarding Nodes

#### 2.2.1.1 Regarding Voltage Values

Pushing the numerical key "1" shows the voltage value of a node. The value appears on the "VOLTAGE" display. The node number appears on the "CURRENT" display with the prefixed character "U". All 60 nodes can be selected by turning the knob.

### 2.2.1.2 Regarding Time Values

Pushing the numerical key "2" shows the time value of a node. The value appears on the "VOLTAGE" display. The node number appears on the "CURRENT" display with the prefixed character "t". All 60 nodes can be selected by turning the knob.

## 2.2.2 Programming nodes

### 2.2.2.1 Programming Voltage Values

First the desired node must be selected by turning the knob as described above. Pressing the numerical key "4" activates the programming mode. The voltage value now can be varied by using the knob. However the new voltage setting is stored only, when the "STORE" button has been pressed!

### 2.2.2.2 Programming Time Values

First the desired node must be selected by turning the knob as described above. Pressing the numerical key "5" activates the programming mode. The time value now can be varied by using the knob. However the new time value setting is stored only, when the "STORE" button has been pressed!

## 2.2.3 Programming Run Conditions

There are four different run conditions available for waveforms, which can be selected through a configuration register:

Content of Configuration Register	Run Condition
0	Waveform runs from node 1 to end
1	Waveform runs from node 1 repetitively
2	Waveform runs from a preselected node to end
3	Waveform runs from a preselected node repetitively

The configuration register can be programmed, by pressing the numerical key "6". The value within the register is displayed in the "VOLTAGE" display. The content can be varied by turning the knob and stored by pressing the "STORE" button.

## 2.2.4 Programming the Start Point

The start point programming mode can be selected by pressing the numerical key "3".

The "CURRENT" display indicates the start point that is currently set. By turning the knob, the desired start point can be selected and stored by pressing the "STORE" button.

## 2.2.5 Running the Waveform

If the power output is switched on, pressing the "WAVEFORM" button starts running the waveform generator under the selected run conditions.

## 2.2.6 Restrictions in Waveform-Running

While running the arbitrary waveform generator, no automatic voltage range switching of the power unit can be made. Therefore it is necessary to limit the power dissipation which may occur. The resulting restrictions are as follows:

these limits are exceeded, the waveform will not be started and the display will show the node, on which the time of 64 seconds is exceeded with the time value flashing.

A single pulse only can be started, if either the runtime will be reduced to 64 seconds or the current value is set to less or equal 2.5A.

Repeating waveforms will only be started, if the current value is set to less or equal 2.5A. In other cases the value of the condition register is flashing in the display to announce the repeat-mode.

If there is a voltage value in the trace, that exceeds the actual voltage setting, the waveform doesn't run immediate. A flashing display, shows the first node meeting this condition.

## 2.2.7 The Option Register of the NGSM32

Four different properties of the NGSM32 can be individually adjusted by the user. This can be done by the option register of the NGSM32. The option register is a four-bit binary register with the following contents:

Bit 4	Bit 3	Bit 2	Bit 1
SETOFF	BEEPER	RECALLON	AUTORANGE

Meaning of the bit-names:

- SETOFF=0: "VSET" or "ISET" mode are not automatically deselected, if no modification of the desired values is made.
- SETOFF=1: "VSET" or "ISET" mode are automatically deselected after about 30 seconds, if no modification of the desired values is made.
- BEEPER=0: The beeper of the NGSM32 is switched off.
- BEEPER=1: The beeper of the NGSM32 is set to active-state and will send out a signal if a suitable event occurs.
- RECALLON=0: The power output of the NGSM32 will be switched off, if new values are loaded by the "RECALL" function.
- RECALLON=1: The power output will remain in the "on"-state, if new values are loaded by the "RECALL" function.
- AUTORANGE=0: The measurement-range will be fixed to A, or mA, according to the "A/mA" state of the pushbutton.
- AUTORANGE=1: The "A/mA" pushbutton will be disabled and the ammeter will be in the autorange-state.

### 2.2.7.1 Programming the Option Register

The content of the option register can be displayed if the pushbutton "A/mA" is pressed after pressing the "RECALL" pushbutton. At the "CURRENT" display the text "OPr" occurs and at the "VOLTAGE" display the actual content of the option register is displayed as a four-bit binary value.

The content of the option register can be varied by the knob. A new value can be stored nonvolatile by pressing the "STORE" pushbutton.

The option register cannot be accessed by an interface-operation.

## 2.3 Error Messages

If fatal errors occur, the following actions will be taken:

The power output will be switched off, the automatic voltage ranging will switch the control element to voltage free state and the display will show the text "FAIL", followed by a three digit error code. In this case the NGSM32 cannot be operated correctly and should be switched off! All error codes are documented in the following table:

Error Code	Explanation
000	A transient dip of the mains voltage has occurred, so that the internal data safeguarding program was started. The NGSM32 must be switched off at the mains switch for a short time to terminate the program correctly. This error may occur if the mains voltage is very low or noisy.
001	The software-watchdog has been activated by an interruption of the correct program flow. This error occurs only if the NGSM32 is defective.



- 002 The multichannel analog/digital converter, performing all measurements within the NGSM32 doesn't work correctly.
  - 003 The NGSM32 is measuring an output voltage which is too high. This error may occur, if the power unit is defective.
  - 004 The microcontroller of the NGSM32 has fetched an illegal opcode. This error can only occur, if the microcontroller is defective.
  - 005 The temperature sensor monitoring the power unit has failed.
  - 050 Data receiving error on interface board. (Only if interface board is installed)
  - 051 Received command via interface board is unknown. (Only if interface board is installed)
  - 052 Data transfer protocol is faulty. (Only if interface board is installed)
  - 053 Interrupt rate from interface board is too high. (Only if interface board is installed)
  - 054 Data transmission error to interface board. (Only if interface board is installed)
  - 100 to 110 Uninspected interrupts of microcontroller subsystems, normally inactive.
- These error messages indicate a malfunction of the microcontroller.

### 3. Operating Principle of the Arbitrary-Waveform-Generator (ARB)

The arbitrary waveform generator (ARB), installed in the NGSM32 serves to generate test pulses. The test pulses 4 of DIN 40 839 parts 1 and 2 are stored at the factory. These test pulses generate a voltage dip, to simulate the closing of the cranking circuit of combustion engines. The test pulse, stored in the voltage range 18V of the NGSM32 can be used for mobiles with 12V on-board networks, the pulse stored in the 32V range can be used for mobiles with 24V on-board networks. To make the user able to adapt the test pulses to his own purposes or to meet other test requirements, the arbitrary waveform generator is programmable within wide boundaries. Restrictions in programming result from limitations in current technology. The following conditions are essential:

Minimum voltage value resolution of a pulse:	10mV
Minimum time interval resolution between nodes:	1ms
Maximum quantity of nodes per voltage range:	60

#### 3.1 Node-Structure

Every node consists of a voltage value in the valid voltage range of the NGSM32 and a time value in the range of 0ms to 4095ms. Nodes are named with Pn at the following, where n is the position of the node (n runs from 1 to 60). The voltage value of a node is named Un at the following, the time value is named tn.

#### 3.2 Execution of a Waveform

When the arbitrary waveform generator is started by pressing the "WAVEFORM" button, a time generator, generating a new voltage value for the NGSM32 every millisecond, is started. The first voltage value is the voltage value of the first node to execute. According to the presetted condition this node can be P1 or any other node (see section 2.2.3).

If the time value of the node is not set to zero, the NGSM32 interpolates the voltage values between two nodes, so that theoretically a straight line links the nodes in the voltage-time-diagram. Due to the digital resolution of the NGSM32 the straight line becomes a step function, if the gradient of the straight line is not zero. The graduation of the step function is calculated as follows:

$$dU=(U(n)-U(n+1))/t(n) \quad dU=\text{step graduation, } n=\text{node position}$$

As a result of the minimum resolution of the analog/digital converter, dU can only be an integer multiple of 10mV. Non integer values for dU will always be rounded off to the next integer value. The errors of division will be summed and added until the sum is greater or equal to 10mV. The value of 10mV will be added then to the actual step value. Any rest eventually remaining will be summed to the following errors of division and the summing-procedure will repeat. The last step between two nodes leads to the programmed value of the node in any way.

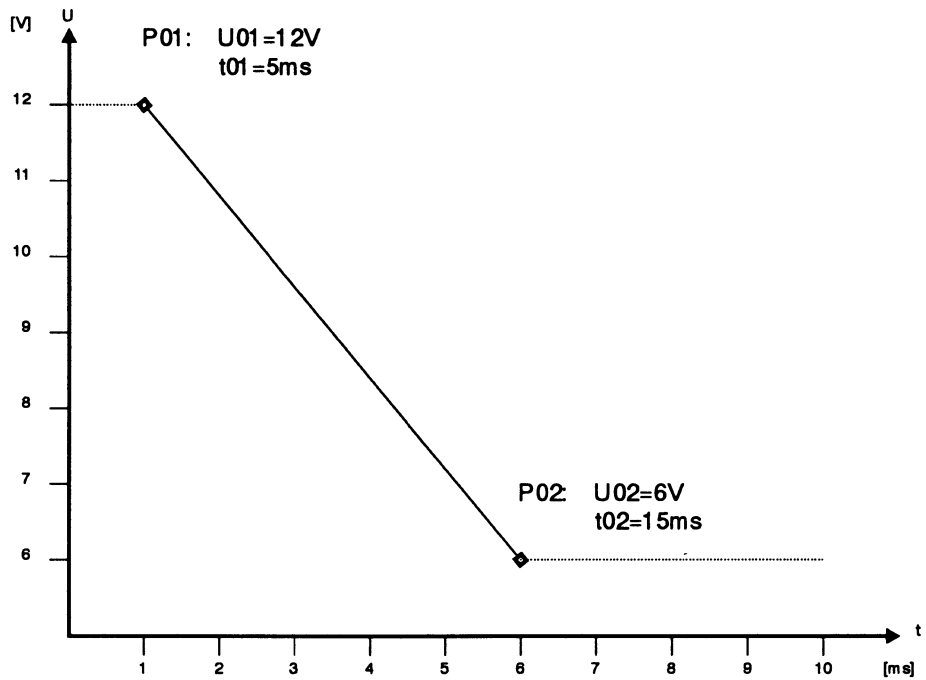


figure 1 The NGSM interpolates between two nodes, so that theoretically a straight line links the nodes.

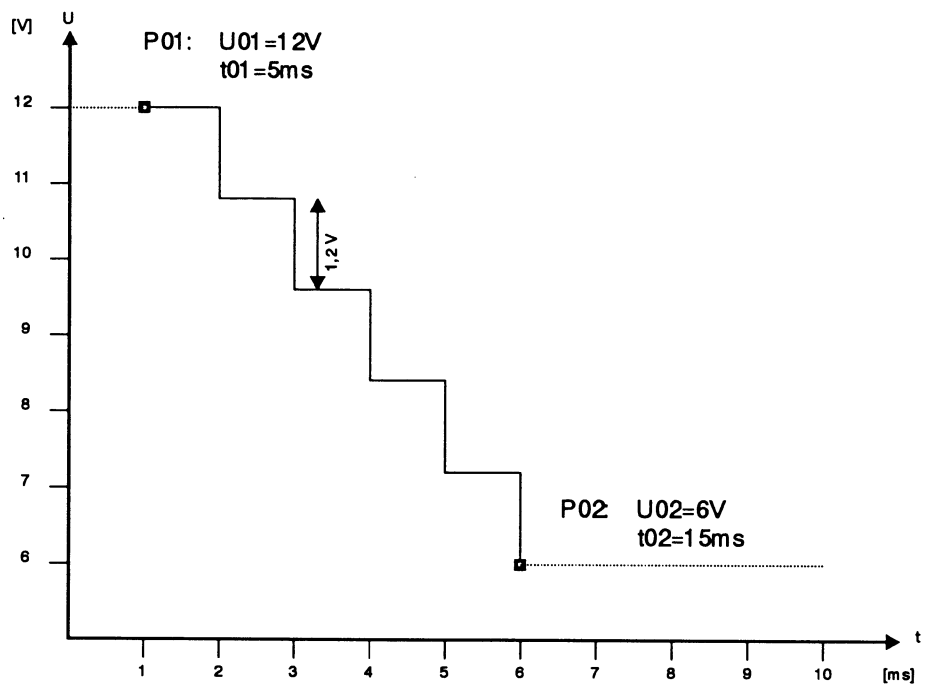


figure 2 Due to the quantization effect the step function is  $dU = (12V - 6V) / 5ms = 1,2V/ms$ .

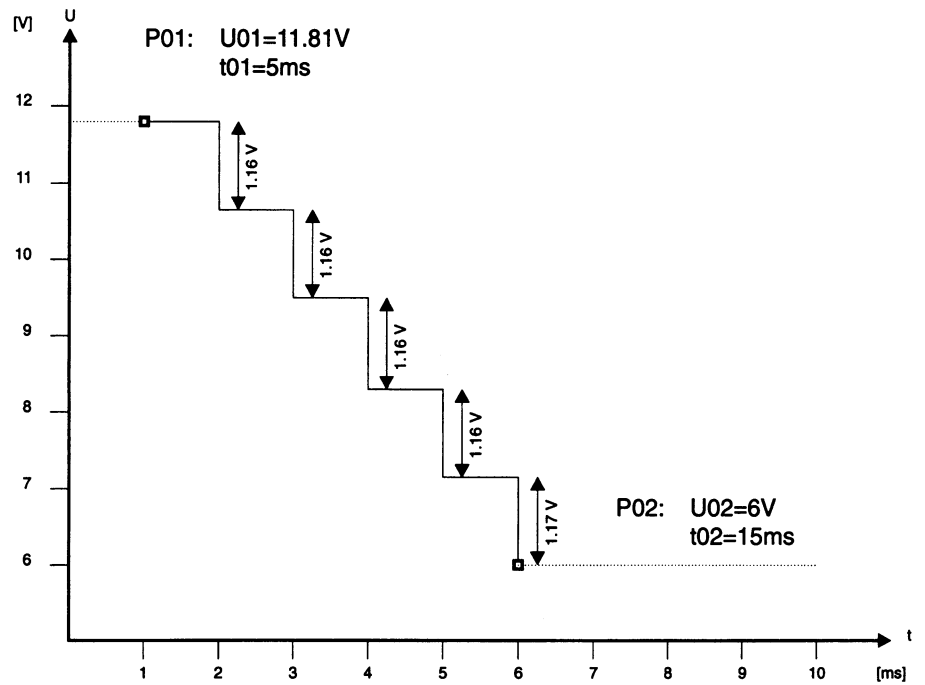


figure 3 The required step value of  $du = (11.81 - 6) / 5ms = 1.162/ms$  is not realizable. The step value is rounded to  $1.16V$ . The difference is calculated to the last step ( $1.16 + 5 \cdot 0.002 = 1.17V$ )

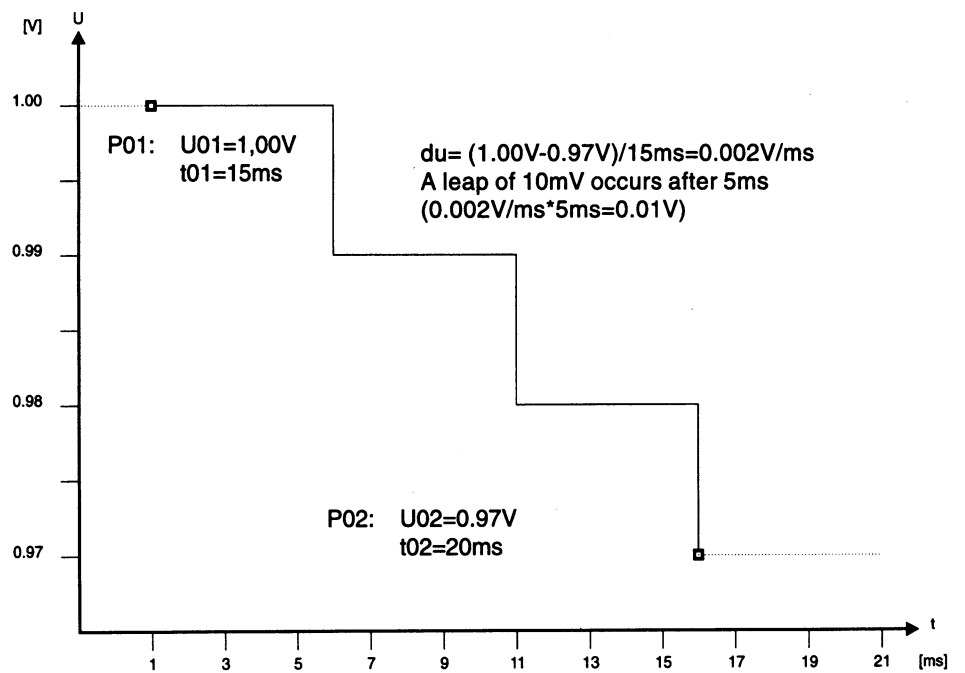


figure 4 If the step value is less than  $10mV$ , the values will be added until a variation of  $10mV$  is possible

### 3.3 Nodes with a Time Value of Zero

If the time value of zero is programmed for a node, the NGSM32 recognizes this node as the last node of a waveform. In dependence of the preselected condition, the generator stops at this node or repeats from the start (see section "Programming Run Conditions").

### 3.4 Programming and Storing of several Waveforms

The nonvolatile memory for waveforms can be used optimally, if several waveforms are stored instead of a single one. Because a node with the time value of zero is recognized as the end of a waveform, the node on the next position can be used as the start point of the next waveform. The end of this waveform is again a node with the time value of zero (see figure 5). Because the start position for a waveform can be preselected by the condition register, a single curve can be selected out of a row of stored waveforms (see section 2.2.3).

### 3.5 Special Cases in repetitively Running of Waveforms

If the configuration register is programmed to repetitively run before the start of a waveform, the time response for the last node (with time value zero) is as follows:

Between the output of the last voltage value at the last node and the first output of a voltage value at the first node, there will be a duration of one millisecond. If a continuous voltage gradient is desired, this duration must be considered.

Another special case is, that there is no node with the time value of zero in the whole memory. In non repetitive mode, the waveform will then be stopped at P60. If repetitive mode is selected, between P60 and P1 will be interpolated as follows:

$$dU=(U(P60)-U(P01))/t(P60)$$

Therefore a continuous transition between P60 and P1 is guaranteed, if the nodes are selected accordingly.

Position	Voltage Value	Time Value	
P01	12V	5mS	Waveform 1 Start Point P01
P02	6V	15mS	
P03	6V	50mS	
P04	7V	100mS	
P05	12V	0mS	
P06	14V	50mS	Waveform 2 Start Point P06
P07	8V	50mS	
P08	9V	50mS	
P09	14V	0mS	
P10	10V	100mS	Waveform 3 Start Point P10
P11	11V	100mS	
P12	10V	100mS	
P13	11V	100mS	
P14	10V	0mS	
P15	18V	200mS	Waveform 4 Start Point P15
P16	10V	30mS	
P17	12V	50mS	
.	.	.	
.	.	.	
P60	.	.	

figure 5 Storage of several waveforms in Memory

### 3.6 The Test Pulses 4 of DIN 40 839

The preprogrammed waveforms, as set by the factory, are corresponding with the test pulses 4 of DIN 40 839 as shown in the following diagram (figure 6).

Because some parameters can vary according to definitions and test conditions, the waveforms are stored in a format, so that adaptations to other test parameters can easily be made. The storage format of the test pulses is registered in the table below the diagram.

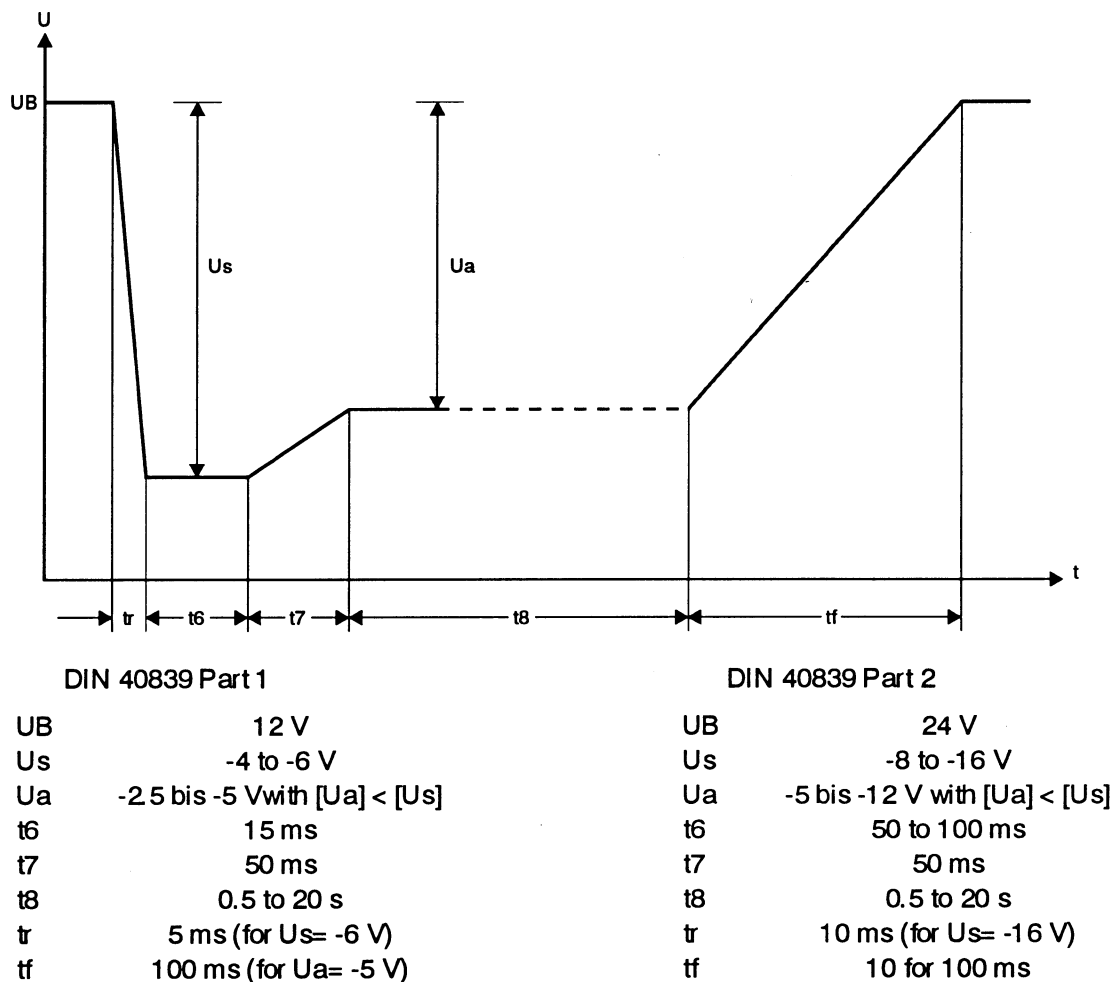


figure 6 Test Pulse 4 according DIN 40839

### 3.7 Memory Content of the Arbitrary Waveform Generator on Shipping

#### Voltage Range 18V:

Node	Voltage	Time
Number	Value	Value
P01	12.00V	5ms
P02	6.00V	15ms
P03	6.00V	50ms
P04	7.00V	100ms
P05	7.00V	100ms
P06	7.00V	100ms
P07	7.00V	100ms
P08	7.00V	100ms
P09	7.00V	100ms
P10	12.00V	0ms
P11 to P60	0.00V	0ms

#### Voltage Range 32V:

Node	Voltage	Time
Number	Value	Value
P01	24.00V	10ms
P02	8.00V	50ms
P03	8.00V	50ms
P04	12.00V	100ms
P05	12.00V	100ms
P06	12.00V	100ms
P07	12.00V	100ms
P08	12.00V	100ms
P09	12.00V	10ms
P10	24.00V	0ms
P11 to P60	0.00V	0ms

If the memory contents of the nodes P01 to P10 where modified, the original values can be reprogrammed quickly on power on (see section 2.1.1.).

#### 4. Interface Boards for the NGSM32

Two different interface boards are available for the NGSM32 as options:

OPTION-B1 RS232: Ident.-Nr. 192.0810.01

OPTION-B2 IEEE/IEC-BUS: Ident.-Nr. 192.0810.02

The respective option can be retro-fitted to the NGSM32.

##### **Important note!**

In the course of a redesign of OPTION-B2 IEEE/IEC-BUS, a new interface card was built. The old version has the board-number 202.406.02. The newer version has the board-number 202.448.00. Both versions are identical on principle but the newer one must not be installed with an isolating foil by retro-fitting an interface board, as mentioned in 4.1. At the newer version there are no jumpers any more (see 4.3.3). At the supplement the newer OPTION-B2 is listed as "6.10 IEEE/IEC-BUS interface new". This new IEEE/IEC-Bus interface card is installed since NGSM serial number 1713 (shipping date: 03.31.1998).

#### 4.1 Retro-fitting an Interface Board

The installation of an interface option can be made by the following steps:

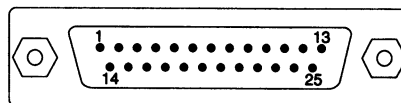
- Disconnect the NGSM32 from mains supply by removing the power cable.
- Unscrew the blind plate, covering the opening for the interface connector, located at the rear of the NGSM32.
- Unscrew and take off the display frame plate carefully.
- Unscrew the upper cover with the handle of the NGSM32.
- Unscrew the left-side cover of the NGSM32.
- Unscrew and take off both left profiles of the enclosure frame.
- Insert the interface board, so that the interface connector fits through the opening in the rear panel.
- Attach the isolating foil provided, so that it fits between the enclosure frame and the interface board and the switch register on the board is left free (*omitted at new OPTION-B2*).
- Reinstall the bottom left profile of the enclosure frame.
- Screw the interface board to the left bottom profile of the enclosure frame with the screws provided.
- Unscrew the regulator board 202.413.xx
- Plug in the flat cable connector of the interface card to the free connector X305 on the regulator board 202.413.xx.
- Reinstall the regulator board 202.413.xx.
- Reinstall the left upper profile of the enclosure frame. Take care to correctly position the regulator board.
- Screw the interface board to the upper left profile with the screws provided.
- Set the switches of the switch register to the desired positions.
- Reinstall covers and display frame plate.

The following part of the manual describes the functions and differences of both interfaces.

#### 4.2 The RS232 Interface

Pin configuration of the RS232 interface

On a NGSM32 with RS232 interface installed, a 25pin sub-D-connector , with the following pinout is located on the rear panel:



## Description of the signal lines

Pin	Name	Description/Function
1	SHIELD	Protected earth / connected to frame
2	TxD	Transmit data/ Output from NGSM to a receiver
3	RxD	Receive data/ Input to the NGSM from a transmitter.
4	RTS *)	Request to send/ Output from NGSM to a receiver.
5	CTS *)	Clear to send/ Input to the NGSM from a transmitter
7	GND	Signal ground / Reference potential for all signal lines.
20	DTR *)	Data terminal ready/ Output from NGSM to a receiver.

\*) This signal lines must only be connected, if the interface board is set to "Hardware Handshaking" (see description of the switch register).

### 4.2.1 Description of the Switch Register

On the interface board, a switch register with eight switches is accessible by removing the left side cover housing. The following functions can be selected with the switch register:

Switch No. and Position	Description/Function
1    2    3	Transmission rate
OFF OFF OFF	9600 Baud
ON   OFF OFF	4800 Baud
OFF ON   OFF	2400 Baud
ON   ON   OFF	1200 Baud
OFF OFF ON	600 Baud
ON   OFF ON	300 Baud
OFF ON   ON	150 Baud
ON   ON   ON	75 Baud



Switch No. and Position	Description/Function
4    5	Handshaking
OFF OFF	No Handshaking
OFF ON	Hardware Handshaking (DTR, RTS, CTS)
ON   OFF	ETX/ACK Software Handshaking
ON   ON	XON/XOFF Software Handshaking

Switch No.	Description/Function
6	Unused

Switch No. and Position	Description/Function
7	Echo-Mode
OFF	Echo off
ON	Echo on

Switch No. and Position	Description/Function
8	Availability
OFF	RS232 interface not available
ON	RS232 interface available

### 4.2.2 Transmission Rate and Format

The transmission rate can be adapted to the connected host system with the switches 1 to 3. The unit "Baud" should be interpreted as bits per second. The transmission format is fixed to:

1 Start bit, 8 Data bits, 1 Stop bit.

The data transmission is full duplex (receiving and transmitting is possible at the same time).

### 4.2.3 Handshaking

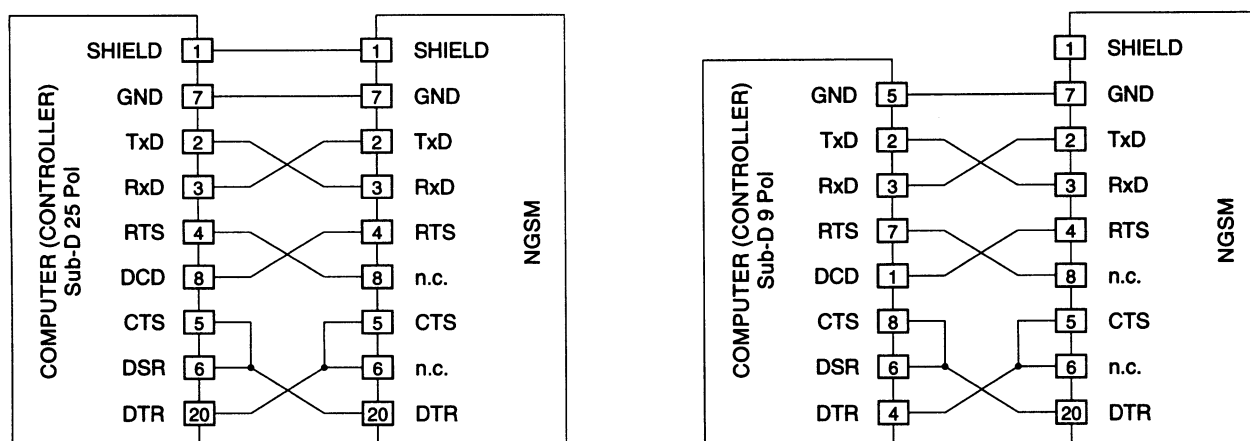
The desired handshake method can be selected with switches 4 and 5.

#### No Handshaking

If no handshaking is set, the following process is recommended: If commands should be sent to the NGSM32, the last character to be transmitted should be "Carriage Return". If answers from the NGSM32 are expected, you must wait for "Carriage Return" as the string-end message. In this way block transfer can be realized. The programmer must provide security for a block length which is smaller than the buffer length of the units (for the NGSM32 it's 128 characters).

### 4.2.4 Hardware Handshaking

For handshaking the signals RTS, CTS, DSR and DTR have to be considered in addition to TxD, RxD and GND. The NGSM32 doesn't need the signal DSR from the host however. The NGSM32 sends data via the TxD-output only if the CTS signal of the host is logical 0. If the NGSM32 isn't able to receive data, it sets the DTR signal to logical 1. The RTS signal is always set and held to logical 0, if the NGSM32 is switched on. To connect a host to the NGSM32, one of the following cables is recommended.



#### ETX/ACK Handshaking

The ETX/ACK protocol is suitable to synchronize block transfers. The process is as follows: After power on and every time when the NGSM32 is able to receive a data block, it sends the message ACK. The NGSM32 doesn't execute any commands and remains in data receiving state until it receives the message ETX from the host. After receiving ETX, all received commands will be executed. After the execution and the probable transmission of any answers or error messages, the NGSM32 sends the message ACK once again.

#### XON/XOFF Handshaking

The XON/XOFF protocol can be used to perform a character by character synchronization of data flow. After power on, the NGSM32 is able to receive data. If the NGSM32 isn't able to receive data any longer, it sends the message XOFF. When the NGSM32 is able to receive data again, it sends the message XON. The NGSM32 transmits answers to the host as long as the host doesn't send the message XOFF. The NGSM32 interrupts the transmission and starts again, when the host is sending the XON message.

#### Echo Function

The echo function, selectable by switch 7 serves to test the interface at first hand, when a new host is to be connected. The characters, echoed by the NGSM32 may not have their original pattern, as they will pass several filter functions. Lower cases will be transformed to upper cases. Invisible control characters and characters with no meaning to the NGSM32 will be transformed to SP. Control characters, necessary to internal controlling the interface functions will not be echoed.



### 4.2.5 Jumper

Some jumpers are located on the component side of the interface board, which are not accessible if the interface board is installed. The jumpers should normally not be changed, but if they are, the following table shows the correct jumper positions.

Jumper positions, if components D504 (EPROM) and D503 (74LS373) are present on the interface board:

Name	Condition
X504	free
X505	free
X506	Jumper installed
X507	free
X508	free

Jumper positions, if components D504 and D503 are not installed on the interface board:

Name	Condition
X504	free
X505	free
X506	Jumper installed
X507	Jumper installed
X508	free

Any other jumper configurations are not permitted!

## 4.3 The IEEE/EC-BUS Interface

### 4.3.1 Pin Configuration of the IEEE/EC-BUS Interface

On a NGSM32 with RS232 interface installed, a 24pin connector , with the following pinout is located at the rear panel:



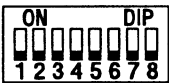
#### Descripton of the Signal Pins

Pin	Name	Description/Function
1 to 4	DI/O 1 to 4	Transmission lines for data, addresses and commands
5	EOI	Signal "End Or Identify"
6	DAV	Signal "Data Valid"
7	NRFD	Signal "Not Ready For Data"
8	NDAC	Signal "Not Data Accepted"
9	IFC	Signal "Interface Clear"
10	SRQ	Signal "Service Request"
11	ATN	Signal "Attention"
12	SHIELD	Protected Earth/Connected to frame
13 to 16	DI/O 5 to 8	Transmission lines for data, addresses and commands
17	REN	Signal "Remote Enable"
18 to 24	GND	Signal ground/ Reference to all signal lines

4.3.2 Description of the Switch Register

On the interface board, a switch register with eight switches is accessible by removing the left side cover housing. The following functions can be selected with the switch register:

Switch No. and Position					Description / Function
1	2	3	4	5	IEC-BUS Address
OFF	OFF	OFF	OFF	OFF	0
ON	OFF	OFF	OFF	OFF	1
OFF	ON	OFF	OFF	OFF	2
ON	ON	OFF	OFF	OFF	3
OFF	OFF	ON	OFF	OFF	4
ON	OFF	ON	OFF	OFF	5
OFF	ON	ON	OFF	OFF	6
ON	ON	ON	OFF	OFF	7
OFF	OFF	OFF	ON	OFF	8
ON	OFF	OFF	ON	OFF	9
OFF	ON	OFF	ON	OFF	10
ON	ON	OFF	ON	OFF	11
OFF	OFF	ON	ON	OFF	12
ON	OFF	ON	ON	OFF	13
OFF	ON	ON	ON	OFF	14
ON	ON	ON	ON	OFF	15
OFF	OFF	OFF	OFF	ON	16
ON	OFF	OFF	OFF	ON	17
OFF	ON	OFF	OFF	ON	18
ON	ON	OFF	OFF	ON	19
OFF	OFF	ON	OFF	ON	20
ON	OFF	ON	OFF	ON	21
OFF	ON	ON	OFF	ON	22
ON	ON	ON	OFF	ON	23
OFF	OFF	OFF	ON	ON	24
ON	OFF	OFF	ON	ON	25
OFF	ON	OFF	ON	ON	26
ON	ON	OFF	ON	ON	27
OFF	OFF	ON	ON	ON	28
ON	OFF	ON	ON	ON	29
OFF	ON	ON	ON	ON	30
ON	ON	ON	ON	ON	illegal



Switch No.	6	7	Description/Function
OFF	OFF		EOS-sequence: CR
OFF	ON		EOS-sequence: CR with EOI
ON	OFF		EOS-sequence: CR LF
ON	ON		EOS-sequence: CR LF with EOI

Switch No. and Position	Description/Function
8	Availability
ON	IEC-BUS Interface not available
OFF	IEC-BUS Interface available

### 4.3.3 Jumper

Some jumpers are located on the component side of the interface board, which are not accessible if the interface board is installed. The jumpers should normally not be manipulated, but if they are, the following table shows the correct jumper positions.

Name	Condition
X504	free
X505	free
X506	Jumper installed
X507	free
X508	free

### 4.3.4 Supported Interface Functions

The following interface functions are realized according to DIN IEC 625 Part 1 or ANSI/IEEE Std. 488.1:

SH1, AH1, T6, L4, SR1, RL1, PP0, DC0, DT0, C0

### 4.3.5 Detection of the "End of String" Message (EOS)

The following configurations to detect EOS are permitted:

1. The ASCII-character "Carriage Return (CR)"
2. The ASCII-sequence "Carriage Return (CR) and Line Feed (LF)"
3. Any character that is transferred with the "End Or Identify (EOI)" message simultaneously.

### 4.3.6 The NGSM32 as Talker

If the NGSM32 is addressed to talk and the controller is reading answers, an end of string (EOS) sequence will be transmitted with the interface message "End Or Identify (EOI)". Different EOS-sequences are available and can be selected by the switches S6 and S7 (see section 4.3.2).

### 4.3.7 Handshaking

If the NGSM32 has identified an EOS-message, it starts executing the received commands. Until all commands stored in the input buffer are executed, the NGSM32 stops the IEC-BUS transfer of acceptor handshaking, by leaving the last received character unquitted (ACDS). As soon as all commands are executed and all answers are transmitted to the output buffer, the IEC-BUS will be released by finishing the acceptor handshaking (ACRS).

### 4.3.8 Service Request

The internal message rsv is sent by the NGSM32 under the following conditions: Firstly the NGSM32 must be prepared by the command "SERV 1". There must be the internal state leading to generate the message SRQ (see section "Service Request Mode"). The internal message rsv will be reset and can be set again, if the Serial Poll State Register is read out by a Serial Poll beforehand.

### 4.3.9 Serial Poll State Register

The Serial Poll State Register contains the following information:

MSB																LSB
0	rsv	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

The reason for sending the message "Service Request" can be found out by reading the Device Condition Register of the NGSM32 (see command "DCR?").

#### **4.3.10 Local Lockout**

If the IEEE/IEC-BUS interface message "Local Lockout" (LLO) is received by the NGSM32, the manual operation will be locked out. If a manual operation is tried, the digital display "VOLTAGE" will show the message "LLO" and an acoustic signal will occur for a short time if the "BEEPER" bit in the option register is set to 1. A return to the local state is possible by setting the REN message to logical zero. The manual operation can also be affected by sending the commands "LLO 0" or "LLO 1" to reset or set the lockout state respectively.

### **4.4 Remote Controlling the NGSM via Interfaces**

#### **4.4.1 Differences to Manual Operation**

Switching over the voltage ranges via remote operation is only possible if the NGSM32 is set to the local lockout state before (see sections 4.3.10 and 4.4.11). The toggle switch "RANGE" has no function in this case. If the manual operation mode is reactivated, the position of the toggle switch is valid again. The same facts apply to the toggle switch "MODE" accordingly.

There is no possibility to emulate the knob function by remote control; Variations of values only can be made by transferring numerical data. The data of the knob cannot be read out via remote control.

#### **4.4.2 Construction of Remote Control Commands**

There are two classes of remote control commands:

Programming commands and query commands.

Programming commands always consist of a command header, one or more separators and a parameter. The end of a programming command is either a semicolon or a CR (Carriage Return).

Query commands always consist of a command header, immediately followed by a question mark or of a command header only, without any separators or parameters. The end of a query command is either a semicolon or a CR (Carriage Return).

#### **4.4.3 Execution of Remote Control Commands**

On RS232 Interface

Remote control commands will be executed, when a CR has been received as the last character by the NGSM32. In case of ETX/ACK handshaking an ETX must additionally be received.

On IEEE/IEC-BUS Interface

Remote control commands will be executed, when a valid EOS message has been received (see Detection of the "End Of String" Message (EOS)).

If several commands are to be transmitted in one string, each command must be separated by a semicolon.

#### **4.4.4 Answers from the NGSM**

On RS232 Interface

The NGSM answers to query commands after execution of a single command, every answer is terminated by a semicolon as a separator. If all received query commands are executed the NGSM will send a CR. In case of ETX/ACK handshaking an ACK will be sent additionally.

On IEEE/IEC-BUS Interface

The NGSM creates an output-string, which can be read out if the NGSM is addressed to talk. If several answers are created, they are separated from each other by a semicolon. The output buffer can store 128 characters. In case of an overflow, the contents will be erased and the buffer will be written from the start.

The NGSM is able to send error messages, except to normal answers if it cannot correctly execute received commands. In the case of an error, further execution of remaining commands will be interrupted. The NGSM32 with RS232 interface installed can also send the message "SRQ!" on its own, if it was prepared therefore (see SERV command).

The end of an output-string is indicated by an end of string (EOS) sequence. The valid EOS-sequence can be selected by the switches S6 and S7 of the switch register (see section 4.3.2).

#### 4.4.5 Representation of Parameters

Parameters which can be processed by the NGSM must meet the following conventions:

Type	Description
c1	A single ASCII-character.
i1	A numeral between 0 and 9
i2	A number without sign and radix point with two significant digits at maximum. Leading zeros will be accepted.
i4	A number without sign and radix point with four significant digits at maximum. Leading zeros will be accepted.
f4	A number without sign and with radix point and two significant digits before and after the radix point. Leading zeros will be accepted and can be omitted.
f3	A number without sign and with radix point and two significant digits before and one after the radix point. Leading zeros will be accepted and can be omitted.

In the following description of remote control commands, parameters are declared as follows:  
<c1>, <i1>, <i2>, <i4>, <f4>, <f3>.

Answers of the NGSM containing parameters will appear in the following formats:

i1	A numeral between 0 and 9
i2	A number with two digits at maximum. Leading zeros will be suppressed.
i4	A number with four digits at maximum. Leading zeros will be suppressed.
i5	A number with five digits at maximum. Leading zeros will be suppressed.
a3	A number with sign, three digits before the radix point and one digit behind the radix point as matissa. If necessary an exponent, of always the pattern E-03, may follow.
v4	A number with sign and two digits before and behind the radix point at maximum.

In the following description of remote control commands, answers will appear as follows: <i1>, <i2>, <i4>, <i5>, <a3>, <v4>.

#### 4.4.6 Description of Remote Control Commands according to their Functions

The notation in upper cases, used in the following overview is not mandatory. Remote control commands and parameters of the type c1 can also be written in lower cases or in mixed notation.

#### 4.4.7 Programming Voltage and Current, Switching on or -off the Output

Command	Comment
VSET <f4> VS <f4>	Set the desired voltage value.
ISSET <f4> IS <f4>	Set the desired current value.
ON <i1> OUT <i1>	Output on (<i1>=1) or output off (<i1>=0).

#### 4.4.8 Set Current Measuring Range and Peak Measurement

Command	Comment
IRNG <i1>	<i1>=0: Set measuring range A. <i1>=1: Set measuring range mA
IRN <i1>	i1>=2 Set measuring range A and peak measurement.
IR <i1>	

PEAK <i1> Peak measurement on (<i1>=1) or off (<i1>=0).

PK <i1>

Command	Comment
TRIG C	Retrigger peak measurement.
TRIG P	
TR C	
TR P	

#### 4.4.9 Operating Mode "Service Request"

To simulate the interface function Service Request of the IEEE/IEC-BUS, the NGSM is able to request service via the RS232 Interface. It must be prepared therefore with a remote control command. If the operation mode "Service Request" is active, the NGSM will send the message "SRQ!" if the following events occur:

Switching over from voltage regulation (CV) to current regulation (CC) or switching off the power output.

If the IEEE/IEC-BUS interface is used, the regular "SRQ" message is sent via the bus if the above mentioned conditions apply.

Command	Comment
SERV <i1>	Operation Mode "Service Request on (<i1>=1) or off (<i1>=0).

#### 4.4.10 Programming and Running the Arbitrary Waveform Generator (ARB)

To program a node of the arbitrary waveform generator (ARB), the node number must be set first. Then the values for voltage and time can be programmed.

Command	Comment
POS <i2>	Address a node of the ARB.
PO <i2>	

WAVE <f4> Programming the voltage value of the addressed node.  
WA <f4>

TIME <i4> Programming the time value of the addressed node.  
TI <i4>

STP <i2> Programming the start point of the ARB. From this point the ARB will run, if the configuration register contains the values 2 or 3.

CON <i1> Programming the configuration register of the ARB.  
CO <i1> <i1>=0: The ARB starts at node 1 and runs up to the first node with the time value 0.  
<i1>=1: The ARB starts at node 1, runs up to the first node with the time value 0 and restarts again at node 1 (repetitive mode). <i1>=2: The ARB starts at the preset start point and runs up to the first node with the time value 0. <i1>=3: The ARB starts at the preset start point, runs up to the first node with the time value 0 and restarts again at node 1 (repetitive mode).

TRIG A	Starts the ARB, if the output of the NGSM is set to on-state.
TR A	The ARB can be stopped with the commands "ON 0" or "ARB 0".
ARB 0	Switches off the programming mode of the ARB, if the NGSM was set to programming mode by manual operation. Interrupts the running of the ARB.

#### 4.4.11 Change Operating Modes "RANGE" and "MODE"

In manual operation the operating modes "RANGE" (18V or 32V) and "MODE" (CC or FB) are selected and displayed by the according toggle switches at the front panel of the NGSM32. To realize a remote operation of this functions, the manual operating mode must be deactivated before.

Command	Comment
LLO <i1>	Manual operation off (<i1>=1) or on (<i1>=0)
PROT <i1>	<i1>=0: mode CC on <i1>=1: mode FB on
RNG <i1>	<i1>=0: range 18V on <i1>=1: range 32V on

If an IEEE/IEC-BUS interface is available, the manual operation mode can also be switched off by the interface message "Local Lockout" (LLO). If the NGSM32 returns to manual operation, the positions of the toggle switches "RANGE" and "MODE" are valid again.

#### 4.4.12 Readout the Voltage and Current Settings

Command	Comment
VSET?	Readout the voltage set value in the format <v4>.
VSET	
VS?	
VS	
ISSET?	Readout the current set value in the format <a3>.
ISSET	
IS?	
IS	

#### 4.4.13 Readout the Voltage and Current Measurements

Command	Comment
VOUT?	Readout the voltage measurement value in the format <f4>.
VOUT	
VO?	
VO	
IOUT?	Readout the current measurement value in the format <a3>.
IOUT	
IO?	
IO	

#### 4.4.14 Readout the "Service Request" Mode State

The operating mode "Service Request" was described before.

Command	Comment
SERV?	The NGSM answers, whether the operating mode "Service Request" is active
SERV	in the format <i1>.
SRQ?	The NGSM answers whether the condition to trigger
SRQ	The "SRQ!" message was fulfilled, even if the operation mode "Service Request" is inactive. In this way the SRQ state can be read out in polling mode, without the NGSM automatically sending the message. If the readout of <i1> is 1, a SRQ condition was present. After readout, the message will be cleared.

#### 4.4.15 Readout the Arbitrary Waveform Generator Data

To readout the data of an arbitrary waveform generator (ARB) node, the node number must be programmed before. The values for voltage and time then can be read.

Command	Comment
POS?	Readout the actual node number in the format <i2>.
POS	
PO?	
PO	
WAVE?	Readout the voltage value of the addressed node
WAVE	in the format <f4>.
WA?	
WA	
TIME?	Readout the time value of the addressed node
TIME	in the format <i4>.
TI?	
TI	
STP?	Readout the actual start point of the ARB
STP	in the format <i2>. The ARB starts from this point, if the configuration register contains the values 2 or 3.
CON?	Readout the configuration register of the ARB
CON	in the format <i1>.
CO?	<i1>=0: The ARB starts at node 1 and runs up to the first node with the time value 0.
	<i1>=1: The CO ARB starts at node 1, runs up to the first node with the time value 0 and restarts again at node 1 (repetitive mode).
	<i1>=2: The ARB starts at the preset start point and runs up to the first node with the time value 0.
	<i1>=3: The ARB starts at the preset start point, runs up to the first node with the time value 0 and restarts again at node 1 (repetitive mode).

#### 4.4.16 The NGSM Device Condition Register (DCR)

All significant internal states of the NGSM are registered in a 16 bit wide register, which can be read out via the interface.

MSB														LSB	
on	arb	prot	rng	cc	cv	pow	mal	ovt	llo	ovli	ovlv	ati	aco	ir	pk



#### 4.4.17 Description of the Bit Positions of the DCR

The active state as described in the following is always fulfilled, if the corresponding bit has the value 1. Exceptional cases are described specially.

Name	Description
on	The output of the NGSM is on
arb	The ARB runs, if on=1 or the ARB programming mode is active, if on=0.
prot	Corresponds to the FB/CC toggle switch position at the front panel of NGSM. prot=0: position CC prot=1: position FB
rng	Corresponds to the 18V/32V toggle switch position at the front panel of NGSM. rng=0: position 18V rng=1: position 32V
cc	NGSM is in current regulation state
cv	NGSM is in voltage regulation state
pow	NGSM indicates OVERLOAD (flashing, yellow LED at the front panel).
mal	NGSM indicates ERROR (yellow LED at the front panel).
ovt	Overtemperature of the power unit (LED "OVERLOAD" glows continuously)
llo	Manual operation mode is switched off
ovli	current measurement range overflow
ovlv	Voltage measurement range overflow
ati	The ARB didn't start in spite of "TRIG A" command, because the permitted runtime is exceeded with respect to the current value setting.
aco	The ARB didn't start in spite of a "TRIG A" command, because repetitive mode is selected and the current value setting is too high.
ir	Measuring range of the ammeter ir=0: A ir=1: mA
pk	Peak current measurement mode is selected.

#### 4.4.18 Readout the NGSM Device Condition Register

Command	Comment
DCR?	The actual content of the DCR is read out
DCR	as 16 bit decimal equivalent. The format of
DC?	the answer is <i5>.
DC	
DR?	
DR	
OUT?	on bit state of DCR in format <i1>.
OUT	
ON?	
ON	
ARB?	arb bit state of DCR in format <i1>.
ARB	
PROT?	prot bit state of DCR in format <i1>.
PROT	
RNG?	rng bit state of DCR in format <i1>.
RNG	
CC?	cc bit state of DCR in format <i1>.
CC	

Command	Comment
CV? CV	cv bit state of DCR in format <i1>.
POW? POW	pow bit state of DCR in format <i1>.
MAL? MAL	mal bit state of DCR in format <i1>.
OVT? OVT	ovt bit state of DCR in format <i1>
LLO? LLO	llo bit state of DCR in format <i1>
OVLI? OVLI	ovli bit state of DCR in format <i1>
OVLV? OVLV	ovlv bit state of DCR in format <i1>
ATI? ATI	ati bit state of DCR in format <i1>.
ACO? ACO	aco bit state of DCR in format <i1>.
IRNG? IRNG IRN? IRN IR? IR	ir bit state of DCR in format <i1>.
PEAK? PEAK PK? PK	pk bit state of DCR in format <i1>.

#### 4.5 Error Messages of the NGSM

The NGSM32 is able to put out several error messages, according to the programming via the interface. All possible error messages are listed in the following.

Error Message	Meaning
INPUT BUFFER OVERFLOW!	The receiver buffer is full, the NGSM cancels the execution of received data.
SYNTAX ERROR!	The NGSM32 is unable to interpret the received string.
ILLEGAL COMMAND!	The NGSM32 doesn't know the received command.
ILLEGAL PARAMETER!	The parameter received doesn't have the correct data format..
PARAMETER TOO LONG!	The parameter value received is too long.
PARAMETER MISSING!	The NGSM received a programming command without parameter.
PARAMETER OVERRANGE!	The parameter value is out of the permitted boundaries.
ISSET TOO HIGH!	A voltage value, which is lower than 4.5V has been set with the actual current value higher than 15A and the voltage range 18V selected.
VSET TOO LOW!	A current value, which is higher than 15A has been set with the actual voltage value less than 4.5V and the voltage range 18V selected.
SET LLO FIRST!	A modification of the "RANGE" or "MODE" function was made without switching off the manual operation mode of the NGSM32 before.
RANGE OVERFLOW!	Measurement range overflow of the voltmeter or the ammeter.

#### 5. Calibration Guide

To prepare the calibration, the upper cover with the handle must be removed from the NGSM. The calibration must be done with suitable test and measurement equipment in the sequence declared below, because the calibration steps depend on each other. All connections and settings on the NGSM32 are valid to relating calibration steps as long as there are no other instructions. The resolution capability and the measurement accuracy of the used test and measurement equipment has to be considered by determining the calibration tolerances and has to be referred by error calculation. For better orientation a component location plan of the trim potentiometers can be found on page 39.

##### 5.1 List of Test and Measurement Equipment

- DC-voltmeter, range 0 to 35V, resolution 1mV
- DC-ammeter, range 0 to 25A, resolution 1mA
- DC-milli-ammeter, range 0 to 200mA, resolution 10µA
- Load of about 0.4 ohms, power rating 200W
- Load or electronic load for a current-carrying capacity of 200mA
- Adjustable line transformer, power rating 1kVA
- Electronic load for a constant current of 20A on 12.5V and about 250W

## 5.2 Adjusting the Zero Point of the Output Voltage

Connect terminal "+" with terminal "+ SENSE" and connect terminal "-" with terminal "SENSE -" at the front panel of the NGSM32. Connect the voltmeter between terminals "+" and "-". Set the "RANGE" switch to "32V". Set the output voltage to 0.00V, turn on the power output. Adjust R373 so that the output voltage is  $\leq 10\text{mV}$  but not negative.

## 5.3 Adjusting the Zero Point of the Voltmeter

Adjust R420 so that the voltmeter at the front panel of the NGSM32 indicates 0.00V. The quantization error at the last digit of the display should not lead to a sign change and should be a maximum of 0.002V.

## 5.4 Adjusting the Zero Point of the Ammeter

Set the NGSM32 to the "A" measuring range.

Adjust R457 so that the ammeter at the front panel of the NGSM32 indicates 0.0A. The quantization error at the last digit of the display should not lead to a sign change to minus.

## 5.5 Adjusting the Zero Point of the Milli-Ammeter

Set the NGSM32 to the "mA" measuring range.

Adjust R391 so that the ammeter at the front panel of the NGSM32 indicates 0.0A. The quantization error at the last digit of the display should not lead to a sign change to minus.

## 5.6 Adjusting the Zero Point of the Peak-Ammeter

Set the NGSM32 to peak measurement mode by the "PEAK" pushbutton

Adjust R379 so that the ammeter at the front panel shows 0.0A.

Note:

The peak value of the ammeter will be frozen to the maximum, two seconds after activating the peak measurement mode! For this reason the measurement must be restarted after every manipulation of R379 by switching off and on the power output by the "POWER ON" pushbutton or by switching off and on the "PEAK" Pushbutton.

## 5.7 Adjusting the maximum Output Voltage Level

Set the voltage value to 32.00V. Adjust R371 so that the connected voltmeter shows a value between 32.00V and 32.04V.

Set the voltage value to 18.00V. Check if the connected voltmeter shows a value of 18V ( $\pm 64\text{mV}$ ). If the measured value is out of this range, readjust the tolerance with R371. Check thereafter, if the 32V point is still within the limits of a  $\pm 64\text{mV}$  deviation.

## 5.8 Adjusting the maximum Voltmeter Level

Set the NGSM32 to an output voltage of 32.00V.

Adjust R409 so that the display at the front panel of the NGSM32 shows the same value as the external voltmeter.

## 5.9 Adjusting the Zero Point of the Current Regulator

Set the "RANGE" toggle switch to the "18V" position. Connect the load of about 0.4 ohms to the power output of the NGSM32 and loop in the ammeter to the load lead. Set the NGSM32 to 10V and 0A, switch on the power output.

Adjust R372, so that a current in the range of 0A to 40mA max. can be measured with the external ammeter.

### **5.10 Adjusting an Output Current of 10A**

Set the NGSM32 to a desired current value of 10A.

Adjust **R370**, so that a current of 10.0A (+/-40mA) can be measured with the external ammeter.

### **5.11 Adjusting the Ammeter at the 9,95A Point**

Set the NGSM32 to a desired current value of 9,95A. Deactivate the "ISET" mode. Adjust **R460** so that the ammeter at the front panel shows the same value as the external ammeter.

### **5.12 Adjusting the Ammeter at the 10,0A Point**

Set the NGSM32 to a desired current value of 10,0A. Deactivate the "ISET" mode. Adjust **R387** so that the ammeter at the front panel shows the same value as the external ammeter.

### **5.13 Adjusting the Ammeter at the 20A Point**

Set the NGSM32 to a desired current value of 20A. Deactivate the "ISET" mode. Adjust **R383**, so that the ammeter at the front panel shows the same value as the external ammeter.

### **5.14 Adjusting the Peak-Ammeter**

Set the NGSM32 to peak measurement mode by the "PEAK" pushbutton. Adjust **R380** so that the ammeter at the front panel shows the same value as the external ammeter.

Note:

The peak value of the ammeter will be frozen to the maximum, two seconds after activating the peak measurement mode! For this reason the measurement must be restarted after every manipulation of **R380** by switching off and on the power output by the "POWER ON" pushbutton or by switching off and on the "PEAK" Pushbutton.

### **5.15 Adjusting the Milli-Ammeter**

Load the NGSM32 with a current of 195mA by using a suitable load resistor and voltage value. Loop in the milli-ammeter to the load lead. Set the "mA" range at the NGSM32.

Adjust **R394**, so that the ammeter at the front panel of the NGSM32 shows the same value as the external milli-ammeter.

### **5.16 Adjusting the Switch Point of the Automatic Range Switching**

Supply the NGSM32 via the adjustable line transformer. Adjust the mains voltage to 220V and keep it constant during the adjustment process. Set the NGSM32 to 10.5V and 20A. Connect the electronic load, switch on the power output and adjust the current to constant 19.5A. Connect the voltmeter with the positive pole to the source pin of V201 on the Power Unit (202.402.xx). Connect the negative pole of the voltmeter to the "-" terminal at the front panel.

Turn **R322** to the right stop. The voltmeter must measure a value less than 16V. Turn **R322** slowly to left, until the automatic range switching changes to the next voltage range. The voltmeter must measure a value between 18V and 20V. The change over is distinctly detectable as a voltage jump and is afflicted with hysteresis. If it wasn't a definite jump, the procedure must be repeated.

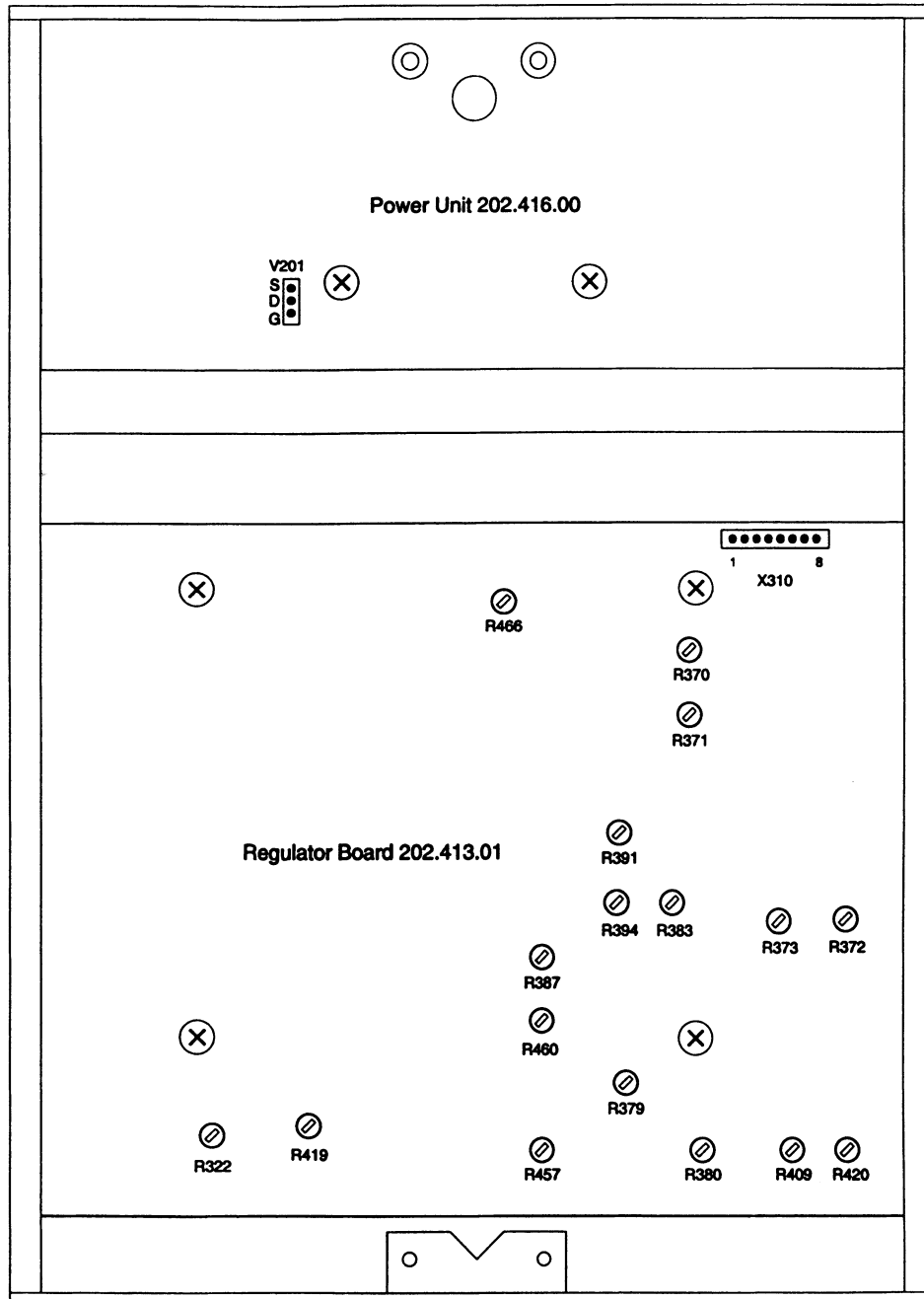
### **5.17 Adjusting the Current Trend Display**

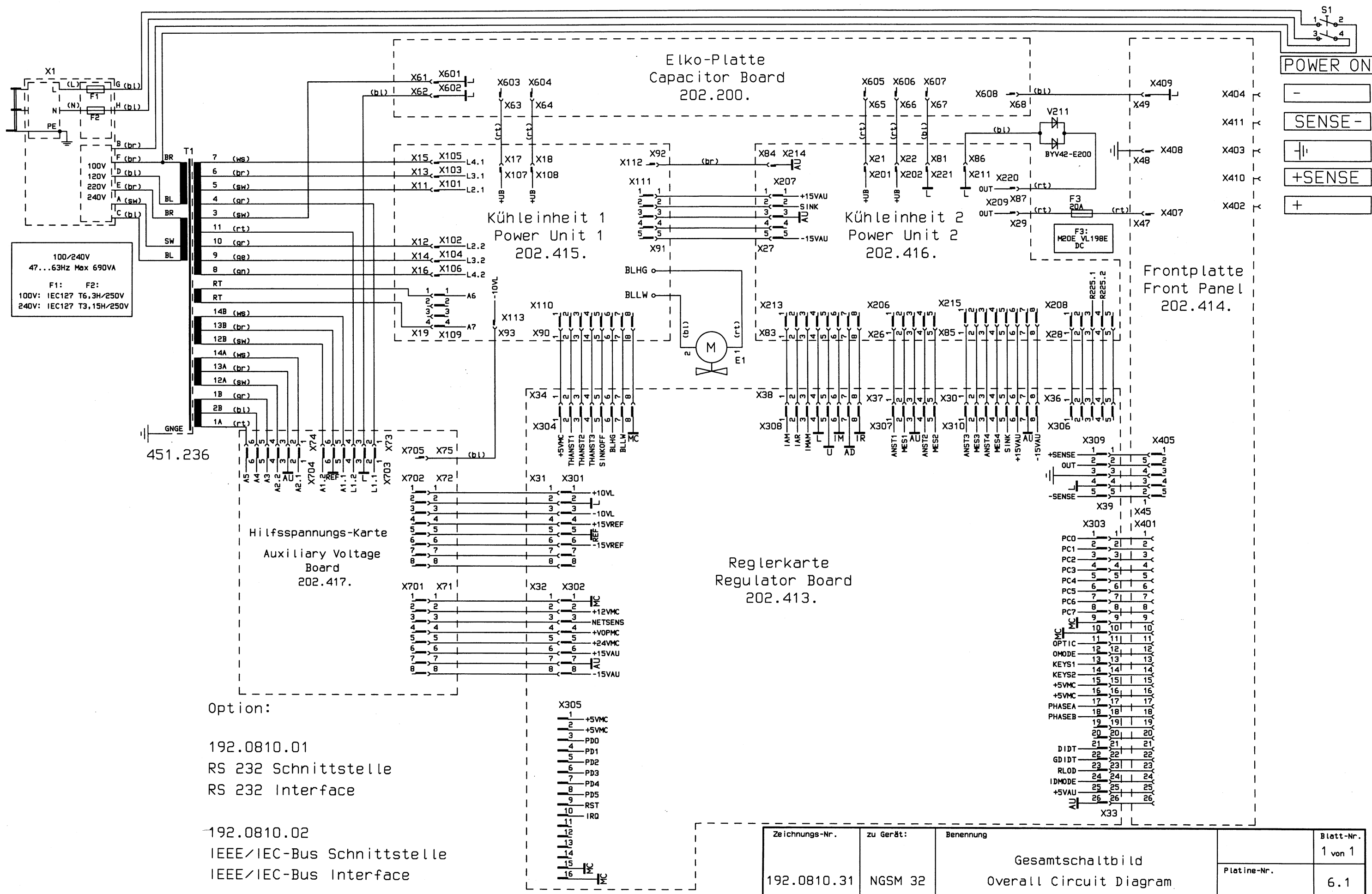
Adjust **R419** so that at a constant load of 19.5A the LED in the middle of the LED bar "di/dt" is glowing.

### 5.18 Adjusting the Zero Point of the dynamic Load Regulation

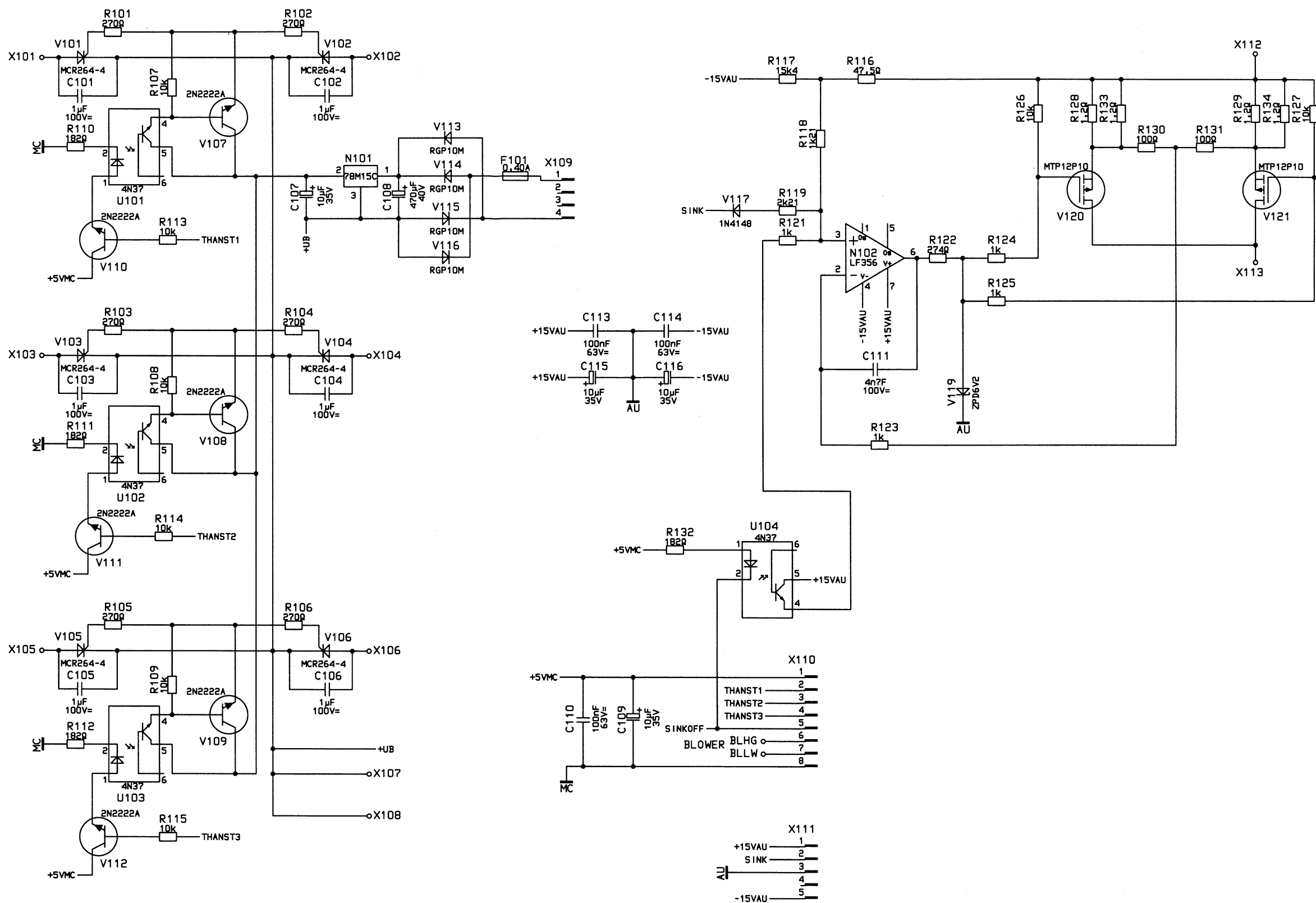
Set the NGSM32 to 5V. Switch off the power output. Disconnect the load from the output terminals. Connect the voltmeter with the negative pole to the "+" output terminal at the front panel. Connect the positive pole of the voltmeter to X310, pin5 at the regulator board 202.413.xx. Adjust **R466** so that the voltmeter shows -0,5V (+/-50mV).

## 5.19 Calibrating components location plan

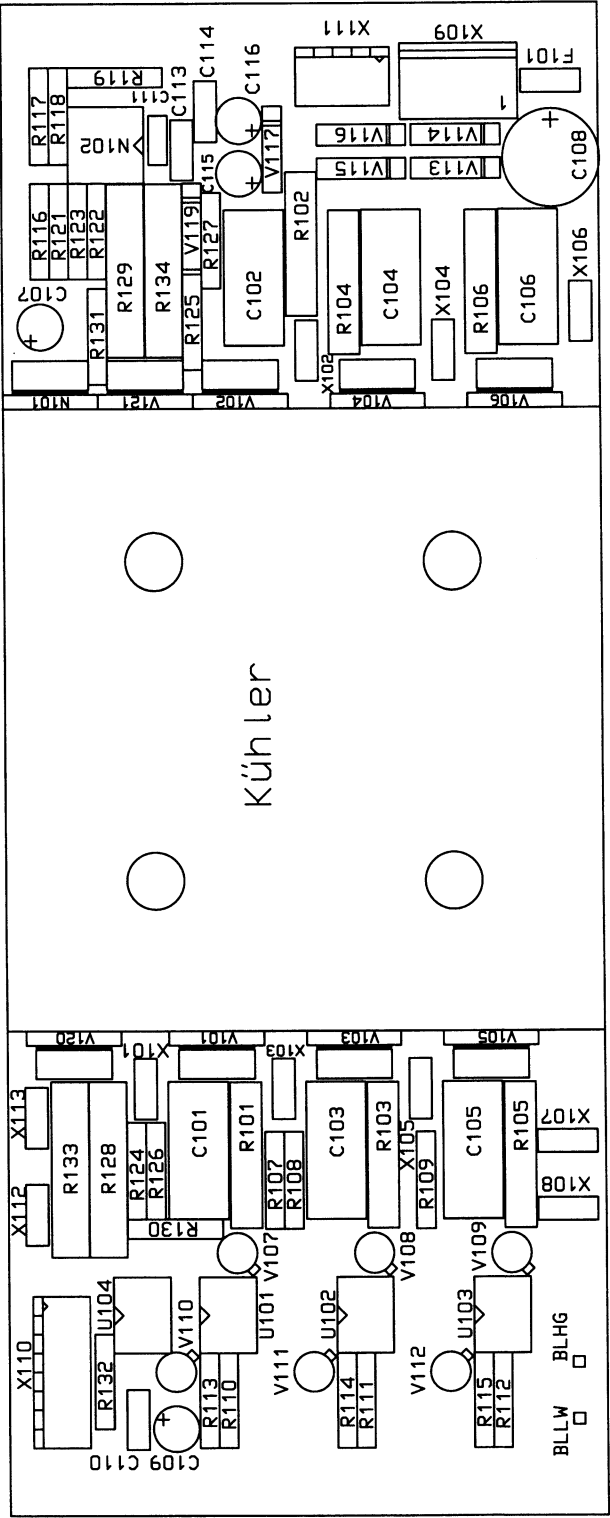




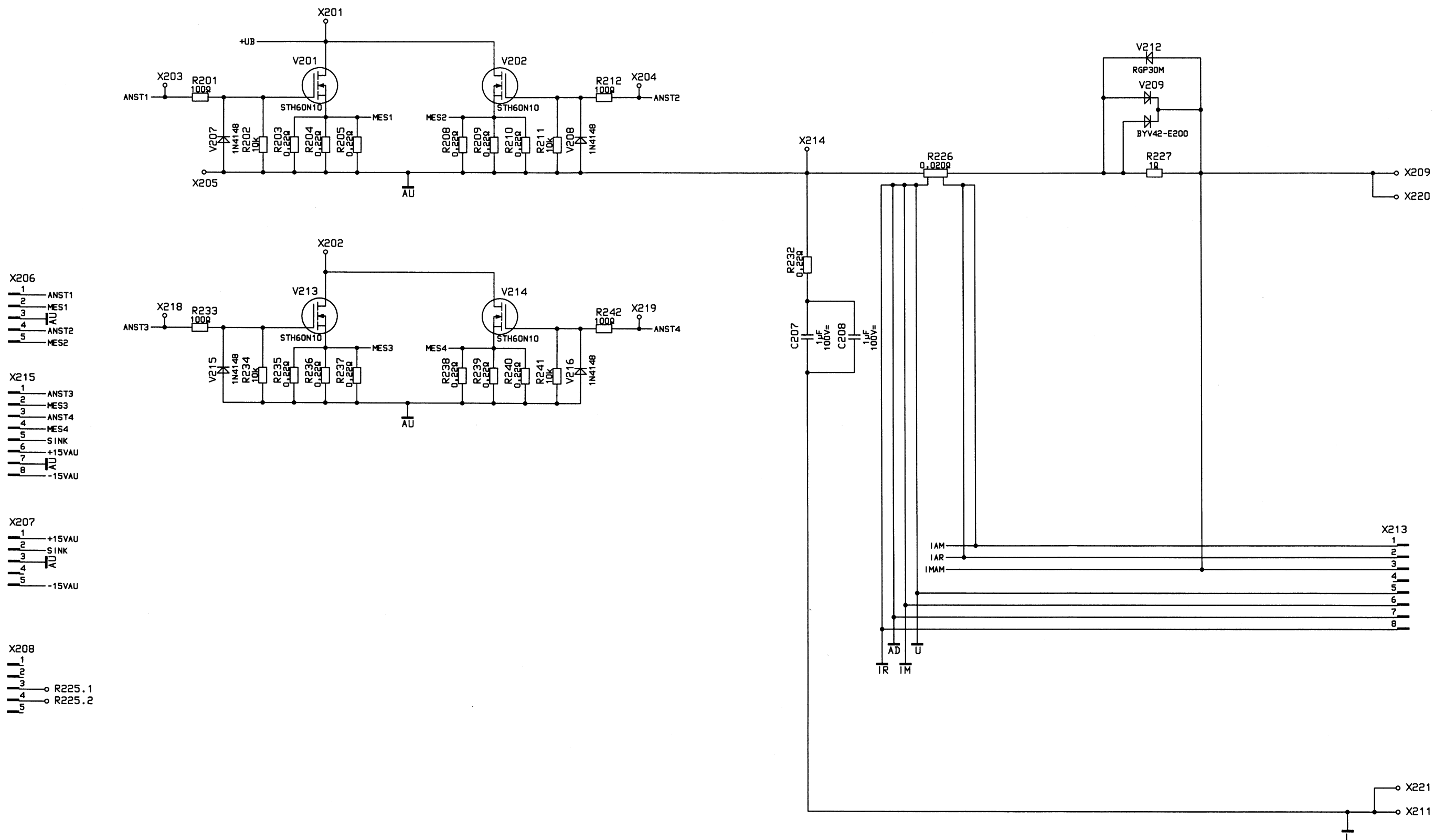




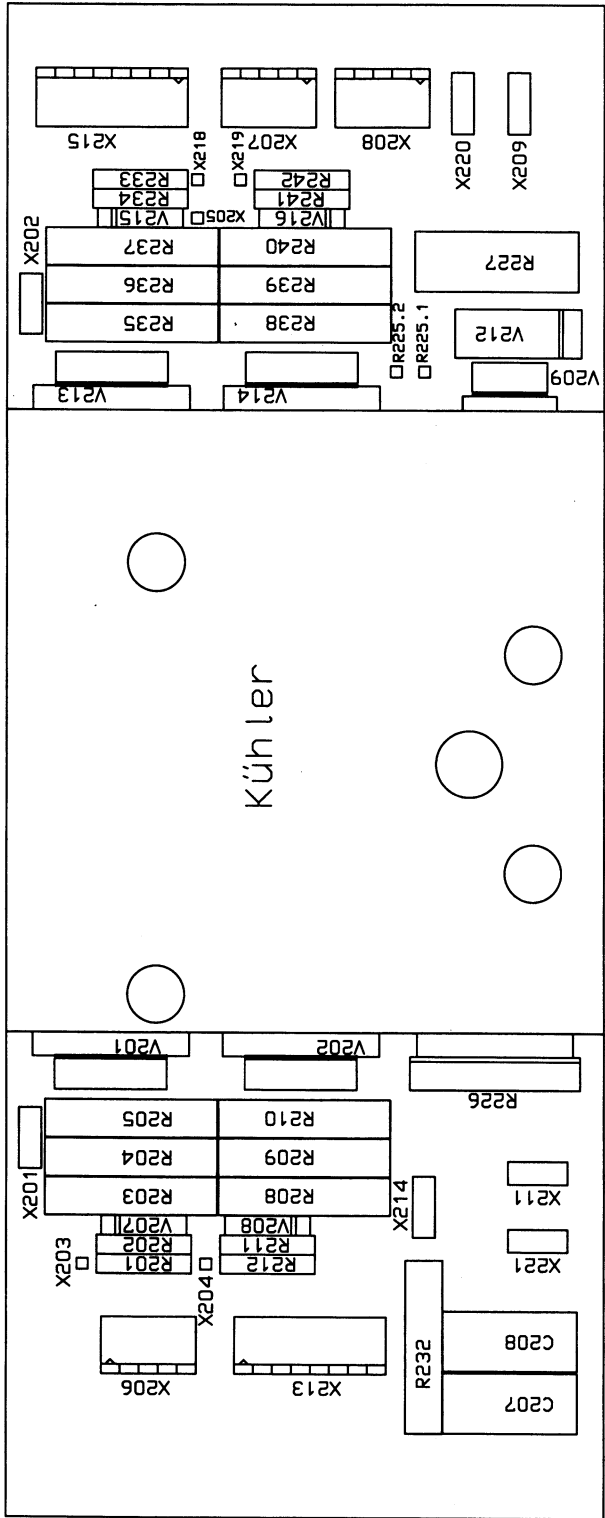
Zeichnungs-Nr.	zu Gerät:	Benennung	Platine-Nr.	Blatt-Nr.
015.144.00	NGSM 32	Kühleinheit 1 Power Unit 1	202.415.00	1 von 1 6.2



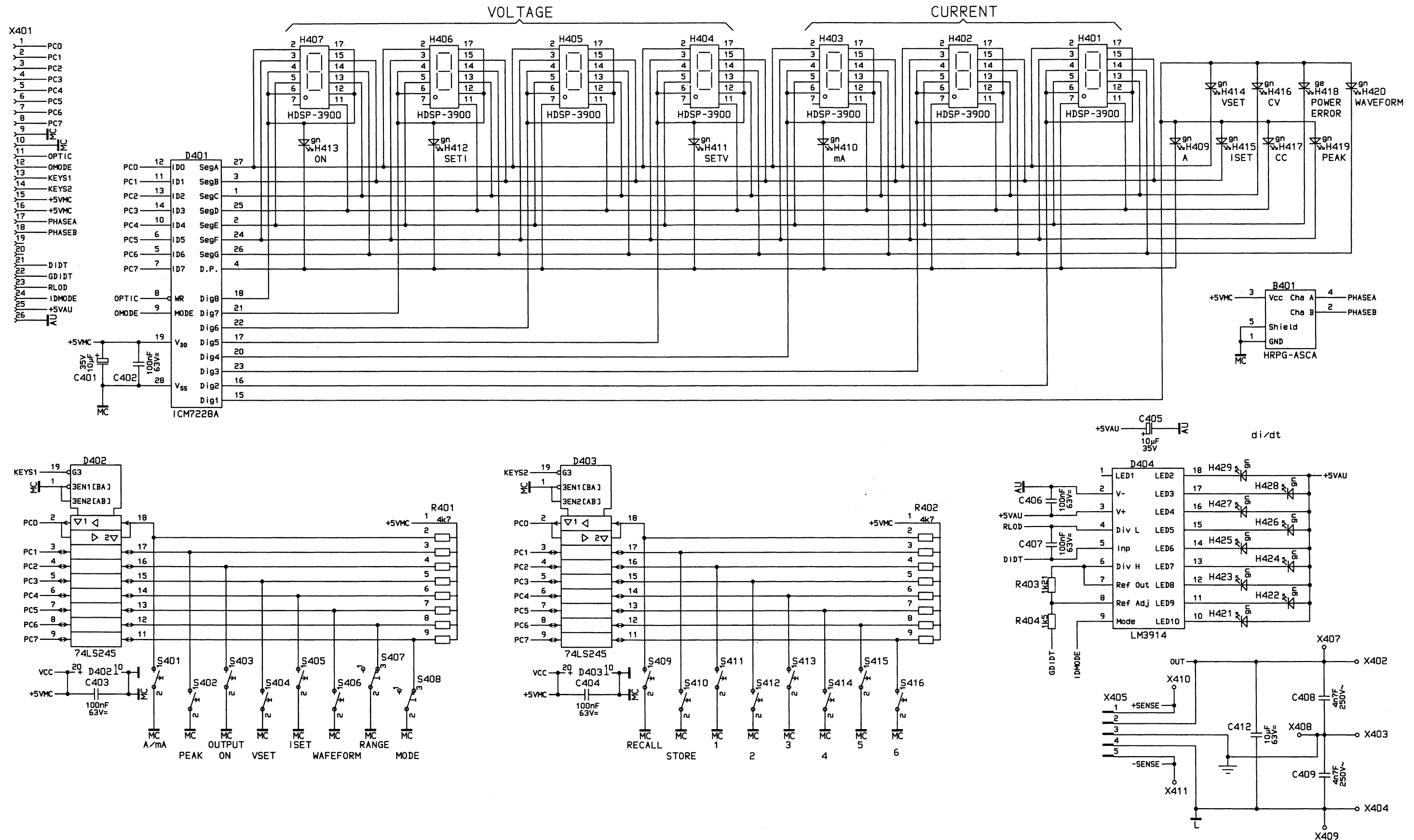
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			Platine-Nr. 202.415.00
			6.2.1



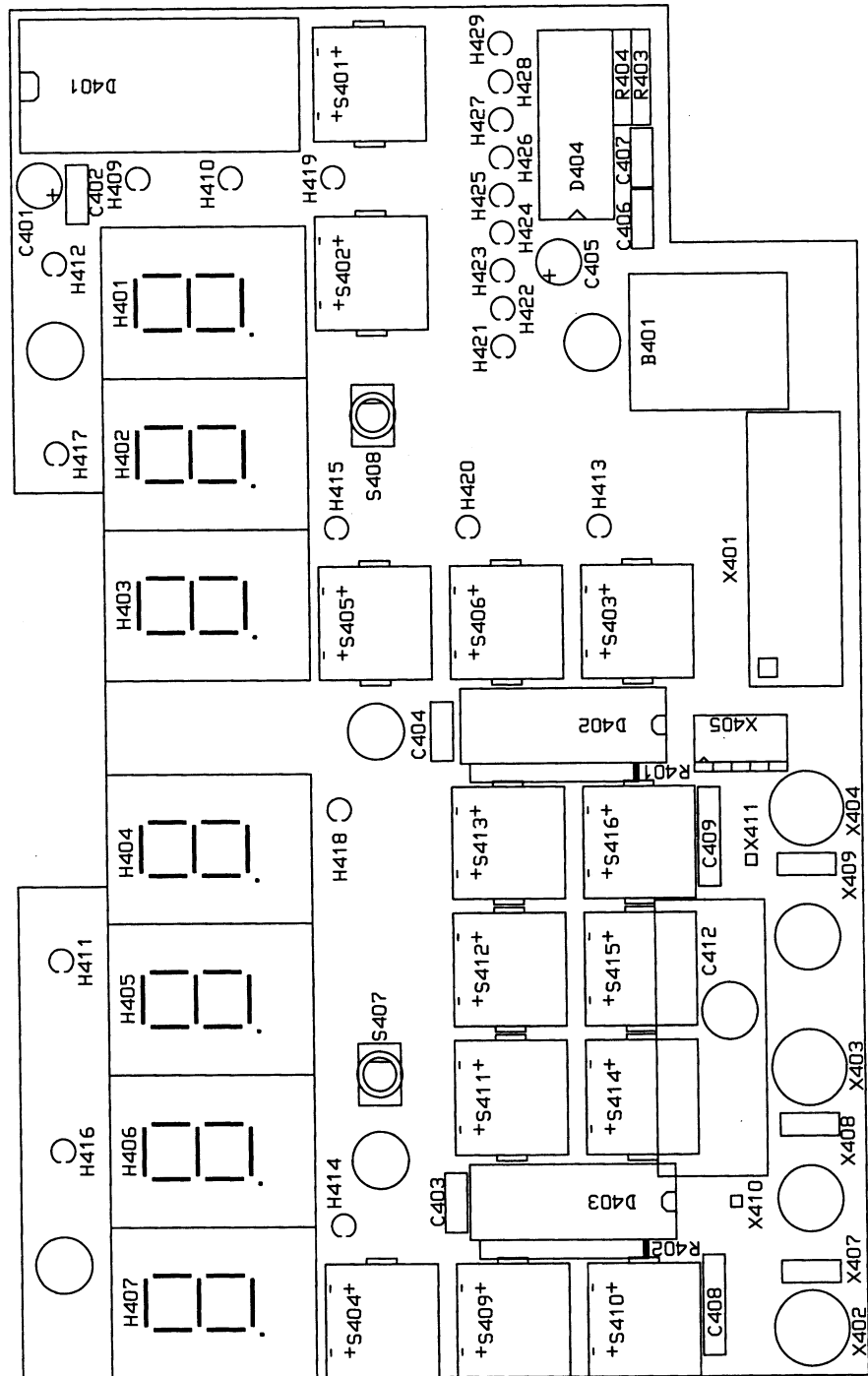
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015.145.00	NGSM 32	Kühleinheit 2 Power Unit 2	1 von 1
			Platine-Nr. 202.416.00
			6.3



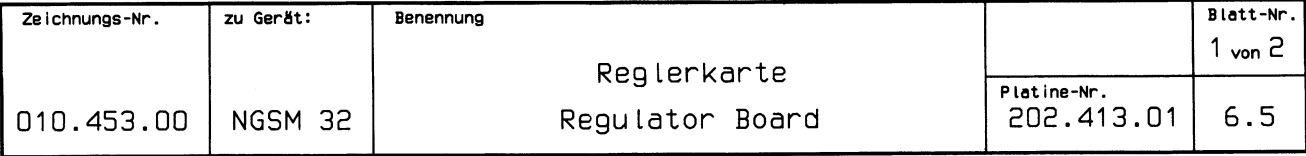
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			Platine-Nr.	1 von 1
015.145.00	NGSM 32	Bestückungsplan Kühleinheit 2 Component Mounting Diagram Power Unit 2	202.416.00	6.3.1

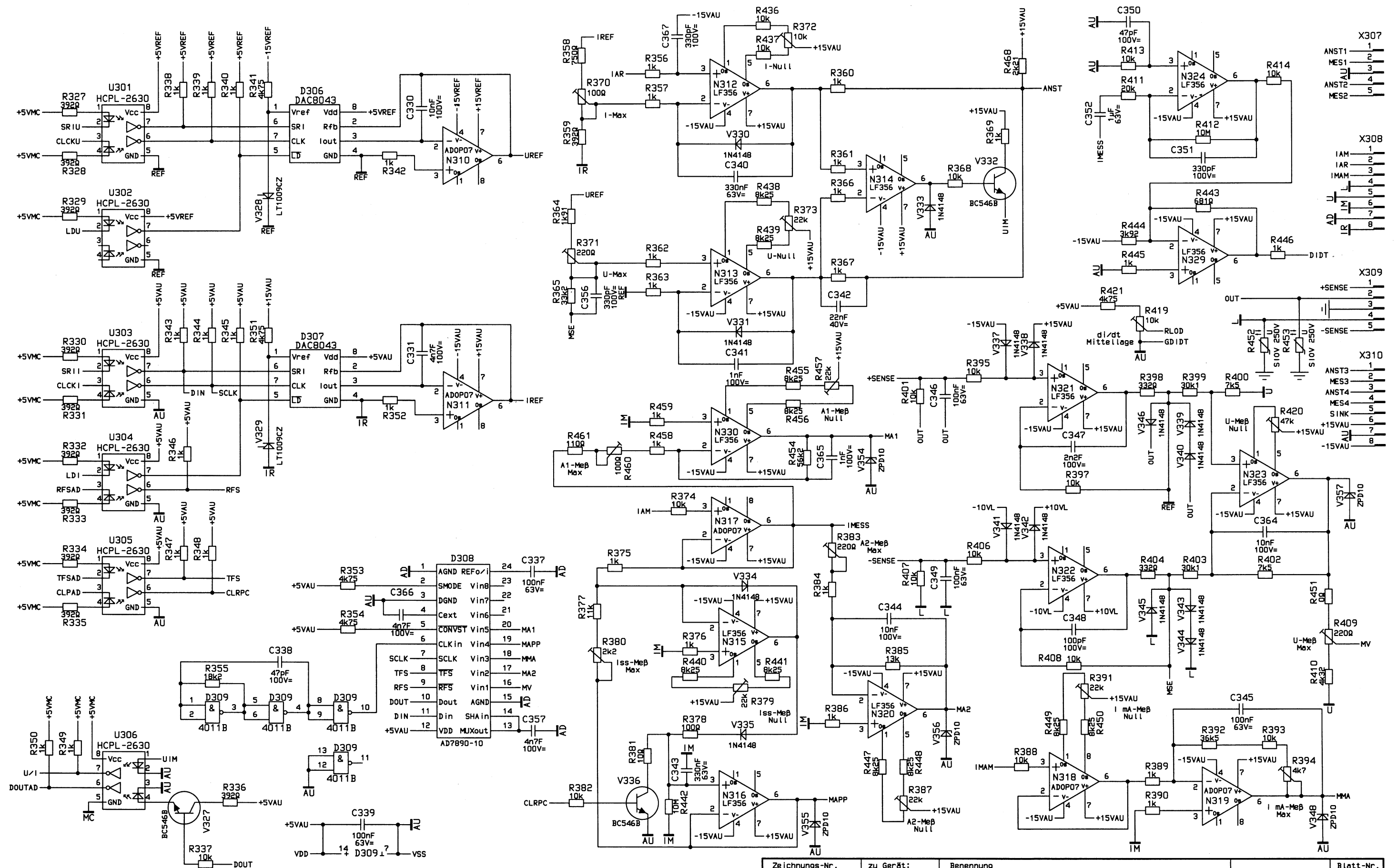


Zeichnungs-Nr.	zu Gerät:	Benennung	Blatt-Nr.
010.454.00	NGSM 32	Frontplatte Front Panel	1 von 1
			Platine-Nr. 202.414.00
			6.4



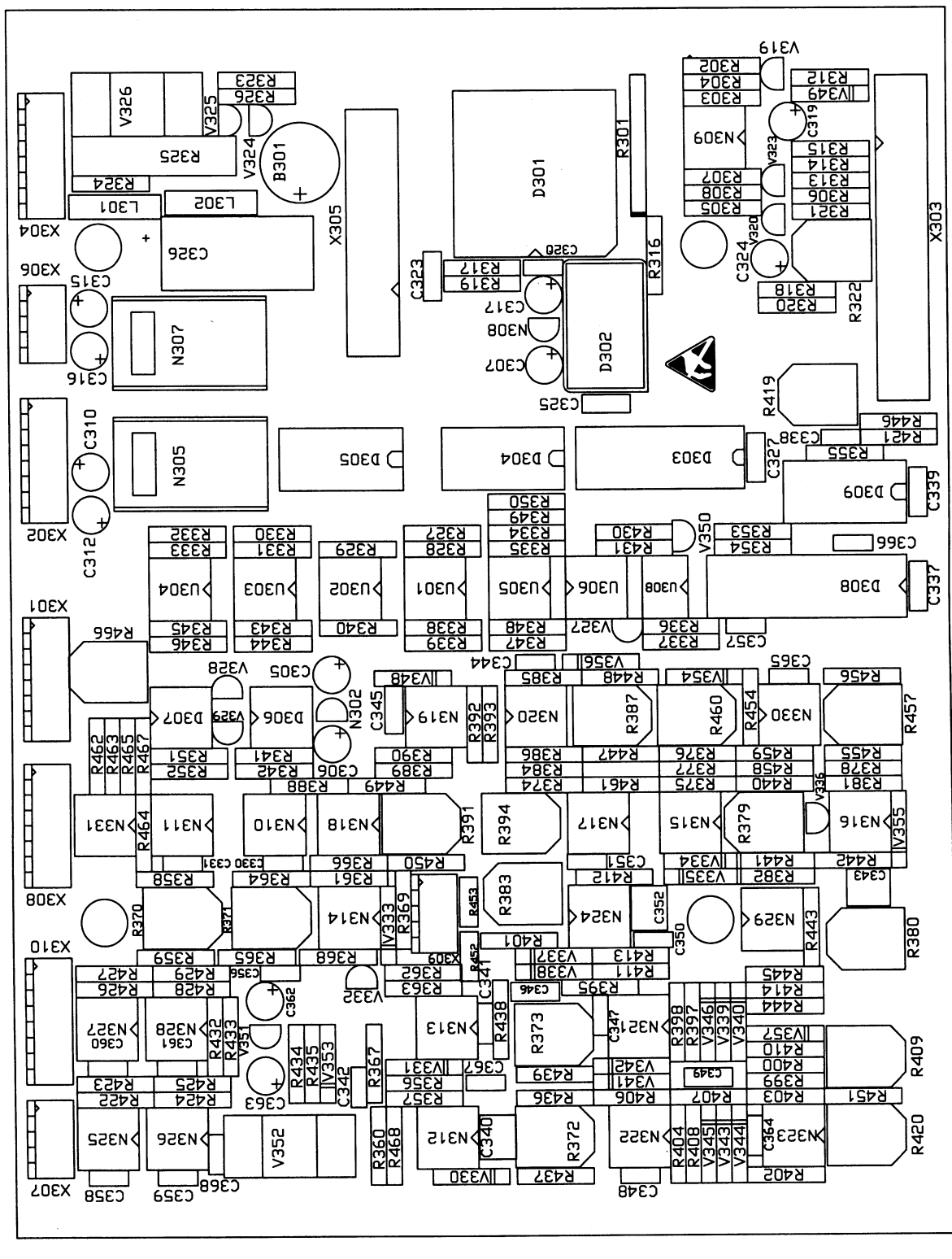
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			Platine-Nr.	1 von 1
010.454.00	NGSM 32	Bestückungsplan Frontplatte Component Mounting Diagram Front Panel	202.414.00	6.4.1





Zeichnungs-Nr.	zu Gerät:	Benennung	Blatt-Nr.
010.453.00	NGSM 32	Reglerkarte Regulator Board	2 von 2
			Platine-Nr. 202.413.01
			6.5

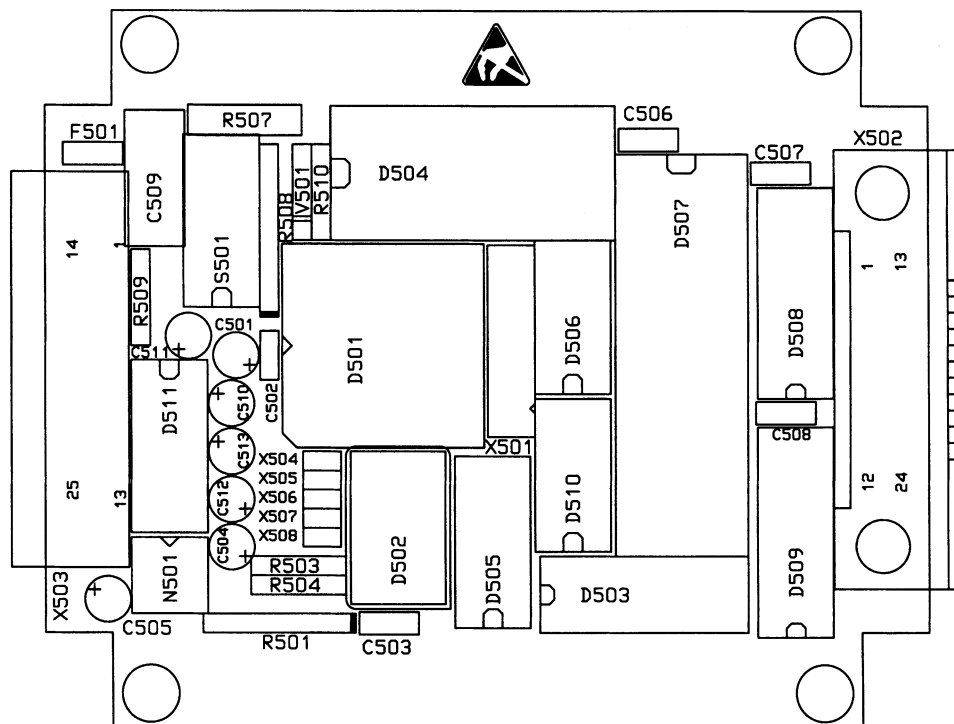




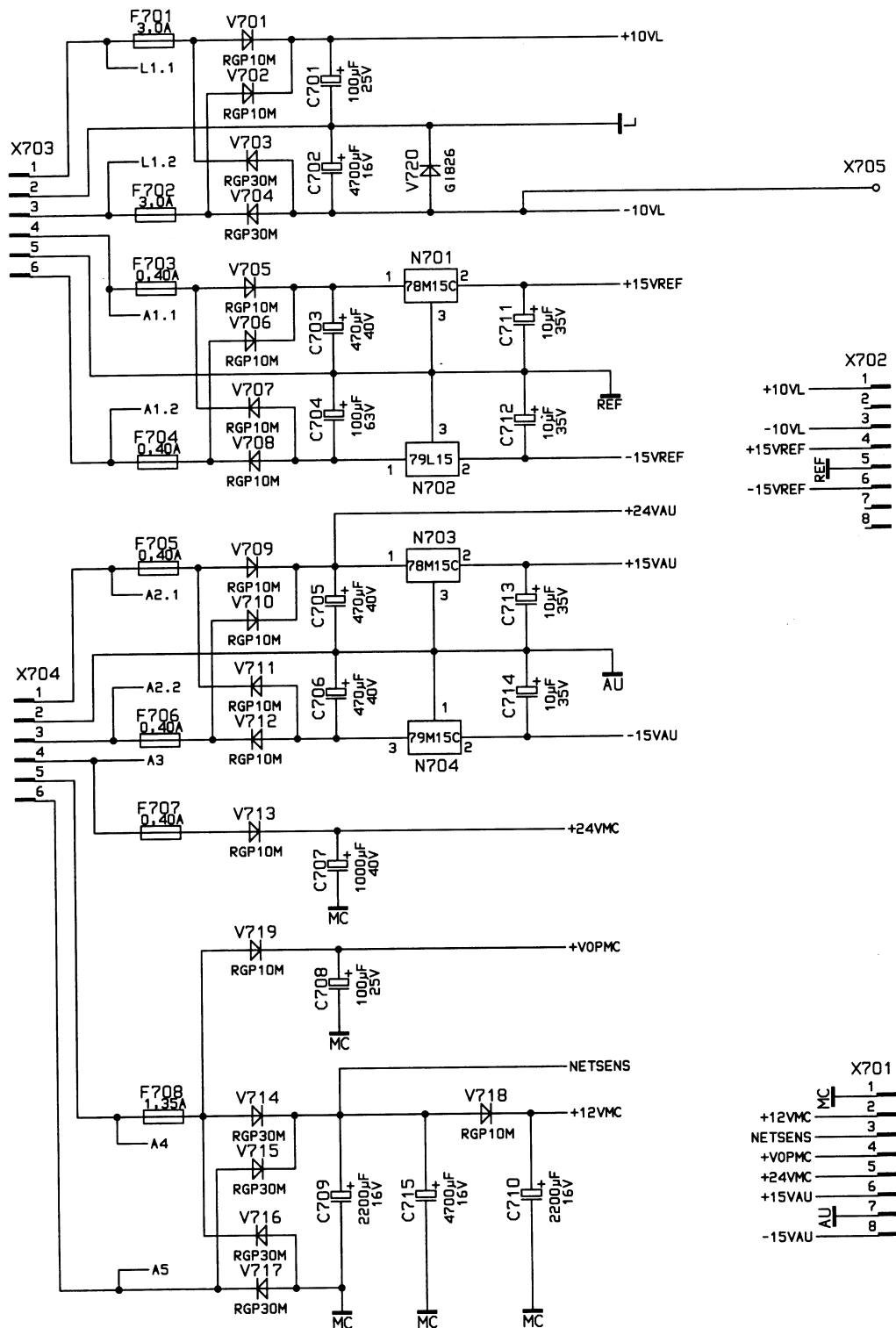
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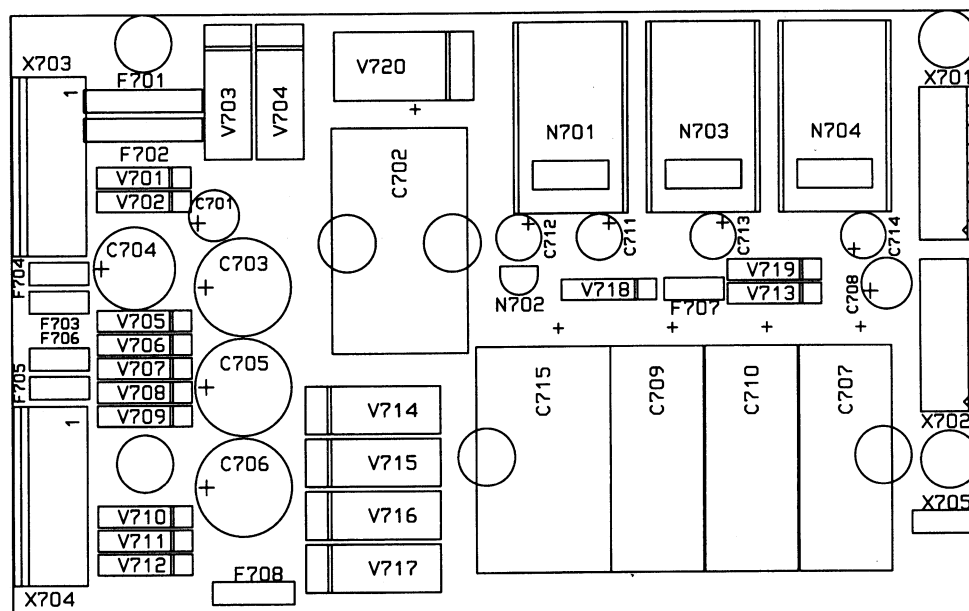




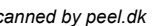
Zeichnungs-Nr.	zu Gerät:	Benennung		Blatt-Nr.
192.810.01	NGSM 32	Bestückungsplan Schnittstellenkarte Component Mounting Diagram Interface Board		1 von 1
			Platine-Nr. 202.406.02	6.8



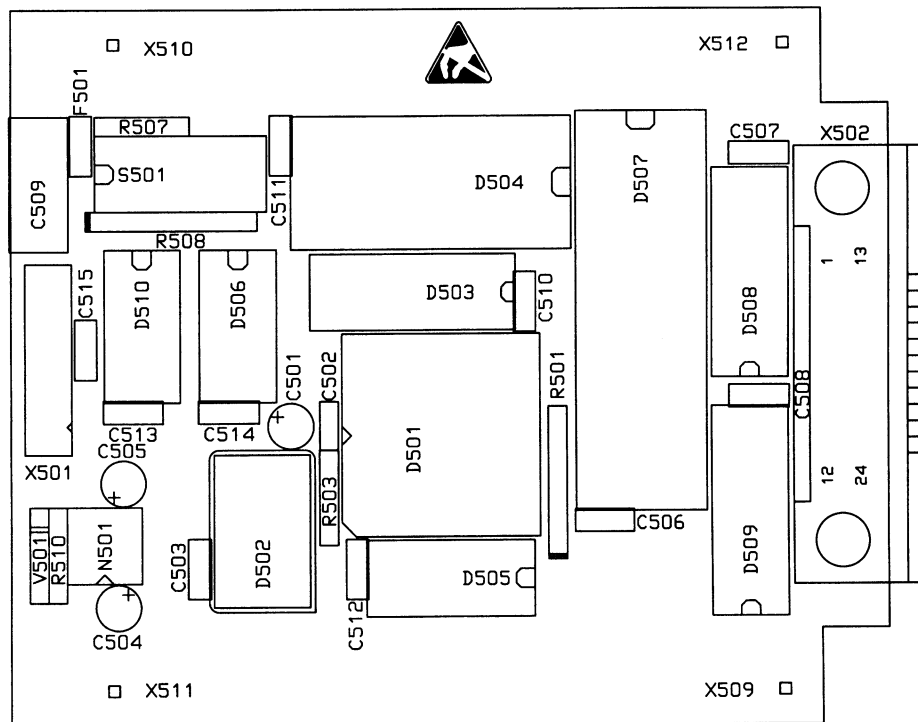
Zeichnungs-Nr.	zu Gerät:	Benennung	Blatt-Nr.
010.457.00	NGSM 32	Hilfsspannungs-Karte Auxiliary Voltage Board	1 von 1
		Platine-Nr. 202.417.01	6.9



Zeichnungs-Nr.	zu Gerät:	Benennung Bestückungsplan Hilfsspannungs-Karte Component Mounting Diagram Auxiliary Voltage Board		Blatt-Nr. 1 von 1
010.457.00	NGSM 32		Platine-Nr. 202.417.01	6.9.1

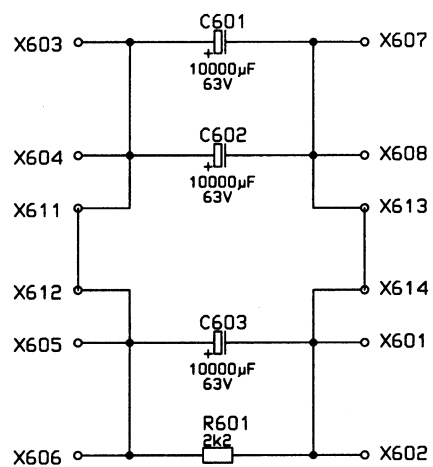


Zeichnungs-Nr.	zu Gerät:	Benennung		Blatt-Nr.
		IEEE/IEC-Bus Schnittstelle neu		1 von 1
192.0810.02	NGSM 32	IEEE/IEC-Bus Interface new	Platinen-Nr. 202.448.00	6.10

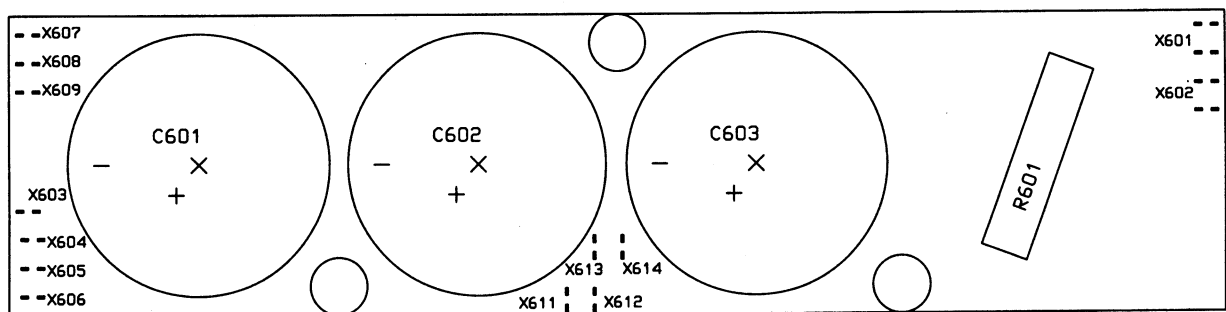


Zeichnungs-Nr.	zu Gerät:	Benennung	Datei:	Blatt-Nr.
			Platine-Nr.	1 von 1
192.810.01	NGSM 32	Bestückungsplan IEEE/IEC-Bus Schnittstellenkarte Component Mounting Diagram IEEE/IEC-Bus Interface Board	202.448.00	6.10.1





Zeichnungs-Nr.	zu Gerät:	Benennung		Blatt-Nr.
010.442.00	NGSM 32	Elko-Platte Capacitor Board		1 von 1
			Platinen-Nr. 202.200.02	6.11



Zeichnungs-Nr.	zu Gerät:	Benennung	Datei:	Blatt-Nr.
010.442.00	NGSM 32	Bestückungsplan Elko-Platte Component Mounting Diagram Capacitor Board	Platine-Nr. 202.200.02	1 von 1 6.11.1