HEIDENHAIN
DR. JOHANNES HEIDENHAIN GmbH
D-8225 Traunreut · Tel. (08669) 31-0

Kundendienst

Service Manual TNC 151

Subject to change (without notice)

DR. JOHANNES HEIDENHAIN GmbH is constantly working on further developments of its TNC Controls. It is therefore possible that details of your Control may differ slightly from those described herein. If that is the case please order a suitably revised issue of the Service Manual.

Copying/Duplication

Issue: 01/87

C o n t e n t s

1. Use of the Service Manual TNC 151

In order to determine the fault condition on an NC machine, a fundamental knowledge of the machine and the drives is necessary, as well a a knowledge of their interaction with the Control and measuring system. In addition, improper use of the Control, such as incorrect NC programming or incorrect selection of machine parameters can lead to the occurrence of fault conditions. Further information in this respect can be found in:

.TNC 151 OPERATING MANUAL
.TNC 151 MOUNTING INSTRUCTIONS AND INTERFACE CIRCUIT CONTROL-MACHINE
.TNC 151 PLC-DESCRIPTION

The TNC 151 Service Manual is used for the diagnosis, localisation and remedying of faults on TNC controlled machines. In chapter 2, Fault Diagnosis, a set of flowcharts enables the user to pinpoint the source of a fault from its symptoms.
An integrated built-in supervision system and a Burn-In Test Program specifically developed for testing the Control can aid in the location of faults.
Important guidance for the exchange of entire Controls, individual boards, or software is given in section 3, Exchange Information.
Section 4, Additional Information, contains a block diagram of the Control, a wiring diagram for each version of the Control, and a list of machine parameters with permissible entry values.

2. Fault Diagnosis

2.1 Procedure for fault-finding

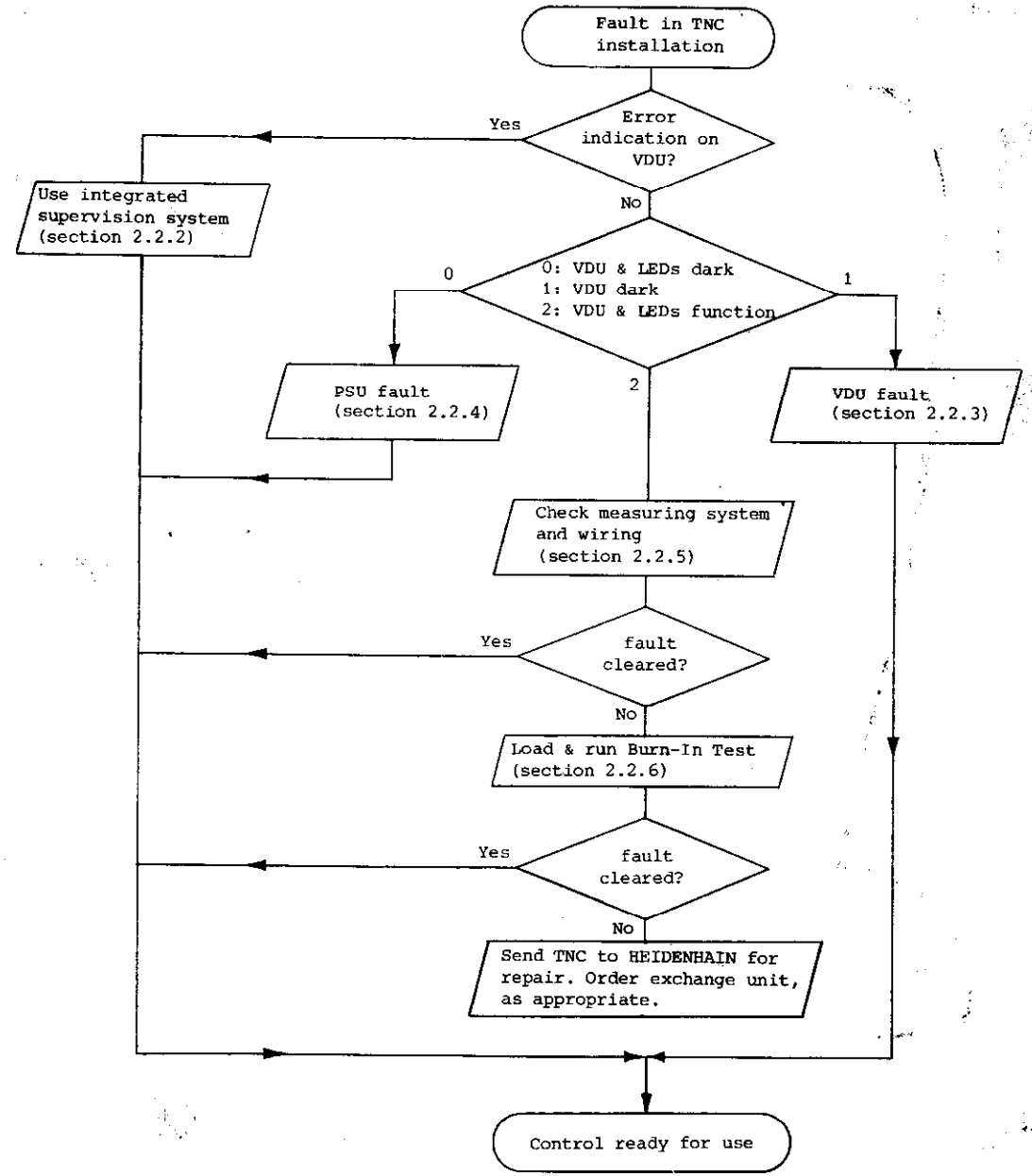
To locate and rectify a fault that has arisen in a TNC installation, it is of foremost importance to analyse the behaviour of the system as a whole: that is, the TNC Control, the machine-tool and the measuring system.
2.2.1 shows, in flow diagram form, the procedure for examining the complete installation.

In addition, the HEIDENHAIN TNC 151 Contouring Control includes an extensive integrated supervision system for the avoidance of entry/operator faults and for the recognition and diagnosis of technical defects in the installation (see section 2.2.2)

The Burn-In Test Program can be used as further support in fault localizing and in the dynamic testing of the Control's hardware (see section 2.2.6).

2.2 Flow diagrams for fault location

2.2.1 Fault diagnosis for the complete installation (Control/Measuring System/Machine-tool)



2.2.2 Use of the integrated supervision system

The TNC 151 incorporates an extensive integrated supervision system for the avoidance of operator-errors and the detection and diagnosis of technical faults in the TNC installation (ie the installation comprising the TNC, the machine-tool and the measuring system).

The supervision system is made up of a mixture of hardware and software within the TNC, and operates continuously whilst the TNC is switched on. If a fault is detected, or if an operator-error occurs, a message will be displayed, indicating (in abbreviated form) the nature of the problem.

Example of operator-**error**:
a) KEY NON-FUNCTIONAL
b) ENTRY VALUE INCORRECT

Example of **fault** with TNC internal electronics:
a) TNC OPERATING TEMP. EXCEEDED
b) EXCHANGE BUFFER BATTERY
c) TNC ELECTRONICS DEFECTIVE 0...3/A...K

Example of **fault** with measuring system:
X-MEASURING SYSTEM DEFECTIVE

Example of **fault** on machine-tool:
GROSS POSITIONING ERROR A

The system distinguishes between what are considered to be harmless **errors** and serious **faults**, in that **faults** are shown as flashing displays. Examples of **faults** are measuring system faults, drive faults and faults in the TNC's internal electronics. The occurrence of a **fault** leads to the machine being switched off via the emergency-stop contactor. The fault must then be rectified before the TNC is switched on again.

Flashing fault messages TNC 151

ASIS X/Y/Z/4 MEAS. SYSTEM DEFECTIVE

EMERGENCY STOP DEFECTIVE

WRONG REFERENCE POINT

EMERGENCY STOP PLC

GROSS POSITIONING ERROR A/B/C/D

TNC OPERATING TEMP. EXCEEDED

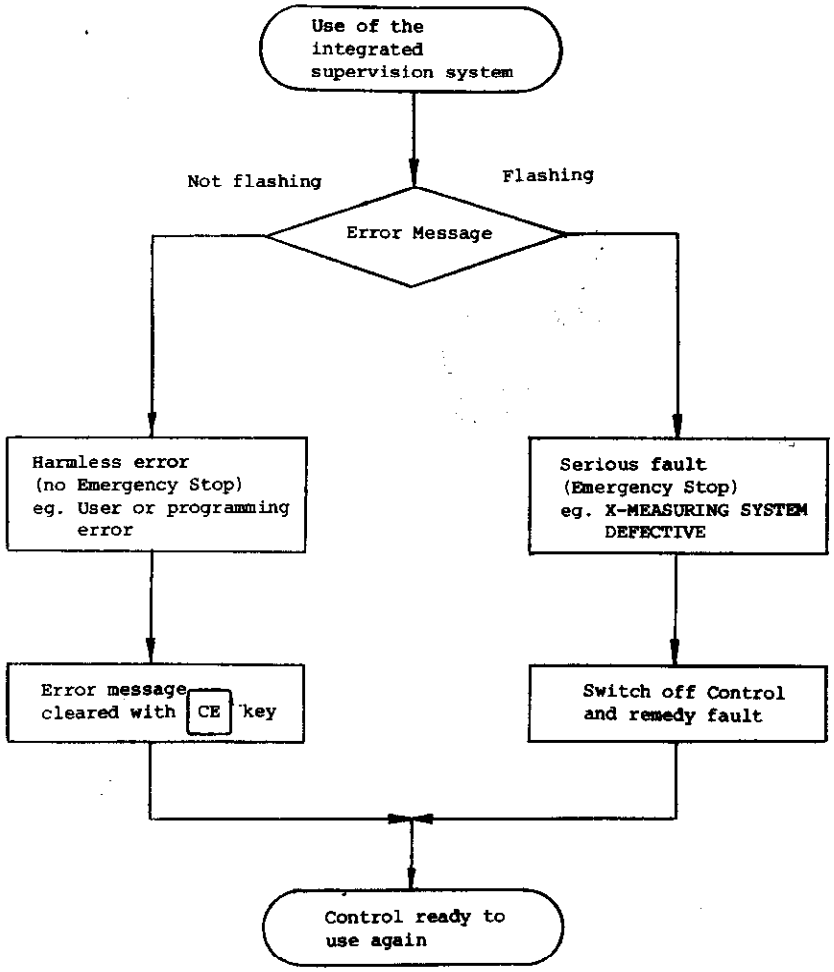
ERROR IN PLC PROGRAM A...Q

TNC ELECTRONICS DEFECTIVE 0...3/A...K

CHECK SUM ERROR XX00...XXFF

The significance of these fault messages is explained on pages 8 to 13

A (non-flashing) **error** message can be cleared by pressing the CE key on the TNC, after which normal operation may resume.
A list of error messages is given on page 7.



Use of the integrated supervision system.

Error message **"EXCHANGE BUFFER BATTERY"**

Particular mention should also be made about the implications of the instruction to exchange the buffer battery:
If the dialogue display indicates "EXCHANGE BUFFER BATTERY", new batteries must be inserted within one week.
The buffer battery compartment is located behind the screw cover in the lower left-hand corner of the operating panel.
When exchanging the batteries, special care should be taken that the polarity is correct (POS-pole of battery outwards).
The battery needs to have IEC designation "LR 6" and must be of the leak-proof type. We especially recommend the use of VARTA Alkaline batteries type "4006". With discharged (or missing) buffer batteries, the memory for the machine parameters and for the user-program will be supported only as long as the mains remains switched on. Continued operation is still possible but the memory contents will become erased in the event of a mains failure. Please note that the TNC has to be switched on when exchanging the buffer batteries. If a mains failure occurs during a battery change (or when the battery is discharged or missing), the re-entry of the machine parameters and the user-program will be necessary.

Error messages TNC 151

The meanings of many of these error messages are explained in:
(i) Operating Manual TNC 155 A/TNC 155 P
(ii) Mounting Instructions and Interface Circuit Control-Machine TNC 151 A/TNC 151 P

KEY NON-FUNCTIONAL
PROGRAM MEMORY EXCEEDED
SEARCH ADDRESS MISSING
TOOL DEF Ø NOT PERMITTED
PROGRAM NUMBER ON TAPE ALLOCATED
JUMP TO LABEL Ø NOT PERMITTED
ENTRY VALUE INCORRECT
CC-BLOCK MISSING
CIRCLE END POS. INCORRECT
TOOL DEF MISSING
TOOL CALL MISSING
LABEL NUMBER NOT ALLOCATED
EXCESSIVE SUPROGRAMMING
ANGLE REFERENCE MISSING
PLANE WRONGLY DEFINED
TOOL RADIUS TOO LARGE
ROUNDING RADIUS TOO LARGE
PATH OFFSET WRONGLY STARTED
PATH OFFSET WRONGLY ENDED
ROUNDING-OFF UNDFINED
ROUNDING-OFF NOT PERMITTED
AXIS DOUBLE PROGRAMMED
WRONG RPM
NO EDITING OF RUNNING PGM
RADIUS COMP. UNDEFINED
LIMIT SWITCH X+
LIMIT SWITCH X-
LIMIT SWITCH Y+
LIMIT SWITCH Y-
LIMIT SWITCH Z+
LIMIT SWITCH Z-
LIMIT SWITCH AXIS 4+
LIMIT SWITCH AXIS 4-
EXCHANGE BUFFER BATTERY
TRANSFERRED DATA INCORRECT
ME: CASSETTE MISSING
ME: CASSETTE LOCKED
ME: WRONG MODE SELECTED
ME: WRONG PROGRAM DATA
ME: CASSETTE EMPTY
ME: PROGRAM INCOMPLETE
ME: TAPE END
WRONG PROGRAM DATA
MACHINE PARAMETER INCOMPLETE
EXT. IN-/OUTPUT NOT READY
MIRROR IMAGE ON TOOL AXIS
WRONG AXIS PROGRAMMED
WRONG SIGN PROGRAMMED
SPINDEL ROTATES MISSING
SLOT WIDTH TOO LARGE
CYCLE INCOMPLETE
SELECTED BLOCK NOT ADDRESSED
PROGRAM START UNDEFINED
POSITIONING ERROR
EMERGENCY STOP
ARITHMETICAL ERROR
OPERATION PARAMETERS ERASED
3D-INTERPOLATION NOT PERMITTED
FURTHER PROGRAM ENTRY IMPOSSIBLE
PROGRAM NUMBER UNAVAILABLE
PROGRAM NUMBER ALLOCATED
LABEL NUMBER ALLOCATED
TOOL NUMBER ALLOCATED
RELAY EXT. DC VOLTAGE MISSING
POWER INTERRUPTED
PGM XXXXXXXX UNAVAILABLE
TWO TOOL DEF XXX WITH PGM CALL
CIRCLE CENTRE UNDEFINED XXXX
ADDRESS LETTER ALREADY ASSIGNED
BLOCK TOO LONG
G-CODE GROUP ALREADY ALLOCATED
ILLEGAL G-CODE
BLOCK NUMBER ALREADY ALLOCATED
BLOCK FORMAT INCORRECT
N-CODE MISSING
BLK FORM DEFINITION INCORRECT
PGM-SECTION CANNOT BE SHOWN
TOO MANY USER PARAMETERS
PROTECTED PGM
ILLEGAL NC-BLOCK
CHAMFER NOT ALLOWED

Fault descriptions TNC 151

VDU Display (flashing)	Fault cause	Possible fault location
X-MEASURING SYSTEM DEFECTIVE Y-MEASURING SYSTEM DEFECTIVE Z-MEASURING SYSTEM DEFECTIVE AXIS 4 MEAS. SYSTEM DEFECTIVE	.Measuring system not connected .Cable damaged .Glass scale dirty or damaged .Scanning head damaged	Measuring system
	.Measuring system supervision damaged	Analogue Board
EMERGENCY STOP DEFECTIVE	.Fault in the emergency stop circuit of the machine (for checking routine see Mounting Instructions and Interface Circuit Control-Machine manual TNC 151 A/TNC 151 P) .Defect in Control's internal Emergency Stop supervision	Analogue Board PLC I/O Board (TNC 151 P) PLC Interface Board (TNC 151 P) SE Board (TNC 151 A) Terminal Board (TNC 151 A)
WRONG REFERENCE POINT	.Traversed-over reference point lies outside of the reference point end position (also see Mounting Instructions and Interface Circuit Control Machine TNC 151 A/TNC 151 P. .Defect in Control/machine interface	Machine (cams/switches "reference end-position" or "reference pulse inhibit") PLC I/O Board (TNC 151 P) PLC Interface Board (TNC 151 P) SE Board (TNC 151 A) Terminal Board (TNC 151 A)

VDU Display (flashing)	Fault cause	Possible fault location
EMERGENCY-STOP PC	With standard PLC program, faulty reply from output A6 ("Lock for spindle on") to input E20 ("reply: Lock for spindle on") Fault message EMERGENCY-STOP PLC appears only when no additional PLC marker is set for the fault message	Terminal board (TNC 151 A)
GROSS POSITIONING ERROR A	.Trailing error greater than value entered in MP 174. (see Mounting Instructions and Interface Circuit Control-Machine manual TNC 151 A/ TNC 151 P) .Deviation from the intended position at standstill greater than the value entered in MP 169 (see Mounting Instructions and Interface Circuit Control-Machine manual TNC 151 A/ TNC 151 P) .Exceeding the range for the continuous position supervision determined by MP 57. (see Mounting Instructions and Interface Circuit Control-Machine manual TNC 151 A/ TNC 151 P) .Relationship between output voltage and traversed distance outside of the defined tolerance. .Defect in the pulse counting section (Control circuitry) after the transducer signal supervision	In the Case of Gross Positioning Errors A/B/C/D the fault could lie with any element in the closed loop servo system. ie Control hardware (CLP Processor Brd.), " " (Analogue Brd.), servo amplifier (offset voltages), " " (gain too low), motor, tacho, measuring system, external forces acting on drives, inappropriate MP values programmed. Aid: 1. Program MP 54 (acceleration) as small as possible. 2. Adjust rapid traverse (as small a trailing error as possible). 3. Gradually increase MP 54. If this does not help: fault in the Control hardware (closed loop) or in the machine

VDU Display (flashing)	Fault cause	Possible fault location
GROSS POSITIONING ERROR B	.The Control-calculated analogue output voltage (implied by trailing error) is greater than 10 V	see above
GROSS POSITIONING ERROR C	.The analogue output voltage actually necessary to obtain a desired speed deviates from the expected, calculated voltage, by more than the voltage programmed in MP 234	see above
GROSS POSITIONING ERROR D	.The actual position at standstill deviates from the intended position by more than the distance programmed in MP 169	see above
TNC-OPERATING TEMP. EXCEEDED	.Ambient temperature inside the TNC has exceeded +65°C .Fault in the temperature supervision	Ambient temperature of Control Analogue Board

CRT display (flashing)	Fault origin	Possible fault location
ERROR IN PLC PROGRAM	Fault with safety-related marker (see PLC-Description manual TNC 155 A/TNC 155 P pages 36....40)	
" " " " A	Start Key Error with safety-related marker	PLC Program, Main Processor Board
" " " " B	Rapid traverse key	" " " " "
" " " " C	Direction latch key	" " " " "
" " " " D	Feed release	" " " " "
" " " " E	Start PLC positioning X-axis	" " " " "
" " " " F	Start PLC positioning Y-axis	" " " " "
" " " " G	Start PLC positioning Z-axis	" " " " "
" " " " H	Start PLC positioning IV-axis	" " " " "
" " " " I	Direction key X+	" " " " "
" " " " J	Direction key X-	" " " " "
" " " " K	Direction key Y+	" " " " "
" " " " L	Direction key Y-	" " " " "
" " " " M	Direction key Z+	" " " " "
" " " " N	Direction key Z-	" " " " "
" " " " O	Direction key IV+	" " " " "
" " " " P	Direction key IV-	" " " " "
" " " " Q	Undefined macro called-up via PLC marker	" " " " "

VDU Display (flashing)	Fault cause	Possible fault location
TNC-ELECTRONICS DEFECTIVE 0	False CRC CHECK-SUM* of machine-related data excluding machine parameters. (Baud rate, limitation, preset etc)	Main Processor/Memory Board
" " " 1	False CRC CHECK-SUM* (machine parameters)	Memory/Main Processor Board
" " " 2	False CRC CHECK-SUM* (user memory)	Memory/Main Processor Board
" " " 3	Integrated Test Program execution incomplete	Main Processor/Memory Board
" " " A	Software error Main Processor	Main Processor Board
" " " B	Software error CLP Processor	CLP Processor Board
" " " C	MID interrupt** CLP Processor	CLP Processor/Main Processor Board
" " " D	CLP Processor instruction stack overflow	CLP Processor Board
" " " E	False instruction: Main Processor ⟶ CLP Processor	CLP Processor/Main Processor Board
" " " F	False instruction (display mode): Main Processor ⟶ CLP Processor	CLP-Processor/Main Processor Board
" " " G	CLP Processor RAM	CLP Processor Board
" " " H	Overflow interrupt	Main Processor Board
" " " I	MID interrupt Main Processor	Main Processor Board
" " " J	Equipped with incorrect language version	Main Processor Board
" " " K	RAM EØØØ...FFFF Main Processor	Main Processor Board

* CRC = Cyclic Redundancy Check
** MID = Macro Instruction Detection

VDU Display (flashing)	Fault cause	Possible fault location
CHECK-SUM ERROR XX00	CRC CHECK-SUM error with EPROM 4 XX = correct CHECK-SUM value 00 = code for faulty EPROMs	Main Processor Board
" " XX02	CRC CHECK-SUM error with EPROM 5	Main Processor Board
" " XX04	" " " " with EPROM 6,7,8	Main Processor Board
" " XX0A	" " " " with EPROM 9	Main Processor Board (PLC program)
" " XX0B	" " " " with EPROM 9	Main Processor Board (PLC dialogue)
" " XX0C	" " " " with EPROM A	Main Processor Board
" " XX10	" " " " with EPROM B,C,D	Memory Board
" " XX17	" " " " with EPROM E	Memory Board
" " XX18	" " " " with EPROM F	Memory Board
" " XX1A	" " " " with EPROM G	Memory Board
" " XX1C	" " " " with EPROM H,K	Memory Board
" " XX1F	" " " " with EPROM K	Memory Board
" " XX20	" " " " with EPROM 2	CLP Processor Board
" " XX21	CRC CHECK-SUM error in RAM area on the CLP Processor Board in which a part of the operating program is stored	CLP Processor Board
" " XX22	CRC CHECK-SUM error with EPROM 3	CLP Processor Board (export version)
" " XX23	CRC CHECK-SUM error in the RAM area on the CLP Processor Board where part of the operating program is stored	CLP Processor Board (export version)
" " XXFF	CRC CHECK-SUM error with PLC-RAM PLC Marker 2815 is set	Main Processor Board

2.2.3 Testing of the VDU and associated circuitry

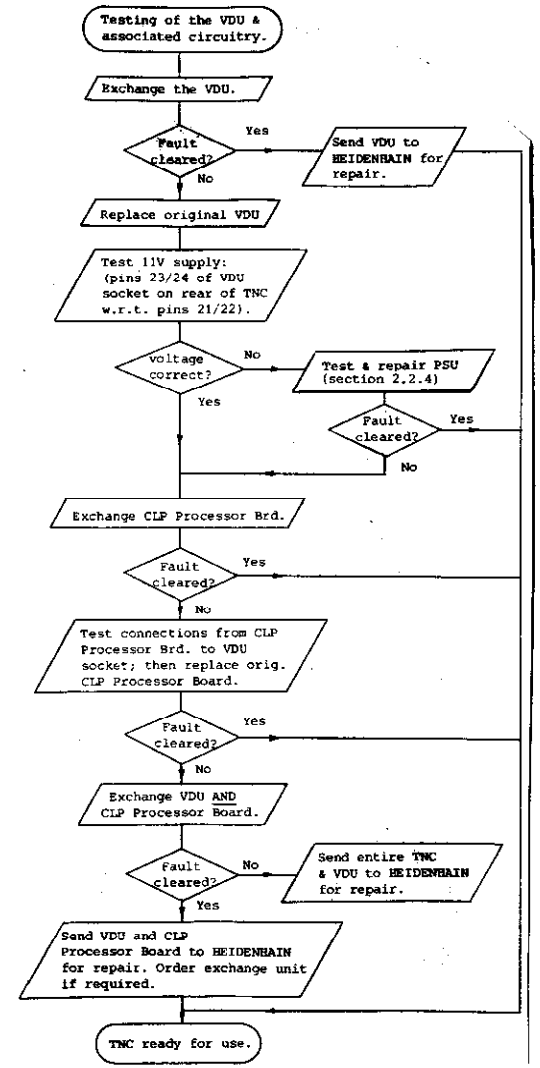
The first objective is to determine whether the fault is actually with the Display Unit, in which case it must be returned to DR JOHANNES HEIDENHAIN for repair, or whether it lies elsewhere, with the asscociated circuitry, in which case repairs may be possible without returning the unit.

The Display Units BE 111 and BE 211 are powered by an 11V dc supply from the Power Supply Board. This is a possible source of the fault, in which case the test and repair procedure continues according to section 2.2.4, Testing of the mains supply and the Power Supply Unit.

If the fault is not due to a detective power supply, it is likely to be due to the CLP Processor Board, which contains the control circuitry for the Display Unit. This can be verified by exchanging the board for one when is known to function correctly.

If the fault still persists then must be due either to bad connections within the TNC (eg on the Connector Board), or to faults on both the VDU and the CLP Processor Board.

See the diagram opposite for a logical procedure for locating the fault in the system.

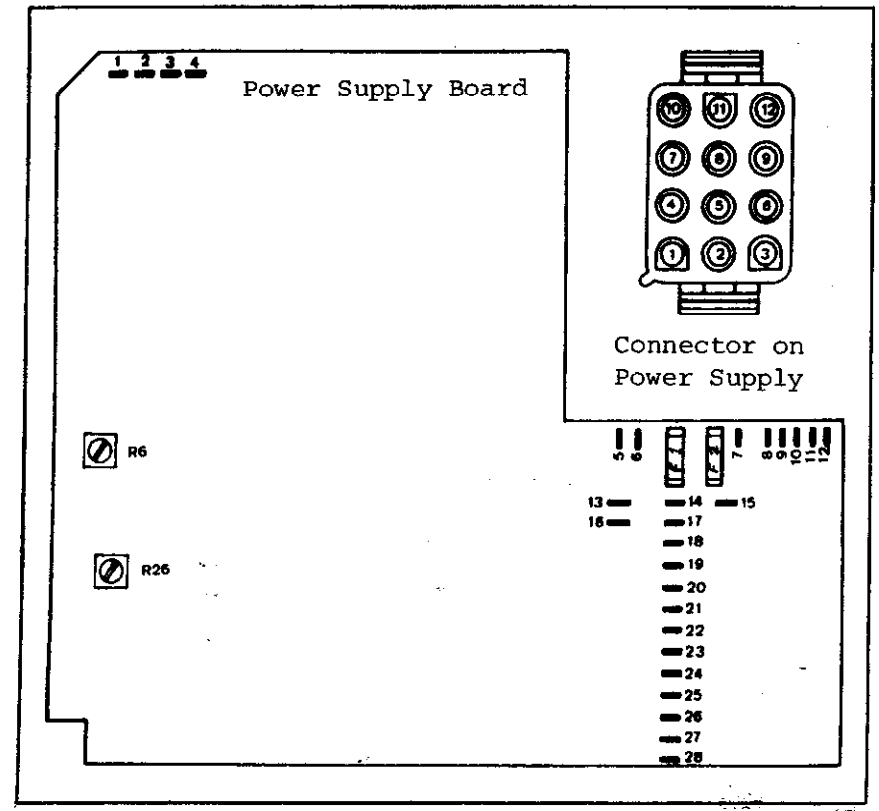


Testing of the VDU and associated circuitry.

2.2.4 Testing of the mains supply and the Power Supply Unit

The procedure for testing the Power Supply Unit is shown in the flow diagram on page 16. As part of that procedure, it may be necessary to test the voltages at various points on the Power Supply Board. The diagram below and the table opposite show the locations of the test points (solder terminals) on the Power Supply Board, and the respective "nominal" and "actual" test voltages under load.

Plug pin	Cable colour	Solder terminal test points	Voltage/Signal	Test values (V) Under load		
1	black	23/24	OV TTL			
2	brown	17	+12 Processor supply	12,0	± 0,5	at 0,15A
3	red	21/22	+5V TTL	5,16	± 0,08	at 3,5A
4	grey	20	-15V Switching reg.	-14,9	± 0,6	at 0,1A
5	blue	27/28	OV Display Unit			
6	green	16	+15V Analogue Board	15,0	± 0,6	at 0,3A
7	yellow	19	+45V Switching reg.	45,2	± 1,5	at 0,06A
8	white	25/26	+11V Display Unit	11,2	± 0,25	at 1,4A
9	green/white	13/8	Reset			
* 10	yellow/white	18	+22V Display	21,6	± 0,8	at 0,01A
* 11	brown/white	15	4,2V ~ Heater	4,2	± 0,2	at 0,17A
* 12	brown/white	14				
-	-	1	21V ~ Mains transf. sec. voltage			
-	-	2				
-	-	3	21V ~ Mains transf. sec. voltage			
-	-	4				
* -	-	5	OV			
* -	-	6	2,1V ~ Mains transf.			
* -	-	7	2,1V ~ sec. voltage			
-	-	9,10,11,12	no connection			



* not used with TNC 151

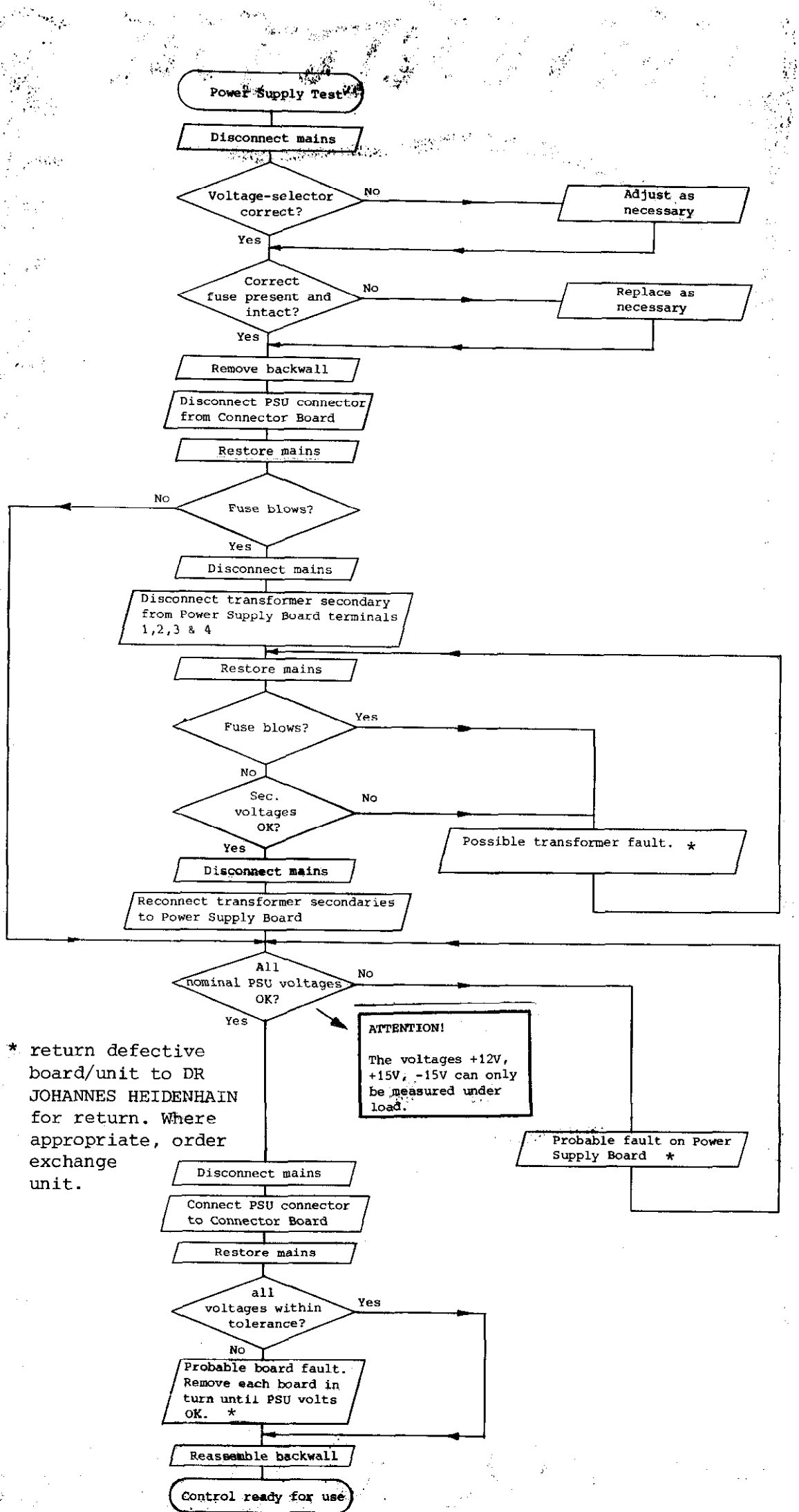
Signal designations for the plug and test points.

Fuses F1 and F2 not used on TNC 151

Test points on the Power Supply Board

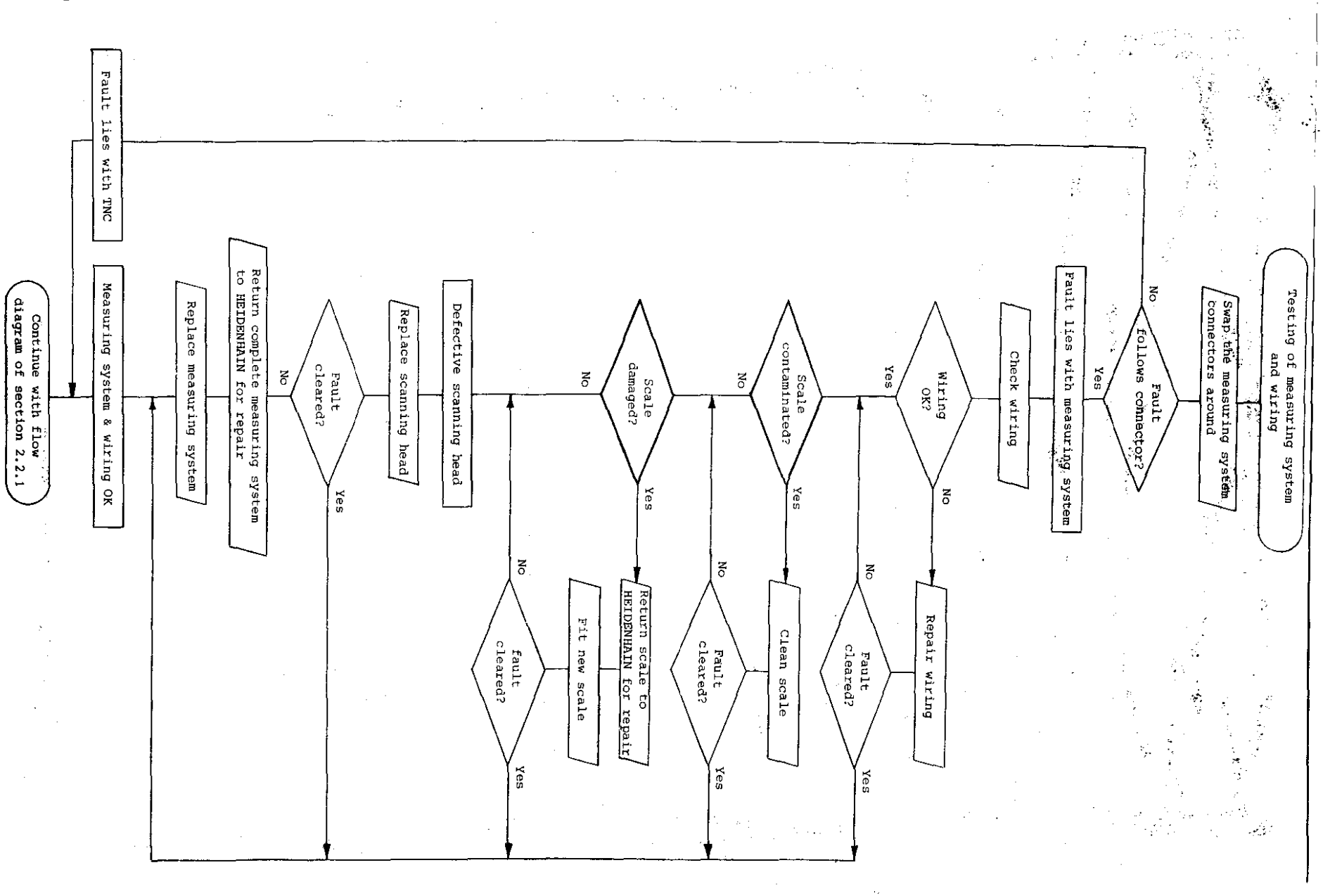
HEIDENHAIN
DR. JOHANNES HEIDENHAIN GmbH
D-8225 Traunreut · Tel. (08669) 31-0
Kundendienst

Procedure for testing the Power Supply Unit



* return defective board/unit to DR JOHANNES HEIDENHAIN for return. Where appropriate, order exchange unit.

2.2.5 Testing of the measuring systems and wiring



2.2.6 Burn-In Test

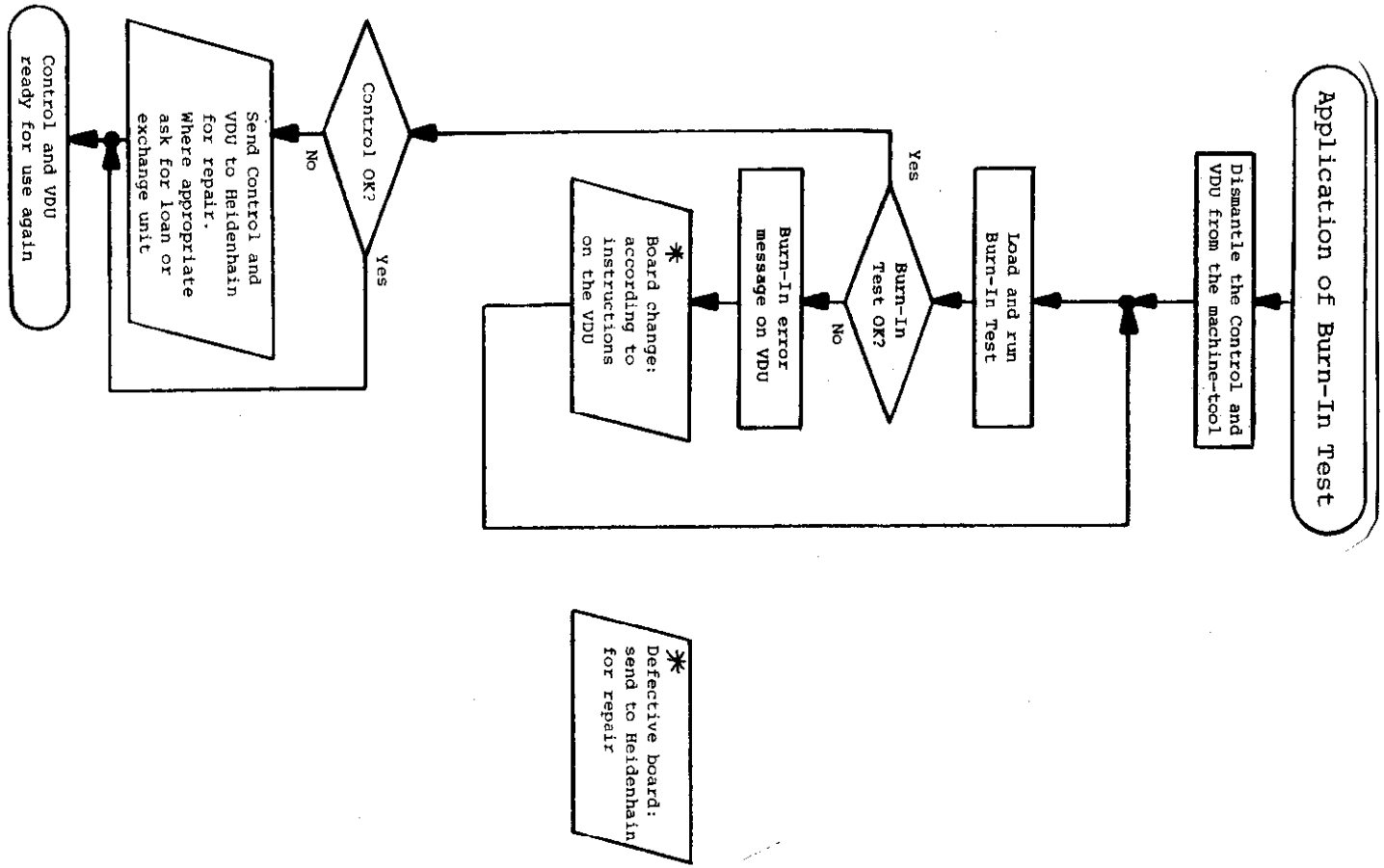
In some cases, inspite of there being definite fault conditions on the control, error messages may not be displayed on the VDU. However, the Control's electronics can be tested with the help of the Burn-In test program.
This test program is a means of dynamically testing the Control's hardware and can be used not only for duration testing but also for fault diagnosis.
The test program is stored on a digital cassette and can be loaded into the Control via magnetic tape units ME 101 B/ 102 B or ME 101 C/102 C (Program versions 212 902 05/ 212 902 07). The test program cannot be loaded into the Control if the flashing error message: "TNC ELECTRONICS DEFECTIVE" is present on the VDU. In this case, the faulty board must be determined by exchanging each board in turn until the fault is eliminated. However, before exchanging any board, it is advisable to check the output voltage from the Power Supply Unit (see section 2.2.4).
To run the Burn-In test program it is neccessary to have a set of Burn-In Test Adapters.

Figs. 2 to 5 show pictorial and schematic representations of each individual adapter.

Depending on the type of Control, (TNC with either a standard SE interface or with an external PLC I/O Board) the appropriate adapters must be connected as shown in fig. 1.

It is important to have the correct test program for the type of Control and for the Control's current NC Software issue. The test programs are listed on page 20. The type of Control can be determined from the identification number of the unit; the issue of the NC Software can be determined from the NC Software issue number. Both these numbers are found on the type-plate on the rear of the Control.

Application of the Burn-In Test



HEIDENHAIN
DR. JOHANNES HEIDENHAIN GmbH
D-8225 Traunreut · Tel. (08669) 31-0

Kundendienst

Burn-In Test Programs for TNC 151 A

on the Philips miniature cassette

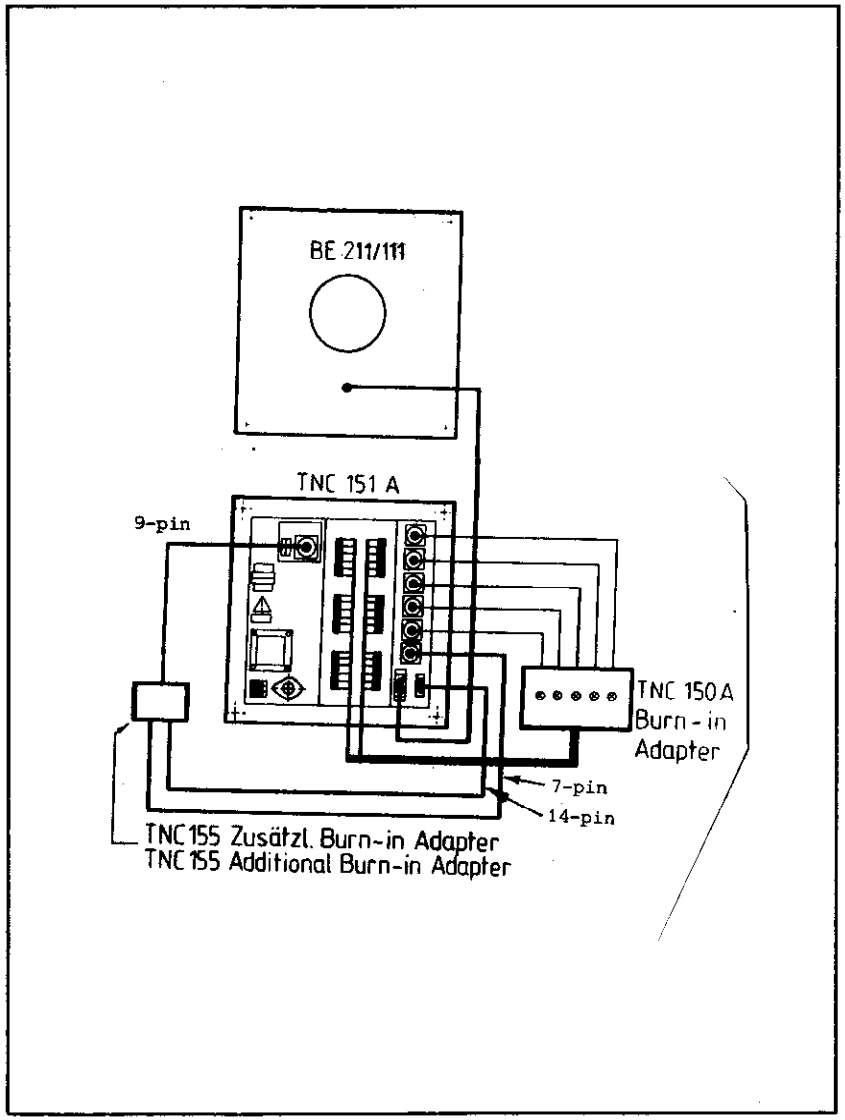
Control Type	Control Id. No.	From NC Software issue	Test dialogue	Test Prog. Id. No.
TNC 151 A	229 134 99 229 134 95	 06	D	230 600 01
TNC 151 A	229 134 99 229 134 95	 06	GB	230 601 01

Burn-In Test Programs for TNC 151 P

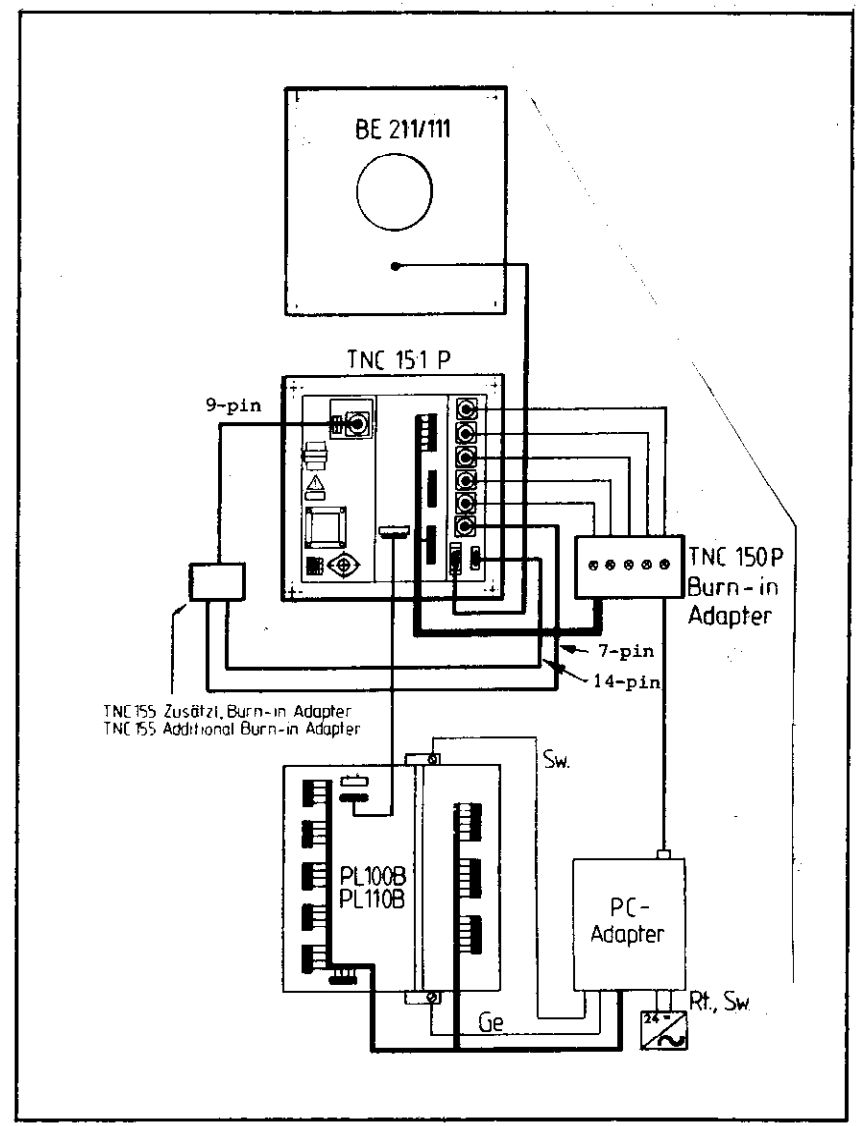
on the Philips miniature cassette

Control Type	Control Id. No.	From NC Software issue	Test dialogue	Test Prog. Id. No.
TNC 151 P	229 136 99 229 136 95	 06	D	230 602 01
TNC 151 P	229 136 99 229 136 95	 06	GB	230 603 01

Fig. 1 Interconnections of Burn-In Adapters and TNC 151

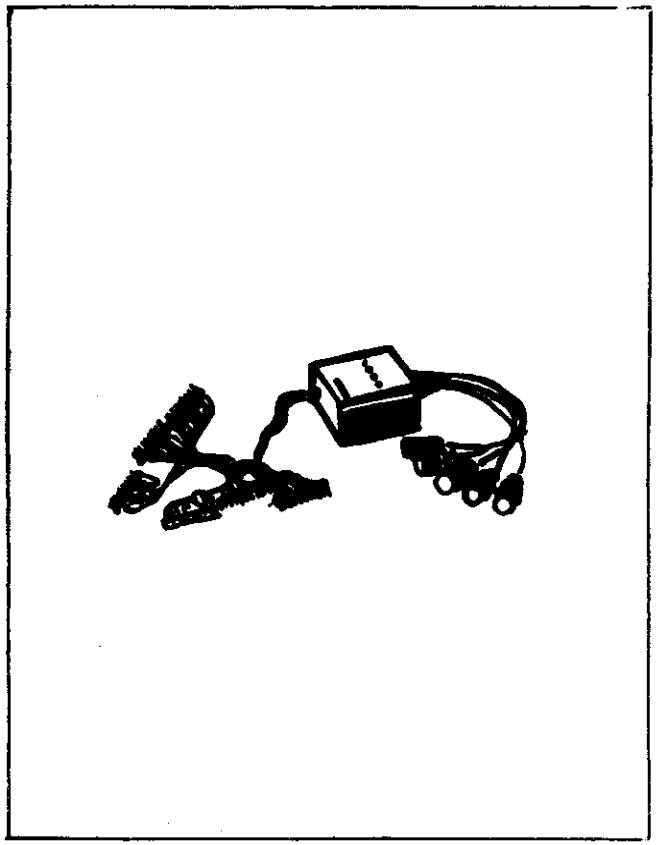


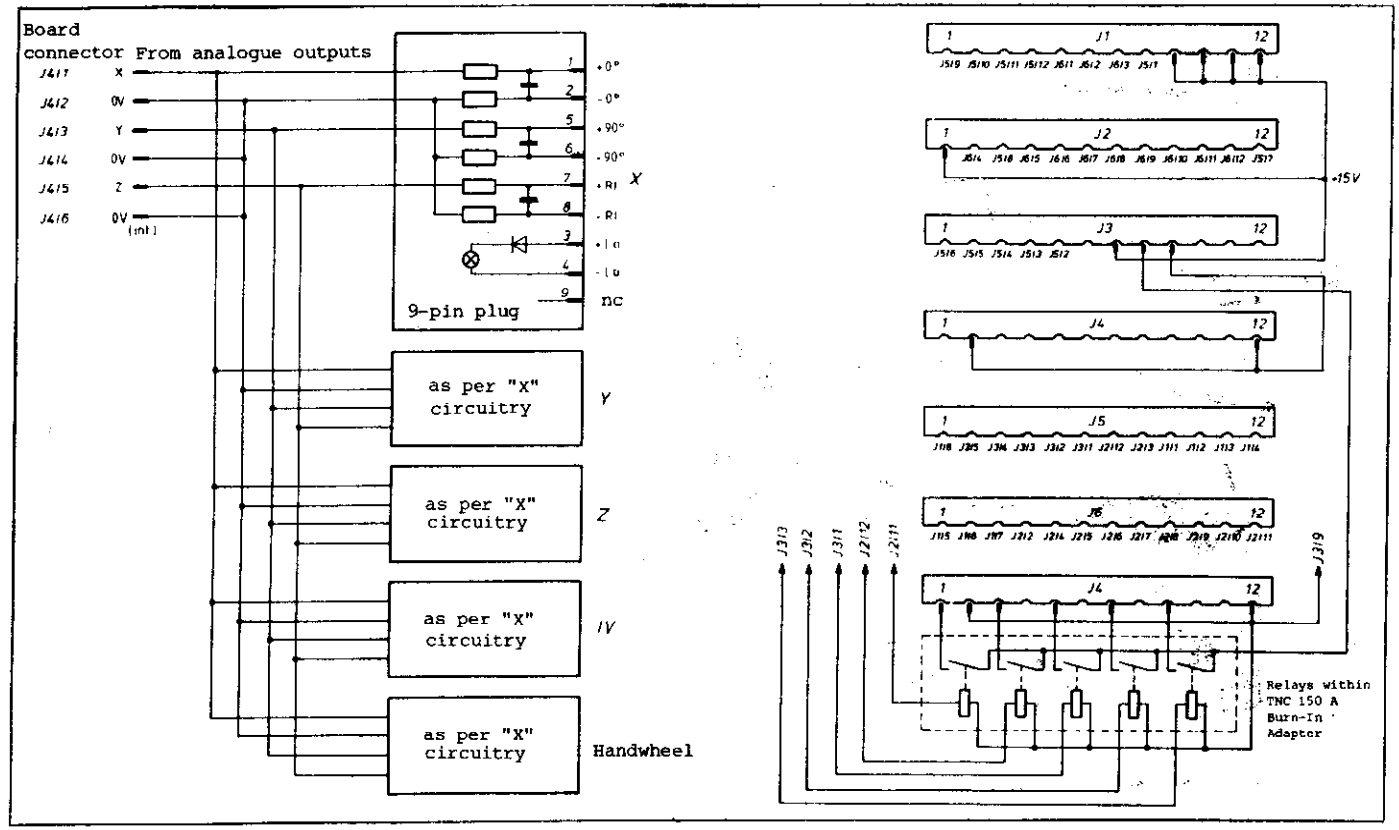
a) TNC 151 A/E



b) TNC 151 P/V

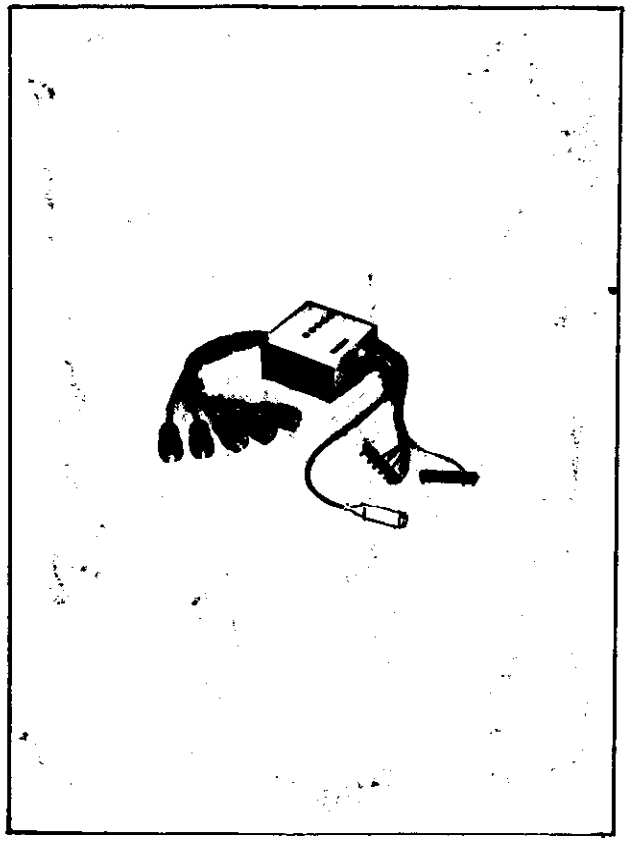
Fig. 2 TNC 150 A Burn-In Adapter (Id. No. 224 874 ZY)

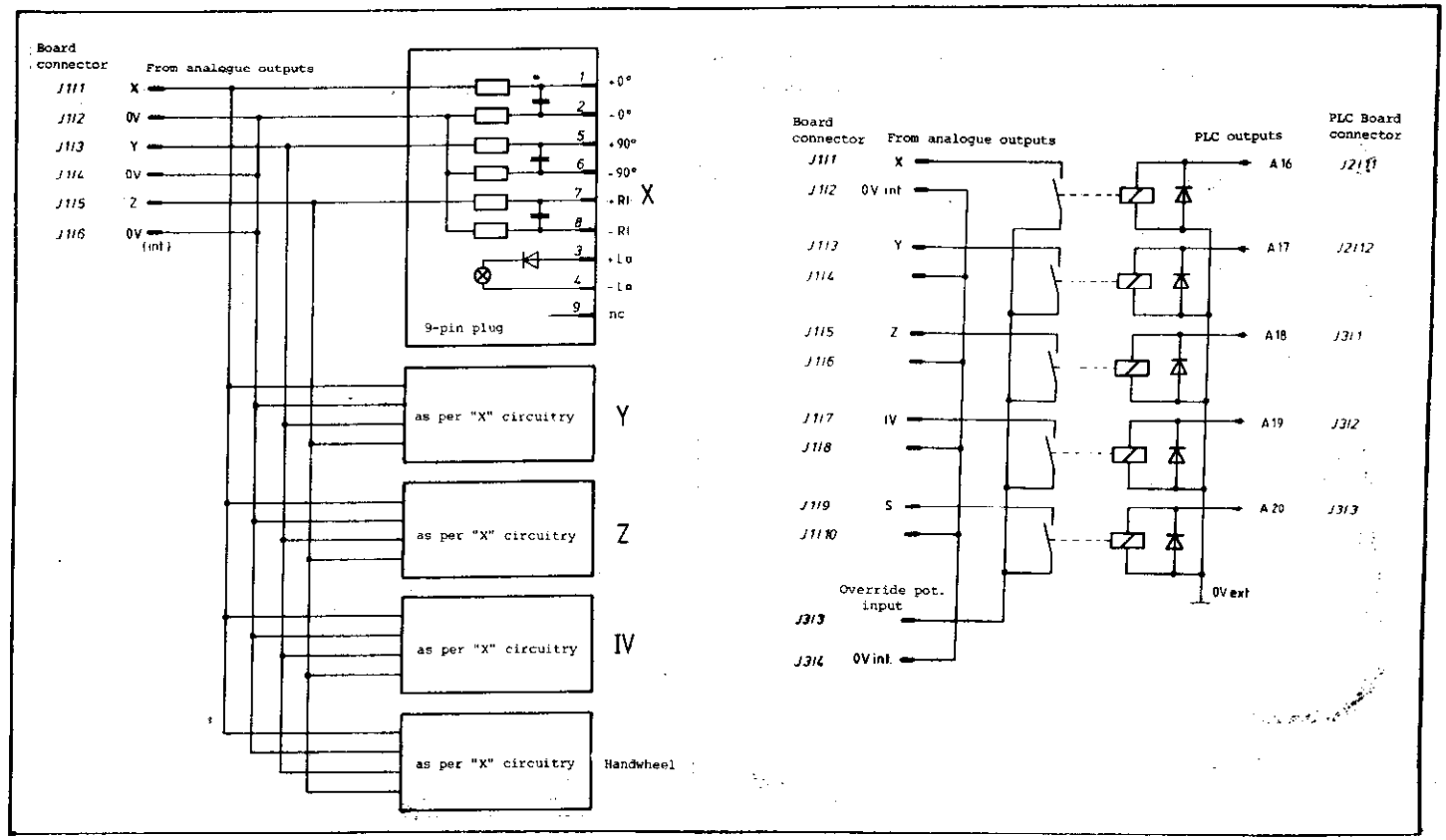




Schematic of interconnections created by connecting the TNC 150 A Burn-In Adapter to the Control.

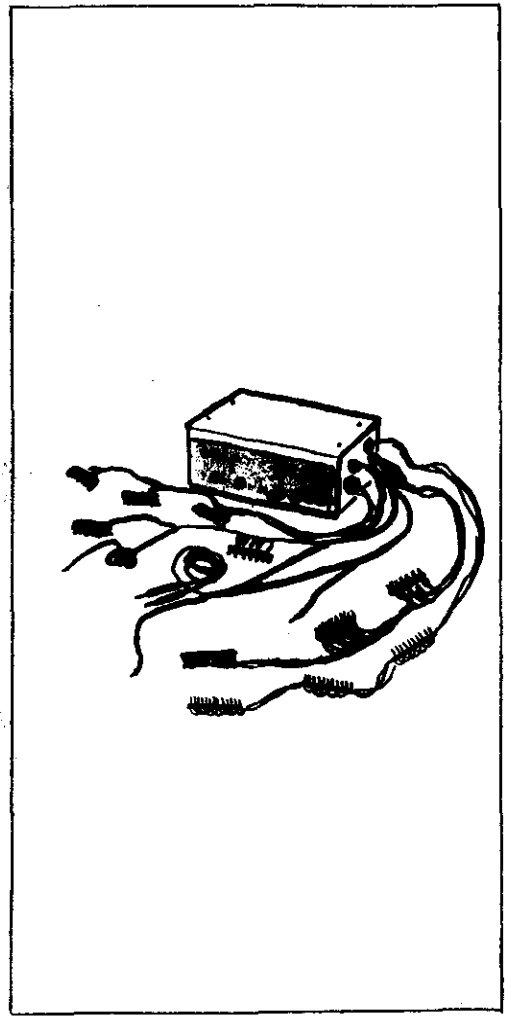
Fig. 3 TNC 150 P Burn-In Adapter (Id. No. 224 875 ZY)

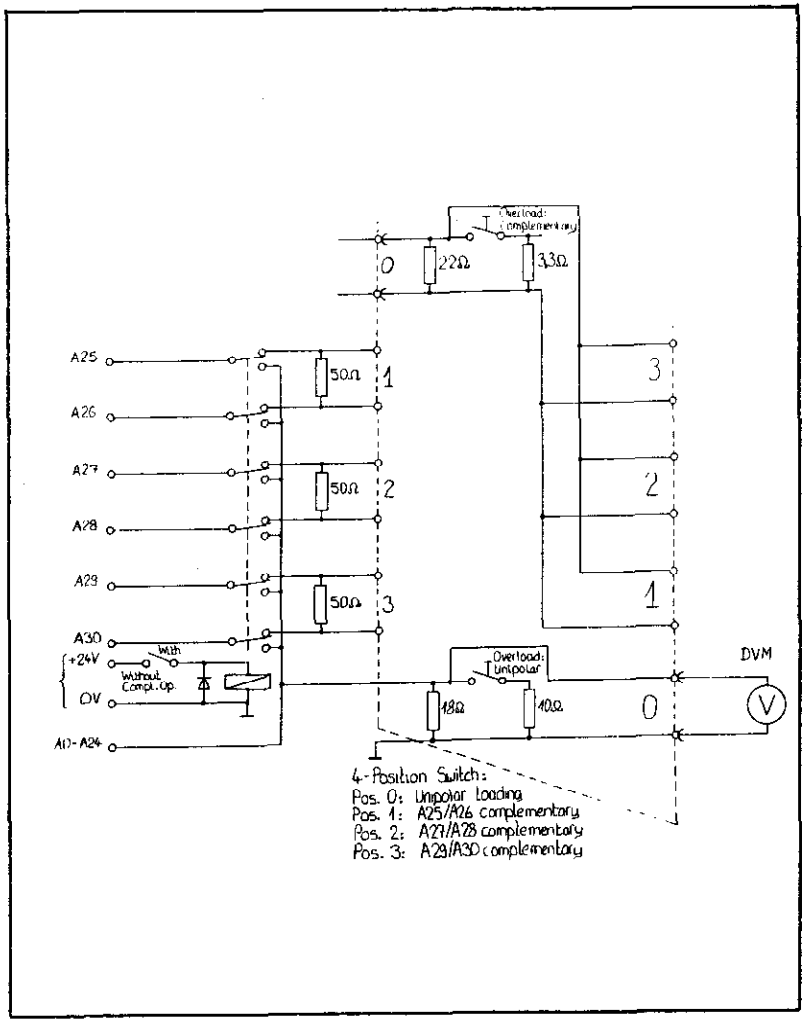


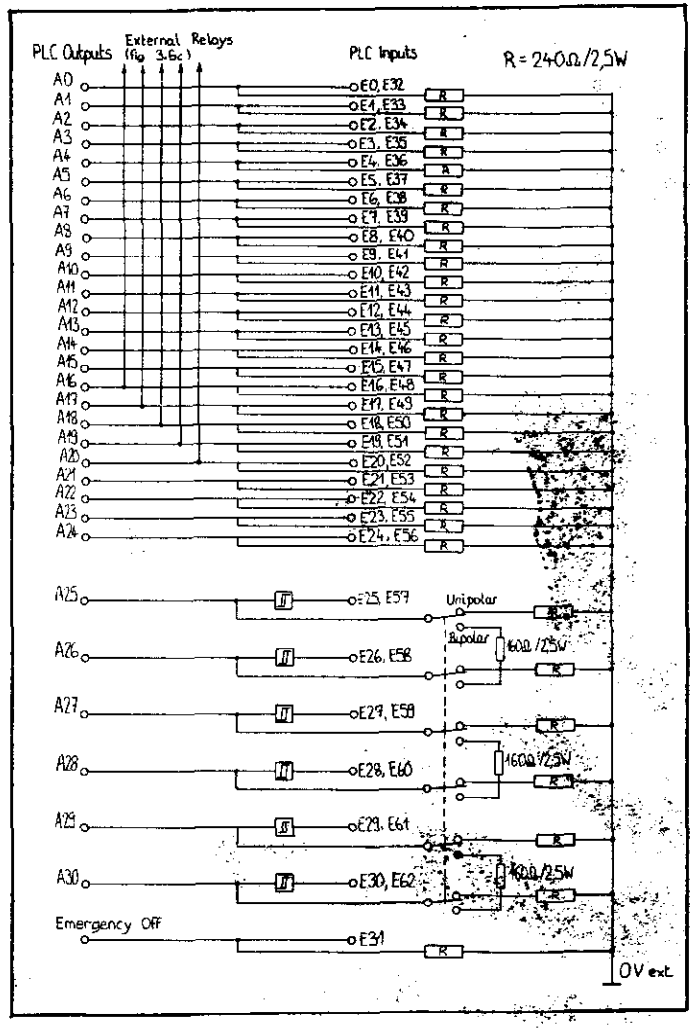


Schematic of interconnections created by connecting the TNC 150 P Burn-In Adapter to the Control.

Fig. 4 PLC Adapter (Id. No. 224 873 ZY)



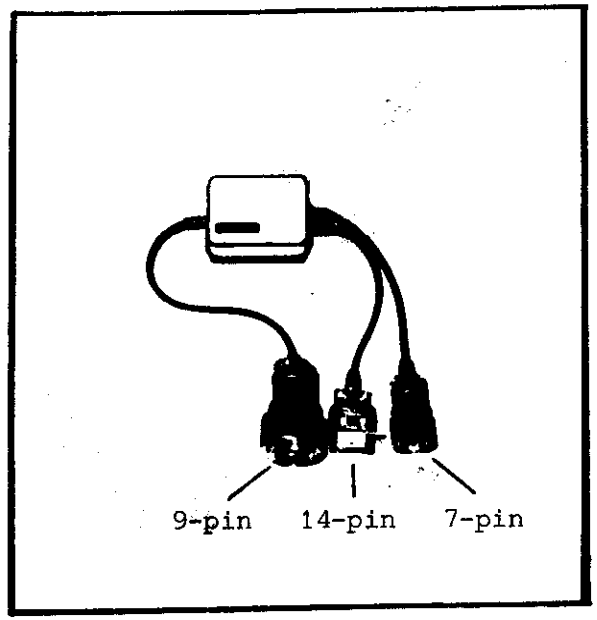


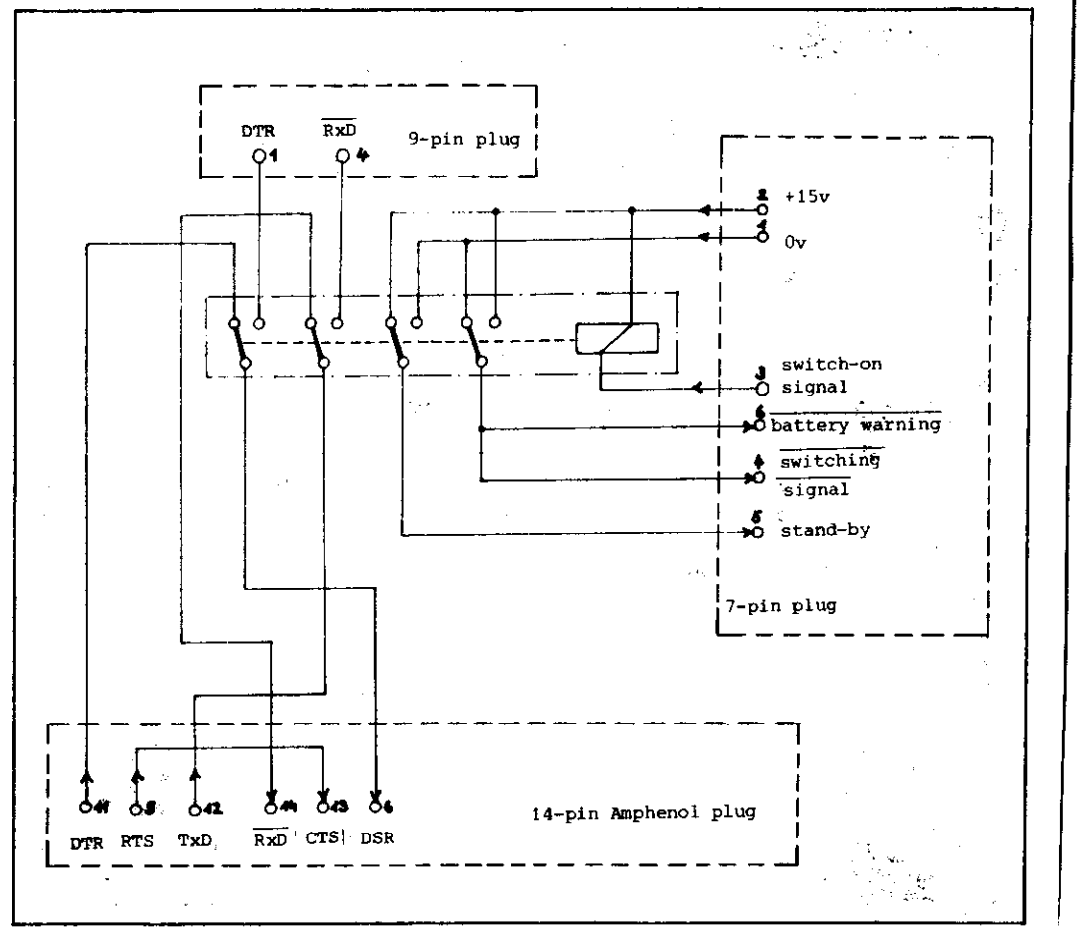


Internal circuitry schematic:
Additional circuitry for overload facility

Internal circuitry schematic:
Standard circuitry, with unipolar/ bipolar switch-over.

Fig. 5 TNC 155 Additional Burn-In Adapter (Id. No. 228 881 ZY)





Internal connections.

Loading the Burn-In test program

(Burn-In test program not already loaded)

1. Connect the Magnetic Tape Cassette Unit (ME 101/102) to the V.24 socket on the rear of the Control.

2. Prepare the ME unit to down-load the test program to the Control by inserting the appropriate program cassette (see list, page 20) and pressing the following buttons:

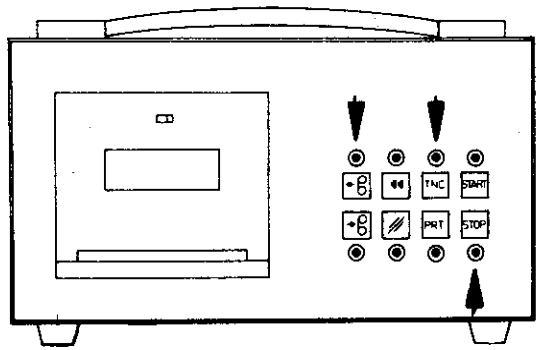


Fig. 6 Initialization of ME unit

3. Control must now be prepared:
   After applying power to the Control, it automatically carries out a memory test. During this time the dialogue

   "MEMORY TEST"

   will be displayed on the VDU.
   Upon completion of this test, the dialogue will be replaced by

   "POWER INTERRUPTED".

The necessary code number for reading in the Burn-In test program is entered by pressing the following keys:

[MOD] - as often as necessary to obtain the display:

"CODE NUMBER =", and then:

[6] [2] [0] [1] [5] [9]

(Errors in entering these numbers can be corrected by pressing [CE]).

4. The data transfer is then initiated by pressing:

   [ENT]

   During the loading of the Burn-In test program from the ME unit, the following dialogue will be displayed:

   "POWER INTERRUPTED
   EXTERNAL DATA INPUT"

   If necessary, the ME unit will first rewind the cassette tape before transmitting the data, blockwise, to the Control. Any user-programs already loaded/programmed into the Control will be **unaffected** by loading the Burn-In test program.

5. The Burn-In test program occupies both tracks of the cassette tape. Consequently, when all the data from the first track has been transferred, the following dialogue will be displayed:

   "EXCHANGE CASSETTE - ME START
   EXTERNAL DATA INPUT"

   To complete the data transfer, turn over the cassette and press the START button on the ME unit. The VDU will again display the dialogue.

"POWER INTERRUPTED
EXTERNAL DATA INPUT"

6. After completion of a sucessful data transfer, the ME unit will rewind the cassette and the VDU will display the question

"EXTERNAL UNIT CONNECTED ?"

Any other display implies either a transmission error or an incorrect/faulty test program cassette.

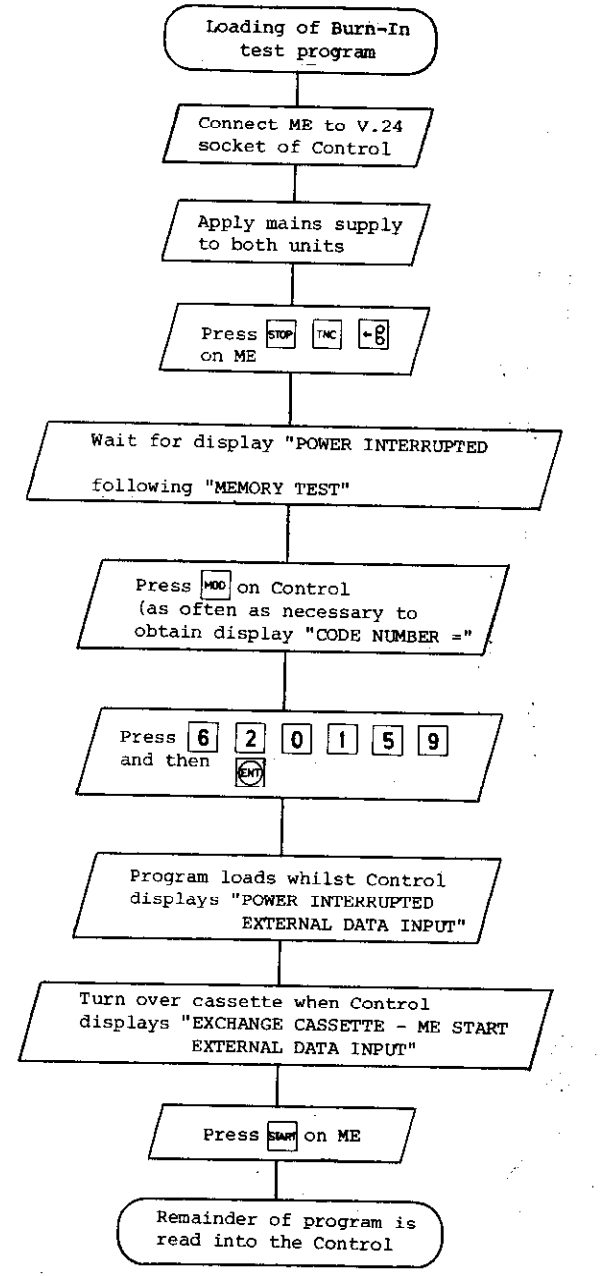


Fig. 7 Loading and Initialization of Burn-In Test Program

Re-initialization of a previously loaded Burn-In test program

The possibility exists that the Burn-In test program has been loaded and then the power removed. In this situation the buffer batteries will maintain the program in memory until the mains is restored.
It is also possible that the system has been warm-booted, during the execution of the Burn-In test, by pressing

CL PGM

Under both of these circumstances the following procedure is to be followed in order to restart the Burn-In test program:

The Control will automatically carry out a memory check. This test takes approx. 17 sec, during which time the dialogue

"MEMORY TEST"

will be displayed on the VDU.
Upon completion of this test, the dialogue will be replaced by

"PRESS NOENT KEY"

IMPORTANT
Only press the key

NO ENT

if you wish to **erase** the Burn-In test program and return to the normal operating system.
To restart the Burn-In test programm press

ENT

The following dialogue will then be displayed:

"EXTERNAL UNIT CONNECTED ?"

Any other display implies an error in the stored test program and the program must be reloaded from the cassette.

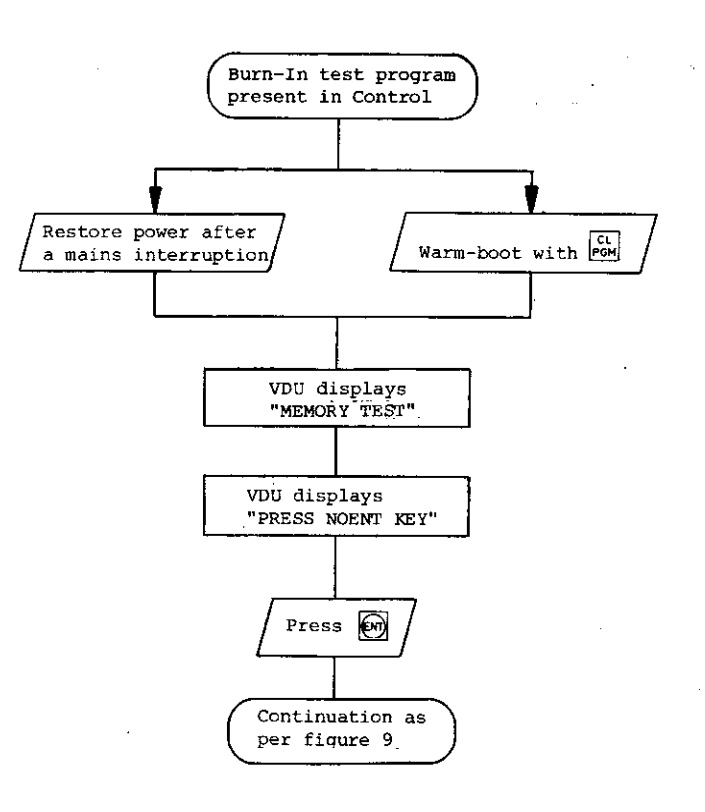


Fig. 8 Re-initialization of a previously loaded Burn-In test program

Continuation of the Burn-In test initialization

The remainder of the initialization procedure must be described in conjunction with the flow diagram of figure 9, page 31

1. Beginning with the display

   "EXTERNAL UNIT CONNECTED ?"

   which refers to the use of an external test computer, the operator must respond by pressing

2. A check is now automatically carried out, to ensure that the test program data has not been corrupted in any way. If an error is detected, the display

   "REREAD-IN PROGRAM XXXX
   CHECK SUM ERROR"

   will appear on the VDU, and the test program must be reloaded from the ME unit.

3. If the keyboard test has not already been carried out (eg. prior to a mains interruption) the option of carrying out this test will now be displayed:

   "JUMP OVER KEYBOARD TEST ?"

   The keyboard test can be skipped by pressing the key

   Any other key will cause the test to be carried out, in which case the following display will appear on the VDU:

   . . . . . E
   . . . . . E
   . . . . . E
   . . . . . E

   The lines of dots represent the individual keys in each of the four keying fields. The keys must now be pressed once each, in a defined sequence, in order that the Control can check that each key is making contact and delivering the correct code to the keyboard interface.
   The keying sequence is as follows:
   a) top right set of 20 keys
   b) top left set of 10 keys
   c) middle left set of 20 keys
   d) bottom right set of 10 keys
   In each case, the sequence is from left to right, beginning with the top row.
   For each correct key-push, the respective dot on the VDU will be replaced with a "*".
   If an incorrect code is received, the keyboard test will start again from the beginning.

   If the keyboard test has previously been carried out (eg before a power failure), the option of carrying out the test is not displayed. In this case, assuming no error message has been stored from a previous run, the program jumps into the sequential tests (see page 32).

4. If the keyboard test has previously been carried out, **and** an error message has been stored from an earlier run, this error message will be displayed and the program will wait for an interrupt (see point 7).

5. In the case of a Control designed for use with an external PLC I/O Board, the following text will appear on the VDU, following a successful keyboard test:

   "0, 1, OR 2 PC-BOARD ?"

   This refers to the number of external PLC I/O Boards connected to the Control during the test, and must be answered with the appropriate numeric key.

6. The final step of the full initialization procedure is the calibration of the two potentiometers on the front panel of the Control. These must be adjusted to give the display:

   "TEST INT.POT, BATTERY TRIGGER
   OVERRIDE POT ADJUST: 100
   SP. ROT. SPEED ADJUST: 100"

   If necessary, the caps of the knobs must be removed, the securing screws slackened, and the knobs realigned and tightened in the 100% position.

7. At the beginning of the initialization procedure, interruptions of the program are inhibited. After completion of the initialization, interrupts are enabled to permit jumps, at any time, to various points in the test procedure. Once the interrupts have been enabled, the test program can be interrupted by pressing one of a number of keys. The keys:

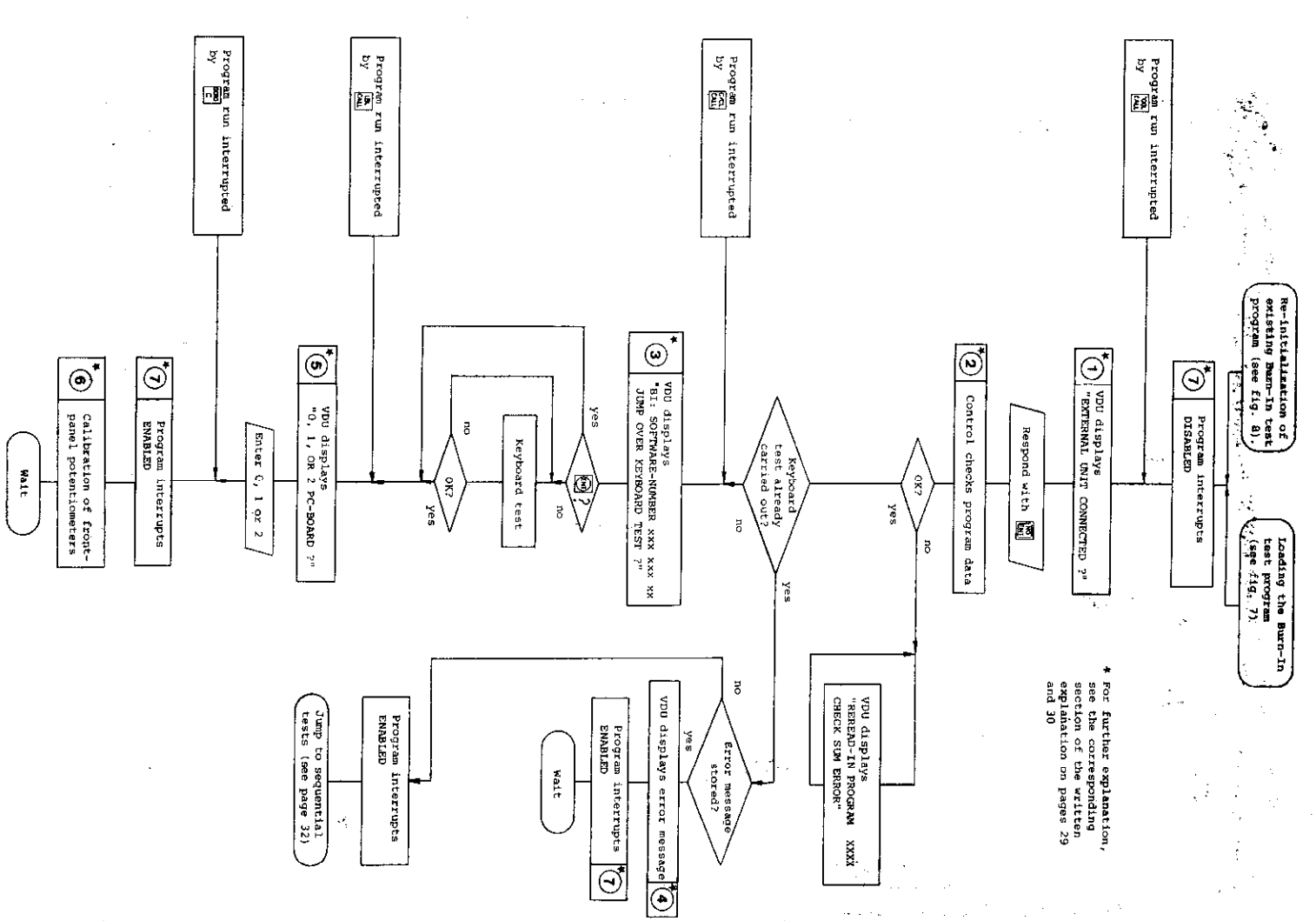
   

   for example, cause restarts at various points during the initialization routine, as shown in figs. 8 and 9.

CL PGM	System re-boot
TOOL CALL	"EXTERNAL UNIT CONNECTED ?"
CYCL CALL	"JUMP OVER KEYBOARD TEST ?"
LBL CALL	"0, 1, OR 2 PC-BOARD ?"
GOTO	"TEST INT.POT, BATTERY TRIGGER OVERRIDE POT ADJUST: 100 SP. ROT. SPEED ADJUST: 100"

Other interrupts are also possible; these are described in the following section.

Fig. 9 Complete initialization of the Burn-In test program



Sequential (duration) tests

Before starting these tests, check that all test adapters are correctly connected, including the connection to the V.24 interface socket.

The following tests are included:

a) Key [·]
"TEST INT.POT, BATTERY TRIGGER"
- Front panel potentiometers must be set to 100 ± 2%

b) Key [0]
"EPROM TEST CPU"
- The check-sums of all EPROMs accessible to the Main Processor Board CPU are checked.

c) Key [1]
"RAMTEST CPU BOARD
- Checks the RAM on the Main Processor Board

d) Key [2]
"RAMTEST MEMORY BOARD"
- Checks the RAM on the Memory Board.
This test must not be interrupted by a mains failure

e) Key [3]
"TEST PC RAM"
- Checks the RAM where the PLC data is held (markers, inputs, outputs, timers, counters etc).

f) Key [4]
"TEST STATIC RAM
CLP PROCESSOR BOARD"

g) Key [5]
"PC INSTRUCT DECODER, ACCU-FF TEST"
The circuitry used for decoding and carrying out the PLC instructions is tested.

h) Key [6]
"INPUT/OUTPUT TEST 1. PC BOARD" (only TNC 151 **P**)
The PLC I/O Board outputs are resistively loaded and connected to the inputs by means of the PC Burn-In Adapter. Each output is connected to 2 inputs. By writing "1"s to the outputs, and checking the corresponding inputs, the Control is able to deduce whether a fault is on an input or an output. If a fault is detected (a "0" on an input) the input conditions are displayed on the VDU:
eg.:
"**INPUT/OUTPUT TEST 1. PLC BOARD**
OUTPUT (or input) FAILURE

```
INPUT    0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9
  0      0 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 20      1 1 1 1 1 1 1 1 1 1 1 0 0 1 1 1 1 1 1 1
 40      1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
 60      1 1 1 1

BURN IN TIME: x,x HRS"
```

always a zero

Input 31 is used to monitor a 20 ms monostable pulse generated on the Emergency Off output. If the duration of this pulses falls outside its tolerance limits, a fault condition will be displayed:
eg.: "MONOFLOP TIME TOO SHORT 20MS"

This pulse can be generated manually by **individual pressing** of the key [+] or, repetitively, by pressing the key twice in quick succession. This repetitive mode will be indicated by a "1" at input position 31 on the VDU.

To aid in locating an I/O fault, each output can be driven individually. By pressing the key

[→]

(after a short delay) the VDU will display the input conditions when only output 0 is being driven high.

eg.: "INPUT 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9

0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	1																

(always a "1")

OUTPUT A0, INPUTS E0, E32

Subsequent pressing of the key

allows successive outputs (in ascending order) to be driven high, or in descending order with the key

All outputs can be cleared with the key

i) Key [7]
"EXT. POT, ANALOG OUTPUT TEST"
Five external relays within the TNC 150 A/P Burn-In Adapter, driven from outputs A16 - A20, are used to connect the analogue outputs X, Y, Z, IV, S, in turn, to the ext. pot. input (see figs. 2/3 pages 22/23). The test is made at three different voltages:
200mV, 5V, 9,5V

j) Key [8]
"TEST V24-INTERFACE"

k) Key [9]
"TEST 3D-SCANNER INTERFACE"
- Checks the interface to the Touch Probe.

f) Key [X]
"TEST SERIAL HANDWHEEL INPUT"
- Checks the interface to the HE 310 Handwheel Unit

m) Key [Y]
"SUPERVISION CIRCUIT TEST"
- checks the threshold values of the circuitry which monitors the measuring system inputs.

n) Key [Z]
"TEST REFERENCE IMPULSE INPUT"
- Checks the effect of a signal applied to the reference-pulse inputs.

o) Key [IV]
"TEST TRANSDUCER INPUTS, EXE"
- Checks the effect of signals applied to the measuring system inputs.

Starting the sequential tests

The test sequence can be started, or restarted at any point by pressing the appropriate key.(eg key [8] to begin with the V.24 interface test.) All 15 keys associated with the sequential tests act as interrupts to the Burn-In test program.

Fault recognition

The detection of a fault will be displayed on the VDU.
The test cycle will be halted and the Burn-In Time stops. If one or more faults arise during the execution of the Burn-In test program, the fault message associated with the first fault will be stored. The stored message can be retrieved at any time by pressing the key

This causes a system re-boot, as explained on page 30.
All fault messages can be cleared with the key

This key also causes a restart of the sequential tests beginning with the test "TEST INT.POT, BATTERY TRIGGER".

Individual test runs

Each of the individual, sequential tests can also be made to run cyclically. To do this, the test program must be interrupted with the key

The VDU will then display:

"1 = CYCLIC
2 = STOP AT FAULT"

Option 1 means that the test (still to be selected) will be run cyclically, regardless of whether a fault is detected.
Option 2 means that the test will be run cyclically until such time as a fault is detected.
When one mode or the other has been selected, the VDU will display:

"SELECT TEST"

The desired test must then be selected with the appropriate key.
Another possible interrupt to the Burn-In test program is by means of the key

With this key the entire set of ASCII characters can be displayed on the VDU.

Calibration check of the Analogue Board ("TRIMMING ROUTINES")

Interrupting the Burn-In test program with the key

gains access to the calibration tests. Exit form these tests is only possible with the key

Within the calibration mode the following tests can be selected:

- Key 1 : Reference amplifier performance *
  ("TRANSMISSION BEHAVIOUR REF. AMP.")
- Key 2 : Analogue output voltage **
  ("ANALOG VOLTAGE OUTPUT")
- Key 3 : 32-step monotonic DAC *
  ("MONOTONIY DAC; 32 STEPS")
- Key 4 : DAC performance *
  ("TRANSMISSION BEHAVIOUR DAC")
- Key 5 : +/- 10V analogue output **
  ("DAC + ANALOG OUTPUT +/- 10V")
- Key 6 : Linearity of analogue output *
  ("DAC + ANALOG OUTPUT LINEARITY")
- Key 7 : Battery voltage check **
  ("TEST BATTERY VOLTAGE")

() text in brackets appears on VDU
*** these tests are not suitable for customer use.**
**** see following explanations:**

Key [2] : Analogue output voltage
The performance of the analogue output circuitry can be checked by connecting a DVM to each of the analogue outputs (eg X-axis: J1, pin1, w.s.t. pin 2) and selecting this test. Using the keys

[X] [Y] [Z] [IV]

voltage increments of 2,44mV, 24,4mV, 244mV and 2,44V respectively can be summed at at each of the analogue outputs (X, Y, Z, IV, S).
eg.: if the X key is pushed 5 times, the Y key 3 times, and the IV key once, the output voltage should read:
(5 x 2,44 mV) + (3 x 24.4 mV) + (1 x 2,44 V) = 2,5254 V

The polarity of the output can be reversed using the key

[+/-]

The output can be cleared using the key

[0]

Key [5] : +/- 10V analogue output

The analogue outputs should generate their maximum output of +10V. The polarity can be reversed as in test 2.

Key [7] : Battery voltage check
A "1" will be displayed on the VDU if the battery voltage is adequate, otherwise a "0" is displayed.

3. Exchange Information

Note: All inputs/outputs from the TNC 151 Control can only be connected to circuits which have voltages conforming to VDE S.73 §8.

Do not disconnect or connect plugs under power!

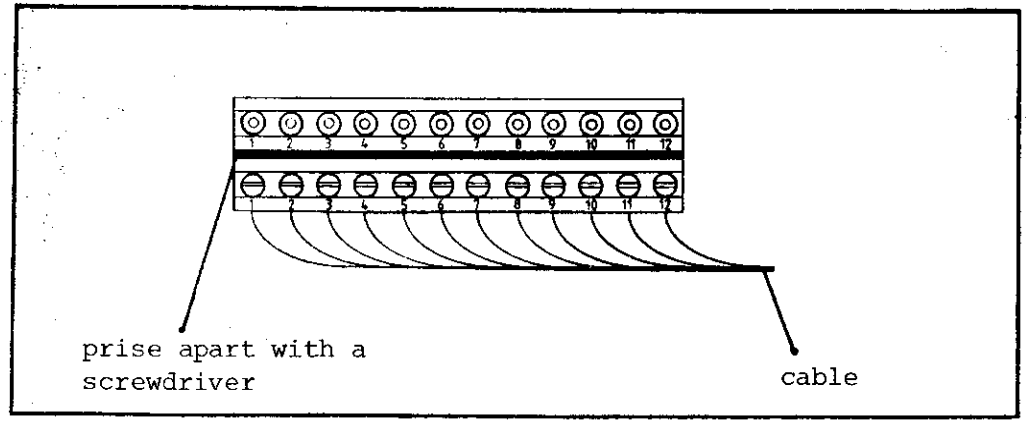
NC machines also need protection and installation safety as required for manually operated machines (e.g. EMERGENCY STOP). Their function should be checked during commissioning of the machine and of a new Control.

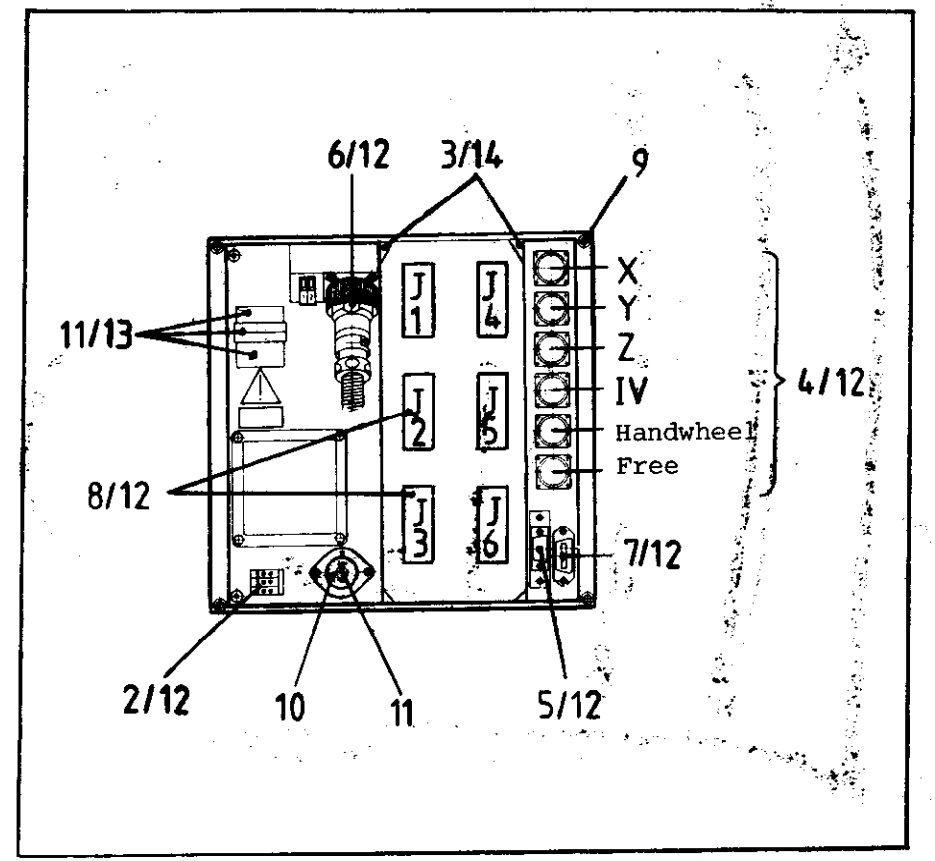
Before exchanging a Control the machine parameters should be noted or stored on magnetic tape!

3.1 Exchanging Control Units

3.1.1 Procedure for exchanging the TNC 151 A/E Control.

1. Gain access to the rear of the Control.
2. Remove the mains supply.
3. Remove the connector box cover-plate from the rear of the Control.
4. Mark the measuring system plugs (X,Y,Z,IV, Electronic Handwheel) and remove them.
5. Disconnect the VDU from the Control.
6. Disconnect the Handwheel Unit from the Control (if present).
7. Disconnect any external data devices.
8. Disconnect connector strips J1-J6, using a screwdriver to prise the connectors apart (Do not unscrew individual wires).

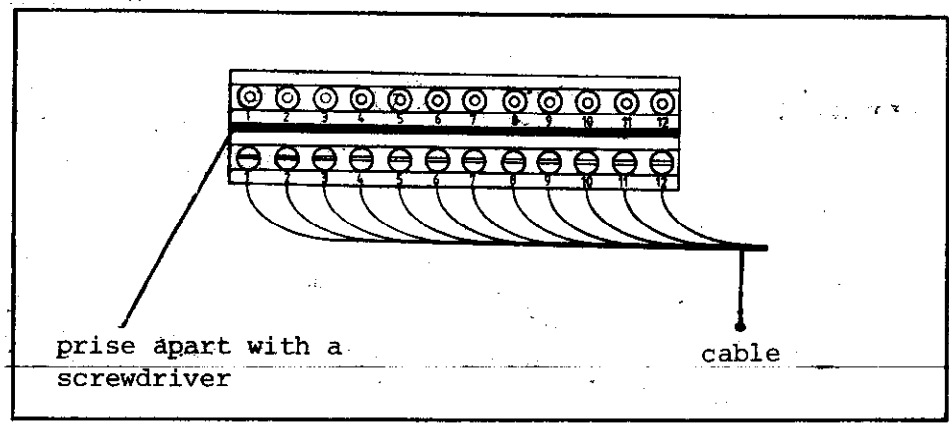


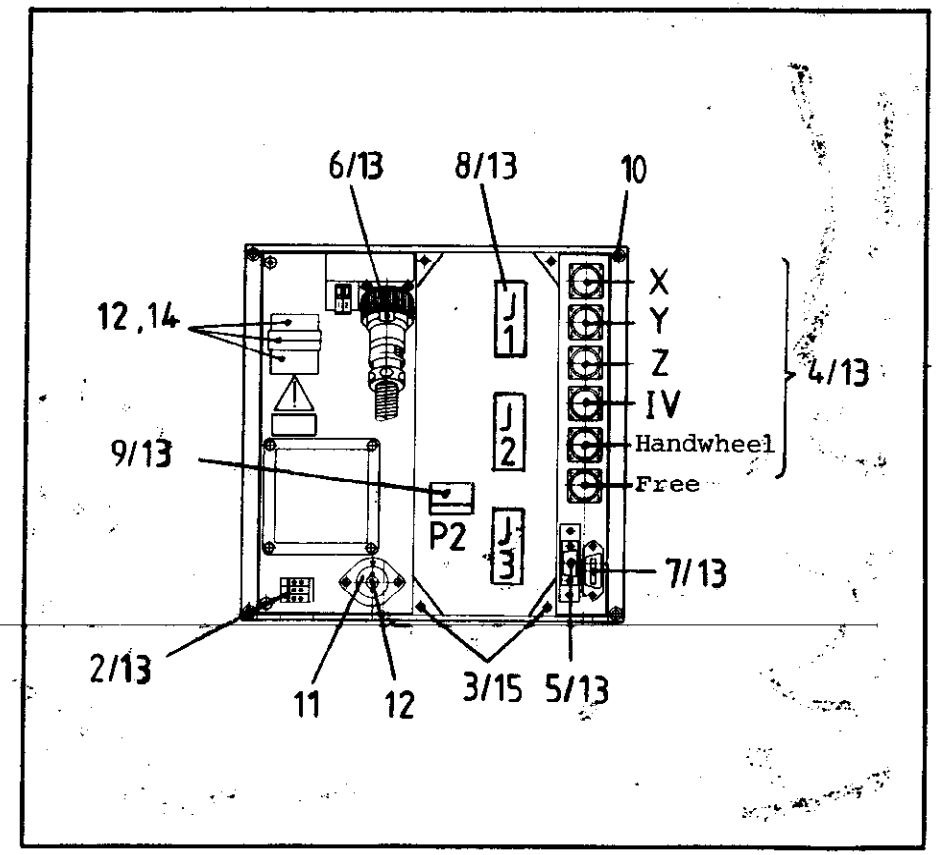


9. Remove the faulty Control, removing the fixing screws if not already removed in 1.
10. Install the new Control - check the voltage selector position.
11. Check the fuse-rating (see type-plate).
12. Reconnect all cables previously removed.
13. Obtain from the type-plate the Control's Id. No., NC and PLC Software Nos., and write them in the machine handbook.
14. Refit the connector box cover-plate.
15. Turn on the mains voltage.
16. Reprogram the machine parameters.
17. TNC is now ready to use.

3.1.2 Procedure for exchanging the TNC 151 P/V Control

1. Gain access to the rear of the Control.
2. Remove the mains supply.
3. Remove the connector box cover-plate from the rear of the Control.
4. Mark the measuring system plugs (X,Y,Z,IV, Electronic Handwheel) and remove them.
5. Disconnect the VDU from the Control.
6. Disconnect the Handwheel Unit from the Control (if present).
7. Disconnect any external data devices.
8. Disconnect connector strips J1-J3, using a screwdriver to prise the connectors apart (Do not unscrew individual wires).
9. Remove the connecting cable P2 to the PL 100 B/110 B from the Control.

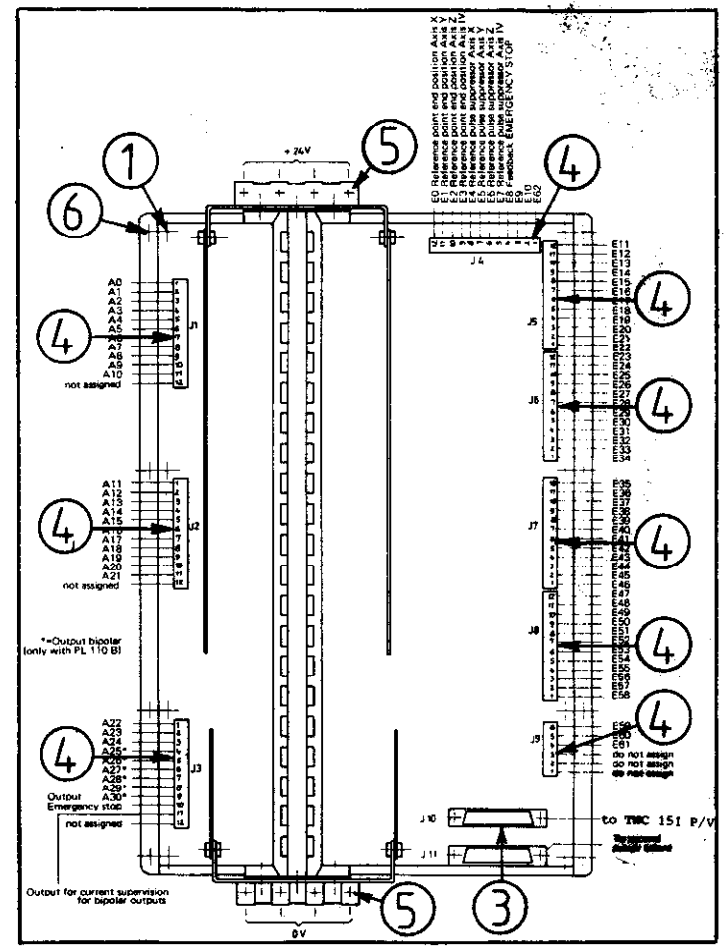




10. Remove the faulty Control, removing the fixing screws if not already removed in 1.
11. Install the new Control - check the voltage-selector position.
12. Check the fuse-rating (see type-plate).
13. Reconnect all cables previously removed.
14. Obtain from the type-plate the Control's Id. No., NC and PLC Software Nos., and write them in the machine handbook.
15. Refit the connector box cover-plate.
16. Turn on the mains voltage.
17. Reprogram the machine parameters.
18. TNC is now ready to use.

3.1.3 Procedure for exchanging the PLC I/O Board of the PL 100 B/110 B

1. Remove the fixing screws of the heatsink cover-plate.
2. Remove the heatsink cover-plate.
3. Disconnect the TNC 151 connecting cable.
4. Disconnect connector strips J1-J9, using a screw driver to prise the connectors apart.
   (Do not unscrew individual wires)
5. Remove the voltage supply (+24V and 0V)
6. Remove the fixing screws of the PL 100 B/110 B unit.
7. Install the new unit following the above procedure in reverse order.



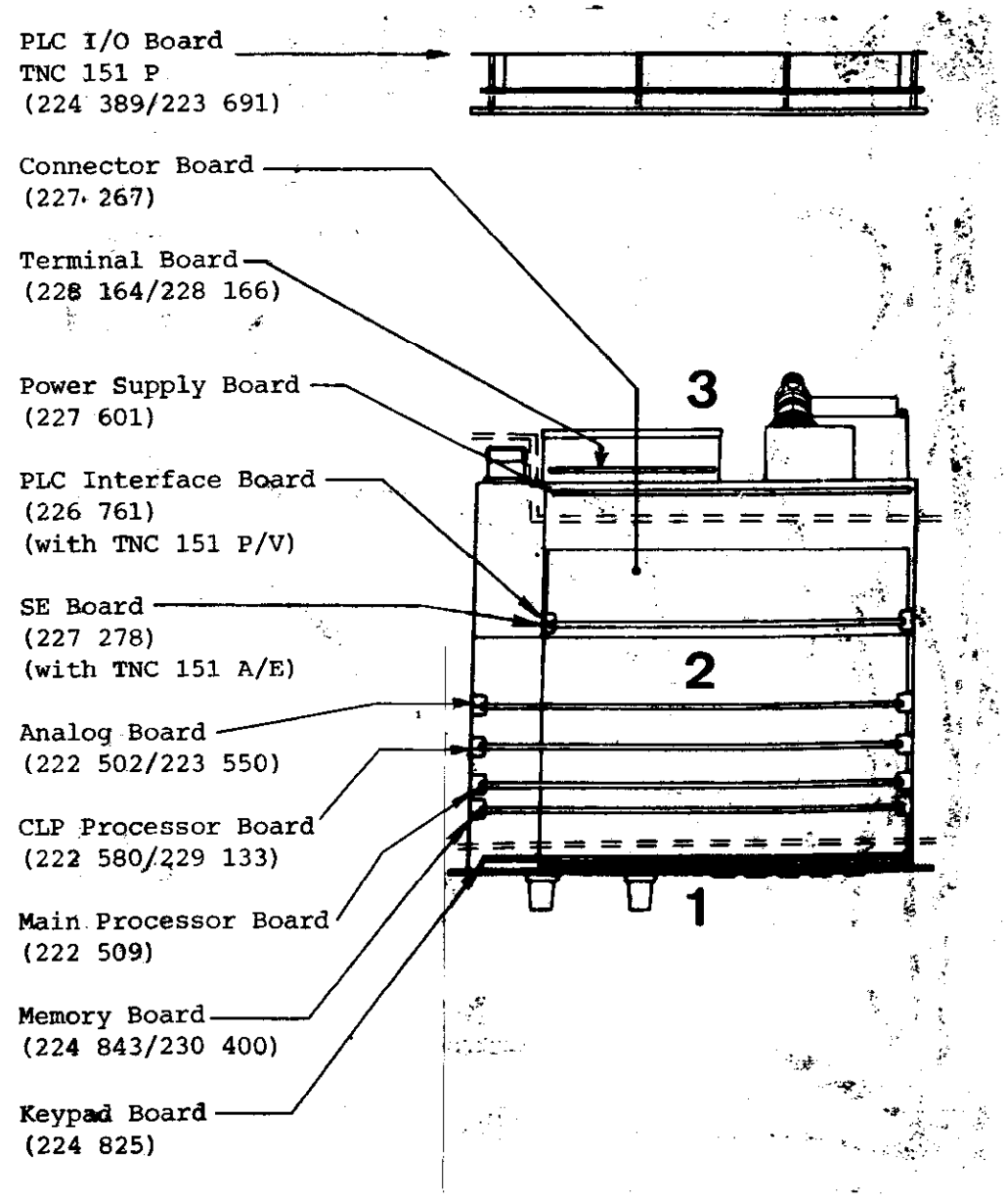
3.2 Board Exchange

Board Arrangement

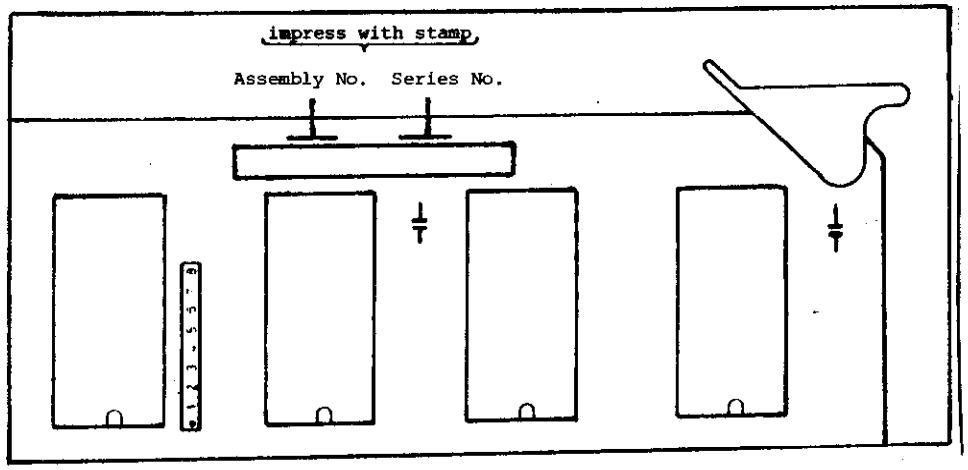
The TNC 151 consists of three main sections:

1) The frontplate/Keypad Board assembly;
2) The housing/Connector Board assembly,
   with five plug-in boards, namely:
   .Memory Board
   .Main Processor Board
   .CLP Processor Board
   .Analogue Board
   .either SE Board TNC 151 A/E
   or PLC Interface Board TNC 151 P/V
3) The backplate, Power Supply Unit and Terminal Board assembly.

Board arrangement TNC 151 A/AR/P/PR
TNC 151 E/ER/V/VR



Caution: .Please observe MOS protection measures when exchanging boards.
.Exchange boards with the same assembly no. only.
The assembly no. is impressed on every board, on the left of the serial no.



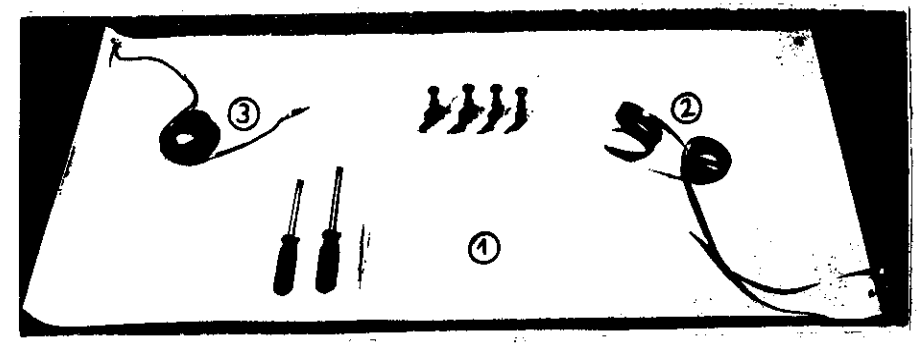
Work area requirements
The TNC 151 contains sub-assemblies with MOS elements. Although MOS ICs are equipped with an input protection diode network, to eliminate the build-up of static charges care must be taken when handling these elements.
The following requirements in the work area must be met:
Prior to working with MOS components or with assemblies containing MOS elements, all table coverings, instruments, tools, and work personnel must be properly grounded.

A portable "MOS-HANDLING-SET" for field service is necessary when exchanging the operating software and/or servicing the TNC 151:

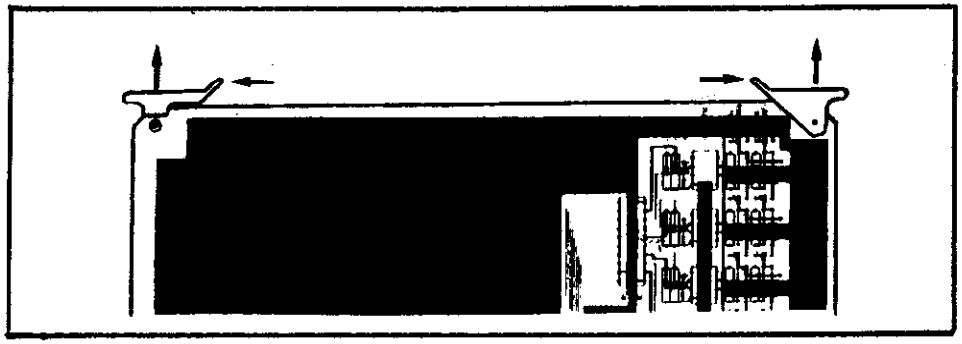
1 a conductive work surface

2 a wristband that provides an electrical connection between person and conductive work surface

3 a cable that equalizes potential differences between conductive work suface and ground



Exchanging the pluggable boards
Unscrew the 5 mounting screws and remove the housing cover.
Removing the boards:
Press the board ejector keys outwards and pull out the individual board form the top.

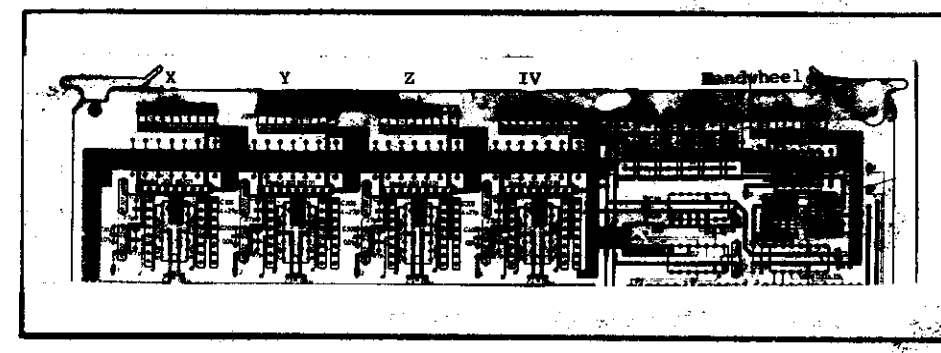


Inserting the boards:
The connectors of the boards are coded: incorrect insertion is therefore avoided. Press the board firmly into the Connector Board using the ejector keys tilted inwards.

Main Processor and CLP Processor Board:
When exchanging these boards insert program EPROM's IC-P3 and IC-P19 on the CLP Processor Board and IC-P4 to IC-P10 on the Main Processor Board.

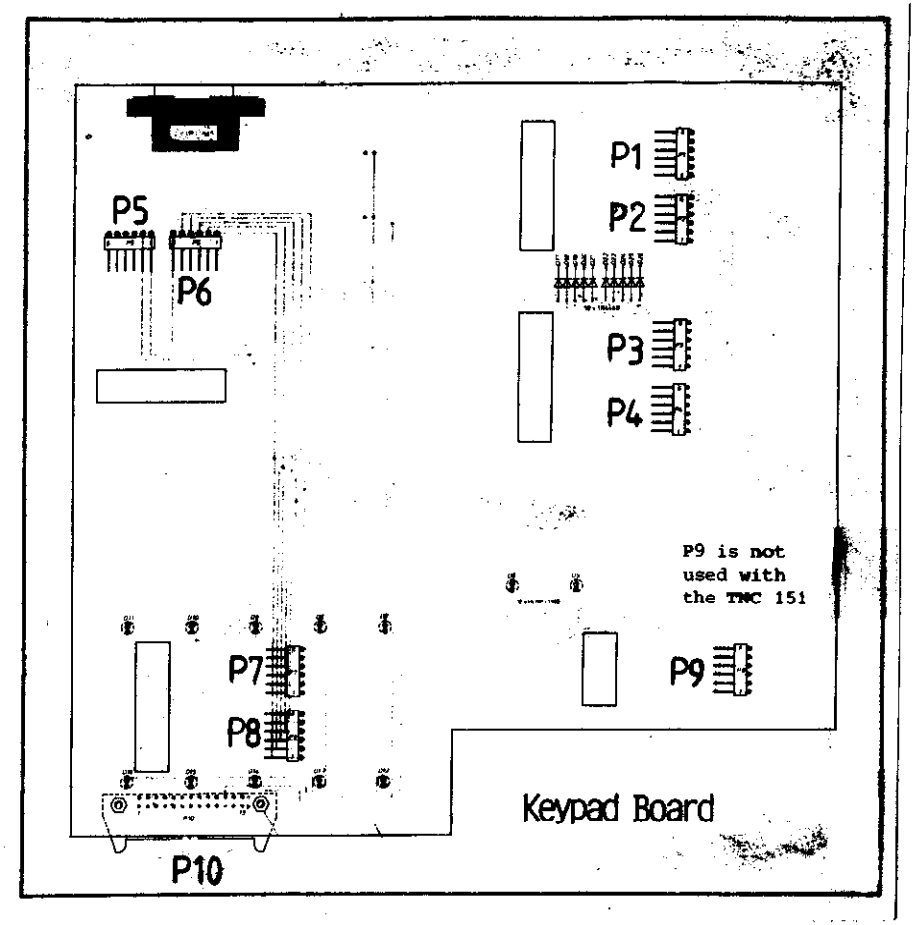
Memory Board:
During the exchange or removal of the Memory Board the buffered RAM will no longer be supplied with voltage, which means that the machine parameters and any user-programs will be lost!
Before inserting the new Memory Board plug in the relevant EPROMs (EPROM IC-P11 to IC-P18), paying particular attention to their correct location and orientation.

Analogue Board
Before removing the Analogue/Analogue TTL Board pull off and mark the connector plugs for the measuring system inputs/ square wave signal inputs and the electronic handwheel input. The connector sockets on the board are coded with coding pins.



Exchanging the Keypad Board:

.Remove the 6 cross-head fixing screws from the frontplate.
.Tilt the frontplate outwards.
.Remove connectors J13 (feedrate-override potentiometer) and J14 (spindle-override potentiometer) from the Connector Board.
.Remove the ribbon cable connector P10 from the Keypad Board.
.Remove the 7 cross-head fixing screws which secure the Keypad Board to the frontplate.
.Pull off the Keypad connectors, P1 to P8 from the Keypad Board.
.Remove the Keypad Board.



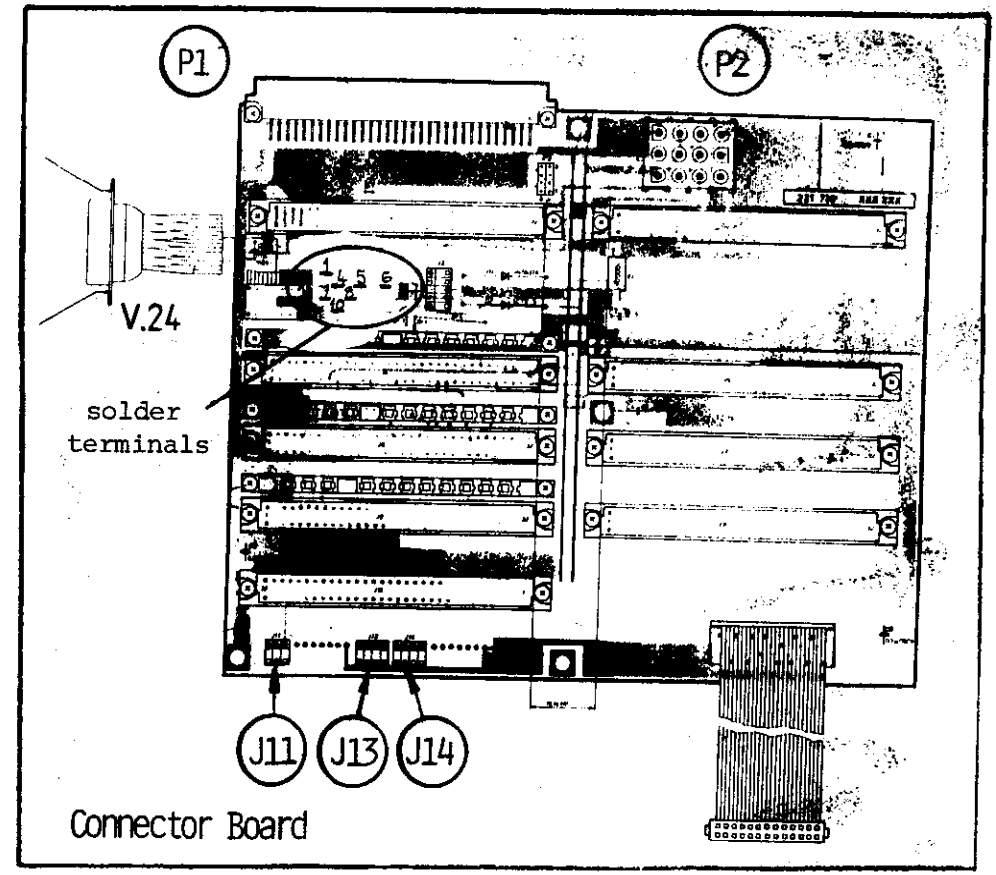
When rebuilding the assembly, ensure that the keypad connectors are firmly engaged in their respective sockets, and that the LEDs project through the corresponding bored holes in the keypad housing.

Exchanging the Power Supply Unit:

.Remove the 4 cross-head mounting screws from the rear of the Control (2 screws are found in the connector box).
.Remove the back wall with the Power Supply Unit and Terminal Board.
.Disconnect the ribbon cable connector, P1, from the Connector Board (see diagram).
.Remove the voltage supply plug, P2, from the Connector Board (see diagram).

Exchanging the Connector Board:

.Remove the 2 cross-head fixing screws of the V.24 connector on the rear of the Control.
.Push the V.24 socket through its recess in the Control housing.
.Unsolder the connectors to the VDU socket from the Connector Board (solder terminals 1,4,5,6,7,8,10). Note the colour of the wire connected to each terminal.
.Pull the Connector Board from the front of the Control housing.



3.3 Software Exchange

General

The TNC 151 operating software is stored in 17 EPROMs.

- IC-P3, IC-P19 (CLP Processor Board)
- IC-P4...IC-P10 (Main Processor Board)
- IC-P11..IC-P18 (Memory Board)

Every operating software is specified with an 8 digit Software No.

example: 227 001 06 complete software Id. No.
227 001 primary software Id. No.
06 update software index

Each of the 17 programmed EPROMs (IC-P3...IC-P19) is specified with an 8 digit Id. No.

example: 227 116 CG complete Id. No. of the Prog. EPROM
227 116 primary Id. No. of the Prog. EPROM
C position on the board
(C = IC-P12, HEXadecimal counting manner)
G update index

The operating software includes

o NC software (IC-P3...IC-P8, IC-P10...IC-P19)
o PLC software (IC-P9)

TNC 151 **A**: Control with o NC software and
o PLC standard software

TNC 151 **P**: Control with o NC software and
o PLC standard software, or
PLC custom software

The **dialogue language** of the TNC 151 is determined by **IC-P10** (located on Main Processor Board) and is discernible from the different Id. Nos. of the programmed EPROMs.

Following dialogue languages are available at this time

German (D)
English (GB)
French (F)
Italian (I)
Spanish (E)
Swedish (S)
Finnish (SF)
Dutch (NL)

The Id. No. of the other programmed EPROMs are the same (for a given IC position) in all languages. (prerequisite: same software issue!)

Exception: **IC-P9 (PLC software)**
The standard PLC program (EPROM position IC-P9) can be replaced with a custom PLC program for the TNC 151 **P**.

IC-P3
The export NC Software differs from the standard NC Software in EPROM position IC-P3.

The dot matrix for all VDU displayed characters is contained in **IC-P19 (character generator)**.

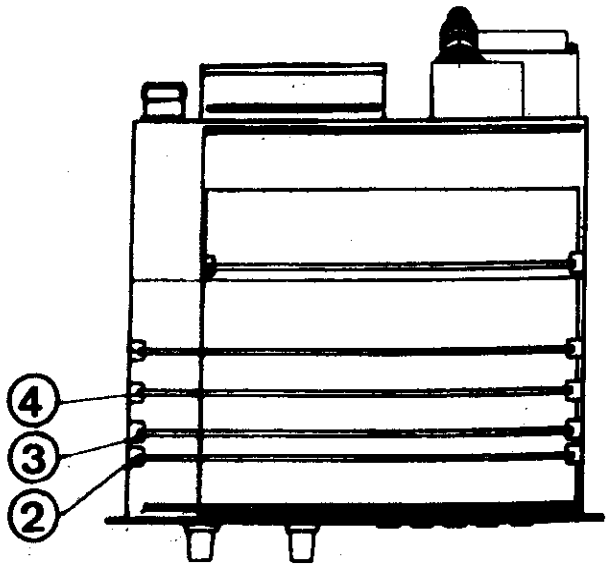
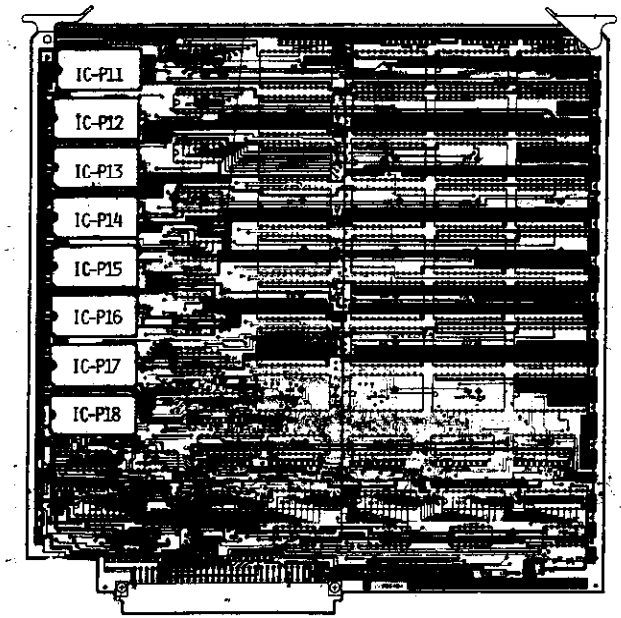
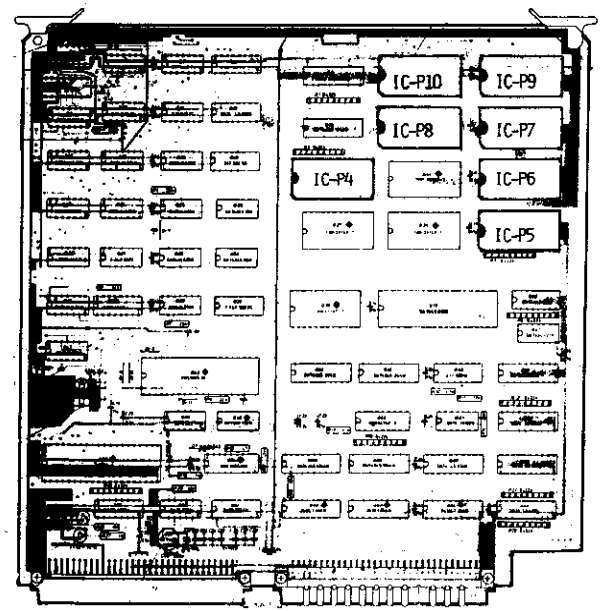


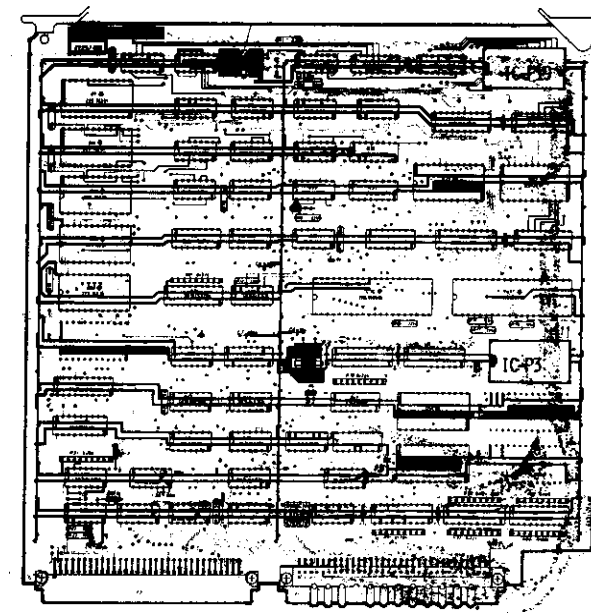
Illustration left: Arrangement of PCBs in the Control
Illustration below: Arrangement of EPROMs on the various boards



2 Memory Board 224 843 ../
230 400 ..



3 Main Processor Board 222 509 ..



4 CLP Processor Board 222 580 ..

Software Exchange

Caution: When exchanging the software observe the MOS protection procedures!

o The cover of the Control can be removed after unscrewing the 5 cross-head mounting screws (top side)

o To exchange the program, the following boards
- Memory Board 2
- Main Processor Board 3
- CLP Processor Board 4

have to be removed from the assembled Control

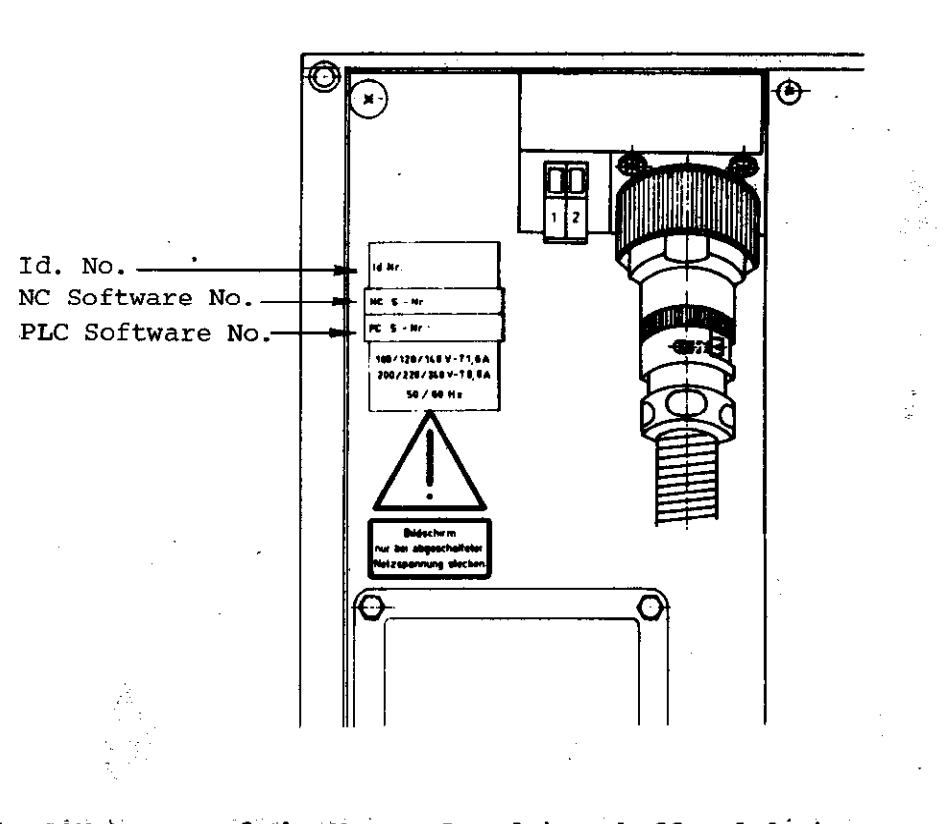
Thereto, lift the board ejector keys and press outwards, pull out board from above and lay onto MOS protection mat.

o Push screwdriver blade carefully between EPROM and socket, remove EPROM with extraction tool and place onto MOS protection mat.

o Insert EPROM into appropriate socket using insertion tool.

Important:
- When exchanging EPROMs, observe the position number (second to last digit of the programmed EPROM Id. No., hexa-decimal counting manner)
- The EPROM package index must point in the same direction as the ICs on the board.
- Visually check if the EPROMs are contacting their respective sockets after an exchange.

- After the software exchange has been concluded, the Id.-Nos. of the NC and PLC software have to be changed. The description plate for the software numbers is found on the rear of the Control under the type-plate.



The RAM memory of the Memory Board is unbuffered during the EPROM (software) exchange. The machine parameters and any stored user-program are therefore erased!

For continued operation, the machine parameters have to be re-entered into memory.

3.4 Replacement Parts, Loan/Exchange/Service Units
Units

Replacement Parts TNC 151

In general, replacement parts are available for all sub-assemblies discernible from the wiring diagrams (see section 4.3). However, it is strongly recommended that all repairs and maintenance work are entrusted to an official HEIDENHAIN agency. No responsibility can be accepted by DR. JOHANNES HEIDENHAIN GmbH for repairs undertaken by anyone else.

The list on page 49 shows the Id. Nos. and names of all parts available for the TNC 151. These parts can be ordered from the department **Kundendienst** (Customer Service) at HEIDENHAIN Traunreut. It is of utmost importance, when ordering, to give (i) the Id. No., (ii) the name, in German, and (iii) the quantity of each part required. Telexed order should be sent to the Kundendienst Telex: 17 866 982 or Teletex 866 982.

Loan, Exchange, Service Units

In order to keeep machine down-time as short as possible, HEIDENHAIN offers a loan and exchange service.

Loan units
Loan units are available, free of charge, for the duration of a repair carried out at HEIDENHAIN Traunreut or by an official HEIDENHAIN agent. The only charges to the customer are the shipping charges.

Exchange units
An exchange unit can be requested for a unit that is returned for repair. This exchange unit is equipped with the latest hardware and software issue and is externally in excellent condition. The only charges to the customer in this case are for the repair of his own unit.

Transaction
Requested loan or exchange units are shipped on the date of request, or the following day, provided that the unit is available from our stock.
A customer's faulty unit should be returned to DR. JOHANNES HEIDENHAIN within 14 days of receiving the exchange unit.

Service units
Service units are new units which are used for service purposes and can be obtained from DR. JOHANNES HEIDENHAIN at non-repeatable discount prices.

Id. No.	Name	
229 134 95	TNC 151 A/E mit 1280 Sätzen	(with 1280 blocks)
229 134 99	TNC 151 A/E mit 3160 Sätzen	(with 3160 blocks)
229 135 95	TNC 151 AR/ER mit 1280 Sätzen	
229 135 99	TNC 151 AR/ER mit 3160 Sätzen	
229 136 95	TNC 151 P/V mit 1280 Sätzen	
229 136 99	TNC 151 P/V mit 3160 Sätzen	
229 137 95	TNC 151 PR/VR mit 1280 Sätzen	
229 137 99	TNC 151 PR/VR mit 3160 Sätzen	
223 836 ..	PL 100 B Leistungs-Pl.	(PLC I/O Board)
223 216 ..	PL 110 B Leistungs-Pl.	(PLC I/O Board)
212 300 ..	BE 111 Bildschirmeinheit	(9" VDU)
222 674 ..	BE 211 Bildschirmeinheit	(12" VDU)
212 282 ..	Gehäuse, Frontteil TNC	(Front panel)
216 394 ..	Gehäuse, kompl.	(Housing assy.)
225 037 ..	Gehäuse, Tastatur-Vorsatz	(ISO format keypad)
224 843 ..	Pl., Speicher-3160 Sätze	(Memory Brd.-3160 Blk.)
230 400 ..	Pl., Speicher-1280 Sätze	(Memory Brd.-1280 Blk.)
222 502 ..	Pl., Analogteil - Sinus	(Analogue Brd.-Sinewave)
223 550 ..	Pl., Analogteil - TTL	(Analogue Brd. - TTL)
222 509 ..	Platine, Hauptrechner	(Main Processor Brd.)
222 580 ..	Pl., Regelkreisrechner	(CLP Processor Brd.)
227 601 ..	Platine, Netzteil	(PSU Board)
212 387 ..	Platine, Entstör	(Mains Filter Board)

Id. No.	Name	
227 278 ..	Platine, SE	(SE Board)
226 761 ..	Platine, PC-Interface	(PLC Interface Brd.)
228 164 ..	Platine, Klemmleiste	(Terminal Brd. for A/E units)
228 166 ..	Platine, Klemmleiste	(Terminal Brd. for P/V units)
224 825 ..	Platine, Tastatur	(Keypad Board)
227 267 ..	Platine, Stecker	(Connector Board)
213 204 ..	Tastenfeld kompl.-20 Tasten	(20-key keypad assy.)
217 737 ..	Tastenfeld kompl.-10 Tasten	(10-key keypad assy.)
217 532 ..	Halter, Batterie kompl.	(Battery holder assy.)
228 168 ..	Potentiometer kompl.	(Potentiometer assy.)
202 370 ..	Spannungswähler m. Si.-halter	(Voltage selector+fuse)
213 206 ..	Klemme Netz- 3 pol. kompl.	(3-way mains conn.)
215 091 ..	Trafo BV 15714	(Transformer)

4. Additional Information

4.1 Block Diagram Description

General
The TNC 155 block diagram shows, in simplified form, the internal functional units of the control, their relationship to the various boards, and their interconnections. The graphic layout of the diagram and the way it is included in single sheets.
- the representation of any of the TNC 155 models (A/AR/P/PR),
- simplified representation of functional processes

Numbers enclosed in dashes inform about the board and its functional unit.
e.g.: -50.1-
- -50.1- → Subdivision of functional unit
- -50.1- → Functional Unit
- -50.1- → Board

Simplified Description of the TNC 155 (Block Diagram)

- Keypad Board (1)
- Memory Board (2)
- Main Processor Board (3)
- CLP Processor/Graphic Board (4)
- Analogue Board/Analogue Board TTL (5)
- with SE Board (6) it corresponds to a A(E)-Type;
- without SE Board, with PLC Interface (6), however
- with PLC I/O-Board(s), it corresponds to a P(V)-Type or, respectively, PR(VR)-Type
- Power Supply Board (7)
- Terminal Board (8)

The functional processes of the control are divided between two microprocessor systems, each comprising:
- Microprocessor (TMS 9995)
- Program Memory (EPROMs)
- Write-Read Memory (RAMs)
- Input/Output facilities (e.g. keypad, screen, measuring system inputs, analog outputs, LEDs, V.24 interfaces etc.)

The functions of the control are divided between the two microprocessor systems as follows:

1. **"Main Processor System"**
   - Keyboard, LEDs
   - User Program Interpreter
   - Provision of programming "environment"
   - Generation of PLC program addresses
   * - Transfer of input and output states between PLC Interface Board, SE Board and PLC RAM
   * - Control of the V.24 interface

2. **"CLP-Processor System"**
   - Ascertainment of instantaneous positions
   - Interpolation Calculations
   - VDU Control
   * - Demand Speed Values to DAC
   * - Interface with handwheel unit

   * Serial data transfer via CRU bus.

Main Processor Unit

- Primarily on the main processor board and the memory board.
- The operating system software is held in EPROMs:

-30.1-	IC-P4 (not mapped)	
-30.3-	IC-P5...IC-P8	Main Proc. Board
-30.3-	IC-P10 (dialogue language)	
-20-	IC-P11...IC-P18	Memory Board

- The RAMs -30.2- on the main processor board can be accessed either by the main processor -30- or by the CLP processor -40-. The intended coordinates, programmed feed, display texts etc. can therefore be transferred.
  These RAMs also serve as register file memory for the main processor -30-.
  User programs, machine parameters, and (under certain circumstances) the PLC program are programmed in RAMs -20.1-.

- The 16-bit address bus is extended to 20-bit by a memory mapper -31-.

- The keyboard controller -32- has the task of driving the LEDs and scanning the keypads -32.1- on the front plate.

- The main processor is connected with V.24 interface -34- via a (serial) CRU-bus. This interface is used to exchange data by means of a magnetic tape unit (ME) or, respectively, an external processor.

- The PLC program contained in IC-P9 -33.1- is processed by the "1-bit-PLC-processor" -33- mounted discretely on the main processor board. The input and output states are stored in a 4k x 1 PLC-RAM -33.2-.

- I/O-Functions:
  a) TNC 151 A-Versions:
  24 galvanically separated inputs (E0 to E23) -60- and 24 floating relay contact outputs (A0 to A22 + emergency stop) -61- on the SE Board. The inputs and outputs are protected on the terminal board (A version) by special protective resistances 5.1k ohms -80- and 47 ohms -80.1-.
  Protective resistances should never be replaced with normal resistances!
  The Analogue outputs are led via LC-filter -81- as protection against the oscillation of analogue outputs.

  b) TNC 151 P-Versions:
  The inputs and outputs are loaded on external PLC I/O-board (e.g. PL 100B or, respectively, PL 100B) which are driven by the main processor -30- via the PLC interface board. The data is serially transferred via the CRU-bus. All lines of this bus as well as the required addresses are galvanically separated by the optocouplers -60- and are converted from the TTL level (5V) to the MOS level (12V) by means of a level converter -61-. Thus a higher noise immunity is obtained.

  Under the control of CRU addresses 63 programmable inputs (E0 to E62) -E2- located on the PLC I/O board are multiplexed on CRUIN 1 line. If 2 PLC I/O boards are connected the inputs from the 2nd board are multiplexed on CRUIN 2. On the PLC interface board either CRUIN 1 or CRUIN 2 are selected -64- and are led to the main processor via CRUIN.

  The serial CRU OUT signal is converted in 31 outputs via a serial-parallel-converter -E1.1-. The outputs (each having its own current supervision -E1-) are transferred via line drivers to the machine interface.
  - An overloaded output only switches off during the period of the overload.
  - If the current supervision detects overcurrent no emergency-stop results in the standard PLC program.

  The input E63 is used to indicate an overloaded output to the main processor -30-.
  PL 100B: 31 unipolar, programmable outputs + emergency-stop protected against overload.
  PL 110B: 26 unipolar, programmable outputs + 5 bipolar outputs and emergency stop protected against overload.
  On the **PLC I/O board** a 12V voltage is generated by an external 24V supply. On the **PLC interface board** this 12V voltage is transformed in a 5V voltage for its TTL modules.

CLP Processor/Graphic Unit:

- Primarily on the CLP processor/graphic board.

- Operating system is contained in EPROM IC-P3 -40.1- (32k x 8).

- The main task is the calculation of the instantaneously intended values of the analog output voltages dependent on:
  .the instantaneous actual positions
  .the programmed intended position
  .the distance of the intended position
  (influence on deceleration ramp)
  .the programmed feed rate
  .the fast traverse rates determined per machine parameter
  .the settings of the override and feed potentiometer
  The calculating speed requires a wait-free RAM -40.2--

- The measuring system signals are processed on the analog board. These signals are amplified at first -50.1- and then subdivided -50- by delaying (phase shifted) and combining them differently. The subdivided 0 degree, 90 degrees and RI signals are then led to the gate arrays -42- of the CLP processor board. The gate arrays are especially developed LSI circuits consisting of different gates and counters in which the direction of the movement and the number of pulses are calculated. This information can then be scanned by CLP processor -40- to ascertain the actual values of the axes.

- The symmetry, the on-to-off ratio and the amplitude of the system signals are constantly controlled by a supervision circuit -50-.

- The signals from the handwheel (if present) are shaped via the functional block -53- and are also processed by the CLP processor.

- If the distance between the control and measuring system is more than 20m, an EXE has to be interposed. The measuring signals are thus already amplified, subdivided, evaluated, supervised and converted in TTL signals. An "R" version of the control is used accordingly (e.g. TNC 155 AR) equipped with a combined EXE connection for X-, Y-, and Z-axis and an analog board TTL. The input amplifiers and the wiring for the signal subdivision are replaced with line receivers -50- on this analog board whose outputs are directly connected to the gate arrays -42- on the CLP processor board. The supervision signal of the EXE is also buffered -50- and transferred to the CLP processor board. The signals of the handwheel are likewise processed -53- as on the "normal" (sine) analog board.

- If instead of linear position transducers incremental encoders are used to ascertain actual values a reference pulse appears once per revolution. Since only one reference pulse is to be evaluated all other reference pulses of the axes X, Y, Z, IV are inhibited on the analog board -50-. The signal lines are connected with the analog board via the PLC I/O board and the PLC interface board. The level conversion MOS/TTL as well as the galvanic decoupling is carried out on the PLC interface boards via -61- and -60-.

- The data of the CLP processor is transferred to the analog outputs via the serial CRU bus. The digital output values calculated for all axes are multiplexed on the CRU OUT line and are converted in a 12 bit parallel format on the analog board. These successive digital values are then converted in analog values (voltages) by means of a DAC -52.1- (digital-analog-converter). These voltages are compared with the adjusted values of the override and feed potentiometers -52- and the results are transmitted to the CLP processor via CRUIN. The output voltages can thus be adapted to the values adjusted by the override or, respectively, the feed potentiometer. The X-, Y-, Z-, IV- and S-analog values generated shortly one after the other at the output of the DAC are allocated to the single axes by means of five sample and hold circuits -52.2-. The five individual analog voltages are amplified and buffered subsequently -52.3- and are led to the terminal board.

- On the analog board the buffer battery (-3,46V) and the internal temperature (65°) of the control are also supervised -51-. The supervision signals are led to the CLP processor via the CRUIN line.

- Two "watch dog" monoflops -51.1- are on the analog board. These must be triggered separately once every 5ms by the CLP processor -40- and once every 20ms by the main processor -30-. If the monoflops are not driven within 5ms or 20ms (error state), an emergency-stop signal is triggered.

- The drive of the screen is another important task of the TNC 151 CLP processor. It only has to write the texts to be displayed into the CRT RAM -41.1-. A special CRT controller TMS 9937 -41- generates the necessary addresses for the CRT RAM and the character generator IC-P19 -41.2- so that the data are transferred to the shift register -41.3- in the right sequence. Thus signal can be inverted by means of an exclusive-or-gate -41.4- to generate an inverse video display. The video signal, the bright/dark signal, the horizontal/vertical sync. signals and an 11V supply are used to operate the screen.

- On the SE-board (or the PLC interface board) the V.24 signals of the handwheel unit HE 310 are connected to the line drivers or, respectively, to the line receivers -62-. A serial interface module -43- on the CLP/graphic board stands between line receivers/drivers and the CLP processor to transfer data with the handwheel unit and to format data. (start/stop pulse e.g.)

- The signals of the 3D-probe are buffered via the 3D-probe-interface on the SE-board (or the PLC interface board) -63- and are evaluated via the counter module -42- on the CLP processor/graphic board.

Power Supply Unit

- +5V are generated for the TTL modules via the forward converter -70-. The flyback regulator -70.1- inductively coupled with the flow converter generates +/-15V for the operation amplifier.

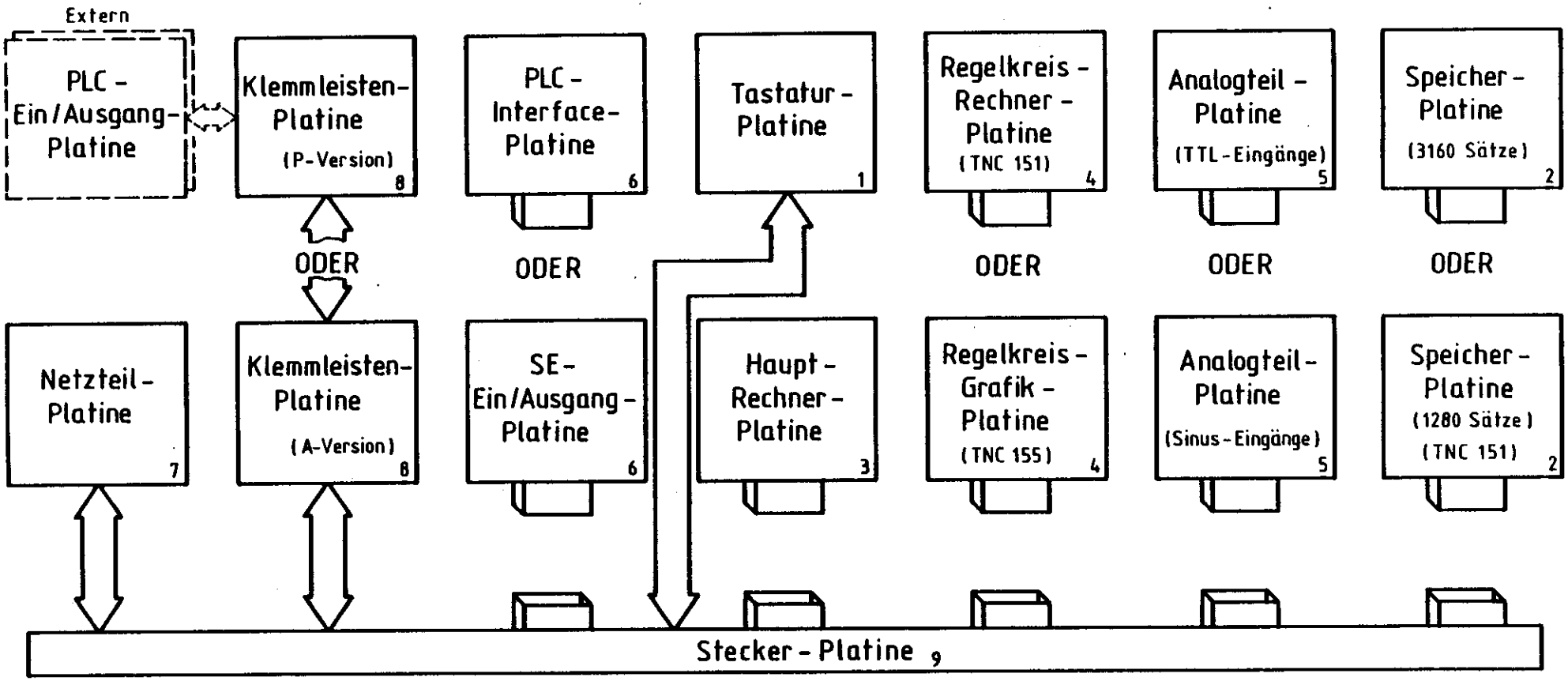
- The +12V supply voltage for the V.24 interface is generated with the help of the +15V by means of a linear regulator -70.2-.

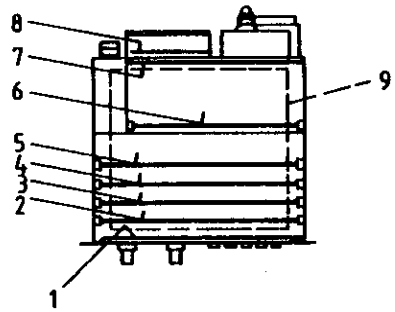
- +11V are generated via the forward converter -70.3- for the TNC 151 (BE 111, BE 211) screen which in contrast to the TNC 155 (BE 411) screen does not have an own power supply unit. The switch regulator -70.01- and -70.31- readjust the output voltage load controlled.

- The soft start -71- limits the relatively high switch-on current.

- On the power supply board there is, moreover, a voltage supervision -72- triggering a reset signal if the power supply is interrupted or if the supply voltage drops below a predetermined minimum level (187V if set for 220V operation) for a short time.
  If U2 (+5V) exceeds if there is a failure the overvoltage recognition -73- is immediately effective and causes the overvoltage protection (thyristor) -73.1- to connect through. Thus U1 is short-circuited coming directly from the power supply transformer -74- via the rectifier -75-. A greater damage at the subsequent electronics is thus inhibited by means of this protective measure.

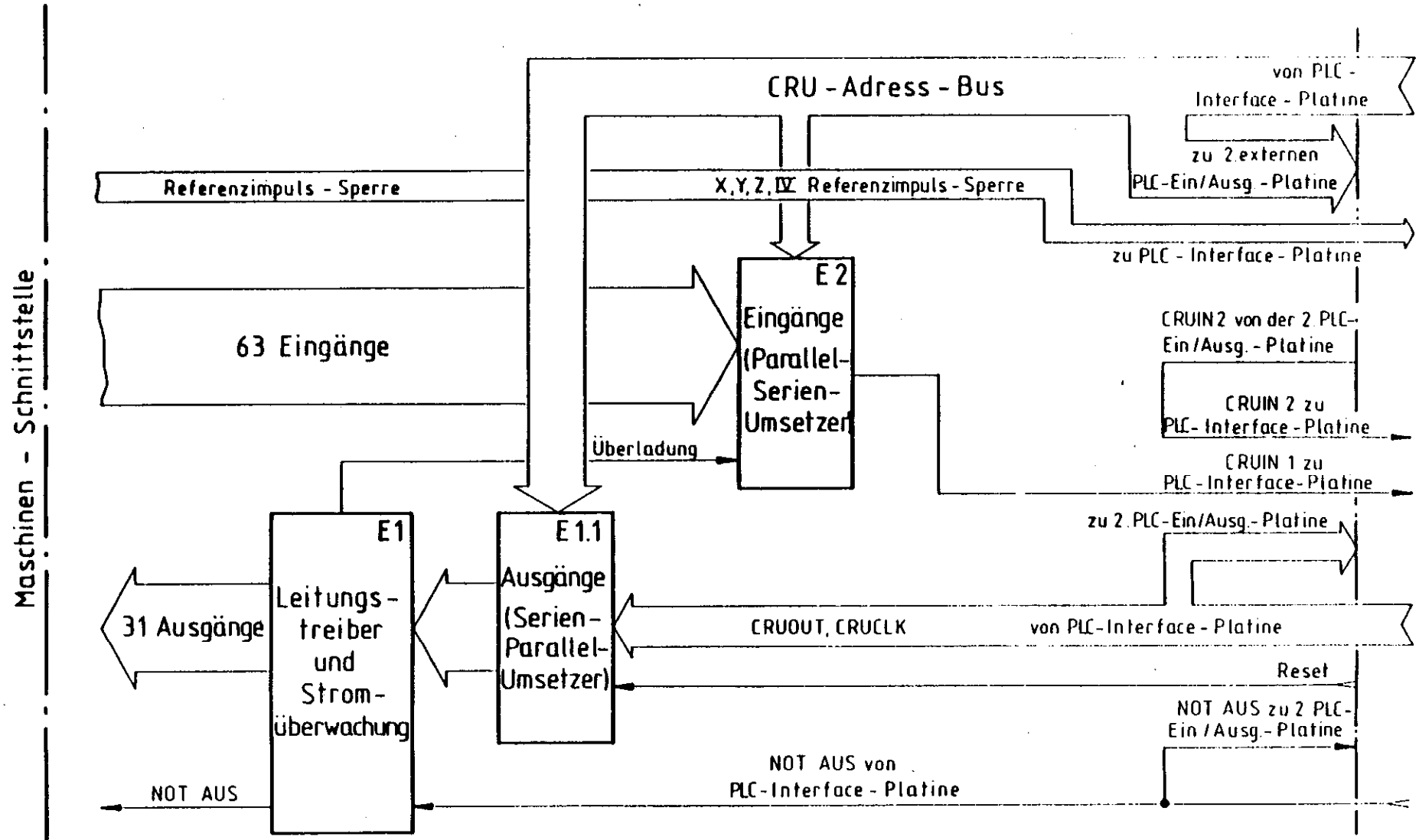
4.2 Block Diagram TNC 151





Zeichnungs-Nr.:
4820 E KD 16025 00

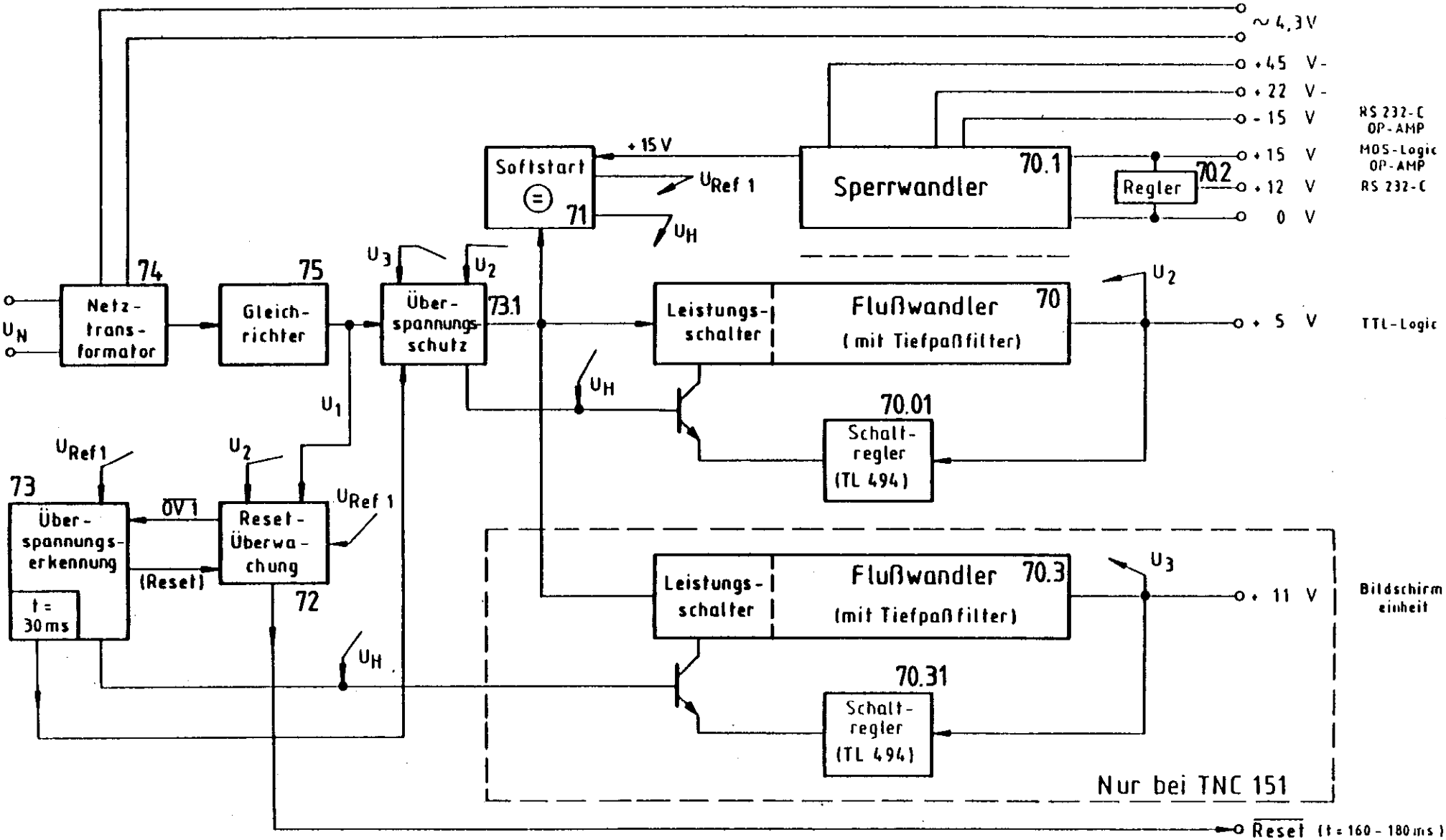
Anordnung der Blockschaltbilder und Platinen für TNC 151 / 155



Blockschaltbild TNC 151/155

(Extern)PLC-Ein/Ausgang-Platine

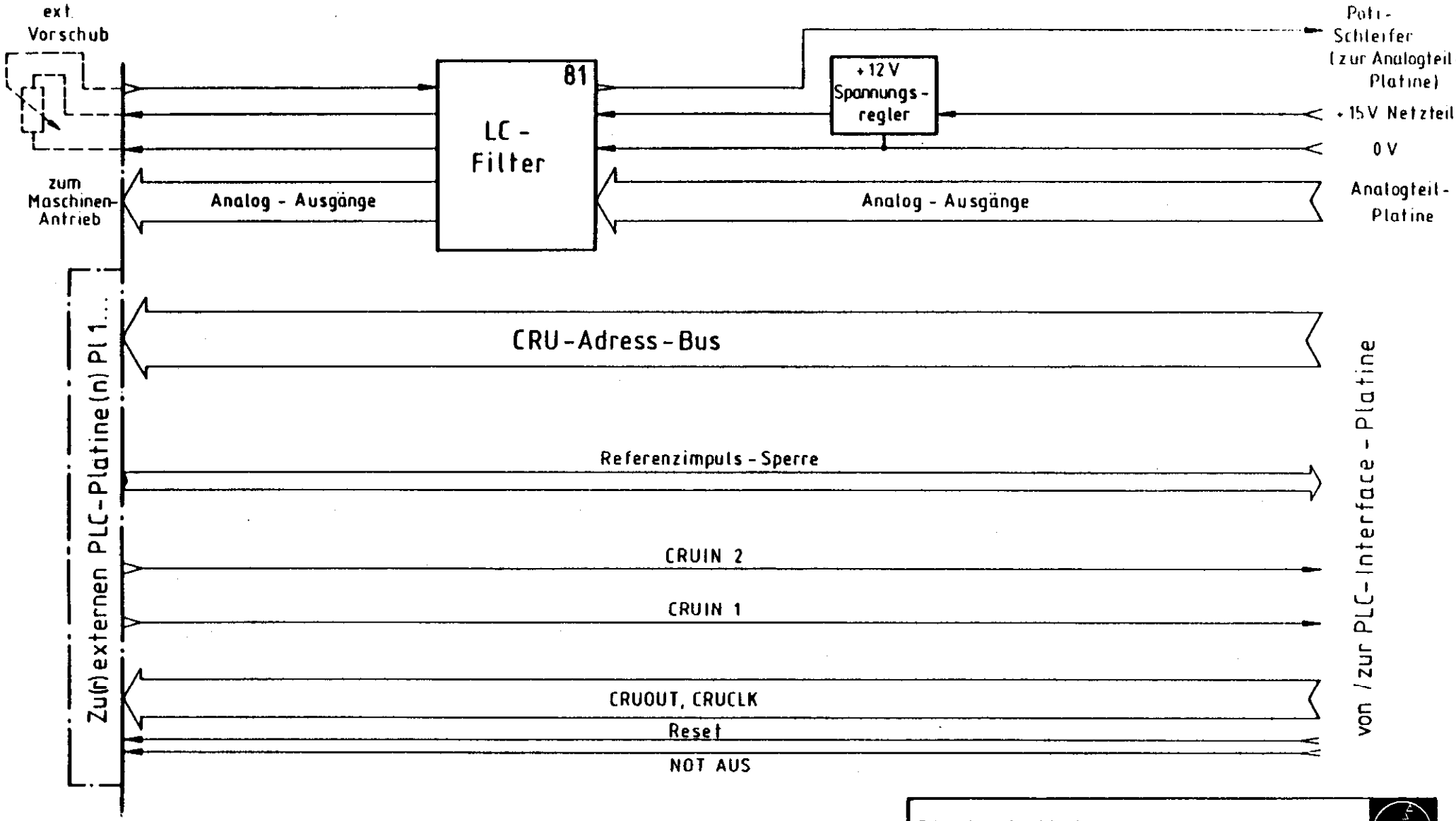
Zeichnungs - Nr.:
4820 E KD 1604500



Zeichnungs - Nr.:
4820 E KD1604600

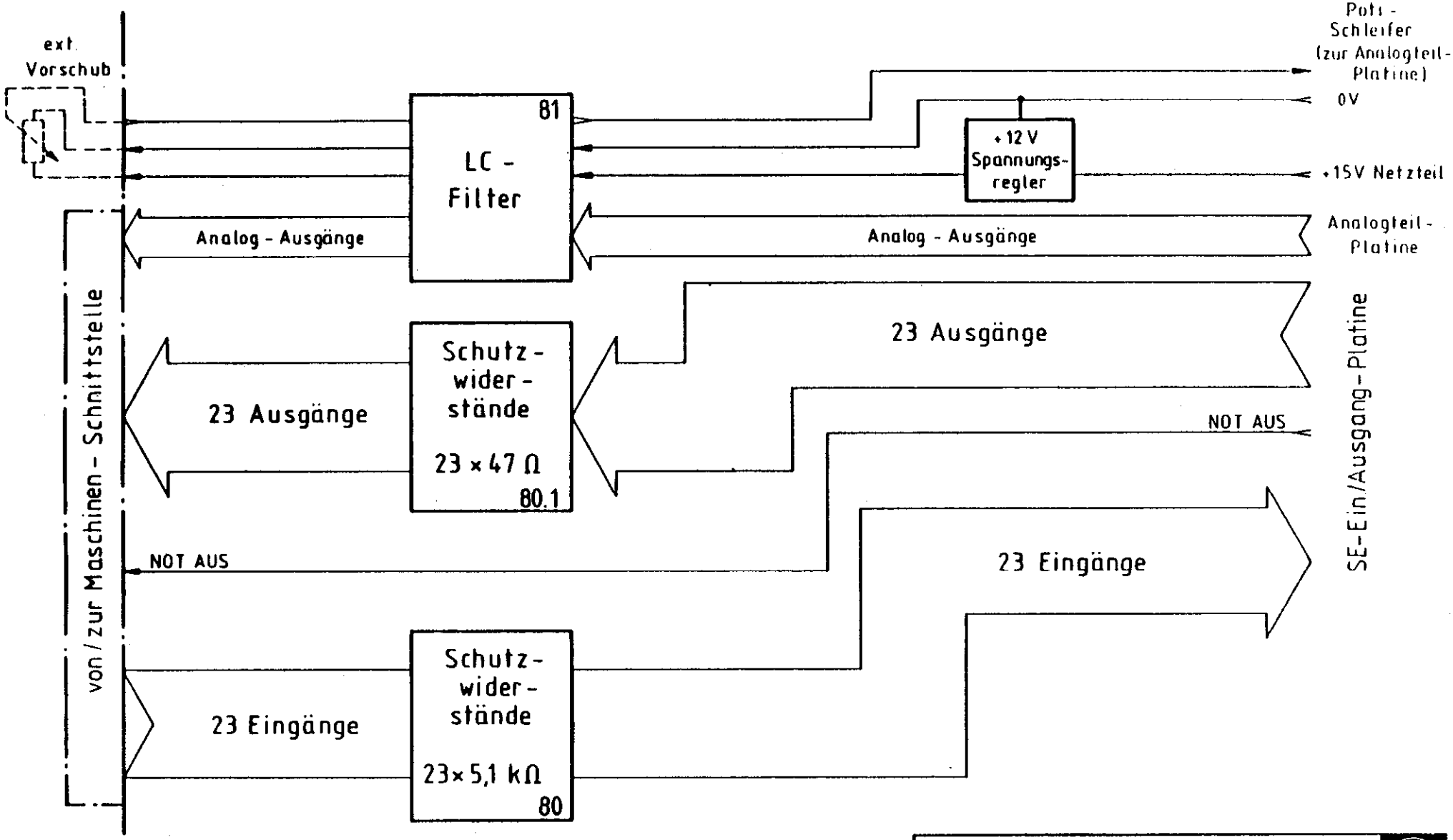
Blockschaltbild TNC 151/155

Netzteil



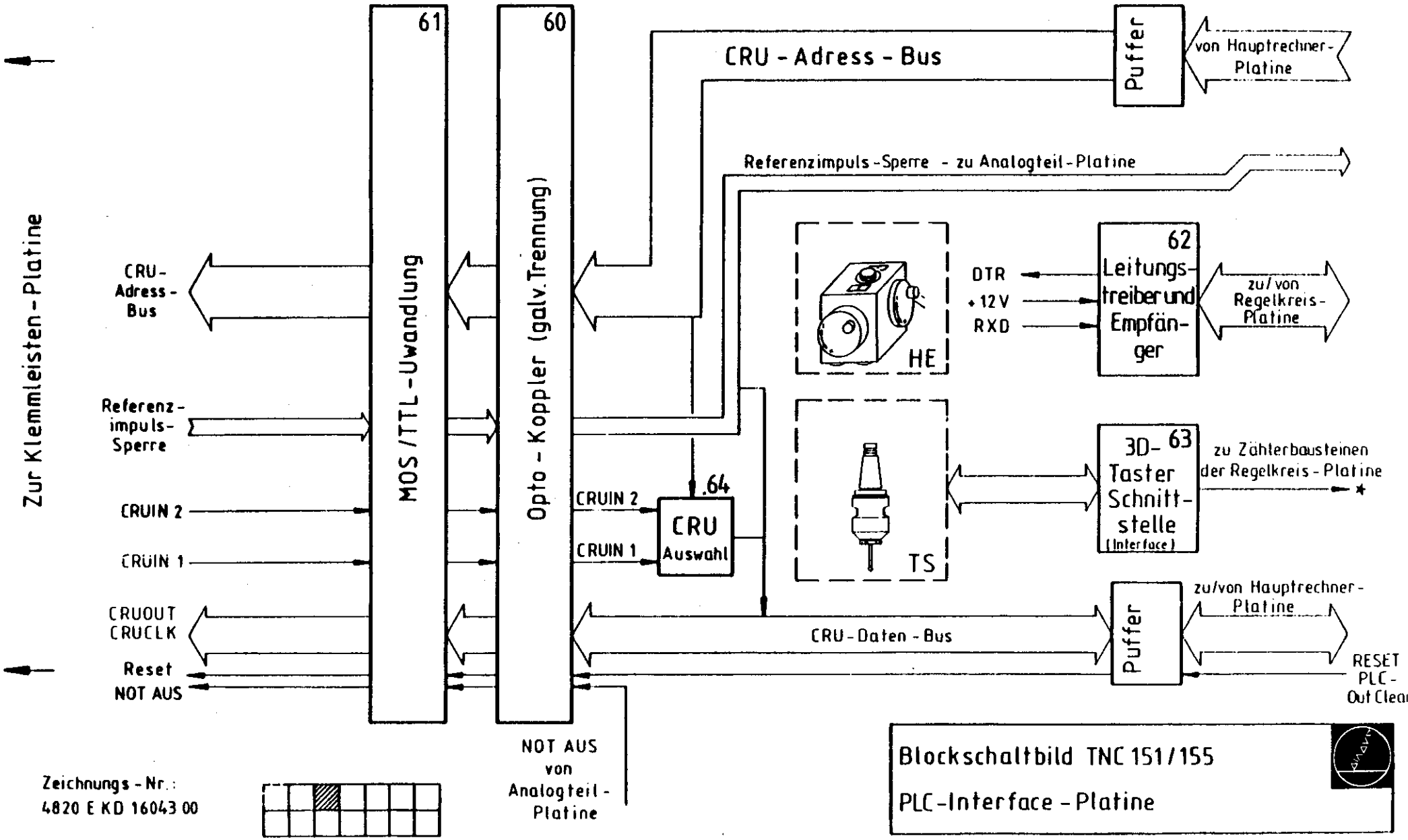
Zeichnungs - Nr.:
4820 E KD 16044 00

Blockschaltbild TNC 151 / 155
Klemmleisten-Platine (P-Version)



Zeichnungs - Nr.:
4820 E KD 1604200

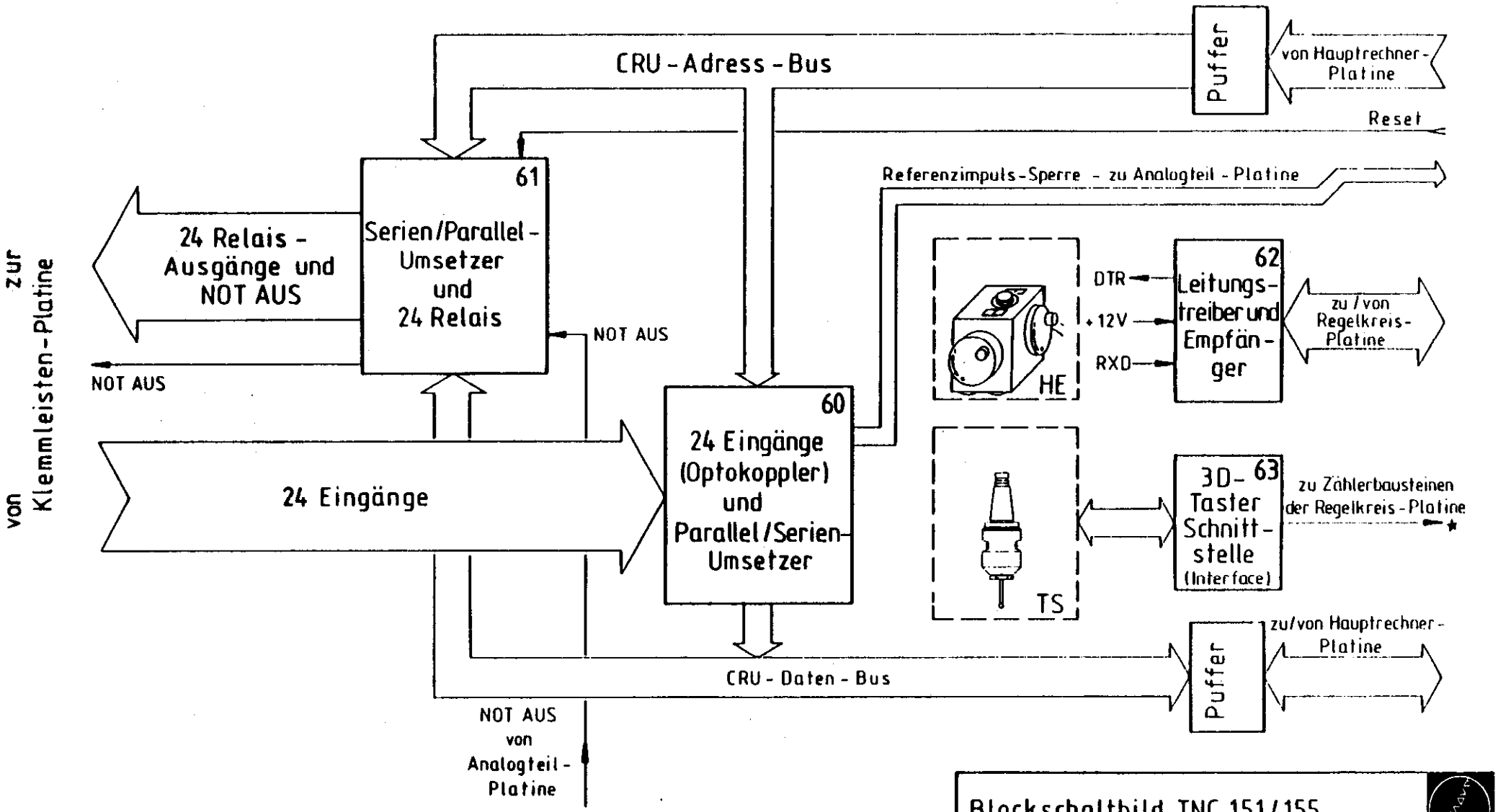
Blockschaltbild TNC 151/155
Klemmleisten - Platine (A-Version)



Zeichnungs-Nr.:
4820 E KD 16043 00

Blockschaltbild TNC 151/155

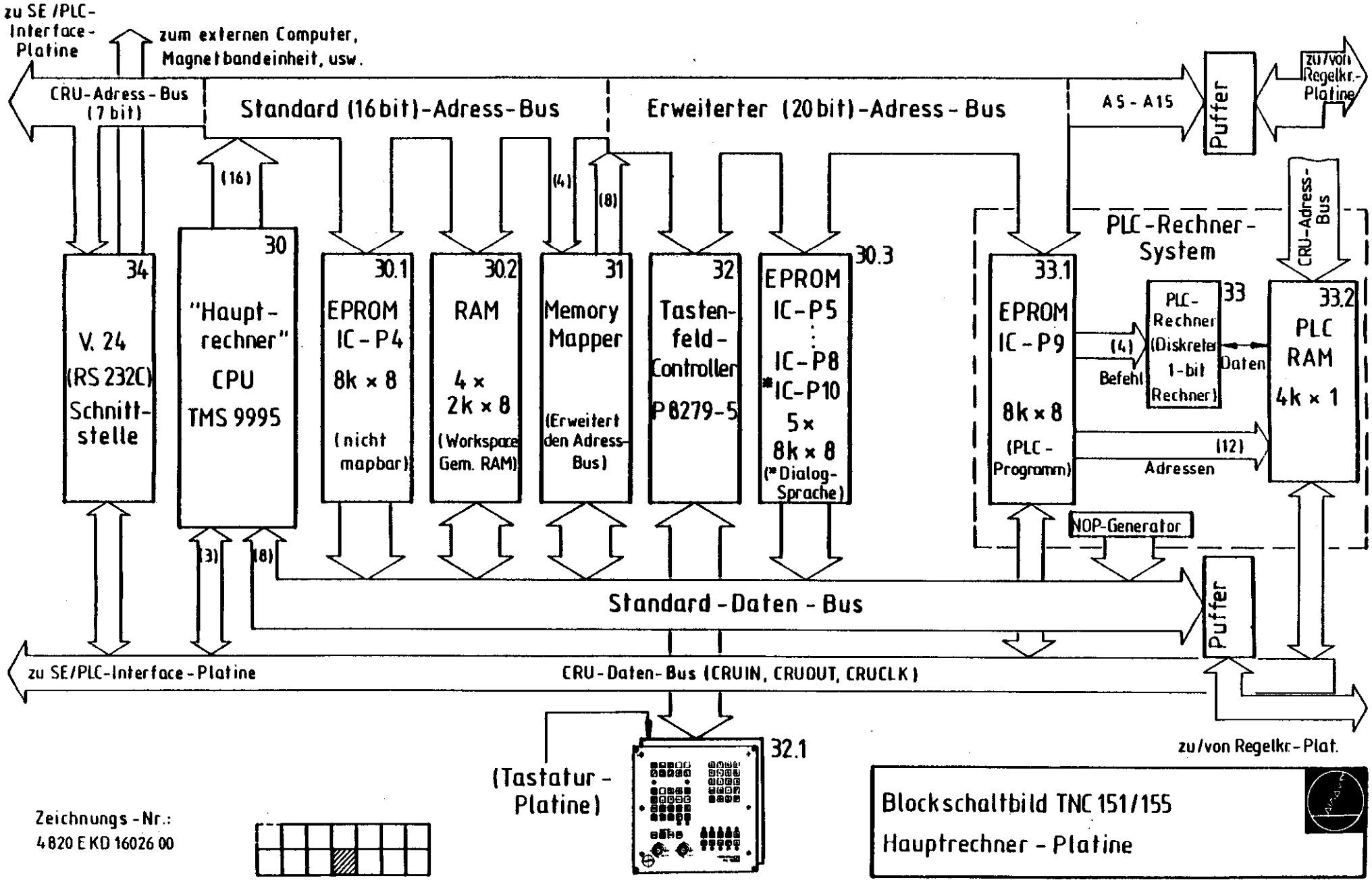
PLC-Interface-Platine



Blockschaltbild TNC 151/155

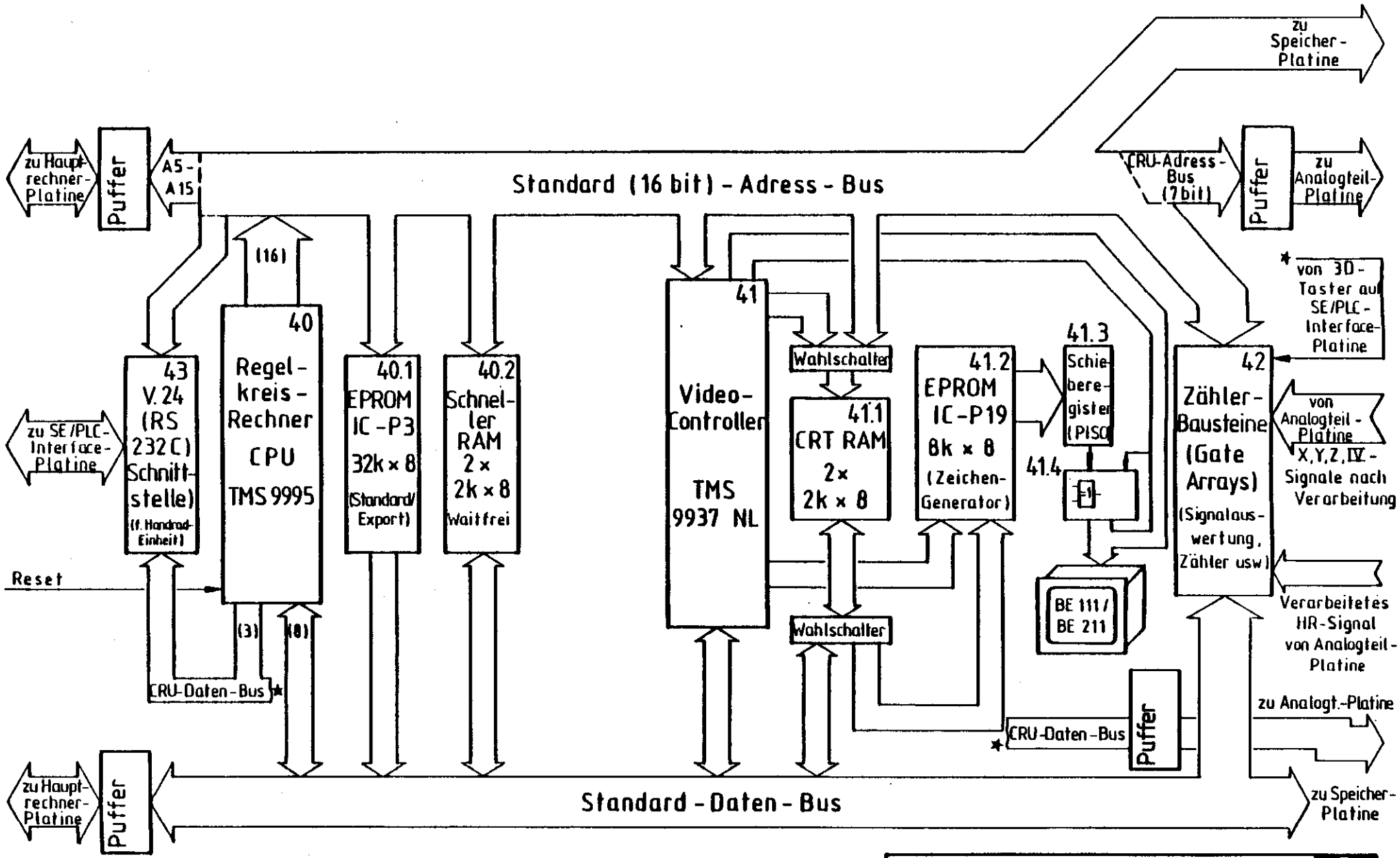
SE - Ein /Ausgang - Platine

Zeichnungs - Nr.:
4820 E KD 16041 00



Zeichnungs-Nr.:
4820 E KD 16026 00

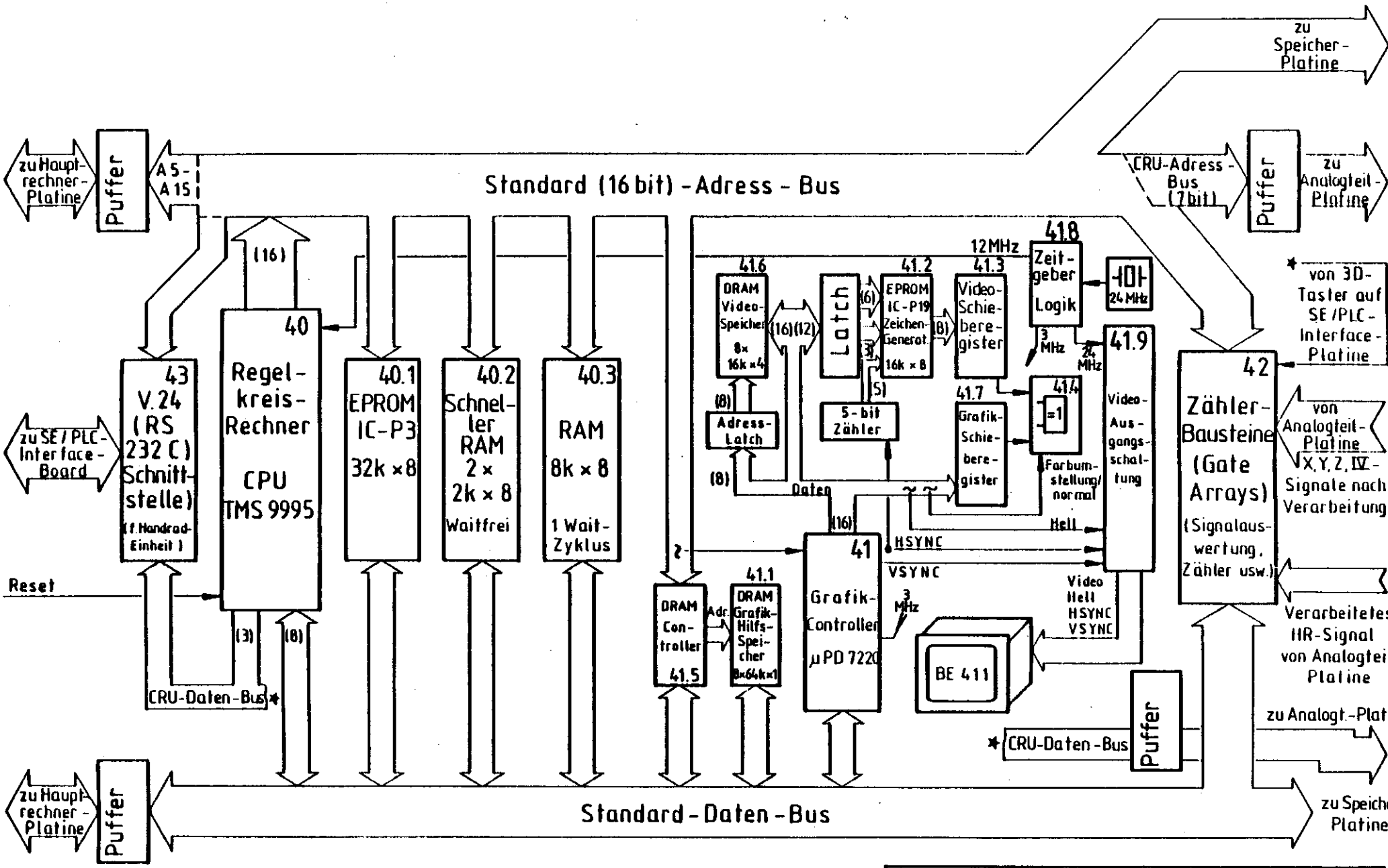
Blockschaltbild TNC 151/155
Hauptrechner - Platine



Blockschaltbild TNC 151

Regelkreis - Rechner - Platine

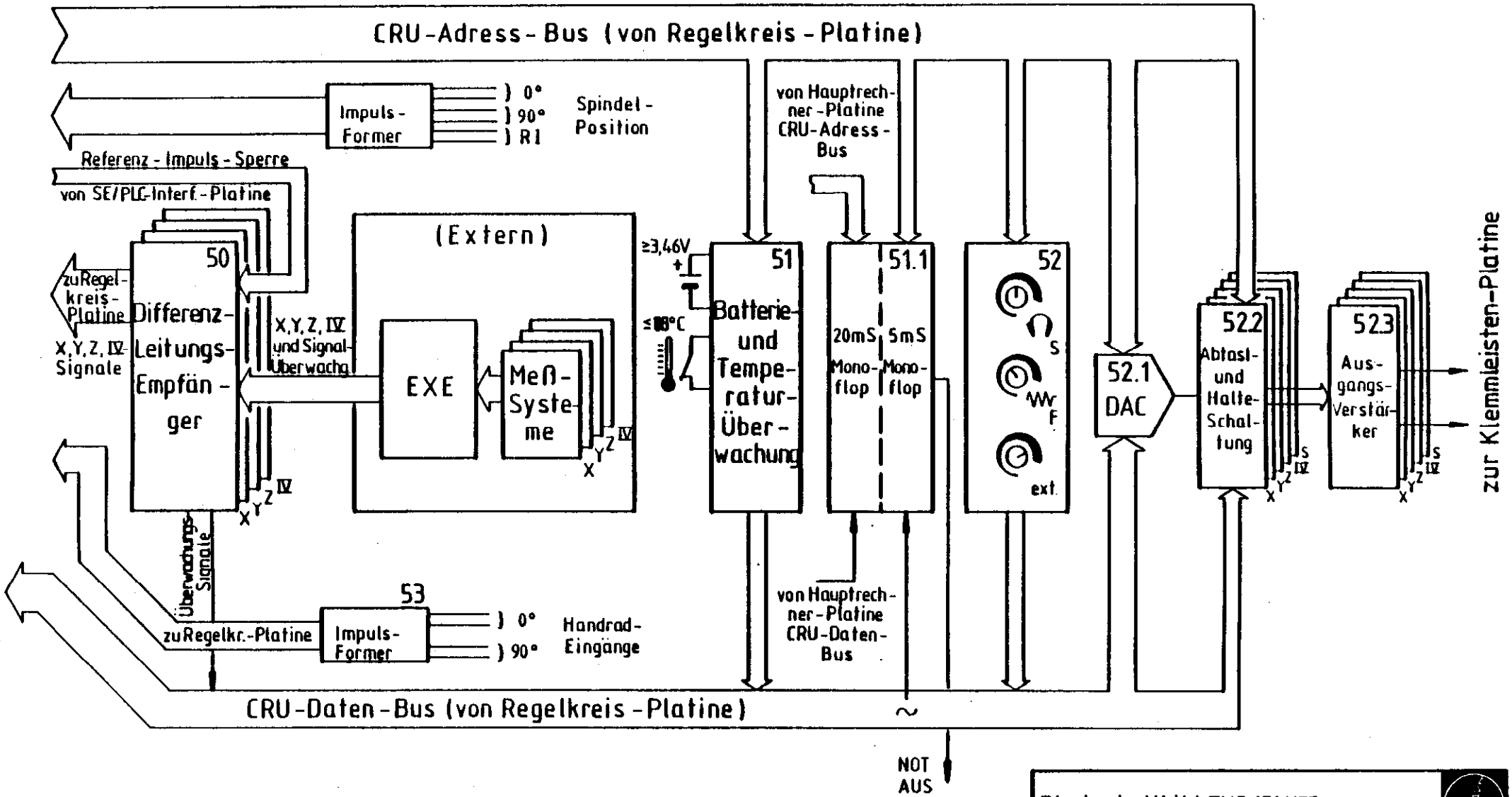
Zeichnungs - Nr.:
4 820 EKD 16029 00



Zeichnungs-Nr.:
4820 EKD 160300

Blockschaltbild TNC 155

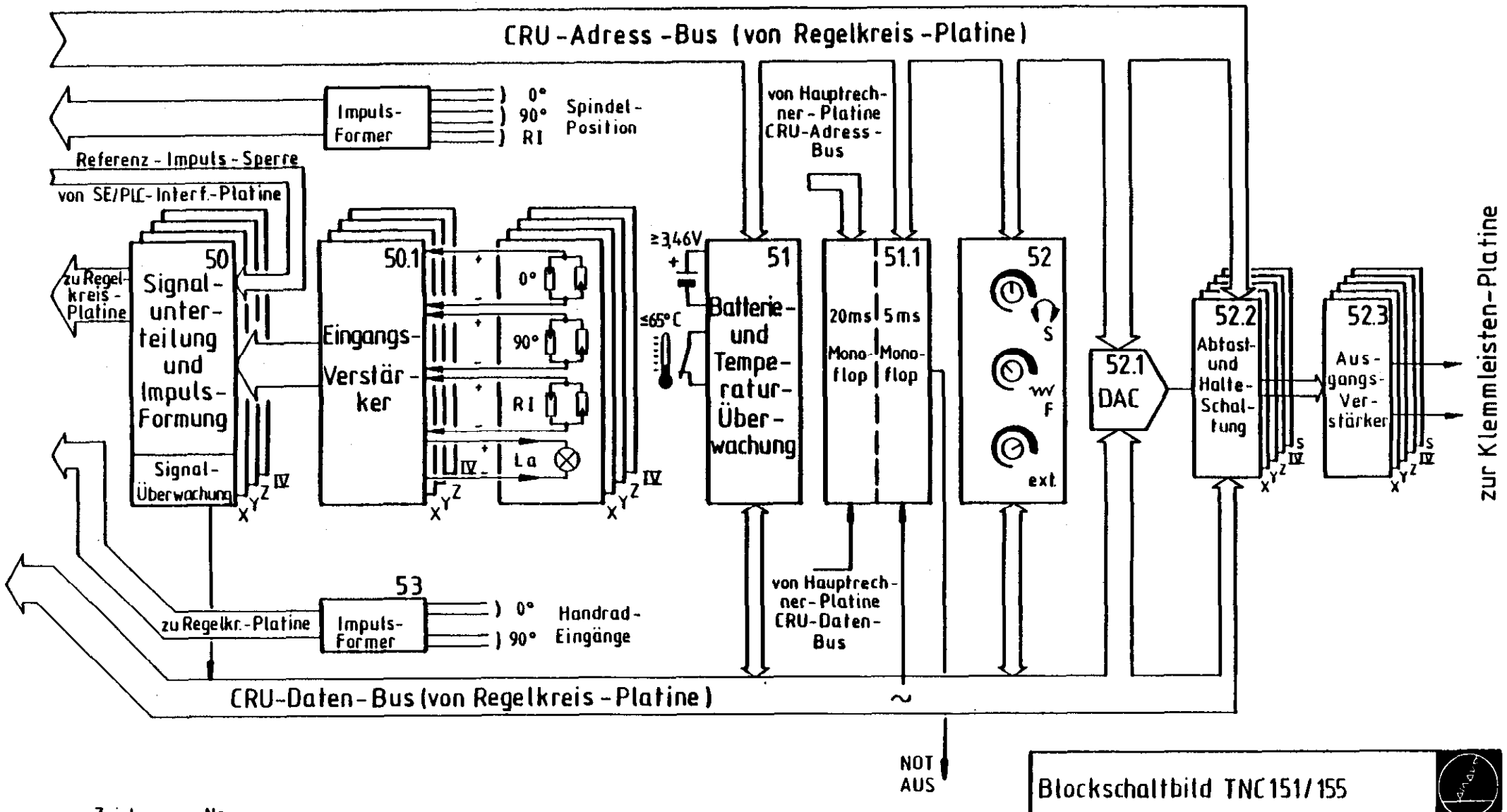
Regelkreis - Grafik - Platine



Zeichnungs-Nr.:
4820 E KD 16028 00

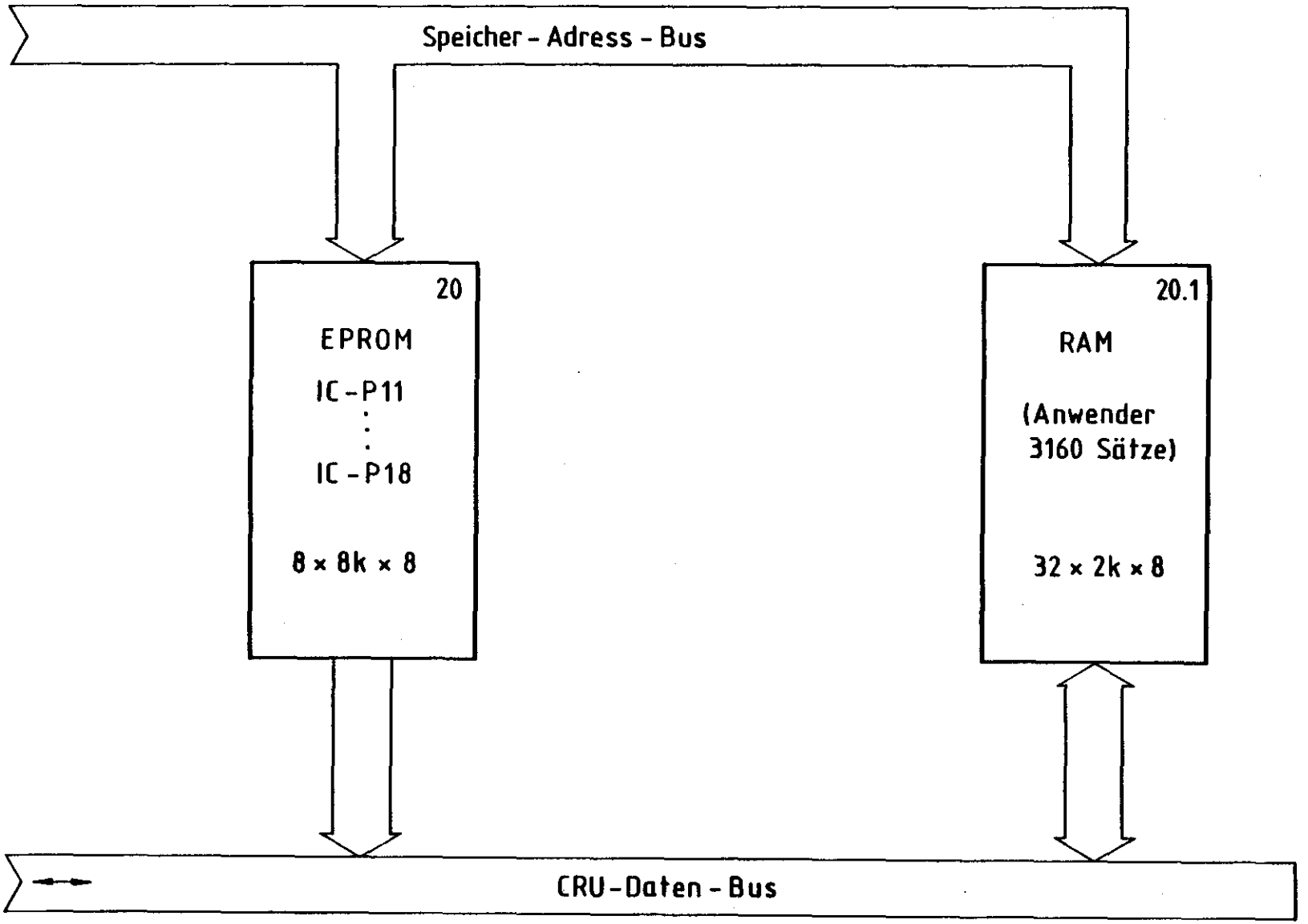
Blockschaltbild TNC 151/155

Analogteil-Platine (TTL-Eingänge)



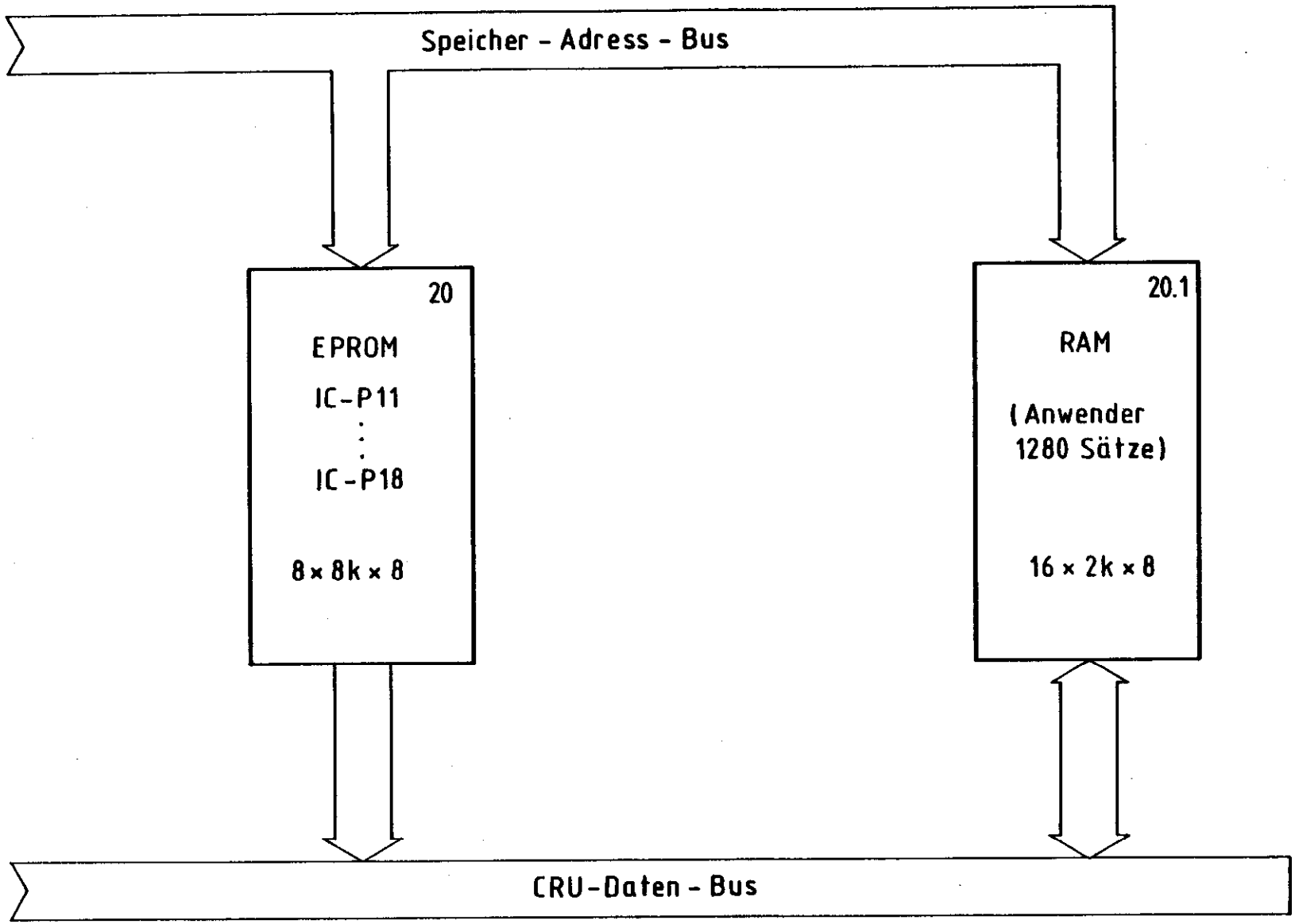
Zeichnungs-Nr.:
4820 E KD 16027 00

Blockschaltbild TNC 151/155
Analogteil-Platine



Zeichnungs - Nr.:
4820 E KD1603100

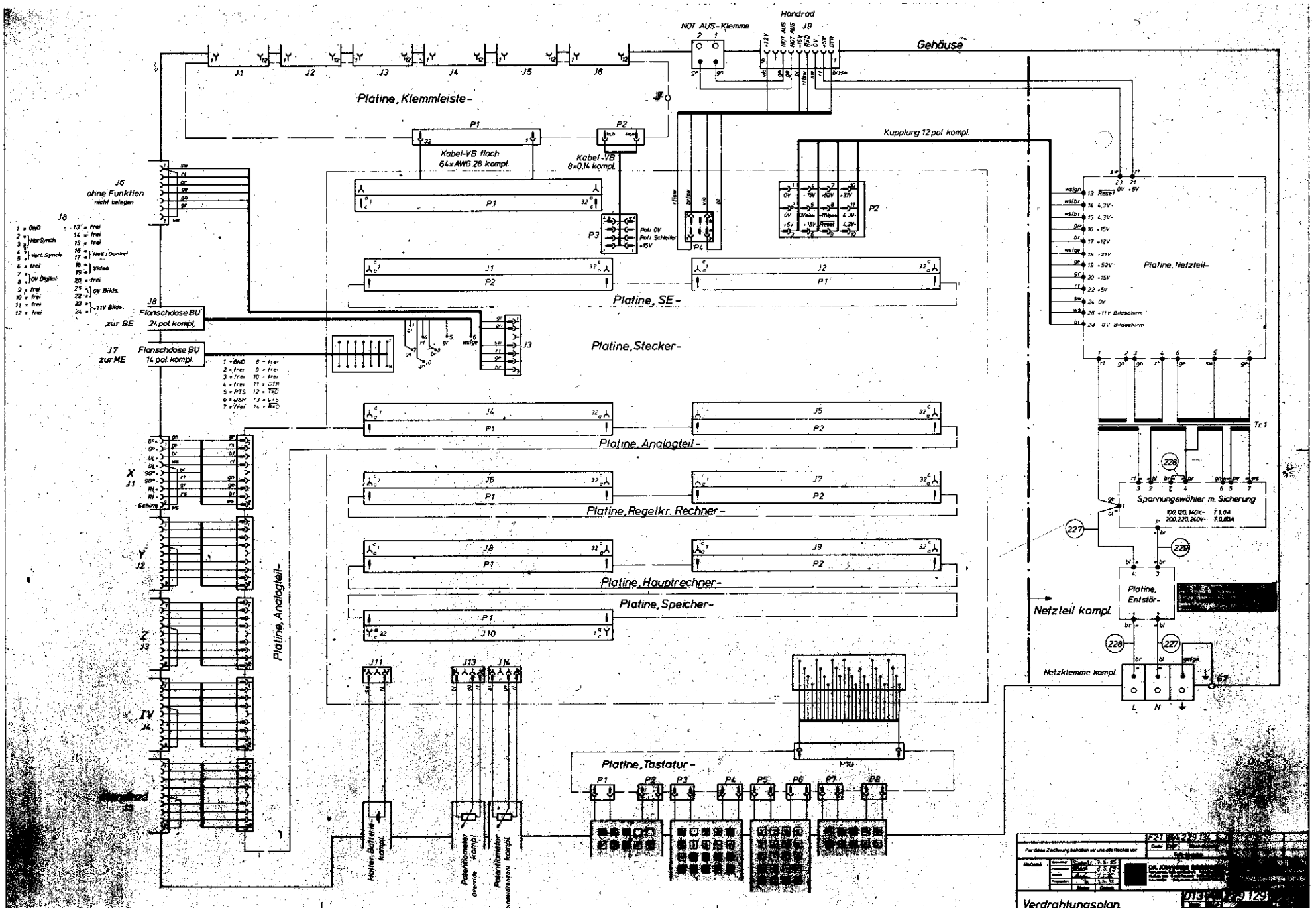
Blockschaltbild TNC 151/155
Speicher - Platine

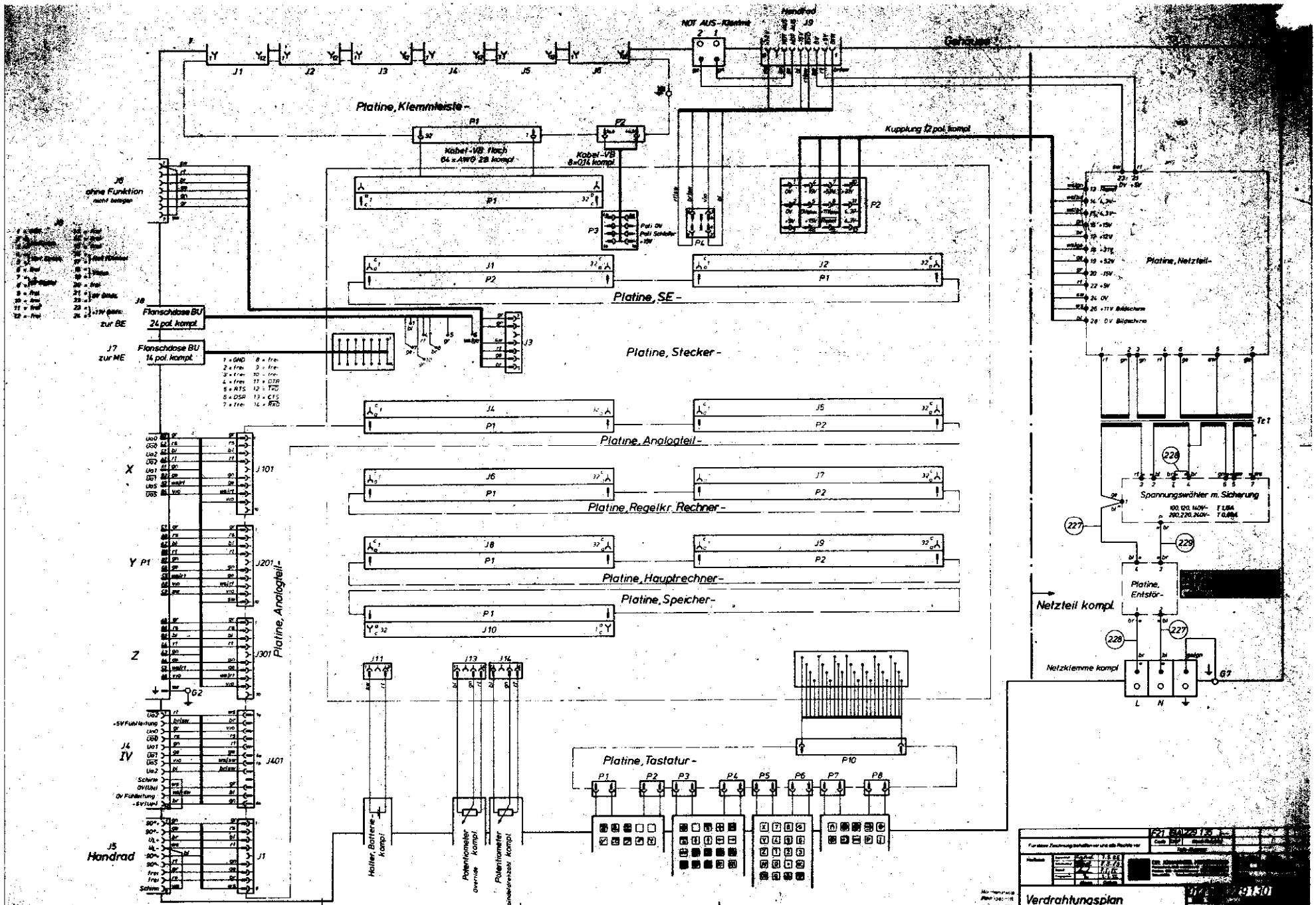


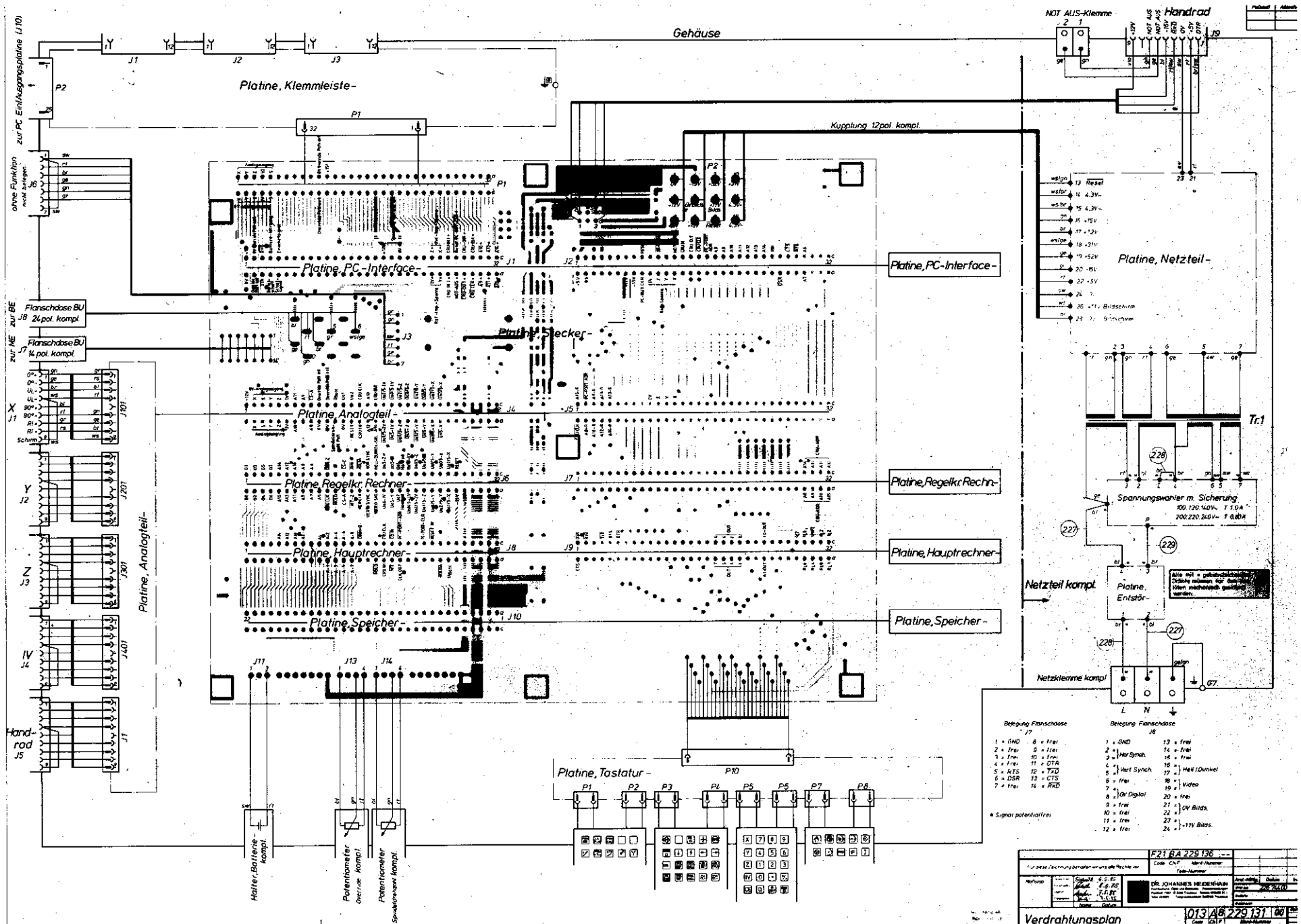
Zeichnungs - Nr.:
4820 EKD 160320 0

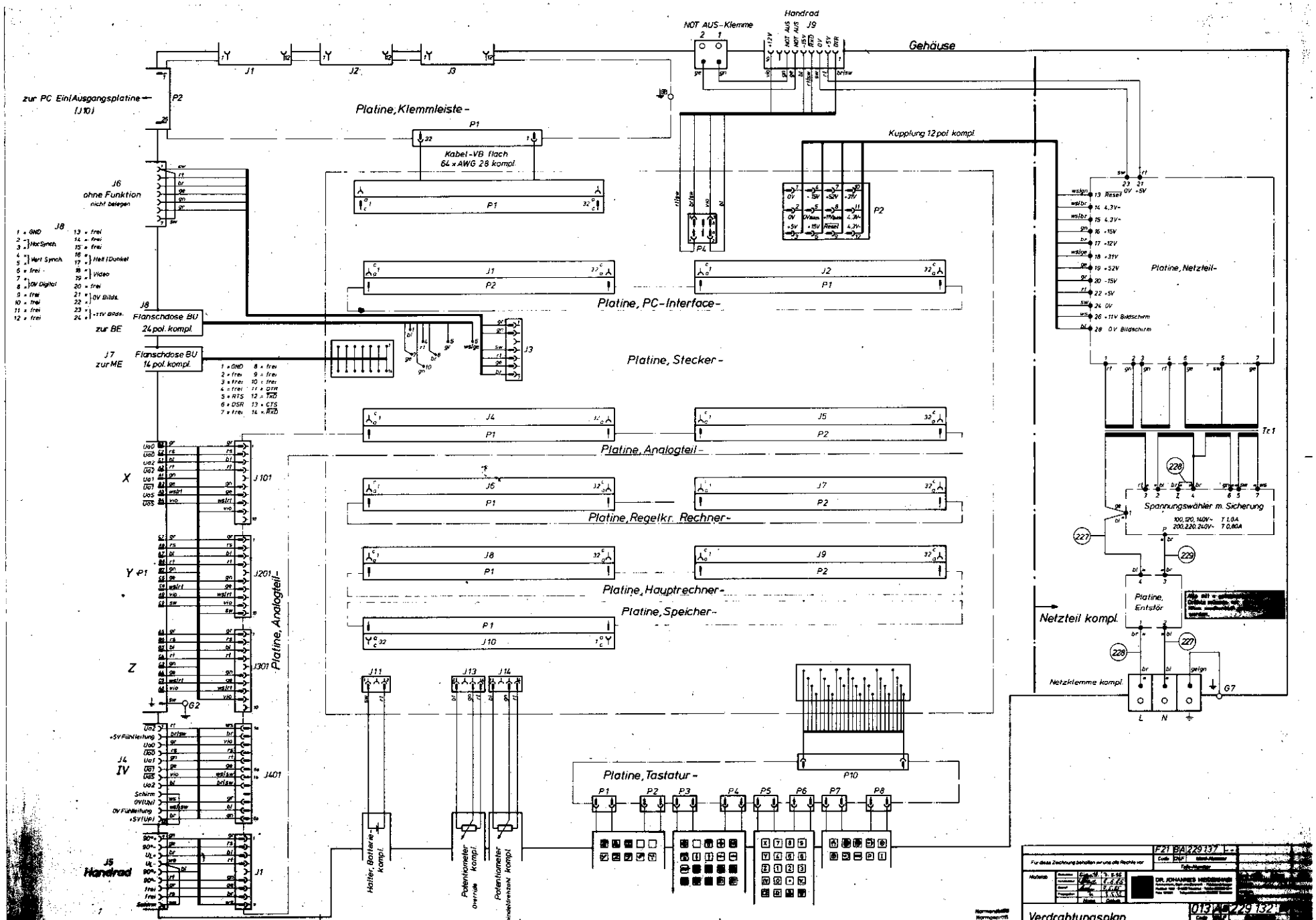
Blockschaltbild TNC 151
Speicher - Platine

4.3 Wiring diagrams


NOT AUS-Klemme
Hondrod
J9
Gehäuse
J1
J2
J3
J4
J5
J6
Platine, Klemmleiste-
P1
P2
Kabel-VB flach
64×AWG 28 kompl.
Kabel-VB
8×0,14 kompl.
Kupplung 12pol kompl.
J8
ohne Funktion
nicht belegen
P3
P4
Poti 0V
Poti Schleifer
+15V
J1
J2
P1
P2
Platine, SE-
Platine, Netzteil-
Flanschdose BU
24pol kompl.
zur BE
J7
zur ME
Flanschdose BU
14 pol kompl.
Platine, Stecker-
J3
Platine, Analogteil-
J4
J5
Tr1
228
Spannungswähler m. Sicherung
227
229
Platine, Regelkr. Rechner-
J6
J7
Platine, Hauptrechner-
J8
J9
Platine, Speicher-
J10
Platine, Entstör-
Netzteil kompl.
Netzklemme kompl.
67
L
N
J11
J13
J14
P10
Platine, Tastatur-
P1
P2
P3
P4
P5
P6
P7
P8
Halter, Batterie-kompl.
Potentiometer kompl.
Potentiometer kompl.
Verdrahtungsplan


Platine, Klemmleiste -
Platine, SE -
Platine, Stecker -
Platine, Analogteil -
Platine, Regelkr. Rechner -
Platine, Hauptrechner -
Platine, Speicher -
Platine, Tastatur -
Platine, Netzteil -
Platine, Entstör -
Platine, Analogteil -
Kuppelung 12 pol. kompl.
Flanschdose BU 24 pol. kompl.
Flanschdose BU 14 pol. kompl.
Spannungswähler m. Sicherung
Netzteil kompl.
Netzklemme kompl
Halter, Batterie- kompl.
Potentiometer override kompl.
Potentiometer kompl.
Handrad
Verdrahtungsplan


Gehäuse
Platine, Klemmleiste-
zur PC Ein/Ausgangsplatine (J10)
ohne Funktion nicht belegen
J1
J2
J3
P1
P2
J6
Kupplung 12pol. kompl.
NOT AUS-Klemme
Handrad
J9
Platine, PC-Interface-
Platine, Stecker-
Platine, Analogteil-
Platine, Regelkr. Rechner-
Platine, Hauptrechner-
Platine, Speicher-
Platine, Netzteil-
Flanschdose BU 24pol. kompl.
zur BE
J8
Flanschdose BU 14 pol. kompl.
zur ME
J7
X J1
Y J2
Z J3
IV J4
Hand-rod J5
J101
J201
J301
J401
Platine, Analogteil-
Platine, PC-Interface-
Platine, Regelkr. Rechn-
Platine, Hauptrechner-
Platine, Speicher-
Tr1
Spannungswähler m. Sicherung
100 120 140V~ T 1,0A
200 220 240V~ T 0,80A
Netzteil kompl.
Platine, Entstör-
Netzklemme kompl.
L
N
Platine, Tastatur-
P10
Halter, Batterie- kompl.
Potentiometer kompl.
Potentiometer kompl.
Belegung Flanschdose J7
Belegung Flanschdose J8
F21 BA 229 136
Verdrahtungsplan
013 AB 229 131 00


Handrad
NOT AUS-Klemme
J9
Gehäuse
J1
J2
J3
zur PC Ein/Ausgangsplatine (J10)
P2
Platine, Klemmleiste -
P1
Kabel-VB flach
64 x AWG 28 kompl.
Kupplung 12pol kompl.
J6
ohne Funktion
nicht belegen
J8
Flanschdose BU
24pol. kompl.
zur BE
J7
Flanschdose BU
14pol. kompl.
zur ME
P4
Platine, PC-Interface -
Platine, Stecker -
Platine, Netzteil -
Platine, Analogteil -
Platine, Regelkr. Rechner -
Platine, Hauptrechner -
Platine, Speicher -
Platine, Tastatur -
Platine, Analogteil -
X
Y
Z
IV
J5
Handrad
J101
J201
J301
J401
G2
Halter, Batterie - kompl.
Potentiometer kompl.
Spannungswähler m. Sicherung
Platine, Entstör
Netzteil kompl.
Netzklemme kompl.
G7
L
N
F21 BA 229 137 L -
013 BA 229 132

4.4 Machine Parameters

Function		Parameter No.	Entry values
Rapid traverse	X	0	80 – 15 999 mm/min
	Y	1	
	Z	2	
	IV	3	(IV: Degrees/min, with axis designation A or B or C)
Manual feed	X	4	
	Y	5	
	Z	6	
	IV	7	
Speed when approaching reference points	X	8	
	Y	9	
	Z	10	
	IV	11	
Signal evaluation	X	12	1 ≙ 20-fold 2 ≙ 10 fold
	Y	13	
	Z	14	
	IV	15	
Traversing direction when approaching reference marks	X	16	0 ≙ Plus-direction 1 ≙ Minus-direction (with correct programming of parameters Nos. 20 to 27)
	Y	17	
	Z	18	
	IV	19	
Counting direction	X	20	0 or 1
	Y	21	
	Z	22	
	IV	23	
Polarity of nominal value voltage	X	24	0 ≙ positive with positive traversing direction 1 ≙ negative with positive traversing direction
	Y	25	
	Z	26	
	IV	27	
Integral factor	X	28	0 – 65 535
	Y	29	
	Z	30	
	IV	31	
Differential factor	X	32	0 – 65.535 (Values from table on section 6.2.2)
	Y	33	
	Z	34	
	IV	35	
Backlash compensation	X	36	– 1.000 mm – + 1.000 mm
	Y	37	
	Z	38	
	IV	39	
Correction factor for linear correction	X	40	– 1.000 mm/m – + 1.000 mm/m
	Y	41	
	Z	42	
	IV	43	

Function		Parameter No.	Entry values
Software limit switch ranges	X+	44	0 to ± 30 000.000 mm
	X–	45	
	Y+	46	
	Y–	47	
	Z+	48	
	Z–	49	
	IV+	50	Angular axis 0 to ± 30 000°
	IV–	51	
Analogue voltage with rapid traverse		52	+4.5 – +9 Volts
Approach speed		53	0.1 – 10 m/min
Acceleration		54	0.001 – 1.5 m/s²
Circular acceleration		55	
Position supervision (eraseable)		56	0.001 – 30 mm
Position supervision (emergency stop)		57	
Position window X, Y, Z		58	0.001 – 0.06 mm
Axis sequence for reference point approach		59	0 ≙ X Y Z IV 1 ≙ X Y IV Z 2 ≙ X Z Y IV 3 ≙ X Z IV Y 4 ≙ X IV Y Z 5 ≙ X IV Z Y 6 ≙ Y X Z IV 7 ≙ Y X IV Z 8 ≙ Y Z X IV 9 ≙ Y Z IV X 10 ≙ Y IV X Z 11 ≙ Y IV Z X 12 ≙ Z X Y IV 13 ≙ Z X IV Y 14 ≙ Z Y X IV 15 ≙ Z Y IV X 16 ≙ Z IV X Y 17 ≙ Z IV Y X 18 ≙ IV X Y Z 19 ≙ IV X Z Y 20 ≙ IV Y X Z 21 ≙ IV Y Z X 22 ≙ IV Z X Y 23 ≙ IV Z Y X
Speed pre-control		60	0 ≙ on 1 ≙ off
Output of tool numbers		61	0 No output 1 Output only when tool number changes 2 Output of tool number with every tool call
Output of spindle speeds codes or as S analogue voltage		62	0 ≙ No output of spindle rpm 1 ≙ Coded output only when rpm changes 2 ≙ Coded output of all rpms 3 ≙ S-Analogue voltage output Gear switching signal only when gear ratio changes 4 ≙ S-Analogue voltage output, Output of gear swithcing signal with every tool call 5 ≙ S-Analogue voltage output without gear switching signal
rpm code limit		63	01991
Oscillatio: when accelerating		64	0.01 – 0.999
Display resolution		65	0 ≙ 1 µm 1 ≙ 5 µm
External feed rate potentiometer		66	0 ≙ internal potentiometer for override and manual feed 1 ≙ external potentiometer for override and manual feed 2 ≙ internal potentiometer for override external potentiometer for manual feed
Dwell time, rotation change of spindle in tapping cycle		67	0 – 65.535 s

Function	Parameter No.	Entry values
Memory function for direction buttons	68	0 ≙ off 1 ≙ on
Special procedure for reference point	69	0 ≙ off 1 ≙ on
Nominal value voltage for spindle drive when tapping	70	0 – 9.999 Volts
Program end character	71	1 – 126 (depending on value of appropriate character on tape)
Selection for control of inhibited axes	72	0 ≙ none Axis inhibited
		1 ≙ X– " "
		2 ≙ Y– " "
		3 ≙ X–, Y– " "
		4 ≙ Z– " "
		5 ≙ X–, Z– " "
		6 ≙ Y–, Z– " "
		7 ≙ X–, Y–, Z– " "
		8 ≙ IV– " "
		9 ≙ X–, IV– " "
		10 ≙ Y–, IV– " "
		11 ≙ X–, Y–, IV– " "
		12 ≙ Z–, IV– " "
		13 ≙ X–, Z–, IV– " "
		14 ≙ Y–, Z–, IV– " "
		15 ≙ X–, Y–, Z–, IV– " "
Pre-cut out time for tapping cycle	73	0 – 65.535 s
Override effective on pressing rapid button	74	0 ≙ Override ineffective 1 ≙ Override effective
Reference signal evaluation for inhibited axes	75	0 ≙ inactive 1 ≙ active
Display and transducer supervision for inhibited axes	76	0 ≙ inactive 1 ≙ active
PLC program from RAM or from EPROM	77	0 1
RPM-range gear ratios		
S-analogue output 0	78	0 – 9.000.000 rpm
1	79	
2	80	
3	81	
4	82	
5	83	
6	84	
7	85	
S-Analogue voltage with S-Override at 100 %	86	0 – 9.999 Volts
S-Analogue voltage with S-Override at max. output voltage	87	
Limitation of S-override		0 – 150 %
Maximum	88	
Minimum	89	
Axis designation for axis IV	90	0 ≙ A 3 ≙ U
		1 ≙ B 4 ≙ V
		2 ≙ C 5 ≙ W
Constant contouring speed at corners	91	0 – 179.999 Angles in degrees
Decimal character in program output via V.24	92	0 ≙ Decimal comma 1 ≙ Decimal point
Overlapping factor with pocket milling	93	0.001 – 1.414

Function	Parameter No.	Entry values
PLC: Counter predetermined value for counter 0 – 15	94 to 109	0 – 65 535 in units of 20 ms
PLC: Timer duration for timer 0 – 15	110 to 125	0 – 65 535 in units of 20 ms
PLC: Position values for 31 coordinates 31 = Ref.	126 to 156	± 30.000.000 mm
Activation of next tool No.	157	0 ≙ No output of next tool number 1 ≙ Output only with change of tool number 2 ≙ Output of next tool No. with every tool call
Setting of 16 markers to binary number	158	0 – 65 535
Automatic lubrication to programmed traversing distance in X	159 to 162	0 – 65 535 (in 65 536-µm-units)
Y		
Z		
IV		
Feed rate for parameters Nos. 126 to 156 X	163	80 – 15 999 mm/min
Y	164	
Z	165	
IV	166	
Display of current feed rate before start in **MANUAL OPERATION** mode (same feed rate in all axes)	167	0 ≙ off 1 ≙ on
Ramp gradient for S-analogue	168	0 – 1.999 Volts/ms
Standstill supervision	169	0.001 to 30 mm
Programming station	170	0 ≙ Control 1 ≙ Programming station: PLC active 2 ≙ Programming station: PLC inactive
Handwheel	171	not yet active, enter 0
Polarity S-analogue voltage	172	0 ≙ M 03: positive voltage M 04: negative voltage 1 ≙ M 03: negative voltage M 04: positive voltage 2 ≙ M 03 and M 04: positive voltage 3 ≙ M 03 and M 04: negative voltage
Cancellation of status display with with M 02 and M 30	173	0 ≙ Status display not to be cancelled 1 ≙ Status display to be cancelled
Trailing error supervision in trailing operation		
Emergency stop	174	0 – 100 mm
erasable	175	
Multiplication factor for K_V-factor	176	0.001 – 1.000
K_V-factor for X	177	0.100 – 10.000
Y	178	
Z	179	
IV	180	
Characteristic kink	181	0 – 100.000 %
Minimum for feed rate override with tapping	182	0 – 150 %
Maximum for feed rate override with tapping	183	
Minimum voltage for S-analogue output	184	0 – 9.999 Volts
Waiting time for cut-out of remaining nominal value voltage with error display "Positioning error"	185	0 – 65.535 s

Function	Parameter No.	Entry values
Tool change position M 92: X-Axis Y-Axis Z-Axis IV-Axis	 186 187 188 189	 ± 30 000.000
Programming of rpm S = 0 permitted (voltage value of MP 184 may be exceeded)	190	0 ≙ S = 0 permitted 1 ≙ S = 0 not permitted
Display of current spindle rpm before start in [illegible] mode	191	0 ≙ no display 1 ≙ display
Position window for axis IV	192	0.001 – 0.05 mm
PLC: Timer duration for timer 16 – 31	193 to 208	0 – 65 535 in units of 20 ms
Support of PLC-macro commands	209 to 212	0 0
"Scaling" cycle effective for 2 or 3 axes	213	0 ≙ the programmed scaling factor is effective in the 3 main axes X, Y, Z 1 ≙ the programmed scaling factor is only effective in the working plane
Programmed stop with M 06	214	0 ≙ Programmed stop with M 06 1 ≙ No programmed stop with M 06

Function	Parameter No.	Entry values
Reserved machine parameter Reserved machine parameter	215 216	Temporarily unassigned, enter 80 Temporarily unassigned, enter 0
Programming language changeover, HEIDENHAIN-dialogue/ISO format	217	0 ≙ Program entry in HEIDENHAIN-dialogue 1 ≙ Program entry in ISO-format
Parameters for definition of the V.24-(RS-232-C) interface	218 219 221 222	0 ≙ 65535 0 ≙ 65535 0 ≙ 65535 0 ≙ 65535
Standard data interface or "Transfer blockwise"	223	0 ≙ standard data interface 1 ≙ "Transfer blockwise"
Parameter for definition of the V.24 (RS-232-C) interface (see	224	0 - 255

The following machine parameters have been extended:

Function	Parameter No.	Entry values
Spare character for ETX/STX	71	0 - 65535
Programmed stop with M 06 CYCL CALL possible with M 89	214	0 ≙ Programmed stop with M 06 No CYCL CALL with M 89 1 ≙ No programmed stop with M 06 No CYCL CALL with M 89 2 ≙ Programmed stop with M 06 CYCL CALL with M 89 3 ≙ No programmed stop with M 06 CYCL Call with M 89