

HEIDENHAIN

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

Kundendienst

Service Instructions TNC 151/155 B/Q

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

This manual is provided subject to the condition that no part of it shall be reproduced in any form or by any means without our prior consent in writing.

Issue: 04/88

Kundendienst

C o n t e n t s

1. Use of the Service Manual	Page 2
2. Fault Diagnosis	" 3
2.1 Procedure for fault-finding	" 3
2.2 Flow diagrams for fault location	" 4
2.2.1 Fault diagnosis for the complete installation	" 4
2.2.2 Use of the integrated supervision system	" 5
2.2.3 Testing of the VDU and associated circuitry	" 14
2.2.4 Testing of the Power Supply Unit	" 15
2.2.5 Testing of the measuring systems and wiring	" 17
2.2.6 Burn-In Test	" 18
3. Exchange Information	" 36
3.1 Exchanging Control units	" 37
3.1.1 Procedure for exchanging the TNC 151/155 B/F Control	" 37
3.1.2 Procedure for exchanging the TNC 151/155 Q/W Control	" 38
3.1.3 Procedure for exchanging the PLC I/O Board of the PL 100/110 B	" 39
3.2 Board Exchange	" 40
3.3 Software Exchange	" 45
3.4 Replacement Parts, Loan/Exchange/Service Units	" 48
3.5 Configurations Liste	" 49
4. Additional Information	" 50
4.1 Block Diagram Description	" 50
4.2 Block Diagrams TNC 151/155	" 55
4.3 Wiring Diagrams	" 68
4.4 Machine Parameters	" 73

Kundendienst

1. Use of the Service Manual TNC 151/155

In order to determine the fault condition on an NC machine, a fundamental knowledge of the machine and the drives is necessary, as well as 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:

- .Operating Manual
- .Mounting Instructions and Interface Circuit Control-Machine
- .PLC-Description

The TNC 151/155 Service Manual is used for the diagnosis, localisation and remedying of faults on TNC controlled machines. In section 2, **Fault Diagnosis**, a set of flowcharts enables the user to pinpoint the source of a fault from its symptoms.

An integrated 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.

Kundendienst

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.

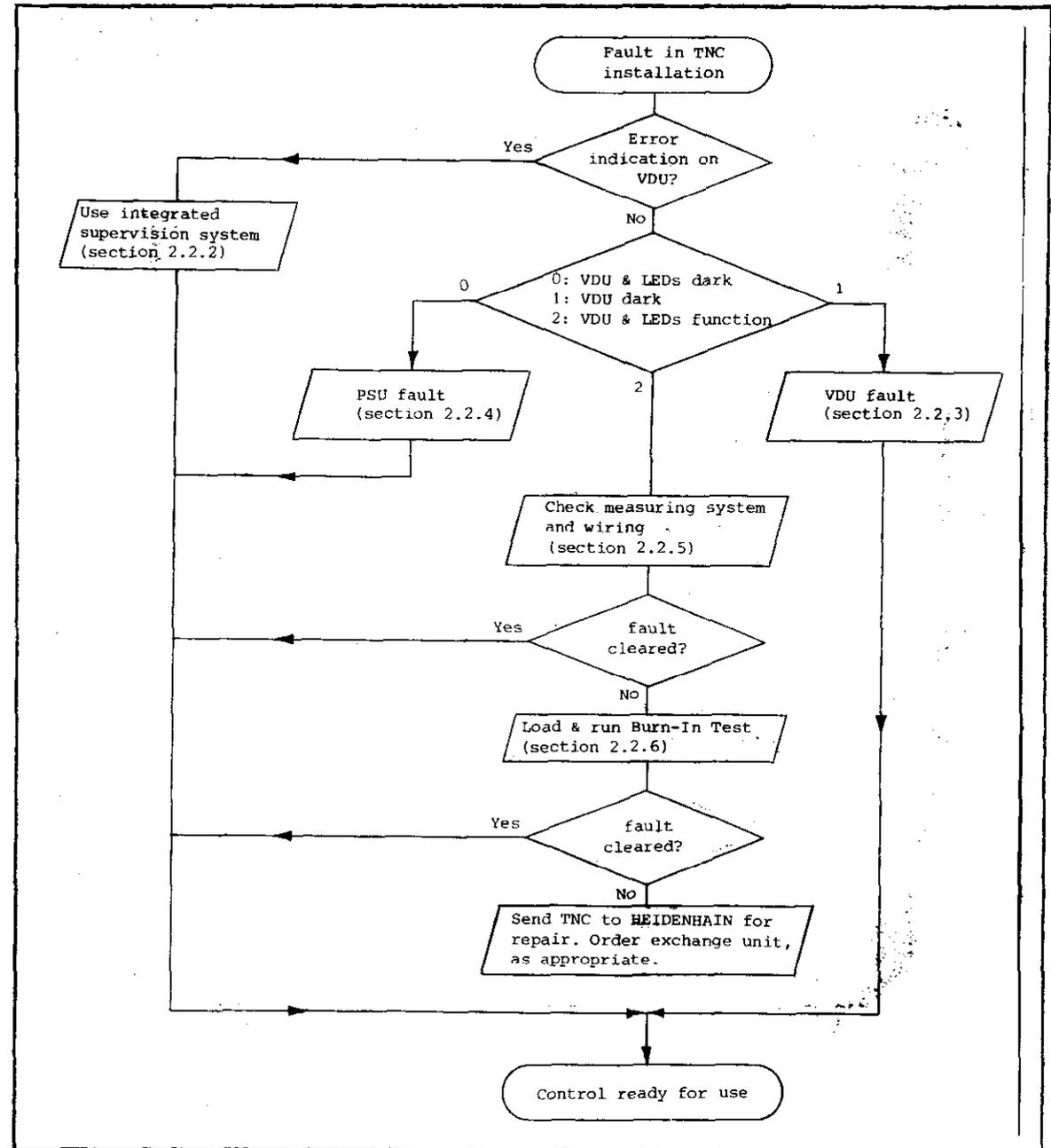
In addition, the HEIDENHAIN TNC 151/155 Contouring Control includes an extensive **integrated supervision system** for the avoidance of entry/operator faults and for the recognition and diagnosis of technical defects in the installation (see section 2.2.2)

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).

Kundendienst

2.2 Flow diagrams for fault location

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



Kundendienst

2.2.2 Use of the integrated supervision system

The TNC 151/155 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 151/155

AXIS 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

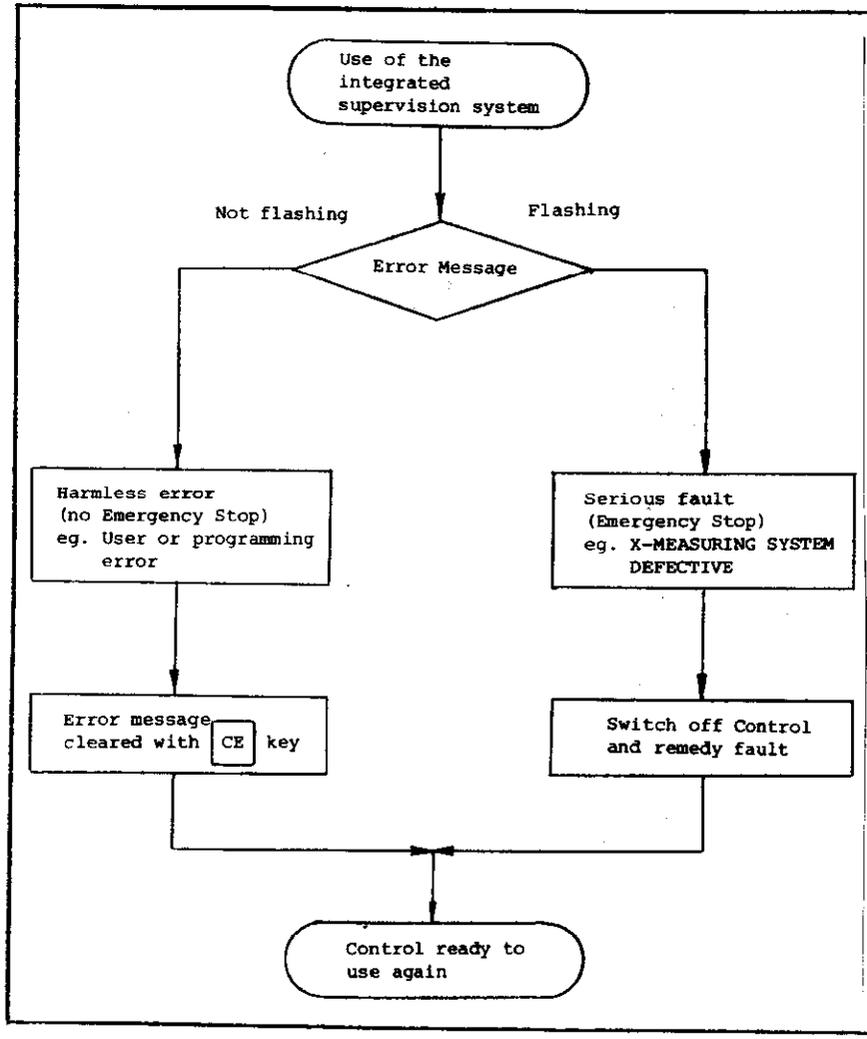
CHECK SUM ERROR XX00...XXFF

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.

Error message "**EXCHANGE BUFFER BATTERY**"

Particular mention should also be made about the implications of the instruction to exchange the buffer battery:
 If the dialog 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.



Kundendienst

Error messages TNC 151/155

The meanings of many of these error messages are explained in:

- Operating Manual
- Mounting Instructions and Interface Circuit Control-Machine
- PLC-Description

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

Kundendienst

Fault descriptions TNC 151/155

VDU Display (flashing)	Fault cause	Possible fault location
TRANSDUCER X DEFECT A TRANSDUCER Y DEFECT A TRANSDUCER Z DEFECT A TRANSDUCER S DEFECT A TRANSDUCER X DEFECT B TRANSDUCER Y DEFECT B TRANSDUCER Z DEFECT B TRANSDUCER S DEFECT B	Fault code: A = signal amplitude fault B = signal frequency fault .Measuring system not connected .Cable damaged .Glass scale dirty or damaged .Scanning head damaged .Measuring system supervision damaged	Measuring system Analog 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 .Defect in Control's internal Emergency Stop supervision	Analog Board PLC I/O Board (TNC 151/155 Q) PLC Interface Board (TNC 151/155 Q) SE Board (TNC 151/155 B) Terminal Board (TNC 151/155 B)
WRONG REFERENCE POINT	.Traversed-over reference point lies outside of the reference point end position (also see Mounting Instructions and Interface Circuit Control Machine .Defect in Control/machine interface	Machine (cams/switches "reference end-position" or "reference pulse inhibit") PLC I/O Board (TNC 151/155 Q) PLC Interface Board (TNC 151/155 Q) SE Board (TNC 151/155 B) Terminal Board (TNC 151/155 B)

Kundendienst

VDU Display (flashing)	Fault cause	Possible fault location
EMERGENCY-STOP PLC	<p>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</p>	Terminal board (TNC 151/155 B)
GROSS POSITIONING ERROR A	<p>.Trailing error greater than value entered in MP 174. (see Mounting Instructions and Interface Circuit Control-Machine manual</p> <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</p> <p>.Exceeding the range for the continuous position supervision determined by MP 57. (see Mounting Instructions and Interface Circuit Control-Machine manual</p> <p>.Relationship between output voltage and traversed distance outside of the defined tolerance.</p> <p>.Defect in the pulse counting section (Control circuitry) after the transducer signal supervision</p>	<p>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/ Graphics Brd.), Control hardware (Analog Brd.), servo amplifier (offset voltages), " " (gain too low), motor, tacho, measuring system, external forces acting on drives, inappropriate MP values programmed.</p>
		<p>Aid:</p> <ol style="list-style-type: none"> 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. <p>If this does not help: fault in the Control hardware (closed loop) or in the machine</p>

Kundendienst

VDU Display (flashing)	Fault cause	Possible fault location
GROSS POSITIONING ERROR B	.The analog output voltage calculated by the control (implied by trailing error) is greater than ± 10 V	see above
GROSS POSITIONING ERROR C	.The analog output voltage required to obtain a desired speed deviates more from the calculated voltage than the voltage programmed in MP 234	see above
GROSS POSITIONING ERROR D	.The actual position at standstill deviates more from the intended position than the distance programmed in MP 169	see above
GROSS POSITIONING ERROR E	Automatic offset adjustment (MP 252) Offset voltage is greater than 100mV	
TNC OPERATING TEMP. EXCEEDED	.Ambient temperature inside the TNC has exceeded +65°C .Fault in the temperature supervision	Ambient temperature of Control Analog Board

Kundendienst

VDU Display (flashing)	Fault cause	Possible fault location
ERROR IN PLC PROGRAM	Fault with non-erasable marker (see also PLC-Description)	
" " " " A	Start Key or incremental positioning X+	PLC Program, Main Processor Board
" " " " B	Rapid Traverse Key or incremental positioning X-	" " " " "
" " " " C	Direction Latch Key or incremental positioning Y+	" " " " "
" " " " D	Feed Release or incremental positioning Y-	" " " " "
" " " " E	Start PLC Positioning X-axis or incremental positioning Z+	" " " " "
" " " " F	Start PLC Positioning Y-axis or incremental positioning Z-	" " " " "
" " " " G	Start PLC Positioning Z-axis or incremental positioning IV+	" " " " "
" " " " H	Start PLC Positioning IV-axis or incremental positioning IV-	" " " " "
" " " " I	Directional Key X+	" " " " "
" " " " J	Directional Key X-	" " " " "
" " " " K	Directional Key Y+	" " " " "
" " " " L	Directional Key Y-	" " " " "

Kundendienst

VDU Display (flashing)	Fault cause	Possible fault location
ERROR IN PLC PROGRAM ...	Error with non-erasable marker (see also PLC-Description)	
" " " M	Directional Key Z+	PLC Program, Main Processor Board
" " " N	Directional Key Z-	" " "
" " " O	Directional Key IV+ or supplementary axis to be changed to another axis M 2590 and M 2591	" " "
" " " P	Directional Key IV- or Start PLC Positioning S-axis	" " "
" " " Q	Non-defined macro called up via PLC marker	" " "

Kundendienst

VDU Display (flashing)	Fault cause	Possible fault location
PROCESSOR CHECK ERROR 0	Incorrect CRC checksum* of machine-related data excluding machine parameters. (Baud rate, limitation, preset etc)	Main Processor Board
" " " 1	Incorrect CRC checksum* (machine parameters)	Main Processor Board
" " " 2	Incorrect CRC checksum* (user memory)	Main Processor Board
" " " 3	Integrated Test Program execution incomplete	Main Processor Board
" " " A	Software error Main Processor	Main Processor Board
" " " B	Software error CLP Processor	CLP Processor/Graphics Board
" " " C	MID interrupt** CLP Processor	Main Processor/CLP Processor/Graphics Board
" " " D	CLP Processor instruction stack overflow	CLP Processor Board
" " " E	False instruction: Main Processor CLP Processor	Main Processor/CLP Processor/Graphics Board
" " " F	False instruction (display mode): Main Processor CLP Processor	Main Processor/CLP Processor/Graphics Board
" " " G	CLP Processor RAM	CLP Processor/Graphics 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 E000...FFFF Main Processor	Main Processor Board
" " " L	Enable a function via machine parameters which is not integrated in the software	False machine parameter

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

Kundendienst

VDU Display (flashing)	Fault cause	Possible fault location
CHECK-SUM ERROR XX00	CRC CHECK-SUM error with EPROM 3 XX = correct CHECK-SUM value 00 = code for faulty EPROMs	Main Processor Board
to		
CHECK-SUM ERROR XX0F	CRC CHECK-SUM error with EPROM 3	Main Processor Board
" " XX10	" " " " with EPROM 4	Main Processor Board
to		
CHECK-SUM ERROR XX1F	CRC CHECK-SUM error with EPROM 4	Main Processor Board
" " XX2B	" " " " with EPROM 5	Main Processor Board
to		
CHECK-SUM ERROR XX2F	CRC CHECK-SUM error with EPROM 5	Main Processor Board
" " XX40	" " " " with EPROM 2	CLP Processor/Graphics Board
" " XX41	CRC CHECK-SUM error in RAM area on the CLP Processor/Graphics Board in which a part of the operating program is stored	CLP Processor/Graphics Board
" " XX42	CRC CHECK-SUM error with EPROM 2	CLP Processor/Graphics Brd. (export vers.)
" " XX43	CRC CHECK-SUM error in the RAM area on the CLP Processor/Graphics Board where part of the operating program is stored	CLP Processor/Graphics Brd. (export vers.)
" " XXFF	CRC CHECK-SUM error with PLC RAM	Main Processor Board
" " XX30	PLC Program from addr. 0-1000H (virtual addr. 30000-30FFFH) in PLC-EPROM/PLC-RAM	Main Processor Board
" " XX31	PLC Program from addr. 1000-FFFECH (virtual addr. 31000-3FFFECH) in PLC-EPROM/PLC-RAM	Main Processor Board

Kundendienst

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 associated circuitry, in which case repairs may be possible without returning the unit.

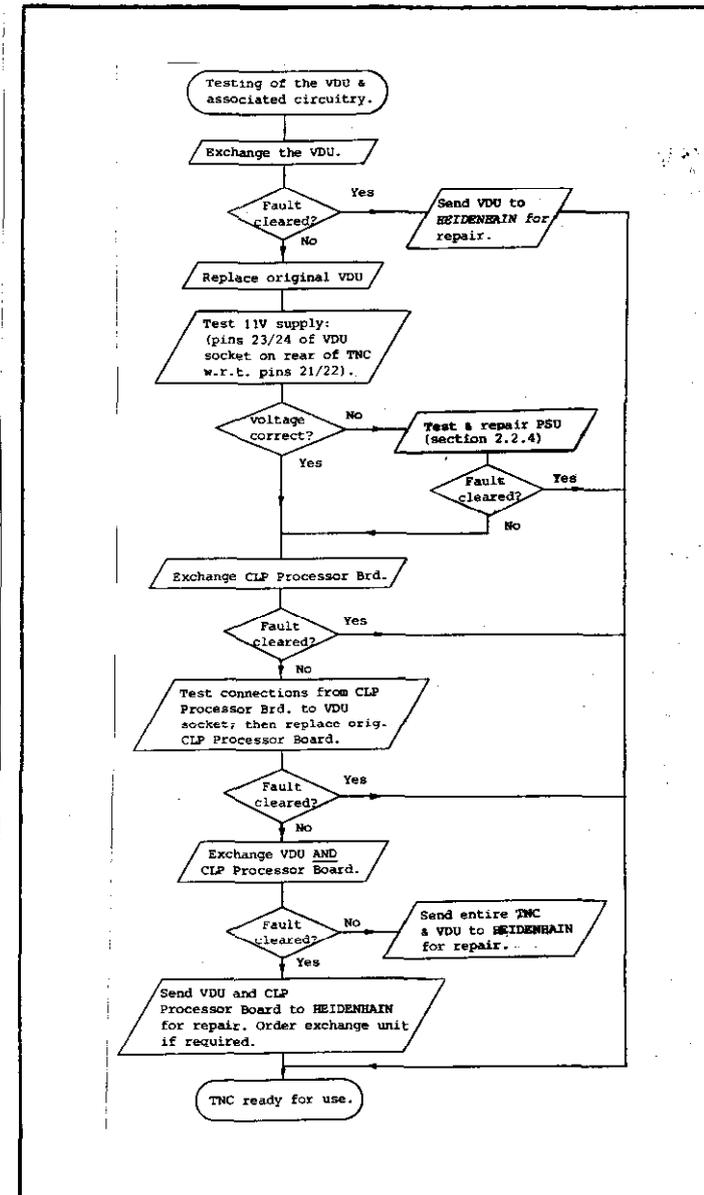
Visual Display Units BE 110 and BE 211 in conjunction with TNC 151

The Display Units BE 111 and BE 211 are supplied 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 defective 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 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 BE 111/211 and associated circuitry

Kundendienst

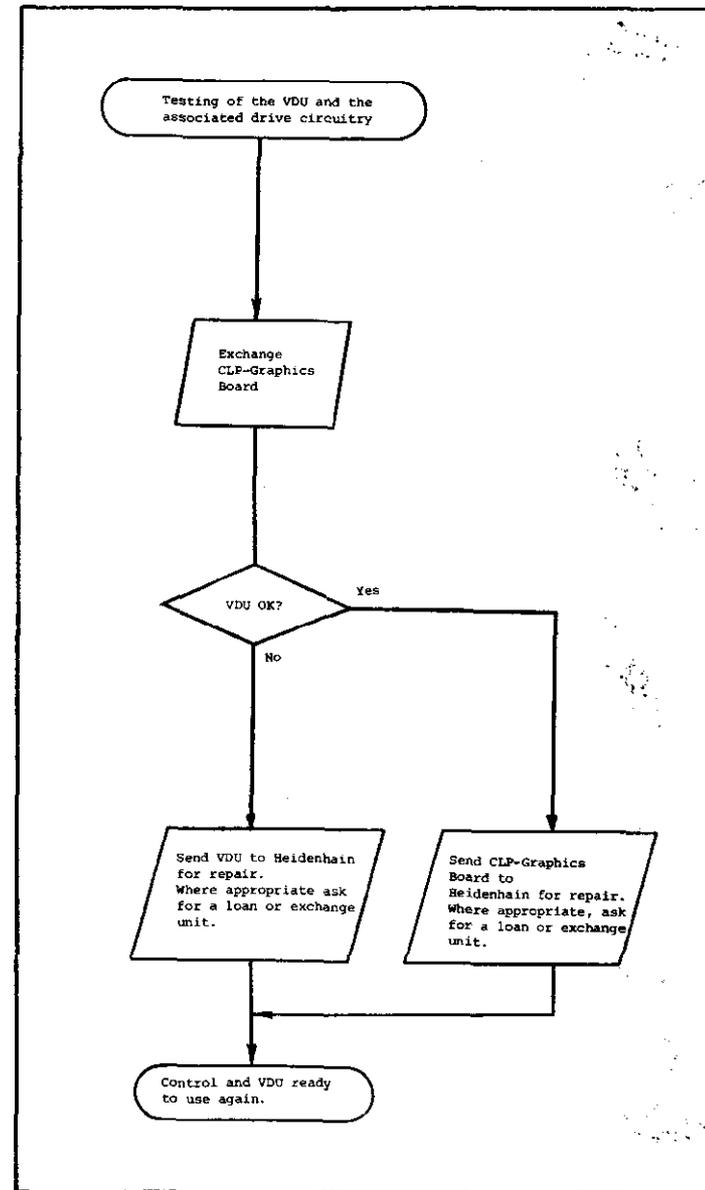
Visual Display Unit BE 411 in conjunction with TNC 155

The Display Units BE 411 is supplied by 11 Vds from the units own integrated power supply. A defect in this power supply may cause an apparent CRT display fault.

If the fault is not due to the defective power supply, it is likely to be due to the CLP-Graphics Board, which contains the control circuitry for the Display Unit. This can be verified by exchanging the board for one which 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-Graphics Board.

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



Testing of the VDU BE 111/211 and associated circuitry

Kundendienst

2.2.4 Testing of 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 under load.

Test Data: Old Power Supply Board (227 601 ..) for TNC 151/155

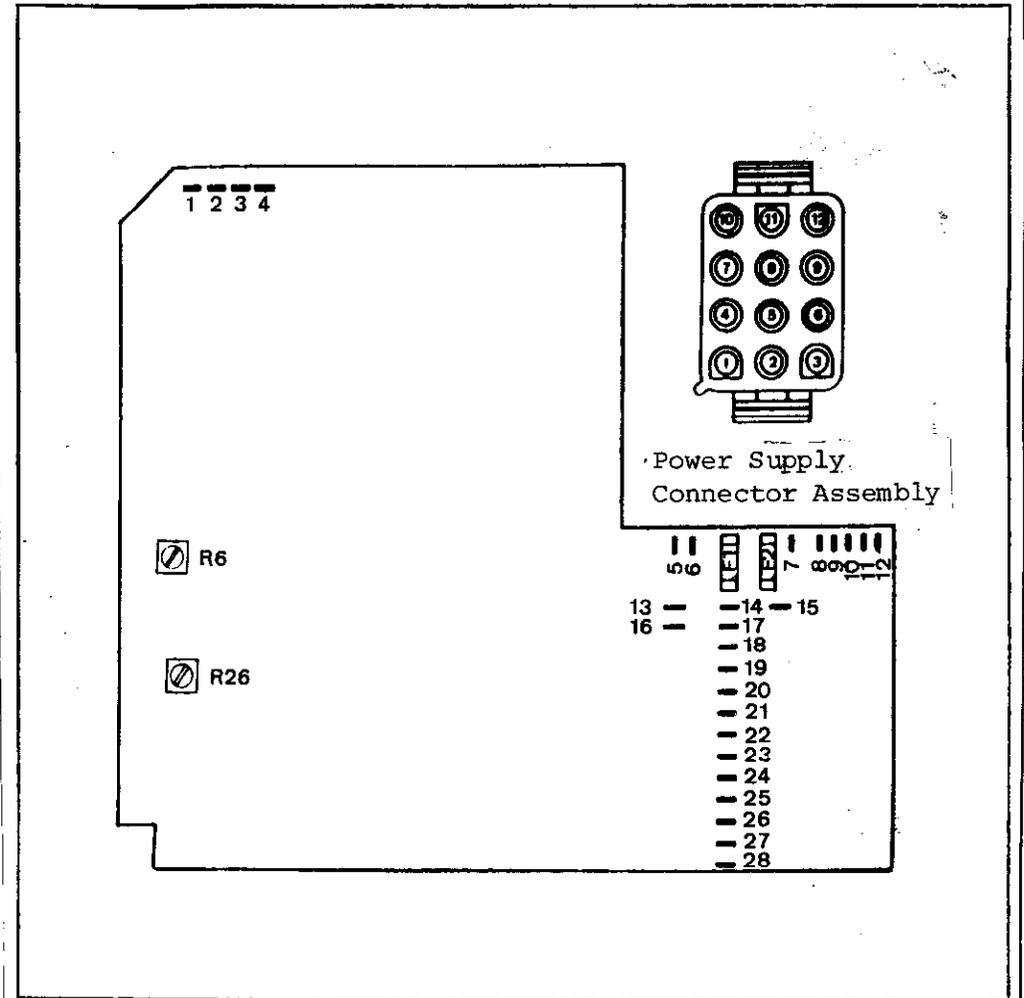
The diagram below and the table opposite show the locations of the test points (solder terminals) on the old Power Supply Board 227 601 .. and the respective "nominal" and "actual" test voltages under load.

Plug and solder terminal signal designation

Plug pin	Cable colour	Solder terminal test points	Voltage/Signal (Nominal)	Test values (V) under load		
1	black	23/24	0V 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
Δ 5	blue	27/28	0V 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
Δ 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	0V			
*	-	6	2,1V ~ Mains transf. sec. voltage			
*	-	7				
-	-	9,10,11,12	no connection			

* not used with TNC 151/155
 Δ not used with TNC 155

Test points on the Power Supply Board 227 601 ..



Fuses F1 and F2 not used with TNC 151

Kundendienst

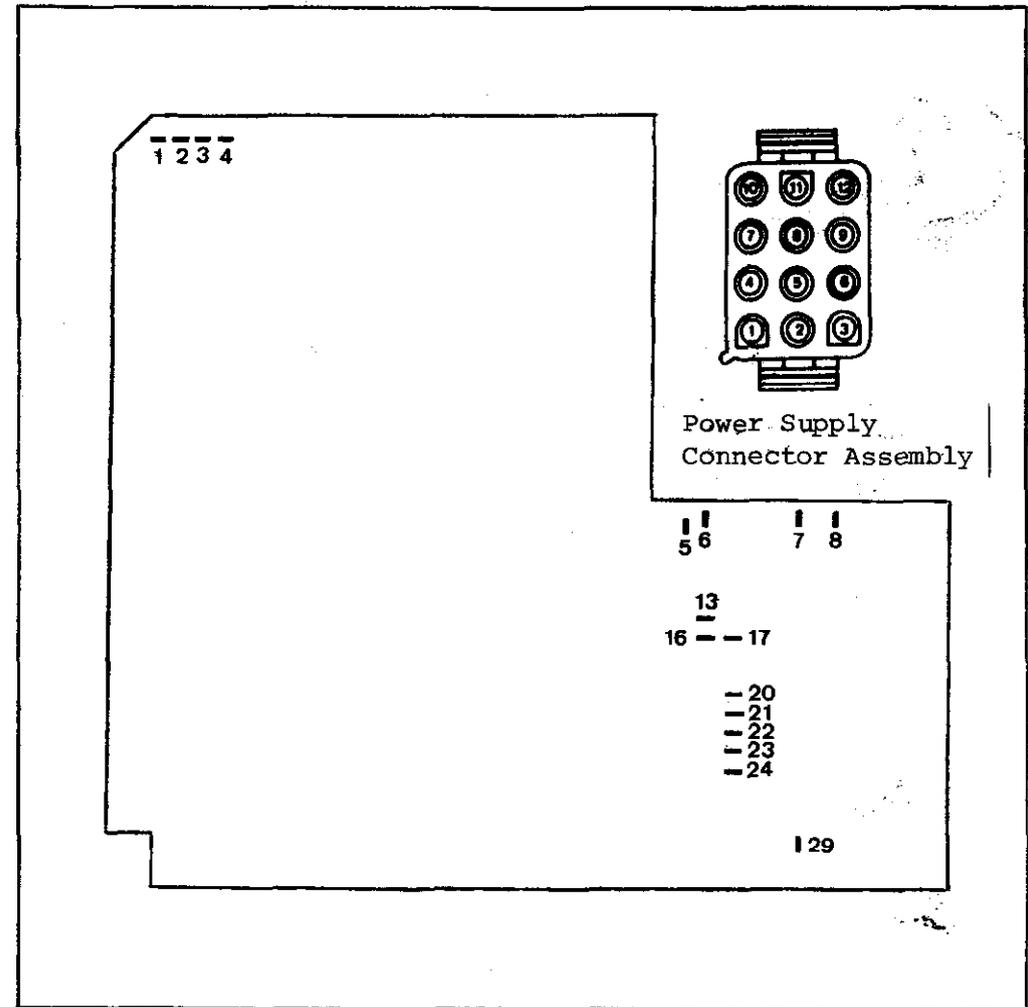
Test Data: New Power Supply Board (230 802 ..) for TNC 155 only!

The diagram opposite and the table below show the locations of the test points (solder terminals) on the new Power Supply Board 230 802 ..., and the respective nominal and actual test voltages under load. Previous TNC 155 Controls may be fitted with Power Supply Board 227 601 .. (as used in the TNC 145/150/151). Test points on the Power Supply Board 230 802 ...

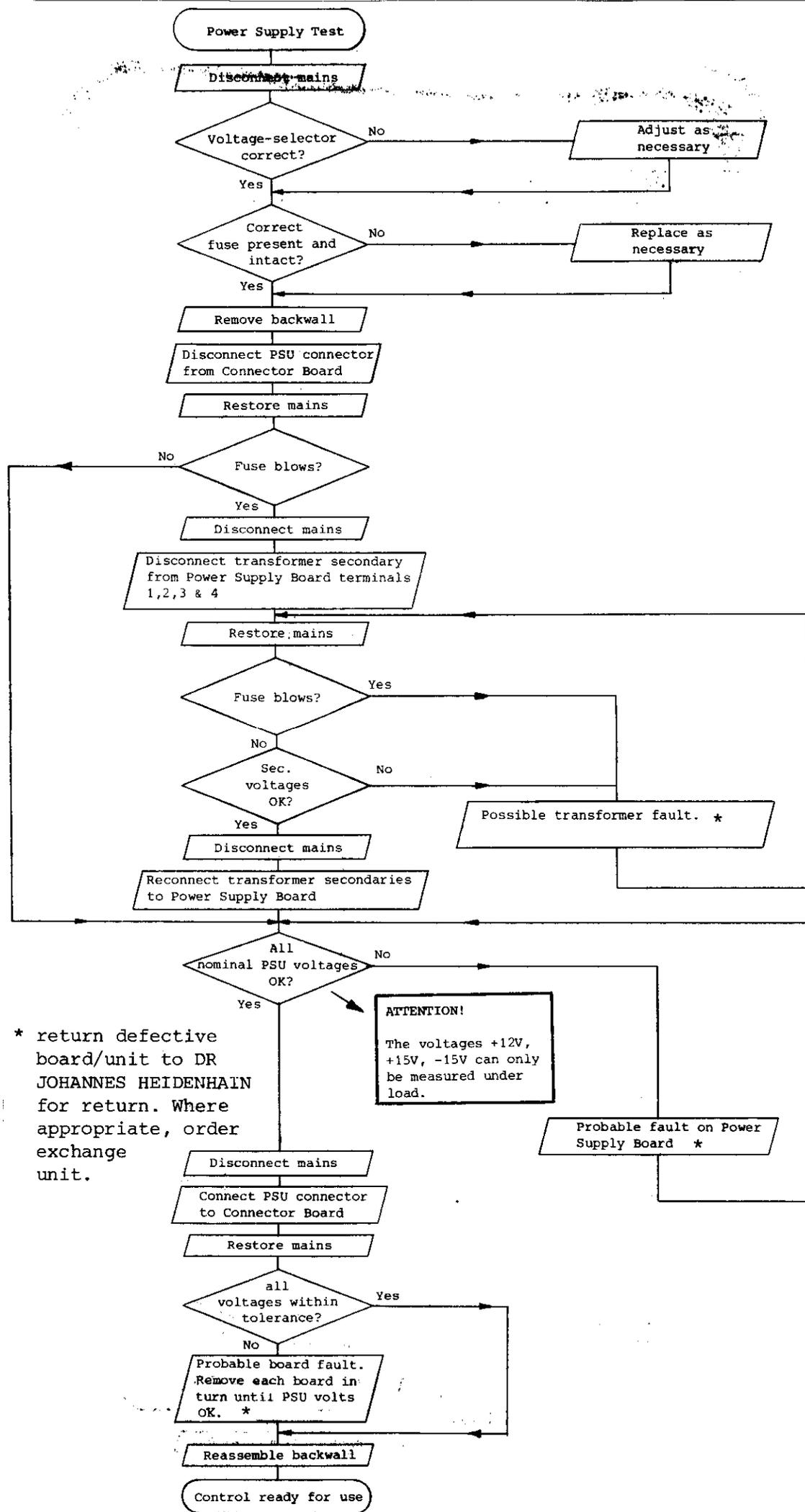
Plug and solder terminal signal designation

Plug pin	Cable colour	Solder terminal test points	Voltage/Signal (Nominal)	Test values (V) under load
1	black	23/24	0V TTL	
2	brown	17	+12 Processor supply	12,0 + 0,5 at 100 ohms
3	red	21/22	+5V TTL	5,2 + 0,1 at 1,5 ohms
4	grey	20	-15V Switching reg.	-15,0 + 1,5 at 150 ohms
5	-	-	n.c.	
6	green	16	+15V Analogue Board	15,5 + 0,1 at 50 ohms
7	-	-	n.c.	
8	-	-	n.c.	
9	green/white	13/8	Reset	
10	-	-	n.c.	
11	-	-	n.c.	
12	-	-	n.c.	
-	-	1	21V ~ Mains transf.	
-	-	2	sec. voltage	
-	-	3	21V ~ Mains transf.	
-	-	4	sec. voltage	
* -	-	5	0V	
* -	-	6	2,1V ~ Mains transf.	
* -	-	7	2,1V ~ sec. voltage	
-	-	9,10,11,12	no connection	

* not used with TNC 151



Procedure for testing the Power Supply Unit



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

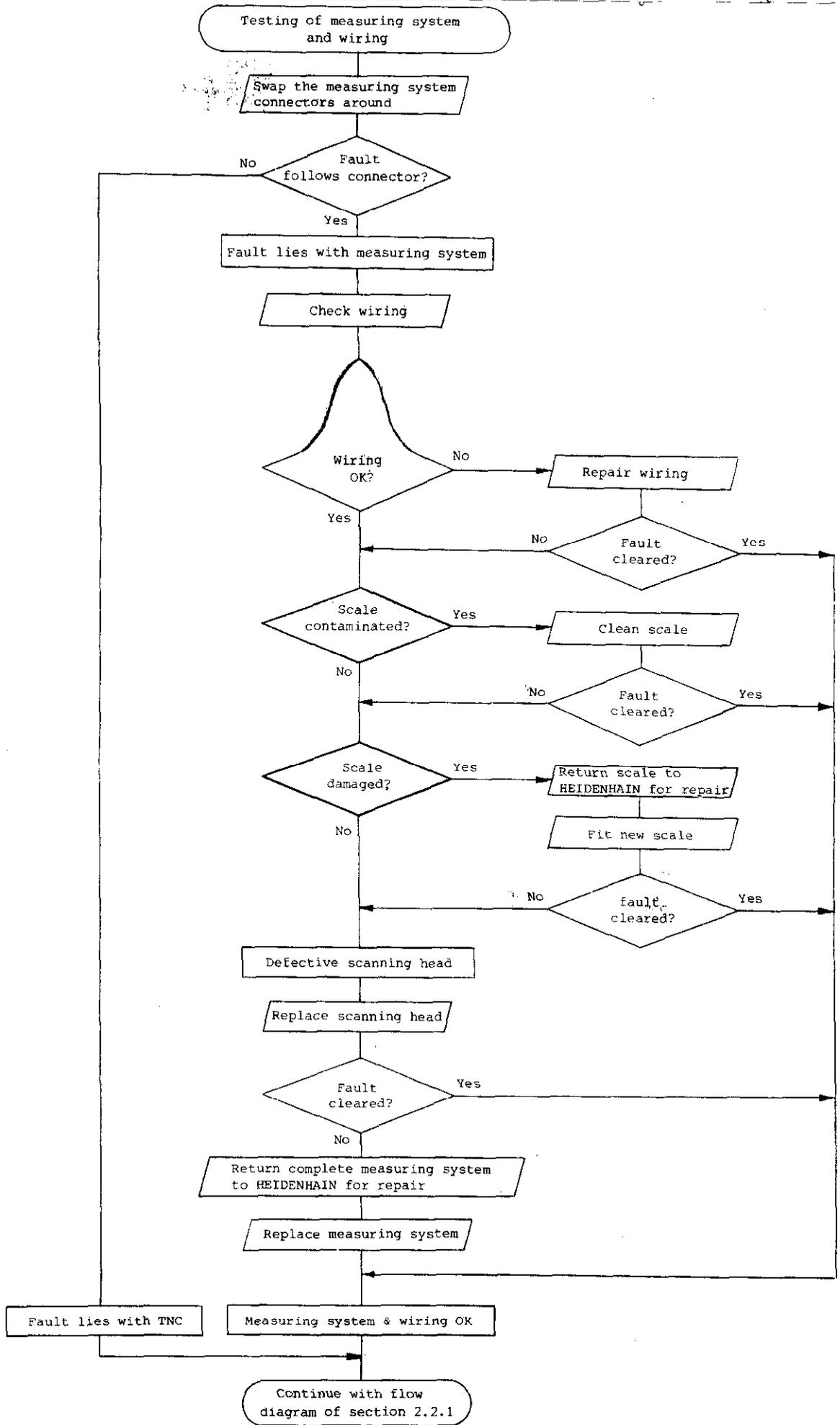
ATTENTION!
 The voltages +12V, +15V, -15V can only be measured under load.

Possible transformer fault. *

Probable fault on Power Supply Board *

Probable board fault. Remove each board in turn until PSU volts OK. *

2.2.5 Testing of the measuring systems and wiring



Kundendienst

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.

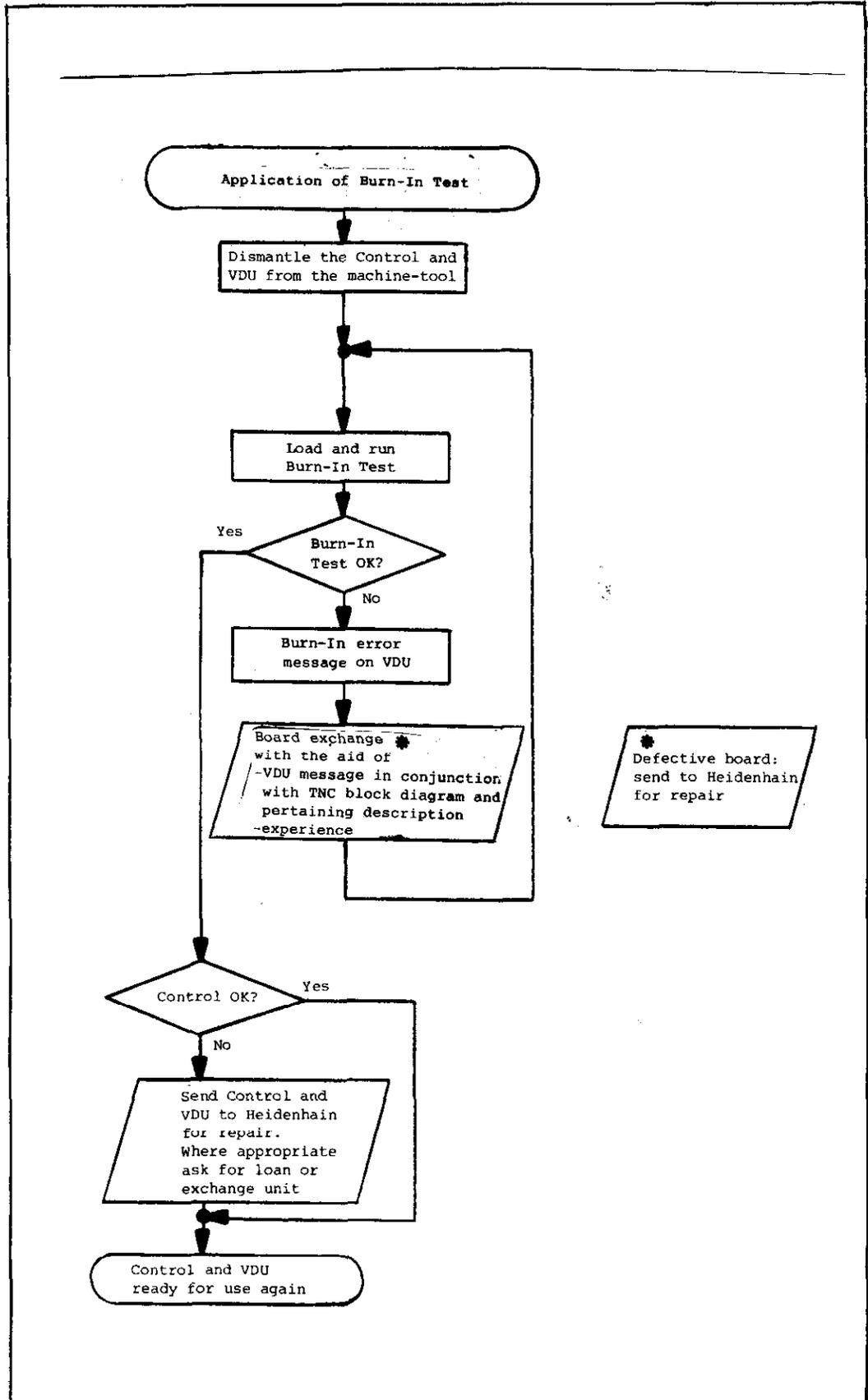
The test program is stored on a digital cassette and can be loaded into the Control via magnetic tape units ME 101 B/102 B or ME 101 C/102 C (Program versions 212 902 05/212 902 09). The test program cannot be loaded into the Control if the flashing error message: "TNC ELECTRONICS DEFECTIVE ." is present 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 necessary to have a set of Burn-In Test Adapters.

Figs. 2 to 4.1 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



Defective board:
send to Heidenhain
for repair



Kundendienst

Burn-In Test Programs for TNC 151 B/F

on the Philips miniature cassette

Control Type	Control Id. No.	From NC Software issue	Test dialog	Test Prog. Id. No.
TNC 151 B	235 565 99 01	D	230 615 02
TNC 151 F	235 565 98			
TNC 151 B	235 565 99 01	GB	230 616 02
TNC 151 F	235 565 98			

Burn-In Test Programs for TNC 155 B/F

on the Philips miniature cassette

Control Type	Control Id. No.	From NC Software issue	Test dialog	Test Prog. Id. No.
TNC 155 B	235 567 99 01	D	230 609 02
TNC 155 F	235 567 98			
TNC 155 B	235 567 99 01	GB	230 610 02
TNC 155 F	235 567 98			

Burn-In Test Programs for TNC 151 Q/W

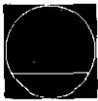
on the Philips miniature cassette

Control Type	Control Id. No.	From NC Software issue	Test dialog	Test Prog. Id. No.
TNC 151 Q	235 566 99 01	D	230 617 02
TNC 151 W	235 566 98			
TNC 151 Q	235 566 99 01	GB	230 618 02
TNC 151 W	235 566 98			

Burn-In Test Programs for TNC 155 Q/W

on the Philips miniature cassette

Control Type	Control Id. No.	From NC Software issue	Test dialog	Test Prog. Id. No.
TNC 155 Q	233 568 99 01	D	230 611 02
TNC 155 W	233 568 98			
TNC 155 Q	233 568 99 01	GB	230 612 02
TNC 155 W	233 568 98			



HEIDENHAIN

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

Kundendienst

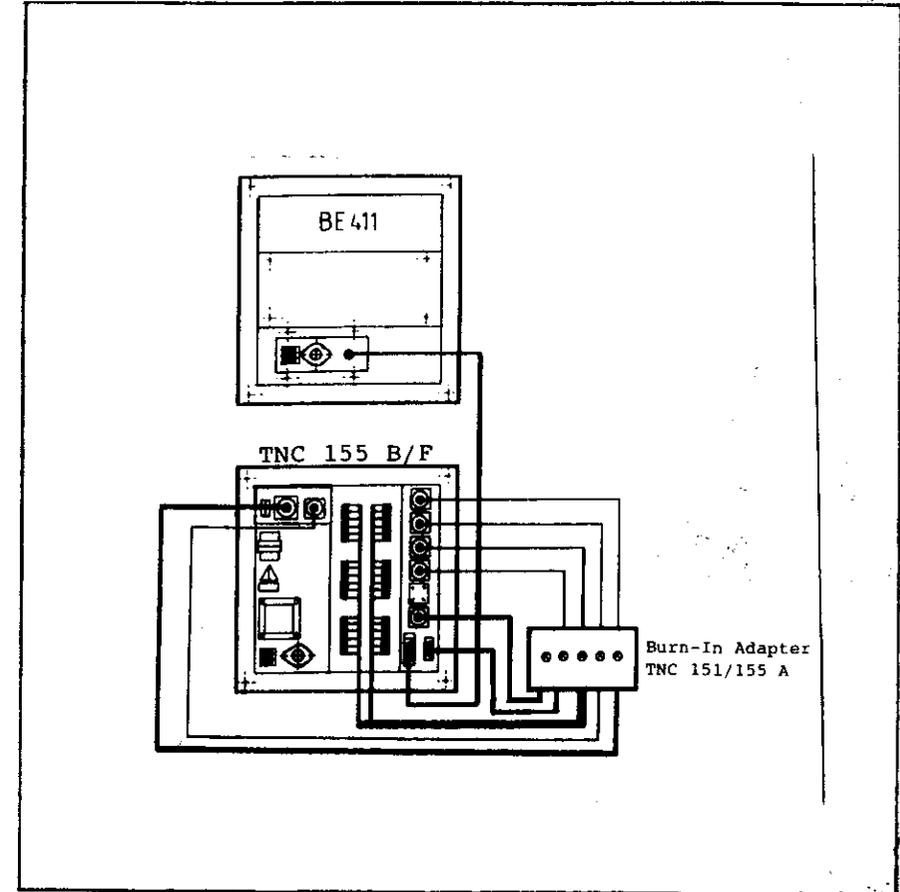
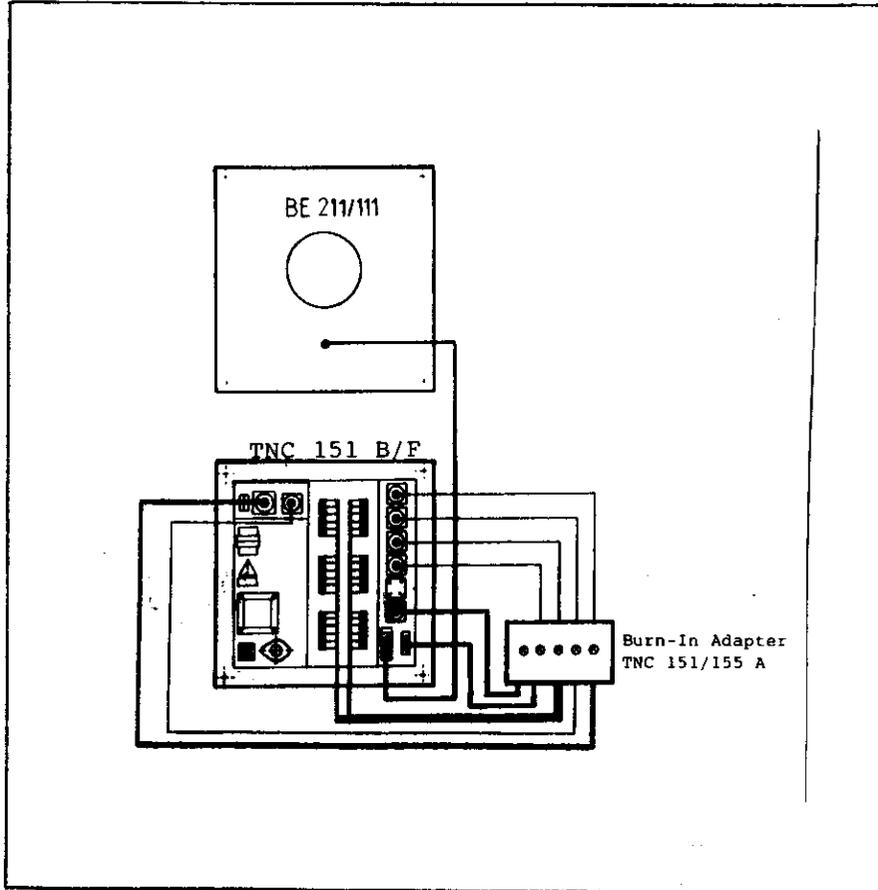
IMPORTANT!

The following section "BURN-IN TEST", pages 21-35 contains the procedure for testing older TNC 151/155 versions and is therefore to be used as a guide only for the newer TNC 151/155 controls described in this manual.

An updated section pertaining to the newer TNC 151/155 is in print. The description contained herein is outdated and should be destroyed upon receiving the updated version.

Kundendienst

Fig. 1 Interconnections of Burn-In Adapters and TNC 151/155 B/F

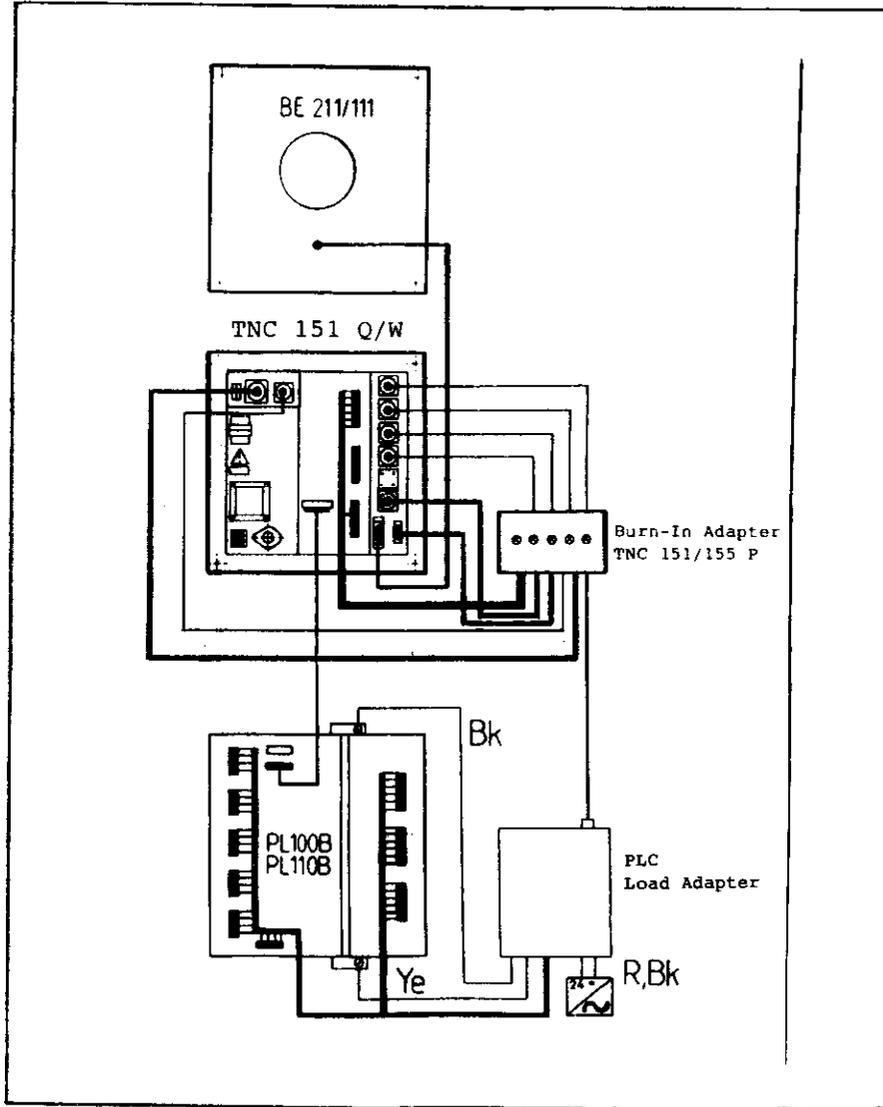


a) TNC 151 B/F

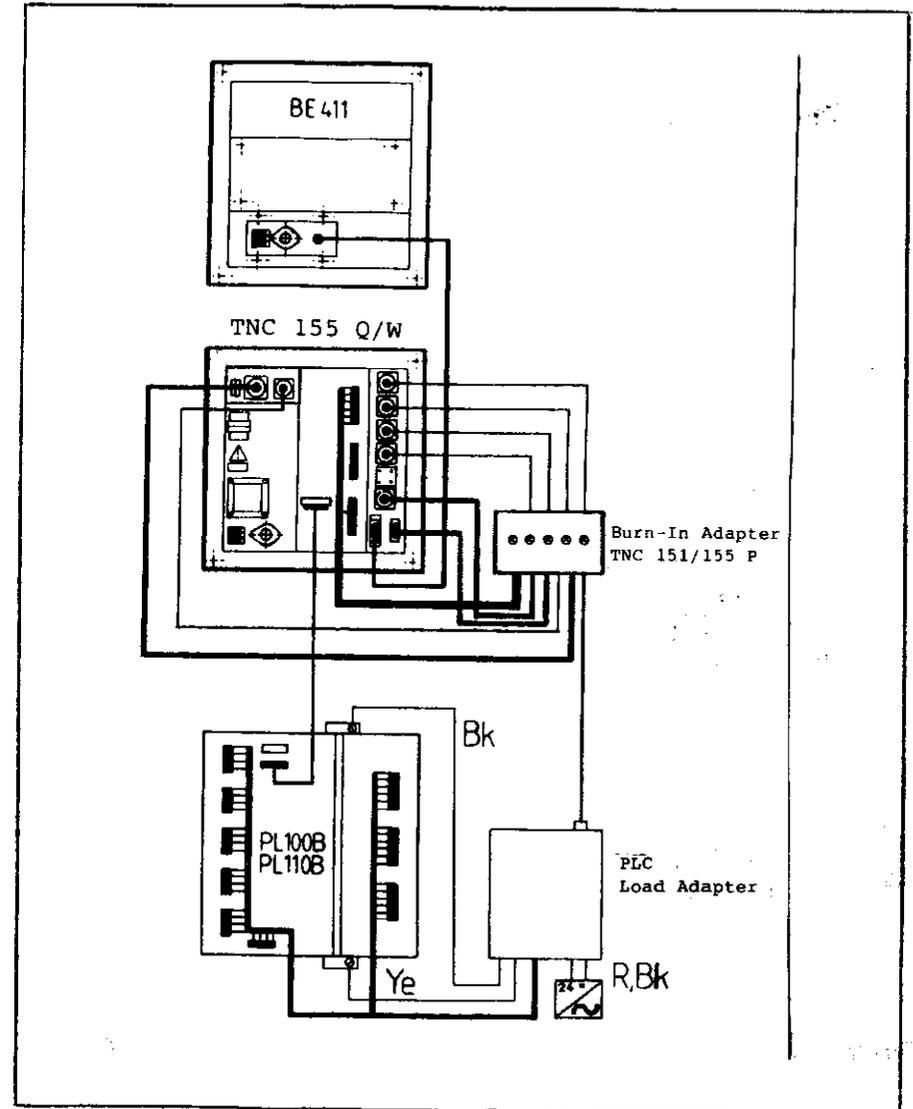
b) TNC 155 B/F

Kundendienst

Fig. 1 Interconnections of Burn-In Adapters and TNC 151/155 Q/W



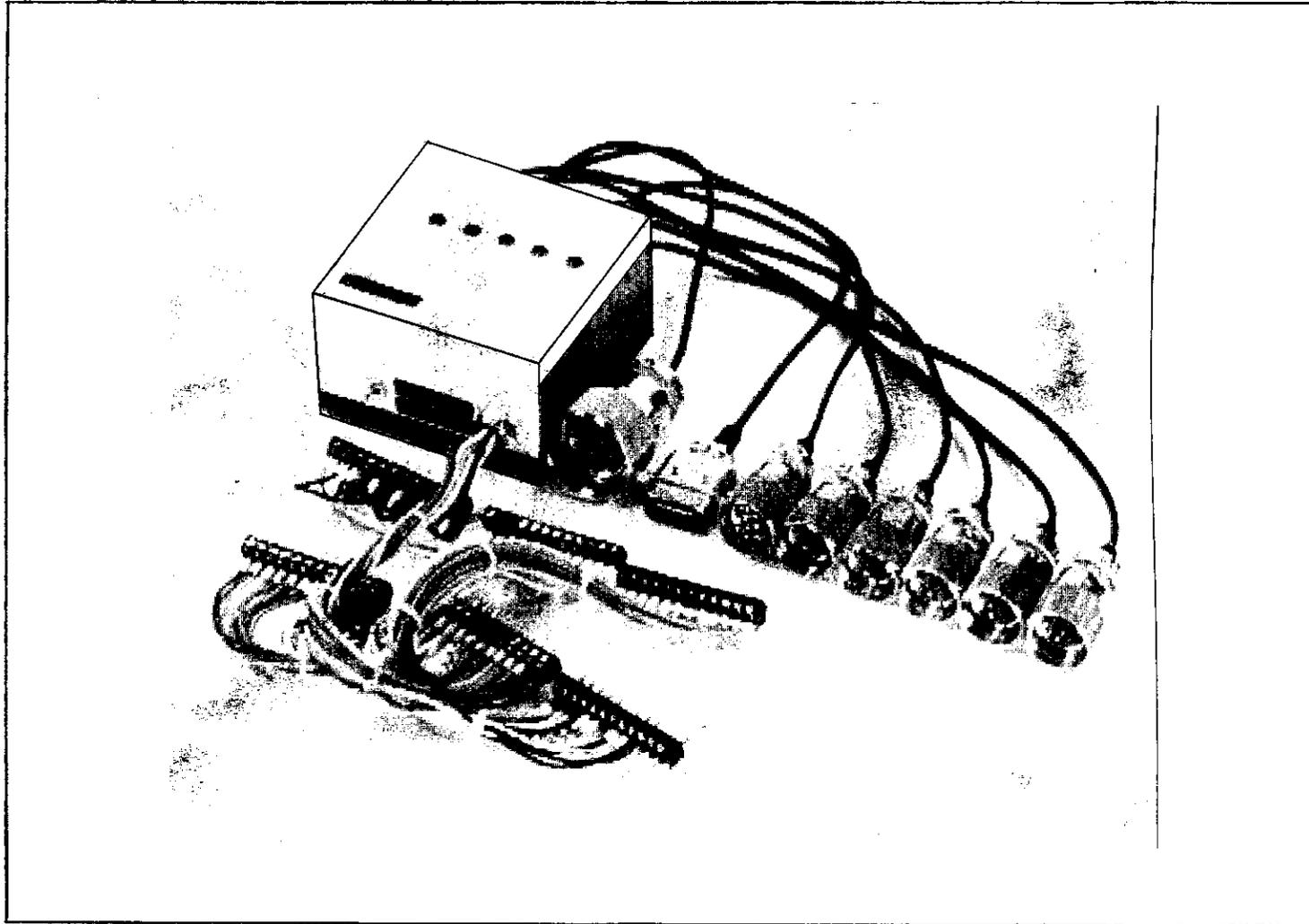
a) TNC 151 Q/W



b) TNC 155 Q/W

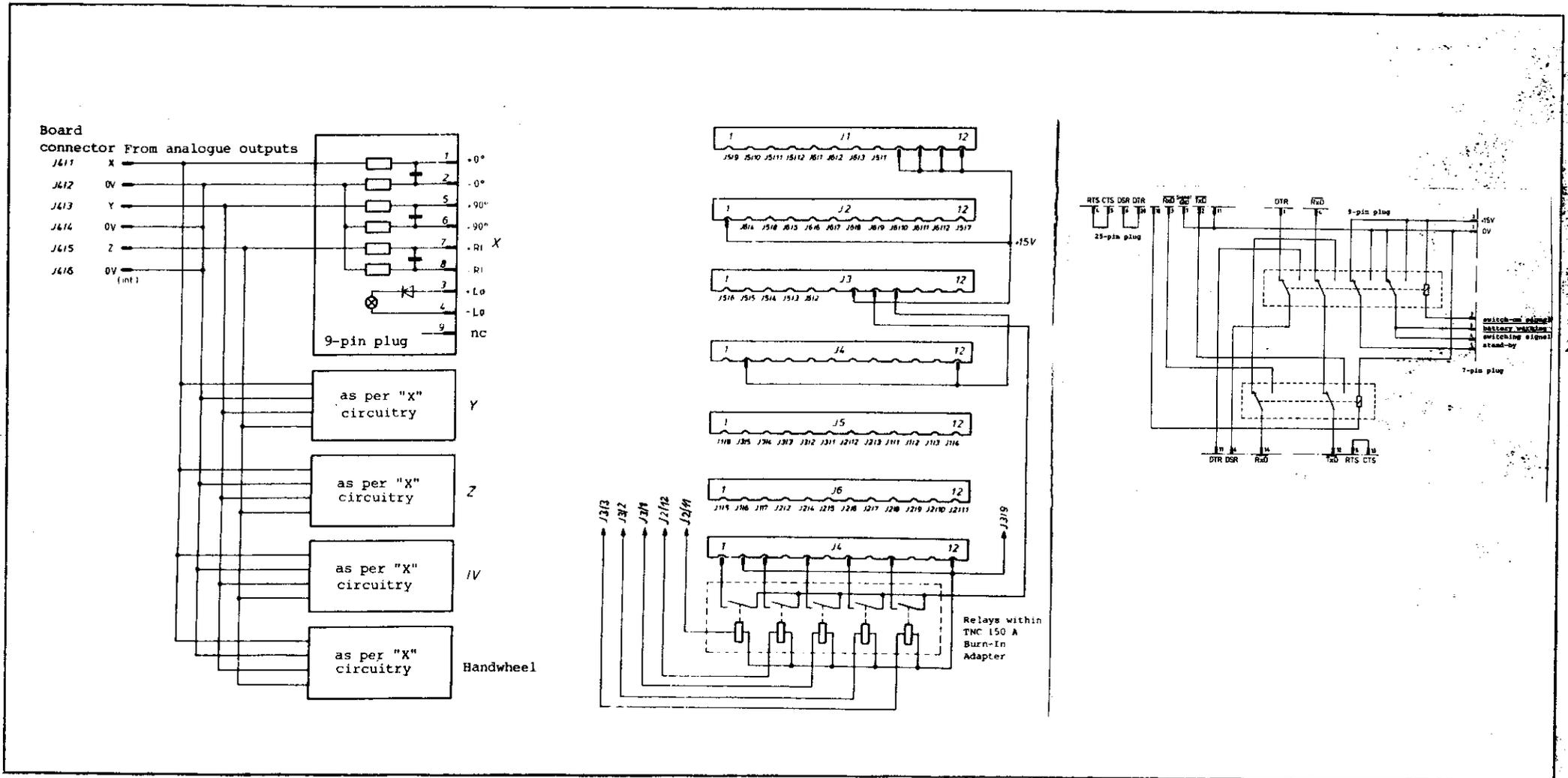
Kundendienst

Fig. 2 Burn-In Adapter TNC 151/155 A (n) (Id.No. 233 514 ZY)



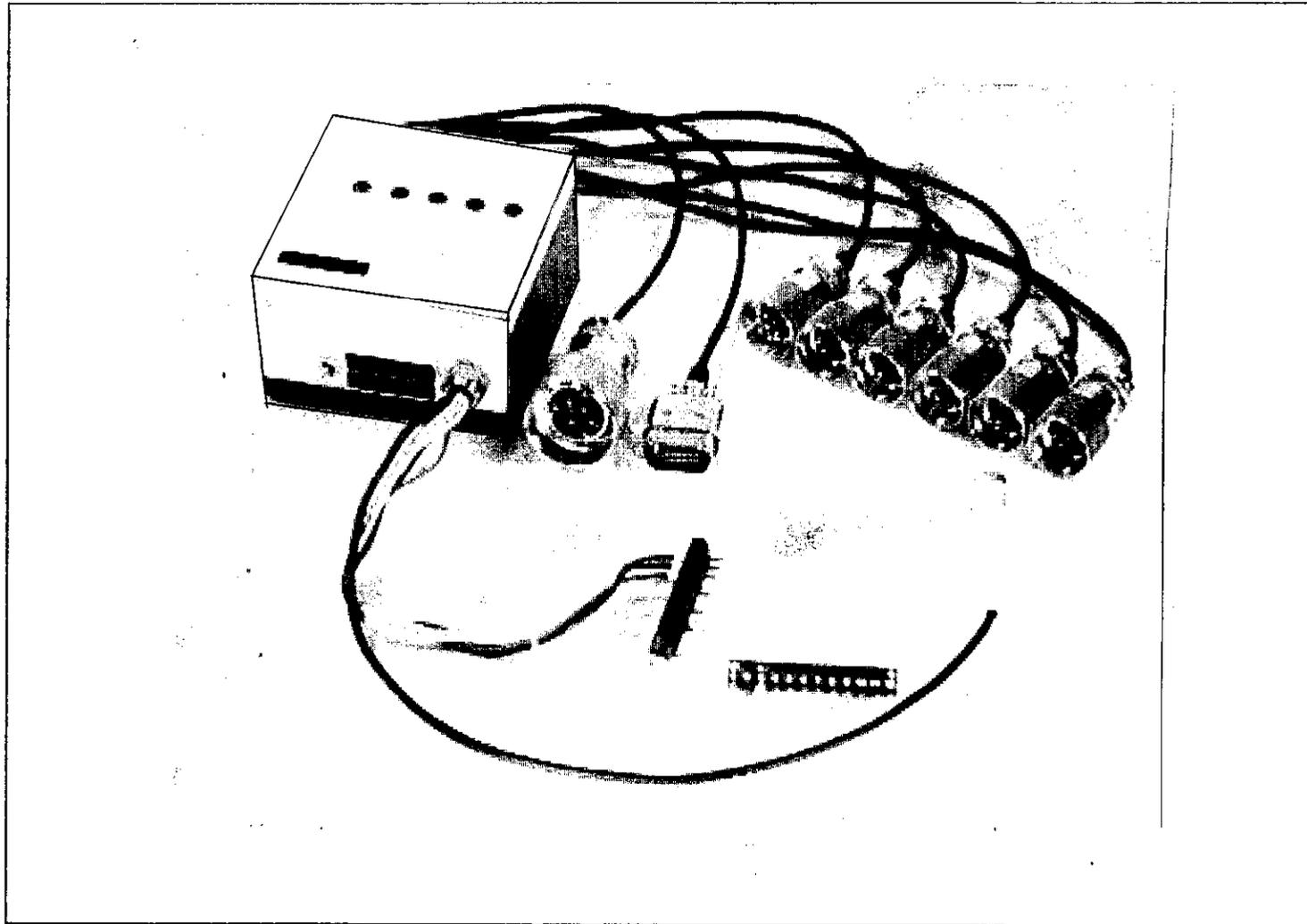
Kundendienst

Fig. 2.1 Burn-In Adapter TNC 151/155 A (n) (Id.No. 233 514 ZY) wiring



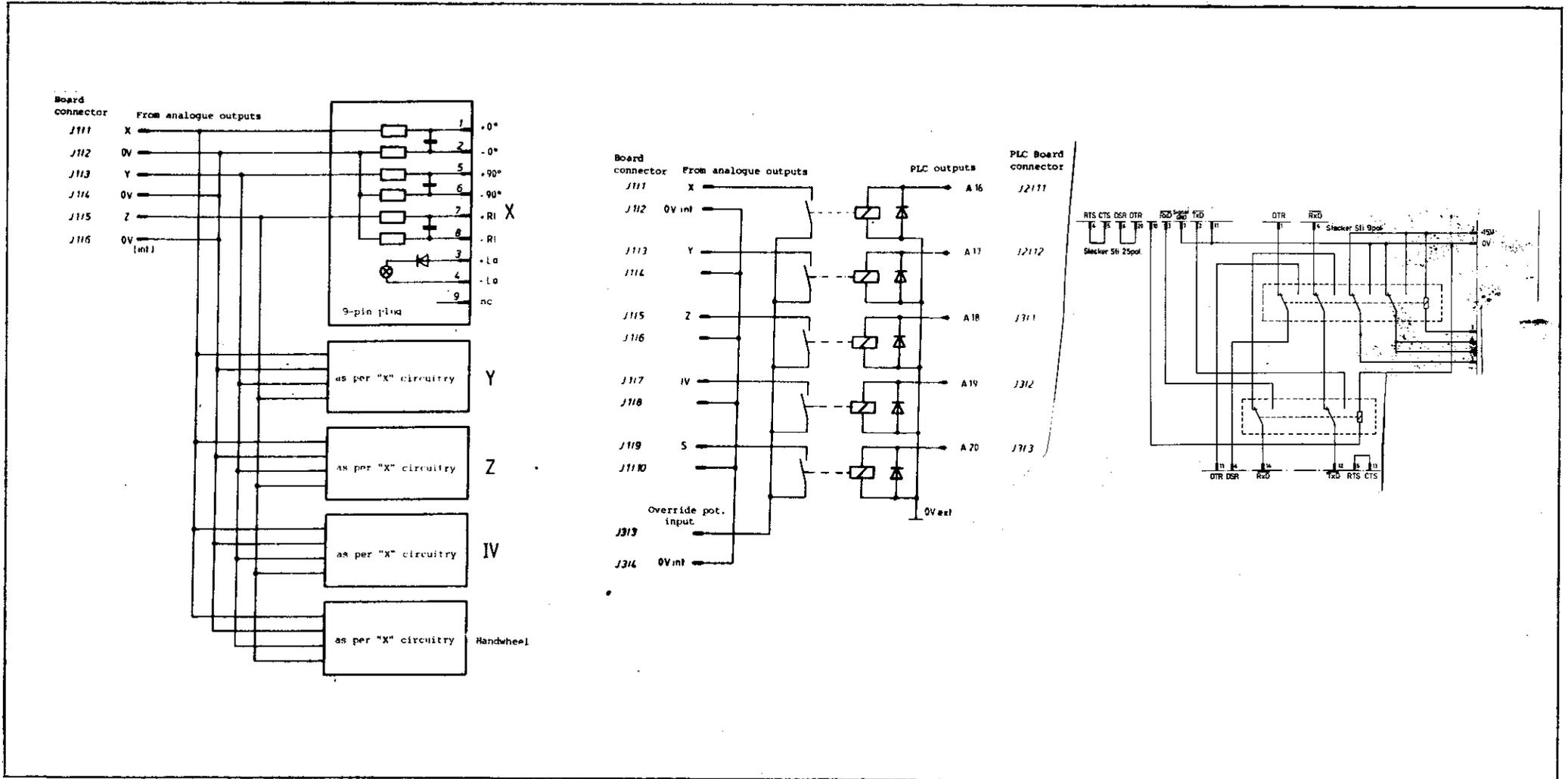
Kundendienst

Fig. 3 Burn-In Adapter TNC 151/155 P (n) (Id.No. 233 513 ZY)



Kundendienst

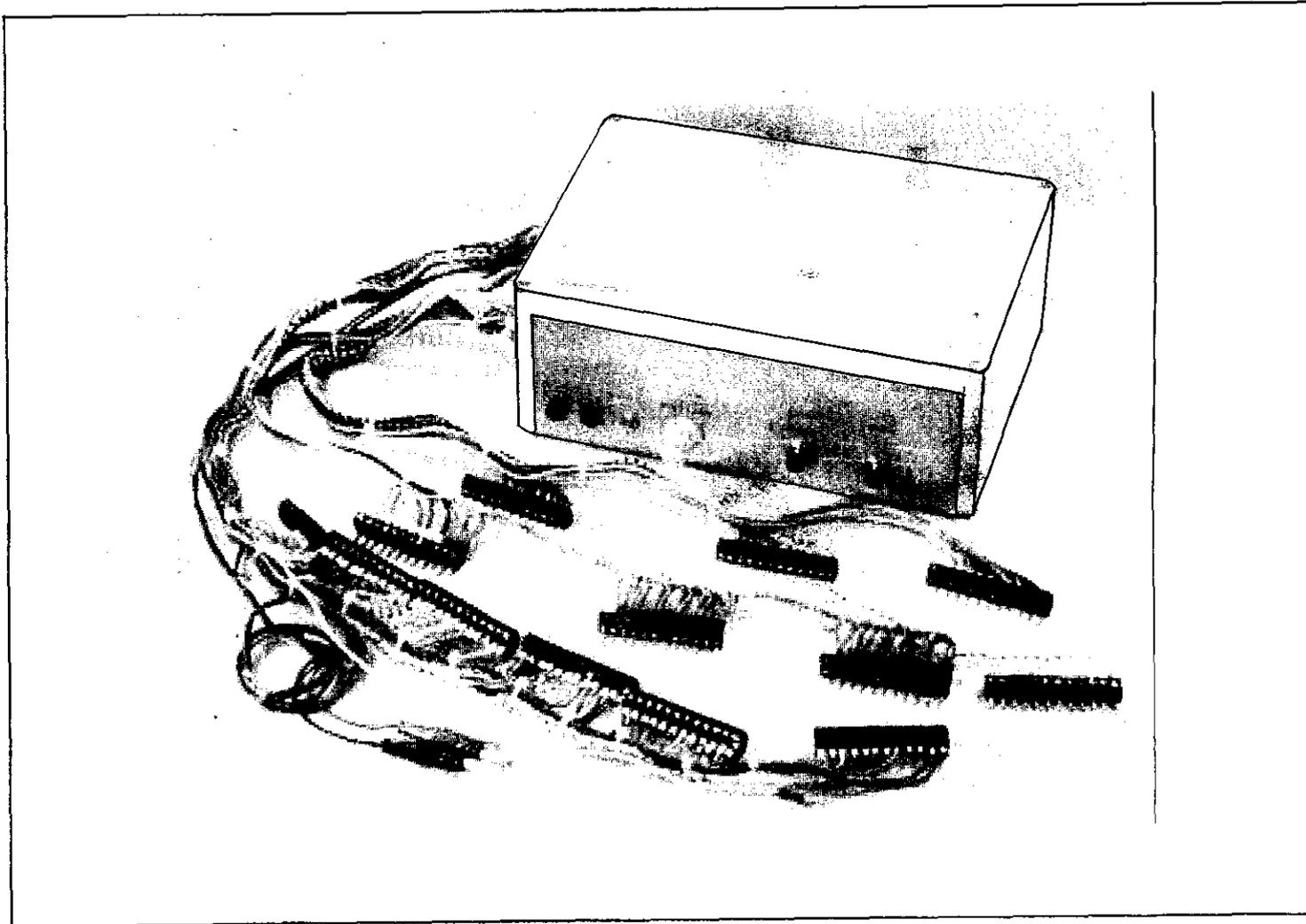
Fig. 3.1 Burn-In Adapter TNC 151/155 P (n) (Id.No. 233 513 ZY) wiring



Kundendienst

Fig. 4 PLC Load Adapter

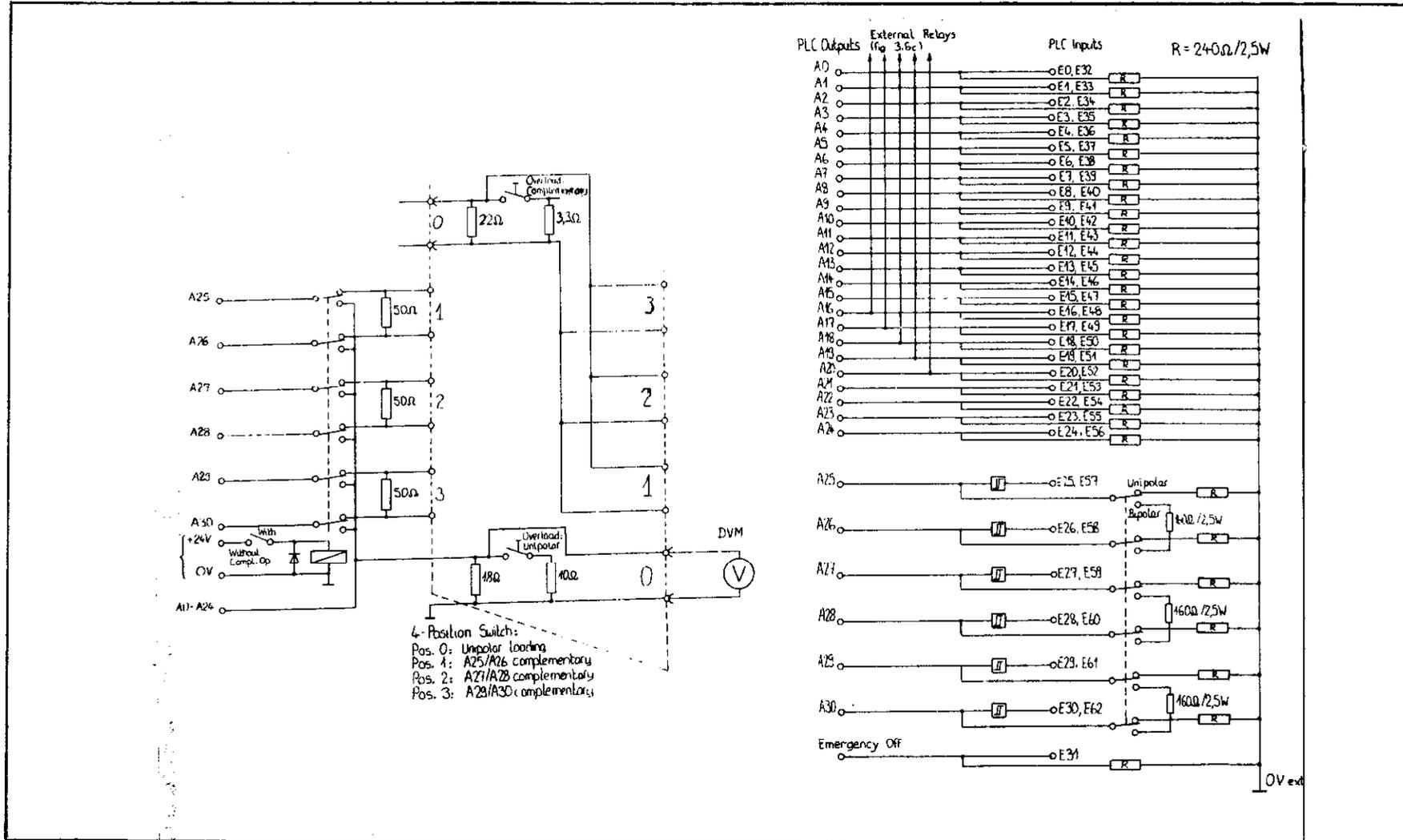
(Id. No. 224 873 ZY)



Kundendienst

Fig. 4.1 PLC Load Adapter

(Id. No. 224 873 ZY) wiring



Additional circuitry for overload facility

Standard circuitry, with unipolar/bipolar switch-over

Kundendienst

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:

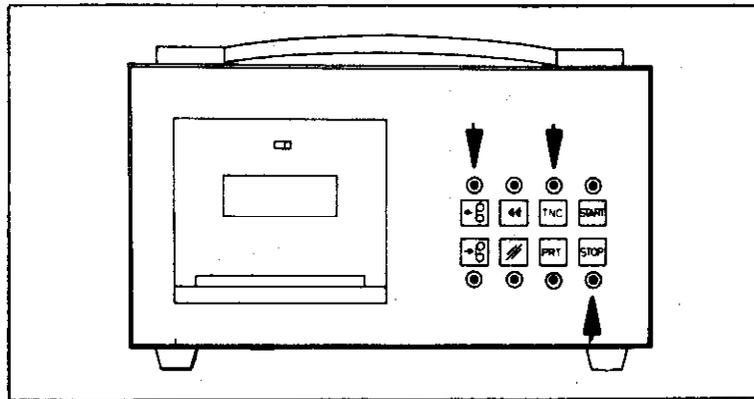


Fig. 6 Initialization of ME unit

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:

- as often as necessary to obtain the display:

"CODE NUMBER =", and then:

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

4. The data transfer is then initiated by pressing:



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

Kundendienst

"POWER INTERRUPTED
EXTERNAL DATA INPUT"

6. After completion of a successful 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.

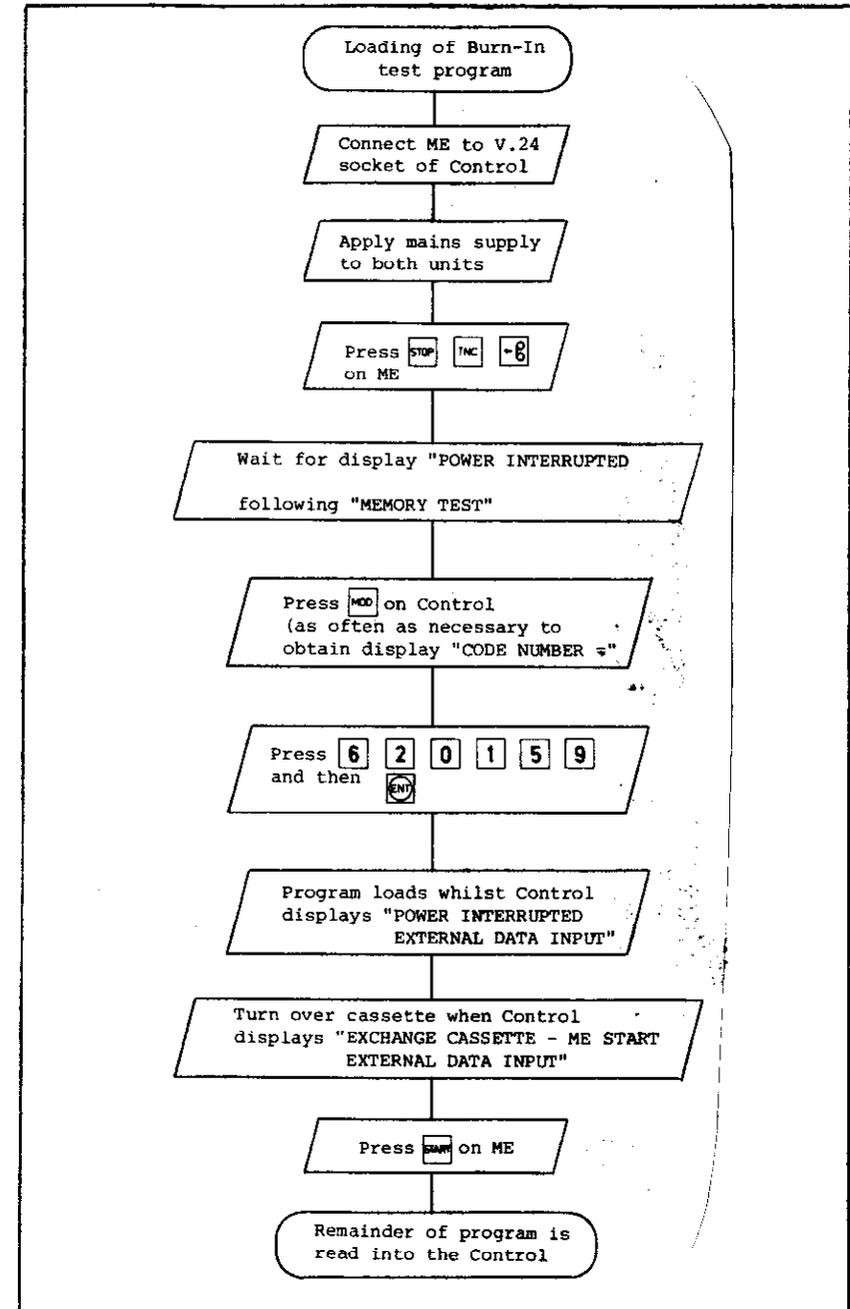


Fig. 7 Loading and Initialization of Burn-In Test Program

Kundendienst

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



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



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

To restart the Burn-In test program press

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.

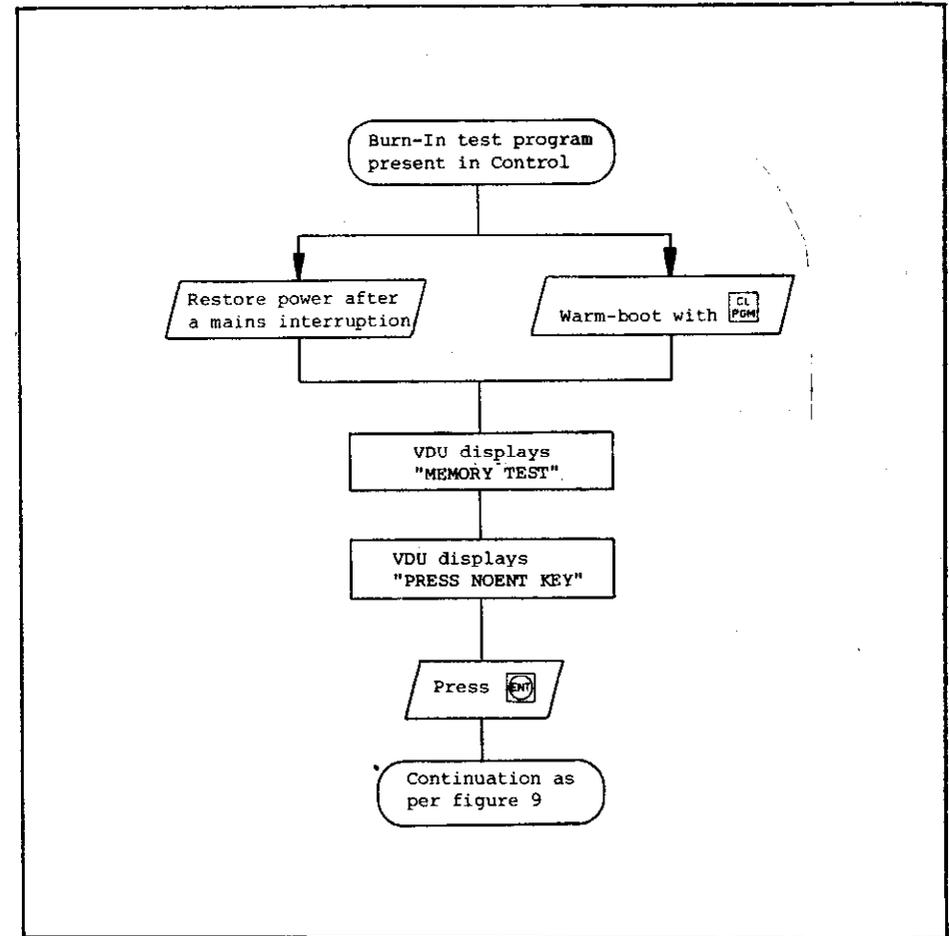


Fig. 8 Re-initialization of a previously loaded Burn-In test program

Kundendienst

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 29

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:

"BI: SOFTWARE NUMBER XXXXXX XX
 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 (only with TNC 155!)
. . . . . 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:

- top right set of 20 keys
- top left set of 10 keys
- middle left set of 20 keys
- bottom left set of 4 keys (only with TNC 155!)
- 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 30).

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, (TNC 151/155 Q/W) 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;





Kundendienst

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:

"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:

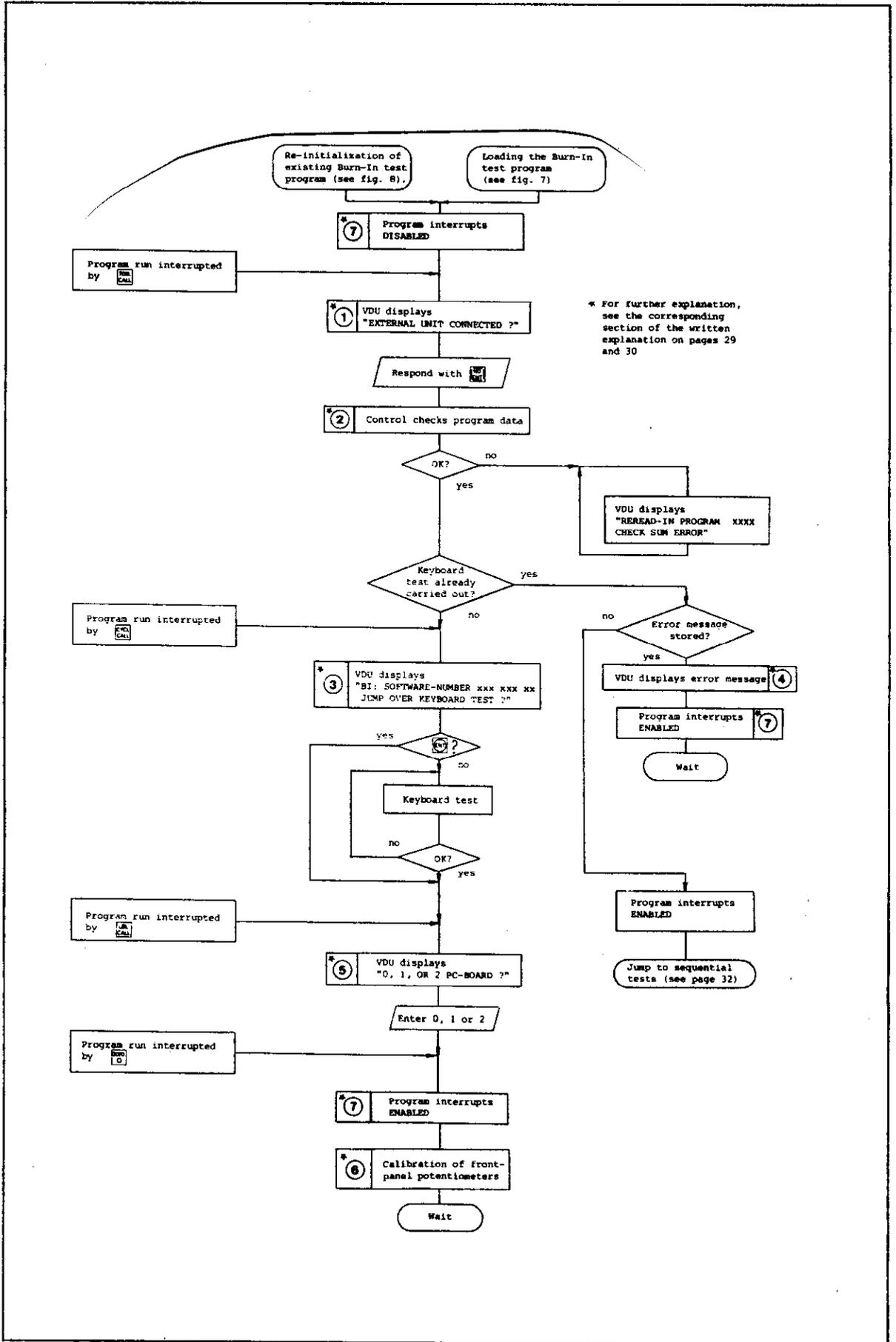
CL PGM
 TOOL CALL
 CYCL CALL
 LBL CALL
 GOTO □

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 □ "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



Kundendienst

Sequential (duration) test

Check that all test adapters are correctly connected, including the connection to the V.24 interface socket.

The sequential test for the TNC 151 is comprised of the following individual tests:

- a) Key **.**
"TEST INT.POT, BATTERY TRIGGER"
The internal potentiometers (on the front panel) are in order when set to $100 \pm 2\%$.
- b) Key **0**
"EPROM TEST CPU"
XXXX XXXX
The contents of the EPROMS addressed by the main processor are tested through their CRC check-sums. The sums of the individual address ranges are displayed in one data word. The MS-byte contains the generated check-sum, the LS-byte contains the expected check-sum. The address range displayed in a fail condition is the first that deviates from the expected check-sum.
- c) Key **1**
"RAM TEST NOT MAPPED"
Addressed is the range from E000H to FFF9H, which is battery backed-up during power interruption.
- d) Key **2**
"RAM TEST MAPPED"
Addressed is the range from FFFFFH and upwards depending on RAMS equipped. During this test, no power interruption should occur.
- e) Key **3**
"TEST PC RAM"
Range: E000H to FFFFH (through CRU addressing)
- f) Key **4**
"TEST STATIC RAM CLP PROCESSOR BOARD"
Range: D800H to DFFFH

The sequential test for the TNC 155 is comprised of the following individual tests:

- a) Key **.**
"TEST INT.POT, BATTERY TRIGGER"
The internal potentiometers (on the front panel) are in order when set to $100 \pm 2\%$.
- b) Key **0**
"EPROM TEST CPU"
XXXX XXXX
the contents of the EPROMS addressed by the main processor are tested through their CRC check-sums. The sums of the individual address ranges are displayed in one data word. The MS-byte contains the generated check-sum, the LS-byte contains the expected check-sum. The address range displayed in a fail condition is the first that deviates from the expected check-sum.
- c) Key **1**
"RAM TEST NOT MAPPED"
Addressed is the range from E000H to FFF9H, which is battery backed-up during power interruption.
- d) Key **2**
"RAM TEST MAPPED"
Addressed is the range from FFFFFH and upwards depending on RAMS equipped. During this test, no power interruption should occur.
- e) Key **3**
"TEST PC RAM"
Range: E000H to FFFFH (through CRU addressing)
- f) Key **4**
"TEST STATIC RAM CLP GRAPHICS BOARD"
Range: A000H to BFFFH
D800H to DFFFH

Kundendienst

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 with Q versions)
 The PLC I/O Board outputs are resistively loaded and connected to the inputs by means of the PLC 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. PC BOARD
 INPUT/OUTPUT 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	0	0	1	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																

AX -- EX, EY

always

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 presses 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.

g) Key **5**
 "TEST DYNAMIC RAM CLP GRAPHICS BOARD"

h) Key **6**
 "TEST VIDEO RAM CLP GRAPHICS BOARD"

i) Key **7**
 "PC INSTRUCT DECODER, ACCU-FF TEST"
 The circuitry used for decoding and carrying out the PLC instructions is tested.

j) Key **8**
 "INPUT/OUTPUT TEST 1. PC BOARD" (only with Q versions)
 The PLC I/O Board outputs are resistively loaded and connected to the inputs by means of the PLC 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. PC BOARD
 INPUT/OUTPUT 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	0	0	1	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																

AX -- EX, EY

always 0

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 presses 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.

Kundendienst

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
 20 0 0 0 0 0 0 0 0 0 0 0 0 1 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
 60 0 0 0 1 ← (always a)
 AX -- EX, EY

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"
 CONNECTION: ANALOG-OVER EXT.
 RELAY ON INPUT EXT. POT
 Five external relays (within the TNC 151/155 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 Burn-In Adapters TNC 151/155 A/P). 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"

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

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
 20 0 0 0 0 0 0 0 0 0 0 0 0 1 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
 60 0 0 0 1 ← (always a)
 AX -- EX, EY

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



k) Key **9**
 "EXT. POT, ANALOG OUTPUT TEST"
 CONNECTION: ANALOG-OVER EXT.
 RELAY ON INPUT EXT. POT
 Five external relays (within the TNC 151/155 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 Burn-In Adapters TNC 151/155 A/P). The test is made at three different voltages: 200mV, 5V, 9.5V

l) Key **X**
 "TEST V24-INTERFACE"

m) Key **Y**
 "TEST 3D-SCANNER INTERFACE"

n) Key **Z**
 "TEST SERIAL HANDWHEEL INPUT"
 Checks the interface to the HE 310 Handwheel Unit

Kundendienst

- m) Key **Y**
 "SUPERVISION CIRCUIT TEST"
 XX XX XX XX
 checks the threshold values of the circuitry which monitors the measuring system inputs.
 The contents of the counter status registers for the X, Y, Z and IV axis are displayed.
- n) Key **Z**
 "TEST REFERENCE IMPULSE INPUT"
 XX XX XX XX
 Checks the effect of a signal applied to the reference-pulse inputs.
 The contents of the counter status registers for the X, Y, Z, IV axis and handwheel are displayed.
- o) Key **IV**
 "TEST TRANSDUCER INPUTS, EXE"
 XXXX XXXX XXXX XXXX XXXX
 Checks the effect of signals applied to the measuring system inputs.
 The contents of the counter status registers for the X, Y, Z, IV axes and handwheel are displayed.

- o) Key **IV**
 "SUPERVISION CIRCUIT TEST"
 XX XX XX XX
 checks the threshold values of the circuitry which monitors the measuring system inputs.
 The contents of the counter status registers for the X, Y, Z and IV axis are displayed.
- p) Key **Q**
 "TEST REFERENCE IMPULSE INPUT"
 XX XX XX XX
 Checks the effect of a signal applied to the reference-pulse inputs.
 The contents of the counter status registers for the X, Y, Z and IV axis are displayed.
- q) Key **Q DEF**
 "TEST TRANSDUCER INPUTS, EXE"
 XXXX XXXX XXXX XXXX XXXX
 Checks the effect of signals applied to the measuring system inputs.
 The contents of the counter status registers for the X, Y, Z, IV axes and handwheel are displayed.

Starting the sequential tests

A detected fault will be displayed on the VDU the test cycle is interrupted and the BURN IN TIME is stopped. With an Override Potentiometer fault the LEDs for the following keys:

↶, **↷**, **↸**, **↹**, **↺** will flash.

With a Spindle Override Potentiometer fault the LEDs for the following keys: **⊕**, **⊖**, **MOD**, **P**, **I** will flash.

With a Battery Trigger fault both the **R_L** and **R_R** LEDs will flash.

In all other cases several LEDs will flash. Through pressing the respective key, each individual test can be restarted.

An error message remains memorized until overwritten by a newly detected fault. An error message can be called up using the **TOOL CALL** and **NO ENT** keys. Pressing the **DEL** key erases the fault message and restarts the sequential tests.

Kundendienst

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"

Pressing key **1** causes the test (still to be selected) to run cyclically, regardless of whether a fault is detected. Pressing key **2** causes the test to 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.

(With TNC 155 only!)

A graphics display consisting of a square grid with a circle in the centre can be displayed by pressing the key marked



Similarly the NC and PLC software numbers can be displayed by pressing the key



Calibration check of the Analogue Board ("TRIMMING ROUTINES")
Interrupting the Burn-In test program with the key



gains access to the calibration tests. Exit from 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 *
("MONOTONIIY 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")
- Key **8**: Transducer pulse count comparison *
("PULSE COUNT OUTPUT")

() text in brackets appears on VDU

* these test are not suitable for customer use.

** see following explanations:

Kundendienst

Key **2** : Analog output voltage

The performance of the analog output circuitry can be checked by connecting a DVM to each of the analog 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 each of the analog 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:
 $(5 \times 2.44\text{mV}) + (3 \times 24.4\text{mV}) + (1 \times 2.44\text{V}) = \underline{2.525\text{V}}$

The polarity of the output can be reversed using the key

+/-

The output can be cleared using the key

0

The hold time of the sample and hold amplifier can be selected to either 5ms or 500ms using the **.** key.

Key **5** : ± 10V analog output

The analog 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.

Key **8** : Transducer pulse count comparison

The counting function of each axis can be checked by connecting a rotary encoder to the respective transducer input.

Key **Q** : Start count after reference mark is detected

Key **Q⁰ DEF** : Stop count after reference mark is detected

If no encoder is connected "VVVVVVVVVV" is displayed in the respective axis (excluding handwheel).

eg. testing using - 100 line rotary encoder
- 20-fold TNC interpolation

$$\begin{aligned} \text{pulse count} &= \text{no. of lines} \times \text{interpolation} \\ &= 100 \times 20 \\ &= 2000 \end{aligned}$$

From this example the display has to be divisible by 2000.

Display: 32000 : 2000 = 16 in order

Display: 32250 : 2000 = 16,125 defective

Kundendienst

3. Exchange Information

Note: All inputs/outputs from the TNC 151/155 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.

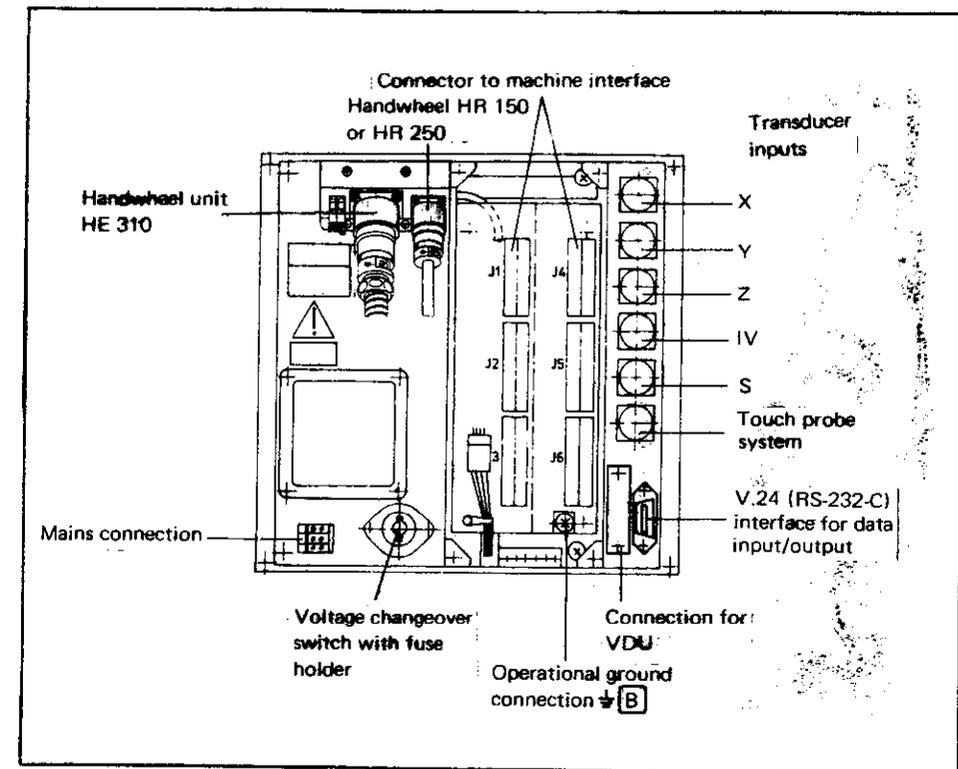
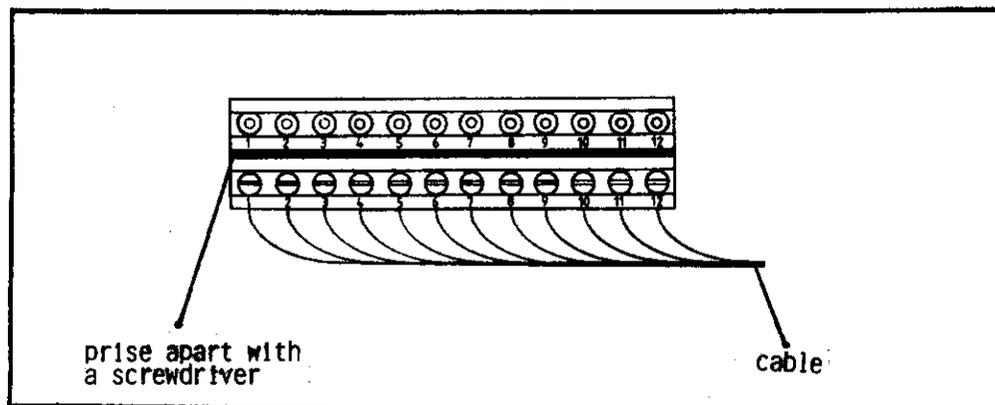
Before exchanging a Control the machine parameters should be noted or stored on magnetic tape!

Kundendienst

3.1 Exchanging Control Units

3.1.1 Procedure for exchanging the TNC 151/155 B/F 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,4, Axes, S if present, 3D Touch Probe) 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).

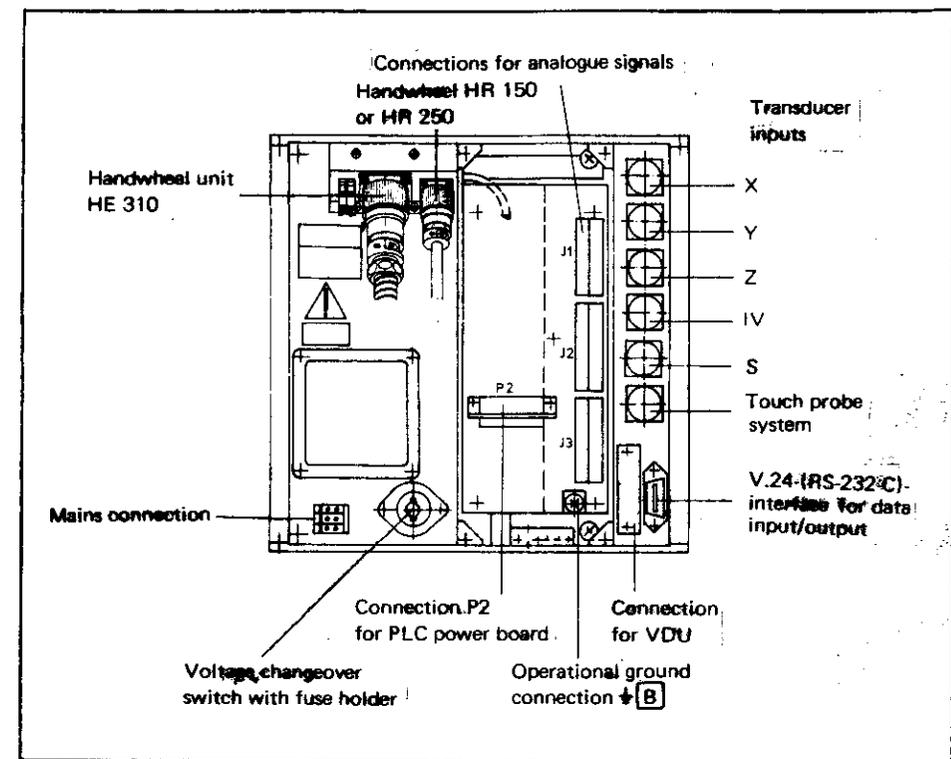
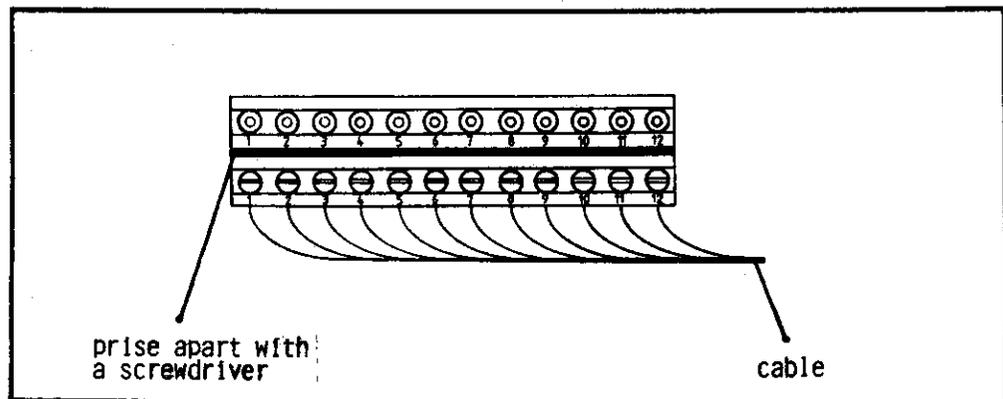


9. Remove the faulty Control, removing the fixing screws if not already removed in 1.
10. Install the new Control - check the voltage selector position.
11. Check the fuse-rating (see type-plate).
12. Reconnect all cables previously removed.
13. Obtain from the type-plate the Control's Id. No., NC and 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.

Kundendienst

3.1.2 Procedure for exchanging the TNC 151/155 Q/W 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,4 Axes, S if present, 3D Touch Probe) 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.

Kundendienst

3.2 Board Exchange

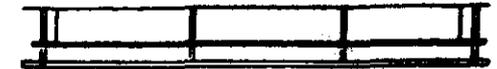
Board Arrangement

The TNC 151/155 consists of three main sections:

- 1) The frontplate/Keypad Board assembly;
- 2) The housing/Connector Board assembly, with five plug-in boards, namely:
 - .Main Processor Board
 - .CLP-Processor/Graphics Board
 - .Analog Board
 - .either SE Board TNC 151/155 B/F or PLC Interface Board TNC 151/155 Q/W
- 3) The backplate, Power Supply Unit and Terminal Board assembly.

Board arrangement TNC 151/155 B/F
 TNC 151/155 Q/W

PLC I/O Board
 TNC 151/155 Q
 (224 389/223 691)



Connector Board
 (233 273)

Terminal Board
 (228 164/228 166)

Power Supply Board
 (230 802)

PLC Interface Board
 TNC 151/155 Q
 (226 761)

SE Board
 TNC 151/155 B
 (227 278)

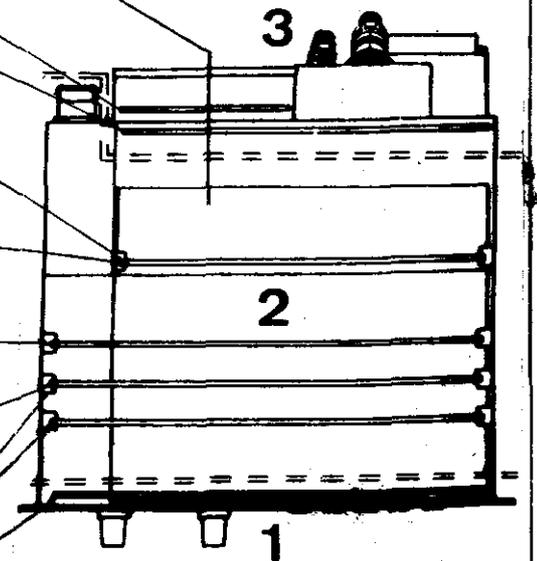
Analog Board
 (232 228/234 509)

CLP Processor Board TNC 151
 (233 556)

CLP-Graphics Board TNC 155
 (233 554)

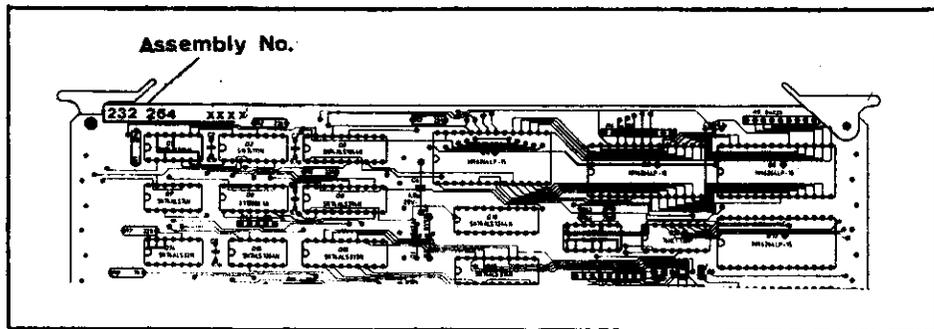
Main Processor Board
 (235 647)

Keypad Board
 (224 825)



Kundendienst

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, to the left of the serial no.

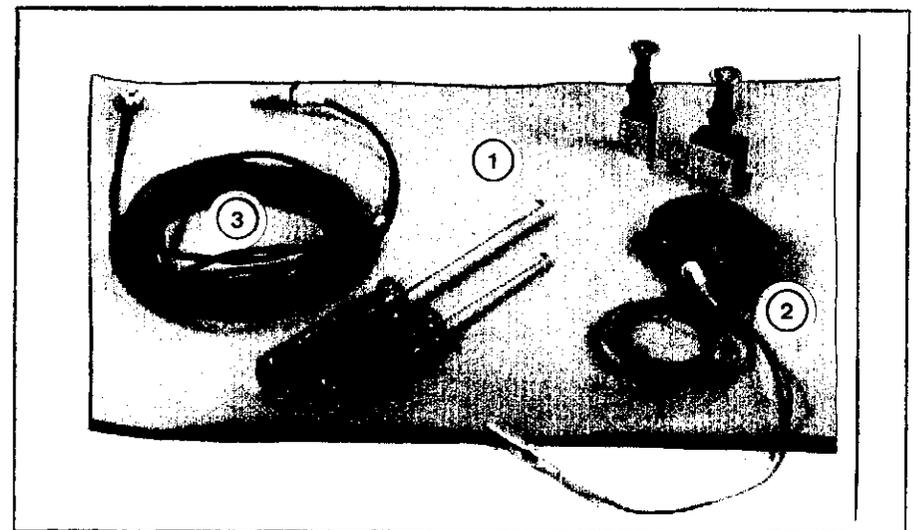


Work area requirements

The TNC 151/155 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 Control:

- 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 surface and ground



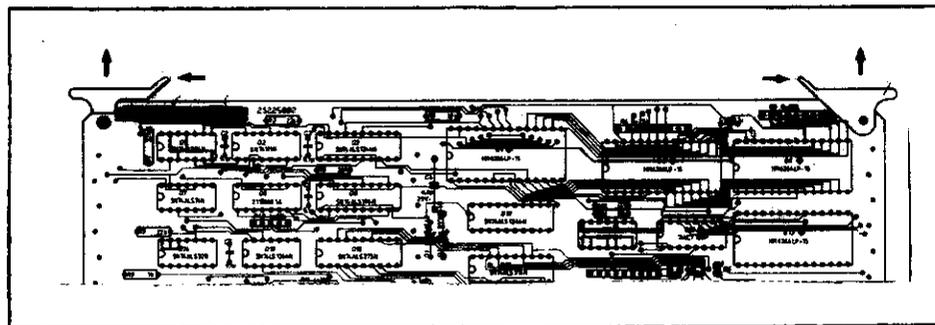
Kundendienst

Exchanging the pluggable boards

Unscrew the 5 mounting screws and remove the housing cover.

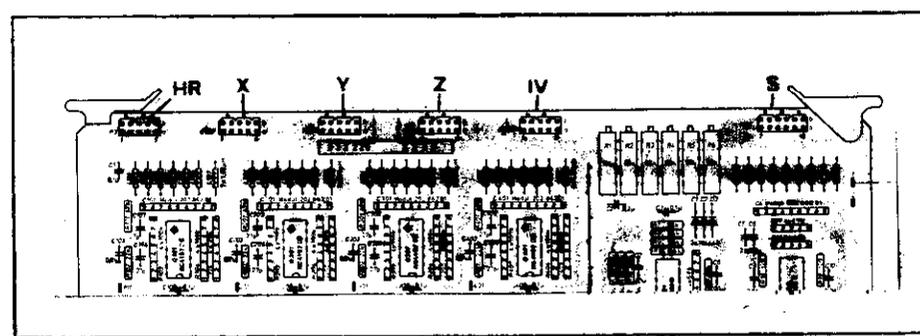
Removing the boards:

Press the board ejector keys outwards and pull out the individual board from the top.



Analog Board

Before removing the Analog/Analog 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.



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/Graphics Board:

When exchanging these boards insert program EPROM's IC-P1 and IC-P2 on the CLP Processor/Graphics Board and IC-P3 to IC-P6 on the Main Processor Board.

Main Processor Board:

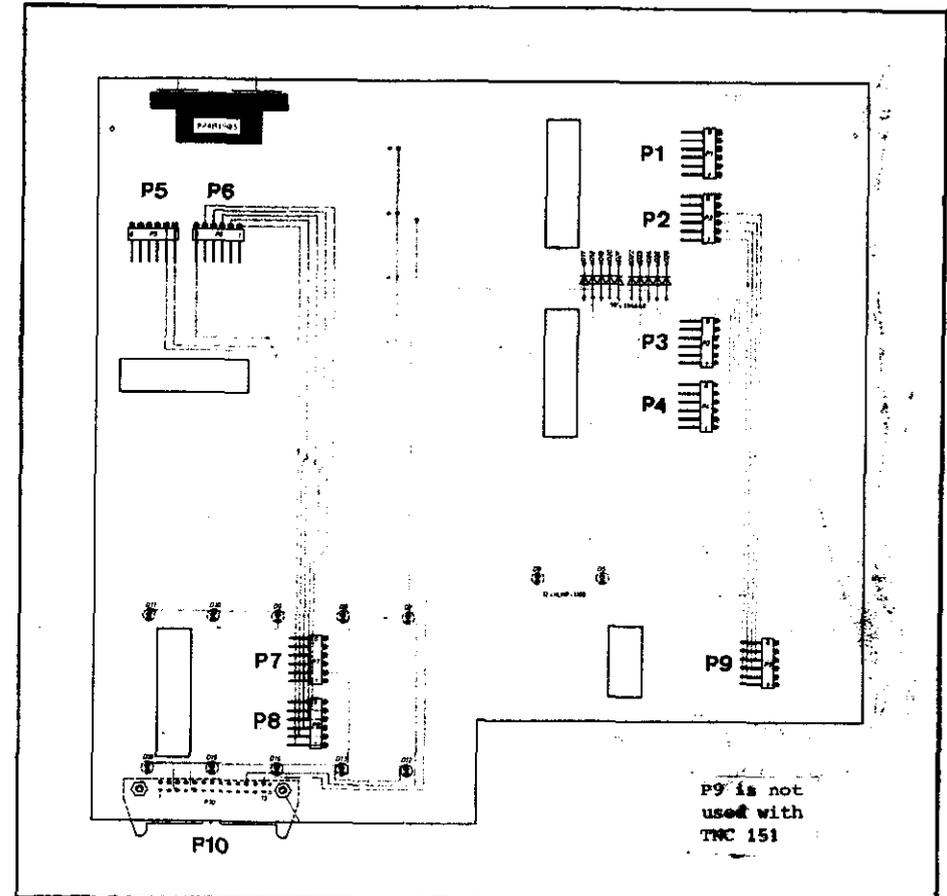
During the exchange or removal of the Main Processor Board the buffered RAM will no longer be supplied with voltage, which means that the machine parameters and any user-programs will be lost!

Before inserting the new Board plug in the relevant EPROMs (EPROM IC-P3 to IC-P6), paying particular attention to their correct location and orientation.

Kundendienst

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 respectively P9 for the TNC 155 from the Keypad Board.
- .Remove the Keypad Board.

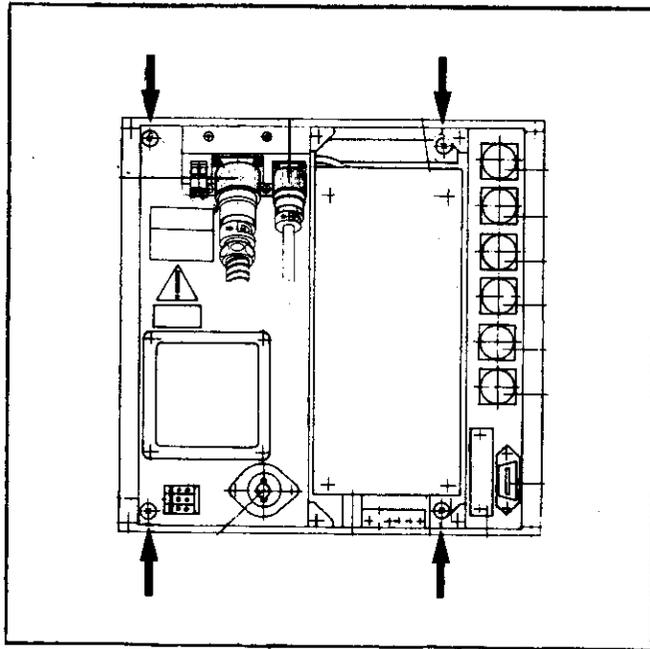


When rebuilding the assembly, ensure that the keypad connectors are firmly engaged in their respective sockets, and that the LEDs project through the corresponding bored holes in the keypad housing.

Kundendienst

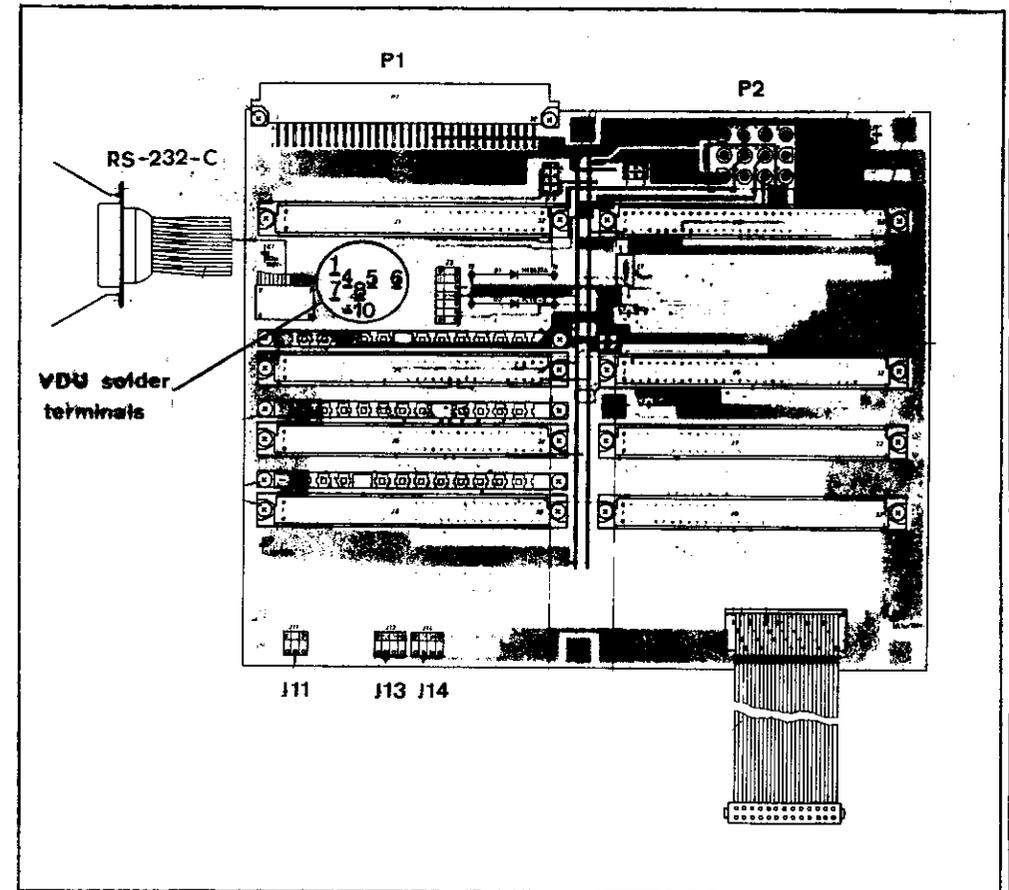
Exchanging the Power Supply Unit:

- 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.



Kundendienst

3.3 Software Exchange

General

The TNC 151/155 operating software is stored in 6 EPROMs consisting of:

- IC-P1, IC-P2 (CLP Processor/Graphic Board)
- IC-P3...IC-P6 (Main Processor Board)

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

example:

TNC 151		TNC 155	
234 000 01	complete software Id. No.	234 020 01	
234 000	primary software Id. No.	234 020	
01	update software index	01	

Each of the 6 programmed EPROMs (IC-P1...IC-P6) is specified with an 8 digit Id. No.:

example:

TNC 151		TNC 155	
234 000 4A	complete Id. No. of the Prog. EPROM	234 020 4A	
234 000	primary Id. No. of the Prog. EPROM	234 020	
4	position on the board	4	
A	update index	A	

The operating software includes:

- o NC software (IC-P2...IC-P5)
- o PLC software (IC-P6)

TNC 151/155 B: Control with o NC software and
 o PLC standard software

TNC 151/155 Q: Control with o NC software and
 o PLC standard software, or
 PLC custom software

The dialog language of the TNC 151/155 is determined by IC-P3 (located on Main Processor Board) and is discernible from the different Id. Nos. of the programmed EPROMs.

Following dialog 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-P6 (PLC software)

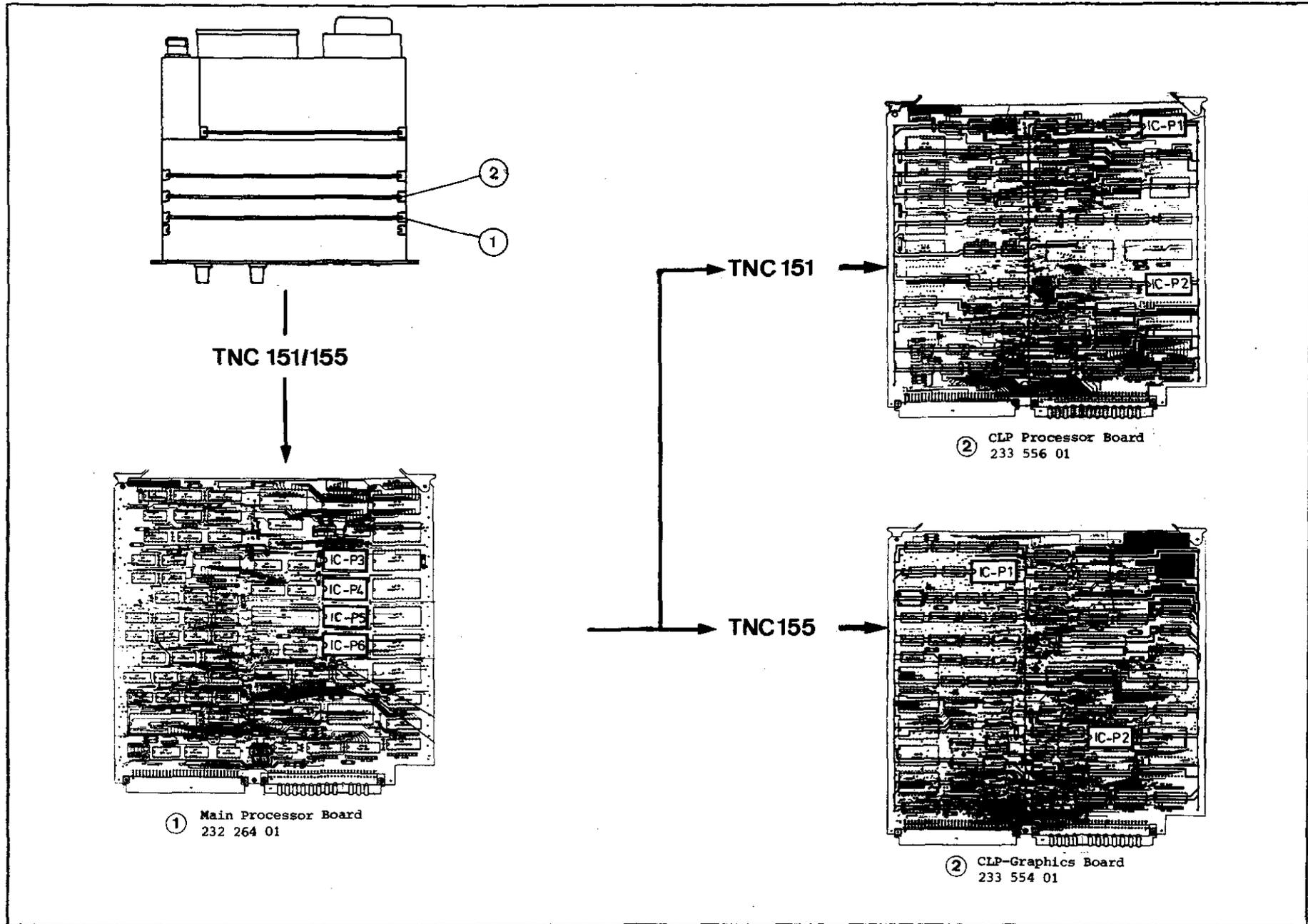
The standard PLC program (EPROM position IC-P6) can be replaced with a custom PLC program for the TNC 151/155 Q.

IC-P2

The export NC Software differs from the standard NC Software in EPROM position IC-P2.

The dot matrix for all VDU displayed characters is contained in IC-P1 (character generator).

Kundendienst



Kundendienst

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
 - Main Processor Board
 - CLP Processor/Graphics Boardhave to be removed from the assembled Control.

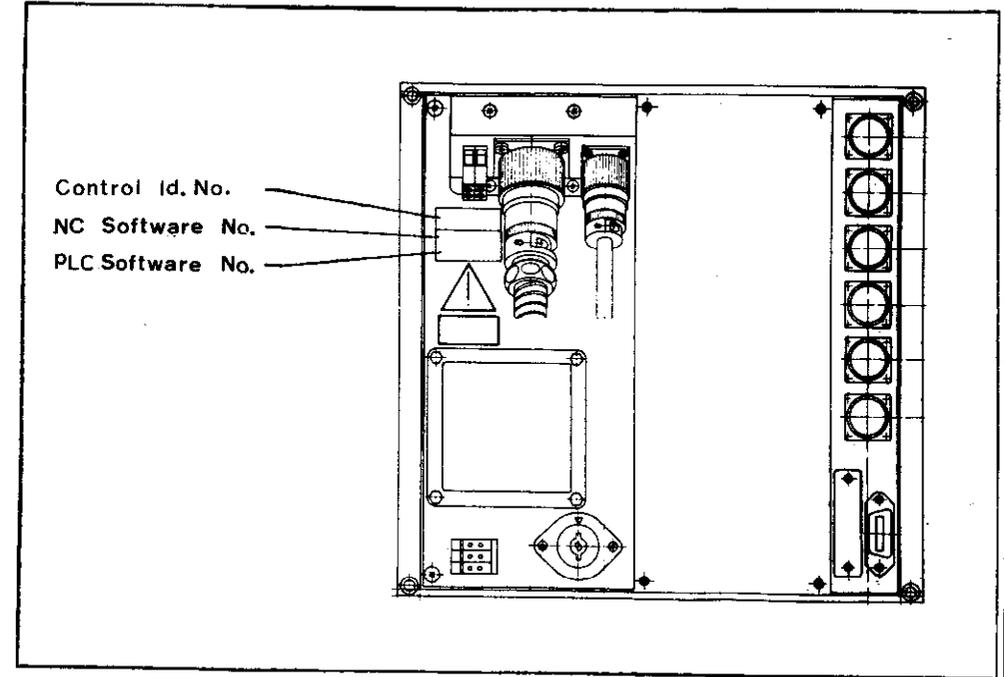
There to, lift the board ejector keys and press outwards, pull out board from above and lay onto MOS protection mat.

- 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.

- 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.

Kundendienst

3.4 Replacement Parts, Loan/Exchange/Service Units

Replacement Parts TNC 151/155

In general, replacement parts are available for all sub-assemblies discernible from the wiring diagrams (see section 4.2). 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 151/155. 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.

Loan, Exchange, Service Units

In order to keep 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.

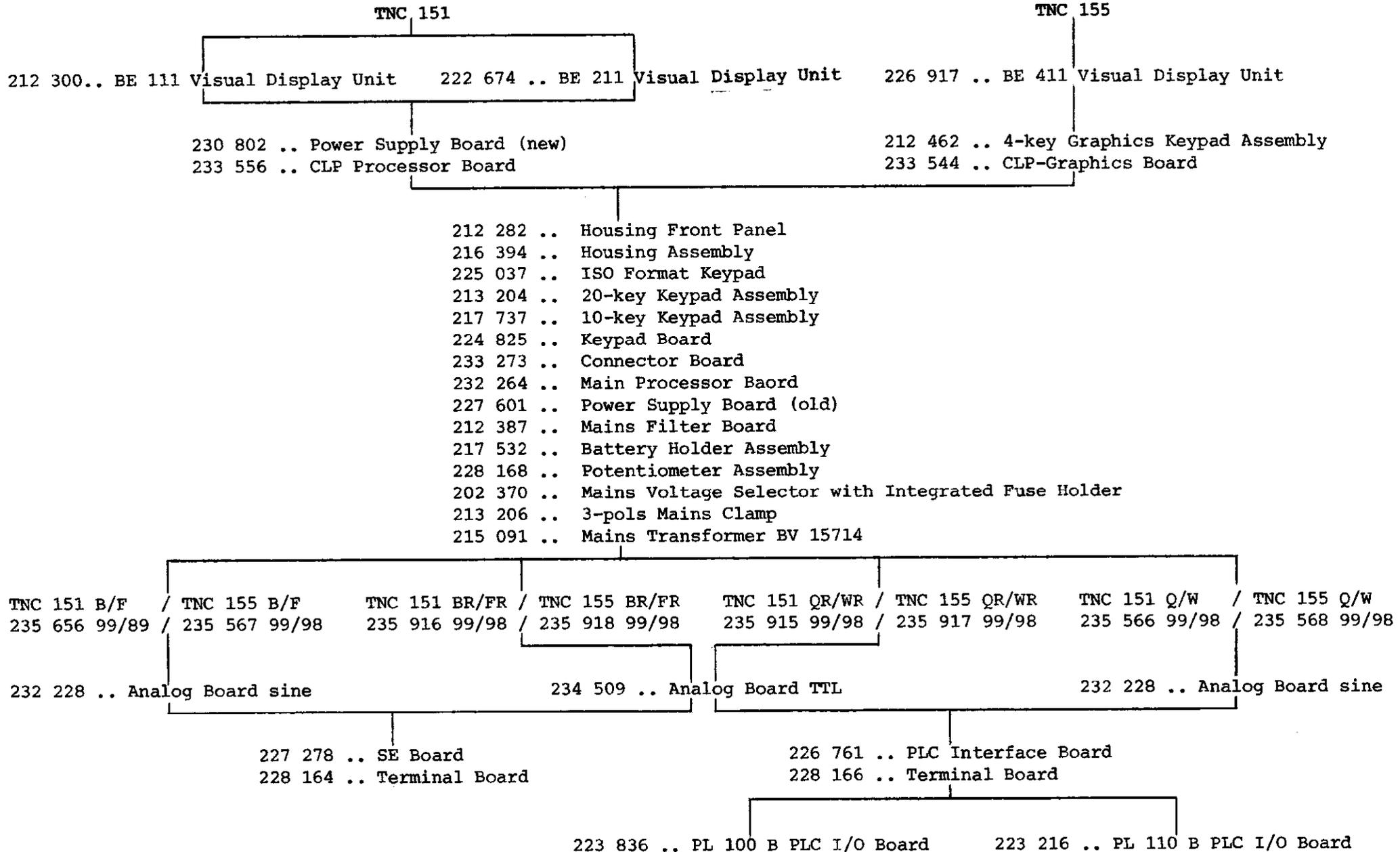
A customer's faulty unit should be returned to DR. JOHANNES HEIDENHAIN within 14 days of receiving the exchange unit.

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.

Kundendienst

3.5 Configuration List



Kundendienst

4. Additional Information

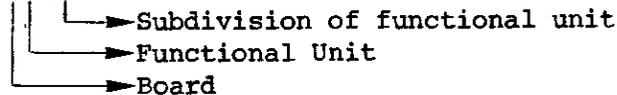
4.1 Block Diagram Description

The TNC 151/155 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 diagrams and the way it is folded permit:

- the representation of any of the TNC 151/155 (B/BR/Q/QR) models
- simplified representation of functional processes

Numbers enclosed between dashes inform about the board and its functional unit.

e.g.: -50.1-



Simplified Description of the TNC 151/155 (Block Diagram)

- Keypad Board (1)
- Main Processor Board (2)
- CLP Processor/Graphics Board (3)
- Analogue Board/Analogue Board TTL (4)
- with SE Board (5) it corresponds to a B(F)-Type;
- without SE Board, with PLC Interface (5), however
- with PLC I/O-Board(s), it corresponds to a Q(W)-Type or, respectively, QR(WR)-Type
- Power Supply Board (6)
- Terminal Board (7)

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"

- Keypad, LEDs
- User Program Interpreter
- Provision of programming "environment"
- Generation of PLC program addresses
- * - Transfer of input and output states via the SE-board or PLC interface and PLC I/O-board
- * - Control of the V.24 interface

2. "CLP/Graphics 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 (which is common to TNC 151 and TNC 155).
- The operating system (NC software) is contained in EPROMs:

- 20.1- IC-P3 (Dialog Language)
- 20.3- IC-P4, IC-P5
- 23.1- IC-P6 (PLC-Software)

Kundendienst

- The RAMs -20.2- on the main processor board can be accessed either by the main processor -20- or by the CLP processor. The intended coordinates, programmed feed, display texts etc. can therefore be transferred. These RAMs also serve as register file memory for the main processor -20-. User programs, machine parameters, and (under certain circumstances) the PLC program are programmed in RAMs -20.4-.

- The 16-bit address bus is extended to 20-bit by a memory mapper 1.

- The keyboard controller -22- has the task of driving the LEDs and scanning the keypads -22.1- on the front plate.

- The main processor is connected with V.24 interface 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 -23.1- is processed by the "1-bit-PLC-processor" -23- mounted discretely on the main processor board. The input and output states are stored in a 8k x 8 PLC-RAM -23.2-.

- I/O-Functions:

a) TNC 151/155 B-Versions:

24 galvanically separated inputs (E0 to E23) -50- and 24 floating relay contact outputs (A0 to A22 + emergency stop) -51- on the SE Board. The inputs and outputs are protected on the terminal board (B/F version) by special protective resistances 5.1k Ω -70- and 47 Ω -70.1-.

Protective resistances should never be replaced with normal resistances!

They are led via LC-filter -71- as protection against the oscillation of analog outputs.

b) TNC 151/155 Q-Versions:

The inputs and outputs are loaded on an external PLC I/O-boards (e.g. PL 100B or, respectively, PL 100B) which is driven by the main processor -20- 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 optocoupler -50- and are converted from the TTL level (5V) to the MOS level (12V) by means of a level converter -51-. 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 -54- and are led to the main processor via CRUIN.

The serial CRUOUT 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 -20-.

PL 100B: 31 unipolar, programmable outputs + emergency-stops protected against overload.

PL 110B: 26 unipolar, programmable outputs + 5 bipolar outputs protected against overload.

On the PLC I/O board a 12V voltage is generated by an external 24V supply PLC I/O board. On the PLC interface board this 12V voltage is transformed in a 5V voltage for its TTL modules.

Kundendienst

CLP Processor System:

- Primarily on the CLP processor board which is common to the TNC 155 CLP/Graphics board.
- Operating system is contained in EPROM IC-P2 -30.1-.
- 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 potentiometerThe calculating speed requires a wait-free RAM -30.2--
- The measuring system signals are processed on the analog board. These signals are amplified at first -40.1- and then subdivided -40- by delaying (phase shifted) and combining them differently. The subdivided 0 degree, 90 degrees and RI signals are then led to the gate arrays -32- 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 -30- 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 -40-.
- The signals from the handwheel (if present) are shaped via the functional block -43- 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 151 BR) 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 -40- on this analog board whose outputs are directly connected to the gate arrays -32- on the CLP processor board. The supervision signal of the EXE is also buffered -40- and transferred to the CLP processor board. The signals of the handwheel are likewise processed -43- 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 -40-. 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 -51- and -50-.

Kundendienst

- 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 DAW -42.1- (digital-analog-converter). These voltages are compared with the adjusted values of the override and feed potentiometers -42- 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 DAW are allocated to the single axes by means of five samples and hold circuits -42.2-. The five individual analog voltages are amplified and buffered subsequently -42.3- 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 -41-. The supervision signals are led to the CLP processor via the CRUIN line.
- Two "watch dog" monoflops -41.1- are on the analog board. These must be triggered separately once every 5ms by the CLP processor -20- 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 -31.1-. A special CRT controller TMS 9937 -31- generates the necessary addresses for the CRT RAM and the character generator IC-P1 -31.2- so that the data are transferred to the shift register -31.3- in the right sequence. Thus signal can be inverted by means of an exclusive-or-gate -31.4- 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.
- The function of the TNC 155 CLP graphic processor is similar. The screen can either be operated in the text or in the graphic mode. The control of the routine processes required for the test and the graphic representation are taken over by the graphic controller μ PD 7220 -31-. This controller has to receive the corresponding commands and pertaining parameters of the CLP processor via the data bus. To permit a fast generation of a given representation all necessary commands and parameters are calculated in advance and are stored in the 64K x 8 dynamic graphic memory. Priority decisions between reading or, respectively, writing and refreshing of the memory are carried out by the DRAM controller -31.5- The graphic controller, which is dependent on the commands received by the CLP processor, sets up the required bit pattern in the 32k x 16 video memory. The constant issue of these data and the synchronisation signal to the screen is also controlled by the graphic controller. In the graphic mode the 16-bit-pixel-words are read out by the CLP processor and are converted in a serial format by means of a graphic shift register -31.7-. The signal can be inverted by means of an exclusive-or-gate -31.4- to generate, under certain circumstances, an inverse video display. In the text mode the video memory contains the 6-bit-ASCII-values and the pertaining mode data. The ASCII values and some of the mode bytes form the addresses for the character generator IC-P1 -31.2-. The bit pattern for the momentarily addressed sequence of the intended sign is converted in a serial format by means of a video shift register -31.3-.

Kundendienst

Under certain circumstances, an inverse video display can again be generated by means of the exclusive-or-gate-wiring -31.4-. A discretely mounted timer circuit synchronizes the procedures of the entire CLP/Graphics board.

- On the SE-board (or the PLC interface board) the V.24 signals of the handwheel unit are connected to the line drivers or, respectively, to the line receivers. A serial interface module on the CLP/Graphics 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 PLC interface board) -53- and is evaluated via the counter module -32- on the CLP processor/graphics board.

Power Supply Unit

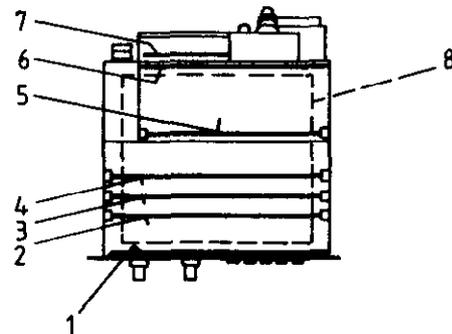
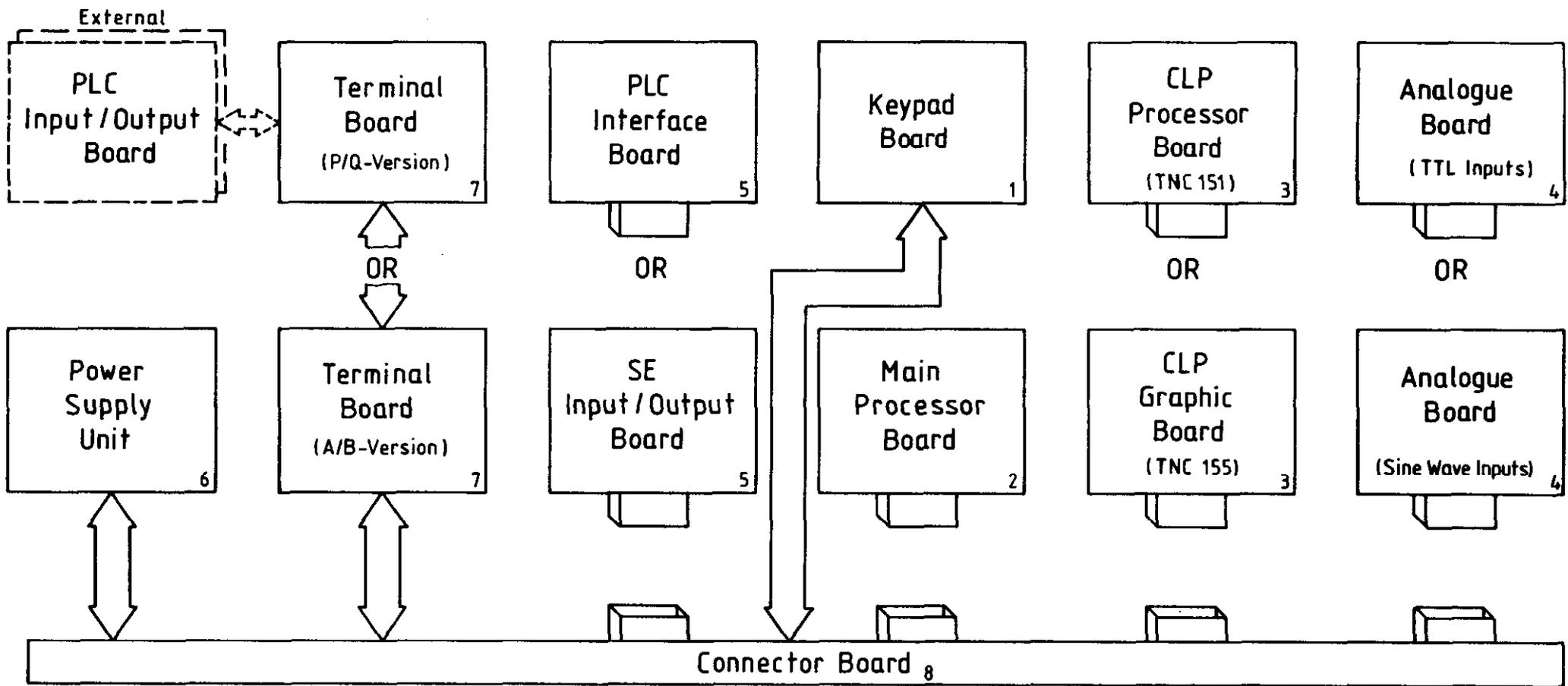
- +5V are generated for the TTL modules via the flow converter -70-. The flyback regulator -70.1- inductively coupled with the flow converter generates +/-15V for the operation amplifier.
- The +12V supply voltage for the V.24 interface is generated with the help of the +15V by means of a linear regulator -70.2-.
- +11V are generated via the flow 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 -62- 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 -63- is immediately effective and causes the overvoltage protection (thyristor) -63.1- to connect through. Thus U1 is short-circuited coming directly from the power supply transformer -64- via the rectifier -65-. A greater damage at the subsequent electronics is thus inhibited by means of this protective measure.

Kundendienst

4.2 Block Diagrams TNC 151/155

Block Diagram	Drawing Number	Page
Arrangement	4820 EKD 1600900	56
PLC-I/O-Board	4820 EKD 1601700	57
Power Supply	4820 EKD 1602000	58
Terminal Board (P/Q-Version)	4820 EKD 1601900	59
Terminal Board (A/B-Version)	4820 EKD 1601800	60
PLC Interface Board	4820 EKD 1601600	61
SE-I/O-Board	4820 EKD 1601500	62
Main Processor Board	4820 EKD 1601000	63
CLP Processor Board	4820 EKD 1601100	64
CLP Graphic Board	4820 EKD 1601200	65
Analog Board (TTL-Input)	4820 EKD 1601400	66
Analog Board	4820 EKD 1601300	67

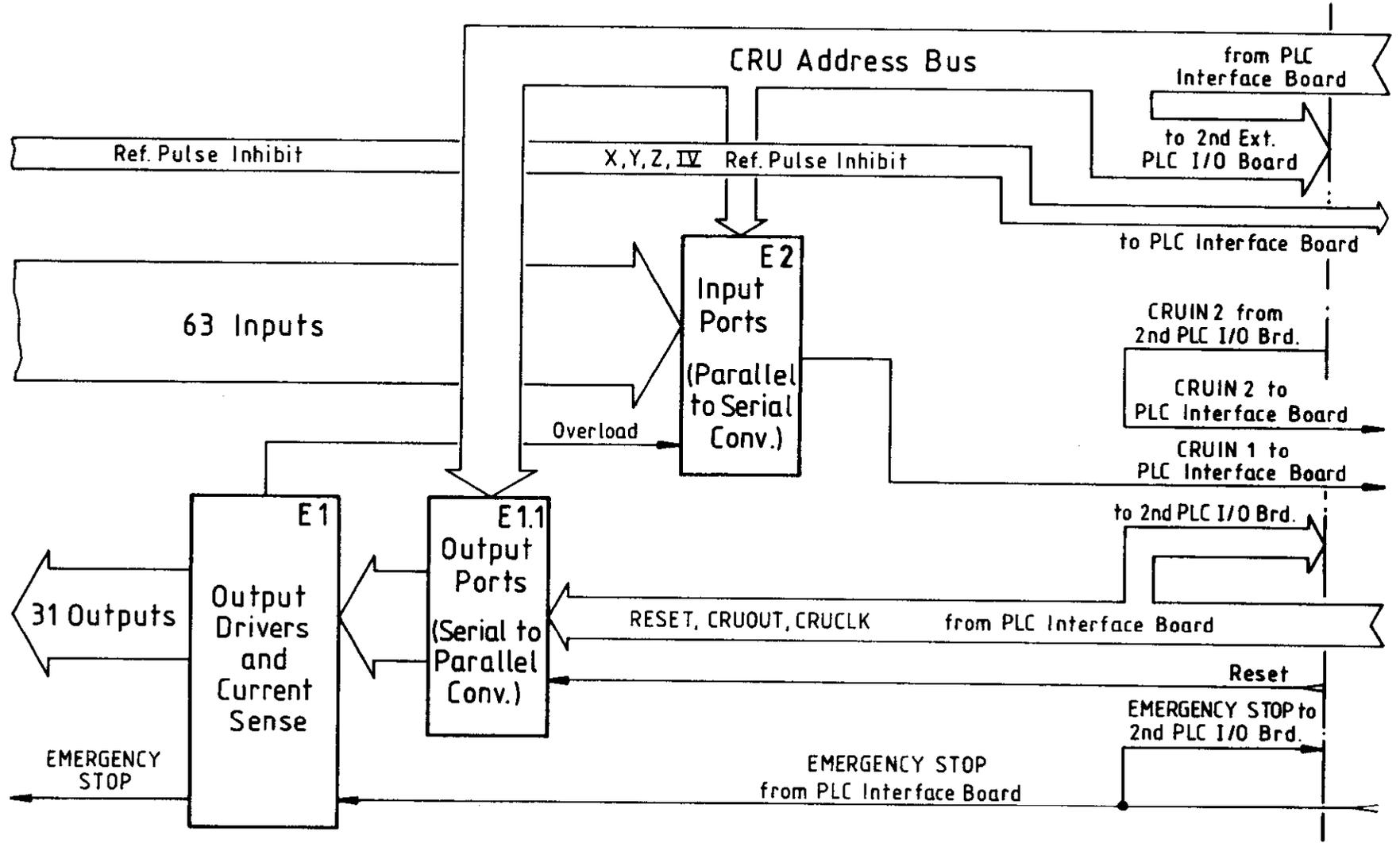


Drawing No.:
4820 E KD 16009 00

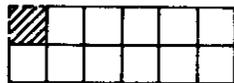


Layout of the Block Diagrams
and Boards in the TNC 151/155

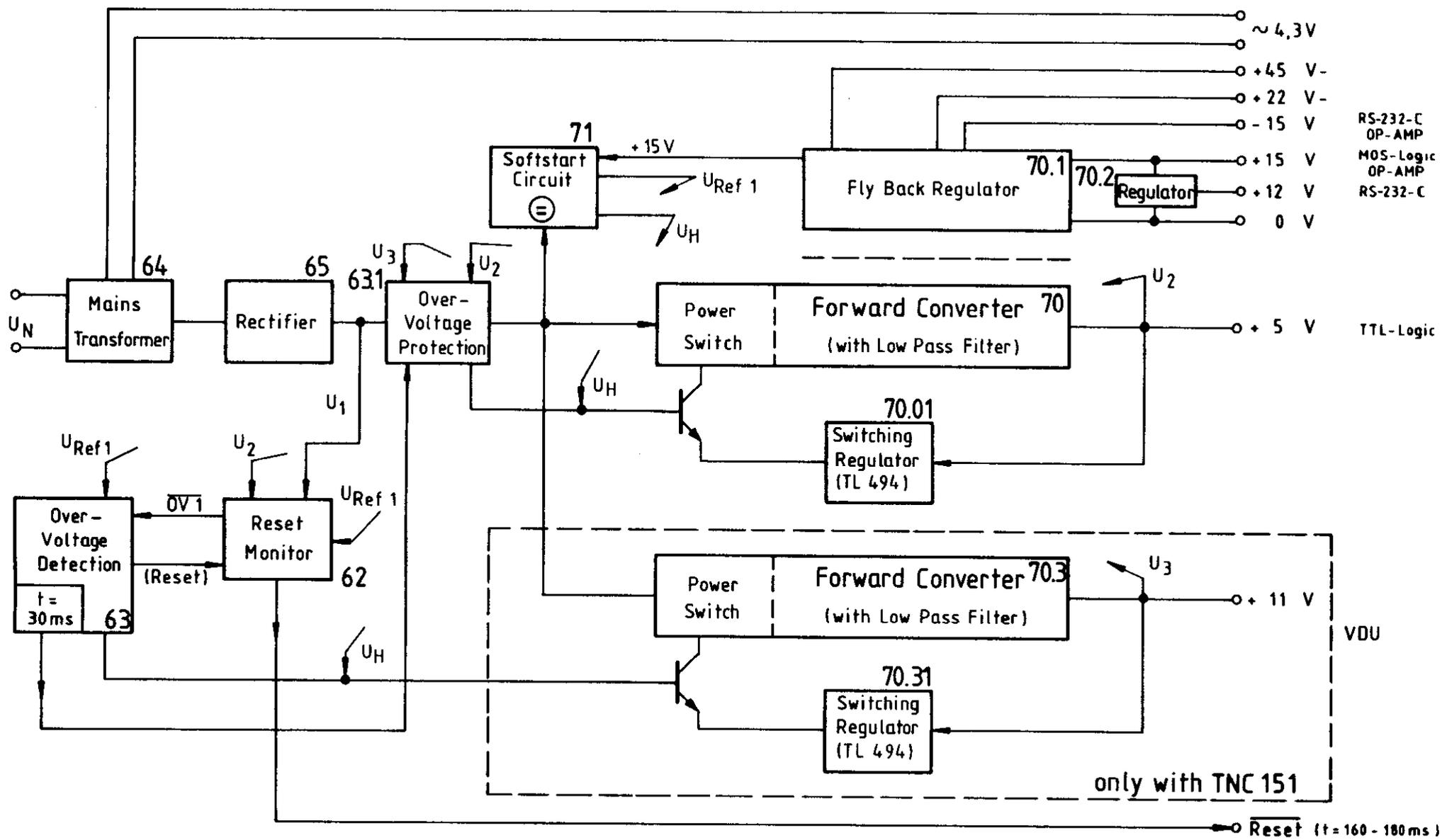
Machine Interface



Drawing - No.:
4820 E KD 16017 00



Block Diagram TNC 151/155
(External) PLC I/O Board



RS-232-C
OP-AMP
MOS-Logic
OP-AMP
RS-232-C

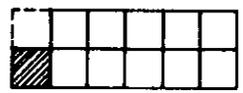
TTL-Logic

VDU

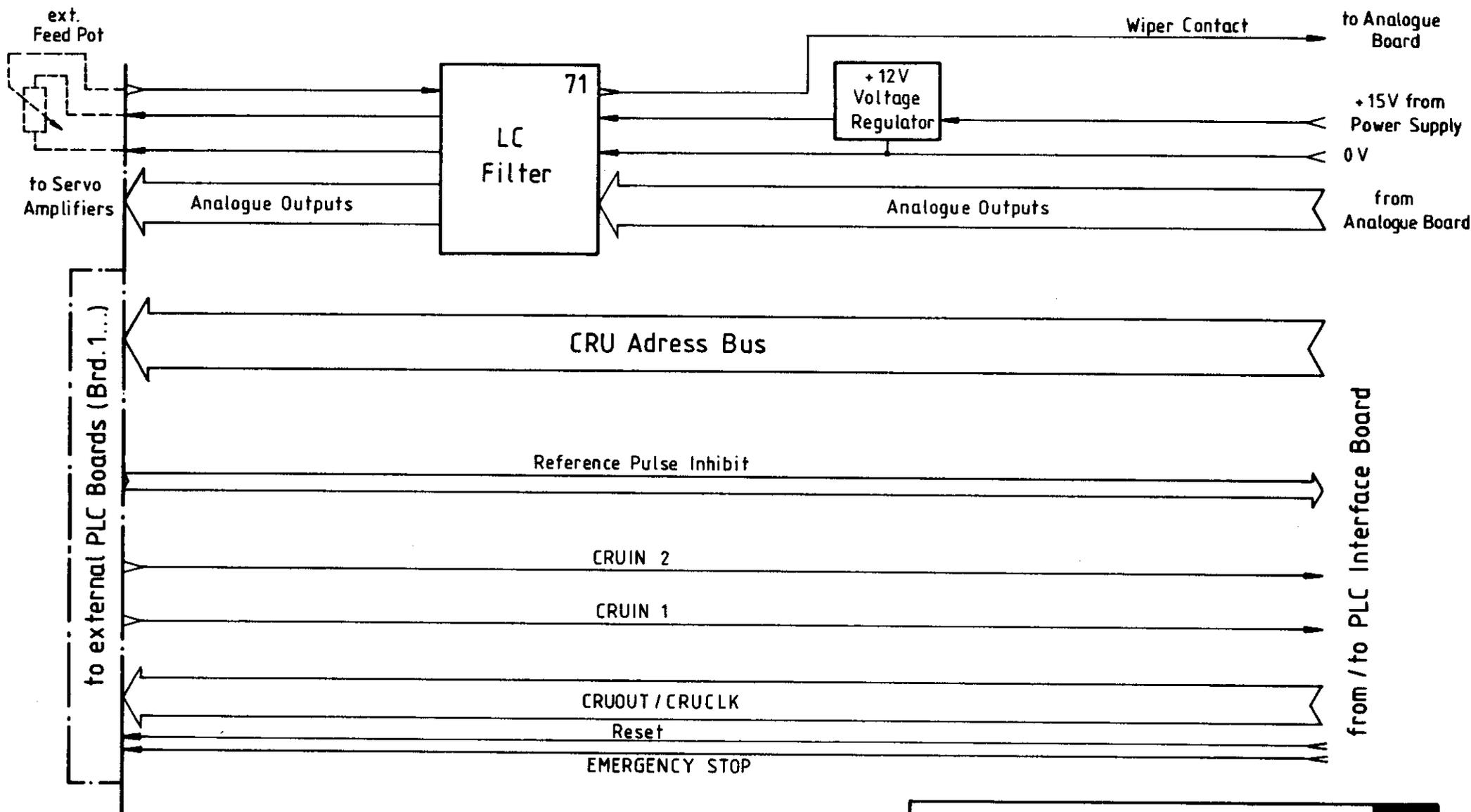
only with TNC 151

Reset (t = 160 - 180 ms)

Drawing No.:
4820 EKD 16020 00



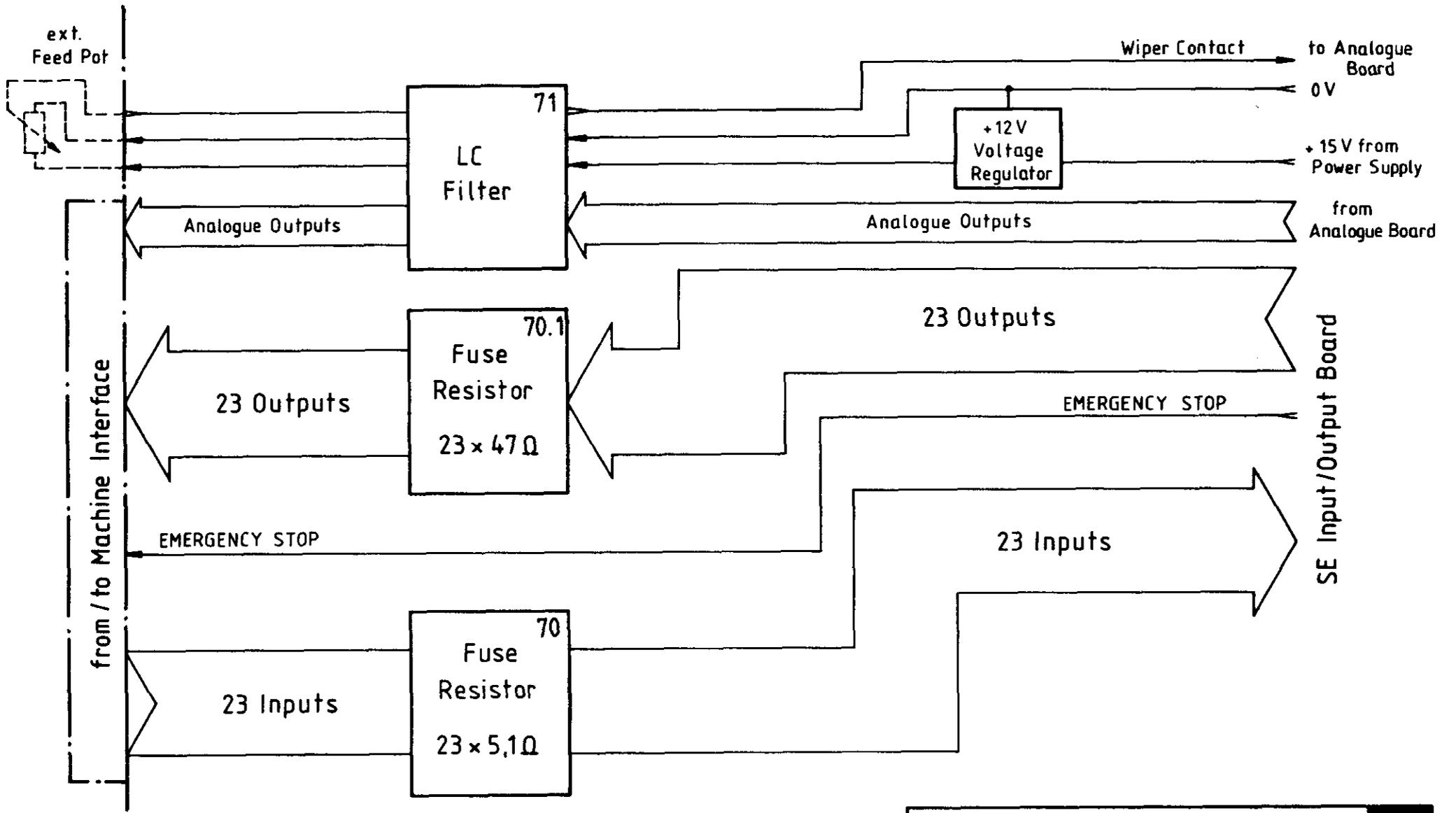
Block Diagram TNC151/155
Power Supply Unit



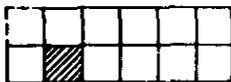
Drawing No:
4820 E KD 16019 00



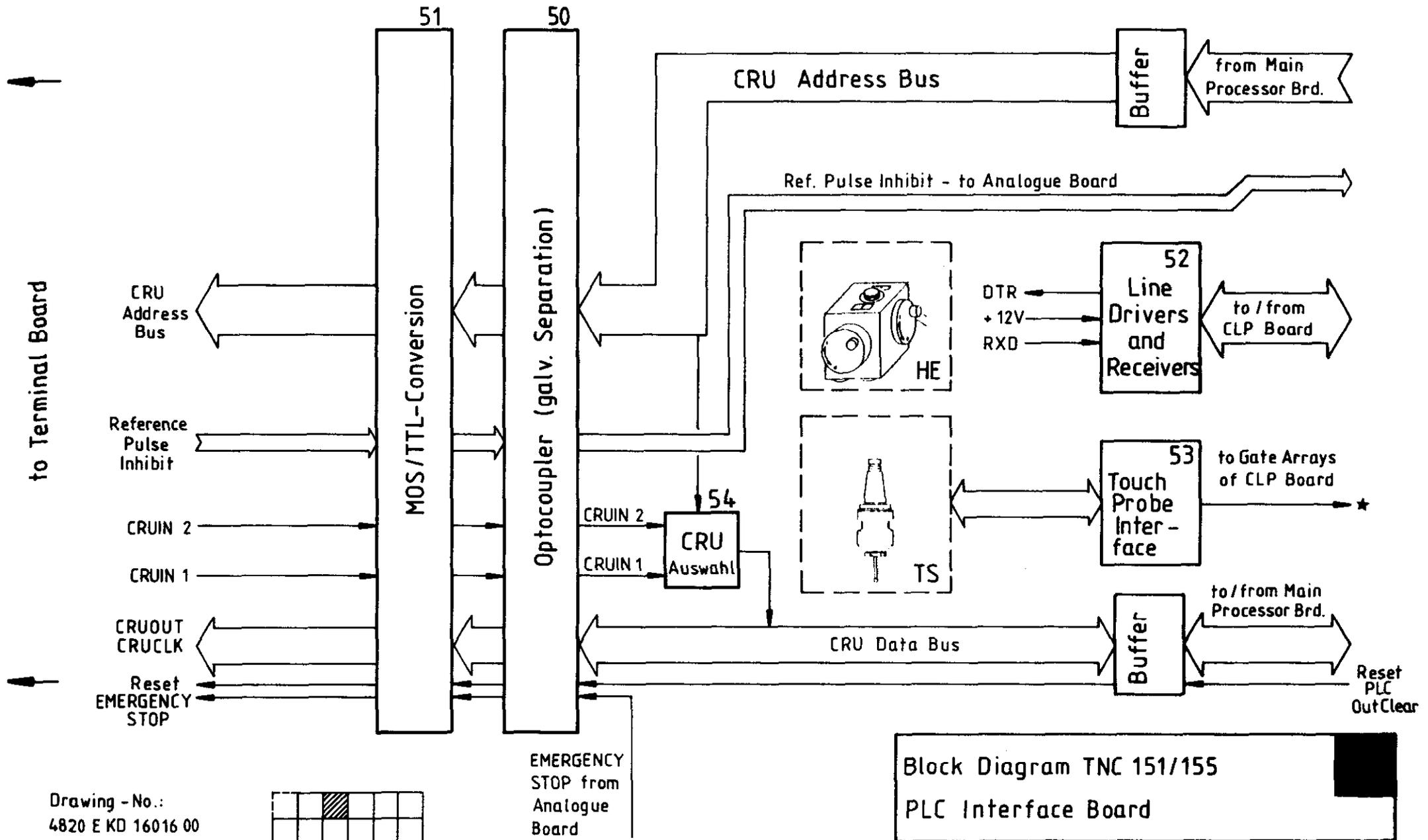
Block Diagram TNC 151/155
Terminal Board (P/Q-Version)



Drawing No:
4820 EKD 16018 00



Block Diagram TNC 151/155
Terminal Board (A/B Version)

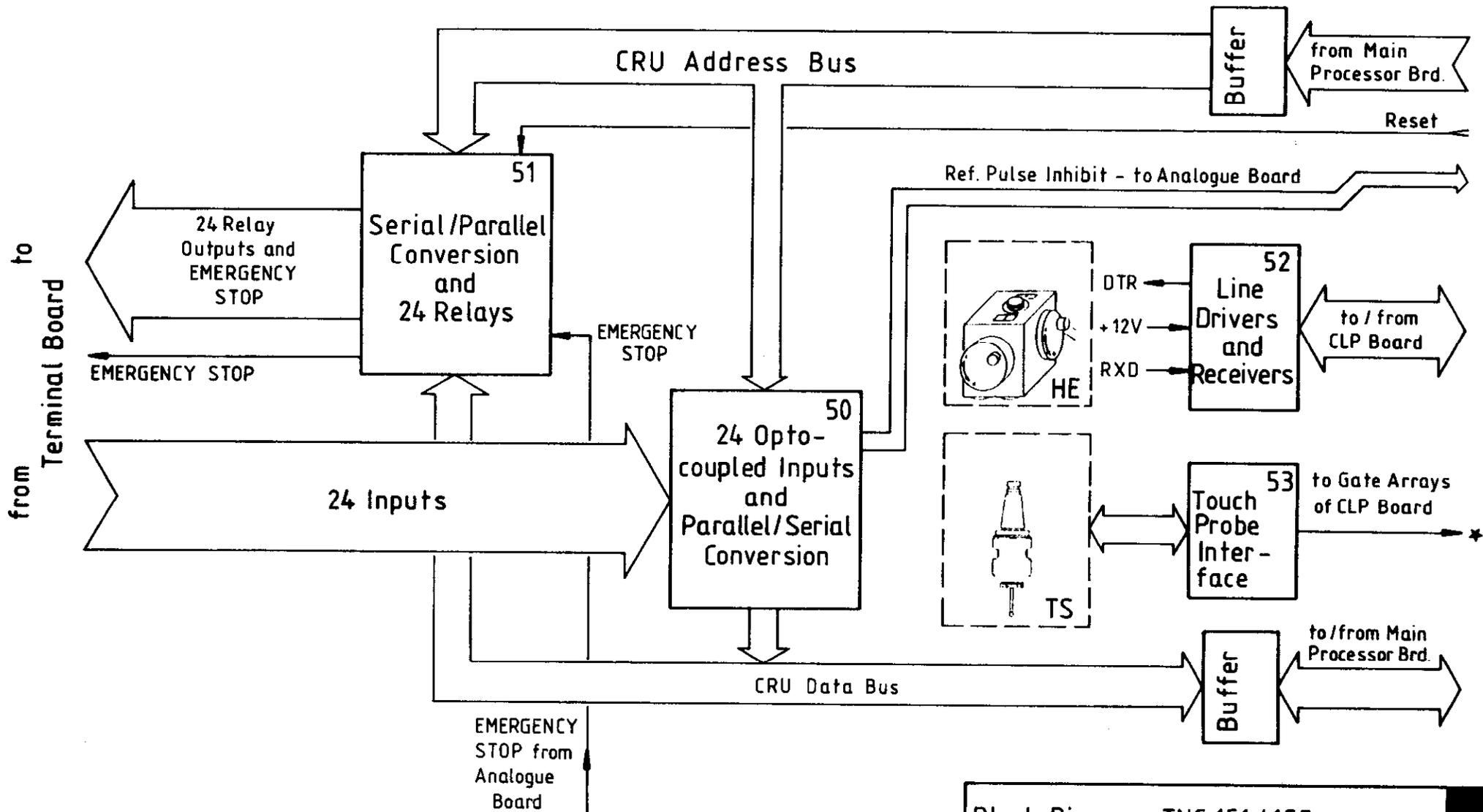


Drawing - No.:
4820 E KD 16016 00

--	--	--	--	--	--	--	--

EMERGENCY STOP from Analogue Board

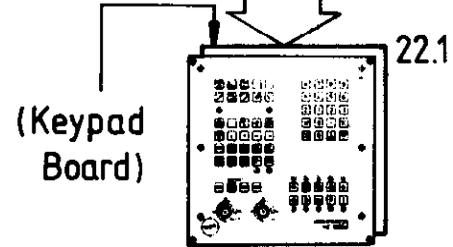
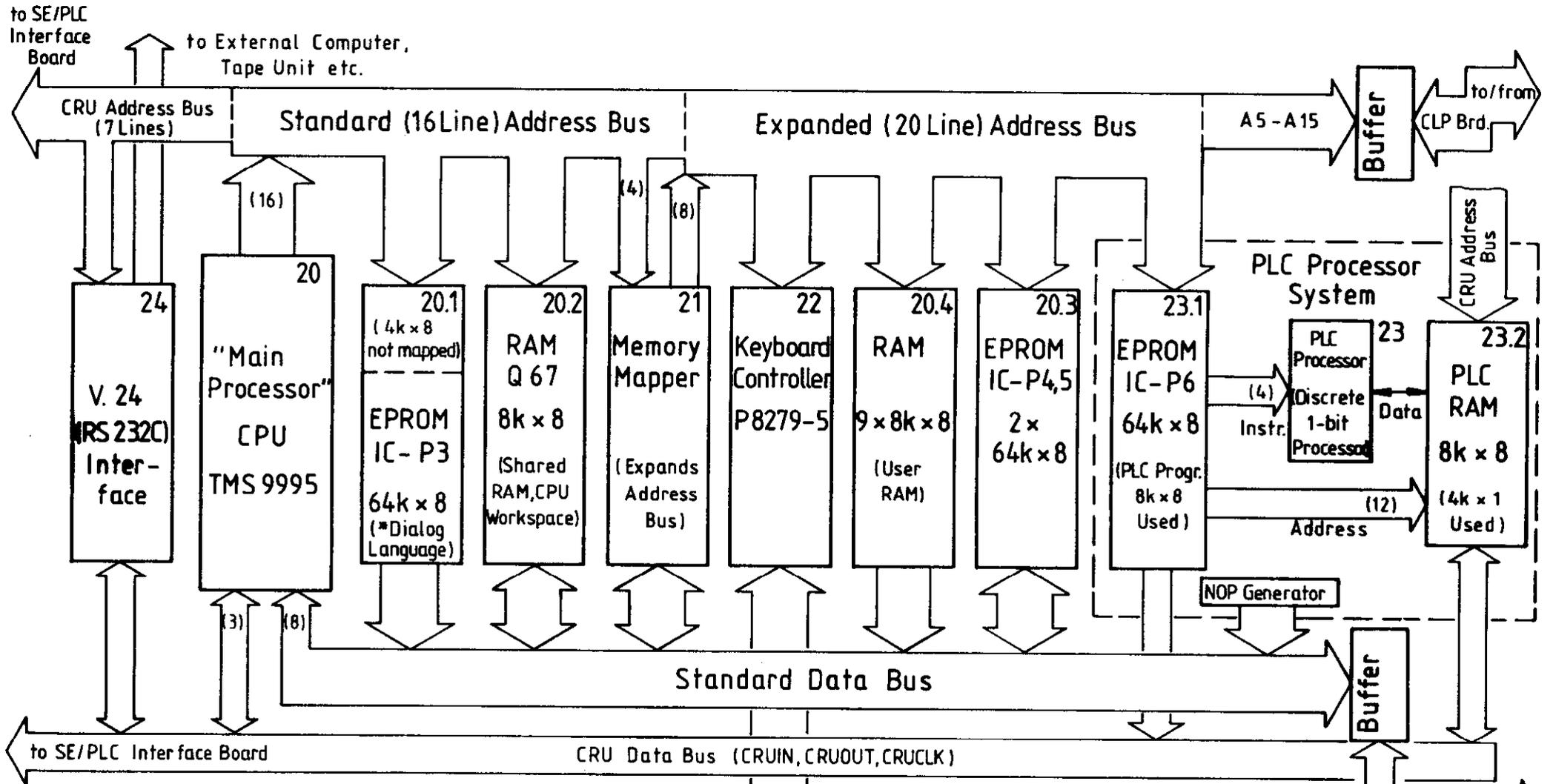
Block Diagram TNC 151/155
PLC Interface Board



Drawing - No.:
4820 E KD 16015 00



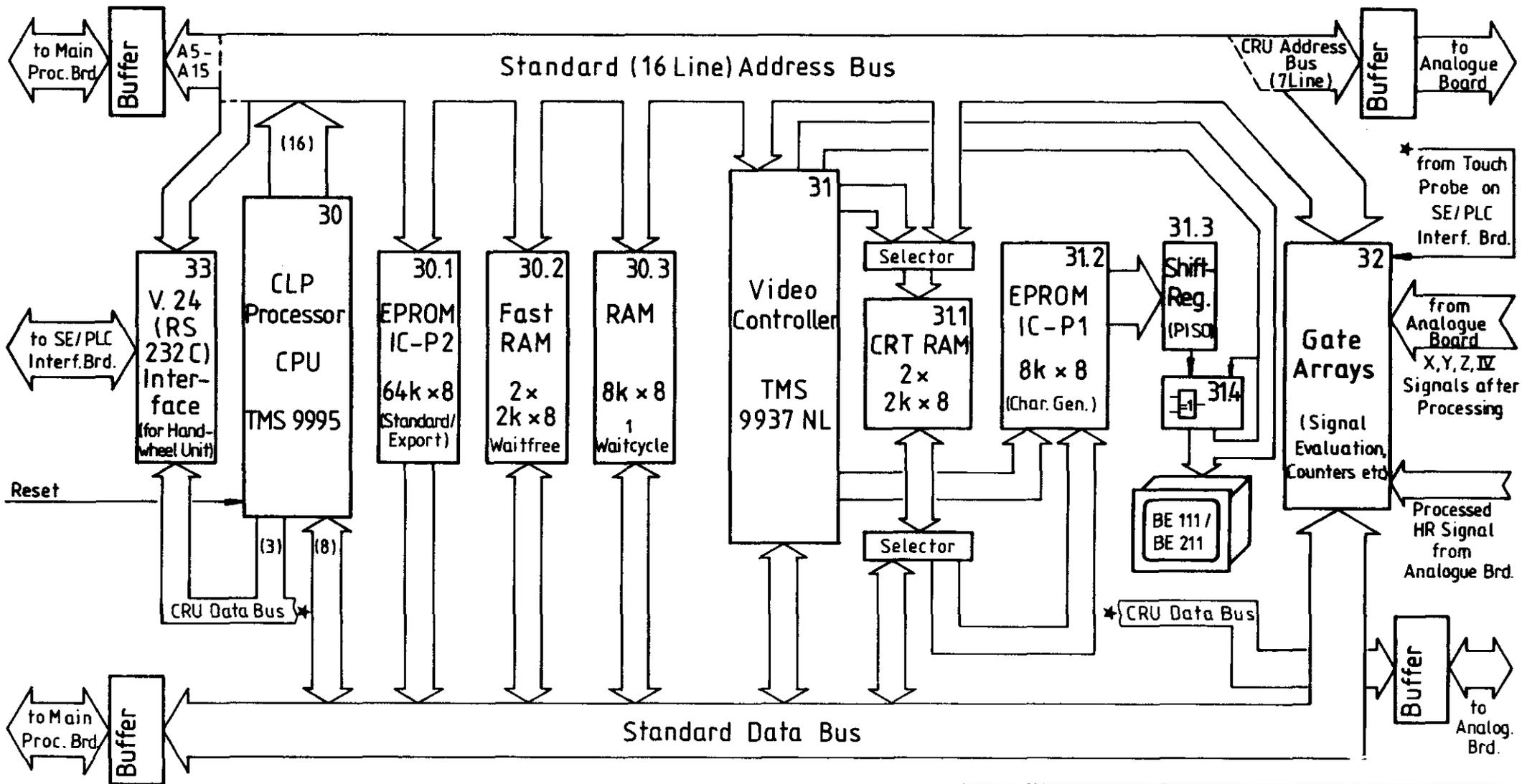
Block Diagram TNC 151/155
SE Input/Output Board



Drawing - No.:
4820 E KD 16010 00



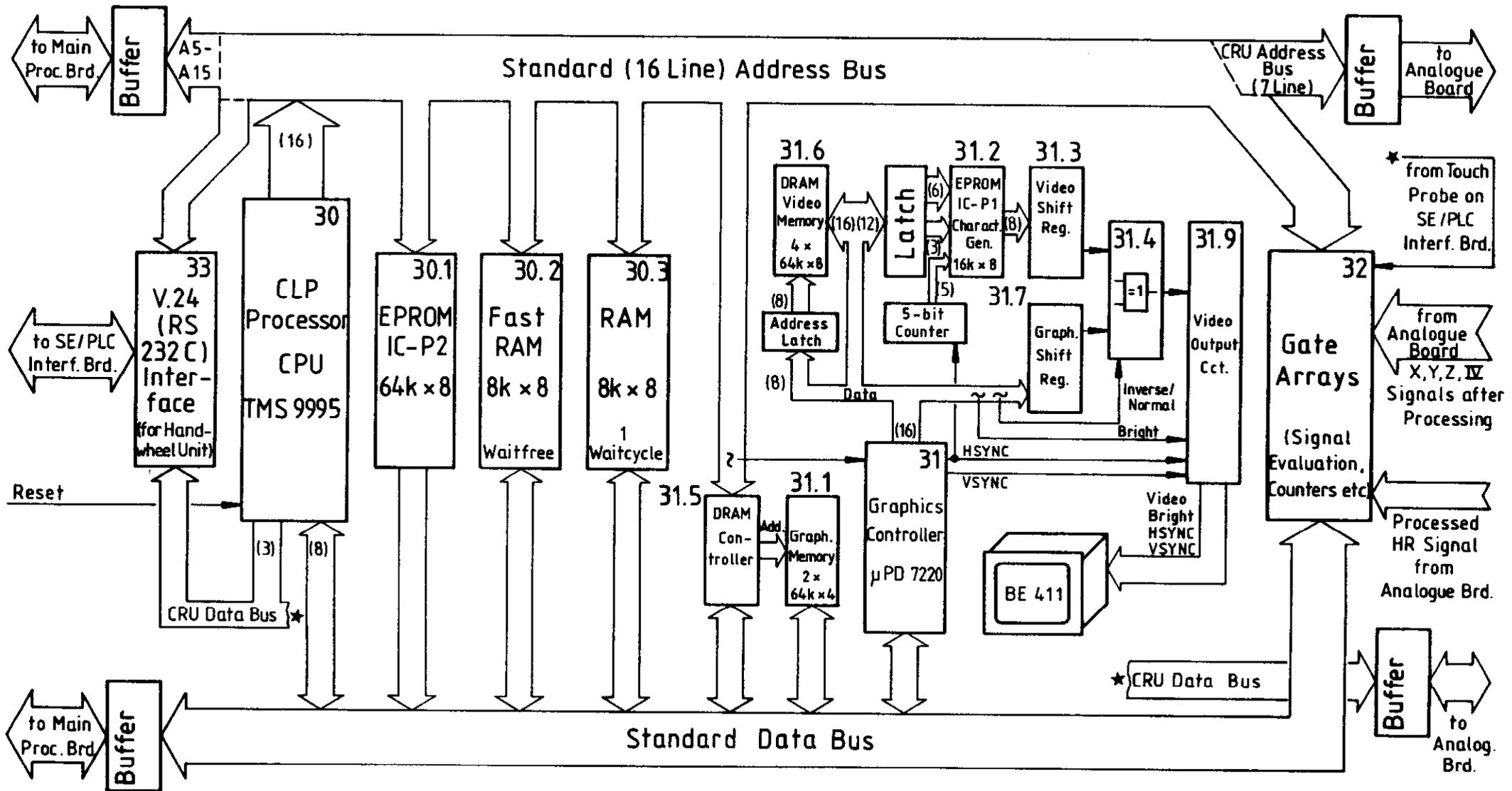
**Block Diagram TNC 151/155
Main Processor Board**



Block Diagram TNC 151
CLP Processor Board

Drawing - No.:
4820 E KD 16011 00

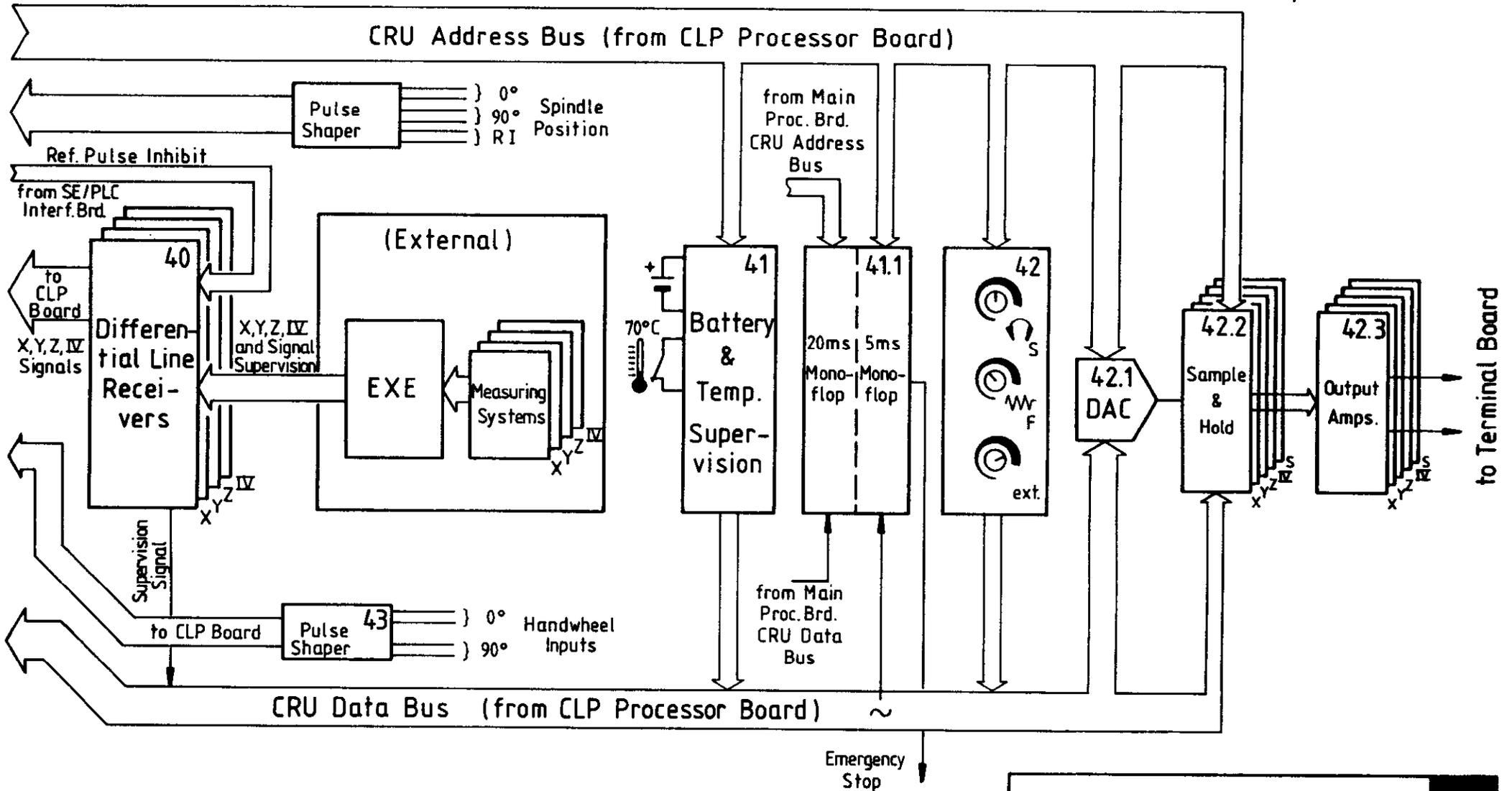




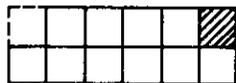
Drawing - No.:
4820 EKD 16012 00



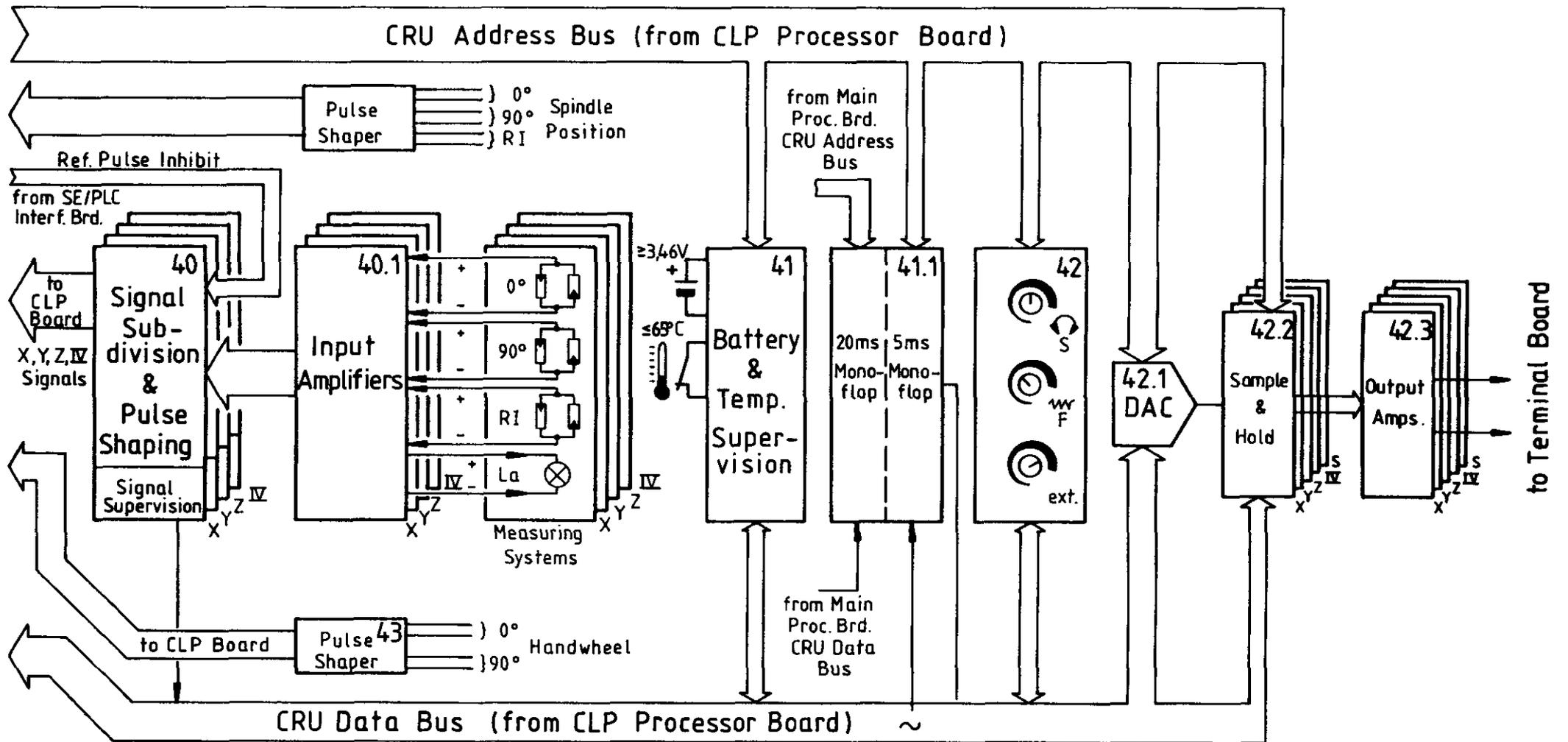
Block Diagram TNC 155
CLP Graphic Board



Drawing - No.:
4820 E KD 16014 00



Block Diagram TNC 151/155
Analogue Board (TTL Inputs)



Drawing - No.:
4820 E KD 16013 00



Block Diagram TNC 151/155
Analogue Board



Kundendienst

4.3 Wiring diagrams

Wiring diagram TNC 151 B Drawing No. 232 239 00 P.69

Wiring diagram TNC 151 Q Drawing No. 232 240 00 P.70

Wiring diagram TNC 155 B Drawing No. 239 292 00 P.71

Wiring diagram TNC 155 Q Drawing No. 232 293 00 P.72

Kundendienst

4.4 Machine parameters

Function		Parameter	Input values	
Rapid traverse	X	0	80 ... 15 999 [mm/min]	
	Y	1		
	Z	2		
	IV	3		
Manual feed	X	4		
	Y	5		
	Z	6		
	IV	7		
Speed when approaching the reference marks	X	8	(Axis IV: degrees/min. with axis designation A or B or C)	
	Y	9		
	Z	10		
	IV	11		
Signal evaluation	X	12	1 $\hat{=}$ 20-fold	2 $\hat{=}$ 10-fold
	Y	13	(max. traversing speed	(max. traversing speed
	Z	14	16 [m/min])	12 [m/min])
	IV	15		
Traversing direction when approaching the reference marks	X	16	0 $\hat{=}$ Plus direction	1 $\hat{=}$ Minus direction
	Y	17	(with correct programming of parameter nos. 20 to 27)	
	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 $\hat{=}$ positive with positive traversing direction 1 $\hat{=}$ 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	
	Y	33		
	Z	34		
	IV	35		

Kundendienst

Function	Parameter	Input values
Backlash compensation	X	36
	Y	37
	Z	38
	IV	39
Correction factor for linear correction	X	40
	Y	41
	Z	42
	IV	43
Software limit switch ranges	X+	44
	X-	45
	Y+	46
	Y-	47
	Z+	48
	Z-	49
	IV+	50
IV-	51	
Analog voltage with rapid traverse	52	
Approach speed	53	
Acceleration	54	
Circular acceleration	55	
Position supervision (erasable)	56	
(in precontrolled mode) (emergency stop)	57	
Position window X, Y, Z	58	
Axis sequence for reference points approach	59	
Speed pre-control	60	

		-1.000 ... +1.000 [mm]
		-1.000 ... +1.000 [°] angular axis
		-1.000 ... +1.000 [mm/m]
		-30 000.000 ... +30 000.000 [mm]
		-30 000.000 ... angular axis
		+30 000.000 [°]
		+4.5 ... +9 [V]
		0.1 ... 10 [m/min]
		0.001 ... 3.0 [m/s ²]
		0.001 ... 3.0 [m/s ²]
		0.001 ... 30.000 [mm]
		0.001 ... 0.5 [mm]
		0 ≐ X Y Z IV 12 ≐ Z X Y IV
		1 ≐ X Y IV Z 13 ≐ Z X IV Y
		2 ≐ X Z Y IV 14 ≐ Z Y X IV
		3 ≐ X Z IV Y 15 ≐ Z Y IV X
		4 ≐ X IV Y Z 16 ≐ Z IV X Y
		5 ≐ X IV Z Y 17 ≐ Z IV Y X
		6 ≐ Y X Z IV 18 ≐ IV X Y Z
		7 ≐ Y X IV Z 19 ≐ IV X Z Y
		8 ≐ Y Z X IV 20 ≐ IV Y X Z
		9 ≐ Y Z IV X 21 ≐ IV Y Z X
		10 ≐ Y IV X Z 22 ≐ IV Z X Y
		11 ≐ Y IV Z X 23 ≐ IV Z Y Z
		0 ≐ on 1 ≐ off

Kundendienst

Function	Parameter	Input values
Output of tool numbers or tool store numbers	61	0 ≙ No output 1 ≙ Output only when tool number changes 2 ≙ Output of every tool number with every tool call 3 ≙ Output of tool magazine number (if MP 225 > 1)
Output of spindle speed codes or as S-analog voltage	62	0 ≙ No output of spindle rpm 1 ≙ Coded output only when rpm changes 2 ≙ Coded output of all rpms 3 ≙ S-Analog voltage output, gear switching signal only when gear ratio changes 4 ≙ S-Analog voltage output, output of all gear switching signals with every tool call 5 ≙ S-Analog voltage output without gear switching signal
rpm code limit	63	00001 ... 00991
Oscillation behaviour when accelerating	64	0.01 - 0.999
Display step	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]
Memory function for directional keys	68	0 ≙ off 1 ≙ on
Special procedure for reference mark approach	69	0 ≙ off 1 ≙ on
Nominal value voltage for spindle drive when changing gear	70	0 ... 9.999 [V]
Program end character	71	0 ... 65 535
Selection for control of inhibited axes	72	0 ≙ no axis inhibited 1 ≙ X- " " 2 ≙ Y- " " 4 ≙ Z- " " 8 ≙ IV- " " Add input values when inhibiting several axes
Pre-cutout time for tapping cycle (only active with BCD-output of spindle rpm)	73	0 ... 65.535 [s]

Kundendienst

Function	Parameter	Input values
<p>Feed rate override and spindle</p> <p>Feed rate override, if rapid traverse key is pressed in operating mode "Program Run"</p> <p>Feed rate override in 2% stages or variable</p> <p>Feed rate override if Rapid Traverse Key and external directional keys are pressed</p> <p>Spindle override in 2% stages or variable</p>	74	<p>0 ≙</p> <ul style="list-style-type: none"> inactive 1 ≙ active 2% stages 2 ≙ variable inactive 4 ≙ active 2% stages 8 ≙ variable <p>Add input values for functions requested</p>
Reference signal evaluation for inhibited axes	75	0 ≙ inactive 1 ≙ active
<p>Display and transducer supervision</p> <p>Display and transducer supervision for inhibited axes</p> <p>Transducer supervision Input X1</p> <p style="padding-left: 150px;">X2</p> <p style="padding-left: 150px;">X3</p> <p style="padding-left: 150px;">X4</p> <p style="padding-left: 150px;">X5</p> <p>The switching-off of the transducer supervision is valid for inhibited and for released axes</p>	76	<p>0 ≙</p> <ul style="list-style-type: none"> switched-off 1 ≙ active active 2 ≙ switched-off active 4 ≙ switched-off active 8 ≙ switched-off active 16 ≙ switched-off active 32 ≙ switched-off <p>Add input values for functions requested</p>
PLC program from RAM or from EPROM	77	0 ≙ RAM 1 ≙ EPROM

Kundendienst

Function	Parameter	Input values
PLC: Timer duration for timer 0 - 15	110 to 125	0 ... 65 535 (in units of 20 ms)
PLC: 30 position values for PLC-positioning	126 to 156	-30 000.000 ... +30 000.000 [mm]
Activation of next tool number or of the following tool magazine number	157	0 ≙ No output of next tool number 1 ≙ Output only with change of tool number 2 ≙ Output of next tool number with every tool call 3 ≙ Output of next tool number, programmable with TOOL DEF (if MP 225 > 1) 0 ... 65 535 (Marker 2192 ... 2207)
Setting of 16 markers to binary number	158	0 ... 65 535 (in 65 535 µm units)
Automatic lubrication to programmed traversing distance in	X Y Z IV	159 160 161 162
Feed rate for parameters nos. 126 to 156	X Y Z IV	163 164 165 166
Display of current feed rate before start in MANUAL (in all axes same feed rate, that means smallest feed rate from parameters 4 to 7)	167	0 ≙ off 1 ≙ on
Ramp gradient for S-Analog	168	0 ... 1.999 [V/ms]
Standstill supervision	169	0.001 ... 30 [mm]
Programming station	170	0 ≙ Control 1 ≙ Programming station: PLC active 2 ≙ Programming station: PLC inactive
Handwheel and measuring probe	171	0 ≙ HR 150/250 TS 511 1 ≙ HE 310 TS 511 2 ≙ HR 150/250 TS 111 3 ≙ HE 310 TS 111

Kundendienst

Function	Parameter	Input values
Polarity of S-Analog voltage	172	0 ≙ M03: positive voltage M04: negative voltage 1 ≙ M03: negative voltage M04: positive voltage 2 ≙ M03 and M04: positive voltage 3 ≙ M03 and M04: negative voltage
Cancellation of status display with M02; M30 and program end	173	0 ≙ Status display is not erased 1 ≙ Status display is erased
Trailing error supervision in trailing operation emergency-stop erasable	174 175	0 ... 100 [mm]
Multiplication factor for Kv-factor	176	0.001 ... 1.000
Kv-factor for	X	0.100 ... 10.000
	Y	
	Z	
	IV	
Characteristic kink	181	0 ... 100.000 [%]
Minimum for feed rate override with tapping	182	0 ... 150 [%]
Maximum for feed rate override with tapping	183	0 ... 150 [%]
Minimum voltage for S-Analog output	184	0 ... 9.999 [V]
Waiting time for cutout of remaining nominal value voltage with error display "Positioning error".	185	0 ... 65.535 [s]
Tool change position M 92:	X-Axis	-30 000.000 ... +30 000.000 [mm]
	Y-Axis	
	Z-Axis	
	IV.-Axis	
Programming of rpm S = 0 permitted (voltage value of MP 184 may be less)	190	0 ≙ S0 = permitted 1 ≙ S0 = not permitted
Display of current spindle rpm before spindle start in "Manual mode"	191	0 ≙ off 1 ≙ on
Position window for axis IV	192	0.001 ... 0.5 [mm or °]
PLC: Timer duration for timer 16-31	193	0 ... 65 535 [in units of 20ms]
	to	
	208	
Support of PLC-macro commands	209	0 ... 65 535
	to	
	212	

Kundendienst

Function	Parameter	Input values
"Scaling" cycle effective for 2 or 3 axes	213	0 ≐ 3 axes (spacial) 1 ≐ 2 axes (machining plane)
Output of M- and T-functions	214	0 ≐
Programmed stop with M06		— programmed stop 1 ≐ no programmed stop
Output of M89		— normal output at the beginning of the block 2 ≐ modal cycle call at the end of the block
Axis standstill if only one spindle rpm is output with a TOOL CALL		— Axis standstill 4 ≐ no axis standstill
Axis standstill with output of an M-function		— Axis standstill 8 ≐ no axis standstill
Exceptions: The axis stands still with M-functions resulting in a programmed stop (as M00, M02 ...) or with a STOP or a CYCL-CALL block		Add input values for functions requested
Touch probe system probing speed	215	80 ... 3000 [mm/min]
Touch probe system measuring distance	216	0 ... 19999.999 [mm]
Switch-over from HEIDENHAIN-Dialog-Programming to DIN/ISO-Programming	217	0 ≐ HEIDENHAIN-Dialog 1 ≐ DIN - ISO
"Blockwise Transfer" ASCII-code for data input	218	0 ... 65 535
"Blockwise Transfer" ASCII-code for data output	219	0 ... 65 535
"Blockwise Transfer" ASCII-code for the beginning and the end of the command block	220	0 ... 12 079
"Blockwise Transfer" ASCII-code to repeat transfer correction or block	221	0 ... 12 079
Data format and transfer stop for data interface V.24	222	0 ... 255
Operating mode data interface V.24	223	0 ≐ "Standard data interface" 1 ≐ "Blockwise Transfer"

Kundendienst

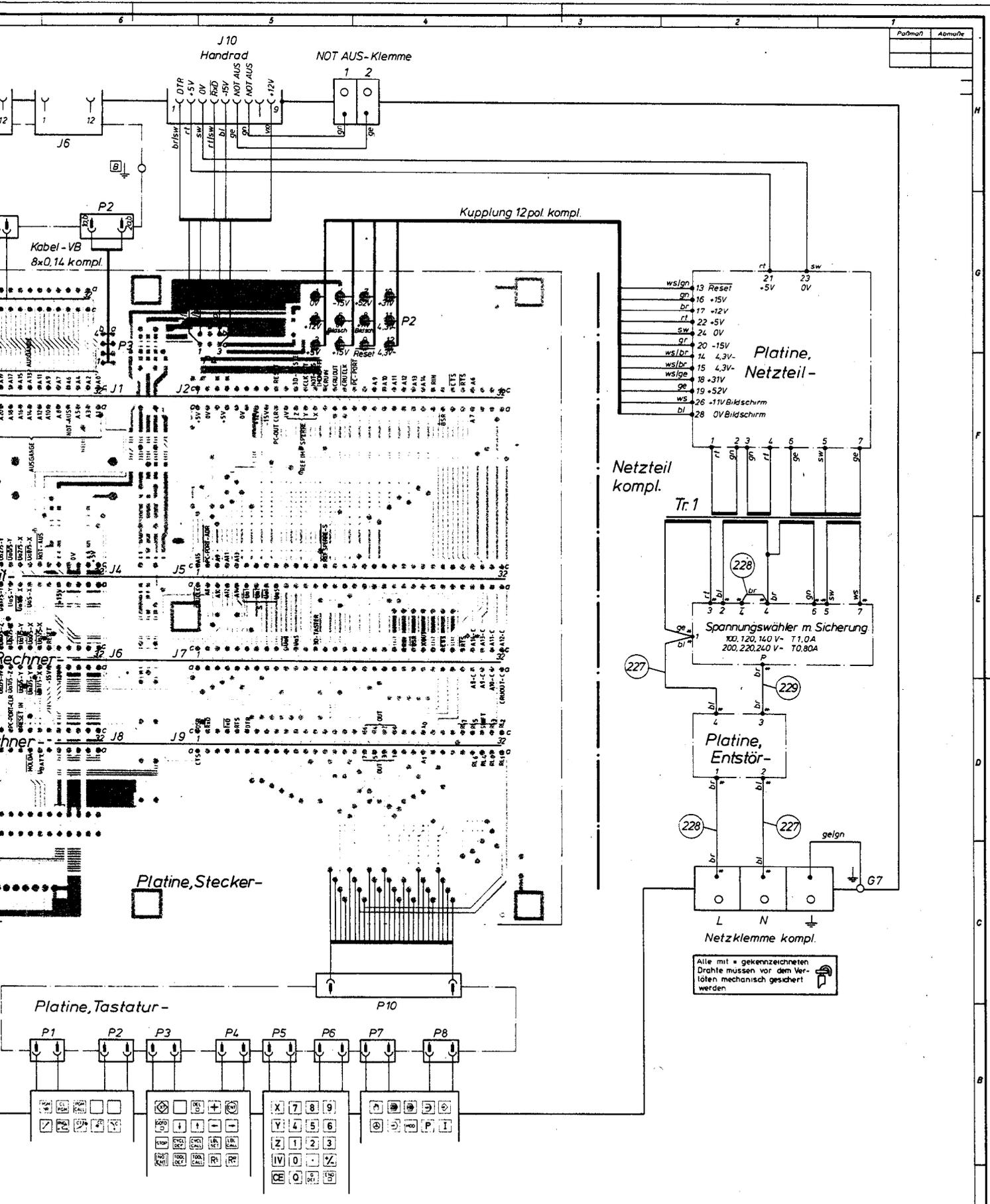
Function	Parameter	Input values
"Blockwise Transfer" ASCII-code data transfer finished	224	0 ... 12 079
Central tool memory	225	0 ^ = no central tool memory 1 ... 99 ≐ central tool memory with number of tool stores
Graphic printout Number of control signs to set the printer inter- face + 1 control sign	226	0 ... 65 535
Graphic printout 2 control signs to set the printer interface	227 228 229	0 ... 65 535
Graphic printout number of control signs in front of every printer line + 1 control sign	230	0 ... 65 535
Graphic printout 2 control signs in front of every printer line	231 232 233	0 ... 65 535
Movement supervision	234	0.03 ... 10 [V]
Touch probe: Safety clearance over measuring point for automatic measuring	235	0 ... 19 999.999 [mm]
Graphic Representation of graphic in three planes Rotating the coordinate system of machining plane	236	0 ≐ ┌ German standard 1 ≐ American standard └ no rotation 2 ≐ rotation by 90°
Activation and function of spindle axis	237	Add input values for function requested 0 ≐ Spindle axis not active 1 ≐ Spindle axis serves to orientate the main spindle without position display 2 ≐ as input value 1, with position display, however (is displayed instead of axis IV) 3 ≐ Spindle axis is not controlled; the position display, however, is active, axis designation A (is displayed instead of axis IV) 4 ≐ as input value 3, axis designation B, however) 5 ≐ as input value 3, axis designation C, however)
Kv-factor for spindle axis	238	0.100 ... 10.000

Kundendienst

Function	Parameter	Input values
Counting direction of spindle axis	239	0 ≙ positive traversing direction 1 ≙ negative traversing direction
Position value of reference mark for spindle axis	240	0 ... 360 [°]
Cycle to mill pockets with any contour	241	0 ≙
Cycle "Reaming" milling direction to rough out contour		— Roughing out contour pockets counterclockwise; with islands clockwise 1 ≙ Roughing out the contour with pockets clockwise; with islands counterclockwise
Cycle "Reaming" sequence for reaming and roughing out		— Mill channel round the island, then ream the pocket 2 ≙ Ream pocket first, then mill channel around the contour
Combining corrected or uncorrected contours		— Combining corrected contours 4 ≙ Combining uncorrected contours
		Add input values for functions requested
Reference mark distance for distance-coded linear transducers		0 ... 65 535
X	242	0 ≙ no distance-coded reference mark
Y	243	Input value for distance-coded reference marks =
Z	244	
IV	245	Ref. distance e.g. 20 mm = 1 000 grating pitch 20 μm
Position window for spindle axis	246	0 ... 65 535 [Incrementals]
Hysteresis for electronic handwheel	247	0 ... 65 535 [Incrementals]
Spindle rpm for spindle orientation	248	0 ... 99 999.999 [U/min]
Setting of 16 markers to binary number	249	0 ... 65 535 (Marker 2208 to 2223)
Setting of 16 markers to binary number	250	0 ... 65 535 (Marker 2224 to 2239)
Touch probe: rapid traverse to scan	251	80 ... 15 999 [mm/min]
Cycle time for automatic offset adjustment	252	1 ... 65 535 [in units of 20 ms] 0 ≙ no automatic adjustment

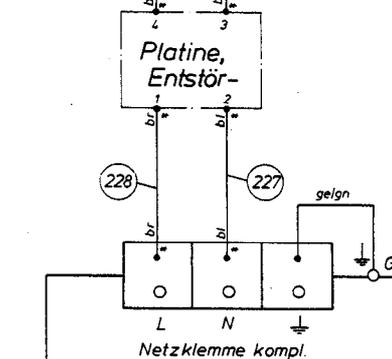
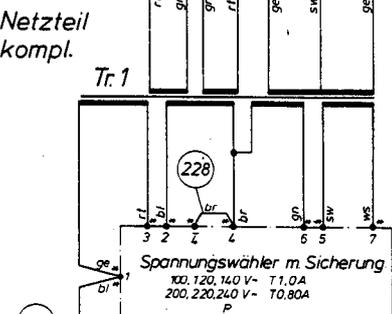
Kundendienst

Function	Parameter	Input values
Allocation of the axes to the measuring system inputs:	X	253
	Y	254
	Z	255
	IV	256
	V	257
		$\emptyset \hat{=} X1$ 1 $\hat{=} Measuring\ system\ input:\ X1$ $\emptyset \hat{=} X2$ 2 $\hat{=} Measuring\ system\ input:\ X2$ $\emptyset \hat{=} X3$ 3 $\hat{=} Measuring\ system\ input:\ X3$ $\emptyset \hat{=} X4$ 4 $\hat{=} Measuring\ system\ input:\ X4$ $\emptyset \hat{=} X5$ 5 $\hat{=} Measuring\ system\ input:\ X5$ Input $\emptyset \hat{=} Standard\ allocation$
Spindle rpm if marker 2501 is set	258	$\emptyset \dots 99\ 999.999$ [U/min] Direction of rotation always positive
Language conversion for user cycles: Difference between dialog numbers of the second (English) and the first dialog.	259	$\emptyset \dots 50$
without function	260	\emptyset
	261	\emptyset
	262	\emptyset
Difference between Q-parameter numbers for "DLG-DEF"-block and "DLG-CALL"-block	263	$\emptyset \dots 50$ \emptyset if only "DLG-CALL"-blocks



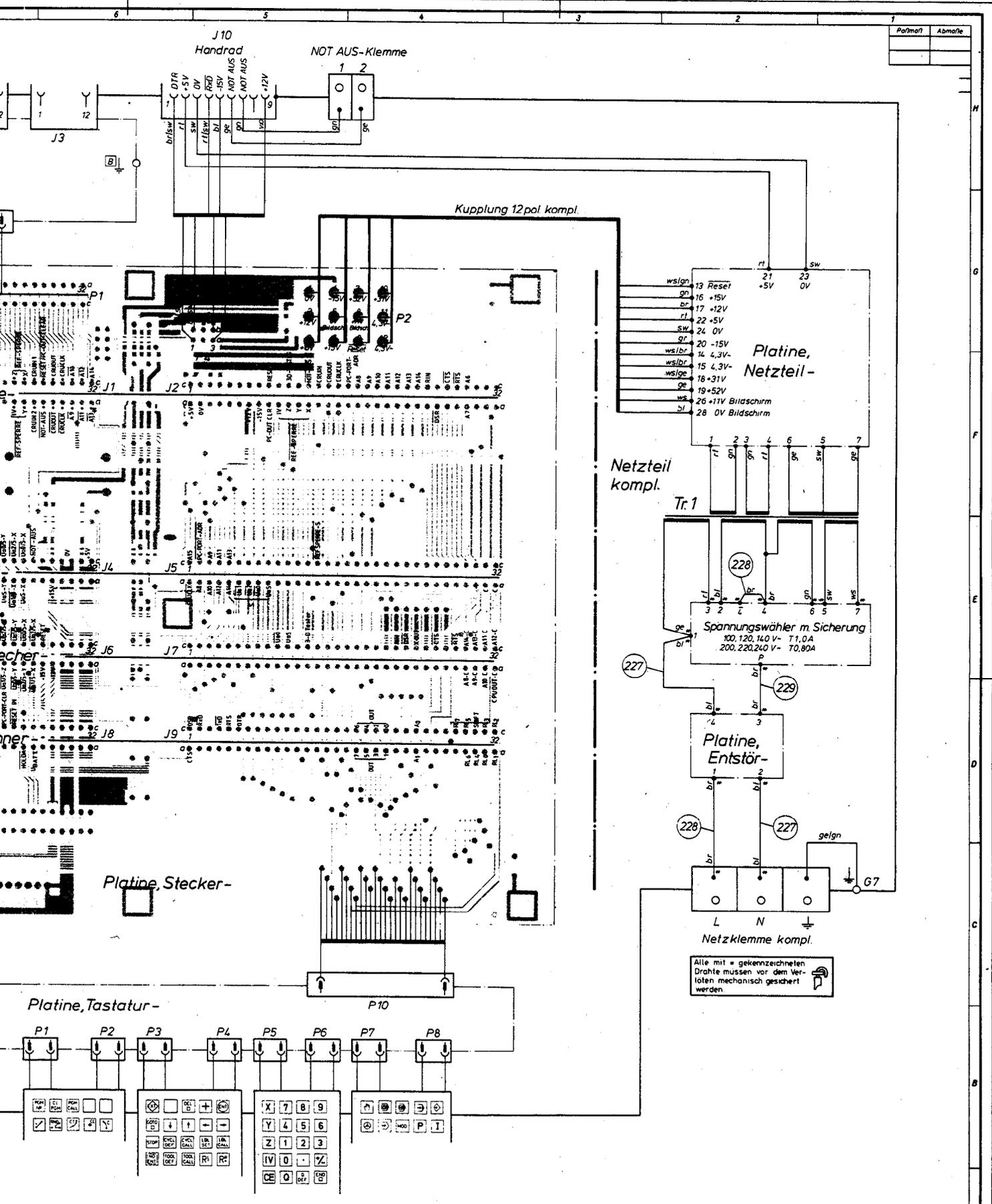
Paßmaß	Abmaße

wsign	13	Reset
gp	16	+15V
br	17	-12V
rt	22	-5V
sw	24	0V
qr	20	-15V
wsbr	14	4,3V-
wsbr	15	4,3V-
wsge	18	+31V
gp	19	+52V
ws	26	-11V Bildschirm
bl	28	0V Bildschirm



Alle mit * gekennzeichneten Drähte müssen vor dem Verlöten mechanisch gesichert werden

F21 BA 233 550 ---		Code (Ch.F.)	Ident.-Nummer
Für diese Zeichnung behalten wir uns alle Rechte vor		Tele.-Nummer	
Maßstab	1:1	DR. JOHANNES HEIDENHAIN	Ang.-Mittg. / Datum
Zeichner	Schall, 16.4.86	Platz 11001, 73 0974, Tübingen	Index
Gepr. / Datum	16.4.86	Platz 11001, 73 0974, Tübingen	Erstellt
Vedrahtungsplan		013 AB 232 239 00	Code (Ch.F.)
		Ident.-Nummer	
		Zeichnungs-Nummer	

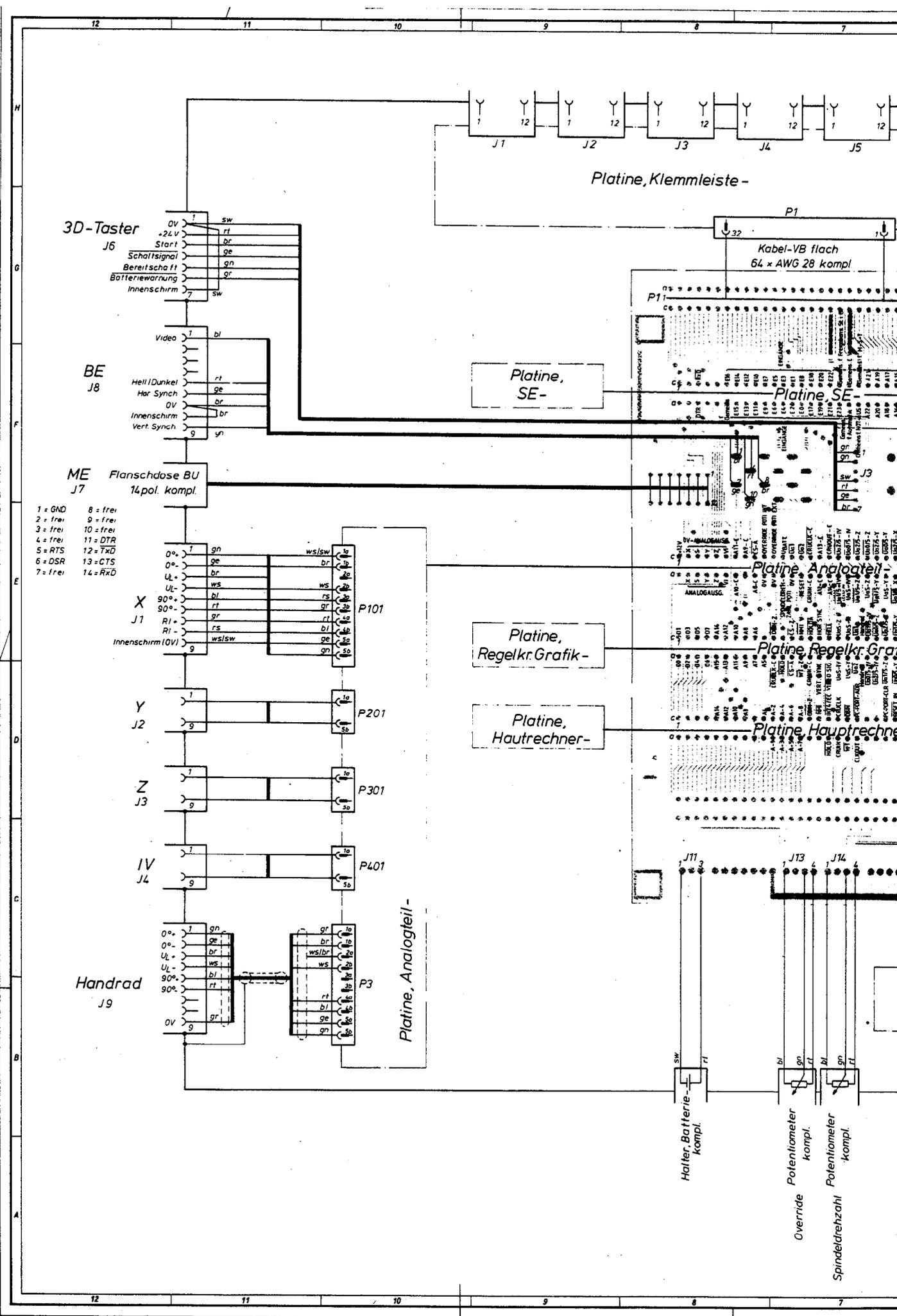


Partikel	Abmaße

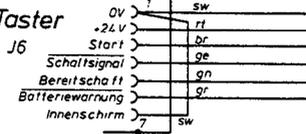
Alle mit * gekennzeichneten
Drahte müssen vor dem Ver-
löten mechanisch gesichert
werden.

F21 BA 233 551 ---		Code ICH F	Ident-Nummer		
Für diese Zeichnung behalten wir uns alle Rechte vor		Teile-Nummer			
Hofstabs	Gezeichnet S. G. V. 14.4.88 S. G. V. 14.4.88 S. G. V. 14.4.88	DR. JOHANNES HEIDENHAIN	And-Menge	Datum	Index
		013 AB 232 240.00			
		Code ICH F		Ident-Nummer	
		Zeichnungs-Nummer			

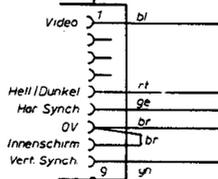
Vedrahtungsplan



3D-Taster



BE



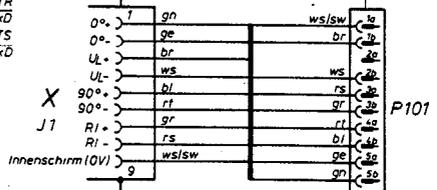
ME Flanschdose BU

J7 14pol. kompl.

- 1 = GND
- 2 = frei
- 3 = frei
- 4 = frei
- 5 = RTS
- 6 = DSR
- 7 = frei
- 8 = frei
- 9 = frei
- 10 = frei
- 11 = DTR
- 12 = TXD
- 13 = CTS
- 14 = RXD

X

J1



Y

J2

Z

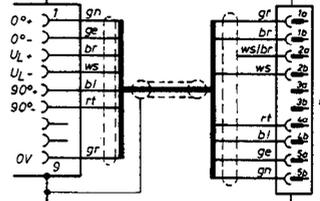
J3

IV

J4

Handrad

J9



Platine, Klemmleiste-

P1

Kabel-VB flach

64 x AWG 28 kompl

Platine, SE-

Platine, SE-

Platine, Regelkr. Grafik-

Platine, Hautrechner-

Platine Analogteil

Platine Regelkr. Graf

Platine Hauptrechner

Platine, Analogteil-

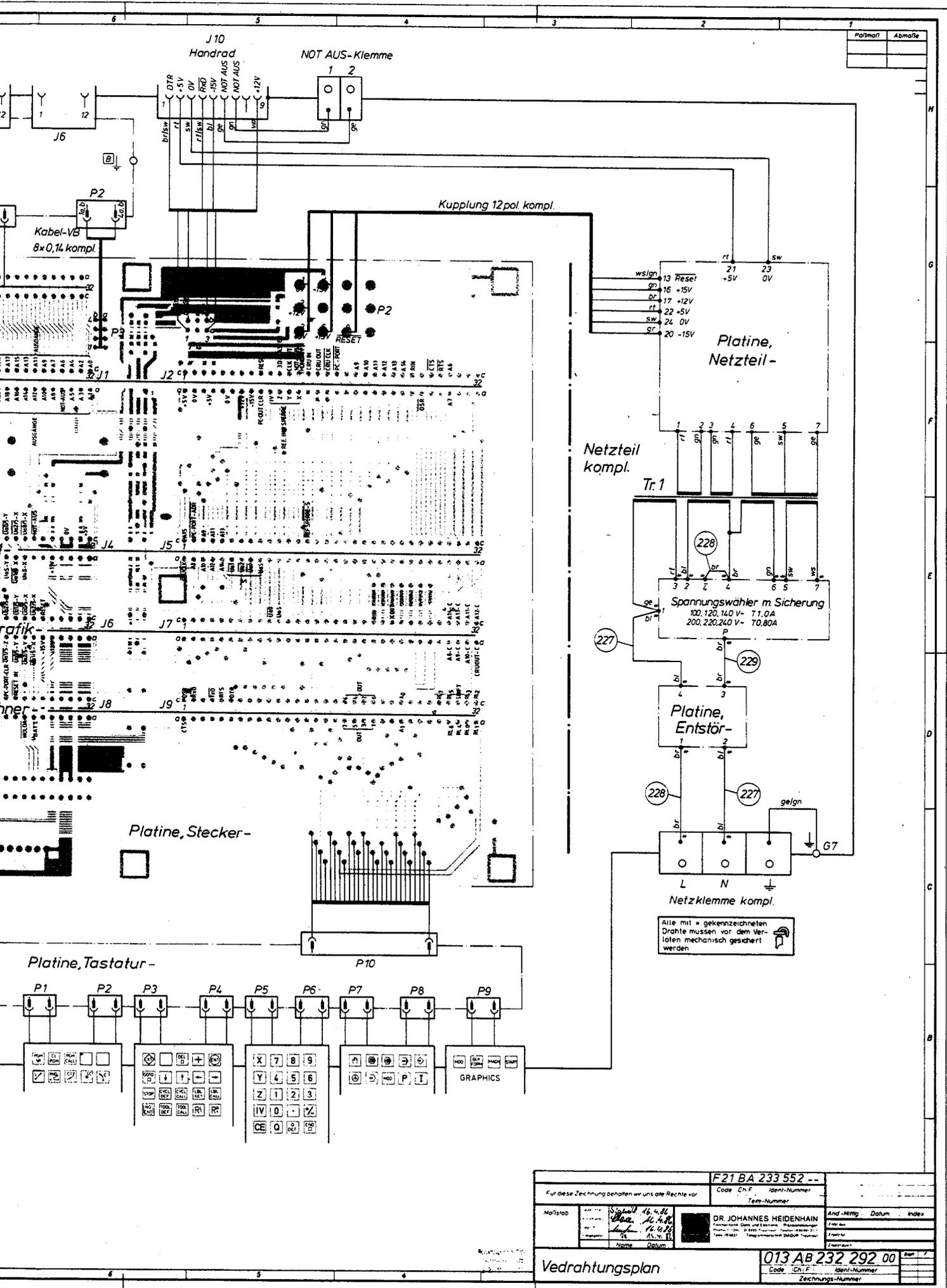
Halter, Batterie kompl.

Potentiometer kompl.

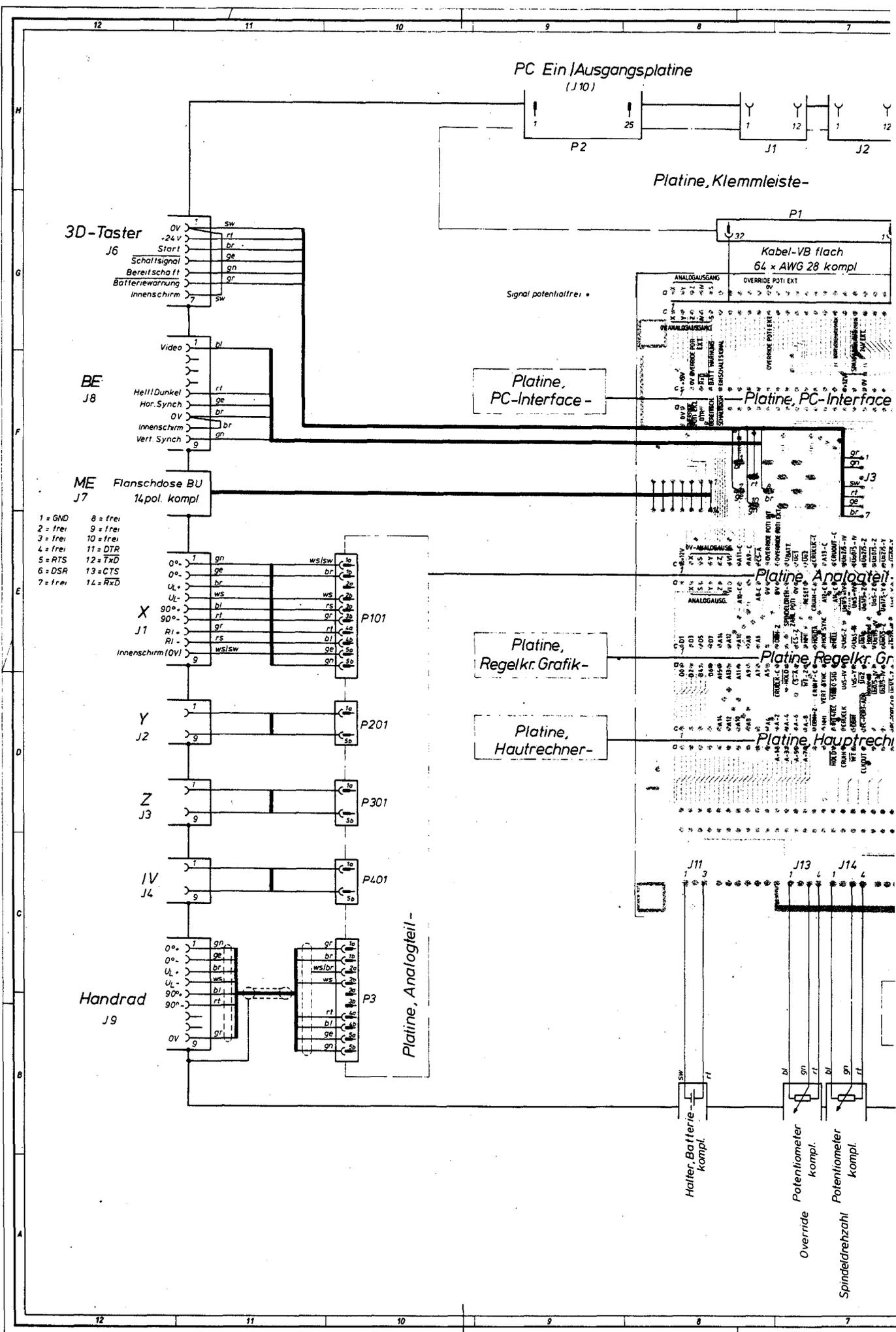
Potentiometer kompl.

Override

Spindelrehzahl



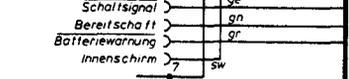
F21 BA 233 552 --		Code	Ch F	Ident-Nummer	
Für diese Zeichnung behalten wir uns alle Rechte vor		Teil-Nummer			
Maßstab	gezeichnet	geprüft	DR. JOHANNES HEIDENHAIN	And-Nr/Typ	Datum
	16.4.86	16.4.86	DR. JOHANNES HEIDENHAIN		
	16.4.86	16.4.86			
	16.4.86	16.4.86			
Name		Datum		Freigegeben	
Vedrahtungsplan		013 AB 232 292 00		Ident-Nr	
		Code		Ch F	
		Ident-Nummer		Zeichnungs-Nummer	



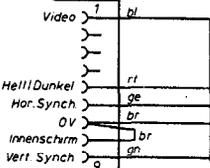
PC Ein/Ausgangsplatine (J10)

Platine, Klemmleiste

3D-Taster J6

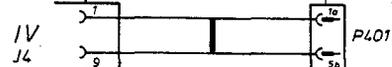
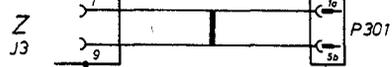
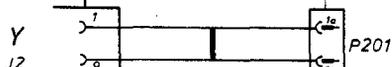
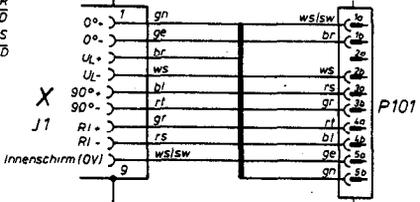


BE J8

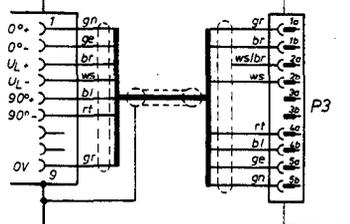


ME Flanschdose BU J7

- 1 = GND
- 2 = frei
- 3 = frei
- 4 = RTS
- 5 = DSR
- 6 = frei
- 8 = frei
- 9 = frei
- 10 = frei
- 11 = DTR
- 12 = TXD
- 13 = CTS
- 14 = RXD



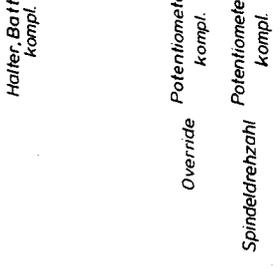
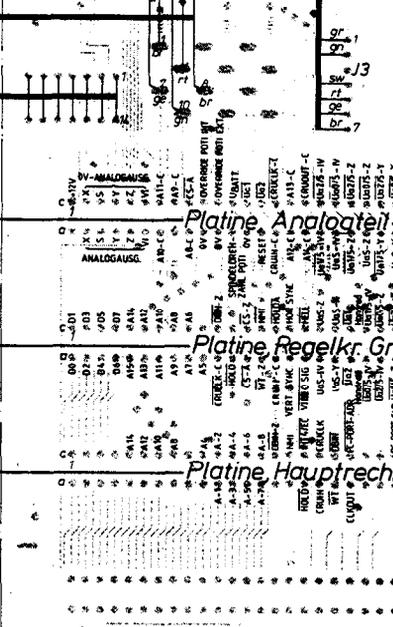
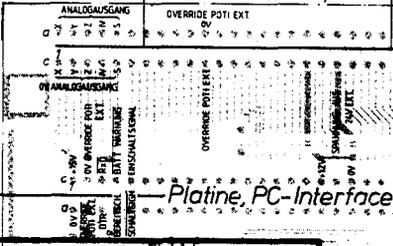
Handrad J9

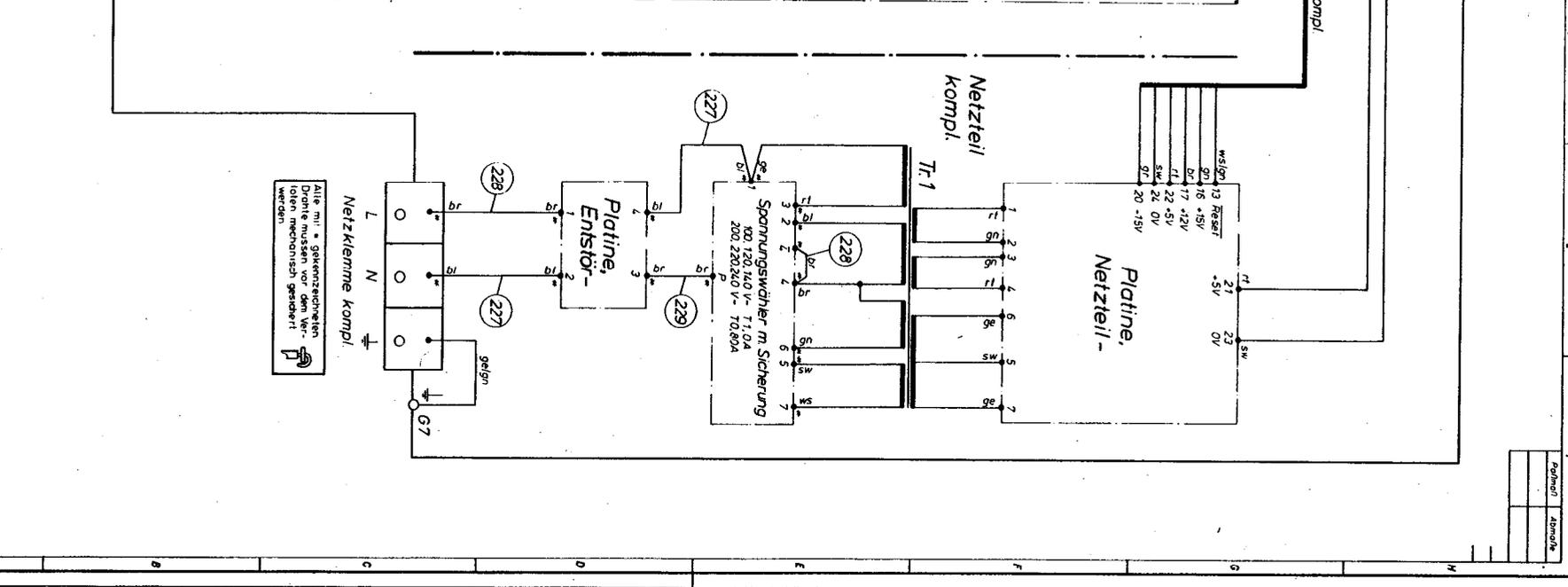
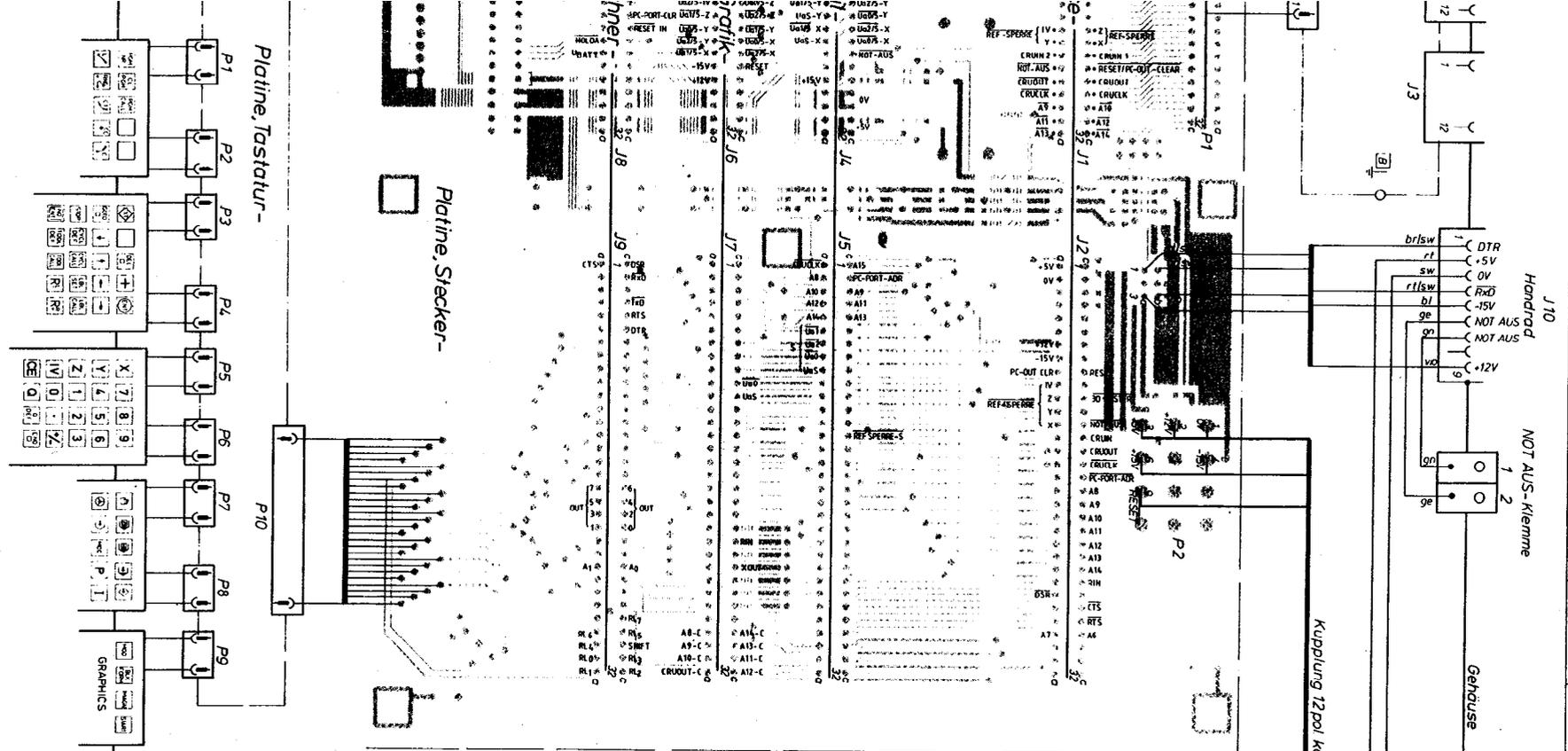


Platine, Analogteil

Platine, Regelkr. Grafik

Platine, Hautrechner





F21 BA 233 553		F21 BA 233 553	
E/F diese Zeichnung darf nicht ohne schriftliche Genehmigung der... MOS/Std		Code: C11 Ident-Nummer	
Zeichner: <i>[Signature]</i> Gezeichnet: <i>[Signature]</i> Datum:		Art-Nr: 013 AB 232 293 00 Code: C11 Ident-Nummer: Zeichnungs-Nummer:	
Dr. JOHANNES HEIDENHAIN Heidenhain AG Industriestraße 1 34109 Heidenheim Telefon: 05341 14-111 Telefax: 05341 14-111		Art-Nr: 013 AB 232 293 00 Code: C11 Ident-Nummer: Zeichnungs-Nummer:	

