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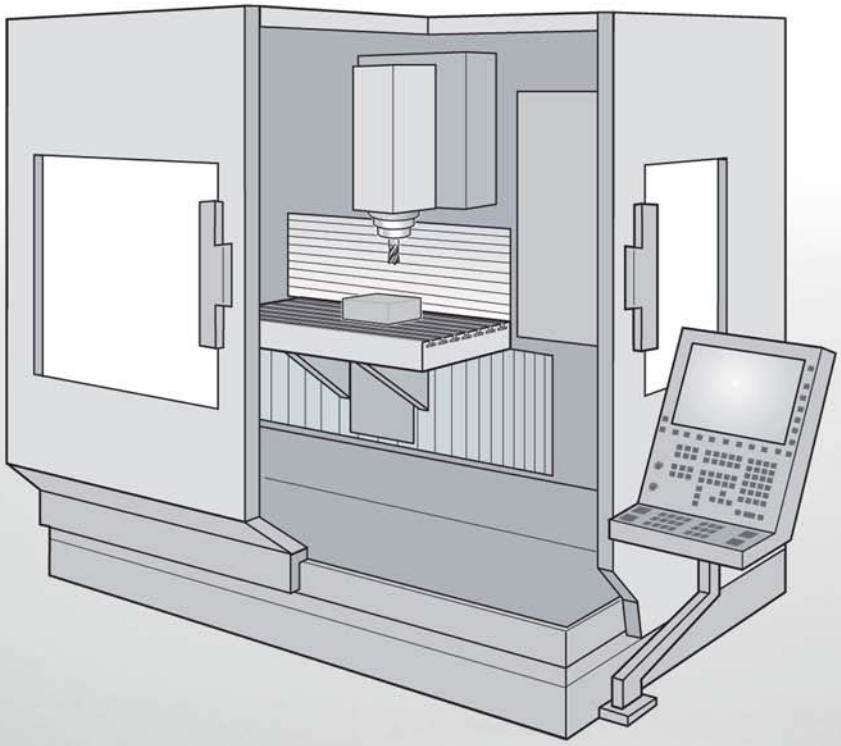

Service Manual

TNC 410

July 2010

Contents

1. How to use this service manual

The service manual TNC 410 can be used to diagnose, locate and eliminate faults on machine tool controlled by TNC.

In order to correctly judge the problems in an NC-controlled machine tool, fundamental knowledge of the machine tool and its drives as well as their interaction with the control and the measuring systems is required. Incorrect behavior of the machine may also result from improper use of the control, NC-programming errors and incorrect or not properly optimized machine parameter values.

For further information in this respect please refer to the

- **Documentation of the machine tool builder**
- HEIDENHAIN **Operating Manual** TNC 410
- HEIDENHAIN **Technical Manual** TNC 410 (for machine tool builders only)
- HEIDENHAIN **CD-ROM TNCguide**

Information on the description of errors in this service manual:

The number in the **first** square brackets refers to the number of the error message in the error list on the CD-ROM; this list can be called by clicking the button NC error messages.
The number in the **second** square brackets (not for all error messages) should be stated when you contact the HEIDENHAIN service.

The Technical Manual is not enclosed with every control.
In general, it is only supplied to the machine tool builder and is updated by HEIDENHAIN, Traunreut. Therefore, it is absolutely necessary to contact the machine tool builder, if errors occur that are due to a machine parameter or to the interface of the control. Support will, however, also be provided by the HEIDENHAIN service department and agencies.
Telephone numbers, addresses and telex/fax numbers can be found on the back side of this service manual and on our homepage: http://www.heidenhain.de.

Valid for software TNC 410:
NC software 286 000 - 011
NC software 286 060 - 071
NC software 280 080 - 091

1.1 Safety Precautions

The **Service Manual** describes the diagnosis, localization, and correction of faults in a TNC-controlled machine tool.

Comprehensive knowledge of the machine and drives, and of their interaction with the control is indispensable for correct evaluation of the performance of an NC controlled machine.

HEIDENHAIN can accept no responsibility for direct or indirect damage or injury, nor for damage or injury caused by improper use or incorrect operation of this device.

AC Power Connection

Any interruption of the grounding conductor inside or outside of the device, or any disconnection of the grounding conductor is prohibited!

Any interruption of the protective ground can make the device dangerous, leading to serious injury to persons and damage to equipment.

PLC Interface

The interfaces for PLC inputs and outputs, machine operating panel, and PL connection comply with the regulations for basic insulation in **IEC 742 EN 50 178.**

All connected devices must comply with the regulations for basic insulation in **IEC 742 EN 50 178.** Failure to follow this instruction can result in serious injury to persons and damage to equipment.

The **maximum** mean dc voltage for PLC inputs is 31 V.

Machine Parameters

Machine parameters must be altered only by the machine manufacturer or after consultation with the machine manufacturer.

Incorrect or non-optimized input values can lead to faulty machine performance and therefore to serious injury to persons and damage to equipment.

Plug Connections, Terminal Connections

Ensure that the main electrical disconnect switch of the machine is off before connecting or disconnecting any plugs or terminals. Failure to follow this instruction can result in serious injury to persons and damage to equipment.

2. Integrated monitoring system

TNC 410 features a comprehensive integral monitoring system to avoid input and operation errors, to locate faults and technical defects of the entire equipment (TNC, measuring systems, machine tool, cables etc.). The monitoring system is a fixed component of the TNC hardware and software; it is active as long as the control is switched on. If a technical defect or an operation error is detected, an error message is displayed on the screen in plain language.

During operation the TNC monitors

- the amplitude of the encoder signals
- the edge separation of the encoder signals
- the absolute position of encoders with distance-coded reference marks
- the current position (monitoring of servo lag)
- the path actually traversed (movement monitoring)
- the position deviation in standstill
- the nominal shaft speed
- the CRC sums of EPROM and RAM
- the supply voltage
- the voltage of the buffer battery
- the operating temperature of the logic unit
- the run time of the PLC program

With digital axes the TNC monitors in addition

- the motor current
- the motor temperature
- the temperature of the power module
- the dc-link power
- the supply voltage of the power module

2.1 Log function of TNC 410

In the TNC 410 a **log** with approx. 100 entries is created continuously and updated according to the FIFO principle. The last **key inputs, control reset, error messages, blinking error messages with register status** are entered into this log.
The log is transferred via data interface with the TNCremo data transfer software; this software can be ordered from HEIDENHAIN, Traunreut with the Id.No. 280 481 – (English), and Id.No. 280 480 – (German). HEIDENHAIN also provides a shareware version of this software for testing.

Excerpt from a log file transferred with TNCremo

```
___Date: 4-Mar-1998___
Key: 0x01A8 -> Enter        05:40:43
Blinkerror:                 05:41:20
  File system error E
Registers(Blinkerror):      05:41:20
D0-3  00000000 0000FFFF 00000000 00000010
 4-7  00000008 00000010 00003780 00000000
A0-3  FFFFFFA0 FFFFFFC0 02C0A000 FFE26200
 4-7  FFE7C3DC 02C0A002 FFC33EE4 FFC33E20
FM FFFF    VO FFFF    SR 0020
PC 004A762A
Reset                       05:41:37
Error:                      05:41:39
  NC: Program memory deleted
Key: 0x01AE -> CE           05:41:57
Error:                      05:41:57
  Power interrupted
Key: 0x01AE -> CE           05:41:59
Error:                      05:42:00
```

3. Minor error messages

Minor (non-blinking) error messages can be cleared by pressing CE .

Further error messages are described in the
- **TNC 410 Operating Manual** (HEIDENHAIN)
- **TNC 410 Technical Manual** (HEIDENHAIN)
- **CD-ROM TNC-GUIDE** (HEIDENHAIN)
- **Documentation of the machine tool builder**

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Error message	Section
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Touch probe not ready <axis>	17.2
Data transfer erroneous	19.3

Note:

The number in square brackets refers to the number of the error in the error list on CD-ROM.

3.1 Causes of minor error messages

Operating parameters erased [947]

- When the control is booted after power-on for the first time (new and exchange controls). When the control is booted for the first time after an NC software exchange;
- Defective buffer batteries and (Gold) capacitor;
- RAM error on the processor board;
- When the control is booted for the first time after a reset of the non-volatile PLC markers and words by entering the code number 531210.

Limit switch <axis> [58]

- "Manual“ operating mode
  The preset **software limit switch** has been reached when traversing with the axis-direction buttons.
- "Automatic“ operating mode
  The **calculated position** of the current block is **beyond the software limit switch range or beyond the additional limit** (set by pressing the soft key >TRAVERSE RANGE<, MOD function). The positioning is not performed.

Machine parameters for the software limit switches

	X+	X-	Y+	Y-	Z+	Z-
Default setting	910.0	920.0	910.1	920.1	910.2	920.2
Activation via PLC	911.0	921.0	911.1	921.1	911.2	921.2
Activation via PLC	912.0	922.0	912.1	922.1	912.2	922.2

	IV+	IV-	V+	V-
Default setting	910.3	920.3	910.4	920.4
Activation via PLC	911.3	921.3	911.4	921.4
Activation via PLC	912.3	922.3	912.4	922.4

Power interrupted

- After a reset signal at the power supply unit (e.g. line voltage drops)
- Important machine parameters have been changed (e.g. MP 110.X, MP 210)
- During each power-on routine (see section “Output Control-is-ready”)

Positioning error [51]

- The servo lag monitor set in the machine parameters 1410.X or 1710.X has responded. (Check the run-in behaviour of the axis and readjust, if necessary.)

PLC program not translated [211]

- After editing, the PLC program must be compiled (translated) anew.

Relay ext. DC voltage missing

- After the message POWER INTERRUPTED was confirmed by pressing the CE key, the TNC waits during the power-on routine for the 24V control voltage (input "acknowledgement control ready for operation, X42/4); see section “Output Control-is-ready”.

System memory overflow!	**[1810]**

The memory available in the TNC is insufficient to perform complicate calculations (e.g. FK graphics, program verification graphics, oscilloscope etc.).
Press CE to confirm the error message and restart the function.

Program memory exceeded!	**[939]**

The program memory of the TNC is not sufficient.
Delete programs no longer required!

Power-fail

The power supply unit transfers a POWER FAIL signal to the LE (see basic circuit diagram), since the supply voltage for the logic unit is below a certain threshold.

Customized error messages by the machine tool builder

<customized text>[1)]	marker	2924	— set
to	to		
<customized text>[1)]	marker	3023	

1) The machine tool builder stores the customized dialogs in the PLC EPROM.

MP: line w/o number [151]

Machine parameter input error:
A line was found without a machine parameter number (not an empty line or comment).

MP: incorrect number [152]

Machine parameter input error:
The given machine parameter does not exist (incorrect number).

MP: separator missing [153]

Machine parameter input error:
No separator was found between the number and the value of the machine parameter.

MP: input value incorrect [154]

Machine parameter input error:
The input value for the machine parameter is incorrect.

MP: defined twice [155]

Machine parameter input error:
A machine parameter has been defined twice.

MP: not defined [156]

Machine parameter input error:
A machine parameter is not defined. The line is generated automatically.

MP: saving not possible [157]

Machine parameter input error:
The machine parameter cannot be saved.

MP: contradictory input [158]

Machine parameter input error:
The values entered for the machine parameters are contradictory, which results in a conversion error.

4. Blinking error messages and their causes

The integrated monitoring system distinguishes between minor and gross errors. **Gross errors** are characterized by a **blinking display** (e.g. malfunctions of the encoders and the drives, data processing errors).
A red window is displayed on the screen which can be moved with the cursor keys.
In the first line of this window the error message is displayed in plain language. Moreover the contents of important registers are displayed.
The error messages are also stored in the logbook of the TNC (see section 2.1)

If a **gross error** occurs, the control opens the contact **"Control is Ready"** which causes an emergency stop of the machine tool.

By switching off the power switch or by pressing END, the emergency stop status can be reset provided that the error cause was corrected.

In this service manual the **blinking error messages** are divided into several groups in order to obtain a structure.

4.1 General error messages
4.2 PLC editor
4.3 Position encoder interface
4.4 Speed encoder interface
4.5 Position monitoring of analog axes
4.6 Position monitoring of digital axes
4.7 General error messages when operating with digital axes
4.8 Error codes from DSP (digital signal processor) when operating with digital axes

4.1 General error messages

Blinking display	Error cause
TNC operating temp. exceeded	The temperature inside the logic unit has exceeded + 70°.
[204]	
Power interrupted	When the control is switched on the power supply unit transfers a POWER FAIL signal to the LE (see basic circuit diagram), since the supply voltage for the logic unit is below a certain threshold.
EMERGENCY STOP defective	Error during the test routine for the output "Control is ready" when the machine is switched on (see also section "Output control-is-ready“).
[203]	
EMERGENCY STOP PLC	This error message is displayed if marker M2815 is set without additional marker (M2924 - M3023).
[205]	
Ext. relay DC voltage missing	No PLC supply voltage available at connector X44.
Checksum error X	The TNC has detected a CRC checksum error during operation.[1)] X = A CRC sum of NC-EPROM 1or 2 incorrect B CRC sum of PLC-EPROM incorrect C CRC sum of NC-EPROM 3 incorrect D CRC sum of NC-EPROM 4 incorrect

CRC = **C**yclic **R**edundancy **C**heck (during data transfer)
1) If one of these error messages comes up repeatedly, please contact HEIDENHAIN.

Customized error messages by the machine tool manufacturer

<customized text>[1)] to <customized text>[1)]	marker 2924 to marker 3023	— **and** marker 2815 set

1) The machine tool manufacturer stores the customized dialogs in the PLC EPROM.

Blinking display	Error cause
Processor check error X **[977]**	X = 0 CRC sum for control data incorrect 1 CRC sum for machine parameters incorrect 2 Checksum for NC memory incorrect 3 Test plane incomplete / will not run 4 Crosstalking of data bits in RAM 5 Crosstalking of addresses in RAM 6 Stack overflow 7 Checksum for PLC program ASCII incorrect 8 Checksum for PLC program Opcode incorrect

If the error message **"Processor check error X"** (X = identification letter, see above) comes up repeatedly, please send the **complete logic unit** to HEIDENHAIN for repair. Please indicate **the error message, the code letters and the register contents**.

Blinking display	Error cause
Processor check error X	X = A Software error B Wrong interrupt Differentiation with register V0: 08 Bus error 0C Address error 10 Illegal instruction 14 Division by 0 18 Error output for CHK command (Check Range) 20 Error output for TRAPV command (Trap on Overflow) 24 Privilege infringement (supervisor command in user mode) 28 Emulator trap 2C Emulator trap 30 - 34 - 38 - 3C Non-initialized interrupt vector 40 Non-initialized interrupt vector 44 Non-initialized interrupt vector 48 Non-initialized interrupt vector 4C - 50 - 54 - 58 - 5C - 60 False interrupt (internal with priority 0) 64-7C Interrupt autovector 4-7, user interrupt $100-$3FC 94-BC TRAP #5 - #15

If the error message **"Processor check error X"** (X = identification letter, see above) comes up repeatedly, please send the **complete logic unit** to HEIDENHAIN for repair. Please indicate **the error message, the code letters and the register contents**.

Blinking display	Error cause
Processor check error X	X = C Time slice overflow with over 200 % utilization D Overflow of command stack, control loop E Illegal command: host --> CLP F Wrong display mode: host --> display H Control loop 'Counter not latched" L Illegal command: CLP M Wrong operating voltage The 5 V operating voltage (Uvcc) of the LE is **not** within the tolerances P Disabled software function activated R PLC positioning, datum shift, oriented spindle stop or switchover of the limit switches activated although MP 7440/bit 2=1 (continuos with M-output) or MP 3030 is set (continuos with S-output) S Memory overflow (malloc)

If the error message **"Processor check error X"** (X = identification letter, see above) comes up repeatedly, please send the **complete logic unit** to HEIDENHAIN for repair. Please indicate **the error message, the code letters and the register contents**.

4.2 PLC editor

Blinking display	Error cause	Y
PLC: invalid command [64]	The TNC cannot interpret the line as a PLC command. (earlier versions: operand for jump is not label)	ESC
PLC: invalid operand type [65]	An unknown operand type was given. The command cannot be used for the given operand type.	ESC
PLC: operand not found [66]	A type was given for the operand, but no value.	ESC
PLC: operand incorrect [67]	Operand out of permissible range An operand number was given that lies outside the range available for this operand.	ESC
PLC: error in text after command [68]	No limiter behind command Behind the PLC command additional characters were found that could not be interpreted.	ESC
PLC: line too long [69]	End of line not found The line is longer than 128 characters.	ESC
PLC: label not defined [70]	A reference was made to a label that has nowhere been defined with LBL, KFIELD or EXTERN.	SC
PLC: end of block not found [71]	At the end of the program file there are PLC commands that are not concluded with an EM or JP command. The danger therefore exists that at runtime an undefined program range is run through.	SC
PLC: program too long [72]	The total length of the program code to be generated exceeds the memory available in the control.	SC

Error classification (not displayed on the screen) !

Y = E: Error recognized during editing; line is not formatted.
S: Error recognized during syntax check in the PLC editor (COMPILE soft key). Under certain circumstances this error is already recognized during the syntax check, otherwise when the compiler is run.
C: Error recognized during compiler run, either when the control is switched on or in the PLC programming mode.

Blinking display	Error cause	Y
PLC: assignment in parentheses [73]	An attempt was made to assign the result of a gated operand, although not all open parentheses had been closed.	SC
PLC: too many parentheses [74]	Excessive nesting of parentheses An attempt was made to nest more than 16 parenthetical expressions in each other.	SC
PLC: jump incorrectly programmed [75]	Jump in gating chain An unconditional jump was programmed, although the assignment chain begun beforehand had not yet been assigned.	SC
PLC: closing parenth. w/o opening [76]	Closing parenthesis without opening parenthesis There are more closing than opening parentheses.	SC
PLC: label incorrectly programmed [77]	Label within parentheses A label was set within a parenthetical calculation. This is illegal because close-parenthesis commands cannot be executed without the associated open-parenthesis commands.	SC
PLC: label incorrectly programmed [78]	Label within a gating chain A label was programmed in a gate that has already been started. This is illegal because the first command behind the label would then have to be interpreted, depending on the course of the program, once as logical connection and once as a load command.	SC
PLC: jump incorrectly programmed [79]	Jump within parentheses A jump command was programmed within parentheses. This is illegal because due to the internal implementation all opening parentheses must be followed by closing parentheses, which would not happen in a jump.	SC
PLC: parenthesis not closed [80]	Parenthesis open at end of block An EM instruction has been programmed in a parenthetical instruction. This is illegal since parentheses must be closed in any case.	SC
PLC: label defined twice [81]	Label defined twice The same label name was used twice for a LBL or a KFIELD instruction. A label name that was imported with EXTERN from another module was used again with a LBL or KFIELD instruction. A name reserved for internal modules (9000 ... 9255) was used with a LBL, KFIELD or EXTERN instruction.	SC
PLC: word assignment missing [82]	Word assignment missing A word assignment was conducted. However, the result was not assigned to an operand, but a new logic operation started.	SC

Error classification (not displayed on the screen) !

Y = S: Error recognized during syntax check in the PLC editor (COMPILE soft key). Under certain circumstances this error is already recognized during the syntax check, otherwise when the compiler is run.

C: Error recognized during compiler run, either when the control is switched on or in the PLC programming mode.

Blinking display	Error cause	Y
PLC: logic assignment missing [83]	A logic operation was performed, but the result was assigned to a new logic operation instead of to an operand.	SC
PLC: word accumulator not loaded [84]	A command was programmed that logically connects, assigns or manipulates the loaded word accumulator, although the word accumulator was not previously loaded.	SC
PLC: logic accumulator not loaded [85]	A command was programmed that logically connects, assigns or manipulates the loaded logic accumulator, although the logic accumulator was not previously loaded.	SC
PLC: opening parenth. incorrect [86]	Accumulators not loaded on "open parenthesis" You programmed an open-parenthesis command without first starting a logic or a word sequence.	SC
PLC: incorrect type in parenth. [87]	Incorrect type of result in parentheses Depending on the logic operation formed before a parenthesis and the parenthesis command used, it is expected that a sequence in parentheses supplies a result of the same type (word / logic). If the types differ, the logic operation requested in the open-parenthesis command cannot be formed.	SC
PLC: jump incorrectly programmed [88]	Conditional jump with invalid logic accumulator You programmed a conditional jump (CMT/CMF/JPT/JPF/EMT/EMF) without first starting a logic operations sequence in the logic accumulator.	SC
PLC: ENDC/ENDK without beginning [89]	ENDC/ENDK without CASE/KFIELD instruction You programmed an ENDC command without a preceding CASE statement, or an ENDK command without a preceding KFIELD label.	SC
PLC: error in CASE/KFIELD [90]	Incorrect command within a CASE table / KFIELD You programmed a command other than CM behind a CASE instruction and before the associated ENDC instruction, or you programmed a command other than K behind a KFIELD and before the associated ENDK label.	SC
PLC: too many entries in CASE [91]	Too many entries in CASE table You programmed a CASE branch with more than 128 entries.	SC

Error classification (not displayed on the screen) !

Y = S: Error recognized during syntax check in the PLC editor (COMPILE soft key). Under certain circumstances this error is already recognized during the syntax check, otherwise when the compiler is run.

C: Error recognized during compiler run, either when the control is switched on or in the PLC programming mode.

Blinking display	Error cause	Y
PLC: CASE/KFIELD is empty [92]	Empty CASE instruction/KFIELD You programmed a CASE instruction followed immediately by an ENDC instruction, or you programmed a KFIELD label immediately followed by an ENDK label.	SC
PLC: string accum. not loaded [93]	You programmed a command to logically connect, assign or manipulate and already loaded string accumulator without first loading the string accumulator.	SC
PLC: string within parentheses [94]	String instruction within parentheses You programmed a string instruction within parentheses. String operations cannot be nested with parentheses.	SC
PLC: string assignment missing [95]	You started a new logic operations sequence without first assigning the logic operation formed in the string accumulator.	SC
PLC: global/external incorrect [96]	GLOBAL/EXTERNAL not at beginning of file You wrote the GLOBAL or EXTERNAL commands behind other program code in the file. These commands must always appear before the program code.	SC
PLC: too many modules [97]	You attempted to link more than 64 files into one program using the USES instruction.	(S)C
PLC: file not found [98]	A file linked with the USES instruction cannot be found.	(S)C
PLC: file too long [99]	The compiled program code of a single file would be larger than 64 kB and therefore cannot be compiled. Split the file into several smaller files and link them with the USES command.	SC
PLC: too many local labels [100]	More than 1000 label assigned in one file. All LBL, KFIELD and EXTERN command are added together with those (hidden) labels created through structured commands. Split the file into several smaller files and link them with the USES command.	SC
PLC: too many global labels [101]	A total of more than 1000 global labels have been defined within the associated files.	C

Error classification (not displayed on the screen) !

Y = S: Error recognized during syntax check in the PLC editor (COMPILE soft key). Under certain circumstances this error is already recognized during the syntax check, otherwise when the compiler is run.

C: Error recognized during compiler run, either when the control is switched on or in the PLC programming mode.

Blinking display	Error cause	Y
PLC: external label not defined [102]	A label declared with EXTERN has not been defined with GLOBAL in any of the associated modules.	C
PLC: external label in case [103]	A label declared with EXTERN has been inserted in the CM list of a CASE command. Define a local module, which in the simplest case only calls the global module via CM.	SC
PLC: external label in JP [104]	You attempted to jump to a label defined with EXTERN using a JP/JPF/JPT command.	SC
PLC: global label defined twice [105]	You defined the same label more than once with GLOBAL in the same or in several files.	(S)C
PLC: incorrect program structure [106]	You programmed an ELSE/ENDI/ENDW/UNTIL command without prior required IF/ELSE/WHELP/ REPEAT command. Several structured commands have not been nested within each other, but have been interlinked. The structures must always be closed in the order opposite to that in which they are opened!	SC
PLC: structure open at file end [107]	Structure open at file end A structured command has been opened and not closed again prior to the end of file.	SC
PLC: global in the main file [108]	You defined a module from the main file as GLOBAL. Only modules from files which are linked with the USES command can be made accessible for other files through the GLOBAL command.	SC
	46...49 free	
PLC: excessive nesting [109]	You attempted to nest more than 32 module calls within each other. You programmed a recursive module call that exceeds the limit of 32 levels.	R
PLC: stack underflow [110]	You attempted to retrieve data from the stack which were not stored there.	R
PLC: stack overflow [111]	You attempted to write more than 128 bytes of data to the stack. Word operands (B/W/D/K) each occupy 4 bytes, logic operands (M/I/O/T/C) 2 bytes each.	R

Error classification (not displayed on the screen) !

Y = S: Error recognized during syntax check in the PLC editor (COMPILE soft key). Under certain circumstances this error is already recognized during the syntax check, otherwise when the compiler is run.

C: Error recognized during compiler run, either when the control is switched on or in the PLC programming mode.

R: Error recognized during run time of the PLC program.

Blinking display	Error cause	Y

PLC: time out [112]	The processing of the program section to be executed cyclically took longer than 10 ms. Check the structure of the subprogram for very calculation-intensive sections that you can start as SUBMIT jobs. The displayed processing time will be increased during RS232 data transfer and in handwheel mode. If you are in doubt, select handwheel mode and simultaneously start data transfer via RS232 (if possible at 38 400 baud); subsequently check "MAXIMUM PROCESSING TIME" in the PLC programming environment. 100% corresponds to 5 ms; with this utilization the block processing rate is still observed. Values should not exceed 150% (safety reserve in the event of unfavourable operating conditions).	R
PLC: CASE out of range [113]	CASE out of range The operand for the CASE instruction contains a value that cannot be interpreted as offset in the CM table (smaller than 0 or greater than table length minus 1).	R
PLC: subprogram not defined [114]	This error currently cannot occur.	R
PLC: index range incorrect [115]	Indexed access out of permissible range The address for a write access to the file types B/W/D/M/I/O/T/C is, through the inclusion of the index register, in a region invalid for these operand types. Due to accessing a constant field the index register contains a value which is not permitted for this field (<0 or > field length –1). Through the inclusion of the index register the address of a string leads to an invalid value. The number of a dialogue (S#Dn[X]) or an error message (S#En[X]) leads to an invalid value (<0 or >999) through the inclusion of the index register. During the addressing of a component string (Sn^X) the value range for the index register (0...127) was exceeded.	R
PLC: error table missing [1524]	A PLC error module 9085/9086 was called although no error table was compiled, or there were no entries in the table.	R
PLC: error in module call [1750]	58	
	59...89 free	

Error classification (not displayed on the screen) !

Y = Error recognized during run time of the PLC program.

4.3 Position encoder interface

Blinking display	Error cause
<Axis>encoder: amplitude too small [44]	Signal amplitude of position encoder too small.
<Axis>encoder: frequency too high [45]	Signal frequency error of position encoder.
<Axis> measuring system defective [46]	Error with distance-coded scales.
Ref mark <axis>: incorrect spacing [62]	On a distance that corresponds to the spacing of two fixed reference marks no ref. mark was detected (only applies for encoders with distance-coded reference marks).

Error cause:
- Encoder not connected
- Cable damaged
- Glass scale contaminated or defective
- Scanning head defective
- Position encoder input of the logic unit defective

4.4 Speed encoder interface

Blinking display	Error cause
Motor enc. zn ampl too small [2203] [DSP 0xC300 (0xF200)]	Signal amplitude error of the Zn track of the speed encoder; the Zn track provides the speed signal for the TNC.
Motor enc. z1 ampl too small [2204] [DSP 0xC310 (0xF210)]	Signal amplitude error of the Z1 track of the speed encoder; the Z1 track provides the absolute position of the rotor in the rotatory field of the stator of a synchronous motor.
Motor encoder <axis> defective [2206] [DSP 0xC370 (0xF270)]	In an axis with synchronous motor the angle deviation of Zn and Z1 tracks of the motor encoder was defined too large after reference mark traverse. Probably the motor encoder in the servo drive is defective.
Motor enc. <axis> line count too high [2189] [DSP 0xC160 (0xF060)]	Motor encoder line count too large for the displayed axis.

Error cause
- Cable of motor encoder damaged
- Graduated disk of motor encoder contaminated or damaged
- Speed encoder input of logic unit defective
- Electronics of motor encoder defective

CAUTION: The speed encoder is a modular system that is integrated into the servo drive. It can only be exchanged **together** with the servo drive.

4.5 Position monitoring of analog axes

Blinking display	Error cause
Excessive servo lag in <axis> [38]	**Position monitoring (servo lag)** •**Operation with velocity feedforward control:** Position monitoring exceeded; defined in machine parameter 1420.X. • **Operation with servo lag:** Servo lag monitoring exceeded; defined in machine parameter 1720.X.
Nominal speed value too high <axis> [39]	**Monitoring of the analogue voltage limit** • The nominal value voltage has reached the limit of ± 10V (± 20V for the spindle); for operation with velocity feedforward control only.
Movement monitoring error in <axis> a [40]	**Movement monitoring** • The distance actually covered in a certain time is less than 1/4th or more than 4x the nominal distance calculated by the control; can be influenced via MP 1140.X.
Standstill monitoring error in <axis> [41]	**Standstill monitoring** • At a standstill the position deviation from the nominal position of an axis is greater than the value entered in machine parameter 1110.X.
Excessive offset in <axis> [42]	**Monitoring of the offset voltage** • During offset adjustment via machine parameter MP1220 an offset voltage of more than 100 mV was determined.
Analog output already assigned <axis> [1123]	With central drive (one analog output for several axes) more than one axis was supposed to be moved.

Error cause:

- Control hardware (logic unit) defective
- Excessive offset voltage at the servo amplifier
- Incorrect speed adjustment at the servo amplifier
- Monitoring function of the servo amplifier has responded (e.g. monitoring of current intensity)
- Electrical defect at the servo amplifier
- Defective motor, encoder or cables
- Mechanical defect (bearing, spindle or guides)
- Excessive mechanical forces on a drive

4.6 Position monitoring of digital axes

Blinking display	Error cause
Excessive servo lag in <axis> [38]	**Position monitoring (servo lag)** •**Operation with velocity feedforward control:** Position monitoring exceeded; defined in machine parameter 1420.X. • **Operation with servo lag:** Servo lag monitoring exceeded; defined in machine parameter 1720.X.
Nominal speed value too high <axis> [39]	**Monitoring of the maximum shaft speed** • During operation with servo lag the speed is limited to the maximum shaft speed. When operating with velocity feed forward control this error message is displayed as soon as the maximum shaft speed is reached. The maximum shaft speed is stored in the motor tables.
Movement monitoring error in <axis> a [40]	**Movement monitoring** • The distance actually covered in a certain time is less than 1/4th or more than 4x the nominal distance calculated by the control. Can be influenced via MP 1140.X.
Movement monitoring error in <axis> b [43]	**Movement monitoring** • The difference between the counts of the position encoder and of the speed encoder has reached the tolerance programmed in MP2800.X (only effective, if two separate encoders are used for the acquisition of nominal position and speed).
Standstill monitoring error in <axis> [41]	**Standstill monitoring** • At standstill the position deviation of an axis is greater than the value entered in machine parameter 1110.X.

Error cause:

- Control hardware (logic unit) defective
- The ready signal of the servo amplifier is missing (see basic circuit diagram)
- The I2t limiting has taken effect.
- Defective motor, position or speed encoder or cables
- Mechanical defect (bearing, spindle or guides)
- Excessive mechanical forces on a drive

4.7 General error messages with digital axes

Blinking display	Error cause
<axis>: motor current not equal 0 [2941] [DSP 0xE140 (0xFFD0)]	Error during pulse confirmation test.
<axis>: MP 2190 incorrect [2199] [DSP 0xC290 (0xF190)]	DC link power of power module incorrect.
< axis >: MP 112 / MP 113 incorrect [2200] [DSP 0xC2A0 (0xF1A0)]	Invalid speed input selected.
< axis >: MP 120 / 121 incorrect [2201] [DSP 0xC2B0 (0xF1B0)]	Invalid connector entered for motor power module.
< axis >: MP 2540 / MP 2550 incorrect [2202] [DSP 0xC2C0 (0xF1C0)]	The machine parameters for the band filter are incorrect.

Blinking display	Error cause
Power stage in axis <axis> too weak [2188] [DSP 0xC150 (0xF050)]	The power module of the displayed axis is too weak.
Power stage <axis>: U-IMAX incorrect [2192] [DSP 0xC1D0 (0xF0D0)]	U-IMAX of the power module of the displayed axis is faulty. U-IMAX = voltage of the current sensor
Power stage <axis>: I-MAX incorrect [2193] [DSP 0xC1E0 (0xF0E0)]	IMAX of the power module of the displayed axis is faulty. IMAX = maximum current
Power stage <axis>not ready [2318]	The ready signal for the power module was switched off during operation.

If an error message from this group is displayed, check the data in the motor tables and contact HEIDENHAIN. Please indicate the **error message**, the **code letter** and the **register contents**.

Blinking display	Error cause
Motor <axis>: Xh; X2; f-n; R2 incorrect [2190] [DSP 0xC170 (0xF070)]	One of the motor data of the displayed axis is incorrect. XH = magnetizing reactance X2 = rotor leakage reactance F-N = rated frequency R2 = rotor resistance, cold
Motor <axis>: n-n; f-n incorrect [2191] [DSP 0xC180 (0xF080)]	One of the motor data of the displayed axis is incorrect. N-N = rated speed F-N = rated frequency
Motor < axis >: t-max incorrect [2194] [DSP 0xC210 (0xF110)]	T-MAX of the motor of the displayed axis is incorrect. T-MAX = maximum temperature
Motor < axis >: I-n incorrect [2195] [DSP 0xC250 (0xF150)]	I-N of the motor of the displayed axis is incorrect. I-N = rated current
Motor < axis >: I-max incorrect [2196] [DSP 0xC260 (0xF160)]	I-MAX of the motor of the displayed axis is incorrect. I-MAX = maximum current
Motor < axis >: n-max incorrect [2197] [DSP 0xC270 (0xF170)]	N-MAX of the motor of the displayed axis is incorrect. N-MAX = maximum speed
Motor temperature too high <axis> [1217] [DSP 0xC330 (0xF230)]	The motor temperature has reached its maximum value. The TNC receives information on the current motor temperature via the speed encoder connectors X15 to X19 in the form of an analog voltage at the pins "temperature +/-". The threshold sensitivity is stored in the motor tables.

If an error message from this group is displayed, check the data in the motor tables and contact HEIDENHAIN. Please indicate the **error message**, the **code letter** and the **register contents**.

Blinking display	Error cause
Motor <axis>: speed not equal Imax [2207] [DSP0xC380 (0xF280)]	The current speed of the motor is not the speed expected at Imax. The direction of rotation is possibly not correct.
Motor <axis>: is not turning [2209] [DSP 0xC3B0 (0xF2B0)]	The motor of the displayed axis is not turning. *Corrective action / diagnosis* • Check the motor supply lines for breaks! • Trace the torque current (I noml) with the PC oscilloscope and observe whether the current is limited (characteristic curve is cut horizontally). Under normal conditions the current must not be limited. • If there is an exponential rise of the motor current, the data in the motor table are probably incorrect. ⇨ Check the motor table!
Motor <axis>: MP 2340 / MP 2350 incorrect [2198] [DSP 0xC280 (0xF180)]	MP 2340 /MP 2350 of the displayed axis are incorrect.

Blinking display	Error cause
Inverter of axes RDY = 1 <axis> [DSP 0xE150 (0xFFE0)]	Incorrect "RDY" status of inverter (HIGH instead of LOW)
Inverter of axes RDY = 0 <axis> [DSP 0xE160 (0xFFE8)]	Incorrect "-RDY" status of inverter (LOW instead of HIGH)
Inverter of spindle RDY = 1 [DSP 0xE150 (0xFFE0)]	Incorrect "RDY" status of inverter (HIGH instead of LOW)
Inverter of spindle RDY = 0 [DSP 0xE160 (0xFFE8)]	Incorrect "-RDY" status of inverter (LOW instead of HIGH)

4.8 Error codes from DSP (digital signal processor) with digital axes

4.8.1 Non-axis specific errors

Screen display	Error cause
DSP error XXXX	XXXX = **General** 0xC001 (0xFF01) Undefined error 0xC002 (0xFF02) Host command not recognized / not valid 0xC003 (0xFF03) Host/DSP watchdog do not match 0xC004 (0xFF04) Undefined interrupt 0xC005 (0xFF05) Unknown hardware code 0xC006 (0xFF06) No V_NOML value received from host 0xC007 (0xFF07) AC fail 0xC008 (0xFF08) EMERGENCY STOP fail 0xC009 (0xFF09) Stack overflow 0xC00A (0xFF0A) Delta signal-pulse width modulation 0xC00B (0xFF0B) Error on memory request 0xC00C (0xFF0C) No speed control interrupt 0xC00D (0xFF0D) Error during sum check (code) 0xC00E (0xFF0E) Time limit of speed interrupt exceeded 0xC00F (0xFF0F) Error on initializing a software timer 0xC010 (0xFF10) Error during LSV2 transfer 0xC011 (0xFF11) Drive started before synchronisation

The error codes in brackets refer to older software versions.

Contact HEIDENHAIN if the error message **"DSP error XXXX"** is displayed repeatedly; please indicate the **error message**, the **code letter** and the **register contents**.

Screen display	Error cause
DSP error XXXX (continued)	XXXX = **Reserved for safety-oriented features** 0xE001 (0xFF81) Error on status comparison NR1/NR2 0xE002 (0xFF82) Error on status comparison NE1/NE2 0xE003 (0xFF83) Error on comparison of the safety-oriented inputs 0xE004 (0xFF84) Error on comparison of the machine-operating panel keys 0xE005 (0xFF85) Wrong level at input of MCU watchdog 0xE006 (0xFF86) Wrong input status "power module ready" of spindle 0xE007 (0xFF87) Wrong input status " power module ready" of axes 0xE008 (0xFF88) Error during speed monitoring (SRGx2/SBHx2) 0xE009 (0xFF89) Wrong gear range transferred 0xE00A (0xFF8A) Incorrect CRC over safety-oriented MPs in DP-RAM 0xE00B (0xFF8B) Error during test of cutout channels 0xE00C (0xFF8C) Unspecific error on MP initialisation

The error codes in brackets refer to older software versions.

Contact HEIDENHAIN if the error message **"DSP error XXXX"** is displayed repeatedly; please indicate the **error message**, the **code letter** and the **register contents**.

4.8.2 Axis-specific errors

Screen display	Error cause
DSP error XXXX	XXXX = **General** 0xC300 (0xF200) Zn track of encoder contaminated (ampl. too small) 0xC310 (0xF210) Z1 track of encoder contaminated (ampl. too small) 0xC320 (0xF220) reserved 0xC330 (0xF230) Motor temperature too high 0xC340 (0xF240) Unknown counter IC model at speed input 0xC350 (0xF250) Power module switches off during operation 0xC360 (0xF260) reserved 0xC370 (0xF270) Excessive angle deviation during alignment; Zn/Z1 tracks do not match 0xC380 (0xF280) Motor cannot be controlled (Imax results in a non-expected rotary movement) 0xC390 (0xF290) Error 3D touch probe / evaluation, latch not with L1 input (G19/G26) 0xC3A0 (0xF2A0) Wrong REF position found 0xC3B0 (0xF2B0) Standstill recognized (V = 0 with IQ_max) 0xC3C0 (0xF2C0) Actual motor current above limit value 0xC3D0 (0xF2D0) Status error PWM IC 0xC3E0 (0xF2E0) Wrong rated motor voltage

The error codes in brackets refer to older software versions.

Contact HEIDENHAIN if the error message **"DSP error XXXX"** is displayed repeatedly; please indicate the **error message**, the **code letter** and the **register contents**.

Screen display	Error cause
DSP error XXXX (continued)	XXXX = **Errors related to machine parameters** 0xC110 (0xF010) Unknown motor type (MP2200) 0xC120 (0xF020) reserved 0xC130 (0xF030) reserved 0xC140 (0xF040) Number of pairs of poles too large (MP2230) 0xC150 (0xF050) ASM: field-defining current (MP2280 > MP2110/MP2310) 0xC160 (0xF060) Grating period of speed encoder 0xC170 (0xF070) ASM: time constant of rotor (MP2290 = 0 or too high) 0xC180 (0xF080) Kink point rpm / noml. rpm (MP2210 = 0 or too high) 0xC190 (0xF0909) Unknown drive mode (MP2000) 0xC1A0 (0xF0A0) reserved 0xC1B0 (0xF0B0) reserved 0xC1C0 (0xF0C0) reserved 0xC1D0 (0xF0D0) Voltage at current sensor (MP2130 too high) 0xC1E0 (0xF0E0) Peak current of power module (MP2110 too high) 0xC1F0 (0xF0F0) Proportional factor of current controller (MP2400 too high) 0xC200 (0xF100) Integral factor of current controller (MP2410 too high) 0xC210 (0xF110) Motor temperature (MP2270 > 255) 0xC220 (0xF120) reserved 0xC230 (0xF130) Oscilloscope parameter incorrect (for testing) 0xC240 (0xF140) Rated current of power module (MP2120 > MP2110/2310) 0xC250 (0xF150) Rated current of motor (MP2300 too high or < MP2280) 0xC260 (0xF160) Peak motor current (MP2310 too high) 0xC270 (0xF170) Maximum motor rpm (MP2220 too high) 0xC280 (0xF180) SM: wrong angle compensation values (MP2340/MP2350) 0xC290 (0xF190) DC-link voltage of power module incorrect 0xC2A0 (0xF1A0) Invalid speed input selected (MP2700) 0xC2B0 (0xF1B0) Invalid PWM output selected (MP2702) 0xC2C0 (0xF1C0) Band filter parameter incorrect (MP2540/MP2550)

The error codes in brackets refer to older software versions.

Contact HEIDENHAIN if the error message **"DSP error XXXX"** is displayed repeatedly; please indicate the **error message**, the **code letter** and the **register contents**.

Screen display	Error cause
DSP error XXXX (continued)	XXXX = **Reserved for safety-oriented features** 0xE110 (0xFFA0) Error on input comparison MCU/CCU (+input no.) 0xE120 (0xFFB0) Error during cyclic call of safety-oriented functions, function was not executed 0xE130 (0xFFC0) Error during signal monitoring 0xE140 (0xFFD0) Error on pulse confirmation test 0xE150 (0xFFE0) Incorrect "RDY" status of inverter (HIGH instead of LOW) 0xE160 (0xFFE8) Incorrect "-RDY" status of inverter (LOW instead of HIGH)

The error codes in brackets refer to older software versions.

Contact HEIDENHAIN if the error message **"DSP error XXXX"** is displayed repeatedly; please indicate the **error message**, the **code letter** and the **register contents**.

Screen display	Error cause
DSP error XXXX	XXXX = **Communication MCU (NC) and CCU (DSP)** 1000 0 Command time-out 1001 0 Command acknowledgement incorrect 1002 0 Command is started before the previous was confirmed 1003 0 Synchronisation error: DSP and NC 1004 0 Wrong message DSP-> NC 1005 0 Too many commands NC-> DSP **When booting** 1100 0 Error during check-sum calculation 1101 0 Time-out during word transfer command (load DSP code) 1102 0 Time-out during check-sum calculation 1103 0 Time-out during GO command **Errors related to the motor table** 1200 0 Insufficient memory when motor table is transferred 1201 0 Incorrect data in motor table

The error codes in brackets refer to older software versions.

Contact HEIDENHAIN if the error message **"DSP error XXXX"** is displayed repeatedly; please indicate the **error message**, the **code letter** and the **register contents**.

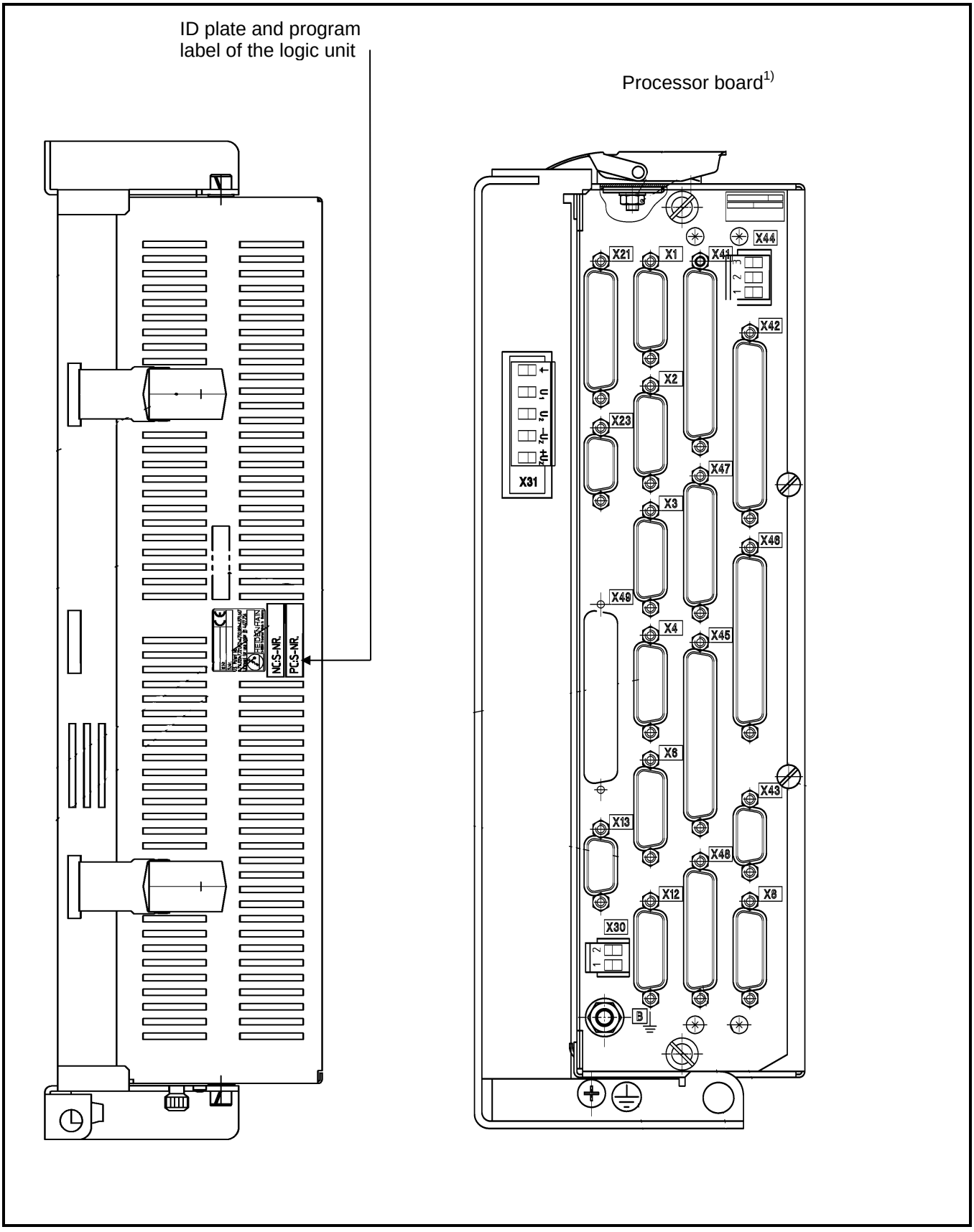
5. TNC 410 hardware components

TNC component	TNC 410 CA/PA	TNC 410 MA
LOGIC UNIT LE 410 CA/PA 1)		
Id.No. XXX XXX -- 2)	x	
LOGIC UNIT LE 410 MA 3)		
Id.No. XXX XXX -- 2)		x
INVERTER UNIT UE 2xx 1)		
Id.No. XXX XXX -- 2)		x
VISUAL DISPLAY UNIT BC 110B (CRT interface) 4)		
Id.No. 260 520 --	x	x
VISUAL DISPLAY UNIT BC 120 (CRT interface) 5)		
Id.No. 313 037 --	x	x
VISUAL DISPLAY UNIT BF 120 6)		
Id.No. 313 506 --	x	x
KEYBOARD UNIT TE 401B 7)		
Id.No. 250 517 05	x	x
KEYBOARD UNIT TE 420 8)		
Id.No. 313 038 01	x	x
PLC I/O BOARD PL 405B (option) 9)		
Id.No. 263 371 22	x	x
PLC I/O BOARD PL 410B (option) 10)		
Id.No. 263 371 --	x	x

1) C versions: with analog nominal speed command interface
P versions: with digital interface to servo amplifier
2) The different versions of the logic unit are distinguished by the following differences:
- Type of the position encoder inputs (11µA, 1Vpp or TTL)
- CRT interface for BC110B/120 **or** flat-panel display BF120
3) Version with integrated HEIDENHAIN inverter
4) Old design (black), 14 inches, connecting cable to logic unit (X43) 15-pin, 2-row
1) New design (grey), 15 inches, connecting cable to logic unit (X43) 15-pin, 3-row (VGA standard)
2) Flat-panel display (grey)
3) Old design (black), matching BC110B
4) New design (grey), matching BC120 and BF120
9) Digital part only (32 PLC inputs / 16 PLC outputs)
10) Version 02: 64 PLC inputs / 32 PLC outputs with analog part
Version 12: 64 PLC inputs / 32 PLC outputs without analog part

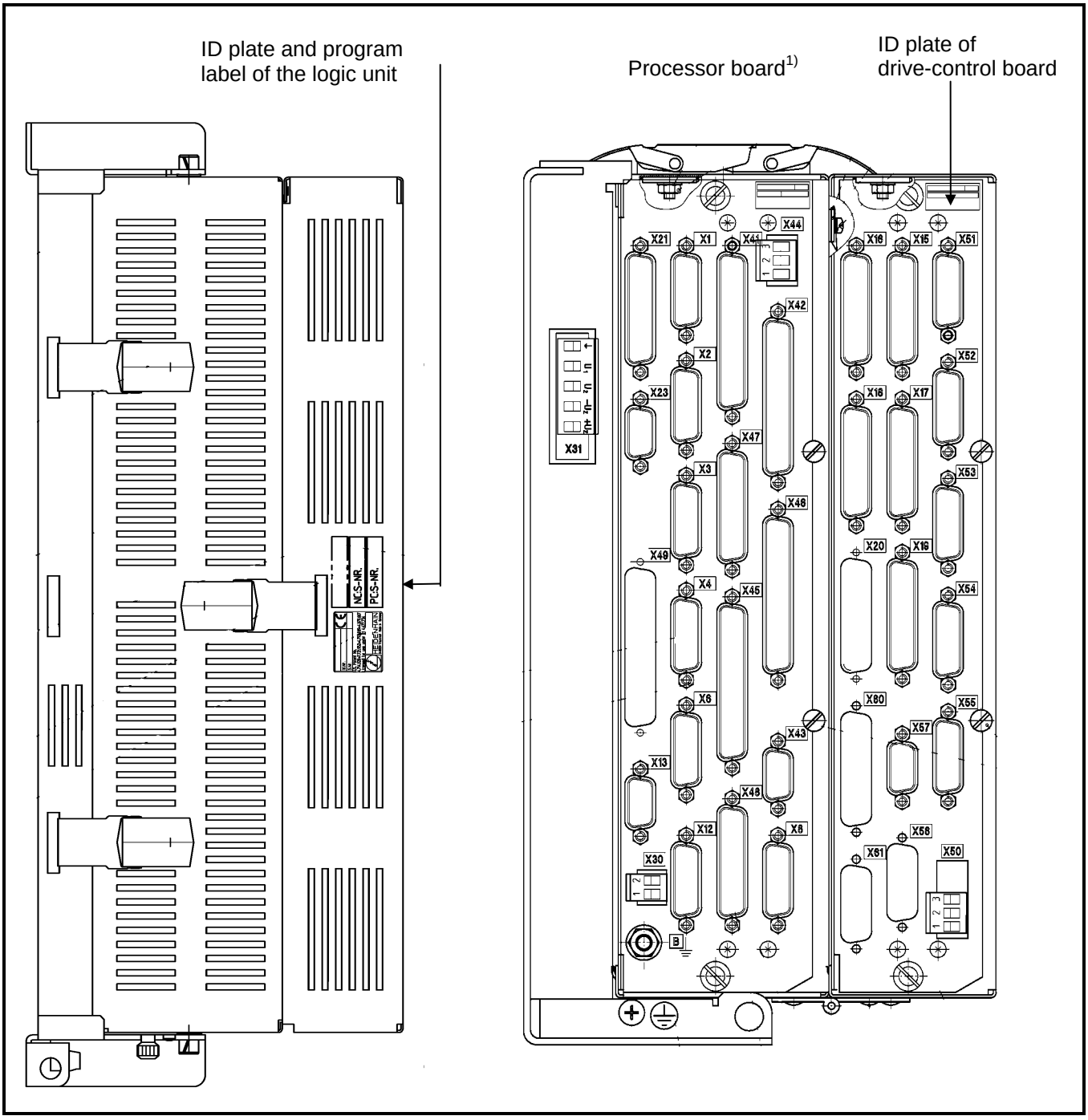
6. LOGIC UNIT LE 410

6.1 Labels on the LOGIC UNIT LE 410 CA



[1)] The ID plate of the processor board is located on the PCB!

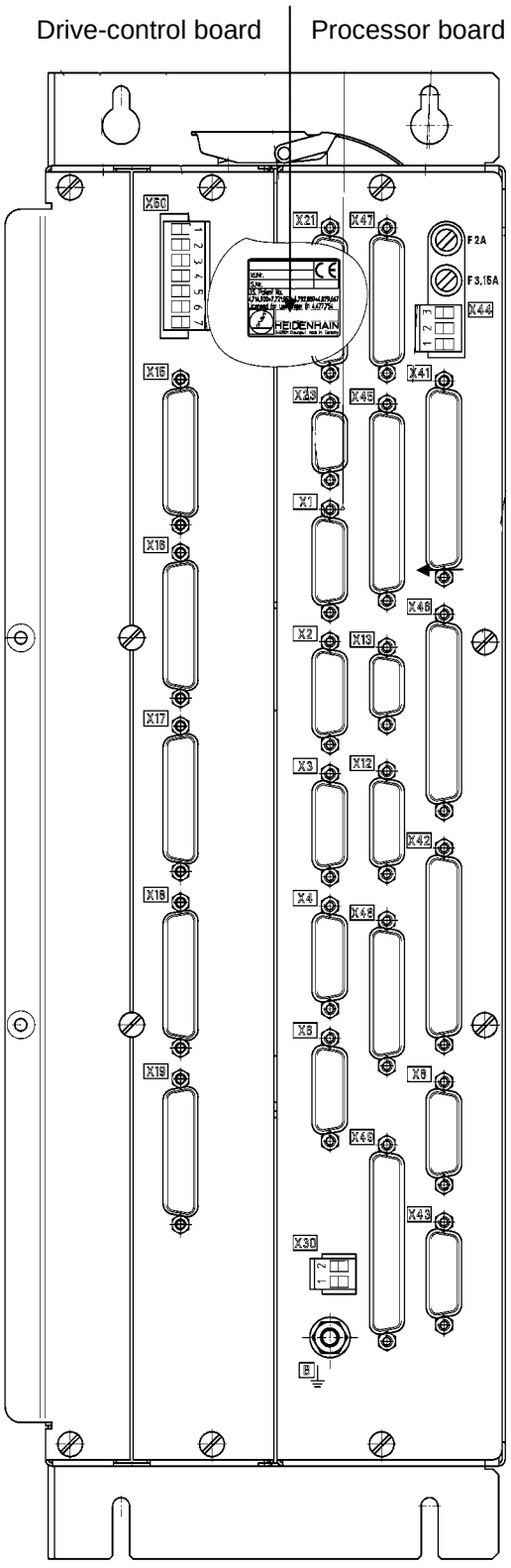
6.2 Labels on the LOGIC UNIT LE 410 PA



[1)] The ID plate of the processor board is located on the PCB!

6.3 Labels on the LOGIC UNIT LE 410 MA

The ID plate of the logic unit is attached to the inner side of the back of the housing



A 2nd ID plate of the logic unit and the program label of the NC software are attached to the outer right side of the back of the housing.

The ID plates of the drive control board and of the processor board are located on the PCB of the respective boards.

6.4 Hardware components of the LOGIC UNIT LE 410

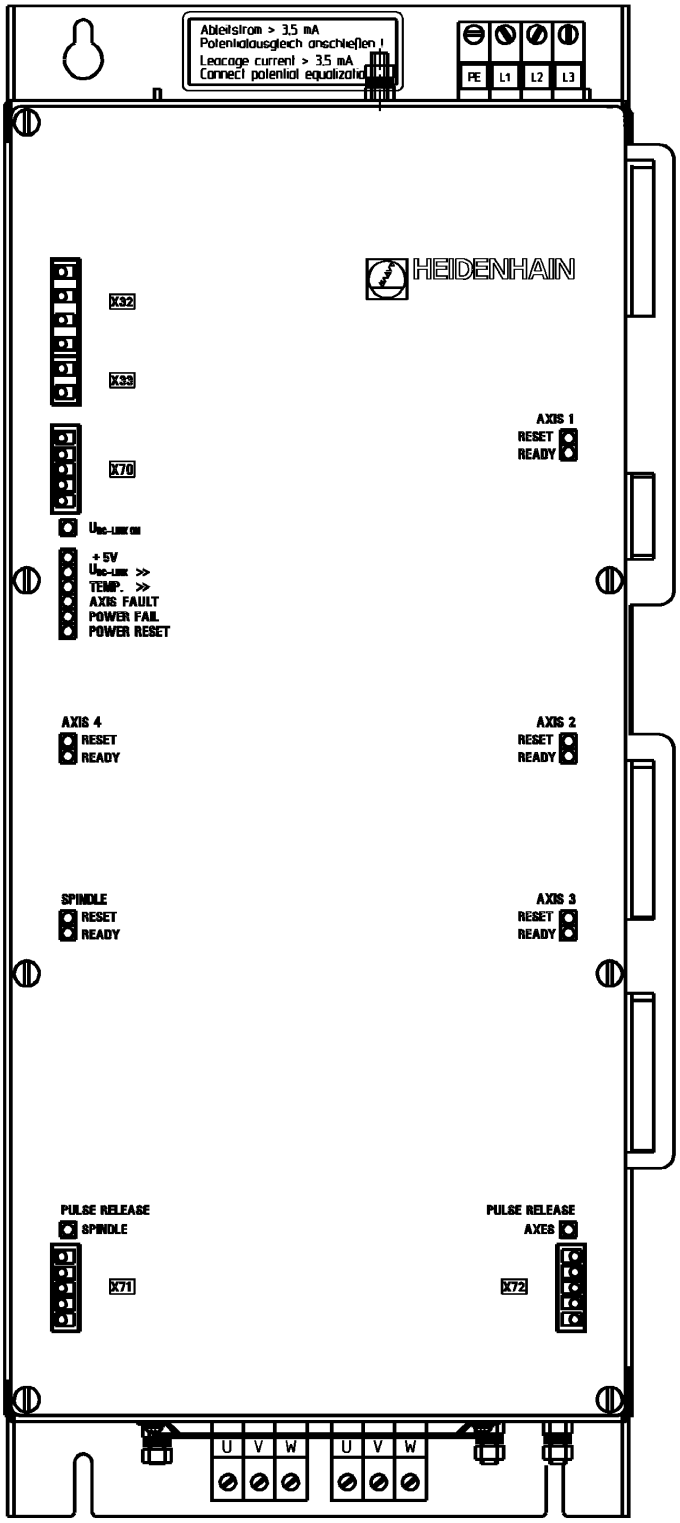
Component	LE 410 CA	LE 410 PA/MA
PROCESSOR board[1)]	x	x
DRIVE-CONTROL board		x
ENCODER INPUT board	x	x

1) The Id.No. of the processor board only refers to the basic board **WITHOUT** any encoder input boards or optional boards.

7. Inverter units UE 2xx

7.1 Labels on the inverter unit UE 210/212/240/242

The ID plate of the inverter unit is located on the outer side on the left plate of the housing. →



8. Connector designations and pin layouts

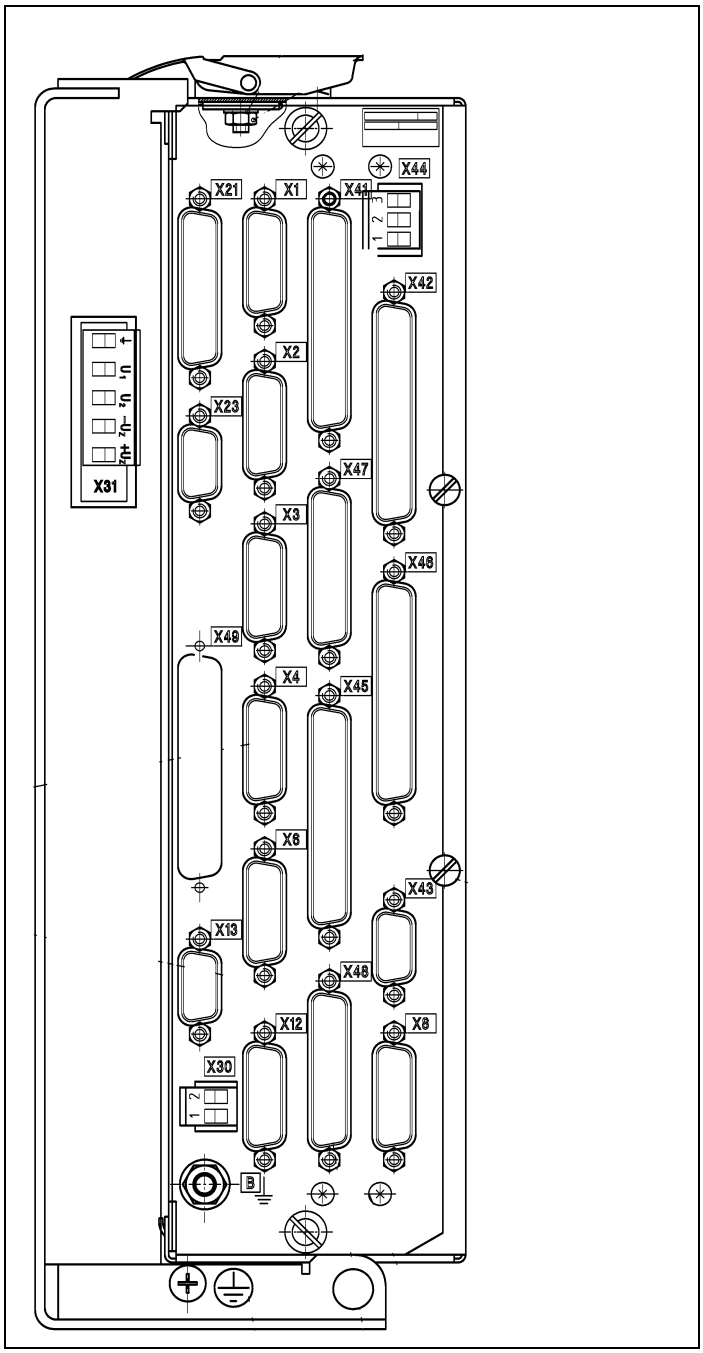
8.1 Connectors on the LOGIC UNIT LE 410

8.1.1 Designation of the connectors on the LOGIC UNIT LE 410

LE 410 CA

NC power-supply

Processor board



Processor board

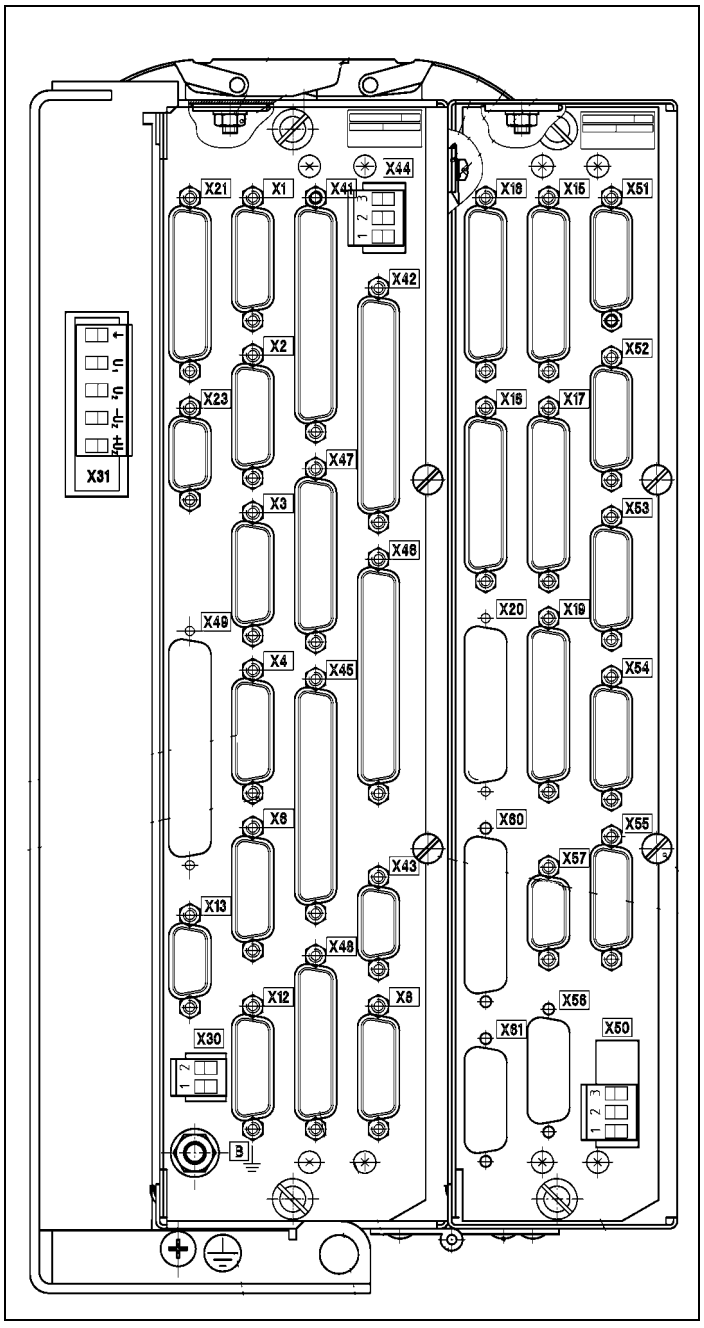
X1 = Position encoder 1st axis
X2 = Position encoder 2nd axis
X3 = Position encoder 3rd axis
X4 = Position encoder 4th axis
X6 = Position encoder 5th axis (spindle)
X8 = Analog outputs 1 - 5
X12 = Touch probe (triggering) for workpiece measurement
X13 = Touch probe (triggering) for tool measurement
X21 = Data interface V.24/RS-232-C
X23 = Serial handwheel
X30 = Spindle ref. signal
X41 = PLC output
X42 = PLC input
X43 = VDU connector CRT (BC) **or**
X49 = VDU connector for flat-panel display
X44 = 24V power supply for PLC
X45 = TNC operating panel
X46 = Machine operating panel
X47 = PLC expansion interface
X48 = PLC analog input (option)

B = Signal ground

X31 = NC power supply (dc-link power supply)

LE 410 PA

NC power - supply | Processor board | Drive-control board



Processor board

X1 = Position encoder 1st axis
X2 = Position encoder 2nd axis
X3 = Position encoder 3rd axis
X4 = Position encoder 4th axis
X6 = Position encoder 5th axis (spindle)
X8 = Analog outputs 1 - 5
X12 = Touch probe (triggering) for workpiece measurement
X13 = Touch probe (triggering) for tool measurement
X21 = Data interface V.24/RS-232-C
X23 = Serial handwheel
X30 = Spindle ref. signal
X41 = PLC output
X42 = PLC input
X43 = VDU connector CRT (BC) **or**
X49 = VDU connector for flat-panel display
X44 = 24V power supply for PLC
X45 = TNC operating panel
X46 = Machine operating panel
X47 = PLC expansion interface
X48 = PLC analog input (option)

Drive-control board

X15 = Speed encoder 1st axis
X16 = Speed encoder 2nd axis
X17 = Speed encoder 3rd axis
X18 = Speed encoder 4th axis
X19 = Speed encoder 5th axis
X50 = Drive enable
X51 = Motor power module 1st axis
X52 = Motor power module 2nd axis
X53 = Motor power module 3rd axis
X54 = Motor power module 4th axis
X55 = Motor power module 5th axis
X57 = reserved

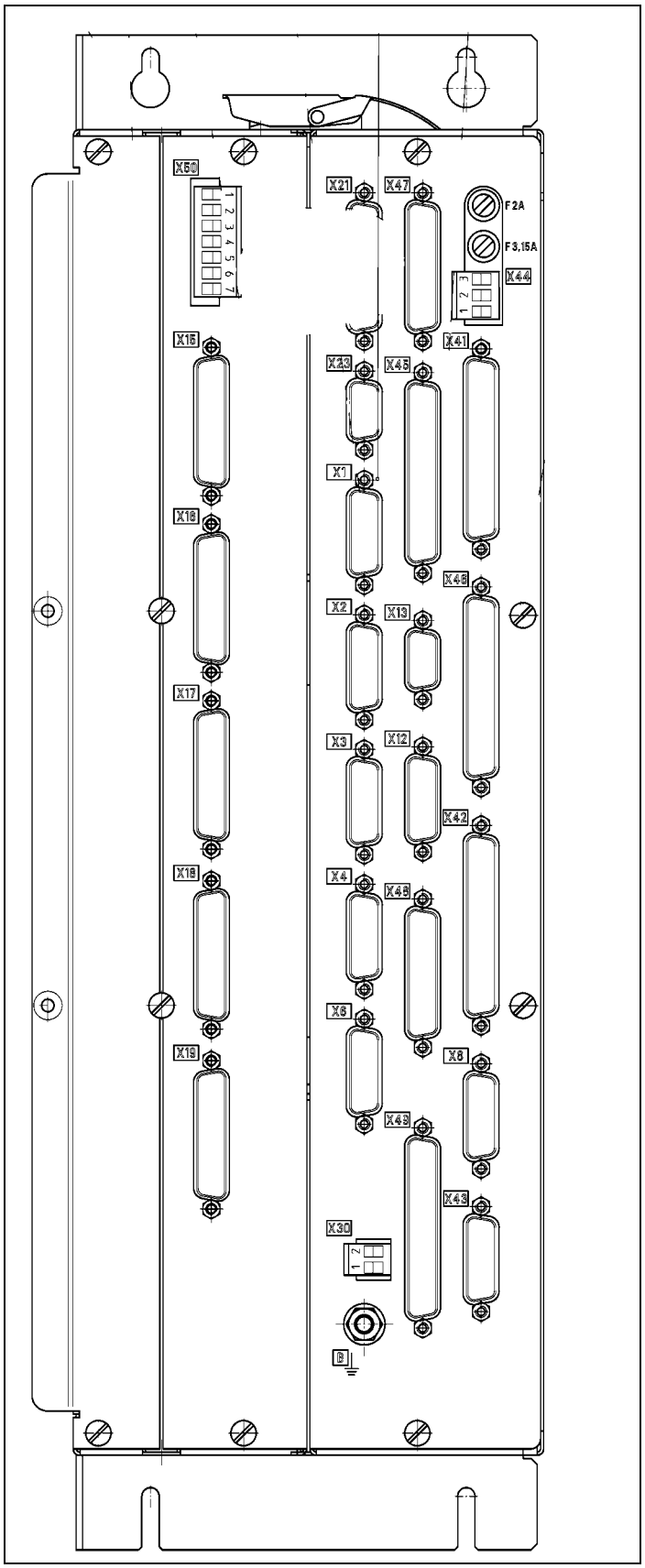
B = Signal ground

X31 = NC power supply (dc-link power supply unit)

LE 410 MA

Processor board

Drive-control board



Processor board

X1 = Position encoder 1st axis
X2 = Position encoder 2nd axis
X3 = Position encoder 3rd axis
X4 = Position encoder 4th axis
X6 = Position encoder 5th axis (spindle)
X8 = Analog outputs 1 - 5
X12 = Touch probe (triggering) for workpiece measurement
X13 = Touch probe (triggering) for tool measurement
X21 = Data interface V.24/RS-232-C
X23 = Serial handwheel
X30 = Spindle ref. signal
X41 = PLC output
X42 = PLC input
X43 = VDU connector CRT (BC) **or**
X49 = VDU connector for flat-panel display
X44 = 24V power supply for PLC
X45 = TNC operating panel
X46 = Machine operating panel
X47 = PLC expansion interface
X48 = PLC analog input (option)

Drive-control board

X15 = Speed encoder 1st axis
X16 = Speed encoder 2nd axis
X17 = Speed encoder 3rd axis
X18 = Speed encoder 4th axis
X19 = Speed encoder 5th axis
X50 = Drive enable

Connection of LE to inverter unit

These connectors are located underneath the cover plate
(Arrangement from top to bottom)

(X7, 34-pin) = Power supply of the logic unit and status signals
(X6, 16-pin) = Connection of motor power module of 1st axis to UE 2xx (output of motor connector X81)
(X5, 34-pin) = Connection of motor power module of 2nd/3rd axis to UE 2xx (output of motor connectors X82/X83)
(X4, 34-pin) = Connection of motor power module of 4th axis/spindle to UE 2xx (outp. of motor connector X84/X80)

B = signal ground

8.1.2 Pin layout of the NC POWER SUPPLY UNIT LE 410 CA/PA

X31 NC power supply

Terminal strip (pluggable) 5-pin

Terminal	Assignment	LE 426PA	LE 426CA
⏚	Protective ground (ye/gr)		
U_1	Phase 1	330V~ to 450V~ via isolating transformer; 50 to 60Hz	140V~ to 450V~ via isolating transformer; 50 to 60Hz
U_2	Phase 2		
–Uz	DC-link voltage–	385V– to 660V–	–
+Uz	DC-link voltage+		

8.1.3 Pin layout of the processor board LE 410 CA/PA/MA

X1,X2,X3,X4 Position encoder 1,2,3,4

Logic unit **LE 410 PA** **Id.No. 297 741.. and 313 516..**
LE 410 CA **Id.No. 296 956.. and 313 517..**

Maximum input frequency: 50kHz
Sinusoidal signal input
Current interface 11µA
Interpolation in the TNC: 1024-fold
Maximum current consumption of each input: 200mA
Flange socket with male insert (15-pin, D-Sub)

Logic unit		Encoder cable	
D-Sub connector (male) 15-pin	**Assignment**	**D-Sub connector (female) 15-pin**	
1	+ 5 V	1	brown
2	0 V	2	white
3	I_1+	3	green
4	I_1–	4	yellow
5	0 V	5	white/brown (internal shield)
6	I_2+	6	blue
7	I_2–	7	red
8	0 V	8	
9	+ 5 V	9	
10	I_0+	10	grey
11	0 V	11	
12	I_0–	12	pink
13	0 V	13	
14	not assigned	14	
15	not assigned	15	
Chassis	external shield	Chassis	external shield

The interface complies with the recommendations in IEC 742 EN 50 178 for separation from line power.

Position encoder 1 V_{pp}

Logic unit **LE 410 MA** **Id.No. 313 490.. and 313 491..**
LE 410 PA **Id.No. 310 088.. and 313 519..**
LE 410 CA **Id.No. 296 957.. and 313 518..**

Maximum input frequency: 350 kHz
Sinusoidal signal input
Voltage interface 1Vpp
Interpolation in the TNC: 1024-fold
Maximum current consumption of each input: 200mA
Flange socket with male insert (15-pin, D-Sub)

Logic unit		**Encoder cable**	
D-Sub connector (male) 15-pin	**Assignment**	**D-Sub connector (female) 15-pin**	
1	+ 5 V (U_P)	1	brown/green
2	0 V (U_N)	2	white/green
3	A+	3	brown
4	A–	4	green
5	0 V	5	
6	B+	6	grey
7	B–	7	pink
8	0 V	8	
9	+ 5 V	9	blue
10	R+	10	red
11	0 V	11	white
12	R–	12	black
13	0 V	13	
14	not assigned	14	violet
15	not assigned	15	
Chassis	external shield	Chassis	external shield

The interface complies with the recommendations in IEC 742 EN 50 178 for separation from line power.

X8 Analog outputs 1 to 5

Flange socket with female insert (15-pin)

Logic unit		Connecting cable	
D-Sub connector (female) 15-pin	**Assignment**	**D-Sub connector (male) 15-pin**	**Color**
1	analog output 1: ±10 V	1	brown
2	analog input	2	brown/green
3	analog output 2: ±10 V	3	yellow
4	do not assign	4	red/blue
5	analog output 3: ±10 V	5	pink
6	do not assign	6	gray/pink
7	analog output 4: ±10 V	7	red
8	analog output 5: ±10 V	8	violet
9	analog output 1: 0 V	9	white
10	do not assign	10	white/gray
11	analog output 2: 0 V	11	green
12	do not assign	12	
13	analog output 3: 0 V	13	gray
14	analog output 4: 0 V	14	blue
15	analog output 5: 0 V	15	black
Chassis	external shield	Chassis	external shield

X12 Triggering touch probe for workpiece measurement

Flange socket with female insert (15-pin)

Logic unit	
D-Sub connector (female) 15-pin	**Assignment**
	0 V
	standby
	start
	+15 V ± 10 % (100mA maximum)
	+ 5 V ± 5 % (100mA maximum)
	$\overline{\text{battery warning}}$
	0 V (U_N)
	trigger signal
	$\overline{\text{trigger signal 1}}$
2, 11 to 15	do not assign
Chassis	external shield

1) Stylus at rest means high level

Adapter cable Id.No. 274 543			**TS120 Id.No. 265 348 .. TS220 Id.No. 293 488 ..**	
D-Sub connector (male) 15-pin		**Coupling on mounting base 6-pin**	**Quick disconnect 6-pin**	
3	pink	4	4	grey
5	grey			
6	brown/green	2	2	brown
7	grey	3	3	grey
8	white/green	1	1	white
9	green	5	5	green
10	yellow	6	6	yellow
Chassis	external shield	Chassis	Chassis	external shield

Connecting cable Id.No. 310 197 ..			**EA Id.No. 262 904 01**		**TS 630**
D-Sub connector (male) 15-pin		**Connector (female) 7-pin**	**Coupling on mounting base 7-pin**		**Id.No. 293 714 ..**
1	white/brown int. shield	7	7	internal shield	
3	grey	5	5	grey	
4	yellow	3	3		
5	brown	2	2	brown	
7	blue	6	6	blue	
8	white	1	1	white	
10	green	4	4	green	
Chassis	ext. shield	Chassis	Chassis	external shield	

X13 Triggering touch probe for tool measurement
Flange socket with female insert (9-pin)

Logic unit	
D-Sub connector (female) 9-pin	**Assignment**
1	standby
2	0 V (U_N)
4	+15 V ± 5% (U_P)
7	+5 V ± 5% (U_P)
8	trigger signal
9	$\overline{\text{trigger signal}}$[1)]
3, 5, 6	do not assign
Chassis	external shield

1) Stylus at rest means high level.

Adapter cable Id.No. 310 200 ..			TT120 Id.No. 295 743 03	
D-Sub connector (male) 9-pin		**Coupling on mounting base (female) 6-pin**	**Connector (male) 6-pin**	
1	pink	6	6	
2	white/green	1	1	white
4	grey	5	5	
7	brown/green	2	2	brown
8	green	3	3	green
9	yellow	4	4	yellow
Chassis	external shield	Chassis	Chassis	external shield

X21 V.24/RS-232-C data interface

Flange socket with female insert (25-pin)

Logic unit		Connnecting cable Id.No. 239 760 ..			Adapter block Id.No. 310 085 01		Connnecting cable Id.No. 274 545 01		
D-Sub connector (female) 25-pin	**Assignment**	**D-Sub connector (male) 25-pin**		**D-Sub connector (female) 25-pin**	**D-Sub connector (male) 25-pin**	**D-Sub connector (female) 25-pin**	**D-Sub connector (male) 25-pin**		**D-Sub connector (female) 25-pin**
1	GND	1	white/brown external shield	1	1	1	1	white/brown external shield	1
2	RxD	2	green	3	3	3	3	yellow	2
3	TxD	3	yellow	2	2	2	2	green	3
4	CTS	4	grey	5	5	5	5	pink	4
5	RTS	5	pink	4	4	4	4	grey	5
6	DTR	6	blue	20	20	20	20	brown	6
7	Signal GND	7	red	7	7	7	7	red	7
20	DSR	20	brown	6	6	6	6	blue	20
8 to 19, 21 to 25	do not assign			8	8	8	8		8
Chassis	ext. shield	Chassis	external shield	Chassis	Chassis	Chassis	Chassis	external shield	Chassis

The interface complies with the recommendations in IEC 742 EN 50 178 for separation from line power.

X23 Serial handwheel

Flange socket with female insert (9-pin)

D-Sub connector (female) 9-pin	Assignment
2	0 V
4	+12 V ± 0.6 V (Uv)
6	DTR
7	TxD
8	RxD
9	DSR
1, 3, 5	do not assign
Chassis	external shield

The interface complies with the recommendations in IEC 742 EN 50 178 for separation from line power.

X30 Spindle reference signal

Terminal	Assignment
1	+24 V
2	0 V

X44 PLC power supply

Terminal strip (pluggable) 3-pin

Terminal	Assignment	PLC outputs
1	+24 V – can be switched off via EMERGENCY STOP	O0 to O23
2	+24 V – cannot be switched off via EMERGENCY STOP	O24 to O30
3	0V	

X41 PLC output

Flange socket with female insert (37-pin, D-SUB)

Logic unit		Connnecting cable Id.No. 244 005 .. / Id.No. 263 954 ..	
D-Sub connector (female) 37-pin	**Assignment**	**D-Sub connector (male) 37-pin**	
1	O0	1	grey/red
2	O1	2	brown/black
3	O2	3	white/black
4	O3	4	green/black
5	O4	5	brown/red
6	O5	6	white/red
7	O6	7	white/green
8	O7	8	red/blue
9	O8	9	yellow/red
10	O9	10	grey/pink
11	O10	11	black
12	O11	12	pink/brown
13	O12	13	yellow/blue
14	O13	14	green/blue
15	O14	15	yellow
16	O15	16	red
17	O16	17	grey
18	O17	18	blue
19	O18	19	pink
20	O19	20	white/grey
21	O20	21	yellow/grey
22	O21	22	green/red
23	O22	23	white/pink
24	O23	24	grey/green
25	O24	25	yellow/brown
26	O25	26	grey/brown
27	O26	27	yellow/black
28	O27	28	white/yellow
29	O28	29	grey/blue
30	O29	30	pink/blue
31	O30	31	pink/red
32	do not assign	32	brown/blue
33	do not assign	33	pink/green
34	"control is ready"	34	brown
35	24 V (PLC) test output; do not assign	35	yellow/pink
36	24 V (PLC) test output; do not assign	36	violet
37	24 V (PLC) test output; do not assign	37	white
Chassis	external shield	Chassis	external shield

X42 PLC input

Flange socket with female insert (37-pin, D-SUB)

Logic unit		**Connecting cable Id.No. 244 005 .. / Id.No. 263 954 ..**	
D-Sub (female) 37-pin	**Assignment**	**D-Sub connector (male) 37-pin**	
1	I0	1	grey/red
2	I1	2	brown/black
3	I2	3	white/black
4	I3 acknowledgement "control is ready "; host computer	4	green/black
5	I4	5	brown/red
6	I5	6	white/red
7	I6	7	white/green
8	I7	8	red/blue
9	I8	9	yellow/red
10	I9	10	grey/pink
11	I10	11	black
12	I11	12	pink/brown
13	I12	13	yellow/blue
14	I13	14	green/blue
15	I14	15	yellow
16	I15	16	red
17	I16	17	grey
18	I17	18	blue
19	I18	19	pink
20	I19	20	white/grey
21	I20	21	yellow/grey
22	I21	22	green/red
23	I22	23	white/pink
24	I23	24	grey/green
25	I24	25	yellow/brown
26	I25	26	grey/brown
27	I26	27	yellow/black
28	I27	28	white/yellow
29	I28	29	grey/blue
30	I29	30	pink/blue
31	I30	31	pink/red
32	I31	32	brown/blue
33	acknowledgement "control is ready"; speed controller (LE 410 MA only)	33	pink/green
34	do not assign	34	brown
35	0 V (PLC) test output; do not assign	35	yellow/pink
36	0 V (PLC) test output; do not assign	36	violet
37	0 V (PLC) test output; do not assign	37	white
Chassis	external shield	Chassis	external shield

X45 TNC operating panel (TE 420)

Flange socket with female insert (37-pin, D-SUB)

Logic unit		Connnecting cable Id.No. 263 954 ..			TE 420
D-Sub connector (female) 37-pin	**Assignment**	**D-Sub connector (male) 37-pin**		**D-Sub connector (female) 37-pin**	**X2 D-Sub connector (male) 37-pin**
1	RL0	1	grey/red	1	1
2	RL1	2	brown/black	2	2
3	RL2	3	white/black	3	3
4	RL3	4	green/black	4	4
5	RL4	5	brown/red	5	5
6	RL5	6	white/red	6	6
7	RL6	7	white/green	7	7
8	RL7	8	red/blue	8	8
9	RL8	9	yellow/red	9	9
10	RL9	10	grey/pink	10	10
11	RL10	11	black	11	11
12	RL11	12	pink/brown	12	12
13	RL12	13	yellow/blue	13	13
14	RL13	14	green/blue	14	14
15	RL14	15	yellow	15	15
16	RL15	16	red	16	16
17	RL16	17	grey	17	17
18	RL17	18	blue	18	18
19	RL18	19	pink	19	19
20	SL0	20	white/grey	20	20
21	SL1	21	yellow/grey	21	21
22	SL2	22	green/red	22	22
23	SL3	23	white/pink	23	23
24	SL4	24	grey/green	24	24
25	SL5	25	yellow/brown	25	25
26	SL6	26	grey/brown	26	26
27	SL7	27	yellow/black	27	27
28	RL19	28	white/yellow	28	28
29	RL20	29	grey/blue	29	29
30	not assigned	30	pink/blue	30	30
31	RL21	31	pink/red	31	31
32	RL22	32	brown/blue	32	32
33	RL23	33	pink/green	33	33
34	spindle override (wiper)	34	brown	34	34
35	feed-rate override (wiper)	35	yellow/pink	35	35
36	+5 V override potentiometer	36	violet	36	36
37	0 V override potentiometer	37	white	37	37
Chassis	external shield	Chassis	external shield	Chassis	Chassis

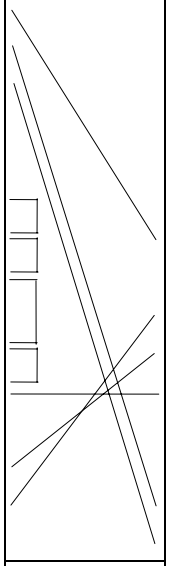
X43 Visual display unit (BC 110B at logic unit with 2-row VDU connector)

Flange socket with female insert (15-pin, D-SUB)

Logic unit Id.No. xxx xxx 3x		Connnecting cable Id.No. 250 477 ..			BC 110 B
D-Sub connector (female) 15-pin 2-row	**Assignment**	**D-Sub connector (male) 15-pin 2-row**		**D-Sub connector (female) 15-pin 2-row**	**X1 D-Sub connector (male) 15-pin, 2-row**
1	GND	1		1	1
2	do not assign	2		2	2
3	do not assign	3		3	3
4	do not assign	4		4	4
5	do not assign	5		5	5
6	do not assign	6		6	6
7	R	7	coaxial, red	7	7
8	GNC	8		8	8
9	VSYNC	9	yellow	9	9
10	HSYNC	10	pink	10	10
11	GND	11	black	11	11
12	do not assign	12		12	12
13	do not assign	13		13	13
14	G	14	coaxial, green	14	14
15	B	15	coaxial, blue	15	15
Chassis	external shield	Chassis	external shield	Chassis	Chassis

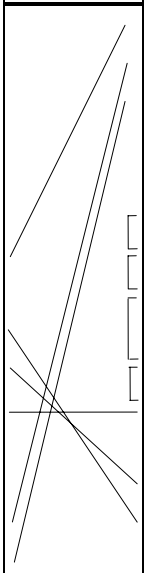
The interface complies with the recommendations in IEC 742 EN 50 178 for separation from line power.

X43 Visual display unit (BC 110B at logic unit with 3-row VDU connector)

Logic unit Id.No. xxx xxx 4x		Extension cable Id.No. 312 878 ..			Adapter 313 434 01	BC 110 B
D-Sub connector (female) 15-pin 3-row	**Assignment**	**D-Sub connector (male) 15-pin 3-row**		**D-Sub connector (female) 15-pin 3-row**	**3-row/ 2-row**	**D-Sub connector (male) 15-pin 2-row**
1	R	1	coaxial I red	1		1
2	G	2	coaxial I green	2		2
3	B	3	coaxial I blue	3		3
4	do not assign	4		4		4
5	do not assign	5		5		5
6	GND	6	coaxial S red	6		6
7	GND	7	coaxial S green	7		7
8	GND	8	coaxial S blue	8		8
9	do not assign	9		9		9
10	GND	10	grey	10		10
11	GND	11	green	11		11
12	do not assign	12		12		12
13	HSYNC	13	pink	13		13
14	VSYNC	14	yellow	14		14
15	do not assign	15		15		15
Chassis	external shield	Chassis	external shield	Chassis	Chassis	Chassis

The interface complies with the recommendations in IEC 742 EN 50 178 for separation from line power.

X43 Visual display unit (BC 120 at logic unit with 2-row VDU connector)

Logic unit Id.No. xxx xxx 3x		Adapter 313 434 02	Extension cable Id.No. 312 878 ..			BC 120
D-Sub connector (female) 15-pin 2-row	Assignment	2-row / 3-row	D-Sub connector (male) 15-pin 3-row		D-Sub connector (female) 15-pin 3-row	D-Sub connector (male) 15-pin 3-row
1	GND		1	coaxial I red	1	1
2	do not assign		2	coaxial I green	2	2
3	do not assign		3	coaxial I blue	3	3
4	do not assign		4		4	4
5	do not assign		5		5	5
6	do not assign		6	coaxial S red	6	6
7	R		7	coaxial S green	7	7
8	GND		8	coaxial S blue	8	8
9	VSYNC		9		9	9
10	HSYNC		10	grey	10	10
11	GND		11	green	11	11
12	do not assign		12		12	12
13	do not assign		13	pink	13	13
14	G		14	yellow	14	14
15	B		15		15	15
Chassis	external shield	Chassis	Chassis	external shield	Chassis	Chassis

The interface complies with the recommendations in IEC 742 EN 50 178 for separation from line power.

X43 Visual display unit (BC 120 at logic unit with 3-row VDU connector)

Logic unit Id.No. xxx xxx 4x		Extension cable Id.No. 312 878 ..			BC 120
D-Sub connector (female) 15-pin 3-row	Assignment	D-Sub connector (male) 15-pin 3-row		D-Sub connector (female) 15-pin 3-row	D-Sub connector (male) 15-pin 3-row
1	R	1	coaxial I red	1	1
2	G	2	coaxial I green	2	2
3	B	3	coaxial I blue	3	3
4	do not assign	4		4	4
5	do not assign	5		5	5
6	GND	6	coaxial S red	6	6
7	GND	7	coaxial S green	7	7
8	GND	8	coaxial S blue	8	8
9	do not assign	9		9	9
10	GND	10	grey	10	10
11	GND	11	green	11	11
12	do not assign	12		12	12
13	HSYNC	13	pink	13	13
14	VSYNC	14	yellow	14	14
15	do not assign	15		15	15
Chassis	external shield	Chassis	external shield	Chassis	Chassis

The interface complies with the recommendations in IEC 742 EN 50 178 for separation from line power.

X49 Visual display unit (BF 120)

Logic unit		Extension cable Id.No. 312 876 ..			Connecting cable Id.No. 312 875 ..			BF 120
D-Sub connector (female) 62-pin	**Assignment**	**D-Sub connector (male) 62-pin**		**D-Sub connector (female) 62-pin**	**D-Sub connector (male) 62-pin**		**D-Sub connector (female) 62-pin**	**D-Sub connector (male) 62-pin**
1	0 V	1		1	1		1	1
2	CLK. P	2		2	2		2	2
3	HSYNC	3		3	3		3	3
4	–BLANK	4		4	4		4	4
5	VSYNC	5		5	5		5	5
6	0V	6		6	6		6	6
7	R0	7		7	7		7	7
8	R1	8		8	8		8	8
9	R2	9		9	9		9	9
10	R3	10		10	10		10	10
11	0 V	11		11	11		11	11
12	G0	12		12	12		12	12
13	G1	13		13	13		13	13
14	G2	14		14	14		14	14
15	G3	15		15	15		15	15
16	0 V	16		16	16		16	16
17	B0	17		17	17		17	17
18	B1	18		18	18		18	18
19	B2	19		19	19		19	19
20	B3	20		20	20		20	20
21	0 V	21		21	21		21	21
22	0 V	22		22	22		22	22
23	–CLK. P	23		23	23		23	23
24	–HSYNC	24		24	24		24	24
25	BLANK	25		25	25		25	25
26	–VSYNC	26		26	26		26	26
27	0 V	27		27	27		27	27
28	–R0	28		28	28		28	28
29	–R1	29		29	29		29	29
30	–R2	30		30	30		30	30
31	–R3	31		31	31		31	31
32	0 V	32		32	32		32	32
33	–G0	33		33	33		33	33
34	–G1	34		34	34		34	34
35	–G2	35		35	35		35	35

Logic unit		Extension cable Id.No. 312 876 ..			Connecting cable Id.No. 312 875 ..			BF 120
D-Sub connector (female) 62-pin	**Assignment**	**D-Sub connector (male) 62-pin**		**D-Sub connector (female) 62-pin**	**D-Sub connector (male) 62-pin**		**D-Sub connector (female) 62-pin**	**D-Sub connector (male) 62-pin**
36	–G3	36		36	36		36	36
37	0 V	37		37	37		37	37
38	–B0	38		38	38		38	38
39	–B1	39		39	39		39	39
40	–B2	40		40	40		40	40
41	–B3	41		41	41		41	41
42	0 V	42		42	42		42	42
43	–DISP.LOW	43		43	43		43	43
44	DISP.LOW	44		44	44		44	44
45	–DISP. ON	45		45	45		45	45
46	DISP.ON	46		46	46		46	46
47	C0	47		47	47		47	47
48	C1	48		48	48		48	48
49	C2	49		49	49		49	49
50	C3	50		50	50		50	50
51	C4	51		51	51		51	51
52	C5	52		52	52		52	52
53 to 62	do not assign	53 to 62		53 to 62	53 to 62		53 to 62	53 to 62
Chassis		Chassis		Chassis	Chassis		Chassis	Chassis

The interface complies with the recommendations in IEC 742 EN 50 178 for separation from line power.

X46 Machine operating panel

Flange socket with female insert (37-pin, D-SUB)

Logic unit		Connecting cable Id.No. 263 954 ..			MB 420	
D-Sub connector (female) 37-pin	**Assignment**	**D-Sub connector (male) 37-pin**		**D-Sub connector (female) 37-pin**	**D-Sub connector (male) 37-pin**	**Key**
1	I128	1	grey/red	1	1	X–
2	I129	2	brown/black	2	2	Y–
3	I130	3	white/black	3	3	Z–
4	I131	4	green/black	4	4	IV–
5	I132	5	brown/red	5	5	V–
6	I133	6	white/red	6	6	X+
7	I134	7	white/green	7	7	Y+
8	I135	8	red/blue	8	8	Z+
9	I136	9	yellow/red	9	9	IV+
10	I137	10	grey/pink	10	10	V+
11	I138	11	black	11	11	FN1
12	I139	12	pink/brown	12	12	FN2
13	I140	13	yellow/blue	13	13	FN3
14	I141	14	green/blue	14	14	FN4
15	I142	15	yellow	15	15	FN5
16	I143	16	red	16	16	Spindle ON
17	I144	17	grey	17	17	Spindle OFF
18	I145	18	blue	18	18	Coolant ON/OFF
19	I146	19	pink	19	19	NC Start
20	I147	20	white/grey	20	20	NC Stop
21	I148	21	yellow/grey	21	21	Rapid
22	I149	22	green/red	22	22	black
23	I150	23	white/pink	23	23	black
24	I151	24	grey/green	24	24	
25	I152	25	yellow/brown	25	25	
26	O0	26	grey/brown	26	26	
27	O1	27	yellow/black	27	27	
28	O2	28	white/yellow	28	28	
29	O3	29	grey/blue	29	29	
30	O4	30	pink/blue	30	30	
31	O5	31	pink/red	31	31	
32	O6	32	brown/blue	32	32	
33	O7	33	pink/green	33	33	
34	0 V (PLC)	34	brown	34	34	
35	0 V (PLC)	35	yellow/pink	35	35	
36	+24 V (PLC)	36	violet	36	36	
37	+24 V (PLC)	37	white	37	37	
Chassis	external shield	Chassis	external shield	Chassis	Chassis	

X47 PLC expansion interface

5V interface

Flange socket with male insert (25-pin, D-SUB)

Logic unit		Connecting cable Id.No. 289 111 ..			1st PL 410 B	
D-Sub connector (male) 25-pin	**Assignment**	**D-Sub connector (female) 25-pin**		**D-Sub connector (male) 25-pin**	**X1 D-Sub connector (female) 25-pin**	**Assignment**
1	0 V	1	brown, yellow, pink, red, violet	1	1	0 V
2	0 V	2	red/blue, brown/green, yellow/brown, grey/brown, pink/brown	2	2	0 V
3	0 V	3	brown/blue, brown/red, brown /black , yellow/grey, yellow/pink	3	3	0 V
4	do not assign	4	grey/green	4	4	serial IN 2
5	Address 6	5	white/green	5	5	address 6
6	INTERRUPT	6	pink/green	6	6	INTERRUPT
7	RESET	7	green/blue	7	7	RESET
8	WRITE EXTERN	8	white/blue	8	8	WRITE EXTERN
9	WRITE EXTERN	9	white/red	9	9	WRITE EXTERN
10	address 5	10	grey/pink	10	10	address 5
11	address 3	11	blue	11	11	address 3
12	address 1	12	green	12	12	address 1
13	do not assign	13		13	13	do not assign
14	board ID 3	14	yellow/blue, pink/blue, yellow/black	14	14	+12 V
15	board ID 4	15	yellow/red, grey/red, pink/red	15	15	+12 V
16	do not assign	16	grey/blue	16	16	board ID 2
17	do not assign	17	green/black	17	17	board ID 1
18	address 7	18	white/yellow	18	18	address 7
19	serial IN 1	19	white/black	19	19	serial IN 1
20	EMERG. STOP	20	green/red	20	20	EMERG. STOP
21	serial OUT	21	white/grey	21	21	serial OUT
22	serial OUT	22	white/pink	22	22	serial OUT
23	address 4	23	black	23	23	address 4
24	address 2	24	grey	24	24	address 2
25	address 0	25	white	25	25	address 0
Chassis	external shield	Chassis	external shield	Chassis	Chassis	external shield

X48 PLC analog input (option)

Flange socket with female insert (25-pin)

D-Sub connector (female) 25-pin	Assignment
1	I_1+ Constant current for Pt 100
2	I_1– Constant current for Pt 100
3	U_1+ Measuring input for Pt 100
4	U_1– Measuring input for Pt 100
5	I_2+ Constant current for Pt 100
6	I_2– Constant current for Pt 100
7	U_2+ Measuring input for Pt 100
8	U_2– Measuring input for Pt 100
9	I_3+ Constant current for Pt 100
10	I_3– Constant current for Pt 100
11	U_3+ Measuring input for Pt 100
12	U_3– Measuring input for Pt 100
14	Analog input 1: –10 V to +10 V
15	Analog input 1: 0 V (reference potential)
16	Analog input 2: –10 V to +10 V
17	Analog input 2: 0 V (reference potential)
18	Analog input 3: –10 V to +10 V
19	Analog input 3: 0 V (reference potential)
13, 20 to 25	do not assign
Chassis	external shield

Observe the polarity of the analog inputs!

8.1.4 Pin layout of the processor board LE 410 PA/MA

X15 to X19 Speed encoder (1 V_{pp})
Maximum input frequency 350 kHz
Voltage interface 1Vpp
Flange socket with male insert (25-pin)

Logic unit		Encoder cable Id.No. 289 440 ..		
D-Sub connector (male) 25-pin	**Assignment**	**D-Sub connector (female) 25-pin**		**Connector (female) 17-pin**
1	(U_P) +5 V or +6.4 V[1)]	1	brown/green	10
2	0 V (U_N)	2	white/green	7
3	A+	3	green/black	1
4	A–	4	yellow/black	2
5	0 V	5		
6	B+	6	blue/black	11
7	B–	7	red/black	12
8	0 V	8	internal shield	17
9	do not assign	9		
10	0 V	10		
11	do not assign	11		
12	do not assign	12		
13	temperature +	13	yellow	8
14	+5 V or do not assign[1)]	14	blue	16
15	analog output (test)	15		
16	0 V	16	white	15
17	R+	17	red	3
18	R–	18	black	13
19	C+	19	green	5
20	C–	20	brown	6
21	D+	21	grey	14
22	D–	22	pink	4
23	+5 V (test)	23		
24	0 V	24		
25	temperature –	25	violet	9
Chassis	external shield	Chassis	external shield	Chassis

X51,X52, X53, X54, X56 Output to motor power module (TNC 410 PA only)

Logic unit		Connecting cable Id.No. 289 208 ..			Expansion board Id.No. 291 070 01	
D-Sub connector (female) 15-pin	**Assignment**	**D-Sub connector (male) 15-pin**		**D-Sub connector (female) 15-pin**	**X1, X2 D-Sub connector (female) 15-pin**	
1	do not assign	1	black	1	1	
2	PWM U_1	2	blue	2	2	
3	PWM U_2	3	grey	3	3	
4	PWM U_3	4	white	4	4	
5	$\overline{\text{Reset}}$	5	green	5	5	
6	Standby	6	white/green	6	6	
7	$I_{actl\ 2}-$	7	grey/pink	7	7	
8	$I_{actl\ 1}-$	8	black	8	8	
9	0V U_1	9	red	9	9	
10	0V U_2	10	pink	10	10	
11	0V U_3	11	brown	11	11	
12	0V (analog)	12	yellow	12	12	
13	$\overline{\text{temp. warning}}$	13	brown/green	13	13	
14	$I_{actl\ 2}+$	14	red/blue	14	14	
15	$I_{actl}+$	15	violet	15	15	
Chassis	external shield	Chassis	external shield	Chassis	Chassis	

Logic level: 5 V
Analog signals I_{actl}: ± 7.5 V
Maximum PWM frequency: 5 kHz

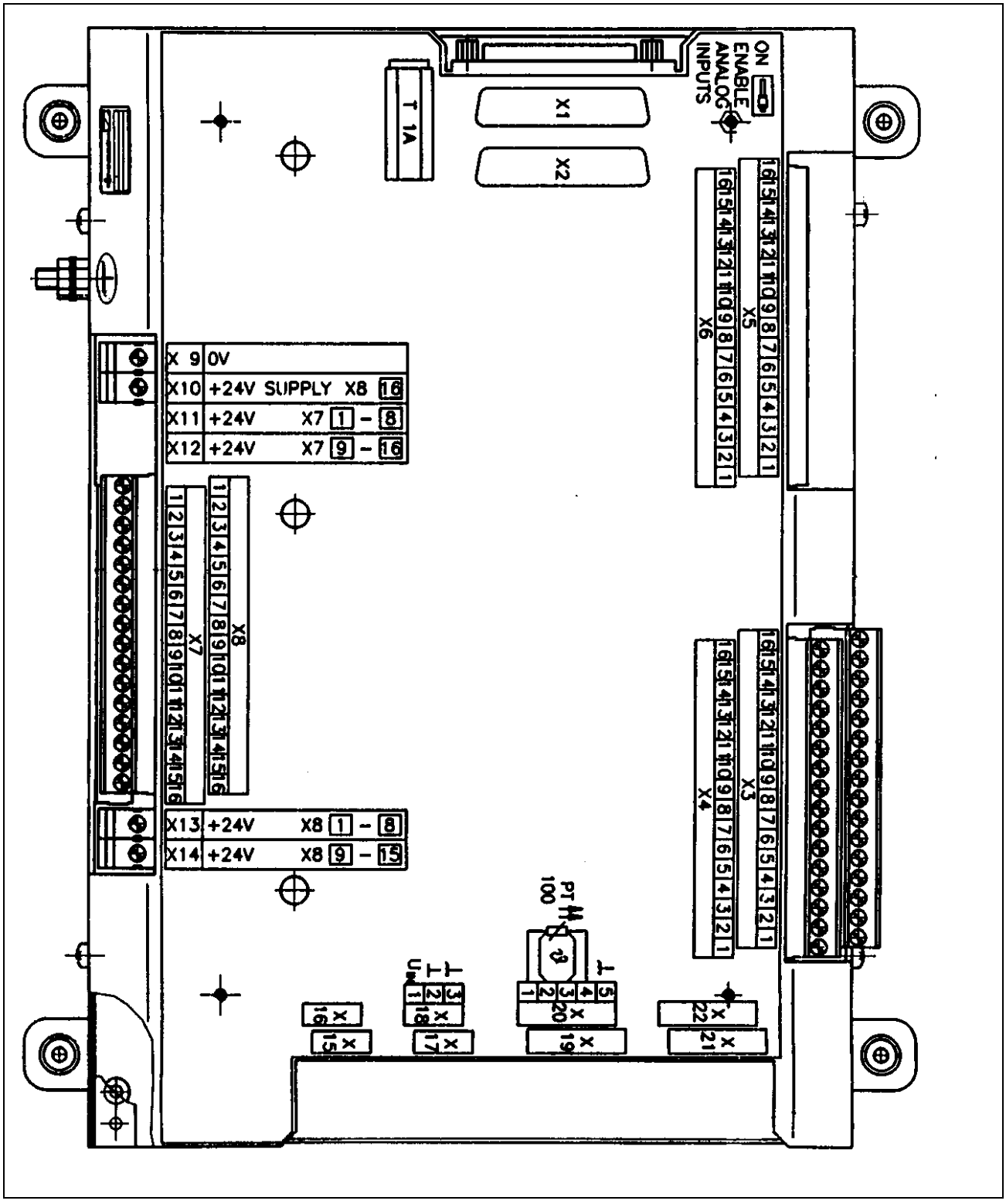
X50 Drive-controller enable

Terminal	Assignment
1	+ 24V– (drive-controller enable)
2	do not assign
3	do not assign
4	do not assign
5	do not assign
6	do not assign
7 *)	0 V (drive-controller enable)

*) The prototype of TNC 410 PA features a 3-pin terminal instead of the 7-pin terminal. In this case connect 24V to pin 1, 0V to pin 3; pin 2 is not connected.

8.2 Connectors on the PLC I/O boards

8.2.1 Connectors on PL 405B



8.2.2 Pin layout of PL 405B

X1 Connection to the LE or to 1st PL

Logic unit		Connecting cable Id.No. 289 111 ..			1st PL 410 B	
D-Sub connector (male) 25-pin	**Assignment**	**D-Sub connector (female) 25-pin**		**D-Sub connector (male) 25-pin**	**X1 D-Sub connector (female) 25-pin**	**Assignment**
1	0 V	1	brown, yellow, pink, red, violet	1	1	0 V
2	0 V	2	red/blue, brown/green, yellow/brown, grey/brown, pink/brown	2	2	0 V
3	0 V	3	brown/blue, brown/red, brown /black, yellow/grey, yellow/pink	3	3	0 V
4	serial IN 2	4	grey/green	4	4	serial IN 2
5	do not assign	5	white/green	5	5	$\overline{\text{address 6}}$
6	do not assign	6	pink/green	6	6	INTERRUPT
7	$\overline{\text{RESET}}$	7	green/blue	7	7	$\overline{\text{RESET}}$
8	$\overline{\text{WRITE EXTERN}}$	8	white/blue	8	8	$\overline{\text{WRITE EXTERN}}$
9	WRITE EXTERN	9	white/red	9	9	WRITE EXTERN
10	$\overline{\text{address 5}}$	10	grey/pink	10	10	$\overline{\text{address 5}}$
11	$\overline{\text{address 3}}$	11	blue	11	11	$\overline{\text{address 3}}$
12	$\overline{\text{address 1}}$	12	green	12	12	$\overline{\text{address 1}}$
13	do not assign	13		13	13	do not assign
14	+ 12 V (from PL)	14	yellow/blue, pink/blue, yellow/black	14	14	+ 12 V
15	+ 12 V (from PL)	15	yellow/red, grey/red, pink/red	15	15	+ 12 V
16	board ID	16	grey/blue	16	16	board ID 2
17	do not assign	17	green/black	17	17	board ID 1
18	do not assign	18	white/yellow	18	18	$\overline{\text{address 7}}$
19	serial IN 1	19	white/black	19	19	serial IN 1
20	EMERG. STOP	20	green/red	20	20	EMERG. STOP
21	$\overline{\text{serial OUT}}$	21	white/grey	21	21	$\overline{\text{serial OUT}}$
22	serial OUT	22	white/pink	22	22	serial OUT
23	$\overline{\text{address 4}}$	23	black	23	23	$\overline{\text{address 4}}$
24	$\overline{\text{address 2}}$	24	grey	24	24	$\overline{\text{address 2}}$
25	$\overline{\text{address 0}}$	25	white	25	25	$\overline{\text{address 0}}$
Chassis	external shield	Chassis	external shield	Chassis	Chassis	external shield

X2 Connection to 2nd PL

1st PL 410 B		Connecting cable Id.No. 289 111 ..			2nd PL 410 B	
X2 D-Sub connector (male) 25-pin	**Assignment**	**D-Sub connector (female) 25-pin**		**D-Sub connector (male) 25-pin**	**X1 D-Sub connector (female) 25-pin**	**Assignment**
1	0 V	1	brown, yellow, pink, red, violet	1	1	0 V
2	0 V	2	red/blue, brown/green, yellow/brown, grey/brown, pink/brown	2	2	0 V
3	0 V	3	brown/blue, brown/red, brown /black, yellow/grey, yellow/pink	3	3	0 V
4	do not assign	4	grey/green	4	4	serial IN 2
5	address 6	5	white/green	5	5	address 6
6	INTERRUPT	6	pink/green	6	6	INTERRUPT
7	RESET	7	green/blue	7	7	RESET
8	WRITE EXTERN	8	white/blue	8	8	WRITE EXTERN
9	WRITE EXTERN	9	white/red	9	9	WRITE EXTERN
10	address 5	10	grey/pink	10	10	address 5
11	address 3	11	blue	11	11	address 3
12	address 1	12	green	12	12	address 1
13	do not assign	13		13	13	do not assign
14	board ID 4	14	yellow/blue, pink/blue, yellow/black	14	14	+ 12 V
15	board ID 3	15	yellow/red, grey/red, pink/red	15	15	+ 12 V
16	board ID 2	16	grey/blue	16	16	board ID 2
17	board ID 1	17	green/black	17	17	board ID 1
18	address 7	18	white/yellow	18	18	address 7
19	serial IN 1	19	white/black	19	19	serial IN 1
20	EMERG. STOP	20	green/red	20	20	EMERG. STOP
21	serial OUT	21	white/grey	21	21	serial OUT
22	serial OUT	22	white/pink	22	22	serial OUT
23	address 4	23	black	23	23	address 4
24	address 2	24	grey	24	24	address 2
25	address 0	25	white	25	25	address 0
Chassis	external shield	Chassis	external shield	Chassis	Chassis	external shield

PLC input on PL 410 B

X3

Terminal	Assignment	
	1. PL	2. PL
1	I64	I192
2	I65	I193
3	I66	I194
4	I67	I195
5	I68	I196
6	I69	I197
7	I70	I198
8	I71	I199
9	I72	I200
10	I73	I201
11	I74	I202
12	I75	I203
13	I76	I204
14	I77	I205
15	I78	I206
16	I79	I207

X4

Terminal	Assignment	
	1st PL	**2nd PL**
1	I80	I208
2	I81	I209
3	I82	I210
4	I83	I211
5	I84	I212
6	I85	I213
7	I86	I214
8	I87	I215
9	I88	I216
10	I89	I217
11	I90	I218
12	I91	I219
13	I92	I220
14	I93	I221
15	I94	I222
16	I95	I223

X8

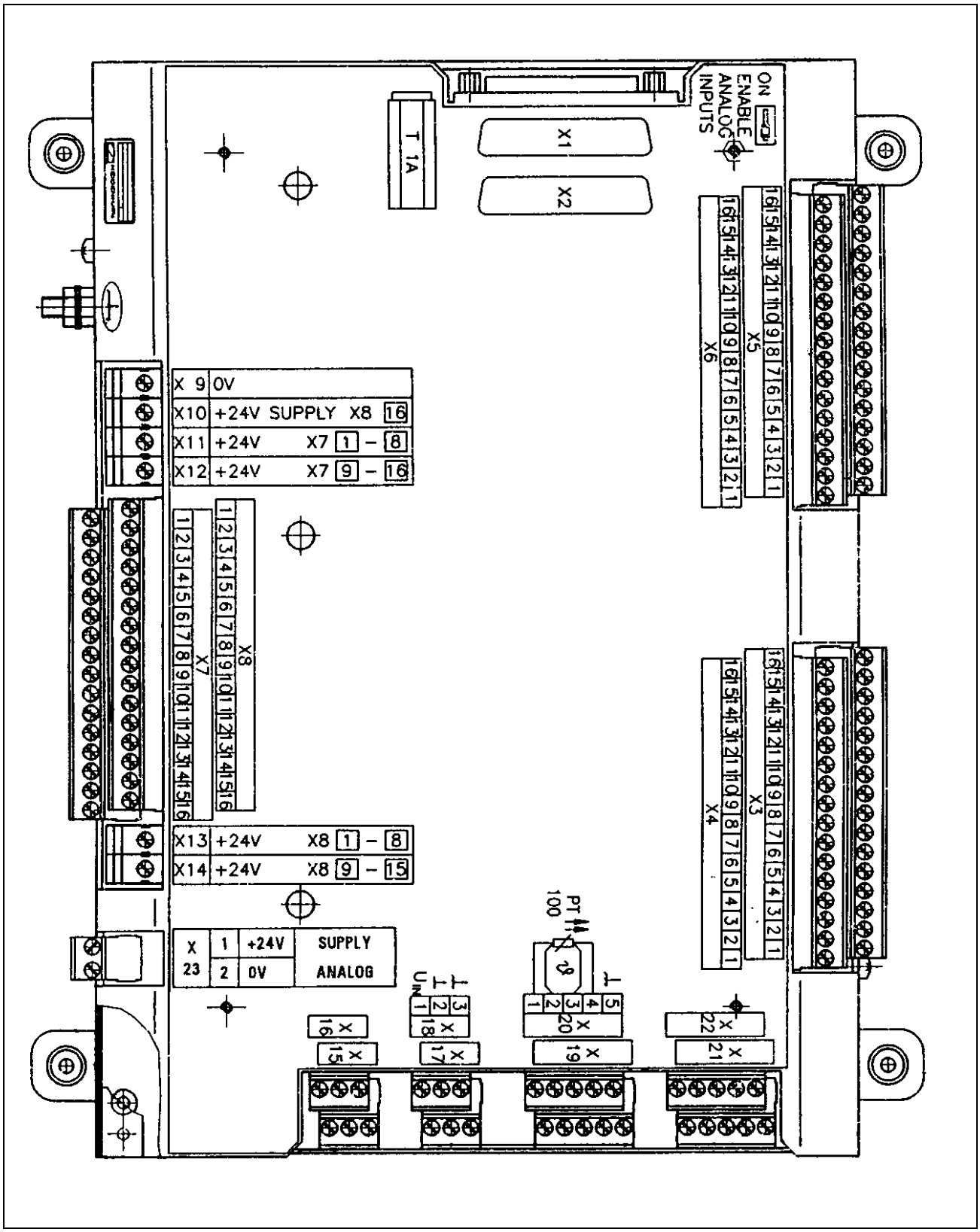
Terminal	Assignment	
	1st PL	**2nd PL**
1	O48	O80
2	O49	O81
3	O50	O82
4	O51	O83
5	O52	O84
6	O53	O85
7	O54	O86
8	O55	O87
9	O56	O88
10	O57	O89
11	O58	O90
12	O59	O91
13	O60	O92
14	O61	O93
15	O62	O94
16	"Control is ready"	

X9, X10, X13, X14 Power supply of PL 405B

Terminal	Assignment	1st PL	2nd PL
X9	0V		
X10	+ 24V- logic supply and "control is ready "		
X13	+ 24V supply for outputs	O48 - O55	O80 - O87
X14	+ 24V- supply for outputs	O56 - O62	O88 - O94

Fuse: F1: F2.5 A (+ 24V- logic supply, fuse not accessible from outside)

8.2.3 Connectors on PL 410B



8.2.4 Pin layout of PL 410B

X1 Connection to LE or to 1st PL

Logic unit		Connecting cable Id.No. 289 111 ..			1st PL 410 B	
D-Sub connector (male) 25-pin	**Assignment**	**D-Sub connector (female) 25-pin**		**D-Sub connector (male) 25-pin**	**X1 D-Sub connector (female) 25-pin**	**Assignment**
1	0 V	1	brown, yellow, pink, red, violet	1	1	0 V
2	0 V	2	red/blue, brown/green, yellow/brown, grey/brown, pink/brown	2	2	0 V
3	0 V	3	brown/blue, brown/red, brown/black, yellow/grey, yellow/pink	3	3	0 V
4	serial IN 2	4	grey/green	4	4	serial IN 2
5	do not assign	5	white/green	5	5	address 6
6	do not assign	6	pink/green	6	6	INTERRUPT
7	RESET	7	green/blue	7	7	RESET
8	WRITE EXTERN	8	white/blue	8	8	WRITE EXTERN
9	WRITE EXTERN	9	white/red	9	9	WRITE EXTERN
10	address 5	10	grey/pink	10	10	address 5
11	address 3	11	blue	11	11	address 3
12	address 1	12	green	12	12	address 1
13	do not assign	13		13	13	do not assign
14	+ 12 V (from PL)	14	yellow/blue, pink/blue, yellow/black	14	14	+ 12 V
15	+ 12 V (from PL)	15	yellow/red, grey/red, pink/red	15	15	+ 12 V
16	board ID	16	grey/blue	16	16	board ID 2
17	do not assign	17	green/black	17	17	board ID 1
18	do not assign	18	white/yellow	18	18	address 7
19	serial IN 1	19	white/black	19	19	serial IN 1
20	EMERG. STOP	20	green/red	20	20	EMERG. STOP
21	serial OUT	21	white/grey	21	21	serial OUT
22	serial OUT	22	white/pink	22	22	serial OUT
23	address 4	23	black	23	23	address 4
24	address 2	24	grey	24	24	address 2
25	address 0	25	white	25	25	address 0
Chassis	external shield	Chassis	external shield	Chassis	Chassis	external shield

X2 Connection to 2nd PL

1st PL 410 B		Connecting cable Id.No. 289 111 ..			2nd PL 410 B	
X2 D-Sub connector (male) 25-pin	**Assignment**	**D-Sub connector (female) 25-pin**		**D-Sub connector (male) 25-pin**	**X1 D-Sub connector (female) 25-pin**	**Assignment**
1	0 V	1	brown, yellow, pink, red, violet	1	1	0 V
2	0 V	2	red/blue, brown/green, yellow/brown, grey/brown, pink/brown	2	2	0 V
3	0 V	3	brown/blue, brown/red, brown/black, yellow/grey, yellow/pink	3	3	0 V
4	do not assign	4	grey/green	4	4	serial IN 2
5	$\overline{\text{address 6}}$	5	white/green	5	5	$\overline{\text{address 6}}$
6	INTERRUPT	6	pink/green	6	6	INTERRUPT
7	$\overline{\text{RESET}}$	7	green/blue	7	7	$\overline{\text{RESET}}$
8	$\overline{\text{WRITE EXTERN}}$	8	white/blue	8	8	$\overline{\text{WRITE EXTERN}}$
9	WRITE EXTERN	9	white/red	9	9	WRITE EXTERN
10	$\overline{\text{address 5}}$	10	grey/pink	10	10	$\overline{\text{address 5}}$
11	$\overline{\text{address 3}}$	11	blue	11	11	$\overline{\text{address 3}}$
12	$\overline{\text{address 1}}$	12	green	12	12	$\overline{\text{address 1}}$
13	do not assign	13		13	13	do not assign
14	board ID 4	14	yellow/blue, pink/blue, yellow/black	14	14	+ 12 V
15	board ID 3	15	yellow/red, grey/red, pink/red	15	15	+ 12 V
16	board ID 2	16	grey/blue	16	16	board ID 2
17	board ID 1	17	green/black	17	17	board ID 1
18	$\overline{\text{address 7}}$	18	white/yellow	18	18	$\overline{\text{address 7}}$
19	serial IN 1	19	white/black	19	19	serial IN 1
20	EMERG. STOP	20	green/red	20	20	EMERG. STOP
21	$\overline{\text{serial OUT}}$	21	white/grey	21	21	$\overline{\text{serial OUT}}$
22	serial OUT	22	white/pink	22	22	serial OUT
23	$\overline{\text{address 4}}$	23	black	23	23	$\overline{\text{address 4}}$
24	$\overline{\text{address 2}}$	24	grey	24	24	$\overline{\text{address 2}}$
25	$\overline{\text{address 0}}$	25	white	25	25	$\overline{\text{address 0}}$
Chassis	external shield	Chassis	external shield	Chassis	Chassis	external shield

X3

Terminal	Assignment	
	1st PL	2nd PL
1	I64	I192
2	I65	I193
3	I66	I194
4	I67	I195
5	I68	I196
6	I69	I197
7	I70	I198
8	I71	I199
9	I72	I200
10	I73	I201
11	I74	I202
12	I75	I203
13	I76	I204
14	I77	I205
15	I78	I206
16	I79	I207

X4

Terminal	Assignment	
	1st PL	2nd PL
1	I80	I208
2	I81	I209
3	I82	I210
4	I83	I211
5	I84	I212
6	I85	I213
7	I86	I214
8	I87	I215
9	I88	I216
10	I89	I217
11	I90	I218
12	I91	I219
13	I92	I220
14	I93	I221
15	I94	I222
16	I95	I223

X5

Terminal	Assignment	
	1st PL	2nd PL
1	I96	I224
2	I97	I225
3	I98	I226
4	I99	I227
5	I100	I228
6	I101	I229
7	I102	I230
8	I103	I231
9	I104	I232
10	I105	I233
11	I106	I234
12	I107	I235
13	I108	I236
14	I109	I237
15	I110	I238
16	I111	I239

X6

Terminal	Assignment	
	1st PL	2nd PL
1	I112	I240
2	I113	I241
3	I114	I242
4	I115	I243
5	I116	I244
6	I117	I245
7	I118	I246
8	I119	I247
9	I120	I248
10	I121	I249
11	I122	I250
12	I123	I251
13	I124	I252
14	I125	I253
15	I126	I254
16	I127	I255

X7

Terminal	Assignment	
	1st PL	2nd PL
1	O32	O64
2	O33	O65
3	O34	O66
4	O35	O67
5	O36	O68
6	O37	O69
7	O38	O70
8	O39	O71
9	O40	O72
10	O41	O73
11	O42	O74
12	O43	O75
13	O44	O76
14	O45	O77
15	O46	O78
16	O47	O79

X8

Terminal	Assignment	
	1st PL	2nd PL
1	O48	O80
2	O49	O81
3	O50	O82
4	O51	O83
5	O52	O84
6	O53	O85
7	O54	O86
8	O55	O87
9	O56	O88
10	O57	O89
11	O58	O90
12	O59	O91
13	O60	O92
14	O61	O93
15	O62	O94
16	"control is ready"	

X9, X10, X11, X12, X13, X14, X23 Power Supply of PL 410B
Terminal strip (X23 also pluggable)

Terminal	Assignment	1st PL	2nd PL
X9	0V		
X10	+ 24V- logic supply and "control is ready"		
X11 1)	+ 24V supply for outputs	O32 - O39	O64 - O71
X12 1)	+ 24V supply for outputs	O40 - O47	O72 - O79
X13	+ 24V supply for outputs	O48 - O55	O80 - O87
X14	+ 24V supply for outputs	O56 - O62	O88 - O94
X23 1) Pin 1 Pin 2	+ 24V- supply for analog part 0V		

Fuse: F1: F2.5 A (+ 24V- logic supply; fuse not accessible from outside)

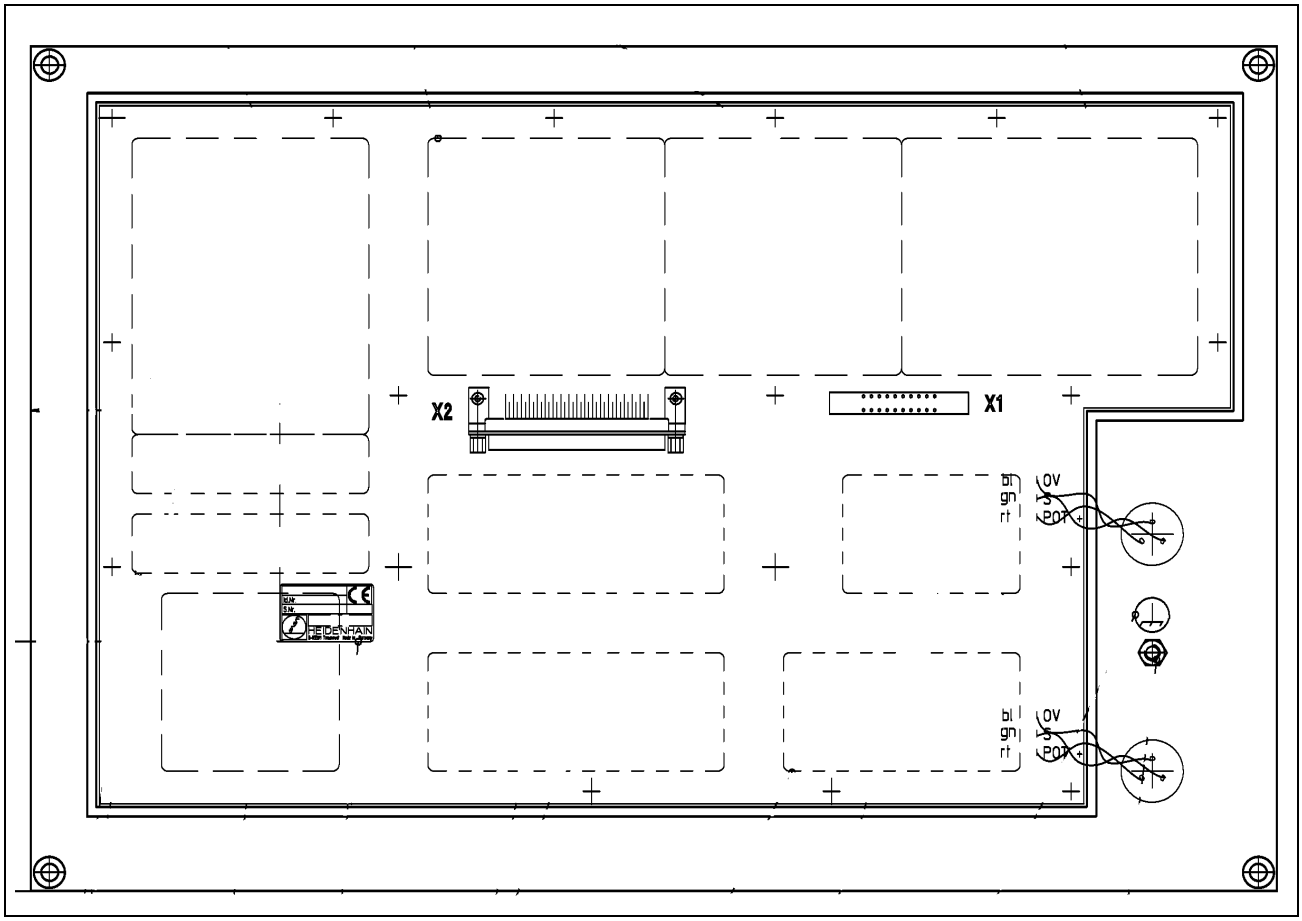
X15 1), X16 1), X17 1), X18 1) Analog inputs ± 10V	
Pin no.	**Assignment**
1	voltage input (± 10V)
2	0V
3	shield

X19 1), X20 1), X21 1), X22 1) Inputs for PT 100 thermistors Four-wire connector with constant current source	
Pin no.	**Assignment**
1	I+ constant current for PT 100
2	U+ measuring input
3	U- measuring input
4	I- constant current for PT 100
5	shield

1) not available on PL 410B, version 12

8.3 Connectors on the keyboard units

8.3.1 Connectors on TE 401B/420



8.3.2 Pin layout of TE 401B/420

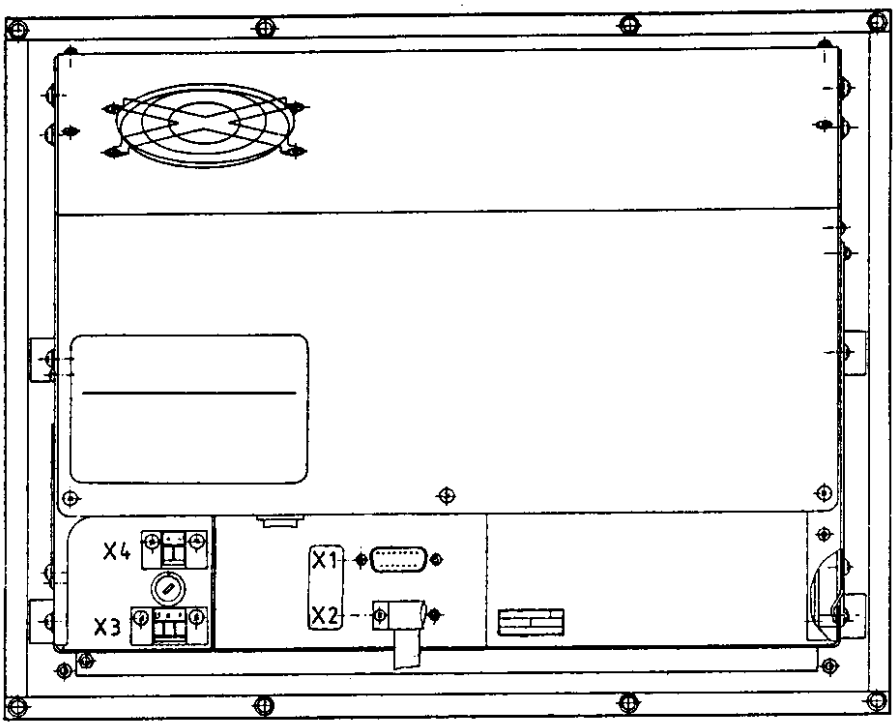
X1 Connection of the soft keys of the visual display unit Plug-type connector with female insert (9-pin)	
Pin no.	**Assignment**
1	SL0
2	SL1
3	SL2
4	SL3
5	do not assign
6	RL15
7	RL14
8	RL13
9	RL12

= key matrix

X2 Connection to the logic unit (LE) Flange socket with male insert (37-pin)	
Pin no.	**Assignment**
1	RL0
2	RL1
3	RL2
4	RL3
5	RL4
6	RL5
7	RL6
8	RL7
9	RL8
10	RL9
11	RL10
12	RL11
13	RL12
14	RL13
15	RL14
16	RL15
17	RL16
18	RL17
19	RL18
20	SL0
21	SL1
22	SL2
23	SL3
24	SL4
25	SL5
26	SL6
27	SL7
28	SL19
29	SL20
30	do not assign
31	RL21
32	RL22
33	RL23
34	spindle override (wiper)
35	feed-rate override (wiper)
36	+ 5V
37	0V

8.4 Connectors on the visual display unit

8.4.1 Visual display unit BC 110 B



X1 Connection to the logic unit Flange socket with male insert 2-row, 15-pin, D-SUB
Pin layout see logic unit X43

X2 Connection of the soft keys to the keyboard unit Flange socket with male insert (9-pin)	
Pin no.	**Assignment**
1	SL0
2	SL1
3	SL2
4	SL3
6	RL15
7	RL14
8	RL13
9	RL12

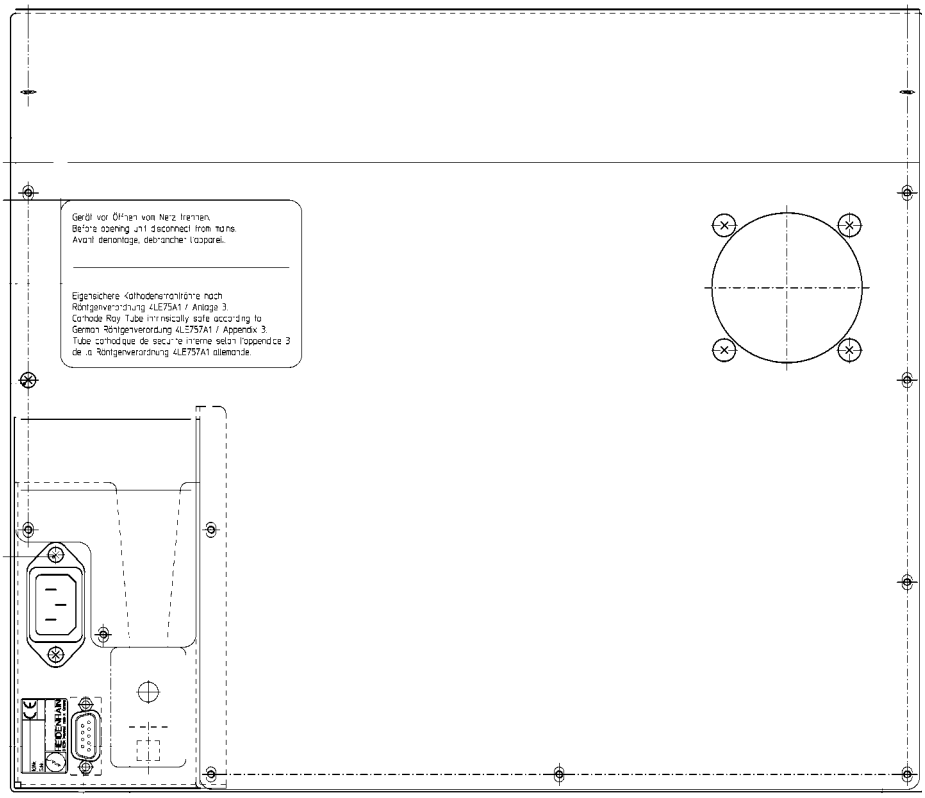
X3 Power connection Clamp connector (3-pin)
Assignment as labelled

X4 Test output [1)] Clamp connector (2-pin)	
Pin no.	**Assignment**
+	6V
-	0V

= key matrix

1) do not use!

8.4.2 Visual display unit BC 120

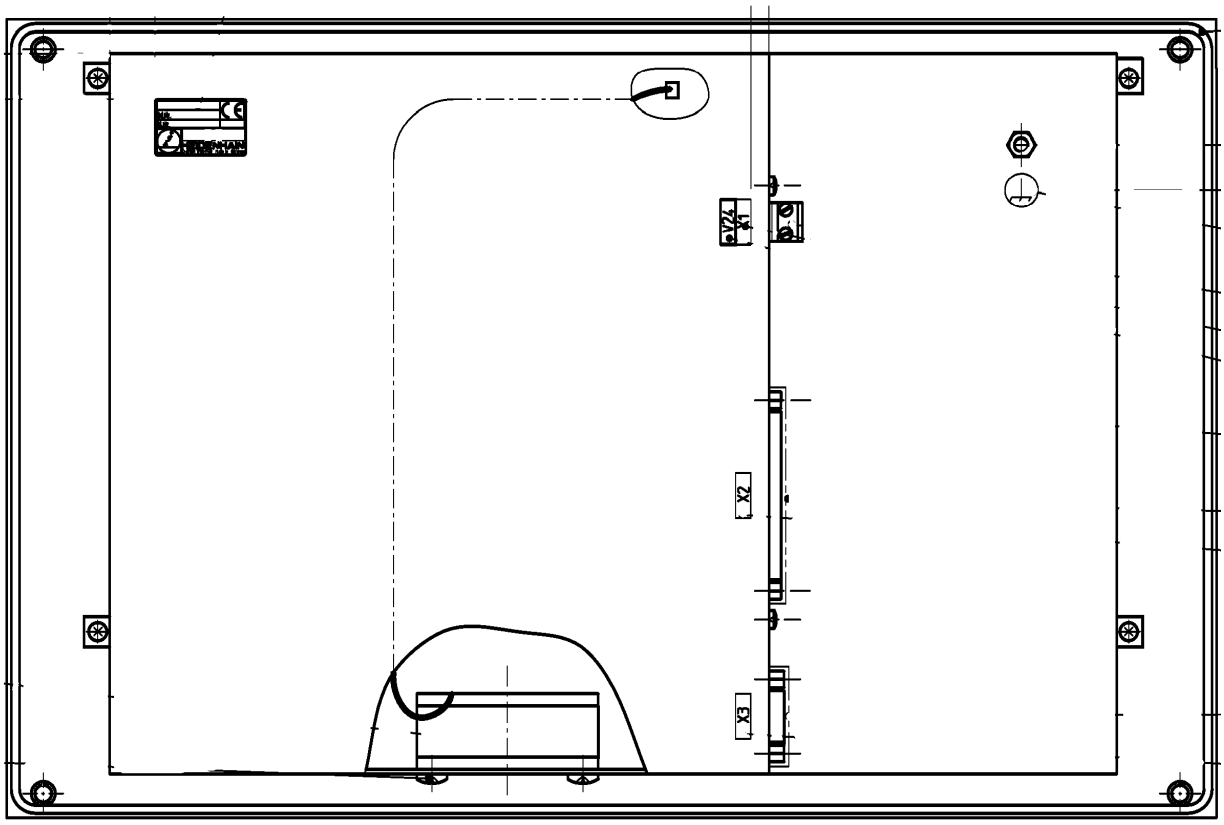


Connection to the logic unit Flange socket with male insert 3-row, 15-pin, D-SUB,
Pin layout see logic unit X43

X2 Connection of the soft keys to the keyboard unit Flange socket with male insert 2-row, 9-pin, D-SUB	
Pin no.	**Assignment**
1	SL0
2	SL1
3	SL2
4	SL3
6	RL15
7	RL14
8	RL13
9	RL12

Power connection with **EURO connector**

8.4.3 Visual display unit BF 120

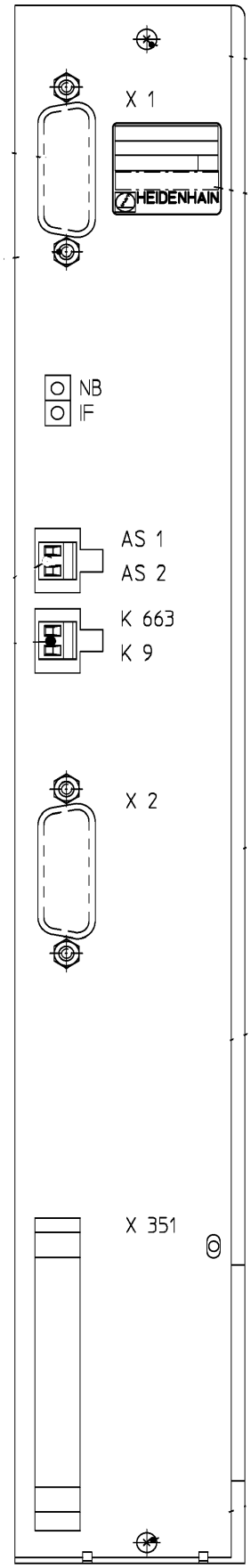


X2 Connection to the logic unit Flange socket with male insert (62-pin)
Pin layout see LE X49

X1 Power supply Terminal strip, pluggable 2-pin	
Pin no.	**Assignment**
1	+24V supply
2	0V

X3 Connection of the soft keys to the keyboard unit Flange socket with male insert (9-pin)	
Pin no.	**Assignment**
1	SL0
2 3	SL1 SL2
4	SL3
6	RL15
7	RL14
8	RL13
9	RL12

8.5 Connectors on the interface board



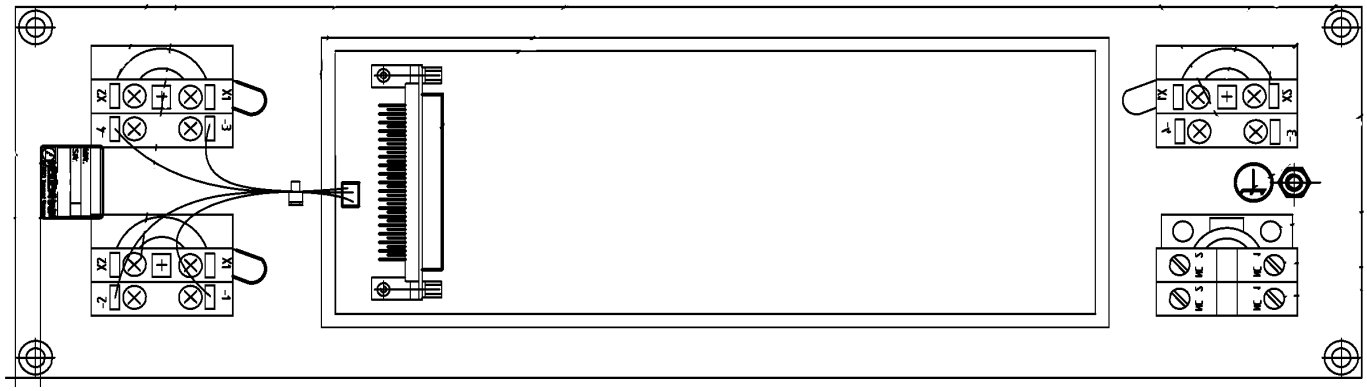
X1 and X2	Connection of motor power module (X51 to X55) of LE 410 PA
X351	SIMODRIVE device bus
NB =	not ready Monitoring of Uz, temperature (power module), supply voltage and pulse enable
IF =	Pulse enable
AS1	Contact 1 of normally closed contact
AS2	Contact 2 of normally closed contact
K663	Safety relay for pulse enable
K9	Supply voltage from SIMODRIVE device bus

X1, X2 Connection of LE 410 PA
D-Sub connector (male) 15-pin

Pin no.	Assignment
1	not assigned
2	PWM U_1
3	PWM U_2
4	PWM U_3
5	$\overline{\text{RESET}}$
6	standby
7	$I_{actl\ 2-}$
8	$I_{actl\ 1-}$
9	0V U_1
10	0V U_2
11	0V U_3
12	0V (analog)
13	$\overline{\text{temperature warning}}$
14	$I_{actl\ 2+}$
15	$I_{actl\ 1+}$
Chassis	external shield

The interface complies with the recommendations in IEC 742 EN 50178 for separation from line power.

8.6 Connectors on machine operating panel MB 420



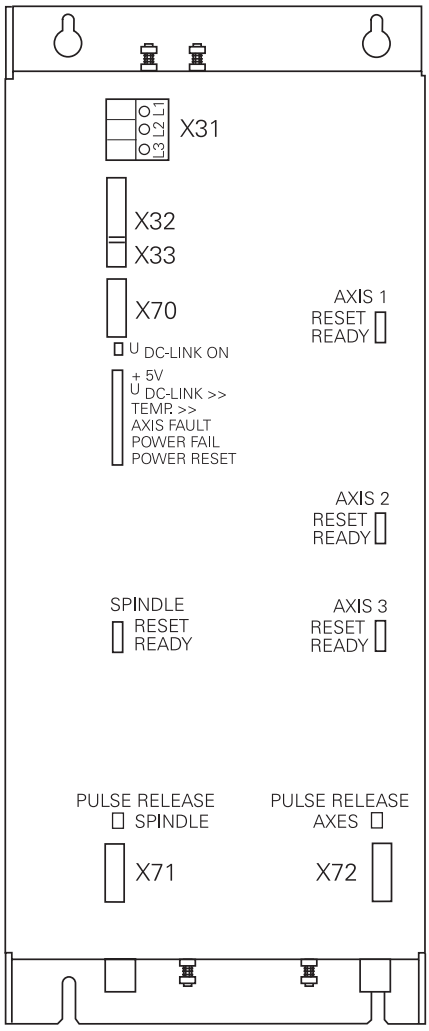
Flange socket with female insert (37-pin, D-SUB)

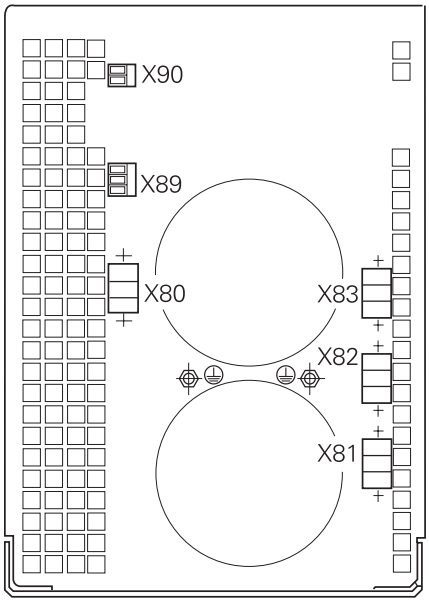
Logic unit		Connecting cable Id.No. 263 954 ..			MB 420	
D-Sub connector (female) 37-pin	**Assignment**	**D-Sub connector (male) 37-pin**		**D-Sub connector (female) 37-pin**	**D-Sub connector (male) 37-pin**	**Key**
1	I128	1	grey/red	1	1	X–
2	I129	2	brown/black	2	2	Y–
3	I130	3	white/black	3	3	Z–
4	I131	4	green/black	4	4	IV–
5	I132	5	brown/red	5	5	V–
6	I133	6	white/red	6	6	X+
7	I134	7	white/green	7	7	Y+
8	I135	8	red/blue	8	8	Z+
9	I136	9	yellow/red	9	9	IV+
10	I137	10	grey/pink	10	10	V+
11	I138	11	black	11	11	FN1
12	I139	12	pink/brown	12	12	FN2
13	I140	13	yellow/blue	13	13	FN3
14	I141	14	green/blue	14	14	FN4
15	I142	15	yellow	15	15	FN5
16	I143	16	red	16	16	spindle ON
17	I144	17	grey	17	17	spindle OFF
18	I145	18	blue	18	18	coolant ON/OFF
19	I146	19	pink	19	19	NC start
20	I147	20	white/grey	20	20	NC stop
21	I148	21	yellow/grey	21	21	rapid
22	I149	22	green/red	22	22	black
23	I150	23	white/pink	23	23	black
24	I151	24	grey/green	24	24	
25	I152	25	yellow/brown	25	25	
26	O0	26	grey/brown	26	26	
27	O1	27	yellow/black	27	27	
28	O2	28	white/yellow	28	28	
29	O3	29	grey/blue	29	29	
30	O4	30	pink/blue	30	30	
31	O5	31	pink/red	31	31	
32	O6	32	brown/blue	32	32	
33	O7	33	pink/green	33	33	
34	0 V (PLC)	34	brown	34	34	
35	0 V (PLC)	35	yellow/pink	35	35	
36	+24 V (PLC)	36	violet	36	36	
37	+24 V (PLC)	37	white	37	37	
Chassis	ext. shield	Chassis	ext. shield	Chassis	Chassis	

The keys for "control voltage ON", "NC STOP" and "NC START" are equipped with lamps that are powered externally with +24V at X2 + ⇨ +24V DC and X1 – ⇨0V.

8.7 Connectors on the inverter units

8.7.1 Connectors on UE 210





X31 Power supply for inverter
X32 Output power supply (L1, L2, +Uz, -Uz)
X33 Power supply for power supply unit (L1, L2)

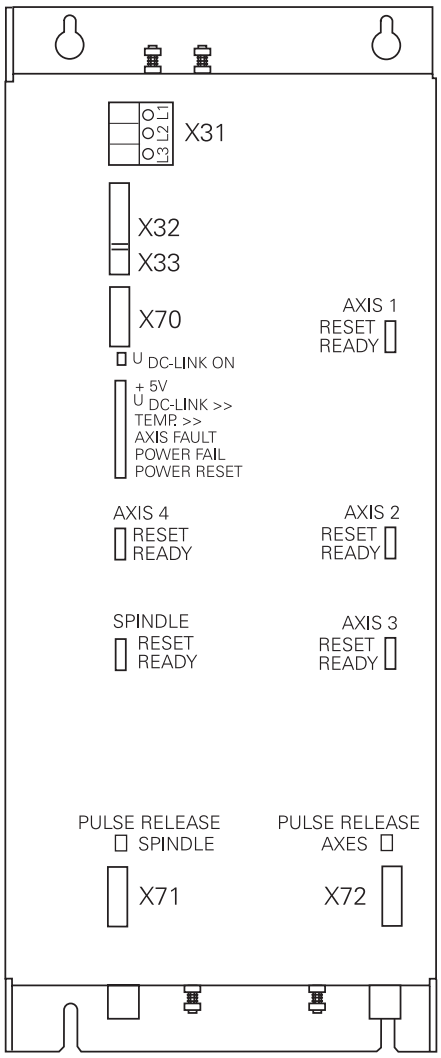
X70 Main relay
X71 Safety relay for the spindle
X72 Safety relay for the axes

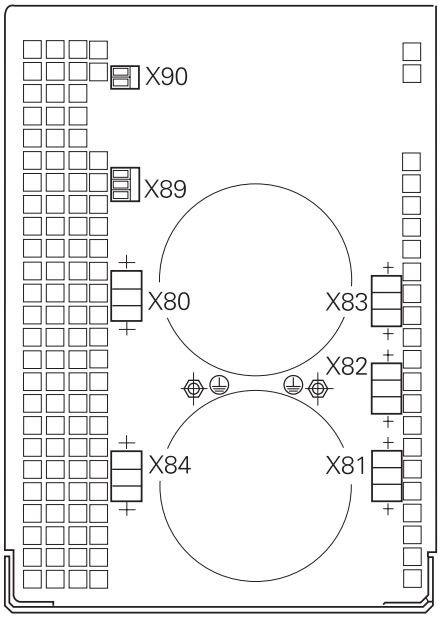
X80 Motor connection: spindle (19 A)
X81 Motor connection: axis 1 (7.5 A)
X82 Motor connection: axis 2 (7.5 A)
X83 Motor connection: axis 3 (7.5 A)

X89 Braking resistor
X90 Fan connector for braking resistor
Supply for "control is ready"
(see basic circuit diagram in appendix)

⏚ Protective ground

Connectors on UE 212





X31 Power supply for inverter
X32 Output power supply (L1, L2, +Uz, -Uz)
X33 Power supply for power supply unit (L1, L2)

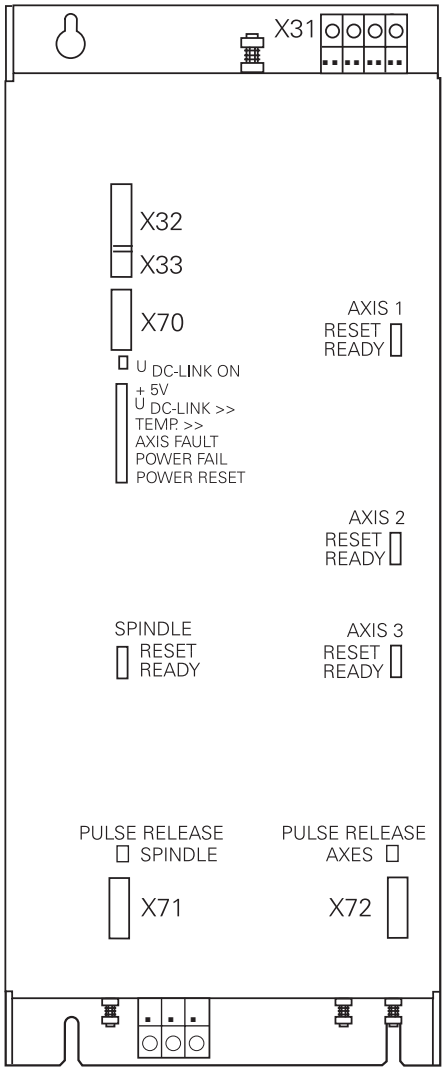
X70 Main relay
X71 Safety relay for the spindle
X72 Safety relay for the axes

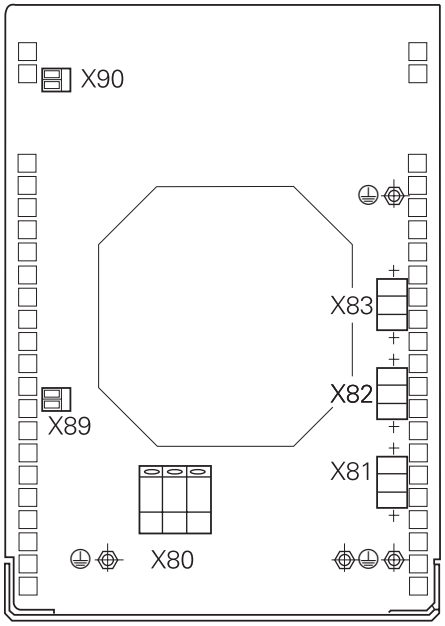
X80 Motor connection: spindle (19 A)
X81 Motor connection: axis 1 (7.5 A)
X82 Motor connection: axis 2 (7.5 A)
X83 Motor connection: axis 3 (7.5 A)
X84 Motor connection: axis 4 (14 A)

X89 Braking resistor
X90 Fan connector for braking resistor
Supply for "control is ready"
(see basic circuit diagram in appendix)

⏚ Protective ground

Connectors on UE 240





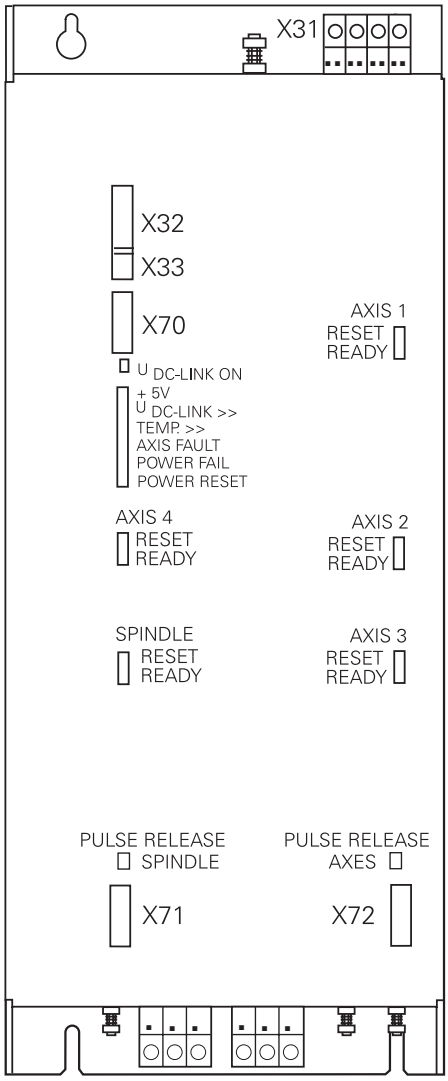
X31 Power supply for inverter
X32 Output power supply (L1, L2, +Uz, -Uz)
X33 Power supply for power supply unit (L1, L2)

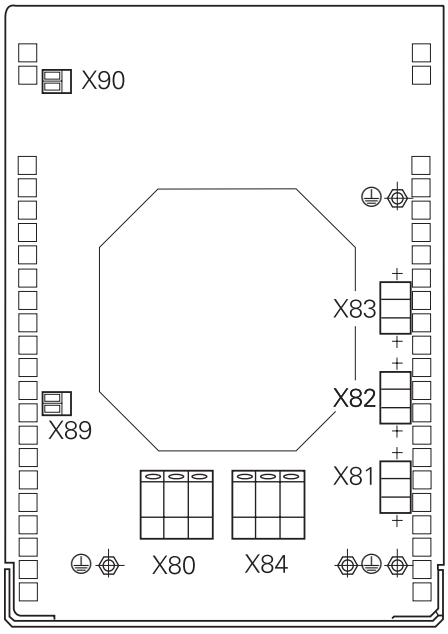
X70 Main relay
X71 Safety relay for the spindle
X72 Safety relay for the axes

X80 Motor connection: spindle (31 A)
X81 Motor connection: axis 1 (7.5 A)
X82 Motor connection: axis 2 (7.5 A)
X83 Motor connection: axis 3 (7.5 A)

X89 Resistor module
X90 External fan connection for resistor module;
Supply for "control is ready"
(see basic circuit diagram in appendix)
⏚ Protective ground

Connectors on UE 242





X31 Power supply for inverter
X32 Output power supply (L1, L2, +Uz, -Uz)
X33 Power supply for power supply unit (L1, L2)

X70 Main relay
X71 Safety relay for the spindle
X72 Safety relay for the axes

X80 Motor connection: spindle (31 A)
X81 Motor connection: axis 1 (7.5 A)
X82 Motor connection: axis 2 (7.5 A)
X83 Motor connection: axis 3 (7.5 A)
X84 Motor connection: axis 4 (23 A)

X89 Resistor module
X90 External fan connection for resistor module; Supply for "control is ready" (see basic circuit diagram in appendix)
⏚ Protective ground

8.7.2 Pin layout of UE 210/UE 212/UE 240/UE 242

X31 Supply voltage for Uz

Connecting terminals	UE 210, UE 212	UE 240, UE 242
L1 L2 L3 PE	30 V~ to 440 V~ 50 to 60 Hz **Cable:** cross-section 6 mm^2 **Line fuse:** 32 A **GND connection:** ≥ 10 mm^2	30 V~ to 440 V~ 50 to 60 Hz **Cable:** cross-section 10 mm^2 **Line fuse:** 50 A **GND connection:** ≥ 10 mm^2

X33 Supply voltage for power supply unit of inverter and of LE 410 MA

Connecting terminals	Assignment
1	bridge to X32/pin 1 (with setup L1 from line 290 V~ to 440 V~, 50 to 60 Hz)
2	bridge to X32/Pin 2 (with setup L2 from line)

X32 Output for supply voltage of power supply unit

Connecting terminals	Assignment
1	bridge to X33/Pin 1 (fuse 4 A)
2	bridge to X33/Pin 2 (fuse 4 A)
3	+ Uz (fuse 4 A)
4	- Uz (fuse 4 A)

Danger of electrical shock!
The inverter unit may only be opened by HEIDENHAIN service staff!
Only connect and disconnect terminals while the unit is not under power!

X80 Spindle motor
X81 Axis motor 1 (7,5 A)
X82 Axis motor 2 (7,5 A)
X83 Axis motor 3 (7,5 A)
X84 Axis motor 4 (UE21x 14 A, UE24x 23 A)

Connecting terminal	Assignment
U	Motor connection U
V	Motor connection V
W	Motor connection W

X70 Main relay
X71 Safety relay for the spindle
X72 Safety relay for the axes

Connecting terminals X70 to X72	Assignment
1	+ 24 V output (for relay coil only)
2	relay coil
3	not assigned
4	normally closed contact 1
5	normally closed contact 2

X89 Braking resistor

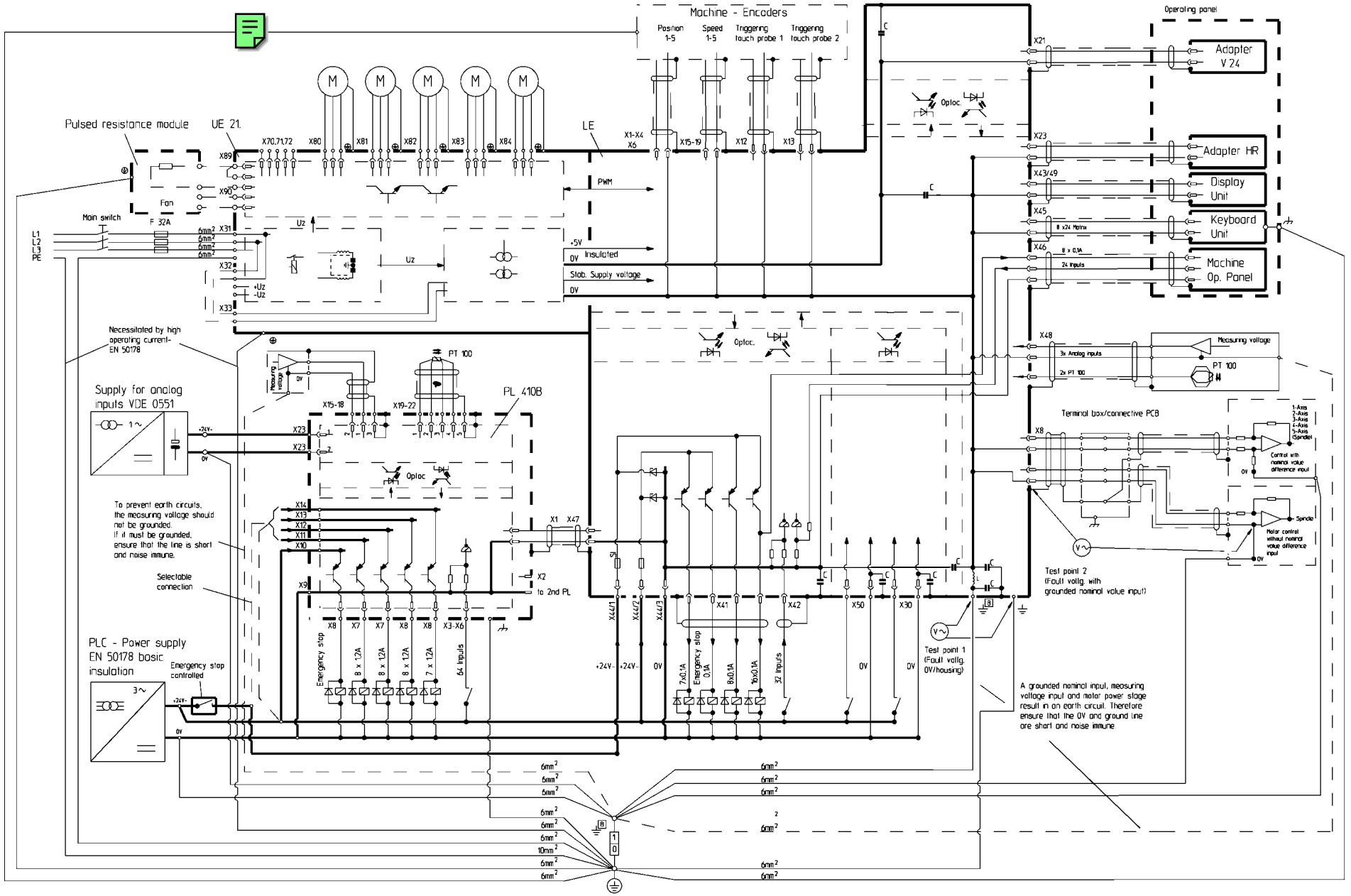
Connecting terminal X89 UE 210/212	Assignment	Internal braking resistor	External braking resistor PW 110; connecting terminal X1
1	+Uz	bridge to pin 2	1
2	internal braking resistor	bridge to pin 1	do not assign
3	–Uz	do not assign	2

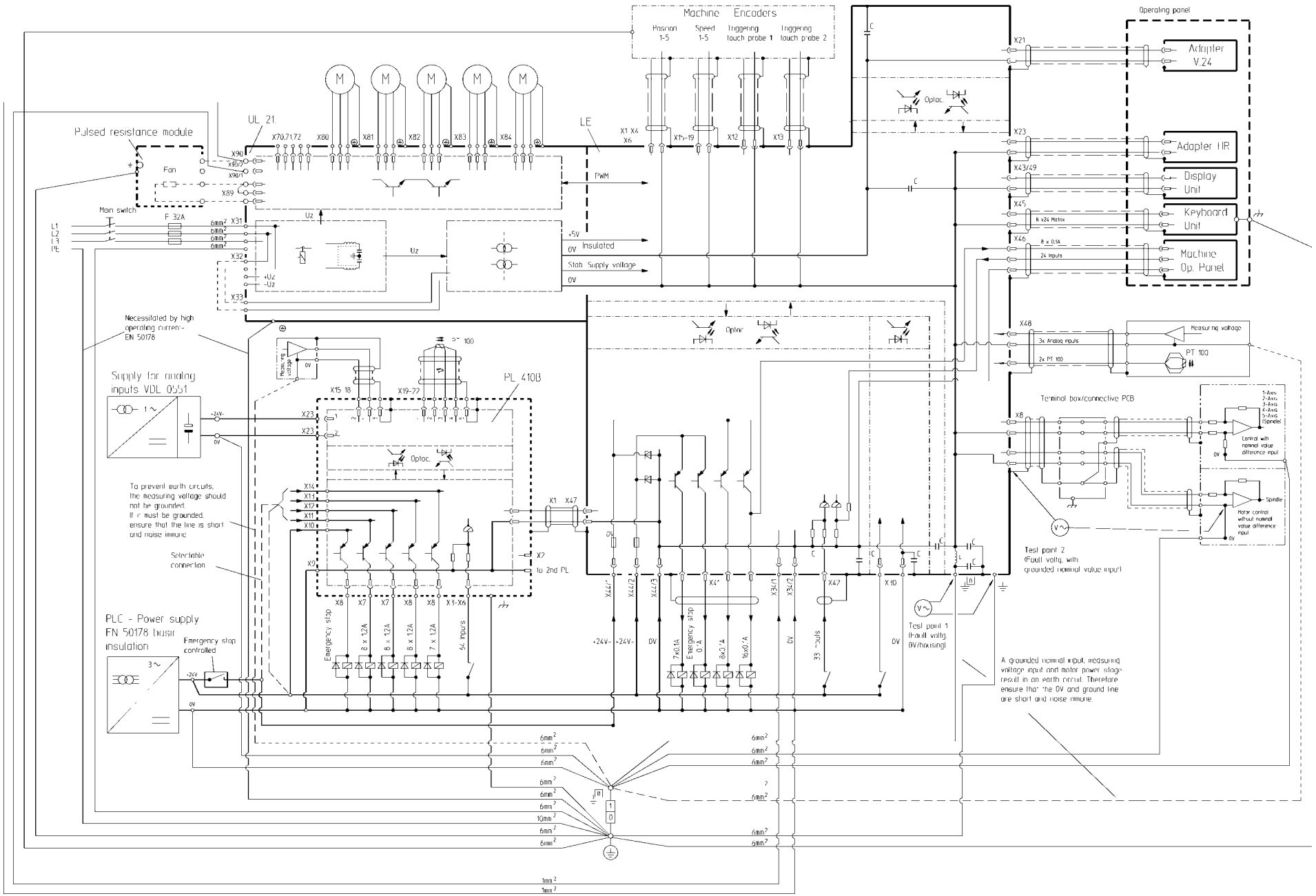
Connecting terminal X89 UE 240/242	Assignment	External braking resistor PW 110; connecting terminal X1
1	+Uz	1
2	–Uz	2

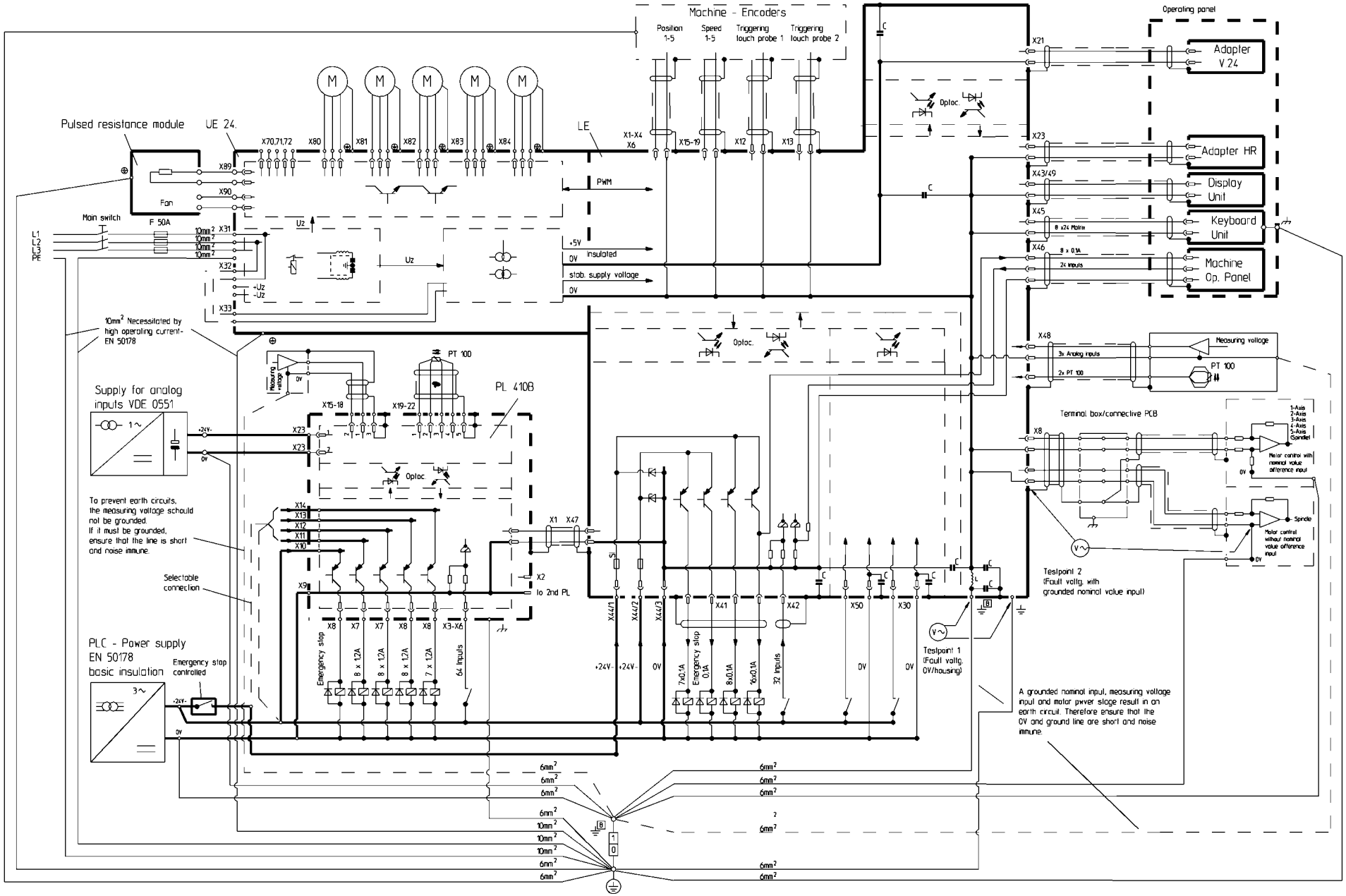
Fan for external braking resistor

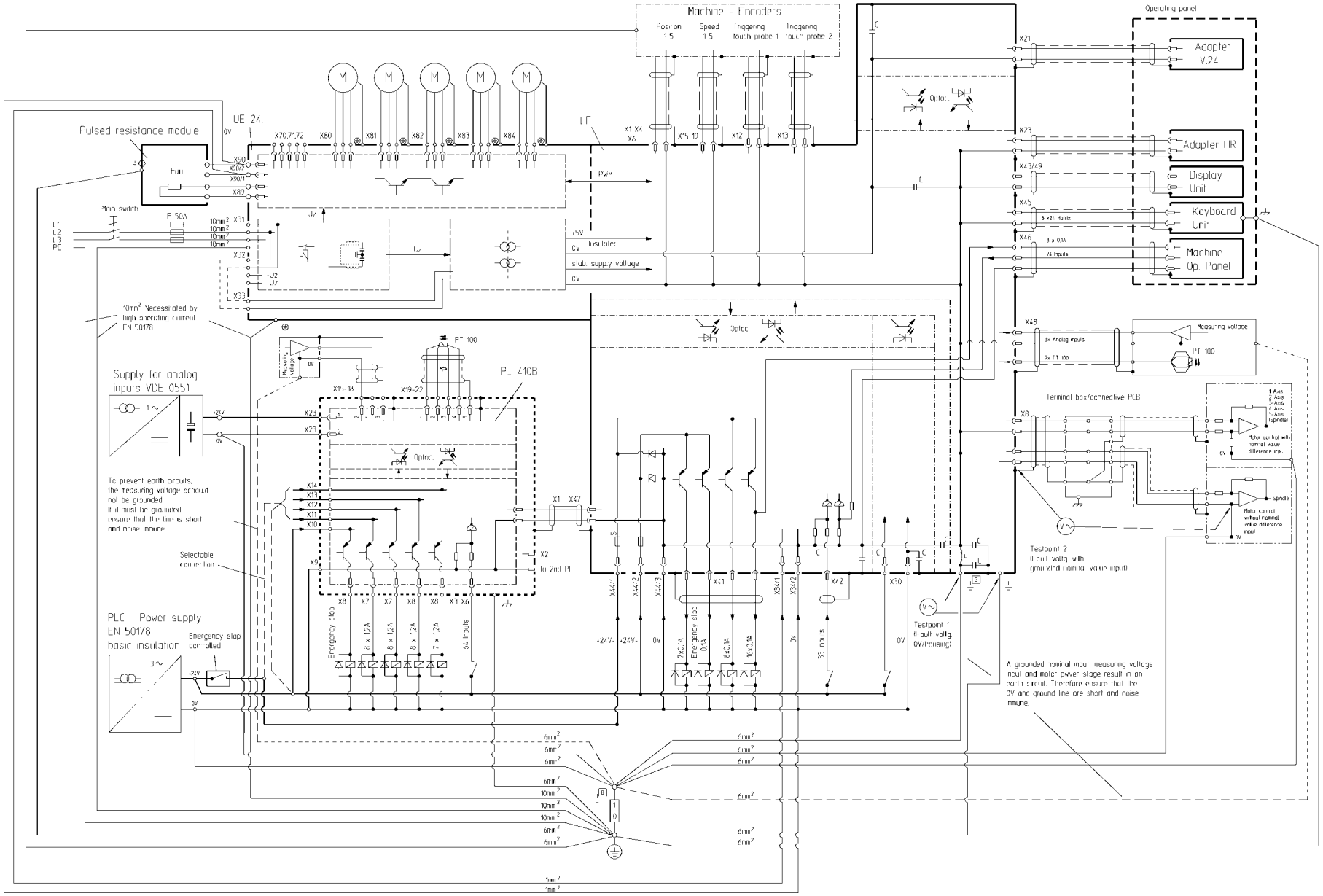
PW110; connecting terminal X2	Assignment
+	+ 24V (PLC)
–	0 V

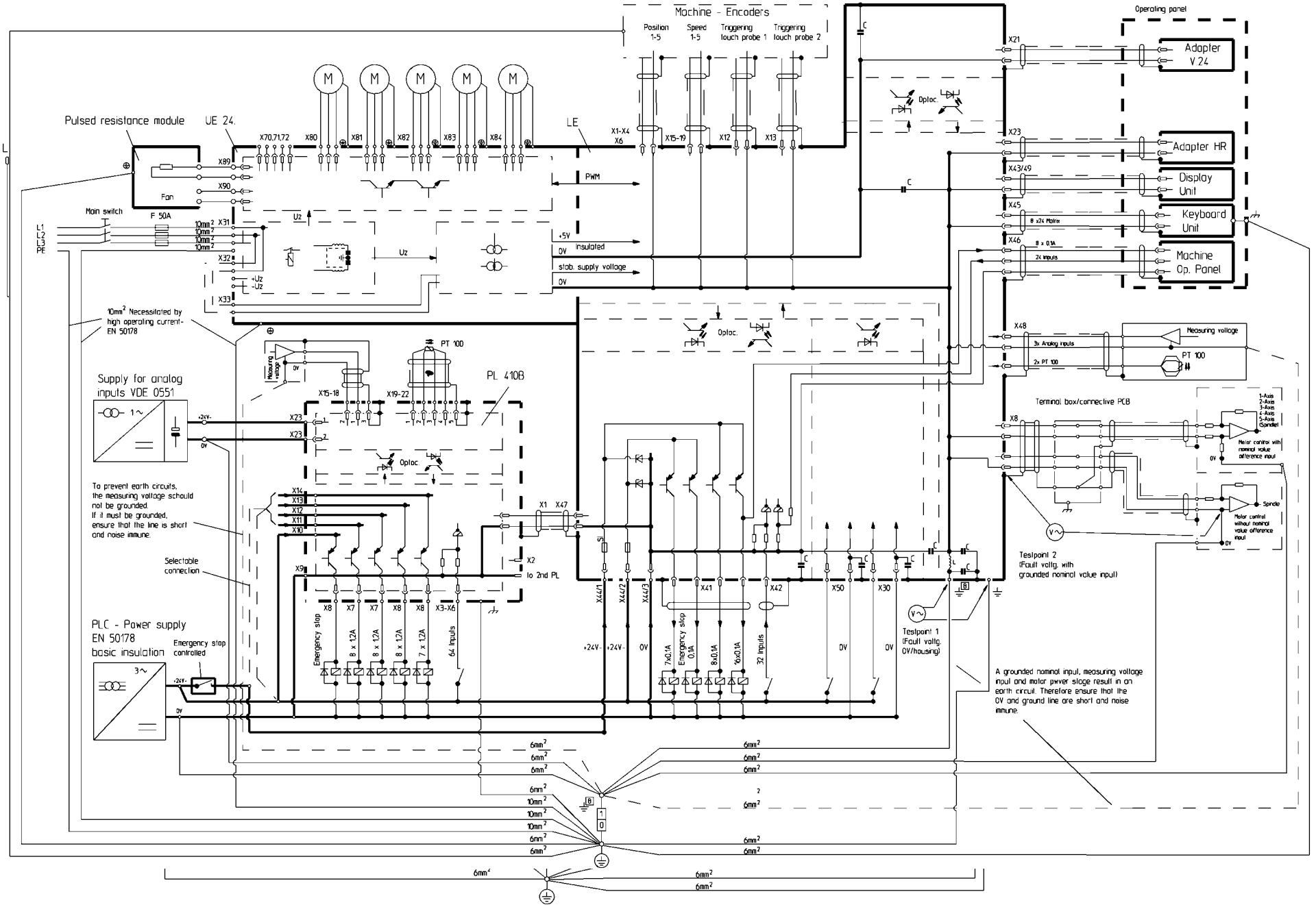
Notes

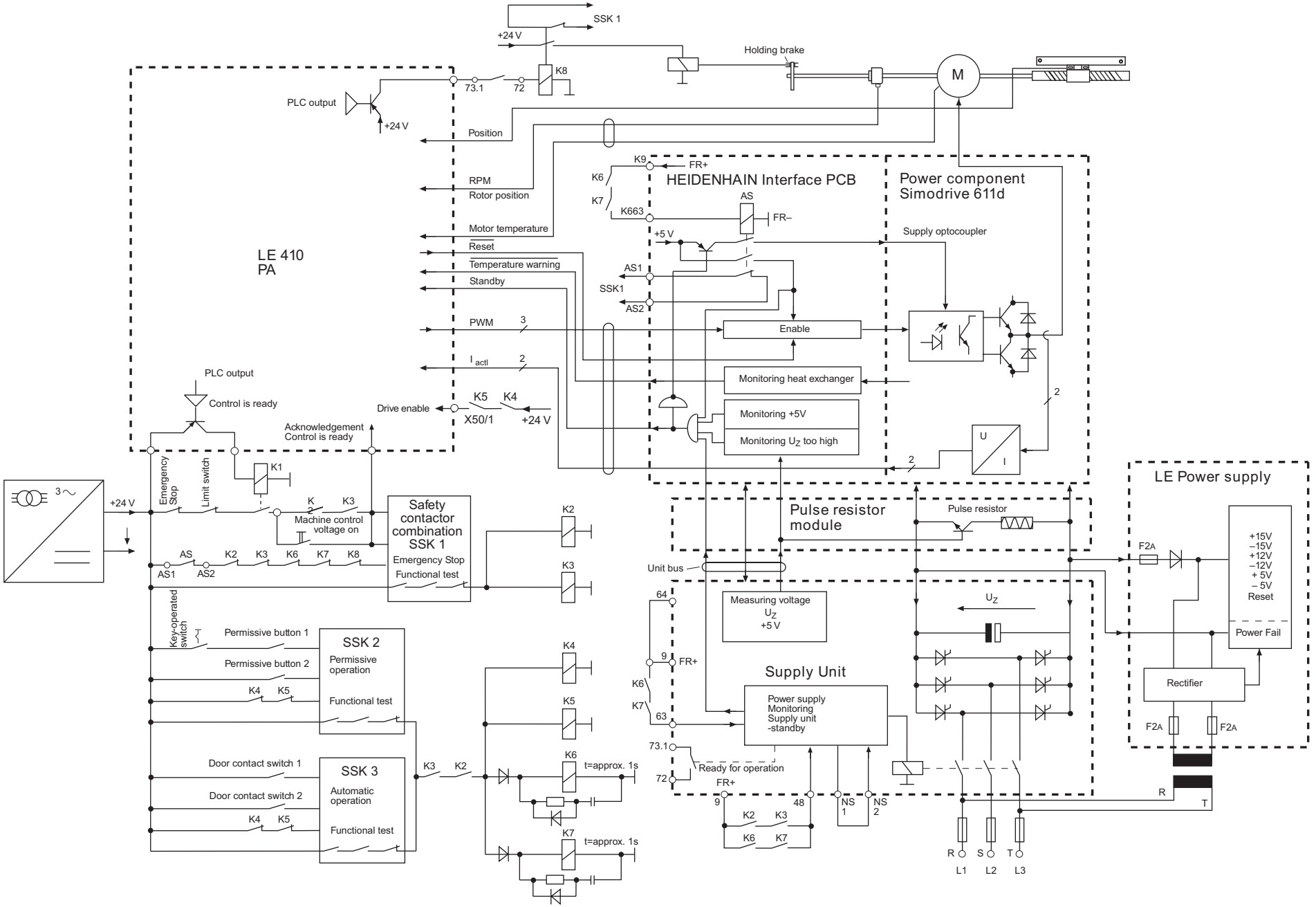

Machine - Encoders
Position 1-5
Speed 1-5
Triggering touch probe 1
Triggering touch probe 2
Operating panel
Adapter V 24
Adapter HR
Display Unit
Keyboard Unit
Machine Op. Panel
Pulsed resistance module
UE 21
Fan
F 32A
Main switch
L1
L2
L3
PE
PWM
+5V
0V
Insulated
Stab. Supply voltage
Optoc.
Necessitated by high operating current- EN 50178
PT 100
Measuring voltage
Supply for analog inputs VDE 0551
PL 410B
Terminal box/connective PCB
To prevent earth circuits, the measuring voltage should not be grounded. If it must be grounded, ensure that the line is short and noise immune.
Selectable connection
X2 to 2nd PL
PLC - Power supply EN 50178 basic insulation
Emergency stop controlled
Emergency stop
64 Inputs
32 Inputs
Test point 2 (Fault voltg. with grounded nominal value input)
Test point 1 (Fault voltg. 0V/housing)
A grounded nominal input, measuring voltage input and motor power stage result in an earth circuit. Therefore ensure that the 0V and ground line are short and noise immune.
Control with nominal value difference input
Motor control without nominal value difference input
Spindle
1-Axis
2-Axis
3-Axis
4-Axis
5-Axis (Spindle)

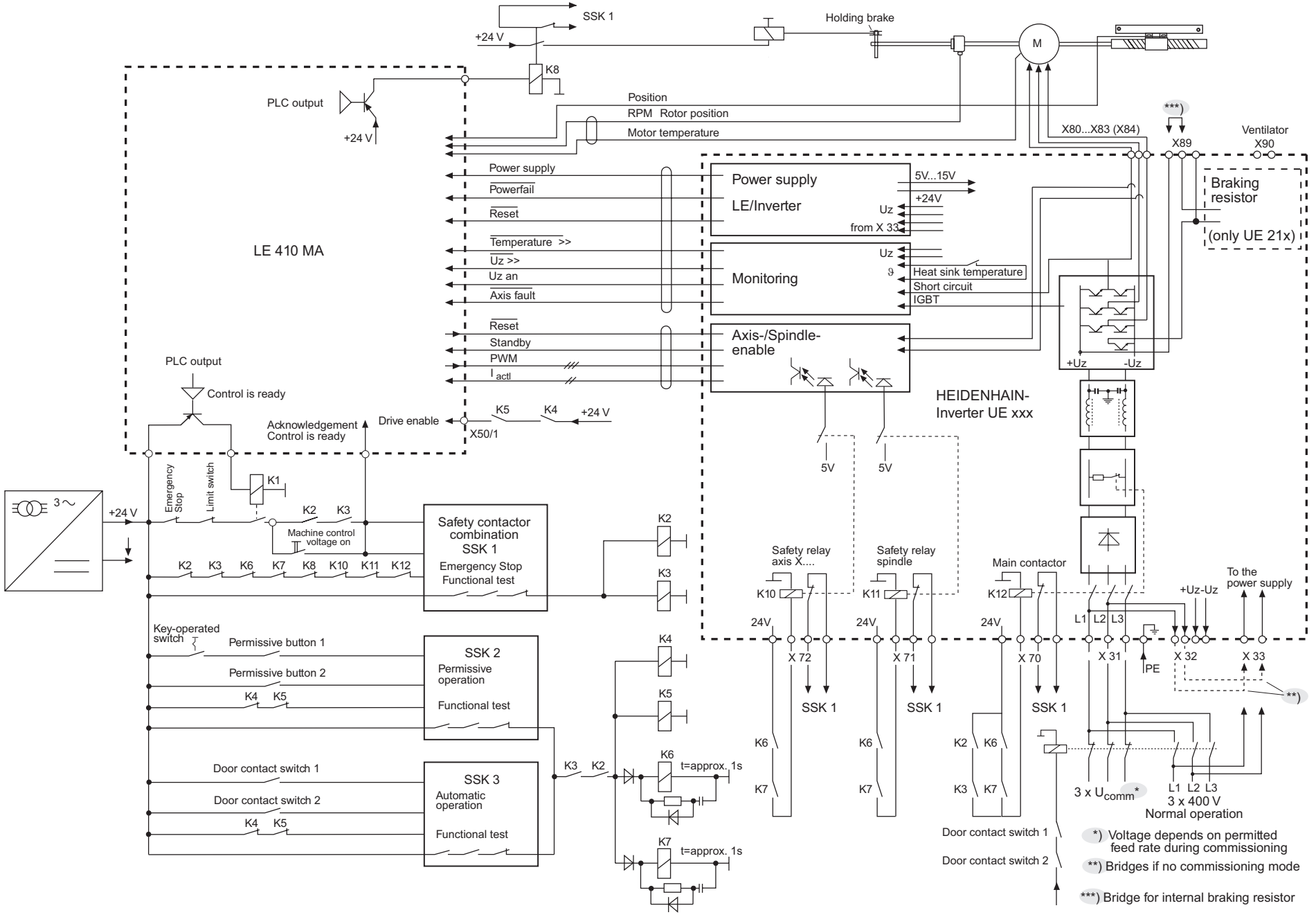

Machine Encoders
Position 1-5
Speed 1-5
Triggering touch probe 1
Triggering touch probe 2
Operating panel
Adapter V.24
Adapter HR
Display Unit
Keyboard Unit
Machine Op. Panel
Pulsed resistance module
UL 21.
Fan
Main switch
F 32A
PWM
+5V
0V Insulated
Stab. Supply voltage
0V
Optoc.
LE
Necessitated by high operating current - EN 50178
Supply for analog inputs VDL 0551
PL 410B
Measuring voltage
PT 100
Terminal box/connective PCB
To prevent earth circuits, the measuring voltage should not be grounded. If it must be grounded, ensure that the line is short and noise immune
Selectable connection
to 2nd PL
PLC - Power supply EN 50178 basic insulation
Emergency stop controlled
Emergency stop
54 inputs
33 inputs
Test point 2 (Fault volt. with grounded nominal value input
Test point 1 (Fault volt. 0V/housing)
A grounded nominal input, measuring voltage input and motor power stage result in an earth circuit. Therefore ensure that the 0V and ground line are short and noise immune.
Control with nominal value difference input
Motor control without nominal value difference input
Spindle

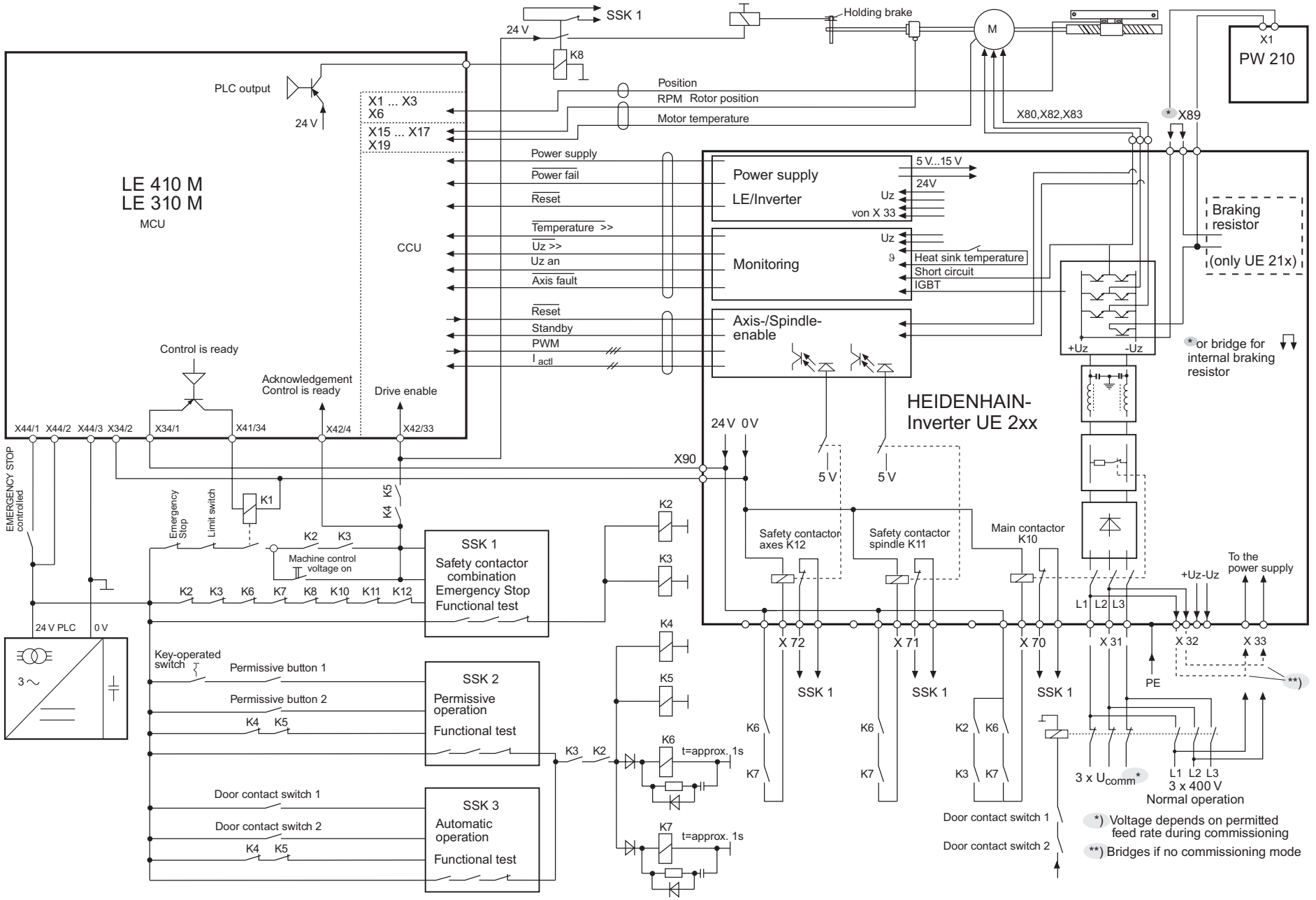

Machine - Encoders
Position 1-5
Speed 1-5
Triggering touch probe 1
Triggering touch probe 2
Operating panel
Adapter V 24
Adapter HR
Display Unit
Keyboard Unit
Machine Op. Panel
Pulsed resistance module
UE 24.
LE
PWM
+5V insulated
0V
stab. supply voltage
0V
Main switch
F 50A
Fan
Optoc.
PT 100
PL 410B
Supply for analog inputs VDE 0551
Measuring voltage
Terminal box/connective PCB
Motor control with nominal value difference input
Motor control without nominal value difference input
Spindle
Testpoint 2 (Fault voltg. with grounded nominal value input)
Testpoint 1 (Fault voltg. 0V/housing)
To prevent earth circuits, the measuring voltage schould not be grounded. If it must be grounded, ensure that the line is short and noise immune.
Selectable connection
to 2nd PL
PLC - Power supply EN 50178 basic insulation
Emergency stop controlled
Emergency stop
64 inputs
32 inputs
A grounded nominal input, measuring voltage input and motor power stage result in an earth circuit. Therefore ensure that the 0V and ground line are short and noise immune.
10mm² Necessitated by high operating current - EN 50178


Machine - Encoders
Position
Speed
Triggering touch probe 1
Triggering touch probe 2
Operating panel
Adapter V.24
Adapter HR
Display Unit
Keyboard Unit
Machine Op. Panel
Pulsed resistance module
UE 24
Main switch
F 50A
Fan
PWM
+5V
0V insulated
stab. supply voltage
0V
Optoc.
PT 100
Measuring voltage
Supply for analog inputs VDE 0551
P_ 410B
Terminal box/connective PCB
To prevent earth circuits, the measuring voltage schould not be grounded. If it must be grounded, ensure that the line is short and noise immune.
Selectable connection
PLC Power supply EN 50178 basic insulation
Emergency stop controlled
Emergency stop
54 inputs
33 inputs
Testpoint 2 4-pol voltg with grounded nominal value input
Testpoint 1 4-pol voltg 0V/housing
A grounded nominal input, measuring voltage input and motor power stage result in an earth circuit. Therefore ensure that the 0V and ground line are short and noise immune.
Motor control with nominal value difference input
Motor control without nominal value difference input
Spindle
1 Axis
2 Axis
3 Axis
4 Axis
Spindle


Machine - Encoders
Position 1-5
Speed 1-5
Triggering touch probe 1
Triggering touch probe 2
Operating panel
Adapter V 24
Adapter HR
Display Unit
Keyboard Unit
Machine Op. Panel
Pulsed resistance module
UE 24.
LE
PWM
+5V
0V insulated
stab. supply voltage
0V
Main switch
F 50A
Fan
Optoc.
PT 100
PL 410B
Supply for analog inputs VDE 0551
Measuring voltage
Terminal box/connective PCB
Testpoint 2 (Fault voltg. with grounded nominal value input)
Testpoint 1 (Fault voltg. 0V/housing)
Selectable connection
to 2nd PL
PLC - Power supply EN 50178 basic insulation
Emergency stop controlled
Emergency stop
64 inputs
32 inputs
To prevent earth circuits, the measuring voltage schould not be grounded. If it must be grounded, ensure that the line is short and noise immune.
10mm² Necessitated by high operating current- EN 50178
A grounded nominal input, measuring voltage input and motor power stage result in an earth circuit. Therefore ensure that the 0V and ground line are short and noise immune.

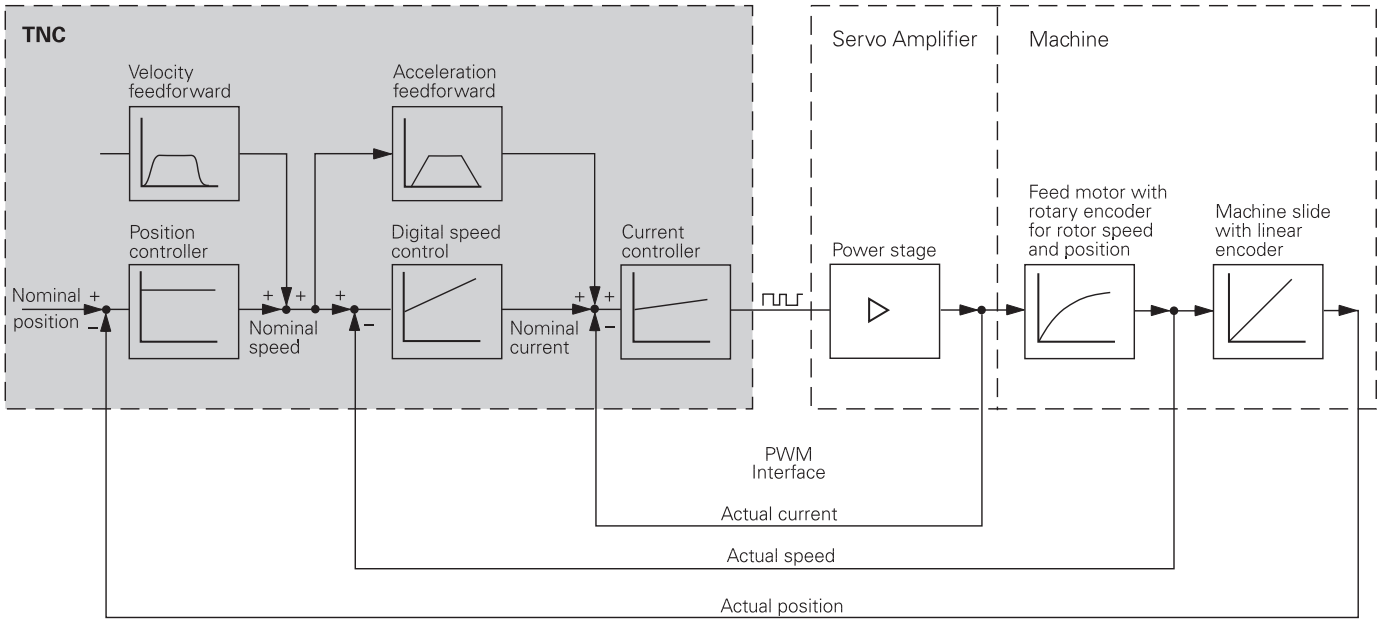

SSK 1
+24 V
Holding brake
K8
73.1
72
M
PLC output
+24 V
Position
RPM
Rotor position
Motor temperature
Reset
Temperature warning
Standby
PWM
3
I actl
2
LE 410
PA
K9
FR+
K6
K7
K663
HEIDENHAIN Interface PCB
AS
FR–
+5 V
Power component
Simodrive 611d
Supply optocoupler
AS1
SSK1
AS2
Enable
Monitoring heat exchanger
Monitoring +5V
Monitoring U_Z too high
2
U
I
PLC output
Control is ready
Drive enable
K5
K4
X50/1
+24 V
Acknowledgement
Control is ready
LE Power supply
3~
+24 V
Emergency Stop
Limit switch
K1
K
2
K3
Machine control voltage on
Safety contactor combination SSK 1
Emergency Stop
Functional test
K2
K3
AS
AS1
AS2
K2
K3
K6
K7
K8
Pulse resistor module
Pulse resistor
Unit bus
F2A
+15V
–15V
+12V
–12V
+ 5V
– 5V
Reset
Power Fail
64
Measuring voltage
U_Z
+5 V
U_Z
9
FR+
Supply Unit
K6
K7
63
Power supply
Monitoring
Supply unit
-standby
Rectifier
F2A
F2A
Key-operated switch
Permissive button 1
Permissive button 2
K4
K5
SSK 2
Permissive operation
Functional test
K4
K5
73.1
72
Ready for operation
FR+
9
48
NS 1
NS 2
K2
K3
K6
K7
R
T
Door contact switch 1
Door contact switch 2
K4
K5
SSK 3
Automatic operation
Functional test
K3
K2
K6
t=approx. 1s
K7
t=approx. 1s
R
S
T
L1
L2
L3


SSK 1
+24 V
K8
Holding brake
M
PLC output
+24 V
Position
RPM Rotor position
Motor temperature
X80...X83 (X84)
***)
X89
Ventilator
X90
Braking resistor
(only UE 21x)
LE 410 MA
Power supply
Powerfail
Reset
Temperature >>
Uz >>
Uz an
Axis fault
Reset
Standby
PWM
I actl
Power supply
LE/Inverter
5V...15V
+24V
Uz
from X 33
Monitoring
Uz
ϑ
Heat sink temperature
Short circuit
IGBT
Axis-/Spindle-enable
+Uz
-Uz
HEIDENHAIN-
Inverter UE xxx
5V
5V
PLC output
Control is ready
Acknowledgement
Control is ready
Drive enable
X50/1
K5
K4
+24 V
3 ~
+24 V
Emergency Stop
Limit switch
K1
K2
K3
Machine control voltage on
Safety contactor combination SSK 1
Emergency Stop
Functional test
K2 K3 K6 K7 K8 K10 K11 K12
Safety relay axis X....
Safety relay spindle
Main contactor
To the power supply
+Uz-Uz
K10
K11
K12
24V
X 72
X 71
X 70
X 31
X 32
X 33
L1 L2 L3
PE
**)
SSK 1
Key-operated switch
Permissive button 1
Permissive button 2
K4 K5
SSK 2
Permissive operation
Functional test
Door contact switch 1
Door contact switch 2
K4 K5
SSK 3
Automatic operation
Functional test
K3 K2
K6
K7
t=approx. 1s
3 x U comm *
L1 L2 L3
3 x 400 V
Normal operation
Door contact switch 1
Door contact switch 2
*) Voltage depends on permitted feed rate during commissioning
**) Bridges if no commissioning mode
***) Bridge for internal braking resistor

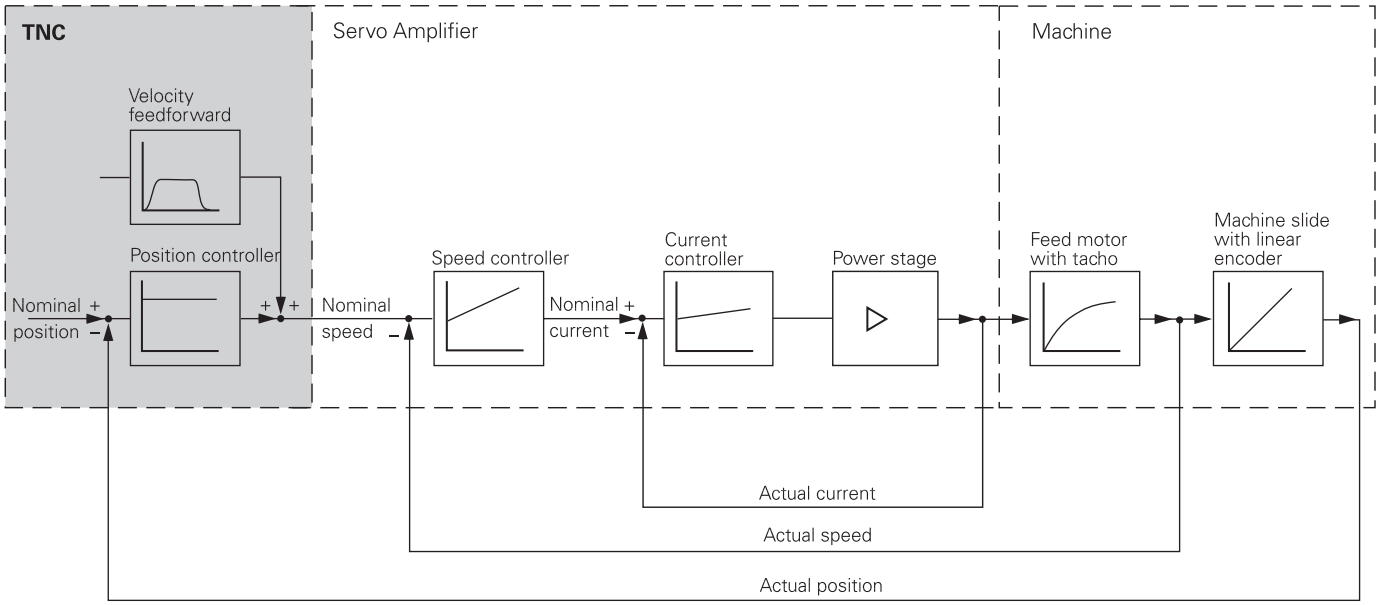

SSK 1
24 V
K8
Holding brake
M
X1
PW 210
PLC output
24 V
X1 ... X3
X6
X15 ... X17
X19
Position
RPM Rotor position
Motor temperature
X80,X82,X83
X89
LE 410 M
LE 310 M
MCU
CCU
Power supply
Power fail
Reset
Temperature >>
Uz >>
Uz an
Axis fault
Reset
Standby
PWM
I actl
Power supply
LE/Inverter
5 V...15 V
24V
Uz
von X 33
Monitoring
Uz
Heat sink temperature
Short circuit
IGBT
Axis-/Spindle-
enable
Braking
resistor
(only UE 21x)
+Uz
-Uz
or bridge for
internal braking
resistor
HEIDENHAIN-
Inverter UE 2xx
Control is ready
Acknowledgement
Control is ready
Drive enable
X44/1 X44/2 X44/3 X34/2
X34/1
X41/34
X42/4
X42/33
24 V 0 V
X90
5 V
5 V
EMERGENCY STOP
controlled
Emergency
Stop
Limit switch
K1
K5
K4
K2
K3
Machine control
voltage on
K2 K3 K6 K7 K8 K10 K11 K12
SSK 1
Safety contactor
combination
Emergency Stop
Functional test
Safety contactor
axes K12
Safety contactor
spindle K11
Main contactor
K10
To the
power supply
+Uz-Uz
L1 L2 L3
24 V PLC
0 V
3 ~
Key-operated
switch
Permissive button 1
Permissive button 2
K4 K5
SSK 2
Permissive
operation
Functional test
K3 K2
K6
t=approx. 1s
K7
t=approx. 1s
Door contact switch 1
Door contact switch 2
K4 K5
SSK 3
Automatic
operation
Functional test
X 72
X 71
X 70
X 31
X 32
X 33
PE
**)
SSK 1
K6
K7
K2 K6
K3 K7
3 x Ucomm *
L1 L2 L3
3 x 400 V
Normal operation
Door contact switch 1
Door contact switch 2
*) Voltage depends on permitted
feed rate during commissioning
**) Bridges if no commissioning mode

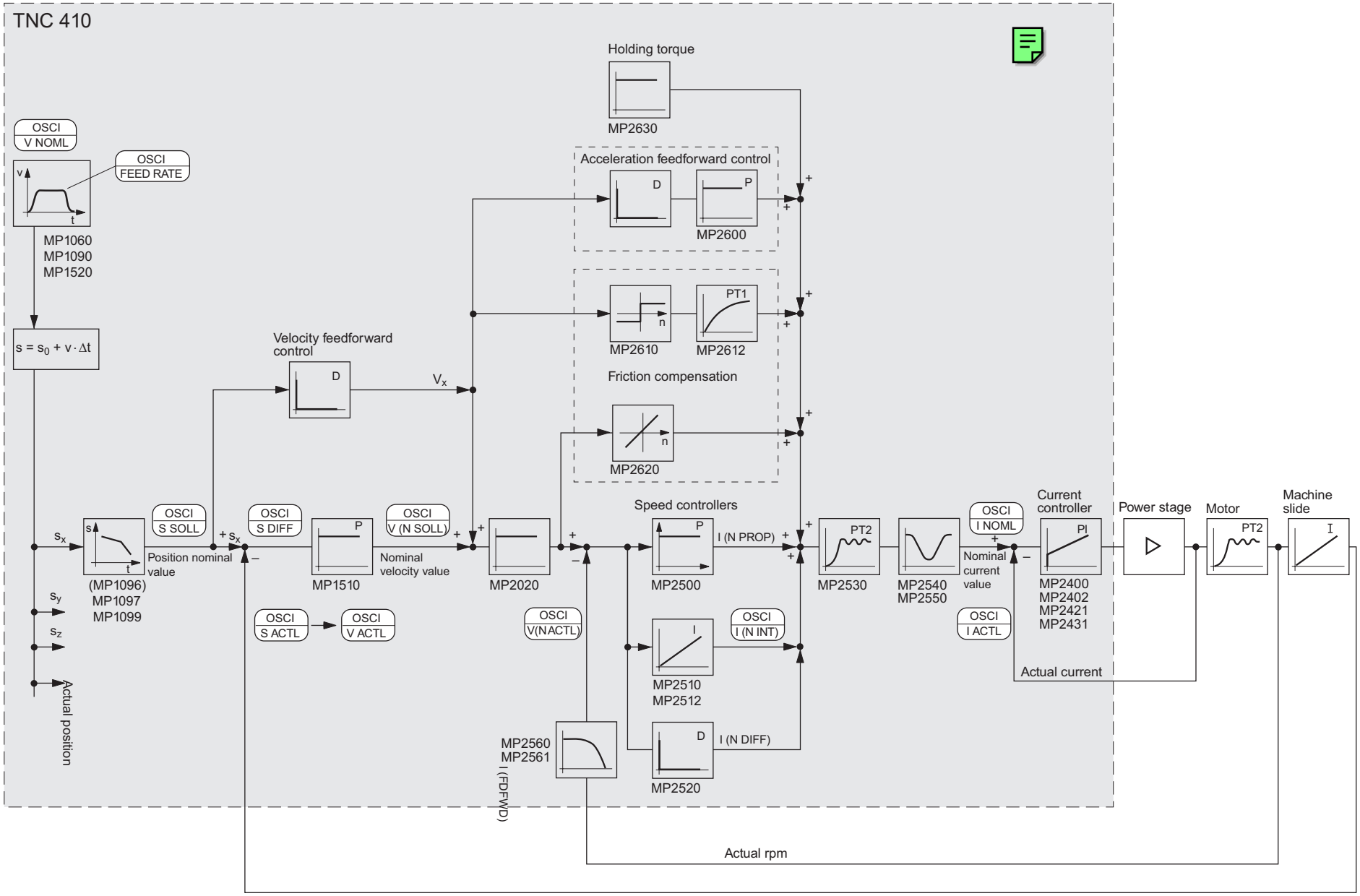
Block diagram of the control loop

Block diagram of an analog axis



Block diagram of a digital axis




TNC 410
Holding torque
MP2630
OSCI V NOML
OSCI FEED RATE
MP1060
MP1090
MP1520
Acceleration feedforward control
D
P
MP2600
PT1
MP2610
MP2612
Friction compensation
MP2620
Velocity feedforward control
V_x
$s = s_0 + v \cdot \Delta t$
Speed controllers
OSCI S SOLL
OSCI S DIFF
OSCI V (N SOLL)
Position nominal value
Nominal velocity value
MP1510
MP2020
MP2500
I (N PROP)
MP2530
MP2540
MP2550
OSCI I NOML
Nominal current value
Current controller
PI
MP2400
MP2402
MP2421
MP2431
Power stage
Motor
PT2
Machine slide
I
(MP1096)
MP1097
MP1099
OSCI S ACTL
OSCI V ACTL
OSCI V(NACTL)
OSCI I (N INT)
OSCI I ACTL
MP2510
MP2512
I (N DIFF)
MP2520
MP2560
MP2561
I (FDFWD)
Actual position
Actual current
Actual rpm

11. Board Descriptions

LE 410 CA

Processor Board

- **Interface**
  Data interface V.24/RS-232-C
  Serial handwheel
  Position encoder inputs
  3-D touch probes
  57 PLC inputs
  31 PLC outputs
  Visual display unit
  Keyboard unit
  Machine operating panel
  PLC I/O boards

- **Monitoring**
  Position encoder inputs
  Axis positions
  Program memory
  Data processing
  EMERGENCY STOP
  Temperature
  Voltages
  Buffer battery

LE 410 PA/MA

Processor Board

- **Interface**
  Data interface V.24/RS-232-C
  Serial handwheel
  Position encoder inputs
  3-D touch probes
  57 PLC inputs
  31 PLC outputs
  Visual display unit
  Keyboard unit
  Machine operating panel
  PLC I/O boards

- **Monitoring**
  Position encoder inputs
  Axis positions
  Program memory
  Data processing
  EMERGENCY STOP
  Temperature inside the logic unit
  Voltages
  Buffer battery

Drive-control board

- **Interface**
  Speed encoder inputs
  Connection of power module

- **Monitoring**
  Motor temperature
  Temperature of servo amplifier
  Speed encoder inputs

12. Power supply

12.1 NC power supply of LE 410 CA/PA

12.1.1 Voltage ranges and connections

The power supply line for the NC part is connected to the terminals of X31.

X31 NC power supply

Connecting terminals	Assignment	LE 410 PA	LE 410 CA
⏚	GND conductor (ye/gr)		
U_1	phase 1	330V~ to 450V~ via	140V~ to 450V~
U_2	phase 2	isolating transformer 50 to 60 Hz	50 to 60 Hz
$-U_Z$	dc-link voltage –	385 V– to 660V– 1)	–
$+U_Z$	dc-link voltage +		

1) other voltage ranges on request

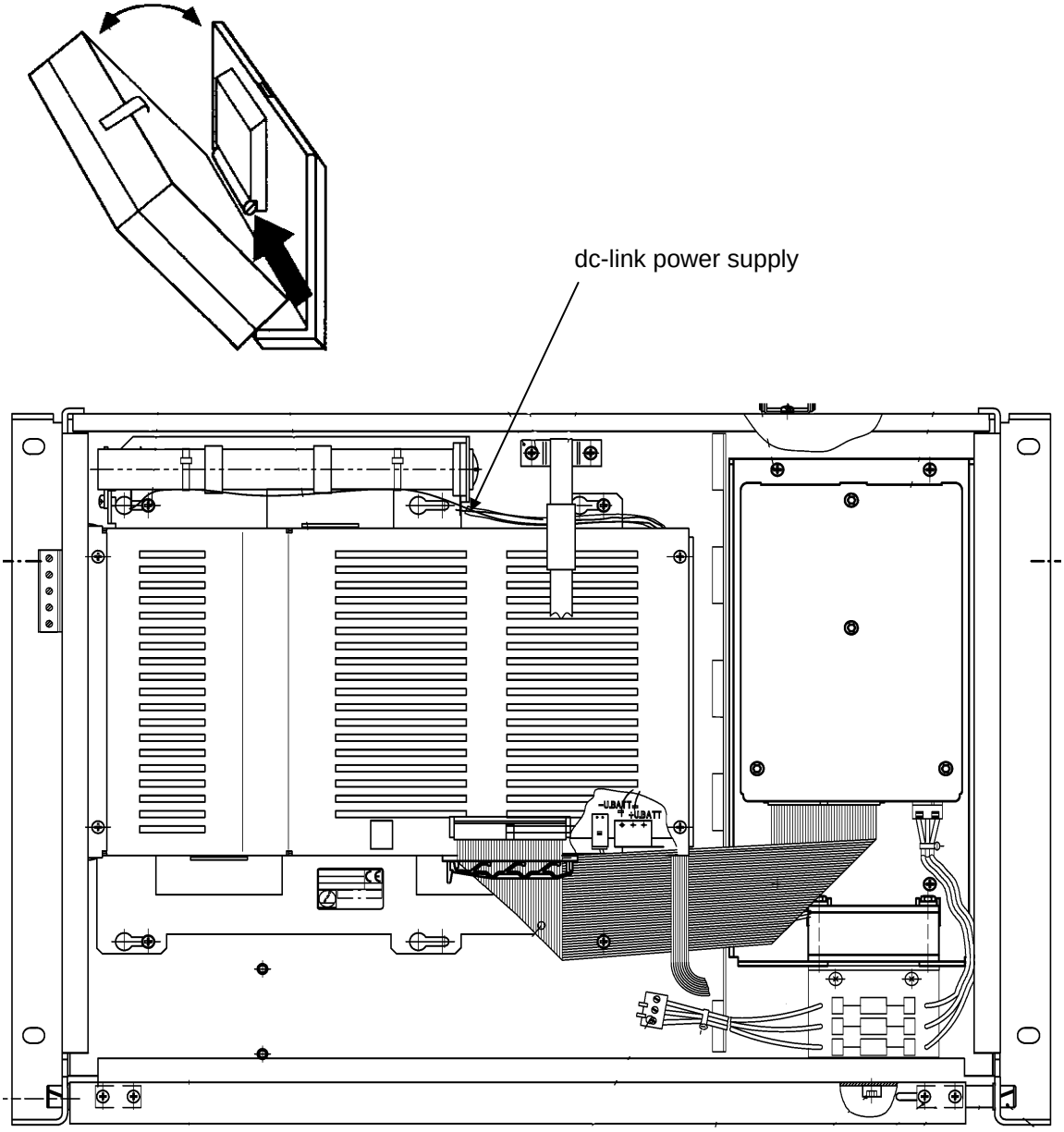
Power consumption: approx. 55 W

LE 410 PA
For LE 410 PA an NC supply voltage of 330 V~ to 450 V~ must be applied at the terminals U_1 and U_2. This voltage must be applied via an isolating transformer (100 VA) with basic insulation according to IEC 742 EN 50 178. To ensure the power supply of the drive control in the case of power failure, the LE must be powered with the dc-link power of the servo amplifier (385 V– to 660 V–) at the terminals +Uz and –Uz.
If the dc-link power is available immediately after power-on, the supply voltage at the terminals U1 and U2 is not required. In this case a bridge must be inserted between +Uz and U1.
A short-time overvoltage (approx. 5 seconds) of up to 720 V– is permissible. If the voltage exceeds 720 V–, the NC switches off the pulse enable ($\overline{\text{Reset}}$) for the IGBT of the power module. The motors run out non-controlled and no power can be fed into the dc link.
If the voltage falls below 385 V– (power fail) the halting procedure for all drives is controlled. The monitor of the supply voltage can be switched on and off via the module 9167. If the voltage falls below 155 V–, the control is reset; the dc-link power supply switches off at 135 V–.

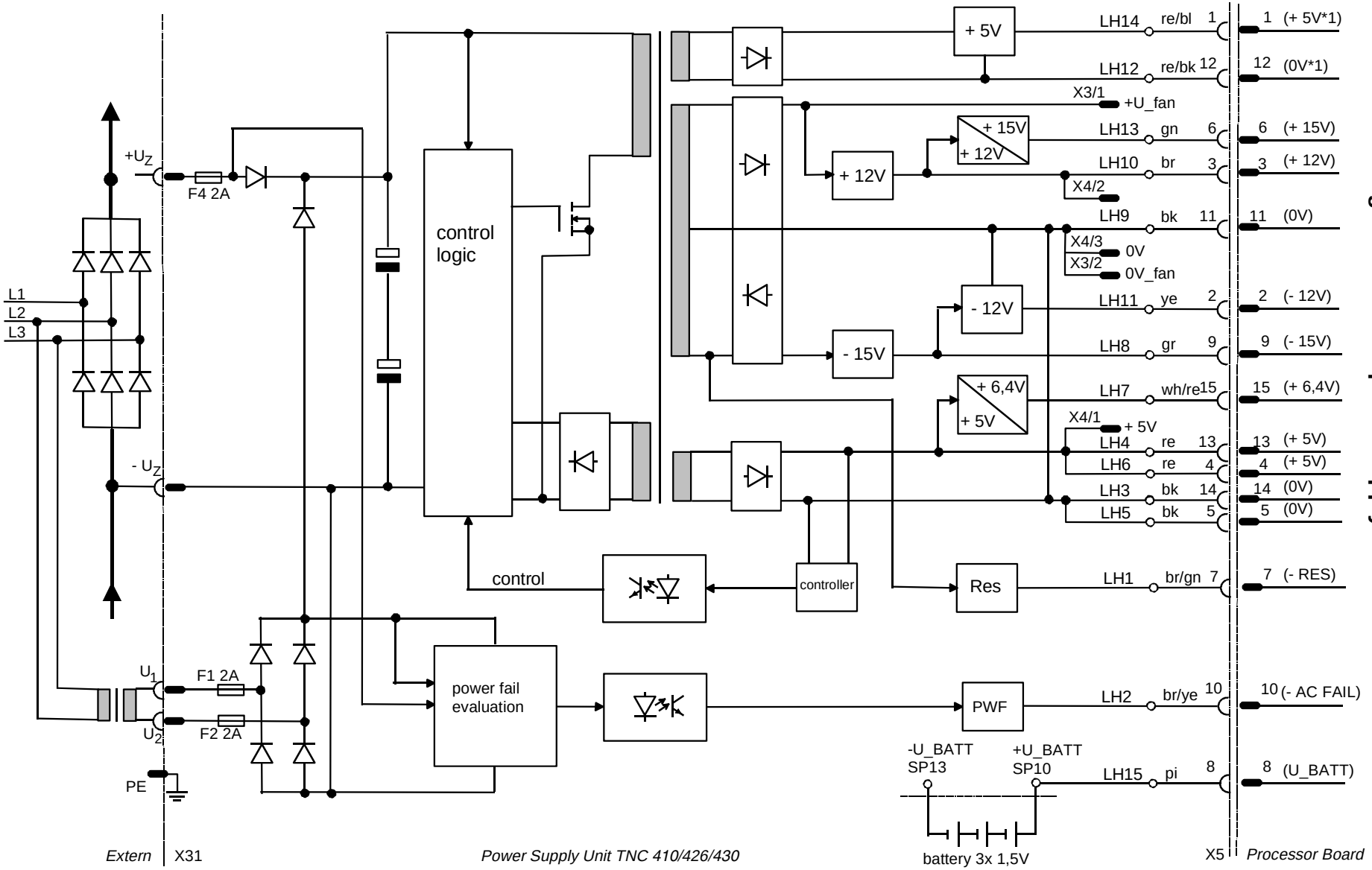
LE 410 CA
For LE 410 CA an NC power supply of 140 V~ to 450 V~ at the terminals U_1 and U_2 is required. The monitoring of the supply voltage must be switched off via module 9167.
To observe the European standards for electromagnetic compatibility (EN 55022), LE 410 CA may only be connected to the public AC line via an isolating transformer or in connection with a line filter.
Among other things these standards have to be observed to attach the CE label.
If a line filter has already been installed for the supply voltage of the inverter, this voltage may also be used for the LE 410 CA.

12.1.2 Mounting attitude of the power supply unit (dc-link power supply)

Danger of electrical shock!
The dc-link power supply unit may only be opened by HEIDENHAIN service staff.



12.1.3 Block diagram of dc-link power supply

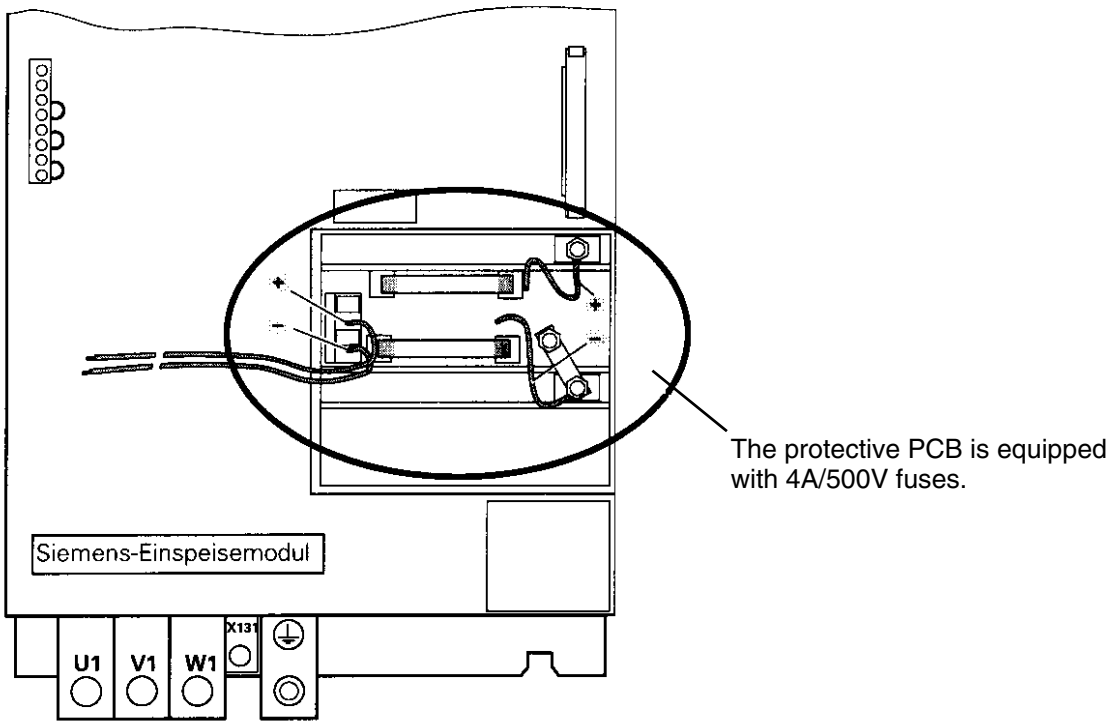


12.1.4 Checking the power supply unit (dc-link power supply)

If an error is detected at the dc-link power supply (all voltages are missing) the supply line (5-pin terminal strip X31) should be inspected first.
The supply lines of the dc-link voltage (P-versions only) may additionally be protected by a protective PCB (see fig. 1).
The voltages generated by the dc-link power supply may **only** be measured on the processor board or on the drive-control board. The test points can be found easily on the respective board.
The measured values and tolerances can be seen from the table below. If a measured value deviates distinctly from the values in the table, the POWER SUPPLY unit is defective.

Danger of electrical shock!
The dc-link power supply unit may only be opened by HEIDENHAIN service staff.
Connect and disconnect the terminals only while the unit is not under power.

Fig. 1:



12.1.5 Table of voltages

Test point on PCB	Ref. point on PCB	Output	U_{RATED}	Tolerance
+ 5V	0V	+ 5V	+ 5V	+/- 0.2V
+ 6,4V	0V	+ 6,4V	+ 6,4V	+/- 0.25V
+ 15V	0V	+ 15V	+ 15V	+/- 0.6V
+ 12V	0V	+ 12V	+ 12V	+/- 0.5V
- 12V	0V	- 12V	- 12V	+/- 0.5V
- 15V	0V	- 15V	- 15V	+/- 0.6V
+ 5V * 1	0V * 1	+ 5V * 1 [1)]	+ 5V-	+/- 0.2V

[1)] floating supply voltage for data interfaces

Observe the safety instructions!

12.2 Power supply of LE 410 MA and inverter units UE2xx

12.2.1 Voltage ranges and connections

X31 Power supply for Uz (dc-link voltage)

Connecting terminals	UE 210, UE 212	UE 240, UE 242
L1 L2 L3 PE	30 V~ to 440 V~ 50 to 60 Hz **Cable**: cross-section 6 mm²	30 V~ to 440 V~ 50 to 60 Hz **Cable**: cross-section 10 mm²
	Line fuse: 32 A **GND connection**: ≥ 10 mm²	**Line fuse**: 50 A **GND connection**: ≥ 10 mm²

X33 Power supply for the power supply unit of inverter and LE 410 MA

Connecting terminals	Assignment
1	bridge to X32/pin 1 (with setup L1 from line 290 V~ to 440 V~, 50 to 60 Hz)
2	bridge to X32/Pin 2 (with setup L2 from line)

X32 Output for supply voltage of power supply unit

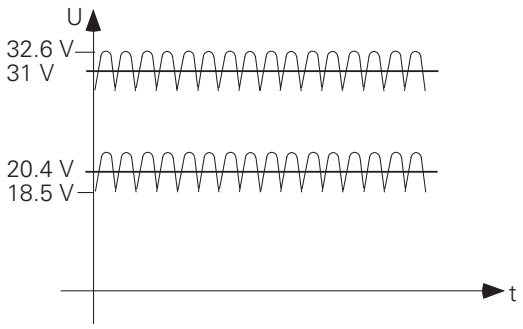
Connecting terminals	Assignment
1	bridge to X33/pin 1 (fuse 4 A)
2	bridge to X33/pin 2 (fuse 4 A)
3	+ Uz (fuse 4 A)
4	- Uz (fuse 4 A)

Danger of electrical shock!
The dc-link power supply unit may only be opened by HEIDENHAIN service staff.
Connect and disconnect the terminals only while the unit is not under power.

12.3 PLC power supply

12.3.1 Voltage range and connections

The PL and the PLC of the LE are operated with a control voltage of 24V- of the machine tool, generated according to IEC 742 EN 50 178 (basic insulation).
Superimposed AC voltage components arising from a non-controlled three-phase bridge connection with a ripple factor of 5% (see German standard DIN 40110/10.75, section 1.2) are permissible.



The 0V line of the PLC supply voltage must be connected to the signal ground of the machine via a grounding conductor (∅ ≥ 6 mm²).

Power supply	**Voltage range** **Mean value of dc voltage**	**Max. current consumption** (if half of the outputs are active simultaneously)	**Power consumption** (if half of the outputs are active simultaneously)
24 V – IEC 742 EN 50 178, basic insulation	lower limit 20.4 V upper limit 31 V voltages up to 36 V are permissible for t < 100 ms.	**LE:** 2 A **PL 410 B:** 20 A	**LE:** 48 W **PL 410 B:** 480 W

X44 PLC power supply at the LE

Terminal	Assignment	Fuse
1	+ 24 V – can be switched off via EMERGENCY STOP	F 3.15 A
2	+ 24 V – cannot be switched off via EMERGENCY STOP	F 2 A
3	0 V	

Danger to internal components!
Only use the originals fuse types as replacement!

Power supply of PL 410 B

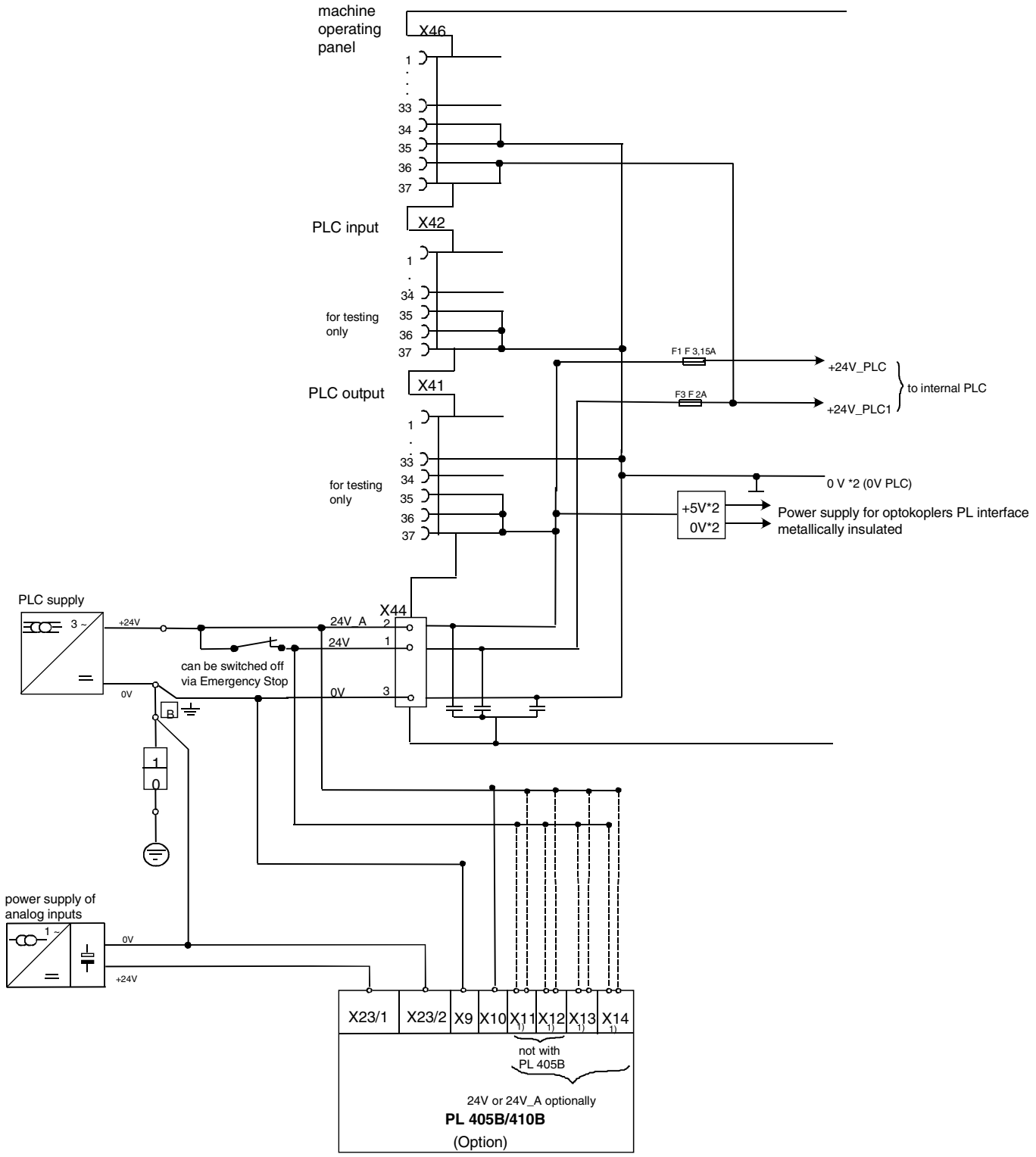
Terminal	Assignment	1st PL	2nd PL
X9	0 V		
X10	+24 V– logic supply and "control is ready“		
X11	+24 V– supply for outputs	O32 – O39	O64 – O71
X12	+24 V– supply for outputs	O40 – O47	O72 – O79
X13	+24 V– supply for outputs	O48 – O55	O80 – O87
X14	+24 V– supply for outputs	O56 – O62	O88 – O94

The PLC I/O board PL 410B is optionally available with additional analog inputs and inputs for the Pt100 thermistors. The power supply for these analog inputs and the thermistors must comply with IEC 742 EN 50 178, 5.88 for separation from line power.

X23 Power supply of the analog inputs of PL 410 B

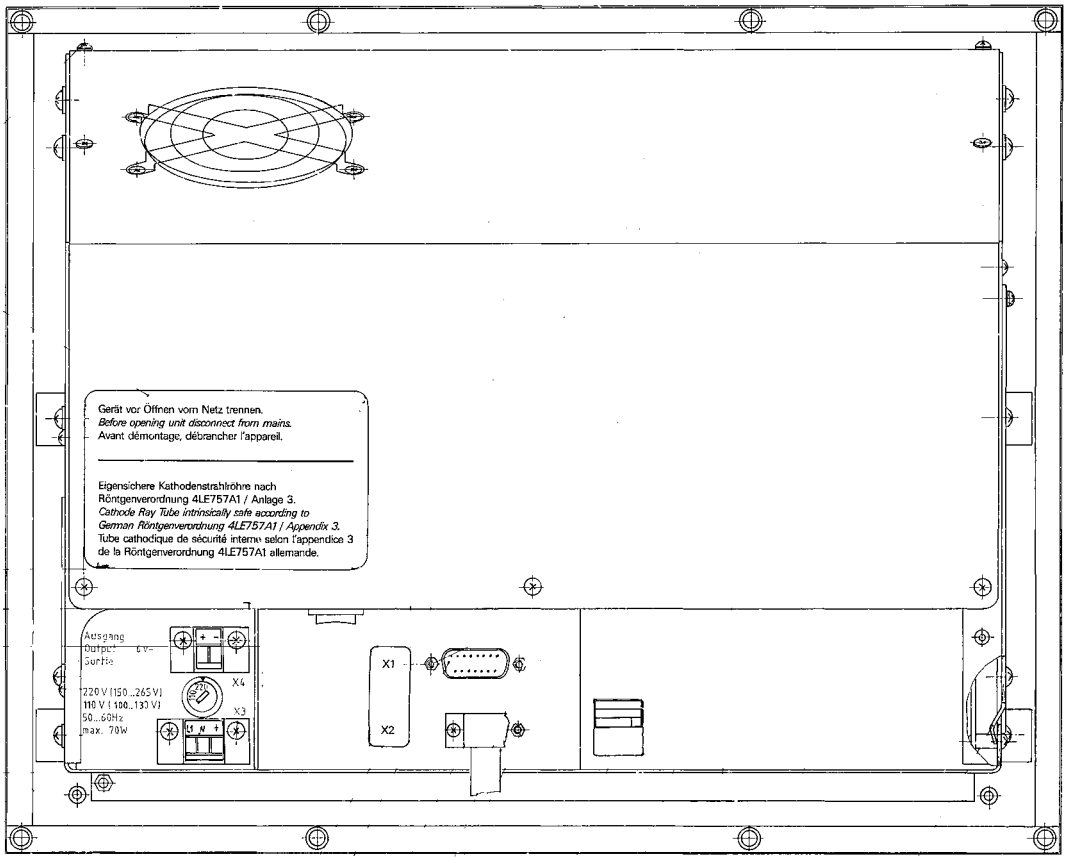
Connecting terminals	Assignment
1	+24 V – (IEC 742 EN 50 178, 5.88 low-voltage electrical separation)
2	0 V

12.3.2 Connection diagram for the PLC power supply



12.4 Power supply of the visual display units

12.4.1 BC 110B



X1 = connection of logic unit
X2 = connection of keyboard unit (for soft keys)

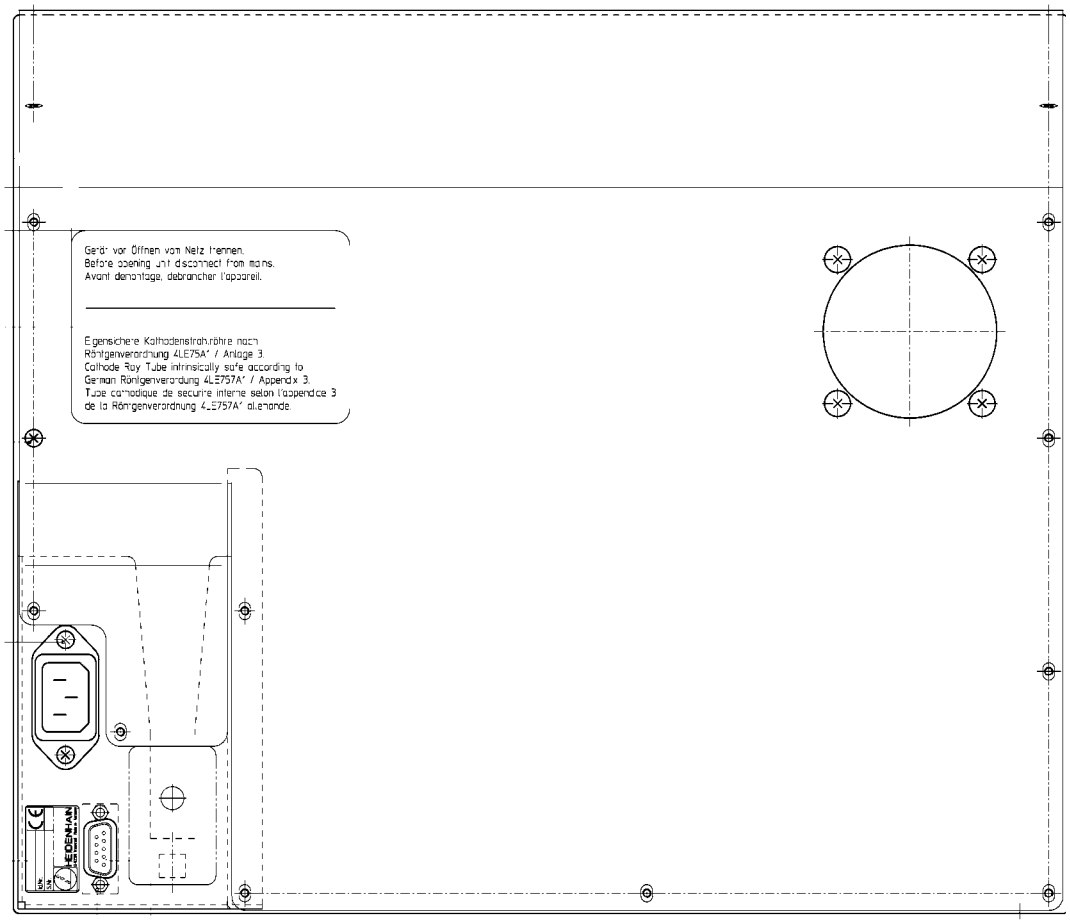
X3 = Line voltage connection		
Line voltage	110 V~	220 V~
Voltage range	85 ... 132 V~	170 ... 264 V~
Line fuse	T 2.0 A	T 2.0 A
Frequency range	49 ... 61 Hz	
Power consumption	60 W	

X4 = Voltage output 1)	
Terminals	Assignment
+	6 V
-	0 V

Note:
The fan of BC 110B is powered internally with + 24V.

1) do not assign

12.4.2 BC 120



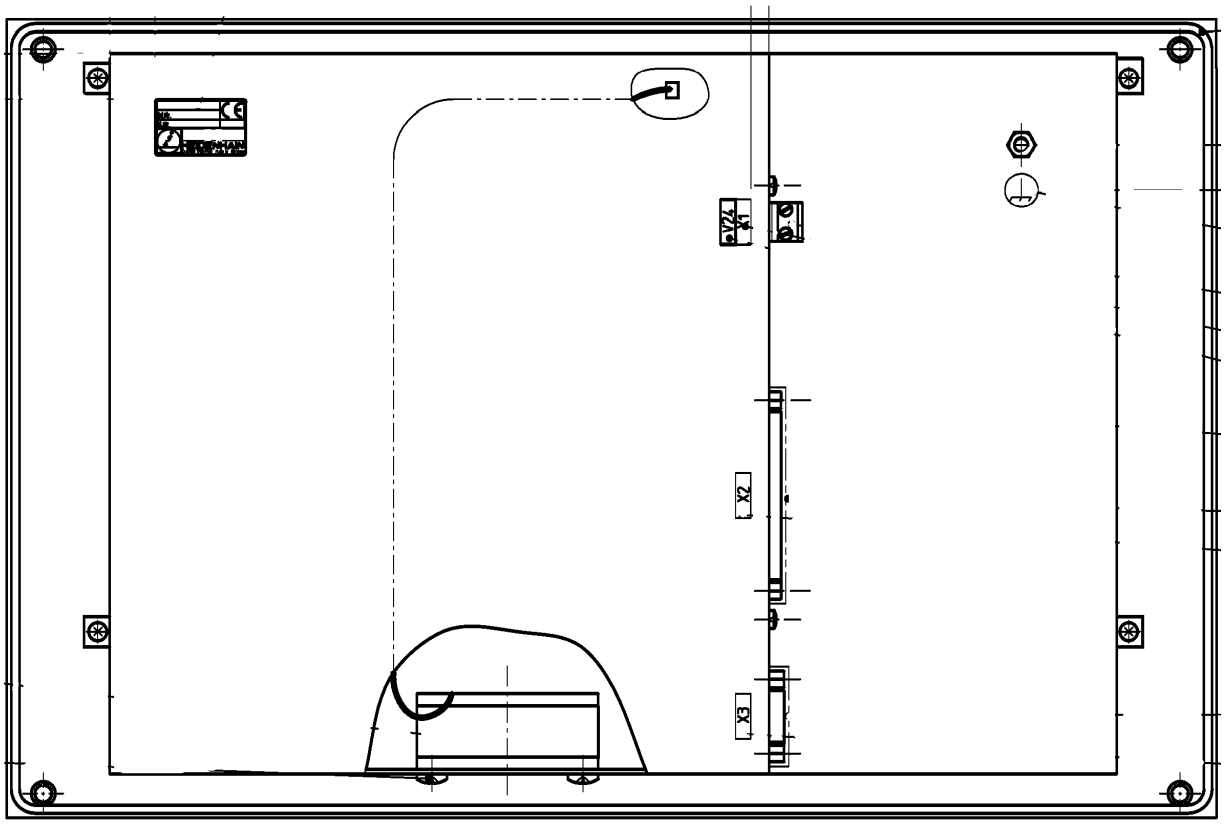
BC 120

Line voltage	100 V to 240 V
Frequency range	50 Hz to 60 Hz
Power consumption	80 W

Line connection with Euro connector

Terminal	**Assignment**
L1	L1 (black)
N	zero conductor (blue)
⏚	GND (yellow/grey)

12.4.3 BF 120



BF 120

X1 Power supply

Connecting terminal	**Assignment**
1	+24V- power supply with basic insulation according to IEC 742, EN 50 178
2	0 V

Power consumption: 15 W

12.5 Buffer battery

The buffer battery is the voltage source for the RAM when the machine is switched off.

If the error message

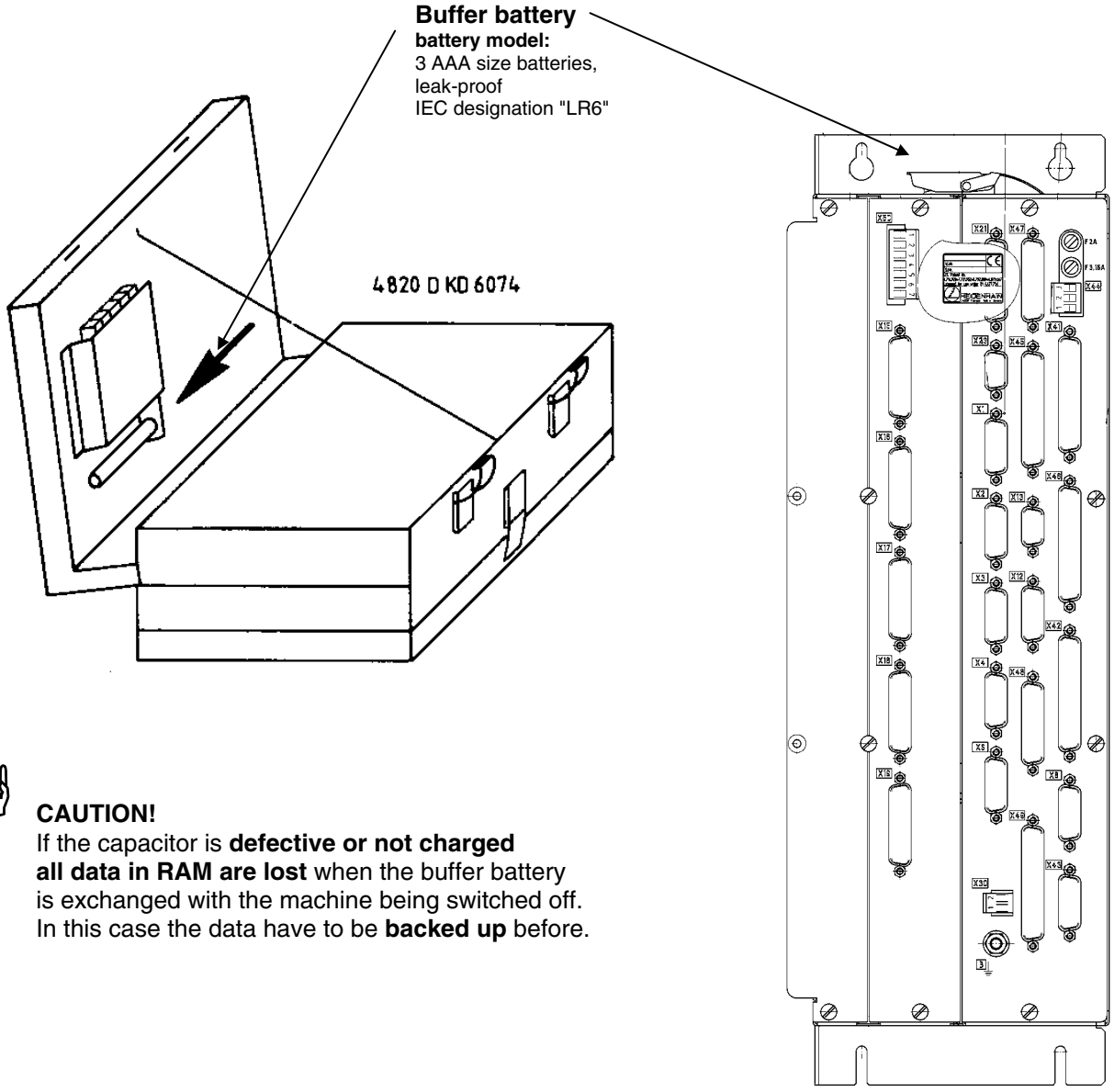
Exchange buffer battery

is displayed, the batteries must be exchanged within one week.
The buffer batteries are located behind a screw fitting in the power supply unit of the LE. To exchange the batteries the LE must be opened by undoing the snaps.

In addition to the batteries the TNC features a capacitor located on the processor board to secure RAM data.
Therefore, the line voltage may be switched off when the batteries are exchanged. Without the batteries, the charge of the capacitor is capable of maintaining the memory contents for about one day.

The buffer battery of LE 410CA/PA is located next to the power supply unit.

The buffer battery of LE 410MA is located at the inner backside of the housing

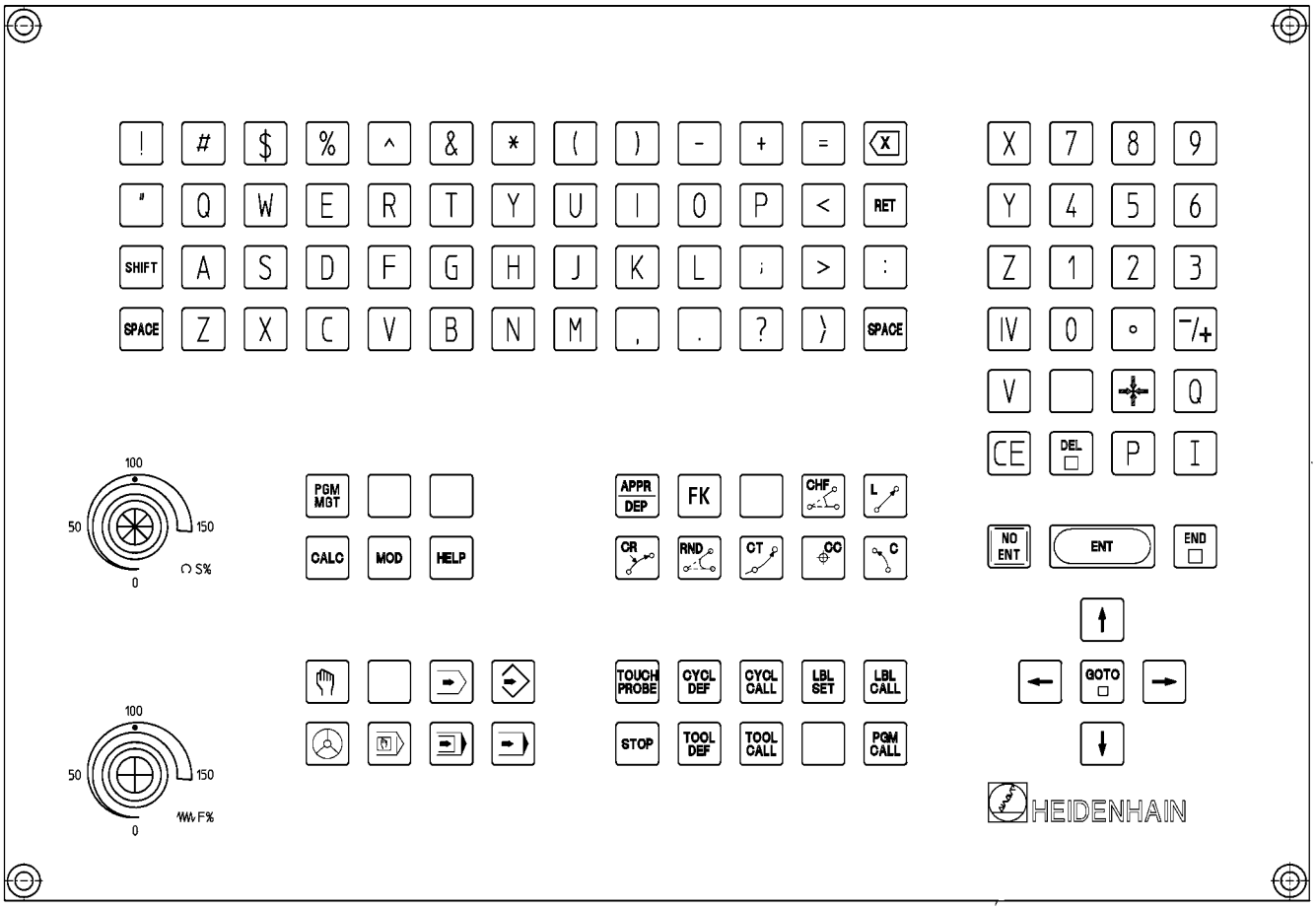


CAUTION!
If the capacitor is **defective or not charged all data in RAM are lost** when the buffer battery is exchanged with the machine being switched off. In this case the data have to be **backed up** before.

13. Keyboard unit TE 401B/420

13.1 Overview

TE 401B Id.No. 250 517 05 (black)
TE 420 Id.No. 313 038 01 (grey)



13.2 Checking the keyboard unit

The keyboard unit can be checked quickly and reliably by means of a test adapter.

13.2.1 Checking the key functions

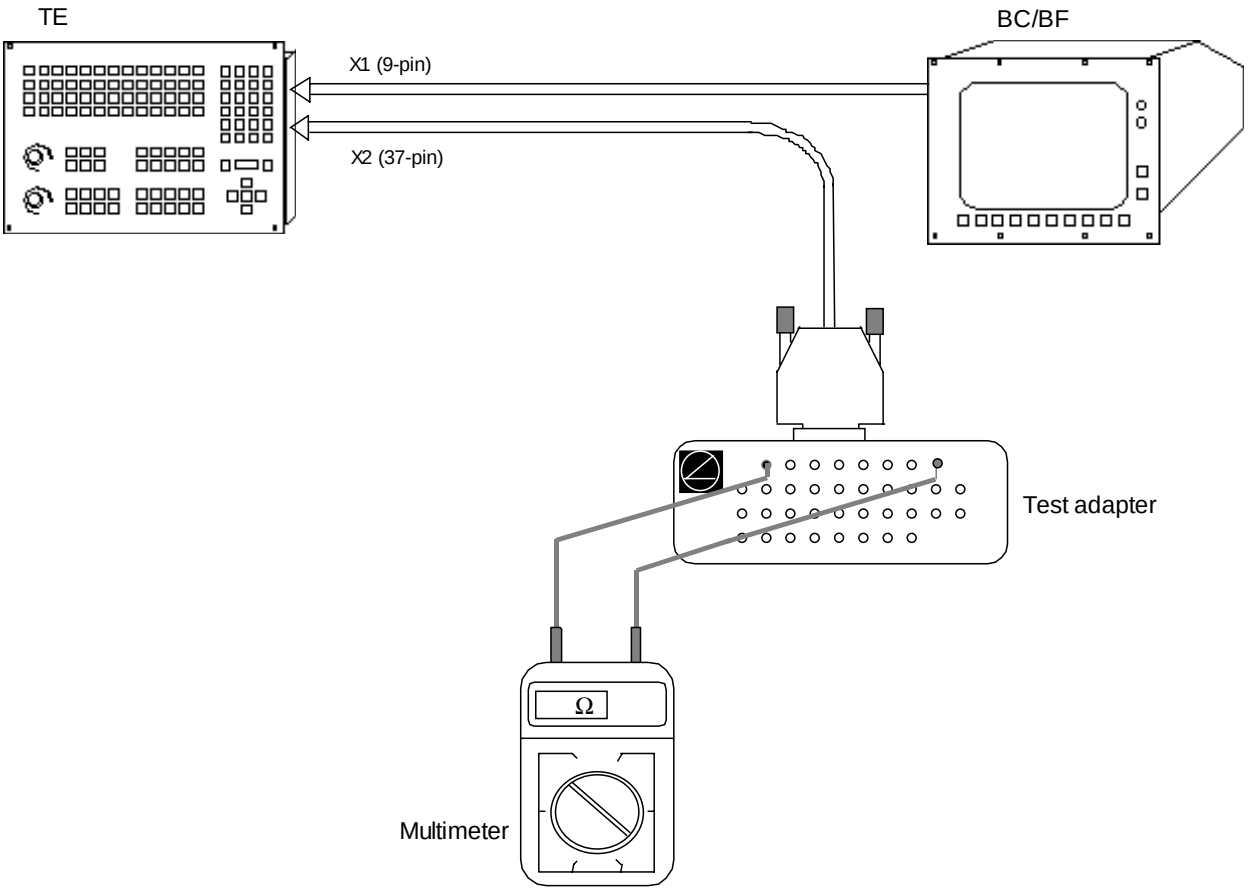
Proceeding:

Observe the safety instructions!

- Switch off power
- Disconnect the keyboard unit from the LE and connect the test adapter to the keyboard unit (see section "Test units").
  The key contacts can now be measured at the test adapter with an ohmmeter.

If e.g. the key PGM MGT is pressed at the TNC operating panel, a resistance of approximately 1Ω must be measured at the adapter (see key matrix in section 13.2.3 and 13.2.4); consider the resistance of the testing wires.

13.2.2 Measuring setup for checking the functions of the NC keys



13.2.3 Key matrix of the keyboard unit

X2 Pin	1	2	3	4	5	6	7	8	9	17	18	19	28	29	31	32	20	21	22	23	24	25	26	27
Key	RL0	1	2	3	4	5	6	7	8	16	17	18	19	20	21	22	SL0	1	2	3	4	5	6	7
!										X							X							
#										X								X						
$											X						X							
%											X							X						
^												X					X							
&												X						X						
*													X				X							
(													X					X						
)														X			X							
−														X				X						
+															X		X							
=															X			X						
⌫																X	X							
"										X								X						
Q										X										X				
W											X								X					
E											X									X				
R												X							X					
T												X								X				
Y													X						X					
U													X							X				
I														X					X					
O														X						X				
P															X				X					

X2 Pin	1	2	3	4	5	6	7	8	9	17	18	19	28	29	31	32	20	21	22	23	24	25	26	27
Key	RL0	1	2	3	4	5	6	7	8	16	17	18	19	20	21	22	SL0	1	2	3	4	5	6	7
<															X					X				
RET																X			X					
SHIFT										X											X			
A										X												X		
S											X										X			
D											X											X		
F												X									X			
G												X										X		
H													X								X			
J													X									X		
K														X							X			
L														X								X		
;															X						X			
>															X							X		
:																X					X			
SPACE										X													X	
Z										X														X
X											X												X	
C											X													X
V												X											X	
B												X												X
N													X										X	
M													X											X
,														X									X	

X2 Pin	1	2	3	4	5	6	7	8	9	17	18	19	28	29	31	32	20	21	22	23	24	25	26	27
Key	RL0	1	2	3	4	5	6	7	8	16	17	18	19	20	21	22	SL0	1	2	3	4	5	6	7
.														X										X
?															X								X	
\															X									X
SPACE																X							X	
PGM MGT								X													X			
							X														X			
						X															X			
CALC					X																X			
MOD						X													X					
HELP		X																						X
	X																						X	
		X															X							
			X																					X
					X																		X	
	X																							X
		X																					X	
			X																				X	
				X																			X	
APPR DEP									X								X							
									X									X						
									X										X					

X2 Pin	1	2	3	4	5	6	7	8	9	17	18	19	28	29	31	32	20	21	22	23	24	25	26	27
Key	RL0	1	2	3	4	5	6	7	8	16	17	18	19	20	21	22	SL0	1	2	3	4	5	6	7
CHF									X											X				
L								X												X				
CR							X													X				
RND							X												X					
CT								X											X					
CC						X														X				
C					X															X				
TOUCH PROBE				X													X							
CYCL DEF								X										X						
CYCL CALL							X											X						
LBL SET						X												X						
LBL CALL					X													X						
STOP					X														X					
TOOL DEF								X									X							
TOOL CALL							X										X							
■						X											X							
PGM CALL					X												X							
X				X																	X			
7			X																		X			
8		X																			X			
9	X																				X			
Y				X																X				
4			X																	X				

X2 Pin	1	2	3	4	5	6	7	8	9	17	18	19	28	29	31	32	20	21	22	23	24	25	26	27
Key	RL0	1	2	3	4	5	6	7	8	16	17	18	19	20	21	22	SL0	1	2	3	4	5	6	7
5		X																		X				
6	X																			X				
Z				X															X					
1			X																X					
2		X																	X					
3	X																		X					
IV				X														X						
0		X																X						
.			X															X						
-/+	X																	X						
V									X												X			
									X													X		
			X																			X		
Q			X														X							
CE					X																	X		
DEL □				X																		X		
P				X																				X
I					X																			X
NO ENT		X																				X		
ENT	X																					X		
END □	X																X							
↑								X														X		
←						X																X		
GOTO □							X															X		
→								X															X	
↓						X																	X	

13.2.4 Key matrix of the VDU keys

BC 110B

X1 Pin 1)	4b	3b	2b	1b	1a	2a	3a	4a
X2 Pin 1)	13	14	15	16	20	21	22	23
Key 2)	RL12	RL13	RL14	RL15	SL0	SL1	SL2	SL3
◁				X		X		
SK1			X			X		
SK2		X				X		
SK3	X					X		
SK4				X			X	
SK5			X				X	
SK6		X					X	
SK7	X						X	
SK8				X				X
▷			X					X
↺	X				X			
↻		X			X			

1) connector on the keyboard unit
2) key on VDU

X1: connection of ribbon cable *VDU ⇨ keyboard unit* (plug-type connector)
X2: connection of cable *keyboard unit ⇨ logic unit* (D-SUB 37-pin)

SK = **s**oft **k**ey (SK1...SK8 from left to right)

BC 120 / BF 120

X1 Pin 1)	4b	3b	2b	1b	1a	2a	3a	4a
X2 Pin 1)	13	14	15	16	20	21	22	23
Key 2)	RL12	RL13	RL14	RL15	SL0	SL1	SL2	SL3
◁				X		X		
↻	X				X			
SK1			X			X		
SK2		X				X		
SK3	X					X		
SK4				X			X	
SK5			X				X	
SK6		X					X	
SK7	X						X	
SK8				X				X
▷			X					X
↻		X			X			

1) connector on the keyboard unit
2) key on VDU

X1: connection of ribbon cable *VDU ⇨ keyboard unit* (plug-type connector)
X2: connection of cable *keyboard unit ⇨ logic unit* (D-SUB 37-pin)

SK = **s**oft **k**ey (SK1...SK8 from left to right)

13.2.5 Checking the potentiometers

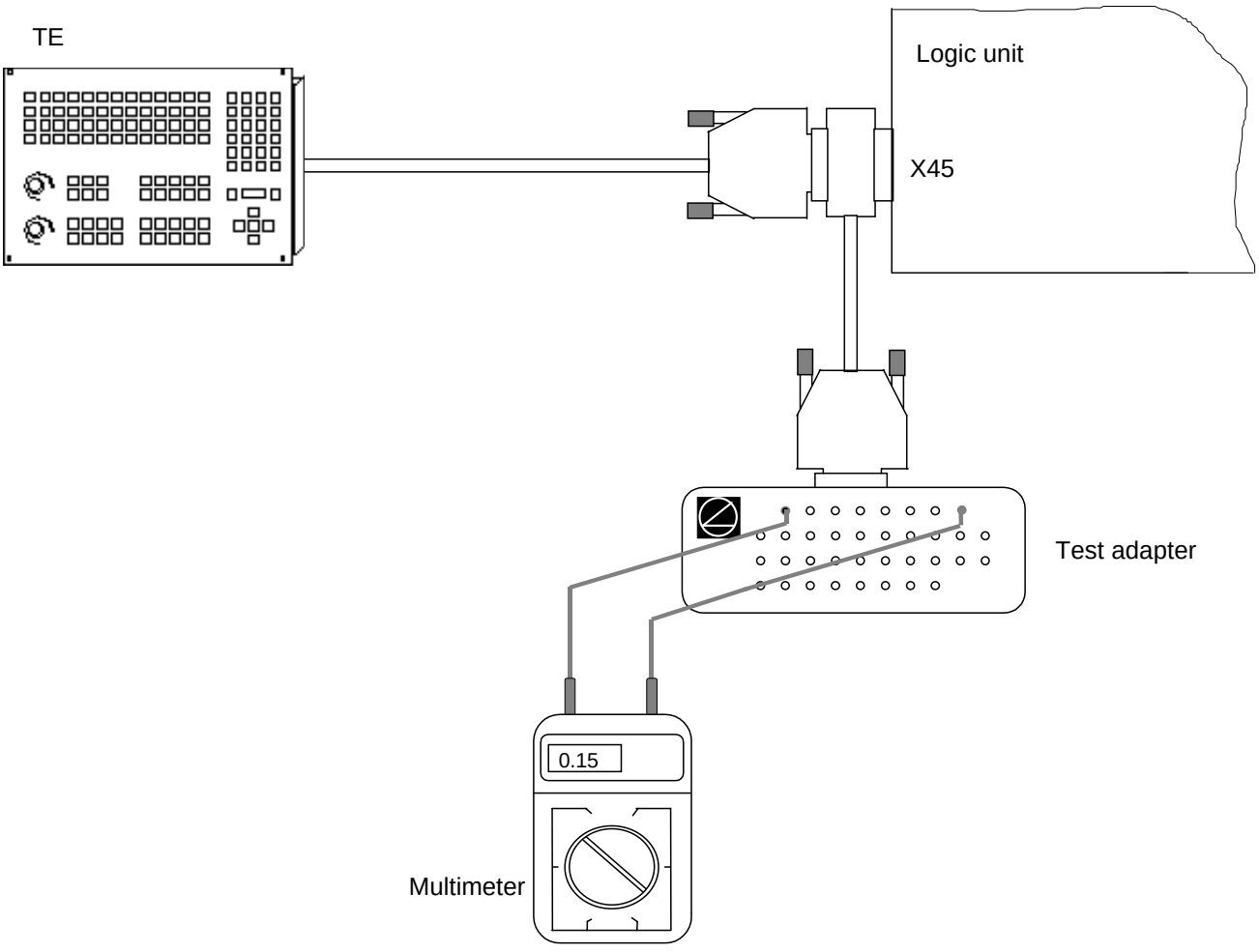
Proceeding:

Observe the safety instructions!

Connect the test adapter to X45 of the logic unit. Now the wiper voltages of the potentiometers can be measured by means of a multimeter.

Potentiometer	**PIN**	**Voltage range**
Override F%	37 = 0V / 35 = + pot	(0 ... approx. 4.95)V
Spindle S%	37 = 0V / 34 = + pot	(0 ... approx. 4.95)V

13.2.6 Measuring setup for checking the potentiometers

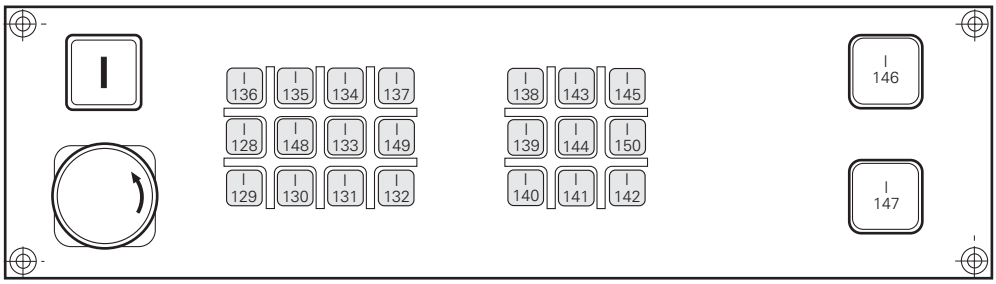


13.2.7 Machine operating panel MB 420

The PLC inputs of the machine operating panel MP 420 (I128 – I150) can be checked at the 37-pin flange socket of MB 420 or a the flange socket X46 (connection of machine operating panel) of the TNC.

For this purpose the TABLE function (see section PLC interface) in the PLC mode is helpful as well.

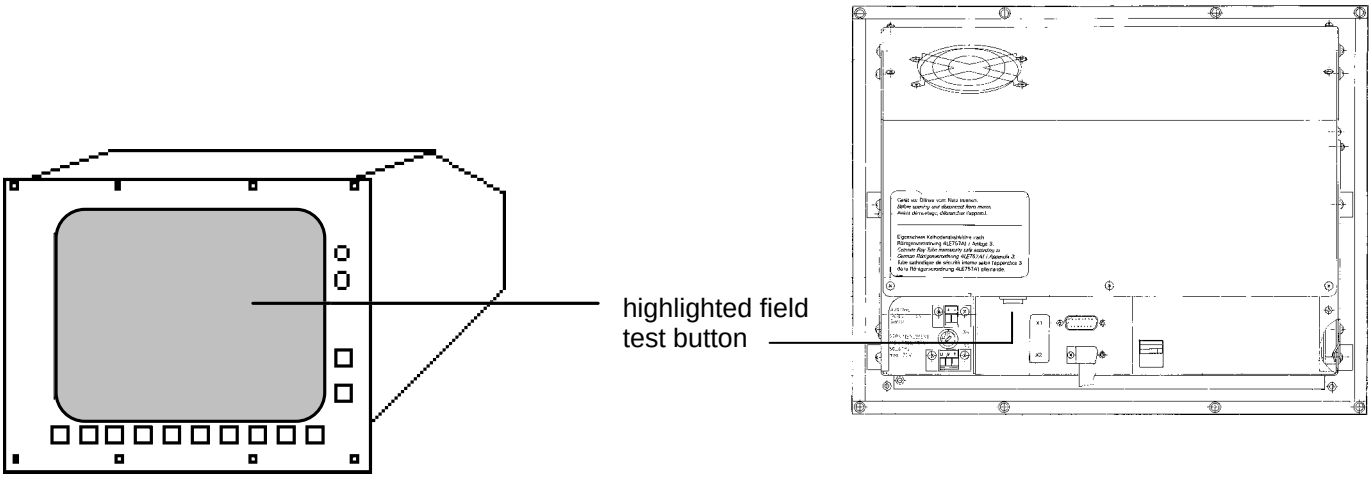
Allocation of the PLC inputs to the keys of MB 420:



14. Visual display units

14.1 Checking the VISUAL DISPLAY UNIT BC 110B

If the screen remains dark when the machine is switched on, first check the power supply (line voltage) of the VDU. If the power supply is functioning properly, a square highlighted filed can be generated on the screen of the VDU (which must be switched on) by pressing the external test button on the back side of the unit.



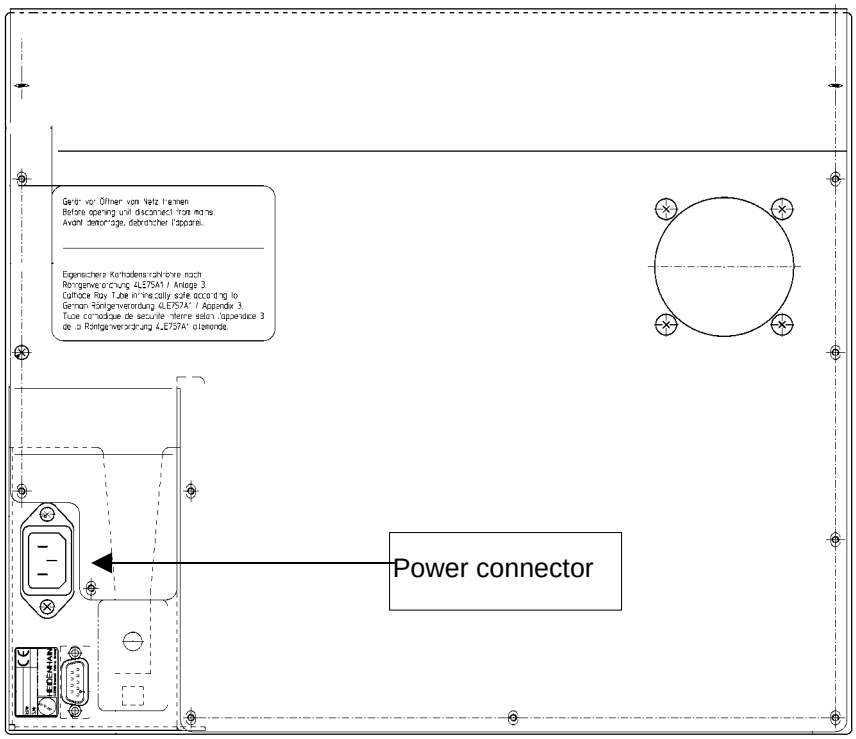
If the VDU generates this highlighted field, the PLC graphics board in the logic unit is probably defective.
If however, the VDU remains dark after the test button has been pressed, the VDU is defective and must be exchanged.

The control signals for the VDU can only be checked by means of an oscilloscope.
The diagrams on the following page have been recorded with the VDU connected. The color signals R-analog, G-analog and B-analog may differ from these diagrams (depending on the machine parameters and on the image depicted).

Pin layout see section 8

14.2 Checking the VISUAL DISPLAY UNIT BC 120

If the screen remains dark when the machine is switched on, first check the power supply (line voltage) of the VDU.



The control signals for the VDU can only be checked by means of an oscilloscope.
The diagrams on the following page have been recorded with the VDU connected. The color signals R-analog, G-analog and B-analog may differ from these diagrams (depending on the machine parameters and on the image depicted).

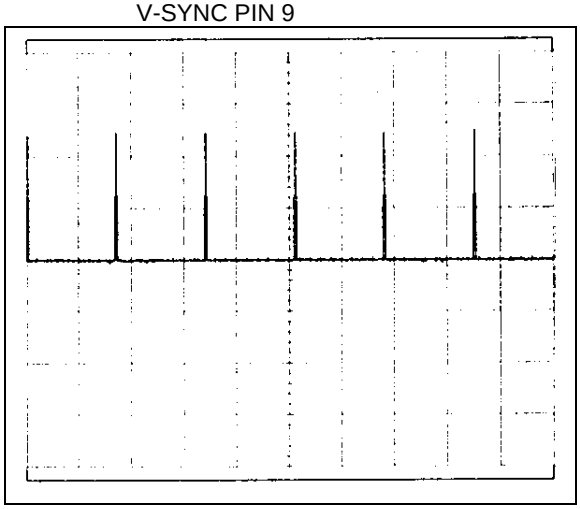
Pin layout of connector X43: see BC 110B!

Pin layout see section 8

Diagrams

V-SYNC PIN 9

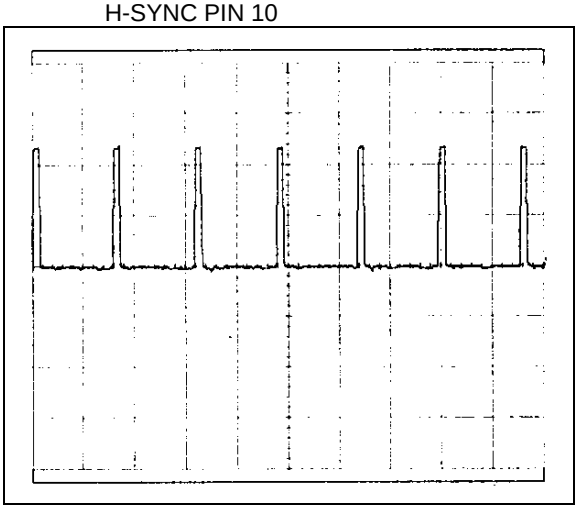
2V/DIV



10 ms/DIV

H-SYNC PIN 10

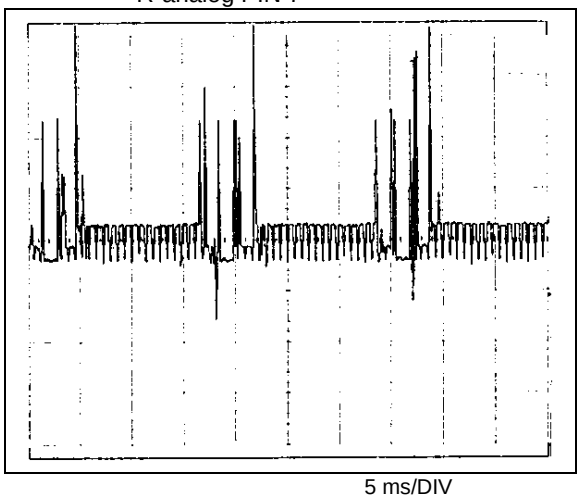
2V/DIV



20 µs/DIV

R-analog PIN 7 1)

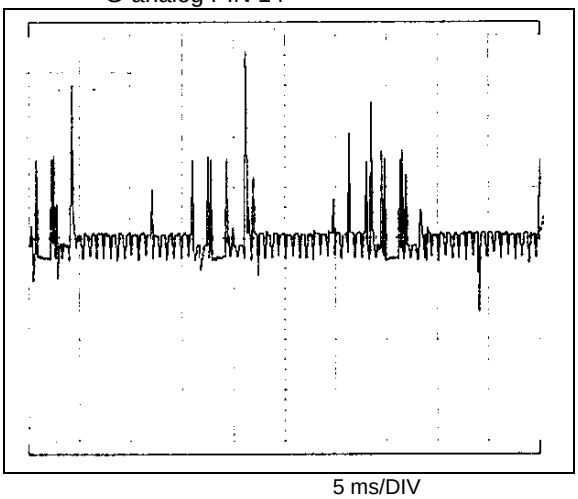
0.2V/DIV



5 ms/DIV

G-analog PIN 14 1)

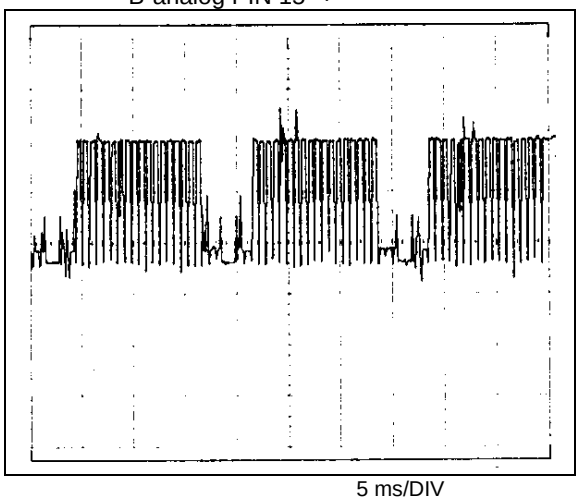
0.2V/DIV



5 ms/DIV

B-analog PIN 15 1)

0.2V/DIV

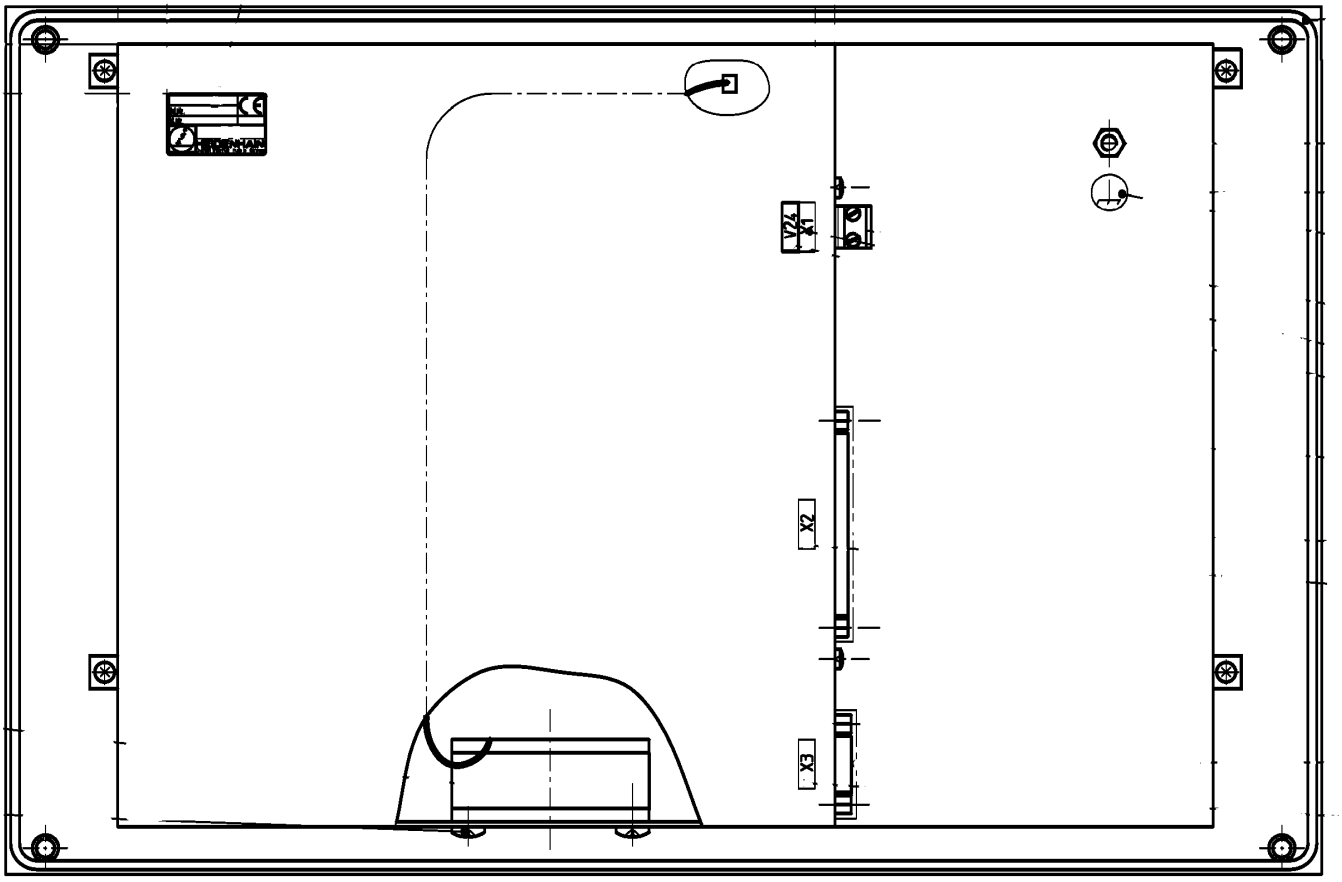


5 ms/DIV

1) If the color signals are measured directly at the output of the logic unit without the VDU connected, the amplitudes are about twice as large.

14.3 Checking the VISUAL DISPLAY UNIT BF 120

If the screen remains dark when the machine is switched on, first check the power supply (line voltage) at the 2-pin connector of the VISUAL DISPLAY UNIT.
If the power supply is in order, the flat-panel display **cannot** be checked further without special testing equipment.



BF 120

X1 Power supply

Connecting terminal	**Assignment**
1	+24V power supply with basic insulation according to IEC 742, EN 50 178
2	0 V

Power consumption: 15 W

15. Encoder interface

15.1 Position encoder circuit

Position encoder inputs on the processor board of the logic unit

X1 = position encoder 1st axis
X2 = position encoder 2nd axis
X3 = position encoder 3rd axis
X4 = position encoder 4th axis
X6 = position encoder spindle

TNC 410 monitors the signals of the position encoders and outputs an error message in plain language depending on the error detected.

<Axis> encoder: amplitude too small

Amplitude error

<Axis> encoder: frequency too high

Signal frequency error (edge separation)

<Axis> measuring system defective

Error with distance-coded scales

Error causes

- Glass scale contaminated or defective
- Scanning head contaminated or defective
- Cable damaged
- Encoder input of the logic unit (LE) defective

Locating an error in the position encoder circuit

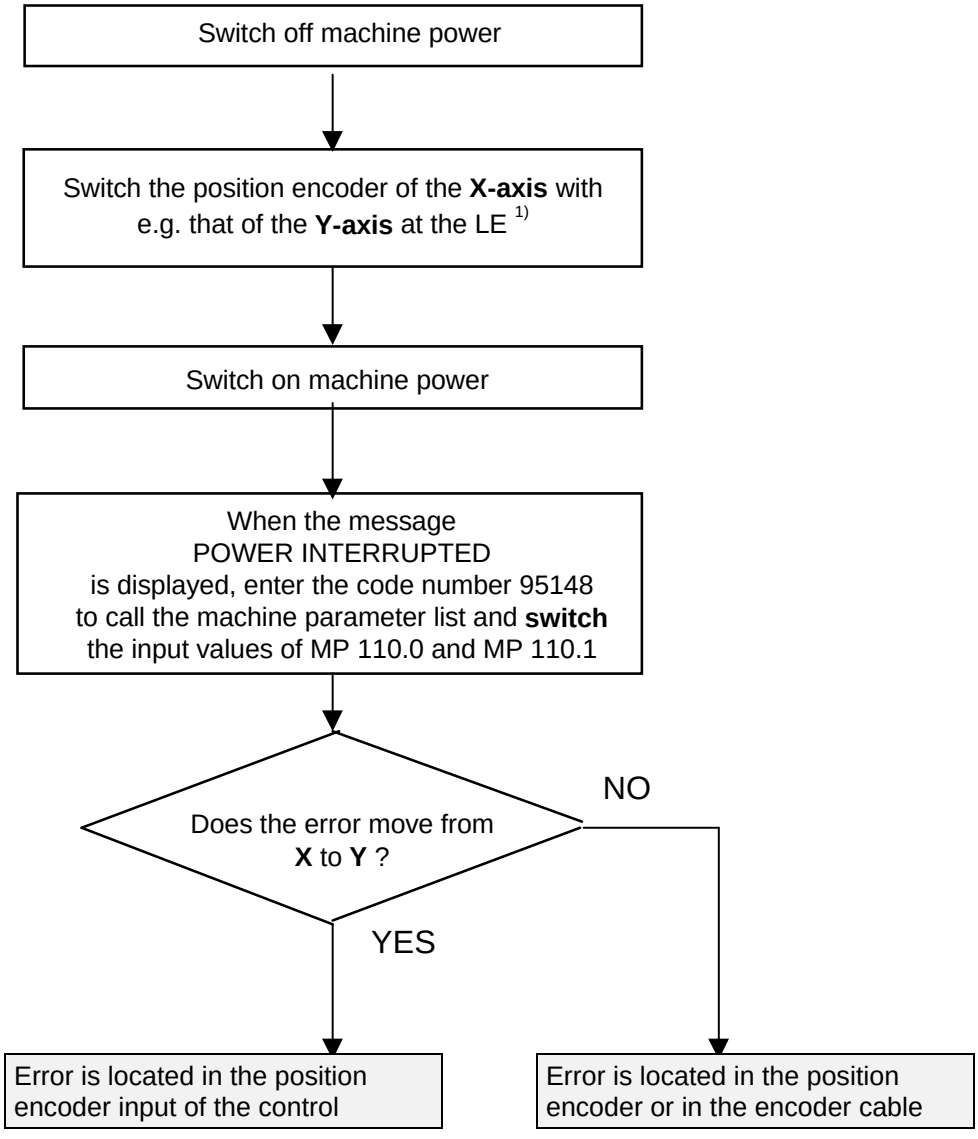
To find out whether the encoder or the encoder input of the logic unit is defective, the encoders can be switched at the logic unit. For this purpose the values of the related machine parameters must be changed, too.

Function	**MP**	**Input value**
Allocation of the position encoder input to the **axes**		
X-axis	110.0	0 = no position encoder
Y-axis	110.1	1 = position encoder input X1
Z-axis	110.2	2 = position encoder input X2
4th axis	110.3	3 = position encoder input X3
		4 = position encoder input X4
		6 = position encoder input X6
Allocation of the position encoder input to the **spindle**	111	see MP 110.X

Flowchart to locate an error in the position encoder circuit

X encoder: amplitude too small

The following machine parameter configuration serves as an **example**:
MP 110.0 = 1 (X-axis at position encoder input X1)
MP 110.1 = 2 (Y-axis at position encoder input X2)
MP 110.2 = 3 (Z-axis at position encoder input X3)
MP 110.3 = 4 (4th axis at position encoder input X4)



1) **Caution:** Only switch encoders that provide the same signal type!

Observe the safety instructions!

15.2 Speed encoder circuit (LE 410 PA/MA only)

Digital axes normally are operated with two encoders per axis.
In most cases sealed encoders are used as position encoders.
The speed encoder is a rotary encoder incorporated in the servo drive.

Speed encoder inputs on the drive-control board of the logic unit:

X15 = speed encoder 1st axis
X16 = speed encoder 2nd axis
X17 = speed encoder 3rd axis
X18 = speed encoder 4th axis
X19 = speed encoder 5th axis

TNC 410 monitors the signals of the speed encoders and outputs an error message in plain language depending on the error detected.

<Axis> motor encoder: Zn ampl. too small

Amplitude error in Zn track

<Axis> motor encoder: Z1-ampl. too small

Amplitude error in Z1 track

<Axis> motor encoder: frequency too high

Signal frequency error (edge separation)

Error causes

- Cable of motor encoder damaged
- Graduated disk of motor encoder contaminated or defective
- Speed encoder input of the logic unit (LE) defective
- Electronics of motor encoder defective

Locating an error in the speed encoder circuit

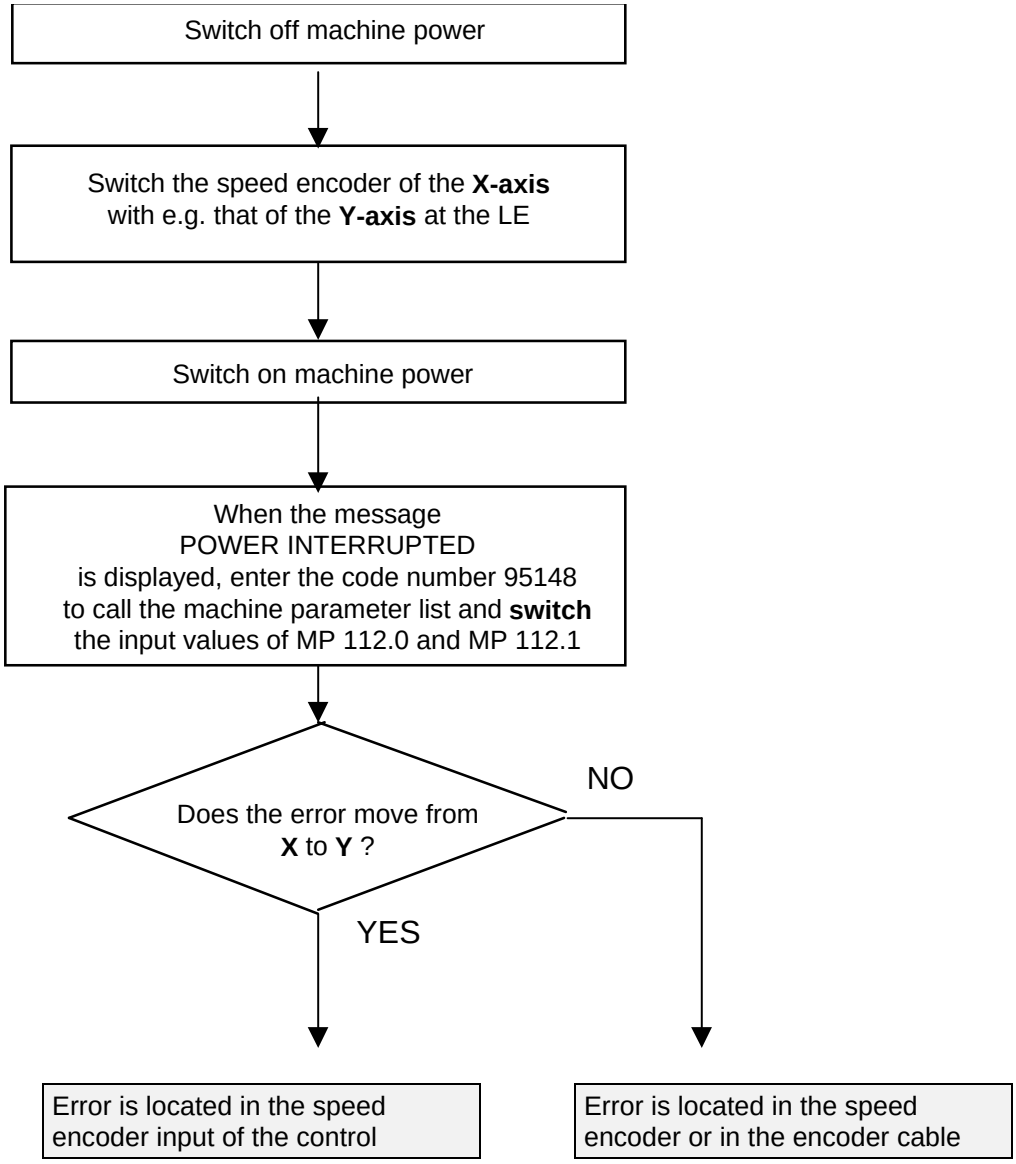
To find out whether the encoder or the encoder input of the logic unit is defective, the encoders can be switched at the logic unit. For this purpose the values of the related machine parameters must be changed, too.

Function	**MP**	**Input value**
Allocation of the speed encoder inputs to the **axes**		
X-axis	112.0	0 = no speed encoder
Y-axis	112.1	15 = speed encoder input X15
Z-axis	112.2	16 = speed encoder input X16
4th axis	112.3	17 = speed encoder input X17
		18 = speed encoder input X18
		19 = speed encoder input X19
Allocation of the speed encoder inputs to the **spindle**	113	see MP 112.X

Flowchart to locate an error in the speed encoder circuit

X motor encoder: Zn amplitude too small

The following machine parameter configuration serves as an **example**:
MP 112.0 = 1 (X-axis at speed encoder input X15)
MP 112.1 = 2 (Y-axis at speed encoder input X16)
MP 112.2 = 3 (Z-axis at speed encoder input X17)
MP 112.3 = 4 (4th axis at speed encoder input X18)



CAUTION: The speed encoder is a modular rotary encoder integrated in the servo drive. It can only be exchanged **together** with the servo drive.

Observe the safety instructions !

15.3 Checking an encoder

In order to make a precise statement on the electrical function of a measuring system, it must be measured with a **phase angle measuring unit** (PWM), an oscilloscope and a leak tester. (see operating instructions of Encoder diagnostic set)

A number of adapters are available to measure the different types of encoder signals (11µA, 1Vpp, TTL) at TNC 410 with the PWM.

You can find a **connection diagram** of the different adapters including Id.Nos. in the section "Test units".

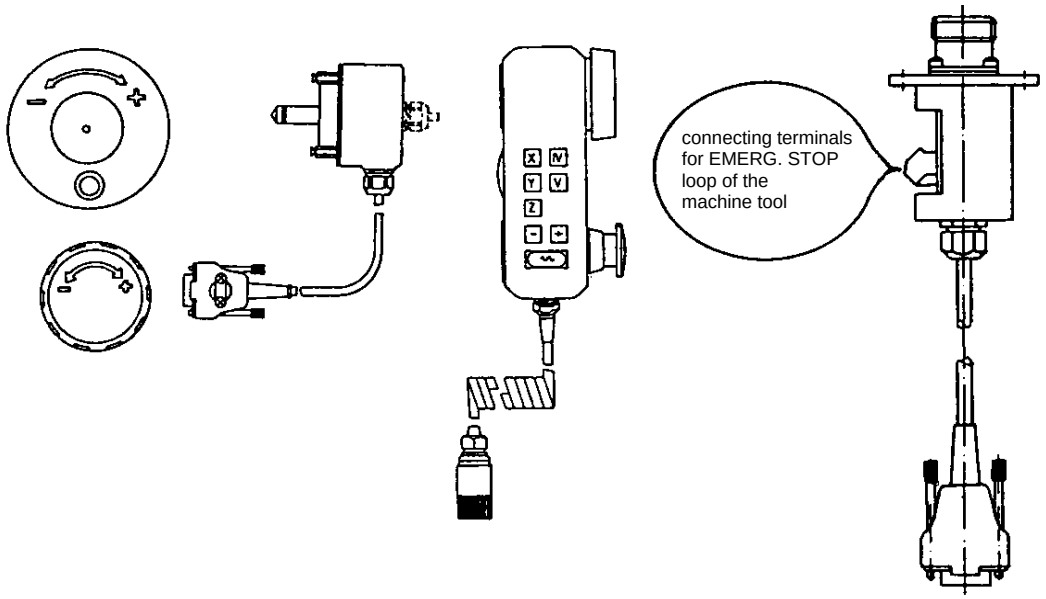
Notes

16. Serial handwheels

A number of serial handwheels can be operated as options with TNC 410. These handwheels are adapted via the machine parameters MP7640 to MP7671.X.

16.1 Handwheel HR 130/330

HR 130	Id.No. 254 040 --	HR 330	Cable adapter for HR 330
HR 130.001	Id.No. 249 371 --	Id.No. 251 534 --	Id.No. 249 889 --



Pin	Color	Signal
2	white	0V
4	brown	+12V
6	yellow	DTR
8	green	RxD

Pin	Color	Signal
1	blue	EMG.
2	blue	STOP
3	green	RxD
4	yellow	DTR
5	brown	+12V
6	white	0V

16.1.1 Checking the data transfer of handwheel HR 130/330

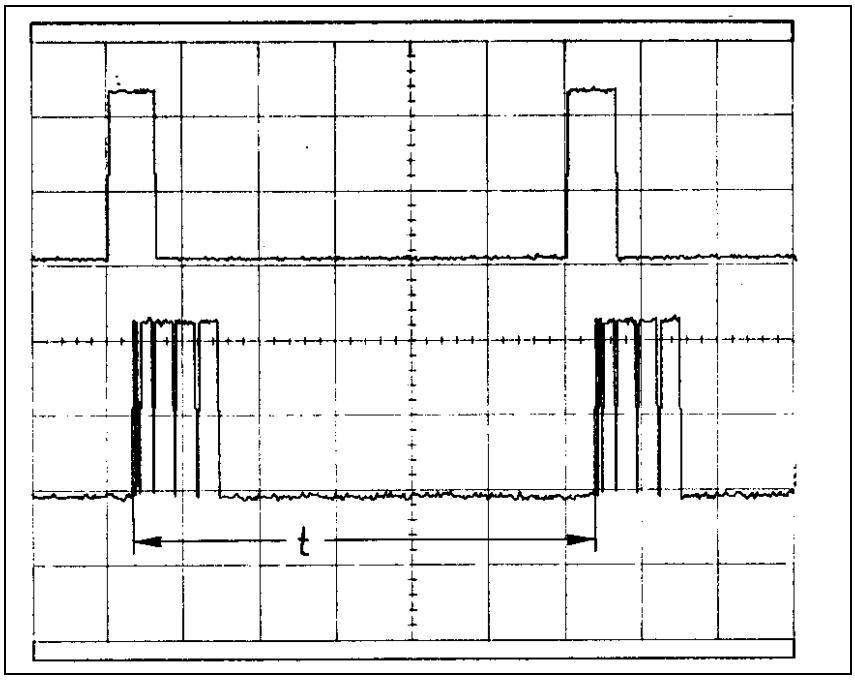
The serial handwheels HR 130 (panel-mounted handwheel without auxiliary keys) and HR 330 (portable handwheel with auxiliary keys) can be checked using an oscilloscope. The following signals can be measured at the handwheel input X23 of the LE. The signals must correspond to the diagrams below:

Pin 6
DTR

0V

Pin 8
RxD

0V



t = 6ms

The handwheel is powered via the logic unit (X23 pin 2 = 0V, pin 4 = + 12V)

16.1.2 Checking the keys of the handwheel HR 330

Depending on machine parameter MP 7640 the HR 330 handwheel behaves as follows:

MP7640 = 1: HR 330 (all keys evaluated by NC)
By pressing the axis buttons on the operating panel the cursor can be moved to Actual value transfer or Datum setting. The axis keys on the handwheel serve to move the handwheel symbol on the screen. The keys RAPID, + and – are directly evaluated by the NC, and the inputs I160 to I162 are set accordingly.

MP7640 = 2: HR 330/130 (all keys evaluated by NC)
The cursor and the handwheel symbol on the screen can be moved by pressing the axis buttons on the operating panel and on the HR.
An axis can also be selected via the TNC keyboard (HR 130 panel-mounted handwheel).
The keys RAPID, + and – are directly evaluated by the NC, and the inputs I160 to I162 are set accordingly.

MP7640 = 3: HR 330 (keys +, – and RAPID evaluated by PLC)
By pressing the axis buttons on the operating panel the cursor can be moved to Actual value transfer or Datum setting. The axis keys on the handwheel serve to move the handwheel symbol on the screen. The keys RAPID, + and – must be evaluated by the PLC. The inputs I160 to I162 are set accordingly.

Allocation of the keys to the PLC inputs

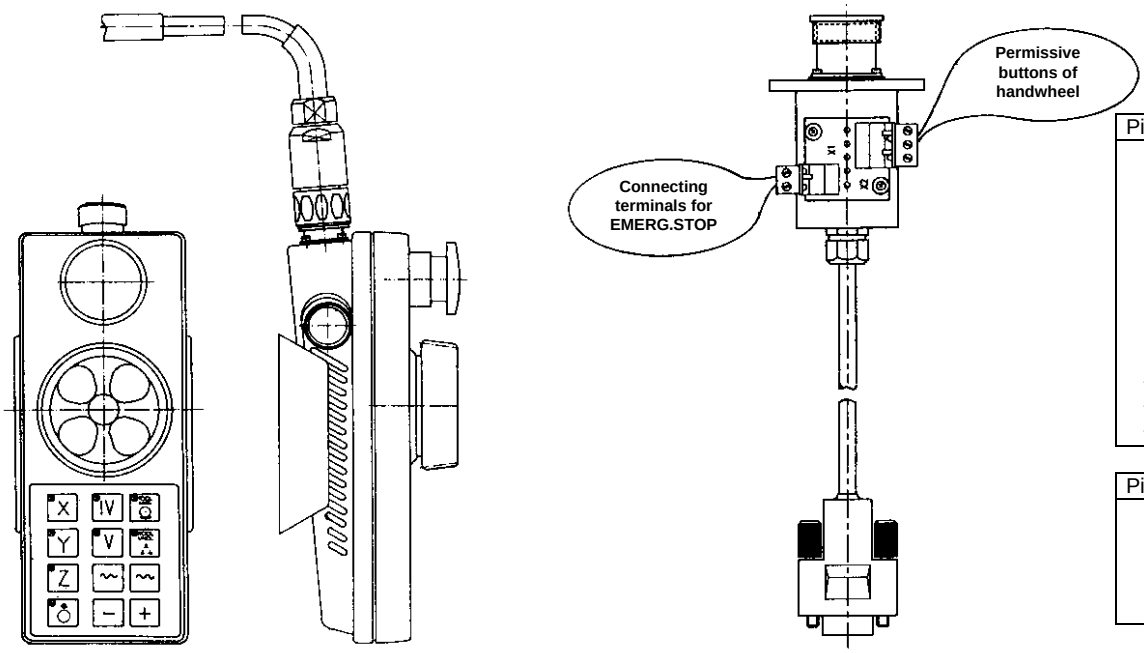
Key on HR	PLC input
+	I160
–	I161
Rapid traverse	I162

16.2 Handwheel HR 332

HR 332

Connecting cable

Adapter connector (12-pin → 9-pin)



Pin	Signal
1	EMERG. STOP
2	EMERG. STOP
3	permissive button[1)]
4	permissive button[1)]
5	permissive button[1)]
6	not assigned
7	TxD
8	RxD
9	shield
10	DSR
11	0V
12	+ 12V

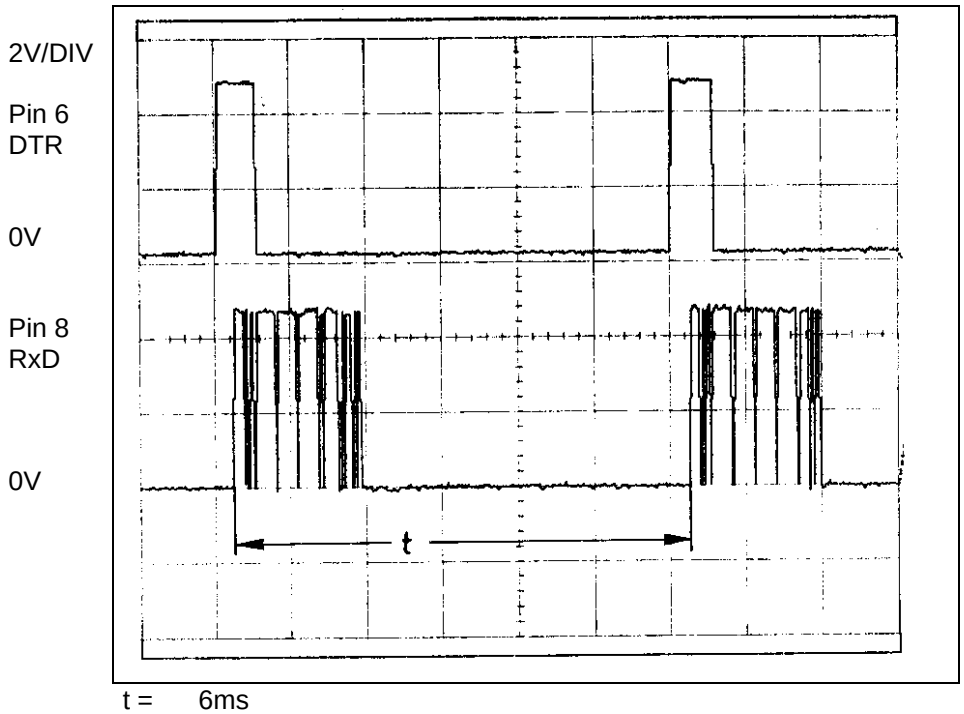
Pin	Signal
2	0V
4	+ 12V
6	DTR
7	TxD
8	RxD

The assignment of the handwheel keys depends on the version

[1)] The number of the permissive buttons and the internal wiring depend on the version of HR 332

16.2.1 Checking the data transfer of handwheel HR 332

The serial handwheel HR 332 can be checked by means of an oscilloscope. The following signals can be measured at the handwheel input X32 of the logic unit. The signals must correspond to the diagram below:



t = 6ms

The handwheel is powered via the logic unit (X23 pin 2 = 0V, pin 4 = + 12V)

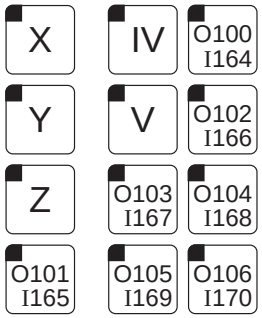
16.2.2 Checking the keys of the handwheel HR 332

MP7640 = 4: **HR 332**
By pressing the axis buttons on the operating panel the cursor can be moved to Actual value transfer or Datum setting. The axis keys on the handwheel serve to move the handwheel symbol on the screen. In MP7645.0 can be defined, whether all twelve keys and the corresponding LEDs can be addressed by PLC or whether the axis buttons and their LEDs are excepted.

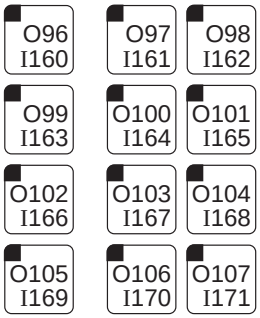
Allocation of the keys and LEDs to the PLC inputs and outputs
Depending on the value entered in MP7645.0 the 12 keys on the HR 332 handwheel are assigned to different PLC inputs and the 12 LEDs to different PLC outputs.
If a key is pressed, the corresponding PLC input is set. If a PLC output is set, the corresponding LED lights up.

Depending on the machine parameter MP 7645.0 the handwheel HR 332 behaves as follows:

If **MP7645.0 = 0**, the keys X, Y, Z, IV and their LEDs are assigned to NC. The remaining keys are assigned to the PLC inputs I164 to I170. The LEDs are assigned to the PLC outputs O100 to O106.



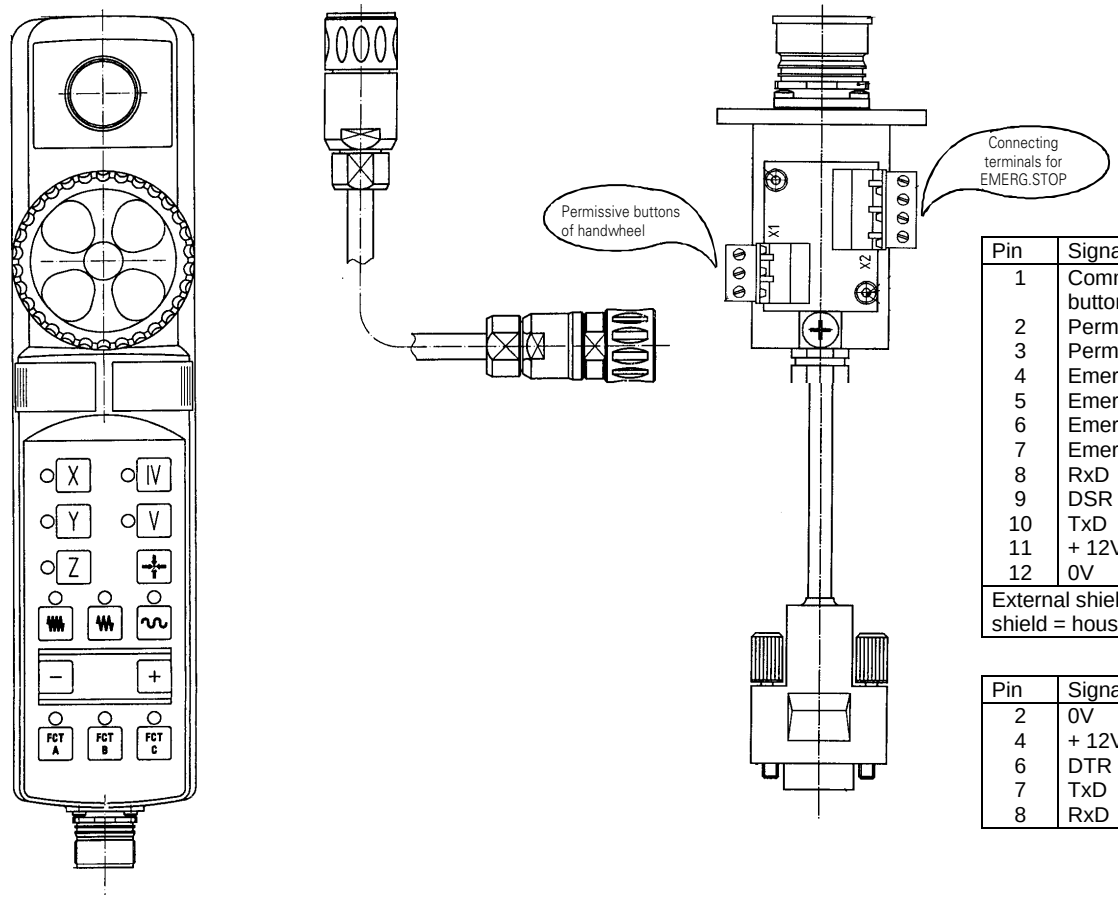
If **MP7645.0 = 1**, all twelve keys are assigned to the PLC inputs I160 to I171 and all LEDs to the PLC outputs O96 to O107. The handwheel symbol in the status window can be set via module 9036.



MP7645 Initializing parameter for the handwheel
When a HR 332 is connected, MP7645.0 has the following meaning:
MP7645.0 Assignment of the keys on handwheel HR 332
Input: 0 = All keys except the axis address keys and the corresponding LEDs can be addressed freely via PLC.
1 = All twelve keys and LEDs can be addressed freely via PLC.

MP7645.1 to MP7645.7 have no function.

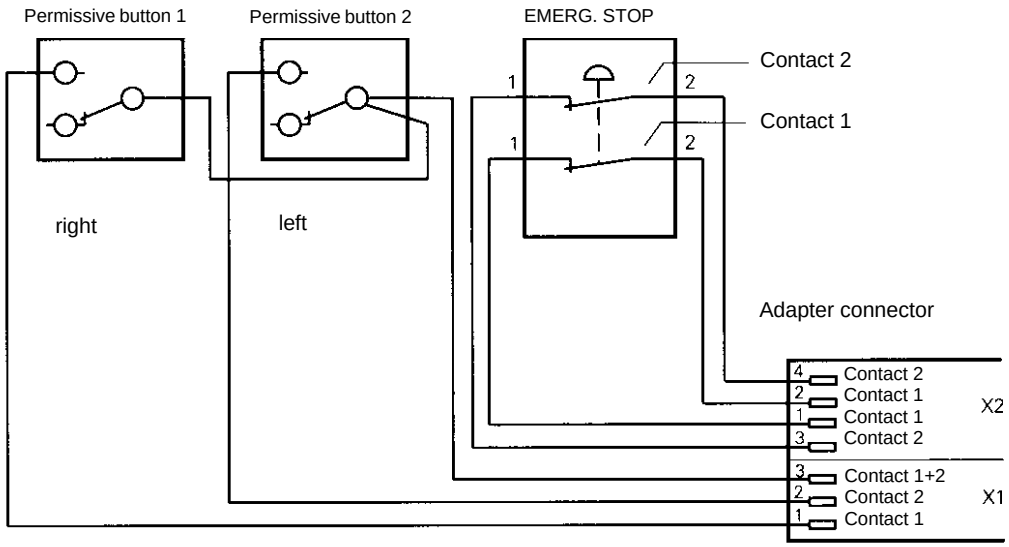
16.3 Handwheel HR 410



Pin	Signal
1	Common permissive button
2	Permissive button 2
3	Permissive button 1
4	Emerg. stop 1
5	Emerg. stop 1
6	Emerg. stop 2
7	Emerg. stop 2
8	RxD
9	DSR
10	TxD
11	+ 12V
12	0V
External shield + internal shield = housing	

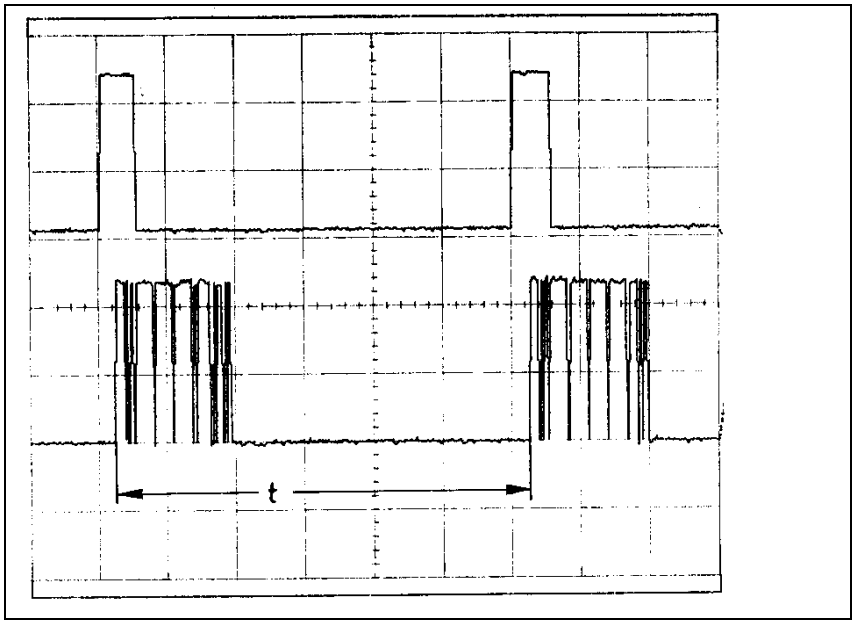
Pin	Signal
2	0V
4	+ 12V
6	DTR
7	TxD
8	RxD

Internal wiring of the contacts of permissive buttons and EMERGENCY STOP button of HR 410:



16.3.1 Checking data transfer of the handwheel HR 410

The serial handwheel HR 410 can be checked by means of an oscilloscope. The following signals can be measured at the handwheel input X23 of the logic unit. They must correspond to the diagrams below:



t = 6ms

The handwheel is powered via the logic unit (X23 pin 2 = 0V, pin 4 = + 12V)

16.3.2 Checking the keys on handwheel HR 410

MP7640 = 6: **HR 410**
In MP7645.0 is defined, whether the keys on the handwheel are evaluated by NC or by PLC.

MP7645.0 = 0
Evaluation of the keys by NC

X		IV
Y		V
Z		ACTL. VALUE TRANSFER
FEED RATE SMALL	FEED RATE MEDIUM	FEED RATE HIGH
–		+
O109 I173	O110 I174	O111 I175

Except the keys A, B and C all keys are evaluated by the NC. In MP7670.x the interpolation factors valid for small, medium and large feed rates are defined. MP7671.x defines the speed valid at low, medium and high speeds. The speed is indicated as %-factor of the handwheel feed rate (MP1020.x).

MP7645.0 =1
Evaluation of the keys by PLC

O96 I160		O97 I161
O98 I162		O99 I163
O100 I164		O103 I167
O104 I168	O105 I169	O106 I170
I171		I172
O109 I173	O110 I174	O111 I175

All keys are evaluated by the PLC. The handwheel axis and the handwheel interpolation factor are set with module 9036. W766 influences the feed rate when a direction key is pressed.

MP7645 Initializing parameter for the handwheel
When a HR 410 is mounted, the meaning of MP7645.0 is as follows:
MP7645.0 Assignment of the keys on handwheel HR 410
Input: 0 = Evaluation of the keys by NC
1 = Evaluation of the keys by PLC

MP7645.1 to MP7645.7 have no function

16.4 Error messages

Handwheel not ready X

[1096]

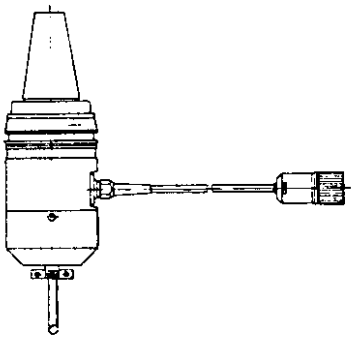
X = A : No peripheral unit connected
B : Code of peripheral unit does not match MP7640
C Y : Contamination (Y = axis)
D : Transmission error during receipt
E : Received BCC check sum incorrect
F : Peripheral unit has recognized wrong code
G : Peripheral unit has recognized wrong BCC check sum
H : Peripheral unit shows transfer error
I : Peripheral unit shows incorrect number of initializing parameter
J : Peripheral unit shows incorrect value of initializing parameter
K : Transmission error during sending
L : Undefined error code

17. 3-D touch probes

17.1 Overview

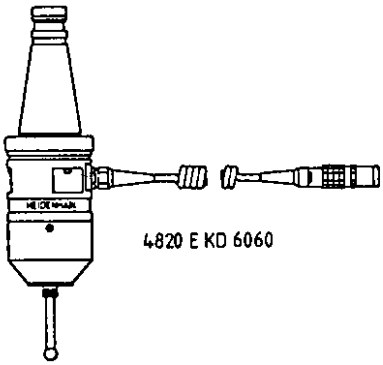
17.1.1 Touch probes for calibration and workpiece setup

TS 220
with connecting cable

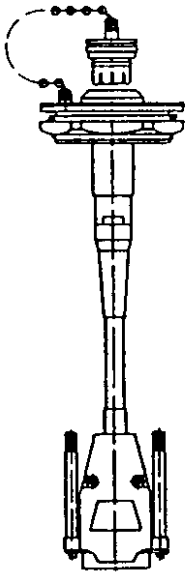


17.1.2 Touch probe for digitizing workpieces

TS 120



Adapter connector for TS 120



Notes

17.2 Error messages

17.2.1 Error messages during probing operation

Touch point inaccessible

[50]
- After starting a probing function no touch point was reached within the traverse defined in machine parameter MP6130

Stylus already in contact

[52]
- The stylus is already deflected at the start of a probing movement.

Probe system not ready

[54]
- Bad or no connection between infrared probe system and receiver (e.g. due to contamination). The two windows of the probe system must be oriented to the transmitter/receiver unit.
- Battery is dead.

Stylus deflection exceeds maximum

[454]
- Digitizing with measuring touch probe: Maximum permissible stylus deflection was exceeded.

Probe system not ready <axis>

[1150]
- The probe system is not ready.

Measuring touch probe selected

[1170]
- You have attempted to start a digitizing cycle for a triggering probe, although a measuring probe is defined in machine parameter MP6200.

Triggering touch probe selected

[1171]
- You have attempted to start a digitizing cycle for a measuring probe, although a triggering probe is defined in machine parameter MP6200.

Calibrate touch probe

[1172]
- You have attempted to automatically measure a tool, although the table probe is not yet calibrated.

17.2.2 Error messages when digitizing 3-D contours

Wrong axis programmed

[331]
- The probe axis in the scanning cycle **RANGE** is not identical with the calibrated touch probe axis.

Faulty range data

[444]
- In the **RANGE** scanning cycle a MIN coordinate is larger than or equal to the corresponding MAX value.
- In the **RANGE** scanning cycle one or several coordinates are beyond the software limit switch range.
- No **RANGE** scanning cycle is defined when the scanning cycles MEANDER or CONTOUR LINES are called.

Mirroring not permitted

[452]

Rotation not permitted

[449]

Scaling factor not permitted

[450]
- Mirroring, rotation or scaling factor were active when the scanning cycles **RANGE, MEANDER** or **CONTOUR LINES** were called.

Incorrect entry in MP <number>

[1149]
- Measuring probe system: double assignment of the probe axis to the machine axes.

Range exceeded

[443]
- During digitizing the stylus went out of the digitizing range, i.e. a part of the 3-D contour is outside the range.

CYCL parameter incorrect

[447]
- The programmed range, line or point spacing is negative or larger than 65 535 mm (only possible with Q-parameter programming).

Touch point inaccessible

[50]
- The stylus was deflected before the range was reached during approach.
- In the scanning cycle **CONTOUR LINES** the stylus was not deflected within the probing range.

Stylus already in contact

[52]
- The stylus is not at rest, although it is not touching the contour.

Plane wrongly defined

[313]

- One of the coordinates of the starting point in the cycle **CONTOUR LINES** is identical with the touch probe axis.

Start position incorrect

[445]

- The starting point coordinate that is identical to the starting axis is outside the range.

Axis double programmed

[307]

- In the **CONTOUR LINES** cycle you programmed the starting position in one axis twice.

.

18. File management of TNC 410

18.1 Calling the file directory

Press key	Function
	TNC in operating mode PROGRAMMING AND EDITING
	Call program directory

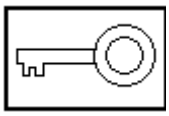
The files stored in the NC memory are now displayed on the screen.
Depending on the application certain file types may be excluded by the machine tool manufacturer. These file types are not available.

File type	Extension in the TNC
NC program HEIDENHAIN plain language	.H
NC program DIN/ISO	.I
Active tool table	TOOL.T
Pocket table	TOOLP.TCH
Pallet table	.P
Point table for digitized data	.PNT
Datum table	.D

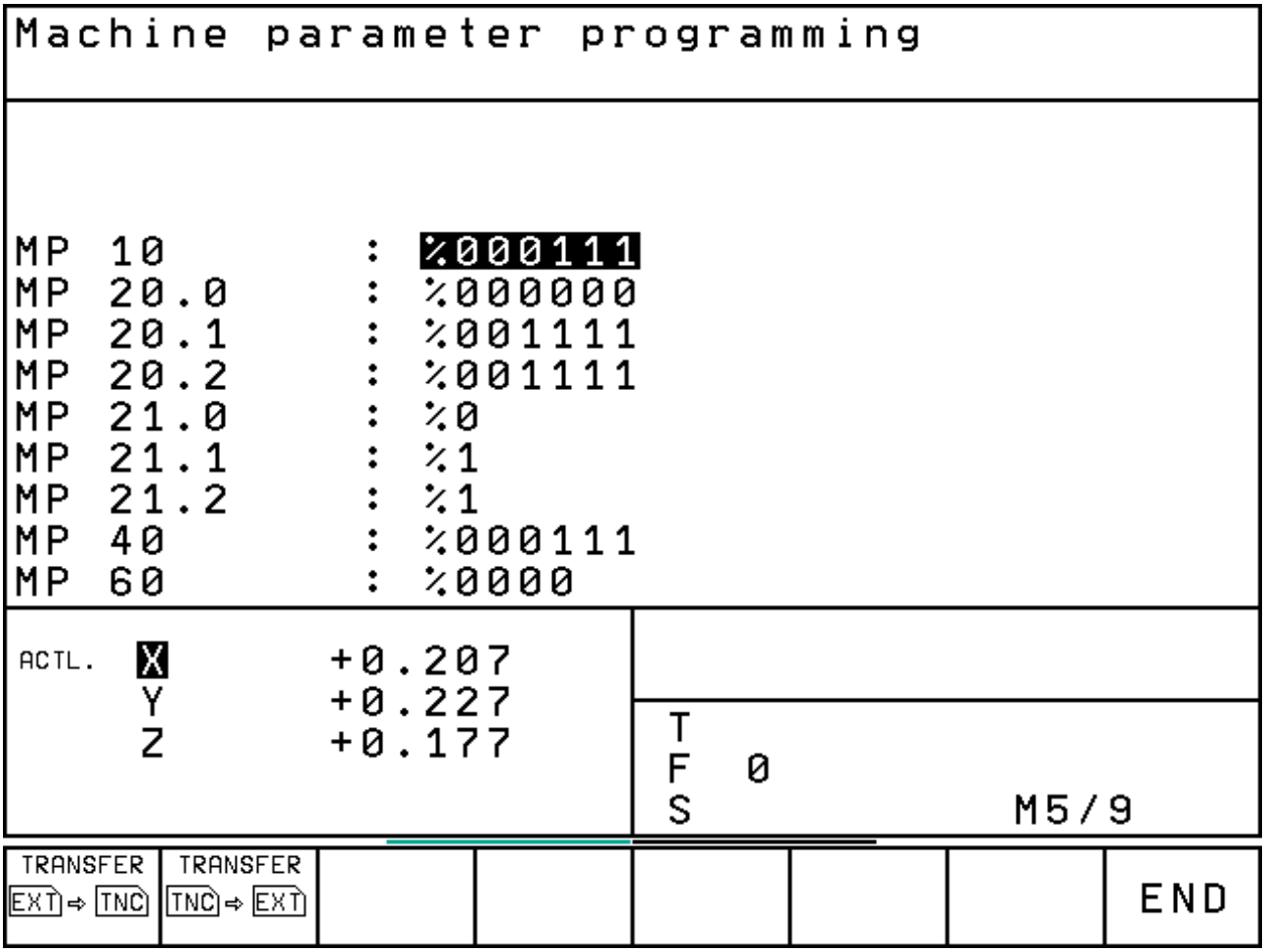
Additional file information:

M: File selected in a "Program Run" mode
P: File protected against erasing and editing

18.2 Calling the machine parameter list for servicing

Press key	Function
	TNC in operating mode PROGRAMMING AND EDITING
MOD	Call subordinate mode "Mode"
	Prepare TNC for input of code number
9 5 1 4 8 ENT	Enter code number, confirm with ENT

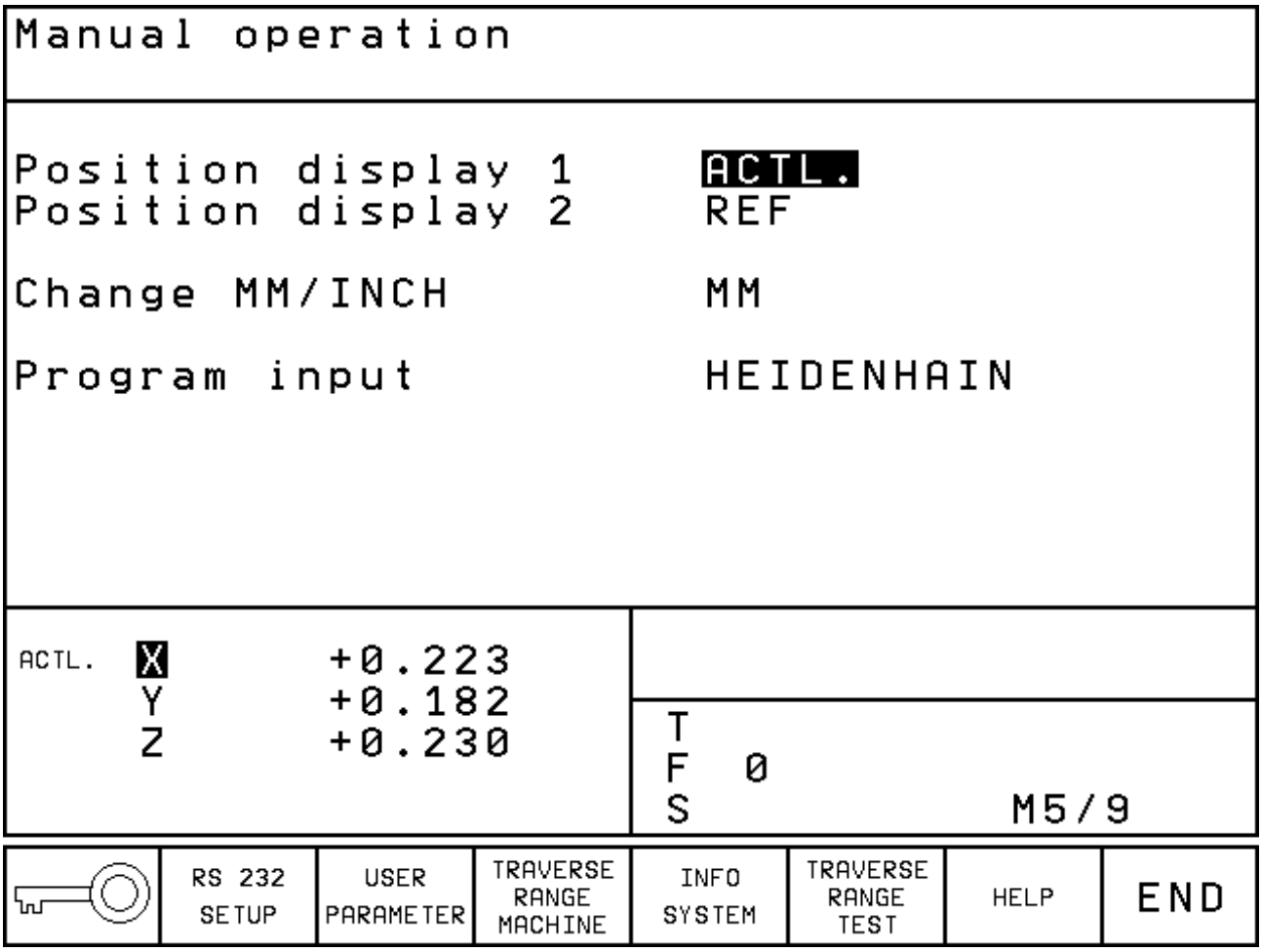
The machine parameter list is now displayed on the screen.

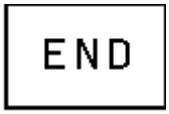


END	Exit machine parameter mode

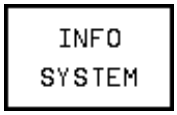
18.3 Switching over the position display for servicing

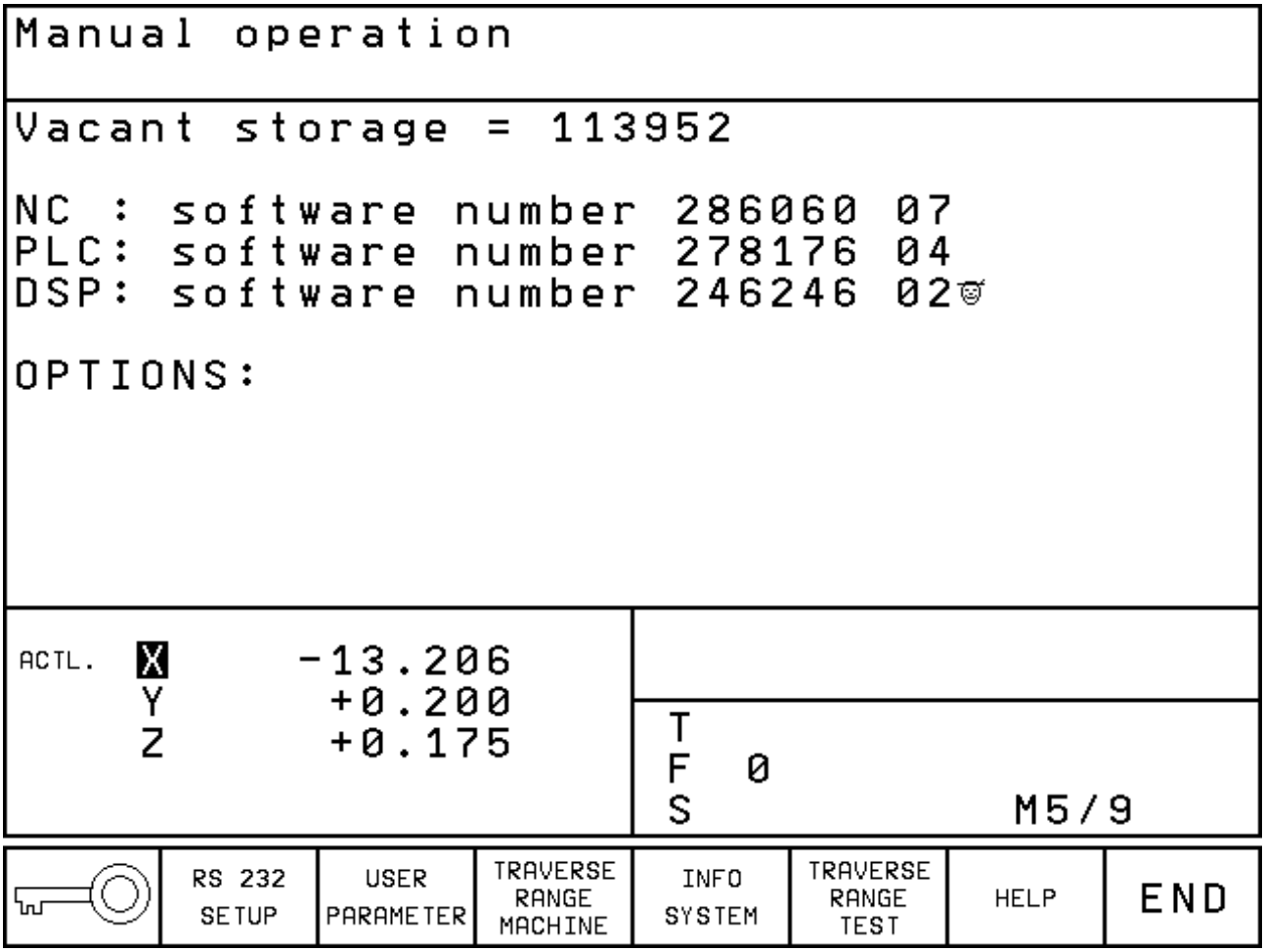
Press key	Function
	TNC in MACHINE operating mode (manual, full sequence etc.)
	Activate MOD function

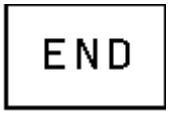


	Select option POSITION DISPLAY if required
	Switch to the desired position display NOML: nominal position DIST: distance-to-go ACTL: actual position REF: distance to reference mark (machine datum); with distance-coded measuring system: scale reference point LAG: current servo lag
	Exit the subordinate mode

18.4 Display of the system information

Press key	Function
	TNC in MACHINE operating mode (manual, full sequence etc.)
	Activate MOD function
	Press soft key



	Exit the system information

19. Data interfaces

19.1 Operating modes of the data interface

For data transfer the TNC 410 can be switched to the following 3 interface operating modes:

FE: For connection of the HEIDENHAIN floppy disk unit FE 401 B (or FE 401 from software 230 626 **03**) or other peripheral units.
HEIDENHAIN data transfer software TNCremo in transfer mode file server (FE)

Data format and protocol adapted to FE 401/B!

Protocol:	blockwise transfer
Data format:	7 data bits, 1 stop bit, even parity
Baud rate:	110 - 115 200 baud
Interface parameters:	fixed
Transfer stop:	software handshake with DC3

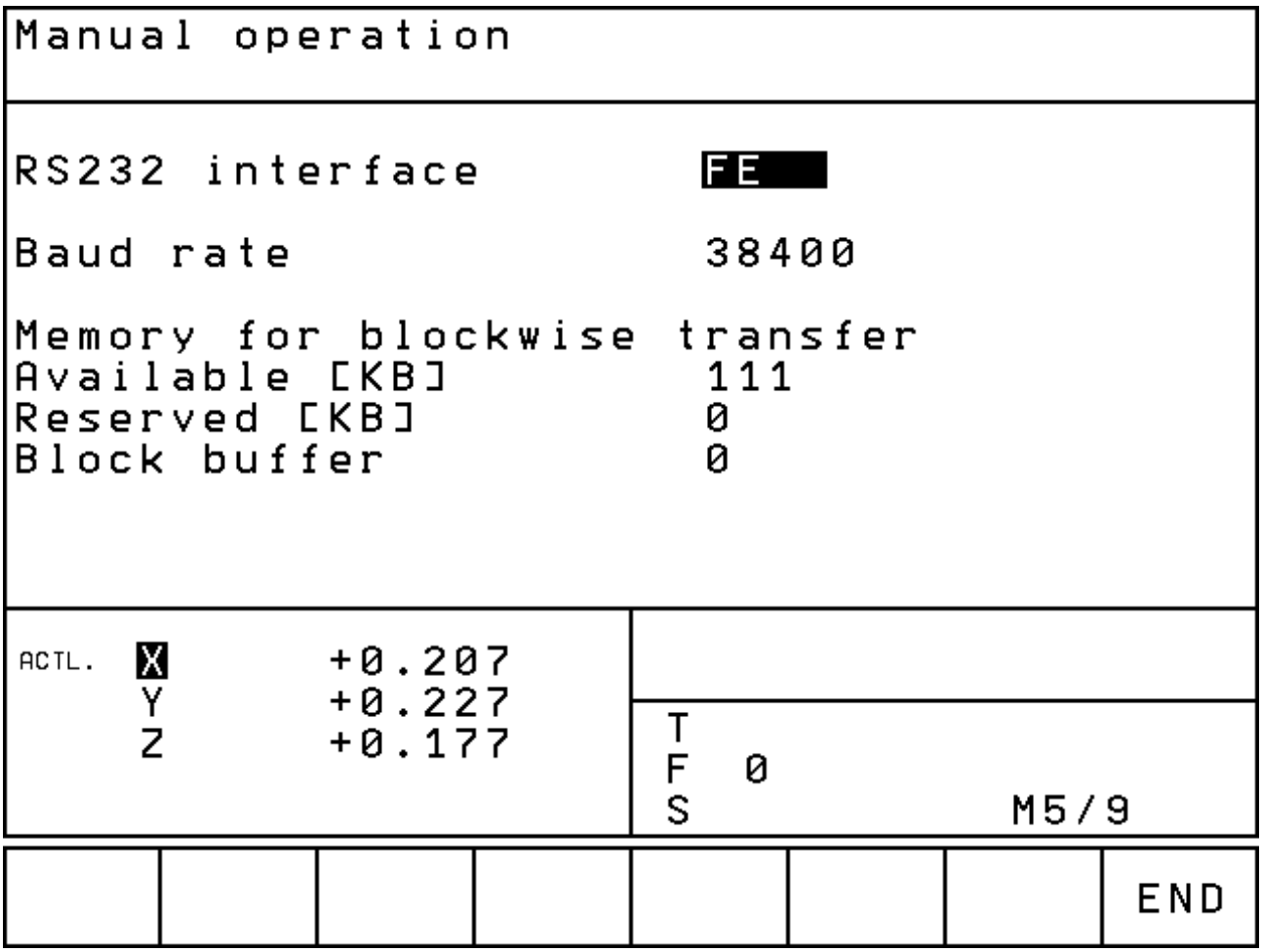
EXT 1: For the adaptation of data transfer in standard format
EXT 2: as well as for blockwise transfer to peripheral units.

Protocol:	standard or blockwise transfer adaptation via machine parameters (from MP 5000)
Data format:	adaptation via machine parameters (from MP 5000)
Baud rate:	110 - 115 200 baud
Interface parameters:	adaptation via machine parameters (from MP 5000)
Transfer stop:	software handshake with DC3 or hardware handshake with RTS, selectable via machine parameters (from MP 5000)

NUL: no function

19.1.1 Interface configuration and allocation of operating modes

In the operating modes PROGRAMMING AND EDITING and TEST RUN the setup for the data interfaces is called by pressing MOD and the soft key RS232 RS422 SETUP.



Explanations:

RS 232 interface: Interface mode
Baud rate: Baud rate for data transfer

Available [kB]: Free NC memory (value entered by the TNC)
Reserved [kB]: Memory reserved for blockwise transfer (for DNC mode only)
Block buffer: Number of NC blocks in the NC memory (for DNC mode only)

By pressing the arrow keys ↓ or ↑ you can select the desired settings and set them according to your requirements with the ENT key.

To exit the MOD function RS 232 SETUP press the soft key END.

19.2 Machine parameters for the data interfaces

In the FE operating mode the interface parameters cannot be changed.

In the operating modes EXT 1 and EXT 2 the interface parameters can be set via the machine parameters MP 5000 and higher.

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19.3 Error messages

19.3.1 Error messages at the TNC in the FE mode

In this operating mode, the floppy disk unit outputs errors in the following format:

(SOH) ERR: (SP) (SP) (SP) [XXX] (ETB) (BCC)
XXX = error number

The following errors may be displayed:

Input/Output Errors

ERR: 001 = wrong command code
ERR: 002 = illegal program name
ERR: 003 = faulty data transfer
ERR: 004 = program incomplete
ERR: 005 = receiving buffer overflow
ERR: 006 = function currently disabled
ERR: 007 = data-buffer overflow

Errors during Program Write or Read

ERR: 010 = program not on disk
ERR: 011 = program erase-protected
ERR: 012 = program is being written to
ERR: 013 = program directory is full
ERR: 014 = disk is full
ERR: 015 = text not found
ERR: 016 = program name already exists
ERR: 017 = disk access active
ERR: 018 = program currently being read

Disk / Drive / Controller Errors

ERR: 100 = disk not initialized
ERR: 101 = sector number too large 1)
ERR: 102 = drive not ready 2)
ERR: 103 = disk is write-protected
ERR: 104 = faulty data on disk 1)
ERR: 105 = sector cannot be found1)
ERR: 106 = check sum incorrect 1)
ERR: 107 = disk controller defective 3)
ERR: 108 = DMA defective 3)
ERR: 109 = disk exchanged during program loading

1) These error messages indicate that the floppy disk is defective; in most cases, they can only be eliminated by reformatting the disk.

2) If this error message comes up with the disk inserted, the drive is probably defective.

3) Hardware defect

19.3.2 Error messages during data transfer

Data transfer erroneous

[189]

X = A Faulty character frame
B Parity error
C Overrun / parity
D Framing
E Framing / overrun
F Framing / parity
G Framing / parity/ overrun
H Overrun of receive buffer (interrupt buffer)
M The control has received the character for "Negative Acknowledgement" (NAK) more than 3 times
N The control has transmitted the character for "Negative Acknowledgement" (NAK) more than 3 times
P Timeout ACK/NAK
R Overrun of block buffer (decoding buffer)

Baud rate not possible

[197]

If the data interfaces (RS 232/RS 422) are active simultaneously, the baud rate of both data interfaces must be the same.

Interface already assigned

[196]

A data interface cannot be used for two operating modes at a time (e.g. DNC mode and simultaneous programming is not possible with one data interface).

Ext. input/output not ready

[200]

- DSR signal missing at the TNC
- Transmission cable defective or incorrect
- Wrong interface assignment

Program incomplete

[194]

Data transfer was aborted before the program was completely loaded.

19.3.3 Error messages in the LSV2 mode

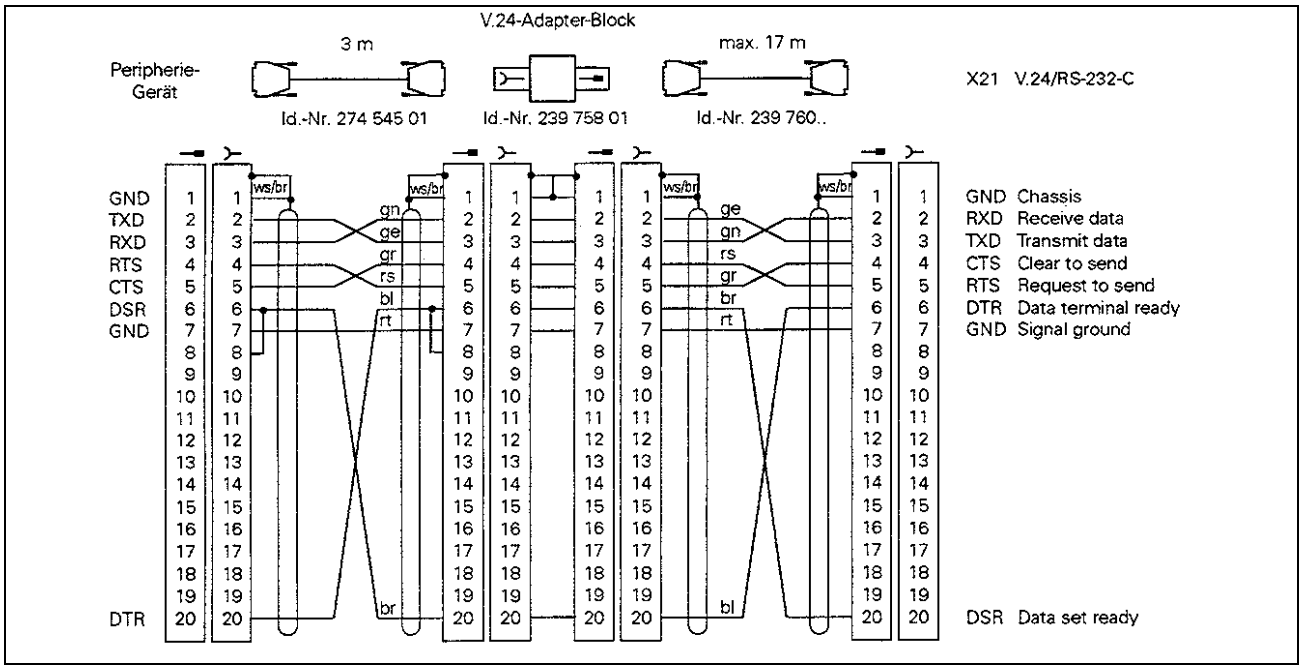
LSV2 X

[198]

X = A DRS signal missing
B Framing / parity / overrun
C The control has transmitted the character for "Negative Acknowledgement" (NAK) more than 3 times
D The control has received the character for "Negative Acknowledgement" (NAK) more than 3 times
E No reaction of the peripheral unit
F RS232 interface assigned
G Baud-rate conflict
H NAK received as response to transmitted ENQ
I Timeout between receiving STX and ETX
J Timeout between transmitting DLE0/NAK and reaction of the peripheral unit in
K the request period
Timeout between transmitting DLE1/NAK and reaction of the peripheral unit in the text period

19.4 Wiring diagrams of the data interfaces

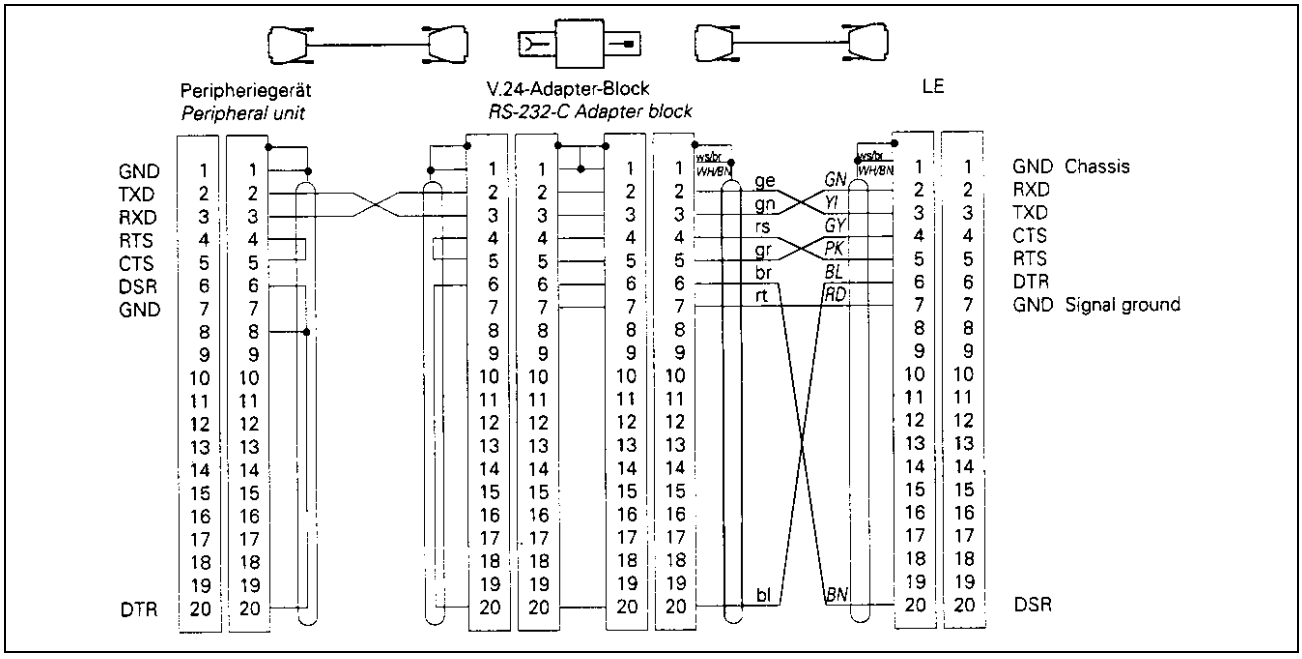
19.4.1 V.24/RS-232-C data interface with RS-232-C adapter block (full wiring)



If the pin layout of your peripheral unit differs from the above layout, the HEIDENHAIN connecting cable cannot be used.

19.4.2 V.24/RS-232-C data interface with RS-232-C adapter block (simplified wiring)

Example:



With this wiring, only transfer stop with DC3 (software handshake) is possible!

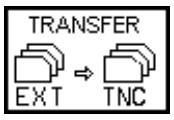
The RS-232-C-/V.24 data interface has **different** pin layouts at the logic unit X21 and at the RS-232C adapter block.

20. Data transfer via data interface

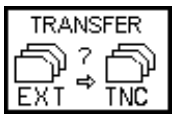
20.1 Data transfer menu

After pressing the soft key 

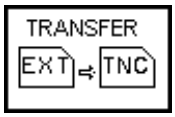
the following soft keys are displayed for data transfer:



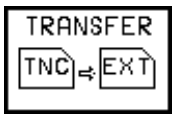
Transfer of all files **into** the TNC without prompting



Transfer of all files **into** the TNC with prompting

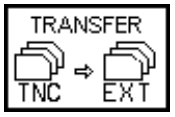


Transfer of the selected file **into** the TNC



Transfer of the selected file to the **external** data medium

Transfer of the **PLC program** as ASCII file to the **external** data medium
(this soft key is only offered in the PLC editor)



Transfer of all files to the **external** data medium without prompting

Display of all files stored on the **external** data medium

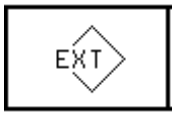
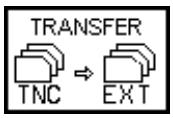
20.2 Data output via the data interface

Note:
The flowcharts on the following pages for file transfer from and to the control are only valid for the data transfer software **TNCremo**, operating mode ***File server FE***. If you use another data transfer software, the proceeding may differ from this description. The software TNCremo, Id.No. 280 480 (German) 280 481 (English), can be ordered from **HEIDENHAIN**, Traunreut. We also offer a shareware version for **testing**.

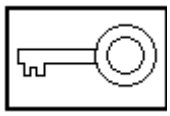
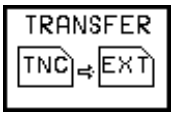
Preparations:

- Start data transfer software **TNCremo** on your PC
- Set control model **TNC 410** at the PC (menu option *Options*)
- Set baud rate and interface at the PC (menu option *Options*)
- Set operating mode ***File server FE*** at the PC (menu option *Connect*)
- Set **FE** operating mode at the TNC
- Set **baud rate** at the TNC

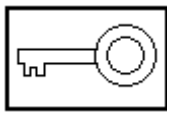
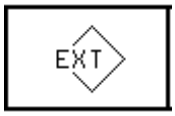
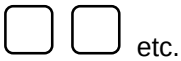
20.2.1 Output of files with the extensions .H, .I, .P, .D, TOOL.T, TOOLP.TCH, .PNT

Press key	Function
	Operating mode PROGRAMMING AND EDITING
	Call file directory
	Activate data transfer menu
	Press soft key All displayed files are transferred without prompting
	Closes the data transfer menu after all files have been transferred

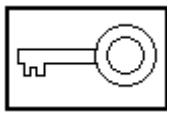
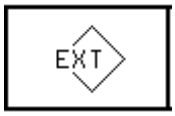
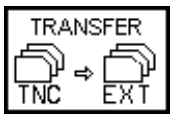
20.2.2 Output of the machine parameter list

Press key	Function
	TNC in operating mode PROGRAMMING AND EDITING
MOD	Call subordinate mode
	Prepare TNC for input of code number
9 5 1 4 8 ENT	Enter code number, confirm with ENT
	Activate data transfer menu
☐ ☐ etc.	Enter the name under which the machine parameter list is supposed to be stored on the data medium (up to 8 characters). The parameter list is stored with the extension **.MP**
ENT	Start data transfer
END ☐	Closes the data transfer menu after all data have been transferred

20.2.3 Output of the PLC program from RAM

Press key	Function
	Operating mode PROGRAMMING AND EDITING
	Call subordinate mode
	Prepare TNC for input of code number
	Enter code number, confirm with ENT
	Activate data transfer menu
	Activate data output
	Enter the name under which the PLC program is supposed to be stored on the data medium (up to 8 characters). The PLC program is stored with the extension **.PLC**.
	Start data transfer.
	Closes the data transfer menu after all data have been transferred

20.2.4 Output of the files for nonlinear axis error compensation .COM, .CMA[1)]

Press key	Function
	Operating mode PROGRAMMING AND EDITING
MOD	Call subordinate mode
	Prepare TNC for input of code number
1 0 5 2 9 6 ENT	Enter code number, confirm with ENT
	Activate data transfer menu
	Start data transfer
END	Closes the data transfer menu after all data have been transferred

1) With the NC software 286 000 – 011 the data for nonlinear axis error compensation are stored in **one** file. This file can also be called by entering the code number.

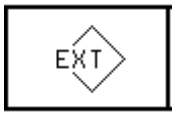
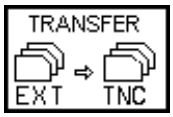
20.3 Data input via the data interface

Note:
The flowcharts on the following pages for file transfer from and to the control are only valid for the data transfer software **TNCremo**, operating mode ***File server FE***. If you use another data transfer software, the proceeding may differ from this description. The software TNCremo, Id.Nos. 280 480 (German) and 280 481 (English), can be ordered from **HEIDENHAIN**, Traunreut. We also offer a shareware version for **testing**.

Preparations:

- Start data transfer software **TNCremo** on your PC
- Set control model **TNC 410** at the PC (menu option *Options*)
- Set baud rate and interface at the PC (menu option *Options*)
- Set operating mode ***File server FE*** at the PC (menu option *Connect*)
- Set **FE** operating mode at the TNC
- Set **baud rate** at the TNC

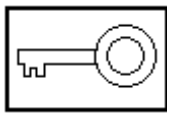
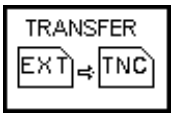
20.3.1 Downloading files with the extensions .H, .I, .P, .D, TOOL.T, TOOLP.TCH, .PNT

Press key	Function
	Operating mode PROGRAMMING AND EDITING
	Call file directory
	Activate data transfer menu
	Press soft key All files stored on the external data medium are downloaded without prompting.
	Closes the data transfer menu after all data have been transferred

20.3.2 Downloading the machine parameter list

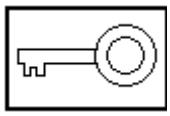
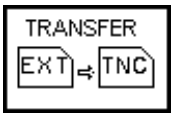
Download of the machine parameter list if the size of the MP file does not change:

If the machine parameter file stored on the external data medium contains exactly the data required by the TNC 410 (**no** machine parameter **added or removed**), the MP list is transferred **without error message**.

Press key	Function
	TNC in Operating mode PROGRAMMING AND EDITING
MOD	Call subordinate mode
	Prepare TNC for input of code number
9 5 1 4 8 ENT	Enter code number, confirm with ENT
	Activate data transfer menu
▢ ▢ etc.	Enter the name under which the machine parameter list is stored on the data medium
ENT	Start data transfer
END ▢	Closes the data transfer menu after all data have been transferred

Download of the machine parameter list if the size of the MP file changes:

If the machine parameter file stored on the external data medium does not exactly contain the data required by the TNC 410 (machine parameter **added or removed**), an **error message** is generated on the screen of the TNC during or after transfer of the machine parameter file.

Press key	Function
	TNC in Operating mode PROGRAMMING AND EDITING
MOD	Call subordinate mode
	Prepare TNC for input of code number
9 5 1 4 8 ENT	Enter code number, confirm with ENT
	Activate data transfer menu
etc.	Enter the name under which the machine parameter list is stored on the data medium
ENT	Start data transfer

Behavior the NC software 286 000 - 011

If during data transfer the error message ENTRY VALUE INCORRECT is displayed, the machine parameter file transferred is not identical to the version required by TNC 410 (machine parameters added or removed). Note down the number of the machine parameter at which the message was generated and continue data transfer by pressing ENT. Enter the missing parameters by hand after data transfer has been finished. Further information in this regard can be obtained from the machine tool builder.

See also next page!

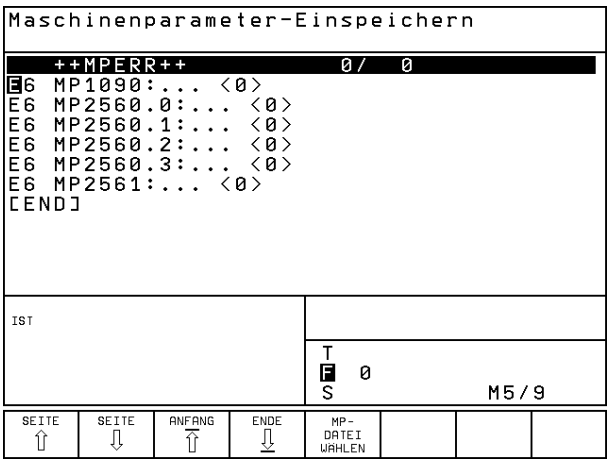
Behavior with NC software 286 060 –071 or 286 080 091

If after data transfer the error message **Program data erroneous** is displayed,

the machine parameter file transferred is not identical to the version required by TNC 410 (machine parameters added or removed). Confirm the error message by pressing the CE key and select the MPERR file. This MP error file contains the faulty machine parameters collected during the downloading process as ASCII string together with an error code.

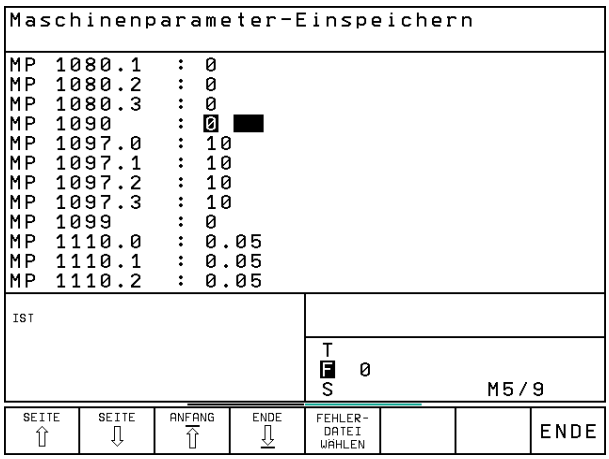
Error codes in the MP error file:

E1 Syntax error
E2 Conversion error MP number / MP index
E3 Conversion error or wrong input range of MP value
E4 Downloading disabled e.g. by PLC/option
E5 MP not expected, machine parameter no longer exists
E6 MP expected but not downloaded, new machine parameter added
In the case of the errors E3, E4, E6 the currently stored MP value is displayed in brackets at the end of the line (e.g.<0>).



MP-DATEI WÄHLEN — Open MP file

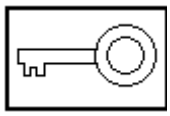
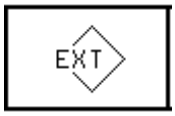
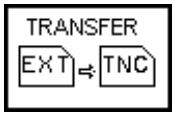
By pressing the cursor keys the desired parameter is selected. After opening the MP file a value can be entered for this machine parameter.



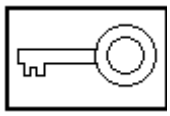
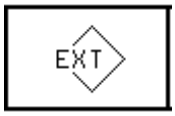
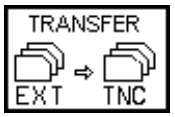
FEHLER-DATEI WÄHLEN — Open error file

For all machine parameters marked by the error code E6 in the MPERR file the entry value in the MP list must be confirmed by pressing ENT. Otherwise the error message "Entry value incorrect" is displayed. Further information can be obtained from your machine tool builder.
This machine parameter is deleted from the MPERR file.

20.3.3 Downloading the PLC program into RAM

Press key	Function
	Operating mode PROGRAMMING AND EDITING
	Call subordinate mode
	Prepare TNC for input of code number
	Enter code number, confirm with ENT
	Activate data transfer menu
	Activate data input
	Enter the name under which the PLC program is stored on the data medium
	Start data transfer
	Closes the data transfer menu after all data have been transferred

20.3.4 Downloading the files for nonlinear axis error compensation .COM, .CMA[1)]

Press key	Function
	Operating mode PROGRAMMING AND EDITING
MOD	Call subordinate mode
	Prepare TNC for input of code number
1 0 5 2 9 6 ENT	Enter code number, confirm with ENT
	Activate data transfer menu
	Press soft key All files stored on the data medium are downloaded without prompting
END	Closes the data transfer menu after all data have been transferred

1) With the NC software 286 000 – 011 the data for nonlinear axis error compensation are stored in **one** file. This file can also be called by entering the code number.

21. Interface to the servo amplifier

21.1 Nominal value output to servo amplifier (analog/digital)

The selection **analog** axis or **digital** axis is made via machine parameter by the machine tool builder.
This parameter also contains the channel / connector configuration for the axes.

MP 120.0	allocation nominal value output **X-axis**
MP 120.1	allocation nominal value output **Y-axis**
MP 120.2	allocation nominal value output **Z-axis**
MP 120.3	allocation nominal value output **4th axis**
MP 121	allocation nominal value output **spindle**

Input values in machine parameters MP 120.x and 121:

TNC 410 CA/PA/MA
0 = control does not output nominal speed
1 = **analog** nominal speed (± 10V) at connector **X8** channel 1
2 = **analog** nominal speed (± 10V) at connector **X8** channel 2
3 = **analog** nominal speed (± 10V) at connector **X8** channel 3
4 = **analog** nominal speed (± 10V) at connector **X8** channel 4
5 = **analog** nominal speed (± 10V) at connector **X8** channel 5

TNC 410 PA
0 = control does not output nominal speed
51 = **digital** nominal value (PWM signal) at connector **X51**
52 = **digital** nominal value (PWM signal) at connector **X52**
53 = **digital** nominal value (PWM signal) at connector **X53**
54 = **digital** nominal value (PWM signal) at connector **X54**
55 = **digital** nominal value (PWM signal) at connector **X55**

TNC 410 MA
0 = control does not output nominal speed
80 = **digital** nominal value (PWM signal) motor connector at terminal **X80** of inverter unit UE 2xx
81 = **digital** nominal value (PWM signal) motor connector at terminal **X81** of inverter unit UE 2xx
82 = **digital** nominal value (PWM signal) motor connector at terminal **X82** of inverter unit UE 2xx
83 = **digital** nominal value (PWM signal) motor connector at terminal **X83** of inverter unit UE 2xx
84 = **digital** nominal value (PWM signal) motor connector at terminal **X84** of inverter unit UE 2xx

21.2 Analog nominal speed interface at connector X8

21.2.1 Specifications of the analog outputs

Load capacity: $R_{Lmin} \geq 5\ k\Omega$
$C_{Lmax} \leq 2\ nF$

Short-circuit stability: The outputs are permanently shortcircuit-proof

Voltage range: $U_{amax} = +10V \pm 100\ mV$
$U_{amin} = -10V \pm 100\ mV$

Resolution:	14 bits = 16 384 steps
Minimum step	$\frac{10\ V}{16\ 384} = 0.6\ mV$

X8 Analog outputs 1 to 5
Flange socket with female insert (15-pin)

Logic unit	
D-Sub connector (female) 15-pin	**Assignment**
1	analog output 1: ±10 V
2	analog input
3	analog output 2: ±10 V
4	do not assign
5	analog output 3: ±10 V
6	do not assign
7	analog output 4: ±10 V
8	analog output 5: ±10 V
9	analog output 1: 0 V
10	0 V analog input
11	analog output 2: 0 V
12	do not assign
13	analog output 3: 0 V
14	analog output 4: 0 V
15	analog output 5: 0 V
Chassis	external shield

21.2.2 Checking the analog nominal speed interface

Proportionally to the traverse speed the control outputs an analog voltage between 0V and ±10V [1]. The easiest way to determine this voltage is to measure with the TEST ADAPTER directly at the LOGIC UNIT or with a multimeter at the connecting terminals of the servo amplifier.

If however, there is no axis movement owing to a defect, proceed as described below to find out, whether the error is located inside or outside the control:

- Switch off the power switch at the machine tool.
- Connect the TEST ADAPTER to the connector X8 of the LE and connect a multimeter to the sockets of the defective axis. If you do not have a test adapter, connect the multimeter to the nominal value input of the servo amplifier.
- Switch on power and control voltage.
- Set the position display to LAG (servo lag) (see section "Switching over the position display").
- Check and adjust the following machine parameters:
  (If you alter a machine parameter, note down the original value and re-enter it after finishing the inspection.)

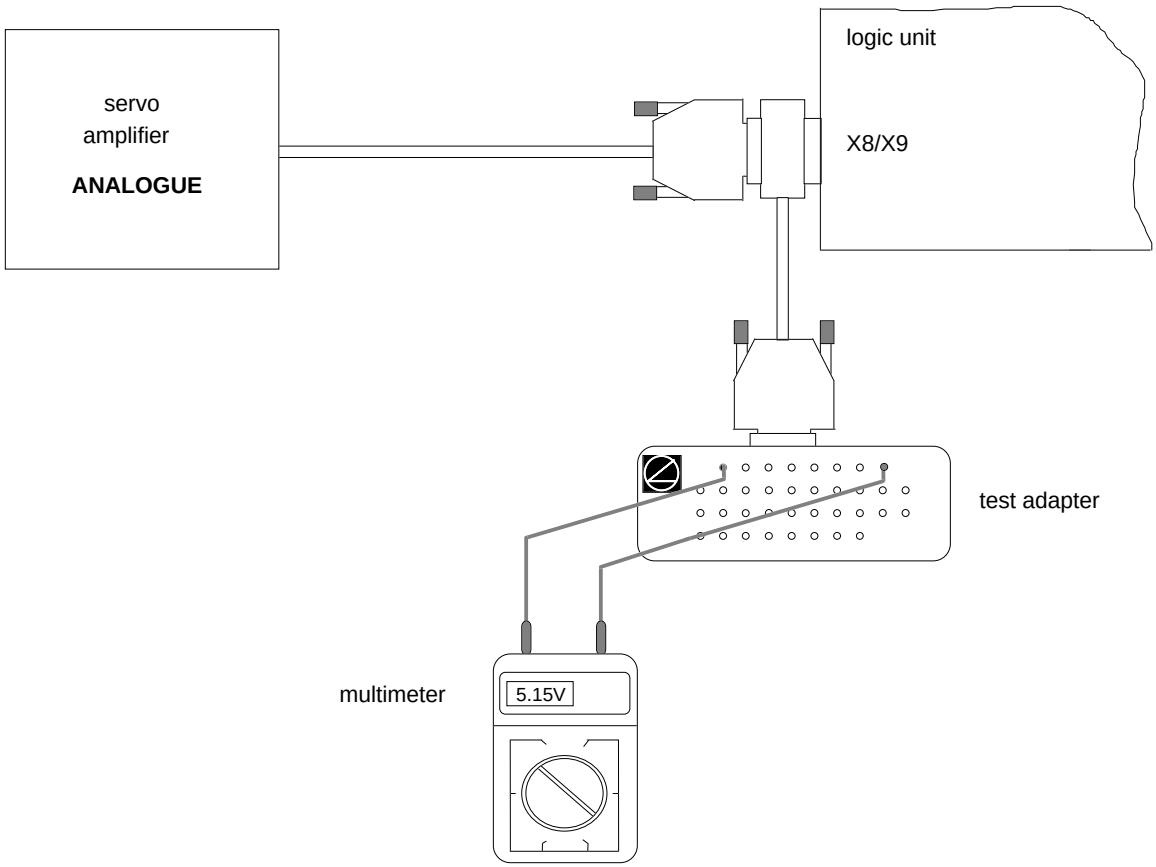
MP	Input value	Function	Original input value
1410.X	30 [mm]	servo lag monitoring (cancellable), feed-forward control	
1420.X	30 [mm]	servo lag monitoring (EMERG. STOP), feed-forward control	
1140.X	9.99 [V]	movement monitoring	
1710.X	300 [mm]	servo lag monitoring (cancellable), trailing mode	
1720.X	300 [mm]	servo lag monitoring (EMERG. STOP), trailing mode	

- Traverse the reference points that need to be traversed before those of the defective axis.
- Turn the override potentiometer of the keyboard unit completely to the left and start reference mark traverse for the defective axis.
- Check the axis enable for the defective axis at the servo amplifier.
- Check the screen display.
  * (Control ready for operation) must be ON, the **F** of the feed rate display must be normally lit (if the display is inverse, the feed rate enable is missing), and the symbol for "Axis not in the position loop"
  (e.g. + X +100,2769) must not follow the position display.
- Turn the override potentiometer slowly to the right and turn it back left again before the servo lag display reaches the limit of the position monitoring.

When the override potentiometer is turned to the right, the control outputs an analog voltage which is increased proportionally to the servo lag up to a maximum value of 10V. The control operates correctly, if a voltage of 10V ± 0.1V can be measured at the test adapter with the multimeter. If no voltage can be measured, switch off the power switch, unplug the connector X8 from the logic unit, disconnect the nominal value line from the servo amplifier and test this line for short-circuit. If the nominal value line is in order, connect X8 to the logic unit again (leave the nominal value line disconnected), switch on the power switch and repeat the measurement with reference mark traverse. If an analog voltage can be measured now, the control operates correctly. If no voltage can be measured, the analogue output of the logic unit is probably defective.

[1] see machine parameter MP1050.X (analogue voltage for rapid traverse)

Measuring setup to check the analog nominal speed interface



Observe the safety instructions!

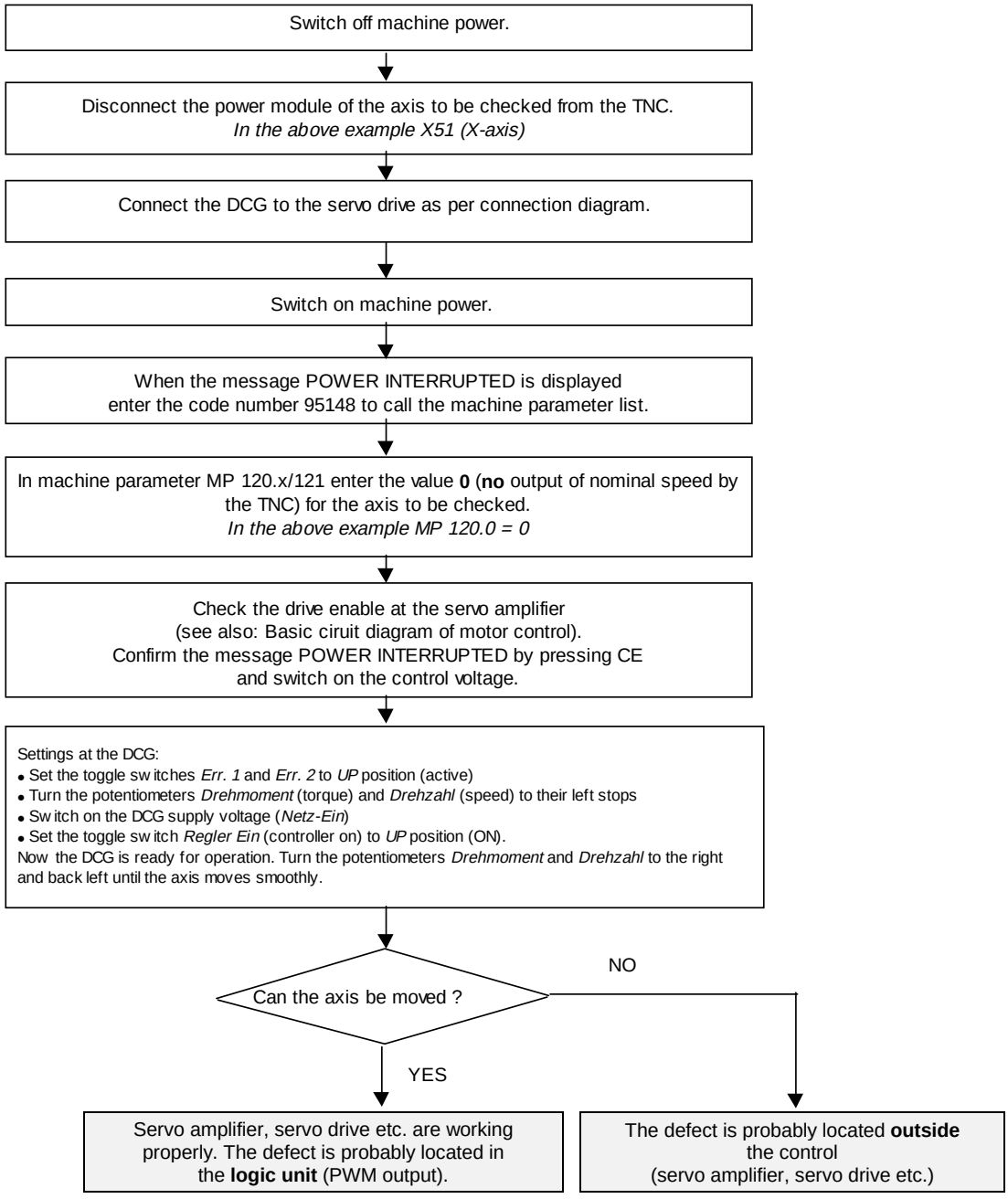
21.3 Digital interface to the servo amplifier

21.3.1 Checking the digital nominal speed interface of TNC 410 PA

Flowchart for checking a digital axis of TNC 410 PA with the DCG:

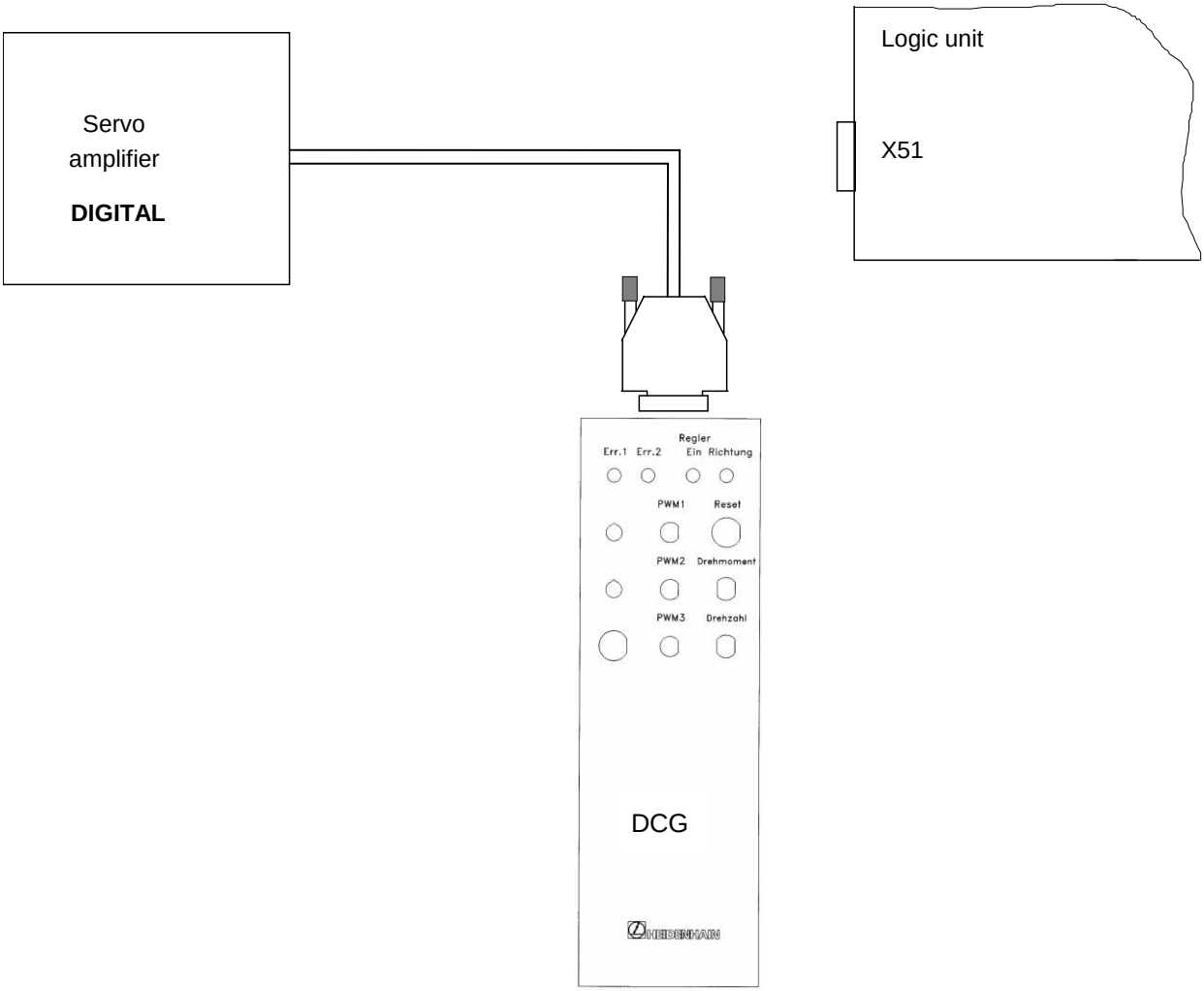
A **digital** servo amplifier can **only** be tested with a DCG (= **D**rive **C**ontrol **G**enerator; see section Test Units).

In the **example** below the **X-axis** is inspected.
The configuration of the machine parameter is supposed to be as follows:
MP 120.0 = 51 (X-axis at motor power module **X51**)
MP 120.1 = 52 (Y-axis at motor power module **X52**)
MP 120.2 = 53 (Z-axis at motor power module **X53**)
MP 120.3 = 54 (4^{th} axis at motor power module **X54**)
MP 121 = 55 (spindle at motor power module **X55**)



Observe the safety instructions !

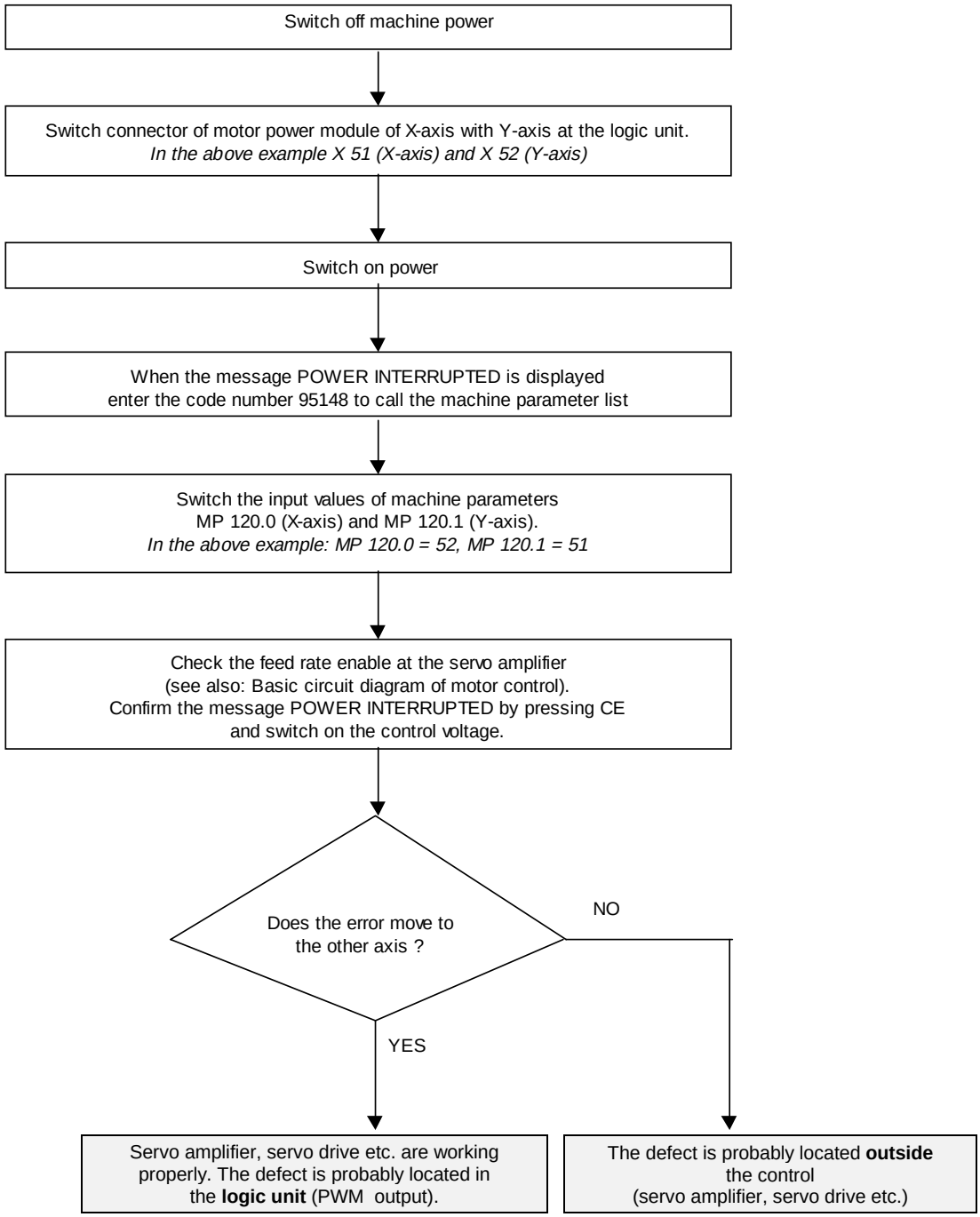
Measuring setup for checking the servo drive of an axis of TNC 410 PA



Observe the safety instructions!

Flowchart for checking a digital axis of TNC 410 PA without DCG:

In the **example** below the **X-axis** is inspected.
The configuration of the machine parameter is supposed to be as follows:
MP 120.0 = 51 (X-axis at motor power module **X51**)
MP 120.1 = 52 (Y-axis at motor power module **X52**)
MP 120.2 = 53 (Z-axis at motor power module **X53**)
MP 120.3 = 54 (4^{th} axis at motor power module **X54**)
MP 121 = 55 (spindle at motor power module **X55**)



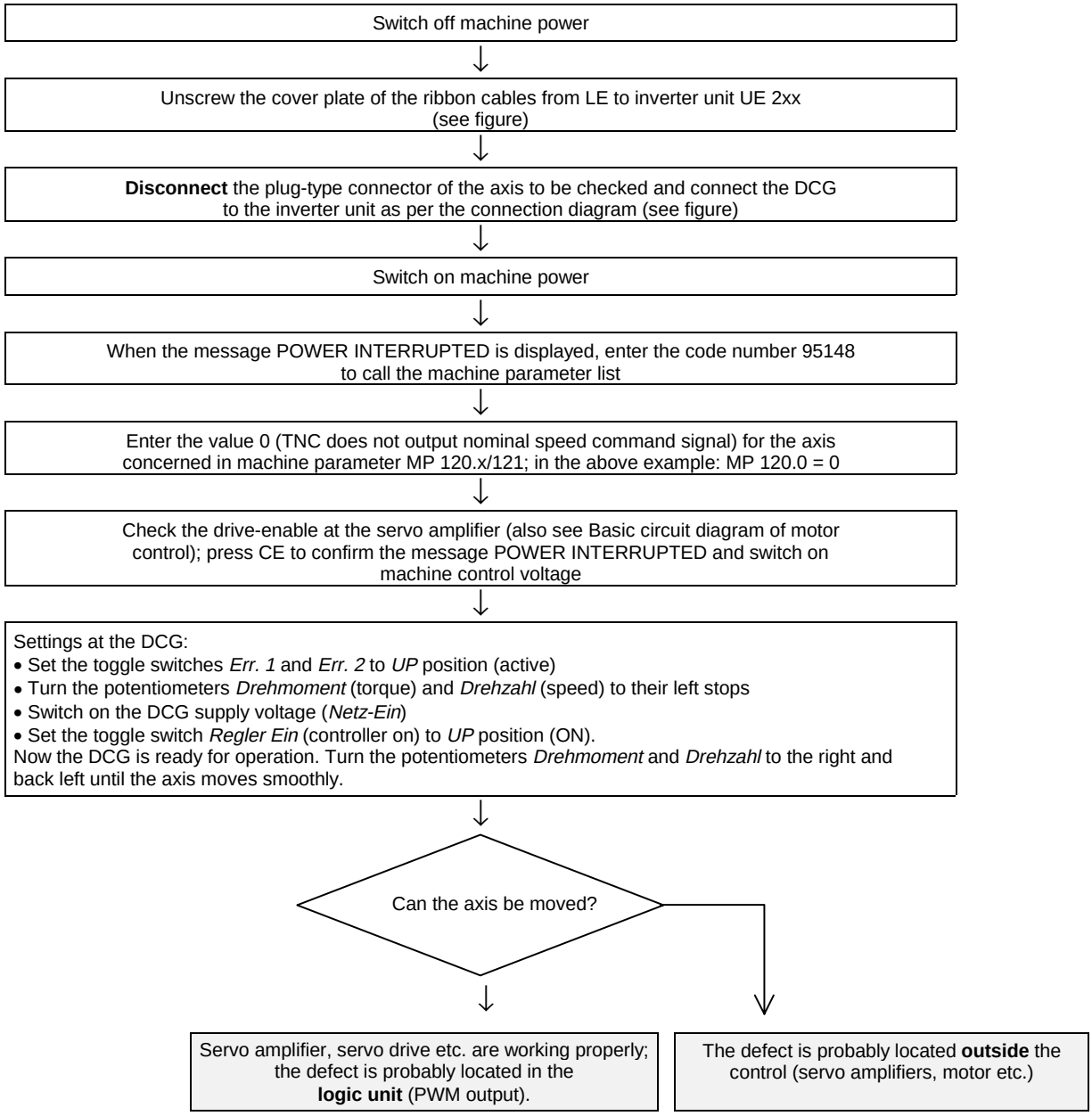
Observe the safety instructions!

21.3.2 Checking the digital nominal value interface of TNC 410 MA

Flowchart for checking a digital axis of TNC 410 MA with the DCG:

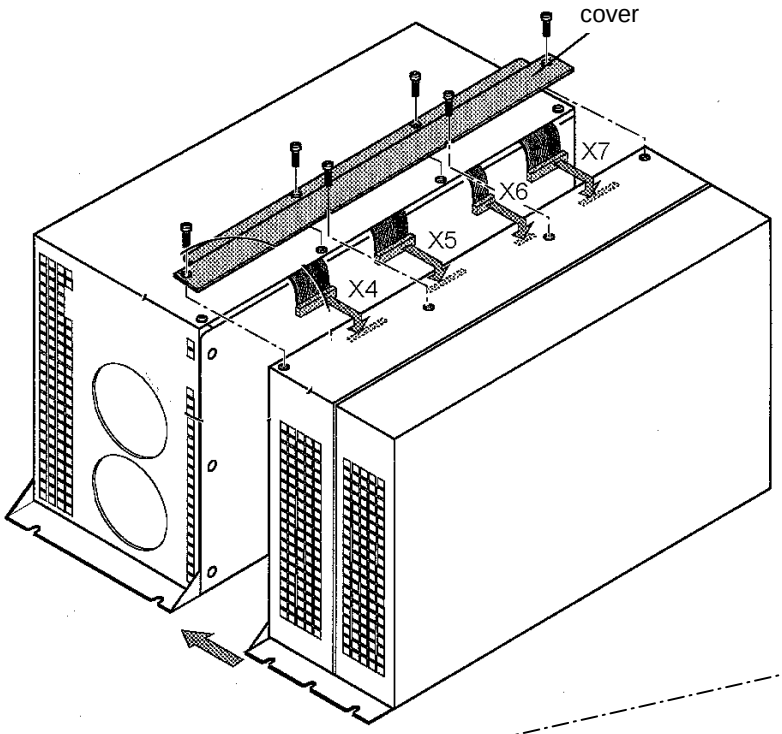
A **digital** servo amplifier can be checked by means of the DCG, **D**rive-**C**ontrol **G**enerator (see also section "Test Units").

In this **example** the **X-axis** is inspected.
The machine parameter configuration is supposed to be as follows:
MP 120.0 = 81 (X-axis at motor connector **X81** of the inverter UE 2xx)
MP 120.1 = 82 (Y-axis at motor connector **X82** of the inverter UE 2xx)
MP 120.2 = 83 (Z-axis at motor connector **X83** of the inverter UE 2xx)
MP 120.3 = 84 (4th axis at motor connector **X84** of the inverter UE 2xx)
MP 121 = 80 (spindle at motor connector **X80** of the inverter UE 2xx)



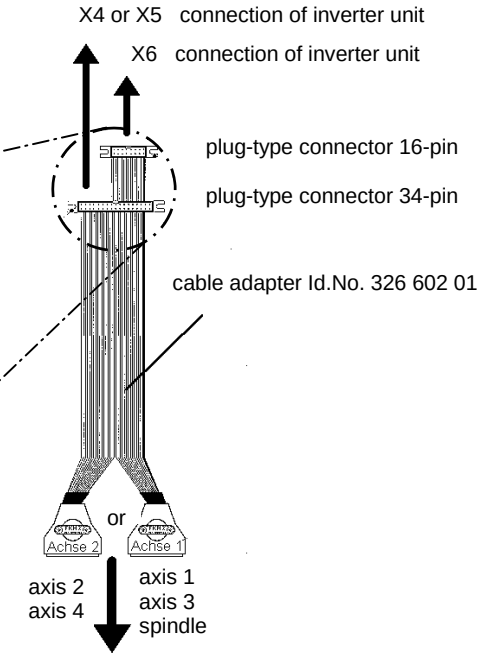
Observe the safety instructions !

Measuring setup for checking the servo amplifier of an axis of TNC 410 MA



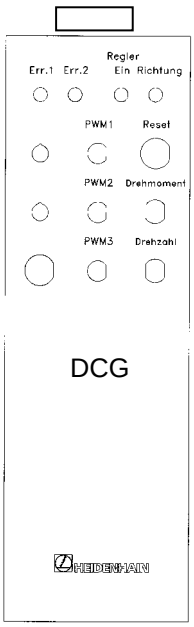
Allocation of the axes to the ribbon cables

X7, 34-pin = power supply of the logic unit and status signals
X6, 16-pin = connection of motor power module **1st axis** at UE 2xx (output motor connector **X81**)
X5, 34-pin = connection of motor power module **2nd/3rd axis** at UE 2xx (output motor connector **X82/X83**)
X4, 34-pin = connection of motor power module **4th axis/spindle** at UE 2xx (output motor connector **X84/X80**)



CAUTION

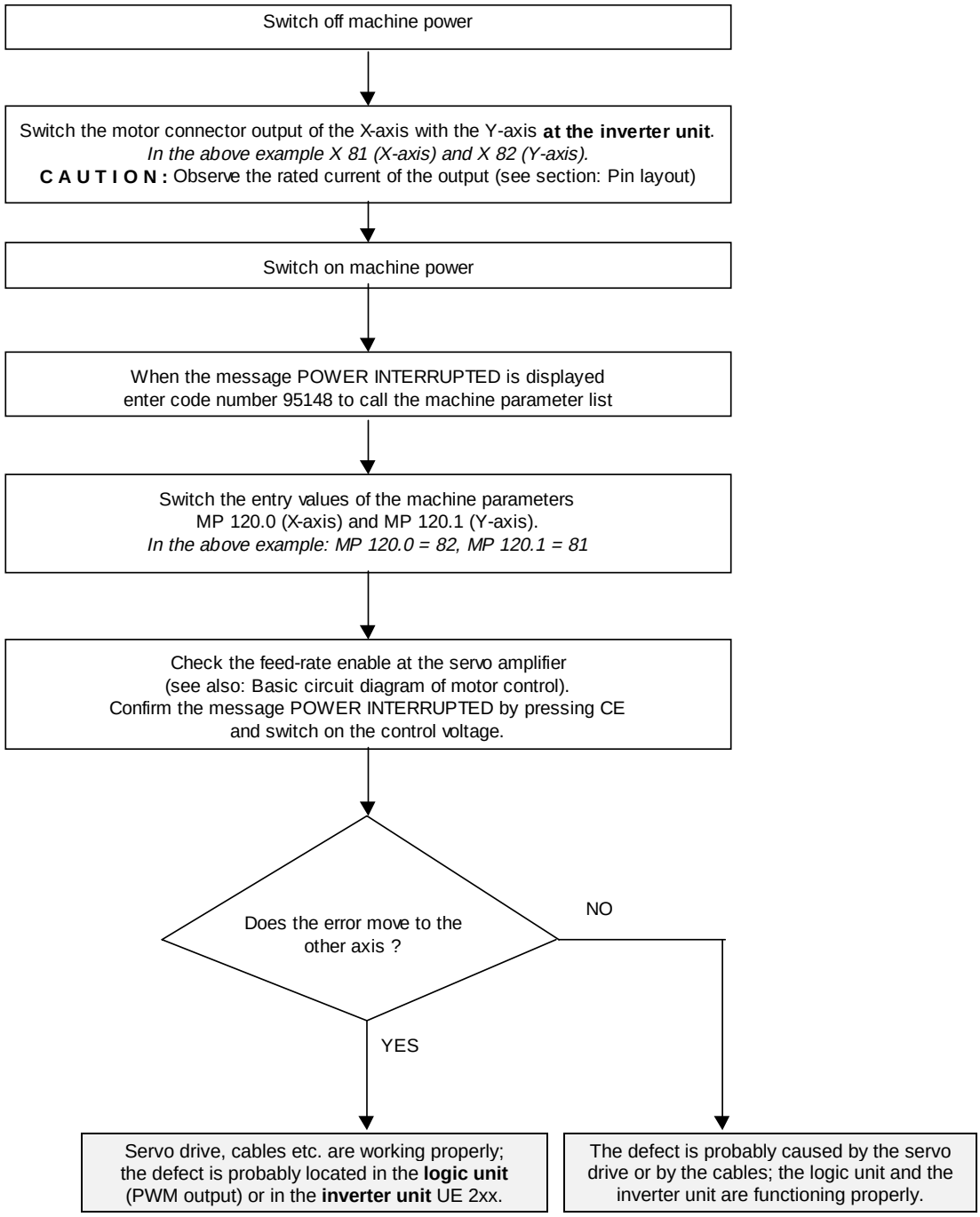
Only connect **ONE** ribbon cable at a time to the DCG by means of the cable adapter.
Never connect both ribbon cables simultaneously!



Observe the safety instructions !

Flowchart for checking a digital axis of TNC 410 MA without DCG:

In this **example** the **X-axis** is inspected.
The machine parameter configuration is supposed to be as follows:
MP 120.0 = 81 (X-axis at motor connector **X81** of the inverter UE 2xx)
MP 120.1 = 82 (Y-axis at motor connector **X82** of the inverter UE 2xx)
MP 120.2 = 83 (Z-axis at motor connector **X83** of the inverter UE 2xx)
MP 120.3 = 84 (4th axis at motor connector **X84** of the inverter UE 2xx)
MP 121 = 80 (spindle at motor connector **X80** of the inverter UE 2xx)



Observe the safety instructions !

21.4 Adjustment of the feed rate at the servo amplifier

21.4.1 Analog axes

Check and adjust the machine parameters.
(If you alter a machine parameter, note down the original value and re-enter it after finishing the inspection.)

MP	Entry value	Function	Original entry value
1390	0	velocity feedforward control [1)] in automatic operating modes ON	
7290.X	4	display step = 1 µm	

- Switch the position display to LAG (display of servo lag).

- Enter the following test program (e.g. for the X-axis)

```
0  BEGIN PGM  X  MM
1  LBL 1
2  X + 0  F  MAX
3  X + 100  F  MAX      (enter a larger traverse range, if possible!)
4  CALL LBL  1  REP  100/100
5  END PGM  X  MM
```

- Run the test program in the operating mode "PROGRAM RUN / FULL SEQUENCE".

- Adjust the feed rate at the servo amplifier (tachometer) such that the display of the servo lag is approximately zero during positioning in both directions.

- Repeat the adjustment for all axes.

- Reset the machine parameters and the position display to the original values.

1) The operating mode "velocity feedforward control" must be optimized!

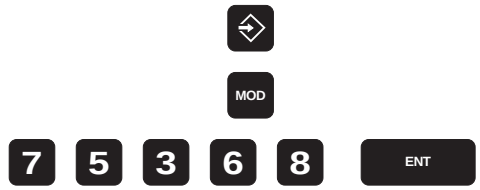
21.4.2 Digital axes

For **digital** axes the feed rate adjustment at the servo amplifier as described in section 21.4.1 is not required.

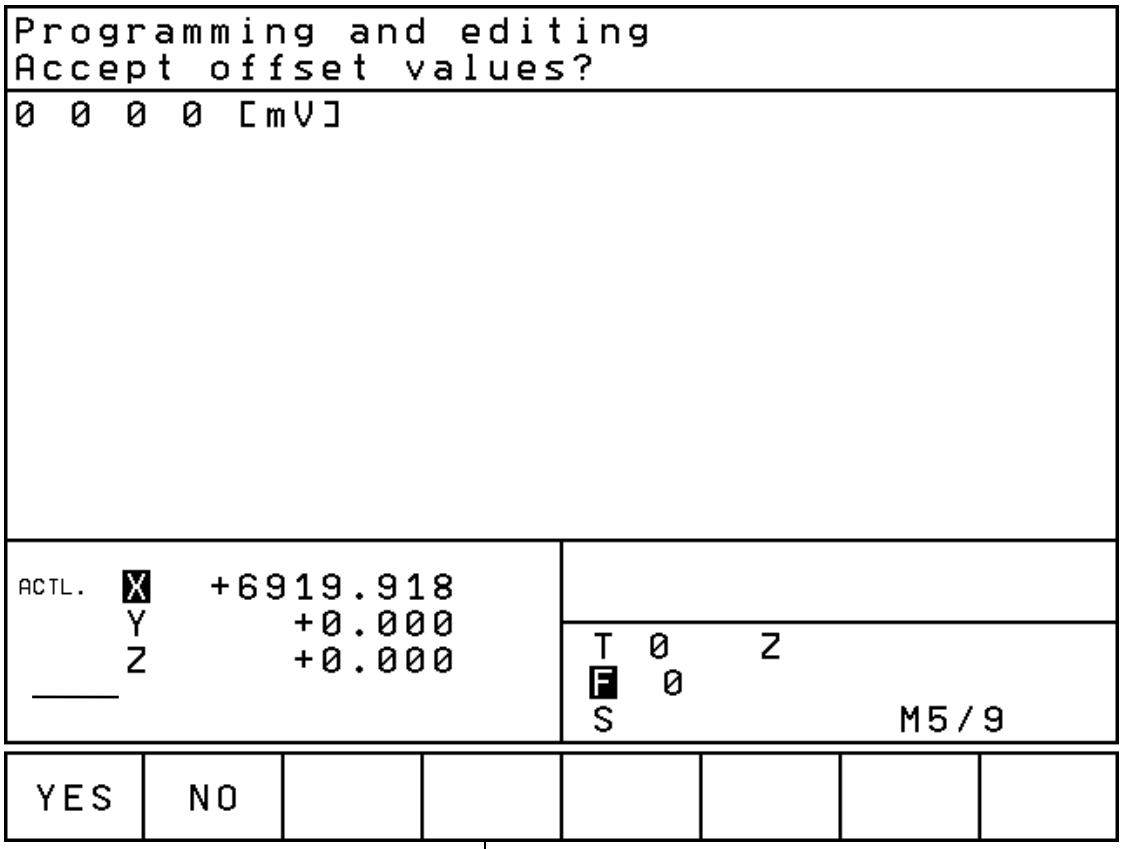
21.5 Offset adjustment

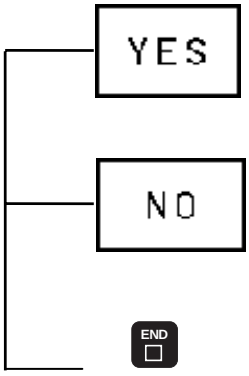
21.5.1 Analog axes

a) Offset adjustment with code number

Press key	Function
	TNC in Operating mode PROGRAMMING AND EDITING Prepare TNC for input of code number Enter code number for offset adjustment and confirm with ENT

On the screen the contents of the offset memory are now displayed in mV.
From left to right: X-axis, Y-axis, Z-axis, 4th axis



	An offset compensation is **executed**. The values are stored in non-volatile memory. The offset adjustment with code number only compensates the **current** offset. Subsequent offset modifications are **not** compensated. Offset compensation is **not executed** or a previous compensation is **cancelled**! End **without** change

b) Cyclic offset adjustment via machine parameter 1220

The machine parameter 1220 contains the cycle time [1s] after which a possibly existing offset is compensated by one converter step.
HEIDENHAIN recommends to program **MP 1220 = 0** (automatic offset adjustment inactive).

c) Offset adjustment at the servo amplifier

- Check and adjust the following machine parameters.
  (Note down the original values before changing a parameter.)

MP	Input values	Function	Original input values
1080.0 1080.1 1080.2 1080.3	0 0 0 0	Integral factor	
1220	0	Automatic adjustment inactive	
1390	0	Feedforward control active	
1510.0 1510.1 1510.2 1510.3	≥ 1 ≥ 1 ≥ 1 ≥ 1	kv factor for feedforward control	
7290.x	4	Display step = 1 µm	

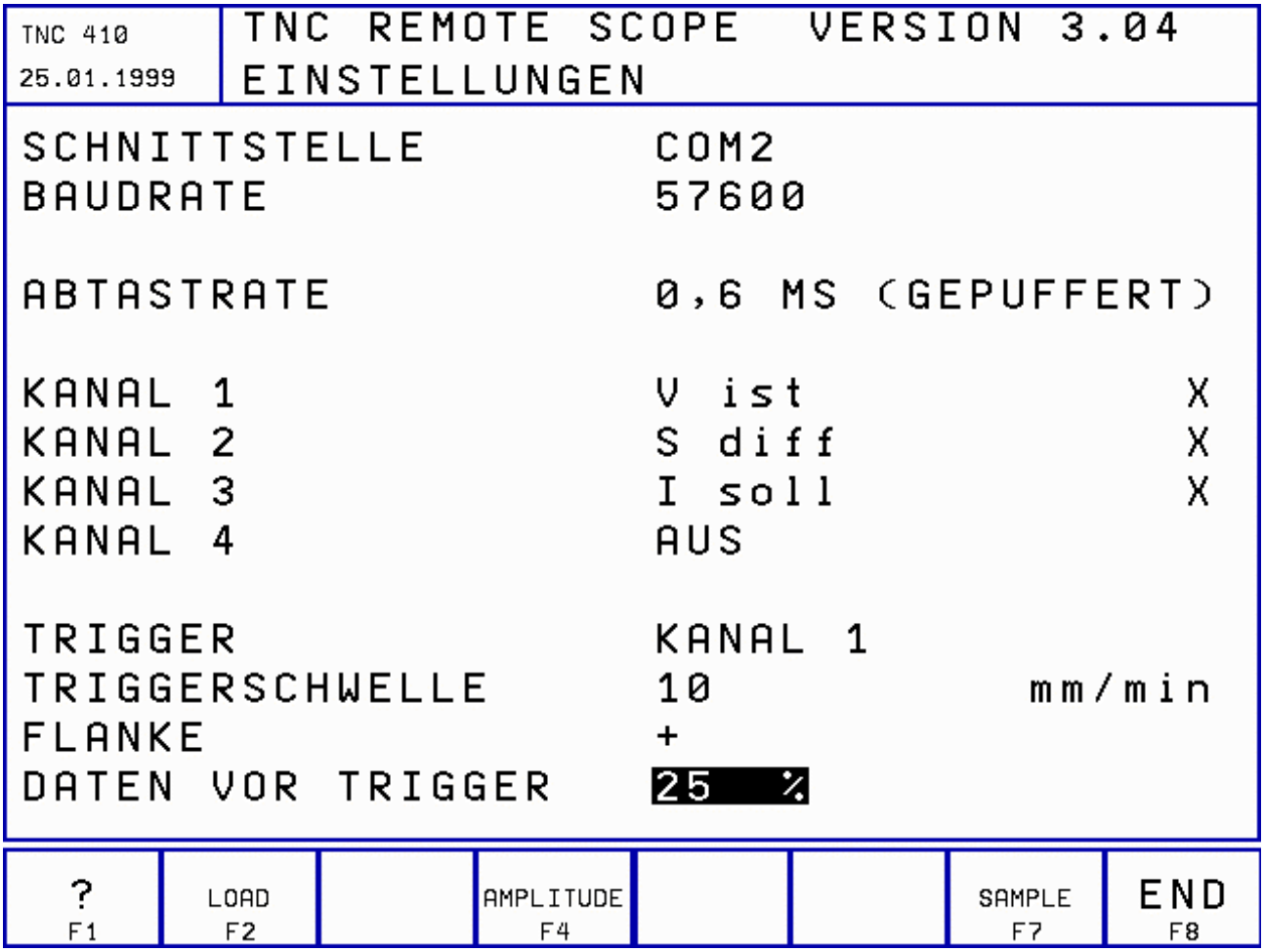
- Switch position display to LAG (display of servo lag); see section "Switching over the position display".
- Cancel the offset compensation with code number (see item a)
- Adjust the offset at the servo amplifier until the values of the individual axes are zero or oscillate symmetrically about zero.
- Reset the machine parameter values and the position display to their original values.

21.5.2 Digital axes

For digital axes the offset adjustment described in section 21.5.1 is not required.

21.6 Remote oscilloscope

TNC 410 features a remote oscilloscope that communicates with the control via the serial data interface.



Description of the settings in the SETUP menu

Move to the desired position by pressing the cursor keys and set the following parameters:

INTERFACE
Serial data interface for communication with the control.

BAUD RATE
Data transfer rate.
Possible settings:
- AUTO: the oscilloscope sets itself according to the value set in the TNC
- 9600 - 115500

SAMPLE TIME
Time resolution for recording.
Possible settings: 0.6ms (buffered)
6ms (not buffered)

CHANNEL 1 TO CHANNEL 4
Select here for each of the four channels which signal you want to record for which axis.

V actl		Actual axis feed rate (mm/min); calculated via position encoder
V noml		Nominal axis feed rate (mm/min); the axis feed rate resulting from the difference of the nominal position values. The servo lag is not taken into account.
F noml		Machining feed rate (mm/min)
S actl		Actual position (mm)
S noml		Nominal position (mm)
S diff		Servo lag of the position controller (mm)
Analog axes:	U analog	Analog voltage = nominal speed (mV)
Digital axes:	v (n actl)	Actual speed (mm/min); calculated via speed encoder and adapted in MP2020
	v (n noml)	Nominal speed (mm/min): output quantity of position controller
	I (n int)	Integral component of nominal current (A)
	I noml	Nominal current that determines the torque (A)

TRIGGER
Here you set the type of recording. Possible settings are:

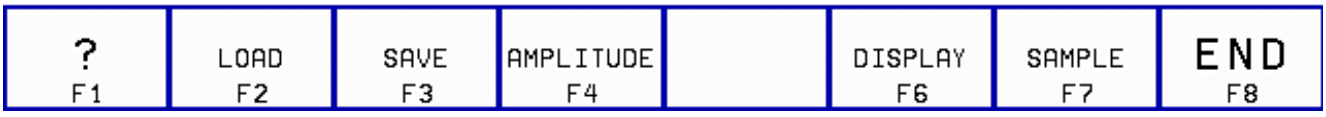
OFF	Recording is started and stopped with soft keys.
SINGLE SHOT	When you press the START soft key the next 4 096 events are stored.
CHANNEL 1 to 4	Recording is started as soon as the trigger threshold of the channel set here is passed.

TRIGGER THRESHOLD
Enter the trigger threshold in the following units:
- Speed [mm/min]
- Position [mm]
- Rotational speed [mm/min]
- Servo lag [mm]
- Analog voltage [mV]
- Current [A]

SLOPE
Here you select whether the rising (positive) or the falling (negative) edge is to be triggered.

PRE-TRIGGER
The stored recording is started by the value set here before the trigger event.
Possible settings: 0/25/50/75/100 %

Description of the soft keys of the remote oscilloscope



F1 Calls the HELP function

F2 Loads settings previously stored with SAVE

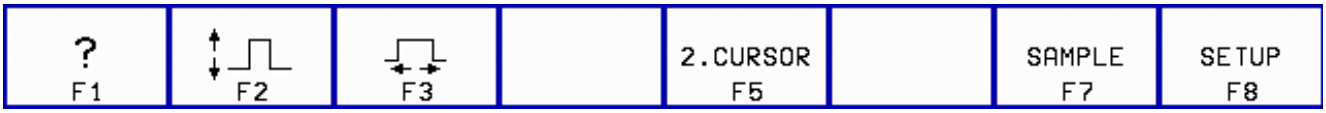
F3 Stores oscilloscope settings and recorded channels in a file

F4 Changes the preset of the Y-deflection (amplitude)

F6 Changes to the oscilloscope display (only possible after recording)

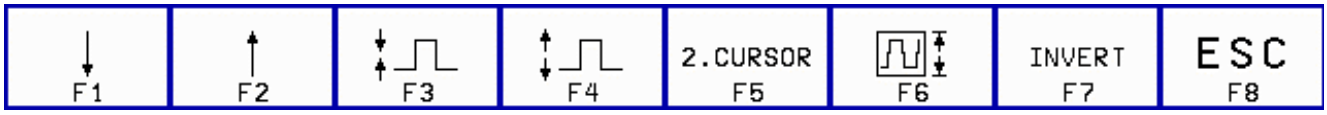
F7 Starts sampling and switches to oscilloscope display

F8 Terminates the Oscilloscope function



F1 Calls the HELP function

F2 Calls the menu for Y-deflection



F1 Moves selected channel downwards

F2 Moves selected channel upwards

F3 Enlarges Y-deflection

F4 Reduces Y-deflection

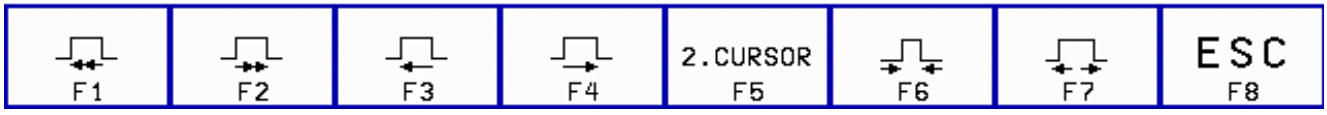
F5 Switches between 1st and 2nd cursor

F6 Activates the setting (Y-deflection etc.) proposed by the oscilloscope

F7 Inverts the characteristic curve of the selected channel

F8 Exits the menu Y-deflection; back to main menu

F3 Calls time-axis menu



F1 Moves characteristic of selected channel to the left in large steps

F2 Moves characteristic of selected channel to the right in large steps

F3 Moves characteristic of selected channel to the left in small steps

F4 Moves characteristic of selected channel to the right in small steps

F5 Switches between 1st and 2nd cursor

F6 Increases time resolution

F7 Reduces time resolution

F8 Terminates the time-axis menu; back to main menu

F5 Switches between 1st and 2nd cursor

F7 Restarts sampling

F8 Back to setup menu (settings)

22. PLC interface

22.1 Specifications

PLC inputs

Voltage range	Logic unit	PL 410 B
"1"-signal: U_i	13 V to 30.2 V	
"0"-signal: U_i	– 20 V to 3.2 V	
Current range:		
"1"-signal: I_i	3.8 mA to 8.9 mA	2.5 mA to 6 mA
"0"-signal: I_i with U_i = 3.2 V	1.0 mA	0.65 mA

Address	Quantity	Unit
I0 to I31	31 + "control is ready"	Logic unit X42 (PLC input)
I128 to I152	25	Logic unit X46 (machine operating panel)
I64 to I127	64	First PLC I/O board
I192 to I255	64	Second PLC I/O board

PLC outputs

Transistor outputs with current limiter

	Logic unit	PL 410 B
Min. output voltage for "1"-signal	3 V below supply voltage	
Rated operating current for each output	0.1 A	1.2 A

- Load capacity: resistance load; inductive load with quenching diode in parallel to inductance.
- It is not permitted to simultaneously short-circuit more than one output on the logic unit. If **one** output is short-circuited the maximum load is not exceeded.
- Only half the PLC outputs may be connected at a time (simultaneity factor 0.5).

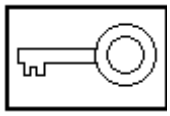
Address	Quantity	Unit
O0 to O30	31	Logic unit X41 (PLC output)
O0 to O7		Logic unit X46 (Machine operating panel)
O32 to O62	31	First PLC I/O board
O64 to O94	31	Second PLC I/O board

22.2 Checking the PLC inputs and outputs

The test unit (see section "Test units") can be used to check the PLC inputs and outputs on the logic unit (X41, X42, X46). The voltage level of the PLC inputs and the output current of the PLC outputs on the PL 405B/410B must be measured directly at the terminals.

PLC inputs

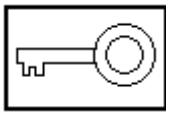
The PLC inputs can be checked as follows:
- Connect the test unit between LE and PLC (measure directly at the PL boards).

Press key	Function
	TNC in operating mode PROGRAMMING/EDITING
MOD	Call subordinate mode
	Prepare TNC for input of code number
8 0 7 6 6 7 ENT	Enter code number, confirm with ENT
TABLE	Call TABLE function
INPUT	Table of the inputs is displayed
Now the logic states of the inputs are displayed on the screen. They must correspond to the voltage levels of the respective inputs (voltage levels: see section 22.1). If there is a difference although the input voltage is correct, probably the PLC input of the processor board or the PLC I/O board PL 405B/410B is defective.	
END	Exit TABLE function

Observe the safety instructions!

PLC outputs

The PLC outputs can be checked as follows:
- Connect the test unit between LE and PL (measure directly at the PL boards).

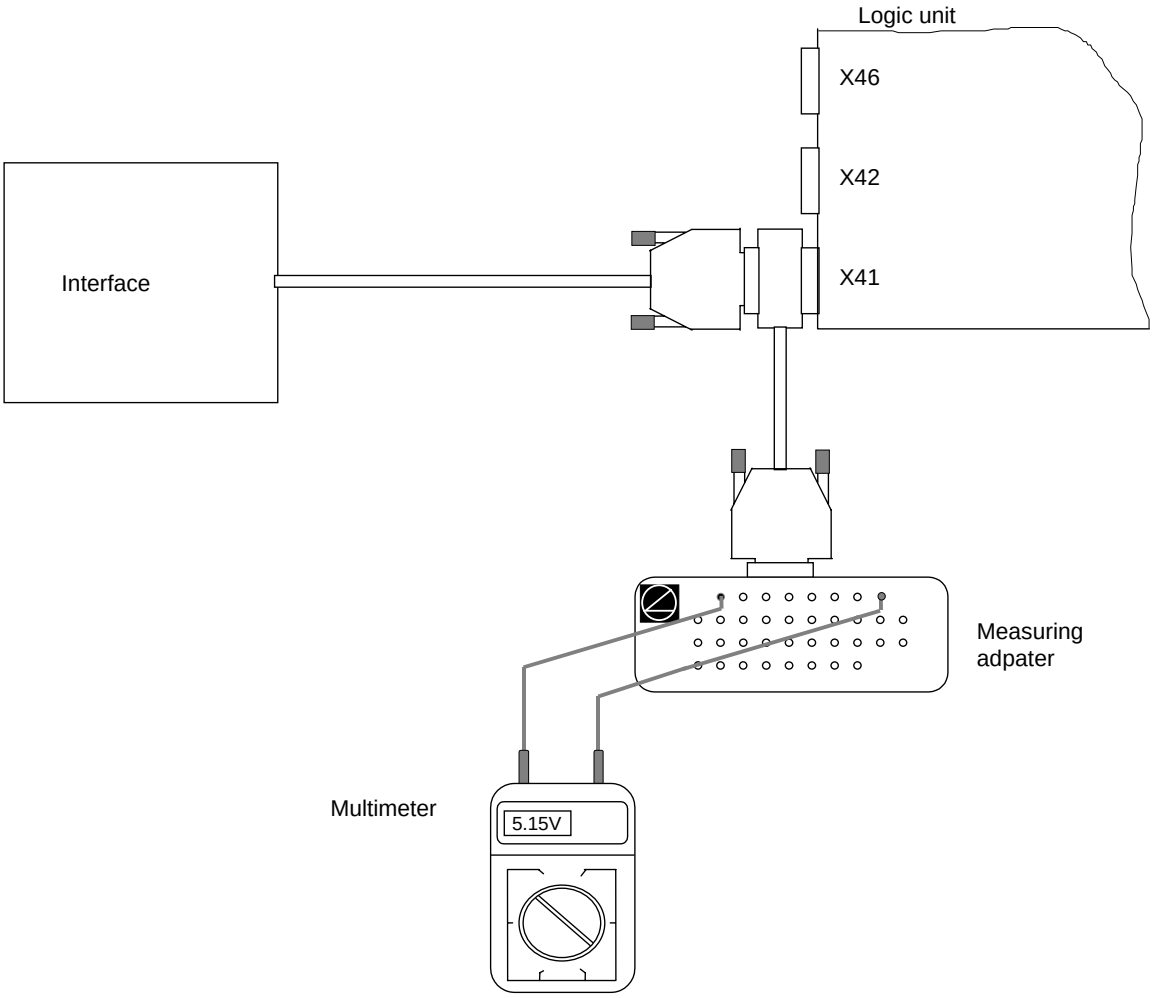
Press key	Function
	TNC in operating mode PROGRAMMING/EDITING
MOD	Call subordinate mode
	Prepare TNC for input of code number
8 0 7 6 6 7 ENT	Enter code number; confirm with ENT
TABLE	Call TABLE function
OUTPUT	Table of the inputs is displayed

Now the logic states of the outputs are displayed on the screen. They must correspond to the voltage levels of the respective outputs. If there is a difference, check the connecting cable for short-circuit and measure the output current at the interface (max. 0.1 A for LE outputs, max. 1.2 A for PL outputs). If the output current is not exceeded and connecting cable is in order, the PLC output board of the processor board or the PLC I/O board PL 405B/410B is defective.

END	Exit TABLE function

 **Observe the safety instructions!**

Measuring setup for the PLC inputs and outputs on the LE

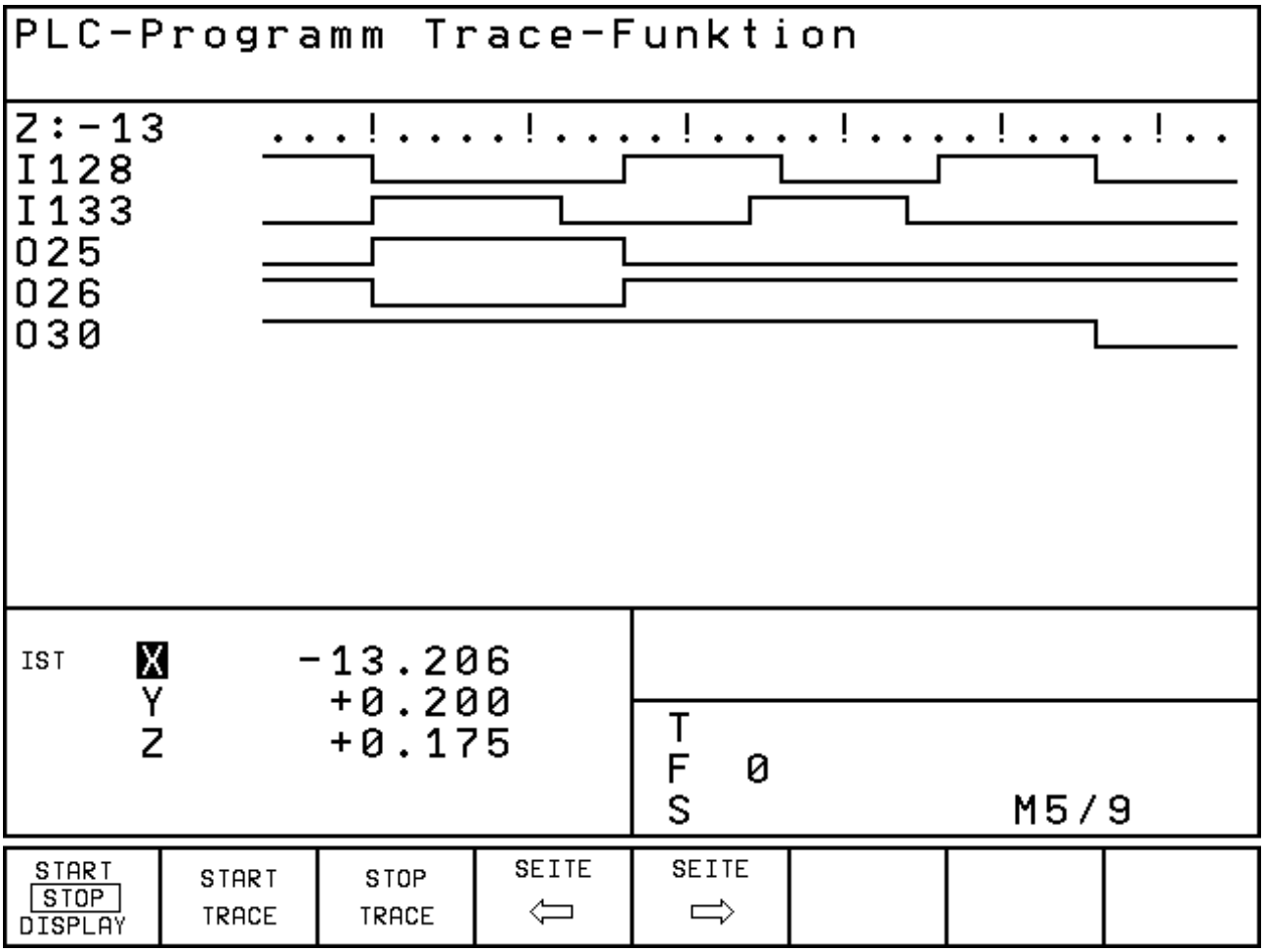


X41 : PLC output
X42 : PLC input
X46 : Machine operating panel

Observe the safety instructions!

22.3 Diagnosis in the PLC mode

22.3.1 LOGIC diagram



The logic states of up to 16 operands (M, I, O, T, C) can be displayed at a time on the screen. 1024 PLC scans can be traced.

Calling the logic diagram:

Press key	Function
DISPLAY TRACE BUFFER	Press soft key

Selecting the operands and starting the tracing function

Press key	Function
SELECT M/I/O/T/C	

A table is displayed from which the operands can be selected. The control requests the positions of the table in a dialogue. Wrong inputs can be cleared by pressing DEL. It is possible to enter a trigger condition for each operand. 512 states are traced before and after a trigger event. The following trigger conditions are possible:

"1" ⇒ trace if the operand is a logical "1"
(trigger on positive edge)

"0" ⇒ trace if the operand is a logical "0"
(trigger on negative edge)

NO ENT ⇒ no trigger
If no trigger condition is entered for any of the operands, the operand states are traced continuously and the last 1024 states are stored.

e.g.: 0 I5 1 ⇒ trigger on positive edge
1 O6 0 ⇒ trigger on negative edge
2 M2003 ⇒ no trigger

START TRACE	Start TRACE function

The trace function is started with START TRACE; STOP TRACE or a trigger event terminate the tracing.

PCTR blinking : trigger condition has not occurred yet
PCTR on : trigger condition has occurred; write access to buffer memory
PCTR off : buffer memory is full; LOGIC DIAGRAM can be called

DISPLAY TRACE BUFFER	Call the logic diagram

22.3.2 TABLE Function

Press key	Function
TABLE	Call TABLE function

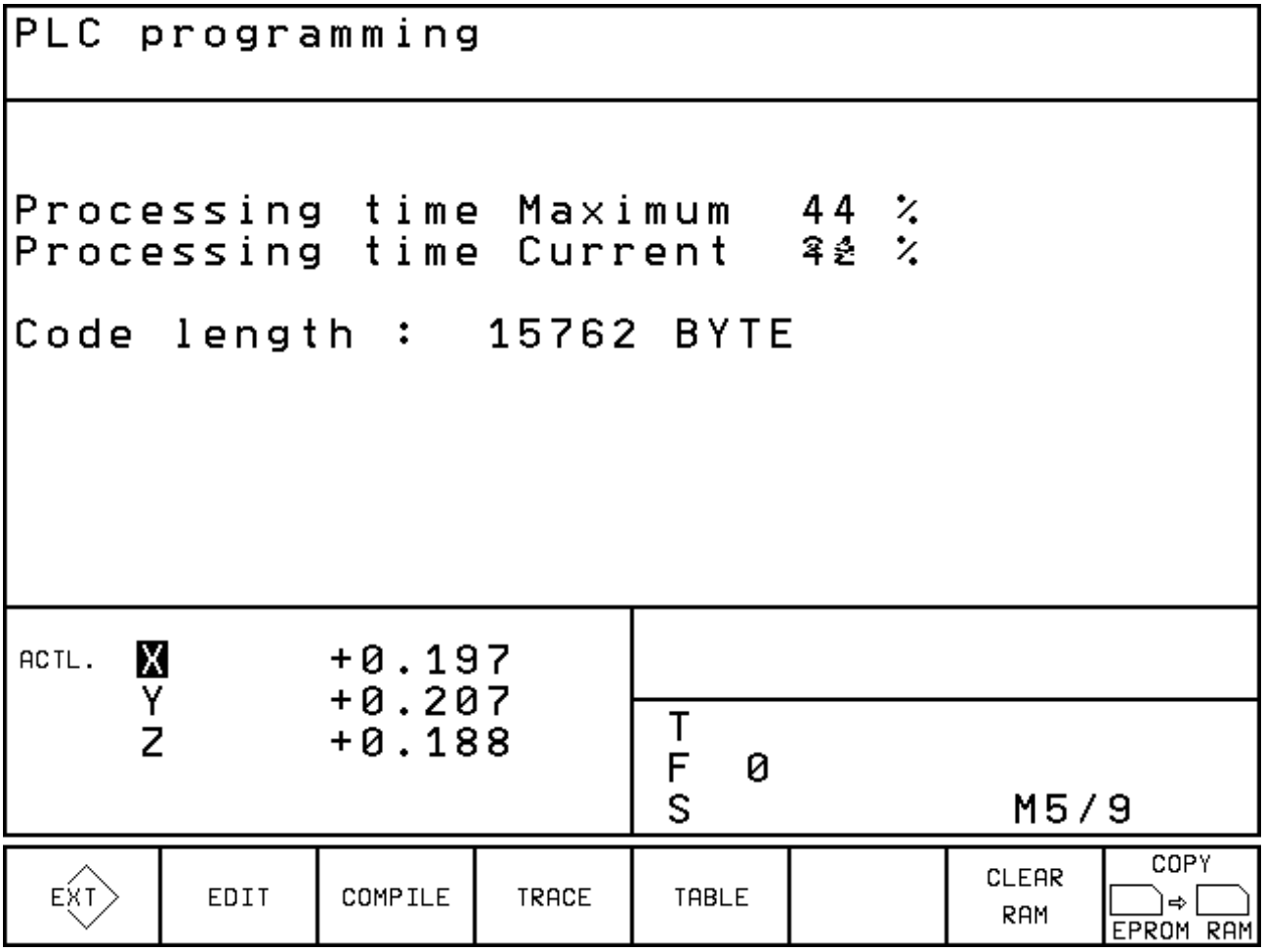
INPUT	OUTPUT	COUNT.	TIMER	MARKER	BYTE	WORD	DOUBLE

▷	Key on VDU

Page ⇧	Page ⇩			DISP [DEC] HEX	SET	RESET	

After pressing a soft key, the corresponding table is activated.
The logic states of the markers, inputs, outputs, counters and timers are dynamically displayed.
In the tables for bytes, words and double words, the display can be switched between HEX and DECIMAL.
With the cursor keys or the GOTO key, positions can be selected within the table.

22.4 Compiling the PLC program



COMPILE	Press soft key The PLC program in the **RAM** is compiled

22.5 Output "Control is ready" and acknowledgement for test " Control is ready "

Important functions are monitored by the TNC 410 by way of a self-diagnosis system (electronic assemblies such as micro-processor, EPROM, RAM, positioning systems, encoders etc.).
For the EMERGENCY STOP routine a PLC input (X42/4) and a PLC output ("Control is ready") are available on the control. The output "Control is ready" is available several times:

Logic unit,	connector X41	pin 34; maximum current consumption 100 mA
PL 405B,	terminal strip X8	pin 16; maximum current consumption 1.2 A
PL 410B,	terminal strip X8	pin 16; maximum current consumption 1.2 A

If the control detects a malfunction, it switches off the output "Control is ready"; a blinking error message is displayed and the PLC program stopped. This error message cannot be cleared by pressing CE. The error must be eliminated and then the power-on routine repeated.

If the input "Control is ready" is switched off by a procedure outside the control, the error message **EMERGENCY STOP** is generated, and the NC sets the markers M4177 and M4178. Moreover, zero is output as nominal speed and the drives are switched off. This error message can be cleared by pressing CE after having switched off and on the control voltage.

The output "Control Ready for Operation" is to switch off the +24V control voltage in the machine tool interface. Since this is an important safety function, the switch-off function of the output "Control Ready for Operation" is tested via the input "Acknowledgement control is ready" each time the control is switched on.

TNC 410 features two monitoring systems (main processor, DSP) which are also tested when the machine tool is switched on.

If the +24V at the input "Acknowledgement control is ready" are missing during the test routine after power-on, the error message **"RELAY EXT. DC VOLTAGE MISSING"** is displayed. If however, the acknowledgement is switched off too late (or not at all) after the output has been switched off, the blinking error message **"EMERGENCY STOP DEFECTIVE"** is generated.

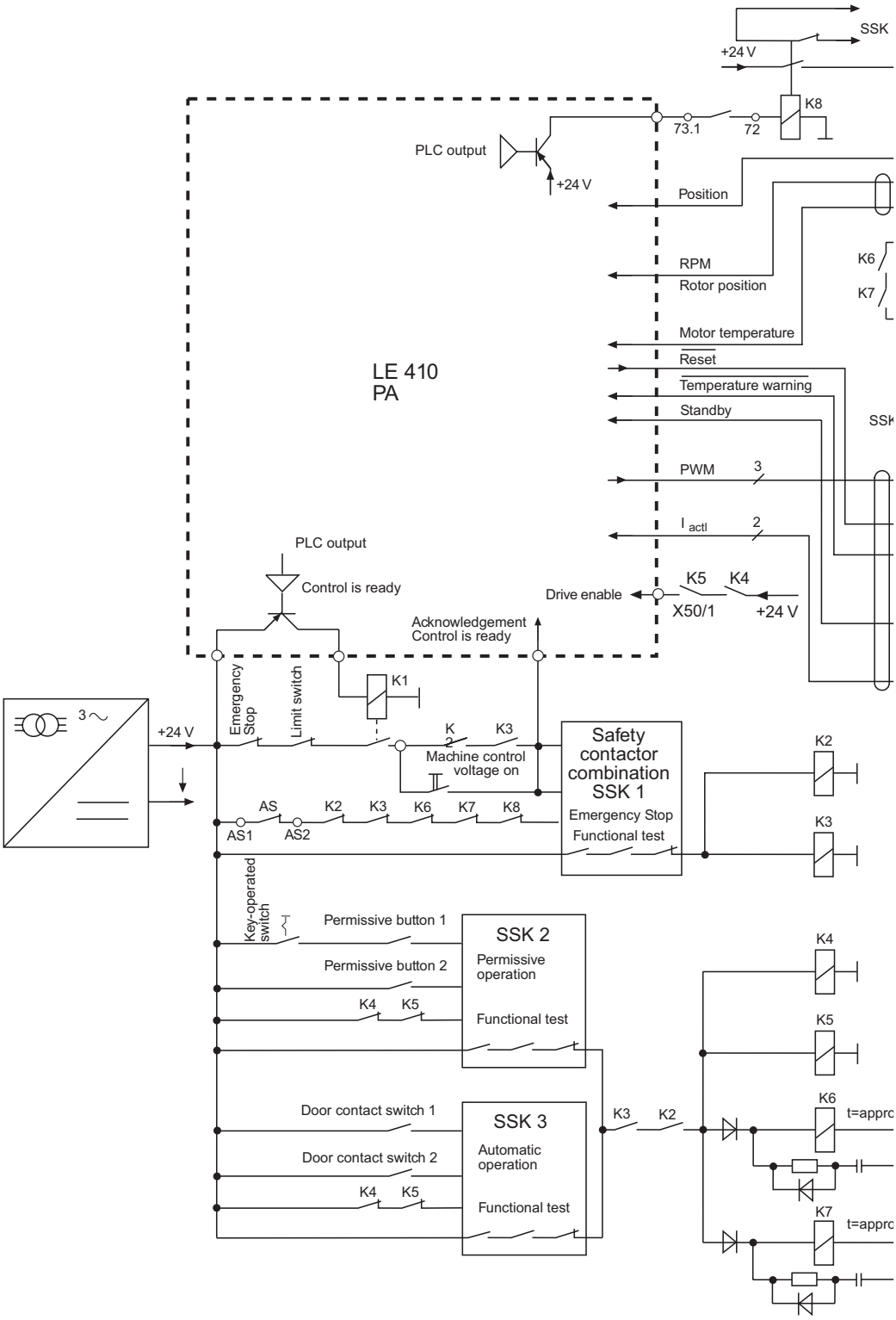
If the control detects an error during the power-on test routine, a bridge can be inserted between the output "Control is ready" and the input "Acknowledgement control is ready" (disconnect the wires) in order to determine whether the defect is due to the control or to the interface. If the error is still present after inserting the bridge and with correct PLC power supply, the defect is located in the logic unit.
If however, the error does not occur with the bridge being inserted, the defect is located in the interface.

Caution!
Do not forget to remove the bridge and to install the standard operating state after the test.

Observe the safety instructions!

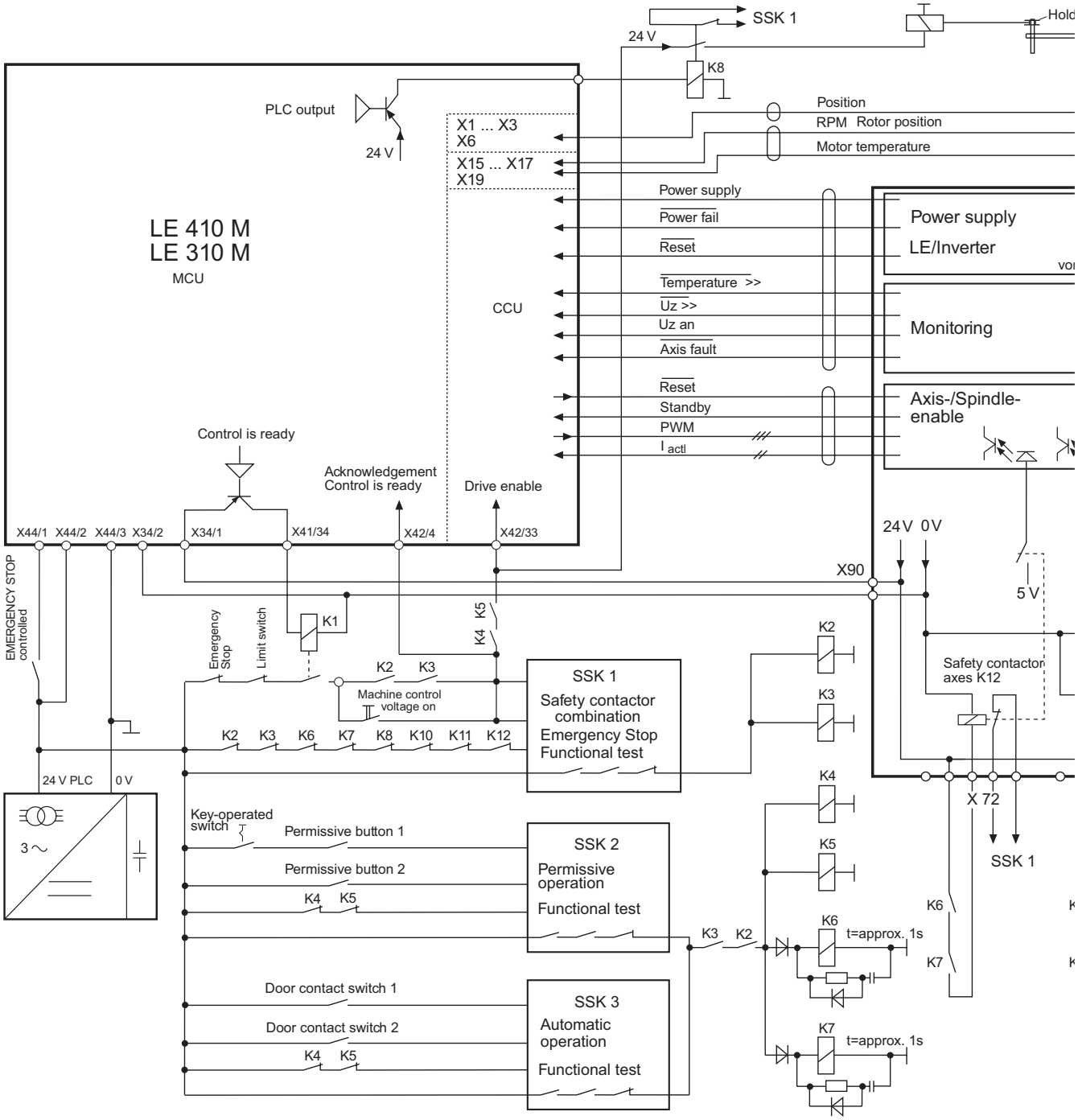
22.5.1 Basic circuit diagram of EMERGENCY STOP interface

Connection diagram TNC 410 PA (CA) and TNC 410 MA (old hardware)
If an error occurs, the output "Control is ready" must generate an EMERGENCY STOP. Since this function is of great importance, the control checks this output each time the power is switched on.



Connection diagram TNC 410 MA (new hardware)

If an error occurs, the output "Control is ready" must generate an EMERGENCY STOP. Since this function is of great importance, the control checks this output each time the power is switched on.

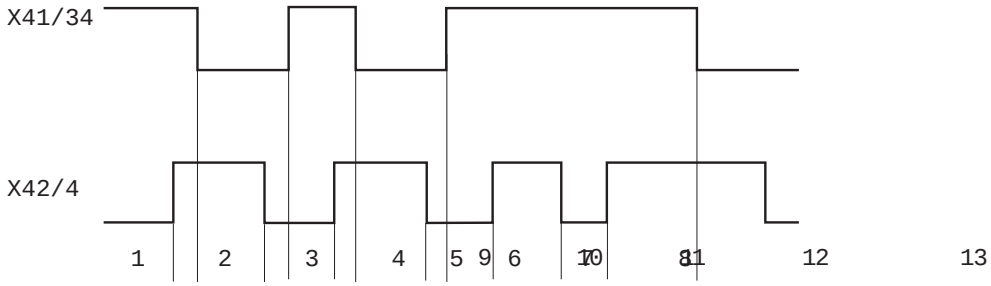


Emergency stop monitoring of TNC 410

A PLC input (X42 / 4) and a PLC output (X41 / 34) "Control is ready" are available at the control for the EMERGENCY STOP routine.
If the control detects a malfunction, it switches off the output "Control is ready"; a blinking error message is displayed and the PLC program stopped. This error message cannot be cleared by pressing CE. The error must be eliminated and then the power-on routine repeated.
If the input "Control is ready" is switched off by a procedure outside the control, the error message EMERGENCY STOP is generated, and the NC sets the markers M4177 and M4178. Moreover, zero is output as nominal speed and the drives are switched off. This error message can be cleared by pressing CE after having switched off and on the control voltage.
If the marker M4580 is set, an EMERGENCY STOP (input "Control is ready") is not transferred to the NC; instead the control loops of all axes and of the spindle are opened and an NC stop executed.

In the case of an error the output "Control is ready" must initiate an EMERGENY STOP. Owing to the great importance of this function the output is tested by the control each time the line voltage is switched on.

TNC 410: Flowchart

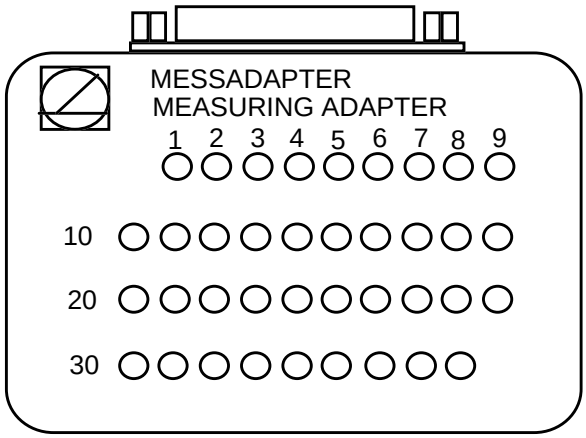


		Screen display
1	Waiting for control voltage	Relay ext. DC voltage missing
2	Recognition of control voltage at X42/4 and switching off the signal "Control is ready“ at X41/34 by main processor (t < 66 ms).	
3	Maximum time in which the acknowledgement "Control is ready“ at X42/4 must be set to zero (t < 380 ms).	If exceeded: EMERGENCY STOP defective
4	Recognition of acknowledgement and setting of X41/34 (t < 20 ms).	
5	Waiting for control voltage	Relay ext. DC voltage missing
6	Recognition of control voltage at X42/4 and switching of the signal "Control is ready“ at X41/34 by DSP (t < 120 ms).	
7	Maximum time in which the acknowledgement "Control is ready“ at X42/4 must be set to zero (t < 380 ms).	If exceeded: EMERGENCY STOP defective
8	Recognition of acknowledgement and setting of X41/34 (t < 120 ms).	
9	Waiting for control voltage	Relay ext. DC voltage missing
10	Normal operation of control; output and acknowledgement "Control is ready“ are high.	
11	Control voltage is switched off from outside.	EMERGENCY STOP
12	Error message can be cleared when control voltage is switched on again; normal operation of control.	
13	When an error is detected the control switches off the output "Control is ready“ (X41/34).	Blinking error message

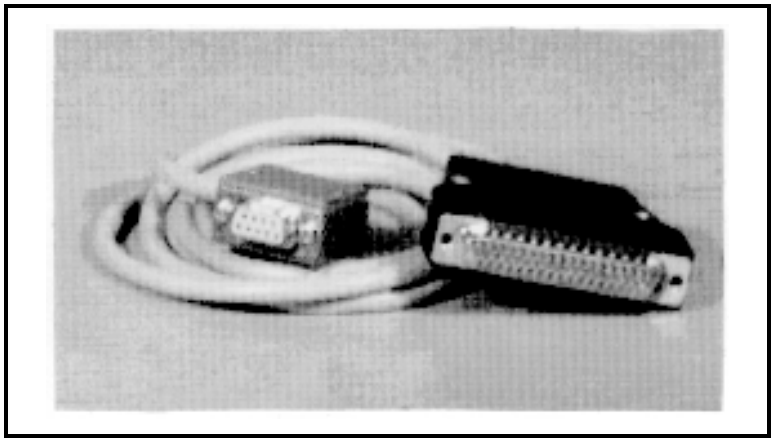
23. Test units

23.1 Universal measuring adapter

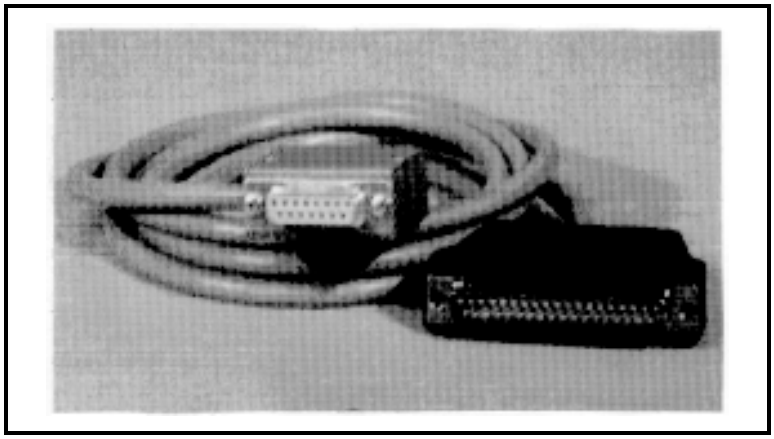
Used:
- Universal test unit for D-Sub connectors, 9-pin to 37-pin (Id.No. 255 480 01)



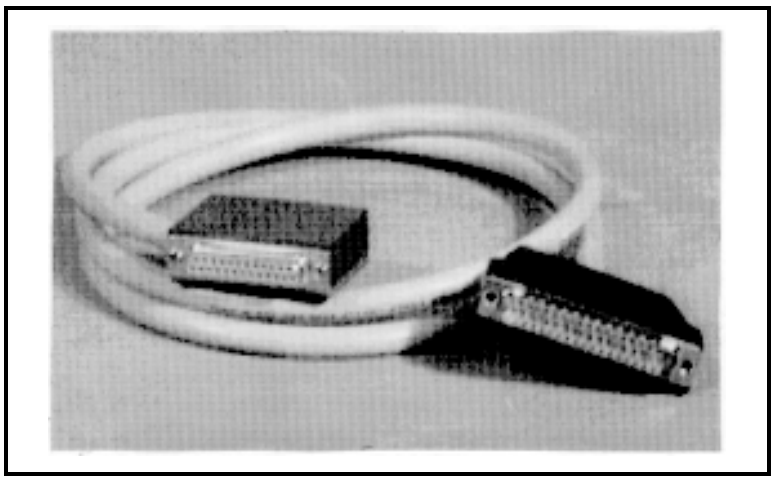
The measuring adapter can be used to test the inputs and outputs of D-Sub connectors (9-pin to 37-pin).
On the following page the adapter cables are shown that are required for the different connectors.



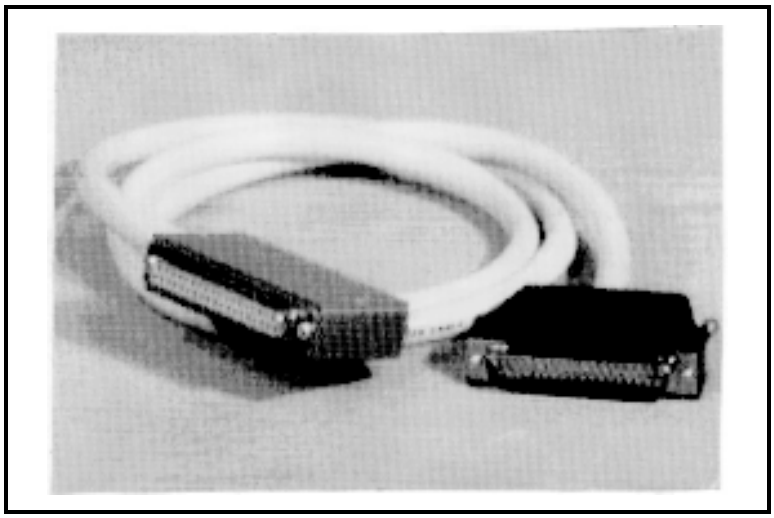
Adapter cable, 9-pin
Id.No. 255 481 01



Adapter cable, 15-pin
Id.No. 255 482 01



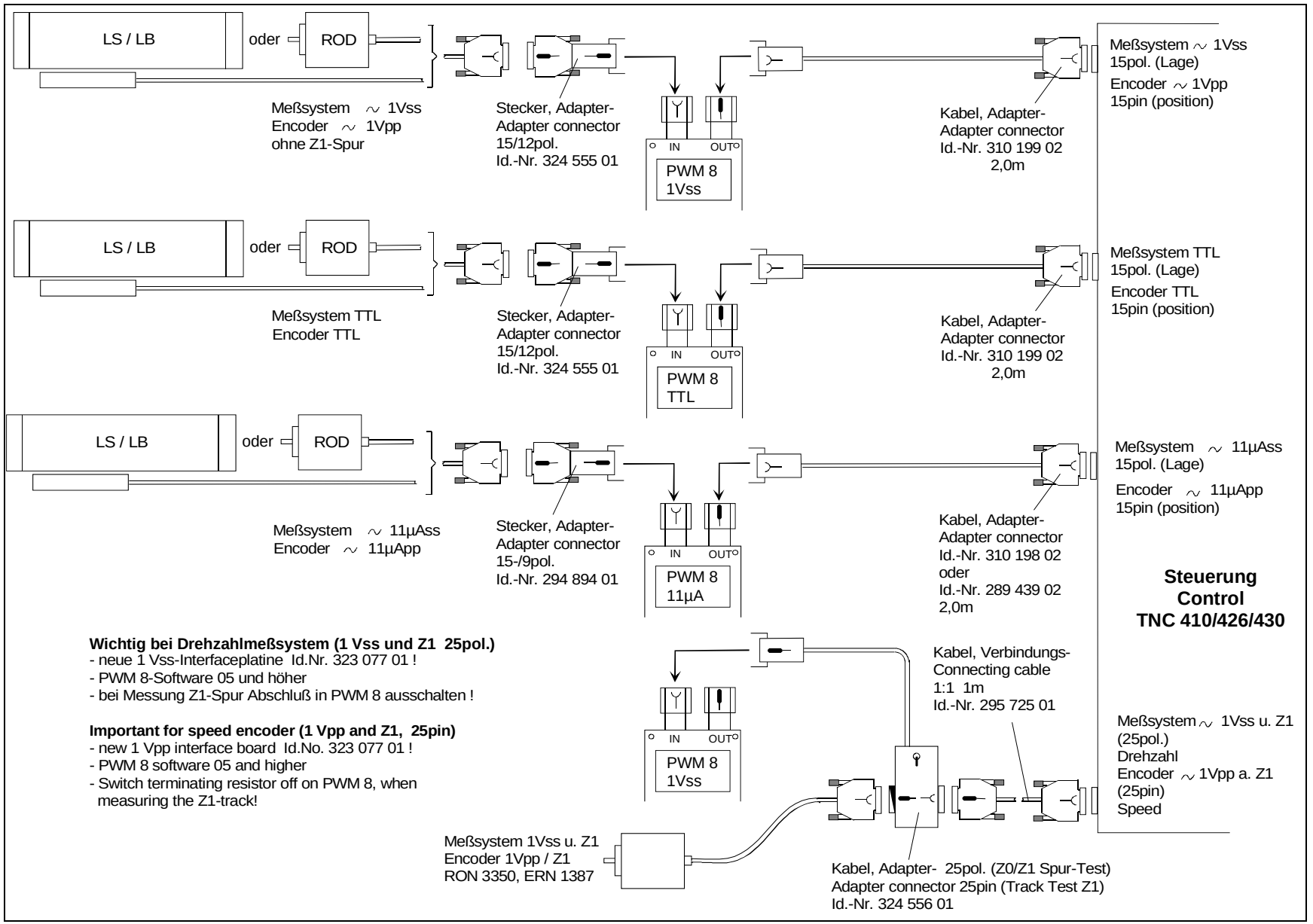
Adapter cable, 25-pin
Id.No. 255 483 01



Adapter cable, 37-pin
Id.No. 255 484 01

23.2 Encoder diagnostic set

Used:
- to test the electrical functions of an encoder
- Id.No. 254 599 01; further information please see from the operating instructions of the Diagnostic Set.
- Adapter block TNC 410 - PWM8 see next page


LS / LB
oder
ROD
Meßsystem ~ 1Vss
Encoder ~ 1Vpp
ohne Z1-Spur
Stecker, Adapter-
Adapter connector
15/12pol.
Id.-Nr. 324 555 01
IN
OUT
PWM 8
1Vss
Kabel, Adapter-
Adapter connector
Id.-Nr. 310 199 02
2,0m
Meßsystem ~ 1Vss
15pol. (Lage)
Encoder ~ 1Vpp
15pin (position)
LS / LB
oder
ROD
Meßsystem TTL
Encoder TTL
Stecker, Adapter-
Adapter connector
15/12pol.
Id.-Nr. 324 555 01
IN
OUT
PWM 8
TTL
Kabel, Adapter-
Adapter connector
Id.-Nr. 310 199 02
2,0m
Meßsystem TTL
15pol. (Lage)
Encoder TTL
15pin (position)
LS / LB
oder
ROD
Meßsystem ~ 11µAss
Encoder ~ 11µApp
Stecker, Adapter-
Adapter connector
15-/9pol.
Id.-Nr. 294 894 01
IN
OUT
PWM 8
11µA
Kabel, Adapter-
Adapter connector
Id.-Nr. 310 198 02
oder
Id.-Nr. 289 439 02
2,0m
Meßsystem ~ 11µAss
15pol. (Lage)
Encoder ~ 11µApp
15pin (position)
Steuerung
Control
TNC 410/426/430
Wichtig bei Drehzahlmeßsystem (1 Vss und Z1 25pol.)
- neue 1 Vss-Interfaceplatine Id.Nr. 323 077 01 !
- PWM 8-Software 05 und höher
- bei Messung Z1-Spur Abschluß in PWM 8 ausschalten !
Important for speed encoder (1 Vpp and Z1, 25pin)
- new 1 Vpp interface board Id.No. 323 077 01 !
- PWM 8 software 05 and higher
- Switch terminating resistor off on PWM 8, when measuring the Z1-track!
IN
OUT
PWM 8
1Vss
Kabel, Verbindungs-
Connecting cable
1:1 1m
Id.-Nr. 295 725 01
Meßsystem ~ 1Vss u. Z1
(25pol.)
Drehzahl
Encoder ~ 1Vpp a. Z1
(25pin)
Speed
Meßsystem 1Vss u. Z1
Encoder 1Vpp / Z1
RON 3350, ERN 1387
Kabel, Adapter- 25pol. (Z0/Z1 Spur-Test)
Adapter connector 25pin (Track Test Z1)
Id.-Nr. 324 556 01

23.3 Drive-control generator (DCG)

Used:

- To drive inverters with PWM interface as nominal speed input
  in connection with HEIDENHAIN controls
  Id.No. 296 737 01

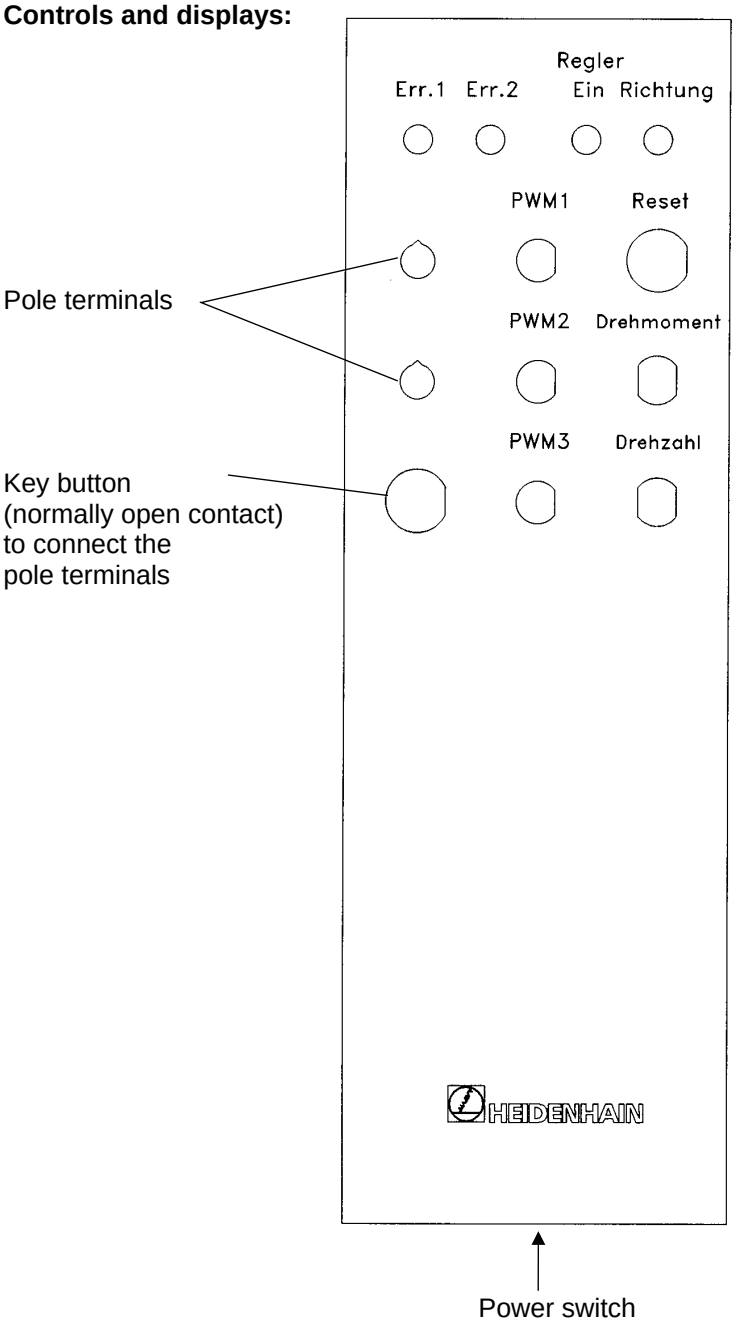
Accessories:

- Adapter cable for connection to PWM interface, 15-pin, D-SUB: Id.No. 289 208-02
- Adapter cable for connection to PWM interface, 16/34-pin, plug-type connector: Id.No. 326 602-01
- Adapter cable for connection to PWM interface, 20-pin, plug-type connector: Id.No. 331 389-01

Specifications:

- Power supply 230V
- Power consumption 4 W
- Speed and torque can be set individually
- Direction can be switched

Controls and displays:



Err.1	toggle switch (STANDBY)
Err.2	toggle switch
	TEMPERATURE WARNING
Regler Ein	toggle switch
Richtung	toggle switch
PWM1	BNC socket
PWM2	BNC socket
PWM3	BNC socket
Reset	key button
Drehmoment	potentiometer
Drehzahl	potentiometer

Description of controls and displays:

Err.1 If the drive does not send a STANDBY signal when the switch is in *UP* position (active), the DCG is not switched on and the axis cannot be moved.
By setting the toggle switch to *DOWN* position (off), the STANDBY signal is not evaluated and the axis can be moved.

Err.2 If the switch is set to *UP* position (active) when the signal $\overline{\text{TEMPERATURE WARNING}}$ is transmitted, the DCG is not switched on and the axis cannot be moved.
By setting the toggle switch to *DOWN* position (off), this signal is not evaluated and the axis can be moved.

Caution:
An error has occurred, if the drive does not output the STANDBY signal or the $\overline{\text{TEMPERATURE WARNING}}$ signal. If the drive is selected nevertheless, the servo amplifier may be **destroyed**.

Regler Ein (controller on) Switch position *UP* (ON): Controller of DCG switched on, DCG is ready for operation.
Switch position *DOWN* (OFF): Controller of DCG switched off, DCG is not ready for operation.

Richtung (direction) When shifting the toggle switch the direction is inverted. The direction can **only** be changed, if the speed is zero.

PWM1 BNC socket for connection of an oscilloscope for PWM signal, phase 1.
PWM2 BNC socket for connection of an oscilloscope for PWM signal, phase 2.
PWM3 BNC socket for connection of an oscilloscope for PWM signal, phase 3.

Reset The drive is reset, when this key button is pressed (axis stops).

Drehmoment (torque) Potentiometer to set the torque; left stop = off.

Drehzahl (speed) Potentiometer to set the speed; left stop = off.

Key button When this button is pressed, the two pole terminals are connected. By means of this function e.g. an external decelerating contactor or a clamping fixture can be selected.

Vertical axes:
After having changed the direction of a vertical axis, the axis may drop (speed and torque = 0).
If required, select decelerating contactor or clamping fixture by means of the key button and pole terminals at the DCG.

Observe the safety instructions !

In order to correctly judge the behaviour of a machine tool controlled by TNC, fundamental knowledge of the machine tool and the drives as well as their interaction with the measuring systems is required.

Considerable damage and personal injury may result from improper use.

HEIDENHAIN can accept no responsibility for any damage or personal injury caused directly or indirectly or by improper use or incorrect operation.

24. Exchange instructions

24.1 Important information

Observe the safety instructions!

24.1.1 Required equipment

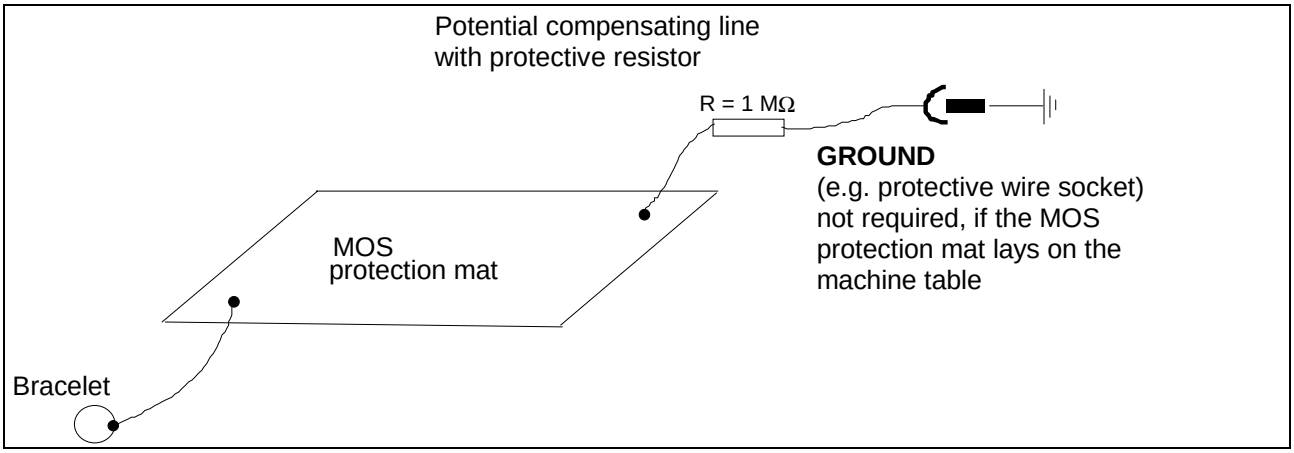
PC with HEIDENHAIN data transfer software TNCremo
1 IC-extraction and insertion tool (for exchanging NC software and boards)
1 MOS protection device (only required for exchanging boards or EPROMs)

24.1.2 MOS protection

When the EPROMs are to be exchanged, a MOS protection is indispensable, since otherwise EPROMs may be destroyed.

Caution!
Avoid any unprotected handling or contact of the boards or EPROMs with statically charged objects (packaging material, storage etc.).

MOS protection



24.1.3 Software compatibility

Exchange units (LOGIC UNIT) are always supplied with the most recent software version. Exchange boards, however, are delivered **without** software and without software enable module.

Therefore, the EPROMs and the software enable module of the defective board must be inserted into the exchange board at site. (Always remove the EPROMs and the software enable module before sending us boards for repair!)

24.2 Exchanging the NC software

The NC software of TNC 410 should be exchanged in the order described below.
Depending on the version of the NC software, the machine tool model and features, some items may by skipped.

24.2.1 Bringing the machine or the axes into a defined status

Machines with swivel head:

- Bring the swivel head into a defined position (starting position).
  Information can be provided by your machine tool builder!

Machines with toolchanger:

- Bring tool changer into a defined position.
  Information can be provided by your machine tool builder!

Machine axes in general:

- Move axes to the middle of the traverse range.
  (away from the hardware limit switches).

24.2.2 Backing up RAM data

Before exchanging the NC software the contents of the RAM must be backed up.

RAM data:

- **Files** (part programs, machine parameters etc.)
- **MODE settings** (position display etc.)
- **TRAVERSE RANGE** (traverse range limits for "Machine“ and "Test“)
- **DATUM** (specified workpiece datum)
- **RS 232 SETUP** (baud rate, operating mode)
- **Calibration data of the probe systems**
- **Non-volatile PLC memory** (markers and words of a certain group)
- **If required, back up the motor tables in RAM (TNC 410PA/M only)**

Reading out the files

All files stored in TNC 410 (depending on machine model and features) must be read out.
The proceeding for reading out a file is described in the section "Data output".

For this purpose HEIDENHAIN offers the data transfer software TNCremo, Id.No. 280 480 – (German) and 280 481 – (English).

Files in the NC memory

Part programs, tool tables etc. are stored in the NC memory.
These files must be read out. Depending on the machine model and features the machine tool builder may have excluded certain file types via machine parameters.

Files in the NC memory	Extension in TNC
NC program HEIDENHAIN plain language	.H
NC program DIN/ISO	.I
Active tool table	TOOL.T
Pocket table	TOOLP.TCH
Pallet table	.P
Point table for digitized data	.PNT
Datum table	.D

Nonlinear axis error compensation

If one or several bits are set in the machine parameter **MP730**, nonlinear axis error compensation is **active** in one or several axes. These files must be read out.
The procedure is described in the section "Data output".

Data for nonlinear axis error compensation	.COM [1)]
Data for nonlinear axis error compensation	.CMA [1)]

1) With NC software 286 000 – 011 the files for nonlinear axis error compensation are stored in **one** file. They can be called with the same code number.

PLC program in RAM

If machine parameter MP4010 = 1 the PLC program is run from the **RAM**.
This file must be read out.
The procedure is described in the section "Data output".

PLC program in RAM	.PLC

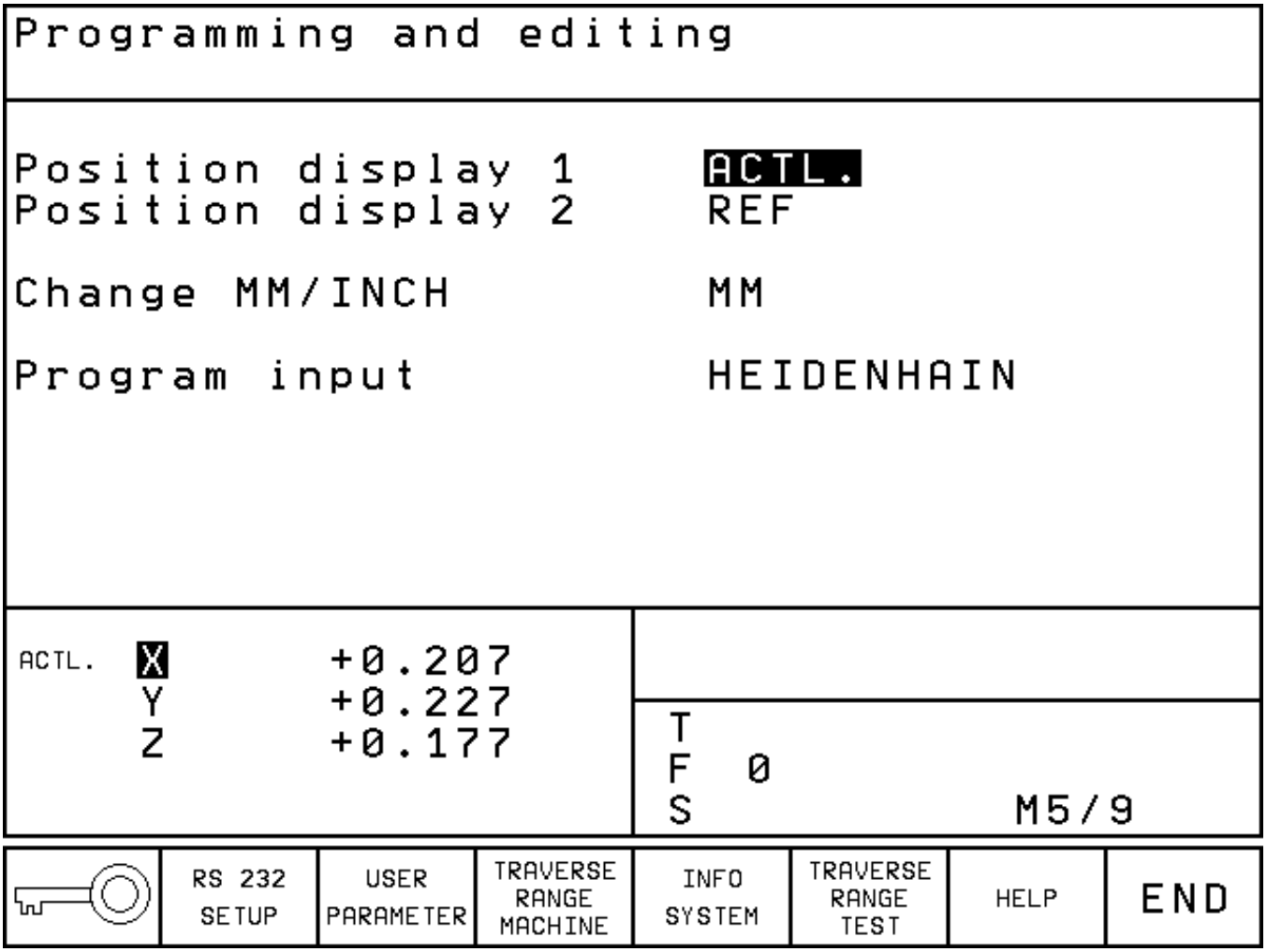
Machine parameter file

The machine parameter file is stored in RAM.
This file must be read out.
The procedure is described in the section "Data output".

Machine parameter file	.MP

MODE Settings

Press key	Function
	TNC in operating mode PROGRAMMING AND EDITING Call subordinate mode

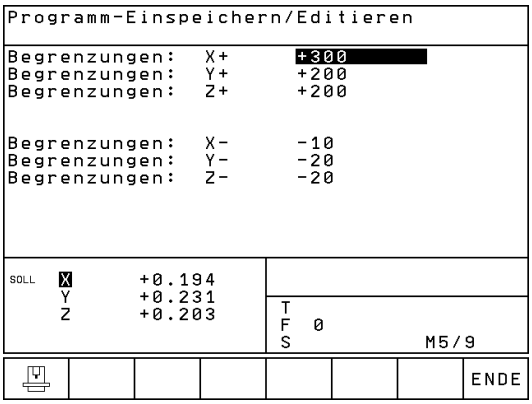


Note down all settings and re-enter the values after having exchanged the NC software!

MODE settings

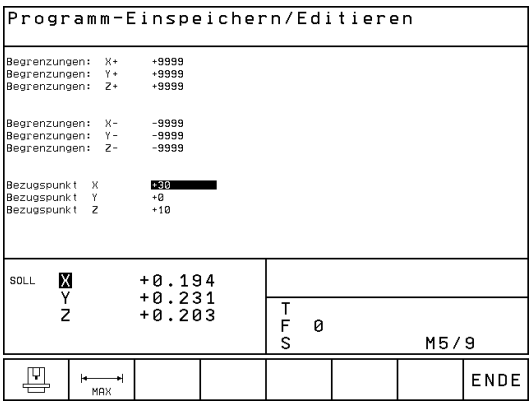
TRAVERSE RANGE

Press key	Function
	TNC in operating mode PROGRAMMING AND EDITING
	Call subordinate mode
	Call MACHINE traverse range settings



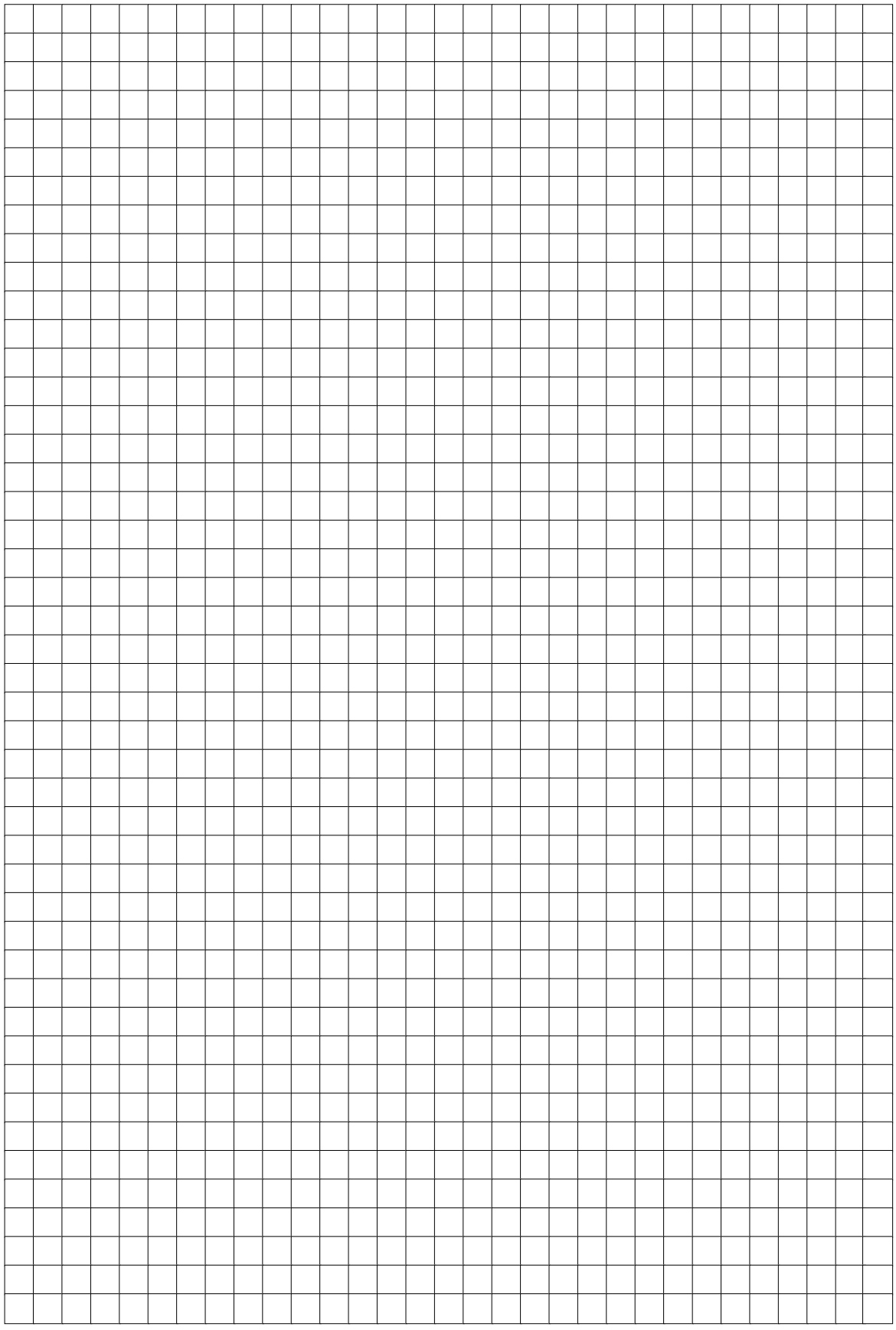
Note down all settings and re-enter the values after having exchanged the NC software!

	Exit the subordinate mode
	Call MODE
	Call TEST traverse range settings



Note down all settings and re-enter the values after having exchanged the NC software!

TRAVERSE RANGE



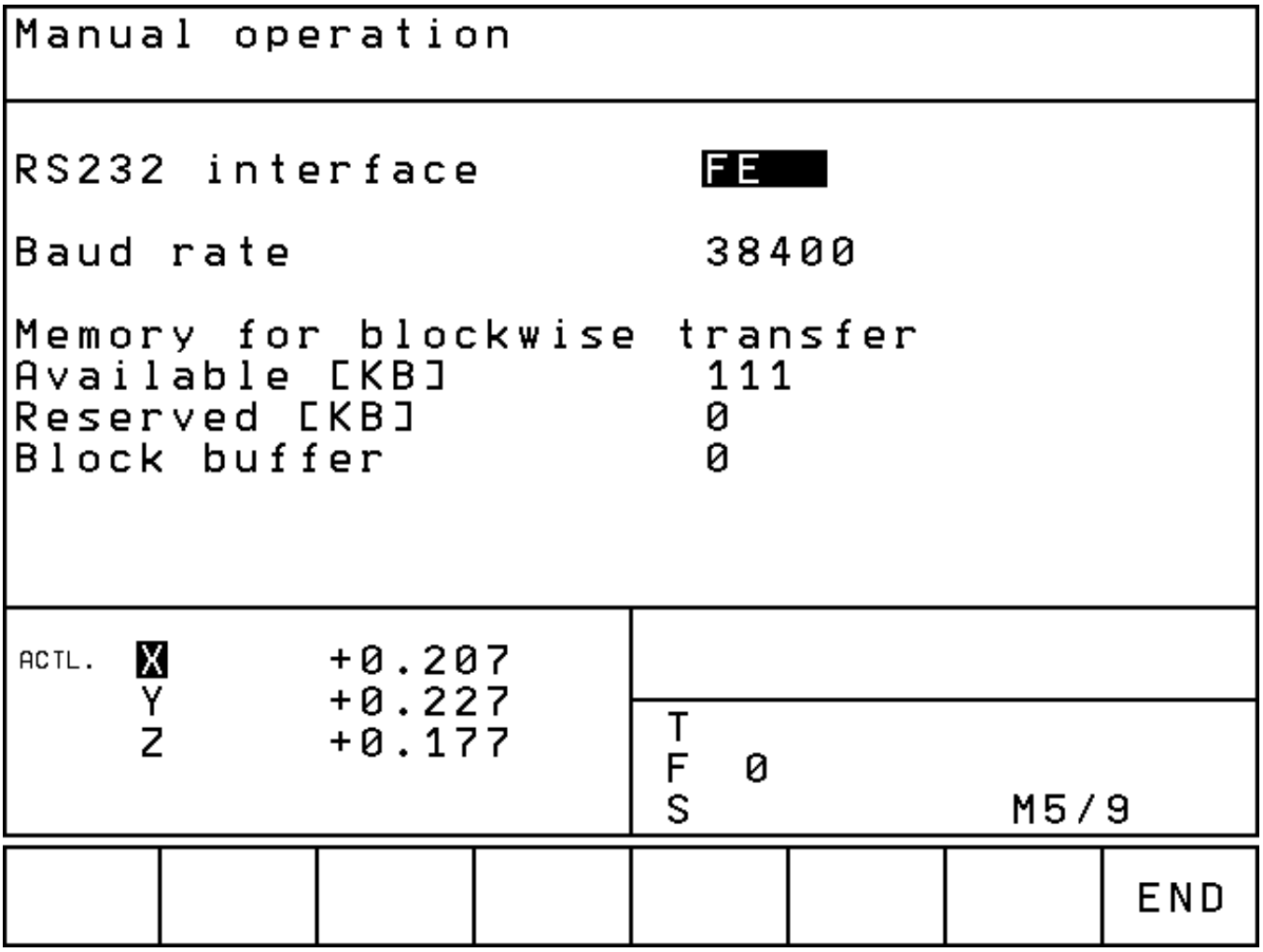
DATUMS (specified workpiece datum)

Press key	Function
Finding the datums	
Switch power off	Switch power off and wait for approx. 10 seconds
Switch power on	
Power interrupted	Clear the message
CE	
Traverse ref. points	Do **NOT** traverse the reference points
Switch the position display to **ACTL** and note down the current position values!	
Setting the datums (e.g. after an exchange of the NC software or on an exchange control)	
Switch power off	Switch power off and wait for approx. 10 seconds
Switch power on	
Power interrupted	Clear the message
CE	
Traverse ref. points	Do **NOT** traverse the reference points
SET DATUM	Call datum setting
X	Call datum setting for e.g. X-axis
Datum set X =	Enter the value (e.g. for the X-axis) determined before the software exchange and confirm with ENT !
Y	Same procedure for the remaining axes
etc.	
END	Return to REF mode and **traverse the reference points**!

DATUMS (specified workpiece datum)

RS 232 setup

Press key	Function
	TNC in operating mode PROGRAMMING AND EDITING
	Call subordinate MODE
	Call subordinate mode RS 232 setup



RS 232 interface: Interface mode
Baud rate: Baud rate for data transfer

Available [kB]: Available NC memory (value entered by the TNC)
Reserved [kB]: Memory reserved for blockwise transfer (for DNC mode only)
Block buffer: Number of NC blocks in the NC memory (for DNC mode only)

Note down all settings and re-enter the values after having exchanged the NC software!

RS 232 SETUP

Calibration of the touch probes

The calibration data of the touch probes do not have to be backed up.
These data are **updated** by calibrating the touch probes again **after** having exchanged the software**.**

Non-volatile PLC memory

The non-volatile PLC memory of TNC 410 B0 - B127
M0 - M999
is **always reset** by an NC software exchange.

Machine tools featuring e.g. an automatic tool changer may lose information this way that may be important for initializing the tool changer after the NC software exchange.
Please contact your machine builder for further information in this respect.

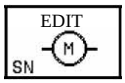
Motor data in RAM (TNC 410PA/M only)

The data for the motor and the power module of a digital axis or spindle are stored in the motor tables.
In general these tables are stored in the PLC EPROM.
However, the machine tool builder may also store these tables in **RAM**.
These data must be backed up. The files are **NOT** displayed in the directory and **CANNOT** be transferred on the data interface.

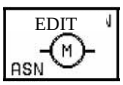
To determine if the motor data are filed in **RAM** please proceed as follows:

- Call the list of machine parameters.
  Note: To backup the current version of the list of machine parameters, the MP list must be transferred via the data interface (see section "Data Transfer“).
- Position the cursor now on MP 2100.0 and switch over the soft key row with key  .
  The soft key 

  is displayed on the screen.
  After pressing this soft key the **table of power modules in RAM** is opened.
  If there is **no** entry in the table, the data of the power modules are filed in the PLC EPROM and do not have to be backed up.
  However, if there are one or more entries in the table these must be transcribed and entered again in the table after the software exchange has been carried out.
  Press key 

  to leave the table of power modules.
- Position the cursor now on MP 2200.0 and switch over the soft key row with key  .
  The soft key 

  is displayed on the screen
  After pressing this soft key the **table of motor data for the synchronous motors in RAM** is opened.
  If there is **no** entry in the table, the data of the power modules are filed in the PLC EPROM and do not have to be backed up.
  However, if there are one or more entries in the table these must be transcribed and entered again in the table after the software exchange has been carried out.
  Press key 

  to leave the table of synchronous motors.
  The **table of motor data for asynchronous motors** is opened with soft key 

  Proceed in the same way as with the table of synchronous motors.

Notes

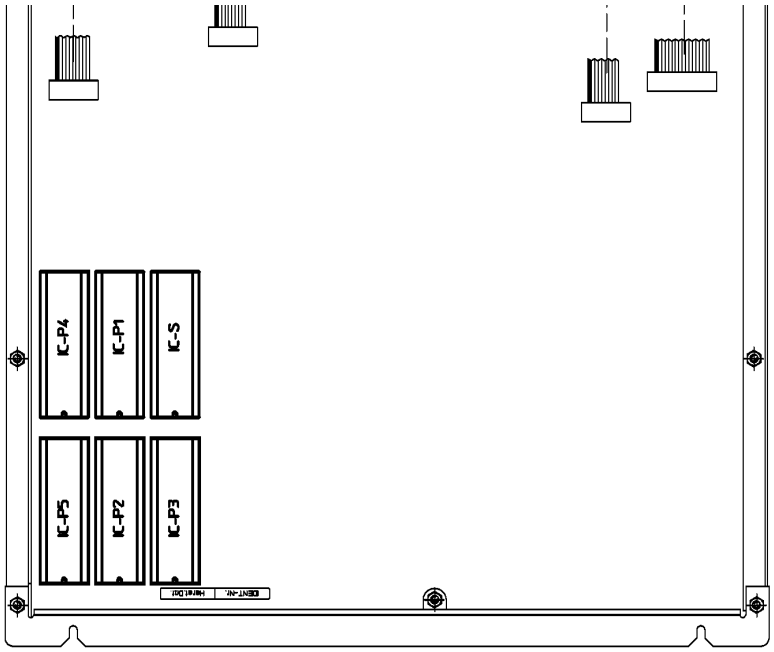
24.2.3 Exchanging the EPROMs on the processor board

- Switch off the machine and exchange the EPROMs using the IC-extraction tool.

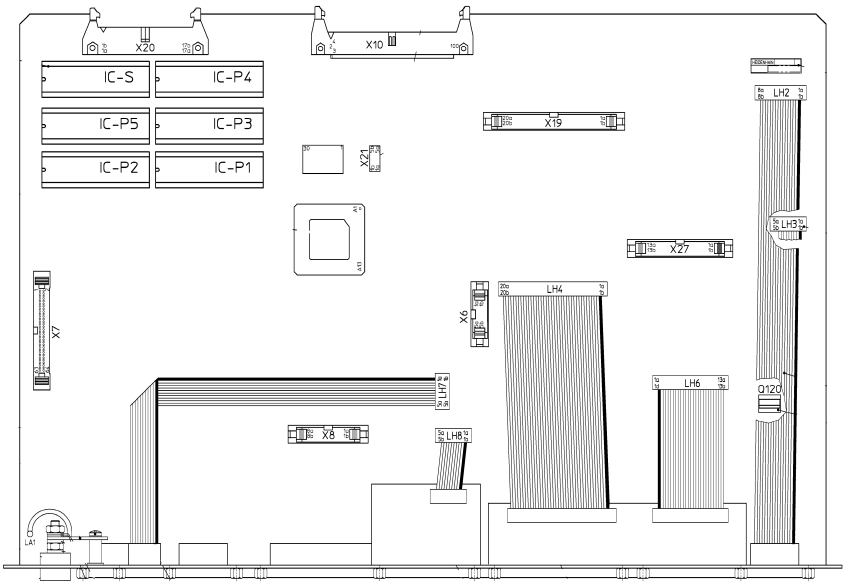
When exchanging the EPROMs, a MOS protection is definitely required, since otherwise MOS components on the board or the EPROMs may be destroyed.
On the next few pages you will find the location diagrams of the NC EPROMs of the different software versions of TNC 410.

NC-EPROM location diagram TNC 410
NC PGM-No. 286 000 – to 286 011 –

Processor board TNC 410 CA and TNC PA (detail)



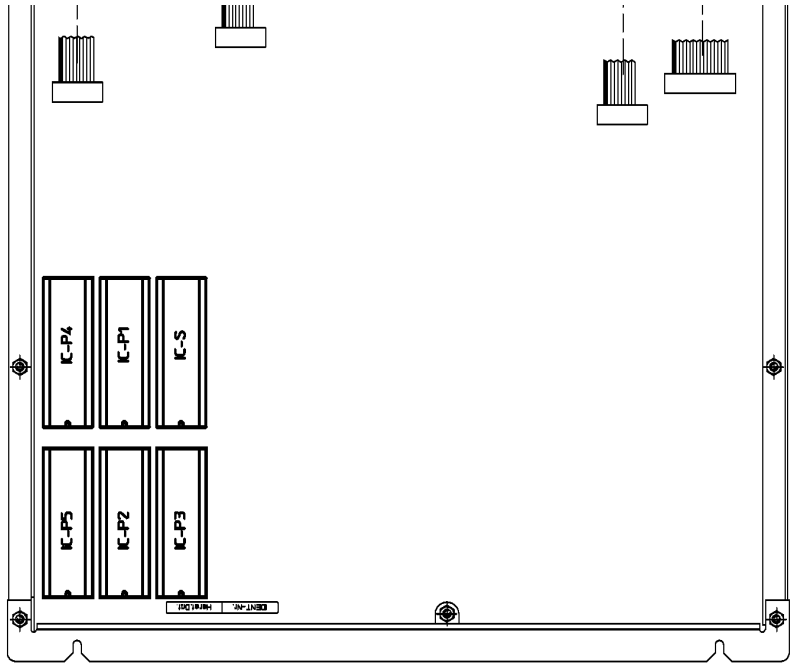
Processor board TNC 410 MA



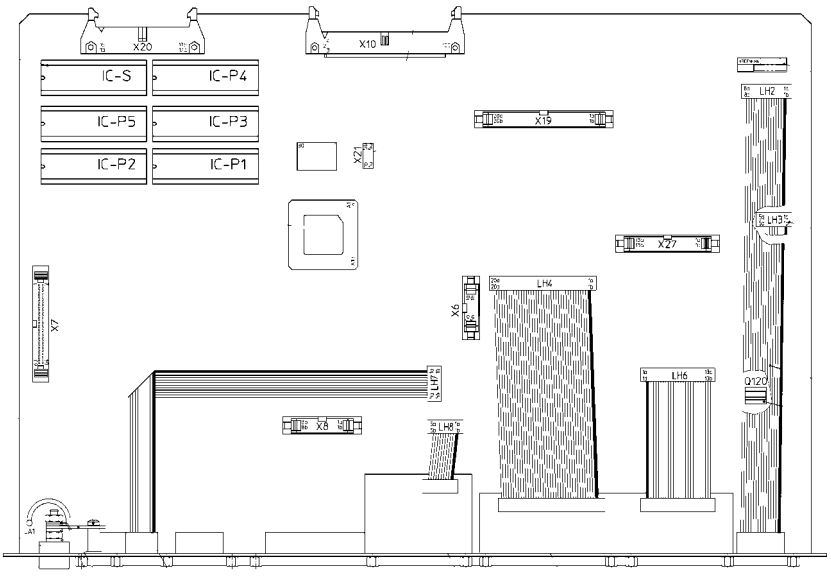
IC-P1	**IC-P2**	**IC-P3**	IC-P4	IC-P5	IC-S
NC software EPROM no. 1	NC software EPROM no. 2	NC software EPROM no. 3	PLC software, not exchanged	Test program, not exchanged	SW module (option), not exchanged

NC-EPROM location diagram TNC 410
NC PGM-No. 286 060 – to 286 071 –

Processor board TNC 410CA and TNC 410PA (detail)



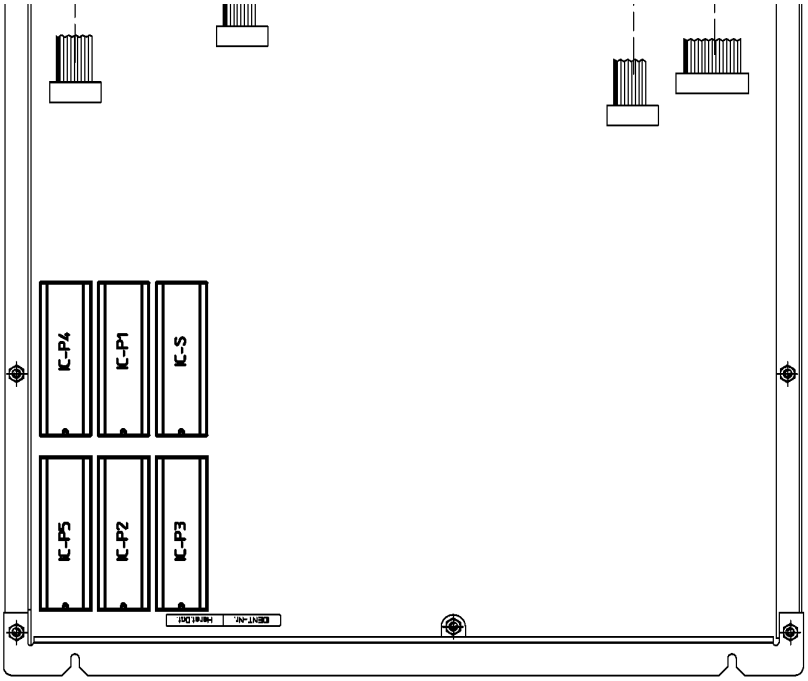
Processor board TNC 410MA



IC-P1	**IC-P2**	**IC-P3**	IC-P4	**IC-P5**	IC-S
NC software EPROM no. 1	NC software EPROM no. 2	NC software EPROM no. 3	PLC-Software, not exchanged	NC software EPROM no. 4	SW module (option), not exchanged

NC-EPROM location diagram TNC 410
NC PGM-No. 286 080 – to 286 091 –

Processor board TNC 410CA and TNC 410PA (detail)



IC-P1	**IC-P2**	**IC-P3**	IC-P4	**IC-P5**	IC-S
NC software EPROM no. 1	NC software EPROM no. 2	NC software EPROM no. 3	PLC software, not exchanged	NC software EPROM no. 4	SW module (option), not exchanged

24.2.4 Putting the control into service

- Switch power on and

confirm the message `Operating parameters erased` by pressing CE .

- **Download the machine parameter file previously backed up via the RS-232 data interface and activate the file.**

TNC 410 automatically activates the machine parameter mode and loads a default machine parameter list (HEIDENHAIN standard values) from the NC EPROM into the RAM.
The machine parameter list backed up before the NC software exchange must be read in via the RS-232 data interface.
See section "Data input".

- All **files** backed up before the NC software exchange must be **read in** via the data interface.
  See section "Data input".

- **MODE settings** must be re-entered

- **TRAVERSE RANGE** (enter traverse range limits)

- **DATUM** (set workpiece datum)

- **RS-232 SETUP** (enter interface settings)

24.2.5 Re-establishing the original state of the machine tool

- Enter code number 75368 to execute an **offset adjustment**

- If **touch probes** are used, they must be **recalibrate** after the software exchange.

- Machines with **swivel head**:
  Re-initialize the swivel head
  Information can be obtained from your machine tool builder

- Machines with **toolchanger**:
  Re-initialize the toolchanger
  Information can be obtained from your machine tool builder

- The non-volatile PLC memory of TNC 410 B0 - B127
  M0 - M999
  is **always reset** by an NC software exchange.
  The settings (e.g. to initialize an automatic toolchanger) must be entered by hand, if they are not covered by the PLC program.
  Information can be obtained from your machine tool builder.

Notes

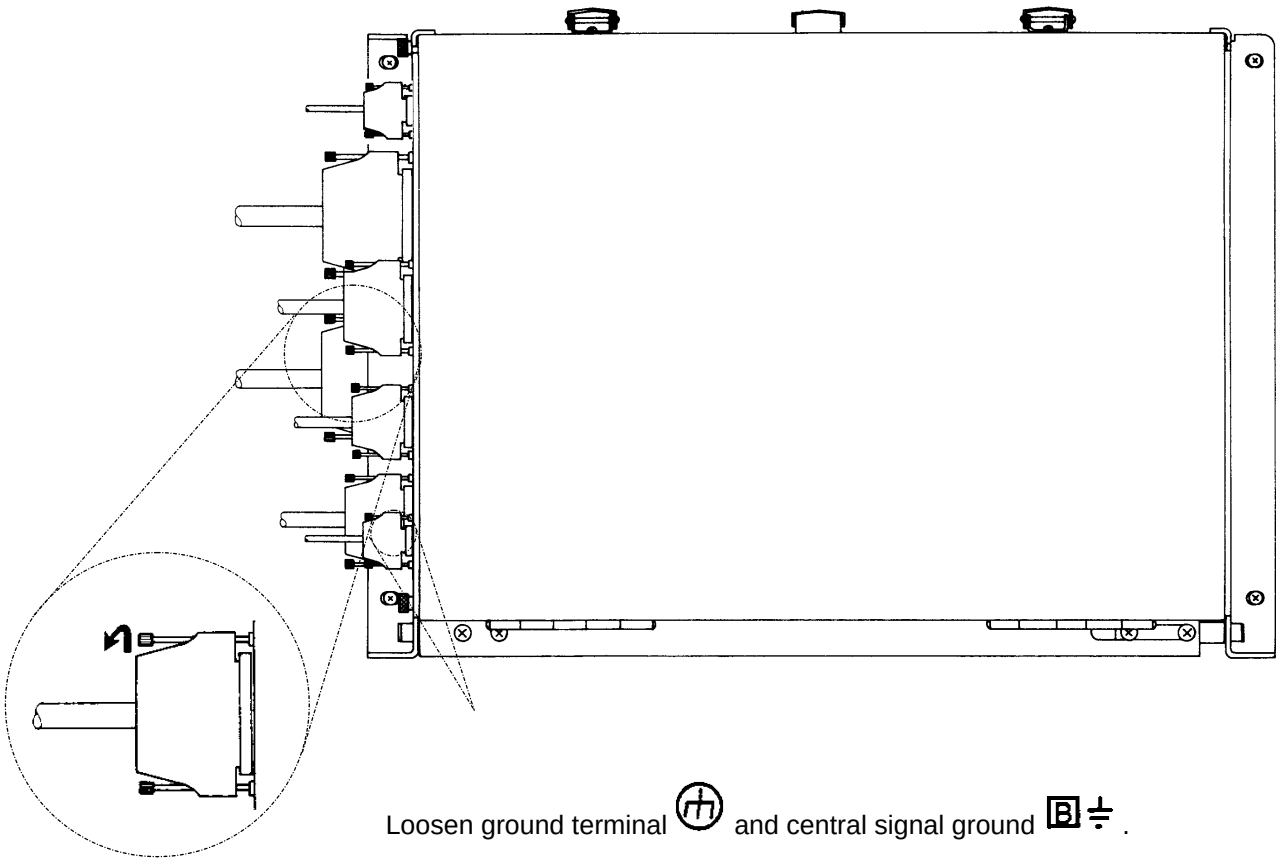
24.3 Exchanging the LOGIC UNIT

24.3.1 Preparations of the machine tool

- Bring the machine / the axes into a defined status (see section 24.2.1).
- Back up the RAM data (see section 24.2.2).

24.3.2 Dismounting the LOGIC UNIT LE 410 CA/PA

a) Switch off machine power.
b) Loosen all plug connections and clamped joints at the LOGIC UNIT.



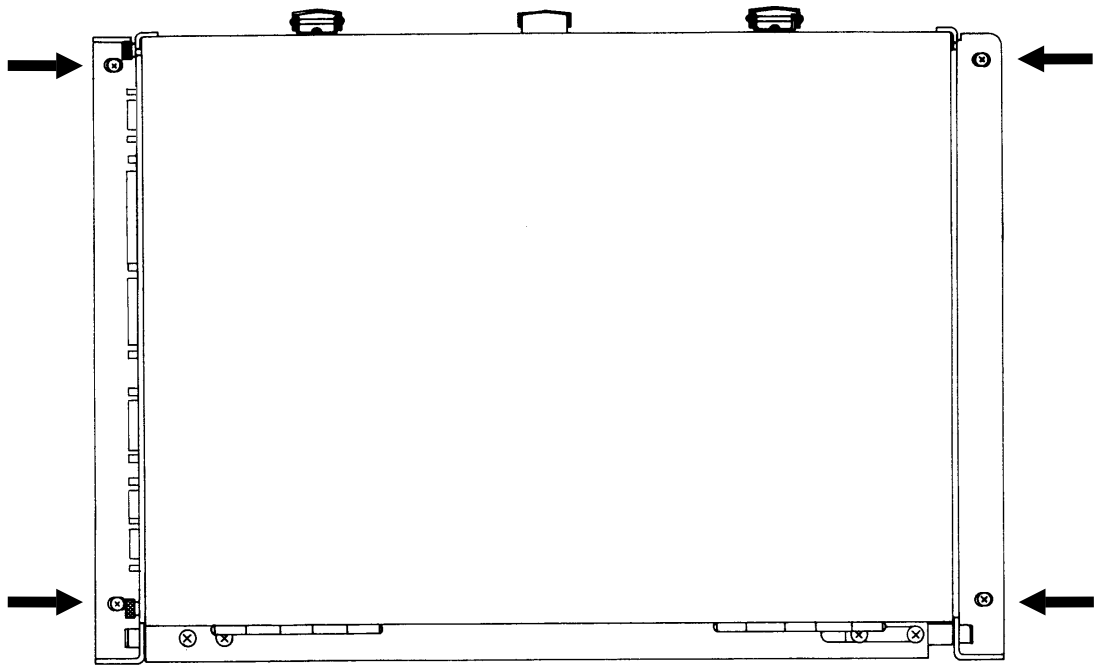
Loosen ground terminal ⏚ and central signal ground ⏚.

Note:
If a PL is mounted at the upper side of the housing,
it must be removed before dismounting the logic unit!

D-Sub connector
Loosen knurled screw

Observe the safety instructions!

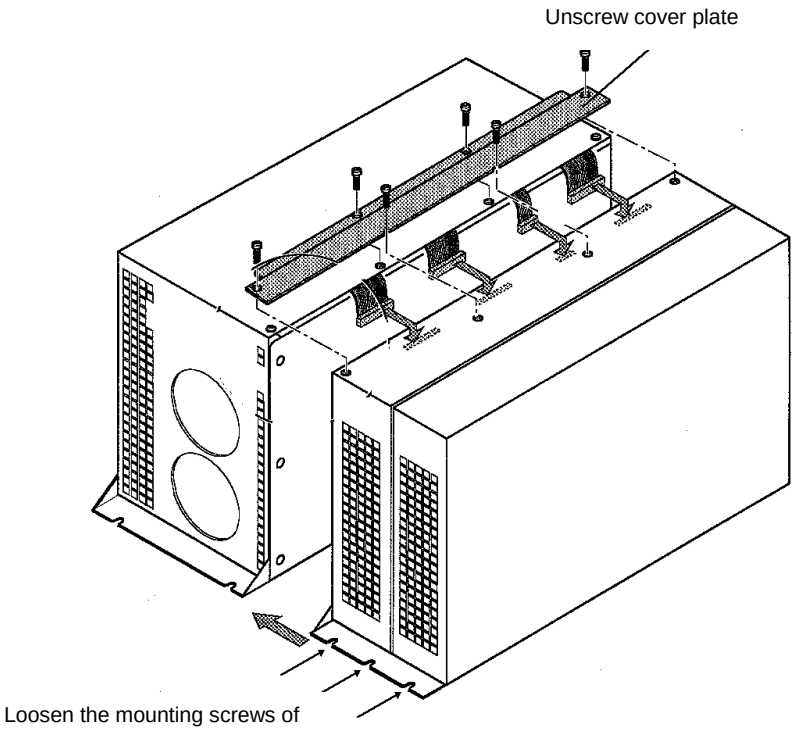
c) Loosen the 4 mounting screws on the logic unit.



d) Remove the defective LOGIC UNIT.

24.3.3 Dismounting the LOGIC UNIT LE 410 MA

a) Switch off machine power.
b) Unscrew the cover plate of the ribbon cables between the logic unit and the inverter unit UE2xx.
c) Loosen all plug connections and clamped joints at the LOGIC UNIT.
d) Loosen the mounting screws on the logic unit.



e) Lift off the defective LOGIC UNIT.

24.3.4 Mounting the LOGIC UNIT

The LOGIG UNIT is mounted in the reverse order as it was dismounted.
a) Mount and fix the LOGIC UNIT.
b) Engage the plug connections and clamped joints.
c) Attach the cover plate of the ribbon cables (TNC 410 MA only).

Observe that no connectors are switched!

d) Switch on power.
e) Put the control into service (see section 24.2.4)
f) Re-establish the original state of the machine tool (see section 24.2.5)

25. Machine parameter list

Excerpt from the Technical Manual TNC 410

4.3 Overview of Machine Parameters

4.3.1 Encoders and Machines

MP	Function and input	Software version and behavior	Page
MP10	Active axes Format: %00xxxx Input: Bits 0 to 3 correspond to axes 1 to 4 0: Axis not active 1: Axis active Bits 4 and 5 reserved, enter 0	RESET	6–17
MP20	Monitoring functions for the axes Format: %00xxxx Input: Bits 0 to 3 correspond to axes 1 to 4 0: Monitoring not active 1: Monitoring active Bits 4 and 5 reserved, enter 0	PLC	6–23
MP20.0	Absolute position with distance-coded reference marks		6–23
MP20.1	Amplitude of encoder signals		6–23
MP20.2	Edge separation of encoder signals		6–23
MP21	Monitoring functions for the spindle Format: %x Input: Bit 0 corresponds to the spindle 0: Monitoring not active 1: Monitoring active	PLC	6–23
MP21.0	Without function—enter 0.		6–23
MP21.1	Amplitude of the encoder signal		6–23
MP21.2	Edge separation of the encoder signal		6–23
MP40	Screen display Format: %00xxxx Input: Bits 0 to 3 correspond to axes 1 to 4 0: Axis is not displayed 1: Axis is displayed Bits 4 and 5 reserved, enter 0	RESET	6–17
MP60	PLC axes Format: %xxxx Input: Bits 0 to 3 axis X to 4 0 = NC axis 1 = PLC axis	RESET	6–29

MP	Function and input	Software version and behavior	Page
MP110.0-3	Assignment of position encoder inputs to the axes Input: 0 to 6 0 = no position encoder at input, then position measurement via motor encoder (only TNC 410M/PA) 1 to 4, 6: Position encoder input X1 to X4, X6	RESET	6–24
MP111	Position encoder input for the spindle Input: 0: No position encoder at input, then position measurement via motor encoder (only TNC 410M/PA) 1 to 4, 6: Position encoder input X1 to X4, X6	RESET	6–25, 6–110
MP112.0-3	Assignment of speed encoder inputs to the axes Input: 0, 15 to 20 0: No speed encoder at input (analog axis) 15 to 19, 20: Speed encoder input X15 to X20	RESET	6–24
MP113	Speed encoder input for the spindle Input: 0: No speed encoder at input (analog spindle) 15 to 19: Speed encoder input X15 to X19	RESET	6–25, 6–112
MP115.0	Position encoder input 1 V or 11 A Format: %xxxxx Input: Bit 0 to bit 3: Position encoder inputs X1 to X4 Bit 4: Position encoder input X6 0: 1 V 1: 11 A	RESET	6–21
MP115.1	Reserved Format: %xxxxx Input: Enter 00000	RESET	6–21

MP	Function and input	Software version and behavior	Page
MP115.2	Input frequency of the position encoder inputs Format: %xxxxx Input: Bit 0 to bit 3: Position encoder inputs X1 to X4 Bit 4: Position encoder input X6 At 1 V: 0: 50 kHz (recommended input value) 1: 350 kHz At 11 A: 0: 50 kHz (recommended input value) 1: 150 kHz	RESET	6–21
MP120.0-3	Assignment of speed encoder outputs to the axes Input: 0, 1 to 5, 51 to 55, 81 to 84 0: No close-loop axis (only displayed) TNC 410 CA/PA/M: 1 to 5: Analog axis 1 to 4 on connection X8 TNC 410 PA/M (modular, UE 2xxB): 51 to 55: Digital axis 1 to 4, PWM output X51 to X55 TNC 410 M (compact, UE 2xx): 81 to 84: Digital axis 1 to 4, motor connection X81 to X84	RESET	6–24
MP121	Nominal speed command output of the spindle input: 0: No close-loop axis (only displayed) TNC 410 CA/PA/M: 1 to 5: Analog output 1 to 5 at terminal X8 TNC 410 PA: 51 to 55: PWM output X51 to X55 TNC 410 M (compact with UE 2xx): 80: Motor connections X80 TNC 410 M (modular with UE 2xxB): 55: PWM output X55 TNC 410M (modular with UM 1xx): 53 to 55: PWM output X53 to X55	RESET	6–25
MP210	Counting direction of position encoder output signals Format: %00xxxx Input: Bits 0 to 3 correspond axis X to 4 0: Positive 1: Negative Bits 4 and 5 reserved, enter 0	RESET	6–22
MP331.0-3	Distance for the number of signal periods in MP332 Input: 0.001 to 99 999.999 [mm] or [°]	RESET	6–20
MP332.0-3	Number of signal periods for the distance in MP331 Input: 1 to 16 777 215	RESET	6–20

MP	Function and input	Software version and behavior	Page
MP334.0-3	Number of signal periods between the reference marks of encoders with distance-coded reference marks Input: 1 to 65 535 0: 1000 (standard setting)	RESET	6–20
MP410.3	Designation of the axis key IV Input: 0 to 5 0 = A 1 = B 2 = C 3 = U 4 = V 5 = W	RESET	6–19
MP420.3	Hirth coupling for the 4th axis Input: 0: No Hirth coupling 1: Hirth coupling (Can be read by the PLC, currently it has no other function in the NC.)	RESET	6–219
MP430.3	Prescribed increment for Hirth coupling Input: 0 to 30 000 [°] (Can be read by the PLC, currently it has no other function in the NC.)	RESET	6–219
MP710.0-3	Backlash compensation Input: -1 000 to +1 000 [mm] or [°]	PLC	6–44
MP711.0-3	Height of peaks during circular movement Input: -1 000 to +1 000 [mm]	RUN PLC	6–58
MP712.0-3	Compensation value per control loop cycle time Input: 0.000 to 1.000 [mm]	RUN PLC	6–58
MP720.0-3	Linear axis error compensation Input: -1 000 to +1.000 [mm/m]	PLC	6–46
MP730	Selection of linear/nonlinear axis error compensation Format: %xxxx Input: Bits 0 to 3 correspond to axes X, Y, Z, 4 0: Linear axis error compensation 1: Nonlinear axis error compensation	RESET	6–46
MP810.0-3	Display mode for rotary axes and PLC auxiliary axes Input: 0 to 99 999.999 [°] 0: Display +/–99 999.999, software limit switches active >0: Modulo value for display, software limit switches not active	PLC	6–146

MP	Function and input	Software version and behavior	Page
MP910.0-3	Positive software limit switches, traverse range 1 Input: -99 999.999 to +99 999 [mm] or [°] (default setting after power on)	PLC	6–27
MP911.0-3	Positive software limit switches, traverse range 2 Input: -99 999.999 to +99 999 [mm] or [°]	PLC	6–27
MP912.0-3	Positive software limit switches, traverse range 3 Input: -99 999.999 to +99 999 [mm] or [°]	PLC	6–27
MP920.0-3	Negative software limit switches, traverse range 1 Input: -99 999.999 to +99 999 [mm] or [°] (default setting after power on)	PLC	6–27
MP921.0-3	Negative software limit switches, traverse range 2 Input: -99 999.999 to +99 999 [mm] or [°]	PLC	6–27
MP922.0-3	Negative software limit switches, traverse range 3 Input: -99 999.999 to +99 999 [mm] or [°]	PLC	6–27
MP950.0-3	Datum for positioning blocks with M92 Input: -99 999.999 to +99 999.999 [mm] or [°] Values with respect to the machine datum	RUN PLC	6–139
MP951.0-3	Simulated tool-change position for TOOL CALL during mid-program startup (block scan) Input: -99 999.999 to +99 999.999 [mm] or [°]	PLC RUN 286 060-20	–
MP960.0-3	Machine Datum Input: -99 999.999 to +99 999.999 [mm] or [°] Values with respect to the first reference mark	RESET	6–39 6–139

4.3.2 Positioning

MP	Function and input	Software version and behavior	Page
MP1010.0-3	Rapid traverse Input: 80 to 300 000 [mm/min]	PLC	6–72
MP1020.0-3	Manual feed Input: 10 to 300 000 [mm/min]	PLC	6–72
MP1030.0-3	Positioning window Input: 0.001 to 2 000 [mm]		6–99
MP1040	Analog axes: Polarity of nominal value voltage Digital axes: Algebraic sign of the nominal speed value Format: %xxxx Input: Bits 0 to 3 correspond axis X to 4 0: Positive 1: Negative	RESET	6–22
MP1050.0-3	Analog axes: Analog voltage at rapid traverse Input: 1 000 to 9 000 [V] Digital axes: without function Input: 1	PLC	6–72
MP1060.0-3	Acceleration Input: 0.001 to 20.0 [m/s]	RUN PLC	6–66
MP1070.0	Radial acceleration Input: 0.001 to 20 000 [m/s]		6–91
MP1070.1	Acceleration at transition elements inserted with M112 Input: 0.001 to 20 000 [m/s]	RUN PLC	6–91 6–93
MP1080.0-3	Analog axes: Integral factor for offset adjustment Input: Enter 0 to 65 535 Digital axes: without function Input: 0	RUN PLC	6–90
MP1090	Maximum permissible jerk during change of feed rate Input: 0 to 1000 [m/s] 0: No jerk limitation (1520 is active) 1 to 1000: Jerk limitation (1520 not active) Recommended input value 10 to 50 In manual and handwheel modes the jerk limitation is not in effect.	RUN PLC	6–66

MP	Function and input	Software version and behavior	Page
MP1097.0-3	Maximum permissible jerk during change of direction. Input: 1 to 1000 [m/s] Recommended input value 20 to 50 (activated by M112 and 7415.1 bit 2=1)		6–67
MP1099	Filter order for nominal position value filter Input: 0 to 7 0 = no nominal position value filter 1 to 7 Filter order Recommended input value 1 to 3 (effective in Program Run Full Sequence/ Single Block modes, MDI, PLC pos.; not effective in Manual and Handwheel modes and in tapping cycle 17)		6–67
MP1110.0-3	Standstill monitoring Input: 0.001 to 30 000 [mm]	PLC	6–98
MP1140.0-3	Threshold at which the movement monitoring goes into effect. Input: Analog axes: 0.030 to 10.000 [V] Digital axes: 0.030 to 10.000 [rpm]	RUN PLC	6–98
MP1150	Delay time for erasing the nominal velocity value with the erasable error message: EXCESSIVE SERVO LAG Input: 0 to 65.535 [s] Recommended: 0 s		6–97
MP1150.0	Delay time for erasing the nominal velocity value with the erasable error message: EXCESSIVE SERVO LAG Input: 0 to 65.535 [s] Recommended: 0 s	As of software 286 0x0-22	-
MP1150.1	Time period for which the monitoring function is to remain off after the fast PLC input defined in MP4130.0 is set. Input: 0 to 65.535 [s] 0: Monitoring functions off Recommended: 0.2 to 0.5	As of software 286 0x0-22	-
MP1150.2	Minimum time period for which the monitoring functions are to remain effective after expiration of the time from MP1150.1. fåé ì íǁ=M=íç=SRKRPR=xëz	As of software 286 0x0-22	-

MP	Function and input	Software version and behavior	Page
MP1152	The parameter defines whether the PLC port (run time 24 ms) or the NC port (run time 6 ms) is used to detect the input I3 (emergency stop, "acknowledgment of control-is-ready"). For certain hardware variants this machine parameter is not visible/editable and is preset with the value 1. Input: 0 or 1 0: Signal of I3 is passed on directly to the NC (NC port) 1: Signal of I3 is led through the PLC port before being passed on to the NC	As of software 286 0x0-22	-
MP1220	Analog axes: automatic cyclic offset adjustment Input: 0 to 65 536 [s] 0: No automatic adjustment	RUN PLC	6–90
MP1320	Direction for traversing the reference marks Format: %xxxx Input: Bits 0 to 3 correspond to axes X, Y, Z, 4 0: Positive 1: Negative	RESET	6–39
MP1330.0-3	Velocity for traversing the reference marks Input: 80 to 300 000 [mm/min]	RESET	6–39
MP1331.0-3	Velocity for leaving the reference mark end position (only for rotary encoders MP1350 = 2) Input: 80 to 500 [mm/min]	RESET	6–39
MP1340.0-3	Sequence for traversing the reference marks Input: 0: No evaluation of reference marks 1: Axis X 2: Axis Y 3: Axis Z 4: Axis 4	RESET	6–39
MP1350.0-3	Type of reference-mark traverse Input: 0: Linear encoder with distance-coded reference marks (old routine) 1: Position encoder with one reference mark 2: Special type (length measurement with ROD) 3: Linear encoder with distance-coded reference marks (new routine) 4: Same as 3 except that two additional reference pulses are evaluated	RESET	6–39

4.3.3 Operation with Velocity Feedforward Control

MP	Function and input	Software version and behavior	Page
MP1390	Velocity feedforward for the POSITIONING WITH MANUAL DATA INPUT, PROGRAM RUN SINGLE BLOCK and PROGRAM RUN FULL SEQUENCE operating modes Input: 0: Operation with velocity feedforward control 1: Operation with following error (lag)	RESET	6–68
MP1391	Velocity feedforward control in the MANUAL and HANDWHEEL operating modes Format: %xxxx Input: Bits 0 to 3 correspond to axes X, Y, Z, 4 0: Operation with following error (lag) 1: Operation with velocity feedforward control	RESET	6–68
MP1410.0-3	Position monitoring for operation with velocity feedforward control (erasable) Input: 0.001 to 30 000 [mm] Recommended: 0.5 mm		6–97
MP1420.0-3	Position monitoring for operation with velocity feedforward control (EMERGENCY STOP) Input: 0.001 to 30 000 [mm] Recommended: 2 mm		6–97
MP1510.0-3	kv factor for velocity feedforward Input: 0.100 to 20.000 [(m/min)/mm]	RUN PLC	6–71
MP1511.0-3	Factor for static friction compensation Input: 0 to 16 777 215 [s]		6–60
MP1512.0-3	Limitation of the amount of the static friction compensation Input: 0 to 16 777 215 [counting steps]		6–60
MP1513.0-3	Feed-rate limitation for static friction compensation Input: 0 to 300 000 [mm/min]		6–60
MP1520	Overshoot behavior Input: 0.100 to 10 000	PLC	6–66

4.3.4 Operation with Following Error (Servo Lag)

MP	Function and input	Software version and behavior	Page
MP1710.0-3	Position monitoring for operation with following error (erasable) Input: 0.000 to 300 000 [mm] Recommended: 1.2 · following error	PLC	6–96
MP1720.0-3	Position monitoring for operation with following error (EMERGENCY STOP) Input: 0.000 to 300 000 [mm] Recommended: 1.4 · following error		6–96
MP1810.0-3	kv factor operation with following error Input: 0.100 to 10 000 [(m/min)/mm]	PLC	6–69
MP1820.0-3	Multiplication factor for the kv factor Input: 0.001 to 1 000	PLC	6–73
MP1830.0-3	Characteristic curve kink point Input: 0.000 to 100.000 [%]	PLC	6–73

4.3.5 Integrated Speed and Current Control

MP	Function and input	Software version and behavior	Page
MP2020.0-3	Linear distance of one motor revolution Input: Analog axes: without function Digital axes: 0 to 100.000 [mm] or [°]		6–98
MP2100.0-3	Model of power module for the axes Input: Name of the selected power stage	RESET	6–260
MP2101	Model of power module for the spindle Input: Name of the selected power stage	RESET	6–260
MP2180	PWM frequency Input: 0 or 3 000 to 7 000 [Hz] 0 = 5000 Hz (for HEIDENHAIN inverters)	RESET	6–264
MP2190	dc-link voltage Input: 0 to 10 000 [V]	RESET	6–264
MP2191	DC-link voltage for spindle Input: 0 to 10 000 [V]		6–264
MP2200.0-3	Motor model for the axes Input: Name of the selected motor	RESET	6–260
MP2201	Motor model for the spindle Input: Name of the selected motor	RESET	6–260
MP2221	Monitoring the reference mark of the spindle speed encoder Input: 0: Monitoring active 1: Monitoring inactive	PLC	6–112
MP2302.0-3	Reference value for I^2t monitoring of axis motors Input: 0 to 1000.000 [· rated current of motor] 0: I^2t monitoring for feed motor switched off; (I^2t monitoring of power module active) 1: Rated current of motor as reference value		6–102
MP2303	Reference value for I^2t monitoring of spindle motor Input: 0 to 1000.000 [· rated current of motor] 0: I^2t monitoring for spindle motor switched off; (It monitoring of power module active) 1: Rated current of motor as reference value		6–102
MP2312.0-3	Reference value for utilization of feed motors Input: 0 to 1000.000 [· rated current of motor] 0 or 1: Reference value is rated current of motor		6–105

MP	Function and input	Software version and behavior	Page
MP2313	Reference value for utilization display of the spindle motor Input: 0 to 1000.000 [· rated current of motor] 0 or 1: Reference value is rated current of motor		6–105
MP2340.0-3	Speed starting from which the field angle begins to shift on synchronous motors for the axes Input: 0 to 30 000 rpm 0: No field angle offset		6–263
MP2341	Speed starting from which the field angle begins to shift (only with synchronous motors for the spindle) Input: 0 to 30 000 rpm 0: No field angle offset		6–263 6–298
MP2350.0-3	Maximum field-angle offset on synchronous motors for the axes Input: 0 to 60 [°]		6–263
MP2351	Maximum field angle shift Input: 0 to 60 [°]		6–263 6–298
MP2361	Time constant for braking the spindle in an emergency stop Input: 0.01 to 5.00 [s] 0: Function inactive		6–126
MP2400.0-3	Gain for current controller at standstill for the axes Input: 0.00 to 9 999.00 [V/A] 0: Controller disable		6–88
MP2401	Gain for the spindle current controller at standstill Input: 0.00 to 9999.99 [V/A] 0: Controller disable		6–112
MP2402.0-3	Gain for current controller at maximum speed for the axes Input: 0.00 to 9999.99 [V/A] 0: Value from 2400.x		6–88
MP2403	Gain for the spindle current controller at maximum speed Input: 0.00 to 9999.99 [V/A] 0: Value from 2401		6–112
MP2500.0-3	Proportional factor of the speed controller for axes Input: 0 to 100 000 [As]	PLC	6–80
MP2501	Proportional factor of the spindle speed controller Input: 0 to 1000.000 [As]	PLC	6–113
MP2510.0-3	Integral factor of the speed controller for axes Input: 0 to 30 000 [A]	PLC	6–80

MP	Function and input	Software version and behavior	Page
MP2511	Integral factor of the spindle speed controller Input: 0 to 30 000 [A]	PLC	6–113
MP2512.0-3	Limiting the integral factor of the speed controller Input: 0.000 to 30.000 [s] (realistically: 0.1 to 2.0)	PLC	6–60 6–84
MP2520.0-3	Differential factor of the speed controller for axes Input: 0 to 1.0000 [As^2]	PLC	6–81
MP2521	Differential factor of the spindle speed controller Input: 0 to 1.0000 [As^2]	PLC	6–113
MP2530.0-3	PT element of the speed controller (second-order time delay) for the axes Input: 0 to 1.0000 [s]	PLC	6–82
MP2531	PT element of the spindle speed controller Input: 0 to 1.0000 [s] 0 = 0.001 s	PLC	6–113
MP2540.0-3	Band-rejection filter damping for the axes Input: 0.0 to 18.0 [dB]	PLC	6–82
MP2541	Band-rejection filter damping Input: 0.0 to 18.0 [dB]	PLC	6–113
MP2550.0-3	Band-rejection filter center frequency for the axes Input: 0.0 to 999.9 [Hz]	PLC	6–82
MP2551	Band-rejection filter for center frequency Input: 0.0 to 999.9 [Hz]	PLC	6–113
MP2560.0-3	Low-pass filter for axes Input: 0: No low-pass filter 1: 1st-order low-pass filter 2: 2nd-order low-pass filter	PLC	6–81
MP2561	Low-pass filter Input: 0: No low-pass filter 1: 1st-order low-pass filter 2: 2nd-order low-pass filter	PLC	6–113
MP2600.0-3	Acceleration feedforward control for the axes Input: 0 to 6.000 [$A/(rev/s^2)$]	PLC	6–83
MP2610.0-3	Friction compensation at low motor speed Input: 0 to 30.0000 [A] 0: No friction compensation (or axis is analog)	PLC	6–61
MP2612.0-3	Delay of the friction compensation Input: 0.0000 to 1.0000 [s] (typically: 0.015 s) 0: No friction compensation (or axis is analog)	PLC	6–61

MP	Function and input	Software version and behavior	Page
MP2620.0-3	Friction compensation at rated speed Input: 0 to 30.0000 [A] 0: No friction compensation (or axis is analog)	PLC	6–61
MP2630.0-3	Holding current for the axes Input: -30.000 to +30.000 [A]	PLC	6–84
MP2800.0-3	Motion monitor for position and speed Input: Analog axes: without function Digital axes: 0 to 99 999.999 [mm] 0: No monitoring	PLC	6–98

4.3.6 Spindle

MP	Function and input	Software version and behavior	Page
MP3010	Output of speed, gear range Input: 0: No output of spindle speed 1: Speed code if the speed changes 2: Speed code at every TOOL CALL 3: Nominal speed value always, G code if the gear range shifts 4: Nominal speed value always, G code at every TOOL CALL 5: Nominal speed value always, no G code 6: Same as 3, but with controlled spindle for orientation 7: Same as 4, but with controlled spindle for orientation 8: Same as 5, but with controlled spindle for orientation	RESET	6–109
MP3020	Speed range for S code output Format: xxyyz xx: S code for minimum speed yy: S-code for maximum speed z: Speed increment - Input: 0 to 99 999	PLC	6–121
MP3030	Axis standstill for S-code output Input: 0: Axis standstill 1: no axis standstill	PLC	6–117
MP3120	Zero speed permitted Input: 0: S = 0 allowed 1: S = 0 not allowed	PLC	6–117
MP3130	Polarity of the nominal spindle speed Input: 0: M03 positive, M04 negative 1: M03 negative, M04 positive 2: M03 and M04 positive 4: M03 and M04 negative	RESET	6–116
MP3140	Counting direction of spindle position encoder output signals Input: 0: Positive counting direction with M03 1: Negative counting direction with M03	RESET	6–116
MP3142	Line count of the spindle position encoder Input: 100 to 9 999 [lines]	RUN PLC	6–110

MP	Function and input	Software version and behavior	Page
MP3143	Mounting configuration of the spindle position encoder Input: 0: Position encoder directly on the spindle 1: Position encoder via transmission (ratio in 3450 and 3451); X30 pin 1 : reference pulse 2: Position encoder via transmission (ratio in 3450 and 3451); X30 pin 1 : reference pulse release 3: Same as input value 1, except that the second reference pulse is evaluated.	RUN PLC	6–111
MP3210.0-7	Analog nominal spindle voltage at rated speed for the gear ranges 1 to 8 Input: 0 to 20 000 [V]	RUN PLC	6–117
MP3210.0-7	Digital spindle motor revolutions at rated speed for the gear ranges 1 to 8 Input: 0 to 20.000 [1000 rpm]	RUN PLC	6–117
MP3240.1	Analog spindle: Minimum nominal value voltage Input: 0 to 9.999 [V]	RESET	6–117
MP3240.1	Digital spindle: Minimum motor speed Input: 0 to 9.999 [1000 rpm]	RESET	6–117
MP3240.2	Analog spindle: Spindle jog voltage for gear shifting (M4009/M4010) Input: 0 to 9.999 [V]	RESET	6–119
MP3240.2	Digital spindle: Motor speed for gear shifting (M4009/M4010) Input: 0 to 9.999 [1000 rpm]	RESET	6–119
MP3310	Limitation for spindle speed override Input: 0 to 150 [%]	RESET	6–120
MP3310.0	Upper limit		6–120
MP3310.1	Lower limit		6–120
MP3411	Ramp gradient of the spindle with M03 and M04 for gear ranges 1 to 8 Input: Analog axes: 0 to 1.999 [V/ms] Digital axes: 0 to 1.999 [(1000/min)/ms]	RUN PLC	6–115
MP3412	Ramp gradient of spindle, multiplier for 3411 Input: 0.000 to 1.999	RUN PLC	6–115
MP3412.0	With M05		6–115
MP3412.1	Multiplier for 3411 for ramp during spindle orientation Input: 0 to 1.999	RUN PLC	6–128 6–115

MP	Function and input	Software version and behavior	Page
MP3412.2	Multiplier for 3411, ramp during tapping	RUN	6–133
	Input: 0 to 1.999	PLC	6–115
MP3412.3	Multiplier for 3411.x, ramp for rigid tapping	RUN	6–136
	Input: 0 to 1.999	PLC	6–115
MP3415	Overshoot behavior of spindle rotation	RUN	6–116
	Input: 0 to 1000 [ms]	PLC	
MP3415.1	Spindle overshoot behavior during spindle orientation	RUN	6–128
	Input: 0 to 1000 [ms]	PLC	6–116
MP3415.2	Overshoot behavior of the spindle during tapping	RUN	6–133
	Input: 0 to 1000 [ms]	PLC	6–116
MP3415.3	Overshoot behavior of the spindle during rigid tapping	RUN	6–136
	Input: 0 to 1000 [ms]	PLC	6–116
MP3420	Spindle position window	RUN	6–128
	Input: 0 to 360 000 [°]	PLC	
MP3430	Deviation of the reference mark from the desired position (spindle preset)	RUN	6–128
	Input: 0 to 360 [°]	PLC	
MP3440.0-7	k factor for spindle orientation for gear ranges 1 to 8	RUN	6–128
	Input: 0.1 to 10 [(1000°/ min) /°]	PLC	
MP3450.0-7	Number of spindle position-encoder revolutions for gear ranges 1 to 8	RUN	6–111
	Input: 0 to 255 0: No transmission	PLC	
MP3451.0-7	Number of spindle position-encoder revolutions for gear ranges 1 to 8	RUN	6–111
	Input: 0 to 255 0: No transmission	PLC	
MP3510.0-7	Rated speed for the gear ranges 1 to 8	PLC	6–117
	Input: 0 to 99 999.999 [rpm]		
MP3515.0-7	Maximum spindle speed for gear ranges 1 to 8	PLC	6–120
	Input: 0 to 99 999.999 [rpm]		
MP3520.0	Speed activation through marker M4011	RUN	6–131
	Input: 0 to 99 999.999 [min]	PLC	
MP3520.1	Spindle speed for oriented stop	RUN	6–128
	Input: 0 to 99 999.999 [rpm]	PLC	

4.3.7 Integral PLC

MP	Function and input	Software version and behavior	Page
MP4010	PLC program from EPROM or RAM Input: 0 = from EPROM 1: from RAM	RESET	7–10
MP4020	PLC positions in format 1/10 000 m Format: %xxxxxxx Input: Bit 6 = 1 PLC positioning through Module 9221 or M4120 to M4124/D528-D544 in format 1/10 000 m; Spindle orientation released by Module 9171 or M4130/D592 in format 1/10 000 m (except tool measurement); Positioning of PLC axes with Module 9120 and 9123 in format 1/10 000 m; Reading of positions with Module 9032 from the MPs 4060.x, 4070, 4210.x, 4230.x, 4231.x; Writing of positions with Module 9031 in 4060.x; Axis error compensation with 4070/W576-W582 in format 1/10 000 m; Storing of position values of 4210.x after D768-D956 in format 1/10 000 m	RESET	6–56
MP4020	PLC Compatibility with TNC 415 / TNC 425 Format: %xxxxxxx Input: Bit 0 = 1 Convert axis words (W1024 and following) to markers. Convert markers (4000 and following) to markers (2000 and following). Bits 1 to 5, bit 7 reserved	RESET	7–35
MP4060.0-3	Traverse distance for lubrication of axes 1 to 4 Input: 0 to 99 999.999 [mm] or [°]	RUN PLC	6–28
MP4070	Compensation amount per PLC cycle for lagged-tracking axis error compensation Input: 0.001 to 0.005 [mm] (0.0001 to 0.005 [mm] with 4020 bit 6 = 1)		6–56
MP4110.0-47	Timer preset value T0 to T47 Input: 0 to 65 535 [PLC cycle times]	RUN PLC	7–14
MP4120.0-31	Counter preset for C0 to C31 Input: 0 to 65 535 [PLC cycles]	RUN PLC	7–15

MP	Function and input	Software version and behavior	Page
MP4130	Numerical designation for fast PLC inputs Input: 0 to 255 [no. of the PLC input]		7–16
MP4130.0	Number of the high-speed PLC input for switching off the monitoring functions Input: 0 to 255 [no. of the PLC input on the LE]		6–96
MP4130.1	No function		-
MP4130.2	Fast PLC input sets marker M4590		7–16
MP4130.3	Fast PLC input sets marker M4591		7–16
MP4130.4	Fast PLC input sets marker M4592		7–16
MP4130.5	Fast PLC input sets marker M4593		7–16
MP4131.0	Activation criterion for fast PLC input for switching off the monitoring functions Input: 0: Activation at low level 1: Activation at high level		6–96
MP4131.1	No function		-
MP4131.2-5	Activation criterion for fast PLC inputs Input: 0: Activate at LOW level 1: Activate at HIGH level		7–16
MP4210.0-47	Setting a number in the PLC (W960 to W968) Input: -99 999.999 to +99 999.999		7–31
MP4220.0-3	Setting a number in the PLC (W960 to W966) Input: 10 to 30 000		7–32
MP4230.0-31	Setting a number in the PLC (through Module 9032) Input: -99 999.999 to +99 999.999		7–33
MP4231.0-31	Setting a number in the PLC (through Module 9032) Input: -99 999.999 to +99 999.999		7–33
MP4310.0-6	Setting a number in the PLC (W976 to W988) Input: 0 to 65 535		7–32

4.3.8 Data Interface

MP	Function and input	Software version and behavior	Page
MP5020	Configuration of the data interface Format: %xxxxxxxxx Input: Bit 0: 0 = 7 data bits, 1 = 8 data bits Bit 1: 0 = any BCC, 1 = BCC not control character Bit 2: 0 = transmission stop by RTS not active, 1 = active Bit 3: 0 = transmission stop by DC3 not active, 1 = active Bit 4: 0 = character parity even, 1 = odd Bit 5: 0 = character parity not desired, 1 = desired Bit 6 = 0, Bit 7 = 0: 1 stop bits Bit 6 = 1, Bit 7 = 0: 2 stop bits Bit 6 = 0, Bit 7 = 1: 1 stop bit Bit 6 = 1, Bit 7 = 1: 1 stop bit Bit 8: 0 = RTS always active, 1 = RTS active only during transmission start Bit 9: 0 = EOT transmitted after ETX, 1 = EOT not after ETX	RUN PLC, CN123	8–14
MP5020.0	Operating mode EXT1		8–14
MP5020.1	Operating mode EXT2		8–14
MP5020.2	Operating mode EXT3 (PLC)		8–14
MP5030	Data transfer protocol Input: 0 = Standard data transfer protocol 1 = Blockwise transfer	RUN PLC, CN123	8–15
MP5030.0	Operating mode EXT1		8–15, 8–15
MP5030.1	Operating mode EXT2		8–15, 8–15
MP5030.2	Operating mode EXT3 (PLC)		8–15, 8–15

MP	Function and input	Software version and behavior	Page
MP5040	Data transfer rate in operating mode EXT3 (data transfer through PLC) Input: 0: 110 baud 1: 150 baud 2: 300 baud 3: 600 baud 4: 1200 baud 5: 2400 baud 6: 4800 baud 7: 9600 baud 8: 19200 baud 9: 38400 baud 10: 57600 baud		8–22

4.3.9 3-D touch probe

MP	Function and input	Software version and behavior	Page
MP6010	Selection of the touch probe Input: 0: Touch probe with cable transmission 1: Touch probe with infrared transmission	PLC, CN123	6–191
MP6120	Probing feed rate (triggering touch probe) Input: 1 to 3000 [mm/min]	RUN PLC, CN123	6–193
MP6130	Maximum measuring range Input: 0.001 to 99 999.999 [mm]	RUN PLC, CN123	6–193
MP6140	Setup clearance over measuring point Input: 0.001 to 99 999.9999 [mm]	RUN PLC, CN123	6–193
MP6150	Rapid traverse in probing cycle (triggering touch probe) Input: 10 to 20 000 [mm/min]	RUN PLC, CN123	6–193
MP6160	M function for probing from opposite directions Input: 1 to 88: Number of the M function for spindle orientation through PLC 0: Function inactive -1: Spindle orientation directly by NC	RUN PLC, CN123	6–194
MP6210	Number of oscillations in normal direction per second Input: 0 to 65.535 [1/s]	RUN PLC, CN123	6–196
MP6230	Feed rate in normal direction Input: 0 to 1 000 [mm/min]	RUN PLC, CN123	6–196

MP	Function and input	Software version and behavior	Page
MP6240	Maximum deflection of the stylus Input: 0 to 10 000 [mm]	RUN PLC, CN123	6–196
MP6260	Output of M90 in NC blocks with digitized data Input: 0: No output of M90 1: Output of M90 in every NC block	RUN PLC, CN123	6–196
MP6270	Rounding of decimal places Input: 0: Output in 0.001-mm steps (1 µm) 0: Output in 0.01-mm steps (10 µm)	RUN PLC, CN123	6–196

4.3.10 Tool Measurement with TT 130

MP	Function and input	Software version and behavior	Page
MP6500	Tool measurement with TT 130 Format: %xxxx Input: Bit 0 0: Cycles for tool measurement disabled 1: Cycles for tool measurement not disabled Bit 1 0: Tool radius measurement allowed. Tool length measurement with rotating spindle 1: Tool radius measurement and individual tooth measurement disabled Bit 2 0: Tool length measurement with stationary spindle (bit 1=1) 1: Tool length measurement with rotating spindle, only if a tool radius offset (TT:R-OFFS) has been entered in the tool table Bit 3 0: Tool measurement with spindle orientation 1: Tool measurement without spindle orientation. Individual tooth measurement not possible. Tool radius measurement possibly faulty.	PLC	6–202
MP6505	Probing direction for tool radius measurement Input: 0: Positive probing direction of the angle reference axis (0° axis) 1: Positive probing direction in the +90° axis 2: Negative probing direction of the angle reference axis (0° axis) 3: Negative probing direction in the +90° axis	PLC, CN123	6–203
MP6507	Calculation of the probing feed rate Input: 0: Calculation of the probing feed rate with constant tolerance 1: Calculation of the probing feed rate with variable tolerance 2: Constant probing feed rate	PLC, CN123	6–205

MP	Function and input	Software version and behavior	Page
MP6510	Max. permissible measuring error for tool measurement with rotating tool Input: 0.002 to 0.999 [mm]	PLC, CN123	6–205
MP6520	Probing feed rate for tool measurement with non-rotating tool Input: 1 to 3000 [mm/min]	RUN PLC, CN123	6–205
MP6530	Distance from tool lower edge to probe contact upper edge for tool radius measurement Input: 0.001 to 99.999 [mm]	PLC, CN123	6–203
MP6531	Diameter or edge length of the TT 130 probe contact Input: 0.001 to 99.999 [mm]	PLC	6–204
MP6540	Safety zone around the probe contact of the TT 130 for pre-positioning Input: 0.001 to 99 999.999 [mm]	PLC, CN123	6–203
MP6540.0	Safety clearance in tool axis direction		6–203
MP6540.1	Safety clearance in the plane perpendicular to the tool axis		6–203
MP6550	Rapid traverse in probing cycle for TT 130 Input: 10 to 20 000 [mm/min]	RUN PLC, CN123	6–203
MP6560	M function for spindle orientation during individual tooth measurement Input: -1: Spindle orientation directly by NC 0: Function inactive 1 to 88: Number of the M function for spindle orientation by PLC	PLC	6–203
MP6570	Max. permissible surface cutting speed at the tooth edge Input: 1 000 to 129 000 [m/min]	PLC, CN123	6–205
MP6580.0-2	Coordinates of the TT 130 probe contact center with respect to the machine datum Input: -99 999.999 to +99 999.999 [mm]	PLC, CN123	6–204

4.3.11 Tapping

MP	Function and input	Software version and behavior	Page
MP7110.0	Minimum for feed rate override during tapping Input: 0 to 150 [%]	RUN PLC	6–133
MP7110.1	Maximum for feed rate override during tapping Input: 0 to 150 [%]	RUN PLC	6–133
MP7120.0	Dwell time for reversal of spindle rotational direction Input: 0 to 65.535 [s]	RUN PLC	6–133
MP7120.1	Advanced switching time of the spindle during tapping with coded spindle-speed output Input: 0 to 65.535 [s]	RUN PLC	6–134
MP7120.2	Spindle slow-down time after reaching the hole depth Input: 0 to 65.535 [s]	RUN PLC	6–133
MP7130	Run-in behavior of the spindle during rigid tapping Input: 0.001 to 10 [°/min]	PLC	6–136
MP7150	Positioning window of the tool axis during rigid tapping Input: 0.0001 to 2 [mm]	PLC	6–136
MP7160	Spindle response during Cycle 17 Input: 0 or 1 0: Spindle orientation before execution of Cycle 17 1: No spindle orientation before execution of Cycle 17	RUN PLC, CN123	6–136

4.3.12 Display and Operation

MP	Function and input	Software version and behavior	Page
MP7210	Programming station Input: 0: Controlling and programming 1: Programming station with PLC active 2: Programming station with PLC inactive	CN123	6–181
MP7212	Power interrupted message Input: 0: Acknowledge message with CE key 1: Message does not appear	RUN PLC, CN123	6–182
MP7220	Block number increment for ISO programs Input: 0 to 250	RUN PLC, CN123	6–178
MP7224	Disabling soft keys for file types Format: %xxxxxxxx Input: Bit 0 — HEIDENHAIN programs .H Bit 1 — ISO programs .I Bit 2 — tool tables .T Bit 3 — Datum tables .D Bit 7 — Point tables .PNT 0: Do not disable 1: Disable Bit 4 to bit 6 reserved	RUN PLC, CN123	6–177
MP7230	Switching the conversational language Input: 0: English 1: Local language (depending on the NC software number)	RUN PLC, CN123	6–181
MP7237	Reset the operating times with ENT Format: %xxx Input: Bit 0 = 1: Reset "control on" with ENT Bit 1 = 1: Reset "program run" with ENT Bit 2 = 1: Reset "spindle on" with ENT	RUN PLC	6–182
MP7251	Defining Q parameters Q60 to Q99 Input: 0 = Q60 to Q99 local 1 to 40 = Q(100 – <input value>) to Q99 global		9–5
MP7260	Number of tools in the tool table Input: 0 to 254	RESET CN123	6–223
MP7261	Number of pockets in the pocket table (tool magazine) Input: 0 to 254	RESET CN123	6–223

MP	Function and input	Software version and behavior	Page
MP7266	Elements of the tool table Input: 0 = no display 1 to 99 = position in the tool table	CN123	6–224
MP7266.0	16-character alphanumeric tool name		6–224
MP7266.1	Tool length		6–224
MP7266.2	Tool radius		6–224
MP7266.3	Reserved		6–224
MP7266.4	Oversize in tool length		6–224
MP7266.5	Oversize in tool radius		6–224
MP7266.6	Reserved		6–224
MP7266.7	Locked tool		6–224
MP7266.8	Replacement tool		6–224
MP7266.9	Maximum tool age (M4543)		6–224
MP7266.10	Maximum tool age TOOL CALL		6–224
MP7266.11	Current tool age		6–224
MP7266.12	Comment on the tool		6–224
MP7266.13	Number of tool teeth		6–224
MP7266.14	Wear tolerance for tool length		6–224
MP7266.15	Wear tolerance for tool radius		6–224
MP7266.16	Cutting direction of the tool		6–224
MP7266.17	Additional information for PLC (Module 9093)		6–224
MP7266.18	Tool offset: length		6–224
MP7266.19	Tool offset: radius		6–224
MP7266.20	Breakage tolerance for tool length		6–224
MP7266.21	Breakage tolerance for tool radius		6–224
MP7266.22-26	Reserved		–
MP7266.27	PLC value (PLC-VAL) –99999.999 to +99999.999	286 060-20	–
MP7267	Elements of the pocket table Input: 0: No display 1 to 5: Position in the pocket table	CN123	6–225
MP7267.0	Tool number		6–225
MP7267.1	Special tool		6–225
MP7267.2	Fixed pocket		6–225
MP7267.3	Locked pocket		6–225
MP7267.4	PLC status		6–225

MP	Function and input	Software version and behavior	Page
MP7270	Feed rate display in the operating modes MANUAL OPERATION and ELECTRICAL HANDWHEEL Input: 0: Display of axis feed rate by pressing an axis direction key (axis-specific feed rate from 1020) 1: Display of axis feed rate also before an axis direction key is pressed. Traverse with smallest value from 1020 for all axes.	RUN PLC, CN123	6–148
MP7274	Display of gear range Input: 0: No display of gear range 1: Display gear range	RUN PLC, CN123	6–148
MP7280	Decimal character Input: 0: Decimal comma 1: Decimal point	RUN PLC, CN123	6–181
MP7285	Tool length offset in the tool-axis position display Input: 0: Tool length is not offset 1: Tool length is offset	RUN PLC, CN123	6–146
MP7290.0-3	Position display step for the axes Input 0: 0.1 mm or 0.1° 1: 0.05 mm or 0.05° 2: 0.01 mm or 0.01° 3: 0.005 mm or 0.005° 4: 0.001 mm or 0.001°	CN123	6–146
MP7295	Disable the datum setting by soft key Format: %00xxxx Input: Bits 0 to 3 correspond to axes X, Y, Z, 4 0: Not disabled 1: Disabled (no DATUM SET soft key, if datum setting is disabled for all axes) Bits 4, 5 reserved. Enter 0.	RUN PLC, CN123	6–139
MP7296	Datum setting through axis keys and highlighted display of axes Input: 0 to 2: 0: Datum setting by axis keys and soft key. Switching of highlighting not possible. Switching of handwheel symbol by axis keys. 1: Datum setting only by soft key. Switching of highlighting by axis key. Switching of handwheel symbol by axis key. 2: Datum setting by axis key and soft key. Switching of highlighting by axis key. Switching of handwheel symbol by axis key.	RUN PLC, CN123	6–140

MP	Function and input	Software version and behavior	Page
MP7300	Erasing the status display and Q parameters Input: 0 to 7 (shown as %xxx) 0: Erase the status display, Q parameters and tool data when a program is selected. 1: Erase the status display, Q parameters and tool data if a program is selected and M02, M30 or END PGM occur. 2: Erase the status display and tool data when a program is selected. 3: Erase the status display and tool data when a program is selected and if M02, M30 or END PGM occur. 4: Erase the status display and Q parameters when a program is selected. 5: Erase the status display and Q parameters when a program is selected and if M02, M30 or END PGM occur. 6: Erase the status display when a program is selected. 7: Erase the status display when a program is selected and if M02, M30 or END PGM occur.	RUN PLC, CN123	6–150
MP7310	Graphic display mode Format: %xxxxxxxx Input: Bit 0 — Projection in three planes: 0: German-preferred projection 1: US-preferred projection Bit 1 — Rotation of the coordinate system in the working plane by 90°: 0: No rotation 1: Rotation by +90° Bit 2 — BLK form is also moved after a datum shift: 0: Not moved 1: Moved according to the datum shift Bit 4: 0: For fixed cycles, draw only the last infeed 1: For fixed cycles, draw all infeeds Bits 3, 5-7 reserved	CN123	6–145

MP	Function and input	Software version and behavior	Page
MP7311	Drawing mode for programming graphics Format: %xxxxxxxx Input: Bit 0: 0: Do not identify penetration points 1: Identify penetration points Bit 1: 0: Do not draw meanders in pockets 1: Draw meanders in pockets Bit 2: 0: Do not draw compensated paths 1: Draw compensated paths Bits 3-7 reserved		6–145
MP7330.0-15	Specifying the user parameters 1 to 16 Input: 0 to 9999.00 (no. of the user parameter)	RUN PLC	6–179
MP7340.0-15	Dialog messages for user parameters 1 to 16 Input: 0 to 999 (line number of the dialog message file)	RUN PLC	6–179

4.3.13 Screen Colors

MP	Function and input	Software version and behavior	Page
MP7350	Color for window frame	RUN PLC	6–142
MP7351	Color for error messages	RUN PLC	6–142
MP7352	Color for Machine operating mode display	RUN PLC	6–142
MP7352.0	Background		6–142
MP7352.1	Text for operating mode		6–142
MP7352.2	Dialog		6–142
MP7353	Color for Programming and Editing operating mode display	RUN PLC	6–142
MP7353.0	Background		6–142
MP7353.1	Text for operating mode		6–142
MP7353.2	Dialog		6–142
MP7354.0	Background		6–142
MP7354.2	Active block		6–142
MP7354	Color for Machine operating mode display	RUN PLC	6–142

MP	Function and input	Software version and behavior	Page
MP7354.1	General program text		6–142
MP7354.3	Background of inactive window		6–142
MP7355	Color for program text in Programming and Editing mode	RUN PLC	6–142
MP7355.0	Background		6–142
MP7355.1	General program text		6–142
MP7355.2	Active block		6–142
MP7356	Color for status window and PLC window	RUN PLC	6–142
MP7356.0	Background		6–142
MP7356.1	Axis positions in the status display		6–142
MP7356.2	Status display other than axis positions		6–142
MP7357	Color for soft keys in Machine mode	RUN PLC	6–142
MP7357.0	Background		6–142
MP7357.1	Symbols		6–142
MP7358	Color for soft keys in Programming and Editing mode	RUN PLC	6–142
MP7358.0	Background		6–142
MP7358.1	Symbols		6–142
MP7360	Color for graphic: 3-D display	RUN PLC	6–142
MP7360.0	Background		6–142
MP7360.1	Top surface		6–142
MP7360.2	Front face		6–142
MP7360.3	Text display in the graphics window		6–142
MP7360.4	Lateral face		6–142
MP7361	Color for graphics: Projection in three planes	RUN PLC	6–142
MP7361.0	Background		6–142
MP7361.1	Top view		6–142
MP7361.2	Front and side view		6–142
MP7361.3	Axis cross and text in the graphic display		6–142
MP7361.4	Cursor		6–142
MP7362	Color for additional status display in the graphic window	RUN PLC	6–142
MP7362.0	Background of graphic window		6–142
MP7362.1	Background of status display		6–142

MP	Function and input	Software version and behavior	Page
MP7362.2	Status symbols		6–142
MP7362.3	Status values		6–142
MP7363	Color for programming graphics	RUN PLC	6–143
MP7363.0	Background		6–143
MP7363.1	Resolved contour		6–143
MP7363.2	Subprograms and frame for zooming		6–143
MP7363.3	Alternative solutions		6–143
MP7363.4	Unresolved contour		6–143
MP7363.5	Meander paths during pocket milling		6–143
MP7363.6	Compensated paths during pocket milling		6–143
MP7364	Color for the help illustrations for cycles	RUN PLC	6–143
MP7364.0-6	Colors 1 to 7 of the graphic program used		6–143
MP7364.7	Line color (color 8 of the graphic program)		6–143
MP7364.8	Color for highlighted graphic elements if defined in the help illustration		6–143
MP7364.9	Background		6–143
MP7366	Color for block scan window	RUN PLC	6–143
MP7366.0	Background		6–143
MP7366.1	Text		6–143

4.3.14 Machining and Program Run

MP	Function and input	Software version and behavior	Page
MP7410	Scaling cycle in two or three axes Input: 0: Scaling cycle is effective in all three principle axes 1: Scaling cycle is effective only in the working plane.	RUN PLC, CN123	6–174
MP7411	Tool data in the touch probe block Input: 0: Use the calibrated data of the touch probe. 1: Use the current tool data from the last TOOL CALL.	RUN PLC, CN123	6–193
MP7415.0	Type of transition element with M112 Input: 0 to 3 (recommended input 3) 0: Insert circular arc (acceleration step at the connection points) 1: Insert cubic spline (no velocity step at the connection points) 2: Insert fifth-degree polynomial (no acceleration step at the connection points) 3: Insert seventh-degree polynomial (no step in the jerk at the connection points)	RUN PLC, CN123	6–93
MP7415.1	Smoothen contour transitions Format: %xxxxxxxx Input: Bit 0: = 0 Do not smoothen contour transitions Bit 0: = 1 Smoothen contour transitions Bit 1 reserved Bit 2: = 1 Jerk limitation from 1097 active Bit 3 =1 very short contour elements (<16 µm) are combined into one element Bits 4 to 8 reserved	RUN PLC, CN123	6–94
MP7420.1	Cycles for milling pockets with combined contours Format: %xxxxxxxx Input: Bit 0 — Milling direction for channel milling: 0: Rough-out of the separate contour areas with individual tool infeeds 1: Rough out of the separate contour areas without withdrawing the tool Bits 1-7 reserved	RUN PLC, CN123	6–174

MP	Function and input	Software version and behavior	Page
MP7420.0	Cycles for milling pockets with combined contours Format: %xxxxxxxx Input: Bit 0 — Milling direction for channel milling: 0: Counterclockwise for pockets, clockwise for islands. 1: Clockwise for pockets, counterclockwise for islands. Bit 1 — Sequence for rough-out and channel milling: 0: First channel milling, then pocket rough-out 1: First pocket rough-out, then channel milling Bit 2 — Merging of listed contours: 0: Contours are merged only if the tool-center paths intersect. 1: Contours are merged if the programmed contours intersect. Bit 3 — Rough-out and channel milling to pocket depth or for every infeed 0: Each process uninterrupted to pocket depth 1: Both processes for each pecking depth before proceeding to the next depth. Bit 4 — Position after completion of the cycle: 0: Tool moves to the same position as before the cycle was called 1: Tool moves axis to the clearance height	RUN PLC, CN123	6–174
MP7430	Overlap factor for pocket milling Input: 0.1 to 1.414	RUN PLC, CN123	6–172

MP	Function and input	Software version and behavior	Page
MP7440	Output of M functions Format: %xxxxxx Input: Bit 0 — Program stop with M06: 0: Program stop with M06 1: No program stop with M06 Bit 1 — Modal cycle call M89: 0: Normal code transfer of M89 at beginning of block 1: Modal cycle call M89 at end of block Bit 2 — Program stop with M functions: 0: Program stop until acknowledgment of the M function 1: No program stop, no waiting for confirmation Bit 3 — Non-functional Bit 4 — Reduced feed rate in the tool axis with M103: 0: Function is not in effect 1: Function is in effect Bit 5 — Axis-in-position marker is set during delay time between two NC blocks 0: Function is not in effect 1: Function is in effect Bit 6 — Non-functional	RUN PLC, CN123	6–168
MP7441	Suppress error message SPINDLE? Format: %xx Input: Bit 0 = 1: Suppress error message SPINDLE=? when fixed cycle is called without M3/M4 Bit 1 = 1: Suppress the warning SPINDLE? if the internal NC spindle status does not match the PLC spindle status.	RUN PLC, CN123	6–109
MP7450	Offsetting the tool change position from MP951.x in block scan Format: %xxxx Input: Bits 0 to 3 correspond to axes 1 to 4: 0: Do not offset 1: Offset	PLC RUN 286 060-20	–
MP7460	Angle for constant contour speed at corners Input: 0.001 to 179.999 [°]	RUN PLC, CN123	6–92
MP7470	Maximum feed rate at 100% override Input: 0 to 300 000 [mm/min] 0 = no limitation	RUN PLC, CN123	–
MP7475	Reference for datum table Input: 0: Reference is workpiece datum 1: Reference is machine datum (MP960.x)	RUN PLC, CN123	6–178

MP	Function and input	Software version and behavior	Page
MP7480.1	With TOOL DEF block Input: 0: No output 1: Tool number output (W264) only when tool number changes 2: Output of tool number (W264) for every TOOL DEF block 3: Output of pocket number (W262) and tool number (W264) only when tool number changes 4: Output of the pocket number (W262) and tool number (W264) for every TOOL DEF block 5: Output of pocket number (W262) and tool number (W264) only when tool number changes. Pocket table is not changed. 6: Output of pocket number (W262) and tool number (W264) with each TOOL DEF block. Pocket table is not changed.		6–231
MP7480.0	With TOOL CALL block Input: 0: No output 1: Tool number output (W264) only when tool number changes 2: Output of tool number (W264) for every TOOL CALL block 3: Output of pocket number (W262) and tool number (W264) only when tool number changes 4: Output of the pocket number (W262) and tool number (W264) for every TOOL CALL block 5: Output of pocket number (W262) and tool number (W264) only when tool number changes; pocket table is not changed 6: Output of the pocket number (W262) and tool number (W264) for every TOOL CALL block. Pocket table is not changed.		6–231
MP7480	Output of the tool and pocket number	RUN PLC	6–231
MP7490	Functions for traverse ranges Input: 1 or 3 1: 3 Ranges of traverse, 3 datums 3: 3 Ranges of traverse, 1 datum	PLC	6–27
MP7490	Display of datums in the traverse range Input: 1 or 3 1: Three ranges of traverse, 3 datums 3: Three ranges of traverse, 1 datum	RUN PLC	6–193

4.3.15 Hardware

MP	Function and input	Software version and behavior	Page
MP7620	Feed-rate override and spindle speed override Format: %xxxxx Input: Bit 0 — Override active if rapid traverse key is pressed in Automatic mode Bit 1- reserved Bit 2 — Override active if rapid traverse key and directional key are pressed in Manual mode Bit 3 — Feed rate override and spindle speed override in 1% steps or according to a nonlinear characteristic curve: 0: 1% steps 1: Nonlinear characteristic curve Bit 4 — Hysteresis spindle override active (always set bit 4)	RUN PLC	6–120, 6–148
MP7640	Handwheel Input: 0: No handwheel 1: HR 330 2: HR 130 5: Up to three HR 150 via HRA 110 6: HR 410 3, 4, 7-10 reserved	RESET	6–208
MP7641	Entry of the interpolation factor Format: %xxxxx Input: Bit 0 = 0 interpolation factor via TNC keyboard 1 Interpolation factor via PLC Module 9036 Bit 1 — Handwheel active in Programming and Editing mode Bit 2 — Interpolation factor by keyboard and module Bit 3 — Handwheel inputs active in every operating mode Bit 4 — Handwheel active during returning to the contour	RUN PLC	6–208
MP7645.0	Evaluation of the handwheel keypad for HR 410 Input: 0: Evaluation of the keys by NC 1: Evaluation of the keys by PLC		6–211
MP7645.0	Assignment of third handwheel by axis selector switch S2 on HRA 110, if 7645.2 = 0 Input: 0: Switch position 1 (at the left stop) 3rd handwheel axis Z Position 2 = Third handwheel axis IV 1: Position 3 = Third handwheel axis Z Position 4 = Third handwheel axis IV 2: Position 3 = Third handwheel axis Z Position 4 = Third handwheel axis IV		6–211

MP	Function and input	Software version and behavior	Page
MP7645.1	Fixed assignment of 3rd handwheel if 7645.2 = 1 Input: 4: Third handwheel axis Z 8: Third handwheel axis IV (410.3)		6–211
MP7645.2	Assignment of a third handwheel via axis selector switch or 7645.1 Input: 0: Assignment by axis selection switch according to 7645.0 1: Assignment by 7645.1		6–211
MP7645.1-7	No function for HR 410		6–211
MP7645.3-7	No function for HRA 110/HR 150		6–211
MP7650	Counting direction for handwheel Input: 0: Negative counting direction 1: Positive counting direction	RUN PLC	6–208
MP7660	Threshold sensitivity for handwheel Input: 0 to 65 535 [increments]	RUN PLC	6–208
MP7670	Interpolation factor for handwheel Input: 0 to 10	RUN PLC	6–208
MP7670.0	Interpolation factor for low speed with HR 410, minimum interpolation factor with HR 130		6–208
MP7670.1	Interpolation factor for medium speed with HR 410		6–208
MP7670.2	Interpolation factor for high speed with HR 410		6–208
MP7671	Manual feed rate in the Handwheel operating mode with HR 410 Input: 0 to 1000 [% of MP1020]	RUN PLC	6–211
MP7671.0	Low speed		6–211
MP7671.1	Medium speed		6–211
MP7671.2	High speed		6–211
MP7680	Machine parameter with multiple function Format: %xxxxxxxxxxxxxxxx Input: Bit 1 — Returning to the contour: 0: Not active 1: Active Bit 2 — Block scan: 0: Not active 1: Active Bit 11 — Block scan always active with PLC 0: Not active 1: Active	RUN PLC	6–176

MP	Function and input	Software version and behavior	Page
MP7680	Machine parameter with multiple function Format: %xxxxxxxxxxxxxxxx Input: Bit 0 — Memory function for axis-direction keys when M4562 is set 0: Not saved 1: Not saved	RUN PLC	6–190
MP7690	MEMORY TEST during switch-on Format: %xx Input: Bit 0 — Test the RAM Bit 1 — Test the EPROM		6–181