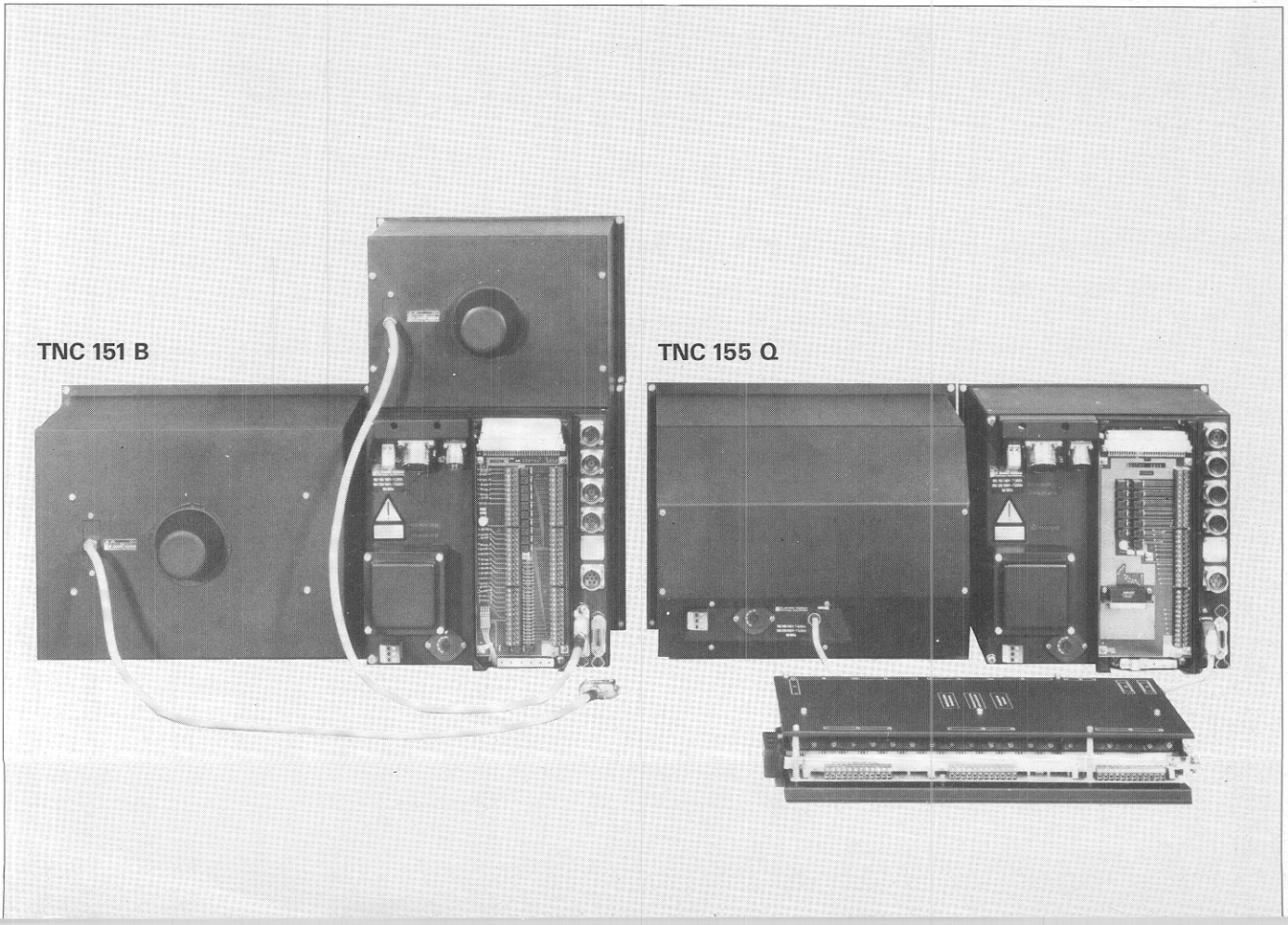
HEIDENHAIN

Mounting Instructions and Interface Circuit Control-Machine

HEIDENHAIN TNC 151 B/TNC 151 Q
HEIDENHAIN TNC 155 B/TNC 155 Q

Contouring Control



December '88

Contents

Transducer input	TNC 151/155-version **without** separate **PLC-board(s)**	TNC 151/TNC 155-version **with PLC-board(s)**
Sinusoidal signals	TNC 151 B/TNC 155 B TNC 151 F/TNC 155 F*	TNC 151 Q/TNC 155 Q TNC 151 W/TNC 155 W*
Squarewave signals	TNC 151 BR/TNC 155 BR TNC 151 FR/TNC 155 FR*	TNC 151 QR/TNC 155 QR TNC 151 WR/TNC 155 WR*

*without 3D-movement and "Transfer blockwise"

We are constantly working on the further development of our TNC-controls. It is therefore possible that a certain control version may deviate from the version described in this manual.

1. General information

The HEIDENHAIN TNC 151/TNC 155-controls are equipped with an integral PLC and are available in two basic versions:

HEIDENHAIN TNC 151 B/TNC 155 B

These control versions are equipped with a simple interface for connection to an external PLC. This so-called "standard interface" has remained unchanged since TNC 145, thus making all contouring controls compatible.

This standard interface has been realized by a PLC-standard program. The following interface description is based on this PLC-standard program.
TNC 151 B/TNC 155 B is supplied with the PLC-standard program. Certain control functions of this PLC-standard program can be activated via machine parameters.

HEIDENHAIN TNC 151 Q/TNC 155 Q

Control with a PLC-power board PL 100 B having
.63 inputs, 9 of which have fixed allocations,
.31 outputs

or with PLC-power board PL 110 B having
.63 inputs, 9 of which have fixed allocations
.25 outputs,
.3 bipolar output pairs

On delivery, this control version also has the standard PLC-program stored.
By using a further PLC-board PL 100 B or PL 110 B, the PLC-inputs and outputs may be doubled.

HEIDENHAIN TNC 151/TNC 155 – Export versions

TNC 151 F/TNC 155 F, for external PLC.
TNC 151 W/TNC 155 W, with integral PLC and external board

These control versions are identical to the versions TNC 151 B/TNC 155 B and TNC 151 Q/TNC 155 Q with exception of the functions "transfer blockwise" and 3D-interpolation.

HEIDENHAIN TNC 151.R/TNC 155.R

The suffix R indicates that the control versions has squarewave (TTL) signal inputs. Transducer connections are via an EXE-digitizing unit.

HEIDENHAIN TNC 151/TNC 155 with SPINDLE ORIENTATION option
Spindle orientation is available as an option and necessitates an extension of TNC-hardware.
The NC-software for spindle orientation, i.e. for the fifth axis is contained in every TNC 151 B/TNC 155 B.

Installation hints for VDU-units
Control versions TNC 151 permit the installation of the VDU-unit BE 111 (9 inch screen) or BE 211 (12 inch screen). TNC 155-versions require the VDU-unit BE 411 (12 inch graphic display screen).

When installing VDU-units, it should noted that these units are sensitive to magnetic fields. The hold and geometry of the screen picture can be distorted by magnetic cross-talk.
In the case of alternating current fields, these can cause periodical picture displacement or picture distortion with the beat frequency from the picture and the mains frequency.
For this reason, permanent magnets, motors, transformers, magnetic switches and similar should not be located in the immediate vicinity of the VDU. As an approximation, we recommend a minimum distance of 0.5 m between the source of interference and the VDU-housing.

In order to maintain a substantial distance between the VDU and the control unit (TNC), we recommend that the TNC only be mounted to the right or beneath the VDU.

2. Combined technical specifications for TNC 151/TNC 155

All TNC 151/TNC 155 inputs and outputs may only be connected to electric circuits with protective low voltage.

Mains power supply	Selectable 100/120/140/200/220/240 V + 10 %/ − 15 %, 48 . . . 62 Hz If the permissible mains voltage tolerances cannot be held, we recommend a voltage regulator type "Voltkraft" which is available from Messrs. Conrad Electronic. The regulator can also be purchased from the HEIDENHAIN Service Department.
Power consumption	**TNC 151** ca. 60 W (with 9" visual display unit BE 111 or with 12" visual display unit BE 211) **TNC 155** Logic and operating unit ca. 45 W 12" visual display unit BE 411 ca. 40 W **Current consumption of PLC-board PL 100 B/PL 110 B** **1st board:** 460 mA ± 25 mA (all inputs and outputs open, 2nd board disconnected) **2nd board:** 360 mA ± 25 mA
Permissible resistance of earthing lead	recommended: $R < 100\ m\Omega$ or max. lead length 10 m with a 4 mm^2 cross-section
Protection against distruction of electronics	1 kV with a 1 MHz surge to IEC 255-4
Ambient temperature	Operation 0 . . . + 45°C (+ 32°F . . . + 113°F) Storage − 30 . . . + 70°C (− 22°F . . . + 158°F)
Protection	Operating panel: IP 54 IEC 529
Weight	Control TNC 151 B/TNC 151 Q: 12 kg Control TNC 155 B/TNC 155 Q: 12 kg 9" VDU-BE 111: 6,8 kg 12" VDU-BE 211: 10 kg 12" VDU-BE 411: 10 kg PLC-board PL 100 B/PL 110 B: 1.2 kg
Dimensions	see section 13

2.1 Specific data for TNC 151 B/TNC 155 B

Control inputs

Potential-free opto-couplers (switched into groups)

Operating voltage	max. 30 V —, filtered
Opto-coupler switched	≧ 15 V
Opto-coupler open	≦ 8 V
Loading per input	≺ 10 mA

Control relay outputs

Potential-free relay contact (switched into groups)

Operating voltage	max. 30 V — / min. 15 V —
Operating current per contact	max. 50 mA
Permissible load	Resistance load; Inductive load only with quenching diode parallel to inductivity

To prevent welding of contacts in the event of short circuiting, every contact is provided with a current limiting resistor of 47 ohms in series.

Caution!
Connect control 0-volt for inputs and outputs of control to a common grounding point!
See wiring and grounding diagram TNC 151/TNC 155. Operational ground ⏚ [B] .

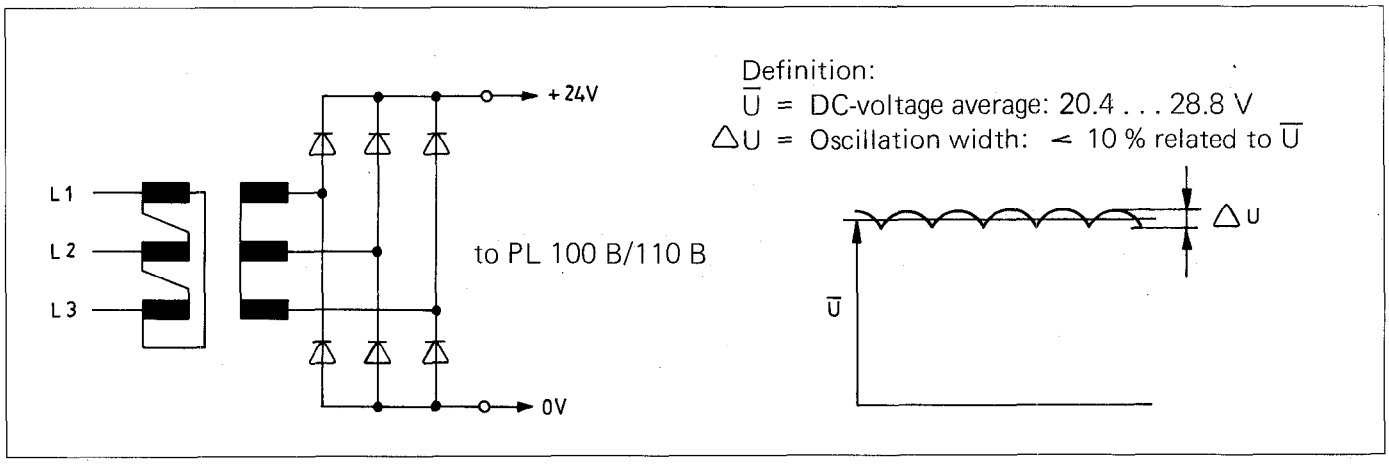
2.2 Specific data for TNC 151 Q/TNC 155 Q

Nominal values and tolerances

External voltage supply for PLC
Nominal voltage: 24 V, —
Voltage range: 20.4 V to 28.8 V

Furthermore, superimposed alternating voltages with a relative oscillation width of 10 % – related to the average DC-voltage value — are permissible.

Circuitry example:

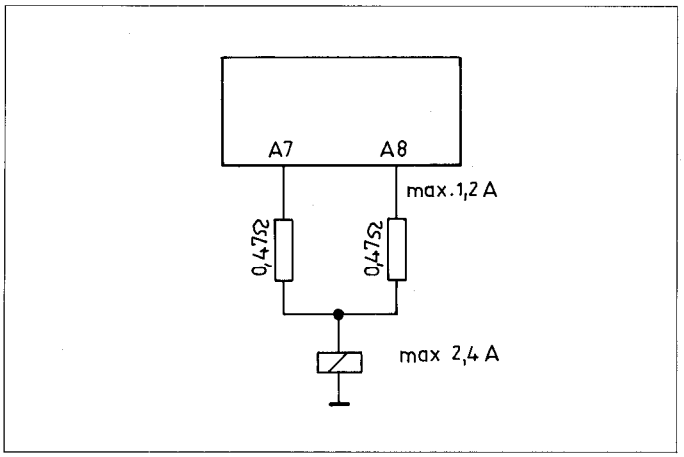


Binary input signals (E0 to E62 and E64 to E126)
Nominal voltage: 24 V —,
Voltage range for signal "1": 16.5 V to 30 V
Voltage range for signal "0": — 3 V to + 4 V
Current range for signal "1": 6.2 mA to 12.6 mA

Please note:
Interference signals ≺1 ms at the PLC-inputs are filtered with a low pass Schmitt-Trigger-input circuit. Long duration interference signals must be faded out via software.

Binary outputs signals (PL 100 B: A0 to A30, A32 to A62; PL 110 B: A0 to A24, A32 to A56 and "Emergency stop")
Nominal voltage: 24 V, –
Max. difference to supply voltage: < 3 V
Max. output current: 1.2 A
Permissible loading: Resistive load; inductive load only parallel to inductivity with quenching diode, max. switching frequency: 50 Hz

Please note:
Adjacent PLC-outputs (e.g. A7 with A8) can be switched to parallel via resistors e.g. 2 x 0,47Ω.



Bipolar outputs (PL 110 B: A25 to A30 and A57 to A62)
Nominal voltage: 15 V –
(measured between two bipolar outputs, with one output switched to signal "1" and the other to signal "0")
Nominal current: 300 mA
Voltage range with nominal current: 14.0 V to 15.5 V
Max. output current 1.2 A for 1 minute
Current limitation range: 1.35 A to 1.6 A
Permissible load: Resistance load;
inductive load only with quenching diode parallel to inductivity
max. switching frequency: 50 Hz

Please note:
Bipolar PLC-outputs may not be switched in parallel.

When using the bipolar outputs as binary output signals:
Voltage for signal "1": >14.2 V
Voltage for signal "0": < 3.0 V
Nominal current: 300 mA
Max. output current 1.2 A for 1 minute

Output current supervision
Supervision of output currents of all bipolar outputs. Output J3/11 provides signal "1" if the sum of the output currents of all bipolar outputs is ≈0.8 A to 0.9 A
Nominal voltage: 24 V –,
Max. output current: 55 mA to 65 mA
Max. difference to supply voltage: <1.5 V

2.3 Transducers for TNC 151/TNC 155

2.3.1 Transducers for TNC 151 B/TNC 155 B, TNC 151 Q/TNC 155 Q

These control versions control the actual position with a digital step of 0.001 mm and subdivides the signal cycle of the transducers by 20 x or 10 x. Incremental linear transducers with a 20 µm or 10 µm grating pitch such as

.LS 107 (measuring lengths 240 mm to 3040 mm)
.LS 704 (measuring lengths 170 mm to 3040 mm)
.LS 403 or LS 404 (measuring lengths 70 mm to 1240 mm, up to 2040 mm with mounting spar)
.LID 300, LID 310

should therefore be used.

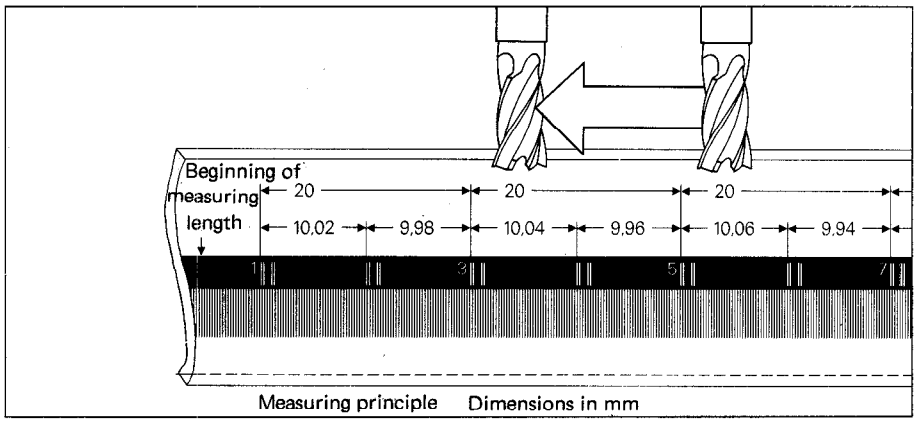
If accuracy requirements permit, measurement with e.g. rotary encoder type ROD 450 connected to the drive spindle is possible. The required number of lines for the encoder is calculated as follows:
Line number / rev. = 50 x lead screw pitch (in mm) with 20 x evaluation (MP 12 – 15)
Line number / rev. = 100 x lead screw pitch (in mm) with 10 x evaluation (MP 12 – 15)

For angle measurement (with axis IV) rotary encoder types ROD 250 and ROD 700 with 18,000 lines are available.

Please note:
If an ROD 450 rotary encoder is to be used in conjunction with a gear for angular positioning, the error of the rotary encoder is decreased proportionally to the ratio of the gear.
The cable length between transducer and TNC-control must not exceed 20 m.

2.3.2 Transducers with distance-coded reference marks for TNC 151/TNC 155

When using linear transducers with distance-coded reference marks, the absolute position value can be retrieved after a traverse of only 20 mm, i.e. after crossing two consecutive reference marks.



Measuring principle Dimensions in mm

The scale consists of a line grating with a 20 µm grating pitch and adjacent reference mark track. The spacing between the reference marks varies by a definite amount. By evaluating the distance from one reference mark to the next, the absolute position can be determined.

The following transducers are available with distance-coded reference marks:

.Sealed linear transducer LS 704 C
Measuring lengths 240 to 3040 mm
.Sealed linear transducer LS 107 C
Measuring lengths 240 to 3040 mm
.Sealed miniature linear transducer LS 403 C/LS 404 C
Measuring lengths 70 to 1240 mm (up to 2040 mm with additional mounting spar)

2.3.3 Transducers for TNC 151.R/TNC 155.R

For cable lengths which exceed 20 m between transducers and control or for transducers which exceed 3040 mm, the control versions TNC 151.R/TNC 155.R are used.

2.3.3.1 Transducers and EXE-units for the X, Y, Z-axes

Transducers for the main axes X, Y, Z are connected to TNC 151.R/TNC 155.R via 3-axis EXE-units with separate voltage supply.

The max. cable length between EXE 8 .. and TNC 151.R/TNC 155.R is 50 m and 20 m between the transducer and the EXE. The total cable length is therefore 70 m.

2.3.3.2 Transducers and EXE-units for axis IV

Subdivision within the pulse shaping electronics is always 5-fold.

a) Control of a rotary axis

Rotary encoder with 18 000 lines	**EXE, with subdivision**	**max. cable length EXE / TNC**
ROD 250 / ROD 700 RON 255 / RON 705	801, 5-fold	50 m connecting cable
ROD 250 / ROD 700 RON 255 / RON 705	602 D, 5-fold	1 m cable on EXE + 9 m extension
ROD 271 RON 275	Pulse shaping stage within ROD	1 m cable on ROD + 9 m extension

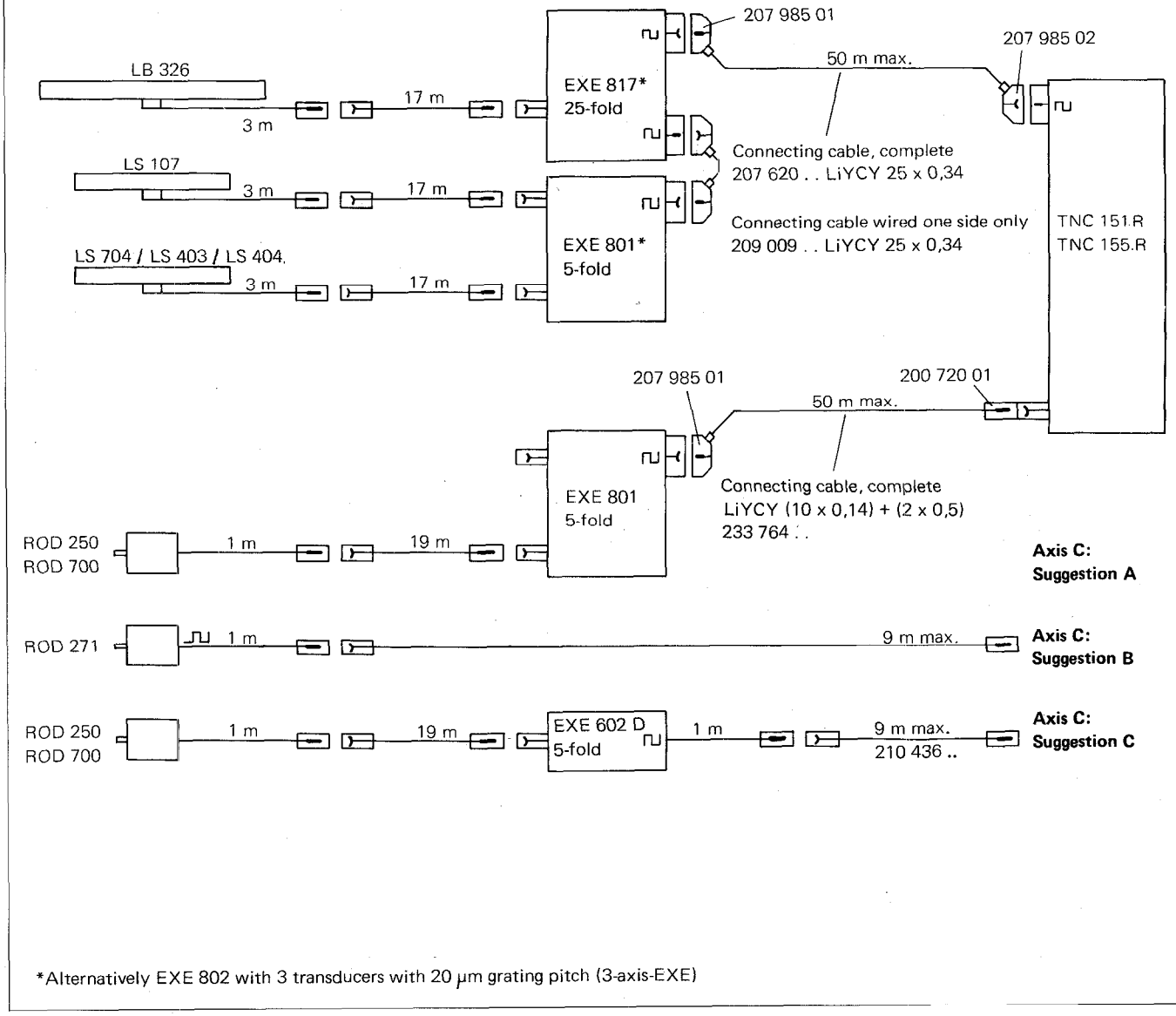
When using a rotary encoder with integral pulse shaping electronics or the pulse shaping electronics unit EXE 602 D, the voltage supply is provided by the TNC 151.R/TNC 155.R.

In order to maintain the correct supply voltage, the total length of the connecting cable between EXE 602 D and the control is limited to 10 m.

b) Control of a linear axis

Transducer	**Grating pitch/ Line number**	**EXE, with signal subdivision**	**max. cable length EXE/TNC**
LS 107, LS 107 C LS 704, LS 704 C LS 403, LS 403 C LS 404, LS 404 C	20 µm	801, 5-fold	50 m Extension cable
LS 107, LS 107 C LS 704, LS 704 C LS 403, LS 403 C LS 404, LS 404 C	20 µm	602 D, 5-fold	1 m cable on EXE + 9 m extension
ROD 450	50 x Spindle pitch in mm	801, 5-fold	50 m connecting cable

2.3.3.3 Transducers for TNC 151.R/TNC 155.R



*Alternatively EXE 802 with 3 transducers with 20 µm grating pitch (3-axis-EXE)

2.4 Rotary encoders for spindle orientation (axis V)

The Vth axis has a transducer input for squarewave signals and 4-fold evaluation. HEIDENHAIN rotary encoders ROD 426 with 1024 lines are used.

In this case, transducer supervision for axis V is to be inactivated.

3. Functions of control inputs / outputs

3.1 External buttons "Start", "Stop" and "Rapid traverse"

The external buttons "Start" and "Stop" are used for starting or interrupting program run or a positioning procedure.

Button	PLC-Allocation	TNC 151 B/TNC 155 B Multipoint connector	TNC 151 Q/TNC 155 Q Multipoint connector PLC-Power board
Start	E22	J 5/2	J 5/1
Stop	E23	J 5/1	J 6/12
Rapid traverse	E21	J 5/3	J 5/2

The required push-buttons for "Stop" (opener) and "Start" as well as "rapid traverse" (closer) are incorporated into the machine pendant or console by the machine tool manufacturer.
Depending on the programming of machine parameter 74, the function of the "rapid traverse" button overrides all other programmed speeds i.e. on pressing the "rapid traverse" button, the machine moves in rapid traverse regardless of any lower programmed feed rate.
It is left to the discretion of the machine tool manufacturer as to whether a "rapid traverse" button is to be fitted. A "rapid traverse" can be programmed directly into the TNC 150 via keyboard-entry
("rapid traverse" = 15999 mm/min or $\frac{6299}{10}$ inch/min.)

3.2 External switch "Manual traverse" in conjunction with X, Y, Z, IV-axis-release

In/Output	PLC-Allocation	TNC 151 B/TNC 155 B Multipoint connector	TNC 151 Q/TNC 155 Q Multipoint connector PLC-Power board
"Manual traverse"	E19	J 5/5	J 5/4
Axis release X	A0	J 1/1	J 1/1
Axis release Y	A1	J 1/2	J 1/2
Axis release Z	A2	J 1/3	J 1/3
Axis release IV	A3	J 1/4	J 1/4

The axis release relays X, Y, Z and IV close after pressing the start button for the reference point approach routine according to the sequence programmed in parameter 59. The axis release relays remain permanently closed after crossing the reference marks so that the machine is kept in a closed loop condition by the control.

Exception:
In all operating modes, the axis release contacts are opened by providing + 24 volts control voltage at input for "Manual traverse" e.g. with traverse of machine in conventional mode with mechanical handwheels.

The positioning loop is closed again if,
.a feed command is output by the control (only for the duration of the feed command) or
.the 24 V is taken off at the input "manual feed"

Transfer of actual position data when opening the positioning loops
With the standard PLC-program as of program number 234 601 03, it can be programmed via machine parameter 158 (setting of markers) as to whether the transfer of actual position data as nominal positions data should take place via the "manual traverse" input
With the entry value 16 384 in machine parameter 158 transfer is initiated. Since the machine parameter can be used to activate various functions, the entry values will have to be added if necessary.

Clamping of axes:
Machines, on which axes could move out of position when the closed loop is off, must be fitted with a clamping facility.

Please note:
Clamped axes are indicated in the display by a decimal point which suffixes the axis designation.

3.3 Feed rate release

Input	PLC-Allocation	TNC 151 B/TNC 155 B Multipoint connector	TNC 151 Q/TNC 155 Q Multipoint connector PLC-Power board
"Feed rate release"	E18	J 5/6	J 5/5

By opening the input "feed rate release", the speed can be ramped down to zero at any time, by means of the "machine acceleration" which is entered as a machine parameter during initial dialogue entry.
If the input "feed rate release" has been opened, this is indicated in the status display by the letter F (inverted).

3.4 M-, S- and T-functions, Strobe signals and feedback signal: "Auxiliary function completed"

In/Output	PLC-Allocation	TNC 151 B/TNC 155 B Multipoint connector	TNC 151 Q/TNC 155 Q Multipoint connector PLC-Power board
Coded outputs M, S and T			
Bit 1 ... 2^0 }	A7	J 2/2	J 1/8
2 ... 2^1 }	A8	J 2/3	J 1/9
3 ... 2^2 } Decade 1	A9	J 2/4	J 1/10
4 ... 2^3 }	A10	J 2/5	J 1/11
5 ... 2^0 }	A11	J 2/6	J 2/1
6 ... 2^1 }	A12	J 2/7	J 2/2
7 ... 2^2 } Decade 2	A13	J 2/8	J 2/3
8 ... 2^3 }	A14	J 2/9	J 2/4
Decoded outputs			
M 03 Spindle cw	A15	J 2/10	J 2/5
M 04 Spindle ccw	A16	J 2/11	J 2/6
M 05 Spindle stop	A17	J 2/12	J 2/7
M 08 Coolant ON	A18	J 3/1	J 2/8
M 09 Coolant OFF	A19	J 3/2	J 2/9
Gating signals			
S-Strobe	A20	J 3/3	J 2/10
M-Strobe	A21	J 3/4	J 2/11
T-Strobe	A22	J 3/5	J 3/1
Input: "Auxiliary function completed"	E17	J 5/7	J 5/6

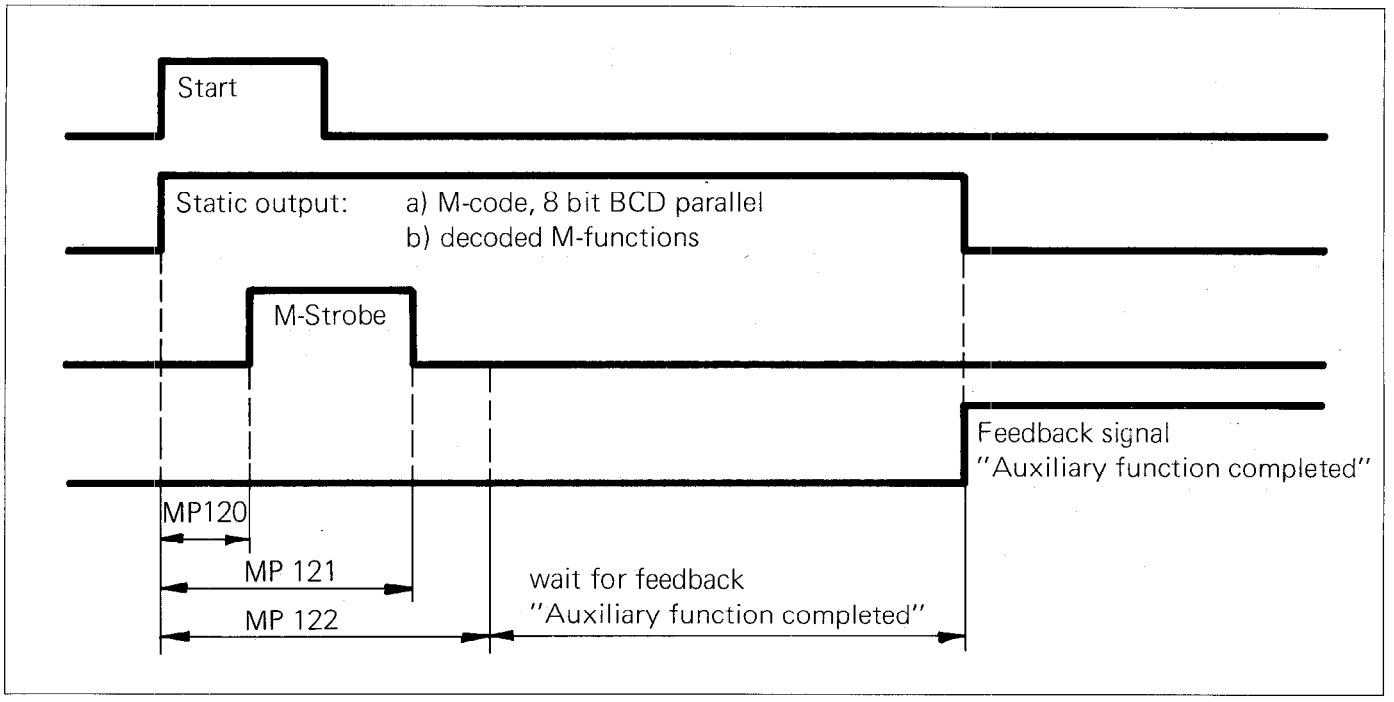
M-, S- and T-functions are provided statically via the same relay outputs of the control. To differentiate whether an M-, S- or T-function is at the output, pulsed strobe signals "M-Strobe", "S-Strobe" and "T-Strobe" are used.

Via machine parameter MP 214 it can be determined as to whether a brief axis standstill occurs with a change of spindle speed during a constant positioning procedure.

3.4.1 Output of M-functions

M-functions operative at block-beginning.

Timing diagram:



Please note:
The programmed time in machine parameter 121 must be less than the time in machine parameter 122.

The M-code is provided as a static signal. The impulse duration of the M-gating signal is programmed with machine parameters 120 and 121. After duration of the time period programmed with 122, the control input ist interrogated for the feedback signal: "Auxiliary function completed". When this input is at + 24 V, the M-code signals are inactive and program run is resumed. If this input is inactive, (at 0 V), the M-code signals are output and program run is interrupted until the input is re-activated (at 24 V).

The number of M-functions depends on the type of decoding in the machine interface.

With external decoding, 100 different M-functions can be programmed.

Without external decoding, 9 different M-functions can be programmed.

a) Coded M-functions
Output is in 8-4-2-1 BCD-code, 2 decades parallel. (Decoded M-functions are present with the corresponding coded M-functions simultaneously). The table on next page shows which M-functions are operative at the beginning or end of a block, and the appropriate coding.

Coding of M-functions

M-Function	Output at Block		Connector J 2 bit 1234 5678
	Beginning	End	
M 00		X	0000 0000
M 01		X	1000 0000
M 02		X	0100 0000
M 03	X		1100 0000
M 04	X		0010 0000
M 05		X	1010 0000
M 06		X	0110 0000
M 07	X		1110 0000
M 08	X		0001 0000
M 09		X	1001 0000
M 10		X	0000 1000
M 11	X		1000 1000
M 12		X	0100 1000
M 13	X		1100 1000
M 14	X		0010 1000
M 15	X		1010 1000
M 16	X		0110 1000
M 17	X		1110 1000
M 18	X		0001 1000
M 19**		X	1001 1000
M 20	X		0000 0100
M 21	X		1000 0100
M 22	X		0100 0100
M 23	X		1100 0100
M 24	X		0010 0100
M 25	X		1010 0100
M 26	X		0110 0100
M 27	X		1110 0100
M 28	X		0001 0100
M 29	X		1001 0100
M 30		X	0000 1100
M 31	X		1000 1100
M 32		X	0100 1100
M 33		X	1100 1100
M 34		X	0010 1100
M 35		X	1010 1100
M 36	X		0110 1100
M 37	X		1110 1100
M 38	X		0001 1100
M 39	X		1001 1100
M 40	X		0000 0010
M 41	X		1000 0010
M 42	X		0100 0010
M 43	X		1100 0010
M 44	X		0010 0010
M 45	X		1010 0010
M 46	X		0110 0010
M 47	X		1110 0010
M 48	X		0001 0010
M 49	X		1001 0010

M-Function	Output at Block		Connector J 2 bit 1234 5678
	Beginnig	End	
M 50	X		0000 1010
M 51	X		1000 1010
M 52		X	0100 1010
M 53		X	1100 1010
M 54		X	0010 1010
M 55	X		1010 1010
M 56	X		0110 1010
M 57	X		1110 1010
M 58	X		0001 1010
M 59	X		1001 1010
M 60		X	0000 0110
M 61	X		1000 0110
M 62	X		0100 0110
M 63		X	1100 0110
M 64		X	0010 0110
M 65		X	1010 0110
M 66		X	0110 0110
M 67		X	1110 0110
M 68		X	0001 0110
M 69		X	1001 0110
M 70		X	0000 1110
M 71	X		1000 1110
M 72	X		0100 1110
M 73	X		1100 1110
M 74	X		0010 1110
M 75	X		1010 1110
M 76	X		0110 1110
M 77	X		1110 1110
M 78	X		0001 1110
M 79	X		1001 1110
M 80	X		0000 0001
M 81	X		1000 0001
M 82	X		0100 0001
M 83	X		1100 0001
M 84	X		0010 0001
M 85	X		1010 0001
M 86	X		0110 0001
M 87	X		1110 0001
M 88	X		0001 0001
M 89*	X	X	1001 0001
M 90	X		0000 1001
M 91	X		1000 1001
M 92	X		0100 1001
M 93	X		1100 1001
M 94	X		0010 1001
M 95		X	1010 1001
M 96		X	0110 1001
M 97		X	1110 1001
M 98		X	0001 1001
M 99		X	1001 1001

Special M-Functions which affect program run are in thick print.

1 = Contact closed
0 = Contact open

*Depends on the programming of parameter 214
**Depends on the programming of parameter 158

b) Decoded M-functions

9 M-functions can be provided directly via relay contact thus making decoding in the machine interface unnecessary.

M 03	M 04	M 05	M 08	M 09	*	M 10,	M 20,	M 40,	M 80

* [ ] M-functions which affect program run

M 00 Coded output after execution of appropriate block – interrupts program run.
Additional decoded output: "Spindle stop" and "Coolant off".

M 02 Coded output after execution of appropriate block – interrupts program run and addresses block No. 1. Cancellation of status display if required (see MP 173).
Additional decoded output: "Spindle stop" and "Coolant off".

M 03 "Spindle clockwise" at block beginning; simultaneous output coded and decoded.

M 04 "Spindle counter-clockwise" at block beginning; simultaneous output coded and decoded.

M 05 "Spindle stop" at block-end; simultaneous output coded and decoded.

M 06 "Tool change", coded output after execution of appropriate block – interrupts program run.
Additional decoded output: "Spindle stop".

M 08 "Coolant on" at block-beginnig; simultaneous output coded and decoded.

M 09 "Coolant off" at block-end; simultaneous output coded and decoded.

M 13 Coded output at block beginning.
Additional decoded output: "Spindle clockwise" and "Coolant on".

M 14 Coded output at block beginning.
Additional decoded output: "Spindle counter-clockwise" and "Coolant on".

M 19 For spindle orientation option, as of PLC-standard program 234 601 03

M 30 Functions as per M 02.

M 89 No output!
Effective at the end of the appropriate block as a modal cycle call if machine parameter MP 214 was entered with 2 or 3 (with MP 214 0 or 1: normal output of M89 at block beginning).

M 90 No output!
For constant speed at corners. Only active in trailing operation (Rough positioning).

M 91 No output!
Approach to tool change position with reference to reference point.

M 92 No output!
Approach to tool change position (programmable in MP 186 – 189, with reference to reference point)

M 94 No output!
Angle value reduction < 360^{0} at block beginning

M 95 No output!
Alteration of run-on behaviour at contour.

M 96 No output!
Alteration of run-on behaviour at contour.

} see operating manual

M 97 No output!
No transitional arc is inserted on external corners.

M 98 No output!
Terminates path correction at block end.

M 99 No output!
Effective at end of appropriate block as per cycle call-block "CYCL CALL".

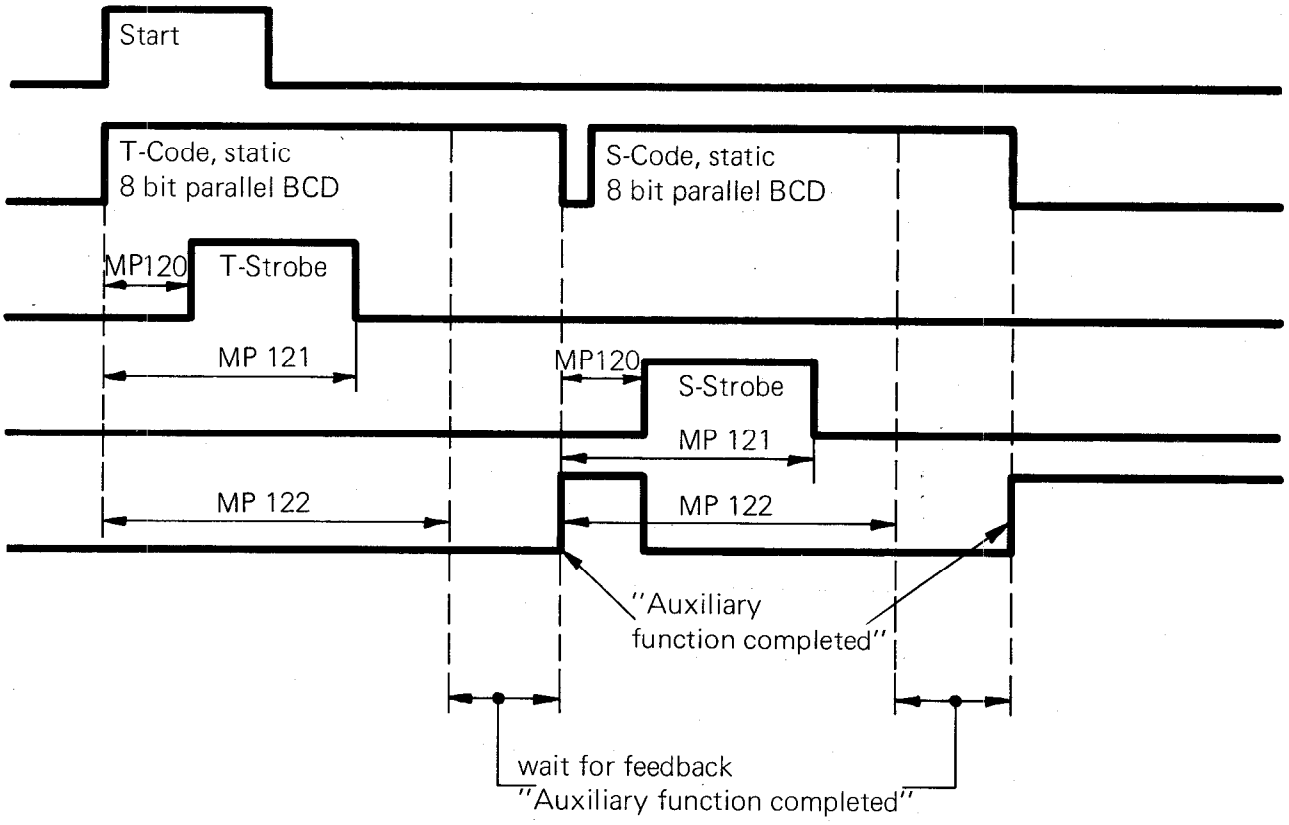
Caution!

The M-function M 93 may not be allocated!
HEIDENHAIN reserves the right to assign this M-function.

3.4.2 Output of S- and T-functions within Tool Call-block

The output of S- and/or T-functions with the gating signals can be either inhibited through relevant machine parameters in the initial dialogue or programmed for output of an S-Analogue voltage with up to 8 gear ratios.

Timing diagram



Please note:

The programmed time in machine parameter 121 must be less than the time in machine parameter 122.

3.4.2.1 Output of T-functions (tool numbers and tool store numbers)

The T-Code is provided as a static signal. The impulse duration of the T-gating signal is determined by machine parameters 120 and 121 (compare 3.4.1 Output of M-functions). After duration of the time period programmed with 122, the control input is interrogated for the feedback signal: "Auxiliary function completed". When this input is at + 24 V the T-code signals are cut-out and the program resumed. If the input is inactive (at 0 V) the T-signals are output and program run is interrupted until the input is re-activated (at + 24 V).

The TNC 151/TNC 155 permits programming of tool numbers from 1 to 254. The tool numbers 1 - 99 in 8-4-2-BCD-code are only output in the programmed tool call blocks; for tool numbers and tool store numbers greater than 99, all 8 output relays pick-up. In addition to the tool number, the tool call block contains the data for the spindle speed S.

3.4.2.2 Output of S-functions (Spindle speeds)

Depending on how machine parameter 62 is programmed, the output of spindle speeds can be in S-Code or via an analogue voltage output with up to 8 programmable gear ratios.

a) Coded output of S-functions (Spindle speeds)

The S-Code is provided as a static signal. The impulse duration of the S-gating signal is determined by parameters 120 and 121 (compare 3.4.1 Output of M-functions). After duration of the time period programmed with 122, the control input is interrogated for the feedback signal: "Auxiliary function completed". When this input is at + 24 V the S-signal is cut-out and the program is resumed. If the input is inactive (at 0 V), the S-signals are provided and the program run is interrupted until the input is re-activated (at + 24 V).

Spindle speeds are entered into the TOOL CALL program blocks with max. 4 digits in r.p.m. and automatically rounded-off to the nearest standard speed by the control. The entered spindle speed is automatically coded by the control in S-Codes in accordance with German standard DIN 66025 page 3, in 100 steps – as listed on next page (Output is in 2-decade BCD-code).

With the machine parameter 63 "RPM-Code", the minimum and maximum permissible speed can be entered. The RPM-steps can be set within the permissible RPM-range.

The code is entered as a 5 digit number:

	No. of decades	S-Code No.
min. RPM ...	2	01 – 99
max. RPM ...	2	01 – 99
Step	1	1 – 9

Example:

The RPM-code "2 0 8 0 2" is entered,
i.e. the minimum spindle-RPM is therefore S 20 (1 RPM), the maximum spindle RPM is S 80 (1000 RPM), the range is more closely defined by the specification that only every second speed is programmable.

Coding of S-functions

S-function	RPM	Connector J 2 bit 1234 5678	
S 00	0	0000	0000
S 01	0,112	1000	0000
S 02	0,125	0100	0000
S 03	0,14	1100	0000
S 04	0,16	0010	0000
S 05	0,18	1010	0000
S 06	0,2	0110	0000
S 07	0,224	1110	0000
S 08	0,25	0001	0000
S 09	0,28	1001	0000
S 10	0,315	0000	1000
S 11	0,355	1000	1000
S 12	0,4	0100	1000
S 13	0,45	1100	1000
S 14	0,5	0010	1000
S 15	0,56	1010	1000
S 16	0,63	0110	1000
S 17	0,71	1110	1000
S 18	0,8	0001	1000
S 19	0,9	1001	1000
S 20	1	0000	0100
S 21	1,12	1000	0100
S 22	1,25	0100	0100
S 23	1,4	1100	0100
S 24	1,6	0010	0100
S 25	1,8	1010	0100
S 26	2	0110	0100
S 27	2,24	1110	0100
S 28	2,5	0001	0100
S 29	2,8	1001	0100
S 30	3,15	0000	1100
S 31	3,55	1000	1100
S 32	4	0100	1100
S 33	4,5	1100	1100
S 34	5	0010	1100
S 35	5,6	1010	1100
S 36	6,3	0110	1100
S 37	7,1	1110	1100
S 38	8	0001	1100
S 39	9	1001	1100
S 40	10	0000	0010
S 41	11,2	1000	0010
S 42	12,5	0100	0010
S 43	14	1100	0010
S 44	16	0010	0010
S 45	18	1010	0010
S 46	20	0110	0010
S 47	22,4	1110	0010
S 48	25	0001	0010
S 49	28	1001	0010

S-function	RPM	Connector J 2 bit 1234 5678	
S 50	31,5	0000	1010
S 51	35,5	1000	1010
S 52	40	0100	1010
S 53	45	1100	1010
S 54	50	0010	1010
S 55	56	1010	1010
S 56	63	0110	1010
S 57	71	1110	1010
S 58	80	0001	1010
S 59	90	1001	1010
S 60	100	0000	0110
S 61	112	1000	0110
S 62	125	0100	0110
S 63	140	1100	0110
S 64	160	0010	0110
S 65	180	1010	0110
S 66	200	0110	0110
S 67	224	1110	0110
S 68	250	0001	0110
S 69	280	1001	0110
S 70	315	0000	1110
S 71	355	1000	1110
S 72	400	0100	1110
S 73	450	1100	1110
S 74	500	0010	1110
S 75	560	1010	1110
S 76	630	0110	1110
S 77	710	1110	1110
S 78	800	0001	1110
S 79	900	1001	1110
S 80	1000	0000	0001
S 81	1120	1000	0001
S 82	1250	0100	0001
S 83	1400	1100	0001
S 84	1600	0010	0001
S 85	1800	1010	0001
S 86	2000	0110	0001
S 87	2240	1110	0001
S 88	2500	0001	0001
S 89	2800	1001	0001
S 90	3150	0000	1001
S 91	3550	1000	1001
S 92	4000	0100	1001
S 93	4500	1100	1001
S 94	5000	0010	1001
S 95	5600	1010	1001
S 96	6300	0110	1001
S 97	7100	1110	1001
S 98	8000	0001	1001
S 99	9000	1001	1001

1 = Contact closed
0 = Contact open

b) Analogue voltage output of spindle speeds (0 to 99 999 rpm)

Outputs	PLC-Allocation	TNC 151 B / TNC 155 B Multipoint connector	TNC 151 Q / TNC 155 Q Multipoint connector PLC-Power board	TNC 151 Q / TNC 155 Q Multipoint connector Control
Spindle analogue voltage				
± 10 volts	–	J4/9	–	J1/9
0 volt	–	J4/10	–	J1/10
Gear ratio 1	A7	J2/2	J1/8	–
2	A8	J2/3	J1/9	–
3	A9	J2/4	J1/9	–
4	A10	J2/5	J1/11	–
5	A11	J2/6	J2/1	–
6	A12	J2/7	J2/2	–
7	A13	J2/8	J2/3	–
8	A14	J2/9	J2/4	–
S-Strobe	A20	J3/3	J2/10	–
Auxiliary function completed	E17	J5/7	J5/6	–

Caution
The 0-volt nominal value output must be grounded (see section 3.16 Wiring). For activation of the spindle with DC-servodrive, the control provides a DC voltage of 0 to ± 10 volts. The polarity of the output voltage is determined by parameter MP172. With the aid of machine parameters 78 to 85, up to 8 gear ratios may be defined. This should be commenced with the entry of the ratio with the lowest speed. The max. voltage at the input of the servo-amplifier which is programmed with machine parameter 87. The S-gating signal is provided with each gear ratio.

After output of M03 or M04, the nominal value voltage with the ramp as programmed with machine parameter 168 are output prior to the feedback-signal "auxiliary function completed". No nominal value voltage output takes place with M05.

The nominal value voltage for the spindle drive during gear change is determined with MP70. For the duration of gear change, the polarity of this voltage MP70 is switched over in accordance with parameters 124 and 125.

The control is fitted with an S-Override potentiometer. The min. and max. voltage values can be programmed with machine parameters (Nos. 86 to 89 and 184).

3.5 Emergency Stop

In/Output	PLC-Allocation	TNC 151 B/TNC 155 B Multipoint connector	TNC 151 Q/TNC 155 Q Multipoint connector PLC-Power board
Emergency Stop (Output)	–	J1/8	J3/10
Emergency stop-test (Input)	E8	J5/8	J4/4

Important functions of the TNC 151/TNC 155 are under constant supervision through self-diagnostics (electronic subassemblies such as microprocessors, the memory read/write-store, positioning systems, transducers etc.). If a fault is detected, it is indicated as a flashing display in the plain language dialogue.
On output of fault-indication, the "emergency stop" contact opens.
The "Emergency Stop" condition of TNC 151/TNC 155 can only be cancelled by switching off the mains voltage, provided that the fault has been rectified. A special mains switch may be necessary for the control only!

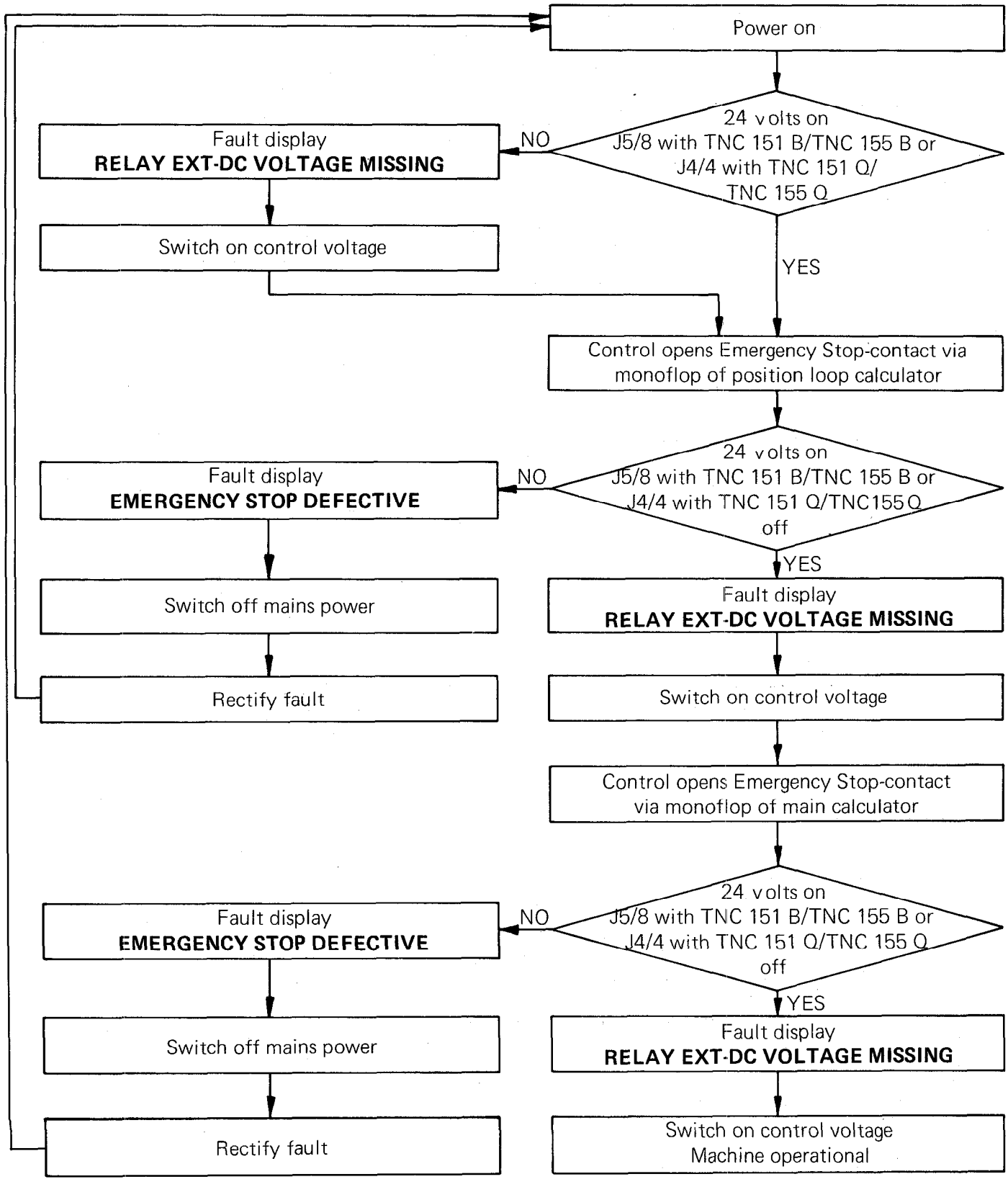
The emergency stop contact must cut-out the 24 V auxiliary voltage in the machine interface. Due to the significance of the emergency stop contact for safety reasons, its function is monitored by the control with each switch-on of power (see flow chart).

The emergency stop contact can be governed by two monoflops:

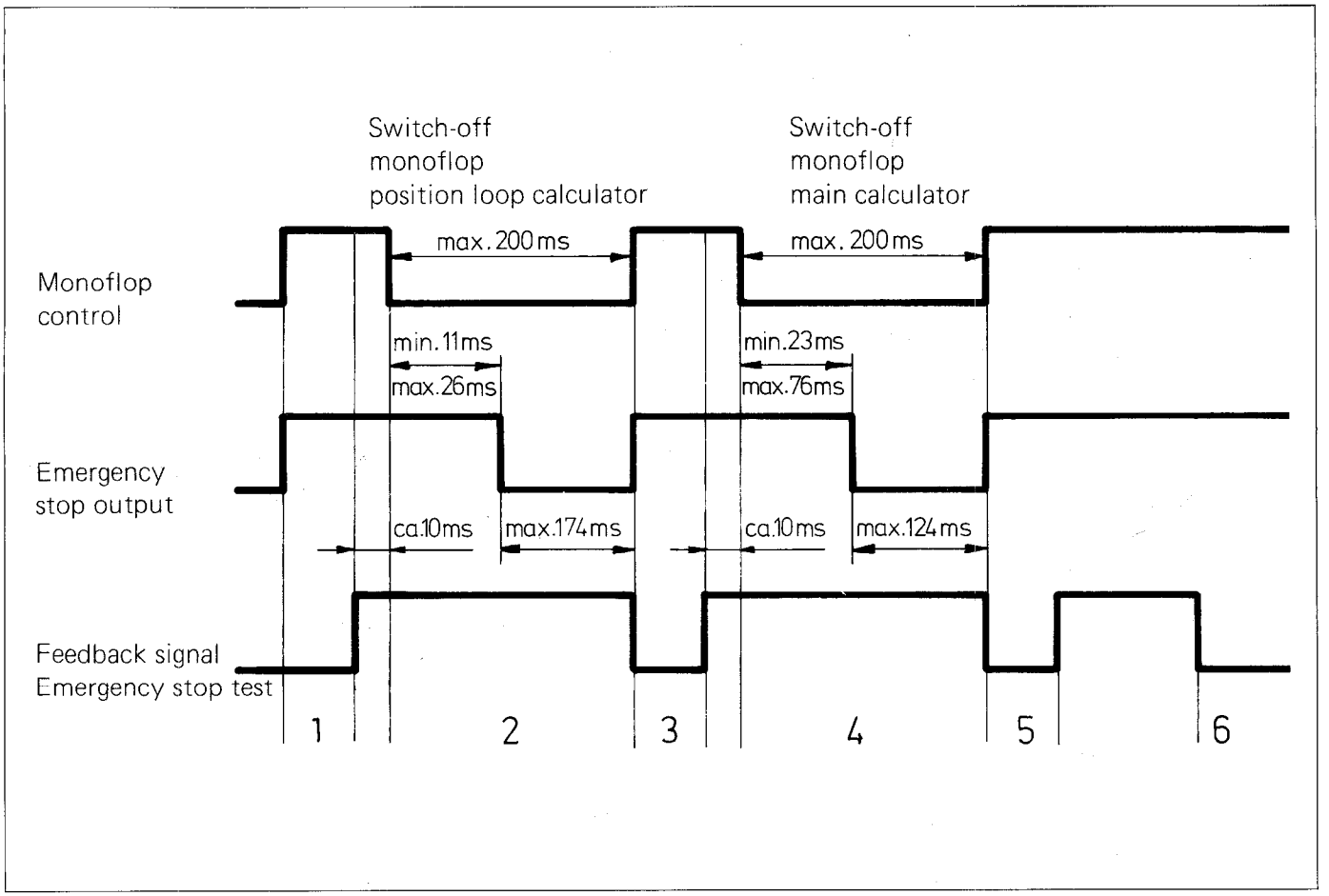
.Monoflop for the position loop calculator
.Monoflop for the main calculator

Both directions of the emergency stop circuit are checked when the control is switched on (see flow-chart).

Procedure for emergency stop supervision



Timing diagram



	Fault display
1. Wait for control voltage	**RELAY EXT-DC VOLTAGE MISSING**
2. Within 200 ms, the control voltage must cut-out, otherwise . . .	**EMERGENCY STOP DEFECTIVE**
3. Wait for control voltage	**RELAY EXT-DC VOLTAGE MISSING**
4. Within 200 ms, the control voltage must cut-out, otherwise . . .	**EMERGENCY STOP DEFECTIVE**
5. Wait for control voltage	**RELAY EXT-DC VOLTAGE MISSING**
6. If the + 24 V control voltage is cut-out by a procedure externally to the control, the TNC 151/TNC 155 displays the fault (this fault is not displayed as a flashing signal and can therefore be cancelled with the CE -key).	**EMERGENCY STOP**

Caution!
The external emergency stop is evaluated by the control as per an external stop. If the emergency stop is activated during an axis traverse, the moving axis is decelerated as with an external stop. Should the external emergency stop block the drive amplifier thus exceeding the programmed values for machine parameter 56 (position supervision, erasable) and machine parameter 57 (position supervision, emergency stop), the fault "Gross positioning error" is displayed.

3.6 Inputs "Reference end position" and "Reference pulse inhibit"

Inputs	PLC-Allocation	TNC 151 B / TNC 155 B Multipoint connector	TNC 151 Q / TNC 155 Q Multipoint connector PLC-Power board
Reference end position X	E0	J5/9	J4/12
Reference end position Y	E1	J5/10	J4/11
Reference end position Z	E2	J5/11	J4/10
Reference end position IV	E3	J5/12	J4/9
Reference pulse inhibit X	E4	J6/1	J4/8
Reference pulse inhibit Y	E5	J6/2	J4/7
Reference pulse inhibit Z	E6	J6/3	J4/6
Reference pulse inhibit IV	E7	J6/4	J4/5

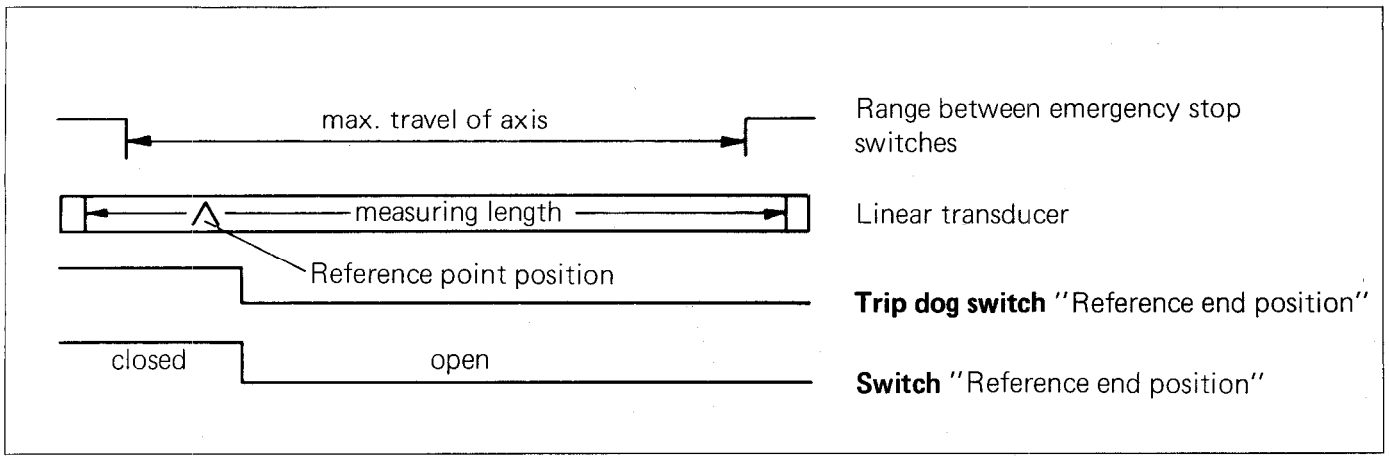
The TNC 151/TNC 155 is equipped with "software-limit switches". The permissible travels of the machine axes are programmed as machine parameters with reference to the location of the reference mark of the specific transducer. (See "Software limit switch" , section 3.7,).

After switching on the mains power of the TNC 151/TNC 155, the reference points of all three machine axes must be traversed over. After pressing the external Start-button, traversing over of the reference points is performed automatically as per the entered machine parameters.
Please note: After entry of the code number 84 159 in the MOD-mode the reference points can also be traversed over by means of the external direction buttons.

For location of reference points it is necessary for each machine axis to have a cam switch ("Reference end position"). The cam for this switch must be positioned such, that when travelling towards the cam, the switch closes shortly before reaching the reference point and remains closed whilst still traversing in the same direction until the emergency stop switch has been passed. A rotary table axis is an exception. For this axis, a permanent bridge from J5/12 (TNC 151 B/TNC 155 B) or J4/9 (TNC 151 Q/TNC 155 Q) to +24 V is required.

3.6.1 Location of "Reference end position" – trip dogs when using linear transducers

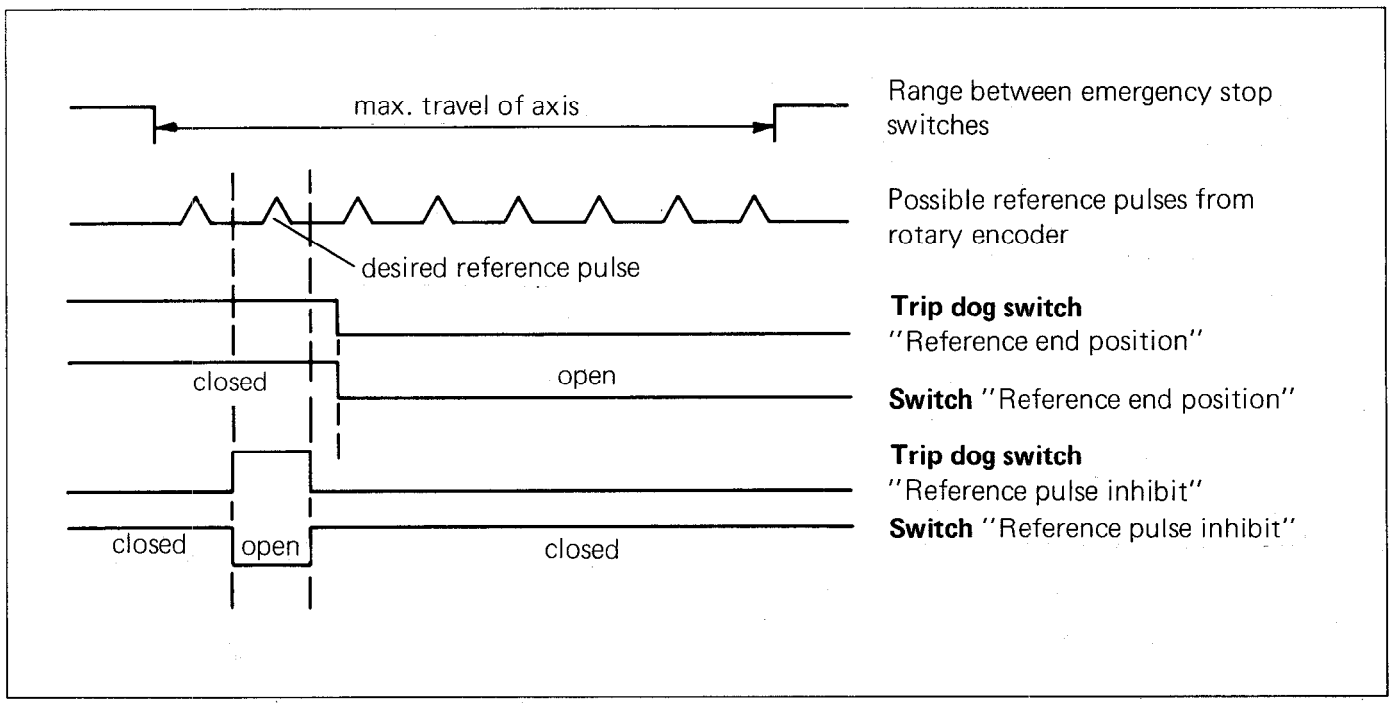
(Inputs for "Reference pulse inhibit" are not required and remain disconnected).



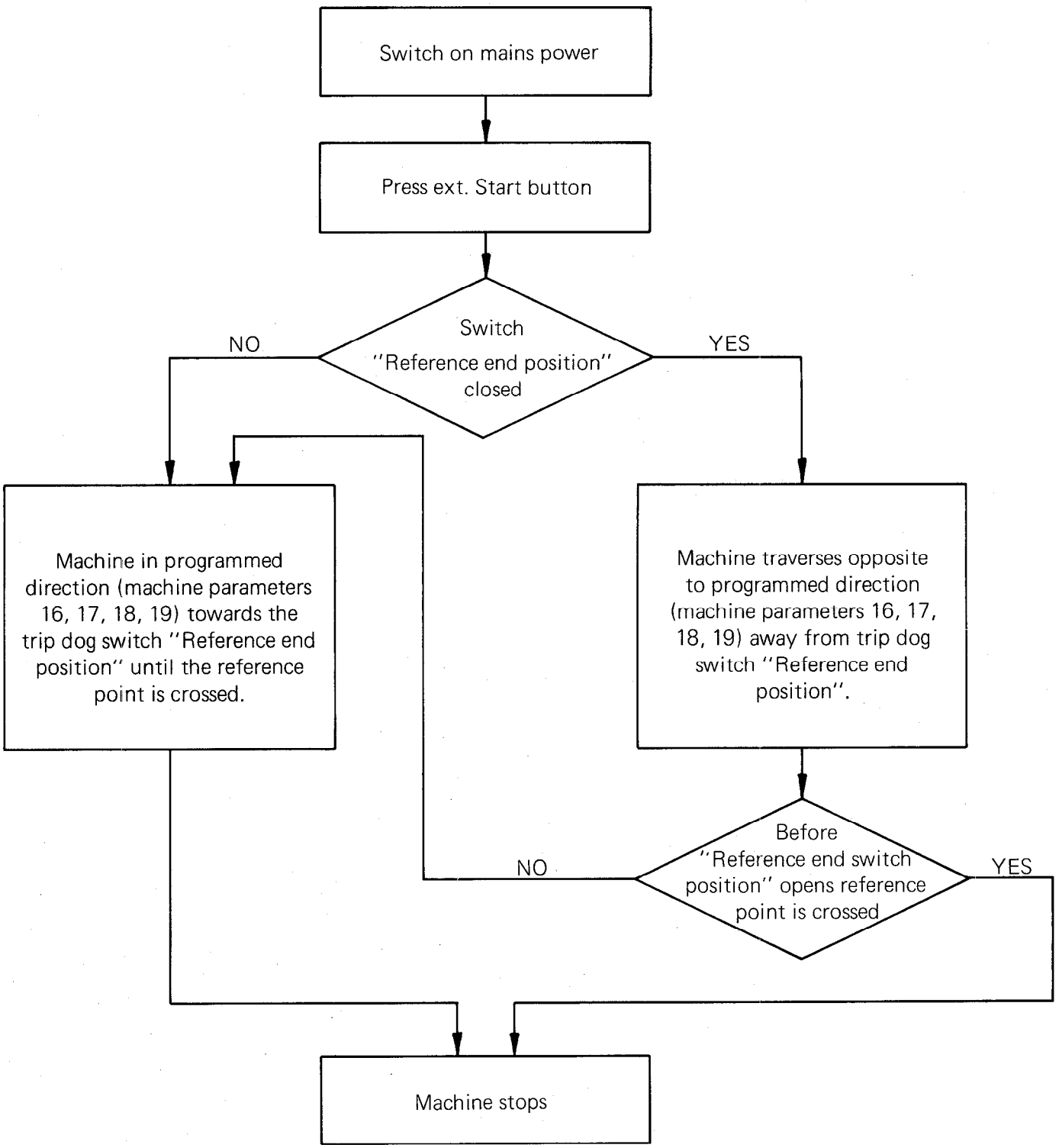
3.6.2 Location of "Reference end position" and "Reference pulse inhibit" – trip dogs when using rotary encoders

With installation of rotary encoders, an additional trip dog switch per axis is necessary for reference pulse suppression.

A rotary encoder produces one reference pulse per revolution, e.g. a spindle pitch of 10 mm will, after 10 ms of travel, transmit one reference pulse. The control will evaluate a reference pulse only when the trip dog "reference end position" is closed and trip dog "reference pulse inhibit" is open. In the example, the trip dog must be adjusted such, that the switch opens 5 mm before the desired reference pulse and closes approx. 5 mm after the reference pulse.



3.6.3 Procedure for traversing over reference points in an axis



3.6.4 Traversing over distance-coded reference marks

If the linear transducers have distance-coded reference marks, (section 2.3.2) the traversing procedure for "passing over the reference marks" is considerably short. Regardless of the position in which the machine axis may be, the TNC 151 B/TNC 155 B can compute the absolute position after passing over the second reference mark, i.e. after a maximum traverse of only 20 mm.

Caution:
When using linear transducers with distance-coded reference marks, the contact for "reference end position" is open.

Both linear transducers with conventional or distance-coded reference marks can be connected to the TNC 151 B/TNC 155 B. For instance, during machining a traverse of 20 mm can be insufficient in a tool-axis to clear the tool for the reference mark routine after a power interruption.

It is, of course, possible to pass over the reference mark with a manual traverse after entering the appropriate code number.

3.6.5 Special sequence for reference point approach

The special sequence for reference point approach is only required when several reference points are located within the machine traverses (e.g. wehn using rotary encoders as transducers) and no additional trip dogs for "reference pulse inhibit" are being used (input J6 contacts 1, 2, 3, 4 with A-Version), (inputs J4 contacts 5, 6, 7, 8 with P-version).

If machine parameter 69 is programmed with "1" the special sequence is active as follows:
Axes which are standing within the vicinity of the reference end position are backed-off from the reference end position cam before approaching the reference points. The appropriate axes are designated by the inverted display "reference point X/Y/Z/IV approach" Finally, the reference point approach procedure is carried out in the normal manner and the first reference point after the closing of the switch "reference end position" is evaluated.

3.7 "Software limit switches"

(Please note, emergency stop limit switches are still necessary on the machine!)
Via machine parameters, it is possible to program TNC 151/TNC 155 for permissible travel of the three axes, see "Software limit switch-range setting".

3.8 External direction buttons and external feed rate potentiometer

Inputs	PLC-Allocation	TNC 151 B / TNC 155 B Multipoint connector	TNC 151 Q / TNC 155 Q Multipoint connector PLC-Power board	TNC 151 Q / TNC 155 Q Multipoint connector control
X + direction	E9	J6/5	J4/3	–
X – "	E10	J6/6	J4/2	–
Y + "	E11	J6/7	J5/12	–
Y – "	E12	J6/8	J5/11	–
Z + "	E13	J6/9	J5/10	–
Z – "	E14	J6/10	J5/9	–
IV + "	E15	J6/11	J5/8	–
IV – "	E16	J6/12	J5/7	–
ext. Potentiometer + 12 V	–	J3/6	–	J3/2
" " brush-contact	–	J3/8	–	J3/3
" " 0 V	–	J3/9	–	J3/4

By applying the 24 volt control voltage via an external direction button, the relevant machine axis can be traversed in the modes: **MANUAL OPERATION, ELECTRONIC HANDWHEEL** and **PROGRAMMING AND EDITING.** The max. speed for each axis is programmed separately via machine parameters 4 to 7.
A feed rate display F is provided in the display screen. This display operates in acoordance with machine parameter 167 either after the start of one axis via display or with the same max. feed rate in all axes prior to start. Machine parameter 74 determines whether the feed rate is output in 2 % stages or variable.

Caution:
With F-display prior to start, the control sets the smallest programmed speed in MP4 to MP7 for all axes.

With a further machine parameter MP66, the input of another existing external feed rate potentiometer can be activated. If no external feed rate potentiometer is used, the feed rate for the direction buttons can be set via the override potentiometer. The rapid traverse button is active with one or several direction buttons.

If the external (START)-button is pressed while one or more direction buttons are held depressed, the traversing directions are memorised depending on the programming of machine parameter MP 68. This motion can be stopped via the external (STOP)-button.

3.9 Control "in operation"

Output	PLC-Allocation	TNC 151 B / TNC 155 B Multipoint connector	TNC 151 Q / TNC 155 Q Multipoint connector PLC-Power board
Control in operation	A4	J1/5	J1/5

During control operation, the contact is closed in modes
POSITIONING MANUAL DATA INPUT, PROGRAM RUN SINGLE BLOCK and
PROGRAM RUN FULL SEQUENCE.

3.10 Control in "Automatic" mode

Output	PLC-Allocation	TNC 151 B / TNC 155 B Multipoint connector	TNC 151 Q / TNC 155 Q Multipoint connector PLC-Power board
Mode "automatic"	A5	J1/6	J1/6

The contact "automatic mode" is open in the modes **MANUAL OPERATION, ELECTRONIC HANDWHEEL** and **PROGRAMMING AND EDITING.** It ist closed in all other modes.

3.11 Lock "Spindle on"

Output	PLC-Allocation	TNC 151 B / TNC 155 B Multipoint connector	TNC 151 Q / TNC 155 Q Multipoint connector PLC-Power board
Lock for "Spindle on"	A6	J1/7	J1/7

The relay output "Lock for spindle on", can be utilized e.g. for indicating when a tool change may take place without endangering the machine operator.
The contact is open when a programmed "spindle stop" and a programmed "program stop" are simultaneously operative.
The contact is closed in **MANUAL OPERATION** mode.

3.12 Input for electronic handwheel-servos

3.12.1 Input for electronic handwheel HR 150 or HR 250

For hand-assisted servo, a separate connector input is provided in addition to the transducer inputs. The electronic handwheel may be connected to this input via a cable of max. 20 m. In the **ELECTRONIC HANDWHEEL** mode both the handwheel and the external direction buttons are active. Pre-selection of the axis to be moved is via the axis-keys X, Y, Z or IV. Pre-selection of traversing range /R.P.M. of handwheel is via input of factors 1 — 10. Depending on the rapid traverses programmed in the machine parameters, the factors for fast traverse can be inhibited.

Factor	Traversing range (mm) per revolution	Operative from programmed rapid traverse of (mm/min)
1	10	6000
2	5	3000
3	2.5	1500
4	1.25	750
5	0.625	
6	0.312	
7	0.156	
8	0.078	
9	0.039	
10	0.019	

3.12.2 Input for dual handwheel unit HE 310

A separate input is provided for this handwheel unit. The portable unit incorporates two handwheels with axis selection buttons and emergency stop button. Simultaneous movement of the machine axes X—Y, X—Z, Y—IV or IV—Z is possible.
A terminal block is located adjacent to the flange input socket for the handwheel unit HE 310 on the rear of the unit. To activate the "EMERGENCY STOP" of the handwheel unit, the external "EMERGENCY STOP"-circuit must be connected via terminals 1 and 2.

3.13 Input for touch probe systems

The control versions TNC 151/TNC 155 are equipped with an input for the 3D-touch probe systems HEIDENHAIN 510 (triggering touch probe for infra-red transmission) or HEIDENHAIN 110 (triggering touch probe for cable transmission).
Touch probe system 110 comprises a touch probe TS 110 and adapter electronics unit APE 110. The touch probe system 510 consists of an (infra-red) touch probe TS 510 and a transmitter/receiver unit with adapter electronics unit APE 510 (dimensions and cable lengths, see operating manual TS 110, TS 510).
Both touch probe systems are used for automatic datum finding and electronic alignment of workpieces.
If the touch probe is to be used on machines with automatic toolchanger, the touch probe system 510 should be used. Either system may be used on machines with manually-operated toolchanger.

3.14 Nominal value-outputs

Output		TNC 151 B / TNC 155 B Multipoint connector	TNC 151 Q / TNC 155 Q Multipoint connector control
X	± 10 volts	J4/1	J1/1
	0 volt	J4/2	J1/2
Y	± 10 volts	J4/3	J1/3
	0 volt	J4/4	J1/4
Z	± 10 volts	J4/5	J1/5
	0 volt	J4/6	J1/6
IV	± 10 volts	J4/7	J1/7
	0 volt	J4/8	J1/8

Caution:
The 0-volt nominal value-outputs must be grounded at the control (see grounding diagrams 3.15, 3.16).

For interface wiring, shielded cables must be used for nominal value-voltages.
The maximum permissible cable length is 20 m with a cross-section of the cores 2 x 0.5 mm^2.

Ramp characteristic
When traversing, the machine traversing speed is controlled; in particular, during acceleration and deceleration.

Via machine parameters, the TNC 151/TNC 155 permits programming of two different ramp characteristics (each ramp identical for all axes):

.If machine parameter 60 is programmed with "0", a "square root characteristic" is formed. This ramp characteristic enables the machine to operate with a very small trailing error.
.If machine parameter 60 is programmed with "1", a ramp characteristic with a "kink" is provided. The control operates with this characteristic in trailing (lag) operation.

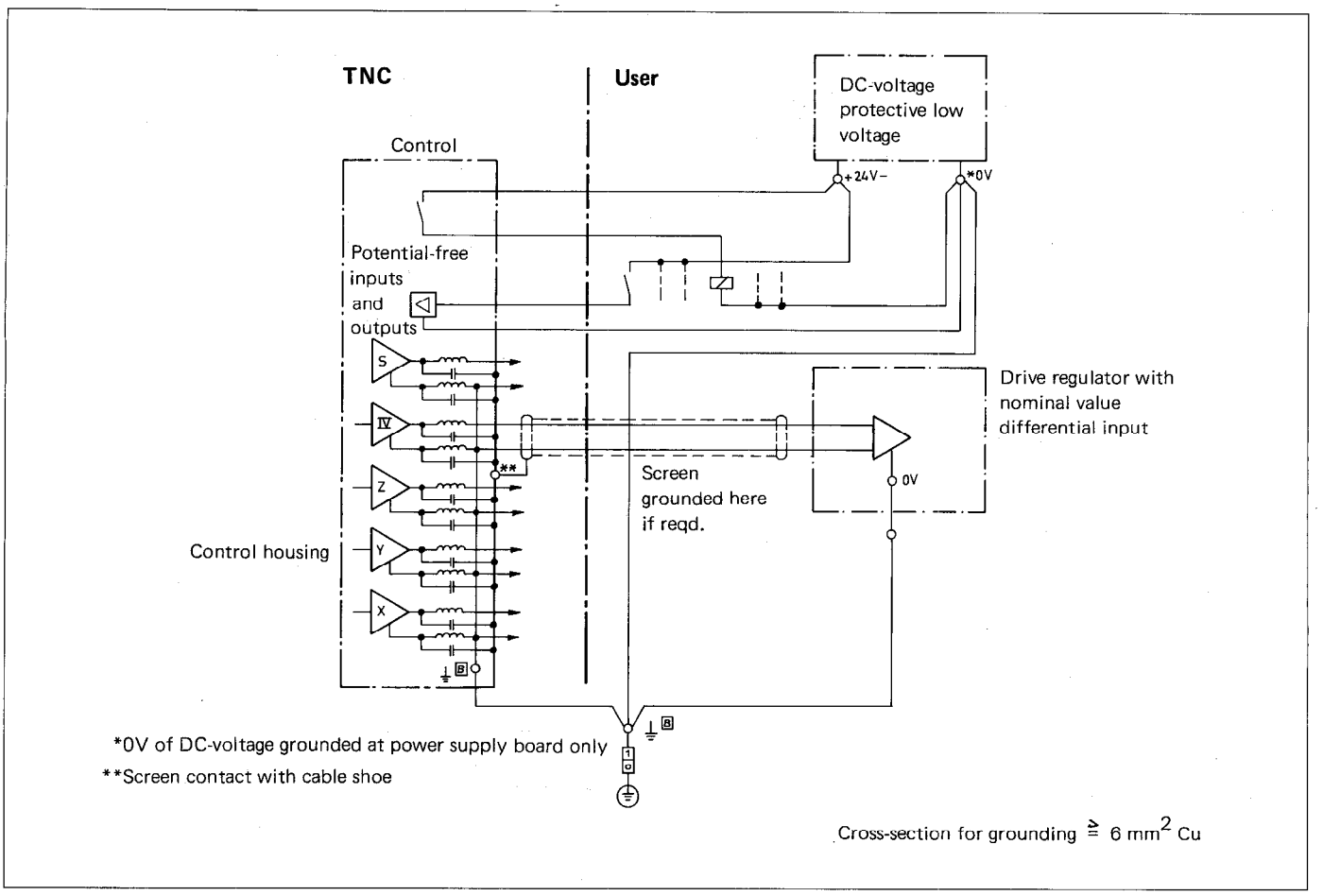
Further information is provided in the section "Machine Parameter".

The "square root characteristic" is selected when high contouring accuracy with high speed is required or despite a fixed K_V-value, the machine acceleration is influenced via MP 54.

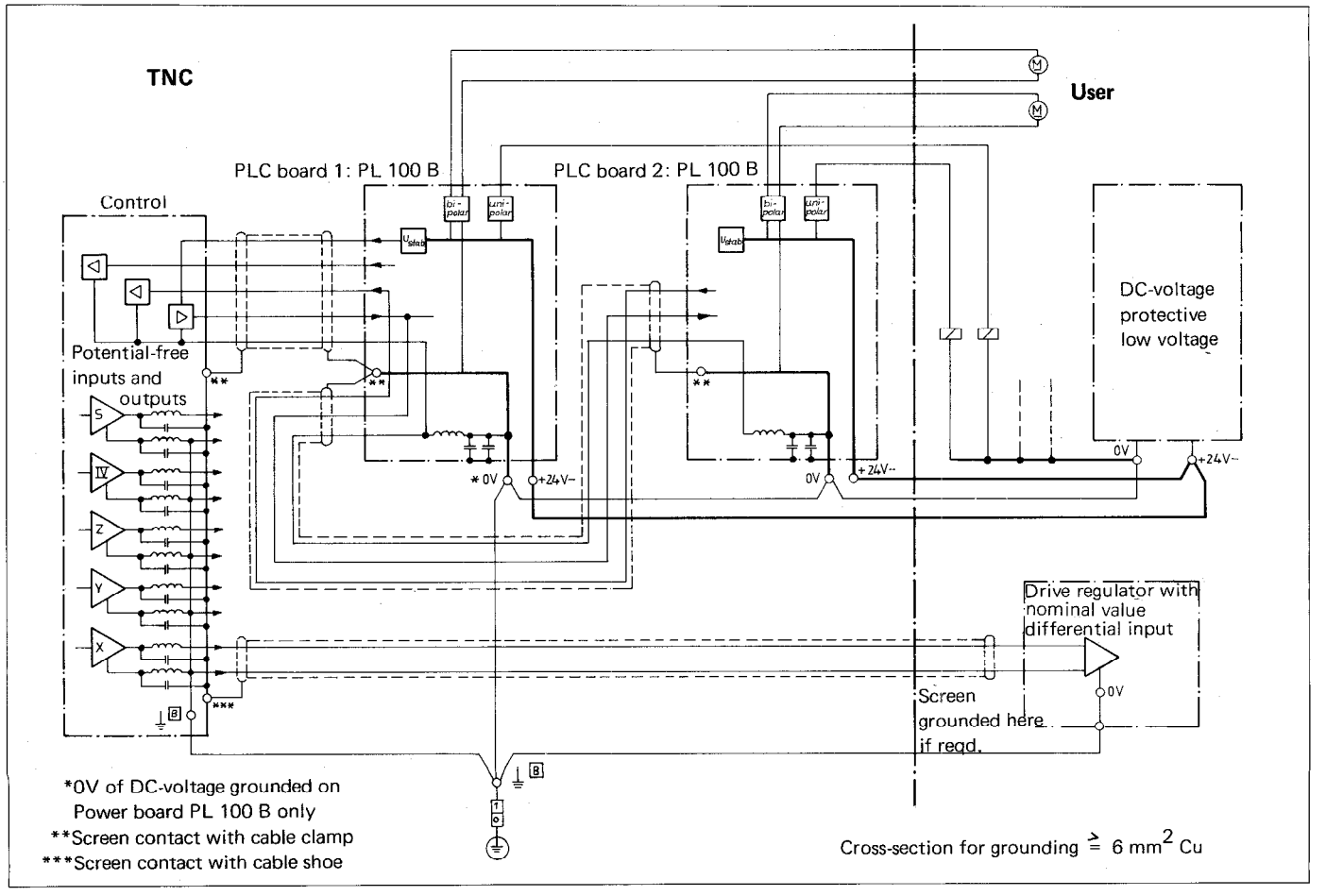
The "linear characteristic" is selected if the contouring accuracy is insignificant at high speed and time-saving acceleration procedures are required. With this, the max. acceleration of the machine is also limited via MP 54.

In the "manual", "programming" and "electronic handwheel"-modes, the TNC 151/TNC 155 always operates with the linear characteristic, i.e. this characteristic must be adjusted even if operation takes place in the other modes using the "square root characteristic".

3.15 Wiring and grounding diagram TNC 151 B/TNC 155 B



3.16 Wiring and grounding diagram TNC 151 Q/TNC 155 Q



4. External data input/output via the RS-232-C (V.24) data interface

During development of the TNC 151/TNC 155, great emphasis was given to shop floor-programming; the operator is prompted by a plain language dialogue.
TNC 151/TNC 155 can also be programmed in standard G-Codes in ISO-format which is an advantage for external programming.

For data transmission, the TNC 151 B/TNC 155 B can be switched to the following 3 operating modes via the MOD-key:

ME – For connection of the HEIDENHAIN magnetic tape units ME 101/ME 102.
Data format and the Baud rate 2400 have been adapted to the ME regardless of the programmed values

FE – For connection of the HEIDENHAIN floppy disc unit FE 401.
Data transmission, such as read-in, read-out or transfer blockwise is performed via a special protocol for data protection.

Regardless of the entered values in the machine parameters for the RS-232-C (V.24) interface, data transmission to the HEIDENHAIN peripheral units has been automatically adapted.

EXT – For adaptation of other peripheral units. The interface for data transmission is adapted via machine parameters and the Baud rate is freely selectable.

Peripherals for the EXT-mode can be:

Tape puncher or reader
Printer or matrix printer for graphics print-out
Bulk memory or programming stations for transfer blockwise or external programming and program storage.

If a peripheral unit with another Baud rate is to be connected to the TNC 151/TNC 155 (without an intermediate ME 101 or ME 102), the Baud rate of the TNC 151/TNC 155 will have to be re-programmed in the sequence as follows:

Select operating mode by pressing MOD .

Press ↓ or MOD several times until the programmed Baud rate is displayed.

Enter new value for Baud rate (if different) (possible values: 110, 150, 300, 600, 1200, 2400, 4800, 9600 Baud).

Press ENT for entry into memory.

Graphics output onto a printer
When printing-out graphics, the control automatically switches to the operating mode "EXT" if "ME" or "FE"-operation has been set via the MOD-function.

Control via XON/XOFF-protocol
When transmitting data with the characters ACK/NAK, DC1 is no longer transmitted in "handshake operation" (MP 222).

The following points should be observed when programming externally

a) A program must begin with the characters CR (Carriage Return) and LF (Line Feed). Both characters must precede the first block otherwise they will be overread when entering via tape.

b) Every program block must finish with LF or FF !

c) The end of the last block must finish with LF, FF and ETX (End of text) or instead of ETX, the character entered with machine parameter 71

d) Every block must contain all information that is requested by the dialogue display when programming.

e) The number of empty spaces between characters is optional.

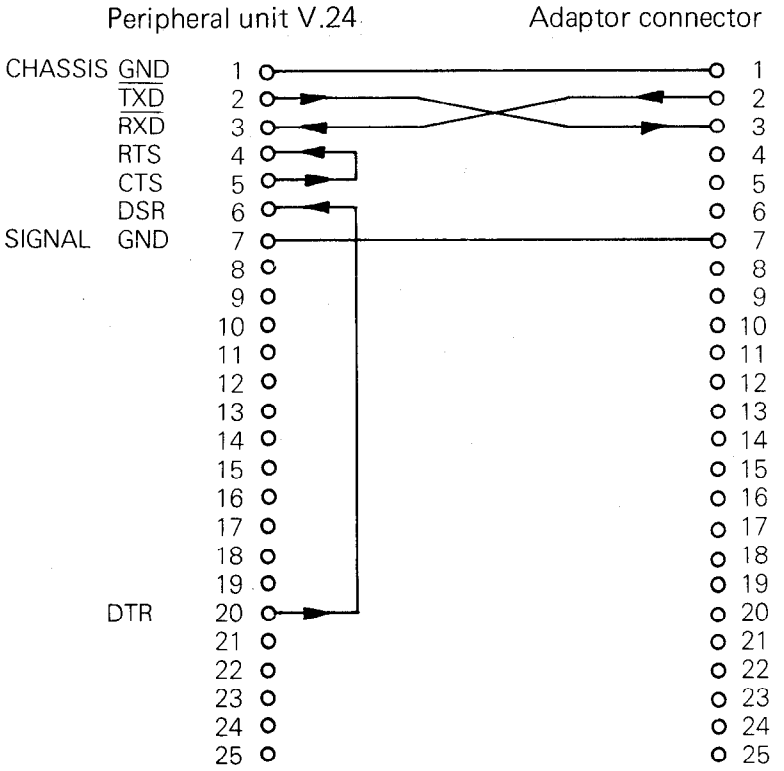
f) On peripheral units, Even Parity-bit-check must be set.

g) A block contains maximum 64 characters.

h) With the aid of the characters "*" and ";" comments can be overread when reading-in to the TNC. The character prefixes the comment after an NC block or at the beginning of each line – e.g. also before the program. A comment is therefore ended with every LF + CR.

A compilation of block formats for TNC 151/TNC 155 is available from HEIDENHAIN.

The following wiring diagram is recommended for connection of a peripheral unit (e.g. printer with paper tape reader/puncher).



Key to signals:

$\overline{\text{TXD}}$	Transmit data
$\overline{\text{RXD}}$	Receive data
RTS	Request to send
CTS	Clear to send
DSR	Data set ready
DTR	Terminal ready

This is set after cancellation of the error message "power interrupted" (as of software version 08)

The peripheral unit must be set to Even Parity

5. Program storage

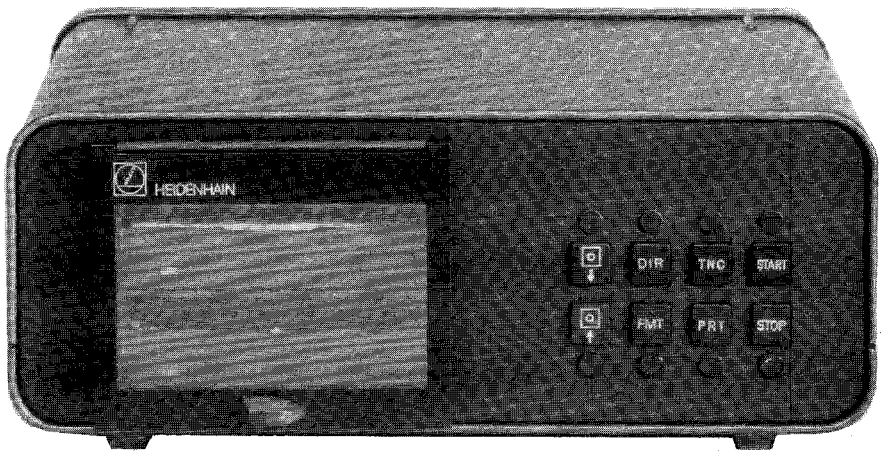
5.1 Floppy disc unit FE 401

FE 401 — portable unit for storage and transfer of long programs which have been compiled at an external programming station, to the TNC.

With very long programs, which exceed the memory capacity of the control, "transfer blockwise" is possible with simultaneous program run.

A further advantage against the magnetic tape units ME 101/ME 102 is the greater storage capacity. For example, up to 256 programs with a total of approx. 25 000 program blocks can be stored. This corresponds to a storage capacity of approx. 790 kBytes.

Moreover, the FE 401 is equipped with 2 disc drives for the copying of disc information.



FE 401

5.2 HEIDENHAIN ME 101 / ME 102 Magnetic tape cassette units

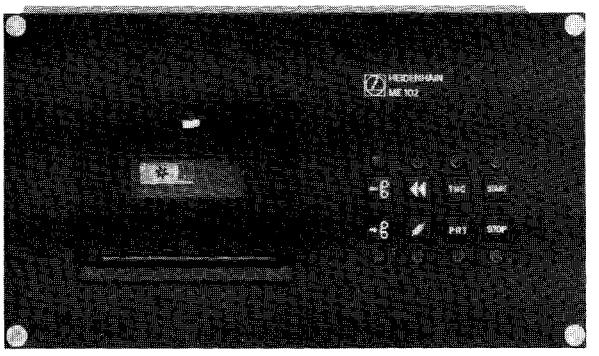
HEIDENHAIN offers special magnetic tape for external data storage.

ME 101 Portable unit for alternate use on several machines.

ME 102 Pendant-type unit for permanent machine mounting.

The magnetic tape units ME 101 and ME 102 are equipped with two data in/output sockets. In addition to the control, normal commercially available peripheral units can also be connected via the RS-232-C (V.24) output of the ME (Connection marked PRT).
The data transmission rate between control and ME is set at 2400 Baud. The transmission rate between the ME and a peripheral unit can be matched with the aid of a stepping switch (110, 150, 300, 600, 1200, 2400, 4800, 9600 Baud).
Detailed information concerning the use of the magnetic tape units can be obtained from the operating manual ME 101 and ME 102.

ME 101

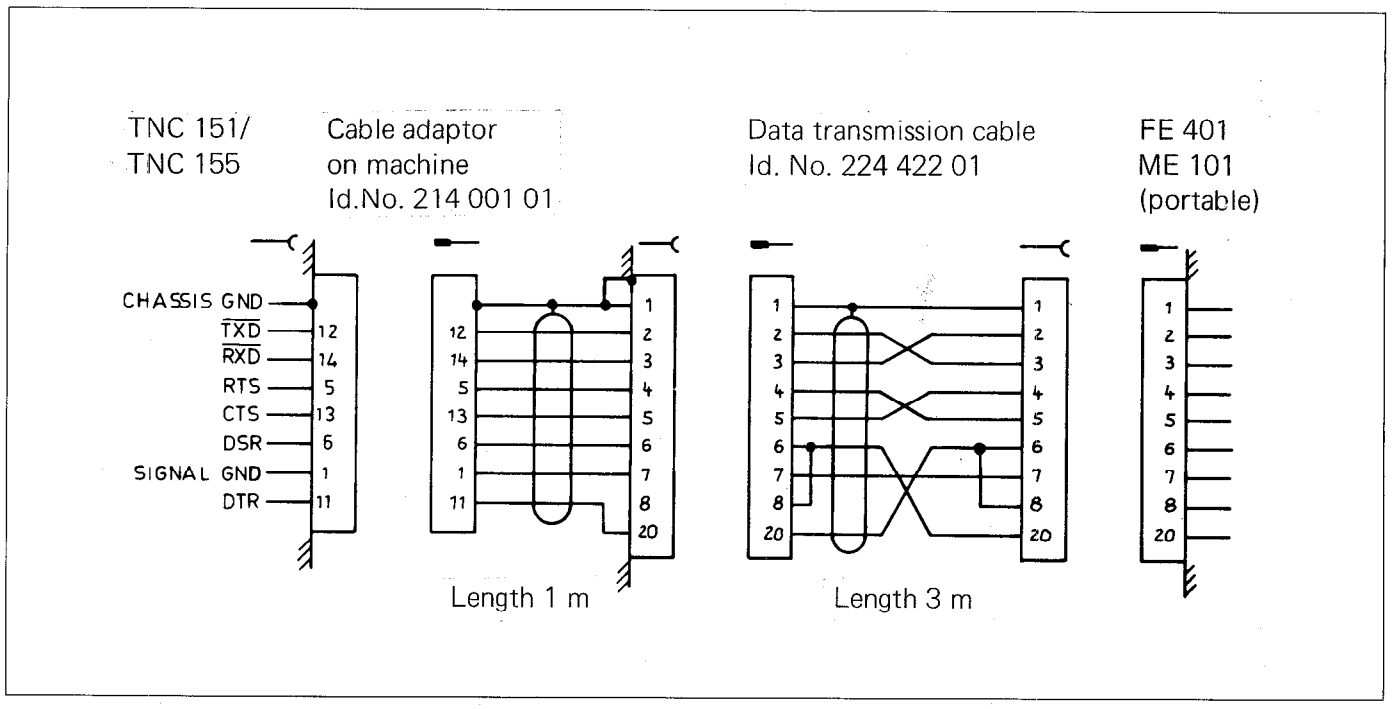


ME 102

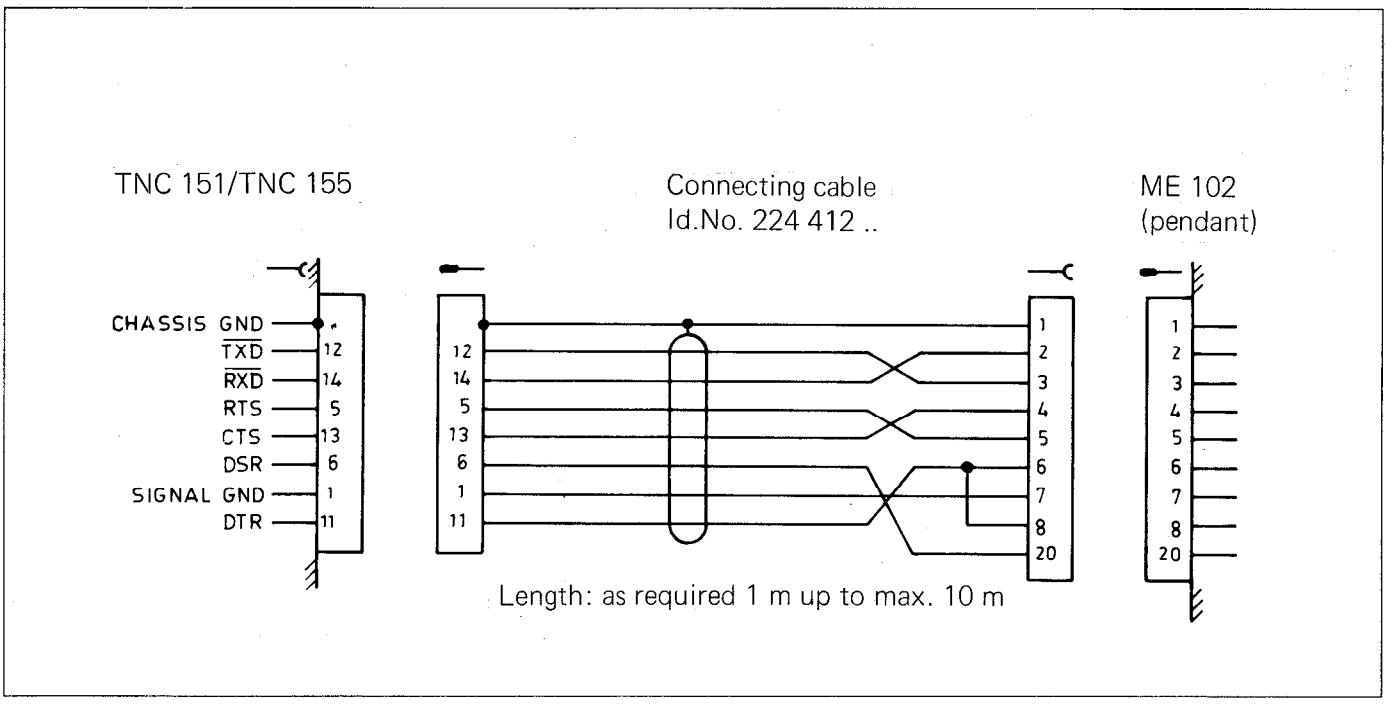
5.3 Connection cables

HEIDENHAIN supplies the following cables:

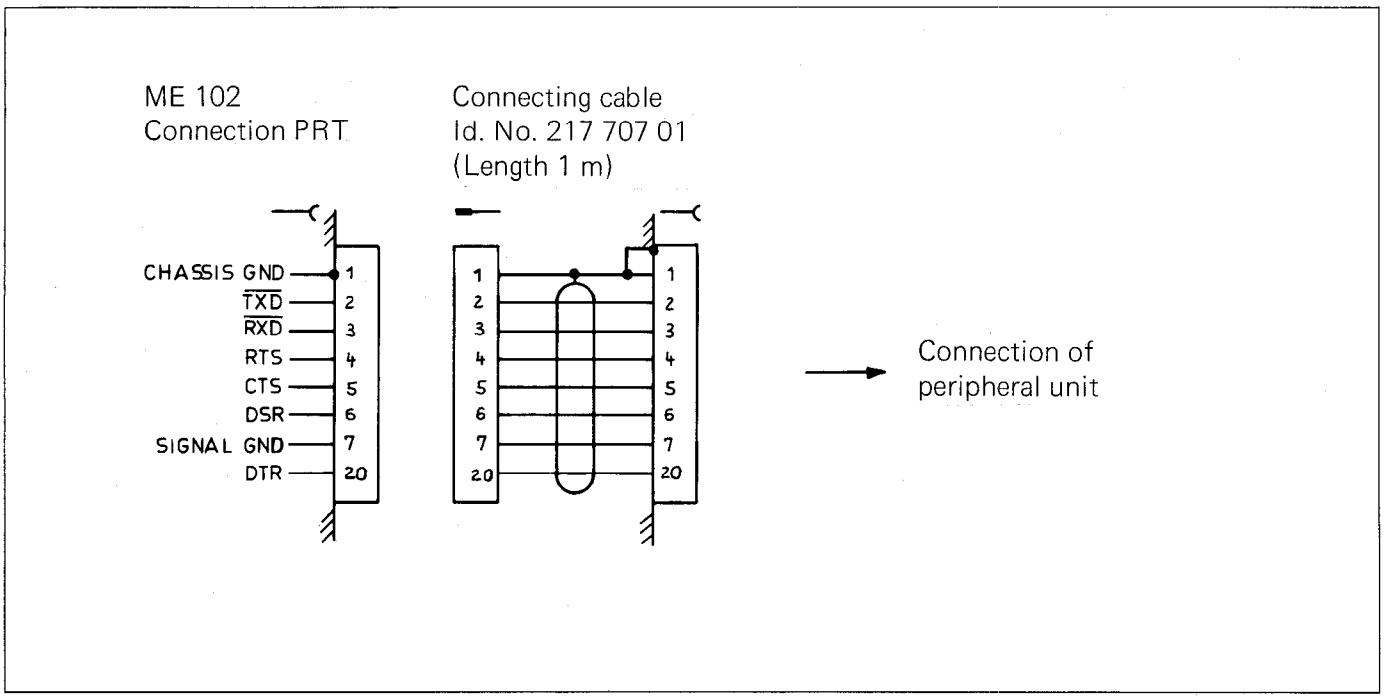
a) Cable adaptor for attachement to the housing in which the TNC 151/TNC 155 is mounted / data transmission cable for connection to **ME 101 or FE 401.**



b) Connecting cable: **ME 102** direct to the TNC.



c) Connecting cable for extension of the V.24 connection of the ME 102 unit (pendant) into the housing in which the ME 102 is mounted (operating panel)



6. Machine parameters / User-parameters

Machine parameters can be split into the following groups:

Machine-specific parameters

For programming of e.g. rapid feeds, spindle speeds. Also for axis designation, counting direction and linear compensation.

Machine parameters for optimization of the positioning loops

For optimising e.g. the trailing error (lag) and positioning behaviour.

Machine parameters for the integral PLC

For activation of certain PLC-program sections or macros. It is also possible to initiate special user-cycles. Nominal values for a PLC-positioning routine can be stored. Further machine parameters permit a central tool memory or the control of a toolchanger.

Machine parameters for adaptation of a data interface

In the EXT-mode of the RS-232-C (V.24)-interface, data formats, control characters and transmission protocols for peripheral units can be programmed.

Machine parameters for electronic handwheels and 3D-touch probe systems

An entry value corresponding to the connected handwheel version and a limitation of the sensitivity is programmed. This prevents the influence of axis movement in the event of shocks.
For the 3D-touch probe system parameters such as the safety clearance, measuring feed and traverse limitation are entered.

Machine parameters which affect NC-programming

Such parameters can be made accessible to the user as user-parameters. Selection and, if necessary, a plain language designation via the PLC-program is made by the machine tool builder.
These can be parameters for:

.Selection of the dialogue language
.Selection of the programming language
.Projection for graphics display in 3 planes
.For the control as a programming station with an inactive machine
.Overstep for pocket milling
.Scaling factor effective in 2 or 3 axes
.Adaptation of the RS-232-C (V.24)-interface in the "EXT"-mode for data transmission units.

Initial commissioning procedure

The following procedure is applicable to machine commissioning:

1) Determination of the parameters of the first group (see section 6.1)
2) Filling out of complete parameter list in the sequence demanded by the TNC 151/TNC 155 (see section 9)
3) Entry of parameters into the control (see section 8.1.3)
4) Optimisation of temporary parameters as per check-list (see section 8)

Erasing machine parameters

Code number 531210
With this, machine parameters can be erased easily. Moreover, the erasable markers M1000 to M2000 are reset.

User-parameters
Up to 16 machine parameters can be made accessible to the machine operator via the MOD-function. These user-parameters can be assigned by the machine tool builder at his own discretion.

Assignment of user-parameters
If a machine parameter is to be made accessible to the user, the lamp beneath the [P] -key must be on when programming the parameters (if necessary press [P] -key). After pressing the [ENT] key, the parameter is suffixed by the letter P.

Example:
MP 217 0 P

If one attempts to program more than 16 user parameters, the following error message is displayed:

TOO MANY USER PARAMETERS.

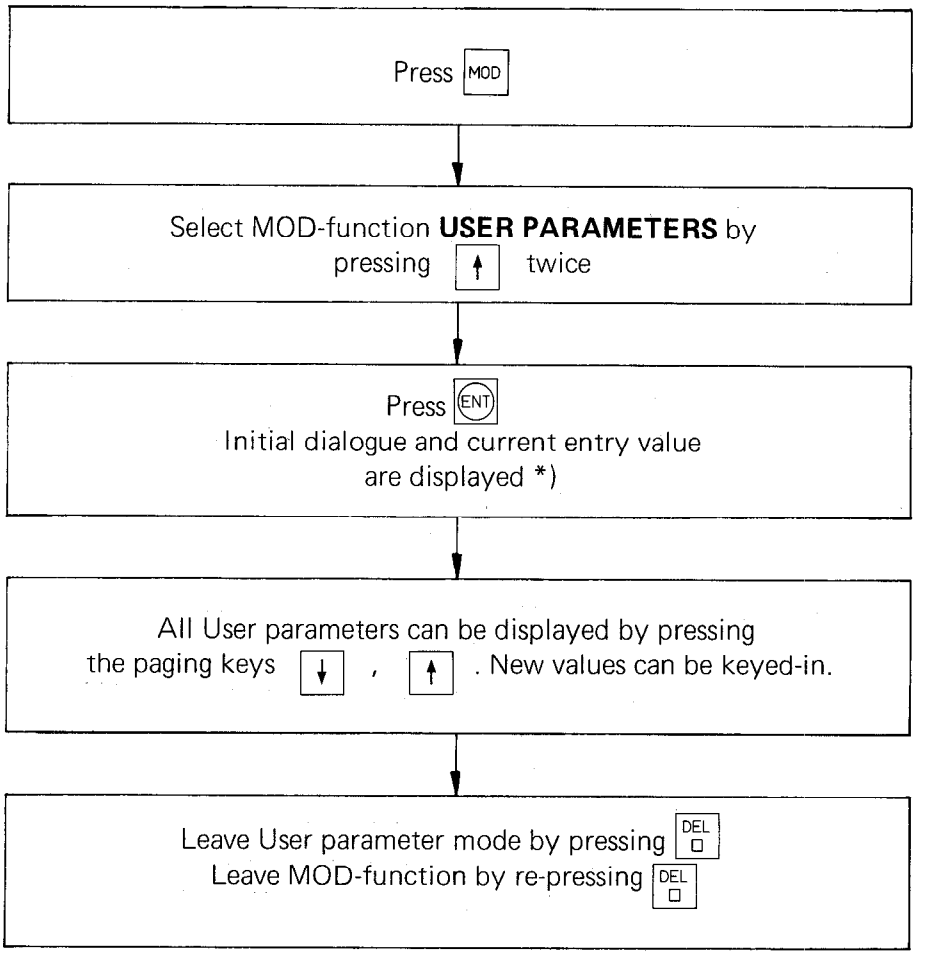
The following dialogue texts ar contained in the PLC-EPROM for the dialogue display of user parameters.

Dialog-display	Machine parameter
USER PAR. 1	Machine parameter with lowest parameter number
USER PAR. 2 USER PAR. 3 USER PAR. 4 USER PAR. 5 USER PAR. 6 USER PAR. 7 USER PAR. 8 USER PAR. 9 USER PAR. 10 USER PAR. 11 USER PAR. 12 USER PAR. 13 USER PAR. 14 USER PAR. 15	Machine parameters allocated according to increasing parameter numbers
USER PAR. 16	Machine parameter with the highest parameter number

Any dialogue text with a max. of 16 characters may be displayed instead of USER PAR. 1 etc. This requires an amendment of the standard PLC-EPROM which can only be performed at the HEIDENHAIN factory in Traunreut, West Germany. Please contact your local HEIDENHAIN-agency or our factory in Traunreut, West Germany.

Please note:
The dialogue texts USER PAR. 1 to USER PAR. 16 are stored in the EPROM under the address of the PLC: ERROR 84 to PLC: ERROR 99. If, however, error messages are required instead of dialogues, the corresponding dialogue texts within the PLC-EPROM must be revised (Address of USER PAR. 1 = Address of PLC: ERROR 99 etc.).
If special dialogues for user-parameters have been set within the customized PLC-program, the correlation between texts and parameter Nos. is shifted if further user-parameters are inserted with the neutral designation USER-PARAMETER.

Call-up of User-parameters via the MOD-function



*) If the machine tool builder has not allocated a dialogue, the display will show USER PAR. 1.

6.1 Machine parameters determined by the machine design or freely determined parameters

6.1.1 Selection of controlled axes, position display axes and/or inactive axes

Function	Parameter No.	Possible entry values	Selected entry values
Selection of inhibited axes for controlled operation	72	Following axes are inhibited: 0 ≙ none 1 ≙ X 2 ≙ Y 3 ≙ X, Y 4 ≙ Z 5 ≙ X, Z 6 ≙ Y, Z 7 ≙ X, Y, Z 8 ≙ IV 9 ≙ X, IV 10 ≙ Y, IV 11 ≙ X, Y, IV 12 ≙ Z, IV 13 ≙ X, Z, IV 14 ≙ Y, Z, IV 15 ≙ X, Y, Z, IV	

With the aid of parameter 72, one or more axes of the 4-axis TNC 151/TNC 155 may be inhibited for controlled operation.

Reference signal evaluation for inhibited axes	75	0 ≙ inactive 1 ≙ active	

With parameter 75, reference signal evaluation for datum reproduction is determined as active or inactive for the inhibited axes.

– Display and transducer supervision for inhibited axes either active or inactive. – Switch-off of transducer Supervision of uninhibited or inhibited axes. The display remains active.	76	0 ≙ inactive 1 ≙ active with inhibited axes: (MP 72, MP 237) 0 ≙ inactive 1 ≙ active with uninhibited or inhibited axes: 2 ≙ X without supervision, Display active 4 ≙ Y without supervision, Display active 8 ≙ Z without supervision, Display active 16 ≙ IV without supervision, Display active 32 ≙ V without supervision, Display active with several non-supervised axes, add figures to entry value.	

Axis designation for axis IV	90	0 ≙ A 1 ≙ B 2 ≙ C 3 ≙ U 4 ≙ V 5 ≙ W	

The axis designation for axis IV is determined with parameter 90. The selection of designation A, B or C determines whether the axis is to be used for control or display of a rotary axis. In this case, the axis is relieved of mm/inch switchover and can operate with another in linear interpolation without tool radius compensation. If U, V or W are selected, the axis is then programmed as an additional linear axis, it can also be used with mm/inch and can operate with one of the other axes in linear or circular interpolation with tool radius compensation.

6.1.2 Machine parameters for feed rates

Function		Parameter No.	Possible entry values	Selected entry values
Rapid traverse	X	0	180 . . . 15 999 [mm/min]	
	Y	1		
	Z	2		
	IV	3	(Axis IV: Angular degrees/min with axis designation A, B or C)	
Manual feed	X	4		
	Y	5		
	Z	6		
	IV	7		

Parameter No. 0 to 3
Rapid traverses for axes are always programmed in mm/min. If axis IV is programmed as a rotary axis, entry for rapid traverse is in degrees/min. (each rapid traverse must be adjusted with 9 V at the servo-amplifier input).

Parameter No. 4 to 7
Manual feeds can be limited independent of the rapid traverses in parameters 0 to 3.

Display of current feed rate before starting in **MANUAL OPERATION**	167	0 ≙ on 1 ≙ off		

Parameter 167 determines whether the current feed rate is displayed before or after actuation of the direction buttons and machine start in the **MANUAL OPERATION** mode.

If "1" i.e. feed rate display before start, is programmed, the feed rates for manual feed (parameter 4 to 7) must have the same value or the control moves the axes at the lowest feed rate of the abovementioned parameters.

External feed rate potentiometer	66	0 ≙ internal potentiometer for override and manual feed rate 1 ≙ external potentiometer for override and manual feed rate 2 ≙ internal potentiometer for override and manual feed rate external potentiometer for manual feed rate	
Override active with actuation of rapid traverse button Feed rate display in 2 % stages or variable	74	see table on following page	
Memory function for direction buttons	68	0 ≙ off 1 ≙ on	

With machine parameter 68 the memory function of the direction buttons can be switched on or off via the ext. start and stop buttons.

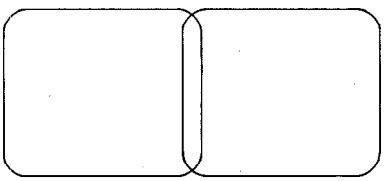
Minimum for feed rate override with tapping	182	0 . . . 150 [%]	
Maximum for feed rate override with tapping	183		

With these parameters, the range of the feed rate override for the tapping cycle can be limited.

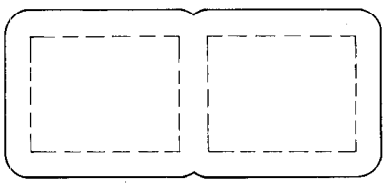
6.1.3 Machine parameters for variable contour pockets

Function	Parameter No.	Entry value
Machining of variable contour pocket Direction for pre-milling of contour	241	0 ≙ Pre-milling of contour Pockets counter-clockwise, Islands clockwise 1 ≙ Pre-milling of contour Pockets clockwise, Islands counter-clockwise
Sequence: clearing and pre-milling of contour		add to current entry value: + 2 ≙ clearing prior to pre-milling of contour otherwise pre-milling first.
Combining of contours		+ 4 ≙ uncorrected contours are combined

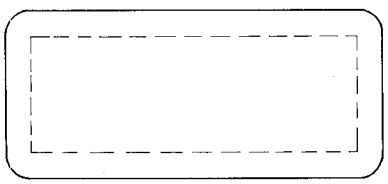
Combining corrected or uncorrected contours
Depending on the entry value contours are combined differently.



Example:
Two pockets intersect each other lightly.



With cycles for the milling of pockets with variable contours, the corrected contours are combined. The control clears the pockets separately, since the corrected contours (the paths of the tool-centrepoint) do not intersect. Material remains on the inner corners.



With cycles for the milling of pockets with variable contours, the uncorrected contours are combined. The control clears the pockets together, since the uncorrected contours are combined and the uncorrected contours intersect. No material remains at the inner corners. In order to combine the uncorrected contours, the control needs more calculating time than when combining corrected contours.

Note:
There may be cases, above all in Q-parameter programs, in which the combining of uncorrected contours can lead to undesirable results.

Note:
If the milling of the channel takes place after roughing out (contour pre-milling), this is only possible with a double flute mill. Roughing out does not commence at the pilot drill locations.

6.1.4 Machine parameters for reference mark approach

Parameter		Parameter No.	Possible entry values	Selected entry values
Velocity when approaching reference points	X	8	80 . . . 15 999 [mm/min] (Axis IV: Angular degrees/min with axis designation A, B or C)	
	Y	9		
	Z	10		
	IV	11		

With these parameters the required velocity for approaching the reference points can be selected. The approach speed and direction have an influence on the accuracy of the reference signal evaluation.

Axis sequence for approaching reference points	59	0	≙	X	Y	Z	IV
		1	≙	X	Y	IV	Z
		2	≙	X	Z	Y	IV
		3	≙	X	Z	IV	Y
		4	≙	X	IV	Y	Z
		5	≙	X	IV	Z	Y
		6	≙	Y	X	Z	IV
		7	≙	Y	X	IV	Z
		8	≙	Y	Z	X	IV
		9	≙	Y	Z	IV	X
		10	≙	Y	IV	X	Z
		11	≙	Y	IV	Z	X
		12	≙	Z	X	Y	IV
		13	≙	Z	X	IV	Y
		14	≙	Z	Y	X	IV
		15	≙	Z	Y	IV	X
		16	≙	Z	IV	X	Y
		17	≙	Z	IV	Y	X
		18	≙	IV	X	Y	Z
		19	≙	IV	X	Z	Y
		20	≙	IV	Y	X	Z
		21	≙	IV	Y	Z	X
		22	≙	IV	Z	X	Y
		23	≙	IV	Z	Y	X

With parameter 59 the axis sequence for reference point approach is determined.
Care should be taken that the tool axis is traversed away from the workpiece first.

Traversing direction for reference point approach	X	16	0	≙	plus-direction
	Y	17	1	≙	minus-direction
	Z	18			
	IV	19			

With these parameters, the traversing direction when approaching the reference points is determined in relationship to the "reference end position" dog. Depending on the location of the reference point on the scale, the dog for the "reference end position" can be fixed at the end of the axis in the plus or minus direction in relationship to the counting directions and in accordance with the "right-hand rule".

Reference mark spacing for transducers with distance-coded reference marks	X	242	0 . . . 65 535 0 ≙ without distance coded reference marks 1 000 ≙ LS 107 C (multiplicator for 20 µm)	
	Y	243		
	Z	244		
	IV	245		

Function	Parameter No.	Possible entry values	Selected entry values
Special sequence for reference point approach	69	0 ≙ off 1 ≙ on	

6.1.5 Machine parameters for output of spindle speeds

Function	Parameter No.	Possible entry values	Selected entry values
Output of spindle speed either coded or as S-analogue voltage	62	0 ≙ No spindle speed output 1 ≙ Coded output only when speed changes 2 ≙ Coded output of all speeds 3 ≙ Output of S-Analogue voltage, gear switch signal only when ratio changes 4 ≙ Output of S-Analogue voltage, gear switch signal with every tool call 5 ≙ Output of S-Analogue voltage without gear switch signal	

With parameter 62 it can be determined whether rpm-commands are output as coded switching commands (2-decade BCD) or as an S-Analogue voltage with up to 8 switching signals for gear change or whether no output should take place.

Limitation rpm-code	63	01991	

With parameter 63 the rpm-limitation is programmed (minimum and maximum rpm and step size) (see page 18).

Please note:
If operation is with S-Analogue voltage output, parameter 63 is to be programmed with 01991.

Function		Parameter No.	Possible entry values	Selected entry values
RPM-range for max. 8 gear ratios with S-Analogue voltage output				
Gear ratio	1	78	0 . . . 99 999 [rpm]	
	2	79		
	3	80		
	4	81		
	5	82		
	6	83		
	7	84		
	8	85		

With these parameters, the definition of the gear stage is via the output of an S-Analogue voltage. The highest possible rpm (with S-Override 100 %) is programmed for each gear stage. The gear stage with the lowest possible rpm is programmed with parameter 78 etc. If less than 8 gear stages are programmed, the unused parameters for gear stages are programmed with "0".

Spindle speeds above and below the pre-programmed rpm

If within an rpm range of a gear ratio a certain spindle speed is not reached or is exceeded, a marker M2504 can be set or reset as of software level 03.
New marker M2504
log. state 1 comparator speed not reached
log. state 0 comparator speed exceeded
If this type of recognition is required, 4 gear ratios are available instead of 8.

Machine parameters
MP78 – MP81 Spindle speed for 4 gear ratios
MP82 – MP85 new function here, the comparator speeds are entered for the 4 gear ratios.

The comparator speed in MP82 is of course, smaller than the maximum speed of the gear ratio corresponding to MP78 (override 100 %).
From this relationship the control is able to recognise if the display of a reduced or excessive speed is required with M2504.
If the entry values of MP78 to MP85 are increasing values, 8 gear ratios are correspondingly programmed and the described function is inactive.

S-Analogue voltage with S-Override 100 %	86	0 . . . 9.999 [V]	

Parameter No. 86 sets the analogue voltage output for gear stages with override = 100 %.

S-Analogue voltage with S-Override at max. output voltage	87	0 . . . 9.999 [V]	

Parameter No. 87 sets the absolute max. of the analogue voltage output for the gear stages.

Function	Parameter No.	Possible entry values	Selected entry values
Limitation of S-Override maximum minimum	 88 89	0 . . . 150 [%]	

With these parameters, the limitation for the S-Override potentiometer is programmed (No. 88 maximum, No. 89 minimum). After reaching the programmed limitation – either max. or min., the S-Analogue voltage remains constant.

Minimum voltage for S-Analogue output	184	0 . . . 9.999 [V]	

With parameter No. 84 the minimum voltage for S-Analogue output can be programmed. This minimum voltage is the permissible minimum value which will not damage the spindle drive.

Please note:
This limitation is ineffective with an activated spindle orientation option.

Nominal value voltage for spindle drive during gear change	70	0 . . . 9.999 [V]	

Parameter No. 70 permits the programming of the oscillating voltage output during gear change.

Ramp gradient for S-Analogue	168	0 . . . 1.999 [V/ms]	

With parameter 168 the ascending flank for S-Analogue voltage output can be programmed.

Polarity S-Analogue voltage	172	0 ≙ M03: positive voltage M04: negative voltage 1 ≙ M03: negative voltage M04: positive voltage 2 ≙ M03 and M04: positive voltage 3 ≙ M03 and M04: negative voltage	
Programming of rpm S = 0 permitted	190	0 ≙ S = 0 permitted 1 ≙ S = 0 not permitted	

Depending on the machine, MP 190 can be programmed to define whether in addition to the minimum output voltage determined with MP 184, the voltage "0" may be output or not in the lowest gear stage.

Display of current spindle rpm before spindle start	191	0 ≙ no display 1 ≙ display	

6.1.6 Machine parameters for output of tool numbers and tool store numbers

Function	Parameter No.	Possible entry values	Selected entry values
Output of tool numbers	61	0 ≙ No output 1 ≙ Output only when tool number changes 2 ≙ Output of tool number with every tool call 3 ≙ Output of tool store number (if MP 225 ≥ 1)	

With parameter 61, the output of tool numbers or tool store numbers is programmed.

Activation of the next tool numbers	157	0 ≙ No output of next tool number 1 ≙ Output only when next tool number changes 2 ≙ Output of next tool number with every tool call 3 ≙ Output of next tool store number with TOOL DEF (if MP 225 ≥ 1)	

With parameter 157 it can be programmed as to whether the next tool number is output — or not — after output of a tool number. Through output of the next tool number or next tool store number, a tool changing facility can be brought into the required position.

Tool change position M92			
X-axis	186	− 30 000.000 ... + 30 000.000 [mm]	
Y-axis	187		
Z-axis	188		
IV-axis	189		

With auxiliary function M92, tool change positions programmed in machine parameters 186 to 189 can be called-up in relationship to the axis reference point.

Central tool memory	225	0 No central tool memory 1 . . . 99 Central tool memory with number of tool store allocations	

If parameter 225 is programmed with a value ≥1, a tool list with 1 to max. 99 tools — with or without special tools — can be defined under program number 0 within the memory of the TNC 151/TNC 155-control.
If an automatic toolchanger is being used, it can be set-up for fixed tool selection or random tool selection, depending on the entry of parameters 61 and 157. Operation of a toolchanger is supported by a PLC-macro-program (see separate description).
If parameter 225 is programmed with 0, a central tool memory is inaccessible and the output of tool store numbers via parameters 61 and 157 is inhibited. The tools then have to be defined within the individual workpiece programs.

6.1.7 Machine parameters for other functions

Function	Parameter No.	Possible entry values	Selected entry values
Resolution	65	0 ≙ 1 µm 1 ≙ 5 µm	

With parameter 65 the resolution of TNC 151/TNC 155 can be programmed for either 1 µm or 5 µm. For optimization of machine parameters, 1 µm is used. The 5 µm resolution is usually sufficient for normal machine operation.

Signal evaluation	X Y Z IV	12 13 14 15	1 ≙ 20-fold max. traversing speed 16 [m/min] 2 ≙ 10-fold max. traversing speed 12 [m/min]	

With these parameters, the signal evaluation for the transducers can be reduced from 20-fold to 10-fold.

Please note:
With 10-fold subdivision the max. traversing speed is 12 m/min (input frequency of control 20 kHz).

Standstill supervision	169	0,001 . . . 30 [mm]	

Parameter 169 determines the range in which non-controlled axes may move without activition of a fault detection signal. If the programmed limitation is exceeded, the control then goes into an emergency stop condition and indicates the flashing message **GROSS POSITIONING ERROR.**

Movement supervision	234	0.03 . . . 10 [V]	

Parameter 234 monitors machine movement when the programmed voltage is output. If no movement takes place, the control goes into the emergency stop condition and indicates the flashing message **GROSS POSITIONING ERROR.**

Off-line programming station	170	0 ≙ Control 1 ≙ Off-line programming station PLC active 2 ≙ Off-line programming station PLC inactive	

Parameter 170 determines whether the control is intended as an off-line programming station or not. If parameter 170 is programmed with 1 or 2, the control requires no transducers or external circuitry.

Cancellation of status display with M02, M30 and program end	173	0 ≙ Status display is not to be cancelled 1 ≙ Status display is to be cancelled	

Program conditions are indicated in the status display of the TNC 151/TNC 155. These status data are required for re-entry into an amended contour after an operational interruption. If these program status data are to be cancelled at the end of the program, MP173 should be programmed with "1".

Function	Parameter No.	Possible entry values	Selected entry values
The "scaling" cycle can apply to 2 or 3 axes	213	0 ≙ The programmed scaling factor is effective in the 3 main axes X, Y, Z 1 ≙ The programmed scaling factor is effective in the working plane	
.Programmed stop with M06 .Output of M89	214	0 ≙ Programmed stop with M06, M89 normal output at beginning of block 1 ≙ No programmed stop with M06, M89 normal output at beginning of block 2 ≙ Programmed stop with M06, M89 modal cycle call at block end 3 ≙ No programmed stop with M06, M89 modal cycle call at block end	
.no axis standstill if – with a TOOL CALL – spindle rpm is output only		... + 4 – if 4 is added to the previous entry value, no axis standstill occurs with output of spindle rpm.	
.no axis standstill with output of an M-function		... + 8 – if 8 is added to the previous entry value, no axis standstill occurs with output of an M-function. Exception: Axis standstill occurs with M-functions which are followed by a programmed stop (such as M00, M02 . . .) or a STOP or CYCL CALL-block	
Switchover HEIDENHAIN-dialogue programming / ISO (G-code)-programming	217	0 ≙ HEIDENHAIN-dialogue 1 ≙ ISO (G-code)-format	
.Projection of display graphics .Coordinate system rotation in the working plane	236	0 ≙ German standard 1 ≙ US-third angle projection 2 – if 2 is added to the previous entry value, the coordinate system is rotated by + 90°.	

6.2 Machine parameters which require optimization during commissioning and preliminary values

6.2.1 Common machine parameters for both ramp characteristics

Function	Parameter No.	Possible entry values	Preliminary entry values	Optimised entry values
Counting direction X	20	0 or 1	0	
Y	21		0	
Z	22		0	
IV	23		0	
Polarity of nominal value voltage X	24	0 or 1	0	
Y	25		0	
Z	26		0	
IV	27		0	
Software limit switch ranges X+	44		+ 30 000.000	
X–	45		– 30 000.000	
Y+	46	– 30 000.000 . . .	+ 30 000.000	
Y–	47	+ 30 000.000 [mm]	– 30 000.000	
Z+	48		+ 30 000.000	
Z–	49		– 30 000.000	
IV+	50		+ 30 000.000	
IV–	51		– 30 000.000	
Analogue voltage with rapid traverse	52	+ 4,5 . . . + 9 [V]	9	9
Acceleration	54	0.001 . . . 1.5 [m/s^2] as of software version 08: 0.001 . . . 3.0 [m/s^2]	Enter 0.2 if machine-dependant value is unknown	
Circular acceleration	55	0.001 . . . 1.5 [m/s^2]	Enter 0.1 when machine-dependent value is unknown	
Integral factor X	28	0 . . . 65 535	0	
Y	29		0	
Z	30		0	
IV	31		0	
Waiting time for cutout of remaining nominal value voltage with error display **POSITIONING ERROR**	185	0 . . . 65,535 [s]	0	

6.2.2 Machine parameter for the "linear characteristic" (Machine parameter 60 = 1)

Function		Parameter No.	Possible entry values	Preliminary entry values	Optimised entry values
K_V-faktor for	X	177	0.100 . . . 10.000	1	
	Y	178			
	Z	179			
	IV	180			

The K_V-factor (speed amplification) determines the amount of lag (positional deviation) with a certain speed.

It is calculated as follows:

$$K_V = \frac{\text{Rapid traverse [m/min]}}{\text{lag [mm]}}$$

The K_V-factor must be adapted to the machine.
If a high K_V-factor is selected, the trailing error (lag) will be very small at a certain speed. If the lag is too small, the axis carriage cannot be positioned exactly as required due to its inertia: the axis oscillates. It can also happen that the position loop excites its own oscillation.

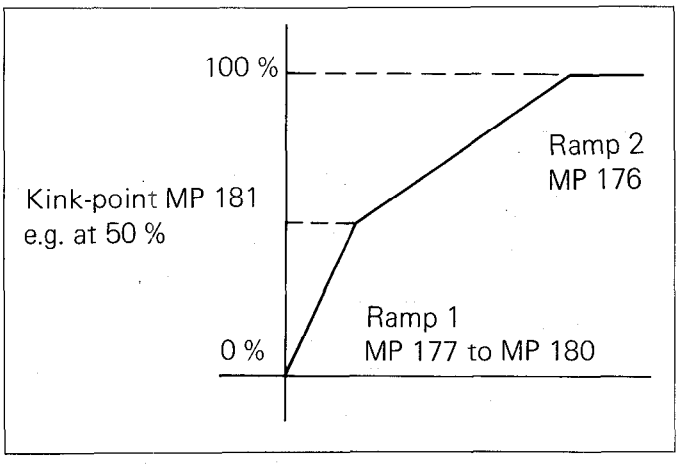
With a K_V-factor which is too small, acceleration and positioning takes place too slow.

Multiplication factor for K_V-factor	176	0.001 . . . 1.000	0.5	

If the multiplication factor is programmed with "1", the K_V-factor given in parameters 177 to 180 is also valid beyond the kinking point. With this entry, every axis must be examined to see that the predetermined nominal positions are traversed over. If this is the case, MP 176 is decreased until precise positioning is accomplished.

Characteristic kinking point	181	0 . . . 100.000 [%]	Depends on max. feed rate of machine	

Multiplication factor for K_V-factor and ramp kinking point
The ramp characteristic has a kink (see sketch)



The gradient of ramp 1 is determined by parameters 177 to 180. Machine parameter 176 is a multiplication factor for parameters 177 to 180 and determines the gradient of ramp 2.
The kinking point is determined by machine parameter 181. Entry is made in % in relationship to the analogue voltage at rapid traverse (9 V).
The kinking point must be greater than the analogue voltage for the highest feed rate.100 % analogue voltage corresponds to rapid traverse.

Trailing error supervision in trailing operation				
(Emergency stop)	174	0 . . . 100 [mm]	50	
(erasable)	175	0 . . . 100 [mm]	30	

6.2.3 Machine parameter for "square root characterisitic" (Machine parameter 60 = 0)

Function	Parameter No.	Possible entry values	Preliminary entry values	Optimised entry values
Speed pre-control	60	0 ≙ on 1 ≙ off	0	0
Factor for difference value X	32	0 . . . 65.535	Values as per values in table on page 41	
Y	33			
Z	34			
IV	35			
Oscillation behaviour when accelerating	64	0.01 . . . 0.999	0.1	
Position approach speed	53	0.1 . . . 10 [m/min]	0.1	
Position supervision erasable	56	0.001 . . . 30 [mm]	10	0.5*
Position supervision emergency stop	57	0.001 . . . 30 [mm]	30	10*

*If the machine permits a narrower limitation, these values should be programmed.

Factor for difference value with differing rapid traverses and K_V-factors

$$K_V = \frac{\text{Rapid traverse [m/min]}}{\text{Lag distance [mm]}}$$

Rapid traverse [mm/min]	K_V = 1	1.2	1.4	1.6	1.8	2
1	3.68	4.42	5.16	5.90	6.63	7.37
2	1.84	2.21	2.58	2.95	3.31	3.68
3	1.22	1.47	1.72	1.96	2.21	2.45
4	0.92	1.10	1.29	1.47	1.65	1.84
5	0.73	0.88	1.03	1.18	1.32	1.47
6	0.61	0.73	0.86	0.98	1.10	1.22
7	0.52	0.63	0.73	0.84	0.94	1.05
8	0.46	0.55	0.64	0.73	0.82	0.91
9	0.40	0.49	0.57	0.66	0.73	0.81
10	0.36	0.44	0.51	0.59	0.66	0.73
11	0.34	0.40	0.47	0.54	0.60	0.67
12	0.31	0.37	0.43	0.49	0.55	0.61
13	0.28	0.34	0.40	0.45	0.51	0.58
14	0.26	0.32	0.37	0.42	0.47	0.53
15	0.25	0.30	0.34	0.39	0.44	0.49
16	0.23	0.28	0.32	0.37	0.41	0.46

6.2.3.1 Error messages GROSS POSITIONING ERROR and POSITIONING ERROR

The error message GROSS POSITIONING ERROR is displayed for various reasons. In order to differentiate the causes of error, the suffixes A – D are displayed:

Error message	Cause
GROSS POSITIONING ERROR A	Overstepping of positon supervision, parameter 57 or 174
GROSS POSITIONING ERROR B	Overstepping the 10 V nominal value voltage of control in square root characteristic operation.
GROSS POSITIONING ERROR C	Overstepping of limit for movement supervision, parameter 234
GROSS POSITIONING ERROR D	Overstepping of limit for standstill supervision, parameter 169

With parameter 56 or 175 – position supervision (erasable) – and 57 or 174 – positon supervision (emergency stop), ranges are set for permanent position supervision of the machine. Supervision is operative as soon as the machine axes are held in closed loops by the control (after traversing over the reference marks).

Overstepping the tolerances in parameter 56 or 175 leads to a control stop and the error display **POSITIONING ERROR.**
The error display is cancelled with the CE-key.
Overstepping of the tolerances of parameter 57 or 174 leads to a control emergency stop and a flashing error message **GROSS POSITIONING ERROR A.** The "emergency stop" must be cancelled by switching off the mains power.

6.2.4 Machine parameters which are determined after compilation of parameters for the ramp characteristic

Function	Parameter No.	Possible entry values	Preliminary entry values	Optimised entry values
Positioning range X, Y, Z	58	0.001 . . . 0.05 [mm]	0.005	
Axis IV	192			

The acceptable range which the control recognises as being "position achieved" can be entered with parameters 58 and 192. For example, by entering 0.05, the machine accepts a position within ± 0.05 (mm) of the nominal position as being "position achieved". The control however, still endeavours to position to the nominal value. Reduction of this positioning range increases the approach time of the machine and the duration from block to block in automatic program run.

Backlash compensation	X	36	– 1.000 . . .	0
	Y	37	+ 1.000 [mm/m]	0
	Z	38		0
	IV	39		0

For indirect linear measurement with rotary encoders, a small amount of backlash can be present between the table movement and the rotary encoder. This backlash can be compensated with parameters 36, 37, 38 and 39. The value 100 µm must, however, not be exceeded.

Function	Parameter No.	Possible entry values	Preliminary entry values	Optimised entry values
Correction factor for linear correction X	40	– 1.000 . . .	0	
Y	41	+ 1.000 [mm/m]	0	
Z	42		0	
IV	43		0	

With parameters 40 to 43, linear corrections of individual axes can be programmed. Correction either affects an extension of the measuring distance or a shortening .

Dwell time-rotation direction change for "tapping cycle"	67	0 . . . 65.535 [s]	3	

With parameter 67, a dwell time can be programmed such, that a change of rotating direction during spindle retraction is prevented.

Advanced switchpoint for "tapping cycle"	73	0 . . . 65.535 [s]	0	

The advanced switchpoint refers to the reaching of the end position of the thread. With the aid of parameter 73, retraction of the spindle can be compensated after the M 05 command.

Constant contouring speed on external corners	91	0 . . . 179.999 angle in degrees	1	

With parameter 91 an angle can be determined on corners on which the control can traverse at constant speed. 2^{o} should be considered as maximum: with greater angles, either the mechanical loading can be too high or the drive demagnetised.

Overlap-cutting with pocket milling	93	0.1 . . . 1.414	1.2	

With machining cycles "pocket milling" and "circular pocket" the number of cuts required are calculated by the control. The maximum pecking depth can be determined with machine parameter 93

The entered value is multiplied by the mill radius for the max. pecking depth in mm (not applicable to variable contour pockets).

6.3 Machine parameters in conjunction with the PLC

For TNC 151/TNC 155, the parameters in the list below may only be altered if the PLC-program is to be amended. Information for amending the PLC-program is given in the PLC-description HEIDENHAIN TNC 151/TNC 155 Contouring Control (please request this manual).

Function	Parameter No.	Possible entry values	Entry values for TNC 151 B/TNC 155 B, TNC 151 Q/TNC 155 Q with standard PLC-program
PLC-program from RAM or EPROM	77	0 ≙ RAM 1 ≙ EPROM	1
PLC-counter predetermined value for counter 0 – 15	94 to 109	0 . . . 65 535 (in units of 20 ms)	0
PLC-Timer duration for Timer 0 – 31	110 to 119	0 . . . 65 535 (in units of 20 ms)	0
	120		2
	121		7
	122		9
	123		12
	124		12
	125		5
	193 to 208		0
PLC-position values for 31 coordinates (31 = Ref.-marker)	126 to 156	– 30 000.000 . . . + 30 000.000 [mm]	0
Setting of 16 markers to binary numbers Transfer of actual position data with "manual positioning" (as of PLC-software-No. 234 601 03)	158	0 . . . 65 535 0 ≙ no transfer of actual position data 16 384 ≙ transfer of actual position data	0
Automatic lubrication after traverse in X	159	0 . . . 65 535 (in units of 65 536 µm)	0
Y	160		
Z	161		
IV	162		
Feed rate for parameters Nos. 126 to 156 X	163	80 . . . 15 999 [mm/min]	80
Y	164		
Z	165		
IV	166		
Support of PLC-macro-commands	209 to 212	–	0
Setting of 16 markers to binary numbers (markers 2208 to 2223)	249	0 . . . 65 535	
Setting of 16 markers to binary numbers (markers 2224 to 2234)	250	0 . . . 65 535	

The control HEIDENHAIN TNC 151 Q/TNC 155 Q can be equipped with customer-specific macro-programs e.g. for support of a tool changer. More detailed information can be obtained from HEIDENHAIN.

6.4 Machine parameters in conjunction with the RS-232-C (V.24) data interface

ASCII-character code

Data transmission via the RS-232-C (V.24) interface is governed by ASCII-characters. The following table indicates the character code:

character	Code DEC	Code BINARY
NUL	000	0000000
SOH	001	0000001
STX	002	0000010
ETX	003	0000011
EOT	004	0000100
ENQ	005	0000101
ACK	006	0000110
BEL	007	0000111
BS	008	0001000
HT	009	0001001
LF	010	0001010
VT	011	0001011
FF	012	0001100
CR	013	0001101
SO	014	0001110
SI	015	0001111
DLE	016	0010000
DC1 (X-ON)	017	0010001
DC2 (TAPE)	018	0010010
DC3 (X-OFF)	019	0010011
DC4	020	0010100
NAK	021	0010101
SYN	022	0010110
ETB	023	0010111
CAN	024	0011000
EM	025	0011001
SUB	026	0011010
ESC	027	0011011
FS	028	0011100
GS	029	0011101
RS	030	0011110
US	031	0011111
SP	032	0100000
!	033	0100001
"	034	0100010
#	035	0100011
$	036	0100100
%	037	0100101
&	038	0100110
'	039	0100111
(	040	0101000
)	041	0101001
*	042	0101010
+	043	0101011

character	Code DEC	Code BINARY
,	044	0101100
–	045	0101101
.	046	0101110
/	047	0101111
0	048	0110000
1	049	0110001
2	050	0110010
3	051	0110011
4	052	0110100
5	053	0110101
6	054	0110110
7	055	0110111
8	056	0111000
9	057	0111001
:	058	0111010
;	059	0111011
<	060	0111100
=	061	0111101
>	062	0111110
?	063	0111111
a	064	1000000
A	065	1000001
B	066	1000010
C	067	1000011
D	068	1000100
E	069	1000101
F	070	1000110
G	071	1000111
H	072	1001000
I	073	1001001
J	074	1001010
K	075	1001011
L	076	1001100
M	077	1001101
N	078	1001110
O	079	1001111
P	080	1010000
Q	081	1010001
R	082	1010010
S	083	1010011
T	084	1010100
U	085	1010101
V	086	1010110
W	087	1010111

character	Code DEC	Code BINARY
X	088	1011000
Y	089	1011001
Z	090	1011010
[	091	1011011
\	092	1011100
]	093	1011101
^	094	1011110
_	095	1011111
`	096	1100000
a	097	1100001
b	098	1100010
c	099	1100011
d	100	1100100
e	101	1100101
f	102	1100110
g	103	1100111
h	104	1101000
i	105	1101001
j	106	1101010
k	107	1101011
l	108	1101100
m	109	1101101
n	110	1101110
o	111	1101111
p	112	1110000
q	113	1110001
r	114	1110010
s	115	1110011
t	116	1110100
u	117	1110101
v	118	1110110
w	119	1110111
x	120	1111000
y	121	1111001
z	122	1111010
{	123	1111011
|	124	1111100
}	125	1111101
~(ALT MODE)	126	1111110
DEL	127	1111111

Function	Parameter No.	bit		Possible entry values
characters for program end and beginning	71	0 – 7 8 – 15	characters for program end characters for program beginning	0 . . . 65 535

With parameter 71 the ASCII-character code for "program end" and "program beginning" is defined for external programming. ASCII-characters 1 – 47 are acceptable.
Determination of entry value:

Example:				
	Program end:	ETX	BINARY-code	00000011
	Program beginning:	STX	BINARY-code	00000010

bit 0 – 7	7	6	5	4	3	2	1	0
Value	128	64	32	16	8	4	2	1
Insert 0 or 1 as appropriate	0	0	0	0	0	0	1	1

bit 8 – 15	15	14	13	12	11	10	9	8
Value	32768	16384	8192	4096	2048	1024	512	256
Insert 0 or 1 as appropriate	0	0	0	0	0	0	1	0

Entry value:

```
    1
    2
+ 512
  515
```

The entry value for machine parameter 71 is 515.

Decimal character in program output via V.24	92	0 ≙ Decimal comma 1 ≙ Decimal point	
Operating mode Data interface V.24 (RS-232-C)	223	0 ≙ "Standard data interface" 1 ≙ "Transfer blockwise"	

Parameter 223 determines the operating mode of the V.24 (RS-232-C)-data interface.

6.4.1 RS-232-C standard data interface via "EXT"-mode

If the TNC 151/TNC 155 is to operate as an RS-232-C standard data interface, the following parameters may be programmed with "0":

	218 219 220 221 224	0

Function	Parameter No.	bit
Data format and transmission stop for RS-232-C/V.24 data interface	222	0 = 0 7 data bits (ASCII-code with 8th bit = parity) 0 = 1* 8 data bits (ASCII-code with 8th bit = 0, 9th bit = parity)
		1 = 0 no BCC check 1 = 1 BCC no control character
		2 = 1 Transmission stop through RTS
		3 = 1 Transmission stop through DC3
		4 = 0 Character parity even 4 = 1 Character parity odd
		5 = 1 Character parity required
		7,6 = 00 1 1/2 stop bits = 01 2 stop bits = 10 1 stop bit = 11 1 stop bit

***Please note:**
With hardcopy printout of a graphics image, the TNC automatically switches to 8 data bits.

Transfer blockwise (as of software level 05)
With blockwise transfer from an external computer to the TNC, data flow is no longer controlled via RTS or DC3, but only via the control characters ACK and NAK.

Control via DSR, DTR
If the control switches the RTS-output to 0 V, the output DTR is simultaneously switched to 0 V (connected to the DSR-input of the peripheral unit). If the DSR-input of the peripheral unit is not allowed to be switched to 0 V during data transmission, a logical "1" should be connected to DSR via a bridge connection.

Example for the determination of the entry value
Data format:

7 data bits (ASCII-code with 8th bit = parity)
Transmission stop through DC3
Character parity even
Character parity required
1 stop bit

bit 0 – 7	7	6	5	4	3	2	1	0
Value	128	64	32	16	8	4	2	1
Insert 0 or 1 as appropriate	1	0	1	0	1	0	0	0

Determined entry value for parameter 222: 168

6.4.2 Operating mode "Transfer blockwise"

Very long programs (e. g. for moulds), which are normally compiled on an external computer, can be read into the TNC 151/TNC 155 via the RS-232-C (V.24) data interface block-by-block, and executed simultaneously.

Computers with bulk memories or the HEIDENHAIN Floppy Disc unit FE 401 may be used. A multitasking system is recommended, so that the computer can perform other tasks whilst being linked to one or more TNC 155-units.

The host computer generally requires a special purpose software for transmission of data to and from the TNC 151/TNC 155.

6.4.2.1 "Transfer blockwise" using the HEIDENHAIN Floppy disc unit FE 401

When in the FE-mode, the RS-232-C (V.24)-interface is automatically adapted to the FE 401, regardless of the machine parameters which have been programmed. Mode selection is initiated by the MOD-function (MOD-key and ENT-key).

6.4.2.2 Transfer blockwise via EXT-mode

TNC 151/TNC 155 is connected to the external computer via the RS-232-C (V.24) data interface in the operating mode "EXT". Control characters for computer link-up are specified by machine parameters.

Data transmission can be started from the TNC 151/TNC 155. After starting, the control transmits a heading block to the external computer. This heading block contains the program number and information specifying whether transmission is to be from the computer to the control or vice-versa. Transmission of this heading block is followed by the machining program.

Each block, which has been transferred, is checked by a "block check character BCC". This is an important check procedure of the "transfer blockwise" mode, since there are no further checks of the machining program possible between data transmission and program execution.

If a transmitted program block has been recognized as error-free, the next block is called up. An erroneous block has to be re-transmitted.

Transferred blocks are read into a buffer memory in the TNC 151 /TNC 155, and can be executed from this memory. During program run, the executed blocks are deleted and new blocks are read into the memory. Continous contouring operation, without interruptions is therefore possible.

The following ASCII-characters are used for control of data transmission (as per ISO/R 646):

SOH ≙ Start of Heading, Binary code 0000001
SOH signifies the data transfer heading: a character sequence which contains the program number and the information "data input" or "data output". Data check for the heading commences with the character SOH (see "Data protection with block check character BCC").

STX ≙ Start of Text, Binary code 0000010
STX signifies the beginning of a program block. Block protection for the text (BCC) commences with STX.

ETB ≙ End of Transmission Block, Binary code 0010111
ETB finalizes a data transmission block. The character following ETB is for data check (BCC).

ETX ≙ End of Text Binary code 0000011
ETX is transmitted at the end of a program.

ACK ≙ Acknowledge, Binary code 0000110
ACK is signalled by the receiving station to confirm that the data block was transmitted error-free.

NAK ≙ Negative Acknowledge, Binary code 0010101
NAK is signalled by the receiving station when an error is detected for a data block. The transmitting station must then re-transmit the block.

EOT ≙ End of Transmission, Binary code 0000100
EOT ends data transmission. This character is transmitted by the TNC 155 to the external computer at the end of a program entry and in the event of an error.

With machine parameters, ASCII-characters (substitute characters) with decimal code from 1 to 47 may substitute the above characters.

Further control characters, which cannot be replaced by machine parameters:

DC1 ≙ Start data transmission (Device Control 1)
DC1 starts data transmission.
DC3 ≙ Interrupt data transmission (Device Control 3)
DC3 interrupts data transmission.

Data protection with "Block Check Character BCC"
"Transfer blockwise" and simultaneous program execution requires data check procedures (ISO 1155 and ISO 2111). For this reason, during the "transfer blockwise" mode of the TNC 151/TNC 155, a parity check of the complete transmitted block (length parity) is performed in addition to the parity check of the individual characters (cross parity). This is performed with the "Block Check Character BCC", which completes the individual bits of the transmitted character of a data block for an even length parity.

At the end of a block, the control checks data transmission via the BCC. For this, the TNC 151/TNC 155 generates a BCC and compares this with the BCC being received. If the generated BCC and the received BCC are identical, the control signals ACK to the peripheral unit.

If the BCC's are not identical, the control signals NAK, and the block must be re-transmitted to the peripheral unit. This procedure is repeated up to 3 times and the following error message is then displayed:

TRANSFERRED DATA INCORRECT

With data output the control can transmit a BCC to the peripheral unit. The TNC 151/TNC 155 then waits for the signal NAK or ACK from the peripheral unit. If the peripheral unit transmits ACK, the next program block is transmitted.

If, however, the peripheral unit transmits NAK, the program block is repeated.

The control repeats the same block up to 3 times. If the peripheral unit transmits NAK each time, the following error message is displayed:

ME: PROGRAM INCOMPLETE

If the calculation of the BCC for "Transfer blockwise" results in a figure which is smaller than HEX 20 (control character), a character "Space" HEX 20 is additionally transmitted before ETB.
With this, the BCC is always greater than HEX 20 and no longer corresponds to a control character.
If the BCC is not checked, this function need not be selected – Machine parameter MP 222.

Example showing the formation of the BCC

bit No.	P*)	6	5	4	3	2	1	0
1. Character SOH	1	0	0	0	0	0	0	1
2. Character %	1	0	1	0	0	1	0	1
3. Character 1	1	0	1	1	0	0	0	1
4. Character 5	0	0	1	1	0	1	0	1
5. Character E	1	1	0	0	0	1	0	1
6. Character ETB	0	0	0	1	0	1	1	1
BCC		1	1	1	0	0	1	0

*)P = bit for character parity (cross parity)

All bits are completed for an even length parity with the BCC (the only exception is the bit for character parity).

Machine parameters determining the interface signals for "Transfer blockwise"
The determination of entry values is described under parameter 71.

Parameter No.	bit	Function	Entry values for:
218	0 . . . 7	% or ASCII-character. Transmitted within command block for **data input** before program number.	% and E: 17701
	8 . . . 15	E or ASCII-character. Transmitted within command block for **data input** after program number.	
219	0 . . . 7	% or ASCII-character. Transmitted within command block for **data output** before program number.	% and A: 16677
	8 . . . 15	A or ASCII-character. Transmitted within command block for **data output** after program number.	
220	0 . . . 7	ETB or substitute character (decimal code 1 – 47)	ETB and SOH: 279
	8 . . . 15	SOH or substitute character (decimal code 1 – 47)	
221	0 . . . 7	ACK or substitute character (decimal code 1 – 47)	ACK and NAK 5382
	8 . . . 15	NAK or substitute character (decimal code 1 – 47)	
224	0 . . . 7	EOT or substitute character (decimal code 1 – 47)	EOT 4

6.4.2.3 "Transfer blockwise" from a peripheral unit to the TNC 151/TNC 155

In operating modes

.TRANSFER BLOCKWISE in **SINGLE BLOCK/AUTOMATIC PROGRAM RUN**

and

.READ-IN SELECTED PROGRAM

data transmission from the peripheral unit to the TNC 151/TNC 155 is performed as follows:

Operation/Dialogue display	Data from TNC (output $\overline{\text{TXD}}$)	Data from peripheral unit (output $\overline{\text{RXD}}$)	Remarks
Select Operating mode Single block/Automatic	–	–	–
Press EXT	–	–	–
Dialogue display: PROGRAM NUMBER	–	–	–
Key-in program number and enter into memory with ENT	–	–	–
Dialogue-display TRANSFER BLOCKWISE	SOH	–	Control transmits SOH (Beginning of heading block)
	%	–	% = Beginning of program number
	Progr.-No.	–	The program number may have 1 – 8 digits *)
	E	–	E = Control waits for data input
	ETB	–	ETB = End of Transmission Block
	BCC	–	BCC is generated between SOH and ETB
	DC1	–	DC1 = Start data transmission
	–	ACK or NAK	The peripheral unit transmits ACK = Data transmission in order NAK = Data transmission erroneous Repeat heading
	–	STX	The peripheral unit transmits STX (Start of text)
	–	Block Text	The first program block is transmitted
	–	ETB	ETB = End of Transmission Block
	–	BCC	BCC is generated between STX and ETB
*)In operating modes .Program directory .Read-in all programs and .Read-in program offered no program number is output by the TNC 151/TNC 155	ACK or NAK	–	The control transmits ACK = Data transmission in order, next block NAK = Data transmission erroneous. Repeat block!
	–	STX	The second program block is transmitted
		Block Text	
		ETB	
		BCC	
	ACK or NAK	etc.	End of Text (program input)
	etc.		
		ETX	
	EOT	–	End of Transmission

6.4.2.4 Characters and block formats for various operating modes

Program input from a peripheral unit into the TNC 151/TNC 155

The TNC transmits the following heading block for activation of entry:		Block format	Program end	From TNC at end of transmission
."Read-in selected program" ."Transfer blockwise" in single block/automatic program run	."Program directory" ."Read-in all programs" ."Read-in program offered"			
SOH/%/Program No./ E/ETB/BCC/DC1 (Program No. max. 8 digits)	SOH/%/E/ETB/BCC/DC1	STX/Block text/ETB/BCC (control transmits NAK or ACK after every block)	ETX	EOT

Program output from the TNC 151/TNC 155 to peripheral unit

The TNC transmits the following heading block before every program	Block format	Program end	
SOH/%/Program No./A/ETB/BCC/DC1 (Program No. max. 8 digits)	STX/Block text/ETB/BCC (control waits for NAK or ACK after every block) *)	ETX	

Heading block for error messages from peripheral unit to TNC 151/TNC 155

SOH/error message/ETB/BCC (the error message may contain up to 32 characters)

*)With NAK, the control repeats the same block up to 3 times. If the peripheral unit transmits NAK, the following error message is displayed:
ME: PROGRAM INCOMPLETE

6.4.3 Hard copy printout of graphics (TNC 155 only)

In the "EXT"-mode, a suitable matrix printer can be connected to the RS-232-C (V.24) data interface of the TNC 155 for hard copy printout of the graphics image. The following parameters are required for controlling the printer (output sequence: information of bits 8 – 15 prior to bits 0 – 7):

Parameter No.	bit	Function	Entry values * for:
226	8 – 15 0 – 7	Number of command characters from the control for setting the printer interface (binary) Command character	3 and ESC: 795
227	8 – 15	Command characters Number of points/Line height (binary)	A and 8 16648
228	8 – 15 0 – 7	unassigned	0
229	8 – 15 0 – 7	unassigned	0
230	8 – 15 0 – 7	Number of command characters from the control before each printer line (binary) Line feed	5 and LF: 1290
231	8 – 15 0 – 7	Command character Command character	ESC and N: 6990
232	8 – 15 0 – 7	Number of points per line	512: 2
233	8 – 15 0 – 7	unassigned	0

*The specified command characters and entry values are valid for the printer type TI OMNI 800 Model 850 XL Printer.

Before setting the printer into operation, check that an 8-bit data format has been programmed.

Parameter No.	Entry value
222	169

As of software version 08:
With hardcopy printout of a graphics image, the TNC automatically switches to 8 data bits.

The TI-Matrix printer is equipped with a code switch. For graphics printout, the following switch setting is required:

Channel 1 on	8 bit data format
Channel 2 off	Line feed non-automatic
Channel 3 off Channel 4 off Channel 5 on	Letter set English (UK)**
Channel 6 on Channel 7 on Channel 8 off	9600 Baud

Connecting cable for TI-Matrix printer

V.24 (RS-232-C) Adapter output 25 pole		TI-printer input 36 pole	
contact:	7	19	SIGNAL GND
	6	34	DSR
	20	33	DTR
	2	16	$\overline{\text{TXD}}$
	5	15	CTS
	3	35	$\overline{\text{RXD}}$

**English (US) Channel 3 off, 4 off, 5 off

6.5 Machine parameters for handwheels and touch probe systems

Function	Parameter No.	Possible entry values
Handwheel and touch probe system	171	0 ≙ HR 150 or HR 250 and TS 510 1 ≙ HE 310 and TS 510 2 ≙ HR 150 or HR 250 and TS 110 3 ≙ HE 310 and TS 110

When using handwheels (without touch probe system) only, program as follows:
for HR 150 or HR 250 0 or 2
for HE 310 1 or 3

When using a touch probe system only (without handwheel), program as follows:
for TS 510 0 or 1
for TS 110 2 or 3

Hysteresis for electronic handwheel	247	0 . . . 65 535 (increments)

In the operating mode "Handwheel" it is possible that shock and vibrations can be transferred to the handwheel thus causing a small movement of the axis due to the rotation of the wheel. This sensitivity can be reduced via machine parameter 247.

6.6 Machine parameters for 3D-Touch probe systems

Please note:
The 3D-Touch probe system version is entered into the TNC via machine parameter MP171.

Measuring velocity / probing	215	80 . . . 3000 [mm/min]

Parameter 215 determines the probing speed.

Rapid traverse / Touch probe system	251	180 . . . 15 999 [mm/min]
Touch probe system measuring distance	216	0 . . . 19999.999 [mm]

Parameter 216 determines the length of the distance in which the measurement is to be performed. If the measuring point cannot be reached within this distance, the following error message is displayed:
TOUCH POINT INACCESSIBLE

Safety distance before measuring point for automatic probing	235	0 . . . 19999.999 [mm]

Parameter 235 determines the safety distance above the programmed measuring position. The machine traverses to this prior position in rapid traverse and then continues to the measuring point at the programmed velocity as per parameter 215.

Please note:
Locking of the spindle, especially when using the 3D-touch probe system TS 110 with cable connection must be realized through the machine tool builder. Please take into account the special markers for the PLC-program, see PLC-description.

Probing with the PLC-program can be modified via special markers.

Marker No.	Function	Signal direction
2022	Signal transmission not ready	NC → PLC
2023	Stylus already deflected at beginning of probing cycle	
2024	Touch probe system not ready (TS 511)	
2025	Stylus was deflected, probing procedure completed	
2026	Probing procedure ended	
2027	Battery voltage too low (TS 511)	

If the touch probe is already deflected before the start of a probing cycle, Marker 2023 is set by the NC-part of the control.
If, during a probing procedure, the stylus is deflected, marker 2025 is set.
If the probing procedure is ended (touch probe position is at safety distance), marker 2026 is set.
Marker 2026 is also set if
.an error message has interrupted the probing procedure
or
.the probing procedure was interrupted through a press of the external STOP-button.

With touch probe system TS 511 there is an additional marker 2024 for the message "Touch probe system not ready" and another marker 2027 if the battery voltage is insufficient.
If the stylus is already deflected when starting the probing procedure, the following error message is displayed:

STYLUS DEFLECTED

7. Commissioning

Commissioning of the machine with TNC 151/TNC 155 should be in accordance with the following check list. An explanation of individual points is provided in the check list where necessary.
Commissioning can only be performed when the drive-servo-amplifiers are optimised and the desired rapid speeds are adjusted on the servo-amplifiers with a 9-volt input voltage.

7.1 Dialog in 2 languages

In addition to the programming language ordered by the customer from HEIDENHAIN, the TNC 151 B / TNC 155 B is also available with a second universal language i.e. English.
In most cases for export machines, this saves the exchanging of language software between commissioning at the machinge tool builder's premises and with the customer.
Before commissioning, i.e. with an erased machine parameter memory, the display shows information in the selected language. After entry of machine parameters, the English plain language dialogue can be selected via MP 92 if 2 is added to the entry value for the decimal point.

Example:

Ordered language	Basic language
French	English

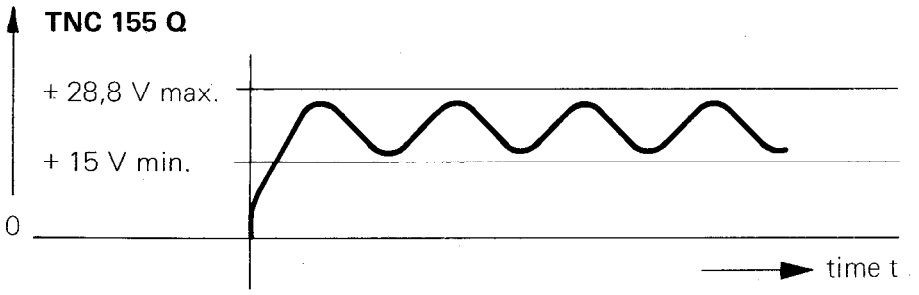
Function	Parameter No.	Entry value
Language switchover Decimal point Text	92	English dialogue = add 2 to the entry value corresponding to the remaining functions.

7.2 Check list for commissioning

7.2.1 Checks prior to machine switch-on

Check setting of the mains power switch and TNC-mains fuses: For 100/120/140 V – fuse T 1.0 A For 200/220/240 V – fuse T 0.8 A	○
The housing in which TNC 151/TNC 155 is to be inserted must have water spray protection to IP54	○
The transducer connectors must have a conductive connection to the machine via the outer shielding of the cable and via the scanning heads.	
a) The connection is made for the X-axis	○
b) The connection is made for the Y-axis	○
c) The connection is made for the Z-axis	○
d) The connection is made for axis IV	○
The inner shield (pin 9) of the transducer connector must have no conductive connection to the connector housing.	
a) No connection on X-axis	○
b) No connection on Y-axis	○
c) No connection on Z-axis	○
d) No connection on axis IV	○
All remaining transducer connector pins must have no conductive connection with pin 9 or connector housing.	
a) No connection on X-axis	○
b) No connection on Y-axis	○
c) No connection on Z-axis	○
d) No connection on axis IV	○
Caution: **The 0-Volt return line of the external 24 V-auxiliary voltage must** be grounded to the **common earthpoint** of the adaptor cabinet (see wiring and grounding diagrams, section 3.15 and 3.16).	○
The input of the servo-amplifiers must be **directly** connected to the appropriate analogue output of TNC 151/TNC 155 via shielded cables (intermediate resistors etc. are not permitted).	○
Caution: The 0-Volt-connections must be grounded at the control (see section 3.14 Nominal value-outputs).	○

7.2.2 Checks after switch-on of adaptor cabinet

Measure external D.C. voltage. Does this meet the specified requirements? **TNC 151 B / TNC 155 B**: + 30 V max.; + 15 V max. **TNC 151 Q / TNC 155 Q**: + 28,8 V max.; + 15 V min.; 0; time t 	○
Commissioning of D.C. drive amplifiers. The rapid traverse speeds must be adjusted with an external nominal voltage of 9 V.	○
Check function of emergency stop-limit switch.	○

7.3 Memory test after switch-on

After mains switch-on, the TNC performs an internal EPROM and RAM-memory test. This test can be inhibited via machine parameter 92 (extended function).

8. Optimization of TNC 151/TNC 155-parameters

A provision for control adjustment is the checking procedure as per check lists 7.2.1 and 7.2.2 and the existence of a PLC-program. Adjustment takes place in accordance with the adjustment check list below:

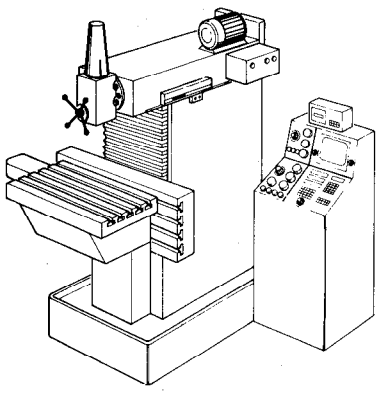
8.1 Adjustment check list

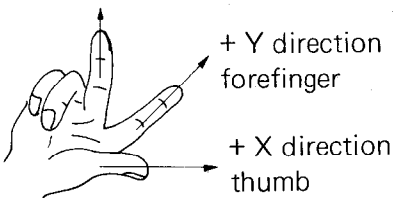
Switch off buffer battery	○
Determine machine traversing directions with "right-hand-rule"	○
Entry of preliminary machine parameters	○
Check traversing and counting directions of individual axes and correct if necessary	○
Set range of software limit switches	○
Offset adjustment	○
Adjustment of "linear characteristic"	○
Fine adjustment, trailing error and optimization of positioning for "linear characteristic"	○
Adjustment of square root characteristic	○
Acceleration (linear and radial)	○
Oscillation on acceleration for "square root characteristic"	○
Approaching speed 1 µm before nominal position for "square root characteristic"	○
Position supervision for "square root characteristic"	○
Integral factor X, Y, Z, IV	○

8.2 Axis designation for NC-machines and "right-hand-rule"

The three main axes are defined by NC-standards. Traversing directions can be determined by the "right-hand-rule".

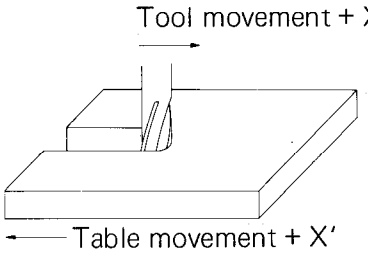
Example:
Universal milling machine





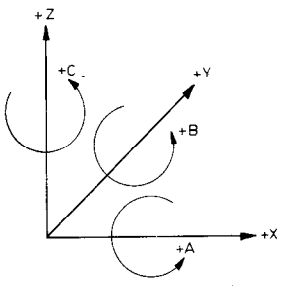
"Right hand rule"
Coordinates are correlated to the fingers.

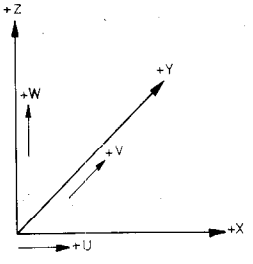
When programming, only **tool movement** is considered (relative movement of tool) i.e. whilst programming the operator always assumes that the tool is moving.



With the universal milling machine as illustrated above, the milling tool should, for example, traverse in a positive direction. However, due to the table moving in this axis and not the tool, the table must move in the left-hand direction. The relative movement of the tool is therefore in the right-hand direction, i.e. in the positive X direction. In this case, the traversing direction of the table is designated X'.

The machine tool manufacturer decides whether the fourth axis is to be used for a rotary table or as an additional linear axis and also which designation this axis will receive on the display screen:





Rotary axis

The rotary axis is designated with the letters **A, B** or **C;** the correlation to the main axes and the rotating direction is shown in the above illustration.

Fourth linear axis

If the fourth axis is to be used as a linear axis, the designation of this axis is **U, V** or **W.**
The correlation to the main axes is shown above.

8.3 Selection of machine axes

8.3.1 Assignment of transducer inputs to the control-internal axes

Four transducer inputs for sinusoidal signals are located on the rear of the TNC. There is also an input for squarewave signals. Transducer connections can be assigned to the "internal axes" via machine parameters 253 to 257.

MP 253	Input X
MP 254	Input Y
MP 255	Input Z
MP 256	Input IV
MP 257	Input V

Entry values: 1 ≙ TNC-internal axis X
2 ≙ TNC-internal axis Y
3 ≙ TNC-internal axis Z
4 ≙ TNC-internal axis IV
5 ≙ TNC-internal axis V

If, for example, the squarewave output X5 for the fifth transducer is to be used for an X-axis (exceeding 3040 mm), value 1 is to be programmed for machine parameter MP 257.

Stand assignment:
Entry value 0 in MP 253 – 257

8.3.2 Axis switchover for axis IV

With the aid of the integral PLC it is possible to interpolate positioning moves e.g. in the control-internal main axes (X, Y or Z) and traverse in machine axis IV (transducer input IV).
The combination possibility can be advantageous if axis IV is to be a main axis which can be unconditionally interpolated.
If both markers are set to 1, the assignment of the internal axes and positioning loops is unchanged.

Axis IV as internal	MP 2590	MP 2591
X-axis	0	0
Y-axis	0	1
Z-axis	1	0

8.3.3 Designation of axis IV

Designation is via machine parameter MP 90

MP 90 axis designation for axis IV

Entry values:

0 ≙ A	3 ≙ U
1 ≙ B	4 ≙ V
2 ≙ C	5 ≙ W

Axis designation for axis IV is determined by parameter 90. Selection of axis designation A, B or C means that the axis is for control or display of a rotary axis. In this case, the axis is relieved from mm/inch conversion and can operate with one of the other linear axes in linear interpolation without tool compensation. If U, V or W is selected, the axis is programmed as an additional linear axis. It is also subject to mm/inch conversion and can work with one or two of the other axes in linear interpolation or with one of the other axes in circular interpolation with tool radius compensation.

8.4 Input/Output diagram for machine parameters

Machine parameters are either keyed or read into an empty memory (commissioning or control exchange) or altered at a machine with the control installed (e.g. switchover DIALOG/ISO).

Machine parameters should always be stored on an external data medium so that they can be read-in via the RS-232-C/V.24-data interface at any time.

With an empty MP-memory, the control displays the following message after power-on:

OPERATING PARAMTERS ERASED

After cancellation of the message via CE, the request for the entry value MPO is displayed

MACHINE PARAMETER MPO ?

Entry is now performed either manually or via the RS-232-C/V.24 data interface.

Please note
With read-in, the data transmission mode ME-FE-EXT is to be set corresponding to the external storage unit. This is carried out via the MOD -key.

8.4.1 Read-in of machine parameters when memory is erased

Read-in of machine parameters is possible in the ME-mode with the ME 101/ME 102 magnetic tape units or the floppy disc unit FE 401.
Before data transmission, check MOD-function for correct operating mode.
With FE 401 read-in of machine parameters is also possible in the FE-mode, if these can be called-up via a program number.
If another peripheral unit is being used instead of the ME or FE, the adaptation as per ME-operation is performed in the EXT-mode, however, another Baud rate can be programmed via the MOD-function.

If the check-sum of the machine parameters is erroneous, the optional dialogue language is always selected as per the NC-software number after "Reset".

The memory in which the machine parameters are stored can be erased via the following code number:
Code number 531210 – Erasing of machine parameters

Simultaneously, PLC-markers M 1000 to M 2000 are reset.

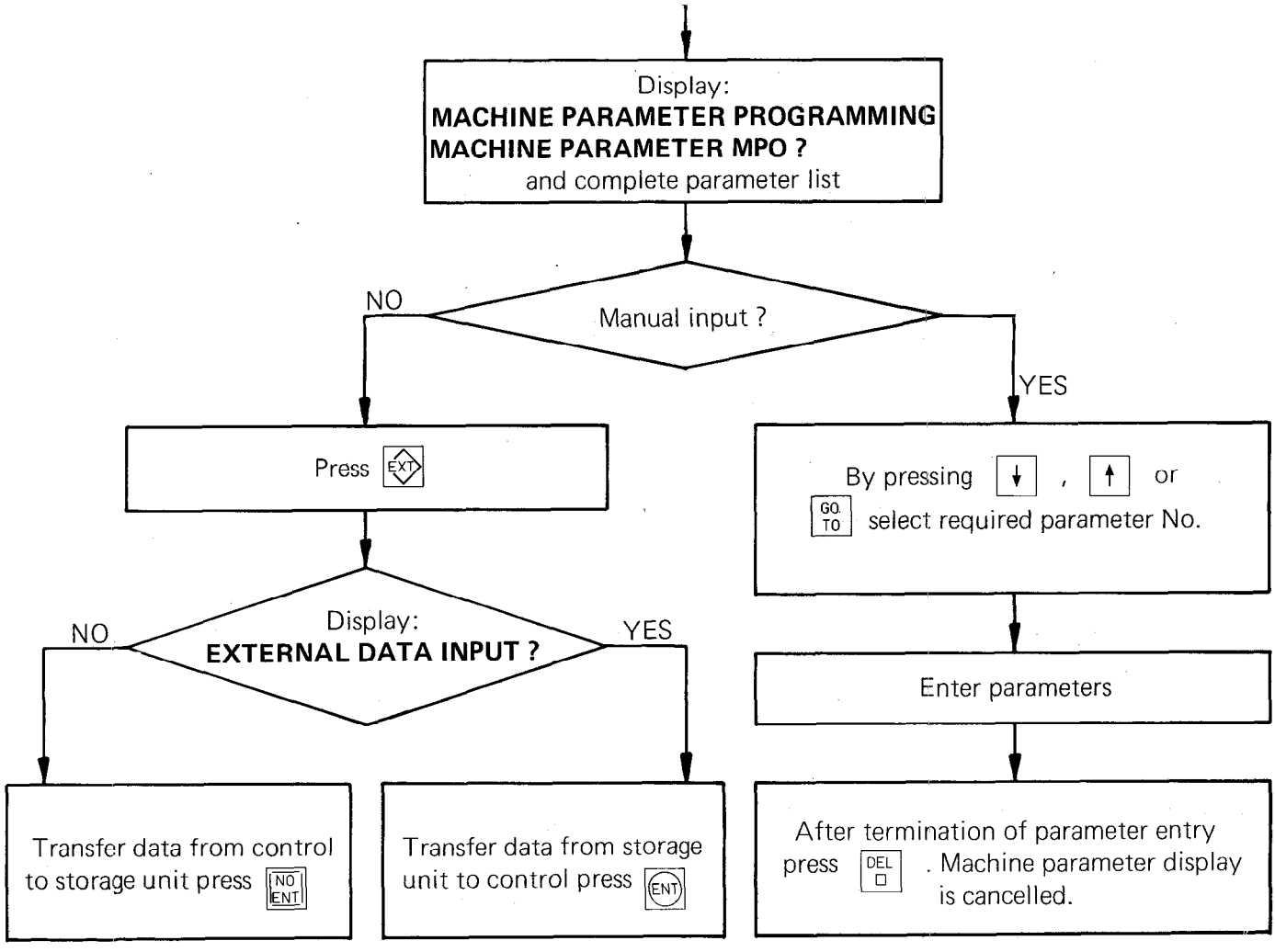
Read-in of machine parameters via the RS-232-C/V.24-interface
When reading-in machine parameters, comments which are designated by "*" or "," are ignored.

8.4.2 Alteration of machine parameters

Code number 95148

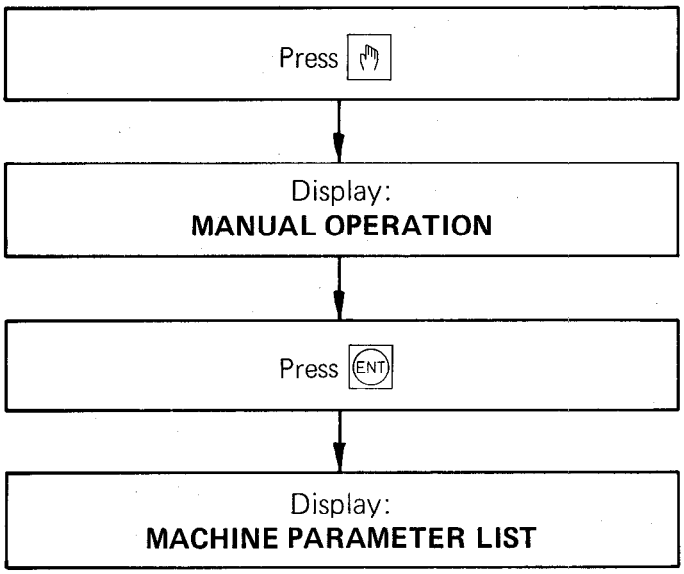
Select machine parameter mode via the code number and alter entry values according to the following sequence:

Input/Output diagram for non-erased parameter memory

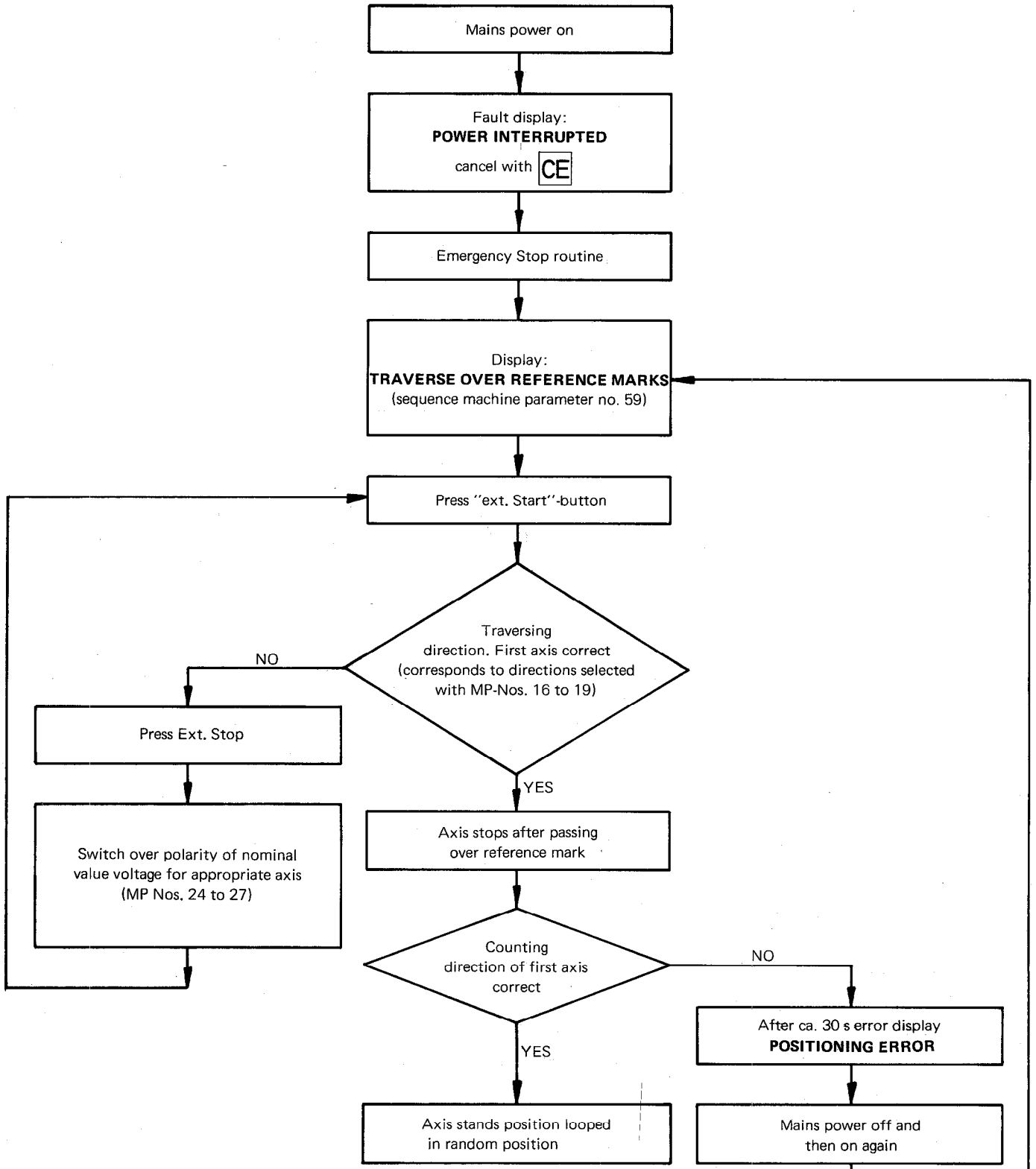


Alteration of parameters during commissioning

If the mains power for the TNC 151/TNC 155 is not switched off after entry of the code number, the parameter list can be re-called as follows:



8.4.3 Checking and correction of axis-traversing and counting directions



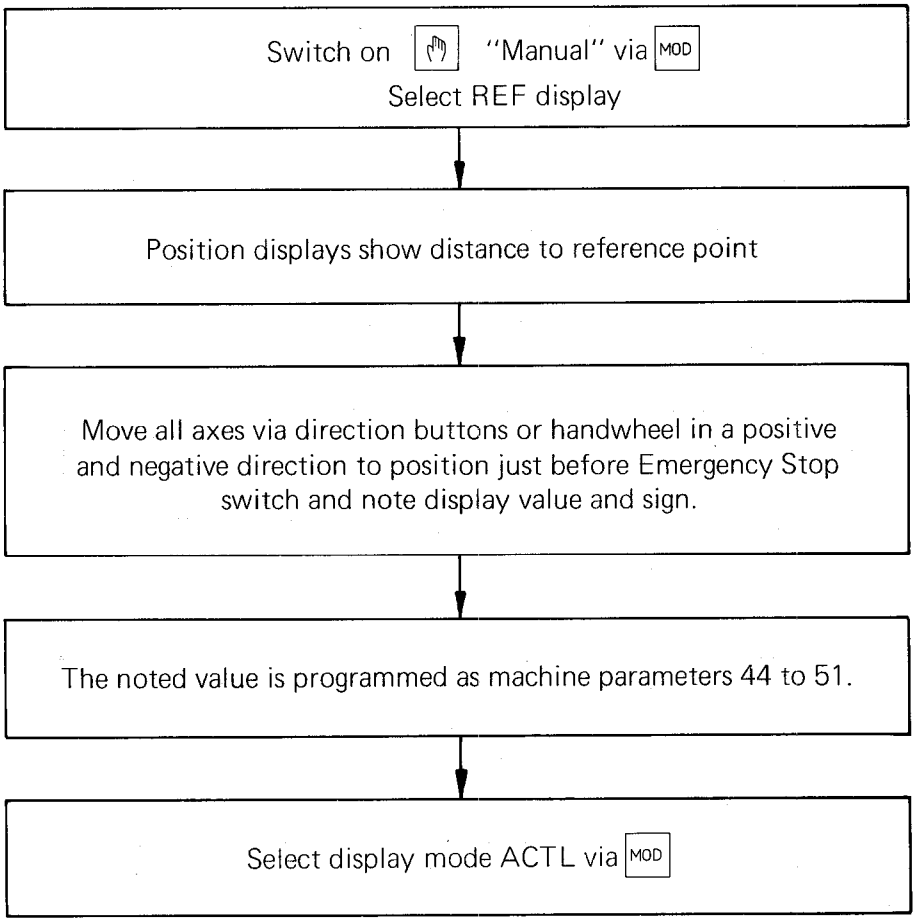
The flow chart must be worked through for each axis!

The axis traversing direction is correct when it corresponds to the programmed values (0 . . . + direction, 1 . . . – direction) of machine parameter 16, 17, 18 or 19, as per the machine directions given in section 8.1.2).
The counting direction is correct when it corresponds to the designated machine directions as per section 8.1.2.

8.5 Setting software limit switch ranges

a) Entry of the maximum possible traverse options of the TNC 151/TNC 155 Control ± 30 000 mm
(Machine parameters 44 – 51, see section 6.2.1)

b) Evaluation of machine-defined axis-limits

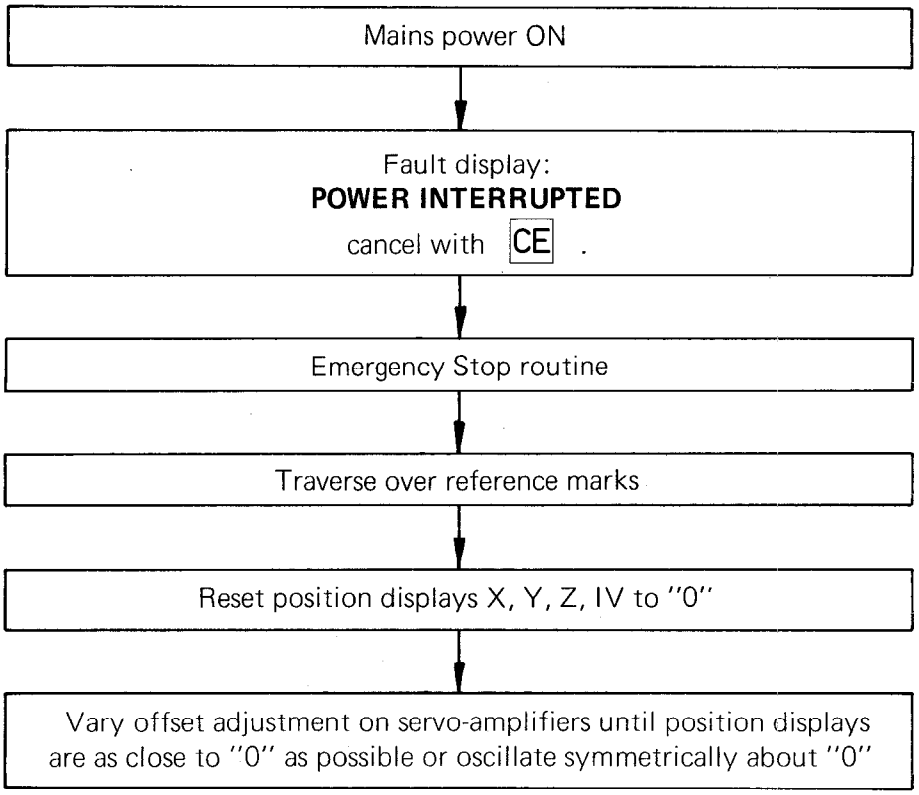


Optimization of machine positioning
By varying the machine parameters that are necessary for the HEIDENHAIN TNC 151/TNC 155 Control output characteristics, the control can be optimized to the machine in question.

8.6 Offset adjustment

Before adjusting the offsets, check that the following machine parameters have been correctly entered.

Function	Parameter No.	Entry
Integral factor X, Y, Z, IV	28 to 31	0
Resolution	65	0



Automatic offset adjustment via the control

An automatic offset-adjustment is possible by entering the code number 75368.
The control displays the offset values in the dialogue line in the sequence X, Y, Z, IV in 2.4 mV-units e.g.

0 1 0 2

The display signifies: no offset in the X-axis, 2.4 mV in Y, no offset in Z, and 4.88 mV in axis IV.
The automatic offset adjustment is selected by pressing ENT . The display offset value is entered into the control which then automatically provides the appropriate compensating voltage at the output.
If the automatic offset adjustment is to be switched off, enter code number 75368 and press NO ENT .
This adjustment however, does not substitute the offset adjustment of the drives as described above.

Automatic cyclic offset adjustment

Via machine parameter 252 a duration can be programmed for repetition of the atuomatic offset adjustment.

Function	Parameter No.	Entry
Cycle duration for automatic offset adjustment	252	0 ≙ no automatic adjustment 1 . . . 65 535 multiplicator for 20 ms

The automatic offset adjustment is carried out if the specified time duration has elapsed and the following conditions are fulfilled:
.all axes are at standstill
.the spindle is not switched on and
.the axes are not clamped.

Moreover, immediately after approaching the reference marks, an offset adjustment is carried out.
With controlled movement, an adjustment is also possible in the duration between "nominal value at target" and "actual value not within target window", providing the nominal value is longer than 5 s at the target.

With every offset adjustment, 2.44 mV are compensated. If the offset voltage is greater than 2.44 mV, full adjustment is achieved after several adjustment cycles.

The max. permissible offset-voltage is 100 mV. If this voltage is reached or exceeded, the following error message is displayed:

"GROSS POSITIONING ERROR E"

8.7 "Linear ramp characteristic" adjustment

This adjustment must always be performed, even if the machine is to operate with a speed pre-control at a later stage.

8.7.1 Fine adjustment of trailing error for "linear ramp characteristic"

The following parameter values should be entered prior to adjustment:

Function	Parameter No.	Entry values
Acceleration	54	0.2
Circular acceleration	55	0.1
Speed pre-control	60	1
Override effective when rapid button is pressed Feed rate display in 2 % stages or continuous	74	7
Trailing error supervision in trailing operation Emergency stop	174	100
erasable	175	90
Multiplication factor for K_V-factor	176	1
K_V-factor for X	177	Normally a K_V-factor of 1 is entered for machine tools
K_V-factor for Y	178	
K_V-factor for Z	179	
K_V-factor for IV	180	
Characteristic kinking point	181	100

With [MOD] set display to trailing error (lag)

↓

In **PROGRAMMING AND EDITING** [◈]

Enter the following program:

```
LBL 1
X 100*  R0  F  15999
X   0   R0  F  15999
CALL LBL 1   Rep 100/100
```

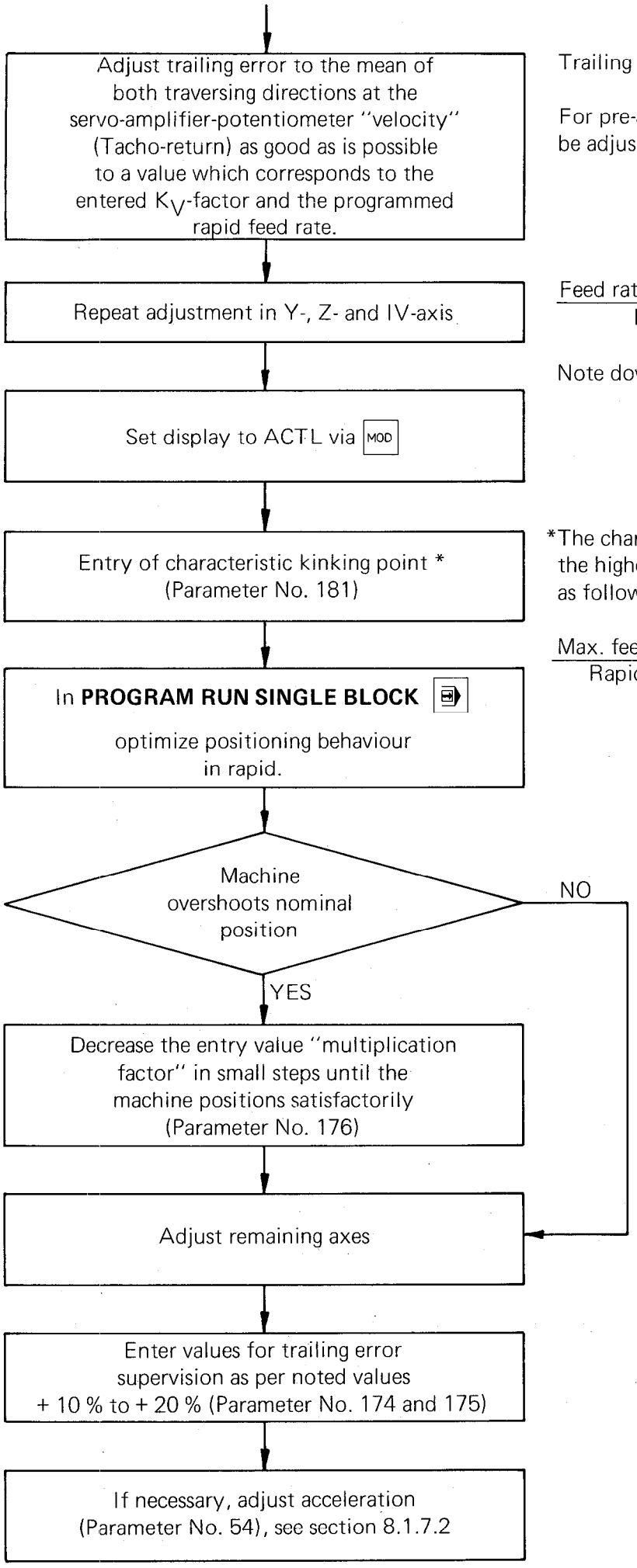
*Program traversing distance as large as possible in the relevant axis.

↓

In **AUTOMATIC PROGRAM RUN** [⇒]

press external start. *
Machine traverses and the position displays indicate trailing error.

If required, reduce feed rate via override potentiometer for pre-adjustment of trailing error.



$$\text{Trailing error [mm]} = \frac{\text{Rapid [m/min]}}{K_V}$$

For pre-adjustment, the trailing error (lag) can be adjusted to the feed rate indicated on the display.

$$\frac{\text{Feed rate [m/min]}}{K_V} = \text{Trailing error [mm]}$$

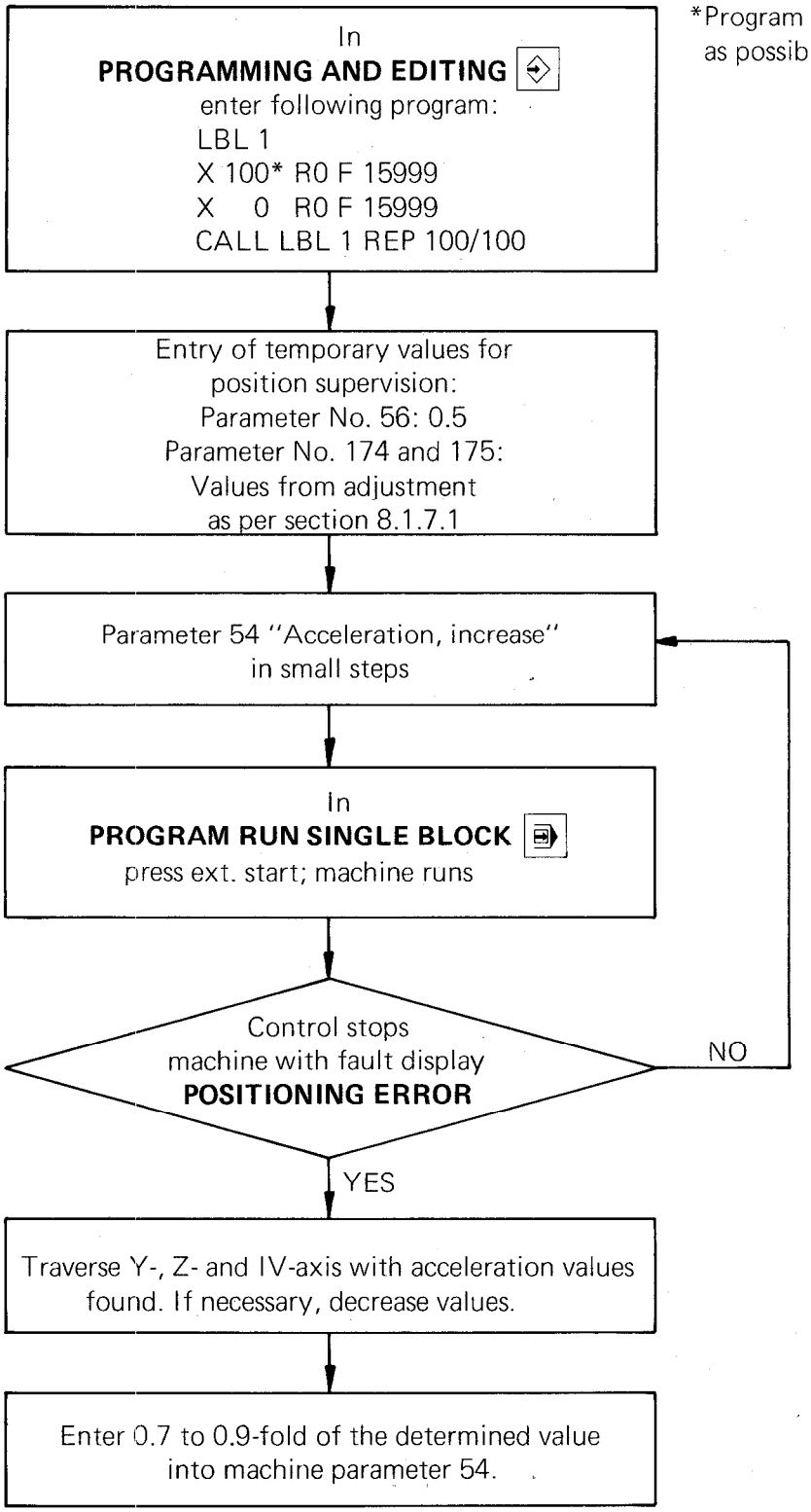
Note down trailing error (lag) values at rapid

*The characteristic kinking point must lie above the highest feed rate of the machine and is calculated as follows:

$$\frac{\text{Max. feed rate}}{\text{Rapid}} \times 100 = [\%]$$

8.7.2 Acceleration (linear and radial)

If the specific machine acceleration is unknown, the machine parameter 54 which is to be entered is determined as follows:



*Program traverse length as large as possible in the relevant axis

Machine parameter 55 "circular acceleration": enter half the value of machine parameter 54.

8.8 Adjustment of "square root characteristic"

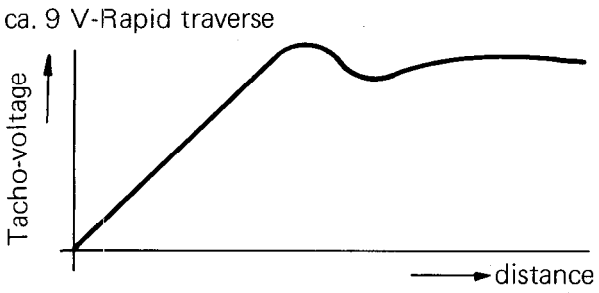
Prior to adjustment, the following parameter values are to be entered:

Function		Parameter No.	Entry values
Integral factor	X	28	0
	Y	29	
	Z	30	
	IV	31	
Differential factor	X	32	Values from table, section 6.2.3
	Y	33	
	Z	34	
	IV	35	
Positioning speed		53	0.1
Acceleration		54	Values from adjustment, section 8.1.7.2
Circular acceleration		55	
Position supervision (erasable)		56	0.5*
Position supervision (emergency stop)		57	10*
Speed pre-control		60	0

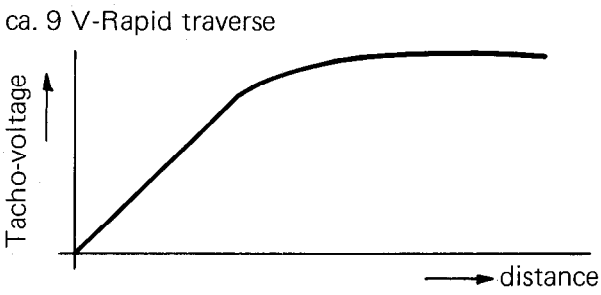
*If the machine drives permit a closer limit, this should be programmed.

8.8.1 Run-in behaviour with acceleration for "square root characteristic"

The configuration of the acceleration ramp is influenced by parameter 64.



Condition 1:
Parameter 64: entered value large



Condition 2:
Parameter 64: entered value small

Adjustment is carried out as follows:

Connect storage oscilloscope to tachometer of servo-amplifier X

In **PROGRAMMING AND EDITING**

Enter the following program:

```
LBL 1
X 100 R0 F 15999
X   0 R0 F 15999
CALL LBL 1 Rep 100/100
```

In **PROGRAM RUN SINGLE BLOCK**

press ext. start;
machine runs

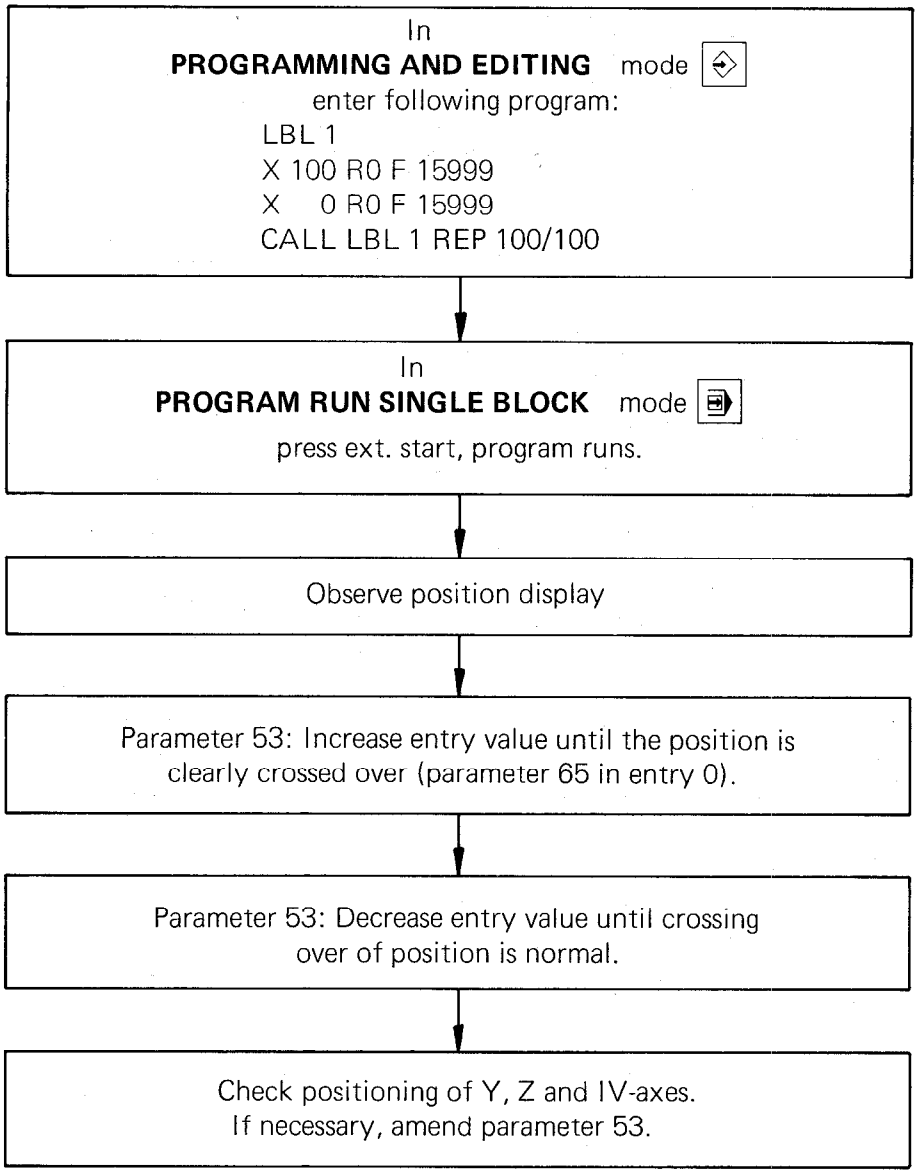
Parameter 64: Increase entry value until oscillation occurs (as per condition 1)

Parameter 64: Decrease entry value until oscillation ceases (as per condition 2)

Check axes Y, Z and IV,
If necessary, amend parameter 64

8.8.2 Approach speed 1 µm before nominal position for "square root characteristic"

Parameter 53 influences the gradient of the deceleration ramp in the vicinity of the nominal position. Adjustment is carried out as follows:



8.8.3 Position supervision for "square root characteristic"

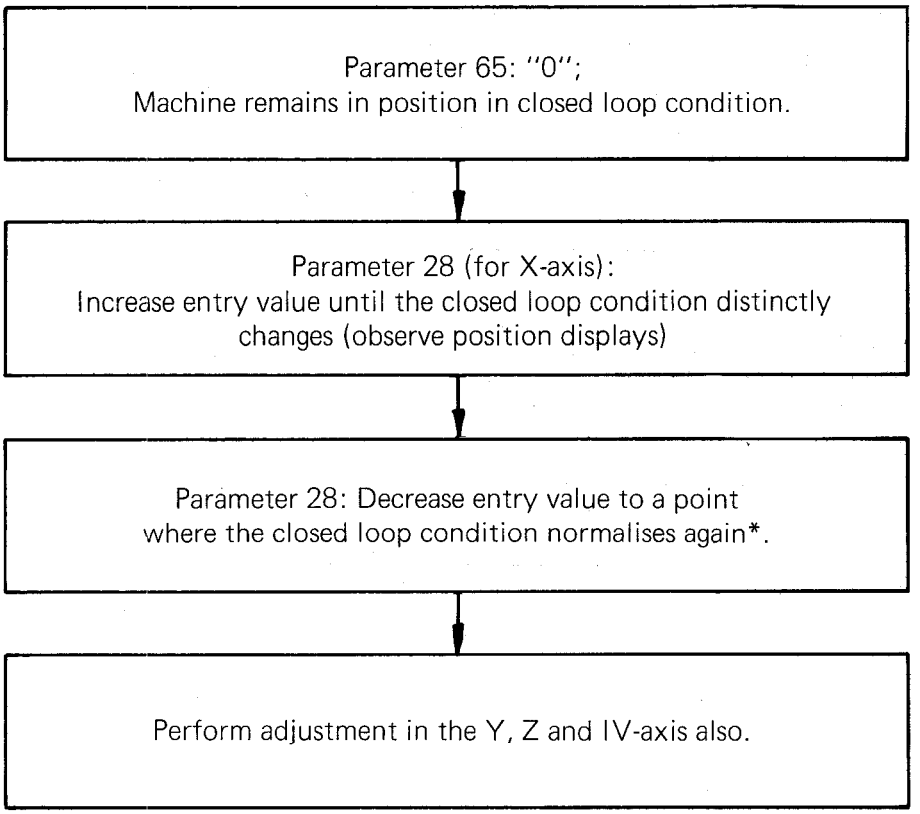
Machine parameters 56, 57:
With parameters 56 – position supervision (erasable) – and 57 – position supervision (emergency stop) – ranges for constant position supervision are defined. This supervision is effective as soon as the machine axes are being held in a closed loop condition by the control (after crossing reference points).
If the limits of parameter 56 are exceeded, a control stop will take place (error code **POSITIONING ERROR**). However, if the limits of parameter 57 are exceeded, the control will react with an emergency stop. The error display **POSITIONING ERROR** can be cancelled with the press of a key, but the "emergency stop" can only be cancelled by switching off the mains power and traversing the axes over the reference marks. Recommended entry values:

Machine Parameter	No.	Entry value	Supervision range
Position supervision (erasable)	56	0,5	± 0,5 mm
Position supervision (non-erasable)	57	10*	± 10 mm

*If the machine drives permit a closer limit, this should be programmed.

8.9 Integral factor X, Y, Z, IV

The integral factor (parameter 28 to 31) affects an automatic offset-adjustment with small position deviations (the offset adjustment of the servo-amplifier must be carried out before definition of the parameters 28 to 31). The parameters are optimized as follows:



*With drives which are slightly backlash-prone, the entry value is "0".

9. Customized macros (User cycles)

Customized macros are NC-programs in which variable program data are programmed via Q-parameters. Programming of customized macros within the NC-program memory takes place via program numbers from 99999968 to 99999999. A maximum of 100 different customer-specific dialogues for cycle designation and entry parameters can be stored within the control.

Standard cycles can be executed within customized macros. Since a standard cycle requires a CYCL-CALL, the customized macro is called up via CYCL DEF.

User cycles (customized macros) can be called-up either via CYCL CALL or already with the cycle definition CYCL DEF. This is determined during compilation of the user cycles.

For definition of the necessary plain language dialogues two possibilities are offered by the TNC:
"DLG-DEF" Call-up of user cycle via CYCL DEF
"DLG-CALL" Call-up of user cycle via CYCL CALL

After dialogue initiation for definition of plain language dialogues with the LBL SET and NO ENT -keys, the following dialogue question is displayed:

DLG-DEF = ENT/DLG-CALL = NO ENT

By pressing the key ENT or NO ENT , the DLG-DEF- or DLG-CALL-block is programmed.

Assignment of a value of the customized macros is made via CYCL DEF as per the permanently stored HEIDENHAIN-cycles. When paging, the customized macros are displayed by the cycle numbers 68 to 99.

Since both "DLG-DEF" and "DLG-CALL" customized macros can be contained in a main program, Q-parameters for the dialogues must be stored in separate Q-address locations.

Begin Q-parameter for dialogue DLG-DEF-block.	263	Entry value is the Q-number for the first dialogue of the DLG-DEF customized macro cycle.

Entry parameters for the "DLG-CALL"-block are assigned to program parameters Q1 to Q14. With the "DLG-DEF"-block the initial entry parameter is assigned to the program parameter which has been established via machine parameter 263.

Example:
If the entry value in machine parameter 263 = 50 the cycle parameters are assigned to the program parameters as follows:

first cycle parameter = Q51
second cycle parameter = Q52

fourteenth cycle parameter = Q64

9.1 Dialogue languages for customized macros

As with standard dialogues, customized macros can also be displayed in two languages.

The entry value for machine parameter MP 259 is added to the dialogue number of the original language. The English text of the appropriate dialogue is stored under this dialogue number.

Language switchover for customized macros	259	Difference between Q-number of dialogue and corresponding translation

Selection – as to whether original or English dialogue – automatically takes place simultaneously to the selection of the plain language standard dialogue via machine parameter MP 92.

Example:

Dialogues for customized macro "Bolt hole circle"

0 Bolt hole circle
1 Number of holes
2 ...

10 Bolt hole circle
11 Number of holes

Entry value in MP 259: 10

9.2 Test of customized macros

Customized macros which are still stored within the NC-program memory can also be recalled via PGM-call. For testing, the operating mode "Single block" is also possible.

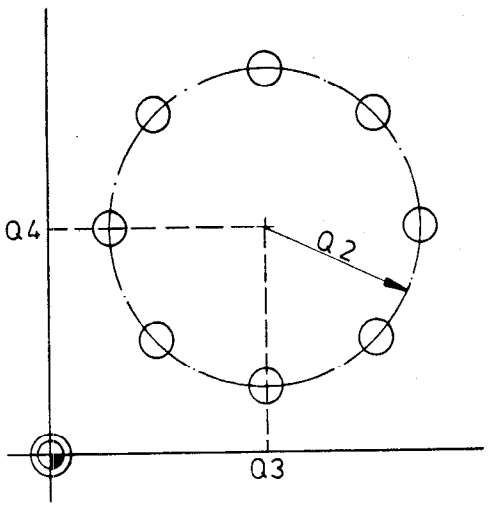
9.3 Repetition of customized macros

Program part repeats cannot be executed within customized macros which have been stored within the EPROM.

Program part repeats can however, be simply programmed via Q-parameter functions (refer to the following example "Bolt hole circle").

9.4 Example of a customized macro

Within the control, the customized macro is stored either in the NC program store or within an EPROM. The "Bolt hole circle"-cycle 68 requires the following entry parameters:



Q1 = Number of holes

Q2 = Radius of pitch circle

Q3 = X-coordinate for pitch circle centre

Q4 = Y-coordinate for pitch circle centre

Q5 = Set-up clearance for Z-axis

Q6 = Drilling depth in Z-axis

Q7 = Feed rate for drilling

The first hole of the pitch circle is located on the 0^{o}-axis of the X-Y-coordinate system. The variable parameter program which is stored derives the hole spacing via the total number of holes and executes machining.

Program example for the customized macro "Bolt hole circle"

```
 0  BEGIN PGM 99999968        MM  P
 1  DLG-DEF  0/1/2/3/4/5/6/7/  /  /  /
 2  FN 1 : Q6 = + Q6 + +Q5
 3  FN 4 : Q50 = +360.000 DIV  +Q1
 4  FN 0 : Q60 = +0.000
 5  CC  X + Q3   Y + Q4
 6  LBL 11
 7  LP  PR + Q2  PA + Q60  R0  F15999  M
 8  L   IZ + Q6            R0  FQ7     M
 9  L   IZ – Q6            R0  F15999  M
10  FN 1 : Q60 = +Q60 + +Q50
11  FN 12 : IF +Q60  LT +361.000  GOTO LBL 11
12  END PGM 99999968              MM  P
```

Parameter program for customized macro 68 "Bolt hole circle" (if stored within the EPROM of the control, display on the VDU is not possible).

9.5 Programming of a customized macro within the NC-program memory

Operating mode _____ 

Dialogue initiation _____ 

PROGRAM NUMBER

▶ ☐ Enter program number between 99999968 and 99999999.

▼

ENT Enter into memory

▼

MM = ENT / INCH = NOENT

▶ ENT for dimensions in mm

or

▶ NO ENT for dimensions in inches

▼

0 BEGIN PGM 99999968

1 END PGM 99999968

▶ LBL SET Dialogue initiation for opening dialogues required for the macro cycle.

▼

NO ENT

▼

DLG-DEF = ENT/DLG CALL = NOENT

0 BEGIN PGM 99999968

1 DLG DEF

2 END PGM 99999968

▶ ☐ Cycle designation

▼

ENT or NO ENT

▼

☐ First dialog number: Cycle parameter Q1

▼

ENT

▼

☐ Second dialog number: Cycle parameter Q2

▼

ENT

▼

⋮ Up to 15 dialogs (0 – 99) can be set

etc.

▼

0 BEGIN PGM 99999968

1 DLG-DEF 0/1/2/3/4/5/6/7

2 END PGM 99999968

▶ ☐ Enter parameter program. Parameters Q1 to Q14 may be entered as entry parameters
Within the macro, all variable parameters may be used.

Please note:
Program part repeats cannot be executed within a customized macro. However, certain jumps i.e. repeats, can be programmed via Q-parameters.

For the customized macro "Bolt hole circle" in section 9.4, the following dialogues must be stored within the EPROM.

Dialogue No. 0	BOLT HOLE CIRCLE
Dialogue No. 1	NUMBER OF HOLES
Dialogue No. 2	RADIUS
Dialogue No. 3	X-COORDINATE
Dialogue No. 4	Y-COORDINATE
Dialogue No. 5	SET-UP CLEARANCE
Dialogue No. 6	TOTAL HOLE DEPTH
Dialogue No. 7	FEED RATE

If the dialogues have not been stored within the EPROM, the following texts, which have been stored by HEIDENHAIN in the standard PLC-EPROM, can be called-up.

0	User Cycl
1	Cycl parameter 1
2	Cycl parameter 2
to . . .	
14	Cycle parameter 14

The cycle designation may comprise 14 characters and 32 characters for parameter designations.

9.6 Nesting of customized macros

Further macros can be called-up within a customized macro. A maximum of 4 nesting levels is possible.

9.7 Special function of program parameters

The tool radius of the last tool call is stored under variable parameter Q108. With this, the last tool radius can be used for parameter calculation and comparison.
The variable parameter Q108 can therefore, not be defined by Q-DEF in the NC-program.

Q108 contains exclusively the tool radius.

Q110 for M-functions which were output last

1 = no M-function output
0 = M03 output
1 = M04 output
2 = M05 after M03
3 = M05 after M04

Q113 mm/inch execution

Program parameter Q113 signifies whether the program is written in mm or inch. This parameter is set after pressing the PGM NR -key and selection of the program.

Selected program has been programmed in mm: Q113 = 0
Selected program has been programmed in inch: Q113 = 1

Program parameter is used if Q-parameter programs are to be executed in both mm and inch modes. Depending on parameter Q113, certain Q-parameters (e. g. the number of repetitions for conditional jumps) can be converted for execution in inch.

9.8 Binary output of customized macros for programming a PLC-EPROM

Customized macros are output in binary with the PLC-program.

Data is output in the following sequence:

.PLC-program
.Macro-programs
.Dialogue texts
(for PLC-error messages and customized macros)
.Customized macros

After output of the dialogue texts, the following dialogue is displayed:

READ-OUT ALL PROGRAMS?

If all programs are to be read-out: ▶ ENT ▼ All macro programs within the EPROM and RAM are output. If a program within the EPROM has the same number within the RAM, the program within the RAM is output.

If only certain programs are to be read-out: ▼ NO ENT

OUTPUT = ENT / END = NO ENT

99999970 99999982 99999993

99999995

▶ ↓ ↑ ← → Set cursor to desired program number

In the program menu only those programs are displayed which are stored within the EPROM ▼ NO ENT Transfer selected program onto tape

OUTPUT = ENT / END = NO ENT

99999970 99999982 99999993

99999995

The cursor is set to the next program number

Should data output from the EPROM be completed ▶ NO ENT Lastly, the control reads out the customized macros from the RAM

PLC-EDITING FUNCTION

The control returns to the mode PLC-EDITING FUNCTION

9.9 Customized macros within a machining program

9.9.1 Example: Definition of the customized macro "Bolt hole circle" in a machining program

(see also section 9.4)

Operating mode _____ 

Dialogue initiation _____ 

CYCL DEF 68 BOLT HOLE CIRCLE		Enter cycle in memory
NUMBER OF HOLES ?		Key-in number of holes
		Enter into memory
RADIUS ?		Key-in pitch circle radius
		Enter into memory
X-COORDINATE ?		Key-in X-coordinate for pitch circle centre
		Enter into memory
Y-COORDINATE ?		Key-in Y-coordinate for pitch circle centre
		Enter into memory
SET-UP CLEARANCE ?		Key-in set-up clearance
		Key-in correct sign
		Enter into memory
TOTAL HOLE DEPTH ?		Key-in hole depth
		Key-in correct sign
		Enter into memory
FEED RATE ?		Key-in feed rate for drilling
		Enter in memory

Display example:

CYCL DEF 68.0 BOLT HOLE CIRCLE	This macro requires 4 program blocks.
CYCL DEF 68.1 Q1 = +27,000	Q1 = Number of holes
Q2 = +40,000 Q3 = +50,000	Q2 = Radius; Q3 = X-coordinate for pitch circle centre
CYCL DEF 68.2 Q4 = +50,000	Q4 = Y-coordinate for pitch circle centre
Q5 = –2,000 Q6 = –20,000	Q5 = Set-up clearance Q6 = Hole depth
CYCL DEF 68.3 Q7 = 100,000	Q7 = Feed rate for drilling
Q8 = Q9 =	

9.9.2 Machining program using the macro "BOLT HOLE CIRCLE"

0	**BEGIN PGM 1000 MM**	
1	**BLK FORM 0.1 Z X + 0,000 Y + 0,000 Z – 20,000**	Blank form definition for
2	**BLK FORM 0.2 X + 100,000 Y + 100,000 Z + 0,000**	graphics display
3	**TOOL DEF 1 L + 0,000 R + 2,000**	Tool definition
4	**TOOL CALL 1 Z S**	Tool call-up
5	**L Z + 2,000 R0 F15999 M03**	Move to set-up clearance
6	**CYCL DEF 68.0 BOLT HOLE CIRCLE**	
7	**CYCL DEF 68.1 Q1 = +27,000 Q2 = +40,000 Q3 = +50,000**	Cycle definition:
8	**CYCL DEF 68.2 Q4 = +50,000 Q5 = –2,000 Q6 = –20,000**	"Bolt hole circle"
9	**CYCL DEF 68.3 Q7 = +100,000 Q8 = Q9 =**	
10	**CYCL CALL M**	Cycle call
11	**END PGM 1000 MM**	

10. Spindle orientation (option)

An orientated spindle stop can be programmed via the positioning loop of the Vth. axis.

This is, for example, important when using an automatic toolchanger or the 3D-Touch probe system TS 510 with infra-red transmission.
Feedback is performed by an incremental rotary encoder ROD 426 with 1024 lines. The maximum spindle speed for orientation is 14 000 rpm.
Nominal value programming is within 0,5 angular degrees.

Nominal values can be calculated as a PLC-positioning routine or from an orientation cycle. Moreover, positioning may be made to the reference mark, the absolute value of which, is stored under parameter MP 240.

Spindle orientation can be solved individually via the PLC-program. In the PLC-standard program a recommended solution is provided as of program No. 234 601 03 which can also be varied via machine parameters.

Spindle orientation takes place from standstill in a clockwise rotation. If the spindle is already rotating, the rotating direction last programmed is valid.

10.1 Machine parameters for spindle orientation

The positioning loop of the Vth. axis is activated and optimized via the following machine parameters:

The input of the Vth axis is designed for squarewave signals with a frequency of max. 250 kHz. The rotary encoder is an ROD 426 with 1024 lines.

Please note:
When using the rotary encoder ROD 426, the transducer supervision for axis V is to be switched off.
With spindle orientation a nominal value minimum limitation (specified by machine parameters) is inactive.

Function	Parameter No.	Entry value
Activation and function of the Vth axis	237	0 ≙ Vth axis inactive 1 ≙ Vth axis serves for orientation of the main spindle without position display 2 ≙ as per entry value 1, however with position display (display instead of IVth axis) 3 ≙ Vth axis uncontrolled, however with position display, axis designation A (display instead of IVth axis) 4 ≙ as per entry value 3, however axis designation B 5 ≙ as per entry value 3, however axis designation C
K_V-factor for Vth axis	238	0, 100 . . . 10,000
Counting direction for Vth axis	239	0 ≙ positive when positive traversing direction 1 ≙ negative when positive traversing direction
Position value to reference mark for Vth axis	240	0 . . . 360,000
Positioning window for Vth axis	246	1 . . . 65 535 (increments)
Spindle speed for spindle orientation	248	0 . . . 99 999 (rpm)
Spindle speed for orientation Special solution without ROD	258	0 . . . 99 999 (rpm) Function activated via marker M2501

10.2 Spindle orientation with standard PLC-program

With the standard PLC-program as of 234 601 03, three possibilities are available for spindle orientation:

.via an orientation cycle
.as a PLC-positioning routine
.to the reference mark (the positioning value for the reference mark is stored under MP 240)

Selection between the 3 possibilities is possible via MP 158.

The entry value for MP 158 is derived from the sum of these entry values and, if applicable, previous entry values.

Function	Parameter No.	Entry value
Spindle orientation with M19	158	0 ≙ inactive 4096 ≙ from orientation cycle or as per MP 240*
Spindle position with M19		8192 ≙ PLC-positioning routine, nominal value from MP 156

The spindle position is activated through M 19, the position is held by itself until M 00, M 02, M 04, M 05, M 13, M 14 or M 30 is output.

With output of M 19, the strobe signal is maintained at 1 until the spindle is orientated. The feedback signal may only take place when the M-strobe is at 0 again. M 05 is simultaneously output with M 19.

*the spindle position is derived from MP 240 if no cycle was programmed.

With spindle positioning for a spindle which is already rotating, the slewing speed is firstly reduced corresponding to the ramp setting (machine parameter MP 248). Positioning then takes place within the positioning loop.

11. List of machine parameters

Function		Parameter No.	Entry values
Rapid traverse	X	0	180 . . . 15 999 [mm/min]
	Y	1	
	Z	2	
	IV	3	(Axis IV: Degrees/min. with axis designation A or B or C)
Manual feed	X	4	
	Y	5	
	Z	6	
	IV	7	
Speed when approaching reference points	X	8	80 . . . 15 999 [mm/min]
	Y	9	
	Z	10	(Axis IV: Degrees/min. with axis designation A or B or C)
	IV	11	
Signal evaluation	X	12	1 ≙ 20-fold (max. traversing speed 16 m/min) 2 ≙ 10-fold (max. traversing speed 12 m/min)
	Y	13	
	Z	14	
	IV	15	
Traversing direction when approaching reference marks	X	16	0 ≙ Plus-direction 1 ≙ Minus-direction (with correct programming of parameters Nos. 20 to 27)
	Y	17	
	Z	18	
	IV	19	
Counting direction	X	20	0 or 1
	Y	21	
	Z	22	
	IV	23	
Polarity of nominal value voltage	X	24	0 ≙ positive with positive traversing direction 1 ≙ negative with positive traversing direction
	Y	25	
	Z	26	
	IV	27	
Integral factor	X	28	0 . . . 65 535
	Y	29	
	Z	30	
	IV	31	
Factor for difference value	X	32	0 . . . 65.535 (Values from table on section 6.2.3)
	Y	33	
	Z	34	
	IV	35	
Backlash compensation	X	36	– 1.000 . . . + 1.000 [mm]
	Y	37	
	Z	38	
	IV	39	Angular axis – 1,000 . . . + 1,000 [°]
Correction factor for linear correction	X	40	– 1.000 . . . + 1.000 [mm/m]
	Y	41	
	Z	42	
	IV	43	
Software limit switch ranges	X+	44	– 30000.000 . . . + 30000.000 [mm]
	X–	45	
	Y+	46	
	Y–	47	
	Z+	48	
	Z–	49	
	IV+	50	Angular axis – 30000.000 . . . + 30000.000 [°]
	IV–	51	

Function	Parameter No.	Entry values
Analogue voltage with rapid traverse	52	+ 4.5 . . . + 9 [V]
Approach speed	53	0.1 . . . 10 [m/min]
Acceleration	54	0.001 . . . 1.5 [m/s^2] As of software version 08: 0.001 . . . 3.0 [m/s^2]
Circular acceleration	55	0.001 . . . 1.5 [m/s^2]
Position supervision (erasable)	56	0.001 . . . 30 [mm]
Position supervision (emergency stop)	57	
Position window X, Y, Z	58	0.001 . . . 0.05 [mm]
Axis sequence for reference point approach	59	0 ≙ X Y Z IV 1 ≙ X Y IV Z 2 ≙ X Z Y IV 3 ≙ X Z IV Y 4 ≙ X IV Y Z 5 ≙ X IV Z Y 6 ≙ Y X Z IV 7 ≙ Y X IV Z 8 ≙ Y Z X IV 9 ≙ Y Z IV X 10 ≙ Y IV X Z 11 ≙ Y IV Z X 12 ≙ Z X Y IV 13 ≙ Z X IV Y 14 ≙ Z Y X IV 15 ≙ Z Y IV X 16 ≙ Z IV X Y 17 ≙ Z IV Y X 18 ≙ IV X Y Z 19 ≙ IV X Z Y 20 ≙ IV Y X Z 21 ≙ IV Y Z X 22 ≙ IV Z X Y 23 ≙ IV Z Y X
Speed pre-control	60	0 ≙ on 1 ≙ off
Output of tool numbers	61	0 ≙ No output 1 ≙ Output only when tool number changes 2 ≙ Output of tool number with every tool call 3 ≙ Output of tool store number (if MP 225 ≥ 1)
Output of spindle speed codes or as S-Analogue voltage	62	0 ≙ No output of spindle rpm 1 ≙ Coded output only when rpm changes 2 ≙ Coded output of all rpms 3 ≙ S-Analogue voltage output Gear switching signal only when gear ratio changes 4 ≙ S-Analogue voltage output, Output of all gear switching signals 5 ≙ S-Analogue voltage output without gear switching signal
rpm code limit	63	01991
Oscillation when accelerating	64	0.01 . . . 0.999
Display resolution	65	0 ≙ 1 µm 1 ≙ 5 µm
External feed rate potentiometer	66	0 ≙ internal potentiometer for override and manual feed 1 ≙ external potentiometer for override and manual feed 2 ≙ internal potentiometer for override external potentiometer for manual feed
Dwell time, rotation change of spindle in tapping cycle	67	0 . . . 65.535 [s]
Memory function for direction buttons	68	0 ≙ off 1 ≙ on
Special procedure for reference point	69	0 ≙ off 1 ≙ on
Nominal value voltage for spindle drive when tapping	70	0 . . . 9.999 [V]
Characters for program end and beginning	71	0 . . . 65 535

Function	Parameter No.	Entry values
Inhibited axes	72	0 ≙ none 1 ≙ X– 2 ≙ Y– 3 ≙ X–, Y– 4 ≙ Z– 5 ≙ X–, Z– 6 ≙ Y–, Z– 7 ≙ X–, Y–, Z– 8 ≙ IV– 9 ≙ X–, IV– 10 ≙ Y–, IV– 11 ≙ X–, Y–, IV– 12 ≙ Z–, IV– 13 ≙ X–, Z–, IV– 14 ≙ Y–, Z–, IV– 15 ≙ X–, Y–, Z–, IV–
Pre-cutout time for tapping cycle (only effective with BCD-output of the spindle speed)	73	0 . . . 65.535 s
Automatic operation: Override with rapid traverse button pressed	74	0 ≙ inactive 1 ≙ active add subsequent entry values depending on required function
Feedrate override		in 2 % -stages, + 2 ≙ variable override
Manual operation: Override with rapid traverse button pressed simultaneously		no override or + 4 ≙ active override
RPM-Override		in 2 % -stages, or + 8 ≙ variable override
Reference signal evaluation for inhibited axes	75	0 ≙ No display "traverse to reference points" for inhibited axes. If the position display of an inhibited axis must count, the reference point is to be traversed over. 1 ≙ "Traverse to reference points" is displayed for inhibited axes 2 ≙ No display "traverse to reference points" for inhibited axes. After a power interruption, position display is set to 0 and counts although reference points have not been approached.
– Display and transducer supervision for inhibited axes either active or inactive – Switch-off of transducer supervision of uninhibited or inhibited axes. The display remains active.	76	0 ≙ inactive 1 ≙ active add to 0 or 1: + 2 ≙ X without supervision + 4 ≙ Y without supervision + 8 ≙ Z without supervision +16≙ IV without supervision +32≙ V without supervision
PLC program from RAM or from EPROM	77	0 ≙ RAM 1 ≙ EPROM
RPM-range gear ratios 1 to 8 S-Analogue output	78 to 85	0 . . . 99 999 [rpm]
S-Analogue voltage with S-Override at 100 %	86	0 . . . 9.999 [V]
S-Analogue voltage with S-Override at max. output voltage	87	

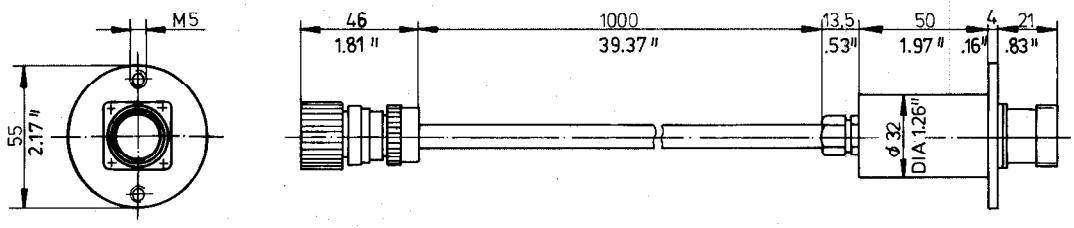
Function	Parameter No.	Entry values
Limitation of S-Override Maximum Minimum	 88 89	0 . . . 150 [%]
Axis designation for axis IV	90	0 ≙ A 3 ≙ U 1 ≙ B 4 ≙ V 2 ≙ C 5 ≙ W
Constant contouring speed on external corners	91	0 . . . 179.999 angles in degrees
– Decimal character	92	0 ≙ Decimal comma, 1 ≙ Decimal point
Selection of first dialogue language		* add to entry value + 2 ≙ dialogue language English
– switch-on test		+ 4 ≙ no memory test * + 8 ≙ no check sum test *
– stop with automatic/single block		+16≙ stop at end of current block *
– Display with inhibited axis IV		+32≙ 359,999° → 0°
Overlapping factor with pocket milling	93	0.1 . . . 1.414
PLC: Counter predetermined value for counter 0 – 15	94 to 109	0 . . . 65 535 (in units of 20 ms)
PLC: Timer duration for timer 0 – 15	110 to 125	0 . . . 65 535 (in units of 20 ms) (120, 121, 122 with standard PLC-program)
PLC: 30 position values for PLC-positioning (nominal value/orientation)	126 to 156	– 30 000.000 . . . + 30 000.000 [mm] (156, with standard PLC-program)
Activation of next tool No. or following store number	157	0 ≙ No output of next tool number 1 ≙ Output only with change of tool number 2 ≙ Output of next tool No. with every tool call 3 ≙ Output of next tool store number, programmable with TOOL DEF (if MP 225 ≥1)
Setting of 16 markers to binary number	158	0 . . . 65 535
Automatic lubrication to programmed traversing distance in X Y Z IV	159 to 162	0 . . . 65 535 (in 65 536-µm-units)
Feed rate for parameters Nos. 126 to 156 X Y Z IV	163 164 165 166	80 . . . 15 999 [mm/min]
Display of current feed rate before start in **MANUAL OPERATION** mode (same feed rate in all axes, i. e. smallest programmed feed rate from parameters 4 to 7))	167	0 ≙ off 1 ≙ on
Ramp gradient for S-Analogue	168	0 . . . 1.999 [V/ms]
Standstill supervision	169	0.001 . . . 30 [mm]
Programming station	170	0 ≙ Control 1 ≙ Programming station: PLC active 2 ≙ Programming station: PLC inactive
Handwheel and touch probe system	171	0 ≙ HR 150 or HR 250 and TS 511 1 ≙ HE 310 and TS 511 2 ≙ HR 150 or HR 250 and TS 111 3 ≙ HE 310 and TS 111

Function	Parameter No.	Entry values
Polarity S-Analogue voltage	172	0 ≙ M 03: positive voltage M 04: negative voltage 1 ≙ M 03: negative voltage M 04: positive voltage 2 ≙ M 03 and M 04: positive voltage 3 ≙ M 03 and M 04: negative voltage
Cancellation of status display with M 02, M 30 and program end	173	0 ≙ Status display not to be cancelled 1 ≙ Status display to be cancelled
Trailing error supervision in trailing operation Emergency stop erasable	174 175	0 . . . 100 [mm]
Multiplication factor for K_V-factor	176	0.001 . . . 1.000
K_V-factor for X Y Z IV	177 178 179 180	0.100 . . . 10.000
Characteristic kink	181	0 . . . 100.000 [%]
Minimum for feed rate override with tapping Maximum for feed rate override with tapping	182 183	0 . . . 150 [%] 0 . . . 150 [%]
Minimum voltage for S-Analogue output	184	0 . . . 9.999 [V]
Waiting time for cutout of remaining nominal value voltage with error display "Positioning error"	185	0 . . . 65.535 [s]
Tool change position M 92: X-Axis Y-Axis Z-Axis IV-Axis	 186 187 188 189	– 30 000.000 . . . + 30 000.000 [mm]
Programming of rpm S = 0 permitted (voltage value of MP 184 may be less)	190	0 ≙ S ≙ 0 permitted 1 ≙ S ≙ 0 not permitted
Display of current spindle rpm before spindle start	191	0 ≙ off 1 ≙ on
Position window for axis IV	192	0.001 . . . 0.5 [mm or °]
PLC: Timer duration for timer 16 – 31	193 to 208	0 . . . 65 535 (in units of 20 ms)
Support of PLC-macro commands	209 to 212	0
"Scaling" cycle effective for 2 or 3 axes	213	0 ≙ the programmed scaling factor is effective in the 3 main axes X, Y, Z 1 ≙ the programmed scaling factor is only effective in the working plane
.Programmed stop with M 06 Output of M 89	214	0 ≙ programmed stop with M 06, M 89 normal output at block beginning 1 ≙ no programmed stop with M 06, M 89 normal output at block beginning 2 ≙ programmed stop with M 06, M 89 modal cycle call at block end 3 ≙ no programmed stop with M 06, M 89 modal cycle call at block end

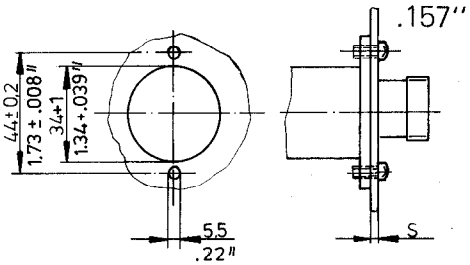
Function	Parameter No.	Entry values
Axis standstill with M-S-function **Exceptions:** Axis standstill takes place with M-functions which are followed by a programmed stop (such as M 00, M 02 ...) or with a STOP or CYCL CALL-block.		.. + 4 ≙ if 4 is added to the above entry value, no axis standstill with output of spindle speed .. + 8 ≙ if 8 is added to the above entry value, no axis standstill with output of M-functions
Touch probe system probing speed	215	80 . . . 3000 [mm/min]
Touch probe system measuring distance	216	0 . . . 19999.999 [mm]
Switchover HEIDENHAIN dialogue programming ISO (G-code)-programming	217	0 ≙ HEIDENHAIN-dialogue 1 ≙ ISO (G-codes)-format
"Transfer blockwise" ASCII-characters for data input	218	0 . . . 65 535
"Transfer blockwise" ASCII-characters for data output	219	0 . . . 65 535
"Transfer blockwise" ASCII-characters for beginning and end of heading block	220	0 . . . 12 079
"Transfer blockwise" ASCII-characters for transmission correction or block repetition	221	0 . . . 12 079
Data format and transmission stop for data interface V.24 (RS-232-C)	222	0 . . . 255
Operating mode data interface V.24 (RS-232-C)	223	0 ≙ "Standard data interface" 1 ≙ "Transfer blockwise"
"Transfer blockwise" ASCII-character, data transmission end	224	0 . . . 12 079
Central tool memory	225	0 ≙ no central tool memory 1 . . . 99 ≙ central tool memory with number of tool stores
Graphics hard copy printout Number of command characters for setting the printer interface + 1 command character	226	0 . . . 65 535
Graphics hard copy printout 2 each of characters for setting the printer interface	227 228 229	0 . . . 65 535
Graphics hard copy printout Number of command characters before each print line + 1 command character	230	0 . . . 65 535
Graphics hard copy printout 2 each of characters before every print line	231 232 233	0 . . . 65 535
Movement supervision	234	0.03 . . . 10 [V]
Touch probe system: safety distance above measuring point for automatic probing	235	0 . . . 19 999.999 [mm]
.Projection of graphics image in 3 planes .Rotation of the coordinate system in the working plane	236	0 ≙ German standard 1 ≙ U.S. third angle projection if 2 is added to the previous entry value, the coordinate system is rotated by + 90°
Activation and function of the Vth axis	237	0 ≙ Vth axis inactive 1 ≙ Vth axis serves for orientation of main spindle, without position display 2 ≙ as per entry value 1, however with position display (display instead of the IVth axis)

Function	Parameter No.	Entry values
		3 ≙ Vth axis uncontrolled, however with position display, axis designation A (display instead of the IVth axis 4 ≙ as per entry value 3, however axis designation B 5 ≙ as per entry value 3, however axis designation C
K_V-factor for Vth axis	238	0.100 . . . 10.000
Counting direction for Vth axis	239	0 ≙ positive for positive traversing direction 1 ≙ negative for positive traversing direction
Position value at the reference mark for Vth axis	240	0 . . . 360.000
Variable contour pocket machining Milling direction for premilling of contour	241	0 ≙ Pre-milling of variable contour pocket in CCW and CW for islands. 1 ≙ Pre-milling of variable contour pocket in CW and CCW for islands.
Sequence: rough-out and contour pre-milling		add to entry value: + 2 ≙ Rough-out prior to contour milling otherwise pre-milling of contour first
Combining of contours		+ 4 ≙ uncorrected contours to be combined
Reference mark spacing for distance-coded HEIDENHAIN linear transducer versions X Y Z IV	 242 243 244 245	0 ≙ no distance-coded reference marks 0 . . . 65 535 [µm]
Positioning window for Vth axis	246	1 . . . 65 535 (incremental)
Hysteresis for electronic handwheel	247	0 . . . 65 535 (increments)
Spindle rpm for spindle orientation	248	0 . . . 99 999 [rpm]
Setting of 16 markers to binary number (markers 2208 to 2223)	249	0 . . . 65 535
Setting of 16 markers to binary number (markers 2224 to 2239)	250	0 . . . 65 535
Rapid traverse / Touch probe system	251	180 . . . 15 999 [mm/min]
Cycle duration for automatic offset adjustment	252	1 . . . 65 535 [in units of 20 ms] 0 ≙ no automatic adjustment
Transducer inputs assignment/positioning loop 1 2 3 4 5	253 254 255 256 257	0 ≙ X / 1 ≙ positioning loop X 0 ≙ Y / 2 ≙ positioning loop Y 0 ≙ Z / 3 ≙ positioning loop Z 0 ≙ IV / 4 ≙ positioning loop IV 0 ≙ V / 5 ≙ positioning loop V
RPM for spindle orientation Depends on marker M2501	258	0 – 99 999 [rpm]
Language switchover for user-cycles	259	0 – 99, corresponding to the difference between Q-number of dialogue and corresponding translation
Non-functional	260 to 262	0
Begin Q-parameter No. for "DLG-DEF"-block	263	0 – 99 0 – if "DLG-CALL" blocks only

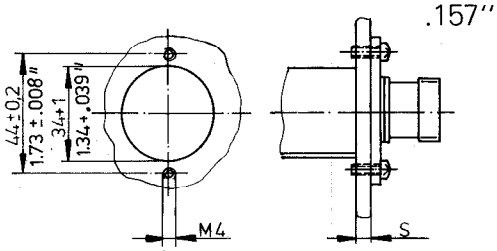
Adapter cable for HR 250
Id.No. 218 228 01



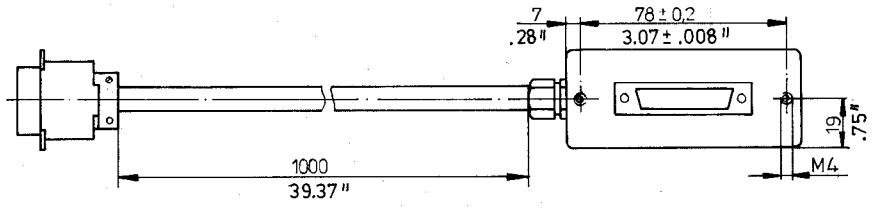
Mounting for wall thickness S < 4



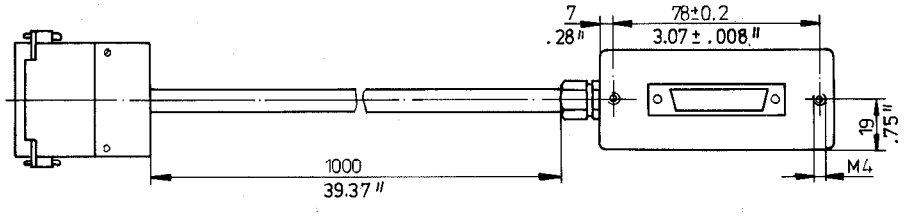
Mounting for wall thickness S > 4



Adapter cable from TNC
to RS-232-C standard connector
Id. No. 214 001 01

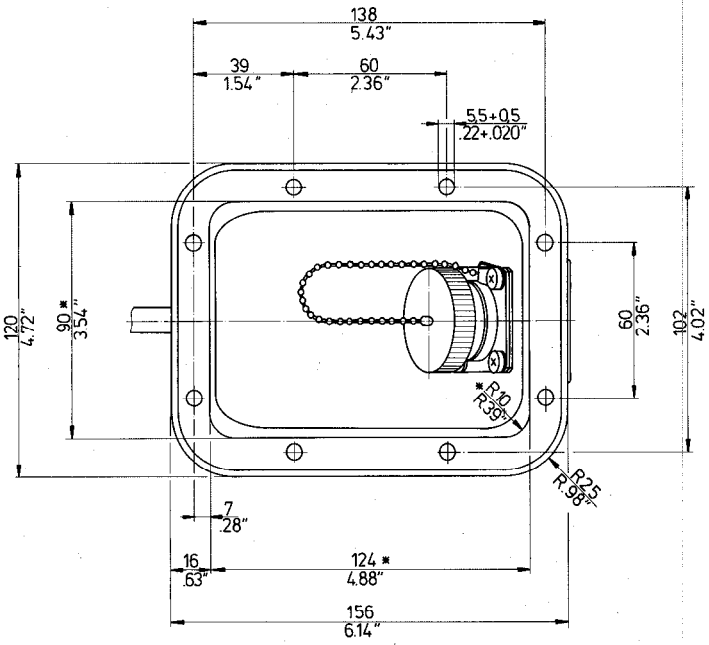


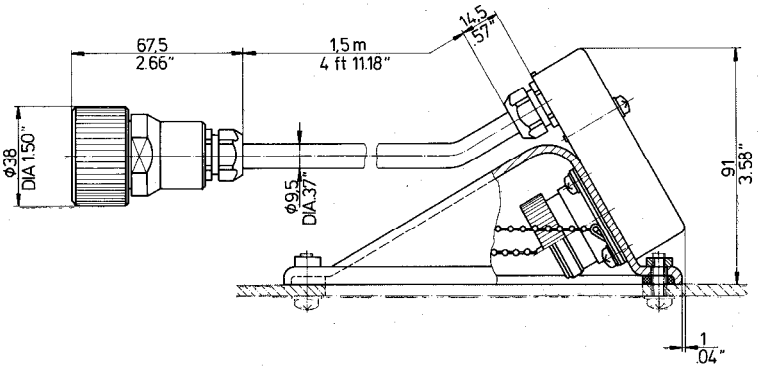
Adapter cable from ME 102
to RS-232-C standard connector
Id. No. 217 707 01

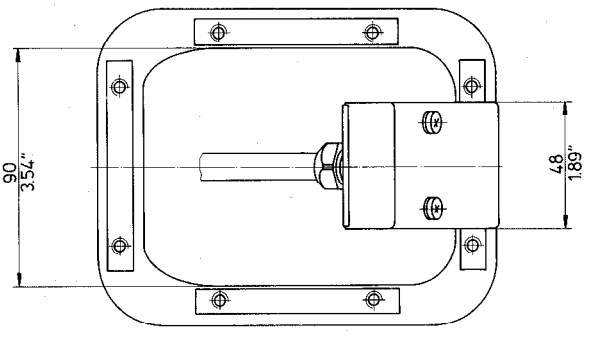


Adapter cable for HE 310

Id.No. 235 430 ..





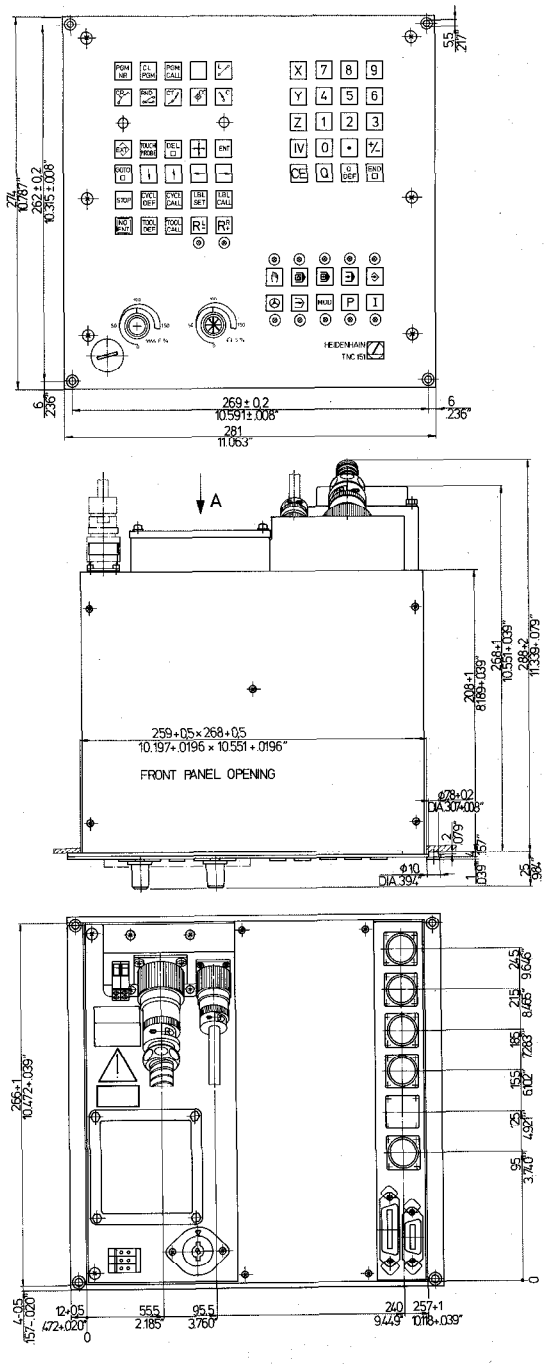


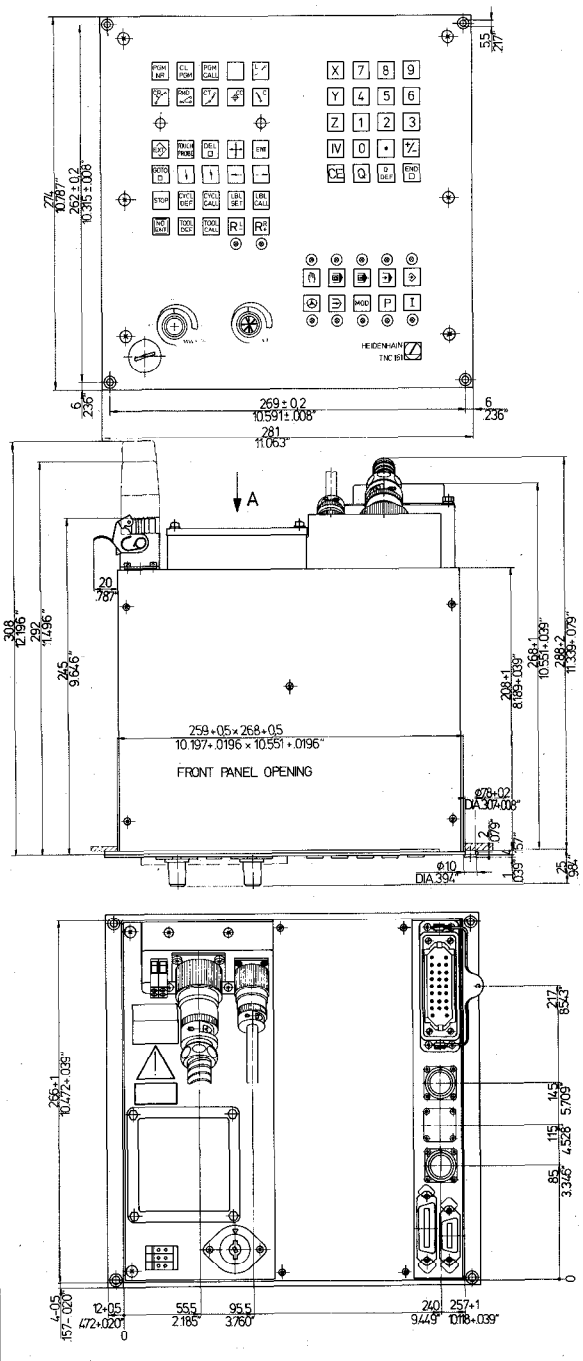
* OPENING FOR MOUNTING

13. Dimensions mm / inch
Control unit

TNC 151 B/Q
TNC 151 F/W

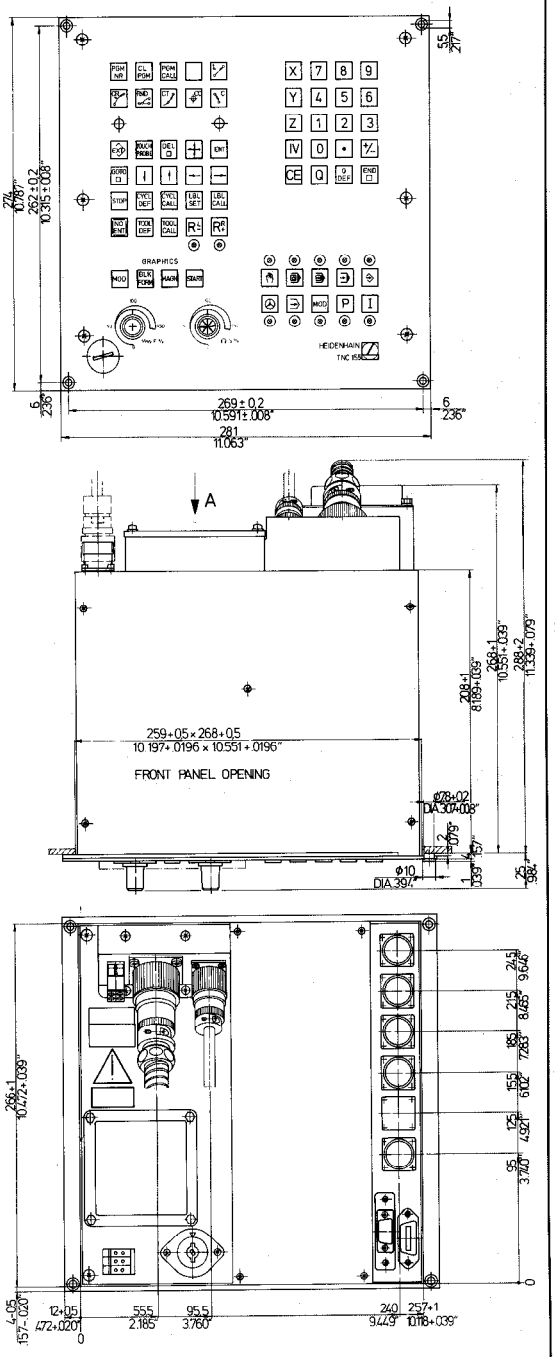
TNC 151 BR/QR
TNC 151 FR/WR



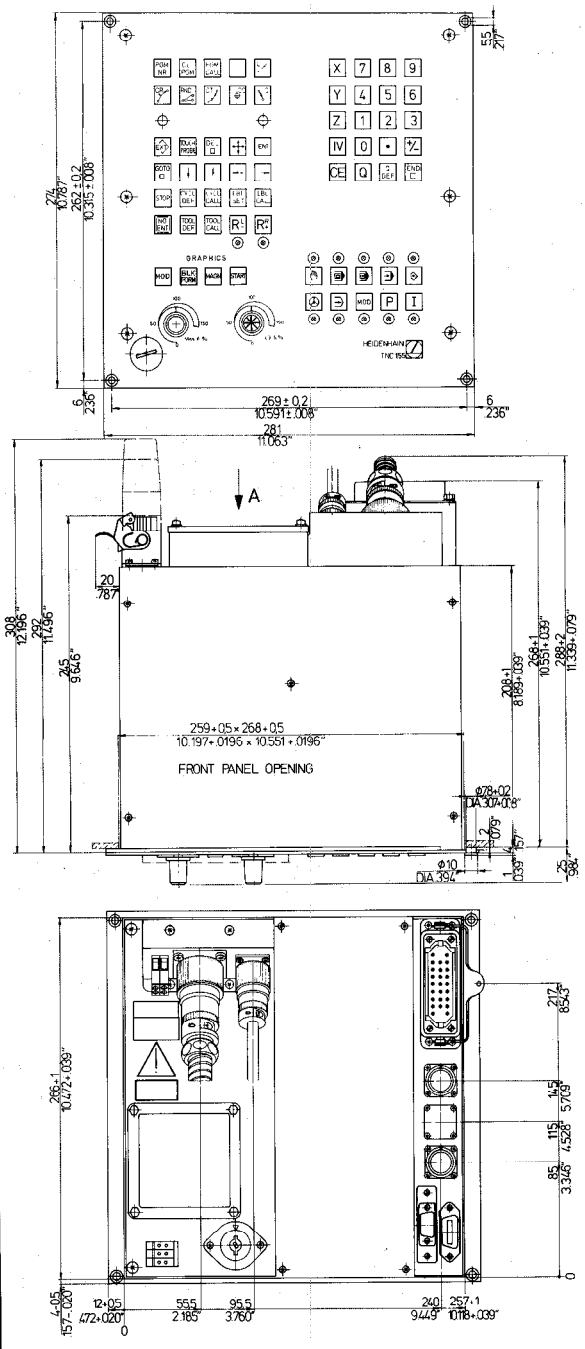


TNC 155 B/Q
TNC 155 F/W

TNC 155 BR/QR
TNC 155 FR/WR

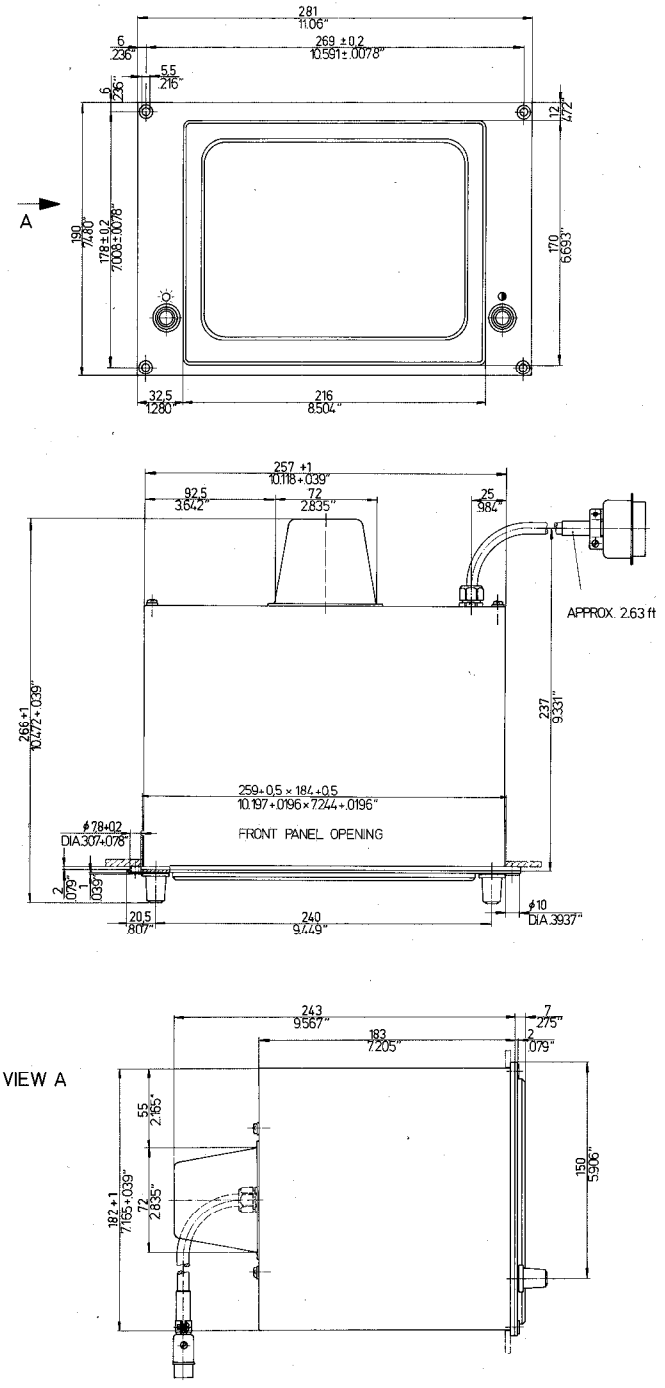


VIEW A

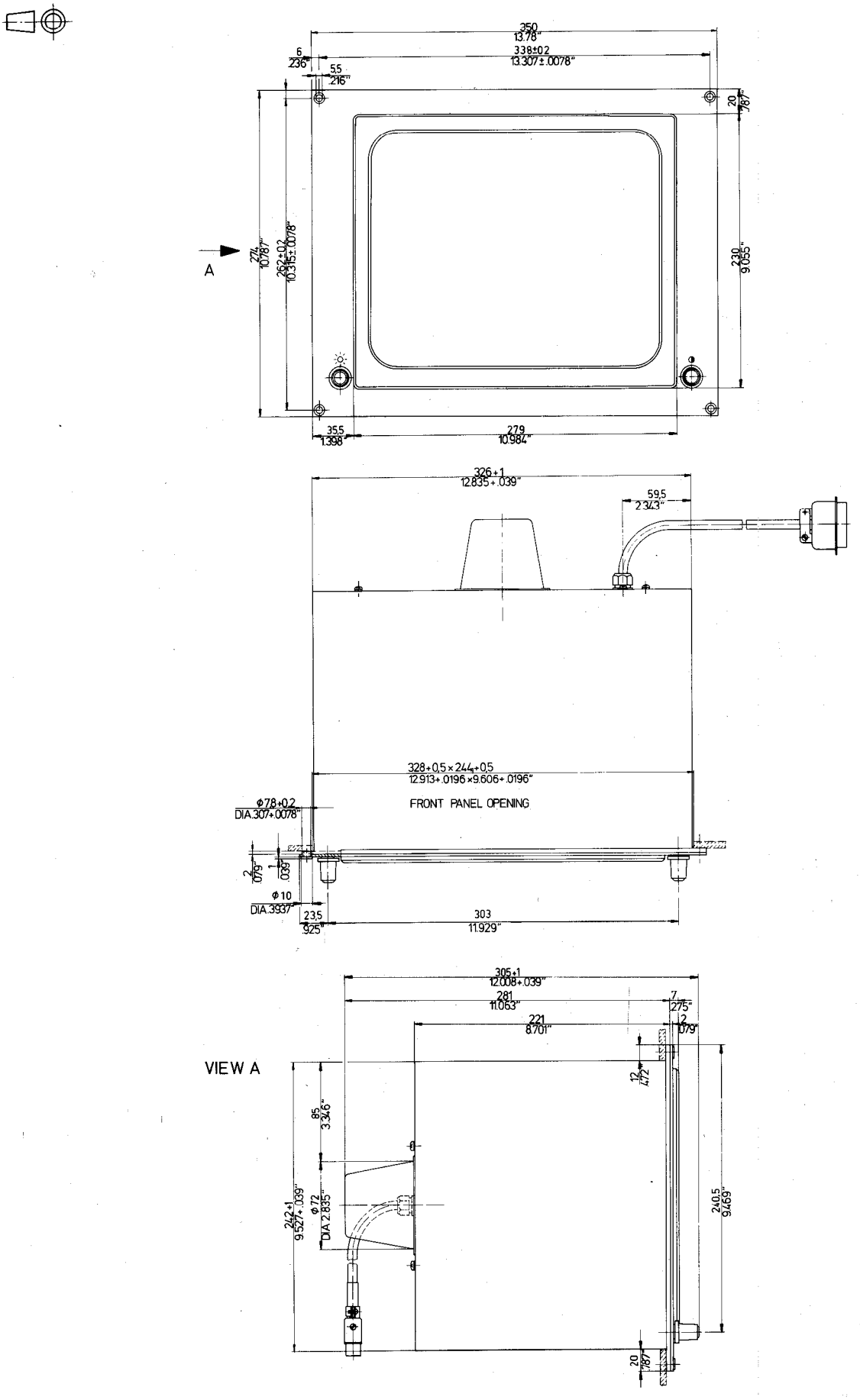


VIEW A

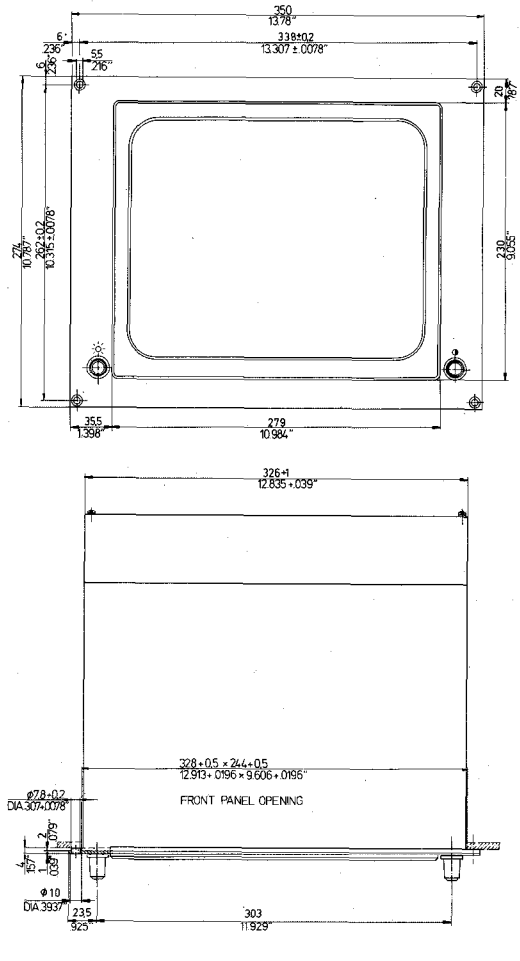
BE 111 (9") for TNC 151

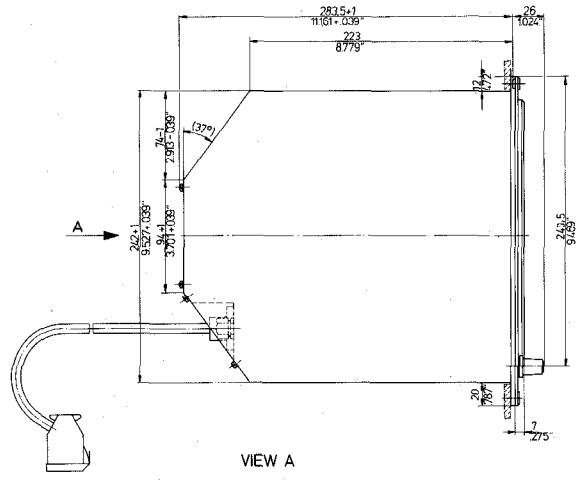


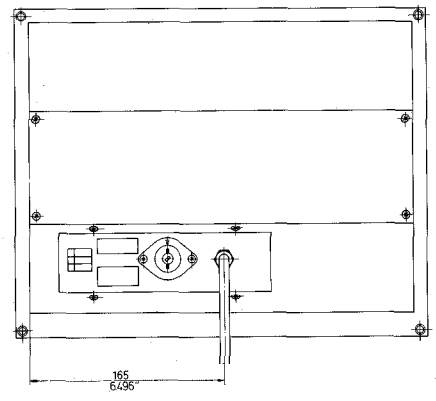
BE 211 (12") **for TNC 151**



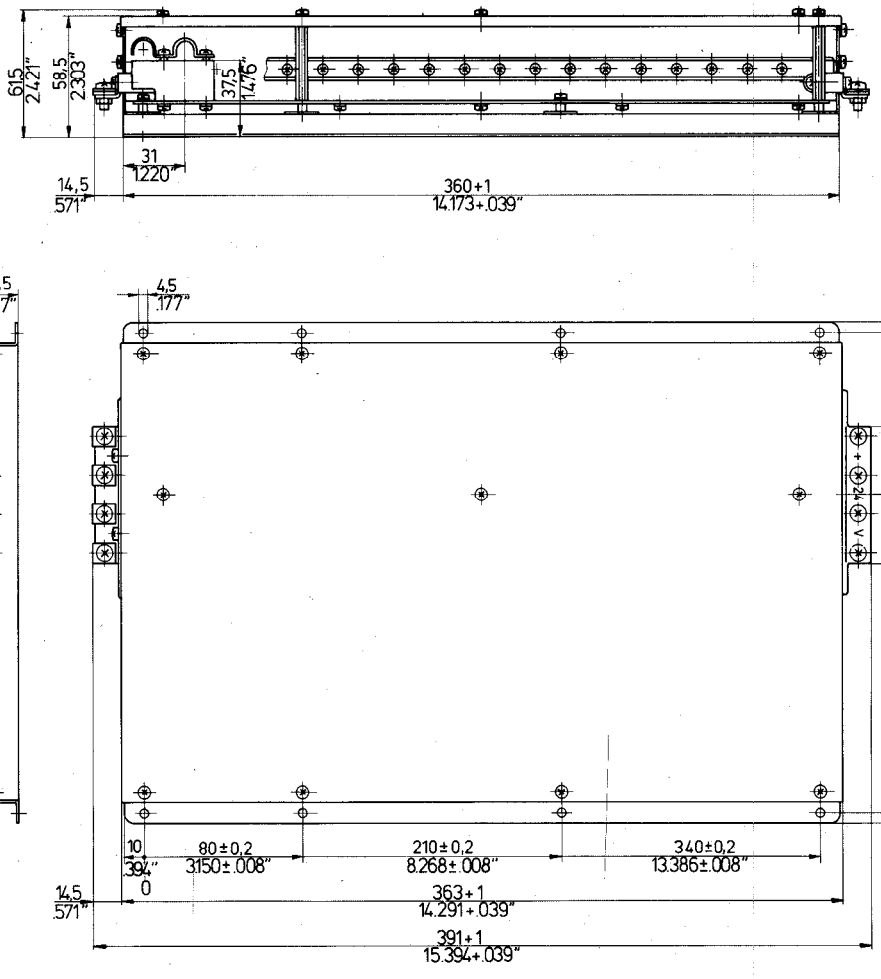
BE 411 (12") **for TNC 155**



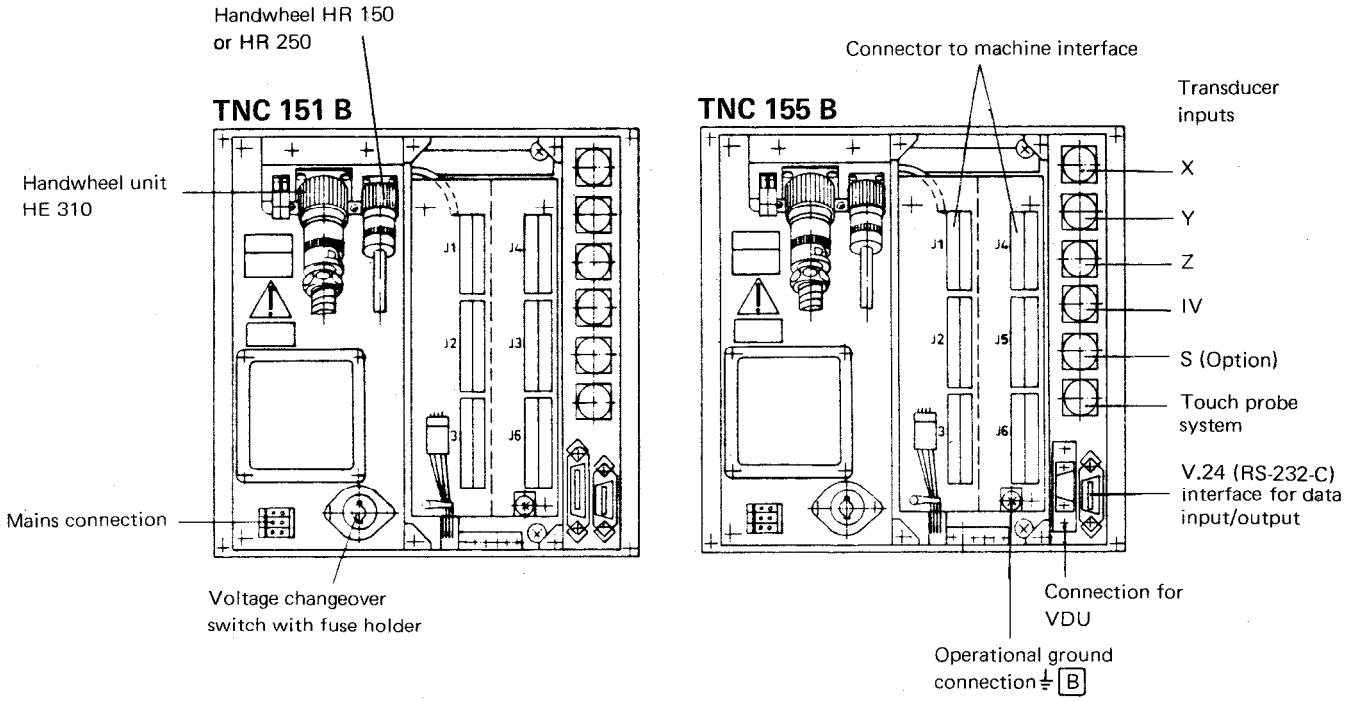




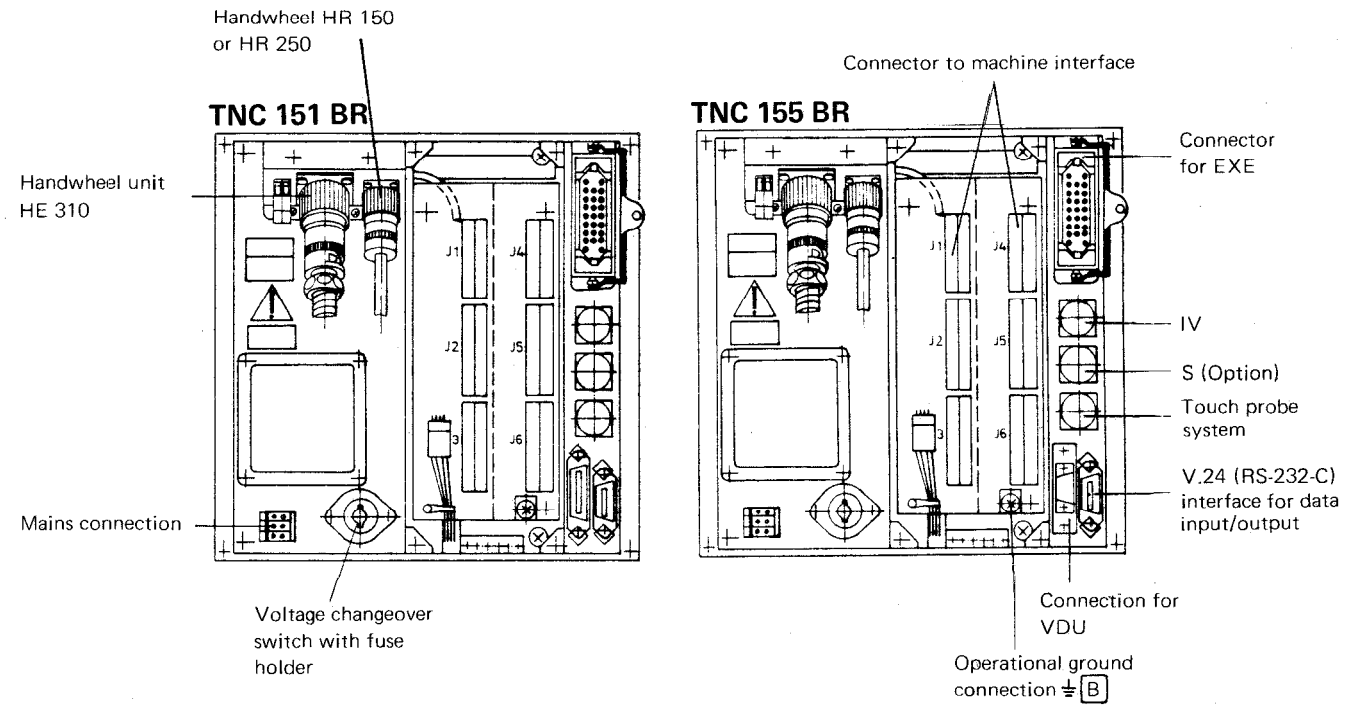
PL 100B/PL 110 B



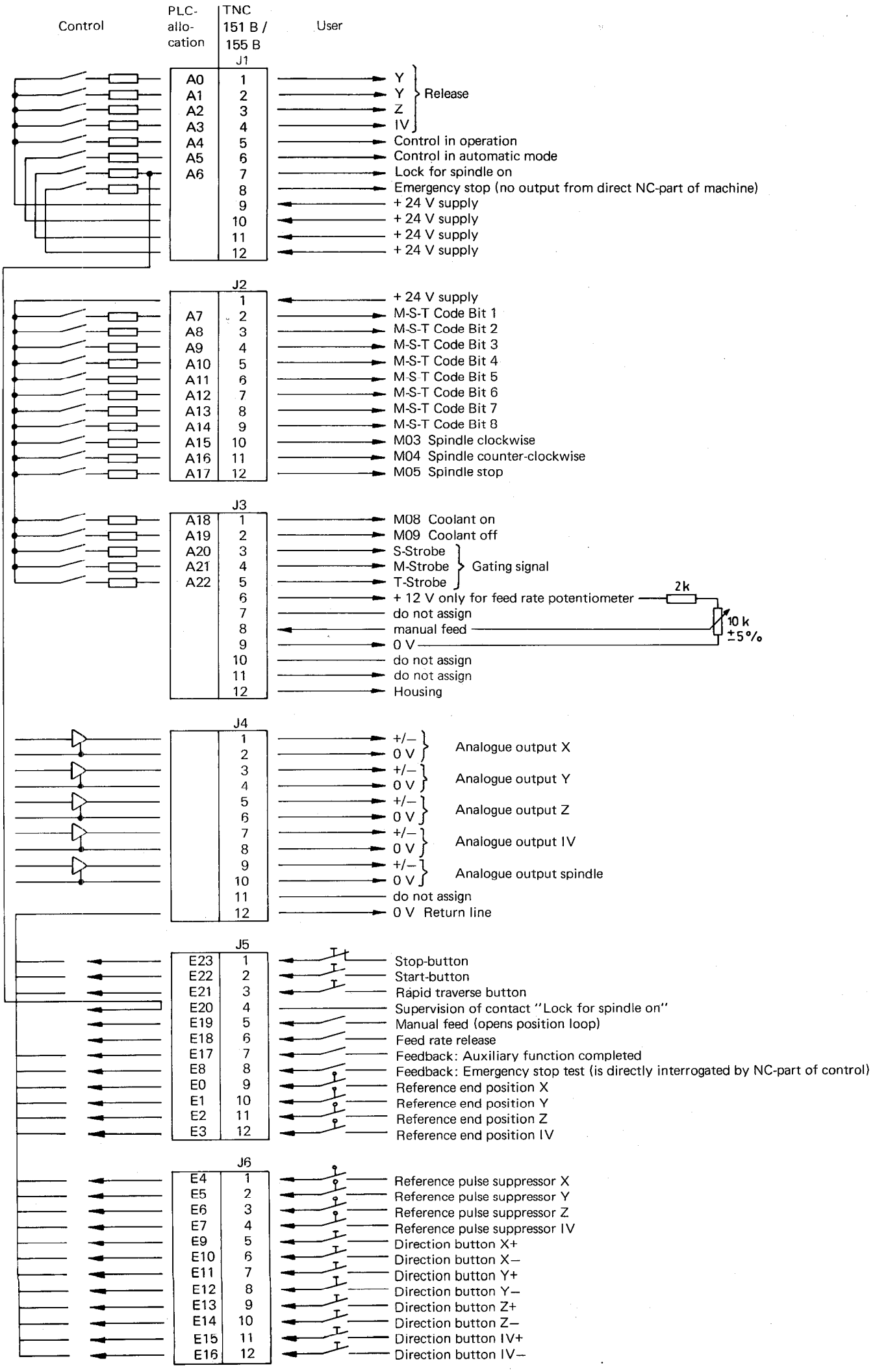
TNC 151 B / TNC 155 B Location of connections



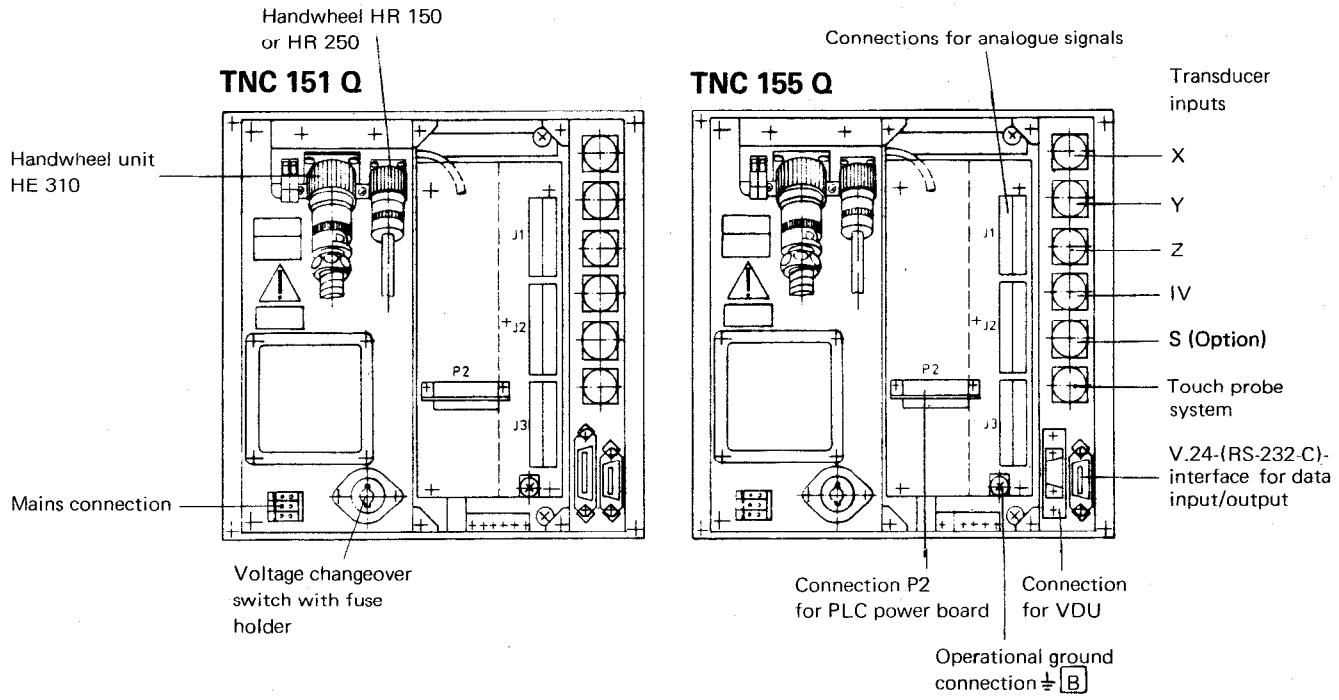
TNC 151 BR / TNC 155 BR Location of connections



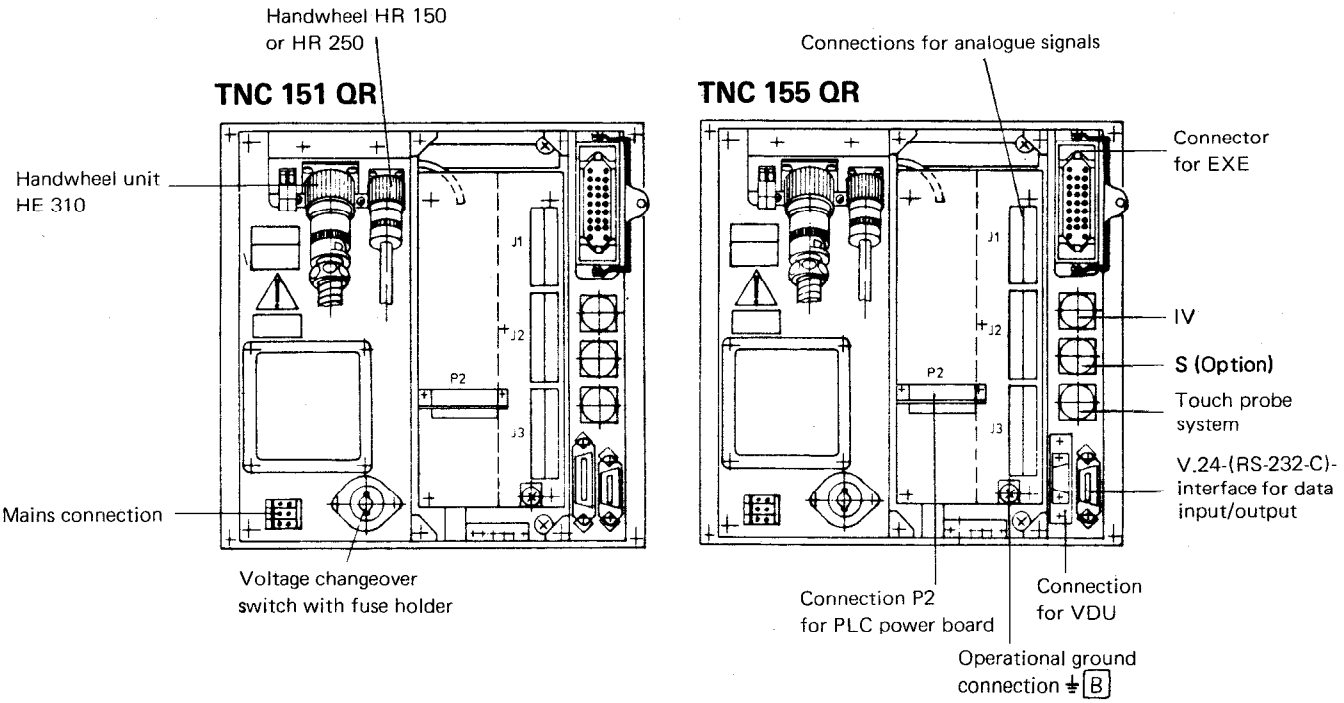
TNC 151 B / TNC 155 B / TNC 151 BR / TNC 155 BR Connections and PLC-allocation



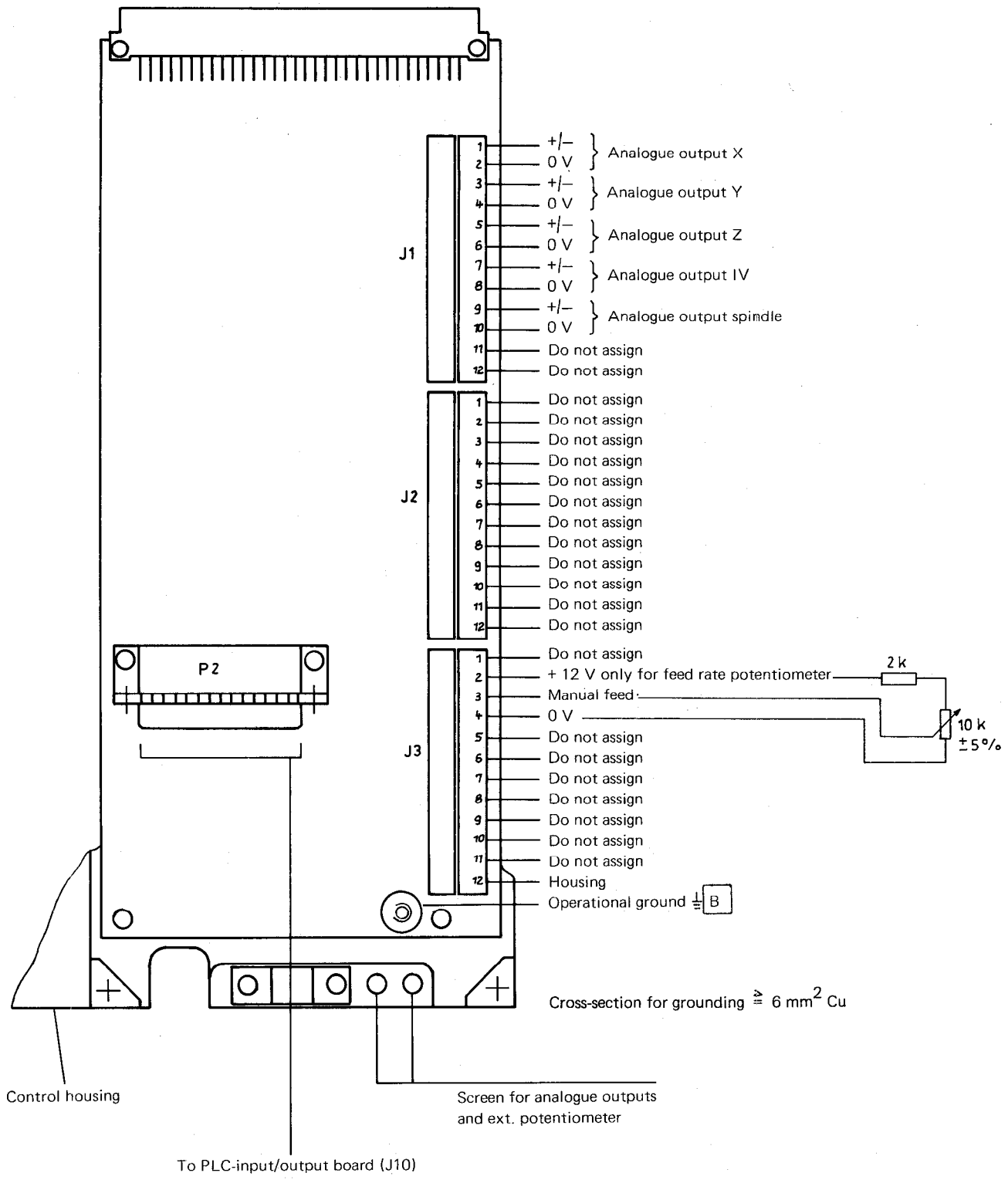
TNC 151 Q / TNC 155 Q Location of connections on control unit



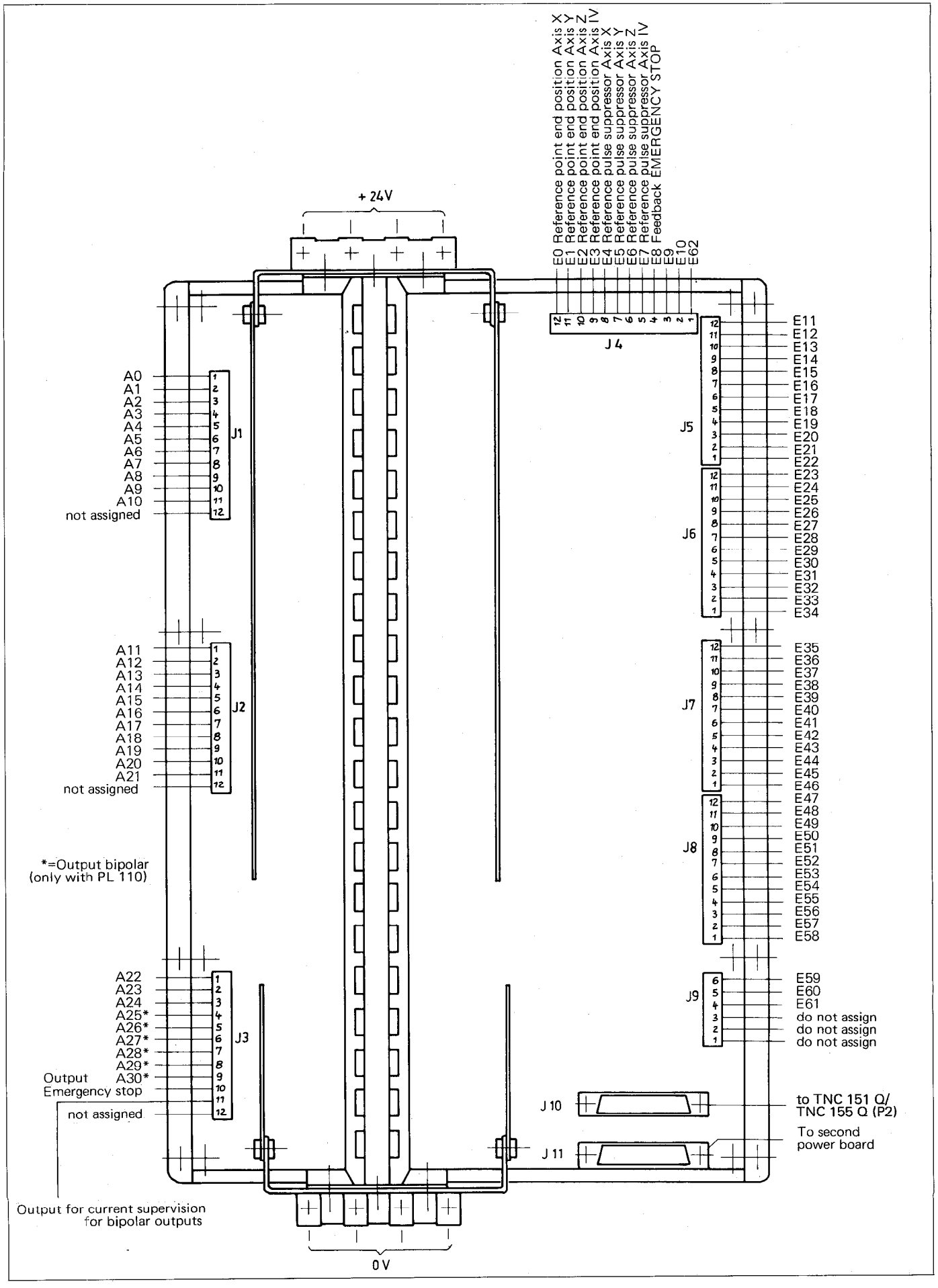
TNC 151 QR / TNC 155 QR Location of connections on control unit



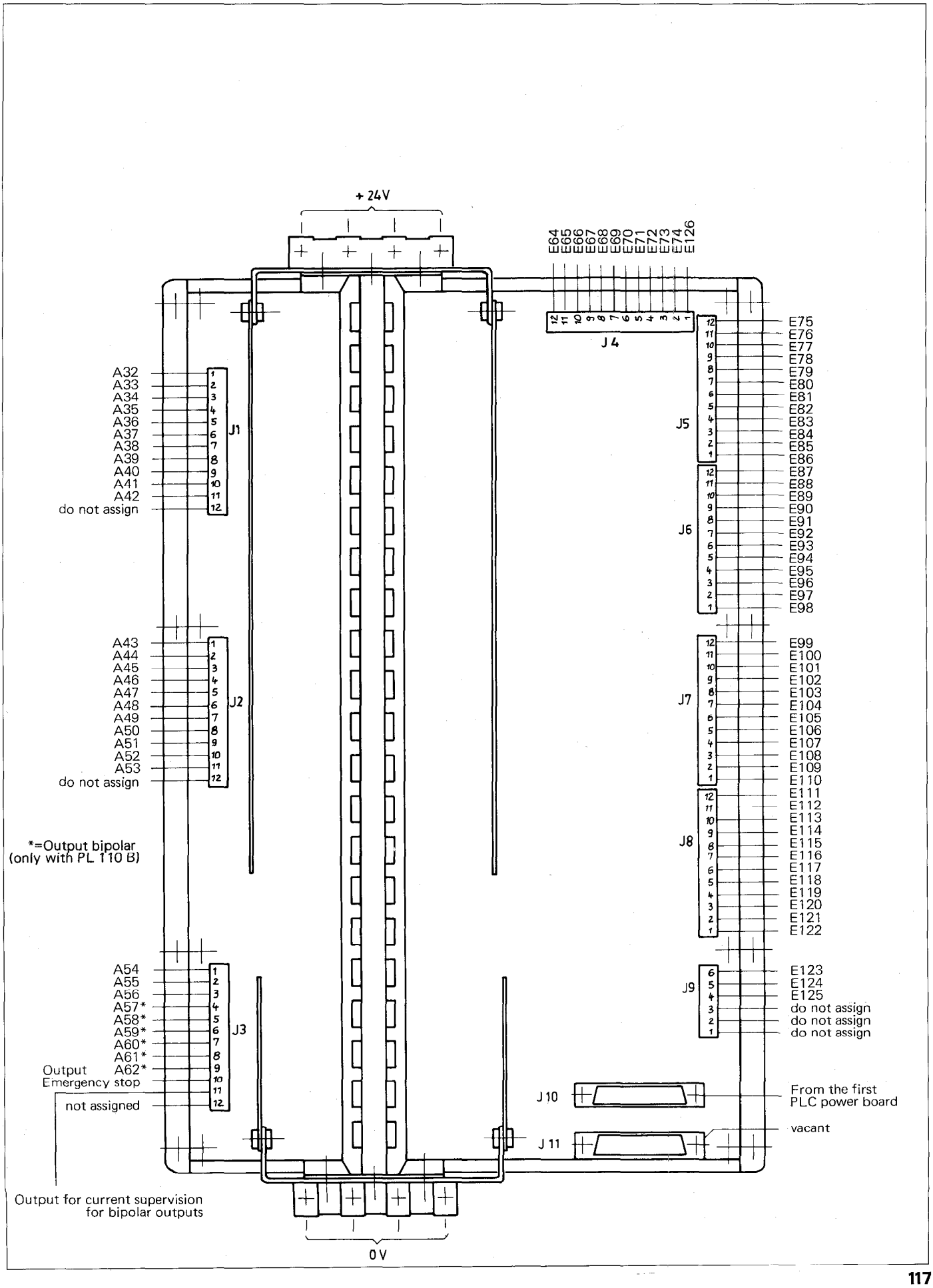
TNC 151 Q / TNC 155 Q / TNC 151 QR / TNC 155 QR Connector for analogue signals



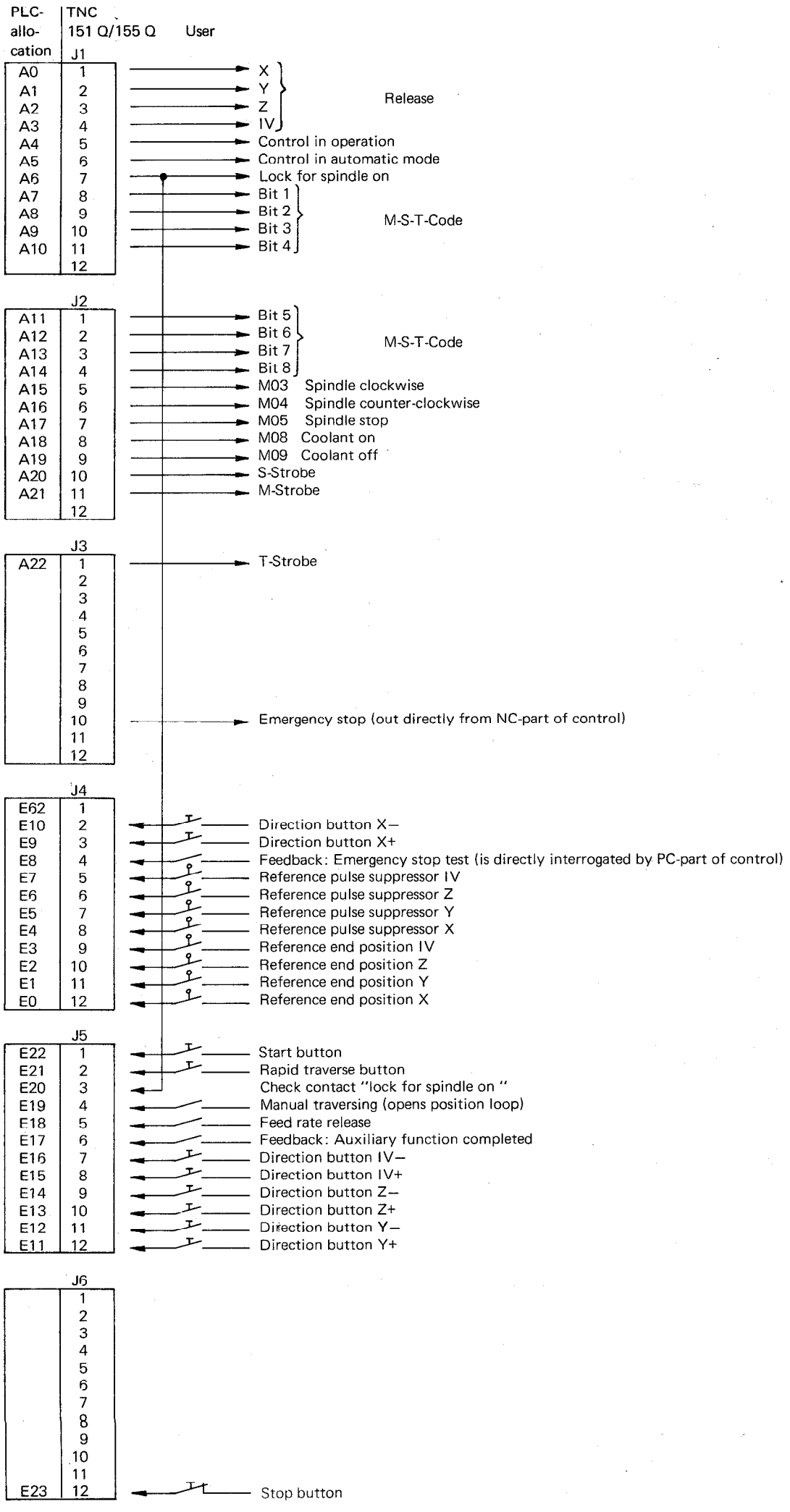
TNC 151 Q / TNC 155 Q / TNC 151 QR / TNC 155 QR Terminals and PLC-allocation of first PLC-board



TNC 151 Q / TNC 155 Q / TNC 151 QR / TNC 155 QR Terminals and PLC-allocation of second PLC-board



TNC 151 Q / TNC 155 Q / TNC 151 QR / TNC 155 QR Terminals and PLC-allocation, PLC-board PL 100 B / PL 110 B for standard PLC-program



HEIDENHAIN

232 686 25 · 5 · 12/88 · H · Printed in West Germany · Subject to technical modifications