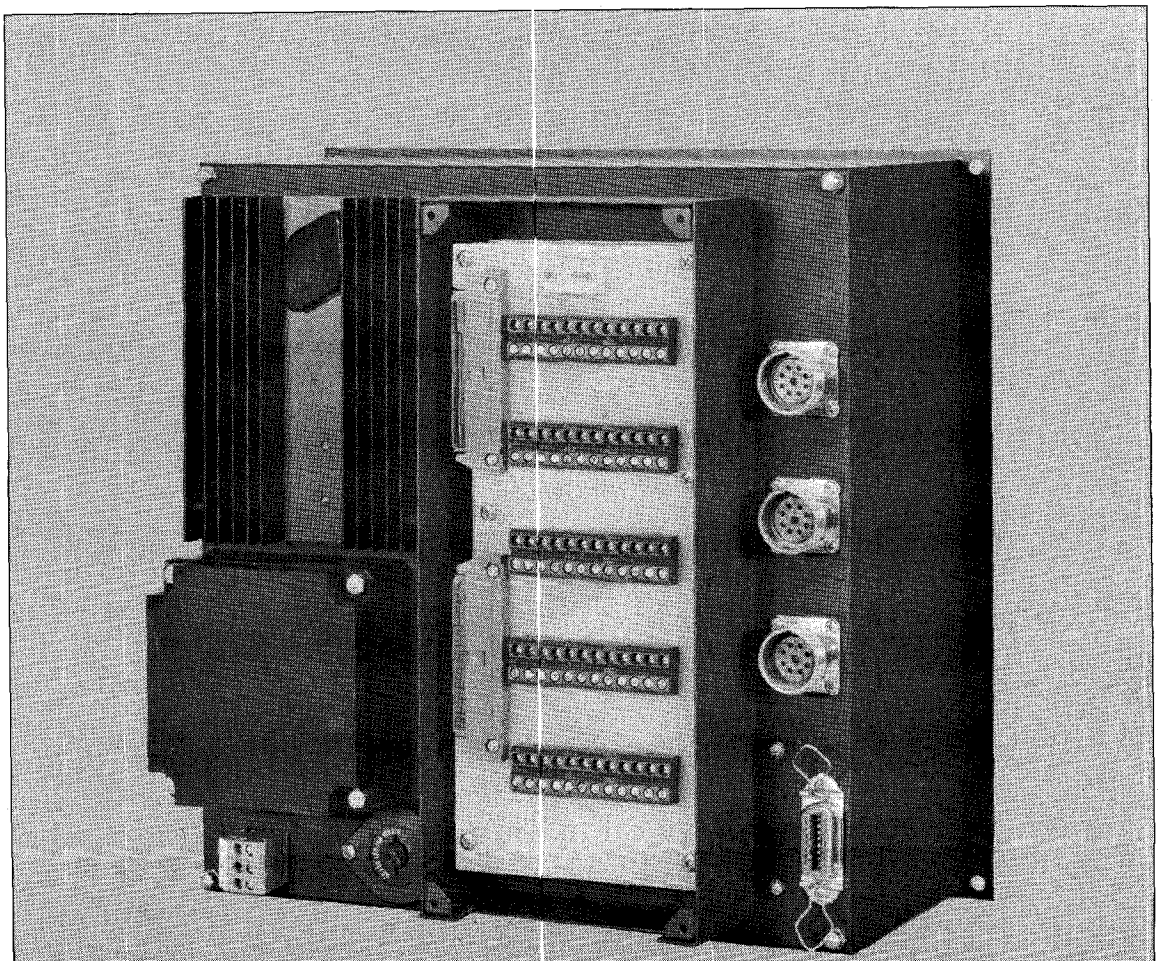
HEIDENHAIN

Mounting Instructions and Interface Circuit Control-Machine

Control HEIDENHAIN TNC 135 B



CONTENTS

1. Introduction

The Control TNC 135 B is a 3-axis Manual Data Input (MDI) control. It has been designed for direct programming on the machine by the machine operator. For this reason, some of its details purposely deviate from established programming standards. Special attention has been given to simple operation and a clear arrangement of the control panel. For this reason, no attempt has been made to save on the number of displays

The keys have been allocated to three groups and care has been taken that keys do not have "double functions".

Hardware variants

The following versions of TNC 135 are available.

TNC 135 B — For connection of linear encoders with 20 µm grating period or rotary encoders.

The earlier control types TNC 135 S and TNC 135 ST has a signal evaluation for the connection of linear encoders with 40 µm grating period.

TNC 135 RT — For the connection of linear encoders with 100 µm grating period or for cables longer than 20 m (66 ft). The encoder inputs are designed for square-wave signals.

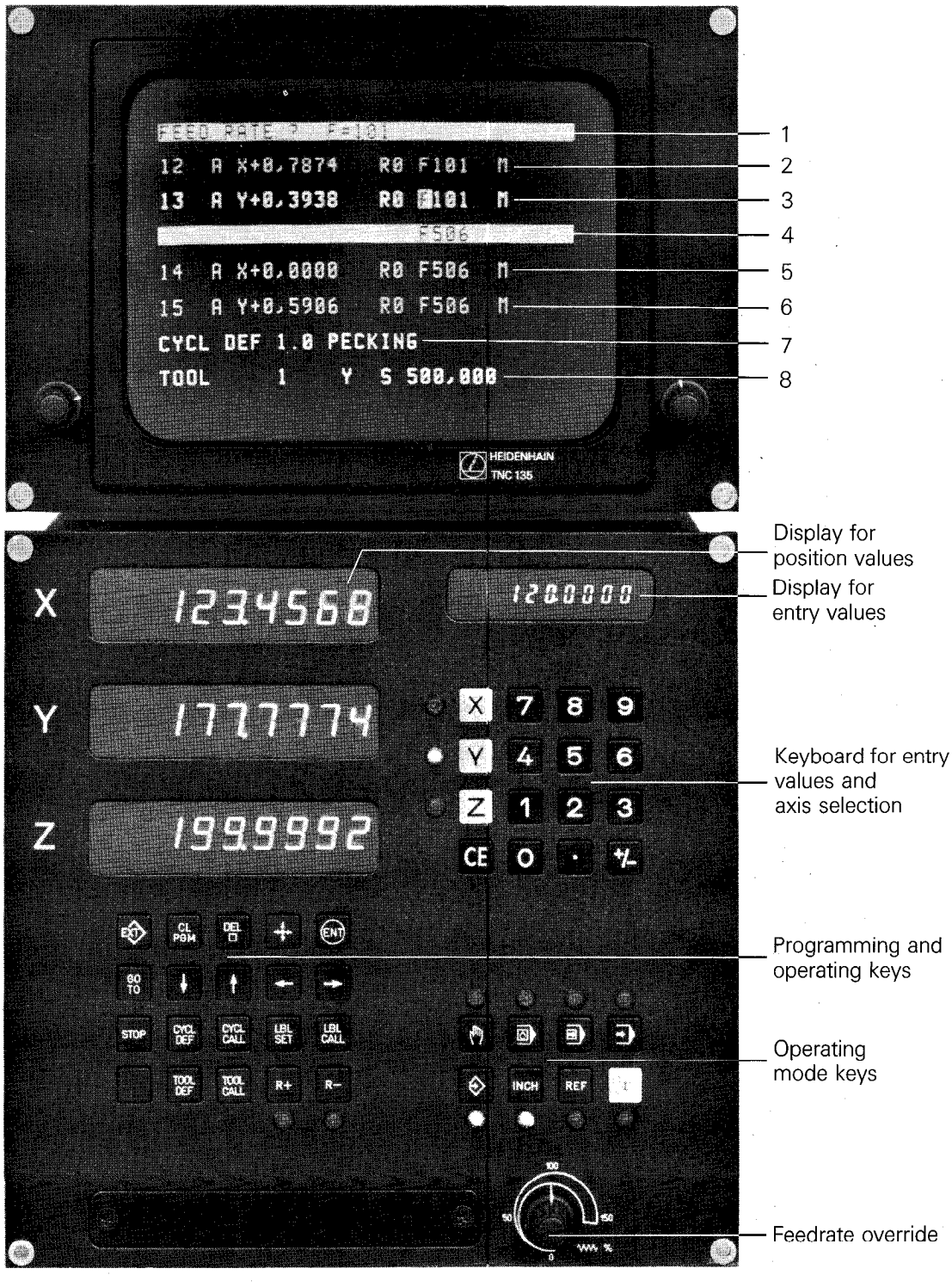
For dialogue and program display, the TNC 135 B has a VDU (visual display unit) instead of the plain dialogue display window.

The independent VDU is connected to the rear of the TNC 135 B control.

The VDU displays 8 lines each having 32 characters.

In order to obtain a clearer VDU-display, certain items of information are displayed brighter or invertedly (brightness adjustment with the right-hand potentiometer on the front panel; the basic brightness is adjusted with the left-hand potentiometer).

Line	Displayed information	Display image
1	Dialogue line (Dialogue for programming, error/fault indication)	green background
2	Program block display (N-1)	normal
3	Current program block (N) and cursor function	bright
4	Editing line	green background
5	Program block display (N+1)	normal
6	Program block display (N+2)	normal
7	Cycle display: call up via CYCL CALL	bright
8	Display: last selected tool	bright



The programming procedure is "dialogue-guided" i.e. the necessary data required for program entry is asked for by the TNC 135 B - in the correct sequence - via the plain language display.

The TNC 135 B has the following facilities:

mm/inch instant conversion

- Tool compensation (radius and length)
- Programming of feed rates, rapid traverse, spindle speeds in mm/min (or 0.1 in./min or rpm)
- Subprograms, program part repeats, fixed program cycles and M-, S- and T-functions.

TNC 135 B - Programming can be performed in the following ways:

- with stationary machine in accordance with a workpiece drawing or program sheet.
- by "keying in" values prior to automatic machining of the first workpiece of a batch or series.
- by transferring actual machine position data during the automatic or conventional machining of a workpiece blank ("playback").
- external programming via the V.24 input/output.
  This input/output enables the connection of a magnetic tape storage unit, or a punched tape unit, or telex, or printer or any other compatible peripheral equipment.

After program entry into the TNC-memory, workpieces can be machined one after the other.

Please note:

TNC 135 B operation is explained in the TNC 135 B "Operating Manual".

1.1 General remarks

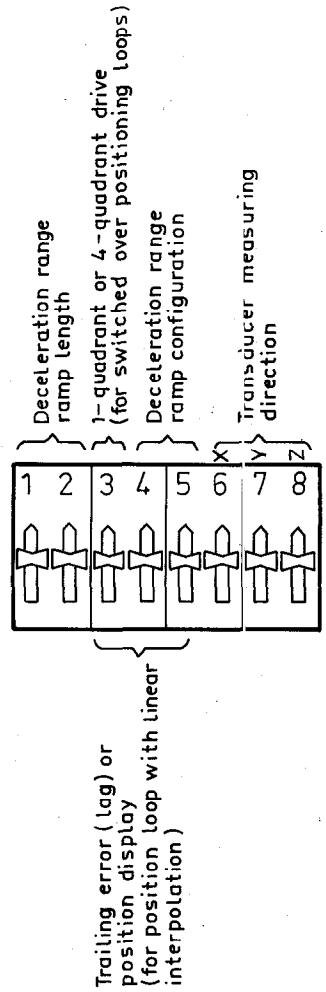
Caution ! All inputs and outputs of the TNC control should be connected to electric circuits which generate voltages in accordance with VDE 0100/5.73 8 (German standard, protective low voltage).

Do not engage or disengage any plug connections whilst unit is under power !

NC machines also require the necessary safety devices as used on manually operated machines (e.g. limit switches, "Emergency STOP" buttons etc.). The proper functioning of the devices should be checked before commencing operation !

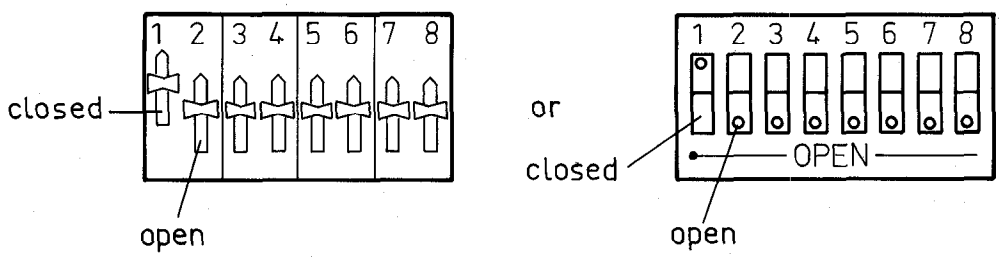
2. Coding switches for measuringdirections ramp configuration and length and displays (diagram)

The code switch with 8 channels is located within the terminal box at the rear of the TNC.



The setting of the channels is mentioned in the appropriate sections.

Please note:
In future a toggle switch might be used in place of the slide switch.
The switch positions (switch open or closed) for both types are indicated in the following diagram.



In this manual only the slide switch is referred to. Setting of the toggle switch is carried out correspondingly.

3. Available Software versions

Four basic software versions are available which were designed for various operating modes.

The TNC 135 B are suitable for:

a) Common drive with switched-over position loops - without backlash

b) Common drive with switched-over position loops - with backlash

c) Single-axis drives with linear interpolation - position loops switched off (simultaneous positioning in two axes possible)

d) Single-axis drives with linear interpolation - permanently closed position loops (simultaneous positioning in two axes possible)

Moreover, the controls are available with the following dialogue languages:

English
German
French
Italian
Portugnese
Russian

Technical details of each software version are dealt with in items 4 and 5. The descriptions in the remaining items are valid for all TNC-versions.

4. Software version: Common drive with switched-over position loop

With this design, the control can be used with a common drive and three electrically-activated axis clutches or with three single axis drives with a common servo amplifier.

With common drive, the axis release relays activate the axis clutches and the servo-amplifier simultaneously. With single axis drives with common servo-amplifier, the motor and tacho-generator of each axis is switched to the servo-amplifier. Only when this procedure is completely ended may the servo-amplifier release be activated (e.g. external time delay < 200 ms).
After reaching the nominal position , the cut-out procedure takes place in reverse order:
Inactivation of servo-amplifier release, then cut-out of drive and tacho-generator from servo-amplifier.

Caution:

The tacho-generators should not (if possible) be switched via the relay contacts. Due to the tacho-generator only supplying one signal, it is recommended that a combined circuit should be formed from the three tacho-signals.

Please note:

The requirements of the servo-amplifier manufacturer must be observed.

Two software versions are available for operation with switched-over position loop:

- for drive spindles with backlash
- for backlash-free drive spindles (ball-screw spindles with direct coupling to axis drives)

4.1 Common drive with backlash

		TNC 135 B
Software: Dialogue	German	214 367
	English	214 368
	French	214 369
	Italian	214 370
	Portugnese	214 379
	Russian	214 383

Suitable servo-amplifiers:

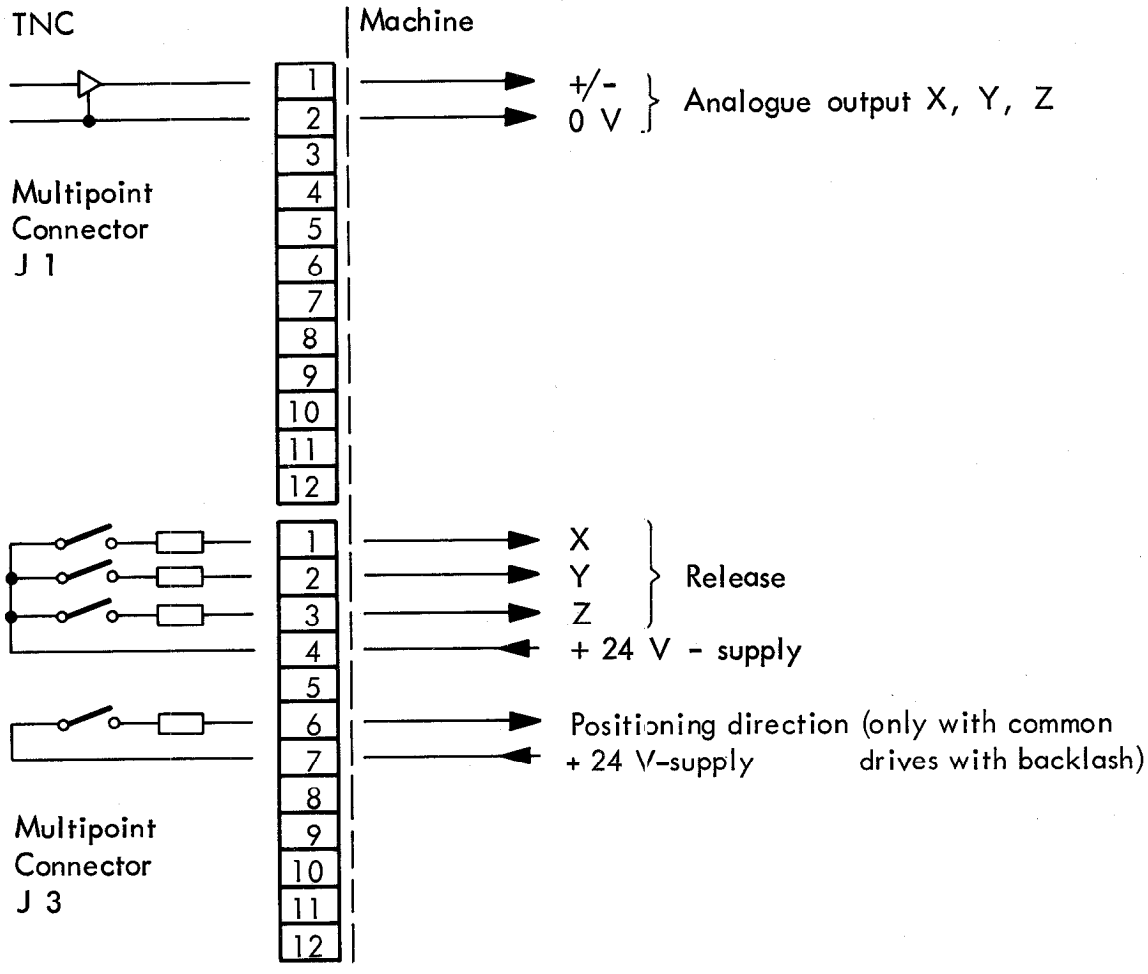
4-quadrant units,

2 and 1-quadrant units (Polarity of drive and tacho-generator are determined by the relay output "positioning direction")

Switch-over from 4-quadrant to 1-quadrant or 2-quadrant operation with the code switch of the third channel.

channel 3	drive type:	 1 or 2-quadr. servo-ampl.	 4-quadr. servo-ampl.

Multipoint-Connector Layout



Owing to the backlash-prone drive spindle the positioning direction is determined before the positioning procedure and held constant for the positioning period.

With the "Override"-potentiometer no machine standstill can be achieved with this positioning loop (offset-voltage).

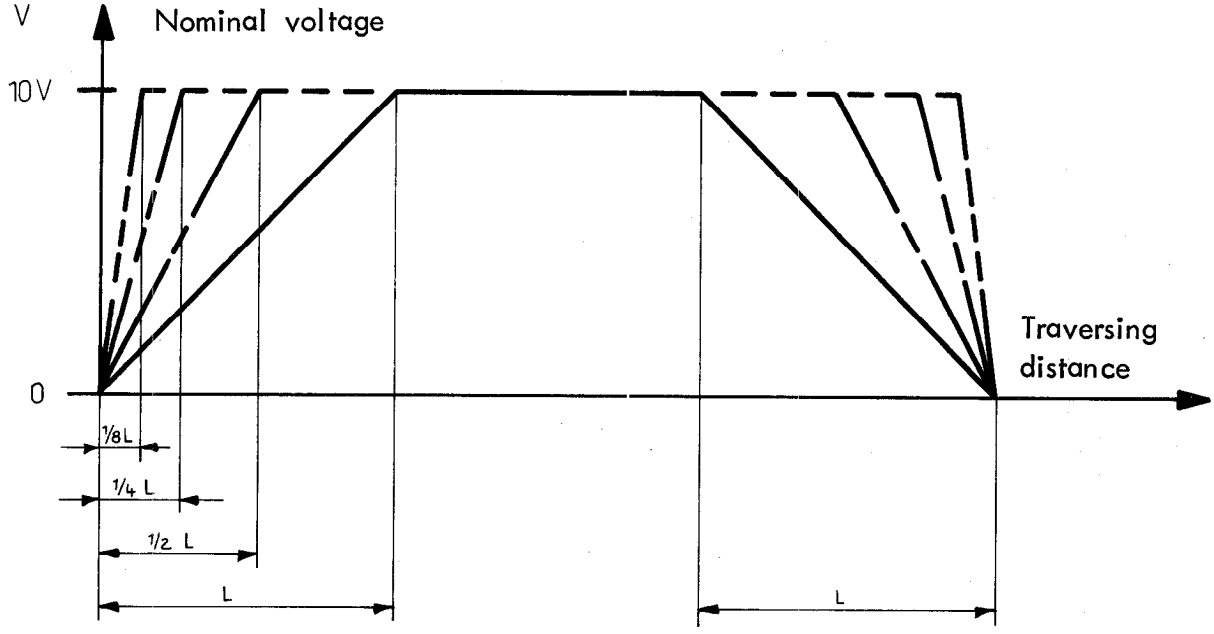
Time sequence of a positioning procedure without auxiliary function output

After start (manual or automatic) the corresponding axis release relay becomes active without time delay. 300 ms later, the velocity-nominal value increases (analogue output X, Y, Z) according to a ramp function until the voltage level of the programmed feedrate has been reached. When nearing the position value, the velocity-nominal value is decreased according to a ramp function.

When the position value has been reached, the position loop is opened (axis relay breaks, the nominal value output remains at OV). A new start is inhibited for a period of 100 ms.

Switch-over of ramp length and ramp configuration of nominal value voltage for switched-over position loop (with backlash)

The length of the acceleration and deceleration ramps of the nominal value can be switched over by means of the switching channels 1 and 2. The length of the ramp is principally dependent on the operating software, the proportional band can be shortened to 1/2, 1/4 or 1/8 of the length L by means of the switches in order to optimally match it to the machine.



L is defined by the operating software. The ramp length for acceleration and deceleration is identical in all 3 axes.

With channels 1 and 2, the length of the "ramping-down" range is switched over. In addition, the configuration of the ramp can be altered with channels 4 and 5.

Ramp configuration	Ramp length (mm) 1/8L (1 2)	1/4 L (1 2)	1/2L (1 2)	1/1L (1 2)
3 gradients (4 5)	4,72	9,44	18,88	37,76
2 gradients (4 5)	2,48	4,96	9,92	19,84
1 gradient (4 5)	1,28	2,56	5,12	10,24

With this software version there is no positioning range (= The difference actual value - nominal value which is recognized by the control as "position reached"). The position loop is cut out when the nominal value has been reached or traversed over.

Optimization of ramping down (Position approach)

In order to improve ramping down, the analogue output voltage can be superimposed with a fixed voltage (zero-displacement) with this software version. The required voltage can be entered in the initial dialogue of the initial starting procedure (refer to item 12.3).

Depending on the TNC 135 B version, this machine parameter is requested for either in plain language:

RAMP DOWN MINIMUM STEP

or in coded form:

MACHINE PARAMETER 08

The voltage can now be entered in stages from 0 ... 20 whereby each step corresponds to 2.5 mV.

4.2 Common drive backlash - free

		TNC 135 B
Software: Dialogue in	German	214 355
	English	214 356
	French	214 357
	Italian	214 358
	Portugnese	214 380
	Russian	214 384

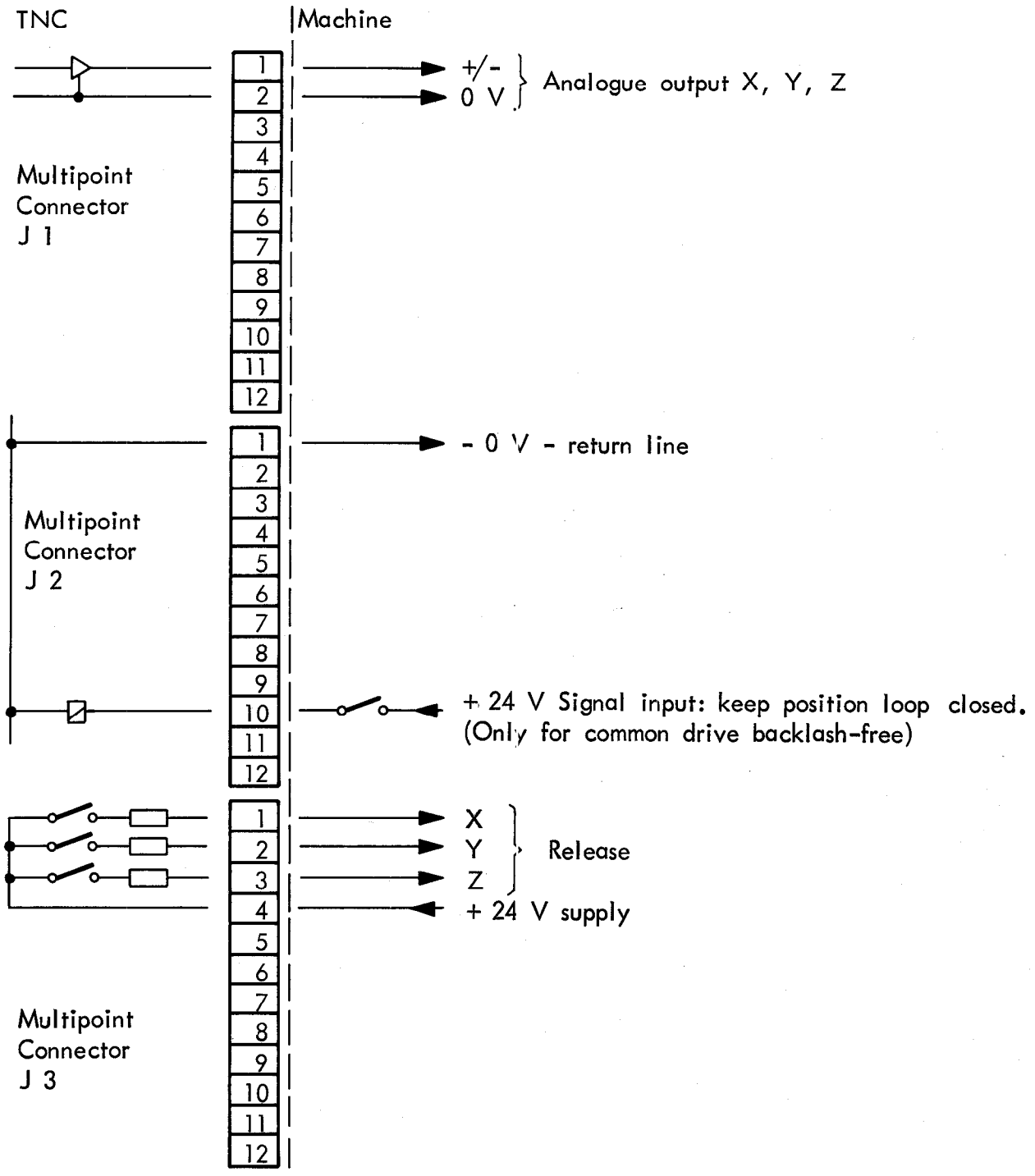
Only a 4-quadrant servo-amplifier is permitted for this position loop.
Contrary to the positioning loop for backlash-prone drive spindles, random change of traverse direction during a positioning procedure is possible.

With this, the machine can be brought to a standstill with the aid of the override potentiometer (0-setting) (reciprocating movement 5 µm). The ramp can be made so steep (see 6.4) that a slight overshoot of the nominal position takes place.
(Shorter approaching time).
This is however, only possible when overshoot of the axes does not interfere (e.g. with boring mills).

Caution:

The code switch of the third channel (switch-over from 4-quadrant to 1 or 2 quadrant operation) does not function with this software version.

Multipoint connector Layout



Please note:

The relay output "positioning direction" (multipoint connector J3, Pin6) is non-functional with the software version for drives without backlash.

Signal input: for keeping positioning loop closed

On machines where a long duration exists until clamping is activated, this input can be used. The control maintains the position loop so long until Pin 10 of connector J2 is without voltage.

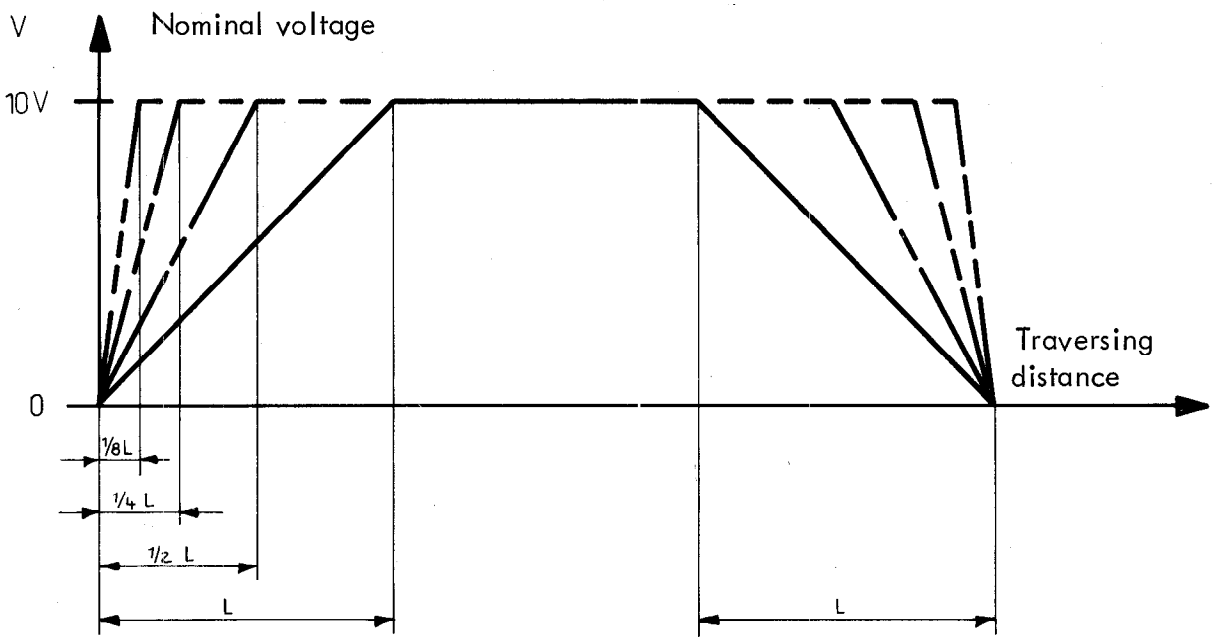
Time sequence of a positioning procedure (without auxiliary function output)

After start, the corresponding axis release relay becomes active without time delay. 200 ms later the velocity - nominal value increases (analogue output X, Y, Z) according to a ramp function until the voltage level of the programmed feedrate has been reached. When nearing the position value, the velocity - nominal value is decreased according to a ramp function.

The axis release relay breaks 50 ms after reaching the nominal position.
The position loop remains for a further 150 ms provided that the feedback "keep position loop closed" is inactive. A new start is possible without delay.

Switch-over of ramp length and ramp characteristics of nominal value voltage for switched-over position loop (without backlash)

The ramp length of the acceleration and deceleration ramp of the nominal value can be switched over by means of the channels 1 and 2. The length of the ramp is principally dependent on the operating software, the proportional band can be shortened to 1/2, 1/4 or 1/8 of the length L by means of the switch in order to optimally match it to the machine.



L is defined by the operating software. The ramp length for acceleration and deceleration is identical in all 3 axes.

With channels 1 and 2, the length of the ramping-down range is switched over. In addition, the configuration of the ramp can be altered with channels 4 and 5.

Ramp configuration	Ramp length (mm) 1/8L (1 2)	1/4L (1 2)	1/2L (1 2)	1/1L (1 2)
3 gradients (4 5)	4,72	9,44	18,88	37,76
2 gradients (4 5)	2,48	4,96	9,92	19,84
1 gradient (4 5)	1,28	2,56	5,12	10,24

The positioning range (nominal value - actual value) is 0 $\pm$ 5 µm for all ramp lengths.

5. Software version: Single axis drive with linear interpolation

5.1 Remarks

The use of a control with linear interpolation is only possible on a machine with three complete drives (i.e. 3 drives, 3 servo-amplifiers for 4-quadrant operation) as well as backlash-free spindles.

5.1.1 "Axis speed Code" for Kv-adjustment with position loop having linear interpolation

For linear interpolation, the adjustment of all three axes for the same Kv-value is necessary. The Kv-value is determined as follows:

$$Kv = \frac{\text{Traversing speed at 9 V}}{\text{Ramp length}} \qquad \left[\frac{\text{m/min}}{\text{mm}}\right]$$

With different axis translations of the machine, there are different Kv-values. An axis translation of 1 : 2 can be compensated for by shortening the ramp length (s) with the aid of the "axis speed code" which is asked for by the dialogue during the initial starting procedure.

Depending on the TNC 131/135 version, this machine parameter is requested for either in plain language or in coded form. With both TNC versions this parameter has different functions.

a) The following code has been defined for cases where the parameter is requested for with dialogue: "SPEED CODE FOR AXES 0 ... 7 ?"

Entry	Normal ramp length in	Half ramp length in
0	X Y Z	
1	Y Z	X
2	X Z	Y
3	Z	X Y
4	X Y	Z
5	Y	X Z
6	X	Y Z
7		X Y Z

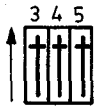
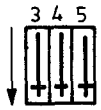
b) The following code has been defined for cases where the parameter is requested for with dialogue: " MACHINE PARAMETER 09 "

Entry	Normal ramp length in	Half ramp length in	Tool-to-workpiece approach in minus direction
0	X Y Z		Yes
1	Y Z	X	Yes
2	X Z	Y	Yes
3	Z	X Y	Yes
4	X Y	Z	Yes
5	Y	X Z	Yes
6	X	Y Z	Yes
7		X Y Z	Yes
8	X Y Z		No
9	Y Z	X	No
10	X Z	Y	No
11	Z	X Y	No
12	X Y	Z	No
13	Y	X Z	No
14	X	Y Z	No
15		X Y Z	No

5.1.2 Adjustment of trailing error (lag)

The Kv-value gives the magnitude of the trailing error (lag) in an axis in (mm) with relation to a speed of 1 m/min and is therfore influenced by the amplification in the velocity loop.

In order to carry out the adjustment the position displays of the TNC 135 B with linear interpolation can be switched over to trailing error display.

Channel 3, 4, 5	Display type	 Actual value	 mean trailing error (lag)

The trailing error (lag) adjustment is performed as follows:

- Adjustment of the rapid traverse speeds of the three axes with 9 volts at the input of the servo-amplifier (battery box).
- Entry of axis speed code in axis translations should differ.
- Switch on trailing error display.
- Define "DIAGONAL PATH" cycle for X and Y, finally for Y and Z each with rapid traverse for a 45° diagonal.
- Determine the axis with the greatest trailing error and adjust the remaining axes via the velocity adjustment of the servo-amplifier with the aid of the "DIAGONAL PATH" cycle.
- After adjustment set TNC to display mode: position value.

Please note:

If the coding switch is switched over to trailing error display, the monitoring systems for spindle, temperature, transducers and traversing direction are no longer active.

Two software versions are available:

- Position loop closed only during the duration of positioning in the axes to be positioned.
- Position loop permanently closed in all 3 axes (holding of last approached position in all axes).

5.2 Linear interpolation with cut-out of positioning loop

	TNC 135 B
Software: Dialogue in German	214 330
English	214 359
French	214 360
Italian	214 361
Portugnese	214 381
Russian	214 385

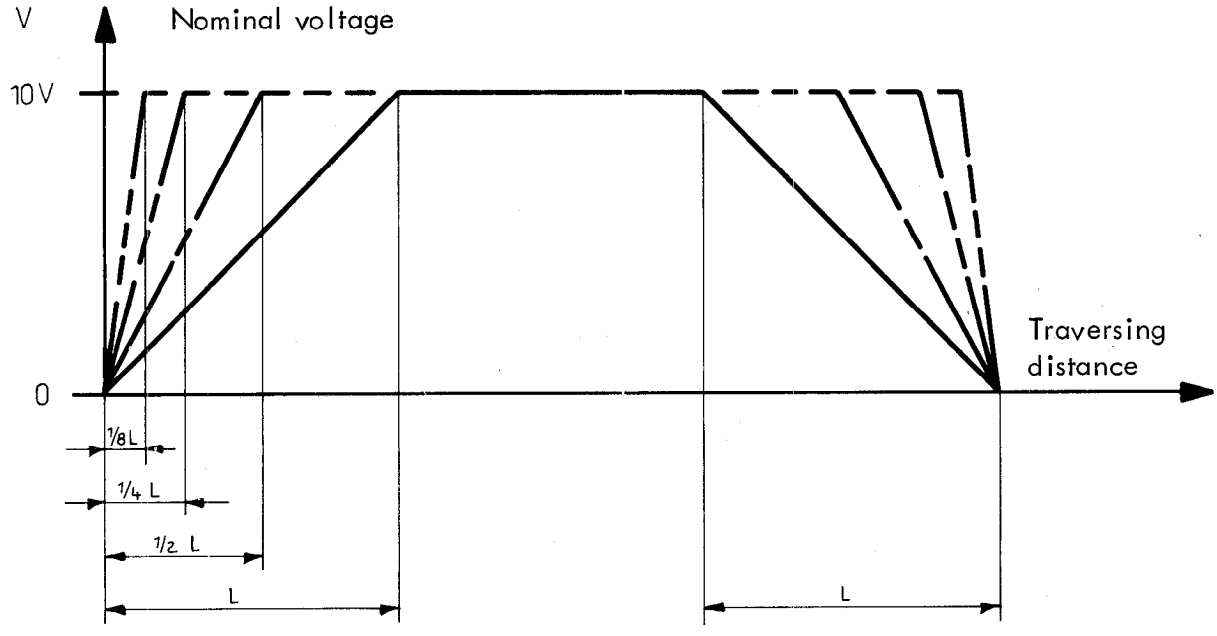
This software version is used when the reciprocating movement (0 ± 5 µm) of the permanently closed position loop interferes (e.g. paraxial milling). In addition to the ramp length, the width of the position range is also varied. The nominal position range is the actual position range which is accepted by the control as the nominal position.

Time sequence of a positioning procedure (without auxiliary function output)

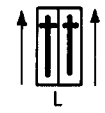
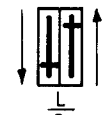
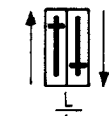
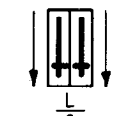
After start, the corresponding axis release relay becomes active without time delay. 200 ms later the velocity - nominal value increases (analogue output X, Y, Z) according to a ramp function until the voltage level of the programmed feedrate has been reached. When nearing the position value, the velocity - nominal value is decreased according to a ramp function.

When the position has been reached the axis must remain in the positioning range for 200 ms. Only when this condition is satisfied, is the axis release and the position loop cut out.

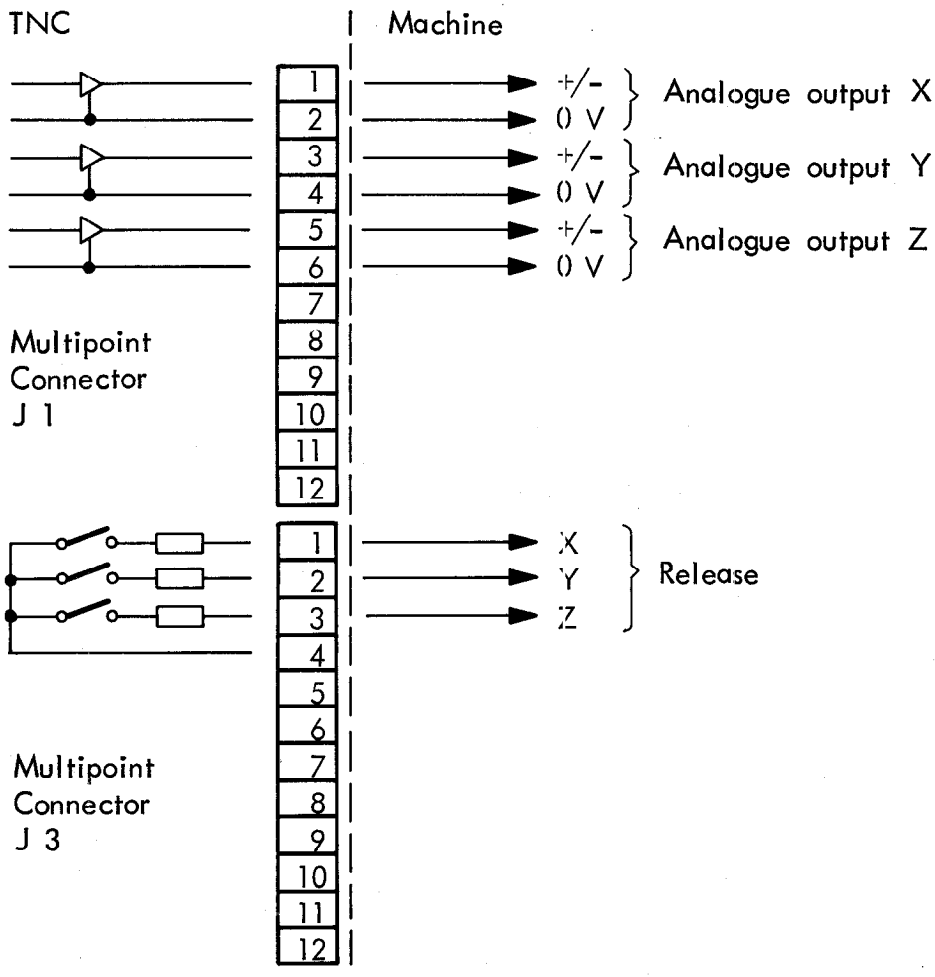
Switch over of nominal value-ramp length with linear interpolation and positioning loop cut-out



L is defined by the operating software. The ramp length for acceleration and deceleration is identical in all 3 axes.

Channel	1 2	1 2	1 2	1 2
Switch setting				
Ramp length	20 mm	10 mm	5 mm	2,5 mm
Positioning range (Position value - Nominal value)	0 ± 20 µm	0 ± 10 µm	0 ± 5 µm	0 ± 5 µm

Multipoint-Connector Layout



Notes

Notes

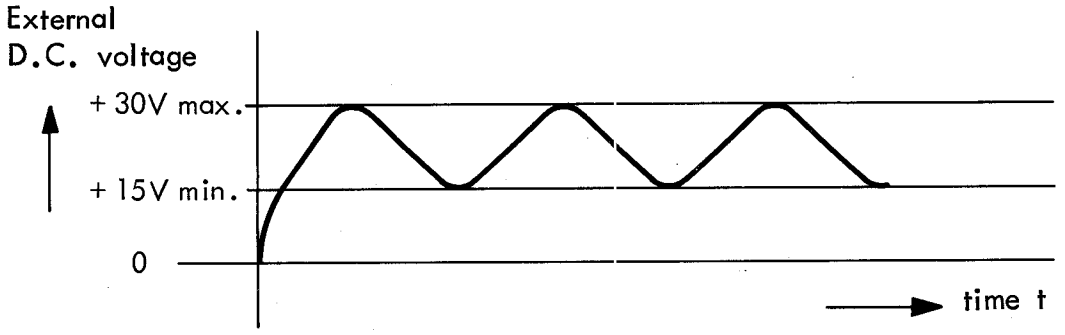
6. Control - inputs

6.1 External D. C. Voltage

A filtered D.C. voltage is required for operation of the control inputs.
Many machines provide a control voltage of 24 V which can be utilized.
If the external D.C. voltage is generated by a bridge rectifier, the input voltage may be max. 22 V~ (measurement with multi-meter). A filter capacitor should be inserted after the rectifier.

The D.C. voltage can also be obtained with a 3-phase bidirectional rectifier without filter capacitor. A regulated power unit can also be used.

The following requirements are necessary for the external D.C. voltage:



The filtered D.C. voltage must not exceed maximal value of 30 V. Even at maximal load the direct voltage should not fall below 15 V, as an exact switching of the relays is then no longer guaranteed. At worst, the external D.C. voltage is loaded with 140 ohms via the inputs of the control. The following currents correspond to these loads:

at 30 V	0.21 A
at 24 V	0.27 A
at 15 V	0.11 A

Important !

The minus pole of the external D.C. voltage should be connected to ground (earthed conductor) (SL) in order to prevent capacitive superimposed A.C. voltage.

6.2 Technical specifications of Relay Coils

The relay coils of the control inputs are connected via floating relays which are combined in groups. The machine must therefore provide an external D.C. voltage for these inputs.

Technical specifications of relay coils

Input resistance (per coil):	2150 ohms ± 15 % at 25°C
Operating voltage (direct current filtered):	
max. permissible peak voltage	30 V
Trip voltage	14 V
drop-out voltage	1.8 V
Typical switching time:	0.5 ms

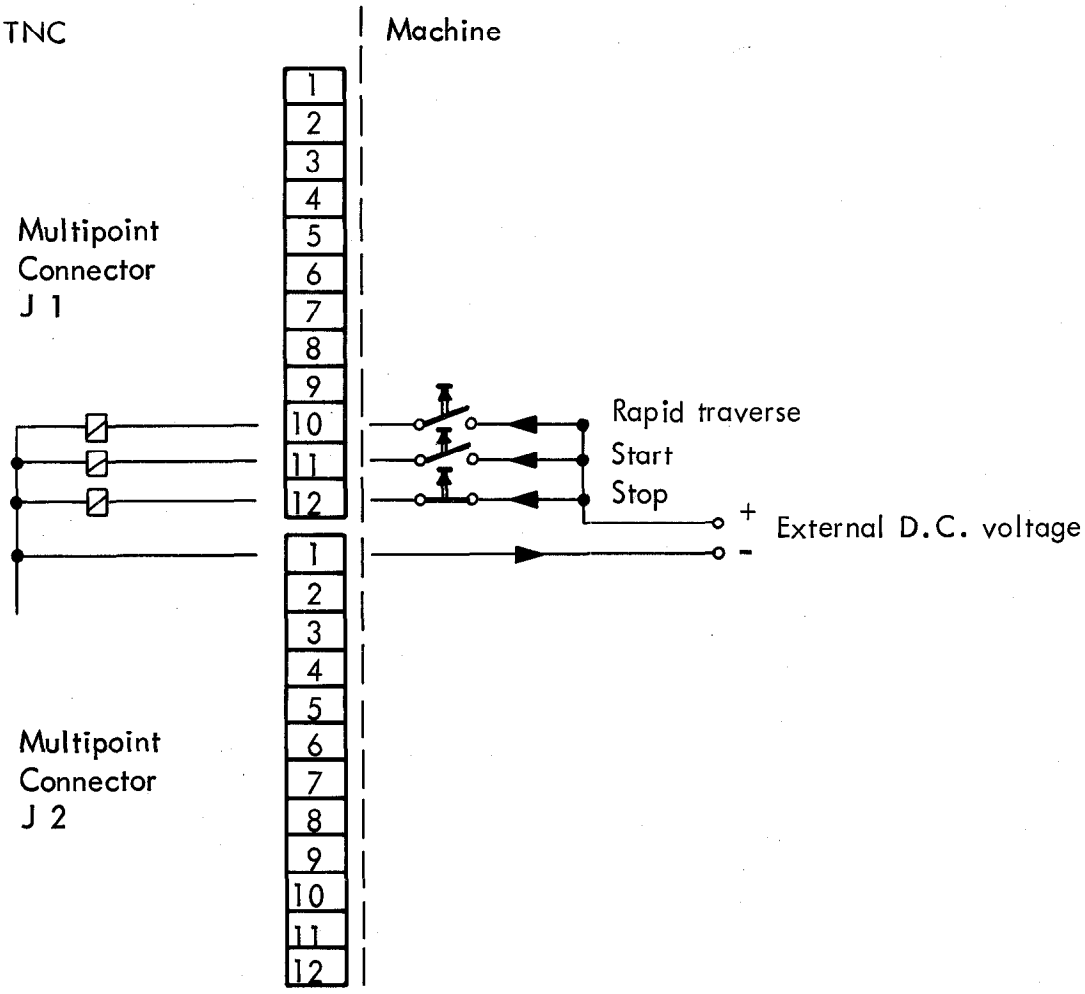
6.3 External buttons "Start", "Stop" and "Rapid traverse"

The inputs of the above-mentioned buttons are located on the multipoint connector J1:
i.e.

Button	Terminal
Start	11
Stop	12
Rapid traverse	10

By means of the appropriate connection of these inputs it is for example, possible to effect an external lock in case two controls operate on one machine.
The required press buttons for "Start" (closer) for "Stop" (opener) and for "Rapid traverse" (closer) are provided by the machine tool manufacturer on the machine pendant or console of the machine.

Multipoint-Connector Layout



The effect of button "rapid traverse" supersedes all programmed speeds, i.e. when button "rapid traverse" is actuated the machine moves at rapid traverse regardless of any lower programmed feed rates and independent of the override potentiometer.

(Exception: Fixed cycle "TAPPING")

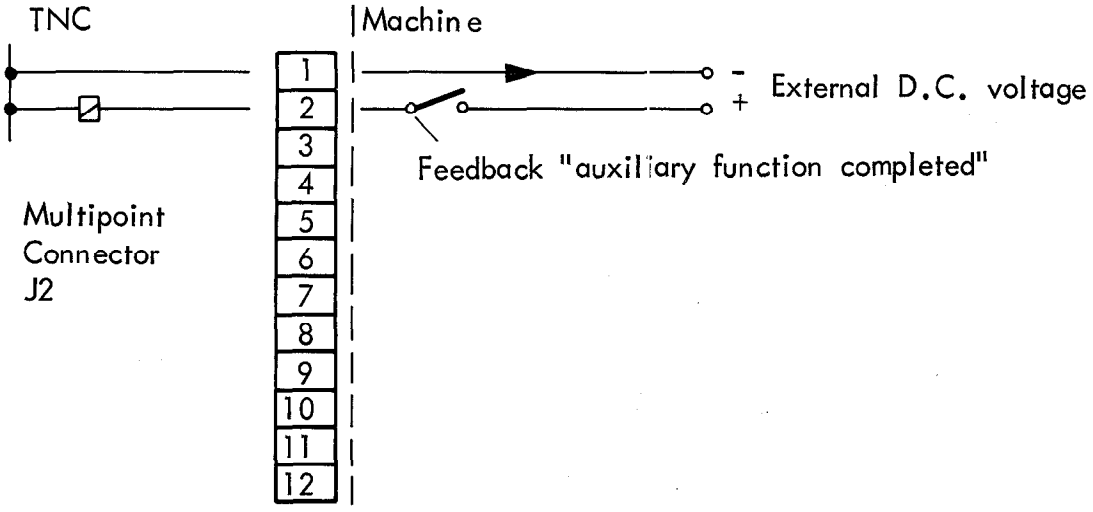
The machine manufacturer may, if required, omit the button "Rapid Traverse". Rapid traverse can also be programmed via the keyboard of the control (command "Rapid Traverse" = 9999 mm/min).

6.4 Feedback "Auxiliary function completed"

The input "Auxiliary function completed" is always interrogated when an M-,T- or S-function has been programmed.
The signal (+ 24 V) is supplied from the interface to the control upon completion of the M -, T- ot S-function. This signal should be provided at least 100 ms after the Strobe signal.

If this input signal is not to be used, the input must be connected to + 24 V.

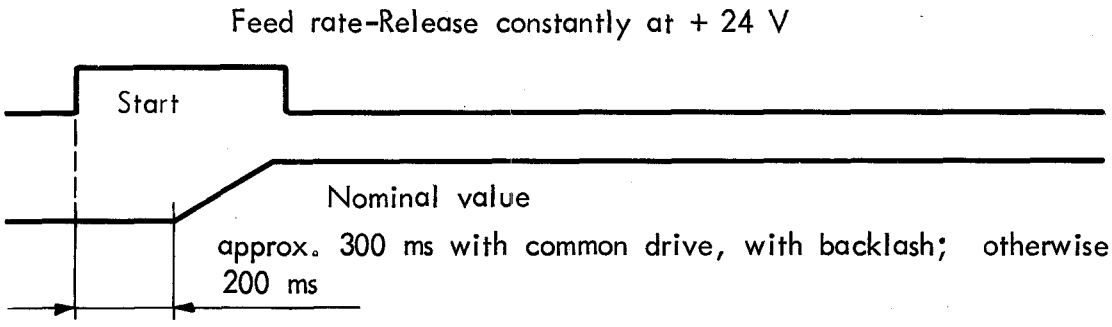
Multipoint -Connector Layout



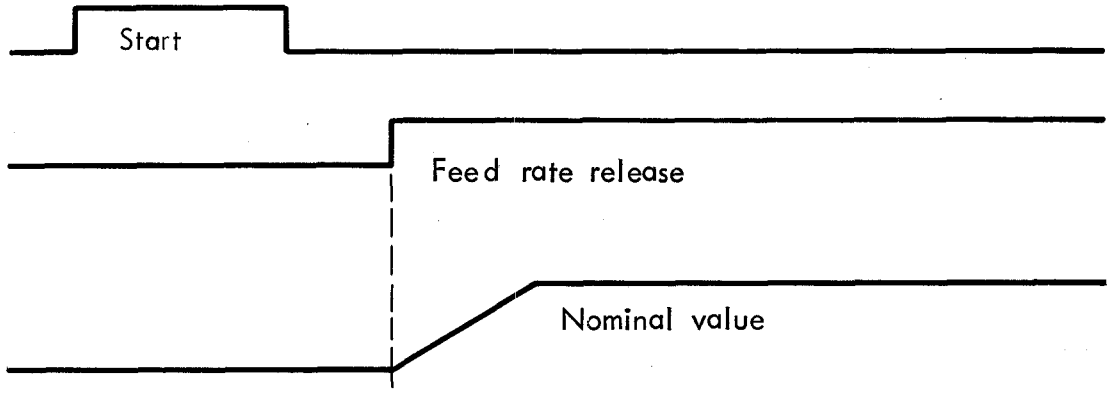
6.5 Feed rate-Release

The input "Feed rate-Release" enables a feed rate-stop (via the ramp which has been set), at any time, and also prevents the output of a nominal value voltage after the pressing of the external start button.

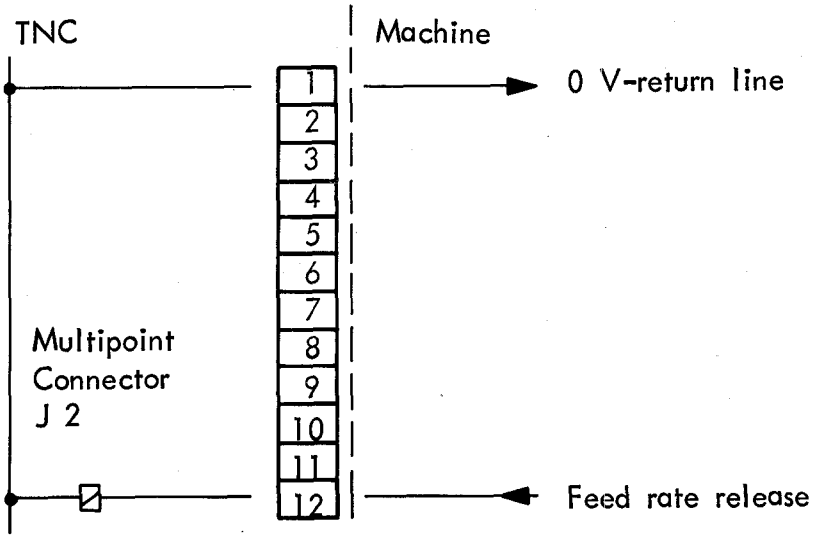
a) If the input "Feed rate-Release" is constantly provided with + 24 V the nominal value ramp is provided without an additional delay.



b) As long as the Feed rate-Release-contact is open, the control withholds the output of the Feed rate-Nominal value until the contact closes and + 24 V are present at the input.



Multipoint-Connector Layout



6.6 Limit switch inputs

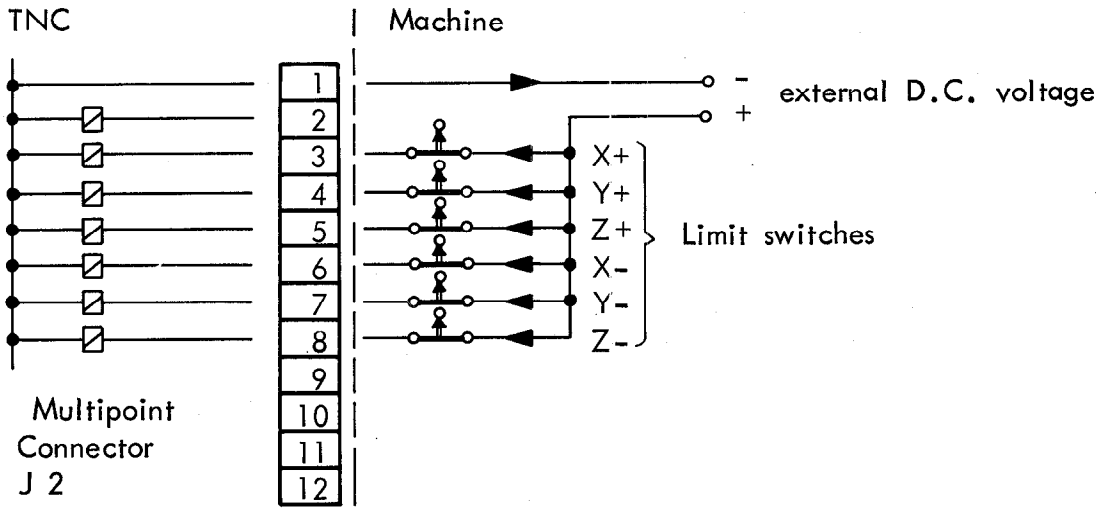
The control TNC 135 B monitores the trailing error and regulates the feed rate of the controlled axes. The control therefore requires the information from the machine when a limit switch is engaged and the machine stops. The control reacts to this information by displaying "LIMIT SWITCH".

Caution:

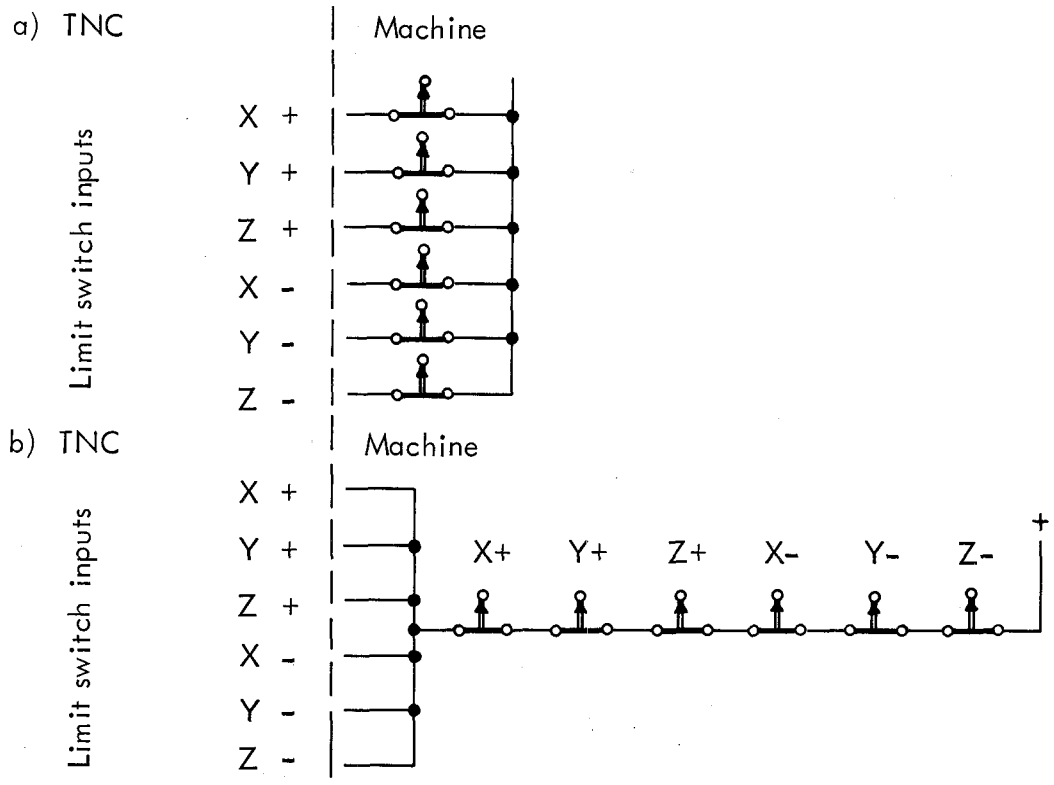
A feed rate-stop cannot be activated via the limit switch-inputs. For this, appropriate adjustments are to be directly carried out on the D.C. servo-amplifier externally to the control as the nominal value-voltage and the axis release relay remain unchanged.

The axis release and the nominal calue can only be cut-out by pressing the CE -key.

Multipoint-Connector-Layout



The limit switch inputs are either controlled individually (Fig. a), corresponding to their designation, or are all parallel-connected and controlled by a series connection of all existing operation limit switches (openers) (Fig. b). In the latter case, after a limit switch has been actuated, the machine can only be moved manually.



Normal limit switches which activate the servo-amplifier are additionally required.

If limit switch inputs are connected directly to the external direct voltage without limit switch contacts, then the control can be started, however, a stop of the machine caused by collision with a limit switch would result in the error display "GROSS POSITIONING ERROR". This error indication can only be cancelled by means of switch-off of the mains voltage, which then requires regeneration of the datum points in the three axes by traversing over the transducer reference marks.

6.7 Input for EMERGENCY STOP-function check

The EMERGENCY STOP-contact is extremely important for the safety of the operator and the protection of the machine. Therefore, this contact is checked each time after switch-on of the mains power supply. The entire EMERGENCY-STOP-check takes place automatically when the 24 V-control voltage is switched on with "mains on".

Sequence of function

- Mains is switched on.
- 24 V must be present at the input J2 Pin 11.
- After mains switch-on, the EMERGENCY STOP-contact within the control is momentarily opened. This must cut-out the control voltage within the switching cabinet.
- The control verifies that no voltage is present at terminal J2 Pin 11.
- If the control voltage has been cut-out by the EMERGENCY STOP-contact, the dialogue display indicates:

  RELAY EXT. DC VOLTAGE MISSING

- After mains switch-on of the control voltage, the TNC is again operational.
- If the control voltage has not been interrupted by the EMERGENCY STOP-contact, the dialogue display indicates:

  EMERGENCY STOP CUT-OUT DEFECTIVE

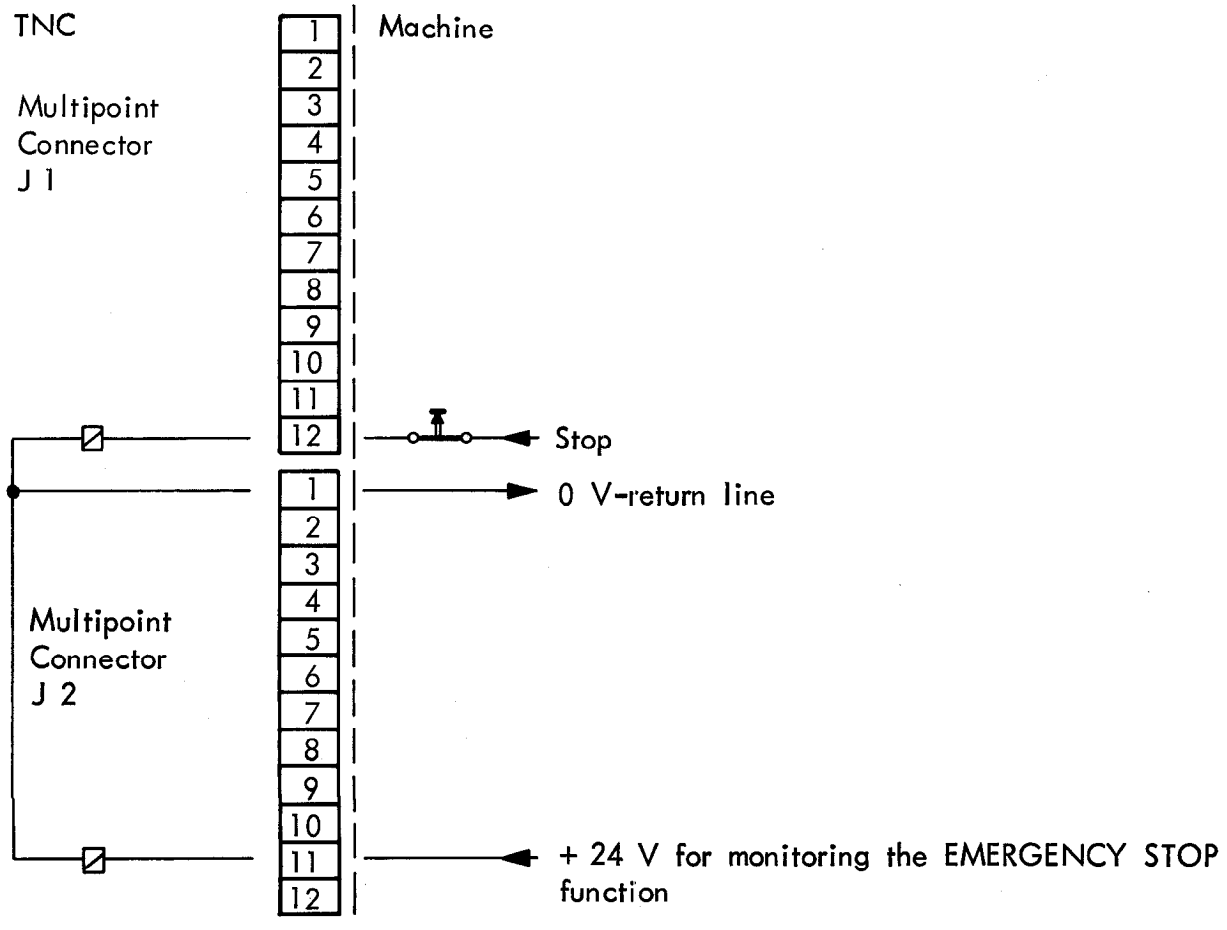
  This fault is indicated by a flashing dialogue display and can only be cancelled by switching off the mains power supply.

Caution:

The input J2 Pin 11 is monitored during control operation. If the control recognizes an external stop button signal or a limit switch signal the terminal J2 Pin 11 is interrogated to verify if 24V is still present. If this is the case, this will lead to the error display:

"EXTERNAL EMERGENCY STOP"

Multipoint Connector-Layout



7. Control-Relay Outputs

7.1 Technical specifications of relay outputs

All relay functions are output via floating relay contacts which are connected in groups. For safety reasons each contact is provided with a current limiting resistor of 47 ohms connected in series. However, this current limiting resistor burns through after approx. 5 secs. with a load exceeding 5 Watts.

Technical specifications of relay outputs

Operating voltage:	max. 30 Volts D.C.
Operating current:	max. 50 mA
Permissible loads:	resistance load, inductive load (relay coil only with quenching diode parallel to the inductive load. With relays operating with alternating voltage, switch RC filter parallel.

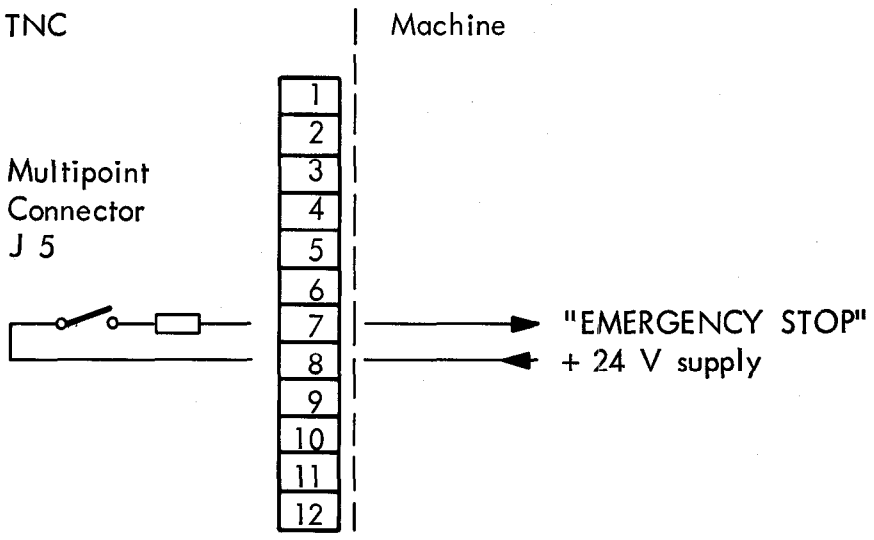
7.2 Output "EMERGENCY STOP"

Important functions of the TNC 135 B control are monitored by means of self-diagnosis. (Electronis subassemblies such as microprocessor, storage for constant values, write-read storage, positioning systems, power failure etc.)

If an error is discovered through this supervision, an error indication in plain language will appear in the dialogue which simultaneously flashes.

With output of this error indication the contact "EMERGENCY STOP" opens.

Multipoint Connector -Layout



The EMERGENCY STOP condition can only be cancelled by switching off the mains power supply of the TNC 135 B provided the cause of the defect has been remedied. The control may require its own mains voltage switch!

In the case of EMERGENCY STOP without simultaneous flashing fault display please contact the factory in Traunreut, Bavaria, W. Germany or your local HEIDENHAIN representation.

7.3 Lock for "Spindle on" output

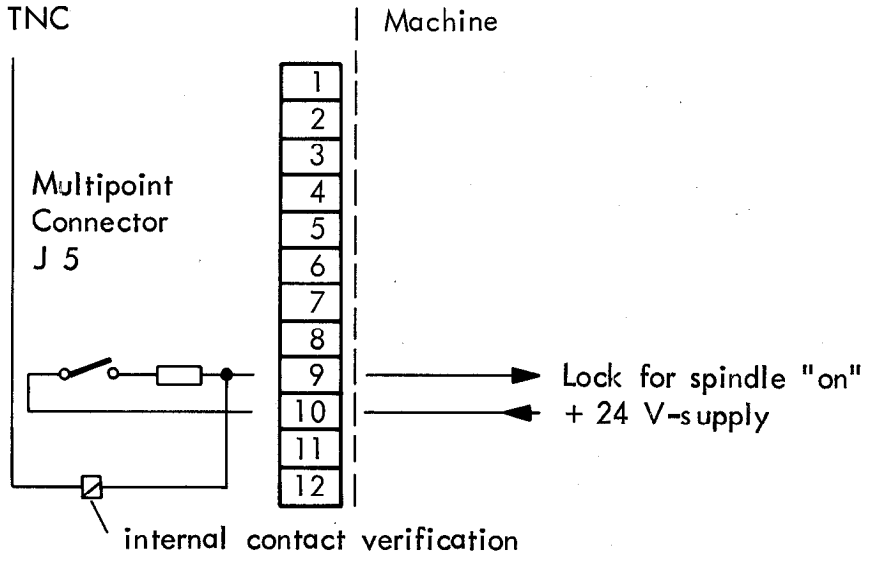
The relay output "Lock for spindle on" can be used as an additional safety precaution in order to lock the spindle during tool changes. The relay contact is opened and spindle rotation is prevented. This applies to e.g. tool changes, where the spindle is to be touched without endangering the operator.

The relay contact is only opened, if the last programmed M-function was "Spindle Stop" (M 05) and the external "Stop"-button was pressed.

It is recommended that this "safe" condition is indicated by a lamp.

The switching contact "spindle lock on" is verified within the control. An error results in generation of signal "EMERGENCY STOP" as well as the display "Spindle interlock defective".

Multipoint Connector-Layout

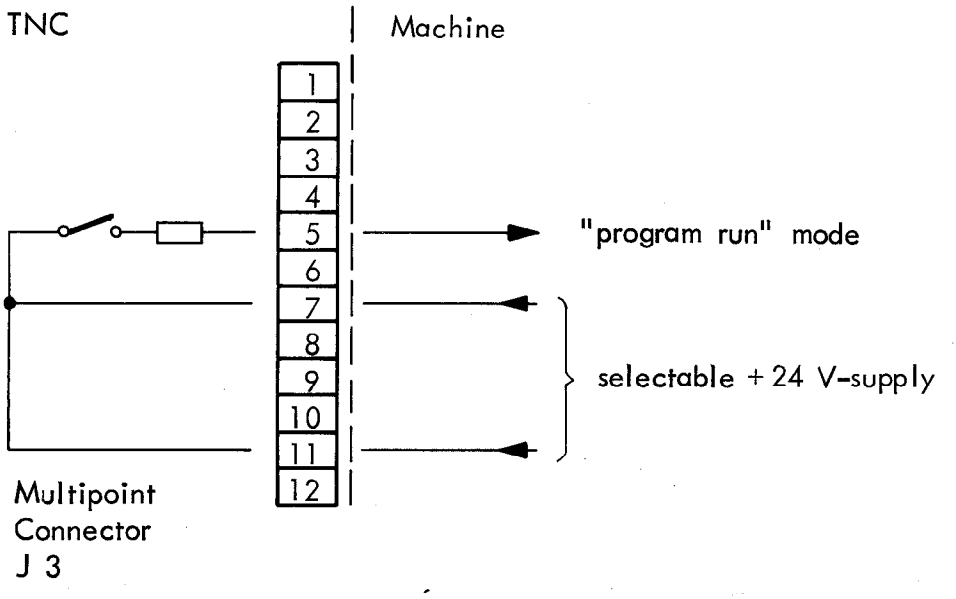


In the manual operating mode the contact on terminal J5/9 is always closed. The supply voltage + 24 V at J5/10 must always be connected otherwise the error indication "Spindle interlock defective" will be displayed.

7.4 Output: TNC in "program run" - mode

This contact is closed when the mode "automatic program run" or "program run single block" has been selected.

Multipoint Connector - Layout



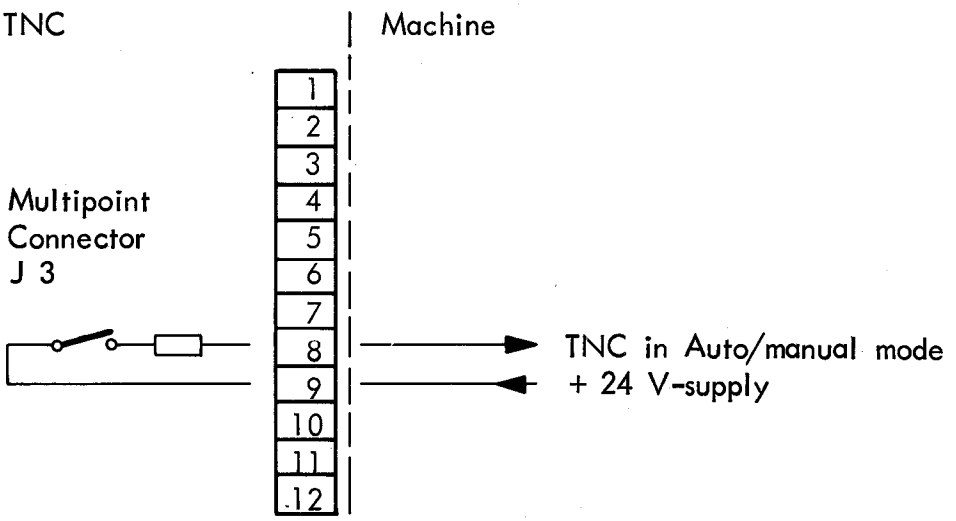
7.5 Output: Control in Auto/Manual mode

This relais output is open in the "manual" mode.

Exception:

If the REF-mode is selected, this contact then closes when the external start-button is pressed and the automatic reference mark approach-mode is selected. After reaching the reference mark the relay output re-opens the contact.

Multipoint Connector-Layout



8. M-T-S-functions

M-T-S-functions are provided statically via the same relay outputs of the control. In order to distinguish whether an M-T- or S-function is being provided, the strobe signals S-Strobe, M-Strobe and T-Strobe are available (pulses).

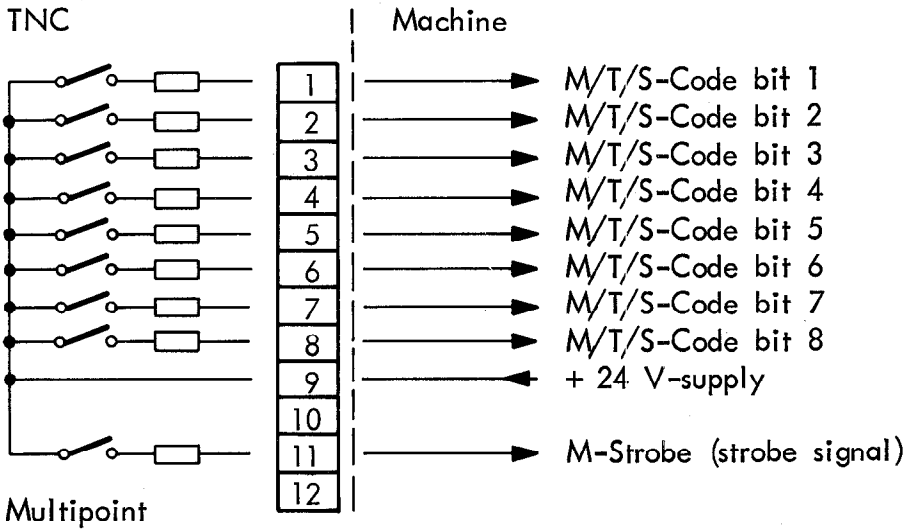
8.1 M-functions (Auxiliary functions)

The number of M-functions is dependent upon the type of evaluation in the machine interface:
with external decoding 100 different M-functions can be programmed,
without external decoding 9 different M-functions can be programmed.

8.1.1 Coded output of M-functions

Output of the M-Functions is carried out in BCD-code via a group of floating relay contacts at multipoint connector J4, the special M-function outputs at multipoint connector J5 are, however, also effective for the appropriate M-function.

Multipoint Connector-Layout



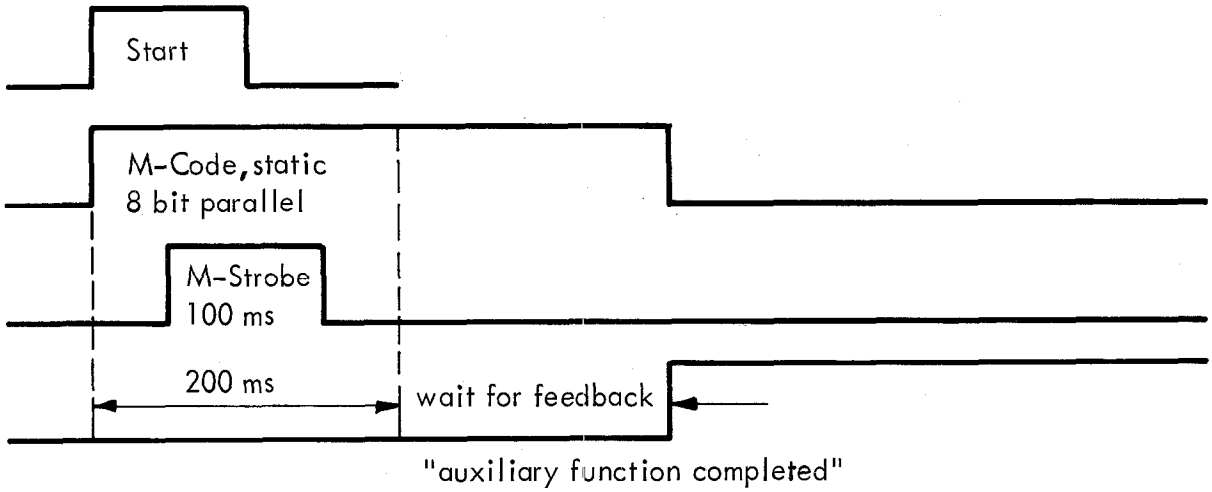
Multipoint Connector J4

Decade 01:	bit 1	2^0
	bit 2	2^1
	bit 3	2^2
	bit 4	2^3
Decade 10:	bit 5	2^0
	bit 6	2^1
	bit 7	2^2
	bit 8	2^3

The M-code is provided as a static signal. 50 ms after the beginning of the output for the M-code value, the M-strobe of 100 ms duration is given. (The M-code output is present for 100 ms as per the M-Strobe).

200 ms after beginning of the M-code output the control input "feedback auxiliary function completed" is interrogated. When this input is at + 24 V, the M-code signals cut-out and program run is continued. If this input is inactive (at 0 Volt), the M-code signals remain and program run is interrupted until the input is re-activated (to 24 V).

Procedure for M-Code output



Coding of M-functions

M-function	Output at block Beginning	End	Multipoint Connector J 4 bit 1234 5678
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 Beginning	End	Multipoint Connector J 4 bit 1234 5678
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		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	X	1010 1001
M 96		X	0110 1001
M 97		X	1110 1001
M 98		X	0001 1001
M 99	internally allocated		

M 00 special M-functions

1 = contact closed
2 = contact open

8.1.2 Direct output of M-functions

9 M-functions can be output directly by relay contact therefore decoding within the machine interface is unnecessary:

The following M-functions can be programmed:

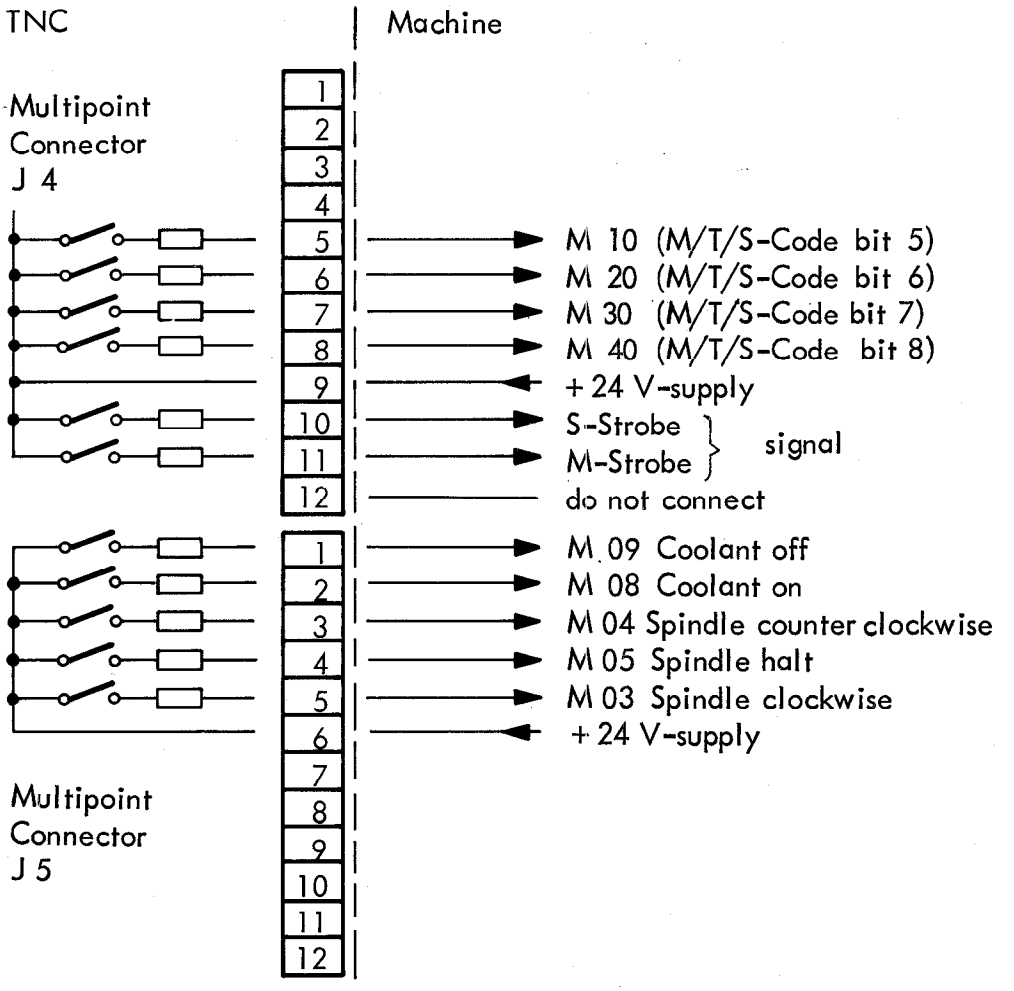
M 03	M 04	M 05	M 08	M 09

* M 10, M 20, M 40, M 80

* ☐ Special M-functions with influence on the program run.

Output of these M-functions is carried out via the relay outputs bit 5 to bit 8 of Multipoint connector J 4, and via 5 additional relay outputs of multipoint connector J 5 (bit 1 to bit 4 at J 4 are simultaneously effective).

Multipoint Connector-Layout



8.1.3 Special M-functions which affect program run

M 00 Interrupts program run after completion of the appropriate block and provides the command "spindle halt" and coolant off" via the direct output relay (simultaneous to M-code)

M 02 Interrupts program run after completion of the appropriate block and addresses block 1; furthermore, "spindle halt" and "coolant off" are also commanded via the direct output relay (simultaneous to M-code).

M 03 "Spindle Clockwise" at beginning of block (simultaneous to M-Code).

M 04 "Spindle counter-clockwise" at beginning of block (simultaneous to M-Code).

M 05 "Spindle halt" at end of block (simultaneous to M-Code).

M 06 Function as per M 00 (without "coolant off")

M 08 "Coolant on" at beginning of block (simultaneous to M-Code).

M 09 "Coolant off" at end of block (simultaneous to M-Code).

M 13 "Spindle clockwise" and "coolant on" at beginning of block (simultaneous to M-Code).

M 14 "Spindle counter-clockwise" and "coolant on" at beginning of block (simultaneous to M-Code).

M 30 Function as per M 02

M 99 Same function as "CYCL CALL" (cycle call-up).

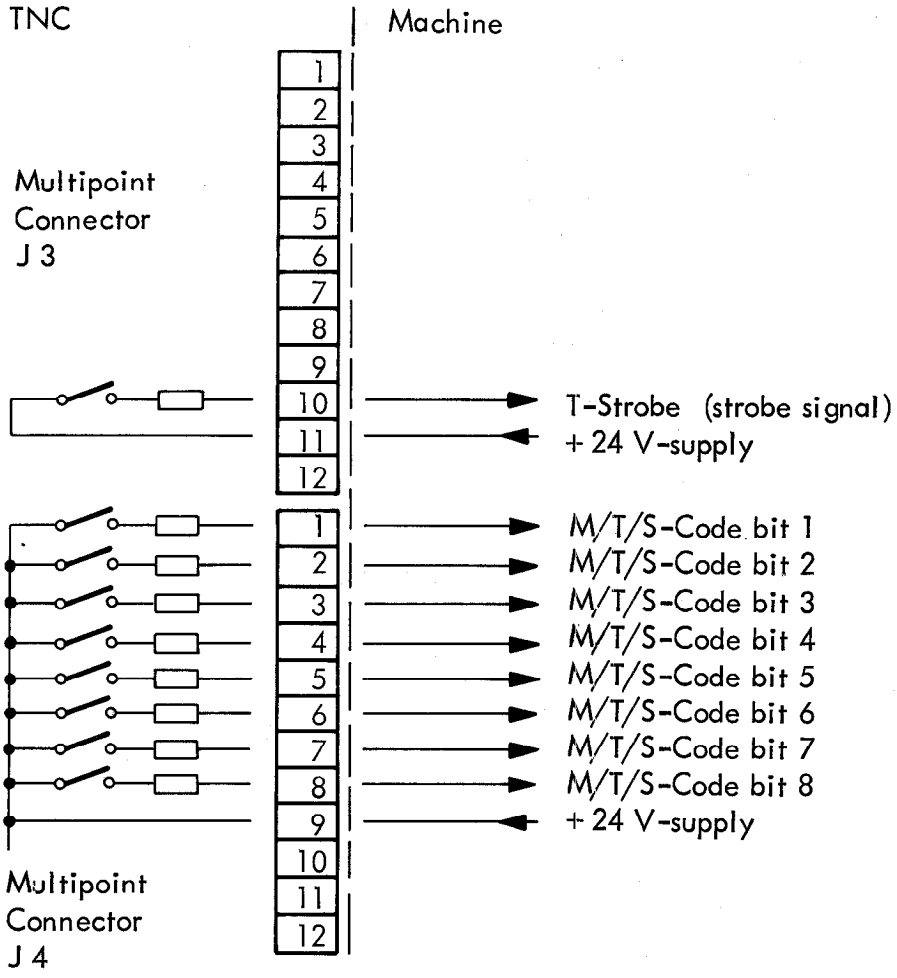
Caution !

The M-functions M 90 - M 99 may not be allocated.
HEIDENHAIN reserves the right to allocate these M-functions. Until now, only the function M 99 has been allocated (operates like a cycle call "CYCL CALL"), however, further applications will follow.

8.2 T-functions (Tool numbers)

The TNC also provides T-functions (Tool numbers 1 ... 99) in the tool call blocks: BCD-code, 2 decades. With tool numbers greater than 99 all output relays pick up. (However, tool numbers 0 ... 255 can still be programmed.).

Multipoint Connector-Layout



The T-code is provided as a static signal. The T-strobe is provided 50 ms after the beginning of the T-code value with a duration of 100 ms. (The T-code output is present for 100 ms as per the T-strobe) 200 ms after beginning of the T-code output, the control input feedback "auxiliary function completed" is interrogated. When this input is at + 24 V the T-code signals are cut-out and program run is continued.

If the input is inactive (at 0V) the T-code signals are provided and program run remains interrupted until the input is re-activated (at + 24 V).

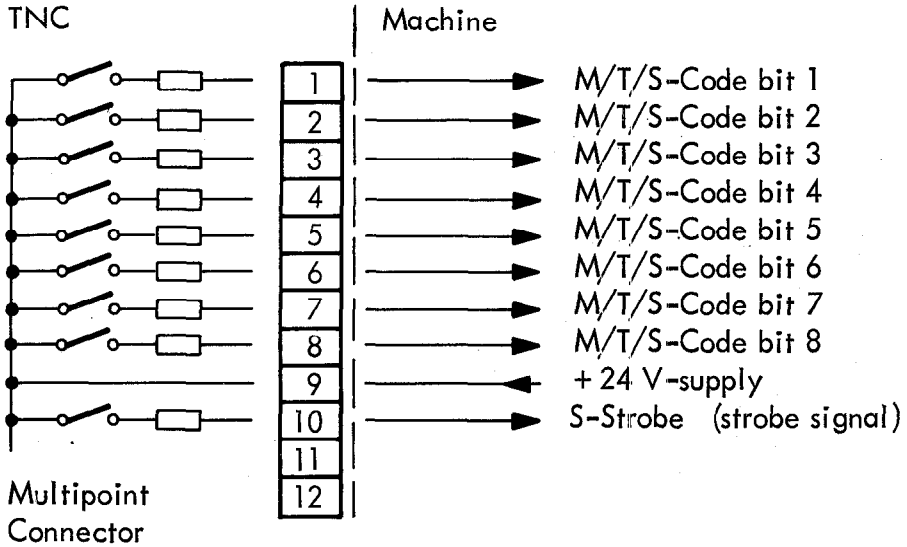
If the same tool number is called several times the output of the T-function only takes place with the first call. The T-code is provided again only when the tool number has changed.

Spindle speeds are entered into the tool call program blocks with max. 4 digits in r.p.m. and automatically rounded off by the control to the nearest standard speed. The entered spindle speed is automatically coded by the control into S-codes in accordance with German Standard DIN 66025 page 3. Output is in 2-decade BCD-code (100 steps) as indicated in the table page 40.

Please note:

The range of programmable spindle speeds can be determined via the RPM-Code during the initial starting procedure in the initial dialogue.

Multipoint Connector-Layout

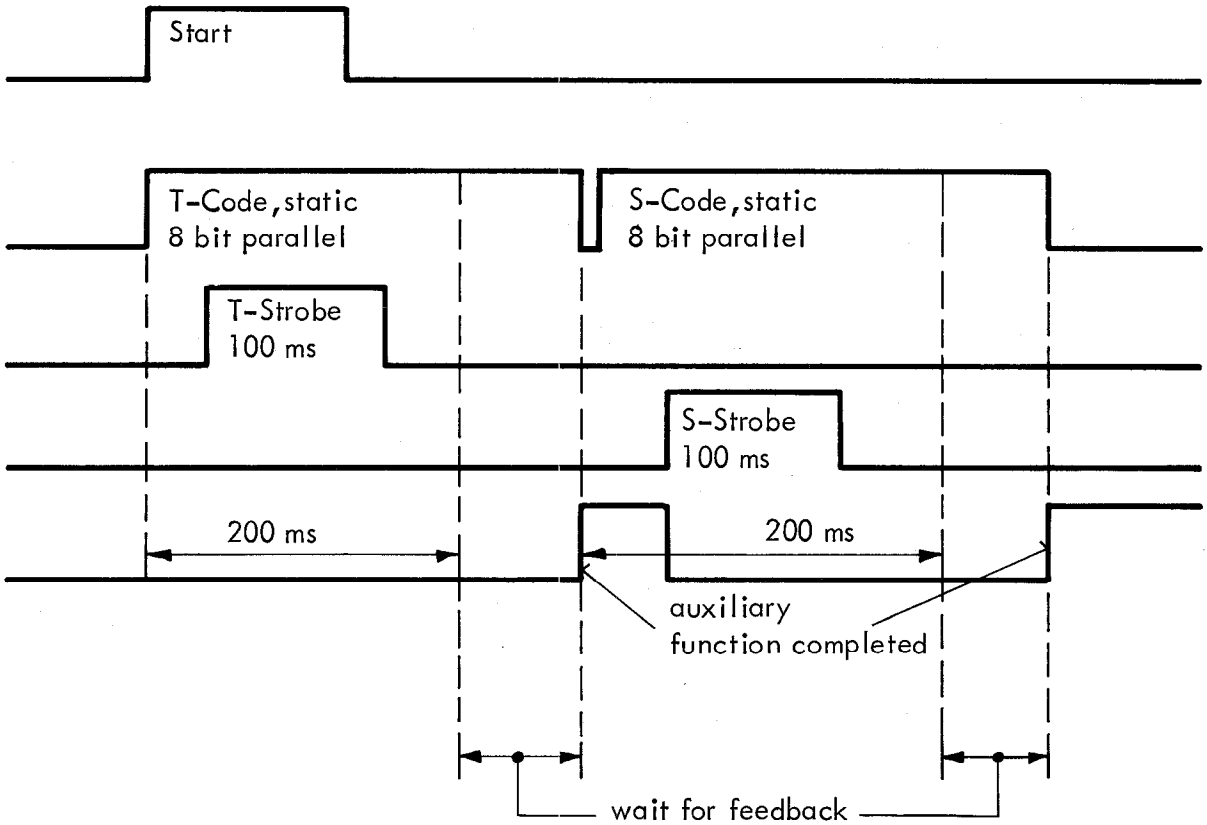


Decade 01:	bit 1	2^0
	bit 2	2^1
	bit 3	2^2
	bit 4	2^3
Decade 10:	bit 5	2^0
	bit 6	2^1
	bit 7	2^2
	bit 8	2^3

The S-code is a static signal. The S-strobe is provided 50 ms after beginning of the S-code value output with duration of 100 ms. (The S-code output is present for 100 ms as per the S-strobe) 200 ms after beginning of the S-code output, the control input "feedback auxiliary function completed" is interrogated. When this input is at + 24 V, the S-code is cut-out and program run is continued.

If the input is inactive (at 0V) the S-code signals are provided and program run remains interrupted until the input is re-activated (at + 24 V).

Diagram of T- and S-code procedures within tool call blocks



Coding of S-functions

S-function	rpm	Multipoint Connector J 4 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	Multipoint Connector J 4 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
2 = contact open

9. Fixed Program cycles

(canned cycles)

For general purpose operation, TNC 135 B possesses "fixed" programmed cycles (canned cycles) for re-occuring machining operations.

At present the following program cycles are permanently programmed:

CYCL DEF 0	DIAGONAL PATH (only for position loop with linear interpolation)
CYCL DEF 1	PECKING
CYCL DEF 2	TAPPING
CYCL DEF 3	SLOT MILLING
CYCL DEF 4	POCKET MILLING
CYCL DEF 5	POLE
CYCL DEF 6	POLAR COORD.
CYCL DEF 9	DWELL TIME

The cycles "pecking", "tapping", "slot milling" and "pocket milling" can only be performed if the machine spindles can be controlled by the auxiliary functions M 03, M 04 and M 05.

Refer to the TNC 135 B Operating Manual for programming of fixed cycles.

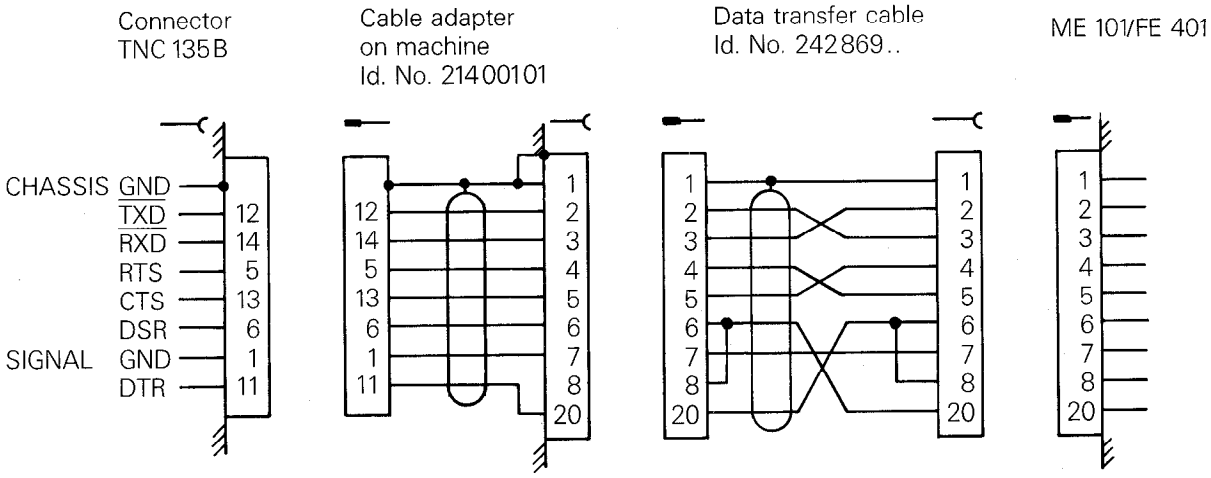
10. External data input and output

10.1 Input/Output connection

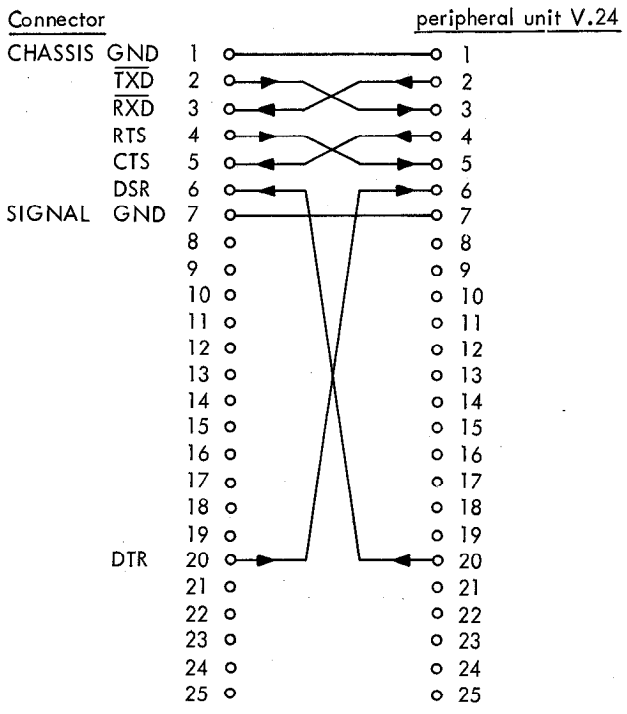
The TNC 135 B control possesses a V.24 (RS-232-C) compatible data input and output facility.

Other peripheral units (e.g. a tape punching and reading unit, telex, printer) can be connected to the TNC if they are fitted with a V.24-compatible connector (an auxiliary unit with a 20 mA data input/output cannot be connected).

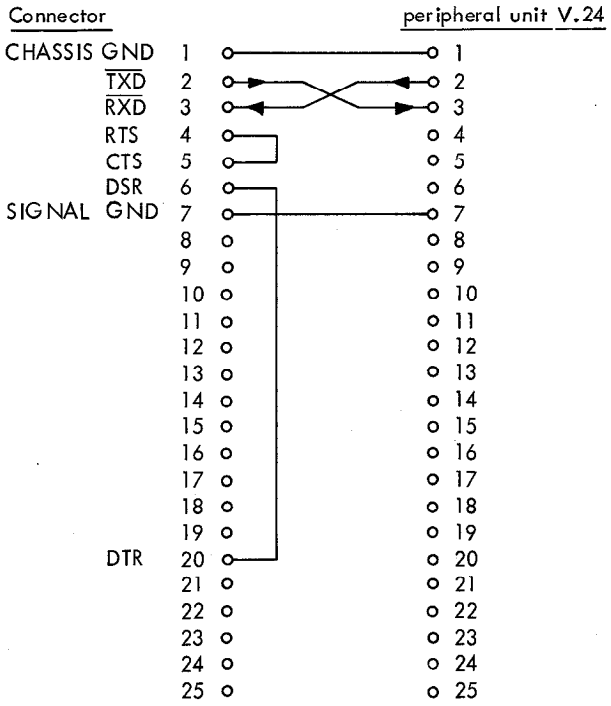
HEIDENHAIN supplies the following connecting cables:



The signal flow in the leads of the V.24 cable can be seen in the following sketch:



The CTS and DSR signals should be active for the duration of transfer (+ 5 V to + 15 V). For this reason, in the case of a data-printer, punched tape reader/punching unit being connected, the following layout of the data transfer cable has proven to be very satisfactory.



The signal designations have the following meanings:

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

Connectable peripheral equipment

Peripheral units should be connected such that the specified Baud rate can be used without limitations. Peripheral units which require a standstill for data trasnfer for certain processes (e.g. carriage return, line shift etc.) may not be connected.

10.2 Baud Rate entry

The transfer rate for the external data-input and output is automatically set to 2400 Baud. Provided that no other transfer rate has been programmed.

This should be performed as follows:

Dialogue display	Reqd. operation/press:	Remarks
-	"manual operating mode" key	
-	EXT	
BAUD-RATE=	0 ... 9 ENT	If reqd., key-in new Baud-Rate: 110, 150, 300, 600, 1200, 2400 - and enter into memory
-		Display off, new Baud-Rate is programmed

If the Baud-Rate is only to be displayed for inspection, proceed as follows:

Dialogue display	Reqd. operation/press:	Remarks
	"manual operating mode" key	
-	EXT	
BAUD-RATE ...		The stored Baud-Rate is displayed
BAUD-RATE ...	DEL	Display goes off

Caution !

Control switch-off with discharged or missing buffer batteries automatically erases the programmed Baud-Rate. A control re-start then automatically sets the value to 2400.

10.3 Operating procedure for data transfer

The TNC 135 B provides the following commands automatically (for print-out line-by-line):

CR: carriage return LF: line feed

SP: space ETX: end of text

With program storage in a tape punching unit the tape has these symbols. With magnetic tape storage, they are on the magnetic tape. (For programming via the external interface, please refer to programming instructions.)

Output procedure with TNC 135 B

Dialogue display	Reqd. operation/press:	Remarks
No block or random program block	Operating mode:  or 	Set TNC to "program run" mode
Random program block	0 ... 9	Select program start or block at which data transfer is to begin
Random program block	GO TO	Jump to block "n"
Program beginning or Program block "n"	EXT	data transfer start
EXTERNAL DATA OUTPUT	-	data output
0	-	data transfer completed

Please note:

Before program entry into the TNC we recommend that the contents of program memory be erased: with external input the program blocks are overwritten with new information. With the new "short" program, it is possible that portions of an existing program remain stored.

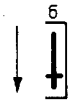
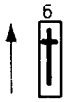
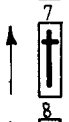
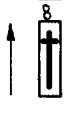
External input procedure with TNC 135 B

Dialogue display	Reqd. operation/press:	Remarks
No block or random program block		TNC in programming mode
random program block	CL PGM	clear program
PROG. ERASE ? YES=ENT/NO=DEL	ENT	clear program verify
0		clear program completed
0	EXT	external data transfer START
EXT. DATA INPUT	-	data entry
block last transferred	-	data entry completed

11. Transducers

11.1 Code switches for counting direction

The counting direction of the transducers can be reversed with the switching channels 6, 7 and 8.

Channel			
6	counting direction X	 normal	 reverse
7	counting direction Y	 normal	 reverse
8	counting direction Z	 normal	 reverse

11.2 Encoders for TNC 135 B

The TNC 135 B control is designed for a resolution (display step) of 0.005 mm or 0.0002 inch.
Following incremental linear encoders with 20 µm can be directly connected:

- LS 603 (measuring lengths 170 mm to 3040 mm)
- LS 303 (measuring lengths 120 mm to 1240 mm), with mounting spar 2040 mm

For measurements of angles (metric system only) the incremental angle encoders ROD 250 and ROD 700 with 18 000 lines/revolution are available. Resolution (display step) is 0.005°.

If accuracy requirements permit, it is also possible to carry out indirect linear measurement e.g. with an angle encoder ROD 450 on the lead screw. The required line number/revolution for this case can be calculated as follows:

Reqd. line numbers/revolution = 50 x spindle pitch (in mm).

As the reference pulse is provided once per revolution in case of indirect linear measurement with an angle encoder, it is advisable to use a reference pulse suppressor unit for reproduction of the datum point by means of the REF.-facility of the TNC 135 B control.

The cable length between encoder and control should not exceed 20 m.
The max. permissible scanning frequency is 25 kHz.

Owing to the permissible cable length of TNC 135 B not exceeding 20 m, a special TNC-design TNC 135 RT has been developed for greater cable lengths. These TNC types have a transducer input for square-wave signals and can therefore only be used in conjunction with an EXE-pulse shaping stage. The EXE-signal is evaluated 4-fold within the TNC.

The max. permissible cable length between transducer and EXE-unit is 20 m. The max. permissible cable length between the EXE and TNC is 50 m. Therefore the total cable length is 70 m.

The following linear encoders can be connected:

Encoder		
LB 326 (max. approx. 30 m)	EXE 802	5-fold
LS 603 (170 mm to 3040 mm)	EXE 802	1-fold

For angle measurement, an incremental angle encoder as mentioned for TNC 135 B can be used, however with 18 000 lines per rev. For signal interpolation the EXE 802 with 1-fold is required. The TNC 135 RT already contains 4-fold evaluation electronics. Therefore we recommend ROD 250 and ROD 700 with 18 000 lines per rev.

Indirect measurement via angle encoder e.g. ROD 450 is also possible. When using the EXE 802 with 1-fold interpolation the line number per rev. can be calculated as follows:

Reqd. line count/revolution = 50 x spindle pitch (in mm).

Layout of 25-pole encoder connector at TNC 135 RT

B2	A1	A2	C1	C2	B3	B4	A3	A4	C3	C4	B5	B6	A5	A6	C5	C6	B7	B8	A7	A8	C7	A9	C8	C9
$\overline{U_{a1}}$	U_{a1}	$\overline{U_{a2}}$	U_{a2}	$\overline{U_{a0}}$	U_{a0}	$\overline{U_{as}}$	U_{as}	$\overline{U_{a1}}$	U_{a1}	$\overline{U_{a2}}$	U_{a2}	$\overline{U_{a0}}$	U_{a0}	$\overline{U_{as}}$	U_{as}	$\overline{U_{a1}}$	U_{a1}	$\overline{U_{a2}}$	U_{a2}	$\overline{U_{a0}}$	U_{a0}	$\overline{U_{as}}$	U_{as}	U_N
X								Z								Y								

U_N = reference for signals Shield on connector housing

12. Starting procedure of a machine with a TNC 135 B control

12.1 Checks before switch-on

12.1.1 Voltage change-over check

The TNC control is provided with a voltage selector with fuse carrier. Operating voltages of 100/120/140/200/220 or 240 V can be selected with the aid of a coin.

Frequency range is 48 to 62 Hz.

Fuses for 100, 120, 140 V: slow-blow 1.0A
200, 220, 240 V: slow-blow 0.8A

12.1.2 Cooling the TNC unit

The upper and lower surfaces of the TNC 131/TNC 135 have cooling slits. These slits are covered with metal plates (which are secured by philips screws). These covers may only be removed when splashwater protection (IP 54) is ensured in the machine pendant.

The best cooling effect for the TNC is achieved when a ventilator (10 W-ventilator is sufficient) is located directly above the TNC with the air flow direction upwards. The machine pendant itself should not be provided with cooling slits in order to prevent contamination of the cooling air (dust, chips, coolant).

Permissible ambient temperature: 0 ... 45° C (32° ... 113° F).

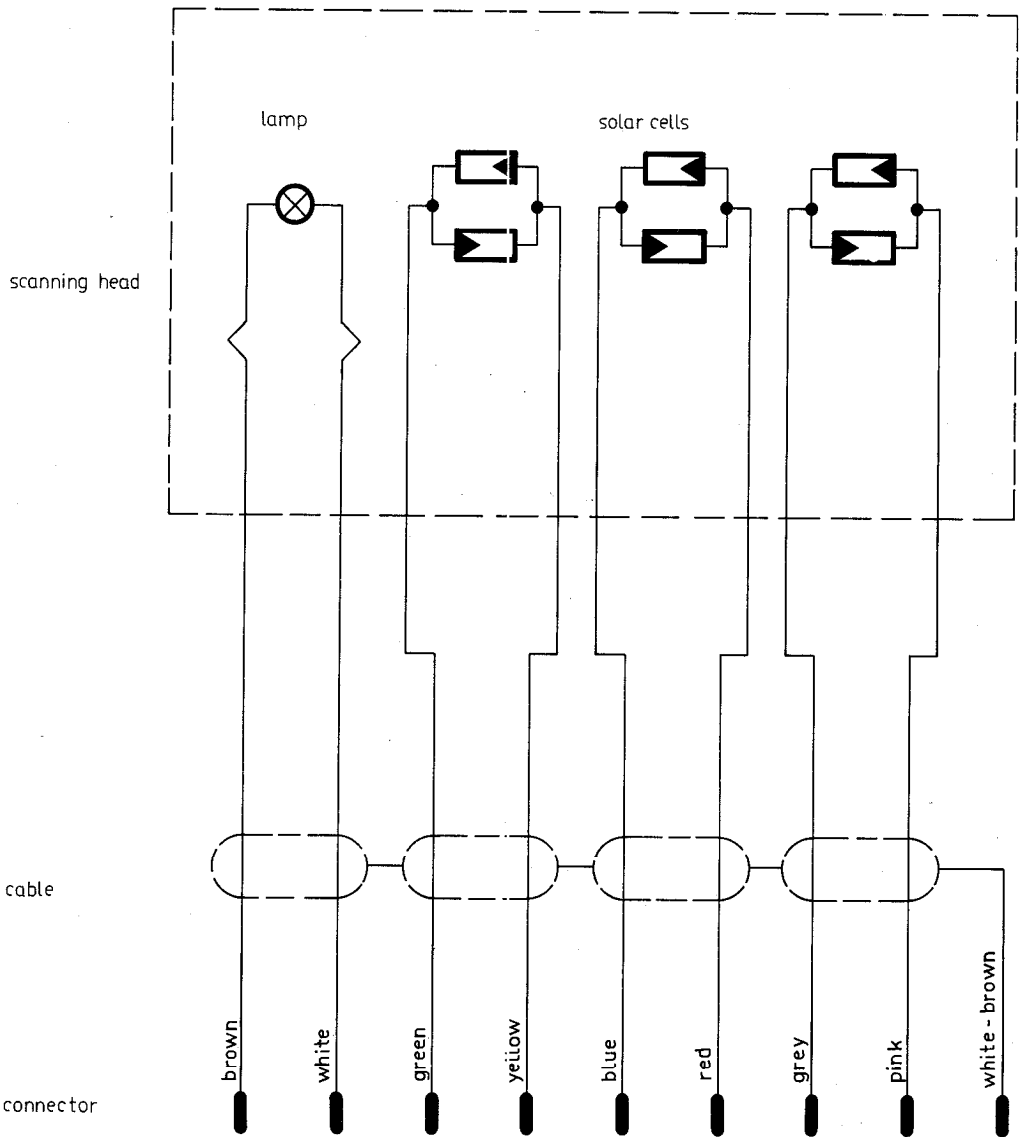
12.1.3 Checking the transducer cable

Please note !

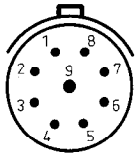
For the following check the transducer cable must be disconnected from the TNC. The following measurements can be performed with a simple ohmmeter.

1. The outer shielding (on connector housing) must be connected to the machine ground.
2. The inner shield (pin 9) must not have any conductive connection with the outer shielding (connector housing).
3. All further connector pins must not have any connection with pin 9 or with the connector housing.

Connector pin designation



connector
212 356 01



Pin No.	3	4	1	2	5	6	7	8	9 *
	+	−	+	−	+	−	+	−	
Allocation	lamp U_L		signal I_{e1} (0°el.)		signal I_{e2} (90°el.)		reference pulse I_{e0}		shield
Input signal electronical value	5V ± 10% appr. 20 mA		15 - 35 µApp		15 - 35 µApp		4-15 µA used part		

* inner shield on pin 9
out shield on connector housing

Disassembly or assembly of connector

Disassembly (for re-use of connector) - Fig. 1/6

- Loosen screws Z of cable clamp A.
- The threaded connection "X" between part A and E has been secured with locking paint at the factory. Do not attempt to loosen this connection by force. We recommend "heating" the connector in the area of this threaded connection with a hot air blower. Care should be taken that neither the cable nor other heat sensitive components of the connector are damaged during this procedure.
- Loosen part E by means of a spanner (SW 19 or 3/4" across flats with max. width 5 mm). Caution! Take care that the connector pins are not damaged when bracing with part G!
- Draw back parts B, C, D and E until the soldering connections of part G are accessible. Disconnect the individual wires by using a suitable soldering iron (30 W recommended). Remove parts A, B, D and E from cable.

Connector assembly

If the connector has been disassembled in accordance with the above procedure, carefully check the free ends of the cable for the purpose of re-use: all cores, tinned ends as well as shield and insulation must be free from any damage! Damaged insulation can cause short-circuiting! Should a new preparation of the cable end be necessary, proceed as follows:

- Remove external insulation in accordance with Fig. 1.
- Draw back shield and cut (Fig. 2).
- Cut insulation and threads and remove interior sheathing (Fig. 3).
- Remove insulation of the individual cores and tin ends (Fig. 4).
- Twist interior shield together and cut to a length of approx. 5 mm, solder wire (0.14 mm^2) white/brown and insulate with thermo-shrinkable tubing dia. 5 mm (5 mm long) (Fig. 4).
- Assemble parts A, B, C, D, E and F onto the cable (Fig. 5).
- Insert tinned ends of cable into the appropriate soldering contacts of part G and solder (soldering iron 30 W).
- Place coupling ring F into correct position.
- Tighten threaded connection "Y" between part E and G. Caution! When bracing with part G care should be taken that the pins are not damaged, it is therefore essential to use appropriate coupling or flange socket!
- Place washer D into part E.
- Arrange cable shielding radially to dia. 17.
- Insert rubber gasket C into part E taking care that the shield is placed between washer D and rubber gasket C. Special care must be taken that no fragments of shielding wires have penetrated into the area of the soldering connections (this can cause short-circuiting).
- Place washer B onto rubber gasket.
- Tigthen threaded connection "X" between part A and part E whilst bracing part E with a spanner.
- Tigthen screws Z of the cable clamp.
- Secure threaded connection "X" with locking paint.

Fig. 1

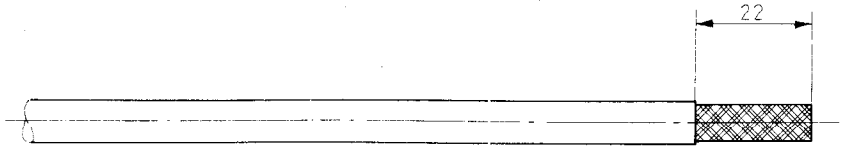


Fig. 2

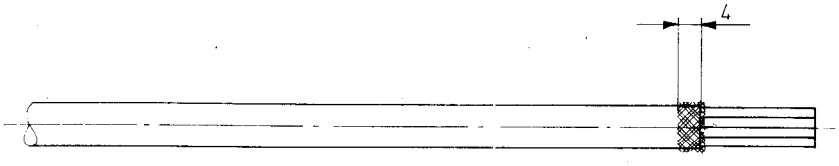


Fig. 3

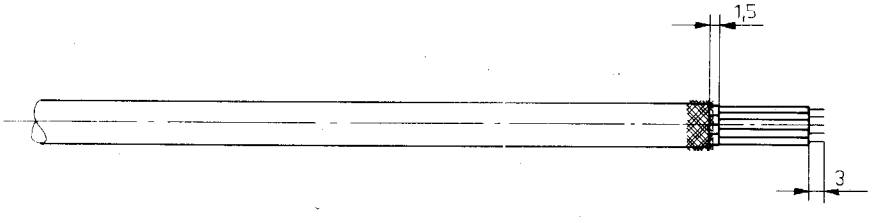


Fig. 4

Fig. 5

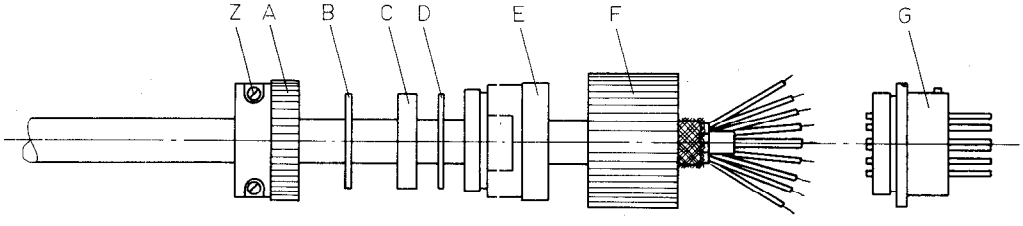
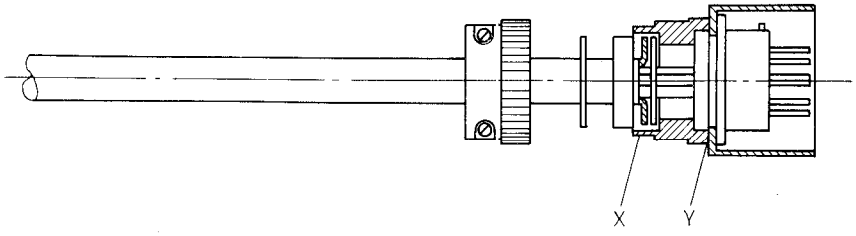


Fig. 6



12.1.4 Grounding of auxiliary voltage

Disconnect the 0V-return circuit from multipoint connector J2/1 and check with ohmmeter against "ground" (SL). A grounded connection must be present otherwise capacitive superimposed D.C. voltages can occur.

12.1.5 Grounding of nominal value input at servo-amplifier

The input of the appropriate servo-amplifier must be directly connected with the appropriate analogue output of the TNC 135 B.
The appropriate 0V-connections must be grounded at the servo-amplifier (SL).

12.2 Switching on the interface cabinet (without TNC)

Caution:

The TNC 135 B is not yet connected.

12.2.1 Checking the external D.C. voltage

Measurement should be carried out to check that the external D.C. voltage (24V) meets the requirements as given on page 22.

12.2.2 Checking the limit switches

Before operation of the servo-drive the function of the EMERGENCY STOP facility and limit switches must be checked.

Moreover, the fixing of the switching cams must be in order.

12.2.3 Set-up of D.C. drive amplifiers
(adjustment of rapid traverses)

With the aid of an external nominal voltage of 9 V (battery case), the rapid traverse speed of the three axes is to be adjusted at the servo-amplifier.

An adjustment of the servo-amplifier input by means of voltage division of the nominal value from the TNC 135 B control is not permitted. This would result in problems with the offset-voltages!

12.3 TNC-Commissioning

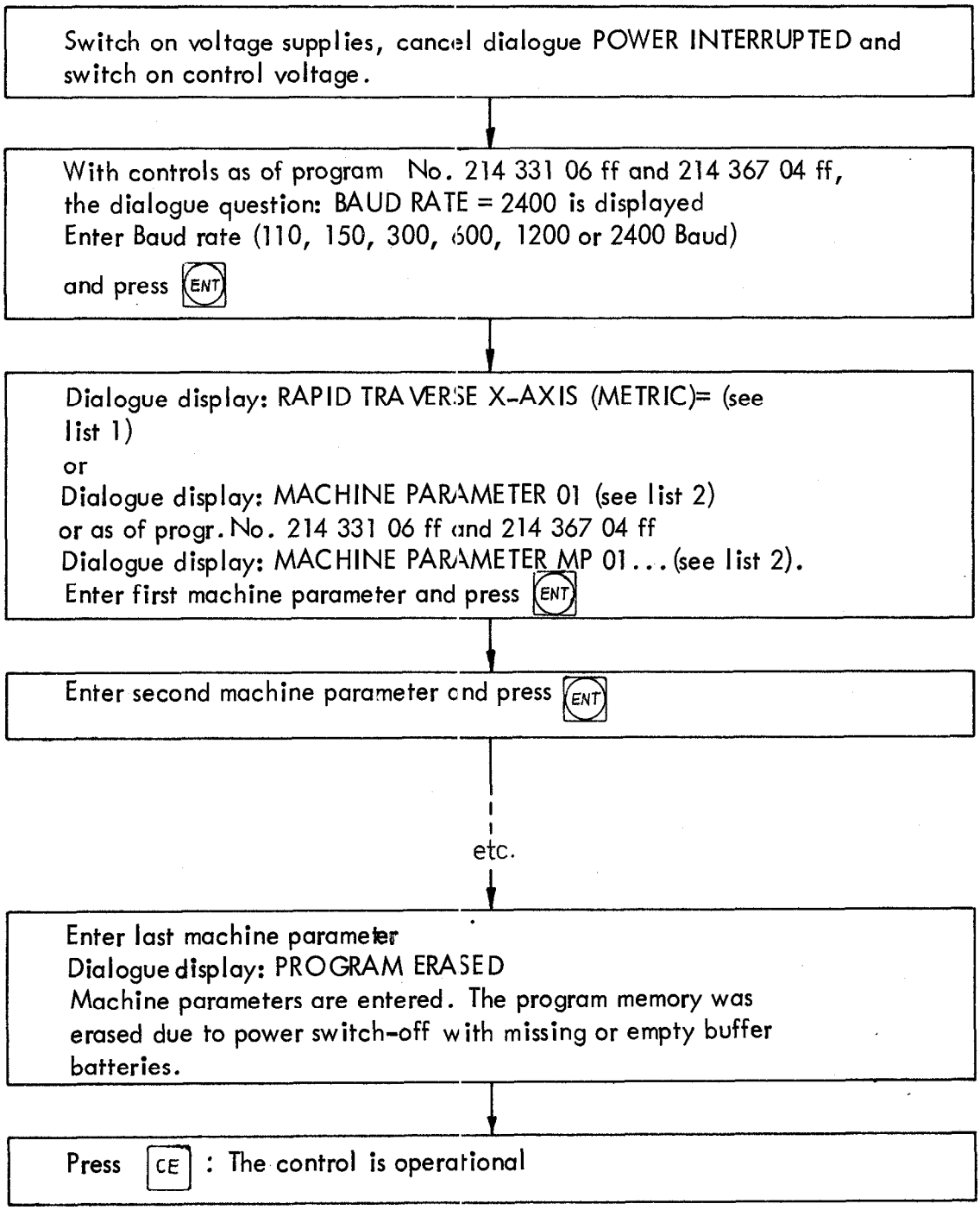
Make connections of multipoint connectors, transducer inputs and mains power supply. Switch on of interface cabinet with the TNC.

12.3.1 Machine parameter programming for first commissioning.

With the first commissioning procedure, machine-specific program data must be entered. Dialogue initiation for machine parameter entry can be performed in two ways:

a) Remove buffer batteries before power switch-on. Machine data already programmed are erased with this type of initiation; all data must be re-entered.

a1) Manual machine parameter entry:



a2) Entry of machine parameters (as of progr. No. 214 331 06 ff and 214 367 04 ff):

Switch on power, cancel display POWER INTERRUPTED and switch on control voltage

↓

Dialogue question: BAUD -RATE = 2400
Enter Baud rate (the magnetic tape cassette unit requires 2400 Baud) and press ENT

↓

Dialogue display: MACHINE PARAMETER MP 01 ...

- Connect magnetic tape cassette unit
- Insert cassette and rewind to tape start
- Select [PGM] and TNC

↓

Press EXT

Dialogue display: EXTERNAL DATA INPUT
Machine parameters are read into the TNC

↓

Dialogue display: PROGRAM ERASED.
Machine parameters are read-in. The program memory was erased due to power switch-off with missing or empty buffer batteries.

↓

Press CE

The control is operational

b) Editing or overwriting of machining parameters already entered.
With this type of programming, the erasing of a stored machine program is prevented.

b1) With older software versions, proceed as follows:

Switch off mains voltage of control and press [⇨]

↓

Dialogue display: RAPID TRAVERSE X-AXIS (METRIC) =(see list 1)
or
MACHINE PARAMETER 01 (see list 2)
The programmed value is in the entry value display.

↓

Transfer old entry value by pressing [ENT]
or
enter new value and press [ENT]

↓

Second machine parameter is displayed.
Transfer old entry value or enter new value.

↓

etc.

↓

All machine parameters are edited.
Dialogue display: POWER INTERRUPTED

↓

Press [CE]
Dialogue display: RELAY EXT. DC VOLTAGE MISSING.

↓

Switch on control voltage. Control is operational.

b2) As of Program No. 214 331 06 ff and 214 367 04 ff machine parameters can be edited by entering a code number.

Addressing a machine parameter via code number:

Select [✋] mode.
Key-in code number 95148 and press [ENT]

↓

Dialogue display: MACHINE PARAMETER MP 01 ...

With the [↓] and [↑] -keys, individual machine parameters can be addressed and edited.

By pressing the [DEL □] -key the memory for machine parameters is left.

Select mode

Key-in code number 95148 and press ENT

Dialogue display: MACHINE PARAMETER MP 01 ...

. Connect magnetic tape unit
. Insert cassette and rewind to tape start.

With external data input, proceed as follows:

Select and TNC on ME-unit

Press EXT on control

Dialogue display: EXTERNAL INPUT? YES=ENT/NO=DEL.

Press ENT

Dialogue display: EXTERNAL DATA INPUT.

Data transfer is initiated. Old machine parameters are overwritten.

With external data output, proceed as follows after entry of the code number.

Select and TNC on ME-unit

Press EXT on control

Dialogue display: EXTERNAL INPUT? YES=ENT/NO=DEL.

Press DEL

Dialogue display: EXTERNAL OUTPUT? YES=ENT/NO=DEL.

Press ENT

Dialogue display: EXTERNAL DATA OUTPUT.

Machine parameters are read-out.

The display indicates the sequence run of machine parameters

or

press DEL

Data transfer is not executed.

Depending on the TNC 135 B version, the machine data is required in either coded form or in plain language.

list 1: Plain language entry

The control requests the following information:

Dialogue request	Entry data (to be filled out by machine tool manufacturer)
RAPID TRAVERSE X-AXIS (METRIC) ? = RAPID TRAVERSE Y-AXIS (METRIC) ? = RAPID TRAVERSE Z-AXIS (METRIC) ? =	. . . .
Only with software-version: commond drive with backlash RAMP DOWN MIMIMUM STEP	. . . . .
RPM CODE ?	. . . . .
Only with software version for simultaneous operation: SPEED CODE FOR AXES 0 ... 7 ?	. . . . .

list 2: Entry of machine parameters via code numbers:

Code number	Appropriate machine parameter	Entry data (to be filled out by machine tool manufacturer)
MACHINE PARAMETER 01	Rapid Traverse X-Axis	. . . . .
MACHINE PARAMETER 02	Rapid Traverse Y-Axis	. . . . .
MACHINE PARAMETER 03	Rapid Traverse Z-Axis	. . . . .
MACHINE PARAMETER 04	Position supervision : leading	. . . . .
MACHINE PARAMETER 05	Position supervision : trailing	. . . . .
MACHINE PARAMETER 06	Standstill range	. . . . .
MACHINE PARAMETER 07	RPM-Code	. . . . .
MACHINE PARAMETER 08	Ramp down minimum step (Only with software-version: "common drive with backlash")	. . . . .
MACHINE PARAMETER 09	Speed Code for axes (This parameter is valid for all software versions with coded entry. The function of this parameter has been extended)	. . . . .
MACHINE PARAMETER 10	Advanced cut-out time for tapping	. . . . .
MACHINE PARAMETER 11	Are S- or T-functions required ?	. . . . .
MACHINE PARAMETER 12	Selection of the active axes ?	. . . . .
MACHINE PARAMETER 13	Duration of direction change on Z-axis (only with progr. No. 214 351 05 ff)	. . . . .
MACHINE PARAMETER 14	Spindle advanced switch-point via time duration or via distance depending on the entry value of MP 10 (as of progr. No. 214 331 06 ff and 214 367 04 ff)	. . . . .

Explanation of Machine Parameter

MACHINE PARAMETER 01 ≙ RAPID TRAVERSE X-AXIS (METRIC) ? =

MACHINE PARAMETER 02 ≙ RAPID TRAVERSE Y-AXIS (METRIC) ? =

MACHINE PARAMETER 03 ≙ RAPID TRAVERSE Z-AXIS (METRIC) ? =

The TNC 135 B possesses an extensive monitoring system. For monitoring the "trailing error" (lag), the TNC requires the max. traversing speeds, i.e. during the initial starting procedure, the entry of the rapid traverse speeds of the three axes is necessary. The greatest programmable rapid traverse speed is 9999 mm/min. The smallest possible value is 60 mm/min. If one axis of the TNC remains unused, the rapid traverse speed for software versions with simultaneous traverse must not be programmed with "zero" because with the cycle DIAGONAL PATH the max. traversing speed is reduced to half of the lowest programmed rapid traverse in the 3 axes.

Caution:

With the initial starting procedure the max. rapid traverse speed must be entered in mm/min even with the imperial measuring mode !

MACHINE PARAMETER 04 (Position supervision: leading error)

This machine parameter defines the permissible range for the leading error of the machine axes. The control compares the calculated position-nominal value with the momentary actual position. If the machine axis travels faster than commanded by the control, the difference between nominal and actual is increased. Upon reaching the predetermined lead limit the dialogue indicates the error "Gross positioning error".
The lead is programmed in 5µm-units(e.g. 200 ≙ 1 mm). Max. entry value: 32767

MACHINE PARAMETER 05 (Position supervision: trailing error)

If the machine axis traverses slower than commanded by the control and the nominal-actual difference increases such that the previously determined trailing limit is reached, the dialogue indicates "Gross positioning error".

The amount of lag is programmed in 5µm-units(e.g. 2000 ≙ 10 mm).
Max. entry value 32767.

MACHINE PARAMETER 06 (Standstill range)

If a non-controlled axis should deviate from its nominal position value to such an extent that the predetermined standstill range is exceeded, the dialogue indicates "Gross positioning error".
The standstill range is programmed in 5µm-units(e.g. 40 ≙ 200µm).
Max. entry value 32767.

MACHINE PARAMETER 07 ≙ RPM-CODE ?

The RPM-code must be entered with all software versions. With this code, a certain rpm-range is selected from the table (see page 40).

The minimum and max. permissible rpm of the spindle can be entered in the rpm-code. The rpm-step can also be determined within the permissible speed range.

The code is entered as a 5-digit number:

X min X X rpm	X max X X rpm	X step
01-99	01-99	1-9

Example: The rpm-code

2 0 8 0 2 is entered,

i.e. the minimum spindle speed is therefore set to S 20 (1 rpm) and the max. spindle speed is set to S 80 (1000 rpm). The speed range is also more clearly defined in that only every second speed is programmable.

The range of speeds for this example is as follows:

S-function	rpm
S 20	1
S 22	1.25
S 24	1.6
S 26	2
.	.
.	.
.	.
S 78	800
S 80	1 000

If, within the machining program, a spindle speed is programmed which is not in accordance with the fixed range, the following error indication will appear in the dialogue display during program run: WRONG RPM

This indication may be caused either by:
- programming of a wrong spindle speed,
- entry of a rpm-code which does not correspond to the machine

Please note:

The speed S 00 is always programmable and cannot be supressed in the rpm-code.

MACHINE PARAMETER 08 ≙ RAMP DOWN MINIMUM STEP

The explanation of this can be found in section 4.1.

MACHINE PARAMETER 09 ≙ SPEED CODE FOR AXES 0 ... 7 ?

a) For controls which have software for simultaneous traverse, the explanation can be found in section 5.1.1.

For controls which have software for non-simultaneous traverse due to the extended function of this parameter, this can also be used with controls for non-simultaneous traverse. (However, only if the machine parameters are requested for in coded form).

With non-simultaneous versions it has the following meaning:

Entry	
0	If tool approaches the workpiece in the minus-direction
8	If tool approaches the workpiece in the plus-direction

MACHINE PARAMETER 10 (Advanced cut-out when tapping)

The advanced cut-out time is programmed in ms-units (e.g. 500 ≙ advanced cut-out of spindle 500 ms before reaching the deceleration ramp). Max. entry value: 32767

As of progr. No. 214 331 06 ff and 214 367 04 ff:

For the spindle advanced switchpoint when tapping, entry values for MP 10 are entered as units of time (ms) or distance (5µm) depending on MP 14

MACHINE PARAMETER 11 (Determination whether S- or T-functions are to be provided)

The control can provide M-, S- and T-functions. However, S- and T-functions are not required in all cases. Parameter 11 serves in determining which functions should be suppressed and not output.

Entry	S-output	T-output
0	Yes	Yes
1	Yes	No
2	No	Yes
3	No	No

As of progr. No. 214 331 06 ff and 214 367 04 ff:

Machine parameters have been extended. It can be selected as to whether the tool number or the S-code

. is output with every call-up

or

with call-up repetition is output or not.

The S and T-output can be made inactive as before.

MP 11	Output with same T-No.	Output with same S-Code	
0	once	always	S, T active
1	-	always	S active
2	once	-	T active
3	-	-	S, T inactive
4	once	always	S, T active
5	-	always	S active
6	once	-	T active
7	-	-	S, T inactive
8	once	once	S, T active
9	-	once	S active
10	once	-	S, T active
11	-	-	S, T inactive
12	always	once	S, T active
13	-	once	S active
14	always	-	T active
15	-	-	S, T inactive

MACHINE PARAMETER 12 (Selection of the active axes)

This machine parameter determines which axes are to be active. If the control is to be used for a machine where less than three axes are to be controlled, certain axes can be inhibited.

Entry	Active axes
0	None
1	X
2	Y
3	X Y
4	Z
5	X Z
6	Y Z
7	X Y Z

Caution:
If the operator includes an axis into a machining program which has not been made active through the dialogue of the initial starting procedure, the error indication "WRONG AXIS PROGRAMMED" is displayed.

MACHINE PARAMETER 13 (Duration for direction change Z)

(only with progr. No. 214 351 05 ff active)

After reaching the nominal position on the Z-axis a direction change takes place. The duration of direction change is entered in 5 ms steps with machine parameter 13

Entry limits: 0...100

MACHINE PARAMETER 14 (Spindle advanced switchpoint via time or direction)

(as of progr. No. 214 331 06 ff and 214 367 04 ff)

Machine parameter 14 determines whether the entry values of machine parameter 10 are to be units of time (ms) or distance (5 µm)

MP 14 = 0: When tapping, spindle advanced switchpoint in ms-units before reaching ramp.

MP 14 = 1: When tapping, spindle advanced switchpoint in 5 µm-units before reaching nominal position.

Buffer batteries

The battery compartment which is located beneath the cover plate on the TNC 135 B front panel, contains a special battery carrier. When inserting new batteries, care should be taken that the polarity conforms to the polarity signs shown on the carrier.

The batteries to be used have IEC-designation "LRG" and must be of the leak-proof type. We especially recommend the use of Mallory Alcaline batteries type "MN 1500".

With discharged (or missing buffer batteries), the program memory is supplied by the mains power supply. Continuation of operation is therefore possible - however, the memory content will be erased in the event of a mains power failure: If a mains power failure occurs during a battery change (discharged or missing batteries) a new starting procedure is required.

If the dialogue display should read "EXCHANGE BUFFER BATTERY" the batteries are to be replaced by new ones ("empty" batteries will, however, keep for at least one week).

12.3.2 Checking measuring direction of transducer in "manual" operating mode

Check that the traversing directions of the machine axes (+ or - display on the control) correspond to the standards. If required, correct display at the control by means of reversal of counting direction of the transducer. This can be carried out by setting the code switches (channels 6, 7 and 8).

Caution !

- If the machine is fitted with directional limit switches these may also have to be reversed.
- If one of the axes traverses with positive nominal value towards the workpiece, the automatic reference mark approach facility must be inhibited in the interface cabinet owing to the TNC providing a positive nominal value in this operating mode !

12.3.3 Checking of traversing direction in controlled operating mode

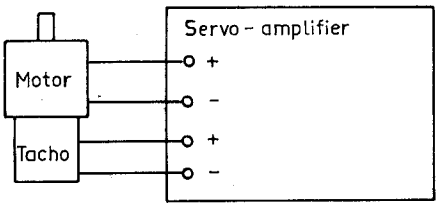
Preset a traverse in each axis with the control in operating mode  . After start observe whether machine traverses in the correct direction. If incorrect, the TNC 135 B control automatically ceases positioning and displays the dialogue "GROSS POSITIONING ERROR".

Caution !

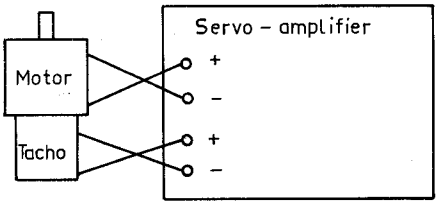
The error indication "GROSS POSITIONING ERROR" indicates!

- the wrong traversing direction of a moving axis
- Lag distance too large
- Standstill limit (200 µm) of a non-controlled axis has been exceeded.

Modification of traversing direction: reverse connections of motor and tachogenerator. Reversing the connections at the analogue output (s) of the TNC 131/135 is not permissible, as terminals 2, 4 and 6 must always be connected to the common ground contact.



Traversing direction incorrect



Traversing direction correct

Caution !

It is absolutely essential to reverse the tacho-generator connection also, otherwise the drive will run away and the machine will be damaged !
After reversing the connections, ensure that the Emergency Stop switch is within easy reach when restarting the machine. With directional limit switches it must be re-checked whether the final step is carried out in the correct manner.

12.3.4 Matching of ramp length

If "GROSS POSITIONING ERROR" appears in the dialogue display, although the traversing direction is correct, then the machine cannot carry out the nominal value command of the control. In this case switch-over of the ramp length is necessary.

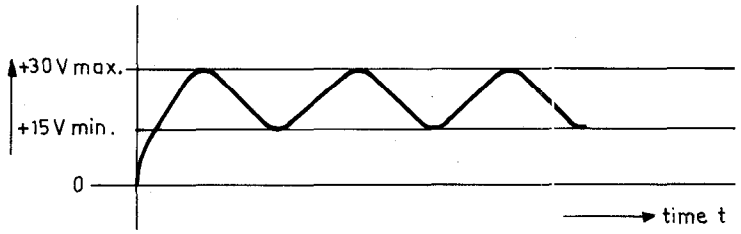
12.3.5 Offset - adjustment

If the machine cannot position from one traversing direction, then this is often caused by an offset-voltage at the servo-amplifier. The offset voltage must be adjusted at the servo-amplifier (refer to adjusting instructions of the servo-amplifier manufacturer).

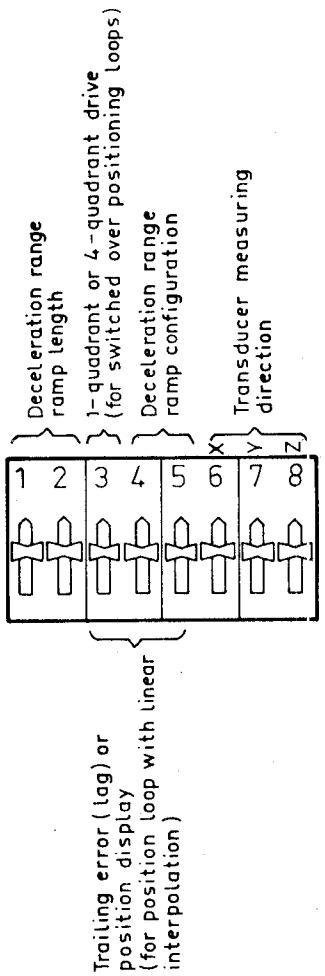
12.3.6 Trailing error (lag) adjustment

The adjustment of trailing error is only necessary if one of both software versions "common drive with linear interpolation" is being used.
(Refer to item 5.1.2 for adjustment procedure).

1.	Checks before machine switch-on:	
1.1	Is the mains selector switch of TNC at correct setting ?	○
1.2	Have the covers been removed from the TNC slits ? (These covers should only be removed, when the machine pendant is splashwater-proof (IP 54)	○
1.3	The outer shield of transducer connector (connector housing) must have an conductive connection to the machine.	
	a) The connection is provided for the X-axis	○
	b) The connection is provided for the Y-axis	○
	c) The connection is provided for the Z-axis	○
1.4	The inner shield (pin 9) of the transducer connector must have no conductive connection to the connector housing.	
	a) No connection at X-axis	○
	b) No connection at Y-axis	○
	c) No connection at Z-axis	○
1.5	All further pins must not have any conductive connection with pin 9 or connector housing	
	a) No connection at X-axis	○
	b) No connection at Y-axis	○
	c) No connection at Z-axis	○
1.6	The 0V-return line of the 24 V auxiliary voltage must be grounded within the adapter cabinet	○
1.7	The inputs of the servo-amplifier(s) must be connected directly with the appropriate analogue output of TNC 135 B (intermediate resistors are not permitted).	○
1.8	The 0V-connections of the servo-inputs must be grounded at the servo-amplifier (connections at J1 pin 2/4/6).	○

2.	Checks after switch on of adapter cabinet:	
2.1	Measure external D.C. voltage. Does this voltage meet the demands ?  	○
2.2	Starting of D.C. drive amplifier: The rapid traverse speeds must be adjusted with an external nominal value voltage to 9V.	○
2.3	Check functioning of limit switches and Emergency Stop-limit switch.	○

3.	Checks after TNC-switch-on	
3.1	Check machine data or enter into memory. (refer to 12.3.1)	○
3.2	Check transducer counting direction in "manual" operating mode.	
	a) X counting direction correct	○
	b) Y counting direction correct	○
	c) Z counting direction correct	○

3.3	Is the traversing direction in the controlled modes correct ? a) X traversing direction correct b) Y traversing direction correct c) Z traversing direction correct	○ ○ ○
3.4	Optimise "ramping down" by setting code switches, channels 1, 2, 4, 5  	○
3.5	With poor positioning in one traversing direction check offset-adjustment at servo-amplifier.	○
3.6	With TNC-version for single-axis drives an simultaneous positioning: Is trailing error in order ? For checking, the channels 3, 4, 5 of the code switch are to be switched downwards. The adjustment is carried out by means of the speed adjustment at the servo-amplifier during the positioning procedure of two axes with a 45°-diagonal path in rapid traverse.	○

3-Axis Manual Data Input Control for incorporation into machine pendant - for machines with common drive or individual axis drives (3 closed loops).

Point-to-Point with straight cut control with additional possibility of traversing in 2 axes simultaneosly for straight-line linear (without tool radius compensation).

Traversing speed	max. 10 m/min.
Display step	0.005 mm/0.0002 inch
Program memory	for 500 blocks with buffer battery back-up 999 blocks optionally
Plain language dialogue-guided operation	(English, German, French or Italian)

TNC 135 Display:

Visual display unit:	The display of the plain language dialogue, program blocks, selected tool and momentary cycle call are shown on the VDU in 8 lines with 32 characters each.
2 Displays	. 8-digit display for entry values; . 7 1/2-decade displays for position values X, Y, Z
Evaluation of transducer reference marks	with buffer battery storage of datum values (automatic datum-set after power-failure by traversing over reference marks)

Operating mode selection via keyboard

1. Manual: Control function inactive (Digital Readout)
2. Controlles Auto/Manual traverse
3. Controlled from memory in single block operation
4. Controlled from memory/automatic run of complete program sequence
5. Programming either by key-in with stationery machine or simultaneously with controlled traverse and single block entry or transfer of actual machine position data.

Data input/output

V.24 compatible, for connection of external programming and recording equipment.

Absolute or Incremental position value entry
Programmable decimal point

mm/inch instant calculation for all entry and display facilities

Feed rate and Rapid traverse-override:
Input-potentiometer incorporated

Tool radius and length compensation

Feed rates and spindle speeds programming via keyboard in mm/min or 0.1 inch /min or rpm

9 M-Functions via direct relay output or optionally 100 M-functions
M 00 - M 99 in coded form -
(2 decades, 8-4-2-1 BCD-Code, separate M-strobe signal)

100 S-Functions in coded form -
(2 decades 8-4-2-1 BCD-Code, separate S-strobe signal)

100 T-Functions 0 ... 99 in coded form -
(2 decades, 8-4-2-1 BCD-Code, separate T-strobe signal)

Programmable STOP via keyboard -
also optionally via M-function M 00

Sub-programs and program part repeats (Nesting up to 8 times)

Fixed program cycles (max. 10)

Automatic block number allocation

Program editing by overwriting block information;
Deletion and insertion of program blocks

Search routines for finding blocks with certain characteristics

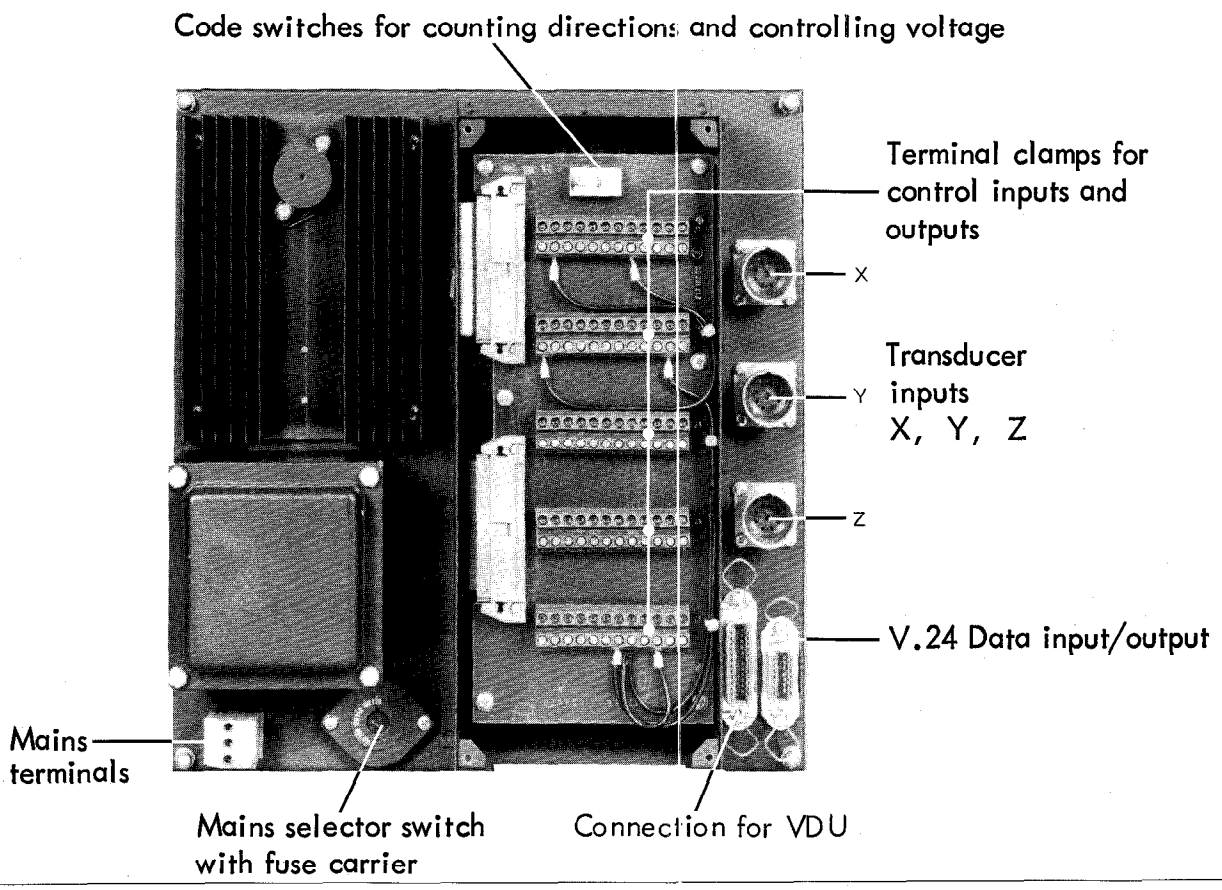
Self-diagnosis fault/detection for important sub-assemblies of control, positioning systems and transducers

Plain language dialogue display of operating errors, malfunctions, and defects

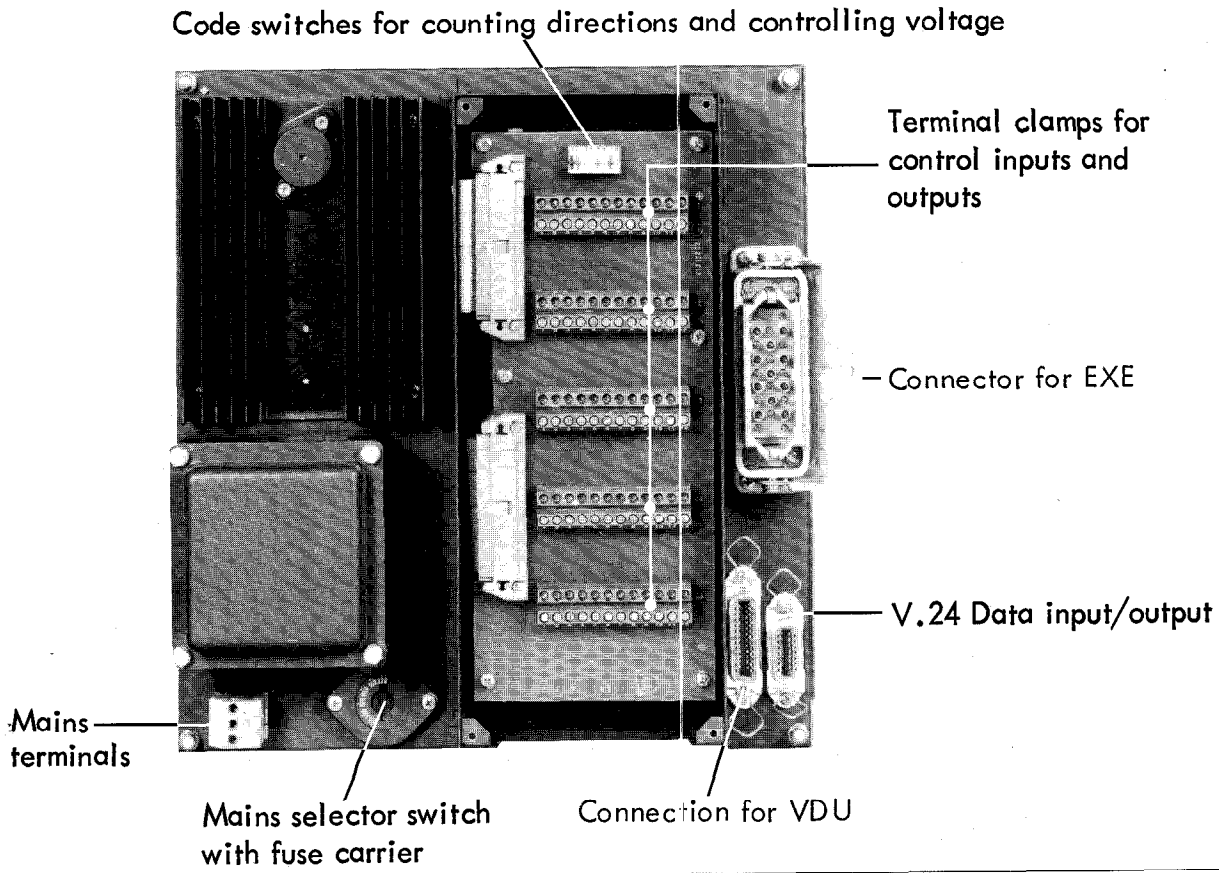
Transducers	TNC 135 B incremental HEIDENHAIN-linear transducers and angle (rotary) encoders (grating pitch 0.02 mm), with sine-wave signal output cable length to TNC max. 20 m TNC 135 RT The transducer signals are converted into square-waves via an (EXE) external pulse shaping unit and finally evaluated (4-fold) within the TNC. Cable length: transducer - EXE max. 20 m, EXE - TNC max. 50 m Suitable transducer e. g. LB 326 (grating pitch 0.1 mm) with EXE 802 (5-fold interpolation)
Control-Inputs	Start-button, Stop-button, Rapid traverse button, Feedback "Auxiliary function completed" Limit switches (X+, X-/Y+, Y-/Z+, Z-) Feedrate release Inputs for checking EMERGENCY STOP-function Signal input: Keep closed loop active (only for software: common drive without backlash)
Control-Outputs	Nominal voltage $\pm$ 10 V at 2 kΩ 1 working contact for each axis release 1 working contact for modes "Manual/Controlled" 1 working contact for "Traversing direction" (only for software: common drive with backlash) 1 working contact "Spindle lock on" 16 working contacts M-, T- ans S-functions 1 static contact "EMERGENCY STOP" 1 working contact "control in program run mode"
Mains power supply	Voltage selector 100/120/140 V: Fuse 1.0A slow-blow 200/220/240 V: Fuse 0.8A slow-blow Mains voltage fluctuations : + 10 % / - 15 % Frequency range: 48 - 62 Hz
Power consumption	TNC 135 approx. 52 W (including VDU)
Ambient temperature	Operation 0° ... 45°C (32° ... 113°F) Storage - 30° ... 70°C (-22° ... 158°F)
Weight	TNC 135 approx. 8.0 kg (18 lb) BE 135 approx. 6.8 kg (15 lb)

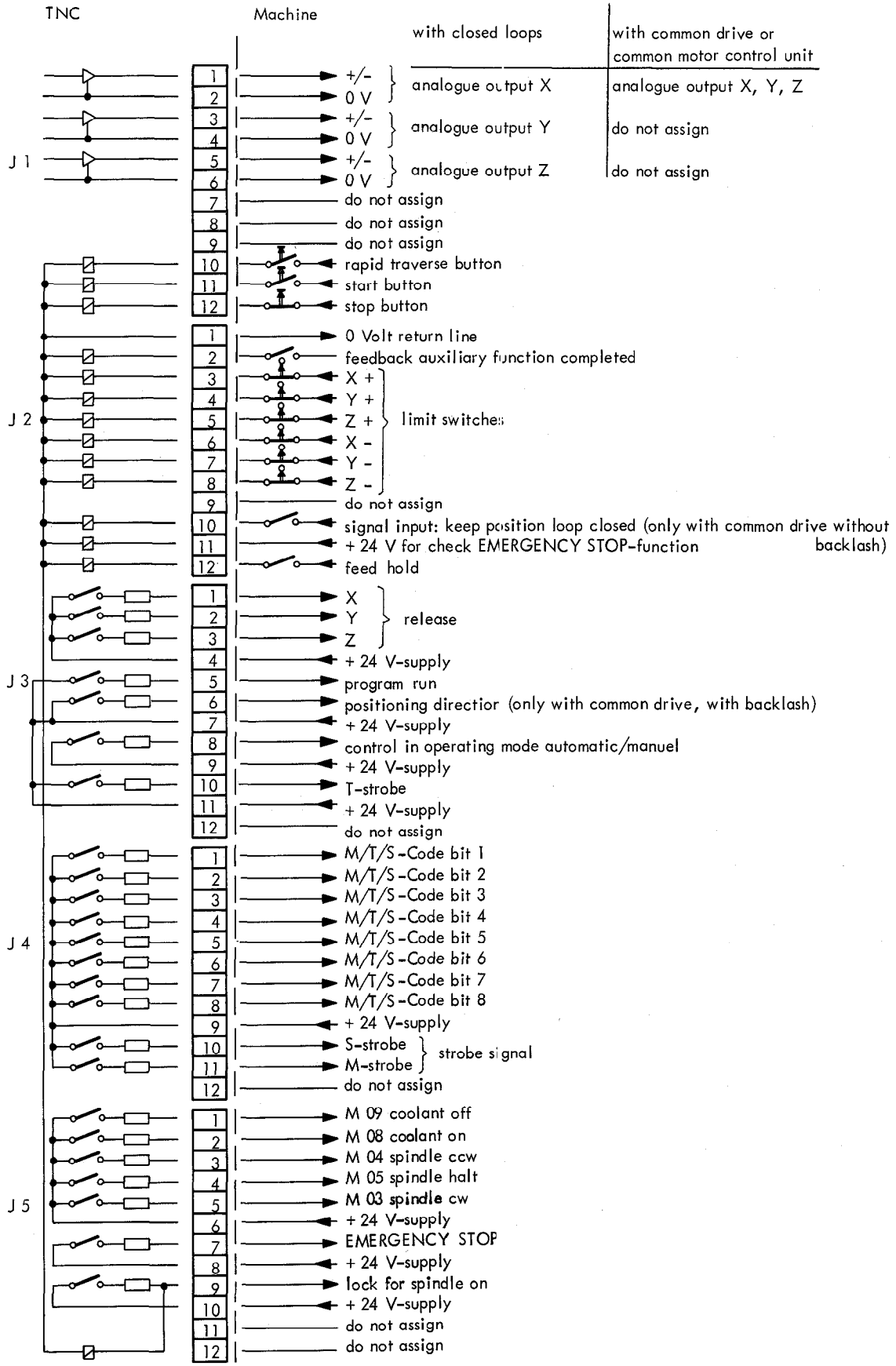
Notes

15.1 Connections TNC 135 B



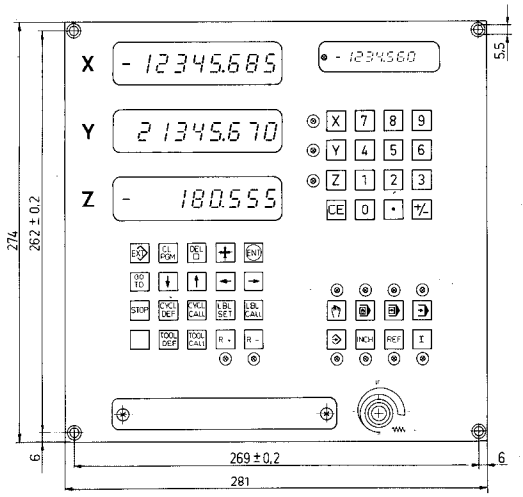
15.2 Connections TNC 135 RT

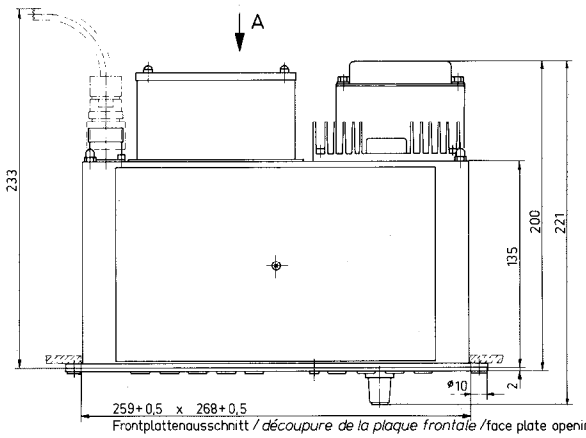


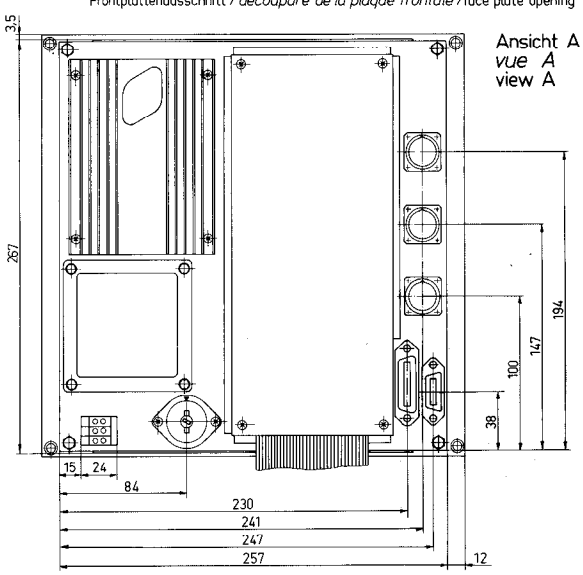

TNC
Machine
with closed loops
with common drive or common motor control unit
J 1
1 +/-
2 0 V
analogue output X
analogue output X, Y, Z
3 +/-
4 0 V
analogue output Y
do not assign
5 +/-
6 0 V
analogue output Z
do not assign
7 do not assign
8 do not assign
9 do not assign
10 rapid traverse button
11 start button
12 stop button
J 2
1 0 Volt return line
2 feedback auxiliary function completed
3 X +
4 Y +
5 Z +
6 X -
7 Y -
8 Z -
limit switches
9 do not assign
10 signal input: keep position loop closed (only with common drive without backlash)
11 + 24 V for check EMERGENCY STOP-function
12 feed hold
J 3
1 X
2 Y
3 Z
release
4 + 24 V-supply
5 program run
6 positioning directior (only with common drive, with backlash)
7 + 24 V-supply
8 control in operating mode automatic/manuel
9 + 24 V-supply
10 T-strobe
11 + 24 V-supply
12 do not assign
J 4
1 M/T/S-Code bit 1
2 M/T/S-Code bit 2
3 M/T/S-Code bit 3
4 M/T/S-Code bit 4
5 M/T/S-Code bit 5
6 M/T/S-Code bit 6
7 M/T/S-Code bit 7
8 M/T/S-Code bit 8
9 + 24 V-supply
10 S-strobe
11 M-strobe
strobe signal
12 do not assign
J 5
1 M 09 coolant off
2 M 08 coolant on
3 M 04 spindle ccw
4 M 05 spindle halt
5 M 03 spindle cw
6 + 24 V-supply
7 EMERGENCY STOP
8 + 24 V-supply
9 lock for spindle on
10 + 24 V-supply
11 do not assign
12 do not assign

Notes

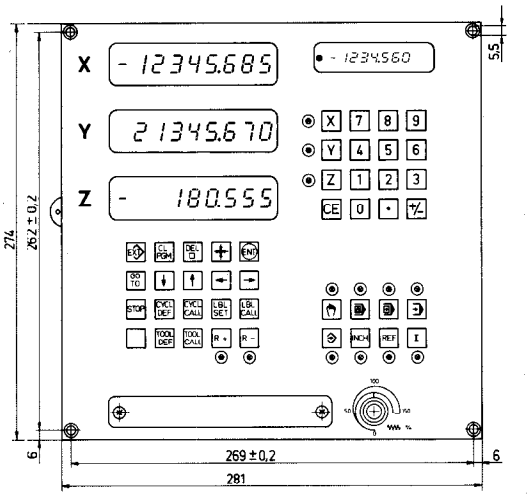
TNC 135 B

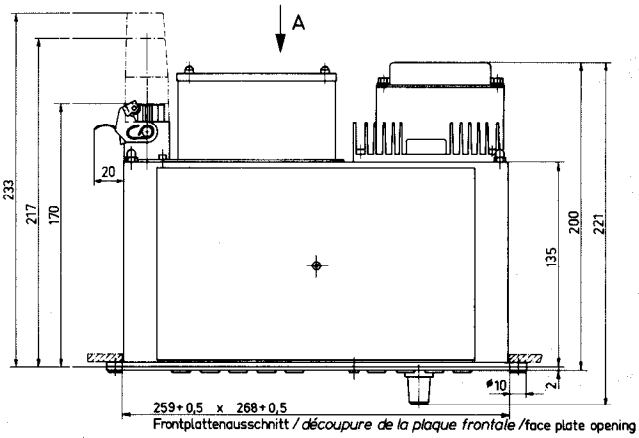


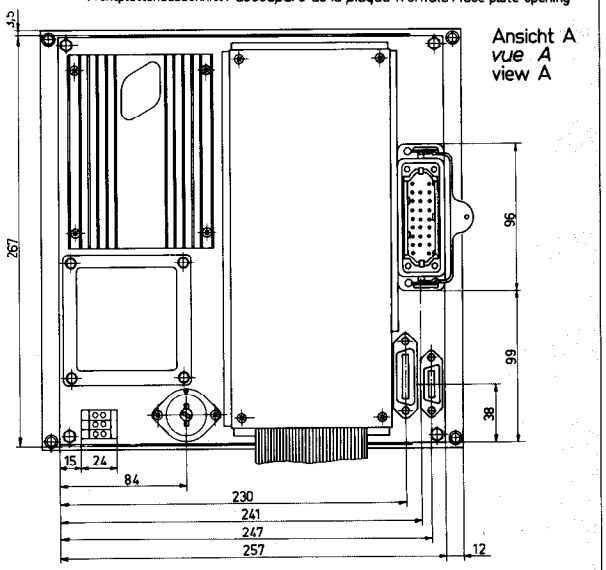




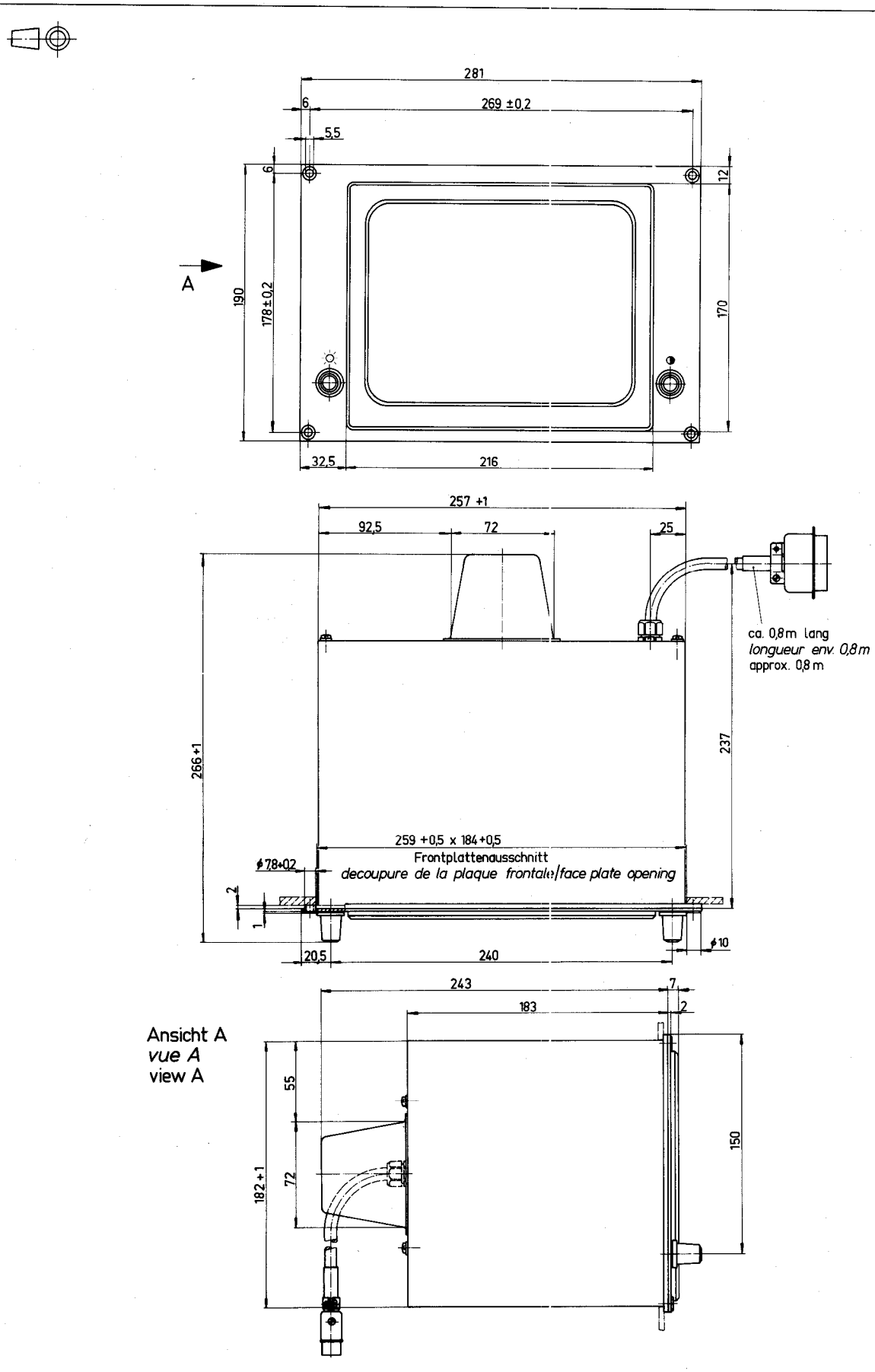
TNC 135 RT



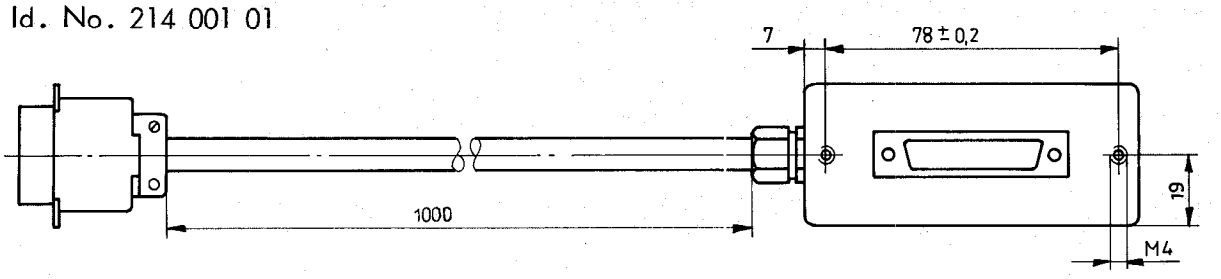




BE 135


281
269 ±0,2
6
5,5
6
12
A
190
178±0,2
170
32,5
216
257 +1
92,5
72
25
ca. 0,8m lang
longueur env. 0,8m
approx. 0,8 m
266+1
237
259 +0,5 x 184+0,5
Frontplattenausschnitt
decoupure de la plaque frontale/face plate opening
ϕ78+0,2
2
1
ϕ10
20,5
240
243
7
183
2
Ansicht A
vue A
view A
55
72
182+1
150

Adapter cable
Id. No. 214 001 01



HEIDENHAIN

216 165 24 · 2 · 5/90 · H · Printed in West Germany · Rights of alteration reserved