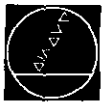

HEIDENHAIN

Technical Manual
TNC 116

Valid for NC Software
246 111

up to version 01

January '93

275 932 20 · 2 · SW01 · 1/93 · S · Printed in Germany · Subject to alteration

Foreword

This Technical Manual has been written for the use of machine tool builders and distributors. It contains important information on installation, electrical connection, commissioning and PLC programming for the HEIDENHAIN TNC 116 Straight-Cut Control.

Excerpts from this manual can be used in your machine documentation. It is possible to convert this manual from its present format (17 cm x 24 cm) to standard letter-size format (DIN A4) by enlarging it by a factor of 1.225.

The pre-punched holes allow this manual to be bound into the current Technical Manuals (such for TNC 407/415)

No documentation can be perfect. Documentation undergoes continual change, and will benefit substantially from your suggestions for additions and improvements. Please assist us by communicating your ideas to us.

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W-8225 Traunreut
Germany

CONTENTS

1 Technical Description

1.1 Technical Data

The TNC 116 is a 3-axis straight-cut control for paraxial machining on simple boring and milling machines using single-axis or common drives without backlash.

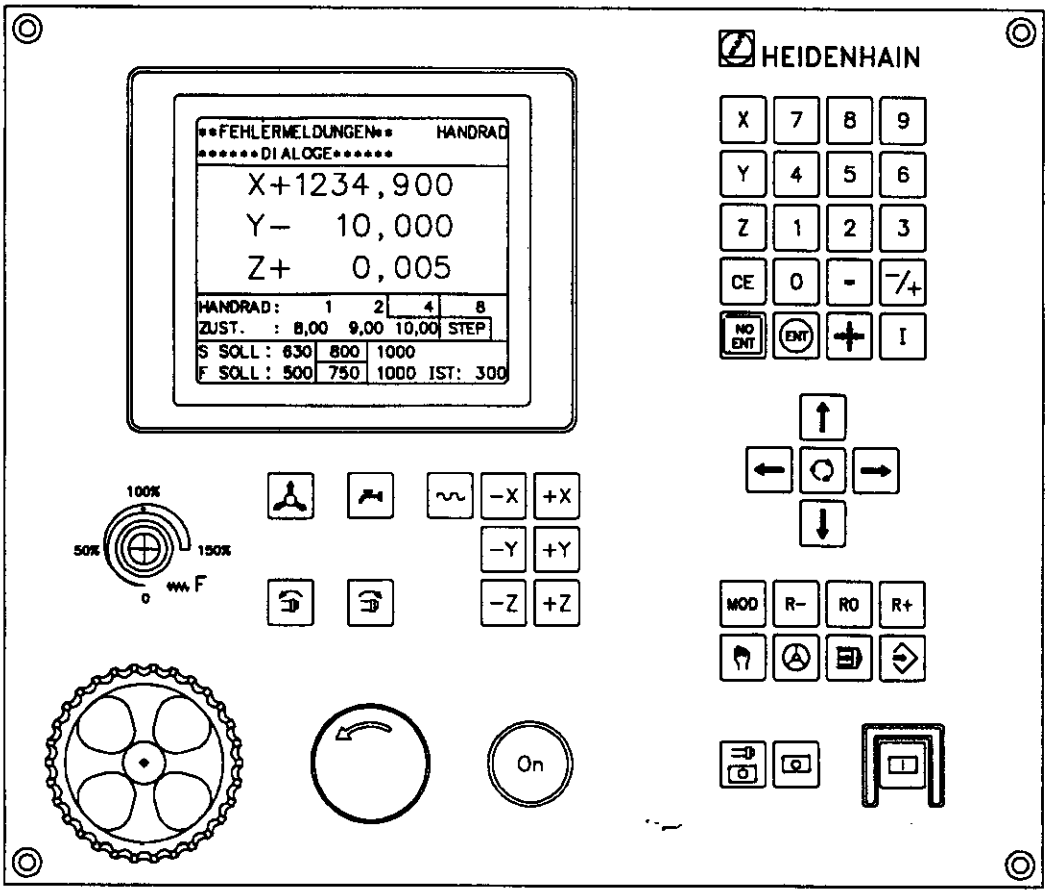
The operating panel contains not only the LCD monitor screen but also the machine axis keys and the electronic handwheel. If the electronic handwheel is not used, it is also possible to use drives with backlash.

TNC 116	Complete with • LCD monitor screen (240×200 pixels, 114×96 mm) • Electronic handwheel (0.5 to 8 mm traverse range/rev.) • Machine operating buttons integrated into the TNC operating panel
Control type	• Straight-cut control for 3 axes • Paraxial positioning
Program memory	• Battery-buffered RAM for NC programs with a maximum of 500 blocks each
Tool	• One tool with compensation of tool length and radius
Operating modes	• Manual • Handwheel (Handwheel, Jog Positioning, Absolute Positioning) • Program execution (single block or full sequence) • Editing
Program input	• Manual position input at TNC operating panel
Display step	• 5 µm (10 µm)
Programmable functions	• Nominal position in absolute or incremental dimensions • Tool radius compensation R+/R– • Spindle speed and feed rate selectable from tables
Additional functions	• Rapid traverse
Max. traverse range	• 4999.999 mm (196.8503 in.)
Max. traverse speed	• 30m/min (1181 ipm)

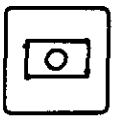
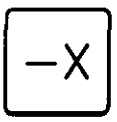
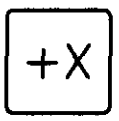
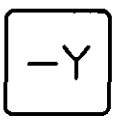
Position feedback	• Incremental HEIDENHAIN encoders 20 µm (40 µm), preferably with distance-coded reference marks with grating period 20 µm
Control inputs	• 3 encoder inputs (3 sinusoidal signal inputs) • 15 PLC inputs + 1 PLC input for EMERGENCY STOP monitoring
Control outputs	• 4 analog outputs for axes X,Y,Z, and spindle S • 15 PLC outputs + 1 PLC output for EMERGENCY STOP
Integrated PLC	• External programming in the form of an instruction list • PLC EPROM with PLC dialogs and error messages
Power supply	• 24 V
Power consumption	• 7 W (without encoders)
Ambient requirements	• Operating temperature: 0 to + 45°C Storage temperature: –30 to + 70°C • Rel. humidity, annual average: < 75% Max. 30 days/year, naturally distributed: < 95%
Languages	• German, English, French, Italian, Spanish
Weight	• 3.3 kg

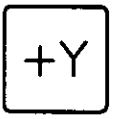
1.2 Hardware

TNC 116
Id.-Nr. 271 209 ..

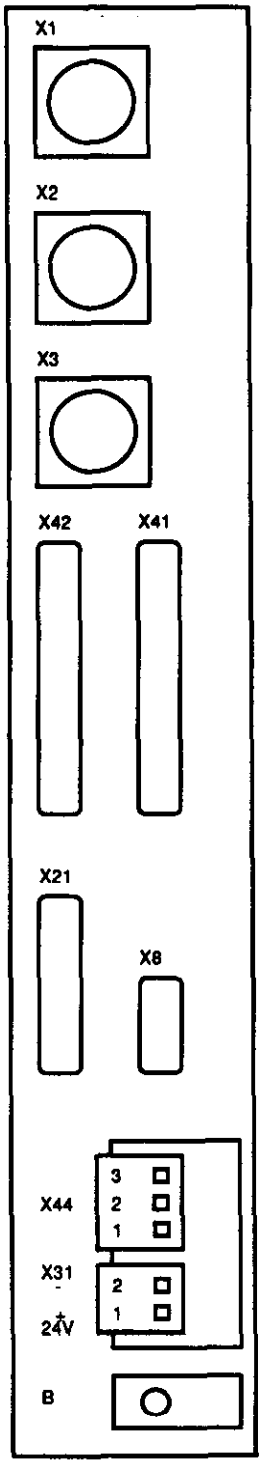


1.3 Machine Function Keys

Key	Function	PLC Rapid Traverse	Opener	Closer
	NC Stop	I128	X	
	Spindle Stop	I129	X	
	NC Start	I130		X
	Open tool holder	I131		X
	Coolant	I132		X
	Rapid traverse	I133		X
	Axis direction X –	I134		X
	Axis direction X+	I135		X
	Axis direction Y –	I136		X

Key	Function	PLC Rapid Traverse	Opener	Closer
	Axis direction Y+	I137		X
	Axis direction Z −	I138		X
	Axis direction Z+	I139		X
	Spindle ON counterclockwise	I140		X
	Spindle ON clockwise	I141		X

1.4 Connector Layout



X1 = Encoder 1 (-)

X2 = Encoder 2 (-)

X3 = Encoder 3 (-)

X41 = PLC Outputs

X42 = PLC Inputs

X21 = Not used

X8 = Nominal value out 1, 2, 3, S

X44 = 24 V Power Supply for PLC

X31 = 24 V Power Supply for NC

B = System ground

X1, X2, X3 Encoders 1,2,3 (sinusoidal signal input)

Flange socket with female insert, 9-pole

Pin	Assignment
1	0^0+
2	0^0-
5	90^0+
6	90^0-
7	RP+
8	RP-
3	+5 V (U_P)
4	0V (U_N)
9	Internal shield
Housing	External shield=unit housing

X8 Nominal value output 1,2,3

Flange socket with female insert, 15-pole

Pin	Signal designation
1	Analog output 1
3	Analog output 2
5	Analog output 3
8	Analog output S
9	0 V analog output 1
11	0 V analog output 2
13	0 V analog output 3
Housing	External shield=unit housing
2,7,10,12,14	Do not assign

X31 Power supply for logic unit (LE)

Connecting terminals

Assignment	Pin
1	+24 V
2	0 V

X44 Power supply for the PLC

Connecting terminals

Connection	Assignment
1	+24 V can be switched off with EMERGENCY STOP
2	+ 24 V cannot be switched off with EMERGENCY STOP
3	0 V

X41 PLC output

Flange socket with female insert, 37-pole

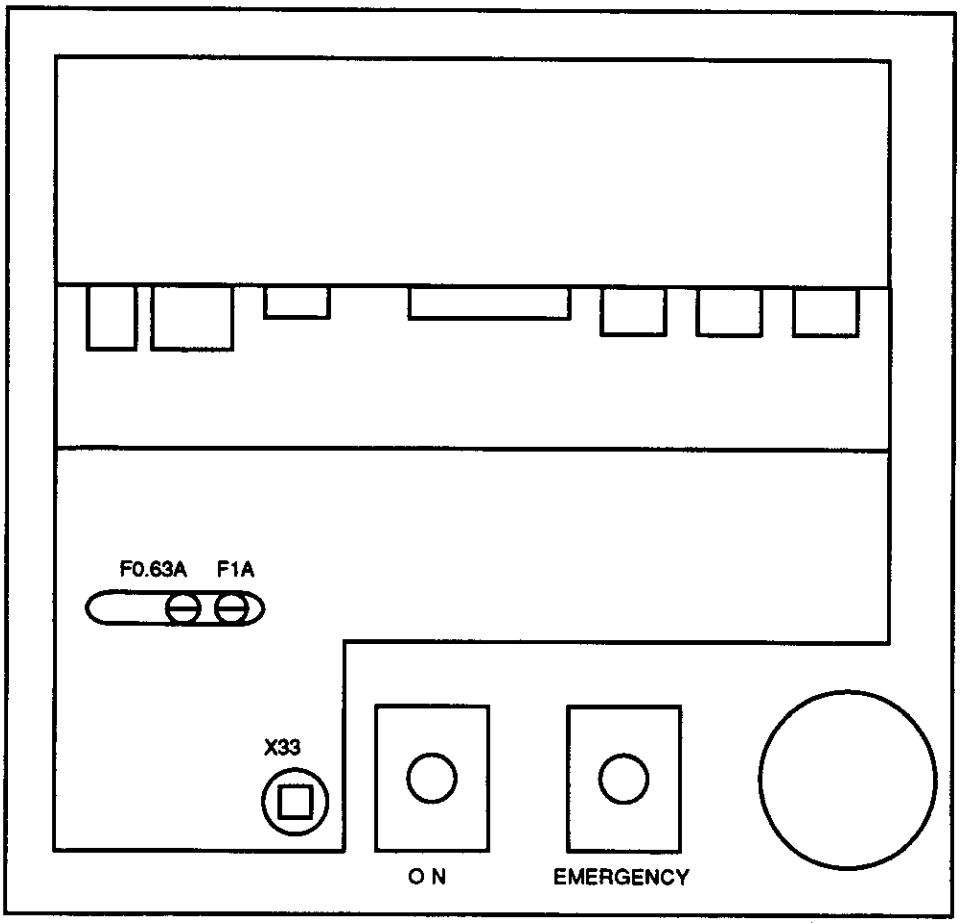
Pin	Assignment
1	O0
2	O1
3	O2
4	O3
5	O4
6	O5
7	O6
8	O7
9	O8
10	O9
11	O10
12	O11
13	O12
14	O13
15	O14
16 to32, 35,36,37	Do not assign
33	0 V (PLC)
34	Control ready
Housing	External shield

X42 PLC Input

Flange socket with female insert, 37-pole

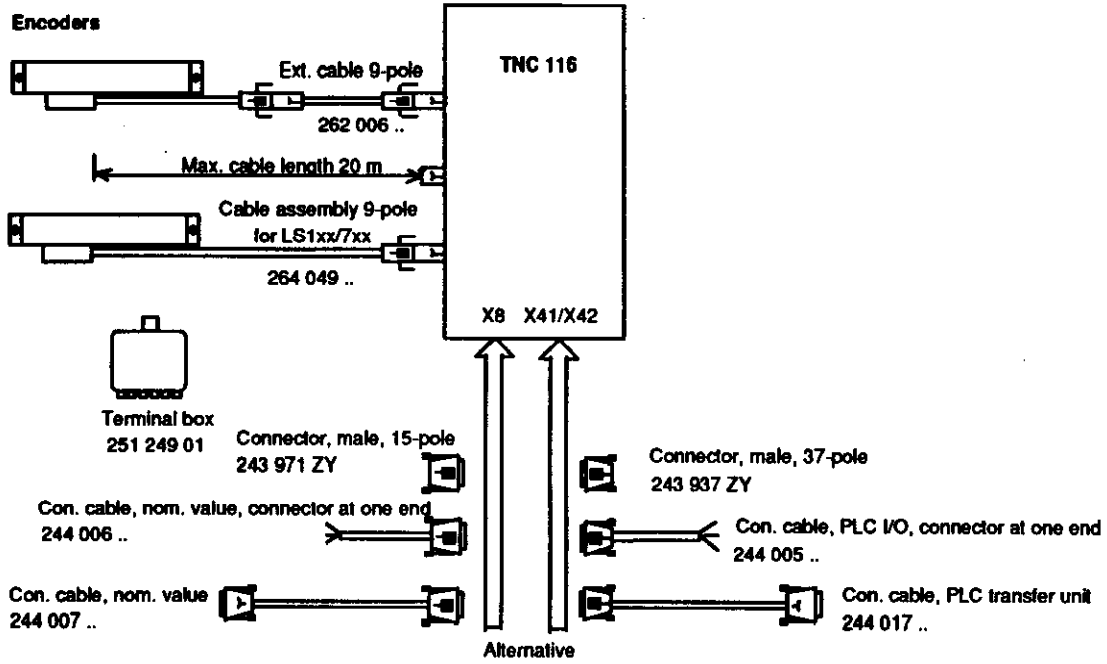
Pin	Assignment
1	I0
2	I1
3	I2
4	I3 Acknowledgment for test "Control is ready"
5	I4
6	I5
7	I6
8	I7
9	I8
10	I9
11	I10
12	I11
13	I12
14	I13
15	I14
16	I15
17 to 37	Do not assign
Housing	External shield

Connector layout



F = Fine-wire fuse, 0.63 A and 1A
X33 = Battery holder (three 1.5 W LR6 batteries)
ON = Control voltage ON
ON switch requires switch element with Id.-Nr. 242 575 01.
EMERGENCY = EMERGENCY STOP
EMERGENCY STOP switch requires switch element with Id.-Nr. 242 575 02.

1.5 Cable Overview



Key

Ext. cable: Extension cable

- For dividing points of connecting cable
- To extend a connecting cable

Con. cable: Connecting cable between two components which do not have their own cable

1.6 Power Supply

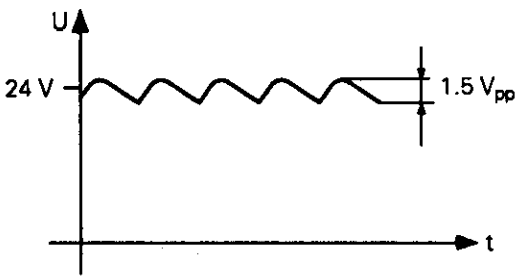
The voltages must conform to the following definitions:

Unit	Supply voltage	Voltage range DC average	Max. current consumption	Power consumption
NC	24 V (VDE 0551)	Lower limit 20.4 V ⎓	Approx. 300 mA	Max. 7 W
PLC	24 V (VDE 0550)	Upper limit 31 V ⎓ [1]	Max. 10 mA per input Max. 100 mA per output At most one input may be short circuited	

[1] Voltage increases up to 36 V ⎓ for t < 100 ms are permissible.

NC Power Supply

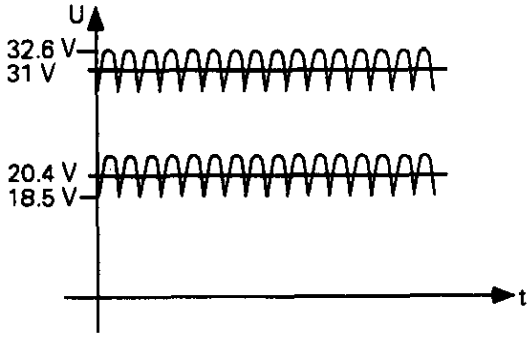
Do not connect the NC of the TNC 116 to the control voltage of the machine! The NC requires its own externally-generated power supply which conforms to DIN VDE 0551. 24 V DC with permissible AC component (ripple voltage) of 1.5 Vpp (recommended filter capacitor 10 000 µF/40 V DC).



PLC Power Supply

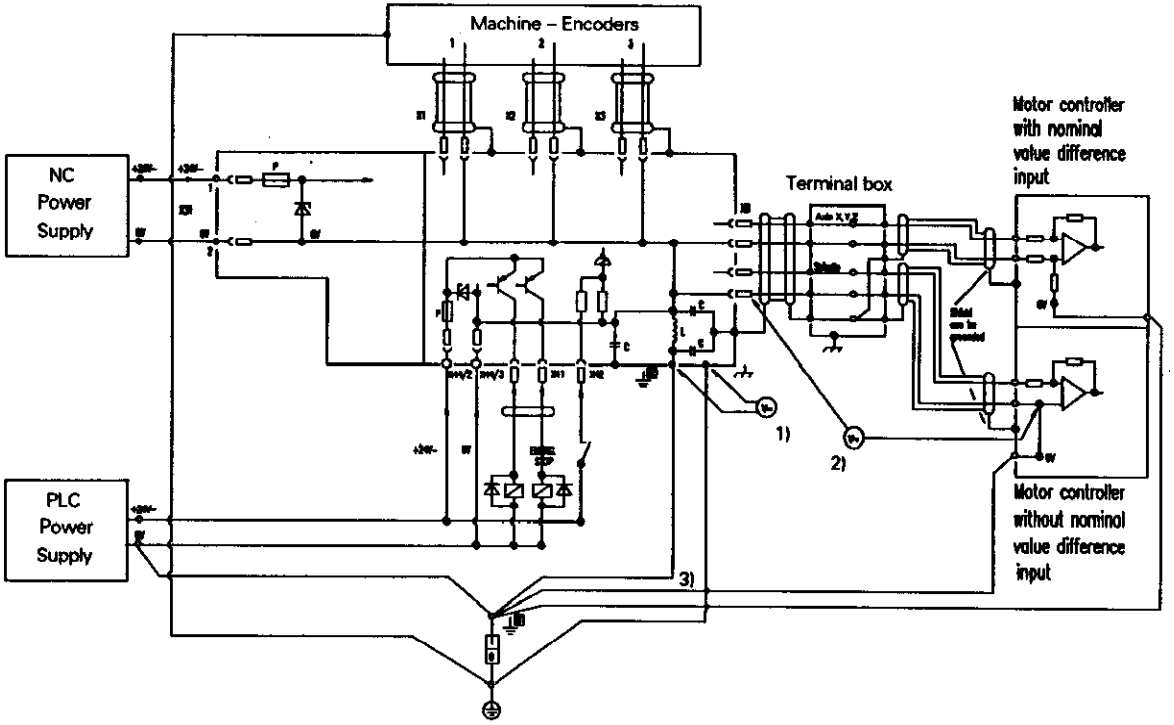
The PLC (PLC inputs and outputs) of the TNC 116 is supplied with the 24 V control voltage of the machine generated in conformance with VDE 0550.

Superimposed AC components such as those arising from a non-controlled three-phase bridge connection without smoothing with a peak-to-average ripple factor (see DIN 40110/1075, section 1.2) of 5% are permissible. This results in a largest absolute value of 33.4 V for the upper limit of the voltage, and a smallest absolute value of 18.5 V for the lower limit.



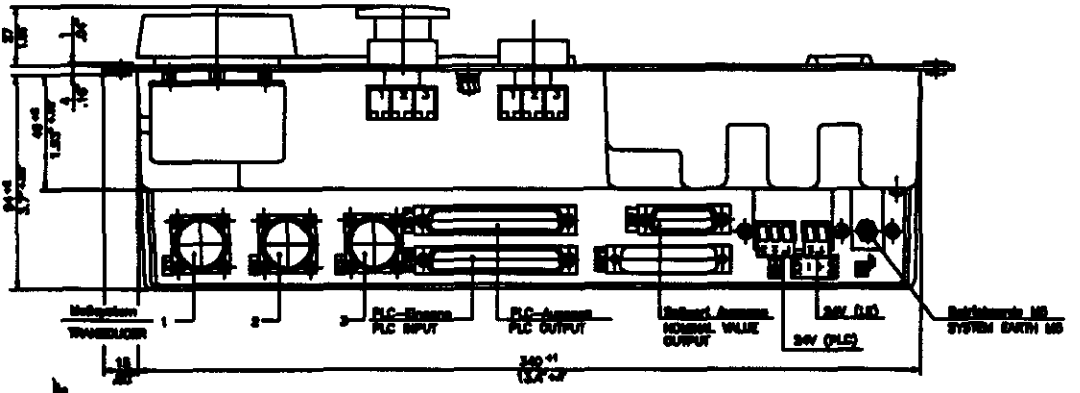
The 0 V line of the PLC power supply must be connected with a ground wire (dia. ≥ 6 mm²) to the main system ground of the machine.

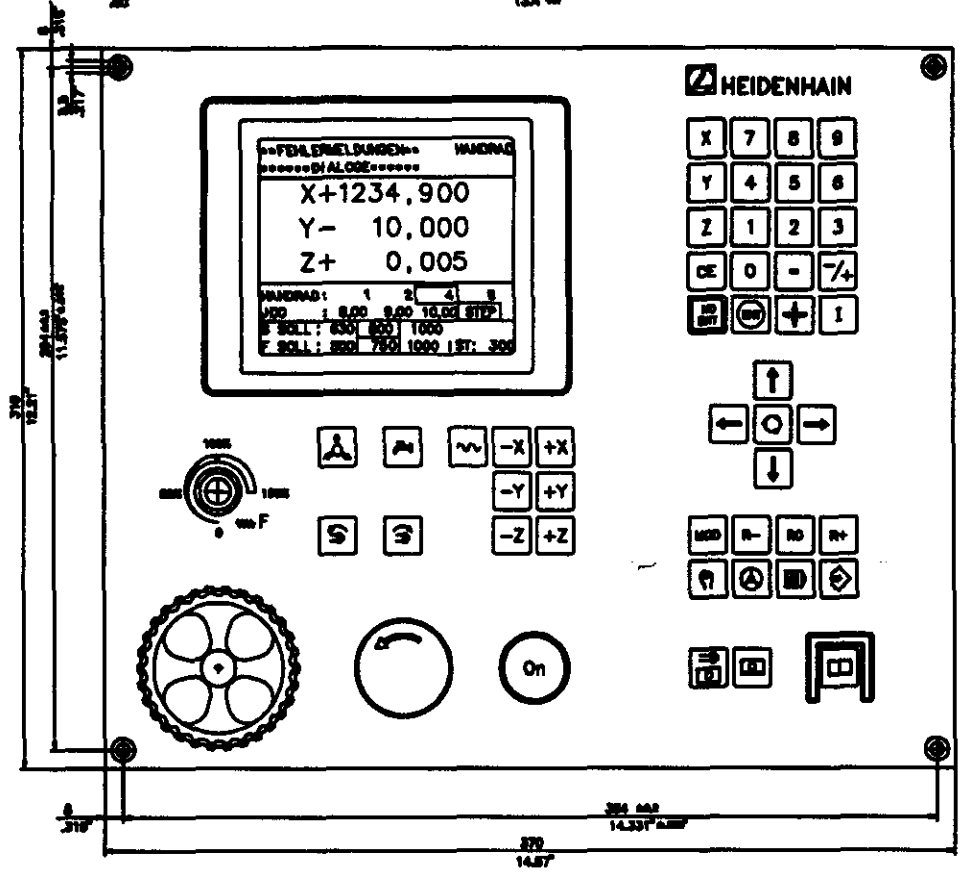
1.7 Grounding Diagram

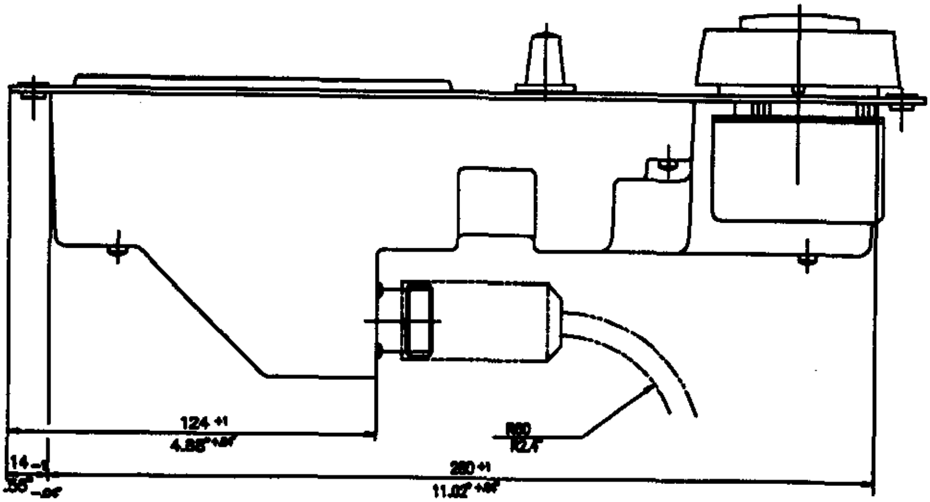


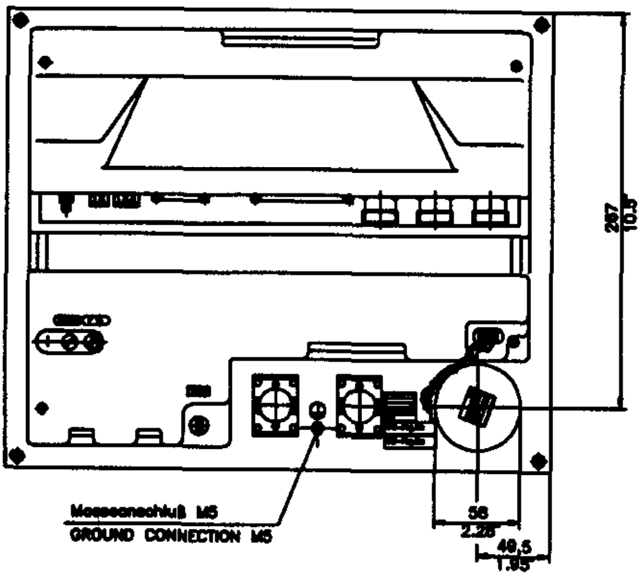
1) Measuring point: noise voltage against housing = 0V
2) Measuring point: noise voltage with grounded nominal value input
3) A ground loop will result if the nominal value input is grounded, so the cable configuration of 0V and the ground line should be short and ensure a low noise voltage.
HEIDENHAIN therefore recommends a motor controller with nominal value difference input.

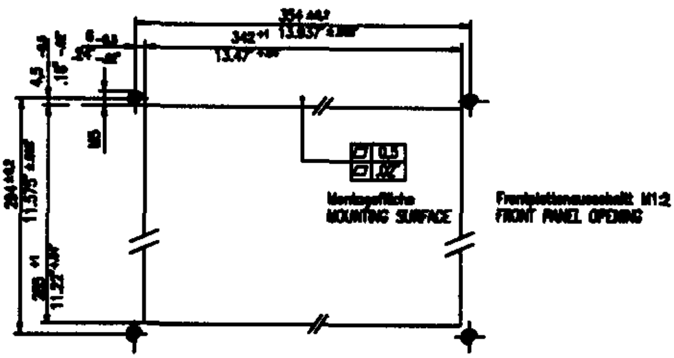
1.8 Dimensions

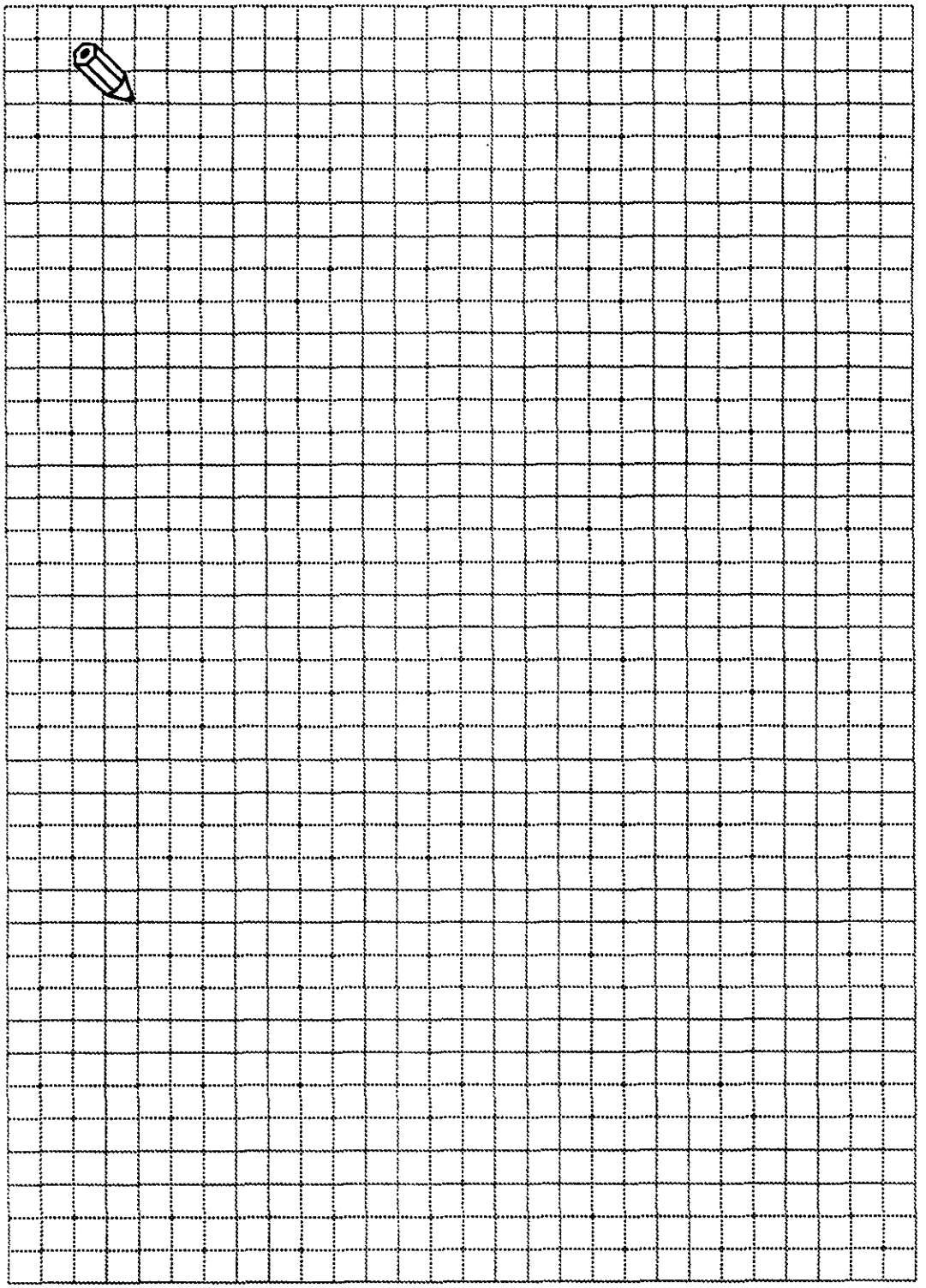





124 +1
R60
R2.4"
280 +1
11.02" +.04"


267
10.5"
Massenanschluß M5
GROUND CONNECTION M5
58
2.28"
49.5
1.95"


342 +1
13.47"
M5
0.5
.02"
Montagefläche
MOUNTING SURFACE
Frontplattenausschnitt M1:2
FRONT PANEL OPENING



2 Machine Parameters

2.1 What Are Machine Parameters?

The TNC requires access to specific data such as the traverse range and accelerations so that the programmed instructions can be executed correctly on the machine.

Machine parameters enable the machine builder to define these data. Machine parameters also allow activation of certain functions for HEIDENHAIN TNC — such as automatic gear changing or manually-changed spindle speed stages — which are required only on certain machine types.

The machine parameter list groups the parameters according to function. These groups deal with the following subjects:

Machine Parameters	Subject
0 – 999	Encoders and machines
1000 – 1399	Positioning
1700 – 1999	Operation with servo lag
3000 – 3999	Spindle
4000 – 4999	Integrated PLC
7200 – 7399	Display and programming
7400 – 7599	Machining and program execution
7600 – 7699	Hardware

When there are several possible input values for a function (such as a separate value for each axis), the machine parameter has an additional index number.

Example:

MP 120: Assignment of the analog outputs

MP 120.0 Analog output for X axis
MP 120.1 Analog output for Y axis
MP 120.2 Analog output for Z axis

Entry values with single-axis drives:

MP 120.0 = 0
MP 120.1 = 1
MP 120.2 = 2

Entry values with common drive on axes X and Z, single drive on axis Y:

MP 120.0 = 0
MP 120.1 = 1
MP 120.2 = 0

2.1.1 User Parameters

The MOD function "User Parameters" allows direct access to certain machine parameters.

2.2 Input and Output of Machine Parameters

If no machine parameters have yet been entered in the TNC (such as before the first commissioning), the TNC displays the list of machine parameters after performing the memory test. The machine parameter values must then be entered manually at the operating panel. Confirm each value you key in by pressing the "ENT" key.

2.2.1 Input Format

A number is entered for each machine parameter. These numbers can be values such as the acceleration in mm/s² or the analog voltage in V.

Some machine parameters have multiple functions. For these machine parameters, the input value has to be calculated depending on the functions to be activated.

Bits 0 to 15 allow up to 16 different functions to be activated by a single machine parameter. The input value is calculated by adding the decimal values of the corresponding bits for the desired functions.

Bit	Significance	Decimal Value
0	2^0	1
1	2^1	2
2	2^2	4
3	2^3	8
4	2^4	16
5	2^5	32
6	2^6	64
7	2^7	128
8	2^8	256
9	2^9	512
10	2^{10}	1024
11	2^{11}	2048
12	2^{12}	4096
13	2^{13}	8192
14	2^{14}	16384
15	2^{15}	32768

Example:

MP 210: Counting direction of the encoder signals

Bit 0	Axis X	+0 = positive +1 = negative
Bit 1	Axis Y	+0 = positive +1 = negative
Bit 2	Axis Z	+0 = positive +1 = negative

You want axis X to count positive, axes Y and Z negative.
The input value for MP 210 is therefore: 0+2+4 = 6

2.2.2 Activating the Machine Parameter List

After entering the values for the machine parameters, you can leave the machine parameter list by pressing "Manual". The control recognizes incorrect entries, which you can then correct.

If no errors are recognized by the control, the machine parameter editor is automatically closed and the control goes into operation.

2.2.3 Changing the Input Values

The machine parameter editor can be called up with the MOD function "Code Number".

Access to the complete list of machine parameters is only possible by entering **code number 95148**.

Only some of the machine parameters can be accessed with the MOD function "User Parameters". User parameters are machine parameters which can be changed by the machine operator (see the TNC 116 User's Manual). User parameters are identified in the following list with **USER**.

To leave the machine parameter editor, press the "Manual" key.

2.3 List of Machine Parameters

2.3.1 Encoders and Machines

Machine Parameter	Function and Input	Change with	Reaction
MP110.0-2	Assignment of encoders to inputs Entry range: 0 to 2 0 = Encoder input X1 1 = Encoder input X2 2 = Encoder input X3		RESET
MP120.0-2	Assignment of the analog outputs Entry range: 0 to 2 0 = Output 1 1 = Output 2 2 = Output 3 With a common drive the corresponding axes are assigned the same output.		RESET
MP210	Counting direction of the encoder signals Entry range: 0 to 7 Bit 0 Axis X +0 = positive +1 = negative Bit 1 Axis Y +0 = positive +2 = negative Bit 2 Axis Z +0 = positive +4 = negative		RESET
MP330.0-2	Grating period Entry values: 20 or 40 20 = Grating period 20 µm Display step 5 µm 40 = Grating period 40 µm Display step 10 µm		RESET
MP730	Non-linear axis error compensation Entry range: 0 to 7 Bit 0 Axis X +0 = not active +1 = active Bit 1 Axis Y +0 = not active +2 = active Bit 2 Axis Z +0 = not active +4 = active		
MP910.0-2	Positive software limit switch Entry range: –99 999.9999 to +99 999.9999 [mm] or [°]		
MP920.0-2	Negative software limit switch Entry range: –4 999.9999 to +4 999.9999 [mm]		

2.3.2 Positioning

Machine Parameter	Function and Entry	Change with	Reaction
MP1010.0-2	Rapid traverse Entry range: 80 to 30 000 [mm/min]		
MP1030.0-2	Positioning window Entry range: 0.005 to 2 [mm]		
MP1040	Polarity of the nominal value voltage with positive direction of traverse Entry range: 0 to 7 Bit 0 Axis X +0 = positive +1 = negative Bit 1 Axis Y +0 = positive +2 = negative Bit 2 Axis Z +0 = positive +4 = negative		
MP1050.0-2	Analog voltage with rapid traverse Entry range: 4.5 to 9 [V]		
MP1060.0-2	Acceleration Entry range: 0.001 to 3.0 [m/s²]		
MP1140	Movement monitoring Entry range: 0.03 to 10 [V]		
MP1320	Traverse direction when crossing the reference marks Entry range: 0 to 7 Bit 0 Axis X: + 0 = positive + 1 = negative Bit 1 Axis Y: + 0 = positive + 2 = negative Bit 2 Axis Z: + 0 = positive + 4 = negative		
MP1330.0-2	Feed rate for crossing the reference marks Entry range: 80 to 30 000 [mm/min]		
MP1340.0-2	Axis sequence when crossing the reference marks Entry range: 0 to 3 0 = No reference mark evaluation 1 = Axis X first 2 = Axis Y first 3 = Axis Z first	USER	REF

Machine Parameter	Function and Entry	Change with	Reaction
MP1350.0-2	Procedure when crossing the reference marks Entry values: 0 or 1 0 = Encoder with distance-coded reference marks 1 = Encoder with one reference mark		REF

2.3.3 Operation with Servo Lag

Machine Parameter	Function and Entry	Change with	Reaction
MP1720.	Position monitoring for operation with servo lag (EMERGENCY STOP) Entry range: 0.001 to 100 [mm]		
MP1810.0-2	Kv factor for operation with servo lag Entry range: 0.1 to 10 [1/min]		

2.3.4 Spindle

Machine Parameter	Function and Entry	Change with	Reaction
MP3130	Polarity of the S analog voltage Entry values: 0 or 1 0 = M03 positive voltage M04 negative voltage 1 = M03 negative voltage M04 positive voltage		
MP3210.0-2	S analog voltage for gear range Entry range: 0 to 9.999 [V]		
MP3240.2	Jog voltage for gear change Entry range: 0 to 9.999 [V]		
MP3410	Ramp gradient for spindle with M03, M04, M05 Entry range: 0 to 1.999 [V/ms]		
MP3510.0-2	RPM for gear ranges Entry range: 0 to 99 999.999 [rpm]		

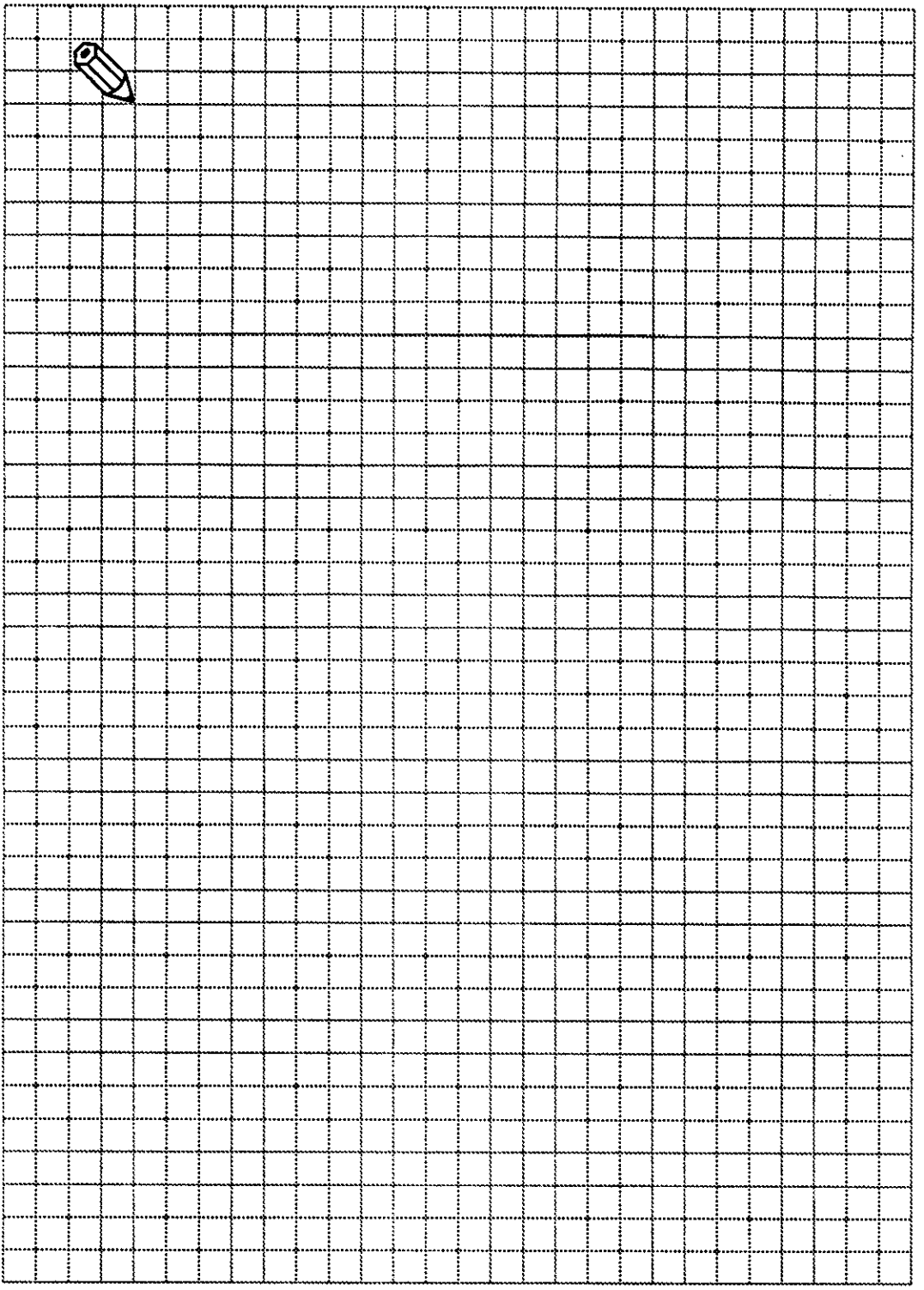
2.3.5 Integrated PLC

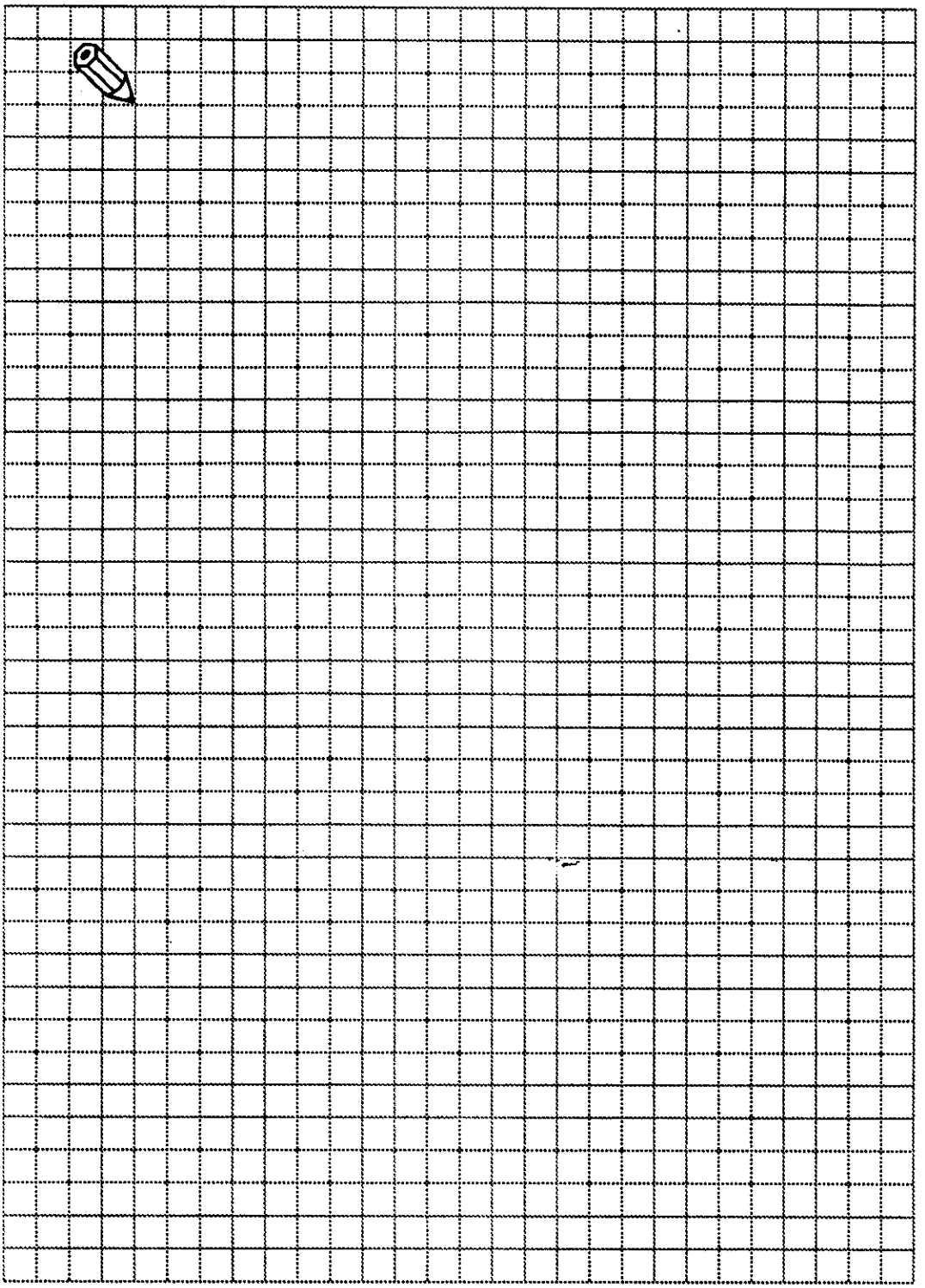
Machine Parameter	Function and Entry	Change with	Reaction
MP4110.0 to MP4110.15	Time for timers T0 to T15 Entry range: 0 to 65 535 [24 ms]		
MP4120.0 to MP4120.7	Pre-set value for counters C0 to C31 Entry range: 0 to 65 535 [24 ms]		
MP4310.0-2	Set a number in the PLC (M2192 to M2194) Entry values: 0 or 1	USER	
MP4310.3	Display spindle speed Entry values: 0 or 1 0 = Display 1 = No display	USER	
MP4310.4-9	Set a number in the PLC (M2196 to 2201) Entry values: 0 or 1		

2.3.6 Display and Operation

Machine Parameter	Function and Entry	Change with	Reaction
MP7210	Programming station Entry values: 0, 1, 2 0 = Control and program 1 = Programming station "PLC active" 2 = Programming station "PLC not active"	USER	RESET
MP7230	Dialog language Entry range: 0 to 4 0 = German 1 = English 2 = French 3 = Italian 4 = Spanish	USER	
MP7285	Taking tool length into account in the position display of the tool axis Entry values: 0 or 1 0 = Tool length ignored 1 = Tool length taken into account	USER	
MP7320	Screen contrast for LCD monitor Entry range: 0 to 15 0 = Lowest contrast 15 = Highest contrast	USER	
MP7321	Unit of measurement: mm or inch Entry values: 0 or 1 0 = mm 1 = inch	USER	
MP7322	Switchover of position display Entry range: 0 to 2 0 = Actual position (ACTL) 1 = Servo lag (LAG) 2 = Reference position (REF)	USER	
MP7323	Enable "Program run full sequence" Entry values: 0 or 1 0 = No "Program run full sequence" 1 = "Program run full sequence" (Hold down "Program Run" key and press "NC Start" key)		

Machine Parameter	Function and Entry	Change with	Reaction
MP7680	Machine parameter with multiple function Entry values: 0 or 1 Bit 0 Memory function for axis direction keys +0 = not stored +1 = stored	USER	
MP7690	Memory test at switch-on Entry range: 0 to 3 Bit 0 RAM test +0 = Memory test at switch-on +1 = No memory test at switch-on Bit 1 EPROM test +0 = Memory test at switch-on +2 = No memory test at switch-on		



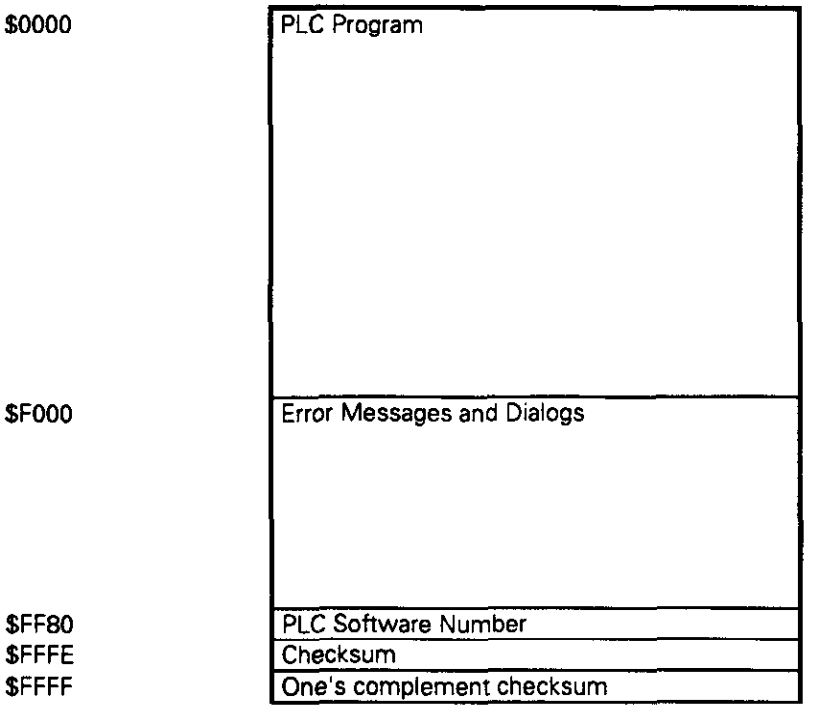


3 PLC Description

3.1 PLC EPROM

The PLC EPROM is a 1 MB chip with 16-bit data width.

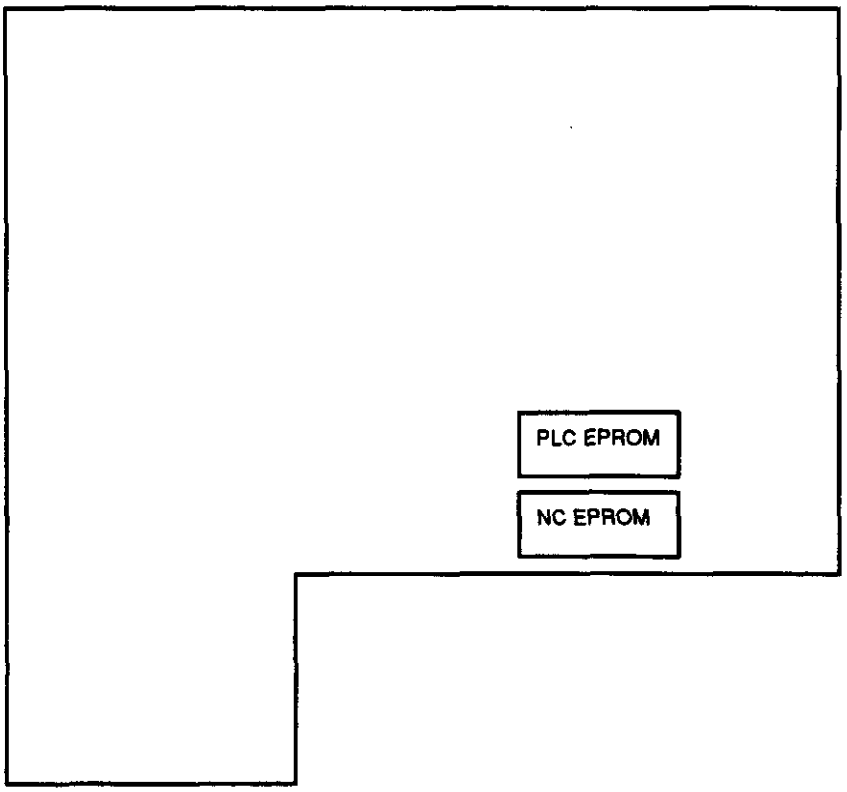
The EPROM is programmed externally either on another TNC control (such as the TNC 360) or at a PC. It is programmed in Motorola format — that is, the MSB of a word is at the first (lower significance) address.



The error messages and dialogs are stored in the following sequence and syntax ('...',0) in the different languages. Up to 30 characters can be stored in each dialog.

German '.....',0
English '.....',0
French '.....',0
Italian '.....',0
Spanish '.....',0

Expansion slots, TNC 116



3.2 Trace Function

Code number 807 667 accesses the tables for inputs, outputs, markers, counters and timers.

To activate the trace function, press the "I" key. Then press the "R–" key to select the tables.

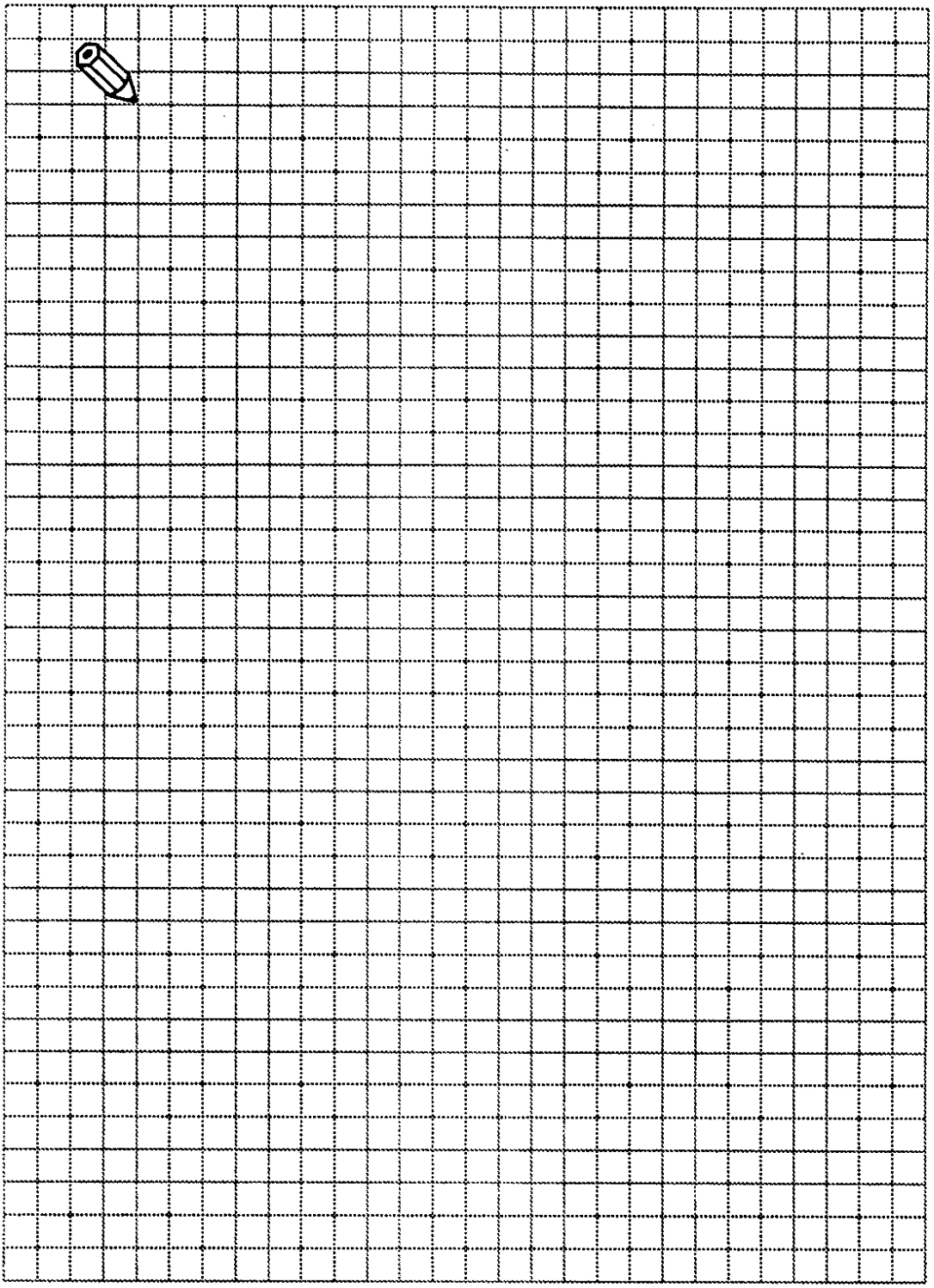
Use "R0" to page up within the list of PLC markers, and "R+" to page down.

To leave the trace function, press "NOENT".

3.3 Markers

Marker	Function	Set	Reset
M2008	Axis X in position	NC	NC
M2009	Axis Y in position	NC	NC
M2010	Axis Z in position	NC	NC
M2043	Change signal gear code	NC	NC
M2051	Operating mode: Manual M2050 Operating mode: Editing	NC	NC
M2052	Operating mode: Electronic Handwheel	NC	NC
M2054	Operating mode: Program Execution	NC	NC
M2057	Operating mode: Cross Reference Marks	NC	NC
M2096	Key X last pressed	NC	NC
M2097	Key Y last pressed	NC	NC
M2098	Key Z last pressed	NC	NC
M2104	*G code S-analog 1st bit (LSB)*		
M2105	*G code S-analog 2nd bit*		
M2106	*G code S-analog 3rd bit (MSB)*		
M2176	*Code – Operating mode (LSB)*		
M2177	*Code – Operating mode*		
M2178	*Code – Operating mode*		
M2179	*Code – Operating mode (MSB)*		
M2180	*1st PLC scan after power-up*	*NC*	*NC*
M2183	Program interruption (display: "Control in operation" blinks)	NC	NC
M2184	Control in operation (display "Control in operation" is on or blinking)	NC	NC
M2185	1st PLC scan after interruption of PLC program	NC	NC
M2186	Enter code number 84159	NC	PLC
M2190	Non-blinking error message is displayed	NC	NC
M2191	Error message "External EMERGENCY STOP" is displayed	NC	NC
M2192 to M2201	Markers which can be influenced through MP4310.0 to MP 4310.9	NC	NC
M2448	NC start (edge evaluation)	PLC	PLC
M2449	Rapid traverse	PLC	PLC
M2450	Memory function for axis direction keys	PLC	PLC
M2451	Feed enable	PLC	PLC
M2456	Manual traverse X+	PLC	PLC
M2457	Manual traverse X–	PLC	PLC
M2458	Manual traverse Y+	PLC	PLC
M2459	Manual traverse Y–	PLC	PLC
M2460	Manual traverse Z+	PLC	PLC
M2461	Manual traverse Z–	PLC	PLC
M2464	Complement NC start	PLC	PLC
M2465	Complement rapid traverse	PLC	PLC
M2466	Complement memory function for axis direction keys	PLC	PLC
M24670	Complement feed enable	PLC	PLC

Marker	Function	Set	Reset
M2472	Complement manual traverse X+	PLC	PLC
M2473	Complement manual traverse X–	PLC	PLC
M2474	Complement manual traverse Y+	PLC	PLC
M2475	Complement manual traverse Y–	PLC	PLC
M2476	Complement manual traverse Z+	PLC	PLC
M2477	Complement manual traverse Z–	PLC	PLC
M2480	Acknowledgment "Gear change carried out"	PLC	PLC
M2481	Spindle enable only here jog operation, gear change if set	PLC	PLC
M2485	Sign from S-analog for M03	PLC	PLC
M2486	Sign from S-analog for M04	PLC	PLC
M2488	NC stop ("0" means stop)	PLC	PLC
M2490	Turn spindle counterclockwise (for gear change)	PLC	PLC
M2491	Turn spindle clockwise (for gear change)	PLC	PLC
M2497	Activation of edge evaluation for PLC inputs Rising edges markers M1500 to M1659 Falling edges markers M1700 to M1859	PLC	PLC
M2498	Enable jog positioning	PLC	PLC
M2512	Jog positioning X+ axis	PLC	PLC
M2513	Jog positioning X– axis	PLC	PLC
M2514	Jog positioning Y+ axis	PLC	PLC
M2515	Jog positioning Y– axis	PLC	PLC
M2516	Jog positioning Z+ axis	PLC	PLC
M2517	Jog positioning Z– axis	PLC	PLC
M2528	Complement jog positioning X+ axis	PLC	PLC
M2529	Complement jog positioning X– axis	PLC	PLC
M2530	Complement jog positioning Y+ axis	PLC	PLC
M2531	Complement jog positioning Y– axis	PLC	PLC
M2532	Complement jog positioning Z+ axis	PLC	PLC
M2533	Complement jog positioning Z– axis	PLC	PLC
M2544	Open control loop X axis	PLC	PLC
M2545	Open control loop Y axis	PLC	PLC
M2546	Open control loop Z axis	PLC	PLC
M2552	Actual/nominal value transfer, X axis	PLC	PLC
M2553	Actual/nominal value transfer, Y axis	PLC	PLC
M2554	Actual/nominal value transfer, Z axis	PLC	PLC
M2556	Reference end position for X axis	PLC	PLC
M2557	Reference end position for Y axis	PLC	PLC
M2558	Reference end position for Z axis	PLC	PLC
M2624	Limit switch X+	NC	NC
M2625	Limit switch X–	NC	NC
M2626	Limit switch Y+	NC	NC
M2627	Limit switch Y–	NC	NC
M2628	Limit switch Z+	NC	NC
M2629	Limit switch Z–	NC	NC
M2924 to M2963	Error messages and dialogs	PLC	NC; PLC



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