CNC3000 Series

CNC3460/400

Installation and Interfacing Manual

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4 IN-/OUTPUT CONF. AXA INTERF.

I/O CARD 1

Output		Input	
Pin nr.	Signal name	Pin nr.	Signal name
1	Cycle interrupt	1	Cycle interrupt (not)
2	NC-Start	2	NC-Start
3	Control on	3	Emergency stop (not)
4	In cycle	4	Next block permitted
5	Manual	5	Mach.function ready
6	Automatic	6	Spindle permitted
7	Clear Control	7	
8	Diagnostic (not)	8	Diagnostic
9	Testrun	9	
10		10	
11	M6	11	
12	Open tool holder	12	
13	Turn TMA	13	
14	Feed	14	
15	G84 (G33)	15	
16	G86/M19	16	
17	Mot. exp. 1st axis	17	Mot. perm. 1st axis
18	Mot. exp. 2nd axis	18	Mot. perm. 2nd axis
19	Mot. exp. 3rd axis	19	Mot. perm. 3rd axis
20	Mot. exp. 4th axis	20	Mot. perm. 4th axis
21	MF-0 address	21	Open loop 1st axis (not)
22	MF-1 address	22	Open loop 2nd axis (not)
23	MF-2 address	23	Open loop 3rd axis (not)
24	MF Change	24	Open loop 4th axis (not)
25	BCD 1 data	25	N-actual = N-command
26	BCD 2 data	26	Memory lock
27	BCD 4 data	27	Mach. Const. input enable
28	BCD 8 data	28	
29	BCD 10 data	29	
30	BCD 20 data	30	Tool selected
31	BCD 40 data	31	
32	BCD 80 data	32	N < N min

I/O CARD 2

Output		Input	
Pin nr.	Signal name	Pin nr.	Signal name
1	Tool break	1	
2	No ext. program call	2	
3		3	
4	Error in NC	4	
5		5	
6		6	
7		7	
8	Reset Probe	8	
9	Blow air	9	
10		10	
11		11	
12		12	
13		13	
14		14	
15		15	
16		16	
17		17	
18		18	
19		19	
20		20	
21		21	
22		22	
23		23	
24		24	
25		25	
26		26	
27		27	
28		28	
29		29	
30	Remote	30	Remote
31		31	
32		32	

5 IN-/OUTPUT CONF. SHW INTERF.

I/O CARD 1

Output		Input	
Pin nr.	Signal name	Pin nr.	Signal name
1	Cycle interrupt	1	Cycle interrupt (not)
2	NC-Start	2	NC-Start
3	Control on	3	Emergency stop (not)
4	In cycle	4	Next block permitted
5	Manual	5	Mach.function ready
6	Automatic	6	Spindle permitted
7	Clear Control	7	
8	Diagnostic (not)	8	Diagnostic
9	Mot. exp. 1st axis neg.	9	
10	Mot. exp. 2nd axis neg.	10	
11	Mot. exp. 3rd axis neg.	11	
12	Mot. exp. 4th axis neg.	12	
13	Remote	13	Remote
14	Feed	14	
15	G84 (G33)	15	
16		16	
17	Mot. exp. 1st axis pos.	17	Mot. perm. 1st axis
18	Mot. exp. 2nd axis pos.	18	Mot. perm. 2nd axis
19	Mot. exp. 3rd axis pos.	19	Mot. perm. 3rd axis
20	Mot. exp. 4th axis pos.	20	Mot. perm. 4th axis
21	MF-0 address	21	Open loop 1st axis (not)
22	MF-1 address	22	Open loop 2nd axis (not)
23	MF-2 address	23	Open loop 3rd axis (not)
24	MF change	24	Open loop 4th axis (not)
25	BCD 1 data	25	N-actual = N-command
26	BCD 2 data	26	Memory lock
27	BCD 4 data	27	Mach. Const. input enable
28	BCD 8 data	28	Home position 1
29	BCD 10 data	29	Home position 2
30	BCD 20 data	30	Tool selected
31	BCD 40 data	31	
32	BCD 80 data	32	N < N-min

I/O CARD 2

Output		Input	
Pin nr.	Signal name	Pin nr.	Signal name
1		1	
2		2	
3		3	
4		4	
5		5	
6		6	
7		7	
8		8	
9		9	
10		10	
11		11	
12		12	
13		13	
14		14	
15		15	
16		16	
17		17	
18		18	
19		19	
20		20	
21		21	
22		22	
23		23	
24		24	
25		25	
26		26	
27		27	
28		28	
29		29	
30		30	
31		31	
32		32	

6 IN-/OUTPUT CONF. DEUMA INTERF.

I/O CARD 1

Output		Input	
Pin nr.	Signal name	Pin nr.	Signal name
1	Cycle interrupt	1	Cycle interrupt (not)
2	NC-Start	2	NC-Start
3	Control on	3	Emergency stop (not)
4	In cycle	4	Next block permitted
5	Manual	5	Mach.function ready
6	Automatic	6	Meas. probe ready
7	Clear Control	7	Proximity switch
8	Diagnostic (not)	8	Diagnostic
9	Mot. exp. 1st axis neg.	9	
10	Mot. exp. 2nd axis neg.	10	
11	Mot. exp. 3rd axis neg.	11	Ext. error 1
12	Mot. exp. 4th axis neg.	12	Ext. error 2
13	Start ext cyclus	13	Ext. error 4
14	Reset probe	14	Ext. error 8
15	Blow air	15	Ext. error 16
16	Ext. meas. cycle	16	Ext. error 32
17	Mot. exp. 1st axis pos.	17	Mot. perm. 1st axis
18	Mot. exp. 2nd axis pos.	18	Mot. perm. 2nd axis
19	Mot. exp. 3rd axis pos.	19	Mot. perm. 3rd axis
20	Mot. exp. 4th axis pos.	20	Mot. perm. 4th axis
21	MF-0 address	21	Open loop 1st axis (not)
22	MF-1 address	22	Open loop 2nd axis (not)
23	MF-2 address	23	Open loop 3rd axis (not)
24	MF Change	24	Open loop 4th axis (not)
25	BCD 1 data	25	
26	BCD 2 data	26	Memory lock
27	BCD 4 data	27	Mach. Const. input enable
28	BCD 8 data	28	
29	BCD 10 data	29	
30	BCD 20 data	30	Tool selected
31	BCD 40 data	31	
32	BCD 80 data	32	

I/O CARD 2

Output		Input	
Pin nr.	Signal name	Pin nr.	Signal name
1		1	
2		2	
3		3	
4		4	
5		5	
6		6	
7		7	
8		8	
9		9	
10		10	
11		11	
12		12	
13		13	
14		14	
15		15	
16		16	
17		17	
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22		22	
23		23	
24		24	
25		25	
26		26	
27		27	
28		28	
29		29	
30		30	
31		31	
32		32	

7 IN-/OUTPUT CONF. SIGMA V6 INTERF.

I/O CARD 1

Output			Input		
Pin nr.	Signal name		Pin nr.	Signal name	
1	STOP	Cycle interrupt (not)	1	OM	Cycle interrupt (not)
2	CYSO	NC-Start	2	CYSI	NC-Start
3	CON	Control on	3	LI	Emergency stop (not)
4		In cycle	4		Next block permitted
5		Manual	5		
6	AAM	Spindle on	6		Spindle permitted +24V
7	LPL	Lamp lubrication	7	FMI	Spindle inserted
8		Diagnostic (not)	8		Diagnostic
9	M23	M23 Coolant	9	CRM	Enable turret rotation
10	M24	M24 Coolant	10	UFA	Tool-change area
11	M31	M31 G84 Coolant	11	AT	Accurate turr. pos.
12	M7	M7	12	ST1	ST1 turr. pos. sign.
13	M8	M8	13	ST2	ST2 turr. pos. sign.
14	RTL	Command lubrication	14	ST3	ST3 turr. pos. sign.
15		G84 (G33)	15	PUC	Manual toolch. finished
16	M20	M20 start robot	16	PEU	Button tool release
17	CSU	Tool release	17		+24V
18	CUM	Manual tool change	18		+24V
19	TIP	Turret in position	19		+24V
20	M80	M80	20		+24V
21	M82	M82	21		+24V
22	CT	Indexing	22		+24V
23	H100	H100 indexing table	23		+24V
24	H200	H200 indexing table	24		+24V
25	H1	H1 indexing table	25		
26	H2	H2 indexing table	26	ML2	Memory lock
27	H4	H4 indexing table	27	ML1	Mem. const. input enable
28	H8	H8 indexing table	28	CAV	Feed enable
29	H10	H10 indexing table	29	FRP	Index table in position
30	H20	H20 indexing table	30	LR	Oil level not O.K.
31	H40	H40 indexing table	31	FL	Lubrication pressure
32	H80	H80 indexing table	32	PCL	Manual lubrication

I/O CARD 2

Output		Input	
Pin nr.	Signal name	Pin nr.	Signal name
1		1	
2		2	
3		3	
4		4	
5		5	
6		6	
7		7	
8		8	
9		9	
10		10	
11		11	
12		12	
13		13	
14		14	
15		15	
16		16	
17		17	
18		18	
19		19	
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22		22	
23		23	
24		24	
25		25	
26		26	
27		27	
28		28	
29		29	
30		30	
31		31	
32		32	

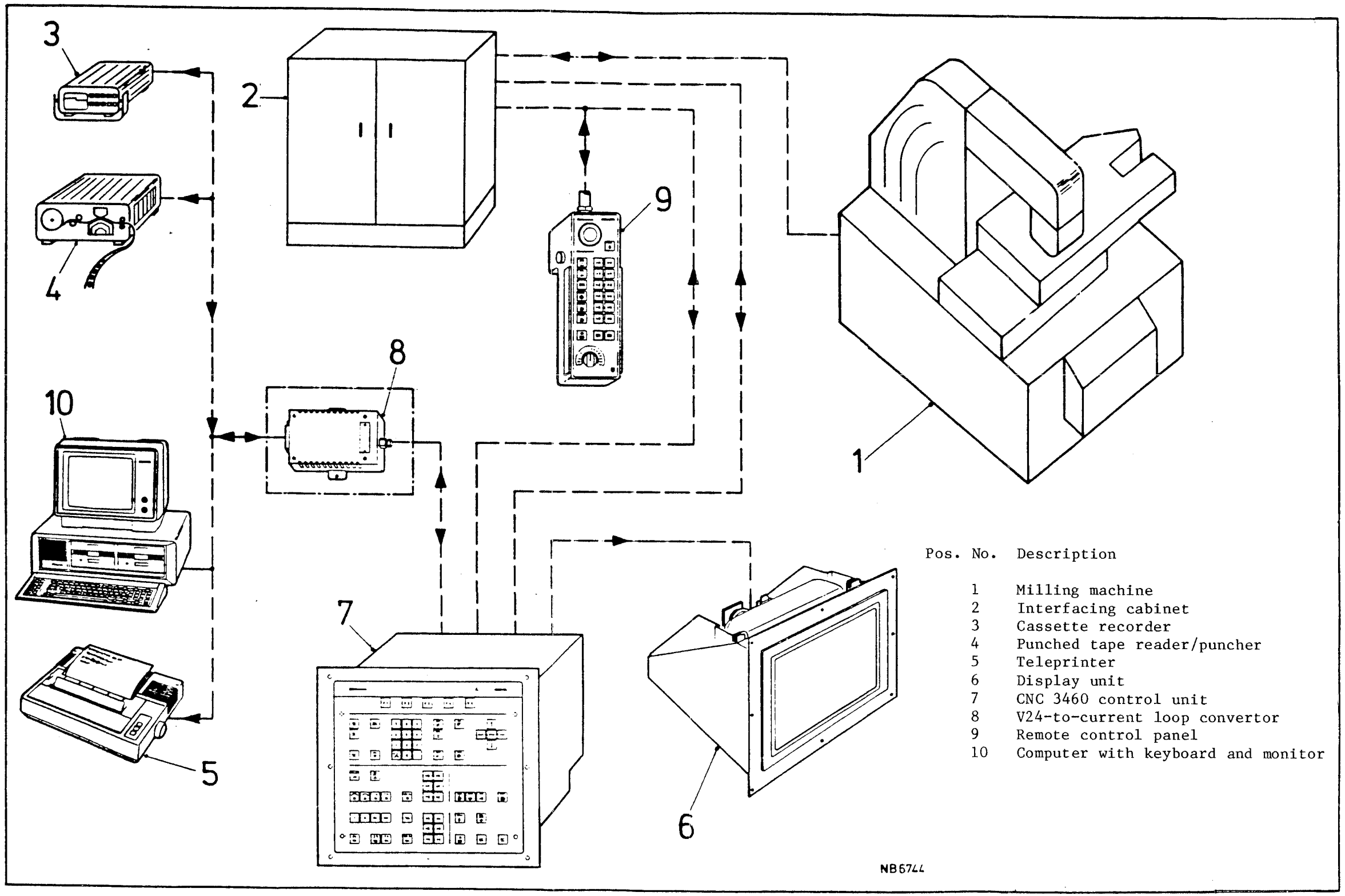
8 IN-/OUTPUT CONF. SIGMA V24 INTERF.

I/O CARD 1

Output		Input	
Pin nr.	Signal name	Pin nr.	Signal name
1	Cycle interrupt	1	Cycle interrupt (not)
2	NC-Start	2	NC-Start
3	Control on	3	Emergency stop (not)
4	In cycle	4	Next block permitted
5	Manual	5	Mach.function ready
6	Automatic	6	Spindle permitted
7	Clear Control	7	
8	Diagnostic (not)	8	Diagnostic
9	M3	9	Pallet 1
10	M4	10	Pallet 2
11	M6	11	Ext. error 1
12	M7	12	Ext. error 2
13	M8	13	Ext. error 4
14	Feed	14	Ext. error 8
15	G84 (G33)	15	Ext. error 16
16	G86	16	Ext. error 32
17	Mot. exp. 1st axis	17	Mot. perm. 1st axis
18	Mot. exp. 2nd axis	18	Mot. perm. 2nd axis
19	Mot. exp. 3rd axis	19	Mot. perm. 3rd axis
20	Mot. exp. 4th axis	20	Mot. perm. 4th axis
21	MF-0 address	21	Open loop 1st axis (not)
22	MF-1 address	22	Open loop 2nd axis (not)
23	MF-2 address	23	Open loop 3rd axis (not)
24	MF Change	24	Open loop 4th axis (not)
25	BCD 1 data	25	
26	BCD 2 data	26	Memory lock
27	BCD 4 data	27	Mach. Const. input enable
28	BCD 8 data	28	
29	BCD 10 data	29	
30	BCD 20 data	30	
31	BCD 40 data	31	
32	BCD 80 data	32	

I/O CARD 2

Output		Input	
Pin nr.	Signal name	Pin nr.	Signal name
1	Toolbreak	1	BCD 1 data
2	No ext. program call	2	BCD 2 data
3		3	BCD 4 data
4	Control error	4	BCD 8 data
5		5	BCD 10 data
6		6	BCD 20 data
7		7	BCD 40 data
8	Reset Probe	8	BCD 80 data
9	Blow air	9	BCD 100 data
10		10	BCD 200 data
11		11	BCD 400 data
12		12	BCD 800 data
13		13	Toolbreak value change
14		14	Ext.progr. call 1 change
15		15	Ext.progr. call 2 change
16		16	Ext. progr. call enable
17		17	
18		18	Meas. probe ready
19		19	
20		20	Cut force limit 1
21		21	Cut force limit 2
22		22	
23		23	
24		24	Conditional jump
25		25	
26		26	
27		27	
28		28	
29		29	
30	Remote	30	Remote
31		31	
32		32	

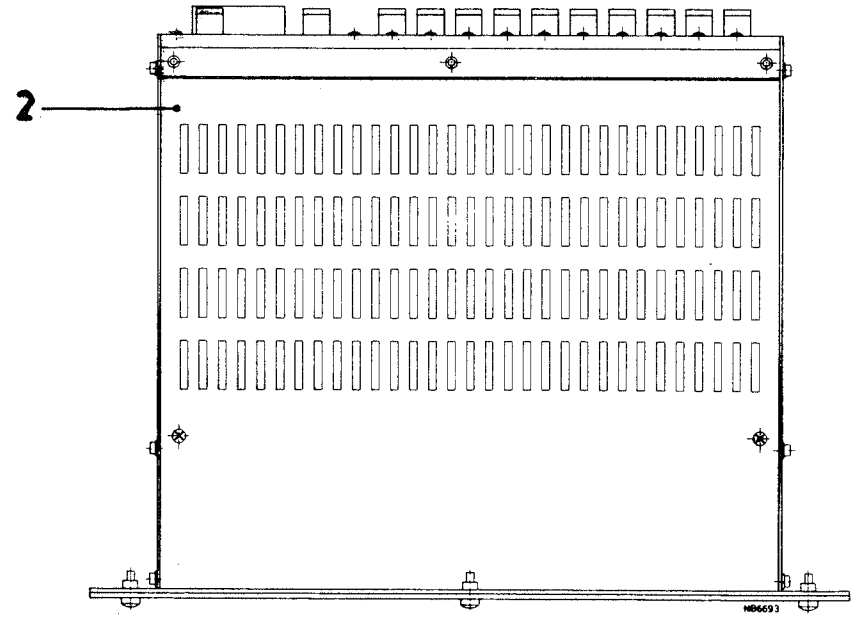


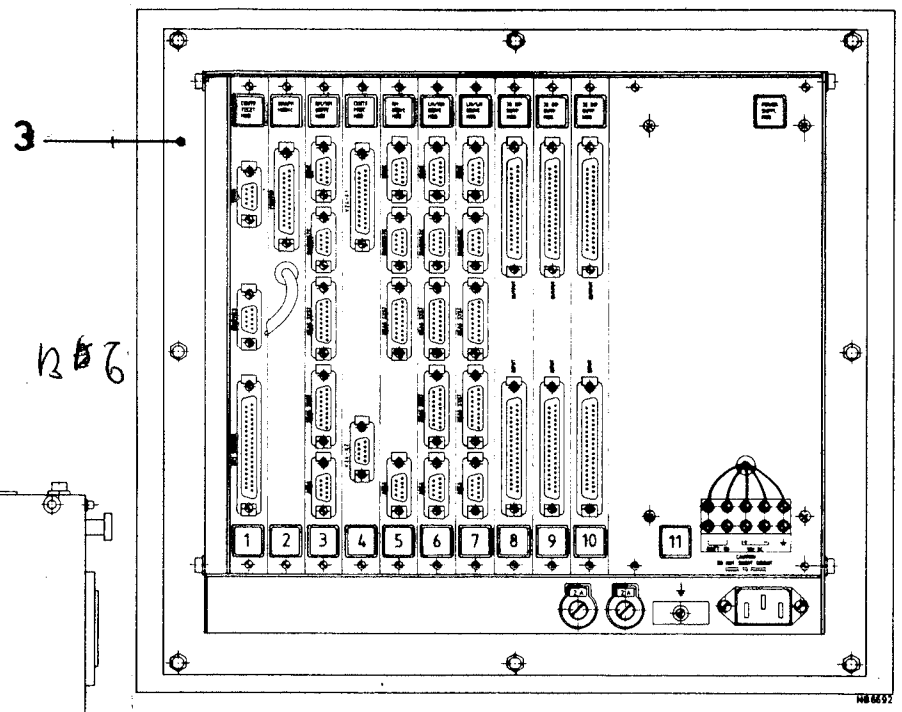
Pos. No.	Description
1	Milling machine
2	Interfacing cabinet
3	Cassette recorder
4	Punched tape reader/puncher
5	Teleprinter
6	Display unit
7	CNC 3460 control unit
8	V24-to-current loop convertor
9	Remote control panel
10	Computer with keyboard and monitor

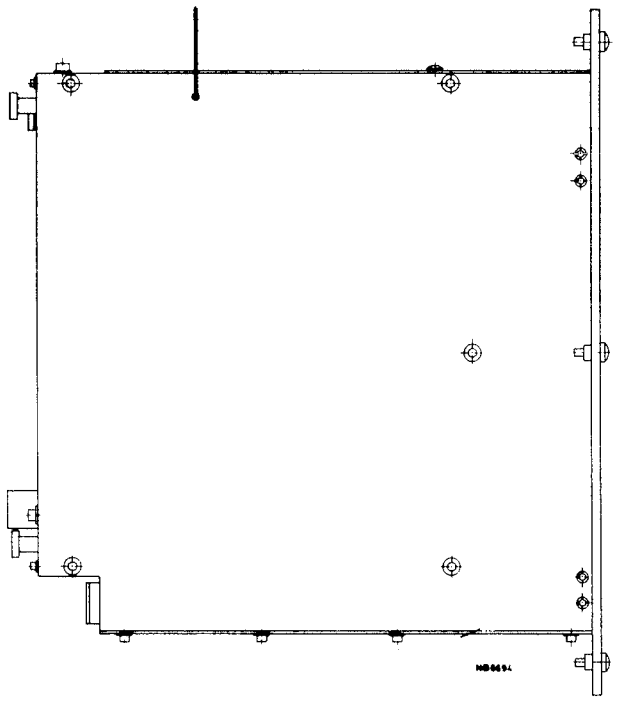
Fig. 2.-1

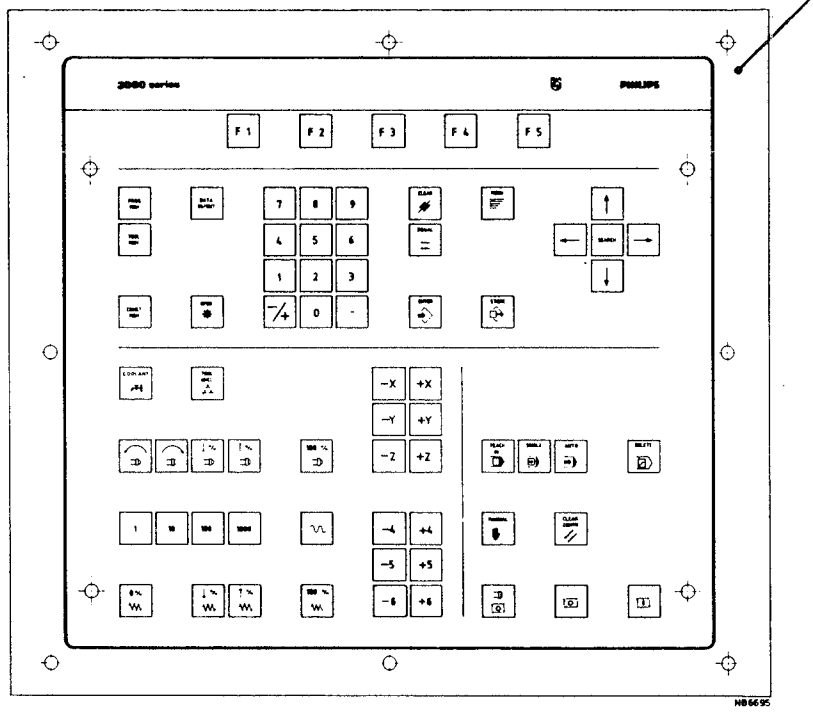
Overview of equipment that may be used in conjunction with the CNC 3460

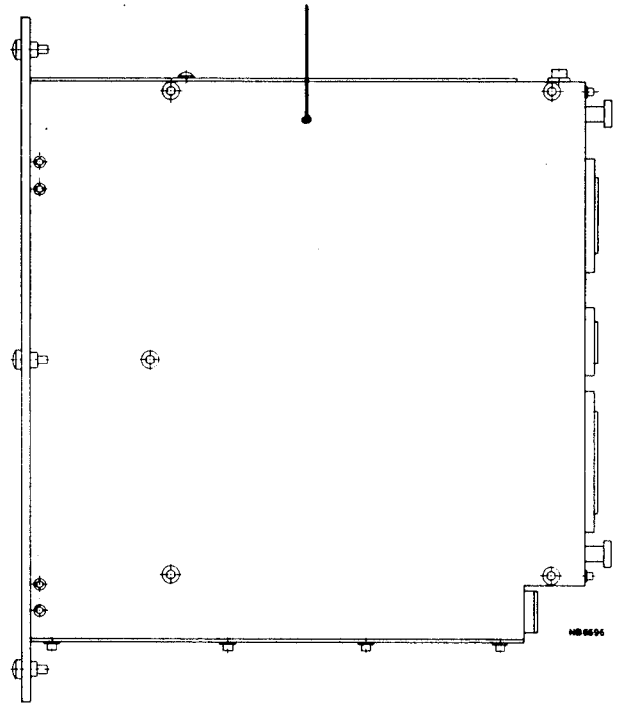
1 Control panel
2 Top view
3 Rear view
4 Left-hand view
5 Right-hand view
6 Bottom view
7 Isometric view

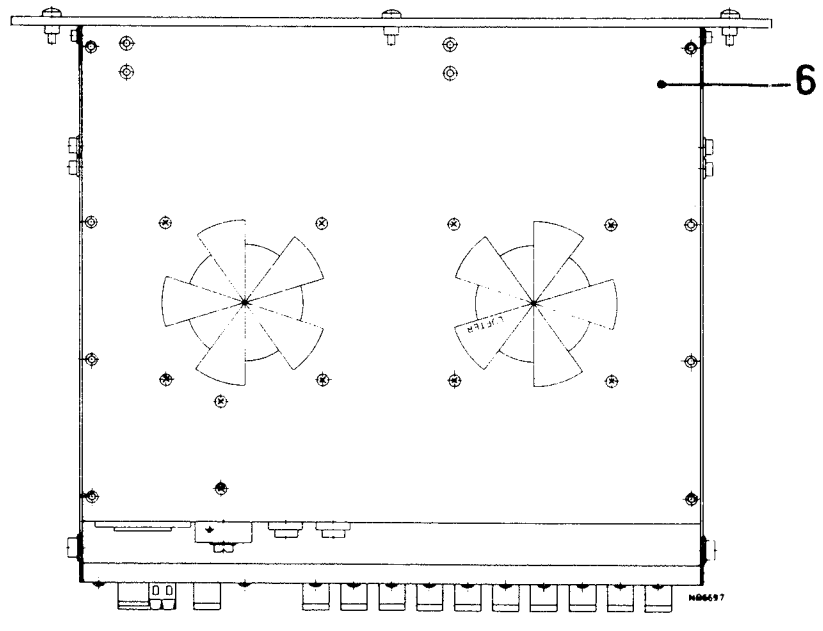












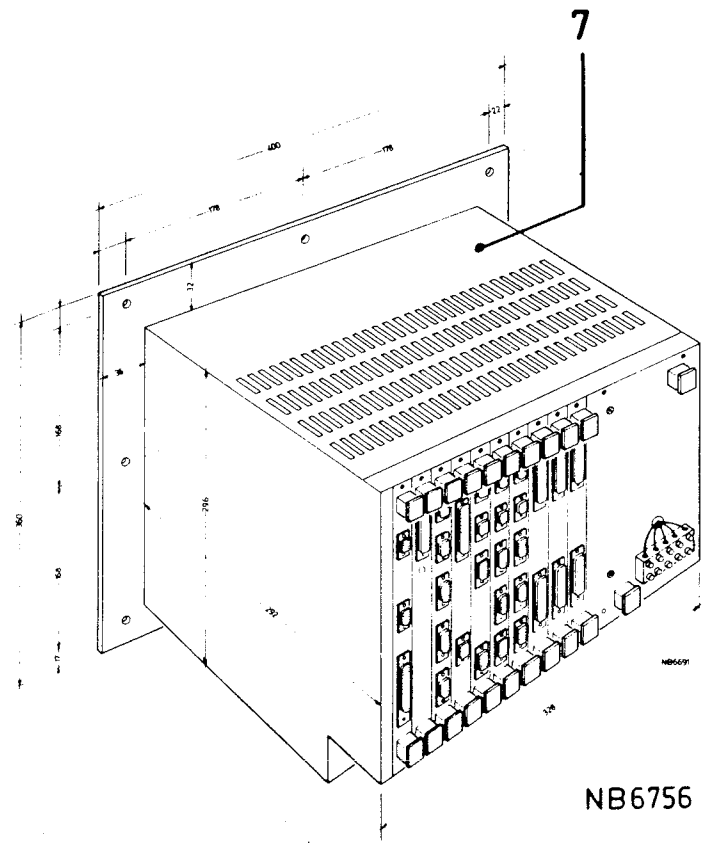
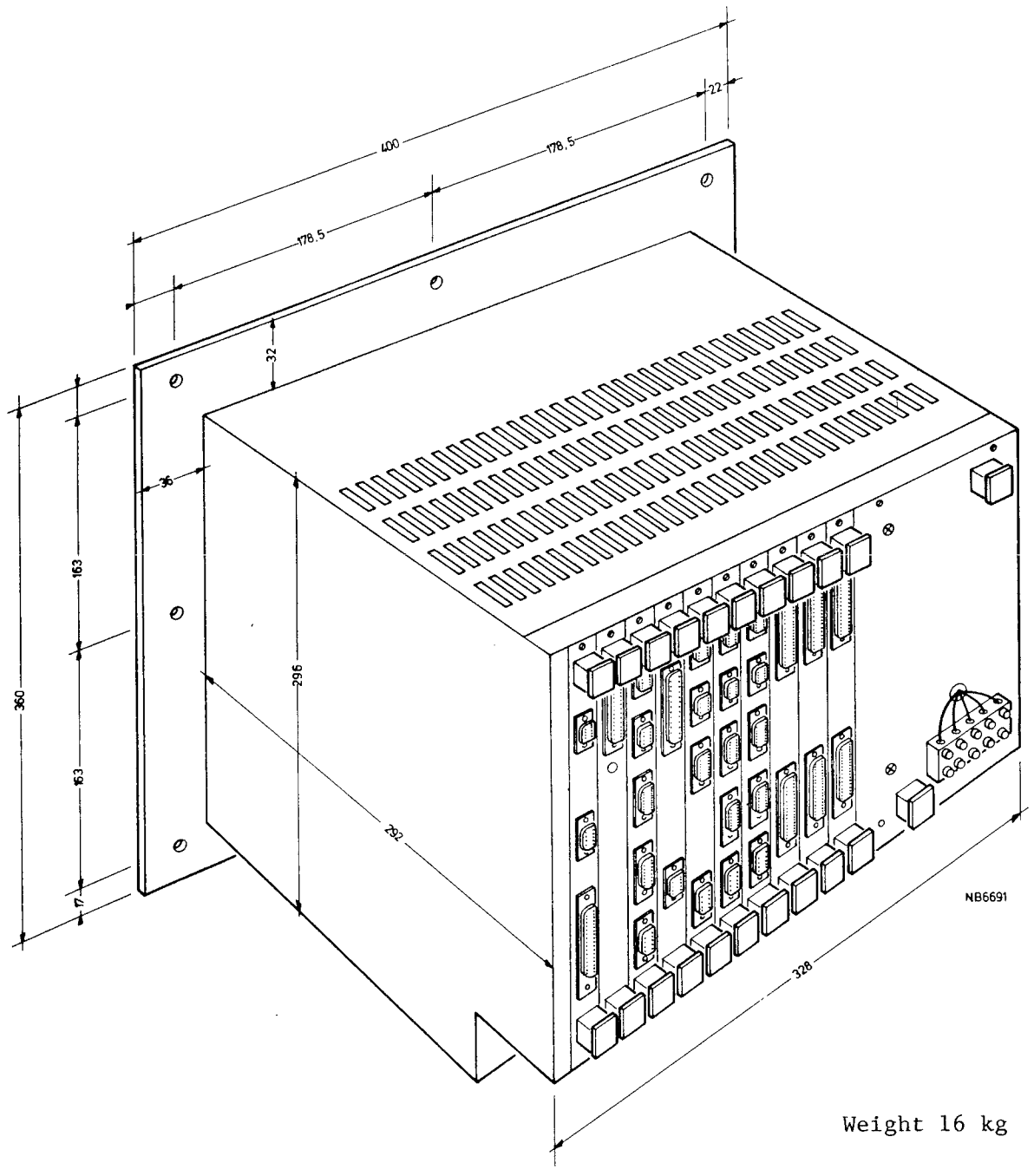


Fig. 3.-1

Views of control unit CNC 3460

DIMENSIONS OF CONTROL UNIT



Weight 16 kg

Fig. 3.-2 Dimensions of control unit CNC 3460

MOUNTING DIMENSIONS OF CONTROL UNIT

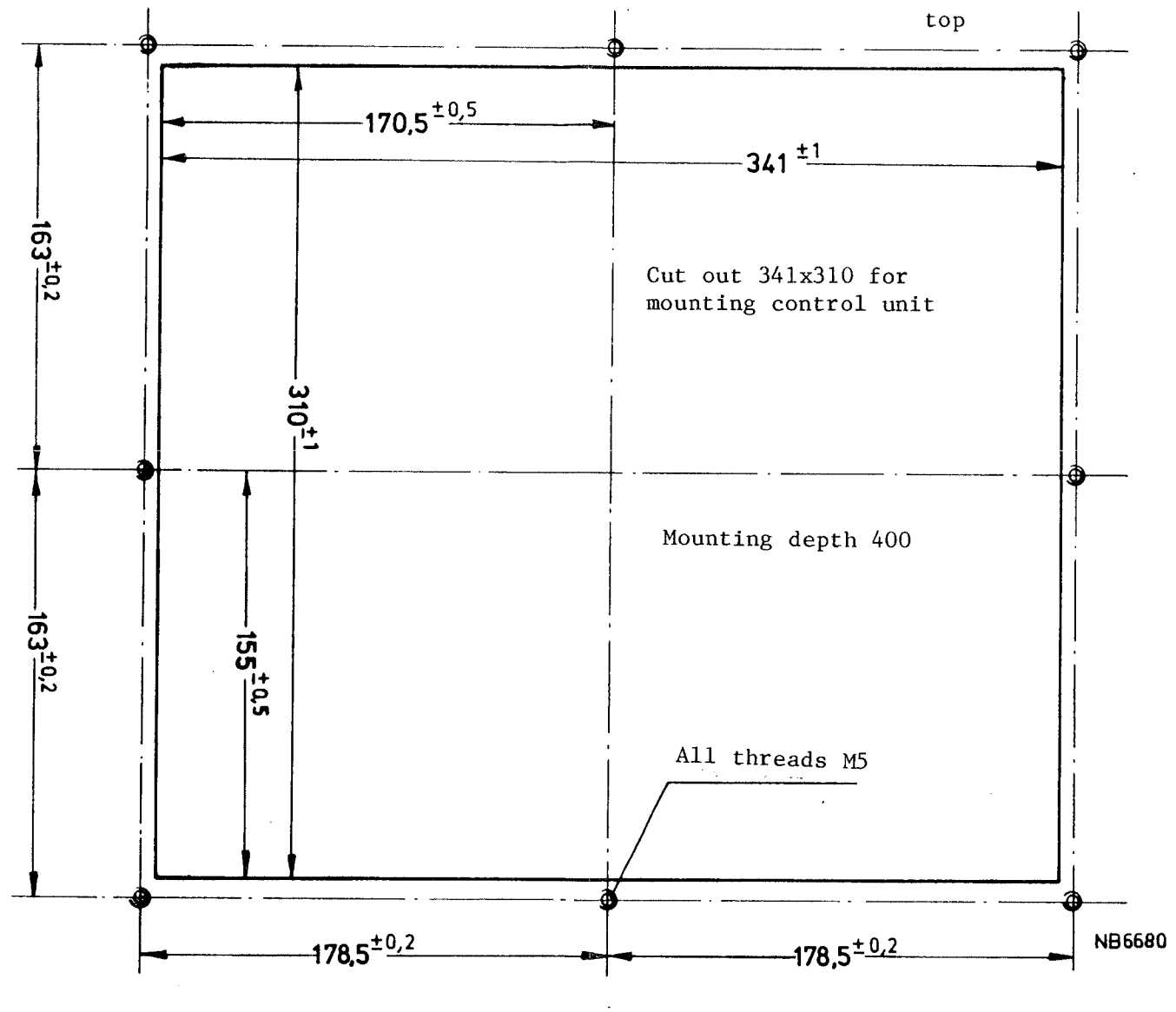
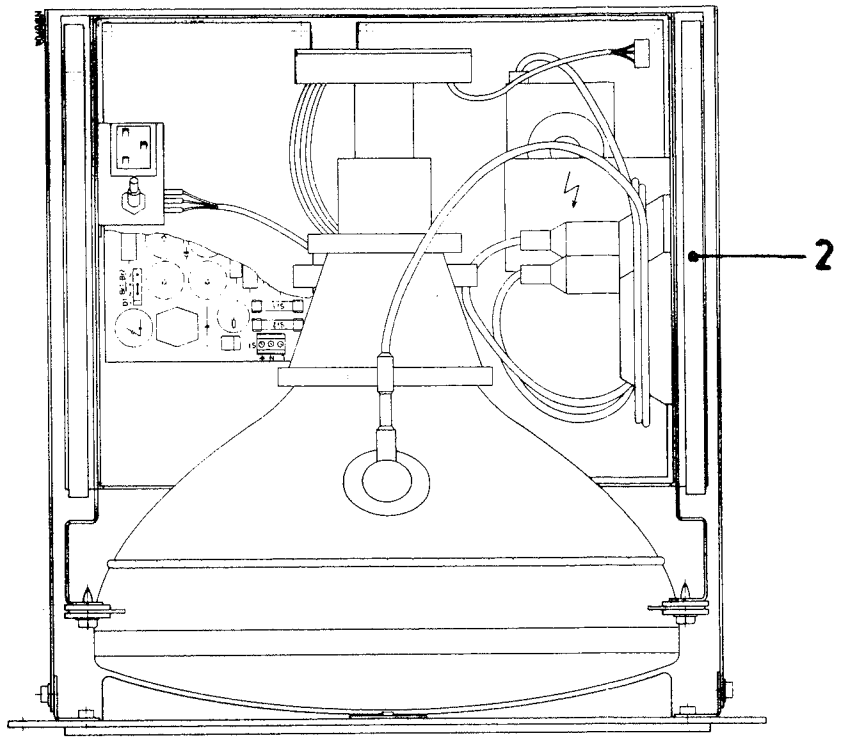
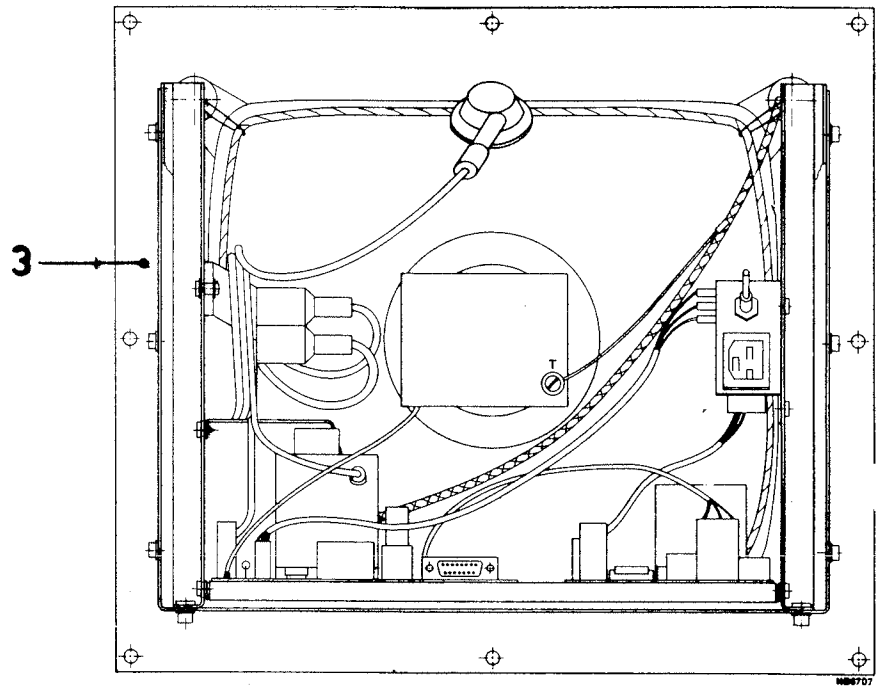
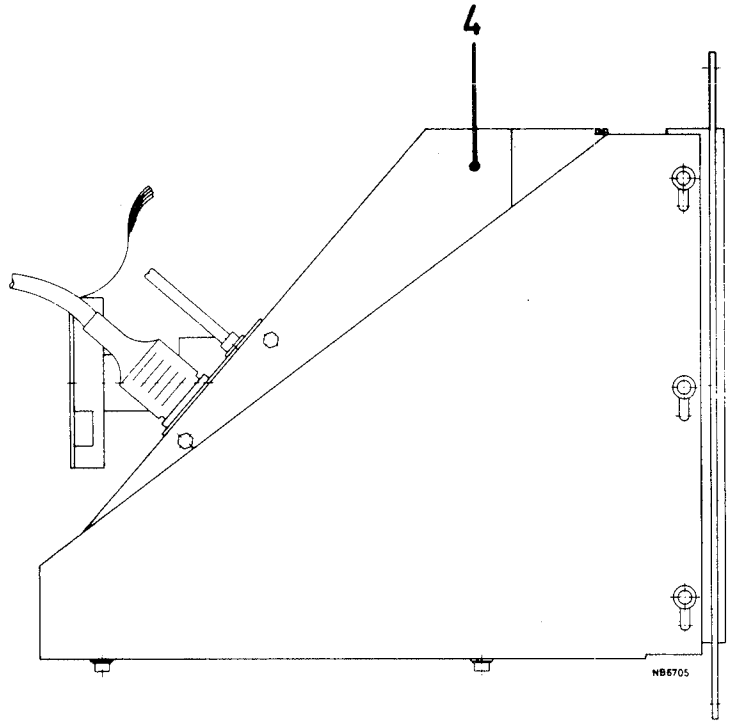


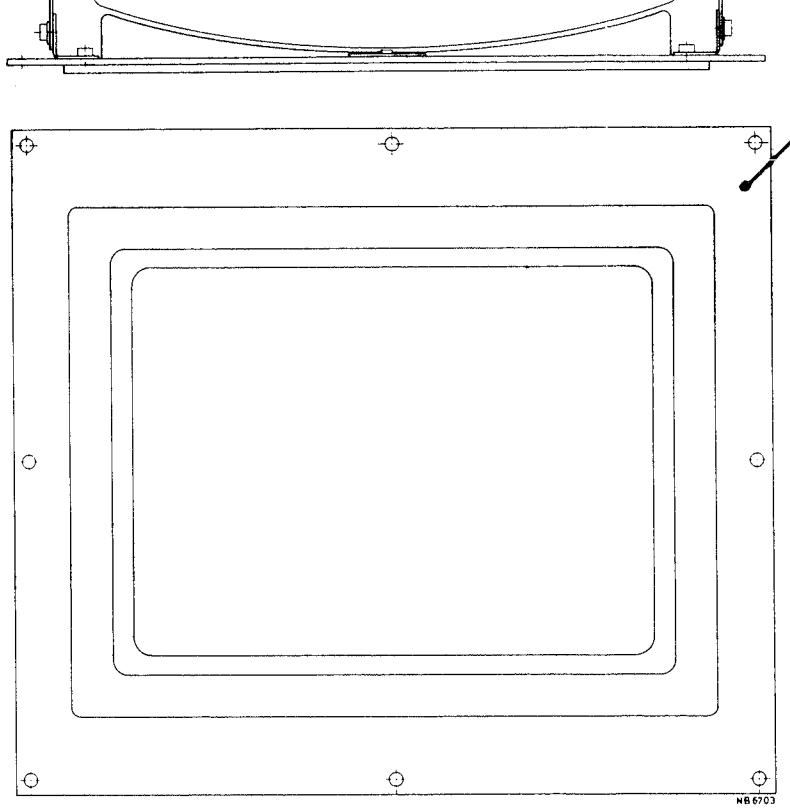
Fig. 3.-3 Mounting dimensions of control unit CNC 3460

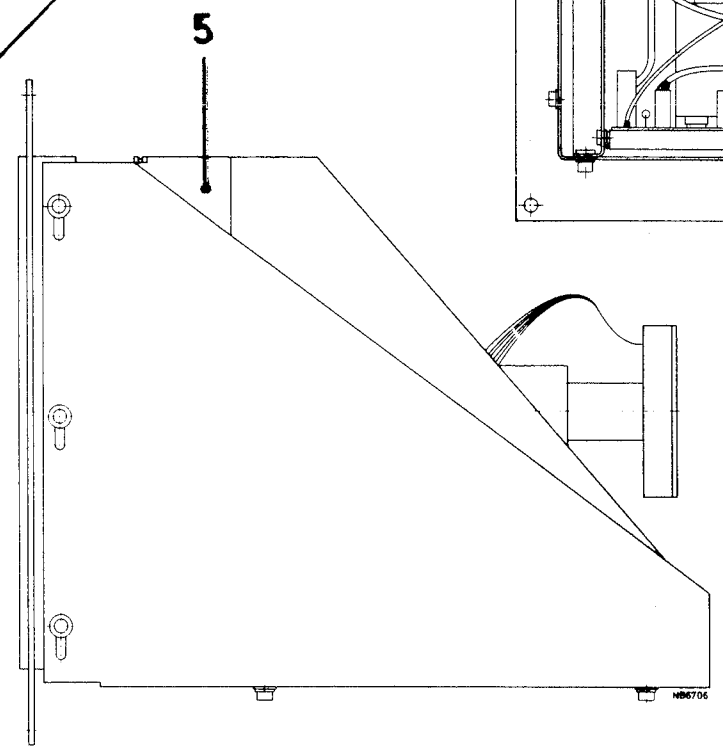
1 Front view, screen
2 Top view
3 Rear view
4 Left-hand view
5 Right-hand view
6 Isometric view











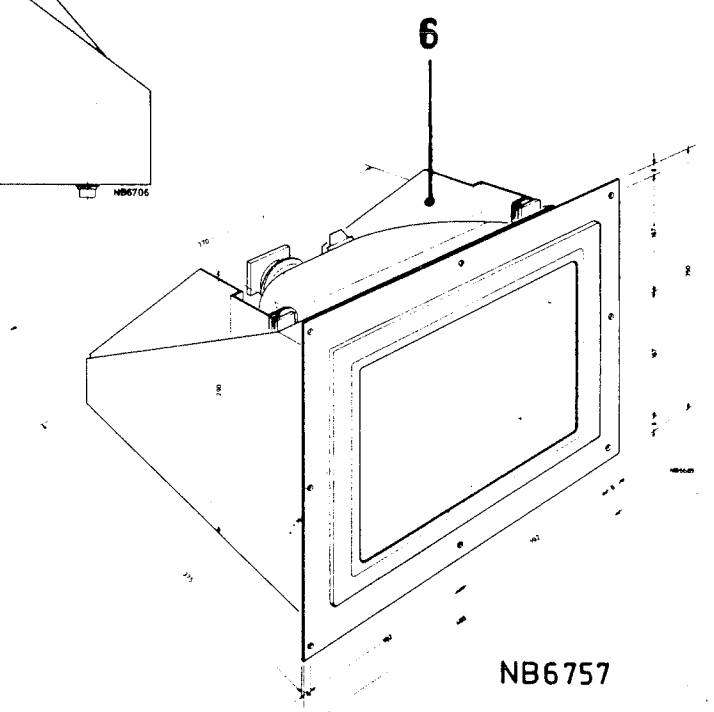
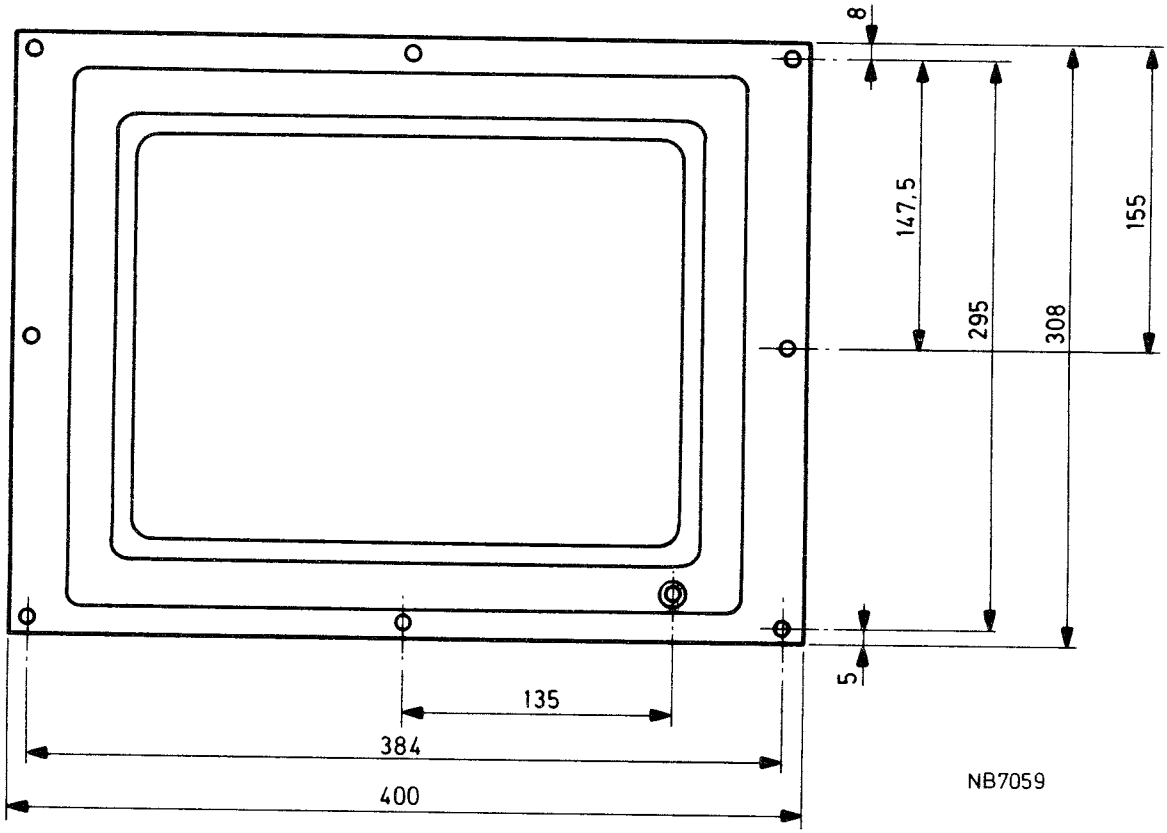


Fig. 3.-4

Views of 14"
colour monitor



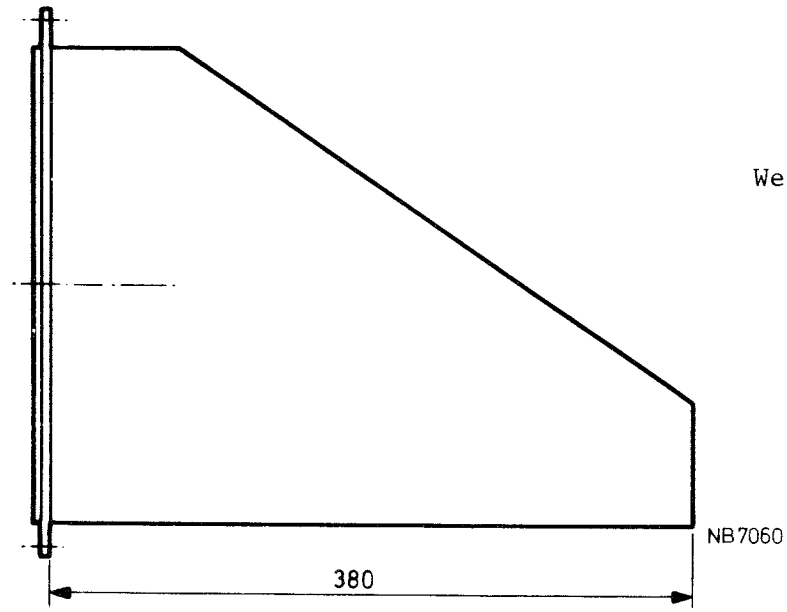


Fig. 3.-5 Dimensions of 14" colour monitor

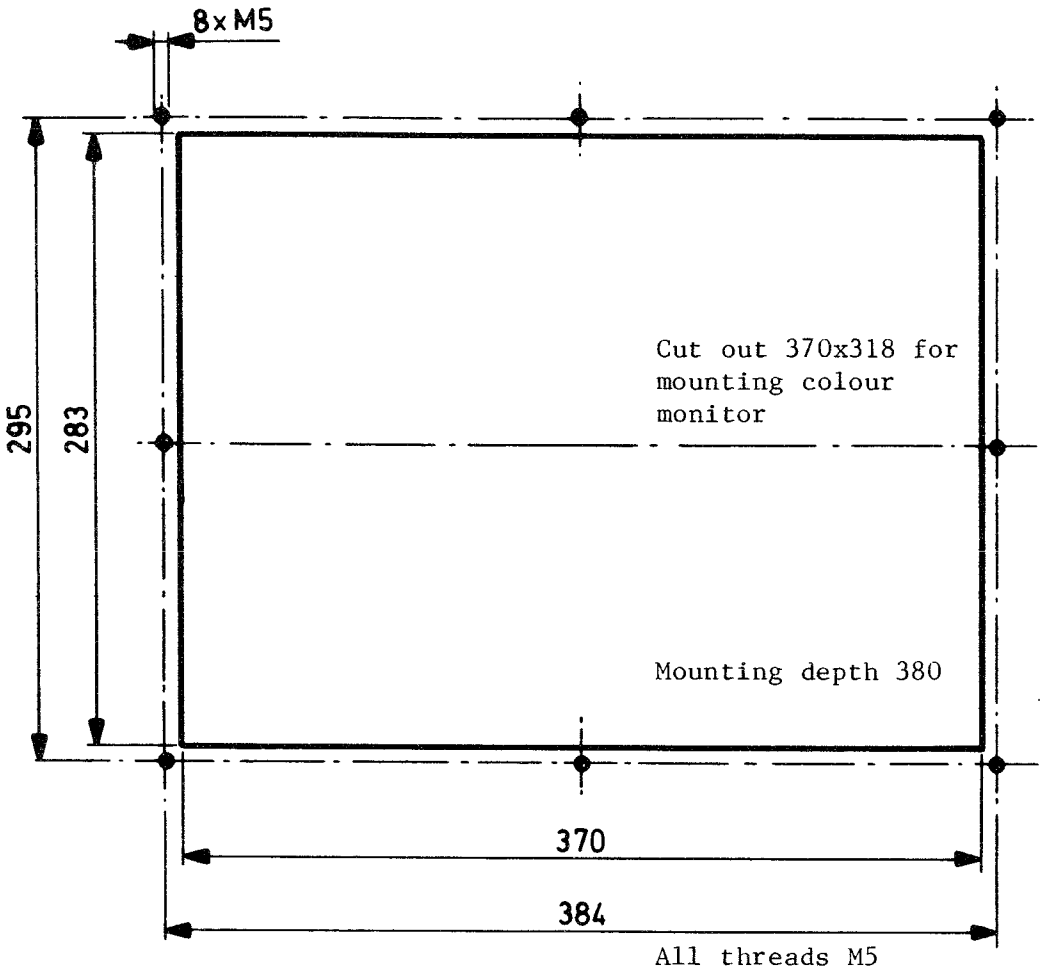
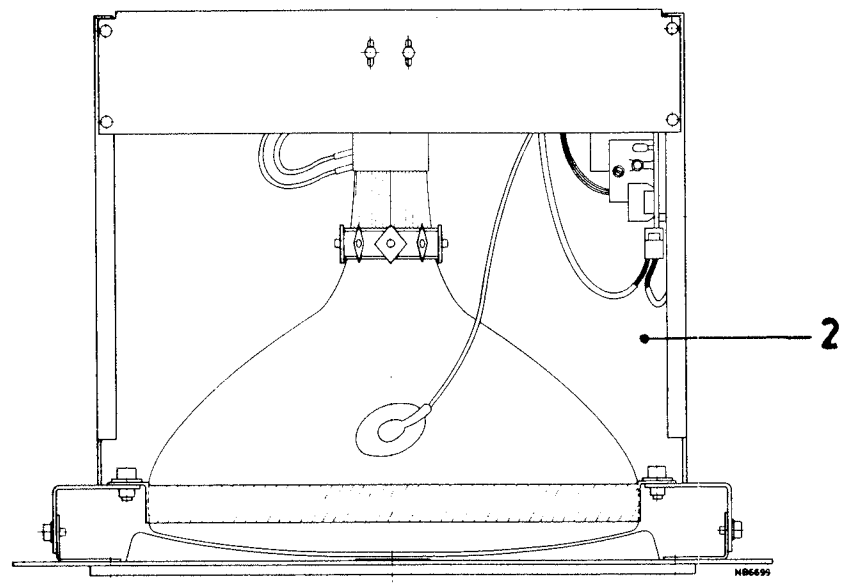
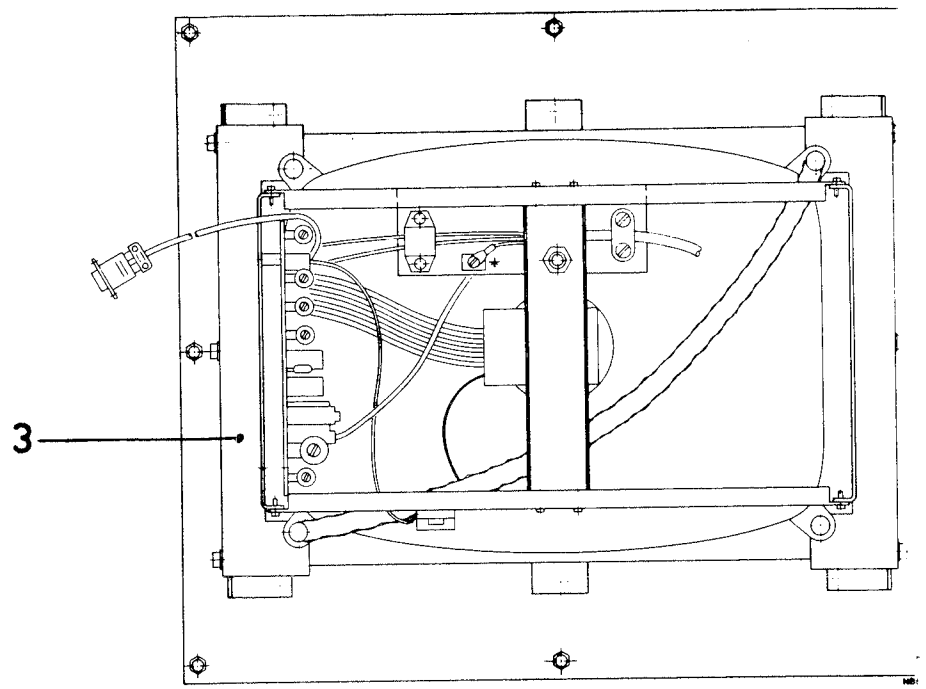
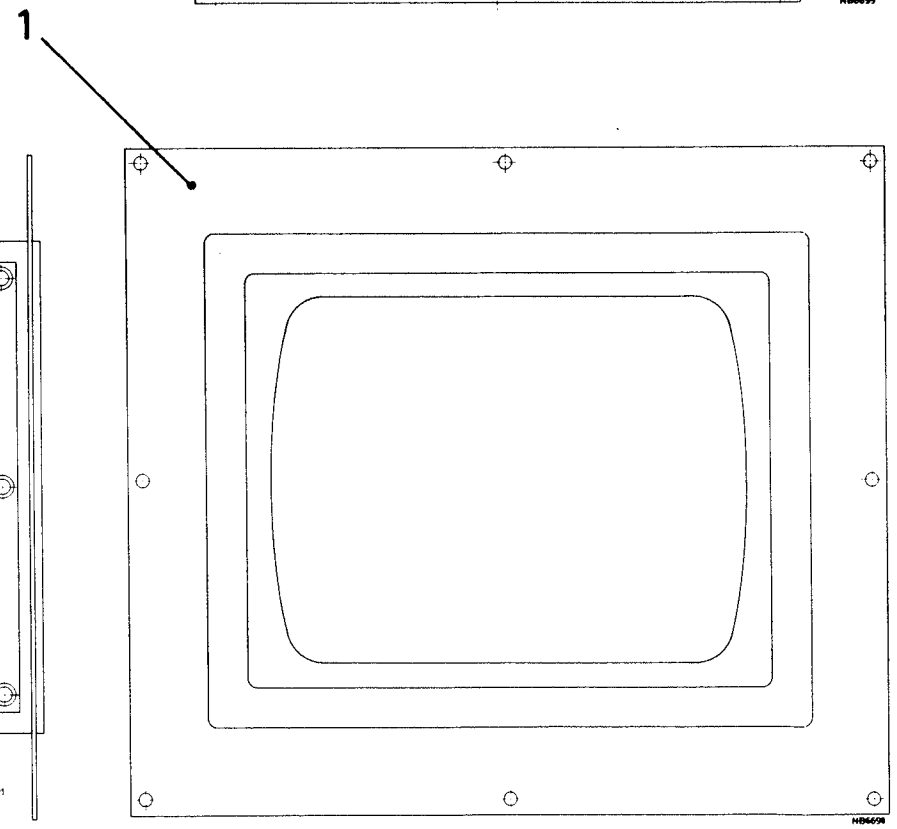


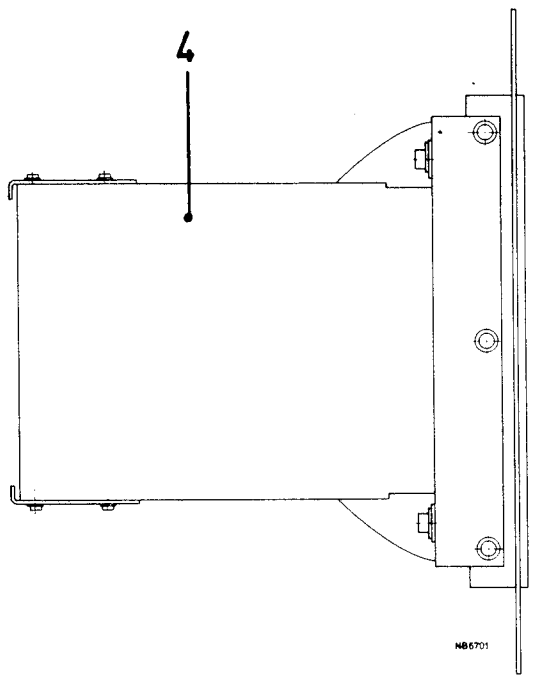
Fig. 3.-6 Mounting dimensions of 14" colour monitor

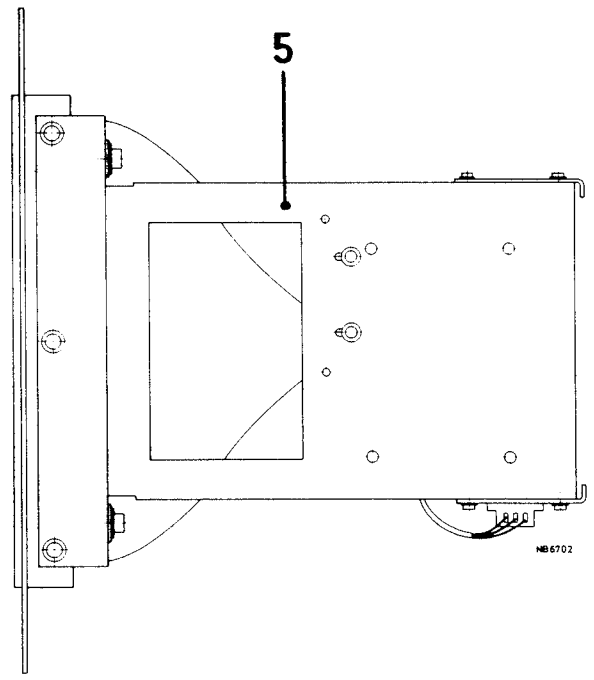
1 Front view
2 Top view
3 Rear view
4 Left-hand view
5 Right-hand view
6 Isometric view

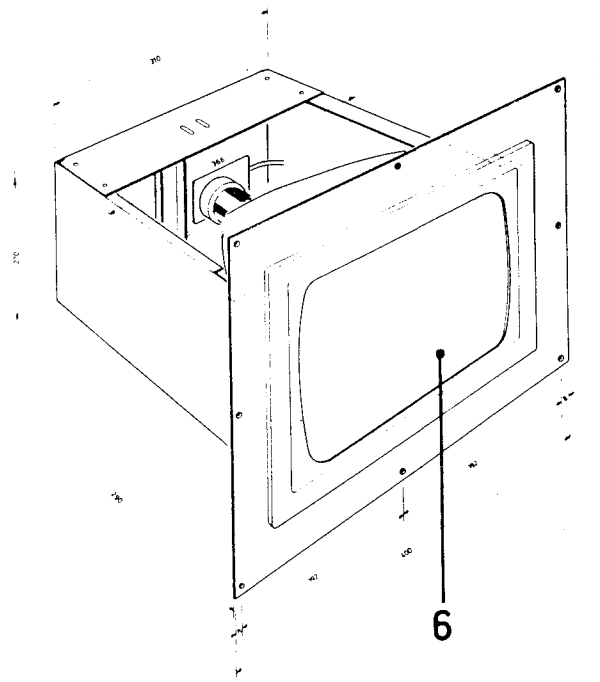












NB6758

Fig. 3.-7

Views of 12" monochrome
monitor FIMI 12GP

DIMENSONS OF MONOCHROME MONITOR

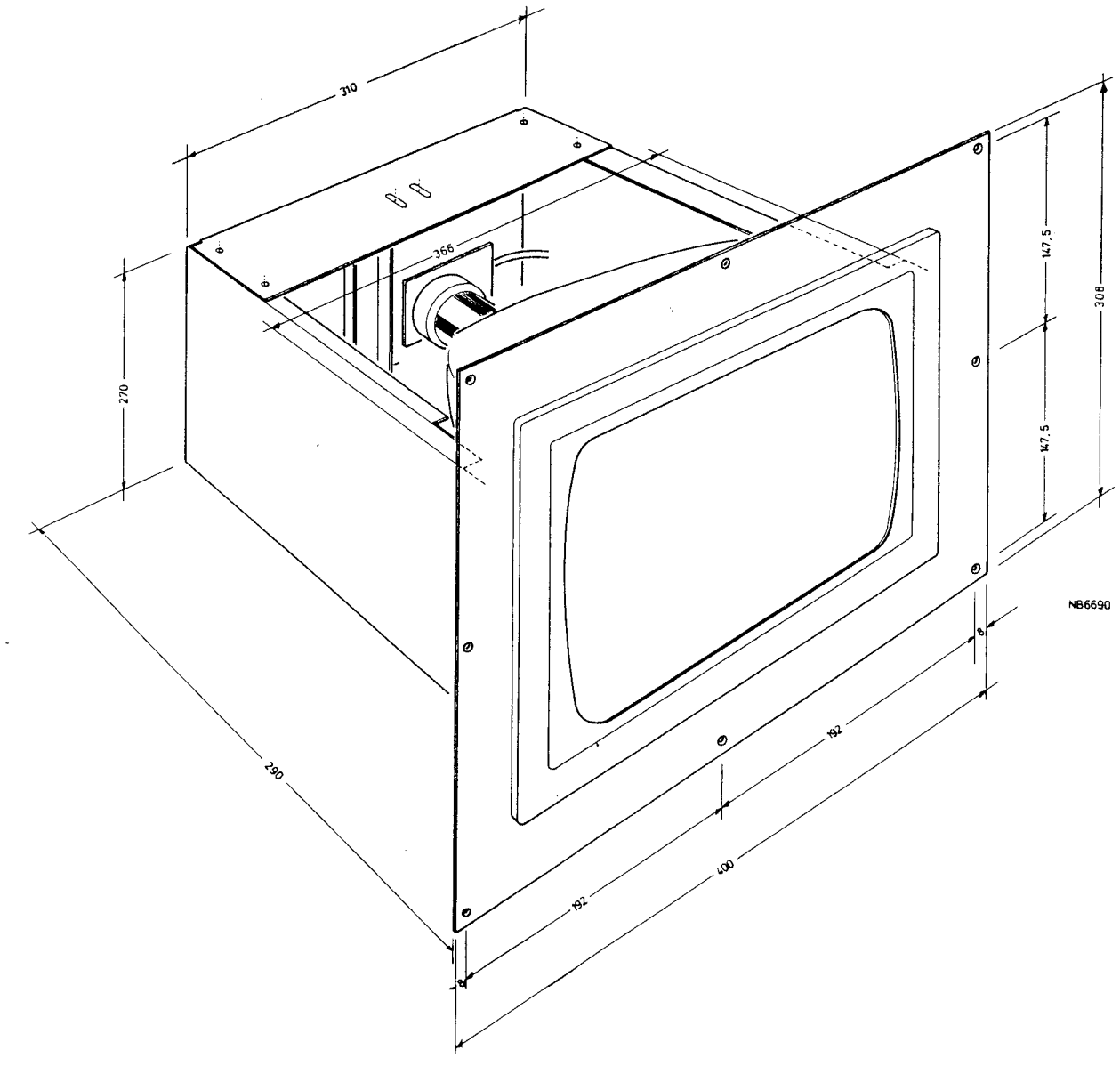


Fig. 3.-8 Dimensions of 12" monochrome monitor FIMI 12GP

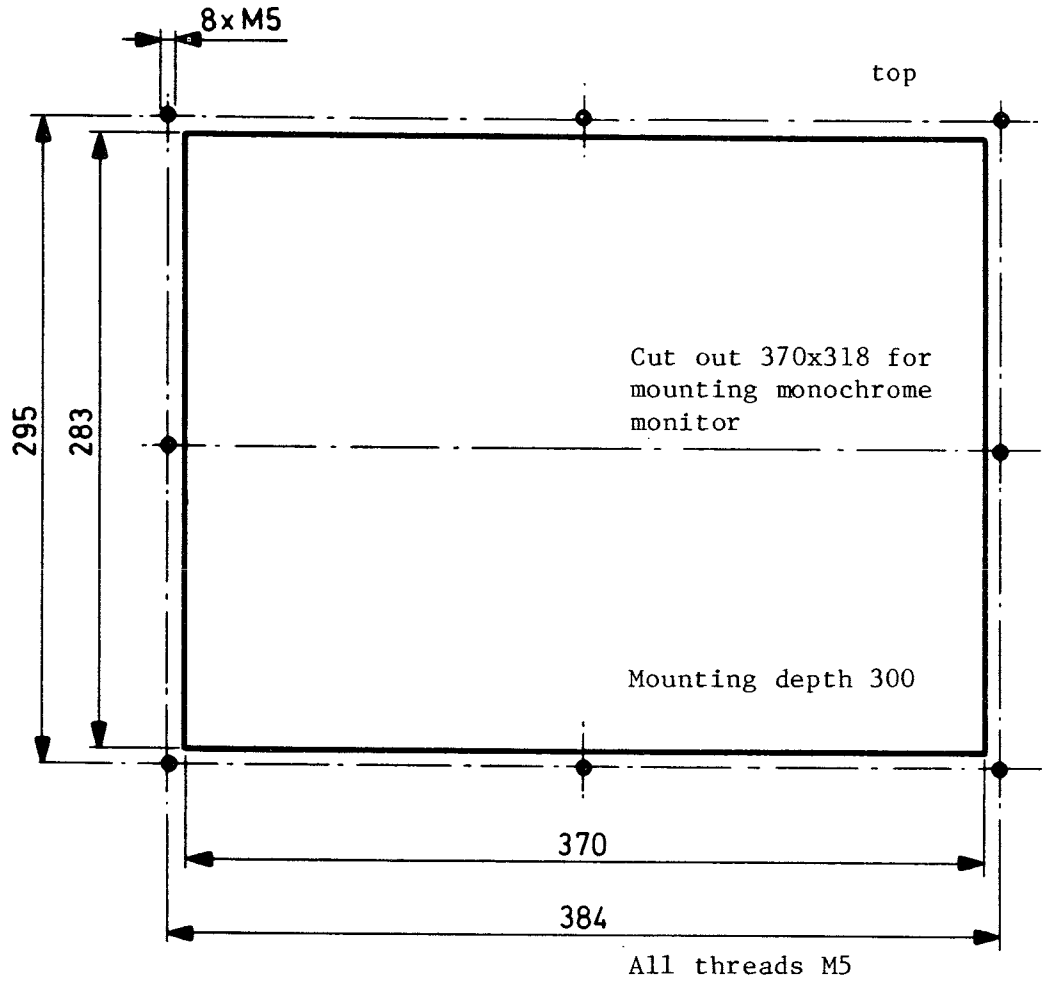


Fig. 3.-9 Mounting dimensions of 12" monochrome monitor FIMI 12GP

The control system CNC 3460 is cooled by two fans located at the bottom of the control unit. Dust filters are not provided.

The ambient temperature (room temperature) is required to be within the range $+5^{o}C$ and $+45^{o}C$.

In order to ensure adequate cooling and keep the control unit clean, it is essential that the cabinet in which the control unit is mounted, be provided with an air intake and an air outlet both with dust filters.

Without filters, dust will rapidly accumulate in the control unit and mix with coolant and lubricant vapours to a dirt film, causing the control system to be adversely affected.

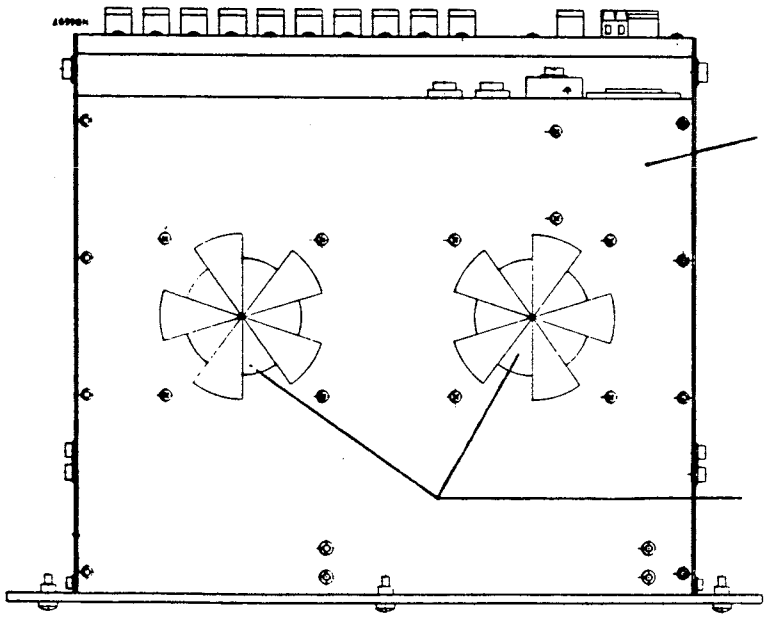
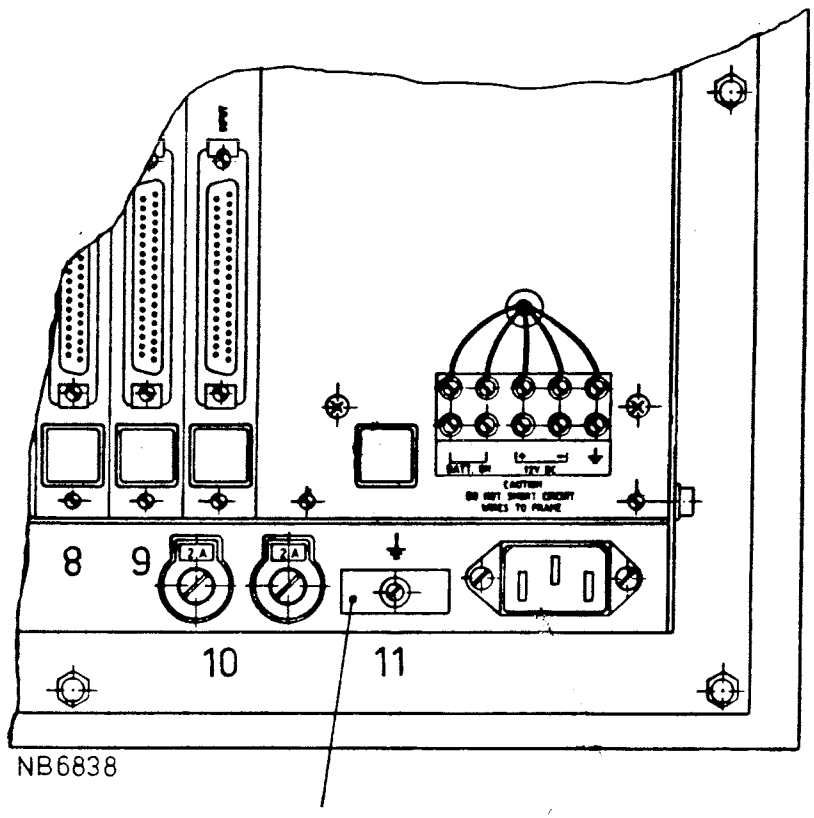


Fig. 4.-1 Bottom view of control unit showing the fans

EARTHING

The control system CNC 3460 must be connected to a reliable earth system via a 6 mm^2 earth lead (minimum value) from the central earth terminal at the rear of the control unit.
Earth loops which can be formed by the screens of the connection cables between the control unit housing and the machine tool should be avoided.



Central earth terminal
for 6 mm^2 earth lead

Fig. 5.-1 Detail of control unit showing earth terminal

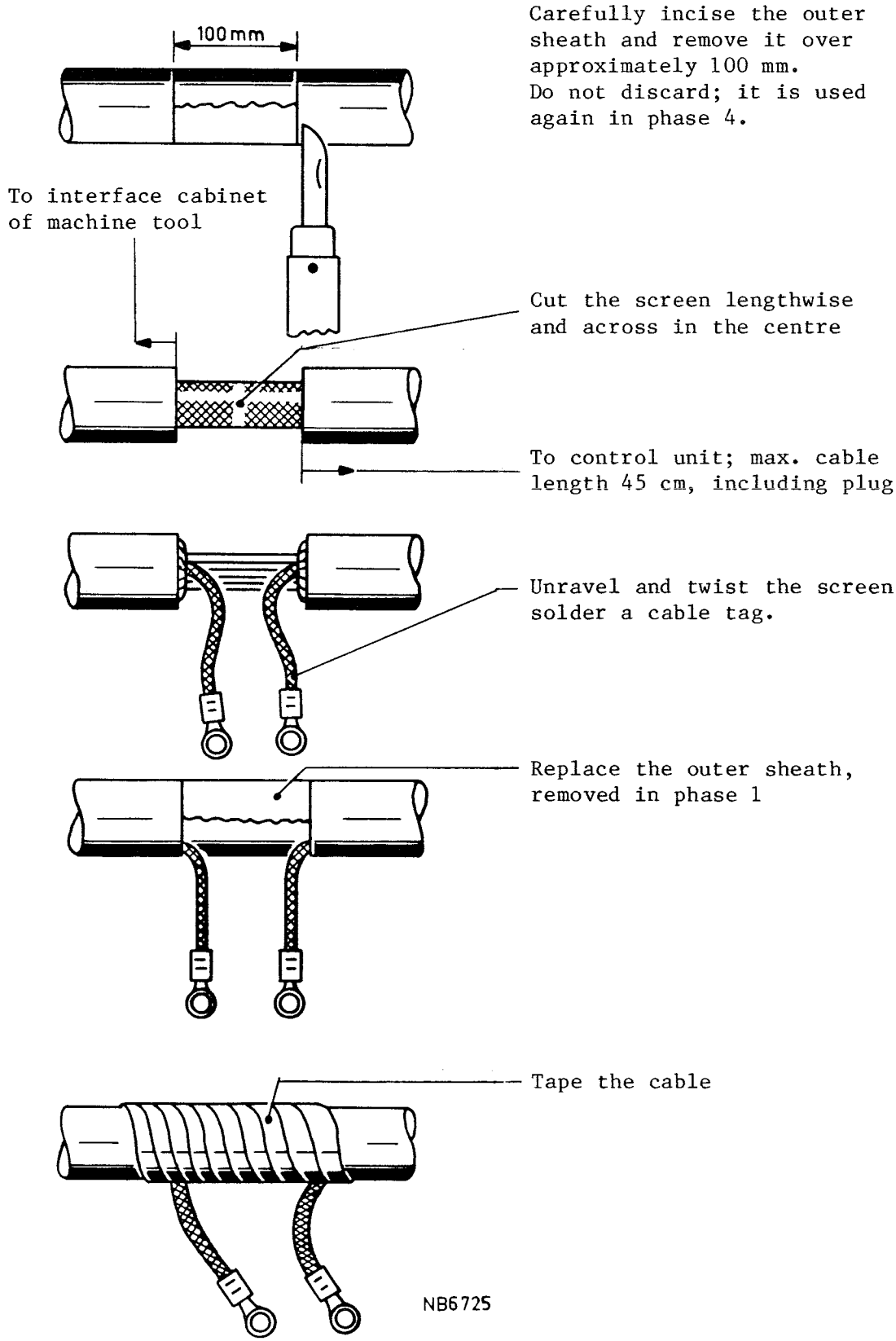


Fig. 5.-2 Cable screen termination

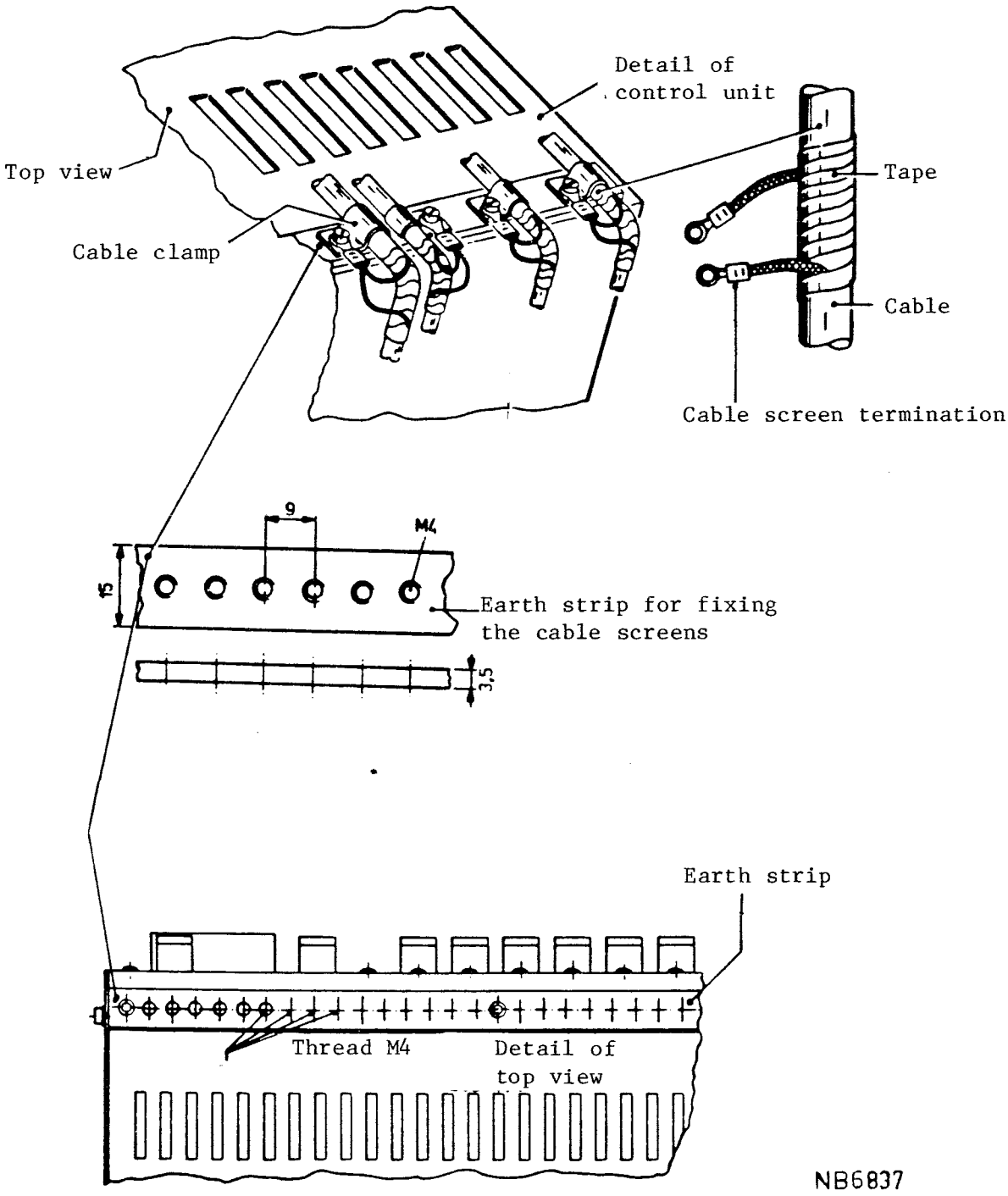


Fig. 5.-3 Cable screen fixing

Fixing the cables to the control unit

The screening of the connection cables between control unit and interfacing cabinet of the machine tool must be earthed to avoid interference.

Note that the cable clamps ar not mounted across the cable screens but across the outer sheath, in order to avoid cable damage. Refer to the figure below.

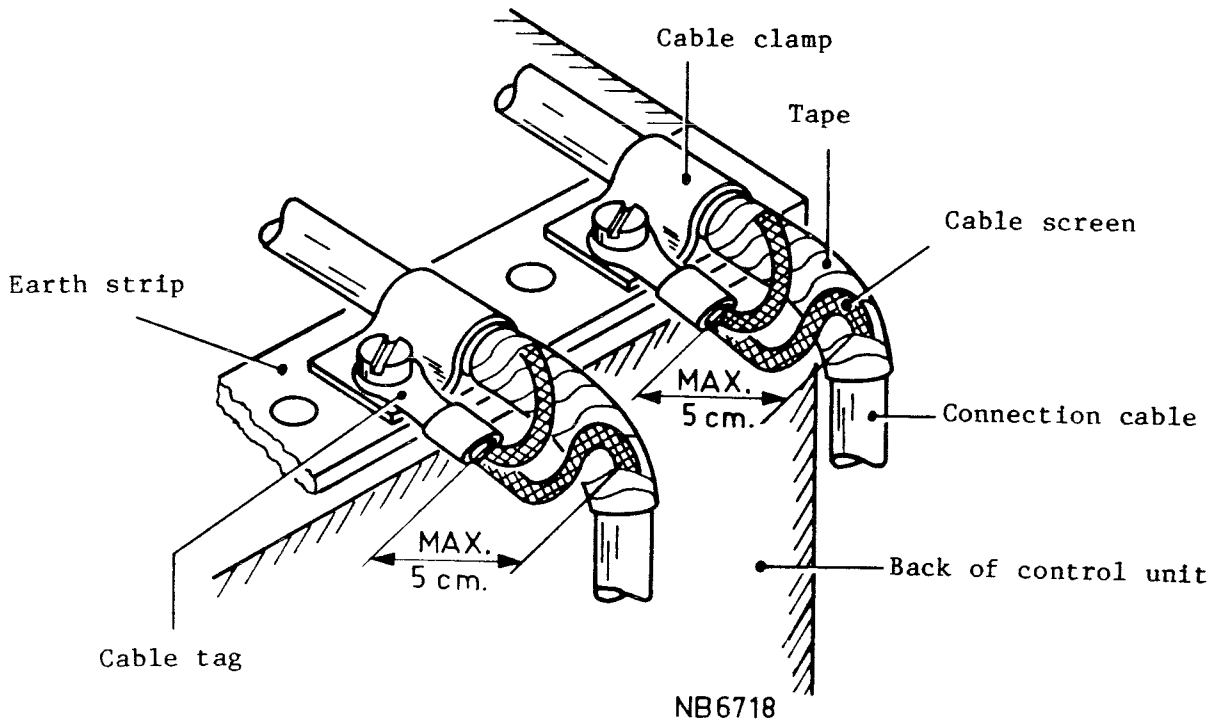


Fig. 5.-4 Fixing the cables to the control unit (top rear)

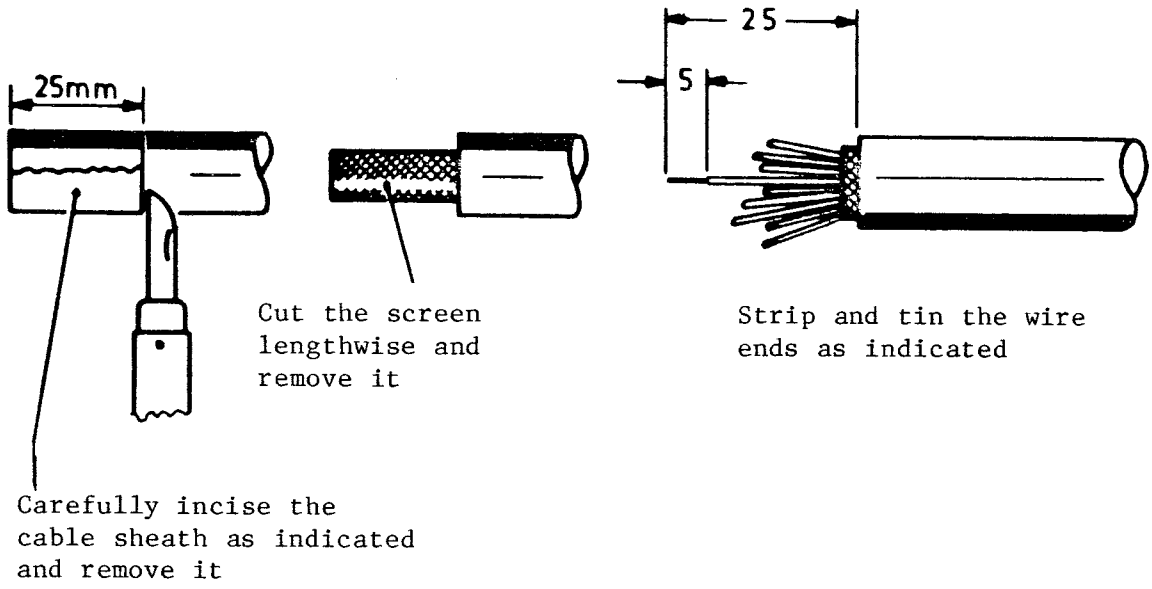


Fig. 5.-5 Cable termination

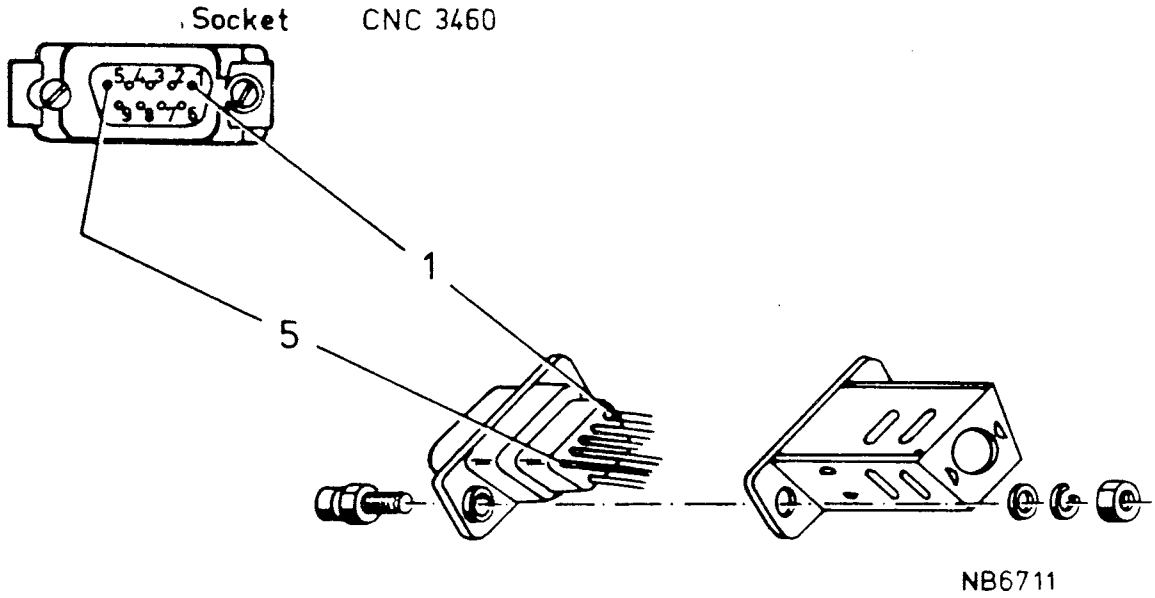


Fig. 5.-6 Wiring the 9-way plug

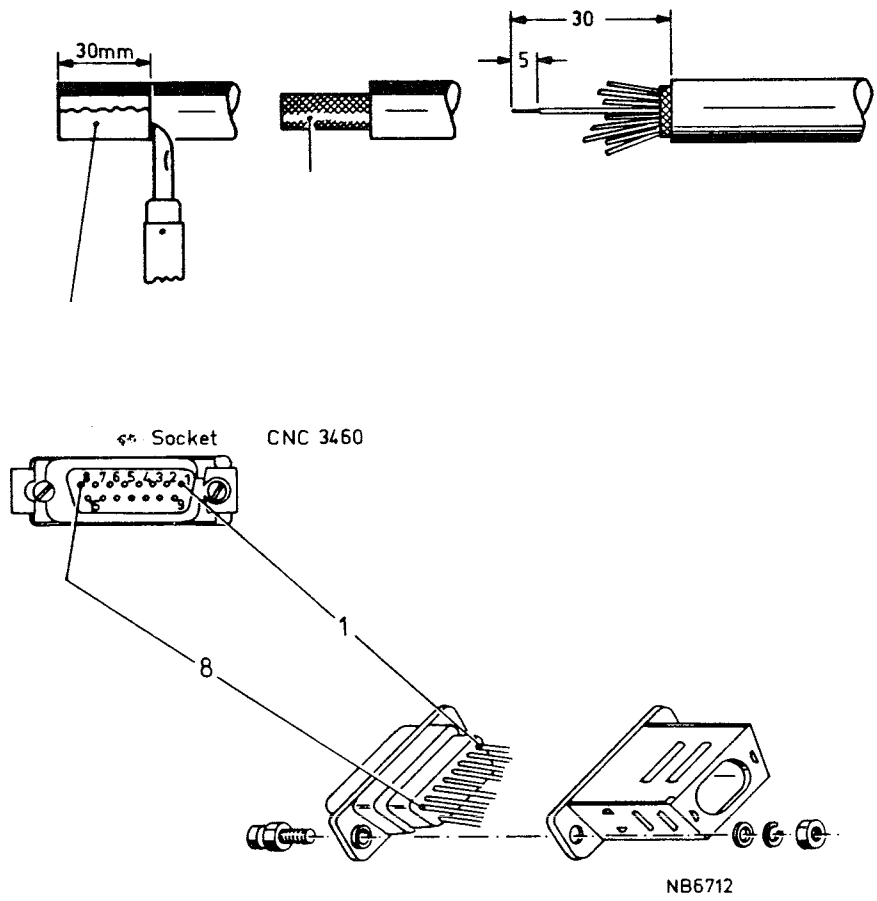


Fig. 5.-7 Wiring the 15-way plug

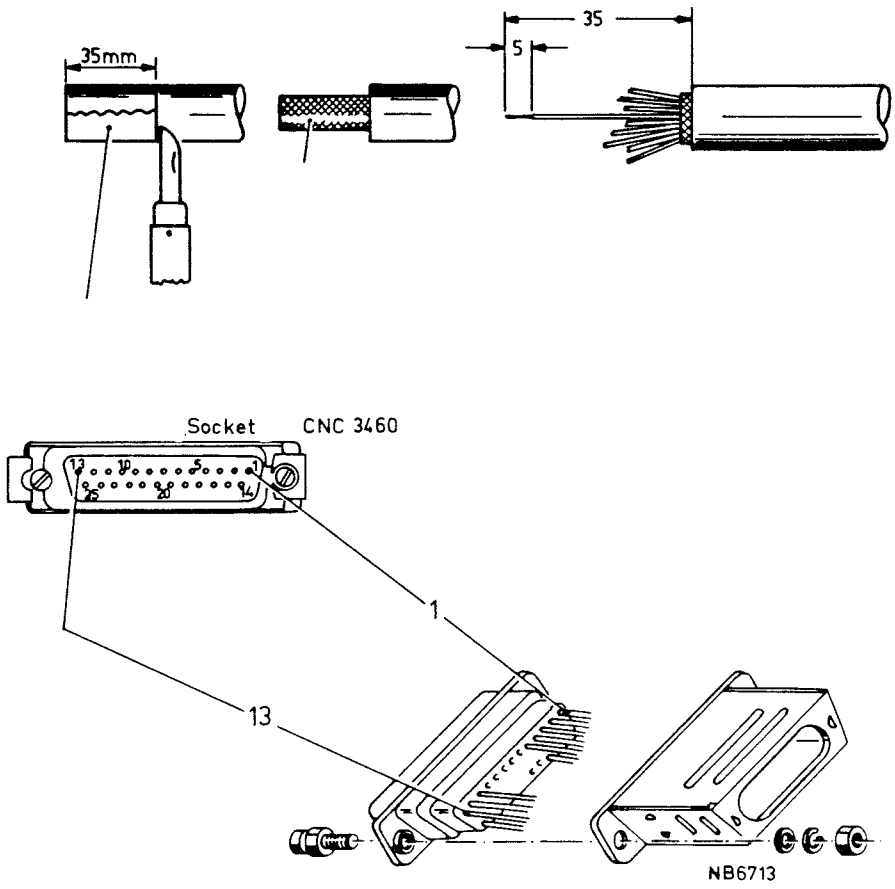


Fig. 5.-8 Wiring the 25-way plug

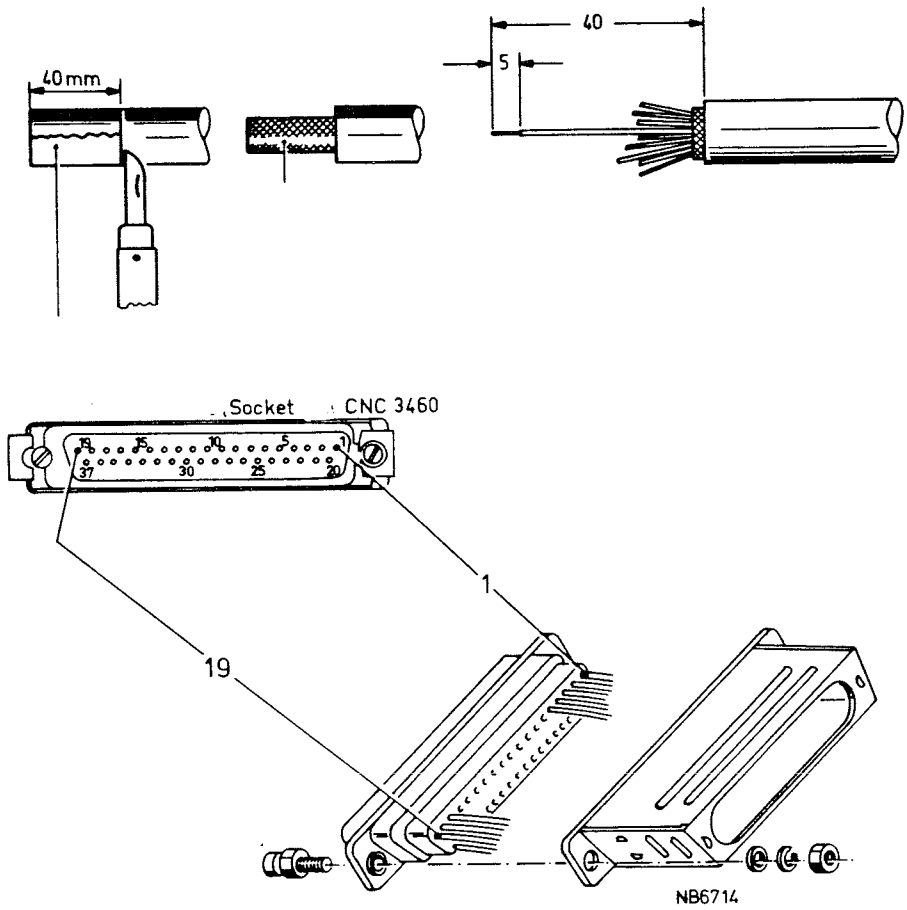
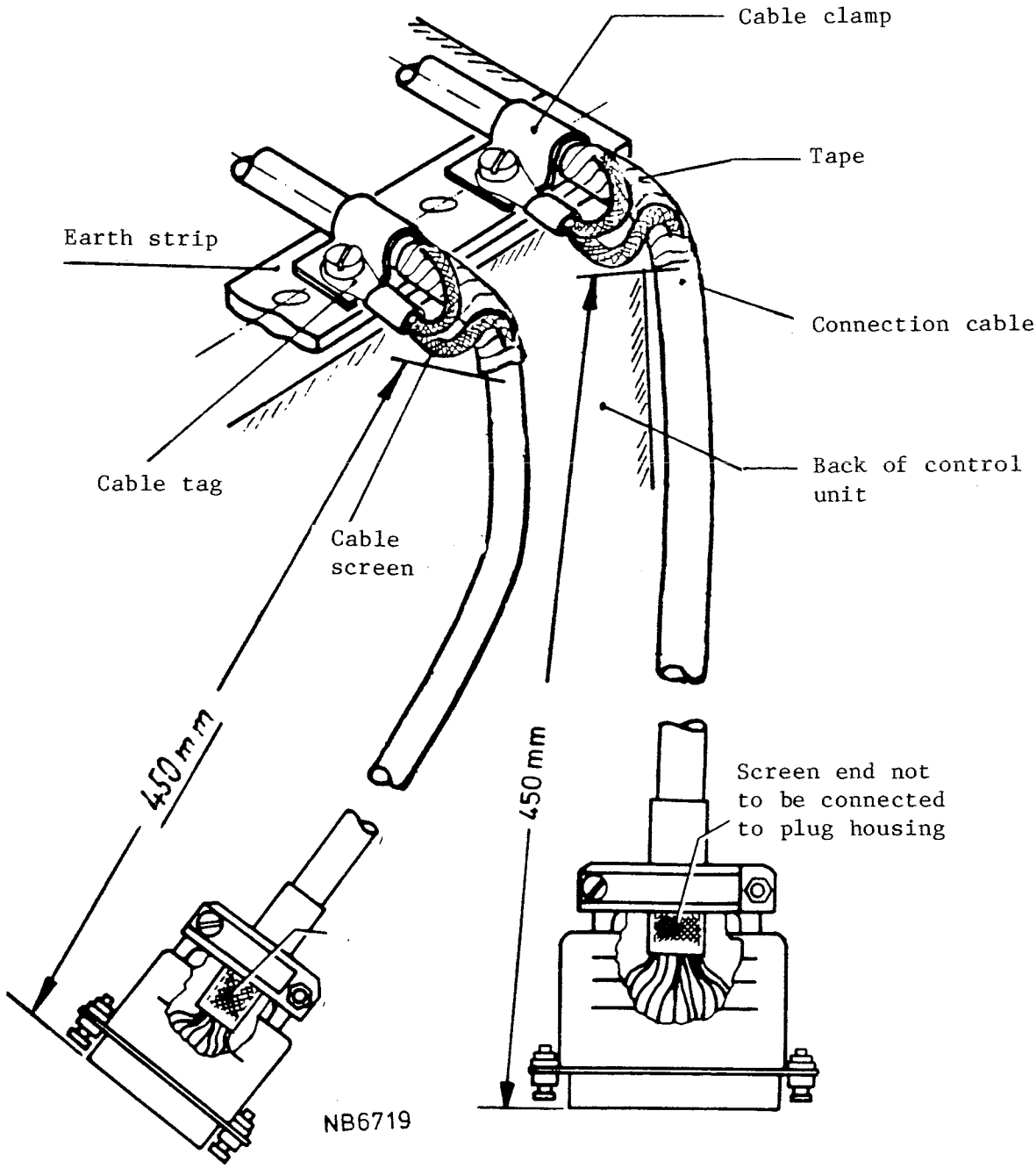
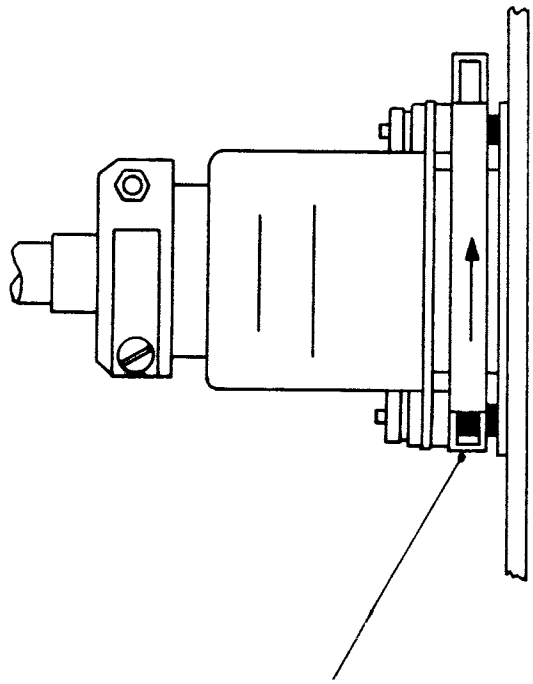


Fig. 5.-9 Wiring the 37-way plug



The overall length of 450 mm includes the plug, irrespective of its size

Fig. 5.-10 Connection cables mounted to control unit



To remove the plug from the module socket, first unlock by pressing in arrow direction.

Fig. 5.-11 Plug unlocked

Insert plug into module socket and lock by pressing in arrow direction.

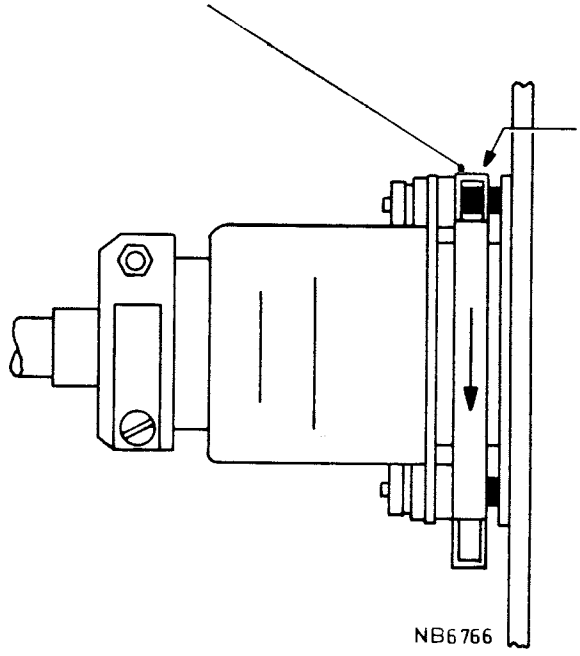


Fig. 5.-12 Plug locked

The control unit as well as the video unit (colour monitor) must be connected to an interference-free mains supply of 220 V 50-60 HZ ± 1 Hz or 110 V 50-60 Hz ± 1 Hz.
The connection to a 110 V mains supply requires some adjustments to be made. Details are given on the following pages.

Permissible voltage variations:
at 220V +10%, -15%
at 110V +10%, -15%

Power consumption:
Control unit CNC 3460 100 VA
Colour monitor 80 VA

The required connection cables (length 3 m, 3 x 1.5 mm^2 conductors) fitted with appropriate plugs are provided with the units.

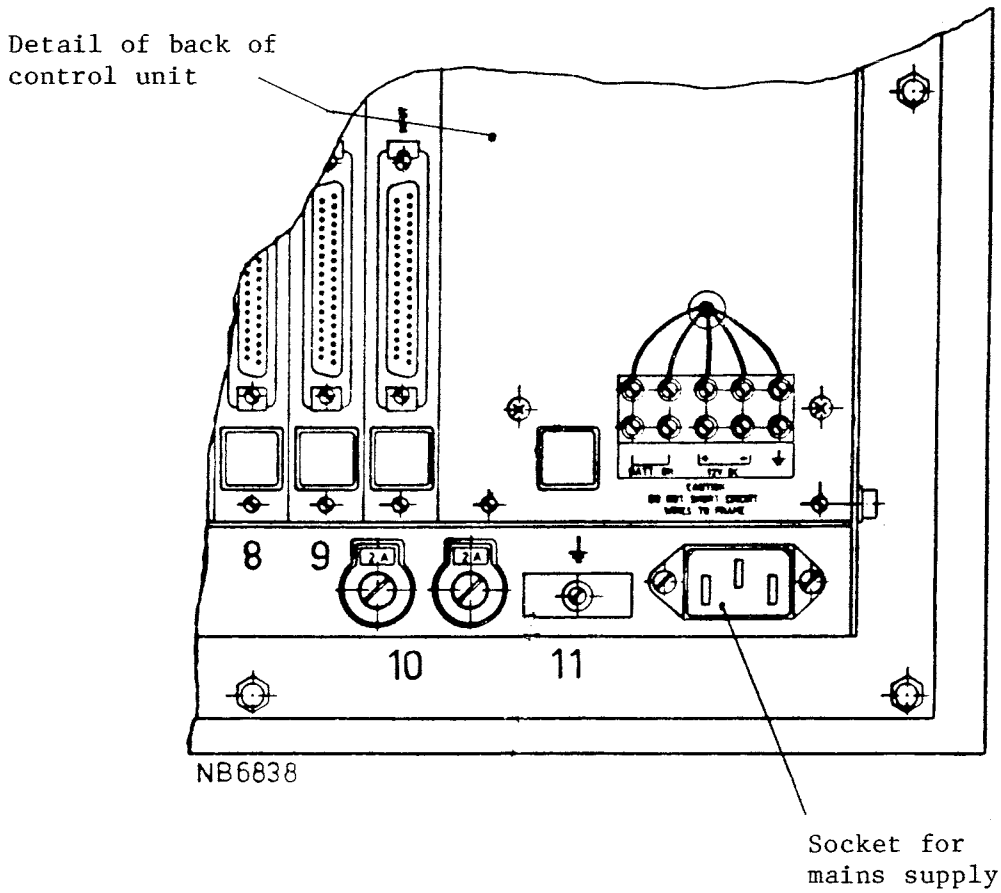


Fig. 6.-1 Detail of control unit showing socket for mains supply

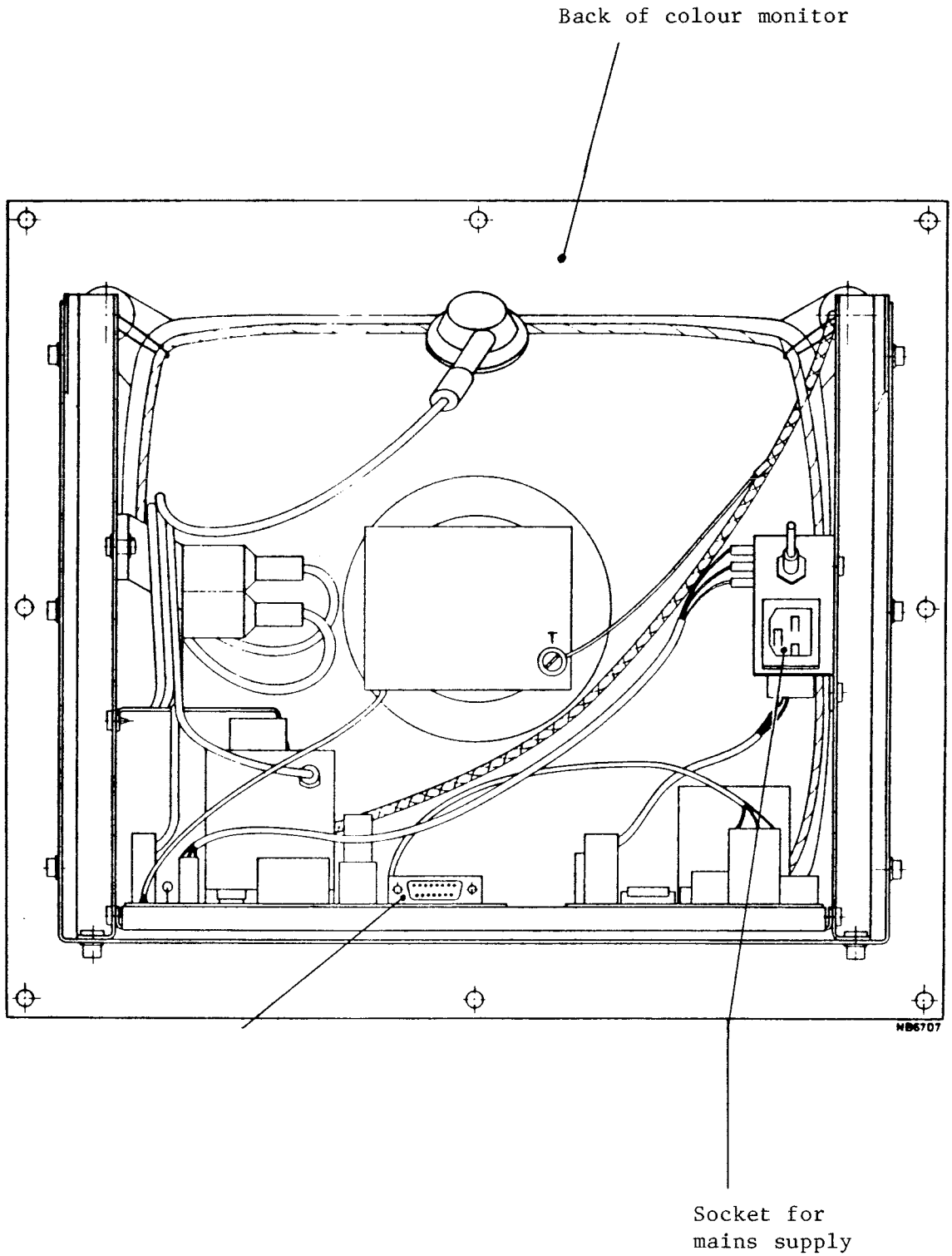
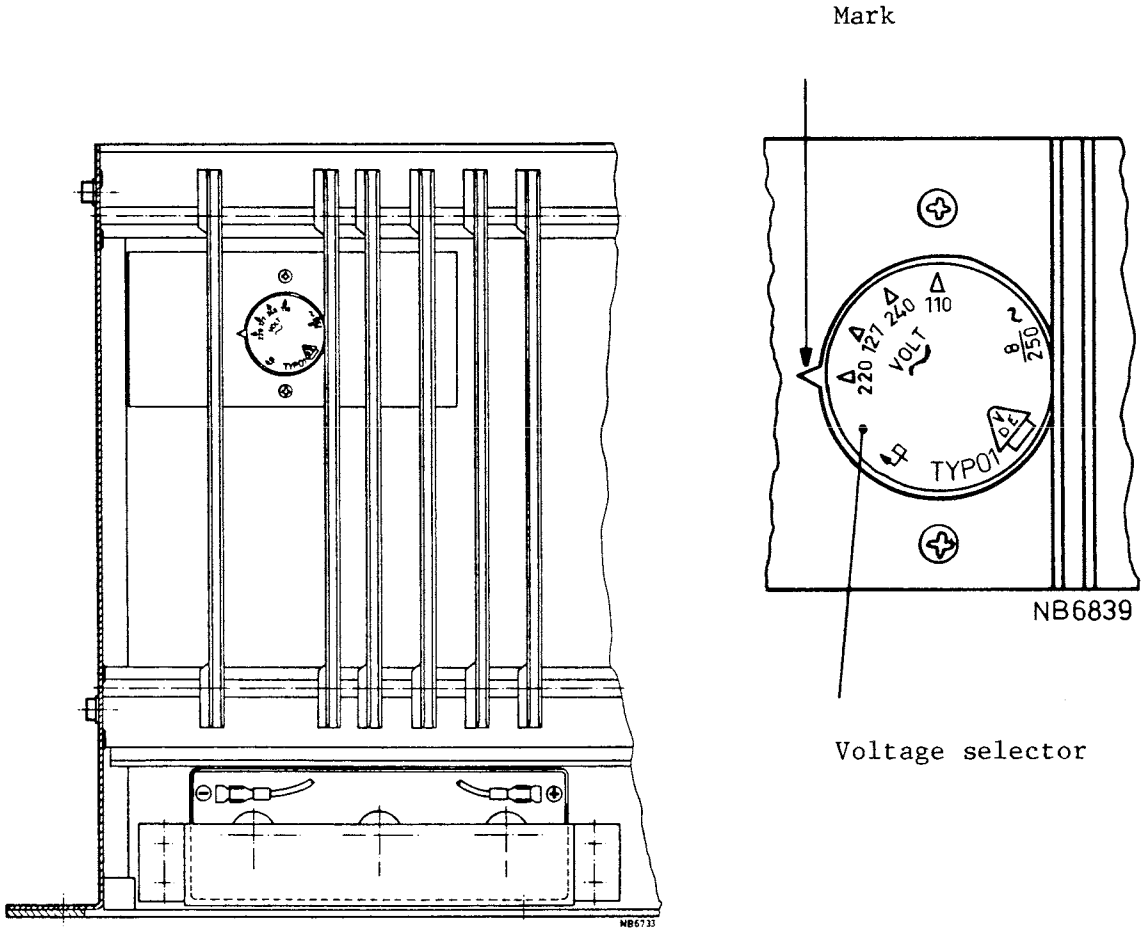


Fig. 6.-2 Back of 14" colour monitor
showing socket for mains supply

The control unit requires two adjustments (referred to as I and II), the colour monitor one adjustment (referred to as III) to be made.

Detail of control unit



Voltage selector

Fig. 6.-3 Switching from 220V to 110V mains supply

Adjustment I for 110 V mains supply - control unit

For a 110V mains supply, the indication 110 on the voltage selector is placed on the mark.

The voltage selector is accessible after removing the power supply module from the control unit (position 11). See also figure 6.-4.

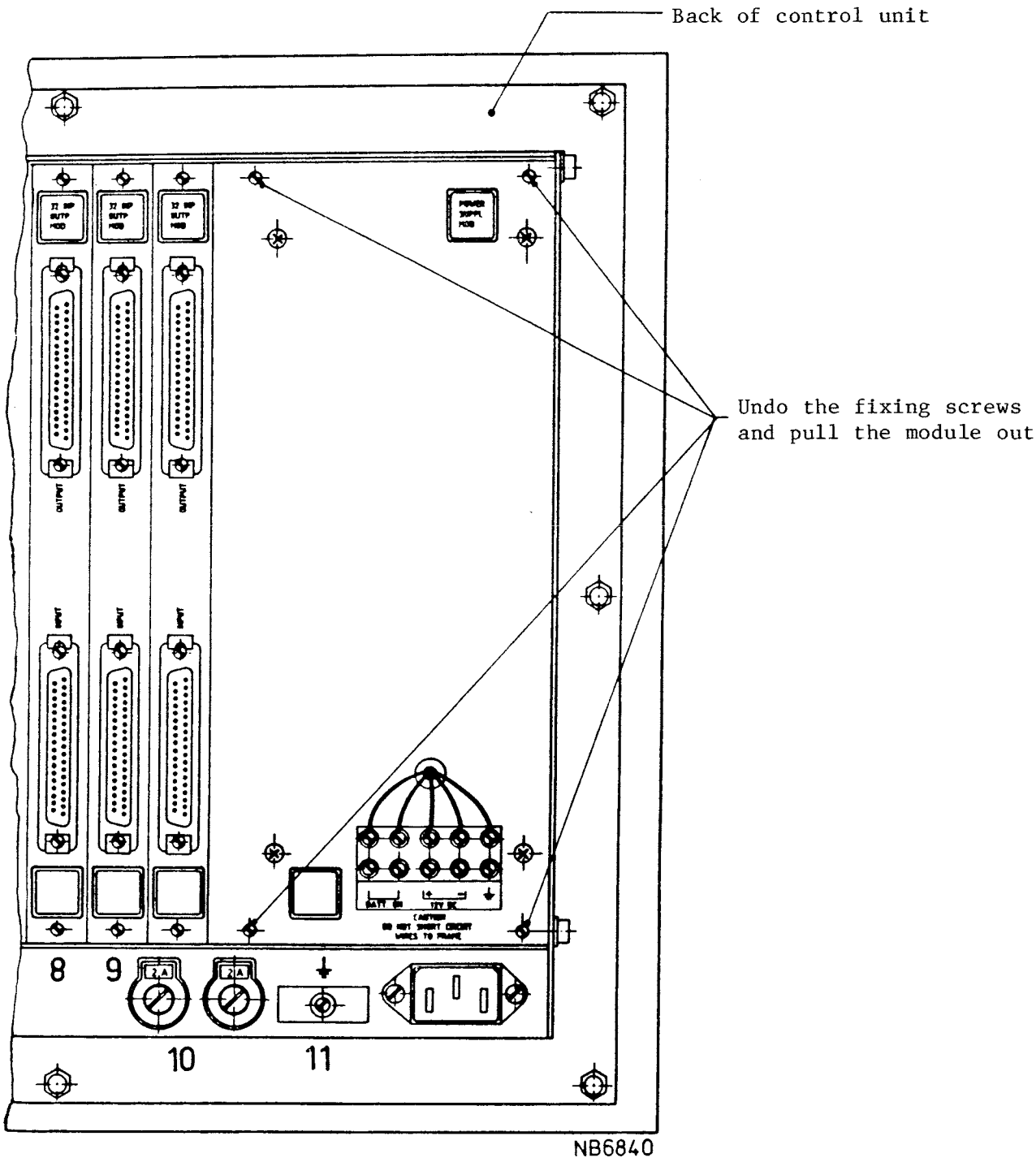


Fig. 6.-4 Detail of back of control unit showing power supply module (position 11) and fixing screws

Solder a wire link (1.5 mm^2) on the pc board of the power supply module as indicated in the figure below.

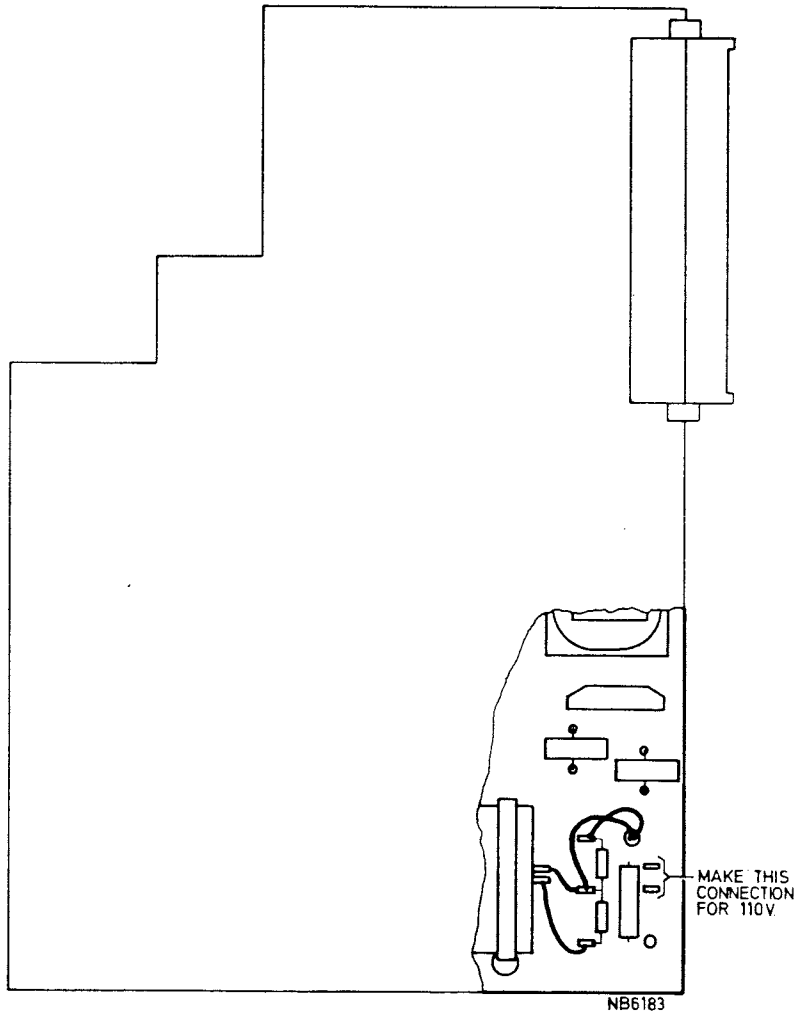


Fig. 6.-5 Detail of pc board in power supply module

After soldering the wire link, the power supply module is fitted again.

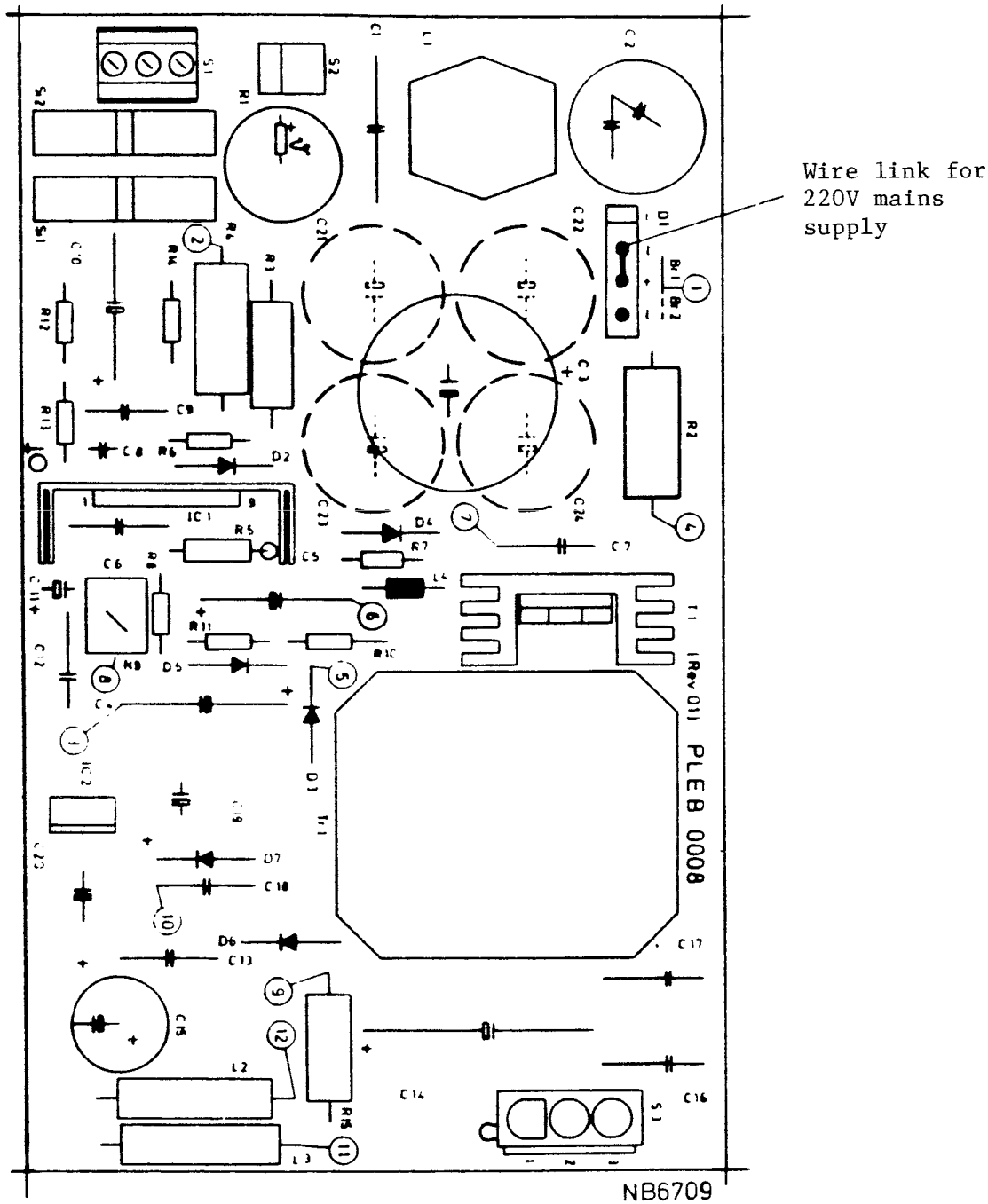


Fig. 6.-6 Power supply pc board in 14" colour monitor

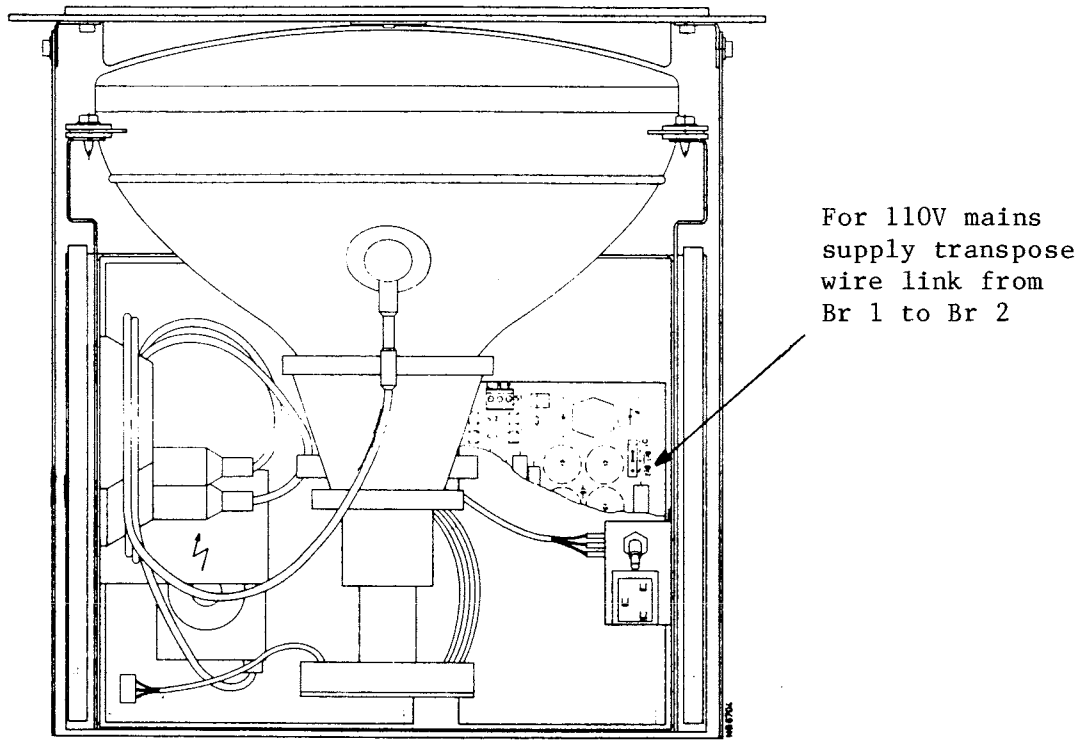


Fig. 6.-7 Top view of 14" colour monitor

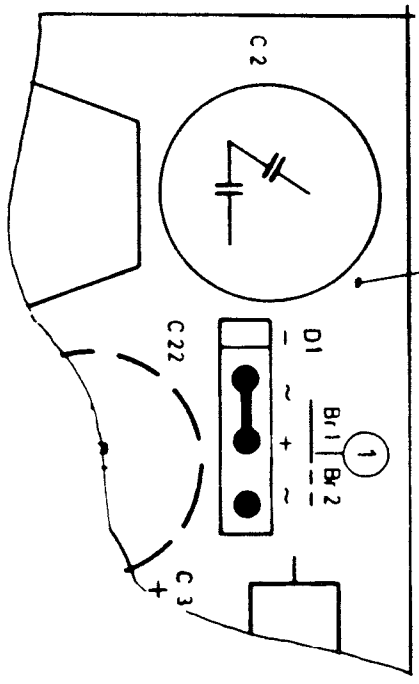


Fig. 6.-8
Wire link for 220V mains supply

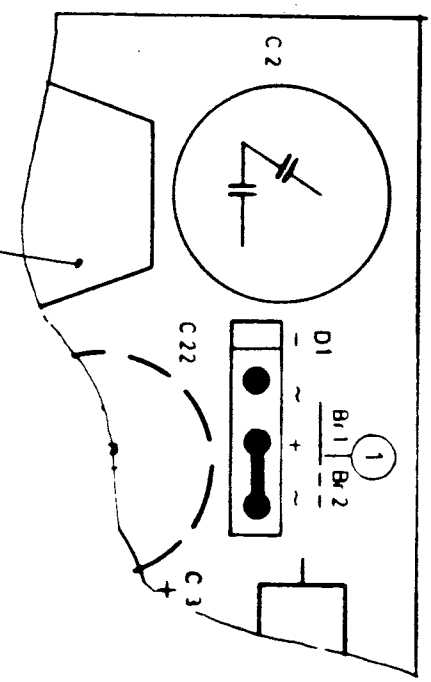


Fig. 6.-9
Wire link for 110V mains supply

Details of
pc board

NB6841

Option 1

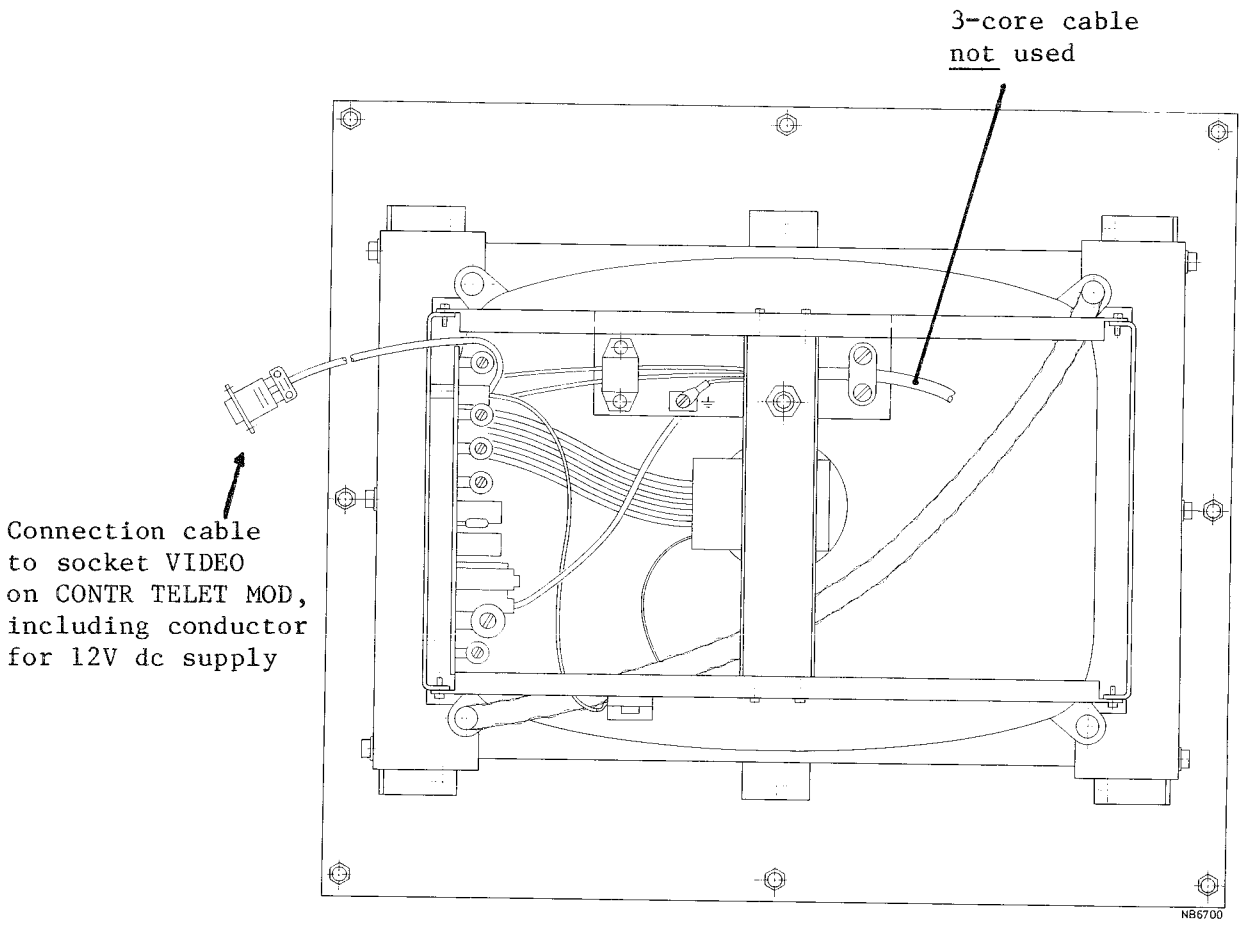


Fig. 7.-1 Rear view of 12" monochrome monior FIMI 12GP

The 12V dc supply for the monochrome monitor is fed via the normal connection cable with 9-way plug to the control unit.

This option is used when the monochrome monitor is located within 1 meter from the control unit.

Option 2

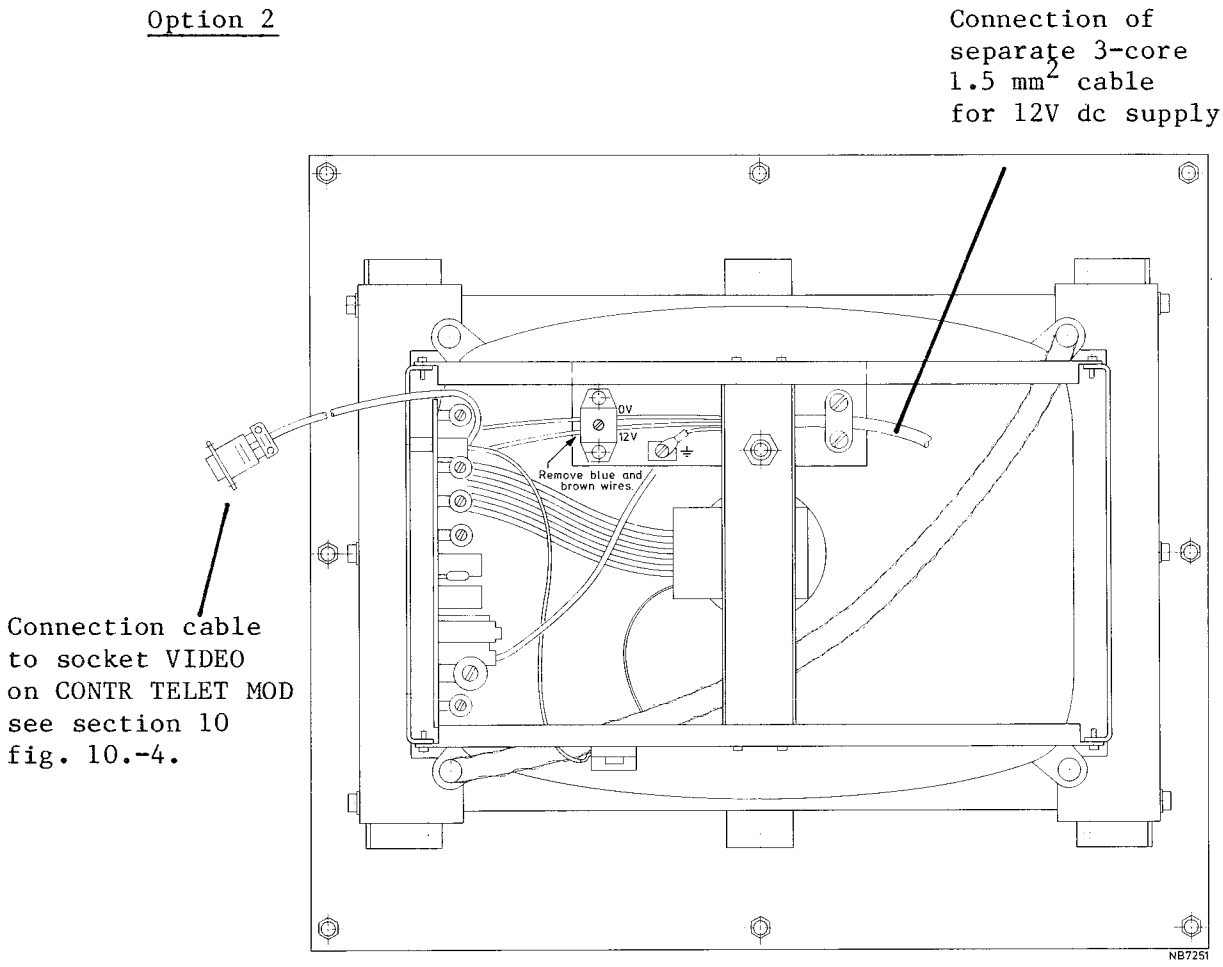


Fig. 7.-2 Rear view of 12" monochrome monitor FIMI 12GP

The 12V dc supply for the monochrome monitor is fed via a separate shielded 3-core cable (2.5 mm²) of suitable length (max. 10 m) to the connection terminal at the rear of the power supply unit, see fig. 7.-3.
This option is used when the monochrome monitor is located at a distance from 1 to 10 meters from the control unit.

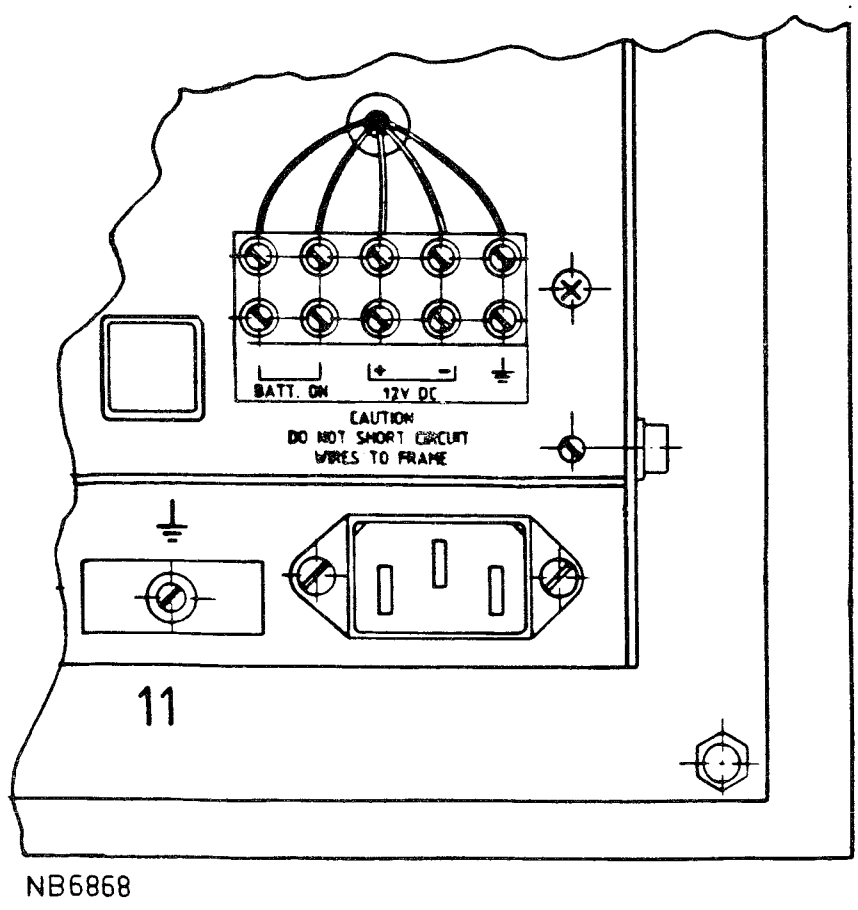


Fig. 7.-3. Connection of the 12V power supply for monochrome monitor.

BACK UP POWER SUPPLY

The control unit is equipped with a back up power supply (in the form of a battery) as a standard provision. It prevents programs from getting lost during power-off for a duration of 1000 hours at most. The battery is charged from the power supply module.

Switching from mains supply operation to back up supply operation is effected automatically via the power supply module.

Detailed information on the back up power supply is given on the following pages.

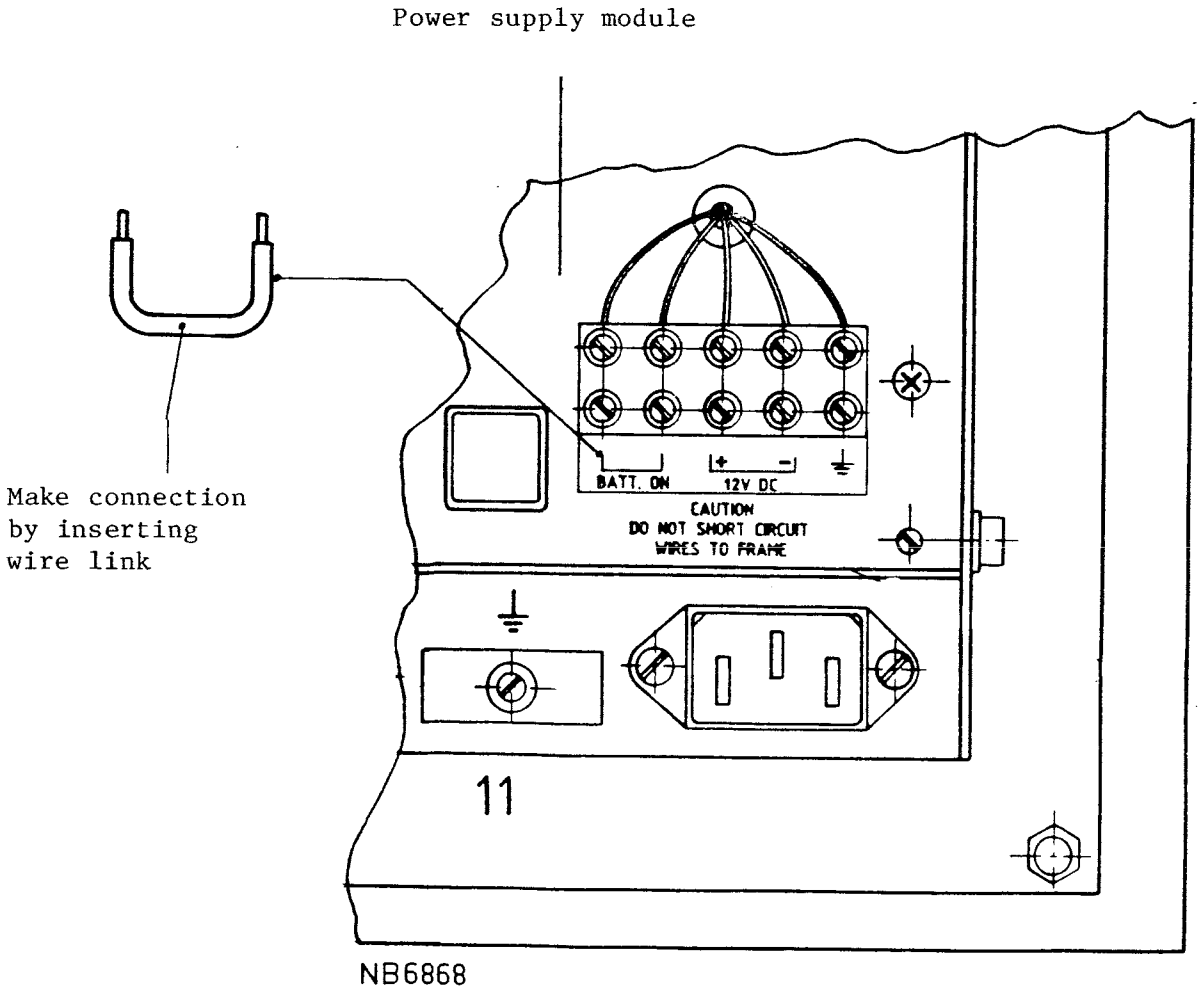


Fig. 8.-1 Detail of back of control unit

Putting the back up power supply into use

The back up power supply is put into use by making the wire link called "BATT. ON" on the power supply module, as illustrated in the above figure.

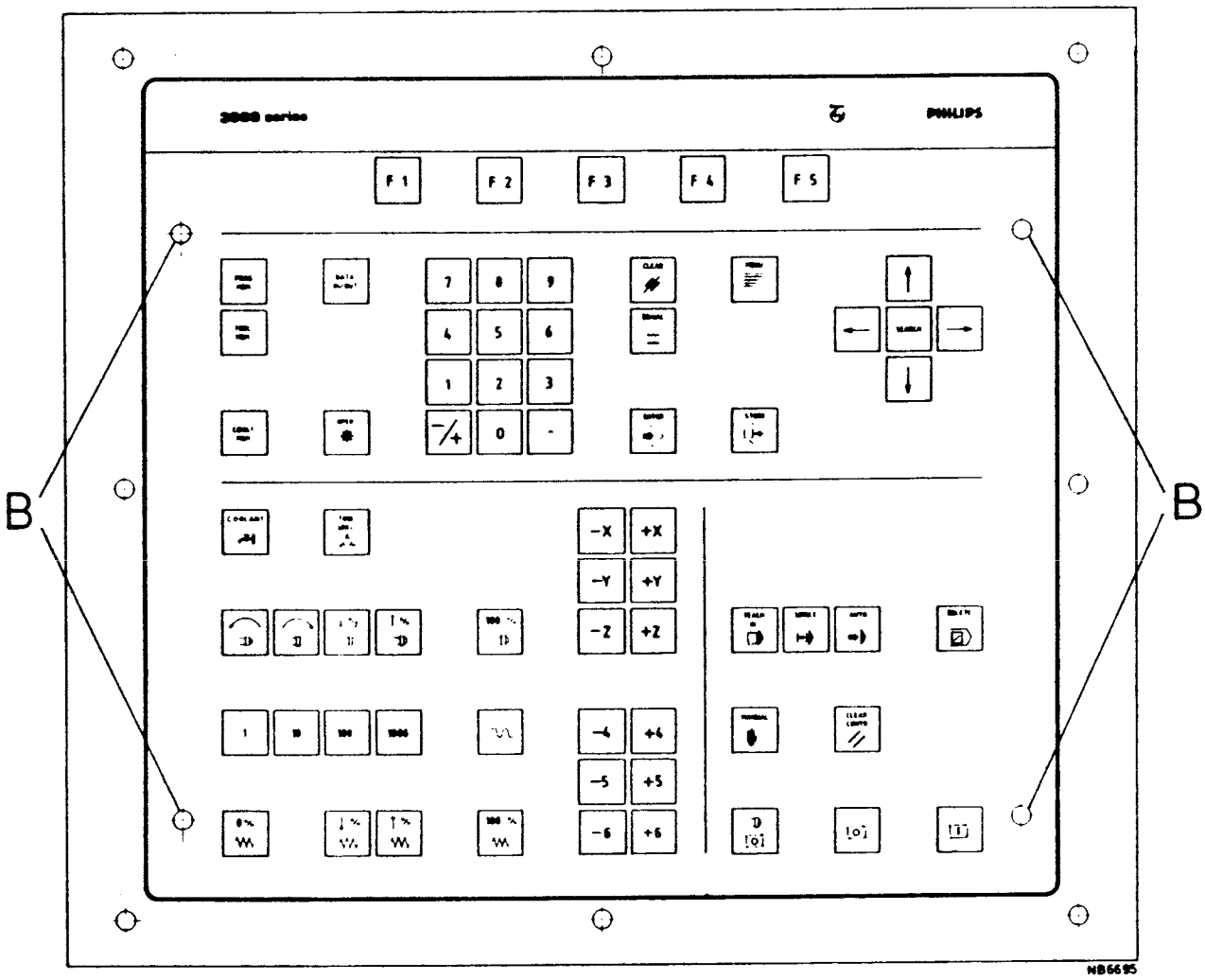


Fig. 8.-2 Front view of the control unit showing the control panel

Removing the control panel

Undo the fixing screws marked B.
Remove the plug at the back and take the control panel out.

Figure 8.-3 shows the front of the CNC without control panel

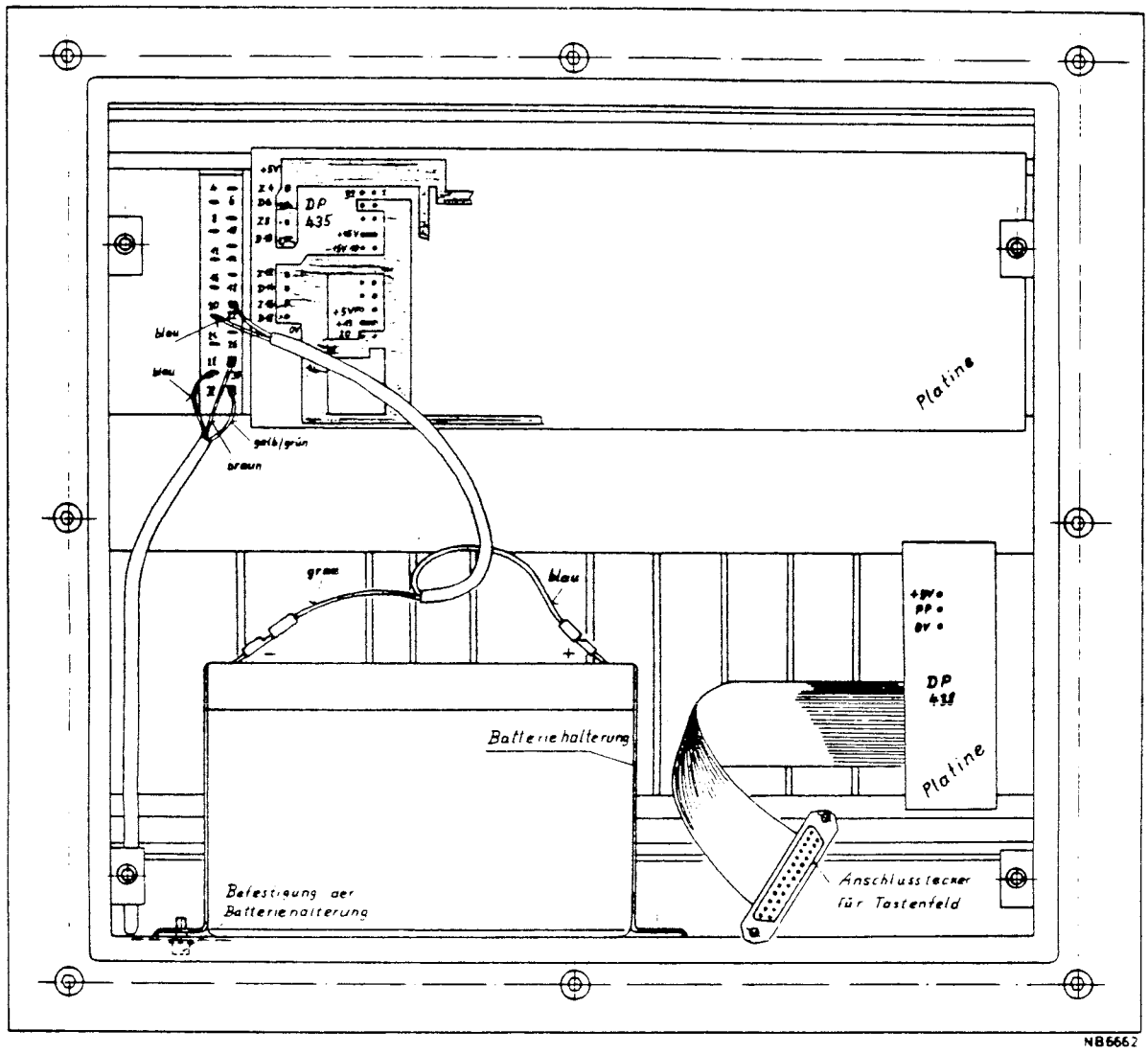


Fig. 8.-3 Front of CNC without control panel

Exchanging the battery

Undo the 4 hexagonal head screws used for fixing the battery holder to the bottom of the control unit and remove the holder.

Pull the grey and blue wires from the battery, take the battery out and put a new one in. Connect the wires again, making sure that the grey wire is connected to the -pole and the blue one to the +pole. Mount the battery holder again.

Mount the control panel again, plugging in the connector at the back and securing the board to the control unit with the same screws.

Precautions when using lead accumulators with gastight cells

Gastight cells should never be exposed to fire or opened by force. They may explode or release toxic material.

Do not short-circuit the cells; they may be overheated.

Gastight cells should not be permanently connected to the circuitry.

Though the cells are provided with safety valves to avoid explosion, the reliablity of the valves can be unpredictably affected when exposed to fire.

The cells contain Potassium Hydroxide (KOH) as an electrolyte.

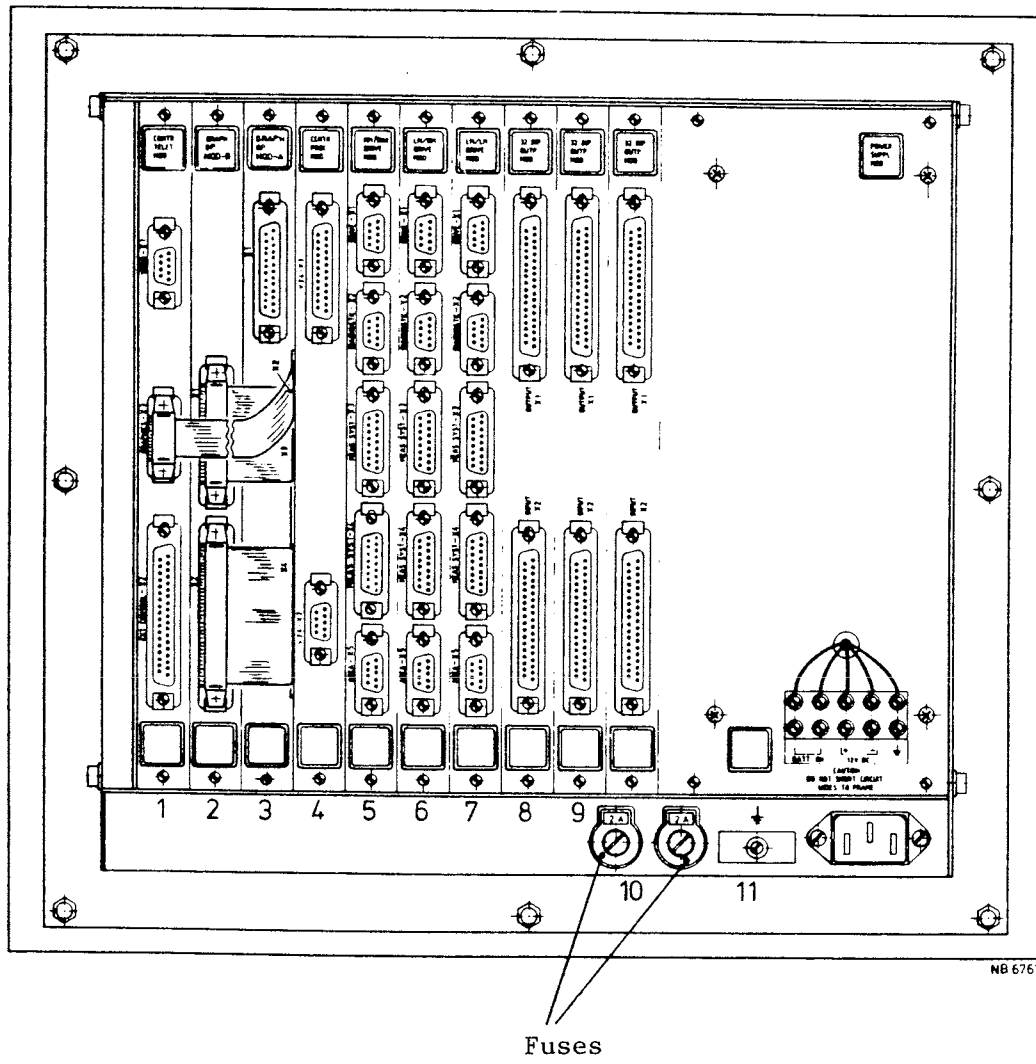


Fig. 9.-1 Rear view of control unit of CNC 3460

The control unit of the CNC 3460 is protected by means of two slow-acting fuses rating 250V/2A.
In case of power failure they need to be checked and, if necessary, replaced.

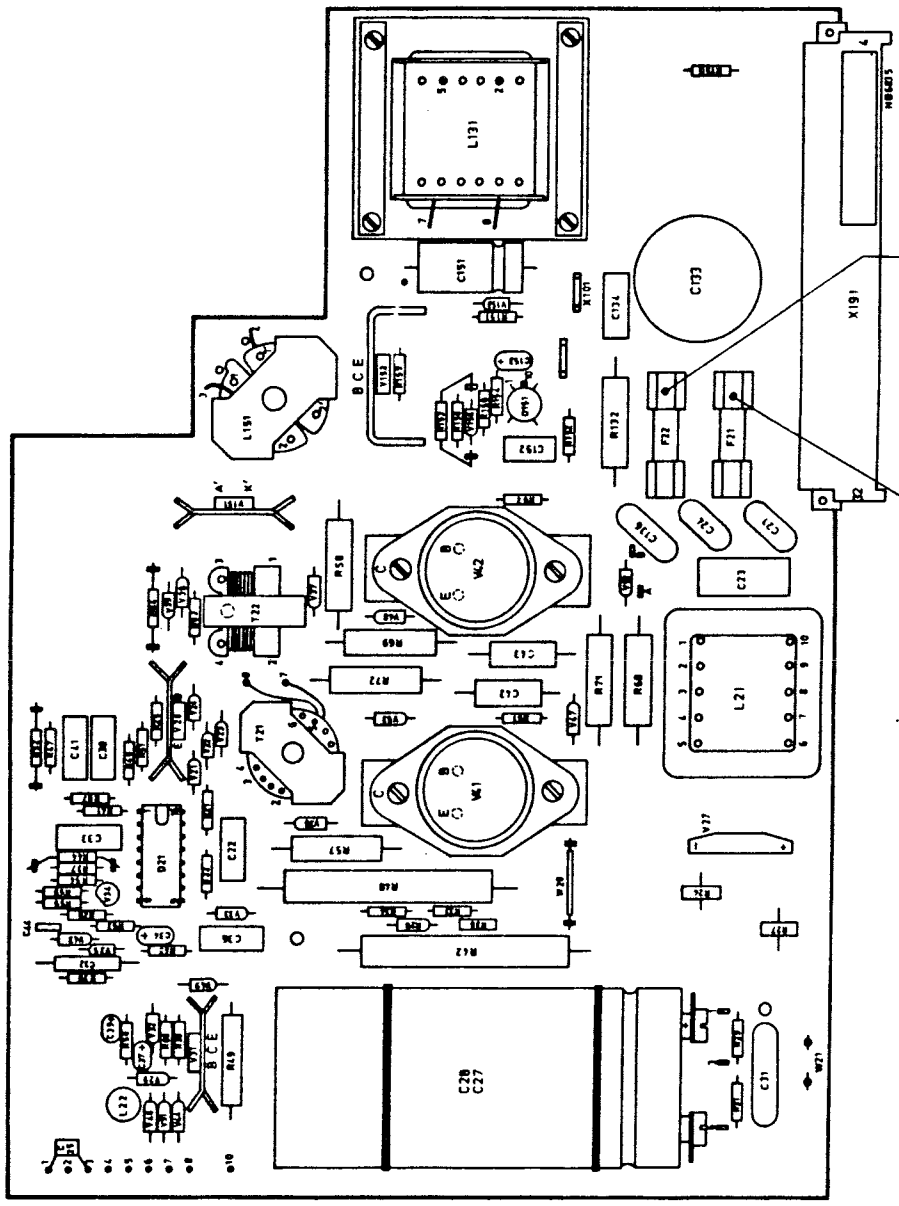


Fig. 9.-2 PC board of power supply module showing the fuses

In case of supply failure the fuses need to be checked and, if necessary, replaced. The power supply module is located at the right back of the control unit.

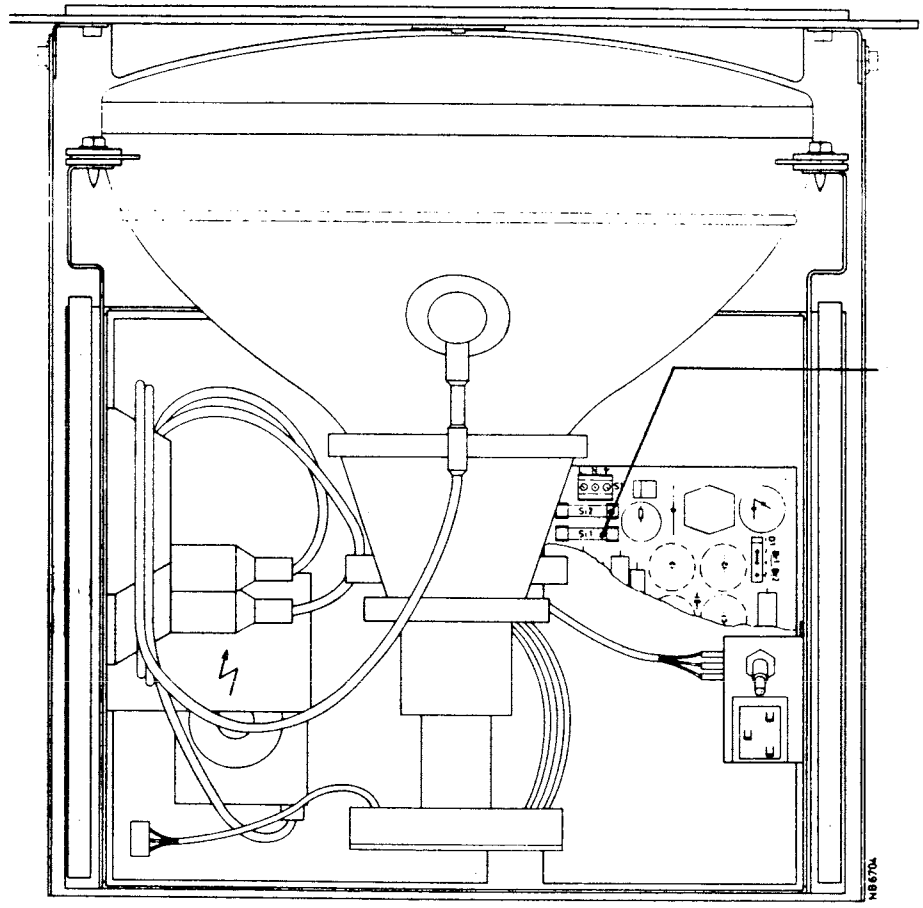
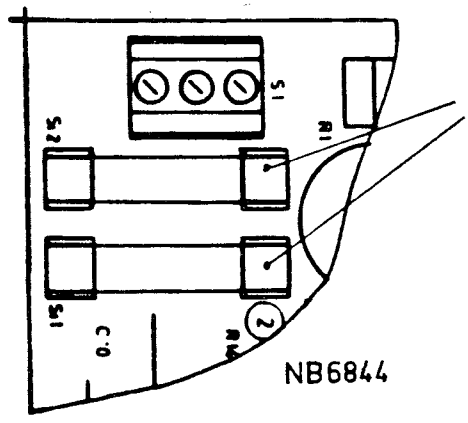


Fig. 9.-3 Top view of 14" colour monitor



Fuse 1.6A slow acting

In case of supply failure check and, if necessary, replace the fuses

Fig. 9.-4 Detail of colour monitor supply board

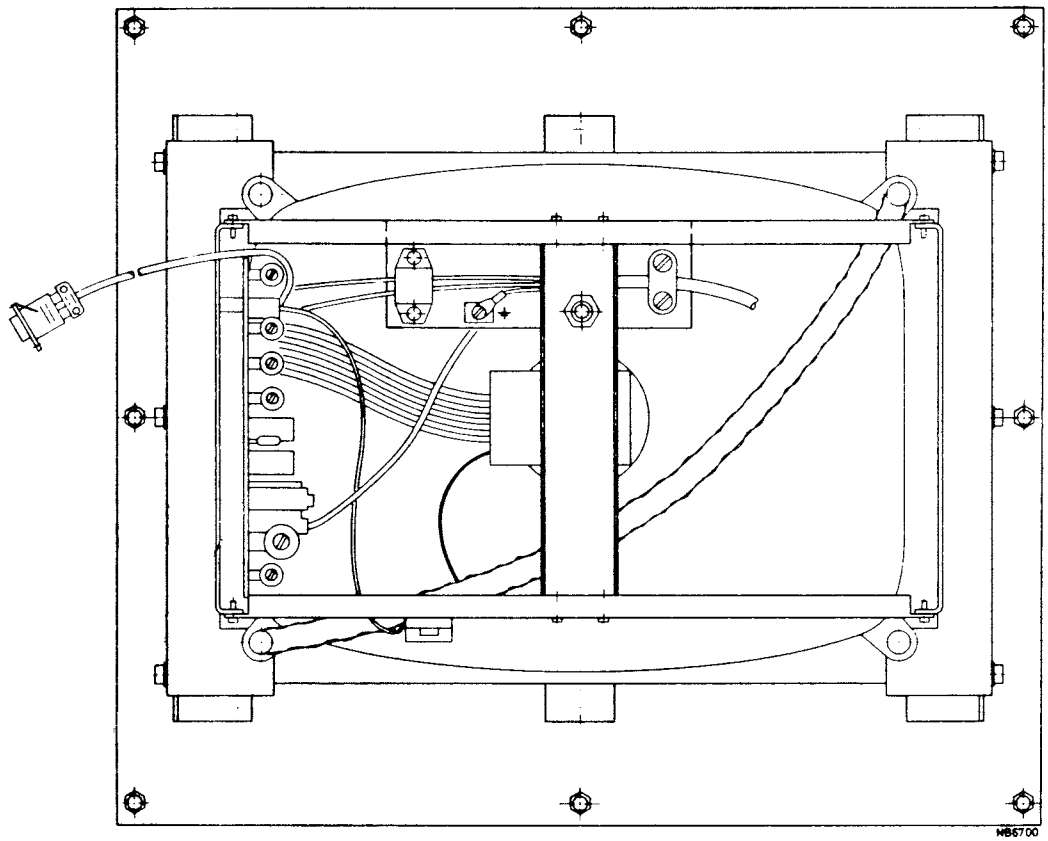


Fig. 9.-5 Rear view of 12" monochrome monitor FIMI 12GP

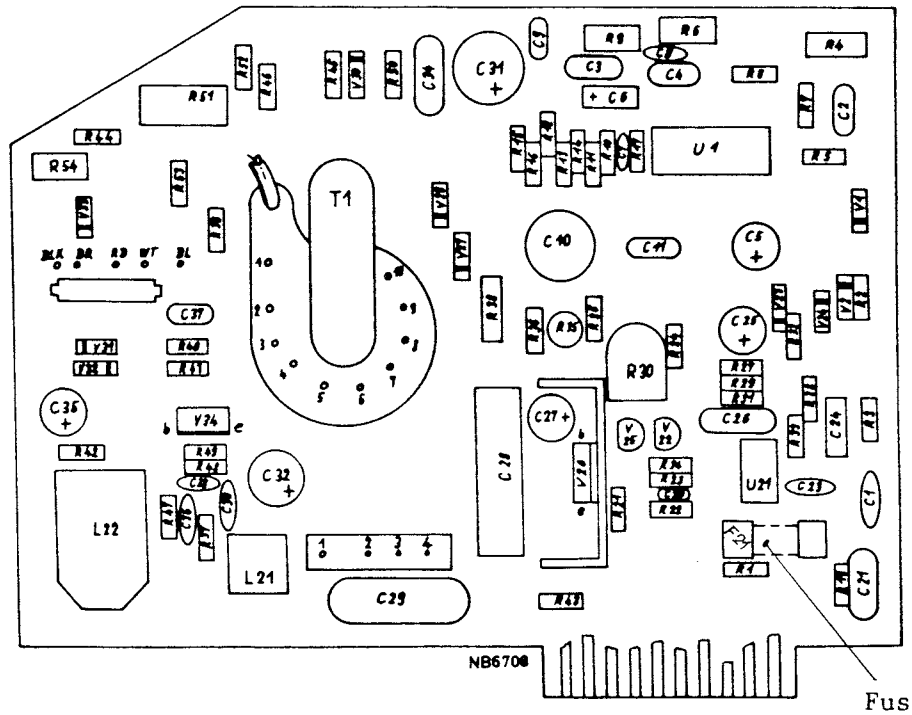
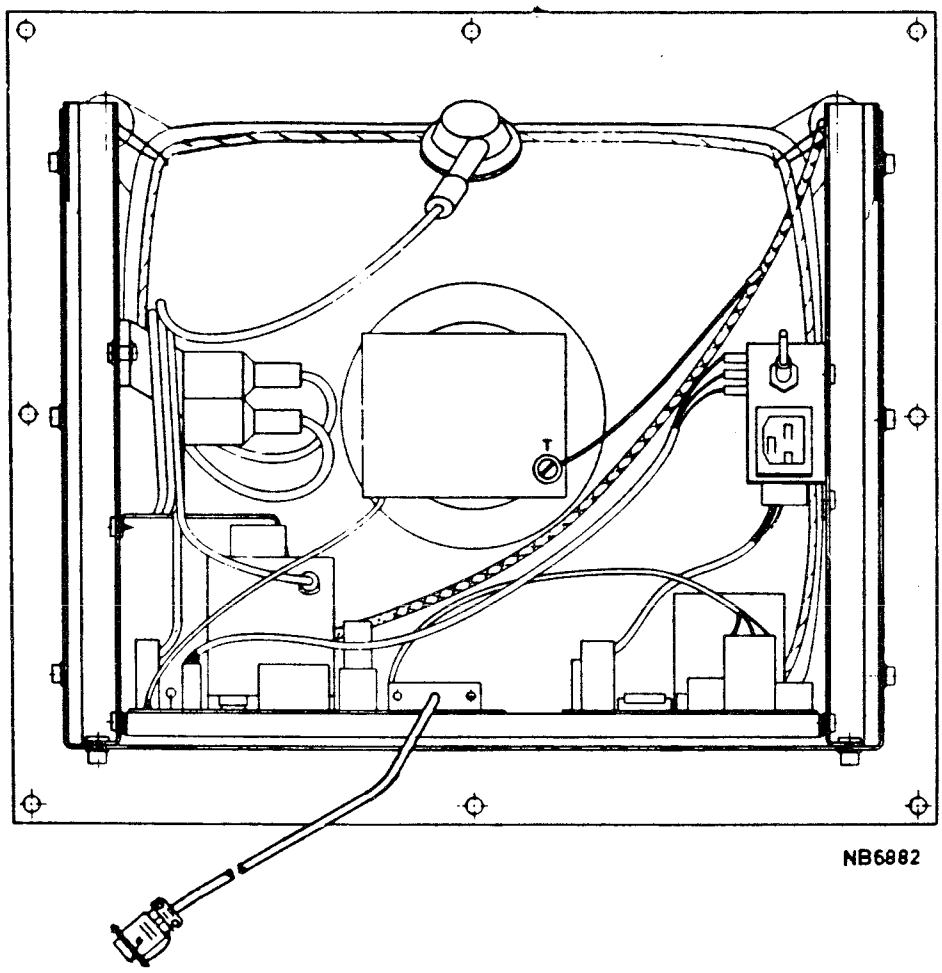


Fig. 9.-6 Monochrome monitor pc board showing the fuse

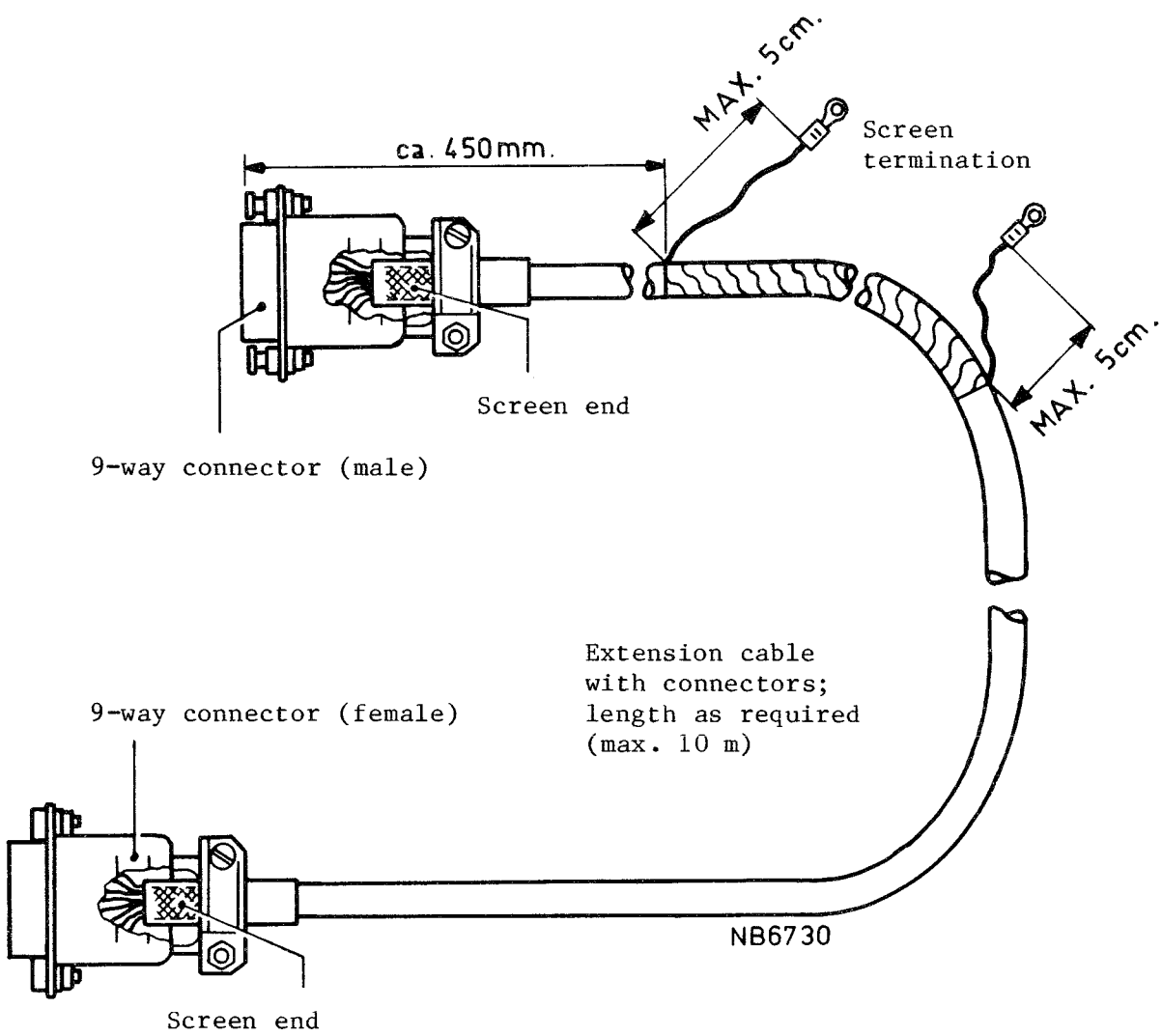
Fuse 1.25A slow acting

In case of supply failure the fuse needs to be checked and, if necessary, replaced.



To be connected - via extension cable - to socket VIDEO on pc board CONTR TELET MOD of control unit.

Fig. 10.-1 Rear view of 14" colour monitor with connection cable

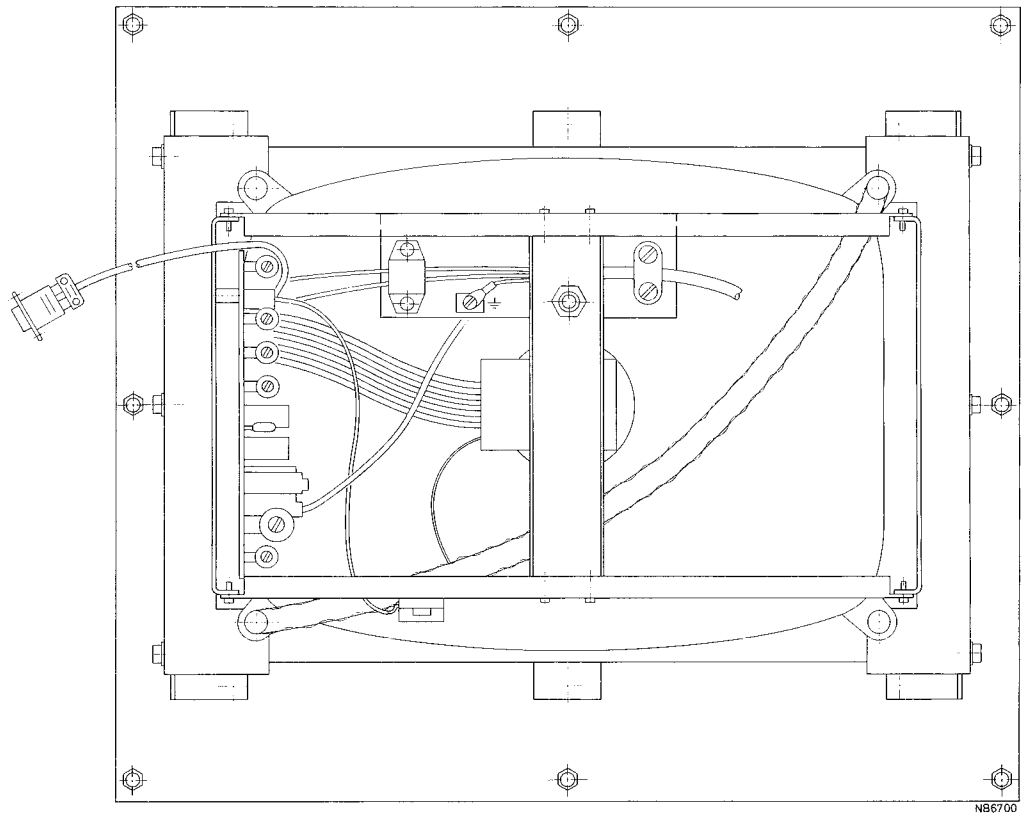


Application :

Connecting colour monitor
to socket VIDEO on
CONTR TELET MOD.
Max. permissible cable
length 10 m.

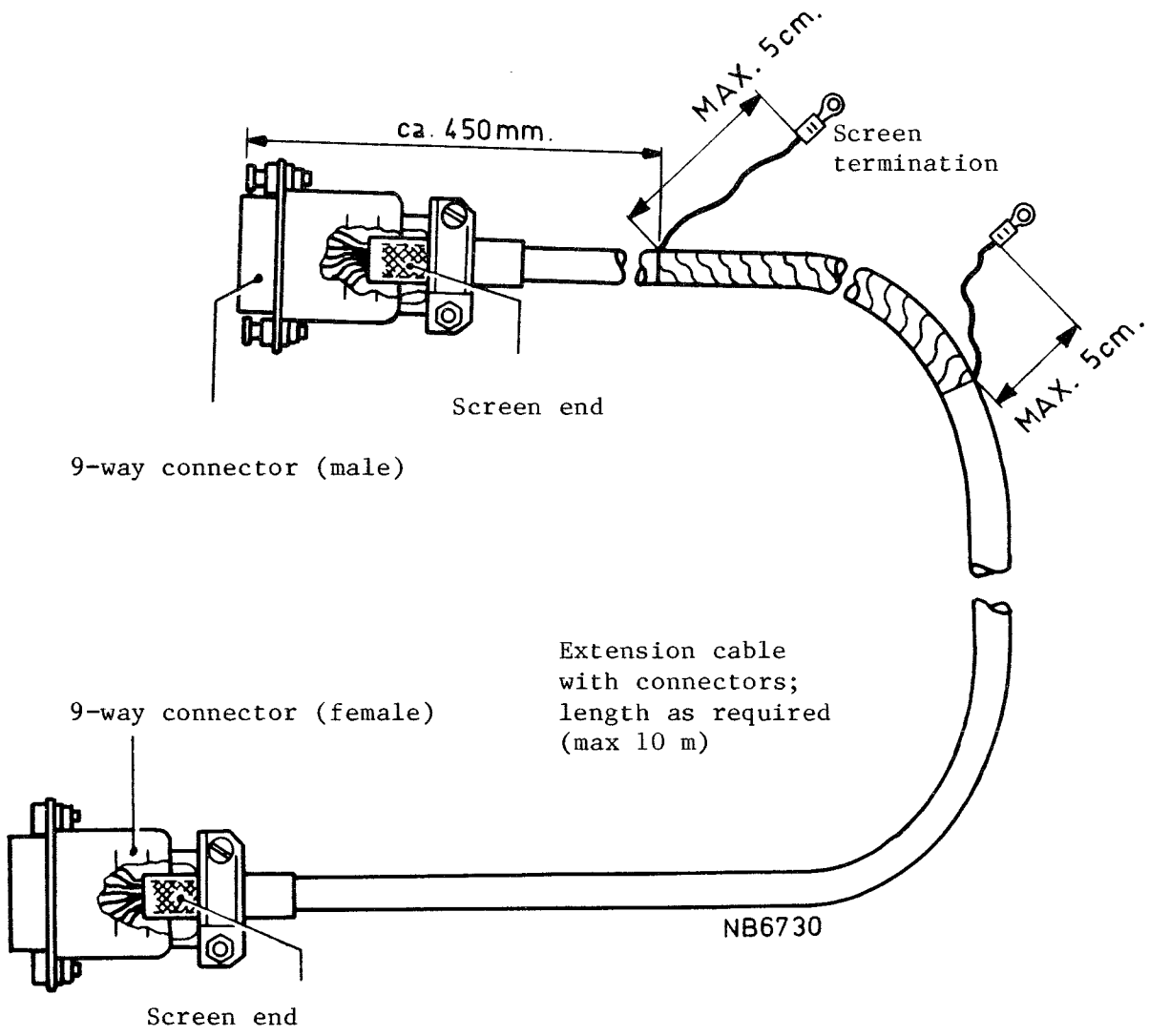
Note :
5 conductors are soldered to both pins nr. 1 (see figure).
To this end, the 5 wires are stripped over 1 cm, the cores twisted together and soldered to the pins. The cable to be used is a 5 x 2-core computer cable, Philips ordering number 0712 220 04052.

Fig. 10.-2 Extension cable for 14" colour monitor.
Connection diagram.



To be connected - via extension cable - to socket VIDEO on pc board CONTR TELET MOD of control unit.

Fig. 10.-3 Rear view of 12" monochrome monitor FIMI 12GP with connection cable



Application :

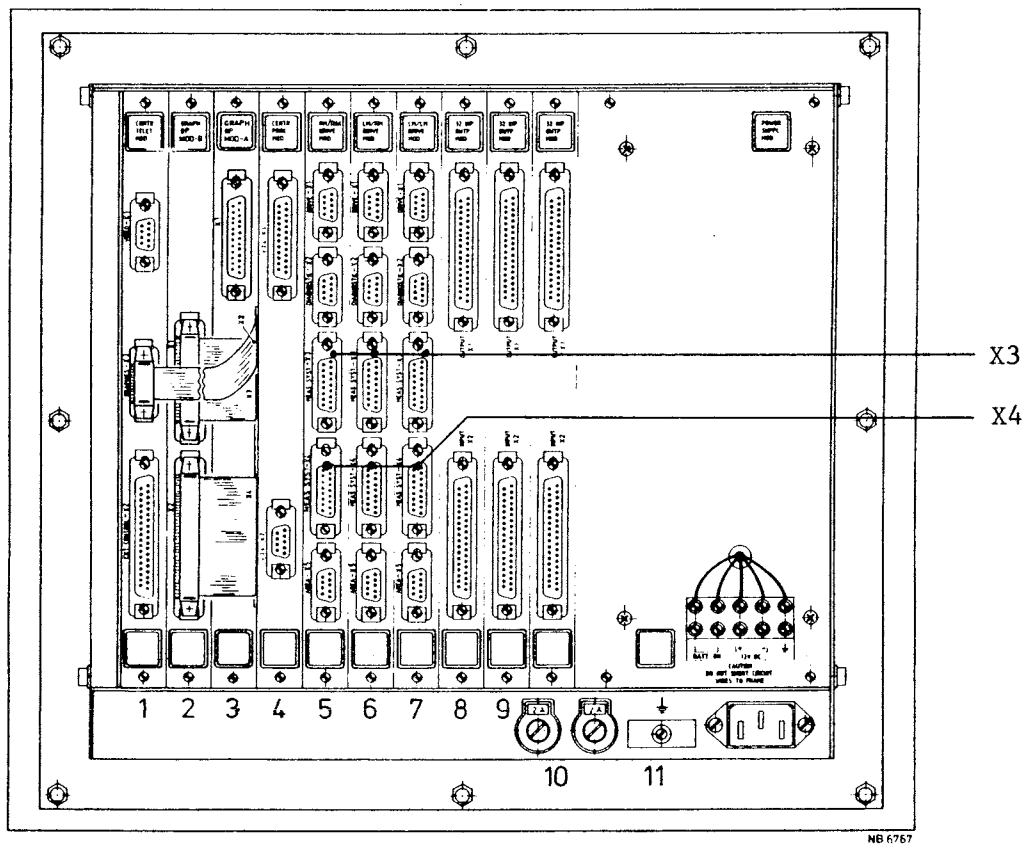
Connecting monochrome
monitor to socket VIDEO
on CONTR TELET MOD.
Max permissible cable
length 10 m.

Note :
3 conductors are to be soldered to both pins nr. 1 (see figure).
To this end, the 3 wires are stripped over 1 cm, the cores twisted together and soldered to the pins. The cable to be used is a 5 x 2-core computer cable, Philips ordering number 0712 220 04052.

Fig. 10.-4 Extension cable for monochrome monitor 12" FIMI 12GP. Connection diagram.

The CNC 3460 allows two types of measuring systems to be connected, viz. an incremental rotary measuring system meeting the specification given in section 11 and/or the Philips PE 2480 linear measuring system.

The type of measuring system to be employed in the different axes depends on the machine tool requirements.
For the integration of a rotary measuring system into the machine tool and for the wiring of the connector on the transducer side refer to the relevant manufacturer´s documentation.
Instructions on integration and wiring of the Philips PE 2480 measuring system can be found in the relevant installation manual, provided with the NC system
The measuring systems are connected to the sockets labelled MEAS SYST on the pc boards designated LM/LM DRIVE MOD, LM/RM DRIVE MOD, RM/RM DRIVE MOD and RM DRIVE MOD in the control unit; see figure 11.-1 below.



RM/RM DRIVE MOD
X3 = Rotary measuring system
X4 = Rotary measuring system

LM/LM DRIVE MOD
X3 = Philips lin. measuring system
X4 = Philips lin. measuring system

LM/RM DRIVE MOD
X3 = Philips lin. measuring system
X4 = Rotary measuring system

RM DRIVE MOD
X3 = Rotary measuring system

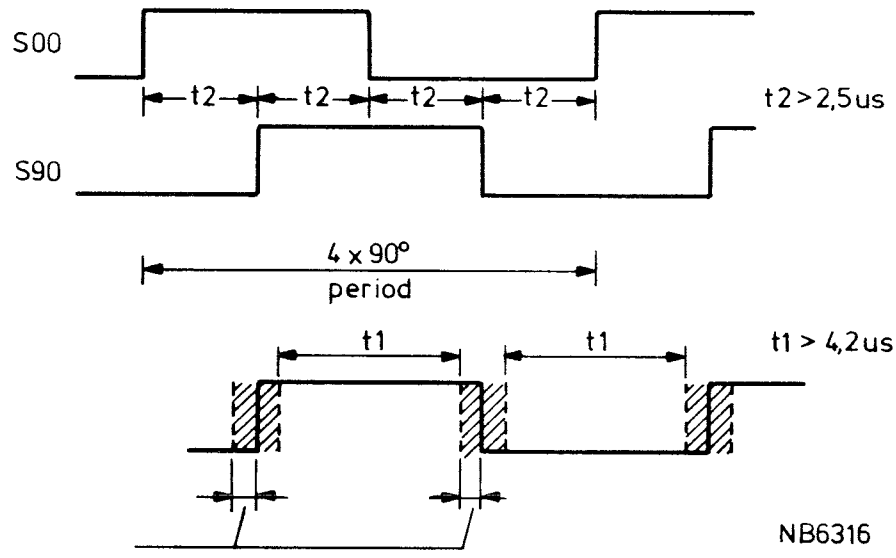
Fig. 11.-1 Measuring system connections

The inputs for the rotary transducer on the measuring system boards in the control unit are suited for S00/S90 signals. A separate input is provided for a positive or negative going marker signal.
The rotary transducers can be supplied from the control unit´s power supply. Both +5V and +12V are available.

Input signal characteristics:

Voltage	Logic "1"	Logic "0"	I sink
+12V	+12V min. +9V	0V max. +3V	16mA
+ 5V	+ 5V min. +3.5V	0V max. +1.5V	16mA

Maximum frequency of S00/S90 signals : 100 kHz

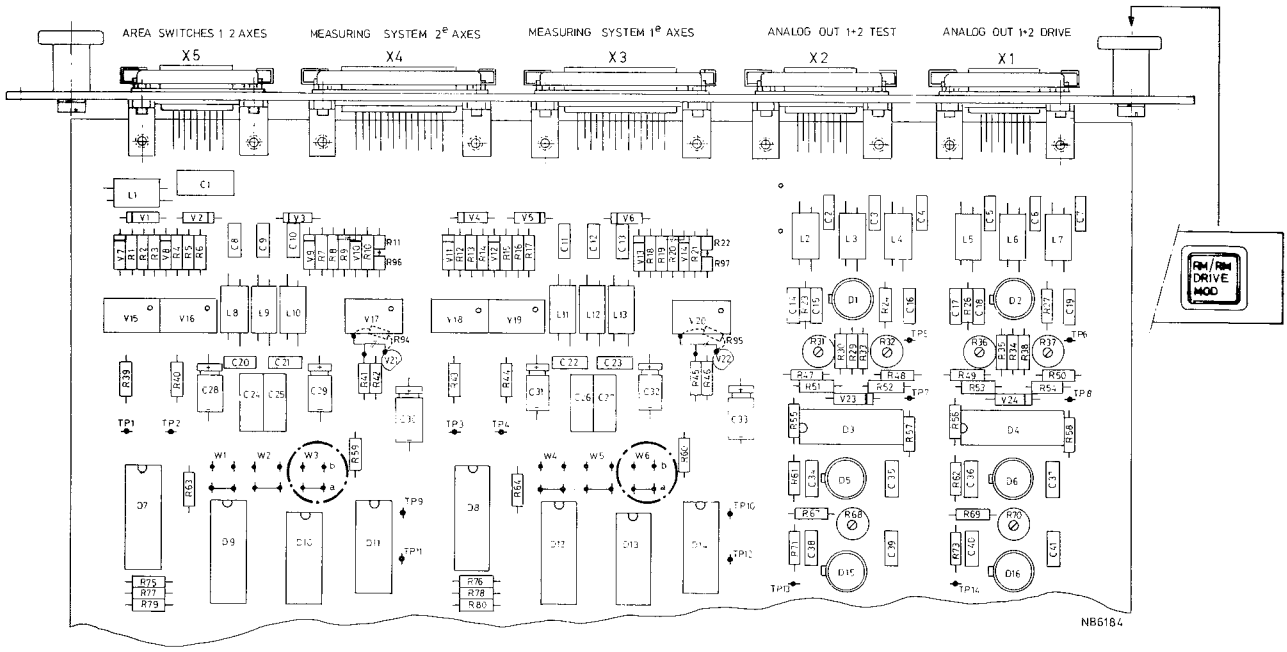


Maximum jitter on signal edges : $\pm$ 15°

Fig. 11.-2 Wave form of S00/S90 signals

Marker pulse

The marker pulse should be a positive or negative going pulse having a minimum duration of 100 us. On delivery, the relevant input is set for a positive going pulse. Negative going pulses require the pc board concerned to be removed from the control unit and set accordingly.
The setting consists in transposing the wire link from position "a" to position "b", as detailed in figure 11.-3.
Before extracting a pc board from or inserting it into the control unit always be sure that the latter is disconnected from the mains supply.



PC board	No. of axis	Jumper connection
LM/LM DRIVE MOD	2 or 4 or 6	W3
RM/RM DRIVE MOD	1 or 3 or 5	W6
RM/RM DRIVE MOD	2 or 4 or 6	W3
RM DRIVE MOD	3 or 5	W6

Fig. 11.-3 Changing the input polarity of the marker pulse

Supplying the rotary transducer

The rotary transducer can be supplied from the control unit´s power supply. Following supply voltages are available:

+12V, max. load per axis 300mA
+ 5V, max. load per axis 300mA

Resolution of the rotary transducer

The resolution is given by the formula:

$$\frac{A \times B}{C}$$

where

A = number of S00/S90 pulses per revolution of the transducer; refer to manufacturer´s specification

B = multiplication factor (1, 2 or 4); to be assigned to machine constants 203/253/303/353/403/453

C = transmission: the displacement of the machine slide in microns per revolution of the transducer (machine tool specification)

In case a rotary table is employed, the revolutions are measured in 0.001^{o}.
Consequently, the rotary transducer used should produce at least 90,000 S00/S90-pulses per revolution. This requires a multiplication factor of 4, for which the value 2 is assigned to the relevant machine constant (usually MC353 or MC303).

Connection cable from the rotary transducer

Wiring instructions for the connection cable and the associated plug are given in section 5 and figure 11.-4.

Connection diagram for 15-way plug to be connected to socket MEAS SYST on pc board LM/RM MOD, RM MOD or RM/RM MOD.

15-way plug

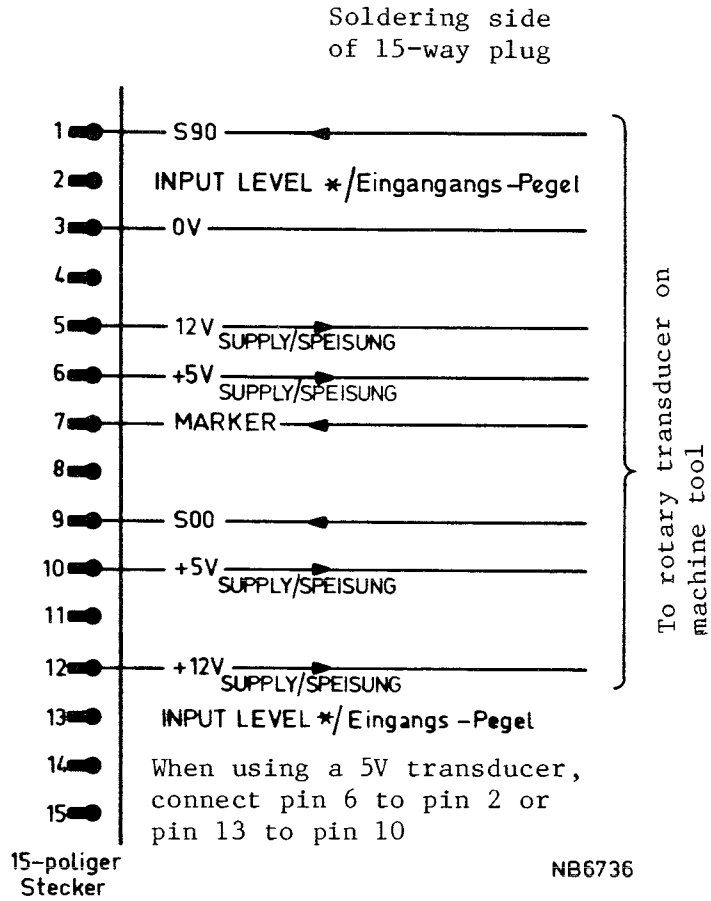


Fig. 11.-4 Wiring of 15-way plug on cable from rotary transducer

For linear measurements, the CNC 3460 requires the Philips PE 2480 linear transducer to be employed.
Wiring instructions for the connection cable and the associated plug are given in section 5 and figure 11.-5.
The 15-way connector is provided with the control system, the 5-way connector with the transducer.

Connection cable from the linear transducer

Connection diagram for
15-way plug to be
connected to socket
MEAS SYST on pc board
LM/LM MOD or LM/RM MOD.

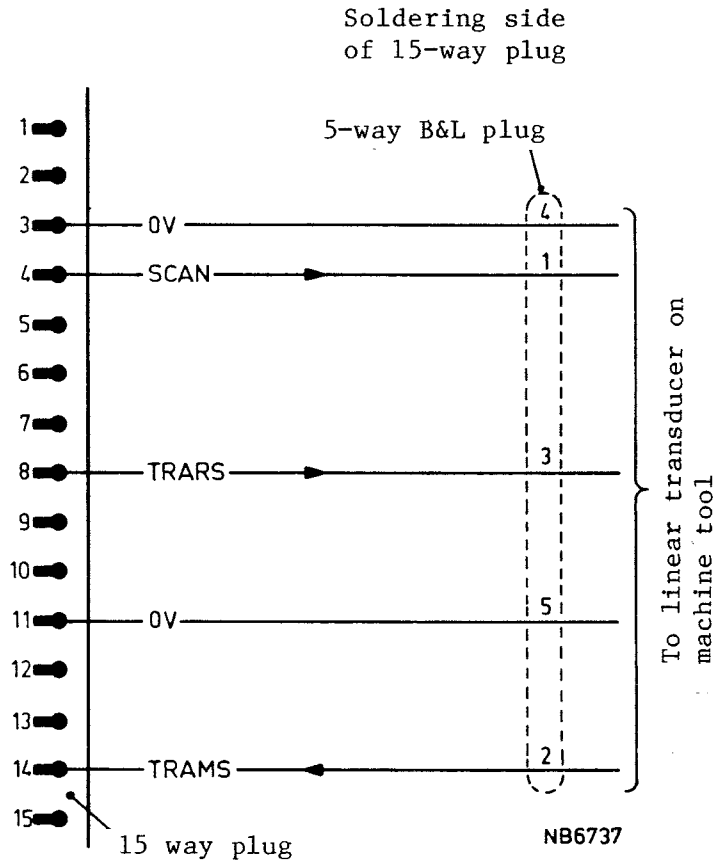


Fig. 11.-5 Wiring of 15-way plug on cable from linear transducer

General information

The NC system allows the machine reference point to be automatically searched for, provided this point has been constructionally defined. The search procedure is described in the installation manual for the linear transducer PE 2480, provided with this apparatus.
When employing a rotary transducer, this information may be helpful in understanding the principles of transducer and area switch alignment for automatic reference point search.

The machine tool has to be equipped with cams at the end of the slides. The cam should overlap the emergency limit switch.
The minimum spacing between the front end of the cam and the limit switch amounts to 32 mm. The cam causes a micro switch, referred to as area switch, to be actuated. At the start of the reference point search a displacement along the axis towards the cam at "search velocity" (RPF feed) is performed (defined by machine constants 231, 281, 331, 381, 431 and 481). When the the cam opens the micro switch, the direction of displacement is reversed. Now, a movement in the opposite direction takes place at "creep speed" (defined by machine constants 232, 282, 332, 382, 432 , 482 - RPF creep speed), until the switch closes again.

When the switch closes again, the control system starts processing the first marker pulse in order to reset the axis or preset it to a given position, defined by machine constants 233, 283, 333, 383, 433 and 483 (RPF zero offset).
The positions of the software limit switches in the axis concerned are now established. Note that the software limit switches are effective only if the reference points in all axes have been established.

When jogging operations are performed before the positions of the software limit switches are established, the cams and the micro switches operate as safeguarding devices and will stop any movements in the axis, so that the emergency switches will not be actuated. For that reason it is recommended that a cam be fitted at the other end of the machine slide as a precaution.

The Philips linear measuring system generates a marker pulse at a fixed position within every 635 um pitch; refer to the installation manual for the PE 2480 transducer.
When a rotary transducer is employed, a marker pulse is generated at a fixed position once per revolution.

Area switch characteristics:

When the area swich is closed (not actuated), the current drawn is 16 mA.

The maximum length of the connection cable (0.34 mm^2) is 100 m.

Axis related machine constants:

1. RPF direction (direction in which reference point search starts)

MC 230	axis 1	+1 or -1 direction, forward or backward
MC 280	axis 2	
MC 330	axis 3	
MC 380	axis 4	
MC 430	axis 5	
MC 480	axis 6	

2. RPF feed during reference point search

MC 231	axis 1	max. 32 m/min, in increments of 0.1 mm/min
MC 281	axis 2	min. value 0.1 mm/min
MC 331	axis 3	
MC 381	axis 4	
MC 431	axis 5	
MC 481	axis 6	

3. RPF creep speed during marker pulse search

MC 232	axis 1	max. 10 m/min, in increments of 0.1 mm/min
MC 282	axis 2	min. value 0.1 mm/min
MC 332	axis 3	
MC 382	axis 4	
MC 432	axis 5	
MC 482	axis 6	

4. RPF zero offset, preset value of reference point relative to machine datum point

MC 233	axis 1	offset value in increments
MC 283	axis 2	
MC 333	axis 3	
MC 383	axis 4	
MC 433	axis 5	
MC 483	axis 6	

5. Positions of software limit switches

MC 235	axis 1	the positive distance in increments
MC 236	axis 1	the negative distance in increments
MC 285	axis 2	
MC 286	axis 2	
MC 335	axis 3	
MC 336	axis 3	
MC 385	axis 4	
MC 386	axis 4	
MC 435	axis 5	
MC 436	axis 5	
MC 485	axis 6	
MC 486	axis 6	

Note: All distances are relative to the reference points in the axes.

The area switches are connected to the sockets AREA (X5) on the pc boards LM/LM DRIVE MOD, LM/RM DRIVE MOD, RM/RM DRIVE MOD or RM DRIVE MOD in the control unit; see figure 11.-6.

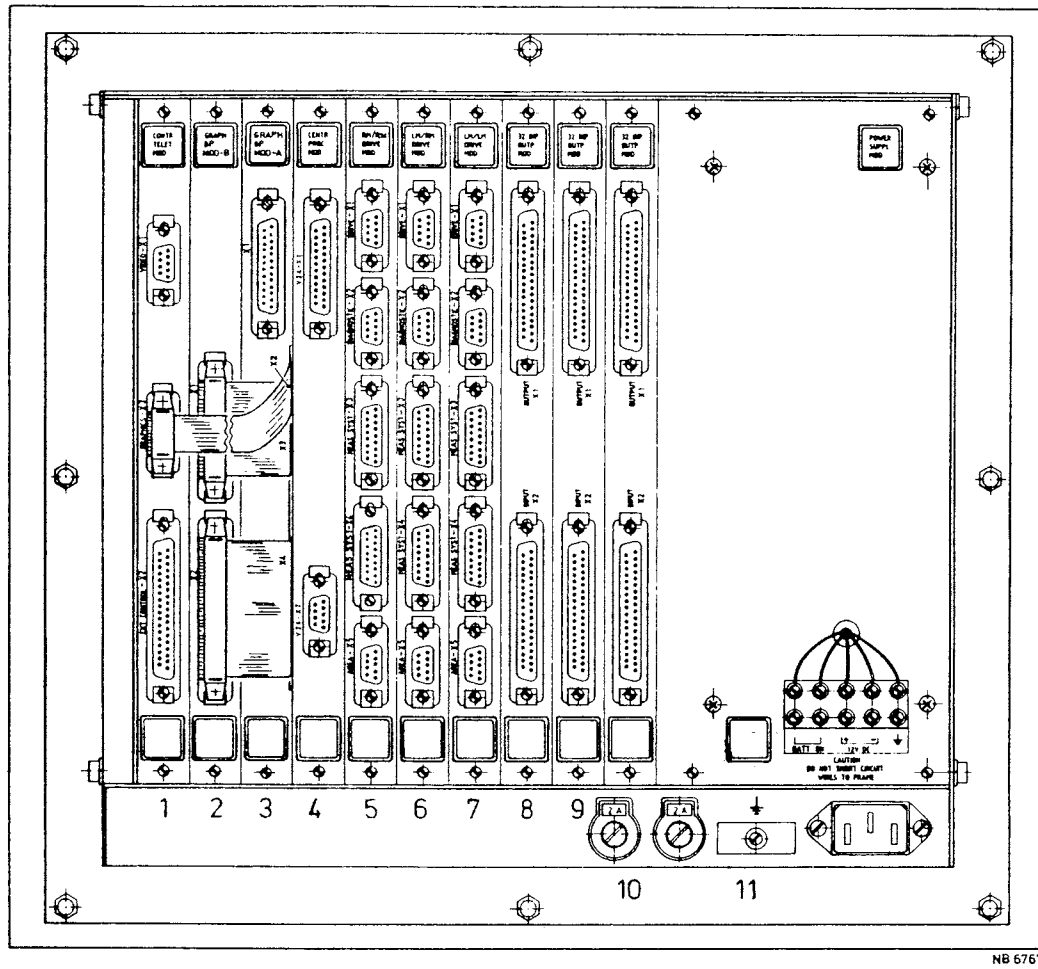


Fig. 11.-6 Connection of the area switches

Connection diagram for 9-way plug to be connected to socket AREA on pc board LM/LM DRIVE MOD, LM/RM DRIVE MOD, RM/RM DRIVE MOD or RM DRIVE MOD.

9-way plug

Soldering side of 9-way plug

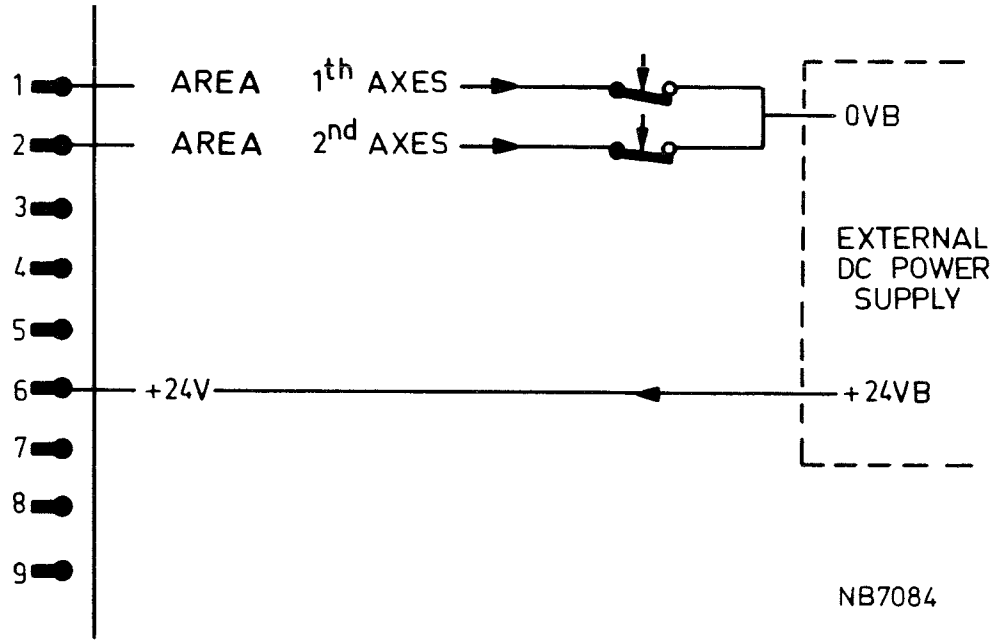


Fig. 11.-7 Wiring of 9-way plug on cable from area switch

ANALOG OUTPUT SIGNALS

SERVO DRIVE AND SPINDLE DRIVE OUTPUT SIGNALS

The control system can provide analog output signals for closed loop servo drive systems for 6 axes at most.
The servo drive systems should have DIFFERENTIAL inputs only.

The characteristics are:
- Output voltage : +10V ... 0V ... -10V
- Output current : 5 mA max.

Adjustments :

See machine constants:

MC 215 to 220 for the first axis

MC 265 to 270 for the second axis

MC 315 to 320 for the third axis

MC 365 to 370 for the fourth axis

MC 415 to 420 for the fifth axis

MC 465 to 470 for the sixth axis

Note: Rapid traverse rate should be achieved at +9V / -9V input voltage on the velocity loop amplifier.

The analogue output signals are available on the sockets DRIVE of the pc boards LM/LM DRIVE MOD, LM/RM DRIVE MOD, RM/RM DRIVE MOD and RM DRIVE MOD; see fig. 12.-1.

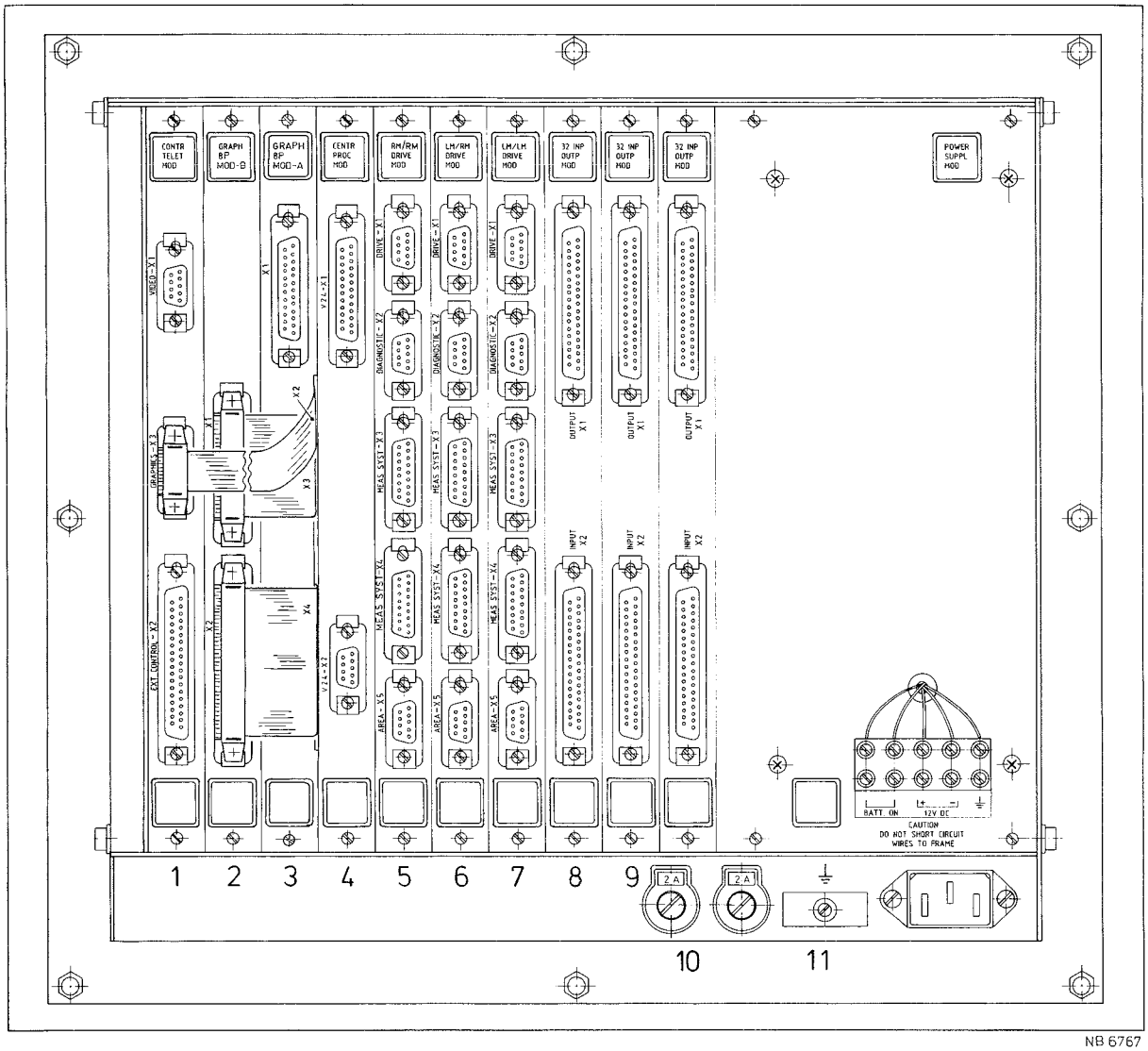


Fig. 12.-1 Analog outputs on drive modules

Wiring instructions on the connection cable for the analog output signals are given in section 5 and fig. 12.-3.

Note: The analog outputs may not be short-circuited, otherwise the drive modules will fail.

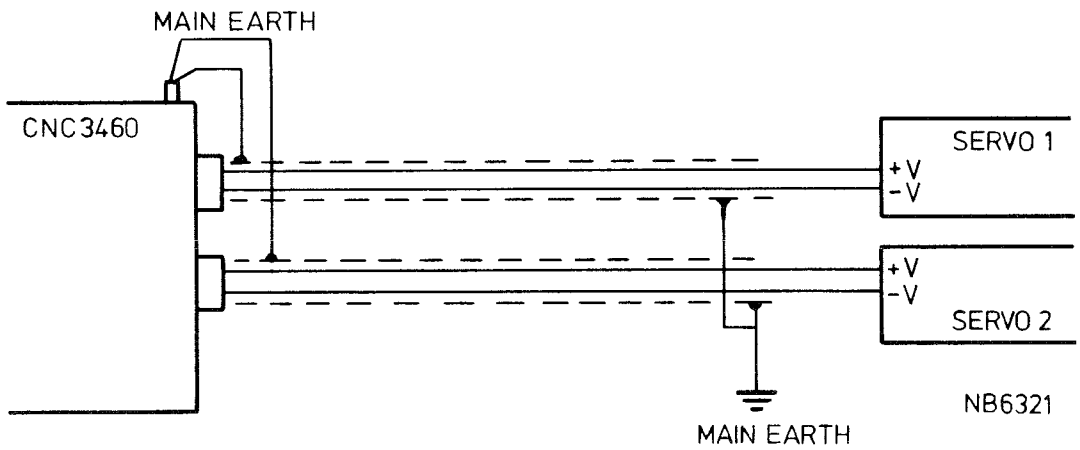


Fig. 12.-2 Cabling for differential inputs

Connection diagram for 9-way plug to be connected to socket DRIVE on pc board LM/LM DRIVE MOD, LM/RM DRIVE MOD, RM/RM DRIVE MOD or RM DRIVE MOD.

To NC system for driving the axes

Soldering side of 9-way plug

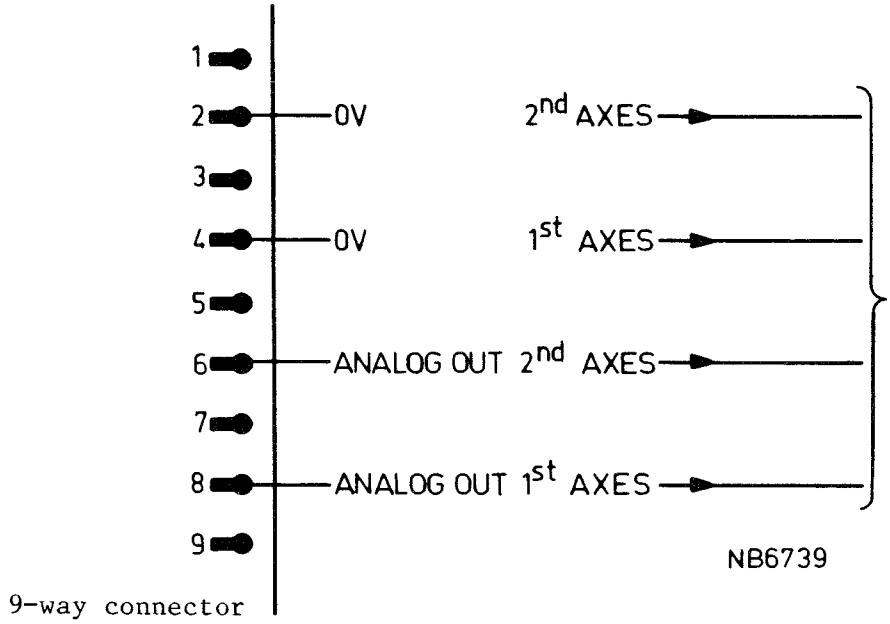


Fig. 12.-3 Wiring of 9-way plug on cable for analog output signals

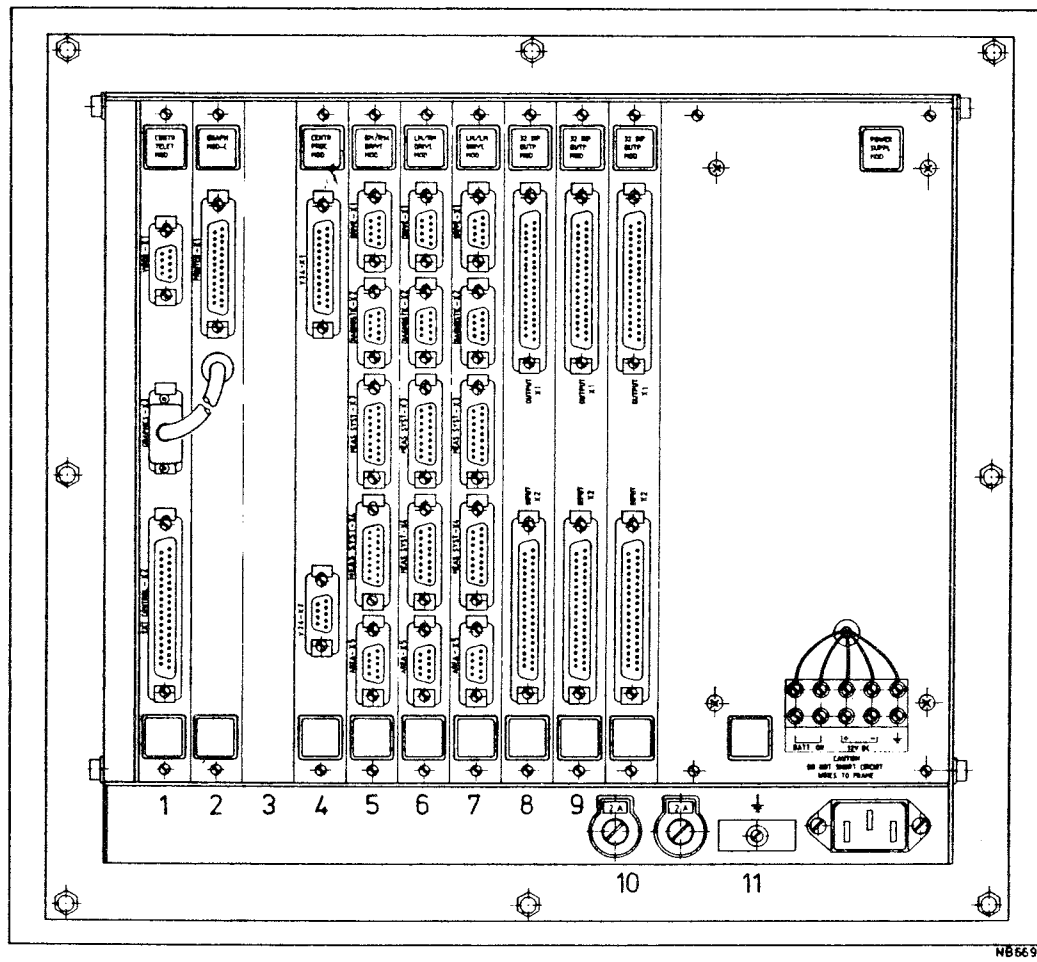


Fig. 13.-1 Arrangement of modules, version I

Pos.	Designation	Abbreviation	
1	CONTROL TELETEXT MODULE	CONTR TELET MOD	
2	GRAPHICS MODULE C	GRAPH MOD-C	
3	not used		
4	CENTRAL PROCESSOR MODULE	CENTR PROC MOD	
5	RM/RM DRIVE MODULE	RM/RM DRIVE MOD	optional
6	LM/RM DRIVE MODULE	LM/RM DRIVE MOD	3rd(X3)+4th(X4) axis
7	LM/LM DRIVE MODULE	LM/LM DRIVE MOD	1st(X3)+2nd(X4) axis
8	32-INPUT/OUTPUT MODULE III	32 INP OUTP MOD	
9	32-INPUT/OUTPUT MODULE II	32 INP OUTP MOD	
10	32-INPUT/OUTPUT MODULE I	32 INP OUTP MOD	
11	POWER SUPPLY MODULE	POWER SUPPL MOD	

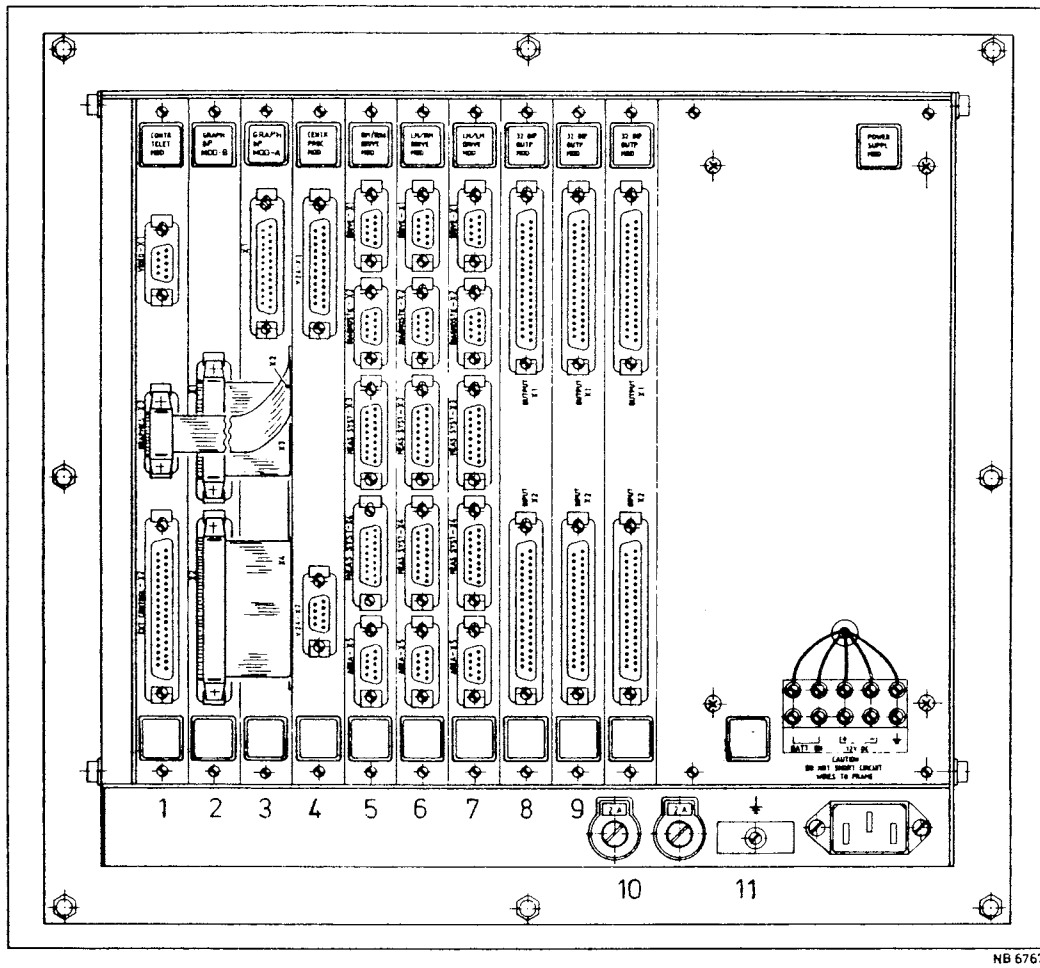


Fig. 13.-2 Arrangement of modules, version II

Pos.	Designation	Abbreviation	
1	CONTROL TELETEXT MODULE	CONTR TELET MOD	
2	GRAPHICS 8P MODULE B	GRAPH 8P MOD B	
3	GRAPHICS 8P MODULE A	GRAPH 8P MOD A	
4	CENTRAL PROCESSOR MODULE	CENTR PROC MOD	
5	RM/RM DRIVE MODULE	RM/RM DRIVE MOD	optional
6	LM/RM DRIVE MODULE	LM/RM DRIVE MOD	3rd(X3)+4th(X4) axis
7	LM/LM DRIVE MODULE	LM/LM DRIVE MOD	1st(X3)+2nd(X4) axis
8	32-INPUT/OUTPUT MODULE III	32 INP OUTP MOD	
9	32-INPUT/OUTPUT MODULE II	32 INP OUTP MOD	
10	32-INPUT/OUTPUT MODULE I	32 INP OUTP MOD	
11	POWER SUPPLY MODULE	POWER SUPPL MOD	

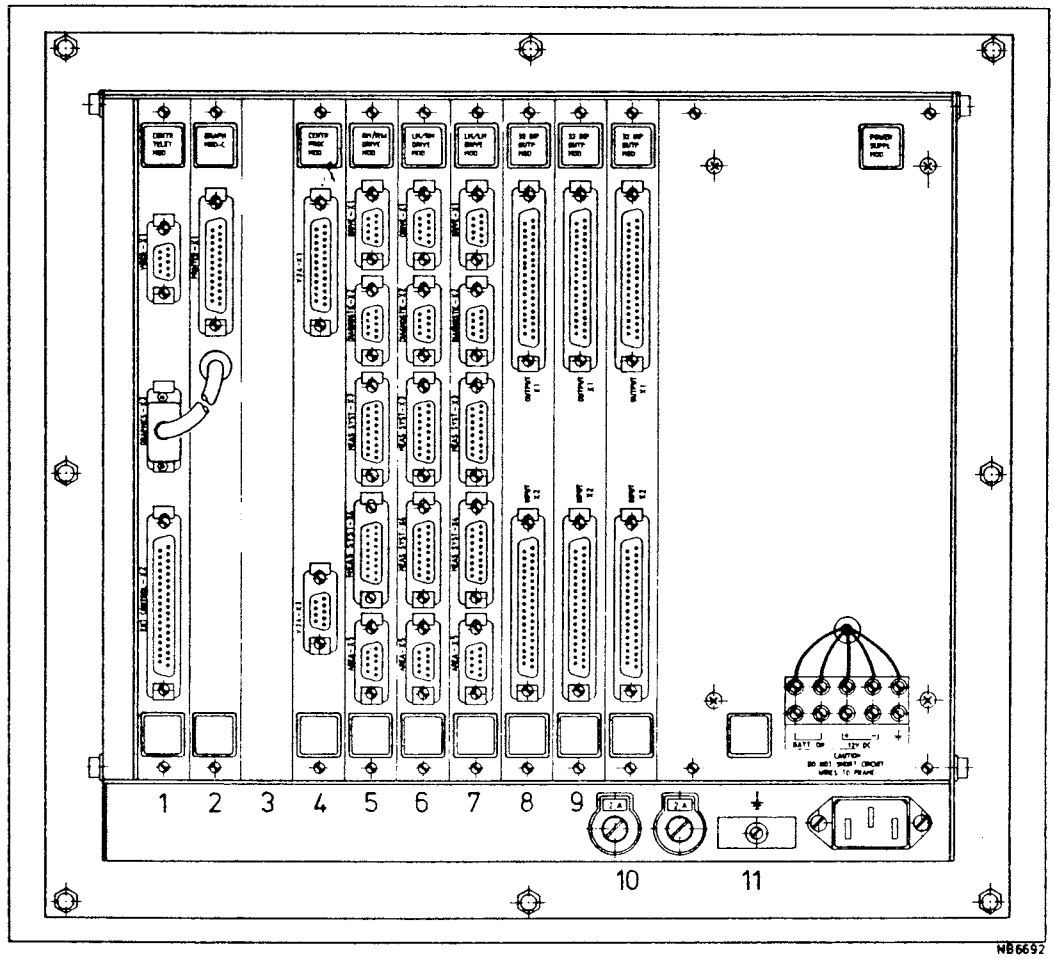


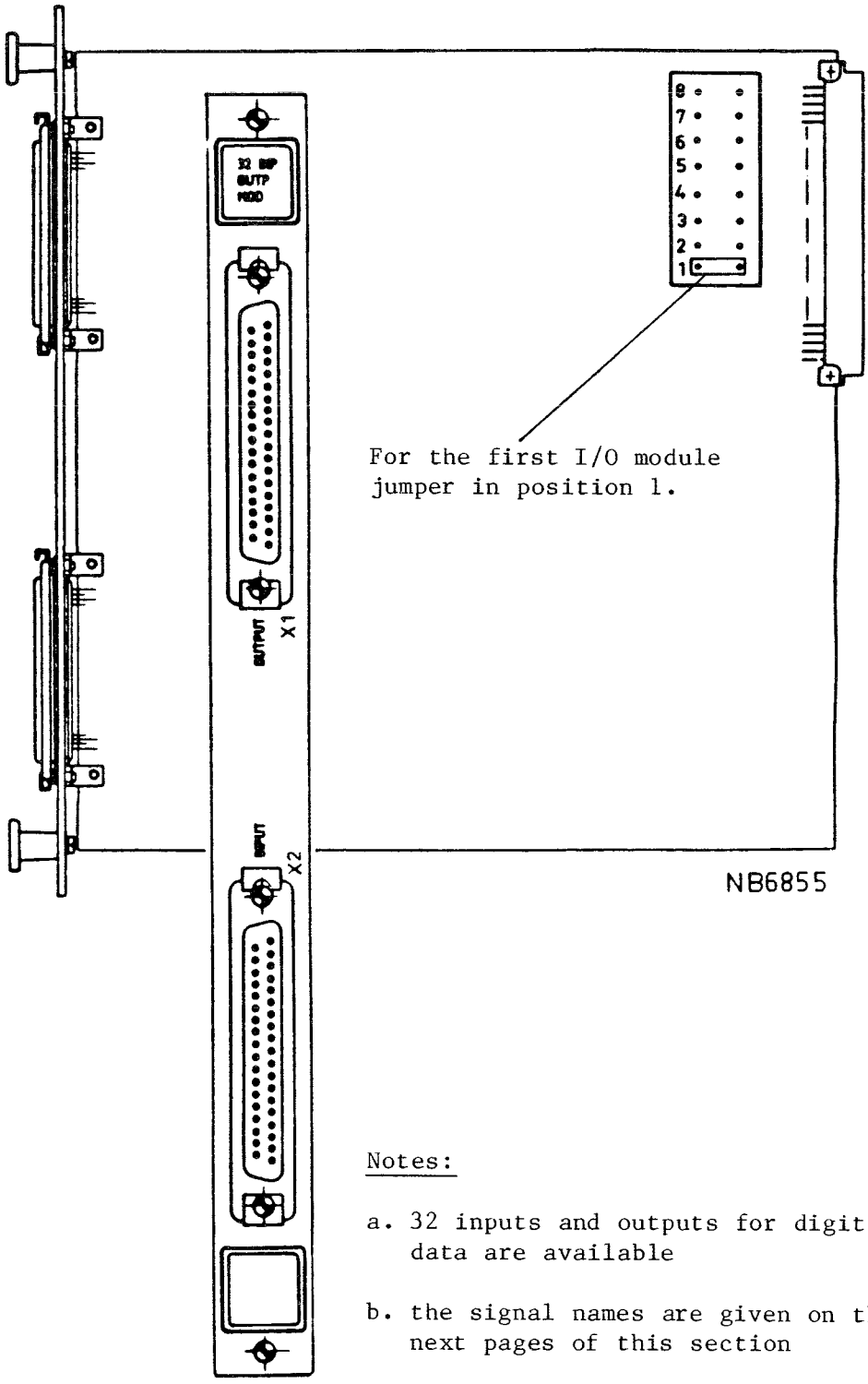
Fig. 13.-3 Arrangement of modules, version III

Pos.	Designation	Abbreviationn	
1	CONTROL TELETEXT MODULE	CONTR TELET MOD	
2	GRAPHICS MODULE C	GRAPH MOD C	
3	not used		
4	CENTRAL PROCESSOR MODULE	CENTR PROC MOD	
5	LM/RM DRIVE MODULE	LM/RM DRIVE MOD	5th(X3)axis + spindle(X4)
6	LM/LM DRIVE MODULE	LM/LM DRIVE MOD	2nd(X3) + 4th(X4) axis
7	LM/LM DRIVE MODULE	LM/LM DRIVE MOD	1st(X3) + 2nd(X4) axis
8	RM DRIVE MODULE	RM DRIVE MOD	handwheel
9	32-INPUT/OUTPUT MODULE II	32 INP OUTP MOD	
10	32-INPUT/OUTPUT MODULE I	32 INP OUTP MOD	
11	POWER SUPPLY MODULE	POWER SUPPL MOD	

Notes on version III :
This version allows for example the employment of 5 axes, 1 spindle and 1 handwheel.

APPLICATION OF THE INPUT/OUTPUT MODULES

The control unit can accomodate 3 pc boards INP/OUTP MOD, referred to as module I, module II and module III.
The basic version of the NC system contains module I only.
When measuring cycles and automation package are required, module II is added.
Module III may be additionally needed for user specific control systems



Notes:

a. 32 inputs and outputs for digital data are available

b. the signal names are given on the next pages of this section

c. for I/O modules II and III place jumpers in positions 2 and 3 resp.

Fig. 14.-1 Front and side views of 32-Input/Output Module

The 32 outputs on this pc board are solid state circuits in accordance with IEC550. Their characteristics are:
Nominal external voltage: 24V (min. 2 V, max. 26V)
Ripple: 4V maximum (between 22V and 26V)
Logic 1: 22V - 26V
Logic 0: 0V - 1V
Maximum load: 100mA
Outputs are not protected against short-circuits

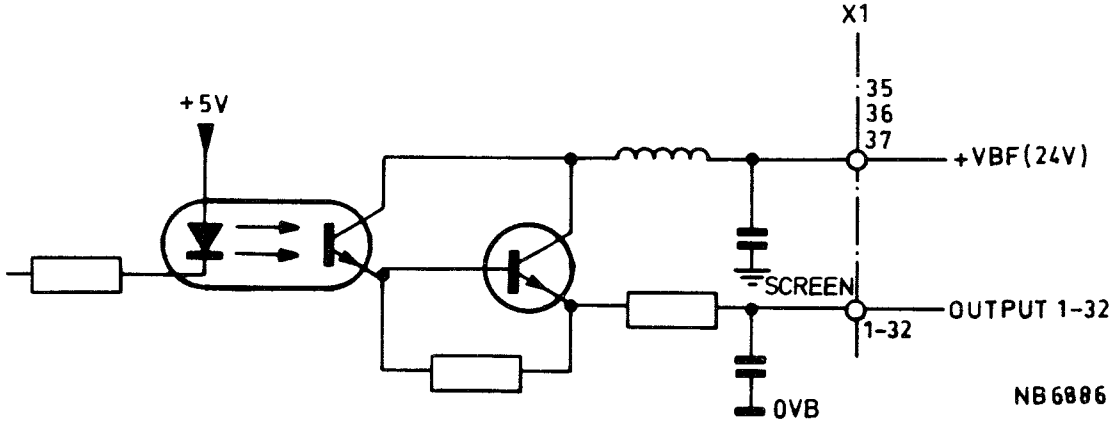


Fig. 14.-2 Output configuration

Note: The 24V supply voltage will be provided by the machine tool manufacturer

List of outputs I/O module I

Pin No.	Signal name
1	Cycle interrupt
2	NC-Start
3	Control on
4	In cycle
5	Manual
6	Automatic/Single
7	Clear Control
8	Unclamp tool
9	M3
10	M4
11	M6
12	M7
13	M8
14	Feed
15	External auto mode
16	Start external cycle (G68/G69)
17	Motion expected 1st axis
18	Motion expected 2nd axis
19	Motion expected 3rd axis
20	Motion expected 4th axis
21	MF-0 address
22	MF-1 address
23	MF-2 address
24	MF change
25-32	BCD Data 1, 2, 4, 8, 10, 20, 40, 80
33-34	Not to be connected
35-37	+24 V supply voltage

Pin No.

1 CYCLE INTERRUPT

Signal: A 100ms pulse, produced when pressing the Feed Hold button or the Feed/Speed Hold button, or when generating an external cycle interrupt.

Interf: When this signal appears the CNC 3460 operations are interrupted. It can be used to interrupt a number of machine tool functions which are not controlled by the CNC 3460.

2 NC-START

Signal: A 100ms pulse, produced on pressing the Start button. It is not used in the control system itself.

Interf: By feeding the signal back to the control via the interface, it can be used to inhibit the execution of a machining operation in the event of the machine tool being not ready to perform it.

3 CONTROL ON

Signal: The signal indicates that the control system is switched on and that there is no Alarm or Emergency Stop condition.
It is set low when:
a. the control is switched off
b. a class A, B, C or D error is detected (refer to the operators' manual)
c. a diagnostic test is running.
d. the control is set in Demo mode.

Interf: The signal indicates that the control is operational.
It can be used to apply high gain to the drive systems.
After switching on the control system, the signal goes high after a time interval of min. 100ms.

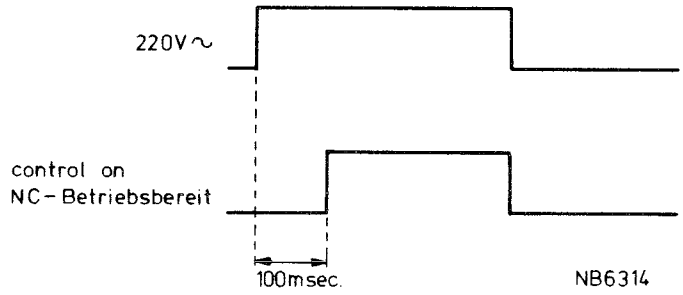


Fig. 14.-3 Timing diagram signal "Control On"

Pin No.

4 IN CYCLE

Signal: The signal indicates that the machine tool is being controlled by the CNC 3460. It is set active in the Teach-in, Single and Auto mode upon command Start.
The signal is set inactive:
. in Teach-in or Single mode, when the programmed instructions are executed
. in Auto mode, when the program is completed (M30)
. when the command Feed Hold or Feed/Speed Hold is given

Interf: The signal can be used to stop the material supply or to lock a door.

5 MANUAL

Signal: The signal indicates that the control system has accepted manual operation.

Interf: The signal causes the interface to be set such that the machine tool can be jogged by means of the jog buttons of the control system.

6 AUTOMATIC/SINGLE

Signal: The signal indicates that the control system has accepted automatic or single operation.

Interf: The signal can be used as a safeguarding signal causing special safety precautions for automatic or single operation to be put into effect.

7 CLEAR CONTROL

Signal: A 100ms pulse, produced when pressing the Clear Control button or automatically by the control system. Clear Control causes the control system to be reset to power-on status.
It is generated automatically upon power on, during execution of M30 and when clearing a class A, B or C error.

Interf: The signal is used as a reset signal in the interface.

8 UNCLAMP TOOL

Signal: A high signal causes the tool holder to open.
A low signal causes the tool holder to close.

Interf: The signal is used for tool clamping/unclamping.

Pin No.

9 M3 - Clockwise spindle rotation (optional)

Signal: The signal is produced when a M3-function becomes effective in a program or during Teach-in. It is set inactive by a M4 or M5-function.

Interf: The signal is used to get a clockwise spindle rotation in the absence of the ´Analog-Spindle´ provision or in the event of a 2-quadrant spindle drive.

10 M4 - Counterclockwise spindle rotation (optional)

Signal: The signal is produced when a M4-function becomes effective in a program or during Teach-in. It is set inactive by a M3 or M5-function.

Interf: The signal is used to get a counterclockwise spindle rotation in the absence of the ´Analog-Spindle´ provision or in the event of a 2-quadrant spindle drive.

11 M6 - Tool change with axis movements (optional)

Signal: The signal is produced when a M6-function becomes effective in a program or during Teach-in. M6 becomes effective at the start of a block (early M).

Interf: The signal indicates that a tool change has to be performed. It can be used to light a pilot lamp, to check spindle rotation and change position.
Reset of the signal depends on the value assigned to MC18:
MC18 = 0 means reset at start
MC18 = 1 means reset by signal Machine function ready
After reset, the program execution is automatically resumed.

12 M7 - Cooling nr. 2 on

Signal: The signal is produced when a M7-function becomes effective in a program or during Teach-in, while a M3 or M4-function is being executed.
The signal goes low when:
. M9 becomes effective
. M5 becomes effective
. Clear Control is given
. a class A, B, C or D error is detected
. Emergency Stop is given

The signal is suppressed when:
. the Feed/Speed Hold button is pressed
. a tool change is effected

It appears again when:
. a restart command is given
. a tool change is completed

Interf: The signal allows cooling nr. 2 to be switched on/off.

Pin No.

13 M8 - Cooling nr. 1 on

Signal: The signal is produced when a M8-function becomes effective in a program or during Teach-in, while a M3 or M4-function is being executed.
The signal goes low when:
. M9 becomes effective
. M5 becomes effective
. Clear Control is given
. a class A, B, C or D error is detected
. Emergency Stop is given

The signal is suppressed when:
. the Feed/Speed Hold button is pressed
. a tool change is effected

It appears again when:
. a restart command is given
. a tool change is completed

Interf: The signal allows cooling nr. 1 to be switched on/off.

14 FEED

Signal: The signal is set active when a G1, G2 or G3 movement or a feed movement in a fixed cycle is started. It is not active during jogging operations. When activated by a G1, G2 or G3 movement, it will be set inactive by Clear Control, G0, G77 or G79. The signal remains active during Feed Hold or Feed/Speed Hold. When activated in one of the operation modes Teach-in, Single and Auto, the signal remains active when changing mode (e.g. from Auto to Manual).

Interf: The signal can be used as a safeguarding signal, for instance to inhibit feed movements when the spindle is stationary.

15 EXTERNAL AUTO MODE

Signal: The signal is set high when the control has accepted the external auto mode.

Interf: The signal is to indicate that the control is in external auto mode, see also input card I input 12.

16 START EXTERNAL CYCLE (G68/G69)

Signal: The signal is generated at the end of each block when a G69 has been programmed. The signal is a 100msec. pulse.
It is generated at the end of each block until a G68 is programmed.

Interf: The signal is used to start an external cycle. The control does not hold the program execution. Next block permitted signal can be used to hold program execution until the external cycle is finished.

Pin No.

17 MOTION EXPECTED 1st AXIS
18 MOTION EXPECTED 2nd AXIS
19 MOTION EXPECTED 3rd AXIS
20 MOTION EXPECTED 4th AXIS

Signal: The signals indicate to the interface that feed movements are requested in the axes concerned. The signals are set inactive by any of the commands Feed Hold, Feed/Speed Hold and Emergency Stop.

Interf: The signals are used to check whether feed movements are permitted. If so, the control system is informed accordingly by signal Motion Permitted.

21 MF - 0)
22 MF - 1) Address decoding signals M, S, T, H
23 MF - 2)

Signal: The MF-signals serve to decode the information on the BCD-data lines, i.e. to determine whether it concerns M-functions, T, S or H-data. The decoding is effected as follows:

Address MF 2 1 0

0 0 0	Spare
0 0 1	M-function
0 1 0	T-data MSD
0 1 1	T-data LSD
1 0 0	S-data LSD
1 0 1	S-data MSD
1 1 0	H-data LSD
1 1 1	H-data MSD

LSD means the two least significant decades
MSD means the two most significant decades
Example: S1643 MSD=16 LSD=43

The MF-signals are output together with the BCD-information and accepted by the interface upon the appearance of signal Change. They are set inactive by signal Machine Function Ready.

Interf: See pin 25 details

24 MF CHANGE

Signal: The signal (min. duration 100ms) is generated 50ms after the Data and MF signals appear on the output. It indicates that Data and MF information can be transferred to the interface. The signal is set inactive by the response signal Machine Function Ready from the interface. When the latter is set inactive, the data is not defined any more.

Interf: See pin 25 details

Pin No.

25-32 DATA 1, 2, 4, 8, 10, 20, 40, 80
BCD OUTPUTS FOR S, T, H AND M INFORMATION

Signal: 8 BCD output signals are provided for the S, T, H and M information not being output in decoded form.

Interf: On the appearance of signal Change the corresponding relay section for M, T, H or S is selected, using the MF-signals. The Data 1, 2, 4, 8, 10, 20, 40, 80 are stored in the interface. When all information has been properly stored, the control system is informed accordingly by interface signal Machine Function Ready. See timing diagram figure 14.-7.

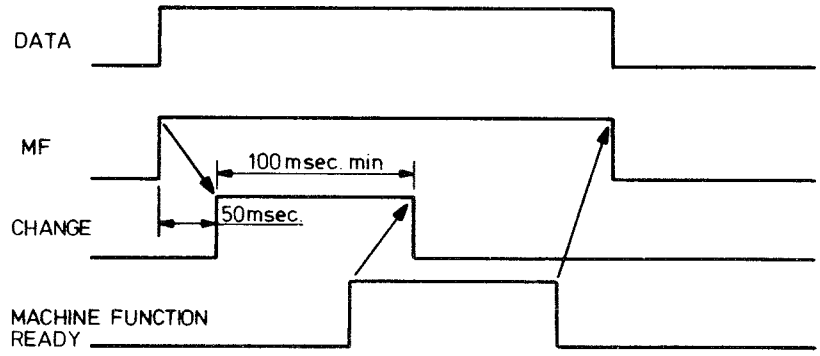


Fig. 14.-4 Timing diagram - signal Machine Function Ready

33-34 Not to be connected

35-37 +24V supply voltages

The 32 inputs on this pc board are solid state circuits in accordance with IEC550. Their characteristics are:
Nominal external voltage: 24V (min. 22V, max. 26V)
Ripple: 4V maximum (between 22V and 26V)
Logic 1 : 22V - 26V
Logic 0 : 0V - 1V
Load: 15mA per input

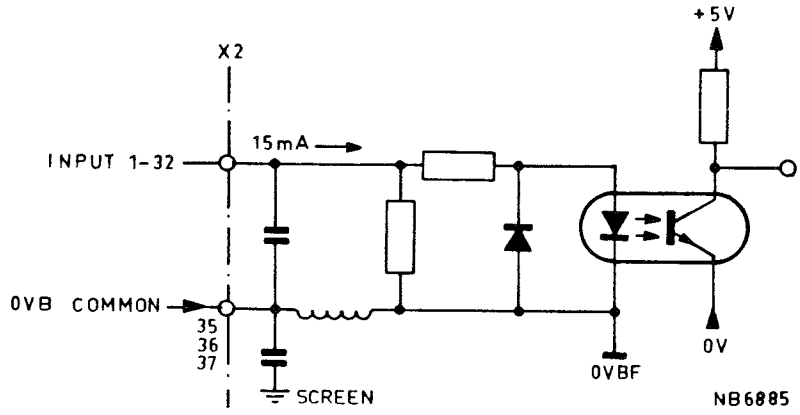


Fig. 14.-5 Input configuration

Note: The 24V supply voltage will be provided by the machine tool manufacturer

List of inputs I/O module I

Pin No.	Signal name
1	Cycle interrupt (not)
2	NC-Start
3	Emergency stop (not)
4	Next block permitted
5	Machine function ready
6	Spindle permitted
7	Not used
8	Diagnostic
9-11	Not used
12	External auto mode
13	Feed override B1
14	Feed override B2
15	Feed override B3
16	Feed override B4
17	Motion permitted 1st axis
18	Motion permitted 2nd axis
19	Motion permitted 3rd axis
20	Motion permitted 4th axis
21	Open loop 1st axis (not)
22	Open loop 2nd axis (not)
23	Open loop 3rd axis (not)
24	Open loop 4th axis (not)
25	N-actual = N-command
26	Memory lock
27	Machine constants memory enable
28	Program/Macro lock enable
29	Conditional jump
30-31	Not used
32	n < n MIN
33-34	Not to be connected
35-37	0 V

DESCRIPTION OF INPUT SIGNALS ON INPUT/OUTPUT MODULE I

Pin No.

1 CYCLE INTERRUPT

Signal: The signal (min. duration 50ms) causes all machine motions to be interrupted. Restart is impossible. After deactivating the signal, operations can be resumed by pressing the Start button.

Note: During the active state of this signal the programmed Motion Expected signals are inactive

Interf: The signal is used as an external Feed Hold command

2 NC-START

Signal: The signal (min. duration 50ms) causes the selected operation for the control system to be started.

Interf: The output signal NC-Start must be fed back as an input signal NC-Start. In this way the start signal can be blocked when the machine tool is not is a safe condition. It can also be used as an external start for the CNC 3460.

3 EMERGENCY STOP

Signal: The signal causes all machine motions, including spindle rotations, to be stopped immediately. The servo drive outputs are set to 0V. The control system retains the positions.

Interf: The provision should be part of the Emergency Stop circuitry of the machine tool.

4 NEXT BLOCK PERMITTED

Signal: The signal serves to inform the control system that the next block may be executed.

Interf: The signal is used to inhibit the execution of a program in the event of the machine tool being not ready to perform the the next block.

5 MACHINE FUNCTION READY

Signal: The signal serves to inform the control system that the interface has accepted the programmed M, H, S or T information

Interf: The signal is used by the interface to enable the output of the next M, H, S or T information

Pin No.

6 SPINDLE PERMITTED

Signal: The signal serves to inform the control system that the Analog-S output is enabled.

Interf: The signal is used to enable or inhibit the Analog-S output.

7 Not used

8 DIAGNOSE

Signal: The signal serves to indicate that the diagnostic test procedure is called for.

Interf: When the signal goes active, the interface must be set such that uncontrolled servo drive voltages and output signals produced when performing diagnostic tests, are prevented from causing any damage to the machine tool.

9-11 Not used

12 EXTERNAL AUTO MODE

Signal: The signal is used to set the control in manual external auto mode.
External auto mode means that the control is forced into automatic program execution, no other auto mode can be selected. Also the Store button and the jog buttons are inoperative.

Interf: When the signal is made high the control generates a manual clear control. Via Start button or external start input the active program can be started.
The input external auto mode must stay high as long as the program is under execution. Making the input low an intervention is generated and the control is set in manual mode.Making the signal low (min. duration 50msec) and high again gives a manual clear control e.g. to restart a program after tool breakage.

13 FEED OVERRIDE B1)
14 FEED OVERRIDE B2) only with option
15 FEED OVERRIDE B3) ´External control panel´
16 FEED OVERRIDE B4)

Signal: External control panel feed override signals.

Interf: Generated by the external control panel, the signals are used to proportionally override the selected feedrate.

It is also possible to mount an external feed override switch

on the machine tool operator's panel.
In this case the feed override switch from the external control panel may not be used.
It is also possible to connect an external feed override switch when there is no external control panel. In this case the value in MC4 must be 5.

Truth table

input 16	15	14	13	Feed override position (%)
0	0	0	0	140
0	0	0	1	120
0	0	1	0	100
0	0	1	1	80
0	1	0	0	60
0	1	0	1	40
0	1	1	0	20
0	1	1	1	10
1	0	0	0	8
1	0	0	1	4
1	0	1	0	2
1	0	1	1	0
				Feed override position (incr.)
1	1	0	0	1
1	1	0	1	10
1	1	1	0	100
1	1	1	1	1000

17 MOTION PERMITTED 1st AXIS
18 MOTION PERMITTED 2nd AXIS
19 MOTION PERMITTED 3rd AXIS
20 MOTION PERMITTED 4th AXIS

Signal: The signals serve to indicate that movements in the axes concerned are permitted.

Interf: The signals are used to inhibit any movements in the axes concerned.

21 $\overline{\text{OPEN LOOP 1st AXIS}}$

22 $\overline{\text{OPEN LOOP 2nd AXIS}}$

23 $\overline{\text{OPEN LOOP 3rd AXIS}}$

24 $\overline{\text{OPEN LOOP 4th AXIS}}$

Signal: The signals allow the servo position loops of the axes concerned to be individually opened. The control system then acts as a digital readout for these axes.

Interf: Since the servo loop of an axis cannot be opened when command Motion Expected is active for that axis, command Open Loop will cause an error message to be produced.

Pin No.

25 N-ACTUAL = N-COMMAND

Signal: The signal is only produced in case the control system is equipped with the Analog Spindle option. It informs the control system that the actual spindle speed equals the programmed spindle speed.

Interf: The program execution can be suspended until the spindle has attained the correct speed. When the signal is not used, the corresponding input should always be high.

26 MEMORY LOCK

Signal: The signal serves to lock or unlock the part program memory, the macro memory and the tool memory.

Interf: The signal is used to prevent illegal acces to the control system memories.

27 MACHINE CONSTANTS MEMORY ENABLE

Signal: The signal serves to indicate that acces to the machine constants memory is requested for machine constants values to be input, output or edited.

Note: After the signal has been switched off, a reference point search must be effected.

Interf: The enabling switch for the machine constants memory should be a key operated switch so as to prevent the memory from being inadvertently accessed and its contents altered.

28 PROGRAM/MACRO LOCK ENABLE

Signal: The signal enables the program/macro lock feature.

Interf: As long as the signal is high the softkey LOCK/UNLOCK is operational. When the input is low the softkey is not operational, meaning that locked programmes or macros are no longer open for editting.

Pin No.

29 CONDITIONAL JUMP (only with option ´Automation Package´)

Signal: A low input (min. duration 100ms) causes the G14/G27 functions not to be executed. If the input goes low during the execution of G14/G27, the operations will be completed. However, the next functions will not be performed.

The input is activated by machine constant 44.
It is active when MC 44 have been assigned the value 1 and inactive when MC 44 have been assigned the value 0 (any jump command will be serviced).

Interf: Depending on the machining status of a workpiece the program can be executed with or without "jumps" or "macros".

30-31 Not used

32 n < n MIN (only with option ´Analog Spindle´)

Signal: The signal is only produced in case the control system is equipped with the Analog Spindle option. It informs the control system that the actual spindle speed is less than the programmed spindle speed.

Interf: The program execution can be suspended until the spindle has attained the correct speed. When the signal is not used, the corresponding input should always be high.

33-34 Not to be connected

35-37 0V

The 32 outputs on this pc board are solid state circuits in accordance with IEC550. Their characteristics are:
Nominal external voltage: 24V (min. 22 V, max. 26V)
Ripple: 4V maximum (between 22V and 26V)
Logic 1: 22V - 26V
Logic 0: 0V - 1V
Maximum load: 100mA
Outputs are not protected against short-circuits

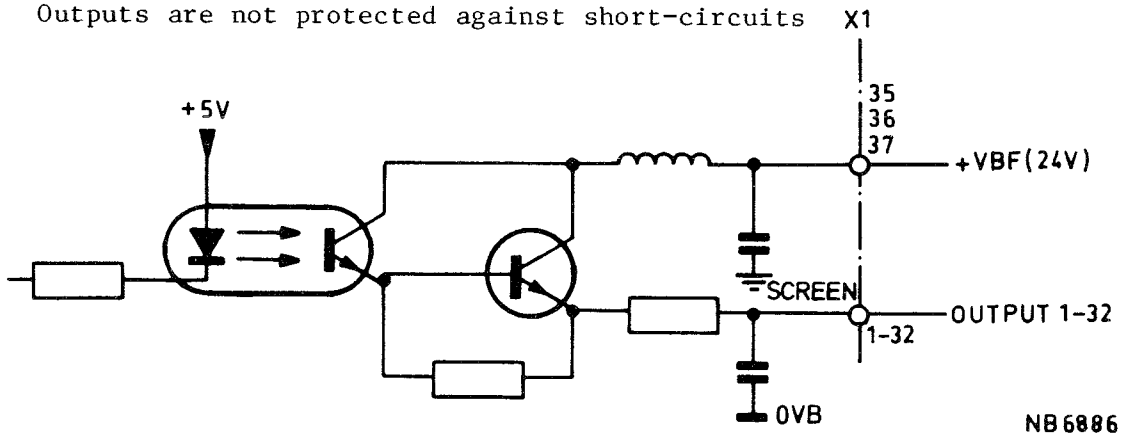


Fig. 14.-6 Output configuration

Note: The 24V supply voltage will be provided by the machine tool manufacturer

List of outputs I/O module II

Pin No.	Signal name
1-13	Not used
14	External program number call
15	Change cutting force monitor data
16-21	Not used
22	Motion expected 5th axis
23	Motion expected 6th axis
24-29	Not used
30	Activating measuring probe
31	Air blowing measuring probe
32	Error message
33-34	Not to be connected
35-37	+24V supply voltages

Pin No.

1-13 Not used

14 EXTERNAL PROGRAM NUMBER CALL (only with option ´Automation Package´)

Signal: There are two program number buffers.
When both buffers are empty and external program call is enabled (section 14, input signal 16), this signal goes high.
As soon as one program number buffer has been filled, the signal goes low. The second program number can still be transferred to the numerical control.
As a rule, only one buffer is used, which means that the signal is set high by the control the moment it has emptied the program number buffer.
The buffers can be cleared by setting input 16 low.

Interf: The signal is used to indicate that new program numbers can be transferred to the data inputs on I/O module II.

15 CHANGE CUTTING FORCE MONITOR DATA
(only with option ´Automation Package´)

Signal: "Change cutting force monitor data" is initiated 50 ms after data for the cutting force monitor is available at the BCD outputs 25 to 32 of I/O module I.
The signal disappears after "Machine function ready" has been generated by the interface. After "Machine function ready" has disappeared, the data becomes undefined.
The signal is high for 100 msec. at least.

Interf: The signal is used to enable data to be transferred to the cutting force monitoring device.

16-21 Not used

Pin No.

22 MOTION EXPECTED 5th AXIS
23 MOTION EXPECTED 6th AXIS

Signal: The signals indicate to the interface that feed movements are requested in the axes concerned. The signals are set inactive by any of the commands Feed Hold, Feed/Speed Hold and Emergency Stop.

Interf: The signals are used to check whether feed movements are permitted. If so, the control system is informed accordingly by signal Motion Permitted.

24-29 Not used

30 ACTIVATING MEASURING PROBE (only with option ´Measuring Cycles´)

Signal: The signal is set high for activating the measuring probe when a measuring cycle has been programmed.

Interf: The measuring probe signals its active state via input 18.

31 AIR BLOWING MEASURING PROBE (only with option ´Measuring Cycles´)

Signal: Active high.
The signal is generated prior to the measuring operation

Interf: The signal is used to switch on the air supply for cleaning the surface to be measured.
The air supply can last 3.8 sec. at most.

32 ERROR MESSAGE (only with option ´Automation Package´)

Signal: The signal goes high when an error is detected by the control. It remains in the high state until the error has been reset.

Interf: The signal is used to indicate that an error has been detected by the control.

33-34 Not to be connected.

35-37 +24V supply voltages

32-INPUT/OUTPUT MODULE II - INPUTS

The 32 inputs on this pc board are solid state circuits in accordance with IEC550. Their characteristics are:
Nominal external voltage: 24V (min. 22V, max. 26V)
Ripple: 4V maximum (between 22V and 26V)
Logic 1 : 22V - 26V
Logic 0 : 0V - 1V
Load: 15mA per input

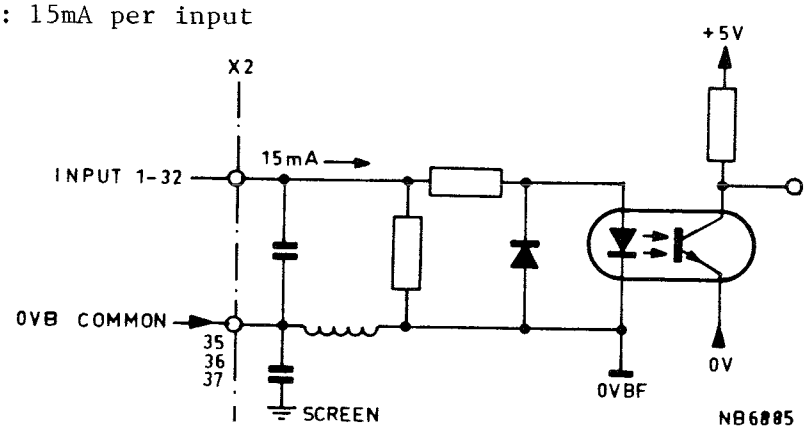


Fig. 14.-7 Input configuration

Note: The 24V supply voltage will be provided by the machine tool manufacturer

List of inputs I/O module II

Pin No.	Signal name
1-4	BCD input 1, 2, 4, 8
5-8	BCD input 10, 20, 40, 80
9-12	BCD input 100, 200, 400, 800
13	Not used
14	Change 1st ext. program call
15	Change 2nd ext. program call
16	External program call enable
17	Not used
18	Measuring probe ready
19	Not used
20	Cutting force limit 1 reached
21	Cutting force limit 2 reached
22	Motion permitted 5th axis
23	Motion permitted 6th axis
24	Open loop 5th axis (not)
25	Open loop 6th axis (not)
26	Not used
27	External Error display bit 1
28	External error display bit 2
29	External error display bit 4
30	External error display bit 8
31	External error display bit 16
32	External error display bit 32
33-34	Not to be connected
35-37	0V

Pin No.

1-4 BCD INPUT 1, 2, 4, 8) only with
5-8 BCD INPUT 10, 20, 40, 80) option
9-12 BCD INPUT 100, 200, 400, 800) ´Automation Package´

Signal: 3-decade BCD data signals used for tool fracture data input or for external program call

Interf: External program call
- fixed
  The last 3 decades of a program number, e.g. N 9235 , are fed to the BCD-inputs (pins 2, 5, 6, 10 must be high).

- variable
  The parameter number with a maximum of 255 is fed to the BCD-input.

13 Not used

14 CHANGE 1st EXT. PROGRAM CALL) only with option
15 CHANGE 2nd EXT. PROGRAM CALL) ´Automation Package´

Signal: The signals serve to transfer data concerned, present at the BCD-inputs, to the control.

Interf: The data must be available at the BCD-inputs 50 ms before the relevant change signal goes high. Minimum duration 100 ms.

16 EXTERNAL PROGRAM CALL ENABLE (only with option ´Automation Package´)

Signal: When high, the signal enables external program call.

Interf: The signal enables the feature "external program call". It needs to stay high as long as the feature is required. Setting the signal low will cause the input buffers to be cleared.

17 Not used

18 MEASURING PROBE READY (only with option ´Measuring Cycles´)

Signal: High when the infra-red path is not obstructed.
Low when the infra-red path is obstructed.

The signal is set low when the infra-red path is obstructed or in the absence of the infra-red signal as a result of too low a supply voltage. The latter needs to be fed back when signal Activation Measuring Probe is produced by the control system; see "Description of output signals on I/O Module II", pin 30.

Interf: The signal is used to indicate that the measuring probe is operational.

Pin No.

19 Not used

20 CUTTING FORCE LIMIT 1 REACHED (only with option 'Automation Package')

Signal: The signal causes the control to produce a warning message.

Interf: The signal indicates that cutting force threshold 1 has been reached.

21 CUTTING FORCE LIMIT 2 REACHED (only with option 'Automation Package')

Signal: The signal causes the control to produce an error message and the machine motions to be stopped.

Interf: The signal indicates that cutting force threshold 2 has been reached.

22 MOTION PERMITTED 5th AXIS
23 MOTION PERMITTED 6th AXIS

Signal: The signals serve to indicate that movements in the axes concerned are permitted.

Interf: The signal can be used to inhibit any movements in the axes concerned.

24 $\overline{\text{OPEN LOOP 5th AXIS}}$

25 $\overline{\text{OPEN LOOP 6th AXIS}}$

Signal: The signals allow the servo position loops of the axes concerned to be individually opened. The control system then acts as a digital readout for these axes.

Interf: Since the servo loop of an axis cannot be opened when command Motion Expected is active for that axis, command Open Loop will cause an error message to be produced.

26 Not used

Pin no.

27-32EXTERNAL ERROR DISPLAY BIT 1-32 (only with option ´Automation Package´)

Signal: The decimal value offered to these inputs will be displayed on the screen, when MC730 is set to 1.
The external error is a class H error, so no further action will be taken by the control.

Interf: When all inputs are low no error code will be displayed.
100 msec. after one of the inputs changes state the external error code which is then present at the inputs is displayed.
Output 32 of output card II will be high as long as an error code is displayed.

33-34 Not to be connected

35-37 0V

DATA COMMUNICATIONS WITH PERIPHERAL EQUIPMENT

This specification covers the requirements for data communications between the CNC 3460/400 system and data communication equipment (peripherals).
Examples of data communication equipment are data recorders and computers.
Here, the format of the transferred data and some protocols for transferring the required data are specified.
The interface characteristics of both interface connectors available on the central processor card are dicussed as well.
The interface specifications are derived from RS232C and RS422.
Each standard is interfaced by means of its own connector on the central procressor module, viz. X1 for RS232 and X2 for RS422.
X1 is in conformity with the standard specification RS232C.
X2 utilizes the electrical specifications of RS422 and RS423.

For proper communication between CNC and peripheral, hardware connection, flow-control and data format should be matched.

Hardware:	RS232C RS422
Flow-control:	XON/XOFF RTS/CTS handshake
Character Set:	ASCII ISO EIA TELEX (5-bit code)
Data format:	One format, specified by Philips

According to international standards the following conventions have been made:
. DCE = Data Communication Equipment, constituted by the CNC.
. DTE = Data Terminal Equipment, constituted by the peripheral.

The CNC 3460/400 uses the standards given hereafter.

Both connectors have three aspects, a functional, an electrical and a mechanical one.

The X1 connector is in conformity with EIA standard RS232-C. This documentation describes the functional, the electrical and the mechanical specification of the communication line. Not all the standard signals are available on this connector, as they are not needed.

The connectors are often referred to as V24 and V11, which is not correct. The following diagram illustrates the relationship between the various standards.

functional	electrical	pin nr.	total	deviation	CNC plug
CCITT V24 +	CCITT V28	+ ISO 2110	= EIA RS232C +	RTS/CTS	= X1
CCITT V24 +	CCITT V10/V11	+ no stand.	= no stand. +	RTS/CTS	= X2

V24 is merely a functional specification. Hence, X1 and X2 of the CNC are both functionally described by V24. The difference between them lies only in the electrical and mechanical specifications. Therefore, connector X1 is best referred to as RS232C and connector X2 as RS422.

RS232C is intended for low speed devices located at distances up to 15 metres.
RS422 is used for higher speeds and longer distances and is less sensitive to interference because of the differential character of the lines. RS422 may be used for distances up to 60 metres.

Signal names, pin numbers and electrical specification of X1 are in accordance with RS232C. The actual functions of the signals are covered in this description and should be considerd as the norm for Philips numerical controls.

Functionally, connector X2 is equivalent to connector X1. Its pin layout is given hereafter. The differences apply to the electrical and mechanical specifications.
The electrical specifications of TxD and RxD are described in RS422, the electrical specifications of the other signals in RS423.

The connection between the CNC and the peripheral is made by a cable fitted with a male D-type connector on the CNC-side and a female D- type connector on the peripheral side.

DESCRIPTION OF CONNECTOR X1 (RS232C)

Pin No.	I/O	Name	RS 232	V24	Description
2	in	TxD	BA	103	Transmitted Data. Data received by the CNC.
3	out	RxD	BB	104	Received Data. Data transmitted by the CNC.
4	in	RTS	CA	105	Request to Send. When this line is active, the peripheral allows the CNC to send.
5	out	CTS	CB	106	Clear to send. When this line is active, the CNC allows the peripheral to send.
6	out	DSR	CC	107	Data Set Ready. This line signals that the connection is all right. The line is active as long as the CNC is operating. The line can be used to detect line-break.
7	---	GND	AB	102	Signal Ground
20	in	DTR	CD	108.2	Data Terminal Ready. Must be active to indicate that a peripheral is connected.

The CNC is a DCE-device according to the RS232C definition. However, the definitions of RTS and CTS differ from those specified by the RS232C/V24 standard. RTS and CTS are used for flow control by means of hardware handshake.

As a minimum, the connection between peripheral and CNC should consist of the following lines: 2, 3, 6, 7 and 20. This is a connection which does not allow RTS/CTS control to be used on it. For flow control on this connection only the XON/XOFF protocol can be used.

For XON/XOFF flow control the minimum connection is to be used.

A full connection, capable of RTS/CTS control, must include all lines listed.

Signals send by the CNC may be disconnected when they are not used. The same applies for the input signals DTR and RTS when they are not used. These signals will then be in the active state.
Time-order diagrams are discussed in section "RTS/CTS flow control".

DESCRIPTION OF CONNECTOR X2 (RS422)

Pin No.	I/O	Name	V24	Description
1	out	CTSA	106	Clear to Send. When this line is active, the CNC allows the peripheral to send.
2	out	DSRA	107	Data Set Ready. This line signals that the connection is all right. The line is active as long as the CNC is operating. The line can be used to detect line-break.
3	in	TxDA	103a	Transmitted Data. Data received by the CNC.
4	out	RxDA	104a	Received Data. Data transmitted by the CNC.
5	---	OVFl	102	Common return line for CTSA, DSRA, RTSA, DTRA.
6	in	RTSA	105	Request to Send. When this line is active the peripheral allows the CNC to send.
7	in	DTRA	108.2	Data Terminal Ready. Should be active to indicate that a peripheral is connected.
8	in	TxDB	103b	Return line for TxDA (3).
9	out	RxDB	104b	Return line for RxDA (4).

Functionally, connector X2 is equivalent to connector Xl. It differs merely with regard to electrical and mechanical specifications. The data circuits TxD and RxD are in conformity with RS422 (balanced two-wire communication). The other circuits are in conformity with RS423 (unbalanced one-wire, common return line).

Note that the definitons of RTS and CTS differ from those specified by the V24-standard. RTS and CTS are used for flow control.

As a minimum, the connection between peripheral and CNC should consist of the following lines: 2, 3, 4, 5, 7, 8 and 9. This is a connection which does not allow RTS/CTS control to be used on it. Pin 6 must be connected to pin 2. For flow control on this connection only the XON/XOFF protocol can be used.

For XON/XOFF flow control it is recommended to disconnect CTSA, whereas RTSA must be connected to a constant active signal.

A full connection, capable of RTS/CTS control, must include all lines listed.

Signals send by the CNC may be disconnected when they are not used. Inputs to the CNC must always be connected. When their functions need to be disabled they must be connected to an active level.

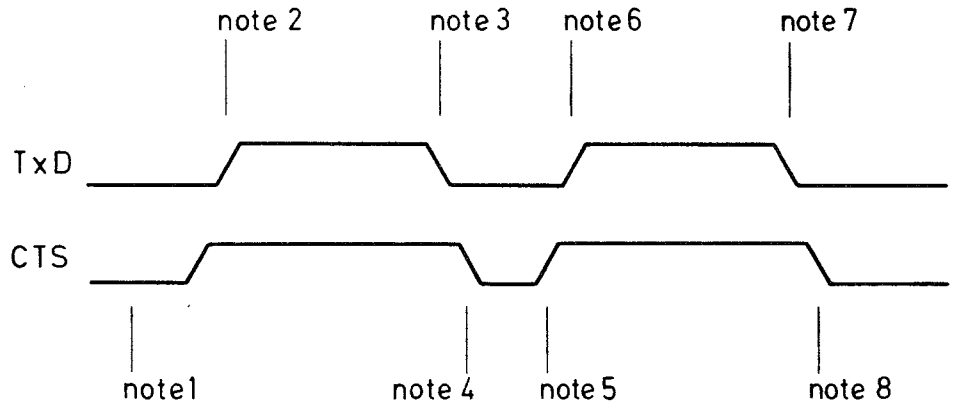
FLOW CONTROL

For flow control of the transmitted data the control lines CTS and RTS may be used as a hardware control.
By means of XON/XOFF characters a software flow control is obtained.

RTS/CTS FLOW CONTROL

The RTS and CTS signals may be used for flow control. CTS is used by the CNC to control the flow of characters transmitted by the peripheral. The pheripheral can use RTS to control the flow of characters transmitted by the CNC.

The following diagram applies to data input by the CNC.



Note 1:
Before transmission the CTS signal is inactive, so that the peripheral cannot transmit data. When the CNC is ready to receive data, the CTS line is made active.

Note 2:
The peripheral will start transmitting a character when CTS becomes active.

Note 3:
The peripheral has finished transmitting the character.

Note 4:
The CNC identifies the incoming characters and deactivates the CTS signal.

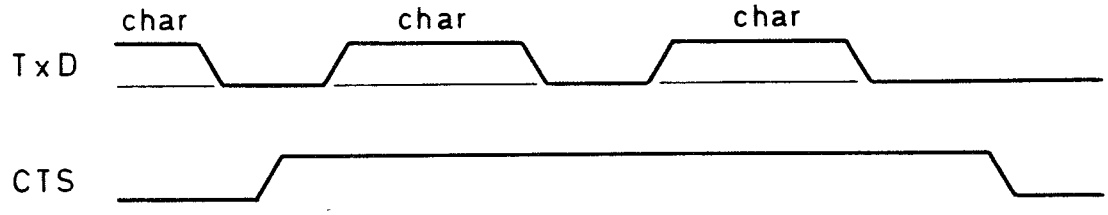
Note 5:
The CNC is ready to receive the next character and activates the CTS signal.

Note 6:
The peripheral transmits the next character.

Note 7:
The character has been transmitted.

Note 8:
The CNC identifies the character and deactivates the CTS signal. According to the CNC this was the last character of the transmission and the CTS signal will remain inactive until the next transmission is started.

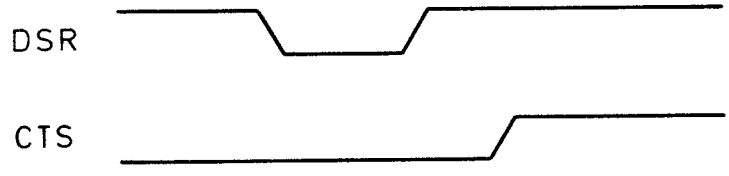
In this scenario the peripheral follows exactly the flow control of the CNC. This need not always be so. The internal data buffer of the CNC allows 128 characters to be read without long delays. This means that the time between note 4 and 5 will be very short, so that the peripheral can transmit characters at full baudrate without reacting immediately on changes on the CTS line. However, when the buffer is nearly full, the CNC will lengthen the time between note 4 and 5 in order for the data to be processed. It is not required for the peripheral to stop transmitting at once. Hence, the following situation is allowed:



This means that the peripheral transmits a few characters after the CNC has deactivated the CTS signal. The CNC will accept these characters. The number of extra characters can be specified with MC773. The larger the number the sooner the CTS signal will be deactivated. The useful size of the buffers decreases when the value stored under MC773 is increased.
The required value for MC773 depends on the characteristics of the peripheral. The value must be higher than the number of characters transmitted by the peripheral after CTS has been deactivated.

When the CNC acts as a transmitter and the peripheral as a receiver, the same diagram applies except for TxD and CTS, which should be replaced by RxD and RTS.

As long as power is applied to the CNC, the DSR line will be in the active state except for a brief moment before a data transfer. The initialization process will then cause DSR to become inactive for a short periode of time.



If this behaviour of DSR confuses the peripheral, the line should be disconnected and replaced by a constant level.

Remark:
Not all peripherals allow RTS/CTS flow control as used by the CNC to be employed. Flow control per character will not be acceptable for some peripherals. Where RTS/CTS handshake poses problems, XON/XOFF flow control should be used.

XON/XOFF FLOW CONTROL

The XON/XOFF protocol is a reasonable standard for flow control on RS232C communication lines. For the CNC it is used in the half-duplex way only. This means that either DTE of DCE transmits a data stream, while the other starts and stops the data stream by transmitting XON and XOFF characters respectively. The binary values of XON and XOFF depend on the character-set used and are stated later in this section.

When the receiving device is ready to receive, it sends an XON-character. The transmitting device will start transmitting after it has received the XON-character. When the receiving device finds that it cannot receive any more characters before long, because of buffer overflow etc., it sends an XOFF-character. The transmitter should stop transmission as soon as possible after having received the XOFF-character.

Note that the employment of XON/XOFF control can pose some problems. The receiver should transmit the XOFF-character before its internal buffers start overflowing and it should be able to receive some characters after the XOFF-character has been sent.
This means that the XON/XOFF protocol cannot be used for flow control per character, as the receiving device is always required to have some buffer capacity.
The transmitter should stop transmitting characters after XOFF has been received, but the character being transmitted should be finished properly. Therefore, the receiver should always be able to receive at least one character after sending XOFF. However, many transmitters have a poor response to XOFF and may therefore transmit a number of characters after XOFF has been received.
The number of characters the CNC should be able to receive after XOFF has been sent, can be stored under MC773. It is recommended to store a number of characters being somewhat larger than the anticipated worst-case number. Frequently, problems are caused by storing too small a number under this machine constant. It is recommended to store a number greater than 10.

When the CNC acts as a transmitter the maximum number of characters sent after XOFF is three.

To avoid the problem of initial deadlock, the receiver should transmit an XON-character when it is able to receive.
After all data has been received, an XOFF-character may be transmitted to avoid loss of characters during the next data transfer.

When receiver and transmitter change roles, the previous state of XON/XOFF will be lost. The transmitter should assume XOFF-state and wait for an XON-character. The receiver is allowed to send the XON-character independent of the previous situation.

The CNC does not provide any control of the peripheral in the form of switching devices on/off and selection of reading or writing. The CNC expects the peripheral to be always in the correct mode to handle the required transmission. This means that the operator must set up both peripheral and CNC prior to transmission.
The CNC uses two handshake lines, so that characters before and during the transmission will not be lost during transmission. This RTS/CTS flow control is as previously described.

It is of course possible to conclude from the signals what the CNC is up to. When the CNC wants to write, the peripheral must be prepared for processing incoming characters. So transmission of characters signals the start of a write-session. The end of a transmission can be recognized from the timing out on the RxD signal. When no transmission occurs for about 5 seconds, it may be assumed that the transmission has been finished.
It is also possible to identify the EOT (End of transmisson)-character terminating each transmission. However, the CNC will transmit a trailer of about 100 NUL-characters, so that it is not desirable to simply terminate the intake of characters. A combination of EOT-identification and time-out might be preferable.

When the CNC wants to read, it will notify the peripheral by either activating the CTS-line or transmitting an XON-character. What actually happens depends on whether RTS/CTS or XON/XOFF flow control is used.
During a transmission the handshake lines will change frequently, so that a change to the inactive state of CTS does not mean the end of a transfer. The end of a transfer can be recognized in two ways. One way is via the timing out on the CTS-line or the XOFF-character. This means terminating the transmission when the line is inactive for more than 5 seconds.
The other way is via detection of the EOT-character, which is used by the CNC as an end-of-file character. The EOT-character itself should be transmitted as well.

Some peripherals, for example the Philips PM4202 data recorder, will produce spurious data when they are switched to the read mode while the CTS-line is active. They may also loose data when switched to the write mode after the CNC starts transmitting. For these reasons it is recommended to always set the peripheral in either the read or write mode before the CNC input/output is activated. The flow control will ensure that no data be lost.

MACHINE CONSTANT SETTINGS

The following machine constants have been reserved for data communication purposes. The settings marked with an asterisk (*) are default values after power on.

MC770 Serial I/O Configuration
* 0 = Local RS232C (for cassette recorders, papertape units)
  1 = Local RS422 (for cassette recorders, papertape units)
  2 = Local RS232C (DNC RS422)
  3 = Local RS422 (DNC RS232C)

MC771 Data I/O Character Set
* 0 = ASCII (8-bit with MSB low)
  1 = ISO (even parity version of ASCII)
  2 = EIA
  3 = TELEX

MC772 Data I/O Automatic recognition + XON/XOFF flow control
* 0 = Automatic recognition off; XON/XOFF off
  1 = Automatic recognition on; XON/XOFF off
  2 = Automatic recognition off; XON/XOFF on
  3 = Automatic recognition on; XON/XOFF on

MC773 Data I/O Overflow capacity of internal buffer
  0...128 = Number of characters the CNC must be able to receive after it has sent a stop command through CTS or XOFF. Default value is 5.

MC775 V24 Number of stopbits transmitted
  0 = One stopbit
* 1 = Two stopbits

MC776 RS232C Baudrate for reading data
  110...4800 = Baudrate at which data has to be transmitted from the peripheral to the CNC. Default value is 2400.

MC777 RS232C Baudrate for transmitting data
  110...4800 = Baudrate at which data has to be transmitted by the CNC. Default value is 2400.

MC785 RS422 Number of stopbits transmitted
  0 = One stopbit
* 1 = Two stopbits

MC786 RS422 Baudrate for reading and transmitting data
  110...4800 Default value is 2400.

MC796 Check for multiple line numbers within part program
  0 = Check
  1 = No check (higher speed for large programs)

DATA FORMAT

The data format divides the data stream in records.
A record is a sequence of data fields terminated by the LF (line feed)-character.
The LF-character may be preceded by the CR (carriage return)-character.
The last record of a data stream must be followed by an EOT-character.
A record consists of one or more data fields. A data field consists of an address-specifier and an optional number. No spaces are allowed between specifier and number.
An address-specifier is an uppercase letter (A to Z).
A number is a sequence of decimal digits (0 to 9) followed by an optional dot (.) and one or more decimal digits.
The data fields may be separated by one or more space-characters, but do not require separators.

FORMAT SYNTAX SPECIFICATION

The Backus-Nauer-Format (BNF) describes a programming language or Format syntactically. By using BNF it is possible to specify which sequence of symbols constitute a syntactically vaid Format.
The variable to be defined is a string of symbols which are permitted in the given language.
The definition of the variable may be used recursively.
The variables are enclosed in the symbols ´<´ and ´>´ in order to distinguish them from symbols in the language itself.
BNF utilizes a number of special relational characters:

::= is used to indicate equivalence
| ´or´-symbol for separating the possible options; for example ´A´ | ´B´ | ´C´ means either A or B or C.
{ } the pattern specified between curly braces is repeated zero or more times
[ ] The pattern specified between brackets is repeated one or more times

```
<datastream>   ::=  <leader> <memspec> { <datarecord> } EOT
<memspec>      ::=  ´%´ <letters> <letter> [ CR ]  LF
<datarecord>   ::=  { <datafield> }  [ CR ]  LF
<datafield>    ::=  <truedata> | <comment>
<truedata>     ::=  <address-spec>  [ <number> ]
<comment>      ::=  ´(´ <printables> ´)´
<address-spec> ::=  <letter> | <special>
<special>      ::=  <letter> <integer> ´=´
<number>       ::=  [ ´-´ | ´+´ ]  <integer>  [ ´.´ <integer> ]
<integer>      ::=  <digit> { <digit> }
<digit>        ::=  ´0´ | ´1´ | ... | ´8´ | ´9´
<letter>       ::=   ´A´ | ´B´ | ... | ´Y´ | ´Z´
<leader>       ::=   { NUL }
```

<datafield> may be separated by one or more blank characters (20h).
<printables> are all printable ASCII characters (20h up to 7Eh) except for character ´}´.

Data format examples

In the following examples an LF character appears at the beginning of a new line and the EOT-character is represented by ´^D´. The leader is not shown.

```
%PM
N9000 (this is the program number)
N1 G0 X1 Y2 Z4
N2       Y-3.1234
N3 E1=-23.4
N5 M30
^D

%TM
T1 L1 R0.5
T4 L4.55 R10.2
^D
```

TRAILING CHARACTERS

After a data transfer, i.e. after the EOT-character, a trailer consisting of NUL-characters is produced by the CNC. Most peripherals will accept and store these characters. When the CNC reads data it will deactivate the line after the EOT-character has been received. This means that the peripheral cannot send the trailer characters. For most peripherals this does not present any problems. However, when the transmitting peripheral is another CNC, a problem arises. The transmitting CNC cannot send its trailer characters and will be blocked . The CNC must be forced to exit the data input/output mode.

AUTOMATIC RECOGNITION OF CHARACTER CODES

The CNC can identify the character set that it has received. For this use is made of the %-character of the memory identifier. Since Telex employs a shift-code to switch between two character subsets, the automatic recognition cannot work. Telex has to be specified explicitly by means of the appropriate machine constant (MC771). The automatic recognition feature must be turned off by assigning 0 to MC772.

CHARACTER SET OVERVIEW

ASCII-code

In accordance with the American Standard Code for Information Interchange the 7-bit code is transmitted in a 8-bit byte with 0 as the most significant bit.

ISO-code (DIN 66024)

This code is equivalent to the ASCII-code, its most significant bit being such that the number of ones in the byte is even. This is called even-parity. This code is recommended since the ASCII-set on which it is based is the most universal code used in computer industry.
ISO has the additional advantage of parity-check for detecting errors.

EIA-code (EIA RS-244-A)

A character code in accordance with the EIA-standard RS-244-A.
EIA-code is not recommended since it is hardly used at present and incompatible with most of the modern computers. XON/XOFF flow control cannot be used in combination with EIA-code.

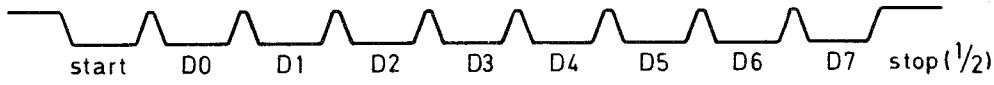
TELEX-code

A 5-bit code compatible with old equipment. XON/XOFF flow control cannot be used in combination with Telex-code. This code is not recommended. It is included only for its compatibility with old equipment.

Note:
The employment of Telex-code or EIA-code does not allow the XON/XOFF flow control to be used. This is due to the fact that the codes used for the XON and XOFF characters are significant data characters of these codes. Hence, only RTS/CTS handshake can be used.

CHARACTER FRAME ENCODING

All the codes are fitted into the same character frame. This is the common asynchronous serial transmission format.



NB7051

D0 is the least significant and D7 the most significant bit of the data byte. The ASCII, ISO and EIA characters are simply mapped onto this frame. The values in the table are hexadecimal bytes which fit into the 8 bits of the frame.

Telex-code is an exception. The numbers in the table are the hexadecimal values of the data bytes. However, the true Telex-code is different.
The mapping of Telex-code onto the byte is as follows:

Data byte	D0	D1	D3	D3	D4	D5	D6	D7	D8
Telex-code	0	T4	T3	T2	T1	T0	0	0	0

Note that the values is the table are the ´data bytes´.

CHARACTER SET TABLES

The following table specifies the hexadecimal codes used in the supported character sets for representing the characters in the first column.

Character	ASCII	ISO	EIA	TELEX
NUL	00	00	7A/7C	00
EOT	04	84	2C	(C) 34
BS	08	88	2A	--
TAB	09	09	3E	--
LF	0A	0A	80	04
CR	0D	8D	80	10
XON	11	11	--	--
XOFF	13	93	--	--
space	20	A0	10	08
%	25	A5	5B	(C) 32
(	28	28	2F	(C) 1E
)	29	A9	5E	(C) 24
*	2A	AA	0A	(C) 0A
+	2B	2B	70	(C) 22
´	2C	AC	3B	(C) 18
-	2D	2D	40	(C) 06
.	2E	2E	6B	(C) 38
/	2F	AF	31	(C) 3A
0	30	30	20	(C) 2C
1	31	B1	01	(C) 2E
2	32	B2	02	(C) 26
3	33	33	13	(C) 02
4	34	B4	04	(C) 14
5	35	35	15	(C) 20
6	36	36	16	(C) 2A
7	37	B7	07	(C) 0E
8	38	B8	08	(C) 0C
9	39	39	19	(C) 38
:	3A	3A	--	(C) 1C
=	3D	BD	1C	(C) 3C

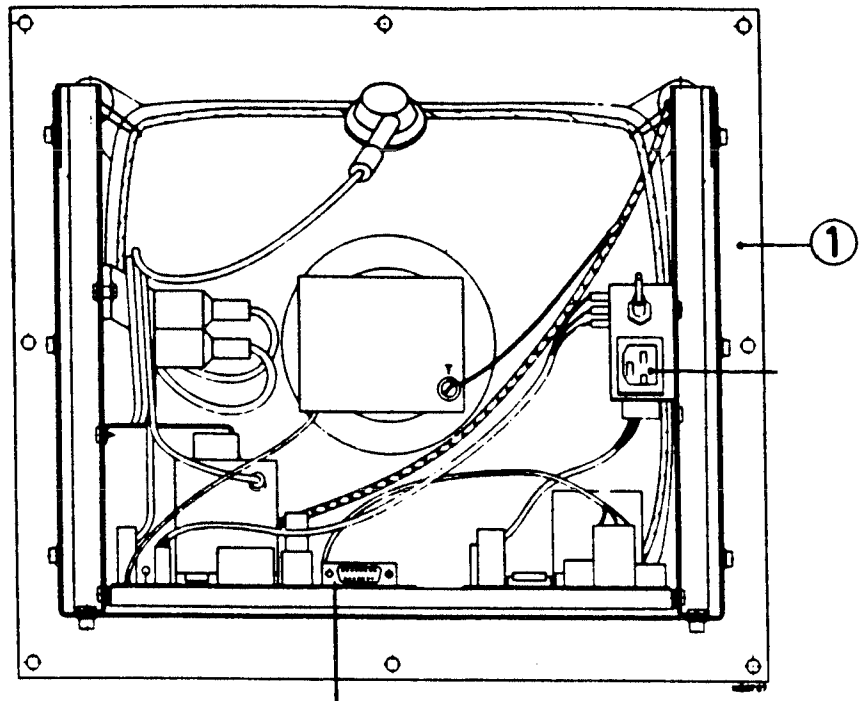
Character	ASCII	ISO	EIA	TELEX
A	41	41	61	(L) 06
B	42	42	62	(L) 32
C	43	C3	73	(L) 1C
D	44	44	64	(L) 12
E	45	C5	75	(L) 02
F	46	C6	76	(L) 1A
G	47	47	67	(L) 34
H	48	48	68	(L) 28
I	49	C9	79	(L) 0C
J	4A	CA	51	(L) 16
K	4B	4B	52	(L) 1E
L	4C	CC	43	(L) 24
M	4D	4D	54	(L) 38
N	4E	4E	45	(L) 18
O	4F	CF	46	(L) 30
P	50	50	57	(L) 2C
Q	51	D1	58	(L) 2E
R	52	D2	49	(L) 14
S	53	53	32	(L) 0A
T	54	D4	23	(L) 20
U	55	55	34	(L) 0E
V	56	56	25	(L) 3C
W	57	D7	26	(L) 26
X	58	D8	37	(L) 3A
Y	59	59	38	(L) 2A
Z	5A	5A	29	(L) 22
DEL	7F	FF	7F	1F

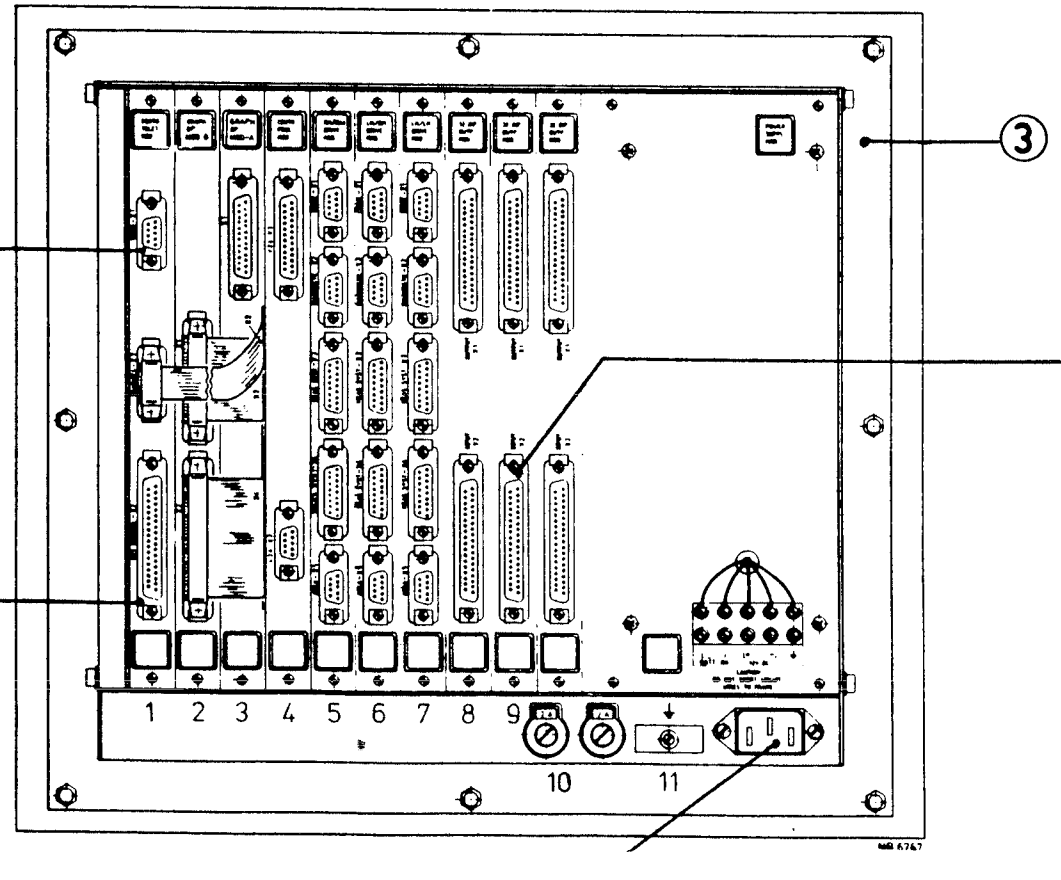
Remarks:

The Telex-code uses shift codes to change the meaning of the following codes.
When a letter-code (3E) is transmitted, all the following characters will belong to the letter-set (preceded by (L) in the table).
When a Cypher-code (3A) is transmitted, all the following characters will belong to the cypher-set (preceded by (C) in the table).
Characters not preceded by (L) or (C) in the table are independent of the shift state.

EIA-code uses shift codes to differentiate between uppercase and lowercase. These shift codes are ignored by the CNC.
It is not possible to employ XON/XOFF flow control with EIA, as the XON/XOFF-codes would overlap with significant data.

In case of ASCII and ISO character sets, a translation is used. This means that all character codes not listed in the above table will be ignored. All lowercase letters (a to z) will be translated into uppercase letters (A to Z).



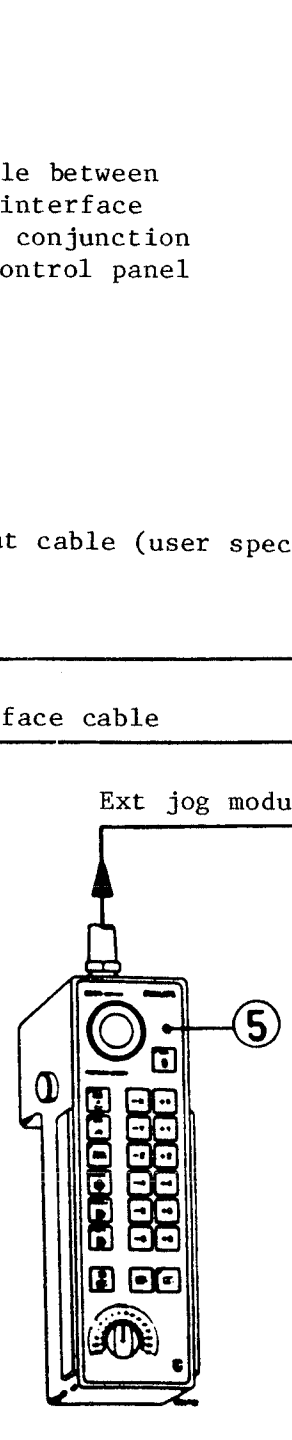


Note :
The interface cable between control unit and interface is only needed in conjunction with the Remote control panel

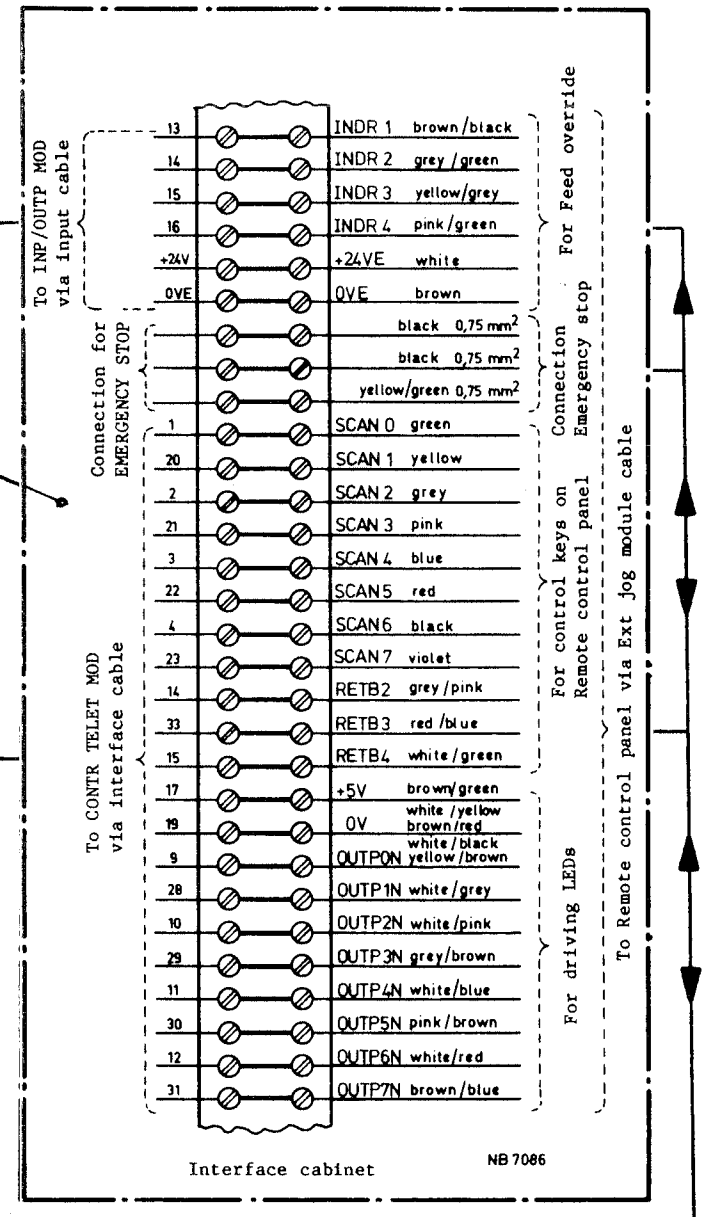
Input cable (user specific)

Interface cable

Ext jog module cable



NB6862



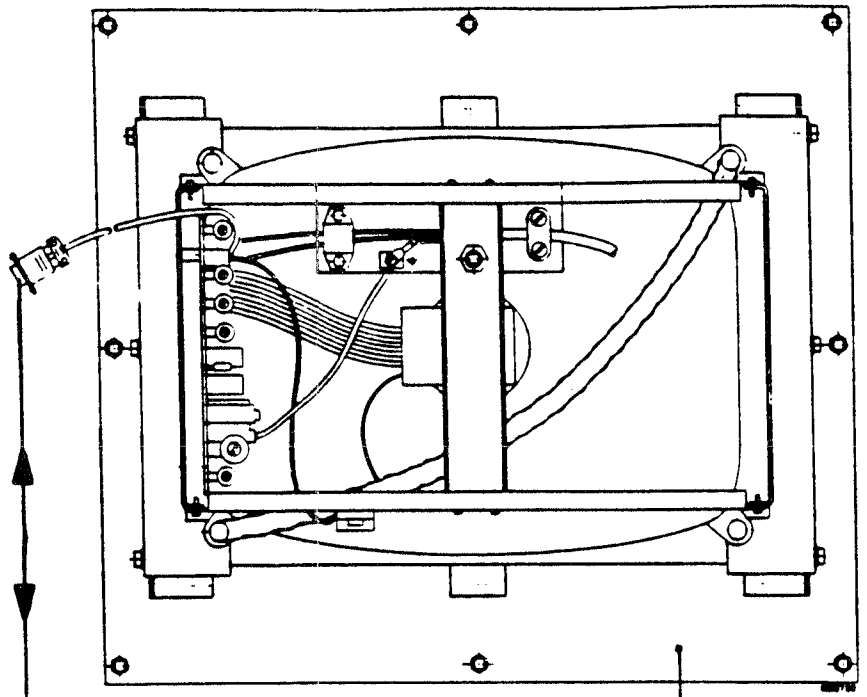
(1) Colour monitor 14"

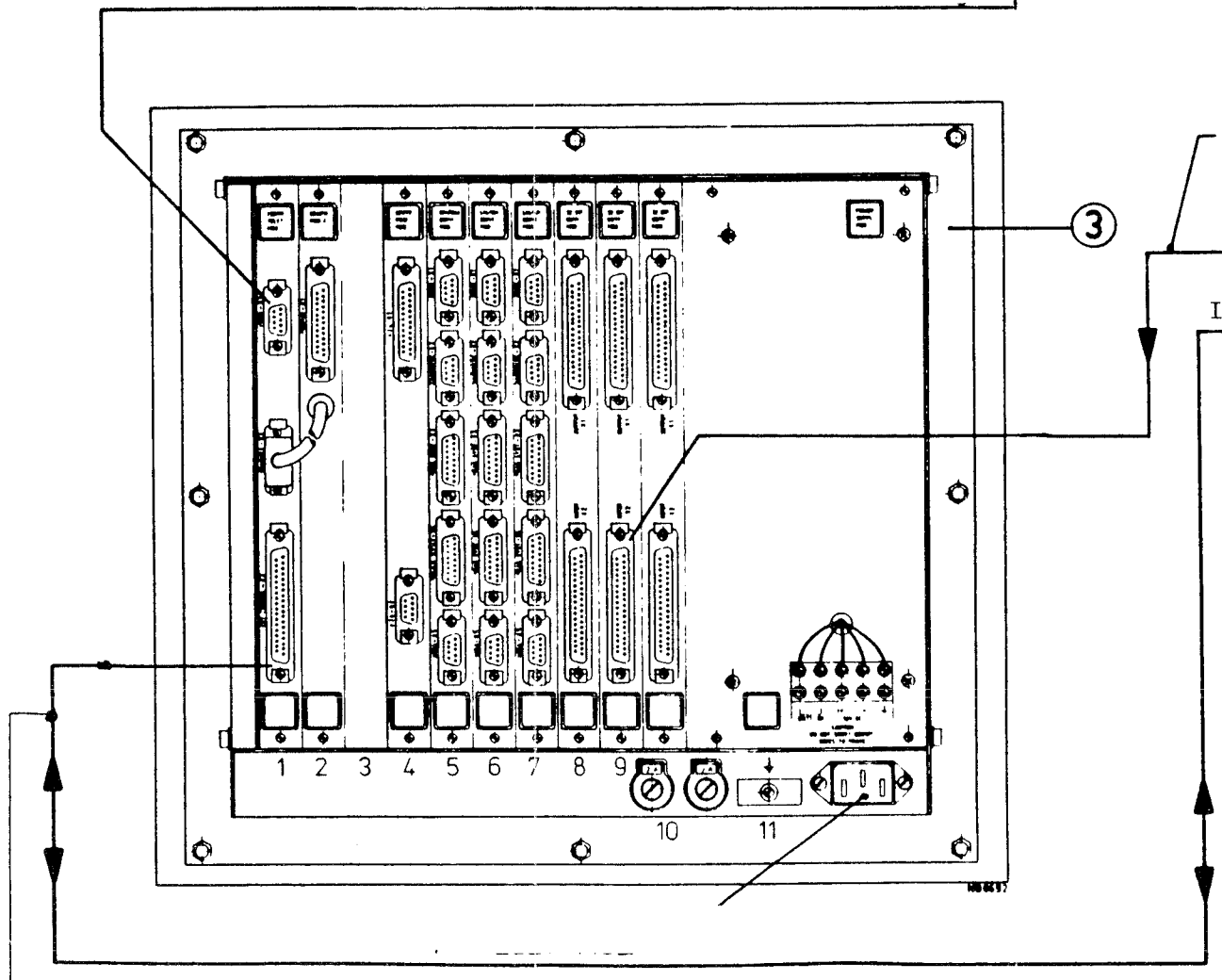
(3) CNC 3460 control unit
(4) Interface cabinet
(5) Remote control panel

Fig. 16.-1
CNC 3460 Connection plan
Option I: with colour monitor

Attention :
When fitting the 37-way plug to the cable, do not wire pins 16, 34, 35, 36 and 37, otherwise interference may be caused to the control unit.

Note :
The interface cable between control unit and interface is only needed in conjunction with the Remote control panel

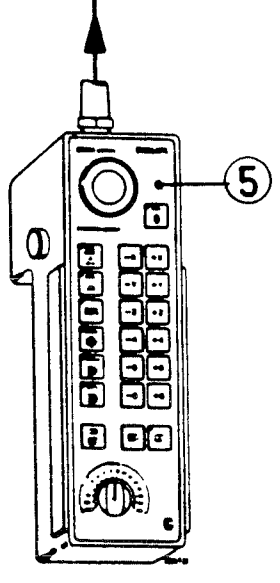


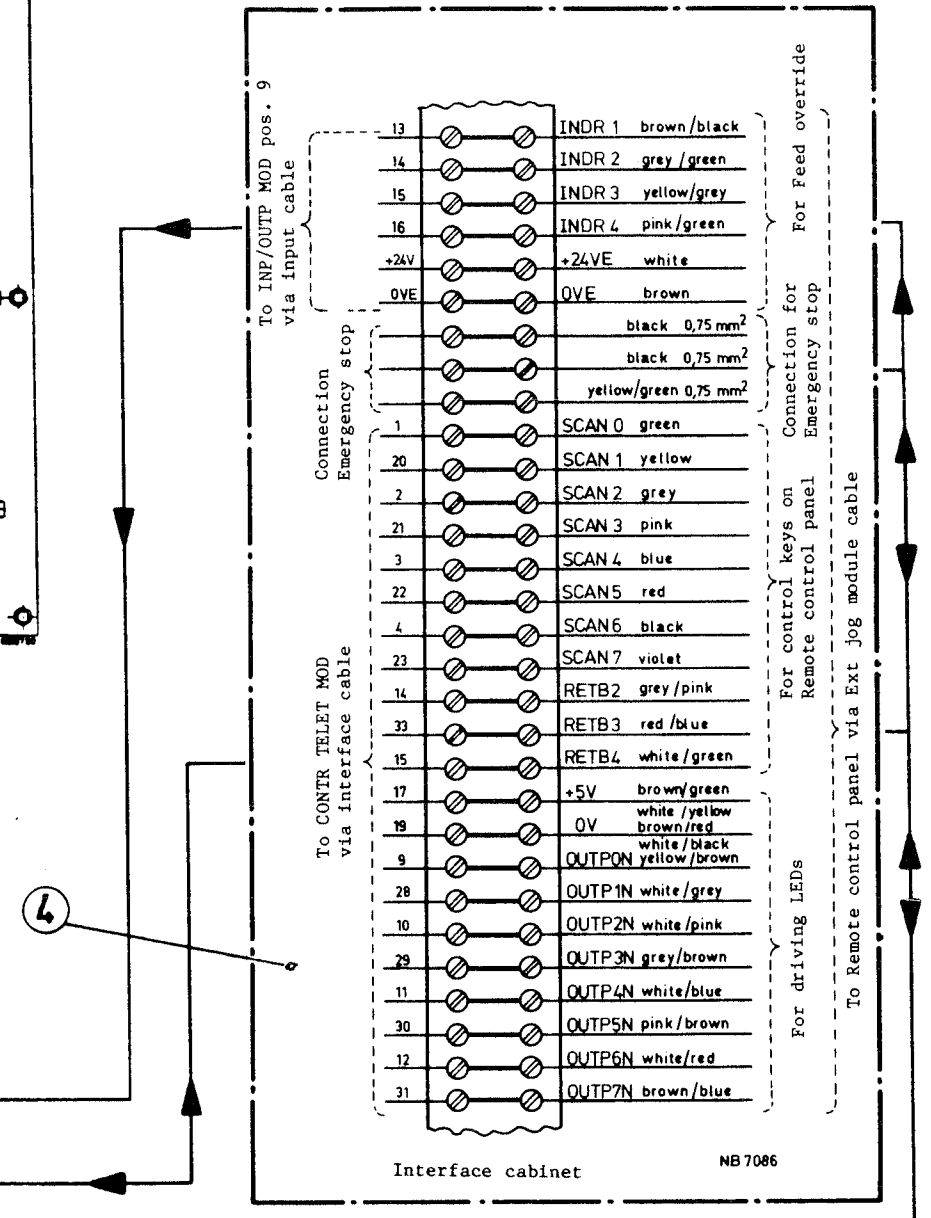


Input cable (user specific)

Interface cable

Ext jog module cable



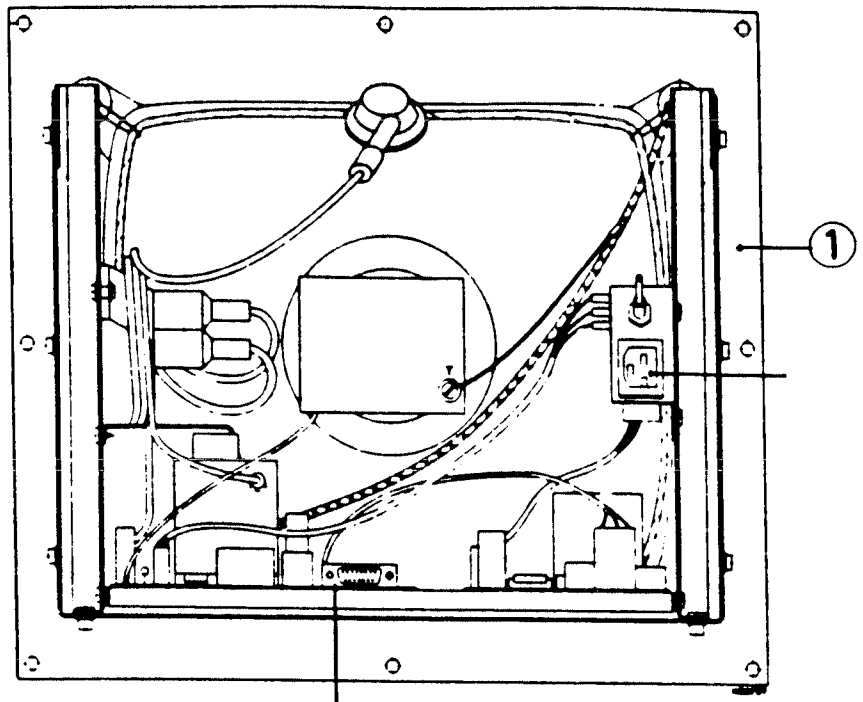


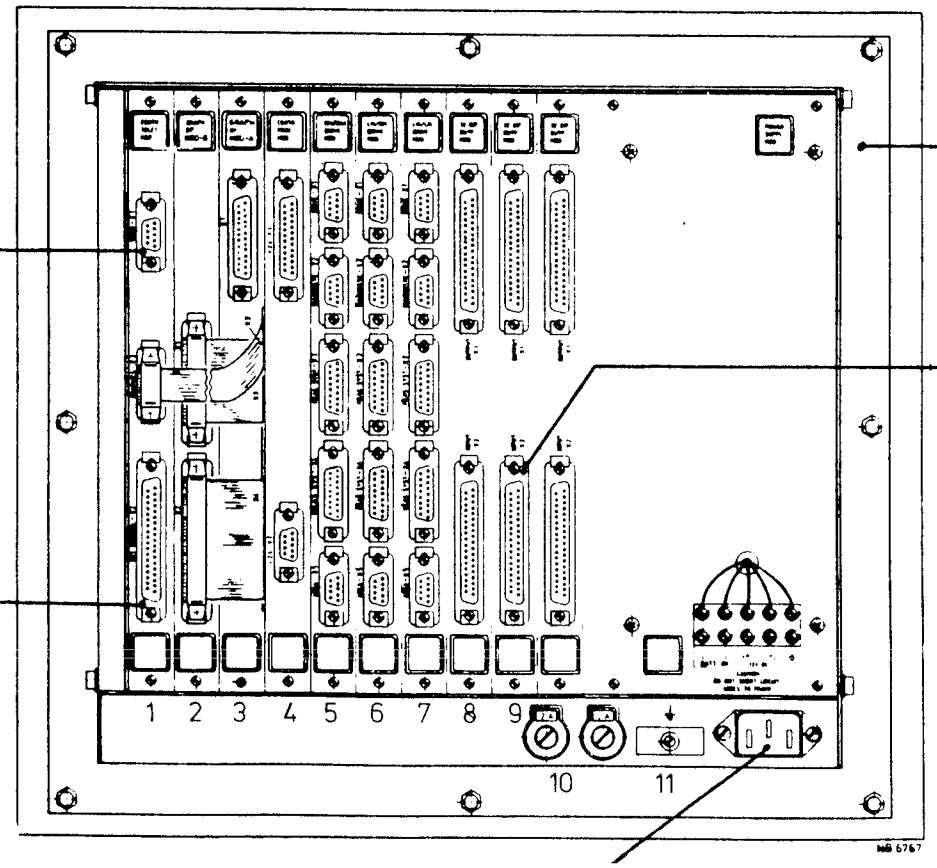
(2) Monochrome monitor 12"
(3) CNC 3460 control unit
(4) Interface cabinet
(5) Remote control panel

NB6863

Fig. 16.-2
CNC 3460 Connection plan
Option II: with monochrome monitor

Attention :
When fitting the 37-way plug to the cable, do not wire pins 16, 34, 35, 36 and 37, otherwise interference may be caused to the control unit





Rear of control panel

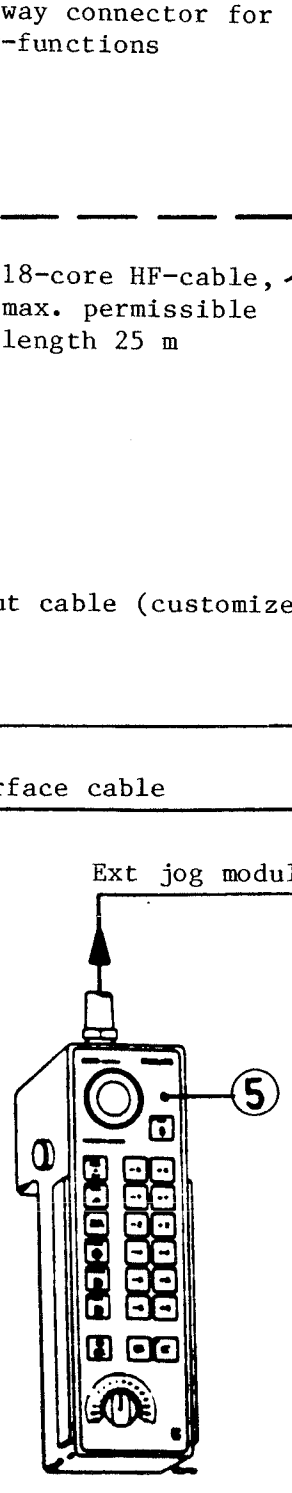
25-way connector for key-functions

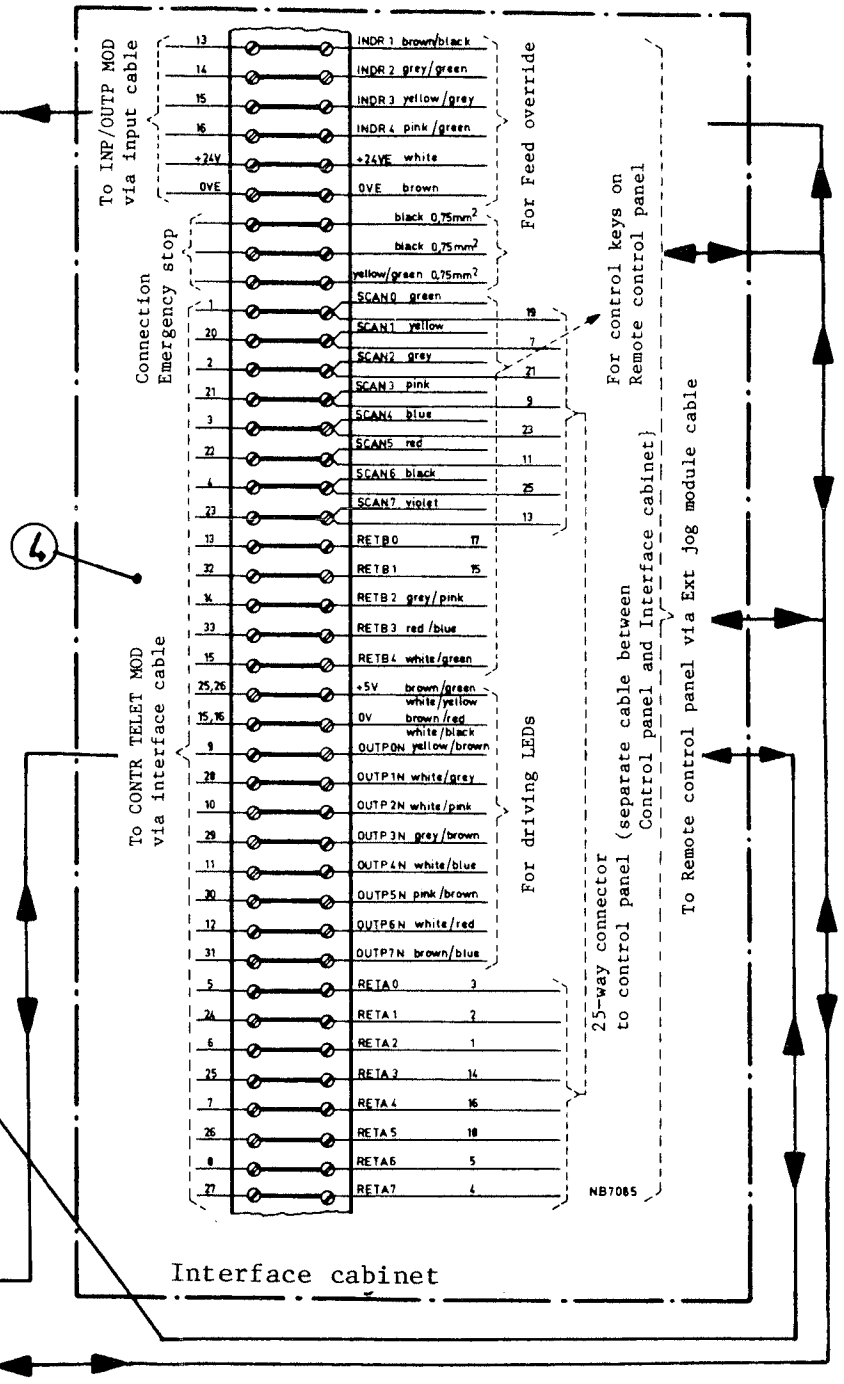
18-core HF-cable, max. permissible length 25 m

Input cable (customized)

Interface cable

Ext jog module cable



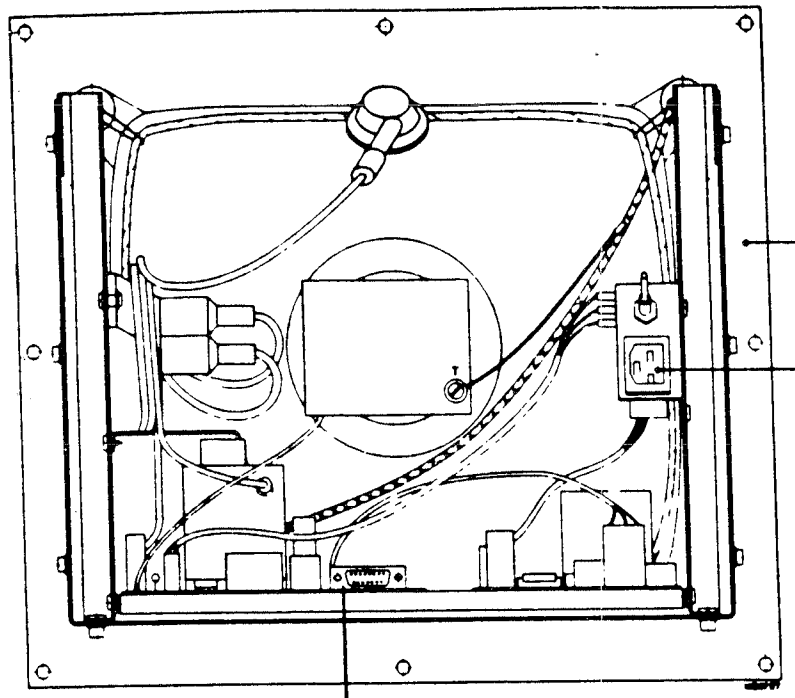


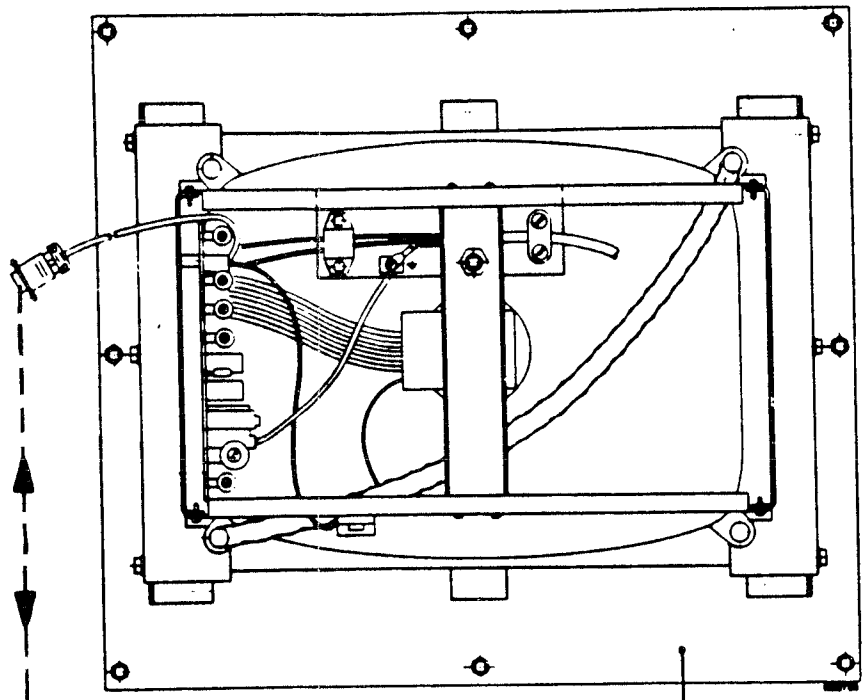
(1) Colour monitor 14"
(2) Control panel
(3) CNC 3460 control unit
(4) Interface cabinet
(5) Remote control panel

NB6864

Fig. 16.-3
CNC 3460 Connection plan
Option III: with externally connected control panel

Attention :
When fitting the 37-way plug to the cable, do not wire pins 16, 34, 35, 36 and 37, otherwise interference may be caused to the control unit

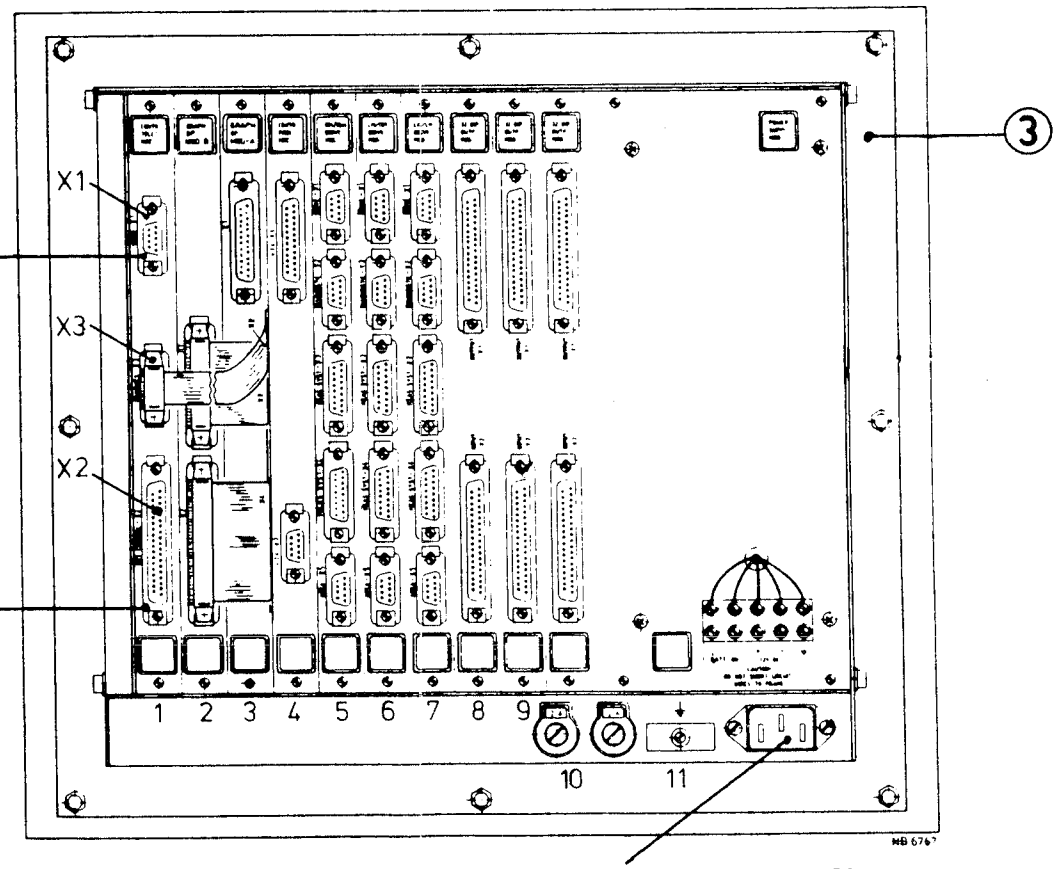




Rear of control panel

25-way connector
for key functions

18-core screened cable,
max. permissible length
25 m

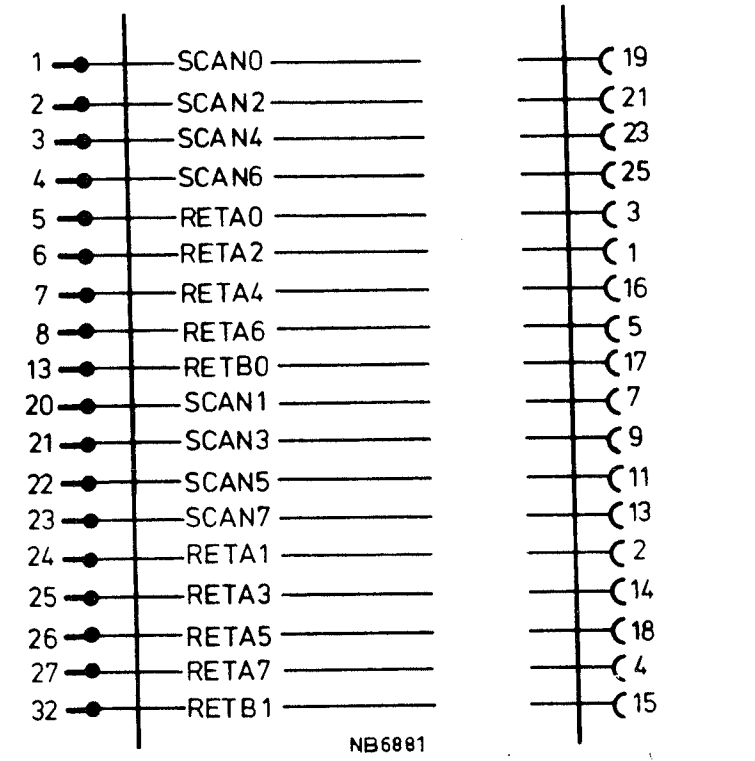


Platz-Nr.	Benennung
1	CONTROL TELETEXT MODUL
2	GRAPHIK 8P MODUL-B
3	GRAPHIK 8P MODUL-A
4	CENTRAL PROCESSOR MODUL
5	RM/RM DRIVE MODUL
6	LM/RM DRIVE MODUL
7	LM/LM DRIVE MODUL
8	32 INPUT/OUTPUT MODUL
9	32 INPUT/OUTPUT MODUL
10	32 INPUT/OUTPUT MODUL
11	POWER SUPPLY MODUL

— Modulbestückung —

(1) Colour monitor 14"
(2) Monochrome monitor 12"
(3) CNC 3460 control unit
(4) Control panel

Note :
Either the colour monitor
or the monochrome monitor
may be employed; choise to be
made by customer



37-way connector to
X2 on CONTR TELET MOD

25-way connector
to control panel

NB 6884

Fig. 16.-4
CNC 3460 Connection plan
Option IV: with externally connected
control panel and without remote
control panel

Attention :
When fitting the 37-way plug to the cable, do not wire pins 16, 34,
35, 36 and 37, otherwise interference may be caused to the control unit

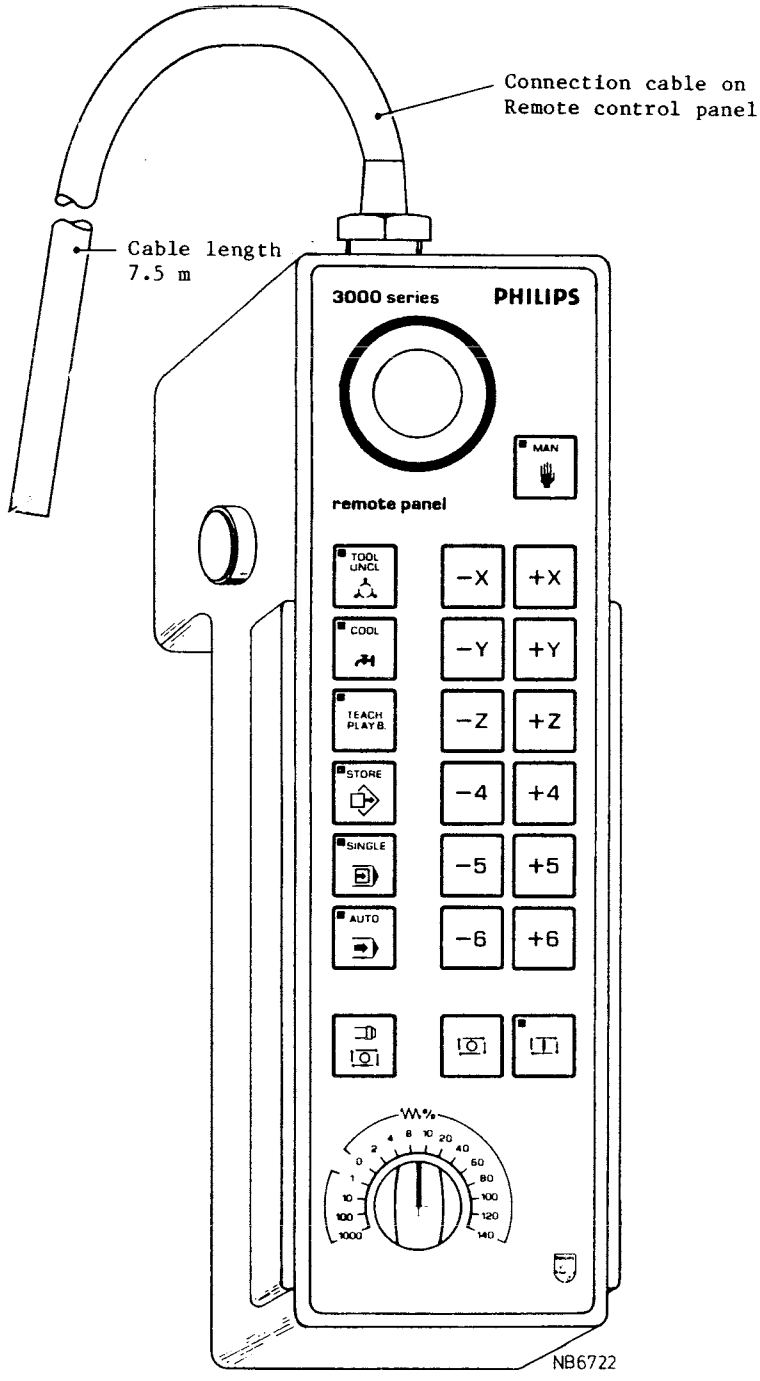
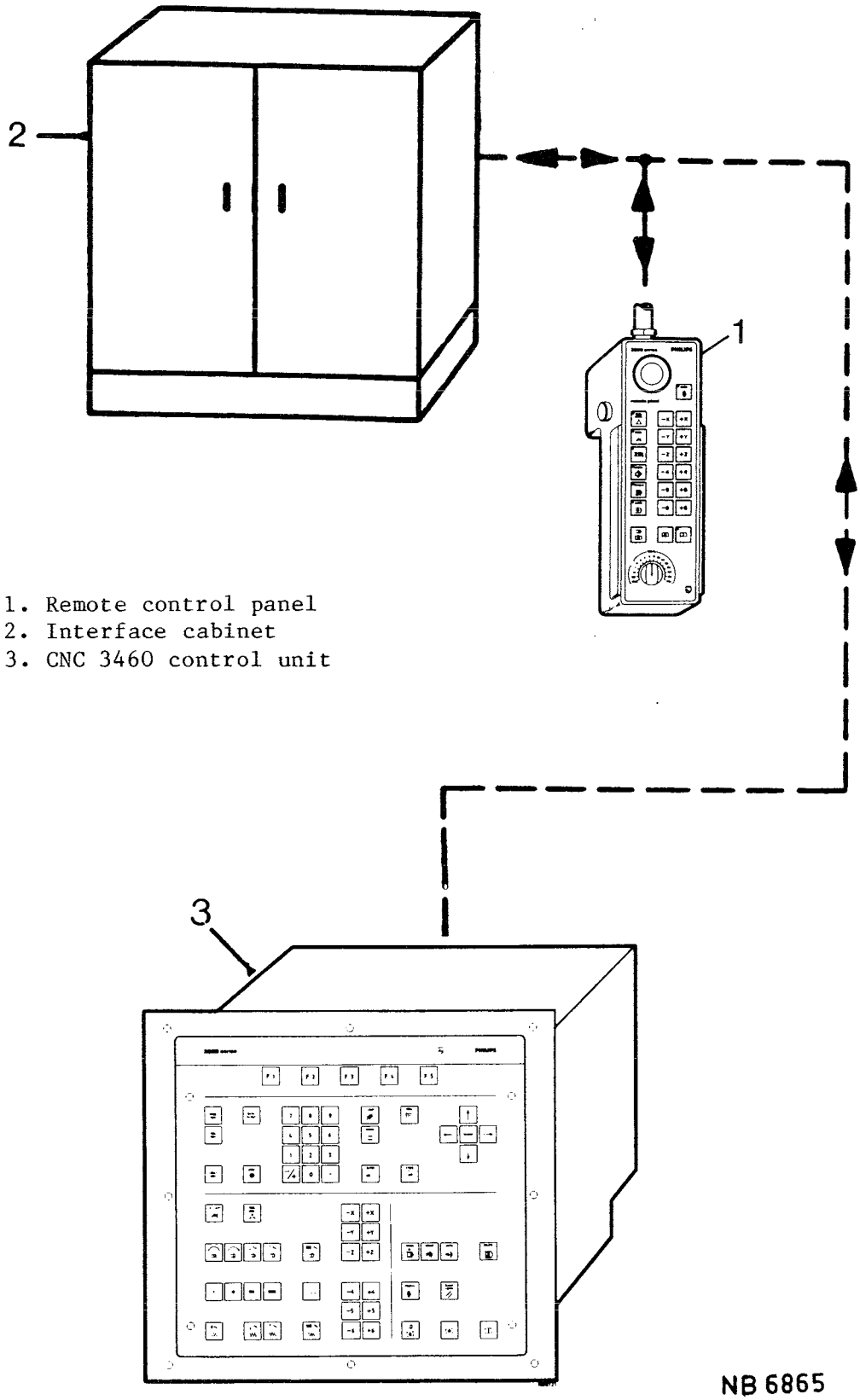


Fig. 17.-1 Remote control panel

Application :

The Remote control panel (optional) is connected to the interface cabinet and enables the machine tool to be remotely manually controlled.
The control keys on this panel have the same functions as the control keys on the control unit of the CNC 3460.



1. Remote control panel
2. Interface cabinet
3. CNC 3460 control unit

Fig. 17.-2 Interconnection of Remote control panel, Interface cabinet and Control unit

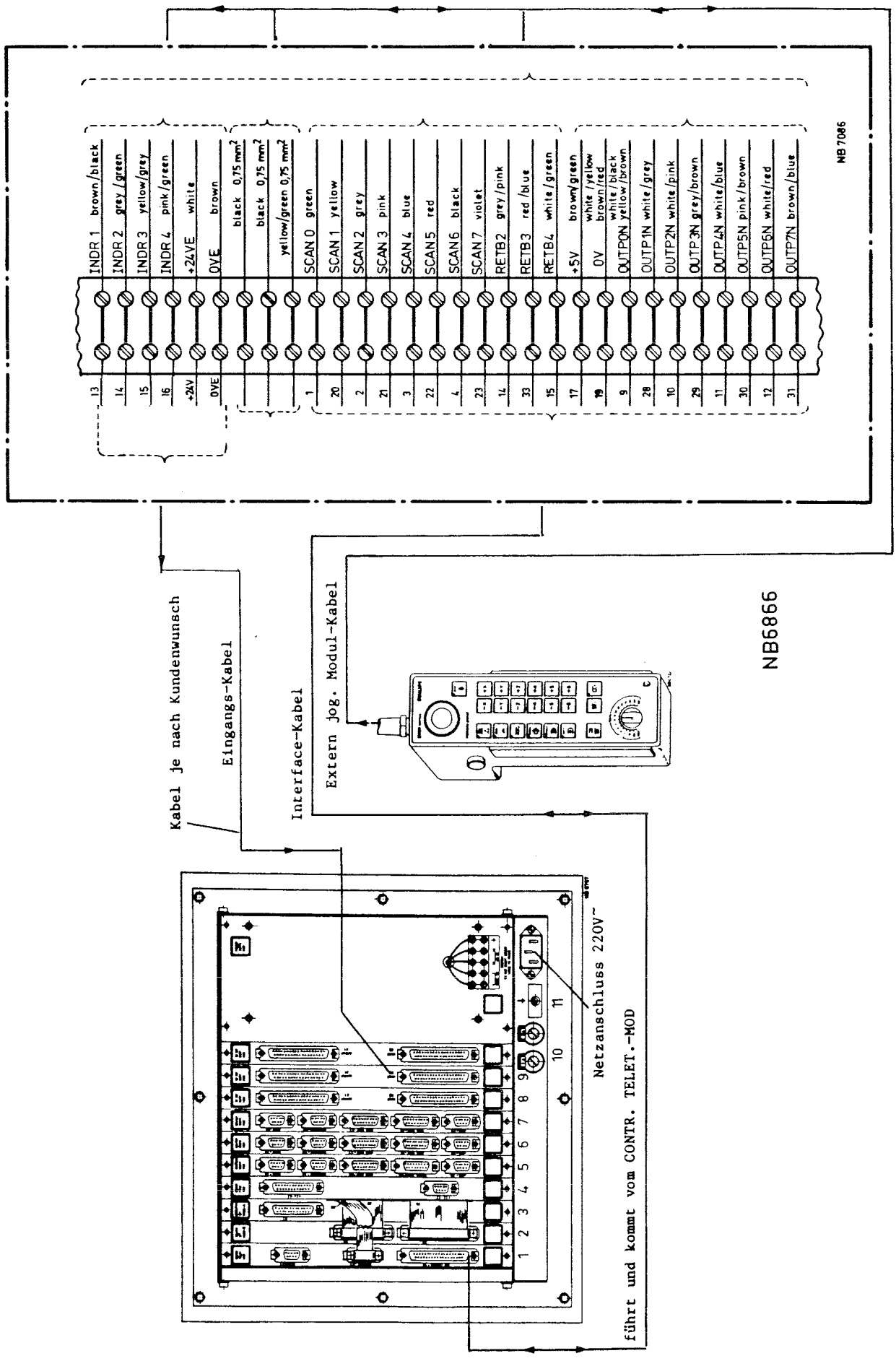


Fig. 17.-3 Diagram illustrating connection of Remote control panel to CNC 3460 control unit via Interface cabinet

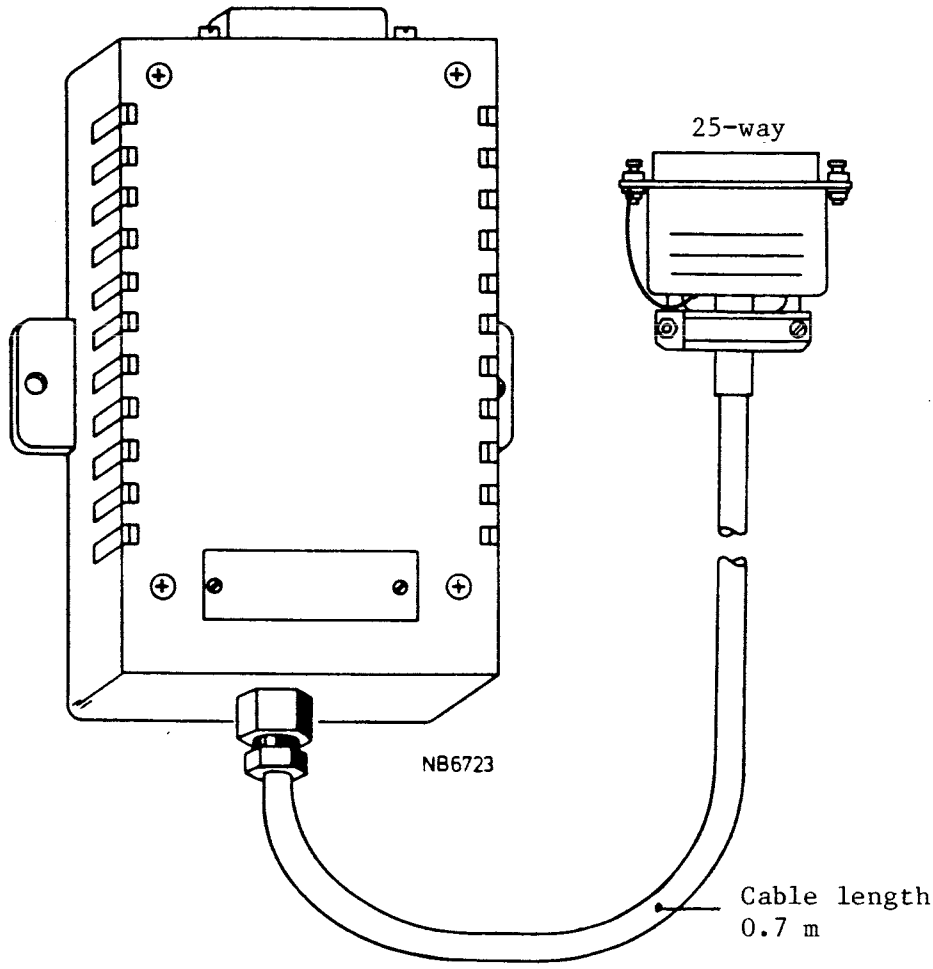
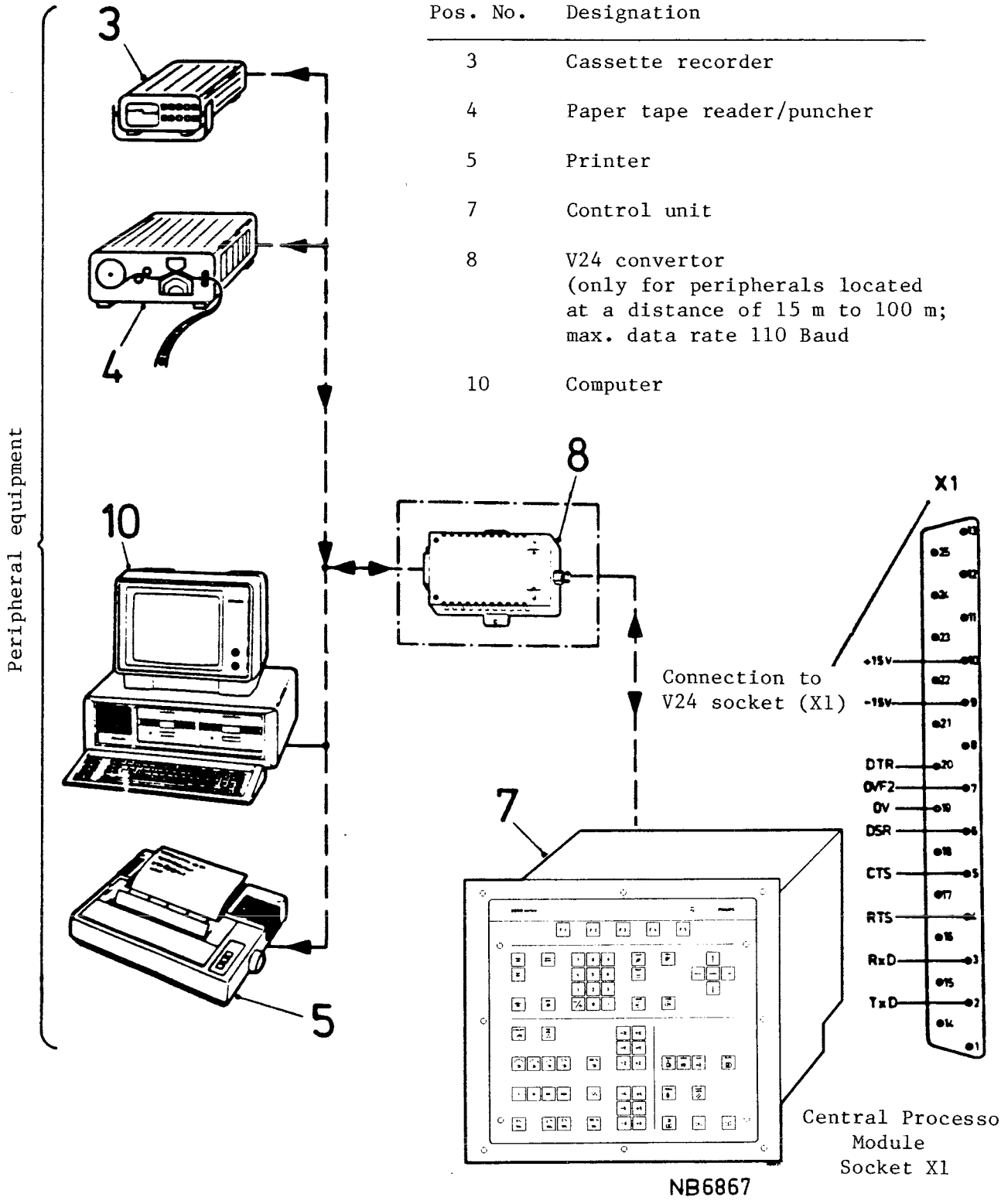


Fig. 18.-1 V24/Current loop convertor assembly

Application :

To be employed for a) Cassette recorder
b) Paper tape reader/puncher
c) Computer
d) Printer

located at a distance up to 100 m from the CNC 3460 control unit, so as to ensure a correct data signal transfer.



Pos. No.	Designation
3	Cassette recorder
4	Paper tape reader/puncher
5	Printer
7	Control unit
8	V24 convertor (only for peripherals located at a distance of 15 m to 100 m; max. data rate 110 Baud
10	Computer

Fig. 18.-2 Application of V24/Current loop convertor.
Pin assignment of V24 socket on Central processor module.

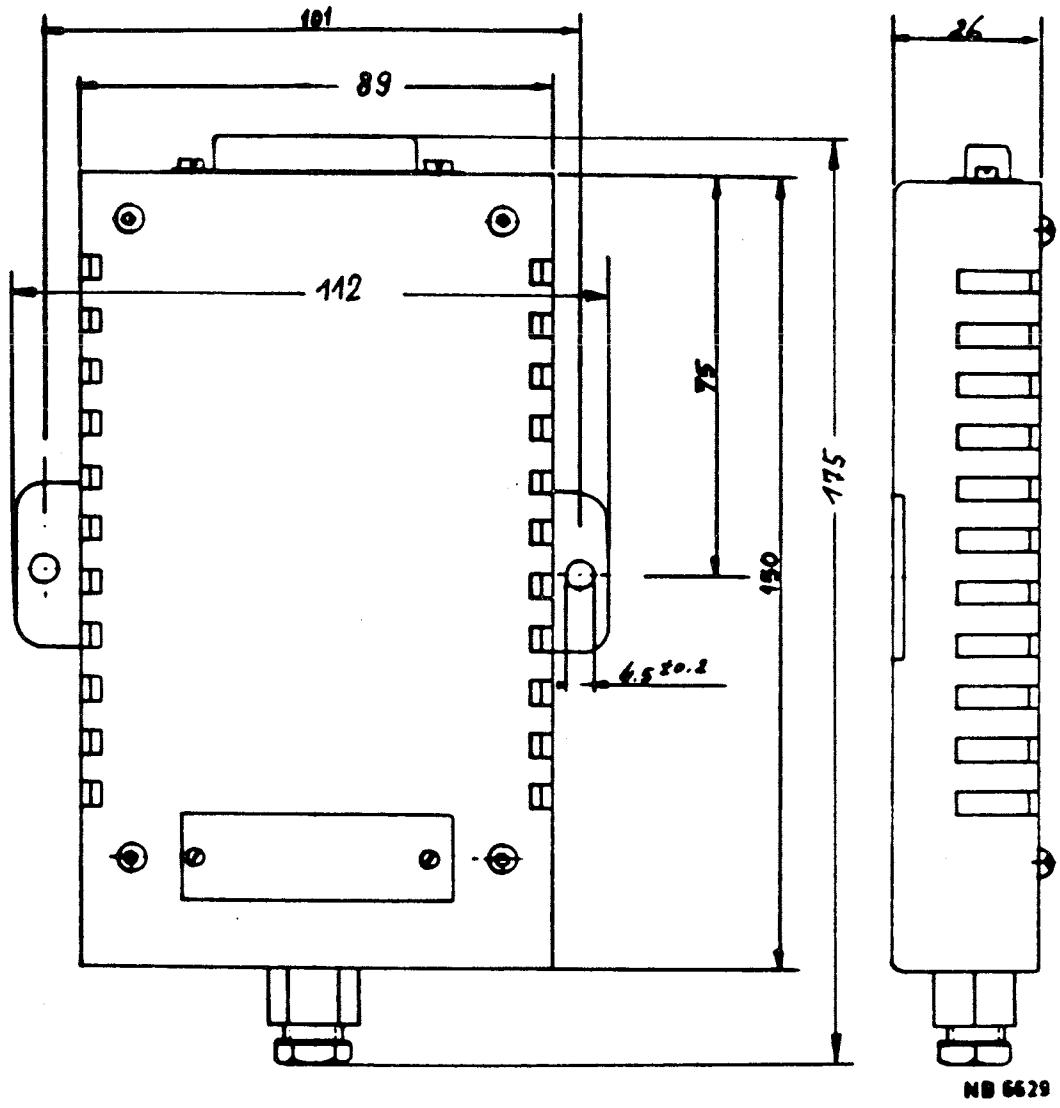


Fig. 18.-3 Mounting dimensions of V24/Current loop convertor

The V24/Current loop convertor is provided with 2 shackles with 4.5 mm holes for screw-mounting

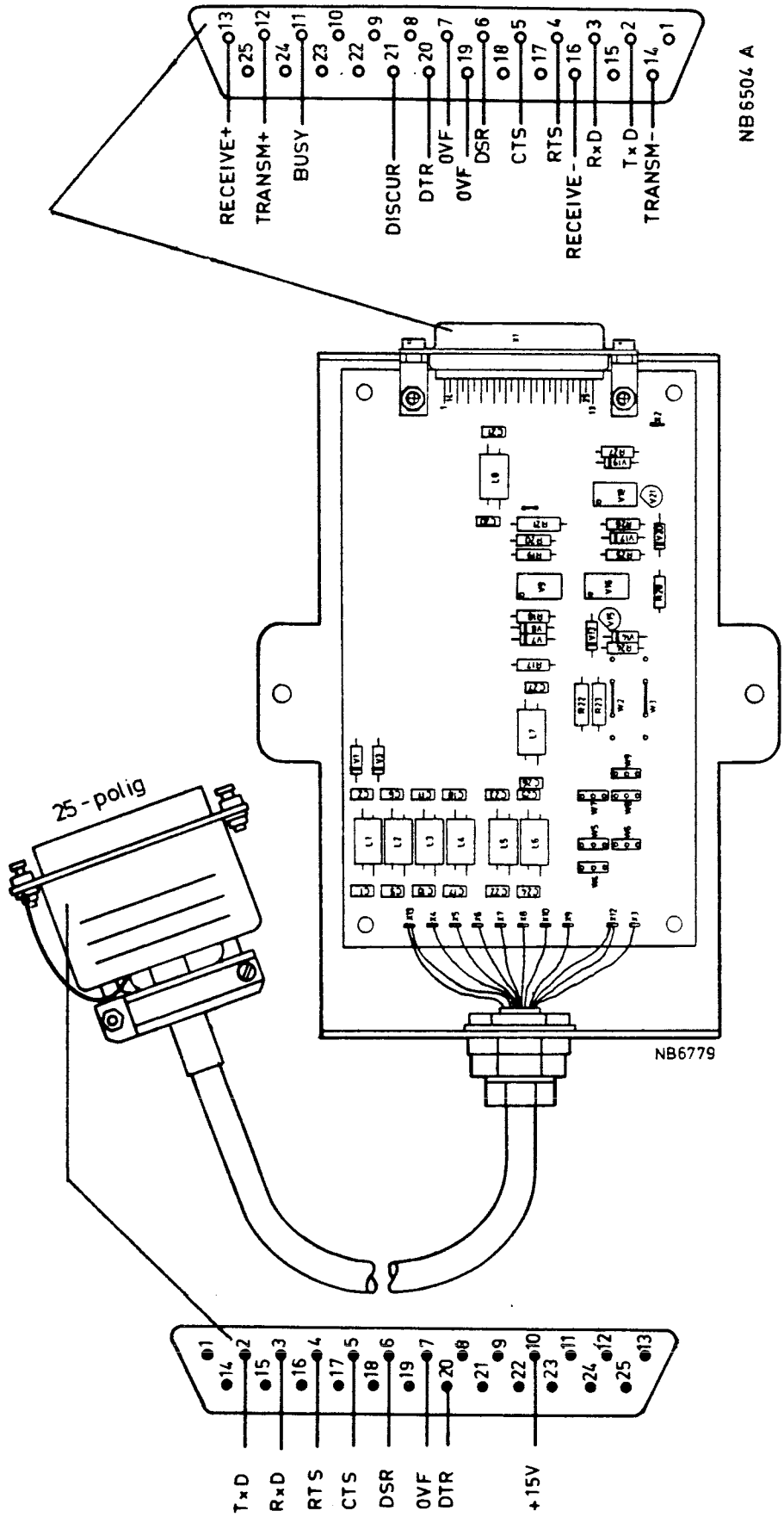


Fig. 18.-4 Inside view of V24/Current loop convertor, showing pc board. Pin assignment of input and output connectors.

Connector X1 on V24 convertor

Pin No.	Input/ Output	Mnemonic	Description
1			Not used
2	Input	TxD	Transmitted data: data from peripheral to convertor
3	Output	RxD	Received data: data from convertor to peripheral
4	Input	RTS	Request to send: peripheral indicates that it is ready to receive data
5	Output	CTS	Clear to send: convertor indicates that it is ready to receive data
6	Output	DSR	Data set ready: indicates that the convertor is enabled
7		OVFF	
8/9			Not used
10		+15V	
11		Busy	Busy= "H": data input is active
12		Transm+	+ External current source for transmitter
13		Receive+	+ External current source for receiver
14		Transm-	- External current source for transmitter
15			Not used
16		Receiv-	- External current source for receiver
17/18			Not used
19		OVF	
20	Input	DTR	Data terminal ready: indicates that the peripheral is enabled
21		Discur	Disable current mode
22/25			Not used
Conn. housing :		screen	X2//X3

The V24 mode causes the current loop circuits to be disabled by means of DISCUR.

CONNECTION BETWEEN V24 CONVERTOR AND PERIPHERAL IN V24 MODE

For the V24 mode, the 25-pin connectors on the connection cable between V24 convertor (X1) and peripheral are wired as illustrated in figure 18.-5.

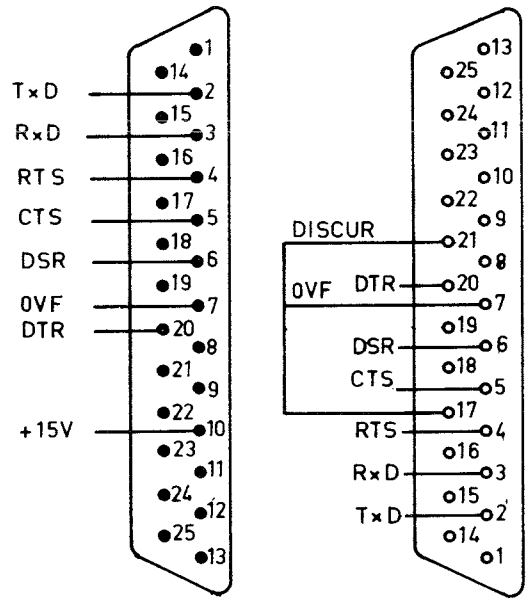


Fig 18.-5 Wiring of connectors for V24 mode

DATA INPUT/OUTPUT

"Data input" is applied to pin 2 of X1 (TxD).

"Data output" is applied to pin 3 of X1 (RxD).

These signals are filtered in the V24 convertor only.

BAUDRATE

The baudrate in V24 mode may be set between 50 and 9600 baud. The baudrates of DCE and peripheral should be the same.

JUMPER SETTINGS

In the V24 mode no jumpers need to be set.

PERIPHERALS

All peripherals having a V24 connection may be connected to the V24 convertor. Examples: digital cassette recorder, floppy disk unit, paper tape reader/puncher, etc.

CURRENT LOOP MODE

After the baud rate and the jumpers have been set the data to be transmitted or received is converted from a voltage controlled signal into a current controlled signal.

Note: the jumpers W4 up to W9 are only used in current loop mode.

When using the current loop mode it must be established whether modem and peripheral operate as receiver or transmitter and whether they are active of passive.

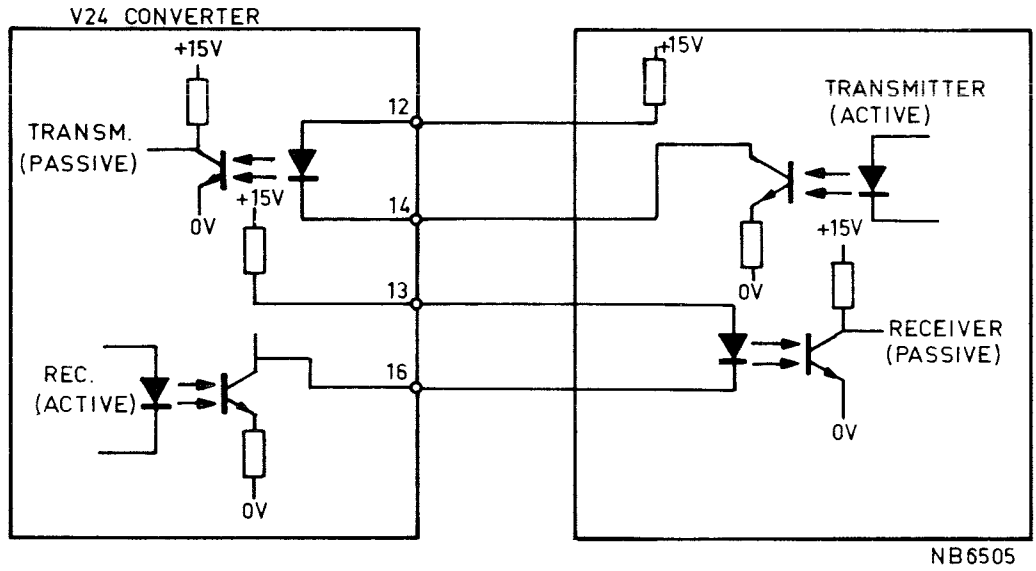


Fig. 18.-6 Block diagram for current loop mode

CONNECTION BETWEEN V24 CONVERTOR AND PERIPHERAL IN CURRENT LOOP MODE

For the current loop mode, the 25-pin connectors on the connection cable between V24 convertor (X1) and peripheral are wired as illustrated in figure 18.-7.

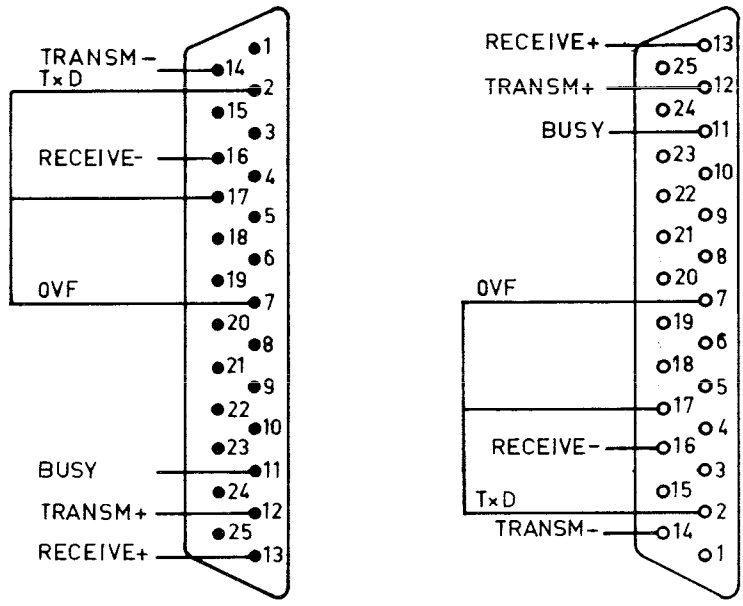


Fig 18.-7 Wiring of connectors for current loop mode

BAUDATE

The baudrate in current loop mode is set to 50 or 110 baud.
When the baudrate is in excess of 110 baud, the data will be affected as a result of the optocouplers being too slow.

JUMPER SETTINGS

The V24 convertor is adapted to the peripheral by means of the jumpers W4 to W9.

Peripheral		Jumper setting
Transmitter	Receiver	W4 W5 W6 W7 W8 W9
Active	Active	
Active	Passive	
Passive	Active	
Passive	Passive	

PERIPHERALS

20 mA current loop peripherals ar allowed to be connected to the V24-convertor.

Note: Check whether the receiver of transmitter is active or passive.

DATA INPUT/OUTPUT

Data input is effected via pin TRANSM + (12) and TRANSM - (14).
The data transmission is current driven and converted by means of optocouplers into a voltage driven transmission.

Data output is effected via pin RECEIVE + (13) and RECEIVE - (16).
The data transmission is current driven and converted in the peripheral into a voltage driven transmission.

XON/XOFF CONTROL

Machine constants allow XON/XOFF control to be activated.
Data will be transmitted by the peripheral on receipt of XON.
On receipt of XOFF the transmission will be stopped.

XON = DC1 = <contr. Q> in ASCII.
XOFF = DC3 = <contr. S> in ASCII.

MACHINE CONSTANTS FOR COMMISSIONING

The characteristics of the installation are to be defined by means of machine constants (MC).
Section 23 gives a survey of all machine constants used.

On the next pages the machine constants suitable for commissioning the numerical control have been listed. The information given in section 20 will be helpful in determining their provisional values for commissioning. Afterwards, all the values can be optimized with the help of the information given in section 23.
All the machine constants should be assigned a (provisional) correct value, otherwise the control will display error code 023 and no functions can be executed.

Remark: It is possible that not all the machine constants listed on the next pages are displayed, due to the fact that some machine constants are related to other machine constants. It is also possible that even after entering the provisional values for all the visible machine constants and after switching off the machine constant enable signal the display shows error 023.
After switching on the machine constant enable signal again the newly initiated machine constant(s) with the faulty value is displayed on the top of the machine constant display. Please refer to the next pages for the provisional values.

MC nr.	MC value	Description	Dimensions
CNC HARDWARE CONFIGURATION			
000	1	Number of I/O modules	0 = 1 I/O module 1 = 2 I/O modules 2 = 3 I/O modules
001	3	Number of meas. system inputs	1 = M.S. input 2 = M.S. inputs
002	80	RAM capacity	1 Kbyte
004	0	Remote control panel	0 = no remote panel 1 = safety switch on 2 = safety switch off 5 = external feed override
009	0	Graphics module	0 = no graphics 1 = 2-plane graphics 2 = 8-plane graphics
MACHINE TOOL CONFIGURATION			
010	3	Number of axes	min. 3 - max. 6
011	0	Plane initialization	0 = G17 1 = G18 2 = G19
014	71	Measuring system resolution	70 = Inch 71 = Metric
018	0	Tool change	0 = M06 manual 1 = M06 automatic
026	0	Retract sequence during M6	0 = no retraction 1 = tool axis 2 = Z - X axis 3 = Z - Y axis 4 = Z - (X+Y) axis
027	32	Number of tools	0 - 255
028	32	Number of tool positions	0 - 255
029	0	Tool life monitoring	0 = funct. not active 1 = error code display + program stop 2 = spare tool
030	0	Tool unclamp function	0 = funct. not active 1 = toggle button 2 = cont. button
031	0	Tool cutting force monitoring	0 = funct. not active 1 = error code display + program stop 2 = spare tool
035	0	Tool data output	0 = BCD-output 1 = four decade tool
042	0	External programm call	0 = funct. not active 1 = fixed PPM calls 2 = variable call memory

MC nr.	MC value	Description	Dimensions
043	0	Number ext. calls	0 - 255
044	0	Conditional jump	0 = jumps always executed 1 = jump execution depends on input
051	0	Activating analog spindle	0 = no analog spindle 1 = analog spindle activated
053	0	Decoded coolant M7 or M8	0 = not decoded 1 = decoded
061	3	Output M	0 = no output 1 = BCD 4 = decoded 5 = decoded + BCD
063	3	Output T	0 = no output 1 = LSD 2 = MSD 3 = LSD + MSD
064	0	Output S	0 = no output 1 = LSD 2 = MSD 3 = LSD + MSD
065	3	Output H	0 = no output 1 = LSD 2 = MSD 3 = LSD + MSD
CNC SOFTWARE CONFIGURATION			
080	0	Selection DEMO	0 = standard operation 1 = DEMO operation
081	0	Display mode	0 = distance to go 1 = following distance 2 = mode 0 + no RPF 3 = mode 1 + no RPF 4 = mode 2 + reset error after 1 sec. 5 = mode 3 + reset error after 1 sec.
082	0	Number of point definitions	0 - 255
083	0	Number of E-parameters	0 - 255
084	0	Display mode of directory	0 = with text 1 = with info
085	16	Number of part programs + sub programs	16 - 1000
090	32767	Display actual G	code number
091	127	Display actual M	code number

MC nr.	MC value	Description	Dimensions
AXES DEFINITIONS			
1st axis			
100	1	Closed/open loop	0 = not used 1 = closed loop 2 = open loop
101	1	Machine Constant block assignment	1 = par.block at MC200 2 = par.block at MC250 3 = par.block at MC300 4 = par.block at MC350 5 = par.block at MC400 6 = par.block at MC450
102	1	Code for axis orientation	1 = 1st.lin.axis pos. 2 = 2nd.lin.axis pos. 3 = 3rd.lin.axis pos. 4 = 1st.rot.axis pos. 5 = 2nd.rot.axis pos. 6 = 3rd.rot.axis pos.
103	88	ASCII-code for ident.	ASCII-coded (X=88)
2nd axis			
105	1	Closed/open loop	0 = not used 1 = closed loop 2 = open loop
106	2	Machine Constant block assignment	same as MC101
107	2	Code for axis orientation	same as MC102
108	89	ASCII-code for ident.	ASCII-coded (Y=89)
3rd axis			
110	1	Closed/open loop	0 = not used 1 = closed loop 2 = open loop
111	3	Machine Constant block assignment	same as MC101
112	3	Code for axis orientation	same as MC102
113	90	ASCII-code for ident.	ASCII-coded (Z=90)
4th axis			
115	0	Closed/open loop	0 = not used 1 = closed loop 2 = open loop
116	0	Machine Constant block assignment	same as MC101
117	0	Code for axis orientation	same as MC102
118	0	ASCII-code for ident.	ASCII-coded (A=65)

MC nr.	MC value	Description	Dimensions
5th axis in address selector			
120	0	Closed/open loop	0 = not used 1 = closed loop 2 = open loop
121	0	Machine Constant block assignment	same as MC101
122	0	Code for axis orientation	same as MC102
123	0	ASCII-code for ident.	ASCII-coded (B=66)
6th axis			
125	0	Closed/open loop	0 = not used 1 = closed loop 2 = open loop
126	0	Machine Constant block assignment	same as MC101
127	0	Code for axis orientation	same as MC102
128	0	ASCII-code for ident.	ASCII-coded (C=67)
1st AXIS PARAMETER BLOCK			
Measuring system			
200	1	Measuring system input	drive number
202	1	Counting direction of measuring system	+1 = pos. direction -1 = neg. direction
203	0	Multiplication factor	0= x1, 1= x2, 2= x4
Velocities			
205	50 000	Rapid traverse	100 incr/min
206	30 000	Jog feed	100 incr/min
Tuning			
215	10 000	Following distance 1	Increments at 9 V
216	10 000	Nod point	Increments
217	10 000	Following distance 2	Increments at 9 V
218	0	Acc/dec mode	0 = no acc/dec 1 = 1st order acc/dec 2 = 2nd order acc/dec 3 = 1st order acc/dec with feed 4 = 2nd order acc/dec with feed
219	0	Acc/dec time constant	msec
220	0	Acc/dec threshold	100 incr/min
221	10	Inpod delay time	x15 msec
222	1000	In-position window	Increments
223	1000	Standstill window	Increments
224	0	Backlash compensation	Increments

MC nr.	MC value	Description	Dimensions
Reference point			
230	1	RPF-direction	+1 = pos. direction -1 = neg. direction
231	30 000	RPF-feed	0.1 mm/min
232	10 000	RPF-creep feed	0.1 mm/min
233	11111	RPF-offset	Increments
234	1	Area switch	0 = using switch + marker 1 = using marker only
Offsets			
235	1000 000	Limit switch positive	Increments
236	-1000 000	Limit switch negative	Increments
237	0	Home position	Increments
240	0	Position of fixed measuring probe	Increments
242	0	Position of centre of calibration ring	Increments
2nd AXIS PARAMETER BLOCK			
Measuring system			
250	2	Measuring system input	drive number
252	1	Counting direction of measuring system	+1 = pos. direction -1 = neg. direction
253	0	Multiplication factor	0= x1, 1= x2, 2= x4
Velocities			
255	50 000	Rapid traverse	100 incr/min
256	30 000	Jog feed	100 incr/min
Tuning			
265	10 000	Following distance 1	Increments at 9 V
266	10 000	Nod point	Increments
267	10 000	Following distance 2	Increments at 9 V
268	0	Acc/dec mode	0 = no acc/dec 1 = 1st order acc/dec 2 = 2nd order acc/dec 3 = 1st order acc/dec with feed 4 = 2nd order acc/dec with feed
269	0	Acc/dec time constant	msec
270	0	Acc/dec threshold	100 incr/min
271	10	Inpod delay time	x 15 msec
272	1000	In-position window	Increments
273	1000	Standstill window	Increments
274	0	Backlash compensation	Increments

MC nr.	MC value	Description	Dimensions
Reference point			
280	1	RPF-direction	+1 = pos. direction -1 = neg. direction
281	30 000	RPF-feed	0.1 mm/min
282	10 000	RPF-creep feed	0.1 mm/min
283	22222	RPF-offset	Increments
284	1	Area switch	0 = using switch + marker 1 = using marker only
Offsets			
285	1000 000	Limit switch positive	Increments
286	-1000 000	Limit switch negative	Increments
287	0	Home position	Increments
290	0	Position of fixed measuring probe	Increments
292	0	Position of calibration ring centre	Increments
3rd AXIS PARAMETER BLOCK			
Measuring system			
300	3	Measuring system input	drive number
302	1	Counting direction of measuring system	+1 = pos. direction -1 = neg. direction
303	0	Multiplication factor	0= x1, 1= x2, 2= x4
Velocities			
305	50 000	Rapid traverse	100 incr/min
306	30 000	Jog feed	100 incr/min
Tuning			
315	10 000	Following distance 1	Increments at 9 V
316	10 000	Nod point	Increments
317	10 000	Following distance 2	Increments at 9 V
318	0	Acc/dec mode	0 = no acc/dec 1 = 1st order acc/dec 2 = 2nd order acc/dec 3 = 1st order acc/dec with feed 4 = 2nd order acc/dec with feed
319	0	Acc/dec time constant	msec
320	0	Acc/dec threshold	100 incr/min
321	010	Inpod delay time	x 15 msec
322	1000	In-position window	Increments
323	1000	Standstill window	Increments
324	0	Backlash compensation	Increments

MC nr.	MC value	Description	Dimensions
Reference point			
330	1	RPF-direction	+1 = pos. direction -1 = neg. direction
331	30 000	RPF-feed	0.1 mm/min
332	10 000	RPF-creep feed	0.1 mm/min
333	33333	RPF-offset	Increments
334	1	Area switch	0 = using marker + switch 1 = using marker only
Offsets			
335	1000 000	Limit switch positive	Increments
336	-1000 000	Limit switch negative	Increments
337	0	Home position	Increments
340	0	Position of fixed measuring probe	Increments
342	0	Position of calibration ring centre	Increments
4th AXIS PARAMETER BLOCK			
Measuring system			
350	0	Measuring system input	drive number
352	1	Counting direction of measuring system	+1 = pos. direction -1 = neg. direction
353	0	Multiplication factor	0= x1, 1= x2, 2= x4
Velocities			
355	50 000	Rapid traverse	100 incr/min
356	30 000	Jog feed	100 incr/min
Tuning			
365	10 000	Following distance 1	Increments at 9 V
366	10 000	Nod point	Increments
367	10 000	Following distance 2	Increments at 9 V
368	0	Acc/dec mode	0 = no acc/dec 1 = 1st order acc/dec 2 = 2nd order acc/dec 3 = 1st order acc/dec with feed 4 = 2nd order acc/dec with feed
369	0	Acc/dec time constant	msec
370	0	Acc/dec threshold	100 incr/min
371	10	Inpod delay time	x 15 msec
372	1000	In-position window	Increments
373	1000	Standstill window	Increments
374	0	Backlash compensation	Increments

MC nr.	MC value	Description	Dimensions
Reference point			
380	1	RPF-direction	+1 = pos. direction -1 = neg. direction
381	30 000	RPF-feed	0.1 mm/min
382	10 000	RPF-creep feed	0.1 mm/min
383	0	RPF-offset	Increments
384	1	Area switch	0 = using switch + marker 1 = using marker only
Offsets			
385	1000 000	Limit switch positive	Increments
386	-1000 000	Limit switch negative	Increments
387	0	Home position	Increments
390	0	Position of fixed measuring probe	Increments
392	0	Position of calibration ring centre	Increments
5th AXIS PARAMETER BLOCK			
Measuring system			
400	0	Measuring system input	drive number
402	1	Counting direction of measuring system	+1 = pos. direction -1 = neg. direction
403	0	Multiplication factor	0= x1, 1= x2, 2= x4
Velocities			
405	50 000	Rapid traverse	100 incr/min
406	30 000	Jog feed	100 incr/min
Tuning			
415	10 000	Following distance 1	Increments at 9 V
416	10 000	Nod point	Increments
417	10 000	Following distance 2	Increments at 9 V
418	0	Acc/dec mode	0 = no acc/dec 1 = 1st order acc/dec 2 = 2nd order acc/dec 3 = 1st order acc/dec with feed 4 = 2nd order acc/dec with feed
419	0	Acc/dec time constant	msec
420	0	Acc/dec threshold	100 incr/min
421	10	Inpod delay time	x 15 msec
422	1000	In-position window	Increments
423	1000	Standstill window	Increments
424	0	Backlash compensation	Increments

MC nr.	MC value	Description	Dimensions
Reference point			
430	1	RPF-direction	+1 = pos. direction -1 = neg. direction
431	30 000	RPF-feed	0.1 mm/min
432	10 000	RPF-creep feed	0.1 mm/min
433	0	RPF-offset	Increments
434	1	Area switch	0 = using switch + marker 1 = using marker only
Offsets			
435	1000 000	Limit switch positive	Increments
436	-1000 000	Limit switch negative	Increments
437	0	Home position	Increments
440	0	Position of fixed measuring probe	Increments
442	0	Position of calibration ring centre	Increments
6th AXIS PARAMETER BLOCK			
Measuring system			
450	0	Measuring system input	drive number
452	1	Counting direction of measuring system	+1 = pos. direction -1 = neg. direction
453	0	Multiplication factor	0= x1, 1= x2, 2= x4
Velocities			
455	50 000	Rapid traverse	100 incr/min
456	30 000	Jog feed	100 incr/min
Tuning			
465	10 000	Following distance 1	Increments at 9 V
466	10 000	Nod point	Increments
467	10 000	Following distance 2	Increments at 9 V
468	0	Acc/dec mode	0 = no acc/dec 1 = 1st order acc/dec 2 = 2nd order acc/dec 3 = 1st order acc/dec with feed 4 = 2nd order acc/dec with feed
469	0	Acc/dec time constant	msec
470	0	Acc/dec threshold	100 incr/min
471	10	Inpod delay time	x 15 msec
472	1000	In-position window	Increments
473	1000	Standstill window	Increments
474	0	Backlash compensation	Increments

MC nr.	MC value	Description	Dimensions
Reference point			
480	1	RPF-direction	+1 = pos. direction -1 = neg. direction
481	30 000	RPF-feed	0.1 mm/min
482	10 000	RPF-creep feed	0.1 mm/min
483	0	RPF-offset	Increments
484	1	Area switch	0 = using switch + marker 1 = using marker only
Offsets			
485	1000 000	Limit switch positive	Increments
486	-1000 000	Limit switch negative	Increments
487	0	Home position	Increments
490	0	Position of fixed measuring probe	Increments
492	0	Position of calibration ring centre	Increments

MC nr.	MC value	Description	Dimensions
SPINDLE PARAMETER BLOCK			
500	0	Connection of Drive module	0 = not connected 1 = Drive module 1, connector 1 2 = Drive module 1, connector 2 3 = Drive module 2, connector 1 4 = Drive module 2, connector 2 5 = Drive module 3, connector 1 6 = Drive module 3, connector 2 7 = Drive module 4, connector 1 8 = Drive module 4, connector 2
Measuring system			
501	0	Resolution of spindle transducer	Imp/rev
502	1	Counting direction of rotary meas. system	+1 = positive
503	0	Multiplication factor of rotary meas. system	0= x1, 1= x2, 2= x4
Velocities			
505	0	Spindle jog	rev/min
Tuning range 1			
515	128	Following distance 1	Increments at 9 V
516	0	Nod point	Increments
517	128	Following distance 2	Increments at 9 V
Tuning range 2			
525	128	Following distance 1	Increments at 9 V
526	0	Nod point	Increments
527	128	Following distance 2	Increments at 9 V
Tuning range 3			
535	128	Following distance 1	Increments at 9 V
536	0	Nod point	Increments
537	128	Following distance 2	Increments at 9 V

MC nr.	MC value	Description	Dimensions
Tuning range 4			
545	128	Following distance 1	Increments at 9 V
546	0	Nod point	Increments
547	128	Following distance 2	Increments at 9 V
Oriented spindle stop			
560	0	Oriented spindle stop mode	0 = no M19 1 = M19 mechanically 2 = M19 with transd. 3 = M19 offset meas. for MC566
561	0	Oriented spindle stop slope	(Rev/min)/15 msec
562	0	Oriented spindle stop Inpod delay time	x15 msec
563	1	1st search speed	Rev/min
564	1	2nd search speed	Rev/min
565	0	Search speed from M5	Rev/min + = M3 direction - = M4 direction
566	0	Offset to marker pulse	1/1000 degree
567	0	Standstill window	Increments
568	0	M19 with D-address	0 = off, 1 = on
Range specification			
570	1	Automatic range selection + open/closed loop	0 = no autorange + open loop 1 = auto range + open loop 2 = no auto range + closed loop 3 = auto range + closed loop
571	0	Maximum spindle speed, range 1	Rev/min with sign
572	0	Maximum spindle speed, range 2	Rev/min with sign
573	0	Maximum spindle speed, range 3	Rev/min with sign
574	0	Maximum spindle speed, range 4	Rev/min with sign
Output to spindle drives			
580	0	Max. analog output voltage	mV
581	0	Min. analog output voltage	mV
582	0	Gear change voltage	mV
590	0	Time between rotation pulse for gear change	X 50 msec.
591	0	duration of rotation pulse for gear change	X 50 msec.

MC nr.	MC value	Description	Dimensions
GENERAL PARAMETERS			
Program format			
705	3	Position decimal point, dimension words	3 = 0000.000 4 = 000.0000
706	3	Position decimal point, feed	3 = 0000.000 4 = 000.0000
707	71	Inch/Metric initialization	70 = Inch 71 = Metric
Geometrics			
710	10	Not used	
711	89	Intersection angle	Degrees
712	0	Circle end point window	Increments
714	0	Scaling mode	0 = absolute in mach. plane 1 = relative in mach. plane 2 = absolute in all linear axes 3 = relative in all linear axes
715	2	Decimal point scaling	Number of decimals
Fixed cycles			
720	0	Pocketing (overlap)	% of tool diameter
723	0	Deceleration distance during tapping	Increments
724	0	Dwell during tapping	x 15 msec (after spindle stop)
730	0	External error	0 = off, 1 = on
731	0	Inputs for open servo loop	0 = inputs disabled 1 = inputs enabled
Feed/Speed			
740	30 000	Maximum feed	100 incr/min
741	30 000	Test feed	100 incr/min
745	100	Maximum feed override	% of commanded feed
746	0	Minimum feed override	% of commanded feed
747	100	Maximum speed override	% of commanded speed
748	50	Minimum speed override	% of commanded speed

MC nr.	MC value	Description	Dimensions
Handwheel			
750	0	Feed	100 incr/min
751	0	Connection of Handwheel	0 = no connection 1 = Drive module 1, connector 1 2 = Drive module 1, connector 2 3 = Drive module 2, connector 1 4 = Drive module 2, connector 2 5 = Drive module 3 connector 1 6 = Drive module 3 connector 2 7 = Drive module 4 connector 1 8 = Drive module 4 connector 2
752	0	Multiplication factor	0= x1, 1= x2, 2= x4
Serial data I/O			
770	0	Serial I/O configuration	0 = local V24, no DNC 1 = local V11, no DNC 2 = local V24, DNC V11 3 = local V11, DNC V24
771	1	Data carrier coding	0 = ASCII 1 = ISO 2 = EIA
772	1	Automatic code recognition	0 = off 1 = on 2 = Mode 0 + XON/XOFF 3 = Mode 1 + XON/XOFF
773	5	Start-stop reader	Number of characters after stop
775	1	Stop bits UART	0 = one stop bit 1 = two stop bits
776	2400	Baudrate	Baud
777	2400	Baudrate	Baud
782	0	Data carrier coding	0 = ASCII 1 = ISO
784	5	Start-stop reader	Number of characters after stop
785	0	Stop bits UART	0 = one stop bit 1 = two stop bits
786	2400	Baudrate (record. and transm.)	Baud

MC nr.	MC value	Description	Dimensions
DNC-operation			
790	0	Block check	0 = no check 1 = no message check 2 = message echo 3 = message to monitor
791	80	Maximum length of DNC-string	Bytes
792	0	Time out for answer DNC	Sec
793	0	Accepted message repeats	Number of repeats
794	0	Initialization DATA I/O	0 = DATA IO 1 = local DNC 2 = remote DNC
795	0	DNC-delay time	msec
796	0	Block number check	0 = on, 1 = off
Measuring cycles			
840	0	Connection of measuring probe	0 = measuring probe not active 1 = Drive module 1, connector 1 2 = Drive module 1, connector 2 3 = Drive module 2, connector 1 4 = Drive module 2, connector 2 5 = Drive module 3, connector 1 6 = Drive module 3, connector 2 7 = Drive module 4, connector 1 8 = Drive module 4, connector 2
841	0	Probe type	0 = inductive 1 = infra red
842	0	Blowing time for surface cleaning	x msec
843	0	Measuring feed	100 incr/min
844	0	Pre-measuring distance	Increments
845	0	Post-measuring distance	Increments
846	0	Resolution of rotatary axis	Incr. 1/1000 degree
847	0	Width of fixed probe	Increments
848	0	Radius of calibration ring	Increments

Preliminary values for MC 203, MC 253, MC 303, MC 353 MC 403, MC 453

The above machine constants allow the resolution of any rotary transducers to be defined. MC203 applies to axis 1, MC253 to axis 2, etc.
Proceed as follows:

Determine the required number of count pulses per S00/S90 cycle.
For 4 pulses per S00/S90 cycle assign the value 2 to the MC concerned.
For 2 pulses per S00/S90 cycle assign the value 1 to the MC concerned.
For 1 pulse per S00/S90 cycle assign the value 0 to the MC concerned.

Any values assigned to these machine constants need not be changed when linear transducers are being used in the corresponding axes or when the axes are not present.

Refer also to section 11, paragraph "rotary measuring system"

Preliminary values for MC 205, MC 255, MC 305, MC 355, MC 405, MC 455

These machine constants allow the maximum velocities (rapid traverse rates) in the machine tool axes to be defined. MC205 applies to axis 1, MC255 to axis 2, etc.
For Metric systems, the values to be assigned to these machine constants are determined by the formula:

MC-value = max. slide velocity (m/min) x 10,000

Example: assuming that the maximum velocity in an axis is 3.5 m/min, the MC value is 3.5 x 10,000 = 35,000

For Inch systems, the values to be assigned to these machine contants are determined by the formula:

MC-value = max. slide velocity (Inch/min) x 100

Example: assuming that the maximum velocity in an axis is 100 Inch/min, the MC-value is 100 x 100 = 10,000

Preliminary values for MC 206, MC 256, MC 306, MC 356, MC 406, MC 456

The values assigned to these machine constants should be equal to those assigned to MC 205, 255, 305, 355, 405, 455.

Preliminary values for MC 215, MC 216 MC 217
MC 265, MC 266, MC 267
MC 315, MC 316, MC 317
MC 365, MC 366, MC 367
MC 415, MC 416, MC 417
MC 465, MC 466, MC 467

The above machine constants allow the preliminary values for the gain of the servo systems to be defined. MC215-217 apply to axis 1, MC265-267 to axis 2, etc.

When one or more axes are not employed, the corresponding machine constants must be assigned the value 32 000.

Figure 20.-1 illustrates how the preliminary values can be determined. The Kv-resultants shown represent a number of gain factors (Kv) used in servo systems.
Proceed as follows:

Draw a horizontal line from the point on the vertical axis indicating the maximum velocity of the slide.
When the Kv-factor of the servo system employed is known, use the closest Kv-resultant. In case of doubt, always use the lower one.
When the Kv-factor is unknown, use the resultant representing Kv 0.5.
Draw a vertical line from the intersection point of the horizontal line just drawn and the Kv-resultant selected.
The point where this vertical line intersects with the horizontal axis gives the value (x1000) to be assigned to machine constants 215, 265, 315, 365, 415 or 465, depending on the axis concerned.
Figure 20.-1 shows that a slide velocity of 4m/min and a Kv-factor of 0.5 produces a MC-value of 9000.

Remarks :

The MC-value found must also be assigned to the associated 2 machine constants of the relevant axis. For instance, the value found for MC215 of axis 1 must be assigned to MC216 and MC217 as well.
The minimum value that can be assigned to these machine constants is 128, the maximum value 32000.

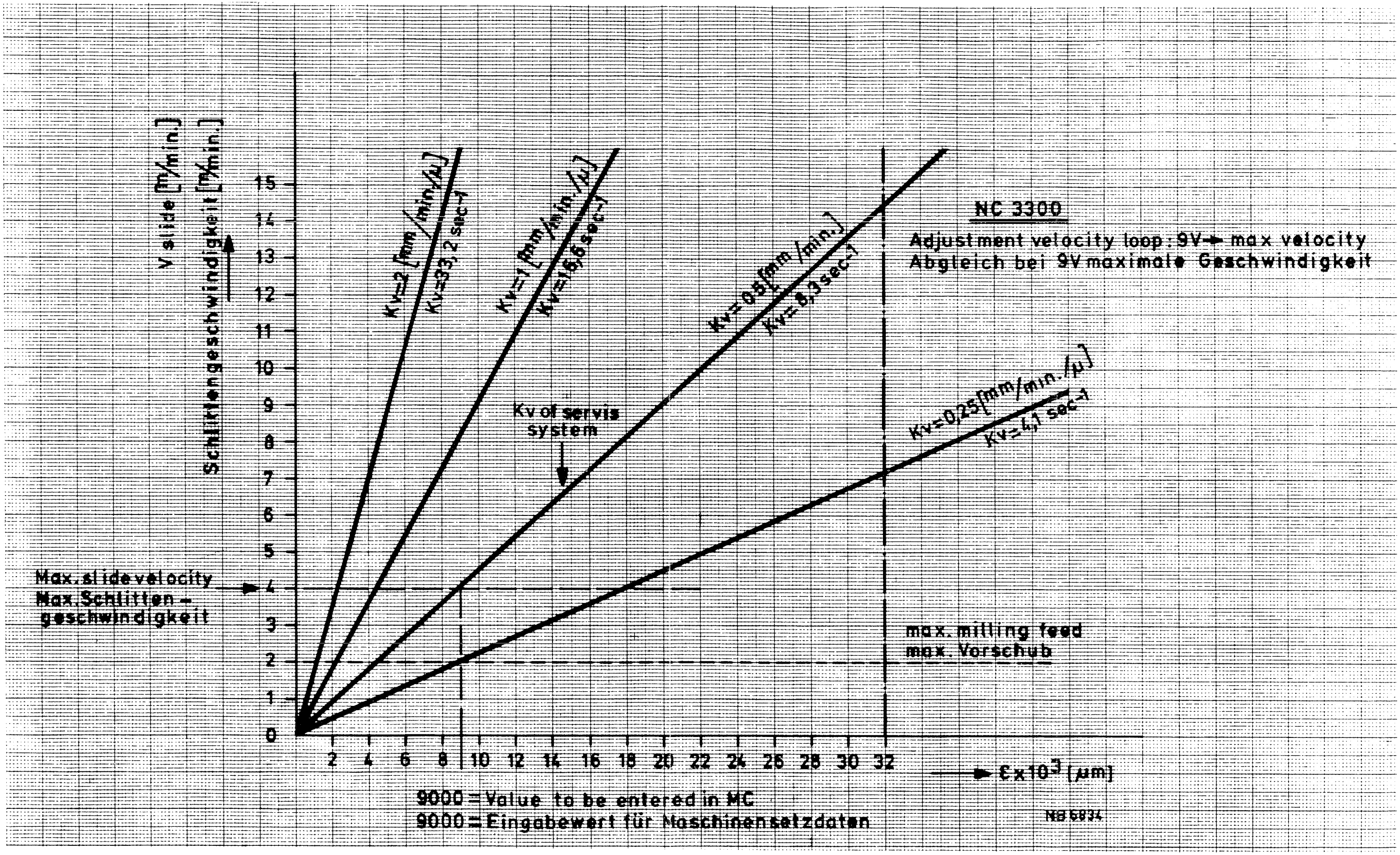


Fig. 20.-1 Graphical determination of the servo drive gain from machine slide velocity and following error

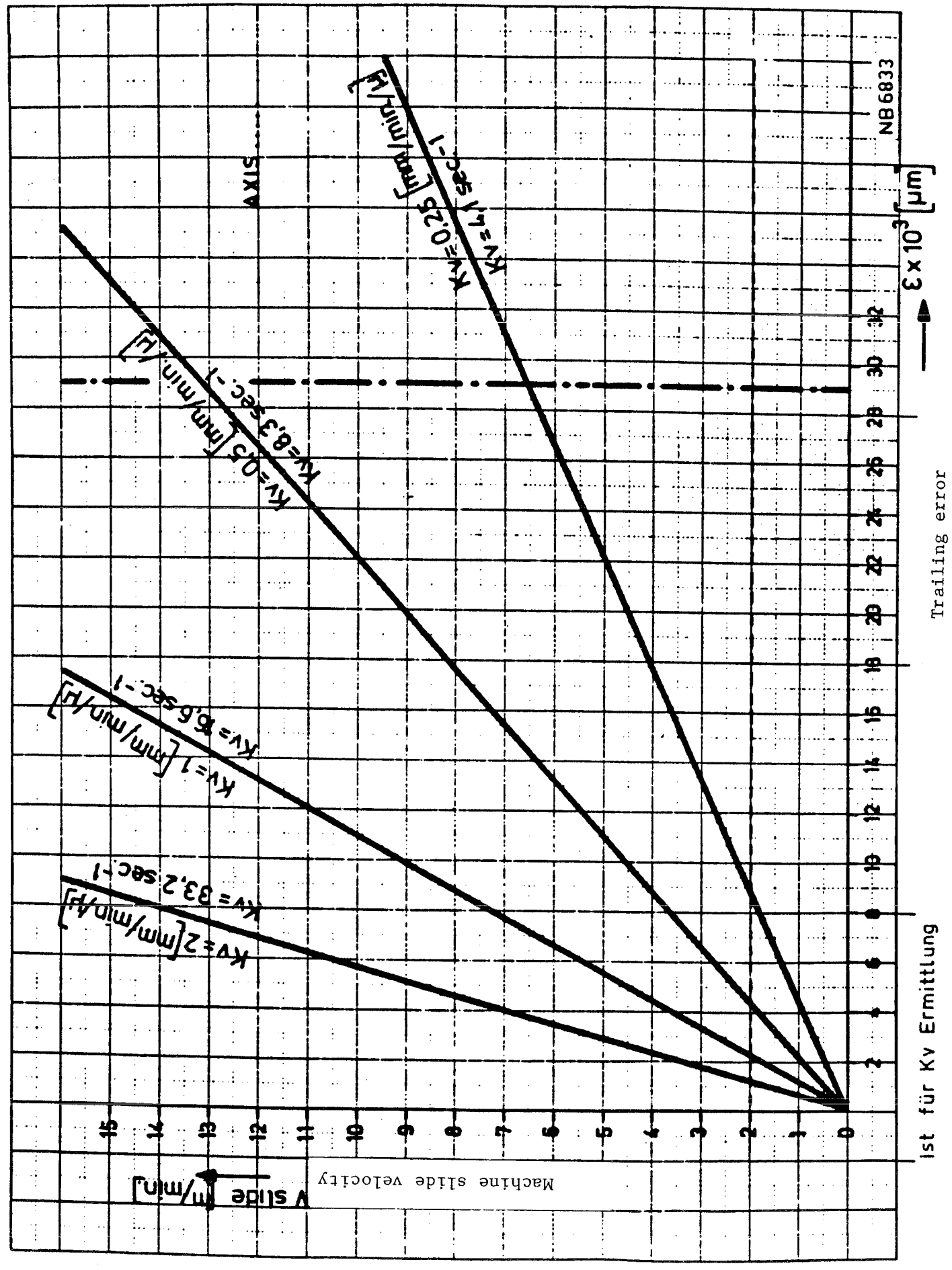


Fig. 20.-2 1st plotting sheet for determination of servo drive gain

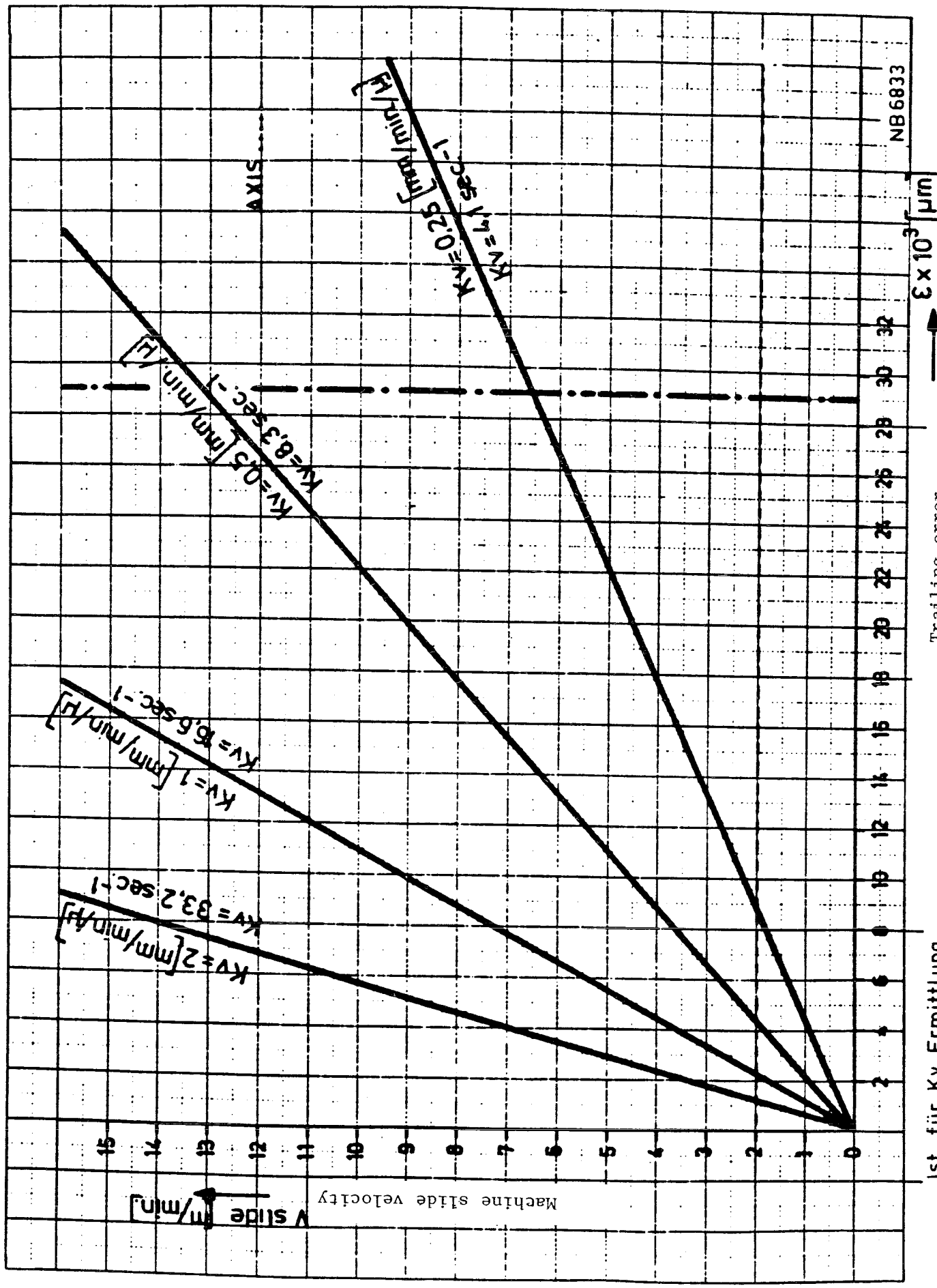


Fig. 20.-3 2nd plotting sheet for determination of servo drive gain

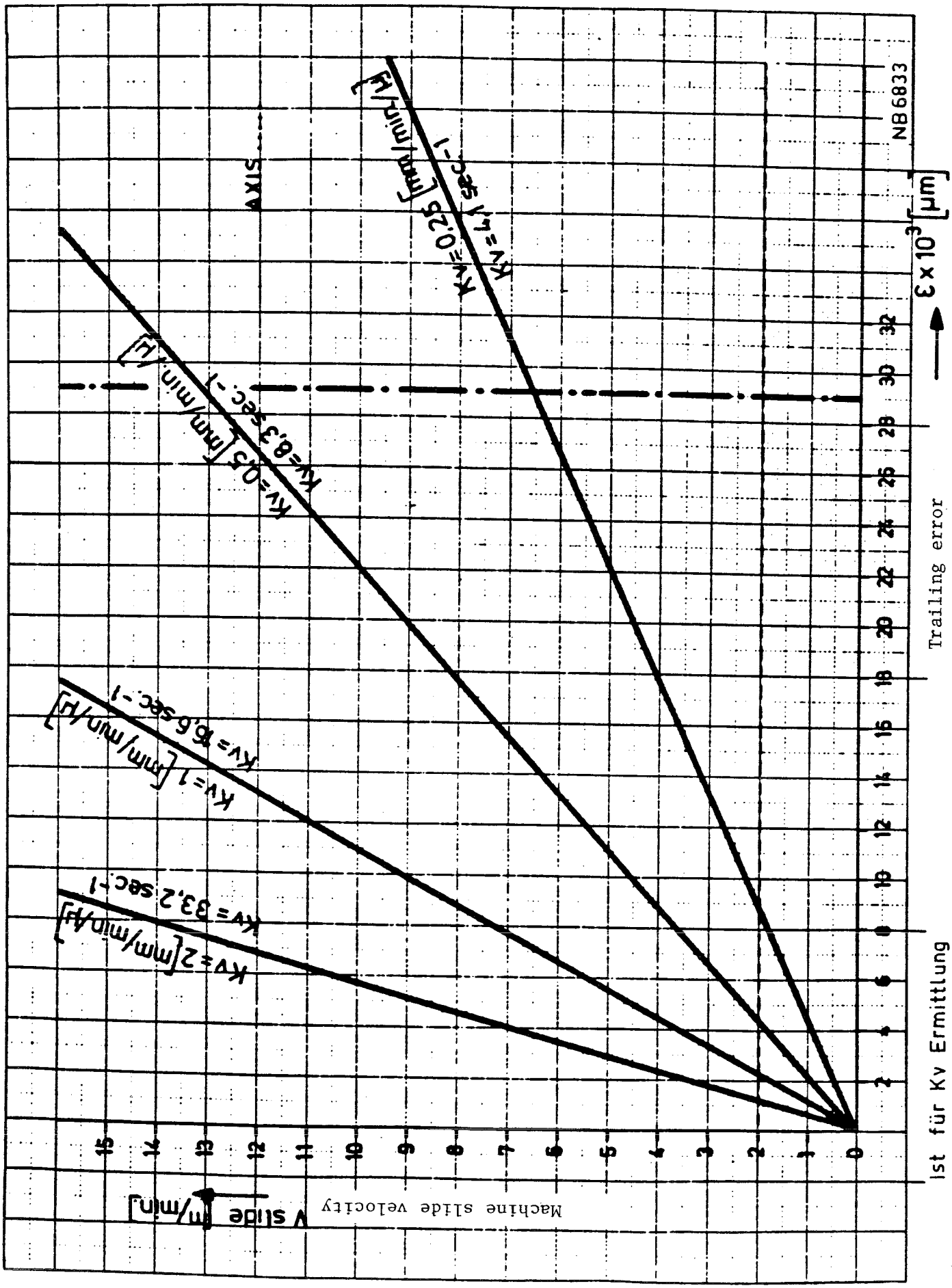


Fig. 20.-4 3rd plotting sheet for determination of servo drive gain

Preliminary values for MC 230, MC 280, MC 330,
MC 380, MC 430, MC 480

These machine constants allow the direction of approach of the Area switches to be defined.
Assign the value +1 for an approach in the positive direction of the axis, and the value -1 for an approach in the negative direction.

Preliminary values for MC 231, MC 281, MC 331,
MC 381, MC 431, MC 481

The values assigned to these machine constants should be half the values assigned to MC 205, 255, 305, 355, 405, 455.

Preliminnary values for MC 234, MC 284, MC 334,
MC 384, MC 434, MC 484

The values assigned to these machine constants should be 1% of the values assigned to MC 231, 281, 331, 381, 431, 481.

Preliminary values for MC 235/236, MC 285/286, MC 335/336
MC 385/386, MC 435/436, MC 485/486

These machine constants allow the positions of the software limit switches to be defined. MC235/236 apply to axis 1, MC285/286 to axis 2, etc.
Proceed as follows: (see fig. 20.-5)

Measure the distance d1 between reference point and position of the negative emergency switch and the distance d2 between reference point and position of the positive emergency switch.
Allow for a safety clearance, depending on the accuracy of the measurements.

Assign the value found for d3 (d1 minus safety clearance) to MC235 (or MC285, 335, 385, 435, 485, depending on the axis) and the value found for d4 (d2 minus safety clearance) to MC236 (or MC286, 336, 386, 436, 486, depending on the axis).
The values are to be entered as increments with sign.

Example:

(One increment is 0.001 mm)

d1 = 500 mm
d2 = 100 mm
d3 = 500 mm - 20 mm (safety clearance) = -480,000 increments
d4 = 100 mm - 20 mm (safety clearance) = + 80,000 increments

Note :

The overall working range of the machine tool slide may not exceed 20 m. This means that |d3| + |d4| may never be in excess of 20,000,000 increments.

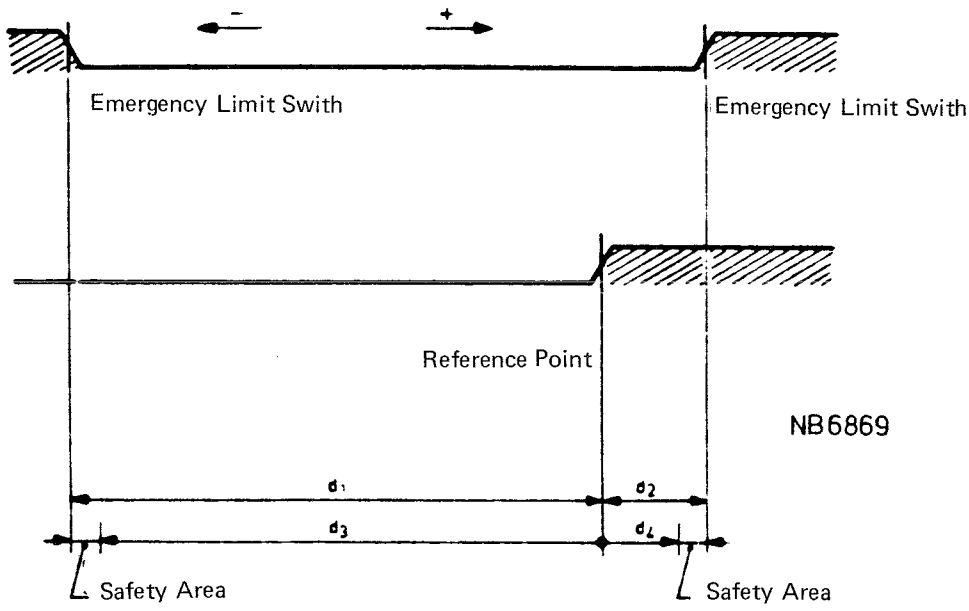


Fig. 20.-5 Determination of the software limit switch positions

INITIAL OPERATION OF THE MACHINE TOOL SLIDES

Make sure that the slides are at the centre of their traversing ranges.
Enable the slide motions one at a time.
Mind the slides might move without being controlled!
If this should occur, the movement will be inhibited within a brief delay as a result of an error detection by the CNC (axis error 04 or 07). In this case, the counting direction for the axis in question must be reversed. This is done by reversing the sign assigned to the relevant machine constant, viz. MC 202, 252, 302, 352, 402, 452, depending on the axis concerned.

When all the slides keep their positions after being enabled, jogging operations may be carried out.

Allow a feed override of 20% using the appropriate key on the control panel of the CNC (see Operation Manual).

Now press the +X button
A movement at low feed rate along the X-axis will occur.
After releasing the +X button the movement should stop.

Should the feed rate increase, even after releasing the +X button the counting direction is incorrect and must be reversed, as described previously.

Allow a feed override of 100% and observe the response of the slide. A slow response or no response at all when the +X button is again pressed signifies that the values assigned to the machine constants for the gain of the servo system of the X-axis are too low (see section 20) and need to be changed.

For the other axes proceed in the same way.

After completion of the adjustment procedure, the slides are to be moved towards the reference points of the respective axes.
Example for the X-axis:

- press the button ENTER
On the screen X-RP will be displayed.

- press the start button

A movement along the X-axis towards the Area switch will be effected. If the direction of motion is not correct, the value assigned to machine constant MC 230 must be reversed.

The procedure is repeated for the other axes.

When the reference points of all axes have been found, the software limit switches become effective. The CNC is now ready for operation.

Next, the final values for all machine constants employed must be determined. Detailed information is given in section 23.

The error codes that can be shown in the screen display of the CNC3460 machine tool controller are of two categories; normal error codes (Section 22.1) and diagnostic error codes (Section 22.2).

Note that the error codes listed in Tables 1 and 2 of this appendix are those error codes which are common to all Philips CNC3460 machine tool controllers. Controllers that have been ´customised` to suit a particular machine tool or a particular manufacturer will have additional error codes that are specific to their application. The meanings of such error codes will be found in the relevant documentation provided by the manufacturer of the machine tool.

22.1. ERROR CODES

If the CNC detects an error during normal operation it will show an error code in the upper right of the screen display. Depending on the error, it may also take some action to prevent the error from causing damage. The three most common types of action which may be taken by the CNC are:

INTERRUPT - Interrupts generated during program execution cause the line >INT< to be shown in the screen display. The CNC is forced into Intervention mode - all axis and spindle drive analog outputs are reset (that is, go to zero volts), all digital outputs that anticipate axis or spindle motion are reset, reference-point finding is stopped, Search is stopped.

OPEN LOOP - Open loop action does not result in any indication in the screen display. All analog outputs for the axes and spindle are reset - motion is stopped, but position is maintained.

R-POINT - R-point action does not result in any message in the screen display until after the error has been cleared, when the line >REF.POINT< is shown to indicate that a reference point search must be performed for one or more axes. R-point action always occurs together with one of the two actions above.

The error codes that can be displayed consist of a letter prefix followed by a number. The letter prefix identifies the general type of the error, as below:

- # - hardware or system software
- M - memory (RAM and PROM)
- X - X-axis
- Y - Y-axis
- Z - Z-axis
- A - A-axis
- B - B-axis
- C - C-axis
- W - handwheel
- S - spindle
- P - programming (during execution) and geometry
- O - operating
- D - data I/O and DNC
- I - interface (various categories)
- G - graphics
- E - external

The above list of error prefixes is in descending order of seriousness, with the #-prefixed error codes the most serious. This is the order in which the error codes are held in the error code list in this section (Table 1).

Note that particular error codes may be more or less serious than the letter prefix suggests (for instance, some programming errors are more serious than some axis errors).

The exact seriousness of each error is given by its 'class', which defines what actions are taken by the CNC. These classes are from 'A' (most serious) to 'H' (least serious), as detailed below:

Class A: System Errors
These errors are caused by a serious failure of the CNC hardware or its system software.

The CNC will halt all axis movement and spindle rotation. It will show an error description in the display as well as an error code.

The CNC can only be cleared by switching it off and re-starting it.

Class B: Checksum Errors
These errors are caused by some failure of RAM or PROM memory. In some cases the memory failure can also cause errors of the other classes.

Interrupt, open loop and R-point actions will result from checksum errors.

The CNC can be cleared by the Clear button in Manual mode, but the error code will reappear in the screen display until an editing mode is selected.

Class C: Position-loss Errors
These errors are caused by the CNC being unable to find the current values for one or more axis positions.

Interrupt, open loop and R-point actions will result from position-loss errors.

The CNC can be cleared by the Clear button in Manual mode.

Class D: Emergency Stop Errors
These errors are caused by conditions which require that the analog outputs' voltages go to zero immediately.

Open loop and R-point actions will result from emergency stop errors. There should be no loss of position.

The CNC can be cleared by the Clear button in Manual mode.

Class E: Stop-execution Errors
These errors are caused by conditions that require that the execution of the part program is halted.

Interrupt action will result from stop-execution errors.

The CNC can be cleared by the Clear button in Manual mode.

Class F: Programming Errors

These errors are generally caused by programming errors that are detected before the block containing the error is executed.

No positive action will result from a programming error, but in Auto mode the execution of the program will be stopped at the end of the block preceding the block with the error.

The CNC can be cleared by the Clear button in Manual or Teach In modes.

Class G: Operating Errors

These errors are caused by the operator making an incorrect keyboard input while editing or while in Teach In or Manual Data Input modes.

No positive action will result from an operating error, but responses to operator keyboard inputs will be stopped.

The CNC can be cleared by the Clear button in any operation mode.

Class H: Warning Errors

These errors are caused by conditions which may result in more serious errors if no action is taken by the operator.

No actions will result from a Warning error.

The CNC can be cleared by the Clear button in any operation mode.

If more than two errors are detected at the same time only the two most serious errors will be given priority and displayed. The error codes are listed in Table 1 of this appendix, overleaf.

TABLE 1 - ERROR CODES

Error Code		Error Description	Error Class
		HARDWARE AND OPERATING SYSTEM ERRORS	
		Note that hardware and OS errors indicate serious faults. If one of the error codes listed below is displayed a qualified service engineer should be called (in the case of # 05 first check the reason for the emergency stop, which may be operator error rather than a serious failure of the CNC).	
# 01	:	OS error: MTOS failure	A
# 02	:	Calculation error	C
# 03	:	Warning: temperature more than 65^{o}C	H
# 05	:	Emergency stop from machine tool	D
# 96	:	OS error: division by zero	A
# 97	:	OS error: arithmetic overflow	A
# 98	:	OS error: unexpected interrupt	A
# 99	:	OS error: general	C

MEMORY ERRORS

M 01	:	MC memory checksum error	B
M 02	:	Tool memory checksum error	C
M 03	:	MC shadow memory checksum error	B
M 21	:	PROM checksum error (PROMs 1 to 4)	B
M 22	:	PROM checksum error (PROMs 5 to 8)	B
M 23	:	PROM checksum error (PROMs 9 to 12)	B
M 60	:	Ram test error (part program/macro memory)	C

AXIS ERRORS

Note that in the axis error codes below `n` will be the axis designation, that is X,Y,Z,A,B or C

n 01	:	Linear measuring system pre-alarm (measuring system signal voltage is low)	H
n 02	:	Measuring system alarm (measuring system signal has failed)	C
n 03	:	Measuring system power supply failure	C
n 04	:	Following error too large	C
n 05	:	Software limit switch tripped	E
n 06	:	Commanded speed of movement is faster than rapid traverse (MC355)	E
n 07	:	Drifting outside no-motion window	D
n 08	:	Commanded speed of movement is faster than max feedrate (MC356)	E

HANDWHEEL ERRORS

W 01	:	HW1 measuring system pre-alarm (measuring system signal voltage is low)	H
W 02	:	HW1 measuring system alarm (measuring system signal has failed)	C
W 03	:	HW1 measuring system power supply failure	C
W 04	:	External measuring system pre-alarm (measuring system signal voltage is low)	H
W 05	:	External measuring system alarm (measuring system signal has failed)	C
W 06	:	External measuring system power supply failure	C
W 99	:	Software limit switch tripped	E

SPINDLE ERRORS

S 01	:	Measuring system pre-alarm (measuring system signal voltage is low)	H
S 02	:	Measuring system alarm (measuring system signal has failed)	D
S 03	:	Measuring system power supply failure	D
S 04	:	Following error too large (closed-loop only)	D
S 05	:	M19 not inside window (MC 562)	D

PROGRAMMING ERRORS

P 01	:	Illegal word in block	F
P 02	:	Necessary word missing from block	F
P 03	:	Unknown G-function	F
P 04	:	No feedrate programmed	F
P 05	:	Circular movement not allowed in rotation axis (G02,G03)	F
P 06	:	Mirror image not allowed in tool axis in fixed cycle (G73)	F
P 07	:	Parameter out of range	F
P 08	:	Blocknumber not in program or macro (G14-G29)	F
P 09	:	Undefined macro (G22)	F
P 10	:	Nesting too deep (G14,G22)	F
P 11	:	No return defined (G22)	F
P 12	:	G-function in block not allowed in Teach In mode	F
P 13	:	Movement not linear (G43,G44)	F
P 14	:	No fixed cycle defined (G77,G79)	F
P 15	:	Spindle direction not programmed (G77,G79)	F
P 16	:	Point not defined	F
P 17	:	Axis programmed that is not on machine tool	F
P 18	:	Block reading error in active program	F
P 19	:	Motion direction not programmed (G43,G44)	F
P 20	:	Tool radius too large (G41,G42,G77,G79)	F
P 21	:	Divide by E-parameter with value zero	F
P 22	:	Reverse number order of block execution	F
P 23	:	Toolradius is zero (G77,G79)	F
P 24	:	Pocket milling overlap less than 20% or more than 100% (G79,MC720)	F
P 25	:	Speed not programmed	F
P 26	:	Parameter in MC out of range	F
P 27	:	T larger than number of tools (MC27,MC28)	F
P 28	:	E-parameter value not programmed	F
P 29	:	E-parameter calculation error	F
P 30	:	Inch program in metric mode, or vice-versa	F
P 31	:	Speed out of range	F
P 32	:	Decrement value in parameter cannot be zero (G14,G79)	F
P 33	:	4th axis is not U,V or W-axis (G20)	F
P 34	:	Programming error in next block (will always be displayed with a second error code to define the error)	F
P 35	:	Endpoint not in circle endpoint window (MC712)	F
P 36	:	Measuring probe collision in measuring cycle	D
P 37	:	Measuring surface not found (no probe contact)	F
P 38	:	Measured deltas larger than tolerance (G49)	F
P 39	:	No measured deltas available (G49)	F
P 40	:	Measuring cycle programmed and measuring probe not activated (MC840)	F
P 41	:	No program number (G23)	F
P 42	:	Block not found (G23)	F
P 43	:	Program not found (G23)	F
P 44	:	Called program is being edited (G23)	E
P 45	:	Return from call is to program that is being edited (G23)	E
P 47	:	Spindle rotation not allowed with active	F

		probe (M03,M04,G45,G46 with MC840 active)	
P 48	:	Zero-point shift not allowed after axes rotation	F
P 49	:	Warning: tool radius larger than programmed radius of concavity	H

GEOMETRY PROGRAMMING ERRORS

Note that some of the geometry programming error codes are general error codes which are always followed by a second subsidiary error code to define the exact type of error.

General error codes are identified in the table below by the list of associated subsidiary error codes that follow the error description (in brackets with an ´&`). Subsidiary error codes are identified by an asterisk (*) next to the error code itself.

P 51*	:	Line with point only not allowed	F
P 52*	:	Line with angle only not allowed	F
P 53*	:	Line with point and angle only not allowed	F
P 54*	:	Line with tangent-point not allowed	F
P 55*	:	Line with intersection-point not allowed	F
P 56*	:	Chamfer not allowed	F
P 57*	:	Circle with point only not allowed	F
P 58*	:	Circle with centre-point only not allowed	F
P 59*	:	Circle with tangent-point not allowed	F
P 60*	:	Circle with intersection-point not allowed	F
P 61	:	Line-line intersection-point not computable	F
P 62	:	Circle-line intersection-point not computable	F
P 63	:	Line-circle intersection-point not computable	F
P 64	:	Circle-line tangent-point not computable	F
P 65	:	Rounding not allowed in line-circle	F
P 66	:	Circle-circle without rounding	F
P 67	:	Circle-circle rounding radius too large	F
P 68	:	Line-circle tangent-point not computable	F
P 69	:	Line-circle rounding radius too large	F
P 70*	:	Rounding not allowed	F
P 71	:	Undefined block	F
P 72	:	Block not allowed	F
P 73	:	Circle centre-point not allowed as line start-point	
P 74	:	´K1=`,´J1=` or ´R1=` definitions not allowed	F
P 80	:	Geometry error in next block (& P56,P57,P70)	F
P 81	:	Linear movement geometry error in next block (& P51,P52,P55,P57-60)	F
P 82	:	Linear movement and chamfer geometry error in next block (& P51,P52,P55-60,P70)	F
P 83	:	Linear movement, chamfer and tangent geometry error in next block (& P51-56)	F
P 84	:	Linear movement, chamfer, tangent and rounding geometry error in next block (& P51-56,P70)	F
P 85	:	Linear movement and rounding geometry error in next block (& P51,P52,P55,P56,P70)	F
P 86	:	Linear movement, rounding and tangent geometry error in next block (& P51-56)	F
P 87	:	Linear movement and rounding and tangent and	F

		rounding geometry error in next block (& P51-56,P70)	
P 88	:	Linear movement and tangent geometry error in next block (& P51-56)	F
P 89	:	Linear movement, tangent and rounding geometry error in next block (& P51-56,P70)	F
P 90	:	Linear-circular movement intersection geometry error in next block (& P51-56)	F
P 91	:	Linear-circular movement intersection and rounding geometry error in next block (& P51-56,P70)	F
P 92	:	Tangent geometry error in next block (& P51-56)	F
P 93	:	Tangent and rounding geometry error in next block (& P51-56,P70)	F
P 94	:	Circular movement intersection geometry error in next block (& P51,P52,P55,P56)	F
P 95	:	Circular movement and tangent geometry error in next block (& P51-56)	F
P 96	:	Circular movement, tangent and rounding geometry error in next block (& P51-56,P70)	F
P 97	:	Circular movement and rounding geometry error in next block (& P51,P52,P55,P56,P70)	F
P 98	:	Circular movement, rounding and tangent geometry error in next block (& P51-56)	F
P 99	:	Circular movement, rounding, tangent and rounding geometry error in next block (& P51-56,P70)	F
P100	:	Circular movement tangent-circle geometry error in next block (& P53-60,P70)	F
P101	:	Circular movement tangent-circle and tangent geometry error in next block (& P51-56)	F
P102	:	Circular movement tangent-circle, tangent and rounding geometry error in next block (& P51-56,P70)	F
P103	:	Circular movement tangent-circle and rounding geometry error in next block (& P53,P56-60,P70)	F
P104	:	Circular movement tangent-circle, rounding and tangent geometry error in next block (& P51-56)	F
P105	:	Circular movement tangent-circle, rounding, tangent and rounding geometry error in next block (& P51-56,P70)	F
P106	:	Circular movement circle geometry error in next block (& P51-57)	F
P107	:	Circular movement circle and rounding geometry error in next block (& P51,P52,P55,P56,P70)	F
P108	:	Circular movement circle, rounding and tangent geometry error in next block (& P51-56)	F
P109	:	Circular movement circle, rounding, tangent and rounding geometry error in next block (& P51-56,P70)	F
P110	:	Change to spare tool cannot programmed (done only by breakage or exceeded tool life)	F

OPERATING ERRORS

0 01	:	Editing of an active part program or macro not allowed	G
0 02	:	No block number entered	G
0 03	:	Searching not successful (edit or Manual mode)	G
0 04	:	Memory error during block reading	G
0 05	:	Block too large (more than 80 chars)	G
0 06	:	Block number already exists	G
0 07	:	Warning: memory overflow imminent	H
0 08	:	Memory overflow	G
0 09	:	Entered number out of range (T,N,E or P)	G
0 10	:	Part program number already exists	G
0 11	:	Block number not searched (use Search button)	G
0 12	:	No part program number entered	G
0 14	:	Memory error reading next block (G41,G42)	G
0 15	:	More than 3 axes before storing (playback)	G
0 17	:	M30 in active program (playback)	G
0 18	:	Insufficient RAM (more needed than MC2 value)	G
0 19	:	Invalid equals sign (=) in word	G
0 20	:	G-function that is not allowed in this mode (playback)	G
0 21	:	Teach In cannot start with part program points active (block with P1,P2,etc has not completed execution)	G
0 22	:	Duplicated position number in tool memory	G
0 23	:	MC data out of range	C
0 24	:	Measuring probe collision	D
0 25	:	Number of external program call allocations exceeds 99	G
0 26	:	External program call parameter is already allocated	G
0 27	:	Tool number is already allocated to a spare tool	H
0 28	:	External program call with unknown part program number	G
0 29	:	External program call with no part program number	G
0 30	:	Plane is not possible with this orientation of the axes	G
0 31	:	No orientation possible with 4th axis	G
0 32	:	4th axis is rotation axis (G20)	G
0 49	:	Program locked	G
0 50	:	Memory area is being read by an active program	G
0 51	:	Number of part programs in memory is equal to MC85, no more will be accepted (manual entry)	G

DATA IN/OUT ERRORS

D 01	:	CM or TM lists cannot be entered while a part program is being executed	G
D 02	:	No block number entered	G
D 03	:	Required record not found in memory	G
D 04	:	Error during data reading from input device	G
D 05	:	Block too large (more than 80 chars)	G
D 06	:	Block number already exists in part program	G
D 07	:	Warning: memory overflow imminent	H
D 08	:	Memory overflow	G
D 09	:	Program number less than 9000 or block number more than 8999	G
D 10	:	Part program number already exists	G
D 11	:	Block number has not been searched	G
D 12	:	No part program number	G
D 13	:	Illegal RAM-length; `end-code` cannot be stored	G
D 19	:	Invalid equals sign (=) in word	H
D 25	:	Number of external program calls is more than MC43	G
D 26	:	External call of program number that is already allocated	G
D 27	:	Tool number is already allocated to a spare tool	H
D 29	:	External program call without allocated part program number (not in Parameter list)	G
D 30	:	Address already entered (duplicated in block)	G
D 31	:	Illegal character (not in character set)	G
D 32	:	Parity error	G
D 33	:	Word length error	G
D 34	:	Cancel or system failure	G
D 35	:	Requested program number is less than 9000	G
D 36	:	Requested memory code is not on the tape (PM, CM, TM, etc, not found)	G
D 37	:	Address has illegal char in data	G
D 38	:	Address without data	G
D 39	:	Block does not start with block number	G
D 40	:	Algebraic expressions only allowed in parameter mode	G
D 41	:	Peripheral not ready	G
D 42	:	Framing error or baudrate overrun error	G
D 43	:	Unknown memory code (not PM, CM, TM, etc)	G
D 44	:	Non-existent address	G
D 45	:	Sign (+,-) not allowed on a non-signed word	G
D 46	:	Invalid or multiple equals sign (=) in word	G
D 47	:	Requested program not found on tape	G
D 48	:	Tape is in inch mode, CNC in metric mode, or vice versa	H
D 49	:	Program locked during I/O operation	H
D 50	:	Memory record is being accessed during data I/O	H

DNC-ERRORS

D 80	:	DNC out of synchronisation	G
D 81	:	Break detected in connection	G
D 82	:	Framing error	G
D 83	:	Parity error	G
D 84	:	Time-out error	G
D 85	:	Block check code failure (LSV-2 error)	G
D 86	:	DNC computer responds with ´NOT READY`	G

INTERFACE ERRORS

I 01	:	Interface not initialised	D
I 02	:	Both ´home select` inputs are at the same level	E

TOOL MONITOR ERRORS

I 10	:	Tool breakage detected	E
I 11	:	Warning: tool life exceeded during machining	H
I 12	:	Tool to be changed into spindle has exceeded its tool life	E
I 13	:	Warning: 1st power level exceeded	H
I 14	:	Tool to be changed into the spindle has already had an I13 or I15 error	E
I 15	:	2nd power level exceeded	E
I 16	:	Tool measurement enabling signal not present	E
I 17	:	Tool measurement value is zero	E
I 18	:	Tool measurement value is too large	E
I 19	:	Measured tool length is larger than the previous value	E

EXTERNAL PROGRAM CALL ERRORS

I 20	:	Previous external call is still waiting (ext. prog. call buffer is full)	H
I 21	:	External program call without part program number (ext. prog. call buffer is empty)	H
I 22	:	Called program is being edited	F
I 23	:	No part program number in parameter for ext. prog. call	F
I 24	:	Part program number from parameter for ext. prog. call is not found in memory	F
I 34	:	Tool holder open (unclamped); cannot start machining	F
I 45	:	The ´next block permitted` signal is not present	H
I 58	:	Tool position value in tool memory is larger than max. value (MC28)	E

SPINDLE AND PROBE INTERFACE ERRORS

I 66	:	Measuring probe´s infrared beam is obstructed or there is a measuring probe collision	D
I 68	:	Actual spindle speed is not the programmed speed or the spindle drive feedback signal has failed	E
I 87	:	Spindle has not stopped or the ´spindle stopped` feedback signal has failed	E

GRAPHIC ERRORS

G 01	:	Programming error in window (G98 for Testruns 5 and 7)	F
G 02	:	Programming error in rough contour (G99 for Testruns 5 and 7)	F
G 20	:	Communication error between Centr. Proc. Mod. and Graph. Mod.	C

EXTERNAL ERRORS

E xx : External error codes are derived from six binary inputs which are only used in conjunction with the optional ´automation package`. The error code number (xx) is the decimal equivalent of the input six-bit binary number (that is; 01 to 63, no 00). The meaning of these numbers is given in the appropriate documentation of the machine tool manufacturer.

22. DIAGNOSTIC ERROR CODES

When CNC is checked for faults with the diagnostic tests contained in the Diagnostic and Service Only modes (see operator`s manual Chapters 13 and 14) the error codes that may be displayed are different to the normal error codes that are listed in Table 1.

These diagnostic error codes are numbers with no letter prefix. They are always preceded by the word >ERROR< and followed by a brief description of the error (for example, >ERROR 50 RAM NOT CONTIGUOUS<). Diagnostic error codes are shown at the bottom of the screen display, unlike normal error codes.

The diagnostic error codes are listed in Table 2 of this appendix, overleaf.

TABLE 2 - DIAGNOSTIC ERROR CODES

Error Number	Error Display text	Error Description
	The CPU contains two counter chips (8253) which set the baudrate for the V11 and V24 UARTS, the following two errors (01 and 02) both suggest some fault with them.	
01	SLOW ERROR	A counter has been found to be slower than the acceptable minimum speed.
02	FAST ERROR	A counter has been found to be faster than the acceptable maximum speed.
08	ALARM	This error refers to the Drive Modules: LMS - The voltage of the measurement signal to the Drive Module is below the minimum acceptable value. RMS - The phase difference between the two measurement signals to the Drive Module is less than the minimum acceptable value. In both cases the measurement system or the connecting cables are defective (see also ERROR 23).
	For the following six errors (09, 10, 11, 12, 14 and 15) to be detected the Central Processor Module V24 test must be run with a ´loopback connector´ (joining DSR to DTR, CTS to RTS and Txd to RxD) on the V24 or V11 sockets (depending on which is selected by MC770). These errors all suggest either faulty connections or a faulty UART.	
09	DTR/DSR	The DTR output and the DSR bit in the UART status buffer do not agree.

10	FRAMING, OVERRUN OR PARITY	One (or more) of the framing, overrun or parity error bits in the UART status buffer is high. Probably UART failure.
11	RECEIVE/TRANSMIT	The transmitted data (one character) does not agree with the received data.
12	RTS/CTS	Transmitted character is not ready to send within acceptable maximum time, or RTS signal is not received.
13	(see ERROR 50)	
14	TRANSMIT	Data bus buffer has not emptied, transmission has not taken place.
15	RECEIVE	Transmitted character has not been received.

For the following two errors (16 and 17) to be detected the Automatic I/O Test must be run with a test lead.

16	I/O NOT CORRESPONDING	The input and output of the channel under test do not agree.
17	INPUT OR OUTPUT	An input or an output of a channel which is <u>not</u> the one being currently tested has changed status (high-to-low or low-to-high).
19	PATTERN NOT CORRECT	The bit pattern that was written to RAM does not agree with the pattern subsequently read from RAM (see also ERROR 50).
21	INTERRUPT NOT RESPONDING	An interrupt has been given to the interrupt controller (8259) but the interrupt register has not been written to.

23	PRE-ALARM	This error only applies to LMS Drive Modules. The voltage of the measurement system signal to the Drive Module is low, but not yet below the acceptable minimum (see also ERROR 08).
29	DRIVE NOT RESPONDING	The selected Drive Module is not reponding or is not installed.
35	PARITY INPUTS	The parity (even or odd) of the inputs does not agree with the setting of the input parity bit of the status byte of the module.
36	PARITY OUTPUTS	The parity (even or odd) of the outputs does not agree with the setting of the output parity bit of the status byte of the module.
50	RAM NOT CONTIGUOUS	The RAM memory has been tested and is not in an unbroken sequence from the lowest address to highest (see also below).
(13	RAM	The RAM memory has been tested and some undefined fault has been detected. Further information may be given in the screen display.)
51	PROM CHECKSUM	The checksum held for a PROM and the calculated checksum do not agree.
52	CHECKSUM BAD IN PROM	The checksums for all the PROMs are held in PROM No. 1. Either this PROM cannot be read or the checksums are not in the correct format (that is, with the next address after each checksum holding the checksum´s ´ones complement`).
53	GRAPHICS RAM ERROR	The RAM memory of the Graphics Module has been tested and a fault has been detected.
54	GRAPHICS PROM CHECKSUM ERROR	The PROM memory of the Graphics Module has been tested and a fault has been detected.

55	BAD GRAPHICS FUNCTION	The selected graphics test has detected an error.

The following three errors can only be detected during the loading of special test programs by service personnel. Users will not normally encounter them.

58	TYPE ERROR	The test program being loaded is of the wrong type (that is, the record format is not correct for the CNC).
59	READ ERROR	A framing, overrun or parity error has occurred during program loading.
60	CHECKSUM ERROR	The checksum and the calculated checksum do not agree in a record of the program being loaded.

CLASSIFICATION

0 to 100	for configuration of CNC and machine tool
100 to 200	for defining axes and spindles
200 to 250	for 1st axis
250 to 300	for 2nd axis
300 to 350	for 3rd axis
350 to 400	for 4th axis
400 to 450	for 5th axis
450 to 500	for 6th axis
500 to 600	for 1st spindle related data
700 to 800	for general data, e.g. geometrical functions, measuring cycles, format of the words on the screen, lubrication etc.
800 to 900	for automatic operation, e.g. for measuring constants, measuring cycles etc.

The machine constants MC0 to MC9 are employed by the CNC system for checking its configuration.
Refer also to the Operator´s manual, section 13 "Diagnostics"

MC0 Number of I/O modules

This machine constants defines the number of I/O modules included in the CNC system.
Assign 0 for 1 I/O module
1 for 2 I/O modules
2 for 3 I/O modules

MC 1 Number of measuring system inputs

This machine constant defines the number of measuring system (LMS or RMS inputs (incl. spindle and electronic handwheel).
Assign 1 for 1 input
2 for 2 inputs
etc.

MC 2 RAM-memory capacity

The capacity of the RAM-memory is specified in the data sheets supplied with the CNC system.
If the value assigned to MC 2 is too high, the CNC system generates an error message (CNC checks non existing memory).
If the value assigned to MC 2 is too low, it is not possible to utilize the entire capacity of the part program memory. It means that error message "memory overflow" will be displayed at an earlier stage.
Enter the value in Kbytes (for instance 64,000 bytes = 64 Kbytes).

MC 4 Remote control panel

Assign 0 for no remote control panel
1 for remote control panel operative, incl. safety switch
2 for remote control panel operative, except safety switch
5 for connection of external feed override switch. See input card 1, inputs 13-16.
The push buttons on the remote control panel are inoperative now.

MC 9 Graphics module

This machine constant defines the type of graphics module included in the CNC system.
Assign 0 for no graphics module connected to Contr Telet Mod
1 for graphics module 2-p graphics connected to Contr Telet Mod
2 for graphics module 8-p graphics connected to Contr Telet Mod

23.2. MACHINE CONFIGURATION

MC 10 Number of axes

This machine constant defines the number of controlled or displayed axes (except spindle and electronic handwheel).
The minimum number of axes is 3.
Assign 3 for 3 axes
4 for 4 axes
etc, up to 6 axes

MC 11 Plane initialization

This machine constant defines the plane that becomes active after power on.
Assign 0 for the G17 related plane
1 for the G18 related plane
2 for the G19 related plane

MC 14 Measuring system resolution

This machine constant defines the resolution (in metric units or in Inches) of the measuring systems employed.
Assign 70 for a machine tool with Inch-type measuring system
71 for a machine tool with metric-type measuring system
All axes are required to have the same resolution.

MC 18 Tool change (manual or automatic)

Assign 0 for M6 manual tool change
1 for M6 automatic tool change

MC 26 Retract sequence during M6

This machine constant defines the retract sequence in the machine tool axes during a tool change programmed with M6.
Assign 0 for no retraction in the axes
1 for a retraction in the tool axis
When the plane is changed, the CNC system automatically selects the new tool axis
2 for a retraction in the Z-axis first, then in the X-axis
3 for a retraction in the Z-axis first, then in the Y-axis
4 for a retraction in the Z-axis first, then in the X- and Y-axes simultaneously

Note: When 2, 3 or 4 has been assigned and the plane is being changed, a retraction in the Z-axis is performed and not in the tool axis.

MC 27 Number of tools

This machine constant defines the number of tools employed.
By this, the size of the tool memory is established. The maximum number of tools that can be stored is 255. Part of the program memory has been reserved for the storage of tool data. Consequently, the smaller the amount of tool data, the more memory space will be available for part programs.
Remark: In the case machine constant 35 is set to 1 the maximum number of tools is 99.

MC 28 Number of tool positions

This machine constant defines the number of tool positions in the magazine. The maximum number that can be stored is 255.

MC 29 Tool life monitoring

A tool life can be assigned to every tool employed.
During machining operations, i.e. feed rate active (G1, G2, G3),
spindle rotating (M3, M4),
TXX <> T0,
the actual and the remaining tool life will be adapted in steps of 1 minute. When the remaining tool life becomes lower than 0, warning I 11 is generated.
When the tool life of the tool concerned is exceeded, either error code I 12 is displayed at the next tool change or the spare tool employed, depending on the value assigned to MC 29.
Error code I 12 will also appear when the tool life of the spare tool is exceeded.
The following value can be assigned to MC 29:
0 = Function not active
1 = Function active; display of error code
2 = Function active; substitution by spare tool
For further details refer to the operator's manual.

MC 30 Tool unclamp button function

This machine constant defines the tool unclamp output signal sequence.
0 = Tool unclamp function not active.
1 = Toggle button function.
Pushing the tool unclamp button inverses the output state of the signal. I.e. when it is high it becomes low, pushing again will make the signal high again.
2 = Cont. button function.
When the button is depressed the output signal is high, releasing the button results in a low output signal again.

MC 31 Tool cutting force monitoring

A cutting force monitor enables the cutting force of every tool to be checked.
Input signal "1st threshold exceeded" produces warning I 13. At the next tool change with the same tool either error code I 14 is displayed or the spare tool employed, depending on the value assigned to MC 31.
Input signal "2nd threshold exceeded" immediately produces error code I 15, causing feed and spindle speed to be inhibited.
The following values can be assigned to MC 31:
0 = Function not active
1 = Signal "1st threshold exceeded" produces an error message
2 = Signal "1st threshold exceeded" causes the spare tool to be used

MC35 Tool data output

There are two ways to output the tool data:

0= The programmed toolnumber (0-255) or the tool-position data (MC28≠0) is output in BCD code.

1= Four decade tool programming is used. The two lowest decades are the toolnumber for the tool memory. Hence only 99 tools can be used. The maximum setting for MC27 is 99.
The tool data output is conform the setting in MC63.

MC 42 External program call

This machine constant defines the type of external program call.
Assign 0 for no external program call
1 for program call with fixed assignment
2 for program call with free assignment
For further details refer to the operator´s manual.

MC 43 Number of external program calls

This machine constant defines the amount of external program call numbers for the variable call memory. The maximum number that can be stored is 255. Part of the program memory has been reserved for the storage of external program calls. Consequently, the smaller the number of external program calls, the more memory space will be available for part programs.

MC 44 Conditional jump

This machine constant defines whether the conditional jump commands in the program will always be executed or can be made inactive by means of an input signal. The following values can be assigned to MC 44:
0 = jump commands are always executed
1 = execution of the jump commands depends on the input signal

MC 51 Activating analog spindle

By means of this machine constant the analog spindle can be activated.
Assign 0 for no analog spindle
1 for analog spindle

MC 53 Decoded cooling M7 or M8

When MC 61 (M-output) has been set for decoded output, MC 53 is inactive. Decoded cooling is then automatically activated.
When MC 61 has been set for BCD output and 1 is assigned to MC 53, decoded cooling is obtained. When 0 is assigned to MC 53, no decoded cooling is obtained.

MC 61 Output of M-functions

This machine constant defines the output of M-functions.
Assign 0 for no output of M-functions
1 for output of all M-functions, BCD-coded
4 for output of decoded M-functions, i.e. M3, M4, M6, M7, M8 are output via separate output lines (see section 14); the remaining M-functions are NOT output
5 for output of both decoded and BCD-coded M-functions, i.e. M3, M4, M6, M7, M8 are output via separate output lines (see section 14); the remaining M-functions are output in BCD

MC 63 Output of BCD-coded T

This machine constant defines the output of the T-number.
Assign 0 for no output of T-numbers
1 for output of the two lowest decades of the T-number
2 for output of the two highest decades of the T-number
3 for output of first the two lowest decades, then the two highest decades

In T1020, for example, 20 are the two lowest decades,
10 the two highest decades

MC 64 Output of BCD-coded S

This machine constant defines the output of the S-word, if no Analog-spindle is provided.
Assign 0 for no output of S-words
1 for output of the two lowest decades of the S-word
2 for output of the two highest decades of the S-word
3 for output of first the two lowest decades, then the two highest decades

In S2475, for example, 75 are the two lowest decades,
24 the two highest decades
Remark: In the case machine constant 51 is set to 1, this machine constant must be assigned 0.

MC 65 Output of BCD-coded H

This machine constant defines the output of the H-function.
Assign 0 for no output of H-functions
1 for output of the two lowest decades of the H-function
2 for output of the two highest decades of the H-function
3 for output of first the two lowest decades, then the two highest decades

In H1020, for example, 20 are the two lowest decades,
10 the two highest decades

23.3. CNC SOFTWARE CONFIGURATION

MC 80 Selection of DEMO-mode

Assigning 0 to this machine constant causes the CNC system to switch to standard operation mode. By assigning 1, DEMO mode is activated. DEMO operation means, that the CNC system is operating without I/O-signals and without measuring system signals. The program execution is simulated in the CNC system. The servo outputs allow an X/Y-recorder to be operated.

MC 81 Display mode

This machine constant allows to select between the display of the distance to go (delta-distance) and the display of the following distance.
Assign 0 for display of the distance to go (normal display)
1 for display of the following distance
2 for display of the distance to go; without reference point search after power on
3 for display of the following distance; without reference point search after power on

Note: Assigning 2 or 3 is only allowed for commissioning of the system and NEVER for normal operation, since THE SOFTWARE LIMIT SWITCHES ARE INOPERATIVE!

4 for display of the distance to go; without reference point search after power on; error messages are not processed, just briefly displayed; uncontrolled displacements may occur!
5 for display of the following distance; without reference point search after power on; error messages ar not processed, just briefly displayed; uncontrolled displacements may occur!

MC 82 Number of point definitions

This machine constant defines the number of point definitions.
A maximum of 255 can be stored.
Part of the program memory has been reserved for the storage of point definitions. Consequently, the smaller the number of point definitions, the more memory space will be available for part programs.

MC 83 Number of E-parameters

This machine constant defines the number of E-parameters (max. 255).
Part of the program memory has been reserved for the storage of E-parameters. Consequently, the smaller the number of E-parameters, the more memory space will be available for part programs.

MC 84 Listing of program numbers with or without information

Assign 0 for listing with text
1 for listing with information on memory requirements and program status

MC 85 Maximum number of part- and subprograms

This machine constant defines the maximum number of part- and subprograms that can be stored in the memory.
The minimum number amounts to 16.
The maximum number is 1000.
When the memory contains a large number of programs, the speed of editing operations is affected.
Remark: After changing this machine constant and switching off the machine constant enable signal the memory of the CNC is initialised again, which means that the all the memories are cleared.

MC 90 Display of actual G-functions

This machine constant defines the G-functions that are to be displayed on the screen. For this, the G-functions are divided into groups and provided with a number code:

```
    1 Group A : 0 1 2 3
    2 Group B : 17 18 19 20
    4 Group T : 25 26
    8 Group S : 27 28
   16 Group C : 40 41 42 43 44
   32 Group P : 51 52
   64 Group D : 53 54 55 56 57 58 59
  128 Group E : 63 64
  256 Group N : 66 67
  512 Group R : 68 69
 1024 Group G : 70 71
 2048 Group M : 72 73
 4096 Group F : 81 83 84 85 86 87 88 89
 8192 Group H : 90 91
16384 Group J : 94 95
```

If, for example, 16 is stored under this machine constant, only the actual functions G40, 41, 42, 43 and 44 are displayed.
The addition of number codes allow several groups to be displayed.
When storing for instance 31, the actual G-functions of the groups A, B, T, S and C will be displayed.

MC 91 Display of actual M-functions

This machine constant defines the M-functions that are to be displayed on the screen. For this, the M-functions are divided into groups and provided with a number code.

```
    1 Group A : 3 4 5 13 14 19
    2 Group C : 7 8 9
    4 Group D : 10 11
    8 Group E : 17 18
   16 Group P : 21
   32 Group D : 22 23
   64 Group B : 41 42 43 44
```

If, for example, 8 is stored under this machine constant, only the actual functions M17 and M18 are displayed.
The addition of number codes allow several groups to be displayed. When storing for instance 31, the actual M-functions of the groups A, C, D, E and P will be displayed.

23.4. AXIS DEFINITION

1st axis

The first axis is the one which is displayed first after having been activated via MC 100.

MC 100 Position servo loop

This machine constant can be assigned the following values:
- 0 = not used
- 1 = closed loop
- 2 = open loop (readout)

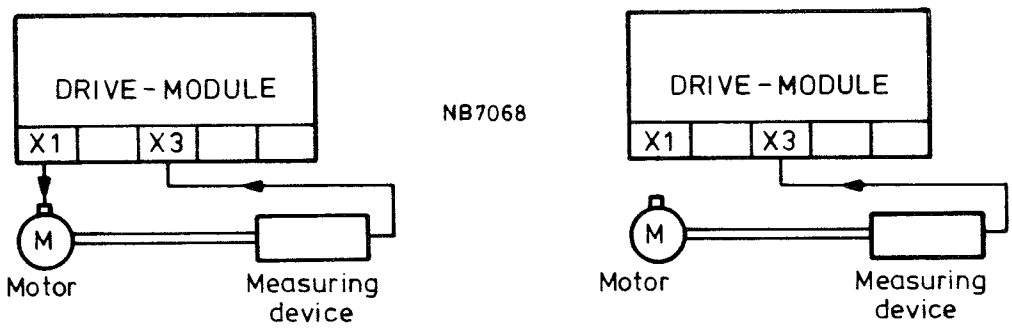


Fig. 23.4.-1 Closed and open servo loops

MC 101 Machine constant block assignment

The machine constants with the axis-related parameters are grouped in "blocks".
The value stored under MC 10 determines how many "blocks" of machine constants are visible.

Depending on the value stored under this machine constant, the axis concerned can be assigned to one of the following blocks:
- 1 = machine constant block 200
- 2 = machine constant block 250
- 3 = machine constant block 300
- 4 = machine constant block 350
- 5 = machine constant block 400
- 6 = machine constant block 450

MC 102 Code for axis orientation

This machine constant defines the axis orientation in a right-handed orthogonal system.
This orientation is employed, for example, to define with linear axes the rotation direction of G02/G03 or to calculate with rotary axes the angle in the measuring cycles.

The following configurations are allowed:
Maximum of 6 linear axes or a minimum of 3 linear axes (the first axes) and all following axes rotary.
E.g.:
- First 4 axes linear + 2 rotary axes is a valid combination
- First 5 axes linear + 1 rotary axis is a valid combination
- First 2 axes linear + 1 rotary axis is an invalid combination
- First 3 axes linear + 1 rotary axis + 2 linear axes is an invalid combination

This machine constant can be assigned the following values:
- 1 = 1st linear axis in positive direction
- 2 = 2nd linear axis in positive direction
- 3 = 3rd linear axis in positive direction
- 4 = 1st rotary axis in positive direction
- 5 = 2nd rotary axis in positive direction
- 6 = 3rd rotary axis in positive direction

Note: A tracking axis or an independent axis can be assigned the orientation code 1.

The axis orientation is explained in the figure below.

1 = X-Axis
2 = Y-Axis
3 = Z-Axis
4 = A-Axis
5 = B-Axis
6 = C-Axis

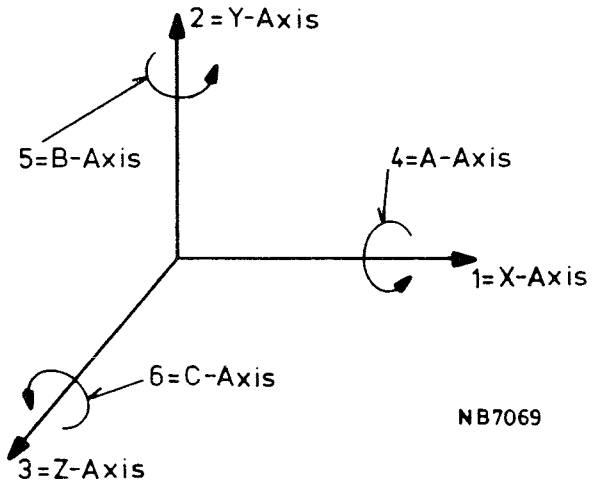


Fig. 23.4.-2 Example of axis orientation

MC 103 ASCII-Code for identification

An identification can be assigned to the axis concerned.
For that, the ASCII-value for the identification character concerned is stored under this machine constant.

Permissible characters with ASCII-value

CHARACTER	ASCII-VALUE	CHARACTER	ASCII-VALUE
A	65	X	88
B	66	Y	89
C	67	Z	90
U	85		
V	86		
W	87		

2nd axis

The second axis is the one which is displayed second after having been activated via MC 105.

MC 105 Position servo loop

Same as MC 100.

MC 106 Machine constant block assignment

Same as MC 101.

MC 107 Code for axis orientation

Same as MC 102.

MC 108 ASCII-Code for identification

Same as MC 103.

3rd axis

The 3rd axis is the one which is displayed third after having been activated via MC 110.

MC 110 Position servo loop

Same as MC 100.

MC 111 Machine constant block assignment

Same as MC 101.

MC 112 Code for axis orientation

Same as MC 102.

MC 113 ASCII-Code for identification

Same as MC 103.

4th axis

The fourth axis is the one which is displayed fourth after having been activated via MC 115.

MC 115 Position servo loop

Same as MC 100.

MC 116 Machine constant block assignment

Same as MC 101.

MC 117 Code for axis orientation

Same as MC 102.

MC 118 ASCII-Code for identification

Same as MC 103.

5th axis

The fifth axis is the one which is displayed fifth after having been activated via MC 120.

MC 120 Position servo loop

Same as MC 100.

MC 121 Machine constant block assignment

Same as MC 101.

MC 122 Code for axis orientation

Same as MC 102.

MC 123 ASCII-Code for idetification

Same as MC 103.

6th axis

The sixth axis is the one which is displayed sixth after having been activated via MC 125.

MC 125 Position servo loop

Same as MC 100.

MC 126 Machine constant block assignment

Same as MC 101.

MC 127 Code for axis orientation

Same as MC 102.

MC 128 ASCII-Code for identification

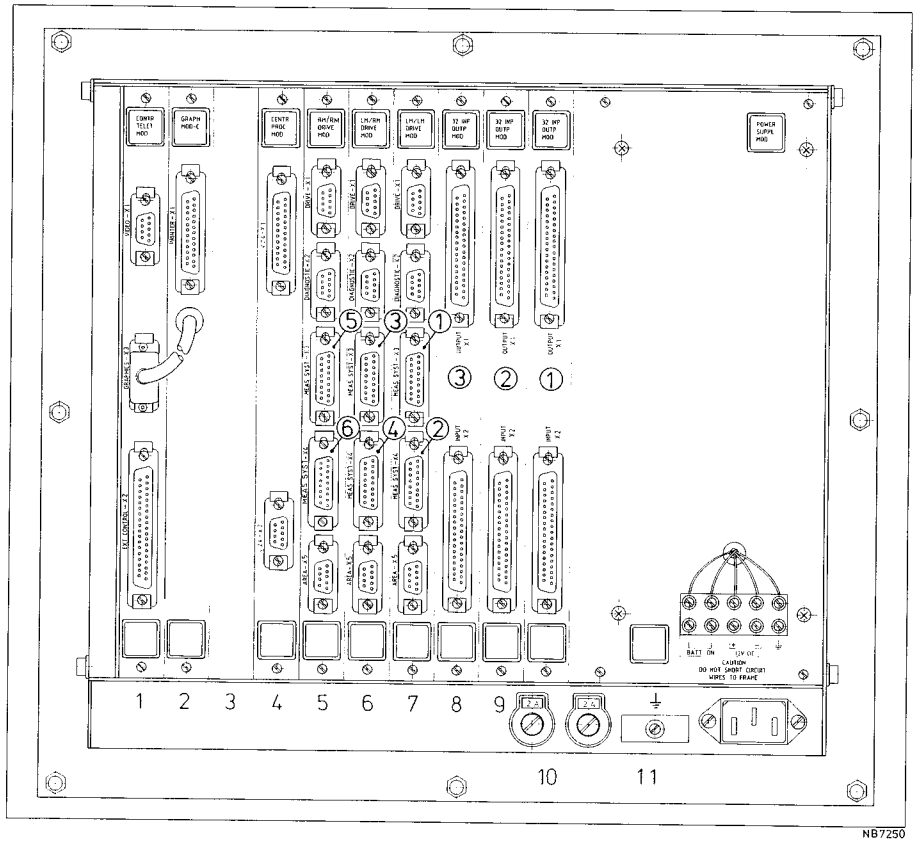
Same as MC 103.

23.5. 1ST "AXIS PARAMETER BLOCK"

23.5.1. Measuring system

MC 200 Measuring system input selection

With this machine constant the 1st "axis parameter block" can be assigned to one of the measuring system inputs and respectively its servo drive output.
The picture below gives the sequence of numbers with which the measuring system input can be linked to this "axis parameter block". Make sure that the same number is not used for the other "axis parameter block", since this will result in unpredictable behaviour of the machine tool.



MC 202 Count direction of measuring system

This machine constant defines the count direction of the measuring system. Assigning 1 will give a positive count direction in one direction of movement in the axis. Assigning -1 will give a negative count direction in the same direction of movement in the axis.

MC 203 Multiplication factor for S00/S90 measuring input signals

This machine constant defines the number of count pulses that is to be decoded per S00/S90-cycle.
Assign 0 for 1 count pulse per S00/S90 cycle
1 for 2 count pulses per S00/S90 cycle
2 for 4 count pulses per S00/S90 cycle

When the axis is fitted with a linear measuring system or when the axis does not exist, the value already stored need not be changed.

23.5.2. Velocities

MC 205 Rapid traverse rate

This machine constant defines the maximum traversing rate for the axis. The traversing rate is stored in steps of 100 increments per minute.

Example: Required rapid traverse rate 6 m/min. The value to be stored under MC 205 is 60 000.

MC 206 Jog feedrate

This machine constant defines the feed rate during jogging at 100% feed override. The feedrate is stored in steps of 100 increments per minute.

23.5.3. Setting the position loop gain

MC 215 Following distance 1

This machine constant defines the position loop gain 1 of the servo drive. Gain 1 is effective until a given nod point, defined by MC 216, is attained. From this point on the (lower) gain 2, defined by MC 217, is put into effect.
As a matter of fact, not the gain factor is stored, but the following distance at which the servo output voltage is maximum.
The following distance is stored in increments.
The smaller the number of increments, the higher the gain; the larger the number of increments, the lower the gain.

Refer also to section 24: Optimization of the machine constants for the servo drives

MC 216 Nod point

This machine constant defines the point where gain 1 (MC 215) changes into gain 2 (MC 217). To this end, the following distance (in increments) at which the gain factor must be changed, is stored.

Refer also to section 24: Optimization of the machine constants for the servo drives

MC 217 Following distance 2

This machine constant defines the position loop gain 2 of the servo drive. Gain 2 becomes effective after a given nod point, defined by MC 216, has been attained.
As a matter of fact, not the gain factor is stored, but the following distance at which the servo output voltage is maximum.
The following distance is stored in increments.
The smaller the number of increments, the higher the gain; the larger the number of increments, the lower the gain.

Refer also to section 24: Optimization of the machine constants for the servo drives

MC 218 Acceleration/deceleration mode

This machine constant activates the acceleration/deceleration feature (See also section 24).

0 = no acc./dec.
1 = acc./dec., first order, only in rapid movements
2 = acc./dec., first order, both in rapid and feed movements
3 = acc./dec., second order, only in rapid movements
4 = acc./dec., second order, both in rapid and feed movements

MC 219 Acceleration/deceleration time constant

As a rule, the above gain control does not satisfy the requirements of larger machine tools. They need a more sophisticated servo drive control.
For this kind of machine tools the CNC system offers a so-called acceleration/deceleration function for the servo drive outputs.
When it is not employed, 0 is assigned to MC 219.
When it is employed, a gain factor has to be set. This is done in the following way:

Store the programmed maximum feedrate under MC 206.
Jog the machine slide at 140% feed override and determine the value for MC 215, as detailed in sections 20 and 24.

After the correct value for MC 215 has been found, the value assigned to MC 206 is changed into the value for rapid traverse rate.
Jogging at 140% feed override will now produce a following distance related error message.
Assign 200 to MC 219.
Jog the slide again. If the error message appears again, increase the value. If no error message appears, decrease the value in order to find the optimum value for MC 219. The minimum value to be assigned to MC 219 is 15, the maximum value is 3000.

MC 220 Acceleration/deceleration threshold

As a rule, the value assigned to this machine constant will be 0. When the acceleration/deceleration function is used (MC 219 > 0), and it is found that the axis responds too slowly when starting and moving into position, a threshold value for the velocity can be stored, below which the function is not operative.

MC 221 "Inpod" - delay time

This machine constant defines the delay time, that must be taken into account after the position stored under MC 222, has been attained. It is put into effect only after a positioning movement and ensures that the machine slide is "in position" before the next command is executed. The delay time is equal to the value assigned to MC 221, multiplied by 15 ms.

Example:
The delay time required is 100 ms. By assigning 7 to MC 221, a true delay time of 105 ms (7x15ms) is achieved.

MC 222 "In position"-window

This machine constant defines the distance (in increments) before the command position, where the "Inpod" delay time (MC 221) must be put into effect. See fig. 23.-3.
Theoretically, the servo output voltage is 0 V at the end of the positioning operation. However, in praxis the servo output will show a small positive or negative offset value. Consequently, the following distance display (MC 81) will show an offset value as well. The distance to be stored under MC 222 has to be slightly larger than the residual following distance. When for instance a residual following distance of 3 or 4 increments is displayed, 10 has to be stored.

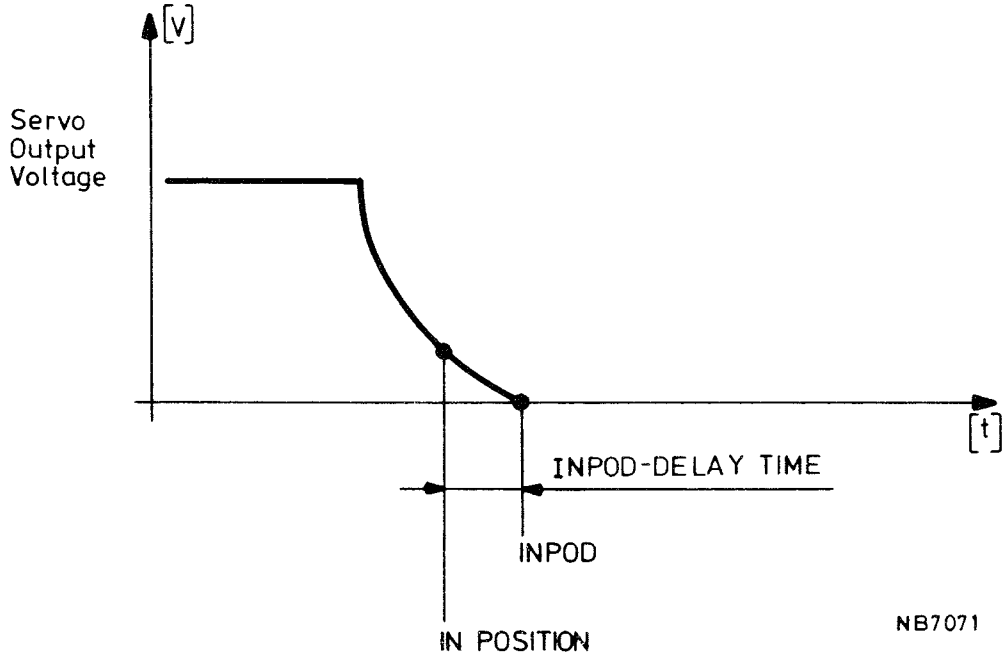


Fig. 23.5.3.-1 "In position"-window

MC 223 Standstill monitoring

The servo loops are permanently checked for errors. This is effected dynamically by checking the following distance. When the following distance increases during standstill, the NC system checks whether the number of increments stored under MC 223 is exceeded. If so, an error message is produced.
When setting the number of increments, the drift of the servo system as well as the displacement in the axis as a result of milling operations are to be taken into account.

MC 224 Backlash compensation

This machine constant defines the compensation of the backlash in the axis. The backlash is stored in increments.
Backlash compensation is only employed with rotary measuring systems. For linear measuring systems, 0 is assigned to this machine constant, otherwise the start of the positioning movement will be erratic.

Reference point (RPF)

MC 230 RPF direction

This machine constant defines the direction of approach of the "area switch". For an approach in positive direction of the axis, 1 is assigned to MC 230, for an approach in negative direction -1.

MC 231 RPF feedrate

This machine constant defines the feedrate, at which the "area switch" is to be approached.
Refer also to section 11: Input signals from the machine reference point. The feedrate is entered in steps of 100 increments/min.

Example: The required RPF feedrate is 2 m/min. The value to be stored under MC 231 is 20 000.

MC 232 RPF creep feed

This machine constant defines the velocity at which the machine slide, after having actuated the area switch, starts moving in the reversed direction for reference point search.
The usual velocity for reference point search is 160 mm/min.
Refer to section 11 for details on the reference point search procedure.
The maximum error related to the approaching velocity is:

at velocities	
up to 80 mm/min	0.5 um
160 mm/min	1 um
330 mm/min	2 um
500 mm/min	3 um

the velocity is entered in steps of 100 increments/min.

Example: The required RPF creep speed is 10 mm/min. The value to be stored under MC 232 is 100.

MC 233 RPF-Offset

This machine constant defines the difference between the machine datum and the reference point. The difference is stored in increments from the range -999999999 to +999999999.

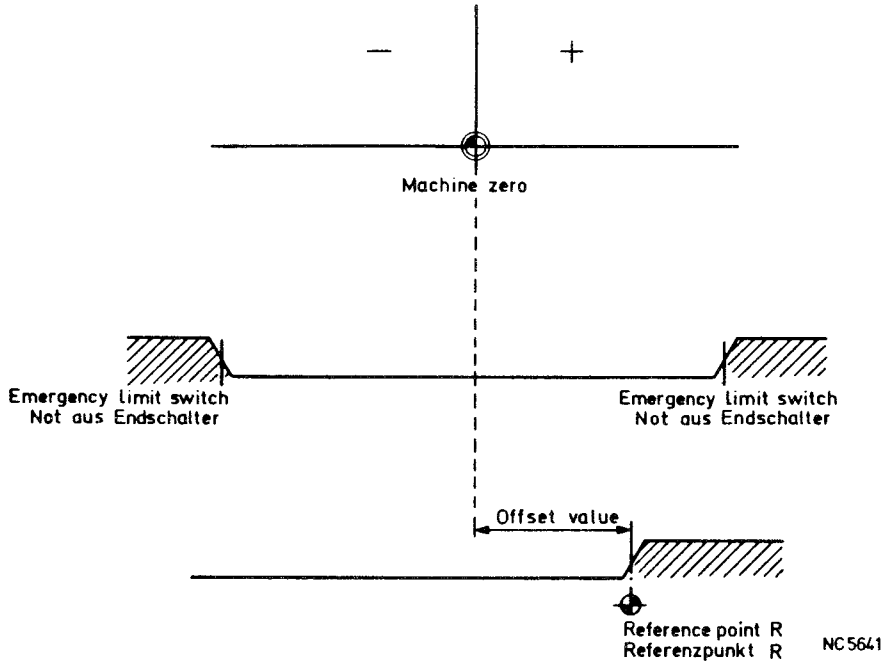


Fig. 23.-4 RPF-Offset

MC 234 Area switch

0=Using area swith + Marker signal
1=Using Marker signal only (E.g. for turntables)

MC 235 Software limit switch (positive direction)

This machine constant defines the position of the software limit switch in positive direction, with respect to the machine reference point in the axis. The position is stored in increments, without sign.

MC 236 Software limit switch (negative direction)

This machine constant defines the position of the software limit switch in negative direction, with respect to the machine reference point in the axis. The position is stored in increments with negative sign.

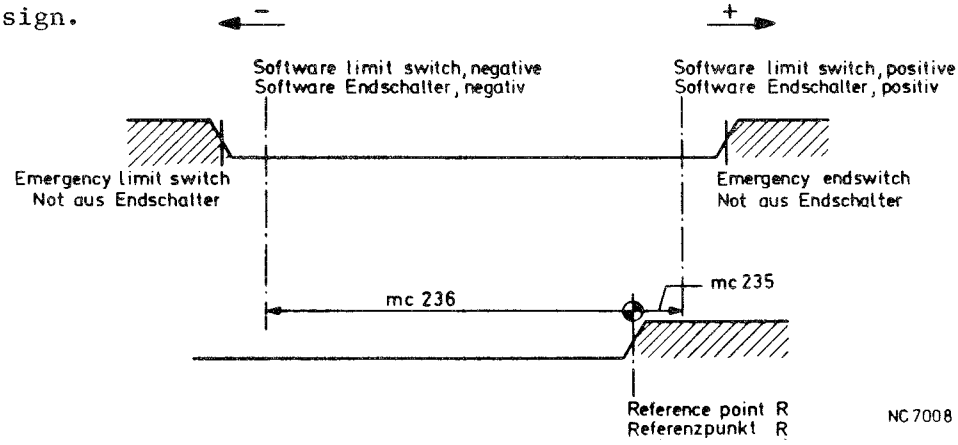


Fig. 23.-5 Establishment of software limit switch positions

MC 237 Home position

This machine constant defines the retract position for tool change. The home position, with respect to reference point R, is stored in increments with sign.

MC 240 Position of fixed measuring probe

This machine constant defines the position of the fixed measuring probe, with respect to reference point R.

MC 242 Position of calibration ring centre

This machine constant defines the position of the calibration ring centre, with respect to reference point R.

MACHINE CONSTANTS 250 TO 492

The machine constants 250 to 292 are equal to machine constants 200 to 242, but apply to the 2nd "axis parameter block".

The machine constants 300 to 342 are equal to machine constants 200 to 242, but apply to the 3rd "axis parameter block".

The machine constants 350 to 392 are equal to machine constants 200 to 242, but apply to the 4th "axis parameter block".

The machine constants 400 to 442 are equal to machine constants 200 to 242, but apply to the 5th "axis parameter block".

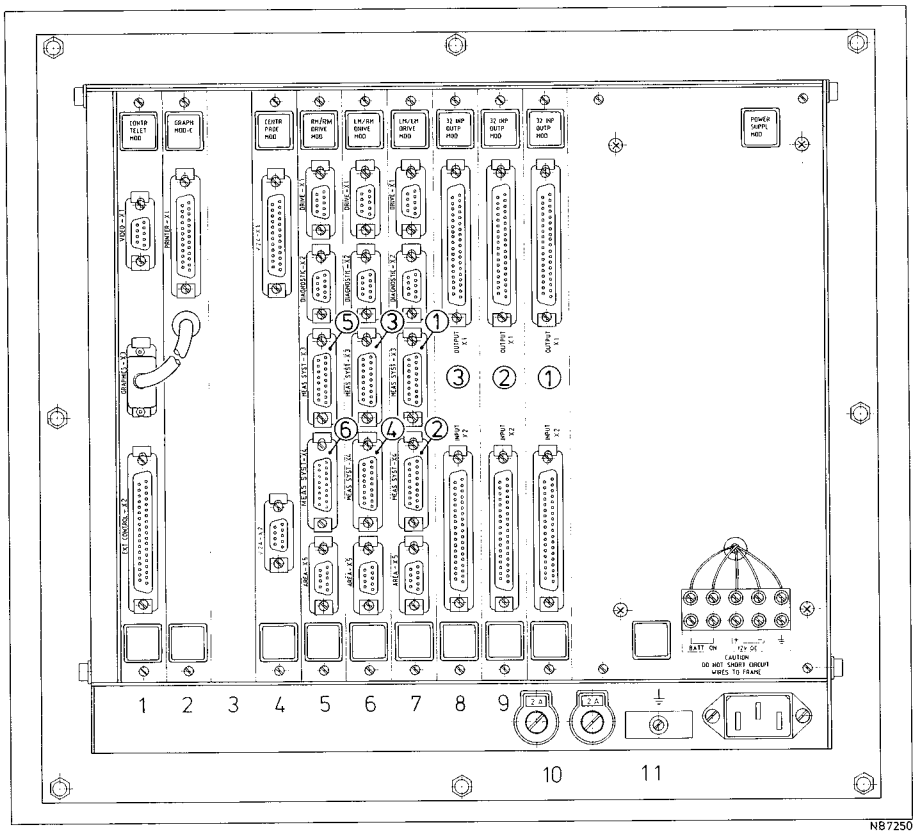
The machine constants 450 to 492 are equal to machine constants 200 to 242, but apply to the 6th "axis parameter block".

Remark: Depending on the number of axes defined with machine constant 10, the relevant machine constants are activated.
In the case the necessary machine constants do not appear on the screen (i.e. when changing MC10 from 3 to 4 and MC350-392 do not appear) switch off the machine constant enable signal (input 27, I/O card I) and switch it on again.
The relevant machine constants are now initialised.

Remark: Machine constants 500 to 582 are only available when machine constant 51 is set to 1.
In the case machine constant 51 is set to 1 and these machine constants are not displayed, switch off the machine constant enable signal (input 27, I/O card I) and switch it on again. The relevant machine constants are now initialised.

MC 500 Output for spindle drive

This machine constant defines the socket to which the spindle drive is connected. The following values can be assigned to it:
0 = no analog spindle output
1 = drive card 1 - socket 1
2 = drive card 1 - socket 2
3 = drive card 2 - socket 1
4 = drive card 2 - socket 2
5 = drive card 3 - socket 1
6 = drive card 3 - socket 2
7 = drive card 4 - socket 1
8 = drive card 4 - socket 2



MC 501 Resolution of spindle transducer

Under this machine constant the number of S00/S90 pulses generated by the transducer per rotation of the spindle, is stored. Since the frequency at the input of the measuring system card may not exceed 100 kHz, the use of for instance a transducer generating 65000 S00/S90 pulses per rotation of the spindle will give a maximum spindle speed of 90 rev/min approx.
When no spindle transducer is used, MC 501 is assigned the value 0.
The value displayed under Actual S is now the calculated value.

MC 502 Count direction of spindle transducer + Inpos window

This machine constant defines the count direction of the spindle transducer.
Assign a positive sign for a positive count direction at M3
a negative sign for a positive count direction at M4

The absolute value of this machine constant defines the inpos window.
The value ranges from -255 to 255 increments.

MC 503 Multiplication factor for the S00/S90 measuring signals

This machine constant defines the number of count pulses generated per S00/S90 cycle.
Assign 0 for 1 count pulse per S00/S90 cycle
1 for 2 count pulses per S00/S90 cycle
2 for 4 count pulses per S00/S90 cycle

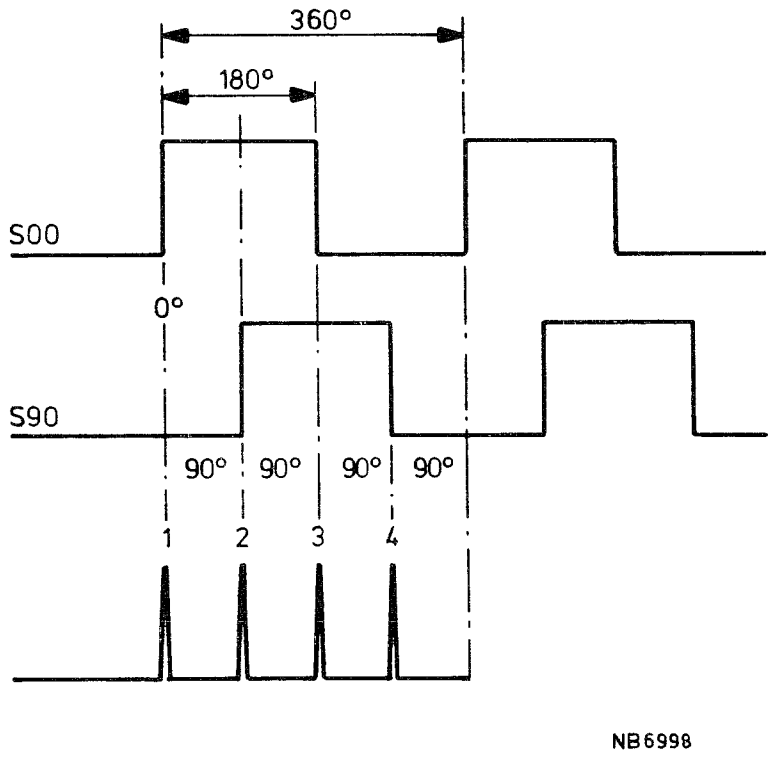


Fig. 23.-6 Determination of count pulses

MC 505 Spindle jog speed

This machine constant only applies to NC systems being fitted with the "Analog spindle" option.
It defines the number of spindle revolutions per minute when operating the Jog button. The number of revolutions may be from -9999 to +9999. When the number of revolutions is stored with a positive sign and the Spindle clockwise button is actuated, a positive analog spindle output voltage is produced. Storing a negative sign will produce a negative output voltage.

Gear range 1

MC 515 Following distance 1

This machine constant defines the position loop gain 1 for the first (lowest) gear range of the spindle drive. Gain 1 is effective until a given nod point, defined by MC 516, is attained. From this point on a (lower) gain 2, defined by MC 517, becomes effective.
As a matter of fact, not the gain factor is stored, but the following distance at which the servo output voltage is 9 V.
The following distance is stored in increments from 128 to 320 000.
The smaller the number of increments, the higher the gain; the larger the number of increments, the lower the gain.

MC 516 Nod point

This machine constant defines the point where gain 1 (MC 515) changes into gain 2 (MC 517). To this end, the following distance (in increments from 128 to 320 000) at which the gain must be changed, is stored.

MC 517 Following distance 2

This machine constant defines the position loop gain 2 for the first (lowest) gear range of the spindle drive. Gain 2 becomes effective after a given nod point, defined by MC 516, has been attained.
As a matter of fact, not the gain factor is stored, but the following distance at which the servo output voltage is 9 V.
The following distance is stored in increments from 128 to 320 000.
The smaller the number of increments, the higher the gain; the larger the number of increments, the lower the gain.

Gear range 2

MC 525 Following distance 1

This machine constant defines the position loop gain 1 for the second gear range of the spindle drive.
For further details see MC 515. Read MC 526 and MC 527 for MC 516 and MC 517 respectively.

MC 526 Nod point

Same as MC 516. Read MC 525 and MC 527 for MC 515 and MC 517 respectively.

MC 527 Following distance 2

This machine constant defines the position loop gain 2 for the second gear range of the spindle drive.
For further details see MC 517. Read MC 526 for MC 516.

Gear range 3

MC 535 Following distance 1

This machine constant defines the position loop gain 1 for the third gear range of the spindle drive.
For further details see MC 515. Read MC 536 and MC 537 for MC 516 and MC 517 respectively.

MC 536 Nod point

Same as MC 516. Read MC 535 and MC 537 for MC 515 and MC 517 respectively.

MC 537 Following distance 2

This machine constant defines the position loop gain 2 for the third gear range of the spindle drive.
For further details see MC 517. Read MC 536 for MC 516.

Gear range 4

MC 545 Following distance 1

This machine constant defines the position loop gain 1 for the fourth (highest) gear range of the spindle drive.For further details see MC 515. Read MC 546 and MC 547 for MC 516 and MC 517 respectively.

MC 546 Nod point

Same as MC 516. Read MC 545 and MC 547 for MC 515 and MC 517 respectively.

MC 547 Following distance 2

This machine constant defines the position loop gain 2 for the fourth (highest) gear range of the spindle drive.
For further details see MC 517. Read MC 546 for MC 516.

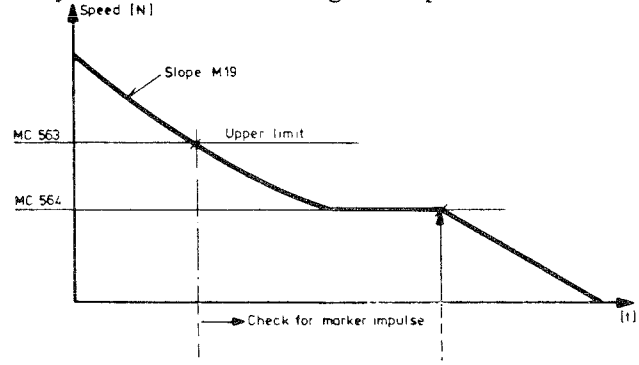
23.7 ORIENTED SPINDLE STOP

MC 560 Oriented spindle stop - Mode

The function "Oriented spindle stop" (M19) is used to bring and keep the spindle in an accurate angular position in order to perform a tool change or a measuring operation. The operation is effected with the aid of the marker pulse from the spindle transducer.
M19 is output during automatic tool change M6 (MC18 = 1).
For the execution of the M19-function there are three options:

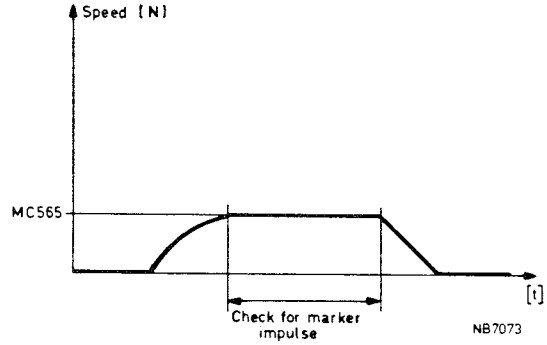
1. Closed loop - Spindle is rotating

   Sequence of operations:
   The spindle speed is reduced until the 1st search speed, defined by MC 563, is attained. Then the marker pulse detection becomes effective. The spindle speed is further reduced until the 2nd search speed, defined by MC 564, is attained. Upon detection of the marker pulse the spindle slows down over a distance equal to the offset value defined by MC 566. The speed is reduced to zero according to a slope defined by MC 561, in such a way that the spindle moves exactly into the M19 angular position.



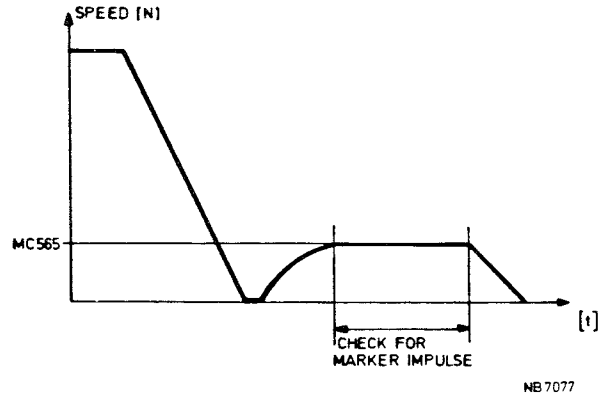
2. Closed loop - Spindle is stationary

Sequence of operations:
The spindle accelerates until the speed defined by MC 565 is attained. The marker pulse is detected and the spindle slows down over a distance equal to the offset value defined by MC 566. The speed is reduced such that the spindle moves exactly into the M19 angular position.



3. Open loop - Spindle is rotating or stationary

When the spindle is rotating in open loop, first M5 "Spindle stop" is issued. As soon as the spindle has stopped the feedback loop is closed and the sequence of operations given under 2. is executed. The feedback loop remains closed until an M3, M4 or M5 is recognized in the program.



The following values can be assigned to MC 560:

0 = no M19

1 = M19 mechanically. M19 is written in the display and output via the BCD data outputs. The execution is effected by the machine interface.
When the spindle has moved into the correct angular position, signal "Machine function ready" must be fed back, after which for example a tool change (M6) can be executed.

2 = M19 with transducer. The execution is effected by the NC system.

3 = The offset value to be stored under MC 566 is determined.
The M19-function is executed as usual. Upon detection of the marker pulse the spindle is stopped. The value, displayed under Actual-S, becomes 0 and then changes into the value representing the running out of the spindle.
The spindle can now be manually moved into the right angular position.
The value displayed under Actual-S is stored under MC 566.

Remark: Machine constants 561-568 are only available when machine constant 560 is set to 2 or 3.
In the case machine constant 560 is set to 2 or 3 and these machine constants are not displayed, switch off the machine constant enable signal (input 27, I/O card I) and switch it on again. The relevant machine constants are now initialised.

MC 561 Oriented spindle stop - Slope

This machine constant defines the slope according to which the search speed of the spindle is reduced until the orientation point is reached.

MC 562 Inpod delay time

This machine constant has the same meaning as machine constant 221, but is valid for the spindle.

MC 563 1st search speed

This machine constant defines the 1st search speed of the spindle. The speed is stored in revolutions per minute (max. 9999).

MC 564 2nd search speed

This machine constant defines the 2nd search speed of the spindle. The speed is stored in revolutions per minute (max. 9999).

MC 565 Search speed from M5

This machine constant defines the search speed of the spindle after "Spindle stop" (M5). The speed is stored in revolutions per minute. By storing a number between 0 and 9999, a clockwise spindle rotation (M3) is obtained. Storing a number between -9999 and 0 will produce a counter-clockwise spindle rotation (M4).

MC 566 Offset to marker pulse

This machine constant defines the offset of the M19 angular position to the point where the marker pulse appears. The offset value is stored in steps of 1/1000 degree, between 0 and 360 000.

MC 567 Standstill monitoring

The spindle servo loop is permanently checked for errors. This is effected dynamically by checking the following distance. When the following distance increases during standstill, the NC system checks whether the number of increments stored under MC 567 is exceeded. If so, an error message is produced.

MC 568 M19 with additional programming of D-address

When 1 is assigned to this machine constant and M19 is programmed, an additional offset value can be programmed under the D-address.
Offset value = value assigned to MC 566 + value stored under D-address.
When assigning 0 to MC 568, the D-address is inactive during the execution of the M19-function.

MC 570 Automatic selection of spindle speed range

- Programmed range selection

  The control system alllow a maximum of 4 spindle speed ranges to be selected, viz. M41 to M44. The figure below shows the characteristics of a 4-range spindle drive.

Range No.

N1	M41
N2	M42
N3	M43
N4	M44

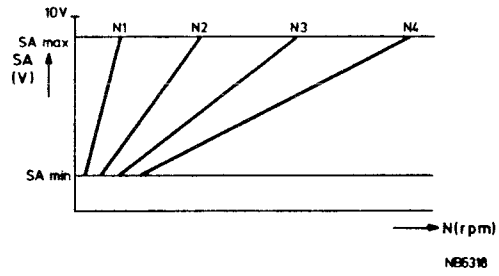


Fig. 23.-7 Characteristics of a 4-range spindle drive, programmed range selection

- Automatic range selection

  In this mode the spindle speed ranges do not overlap. The NC system automatically sets the range to the programmed speed, unless a range has been programmed. The figure below shows the characteristics of the standard 4-range spindle drive.

Range No.

N1	M41
N2	M42
N3	M43
N4	M44

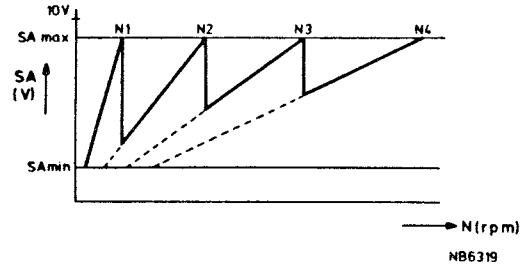


Fig. 23.-8 Characteristics of a 4-range spindle drive, automatic range selection

- Sequence of operations

  When a new S is programmed and "Cycle Start" is set active, the analog output is immediately set to a new level in the active range, provided no new range has been programmed and the new level lies within the active range. Otherwise, the NC system will generate a new range.

Programming a new range or automatic generation of a new range by the NC system shows the following sequence of operations:

1. Analog output is set to "gear change level".
2. Output of new range (M41-M44); (in conformity with M-output, section 14, output signals I/O module I, pin 25)
3. Signal "Machine function ready" is set high.
4. End of gear change: signal "Machine function ready" is set low.
5. Output of new range is ready. Analog output goes to the programmed level.

Note:
Spindle rotation can be disabled at any time by setting signal "Spindle permitted" low. After the gear change the signal must be set high again.

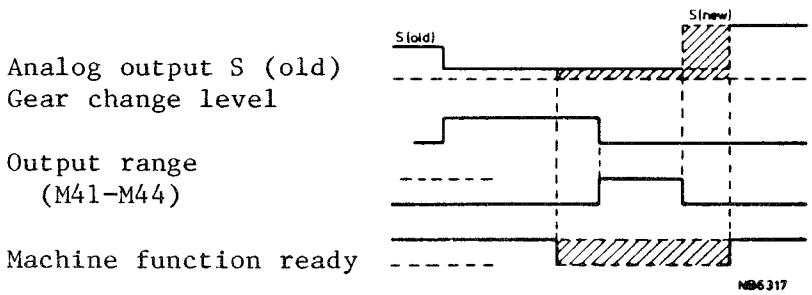


Fig. 23.-9 Timing diagram analog spindle range selection

MC 570 can be assigned the following values:
0 = no automatic range selection (open loop)
1 = automatic range selection (open loop)
2 = no automatic range selection (closed loop)
3 = automatic range selection (closed loop)
Remark: This machine constant is not available when machine constant 501 is set to 0.

MC 571 Maximum spindle speed, 1st range

This machine constant is only employed uhen the option "Analog spindle" is provided. It defines the maximum spindle speed per minute for the first range. The speed is stored in revolutions/min (max. 9999) with sign. A positive sign causes Analog-S to be positive with M3 and negative with M4, a negative sign to be negative with M3 and positive with M4.

MC 572 Maximum spindle speed, 2nd range

This machine constant is only employed when the option "Analog spindle" is provided. It defines the maximum spindle speed per minute for the second range. The speed is stored in revolutions/min (max. 9999) with sign. A positive sign causes Analog-S to be positive with M3 and negative with M4, a negative sign to be negative with M3 and positive with M4.

MC 573 Maximum spindle speed, 3rd range

This machine constant is only employed when the option "Analog spindle" is provided. It defines the maximum spindle speed per minute for the third range. The speed is stored in revolutions/min (max. 9999) with sign. A positive sign causes Analog-S to be positive with M3 and negative with M4, a negative sign to be negative with M3 and positive with M4.

MC 574 Maximum spindle speed, 4th range

This machine constant is only employed when the option "Analog spindle" is provided. It defines the maximum spindle speed per minute for the fourth range. The speed is stored in revolutions/min (max. 9999) with sign. A positive sign causes Analog-S to be positive with M3 and negative with M4, a negative sign to be negative with M3 and positive with M4.

MC 580 Maximum analog output voltage

This machine constant is only employed when the option "Analog spindle" is provided. It defines the maximum voltage applied to the spindle drive. The voltage is stored in mV.
When the maximum permissible voltage at the input of the spindle drive is 8 V, 8000 is stored under MC 580.

MC 581 Minimum analog output voltage

This machine constant is only employed when the option "Analog spindle" is provided. It defines the minimum voltage required to obtain the appropriate motor response for spindle driving . The voltage is stored in mV. See also MC 580.

MC 582 Gear change output voltage

This machine constant is only employed when the option "Analog spindle" is provided. It defines the voltage required to obtain the necessary spindle motor rotation for gear changing. The voltage is stored in mV.

MC 590 Spindle gear change, time between rotation pulses

See also MC 591.
The time between two rotation pulses is entered in this machine constant in steps of 50 msec.
Entering a zero in this machine constant gives a non alternating gear change output voltage. (In this case also MC 591 must be 0).

MC 591 Spindle gear change rotation pulse duration

For gear changing it can be necessary to have the spindle moving alternately with M3 and M4. To do so the control outputs the gear change voltage (MC 582) alternately positive and negative with an active duration defined in this machine constant.
Entering a zero in this machine constant gives a non alternating gear change output voltage.
The duration is entered in steps of 50 msec, e.g. entering 20 means 1000 msec rotation pulses. The maximum value is 255 (12750 msec).

23.9 GENERAL PARAMETERS

23.9.1 Program format

MC 705 Position of decimal point in dimension words

This machine constant defines the position of the decimal point in the axis addresses. The position is given by the smallest number of the programmed increments.

Example:

Resolution	Display	Value assigned to MC
0.001 mm	0000.000	3
0.0001 inch	000.0000	4

MC 706 Position of decimal point in feed rate

This machine constant defines the place of the decimal point in the feed rate. The position is given by the smallest number of the programmed increments.
Example:
The feed rate is programmed in steps of 0.01 mm/min.
MC 706 is assigned the value 2.

MC 707 Inch/metric initialization

This machine constant defines the unit of programming (inches or metric units). When, after switching on, programming in inches is required, 70 is to be stored under MC 707. For programming in metric units, 71 is to be stored.

MC 710 Not used

This machine constant is reserved for later options. Please enter the value 10 in this machine constant.

MC 711 Intersection angle

When a program contains a radius correction, the intersection angle determines whether an intersection is calculated or an intermediate block with an circular movement inserted, to round off the angle. The intermediate block is executed as soon as the angle is smaller than the number of degrees stored under MC 711.
The minimum angle is 0.001^{o}, the maximum angle 180^{o}.

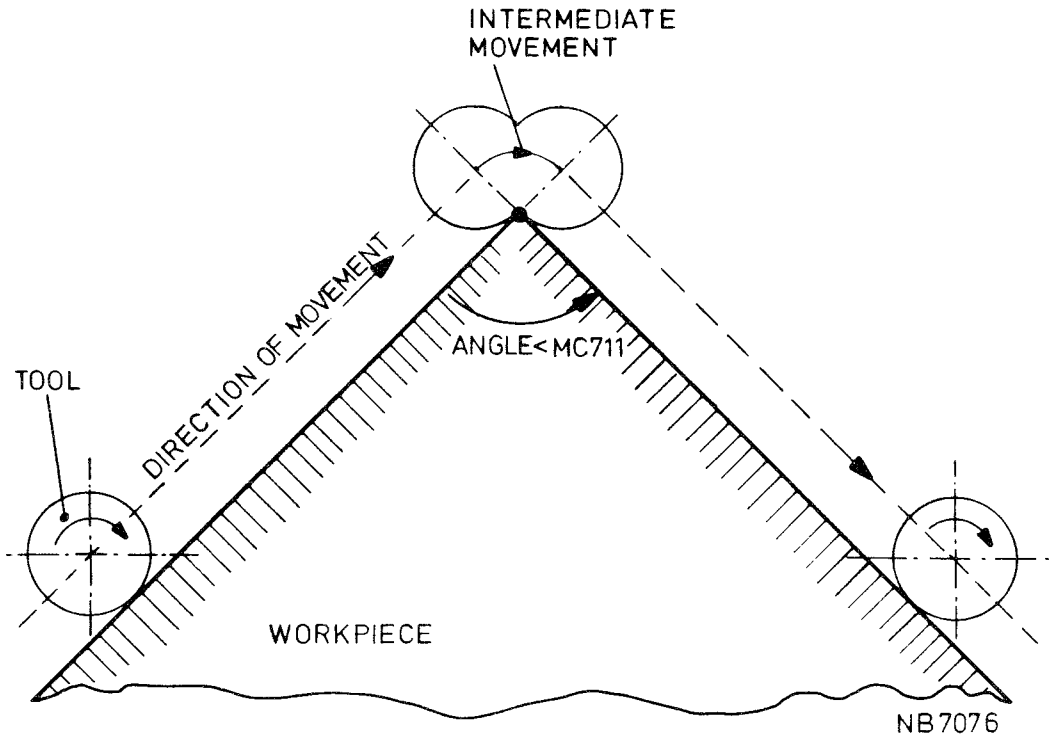


Fig. 23.-10 Explanation to intersection angle

MC 712 Circle end point window

This machine constant defines the correction of a programmed circle end point or of an incorrectly programmed circle centre point.
The correction value is stored in increments between 0 and 9999999.

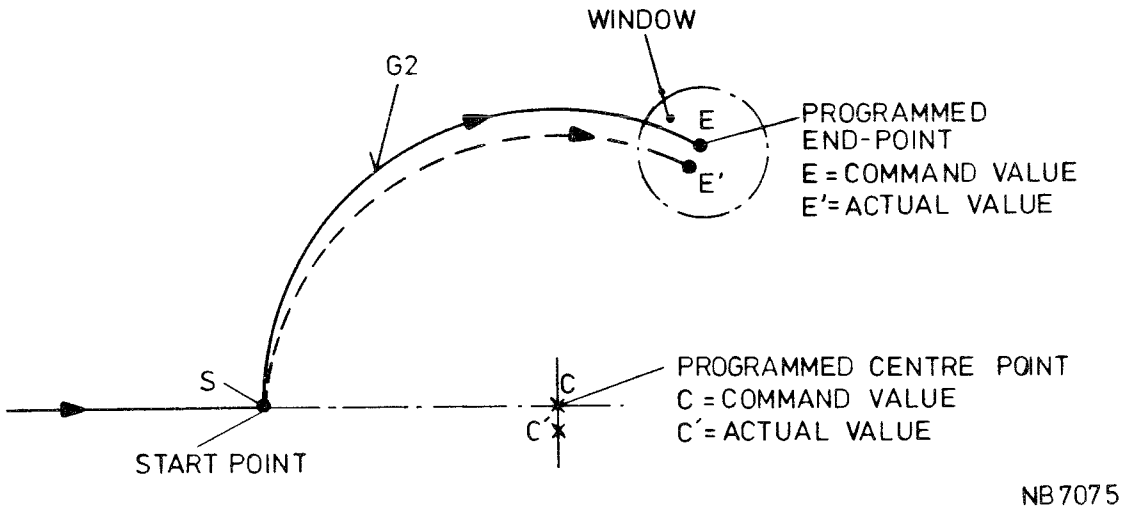


Fig. 23.-11 Explanation to circle end point window

MC 714 Scaling mode

Scaling can be programmed by a factor or by a percentage. Besides, it can be established whether scaling is only executed in the machining plane (e.g. G17 in the X/Y-plane) or in all linear axes.
MC 714 can be assigned the following values:
0 = scaling in the machining plane, programmed by a factor
1 = scaling in the machining plane, programmed by a percentage
2 = scaling in all linear axes, programmed by a factor
3 = scaling in all linear axes, programmed by a percentage

MC 715 Position of decimal point for scaling

This machine constant defines the position of the decimal point when scaling has been programmed.
When scaling has been programmed by a factor, from 0 to 6 decimal positions can be programmed, depending on the value assigned to MC 715.
Example:
0 = no decimal position
1 = 1 decimal position
etc. up to 6 decimal positions
When scaling has been programmed by a percentage, from 0 to 4 decimal positions can be programmed, depending on the value assigned to MC 715.
Example:
0 = no decimal position
1 = 1 decimal position
etc. up to 4 decimal positions

23.10 FIXED CYCLES

MC 720 Overlap during pocket milling

This machine constant defines the percentage of the cutting tool diameter used for overlapping during pocket milling (G87 and G89), in case no I-value is programmed. A percentage between 1 and 100 can be stored.

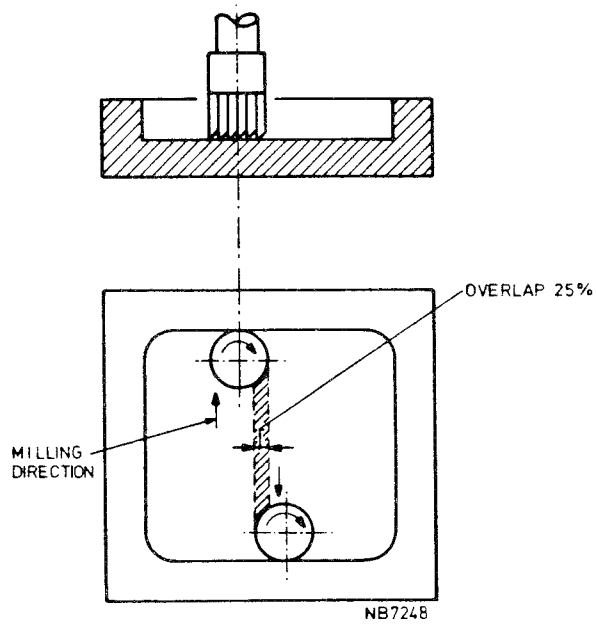
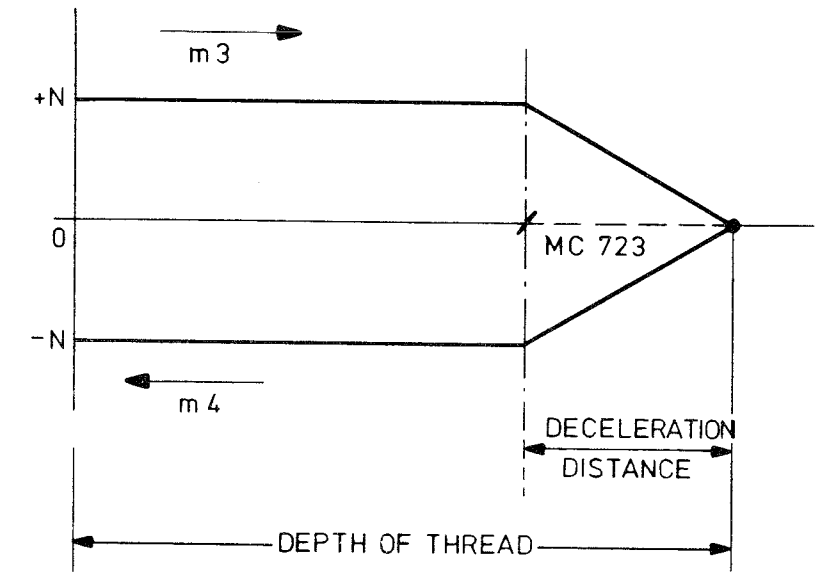


Fig. 23.-12 Overlap pocket milling

MC 723 Deceleration distance during tapping

This machine constant defines the deceleration distance during tapping cycles. Over this distance spindle speed and feed rate are reduced in a linear way. At restart, spindle speed and feed rate are accelerated over the same distance. In that way tool breakage at "Cycle Interrupt" is avoided. The value assigned to MC 723 can be overruled by an I-value programmed in the G84-cycle.
An example is given in the figure below.



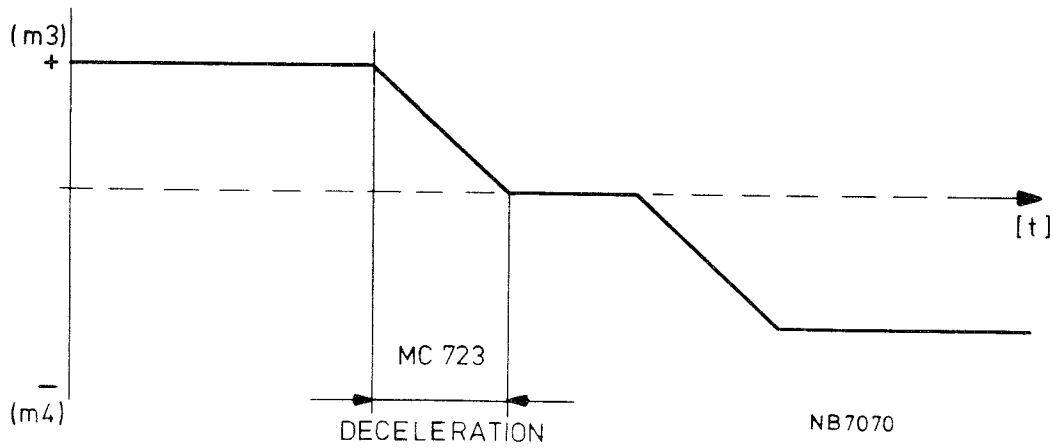


Fig. 23.-13 Deceleration distance during tapping cycle

MC 724 Dwell during tapping

This machine constant defines the dwell after Spindle stop during tapping cycles with G84 and drilling cycles with G86.
The dwell is stored in periods of 15 ms, with a maximum of 255.
Example:
The required dwell is 50 ms.
Under MC 724 the value 4 is stored.
The true dwell will then be 60 ms (4 x 15 ms).

MC 730 External error

0= External error feature switched off.
1= Via input module 2, inputs 27-32, error information in binary code can be given.
The decimal value will be displayed on the screen.
The error is a class H error, so no further action will be taken by the control.
100 msec after one of the inputs changes the new error is displayed on the screen.

MC 731 Inputs for open servo loop

When 0 is assigned to this machine constant, the inputs which determine whether the servo loop is opened or closed, are set inactive.
Consequently, the servo loop will always be closed.
When 1 is assigned to MC 731, the inputs concerned are set active.
A low input means closed loop, a high input means open loop.

23.11 FEED RATE OR SPINDLE SPEED

MC 740 Maximum operating feed rate

This machine constant defines the maximum operating feed rate.
The feed rate is stored in steps of 100 increments per minute.
If, for example, the operating feed rate is required to be 3 m/min, 30 000 is stored under MC 740.

MC 741 Testrun feed rate

This machine constant defines the feed rate during a testrun.
The feed rate is stored in steps of 100 increments per minute.
If, for example, the testrun feed rate is required to be 2 m/min, 20 000 is stored under MC 741.

MC 745 Maximum percentage of feed override

This machine constant defines the maximum percentage of the programmed feed rate that can be set by the feed override buttons.
The percentage (between 100 and 150) is stored in steps of 5%, i.e. the increment/decrement value when pressing the feed override button.

MC 746 Minimum percentage of feed override

This machine constant defines the minimum percentage of the programmed feed rate that can be set by the feed override buttons.
The percentage (between 0 and 50) is stored in steps of 5%, i.e. the increment/decrement value when pressing the feed override button.

MC 747 Maximum percentage of speed override

This machine constant defines the maximum percentage of the programmed spindle speed that can be set by the speed override buttons.
The percentage (between 100 and 150) is stored in steps of 5%, i.e. the increment/decrement value when pressing the feed override button.

MC 748 Minimum percentage of speed override

This machine constant defines the minimum percentage of the programmed spindle speed that can be set by the speed overrride buttons.
The percentage (between 0 and 50) is stored in steps of 5%, i.e. the increment/decrement value when pressing the feed override button.

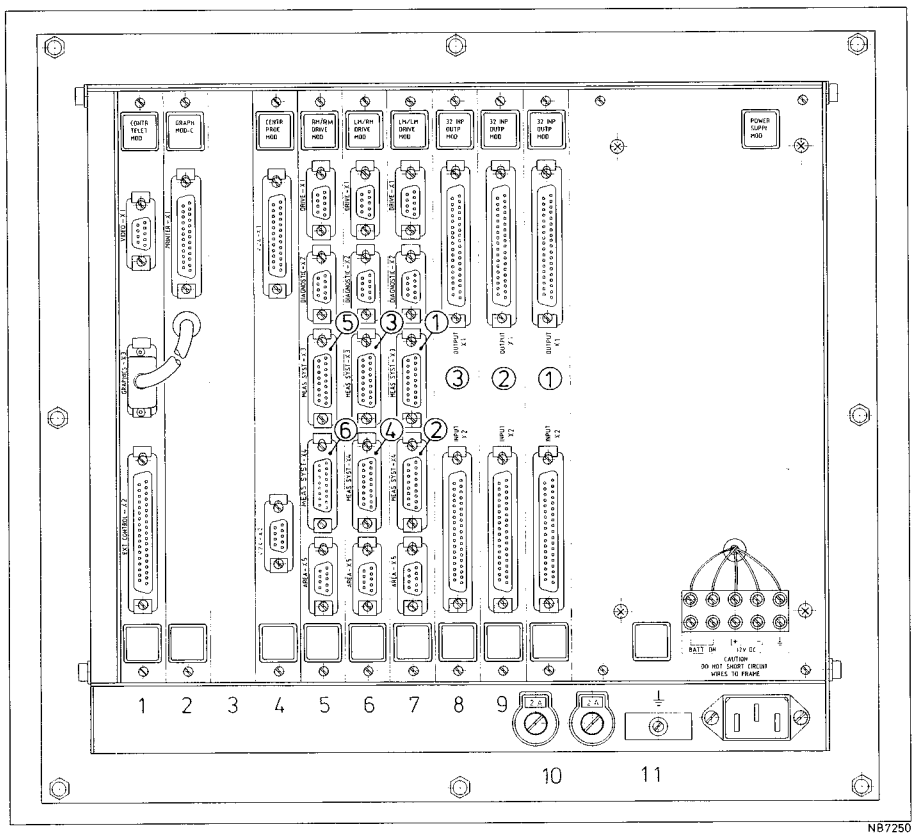
23.12 ELECTRONIC HANDWHEEL

MC 750 Feed rate

This machine constant defines the feed rate when rotating the handwheel. The feed rate is stored in steps of 100 increments.

MC 751 Connection 1st handwheel

This machine constant defines the socket to which the handwheel is connected.
The following values can be assigned to it:
0 = no handwheel connected
1 = drive card 1 - socket 1
2 = drive card 1 - socket 2
3 = drive card 2 - socket 1
4 = drive card 2 - socket 2
5 = drive card 3 - socket 1
6 = drive card 3 - socket 2
7 = drive card 4 - socket 1
8 = drive card 4 - socket 2



MC 752 Multiplication factor for the S00/S90 handwheel signals

This machine constant defines the number of count pulses that has to be generated per S00/S90 cycle. The following values can be assigned to it:
0 = 1 count pulse per S00/S90 cycle
1 = 2 count pulses per S00/S90 cycle
2 = 4 count pulses per S00/S90 cycle
Further details are given in Fig. 23.-16.

MC 770 Serial data input/output configuration

The control unit includes a V24 and a V11 interface for data transfer.Data transfer can be effected in the following modes:

LOCAL: data transfer between an external (passive) peripheral, e.g. cassette recorder, and the NC system.

DNC LOCAL/
DNC REMOTE: data transfer between an external (intelligent) computer and the NC system.

This machine constant enables the interfaces to be set to DATA I/O LOCAL operation or to DNC operation.
It is recommended to use the V24-connection for DATA I/O LOCAL operation and the V11-connection for DNC operation (refer also to the operator´s manual, section DNC).
MC 770 can be assigned the following values:
0 = Local V24, no DNC
1 = Local V11, no DNC
2 = Local V24, DNC V11
3 = Local V11, DNC V24

MC 771 Data carrier coding - Data I/O Local operation

This machine constant defines the code used for coding the data carrier information. The code to be used is given by the external data peripheral. MC 771 can be assigned the following values:
0 = for a data peripheral operating with ASCII-code
1 = for a data peripheral operating with ISO-code
2 = for a data peripheral operating with EIA-code

MC 772 Automatic code recognition - Data I/O Local operation

This machine constant enables the NC system to recognize the code sent by the data peripheral. The code is displayed on the screen and the data loaded into the control system memory, provided it is ASCII, EIA or ISO-coded.
The automatic code recognition can be disabled. In that case, only data coded in accordance with the code defined by MC 771 will be read.
This machine constant also enables XON/XOFF operation to be selected. This operation mode is required when a V24 -> current loop converter is being used.
MC 772 can be assigned the following values:
0 = no automatic code recognition, no XON/XOFF operation
1 = automatic code recognition, no XON/XOFF operation
2 = no automatic code recognition, XON/XOFF operation
3 = automatic code recognition, XON/XOFF operation
See also section 15.

23.13.1 RS 232-C, V24 interface

MC 773 V24: Character termination after stop reading

A great deal of data peripherals generate one or more characters after signal CTS has gone low. To prevent these characters from being ignored by the control unit, the number of characters (minimal 5) that is to be read after signal CTS has gone low, is stored under MC 773.

MC 775 V24: STOPBITS UART

This machine constant defines the number of stopbits required by the external data peripheral.
The following values can be assigned to it:
0 = 1 Stopbit
1 = 2 Stopbits

MC 776 V24: Baudrate for recording (from peripheral)

This machine constant defines the baudrate specified for the transmitter. Values between 110 and 4800 baud can be stored.

MC 777 V24: Baudrate for transmitting (to peripheral)

This machine constant defines the baudrate specified for the receiver. Values between 110 and 4800 baud can be stored.

23.13.2 Serial data input/output - DNC operation

Remark: Machine constants 782 and 784 are only available when machine constant 770 is set to 2 or 3.
In the case machine constant 770 is set to 2 or 3 and these machine constants are not displayed, switch off the machine constant enable signal (input 27, I/O card I) and switch it on again. The relevant machine constants are now initialised.

MC 782 Data carrier coding

This machine constant defines the code used for coding the data carrier information. The code to be used is given by the external data peripheral. MC 782 can be assigned the following values:
0 = for a data peripheral operating with ASCII-code
1 = for a data peripheral operating with ISO-code

MC 784 Number of characters after stop reading

A great deal of data peripherals generate one or more characters after signal CTS has gone low. To prevent these characters from being ignored by the control unit, the number of characters (minimal 5) that is to be read after signal CTS has gone low, is stored under MC 784.

23.13.3 RS 449, V11 interface

MC 785 V11: STOPBITS UART

This machine constant defines the number of stopbits required by the external data peripheral.
The following values can be assigned to it:
0 = 1 Stopbit
1 = 2 Stopbits

MC 786 V11: Baudrate for recording and transmitting

This machine constant defines the baudrate for recording and transmitting. Values up to 9600 baud can be stored.

23.14 DNC OPERATION

Remark: Machine constants 790-796 are only available when machine constant 770 is set to 2 or 3.
In the case machine constant 770 is set to 2 or 3 and these machine constants are not displayed, switch off the machine constant enable signal (input 27, I/O card I) and switch it on again. The relevant machine constants are now initialised.

MC 790 Block check

This machine constant defines the various block checks of the DNC-connection. Refer also to the specification on DATA IO/DNC, section 25.
MC 790 can be assigned the following values:
0 = no check of the connection
1 = no check of the block check characters (BCC). The position of the BCC must be occupied. Its value is immaterial. The BCC is output in outgoing blocks.
2 = Echo of the received LSV/2-telegram to the DNC-computer. No check of the BCC. In this test mode the telegram received from the NC system is sent back. The incoming BCC is not checked and the outgoing BCC is recalculated.
3 = Echo of the incoming and sent characters to the screen. No check of the BCC. Each character received from the NC system is displayed on the third line of the screen. Each character sent by the NC system is displayed on the fourth line of the screen. The control characters are displayed as a point, the remaining characters with their values. The BCC is output without being checked.

MC 791 Maximum length of the DNC data sequence

This machine constant defines the maximum length of the telegrams (maximum length of useful data) under the LSV/2 protocol. The amount of useful data may be from 80 to 120 Bytes. Refer also to section 25.

MC 792 Time out for DNC

This machine constant defines the time out for DNC (from 0 to 128 s). After the NC system has sent ENQ and after transfer of the LSV/2 telegram DLE STX ..... DLE ETX BCC, the NC system waits for an answer during the defined time out. When no answer has been received within this time, ENQ is sent again. Refer also to section 25.

MC 793 Number of accepted message repeats

This machine constant defines the number of ENQ-repeats (from 0 to 12) after the time out defined by MC 792. Refer also to section 25.

MC 794 Initialization of the DATA I/O mode

This machine constant defines the DATA I/O mode that becomes active after the NC system has been switched on. The following values can be assigned to it:
0 = Data I/O from cassette recorder
1 = Local operation of DNC
2 = Remote operation of DNC, controlled from central computer (REMOTE)
Refer also to section 25.

MC 795 DNC-delay time

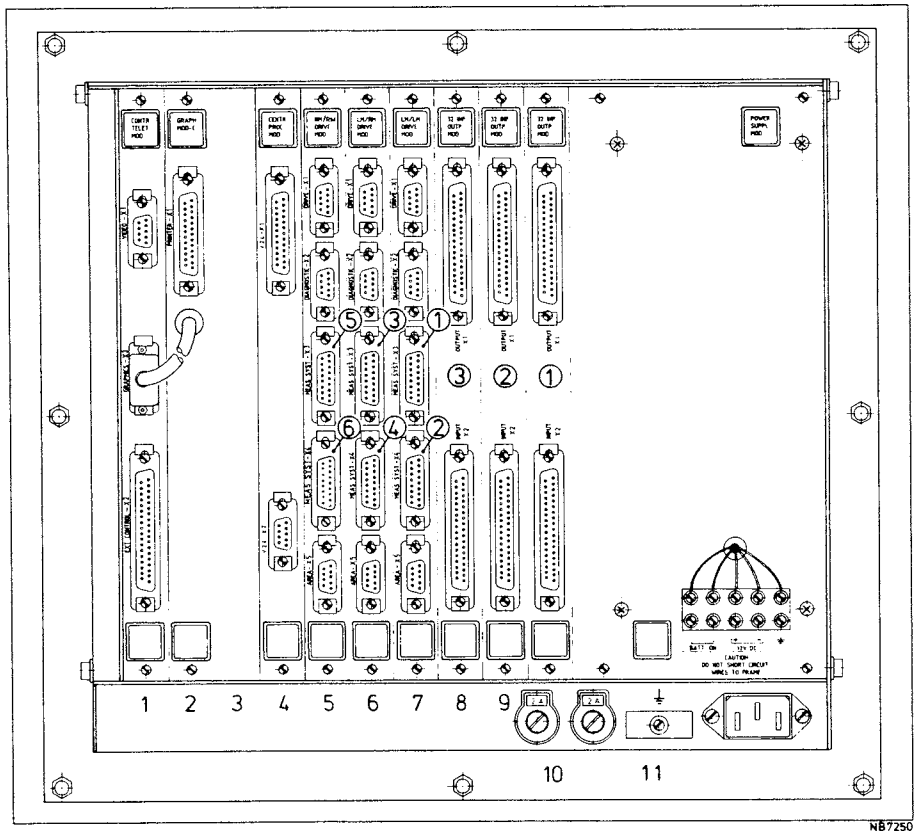
When using V24 or V11 interface without the handshake signals a delay time can be introduced between "reading" and "writing" and vice versa, to enable the peripheral to switch over too.
The delay time is entered in msec.
In the case that 2 CNC´s are communicating, 50 msec must be entered in this machine constant.

MC 796 Block number check

By means of this machine constant the block number check can be disabled and hence the speed of data processing increased.
MC 796 can be assigned the following values:
0 = Block number check disabled
1 = Block number check enabled
Refer also to section 25.

MC 840 Measuring probe connection

This machine constant defines the number of the drive card to which the measuring data are applied.
The measuring probe is connected to the input "Area".
The measuring probe may also be connected to the drive card assigned to the electronic handwheel.
0= No measuring probe connected.
The figure below shows the numbers, which are related to the area connector concerned.



MC 841 Measuring probe type

This machine constant enables two types of measuring probes to be selected. The following values can be assigned to it:
0 = inductive measuring probe, fixed or moving
1 = infra-red measuring probe
Refer to the figures below.

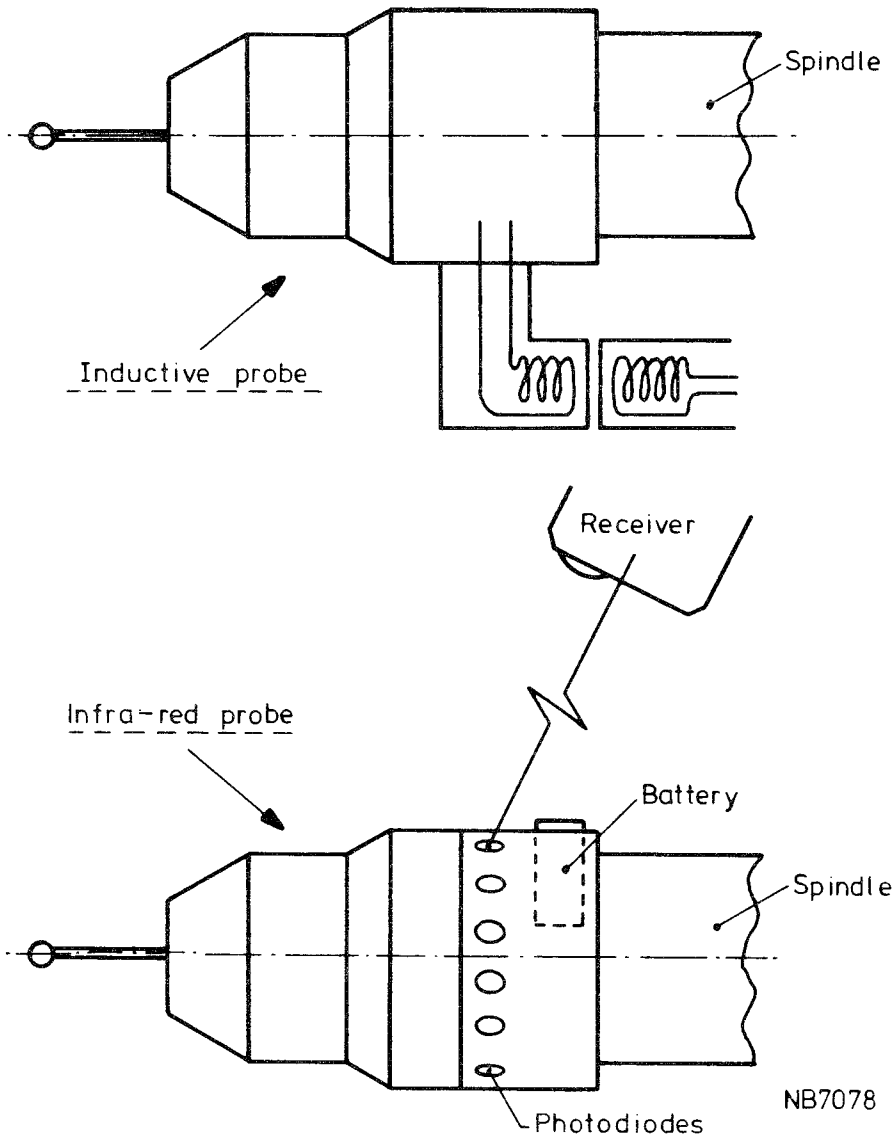


Fig. 23.-14 Types of measuring probes

MC 842 Duration of air supply

This machine constant defines the time during which output 31 of I/O Module I is set high at the start of the measuring movement defined by MC 844. This output serves to switch on the air supply required for cleaning the workpiece surface to be measured. The time is stored in steps of 100 ms, with a maximum of 3840 steps.

MC 843 Measuring feed rate

This machine constant defines the feed rate used for the measuring probe to contact the workpiece. The feed rate is stored as a value between 0 and 999999999 times 100 incr/min.
For linear measuring systems a feed rate of 0.14 m/min is recommended, for rotary measuring systems a feed rate of 1.2 m/min. In this way, the NC system will attain an accuracy of 1 um. The overall accuracy depends on the machine tool.

MC 844 Pre-measuring distance

This machine constant defines the pre-measuring distance, i.e. the distance between the starting point of the slow measuring movement and the programmed measuring point. The distance is stored in increments between 0 and 999999999.
The figure below shows the measuring operation.

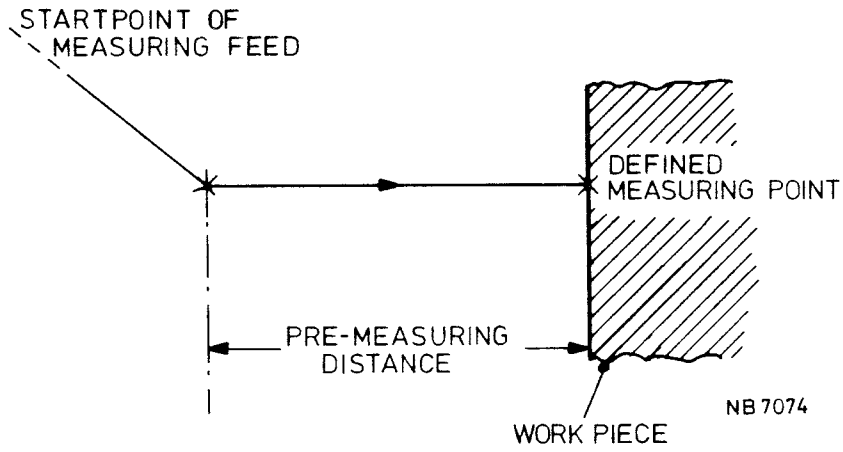


Fig. 23.-15 Pre-measuring distance

Note: The movement from the starting point to the pre-measuring distance is performed at rapid traverse rate, simultaneously in all axes. When all axes are "In position", the measuring movement in the programmed axis is performed.

MC 845 Post-measuring distance

This machine constant defines the post-measuring distance, i.e. the distance between the defined measuring point and the point where the measuring movement is switched off. The distance is stored in increments between 0 and 999999999. When the measuring movement is completed and the probe has not contacted any surface, the movement is switched off. A return to the starting point of the movement is performed. At the same time an error message is generated.
The figure below shows the measuring operation.

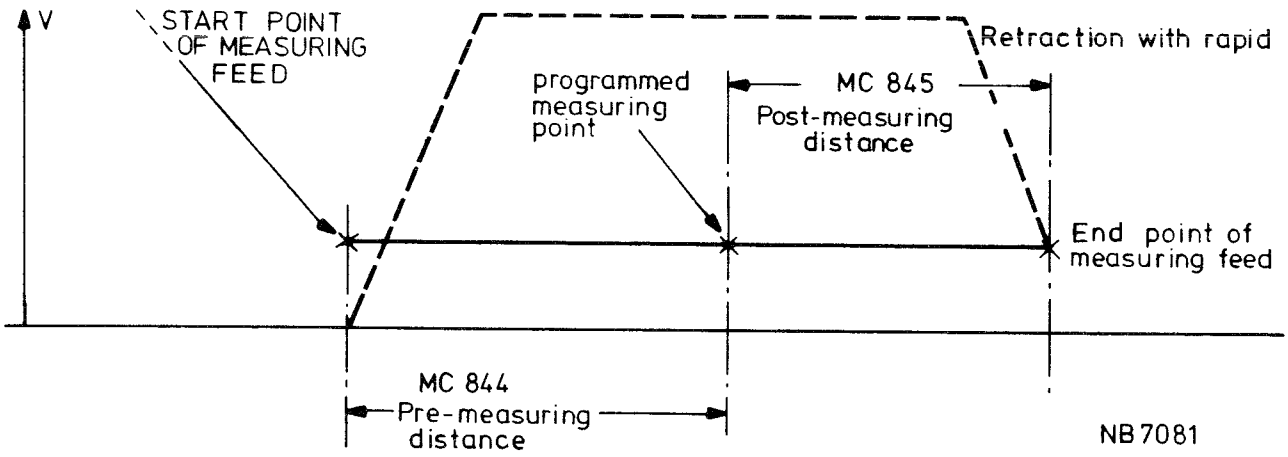


Fig.23.-16 Post-measuring distance

MC 846 Resolution of the rotary axis

This machine constant defines the resolution in degrees per count pulse of the rotary table measuring system. The resolution is required when the G50-function is to be executed with rotary table correction. It is stored by means of a number between -999999999 and +999999999 as increments x 1/1000 degree.
When, for example, the resolution per count pulse is 0.5^{o}, 500 is stored under MC 846. When the resolution is 1^{o}, 1000 is stored. Refer to the figure below.

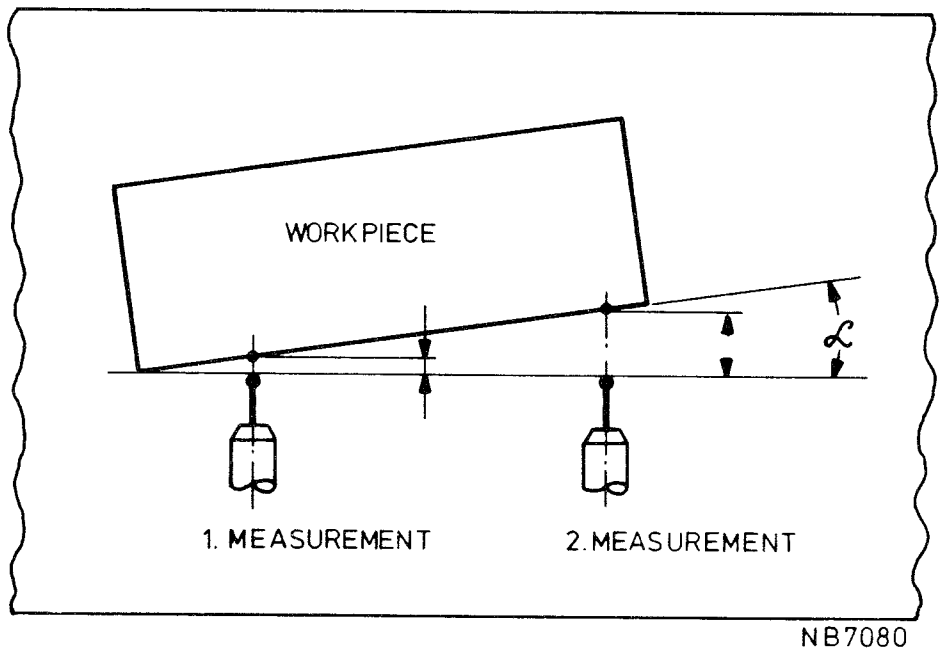


Fig.23.-17 Resolution of the rotary axis

MC 847 Width of the fixed measuring probe

During the measuring cycles the fixed measuring probe is approached from various directions. The machine constants 240, 290, 340, 390, 440 and 490 define the position of the fixed measuring probe as a point. However, the probe has a given width for all directions, as shown in the figure below. This width is stored under MC 847 in increments (max. 999999999).

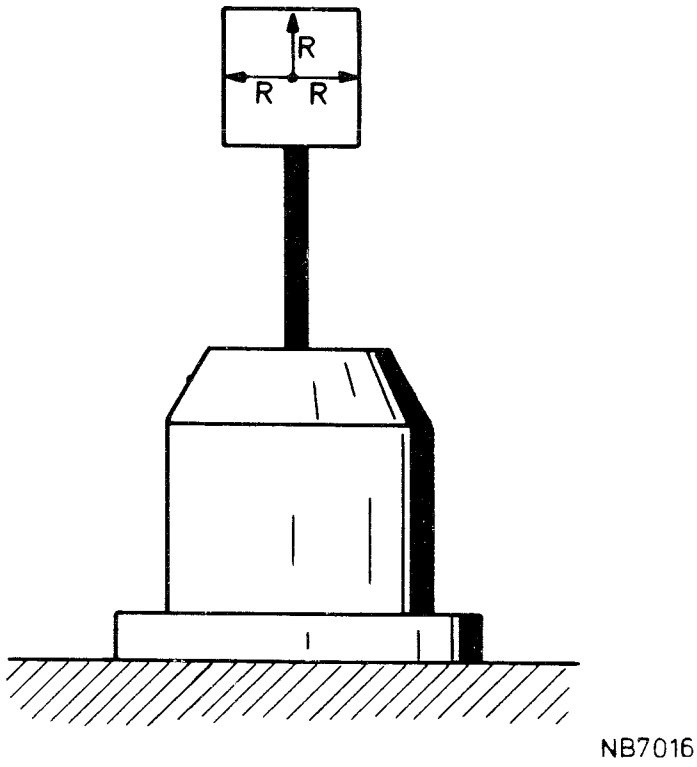


Fig.23.-18 Width of the fixed measuring probe

MC 848 Radius of calibration ring

The calibration of a moving measuring probe requires a calibration ring to be used. The radius of this ring is stored under MC 848 in increments (max. 999999999). Refer to the figure below.

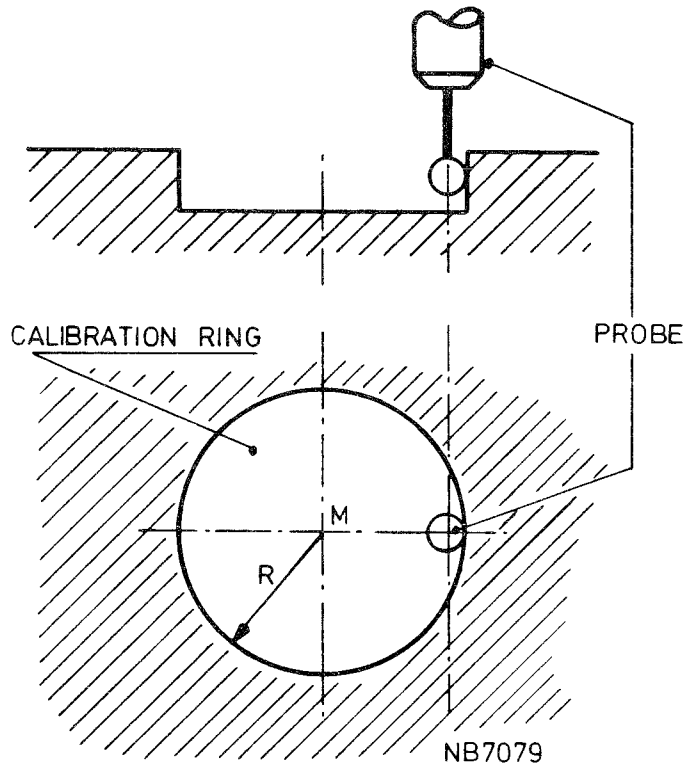


Fig.23.-19 Calibration ring

MACHINE CONSTANTS LIST CNC3460/V400

MC nr.	MC value	Description	Dimensions
CNC HARDWARE CONFIGURATION			
000	.....	Number of I/O modules	0 = 1 I/O module 1 = 2 I/O modules 2 = 3 I/O modules
001	.....	Number of meas. system inputs	1 = M.S. input 2 = M.S. inputs
002	.....	RAM capacity	1 Kbyte
004	.....	Remote control panel	0 = no remote panel 1 = safety switch on 2 = safety switch off 5 = external feed override
009	.....	Graphics module	0 = no graphics 1 = 2-plane graphics 2 = 8-plane graphics
MACHINE TOOL CONFIGURATION			
010	.....	Number of axes	min. 3 - max. 6
011	.....	Plane initialization	0 = G17 1 = G18 2 = G19
014	.....	Measuring system resolution	70 = Inch 71 = Metric
018	.....	Tool change	0 = M06 manual 1 = M06 automatic
026	.....	Retract sequence during M6	0 = no retraction 1 = tool axis 2 = Z - X axis 3 = Z - Y axis 4 = Z - (X+Y) axis
027	.....	Number of tools	0 - 255
028	.....	Number of tool positions	0 - 255
029	.....	Tool life monitoring	0 = funct. not active 1 = error code display + program stop 2 = spare tool
030	.....	Tool unclamp function	0 = funct. not active 1 = toggle button 2 = cont. button
031	.....	Tool cutting force monitoring	0 = funct. not active 1 = error code display + program stop 2 = spare tool
035	.....	Tool data output	0 = BCD-output 1 = four decade tool
042	.....	External programm call	0 = funct. not active 1 = fixed PPM calls 2 = variable call memory

MC nr.	MC value	Description	Dimensions
043	.....	Number ext. calls	0 - 255
044	.....	Conditional jump	0 = jumps always executed 1 = jump execution depends on input
051	.....	Activating analog spindle	0 = no analog spindle 1 = analog spindle activated
053	.....	Decoded coolant M7 or M8	0 = not decoded 1 = decoded
061	.....	Output M	0 = no output 1 = BCD 4 = decoded 5 = decoded + BCD
063	.....	Output T	0 = no output 1 = LSD 2 = MSD 3 = LSD + MSD
064	.....	Output S	0 = no output 1 = LSD 2 = MSD 3 = LSD + MSD
065	.....	Output H	0 = no output 1 = LSD 2 = MSD 3 = LSD + MSD

CNC SOFTWARE CONFIGURATION

080	.....	Selection DEMO	0 = standard operation 1 = DEMO operation
081	.....	Display mode	0 = distance to go 1 = following distance 2 = mode 0 + no RPF 3 = mode 1 + no RPF 4 = mode 2 + reset error after 1 sec. 5 = mode 3 + reset error after 1 sec.
082	.....	Number of point definitions	0 - 255
083	.....	Number of E-parameters	0 - 255
084	.....	Display mode of directory	0 = with text 1 = with info
085	.....	Number of part programs + sub programs	16 - 1000
090	.....	Display actual G	code number
091	.....	Display actual M	code number

MC nr.	MC value	Description	Dimensions
AXES DEFINITIONS			
1st axis			
100	.....	Closed/open loop	0 = not used 1 = closed loop 2 = open loop
101	.....	Machine Constant block assignment	1 = par.block at MC200 2 = par.block at MC250 3 = par.block at MC300 4 = par.block at MC350 5 = par.block at MC400 6 = par.block at MC450
102	.....	Code for axis orientation	1 = 1st.lin.axis pos. 2 = 2nd.lin.axis pos. 3 = 3rd.lin.axis pos. 4 = 1st.rot.axis pos. 5 = 2nd.rot.axis pos. 6 = 3rd.rot.axis pos.
103	.....	ASCII-code for ident.	ASCII-coded (X=88)
2nd axis			
105	.....	Closed/open loop	0 = not used 1 = closed loop 2 = open loop
106	.....	Machine Constant block assignment	same as MC101
107	.....	Code for axis orientation	same as MC102
108	.....	ASCII-code for ident.	ASCII-coded (Y=89)
3rd axis			
110	.....	Closed/open loop	0 = not used 1 = closed loop 2 = open loop
111	.....	Machine Constant block assignment	same as MC101
112	.....	Code for axis orientation	same as MC102
113	.....	ASCII-code for ident.	ASCII-coded (Z=90)
4th axis			
115	.....	Closed/open loop	0 = not used 1 = closed loop 2 = open loop
116	.....	Machine Constant block assignment	same as MC101
117	.....	Code for axis orientation	same as MC102
118	.....	ASCII-code for ident.	ASCII-coded (A=65)

MC nr.	MC value	Description	Dimensions
		5th axis in address selector	
120	.....	Closed/open loop	0 = not used 1 = closed loop 2 = open loop
121	.....	Machine Constant block assignment	same as MC101
122	.....	Code for axis orientation	same as MC102
123	.....	ASCII-code for ident.	ASCII-coded (B=66)
		6th axis	
125	.....	Closed/open loop	0 = not used 1 = closed loop 2 = open loop
126	.....	Machine Constant block assignment	same as MC101
127	.....	Code for axis orientation	same as MC102
128	.....	ASCII-code for ident.	ASCII-coded (C=67)
		1st AXIS PARAMETER BLOCK	
		Measuring system	
200	.....	Measuring system input	drive number
202	.....	Counting direction of measuring system	+1 = pos. direction -1 = neg. direction
203	.....	Multiplication factor	0= x1, 1= x2, 2= x4
		Velocities	
205	.....	Rapid traverse	100 incr/min
206	.....	Jog feed	100 incr/min
		Tuning	
215	.....	Following distance 1	Increments at 9 V
216	.....	Nod point	Increments
217	.....	Following distance 2	Increments at 9 V
218	.....	Acc/dec mode	0 = no acc/dec 1 = 1st order acc/dec 2 = 2nd order acc/dec 3 = 1st order acc/dec with feed 4 = 2nd order acc/dec with feed
219	.....	Acc/dec time constant	msec
220	.....	Acc/dec threshold	100 incr/min
221	.....	Inpod delay time	x15 msec
222	.....	In-position window	Increments
223	.....	Standstill window	Increments
224	.....	Backlash compensation	Increments

MC nr.	MC value	Description	Dimensions
Reference point			
230	.....	RPF-direction	+1 = pos. direction -1 = neg. direction
231	.....	RPF-feed	0.1 mm/min
232	.....	RPF-creep feed	0.1 mm/min
233	.....	RPF-offset	Increments
234	.....	Area switch	0 = using switch + marker 1 = using marker only
Offsets			
235	.....	Limit switch positive	Increments
236	.....	Limit switch negative	Increments
237	.....	Home position	Increments
240	.....	Position of fixed measuring probe	Increments
242	.....	Position of centre of calibration ring	Increments
2nd AXIS PARAMETER BLOCK			
Measuring system			
250	.....	Measuring system input	drive number
252	.....	Counting direction of measuring system	+1 = pos. direction -1 = neg. direction
253	.....	Multiplication factor	0= x1, 1= x2, 2= x4
Velocities			
255	.....	Rapid traverse	100 incr/min
256	.....	Jog feed	100 incr/min
Tuning			
265	.....	Following distance 1	Increments at 9 V
266	.....	Nod point	Increments
267	.....	Following distance 2	Increments at 9 V
268	.....	Acc/dec mode	0 = no acc/dec 1 = 1st order acc/dec 2 = 2nd order acc/dec 3 = 1st order acc/dec with feed 4 = 2nd order acc/dec with feed
269	.....	Acc/dec time constant	msec
270	.....	Acc/dec threshold	100 incr/min
271	.....	Inpod delay time	x 15 msec
272	.....	In-position window	Increments
273	.....	Standstill window	Increments
274	.....	Backlash compensation	Increments

MC nr.	MC value	Description	Dimensions
Reference point			
280	.....	RPF-direction	+1 = pos. direction -1 = neg. direction
281	.....	RPF-feed	0.1 mm/min
282	.....	RPF-creep feed	0.1 mm/min
283	.....	RPF-offset	Increments
284	.....	Area switch	0 = using switch + marker 1 = using marker only
Offsets			
285	.....	Limit switch positive	Increments
286	.....	Limit switch negative	Increments
287	.....	Home position	Increments
290	.....	Position of fixed measuring probe	Increments
292	.....	Position of calibration ring centre	Increments
3rd AXIS PARAMETER BLOCK			
Measuring system			
300	.....	Measuring system input	drive number
302	.....	Counting direction of measuring system	+1 = pos. direction -1 = neg. direction
303	.....	Multiplication factor	0= x1, 1= x2, 2= x4
Velocities			
305	.....	Rapid traverse	100 incr/min
306	.....	Jog feed	100 incr/min
Tuning			
315	.....	Following distance 1	Increments at 9 V
316	.....	Nod point	Increments
317	.....	Following distance 2	Increments at 9 V
318	.....	Acc/dec mode	0 = no acc/dec 1 = 1st order acc/dec 2 = 2nd order acc/dec 3 = 1st order acc/dec with feed 4 = 2nd order acc/dec with feed
319	.....	Acc/dec time constant	msec
320	.....	Acc/dec threshold	100 incr/min
321	.....	Inpod delay time	x 15 msec
322	.....	In-position window	Increments
323	.....	Standstill window	Increments
324	.....	Backlash compensation	Increments

MC nr.	MC value	Description	Dimensions
Reference point			
330	.....	RPF-direction	+1 = pos. direction -1 = neg. direction
331	.....	RPF-feed	0.1 mm/min
332	.....	RPF-creep feed	0.1 mm/min
333	.....	RPF-offset	Increments
334	.....	Area switch	0 = using marker + switch 1 = using marker only
Offsets			
335	.....	Limit switch positive	Increments
336	.....	Limit switch negative	Increments
337	.....	Home position	Increments
340	.....	Position of fixed measuring probe	Increments
342	.....	Position of calibration ring centre	Increments
4th AXIS PARAMETER BLOCK			
Measuring system			
350	.....	Measuring system input	drive number
352	.....	Counting direction of measuring system	+1 = pos. direction -1 = neg. direction
353	.....	Multiplication factor	0= x1, 1= x2, 2= x4
Velocities			
355	.....	Rapid traverse	100 incr/min
356	.....	Jog feed	100 incr/min
Tuning			
365	.....	Following distance 1	Increments at 9 V
366	.....	Nod point	Increments
367	.....	Following distance 2	Increments at 9 V
368	.....	Acc/dec mode	0 = no acc/dec 1 = 1st order acc/dec 2 = 2nd order acc/dec 3 = 1st order acc/dec with feed 4 = 2nd order acc/dec with feed
369	.....	Acc/dec time constant	msec
370	.....	Acc/dec threshold	100 incr/min
371	.....	Inpod delay time	x 15 msec
372	.....	In-position window	Increments
373	.....	Standstill window	Increments
374	.....	Backlash compensation	Increments

MC nr.	MC value	Description	Dimensions
Reference point			
380	.....	RPF-direction	+1 = pos. direction -1 = neg. direction
381	.....	RPF-feed	0.1 mm/min
382	.....	RPF-creep feed	0.1 mm/min
383	.....	RPF-offset	Increments
384	.....	Area switch	0 = using switch + marker 1 = using marker only
Offsets			
385	.....	Limit switch positive	Increments
386	.....	Limit switch negative	Increments
387	.....	Home position	Increments
390	.....	Position of fixed measuring probe	Increments
392	.....	Position of calibration ring centre	Increments
5th AXIS PARAMETER BLOCK			
Measuring system			
400	.....	Measuring system input	drive number
402	.....	Counting direction of measuring system	+1 = pos. direction -1 = neg. direction
403	.....	Multiplication factor	0= x1, 1= x2, 2= x4
Velocities			
405	.....	Rapid traverse	100 incr/min
406	.....	Jog feed	100 incr/min
Tuning			
415	.....	Following distance 1	Increments at 9 V
416	.....	Nod point	Increments
417	.....	Following distance 2	Increments at 9 V
418	.....	Acc/dec mode	0 = no acc/dec 1 = 1st order acc/dec 2 = 2nd order acc/dec 3 = 1st order acc/dec with feed 4 = 2nd order acc/dec with feed
419	.....	Acc/dec time constant	msec
420	.....	Acc/dec threshold	100 incr/min
421	.....	Inpod delay time	x 15 msec
422	.....	In-position window	Increments
423	.....	Standstill window	Increments
424	.....	Backlash compensation	Increments

MC nr.	MC value	Description	Dimensions
Reference point			
430	.....	RPF-direction	+1 = pos. direction -1 = neg. direction
431	.....	RPF-feed	0.1 mm/min
432	.....	RPF-creep feed	0.1 mm/min
433	.....	RPF-offset	Increments
434	.....	Area switch	0 = using switch + marker 1 = using marker only
Offsets			
435	.....	Limit switch positive	Increments
436	.....	Limit switch negative	Increments
437	.....	Home position	Increments
440	.....	Position of fixed measuring probe	Increments
442	.....	Position of calibration ring centre	Increments
6th AXIS PARAMETER BLOCK			
Measuring system			
450	.....	Measuring system input	drive number
452	.....	Counting direction of measuring system	+1 = pos. direction -1 = neg. direction
453	.....	Multiplication factor	0= x1, 1= x2, 2= x4
Velocities			
455	.....	Rapid traverse	100 incr/min
456	.....	Jog feed	100 incr/min
Tuning			
465	.....	Following distance 1	Increments at 9 V
466	.....	Nod point	Increments
467	.....	Following distance 2	Increments at 9 V
468	.....	Acc/dec mode	0 = no acc/dec 1 = 1st order acc/dec 2 = 2nd order acc/dec 3 = 1st order acc/dec with feed 4 = 2nd order acc/dec with feed
469	.....	Acc/dec time constant	msec
470	.....	Acc/dec threshold	100 incr/min
471	.....	Inpod delay time	x 15 msec
472	.....	In-position window	Increments
473	.....	Standstill window	Increments
474	.....	Backlash compensation	Increments

MC nr.	MC value	Description	Dimensions
Reference point			
480	.....	RPF-direction	+1 = pos. direction -1 = neg. direction
481	.....	RPF-feed	0.1 mm/min
482	.....	RPF-creep feed	0.1 mm/min
483	.....	RPF-offset	Increments
484	.....	Area switch	0 = using switch + marker 1 = using marker only
Offsets			
485	.....	Limit switch positive	Increments
486	.....	Limit switch negative	Increments
487	.....	Home position	Increments
490	.....	Position of fixed measuring probe	Increments
492	.....	Position of calibration ring centre	Increments

MC nr.	MC value	Description	Dimensions
SPINDLE PARAMETER BLOCK			
500	.....	Connection of Drive module	0 = not connected 1 = Drive module 1, connector 1 2 = Drive module 1, connector 2 3 = Drive module 2, connector 1 4 = Drive module 2, connector 2 5 = Drive module 3, connector 1 6 = Drive module 3, connector 2 7 = Drive module 4, connector 1 8 = Drive module 4, connector 2
Measuring system			
501	.....	Resolution of spindle transducer	Imp/rev
502	.....	Counting direction of rotary meas. system	+1 = positive
503	.....	Multiplication factor of rotary meas. system	0= x1, 1= x2, 2= x4
Velocities			
505	.....	Spindle jog	rev/min
Tuning range 1			
515	.....	Following distance 1	Increments at 9 V
516	.....	Nod point	Increments
517	.....	Following distance 2	Increments at 9 V
Tuning range 2			
525	.....	Following distance 1	Increments at 9 V
526	.....	Nod point	Increments
527	.....	Following distance 2	Increments at 9 V
Tuning range 3			
535	.....	Following distance 1	Increments at 9 V
536	.....	Nod point	Increments
537	.....	Following distance 2	Increments at 9 V

MC nr.	MC value	Description	Dimensions
Tuning range 4			
545	.....	Following distance 1	Increments at 9 V
546	.....	Nod point	Increments
547	.....	Following distance 2	Increments at 9 V
Oriented spindle stop			
560	.....	Oriented spindle stop mode	0 = no M19 1 = M19 mechanically 2 = M19 with transd. 3 = M19 offset meas. for MC566
561	.....	Oriented spindle stop slope	(Rev/min)/15 msec
562	.....	Oriented spindle stop Inpod delay time	x15 msec
563	.....	1st search speed	Rev/min
564	.....	2nd search speed	Rev/min
565	.....	Search speed from M5	Rev/min + = M3 direction - = M4 direction
566	.....	Offset to marker pulse	1/1000 degree
567	.....	Standstill window	Increments
568	.....	M19 with D-address	0 = off, 1 = on
Range specification			
570	.....	Automatic range selection + open/closed loop	0 = no autorange + open loop 1 = auto range + open loop 2 = no auto range + closed loop 3 = auto range + closed loop
571	.....	Maximum spindle speed, range 1	Rev/min with sign
572	.....	Maximum spindle speed, range 2	Rev/min with sign
573	.....	Maximum spindle speed, range 3	Rev/min with sign
574	.....	Maximum spindle speed, range 4	Rev/min with sign
Output to spindle drives			
580	.....	Max. analog output voltage	mV
581	.....	Min. analog output voltage	mV
582	.....	Gear change voltage	mV
590	.....	Time between rotation pulse for gear change	X 50 msec.
591	.....	duration of rotation pulse for gear change	X 50 msec.

MC nr.	MC value	Description	Dimensions
GENERAL PARAMETERS			
Program format			
705	.....	Position decimal point, dimension words	3 = 0000.000 4 = 000.0000
706	.....	Position decimal point, feed	3 = 0000.000 4 = 000.0000
707	.....	Inch/Metric initialization	70 = Inch 71 = Metric
Geometrics			
710	.....	Not used	
711	.....	Intersection angle	Degrees
712	.....	Circle end point window	Increments
714	.....	Scaling mode	0 = absolute in mach. plane 1 = relative in mach. plane 2 = absolute in all linear axes 3 = relative in all linear axes
715	.....	Decimal point scaling	Number of decimals
Fixed cycles			
720	.....	Pocketing (overlap)	% of tool diameter
723	.....	Deceleration distance during tapping	Increments
724	.....	Dwell during tapping	x 15 msec (after spindle stop)
730	.....	External error	0 = off, 1 = on
731	.....	Inputs for open servo loop	0 = inputs disabled 1 = inputs enabled
Feed/Speed			
740	.....	Maximum feed	100 incr/min
741	.....	Test feed	100 incr/min
745	.....	Maximum feed override	% of commanded feed
746	.....	Minimum feed override	% of commanded feed
747	.....	Maximum speed override	% of commanded speed
748	.....	Minimum speed override	% of commanded speed

MC nr.	MC value	Description	Dimensions
Handwheel			
750	.....	Feed	100 incr/min
751	.....	Connection of Handwheel	0 = no connection 1 = Drive module 1, connector 1 2 = Drive module 1, connector 2 3 = Drive module 2, connector 1 4 = Drive module 2, connector 2 5 = Drive module 3 connector 1 6 = Drive module 3 connector 2 7 = Drive module 4 connector 1 8 = Drive module 4 connector 2
752	.....	Multiplication factor	0= x1, 1= x2, 2= x4
Serial data I/O			
770	.....	Serial I/O configuration	0 = local V24, no DNC 1 = local V11, no DNC 2 = local V24, DNC V11 3 = local V11, DNC V24
771	.....	Data carrier coding	0 = ASCII 1 = ISO 2 = EIA
772	.....	Automatic code recognition	0 = off 1 = on 2 = Mode 0 + XON/XOFF 3 = Mode 1 + XON/XOFF
773	.....	Start-stop reader	Number of characters after stop
775	.....	Stop bits UART	0 = one stop bit 1 = two stop bits
776	.....	Baudrate	Baud
777	.....	Baudrate	Baud
782	.....	Data carrier coding	0 = ASCII 1 = ISO
784	.....	Start-stop reader	Number of characters after stop
785	.....	Stop bits UART	0 = one stop bit 1 = two stop bits
786	.....	Baudrate (record. and transm.)	Baud

MC nr.	MC value	Description	Dimensions
DNC-operation			
790	.....	Block check	0 = no check 1 = no message check 2 = message echo 3 = message to monitor
791	.....	Maximum length of DNC-string	Bytes
792	.....	Time out for answer DNC	Sec
793	.....	Accepted message repeats	Number of repeats
794	.....	Initialization DATA I/O	0 = DATA IO 1 = local DNC 2 = remote DNC
795	.....	DNC-delay time	msec
796	.....	Block number check	0 = on, 1 = off
Measuring cycles			
840	.....	Connection of measuring probe	0 = measuring probe not active 1 = Drive module 1, connector 1 2 = Drive module 1, connector 2 3 = Drive module 2, connector 1 4 = Drive module 2, connector 2 5 = Drive module 3, connector 1 6 = Drive module 3, connector 2 7 = Drive module 4, connector 1 8 = Drive module 4, connector 2
841	.....	Probe type	0 = inductive 1 = infra red
842	.....	Blowing time for surface cleaning	x msec
843	.....	Measuring feed	100 incr/min
844	.....	Pre-measuring distance	Increments
845	.....	Post-measuring distance	Increments
846	.....	Resolution of rotatary axis	Incr. 1/1000 degree
847	.....	Width of fixed probe	Increments
848	.....	Radius of calibration ring	Increments