

**SIEMENS**

**AUTOMATION SYSTEMS  
TECHNICAL SERVICES**

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COMMISSIONING CHECKLIST  
AND COMMISSIONING MANUAL  
PART 1 N.C.

# SINUMERIK System 8

**Schule für  
Industrieelektronik und SINUMERIK  
Erlangen**

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## 0.1 Introduction

The integrated circuits in the control are very sensitive to high voltages, such as occur with static electricity. For this reason one should never touch either the integrated circuits or the p.c.b. tracks without first discharging oneself on some earthed part of the machine. This is particularly important where p.v.c., rubber or other man-made shoe materials or certain types of carpet are involved.

The door of the cabinet containing the control should not be left open for unnecessarily long periods of time.

No work on the printed circuit boards, bus cable or power supply leads must be carried out whilst the control is switched on.

When the control is switched off the information in the CMOS RAM's is maintained with a 5 V battery. Care must be taken therefore not to short out the 5 V line to any other line otherwise information will be corrupted and maybe the p.c.b. tracks burnt through.

Note: In this manual the description of the machine data is based on software edition 11 (July 1981). For other software editions the service bulletins should be consulted.

S I N U M E R I K S Y S T E M 8

0.2 Commissioning Checklist

When a section is completed the circle "yes" should be marked.  
 The table should be filled out in pencil.  
 All questions requiring data as their answer rather than simply "yes" should be completed.  
 Descriptions of the individual sections are to be found in the commissioning manual.

First Commissioning

Second Commissioning

Name	Siemens office	Dates	Name	Siemens office	Dates
customer's name	Location	from to	End customer's name	Location	from to

1. Are the prerequisites for the commissioning fulfilled? yes
2. Visual check: Mains connection, Emergency Stop, Earthing, Position measuring devices, cable layout, screening, operating panel etc. yes
3. Software system:  
 Is the software edition still valid? What level is the edition? [ ]
4. Voltage checks and function checks. Mains input voltage [ . . . V ]  
 Has the type of control been established? yes
5. Machine data entered, software limit switches set, feedrates and increments entered, speed limit for spindle set? yes
6. Position control loop for the axes commissioned: i.e. Axis speeds, tacho adjustment, multiplication factor, position loop gain, acceleration, position loop monitoring, analogue spindle speed? All adjustments carried out and checked? yes

Optimisation of drives

Axis	X	Y	Z	4	5
Maximum speed $V_{max}$ [mm/min]					
Tacho adjustment $\frac{U_{max}}{V_{max}}$ [V] at [mm/min]					
Position loop gain [m/min/mm]					

Axis	6	7	8	9	10
Maximum speed $V_{max}$ [mm/min]					
Tacho adjustment $\frac{U_{max}}{V_{max}}$ [V] at [mm/min]					
Position loop gain [m/min/mm]					

- 7. Tape reader settings checked? yes
- 8. Are all the normal functions checked?  
Has this function check been carried out with a test tape yes
- 9. Procurement of machine data tape and the associated read out:  
Tape left in the control cabinet?  
Read-out stuck into log-book? yes   
Has the customer been shown how to check and adjust the following:  
Drift compensation  
Referencepoint adjustment  
Backlash compensation  
Pitch error compensation, sag compensation  
How to enter these data into the machine data or modifying the machine data to accomodate the above data yes   
Has a commissioning report been written and subsequently signed by the customer yes   
Has a copy of this checklist been left in the logbook yes


List of options

- |   |   |  |
|---|---|--|
| <input type="checkbox"/> C62<br>2 data in/output terminals        | <input type="checkbox"/> B61 3-D Interpolation            | <input type="checkbox"/> B72 Milling fixed cycles                |
| <input type="checkbox"/> B71 Polarco-ordinates                    | <input type="checkbox"/> B73 Cylindrical milling          | <input type="checkbox"/> B75 Brief description of path           |
| <input type="checkbox"/> B63 Polar co-ordinates, radius prog'ing  | <input type="checkbox"/> C42-45 Bubble memory MS120       | <input type="checkbox"/> E41 Analogue spindle speed output       |
| <input type="checkbox"/> B62 radius prog'ing                      | <input type="checkbox"/> C48,C49 CMOS RAM memory MS125    | <input type="checkbox"/> H56 Lead screw pitch error compensation |
| <input type="checkbox"/> E31 Threadcutting, feed/rev.             | <input type="checkbox"/> H17 Tool radius comp.(turning)   | <input type="checkbox"/> H57 Pitch error and sag compensation    |
| <input type="checkbox"/> H81 199 Tool off-sets<br>12 zero offsets | <input type="checkbox"/> H11 cutter radius comp.(milling) | <input type="checkbox"/> K42 Digital measuring K44..50 system    |
| <input type="checkbox"/> K07 Master/slave axes<br>Axis swop       | <input type="checkbox"/> B72 Fixed cycles (turning)       |  |

Signature First commissioning .....

Second commissioning .....

0.3 Display and Input list using display mode Z0

Ident-number	Name of parameter	Description of display or input		Sign	No. of decades
N1-N2	ZOF	Two zero offsets for each axis on Sprint 8T, 8TL. (G54, G55)	x	$\pm$	8
N1-N4	ZOF	4 zero offsets for each axis on Sprint 8M (G54 to G57)	x	$\pm$	8
N1-N12	ZOF	12 zero offsets for each of the 10 axes on 8MC (3 x G54 to G57)	x	$\pm$	8
N13	ZOA	Programmable zero offset (G59)	/	$\pm$	8
N14	ZOE	External zero offset from interface	/	$\pm$	4
N15	G25	Limit of working area in negative direction (G25)	x	$\pm$	8
N16	G26	Limit of working area in positive direction (G26)	x	$\pm$	8
N17	POS	Values in external position display	x	$\pm$	8
N18	DRF	Differential resolver shift	/	$\pm$	8
N19	G26	Maximum spindle speed	x	+	4
N20	G92	Maximum spindle speed applicable with constant cutting speed	x	+	4
N21	G92	Run-up time for feed drive when thread cutting	x	+	1
N22	M19	orientated spindle stop, M19	x	+	3
N23	DRY	Dry run feed rate	x	+	5
N24	RAP	Rapid traverse speed	x	+	5
N25	SE1	Miscellaneous parameters 1)	x	/	8
N26	SE2	Miscellaneous parameters 2)	x	/	8
N100 to N199	R00 to R99	100 R-Parameters			

SE1/SE2



Bit 7 6 5 4 3 2 1 0

1) SE 1 :

value Bit	0	1
0	Input with decimal point	Input without decimal point
1	Input resolution $10^{-4}$ inch with G70	Input resolution $10^{-5}$ inch with G70
2	Tape block parity off	Tape block parity on
3		
4	No programme compatibility	Programme compatibility
5	Tapes given out in ISO code	Tapes given out in EIA code
6	No storage of last 100 operations	Last 100 operations remembered by control
7	8N: "H" with "." or "/" programme,	8N: "H" without "." or "/" taken to mean block skip (/)

2) SE 2

value Bit	0	1
0	Displayed co-ordinates w.r.t. machine zero point	Displayed co-ordinates w.r.t. work piece zero point
1	External position display accuracy $1 \mu\text{m}$	External position display $10 \mu\text{m}$
2		
3		
4		
5		
6		
7		

0.4 Machine Data

Machine data are stored in the memory area called up when the TEST button is pressed. Whilst display of machine data is not affected by the setting of the service switch, machine data can only be altered when the service switch is set to position number 2.

N100-N259	Machine data specific to each axis
N270-N287	Machine data specific to slave axes (only on 8MC)
N300-N306 N310-N316 N320-N329	Special machine data for 8MC
N340-N382	Machine data applicable to all axes or to spindle
N383-N385	Special machine data for 8T or Sprint 8T
N386-N399	Special machine data for 8N
N400-N755	General machine data bits

MACHINE DATA SINUMERIK 8T/SPIRNT 8T				Date:			
N	Value	Description	Maximum Value	N	Value	Description	Maximum Value
100		In-position tolerance	32000 [μ]	350		Destination approach speed	15000 [mm/min]
101							
110		Drift tolerance	32000 [μ]	351		Frequency of signal *SERVO ENABLE	15000 [ms]
111							
120		Acceleration	32000 [0.01ms <sup>-2</sup> ]	352		Ext.activated creep speed	15000 [mm/min]
121							
130		Max. speed	15000 [mm/min]	353		Delayed activation of position monitoring	32000 [ms]
131							
140		Max. command value	8192 [velo]	354		Fault trigger level for command value	8192 [velo]
141							
150		kV-Factor	10000 [0.01s <sup>-1</sup> ]	355		Arc end point tolerance	32000 [μ]
151							
160		Limit switch +	+9999999μ	356		Threshold for CRC at corners	32000 [μ]
161							
170		Limit switch -	+9999999μ	357		Amount of spindle drift	+1000 [velo]
171							
180		Ref. point	+9999999	358		Spindle speed tolerance	9999 [1/min]
181							
190		Backlash	+500μ	359		Speed limit for each gear	9999 [1/min]
191				360			
200		Pitch error	127μ	361			
201				362			
210				363			
211		Zero point shift	+9999μ	364			
220		Mult-gain	32000	365		Acceleration time for each gear	32000 [4ms]
221				366			
230		Drift comp.	+1000 [velo]	367			
231				368			
240		Pointer-pitch error	1023	369			
241				370			
250		Frequency of compensation points	32000 [10μ]	371		Second acceleration time for large inertia	32000 [4 ms]
251				372			
260		Lead screw gearing factor	75 [0.1]	373			
261				374			
				375			
				376			
				377		Minimum motor-speed for spindle	8192 [velo]
				378		Reduced spindle speed for M19 approach	9999 [1/min]
				379		Pendle speed	8192 [velo]
				380		Time constant for gentle deceleration	32000 [1 ms]
				381		Redundant push buttons on operator's panel	32000
				382		control number	99999999
				383		Pullback distance in X for tool change	9999999μ
				384		Pull back distance in Z for tool change	9999999μ
				385		2nd software limit in X	+9999 [μ]

N	Value	Description	Maximum Value
345		contour monitoring threshold feedrate	1500 [mm/min]
346		Contour monitoring tolerance band	1500
347		Orientated spindle stop gain	1000 [1/min/360°]
348		Orientated spindle stop tolerance	1000 [1/11°]
349		Spindle stop hold time	16000 [ms]

Machine Data SINUMERIK 8T/Sprint 8T									Date:	
Ident no.	bit								Z0	
	7	6	5	4	3	2	1	0		
N 400									N 15	X -99 999.
N 401										Z -99 999.
N 402									N 16	X 99 999.
N 403										Z 99 999.
N 404									N 19	S (max. spindle)
N 413									N 20	S (max. spindle)
N 414									N 23	F (dry run feed)
N 423									N 24	F (jog speed)
N 424										
N 425										
N 426										
N 427										
N 428										
N 429										
N 430										
N 431										
N 432										
N 436										
N 437										
N 438										
N 439										
N 440										
N 441										

JOG	F (Feed)
INCR	F (Feed)
	I (Increment)
REF	F (Rapid)

MACHINE DATE SIMUMERIK 8M/SPRINT 8M				Date:			
N	Value	Description	Maximum Value	N	Value	Description	Maximum Value
100		In-position tolerance	32000 [ $\mu$ ]	260		Lead screw gearing factor	75 [0.1]
101							
102							
103							
110		Drift tolerance	32000 [ $\mu$ ]	345		Contour monitor. threshold speed	1500 [mm/min]
111							
112							
113							
120		Acceleration	32000 [0.01ms <sup>-2</sup> ]	346		Contour monitor. tolerance bard	1500
121							
122							
123							
130		Max. speed	15000 [mm/min]	347		Orientated spindle stop gain	1000 [1/m/r/360°]
131							
132							
133							
140		Max. command value	8192 [velo]	348		Orientated spindle stop tolerance	1000 [1/11°]
141							
142							
143							
150		kV-Factor	10000 [0.01s <sup>-1</sup> ]	349		Spindle stop hold time	16000 [ms]
151							
152							
153							
160		Limit switch +	+9999999 $\mu$	350		Destination approach speed	15000 [mm/min]
161							
162							
163							
170		Limit switch -	+9999999 $\mu$	351		Frequency of signal *SERVO ENABLE	15000 [ms]
171							
172							
173							
180		Ref. point	+9999999	352		Ext.activated creep speed	15000 [mm/min]
181							
182							
183							
190		Backlash	+500 $\mu$	353		Delayed activation of position monitoring	32000 [ms]
191							
192							
193							
200		Pitch error	127 $\mu$	354		Fault trigger level for Command value	8192 [velo]
201							
202							
203							
210		Zero point shift	+9999 $\mu$	355		Arc end point tolerance	32000 [ $\mu$ ]
211							
212							
213							
220		Mult-gain	32000	356		Threshold for CRC at corners	32000 [ $\mu$ ]
221							
222							
223							
230		Drift comp.	+1000 [velo]	357		Amount of spindle drift	+1000 [velo]
231							
232							
233							
240		Pointer-pitch error	- 1023	358		Spindle speed tolerance	9999 [1/min]
241							
242							
243							
250		Frequency of compensation points	32000 [10 $\mu$ ]	359		Speed limit for each gear	9999 [1/min]
251							
252							
253							
				360			
				361			
				362			
				363			
				364			
				365		Acceleration time for each gear	32000 [4ms]
				366			
				367			
				368			
				369			
				370			
				371		Second acceleration time for large inertia	32000 [4ms]
				372			
				373			
				374			
				375			
				376			
				377		Minimum motor speed for spindle	8192
				378		Reduced spindle speed for M19 approach	9999 [1/min]
				379		Pendle speed	8192 [velo]
				380		Time constant for gentle deceleration	32000 [1ms]
				381		Redundant push buttons on Operator's panel	32000
				382		control number	99999999

Machine Data SINUMERIK 8M/Sprint 8M								Date:
Ident no	Bit							Z0
	7	6	5	4	3	2	1	
N 400								
N 401								
N 402								
N 403								
N 404								
N 405								
N 406								
N 413								
N 414								
N 415								
N 416								
N 423								
N 424								
N 425								
N 426								
N 427								
N 428								
N 429								
N 430								
N 431								
N 432								
N 436								
N 437								
N 438								
N 439								
N 440								
N 441								
N 442								
N 443								

N 15	X -99 999.
	Y -99 999.
	Z -99 999.
	4 -99 999.
N 16	X 99 999.
	Y 99 999.
	Z 99 999.
	4 99 999.
N 19	S (max. spindle)
N 20	S (max. spindle)
N 23	F (dry run feed)
N 24	F (jog speed)

JOG	F (Feed)
INCR	F (Feed)
	I (Increment)
REF	F (Rapid)

MACHINE DATE SIUMERIK 8MC				Date:			
Axes 1 to 5				Axes 6 to 10			
N	Value	Description	Maximum Value	N	Value	Description	Maximum Value
100		In-position tolerance	32000 [μ]	105		In-position tolerance	32000 [μ]
101				106			
102				107			
103				108			
104				109			
110		Drift tolerance	32000 [μ]	115		Drift tolerance	32000 [μ]
111				116			
112				117			
113				118			
114				119			
120		Acceleration	32000 [0.01ms <sup>-2</sup> ]	125		Acceleration	32000 [0.01ms <sup>-2</sup> ]
121				126			
122				127			
123				128			
124				129			
130		Max. speed	15000 [mm/min]	135		Max. speed	14500 [mm/min]
131				136			
132				137			
133				138			
134				139			
140		Max. command value	8192 [velo]	145		Max. command value	8192 [velo]
141				146			
142				147			
143				148			
144				149			
150		kV-Factor	10000 [0.01s <sup>-1</sup> ]	155		kV-Factor	10000 [0.01s <sup>-1</sup> ]
151				156			
152				157			
153				158			
154				159			
160		Limit switch +	+99999999μ	165		Limit switch +	+99999999 [μ]
161				166			
162				167			
163				168			
164				169			
170		Limit switch -	+99999999μ	175		Limit switch -	+99999999 [μ]
171				176			
172				177			
173				178			
174				179			
180		Ref. point	+99999999	185		Ref. point	+99999999 [μ]
181				186			
182				187			
183				188			
184				189			
190		Backlash	+500μ	195		Backlash	+ 500μ
191				196			
192				197			
193				198			
194				199			

MACHINE DATE SINUMERIK 8MC				Date:			
Axes 1 to 5				Axes 6 to 10			
N	Value	Description	Maximum Value	N	Value	Description	Maximum Value
200		Pitch error	127 $\mu$	205		Pitch error	127 $\mu$
201							
202							
203							
204							
210		Zero point shift	+9999 $\mu$	215		Zero point shift	+9999 $\mu$
211							
212							
213							
214							
220		Mult-gain	32000	225		Mult-gain	32000
221							
222							
223							
224							
230		Drift comp.	+1000 [velo]	235		Drift comp.	+1000 [velo]
231							
232							
233							
234							
240		Pointer-pitch error	1023	245		Pointer-pitch error	1023
241							
242							
243							
244							
250		Frequency of compensation points	32000 [10 $\mu$ ]	255		Frequency of compensation points	32000 [4ms]
251							
252							
253							
254							
260		Lead screw gearing factor	75 [0.1]	265		Lead screw gearing factor	75 [0.1]
261							

Axes 11 to 12			
N	Value	Description	Maximum Value
270		Backlash	+500 [ $\mu$ ]
271			
272		Pitch error	127 [ $\mu$ ]
273			
274		Zero point shift	9999 [ $\mu$ ]
275			
276		Mult gain	32000
277			
278		Drift comp.	+1000 [velo]
279			

Axes 11 to 12			
N	Value	Description	Maximum Value
280		Pointer pitch error	1023
281			
282		Frequency of comp.pt.	32000 [ $\mu$ ]
283			
284		Lead in sync.axes	6000 [0.001]
285			
286		Max. diff. slave axes	32000 [ $\mu$ ]
287			

MACHINE DATE SINUMERIK 8MC				Date:			
N	Value	Description	Maximum Value	N	Value	Description	Maximum Value
300		7 additional ref.points for 1st axis	+99999999μ	350		Destination approach speed	15000 [mm/min]
301				351		Frequency of signal *SERVO ENABLE	15000 [ms]
302				352		Ext.activated creep speed	15000 [mm/min]
303				353		Delayed activation of position monitoring	32000 [ms]
304				354		Fault trigger level for command value	8192 [velo]
305				355		Arc end point tolerance	32000 [μ]
306				356		Threshold for CRC at corners	32000 [μ]
310		7 additional error pointers for 1st axis	1023	357		Amount of spindle drift	+1000 [velo]
311				358		Spindle speed tolerance	9999 [1/min]
312				359		Speed limit for each gear	9999 [1/min]
313				360			
314				361			
315				320		Sag comp.	127 [μ]
316				321		Pointer f.sag	1023
322		7 additional pointers for sag on 1st axis	1023	362		Acceleration time for each gear	32000 [4ms]
323				363			
324				364			
325				365			
326				366			
327				367			
328				368			
329		Frequency of sag comp.	32000 [10μ]	369		Second acceleration time for large inertia	32000 [4 ms]
				370			
				371			
				372			
				373			
				374			
				375			
				376			
345		Contour monitoring threshold feedrate	1500 [mm/min]	377		Minimum motor speed for spindle	8192 [velo]
346		Contour monitoring tolerance band	1500	378		Reduced spindle speed for M19 approach	9999 [1/min]
347		Orientated spindle stop gain	1500	379		Pendle speed	8192 [velo]
348		Orientated spindle stop tolerance	1000 [1/min/360°]	380		Time constant for gentle deceleration	32000 [1 ms]
349		Spindle stop hold time	16000 [ms]	381		Redundant push buttons on operator's panel	32000
				382		control number	99999999

MACHINE DATE SINUMERIK 8MC									Date:								
Ident-no.	Bit								Ident-no.	Bit							
	7	6	5	4	3	2	1	0		7	6	5	4	3	2	1	0
N 400									N 444								
N 401									N 445								
N 402									N 446								
N 403									N 447								
N 404									N 448								
N 405									N 449								
N 406									N 450								
N 407									N 451								
N 408									N 452								
N 409									N 453								
N 410									N 454								
N 411									N 455								
N 412									N 456								
N 413									N 457								
N 414									N 458								
N 415									N 459								
N 416																	
N 417																	
N 418																	
N 419																	
N 420																	
N 421																	
N 422																	
N 423																	
N 424																	
N 425																	
N 426																	
N 427																	
N 428																	
N 429																	
N 430																	
N 431																	
N 432																	
N 433																	
N 434																	
N 435																	
N 436																	
N 437																	
N 438																	
N 439																	
N 440																	
N 441																	
N 442																	
N 443																	

Z0	
N 15	X -99 999.
	Y -99 999.
	Z -99 999.
	4 -99 999.
N 16	X 99 999.
	Y 99 999.
	Z 99 999.
	4 99 999.
N 19	S (max. spindle)
N 20	S (max. spindle)
N 23	F (dry run feed)
N 24	F (jog speed)

JOG	F (Feed)
INCR	F (Feed)
	I (Increment)
REF	F (Rapid)

MACHINE DATE SINUMERIK 8N				Date:							
N	Value	Description	Maximum Value	N	Value	Description	Maximum Value				
100		In-position tolerance	32000 [10 $\mu$ ]	345	-	Contour monitoring threshold speed	1500 [mm/min]				
101				346				Countor monitoring tolerance band	1500		
102				Drift tolerance	32000 [10 $\mu$ ]	350		Destination approach speed	15000 [mm/min]		
110		Acceleration	32000 [0.1ms <sup>-2</sup> ]			351		Frequency of signal .SERVO ENABLE	15000 [mm/min]		
111						120		352		Ext.activated creep speed	15000 [mm/min]
112								121		353	
120		Creep speed in Y Manual speed X, Y, B	15000 [mm/min]	122		354	Fault trigger level for command value	8192 [velo]			
121				130					131		355
122		Max. speed in Auto X,Y,B	15000 [mm/min]			132		356	Threshold for CRD at corners	32000 [ $\mu$ ]	
130				140		133					381
131		Max. command value	8192 [velo]			134		382	Control number	999999999	
132				141		135					
140		kV-Factor	10000 [0.01s <sup>-1</sup> ]			142					
141				150		143					
142		Limit switch +	+999999 $\mu$			144					
150				151		145					
151		Limit switch -	+999999 $\mu$			146					
152				170		147					
160		Ref. point	+9999999			148					
161				171		149					
162		Backlash	+500 $\mu$			150					
170				200		151					
171		Pitch error	127 $\mu$			152					
172				210		153					
180		Zero point shift	+9999 $\mu$			154					
181				220		155					
182		Mult-gain	32000			156					
190				221		157					
191		Drift comp.	+1000 [velo]			158					
192				230		159					
200		Pointer pitch error	1023			160					
201				240		161					
202		Frequency of compensation points	32000 [10 $\mu$ ]			162					
210				250		163					
211		Lead screw gearing fact.	75 [0.1]			164					
212				251		165					
220		252				166					
221				260		167					
222		261				168					
230						169					
231				170							
232				171							
240				172							
241				173							
242				174							
250				175							
251				176							
252				177							
260				178							
261				179							

SPECIAL MACHINE DATE SINUMERIK 8N				Date:			
N	Value	Description	Maximum Value	N	Value	Description	Maximum Value
386		Check sum for 3 <sup>rd</sup> axis tool change	99	393		Max. feedrate for mod. accel.	3000 [m/min x10 <sup>-2</sup> ]
387		Onset of braking before clamps	32767 [mm]	394		Accel. at threshold feedrate	1 [m/s <sup>2</sup> x10 <sup>-1</sup> ]
388		Clamp danger area	20000 [0.01mm]	395		Accel. at max. feedrate	20 [m/s <sup>2</sup> x10 <sup>-1</sup> ]
389		Max. nibble accel.	32767 [ms <sup>-2</sup> x10 <sup>-1</sup> ]	396		Delayed dutch engage	5[ms]
390		Settling time in M24	127 ms	397		Stokes/min	32767 [ /min]
391		Settling time in M24	4 ms	398		Aux. stokes/min	32767 [ /min]
392		Threshold feedrate for mod.accel.	100 [m/minx10 <sup>-2</sup> ]	399		Accel.scaling factor for punch/nibble	

MACHINE DATE SINUMERIK 8N										
Ident no.	Bit								Ident no.	
	7	6	5	4	3	2	1	0		
N 400									N 15	X -99 999.
N 401										Y -99 999.
N 402									N 16	X 99 999.
N 403										Y 99 999.
N 404										
N 405										
N 413									N 23	F (dry run feed)
N 414									N 24	F (jog speed)
N 415										
N 423										
N 424										
N 425										
N 426										
N 427										
N 428										
N 429										
N 430										
N 431										
N 432										
N 436										
N 437										
N 438										
N 439										
N 440										
N 441										
N 442										
N 459										

JOG	F (Feed)
INCR	F (Feed)
	I (Increment)
REF	F (Rapid)

## Machine Data Bits - General View

Ident no.	Axis	Bit								
		7	6	5	4	3	2	1	0	
N400S		Duration of change signal				②	Name of radius or chord			①
N401S		Delay before change signal				②	Name of angle			①
N402S		Duration of signal M02/M30				②	Name of auxilliary function Teta			①
N403S	1	Nearest mm, deg.	Nearest half mm, deg.	Circular axis	Axis present	Axis name			①	
N404S	2	Nearest mm or deg.	Nearest half mm or deg.	Circular axis	Axis present	Axis name			①	
N405S	3	Nearest mm or deg.	Nearest half mm or deg.	Circular axis	Axis present	Axis name			①	
N406S	4	Nearest mm or deg.	Nearest half mm or deg.	Circular axis	Axis present	Axis name			①	
N407S	5	Nearest mm or deg.	Nearest half mm or deg.	Circular axis	Axis present	Axis name			①	
N408S	6	Nearest mm or deg.	Nearest half mm or deg.	Circular axis	Axis present	Axis name			①	
N409S	7	Nearest mm or deg.	Nearest half mm or deg.	Circular axis	Axis present	Axis name			①	
N410S	8	Nearest mm or deg.	Nearest half mm or deg.	Circular axis	Axis present	Axis name			①	
N411S	9	Nearest mm or deg.	Nearest half mm or deg.	Circular axis	Axis present	Axis name			①	
N412S	10	Nearest mm or deg.	Nearest half mm or deg.	Circular axis	Axis present	Axis name			①	
N413S	1	Which measuring system? ③		Noise signal smoothing	Actual value divided by two	Actual value times two	Sign change: actual value	Sign change: command value	Ref.pt. in neg. dir.	
N414S	2	Which measuring system? ③		Noise signal smoothing	Actual value divided by two	Actual value times two	Sign change: actual value	Sign change: command value	Ref. pt. in neg. dir.	
N415S	3	Which measuring system? ③		Noise signal smoothing	Actual value divided by two	Actual value times two	Sign change: actual value	Sign change: command value	Ref. pt. in neg. dir.	

Machine data bits

Ident- no.	Axis	Bit									
		7	6	5	4	3	2	1	0		
N416S	4	Which measuring system?	③	Noise signal smoothing	Actual value divided by two	Actual value times two	Sign change: actual value	Sign change: command value	Ref.pt. in neg. dir.		
N417S	5	Which measuring system?	③	Noise signal smoothing	Actual value divided by two	Actual value times two	Sign change: actual value	Sign change: command value	Ref. pt. in neg. dir.		
N418S	6	Which measuring system?	③	Noise signal smoothing	Actual value divided by two	Actual value times two	Sign change: actual value	Sign change: command value	Ref. pt. in neg. dir.		
N419S	7	Which measuring system?	③	Noise signal smoothing	Actual value divided by two	Actual value times two	Sign change: actual value	Sign change: command value	Ref. pt. in neg. dir.		
N420S	8	Which measuring system?	③	Noise signal smoothing	Actual value divided by two	Actual value times two	Sign change: actual value	Sign change: command value	Ref. pt. in neg. dir.		
N421S	9	Which measuring system?	③	Noise signal smoothing	Actual value divided by two	Actual value times two	Sign change: actual value	Sign change: command value	Ref. pt. in neg. dir.		
N422S	10	Which measuring system?	③	Noise signal smoothing	Actual value divided by two	Actual value times two	Sign change: actual value	Sign change: command value	Ref. pt. in neg. dir.		
N423S		Command value zero at limit switch	G70 is reset state	Measuring system units	④	Non volatile offset	Aux. func. before move?	Aux. functions by block preselect	⑦		
N424S			Difference of 2 tool offsets to H function	x Axis dia. input tool wear	x Axis dia. prog'ing with G92	x Axis diameter prog'ing with G90	Ignore offsets with G53	Keep button pressed in REF, RPS, INC	Tool length by non. prog.axis		
N425S		Long cable to panel	M17 not issued	cust'er panel present	Prog'able interface present	op.panel multi purpose	Next LF means start	With G92 no accounting for: tooloffset Zero offset			
N426S		Key switch in dry run	active	Steady speed change	2 Hand wheels present	Hand wheel present	Ext.pos. display non.-vol.	Hand wheel accounted	Ext pos. display		
N427S		Data start in MDI-Aut	Key must be open for input into:								
		Z0-Data	Tool offset	Tool wear	Prog. correcting	Preset	Block preselect	over-write			
N428S		Type of unit	Data I/O interface 1					Baudrate	⑥		
N429S		Type of unit	Data I/O interface 2					Baudrate	⑥		
N430S		EIA-code for funny a, @									
N431S		No. of bytes to service customer panel				⑨	Programmable interface address list no.				⑧

## Machine data bits

Ident- no.	Axis	B i t								
		7	6	5	4	3	2	1	0	
N432S		Which axis for constant cutting speed				⑩	Which axis parallel to 4 <sup>th</sup> axis			①
N433S	only 8MC	Number of master axis for slave axis 12				⑩	Number of master axis for slave axis 11			⑩
N434S	only 8MC	Slave axis 12 setting time					Slave axis 11 settling time			
N435S	only 8MC	Which axis compensated? ⑩				Sag compensation				⑩
N436S	spindle		orient. stop M19	Sync. pulse	MS230 MS250 range	Units of speed	Pulse check active	Actual value reverse?	Speed double	
N437S		M/C data loaded						corners taken gently	2 decades tool offset number	
N438S		Cutter radius comp.	Fixed cycles	Cylinder milling	Polar co-ord	Axis swap. (8MC only)	199 Tool offsets (8MC only)	Threads Feed/ rev.	2.V24 I/O channels active	
N439S		Dig. measuring system	Pitch error and sag compensat.	Analogue spindle	Programme compatibility	MS 125 present	Radius prog'ing	3-D interpolation	Brief descrip. of contour (not 8MC)	
N440S	1 MS310 MS230	Rotor signal monitoring level		0 1 0 0 1 0 1 0 Analogue measuring system - amplitude correction. Rec'd bit pattern is 010010						A
N441S	1	Rotor signal monitoring level		Analogue measuring system - amplitude correction.						A
N442S	3	Rotor signal monitoring level		Analogue measuring system - amplitude correction.						A
N443S	4	Rotor signal monitoring level		Analogue measuring system - amplitude correction.						A
N444S	6	Rotor signal monitoring level		Analogue measuring system - amplitude correction.						A
N445S	7	Rotor signal monitoring level		Analogue measuring system - amplitude correction.						A
N446S	8	Rotor signal monitoring level		Analogue measuring system - amplitude correction.						A
N447S		Rotor signal monitoring level		Analogue measuring system - amplitude correction.						A



Machine data bits coding

① Name of axis, radius, chord, angle, auxilliary function Teta

② Time setting

Bits	Name
0000	X
0001	Y
0010	Z
0011	A
0100	B
0101	C
0110	U
0111	V
1000	W
1001	E
1010	H
1011	P
1100	Q

Bits	Time in ms
0000	10
0001	20
0010	30
0011	40
0100	50
0101	60
0110	70
0111	80
1000	90
1001	100
1010	110
1011	120
1100	130
1101	140
1110	150
1111	160

③ Type of measuring system

Bits	
00	Analogue (Resolver or Inductosyn)
01	Digital (Haidenhain or pulse coder)

④ Increments of measuring system

Bits	
00	$1/2 * 10^{-3}$ mm or degré
01	$1/2 * 10^{-4}$ inch
10	$2 * 10^{-5}$ inch
11	$1/2 * 10^{-2}$ mm

Machine data bits coding (continued)

## ⑤ Type of unit

Bits	Abbreviation	
0000	_____	
0001	PTR	(Fanuc tape reader with reels) (only one V24 interface possible)
0010	PTR	(Fanuc tape reader without reels)
0011	PTR	(Facit 4030)
0100	PUN	(Puncher)
0101	_____	
0111	_____	
1000	R/P	(combined tape reader/puncher full duplex)
1001	TTY	(combined tape reader/puncher half duplex)
1010	R/P	(combined tape reader/puncher full duplex character controlled input)
1011	_____	
1100	_____	
1101	_____	
1110	_____	
1111	_____	

(Half duplex operation is only possible at V24-2 interface - socket X104)

## ⑥ Baudrate (1 Baud is 1 bit per second)

Bits	Baud	Typical examples	N428S or N429S
000	110		
001	150	17X → Fanuc Reader with reels	9600 Baud S00010111
010	300	27X → Fanuc REader without reels	9600 Baud S00100111
011	600	82X → PT80 interface unit	300 Baud S10000010
100	1200	43X → Facit 4070 puncher	600 Baud S01000011
101	2400	80X → Teletype ASR3320 full duplex	110 Baud S10000000
110	4800	90X → Teletype ASR3320 half duplex	110 Baud S10010000
111	9600		

## ⑦ Auxilliary functions by block preselect

Bits	When the functions at issued
00	Not at all
01	issued after cycle start
10	issued during search for preselected block
11	_____

● Machine Data bits coding (continued)

⑧ Programmable interface address list number

Bits	PC
0000	AG150, AG130W

⑨ No. of bytes to service customer panel

Bits	
0000	1 Byte
0001	2 Byte
⋮	
1111	16 Bytes

⑩ Number of Axis

Bits	
0000	no axis
0001	1 <sup>st</sup> axis
0010	2 <sup>nd</sup> axis
⋮	
1010	10 <sup>th</sup> axis

### 0.5 Display of measuring circuit parameters

Storage locations TEST N800 to N915 accommodate useful measuring circuit and main spindle data. The correct button pushing sequence is described in section 10.1.

Axis no.	Input no.	Display	units
1 2 3 ⋮ 10	N800 N801 N802 ⋮ N809	Following error	μm
1 2 3 ⋮ 10	N810 N811 N812 ⋮ N819	Present actual position (with respect to Reference point)	μm
1 2 3 ⋮ 10	N820 N821 N822 ⋮ N829	Command speed value	Velo 8192 velo=10Volt
1 2 3 ⋮ 10	N830 N831 N832 ⋮ N839	Axis movement within previous scantime	μm/ scanning time
1 2 3 ⋮ 10	N840 N841 N842 ⋮ N849	Contour deviation	μm
1 2 3 ⋮ 10	N850 N851 N852 ⋮ N859	actual position loopgain	0.001 $\frac{\text{m/min}}{\text{mm}}$

Measuring circuit parameters

Axis no.	Input number	Display	Unit
11	N900	Following error	$\mu\text{m}$
12	N901		
11	N902	Present actual position	$\mu\text{m}$
12	N903		
11	N904	Command speed	velo
12	N905		
11	N906	Axis movement within previous scan time	$\mu\text{m}/\text{scanning}$ time
12	N907		
11	N908	Difference between positions of Master and Slave	$\mu\text{m}$
12	N909		
Spindle	N910	Demanded spindle speed	Velo
Spindle	N911	Spindle position	360/4096 degrees
11	N912	Contour diviation	$\mu\text{m}$
12	N913		
11	N914	actual position loop gain (kV factor)	0.001 $\frac{\text{m/min}}{\text{mm}}$
12	N915		

0.6 Interface test, Input signals to N.C.

See section 10.1 for the significance of the asterisk after the pin number

Selection is made with TEST N3

① means 1<sup>st</sup> axis, ② 2<sup>nd</sup> axis etc.

Ident no.	Rel.Adr.	Bit number							
	PC Marker	7	6	5	4	3	2	1	0
	MS 180								
N3	A0 M02		①	①	①	①	①	①	①
	Plug/Pin	X182.9 (*)	.8 (*)	.7 (*)	.6 (*)	.5 (*)	.4 (*)	.3 (*)	.2 (*)
	A1 M03		②	②	②	②	②	②	②
	Plug/Pin	X182.17 (*)	.16 (*)	.15 (*)	.14 (*)	.13 (*)	.12 (*)	.11 (*)	.10 (*)
	A2 M04		③	③	③	③	③	③	③
	Plug/Pin	X182.25 (*)	.24 (*)	.23 (*)	.22 (*)	.21 (*)	.20 (*)	.19 (*)	.18 (*)
	A3 M05		④	④	④	④	④	④	④
	Plug/Pin	X182.33 (*)	.32 (*)	.31 (*)	.30 (*)	.29 (*)	.28 (*)	.27 (*)	.26 (*)
	A4 M06		⑤	⑤	⑤	⑤	⑤	⑤	⑤
	Plug/Pin	X182.42 (*)	.41 (*)	.40 (*)	.39 (*)	.38 (*)	.37 (*)	.36 (*)	.35 (*)
A5 M07		⑥	⑥	⑥	⑥	⑥	⑥	⑥	
A6 M08		⑦	⑦	⑦	⑦	⑦	⑦	⑦	
A7 M09		⑧	⑧	⑧	⑧	⑧	⑧	⑧	
A8 M10		⑨	⑨	⑨	⑨	⑨	⑨	⑨	
A9 M11		⑩	⑩	⑩	⑩	⑩	⑩	⑩	
			*Axis driven externally without N.C.	Axis disable	Switch on creep speed i.e. ref.pt approach	*Feed enable	*Servo enable	Limit switch minus	Limit switch plus

Interface test, Input signals

See section 10.1 for the significance of the asterisk after the pin number

Selection is with TEST N4

Ident no	Rel. Adr. P.C. Marker	Bit number							
		7	6	5	4	3	2	1	0
		MS 180							
A10 M12	2 <sup>nd</sup> software limit in X active	*NC Start	Emergency Stop	*Display data from interface	1 <sup>st</sup> op. panel active	*op. panel inactive	*cancel remaining distance	*4 <sup>th</sup> Axis is main axis	
Con/Pin	X183.45(*)	.44(*)	X182.1(*)	.42(*)	.41(*)	.41(*)	.40(*)	.39(*)	
A11 M13	*Read-in enable	*Axis swop.	* Feedrate multiplication factor				*1 <sup>st</sup> p'grammed feed	*overall feed enable	
Con/Pin	X182.34(*)	X183.50(*)	X182.50(*)	.49(*)	.48(*)	.47(*)	.46(*)	.45(*)	
A12 M14	Creep speed ext.	* Gear selection			* Spindle 2 <sup>nd</sup> acceleration time		* Spindle direction c.w.	Stop	
Con/Pin	X184.47(*)	.32(*)	.31(*)	.30(*)	.17(*)	.16(*)	.15(*)	.14(*)	
A13 M15	Cancel remaining sub. prog. runs	Fixed cycle inhibit	*No aux. functions issued	*Zero offset group		* Mirror image operation			
Con/Pin	X183.46(*)	X184.49(*)	.48(*)	X182.44(*)	.43(*)	X183.49(*)	.48(*)	.47(*)	
A14 M16	* Type of information transfer								
Con/Pin	X183.25(*)	.24(*)	.23(*)	.22(*)	.21(*)	.20(*)	.19(*)	.18(*)	
A15 M17	* Type of information transfer								
Con/Pin	X183.33(*)	.32(*)	.31(*)	.30(*)	.29(*)	.28(*)	.27(*)	.26(*)	
A16 M18	Axis - code								
Con/Pin	X184.50	.33	X183.34	.1	.38	.37	.36	.35	
A17 M19	First byte for external data input								
Con/Pin	X183.9	.8	.7	.6	.5	.4	.3	.2	
A18 M20	Second byte for external data input								
Con/Pin	X183.17	.16	.15	.14	.13	.12	.11	.10	

N4

Interface test decoding

## \* Gear selection

(N4 A12)

Range	C	B	A
1	1	1	1
2	1	1	0
3	1	0	1
4	1	0	0
5	0	1	1
6	0	1	0

## Axis code

(N4 A16)

Axis	D	C	B	A
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
10	1	0	1	0
Radius	1	1	1	1

## Zero offset group

(N4 A13)

Group	B	A
1	1	1
2	1	0
3	0	1

Interface test: Output signals. Selection is made with TEST N6. See section 10.1 for measuring of the asterisks.

Ident no	Rel. Adr.	Bit number							
	PC Marker	7	6	5	4	3	2	1	0
	M 180								
TEST  N6	A0	*Prog running	Control busy	*N.C. Ready for Interface	*N.C. ready 1.				
	M21						(1)	(1)	(1)
	Con/Pin	X184.36 (*)	X186.50 (*)	.48 (*)	X184.4 (*)	.8 (*)	.7 (*)	.6 (*)	.5 (*)
	A1	*Position reached Aux.-func. o/p-Nibble	*Thread cutting G33/G63	*End of prog'me M02/M30	*Prog' halt M00/M01				
	M22						(2)	(2)	(2)
	Con/Pin	X186.49 (*)	X184.20 (*)	.19 (*)	.18 (*)	.24 (*)	.23 (*)	.22 (*)	.21 (*)
	A2	*MDI-Auto	*Buffer store empty	*Single block	*Rapid G00				
	M23						(3)	(3)	(3)
	Con/Pin	X185.46 (*)	.45 (*)	X184.37 (*)	X185.29 (*)	X184.28 (*)	.27 (*)	.26 (*)	.25 (*)
	A3	*Preset	*Data in/out	*MDI	*Auto				
M24						(4)	(4)	(4)	
Con/Pin	X185.50 (*)	.49 (*)	.48 (*)	.47 (*)	X184.41 (*)	.40 (*)	.39 (*)	.38 (*)	
A4	*Referencing	*Repos	*Incremental	*Setting up					
M25						(5)	(5)	(5)	
Con/Pin	X185.33 (*)	.32 (*)	.31 (*)	.30 (*)	X184.45 (*)	.44 (*)	.43 (*)	.42 (*)	
A5									
M26						(6)	(6)	(6)	
A6									
M27						(7)	(7)	(7)	
A7									
M28						(8)	(8)	(8)	
A8									
M29						(9)	(9)	(9)	
A9									
M30						(10)	(10)	(10)	
						*Ref.pt. reached	*Move command - ve	*Move command + ve	

Interface test: Output signals. See section 10.1 for the meaning of the asterisks.

Selection is with TEST N7

Ident no.	Rel. Adr.	Bit number							
	PC Marker	7	6	5	4	3	2	1	0
	MS 180								
TEST N7	A10 M31	Spindle direction over-speeding		* Spindle speed correct		* Change signal			
	Con/Pin	X184.12(*)	.11(*)	.10(*)	.9(*)	X185.36(*)	X186.29(*)	X185.4(*)	X186.4(*)
	A11 M32	10 <sup>1</sup> H Word				10 <sup>0</sup>			
	Con/Pin	X186.12	.11	.10	.9	.8	.7	.6	.5
	A12 M33	10 <sup>3</sup> H Word				10 <sup>2</sup>			
	Con/Pin	X186.20	.19	.18	.17	.16	.15	.14	.13
	A13 M34	10 <sup>5</sup> H Word				10 <sup>4</sup>			
	Con/Pin	X186.28	.27	.26	.25	.24	.23	.22	.21
	A14 M35	10 <sup>1</sup> T Word				10 <sup>0</sup>			
	Con/Pin	X185.12	.11	.10	.9	.8	.7	.6	.5
	A15 M36	10 <sup>3</sup> T Word				10 <sup>2</sup>			
	Con/Pin	X185.20	.19	.18	.17	.16	.15	.14	.13
	A16 M37	10 <sup>5</sup> T Word				10 <sup>4</sup>			
Con/Pin	X185.28	.27	.26	.25	.24	.23	.22	.21	
A17 M38	10 <sup>1</sup> S Word				10 <sup>0</sup>				
Con/Pin	X186.39	.38	.37	.36	.35	.34	.33	.32	
A18 M39	10 <sup>3</sup> S Word				10 <sup>2</sup>				
Con/Pin	X186.47	.46	.45	.44	.43	.42	.41	.40	
A19 M40	10 <sup>1</sup> M Word				10 <sup>0</sup>				
Con/Pin	X185.44	.43	.42	.41	.40	.39	.38	.37	



0.7 List of alarms

Note: 3<sup>rd</sup> decade is the least significant

clear	3 <sup>rd</sup> dec 1+ 2nd dec	S	7	6	5	4	3	2	1
	00				Axis 1	Axis 1	Axis 1	Axis 1	Axis 1
	01				Axis 2	Axis 2	Axis 2	Axis 2	Axis 2
	02				Axis 3	Axis 3	Axis 3	Axis 3	Axis 3
	03				Axis 4	Axis 4	Axis 4	Axis 4	Axis 4
	04				Axis 5	Axis 5	Axis 5	Axis 5	Axis 5
	05				Axis 6	Axis 6	Axis 6	Axis 6	Axis 6
	06				Axis 7	Axis 7	Axis 7	Axis 7	Axis 7
	07				Axis 8	Axis 8	Axis 8	Axis 8	Axis 8
	08				Axis 9	Axis 9	Axis 9	Axis 9	Axis 9
	09				Axis 10	Axis 10	Axis 10	Axis 10	Axis 10
	10		Axis 1		Axis 1	Axis 1	Axis 1	Axis 1	Axis 1
	11		Axis 2		Axis 2	Axis 2	Axis 2	Axis 2	Axis 2
	12		Axis 3		Axis 3	Axis 3	Axis 3	Axis 3	Axis 3
	13		Axis 4		Axis 4	Axis 4	Axis 4	Axis 4	Axis 4
	14		Axis 5		Axis 5	Axis 5	Axis 5	Axis 5	Axis 5
	15		Axis 6		Axis 6	Axis 6	Axis 6	Axis 6	Axis 6
	16		Axis 7		Axis 7	Axis 7	Axis 7	Axis 7	Axis 7
	17		Axis 8		Axis 8	Axis 8	Axis 8	Axis 8	Axis 8
	18		Axis 9		Axis 9	Axis 9	Axis 9	Axis 9	Axis 9
	19		Axis 0		Axis 10	Axis 10	Axis 10	Axis 10	Axis 10
	20		Axis 1	Ax. 11 Slave fault	Axis 11	Axis 11	Axis 11	Axis 11	Axis 11
	21		Axis 2	Ax. 12 slave fault	Axis 12	Axis 12	Axis 12	Axis 12	Axis 12



During motion servo enable was lost

Limit of working area

Limit of working area

Negative limit switch

Positive limit switch

Measuring circuit signal corruption

Drift too large

Hardware fault in measuring system




Command/actual value ratio too large

Commandspeed value too high

Axis not holding in position



## List of alarms (continued)

Clear * +	3rd dec.		8	7	6	5	4	3	2	1
	1st, 2nd dec.									
	50			Nibble bero fault	CRC contour fault	Fault in contour descript.	Block structure  Minor	Error in polar co- ord circle rad. prog'ing	More than 6 Geam param fault	General
	51				Block construc- tion faulty	Preselect block notfound	Block with > 120 char.	Memory full	Input inhibited	RESET comes First.
	52	kV factor not deter- mined Contour	kV factor of axes not equal check		Axis moving no playback p					Info. transfer/ strobe fault
	53		Last prog. has no termination	> 5 axes in one block	Axis moving no playback poss MDR Error	Playback on- ly, when MDI inter- rupted	playback as 1st block not allowed	Prog.no. already used		> 40 charac. in block
	70					M/C data fault	system programme fault			Bubble memory not organized
	71							Battery on MS 125		Battery on MS 140

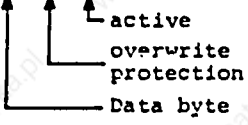
\*\* Input row (row in bottom left hand corner of display) must be completely cleared.

0.8 ENGINEERING PANEL

INPUT LIST

FUNCTION		BUTTON	
HEXA NUMBER	0	0	
	1	1	
	2	2	
	3	3	
	4	4	
	5	5	
	6	6	
	7	7	
	8	8	
	9	9	
	A	. 0	
	B	. 1	
	C	. 2	
	D	. 3	
	E	. 4	
	F	. 5	
COMMAND STOP		7	LF
GO (LOOP COUNTER 0...FF)		G	[X X] LF
STEP (LOOP COUNTER 0...FF)		S	[X X] LF
NEXT STEP			LF
DISPLAY MEMORY		M	LF
CHANGE SEGMENT		S	S S S S LF
CHANGE OFFSET		L	0 0 0 0 LF
CHANGE DATAWORD		X	D D D D LF
INCREMENT OFFSET (+2)			LF
DISPLAY ALL REGISTERS		R	LF
DISPLAY/CHANGE REGISTER		X	X X LF (REGISTER NR. 0-E)
NEXT REGISTER			LF
DISPLAY BREAKPOINT		F	LF
ACTIVATE BREAKPOINT		F	I LF
SET BREAKPOINT		F	S S S S [-] 0 0 0 0 [T / I] LF
DISPLAY CPU-NUMBER		N	LF
SET CPU-NUMBER		N	X LF
END OF "DISPL. MEMORY" OR "STEP" OR "DISPL. REGISTER"-MODE		I	LF
CANCEL BUTTON (CANCELS LATEST CHARACTERS)		/	
SEPARATION BUTTON		-	
INPUT BUTTON		LF	(ECHO *)

(LEADING ZERO'S CAN BE OMITTED)



1. Prerequisites for commissioning. These are the items to which the customer must first attend.
  - 1.1 Correct machine data must be available.
  - 1.2 Electrical and mechanical work on the machine must be finished. It must be possible to drive the axes-check this with the customer present at the machine.
  - 1.3 The interface must be coupled with both the machine and SINUMERIK according to the recommendations in the interface description.

If a bus connected PC is being used the STATUS programme should be inserted and the various links on the interface p.c.b's (i.e. memory addressing and input/output addressing) should be checked (please see commissioning manual part 2).
  - 1.4 Measuring system installed and wired up.
  - 1.5 Cables to the interface and to the machine from the N.C. should be connected. Cable screens should be earthed at the control as specified in the "Interface Description". Cables to the customer module must have screens which are attached to the chassis.
  - 1.6 See section 2.3. for earthing and interference precautions.
  - 1.7 A test tape should be available to check all the functions of the control.
  - 1.8 People should be provided by the customer to assist with work on the machine (e.g. operating the machine).
  - 1.9 For safety's sake the limit switches may be brought in a little.
  - 1.10 If the measuring circuit cables, are not single cables but comprise several sections check that the sections are making good contact, the screening is satisfactory and that they are not mechanically stressed.

## 2 Visual check of the SINUMERIK control

### 2.1 Mains connection: Single phase 220 V

Tolerances:           220 V -15 % to 230 V +10 %  
                           50 - 60 Hz  $\pm$  6 %

Separate mains cable (3 core 2.5 mm<sup>2</sup>) with following fusing:

P.c.b. cabinet	6 A fuse
Operators panel	6 A fuse
Tape reader/printer	6 A fuse
External interface	6 A fuse.

or common fuse, 6-10A, for all components.

Any unused cores in the mains cable should not be left free but should be connected to either a phase or neutral line.

p.c.b. cabinet

connector X1

Earth	L1	N L2	1	2
-------	----	---------	---	---

Operator's panel

L1   Earth   L2/N

connector

1	2	3
---	---	---

Tape reader

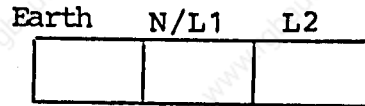
L1   L2/N   Earth

connector

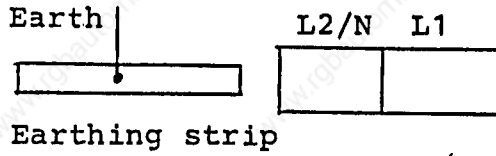
1	2	3	4
---	---	---	---

Mains unit for external position display

connector



SINUMERIK cabinet



connector

2.2 Customer module with the following buttons

- Emergency Stop
- Spindle ON, OFF
- Feed ON, OFF
- Power ON
- Cycle
- Panel keyswitch

A screened cable should be used to connect this module to the interface.

## 2.3 Earthing and interference precautions

To reduce interference, thereby ensuring trouble free operation of the control, proper earthing, without loops and using cables of the required cross-section is imperative.

### 2.3.1 Earthing

The separate cabinets of the control are earthed via the earth core of their mains cable.

The overall machine should have a central earthing strip according to EVU regulations, to which all the individual earth cables of the machine should be connected. The earth cables from the following components should also be connected to this earthing strip:

- control cabinet (10 mm<sup>2</sup>)
- machine frame (16 mm<sup>2</sup>)
- motors
- earth windings of transformers.

The earth cables should follow the most direct path. The reference potential,  $M_{INT}$ , of all parts of the SINUMERIK is also connected via the cabinet to earth.

### 2.3.2 Interface signal suppression

In addition to the earthing requirements, other precautions must also be taken to ensure trouble free operation of the control. These precautions include screened signal cables, potential compensation cores and special 0 V connections.

### 2.3.3 Screened signal cables

Where the documentation advocates them, screened cables must be used. The specified connectors and only they may be installed. The Siemens connectors are so constructed that the screen is electrically connected with the cabinet and hence to earth. In all parts of the control having their own mains supply, the 0 V line is connected electrically with the cabinet.

The 0 V lines of all parts of the control with their own mains supply are intended to be connected together via the cable screens, therefore the screens should be connected at both ends of the cable. Parallel to the signal cables, to ensure that the cable screens do not have to carry excessive current, a potential compensation cable (4 mm<sup>2</sup>) should be laid and at each end connected to the cabinet concerned. These compensation wires must be introduced when the cable screen can, for practical reasons, only be connected at one end.

Those components of the system which do not have their own power supply generally have a 5 V supply from a fundamental part of the control (e.g. p.c.b. cabinet). The screens of the cables to these components (e.g. pulse coder) are left free at the component end. No potential compensation cable should be installed. The 0 V line of these components should not be connected with the housing but should be connected with the 0 V of the overall control via the signal cable.

The picture on page 2-4 shows how the cable screens for components from the SIMATIC S5 range should be connected.

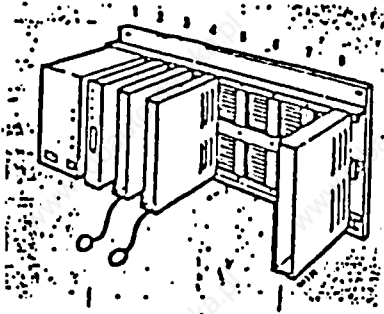
Note

From Nov. 80 the enclosures which can be fitted to the following logic boards from the S5 range will be supplied with a flying earth lead:

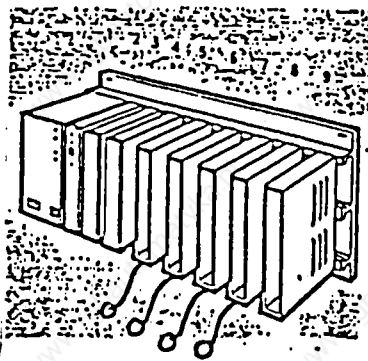
6ES5 310, 390, 501, 511, 512.

The screen of the cable connected to the p.c.b. should be bared and the flying earth lead clamped around the cable at this point.

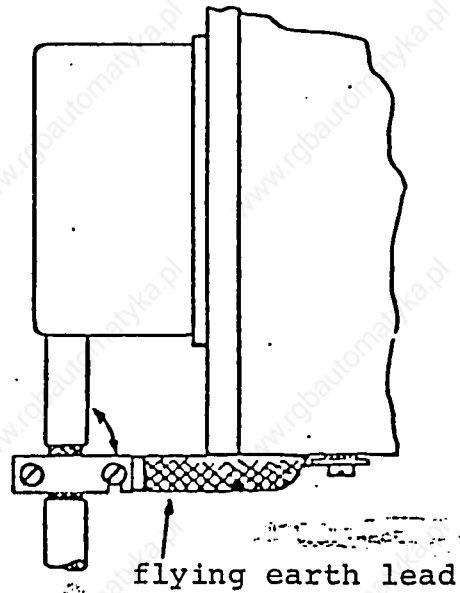
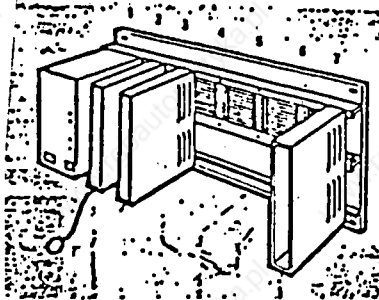
AG 130A



AG 150A



EG 182A



Cables carrying low frequency signals (e.g. from the SINUMERIK to a relay interface) should be screened as far as the main connector block in the relay cabinet. In the case of a relay interface the cable screen should only be connected at the MS 180 end of the cable. If it is not convenient to use a screened cable and single wires are used to transmit signals (e.g. from digital input/outputs of the S5 interface) then these wires should be run in their own channel, separated from any heavy current conductors.

Note: The only point of connection between the 0 V line of SIMOREG Thyristor and Transistor units and 0V of the N.C. is via the 0 V return of the command speed cable from the N.C. to the drive (i.e. the cable to terminal no. 14).

#### 2.3.4 Special 0 V connections

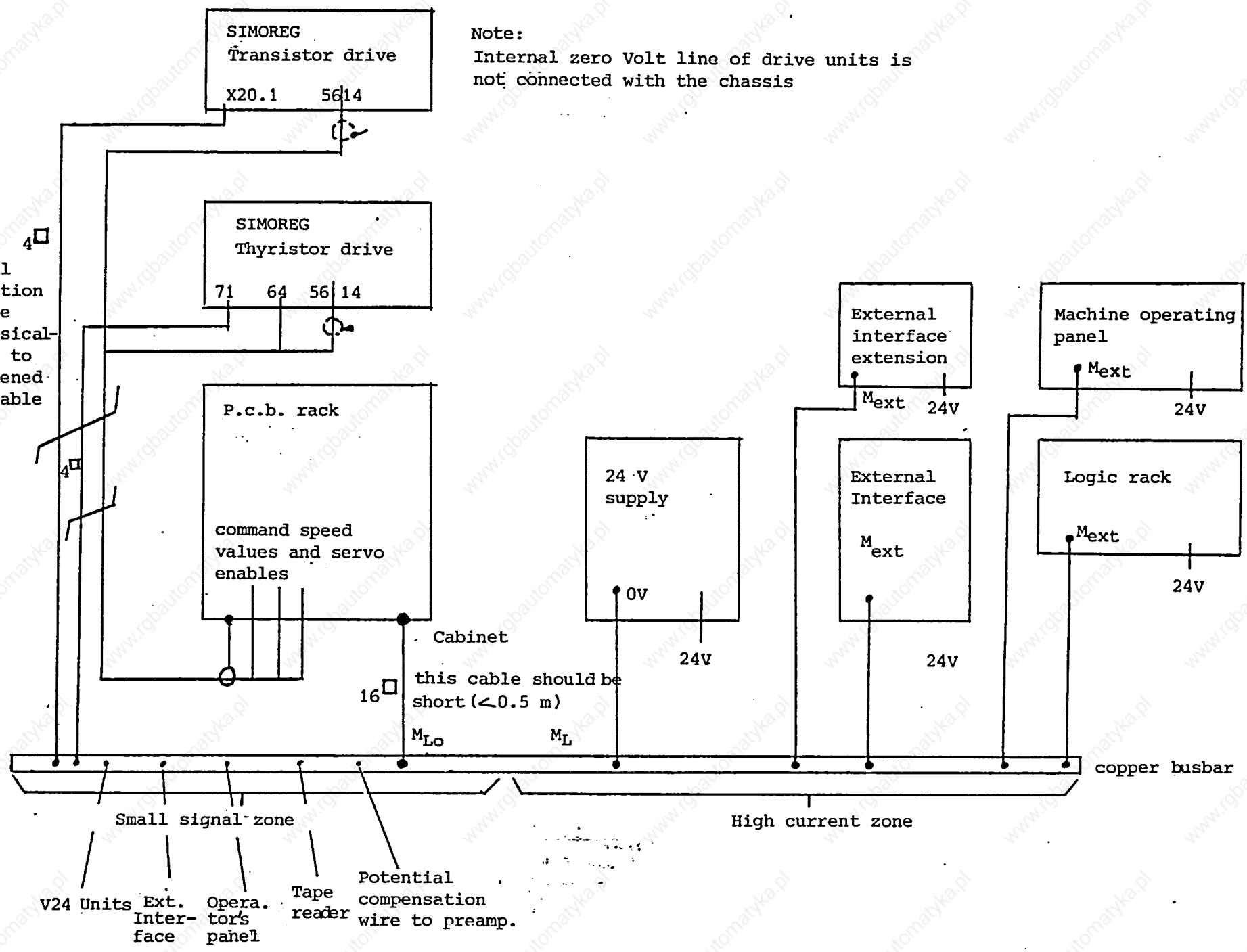
- 1) No potential drops can be tolerated along the cables between the SINUMERIK and either the feed drive or main spindle drive since here millivolts and milliamps are important.
- 2) The 24 V supply for the input/output of the interface and operators panel elements deals in Amps but must use the same 0 V line as the rest of the system.

To meet these two requirements a 0 V strip is suggested as shown in the picture on page 2-6.

- 3) Interference currents from low frequency signals (e.g. Input signals to the MS 180 from the interface) can be suppressed with the 0 V strip. On the MS 180 the input filters lead down to 0 V of the SINUMERIK.

Note:  
 Internal zero Volt line of drive units is not connected with the chassis

Potential compensation wires are kept physically close to the screened signal cable



Small signal-zone

High current zone

V24 Units Ext. Interface

Opera-tors panel

Tape reader

Potential compensation wire to preamp.

## 2.4 Position measuring devices

### 2.4.1 Analogue measuring systems

Special attention must be given to the installation of Inductosyn or resolvers, e.g., Inductosyn slider, scales, air gap, Resolver plugs and connectors. Useful notes are to be found in the booklet Inductosyn installation and adjustment order no: E 321/1044. Parallel to the SIN and COS windings of Siemens or Kearfott Resolvers, a  $39\ \Omega$  1/2 W resistor should be connected (resistor tolerance 1 % Temp. coefficient 50 ppm). Other makes of resolver can lead to problems with accuracy and surface finish.

### 2.4.2 Special cases

MS 200 with 3 axes and 3 resolvers.

In this case the  $39\ \Omega$  resistors are not connected to the SIN and COS windings of the resolver connected to the third axis because the monitoring of the rotor signal on the MS 200 is only designed for two load resistors.

### 2.4.3 Digital measuring systems

The following measuring devices can be used for digital measuring systems ROD 2500, ROD 5000, ROD 2000 and Haidenhain linear scales with EXE.

The pulses from the measuring device will be multiplied within the control. By correct choice of lead screw pitch, one pulse within the control should correspond to one measuring system increment (i.e.  $0.5 \times 10^{-3}$  mm,  $0.5 \times 10^{-4}$  inch,  $2 \times 10^{-5}$  inch,  $0.5 \times 10^{-2}$  mm).

This matching-up of the measuring system units can also be done with machine data bits: partial actual value times 2 or partial actual value divided by 2. The maximum speed of the axis is set by the maximum pulse frequency of the encoder or by the maximum speed of the control.

## 2.5 Additional checks

### 2.5.1 Operating panel

Switches, buttons, lamps, plasma display: Are they all in working order after transport?

2.5.2 Miscellaneous: Is the tape reader, if supplied, in working order? Are all p.c.b's screwed to the frame? Have spare fuses and a log book been supplied?

2.5.3 Check to see that all p.c.b's are the latest editions as given in the service handbook.

2.5.4 Are all i.c.'s mounted in sockets correctly inserted in these sockets.

2.5.5 Cabinet version only: Check that all internal cable connections are secure.

## 2.6 Measuring system cable

Cases have arisen in the past where customers have used non standard cables for the measuring system. This led to difficulties with the setting up.

What should be done in this case?

In the first instance the customer should be advised to use the cables given in the interface description. If the customer wants to make up his own cables he should do it as Siemens specify and using materials recommended by Siemens.

If, on the other hand, the customer contravenes Siemens recommendations, the service engineer should inform the relevant sales office immediately. The sales office then has the job of explaining the situation to the customer. It is not sufficient for the service engineer to tell the customer that the cables are not good enough and that he must bear the responsibility for working with the cables.

In some cases it is not immediately obvious if the customer has used recommended cables. Therefore at each commissioning a special check should be made to see what type of cables have been used.

### 3.1 Measuring system

#### 3.1.1 Analogue measuring systems

MS200: No bridges need to be inserted on the MS200 and the machine data bits N440 to N451 are inactive. In the case of Inductosyn, an adapter cable type 8W0Z connects up to the MS200. The p.c.b. MS205 is an integral part of the 8W0Z. To enable the current adjustment to be made a potentiometer is built into the COSINE supply. In some cases it may be easier to do the adjustment by removing the potentiometer and the  $56\ \Omega$  resistor and connecting appropriate resistors in parallel with the  $30\ \Omega$  resistors of the SIN and COS supply on the MS 205 (see circuit diagrams for MS205). The parallel resistor should be chosen to give the input voltage which gives the smallest current. By this means the error margin is maximised (higher current input into the slider).

The amplitude of the error voltage should be about 2 V peak to peak. It should be measured between pins 11 and 12 on the adapter plug (MROTM-, MROTS-).

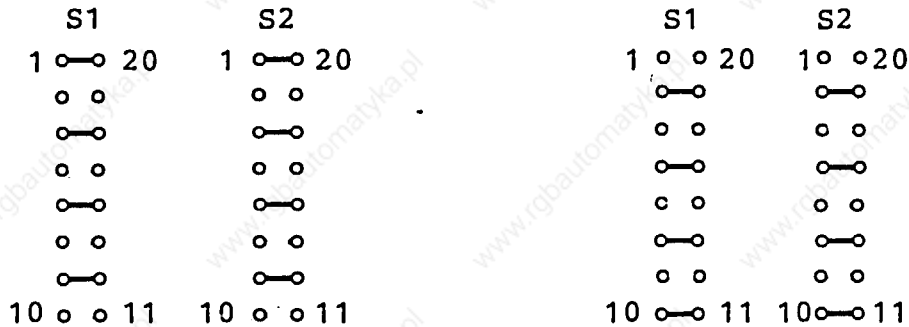
MS311: No bridges need to be inserted on this p.c.b. The adjustment of the SIN and COS voltages, as well as the fault monitoring threshold is done with machine data bits N440 to N451. The normal fault monitoring threshold is the bit pattern 11.

Adapter cable 8W0 should be used if Inductosyns are being installed. The  $56\ \Omega$  resistors (parallel) to the SIN and COS voltages should be removed so that the software adjustment operates properly. The resistors are R46, R21 or R26, R5 (see circuit diagrams).

The error voltage should be about 2 V peak to peak (measured at pins 11 and 12, ROTG, ROTG). The Inductosyn adaption (N400 - N451) should also be done for resolvers. The recommended bit pattern is 11010010 but this should be checked to see that the results are satisfactory.

MS230: The comments made for the MS311 also apply here. In this case the resistor numbers of the parallel resistors are R212, R97, R210, R85, R208, R74, R205, R63. The fourth axis can also be used to drive a digital measuring system, but to do this the two sets of bridges S1, S2, must be turned round.

a. Digital measuring system      b. Analogue measuring system



Fault monitoring threshold

Bit pattern	Threshold
0 0	2 - 2.1 $V_{rms}$
0 1	1.1 - 1.25 $V_{rms}$
1 0	0.56 - 0.73 $V_{rms}$
1 1	0.27 - 0.455 $V_{rms}$

### 3.1.2 Digital measuring systems

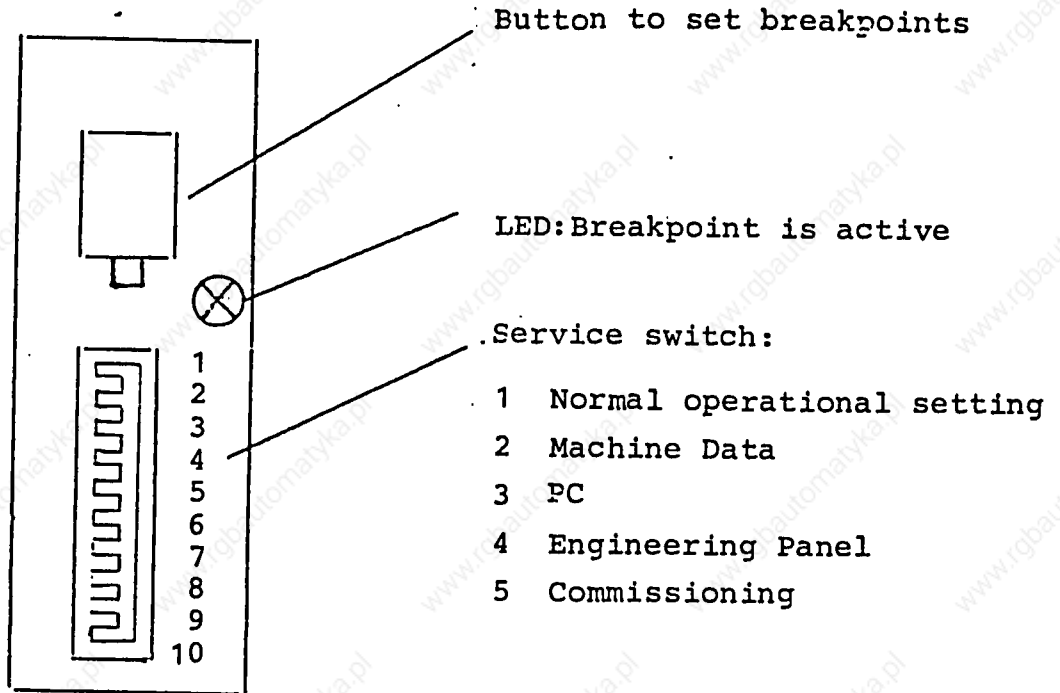
MS321: No bridges need to be considered with this measuring board, for each axis which uses the MS321, bits 7, 6 of the corresponding machine data (N413 to N420) will be set to 01. (Note, up to stand 10 bits 7, 6, 5 of the corresponding machine data (N413 to N420) would have been set to 010). The machine data bit "Digital measuring system", N439 bit 7, should be set.

The measuring circuit fault monitoring (Alarms 104 to 214) will detect faults in the signals A, A\*, B, B\*, Z, Z\* or corrupted signals in the care of the Haidenhain system.


MS250: There are no bridges to be considered.

This measuring board can be installed with the 8T, Sprint 8T, Sprint 8M and 8N. The board can cope with 4 axes and 1 spindle. The comments regarding the MS321 also apply here.

3.2 Service switch



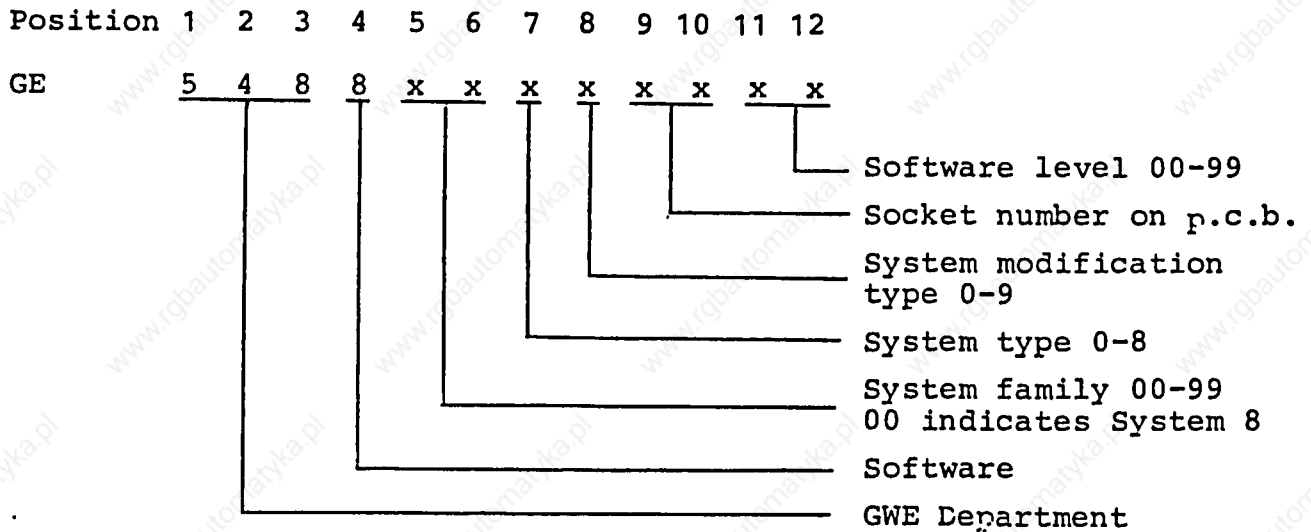


If one fault is displayed up, the activation of the page button  will move the display to any further defective EPROMs. If no more are present the programme will jump into the normal system operation.

All EPROMs present in the control (including options) will be checked. Such a check which takes place more frequently than at system reset will be introduced later.

SINUMERIK System 8 - Software nomenclature

-- To identify PROMs a twelve digit system has been introduced which looks after the interests of GWE, Development and Service.



Explanation of the groups of numbers:

Position 1-4: These digits are always the same and indicate the GWE Data preparation group.

Position 5-6: System 8 always has 00 in these positions

Position 7: This digit indicates the type of system

- 0 Basic System 8
- 1 8T
- 2 Sprint 8T
- 4 Sprint 8M
- 5 8MC
- 6 8N

Position 8: This position gives information about the software family

- 0 Plasma display text in English..
- 1 Plasma display text in German
- 8 Commissioning
- 9 Diagnostics

Position 9-10: The number assigned to each EPROM socket increases as the start address of the EPROM belonging in that socket increases. Two EPROMs are assigned to all software addresses, one for the higher byte and one for the lower byte. With the new PROM socket numbers, see page 3-6, for one group of addresses there is always an odd number for the lower byte and the next higher even number for the higher byte. At the moment p.c.b.'s are in circulation with two different ways of identifying which PROM belongs in which socket. The older boards carry only the screen printed number Dxx (eg D9, D10 etc.), whilst the newer boards have simply the PROM socket number 02, 03 etc.

Page 3-6 shows how the two systems are compatible. In the service bulletins only the new PROM socket number will be given. It should be noted that the old D-number and new PROM socket number are not the same for a given PROM.

Position 11-12: The number of the software level is the same as the last digits of the number of the service bulletins which deal with that level.

#### General comments

To be able to identify a particular EPROM it suffices to state the last 8 digits of the number.

In the number EPROM the corresponding PROM socket number is always the last two digits before the last decimal point and the software level is the last two digits after the last decimal point.

The software level can be checked with the engineering panel using the following sequence

```
M LF  
S 0 LF  
L 20 LF
```

A number will appear in the bottom line of the display. The last four digits of this number show the software level.

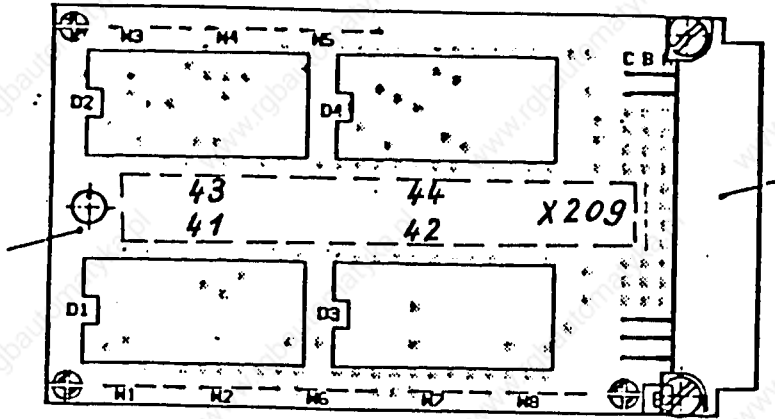
SINUMERIK System 8. Options list								
Function	Order no. MLFB	Machine data		System-type				
		Id. no.	Bit	BT	Spr. BT	Spr. BM	BM	BN
2 serial data in/out terminals	C62	N438	Ø	○	○	○	○	○
Extension pack 2. Polar co-ordinates, radius programming	B71	N438 N439	4	—	—	—	○	—
			2	—	—	—	○	—
Polar co-ordinates	B63	N438	4	—	○	○	—	○
radius programming	B62	N439	2	—	○	○	—	—
Thread cutting and Feed/rev.	E31	N438	1	×	×	○	○	—
Extension pack 3 199 Tool offsets, 12 zero off.	H81	N438	2	—	—	—	○	—
Extension pack 4 Master/slave axes Axis swap	K07	N438	3	—	—	—	○	—
3D Interpolation	B61	N439	1	—	—	○	○	—
Cylindrical milling	B73	N438	5	—	—	—	○	—
Bubble memory	C42...45	—	—	○	○	○	○	○
C-MOS memory	C48, C49	N439	3	○	○	○	○	○
Tool radius comp. (turning)	H17	N438	7	○	○	—	—	—
Cutter radius comp. (milling)	H11	N438	7	—	—	×	○	○
Fixed cycles (turning)	B72	N438	6	○	○	—	—	—
Milling fixed cycles	B72	N438	6	—	—	○	○	—
Brief description of path	B75	N439	Ø	—	○	○	—	○
Extension pack 1 Analogue spindle speed outp.	E41	N439	5	○	○	○	○	—
Pitch error comp.	H56	N439	6	○	○	○	—	○
Pich error comp., sag.comp.	H57	N439	6	—	—	—	○	—
Digital measuring system	K42 K44...50	N439	7	○	○	○	○	○
Programme compatibility		N439	4	○	○	○	○	—
Basic set 6FC 3...	081	OEA, OFA		×				
	061	OEA, OFA			×			
	341	OEA, OFA				×		
	351	OAE, OFA					×	
	621	OEA, OFA						×

Explanation: X Fitted as standard  
 O option  
 - not available

Cross reference table for new PROM socket number and old screen printed number

start address 'H'	New PROM socket High Low	P.c.b.	P.c.b. comp.		Screen printed position		P.c.b. comp.	Screen printed position		REPROM PROM Typ	system func.
			High	Low	High	Low		High	Low		
Type 1											
20000	02	MS 100	MS 800	X105-D1	X105-D3	X105-D1	MS810	D1	D4	2532	Master
22000	04			D4	D4	D2		D2	D3		
24000	06		MS 800	X106-D1	X106-D3	X106-D1		D5	D6		
26000	08		MS 800	D4	D4	D2		D7	D8		
28000	10		MS 800	X107-D1	X107-D3	X107-D1		D9	D10		
2A000	12		MS 800	-D2	-D4	D2		D11	D30		
20000	14		MS 800	X108-D1	X108-D3	X108-D1		D12	D31		
2E000	16			-D2	-D4	-D2		D13	D32		
30000	18							D14	D22		
32000	20							D15	D23		
34000	22							D16	D24		
36000	24							D17	D25		
38000	26							D18	D26		
3A000	28							D19	D27		
3C000	30							D20	D28		
3E000	32	MS 100					MS810	D21	D29		Master
Type 2											
00000	42	MS 200	MS 800	X209-D1	X209-D3	X209-D1					C-Slave
02000	44			-D2	-D4	-D2					
0C000	46		MS 800	X210-D1	X210-D3	X210-D1					
0E000	48			-D2	-D4	-D2					
00000	52	MS 300	MS 800	X302-D1	X302-D3	X302-D1					I-Slave
02000	54			-D2	-D4	-D2					
10000	56		MS 800	X308-D1	X308-D3	X308-D1					S-Slave
12000	58			-D2	-D4	-D2				2532	
FFFF0	82	MS 100		D130	D130	D131				74S288	Re-start
FFFF0	84	MS 200		D111	D111	D112					
FFFF0	86	MS 300		D14	D14	D15					
FFFF0	88			D99	D99	D100				74S288	

MS 800

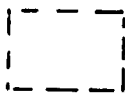


D1 ... D4      Screen printed position

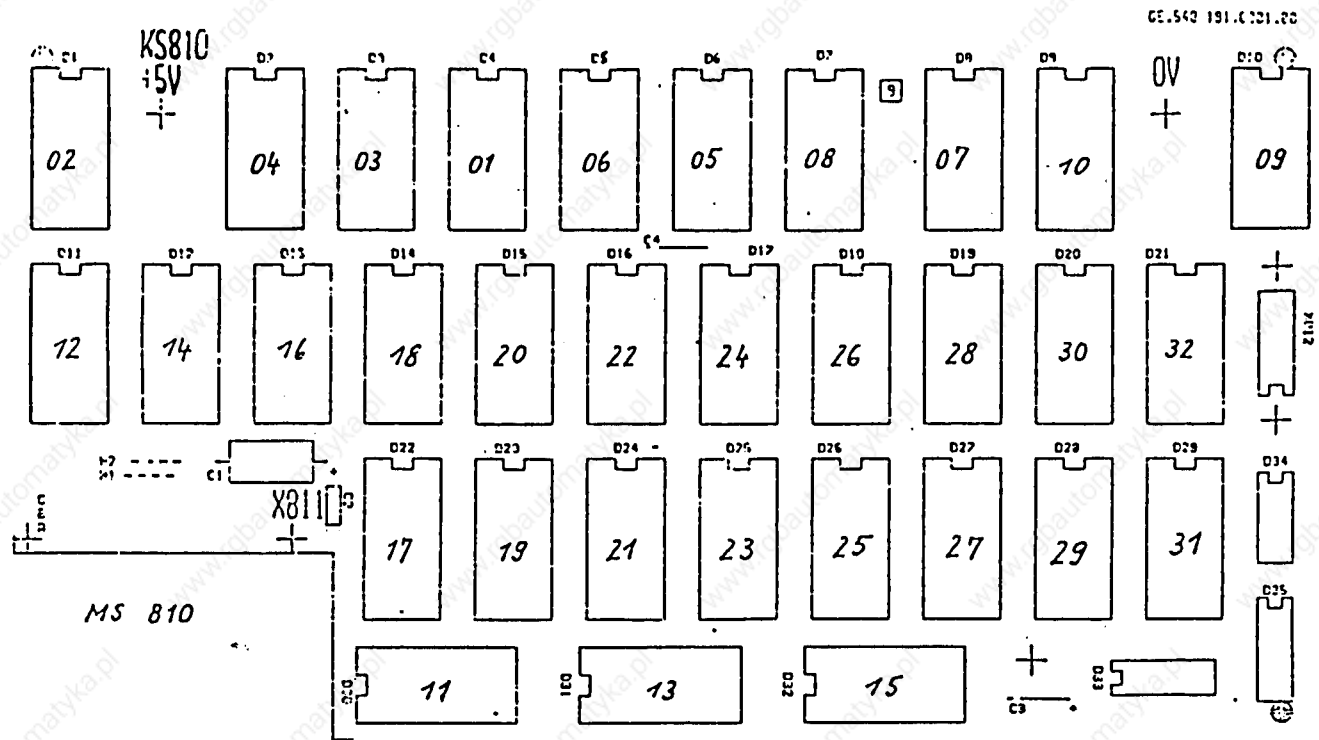
41 ... 44      PROM socket number

This is when the MS 800 is integrated  
(as C-Slave) on the MS200.

X209            Connector number of MS 200



Stick on label showing PROM socket number



D1 ... D32    Screen printed position number

01 ... 32    PROM. socket number

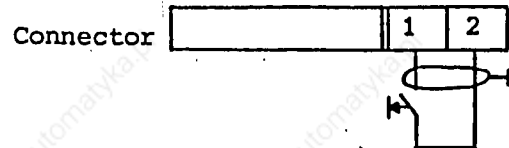
The MS 810 is only ever used as a plug in on the MS 100.

Hitherto the PROM socket number has been stamped on top of the screen printed position number. Eventually only the Prom socket number will appear on the printed circuit board.

#### 4. Input voltage and other binary checks

##### 4.1 Conditions to allow the control to be switched on

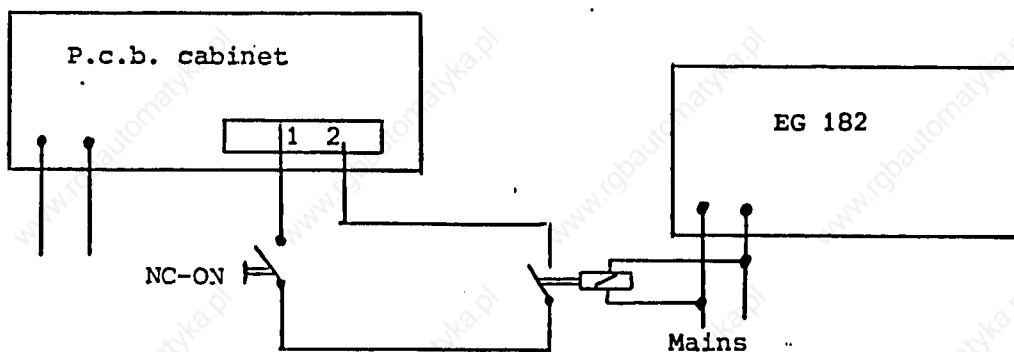
The control-ON button should be connected via a screened cable to the terminals 1 and 2 of the p.c.b. cabinet of the SINUMERIK. The time required for the control to switch on is about 500 ms. If the control refuses to switch on, the button "control-ON" should not be depressed for more than 5 secs.



4.1.1 All components of the control can be supplied with voltage before the p.c.b. cabinet but must not, however, be switched on later than the p.c.b. cabinet.

4.1.2 An external interface must be switched on before or at the latest simultaneously with the p.c.b. cabinet.

4.1.3 If an interface extension unit with its own power supply is being used (EG182) in conjunction with a SINUMERIK with internal interface, then the extension unit must be switched on first. The following diagram is a suggestion for the switch on circuit.



4.1.4 If the 5 V for an interface is applied at the same time as the 24 V supply, then section 4.1.2 applies. The 24 Volt load supply input/output drivers must be switched on before the interface (this applies also to the MS180).

Usually the correct operation of the fans is monitored with the temperature sensing devices throughout the control. The relevant signals are fed back to the power supply. If an EG182K is being used (that is an interface extension unit without its own power supply) the signal from the temperature sensing device should be fed into the interface just as an ordinary input signal.

#### 4.2 Power supply

Connector X144 should be pulled free and mains voltage applied to the p.c.b. cabinet. The voltage should be checked at the connector strip in the bottom left hand corner of the cabinet.

Mains voltage	220 V	-15 %
	230 V	+10 %
Frequency	50-60 Hz	
Current drain	3 A <sub>rms</sub> at 220 V	
Permissible mains interruption	10 ms at 220 V	
Operation temperature band	0 - 60°C	
Level of temperature monitoring	63°C ± 2.8°C	
switch-on time	< 500 ms	
mains voltage protection	Fuses blow at. >280 V input	

#### 4.3 Switch-on phase

The interface cables and "command speed to drives" cable should be removed so that the axes cannot move.

##### Integrated interface

To get an internal interface running with a minimum of trouble, assuming that the interface is in working order in the first place, the following procedure should be adopted:

- switch on system with cancel 0 (see section 4.4) or carry out overall cancel with PG 670.
- switch interface from "BETRIEB" to STOP.

- Switch on the N.C. and when the only LED on the MS100 still illuminated the one indicating "MS 700 fault", move the switch from "STOP" to "BETRIEB".
- Carry out Hardware Reset (i.e. switch off and on again or press the reset button on the MS 140).

The control should now be up and running. The display should be in "AUTO" or if the service switch is in position 4 the engineering panel should be up and in the "HALT" condition. The fans motors and tape reader motors should be running. If any of these conditions are not fulfilled the relevant fuses and supply voltages should be checked.

4.3.1 Fuses

Position	Identification	Rated current	Dimensions (mm)
P.c.b. cabinet	F1	4A mtr	8 x 40
	F2	0.63A mtr	5 x 20
MS 180	F1	2.5A	5 x 20
	F2	2.5A mtr	
	F3	2.5A	
Operator's panel		2A mtr	8 x 40
	F3	0.05A mtr	5 x 20
	F4	0.1A mtr	5 x 20
MS 600	F1	4A	5 x 20
Tape Reader	F2	4A	5 x 20
	F3	2A mtr	5 x 20
	F4	0.16A	5 x 20
	F5	0.16A	5 x 20

4.3.2 D.c. voltages

The 5 V supply can be measured at the front panel of the power supply MS 140. The potentiometer "5V Reference" can be used to adjust the 5V supply which should lie between 5V and 5.25 V.

4.3.3 Storage of switch-off circumstances

The two LED's labelled "input voltage" and "output voltage" on the front of the power supply, MS 140, indicate the cause of the last switch off, a) if the input voltage LED is lit, as is the normal case, then this means the control switched off because the input voltage disappeared, b) if the output voltage LED is lit, this means that the control switched off because one of the internal voltages has gone outside of its specification. Even when the control is switched off the reason for switch off can be checked by pressing the button "Voltage monitoring".


4.4 Function Test

Roughly speaking, if all the LED's on the MS 100 are out, then the control is in working order.

If the LED "Fault" on the "flexible" operators panel is lit then the panel is no longer being serviced by the N.C. In this case it may well be that other LED's on the MS 100 are also lit. If, however, the "Fault" LED on the operator's panel is the only one to be lit and the control is switched on, the reason is probably a parity fault between the N.C. and the operators panel (faulty cable or MS 400?).

#### 4.5 Description of cancelling operations

This section deals with the resetting of selective areas of memory within the control or interface. This clearing of data may have to be implemented if the control cannot be switched on or brings garble into the display.

The cancelling operations are executed in the following manner. The cancel button  and one of the digit buttons are both pressed and Hardware Reset made (i.e. Reset button on MS 140 pressed or control off and on). The two buttons should kept depressed until the display appears.

##### Memory area reset

RAM memory on interface (only possible when M/c data N437/7 and N425/4 are 1 and interface is switched to STOP)

Bubble memory MS 120

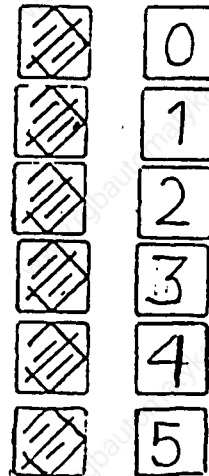
EAROM on MS 100 (machine data)

CMOS memory on MS 100

Setting data on MS 100  
(this is a part of the CMOS on MS100)

CMOS memory on MS 125 (extended programme memory)

##### Buttons to be pressed



#### 4.6 Establishing the type of control

At the first commissioning and after the cancel 2 operation, or when a new MS 100 has been installed, the control must be told what type it is.

The procedure for doing this is as follows.

1. Cancel 2 as in 4.5.
2. Switch off control.
3. Press the input button and one of the following digit buttons and at the same time switch the control on.

The buttons must be kept depressed until the display comes up.



Sprint 8T, 8T



Sprint 8M



8MC



8N

#### 4.7 Emergency stop and limit-switches

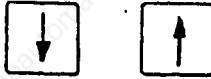
The control should be switched off and the interface cables connected. The "command to drives" plug is still disconnected. Using the interface test (chapter 10 and section 0-6) the correct operation of the emergency stop circuit and limit switches can be checked.

## 5. General information regarding input of machine and setting data

### 5.1 Display mode TEST

Using the display mode TEST the machine data can be observed.


The page buttons



and Cursor buttons



can be used to manipulate the display.

It is possible to jump straight to a machine datum by inputting the number and pressing the button marked  .

The lowest line in the display, the input line, will contain the number of the machine datum at which the cursor currently stands. This can be cleared by pressing the CLEAR button, when, for instance, a preselection of a machine datum is to be made.

The value of a machine data can only be altered in the MDI mode and with the service switch in position 2 (Exception: Drift compensation is independent of the position of service switch).

No machine data have decimal points, through some have a sign. The smallest input value is 1 and the largest is given for each datum in the lists in chapters 0 and 11.

If machine data are being given in inches the size of the unit is set by the zero offset data N25,SE1,bit 1. This bit determines whether the unit is  $10^{-4}$  inch or  $10^{-5}$  inch.

E.g.

To set machine datum N106 to 3658.


N106 is a machine datum specific to a particular axis.

Press TEST button and preselect N106 i.e. N106 and



The following display will appear:

Line	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
1	N	106																														
2																																
3																																
4																																
5																																
6																																
7																																
8	M	106																														

Press MDI button and type in S 3658. Finally press input button  and the machine datum will be taken in by the control.



Example

To set m/c datum N402 to 10010101. From N400 upwards the machine data consist of bit patterns, where each bit has a particular significance

Select TEST

and preselect N402



The following display will appear

Row	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
	M	D	I	1	2																	
	4	0	0			C	0	1		S	0	1	0	1	0	0						
	4	0	1							S	0	1	0	1	0	1	1					
	4	0	2							S	0	1	0	1	1	0	0					
	4	0	3							S	0	0	0	1	0	0	0					
	4	0	4							S	0	0	0	1	0	1	0	1				
	4	0	5							S	0	0	0	1	0	0	1	0				
	M	4	0	2																		

MDI mode select

S10010101



type in S, followed by required pattern and finally the input button.

## 5.2 Display mode ZERO OFFSET (Setting Data)

Before the machine can be moved there is some minimal information which must be entered into the zero offset registers:

### 1. Limits of the working area N15, N16.

N15 is for the negative limit and N16 is for the positive limit. Whether or not values may be entered to the right of the decimal point depends on the value of SE1 Bit 0 (N25 in Z0).

### 2. Programmed spindle speed monitoring in N19, N20.

### 3. Dry run feed rate and rapid traverse speed in N23, N24.

It is not possible to enter these data via a punched tape.

## 5.3 Entering the feedrates and increments to be used during setting up


Increment values and feedrates must be entered into the control, to be used during the "setting up" operations (JOG, INC, REF).

Input of the various parameters is as follows:

e.g. JOG feedrate must be  $1000 \text{ mm min}^{-1}$

a) Key switch must be in unlocked position.

b) Select JOG and clear the bottom line of the display with the cancel button.

c) Type in F1000 and press the input button . "1000" will then appear higher in the display by the letter F.

The following information must be entered.

JOG: Under address F the jog feedrate

Under address I the increment of the hand wheel when present (I1, I0, or I100 are possible values).

INC: Under address F the feedrate (e.g. 500 mm/min) for incremental movements.

Under address I the actual size of the increment.

REF Under address F, the speed with which the control should travel to the reference point switch.

## 5.4 Input of machine data via tape

The machine data can be entered via a punched paper tape.

The tape for machine data should have the following format.

```
% TE LF
N100 S ... LF
N101 S ... LF
.
.
.
M02 LF
```

### Sequence of operations

Cancel 2 (see 4.5)

Establish the type of control (4.6)

Set the service switch to position 2.

Reset



TEST



MDI



By hand, into address N428, the type of input unit to be used and its Baudrate should be entered.

After cancel 2 has been made the machine data tape may only be entered via input terminal marked "X103 V24-1".

Operating procedure:

Data in Out



Move the cursor to before the words "IN FROM" on the screen:  
Switch the input device (teletype, Facit etc) on.

Data Start



Whilst the data is being read in, half way down the screen the letters TE and at the bottom of the screen the words CONTROL IN ACTION are to be seen.

After the tape has been entered any editing of the machine data which may be necessary can be done by hand.

The drift compensation should be executed by selecting

MDI



TEST



Select machine datum N230  
and press the EDIT button.

The control will automatically enter a drift compensation for each axis.

At the end of this part of the commissioning the service switch should be reset to position 1.

### 5.5 "Black box" recorder of last 100 operations

With the so-called "black box" the last 100 inputs to the control will be stored. "Inputs" means in this context

1. Buttons pressed
2. Switch positions altered
3. Inputs from the VDI interface
4. Stobes from the interface.

The "black box" is activated by setting Bit 6 of SE1 and the key switch must be in the locked position.

The inputs can be seen by selecting TE61 to TE70 (that is TEST N61 to TEST N70).

On each of these 10 pages 10 input "transactions" will be displayed. Under N61 the most recent inputs will be shown, where A0 is the latest input, A1 the next latest and so on. Page N70 will show the 91<sup>st</sup> to 100<sup>th</sup> previous inputs.

#### Sources of input

1. "K" indicates an input button
2. "S" indicates a switch

The display will indicate which button has been pressed and to which new positions the switches have been moved. The information will be displayed in the same form as that in which it is presented to the N.C.

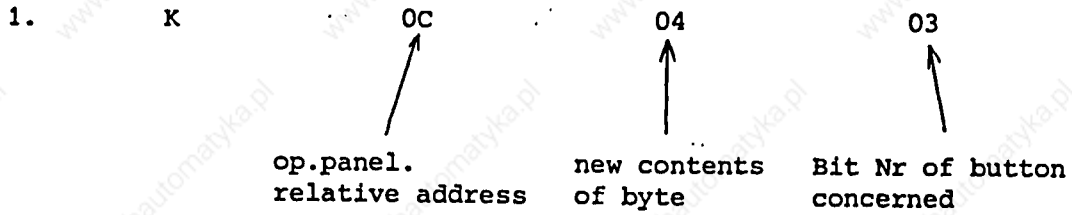
3. "I" indicates a signal from the interface

All alterations in the state of the extended VDI interface between P.C. and N.C. or external interface and N.C., including strobe signals (TE N3 to N8) will be displayed.

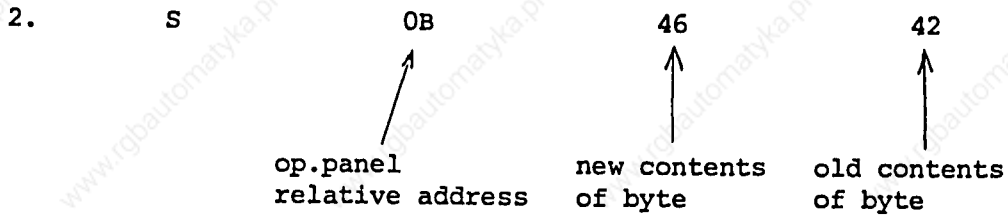
4. "T" indicates a strobe signal.

After the strobe signal the axis code and the contents of the datachannel will be displayed.

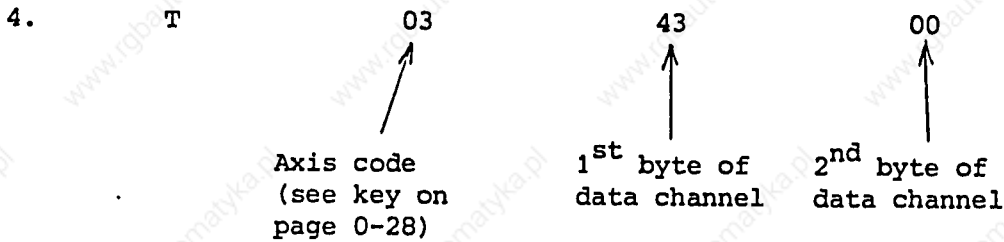
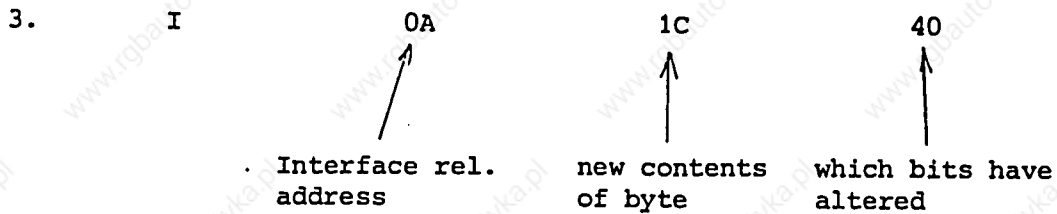
Typical format



In this case the "reset" button was pressed.



In this case the block skip button has been reset.





Example 2

This example is the same as example 1 except that all the entries have moved down 1 position to make way for the most recent input.

1st row dependent on op.mode														
													AB	222
X	6	1		OP/PC										
A		Ø	K	Ø1C	Ø4	Ø3	A	7	I	ØA	1C	4Ø		
A		2	I	Ø1	ØØ	2Ø	A	3	K	ØC	Ø4	Ø3		
A		4	K	Ø8	ØC	Ø3	A	5	K	Ø6	Ø1	Ø1		
A		6	K	Ø6	Ø1	Ø1	A	7	K	Ø5	Ø1	Ø1		
A		8	T	Ø3	43	ØØ	A	9	I	ØE	FD	Ø2		
N	6	1												

The last ten inputs in this example are:

0	Op. panel	"Reset"button pressed
1	From interface	"NC start"signal received
2	From interface	"Axis disable"for 2 <sup>nd</sup> axis removed
3	Op. panel	"Reset"button pressed
4	Op. panel	"Input" button pressed
5	Op. panel	"0" button pressed
6	Op. panel	"0" button pressed
7	Op. panel	"0" button pressed
8	Strobe	3 <sup>rd</sup> Axis value 4300 (µm)
9	Interface	Strobe external offset received

SINUMERIK 8-Interface signals listed by Programmable interface addresses

Input signals PC to NC

I-cent P.C. marker	Bit-weighting							
	80	40	20	10	8	4	2	1
I 00 P02.		①	①	①	①	①	①	①
I 01 P03.		②	②	②	②	②	②	②
I 02 P04.		③	③	③	③	③	③	③
I 03 P05.		④	④	④	④	④	④	④
I 04 P06.		⑤	⑤	⑤	⑤	⑤	⑤	⑤
I 05 P07.		⑥	⑥	⑥	⑥	⑥	⑥	⑥
I 06 P08.		⑦	⑦	⑦	⑦	⑦	⑦	⑦
I 07 P09.		⑧	⑧	⑧	⑧	⑧	⑧	⑧
I 08 P10.		⑨	⑨	⑨	⑨	⑨	⑨	⑨
I 09 P11.		⑩	⑩	⑩	⑩	⑩	⑩	⑩
		*Axis driven externally	Axis disable	creep speed	*feed enable	*servo enable	Limit switch minus	Limit switch plus

w/o N.C.

Axes: 8T/Sprint 8T    ① = x    ② = z  
 Sprint 8M/8MC    ① = x    ② = y    ③ = z

Inputs signals PC to NC

Ident no.	Ident	Bit weighting								
	P.C.Marker	80	40	20	10	8	4	2	1	
	PC-Add.									
TE	I OA M12	2 <sup>nd</sup> software x limit active (2.9.9i)	*NC start (2.7.2)	Emergency stop (5.1.2)	*Display data from interface (2.3.3)	1 <sup>st</sup> op. panel active (2.8.1)	*op. panel inactive (2.8.2)	*cancel remaining distance (2.9.4)	*4 <sup>th</sup> axis is main axis (2.9.13.1)	
	I OB M13	*Read-in enable (2.9.1)	*Axis swop. (2.9.16)	*Feedrate multiplication factor (2.9.11)				*1 % programmed feed (2.9.12)	*overall feed enable (2.9.2)	
	I OC M14	Creep speed ext. (2.9.6)	"Gear selection (2.10.5)			*Spindle 2 <sup>nd</sup> acceleration time (2.10.1)		Pendle (2.10.2)	*Spindle direction stop (2.10.3) (2.10.4)	
	I OD M15	Remaining sub.prog. runs cancel (2.9.15)	Fixed cycle inhibit (2.8.3)	*No aux. functions issued (2.12.2)	*Zero offset group (2.9.10)		*Mirror image operation (2.9.17)			
	N61-N70	I OE M16	*Type of information transfer							
			1	Spindle speed (2.10.6/2.11.3f)	Feedrate (2.11.3e)	Feedrate (2.11.3e)	Prog. No. (2.11.3d)	add.zero offset (2.11.3c)	add. correction (2.11.3b)	tool offset (2.11.3a)
		I OF M17	*Type of information transfer							
			R-Param word 3 (2.11.3g)	R-Param word 2 (2.11.3g)	R-Param word 1 (2.11.3g)	1	1	Interface alarm (2.11.3i)	Ref.pt. no. (2.11.3i)	master/slave mode (2.11.3h)
		T M18	Axis code (2.11.2)							
							D	C	B	A
	T M19	First byte for external data input (2.11.1)								
		H	G	F	E	D	C	B	A	
	T M20	Second byte for external data input (2.11.1)								
		Q	P	O	N	M	L	K	I	

The numbers in brackets e.g. (2.9.17) refer to the relevant sections of the "interface description part 2"

Operator's panel signals: PC to NC (8T)

In each box the small numbers indicate the switch or button number.

Ident P.C. Marker 0	bit - number							
	7	6	5	4	3	2	1	
K00 MS2.	0	JOG/ Handwheel	Incremental	Repos	Reference	Preset	M01 auto	
K01 MS3.	0	Auto	Data in/out	Test	Part. Prog.	Tool offset	Zero offset	
K02 MS4.	0	%	/	L	N	G	X	Z
K03 MS5.	0	vacant button	I	K	vacant button	@	R	F
N61 N70 K04 MS6.	0	S	T	H	M	A		
K05 MS7.	0							
K06 MS8.	0	6	5	4	3	2	1	0
K07 MS9.	0	-	.	LF	9	8	7	
K08 MS9.	0			Input	Edit	Cancel	Clear	
K09 MS9.	0			vacant button	vacant button	vacant button	vacant button	







Operators panel signals: PC to NC (8MC)

Ident P.C. marker E	7	6	5	4	3	2	1	
								Bit - number
K00 182.	0	Jog Handwheel	In- cremental	Repos.	Reference	Preset	MDI auto	
K01 183.	0	MDI	Auto	Data In/out	Test	Part. Prog.	Tool offset Zero offset	
K02 184.	0	%	/	:	N	G	L	D
K03 185.	0	vacant button	X	Y	Z	U	V	W
K04 186.	0	P	C	E	Q	I	J	K
K05 187.	0	@	R	F	S	T	H	M
K06 188.	0	6	5	4	3	2	1	0
K07 189.	0	-	.	LF	9	8	7	
K08 190.	0		vacant button	Input	Bit	Cancel	Clear	
K09 191.	0	O	(	)	SP	vacant button	vacant button	vacant button



## 6. Commissioning the feed drives

Section 6.1 describes how to commission the feed drives in conjunction with the SINUMERIK 8T, 8M and using the special commissioning software, whilst section 6.2 deals with the commissioning by conventional techniques for other types of SINUMERIK 8.

### 6.1 Commissioning with the special software

Before the commissioning is started the slides should be brought to approximately half way along their possible travel. In the commissioning programme the axes will be moved to and fro about this middle position. It should be ensured that all the buttons in the emergency stop circuit are in working order. Servo enable will be given out by the N.C. to allow the drives to operate.

The commissioning programme uses the following interface signals: Output signals from the N.C. "NC BBC1", "NC Ready to interface", "setting up/handwheel". Move commands will also be given out as needed.

Input signals to the N.C.-"Emergency Stop", "Servo not ready" from the measuring system, "Servo enable", "feed enable", positive and negative limit switches will be used by the commissioning software.

Servo enable contacts which come from the measuring system p.c.b's are used. If any big problems arise the signal "NC ready" will be cancelled.

Note: If the signal "servo enable" is not wired up to the drive and the tacho happens to be wired back to front, it is not possible to stop the axis running away with the commissioning programme.

The tacho adjustment for the feed drives should be such that 8 V command speed value corresponds to rapid traverse or 4 V command speed value if the rapid speed is less than 750 mm/min. This is taken care of in one of the tests.

### General instructions

The EPROM modules for the commissioning software should be plugged into the MS 100 and MS 200 (or MS 230). The plug "command to drives" should be connected. The text which appears on the screen leads the operator through the programme and the remarks in this guide should complement that text.

To operate the programme the following buttons are active



The %-button is used to move from one test to the next.

The following introductory questions are asked:

- a) What type of interface (PC-programmable, or MS 180)?
- b) What type of operator's panel (8T, 8M)?
- c) Number of axes?
- d) Which axis is now to be commissioned?
- e) What is the rapid traverse speed in mm/min.

The answers can be made with the digit buttons "0" to "9" and entered with the input button.

Finally, the choice is offered of going through the programme step by step or straight through automatically. This latter mode is very convenient if an already completed commissioning is simply to be checked.

### 6.1.2 Description of steps

#### 1<sup>st</sup> Test Tachopolarity (Start with % button)

The integrity and correct polarity of the speed loop will be checked.

#### 2<sup>nd</sup> Test Drift adjustment (Start with % button)

If the drift is outside a tolerance band the drive will be enabled so that the drift potentiometer on the drive can be adjusted. This step may be terminated with the / button.

3<sup>rd</sup> test: Movement check (start with % button)

In this test a small positive and negative command value will be issued to the drive to see that the axis does actually move in both directions.

4<sup>th</sup> test: Tacho adjustment (start with % button)

This test provides the opportunity to adjust the tacho potentiometer on the drive to ensure that command speed and actual speed are the same. The potentiometer should be adjusted so that a command voltage of 8 V gives the correct rapid traverse speed. If the rapid traverse speed is less than  $750 \text{ mm/min}^{-1}$  then the corresponding voltage is 4 V instead of 8 V.

If there is a big discrepancy between command and actual values the gear ratio should be checked, if a gearing is incorporated. The test can be terminated with the / button.

5<sup>th</sup> test: Travel direction test (start with % button)

This is an optical check to see that with positive command voltage the axis moves in the positive direction and vice versa. The test can be terminated with either % or / button.

6<sup>th</sup> test: Optimisation test (start with % button)

In this test the speed loop response will be optimised. The axis will be driven alternately in positive and negative directions for 1 sec. The display shows the step function response of the drive. In each motion sequence two acceleration and two braking responses will be displayed. Section 6.1.3 gives a description of what is to be seen on the display. The command speed can be altered with the "/" button and the following speeds should be selected to check the optimisation 1 %, 3 %, 10 %, 30 % of rapid traverse speed. Each movement sequence must be started with the % button. The test may be terminated by entering 0 %.

7<sup>th</sup> test: Position loop check

In this test the position loop will be closed and its correct polarity checked. A compensation will also be made automatically for any drift.

### 8<sup>th</sup> Test: Calculation of Multgain (Start with % button)

This test runs automatically and drives the axis four times. After each movement the multgain is calculated and displayed. After the fourth check the average value is calculated and used by the control in the next section.

Note: The significance of Multgain factor is presented in section 6.2.4.

### 9<sup>th</sup> Test: kV factor calculation

In this test the correct kV factor for the axis is ascertained. An approximate kV factor in the correct units (see page 11-7) is entered using the digit buttons and Input button. The control will now drive the axis with this kV factor and show the response on the display, after which the kV factor may be altered if necessary. The movement is started with the % button. The results consist of two acceleration and two braking sequences. The last kV factor chosen will be used in the next test.

### 10<sup>th</sup> Test: Acceleration/Deceleration factor calculation (Start with % button)

On the basis of the response obtained in the optimisation test at 30 % rapid traverse, the control will choose an approximate value for the acceleration/deceleration. This acceleration or deceleration will be used in this test to accelerate the axis to rapid traverse and subsequently to decelerate the axis to standstill. The response will be displayed on the screen. After each movement the acceleration can be reduced in stages with the "/" button.

### Display of values (Start with % button)

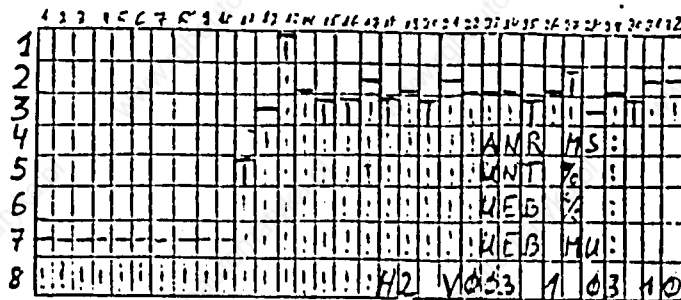
In the final display picture all the values which have been chosen during the preceding tests will be shown so that the operator can note them down. Pressing the % button once more after this final display will restart the test from the beginning, and this time another axis would be chosen. After all the axes have been commissioned the commissioning software should be replaced by the normal system software. The machine data selected during the commissioning should be entered into the control.

### 6.1.3 Description of control display during application of commissioning software

The PAGE and CURSOR buttons are the important ones with respect to the control display.

After each trial movement of the axis the response curve is brought into the display. The vertical dimensions are normalized with respect to the top edge of the screen. The control will automatically choose the best time scale in the horizontal axis, and this scale will remain constant so long as the speed used for the test remains the same.



Example of the display





#### Description of the expressions which appear on the display

Starting from the left the horizontal scale is defined:

e.g. H2 The 2 indicates 2 complete measuring cycles per column. Each cycle is 4 ms, therefore each column represents 8 ms.

The button "cursor to right", , will alter the time scale. The button "cursor to left", , will shift the picture to the left. The picture can effectively be shifted back by altering the time scale.

The scale in the vertical direction comes next e.g. V003. 003 indicates 3  $\mu\text{m}$  per line. The vertical scale can be altered with the Page buttons  and .

The next digit is either 1 or 0. 1 indicates acceleration and 0 deceleration.

The next information along the bottom line indicates the speed. For the speed loop two numbers, each of two digits, will be given whilst for the position loop only one number will be given.



The engineering panel can be operated as follows to set M12.4 to 1.

- With the commissioning software plugged in, switch on the N.C. and FC.
  - Press NMI button on MS100.
  - Enter the breakpoint F5DC0-18I LF
  - Enter G LF
  - Enter M LF
  - Enter offset address L18 LF
  - Enter segment address S5DC0 LF
- } See commissioning manual, part 2, page 16-3. These two commands enter the address of M12.

Enter X10 LF (this sets M12.4 to 1)

Enter G LF.

Commissioning software level 01

With software level 01 it is possible that, after the N.C. has been switch on, instead of the text "MS180-PC vorhanden" garbled characters appear although at the top of the display the usual "Inbetriebnahme System 8" appears.

The reason is that Marker 12.4 is 0 when it should be 1. This signal is called "\*P.C. Information from interface" (see Interface description, part 2: Input signals PC NC).

The following circumstances can lead to M12.4 being 0.

a) PC is in STOP so that the interface is not being scanned.

Action: Reset the PC so that the green LED lights up.

b) A fault in the PC programme has set M12.4 to 0.

Action: I) Switch PC to STOP

II) Set M12.4 to 1 with the engineering panel, as described at the end of this appendix.

III) Correct the fault in the interface programme with the commissioning software or the PG 670.

IV) With the sliding switch restart the interface.

V) Switch off the NC and on again or press the reset button on the MS140.

c) If the PC cannot be restarted as suggested above and the STATUS programme is already stored in the PC memory, the RAM memory of the PC may have to be cleared. This is done as follows:

Set M12.4 to 1 with the engineering panel (this is described at the end of this appendix).

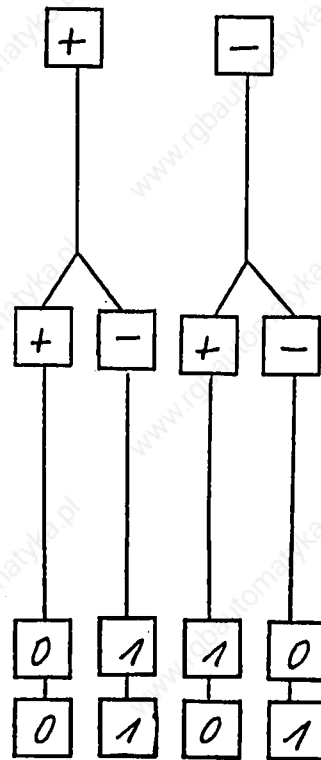
Execute Hardware Reset (Reset button on MS140 or mains off/on) clear interface memory with commissioning software (see commissioning manual. Part 2. Section 7).

6.2 Commissioning the axes by conventional techniques

6.2.1 Correct setting of the feed back polarity

It is possible for the axis to run away at maximum speed if the polarity of either speed or position loop is wrong. Therefore these polarities must be checked beforehand as follows.

- a) Establish which direction is taken as positive. This is taken from either the machine builder or ISO standard.
- b) What voltage polarity must be applied to the feed drive to move the axis in positive direction? (Ask the machine builder or check with a battery box)
- c) Check the polarity of the position loop feedback. Move the axis mechanically in positive direction and observe the direction of change of the actual position display.



Set the machine data bits as follows:

Command value sign change  
 Actual value sign change

The relevant machine data bits are N413 to N422, according to axis, bits 1, 2.

Bit 1 is sign change command value  
 Bit 2 is sign change actual value.

### 6.2.2 Closing the position loop

The axis should now be in a state where the position loop can be safely closed.

With the control switched off, the "command to drives" cable should be plugged in and any other inhibits for this particular axis removed (eg missing fuses). The other axes should be still disabled.

Switch the control on. If the axis starts to run away the "Emergency Stop" should be activated.

Possible reasons for runaway of axis:

- a) Symptom: Axis runs away with maximum speed.  
Reason: Polarity of speed or position loop wrong machine data bits wrong.
- b) Symptom: Axis moves with constant, slow speed.  
Reason: Position loop not closed.  
Cause: Coupling to resolver is loose  
Faulty resolver cable - this should cause the monitoring system to display the fault.
- c) Symptom: Axis drifts with creep speed  
Reason: Command value is not reaching the drive.
- d) Symptom: Axis oscillates  
Reason: Tacho feedback open or wrongly poled,  
optimization wrong,  
kV factor too high.

### 6.2.3 Interrelation of tacho adjustment, maximum axis speed and maximum command value

The maximum axis speed for the axes is stated in machine data Test N130 to N139.

The maximum command value which will ever be issued by the control for each axis is stated in the machine data Test N140-. N149.

#### Case A

The maximum permitted command value to the servo unit is greater than or equal to 10 V.

In this case Test N140 to N149, according to axis, will be set at 8191 (i.e. maximum command value ever issued is 10 V).

The maximum axis speed will be entered into Test N130 to N139. So that the position loop can regulate properly the tacho adjustment should be such that a command value of 8V produces the maximum axis speed. This means that the voltage between 8 V and 10 V can be used by the control to control possible overshoot.

#### Case B

The maximum permitted command value to the servo unit is less than 10 V eg. 5 V.

In Test N140 to Test N149 the value 4100 will be entered (this corresponds to 5 V maximum command value).

The maximum axis speed will be entered into Test N130 to N139. The tacho adjustment will be made so that 4 V command value from the N.C. produces the maximum axis speed. Once again the voltage between 4 V and 5 V will only be used by the control to regulate possible overshoot.

The tacho adjustment is made with the appropriate potentiometer on the drive. It would not normally be carried out at the maximum speed but at some proportion of it, say one tenth of maximum speed.

Of the two cases A and B just mentioned, case A is preferable since the control has a greater voltage range at its disposal over which it can control the speed.

#### 6.2.4 Multi-gain factor

Test N220 to N229 and N276, 277

The Multi-gain is a factor which contributes to the command value to the servo unit.

The multi-gain factor enables axes with different maximum speeds to use fully their available command value range. The kV factors of axes which work together in linear interpolation must be the same. This is the case if the multi-gain is calculated according to the following formula

$$\text{Multigain} = \frac{3 \times 10^7}{V_{\max}} \cdot \frac{U_{\max}}{10}$$

where

$V_{\max}$  is the maximum axis speed

the units of  $V_{\max}$  are as follows:

for metric system the units are mm/min,

for circular axes the units are degrees/min

for inch systems ( $5 \times 10^{-5}$  inch resolution) the units are  
inch/min

for inch systems ( $2 \times 10^{-5}$  inch resolution) the units are  
inch/min

and the formula becomes

$$\text{Multigain} = \frac{1.2 \times 10^{-7}}{V_{\max}} \cdot \frac{U_{\max}}{10}$$

In all cases  $U_{\max}$  is the command voltage from the N.C. which produces the maximum speed  $V_{\max}$ .

#### Special note for inch measuring system

With the inch measuring system, one resolver revolution corresponds to 0.1 inch. This distance must be artificially increased to 0.2 inch if the inch resolution of  $5 \times 10^{-4}$  is being used.

There are two ways of achieving this; firstly, installing appropriate gearing between the lead screw and the resolver, secondly, setting the machine data bit "Partial actual value divided by two".



### 6.2.5 Position loop gain, kV Factor

kV factor is defined by the following formula:

$$kV = \frac{\text{Speed in millimetres per minute}}{\text{Following error in mm}}$$

Ideally, to minimise contour deviations, the kV factor should be as high as possible. If it is too high, however, the axis will be unstable and the mechanics of the machine will be unnecessarily stressed. The maximum practical kV factor will be dependent upon the general response of the drives and quality of the machine.

As a rule of thumb, standard production line machines will have a kV between 1 and 1.5 m/min/mm. For such machines the kV will be set at the standard value and as a routine check the response of the measuring system observed for overshoot or instability.

An indispensable prerequisite of good position loop response is a correctly optimised speed loop.

#### Procedure to set or check the kV factor

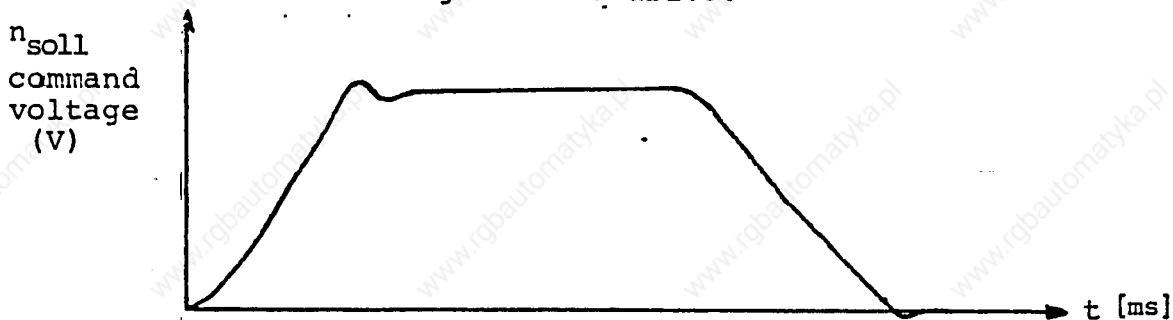
The dynamic response of the measuring system is used to arrive at the optimal kV setting. The dynamic response must never go into the nonlinear or saturation region which means, in practice, the acceleration entered into Test N120 etc. should be temporarily about half of the normal operating value so that the drive does not accelerate or decelerate at the current limit.

The kV factor should be entered according to the following formular into Test N150 to N159, according to axis.

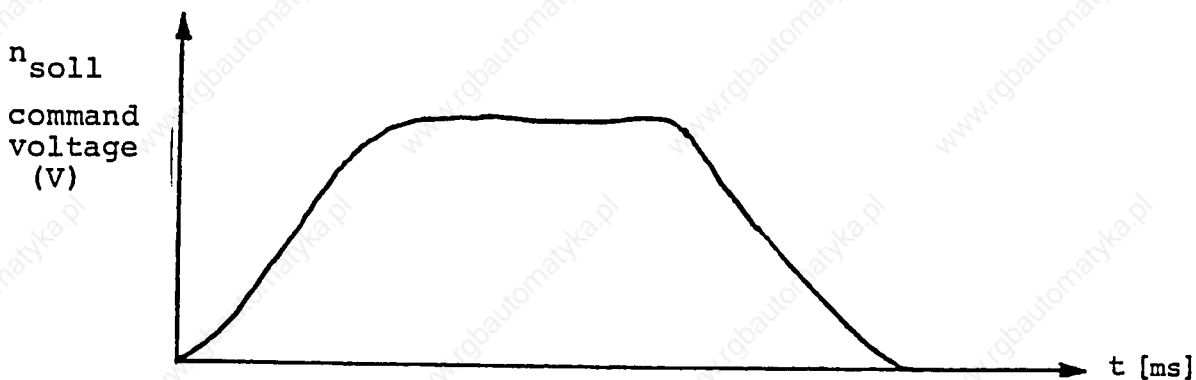
$$k_v (0.01 \text{ s}^{-1}) = 1666 \cdot k_v \frac{\text{m/min}}{\text{mm}}$$

So if, for example, the  $k_v$  should be 1.0 the actual number entered would be 1666.

The response of the position loop should be checked with either a storage oscilloscope or a chart recorder. The actual measuring point is the command voltage to the drive.



Axis overshoots on acceleration and on deceleration, i.e. travels past the stop position, therefore  $k_v$  factor is too high.



$k_v$  factor has been reduced so that no overshoot or bad positioning occurs.

By increasing the sensitivity of the measuring instrument the deceleration characteristic of the drive, as the final position is reached, should be observed. There must be no travelling past the final position.

The following factors can lead to overshoot in the response:

Acceleration is too large (axis stays too long at current limit).

Response time of the speed loop too large.

Speed loop faulty (may possibly need re-optimising).

Slackness in the mechanics

Mechanics skewing on horizontal parts .

On vertical axes, bending due to the weight.

Axes which move simultaneously in linear or circular interpolation should have the same kV factor, chosen to suit the response of the dynamically poorer axis. As a safety measure the final kV factor chosen should be about 10 % smaller than the maximum possible determined by the above procedure.

How to check the kV factor after the axes have been commissioned

First of all, the drift compensation should be done. When the axis is travelling with the same speed in positive and then in negative direction the following error should be the same in both cases. The following error can be seen in Test N800 to N809 and N900, N902, according to axis. For correct interpolation the axes concerned should have the same following error when travelling with the same speed, assuming, as advocated above, they have the same kV factor. Any deviation must be eliminated via the Mult-gain factor or via the tacho adjustment on the servo unit.

### 6.2.6 Acceleration Test N120 to N129

The axes will accelerate or decelerate with the rate of speed change given in Test N120 to N129. The aim is to accelerate and decelerate as quickly as possible, and to position as neatly as possible without being too severe on the mechanics of the machine.

The machine builder should be able to say what acceleration or deceleration the machine will be able to take, the value normally lies between  $0.3 \text{ ms}^{-2}$  and  $2 \text{ ms}^{-2}$ .

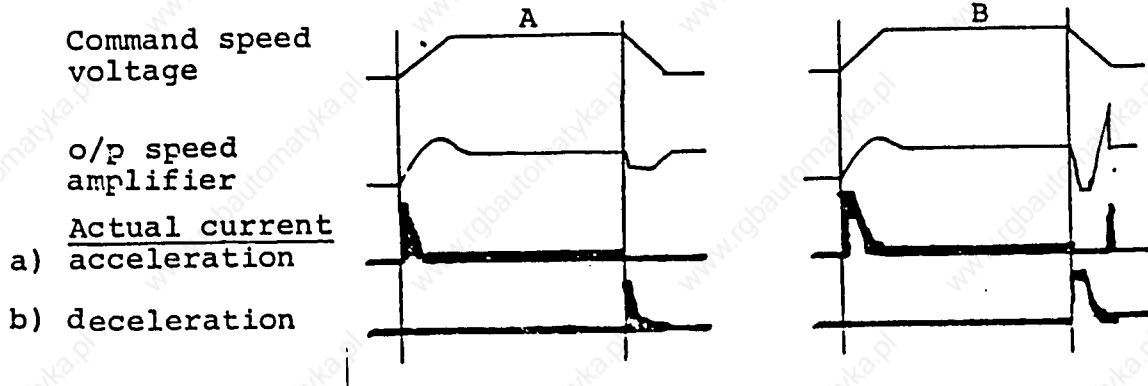
#### Determination of the acceleration

The correct acceleration will fulfill the criterion that the axis will accelerate to maximum speed and decelerate from maximum speed to zero without either over- or under-swing occurring.

The check should be carried out with the heaviest usual load on each axis.

Using either a storage scope or a chart recorder the speed command voltage to the drive, the actual current and the output of the speed amplifier should be monitored to see for how much of the movement the drive remains at the current limit.

The test value of acceleration should be entered and the axis driven at maximum speed. It is permissible for the drive to reach the current limit. However, during the braking sequence, the drive should have come down from the current limit well before the final position is reached. If it does not do this, the axis will overshoot the final position. The acceleration should be reduced therefore.

Examples of possible results

Example A shows the response with the correct-acceleration.

Example B In this example the acceleration is too high. The current wave form remains at the current limit (current limit is recognizable by the flat top of the current response) for too long.

Once again the actual acceleration eventually entered into the machine should be about 10 % smaller than that determined in the above test. This is to ensure that minor alterations in the dynamics (e.g. different viscosity of the oil, tightening of the gears) do not bring the drive once again to the current limit for too long during acceleration or braking.


Acceleration values of axes involved in interpolation need not be the same.

Test N350Final positioning speed

This speed should be chosen such that the axis comes neatly into position when approaching reference point or after decelerating from rapid traverse. As a general rule it should be less than 500 mm/min and if a programmable interface is being used it should be less than 200 mm/min.

### 6.2.7 "In-position" tolerance and monitoring

#### Test N100 to N109 "In-position tolerance"

When an axis is approaching its final position, the "NOT IN POSITION" light  will not extinguish until the following error has reduced to less than the value of the corresponding machine datum Test N100 to N109. Until this criterion is fulfilled the next programme block will not be executed. The in-position tolerance should be between 10  $\mu$  and 50  $\mu$  depending on the wishes of the machine builder, and on how well the position and speed loops are adjusted. It must, however, be at least twice as large as the following error of the axis when stationary.

#### TEST N110 to N119 Position drift limit

The alarms 101, 111, 121 etc to 211 occur when one of the axes drifts or is pushed out of its stationary position. These alarms lead to the drive enable being removed and the mechanical brakes being applied. These alarms will be issued when the standstill position deviation exceeds the relevant machine datum Test N110 to N119. Normally the value of the position drift limit should be about twice the corresponding "in-position tolerance" given under Test N100 to N109, i.e. the normal value will be between 20  $\mu$  and 100  $\mu$ .

#### Test N353. Delay time for position monitoring

This is the time between the "NOT IN POSITION" light extinguishing and the position drift monitoring becoming active. The delay allows the axis to settle into its final position. If the delay is too short the alarms 101, 111, 121 etc to 211 may occur.

The units for Test N353 are milliseconds. The values lay typically between 160 and 1600 and 400 is a standard value.

### 6.2.8 Contour monitoring

The contour monitoring works in the following manner: After as axis has completed an acceleration or deceleration the following error will settle to a steady value. Generally, load variations on the axis will be taken care of by the speed regulator and will not affect the following error. The following error will only be affected when, due to a large load variation, eg tool brake, the speed regulator saturates. This is the criterion for the contour monitoring becoming active. The contour deviation is allowed a tolerance band so that no false alarms occur due to slight deviations in the speed of the servo motor. For similar reasons the contour monitoring is not active immediately after a change of speed has finished, but a small time delay is allowed to elapse. The size of the tolerance band and the length of the time delay are dependent upon the actual kV factor of the axis.

To ensure a good finish to the job all the axes which move together in interpolation must have the same value of kV factor. The actual kV factor, as well as being influenced by the machine data Test N150 etc and Mult gain Test N220 etc, is also affected by tacho adjustment at the servo drive, actual value multiplying factors, gearing etc. Because of this, the control has the facility to measure actual kV factor of the axes. The control calculates the kV factor from the command speed and the corresponding following error. The kV factor is measured when the control has been travelling for at least three seconds at the "Jog" feedrate with the feedrate override on 100 % (+ 25 %). This value for the feedrate will remain stored when the control is switch off and when a machine datum is altered.

The kV factor will be cancelled when the drift compensation is done.

The actual kV factor is displayed in location Test N850 etc, and has dimensions of  $\frac{\text{m/min}}{\text{mm(following error)}} \times 1000$ . These

dimensions are standard in the machine tool industry, typically the value would lie between 500 and 1800. The actual kV factor will be cancelled when a machine datum is altered. When the actual kV factors of all the axes have been determined the control will check to see that they are equal to within a tolerance of 50. Alarm 527 (kV factors unequal) will be issued if the difference exceeds 50, assuming that the control has in fact calculated the kV-factors of all the axes present. The alarm will also be given out if a machine datum is altered. The old kV-factor will remain valid so long as no machine data are altered. Some machines must however be used with axes whose kV-factors are unequal, for example, circular axes. If the control has not calculated the kV factors of all the axes this will be signalled with Alarm 528 when the control is switched on or when a machine datum is altered.

The important machine data for the contour monitoring are Test N345 and N346.

The speed (in mm/min) above which contour monitoring should be active is written in Test N345. If the contents of the machine datum are zero then, at standstill, the axis will be checked for stationary in-position drift (Test N110 etc).

The width of the tolerance band for contour monitoring is calculated by the control with the following formula

$$\text{Width of tolerance band } (\mu\text{m}) = \frac{\text{Test N346} \times 163}{\underbrace{\text{kV} \times 1000}_{\text{Test N850 etc}}}$$

This demonstrates the significance of Test N346.

If nothing is written into Test N346 the control will automatically assume the value 2000. In this case, for example, with a kV factor of 1, the tolerance band would be 326  $\mu\text{m}$  and for a kV factor of 2 it would be 163.

The actual contour deviation can be seen in memory area Test N840 etc.

The contour monitoring is inactive if the command value is changing, ie acceleration/deceleration. Because of this, during circular interpolation contour monitoring would be inactive. However, to overcome this problem in circular interpolation, the signs of the following error, command value and actual value are continually compared. Any discrepancy which persists for longer than a delay time, whose duration is proportional to the kV factor, will be signalled with the contour monitoring alarm.

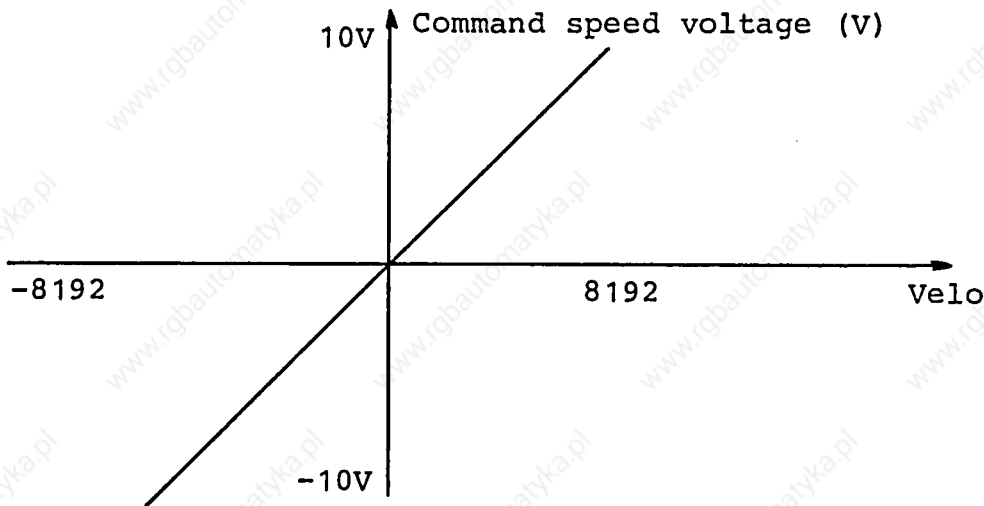
If the contour tolerance band is exceeded, the alarms 103, 113 etc., will be issued. The drive will be brought to standstill by the command value making a step function jump to zero. The servo enable signals will be taken away and the control will enter the position following mode, that is, the N.C. keeps track of any movement of the axes caused by an external driving source. The alarms can be cleared with the reset button. A possible cause of the alarm "contour monitoring" may be poor optimisation of the drives, or kV factor too large, these two possibilities are especially important if both Test N345 and N346 are set at zero.

The alarms 103, 113 etc. could also arise if, during acceleration or deceleration, the axis does not reach its final speed within the time limit set by the kV factor.

Any discrepancy which occurs after the kV factor proportional delay time has elapsed will be signalled with the contour monitoring alarm.

### 6.2.9 Analogue spindle speed

The command speed voltage will be issued to the spindle drive as a d.c. voltage via the measuring board, be it MS200, MS230 or MS300. The command speed voltage can be read in TEST N910 in Velo units when 8193 Velos represent 10 V.



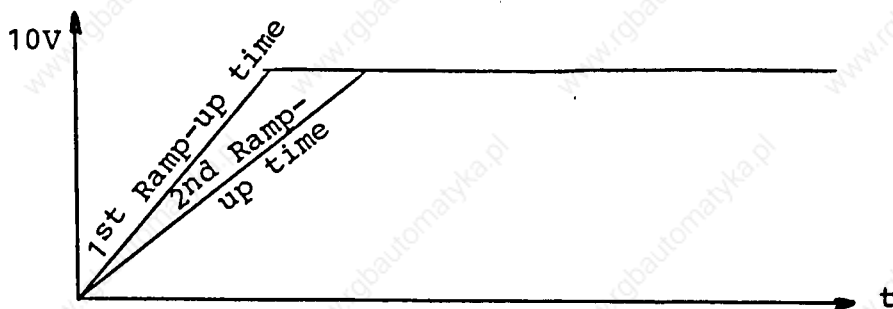
The machine can have up to six gear ranges. The spindle speeds corresponding to a command speed voltage of 10 Volts in each of these gear ranges are entered into the machine data Test N359 to Test N364.

The interface is responsible for telling the control which gear range is engaged. These signals come via the input word Test N4 A12 bits 4, 5, 6.

TEST	Speed	Gear Range	Input signal Test N4		
			A12 bits 4	5	6
N359	S1000	1	1	1	1
N360	S2000	2	1	1	0
N361	S3000	3	1	0	1
N362	S3000	4	1	0	0
N363	S3000	5	0	1	1
N364	S3000	6	0	1	0

### Spindle speed ramp-up time

Machine data are provided to allow two ramp-up times for the spindle in each of the gear ranges. The second ramp-up time becomes effective when the appropriate signal is received from the interface. These ramp up times govern the gradient of the ramp in each change of spindle speed. The ramp-up time is, by definition, the time for the command voltage to the spindle to increase from zero to the voltage corresponding to the maximum speed in that gear range (usually 10 V). The ramp-up time "0" is allowed, that is a step function change in command voltage. The machine data concerned are Test N365 to N376.



### Test N377 Minimum motor speed

As described in chapter 2 the number of Velos entered into machine datum N377 corresponds to the smallest permissible spindle motor speed.

### Test N357 Spindle drift compensation

The number of Velos entered into machine datum N357 corresponds to the drift compensation for the spindle. The criterion that the drift value is correct is that with a very small spindle speed selected, first in one direction of rotation and then in the other, the actual spindle speed in the two directions is the same.

### Test N358 Spindle speed tolerance

The permissible discrepancy between programmed spindle speed and the actual spindle speed, as it is measured with a spindle encoder, can be stipulated in the machine datum Test N358. It should be large enough so that, when all is in working order, the actual spindle speed remains within tolerance throughout the entire speed range.

### 6.3 Pitch error and sag compensation

Pitch error compensation is a standard facility for the 8T, Sprint 8T, 8M and Sprint 8M. In addition to pitch error compensation, the 8MC also has the facility for axis sag compensation. Any number of the available axes can be compensated for pitch error and, where applicable, axis sag. However, the total number of compensation points from all the compensated axes, both pitch error and axis sag, is limited to 1024.

#### 6.3.1 Pitch error compensation

The salient machine data are:

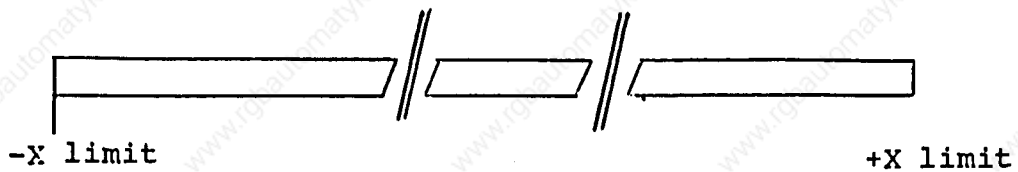
Test N200 to N209, 272, 273	The size of the compensation eg 20 $\mu\text{m}$ .
Test N250 to N259, 282, 283	The distance between compensation points eg 10 mm
Test N240 to N249, 280, 281	The compensation point number of the axis reference point eg 251.

Each compensation point has a number between 0 and 1023. For example suppose on a milling machine two of the three axes are to be compensated, the X and Y say. It is decided that for the X axis, whose length is 1 m, a compensation will be made every 20 mm. The reference point for the X axis is 260 mm from the -X limit switch.

The Y axis is 1.5 m in length and will be compensated every 10 mm. The reference point is in the middle of the axis, i.e. 750 mm from each end.

For the X axis the compensation value will be 5  $\mu$  and for the Y axis it will be 10  $\mu$ .

X axis



Distance from | | | |  
 -X limit (mm) 0 20 40 60

| | |  
 960 980 1000 mm

260

Reference point



Compensation  
 point number: 0 1 2 3

13

47 49 50

Y axis



Reference point



Distance from  
 -Y limit (mm) 0 10 20

740 750 760 1480 1490 1500

Compensation  
 point number:  
 (continues on  
 from X axis) 51 52 53

85 86 87 199 200 201

In this example the machine data would be set as follows:

Size of compensation X Y	Test N200 = 5
	Test N201 = 10
Distance between compensation points (10 µm per unit)	Test N250 = 2000
	Test N259 = 1000
Compensation point number of axis reference point	Test N240 = 13
	Test N249 = 86

In the example the compensation points 202 to 1053 are not used. The last compensation point number of one axis must "butt up" to the first of the next axis (in this example compensation points 50 and 51) there must be neither overlapping nor gaps in the compensation point numbers.

A two bit pattern is used to stipulate whether at each of the compensation points the compensation is to be added, subtracted or neither added nor subtracted (i.e. no compensation) to the axis position.

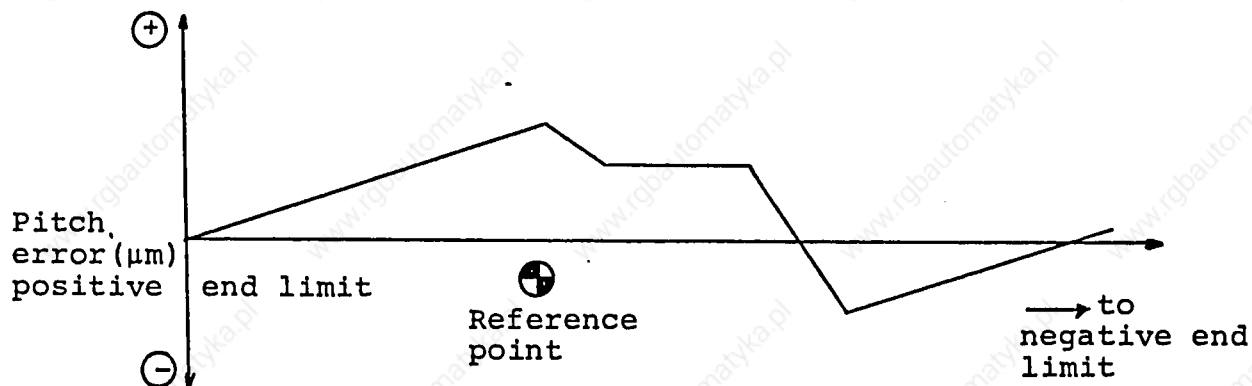
high bit	low bit	
0	0	No compensation
1	1	Compensation to be added
1	0	Compensation to be subtracted

This bit pattern can be entered into machine data Test N500 bits 1 and 0 to state the type of correction at compensation point 0, into Test N500 bit 3 and 2 for compensation point 1 and so on to Test N755 bits 7, 6 for compensation point 1023.

Bit	7	6	5	4	3	2	1	0
N500	3		3		1		0	
N501	7		6		5		4	
N502	11		10		9		8	
N512	51		50		49		48	
N513	55		54		53		52	
N550	203		202		201		200	
N754	1019		1018		1017		1016	
N755	1023		1022		1021		1020	

### Measurement of the pitch error curve

First the machine is taken to the reference points to synchronize the measuring systems. The axis is then taken to the negative limit. Beginning from here, moving in a positive direction, the pitch error curve is built up with the aid of an external measuring device (eg a Laser) and the position display of the N.C. A typical error curve is shown:



When, travelling in a positive direction, the distance shown by the external measuring device is greater than that shown by the N.C., the compensation must be added and vice versa.

This final point is very important. After the error curve has been produced, the various parameters must be "juggled" so that no compensation needs to be made at the reference point and so that the reference point actually coincides with a compensation point. These two important requirements also apply to additional reference points along the axis.

### 6.3.2 Axis sag compensation

A typical application of sag compensation would be on a milling machine where the milling head and spindle were mounted on a gantry above the table. The gantry cross member would move up and down the vertical pillars, let this be the Z axis. The milling head would move from side to side along the horizontal part of the gantry, let this be the X axis.

Clearly as the milling head moves towards the middle of its travel, depending on its weight, the cross member supporting it will tend to bend or sag. In this case, therefore, depending on the position of the X axis, or leading axis, the position of the Z axis, or compensated axis, would be corrected, in this case taken a little higher to account for the sag.

The roles played by the various parameters in sag compensation are very similar to those of their counterparts in pitch error compensation, however, an illustrative example should help to clarify the situation still further. As mentioned above, the vertical axis, that is the compensated axis, is the Z axis and the horizontal axis, or leading axis, is that across the top of the gantry, the X axis. The X axis is 5 m in length. The reference point is 200 mm from the -X limit. The compensation is to be made every 20 mm and the compensation, to be applied to the Z axis, is 10  $\mu\text{m}$ . The numbers allocated to the compensation points should carry straight on from the last compensation point number for pitch error compensation. Let the example used earlier to illustrate pitch error compensation be combined with this example to help to clarify the point. The final pitch error compensation point had the number 1500. Therefore the first sag compensation point, i.e. that nearest to the -Y limit, will have the number 202. The relevant machine data, together with their values appropriate to this example, are presented in the following table.

Name of machine datum	Number	Value
Size of compensation in $\mu\text{m}$	Test N320	10
Compensation point number of X axis reference point (see picture below)	Test N321	212
Distance between compensation points in units of $10 \mu\text{m}$	Test N329	2000

X Axis

-X limit



+X limit

Reference point



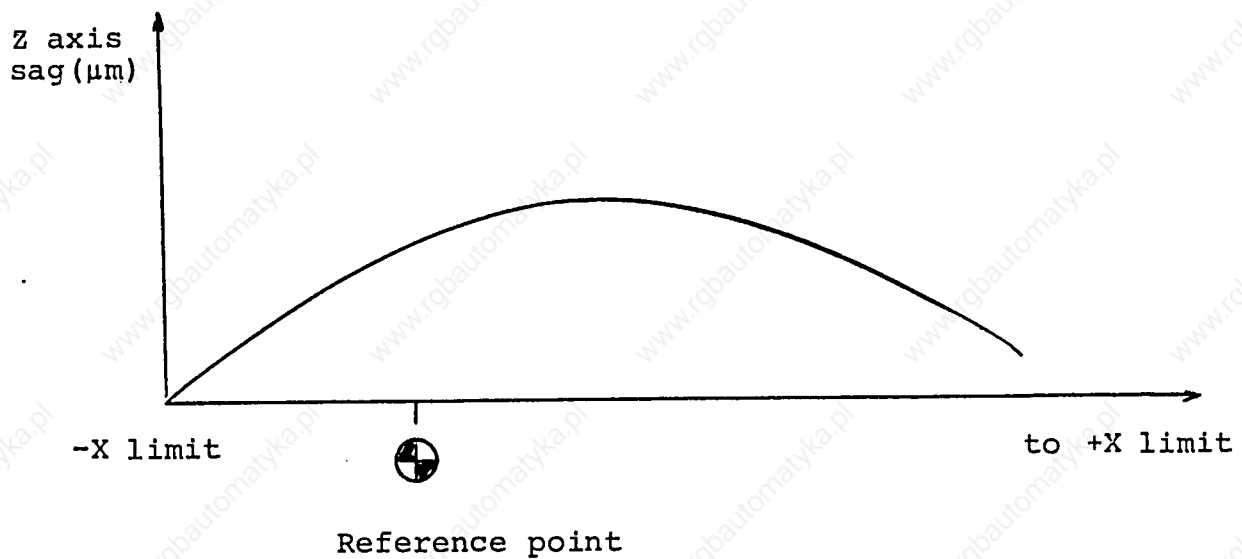
Distance from

-X limit (mm)	0	20	40	200	220	240	4960	4980	5000
Compensation point number	202	203	204	212	213	214	448	449	450

The type of compensation to be made at each of the points, that is addition, subtraction or no compensation, is specified by exactly the same bit pattern used for pitch error compensation. This bit pattern is stored in the machine data in the position appropriate to the compensation to the compensation point number. So, taking the pitch error and sag compensation example still further: The bit pattern for the last pitch error compensation point i.e. point number 201 of the Y axis is stored in Test N550 bits 3.2. Compensation point number 202 is the first sag compensation point for the X axis and the bit pattern for the type of correction is held in Test N550 bit 5,4. This can be seen from the table on page 6-18.

### Measurement of the sag curve

First the machine is taken to the reference point to synchronize the measuring systems. In this example the X axis would then be taken to the negative end limit and measurements made at points in the direction of the positive end limit. At each point the position of the Z axis would be measured with an external measuring device (eg Laser) and the result compared with that indicated by the actual position display of the N.C. By these means a sag curve would be produced, which would have a typical appearance as shown.



As with pitch error compensation, the parameters must be manipulated so that the positions of the reference point or points coincide with compensation points, and also so that at the primary reference point no compensation is made.

#### 6.4 Amplitude adjustment for analogue measuring systems

With the machine data Test N440 to N451 bits 0 to 5 it is possible to adjust the amplitude of the COS.voltage to the resolver to make it the same as that of the SIN.voltage. In practice, for resolvers, the voltages across the COS and SIN coil should be the same, whilst, for inductosyn, the currents flowing through the COS and SIN coils should be the same. The obvious advantage of this method of correction is that the adjustment no longer depends on the setting of a potentiometer.

The correction possible is divided into 64 steps, each step corresponding to 0.25  $\mu$ m.

Bit No	5	4	3	2	1	0	
TEST N440	0	0	0	0	0	0	Zero correction
to	0	0	0	0	0	1	
N451	0	1	0	0	1	0	Middle value for resolver
	1	1	1	1	1	1	Max correction

The "rule of thumb" mean value for resolvers corresponds to 010010. This can change plus or minus 3 bits due to tolerances in the integrated circuit line driver for the coils. An analogue voltage compensation can also be made.

In the case of inductosyn, the correct value for the amplitude correction must be determined empirically, "see Inductosyn commissioning" in section 6.5.

Bits 6 and 7 of the machine data N440 to N451 specify the threshold of the error signal fault detection. The value 11 is the standard value for resolvers.

Bit combination		Monitoring threshold		(peak to peak voltage measured after the input filter)
0	0	~	5.6 V <sub>pp</sub>	
0	1	~	3.4 V <sub>pp</sub>	
1	0	~	1.8 V <sub>pp</sub>	
1	1	~	1.0 V <sub>pp</sub>	

## 6.5 Commissioning an inductosyn

The 56  $\Omega$  parallel resistors for the SIN and COS voltages should be removed in the case of MS 230 or MS 310 (eg for the 1<sup>st</sup> axis on the MS 310 these resistors are R46 and R21). The pre-amp type VFK 200 should be used. The two cables, one to the measuring head and the other from the pre-amp can be connected separately using the cable connector 8WO (8WOZ in the case of the MS200).

With the MS 230 and MS 310 the current correction for the two coils is entered into machine data Test N440 to Test N451. To do the current correction the special commissioning case is required. The case contains a special adapter plug. The current should be measured with an a.c. measuring instrument. The current in the SIN coil can be measured at bridge 6 on the adapter and has a constant value whereas the current in the COS winding can be measured at bridge 9 and its size can be altered with the machine data. The machine data should be adjusted till the magnitude of the two currents is the same. If the MS 200 and cable connector 8WOZ is being used the correction is made with the potentiometer on the MS 205. The MS 205 is an integral part of the assembly 8WOZ.

The error signal should have a sinusoidal form without any saturation at the peaks. The amplitude should be about 2 Volts peak to peak and can be measured using the adapter plug at pins 11 and 12. The amplitude can be altered with resistor R2 on the VFK 200, the smaller R2, the larger the voltage. It is often necessary to reduce the value of R2 maybe right down to zero. A 20 k $\Omega$  potentiometer is used instead of a resistor in the pre-amp VFK 200 A03.

The error signal monitoring, Test N440 to N451 bits 6 and 7, should be set to 11.

All the information concerning the installation of the scales and measuring head can be found in the booklet "Montage und Justieranleitung Inductosyn" order no. E 321/1044 (German edition).

## 7. Serial Data in/out interface and System 8

System 8 possesses two serial data interfaces (connectors on the MS100 are marked X103, X104). They can be used in the full-duplex V24 or 20 mA mode. X104 may also be used in the 20 mA half duplex mode.

### 7.1 A description of the control signals which are active when information is being received by the SINUMERIK

This description does not apply to the FANUC reader with MS 600.

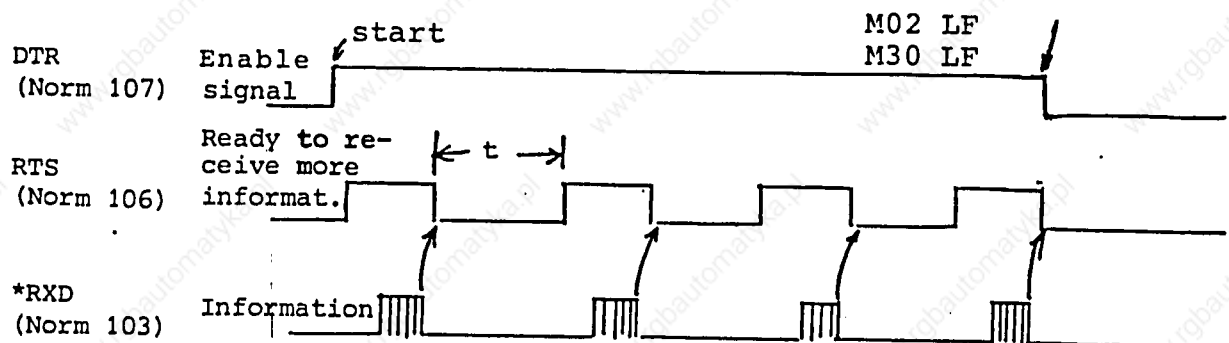
#### Control signals from the System 8 to the terminal

DTR                      Data Terminal Ready

(X103 pin 6)              For the whole of the time between the start signal and the signal for the end of the information transfer, (i.e. "M02... LF" or "M30... LF") this signal is a "1"

RTS                      Request to send

(X103 pin 5)              During the reading operation this signal will alternate between "1" and "0" respectively as the SINUMERIK is ready to receive more information or is still "digesting" the last lot.



In the diagram the time "t" is the time the control needs to process each character.

The signal form must conform to the specification DIN 66020 or RS232. All the signals are referenced to the zero volt line of the system (connector X103 pin 7 Norm 107). The maximum Baudrate is 9600 Baud, and the first part of the relevant machine data will appear so:

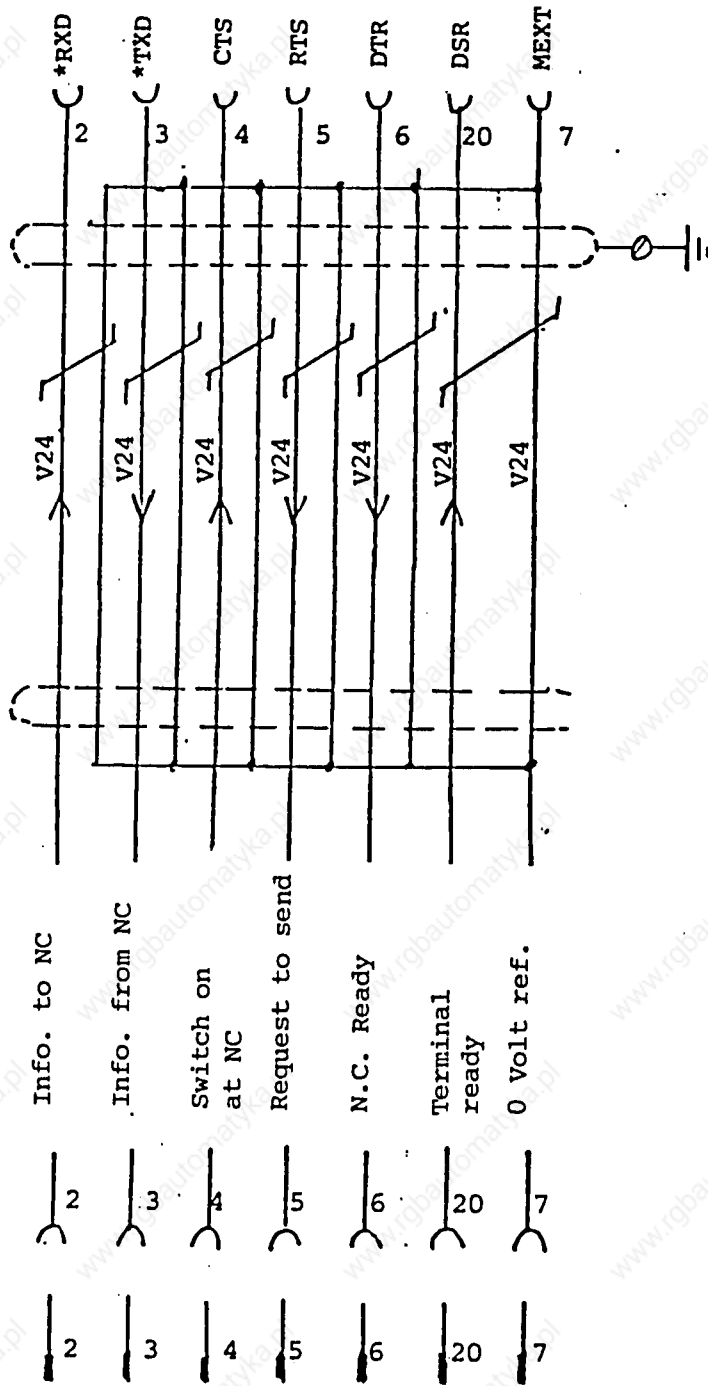
```
- N428 S 10100 ...
  N429 S 10100 ...
```

V-24 interface signal summary

DUE	Connector X103, X104 pin number	Name		DEE
	1	Screen	E1 (101)	
RXD	2	Information to N.C.	D1 (103)	TXD
TXD	3	Information from N.C.	D2 (104)	RXD
CTS	4	Data transfer start request to N.C.	S2 (105)	RTS
RTS	5	Request to send	M2 (106)	CTS
DTR	6	N.C. ready	M1 (107)	DSR
MEXT	7, 21	0 Volt reference line	E2 (102)	GND
DSR	20	Terminal is ready	S1.2 (108/2)	DRT

7.2 V-24 Interface (full duplex)

7.2.1 Pin allocation - connectors X103, X104



Connector at the SINUMERIK end

Type: 20 way subminiature socket - Cannon

Note: Pins 12, 13, 16, 21, 24, 25 are for the 20 mA interface make sure that nothing on the terminal connects with these pins.

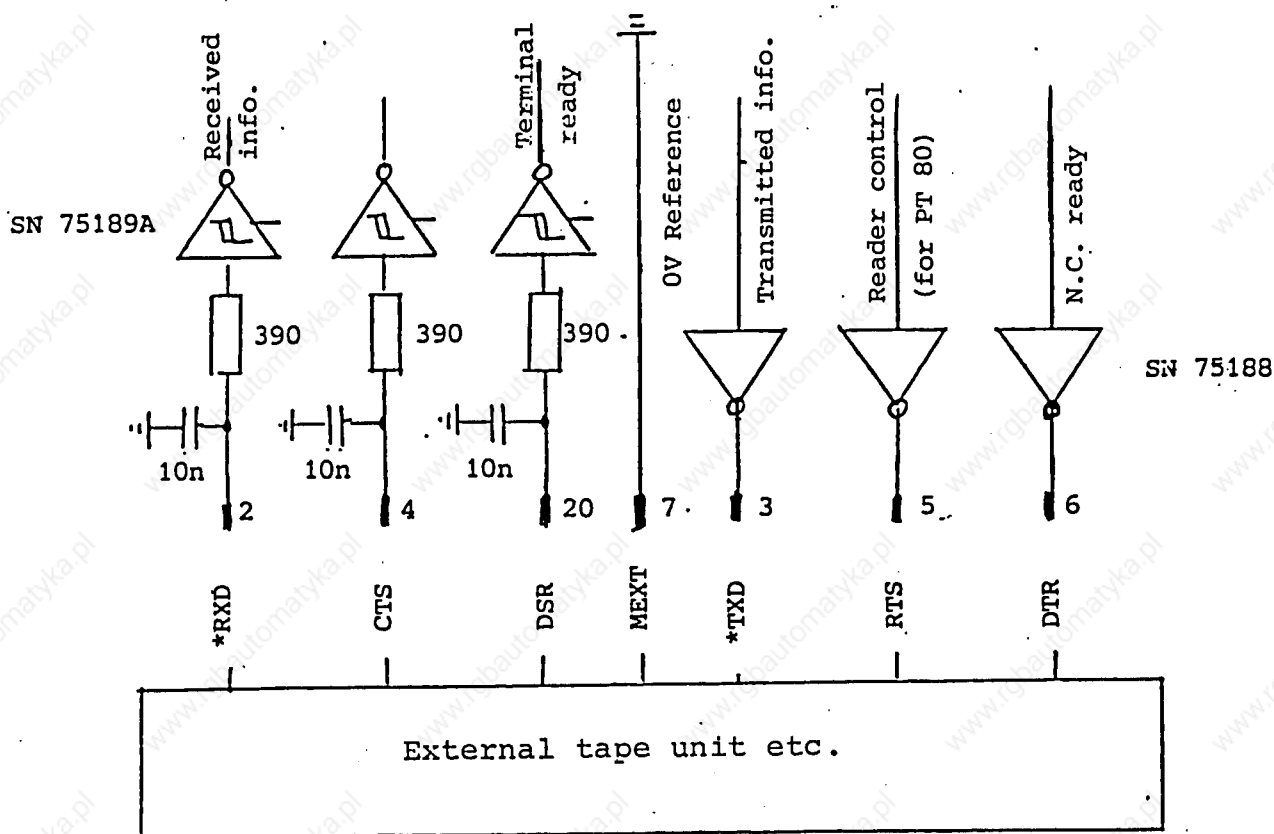
Connector at the data terminal

a) Type: 8WU  
Tinned wire ends without housing  
Order no: 6FC9 340-5R

b) Type: 8WT 25 way subminiature socket  
Order no: 6FC9 340-5R

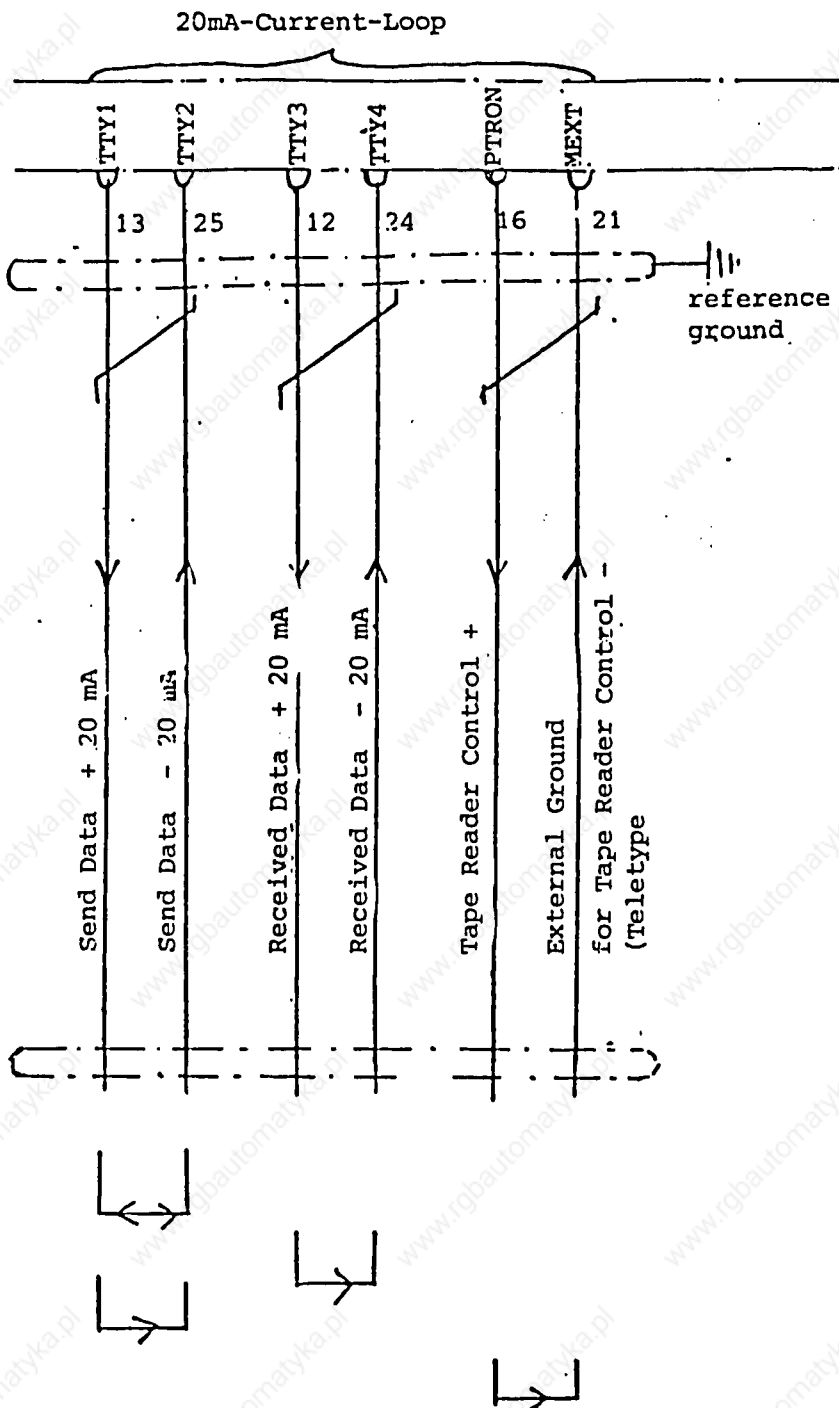
c) Type: 8WV 25 way subminiature plug  
Order no: 6FC9 340-5SB

7.2.2 V24 Interface circuit diagram of the MS100  
in the area of connectors X103/104



7.3 20 mA Interface

7.3.1 Pin allocation on connectors X103, X104



Connector at the SINUMERIK end

25 way subminiature Cannon socket

Note: Pins 2, 3, 4, 5, 6, 7, 20 are reserved for the V24 interface. Ensure that nothing else is connected to these pins.

Cable 8WU

The customer should provide a convenient connector at the data terminal end of the cable.

This loop is data in/out half duplex 20 mA.

These loops are for data in/out, full duplex 20 mA.

This loop is for TELETYPE ASR 33-3WA/SI

7.3.2 Circuit diagram for 20 mA interface (full duplex)

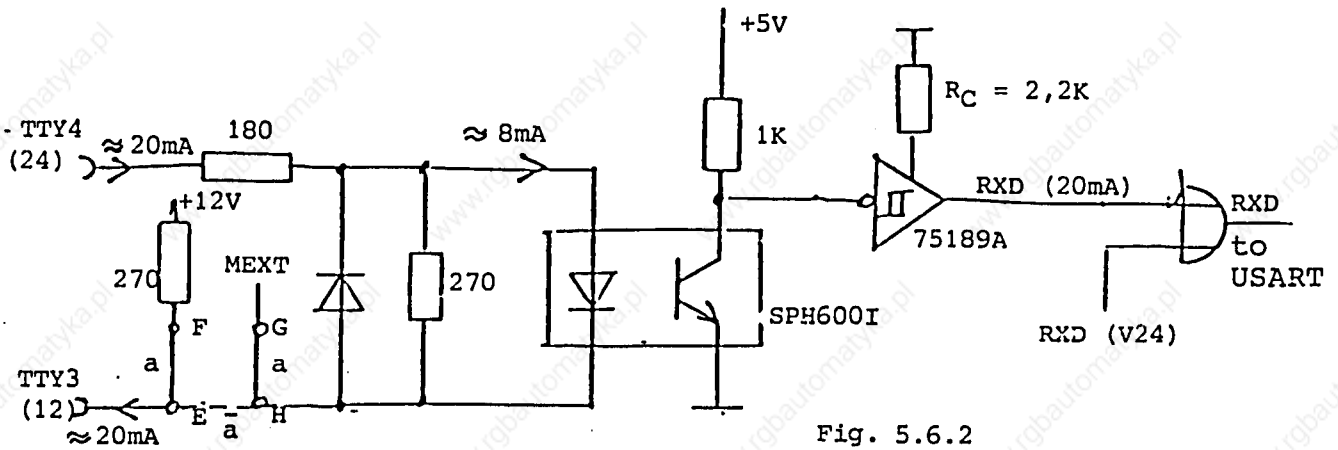
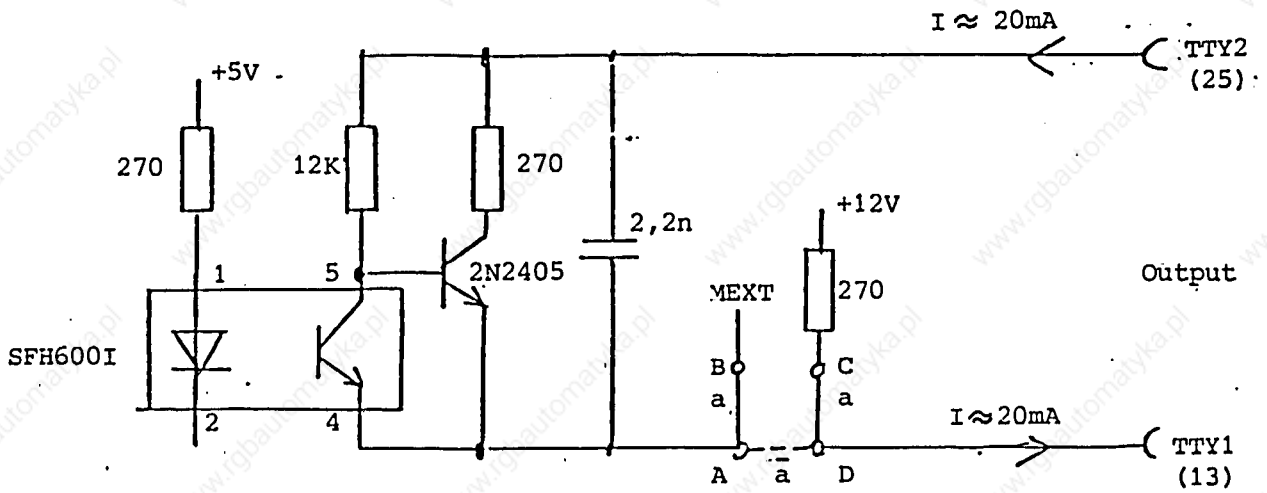


Fig. 5.6.2

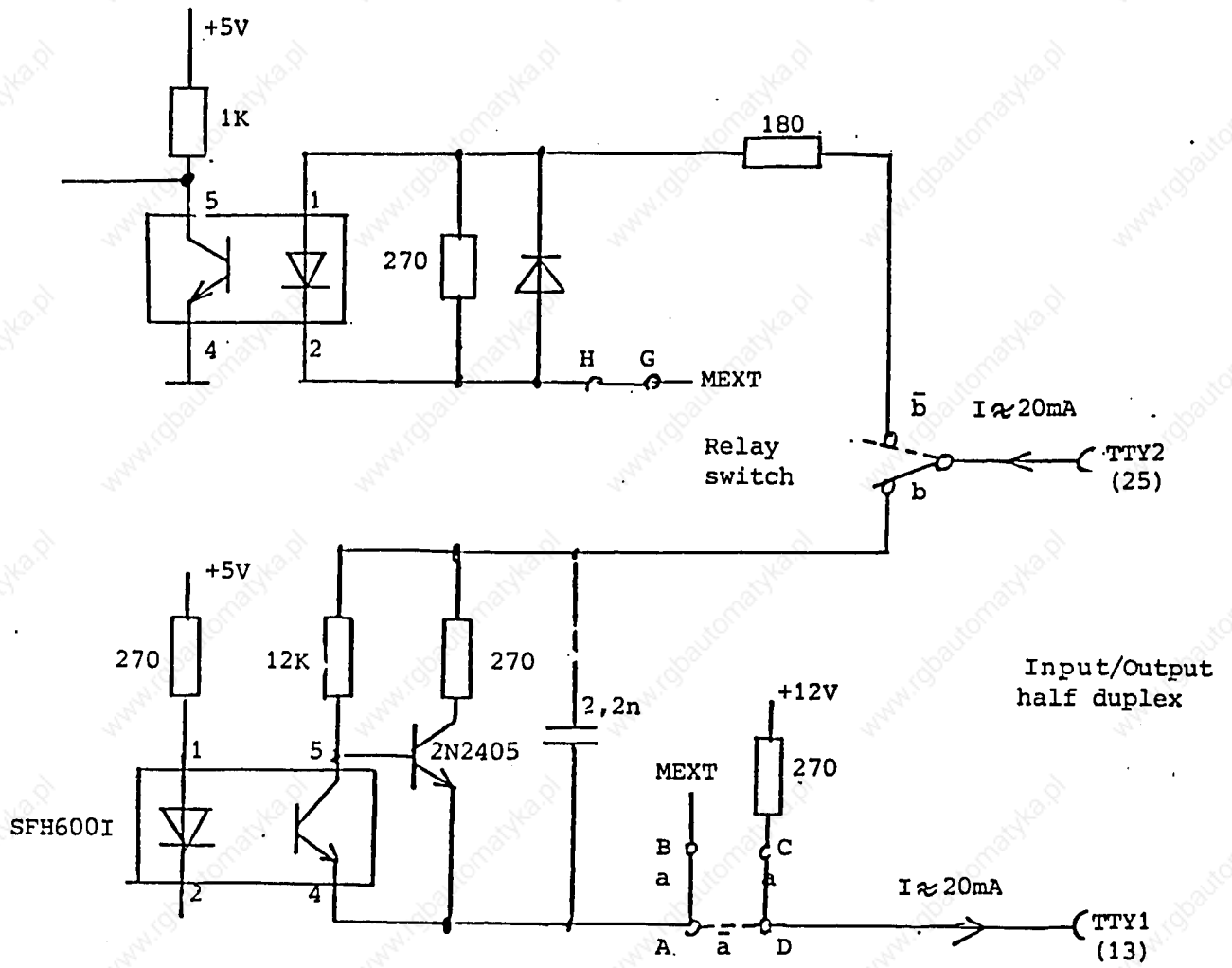
a) 20 mA Receiver stage



b) 20 mA Transmitter stage

Links a: active 20 mA interface  
ā: passive 20 mA interface

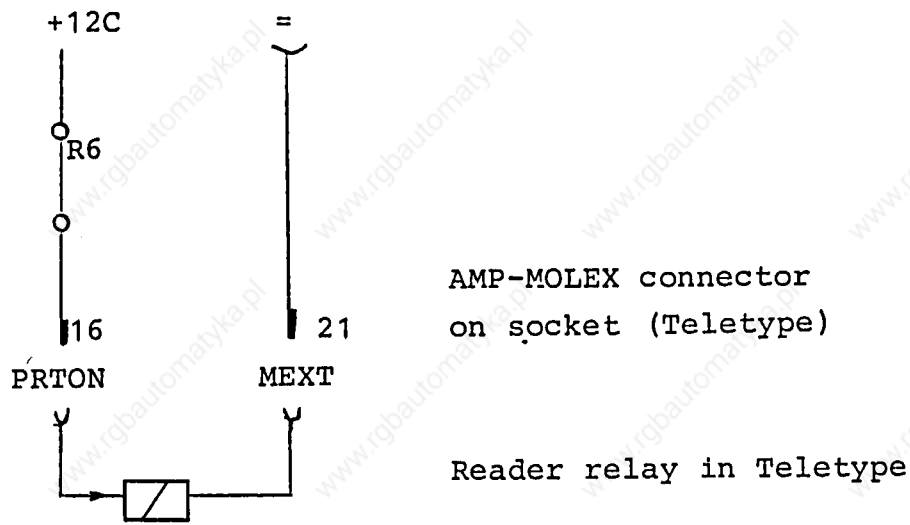
7.3.3 Circuit diagram for 20 mA Interface (half duplex)



Links a: active 20 mA interface  
 $\bar{a}$ : passive 20 mA interface

Relay contacts b: transmitt  
 $\bar{b}$ : receive

### 7.3.4 Schematic for control of Teletype ASR33-3WA/SI



### 7.4 Types of cable for serial interfaces

8WT: For V24 interface (reader, PT80). Sockets at each end.

8WV: For V24 interface (FACIT 4030)  
Socket-plug (FACIT 4040)

8WU: For V24 or 24 mA Interface  
Socket at one end and at the other free wire ends  
to enable customer to deploy a suitable connector.

## 7.5 Connection requirements for Read/Punch devices

With the exception of the 20 mA passive interface the need to solder bridges on p.c.b's or set switches has been abolished on the System 8. The wiring of the cable stipulates whether a 20 mA or V24 unit is being used. The Baudrate is set in the machine data. Which of the two interfaces the data transfer uses and the direction of the transfer is selected by the operator.

Note: The machine data N428/9 specify what type of device may be connected to each interface connector. When the user programme is coming from tape rather than from the memory the tape reader must always be connected to Interface 1 (X103).

### 7.5.1 Fanuc reader with V24 Interface

#### 7.5.1.1 Reader with reels and rewind

Interface	:	V24 full duplex
Baudrate	:	9600 Baud
Character format	:	1 Start bit
		8 data bits
		1 parity bit (even)
		2 stop bits
Max. Reading speed:	Forward	: 250 Char/s
	Rewind	: 500 char/s

Machine datum is 17 Hex

#### 7.5.1.2 Reader without reels or rewind

All details are the same as section 7.5.1.1 except the machine data is 27 Hex.

### 7.5.2 Special comments for the Siemens data terminal PT80

Note: The PT80 must be equipped with the STT104 interface

Type of interface: V24 full duplex

Baudrate : 300 Baud

Character format : 1 Start bit

7 Data bits

1 Parity bit

2 Stop bits

#### Necessary bridges on the p.c.b. STT104

Plug X5 bridge 4 Half duplex mode (for protocol print on input)

Plug X6 bridge 3 Ready for call-up

bridge 4 Call-up channel always ON

Plug X7 bridge 1 ) for service purposes only, should  
4 ) not be altered  
5 )

Solder link X8 W4.1 } non-stabilized power supply for LAT.  
W4.2 }

#### Necessary bridges of the p.c.b. main electronics GE

Plug X13 free

Plug X14 bridge 7 even parity

Plug X15 bridge 3 At switch-on automatic rewind

bridge 4 } Print-out feed with automatic

bridge 5 } carriage return

bridge 6 Switch for normal/sloping text during transmitting/receiving

Plug X16 free

The machine datum is 82 Hex.

### 7.5.3 Special comments for the FACIT 4030

Type of interface : V24 full duplex (or 20 mA current loop)  
Baudrate : 1200 Baud  
Character format : 1 Start bit  
                  8 Data bits  
                  2 Stop bits  
Reading speed : 100 Characters/second

Bridges on the interface p.c.b.

Bridge	Function	Bridge identification
A	V24 or 20 mA	W1
E	Chassis earth	W2
G	V24	W3
O	1200 Baud	W4
U	All Baudrates except 110	W6

The machine datum is 34 Hex.

#### 7.5.4 Special comments for the tape reader FACIT 4070 with MI77

Note: Interface board Facit MI 77 must be connected.

Type of interface : V24 full duplex or 20 mA  
Baudrate : 600 Baud  
Character format : 1 Start bit  
                  8 Data bits  
                  2 Stop bits

Max. punching speed 54 characters/second.

#### Switch positions on MI 77

S1 All switches "OFF"

S2 S2-1 OFF  
      2 OFF  
      3 ON Bit 8 or parity track  
      4 OFF 2 Stop bits  
      5 OFF No parity  
      6 OFF 8 bit  
      7 OFF 8 bit  
      8 OFF even check

S3: Switch position  $\overline{V24/TTY}$

Operating mode switch: Serial (Right hand position)

With 20 mA mode S3:  $\overline{V24/TTY}$

The machine datum is 43 Hex.

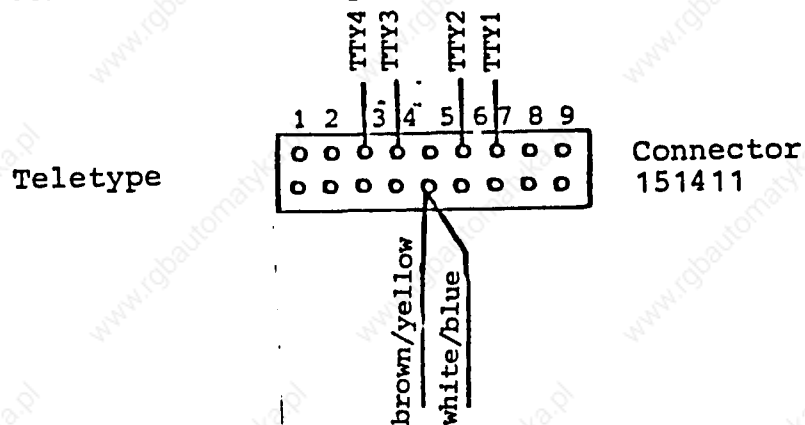
### 7.5.5 Special comments for Teletype: full duplex type ASR33-3WE

Sections 7.5.6 and 7.5.7. should also be consulted.

Type of interface : 20 mA half/full duplex  
 Baudrate : 110 Baud  
 Character format : 1 Start bit  
                   8 Data bits  
                   2 Stop bits

Reading/Punching speed 10 Characters/second.

Teletype connections for duplex mode



The machine datum is 80 Hex.

### 7.5.6 Special comments for Teletype-half duplex type ASR33-3WE

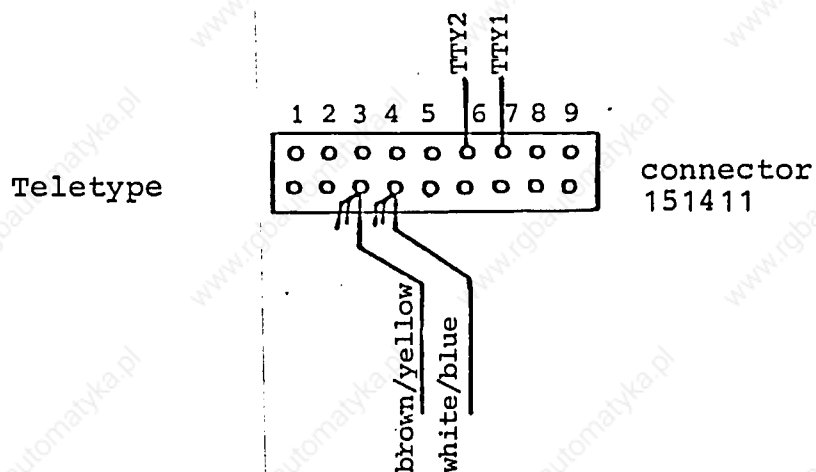
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Note: Half duplex should only be selected if it is required by other controls which use the same Teletype.

The connections should be according to the notes in section 7.4. For this type of unit it is only possible to use connector X104.

Data: see 7.5.5

Teletype connections for half duplex mode



The machine datum is 90 Hex.

7.5.7 Special comments for reader-puncher unit full duplex  
Teletype Type ASR33-3WA/SI (with reader control)

The general data are the same as in section 7.5.5. It is only possible to read from the Teletype when the Read-relay in the teletype has been energized with the signal PRTON.

Note: The SINUMERIK is set up to communicate with Teletypes possessing 12V Read relays. For 6 V relays an appropriate resistor must be soldered into R6 on the MS100 in place of the usual wire link.

The machine datum as 80 Hex.

7.5.8 Special comments for the reader/puncher unit  
FACIT 404 with adapter board 5148

Type of interface : V24 full duplex  
Baudrate : 600 Baud  
Characterformat : 1 Start bit  
                  8 Data bits  
                  2 Stop bits

Max. reading/punch speed: 54 characters/sec.

Necessary links on the adapter board 5148

PS3-3	600 Baud read
PS4-1	600 Baud punch
PS5-3	Clear to send ON
PS5-4	RTS ON

Any other links should be taken out.

The machine datum is 83 Hex.



The test points are as follows:

CH1	Information	channel	1
CH2	"	"	2
CH3	"	"	3
CH4	"	"	4
CH5	"	"	5
CH6	"	"	6
CH7	"	"	7
CH8	"	"	8
CHPS	Transport channel		
OHG	Zero Volt reference		

Note: It is highly probable that reading fault will occur if a different type of tape is used from that for which the reader has been set-up.

8.1 Moving the axes in the "setting up" modes

The equipment has now, by this stage of the commissioning reached the following level: The command value cables are plugged-in. The position loop is closed and its feedback factor is correct, all the polarities around the loops are correct.

If the axis still cannot be driven, it could be because of the following fault indications.

Alarm	Fault
223	Emergency Stop
222	General axis inhibit, servos not ready
00 * : 09 *=1,2	Limit switch (either mechanical or software) has tripped. The mechanical limit switch may be checked with the interface test (see section 10). The software limits are only active after the machine has been referenced. The limits may be checked in machine data N160-N169, N170-N179 and N385.
0* : 3* *=5	Servo enable of one axis which was in motion has been removed by the interface.
206 216	8MC only. Tolerance deviation by master and slave axes (11, 12) exceeded). Machine data N286, 287 may need adjusting
10* : 21* *=2	The command speed voltage is higher than the limit set by machine datum N354.
10* : 21* *=1	Standstill position tolerance has been exceeded. One of the machine data N110-N119 may need increasing.
10* : 21*	Contour monitoring
10* : 22* *=4	Measuring circuit monitoring for an axis or for the spindle has tripped. This can only be cleared with Hardware-reset.

The following signals are also necessary to enable the axes to be driven in the "setting up" mode (note no alarm indication is issued if the signals are not present).

Feed enable X, Y, Z, 4 to 10	Test N3 A0-A9 bit 3
Overall feed enable	Test N4 A11 bit 0
No axis inhibit X,Y,Z,4 to 10	Test N3 A0-A9 bit 5
Servo enable X,Y,Z,4 to 10	Test N3 A0-A9 bit 2
No "axis movement without N.C."	Test N3 A0-A9 bit 6

If any of the feed enable or servo enable signals is missing the "feed hold" LED will illuminate as soon as the direction button for any axis is pressed. The speed at which the axes move in either feed or rapid traverse will depend upon the speed that has been entered into the control. It is also dependent upon the setting of the feedrate or rapid traverse override switch. If the speed is different from the expected speed, particularly if it is much lower, it may be that one of the following signals is present.

I) External creep speed	Test N4 A12 bit 7
II) Feedrate multiplication factor	Test N4 A11 bit 2-5
III) 1 % programmed feedrate	Test N4 A11 bit 1

Also during this part of the commissioning the following functions should be tested:

Limit switches

External creep speed

1 % programmed feedrate and feedrate multiplication factor

Incremental movements

Travelling to reference point

## 8.2 Operating from a programme

The ability to operate the machine from a programme is a useful tool for setting up the remaining parts of the machine.

The signal "Read-in enable" Test N4 A11 bit 7 must be present. The signal "NC start" and the various interlocks that inhibit this signal should also be in working order.

It should also be borne in mind that the enabling of the axes via "feed enable" may be interlocked with the selection of a spindle speed, the issue of a tool number, auxiliary function or such like. The signal Test N4 A13 bit 5 "\* Auxilliary function inhibit" should be absent.

Having checked all the above points, the movement of the axes should be checked using a programme either on tape or in the programme memory.

### 8.3 Function check with a test tape

The machine manufacturer should write a programme to test all the following functions of the contro. The programme tape would be loaded into the control memory and the test started.

The functions to test are:

- Block number display
- Zero offset
- Interpolation
- Correction of data (eg m/c data, tool offsets)
- Tool offsets
- S, T, M, H functions
- Thread cutting
- Single Block, block delete
- M01, conditional programmed stop
- End of programme M02, M30 and rewind to start
- Subprogrammes and R-parameters
- Programme editing
- Operation from programme memory
- Output of programmes to puncher

### 8.4 Servo drift compensation

When the feedback loops of the axes have been closed and the drives are finally in working order the drift compensation should be done. If the axes cannot be moved and the "Not in position" LED is illuminated, although the axes are stationary, then it is a certainty that the drift compensation must be made. The method is as follows:



TEST



MDI



Clear (to clear bottom line of display)

N230 select correct machine datum for drift N230



Edit

Note: To do the drift compensation the servo- and feed enable signals must be present.

## 9. Jobs for the final stages of the commissioning

### 9.1 Making a machine data tape

For each machine a machine data tape must be produced. The simplest way of doing this is to punch out the machine data from the Test memory area of the control, obtaining the print-out and tape simultaneously. The method of achieving this is described in the operator's manual, section 2.10. Prior to this, of course, the machine data will have been chosen and entered piecemeal into the control. It is also possible to use some data preparation equipment quite divorced from the control by typing in the machine data and obtaining the tape.

The machine data tape should be left in the control cabinet and the print out put into the logbook.

After the commissioning has been finished, the service switch should be returned to the position 1, to safeguard the machine data.

### 9.2 Machine data tape

Every time a machine datum is altered a new tape and print out should be produced to replace the old. Sections 2.10 and 5.4 of the operators manual and commissioning manual respectively give the procedure for reading in the machine data tape.

When a series of identical machines are manufactured it is convenient to produce a standard machine data tape which can be fed into each machine. Some machine data however (e.g. drift compensation, pitch error compensation, zero point shift) will be peculiar to each separate machine and will not be incorporated into the standard tape.

In the pages 0-7 to 0-16 of chapter 0 there are tables with the number of the machine datum, an empty box, and a few key words to serve as a description of the machine datum. These tables are meant to serve as a general view of the machine datum and the standard value for each datum could be entered in the empty box. A more exhaustive description of the machine data can be found in chapter 11.

### 9.3 Customer familiarisation

The customer's maintenance and operating personnel should be shown how to operate the machine and how to make use of all its facilities. The instruction of the customer should be taken to such a level that he can accomplish the following tasks in the absence of the Siemens man:

- a) Adjustment of reference point (i.e. measuring system zero point shift)
- b) Backlash compensation
- c) Pitch error compensation
- d) Sag compensation

### 9.4 Closing paperwork and formalities

When the commissioning is completed and everything is functioning correctly the log book should be filled in and, on the necessary paperwork, the customer's signature obtained.

### 9.5 Checklist for the log book

A copy of the completed commissioning checklist should be placed in the logbook.

10. Interface test10.1 How to check the signals

The interface test is used to determine if all the various signals which pass to and for between control and interface are correct and present at the expected level. This helps to pin any problem down to within or without the control.

If the digital input/output board MS180 is being used it should be made clear that in the case of output signals from the N.C., the interface test only looks at the signals prior to them reaching the output stages. If there is any doubt about an output signal, it should be checked at the pin on the connector where the signal leaves the control

Example To examine Test N3 of the interface test. N3 contains bytes A0 to A9, which are inputs to the N.C. from such things as limit switches, servo enables and feed enables.

Select test



Test

Clear bottom  
line of display

Clear

Select required page  
numberBring page number  
to display

Two examples of the display, one for an input page and one for an output page are shown on page 10-3.

An asterisk by the name of the signal eg "\*NC Start", means that the signal is active low. The display will show a "0" when the signal comes and otherwise a "1".

If a PC is used the signals are displayed in the same form as they are processed in the interface.

A special comment must be made for the MS180

### Input signals

Regardless of whether asterisks stand by the signal name and/or pin number:

24 V at the pin will give a 0 in the display

0 V at the pin will give a 1 in the display

If an asterisk stands by the pin number

	Display	
	1	0
Asterisk by the name	Signal absent	Signal present
No asterisk by the name	Signal present	Signal absent

If no asterisk stands by the pin number

	Display	
	1	0
Asterisk by the name	Does not occur	Does not occur
No asterisk by the name	Signal absent	Signal present

### Output signals

Regardless of asterisk, the general rule is that a "1" in the display means the signal is present and 24 V should be present at the output pin.

Examples of the display

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Z			N						L						N																
3			I N P U T						F R O M						P C																
A			0						A						1																
A			2						A						3																
A			4						A						5																
A			6						A						7																
A			8						A						9																
N			Ø Ø 3																												


1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Z			N						L						N																
6			O U T P U T						T O						P C																
A			Ø Ø 1 Ø 1 Ø 1 Ø Ø						A						1																
A			2						A						3																
A			4						A						5																
A			6						A						7																
A			8						A						9																
N			Ø Ø 6																												

## 11. Description of the machine data

The machine data are stored in the memory area selected with the Test button. Whilst alteration of machine data is only possible with the service switch in position 2, the display of machine data is possible whatever the setting of the service switch.

			Page No's
11.1	N100-N259	Axis related machine data	11-2 to 11-18
	N270-N287	Machine data related to slave axes	11-11 to 11-21
11.1	N300-N306 N310-N316 N320-N329	Special machine data related to 8MC	11-22 to 11-26
11.1	N340-N382	Machine data common to all axes and spindle	11-27 to 11-54
11.1	N383-N385	Machine data related to 8T, Sprint 8T	11-55 to 11-56
11.1	N386-N399	Machine data related to 8N	11-22 to 11-26
11.2	N400-N755	Individual machine data bits	11-62

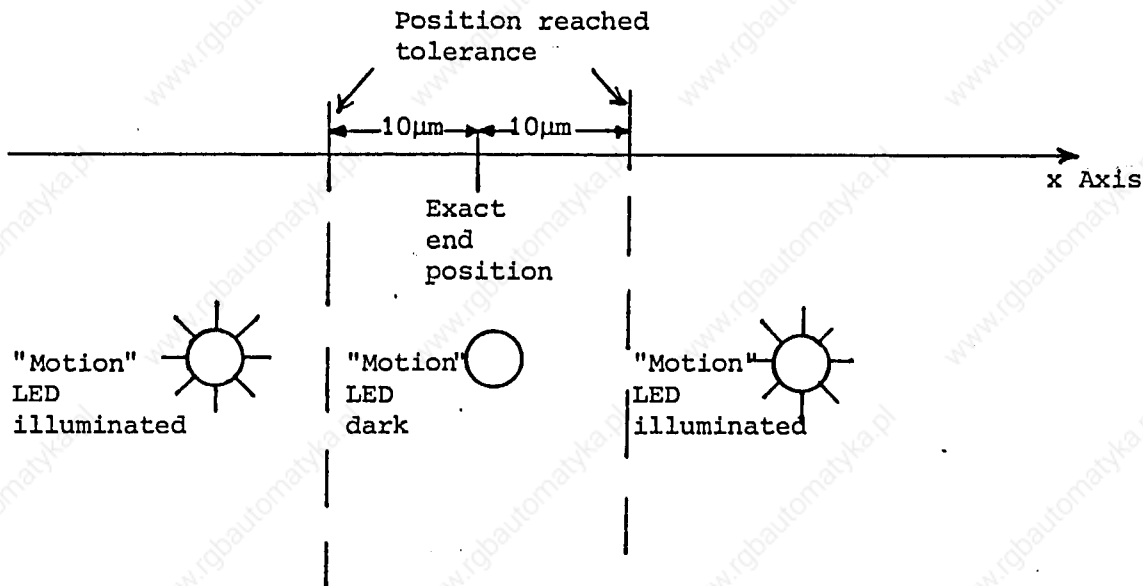
Memory area: Test

Axis no	I/P no	Adr	Sign	Description	
1	N 100	S	+	Position reached tolerance	
2	N 101				
3	N 102				
4	N 103				
5	N 104				
6	N 105				
7	N 106				
8	N 107				
9	N 108				
10	N 109				
11	N				
12	N				
		Measuring syst.units	Input limits	In-crement	Units
Metric, circular		$0.5 \times 10^{-3}$ mm	0 32000	1	1 $\mu$ m; $10^{-3}$ deg.
Metric		$0.5 \times 10^{-2}$ mm	0 32000	1	10 $\mu$ m
Inch		$0.5 \times 10^{-4}$ mm	0 32000	1	$10^{-4}$ in
Inch		$2 \times 10^{-5}$ mm	0 32000	1	$10^{-5}$ in

At the end of any movement the axis will be regarded as having come into position when the command position plus or minus the "position reached tolerance" has been reached.

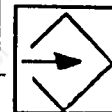
If the axis does not come within the tolerance then the "MOTION" LED will remain illuminated. If this is the case and the axis is nevertheless stationary the drift compensation may require re-peating.

Eg If N100 is S10



Memory area:Test

Axis no	I/P no	Adr	Sign	Description		
1	N 110	S	+	Stationary in-position tolerance		
2	N 111					
3	N 112					
4	N 113					
5	N 114					
6	N 115					
7	N 116					
8	N 117					
9	N 118					
10	N 119					
11	N					
12	N					
		Measuring syst.units	Input limits		In-crement	Units
Metric, circular		$0.5 \times 10^{-3}$ mm	0	32000	1	$1 \mu\text{m} 10^{-3}^\circ$
Metric		$0.5 \times 10^{-2}$ mm	0	32000	1	10 $\mu\text{m}$
Inch		$0.5 \times 10^{-4}$ mm	0	32000	1	$10^{-4}$ in
Inch		$2 \times 10^{-5}$ mm	0	32000	1	$10^{-5}$ in



When the axis is stationary the NC monitors the actual deviation of the axis from its desired position. Depending on the axis, the Alarms 101, 111, 121 etc. to 211 will come if the deviation exceeds the value stored under this machine datum. The "stationary in-position tolerance" must be larger than the corresponding "Position reached tolerance".

Two possible fault situations could be:

- The servo-enable for a feed drive defaults in the interface and that axis is subsequently held mechanically by the interface. It would not be possible for the N.C. to correct any small movement of that axis.
- Although the N.C. is still in control of the position loop, the axis shifts due to some mechanical force or due to a fault in the drive.

Memory area: Test

Axis no	I/P no	Adr	Sign	Description		
1	N 120	S	+	Acceleration factor		
2	N 121					
3	N 122					
4	N 123					
5	N 124					
6	N 125					
7	N 126					
8	N 127					
9	N 128					
10	N 129					
11	N					
12	N					
		Measuring syst.units	Input limits		In- crement	Units
Metric, circular		$0.5 \times 10^{-3}$ mm	0	1000	1	$10^{-2} \text{ms}^{-2} 10 \text{deg s}^{-2}$
Metric		$0.5 \times 10^{-2}$ mm	0	1000	1	$10^{-1} \text{ms}^{-2}$
Inch		$0.5 \times 10^{-4}$ mm	0	500	1	1 inch $\text{s}^{-2}$
Inch		$2 \times 10^{-5}$ mm	0	5000	1	0.1 inch $\text{s}^{-2}$

The acceleration factors, one for each axis, do not all need to be equal. When axes are interpolating together the control will select the lowest of the acceleration factors involved. A slave axis is automatically allocated the same acceleration factor as the respective master axis.

Memory area: Test

Axis no	I/P no	Adr	Sign	Description		
1	N 130	S	+	Maximum feedrate		
2	N 131					
3	N 132					
4	N 133					
5	N 134					
6	N 135					
7	N 136					
8	N 137					
9	N 138					
10	N 139					
11	N					
12	N					
		Measuring syst.units	Input limits		In- crement	Units
Metric, circular		$0.5 \times 10^{-3}$ mm	0	15000	1	1mm/min, deg/min
Metric		$0.5 \times 10^{-2}$ mm	0	15000	1	10mm/min
Inch		$0.5 \times 10^{-4}$ mm	0	6000	1	0.1 inch/min
Inch		$2 \times 10^{-5}$ mm	0	6000	1	0.01 inch/min

In a "G01" movement the maximum permissible feedrates are stipulated by these machine data. In a "G00" movement the speeds in these machine data will be the speeds which the NC uses. The following example, however, should be borne in mind.


Maximum feedrate X Axis 12 m/min<sup>-1</sup>  
Z Axis 10 m/min<sup>-1</sup>

Suppose a rapid traverse move at 45° is programmed. To make the actual path a straight line, rather than a "dog leg", the X axis will not exceed 10 m/min<sup>-1</sup>, this being the maximum the Z Axis will manage.

Meaning of N130, N131 for 8N

For the 8N, machine data N130 and N131 have different meanings. N130 is the safety reduced speed at the end of the Y axis (see N387, N388) and for "setting up" in X, Y, B. N131 is the maximum speed in Automatic for X, Y and B.

Memory area: Test

Axis no	I/P no	Adr	Sign	Description	
1	N 140	S	+	Max. command voltage to to feed drives	
2	N 141				
3	N 142				
4	N 143				
5	N 144				
6	N 145				
7	N 146				
8	N 147				
9	N 148				
10	N 149				
11					
12					

Input			
Limits		Increment	Units
0	8191	1	1 VELO = $\frac{10 \text{ Volt}}{8192}$

The number of Velos entered into each of these machine data stipulates the maximum command voltage that will be issued to the respective feed drive.

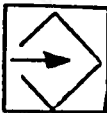
To enable the position loop to react to any overshoot that may occur when the axis accelerates to its maximum feedrate (N130, 131 etc.), the voltage represented by any of these machine data should be about 20 % higher than the respective command voltage for maximum feedrate (n130, N131 etc.).

Example:

If the maximum command voltage to the X axis were 10 V (ie N140 = 8191), the tacho adjustment at the drive would be set so that 8V command voltage produced the maximum feedrate. This would ensure the 20 % margin mentioned above.

As this 20 % margin is reduced the axis will develop the tendency to move very unevenly at rapid traverse.

Memory area:Test

Axis no	I/P no	Adr	Sign	Description	
1	N 150	S	+	Position loop gain factor (kV factor)	
2	N 151				
3	N 152				
4	N 153				
5	N 154				
6	N 155				
7	N 156				
8	N 157				
9	N 158				
10	N 159				
11					
12					

Input			
Limits		Increment	Units
0	10000	1	0.01 sec <sup>-1</sup>

Conversion

$$K_V (0.01 \text{ s}^{-1}) = 1666 \cdot k_V \left( \frac{\text{m/min}}{\text{mm}} \right) \quad \text{or}$$

$$K_V (0.01 \text{ s}^{-1}) = 1666 \cdot k_V \left( \frac{\text{mm/min}}{\mu\text{m}} \right)$$

Each axis has its own kV factor, which may differ from that of the other axes. However, axes which interpolate together must have the same kV factor. Slave axes also have the same kV factors as their respective master axes.

Memory area:Test

Axis no	I/P no	Adr	Sign	Description		
1	N 160	S	+	Positive software end-limit		
2	N 161					
3	N 162					
4	N 163					
5	N 164					
6	N 165					
7	N 166					
8	N 167					
9	N 168					
10	N 169					
11						
12						
		Measuring syst.units	Input limits		In- crement	Units
Metric, circular		$0.5 \times 10^{-3}$ mm	0	99 999999	1	$1 \mu\text{m} 10^{-3}$ deg.
Metric		$0.5 \times 10^{-2}$ mm	0	99 999999	1	10 $\mu\text{m}$
Inch		$0.5 \times 10^{-4}$ mm	0	99 999999	1	$10^{-4}$ inch
Inch		$2 \times 10^{-5}$ mm	0	99 999999	1	$10^{-5}$ inch

In addition to the mechanical limit switches, software limits can also be introduced. The software limits are only effective after the machine has been referenced. Alarms 001, 011, 021 to 091 according to axis will be issued when that axis comes up to the software endlimit.

Memory area:Test

Axis no	I/P no	Adr	Sign	Description		
1	N 170	S	+	Negative software end limit		
2	N 171					
3	N 172					
4	N 173					
5	N 174					
6	N 175					
7	N 176					
8	N 177					
9	N 178					
10	N 179					
11						
12						
		Measuring syst.units	Input limits		In-crement	Units
Metric, circular		$0.5 \times 10^{-3}$ mm	0	99 999999	1	1 $\mu$ m $10^{-3}$ deg.
Metric		$0.5 \times 10^{-2}$ mm	0	99 999999	1	10 $\mu$ m
Inch		$0.5 \times 10^{-4}$ mm	0	99 999999	1	$10^{-4}$ inch
Inch		$2 \times 10^{-5}$ mm	0	99 999999	1	$10^{-5}$ inch

These are the negative counterparts to machine data N160 to N169, and the comments made there apply here.

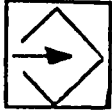
The alarms 002, 012, 022 etc. to 092 depending on axis will be issued when the axis reaches the negative end limit.

Memory area:Test

Axis no	I/P no	Adr	Sign	Description		
1	N 180	S	+	Reference point co-ordinates		
2	N 181					
3	N 182					
4	N 183					
5	N 184					
6	N 185					
7	N 186					
8	N 187					
9	N 188					
10	N 189					
11						
12						
		Measuring syst.units	Input limits		In- crement	Units
Metric, circular		$0.5 \times 10^{-3}$ mm	0	9999 9999	1	1 $\mu$ m $10^{-3}$ deg.
Metric		$0.5 \times 10^{-2}$ mm	0	9999 9999	1	10 $\mu$ m
Inch		$0.5 \times 10^{-4}$ mm	0	9999 9999	1	$10^{-4}$ inch
Inch		$2 \times 10^{-5}$ mm	0	9999 9999	1	$10^{-5}$ inch

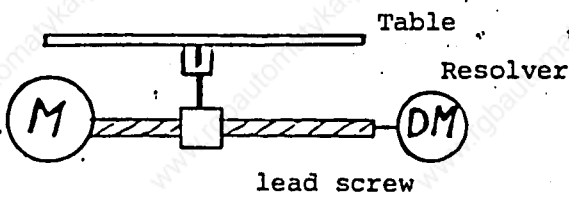
The co-ordinates of the reference point are with respect to the machine zero point. When the machine is moved to reference point it is the values written in these machine data that will be loaded into the actual position display.

Memory area : Test

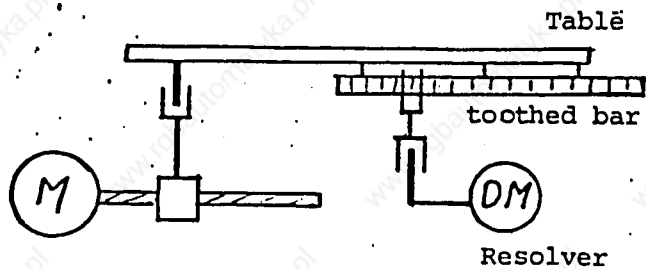
Axis no	I/P no	Adr	Sign	Description		
1	N 190	S	+	Backlash compensation		
2	N 191					
3	N 192					
4	N 193					
5	N 194					
6	N 195					
7	N 196					
8	N 197					
9	N 198					
10	N 199					
11	N 270					
12	N 271					
		Measuring syst.units	Input limits		In-crement	Units
Metric, circular		$0.5 \times 10^{-3}$ mm	0	500	1	$1 \mu\text{m} \cdot 10^{-3}$ deg
Metric		$0.5 \times 10^{-2}$ mm	0	500	1	10 $\mu\text{m}$
Inch		$0.5 \times 10^{-4}$ mm	0	500	1	$10^{-4}$ inch
Inch		$2 \times 10^{-5}$ mm	0	500	1	$10^{-5}$ inch

The diagram below illustrates positive and negative backlash. For positive backlash, the compensation must be positive and vice versa.

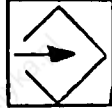
Positive backlash  
(normal case)



Negative backlash



Memory area: Test

Axis no	I/P no	Adr	Sign	Description		
1	N 200	S	+	Pitch error compensation		
2	N 201					
3	N 202					
4	N 203					
5	N 204					
6	N 205					
7	N 206					
8	N 207					
9	N 208					
10	N 209					
11	N 272					
12	N 273					
		Measuring syst.units	Input limits		In-crement	Units
Metric, circular		$0.5 \times 10^{-3}$ mm	0	127	1	$1 \mu\text{m } 10^{-3}$ deg
Metric		$0.5 \times 10^{-2}$ mm	0	127	1	10 $\mu\text{m}$
Inch		$0.5 \times 10^{-4}$ mm	0	127	1	$10^{-4}$ inch
Inch		$2 \times 10^{-5}$ mm	0	127	1	$10^{-5}$ inch

Each axis may have its own particular compensation for pitch error. This machine datum, according to axis, is the correction which will be applied at each compensation point.

Memory area:Test

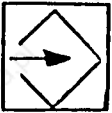
Axis no	I/P no	Adr	Sign	Description		
1	N 210	S	+	Measuring system zero crossing shift		
2	N 211					
3	N 212					
4	N 213					
5	N 214					
6	N 215					
7	N 216					
8	N 217					
9	N 218					
10	N 219					
11	N 274					
12	N 275					
		Measuring syst.units	Input limits		In-crement	Units
Metric, circular		$0.5 \times 10^{-3}$ mm	0	9 999	1	$1 \mu\text{m} 10^{-3}$ deg.
Metric		$0.5 \times 10^{-2}$ mm	0	9 999	1	10 $\mu\text{m}$
Inch		$0.5 \times 10^{-4}$ mm	0	9 999	1	$10^{-4}$ inch
Inch		$2 \times 10^{-5}$ mm	0	9 999	1	$10^{-5}$ inch

Normally the machine will regard reference point for each axis as the next zero crossing of the measuring system after the reference point switch is left. If, however, the reference point is a few millimetres out, say, rather than move the switch, a software shift can be entered into these machine data. A positive value in the machine data will move the reference point in the positive direction from the zero crossing and vice versa.

For the different measuring systems the zero crossings come at the following intervals.

Resolver or Inductosyn (Metric) = 2 mm  
 Resolver or Inductosyn (Inch) = 0.1 inch (0.2 inch)  
 Circular Inductosyn (360 Pole) = 2 degrees

Memory area:Test

Axis no	I/P no	Adr	Sign	Description	
1	N 220	S	+	Multgain factor	
2	N 221				
3	N 222				
4	N 223				
5	N 224				
6	N 225				
7	N 226				
8	N 227				
9	N 228				
10	N 229				
11	N 276				
12	N 277				

Input			
Limits		Increment	Units
1	32000	1	$\frac{3 \cdot 10^7}{V_{\max} \text{ (mm/min)}}$

The control calculates the command voltage to the feed drives according to the following formula

$$\text{VELOVAL} = \text{MULTGAIN} \cdot \text{kV} \cdot \text{s}$$

Veloval = command value voltage  
 Multgain = Multgain factor  
 kV = kV factor  
 s = following error

Once the maximum feedrate (machine data N130 to N139),  $V_{\max}$ , and the command value voltage ( $U_{\max}$ ) for this feedrate have been fixed the multgain is also fixed according to the following formula..

$$\text{Multgain (N220 to N229, N276, N277)} = \frac{3 \times 10^7}{V_{\max}} \cdot \frac{U_{\max}}{10 \text{ (V)}}$$

where  $U_{\max}$  = command value voltage for maximum feedrate (V)

$V_{\max}$  = maximum feedrate in mm/min

the constant underneath  $U_{\max}$  also has the units "Volts".

Example

$V_{\max}$  is 10000 mm/min and  $U_{\max}$  is 8V


$$\text{Multgain} = \frac{3 \cdot 10^7}{10^4 (\text{mm/min})} \cdot \frac{8\text{V}}{10\text{V}} = 2400 \frac{\text{min}}{\text{mm}}$$

This formula ensures that the units of the kV factor actually applicable to each axis are m/min.mm. or mm/min.µm.

The following table gives the multgain factors for two cases, 8V and 4V, of command value voltage for maximum feedrate against different maximum feedrates.

Maximum feedrate m/min	Command voltage for maximum feedrate	
	4 V	8 V
15		1600
14		1714
13		1846
12		2000
11		2182
10		2400
9		2667
8		3000
7		3429
6		4000
5		4800
4		6000
3		8000
2		12000
1	12000	24000
0,8	15000	30000
0,75	16000	32000
0,6	20000	
0,5	24000	
0,4	30000	

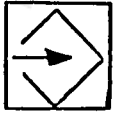
Memory area: Test

Axis no	I/P no	Adr	Sign	Description	
1	N 230	S	+	Drift compensation	
2	N 231				
3	N 232				
4	N 233				
5	N 234				
6	N 235				
7	N 236				
8	N 237				
9	N 238				
10	N 239				
11	N 278				
12	N 279				

Input			
Limits		Increment	Units
0	1000	1	Velo = $\frac{10 \text{ V}}{8192}$

These machine data compensate for the drift of the respective feed drives. By entering the correct values into the data the following error at standstill can be reduced to zero or thereabouts. However the usual method of compensating for drift using these machine data is described in section 8.4 of this manual.

Memory area: Test

Axis no	I/P no	Adr	Sign	Description	
1	N 240	S	+	Compensation point number of axis reference point	
2	N 241				
3	N 242				
4	N 243				
5	N 244				
6	N 245				
7	N 246				
8	N 247				
9	N 248				
10	N 249				
11	N 280				
12	N 281				

Input			
Limits		Increment	Units
0	1023	1	-


These machine data are only used when pitch error compensation is applied. Each machine datum will be a number between zero and 1023. Each datum gives the compensation point number of the reference point in that axis. A detailed description will be found in section 6.3.1.

Memory area: Test

Axis no	I/P no	Adr	Sign	Description		
1	N 250	S	+	Distance between pitch-error compensat on points		
2	N 251					
3	N 252					
4	N 253					
5	N 254					
6	N 255					
7	N 256					
8	N 257					
9	N 258					
10	N 259					
11	N 282					
12	N 283					
		Measuring syst.units	Input limits		In- crement	Units
Metric, circular		$0.5 \times 10^{-3}$ mm	0	32000	1	10 $\mu$ m 10 <sup>-2</sup> deg
Metric		$0.5 \times 10^{-2}$ mm	0	32000	1	100 $\mu$ m
Inch		$0.5 \times 10^{-4}$ mm	0	32000	1	10 <sup>-3</sup> inch
Inch		$2 \times 10^{-5}$ mm	0	32000	1	10 <sup>-4</sup> inch

The machine data concern pitch error compensation and state the distance between compensation points for each axis. A more exhaustive treatment can be found in section 6-3-1.

Memory area:Test

Axis no	I/P no	Adr	Sign	Description	
1	N 260	S	+	Lead screw gearing factor	
2	N 261				
3	N 262				
4	N 263				
5	N 264				
6	N 265				
7	N 266				
8	N 267				
9	N 268				
10	N 269				
11	N 288				
12	N 289				

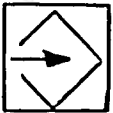
  

Input			
Limits		Increment	Units
0	75	5	$10^{-1}$

In the machine data as a whole there are three groups of data which are effectively multipliers for the pulses which the control generates as a result of the movement signal from the resolver. (These are bits 3, 4 of machine data N413 to N422, actual value times 2, actual value times 0.5 respectively and this group N260 to N269, N288, N289, depending upon the axis.) Taking all these possibilities into consideration it is possible to multiply the actual value pulses by a series of values ranging from 0.25 to 15.

Normally the lead screw pitch and gearing between resolver and lead screw result in one revolution of the resolver corresponding to 2 mm of movement. These multipliers allow this relationship to be different. For example, if instead of 2 mm movement the figure was 5 mm for the X axis then N260 would be 25, assuring bits 3, 4 of datum N413 were both zero.

Memory area: Test


Axis no	I/P no	Adr	Sign	Description	
11 12	N 284 N 285		+	Gain factor of anticipatory control for slave axes	
		S			

Input			
Limits		Increment	Units
0	6000	1	$10^{-3}$

This machine data, which are only applicable to the 8MC, have not yet been set.


Memory area:Test

Axis no	I/P no	Adr	Sign	Description		
11 12	N 286 N 287	S	+	Maximum difference tolerance between master and slave axes		
						
		Measuring syst.units	Input limits		In-crement	Units
Metric, circular		$0.5 \times 10^{-3}$ mm	0	32000	1	$1 \mu\text{m} 10^{-3}$ deg
Metric		$0.5 \times 10^{-2}$ mm	0	32000	1	10 $\mu\text{m}$
Inch		$0.5 \times 10^{-4}$ mm	0	32000	1	$10^{-4}$ inch
Inch		$2 \times 10^{-5}$ mm	0	32000	1	$10^{-5}$ inch

8MC only

These machine data state the maximum discrepancy in actual position that will be tolerated between each slave axis and its respective master axis. If the tolerance is exceeded alarms 206 or 216 will appear.

Memory area:Test


Axis no	I/P no	Adr	Sign	Description		
1	N 300 N 301 N 302 N 303 N 304 N 305 N 306	S	+	Co-ordinates of additional seven reference points for the first axis.		
						
		Measuring syst.units	Input limits	In-crement	Units	
Metric, circular	$0.5 \times 10^{-3}$ mm	0	999999	1	$1 \mu\text{m} 10^{-3}$ deg	
Metric	$0.5 \times 10^{-2}$ mm	0	999999	1	10 $\mu\text{m}$	
Inch	$0.5 \times 10^{-4}$ mm	0	999999	1	$10^{-4}$ inch	
Inch	$2 \times 10^{-5}$ mm	0	999999	1	$10^{-5}$ inch	

8MC only

In the first axis up to seven additional reference points can be used. Which of these seven additional reference points is active is set by a signal from the interface (A15, A17, A18 i.e. Reference point number and two bytes for external data input).

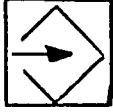
Note: If pitch error compensation or sag compensation or both are being use, then the positions of the additional reference points must coincide with correction points. The numbers of these reference points must be entered in machine data N310-N316 or N322 to N328.

Memory area:Test

Axis no	I/P no	Adr	Sign	Description	
1	N 310 N 311 N 312 N 313 N 314 N 315 N 316	S	+	Pitch error compensation point numbers for the additional reference points	
Input					
Limits		Increment		Units	
0		1023		1 -	


For pitch error compensation each additional reference point must coincide with a compensation point whose number would be entered in this group of machine data. The machine data are exactly analagous to N240.

Memory area:Test

Axis no	I/P no	Adr	Sign	Description		
	N 320	S	+	Size of sag compensation		
						
		Measuring syst.units	Input limits		In- crement	Units
Metric, circular		$0.5 \times 10^{-3}$ mm	0	127	1	$1 \mu\text{m} \cdot 10^{-3} \text{ deg}$
Metric		$0.5 \times 10^{-2}$ mm	0	127	1	10 $\mu\text{m}$
Inch		$0.5 \times 10^{-4}$ mm	0	127	1	$10^{-4}$ inch
Inch		$2 \times 10^{-5}$ mm	0	127	1	$10^{-5}$ inch

This machine datum states the size of the sag compensation that will be made at each of the sag compensation points. For more information section 6.3.2 should be consulted.


Memory area; Test

Axis no	I/P no	Adr	Sign	Description		
	N 321 N 322 N 323 N 324 N 325 N 326 N 327 N 328	S	+	Sag compensation point number for main reference point and for additional reference points		
Input						
		Limits		Increment	Units	
		0		1023	1	-

If sag compensation is being used the main and additional reference points must coincide with compensation points whose numbers are entered into these machine data, N321 being for the main reference point and N322 to N328 for the additional reference points if they are being used.


These machine data are exactly analagous to N240 for pitch error compensation.

Memory area:Test

Axis no	I/P no	Adr	Sign	Description		
	N 329	S	+	Distance between sag compensation points		
						
		Measuring sys.units		Input limits	In- crement	Units
	Metric, circular	$0.5 \times 10^{-3}$ mm	0	32000	1	$10 \mu\text{m} 10^{-2}$ deg
	Metric	$0.5 \times 10^{-2}$ mm	0	32000	1	100 $\mu\text{m}$
	Inch	$0.5 \times 10^{-4}$ mm	0	32000	1	$10^{-3}$ inch
	Inch	$2 \times 10^{-5}$ mm	0	32000	1	$10^{-4}$ inch

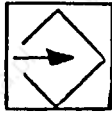
This machine datum states the distance between sag compensation points, and is described in section 6.3.2.

Memory area: Test

Axis no	I/P no	Adr	Sign	Description			
	N 345	S	+	Minimum feedrate for contour monitoring			
							
				Measuring sys.units	Input limits	In- crement	Units
				$0.5 \times 10^{-3}$ mm	0      15000	1	1mm/min, 1deg/min
				$0.5 \times 10^{-2}$ mm	0      15000	1	10 mm/min
				$0.5 \times 10^{-4}$ mm	0      6000	1	0.1 inch/min
				$2 \times 10^{-5}$ mm	0      6000	1	0.1 inch/min

The contour monitoring will be inactive below the feedrate entered into this machine datum. The usual value of the datum is zero, that is contour monitoring always active. Please see section 6.2.8.

Memory area:Test

Axis no	I/P no	Adr	Sign	Description	
	N 346		+	Tolerance band for contour monitoring	
		S			

Input			
Limits		Increment	Units
0	15000	1	-

This machine datum states the tolerance for the contour deviation. The tolerance band as a dimension is calculated by the control thus:

$$\text{Tolerance band} = \frac{N346 \times 163}{(kV \times 1000)} \cdot \mu\text{m}$$

Where:

N346 = Contents of machine datum N346

(kV x 1000) = kV factors observed in Test N850 to N859

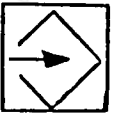
eg N346 = 1000

$$(kV \times 1000) = 1200 \frac{\text{m}}{\text{m/min}}$$

$$\text{Tolerance band} = \frac{1000 \times 163}{1200} = 136 \mu\text{m}$$

If the value zero is entered the control will automatically assume a value of 2000.

Memory area:Test

Axis no	I/P no	Adr	Sign	Description	
	N 347		+	Gain factor for spindle position control loop, M19	
		S			


  

Input			
Limits		Increment	Units
0	10000	1	r.p.m/360°

Recommended value is 200.


If orientated spindle stop (M19) is being implemented, this machine datum stipulates the gain of the feedback loop which controls the orientation of the spindle.

Memory area:Test

Axis no	I/P no	Adr	Sign	Description	
	N 348		+	In-position tolerance for M19	
<b>Input</b>					
Limits		Increment		Units	
0		1000		1	
				1/11 deg.	

When orientated spindle stop is being used the signal "Position reached" will be issued to the interface as soon as the actual position of the spindle has reached the required stopping position plus or minus the tolerance given in machine datum N348. The minimum tolerance that may be entered is one increment of the rotary encoder. One increment corresponds to 360 degrees divided by 4096 pulses.


Memory area:Test

Axis no	I/P no	Adr	Sign	Description	
	N 349	S	+	Spindle stop hold time	

Input			
	Limits	Increment	Units
	0	16000	1
			1 ms

The time value entered into this machine datum is the delay time before the spindle regulator enable signal is taken away after the spindle has reduced its speed to zero. This is to prevent the spindle drifting out of position once it has stopped.

Memory area:Test


Axis no	I/P no	Adr	Sign	Description		
	N 350		+	Destination approach speed		
		S				
		Measuring syst.units	Input limits		In- crement	Units
Metric, circular		$0.5 \times 10^{-3}$ mm	0	15000	1	1mm/min, 1deg/min
Metric		$0.5 \times 10^{-2}$ mm	0	15000	1	10 mm/min
Inch		$0.5 \times 10^{-4}$ mm	0	6000	1	0.1 inch/min
Inch		$2 \times 10^{-5}$ mm	0	6000	1	0.01 inch/min

The speed entered into this machine datum has two roles:

- When operating from a programme and the machine is approaching its destination point this is the speed with which that destination point will be approached. The speed should be chosen so that the machine comes gently into position.
- In the mode "machine referencing", as soon as an axis meets the leading edge of the reference point switch it will brake from the speed shown under "F" in the display mode "REF" to this destination approach speed. More information can be found in the "Interface description part 2" section 2.9.5.

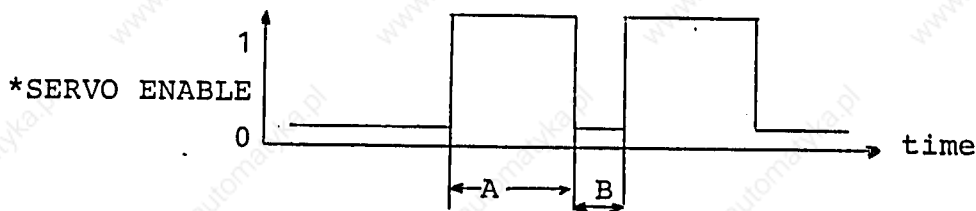
If an integrated P.C. Interface (eg S5-150) is being used, to allow for the cycle time, the destination approach speed should not be greater than 200 mm/min.

Memory area: Test

Axis no	I/P no	Adr	Sign	Description	
	N 351		+	Frequency of the signal *SERVO ENABLE	

Input			
Limits	Increment	Units	
0	15000	1	1 ms

This machine datum is helpful when a direct measuring system is employed (eg Inductosyn). It may be that some slackness exists between the table and the slides, as a result of which the table develops a low frequency oscillation (period 1 to 5 seconds). To overcome this, the signal \*SERVO ENABLE would be a square wave signal rather than a d.c. level. The period would appear as follows.




A = Set by machine datum N351.

B = A fixed time of between 10 and 20 ms

Additionally the interface would be built so that when the signal \*"Servo enable" was not present the integral part of the speed amplifier would be short circuited.

If the value of N351 is zero the feature is inactive, if the feature is used, the recommended value is 15000 ms.


Memory area: Test

Axis no	I/P no	Adr	Sign	Description		
	N 352	S	+	Externally activated creep speed		
						
		Measuring syst.units	Input limits	In- crement	Units	
Metric, circular	$0.5 \times 10^{-3}$ mm	0	15000	1	1mm/min, 1deg/min	
Metric	$0.5 \times 10^{-2}$ mm	0	15000	1	10 mm/inch	
Inch	$0.5 \times 10^{-4}$ mm	0	6000	1	0.1 inch/min	
Inch	$2 \times 10^{-5}$ mm	0	6000	1	0.1 inch/min	

As long as the input signal "Creep speed external" Test N4 A12 bit 7 is active, all movements of the axes will be carried out with the speed entered into this machine datum, regardless of operating mode.

If the signal "creep speed external" becomes active just before the end limit switch then the speed should be chosen low enough so that the axis can stop virtually immediately after the end limit switch rather than going right on to the emergency stop switch.

Memory area:Test

Axis no	I/P no	Adr	Sign	Description	
	N 353	S	+	Delayed activation of position monitoring	

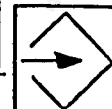
Input			
Limits		Increment	Units
0	32000	1	1 ms

The usual value is 400 ms. The datum is active in the following instances:

1. When an axis has reached its end position after a movement, the "stationary in-position tolerance" i.e. Test N110-N119 will only become active after the time set in N353 has elapsed. The time should be large enough to allow the largest expected following error to reduce to zero.
2. After the "emergency stop" circuit has been activated, or any other condition that leads to the axes being immediately braked to zero, the time specified in the machine datum N353 will elapse before the servos are disabled.
3. When the interface disables the servo of a moving axis, the "stationary in-position tolerance" will only become active when the time given in N353 has elapsed.

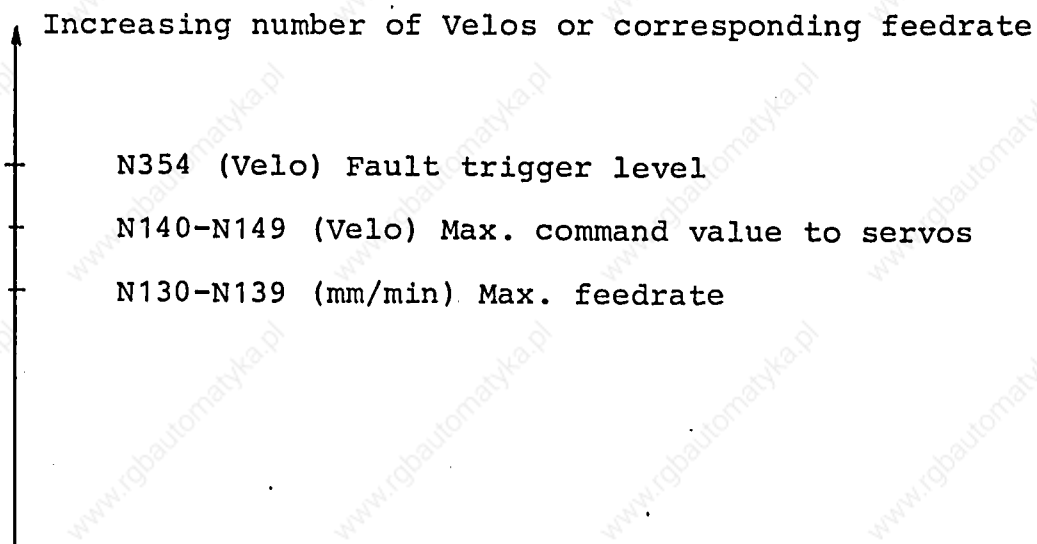
Memory area: Test

Axis no	I/P no	Adr	Sign	Description
1	N 354	S	+	Fault trigger level for command value
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				




Input			
Limits	Increment	Units	
0	8192	1	1 Velo = $\frac{10 V}{8192}$

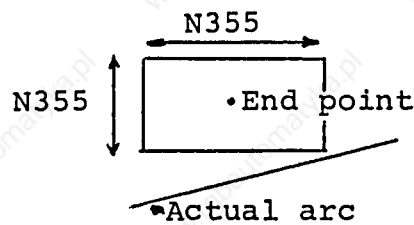
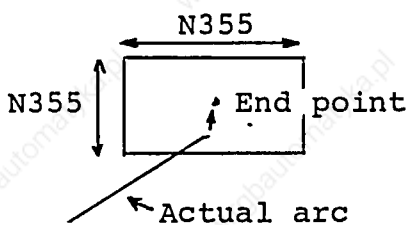
This machine datum is a fault trigger level of the command value to the servos. Alarm 102, 112 etc. to 212 will be issued depending upon which axis is involved. The value may be as low as but no lower than the values entered into the machine data N140-N149. The relative magnitudes of the machine datum related to command value are as follows:



Memory area: Test

Axis no	I/P no	Adr	Sign	Description		
	N 355	S	+	Arc end point tolerance		
						
		Measuring syst.units	Input limits		In- crement	Units
Metric, circular		$0.5 \times 10^{-3}$ mm	0	32000	1	$1 \mu\text{m}, 10^{-3} \circ$
Metric		$0.5 \times 10^{-2}$ mm	0	32000	1	10 $\mu\text{m}$
Inch		$0.5 \times 10^{-4}$ mm	0	32000	1	$10^{-4}$ inch
Inch		$2 \times 10^{-5}$ mm	0	32000	1	$10^{-5}$ inch

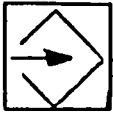
This machine datum is important in circular interpolation. The value entered into the machine datum forms a tolerance window about the programmed end point. If the programmed arc never enters the tolerance window alarm 308 will appear

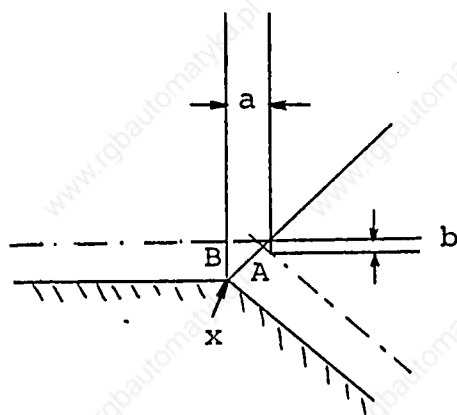


Here the actual arc completely misses the tolerance window surrounding the end point.

The check as to whether the actual arc will enter the tolerance window will be done by the control before the arc is started. The arc will only be started if the result of the check is satisfactory.

Memory area: Test

Axis no	I/P no	Adr	Sign	Description				
	N 356	S	+	CRC at corners, threshold for the insertion of an arc				
								
				Measuring syst.units	Input limits	In-crement	Units	
				Metric, circular	$0.5 \times 10^{-3}$ mm	0 32000	1	$1 \mu\text{m} 10^{-3}$ deg.
				Metric	$0.5 \times 10^{-2}$ mm	0 32000	1	10 $\mu\text{m}$
				Inch	$0.5 \times 10^{-4}$ mm	0 32000	1	$10^{-4}$ inch
				Inch	$2 \times 10^{-5}$ mm	0 32000	1	$10^{-5}$ inch




--- Path of cutter centre

////// Workpiece contour

If, in the above diagram the value of "a" or "b" is above the value of the machine datum N356, then the centre of the cutter will describe a small arc, centred on the corner, x, at the workpiece contour, to get from point A to point B.

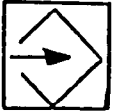
The recommended value for N356 is from 10 to 50  $\mu\text{m}$ .

Memory area : Test

Axis no	I/P no	Adr	Sign	Description	
Spindle	N 357	S	+	Drift compensation for spindle	
Input					
Limits		Increment		Units	
0	1000	1	Velo = $\frac{10\text{Volt}}{8192}$		

This machine datum is used when the spindle speed is issued directly by the N.C. as an analogue voltage. The drift should be adjusted such that with a small command speed, in each direction, the actual spindle speed is the same.

Memory area: Test

Axis no	I/P no	Adr	Sign	Description	
Spindle	N 358	S	+	Spindle speed tolerance	
					
Speed range		Input limits		In-crement	Units
1 - 999 rpm		0	9999	1	1 rpm
0.1 - 999 rpm		0	9999	1	0.1 rpm

This machine datum is used when the analogue spindle speed facility is being used and a pulse coder is attached to the spindle.

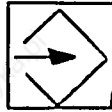
The machine datum represents a tolerance above and below the programmed spindle speed and so long as the actual speed lies within this tolerance the output signal "spindle speed correct" Test N7, A10 bit 5 will be present. This signal will, for instance, only appear when the spindle has speeded up from rest to the programmed speed.

If the actual spindle speed is on the top side of the tolerance the signal "Spindle overspeeding" will be issued, Test N7, A10, bit 6.

This signal ("spindle overspeeding") could be used in the interface to disable both the spindle and the axis drives.

The units of the machine datum are either r.p.m. or r.p.m times  $10^{-1}$  depending on whether Test N436 bit 6 is a zero or a one.

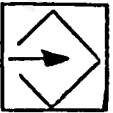
Memory area:Test

Axis no	I/P no	Adr	Sign	Description	
Spindle	N 359 N 360 N 361 N 362 N 363 N 364	S	+	Speed limit for up to six gear ranges	
	Speed range	Input limits		In-crement	Units
	1 - 9999 rpm	0	9999	1	1 rpm
	0.1 - 9999 rpm	0	9999	1	0.1 rpm

Each machine datum gives the spindle speed that will be reached, in the respective gear, when the command voltage to the spindle is 10 Volts. N359 corresponds to gear range 1, N360 to gear range 2 etc.

The input signals for the gear selection are in Test N4 A12 bits 4 to 6.

Memory area:Test

Axis no	I/P no	Adr	Sign	Description	
Spindle	N 365	S	+	Speed-up time for each gear	
	N 366				
	N 367				
	N 368				
	N 369				
	N 370				

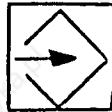
  

Input			
Limits		Increment	Units
0	32000	1	4 ms

With these machine data a spindle "ramp-up" or "speed-up" time for each gear range can be selected. The time (in milliseconds) entered is the time required for the spindle to go from zero to maximum speed in that gear, divided by four.

e.g. In gear range 1, the acceleration time is 400 ms, then N365 will be set to S100.

Memory area: Test

Axis no	I/P no	Adr	Sign	Description	
Spindle	N 371	S	+	Second speed up time for large inertia	
	N 372				
	N 373				
	N 374				
	N 375				
	N 376				


  

Input			
Limits		Increment	Units
0	32000	1	4 ms

These machine data are treated in the same way as N369 to N370. They are provided so that each gear range can also have a second speed-up time if necessary (eg if a very heavy workpiece or tool were mounted in the spindle).

This special speed-up time is activated via the input signal Test N4 A12 bit 3 "\*second speed up time".

Memory area: Test

Axis no	I/P no	Adr	Sign	Description	
Spindle	N 377	S	+	Minimum motor speed for spindle	

Input			
Limits		Increment	Units
0	8191	1	1 Velo = $\frac{10 \text{ V}}{8192}$


This is the minimum spindle motor speed. Even running of the spindle motor can be guaranteed down to this speed. This machine datum also has implications for constant cutting speed; if the radius is becoming larger then the spindle motor speed will not reduce below the value in this machine datum.

Input is in units "VELO" e.g. if the maximum and minimum motor speeds were 3500 rpm and 50 r.p.m. respectively then the value of N377 would be calculated so:

$$N377 = \frac{50}{3500} \times 8192 = 117$$


To arrive at the correct value of minimum motor speed, the value 0 should be initially entered. The spindle should be started in its lowest gear range at the lowest speed. This corresponds to the lowest motor speed. The motor speed can be read off in Velos in Test N910 and this value, disregarding the sign, entered into N377.

Memory area: Test

Axis no	I/P no	Adr	Sign	Description		
Spindle	N 378	S	+	Reduced spindle speed for M19 approach		
						
N 436 bit 6	Spindle speed range		Input limits		In- crement	Units
0	1 - 9999 rpm		0	9999	1	1 rpm
1	0.1 - 9999 rpm		0	9999	1	0.1 rpm

When orientated spindle stop M19 is being used this is the spindle speed with which the final orientation will be approached.

Memory area:Test

Axis no	I/P no	Adr	Sign	Description	
Spindle	N 379	S	+	Pendle speed	

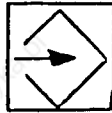
  

Input			
Limits		Increment	Units
0	8191	1	1 Velo = $\frac{10 \text{ V}}{8192}$

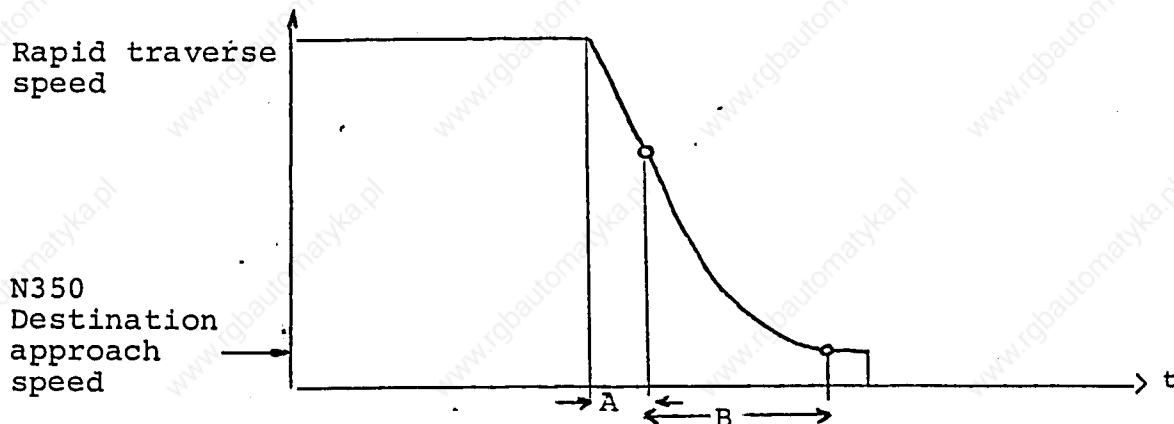
When a gear change is being made this is the speed at which the spindle motor will pendle whilst the gears are engaged.

The speed-up time (N365 etc) will be ineffective when the gears are being engaged and the current limit of the spindle drive should be reduced. The pendle action will be initiated when the N.C. receives the input signal "Spindle pendle", Test N4 A12 bit 2.

Memory area: Test

Axis no	I/P no	Adr	Sign	Description	
	N 380	S	+	Time constant for gentle deceleration	
Input					
		Limits	Increment	Units	
		0	32000	1	1 ms

When an axis is braking from rapid traverse for the approach to the destination point. The deceleration curve can take the form of a decaying exponential as shown in the diagram.



Time A: Deceleration according to machine data N120 etc.

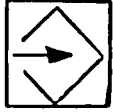
Time B: Deceleration via an exponential function with N380 as the time constant.

This feature could be used for example, if it were necessary to have all the mechanical drive parts, gears, belts etc, de-stressed at the final positioning. To arrive at the best value for the machine datum the following rule of thumb can be used

$$N380 = \frac{100}{4 a} \quad \text{to} \quad N380 = \frac{100}{a}$$

where  $a$  is the acceleration entered in N120 is  $\text{ms}^{-2}$ .

Memory area:Test


Axis no	I/P no	Adr	Sign	Description	
	N 381	S	+	Redundant push buttons on operators panel	

Input			
Limits		Increment	Units
0	32000	1	-

This machine datum represents the sum of the identification numbers of the redundant push buttons on the operators panel.

It is determined at the first commissioning using the diagnostic programme (see Diagnostic manual)

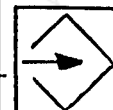
Memory area:Test

Axis no	I/P no	Adr	Sign	Description		
1 2	N 383 N 384	S	+	Max. pull back distance for tool change		
						
		Measuring syst.units	Input limits		In- crement	Units
Metric, circular		$0.5 \times 10^{-3}$ mm	0	9999999	1	$1 \mu\text{m}$ $10^{-3}$ deg
Metric		$0.5 \times 10^{-2}$ mm	0	9999999	1	10 $\mu\text{m}$
Inch		$0.5 \times 10^{-4}$ mm	0	9999999	1	$10^{-4}$ inch
Inch		$2 \times 10^{-5}$ mm	0	9999999	1	$10^{-5}$ inch

These machine data only apply to the 8T and Sprint 8T. When the tool change cycles are being used (eg L92), the values of the clearance parameters are limited by these machine data.

Memory area:Test

Axis no	I/P no	Adr	Sign	Description		
1	N 385		+	2 <sup>nd</sup> software limit switch in direction X negative		
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
		Measuring syst.units	Input limits		In- crement	Units
Metric, circular		$0.5 \times 10^{-3}$ mm	0	9999999	1	$1 \mu\text{m} 10^{-3}$ deg
Metric		$0.5 \times 10^{-2}$ mm	0	9999999	1	10 $\mu\text{m}$
Inch		$0.5 \times 10^{-4}$ mm	0	9999999	1	$10^{-4}$ inch
Inch		$2 \times 10^{-5}$ mm	0	9999999	1	$10^{-5}$ inch

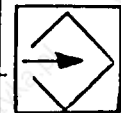


Only applicable to 8T and Sprint 8T

The 2<sup>nd</sup> software limit in X minus, which is actuated via the signal "2<sup>nd</sup> software limit active" (Test N4 A10 bit 7), should be set before the 1<sup>st</sup> software limit. It could be used for example if the tail stock were up.

Memory area : Test

Axis no	I/P no	Adr	Sign	Description
	N 387 N 388	S	+	Clamp danger area



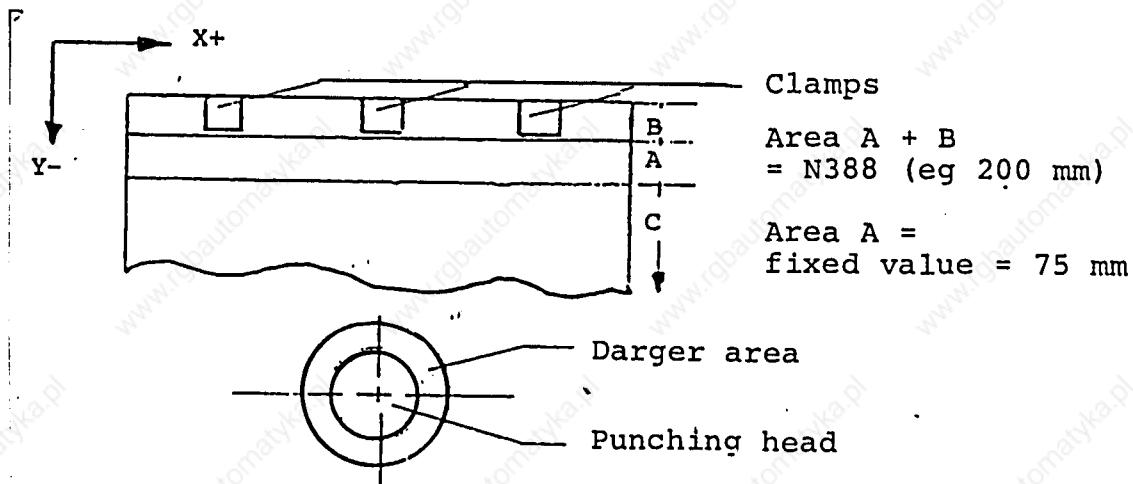
Input			
Limits		Increment	Units
0	32767	1	mm

There are three working zones, A, B and C.

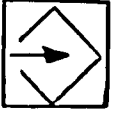
Area A: Braking area: This area is set by the braking ability of the axes, that is, it is a fixed value and is entered into machine datum N387.

Area B: Clamp area: This is the area in which, due to the possibility of a collision between the clamps and the punching head, the axes will travel with the reduced speed entered in machine datum N130.

Area C: Safe area: In this area the axes will move with the programmed speed.




Memory area:Test

Axis no	I/P no	Adr	Sign	Description	
	N 389			Maximum nibbling acceleration	
		S			

Input			
	Limits	Increment	Units
0	32767	1	$\text{ms}^{-2} \times 10^{-1}$

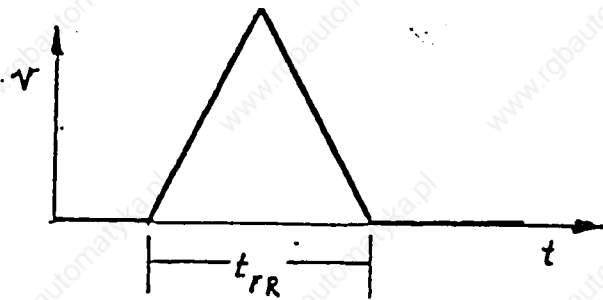
The machine datum states the maximum permitted acceleration of the axes when nibbling has been programmed.

Memory area: Test

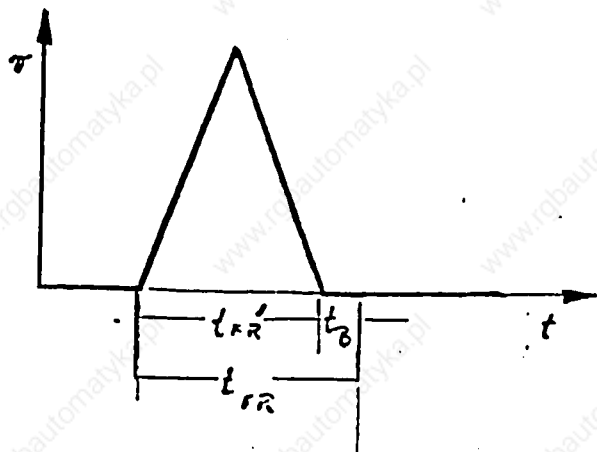
Axis no	I/P no	Adr	Sign	Description	
	N 390			Settling time for M22	
		S			

Input			
Limits		Increment	Units
0	127	1	ms

The time for which the drive is enabled in the nibble mode M22 can be reduced with this machine datum so that at the end of the movement the axis has a little time to settle.



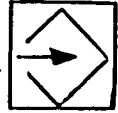
N390 = 0 ms  
 $t_{FR}$  = measured drive enable time



N390 =  $t_B$  ms  
 $t_{FR}' = t_{FR} - t_B$

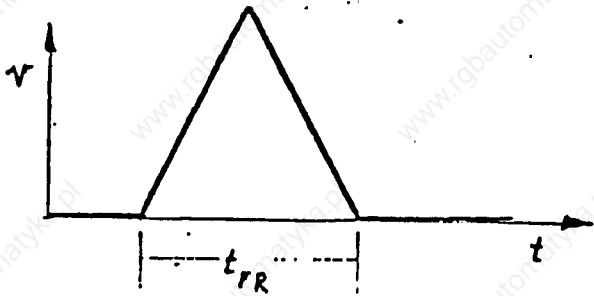
Memory area: Test

Axis no	I/P no	Adr	Sign	Description
	N 391	S		Settling time for M24



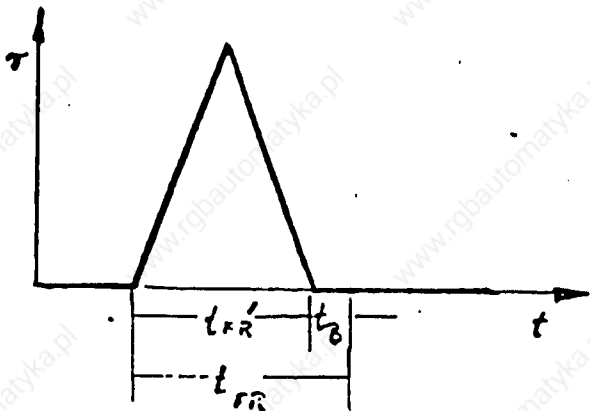
Input			
Limits	Increment	Units	
0	127	1	ms

The time for which the drive is enabled in the nibble mode M24 can be reduced with this machine datum so that at the end of the movement the axis has a little time to settle.



$$N390 = 0 \text{ ms}$$


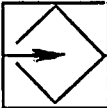
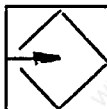
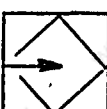
$$t_{FR} = \text{measured drive enable time}$$



$$N390 = t_B \text{ ms}$$

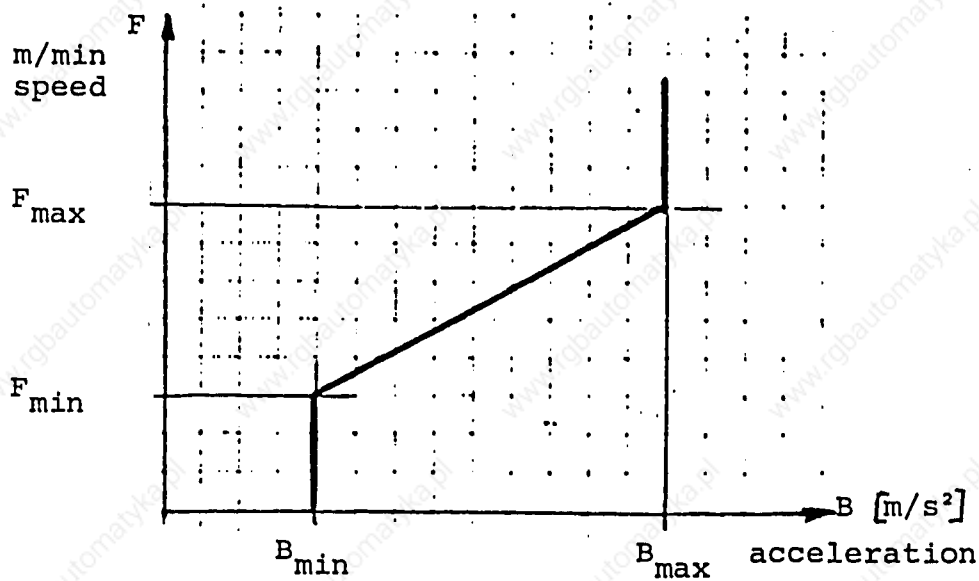
$$t_{FR}' = t_{FR} - t_B$$

Memory area Test (only 8N)

Axis no.	Input no.	Address	Sign	Description	
	N 392	S		Threshold feedrate for modified acceleration, $F_{max}$	
	N 393	S		Maximum feedrate for modified acceleration, $F_{max}$	
	N 394	S		Acceleration at threshold feedrate, $B_{min}$	
	N 395	S		Acceleration at maximum feedrate, $B_{max}$	

limits		Input incr.	Units
0	32767	1	m/min x 10 <sup>-2</sup> or m/s <sup>2</sup> x 10 <sup>-1</sup>

With programmed G01, unless nibbling is also programmed, the acceleration is altered in direct proportion to the programmed speed. The machine data  $B_{max}$ ,  $B_{min}$ ,  $F_{max}$ ,  $F_{min}$  define the area of operation of this modified acceleration.



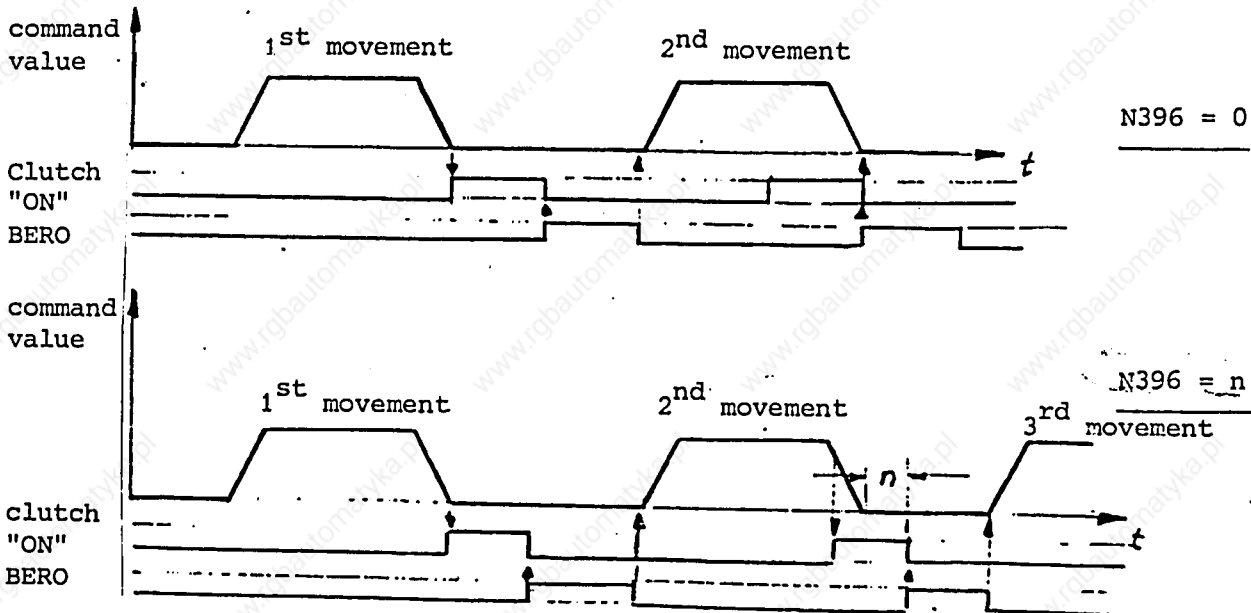
Memory area Test

Axis no	I/P no	Adr	Sign	Description
	N 396			Clutch engage time after position reached
		S		

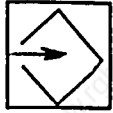
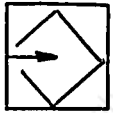
  

Input			
Limits	Increment	Units	
0	127	1	ms

With this machine datum it is possible to pull forward the point, in a punching cycle, M25, with E or H after position reached, where the clutch is engaged. This means effectively the punching rate can be increased.




Memory area Test (8N only)

Axis no.	Input no.	Address	Sign	Description	
	N 397	S		Number of strokes/min	
	N 398	S		Auxilliary number of strokes/min	

Limits	Input		Units
		Increm.	
0	32767	1	Strokes/min

These machine data are stipulated by the machine manufacturer

Memory area Test (8N only)

Axis no	I/P no	Adr	Sign	Description	
	N 399			Multiplying factor for initial acceleration in punching or nibbling	
		S			

Input			
Limits		Increment	Units
0	127	1	-

$$\text{Acceleration at start of movement} = 2 \times B + \frac{(N399) \times B}{2}$$

B = normal acceleration

## 11.2 Description of the machine data bits

### 11.2.1 Name used to represent auxilliary functions Teta N402 bit 0-3 Normally H

Name used to represent angles N401 Bit 0-3 Normally A

Name used to represent radius, arc or chord  
N400 Bit 0-3 Normally B or P

---

With the appropriate bit combination the button will be defined which is used to call up each of the parameters above. When that button is pressed the correct letter will appear in the display. The same allocation of letter to parameter must also be observed on punched tapes. The names used to represent the parameters above must not be duplicated with the names of the axes.

11.2.2 Duration of change signal	N400	Bit 4-7
Delay before change signal	N401	Bit 4-7
Duration of M02/M30	N402	Bit 4-7

---

The significance of these machine data bits can best be read in the interface description.

### 11.2.3 Name used to represent each axis (N403-N412 bit 0-3)

The name of the axis will be defined for the button, display and programming by the allocation of the appropriate bit combination to these machine data. If necessary, it is possible to change the letter attached to any button by removing the plastic cover of the button, so that the letter corresponds to the name allocated to the axis called up by that button.

### 11.2.4 Axis is present (N403-N412 bit 4)

These machine data bits tell the measuring system which axes are present on the machine. Gaps in the allocation are permitted, eg Axes 1, 2, 3 may be present, 4 not present but 5 present.

### 11.2.5 Circular axis N403-N412 Bit 5

If this bit is set the control will automatically execute the following functions: a) pitch error compensation will be done over 360°, b) the actual value will be reset to zero after 256 revolutions, c) the axis will be programmed in degrees even if the measuring system or programming of the machine is inch.

### 11.2.6 Rounding up to nearest half or whole millimetre or degree (N403-N412 Bit 6, 7)

If these bits are set, all the programming must be to the nearest half or whole millimetre or degree. The "INC" mode does not work and in "JOG" mode the movements will be rounded up to the nearest half or whole unit.

### 11.2.7 Reference point in negative direction (N413-N422 bit 0)

This bit means that the reference point in that axis is approached from the negative, rather than the positive direction, and the referencing will start by depressing the minus direction button, the positive direction button being inactive.

### 11.2.8 Sign change of command value or actual value (N413 to N422 bit 1, 2)

Command value: This means that, contrary to convention, a movement in positive direction will be achieved with a negative command value.

Actual value: This means that the sign of the actual value will be changed inside the control.

### 11.2.9 Actual value multiplied or divided by two (N413-N422 Bit 3,4)

These machine data, which find their application normally in digital measuring systems, can be used to adapt the increment resolution of the measuring device to the units of the measuring system.

### 11.2.10 Which measuring system (N413-N422 bit 6-7)

These machine data tell the control what type of measuring system each axis has. If a digital measuring system is being used the appropriate option must have been ordered and the machine data bit (N439 bit 7) set.

### 11.2.11 Noise signal limiting for actual value (N413-N422, bit 5)

The function of this machine data bit (each axis is allocated a bit) is to take account of and limit the effects of noise signals which arise, generally, with direct measuring systems (Inductosyn, Heidenhain) due to mechanical vibration of the axis or noise signals induced in the conductors.

The noise signal monitoring works as follows:

The starting point is that the axis is either stationary or moving with a constant speed. The actual value will be sampled at a given frequency. The difference between the actual value from one sampling point and the subsequent sampling point may not be greater than 10  $\mu\text{m}$ . If the difference is greater than 10  $\mu\text{m}$  the amount by which it exceeds 10  $\mu\text{m}$  will be added to the contents of a store, called a smoothing store. For example if the deviation were 18  $\mu\text{m}$ , then 8  $\mu\text{m}$  would be added to the smoothing store. When the contents of the smoothing store have reached a certain limit (250  $\mu$ ), the actual position register will be updated by the 250  $\mu$  and the smoothing store will be cleared. This correction will be done over one sampling period rather than spread over several

If, on the other hand, the deviation between sampling periods is less than 10  $\mu\text{m}$  (say 4  $\mu\text{m}$ ) then the amount by which it falls short of 10  $\mu\text{m}$  (ie 6  $\mu\text{m}$ ) will be subtracted from the smoothing store (eg initially it had contents of 219, now, with 6 less, it will contain 213).

When the command value is altering, that is during acceleration or deceleration, the noise signal limiting will only become active after a small time delay, whose duration is inversely proportional to the actual kV factor. When the axis is being driven externally from outside the NC, though the NC is keeping track of the motion (in German "Nachführbetrieb") and the noise signal limiting is active, the actual value display will alter between 0.5 and 1.5 seconds after the axis has come to rest because of the smoothing store. Furthermore in this mode, when the command value is altering (ie deceleration/acceleration) this smoothing store will be reset over one period and its contents used to update the actual position register.

The noise signal limiting should be activated wherever direct, analogue measuring systems are being used.

#### 11.2.11a Auxilliary functions by block pre-select (N423 bit 0,1)

These data determine if, when the programme is to be started from a pre-select block, the auxilliary functions, coming before the preselected block in the programme, should be issued and, if so, how. The bit combination on page 0-22 gives the various possibilities.

#### 11.2.12 Auxilliary functions issued before the movement (N423 bit 2)

It is possible to choose, and this choice should be made by the machine manufacturer, if the auxilliary functions in any block should be issued during or before the movements programmed in that block.

#### 11.2.13 Non volatile offset (N423 bit 3)

This bit means that when the control is switch on and referenced any pre-set offset from earlier work with the control will remain active rather than be cleared.

#### 11.2.14 Measuring system units (N423 bit 4,5)

The table on page 0-21 gives the bit combination for the different measuring system units.

### 11.2.15 G70 is reset state (N423 bit 6)

This machine data bit defines which dimension system, inch (G70) or metric (G71), is selected by default if no specific selection is made in the programme.

### 11.2.16 Command value zero at limit switch (N423 bit 7)

If the interface has been designed such that the position loop is broken when an end limit switch is activated, this machine data bit must be zero. If the position loop is not opened at an end limit switch and the bit is set to a "one" then as soon as the limit switch is activated the command value will make a step function change to zero and the remaining axis movement will be due to the following error. If the bit is a zero, the command value will ramp down to zero when the end limit switch is actuated. This is also exhaustively described in the interface description.

### 11.2.17 Tool length by non-programmed axis (N424 bit 0)

When the function G40 is programmed, that is, cancel tool offset, and this bit is set, both the X and the Z offset will be cancelled at the next movement block although that movement block need only have movement in one of the axes X or Z.

### 11.2.18 Keep direction key pressed in modes REF, RPS, and INC (N424 bit 1)

If this machine data bit is set then the axes will only move, when the modes REF, RPS or INC have been selected, so long as the appropriate direction key is pressed.

### 11.2.19 Ignore offsets with G53 (N424 bit 2)

If this bit is set and G53 is programmed the following will be rendered inactive

- all zero offsets
- preset offsets
- G92 offset
- DRF (Differential resolver) offset.

This means that in a block with G92 any axis values will be with respect to the machine co-ordinate system (as displayed under TE N810).

11.2.20 Diameter programming (N424): with G90 (bit 3), with G92 (bit 4), with tool wear (bit 5)

The machine tool manufacturer makes the choice regarding these data bits. In special cases they can also be applied to the Sprint 8M and 8MC.

11.2.21 Difference of two tool offsets to H-Function (N424 bit 6)

Will be defined later.

11.2.22 With G92 the tool offset or zero offset will not be taken into account (N425 bit 0-1)

If this machine data bit is not set (i.e. a zero) then any tool or zero offset will be taken into consideration when the function G92 is used.

eg N420 G92 X200...LF

Value loaded into  
actual value register

Tool offset X = 20.3

N425 bit 1	
0	1
220.3	200

11.2.23 Next "LF" means start (N425 bit 2)

This machine data bit is important when the programme is coming from tape rather than memory. The start of the programme on tape is normally realised with a "%" sign. If this bit is set then the control will accept any of the "LF" signs at the end of each of the blocks as a start command. The tape can therefore be started at any point rather than only at the start.

11.2.24 Multipurpose operators panel (N425 bit 3)

This bit may only be set if an integrated PC or bus-coupled PC is being used (eg S5 interface). The NC operator's panel can then be used also to check the various signals in the interface (eg STATUS programme). More details can be found in the interface description.

#### 11.2.25 Programmable interface present (N425 bit 4)

This bit should only be set when an integrated PC or external buscoupled PC is being used.

#### 11.2.26 Customer's operating panel present (N425 bit 5)

This bit must be set if the customer's own operating panel supplements that of the normal NC system. The p.c.b. MS500 must be connected to the operators panel (plug X401). Machine data bits N431 bit 4-7 also concern this feature which is described in chapter 7 of the Interface description part 2.

#### 11.2.27 Long cable (ie 50 to 300 m) to operating panel (N425 bit 7)

In order to account for any timing delays when a long cable to the operators panel is being used this bit should be set.

#### 11.2.28 External position display (N426, bit 0)

This bit should be set if the external position display, which is connected to the normal operators panel, is being used. This feature is described in the interface description part 2, chapter 8.

#### 11.2.29 (Hand wheel accounted) The differential resolver offset will be accounted for in the external position display (N426 bit 1)

This bit means that the increments of the handwheel will be taken into consideration in the external position display.

#### 11.2.30 External position display non-volatile (N426 bit 2)

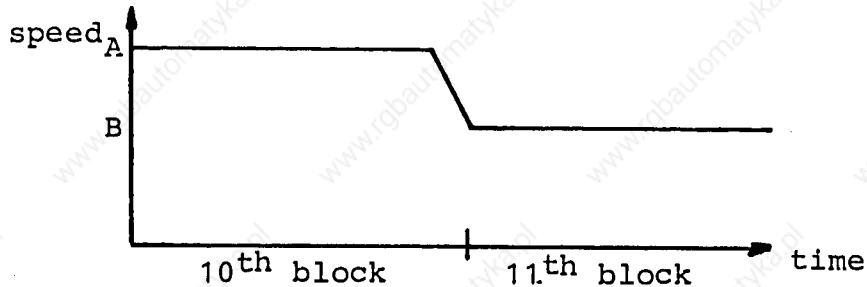
The co-ordinate values displayed in the external position display may be with respect to any point the operator chooses. If this offset should remain when the control is switched off this bit should be set.

#### 11.2.31 Hand wheel present (N426 bit 3,4)

If one hand wheel is present bit 3 must be set, if two are present bits 3 and 4 must be set.

### 11.2.32 Steady speed change (N426 bit 5)

If, between two consecutive blocks, there is a speed change, and if this bit is set, then the speed change will be completed before the start of the second of the two blocks.



A, B represent the speeds programmed in the 10<sup>th</sup> and 11<sup>th</sup> blocks respectively.

### 11.2.33 Key switch must be unlocked for input into (N426 bit 7 N427 bit 0-7)

By the appropriate selection of the bits it is possible to secure various sections of data stored in the machine against undesired alterations.

### 11.2.34 Data in/out interfaces (N428, N429)

According to what data terminals are being used these machine data bits should be set with the help of the table on page 0-22. Some examples are contained in chapter 7. N428 and N429 are allocated to the terminals X103, X104, respectively, on the MS100.

### 11.2.35 EIA code for funny a @ (N430)

In EIA there is no function code for @ so a bit pattern must be selected to define @. The normal pattern is 01101101.

### 11.2.36 Programmable interface address list number (N431 bit 0-3)

These machine data bits are selected according to the table on page 0-23. It is only applicable if an integrated PC is being used.

### 11.2.37 Number of bytes to service customer's operating panel (N431 bit 4-7)

The number stored in these machine data bits (see table on page 0-23) will depend on the number of buttons, switches, indicators etc. that are incorporated into the customer's operating panel.

11.2.38 Which axis is parallel to fourth axis (N432 bit 0-3)

These machine data bits are only active for the Sprint 8M (see also Interface description part 2 section 2.9.13 and 8MC/8M programming instructions section 3.5.1).

11.2.39 Which axis for constant cutting speed (N432 bit 4-1)

These machine data bits define for which axis the feedrate is to be modified to produce constant surface speed. For 8T and Sprint 8T the input is 0001.

11.2.40 Number of master axis for slave axis (N433 bit 0-7)

To be defined later.

11.2.41 Slave axis settling time N434

To be defined later.

11.2.42 Sag compensation (N435 bit 0-7)

The table on page 0-23 gives the bit pattern. Sag compensation is described in section 6.3.2.

11.2.43 Spindle speed double (N436 bit 0)

To be able to realise double the normal maximum spindle speed allowed by the spindle encoder, a spindle to encoder gearing of 2:1 could be included. This machine bit would ensure the necessary doubling of the pulses from the encoder. With this feature the maximum speed would be 9999 rpm or 999.9 rpm.

11.2.44 Change sign of actual value from spindle (N436 bit 1)

This change of the sign of the spindle actual speed value will be taken into account in such things as the display and monitoring.

11.2.45 Pulse check active (N436 bit 2)

This bit activates the monitoring of the spindle position loop. The signals A,  $\bar{A}$ , B,  $\bar{B}$ , Z and  $\bar{Z}$  will be monitored (does not apply to MS200, MS300).

#### 11.2.46 Units of speed (spindle speed in 0.1 rpm N436 bit 3)

With this bit set, the units of spindle speed are not r.p.m. but r.p.m x 10<sup>-1</sup>

eg. For 99 r.p.m S990 would be programmed.

The spindle speed displayed will be correct (99 r.p.m.) and the monitoring will automatically take account of the times ten factor. The maximum speed with this bit set is 999.9 r.p.m.

#### 11.2.47 MS230, MS250 extended speed range (N436 bit 4)

If either of the p.c.b.'s MS230 or MS250 is being used the speed range can be extended to 9999 r.p.m. without any external modifications, such as gears.

#### 11.2.48 Sync. pulse. Specialized thread synchronisation (N436 bit 5)

With this synchronisation the hardware zero marker will be directly evaluated.

Example: With external null marker shift via the interface the thread synchronisation can be influenced.

Firm mainly using the facility: Wohlenberg, Hannover.

#### 11.2.49 Internal orientated spindle stop (M19) (N436 bit 6)

If the bit is set the function "M19" will be issued in the control via S-analogue. If the bit is not set "M19" will only be issued to the interface (see Interface description Part 2, section 2.6.18). M19 can only be used in the automatic mode. The polarity around the spindle position loop must be correct (ie. clockwise rotation of the spindle must produce a positive actual spindle speed).

#### 11.2.50 2 Decades tool offset numbers (N437 bit 0)

Only applicable to 8T and Sprint 8T.

According to the machine builder's wishes the tool offset number can be 1 or 2 decades. in which cases the highest offset numbers will be 9 and 32 respectively (see programming manual section 4.3).

#### 11.2.51 Machine data loaded (N437 bit 7)

This machine datum is the "go ahead" for the interface to execute its normal operating programme. It should be checked that machine datum N425 bit 4 is correctly adjusted.

#### 11.2.52 N438, N439

These machine data are to activate each of the various options assuming that the option has been purchased and installed.

#### 11.2.53 Amplitude correction for analogue measuring system (N440-N451 bit 0-5)

These machine data are important for resolver or Inductosyn applications. See section 6.4.

#### 11.2.54 Rotor signal monitoring (N440-N451, bit 6-7)

These machine data are important for resolver or Inductosyn applications. See section 6.4.

#### 11.2.55 Master/Slave axes (N452-N457 bit 0-1)

The numbers of the master and corresponding slave axes are entered here according to the table give on page 0-23.

The activation of the master/slave operation comes from an interface signal (Test N4 A15 bit 0).

The programmed axis is the master axis and the slave will follow the movements accordingly.

Example: 2 axes are programmed and for both the master/slave operation is selected, as far as the control is concerned, this is 2-D interpolation.

#### 11.2.56 Axis swop (N450 bit 0-7)

To be defined later.

11.2.57 M17 not issued (N425 bit 6)

M17, end of subprogramme, will not be issued as an M function to the interface, thereby saving a little time. M17 must however stand in a block by itself and the signal "Fixed cycle inhibit" (Test N4 A13 bit 6) must be active.

11.2.58 Corners taken gently (N437 bit 1)

This machine datum prevents the feedrate changing suddenly at corners on the contour. It would be typically applied on a lathe where small radii. are programmed and a the tool radius is large relative to the programmed radius.

## 12. Engineering panel of the SINUMERIK System 8

The engineering panel is an integral part of each control, and is activated by setting the service switch to the 4<sup>th</sup> position from the top.

### 12.1 Prerequisites for operation of engineering panel

### 12.2 Uses of the engineering panel

### 12.3 Principles of operation

3.1 Activating the engineering panel

3.2 Display

3.3 Breakpoints

### 12.4 List of the various commands

4.1 Service switch

4.2 Stop command

4.3 Display and modification of memory contents

4.4 Display and modification of register contents

4.5 Setting a breakpoint

4.6 C.P.U. number

4.7 G0 command

4.8 Single step command

### 12.1 Prerequisites for operation of engineering panel

To be able to use the engineering panel the computer must be in working order (C.P.U., memory, input/output boards), so must the operator's panel and the communication link between computer and operator's panel.

### 12.2 Uses of the engineering panel

- Display of, and, in the case of RAM data, alteration of contents of memory.
- Display and alteration of contents of registers.
- Setting breakpoints (at both programme addresses and addresses in the data area).
- Starting and stopping the programme.
- Single step mode with display.

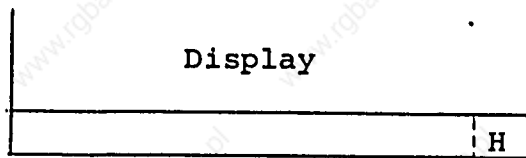
### Principles of operation

#### Activating the engineering panel

As soon as the CPU notices that the service switch is on position 4, it will run through the engineering or supervisory programme, in which only certain of the push buttons continue to be active. When the engineering programme has been selected and the CPU is running, data can be displayed (1 word at a time) and altered, breakpoints can be set and activated. In the halt condition the C.P.U. runs around a loop in the engineering programme, in which all interrupt levels are blocked, waiting for commands from the operator. The halt condition can be realised as follows:

- STOP command (= A stop in the engineering programme).
  - A break point being reached
  - NMI button
- } A STOP due to NMI at any point in the programme

The "STOP" condition will be shown in the display as follows:



If the programmed is stopped with an interrupt (NMI or single step) the contents of all the registers will be maintained, so that the programme can be restarted from that point.

After the programme has stopped (due to NMI or single step) the contents of all registers can be displayed and altered.

The programme can be restarted with a GO or STEP command.

Characteristics of the "STOP" condition "H":

- CPU's are ready for input commands and are now waiting in the engineering mode.
- The interrupt flags of all CPU's are cleared (Interrupts will be ignored).
- CPU's can be either on the NMI level or on the lowest level.

- Register display

IM = 80 xx CPU is on the NMI or single step level, the display shows the present state of the register

or

IM = 00 xx CPU is on the lowest level. The display shows the state of the register at the last breakpoint or single step, rather than the present state of the register. In this condition "Single step mode" is not possible.

- Registers are not displayed when the "STOP" condition has occurred due to the  button has been pressed or because the CPU is in "Single step mode" in the engineering programme ("H" stop in level B).

### 12.3.2 Display

When a programme is running in the engineering panel mode it will service the display in the normal fashion, only the 8<sup>th</sup> line at the bottom will be dedicated to the engineering panel. If the programme stops and the CPU is waiting in the engineering routine, the entire display can be used to display the contents of the registers.

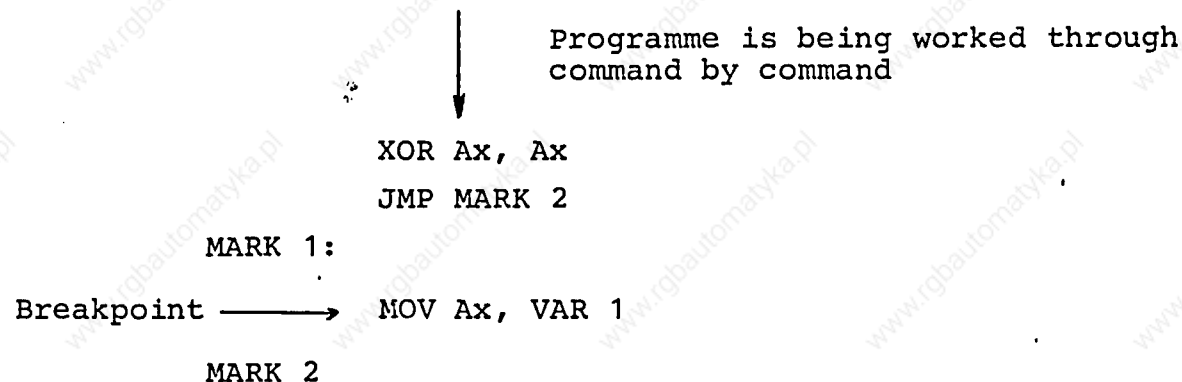
### 12.3.3 Breakpoints

If the processor is required to stop at a particular programme address, an address which is to be found in the ROM area, the CPU will be stopped with an interrupt when the required address appears on the address bus.

To increase its speed 8086 has a buffer store which acts like an instruction queue. The instruction will be executed some time after it was read in. According to the lengths of the instructions in the queue the processor could stop anywhere between one and five instructions too early. If the queue is empty, that is the execution times of the instructions were quite short, the processor may only be able to stop one instruction too late.

Because of this it is not possible to determine after an NMI if the processor has stopped before or after the desired address.

#### Example of fault



The processor fetches the MOV command before it has executed the jump command preceding it, and immediately stops, although the MOV command is not due to be executed (due to JMP MARK 2). By checking the address in the display at which the processor has stopped the operator can see if the stop has occurred at the required address or not.

If the breakpoint is set at an address to be found in the data area the processor always stops after the corresponding command has been executed.

The reading in of op-codes is done word by word, ie. only even numbered addresses will be issued. If the breakpoint is set on an odd-numbered address the bit A0 of the breakpoint register must not be set.

If the breakpoint address is the destination of a jump, the processor will issue A0 (ie. A0 must be blocked via the hardware).

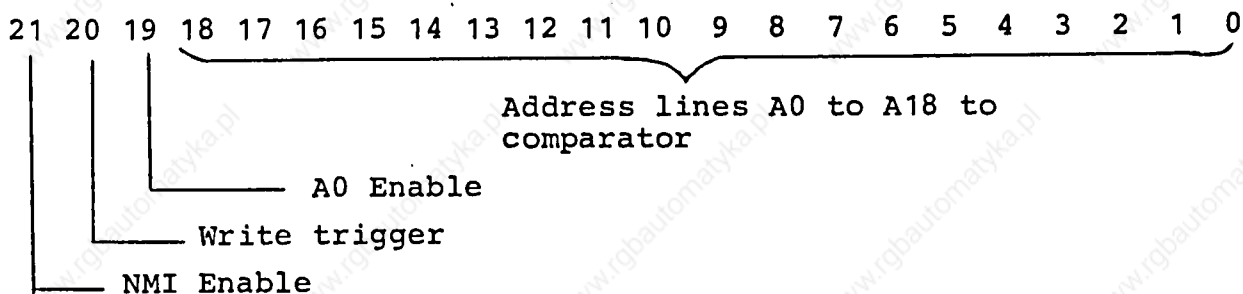
If the breakpoint occurs at an access to the data memory, bit A0 will still be zero since the addressing is done word by word.

If the breakpoint is set at an access to a single data byte (eg. Flags) bit A0 must be set.

A0 = 0 Trigger at a word or byte with an even numbered address

A0 = 1 Trigger at a data-byte with an odd numbered address.

#### Breakpoint register



The break point register can be set whilst the programme is running. The NMI Enable bit can be set when the command is entered or with the breakpoint push button (this push button is to be found on the operators panel just above the service switch). Even when the normal system programme is running this breakpoint pushbutton is still active. A breakpoint can therefore be activated although the service switch is not set to "Engineering panel". The interrupt thus produced stops the programme and starts the engineering programme. Engineering panel commands can be entered (without setting the service switch to "Engineering panel").

"Non maskable interrupt" (NMI) is used to prevent the masking or ignoring of a breakpoint interrupt.

The NMI can also be made using the NMI button on the MS100, regardless of whether a breakpoint has been set.

The NMI sets a flip-flop which will be cleared once the Interrupt-Service routine has been completed. After the processor has been stopped by an NMI the CPU number and the programme address (CS- and IP-Register) of the next command due to be executed will be shown in the eighth line of the display.

## 12.4 List of the various commands

Each command must be issued to the control by pressing the  LF button.

In the following description of operations information or data in brackets is optional  .

- 12.4.1 Service switch - Put to position 4, "Engineering panel"
- Programme will run on
  - Display will be serviced as before
  - Only engineering panel commands can be entered.

- 12.4.2 STOP command - The 3 CPU's will stop in the engineering routine by pressing  %  LF

### 12.4.3 Display and modification of memory contents

M  LF Display will be thus:

```

s s s s - o o o o - d d d d
  └───┘   └───┘   └───┘
Segment  Offset  Data

```

After M has been entered the address (segment and offset) and data of the last M command will be displayed.

- The segment address can be altered by entering  S with the new segment address and then  LF .
- The offset address can be altered by entering  L with the new address and then  LF .
- The data can be altered by entering  X and the new data (input is by words - high byte - low byte) and then  LF .
- The offset address can be incremented by 2 (ie. to display the next data word) by pressing the  LF button. The data can then be modified as just described.

- The M command will be terminated if any button other than those mentioned above are pressed or if the command terminate sequence  I  LF is used.

When the offset or segment addresses are being altered care must be taken that during the change the control doesn't "see" any address it cannot access and thereby stop. Under this condition the control can only be restarted with hardware reset.

#### 12.4.4 Display and modification of contents of registers

- Display all registers

R  LF

- Particular register display and alter

X  n  LF

n = Register number.

After the  X command has been made the register code and contents will appear in the bottom line of the display. At this point the contents of the register can be altered or the next register be displayed by pressing the  LF button.

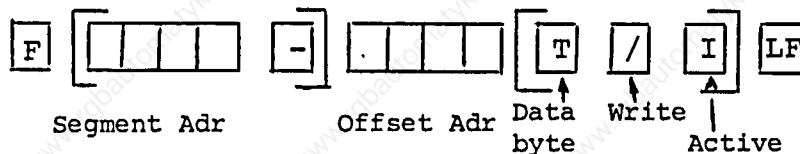
Register numbers:

AX :	0	Accumulator
BX :	1	Base register
CX :	2	Count register
DX :	3	Data register
SP :	4	Stackpointer
BP :	5	Base pointer
SI :	6	Source index
DI :	7	Destination index
CS :	8	Code Segment
DS :	9	Data Segment

SS : A Stack segment  
 ES : B Extra segment  
 IP : C Command pointer  
 FL : D Status flag  
 IM : E Interrupt mask register

#### 12.4.5 Setting a breakpoint

The stop address consists of a segment address (code- or data segment) and an offset address. Additionally if the breakpoint is set at a data cell, it should be specified whether the halt should be made at a byte at a - WRITE - or at a - READ or WRITE -. The breakpoint can be activated with the setting command or, after the service switch has been moved to position 4, with the activating pushbutton adjacent to the service switch.



After the breakpoint has been reached the comparator will be made inactive

[F] [I] [LF] = activate again  
 [F] [LF] = Display of the breakpoint  
 and control bits

#### 12.4.6 C.P.U. Number - display and modification

[N] [ ] [LF] CPU Nr 0 Master  
 1 Slave 1 (Interpolation)  
 2 Slave 2 (Servo processor)

To select a C.P.U. other than the one already being assumed by the engineering panel, the appropriate number must be entered in  .

Memory, Register, Breakpoint and Single Step commands all apply to the CPU selected by the numbers 0, 1, 2. All other commands apply to all CPU's.

#### 12.4.7 G0 command. Start command for simulation



lap counter

The engineering panel routine will be left and the programme continued from the point at which it was interrupted by the NMI or Stop command, or at a different address if the instruction pointer (and maybe code segment register) have been reset. All three CPU's will continue to run until a breakpoint generates an NMI.

With the "lap counter" a certain number of times past the breakpoint can be made, up to the number in the lap counter (0 corresponds to one lap).

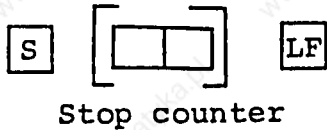
When the lap counter number has been reached the CPU's will be stopped and the address displayed.

If no breakpoint has been set, the CPU's will run until a stop command is entered.

If the command   is entered and subsequently the service switch moved from 4 to 1 the system will transfer to its normal mode.

12.4.8 Single step command

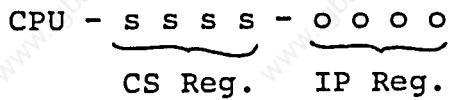
In this mode one step corresponds to one command.



The C.P.U. to be tested is selected as described in section 12.4.6. The C.P.U. will restart at the point of interruption by an N.M.I, or at the address written into the instruction pointer. After each command has been executed the CPU stops. Each step is made by pressing the LF button.

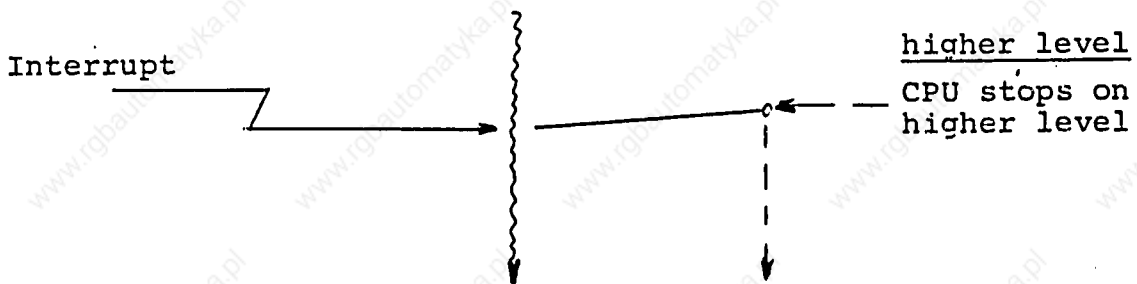
A prescribed number of steps that should be executed before the next stop, can be entered into the "step counter" shown above, (0 corresponds to one step).

After each step or number of steps, if the step counter is being used, the current programme address will be displayed.



12.4.8 Special points to note with single-step-mode

If, in the single step mode, a higher priority interrupt comes before the command is executed the C.P.U. will go to the higher level and execute the single step interrupt routine.



Test programme in single step mode

If an IRET command should be executed and an interrupt comes with a higher priority than the original level, the processor will jump into the new interrupt routine and will not execute the single step interrupt routine.

- The pre-selected CPU continues running although the other CPU's are in the stop condition.
- When using single step mode it is best to mask the other interrupt levels.

Example:

Levels, which should be disabled, should have a 1 in the interrupt mask.

eg. Only interrupt 5 should be enabled

Bit	7	6	5	4	3	2	1	0	this corresponds to hexadecimal DF
	1	1	0	1	1	1	1	1	

IM must be set to DF Hex.