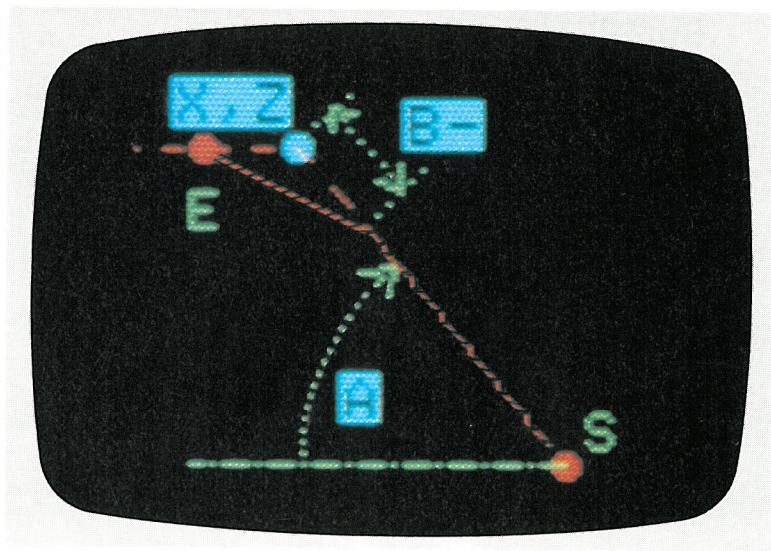
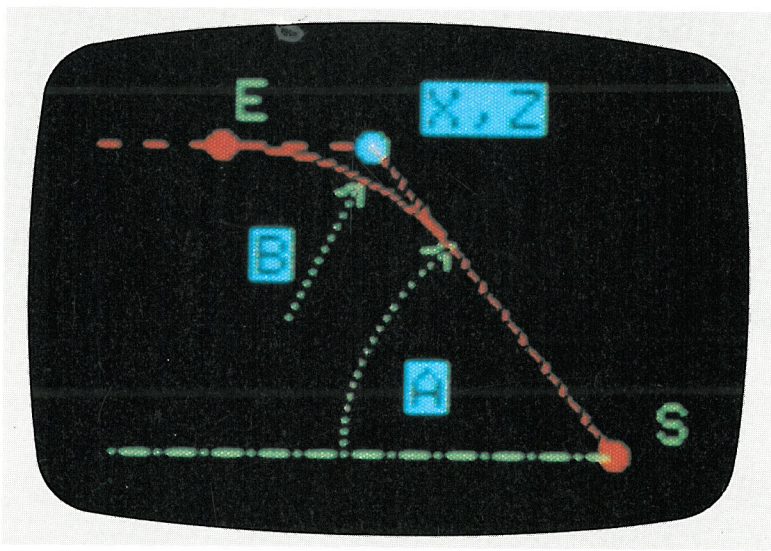
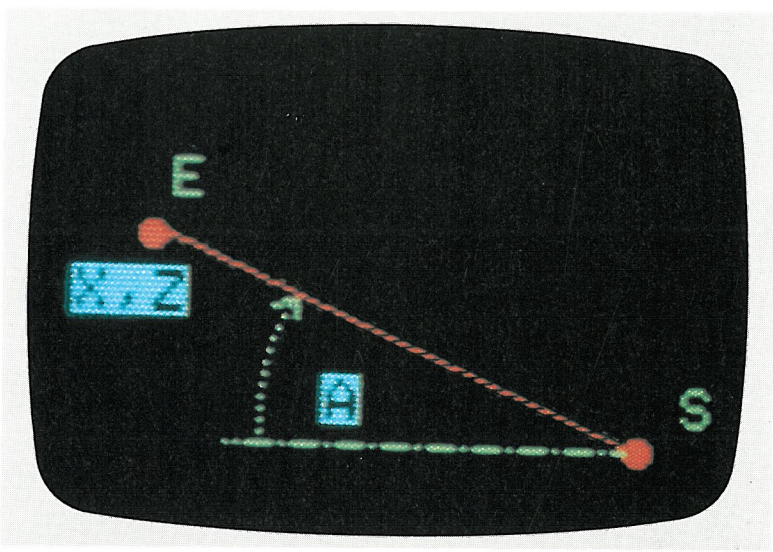
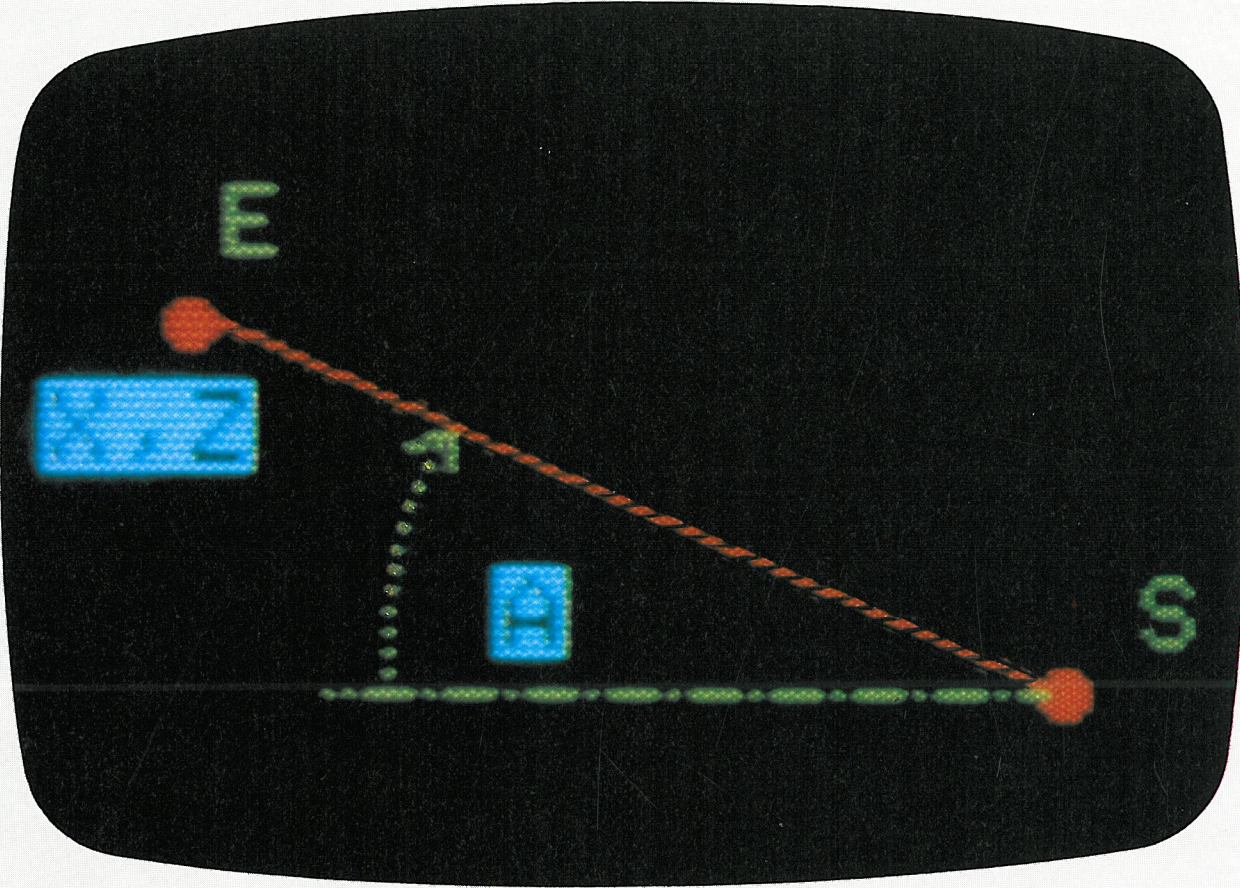


# Geometric options with G1





**X** = Target diameter

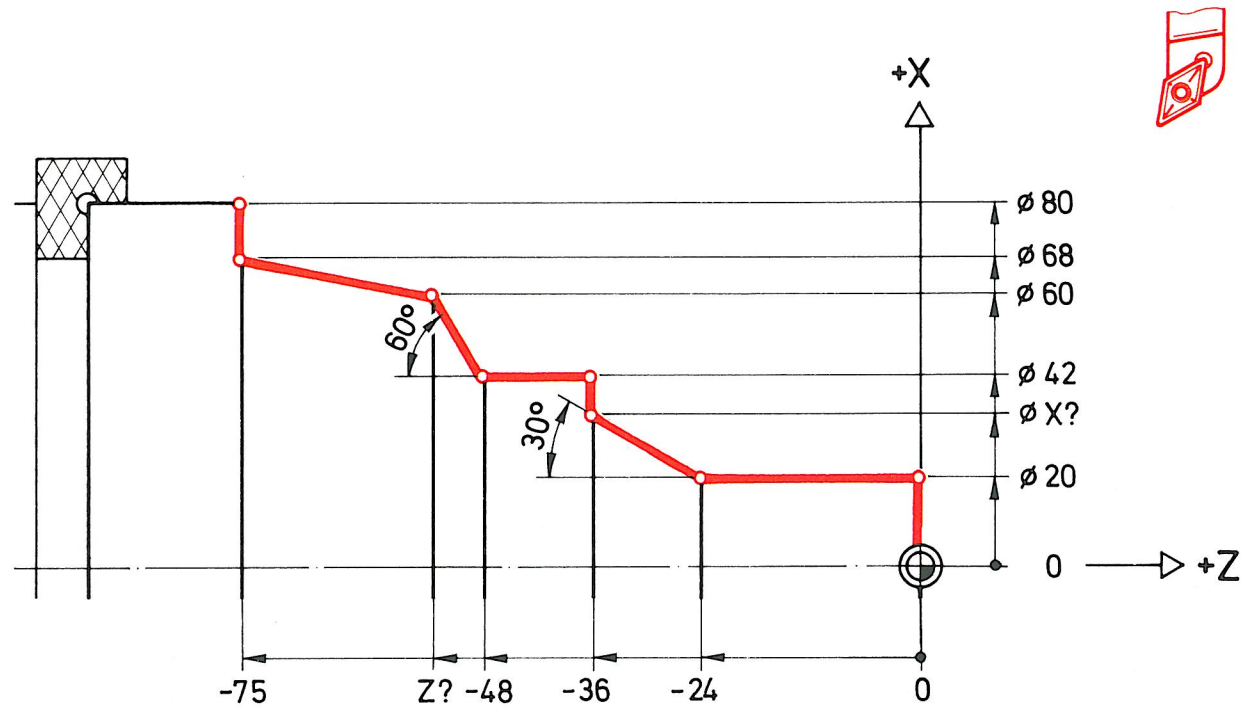
**Z** = Target length

**A** = Angle

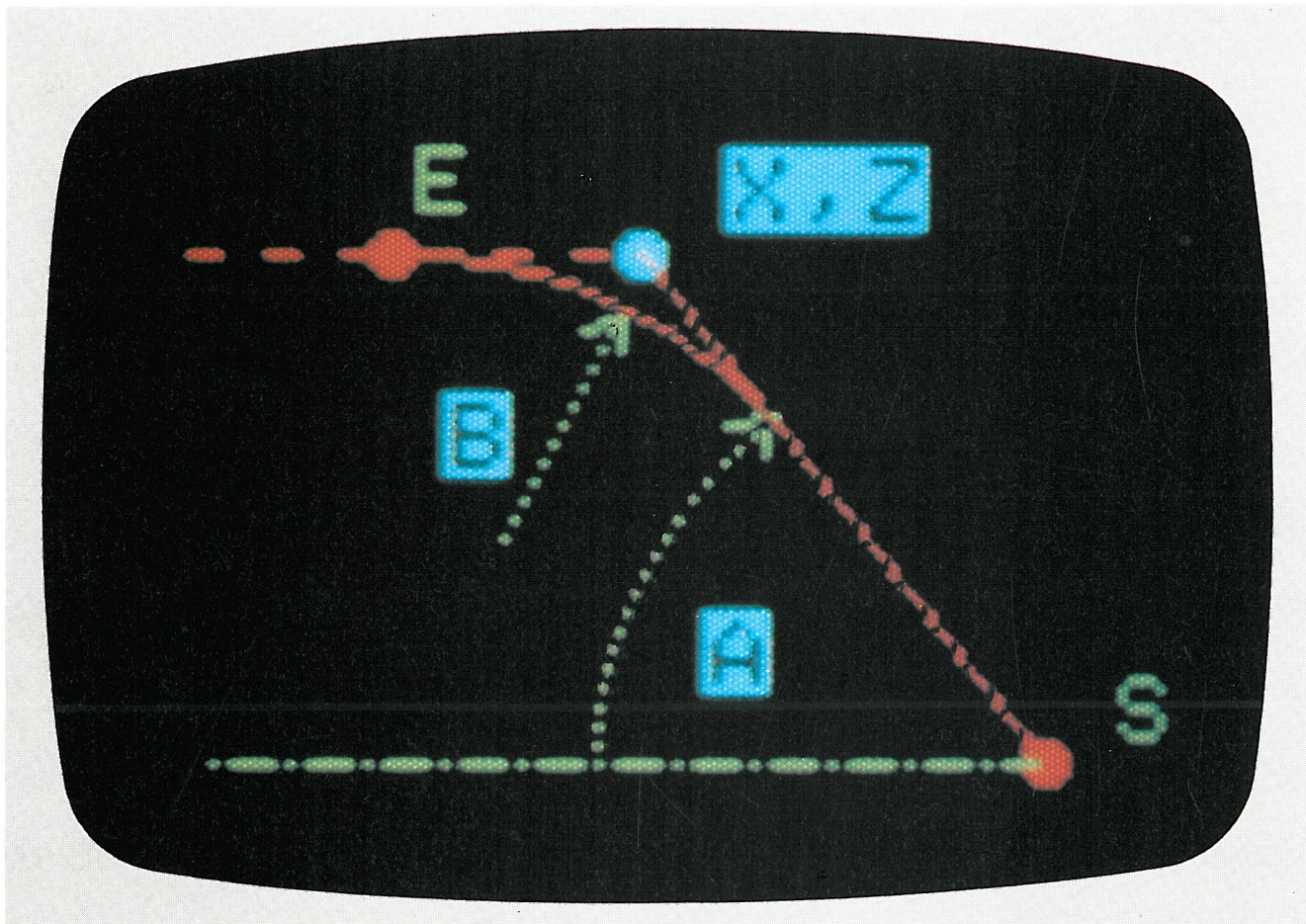


21.1

# G1 linear interpolation with X, Z and angle A



% 1001		N	G	X	Z	Auxiliary addresses	F	S	T	M
		N1	G0	X0	Z2					
		N2	G42 G1		Z0					
		N3	G1	X20						
		N4	G1		Z-24					
		N5	G1	X?	Z-36	A30				
		N6	G1	X42						
		N7	G1		Z-48					
		N8	G1	X60	Z?	A60				
		N9	G1	X68	Z-75					
		N10	G1	X80						
		N11	G40 G1	X82						
		N12								M30



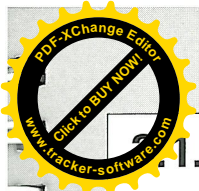
**X** = Target diameter

**Z** = Target length

**E** = Actual end point of the radius

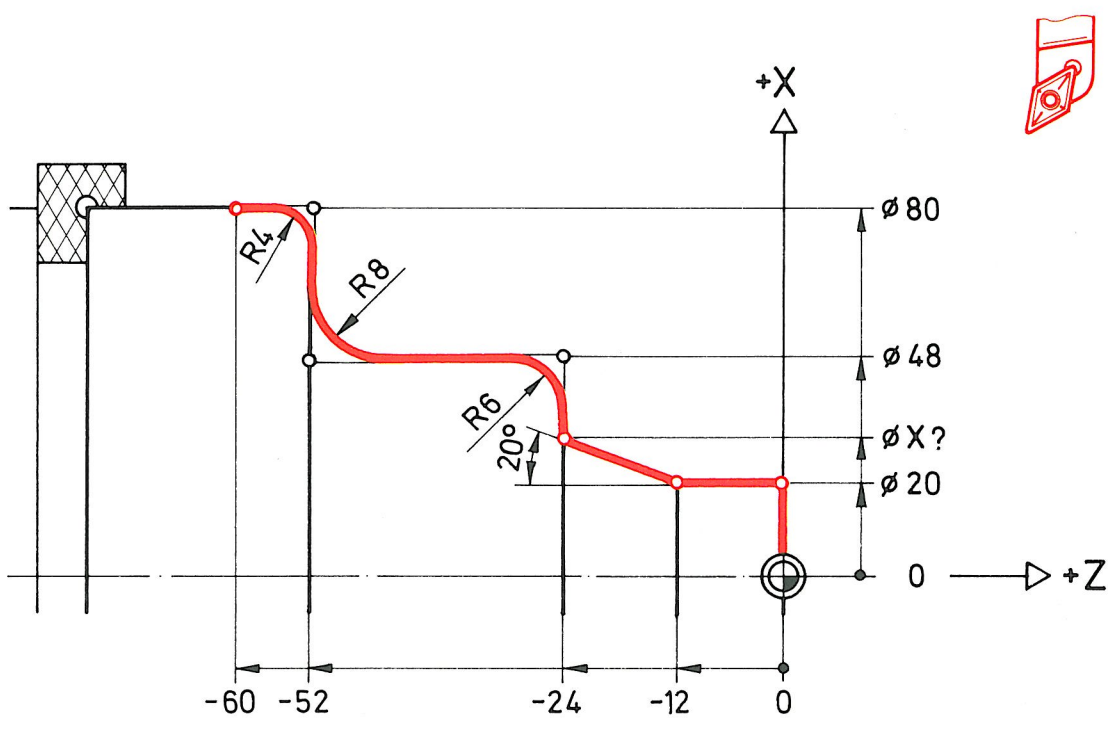
**A** = Angle

**B** = Tangential arc



# 3.1.2

## G1 linear interpolation X, Z, A and tangential radius B



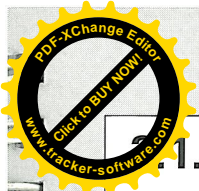
% 1002		N	G	X	Z	Auxiliary addresses	F	S	T	M
N1	G0	X0	Z2							
N2	G42 G1		Z0							
N3	G1	X20								
N4	G1		Z-12							
N5	G1	X?	Z-24	A20						
N6	G1	X48		B6						
N7	G1		Z-52	B8						
N8	G1	X80		B4	E0.08*					
N9	G1		Z-60							
N10	G40 G1	X82								
N11										M30

\* Special feed rate for small blending radii and chamfers.

Note:

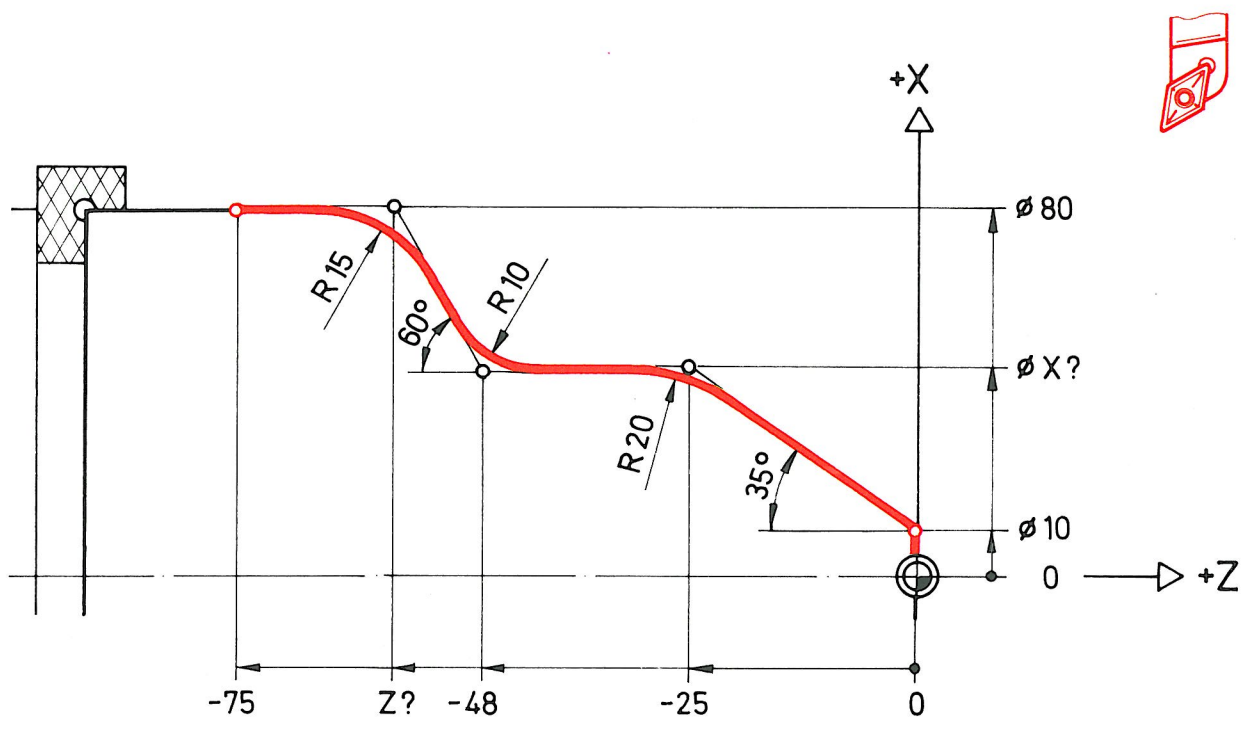
These contours can alternatively be programmed with G87. This however has the disadvantage that only 90° radii can be programmed (see chapter 3.1.3ff).



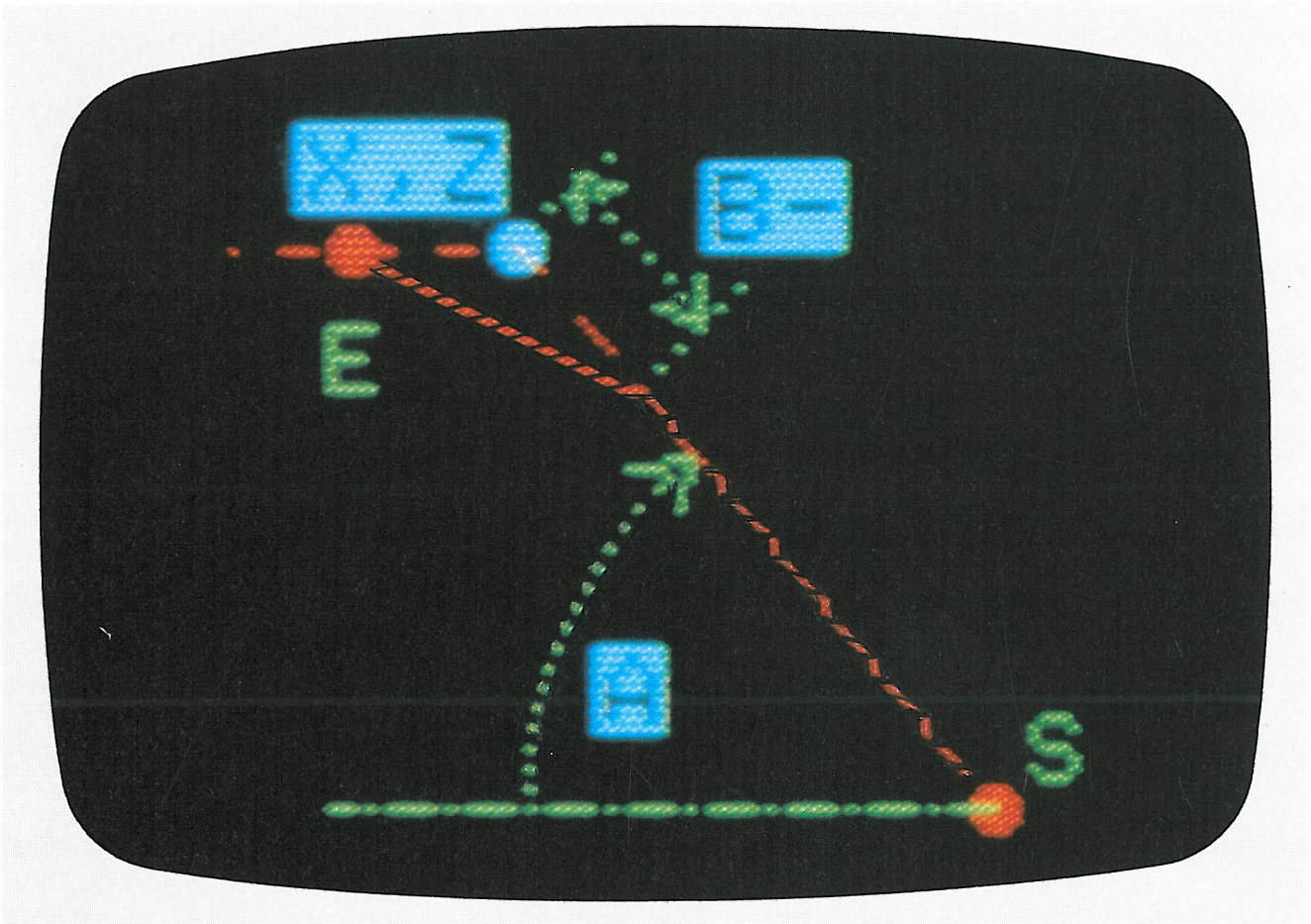


1.3

# G1 linear interpolation with X, Z, A and tangential radius B



%		1003								
N	G	X	Z	Auxiliary addresses			F	S	T	M
N1	G0	X0	Z2							
N2	G42 G1		Z0							
N3	G1	X10								
N4	G1	X?	Z-25	A35	B20	E0.08				
N5	G1		Z-48		B10					
N6	G1	X80	Z?	A60	B15					
N7	G1		Z-75							
N8	G40 G1	X82								
N9										M30



**X** = Target diameter

**Z** = Target length

**E** = Actual end point of chamfer

**A** = Angle

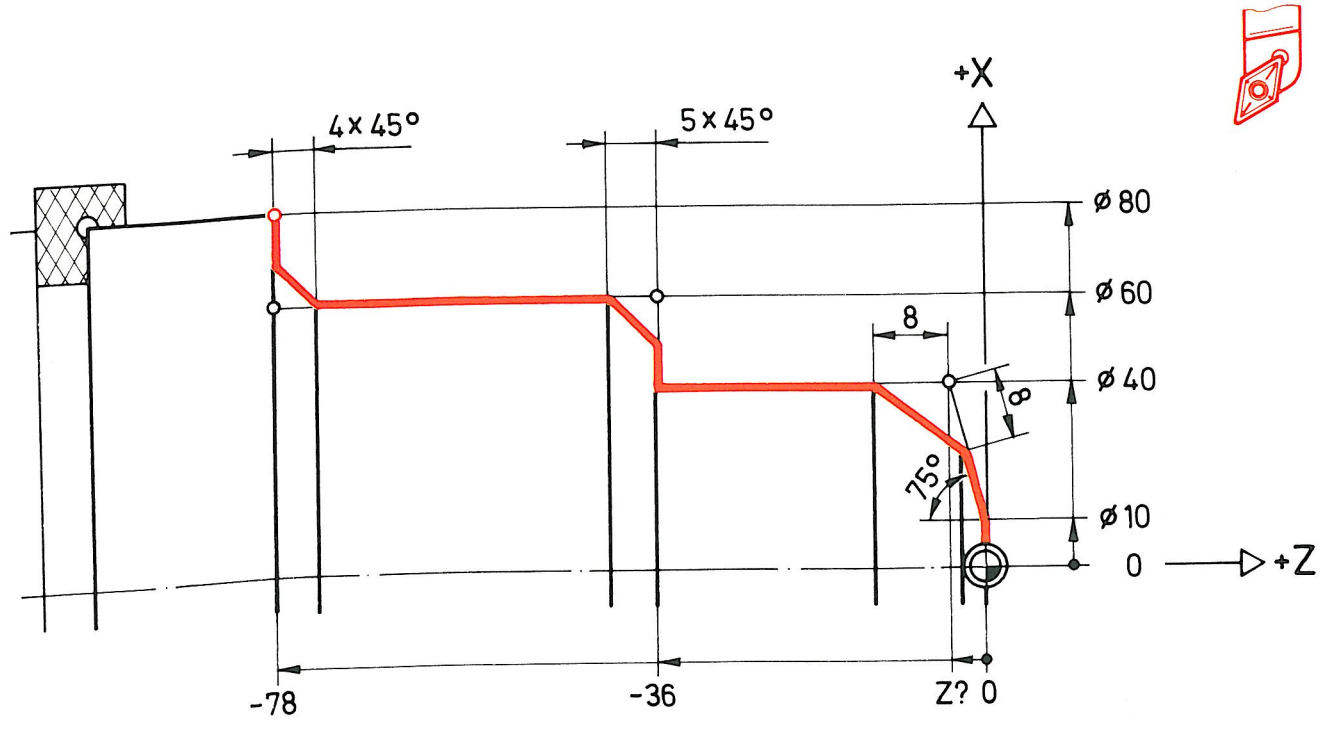
**B-** = Chamfer





3.1.4

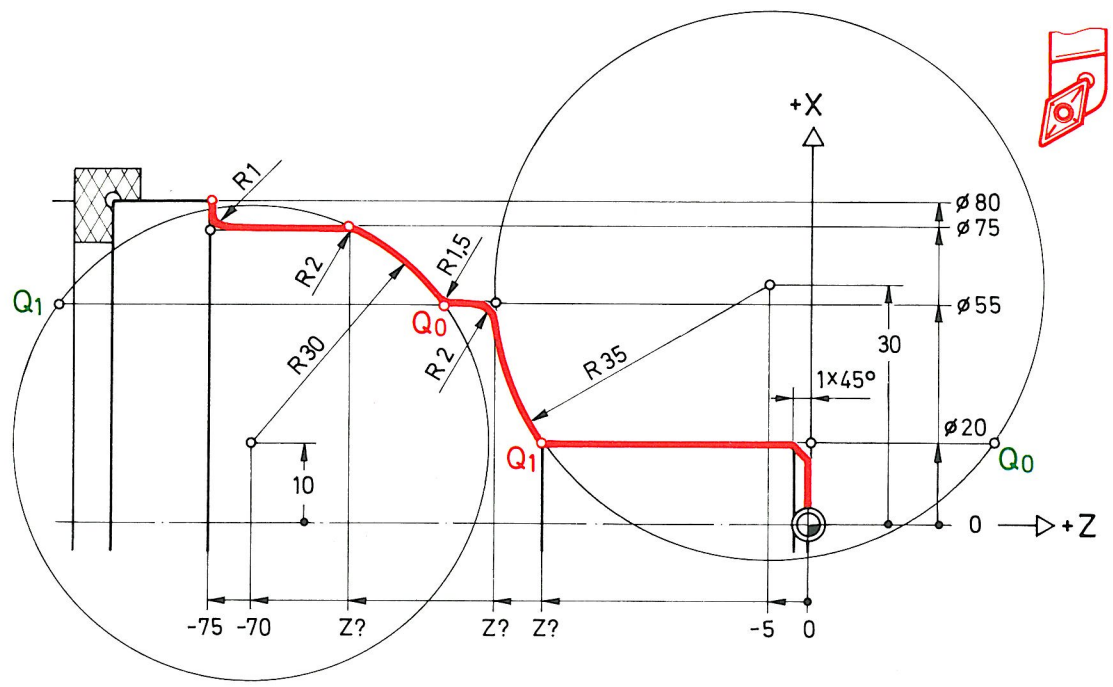
# Linear interpolation G1 with X, Z, A and chamfer B



% 1004		X	Z	Auxiliary addresses	F	S	T	M
N	G	X0	Z2					
N1	G0	X0	Z2					
N2	G42 G1		Z0					
N3	G1	X10						
N4	G1	X40	Z?	A75 B-8				
N5	G1		Z-36					
N6	G1	X60				B-5		
N7	G1		Z-78			B-4		
N8	G1	X80						
N9	G40 G1	X82						M30
N10								

Note:  
The external chamfer 5 x 45° can also be programmed with G88.

# Linear interpolation with Q0 and Q1 quadrant recognition



% 1005		X	Z	Auxiliary addresses	F	S	T	M
N1	G0	X0	Z2					
N2	G42 G1		Z0					
N3	G1	X20						
N4	G1		Z?	A0 Q1				B-1
N5	G12	X55	Z?	I30 K-5 R35				B0
N6	G1		Z?	A0 Q0				B2
N7	G13	X75	Z?	I10 K-70 R30				B1.5
N8	G1		Z-75					B2
N9	G1	X80						B1
N10	G40 G1	X82						
N11								M30

Take note that:

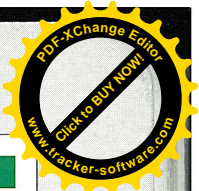
The Q0 and Q1 addresses are required in special cases where a straight line runs into a radius.

- Q0 = Intersection point straight — radius right.
- Q1 = Intersection point straight — radius left

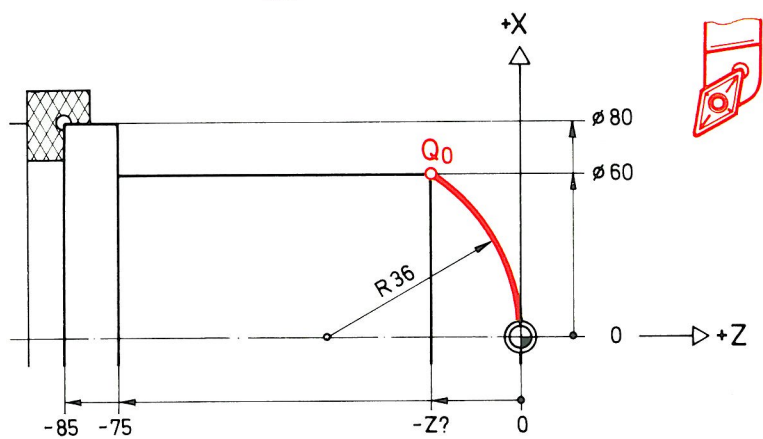
These addresses are not required if the contour consists of G1 elements or if the intersection point of the straight — radius is clearly defined by the X and Z coordinates.

If no Q0 is programmed, the Q0 is automatically effective.

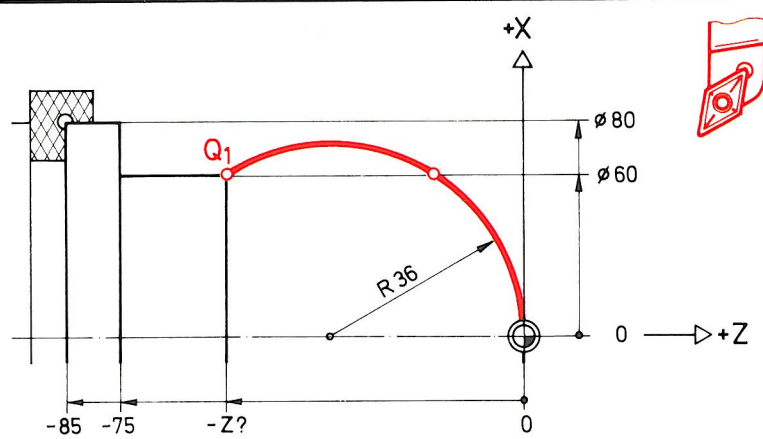
In accordance with the programme, Q0 and Q1 must be interchanged.



# Circular interpolation with Q0 and Q1 quadrant recognition

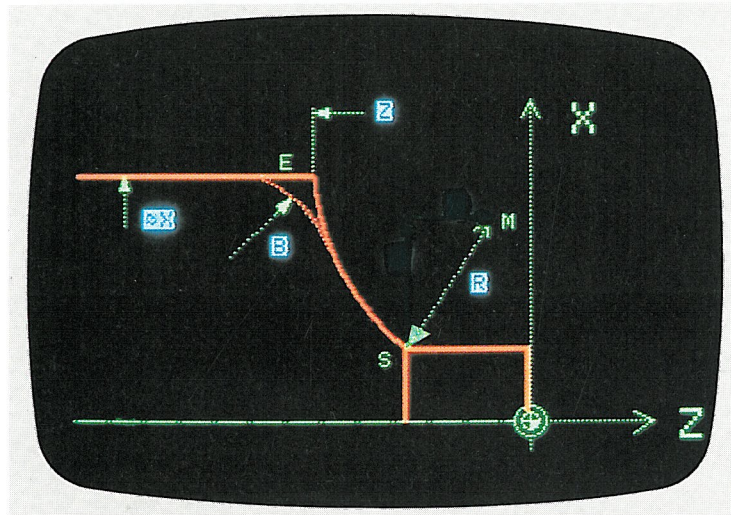


% 1006		N	G	X	Z	Auxiliary addresses	F	S	T	M
N1	G0	X0	Z2							
N2	G42 G1	X60	Z0							
N3	G3	X60	Z?	10	K-36	B0	Q0			
N4	G1		Z-75							
N5	G1	X80								
N6	G40 G1	X82								
N7										M30

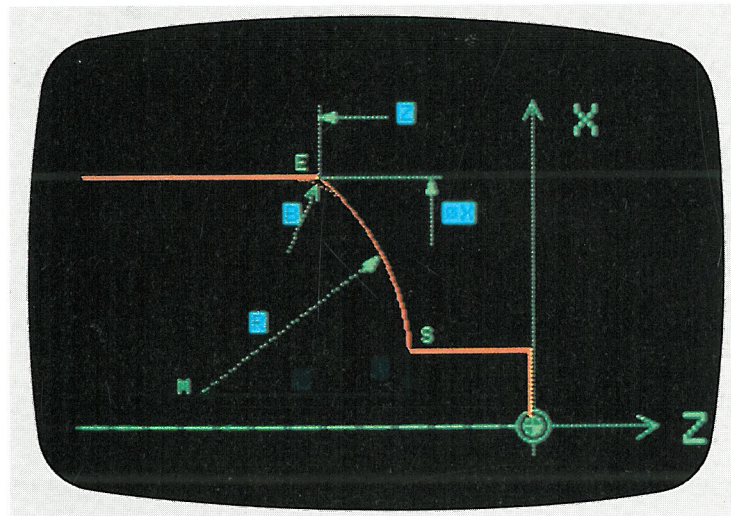


% 1007		N	G	X	Z	Auxiliary addresses	F	S	T	M
N1	G0	X0	Z2							
N2	G42 G1	X60	Z0							
N3	G3	X60	Z?	10	K-36	B0	Q1			
N4	G1		Z-75							
N5	G1	X80								
N6	G40 G1	X82								
N7										M30

## G2



## G3



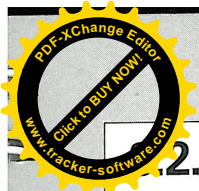
**X** = Target diameter

**Z** = Target length

**R** = Radius value

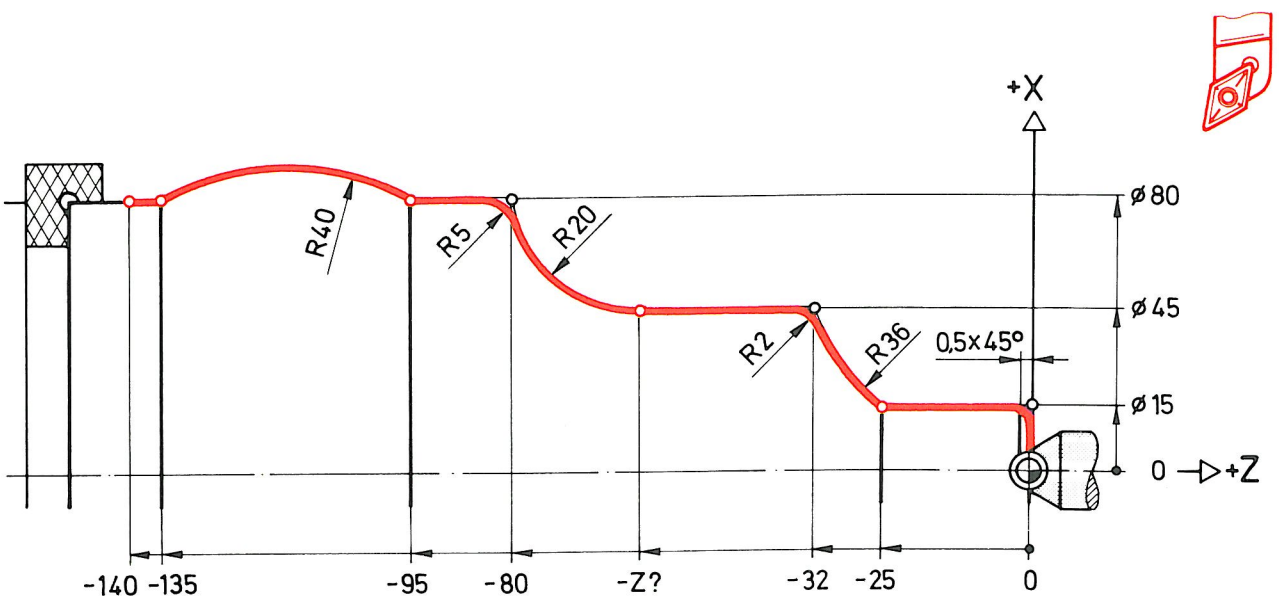
**B** = Tangential arc

**B = 0**: Sign for non-tangential intersection point



# 2.2

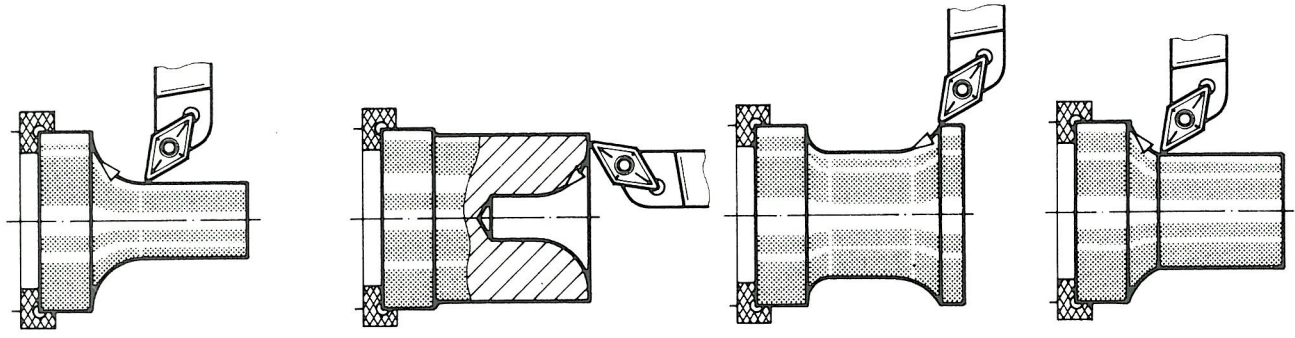
## Circular interpolation G2/G3 with X, Z, R and B



% 1008		N	G	X	Z	Auxiliary addresses	F	S	T	M
		N1	G0	X13	Z2					
		N2	G42 G1		Z0					
		N3	G1	X15		B-0.5 E0.05				
		N4	G1		Z-25	B0				
		N5	G2	X45	Z-32	R36 B2				
		N6	G1		Z?	A0				
		N7	G2	X80	Z-80	R20 B5				
		N8	G1		Z-95	B0				
		N9	G3	X80	Z-135	R40 B0				
		N10	G1		Z-140					
		N11	G40 G1	X82						
		N12								M30

Take note that:  
 If straights run into radii or radii into straights, where the intersection point is not tangential than B0 must be programmed in.

# Establishing the I and K lengths with G2/G3

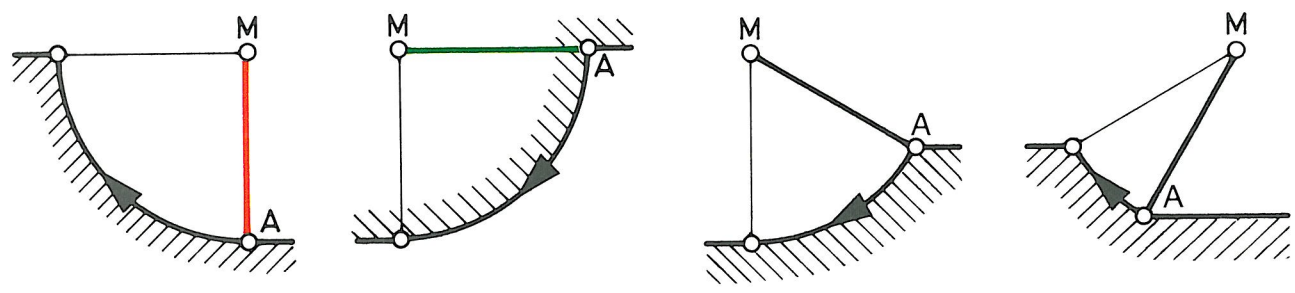


In certain cases it is necessary to programme radial traverses with I and K addresses (instead of R).

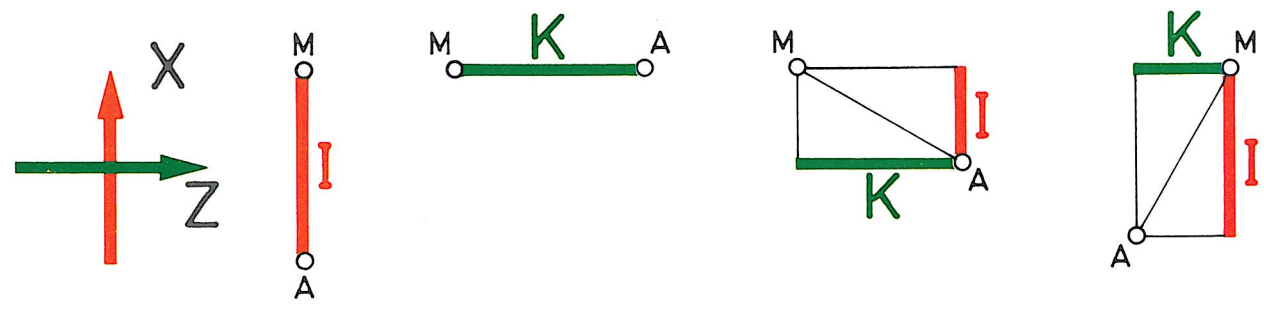
Block format: N... G... X... Z... I\*... K\*

\* I relates to X  
K relates to Z.

For I and K only the start point A and the centre of the radius M are of relevance.

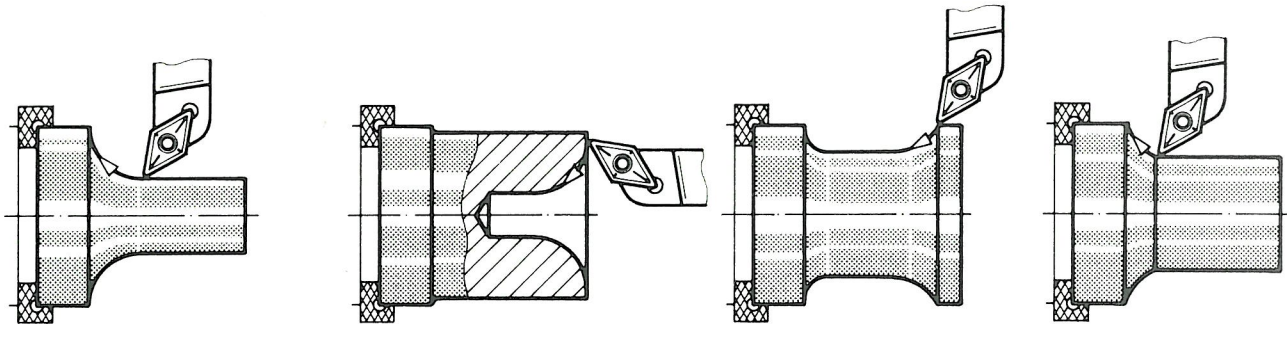


The I and K are parallel to X and Z between points A and M.



2.4

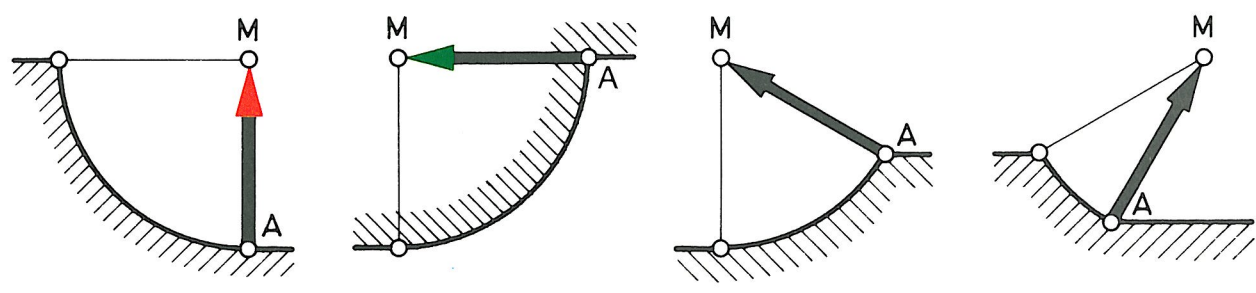
# Establishing the sign for I and K with G2/G3



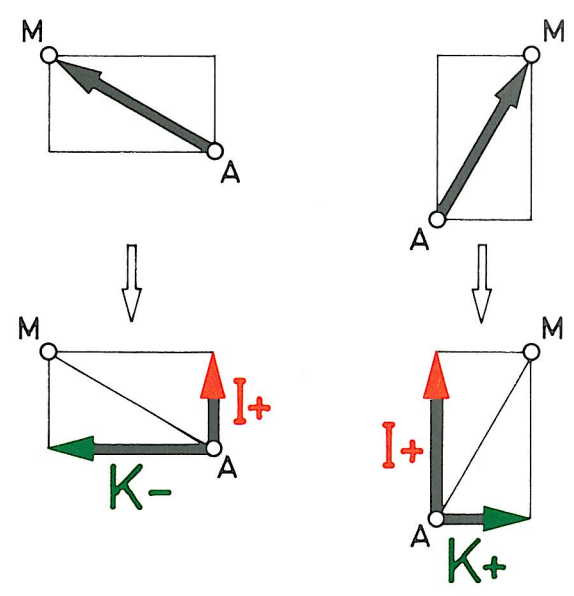
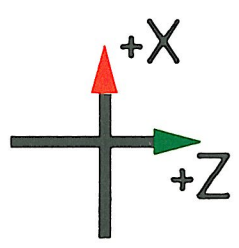
The I and K lengths can have either a **positive** or **negative** sign.

Steps to establish sign:

1. Look from **A** to **M** and insert the directional arrow.

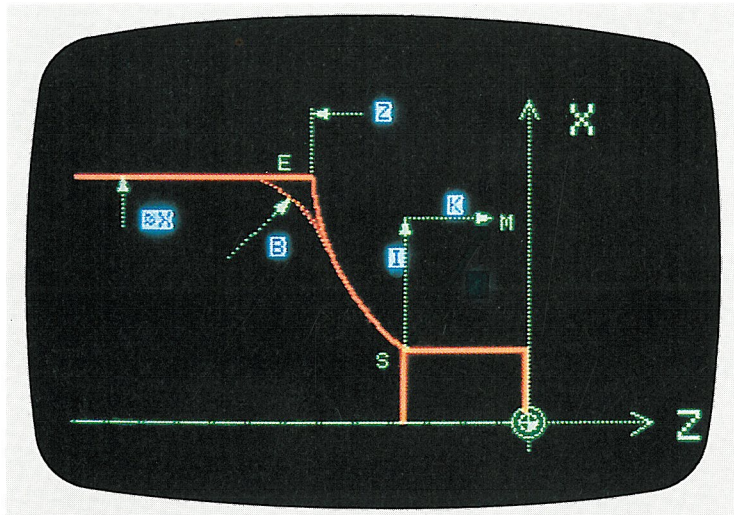


2. If the line A — M is **not** vertical or horizontal, the line must be "vectored".

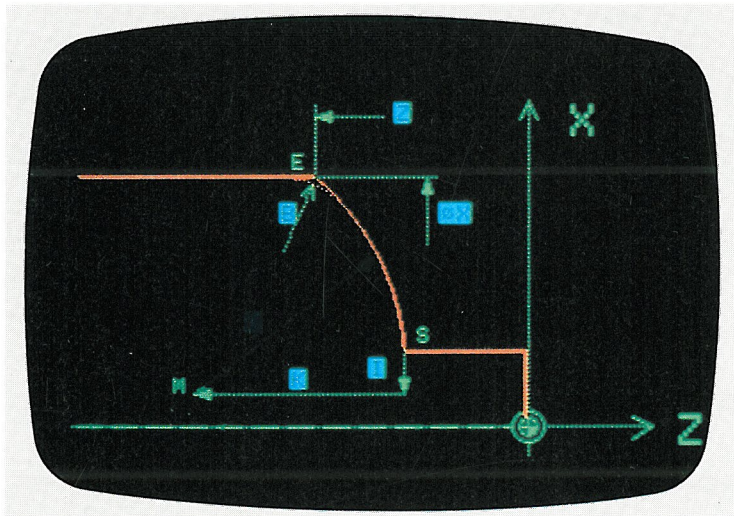


3. The **signs** for I and K result from the comparison with the axis directions x and z.

## G2



## G3



**X** = Target diameter

**Z** = Target length

**I\*** = Radius centre point in X direction (incremental)

**K** = Radius centre point in Z direction (incremental)

**B** = Tangential arc

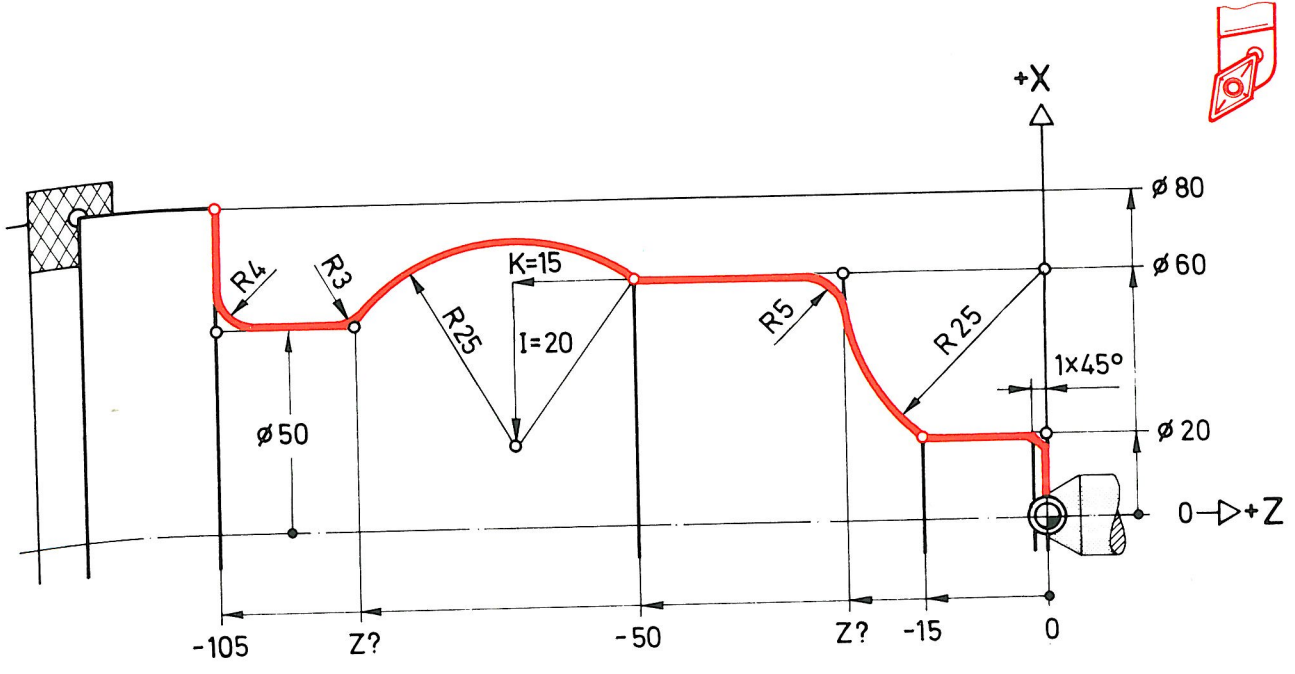
\* Note: I is always the radius value!





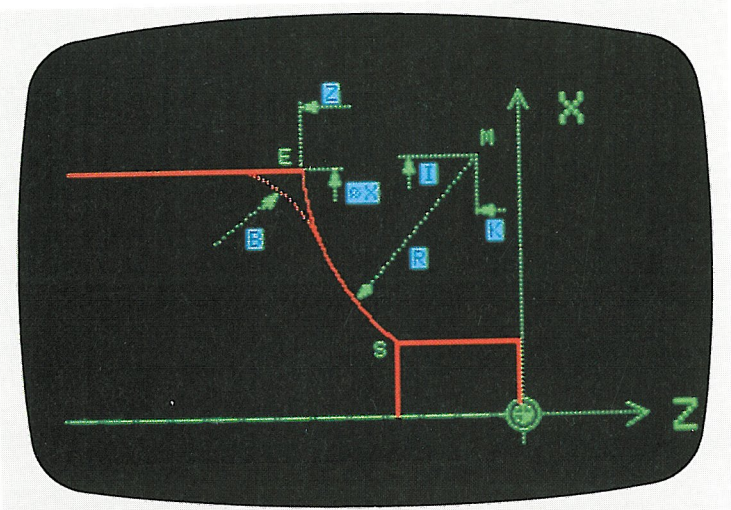
### 3.2.5

# Circular interpolation G2/G3 with X, Z, I, K and B

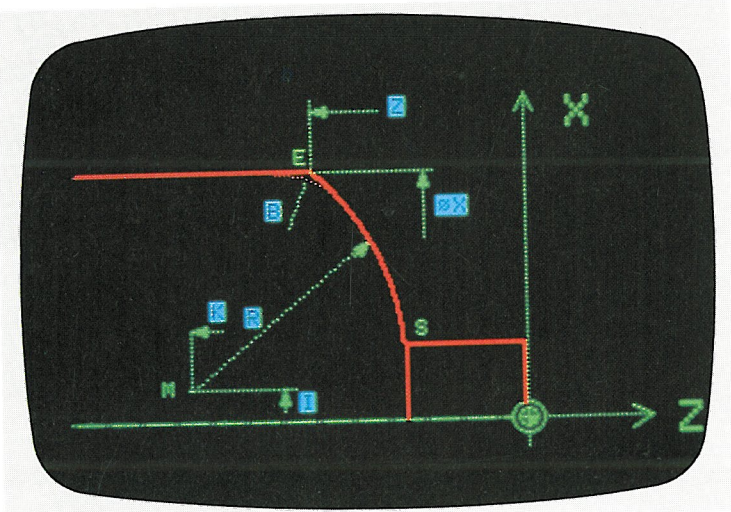


% 1009		X	Z	Auxiliary addresses	F	S	T	M
N	G	X16	Z2					
N1	G0	X16	Z2					
N2	G42 G1		Z0					
N3	G1	X20		B-1				
N4	G1		Z-15	B0				
N5	G2	X60	Z?	I20 K15 B5				
N6	G1		Z-50	B0				
N7	G3	X50	Z?	I-20 K-15 B3				
N8	G1		Z-105	B4				
N9	G1	X80						
N10	G40 G1	X82						M30
N11								

## G12



## G13



**X** = Programmed target diameter

**Z** = Programmed target length

**I\*** = Radius centre point in X direction (absolute value)

**K** = Radius centre point in Z direction (absolute value)

**R** = Radius value

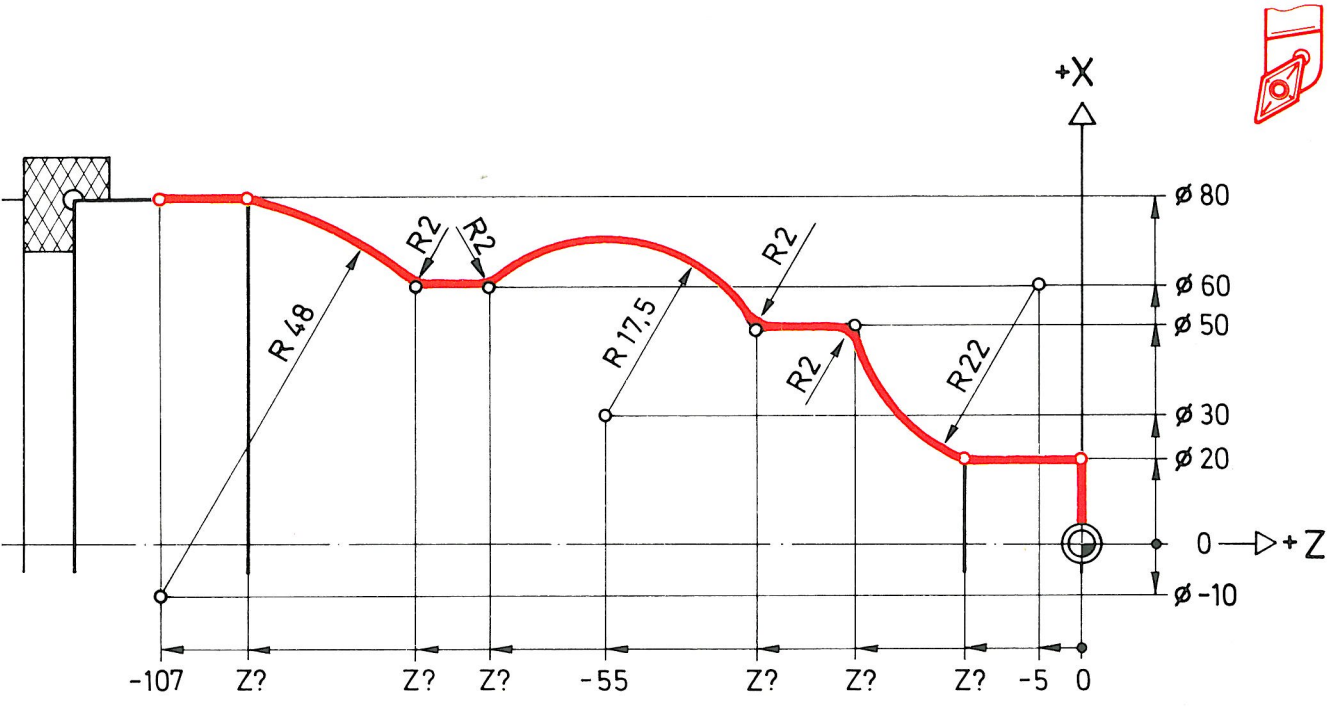
**B** = Tangential arc

\* Note: I is always the radius value!

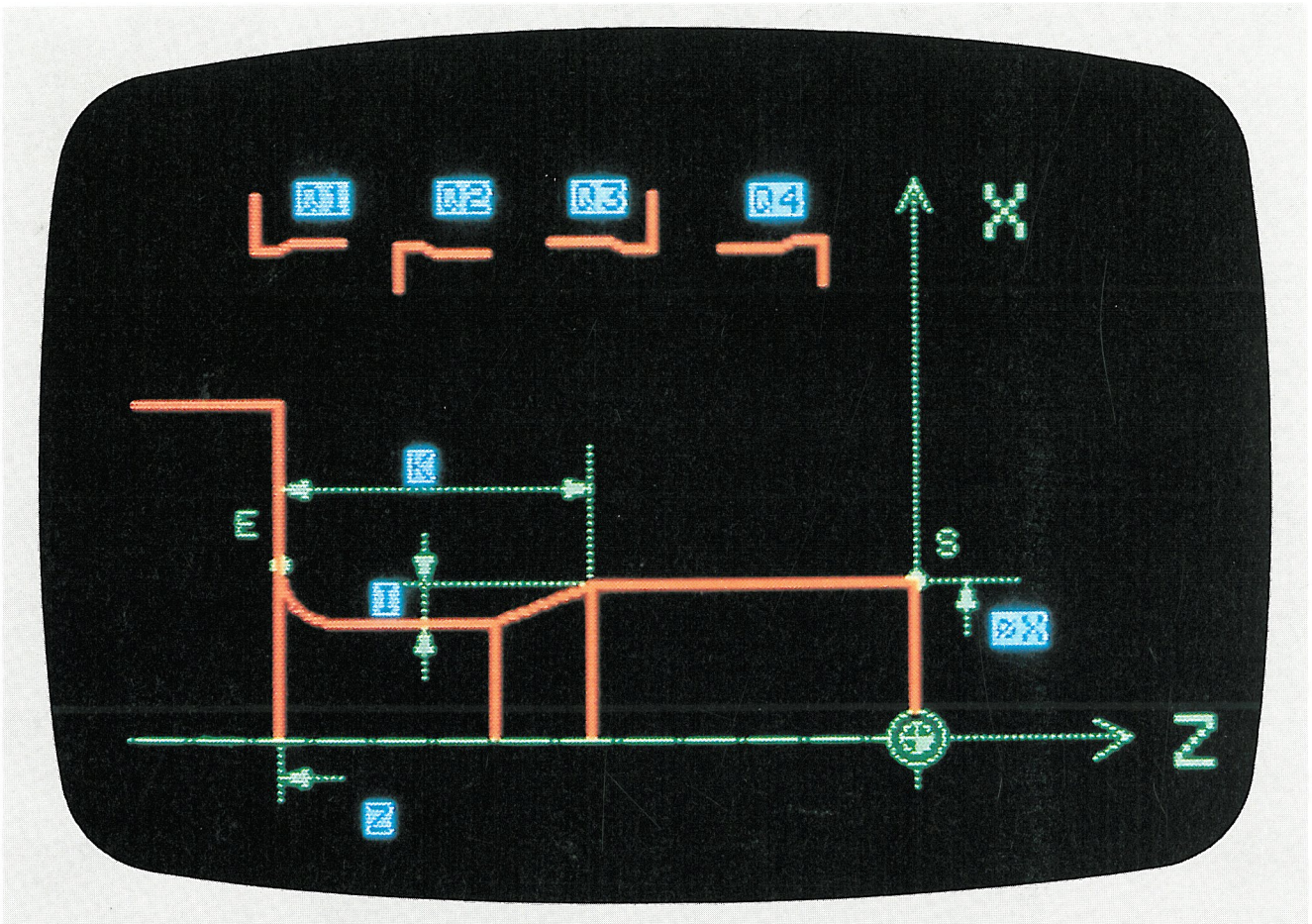


# Circular interpolation G12/G13 with X, Z, I, K, R and B

With G12/G13 the centre point is given in **absolute** values.



% 1010										
N	G	X	Z	Auxiliary addresses			F	S	T	M
N1	G0	X0	Z2							
N2	G42 G1		Z0							
N3	G1	X20								
N4	G1		Z?	A0 B0		Q1				
N5	G12	X50	Z?	I30 K-5	R22	B2				
N6	G1		Z?	A0 B2						
N7	G13	X60	Z?	I15 K-55	R17.5	B2 Q1				
N8	G1		Z?	A0 B2						
N9	G13	X80	Z?	I-5 K-107	R48	B0 Q0				
N10	G1		Z-107							
N11	G40 G1	X82								
N12										M30



**X** = Outside diameter

**Z** = Target length

**Q** = Quadrant recognition

**I\*** = 1. Depth of DIN 76 undercut  
2. Grinding tolerance to DIN 509

**K** = 1. Width DIN 76 undercut  
2. DIN 509, form F

\* Take note: I is always the radius value!

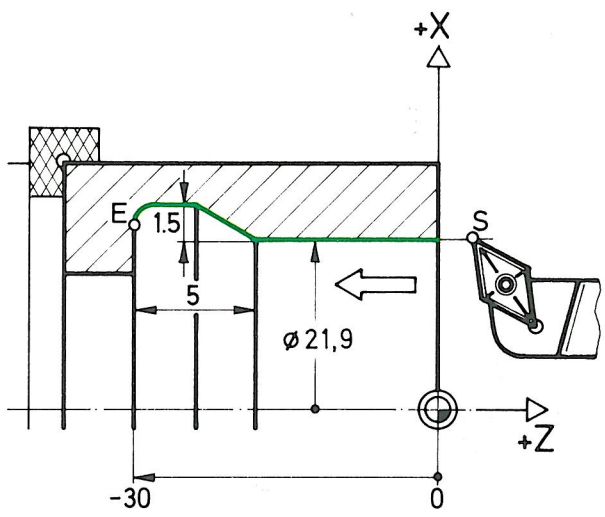
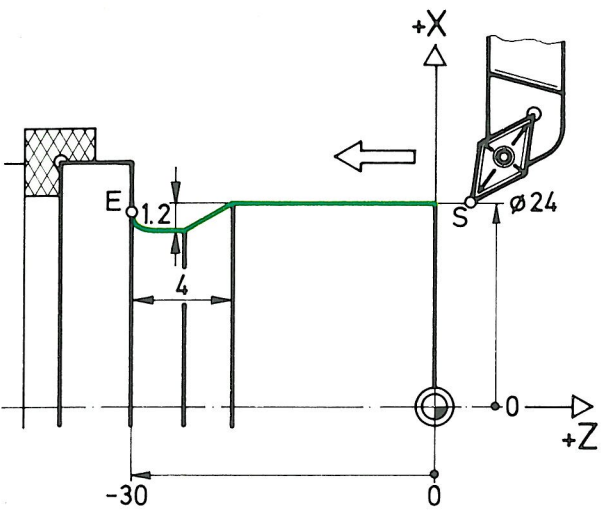
.4.1

# Quadrant recognition with undercut G85

The Q adress determines the position of the undercut.

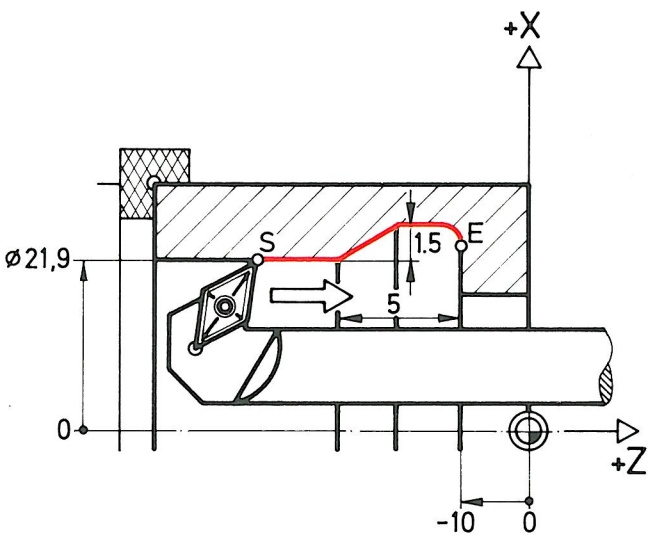
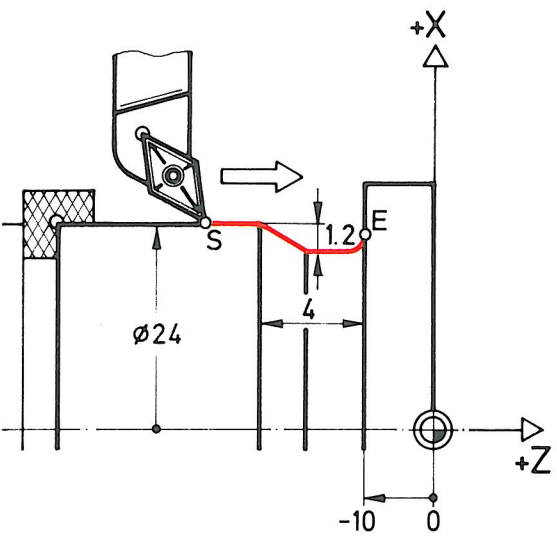
External

Internal



N... G85 Z-30 **Q1** I1.2 K4

... G85 Z-30 **Q2** I1.5 K5



N... G85 Z-10 **Q3** I1.2 K4

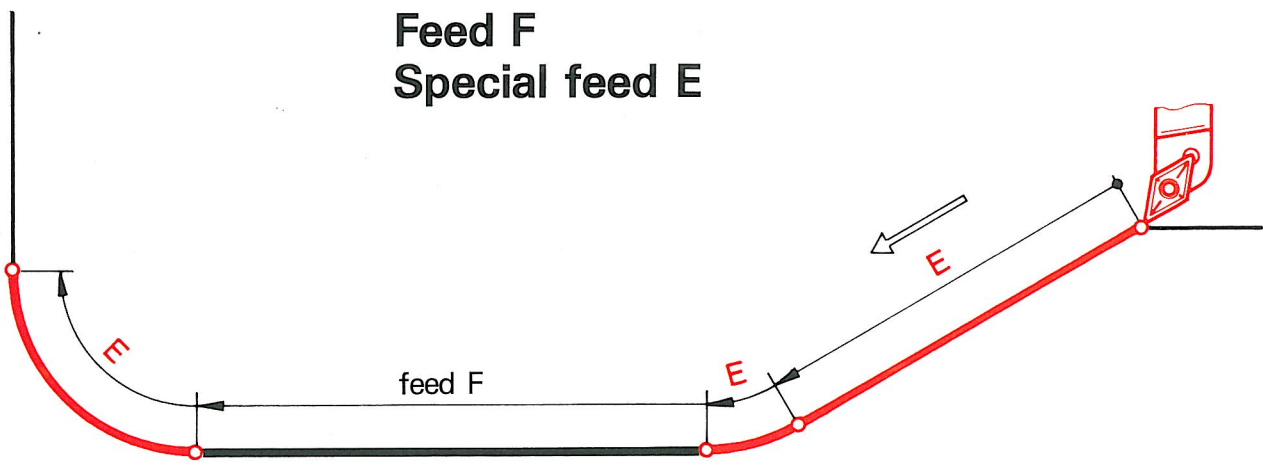
... G85 Z-10 **Q4** I1.5 K5



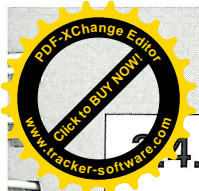
# Special features with G85

## Feed programming for an undercut

N	G	X	Z	Auxiliary addresses	F	S	T	M
	G85		Z-30	Q1 I1.8 K8.7 E0.08				



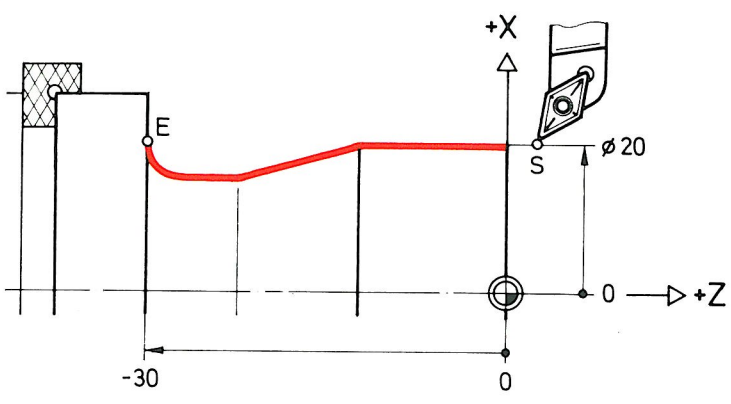
**Note:**  
 Tapers and radii can be produced as desired with a special feed **E**.  
 The rest of the contour is carried out with the previously programmed feed **F** of tool nose radius compensation is required, then this has to be selected in advance.



### 4.3

# G85 for DIN 509 and DIN 76 undercuts

## 1. DIN 509, form E undercut

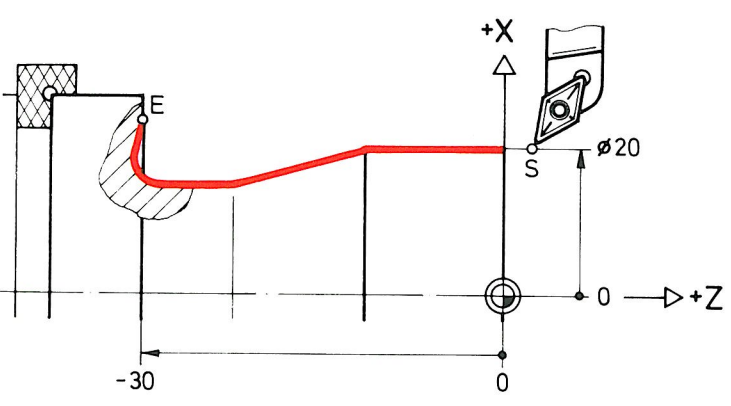


```

... G0 X20 Z2
G85 Z-30 Q1 E0.08
... G1 X30

```

## 2. DIN 509, form F undercut



Programme without grinding allowance

```

... G0 X20 Z2
G85 Z-30 Q1 KO
... G1 X30 Form F

```

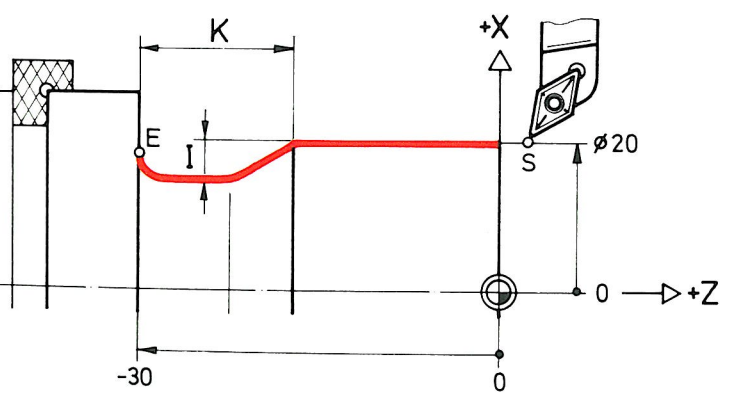
Programme with grinding allowance

```

... G0 X20.3 Z2
G85 X20 Z-30 Q1 10.15 KO
... G1 X30 Grinding allowance (radial)

```

## 3. DIN 76 Thread undercut

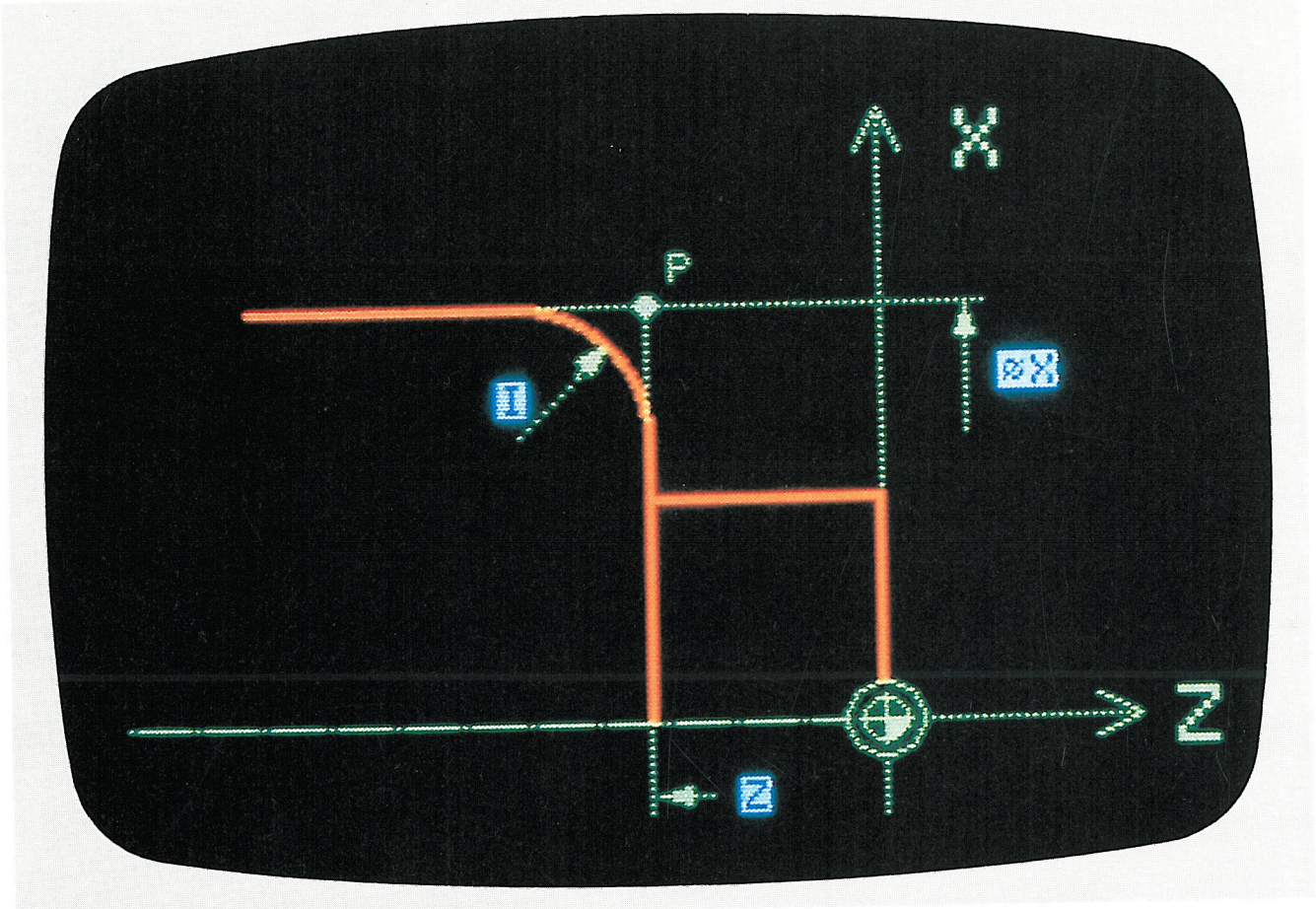


```

... G0 X20 Z2
G85 Z-30 Q1 11.8 K8
... G1 X30

```

Depth I |  
Width K



**X** = Target diameter

**Z** = Target length

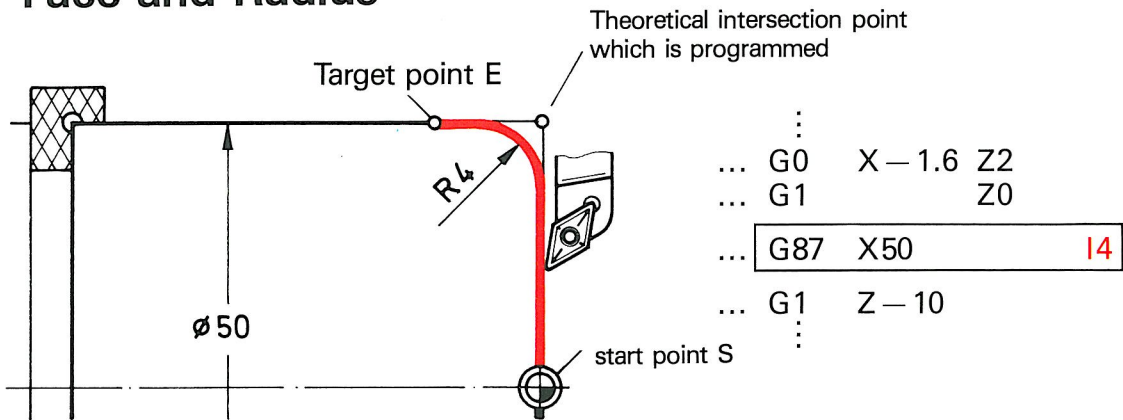
**l** = Radius value



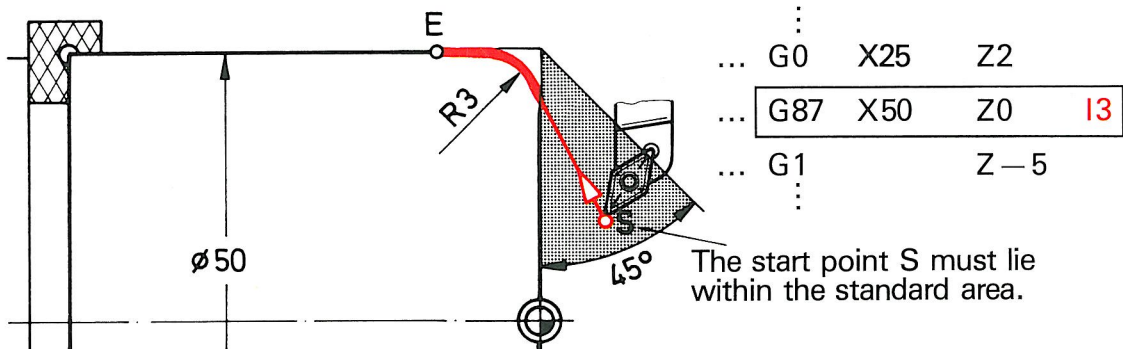
# G87 special radius with X, Z and I

G87 is only used for simple radii: TNRC is automatically activated.

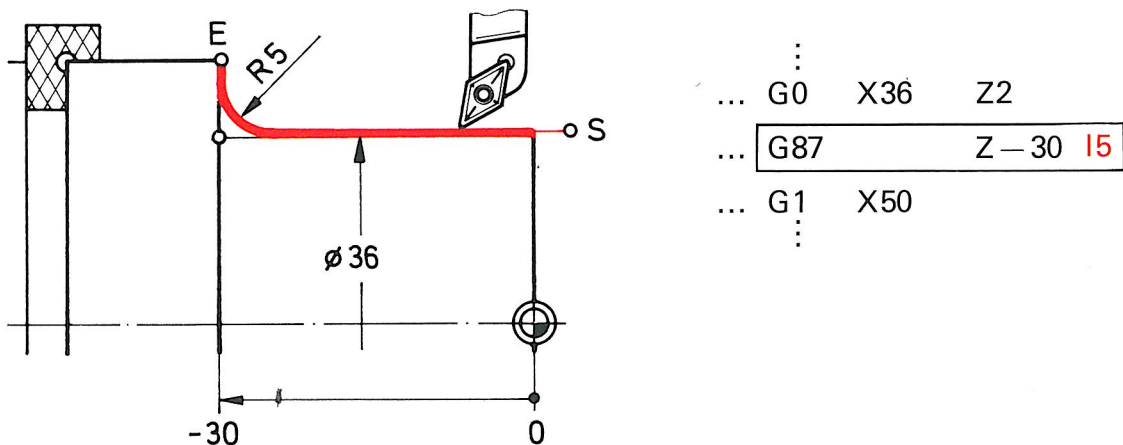
## Case 1: Face and Radius

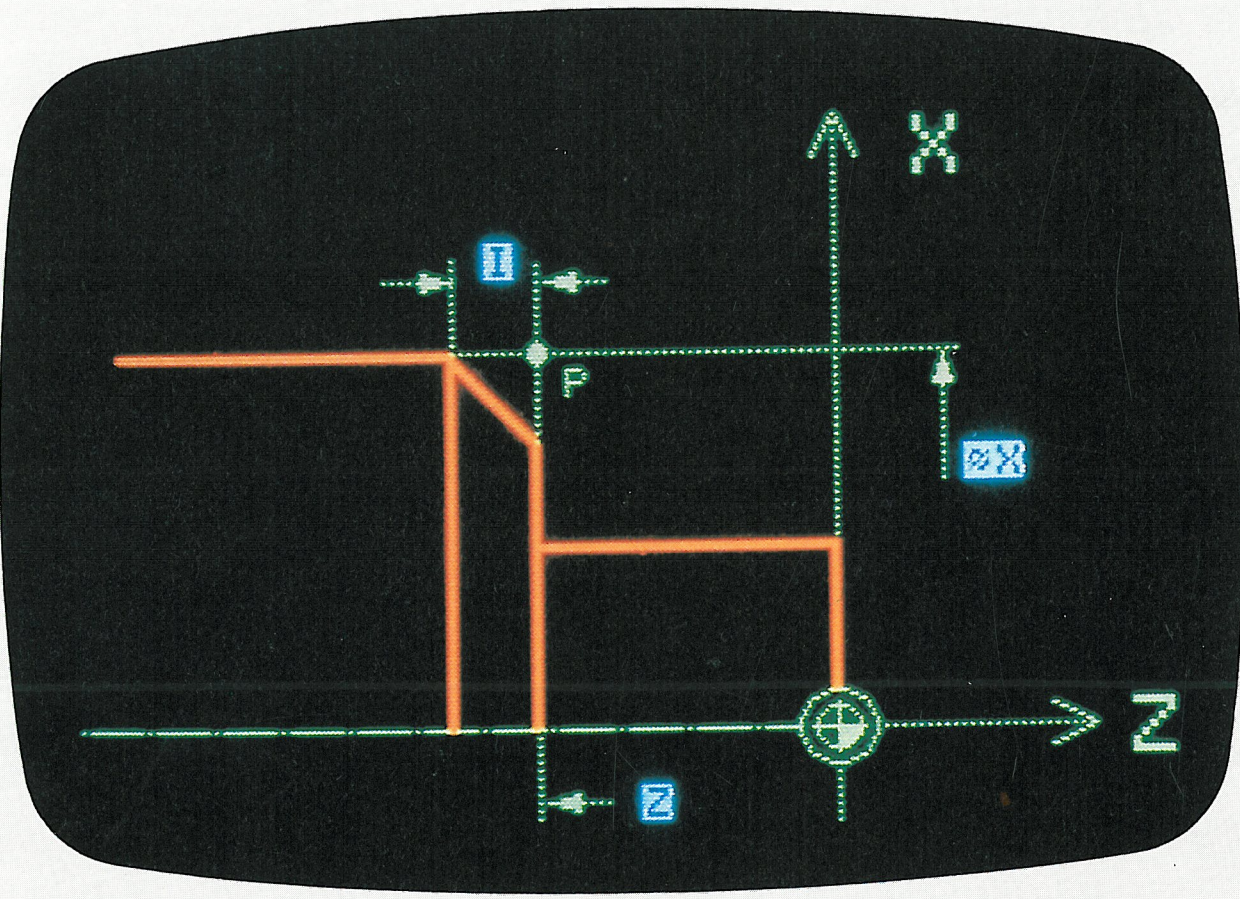


## Case 2: Radius only



## Case 3: Longitudinal turning and radius





**X** = Target diameter

**Z** = Target length

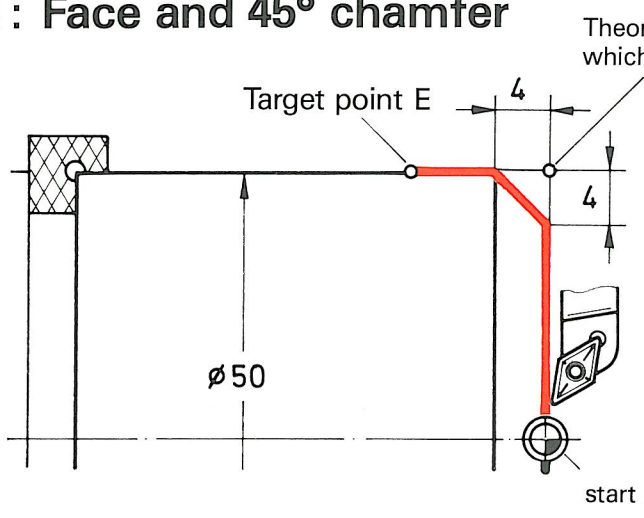
**l** = Size of chamfer



# G88 special chamfer with X, Z and I

G88 is only used with 45° chamfers: tool nose radius compensation is automatically effective.

## Case 1: Face and 45° chamfer

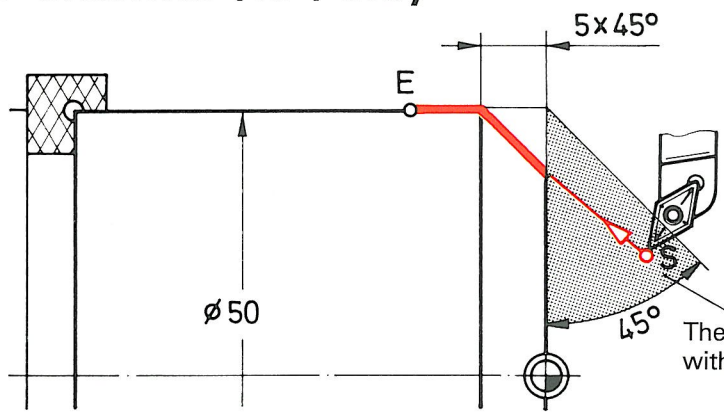


```

... G0 X-1.6 Z2
... G1 Z0
... G88 X50 I4
... G1 Z-10

```

## Case 2: Chamfer (45°) only



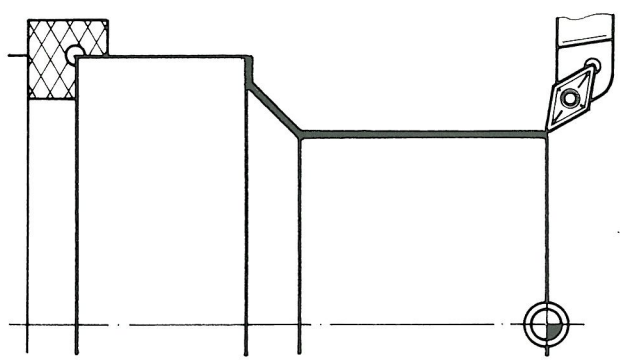
```

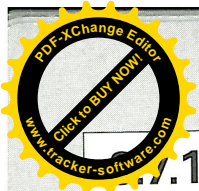
... G0 X25 Z2
... G88 X50 Z0 I5
... G1 Z-10

```

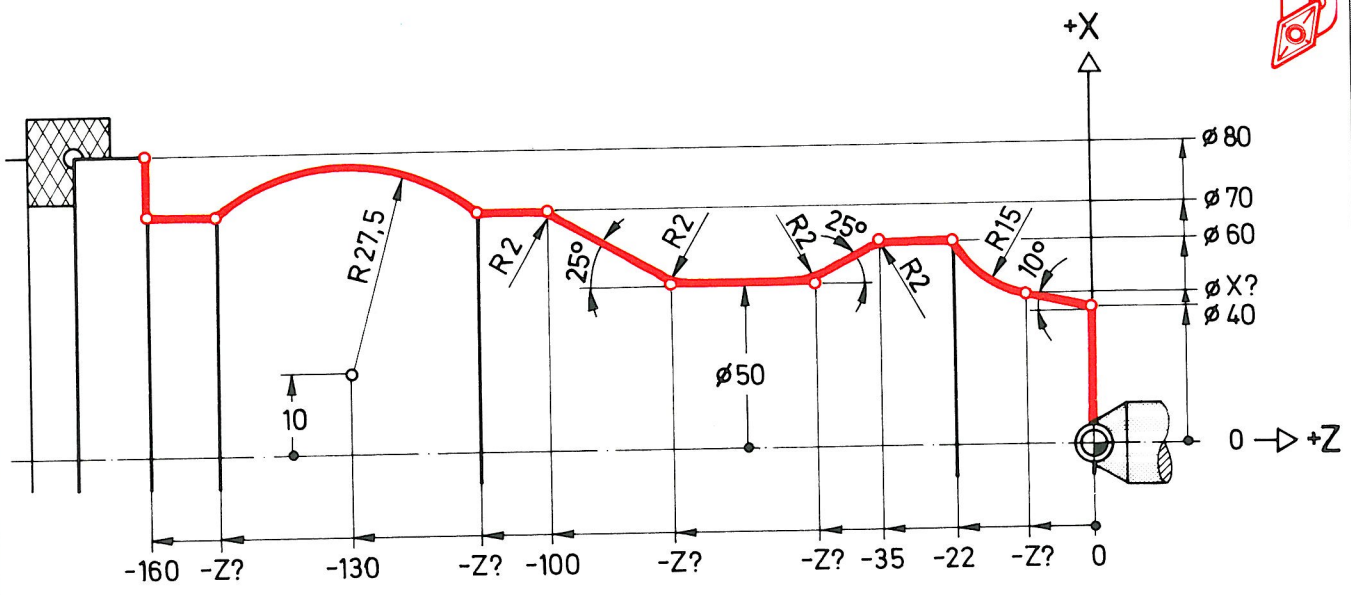
The start point S must lie within the shaded area.

## Case 3: not possible





# Contour programme 1 (shaft)



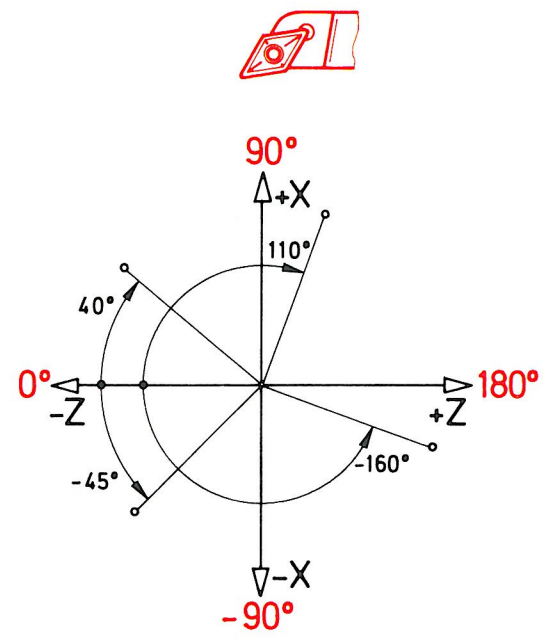
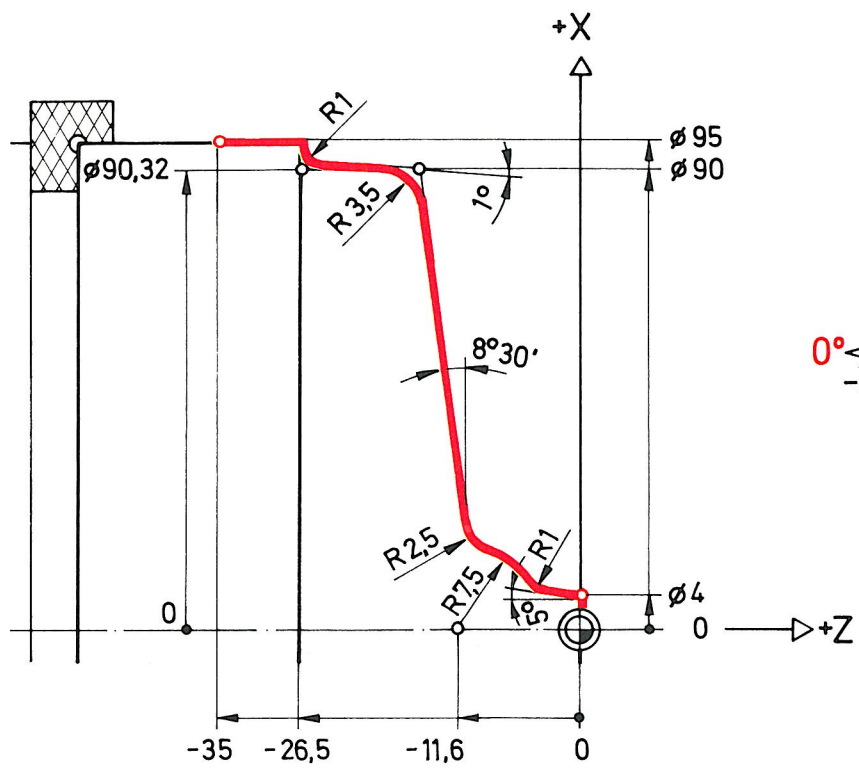
% 1011		N	G	X	Z	Auxiliary addresses	F	S	T	M
N1	G0	X38	Z2							
N2	G42 G1	X40	Z0							
N3	G1	X?	Z?	A10						
N4	G1	X?	Z?	R15	B0					
N5	G2	X60	Z-22		B2	E0.08				
N6	G1		Z-35	A-25	B2					
N7	G1	X50	Z?	A0	B2					
N8	G1		Z?	A25	B2	E0.08				
N9	G1	X70	Z-100	A0	B0					
N10	G1		Z?							
N11	G13	X70	Z?	R27.5	I10	K-130	B0			
N12	G1		Z-160							
N13	G1	X80								
N14	G40 G1	X82								
N15										M30

This example only covers a longitudinally pre-turned component.

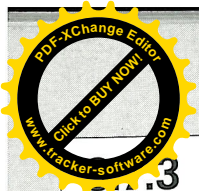


1.2

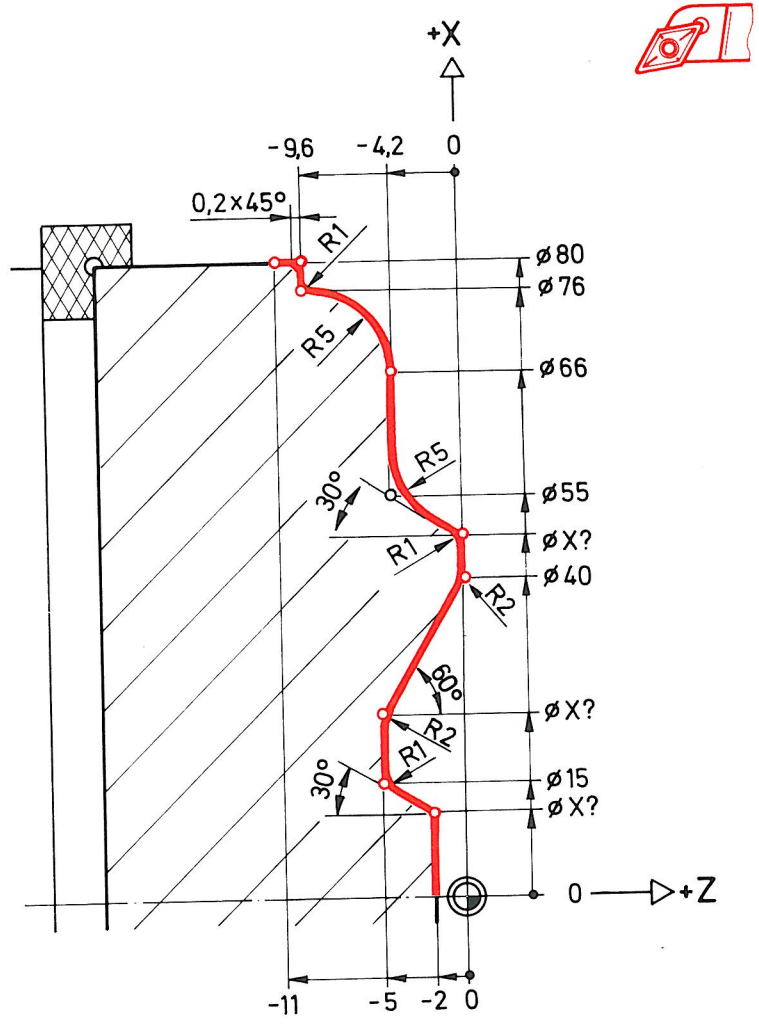
# Contour programme 2 (die)



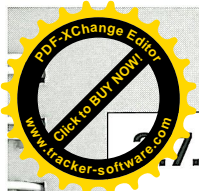
% 1012									
N	G	X	Z	Auxiliary addresses		F	S	T	M
N1	G0	X97	Z-35						
N2	G41 G1	X95							
N3	G1		Z-26,5						
N4	G1	X90,32		B1	E0.05				
N5	G1	X90	Z?	A-179	B3.5	E0.08			
N6	G1	X?	Z?	A-98,5	B2,5				
N7	G12	X?	Z?	I0	K-11,6	R7,5	B1		
N8	G1	X4	Z0	A-175					
N9	G1	X0							
N10	G40 G1		Z2						
N11									M30



# Contour programme 3 (punch)

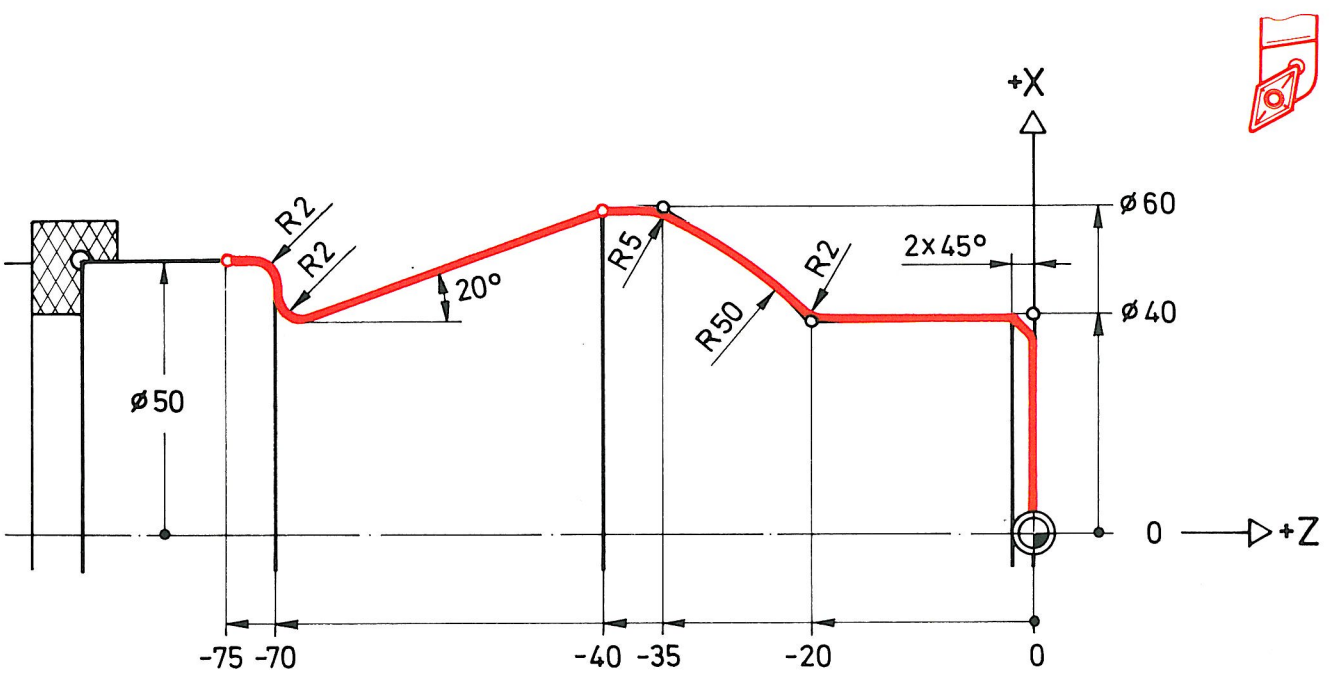


%		1013					F	S	T	M
N	G	X	Z	Auxiliary addresses						
N1	G0	X82	Z-11							
N2	G41 G1	X80								
N3	G1		Z-9.6		B-0.2					
N4	G1	X76			B1					
N5	G2	X66	Z-4.2	R5						
N6	G1	X55			B5					
N7	G1	X?	Z0	A-150	B1					
N8	G1	X40			B2					
N9	G1	X?	Z-5	A-60	B2					
N10	G1	X15			B1					
N11	G1	X?	Z-2	A-150						
N12	G1	X0								
N13	G40 G1		Z0							
N14									M30	



1.1.4

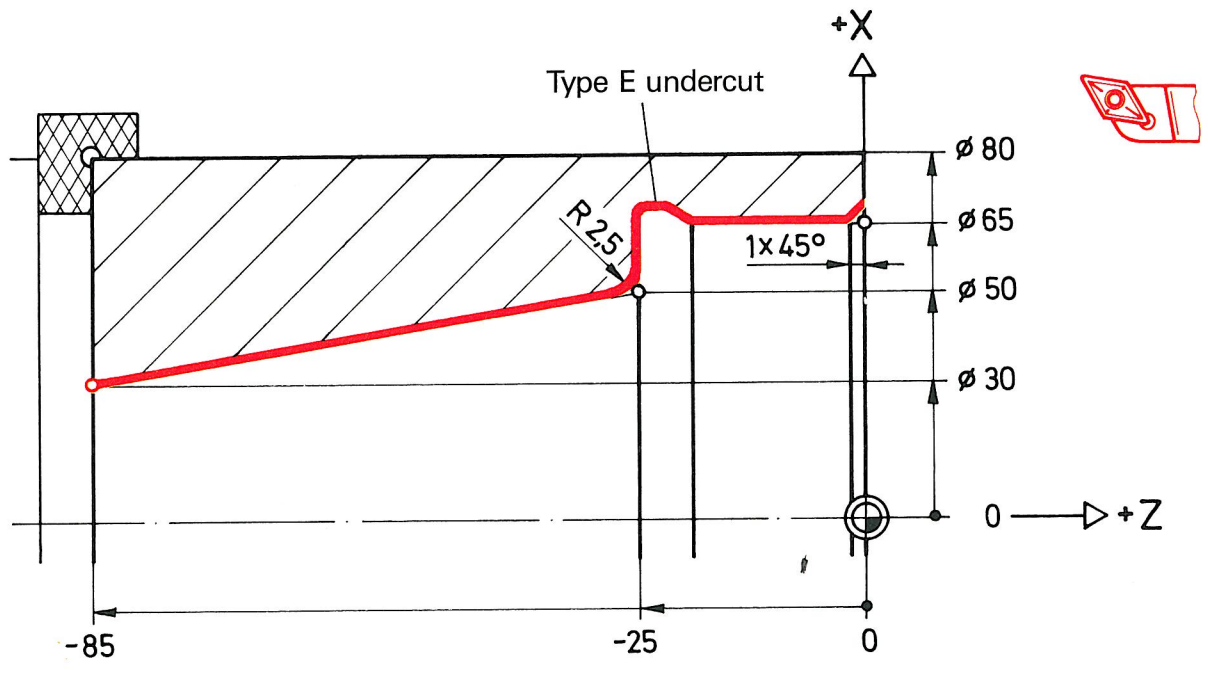
# Contour programme 4 (form part)



% 1014			Auxiliary addresses				F	S	T	M
N	G	X Z								
N1	G0	X35 Z2								
N2	G42 G1	Z0								
N3	G1	X40	B-2							
N4	G1	Z-20	B2							
N5	G3	X60 Z-35	R50 B5							
N6	G1	Z-40								
N7	G1	X? Z-70	A-20 B2							
N8	G1	X50	B2							
N9	G1	Z-75								
N10	G0	X65								
N11	G40 G0	Z2								
N12										M30



# Contour programme 5 (bush)



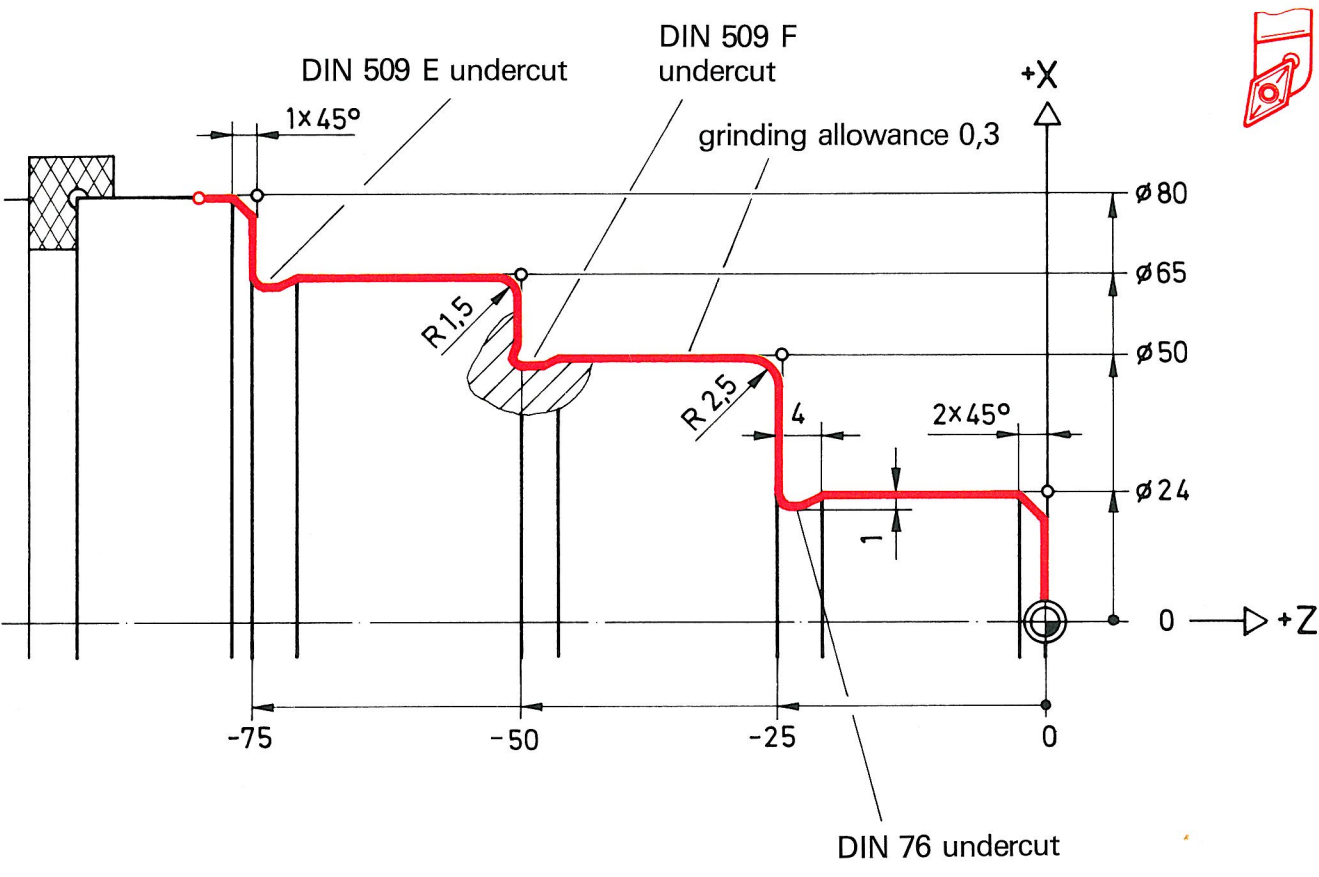
%		1015		Auxiliary addresses		F	S	T	M
N	G	X	Z						
N1	G0	X70	Z2						
N2	G41 G1		Z0						
N3	G1	X65		B-1	E0.08				
1/N4	G85		Z-25	Q2	E0.05				
2/N5	G1		Z-25						
N6	G1	X50		B2.5					
N7	G1	X30	Z-85						
N8	G1		Z-87						
N9	G40 G1	X28							
N10									M30



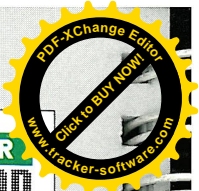


7.6

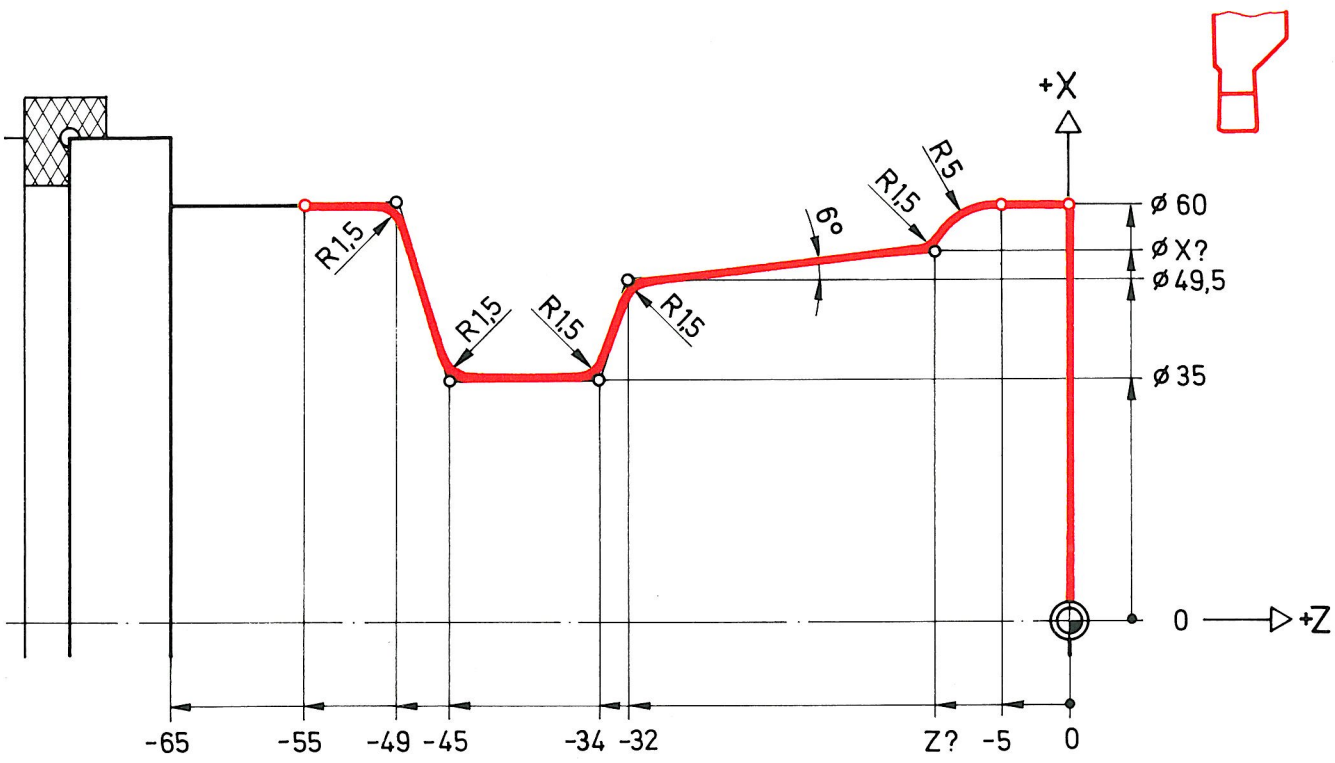
# Contour programme 6 (stepped bolt)



% 1016		X	Z	Auxiliary addresses	F	S	T	M
N1	G0	X-1.6	Z2					
N2	G1		Z0					
N3	G88	X24		I2				
N4	G85		Z-25	I1 K4 Q1 E0.08				
N5	G87	X50,3		I2.65				
N6	G85	X50	Z-50	I0.15 K0 Q1 E0.08				
N7	G87	X65		I1.5				
N8	G85		Z-75		Q1 E0.08			
N9	G88	X80		I1				
N10	G1		Z-77					
N11								M30



# Contour programme 7 (recess)

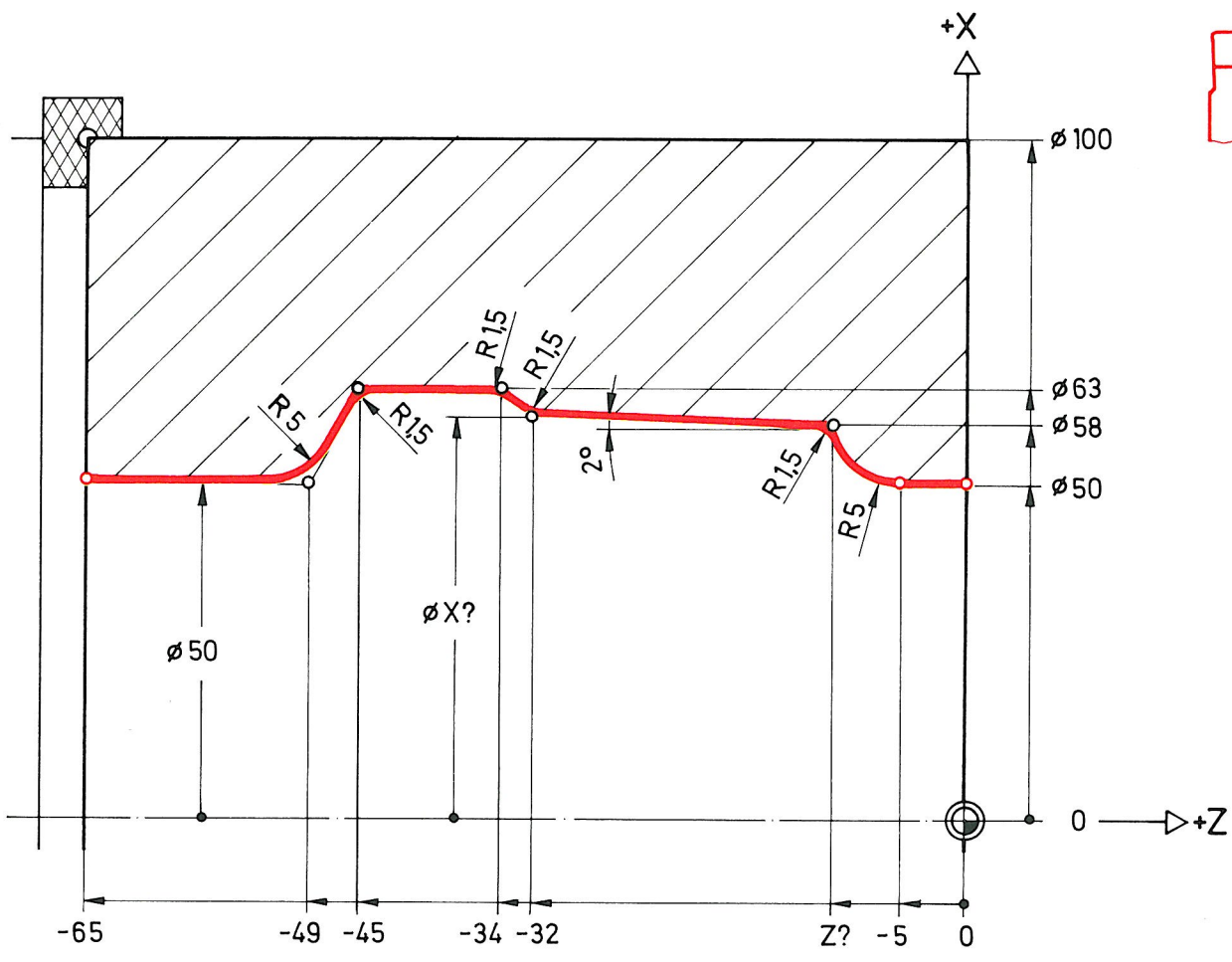


% 1017		X	Z	Auxiliary addresses			F	S	T	M
N1	G42 G1	X60	Z-3							
N2	G1		Z-5							
N3	G3	X?	Z?	R5	B1.5	E0.05				
N4	G1	X49.5	Z-32	A-6	B1.5	E0.05				
N5	G1	X35	Z-34		B1.5	E0.05				
N6	G1		Z-45		B1.5	E0.05				
N7	G1	X60	Z-49		B1.5	E0.05				
N8	G1		Z-55							
N9	G40 G1	X62								
N10									M30	



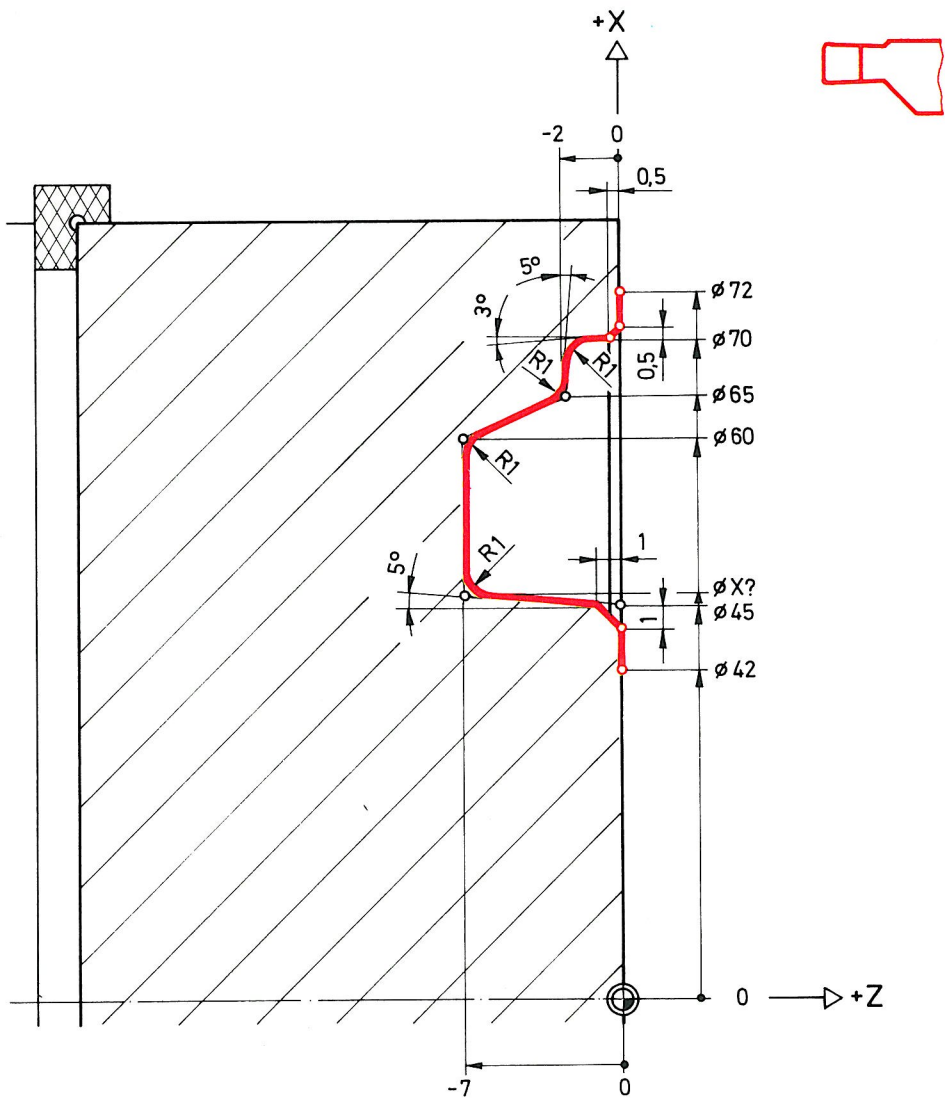
7.8

# Contour programme 8 (internal recess)



% 1018		N	G	X	Z	Auxiliary addresses	F	S	T	M
N1	G41 G1	X50	Z-3							
N2	G1		Z-5							
N3	G2	X58	Z?	R5		B1.5				
N4	G1	X?	Z-32	A2		B1.5				
N5	G1	X63	Z-34			B1.5				
N6	G1		Z-45			B1.5				
N7	G1	X50	Z-49			B5				
N8	G1		Z-55							
N9	G40 G1	X48								
N10										M30

# Contour programme 9 (recess on the face)



%		1019		Auxiliary addresses		F	S	T	M
N	G	X	Z						
N1	G42 G0	X42	Z1						
N2	G1		Z0						
N3	G1	X45		B-1					
N4	G1	X?	Z-7	A5	B1				
N5	G1	X60		B1					
N6	G1	X65	Z-2	B1					
N7	G1	X70	Z?	A95	B1				
N8	G1	X?	Z0	A177	B-0.5				
N9	G1	X72							
N10	G40 G1		Z1						
N11									M30