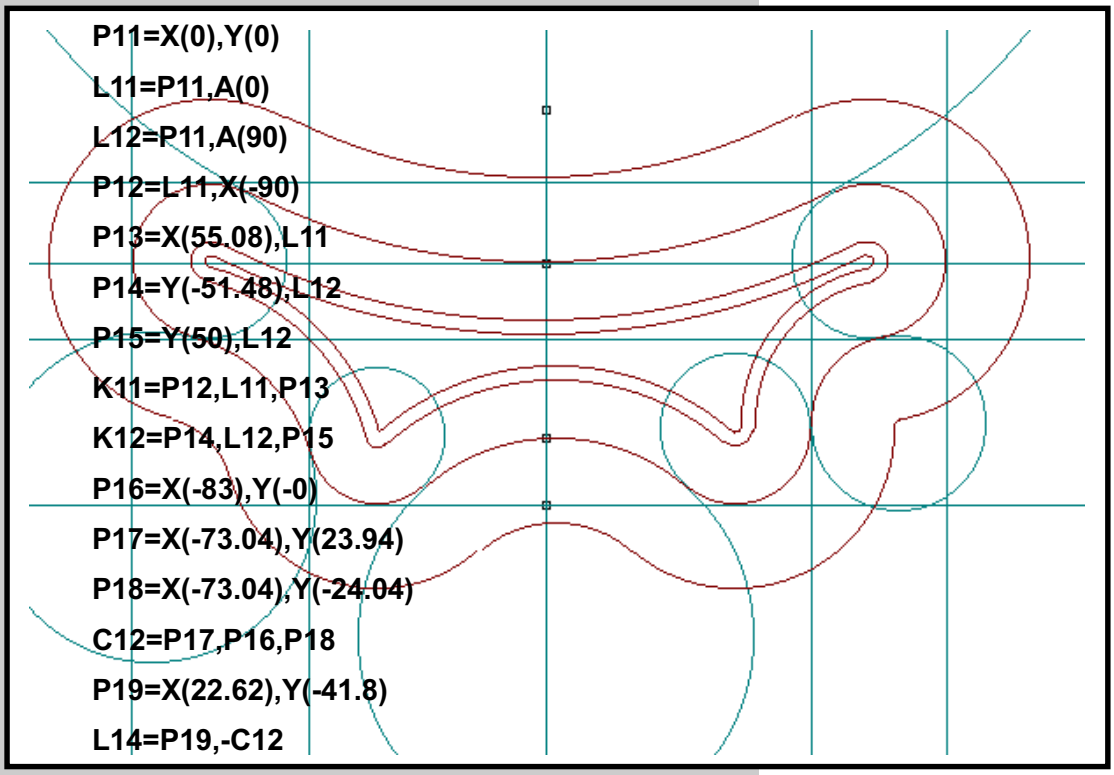
Geometrical Language Description



SPRUT Technology Inc.

CONTENTS

INRODUCTION

Designation and area of appliance

Geometrical processor is designed to execute geometrical calculations, concerned with determination of geometrical objects on a plane, calculation of parameters of their mutual location and modifications of these objects. The language of the geometrical processor is used in the planar creation mode. The geometrical processor operates with the following data types:

- Point
- Straight Line (hereinafter referred to as LINE)
- Circle
- Contour
- Coordinate system

The presence of the listed data types allows operating with geometrical definitions.

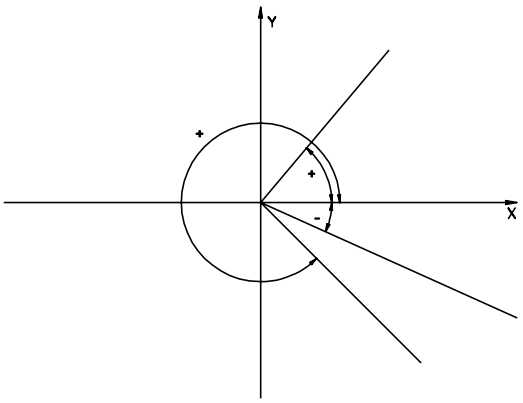
Geometrical processor can be used in solution of a wide range of problems, concerned with geometrical calculations.

Measurement units

In the language of monitor, it is common to define:

- Linear measurements in millimeters
- Angles in degrees, with decimal portions, i.e. decimal number.

An angle is positive, if counted out from the positive direction of the “X” axis counter-clockwise. An angle is negative, if counted out from the positive direction of the “X” axis clockwise.



Definitions, applicable in the language

Identifiers of types of geometrical objects have the following designations:

O1, O2, O3…On - coordinate systems;
O1, P2, P3…Pn - points:
L1, L2, L3…Ln - line lines;
LX, LY - coordinate axes of the initial system;
C1, C2, C3…Cn - circles;
K1, K2, K3…Kn - contours.

Identifiers of geometrical functions have the following designations:

X, Y- coordinates;
A – angle;
M - distance;
R – radius;
D – diameter;
N – number or amount.

When writing operators the difference between capital and small letters does not matter.

Parameterization of geometrical objects

In any operator of geometrical language instead of any numerical value, a variable or an arithmetical expression can be used.

At that, the variable separates from an identifier by a blank space or a dot. An arithmetical expression encloses in oval brackets.

1 DEFINITION OPERATORS OF GEOMETRICAL ELEMENTS

1.1 COMMON REGULATIONS

1.1.1 Creation of an operator, types of geometrical variables

Assignment of geometrical elements in the language is performed by means of calculation operators and giving value to variables of "point", "line", "circle", "coordinate system" types. In the left part of the operator there is a variable which identifies a being assigned geometrical object, and in the right part – one of multitude of acceptable methods of the object's definition. By a type of a variable defines its possible values, operations of the variable definition, and its use. There is a strict mnemonic connection between the type of a variable and its designation. For instance, all variables of "line" type have designation "L" with an identification number. Therefore, designations of variables are included into the Language dictionary and are the subordinate words.

In common view the operator of a geometrical object assignment has the following format:

Identifier of a type with a number = a list of parameters in the assignment method format.

or

Identifier of a type with a number [a list of parameters in the assignment method format].

The parameters can be geometrical functions, identifiers of earlier defined geometrical elements or enclosed operators of geometrical element assignment. Formats of assignment methods are described in the present topic. If a method of assignment envisages indication of coordinates by two axes, then it is possible to omit identifiers "X" and "Y". At that, the first number is interpretated as a coordinate on the "X" axis, and the second, as a coordinate on the "Y" axis.

If an element is used in assignment of a contour or another element, it can be re-defined, by assigning a new element with similar identifier. Exploitation and re-definition within one operator is acceptable.

Example:

L20=L20, M50

being defined line — earlier defined line

1.1.2 Directions of lines and circles

Being defined geometrical elements as default locate in the horizontal plane “XOY”. Assignment is performed in the right rectangular coordinate system.

Positive direction of a line is defined in its assigning, and do not change further. For instance, if a line is defined by two points, then positive is direction from the first point to the second; and if a line is defined as parallel to the earlier defined one, then positive directions of the lines coinside.

Positive direction of a line is the direction counter-clockwise. All defined circles has positive direction independently from their direction when were defined.

1.1.3 Assignment of a coordinate system

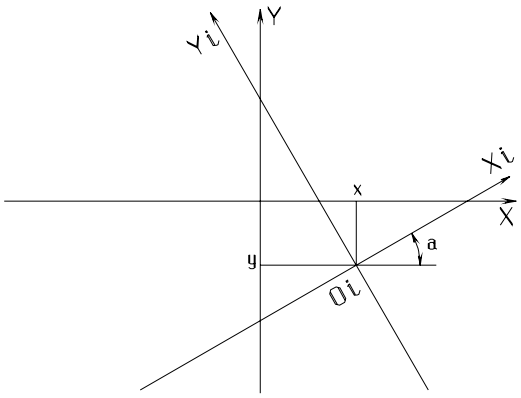
The initial coordinate system accepts as default and is primary. All assigned coordinate systems are relative and lie in the initial. Parameters of all geometrical elements, being defined in the relative system, automatically recalculates in the primary coordinate system

- **Assignment of a new system by coordinates of a center and the rotation angle relatively the primal system.**

Format:

Oi = Xx, Yy, Aa

Oi – new coordinate system;
Xx – coordinates of center;
Aa – rotation angle.

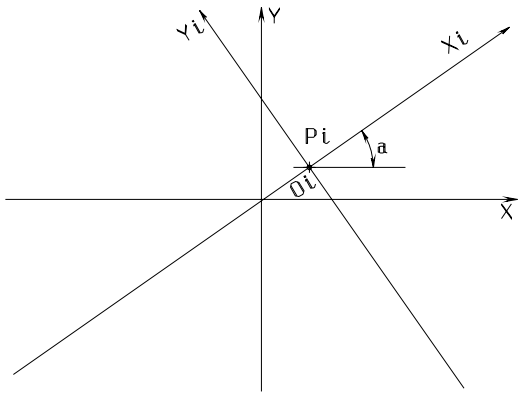


- **Assignment of a new coordinate system by indicating an identifier of the earlier defined point, in which the center is located, and by the rotation angle relatively the primal system.**

Format:

Oi = Pj, Aa

Pj –point of the center



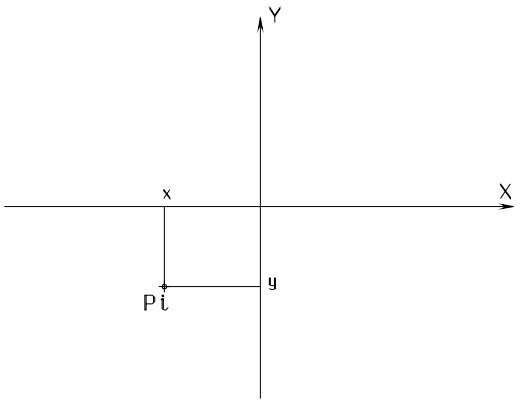
1.2 POINT ASSIGNMENT

1.2.1 Point assignment by rectangular coordinates

- **Point assignment by coordinates in the primal system**

Format:

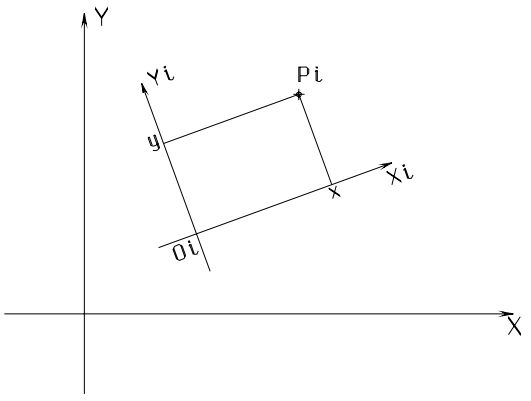
Pi = Xx, Yy



- **Determination of a point by coordinates in the defined system, different from the primal.**

Format:

Pi = Xx, Yy, Oi



1.2.2 Point assignment by polar coordinates

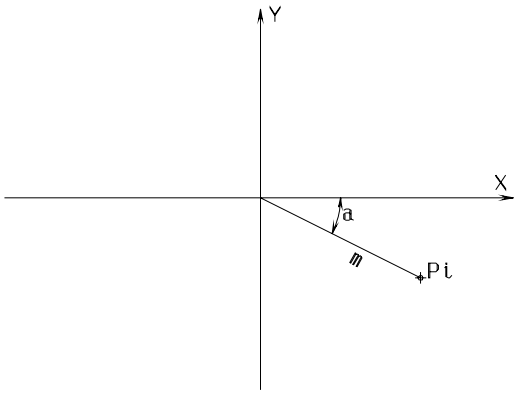
■ Relatively the beginning of coordinates

Format:

Pi = Mm, Aa

Mm – length of a vector, which connects the defined point with the beginning of coordinates

Aa – an angle between a vector and the positive direction of the “X” axis



■ Relatively the point defined earlier

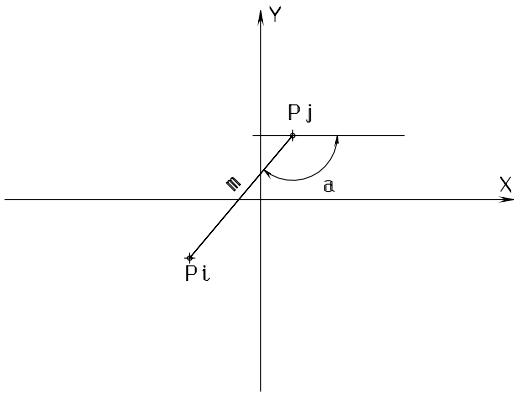
Format:

Pi = Mm, Aa, Pj

Mm – length of a vector connecting the defined point and the earlier defined point

Aa – an angle between a vector and the positive direction of the “X” axis

Pj – the earlier defined point



■ **In the relative coordinate system**

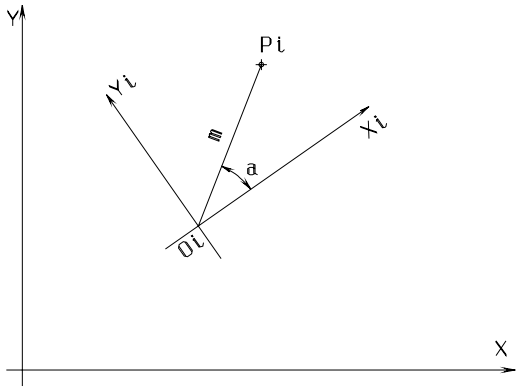
Format:

Pj = Mm, Aa, Oi

Mm – length of a vector connecting the defined point and the earlier defined point

Aa – an angle between a vector and the positive direction of the “X” axis

Oi – the earlier defined coordinate system



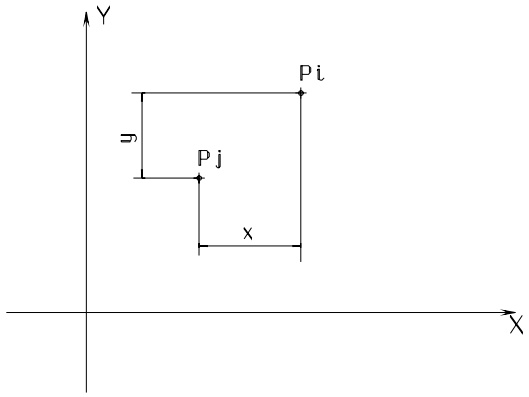
1.2.3 Point assignment by increment of coordinates relatively the earlier defined point

Format:

Pi = Pj, Xx, Yy

Pj – the earlier defined point

Xx, Yy – transition by X and Y coordinates accordingly

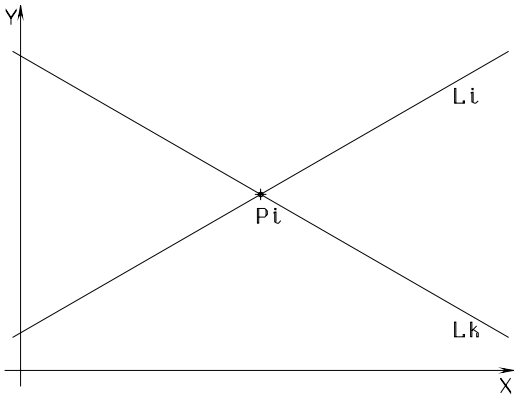


1.2.4 Point assignment by intersection of two lines

Format:

Pi = Li, Lk

Li and Lk – earlier defined lines



1.2.5 Point, defined by polar coordinates relatively the earlier defined point

Format:

Pi=Pj,Pk,Aa

Pj – the earlier defined point

Pk – a point, the distance to which from the Pj point is the length of a vector

Aa – an angle between vectors and the positive direction of the “X” system

Example:

```
for i=3 to 12 do p.i=p[0,0],p[-60,0],a(i*10)
```

1.2.6 Point, as the center of the earlier defined circle

Format:

Pi = Cj

1.2.7 Point assignment by intersection of a line and a circle

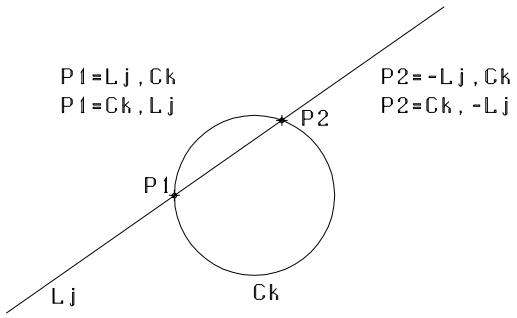
A line and a circle usually intersect in two points. In order to determine the number of a point of intersection, it is necessary to look along a line at that direction, at which the line enters into the point assignment operator. Thus, one of point can be selected by indicating a corresponding sign of a line in the point assignment operator. Positive direction of a line accepts in the operator as default. To indicate a negative direction it is necessary to put the "-" symbol before the identifier of a line.

Format:

Pi = Lj, Ck

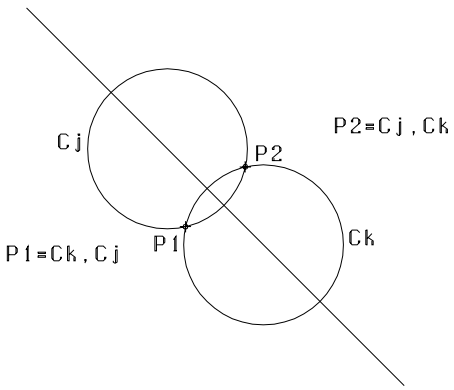
Lj – the earlier defined line

Ck – the earlier defined circle



1.2.8 Point assignment by intersection of two circles

Two circles, usually intersects in two points. In order to select a required point, it is necessary to define a number of an intersection. To do so, connect in one's mind centers of circles of a line (auxillary line), direct view along this line in direction coinciding with the order of indicating of circles in the operator, i.e. from the first indicated circle to the second. The being assigned point will be located on the left. Thus, the order of recording of circles in the point assignment operator defines by locating of centers of circles on the auxillary line.



Format:

Pi = Cj, Ck

Cj and Ck – earlier defined circles

1.2.9 Assignment of a point of the axial symmetry

This method allows to define a point, located symmetrically to the earlier defined point relatively an arbitrary defined line, coinciding with one of coordinate axes.

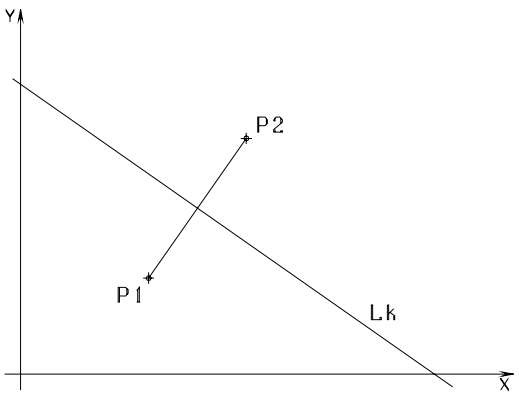
- **A point symmetrical to the present point relatively an arbitrary line.**

Format:

Pi = Pj, Lk <parameters>

Pj – the earlier defined point

Lk – the earlier defined line



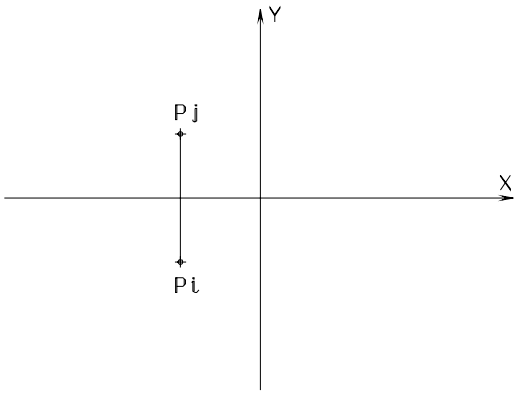
- **A point symmetrical to the present point relatively one of coordinte axes**

Formats:

Pi = Pj, LX
Pi = Pj, LY

LX – the axis “X” of the primal coordinate system

LY – the axis “Y” of the primal coordinate system



1.2.10 Point assignment by transition to a new coordinate system

Two possible ways:

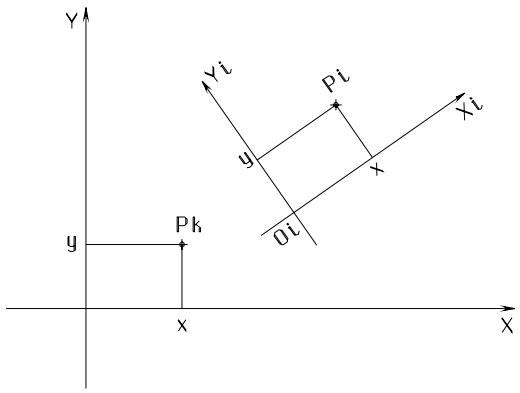
- **A being assigned point is located in a new coordinate system likewise the initial point in the primal**

Format:

Pi = Oi, Pk

Pj – the earlier defined point

Oi – the earlier defined coordinate system



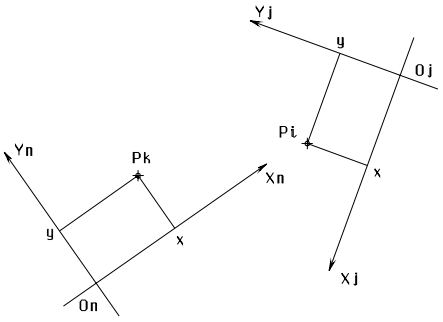
- **A being assigned point is located in a new coordinate system likewise the initial point in the indicated defined system**

Format:

Pi = Oj, Pk, On

Oi – the system where the assigned point is located

On – the system where the initial point is located



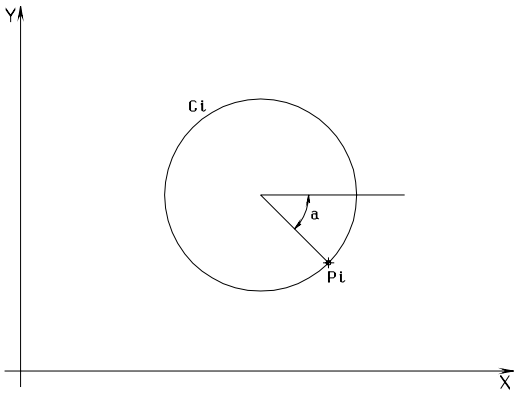
1.2.11 Point assignment, lying on a circle under the defined central angle

Format:

Pi = Ci, Aa

C – the earlier defined circle

Aa – an angle of a vector, connecting the center of a circle and the defined point



1.2.12 Point, defined by one of coordinates and lying on a line

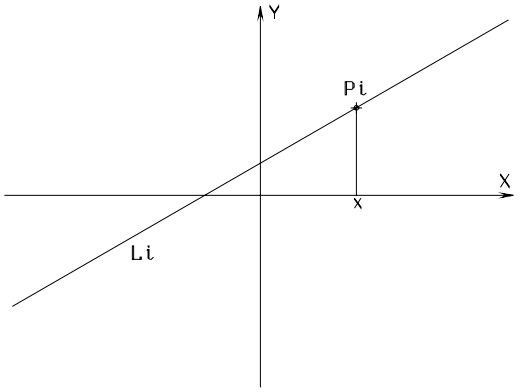
- **With the defined "X" coordinate**

Format:

Pi = Xx, Li

Xx - a "X" coordinate

Li – the earlier defined line



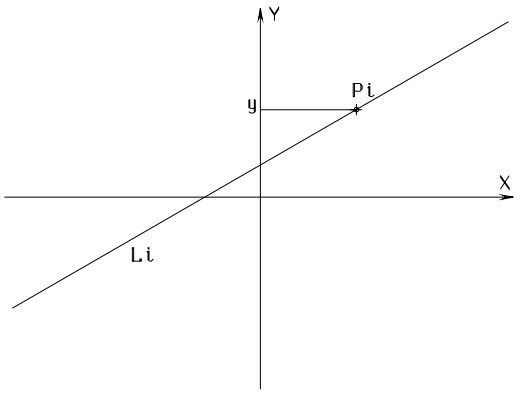
- **With the defined "Y" coordinate**

Format:

Pi = Yy, Lia

Yy- an "Y" coordinate

Li - the earlier defined line



1.2.13 Assignment of a point, lying on a line at distance from the earlier defined point

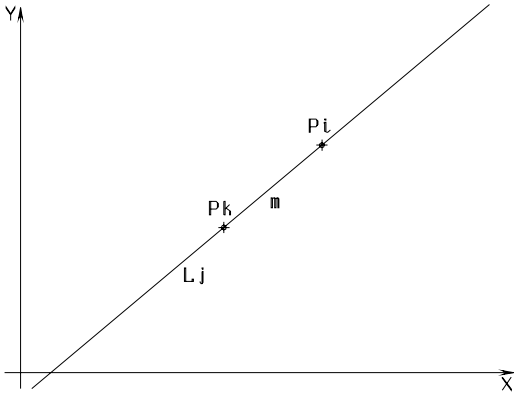
Format:

Pi = Lj, Mm, Pk

Li – the earlier defined line

Mm – distance

Pk – the earlier defined point



1.2.14 Point, as the nodal point of a contour

An operator allows to define a point, as a point of intersection of two consequent elements of contour

Format:

Pi = Kj, Nn

Kj – the earlier defined contour

Nn – number of a point in the contour

1.2.15 Point, defined by intersection of a line and a contour

To select one point from the points of intersection, One should indicate the number of a sought point in direction of a line. When counting points of intersection, it is necessary to consider the following rules:

- If one of sections of a contour belongs to a line, then points of intersection are the first and the final points of the section
- If a line passes through the point of intersection of two adjoining elements of a contour, then only one point is counted
- If a line passes through a point of intersection of two not adjoining elements of a contour, then both points are counted

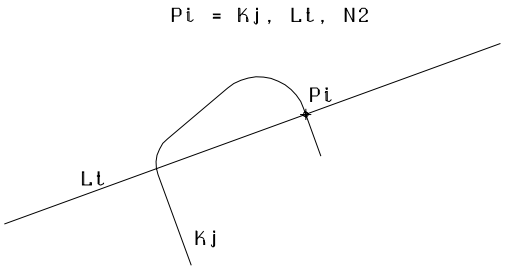
Format:

Pi = Kj, Lt, Nn

Kj – the defined contour

Lt – the earlier defined line

Nn – number of point of intersection



1.2.16 Point, defined by intersection of a circle and a contour

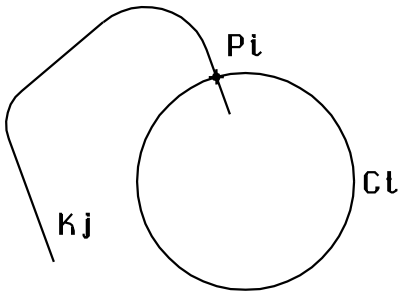
To select one of points of intersection One should indicate the number of a sought point in rounding a counter. When counting points of intersection it is necessary to consider the following rules:

- If one of arcs of contour belongs to a circle, then points of intersection are the first and the final points of the arc
- If a circle passes through a point of intersection of two adjoining elements of a contour, then only one point is counted
- If a circle passes through a point of intersection of two not adjoining elements of a contour, then both points are counted

Format:

Pi = Kj, Ct, Nn

Ct – the defined circle



1.2.17 Point, defined by intersection of two contours

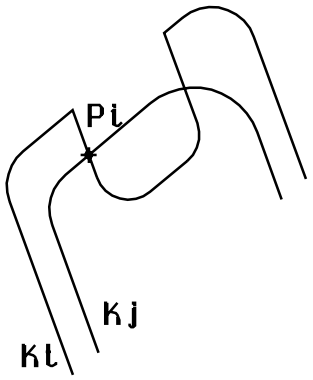
To select one of points of intersection one should indicate the number of sought point in rounding by first of defined contours. When counting points of intersection it is necessary to consider the following rules:

- If one of elements of a contour belongs, coincides or overlaps with an element of another contour, points of intersection are the first and the final points of elements, belonging to both contours.
- If an element passes through the point of intersection of two adjoining elements of another contour,then one point is counted
- If an element passes through the point of intersection of two not adjoining elements of another contour, then two points are counted.

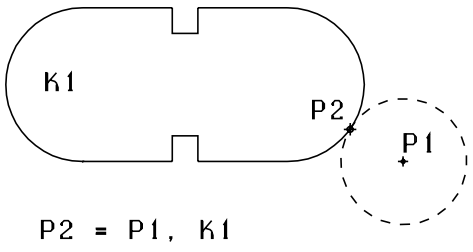
Format:

Pi = Kj, Kt, Nn

Kj, Kt – defined contours



Nn – number of a point of intersection



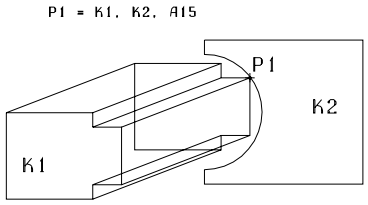
1.2.19 Touch point of two contours in transition of one of them towards the indicated direction until collision with the second

Format:

Pi = Kj,Kk,Aa

Kj, Kk - the earlier defined contours

Aa – an angle of direction of a contour transition Kj



1.2.20 Point, laying on a contour at the indicated distance along a contour from the earlier defined point

Format:

P(i) = K(k),P(j),Mm

m – a distance along a contour from the Pj point

in negative sense – the distance against the direction of a contour

1.2.21 Point scaling

Format:

Pi=Pj,Pk,Mm

Pj – the initial point

Pk – a point of the center of scaling

Mm – a scaled coefficient

Example: p1= p2[0,0],p3[20,0],m5

1.2.22 Projection of a point on a circle

Format:

Pi=Pj,Ck

Pj – the initial point

Ck – a circle on which point Pj is projected

If before “Ck” there is the sign “-“, then the furthest point will be found, otherwise – closest.

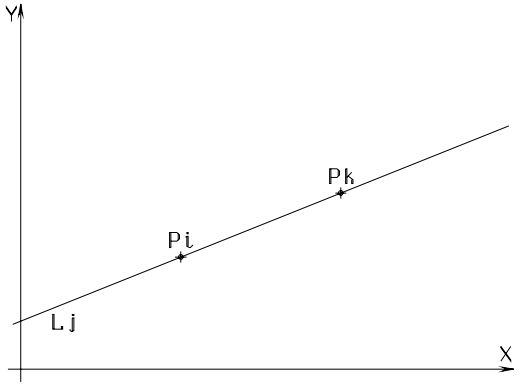
1.3 LINE ASSIGNMENT

1.3.1 Line passing through two points defined earlier

Format:

Li = Pi, Pk

Pi, Pk – earlier defined points



1.3.2 Line passing through a point under the defined angle

If an identifier of the "A" angle enters an operator with the "-" symbol, then the angle counts out clockwise.

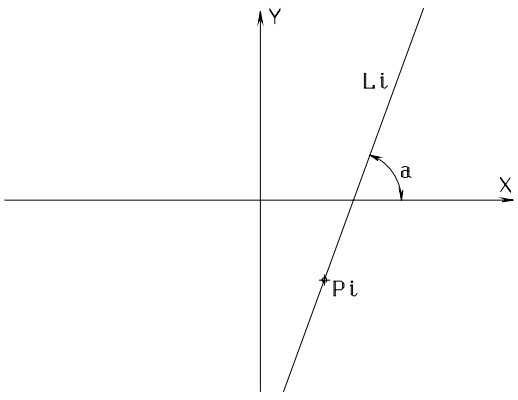
- **A line passing through a point under the defined angle to the "X" axis**

Format:

Li = Pi, Aa

Aa – an angle between the defined point and the "X" axis

Pi – the earlier defined point



- **A line passing through a point, defined by coordinates under the defined angle to the "X" axis, in the relative coordinate system**

Format:

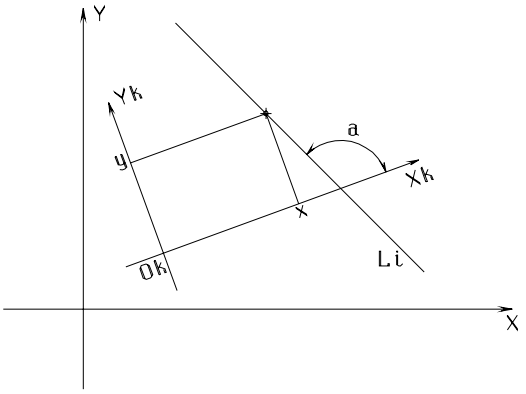
Li = Xx, Yy, Aa, Ok

Ok – a coordinate system defined earlier

Xx, Yy – coordinates of a point in the "Ok" system

Aa – an angle between the defined line and the "X" axis of the "Ok" coordinate system

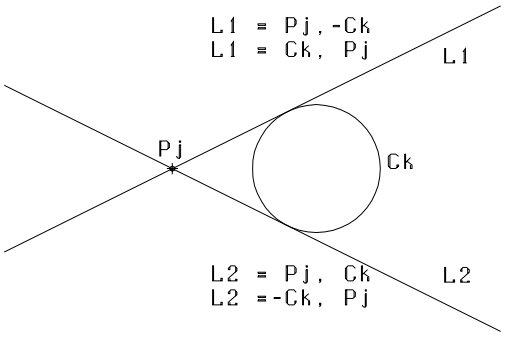
If in an operator instead of coordinates one enters the earlier defined point, then definitions of its coordinates will be interpretated in the "Ok" system



1.3.3 Line passing through a point, tangent to the defined circle

Usually only two lines pass through a point and are tangent to a circle. In order to select one of them, it is necessary to define with which sign the identifier of the circle should enter an operator. Sign "+" is not compulsory. A circle has the sign "+" if in the point of touching with a line, the positive direction of a circle coincides with direction of the line. At that, the direction of the line is from the first element to the second.

A circle has "-" sign, if in the point of touching with the defined line directions are diverse.



Formats:

Li = Pj, Ck
Li = Ck, Pj

Pj – the defined point

Ck – the defined circle

1.3.4 Line tangent to a circle under the defined angle

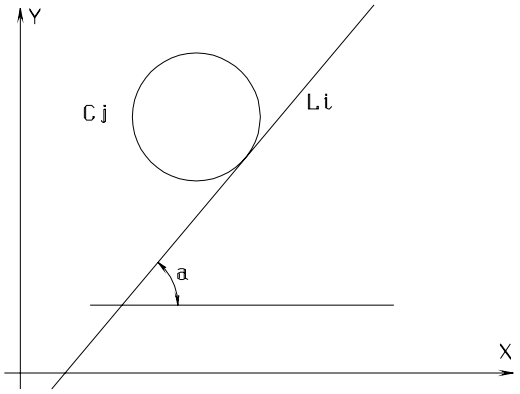
Two lines tangent to a circle under the defined angle are possible. To select one of them it is necessary to define the sign of the circle, analogically to the previous paragraph.

Format:

Li = Cj, Aa

Cj – the earlier defined circle

Aa – an angle between the positive direction of the "X" axis and the defined line



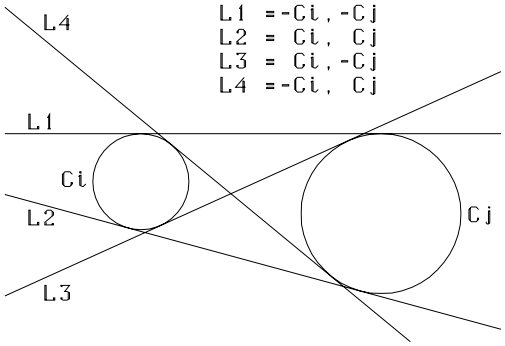
1.3.5 Assignment of a line tangent to two circles

Usually, exist only four lines tangent to two circles. Selection of one of them can be done by specification of signs of circles and the order of their inclusion into an operator. To define the order of specification of circles in the operator, it is necessary to look along the positive direction of a line. The order of touch points corresponds to the order of specification of circles in the operator.

Format:

Li = Cj, Ck

Cj ,Ck – earlier defined circles



1.3.6 Assignment of a line parallel to the given one

The “M” parameter is the distance between lines. ”M” is positive, if a being defined line is on the left from the initial line, in coincidence of a view and the direction of a line. “M” is negative, if a being defined line is on the right from the initial line, in coincidence of a view and the direction of a line.

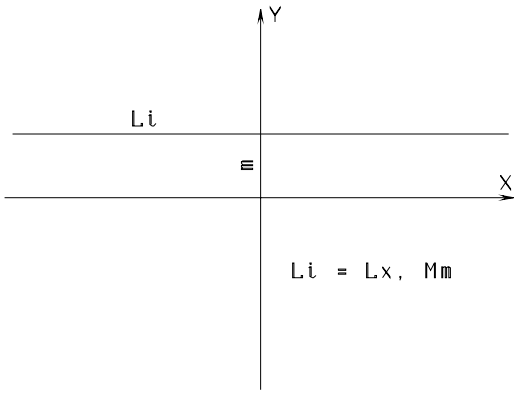
- **A line, parallel to one of coordinate axes, passing to the defined distance from the axis.**

Li = Lx, Mm
Li = Ly, Mm

Lx – the “X” axis of the primal coordinate system

Ly – the “Y” axis of the primal coordinate system

Mm – the distance

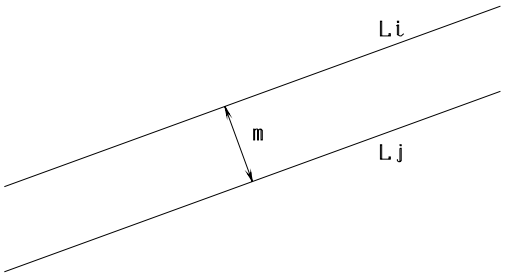


- **A line, parallel to an arbitrary defined plane, passing to the defined distance**

Format:

Li = Lj, Mm

Lj – the earlier defined line



1.3.7 Line tangent to a contour under the defined angle

Two lines, tangent to a contour under the defined angle are possible. To select one of them it is necessary to define the sign of a contour in the operator.

The sign is positive, if a being defined line is on the left from a contour, in coincidence of a view and a positively directed being defined line

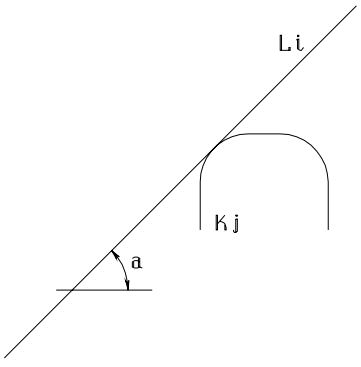
The sign is negative, if a being defined line is on the right from a contour, in coincidence of a view and a positively directed being defined line.

Format:

Li = Kj, Aa

Kj – the earlier defined contour

Aa – an angle between the positive direction of the “X” axis and the defined line.



1.3.8 Line passing through a point and tangent to a contour

Two lines passing through a point and tangent to a contour are possible. To select one of them it is necessary to define a sign of a contour in the operator.

The sign is positive, if a being defined line is on the left from a contour, when looking from a point to he contour.

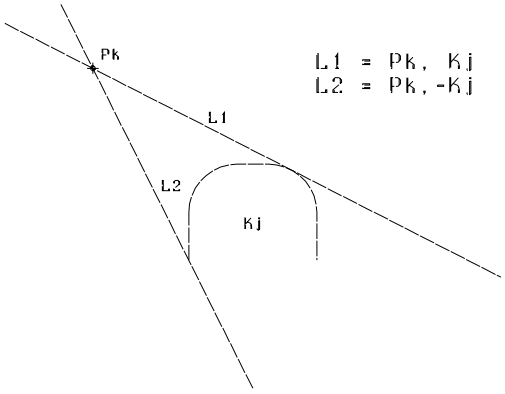
The sign is negative, if a being defined line is on the right from a contour, when looking from a point to the contour.

Format:

Li = Pk,Kj

Kj – the earlier defined contour

Pk - the earlier defined point



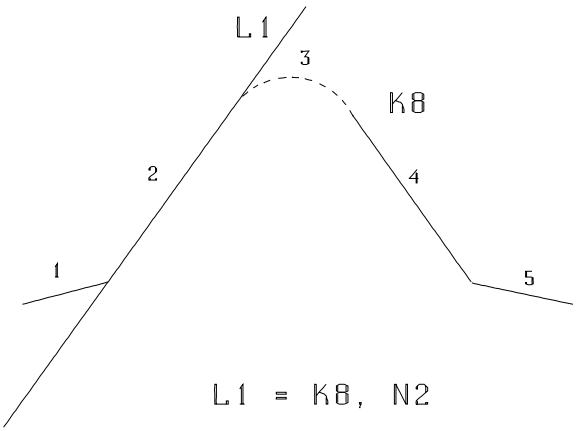
1.3.9 Line as an element of the earlier defined contour

Format:

Li = Kj, Nn

Kj – the earlier defined contour

Nn – a contour element number



1.3.10 Line defined by coefficients of a normal equation of a line

Format:

Li = a, b, c

a, b, c – coefficients of a normal equalization of a line

1.3.11 Transition of a line

Format:

Li=Lj,Xx,Yy

Lj – the earlier defined line

Xx, Yy – displacement by X and Y coordinates

Eample:

```
l2=l1[-0.7,0.5,10],X50,Y20
```

1.3.12 Rotation of a line around a point to the defined angle

Format:

Li=Lj,Pk,Aa

Lj – the initial circle

Pk – the center of rotation

Aa – an angle of rotation

Example:

```
l1=l3[ly,m0],p1[0,0],a20
l2=l4[lx,m0],p1,a4
```

1.3.13 Line scaling

Format:

Li=Lj,Pk,Mm

Lj – the initial circle

Pk – a point of the center of scaling

Mm – a scaled coefficient

Example:

```
l1=l3[lx,m50],p1[0,0],m2
l2=l4[ly,m50],p1,m0.5
```

1.4 CIRCLE ASSIGNMENT

1.4.1 Circle, defined by a center and a radius

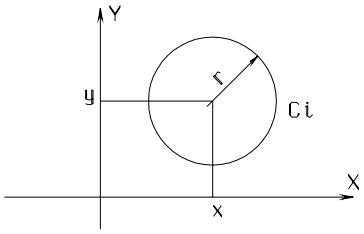
- **A circle defined by coordinates of a center and a radius**

Format:

Ci = Xx, Yy, Rr

Xx, Yy – coordinates of a center

Rr – a radius

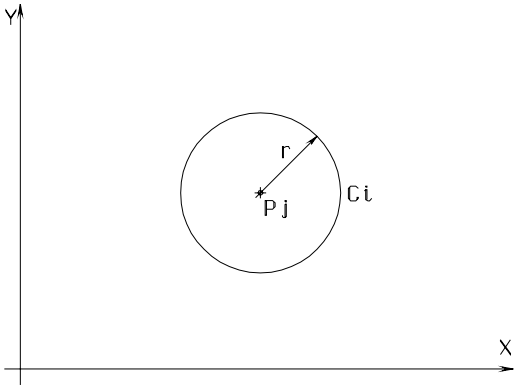


- **A circle defined by a point and a radius**

Format:

Ci = Pj, Rr

Pj – the earlier defined point



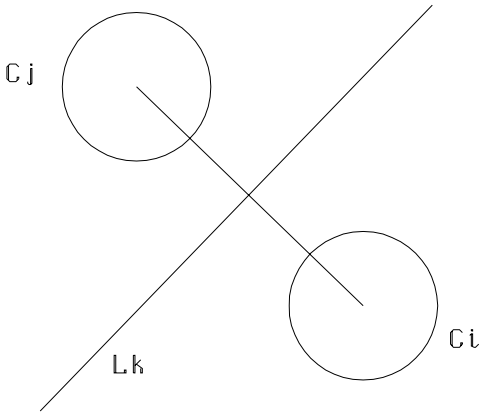
1.4.2 Circle, symmetrical to the initial circle relatively a line

Format:

Ci = Cj, Lk

Cj – the earlier defined circle

Lk – the earlier defined line



1.4.3 Circle, defined by displacement of the initial circle

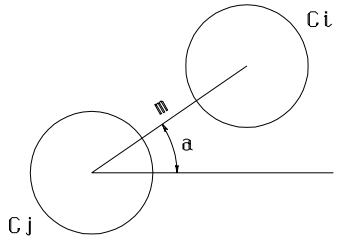
Format:

Ci = Cj, Mm, Aa

Cj – the earlier defined circle

Mm – length of the transference vector

Aa – an angle of the transference vector



1.4.4 Circle with the defined center, tangent to a line

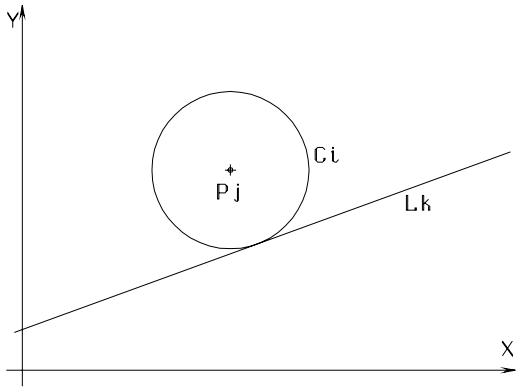
Formats:

Ci = Pj, Lk
Ci = Xx, Yy, Lk

Pj – the earlier defined point

Lk – the earlier defined line

Xx, Yy – point coordinates



1.4.5 Circle with the defined center, tangent to another circle

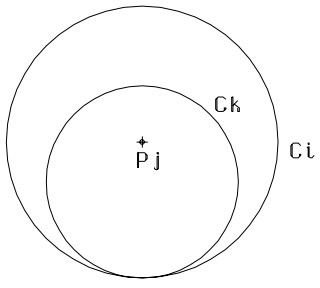
Usually, exist only two of such circles. In the present variant, a being defined circle has external touch with an earlier assigned, in another – internal. To select the external touch it is necessary to define the "-" sign for the initial circle in the operator.

Format:

Ci = Pj, Ck

Ck – the earlier defined circle

Pj – the earlier defined point



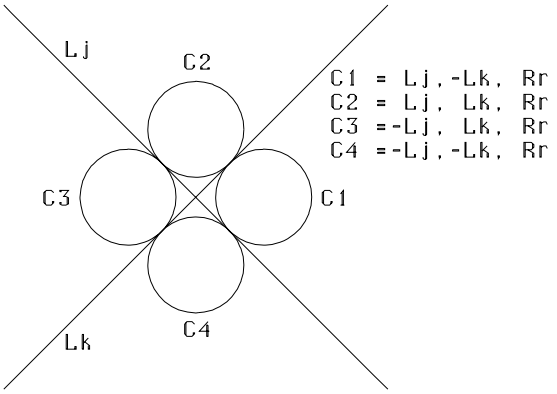
1.4.6 Circle of the defined radius, tangent to two lines

The order of recording of lines is not important. Signs of lines in the circle-defining operator are the indications of coincidence or not coincidence of direction of a line and a being defined circle in the touch point. If in the touch point directions do not coincide, then the line has the "-" sign.

Format:

Ci = Lj, Lk, Rr

Lj, Lk – defined lines

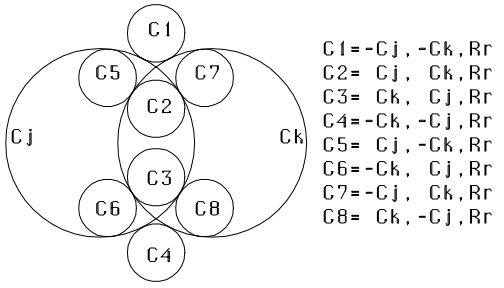


1.4.7 Circle of the defined radius, tangent to two circles

To select a required variant it is necessary to define in the operator the order of assignment of the initial circles, and its signs. The order defines as follows:

- Centers of the initial circles, in one's mind are connected with a line
- Direction of a view along the line must be selected in such a way, so that the center of a being defined circle is on the right
- The order of indication of circles in the operator must coincide with the order of disposition of centers of those circles on the line.

Signs, with which the initial circles enter the operator, indicate on coincidence or not coincidence of directions in the touch point with a being defined circle. In not coincidence of directions, a circle enters the operator with the "-" sign.



Format:

Ci = Cj, Ck, Rr

Ci, Ck – earlier defined circles

1.4.8 Circle of the defined radius, tangent to the earlier defined line and circle

To define the order of recording of elements in the operator, it is necessary do the following;

- Imagine a line as an arc of a circle with an endless radius with a center on the left from the line. (a view must coincide with the positive direction of the line)
- In one's mind connect by a segment the center of the imagined arc with the center of the defined circle
- Direction of a view on the section should be chosen in such a way, so that the being defined circle is on the left

The order of recording of elements in the operator must correspond to dislocation of centers of the initial elements on the imagined section in the direction of a view.

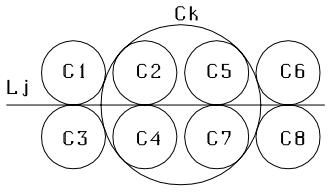
Definition of a sign of a line (reference in the paragraph "Circle of the defined radius, tangent to two lines"), sign of a circle (reference in the paragraph "Circle of the defined radius, tangent to two circles").

Formats:

Ci = Lj, Ck, Rr
Ci = Ck, Lj, Rr

Ck – the earlier defined circle

Lj – the earlier defined line



1.4.9 Circle of the defined radius, passing through a point and tangent to a line

To define the order of recording of elements in the operator, it is necessary do the following;

- Imagine a line as an arc of a circle with an endless radius with a center on the left from the line. (a view must coincide with the positive direction of the line)
- In one's mind connect by a segment the center of the imagined arc with the center of the defined circle
- Direction of a view on the section should be chosen in such a way, so that the center of the being defined circle is on the left

The order of recording of elements in the operator must correspond to the sequence of their dislocation on the imagined section

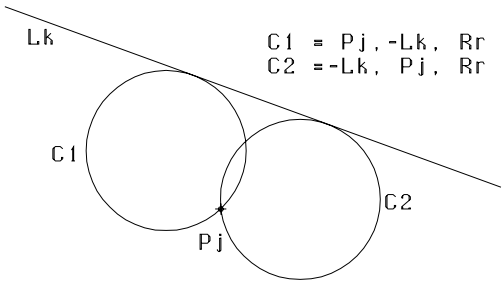
The rule of defining of a sign of a line (reference in the paragraph "Circle of the defined radius, tangent to two lines').

Formats:

Ci = Pj, Lk, Rr
Ci = Lk, Pj, Rr

Pj – the earlier defined point

Lk – the earlier defined line



1.4.10 Circle of the defined radius, passing through a point and tangent to a circle

To define the order of recording of elements, it is necessary do the following;

- In one's mind connect by a section the center of the initial circle and a point
- Direction of a view on the section should be chosen in such a way, so that the center of the being assigned circle is on the left.

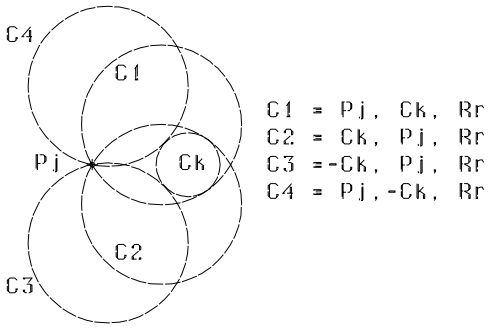
The order of recording of elements in the operator must correspond to the sequence of their dislocation on the imagined section

Formats:

Ci = Pj, Ck, Rr
Ci = Ck, Pj, Rr

Pj – the earlier defined point

Ck – the earlier defined circle



1.4.11 Circle of the defined radius, passing through two points

To define the order of recording of elements in the operator, it is necessary do the following;

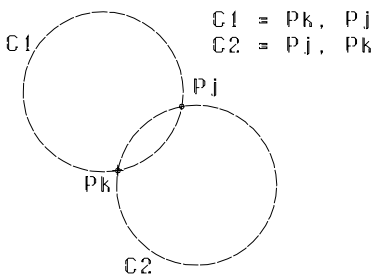
- Connect the initial points by a section
- Direction of a view on the section should be chosen in such a way, so that the center of the being assigned circle is on the left.

The order of recording of elements in the operator must correspond to the sequence of their dislocation on the imagined section

Format:

Ci = Pj, Pk, Rr

Pj, Pk – earlier defined points



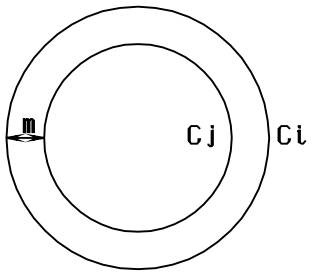
1.4.12 Circle, concentric to the present circle

The “M” parameter is a difference of radiuses of the initial circle and an assigned. “M” is positive, if the initial circle is internal relatively the assigned. “M” is negative, if the initial circle is external relatively the assigned.

Format:

Ci = Cj, Mm

Cj – the earlier defined circle



1.4.13 Circle with a center in the defined point and tangent to a contour

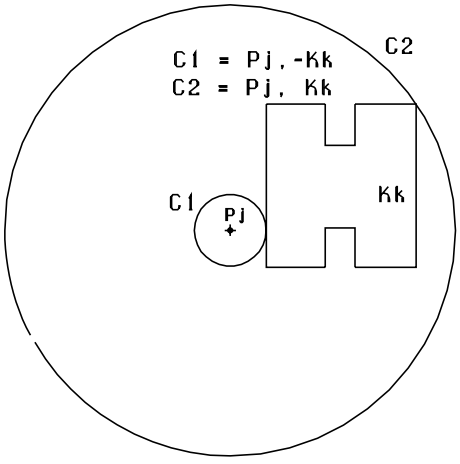
If an identifier of a contour enters the operator with the sign “+”, then the touch is internal, otherwise – external.

Format:

Ci = Pj, Kk

Pj - the earlier defined point

Kk - the earlier defined contour



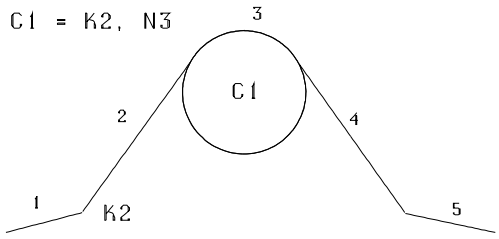
1.4.14 Circle, as an element of the earlier defined contour

Format:

Ci = Kj, Nn

Kj - the earlier defined contour

Nn – a number of the contour's element



1.4.15 Rotation of a circle around a point to the defined angle

Format:

Ci=Cj,Pk,Aa

Cj – the initial circle

Pk – the center of rotation

Aa – an angle of rotation

Example:

```
c1=c3[0,40,30],p1[0,0],a20
c2=c4[60,0,50],p1,a40
```

1.4.16 Circle scaling

Format:

Ci=Cj,Pk,Mm

Cj – the initial circle

Pk – the point of the center of scaling

Mm – scaling coefficient

Example:

```
c1=c3[50,0,30],p1[0,0],m0.5
c2=c4[0,50,20],p1,m2
```

1.5 CIRCLE, DEFINED FROM THE CONDITION OF THREE CONTACTS

To select one of possible circles it is necessary to define correctly signs of parameters (if they are not points) and their sequence.

Definition of a sign of a line (ref. in the paragraph “Circle of the defined radius, tangent to two lines”) and sign of a circle (ref. in the paragraph “Circle of the defined radius, tangent to two circles”).

To select the correct sequence of parameters in the operator it is necessary to enumerate them, starting from anyone, in the order of their contact with a being defined circle in rounding counter-clockwise.

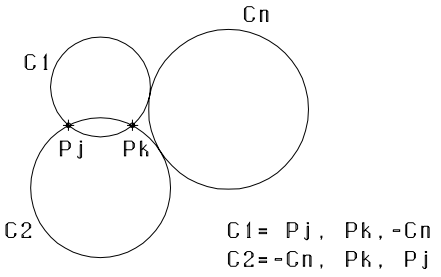
1.5.1 Circle, passing through two points and tangent to the present circle

Formats:

Ci = Pj, Pk, Cn
Ci = Pj, Cn, Pk
Ci = Cn, Pj, Pk

Pj, Pk – earlier defined points

Cn – the earlier defined circle



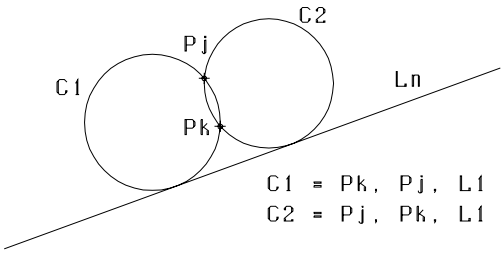
1.5.2 Circle, passing through two points and tangent to the present line

Formats:

Ci = Pj, Pk, Ln
Ci = Pj, Ln, Pk
Ci = Ln, Pj, Pk

Pj, Pk – earlier defined points

Ln – the earlier defined line



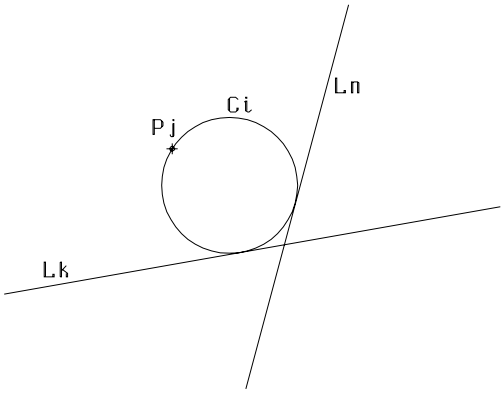
1.5.3 Circle, passing through one point and tangent to two lines

Formats:

Ci = Pj, Lk, Ln
Ci = Lk, Pj, Ln
Ci = Lk, Ln, Pj

Pj – the earlier defined point

Lk, Ln - earlier defined lines



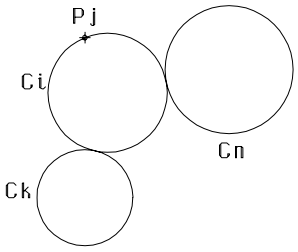
1.5.4 Circle, passing through one point and tangent to two circles

Formats:

Ci = Pj, Ck, Cn
Ci = Ck, Pj, Cn
Ci = Ck, Cn, Pj

Pj – the earlier defined point

Ck, Cn – earlier defined circles



1.5.5 Circle, passing through one point and tangent to a line and a circle

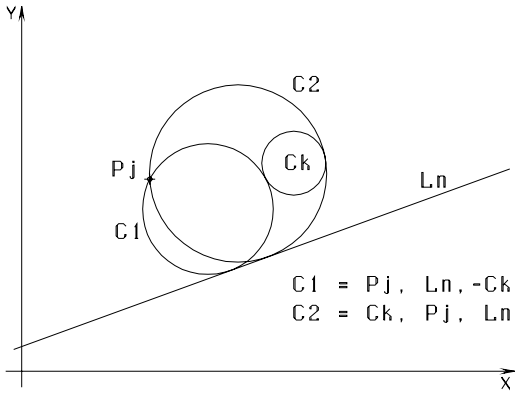
Formats:

Ci = Pj, Ck, Ln
Ci = Ck, Pj, Ln
Ci = Ck, Ln, Pj
Ci = Pj, Ln, Ck
Ci = Ln, Pj, Ck

Pj – the earlier defined point

Ck – the earlier defined circle

Ln – the earlier defined line



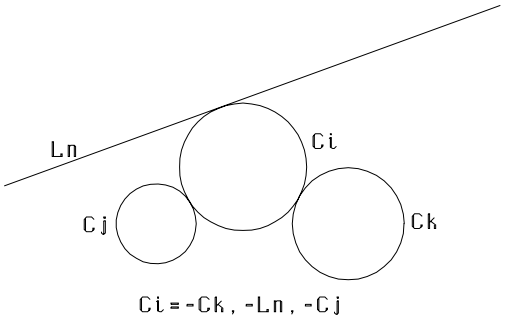
1.5.6 Circle, tangent to two circles and a line

Formats:

Ci = Cj, Ck, Ln
Ci = Cj, Ln, Ck
Ci = Ln, Cj, Ck

Cj, Ck – earlier defined circles

Ln – the earlier defined line



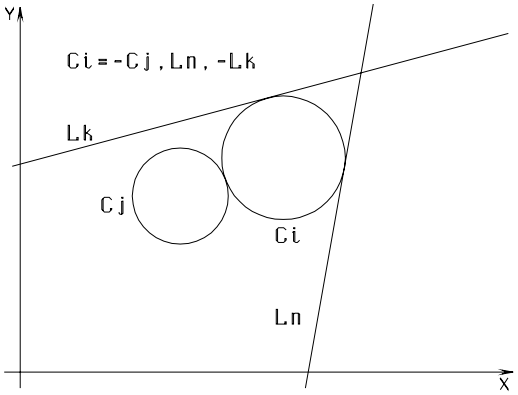
1.5.7 Circle, tangent to two lines and a circle

Formats:

Ci = Cj, Lk, Ln
Ci = Lk, Cj, Ln
Ci = Lk, Ln, Cj

Cj – the earlier defined circle

Lk, Ln - earlier defined lines

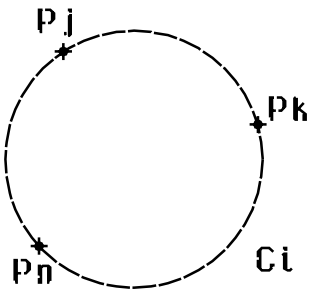


1.5.8 Circle, passing through three points

Format:

Ci = Pj, Pk, Pn

Pj, Pk, Pn – earlier defined points

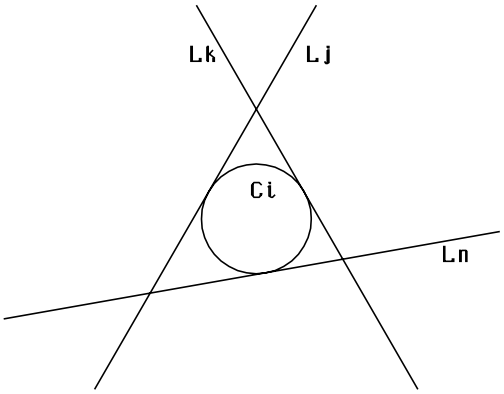


1.5.9 Circle, tangent to three lines

Format:

Ci = Lj, Lk, Ln

Lj, Lk, Ln – earlier defined lines



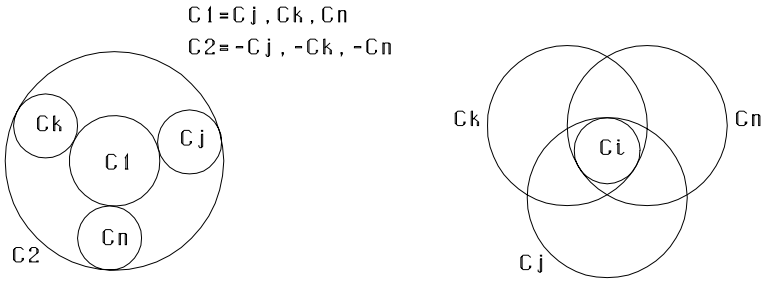
1.5.10 Circle, tangent to three circles

Formats:

Ci = Cj, Ck, Cn
Ci = Cj, Ck, Cn, N2

Cj, Ck, Cn – earlier defined circles

There is a possible case, at which indicated conditions for selection of one of circles is not enough. For selection of the internal circle it is necessary to indicate the modificator #2



1.6 CONTOUR

1.6.1 Conception of a contour

A contour in geometrical processor is a joining of segments of geometrical elements. An assignation operator in the left part, contains identifier of a contour – "K", with the contour's number. In the right part – a list of parameters in accordance with one of acceptable methods of assignation.

For a contour exists a definition called direction of rounding. Thus, a contour described as :

K1 = P10, L1, -C10, -L12, P3

and contour:

K2 = P3, L12, C10, -L1, P10

have opposite directions of rounding.

The amount of simultaneously defined contours is limited only by the RAM capabilities (for every contour, in the RAM stores the adress of the begining and the adress of the ending of a contour in the file GPS.DAT)

Re-definition of used contours, by means of conferring to an identifier a new meaning is possible.

Accepts usage of the earlier defined contour and re-definition of a contour with the similar identifier within one operator.

Example:

K10 = K10, M5

being defined contour — earlier defined contour

1.6.2 Formation of a contour from the defined geometrical elements

■ Operator creation

At that method of assigning the right part of an operator contains enumeration of elements of a contour in such sequence, in which they penetrate into it. Description of a contour begins from a point, laying on the first element (circle or a line) and finishes by a point, laying on the last element.

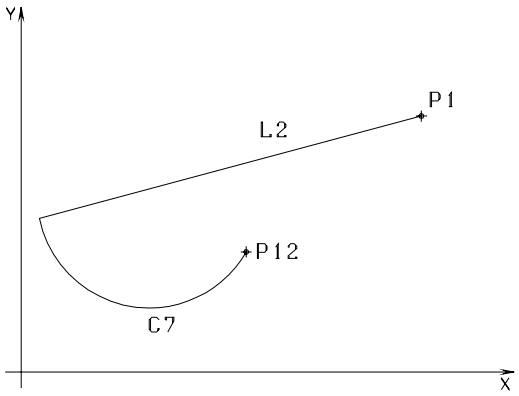
In order to describe a contour it is necessary to previously define all its elements (otherwise enclosed operators of definition of this elements must be as parameters), except for radiuses of rounding, which could be defined directly in the contour definition operator (i.e. without corresponding circle).

If in a contour exists intersection of a line and a circle, then one should define a number of intersection point, at which it is necessary to perform a transition from one element to another. To do so, one should look along a line in direction with which it enters a contour. The first point of transition sets as default. To define the second point it is necessary to define the modifier #2.

If in an operator exists intersections of two circles, the one should define the number of intersection point at which it is necessary to perform a transition from one circle to another. To do so, one should look along a line connecting centers of the circles in direction from the first circle to the second. The first point at that, will be on the left. The first point of transition sets as default. To define the second point it is necessary to define modifier #2.

The first and the last points can be left undefined in the operator of contour assignment. In this case, the first point will be the point of intersection of two initial elements, and the last point will be the point of intersection of two final elements of a contour.

Example: K23 = P1, -L2, N2, C7, P12

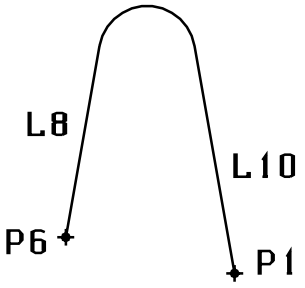


1.6.3 Rounding radius

The rounding radius is an arc of a circle, conjugating intersecting geometrical elements. Identifier, pointing on the presence of rounding, inserts into a contour assignment operator between identifiers of conjugating elements. At that, it is necessary to conceder the sign, with which an arc enters a contour.

If for conjugated elements assigned a number of intersection point , then identifier of rounding inserts after the “N” parameter.

Example: K10 = P6, L8, -R20, L10, P1



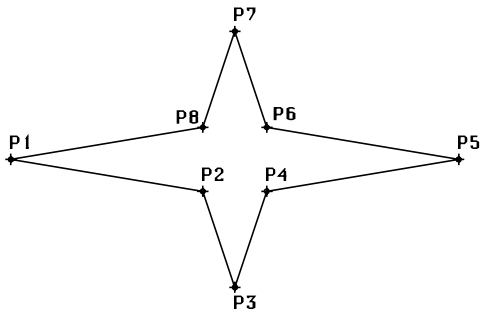
1.7 CONTOUR, DEFINED BY MULTITUDE OF POINTS

1.7.1 Contour – brocken line

The right part of the contour assignment operator contains enumeration of points at that sequence, at which they should be connected by segments.

Formar:

Ki = Pj, Pk,..., Pn



K1=P1,P2,P3,P4,P5,P6,P7,P8,P1

1.7.2 Spline

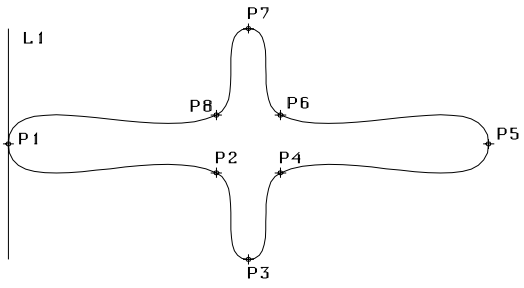
The first parameter in an operator is the “M” identifier, which indicates the magnitude of deviation at approximation by spline sections – broken line. After that follows the initial condition (line or circle), then enumeration of points at that sequence, at which they should be connected at spline interpolation – broken line. The operator finishes by definition of condition on the end of spline - broken line (line or circle).

The first point must lie on the element, defining initial condition

The last point must lie on the element, defining final condition

Format:

Ki = Mm, Lt, Pj, Pk,..., Pn, Lq
Ki = Mm, Ct, Pj, Pk,..., Pn, Lq
Ki = Mm, Ct, Pj, Pk,..., Pn, Cq
Ki = Mm, Lt, Pj, Pk,..., Pn, Cq



K1=M0.1,-L1,P1,P2,P3,P4,P5,P6,P7,P8,P1,-L1

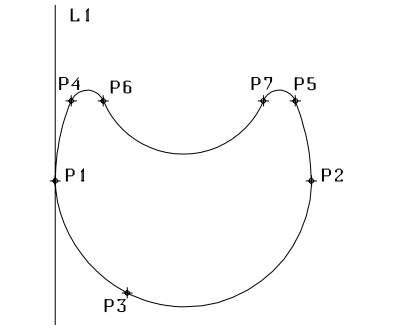
1.7.3 Approximation by arcs

This method of assignment allows to define on a multitude of points a smooth contour, elements of which are tangent arcs. There is a possible case then in the initial data three points, laying on one line are defined one after one. Then, corresponding arc will degenerate into a section of a line.

The first parameter in the operator is the identifier of geometrical an element (line or circle), defining the initial condition. Further follows enumeration of points in that sequence, in which they should be connected be arcs in approximation.

Formats:

Ki = Lt, Pj, Pk,..., Pn
Ki = Ct, Pj, Pk,..., Pn



K1=L1,P1,P4,P6,P7,P5,P2,P3,P1

1.7.4 Spiral of Archimed

Format:

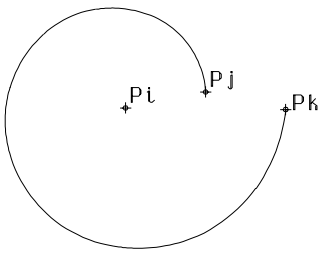
Ki = Mm, Pi, Pj, Pk

Mm – magnitude of deviation of the defined contour from theoretical spiral of Archimed; at that a sign in operanda assigns direction of a spiral

Pi – point of the center of a spiral

Pj – the initial point

Pk – the final point of a spiral



1.8 MODIFICATION OF A CONTOUR

Geometrical processor allows to assign contours, as modification of earlier defined contours. This feature includes the following means:

- Parallel transfer
- Transfer – rotation
- Transfer in relative coordinate system
- Assignment of a contour of an axial symmetry
- Creation of an equidistant contour
- Multiple rotation with joining
- Multiple transfer with joining
- Contour defined by transfer of the initial contour to defined direction untill collision with another contour
- Change of direction of rounding
- Joining of contours
- Selection of a contour, as a sub-multitude of earlier defined contour

1.8.1 Parallel transfer

Definition of a contour by parallel transfer of the earlier defined contour can be done by two methods:

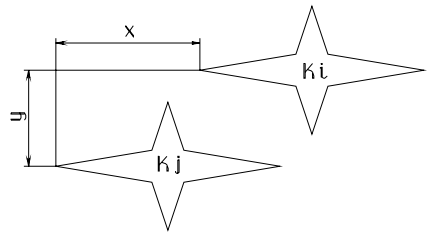
- **Assignment of parallel transfer by transferences along the "X" and "Y" axes of the initial contour**

Format:

Ki = Kj, Xx, Yy

Xx – transference by the "X" axis

Yy – transference by the "Y" axis



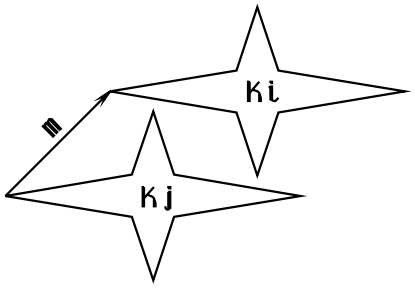
■ **Assignment of parallel transfer by a vector**

Format:

Ki = Kj, Aa, Mm

Mm – length of a transition vector

Aa – an angle between the positive and negative directions of the “X” axis and a vector



1.8.2 Transfer – rotation

To define a contour by transfer – rotation of an assigned contour enters a definition of a point of rotation center. Transformation can be presented as the following sequence of actions:

- Rotation of the initial contoue around the point of rotation center
- Parallel trasfer of a turned contour

Parallel transfer of turned contour assigns by combining of a point of rotation center with the defined point

Format:

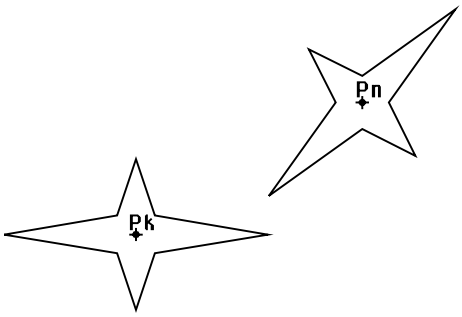
Ki = Kj, Pk, Pn, Aa

Kj – the initial contour

Pk – point of rotation center

Pn – a point, with which “Pk” combines for creation of trancfer

Aa – a rotation angle



1.8.4 Transfer of a contour to the relative coordinate system

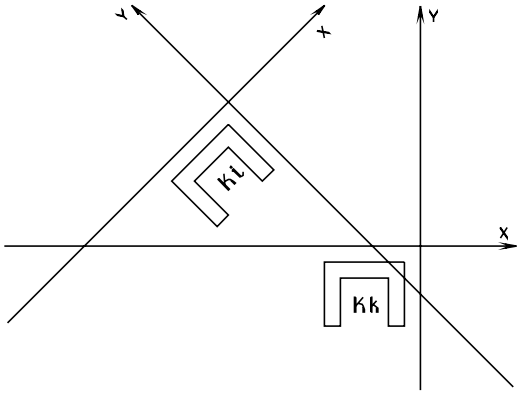
Assigning of a contour by the transfer of the initial contour into another coordinate system basicaly has the following formula: a being assigned contour located in defined coordinate system is the same, as the initial contour located in the initial coordinate system.

- **Assigning of a contour by transfer of the initial contour from the primal system to the relative**

Format:

Ki = Oj, Kk

Oi – the earlier defined relative coordinate system



- **Assigning of a contour by transfer of the initial contour from one relative coordinate system, to another**

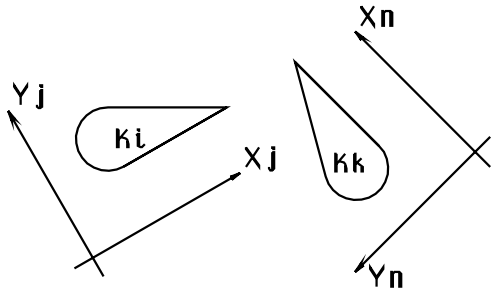
Format:

Ki = Oj, Kk, On

Oj – a relative coordinate system, into which a assigned contour is to be lecated

Kk – the initial contour

On – a relative coordinate system, in which locates the initial contour



1.8.4 Assignment of a contour by the axial symmetry

Axial symmetry allows to define a contour symmetrical to the present relatively an arbitral line. At that, at the defined contour changes direction of rounding relatively to the initial contour.

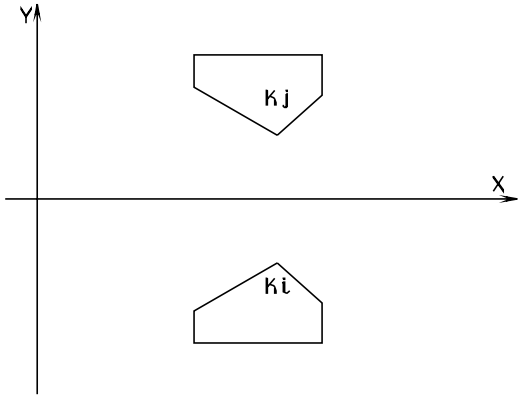
- **Symmetry relatively one of axes of the primal coordinate systam**

Format:

Ki = Kj, Lx
Ki = Kj, Ly

Lx – the “X” axis

Ly – the “Y” axis

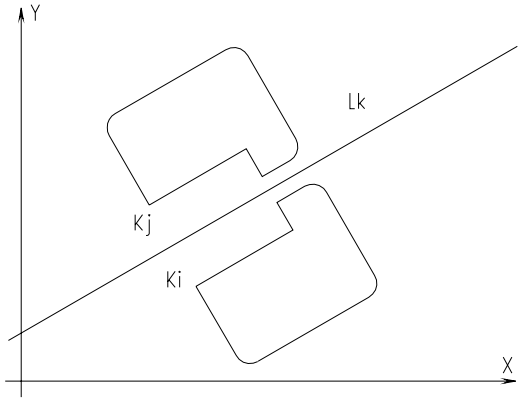


- **Symmetry relatively an arbitral line**

Format:

Ki = Kj, Lk

Lk – the defined line



1.8.5 Creation of an equidistant contour

This method allows to define contour, equdistant to the initial contour

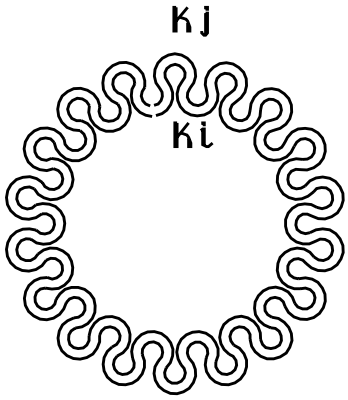
Format:

Ki = Kj, Mм {, ANG a}

Mm – a value of equidistant

a – an angle of rounding

If an angle between neighbouring elements is less than “a”, then adds an arc of rounding



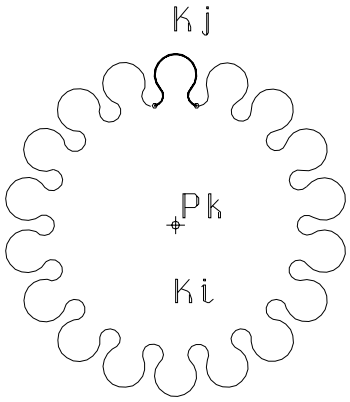
1.8.6 Multiple rotation with joining

Creation of a contour by this method can be presented as:

- Multiple rotation of the initial contour round the point of rotation center by such a method, so that the initial point of every following contour coinsides with the final point of the previous.
- Joining of all obtained by rotation contours into the resulting contour

The initial contour is a segment of the defined. The centre of rotation is defined by a point. For correct assigning it is necessary to accomplish the following conditions:

- The initial point of controur, final poin of contour and the point of rotation center must not coincide



- The initial and final points of the initial contour must be equally distanced from the point of rotation center

Format:

Ki = Kj, Pk, Nn

Pk – the defined point, the center of rotation

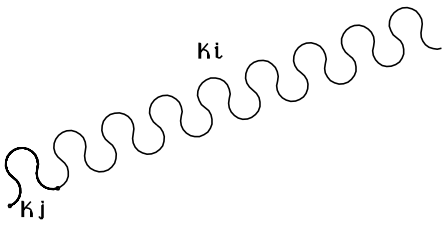
Nn – number of rotations

1.8.7 Multiple transfer with joining

Creation of a contour by this method can be presented as follows:

- Multiple parallel transfer of the initial contour by such a method, so that the initial point of every following transfered contour coinside with the final of a previous.
- Joining of all obtained by transfer contours into the resulting contour

The initial contour is a segment of defined. For correct assigning it is necessary to accomplish the following condition: the initial and the final points of the initial contour must not coinside



Format:

Ki = Kj, Nn

Nn – number of tansfers

1.8.8 Contour defined by transfer of the initial contour to the defined direction up to the collision with another one

Format:

Ki = Kj, Kk, Aa

Kj – the initial contour

Kk – the earlier defined contour

Aa – an angle of transfer direction of the initial contour

1.8.9 Change of a direction of rounding

This method allows to assign a contour, coinsiding with the initial and possessing of opposite direction of rounding

Format:

Ki = - Kj

If sign ”-“ is not defined, then a being defined contour will be identical to the initial.

1.8.10 Joining of contours

This method allows to assign a contour , as a joining of earlier described contours

Format:

Ki = Kj, Kk,..., Kn

For correct assigning it is necessary to accomplish the following condition: the final point of every previous contour must coincide with the initial point of every following contour. At a necessety, parameters of connection of being unified by arcs contours: Ki = Kj, Rr, Kk, Rs,..., Kn, can be defined in an operator.

1.8.11 Contour defined by scaling of the initial contour

Format:

Ki=Kj,Pk,Mm

Kj – the initial contour

Pk – the point of center of scaling

Mm – scaling coefficent

1.8.12 Selection of a contour, as a sub-multitude of the initial contour

- **Selection of a sub-contour by numbers of elements**

Format:

Ki = Kj, Nn, Nm

Nn – number of the initial element

Nm – number of the final element

- **Selection of a sub-contour between two arbitral points, lying on the initial contour**

Format:

Ki = Kj, Pk, Pl

Kj – the initial contour

Pk, Pl – the initial and the final points of a being selected contour

1.8.13 Rounding in the nodal point of the initial contour

Format:

Ki=Kj,Nn,Rr

Kj - the initial contour

Nn – number of a nodal point

Rr – radius of rounding

Example:

```
k1=p[0,0],p[40,0],p[40,-50],p[-40,-50],p[-40,-70]
k2=k1,n(2),r(10)
```

1.9 GEOMETRICA2L FUNCTIONS

Geometrical functions are meant for transformation of geometrical data types into real data types. In the language of a dialogue monitor with a fully loaded geometrical process, it is allowed to use geometrical functions equally to the standard matheatical ones. (reference: description of the language of a dialogue monitor of the SPRUT package).

1.9.1 Functions of transformation of geometrical elements parameters into real data types

1) X[Pi] - coordinate “X” of point Pi;

2) Y[Pi] - coordinate “Y” of point Pi;

3) X[Ci] - coordinate “X” of circle center Ci;

4) Y[Ci] - coordinate “Y” of circle center Ci;

5) R[Ci] - radius of circle Ci;

6) A[Li] - an angle between the positive direction of the “X” axis and the line Li;

1.9.2 Functions of transformation of geometrical elements` mutual location parameters into the real data types

1) A[Li,Lk] – angle between the lines Li and Lk;

2) A[Pi] – central angle of a point (a slope angle of a line, connecting the beginning of a coordinate system with the point Pi);

3) A[Pi,Pk] – slope angle of a line, connecting the points Pi,Pk;

4) M[Pi,Pk] – distance between the points Pi and Pk;

5) M[Pi,Lk] – shortest distance between the line Lk and the point Pi;

6) M[Li,Lk] – shortest distance between the lines Li и Lk;

7) M[Li,Ck] – shortest distance between the line Li and circle Ck;

8) M[Pi,Ck] – shortest distance between the point and circle Pi Ck;

9) M[Ci,Ck] – shortest distance between the circles Ci и Ck;

10) M[Pi,Kj] – shortest distance between the point Pi and contour Kj;

11) M[Ki,Pj,Pk] – length of a part of the contour Ki, located between the points Pj и Pk;

12) M[Ki,Kj,Aa] – distance between the contours Ki и Kj in the direction Aa;

1.9.3 Functions of calculation of the ortogonal distance between two points by axes "X" and "Y"

Distance has a sign corresponding to the direction fron the first point to the second

Format:

X[Pi,Pj],	*Y[Pi,Pj],*
X[Pi,Cj],	*Y[Pi,Cj],*
X[Ci,Cj],	*Y[Ci,Cj]*

Example:

```
p1=100,100
p2=-100,-100
c1=x50,y0,r50
c2=x-50,y0,r30
xPP=X[p1,p2]
yPP=Y[p1,p2]
xPC=X[c1,p1]
yPC=Y[p1,c1]
xCC=X[c1,c2]
yCC=Y[c1,c2]
```