Programming Manual

CNC TURRET PUNCH PRESS

HYBRID

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Contents

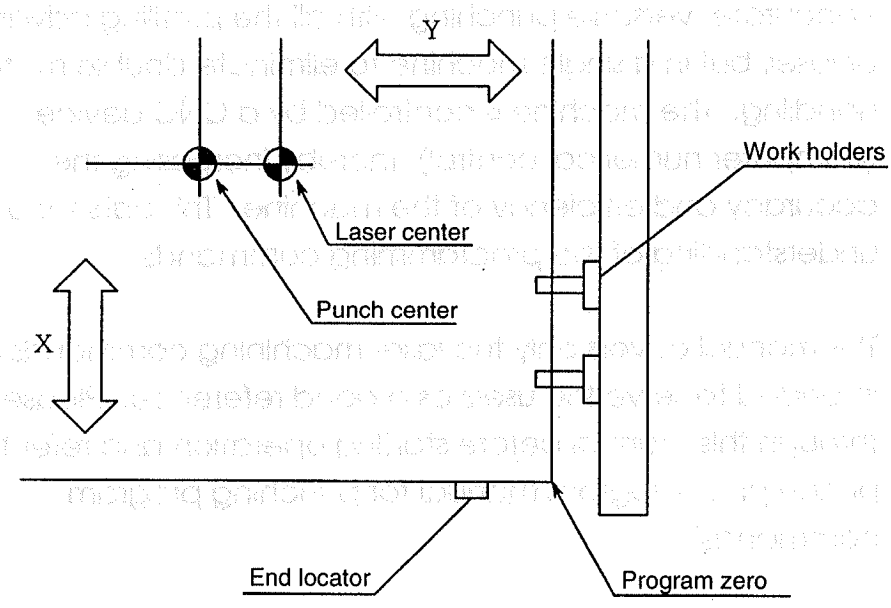
Section 1 Overview

The hybrid machine combines both turret punch press and laser generator. This provides the users the best of both worlds - accurate, versatile punching with all the profiling advantages of laser, but in a single machine to eliminate double material handling. The machine is controlled by a CNC device (computer numerical control), thereby increasing the accuracy and efficiency of the machine. This calls for a better understanding of the programming commands.

This manual covers only the laser machining commands and is intended to serve the users as a good reference. Please go through this manual before starting operation and refer to punch press program manual for punching program commands.

1-1 Machining Range

The following diagram explains the program and machine centers. The work holders are represented at the bottom of the diagram and the end locator at the left. The contact point of left and the bottom line of the sheet becomes the program zero point.



As the punch and laser centers are different from each other, the range dimensions are mentioned separately.

Machining dimensions & range :

		X	Y
Laser	C3000HYB V3000HYB	0~2000	0~1225
	C3500HYB	0~2000	0~1530
	M5000HYB V5000HYB	0~2500	0~1525
	FL-1544	0~1250	0~1250
Punching	C3000HYB V3000HYB	0~2000	0~1250
	C3500HYB	0~2000	0~1525
	M5000HYB V5000HYB	0~2500	0~1525
	FL-1544	0~1250	0~1250

* This is the range of machining available when a steel plate is clamped.

Program input dimensions & range :

		X	Y
Laser	C3000HYB V3000HYB	-25~2025	-5~1250
	C3500HYB	-25~2025	-5~1550
	M5000HYB V5000HYB	-25~2525	-5~1530
	FL-1544	-20~1270	-5~1280
Punching	C3000HYB V3000HYB	-25~2025	Double track (In-station: 0~1620, Out-station: -70~1550) Single track (-25~1550)
	C3500HYB	-25~2025	In-station: 0~1920, Out-station: -70~1850
	M5000HYB V5000HYB	-25~2525	In-station: 0~1900, Out-station: -70~1830
	FL-1544	-20~1270	-30~1580

Note : The "HIGH-NBL" (high nibbling) command can not be used in a laser turret punch press.

1-2 Table Speed

As laser cutting involves circular interpolation unlike punching, there is a need for changing the cutting speed within a program. As regard to punching, the maximum table speeds depend on the machine model (refer to the specification sheet), while the maximum laser cutting speed is 10m/min.
Cutting speed (F code) is determined depending upon the material type, sheet thickness, power output, frequency, duty and profile to be cut. Speed can be changed within one program. These speeds can be further adjusted from 0 to 200% using override switch.

(1) Commands within the program

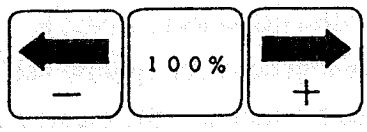
【Example】

LAL/X500 Y200 F240

"F240" in this block specifies a table speed of 2.4m/min. (When there is no machining speed command after a laser enable command, the table will not move.) F codes should be entered into the laser mode.

LAL/X50 Y200 F300
X300 Y400 F200
CIR/500 350 230 F100
X800 Y50 F250 (LHS/in the laser mode)

(2) Overriding feed rate

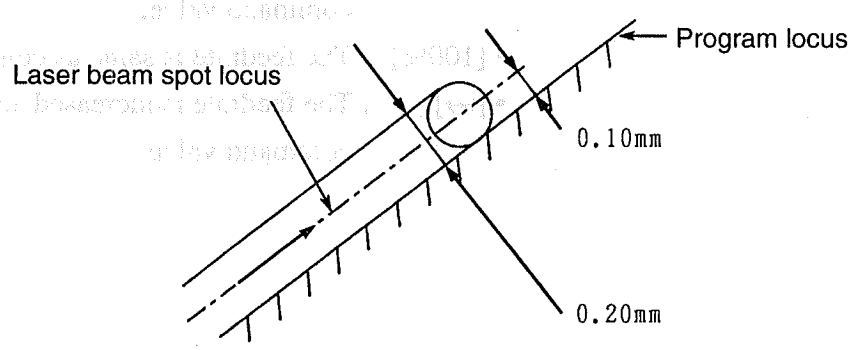


The cutting feedrate of laser head can be controlled with reference to the commanded feedrate in terms of percentage. The override value is displayed in the "Laser cutting parameters display" as shown below.

- [←] : The feedrate is reduced below 100% of command value.
- [100%] : The feedrate is same as command value.
- [→] : The feedrate is increased above 100% of command value.

1-3 Laser Kerf Offset

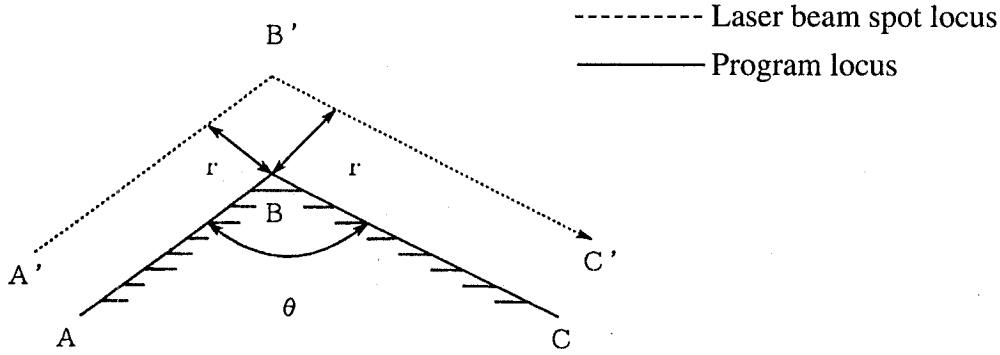
As laser beam spot diameter is not 0, spot diameter must describe a locus offset to half of the spot diameter. Because of the difficulty of creating a program considering only half of the spot diameter, the software of the machine is programmed to automatically create a locus in which only half of the spot diameter is offset. Laser beam spot diameter is 0.20mm, and the portion which is offset is half of that, or 0.10mm.



The Locus When Setting the Kerf Offset

(1) When the shape of the work includes an obtuse angle

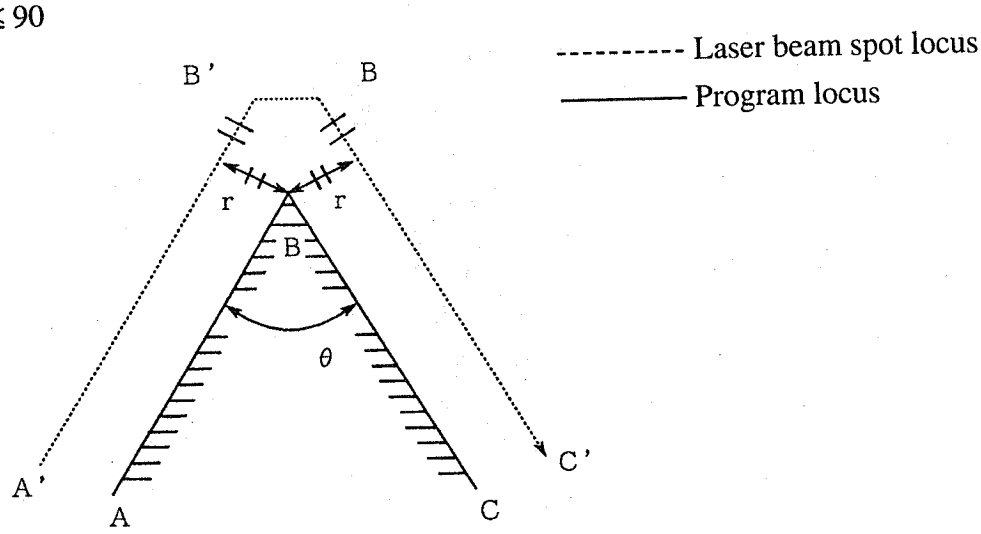
$90 \leq \theta \leq 180$



When commands are given for points A, B and C, the spot locus appears as A'B'C'.

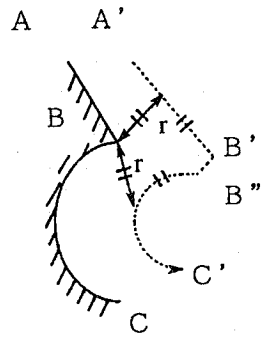
(2) When the shape of the work includes an acute angle

$0 \leq \theta \leq 90$



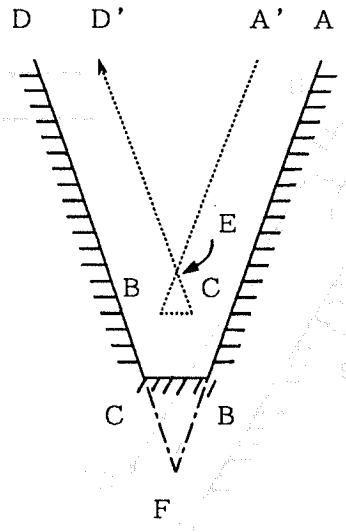
When commands are given for points A, B and C, the laser beam spot locus appears as A'B'B"C'. Compensation for B'B" will be made on the outside of point B.

(3) When the shape of the work includes a straight line connected to an arc



When commands are given for A and BC, the laser beam spot locus appears as A'B'B"C'. Compensation for B'B" will be made on the outside of point B.

(4) When machining the inside of an acute angle



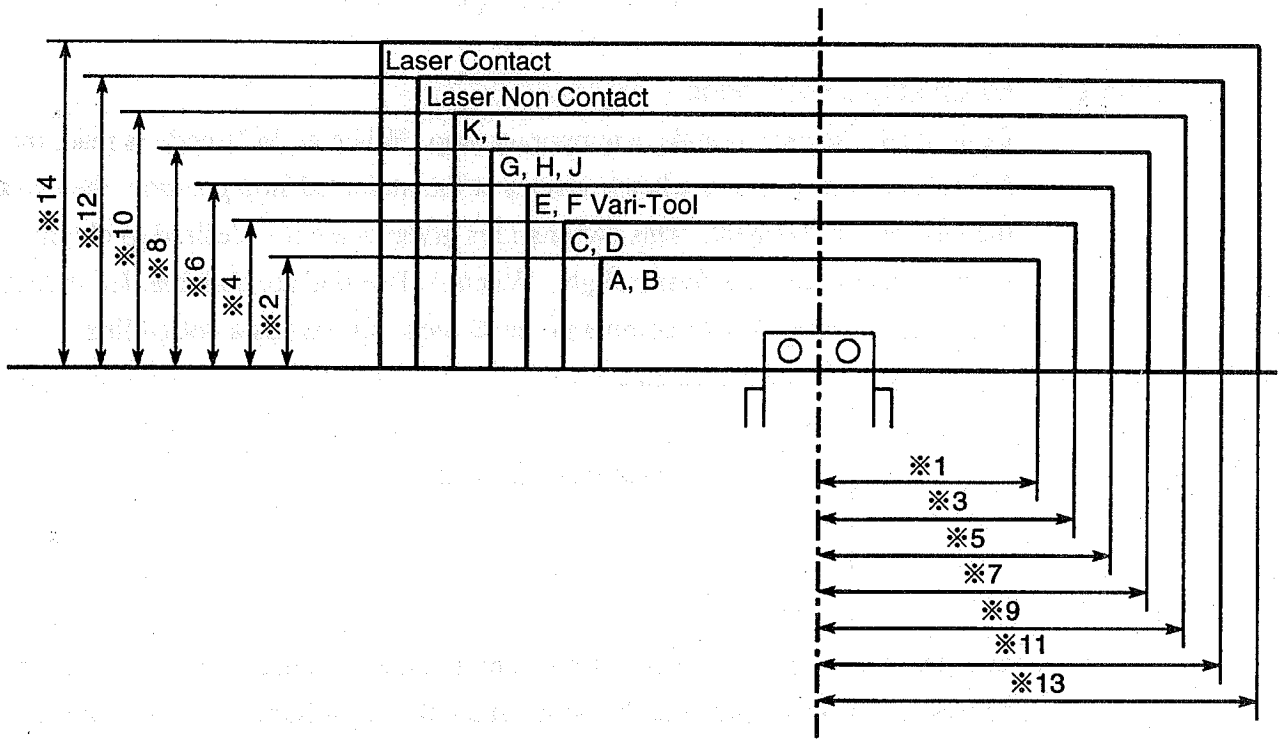
When commands are given for points A, B and C, the laser beam spot locus appears as A'B'C'D', with B' and C' describing a straight line that interferes with straight lines AB and CD. Thus, the actual locus should be given as A'E'D'. However, when it is desired to obtain a program using A'E'D', program using AF and FD.

1-4 Work Holder Safety Zone

In order to protect the work holder, the laser cannot be allowed to machine within the zone containing the work holder. This zone is called the work holder safety zone. When machining is attempted within the work holder safety zone, the following alarms will appear and the machine will stop.

"1085 CLP UNDER LASER" "2020 WORK HOLDER SAFETY ERROR"

The zones within which machining is not allowed are shown below.



Station / Model	A, B		C, D		E, F		G, H, J		K, L		Laser Non Contact		Laser Contact	
	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
	※1	※2	※3	※4	※5	※6	※7	※8	※9	※10	※11	※12	※13	※14
C-3000H, V-3000H, C-3500H	70	40	84	54	99	69	117	87	127	97	110	65	110	65
C-3000H, V-3000H, C-3500H with loader	83	40	98	54	113	69	130	87	140	97	123	65	123	65
M-5000H, V-5000H	70	40	84	54	99	69	117	87	127	97	123	94	123	94
M-5000H, V-5000H with loader	83	40	98	54	113	69	130	87	140	97	137	94	137	94
FL-1544	70	40	84	54							85	40	110	65
FL-1544 with loader	83	40	98	54							99	40	123	65

While making the programs, please take the work holder safety zone also into consideration.

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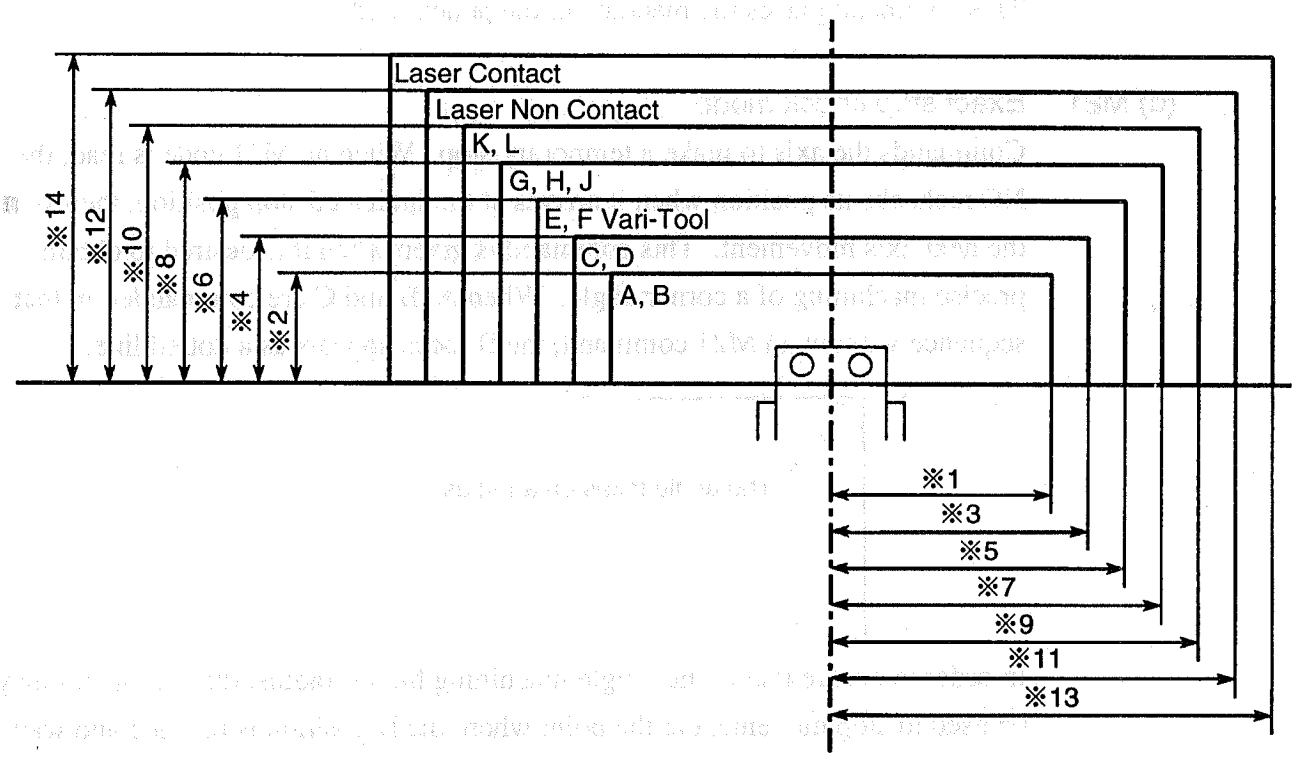


Station / Model	A, B		C, D		E, F		G, H, J		K, L		Laser Non Contact		Laser Contact	
	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y	X	Y
	※1	※2	※3	※4	※5	※6	※7	※8	※9	※10	※11	※12	※13	※14
C-3000H, V-3000H, C-3500H	70	40	84	54	99	69	117	87	127	97	110	65	110	65
C-3000H, V-3000H, C-3500H with loader	83	40	98	54	113	69	130	87	140	97	123	65	123	65
M-5000H, V-5000H	70	40	84	54	99	69	117	87	127	97	123	94	123	94
M-5000H, V-5000H with loader	83	40	98	54	113	69	130	87	140	97	137	94	137	94
FL-1544	70	40	84	54							85	40	110	65
FL-1544 with loader	83	40	98	54							99	40	123	65

While making the programs, please take the work holder safety zone also into consideration.

(g) M24 Laser mode

This command places the machine in the laser mode. However, since the M24 code is included in LAL/(LAR) commands (laser mode in), it does not normally appear in machining programs.

(h) M26 Laser mode cancel

This command cancels the laser mode. However, since the M26 code is included in LED/commands (laser mode out), it does not normally appear in machining programs.

(i) M27 Pulse 1 mode

This command places the laser beam into the pulse generator mode. The M27 code is utilized for pierce pulses, and may be freely selected with a SET command.

(j) M28 CW (continuous laser generation) mode

This command is a toggle for turning the CW mode on and off. It is used when it is desired to perform linear processing for an extended period of time or at high speed.

(k) M34, M35 Pulse 2 and 3 modes

This machine allows the setting of three types of pulse modes, including the M27 code. These are normally used as follows.

For instance, the M27 code may be considered the pulse mode for piercing, while the M34 code is the thin sheet mode and the M35 code the thick sheet mode.

(l) M55 External deceleration mode (enabled for ±X, ±Y directions)

This may be used after laser machining with a coordinate value to move the work to a position on the work chute to enable proper falling of the component into the chute.

(m) M56 External deceleration cancel and work chute operation

This command cancels the external deceleration mode and performs chute operation. Thus, after the work chute has been lowered 10 mm and the finished product has been removed from the work, the chute is tilted at an angle and the finished product is ejected. After a short period of time, the chute is closed and raised to its original position, completing the entire sequence in a single operation.

(n) M57 External deceleration mode cancel and work chute operation

Same as M56 except for the fact that work check will not be carried out.

(O_1) M100 Material cut condition set mode

This code is used for distinguishing pulse cut conditions and material cut conditions. When using this M code, command material codes (material and thickness) using "MAT" and cut conditions using M codes for laser cutting (M111 ~ M115).

(O_2) M101~M102 Material cut condition piercing mode

These codes are used for selecting piercing when M100 has been commanded. When any of these codes is not commanded, it defaults to M101.

(O_3) M111~M115 Material cut condition laser cutting code

These codes are used for selecting a laser cutting type when M100 has been commanded.

Use these M codes as follows:

M111..... High speed
M112..... Middle speed
M113..... Low speed
M114..... N_2/air cut
M115..... Marking

(p) M121 Piercing mode

This command allows the piercing mode to be executed at the start of the machining (start hole machining).

(q) M122 Piercing mode cancel

This command allows machining to commence from the starting point without piercing, and is used to start machining from a punched hole or from the outside of the material.

(r) M123 Marking mode

This code is used when it is not desired to cut the work, but to perform operations such as the marking of characters into the surface. The assist gas will automatically be switched to argon/nitrogen gas.

(s) M124 Marking mode cancel

This command cancels the marking mode. The assist gas will be automatically switched to oxygen.

(t) M125 Air cut (option)

Air will be selected as assist gas.

(u) M71~M74 Gas pressure setting

These commands allow the setting of the assist gas pressure. There are four solenoids and four regulators in the assist pressure feed line which adjust the pressure of the gas. When the NC reads an M code, the corresponding solenoid is actuated and the regulator opens, causing gas to be supplied at the preset pressure. M codes for adjusting the gas pressure have to be changed depending upon plate thickness, material and output.

M71 is the pressure used for piercing, and is set between 0.5~0.7 kg/cm^2 using the regulators. M72 through M74 are cutting gas pressure and should be set according to the plate thickness and material.

For example:

M72: 1kg/cm^2	Thin-steel plate
M73: 2kg/cm^2	Thick-steel plate
M74: 3~4 kg/cm^2	Stainless steel/aluminium

<Electro-pneumatic proportional valve> Assist gas code

Set up gas pressure for "ASSIST GAS CODE" on the pulse cut condition set screen.

(v) M128 Select non-contact type height sensor (option)

This command switches the height sensor to the non-contact mode. During profiling, do not change the mode.

(w) M129 Select contact type height sensor (option)

This command switches the height sensor to the contact mode. During profiling, do not change the mode. When the power is turned on, the contact mode is automatically chosen.

(x) M132 Profile mode (option)

This command switches the laser head to the profile mode. When the power is turned on, the profile mode is automatically chosen.

(y) M133 Profile mode cancel (option)

This command switches the laser head to the constant height mode.

(z) M134 Cutting failure level 1 check mode (option)

M135 Cutting failure level 2 check mode (option)

M136 Cutting failure levels 1 & 2 check mode cancel (option)

Two detection levels 1 (low) & 2 (high) are provided for detecting burning and gouging. M136 cancels these modes. When the power is turned on, M136 is automatically chosen.

★ It is not possible to command these M codes in the block of pattern function.

★ If one block contains two or more M codes, the last M code becomes effective.

1-6 S Codes (Output Control)

Laser output has be set according to the material being machined, its sheet thickness, and depending on whether the CW or pulse modes are used. Variations may exist within a program. This laser power output is represented by "S" code in the program and can be input in increments of 1W.

Program input range :

1000W type : 0~1000 (W)
1500W type : 0~1500 (W)
2000W type : 0~2000 (W)

1-7 Laser Cutting Program Information

Laser cutting program can be made in two methods.

- Pulse cut: This is the format where cut condition data is independently commanded in program.

- Material cut: This is the format where cut condition data is predetermined for each M code for use in program.

<Points related to pulse cut and material cut programming>
As the cutting conditions of pulse cut and material cut and different, M100 is inserted in the program mode to differentiate between them. With regard to material cut, as the cutting conditions are decided on the basis of thickness and the type of material, MAT/command have to be used.
The following explains the cutting program format and the cutting conditions.

(1) Pulse cut condition

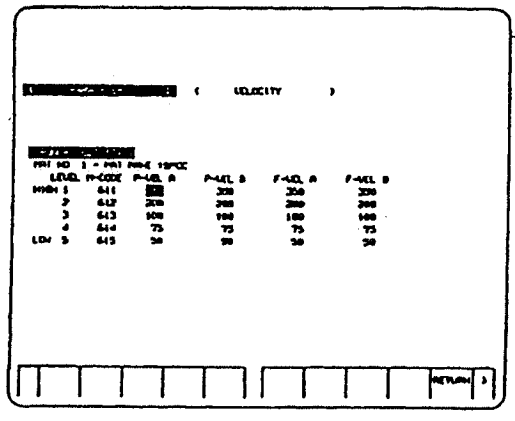
```
O****;
SET/600 700 800 900 0 0 0 1;
M121;
M21;
M71;
LAR/X100Y100F300;
M28S900;
X_ _ _ Y _ _ _;

LED/DX0DY0;
```

Piercing is done with power output 900W, frequency 500Hz, duty 20% for 1 second.

Cutting is performed at power 900W, freqency 2000Hz.

Duty 100%, speed 300cm/min.



★ Pulse 1 M27 data is used for piercing mode.

★ Make sure to press "reset" before starting the laser cutting operation. If not "reset", the data before change will be selected. For example, if the cutting data is changed after stopping the operation with a "M00" command and cutting is performed without "reset", then the data before change is selected. So either "reset" has to be pressed before operation or program has to be carried out up to "M30".

(2) Material cut condition

O****;

M100;

MAT/B1 H1.2;

M111;

M121;

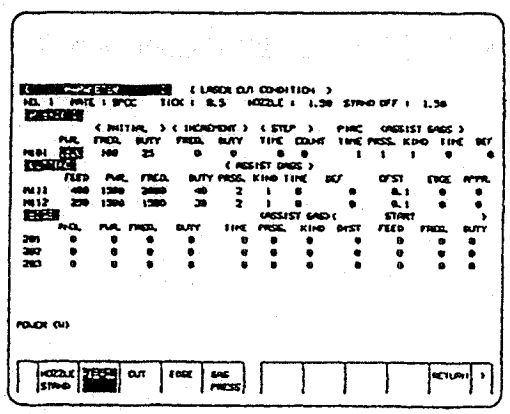
M21;

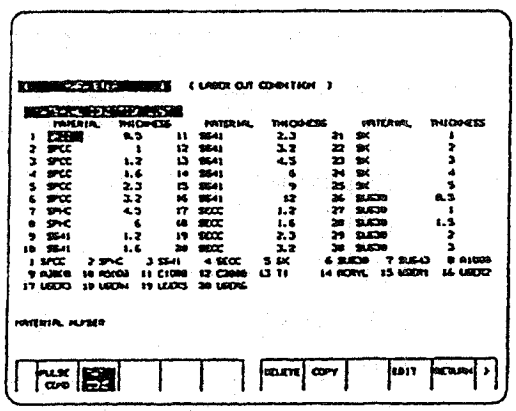
LAR/X100Y100M28;

X_ _ _ Y _ _ _;

LED/DX0DY0;

Cutting is carried out with power 1500W, frequency 1500Hz, duty 80%, speed 300cm/min.





★ "M100" makes the system recognize it as a material cut condition. "B1H1.2" commands that the material cut condition for SPCC with thickness of 1.2 is to be used. "M101" is used for piercing, and "M111" is used for laser cutting.

★ In programs including "M100", MAT/ commands are imperative. Without them, an error is triggered before a laser oscillation command.

<Use of material cut condition program and independent material command>

★ When you desire to change a value in material cut condition program, command it after the block of M code for laser cutting (M111 ~ M115).

【Example】

```
O****;
M100;
MAT/B1H1.2;
M111;                  Data in cut condition file M111 becomes effective.
LAR/X50Y50F350;        Speed is changed to "F350".
S900;                  Main power is changed to :S900".
  :
  :
  :
```

★ When an M code for laser cutting is commanded in program again, it writes over all cut condition data.

【Example】

```
O****;
M100;
MAT/B1H1.2;
M111;
LAR/X50Y50F350;
S900;
  :
  :
LED/DX0DY0;
M112;                  Data in cut condition file M112 becomes effective.
LAR/X100Y100
  :
  :
```

Command format

MAT/Ba Hb Dc Ed Fe Sf Pg Qh ;

"a" Material code list

Input code No. 1~20

Code No.	Type	Description	Code No.	Type	Description
1	SPCC	Cold rolled mild steel plate	11	C1000	Copper
2	SPHC	Hot rolled steel plate	12	C2000	Brass
3	SS41	Rolled steel for general structure	13	TI	Titanium
4	SECC	Electrolytic zinc-coated steel	14	ACRYL	Acrylic
5	SK	Carbon tool steel	15	SPG	Zinc-coated steel 1
6	SUS30	Austenitic stainless steel	16	USER 1	Other 1
7	SUS43	Ferritic stainless steel	17	USER 2	|
8	A1000	Aluminium	18	USER 3	|
9	A2000	Alloy steel (High strength)	19	USER 4	|
10	A5000	Alloy steel (Medium strength)	20	USER 5	Other 5

"b" Thickness data

0.01~99.99 (mm)

0.001~9.999 (inch)

"c" Cutter compensation number

The commanded D code becomes effective when laser oscillation is started; if there is no command, it defaults to No. 1.

"d" Profile offset

Profile offset for laser cutting can be specified. 0.01 mm unit

"e" Speed

"f" Out put

0~1500 (2000)W

"g" Frequency

0~2000Hz

"h" Duty

0~100%

【Example】

MAT/B1H1.2;

MAT/B5 H2.3D2E0.01;

MAT/B20H0.8E-0.02;

Section 2 Set Command

When using a laser for cutting, a high-output beam is emitted at a metal sheet, causing the plate to melt until it is pierced resulting in rapid explosive oxidization, which is dangerous.

For this reason, it is necessary to gradually increase the output power in stages. The SET/ command is used to raise output step by step to final power in this way.

SET/a b c d t1 t2 t3 t4

"a, b, c, d" Output at output meter (watts)

The values for a, b, c and d are determined through experience.

"t1, t2, t3, t4" Dwell value (output hold time)

Output at "a" is done for the time given in "t1", output at "b" is done for the time given in "t2", etc.

Dwell value	0	1	2	3	4	5	6	7	8	9
Time (seconds)	0	1	2	3	4	5	6	7	8	9

The SET/ command normally comes at the start of the program and establishes the conditions for piercing.

【Example】

SET/300 400 500 600 1 1 1 1

The values "300", "400", "500" and "600" must be determined through setting the S code in the MDI mode (M27 in the pulse mode) so that they match data learned through experience. However, frequency and pulse duty must be set before this command is entered.

When sheet thickness is thin, however, piercing can be done with direct output, without having to raise output in four stages.

【Example】

SET/400 400 400 400 0 0 0 1

If M121 (piercing mode) is input, the SET command is executed every time the laser mode is enabled within a program.

【Example】

```
X1250 Y1070 M03
M121
SET/400 400 400 500 0 0 1 2
M21
M72
LAL/X50 Y50 F145 ..... Laser mode enabled
   :
S280 ..... Output changed
   :
LED/DX0 DY0
LAR/X90 Y80 F200 ..... Laser mode enabled
   :
LED/DX0 DY0
```

SET/ is executed every time the laser mode is enabled. This means that the pulse mode is enabled for output each time the mode is activated.

Section 3 Enabling the Laser Mode

Command format

LAR/Xa Yb Fv ..... (1)

LAL/Xa Yb Fv ..... (2)

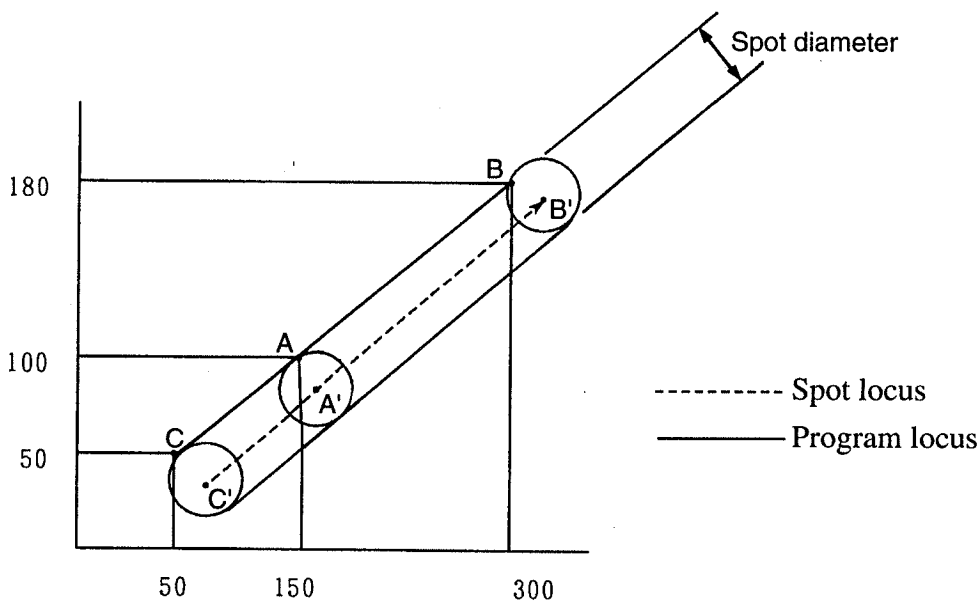
Commands (1) and (2) enable the laser mode. The X- and Y-axes are positioned at point (a, b), the laser torch is lowered, and piercing carried out at the output specified by the SET/ command.

"a, b" X- and Y-coordinates where the laser torch is lowered.
Can be input in millimeters as a decimal fraction of up to two places (0.01 mm).

'v" Table speed (interpolation)
Can be input up to F1000 possible in increments measured in cm/min.

The difference between LAR and LAL is that the first offsets the laser locus to the right relative to the program locus, while the second offsets the laser locus to the left. The F code specifying the speed to be used there after is normally input in the same block that the laser mode is enabled. Torch offset is also effective for the coordinate values specified by LAL/or LAR/.

【Example】 Cutting between points C and B



```
LAR/X50 Y50 F150
X150 Y100 ..... *
X300 Y180
   :
```

* When point A is programmed in N21, torch offset is executed for both points A and C, and C'A' becomes the laser locus.

★ Specify absolute coordinates for LAL/ or LAR/.

★ Do not place two or more blocks in succession in which no axis movement is designated between an LAL/ or LAR/ command and an LED/ command, or kerf offset will be shifted.

Section 4 Cancelling the Laser Mode

Command format

LED/Xa Yb ..... (3)

or

LED/DXa DYb ..... (4)

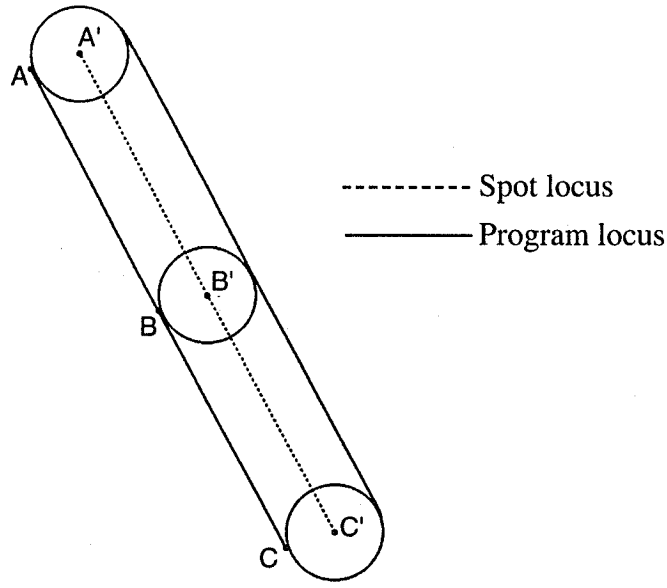
Laser cutting is stopped by the LED/ command at point (a, b). Absolute specification (distance from the program zero) is used for (3), but for (4) incremental values from the final point of the previous block are used.

"a, b" X- and Y-axis coordinates at machining end point.
Can be input in millimeters, as a decimal fraction of up to two places (0.01 mm).

The laser torch is not offset at the point specified by the LED/ command. This means that the laser mode is normally disabled as follows:

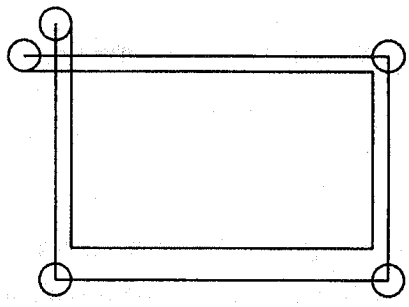
X a Y b ..... Configuration end point

LED/DX0 DY0 ..... Laser mode disabled

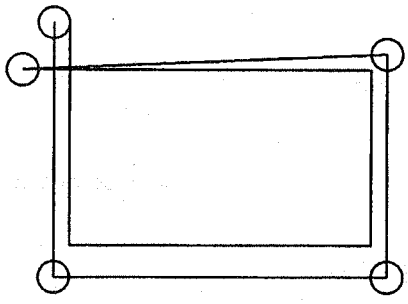


The following programs are similar, but pay attention to the different ways in which each of the programs end.

(1) LAR/X500 Y500 +20
Y400
X700
Y500
X500 -30
LED/DX0 DY0



(2) LAR/X500 Y500 +20
Y400
X700
Y500
LED/X500 -30



In the LED block, the laser torch moves while laser offset is being cancelled, resulting in the diagonal cutting shown in example (2).
Write the program so that the block prior to the LED command gives the configuration end point.

Section 5 Linear Interpolation

A] Command format

X a Y b ..... Absolute specification

DX a DY b ..... Incremental specification

The coordinates specified within the laser mode may be absolute or incremental. When the values are specified interpolation is executed at the speed specified by the F code. Absolute and incremental specifications may also be mixed within a single block.

X a DY b
DX a Y b

"a, b" X- and Y-axis coordinates

B] LASER LINE

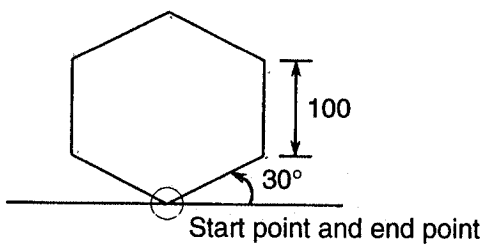
LLI/ ℓ θ

With this command, the laser cut is done from present position along a straight line of length ℓ at an angle θ with reference to X-axis.

" ℓ " : Length of line
Least input increment in mm is 0.01.
Must always be a positive value.

" θ " : Angle of line with reference to X-axis
+ve value for counter-clockwise direction
-ve value for clockwise direction

【Example】 LLI/100 30;
LLI/100 90;
LLI/100 150;
LLI/100 210;
LLI/100 270;
LLI/100 330;



Section 6 Circular Interpolation

6-1 CIR/

Command format

CIR/X1 Y1 θ

An arc of θ degrees centered on point (X1, Y1) is made from the current torch position. The machining radius is determined automatically from the current point and the center point.

"X1, Y1" Center point for circular interpolation
Can be input in millimeters as a decimal fraction of up to two places (0.01 mm).

"θ" Machining angle
$-360 \leq \theta \leq 360$

Cutting is executed in the counterclockwise direction when positive, and in the clockwise direction when negative.

6-2 LCI/

Command format

LCI/L a b r ..... (1)
LCI/R a b r ..... (2)
LCI/L a b -r ..... (3)
LCI/R a b -r ..... (4)

The arc end point (a, b) and radius "r" are given, and an arc is made from the current torch point to the end point along this radius. However, this command cannot be used to cut full circles.

"R, L" Cutting direction
R : clockwise
L : counterclockwise

"a, b" X- and Y-axis coordinates of the arc end point

Can be input in millimeters as a decimal fraction of up to two places (0.01 mm).

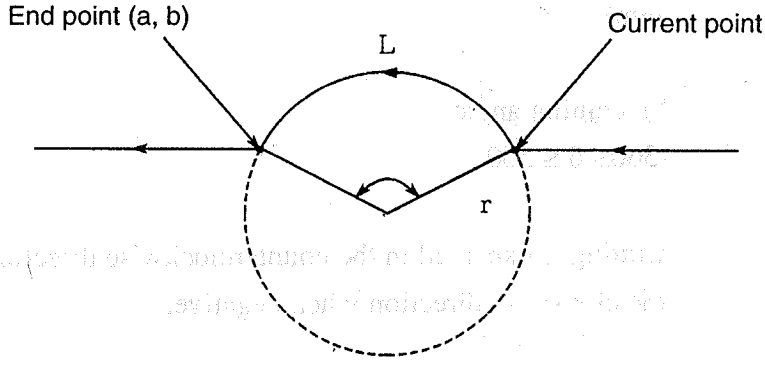
"r" Arc radius

Can be input in millimeters as a decimal fraction of up to two places (0.01 mm).

Positive when the arc angle is less then 180° and negative when the arc angle is greater than 180°.

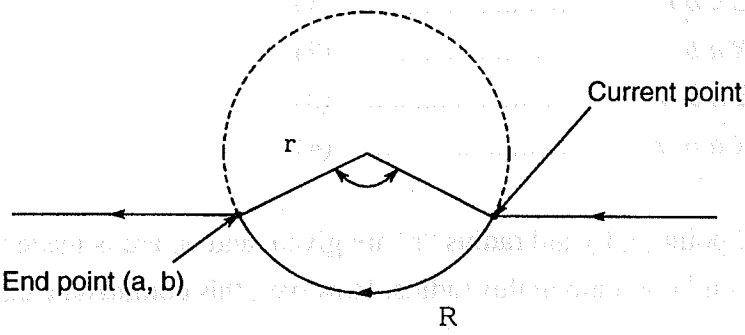
The differences between blocks (1) through (4) are explained by the following figures.

(1)

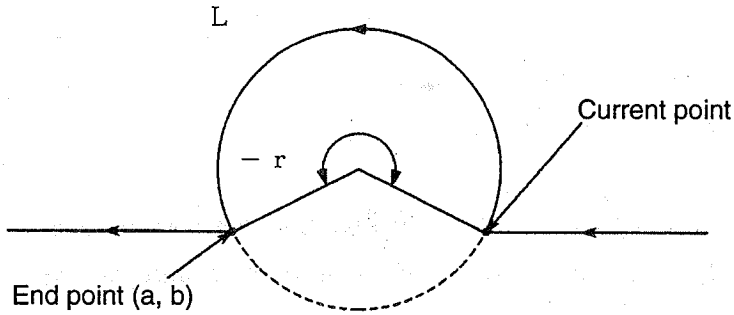


The solid line indicated by the arrow is the laser locus.

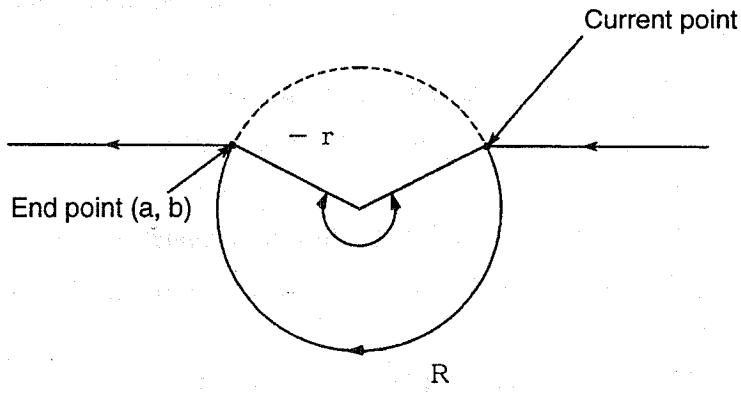
(2)



(3)



(4)



LASER RADIUS

LAR/a X2 Y2 XC YC

With this command, the laser cut is done from the present position to the end point defined by the absolute coordinates X2, Y2, along an arc of a circle whose center is located at coordinates XC, YC.

"a" : Cutting direction from current position
R (RIGHT) ..... for clockwise direction
L (LEFT) ..... for counter-clockwise direction

"X2, Y2" : End point absolute coordinates
Least input increment in mm is 0.01.

"XC, YC" : Arc center point absolute coordinates
Least input increment in mm is 0.01.

Note : Both end point and center point have to be commanded in absolute coordinate values only.

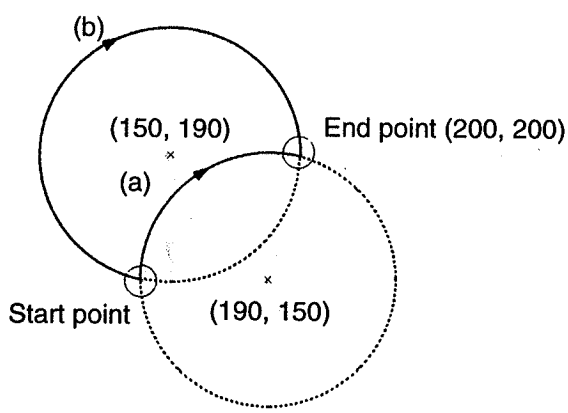
(Example)

For arc (a)

LRA/R 200 200 190 150;

For arc (b)

LRA/R 200 200 150 190;



6-4 LHS/-LHE/

Command format

M72~M74
LHS/
*M_S_*
Xa1 Yb1 Rr1 Fs1
Xa2 Yb2 Rr2 Fs2
:
LHE/

This command is used to make the laser create holes. LHS/ enables the HOLE mode, and a circular hole centered on point (a1, b1) with a radius r1 is cut at the speed s1 specified by the F code and the output p1 specified by S.

When one hole has been cut, the machine moves to the next at the positioning speed and begins cutting.

"X, Y" Hole center point
Can be input in millimeters as a decimal fraction of up to two places (0.01 mm).

"R" Hole radius
Can be input in millimeters as a decimal fraction of up to two places (0.01 mm).

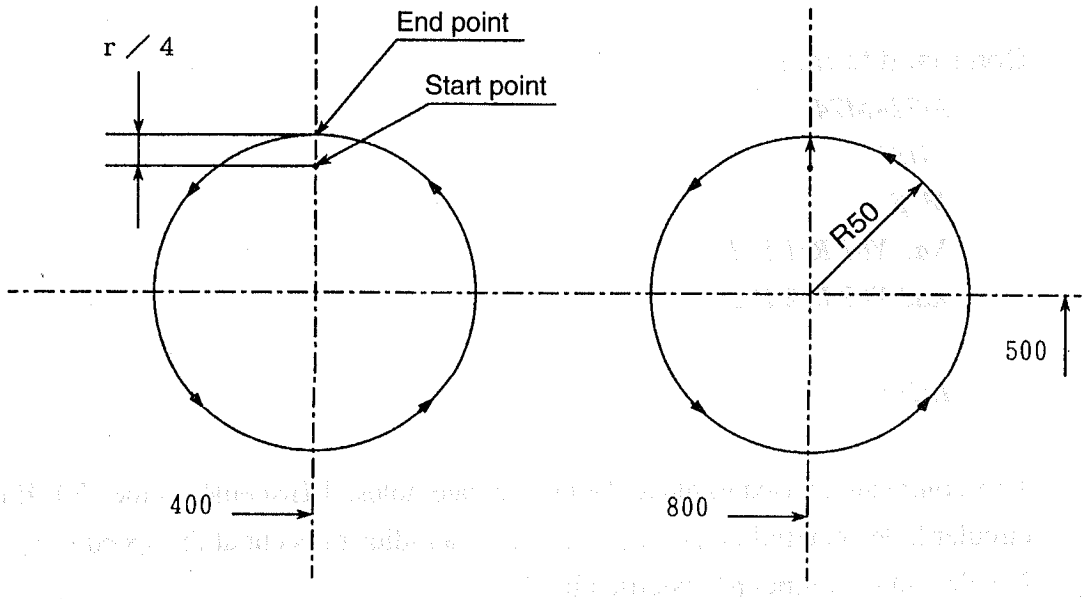
"F" Table interpolation
Up to three digits may be entered, in units or cm/min.
【Example】 F150 ..... 150cm/min.

"S" Output (based on experience)

"M" Output selection (CW or pulse 1~3 mode)

The LHS/ command enables the HOLE mode, but since this command itself also enables the laser mode, it is not necessary to use the LHS/-LHE/ loop within a laser mode activated by LAR/ or LAL/.

【Example】



LHS/
X400 Y500 R50 F100
M56
X800
LHE/

Piercing at the start point is carried out according to the conditions selected with the SET/ command at the beginning of the program.
Since the start point is always within the circle, the CIR/ command should be used when creating circular products from the metal plates.

Section 7 Cutting Pattern Commands

The pattern cutting commands function in WIEDEPOINT. (Murata's unique programming language software) enable profile cutting of various figures by laser.

1) The starting point of pattern is the current position of laser head or the position commanded by a MOV/ command just prior to the pattern command. This start point also becomes the end point of the laser pattern (laser head return point).
2) The start and end point as defined above becomes the center point of the pattern.
3) The cutting start point (piercing point) of the pattern is always from the +Y direction from the pattern command start point as defined above (assuming rotation angle of pattern is θ).
4) The approach width is with reference to the starting point of the pattern profile and lies on the intersecting line which separates the pattern into 4 quarters.
5) In-position check (CNC function) is executed at the corner points of the profile for improving accuracy.
6) Pattern commands cannot be commanded when the laser mode is on (Between LAR or LAL and LED, LHS and LHE).

7-1 SQR/

SQUARE

SQR/a x℄ y℄ θ p j

This command produces a laser pattern of rectangular shape from the current position (or as defined by MOV/) as center of the rectangle with a length of x℄ along X-axis. y℄ along Y-axis and rotated through θ degrees with reference to the X-axis. The cut start point (approach to the profile) is either (IN) inside or (OUT) outside the profile and also the laser cut offset is correspondingly decided.

"a" : Direction of laser cut offset

I (IN)	.....	The offset is given inside the profile.
O (OUT)	.....	The offset is given outside the profile.

"x℄ , y℄" : Profile lengths along X and Y directions (assuming rotation angle as 0).
Least input increment in mm is 0.01.
Must be +ve values.

"θ" : Rotation angle of the profile

The profile is rotated with reference to X-axis by angle θ with center of rotation as datum point. +ve value indicates counter-clockwise rotation.

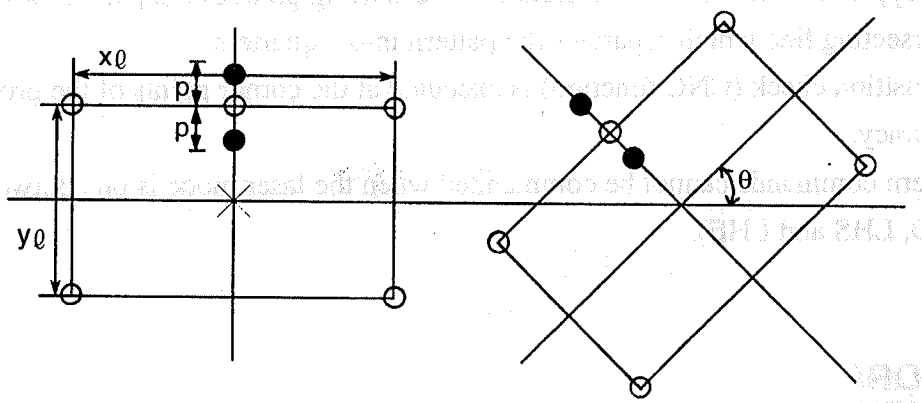
"p" : Approach width (Always must be +ve)

If no approach is required, p=0.

"j" : Joint width (Always must be +ve)

If no micro joint is required, j=0 or no input.

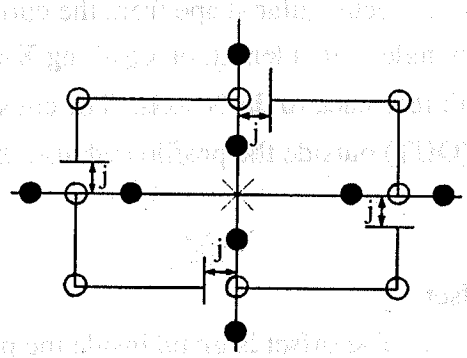
<Figure showing the parameters>



Rotation angle = 0°

Rotation angle = 45°

<Micro-joint width>



× : Pattern datum point

◯ : In-position check point

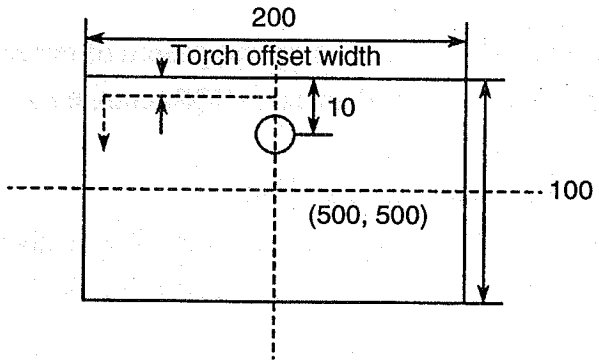
● : Cut start points (Piercing points)

【Example】

M28S900;..... Laser condition setting

MOV/X500 Y500;

SQR/I 200 100 0 10;



☆ Program error "Alarm No. 80" is output in following cases:

- If any of xℓ or yℓ data is set "0".
- If the approach width "p" is more than or equal to half the length xℓ or yℓ.
- If the joint width "j" is more than or equal to half the length xℓ or yℓ.
- If the kerf offset value (D1) is more than or equal to half the length xℓ or yℓ.

SQUARE ROUND

SRR/a x ℓ y ℓ r θ p j

This pattern command produces a laser cut pattern of rectangle shape with rounded corners. All parameters except "r" are identical to SQR/ command.

"a" : Direction of laser cut offset
I (IN) ..... The offset is given inside the profile.
O (OUT) ..... The offset is given outside the profile.

"x ℓ, y ℓ" : Profile lengths along X and Y directions (assuming rotation angle as 0)
Least input increment in mm is 0.01.
Must be +ve values.

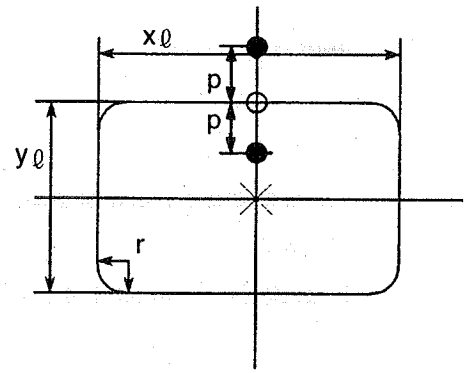
"r" : Corner radius (Always must be +ve)

"θ" : Rotation angle of the profile
The profile is rotated with reference to X-axis by angle θ with center of rotation as datum point. +ve value indicates counter-clockwise rotation.

"p" : Approach width (Always must be +ve)
If no approach is required, p=0.

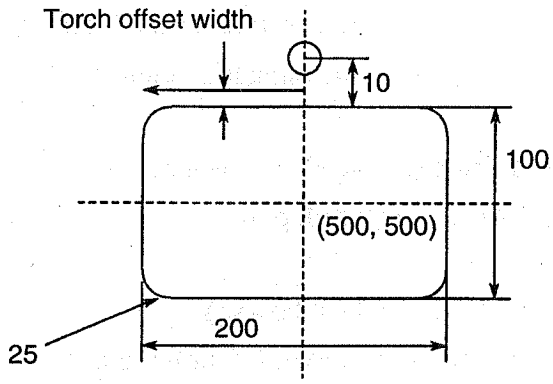
"j" : Joint width (Always must be +ve)
If no micro joint is required, j=0 or no input.

<Figure showing the parameters>



Micro-joint width definition is same as for SQR/ command.

【Example】
M28S900;
MOV/ X500 Y500;
SRR/ O 200 100 25 0 10;



☆ Program error "Alarm No. 80" is output in following cases as explained for SQR/ command. In addition, it is also output in case when corner radius "r" is more than or equal to half the length xℓ or yℓ.

- If any of xℓ or yℓ data is set to "0".
- If the approach width "p" is more than or equal to half the length xℓ or yℓ.
- If the joint width "j" is more than or equal to half the length xℓ or yℓ.
- If the kerf offset value (D1) is more than or equal to half the length xℓ or yℓ.

ROUND-E

RDE/a x ℓ y ℓ θ p j

This pattern command produces a laser cut pattern of round-ended rectangle shape of lengths x ℓ and y ℓ (along X and Y directions).
The other parameters have identical definitions as that for SQR/ command.

"a" : Direction of laser cut offset
I (IN) ..... The offset is given inside the profile.
O (OUT) ..... The offset is given outside the profile.

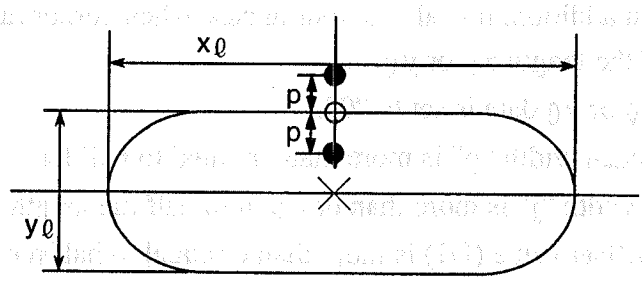
"x ℓ , y ℓ " : Profile lengths along X and Y directions (assuming rotation angle as 0)
Least input increment in mm is 0.01.
Must be +ve values.

"θ" : Rotation angle of the profile
The profile is rotated with reference to X-axis by angle θ center of rotation as datum points. +ve value indicates counter-clockwise rotation.

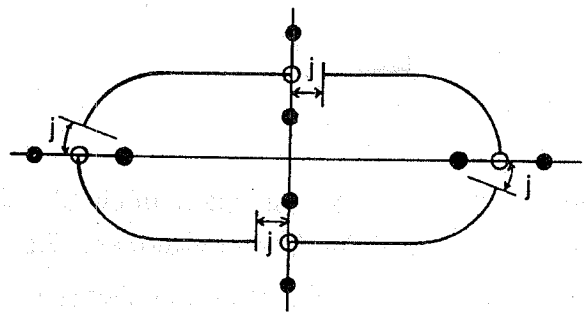
"p" : Approach width (Always must be +ve)
If no approach is required, p=0.

"j" : Joint width (Always must be +ve)
If no micro joint is required, j=0 or no input.

<Figure showing the parameters>



<Micro-joint width definition>

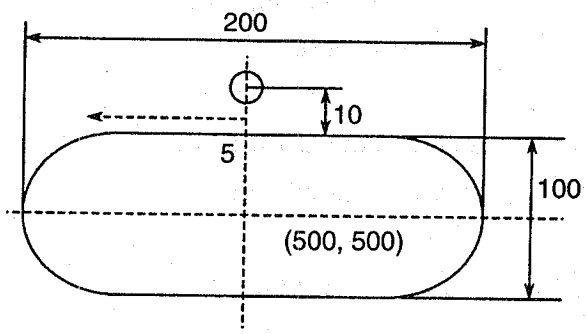


【Example】

M28S900;

MOV/ X500Y500;

RDE/ O 200 100 0 10;



☆ Program error "Alarm No. 81" is output in the following cases same as that for SQR/ command.

- If any of x_ℓ or y_ℓ data is set "0".
- If the approach width "p" is more than or equal to half the length y_ℓ.
- If the joint width "j" is more than or equal to half the length y_ℓ.
- If the kerf offset value (D1) is more than or equal to half the length x_ℓ or y_ℓ.

RING

RNG/ a ℓ p j

This pattern command produces a laser cut pattern of circular shape whose center is the current position (or that defined by MOV/ command) and diameter is " ℓ ". The approach position (Piercing) and the laser cut offset is given either (IN) inside or (OUT) outside the circle.

"a" : Definition same as for SQR/

I (IN) ..... The offset is given inside the profile.

O (OUT) ..... The offset is given outside the profile.

" ℓ " : Diameter of the circle cut.

Least input increment in mm is 0.01.

Always must be +ve value.

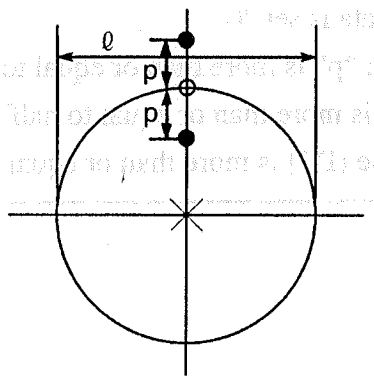
"p" : Approach width (same as for SQR/)

If no approach is required, p=0.

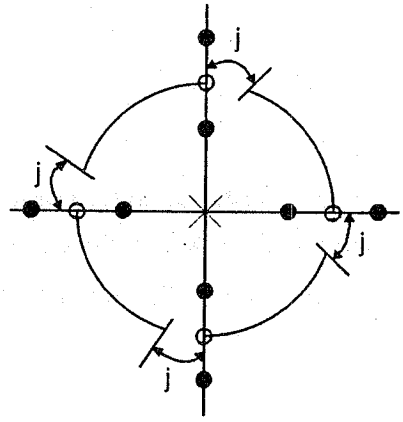
"j" : Joint width (same as for SQR/)

If no micro joint is required, j=0 or no input.

<Figure showing the parameters>



<Micro-joint width>

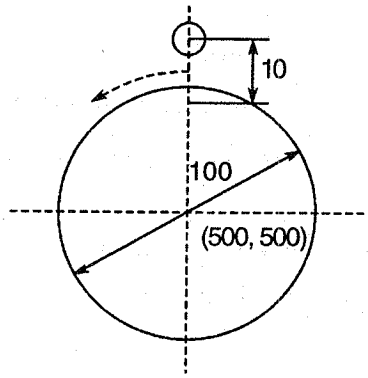


【Example】

M28S900;

MOV/ X500Y500;

RNG/ O 100 10;



☆ Program error "Alarm No. 81" is output in following cases:

- Diameter " ℓ " is "0".
- Approach width "p" is more than or equal to half the diameter " ℓ ".
- Joint width "j" is more than or equal to half the diameter " ℓ ".
- Kerf offset value (D1) is more than or equal to half the diameter " ℓ ".

SINGLE CUT RING

SRN/ a x ℓ y ℓ θ p j

This pattern command produces a laser cut pattern of a single-D shape whose diameter is x ℓ and width is y ℓ and the center of the circle is the current position (or that defined b MOV/ command). The approach width, joint width and laser offset are defined in the same way as for SQR/ command.

"*a*" : Laser beam offset direction - same as defined for other commands

"x ℓ" : Length of pattern in X-direction (diameter of the circle)

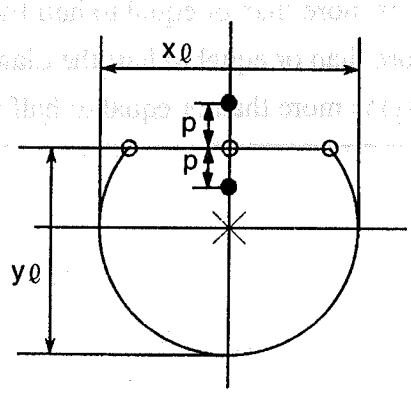
"y ℓ " : Length of the pattern in Y-direction
Other definitions as for SQR/ command

"θ " : Rotation angle of the profile
The profile is rotated with reference to X-axis by angle θ with center of rotation as datum point. +ve value indicates counter-clockwise rotation.

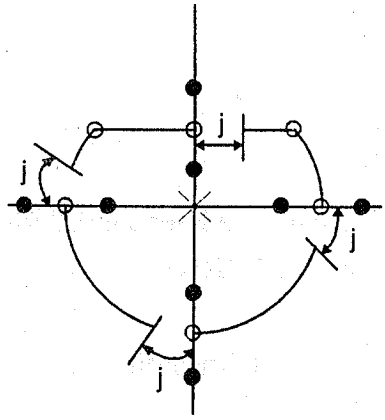
"p" : Approach width (Always must be +ve)
If no approach is required, p=0.

"j" : Joint width (Always must be +ve)
If no micro joint is required, j=0 or no input.

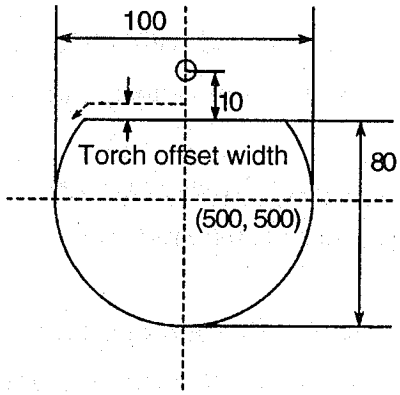
<Figure showing the parameters>



<Micro-joint width>



【Example】
M28S900;
MOV/ X500 Y600;
SRN/ O 100 80 0 10;



☆ Program error "Alarm No. 82" is output in following cases".

- "x ℓ" or "y ℓ" value is "0".
- "y ℓ" is less than or equal to half of "x ℓ".
- "y ℓ" is more than or equal to "x ℓ".
- Approach width "p" is more than or equal to half of "y ℓ".
- Joint width "j" is more than or equal to half of "y ℓ".
- Kerf offset (D1) is more than or equal to x ℓ -y ℓ/2.
- Kerf offset (D1) is more than or equal to x ℓ -y ℓ.

DOUBLE CUT RING

DRN/ a x ℓ y ℓ θ p j

This pattern command produces a laser cut pattern of double-D shape and the definition of parameters is same as that for SRN/ command.

"a" : Laser beam offset direction - same as defined for other commands

"x ℓ" : Length of pattern in X-direction (Diameter of the circle)

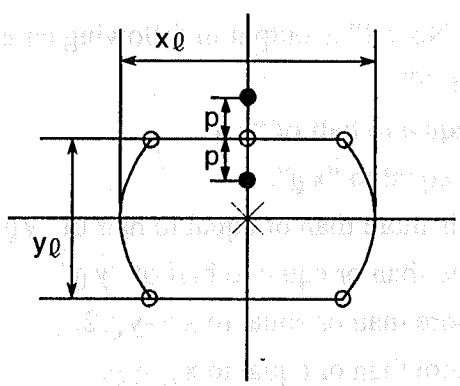
"y ℓ" : Length of the pattern in Y-direction
Other definitions as for SQR/ command

"θ " : Rotation angle of the profile
The profile is rotated with reference to X-axis by angle θ with center of rotation as datum point. +ve value indicates counter-clockwise rotation.

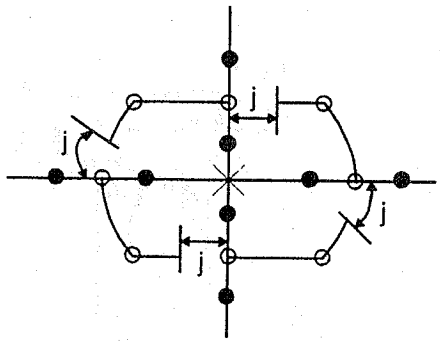
"p" : Approach width (Always must be +ve)
If no approach is required, p=0.

"j" : Joint width (Always must be +ve)
If no micro joint is required, j=0 or no input.

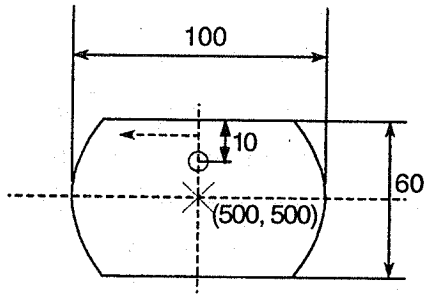
<Figure showing the parameters>



<Micro-joint width>



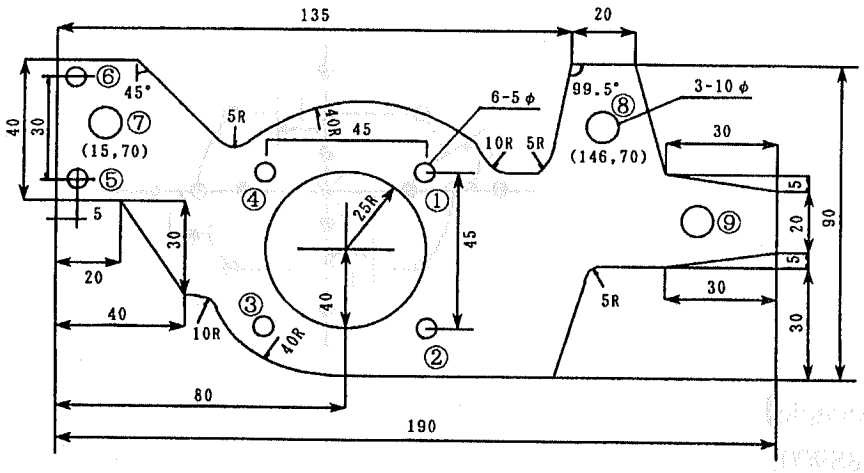
【Example】
M28S900;
MOV/ X500Y500;
DRN/ I 100 60 0 10;



☆ Program error "Alarm No. 83" is output in following cases:

- "x ℓ" or "y ℓ" is "0".
- "y ℓ" is more than or equal to "x ℓ".
- Approach "p" is more than or equal to half of "y ℓ".
- Joint width "j" is more than or equal to half of "y ℓ".
- Kerf offset value (D1) is more than or equal to half of "y ℓ".
- Kerf offset value (D1) is more than or equal to (x ℓ-y ℓ).

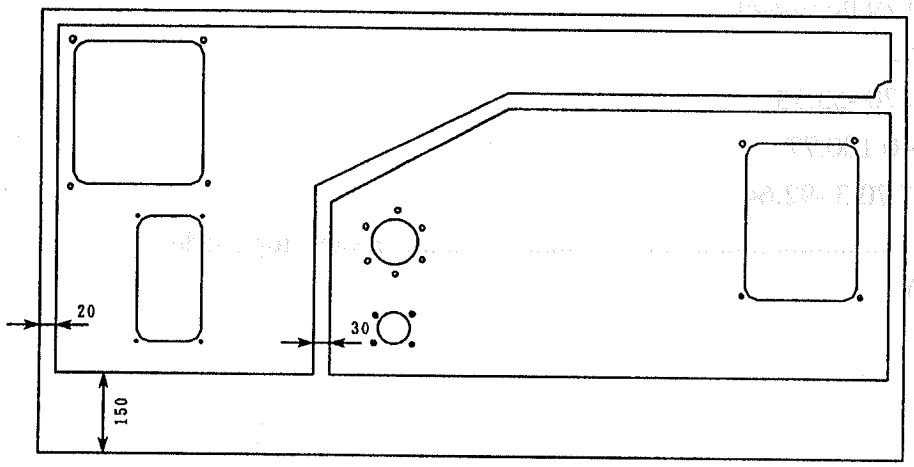
[Sample program 1]

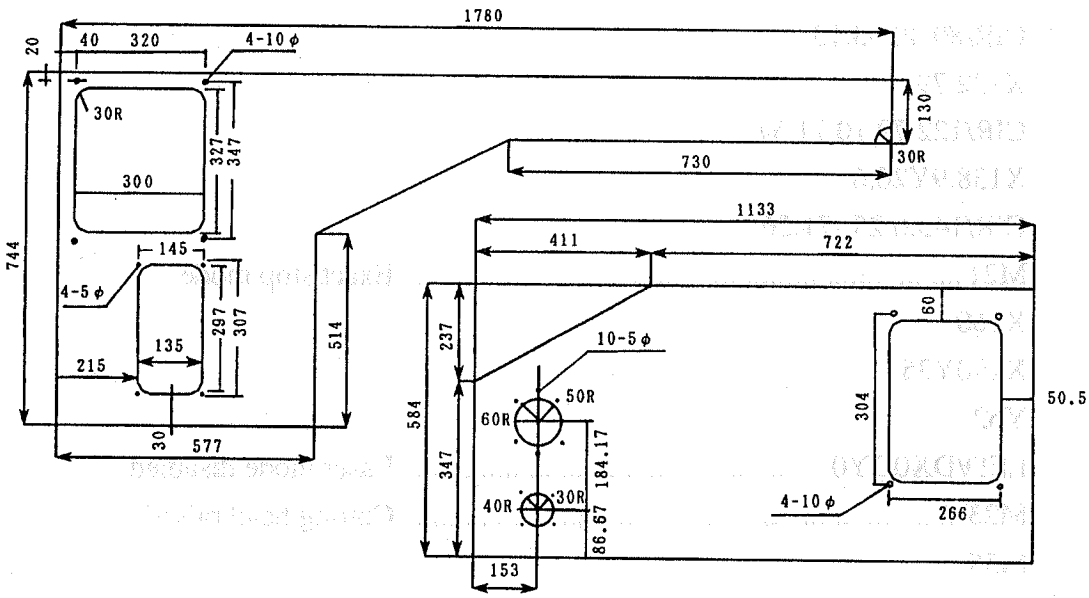


X2000Y1525M00 ..... Loading position
OFS/X30Y40
M20 ..... Punch mode
X102.5Y62.5T3 ..... ①
Y17.5 ..... ②
X57.5 ..... ③
Y62.5 ..... ④
X5Y55 ..... ⑤
Y85 ..... ⑥
Y15Y70T4 .. .. ⑦
X146Y70 ..... ⑧
X170Y45 ..... ⑨
SET/700 700 800 800 0 0 1 2
M121 ..... Piercing mode
M21 ..... Exact stop mode
M74 ..... Gas level 4
LAL/X80Y60F25 ..... Laser mode enabled
M34S850 ..... Pulse mode
Y65
CIR/80 40 360
LED/DX0DY0 ..... Laser mode disabled
M56 ..... Work chute open
M72 ..... Gas level 2
LAR/X198.17Y53.64F340 ..... Laser mode enabled
M28S950 ..... CW mode
X160Y60
X155Y90

X135
M22 ..... Exact stop mode canceled
X130.7Y64.2
CIR/125.76 65 -80.54
X120Y60
CIR/120 70 -53.13
CIR/80 40 100.77
CIR/46.7 70.3 -92.64
M21 ..... Exact stop mode
X20Y90
X0Y90
Y50
X20
X40Y20
M22 ..... Exact stop mode canceled
CIR/40 10 -53.13
CIR/80 40 53.13
X122.79
CIR/122.79 10 71.57
X138.9Y26.6
CIR/143.6 25 -71.56
M21 ..... Exact stop mode
X160
X190Y35
Y62
LED/DX0DY0 ..... Laser mode disabled
M23 ..... Cutting head raised
M55
DX100
M56 ..... Work chute open
OFS/X0Y0
X2000Y1525M30

[Sample program 2]





X2000Y1525M00 ..... Loading position
M20 ..... Punch mode
MOV/X816.99Y420.84T3 ..... (5Ø)
BHC/60 30 6
MOV/X816.99Y236.67
BHC/40 45 4
X355Y175T4 ..... (10Ø)
GRD/U 307 1 L 145 1
Y40Y527
GRD/U 347 1 R 320 1
SET/700 700 700 700 0 0 1 2
M121 ..... Piercing mode
M21 ..... Exact stop mode
M72 ..... Gas level
LAL/X282.5Y185F350 ..... Laser mode enabled
M28S900 ..... CW mode
DY-5
X335
CIR/335 195 90
Y462
CIR/335 462 90
X230
CIR/230 462 90
Y195
CIR/230 195 90
X282.5
LED/DX0DY0 ..... Laser mode disabled
M56 ..... Work chute open
LAL/X200Y542 ..... Laser mode enabled
DY-5
X320
CIR/320 567 90
Y834
CIR/320 834 90
X80
CIR/80 834 90
Y567
CIR/80 567 90
X200
LED/DX0DY0 ..... Laser mode disabled

M56 ..... Work chute open
LHS/ ..... Laser hole mode start
X816.99Y420.84R50
M56 ..... Work chute open
X816.99Y236.0R30
M56 ..... Work chute open
LHE/ ..... Laser hole mode end
LAR/X1495Y899 ..... Laser mode enabled
DY-5
X20
Y150
X636.99
Y514
X1070Y764
X1495
LED/DX0DY0 ..... Laser mode disabled
M23 ..... Cutting head raised
LAR/X1078.04Y739 ..... Laser mode enabled
DY-5
X666.99Y497
Y150
X1495
LED/DX0DY0 ..... Laser mode disabled
M23 ..... Cutting head raised
X1000Y400M03
REP/DX900
M20 ..... Punch mode
X1749.5Y647T4 ..... (10Ø)
CRD/D 304 1 L 266 1
LAL/X1634.5Y315 ..... Laser mode enabled
DY-5
X1719.5
CIR/1719.5 340 90
Y644
CIR/1719.5 644 90
X1549.5
Y340
CIR/1549.5 340 90
X1634.5

LED/DX0DY0 ..... Laser mode disabled
M56 ..... Work chute open
LAR/X1495Y145 ..... Laser mode enabled
DY5
X1800
Y734
X1078.34
LED/DX0DY0 ..... Laser mode disabled
M23 ..... Cutting head raised
LAR/X1495Y759 ..... Laser mode enabled
DY5
X1770
CIR/1800 764 -90
Y894
X1495
LED/DX0DY0 ..... Laser mode disabled
M23 ..... Cutting head raised
X1250+900M03
FRM/1250
X2000Y1525M30