CNC TURRET PUNCH PRESS

AE NT SERIES
AE 255NT/2510NT
(AMNC-F)

PROGRAMMING MANUAL
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PROCESS FROM DIAGRAM TO PARTS

Diagram → First quadrant of X-Y coordinate system

Unit of measurement for programs
All dimensions for programs are based on units of 0.01 mm (millimeters) or 0.001" (inches).

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Calculation</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 mm</td>
<td>100.00</td>
<td>10000 (100.)</td>
</tr>
<tr>
<td>35.5 mm</td>
<td>35.50</td>
<td>3550 (35.5)</td>
</tr>
<tr>
<td>0 mm</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Calculation</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>50&quot;</td>
<td>50.000</td>
<td>50000 (50.)</td>
</tr>
<tr>
<td>12.7&quot;</td>
<td>12.700</td>
<td>12700 (12.7)</td>
</tr>
<tr>
<td>0&quot;</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
CALCULATION OF COORDINATES

X- and Y-coordinates
Absolute value: Distance from origin
Incremental value: Distance from previous position

<table>
<thead>
<tr>
<th>Hole</th>
<th>X-coordinate</th>
<th>Y-coordinate</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>①</td>
<td>100.00</td>
<td>100.00</td>
<td></td>
</tr>
<tr>
<td>②</td>
<td>300.00</td>
<td>100.00</td>
<td></td>
</tr>
<tr>
<td>③</td>
<td>300.00</td>
<td>200.00</td>
<td>Absolute</td>
</tr>
<tr>
<td>④</td>
<td>400.00</td>
<td>300.00</td>
<td></td>
</tr>
<tr>
<td>⑤</td>
<td>600.00</td>
<td>300.00</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hole</th>
<th>X-coordinate</th>
<th>Y-coordinate</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>①</td>
<td>100.00</td>
<td>100.00</td>
<td>Absolute</td>
</tr>
<tr>
<td>②</td>
<td>200.00</td>
<td>0*</td>
<td>Incremental</td>
</tr>
<tr>
<td>③</td>
<td>0*</td>
<td>100.00</td>
<td></td>
</tr>
<tr>
<td>④</td>
<td>100.00</td>
<td>100.00</td>
<td></td>
</tr>
<tr>
<td>⑤</td>
<td>200.00</td>
<td>0*</td>
<td></td>
</tr>
</tbody>
</table>

*In the case of zero, no decimals are needed.
PROGRAMMING PROCEDURE

1. Determining punching method

2. Determining positions of workclamps

**NOTICE**

Before changing the workclamp position, press and illuminate the MANUAL button on the main control panel. If the workclamp position is changed in the NC mode other than MANUAL, the workclamp position may not be read in the next automatic operation, causing the workclamp to be punched.

Position the workclamps as far apart as possible and check the "dead zone".

3. Checking tools and station numbers

**Example:**

a) 150 mm dia. round hole → nibbling with a 30 mm dia. punch

b) 500 mm × 600 mm square opening → shear-proof punching with a 50 mm × 50 mm square punch

c) Check to ensure that all tools are mounted on the turret.

4. Determining punching sequence

This must be determined by taking into consideration both punching time and accuracy. Observe the following general precautions:

a) Begin and finish with the upper right corner of the diagram.

b) Begin with small holes, then square holes, and notching; extrusion and countersinking come last.

c) The tools should not be selected more than twice except when the procedure requires only a change of striker position.

d) In multiple-part punching, shearing of the worksheet should be done last.

5. Calculating coordinates

Calculate the coordinates in units of 0.01 mm (millimeters) or 0.001" (inches).

6. Checking

Check the workclamp positions, punching sequence and coordinates.
PUNCHING RANGE

The punching range is as listed below. When the X-coordinate exceeds the punching range, automatic repositioning is required.

<table>
<thead>
<tr>
<th>Model</th>
<th>Throat depth</th>
<th>Origin (X-axis distance)</th>
<th>Origin (Y-axis distance)</th>
<th>X-axis travel distance</th>
<th>Y-axis travel distance by track</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100's (inner)</td>
</tr>
<tr>
<td>AE255NT</td>
<td>1320.</td>
<td>1210.</td>
<td>1270.</td>
<td>-70. to 1220.</td>
<td>30. to 1340.</td>
</tr>
<tr>
<td>AE2510NT</td>
<td>1320.</td>
<td>2500.</td>
<td>1270.</td>
<td>-10. to 2510.</td>
<td>30. to 1340.</td>
</tr>
</tbody>
</table>

Unit: mm
CAUTIONS ON PUNCHING

a) Notching should not be performed with a punch of the same size as the notch.

(20 mm x 20 mm square punch is used.)

b) Do not punch along the shorter punch side when using a long rectangular punch.

(30 mm x 30 mm square punch is used.)

c) When shear-proof punching is performed, the feed pitch should be larger than 1/2 the punch width, but smaller than the entire punch width minus 0.5 mm.

d) The depth of notching should not be less than the worksheet thickness.

e) Determine the punching method so that the stripper plate holds the worksheet as much as possible.
f) The force required to punch the worksheet must not exceed the press capacity. The required punching force is obtained by the following formula:

\[
P: \text{Force required} \\
A: \text{Length of cut edge} \\
t: \text{Thickness of worksheet} \\
\tau: \text{Shearing strength of worksheet}
\]

g) Do not punch in the workclamp dead zone. Punching in the workclamp dead zone may punch the workclamp or distort the worksheet.

**BASIC FUNCTION CODES**

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>G00</td>
<td>&quot;G&quot; function (Preparatory function)</td>
</tr>
<tr>
<td>M00</td>
<td>&quot;M&quot; function (Miscellaneous function)</td>
</tr>
<tr>
<td>T___</td>
<td>&quot;T&quot; function (Tool function)</td>
</tr>
<tr>
<td>NOOOO</td>
<td>Sequence number</td>
</tr>
<tr>
<td>OOOOO</td>
<td>Program number</td>
</tr>
</tbody>
</table>

**NOTE**

- O program numbers are not used for creating normal punching programs, but for creating subprograms and maintenance programs. The punching programs are named in 32 or less alphanumeric characters to distinguish each of them.

**TAPE FORMAT**

Arrange the function codes as follows:

N00000 G00 G00 X±0000000 Y±0000000 T___ C±0000000 M00

**NOTE**

- Unnecessary codes need not be entered.
- Enter only necessary digits of X, Y, C and N.
- The plus sign (+) of X, Y and C can be omitted.
**G92: ESTABLISHING COORDINATE SYSTEM**

This code is used to designate the distance from the worksheet origin to the punch center. Enter "G92" and the distances in the X- and Y-axis direction.

<table>
<thead>
<tr>
<th>Model</th>
<th>Metric-specification machine</th>
<th>Inch-specification machine</th>
</tr>
</thead>
<tbody>
<tr>
<td>AE255NT</td>
<td>G92 X1210.00 Y1270.00</td>
<td>G92 X47.638 Y50.000</td>
</tr>
<tr>
<td>AE2510NT</td>
<td>G92 X2500.00 Y1270.00</td>
<td>G92 X98.425 Y50.000</td>
</tr>
</tbody>
</table>

*1210 mm for AE255NT*
G06: DESIGNATION OF WORKSHEET THICKNESS AND MATERIAL

This code is used to designate the worksheet thickness and material. Enter "G06" at the beginning of the program. When "G06" is omitted, the thickness is 6.3 mm and the material is mild steel.

A: Worksheet thickness 0.1 to 6.3 mm (0.002" to 0.248")
B: Worksheet material

0: Mild steel (SPC or CRS)
1: Stainless steel (SUS)
2: Aluminum (AL)

The decimal point in the thickness data is handled as follows:

<table>
<thead>
<tr>
<th>Command data</th>
<th>Effective data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.6</td>
<td>1.6 mm</td>
</tr>
<tr>
<td>2.36</td>
<td>2.3 mm (Omit the numerals below the second place of decimals.)</td>
</tr>
<tr>
<td>63</td>
<td>0.6 mm (Omit the numerals below the second place of decimals.)</td>
</tr>
</tbody>
</table>

Example:

G06 A1.0 B0 (1-mm thick mild steel worksheet is designated.)

G92 X___ Y___

G90: ABSOLUTE PROGRAMMING

When the absolute values are used for coordinates, enter "G90" prior to the coordinates. If the absolute values are used at the subsequent blocks of the program, it is not necessary to enter "G90" again until incremental values are used. The value of the X- or Y-axis which does not move can be omitted.

Example:

1. G90 X100.00 Y100.00 (Absolute)
2. X300.00 Y100.00 (Absolute)
3. X300.00 Y200.00 (Absolute)
4. X400.00 Y300.00 (Absolute)
5. X600.00 Y300.00 (Absolute)
G91: INCREMENTAL PROGRAMMING

When the incremental values are used for coordinates, enter "G91" prior to the coordinates. If the incremental values are used at the subsequent blocks of the program, it is not necessary to enter "G91" again until absolute values are used. The value of the X- or Y-axis which does not move can be omitted.

Example:

1. G90  X100.00  Y100.00  (Absolute)
2. G91  X200.00  Y0   (Incremental)
3. X0   Y100.00  (Incremental)
4. X100.00  Y100.00  (Incremental)
5. X200.00  Y0   (Incremental)
G20/G21: INCH/METRIC SELECT FUNCTION

The unit of the input program can be set either to the metric or inch system. When the inch unit is used, enter "G20" directly before the worksheet thickness and material designation command G06 as a single block; when the metric unit is used, enter "G21" as a single block. Observe the following general precautions:

a) The commands G20 and G21 should always be entered as a single block.

b) Do not enter the "G20" or "G21" anywhere within the program.

c) When entering the "G92", enter it after the "G20" or "G21". Be sure that the unit to be used in operation is selected by the "G20" or "G21" and that the distance values at the "G92" are set in the corresponding unit.

d) The origin setting values differ between the metric-specification and inch-specification machines. Keep this fact in mind before using the inch-metric select function.

<table>
<thead>
<tr>
<th>Model</th>
<th>Metric-specification machine</th>
<th>Inch-specification machine</th>
</tr>
</thead>
<tbody>
<tr>
<td>AE255NT</td>
<td>X1210.00 (47.638)*</td>
<td>X47.638 (1210.00)**</td>
</tr>
<tr>
<td></td>
<td>Y1270.00 (50.000)</td>
<td>Y50.000 (1270.00)</td>
</tr>
<tr>
<td>AE2510NT</td>
<td>X2500.00 (98.425)*</td>
<td>X98.425 (2500.00)**</td>
</tr>
<tr>
<td></td>
<td>Y1270.00 (50.000)</td>
<td>Y50.000 (1270.00)</td>
</tr>
</tbody>
</table>

* The numerals in parentheses indicate the origin setting values when the unit mode has been changed from metric to inch.
** The numerals in parentheses indicate the origin setting values when the unit mode has been changed from inch to metric.

e) When the NC coordinate system is already set to the inch or metric unit dimensions, the corresponding "G20" or "G21" need not be entered.

f) To confirm whether the NC coordinate system is set to the inch or metric unit dimensions, return the X- and Y-axes to their origins in the RETRACT mode, at this point, check the displayed values and consult the values shown in the table above for identification.

g) When the "G20" or "G21" is commanded without the A-axis (press axis) at the top dead center, an alarm occurs.

h) When the unit mode is changed, perform trial punching and check the processing conditions before actual punching.
TOOO: DESIGNATION OF TOOL NUMBER

This code is used to designate the turret station number in order to select the tool to be used. If the same tool is to be used continuously, it is not necessary to enter this code again until a different tool is needed.

Example:

G92 X2500.00 Y1270.00  
G90 X500.00 Y300.00 T102  
G91 X50.00 (T102 is omitted.)  
X50.00 (T102 is omitted.)  
G90 X700.00 Y450.00 T201

G50: HOME RETRACT

When "G50" is entered, the X- and Y-axes return to their origins, and the striker moves to the center position. No punching occurs during the retraction. The offset values designated by "G93," "G94" and "G98" are canceled. "G50" must be entered as a single block at the end of the program; however, the sequence number can be entered along with it.

BLOCK DELETION

Basic format of BLOCK DELETION

/      X___ Y___
G90  X___ Y___ T___

If a slash character is entered at the beginning of a block and if the BLOCK SKIP button is pressed and its lamp is turned on, the block command following the slash character is disregarded. If the lamp is turned off, the command is not disregarded but is executed.

Example:

G90 X320.00 Y210.00 T203  
G91 X50.00  
/ X100.00 Y100.00 T304  
G90 X570.00 Y310.00 T304

If the block following the block deletion command is entered in incremental coordinates, the position where the lamp of the BLOCK SKIP button is turned on is different from that where the lamp is turned off. If T304 is omitted for the reason that the same tooling is used, the block following the block deletion command is executed using T203 when the lamp of the BLOCK SKIP button is turned on.
**OOOOOO: PROGRAM NUMBER**

When some programs are to be stored in memory, a maximum of 4-digit numeral (from 0 to 7999) is added directly after "O," at the beginning of the program for identification of individual programs. Zeros which directly follow "O" may be omitted.

This program number can also be input from the keyboard of the NC unit when storing the programs in memory.

**Example:**

```
O0014
  G06  A___  B___
  G92  X2500.00  Y1270.00
  *
  *
  *
  G50
```

---

**NOTE**

- Subprograms cannot be called unless preregistered in the NC memory. Program numbers that can be used for subprograms are O100 to O7999.
- Program numbers O8000 to O9999 are used by AMADA for its custom macro programs. Do not use them for your punching programs.
- Program names to be used for calling or editing punching programs on the screen are 32 or less alphanumeric characters.
- After a punching program is called on the screen, it is automatically assigned the number O1 and can be executed.

---

**NOOOOO: SEQUENCE NUMBER**

Any numeral (from 1 to 99999), with five or less digits, beginning with "N" can be entered at the beginning of each block. This code is used for indexing each block.

The sequence number need not be entered if it is not necessary. Entry at key points instead of all blocks will be useful. Zeros which directly follow "N" may be omitted.

**Example:**

```
  G06  A___  B___
  G92  X2500.00  Y1270.00
  N0001  G90  X500.00  Y300.00  T102
  N0002  G91  X50.00
  N0003  X50.00
  N0004  G90  X650.00  Y450.00  T306
  N9999  G50
```
**C±θ: TOOL ANGLE COMMAND**

\[
\begin{align*}
X & \quad Y & \quad T & \quad C\pm\theta
\end{align*}
\]

This code is used to control the angular orientation of punches and dies installed in the Auto-index station.

Auto-index punching is performed after the X-, Y-, T- and C-axes have been positioned. In the C-axis command, the value and sign of \( \theta \) determine the angle of the punch and die with respect to the X-axis.

- **T**: Auto-index station number
- **C**: Tool angle "± \( \theta \)" Counterclockwise: positive (+), Clockwise: negative (−)

When using this code, keep the following in mind:

1. The angular input must be in the absolute angular value, referenced to the X-axis. The minimum angular input is 0.01°.
2. If both X- and Y-coordinates are not entered, the Auto-index station and tool angle will be selected, but punching will not be performed.
3. When the C-axis commands are used within pattern command blocks G26, G29, G68, and G78, the Auto-index tool angle will be automatically compensated in the tangential direction with the progress of hole punching.
4. When the C-axis commands are used within the following commands, the C-axis commands will be ignored and machine operation will continue. G92, G93, G94, G72, G25, G27, G98, G75, G76, G04, U, V and W
5. For stations other than Auto-index stations, trying to use a C-axis command will cause a program error.
6. When a program block with commands to use a different station follows the Auto-index punching commands, the C-axis will be returned to its zero degree position after the punching operation at the Auto-index station is finished, then the next station will be selected.
   
   G90  X500.00  Y600.00  T____  C45.00 → Punching operation at Auto-index station.
   
   X350.00  Y200.00  T201 → T201 is selected after C-axis has returned to its zero degree position.

7. When the same Auto-index station is to be used two or more times in succession with the same tool angle, the T- and C-axis commands may be omitted in the second and subsequent blocks.
   
   G90  X500.00  Y600.00  T____  C45.00
   
   X350.00  Y200.00 →Punched with T____ and C45.00
Example:

![Diagram showing punch and die positioning](image)

G90  X100.00  Y50.00  T___  C30.00 (or C−330.00)

The punch and the die will be positioned 30° (or −330°) with respect to the X-axis.
Part II

Function Codes

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G FUNCTION CODES

G70: PUNCH OFF (NO PUNCHING)

This code is used to position the worksheet without punching so that the workclamps will move away from the die or the workholders can hold the worksheet when automatic repositioning is performed. Enter "G70" prior to entering X Y.

Example:

G90 X100.00 Y100.00
G70 X300.00

The axes move at a position of "X300.00 Y100.00" without punching.

"G70" can be entered with "G90" or "G91."

G90 X100.00 Y100.00 (Punching)
G70 G91 X200.00 (No punching)
G90 Y300.00 (Punching)

G27: AUTO-REPOSITIONING

This code is used to extend the punching range in the X-axis direction. Enter "G27" and the X-axis travel distance. The X-axis travel distance must be designated by an incremental value.

Example:

G27 X500.00

The following show the repositioning cycle for a G27 X500.00 command.

(1) Work hold: The workholders hold the worksheet.
(2) Unclamp: The workclamps open.
(3) G91 Y2.40: The Y-axis moves 2.40 mm in the positive direction from the current position.
(4) X–500.00: The X-axis moves 500.00 mm in the negative direction from the current position.
(5) Y–2.40: The Y-axis moves 2.40 mm in the negative direction.
(6) Clamp: The workclamps close.
(7) Work release: The workholders release the worksheet.

Y- and X-axis movement

G25: AUTO-REPOSITIONING

When the worksheet edge which is clamped has a bend or curves, and excessive burrs, enter "G25" instead of "G27" to ensure accurate repositioning. These factors can cause inaccurate worksheet positioning when automatic repositioning is performed, unless "G25" is commanded. When "G25" is entered, the same movement will be obtained as in the following:

\[
2.4 \text{ mm} \downarrow \quad \text{G25} \quad \text{X} \quad \uparrow 1.2 \text{ mm}
\]

First the Y-axis moves 2.40 mm in the positive direction from the current position. Then the X-axis moves "X" from the current position and the Y-axis moves 1.20 mm in the negative direction. Next, the X-Y coordinate system is offset by "Y1.20" to compensate for the difference between the Y-axis positions before and after the automatic repositioning.

After "G25" is commanded, the punching range along the Y-axis is moved 1.20 mm in the negative direction from the standard punching range.

\[-11.2 \text{ mm} \leq Y \leq 1298.8 \text{ mm}\]
HINTS ON AUTO-REPOSITIONING

a) X-axis travel distance → as small as possible
   [Maximum punching position (X-coordinate)] – 2510 mm*

b) Workclamp positions → as far apart as possible
   Consider the following:
   • Dead zone
   • Worksheet size
   • Notches

c) First punching range → as large as possible

d) Reposition
   • Ensure that the worksheet is under the workholders.
   • Ensure that the workclamps do not pass between the upper and lower turret disks when automatic repositioning is done.
     Y200.00 (min.)
   • Ensure that the X absolute coordinate is greater than the X-axis travel distance. (Overtravel will occur.)

e) Coordinates after "G27" or "G25"
   Use dimensions as per diagram. Mode of "G90" and "G91" does not change.

f) Avoid changing tools immediately after automatic repositioning to save punching time.

g) Punching range after automatic repositioning
   \[-10 \text{ mm} + \text{X-axis travel distance}] \leq X \leq [2510 \text{ mm}^* + \text{X-axis travel distance}]
   If a G27 X500.00 command has been executed, the punching range after automatic repositioning is as follows:
   \[490 \text{ mm} \leq X \leq 3010 \text{ mm}^{**}\]

   *1280 mm for AE255NT
   **1780 mm for AE255NT

G01: LINEAR INTERPOLATION START
G00: LINEAR INTERPOLATION CANCEL

Example:

G01 F8000 Linear interpolation start
•
•   (Slitting program)   \{Linearity interpolated\}
•
G00 Linear interpolation cancel
Usually, the X- and Y-axes move at the same speed. When there is a command to position the two axes simultaneously, the X- and Y-axes first move in the direction of 45° and then move parallel in the direction of the greater movement. (See the upper right figure.) "G01" is a command to complete these axis movements in the X-Y coordinate system over the shortest distance. (See the lower right figure.) "G01" is modally valid until canceled by "G00." In the G01 block, set the F-code at 8000 (8 m/min.) or less.

**NOTE**

- Linear interpolation is specified for slitting at a given angle (refer to page II-42). Do not specify it for any other purpose.
- When linear interpolation is specified, the travel distance is minimized, but since the maximum axis speed is lowered, the total positioning time is increased.
- A program error is caused when the F-code is not entered in the G01 block or when the T- and C-codes are entered between "G01" and "G00."

**G04: DWELL**

When "G04" is commanded, operation stops during the time specified by "X." The minimum programmable increment of the value following "X" is 0.01 sec.

**Example:**

G04 X10.00 → Operation stops for 10 sec.

**G72: PATTERN ORIGIN**

<table>
<thead>
<tr>
<th>G90</th>
<th>G72</th>
<th>X___</th>
<th>Y___</th>
</tr>
</thead>
<tbody>
<tr>
<td>G91</td>
<td>G72</td>
<td>X___</td>
<td>Y___</td>
</tr>
</tbody>
</table>

This code is used to designate the origin of a pattern. The pattern origin can be entered in absolute or incremental coordinates.

**NOTE**

- If incremental coordinates are given after a pattern command, they must refer to the final pattern point.
Example:

G90  G72  X500.00  Y300.00
"G72" merely specifies the coordinates; neither positioning nor punching is performed. Do not enter the M- or T-code in a block with "G72." For example, never enter:

G90  G72  X300.00  Y200.00  T201
G91  G72  X150.00  Y250.00  M00

G26: BOLT HOLE CIRCLE [BHC]

\[
\text{G26 } I \pm r \ J \pm \theta \ K \pm n \ T
\]

On the circumference of a circle having a radius "r" with either the current position or a point designated by "G72" as the center, "n" holes dividing the circumference into "n" equal parts are punched, starting from a point at an angle of "\theta" to the X-axis.

- **I**: Radius of circle "r," positive value
- **J**: Starting angle "\pm \theta" Counterclockwise: positive, Clockwise: negative
- **K**: Number of holes "\pm n" Counterclockwise: positive, Clockwise: negative

Example:

- Initial punch
- 6 holes — 10 mm dia.
- 10 mm dia.: T203
- Pattern origin
- Final punch
- Final pattern point

G72  G90  X300.00  Y250.00
G26  I80.00  J45.00  K6  T203

- When punching the same hole at the pattern origin (X300.00, Y250.00), omit "G72" and enter "T203" in the upper command block.
- The final pattern point coincides with the pattern origin.
Program example using Auto-index station

The first punching will be performed with the tool angle positioned 135° (–225°) with respect to the X-axis and the second and subsequent punchings will be performed with the tool angle automatically compensated in the tangential direction.

- When the pattern origin (X400.00, Y500.00) is to be punched also, omit "G72" and enter "T____ C±θ" in the upper command block.

  G90  X400.00  Y500.00  T____  C±θ
  G26  I100.00  J45.00  K4  C135.00

- When there is no C-axis command in the pattern command block, the pattern punching will be performed without compensation of the tool angle.

  G90  X400.00  Y500.00  T____  C0
  G26  I100.00  J45.00  K4
G28: LINE AT ANGLE [LAA]

Starting from either the current position or a point designated by "G72," "n" holes are punched with an interval of "d" at an angle of "θ" to the X-axis.

I: Interval "±d"
When "d" is negative, punching is performed in the opposite direction from that of the positive "d."

J: Angle "±θ"
Counterclockwise: positive,
Clockwise: negative

K: Number of holes "n" (not including the pattern origin)

NOTE
"d" and "θ" must be given as follows:
d = 200 mm → 200.00 (d = 20" → 20.000)
θ = 45°30' → 45.50
θ = 45° → 45.00

Example:

- When punching the same hole at the pattern origin (X300.00, Y200.00), omit "G72" and enter "T203" in the upper command block.
- When "I25.00" becomes "I–25.00," punching is performed in the direction of 180° symmetry (210°).
Program example using Auto-index station

The punch and die will be positioned 30° (–330°) with respect to the X-axis and the Auto-index punching will be performed according to the G28 command.

- When the pattern origin (X100.00, Y50.00) is to be punched also, omit “G72” and move “T___ C30.00” to the end of the upper command block.

G90  X100.00  Y50.00  T___ C30.00

G29: ARC [ARC]

On an arc having a radius "r" with either the current position or a point designated by "G72" as the center, "n" holes with an angle interval of "±Δθ" are punched, starting from a point at an angle of "±θ" to the X-axis.

I: Radius of circle "r," positive value
J: Starting angle "±θ"
   Counterclockwise: positive,
   Clockwise: negative
P: Angle interval "±Δθ"
   Counterclockwise: positive,
   Clockwise: negative
K: Number of holes "n"
Example:

- When punching the same hole at the pattern origin (X480.00, Y120.00), omit "G72" and enter "T203" in the upper command block.
- When "P15.00" becomes "P–15.00," punching is performed in a clockwise direction beginning with the starting point.

G36: GRID-X [GRD-X]
G37: GRID-Y [GRD-Y]

Starting from either the current position or a point designated by "G72," a grid pattern of "n1" holes with an interval of "d1" parallel to the X-axis and "n2" holes with an interval of "d2" parallel to the Y-axis is punched. Command "G36" to start punching along the X-axis and "G37" to start punching along the Y-axis.

I : Interval "$\pm d_1" +X direction: positive, –X direction: negative
P: Number of holes in X-axis direction "n1" (not including the pattern origin)
J: Interval "$\pm d_2" +Y direction: positive, –Y direction: negative
K: Number of holes in Y-axis direction "n2" (not including the pattern origin)
Example:

```
G72  G90  X350.00  Y410.00
G36  I50.00  P3   J–20.00  K5  T203
```

- When punching the same hole at the pattern origin (X350.00, Y410.00), omit "G72" and enter "T203" in each upper command block.
G66: SHEAR PROOF [SHP]

Starting from either the current position or a point designated by "G72," a shear proof with a length of "l ± 2d" and a punch width of "w₁ × w₂" is performed at an angle of "θ" to the X-axis.

I: Punching length "l"
J: Angle "±θ" Counterclockwise: positive,
   Clockwise: negative
P: Punch width "±w₁" (the width in the angle "θ" direction)
Q: Punch width "±w₂" (the width in the direction of 90° to "θ")
D: Compensation value "±d" (in relation to the punching length "l")
   If d = 0, "D" can be omitted.

NOTE
- The values of "w₁" and "w₂" must have the same sign.
- When a square punch is used (w₁ = w₂), "Q" can be omitted.

Example:
When "G72" is omitted and "T369" is entered in the upper command block, the pattern origin (X350.00, Y210.00) is also punched.

When "P20.00" becomes "P–20.00," a shear proof is performed in the direction of the dotted line.

"I" must be at least 1.5 times as large as "P."

The final pattern point does not coincide with the final punch center.

When "D0.15" becomes "D–0.15," the overall punching length "I" is 0.3 mm shorter as determined by 0.15 × 2 = 0.3.

**G67: SQUARE [SQR]**

Starting from either the current position or a point designated by "G72," a rectangular opening with a length of "l₁" parallel to the X-axis and a length of "l₂" parallel to the Y-axis is punched, using a square punch with a width of "w."

I : Opening length in X-axis direction "±l₁" +X direction: positive, –X direction: negative

J: Opening length in Y-axis direction "±l₂" +Y direction: positive, –Y direction: negative

P: Punch width "w," positive value only
   Use a square punch only.

**Example:**

```
G72  G90  X560.00  Y370.00
G 6 7
  I–240.00  J–120.00  P20.00  T342
M 0 0
```

When "G72" is omitted and "T342" is entered in the upper command block, the pattern origin (X560.00, Y370.00) is also punched.

When "G67" is commanded, "M00" or "M01" should be entered in order to remove scrap.

The pattern origin should normally be designated in the upper right corner of the rectangular opening in order to remove the scrap easily.

Both "I" and "J" must be at least three times as large as "P."
G68: NIBBLING ARC [NBL-A]

| G68 | I | J \( \pm \theta_1 \) | K \( \pm \theta_2 \) | P \( \pm \phi \) | Qd | T |

On the circumference of a circle having a radius \( r \) with either the current position or a point designated by "G72" as the center, nibbling with an interval of \( d \) is performed by using a punch with a diameter of \( \phi \), starting from a point at an angle of \( \theta_1 \) to the X-axis and moving up to an incremental angle of \( \theta_2 \).

I: Radius \( r \), positive value
\( r < 57000.00 \text{ mm} \)

J: Starting angle \( \pm \theta_1 \)
- Counterclockwise: positive,
- Clockwise: negative

K: Angle in which nibbling occurs \( \pm \theta_2 \)
- Counterclockwise: positive,
- Clockwise: negative

P: Punch diameter \( \pm \phi \)
Enter the positive value when nibbling the outer side of the circle and the negative value when nibbling the inner side. Enter zero when nibbling on the arc with the radius \( r \).

Q: Nibbling interval \( d \), positive value only
- Worksheet thickness \( d \leq 8 \text{ mm} \)

**NOTE**

- Maximum worksheet thickness for nibbling: 3.2 mm
Example:

- When "G72" is omitted and "T306" is entered in the upper command block, the pattern origin (X600.00, Y530.00) is also punched.
- When nibbling a worksheet with a thickness of more than 3.2 mm, use the G29 (ARC) or G78 (PUNCHING ARC) command.
- When scrap remains inside, make "J" 90° or 45° and enter "M00" or "M01" in order to remove the scrap.

G72  G90  X600.00  Y530.00
G68  I300.00  J30.00  K110.00  P–25.00  Q6.00  T306
Program example using Auto-index station

The tool angle is positioned 115° (–245°) with respect to the X-axis and it will be automatically compensated in the tangential direction with the progress of hole nibbling.

- When the pattern origin (X400.00, Y500.00) is to be punched also, omit "G72" and enter "T___ C±θ" in the upper command block.

```
G90  X400.00  Y500.00  T___ C±θ
G68  I60.00  J25.00  K45.00  P0  Q6.00  T___ C115.00 (or C–245.00)
```

- When the nibbling interval "d" or nibbling interval angle "θ" exceeds the following maximum value, a program error will occur.

Maximum nibbling interval: 8 mm
Maximum nibbling interval angle: 8°
Relation between nibbling interval and nibbling interval angle:

\[ \theta = 2 \sin^{-1} \frac{d}{2r} \]

- \( r \): Radius
- \( d \): Nibbling interval
- \( \theta \): Nibbling interval angle

Even if the nibbling interval "d" is within its limit, the calculated nibbling interval angle "\( \theta \)" may exceed its limit when the radius "r" is small \( (r < 57.34) \).

- When the radius "r" is 25 mm and the nibbling interval "d" is 6 mm
  \[ \theta = 2 \sin^{-1} \left( \frac{6}{2 \times 25} \right) \]
  \[ = 2 \times 6.89^\circ \]
  \[ = 13.78^\circ \rightarrow \text{Program error} \]

- When the radius "r" is 50 mm, the largest nibbling interval "d" is 6.97 mm.
G69: NIBBLING LINE [NBL-L]

Starting from either the current position or a point designated by "G72," nibbling with an interval of "d" and a length of "l" at an angle of "θ" to the X-axis is performed using a punch with a diameter of "φ."

I: Length "l" (from the initial punch center to the final punch center)

J: Angle "±θ"
   Counterclockwise: positive,
   Clockwise: negative

P: Punch diameter "±φ"
   When the value is positive, nibbling is performed on the left side of the straight line (on the hatched side in the figure); when it is negative, nibbling is performed on the right side of the straight line.

Q: Interval "d," positive value only
   Worksheet thickness < d ≤ 8 mm

NOTE
- Maximum worksheet thickness for nibbling: 3.2 mm

Example:

G72 G90 X300.00 Y120.00
G69 I180.00 J30.00 P25.00 Q6.00 T315

- When "G72" is omitted and "T315" is entered in the upper command block, the pattern origin (X300.00, Y120.00) is also punched.
- When P = 0, the initial punch center coincides with the pattern origin.
- When nibbling a worksheet with a thickness of more than 3.2 mm, use the G28 (LINE AT ANGLE) or G79 (PUNCHING LINE) command.
G78: PUNCHING ARC [PNC-A]

| G78 |  lr |  J±θ₁ |  K±θ₂ |  P±φ |  Qd |  Dt |  T |

On the circumference of a circle having a radius "r" with either the current position or a point designated by "G72" as the center, a punching operation which is the same as the NIBBLING ARC (G68) is performed at an interval of "d," using a punch with a diameter of "φ," starting from a point at an angle of "θ₁" to the X-axis and moving up to an incremental angle of "θ₂."

I: Radius "r," positive value
J: Starting angle "±θ₁" Counterclockwise: positive, Clockwise: negative
K: Angle in which punching occurs "±θ₂" Counterclockwise: positive, Clockwise: negative
P: Punch diameter "±φ"
   Enter the positive value when punching the outer side of the circle and the negative value when punching the inner side. Enter zero when punching on the arc with the radius "r."
Q: Punching interval "d," positive value only
   Worksheet thickness < d
D: Worksheet thickness "t"

NOTE
   When "t" is larger than "d," it is regarded as a program error.

Example:

Final pattern point

Final punch

Initial punch

Pattern origin

G72  G90  X600.00  Y600.00
G78  I230.00  J25.00  K110.00  P-30.00  Q6.00  D4.50  T306

t: 4.5 mm
30 mm dia.: T306
• When "G72" is omitted and "T306" is entered in the upper command block, the pattern origin (X600.00, Y600.00) is also punched.
• When scrap remains inside, make "J" 90° or 45° and enter "M00" or "M01" in order to remove the scrap.

G79: PUNCHING LINE [PNC-L]

Starting from either the current position or a point designated by "G72," a punching operation which is the same as the NIBBLING LINE (G69) is performed at an interval of "d," using a punch with a diameter of "φ," in a length of "l" at an angle of "θ" to the X-axis.

I: Length "l" (from the initial punch center to the final punch center)
J: Angle "±θ" Counterclockwise: positive,
   Clockwise: negative
P: Punch diameter "±φ"
   When the value is positive, punching is performed on the left side of the straight line; when it is negative, punching is performed on the right side of the straight line. Refer to the NIBBLING LINE (G69) on page II-19.
Q: Interval "d," positive value only
   Worksheet thickness < d
D: Worksheet thickness "t"

**NOTE**

* When "t" is larger than "d", it is regarded as a program error.

**Example:**

```
G72  G90  X300.00  Y120.00
G79  I210.00  J25.00  P30.00  Q6.00  D4.50  T306
```

• When "G72" is omitted and "T306" is entered in the upper command block, the pattern origin (X300.00, Y120.00) is also punched.
• When P = 0, the initial punch center coincides with the pattern origin.
G93: OFFSET-1 [OFS-1]

<table>
<thead>
<tr>
<th>G90</th>
<th>G93</th>
<th>X___</th>
<th>Y___</th>
</tr>
</thead>
<tbody>
<tr>
<td>G91</td>
<td>G93</td>
<td>X___</td>
<td>Y___</td>
</tr>
</tbody>
</table>

This code designates the origin of a local coordinate system. The code is merely for establishing the local coordinate system; it is not to be used for positioning or punching. Do not enter the T- or M-code with "G93." For example, never enter:

G90  G93  X50.00  Y100.00  T201

Basic format of a program using "G93"

<table>
<thead>
<tr>
<th>G06</th>
<th>A___</th>
<th>B___</th>
</tr>
</thead>
<tbody>
<tr>
<td>G92</td>
<td>X2500.00</td>
<td>Y1270.00</td>
</tr>
<tr>
<td>G90</td>
<td>G93</td>
<td>X___</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X___</td>
</tr>
</tbody>
</table>

...

G50

Example:

X-Y coordinate system: Basic coordinate system (Global coordinate system)
X'-Y' coordinate system: Local coordinate system
X"-Y" coordinate system: Local coordinate system

a) When designating the X'-Y' coordinate system
G90  G93  X50.00  Y75.00

b) When designating the X"-Y" coordinate system
G90  G93  X200.00  Y125.00  or  G91  G93  X150.00  Y50.00
c) Method of designating point A
   - G90  X300.00  Y205.00  T203
   - G90  G93  X50.00  Y75.00  X250.00  Y130.00  T203
   - G90  G93  X50.00  Y75.00  G93  X200.00  Y125.00  (or G91  G93  X150.00  Y50.00)  X100.00  Y80.00  T203

d) When returning from the local coordinate system to the global coordinate system
   - G90  G93  X0  Y0

G94: OFFSET-2 [OFS-2]

<table>
<thead>
<tr>
<th>G94</th>
<th>Xax</th>
<th>Yay</th>
<th>Pnx</th>
<th>Kny</th>
<th>Qt</th>
<th>Dₜα</th>
</tr>
</thead>
</table>

This code is used to designate the origin of a local coordinate system when taking "bending factor" into consideration.

X: Bending length in X-axis direction "ax"
Y: Bending length in Y-axis direction "ay"
P: Number of bends in X-axis direction "nx"
   The number of bends on the origin side should be entered by a positive number.
K: Number of bends in Y-axis direction "ny"
   The number of bends on the origin side should be entered by a positive number.
Q: Worksheet thickness "t," positive
D: Bending coefficient "α," positive and entered by percentage

Basic format of a program using "G94"

G06  A___  B___
G92  X2500.00  Y1270.00
G90  G94  X___  Y___  P___  K___  Q___  D___
   X___  Y___  T___

G50
Example:

\[ \alpha = 150 \]

Method for returning to the global coordinate system is the same as that of "G93."

G90  G94  X60.00  Y25.00  T203

Determining "\( \alpha \)"

\[ L = (D + E) - \alpha t \]
Example:
When the worksheet thickness "t" is 2.0 mm, the bending coefficient "α" is obtained using the following formula:

\[ \times 100\% \quad \text{(The developed length "L" is obtained by subtracting 3.6 mm from "D + E.")} \]

\[ = \frac{3.6}{2.0} \times 100\% \]

\[ = 180 \rightarrow \text{Therefore, } \alpha = 180 \]

G73: SYMMETRY (OPTION)

G 7 3   X a   Y b   Q n   W w

When patterns of holes to be punched are symmetrical, they can easily be programmed by using this command and the macro function (see page II-46).

X: Distance from specified-pattern reference point O to symmetrical pattern reference point along X-axis (dimension "a")
Y: Distance from specified-pattern reference point O to symmetrical pattern reference point along Y-axis (dimension "b")
Q:n = 1: Specified pattern punching
n = 2: Symmetrical pattern punching along X-axis, centered on "a"/2
n = 3: Symmetrical pattern punching along Y-axis, centered on "b"/2
n = 4: Symmetrical pattern punching along both X- and Y-axes, centered respectively on "a"/2 and "b"/2
W: Macro number storing specified pattern

n = 3 Ref. pt.  n = 4 Ref. pt.

15 mm dia.: T303
Program example:
When "a" is 600 mm and "b" is 400 mm in the diagram on the preceding page, the program is as follows:

```
G06  A___  B___  
G92  X___  Y___  
N001  G90  G93  X110.00  Y120.00  → Specified pattern (n = 1) reference point is defined.
    U1
N002  X40.00  Y20.00  T303
    Y70.00
    G28  I55.00  J0  K2
    V1
    → Specified pattern (n = 1) is punched and these data are simultaneously stored.
N003  G73  X600.00  Y400.00  Q4  W1  → Symmetrical pattern (n = 4) is punched.
N004  G73  Q3  W1  → Symmetrical pattern (n = 3) is punched.
N005  G73  Q2  W1  → Symmetrical pattern (n = 2) is punched.
N006  G91  X300.00  Y200.00  → Hole A is punched.
    G50
```

- Once "X" and "Y" are entered in the G73 block, they may be omitted in the second and subsequent G73 blocks if the symmetrical axes are the same (see blocks N004 and N005 in the above program).
- When the block following "G73" is an incremental statement, the incremental dimensions start from the specified-pattern reference point (see block N006 in the above program).
• "G73" can be commanded within a macro in the multiple-part program (see below).

```
G98  X___  Y___  I___  J___  P___  K___
     Uxx
     __________
     __________
     __________
     Vxx
     UOO
G73  X___  Y___  Q___  Wxx
G73  Q___  Wxx
G73  Q___  Wxx
G73  Q___  Wxx
     VOO
G75  WOO  Q___
     •
     •
     •
     xx: Macro number 60 to 89
     OO: Macro number 01 to 59

• M- and T-codes cannot be entered with "G73".
# M FUNCTION CODES

## M-code list

<table>
<thead>
<tr>
<th>M-code</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>M00</td>
<td>Program stop</td>
</tr>
<tr>
<td>M01</td>
<td>Optional stop</td>
</tr>
<tr>
<td>M02</td>
<td>Program end</td>
</tr>
<tr>
<td>M08</td>
<td>Beginning of punching completion signal delay</td>
</tr>
<tr>
<td>M09</td>
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</tr>
<tr>
<td>M10</td>
<td>Work hold and unclamp</td>
</tr>
<tr>
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<td>Work hold and release</td>
</tr>
<tr>
<td>M12</td>
<td>Nibbling pattern</td>
</tr>
<tr>
<td>M13</td>
<td>Press mode cancel</td>
</tr>
<tr>
<td>M30</td>
<td>End of tape</td>
</tr>
<tr>
<td>M31</td>
<td>Rear workholder and cassette cylinder lower*</td>
</tr>
<tr>
<td>M32</td>
<td>Side table bearings lower*</td>
</tr>
<tr>
<td>M33</td>
<td>Loading command*</td>
</tr>
<tr>
<td>M34</td>
<td>Unloading command*</td>
</tr>
<tr>
<td>M35</td>
<td>Job search end*</td>
</tr>
<tr>
<td>M36</td>
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</tr>
<tr>
<td>M37</td>
<td>Penultimate worksheet signal*</td>
</tr>
<tr>
<td>M38</td>
<td>Job end signal*</td>
</tr>
<tr>
<td>M39</td>
<td>Total job end signal*</td>
</tr>
<tr>
<td>M80</td>
<td>Workchute open*</td>
</tr>
<tr>
<td>M81</td>
<td>Workchute close*</td>
</tr>
<tr>
<td>M96</td>
<td>Subprogram recall command</td>
</tr>
<tr>
<td>M97</td>
<td>Subprogram end command</td>
</tr>
<tr>
<td>M120</td>
<td>Mild mode on</td>
</tr>
<tr>
<td>M121</td>
<td>Mild mode cancel</td>
</tr>
</tbody>
</table>

*Optional function*
<table>
<thead>
<tr>
<th>M-code</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>M500</td>
<td>Punching pattern (punch without shear angle)</td>
</tr>
<tr>
<td>M501</td>
<td>Punching pattern (punch with shear angle)</td>
</tr>
<tr>
<td>M502 to M505</td>
<td>Knockout pattern</td>
</tr>
<tr>
<td>M570 to M575</td>
<td></td>
</tr>
<tr>
<td>M506 to M509</td>
<td>Slitting pattern</td>
</tr>
<tr>
<td>M510 to M559</td>
<td>Forming pattern</td>
</tr>
<tr>
<td>M800 to M999</td>
<td></td>
</tr>
<tr>
<td>M560 to M569</td>
<td>Marking pattern</td>
</tr>
<tr>
<td>M681 to M683</td>
<td>Punching speed</td>
</tr>
<tr>
<td>M686</td>
<td>Punching speed command cancel</td>
</tr>
<tr>
<td>M687</td>
<td>Standby position compensation cancel</td>
</tr>
<tr>
<td></td>
<td>(for forming patterns)</td>
</tr>
<tr>
<td>M690</td>
<td>Press air blow</td>
</tr>
<tr>
<td>M691</td>
<td>Press air blow cancel</td>
</tr>
<tr>
<td>M692</td>
<td>Press raise</td>
</tr>
<tr>
<td>M693</td>
<td>Press raise cancel</td>
</tr>
<tr>
<td>M696</td>
<td>NEX tool punching mode on</td>
</tr>
<tr>
<td>M697</td>
<td>NEX tool punching mode cancel</td>
</tr>
</tbody>
</table>
M00: PROGRAM STOP

Enter "M00" if a program stop is desired.

Example:
Punching a 300 mm × 500 mm rectangular opening with a 50 mm × 50 mm square punch.

G72  G90  X1000.00  Y500.00
G67  I–500.00  J–300.00  P50.00  T219
M00 (Machine stops here)

When "M00" is read, the machine stops. When the START button is pressed after scrap has been removed, the machine will continue the punching operation. "M00" must be entered as a single block; however, the sequence number can be entered with it.

M01: OPTIONAL STOP

This code has the same function as "M00"; however, the machine will stop only when the OPTIONAL STOP button is pressed and its lamp is turned on. (Refer to the OPERATOR'S MANUAL.)
M08: BEGINNING OF PUNCHING COMPLETION SIGNAL DELAY  
M09: END OF PUNCHING COMPLETION SIGNAL DELAY  

These codes are used for forming, marking and knockout. They are also used for punching thick worksheets. The timing at which axis travel starts after punching is delayed between "M08" and "M09."

G06 A___ B___  
G92 X___ Y___  
G90 X___ Y___  
•  
•  
•  
M510  
M08  
G90 X___ Y___  
•  
•  
•  
G28 I___ J___ K___  
•  
•  
•  
M09  
M13  
•  
•  
•  
G50

Do not place any nibbling command between "M08" and "M09."

M80: WORKCHUTE OPEN  
(usable on machine equipped with workchute)  
M81: WORKCHUTE CLOSE  
(usable on machine equipped with workchute)

These codes are used to open and close the workchute.

M692 → Press raise command  
M80 → Workchute open  
G04 X___  
M81 → Workchute close  
M693 → Press raise cancel command

When closing the workchute, enter the dwell command (G04 X___) to delay the workchute close timing. Enter the press raise command (M692) to raise the press to the top dead center.
M120: MILD MODE ON  
M121: MILD MODE CANCEL

These codes are used to change from the mild mode to the normal mode and vice versa. “M120” and “M121” must be entered as a single block.

NOTE

“M120” and “M121” are commanded for punching in the mild mode. Their functions are the same as turning on and off the lamp of the FEEDRATE FA button on the control panel. The X- and Y-axes are accelerated or decelerated more slowly between “M120” and “M121” than specified in other portions of the program.

Example:

```
  M120  → Mild mode on
    X___  Y___  T___  
    X___  → Punching in mild mode
    G28    I___  J___  K___
    M121  → Mild mode cancel
    
  → Punching in normal mode
```
M681 TO M683: PUNCHING SPEED COMMAND
M686: PUNCHING SPEED COMMAND CANCEL

"M681" to "M683" correspond to the PRESS SPEED buttons labeled F1 to F3, respectively. The punching speed can be designated only in the punching press mode. A punching speed commanding M-code remains effective until "M686" or another punching speed command is executed. These M-codes must be entered as a single block.

NOTE

- If an M-code command is different from a PRESS SPEED button selection, the lower punching speed becomes effective.
- When the PRESS SPEED AUTO button is lighted and the program has no punching speed command or has the punching speed command canceled, the punching speed is automatically set for each punching.

Example: (Punching speed selection by M-code)

G06 A___ B___
G92 X___ Y___
G90 X200. Y100. T345
G28 I20. J0 K3
M683
G90 X500. Y500. T201
G36 I100. P2 J40. K3  \[→ Punching at "F3"\]
G50
M687: STANDBY POSITION COMPENSATION CANCEL
(FOR FORMING PATTERNS)

The punch standby position (top stroke end) in a forming pattern is always compensated to the highest position to avoid interference between the worksheet and tools.

After M687 is specified and the compensated punch standby position is reset, processing starts at the standby position of the subsequently specified press mode recall M-code. M687 is used for rapid processing at a lower standby position after forming.

Example

M510; Forming pattern
: (Processing program) Standby position compensated to highest position
M13; Press mode cancel
G27 X_; Auto-repositioning
M687; Standby position compensation cancel
M500; Punching pattern
: (Processing program) Newly specified standby position

When M687 is specified after auto-repositioning, processing is done with the high standby position canceled.

NOTICE

After M687 is specified, processing starts at another standby position despite the previous forming operation. The worksheet may consequently interfere with the tools, depending on the relationship between the forming dimensions and standby position.

In a press pattern after M687, check the forming dimensions and processing sequence, and set an appropriate standby position.

NOTE

Before specifying M687, cancel the forming pattern by M13.
M690: PRESS AIR BLOW
M691: PRESS AIR BLOW CANCEL

"M690" or "M691" must be entered as a single block. When "M690" is commanded, the air blowing of the tools is performed. When "M691" is commanded, the air blowing of the tools is canceled.

\[
\begin{align*}
M690 & \rightarrow \text{Press air blow} \\
G90 & \begin{array}{c}
X\_\_\_ \ Y\_\_\_ \ T\_\_\_
\end{array} \\
& \rightarrow \text{Air blowing of tools is performed.}
\end{align*}
\]

In the nibbling and slitting press modes, the air blowing of the tools is always performed, including the period of axis travel, between "M690" and "M691." When the PRESS TOP DEAD CENTER button is lighted or when the press raise command (M692) is executed and the press is punching from the top dead center, the air blowing of the tools is performed as long as the punching operation is performed. In a press mode other than nibbling and slitting, the air blowing of the tools is performed as long as the punching operation is performed.

M692: PRESS RAISE
M693: PRESS RAISE CANCEL

"M692" or "M693" must be entered as a single block. When "M692" is commanded, the press starts punching from the top dead center, while "M693" is commanded, the press raise command is canceled and the press starts punching from the top stroke end.

\[
\begin{align*}
M692 & \rightarrow \text{Press raise} \\
G90 & \begin{array}{c}
X\_\_\_ \ Y\_\_\_ \\
X\_\_\_ \ Y\_\_\_
\end{array} \\
& \rightarrow \text{Punching from top dead center}
\end{align*}
\]

"M692" has the same function as when the PRESS TOP DEAD CENTER button is lighted.
M696: NEX TOOL PUNCHING MODE ON
M697: NEX TOOL PUNCHING MODE CANCEL

These codes are used to use NEX tools. “M696” and “M697” must be entered as a single block. When “M696” is commanded and “T_” is entered in the lower command block, the press starts punching from the top stroke end for a NEX punch, which can be set on the PROCESSING CONDITION display. When “M697” is commanded, the NEX tool punching mode on command is canceled and the press starts punching from the top stroke end.

M696
G28 I__ J__ K__ T__ → NEX tool punching mode on
X__ Y__ → Punching from top stroke end for NEX punch
M697
X__ Y__ → NEX tool punching mode cancel
·               → Punching from top stroke end
Press mode recall and cancel

M〇〇〇  Press mode recall

M13  Press mode cancel

To recall a press mode registered on the PROCESSING CONDITION display, enter the M-code for the press mode in question (refer to the following pages). The press mode recalled by the M-code remains effective until "M13" is entered or another press mode is recalled. These M-codes must be entered as a single block.

Basic Program:

```gcode
G06  A___ B___
G92  X___ Y___
G90  X___ Y___
G36  I___ P___ J___ K___
M〇〇〇  → Press mode recall
G72  X___ Y___
G66  I___ J___ P___ Q___ T___
M13  → Press mode cancel
G50
```

M500, M501: PUNCHING

"M500" is entered for punching with a standard punch having a flat edge and "M501" is entered for punching with a punch having a shear angle.

NOTE

You can confirm or set punching parameters on the PROCESSING CONDITION display.

```gcode
M500  → For standard punch
G90  X100. Y150. T342 (standard punch)
G90  X200. Y350. T255 (standard punch)
G36  I50. P3 J75. K2
M13  → Mode cancel
M501  → For punch with shear angle
G72  X120. Y100.
G66  I200. J0 P110. Q10. T201 (punch with shear angle)
M13  → Mode cancel
```
"M500" and "M501" can be omitted in the program when the "SHEAR TOOL" of the tooling data parameters is set for the turret station to be used. If the parameter setting is different from the M-code in the program, the press performs the punching operation in the same way as when "M501" is commanded.

**NOTE**

*You can confirm or set the tooling data parameters on the TOOLING DATA display.*

### M12: NIBBLING

When "M12" is entered, the press performs the punching operation without decelerating above the worksheet.

**NOTE**

*You can confirm or set nibbling parameters on the PROCESSING CONDITION display.*

```
M12      → Nibbling mode
G90 X230. Y300. T303
G36 I150. P3 J40. K2
M13      → Mode cancel
```

When the nibbling command "G68" or "G69" is entered in the block following "M12," the nibbling interval "Q" must not exceed the permissible pitch limit of 8 mm.

```
M12      → Nibbling mode
G72 X300. Y400.
M13      → Mode cancel
```
When performing a forming operation, an M-code that meets the content of the forming operation to be performed is entered. The press operation in the block following the M-code is performed according to the data set for the parameters of the M-code.

**NOTE**

You can confirm or set the forming parameters on the PROCESSING CONDITION display.

```
M510 → Forming
(M08) → Beginning of punching completion signal delay
G90 X500. Y300. T201 (Forming tool)
G28 I30. J0 K10
(M09) → End of punching completion signal delay
M13 → Mode cancel
M511 → Forming
(M08) → Beginning of punching completion signal delay
G90 X20. Y150. T333
G36 I800. P1 J400. K1
(M09) → End of punching completion signal delay
M13 → Mode cancel
```

"M08" and "M09" are entered as required.
**M560 TO M569: MARKING**

When performing a marking operation, an M-code that meets the content of the marking operation to be performed is entered. The press operation in the block following the M-code is performed according to the data set for the parameters of the M-code.

---

**NOTE**

You can confirm or set the marking parameters on the PROCESSING CONDITION display.

<table>
<thead>
<tr>
<th>M560</th>
<th>→ Marking</th>
</tr>
</thead>
<tbody>
<tr>
<td>(M08)</td>
<td>→ Beginning of punching completion signal delay</td>
</tr>
<tr>
<td>G90</td>
<td>X130. Y280. T201 (Marking tool)</td>
</tr>
<tr>
<td>X350.</td>
<td></td>
</tr>
<tr>
<td>(M09)</td>
<td>→ End of punching completion signal delay</td>
</tr>
<tr>
<td>M13</td>
<td>→ Mode cancel</td>
</tr>
</tbody>
</table>

"M08" and "M09" are entered as required.

---

**M502 TO M505: KNOCKOUT**

**M570 TO M575: KNOCKOUT**

When performing a knockout operation, an M-code that meets the content of the knockout operation to be performed is entered. The press operation in the block following the M-code is performed according to the data set for the parameters of the M-code.

---

**NOTE**

You can confirm or set the knockout parameters on the PROCESSING CONDITION display.

<table>
<thead>
<tr>
<th>M502</th>
<th>→ Knockout</th>
</tr>
</thead>
<tbody>
<tr>
<td>(M08)</td>
<td>→ Beginning of punching completion signal delay</td>
</tr>
<tr>
<td>G90</td>
<td>X350. Y180. T246 (Knockout tool)</td>
</tr>
<tr>
<td>Y350.</td>
<td></td>
</tr>
<tr>
<td>(M09)</td>
<td>→ End of punching completion signal delay</td>
</tr>
<tr>
<td>M13</td>
<td>→ Mode cancel</td>
</tr>
</tbody>
</table>

"M08" and "M09" are entered as required.
M506 TO M509: SLITTING

When performing a slitting operation, an M-code that meets the content of the slitting operation to be performed is entered. The press operation in the block following the M-code is performed according to the data set for the parameters of the M-code.

NOTE

Slitting is performed by using dedicated tools. For the programming method for slitting, refer to the operator’s manual of slitting tools. Also refer to the operator’s manual of slitting tools for the set values of slitting parameters.

You can confirm or set the slitting parameters on the PROCESSING CONDITION display.

1. When slitting feed direction is 0°, 90°, 180° or 270°

M690 → Press air blow
M506 (M507, M508, M509) → Slitting mode
G90 Xa Yb T___ C___
G28 Id1 Jθ Kn
M13 → Mode cancel
G28 Id2 Jθ K1 → Final cutting punch
M691 → Press air blow cancel

a: X-coordinate of initial punch center
b: Y-coordinate of initial punch center
θ: Angle corresponding to slitting feed direction (0°, 90°, 180°, 270°)
da1: Feed pitch
The feed pitch is set according to the worksheet thickness and material and the punch to be used. (It is initially set at about 5 mm and is then adjusted as required according to the check results of the slit product.)
n: Feed frequency
[Slitting length (L) – Wide-side length of punch (H)] / Feed pitch
When the calculated value is a fraction, omit the numerals below the first place of decimals.
d2: Feed pitch
[value omitted at the feed frequency "n"] × [Feed pitch "d;"]
When the value calculated at the feed frequency "n" is an integer, enter zero.
2. When slitting feed direction is arbitrary angle

Since a chip not separated from the worksheet occurs in the die, a linear interpolation is required.

![Diagram of initial punch and angle θ]

M690 → Press air blow
M506 (M507, M508, M509) → Slitting mode
G90 Xa Yb T___ Cθ
G01 F8000 → Linear interpolation start
G28 Id1 Jθ Kn
M13 → Mode cancel
G28 Id2 Jθ K1 → Final cutting punch
G00 → Linear interpolation cancel
M691 → Press air blow cancel

a: X-coordinate of initial punch center
b: Y-coordinate of initial punch center
θ: Angle corresponding to slitting feed direction
d1: Feed pitch
The feed pitch is set according to the worksheet thickness and material and the punch to be used. (It is initially set at about 5 mm and is then adjusted as required according to the check results of the slit product.)
n: Feed frequency
[Slitting length – Wide-side length of punch] / Feed pitch
When the calculated value is a fraction, omit the numerals below the first place of decimals.
d2: Feed pitch
[Value omitted at the feed frequency "n"] × [Feed pitch "d1"]
When the value calculated at the feed frequency "n" is an integer, enter zero.
G01 F___: Linear interpolation start
    Positioning becomes linear interpolation (over the shortest distance).
G00: Linear interpolation cancel
    Positioning becomes normal positioning.

NOTE

- When "G01" has no F-code, a program error occurs.
- The F-code is usually entered not to exceed "8000" (8 m/min). "8000" is normally entered.
- When the T- and C-codes are placed between "G01" and "G00," a program error occurs.

3. When single-stroke punching is performed with slitting punch

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M690</td>
<td>Press air blow</td>
</tr>
<tr>
<td>M506 (M507, M508, M509)</td>
<td>Slitting mode</td>
</tr>
<tr>
<td>M13</td>
<td>Mode cancel</td>
</tr>
<tr>
<td>G90</td>
<td>X___ Y___ T___ C___</td>
</tr>
<tr>
<td>M691</td>
<td>Press air blow cancel</td>
</tr>
</tbody>
</table>
When a pattern specified by the command G26 (BHC), G28 (LAA), G29 (ARC), G36 (GRD-X), G37 (GRD-Y), G66 (SHP), G67 (SQR), G68 (NBL-A), G69 (NBL-L), G78 (PNC-A) or G79 (PNC-L) is to be punched repeatedly, the pattern can be memorized and recalled whenever required.

To memorize a pattern, enter the address letter "A" along with a one-digit numeral (from 1 to 5). To recall the pattern, enter the address letter "B" and the same one-digit numeral as used at "A."

"AO" should always be entered at the front of the pattern command block; "BO" must be entered as a single block by itself. "AO" and "BO" are only used for the pattern memory and recall. Memorization and recalling of coordinates are impossible with these.

Example:

G72 G90 X350.00 Y250.00
A1 G26 I150.00 J0 K6 T203 → Pattern memory
G72 X850.00
B1 → Pattern recall
FO: DESIGNATION OF AXIS FEED SPEED

The axis feed speed can be changed by this code. "FO" must be entered as a single block. The axis feed speed is decreased as the value following "F" is changed from 1 to 4 (1 → 2 → 3 → 4). This code has the same function as the FEEDRATE button. When there is a difference between the axis feed speed commanded by this code and that set by the FEEDRATE button, priority will be given to the slower axis feed speed. The command of the F-code remains effective until a new F-code is entered. If no F-code is commanded, the axes move at the feed speed set by the FEEDRATE button.

G90  X___  Y___  T___
F3
X___  Y___
X___  Y___  → Axis travel at "F3"
F1
X___  Y___
X___  Y___  → Axis travel at "F1"
1. Macro storing

Using the macro function, the contents of multiple blocks of data can be stored in memory as a single macro; and the stored data can be recalled whenever required. To store multiple blocks of data, enter the address letter "U" along with a two-digit numeral (from 01 to 99) as a single block, preceding the multiple blocks which you wish to memorize, and enter as a single block the address letter "V" and the same two-digit numeral as used at "U," after the multiple blocks which you wish to memorize.

The two-digit numeral following "U" or "V" is called the "macro number." This macro number comes in the following three types:

- 01 to 59: The blocks of data between "U" and "V" remain stored while they are simultaneously being executed.
- 60 to 89: The blocks of data between "U" and "V" are only stored in memory.
- 90 to 99: Storing of multiple macros is accomplished.

2. Macro recalling

The multiple blocks of data which were stored by "U" and "V" can be recalled by the address letter "W" along with the same two-digit numeral as used at "U" and "V."

3. Example

```
G06  A___ B___
G92  X2500.00  Y1270.00
   
   U02
G90  X100.00  Y500.00  T345
G72  X150.00  Y700.00
A1  G66  I100.00  J30.00  P20.00
N100  M00
G72  X450.00  Y600.00
B1
V02
   
   
```

These commands remain stored while they are simultaneously being executed.

II-46
U70
G90  X200.00  Y100.00  T304
G37  8.00  P3  J10.00  K10
G90  X1000.00  Y800.00
G28  25.00  J−90.00  K6
V70
W02 → Recalling and executing commands stored between "U02" and "V02"
W70 → Recalling and executing commands stored between "U70" and "V70"

4. Multiple recalling of macro

The data which were stored as macro can be recalled, and the recalled data can also be stored and then be recalled again. This multiple recalling is possible up to triple level.

Example:

U05

V05

W05

V20

U70

W20

V70

W70

The above commands are executed in the following sequence:
5. Memory capacity for macro (Macro numbers 01 to 89)

The maximum memory capacity for macro is 3100 characters. One character equals:
• One address letter (G, X, Y, T, M, etc.)
• One numeral (1, 2, 3, ......, 0)
• One symbol (CR, LF, –, /, etc.)
The delete, space, and other codes which are ignored by the NC are not considered as characters.

6. Storing and recalling of multiple macros

Multiple macros can be stored and recalled by using the macro numbers 90 to 99. These macro numbers are only capable of defining a group of multiple macros as one macro, and they are unable to store execution commands. The maximum number of single macros that can be stored by each of the macro numbers 90 to 99 is 15.

Example:

U90
U01
•
•
•
V01
U10
•
•
•
V10
U15
•
•
•
V15
G90  X100.00  Y200.00 → This block is not stored.
U02
•
•
•
V02
V90
•
•
W90 = { W01
        W10
        W15
        W02
II-48
7. Macro memory setting

When any of the following conditions (a) to (c) occurs, all stored macros will be erased from memory:

(a) The NC power has been turned off.
(b) The RESET key has been pressed.
(c) "G50," "M02" or "M30" has been commanded.

However, the macros can be retained in memory under the above-mentioned conditions by setting the NC. For the NC setting procedure, refer to the OPERATOR'S MANUAL.
Part III
Multiple-Part Punching

General description and programming example...............................III-2
G98: Setting of reference point and
layout for multiple-part punching........................................III-5
UO to VO: Storing of part program.......................................III-8
G75, G76 W O Q: Recalling and execution of part
program ..............................................................III-10
Inclusion and priority relations between G98 and G93..................III-14
First punching, others punching, and all punching ......................III-14
GENERAL DESCRIPTION AND PROGRAMMING EXAMPLE

1. Multiple-part punching function

This function is used to punch multiple products which have the same punching pattern from one worksheet. Once the punching of only one product is programmed, the punching of multiple products with any desired layout on the worksheet can be performed by using simple commands.

2. Removal of each product after multiple-part punching

When punching twelve products from one worksheet, such as the one shown in the figure below, the following three removal methods can be used:

![Diagram of multiple parts punching](image)

a. Micro-joint method

The hatched portions are punched out in the "Micro-joint" method.

Punching 12 products from one worksheet
As shown in the figure, the hatched portions are punched out by rectangular punches in such a manner that the four corners of each product remain unpunched. The four corners are connected to the worksheet by means of an approx. 0.15 mm joint. After completing the entire punching process, the worksheet with punched products is unloaded from the machine, and each product is then separated from the worksheet.

b. Separation method
Each product is separated from the worksheet after punching. Each time one product is cut out, the operator stops the machine and removes the product using a magnet or by other means.

c. Workchute method
Each product which is separated from the worksheet automatically drops into the workchute.
3. Program example using multiple-part punching function

The program for punching the product shown in the figure on page III-2 using the "micro-joint" method is as follows:

G06  A1.6  B0
G92  X2500.00  Y1270.00
G98  X30.00  Y100.00  J400.00  J250.00  P3  K2  \( \rightarrow (1) \) The reference point for multiple-part punching is set.

\begin{align*}
U1 \\
G90  & X370.00  Y210.00  T304 (8\phi) \\
Y10.00 & \\
X10.00 & \\
Y210.00 & \\
G72  & X120.00  Y110.00 \\
A1  G26 & I50.00  J45.00  K4  T203 (4\phi) \\
G72  & X260.00 \\
B1 & \\
V1 & \\
\end{align*}

(2) Program (part program) for punching one product. This part program is stored.

\begin{align*}
U2 \\
X260.00  & Y110.00  T219 (60\phi) \\
X120.00 & \\
V2 & \\
\end{align*}

(3) Program (part program) for punching the exterior shape of one product. This part program is stored.

\begin{align*}
U3 \\
G72  & X380.00  Y220.00 \\
G66  & I220.00  J–90.00  P85.00  Q5.00  D–0.15  T255 (5 \times 85) \\
G72  & X0  Y0 \\
G66  & I220.00  J90.00  P85.00  Q5.00  D–0.15 \\
V3 & \\
\end{align*}

(4) Recalling and execution of each part program for the specified punching layout.

\begin{align*}
G76  W1  & Q4 \cdots U1–V1 execution command \\
G76  W2  & Q5 \cdots U2–V2 execution command \\
G76  W3  & Q2 \cdots U3–V3 execution command \\
G75  W4  & Q3 \cdots U4–V4 execution command \\
G50 & \\
\end{align*}

After preparing the above program, one product in the lower left corner in the figure on page III-2 can be first-punched by button operation on the screen. After checking the dimensions of the product, the punching of multiple products over the entire surface of the worksheet can then be performed.

III-4
G98: SETTING OF REFERENCE POINT AND LAYOUT FOR MULTIPLE-PART PUNCHING

G98  XxA  YyA  l/x  J/y  Pnx  Kny

xA: X-coordinate of reference point
yA: Y-coordinate of reference point
l/x: Pitch along X-axis
l/y: Pitch along Y-axis
nx: Number of products in X-axis direction, excluding product at reference point
ny: Number of products in Y-axis direction, excluding product at reference point

If xA = 30 mm, yA = 80 mm, l/x = 400 mm and l/y = 250 mm in the above figure, the program is:

G98  X30.00  Y80.00  l400.00  J250.00  P3  K2

NOTE
- The reference point for punching multiple products must be located in the lower left corner of the product which is located at the lower left portion of the worksheet.
- The values "l/x," "l/y," "nx" and "ny" of l, J, P, K specified by "G98" must be either zero or positive values.
Example 1:
This shows the punching of products only in the X-axis direction.

If $x_A = 30 \text{ mm}$, $y_A = 80 \text{ mm}$ and $\ell_x = 250 \text{ mm}$ in the above figure, the program is:

$$G98 \ X30.00 \ Y80.00 \ I250.00 \ J0 \ P5 \ K0$$

As shown above, $J/\ell_y = 0$ and $K/y = 0$.

Example 2:
This shows the punching of products only in the Y-axis direction.

If $x_A = 30 \text{ mm}$, $y_A = 80 \text{ mm}$ and $\ell_y = 150 \text{ mm}$ in the above figure, the program is:

$$G98 \ X30.00 \ Y80.00 \ I0 \ J150.00 \ P0 \ K3$$

As shown above, $I/x = 0$ and $P/x = 0$.
Example 3:
When there is no cutting area between products and the outer edges of each product are cut either by shearing or other procedures after punching (trimming will be necessary).

If \( x_A = 20 \text{ mm} \), \( y_A = 100 \text{ mm} \), \( l_x = 450 \text{ mm} \) and \( l_y = 260 \text{ mm} \) in the above figure, the program is:

\[
\text{G98 } X20.00 \hspace{1mm} Y100.00 \hspace{1mm} I450.00 \hspace{1mm} J260.00 \hspace{1mm} P3 \hspace{1mm} K2
\]

Example 4:
This is an example of a situation where there is neither a cutting area between products nor a clamping area and trimming is not performed.

If \( l_x \) (product length along X-axis) = 450 mm and \( l_y \) (product length along Y-axis) = 260 mm in the above figure, the program is:

\[
\text{G98 } X0 \hspace{1mm} Y0 \hspace{1mm} I450.00 \hspace{1mm} J260.00 \hspace{1mm} P3 \hspace{1mm} K2
\]
UOO TO VOO: STORING OF PART PROGRAM

To store the part program for one product, "U" and a two-digit numeral (macro number) must be entered at the beginning of the part program to be stored, and "V" and the same two-digit numeral as used at "U" must also be entered at the end of the part program. The part program thus positioned between "U○○" and "V○○" is stored in memory.

NOTE

- The same macro numbers must be attached to "U" and "V" in order to store one part program.
- Three types of macro numbers are available; one type ranges from 01 to 59, another type from 60 to 89 and the other type from 90 to 99.
- The macro numbers 01 through 05 can be specified as one digit by omitting the leading zero.
- On the macro numbers 01 through 89, the maximum limit of the part program allowed to be stored is 3100 characters on one processing tape.

Program example 1:

In this example, the processing by one type of tool (also including tools which are selected by simply moving the striker) is stored as a part program.

In this program, the processing by one type of tool is performed on the whole surface of the worksheet. Then, the next type of tool is selected and the processing by it also is made on the whole surface of the worksheet. The time required for selection of tool can thus be reduced.

U1
X370.00 Y210.00 T304 (8φ)
Y10.00
X10.00
Y210.00
G72 X120.00 Y110.00
A1 G26 I50.00 J45.00 K4 T203 (4φ)
G72 X260.00
B1
V1
U2
X260.00 Y110.00 T219 (60φ)
X120.00
V2
Program example 2:
In this example, the processing for one product by five types of tools is stored as a part program.

All processing of one product is performed by using five types of tools. Then, all processing of the next product is also performed by using the same five types of tools. The time for selection of tools increases. Although the program is simple, the processing time is greater than in example 1 above.

U50
X370.00 Y210.00 T304
Y10.00
X10.00
Y210.00
G72 X120.00 Y110.00
A1 G26 J50.00 J45.00 K4 T203
G72 X260.00
B1
X260.00 Y110.00 T219
X120.00
G72 X380.00 Y220.00
G66 I220.00 J–90.00 P85.00 Q5.00 D–0.15 T255
G72 X0 Y0
G66 I220.00 J90.00 P85.00 Q5.00 D–0.15
G72 X380.00 Y0
G66 I380.00 J180.00 P110.00 Q10.00 D–0.15
V50
G75, G76 W○○ Q○: RECALLING AND EXECUTION OF PART PROGRAM

The part program for punching one product entered between "U○○" and "V○○" is recalled by "W○○," and the program is executed to process all products according to the punching layout designated by "G98."

1. G75: Execution of horizontal (X-axis direction) grid

   The part program entered between "U○○" and "V○○" is executed in the order shown below.

![Diagram](image1)

2. G76: Execution of vertical (Y-axis direction) grid

   Execution is accomplished as shown below.

![Diagram](image2)
3. **QO: Designation of starting point**

   This designates the corner of the punching layout from which the punching operation will begin by "G75" or "G76."

   Q1: Lower left corner  Q3: Upper left corner  
   Q2: Lower right corner  Q4: Upper right corner

   ![Diagram of QO designation](image)

4. When punching multiple products in a single horizontal row

   G: "G75" is used.  
   Q: 1 or 2 can be used.

   ![Diagram of horizontal punching](image)

5. When punching multiple products in a single vertical row

   G: "G76" is used.  
   Q: 1 or 3 can be used.
6. Combination method of G75 and Q1 to Q4, or G76 and Q1 to Q4
   
a) Either "G75" or "G76" must be selected so that the distance of movement can be minimized.

b) If the processing of a part program starts from the upper right corner (Q4) and ends at the upper left corner (Q3), the processing of the next part program should start at the upper left corner (Q3) in order to guarantee efficient movement.

c) When cutting the outside shape in the process of punching multiple products, it is desirable to start the punching at the upper portion of the worksheet and move lower in sequence. For such a procedure, enter the command of: G75 WOO Q4 or 3.

7. U90 to V90

If the starting point designated by "Q" is unchanged and either "G75" or "G76" is to be used alone, it is possible to represent multiple sets of "U OO" and "VOO" by a single "UOO" and "V0O." The macro number for this function is 90 to 99.

**NOTE**

In each of the macro numbers 90 to 99, it is possible to store a maximum of 15 types of part programs.

**Application example of macro numbers in nineties (90 to 99):**

<table>
<thead>
<tr>
<th>G06</th>
<th>A___ B___</th>
<th>G06</th>
<th>A___ B___</th>
</tr>
</thead>
<tbody>
<tr>
<td>G92</td>
<td>X2500.00</td>
<td>Y1270.00</td>
<td>G92</td>
</tr>
<tr>
<td>G98</td>
<td>X30.00</td>
<td>Y100.00</td>
<td>I400.00</td>
</tr>
<tr>
<td>U90</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U1</td>
<td>X370.00</td>
<td>Y210.00</td>
<td>T304</td>
</tr>
<tr>
<td></td>
<td>Y10.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>X10.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Y210.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>G72</td>
<td>X120.00</td>
<td>Y110.00</td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>G26</td>
<td>I50.00</td>
<td>J45.00</td>
</tr>
<tr>
<td>G72</td>
<td>X260.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U2</td>
<td>X260.00</td>
<td>Y110.00</td>
<td>T219</td>
</tr>
<tr>
<td></td>
<td>X120.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>V2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

III-12
The left side program is an example of the application of the macro numbers in the nineties. These two programs (left and right sides) are equivalent in movement of the machine.
INCLUSION AND PRIORITY RELATIONS BETWEEN G98 AND G93

a) The X- and Y-coordinates specified by "G98" are determined by the coordinate system which is set by "G92."

b) The coordinate system set by "G98," once specified, cannot be canceled except by using the subsequent command "G98" or "G50," pressing the RESET key or turning off the power.

c) The X- and Y-coordinates specified by "G93" are determined by the coordinate system which is set by "G98."

d) "G93" which is specified prior to the setting of "G98" will remain effective even after "G98." The values obtained by adding the X- and Y-coordinates of "G98" and the X- and Y-coordinates of "G93," respectively, will determine the origin of this program.

FIRST PUNCHING, OTHERS PUNCHING, AND ALL PUNCHING

In the conventional method of multiple-part punching, punching must be accomplished over the whole surface of the worksheet, and then dimensional and accuracy checks must be conducted. Should the program contain any error, substantial worksheet and time losses would result. However, in this multiple-part punching function, selection between three types of processing is available by button operation on the screen, i.e. "first punching for one product," "multiple punching for remaining products after first punching" and "all punching." For details on this operation, refer to "Displays" in the OPERATOR'S MANUAL.
Part IV

Subprograms

Subprogram format...........................................................................................................IV-2
Recalling format of subprogram.........................................................................................IV-2
Multiple recalling of subprogram........................................................................................IV-2
When programs contain patterns which repeat frequently, these patterns can be stored in memory in advance as subprograms to be recalled as required.

**SUBPROGRAM FORMAT**

<table>
<thead>
<tr>
<th>OOOOO</th>
<th>Subprogram number (100 to 7999)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Punching program</td>
</tr>
<tr>
<td>M97</td>
<td>Command for subprogram finish</td>
</tr>
</tbody>
</table>

Enter a subprogram number "OOOOO" to the beginning of the punching program and enter "M97" to the end of the punching program.

**RECALLING FORMAT OF SUBPROGRAM**

```
M96  PLLL
```

P: Program number to be recalled (100 to 7999)
L: No. of repetition times (up to a maximum of 9999)

The subprogram is recalled by programming "M96" followed by the program number designated by "P" and the number of repetition times designated by "L." When "L" is omitted, there will be only one recalling.

**MULTIPLE RECALLING OF SUBPROGRAM**

A subprogram can recall another subprogram as shown above.
Part V

References

Hints on programming by shape .............................................................. V-2
  1. Corner notches ............................................................................... V-2
  2. 45° corner notches .......................................................................... V-3
  3. Small rectangular opening ............................................................ V-8
  4. Long rectangular hole ..................................................................... V-9
  5. Large rectangular opening ............................................................ V-11
  6. Rectangular opening with rounded corners .................................. V-12
Reference data .................................................................................. V-15
HINTS ON PROGRAMMING BY SHAPE

1. CORNER NOTCHES

Example:

When punching 20 mm × 20 mm notches in four corners of a 300 mm × 500 mm worksheet with a 30 mm × 30 mm sq. punch

When punching the corner notch ①, the center position of the punch is commanded in the program as follows:

X: 20 – 30/2 = 5 mm
Y: 20 – 30/2 = 5 mm

The center of the punch is thus located by:

G90  X5.00  Y5.00

When punching the corner notch ②, the center position of the punch is calculated as follows:

X: 5 mm as for ①
Y: 300 – 20 + 30/2 = 295 mm

When punching the corner notch ③, the center position of the punch is calculated as follows:

X: 500 – 20 + 30/2 = 495 mm
Y: 295 mm as for ②

When punching the corner notch ④, the center position of the punch is calculated as follows:

X: 495 mm as for ③
Y: 5 mm as for ①
The program for punching the four corner notches is thus prepared as follows:

1. G90  X5.00  Y5.00  T  
2. Y295.00  
3. X495.00  
4. Y5.00

Example:
When punching an 80 mm × 100 mm notch with a 50 mm × 50 mm sq. punch

G90  G72  X–2.00  Y40.00  
A1  G66  I102.00  J0  P–50.00  T  
G72  X–2.00  Y80.00  
B1

2. 45° CORNER NOTCHES

Example:
When a 45° notch can be punched in a single operation

a) Determine the punch to be used.
   Since the length of the oblique side of the notch is 30 × 1.414 = 42.42 mm, the notch can be punched in a single operation with a 50 mm × 50 mm sq., 45° punch.

b) Calculate the center position of the punch.
   \[ S = \frac{P \times \sqrt{2}}{2} (= P \times \sin 45^\circ) \]
   \[ H = 2 \times S = P \times \sin 45^\circ \]
c) Determine the coordinates of the punch center.

(1) For the notch, position the center of the punch on the Y-axis. The X-coordinate of the punch center is 0.

(2) Calculate the length S.
\[ S = \text{punch width} \times \frac{1}{2} \]
Thus,
\[ S = 50 \times \frac{1}{2} = 35.35 \text{ mm} \]

(3) The Y-coordinate of the punch center is
\[ Y = 30 - S = 30 - 35.35 = -5.35 \]
and the provisional punch center is
X₀  Y₀ = 5.35

(4) Since a needlelike projection may occur on the edge of the worksheet in this condition, shift the punch by 1 mm each in the X-axis and Y-axis directions so that the edge of the punch does not coincide with the edge of the worksheet.

(5) Since the X-coordinate is shifted by 1 mm in the negative direction and the Y-coordinate is shifted by 1 mm in the positive direction, the center of the punch is
\[ X: 0 - 1.00 = -1.00 \]
\[ Y: -5.35 + 1.00 = -4.35 \]
and the program is
\[ \text{G90 } X-1.00 \ Y-4.35 \ \text{T} \] (50 mm × 50 mm sq. punch)
The notches 2 to 4 are similarly programmed.

X: –
Y: –

X: +
Y: +

• Provisional coincidence point
  ← Shift direction

2  X: 0 – 1.00 = –1.00
   Y: 300 – 30 + 35.35 – 1.00 = 304.35
3  X: 500 – 30 + 35.35 + 1.00 = 506.35
   Y: 300 – 30 + 35.35 – 1.00 = 304.35
4  X: 500 – 30 + 35.35 + 1.00 = 506.35
   Y: 30 – 35.35 + 1 = –4.35

The program thus becomes as follows:

1  G90  X–1.00  Y–4.35  T____ (50 mm × 50 mm sq.)
2  Y304.35
3  X506.35
4  Y–4.35
Example:
When a 45° notch cannot be punched in a single operation

40 mm x 40 mm sq. (45°): T219

The starting and finishing points of notching should be shifted about 1 mm in order to ensure accurate notching.
Notching lower left corner

a) Provisional starting point (0) "X₁, Y₁" (Absolute coordinates)

\[
X₁ = \text{[Notch size "E"]} - \frac{1}{2} \text{[Diagonal punch size "H"]}
\]

\[
Y₁ = 0
\]

H = \sqrt{2} \times 40
= 1.414 \times 40 = 56.56 \text{ mm}

b) Starting point (0') "X₀, Y₀" (Absolute coordinates)

Shift both X- and Y-axes about 1 mm from (0).

\[
X₀ = X₁ + 1 \text{ mm}
\]

\[
Y₀ = Y₁ - 1 \text{ mm} \quad \text{(In case of the lower left corner (i))}
\]

c) Punching frequency and feed pitch

Travel distance \( L = \text{[Notch size "E"]} - \frac{H}{2} + 2 \times 1 \text{ mm} \)

Punching frequency \( N = \)

When decimal numbers are obtained

Ex.: 2.3 → 3

When integral numbers are obtained

Ex.: 3 → 4

Feed pitch \( P = \frac{L}{N} \)

NOTE

The feed pitches of the X- and Y-axes should be equal and should be larger than \( H/4 \), but smaller than \( H/2 \) minus 0.5 mm.

---

V-7
a) \[ X_1 = 100 - \frac{1}{2} \times 56.56 = 71.72 \text{ mm} \]
\[ Y_1 = 0 \text{ mm} \]

b) \[ X_0 = 71.72 + 1 = 72.72 \text{ mm} \]
\[ Y_0 = 0 - 1 = -1.00 \text{ mm} \]

c) \[ L = 100 - 28.28 + 2 = 73.72 \]
\[ N = \frac{74}{28.28} = 2.62 \rightarrow 3 \text{ times} \]
\[ P = \frac{74}{3} = 24.67 \text{ mm} \]

Therefore the program is:
\[ \text{G90 X72.72 Y-1.00 T219 (40 mm x 40 mm sq. 45°)} \]
\[ \text{G91 X-24.67 Y24.67 (3 times)} \]

3. SMALL RECTANGULAR OPENING

"G36" or "G37" is commanded in place of "G67" for punching a small rectangular opening without any scrap.

**Example:**

When punching a 300 mm x 100 mm rectangular opening with a 50 mm x 50 mm sq. punch

a) Determine the coordinates of the initial punch center.
\[ X: 200 + 25 = 225 \text{ (mm)} \]
\[ Y: 300 + 25 = 325 \text{ (mm)} \]

b) Calculate the punching frequency "P" and feed pitch "I" in the X-axis direction.
\[ = 1.0 \rightarrow 2 \]
\[ = 25 \text{ (mm)} \]

c) Calculate the punching frequency "K" and feed pitch "J" in the Y-axis direction.
\[ = 5.0 \rightarrow 6 \]
\[ = 41.666 \rightarrow 41.67 \text{ mm} \]
d) The 100 × 300 mm rectangular opening can be punched on the grid shown at right and the program becomes as follows:

   \[
   \begin{align*}
   &G90 \ X825.00 \ Y325.00 \ T219 \\
   &G36 \ I25.00 \ P2 \ J41.67 \ K6
   \end{align*}
   \]

4. LONG RECTANGULAR HOLE

a) First punch position "X₀, Y₀" (Absolute coordinates)

   \[
   \begin{align*}
   &X₀ = [X \text{ value at left end}] + 1/2 \ [Punch \ length \ along \ X-axis] \\
   &Y₀ = [Y \text{ value at lower end}] + 1/2 \ [Punch \ length \ along \ Y-axis]
   \end{align*}
   \]

b) Travel distance "L"

   \[
   L = [\text{Total length}] – [\text{Punch width}]
   \]

c) Punching frequency "N"

   - When decimal numbers are obtained
     Ex.: 6.2 → 7
   - When integral numbers are obtained
     Ex.: 9 → 10

d) Feed pitch "P"

---

NOTE

"P" should be larger than 1/2 the punch width, but smaller than the entire punch width minus 0.5 mm.

d') Feed pitch "P'

Round decimal fractions of 0.005 thru 0.009 to 0.01.
Example:
When punching a 20 mm × 150 mm rectangular hole with a 20 mm × 20 mm sq. punch (Punching begins with the left side of the hole)

\[
20 \text{ mm} \times 20 \text{ mm sq.:} \quad \text{T306}
\]

\[
\begin{align*}
\text{a)} \quad X_0 &= 200 + \frac{1}{2} \times 20 = 210 \text{ mm} \\
& \quad Y_0 = 300 + \frac{1}{2} \times 20 = 310 \text{ mm} \\
\text{b)} \quad L &= 150 - 20 = 130 \text{ mm} \\
\text{c)} \quad N &= 130/20 = 6.5 \rightarrow 7 \text{ times} \\
\text{d)} \quad P &= 130/7 = 18.57 \text{ mm}
\end{align*}
\]

Therefore the program is:

\[
\begin{align*}
\text{G90} & \quad \text{X210.00} \quad \text{Y310.00} \quad \text{T306 (20 mm} & \times 20 \text{ mm sq.)} \\
\text{G91} & \quad \text{X18.57} \\
& \quad \text{X18.57} \\
& \quad \text{X18.57} \\
& \quad \text{X18.57} \\
& \quad \text{X18.57} \\
& \quad \text{X18.57} \\
& \quad \text{X18.57}
\end{align*}
\]

The G66 command can be used for this long rectangular hole punching (see page II-13).
5. LARGE RECTANGULAR OPENING

a) Punching procedure
   Finish punching at the upper right corner in order to remove scrap easily.

b) First punch position "X₀, Y₀" (Absolute coordinates)
   \[ X₀ = [X \text{ value at right end}] - \frac{1}{2} \text{ [Punch length along X-axis]} \]
   \[ Y₀ = [Y \text{ value at upper end}] - \frac{1}{2} \text{ [Punch length along Y-axis]} \]

c) Punching frequency and feed pitch of 1

d) Punching frequency and feed pitch of 2

e) Prepare the program in accordance with the punching sequence.

   **NOTE**
   Do not punch the final punch position because the last punch falls on the first punch position.

f) Enter "M00" or "M01" in order to remove the scrap.

Example:

When punching a 200 mm × 300 mm rectangular opening with a 30 mm × 30 mm sq. punch

![Diagram of punching sequence](image)

a) ① → ② → ③ → ④

b) \[ X₀ = [400 + 1/2 × 300] - [1/2 × 30] = 535 \text{ mm} \]
   \[ Y₀ = [250 + 1/2 × 200] - [1/2 × 30] = 335 \text{ mm} \]

c) \[ L = 300 - 30 = 270 \text{ mm} \]
   \[ N = 270/30 = 9.0 → 10 \text{ times} \]
   \[ P = 270/10 = 27 \text{ mm} \]

d) \[ L = 200 - 30 = 170 \text{ mm} \]
   \[ N = 170/30 = 5.6 → 6 \text{ times} \]
   \[ P = 170/6 = 28.33 \text{ mm} \]
Therefore the program is:
G90   X535.00   Y335.00  T210 (30 mm \times 30 mm sq.)
G91   X–27.00  (10 times)
     Y–28.33  (6 times)
X27.00  (10 times)
     Y28.33  (5 times)
M00

The G67 command can be used for this large rectangular opening (see page II-14).

6. RECTANGULAR OPENING WITH ROUNDED CORNERS

a) Punching procedure
   First, punch 4 corners of 8R.
   Finish punching at the upper right corner.

b) Punching positions for 4 corners.
   Punching position for one corner → Absolute coordinates
   Punching positions for other corners → Incremental coordinates
   (Hole length – 2 × R)

c) First punch position with a square punch \((X_0, Y_0)\) → Absolute coordinates

d) Punching frequency and feed pitch of ①

e) Punching frequency and feed pitch of ②

f) Travel distance from the finishing point on one side to the starting point on another side → Incremental coordinates
   X value: Radius
   Y value: Radius

g) Prepare the program in accordance with punching procedures.

h) Enter "M00" or "M01" in order to remove scrap.
Example:

When punching a 150 mm × 250 mm opening with rounded corners of 8R, using a 16 mm dia. round punch and a 20 mm × 20 mm square punch

a) 4 corners and then ① → ② → ③ → ④

b) Absolute coordinates (upper right corner)

\[ X = [500 + 1/2 \times 250] – 8 = 617 \text{ mm} \]
\[ Y = [300 + 1/2 \times 150] – 8 = 367 \text{ mm} \]

Incremental coordinates

\[ X = 250 – [2 \times 8] = 234 \text{ mm} \]
\[ Y = 150 – [2 \times 8] = 134 \text{ mm} \]

c) Position of the first square punching

\[ X_0 = [500 + 1/2 \times 250 – 8] – [1/2 \times 20] = 607 \text{ mm} \]
\[ Y_0 = [300 + 1/2 \times 150] – [1/2 \times 20] = 365 \text{ mm} \]

d) \[ L = [250 – 2 \times 8] – 20 = 214 \text{ mm} \]

\[ N = 214/20 = 10.7 \rightarrow 11 \text{ times} \]
\[ P = 214/11 = 19.45 \text{ mm} \]

e) \[ L = [150 – 2 \times 8] – 20 = 114 \text{ mm} \]

\[ N = 114/20 = 5.7 \rightarrow 6 \text{ times} \]
\[ P = 114/6 = 19 \text{ mm} \]

f) \[ X = 8 \text{ mm} \]
\[ Y = 8 \text{ mm} \]
Therefore the program is:

G90  X617.00  Y367.00  T105 (16 mm dia.)
G91  X–234.00
     Y–134.00
     X234.00
G90  X607.00  Y365.00  T306 (20 mm × 20 mm sq.)
G91  X–19.45  (11 times)
     X–8.00   Y–8.00
     Y–19.00  (6 times)
     X8.00    Y–8.00
     X19.45   (11 times)
     X8.00    Y8.00
     Y19.00   (6 times)

M00
REFERENCE DATA

1. Punching range

**AE255NT**
- X-axis: –70 mm to 1220 mm
- Y-axis: +30 mm to 1340 mm (inner track)
  - –10 mm to 1300 mm (center track)
  - –50 mm to 1260 mm (outer track)

**AE2510NT**
- X-axis: –10 mm to 2510 mm
- Y-axis: +30 mm to 1340 mm (inner track)
  - –10 mm to 1300 mm (center track)
  - –50 mm to 1260 mm (outer track)

2. Positions of workholders

3. Workclamp dimensions