APPENDIX A
APPENDIX B
APPENDIX C
APPENDIX D
APPENDIX E
APPENDIX F
APPENDIX G
All the experimental data in Appendix A, Appendix B, Appendix C, Appendix D, Appendix E, Appendix F and Appendix G is given in the attached disc below.
APPENDIX H

EDM Specifications
CHAPTER 2. SPECIFICATIONS

2-1 Appearance of Machine and Designation of Its Components

(The photo shows A30R including options.)
Table size (width x depth) 520 x 350 (ceramic surface table) mm
Machining tank size (width x depth x height) 662 x 493 x 250 mm
Fluid level control range (from table top) 65 - 200 mm
Maximum machining tank capacity 772 L
Table longitudinal travel (X axis) 300 mm
Table cross travel (Y axis) 250 mm
Spindle vertical travel (Z axis) 250 mm
Maximum electrode weight 25 (10 when ATC is used) kg
(The maximum electrode weight varies according to the discharge area and the roughness of the machined surface.)
Maximum workpiece weight 400 kg
Electrode holder dimension 100 mm
Distance from electrode holder surface to table top 240 - 490 mm
Distance from TP-02 to table top 188 - 438 mm
Distance from floor to table top 900 mm
Machine size (width x depth x height) 1,270 x 1,905 x 2,125 mm
Area required for installation (width x depth) 1,400 x 2,030 mm
Machine weight 2,000 kg
service tank

External dimensions (width x depth x height)  
440 x 1,100 x 800mm

Weight  
(empty) 100kg

Capacity  
191ℓ

Fluid filtration method  
Replaceable paper filter  
(MF-2400 internal pressure system)

"ITC (Automatic Tool Changer) ***Option"

Number of tool holders  
Up to 8

Applicable tool holder type  
Sodick TP Series

Maximum static electrode weight  
10 (including TP holder) kg

Distance between tool pots  
152mm

Power  
Pneumatic
Machine

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table size (width × depth)</td>
<td>520 × 350 (ceramic surface table) mm</td>
</tr>
<tr>
<td>Machining tank size (width × depth × height)</td>
<td>662 × 492 × 250 mm</td>
</tr>
<tr>
<td>Fluid level control range (from table top)</td>
<td>65 ~ 200 mm</td>
</tr>
<tr>
<td>Maximum machining tank capacity</td>
<td>77 l</td>
</tr>
<tr>
<td>Table longitudinal travel (X axis)</td>
<td>300 mm</td>
</tr>
<tr>
<td>Table cross travel (Y axis)</td>
<td>250 mm</td>
</tr>
<tr>
<td>Spindle vertical travel (Z axis)</td>
<td>250 mm</td>
</tr>
<tr>
<td>Maximum electrode weight</td>
<td>25 (15 when SNT holder is used) kg</td>
</tr>
<tr>
<td>(The maximum electrode weight varies according to the discharge area and the roughness of the machined surface.)</td>
<td>(10 when ATC is used)</td>
</tr>
<tr>
<td>Maximum workpiece weight</td>
<td>400 kg</td>
</tr>
<tr>
<td>Distance from electrode holder surface to table top</td>
<td>165 ~ 415 mm</td>
</tr>
<tr>
<td></td>
<td>900 mm</td>
</tr>
<tr>
<td>Machine size (width × depth × height)</td>
<td>1,270 × 1,905 × 2,365 mm</td>
</tr>
<tr>
<td>(The machine height varies according to the Z axis stroke.)</td>
<td></td>
</tr>
<tr>
<td>Area required for installation (width × depth)</td>
<td>1,450 × 2,030 mm</td>
</tr>
<tr>
<td>Machine weight</td>
<td>2,100 kg</td>
</tr>
</tbody>
</table>

Spindle rotation mechanism

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spindle taper</td>
<td>NT-35 taper</td>
</tr>
<tr>
<td>Spindle rotation speed</td>
<td>200 ~ 1,700 rpm</td>
</tr>
<tr>
<td>Indexing resolution</td>
<td>64,800 (20 sec)</td>
</tr>
</tbody>
</table>
vice tank

External dimensions (width x depth x height) 440 x 1,100 x 800 mm

Weight (empty) 100 kg

Capacity 191 L

Fluid filtration method Replaceable paper filter (MF-2400 internal pressure system)

C (Automatic Tool Changer)  Option

Number of tool holders Up to 16

Applicable tool holder type Sodick SNT Series

Maximum static electrode weight 10 (including SNT holder) kg

Distance between tool pots 76 mm

Power Pneumatic

※When an electrode with a weight of more than 15 kg is to be used, use a heavy electrode faceplace of φ90 mm.
Outline Drawing of A30R
### BEFORE YOU START MACHINING

- **Before Starting the Machining**

  The steps you should follow before you start machining with Sodick's mold making EDM machine are indicated below in flowchart form.

<table>
<thead>
<tr>
<th>Breaker ON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reset switch ON</td>
</tr>
<tr>
<td>SOURCE switch ON</td>
</tr>
<tr>
<td>POWER switch ON</td>
</tr>
<tr>
<td>Select the MDI mode on the MANUAL screen.</td>
</tr>
<tr>
<td>Feed the axes to machine zero point. (Feed the X-, Y-, and Z-axis to the travel limit in the negative direction.)</td>
</tr>
<tr>
<td>Check that the machine coordinates are set to zero on the DISPLAY screen.</td>
</tr>
<tr>
<td>Mount a workpiece on the table.</td>
</tr>
<tr>
<td>Mount the electrode.</td>
</tr>
<tr>
<td>Execute positioning.</td>
</tr>
<tr>
<td>Input, call, and edit the program.</td>
</tr>
<tr>
<td>Check the program in the dry run mode.</td>
</tr>
<tr>
<td>Save the program.</td>
</tr>
<tr>
<td>Prepare for machining.</td>
</tr>
<tr>
<td>Start machining.</td>
</tr>
</tbody>
</table>

  **Note:** The Z-axis may alternatively be fed to the travel limit in the positive direction.

  **Note:** If the Z-axis is at the positive travel limit, the axis stroke is displayed.

The following gives you the detailed procedure for the steps indicated above.
To input a program to the KC, you can select any of the following methods:

- Input using paper tape
- Input using the RS-232C interface
- Input using the keyboard
- Calling a program from the user disk

**<Inputting a program using the keyboard>**

Use the following procedure to create a new program.

Procedure:

1) Select the edit mode.

2) Move the cursor to NEW FILE using the cursor keys.

3) Select EXCHANGE by pressing the [HF1] key under the screen.

4) Input a program from the keyboard.

After entering each line of the program, press the \[ → \] key to start a new line.

**<Calling a program from the user disk>**

Use the following procedure to call a program created using an automatic programming system other than that supplied by Sodick, or a program created previously and saved, from a floppy disk.

1) Select the [EDIT] main mode and then select the [FILE] sub mode.

2) Select LOAD by pressing the [HF1] key under the screen.

3) Locate the cursor at the file name of the file to be loaded.

4) Press the [ENT] key.

The selected file name will appear in the MEMORY column on the right side of the screen.

5) Press the [EDIT] main mode selection key again.

The program will be displayed on the screen.
### Frequently used keys

<table>
<thead>
<tr>
<th>Key</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENTER</td>
<td>Used to execute an operation.</td>
</tr>
<tr>
<td>OFF</td>
<td>Used to stop an operation.</td>
</tr>
<tr>
<td>ACK</td>
<td>Cancel key</td>
</tr>
<tr>
<td>HALT</td>
<td>Used to make a temporary stop.</td>
</tr>
<tr>
<td>RST</td>
<td>Restart</td>
</tr>
<tr>
<td>ST</td>
<td>Disables contact detection.</td>
</tr>
<tr>
<td>MFR 0 - 3</td>
<td>Used to select the table feed speed.</td>
</tr>
<tr>
<td>UN CLAMP (R type only)</td>
<td>Used to remove an SNT holder.</td>
</tr>
<tr>
<td>CLAMP (R type only)</td>
<td>Used to mount an SNT holder.</td>
</tr>
<tr>
<td>Return key</td>
<td>Return key (used to move to a new line in a program)</td>
</tr>
<tr>
<td>SPACE</td>
<td>Used to input a space equivalent to one character.</td>
</tr>
<tr>
<td>BS</td>
<td>Backspace key: deletes one character to the left of the current cursor position.</td>
</tr>
<tr>
<td>SHIFT</td>
<td>Used to input the upper character in the case of keys marked with upper and lower characters.</td>
</tr>
</tbody>
</table>

![Keyboard Diagram](image)
Commands and Basic Operations Used for Machining

<Program Input in the MDI Mode>

Procedure:

1) Select the manual mode by pressing the [M'AL] main mode selection key. The, press the [MDI] submode selection key.

2) Manually feed the electrode to the machining position.

3) Key in as indicated below.

   G80 Z−

   This will bring the electrode into contact with the top surface of the workpiece.

4) Key in as indicated below.

   G92 Z0

   This sets “0” as the Z coordinate for the actual position.

5) Key in as indicated below.

   G00 M05 Z1.0

   This moves the electrode 1 mm above the surface of the workpiece.

6) Key in as indicated below.

   G90 G54 G01 C***Z−5.0 M04

   This means “machine to −5.0 mm level on the Z-axis in the absolute coordinate system specified by G54”.

7) Key in M02.

   This ends machining.

8) Press the [ENT] key.

   The keyed in program is executed.

<Description of Codes>

G80: Feed until the contact detection function operates.

G92: Coordinate setting command

G00: Feed command

G90: Absolute coordinates

G54: Specifies work coordinate system 0

C***: Calls machining conditions

G01: Linear interpolation (machining command)

M04: Return to the machining start position.

M05: Disable the contact detection function.

NOTE: It is possible to input and execute simple programs in the MDI mode, but more complex programs have to be input in the edit mode and executed in the run mode.
MACHINING CONDITIONS

1 Description of Parameters

ON: Discharge pulse time

This parameter is used to set the pulse ON duration (the duration for which voltage is applied across the poles).

Setting of a larger value causes higher energy to be generated.

OFF: Pause duration

This parameter is used to set the pulse OFF duration (the duration for which voltage is not applied across the poles).

Setting of a larger value causes a longer pulse OFF duration, which stabilizes machining but decreases the machining speed.

MA: Pause duration magnification

This parameter is used to extend the pause duration by multiplying it by an integral value up to 10; it is adjusted in accordance with the machining status.

IP: Main power supply peak value

This parameter is used to set the peak value of the current to be supplied (current wave height value).

The energy of one pulse is determined by the setting for IP, V (main power supply voltage), and ON (discharge pulse time).

SV: Servo reference voltage

This parameter is used to set the servo reference voltage between the electrode and the workpiece.

The larger the set value, the higher the average machining voltage applied, which makes machining more stable but decreases the machining speed and increases the gap across which discharge occurs.

With the G type power supply unit, the voltage value is set directly.

UP: Jump ascent time

DN: Discharge continuation time (jump descent time)

LN: Pattern selection for LORAN operation

These parameters are used to set the pattern for LORAN operation, the LORAN plane and servo conditions, and the LORAN format.

STEP: Eccentric distance from the head center line for LORAN operation (2 to 9999)

This parameter is used to set the amount of orbiting motion in LORAN operation. The set value is the orbiting distance for one side.
PL: Polarity switching

This parameter is used to set the polarity of the electrode and the workpiece.

Example:

+: Reverse polarity (electrode is positive)

-: Normal polarity (electrode is negative)

V: Main power supply voltage

This parameter is used to set the main voltage.

It determines the energy of discharge pulses along with the IP parameter.

HP: Auxiliary power supply circuit

This parameter is used to select the auxiliary power supply according to the combination of materials and the purpose of machining.

PP: ON/OFF status of breaker circuit, selection of PIKADEN pulse

This is a discharge circuit that considerably reduces electrode wear in Cu - St.

C: Gap capacitor circuit

This parameter is used to select the capacitor circuit. This gives the pulse impact, giving it the exceptional power required for machining such as fine hole machining and machining of cemented carbide.

For no-wear machining with systems such as Cu-St, this parameter must be set to zero (C = 0).

S: Servo speed

This parameter sets the axis speed for infeeding the electrode. It is normally set in the range 1 to 3.

L: LORAN speed

This parameter sets the speed for orbiting motion. It is usually set in the range 1 to 3.

LP: Quadrant LORAN pattern

This parameter enables you to set different LORAN patterns for each quadrant.
APPENDIX I

EPMA Analysis Print Out
<table>
<thead>
<tr>
<th>Elt.</th>
<th>Conc. (wt%)</th>
<th>Norm Conc. (wt%)</th>
<th>Norm Conc. (at%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>O</td>
<td>0.7815</td>
<td>0.6217</td>
<td>1.3974</td>
</tr>
<tr>
<td>Sn</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>Cu</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>Zn</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>Pb</td>
<td>0.0451</td>
<td>0.0474</td>
<td>0.0062</td>
</tr>
<tr>
<td>Si</td>
<td>0.4336</td>
<td>0.4360</td>
<td>0.4337</td>
</tr>
<tr>
<td>El</td>
<td>0.1243</td>
<td>0.1367</td>
<td>0.0170</td>
</tr>
<tr>
<td>Mg</td>
<td>0.5477</td>
<td>0.5758</td>
<td>0.6446</td>
</tr>
<tr>
<td>Al</td>
<td>90.9020</td>
<td>95.5789</td>
<td>96.3843</td>
</tr>
<tr>
<td>Mn</td>
<td>0.0007</td>
<td>0.0008</td>
<td>0.0004</td>
</tr>
<tr>
<td>Fe</td>
<td>0.0351</td>
<td>0.0369</td>
<td>0.0186</td>
</tr>
<tr>
<td>Cr</td>
<td>2.1542</td>
<td>2.2650</td>
<td>1.0457</td>
</tr>
<tr>
<td>Mo</td>
<td>0.0103</td>
<td>0.0106</td>
<td>0.0031</td>
</tr>
<tr>
<td>Ag</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>V</td>
<td>0.0403</td>
<td>0.0424</td>
<td>0.0226</td>
</tr>
<tr>
<td>Ti</td>
<td>0.0269</td>
<td>0.0219</td>
<td>0.0124</td>
</tr>
<tr>
<td>Ni</td>
<td>0.0091</td>
<td>0.0096</td>
<td>0.0044</td>
</tr>
<tr>
<td>Sb</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
<tr>
<td>Cd</td>
<td>0.0000</td>
<td>0.0000</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

**Total:** 95.1668   100.0000   100.0000

- be careful, strong correction for C { 0.00}
- be careful, strong correction for Sn { 0.00}
- be careful, strong correction for Cu { 0.00}
- be careful, strong correction for Zn { 0.00}
- be careful, strong correction for Ag { 0.00}
- be careful, strong correction for Cr { 0.00}
- be careful, strong correction for Sb { 0.00}
- be careful, strong correction for Cd { 0.00}