Roland DG

COMPUTER AIDED MODELING MACHINE

CAMM-3

MODEL PNC-3000

USER'S MANUAL

ROLAND DG CORPORATION

WARNING
To reduce the risk of fire or electric shock, do not expose this appliance to rain, water or wet locations.

Warning

This equipment has been certified to comply with the limits for a Class B computing device, pursuant to Subpart J of Part 15 of FCC Rules. Only Computers certified to comply with the Class B limits may be attached to this equipment. Operation with non-certified computing device is likely to result in interference to radio and TV reception.

Radio and Television Interference

The equipment described in this manual generates and uses radio-frequency energy. If it is not installed and used properly, that is, in strict accordance with our instructions, it may cause interference with radio and television reception.

This equipment has been tested and complies with the limits for a Class B computing device in accordance with the specifications in Subpart J, Part 15, of FCC rules. These rules are designed to provide reasonable protection against such interference in a residential installation. However, there is no guarantee that the interference will not occur in a particular installation, especially if you use a "rabbit ear" television antenna. (A "rabbit ear" antenna is the telescoping-rod type usually contained on TV receivers.)

You can determine whether your computer is causing interference by turning it off. If the interference stops, it was probably caused by the computer or its peripheral devices. To further isolate the problem:

- Disconnect the peripheral devices and their input/output cables one at a time. If the interference stops, it is caused by either the peripheral device or its I/O cable. These devices usually require shielded I/O cables. For Roland DG peripheral devices, you can obtain the proper shielded cable from your dealer.

If your computer or its peripheral devices does cause interference to radio or television reception, you can try to correct the interference by using one or more of the following measures:

- Turn the TV or radio antenna until the interference stops.
- Move the computer or its peripheral devices to one side or the other of the TV or radio.
- Move the computer or its peripheral devices farther away from the TV or radio.
- Plug the computer or its peripheral devices into an outlet that is on a different circuit than the TV or radio. (That is, make certain the computer or its peripheral devices and the radio or television set are on circuits controlled by different circuit breakers or fuses.)
- Consider installing a rooftop television antenna with coaxial cable lead-in between the antenna and TV.

If necessary, you should consult your dealer or an experienced radio/television technician for additional suggestions. You may find helpful the following booklet, prepared by the Federal Communications Commission.:

"How to Identify and Resolve Radio-TV Interference Problems"

This booklet is available from the U.S. Government Printing Office, Washington, DC 20402, stock number 004-000-00345-4.

1 THE CAMM-3 CONCEPT 1-1

The Roland DG CAMM-3 (Computer Aided Modeling Machine) is a compact, personal-use modeling machine which allows the designer to try out ideas in three dimensional form with the same data and programs used for drawing plans on an X-Y plotter. Other interesting applications for the CAMM-3 include letter engraving, PC board drilling, small lot production, and various jobs that would normally require expensive NC production machinery.

The potential of the CAMM-3 depends greatly upon the tools and materials it is used with. The word "tools," in this case, takes on a wide meaning. Software, the use of other peripherals (such as an X-Y plotter), clamps, vises and cutting tools all have a strong effect upon the efficiency and capability of the CAMM-3.

Roland DG offers a line of optional accessories including: straight and ball end type end mills, a spindle unit to chuck drill bits, machine wax (for modeling), a machine vise, data buffer unit and others. As in the case of the spindle unit for drill bits, many of these accessories are necessary to perform certain operations with the CAMM-3. If you do not already have such tools on hand, we strongly recommend that you study the list of options in chapter III, and make your selection of basic tools.

The CAMM-3 can model, drill or engrave plastics, wax, wood, even aluminum and brass. But it must be said here that the CAMM-3 is not a heavy-duty piece of equipment that can endure factory use or turn out hard metal parts with the ease of an NC milling machine or machining center. The compact, easy-to-use CAMM-3 has been designed with the personal computer user in mind. Thus, the user who is accustomed to turning out steel parts on larger equipment will have to put experience gained on such machinery aside and approach the CAMM-3 from the viewpoint of a designer at work at a drafting board. This is especially true when writing programs for the CAMM-3.

Read this manual well and understand the capabilities of the CAMM-3 before you begin to use it. If you do, you will soon reap the benefits of "personalized" computer-aided design and modeling.

1. THE CAMM-3 AND STANDARD ACCESSORIES

(1) Setting up the CAMM-3

If you have not set up the CAMM-3 according to the directions in the instruction sheet entitled "READ BEFORE UNPACKING" that came with packed together with your unit, Set it up according to the following instructions.

— NOTE —
The CAMM-3 is HEAVY. Two people will be needed to unpack it. Be sure that you have a suitable place for the CAMM-3 before you unpack it. You will need a strong, level table placed near an electrical outlet. An area of at least 68 by 58 centimeters will be necessary. Make sure there is enough room for the CAMM-3 to operate safely! Once you have measured your surface and found it to be suitable, continue to follow the instructions below.

① It is assumed that you have opened the box that the CAMM-3 has come in from the top. Lift off the styrofoam packing placed on top of the CAMM-3.

② Remove the cardboard and styrofoam enclosure from around the unit together with the accessories attached to the inside of it. Place the accessories aside in a safe place.

③ Note the 4 carrying bolts; 2 in front and 2 in back. With one person at each end of the unit, grab the carrying bolts and lift the unit out of the box. Place it on the floor.

④ Note the 2 boards on either side of the CAMM-3's X-Y table, held to the plywood packing base with 4 nuts. Unscrew the nuts and remove the boards.

⑤ Now the CAMM-3 can be lifted and placed where desired.

⑥ Once the CAMM-3 is in place, unscrew the 4 carrying bolts from the front and the back of the unit. Keep these carrying bolts in a safe place, you will need them the next time you move the CAMM-3. Keep all packing materials for safe and convenient transportation in the future.

⑦ The 2 axis motors should be connected properly. The X axis motor cord originates from under the X-Y table. The Y axis motor cord originates from the rear of the bottom of the unit.

— CAUTION —
If these cords are not connected correctly, the unit may be damaged upon operation.

⑧ Connect the controller panel cord to the connector marked "control panel."

— CAUTION —
Don't touch any of the controls on the controller panel except the one you will be instructed to press later.

⑨ The controller panel is held to the front of the unit with magnets. Use it unattached, or attach it to the unit if you wish.

⑩ Find the red button on the Display panel marked EMERGENCY STOP. This button will stop the CAMM-3 and reset it no matter what operation is being performed.

⑪ Connect the power cable to the connector on the lower right hand side of the unit.

⑫ Plug in the power cable.

⑬ Stand to one side and turn on the unit with the power switch on the lower right hand side of the unit. You may hear the sound of the spindle motor turning for an instant and then stopping.

— CAUTION —
Should you, by chance, press a key on the controller panel and cause the CAMM-3 to move by mistake, press the EMERGENCY STOP button IMMEDIATELY.

⑭ Your next task is to remove the styrofoam block from the X-Y table. Being very careful not to touch any other button on the controller panel, find the +Z key in the JOG area of the controller panel.

⑮ You will now raise the spindle unit of the CAMM-3 to remove the styrofoam block. Press the +Z key of the JOG section of the control panel. The spindle unit will begin to rise. Release the key once the styrofoam block is cleared.

⑯ Remove the styrofoam block.

⑰ Turn the CAMM-3 off. DON'T ATTEMPT TO USE THE CAMM-3 WITHOUT STUDYING THIS USER'S MANUAL THOROUGHLY.

(2) Checking the CAMM-3 and Standard Accessories

a. Packing Materials

1 Box
1 Plywood Base
4 Bolts
4 Nuts
2 Boards (to secure table)
1 Protective Cardboard/Styrofoam Encasement
1 Protective Cardboard/Styrofoam Top

Keep all packing materials for transportation of the CAMM-3.

b. Standard Accessories

Packed together with your CAMM-3 unit are the following standard accessories:

ITEM	USE
1 ϕ6 Collet Chuck	To hold tools (end mills) in spindle unit.
1 Tool Kit	This kit contains various tools for the changing of tools and spindle units.
1 AC Cord	Power cord.
4 Carrying Bolts	To move the CAMM-3.
1 Sensor Switch	For positioning the cutting tools before running the CAMM-3.
2 Fuses	Spare fuses.
4 AC Motor Brushes	Spare Brushes. Don't attempt to replace these by yourself.
2 T Nuts	To fix vises or jigs to X-Y table.
1 User's Manual	Source of specifications and proper procedure.
1 CAMM-GL1 Command Reference Manual	CAMM-GL1 command list and programming information included for easy reference.
1 Maintenace Manual	For sevicing personnal.

Check to see if all of these standard accessories have arrived together with your unit. You will need them for regular use.

(3) A Word About Safety

With proper use, the CAMM-3 is a safe, easy-to-use Computer Aided Modeling Machine. However, when used incorrectly, it can be very dangerous!

To be able to cut, mill, bore and engrave light metals such as aluminum, it is necessary to apply a great deal of force. The cutting tools the CAMM-3 uses are sharp and spin at very high speeds. They can easily cause injury if the proper care is not taken during operation.

The safe way to operate the CAMM-3 is the right way. Proper care, use and maintenance of your unit will also lead to better, more precise work. Here are some important things to remember:

a. GROUNDING INSTRUCTION

[WARNING]
In the event of a malfunction or breakdown, grounding provides a path of least resistance for electric current to reduce the risk of electric shock. This tool is equipped with an electric cord having an equipment-grounding conductor and a grounding plug. The plug must be plugged into a matching outlet that is properly installed and grounded in accordance with all local codes and ordinances.

Do not modify the plug provided—if it will not fit the outlet, have the proper outlet installed by a qualified electrician.

Improper connection of the equipment-grounding conductor can result in a risk of electric shock. The conductor with insulation having an outer surface that is green with or without yellow stripes is the equipment-grounding conductor. If repair or replacement of the electric cord or plug is necessary, do not connect the equipment-grounding conductor to a live terminal.

Check with a qualified electrician or service personnel if the grounding instructions are not completely understood, or if in doubt as to whether the tool is properly grounded.

Use only 3-wire extension cords that have 3-prong grounding plugs and 3-pole receptacles that accept the tool's plug.

Repair or replace damaged or worn cord immediately.

b. CAMM-3 INSTRUCTION

[WARNING]

1. **KEEP GAUGES IN PLACE** and in working order.
2. **REMOVE ADJUSTING KEYS AND WRENCHES.** Form habit of checking to see that keys and adjusting wrenches are removed from tool before turning it on.
3. **KEEP WORK AREA CLEAN.** Cluttered areas and benches invite accidents.
4. **DON'T USE IN DANGEROUS ENVIRONMENT.** Don't use power tools in damp or wet locations, or expose them to rain. Keep work area well lighted.
5. **DON'T FORCE TOOL.** It will do the job better and safer at the rate for which it was designed.
6. **USE RIGHT TOOL.** Don't force tool or attachment to do a job for which it was not designed.
7. **WEAR PROPER APPAREL.** Do not wear loose clothing, gloves, neckties, rings, bracelets, or other jewelry that might get caught in moving parts. Nonslip footwear is recommended. Wear protective hair covering to contain long hair.
8. **ALWAYS USE SAFETY GLASSES.** Everyday eyeglasses only have impact resistant lenses, they are NOT safety glasses. Also use face or dust mask if cutting operation is dusty.
9. **SECURE WORK.** Use clamps or a vise to hold work when practical. It's safer than using your hand and it frees both hands to operate tool.

10. **DON'T OVERREACH.** Keep proper footing and balance at all times.

11. **MAINTAIN TOOLS WITH CARE.** Keep tools sharp and clean for best performance and to reduce the risk of injury to persons. Follow instructions for lubricating and changing accessories.

12. **TURN POWER OFF** before servicing; when changing accessories, such as blades, bits, cutters, and like.

13. **REDUCE THE RISK OF UNINTENTIONAL STARTING.** Make sure power switch is in off position before plugging in.

14. **USE RECOMMENDED ACCESSORIES.** Consult the user's manual for recommended accessories. The use of improper accessories may cause risk of injury to persons.

15. **NEVER STAND ON TOOL.** Serious injury could occur if the tool is tipped or if the cutting tool is unintentionally contacted.

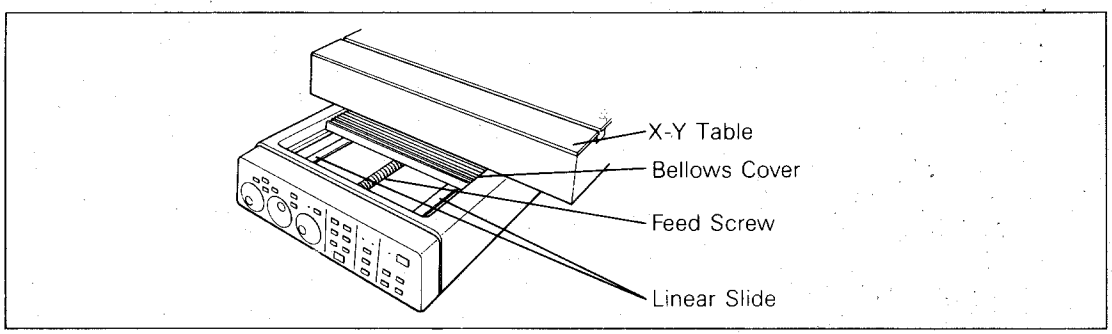
16. **CHECK DAMAGED PARTS.** Before further use of the tool, a guard or other part that is damaged should be carefully checked to determine that it will operate properly and perform its intended function—check for alignment of moving parts, binding of moving parts, breakage of parts, mounting, and any other conditions that may affect its operation. A guard or other part that is damaged should be properly repaired or replaced.

17. **NEVER LEAVE TOOL RUNNING UNATTENDED. TURN POWER OFF.** Don't leave tool until it comes to a complete stop.

(4) Maintenance

a. User Maintenance

After finishing operating the CAMM-3, first clean all around it with a cleaner. Then open the bellows cover on the base and clean inside of the base with a cleaner thoroughly and carefully as metal dust, if left, will deteriorate the mechanical system. Also, apply grease to the feed screw and linear slides by moving the X-Y table so that grease is applied all along each part. But be sure to keep the power switch OFF except when moving the table.



If the unit body is stained, wipe clean with a cloth damped with water or detergent. So much is for user maintenance. It is not necessary to lubricate any parts other than as described above. Be sure not to attempt opening any place except the pulley cover and the bellows cover on the base as it will lead to a danger.

b. Servicing

The CAMM-3 should be serviced after every 250 hours of use to prevent the gradual attrition of parts. On such occasions the Maintenance Manual and Motor Brush should be made available to servicing personnal. Failure to have the CAMM-3 regularly serviced may lead to operating difficulties.

Remember, your safety, the quality of your work, and the life of your tools depend on your attitude. Respect your work and your tools.

1. A GENERAL DESCRIPTION

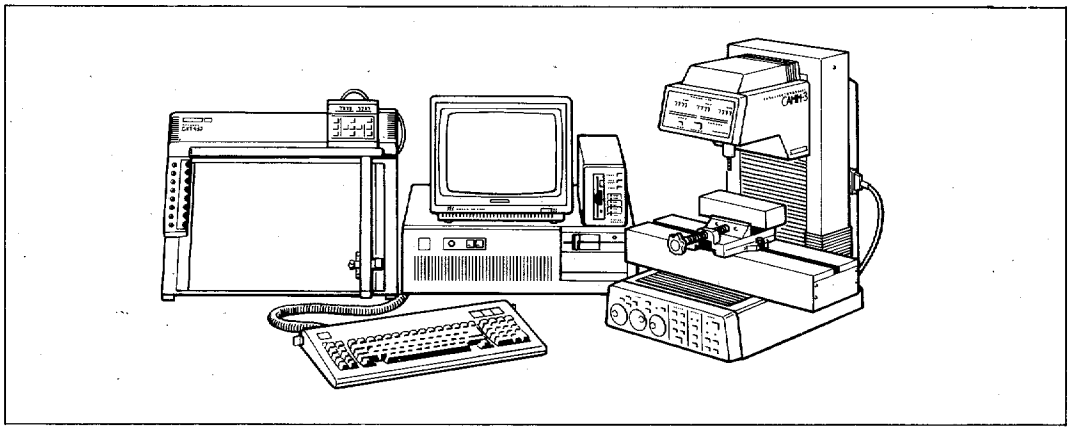
(1) The Meaning of "Modeling"

The CAMM-3 has many capabilities as a compact, computercontrolled piece of production machinery. Manual controls are sufficient to move the CAMM-3 without external control (as in the case of "teaching"), and with light materials it can even produce small lots of certain items. But the CAMM-3 should not be misunderstood as a small version of its big brother, the NC milling machine. As its name suggests, it performs best as a Computer Aided Modeling Machine.

Modeling is best performed with industrial wax, and does not produce a "usable" object. The wax models made on the CAMM-3 aid in the revision of CAD-produced plans drawn on another relative of the CAMM-3 — the X-Y plotter. While experimenting with designs and modifications, it is not likely that work can be completed in one ideal process of steps. It usually takes many remakes and checks of the model.

In the designing process, the most inefficient use of time occurs during the gap between the completion of the blueprint and the production of a prototype or some kind of model. Consider the case in which a blueprint is completed by in-house designers and then given to another company that specializes in the making of prototypes. The time it takes to complete the work can range from days to weeks — not to mention the extra cost involved. In such cases months can pass before completion of the design. The design/prototype testing process can become a large barrier in the effort to improve the efficiency of the R&D process.

The CAMM-3 CAD/CAM system allows the designer to see his or her ideas take shape immediately on the monitor screen, in the form of blueprints on the X-Y plotter, and as a 3D model on the CAMM3.



There are objects whose design can be verified with the exact dimensions as they appear on 2 dimensional blueprints. But there are also objects that require modification due to aspects that do not appear on paper. Mating surfaces and corners must be tried out or felt to be sure the design of the piece is correct. With the CAMM-3 the actual object is made — allowing the designer to spot mistakes and inconveniences in the design easily.

Also, ordering out for prototype work can result in leaks in corporate security. The use of the CAMM-3 can avoid this danger and produce merits that cannot be valued in monetary terms.

The CAMM-3 is not for the large scale CAD/CAM system. It is a small modeling machine that becomes an extension of the designer. It creates a personal design development system.

(2) Computer Control

It is best to think of the CAMM-3 as an extension of your X-Y plotter. It is moved by commands that are identical to plotter commands. Capabilities such as scaling and character engraving are controlled the same way as they are with an X-Y plotter.

a. Graphic Language Intelligence

The CAMM-3 has built-in intelligent functions. These can be used with the user's own programs or through commercial software. For more information on these functions, refer to the CAMM-GL1 command list in the CAMM-GL1 Command Reference Manual.

1) SCALING/WINDOWING
With these functions it is possible to scale the cutting area up or down, or take pieces out of the blueprints made on the computer in order to fit the actual size of the modeling material.

2) INTERNATIONAL FONT SET
The font set includes: Katakana and Hiragana (Japanese); English; German; French; Scandinavian; Spanish; etc.; for easy letter engraving.

3) LETTER SIZE/SLANT/ROTATION
Letters can be slanted, enlarged, rotated and elongated (height or width) easily.

4) SHAPES
Short commands are used to cut curves, circles and other shapes. Hatching capability makes it simple to cut away large areas of material with a minimum of commands.

b. 3 Dimensional and 2.5 Dimensional Operations

Operations done with the CAMM-3 can be classified in two categories: 3 dimensional and 2.5 dimensional. 3 dimensional operations require the movement of all three axes at the same time. The CAMM-3 can perform 3 dimensional operations only in straight lines. This is called "three dimensional linear interpolation" in NC terminology. The CAMM-3 does this with its manual controls in data input mode, and with the computer using the "Z" command. Although movement is in straight lines, with the proper algorithm it is possible to produce wave shapes by repeating the "Z" command many times.

However, there are times, especially when modeling, when the operator wishes to use X-Y (2 dimensional) data to cut with. X-Y plotter data and commands alone are sufficient to move the X-Y table of the CAMM-3, but the cutting tool must be moved to the proper depth. This is done with the "@" command or manual setting of the cutting tool. X-Y data is used to cut "steps" into the material. Such operations are called "2.5 dimensional operations." For more information about the software capabilities of the CAMM-3, consult the CAMM-GL1 Command Reference Manual.

(3) Data Input Mode (Teaching)

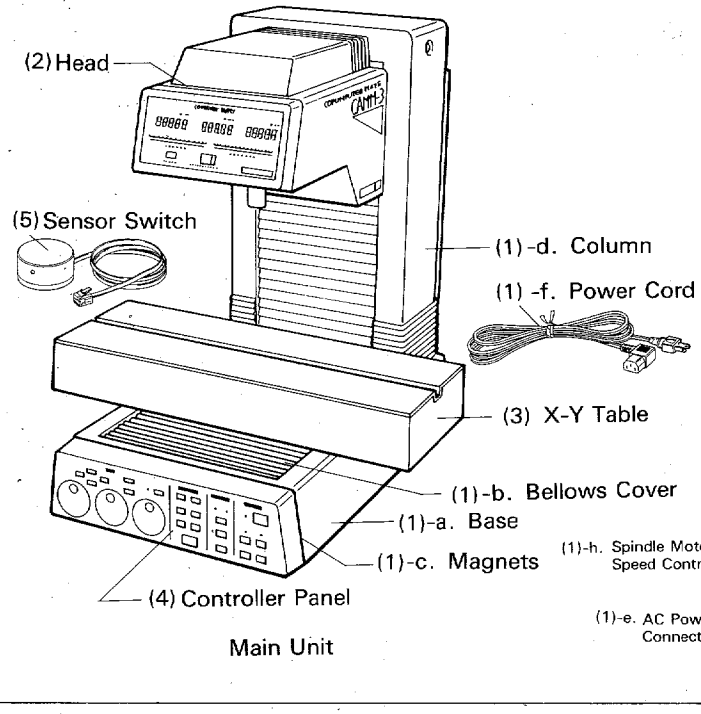
When the CAMM-3 is in the data input mode, 160 positions can be written into the memory and used to move the CAMM-3. These positions are lost when the power is turned off. One of the advantages that teaching has is that the operator can see what and how the material will be cut. In the case of programs it is more difficult to imagine the results. Teaching can also be used for simple operations such as re-surfuracing materials. Character engraving, however, is not possible with the data input mode. More information about procedure in data input mode can be found in chapter 4.

(4) Interfaces

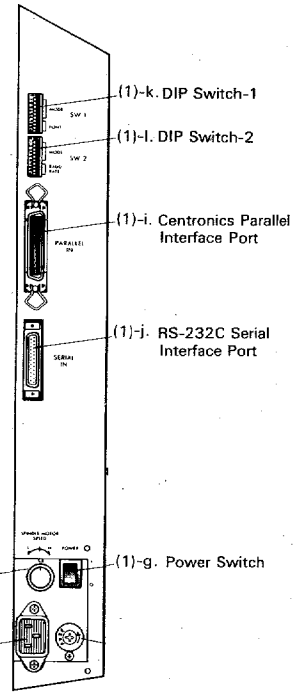
The CAMM-3 has both a Centronics parallel interface and an RS-232C serial interface. These interfaces are used to allow the CAMM-3 to be included in a variety of personal CAD/CAM systems. Data transmission to the CAMM-3 is possible from different computers with the optional connecting cables. Make sure you have the correct cable for your computer. More information about interfacing the CAMM-3 can be found in chapter 4.

2. FUNCTIONS

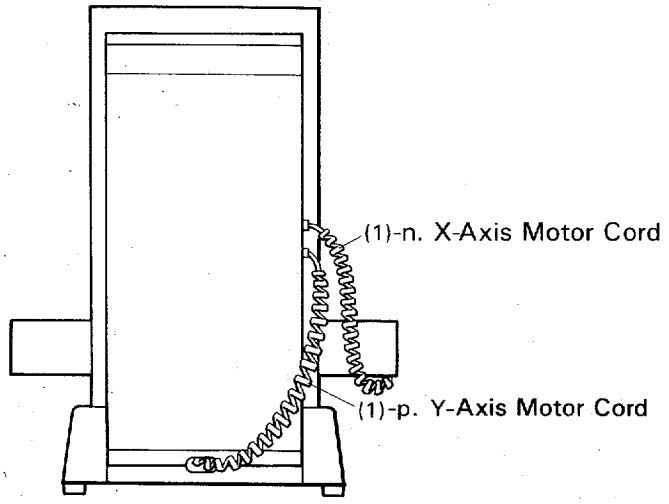
(1) Main Unit

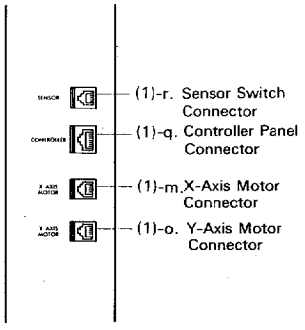


Main Unit



Right Side of Main Unit





Left Side of Main Unit

(1)-a. Base
Supports X-Y table and column. Screw and slideways under bellows cover must be greased periodically.

(1)-b. Bellows Cover
Keeps dust and cuttings off of screw.

(1)-c. Magnets
Hold Controller Panel to Base.

(1)-d. Column
Supports head. Contains control circuits.

(1)-e. AC Power Connector
Power cord is connected here.

(1)-f. Power Cord

(1)-g. Power Switch
Turns the CAMM-3 on and off. When this switch is turned on, the spindle may turn for an instant and then stop. Keep hands off of the spindle when turning this switch on.

(1)-h. Spindle Motor Speed Control
Controls the speed (rpm) of the spindle motor. In other words, it controls the spinning speed of the cutting tool.

(1)-i. Centronics Parallel Interface Port
For parallel connection to computer of SYA-350 buffer unit.

(1)-j. RS-232C Serial Interface Port
For serial connection to computer of SYA-350 buffer unit.

(1)-k. DIP Switch 1

(1)-l. DIP Switch 2

(1)-m. X Axis Motor Connector
Where axis X motor cord only is connected.

(1)-n. X Axis Motor Cord
Connects X axis motor to power source.

(1)-o. Y Axis Motor Connector
Where axis Y motor cord only is connected.

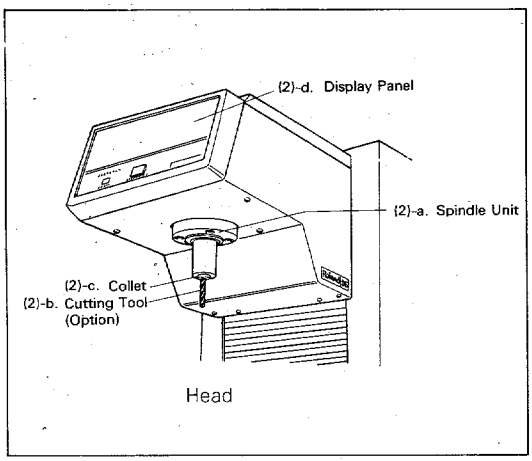
(1)-p. Y Axis Motor Cord
Connects Y axis motor to power source.

(1)-q. Controller Panel Connector
Where controller panel cord only is connected.

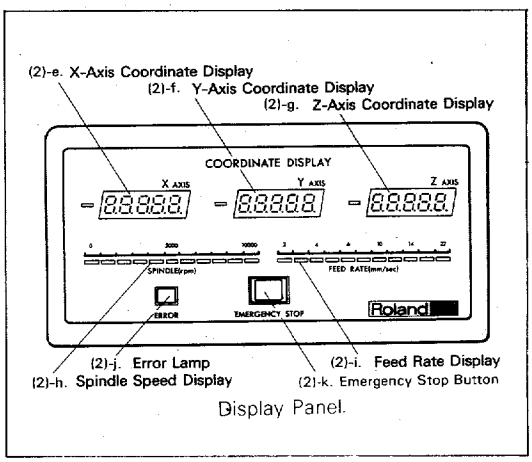
(1)-r. Sensor Switch Connector
Where the sensor switch cord only is connected.

(2) Head

The head contains the spindle. Head movement is Z axis movement. The movement of the head can be controlled manually with the Z axis JOG controls of the controller panel.



Head



Display Panel

(2)-a. Spindle Unit
The standard spindle unit can accommodate only tools held by a collet chuck. A ϕ 6 collet chuck is provided as standard equipment along with the tools needed to loosen and change it. A drill chuck equipped spindle unit is available for chucking drill bits only.

(2)-b. Cutting Tool (end mill)
The cutting tool used most often for modeling the end mill. Many different types of tools can be used.

(2)-c. Collet Chuck
The standard collet chuck is for tools of a diameter of 6mm. Other collet chucks are available. Be sure to have a collet chuck for all tools that you wish to use with the standard collet chuck spindle unit.

(2)-d. Display Panel
Shows the current position of the cutting tool and the status of the CAMM-3.

(2)-e. X Axis Coordinate Display
Shows current X axis coordinate in units of 0.01mm.

(2)-f. Y Axis Coordinate Display
Shows current Y axis coordinate in units of 0.01mm.

(2)-g. Z Axis Coordinate Display
Shows current Z axis coordinate in units of 0.01mm.

(2)-h. Spindle Speed Display
Shows current speed (rpm) of spindle (cutting tool).

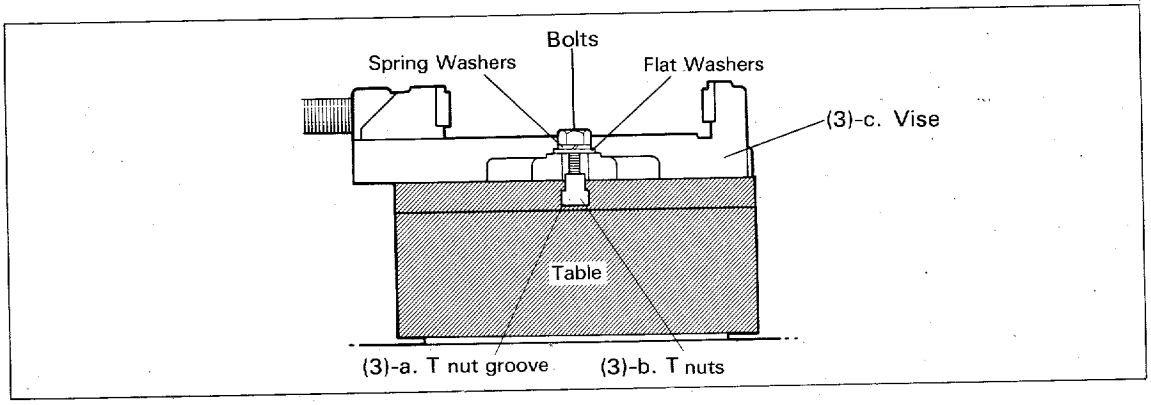
(2)-i. Feed Rate Display
Shows current feed rate (mm/sec). Shows feed rate setting when CAMM-3 is not moving and actual speed when moving. Also used to display type of error.

(2)-j. Error Lamp
Lights up in cases of errors.

(2)-k. Emergency Stop/Reset Button
Used to stop the CAMM-3 in case of emergency. This button also resets the CAMM-3 and clears its memory.

(3) X-Y Table

Facing the CAMM-3, left/right table movement is X axis movement — front/back movement is Y axis movement. The movement of the table can be controlled manually with the X and Y axis JOG controls of the controller panel.



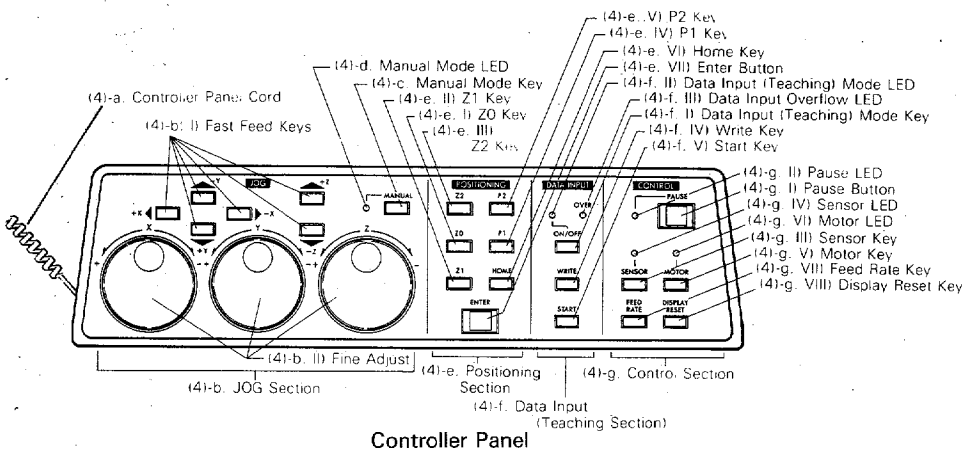
(3)-a. T Nut Groove
Holds T nuts that are used to secure vises, jigs, clamps, and other devices that hold the material to be cut.

(3)-b. T Nuts
Turned upside-down, these slide into the groove of the table and are used to secure vises, jigs, clamps, and other devices that hold the material to be cut.

(3)-c. Vise (option)
Sold separately, this vise has been designed especially for the CAMM-3. The CAMM-3 can use a variety of vises and jigs.

(4) Controller Panel

Removable for remote control. Remote control becomes necessary at times when the base is obstructed by large objects, clamps, jigs, etc., that are secured to the table.



Controller Panel

(4)-a. Controller Panel Cord
Connects controller panel to control circuits in the column.

(4)-b. JOG Section
The fast feed keys and fine adjust dials in this section control the movement of the CAMM-3 along X, Y and Z axes. These keys and dials are only effective in manual mode.

I) Fast Feed Keys
Move the X-Y table and head rapidly. In sensor mode the speed of these keys is slowed for safe positioning.
+X — X-Y table movement left.
−X — X-Y table movement right.
+Y — X-Y table movement front.
−Y — X-Y table movement back.
+Z — Head movement up.
−Z — Head movement down.

II) Fine Adjust Dials When moved slowly, each click of these dials will move the X-Y table or head 0.01mm.

(4)-c. Manual Mode Key Puts the CAMM-3 in manual or computer control mode. Clears memory when held for longer than 0.5 seconds while CAMM-3 is being paused (see pause button).

(4)-d. Manual Mode LED When this is lit the CAMM-3 is in manual mode.

(4)-e. Positioning Section The keys in this section are used for scaling, homing and positioning the CAMM-3. These keys are effective only in manual mode.

I) Z0 Key
Used with the enter button to define the current Z axis position as the origin of the Z axis of the work coordinate system. When pressed alone the cutting tool will lower slowly to this position.

II) Z1 Key
Used with the enter button to define the current Z axis position as the level to which the cutting tool should lower to to cut. When pressed alone for more than 0.5 seconds the cutting tool will start to spin and move slowly to this position. When at this position, the cutting tool will start to spin.

III) Z2 Key
Used with the enter button to define the current Z axis position as the level to which the cutting tool should rise to clear the material being cut. When pressed alone the cutting tool will move slowly to this position.

IV) P1 Key
Used with the enter button to define the current X and Y axis positions as the coordinates of the origin of the work coordinate system. When pressed alone for more than 0.5 seconds the X-Y table will move to this position.

V) P2 Key
Used with the enter button to define the current X and Y axis positions as the coordinates of the farthest point on the X-Y plane of the work coordinate system. When pressed alone for more than 0.5 seconds the X-Y table will move to this position.

VI) Home Key
Used with the enter button to define the current X, Y axis positions as the home position. When pressed alone for more than 0.5 seconds and X-Y table will move to this position, and the cutting tool will move to the origin of the work coordinate.

VII) Enter Button
Used with other keys of the positioning section to define the current position of the CAMM-3 as positioning data.

(4)-f. Data Input (Teaching) Section
The keys in this section are used to "teach" positions to the CAMM-3, by writing them into its memory, and then have the CAMM-3 run through them in the order they were input. These keys can only be used in the manual mode.

I) Data Input (Teaching) Mode Key
Puts CAMM-3 into the data input (teaching) mode. Also used with feed rate key to change the feed rate of the Z axis.

II) Data Input (Teaching) Mode LED
When this LED is lit the CAMM-3 is in the data input (teaching) mode. Blinks when X-Y coordinates input are minus.

III) Data Input Overflow LED
When the memory is full (160 positions) this LED is lit.

IV) Write Key
Used to write the current position (X, Y, Z) into the memory. With enter button, this key will erase the last position taught.

V) Start Key
Effective only in teaching mode. Used to start the run of the CAMM-3 through the positions "taught" in the data input mode. When pressed, the tool will be raised, and the CAMM-3 will run through all positions taught.

(4)-g. Control Section

The keys and button in this section are used to control the non-axis-related capabilities of the CAMM-3.

I) Pause Button
Used to pause the operation of the CAMM-3 in either computer control or manual mode. Also used to cancel errors and with the manual key to clear the CAMM-3 buffer of all positions taught. When pressed, the current operation will be completed and the CAMM-3 will stop all movement. This button does not halt the CAMM-3 immediately. While the CAMM-3 is paused with this button, the sensor key, feed rate key, motor key and display reset key are all effective. To continue movement, press the pause button again.

II) Pause LED
When the pause button has been pressed and the CAMM-3 has been paused, this LED will stay lit. While this LED is lit, the sensor key, feed rate key, motor key and display reset key are all effective and the CAMM-3 buffer can be cleared by pressing the manual key for more than 0.05 seconds. Blinks when an error has occurred.

III) Sensor Key
Used to put the CAMM-3 in and out of the sensor positioning mode.

IV) Sensor LED
While this LED is lit, the CAMM-3 is in the sensor positioning mode.

V) Motor Key
Used to start or stop the spindle motor in manual mode. Press more than 0.05 seconds.

VI) Motor LED
While this LED is lit, the spindle motor is running.

VII) Feed Rate Key
Used with pause button to change the feed rate for all X and Y axes. Used with pause button and data input mode key to change feed rate for Z axis.

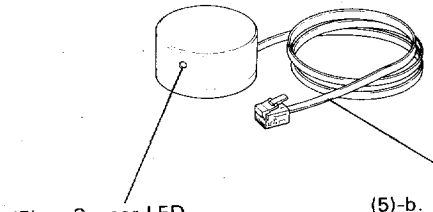
VIII) Display Reset Key
Used to set all coordinate displays to 0. Use of this key does not effect any other settings. To return the display to the work coordinate system, home the CAMM-3 and press this key again.

(5) Sensor Switch

Used to aid in accurate and simple cutting tool positioning. Take care not to use this switch with delicate tools such as the character engraving tool.

(5)-a. Sensor LED Lights when contact with the cutting tool has been made.

(5)-b. Sensor Cord Attached to sensor connector on column.



3. PREPARATIONS FOR USE

Before you use the CAMM-3, read the precautions listed in the previous chapter.

(1) Working Environment

TEMPERATURE
The CAMM-3 can operate in an environmental temperature from 0°C to 40°C. However, it is best to keep it at normal room temperature. If the room you are using the CAMM-3 in has been cold for more than an hour, it wouid be best to warm it before operating it.

WORKING AREA
Clear the area around the CAMM-3 so that the X-Y table and the head have enough room to move without hitting anything. Have on hand a small vacuum cleaner or whisk broom to clean cuttings that will result from operation. Be sure you are dressed properly.

(2) Installation

SUPPORT
Be sure that the table you place the CAMM-3 on is strong enough to hold it. It weighs 55 kilograms and vibration results from spindle and X-Y table movement during operation.

COMPUTER CONNECTIONS
Be sure all connections with the host computer and/or the SYA-350 data buffer unit are in order before you turn on the CAMM-3.

POWER
If the power cord is not connected, connect it to the connector at the base of the column on the right hand side first, then plug it into the electrical outlet.

[WARNING]
The spindle unit may start up and turn for an instant when you turn on the power switch. **STAY AWAY FROM THE SPINDLE UNIT** and turn on the CAMM-3.

(3) Transportation

Be sure to keep the CAMM-3 upright when moving it. Use the carrying bolts provided.

SHORT DISTANCES
Use the four carrying bolts to carry the CAMM-3. Carrying the CAMM-3 any other way is very difficult and dangerous. Two people are needed to carry it. Disconnect and remove the controller panel to screw in the two front bolts into the base. The other two bolts go into the base at the bottom of the column.

LONG DISTANCES
Disconnect and remove the controller panel to screw in the two front bolts into the base. The other two bolts go into the base at the bottom of the column. To store the CAMM-3 or transport it long distances use the packing materials it came with. Put the bolts through the hole in the plywood base. Place the CAMM-3 on the plywood base with the bolts in the board on either side of the base. Place the two thin boards on either side of the table and secure them onto the bolts with the 4 nuts. Lift the CAMM-3 with the carrying bolts and lower it carefully into the box. Place the standard accessories in their places in the protective cardboard and styrofoam encasement and place the encasement around the CAMM-3. Place the cardboard and styrofoam top on the enclosure and close the flaps of the box.

(4) Tools

Be sure your tools are in proper condition before using them. Also be sure that you have all the tools that you will need before you begin. In the case of the character engraving tool, you will probably need more than one, as it tends to wear out.

Do you have all the tools necessary to change tools? Collet chuck wrench, allen wrenches, etc. Do you plan to change spindle units?

(5) Attachments and Attaching

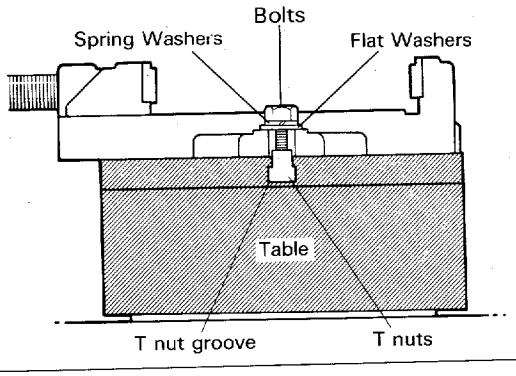
a. Power Cord
When connecting the power cord, be sure that you connect the connector end before plugging it in.

b. Connecting Cables
Check to see if all computer connections and buffer have been made with the correct cables.

c. Axis Motor Cables
Be sure that the cords for the axis motors are connected to the proper connector on the column. Misconnection could result in damage to the machine.

* The X axis motor cord comes from under the X-Y table.
* The Y axis motor cord comes from the hole at the base of the column.

d. Options
I) Vise
The Roland DG machine vise comes equipped with special T nuts. Be sure to use these T nuts to attach the vise to the X-Y table. They will assure a secure, level fit. The inner plates of the jaw of this vise are level with the X-Y table and any material placed in them will also be level and off of the base of the vise so that holes can be drilled through the material.



* Turn the T nuts upside-down and slide the bolts through the holes on either side of the vise.
* Place the flat washers on first, then the spring washers.
* Twist the nuts on to the bolts.
* Slide the T nuts into the T nut groove in the X-Y table.
* Locate the vise in the desired place and tighten the nuts.

II) Spindle Units

Spindle units can be changed. Be sure you have the standard tool kit on hand for this operation if necessary. The tool kit will also be necessary for changing tools that use the collet chuck. Make sure that you also have all collet chucks on hand that you will need. The method of changing the spindle unit is descrived in the "ZS-1 Spindle Unit For Drilling Instruction Manual" suplied with the ZS-1.

III) Optional End Mills and Character Cutter

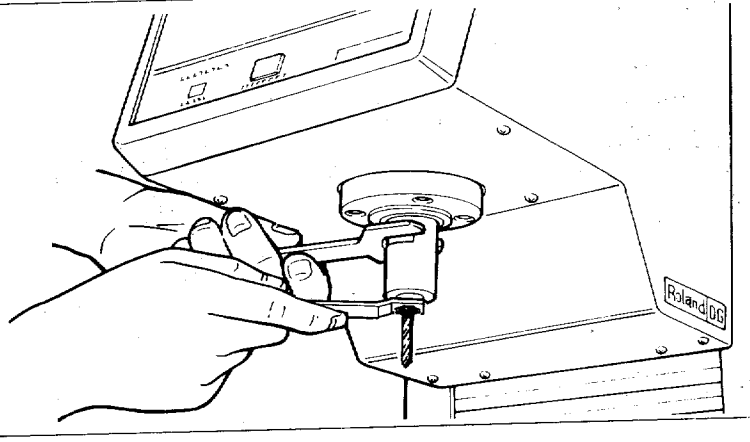
[WARNING]

Turn off the power switch before changing the tool.

— CAUTION —

It is easy to drop tools when changing them. It is a good idea to put a cardboard box underneath the tool so that it is not damaged if it does fall. Tools fall easiest when loosening them to change. The character cutting tool is especially easy to damage.

* Secure the spindle unit with the large collet chuck wrench.
* Insert the shank of the tool in the collet chuck.
* Tighten the collet chuck with your hands to keep the tool from falling.
* Once it is secure, use the smaller wrench to loosen or tighten the collet chuck.



e. Example of Procedure (Using CAMM-KIT A)

The following is an example which uses the contents of the optional CAMM-KIT A to show the proper procedure for beginning modeling with the CAMM-3.

After dressing properly, the operator checks to see if his computer is in order and the the CAMM-3 to see if all proper connections have been made:

Power Cord
Axis Motor Cords
Controller Panel Cord
Computer and Buffer Connecting Cables

Then, the operator checks the area to see that nothing is in the way of the CAMM-3 and that all is clean and in order. Since the purpose of the day's work is modeling with wax, a small household vacuum cleaner will be sufficient for clean up during and after operation.

The operator then takes the two T nuts that came with the vise in CAMM-KIT A and attaches them to the holes on either side of the vise. The T nuts fit into the T nut groove and the vice is slid onto the X-Y table. Placing it in the middle of the table, the operator tightens the T nuts. The vise is now in place.

The operator then takes out the standard tool kit, the standard collet chuck, and the 6mm diameter end mill. The collet chuck is easy to screw in by hand. After screwing it in most of the way, the operator puts the shank of the end mill in the collet chuck and tightens it firmly by hand. Then the operator takes the two collet chuck wrenches from the standard tool kit and holds the spindle unit with the large one while tightening the collet chuck with the small one.

After replacing the wrenches in the tool kit case, the operator turns on the CAMM-3, being careful not to touch the spindle unit. When the CAMM-3 turns on, the spindle spins for an instant and the coordinate displays of the display panel flash on and off. The operator presses the HOME key and the spindle rises as the XY table moves off the the right rear corner.

The operator places the modeling wax in the jaws of the vise, letting it ride on the grooves of the inner plates. He tightens the vice carefully.

Next the operator will set the Z axis positions and the work coordinate system (see chapter IV) and he is ready to begin work. While working, he periodically vacuums the cuttings from around the CAMM-3. When his 5 year old daughter comes into the room and looks curiously at the CAMM-3 he explains to her what he is doing with it but cautions her and tells her to look at it from a distance. He is also careful to keep floppy disks in a box away from the CAMM-3. His computer and other peripherals are set up on a separate table that is easy to keep clean.

When finished, the operator cleans up, turns off the CAMM-3, removes the end mill he is using and puts all his tools away. After washing his hands, he tends to his computer and plotter, putting everything back in its place. By the time he switches off the light switch of the room, the CAMM-3 is clean and tidy, ready for work again tomorrow.

(6) Changing Drive Belt Installing Position

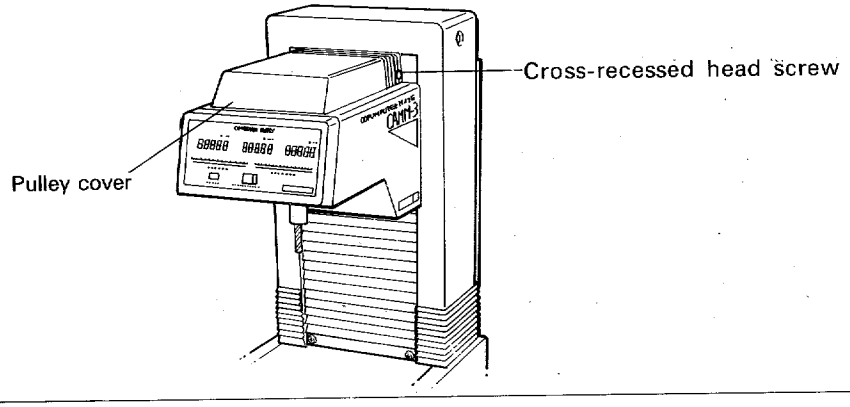
[WARNING]

Turn off the power switch before changing Drive Belt.

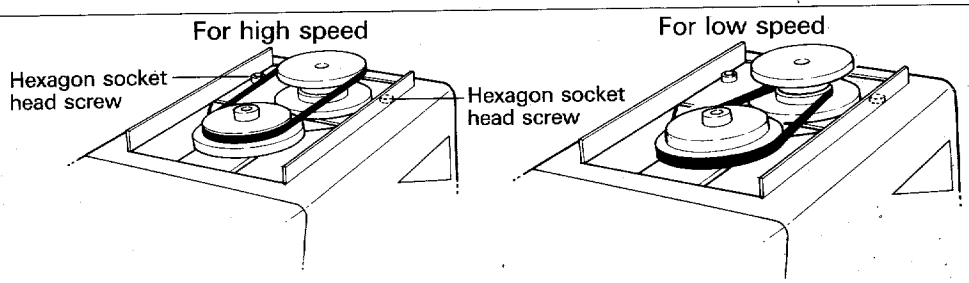
Two types of the Spindle Moter speed are available by reinstalling the drive belt. If the drive belt is installed on the low speed pulley, the speed can be varied continuously between 3000 rpm and 5000 rpm with the Spindle Motor speed control and if on the high speed pulley between 5000 rpm and 8000 rpm. The spindle belt is installed on the high speed pulley for shipment.

Drive belt reinstallation procedure

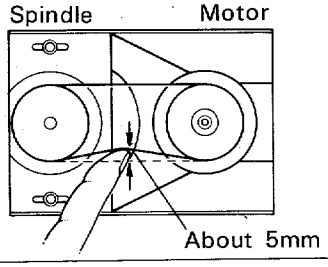
a) Remove Cross-recessed head screws at both sides of the pulley cover and remove it by pulling it up.



b) Loosen the hexagon socket head screws on both sides of the motor top and reinstall the drive belt by moving the motor toward the spindle unit.



c) Adjust the belt as follows. Push the motor to the opposite direction of the spindle so that the belt deflection is about 5mm when pushed lightly with a finger and then fix it with hexagon socket head screws on both sides of the motor.



4. OPTIONAL ACCESSORIES (TOOLS)

The CAMM-3 user must have the correct tools for the job at hand. Roland DG optional accessories have been chosen for their fine quality and suitability to modeling and other work with the CAMM-3. Some of these items, such as connecting cables, are essential for work with the CAMM-3. Please read the following information, and make your selection carefully.

(1) Connecting Cables

Different computers will require different cables. Also, if you plan to use the CAMM-3 with the SYA-350 buffer unit you may need two different cables.

Type

Product Name	Length	Interface Type	Remarks
XY-APL	1.5m	Parallel (Centronics)	CAMM-3 ↔ Apple II, Cable is Equipped with Interface Card
XY-IPC	1.5m	Parallel (Centronics)	CAMM-3 ↔ IBM PC, PC/XT, PC/AT
XY-PC6	1.5m	Parallel (Centronics)	CAMM-3 ↔ SYA-350
XY-PC6S	2.0m	Parallel (Centronics)	CAMM-3 ↔ SYA-350
XY-RS-11	1.5m	Serial (RS-232C)	CAMM-3 ↔ SYA-350 CAMM-3 ↔ Apple II (interface card required)
XY-RS-31	3.0m	Serial (RS-232C)	CAMM-3 ↔ SYA-350 CAMM-3 ↔ Apple II (interface card required)
XY-RS-13	1.5m	Serial (RS-232C)	CAMM-3 ↔ IBM PC, PC/XT
XY-RS-33	3.0m	Serial (RS-232C)	CAMM-3 ↔ IBM PC, PC/XT
XY-RS-14	1.5m	Serial (RS-232C)	CAMM-3 ↔ IBM PC, PC/XT
XY-RS-34	3.0m	Serial (RS-232C)	CAMM-3 ↔ IBM-PC/AT

(2) End Mills and Collet Chucks

Cutting tools can cost a great deal of money. Think well about what you want to do before buying them. Since the CAMM-3's strength is limited to the machining of light metals such as aluminum and brass, you should limit your investment in tools to those that are appropriate for such light use. Remember, you will not be able to machine steel or other hard materials with the CAMM-3. However, keep in mind the fact that the longer the life of your tools, the more the return on your investment.

The end mills offereheling use in mind. That is to say, for the cutting of modeling materials such as the machine wax also offered in this line-up of optional accessories. They are able to cut light metals (aluminum, brass, and other light alloys). However, if you plan to do a lot of work in such metals, we recommend that you look into some longer-lasting tools offered by your local industrial supplier. Also, materials such as wood may require tools with a different type of cutting edge.

All Roland DG end mills, and the Roland DG character cutter, are made of high speed steel. The ZHS end mills cost less than the ZUS and ZUB super hard high speed steel end mills. However, the ZUS and ZUB end mills will last longer and stand up better to use with materials harder than the machine wax just mentioned.

"Square end" milling tools (ZHS and ZUB) create flat surfaces and "steps" "Ball end" (ZUS) tools are better for rounded and wavy shapes. Each end mill must be chucked with its own "collet chuck" of similar diameter. This is because stress is applied to the tools from the side as milling is performed. The tool must be held as tightly as possible or it would soon loosen and wobble. The collet chuck provides a tighter fit than the conventional drill chuck. This is why the CAMM-3 arrives with a collet chuck spindle unit as standard equipment. Note the collet chuck set (ZC-1) for end mills of different diameters. Be sure to have a collet chuck for every end mill you purchase.

Tools that use the standard collet chuck are changed with the collet wrenches supplied in the standard tool kit. The procedure to change them is described in the "Preparations for Use" section.

ITEM	No.	DESCRIPTION
End Mills	ZHS-100	φ1 3ℓ × 6d × 45L 2NT
•Conventional High Speed	ZHS-200	φ2 5ℓ × 6d × 50L 2NT
Steel End Mills	ZHS-300	φ3 8ℓ × 6d × 50L 2NT
Square End Type	ZHS-400	φ4 8ℓ × 6d × 60L 2NT
	ZHS-500	φ5 10ℓ × 6d × 60L 2NT
	ZHS-600	φ6 12ℓ × 6d × 60L 2NT
•Super Hard High Speed	ZUS-300	φ3 15ℓ × 3d × 60L 2NT
Steel End Mills	ZUS-400	φ4 20ℓ × 4d × 60L 2NT
Square End Type	ZUS-500	φ5 25ℓ × 5d × 60L 2NT
	ZUS-600	φ6 25ℓ × 6d × 60L 2NT
Ball End Type	ZUB-150	R1.5 10ℓ × 3d × 65L 2NT
	ZUB-200	R2.0 12ℓ × 4d × 65L 2NT
	ZUB-250	R2.5 20ℓ × 5d × 65L 2NT
	ZUB-300	R3.0 30ℓ × 6d × 65L 2NT
•Collet Chuck Set	ZC-1	φ5, φ4, φ3, φ3.175 (1 ea.)

(3) Drill Chuck Spindle Unit

The entire spindle unit must be changed to accommodate drill bits. The special spindle unit ZS-1 can chuck drill bits up to a diameter of 6.5mm. This drill chuck spindle unit cannot be used for any operations but straight up and down drilling and boring. This unit is changed using the two allen wrenches that are included in your standard tool kit. The method of changing the spindle unit is described in the "ZS-1 Spindle Unit For Drilling Instruction Manual" Supllied with the ZS-1.

Spindle Unit for Drill Bits

ZS-1

φ6.5 (Max.) Drill Chuck

(4) Machine Vise

Choosing the proper vise is essential for efficient, accurate work. If you do not have a special chuck, jig or vise yet, we recommend that you purchase the Roland DG machine vise: ZV-1.

The ZV-1 it is well suited for holding modeling wax and various other materials. It is built low to save space. Its jaw plates are gooved at the top to hold blocks or boards, level, and off of the base of the vice. This means that it is possible to drill through materials without hitting the vice. Other vises cannot hold materials level except when they are placed on the base of the vise itself.

The ZV-1 can hold boards as thin as 3mm. It comes together with special T nuts to hold it level and securely on the table. Be sure to use these T nuts when securing the Roland DG machine vise. You will need a 13 millimeter wrench to secure the vise to the X-Y table. Instructions for installation are in the "Preparations for Use" section.

Machine Vise

ZV-1

Jaw: 100mm (X) × 125mm (Y, Max.)
Height: 50mm (Z)

(5) Character Engraving Tool

For letter (character) engraving, on metal or any other material, the special engraving tool ZEC-100 is needed. The ZEC-100 is made of super hard high speed steel to last as long as possible. However, since the tip of the tool bears the brunt of the work, it is bound to wear out sooner than other super hard tools. We recommend that you have more than a few cutters on hand for character engraving work, no matter what materials you plan to use. Do not use the sensor switch with the character engraving tool as it may blunt the tip. The character engraving tool uses the standard collet chuck. Change it with the collet wrenches supplied in the standard tool kit. The procedure to install it is described in the "Preparations for Use" section.

Character Engraving Cutter (super hard)

ZEC-100
ϕ6 × 50L

(6) Modeling Wax

Roland DG modeling wax: ZW-100/200 is high quality industrial wax made especially for modeling. Its uniform consistency guarantees an accurate rendering of shapes, and its soft, "soap-like" texture allows the CAMM-3 to cut quickly and take less time to finish the model. ZW-100 and ZW-200 wax block packages are available to users in countries where local industrial suppliers do not carry such industrial wax.

Modeling Wax

ZW-100
75mm × 70mm × 38mm (t) 10 pcs.
ZW-200
75mm × 176mm × 40mm (t) 10 pcs.

(7) CAMM-KIT A, B, C

The CAMM-KITs have been prepared to make decisions easier for the new user.

CAMM-KIT A: Machine Vise
2 End Mills
Modeling Wax

This kit contains just enough to use the CAMM-3 for the first time. If you choose it we recommend that you also purchase other tools suited to the use you have in mind.

CAMM-KIT B: Machine Vise
16 End Mills
Collet Chucks for End Mills
2 Modeling Wax

This kit contains the tools needed to begin serious modeling operation. Both straight end and ball end type end mills are included.

CAMM-KIT C: Machine Vise
10 Character Engraving Cutters

This kit is for the user who wishes to use the CAMM-3 mainly for letter (character) engraving.

ITEM	No.	DESCRIPTION	ITEM	No.	DESCRIPTION	ITEM	No.	DESCRIPTION
CAMM-KIT A (for modeling)	ZK-100	ZV-1 x 1, ZHS-300 x 1 ZHS-600 x 1, ZW-100 x 1	CAMM-KIT B (for modeling)	ZK-200	ZV-1 x 1, ZC-1 x 1 ZHS-100 x 2, ZHS-200 x 2 ZHS-300 x 2, ZHS-400 x 2 ZHS-500 x 2, ZHS-600 x 2 ZUB-150 x 1, ZUB-200 x 1 ZUB-250 x 1, ZUB-300 x 1 ZW-100 x 1, ZW-200 x 1	CAMM-KIT C (for character engraving)	ZK-300	ZV-1 x 1, ZEC-100 x 10

(8) Data Buffer Unit

The SYA-350 is a disk-drive-equipped buffer unit that can be placed between the host computer and the CAMM-3 to free up the host computer for other jobs while the buffer unit feeds modeling data to the CAMM-3. Modeling data can be stored with the 3.5 inch disk drive and used repeatedly from the SYA-350 — or even in a separate off-line SYA-350/CAMM-3 system.

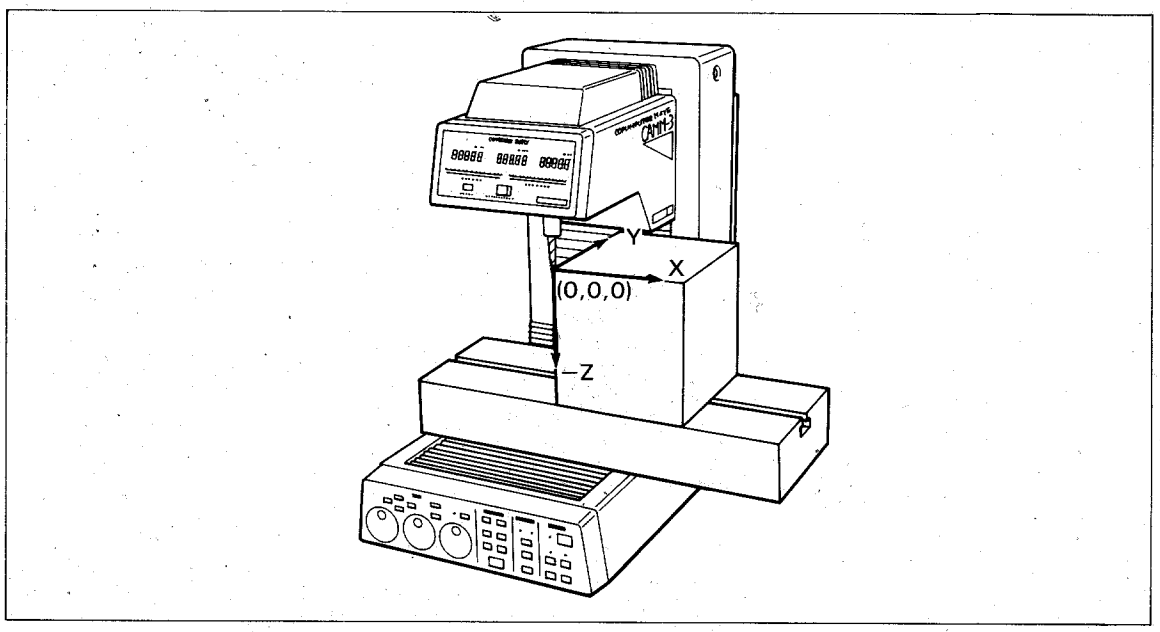
SYA-350
3.5" Disk Drive Equipped, Centronics (IN/OUT) and RS-232C (IN/OUT) Ports, Off-Line Operating Capable, Repeat Operation Capable

1. THE CAMM-3 COORDINATE SYSTEMS

There are three types of coordinate systems that the operator of the CAMM-3 must know about:

The Machine Coordinate System
The Work Coordinate System
The User Coordinate System

It is easiest to think of these systems as blocks that are set on the X-Y table. The **machine coordinate system** is the largest of these blocks. When the CAMM-3 is turned on and the HOME key is pressed this is the coordinate system that is in effect. The cutting tool is in the "home" position, or, in other words, it is touching the "origin" (0,0,0) of the system.



In all CAMM-3 coordinate systems there is a plus X axis and a plus Y axis — but no plus Z axis. This is because the cutting tool moves in the plus direction (up) only to clear the work being done. It is the minus Z movement (down) that is the most important because this is the direction in which cutting is done.

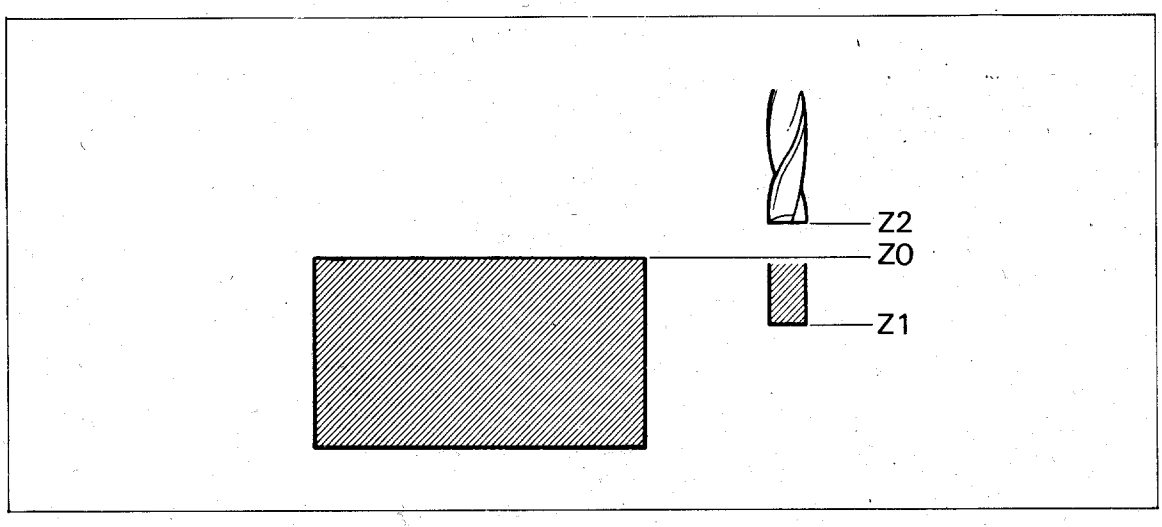
The machine coordinate system is not sufficient for working. It is the "hard" limits of the CAMM-3. The CAMM-3 will not move past these limits. This is inconvenient because it will often be necessary for the cutting tool to clear the work in order to bring it to a different position — without cutting the material. This is called "positioning" as opposed to "cutting." Imagine that you must work within a box. If your material is a big as the box there would be no room between the sides of the box and the material to put your hands or tools in. The same is the case with the CAMM-3. If our material is as large as the "box" of the machine coordinate system we will not be able to position when we need to. Therefore it is convenient to be able to tell the machine where our material is within the machine coordinate system. This is done by determining the **work coordinate system.**

The work coordinate system is a smaller box than the machine coordinate system. It is not as high. Like the machine coordinate system, it has a minus Z axis, a plus X axis, and a plus Y axis.

The Z axis coordinate of the home position, or origin (0,0,0) of the work coordinate system is called "Z0." Z0 can be set manually from the controller panel (Z0 and ENTER). The CAMM-3 puts Z0 at the last position set, whether manually or by computer.

The "clear" position (or level, as it is only a Z axis coordinate) is called "Z2." We need to set a Z2 position because there are times when we want to clear the work and position with the "M" or "^PU" commands. The commands need to have a Z2 position to go to. When they are received by the CAMM-3, it will raise the cutting tool to the last Z2 position set and move as directed. The Z2 position is set manually with the Z2 key and ENTER button or by computer with the "@" command. As with Z0, the last position set is effective.

The "cut" position (or level) is called "Z1." When the "D" or "PD" commands are received the cutting tool lowers to this point and cuts. Z1 is set with the Z1 key and the ENTER button or with the "@" command.

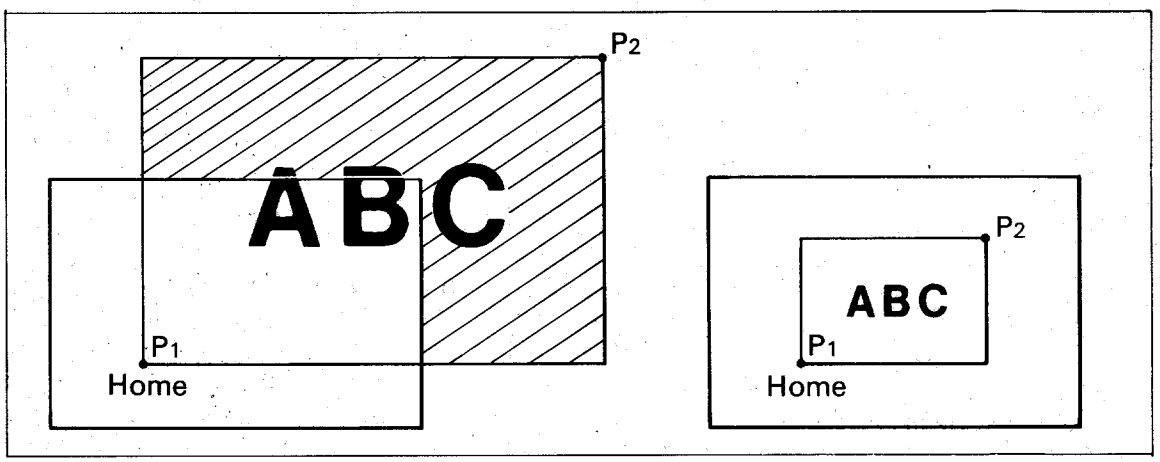


If you are familiar with X-Y plotter commands, you will remember that "^PU" means "pen up," and "PD" means "pen down." In the case of an X-Y plotter, there are only two possible levels for the pen to be at. With the CAMM-3 "^PU" means "clear work" and "PD" means "cut work." The CAMM-3 needs to know at what level to do this. Hence the need for the three Z points of the work coordinate system.

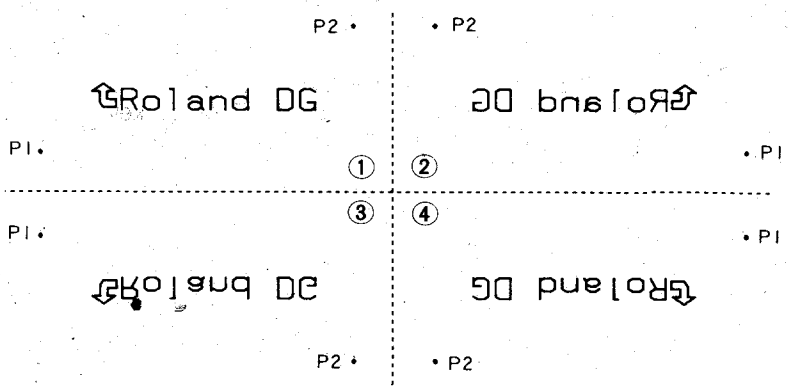
The "home" position, or origin (0,0,0) of the work coordinate system has X-Ydinates as well. These are set with the HOME key and the ENTER button of the controller panel or the with the "IP" command (P1/P2 input). The last position set is effective.

But we may also want to adjust the scale of our coordinate system. This can be done by creating the user coordinate system with the "P1" and "P2" points and by "scaling." These points will change the scale of the X and Y axes. The scale of the Z axis cannot be changed.

The machine coordinate system and the work coordinate system both use units of 0.01mm for all three axes. But what if you want to cut an object that is larger than the machine coordinate system allows? By setting P1 and P2 within the limits of the machine coordinate system, or changing the size of the unit of your X and Y axes, your object can be scaled down to a size that the CAMM-3 can handle. The work coordinate system, plus the newly scaled X and Y axes, compose the user coordinate system. The home position (origin) of the user coordinate system is the Z axis coordinate of Z0 and the X-Y coordinates of P1. This is the same as for the work coordinate system.



The P2 point of the user coordinate system can be set outside the limits of the machine coordinate system with computer commands. In this case, when the cutting tool reaches the limit of the machine coordinate system it will rise to the Z2 point and enter at the next commanded point that is within the machine coordinate system.



Points P1 and P2 can be set manually with the P1 and P2 keys and the ENTER button of the controller panel or with the "IP" command. When P1 and P2 are set manually, the units of the X and Y axes are scaled down automatically. Scaling can also be done with the "^SC" command. As with all other coordinate systems, the last designations remain effective.

You will note that the POSITIONING section of the controller panel is divided into two areas. The left hand side is for Z axis-related positioning, and the right hand side is for X-Y plain-related positioning. Also remember that "positioning" can mean "clearing the material and moving," or "determining a position (Z0, P1, home, etc.) to be at certain coordinates."

2. MANUAL POSITION SETTINGS

(1) Setting Z0, Z1 and Z2 Positions

Z0 — 0 on the Z axis of the work and/or user coordinate system.
Z1 — "Cut" position (level).
Z2 — "Clear" position (level)..
The relationship of Z0 ,Z1 and Z2 must be:

$$Z2 \geqq Z0 \geqq Z1$$

or an error will result.

Z0 is set so as to be at the same level as the surface of the material to be worked on. In the case that the material is not in block form, Z0 is usually set at the highest point of the material. Any movement at a level higher than Z0 should not result in cutting. Movement below the Z0 level will cut the material.

Z1 and Z2 can be determined in the computer control mode with commands. But Z0 must be set manually. If no settings are made be the operator, Z0, Z1 and Z2 are all left at the machine coordinate settings. Once the position of Z0 is set, Z1 and Z2 are automatically set at the same position.

a. Manual Z0, Z1 and Z2 Position Setting

1) Put the CAMM-3 in manual mode.
2) Use the JOG keys and dials to bring the tip of the cutter to the surface of the material or whatever level you plan to set Z0 at.

3) Enter the Z0, Z1 or Z2 position in the following way:
   A) Hold the ENTER key down and press the Z0, Z1 or Z2 key.
   B) Keep pressing the ENTER key and let go off the Z0, Z1 or Z2 key.
   C) Now let go off the ENTER key.

b. Using the Sensor to Set Z0

The standard sensor switch can be used to set Z0 easily and with accuracy.

— CAUTION —
Some tools, such as the optional character engraver, may be damaged when they are brought to the surface of the sensor switch.

1) Put the CAMM-3 in manual mode.

2) Connect the sensor switch to its special connector on the left side of the column of the main unit.

3) Place the sensor on the material.

4) Use the JOG keys to bring the tip of the cutting tool close to the sensor switch without touching it.

5) Once the cutting tool is close to the sensor switch, let go off the JOG key (-Z).

6) Press the SENSOR key and the LED will light up.

— CAUTION —
Be sure the SENSOR LED is lit before you continue with this operation.

7) Now, when you use the JOG keys, the cutting tools will be lowered at half normal speed. Press the -Z key and lower the cutting tool on to the sensor switch. The cutting tool will stop automatically when it touches the sensor switch.

8) Press the +Z key and raise the tool enough to remove the sensor switch.

9) Remove the sensor switch.

10) Press the SENSOR key. The LED will turn off.

11) Press the Z0 key and the cutting tool will automatically lower to the surface of the modeling material. Z0 is now set. The Z AXIS display of the display panel will show only zeros. If you did not press the SENSOR key, SENSOR LED will blink.

(2) Setting the Home Position

The home position is X - 0, Y - 0, Z - 0 on either the machine or work coordinate system. If the setting described below is not made after turning the CAMM-3 on, the CAMM-3 will return to the machine home position when the HOME key is pressed for more than 0.5 seconds or the "H" command is received. Since Z0 is set with the Z0 key, the HOME key is used to determine the origin of the work coordinate system only on the X and Y axes. It is not possible to set a minus value for the home coordinates. Once the home position is set, when the HOME key is pressed for more than 0.5 seconds or the "H" command is received the CAMM-3 will move to the new position.

1) Put the CAMM-3 in manual mode.

2) Use the JOG controls to bring the CAMM-3 to the desired home position.

3) Hold the ENTER button and press the HOME key.

(3) Setting P1 and P2

When a setting is made with the HOME key, the same setting becomes P1. If the P1 position is reset with the P1 key or a computer command, the P1 position and home position become separate. P2 is the limit of the user coordinate system. Its coordinates are the limits for both the X and Y axes. P1 and P2 can be set with computer commands as well. The last setting made is effective. It is not possible to set a minus value for the P1 or P2 coordinates. Press the P1 or P2 key for more than 0.05 seconds to move the CAMM-3 to the currently set P1 or P2 points.

Auto Scale Mode ON — (standard setting, DIP switch 1 - ① OFF) If no scaling command has been received, P1 automatically becomes 0,0 and P2 becomes 18000, 15000. The actual size of the units of the coordinate system shrink accordingly.

Auto Scale Mode OFF — (DIP switch 1 - ① ON) Units of coordinate system remain at 0.01mm until scaling command is received.

1) Put the CAMM-3 in manual mode.

2) Use the JOG controls to bring the CAMM-3 to the desired position.

3) Hold the ENTER button and press either the P1 or P2 key.

3. FEED RATE SETTINGS

Feed rates can be set manually or with commands. The Z axis feed rate can also be controlled with the DIP switch. The last setting made stays effective.

Settings are divided into two types: the X and Y axis feed rates, and the Z axis feed rate. When the CAMM-3 is in computer control mode, X and Y axis feed rates can be changed manually by using the PAUSE button. This makes it possible to change the feed rate while a program is being run. The Z axis feed rate can be changed alone in manual mode. The X and Y axis feed rate is always the same.

The feed rate setting controls the speed of movement in computer control mode or in data input (teaching) mode. It does not effect the speed of the JOG controls. The dwell command also effects the speed of the operation being done. While it does not effect the feed rate of the axes, it pauses (not halts) the CAMM-3 between commands in order to make for a better finish.

To choose the proper feed rate for all axes, you must take into consideration the nature of your materials and the type of tools you plan to use.

(1) Manual X, Y and Z Axis Feed Rate Setting

a. Press MANUAL key and light manual LED. In computer control mode, press the PAUSE button and light up the PAUSE LED.

b. Press the FEED RATE key and watch the change in the FEED RATE display of the display panel.

c. Set the feed rate at the desired setting.

d. Press the MANUAL key to return to computer control mode, or press the PAUSE button to continue running the program in computer control mode.

(2) Manual Z Axis Feed Rate Setting

The Z axis is automatically changed together with the X and Y axis feed rate. However, there are times when you may want to change the Z axis feed rate alone. This can be done in manual mode, but not in computer control mode with the pause button as with the 3 axis feed rate setting: However, in computer control mode computer the command for Z axis feed rate change can be used.

a. Press MANUAL key and light manual LED.

b. Press the DATA INPUT key and light up the DATA INPUT LED.

c. Press the FEED RATE key and watch the change in the FEED RATE display of the display panel.

d. Set the feed rate at the desired setting.

e. Press the DATA INPUT key and turn off the DATA INPUT LED.

f. Press the MANUAL key to return to computer control mode.

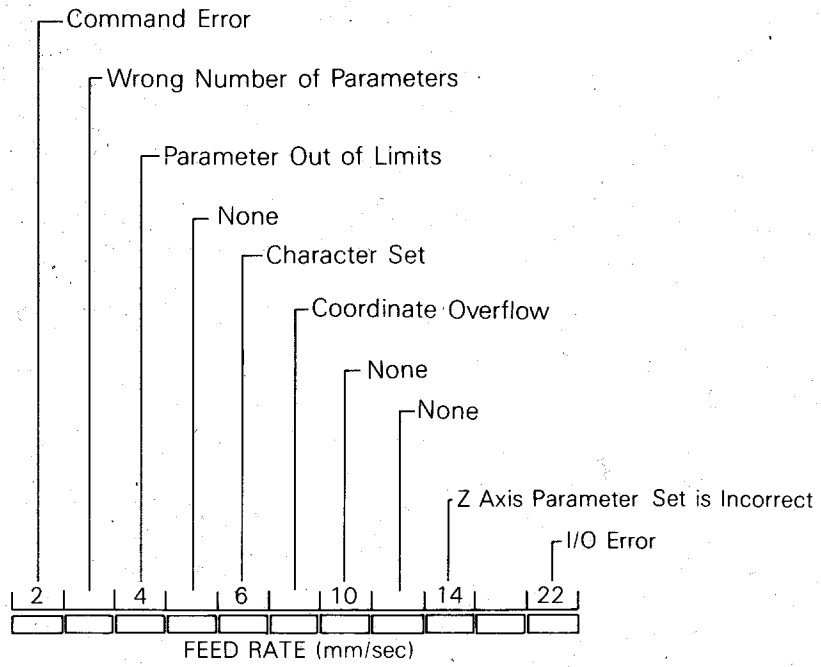
(3) DIP Switch Z Axis Feed Rate Setting

The X, Y and Z axes' feed rate can be specified with DIP switch 1-②. When DIP switch 1-② is set OFF, the minimum feed rate becomes 1 (mm/sec) and about 0.4 (mm/sec) when it is set ON. The default value of the feed rate in the Z axis direction can be specified with DIP switches. Use DIP switch 1-③ to specify it at the power ON.
When DIP switch 1-③ is ON, the default value becomes 22 (mm/sec) and when it is OFF, the default value becomes 2 (mm/sec) if DIP switch 1-② is OFF and about 0.4 (mm/sec) if DIP switch 1-② is ON.

4. ERRORS AND ERROR DISPLAY

(1) Error Displays

When an error occurs, the ERROR lamp of the display panel lights up and the FEED RATE display will light up at a certain place to inform the nature of the error. The meaning of the FEED RATE display is as follows:



(2) Taking Care of Errors

Take care of errors as they occur. Once an error occurs the following operations may be affected in ways that could result in damage to the work being done or to the CAMM-3 itself. In principle, it is best to stop all work and begin again by pressing the EMERGENCY STOP button and resetting the CAMM-3.

If the PAUSE button is pressed the CAMM-3 will ignore the source of the error and continue on to the next line in the program. Be sure to watch carefully if you choose to do this, and be ready to press the EMERGENCY STOP button if necessary.

5 DATA INPUT MODE AND TEACHING 5-1

1. TEACHING IN DATA INPUT MODE

The data input mode and data input keys of the controller panel to run the CAMM-3 without connection to a computer. Up to 160 positions can be input into, or "taught to" a RAM in the CAMM-3. The CAMM-3 can then be made to cut by moving from position to position in the order they were input. These positions are erased from the CAMM-3 RAM when the power is cut or the EMERGENCY STOP button is pressed. Scaling (the user coordinate system) has no effect on the positions taught in the data input mode.

2. PROCEDURE

Positions are taught to the CAMM-3 as follows:

* Press the DATA INPUT key and light the DATA INPUT LED.
* Use the JOG controls to bring the CAMM-3 to the desired position.
* Press the WRITE key. The position is now written in the CAMM-3 RAM.

Repeat this procedure as many times as you wish. 160 positions can be written. When the memory is full, the OVER LED will light up.

To run the CAMM-3 through the positions written, be sure the DATA INPUT LED is lit. If you wish to change the feed rate do so now with the FEED RATE key while the DATA INPUT LED is lit. Press the START key and the spindle will begin to turn at the speed set with the Spindle Speed Control and the CAMM-3 will move at the currently set feed rate to the home position or the origin of the current work coordinate system if that is different from the home position. When the last position is reached the spindle will continue to turn. Press the MOTOR key to stop it.

As long as the power is not cut or the EMERGENCY STOP button is not pressed, the CAMM-3 will be able to run through this same sequence of positions when the START key is pressed. The positions written will stay in the RAM even if the DATA INPUT LED is not on. Home and P1/P2 positions can be changed without affecting this data.

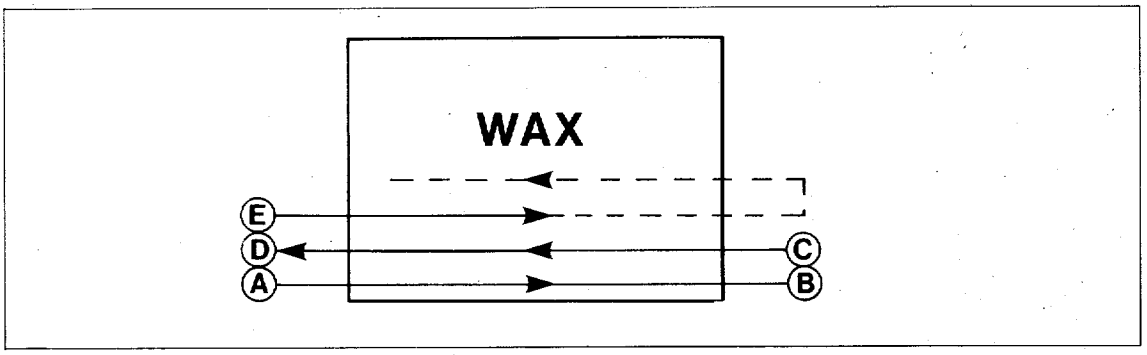
To erase the last position written hold the ENTER button and press the WRITE key.

To exit from the data input mode, press the DATA INPUT key and turn off the DATA INPUT LED.

— NOTE —
The CAMM-3 will cut in straight lines to the points written in its memory and **not** according to the way you have moved the JOG controls to attain those points. Remember to press the WRITE key **every** time you wish the CAMM-3 to make a change in direction.

3. TEACHING EXAMPLE — RESURFACING WAX BLOCKS

The CAMM-3 operator can "teach" positions to the CAMM-3 to perform simple operations such as resurfacing blocks of modeling wax without using commands from the computer. Of course, the same operation can be done with a simple program from the computer if desired.



Teaching the CAMM-3 to Re-surface a Rectangular block of Wax

All X-Y table and spindle movement is done with the JOG controls.

1. Secure the wax with the vise.
2. Put the CAMM-3 in manual mode (press the MANUAL key and light the LED).
3. Set Z0 at the surface level of the modeling wax.
4. Set the home position at "A" in the illustration.
5. Put the CAMM-3 in data input mode (press the DATA INPUT ON/OFF key and light the LED).
6. Press the MOTOR key and light the MOTOR LED.
7. Lower the spindle approximately 2mm.
8. Press the WRITE key, this will write the position into the memory of the CAMM-3.
9. Move the X-Y table back and forth to each of the points shown in the illustration. Each time a point is reached, press the WRITE key and the point will be written into the memory of the CAMM-3.
10. Once the block has been resurfaced, press the HOME key and bring the CAMM-3 back to the home position.
11. If you have many other blocks of the same shape you can resurface without resetting Z0 and proceed with step 15. If you just want to resurface the one block, turn it over.
12. Reset Z0 to the surface of the wax.
13. Set the home position at point "A".
14. Set the feed rate at 22.
15. Press the START key. The CAMM-3 will automatically resurface the back of the wax.

1. IBM AND APPLE CONNECTION

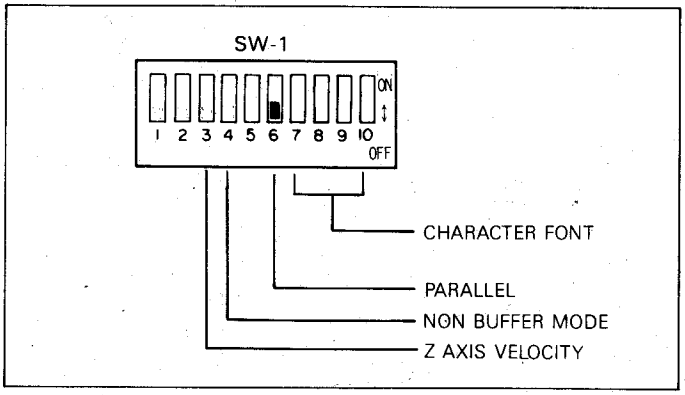
(1) IBM PC (5150), PC XT (5160), PC AT (5170)

a. Parallel Connection

An interface card is required. Use a parallel printer adaptor or a monochrome display and parallel printer adaptor.
See the operating manual of the interface card for details of instation.

Connecting Cable: Use the IBM printer cable or Roland DG XY-IPC.

Make sure that the CAMM-3 power is OFF and then set DIP switch 1 as shown below.



Connect the printer cable to the PARLLEL IN on the side panel of CAMM-3.

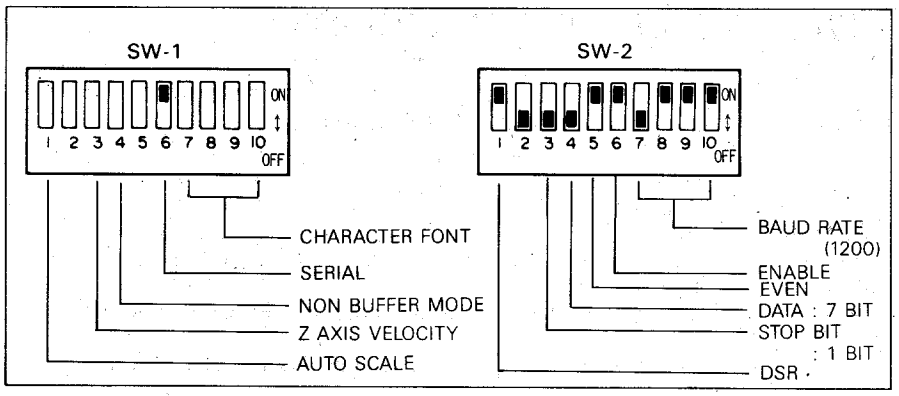
b. Serial Connection

An interface card is required. Use either:
* IBM asynchronous communications adaptor.
* IBM Serial/Parallel Adaper for PC, PC/XT and PC/AT.

See the operating manual of the interface card for details of insallation etc..

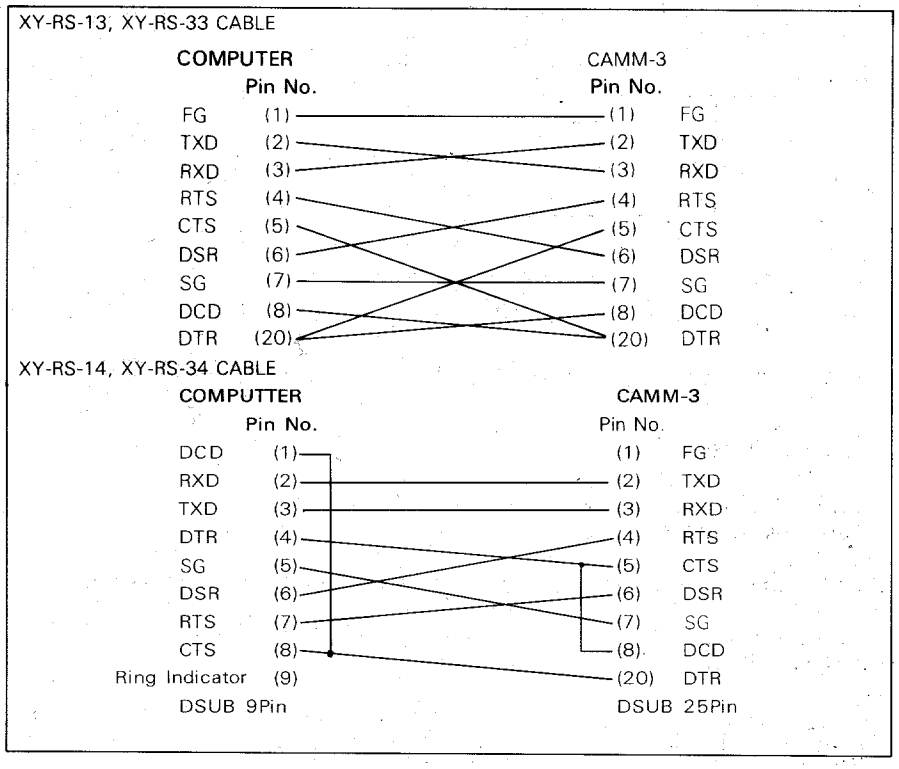
Connecting cable: Use the Roland DG XY-RS-13, XY-RS-33 (PC,PC/XT), XY-RS-14, XY-RS-34 (PC AT).

Make sure that the CAMM-3 power is OFF and then set DIP switch 1 and 2 as follows. (The following exanmple shows the Case of connection at 1200 baud, even prity, stop bit Data 7.)



Connect the Roland DG XY-RS-13 or XY-RS-33 cable to the SERIAL IN on the rear panel of CAMM-3.

The internal wiring connections of the Roland DG XY-RS-13 or XY-RS-33 cable are as shown below.

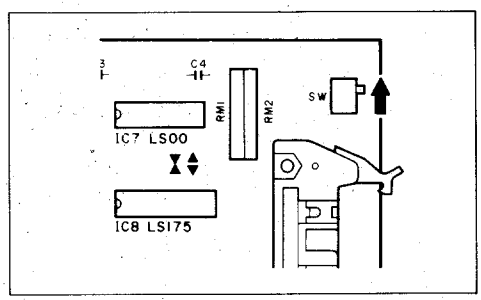


(2) APPLE II, IIe

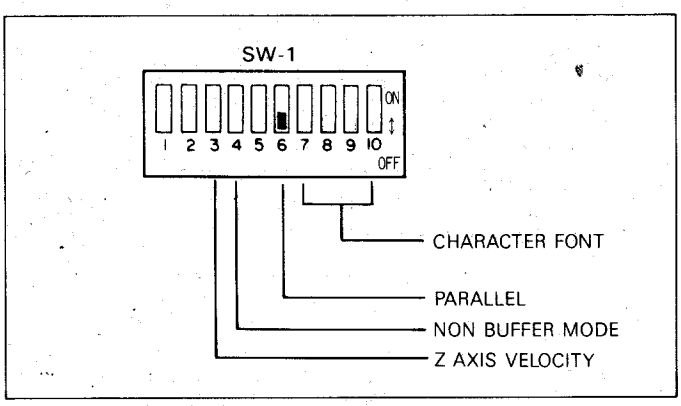
a. Parallel Connection

An interface card is required. Use the Roland DG XY-APL card. See the manual supplied with the XY-APL for details of installation etc.

Set the switch on the XY-APL as shown below.



Make sure that the CAMM-3 power is OFF and then set DIP switch 1 as shown below.



Connect the cable from the Roland DG XY-APL to the PARALLEL IN on the side panel of CAMM-3.

This completes connection. See the Roland DG XY-APL manual for details of the interface card. Use the cable supplied with the Roland DG XY-APL.

Note:
If a parallel printer card and cable other than the XY-APL is used the CAMM-3 will not operate unless bit 7 (MSB) is set to LOW or modified.

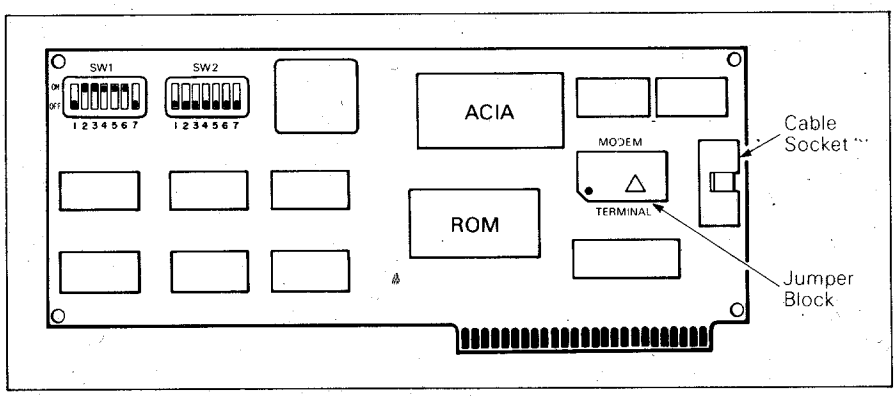
b. Serial Connection

An interface card required. Use the APPLE II Super Serial Card.

The following example shows the case of connection at 1200 baud, even parity, stop bit 2, and data bit 7.

Set DIP switches 1 and 2 on the Super Serial Card as shown in Fig.1.

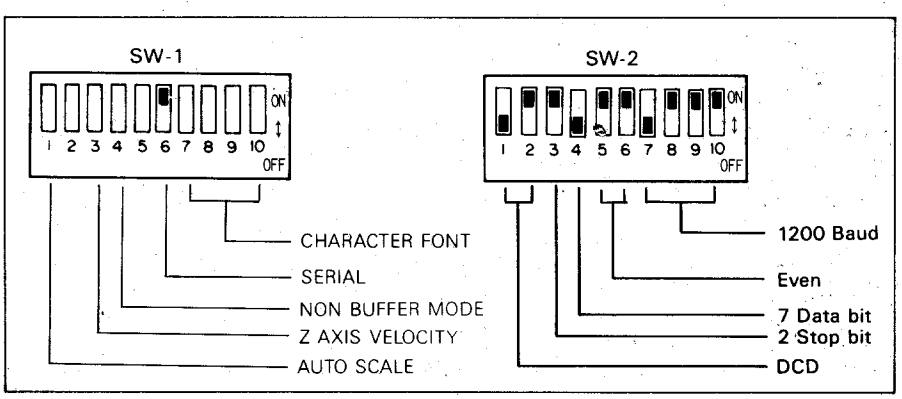
Set the jumper block so that the triangle is as shown in Fig.1. (ie. set to the communication mode.)



Switch the APPLE power OFF, remove the top cover and plug the Super Serial Card into slot #2. See the Super Serial Card manual for details.

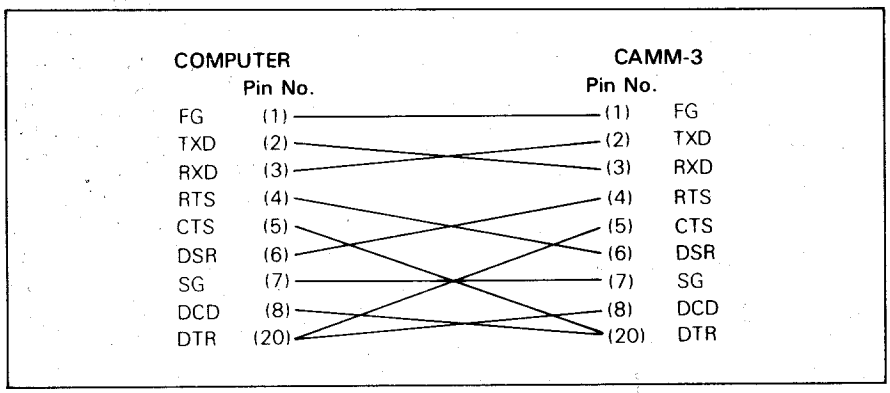
Connect the Roland DG XY-RS-11 or XY-RS-31 cable to the 25-pin connctor on the Super Serial Card.

Make sure that the CAMM-3 power is OFF and then set DIP switches 1 and 2 as shown below.



Connect the Roland DG XY-RS-13 cable to the SERIAL IN on the side panel of CAMM-3.

This completes connection. See the Super Serial Card manual for details of baud rate and parity checking.
The internal wiring connections of the Roland DG XY-RS-11 or XY-RS-31 cable are as shown below.



2. PREVENTING DEVICE TIMEOUT

The CAMM-3 operaters much slower than other computer peripherals. It may give busy signals too long to the host computer while executing a particular long operation and cause the computer to give up and resort to a divice timeout message. There are ways to help prevent this. The following commands will help if you are using the IBM 5150, 5160, or 5170.

Boot the disk operating system (DOS) and execute the following:

Parallel Connection:
A>MODE LPT1:,,P

Serial Connection:
A>MODE COM1:9600,,,,P

or with BASIC in a serial connection —
OPEN "COM1:9600,E,7,1,CS65535,DS65535" AS #1

The performance of the CAMM-3 depends greatly on the tools and materials used for operations. All tools lose their edge with use and all materials differ in consistency. In this chapter only the basics of tool and material selection will be covered. You will need to gain experience with the CAMM-3 in order to make the proper decisions about the tools and materials you should use. The tools discussed will be limited to those sold separately by Roland DG.

1. MATERIALS

(1) Modeling Wax

Industrial wax such as the type offered by Roland DG (ZW-100,ZW-200) is ideal for modeling operations due to its uniformity of consistency and texture that gives equal resistance to the cutting tool throughout the operation. Softer than other materials, this wax also cuts quickly and saves time. Satisfactory results are assured when this wax is used with Roland DG end mills, also sold separately.

(2) ABS Plastic

ABS, or Acrylonitrile-Butadiene-Styrene cuts relatively well and makes a good working model due to its harder consistency.

(3) Acrylics

These materials do not cut well and is not advised for modeling operations. At lower feed rates cuttings of the material tend to cling to the cutting tool.

This material is better used in engraving operations.

(4) Aluminum, Brass

Cutting these light metals takes much longer than wax or plastic. The amount cut in one stroke must be made less and the feed rate must be set much lower. Ridges and burrs form much easier and it is difficult to attain a smooth finish. You will need to lubricate the material surface with oil before cutting and take greater care in cleaning.

Bits and filings of metal must be kept from falling into the base of the CAMM-3 and, of course, from the area in which the host computer is located. It is advisable to have a vacuum cleaner capable of handling metal cuttings on hand when you work with light metals. Also, after working with metal, lift the bellows cover of the base and clean and relubricate the screw and slideways.

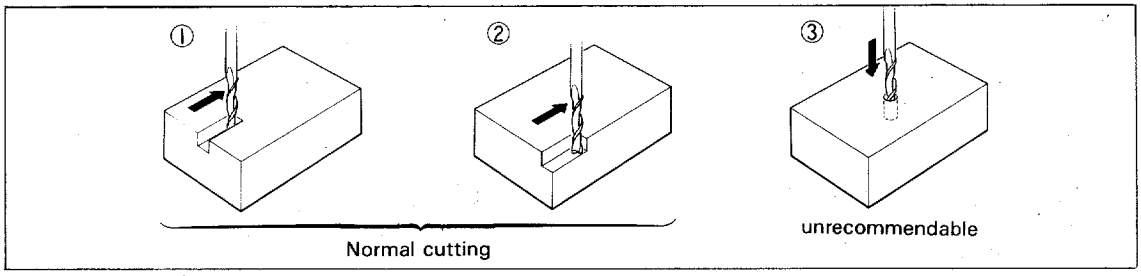
2. END MILLS AND CUTTING AMOUNT

The less the amount that is cut, the faster the operations will go and the less the strain on the cutting tool. You must take the hardness and sharpness of your cutting tool and the hardness of your material into consideration before determining how deep (Z1) you plan to cut. The table in this chapter is only one example of cutting speed and amount for new blades. It is meant as a guide and not to be a hard and fast rule for choosing blades. Use your own judgement to set up the best conditions for cutting.

(1) Speed is the most important factor in cutting and milling operations. Generally speaking, the smaller the diameter of the cutting tool, the faster it can be spun. The faster the rpm and the slower the feed rate, the better the finish of the cut surface.

(2) Given the same material, and cutting time, the amount cut will be the same. However, if the cutting tool is long or thin, the hardness of the tool becomes a factor.

(3) End mills cut from the "end" of a piece of material. They are not meant for drilling or boring operations. **Never try to bore into metal or acrylics with an end mill.** If it is necessary to rout an area in the middle of the material, bore a hole with a drill bit first and follow up with an end mill.

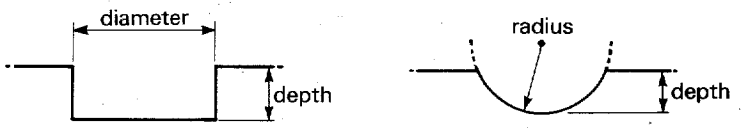


3. THE CHARACTER ENGRAVING TOOL

The optional Roland DG character engraving tool is a delicate tool and must be used and handled carefully. The point can easily break if dropped, so be careful when changing it.

Use the character engraving tool at high spindle speed.

TOOL	SPINDLE(rpm)	CUTTING AMOUNT (mm) diameter × depth	FEED RATE (mm/sec.)
Modeling Wax (Roland DG Option ZW-100,ZW-200)			
ZHS-300	8000	3.0 × 3.0	5 ~ 12
ZHS-600	6000	6.0 × 6.0	4 ~ 10
ZUS-600	6000	6.0 × 6.0	4 ~ 8
ABS Plastic			
ZHS-100	8000	1.0 × 0.5	2 ~ 8
ZHS-300	8000	3.0 × 3.0	8 ~ 10
ZHS-600	6000	6.0 × 4.5	5 ~ 8
ZUS-600	6000	6.0 × 4.0	4 ~ 8
ZUB-300	6000	3.0 × 3.0 (radius × depth)	5 ~ 8
ZEC-100	8000	0.5 (depth only)	4 ~ 10 (z axis feed rate is 2)
Acryl			
ZHS-100	8000	1.0 × 0.5	7 ~ 10
ZHS-300	8000	3.0 × 1.5	4 ~ 6
ZHS-600	6000	6.0 × 2.0	2 ~ 4
ZUS-600	6000	6.0 × 3.0	2 ~ 3
ZEC-100	9000	0.3 (depth only)	2 ~ 8 (z axis feed rate is 2)
		0.5 (depth only)	2 ~ 6
Aluminum			
ZHS-300	8000	3.0 × 0.5	1 ~ 2
ZHS-600	6000	6.0 × 0.5	1 ~ 2
ZUS-600	6000	6.0 × 0.3	1 ~ 2
ZUB-300	8000	3.0 × 0.2 (radius × depth)	1 ~ 2
ZEC-100	8000	0.3 (depth only)	1 ~ 2
Brass			
ZHS-300	8000	3.0 × 0.5	1 ~ 3
ZHS-600	6000	6.0 × 0.5	1 ~ 2
ZUS-600	6000	6.0 × 0.5	1 ~ 2
ZUB-300	8000	3.0 × 0.3 (radius × depth)	1 ~ 2
ZEC-100	8000	0.3 (depth only)	1 ~ 2



1. DIFFERENCES BETWEEN AND X-Y PLOTTER AND THE CAMM-3

In chapter 3 the difference between 3 dimensional operations and "2.5" dimensional operations was discussed. The CAMM-3 can use 2 dimensional plotter data to move its X-Y table. Since the CAMM-3 understands the same commands that move the Roland DG flat-bed X-Y plotters of the DXY series (DXY-880A, DXY-980A, etc.). These commands are included in CAMM-GL1, the language used to operate the CAMM-3. The CAMM-3 can therefore also be used with commercial CAD software that operates these plotters.

However, the limits of the CAMM-3 machine coordinate system are 1/10 those of an X-Y plotter. Distances will therefore be scaled down to 1/10 those of the lines drawn on an X-Y plotter.

The following is a list of commands that are understood by DXY plotters but not by the CAMM-3:

Command	Operation
L B ^LT	Ignores. (Cutting along the solid line even after exection.)
X J ^AA ^AR ^DC ^DP ^SM ^SP ^TL ^UC ^XT ^YT	Ignores. (No operation but moves on to the operation of next command.)
^IM	Ignores. (All errors displayed even after execution.)
^OE ^OD ^OI ^OO	Results in an error (Command error).

Every command other than the above that is not included in CAMM-GL 1 results in an error (command error).

Since the data gained with CAD software does not control any Z axis movement, you will have to do this in some other way. Chapter IV discusses the Z axis positions "Z0, Z1" and "Z2." CAD software does not need these positions because it assumes that the plotter pen will either have to be put "up" or "down." "Up" in the case of the CAMM-3 is the Z2 position. "Down" is the Z1 position. It is therefore important to understand how to set these positions.

2. USING AUTOCAD

It is best to draw plans of the object you plan to produce on the CAMM-3 to its exact dimensions. To do this you will have to output data to the CAMM-3 in a different scale. Also remember that the ^IP command is included in the "plot" output, so your manual P1 and P2 settings will be cancelled.

At the "Configuration" display, select either the Roland DG DXY-800 or the DXY-101. Use parallel interface.

The CAMM-3 DIP switch settings should be as follows:

PARALLEL

SW 1	SW 2
All OFF	All ON

At the "Plot" display you will have to change the scale of the output data. The CAMM-3 will move in steps of 1/100mm and the data is scaled to move the plotter in steps of 1/10mm. At the "Plot Drawing" display, change the size to 10 times the original. Change the "Plotting Area" to ten times the original as well.

Make sure the CAMM-3 is ready to operate and that you have taken all the necessary safety precautions described in chapter 2 of this manual.

— NOTE —
The CAMM-3 moves much slower than an X-Y plotter. Depending on the materials, cutting tools and feed rates used, the CAMM-3 may not be able to accept data fast enough from the host computer. In such cases the computer may give up and send a "device timeout" message. If you are having such problems, the SYA-350 buffer unit (sold separately) will solve them.

1. MODE TABLE

MODE	CONTROL
*1. Manual Mode	Manual Mode Key Manual LED ON
*2. Data Input (Teaching) Mode	Data Input Mode Key Data Input Mode LED ON
*3. Non-Buffer Mode	DIP Switch 1 - ④ ON
*4. Auto Scale Mode	DIP Switch 1 - ① OFF
*5. Slow Mode	DIP Switch 1 - ② ON

*1. Setting the "MANUAL" key ON puts the CAMM-3 into the manual mode in which the CAMM-3 can be operated by using the operation panel. Setting it OFF makes all the keys except the "MANUAL" and "PAUSE" and "EMERGENCY STOP" keys ineffective.

*2. Setting the "DATA INPUT" ON puts the CAMM-3 into the data input (teaching) mode. In this mode, the movement obtained by manually operating the CAMM-3 independently without connecting the computer can be stored in the CAMM-3 and cutting according to the same movement is available.

*3. Setting the DIP switch 1-④ ON puts the CAMM-3 into the non-buffer state, which is very convenient when debugging the program.

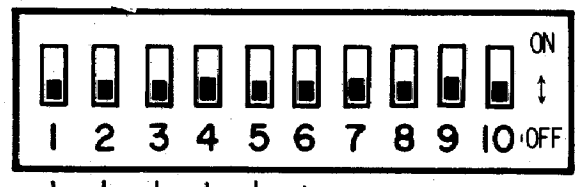
*4. Setting the DIP switch 1-① OFF puts the CAMM-3 into the autoscale mode. In this mode, cutting on the reduced scale is possible by only specifying P1 and P2 by means of the ^IP command or through the manual operation. If the DIP switch 1-① is ON (i.e., in the non-autoscale mode), no reduction is available till the SC command is executed.

*5. When DIP switch 1-② is set ON, the mode is set to SLOW mode, that is, the minimum feed rate of X, Y and Z axes is specified to about 0.4 (mm/sec) and when set OFF, it is specified to 1 (mm/sec).

(NOTE) As to *3, *4 and *5, note that setting each DIP switch ON and OFF after the power ON is invalid.

2. DIP SWITCH SETTING LIST

SW-1



ON/OFF Disable/Enable — AUTOSCALE

ON/OFF — SLOW MODE

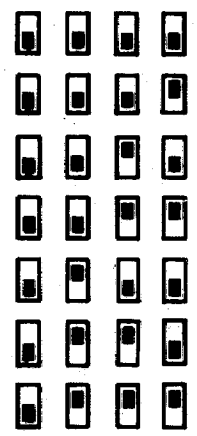
22/SLOW — Z AXIS VELOCITY (mm/sec.)

ON/OFF — NON BUFFER MODE

NC

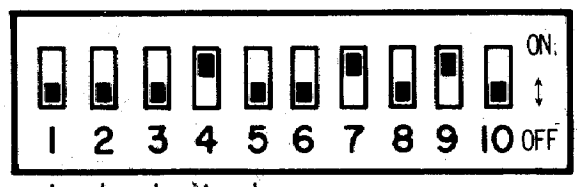
SERIAL/ PARALLEL CONNECTION

CHARACTER FONT



- ANSI ASCII (I)
- ANSI ASCII (II)
- French German
- Scandinavian
- Spanish Latin American
- Roland Swedish
- Roland Danish, Norwegian

SW-2



ON/OFF

ON/OFF — DSR ENABLE

ON/OFF — DCD ENABLE

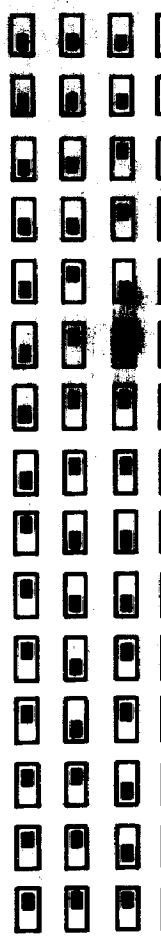
2bit/1bit — STOP BIT

8bit/7bit — DATA

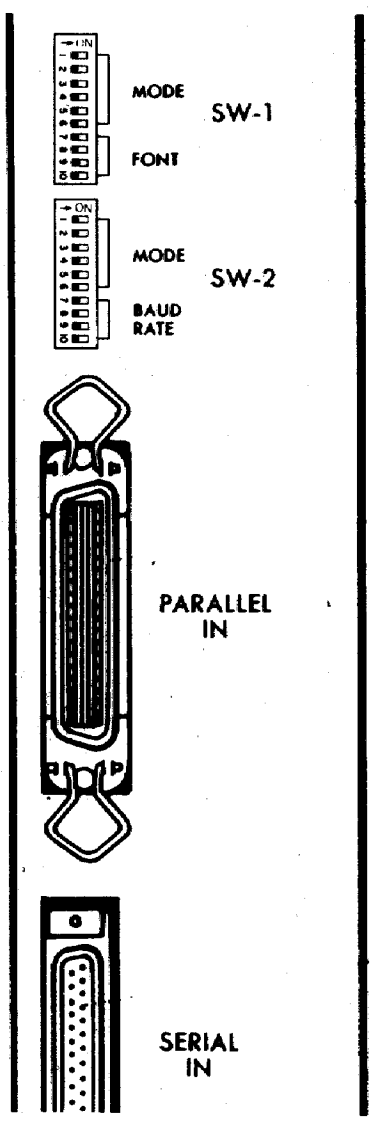
EVEN/ODD — PARITY

ENABLE/DISABLE — PARITY

BAUD RATE



- 50 BAUD
- 75 BAUD
- 110 BAUD
- 134.5 BAUD
- 200 BAUD
- 300 BAUD
- 600 BAUD
- 1200 BAUD
- 1800 BAUD
- 2000 BAUD
- 2400 BAUD
- 3600 BAUD
- 4800 BAUD
- 7200 BAUD
- 9600 BAUD



Function of DIP switches

1 - ①
If this is kept OFF, scaling is possible only by setting P1 and P2. (If it is turned ON, scaling is impossible only by setting P1 and P2.)

1 - ②
Specifies the minimum feed rate of X, Y and Z axes. The minimum feed rate is 1 (mm/sec) when it is OFF and about 0.4 (mm/sec) when it is ON.

1 - ③
Specifies the default value of the feed rate of the tool in the Z direction. When it is ON, the default value is 22 (mm/sec) and when it is OFF, the default value is 2 (mm/sec) if DIP switch 1-② is OFF but about 0.4 (mm/sec) if DIP switch 1-② is ON.

1 - ④
This should be kept OFF normally. Turning it ON sets CAMM-3 in the non-buffer state, therefore, it is convenient when debugging the program.

1 - ⑥
This setting depends on CAMM-3 connection with the computer, whether parallel (Centronics) or serial (RS-232C).

1 - ⑦ to 1 - ⑩
They set the designated character set of the particular font for each country initially in the program. Refer to the description under "^CS command" in the separate "COMMAND REFERENCE MANUAL".

2 - ①, 2 - ②
It should be kept OFF normally.

2 - ③ to 2 - ⑩
Set the conditions of the baud rate, parity check, etc. so that there must be set the same as those of the computer when CAMM-3 is connected serially (RS-232C).

3. CHARACTER CODE TABLE

Character set

→ High-order digit　ASCII　U1　U2

↓ Low-order digit

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	8	9	A	B	C	D	E	F
0				0	③	P	⑨	p		｜		－	タ	ミ		ｷ				－	た	み	－	生
1			!	1	A	Q	a	q		K	。	ｱ	ﾁ	ﾑ	ｱ	ｐ			。	あ	ち	む	二	円
2			"	2	B	R	b	r		｜	「	ｲ	ﾂ	ﾒ	ｲ	ｑ			「	い	つ	め	三	年
3	ETX		①	3	C	S	c	s		M	」	ｳ	ﾃ	ﾓ	ｳ	ｒ			」	う	て	も	四	月
4			$	4	D	T	d	t		N	、	ｴ	ﾄ	ﾔ	ｴ	ｓ			、	え	と	や	五	日
5			%	5	E	U	e	u		Ξ	・	ｵ	ﾅ	ﾕ	ｵ	ｔ			・	お	な	ゆ	六	時
6			&	6	F	V	f	v		O	ヲ	ｶ	ﾆ	ﾖ	ｶﾞ	ｕ			を	か	に	よ	七	分
7			②	7	G	W	g	w		Π	ｧ	ｷ	ﾇ	ﾗ	ｷﾞ	ｖ			ぁ	き	ぬ	ら	八	秒
8	BS		(	8	H	X	h	x	Α	P	ｨ	ｸ	ﾈ	ﾘ	ｸﾞ	ｗ			ぃ	く	ね	り	九	火
9			)	9	I	Y	i	y	Β	Σ	ｩ	ｹ	ﾉ	ﾙ	ｹﾞ	ｘ			ぅ	け	の	る	十	水
A	LF		*	:	J	Z	j	z	Γ	T	ｪ	ｺ	ﾊ	ﾚ	ｺﾞ	ｙ			ぇ	こ	は	れ	百	木
B	VT		+	;	K	④	k	⑧	Δ	T	ｫ	ｻ	ﾋ	ﾛ	ｻﾞ	ｚ			ぉ	さ	ひ	ろ	千	金
C			,	<	L	⑤	l	⑨	E	Φ	ｬ	ｼ	ﾌ	ﾜ	ｼﾞ	｛			ゃ	し	ふ	わ	万	土
D	CR		－	=	M	⑥	m	⑩	Z	X	ｭ	ｽ	ﾍ	ﾝ	ｽﾞ	｜			ゅ	す	へ	ん	¥	
E	SO		.	>	N	⑦	n	⑪	H	Ψ	ｮ	ｾ	ﾎ	ﾟ	ｾﾞ	｝			ょ	せ	ほ	゜	〒	
F	SI		/	?	O	⑧	o	ト	θ	Ω	ｯ	ｿ	ﾏ	・	ｿﾞ	～			っ	そ	ま	・	〇	

International Character Set

type set	①	②	③	④	⑤	⑥	⑦	⑧	⑨	Ⓐ	Ⓑ	Ⓒ	Ⓓ
(0):ANSI ASCII (I)	#	'	@	[	\	]	^	_	`	{	¦	}	~
(1):ANSI ASCII (II)	#	'	@	[	↓	]	↑	←	→	π	⊢	→	~
(2):French/German	£	'	@	[	ç	]	^	`	¨	°	¨	'	
(3):Scandinavian	£	'	@	Ø	Æ	ø	æ	`	¨	°	¨	°	
(4):Spanish/Latin	¿	'	@	[	¦	]	^	`	~	~	~	~	
(6):Swedish	#	'	É	Ä	Ö	Å	Ü	_	é	ä	ö	å	ü
(7):Danish/Norwegian	#	'	@	Æ	Ø	Å	Ü	_	'	æ	ø	å	ü
(13):Katakana(Japanese)	ASCII codes 20 (H) to 5F (H) are set to characters of A0 (H) to DF (H) of U1. ASCII codes 60 (H) to 7F (H) are set to characters of blank.												
(14):Hiragana(Japanese)	ASCII codes 20 (H) to 7F (H) are set to characters of A0 (H) to FF (H) of U2.												
(15):Mark	ASCII codes 41 (H) to 4F (H) (A to 0) are set to the following marks. A B C D E F G H I J K L M N O □ ◯ △ + × ◇ ♠ ⧖ ⧗ ♈ ⌑ ✳ ⧖ ｜ ✡												

Characters in the [ ] have the automatic backspace feature.

4. CONNECTION TYPES

(1) Parallel Connection

The input terminal CAMM-3 is compatible with Centronics Standard and can be connected to printer ports of most computers, using a printer cable. For methods of connection with various computers refer to "Connection with Primary Personal Computers". The CAMM-3 specification is as follows.

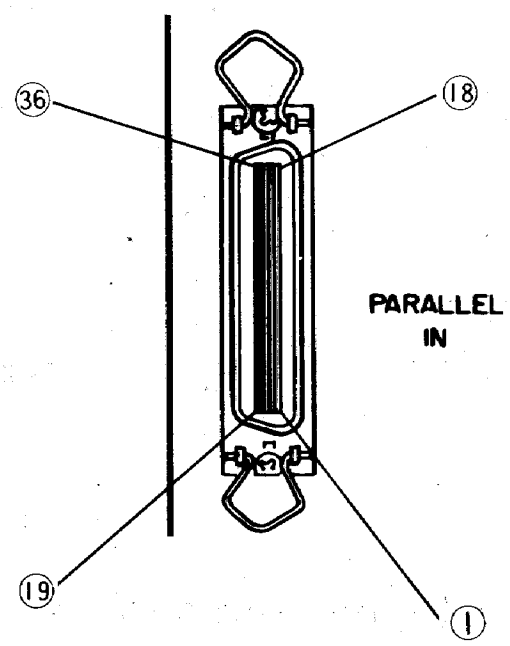
a. Connector

Use DDK 57-30360, AMP 552235-1 or equivalent. The CAMM-3 is provided with HRS RC10-36R3-LW or equivalent.

NC	36	18	HIGH ※※
NC	35	17	GND
NC	34	16	GND
GND	33	15	NC
HIGH ※	32	14	NC
NC	31	13	HIGH ※
GND	30	12	GND
	29	11	BUSY
	28	10	$\overline{\text{ACK}}$
	27	9	D 7
	26	8	D 6
	25	7	D 5
	24	6	D 4
	23	5	D 3
	22	4	D 2
	21	3	D 1
	20	2	D 0
	19	1	$\overline{\text{STROBE}}$

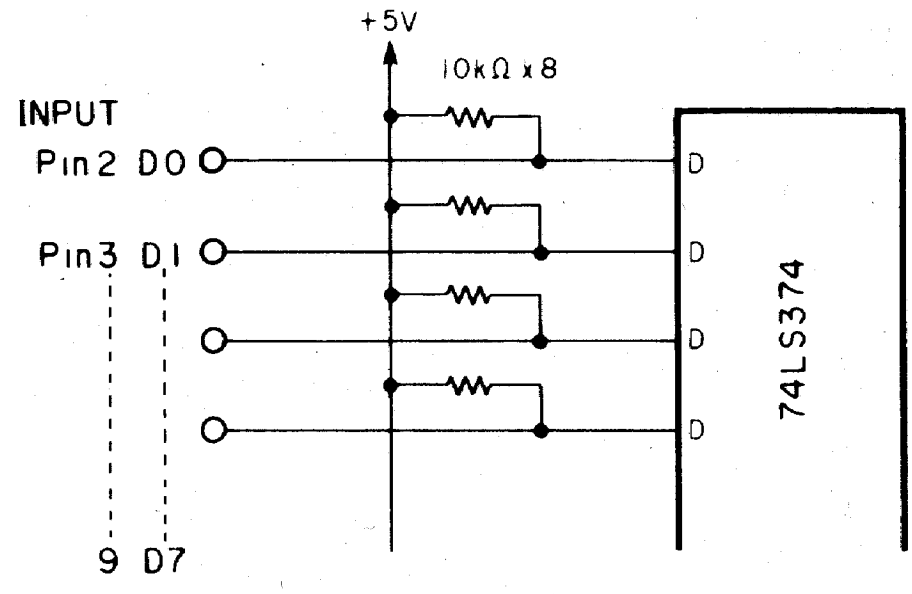
※ = 4.7KΩ + 5V

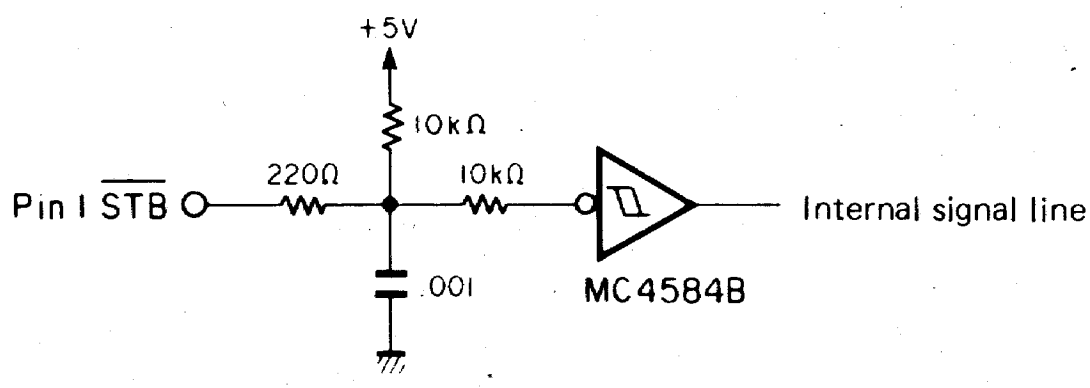
※※ = 100Ω + 5V

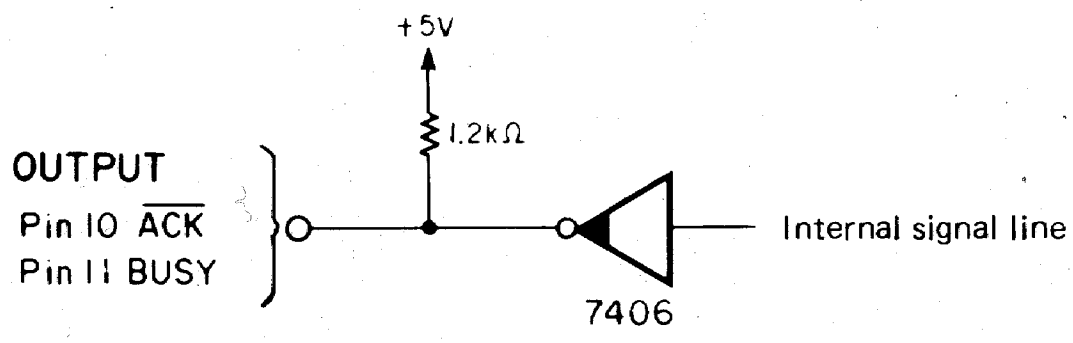


b. Input/Output Signal Lines

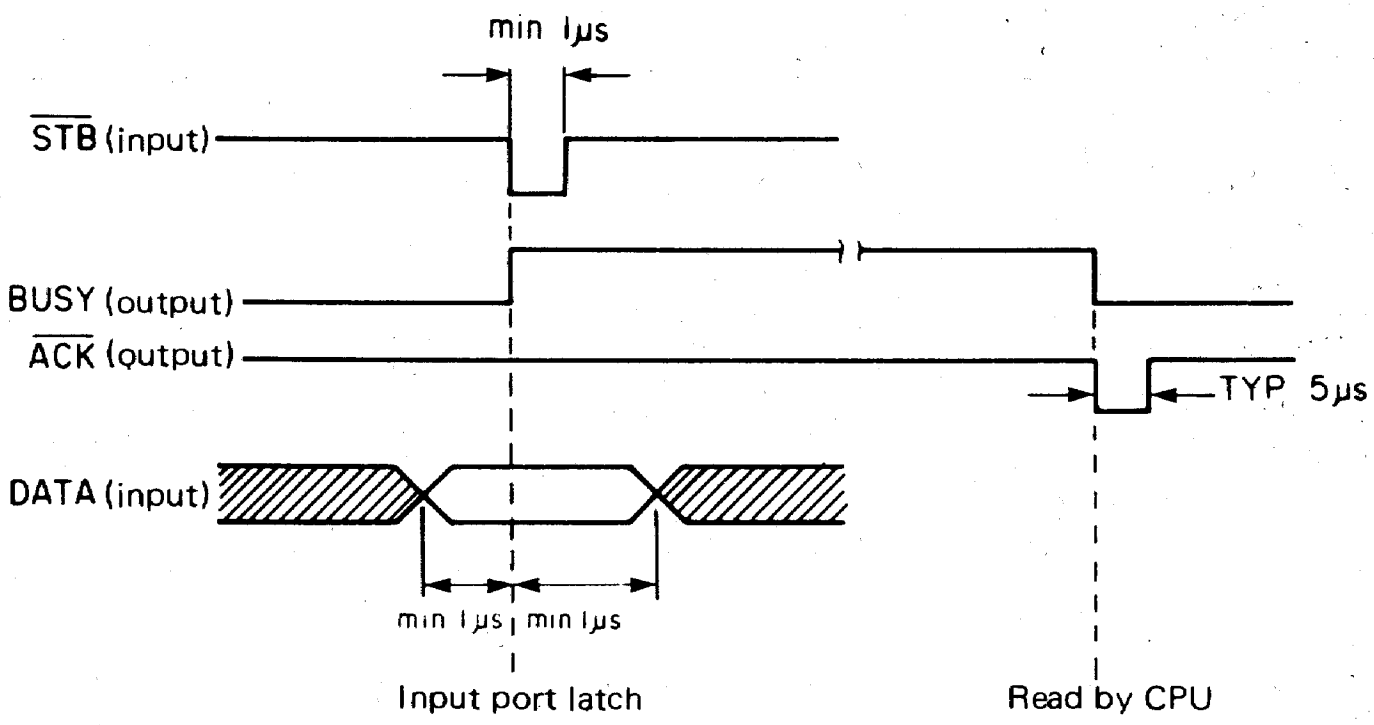
Input/output signals of individual terminals are as follows.







c. Input/Output Signal Timing Chart



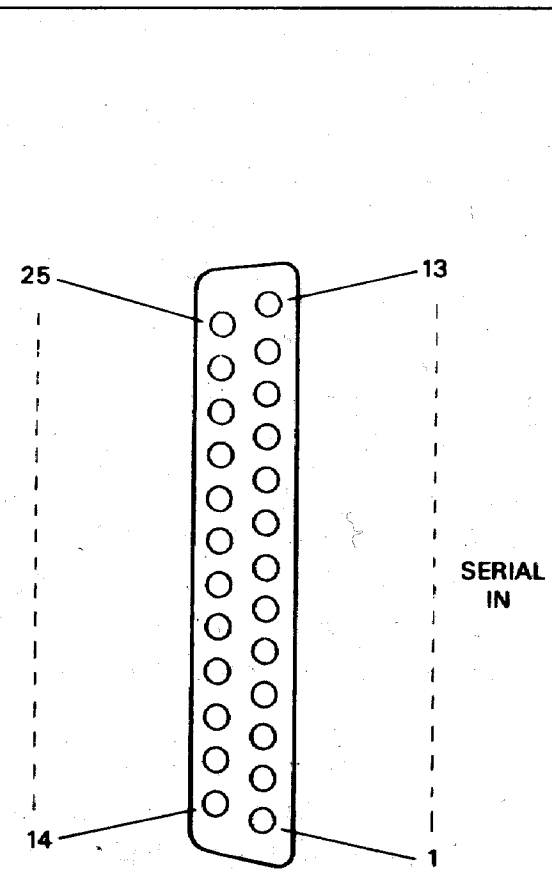
(2) Serial Connection

For serial (RS-232C) connection with various computers, refer to "Connection with Primary Personal Computers". For other computers or conditions refer to the following.

a. Connector

Use JAL DB-25PA-XX or equivalent. The CAMM-3 is provided with DBLC-25AF or equivalent.

RS-232C connector

Terminal No.	Signal	Pin connection
1	FG	
2	TXD	
3	RXD	
4	RTS	
5	CTS	
6	DSR	
7	SG	
8	DCD	
9	NC	
10	NC	
11	NC	
12	NC	
13	NC	
14	S. TXD	
15	NC	
16	S. RXD	
17	NC	
18	NC	
19	NC	
20	DTR	
21	NC	
22	NC	
23	NC	
24	NC	
25	NC	

b. Signal Lines

Pin No.	Abbrev.	Description	I/O
1	FG	Security line which is normally connected with the computer frame. Connected to the CAMM-3 frame.	[Com]
2	TXD	Transmit data: Data output from the CAMM-3 to the computer. Connected to the receive data line of the computer. SPACE = " 0 " = +12V MARK = " 1 " = −12V	[Output]
3	RXD	Receive data: Data receive line of the CAMM-3 from the computer. Connected to the transmit data line of the computer. SPACE = " 0 " = +3V to +25V MARK = " 1 " = −3V to −25V	[Input]
4	RTS	Request to send. Output from the CAMM-3 to the computer. When DIP SW 1-⑤ is set ON (to serial), only ON (+12V) is outputted. With DIP SW 1-⑤is set OFF (to parallel), always OFF (−12V) is outputted. *Since it is set when the power switch is turned ON, turning OFF then ON the power switch is necessary for re-setting.	[Output]
5	CTS	Clear to send: Input from the computer to the CAMM-3. When the signal line is ON (+3V to +25V), the CAMM-3 is ready to output data, or when the line is OFF (−3V to −25V), no data will be output. When unconnected, the CAMM-3 operates with its always ON status.	[Input]
6	DSR	Data set ready: Normally this line is connected with a line to indicate ready-to-operate status of a modem. Input from the **computer to the CAMM-3. Same as for CTS when unconnected, with no problem normal operation of the CAMM-3.**	[Input]
7	SG	**Signal ground, connected with the internal ground line in the CAMM-3.**	[Com]
8	DCD	Carrier detect, indicating data receive carrier detection. Input from the computer to the CAMM-3. Same as for DSR when unconnected. Note: Select either DSR or CD by DIP SW 2-⑨ and ⑩. If computer output is connected when both 9 and 10 are ON, the driver IC of the computer can be damaged. The CAMM-3 output is not controlled by ON/OFF of this line.	[Input]
14	S. TXD	Normally, do not connect.	
16	S. RXD	Normally, do not connect.	
20	DTR	Data terminal ready: signal to indicate that the system is ready to communicate. As in RTS, with DIP SW 1-⑤ set to ON (to serial), The CAMM-3 outputs ON (+12V). When hardware handshake is enabled by the ESC @ command and remaining capacity of the buffer is 1/4, DTR is OFF (−12V). When remaining capacity is resumed to 1/2, DTR is ON (+12V). When hardware handshake is set to disable by the ESC @ command, DTR is always +12V. DTR can be connected with CTS, DSR or DCD of the computer for handshaking, provided that the computer should have a function to monitor the above signal line and stop the data output.	[Output]

5. SPECIFICATIONS

■ CAMM-3 MODEL PNC-3000 SPECIFICATIONS

XY TABLE SIZE	500mm × 170 mm (19-11/16" × 6-11/16")
AXIS TRAVEL (X·Y·Z)	180mm × 150mm × 150mm (7-1/16" × 5-7/8" × 5-7/8")
TOOL CHUCK	Collet Type (drill chuck optional)
PRECISION	0.01mm/step (Internal Processing at 0.005mm/step)
MAX.FEED RATE (SPEED)	1.2m/min. (set either manually or by programming)
SPINDLE MOTOR	100W, AC Commutator Motor
WEIGHT	55kg. (121.3 lbs.)
SIZE (W·H·D)	500mm × 580mm × 580mm
(DIMENSIONS)	19-11/16" × 22-3/4" × 22-3/4"
SPINDLE RPM	3,000 ~ 8,000 rpm (with manual control)
INTERFACE	Parallel (Centronics)/Serial (RS-232C)
DISPLAY	X, Y and Z Axis Digital Coordinate Displays (unit-0.01mm)
	Table Feed Rate
	Spindle RPM
	Error Indicator
CONTROLS	Control—PAUSE, MOTOR ON/OFF, DISPLAY RESET, SENSOR, FEED RATE
	Data Input—ON/OFF, WRITE, START
	Positioning—Z0, Z1, Z2, P1, P2, HOME, ENTER
	JOG—Fast Feed Keys (X, Y, Z)
	Fine Adjust Dials (X, Y, Z), MANUAL ON/OFF
	Emergency Stop; Spindle Motor Control;
	Power Switch
CONTROL COMMANDS	CAMM-GL1 (CAMM Graphic Language 1)
STANDARD ACCESSORIES	ϕ 6 Collet Chuck
	Collet Wrenches (2)
	AC Cord
	Carrying Bolts (4)
	Sensor Switch
	Fuses (2)
	AC Motor Brushes (4)
	Allen Wrenches (2)
	T Nut Sets (2)
	User's Manual
	Command Reference Manual

Changes in Specifications, accessories, options and commands may occur without notice.