

MACHINEMATE[®]

Product Guide

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Capabilities

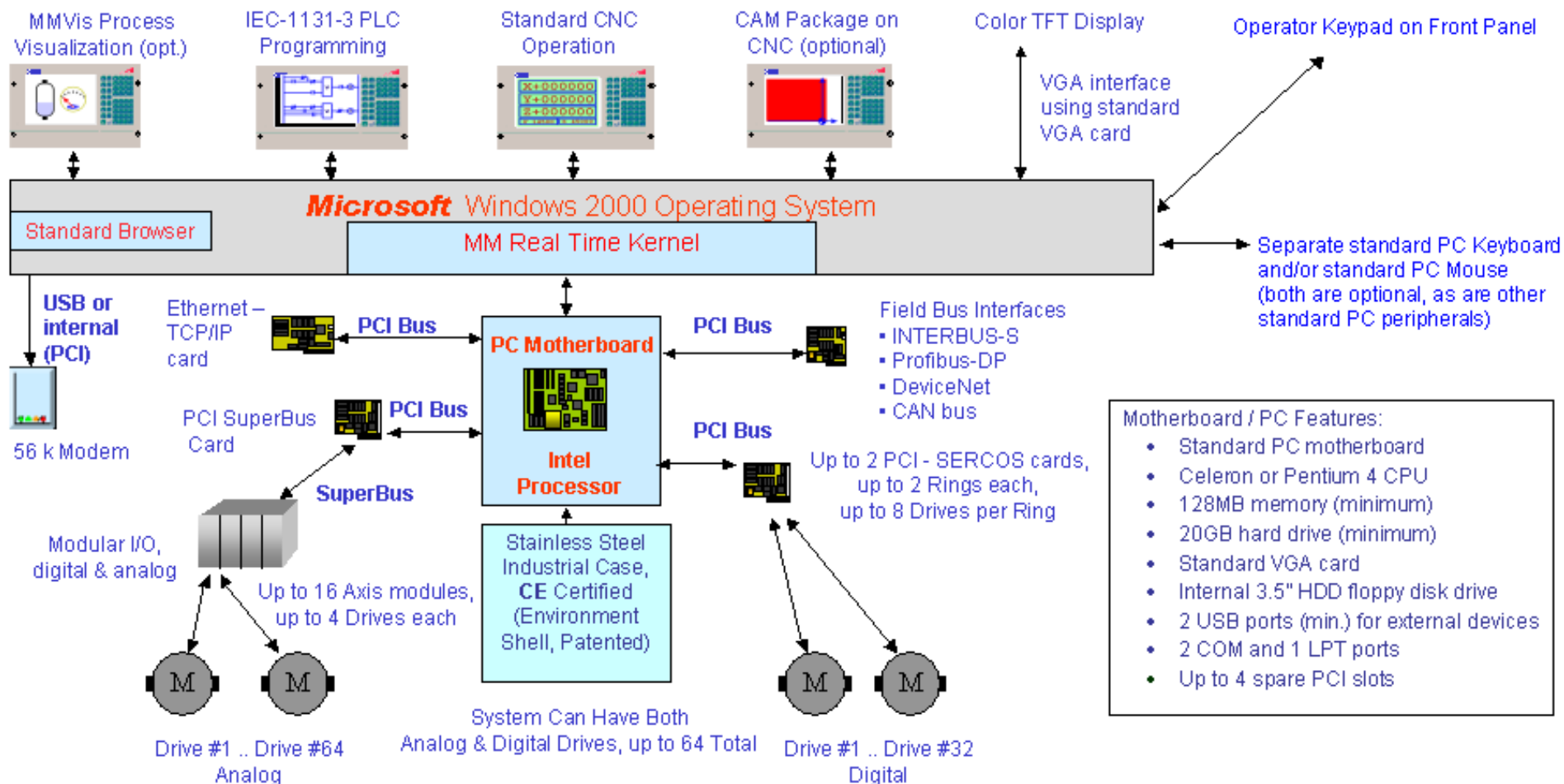
Specifications

Standard Features

CNC Engines

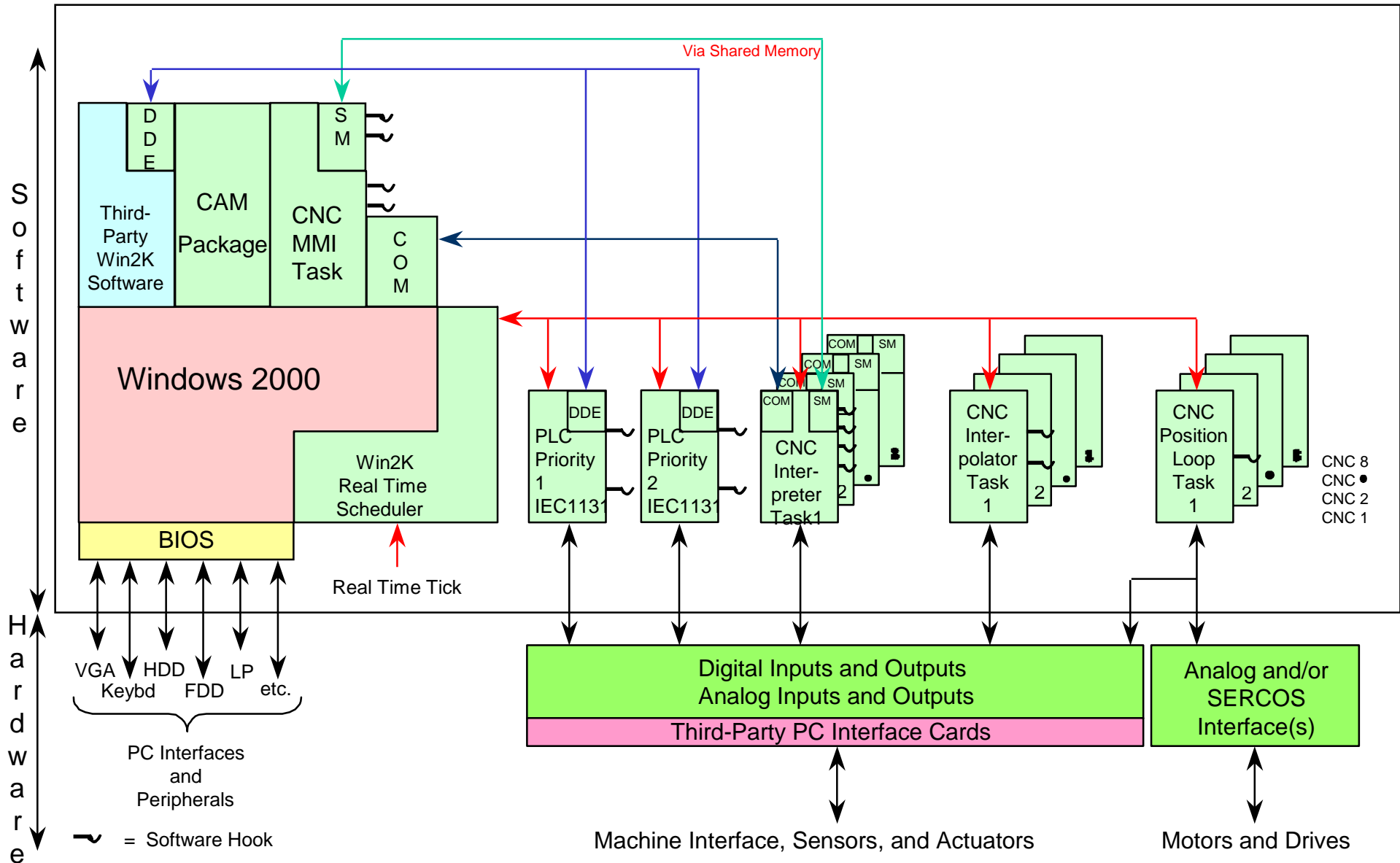
Accessories

MACHINEMATE - Open PC Based CNC - Using International Standards



MACHINEMATE® CNC Architecture

All Software Runs on the Main PC Processor (Celeron 1 GHz+, Pentium 4 1.7Ghz+)



MACHINEMATE® - A CNC That is Truly Open

| CNC Functions | Software | Hardware |
|---------------|---|---|
| MMI and COM | MMI & CAM or Third-Party S/W Compile Cycles Ethernet | PC hardware PC Motherboard, Third-Party PC PCI Boards |
| CNC Kernel | CNC Kernel DDE Interface or Applications through Compile Cycles (C++) | Third-Party PC PCI Boards |
| PLC | Software PLC (IEC 1131-3) or Other Soft PLC or C++ | Discrete I/O InterBus-S, Profibus, CAN Bus, DeviceNet via PCI Board |
| Drives | SERCOS Protocol or Analog Drives | SERCOS Board, Analog ± 10 V, Third-Party Drives (S or A) |

**Open Standards
or
Third-Party
Standards**

Proprietary
Components
Provided by
MACHINEMATE, INC.

Application Technologies

- HSC Drilling
- 2½D Milling
- 2½D Machining Center
- 2½D HSC Milling
- Multi-Station CNC Milling
- Two-Axis Turning (Standard and Sub-Micron)
- High Precision Turning
- Diamond Turning (Nanometer)
- Multi-Spindle Turning
- Combined Milling/Turning
- High-Precision Measuring Machines
(3D-Probe or 3D Laser Scanner)
- 2D Laser Cutting
- 2D Laser Welding
- 2D Plasma Cutting
- Electrical Die Sinking
- Electrical Wire Cutting
- Glass Cutting
- Glass Grinding
- High Precision Aspherical Glass Grinding
- Gear Hobbing
- Electron Beam Welding
- Five-Axis Milling (Includes Gantry
Machines)
- Five-Axis HSC Milling
- Five-Axis Turbine Blade Milling
- Five-Axis Laser Cutting
- Five-Axis Laser Welding
- Five-Axis Surface Treatment
- Five-Axis Grinding
- Five-Axis Wood Milling

MACHINEMATE® Windows 2000 CNC Model

PERFORMANCE DATA

| | | L2 or eCNC – H | L2 or eCNC – HS | eCNC – HSB |
|--|------|----------------------|----------------------|----------------|
| Blocks per Second (ISO) | | 225 | 450 | 1800 |
| Typical Position Loop Gain | | 4 | 7 | 15 |
| CNC Stations (standard/max.) | | 1/2 | L2: 1/2, eCNC: 1/4 | 1/8 |
| Standard Number of Axes | | 4(A)/8(S) | 4(A)/8(S) | 4(A)/8(S) |
| Maximum Number of Axes | | L2:12(8S),eCNC:16 | L2: 12(8S), eCNC: 32 | 64/64(A)/32(S) |
| Dynamic Block Buffer [Blocks] | Base | 50 | 50 | 50 |
| | Max. | 1000 | 1000 | 1000 |
| NC Program Memory [KB/MB] (on CNC / on hard disk) | Base | 128/8000 | 128/8000 | 128/8000 |
| | Max. | 872/8000+ | 872/8000+ | 872/8000+ |
| PLC Memory [KB] | Base | 64 | 64 | 64 |
| | Max. | 256 | 256 | 256 |
| Inputs/Outputs | Base | L2S:24/16 else 48/32 | L2S:24/16 else 48/32 | 48/32 |
| | Max. | 792/528 | 792/528 | 792/528 |

Note: A – Analog Axes; S – SERCOS Axes

MACHINEMATE® Windows NT CNC Model

PERFORMANCE DATA

| | | MM1 | MM3 | MM5 | MM7 |
|--|------|-----------|-----------|-------------|-------------|
| Blocks per Second (ISO) | | 112 | 225 | 450 | 1800 |
| Typical Position Loop Gain | | 3 | 4 | 7 | 15 |
| CNC Stations (standard/max) | | 1/2 | 1/2 | 1/4 | 1/8 |
| Standard Number of Axes | | 4(A)/8(S) | 4(A)/8(S) | 4(A)/8(S) | 4(A)/8(S) |
| Maximum Number of Axes | | 8(A)/8(S) | 8(A)/8(S) | 16(A)/32(S) | 16(A)/32(S) |
| Dynamic Block Buffer [Blocks] | Base | 50 | 50 | 50 | 50 |
| | Max. | 1000 | 1000 | 1000 | 1000 |
| NC Program Memory [KB/MB] (on CNC / on hard disk) | Base | 128/800 | 128/800 | 128/800 | 128/800 |
| | Max. | 872/2100 | 872/2100 | 872/2100 | 872/2100 |
| PLC Memory [KB] | Base | 64 | 64 | 64 | 64 |
| | Max. | 256 | 256 | 256 | 256 |
| Inputs/Outputs | Base | 24/16 | 24/16 | 48/32 | 48/32 |
| | Max. | 792/528 | 792/528 | 792/528 | 792/528 |

Note: A – Analog Axes; S – SERCOS Axes

FACTS = Fast & ACcuraTe & Smooth - Components

Geometry Look-Ahead

Checks for violations of the established tolerance band during direction changes of the contour. Velocity and acceleration will be adjusted such that the tolerance band will not be exceeded.

Dynamic Look-Ahead

Checks during interpolation whether velocity or acceleration are exceeding the respective maximum values for the machine. The path velocity will be adjusted accordingly.

Adaptive ART

A self-adapting algorithm, which enables the feed forward function to achieve zero lag operation even in case of velocity changes on arcs, helix and spline. (ART=Advanced Regulation Technology)

Adaptive Path Filter

Checks for critical frequency ranges during the control process; limits resonances within the control loop in context with the path.

Cubic Spline Interpolator

Located between interpolator and position controller. Is based on cubic spline and introduces smooth acceleration transitions between points of interpolator and position controller.

Ramp Function

Linear ramps (for maximum productivity) are combined with smoothing through exponential behavior. This method yields highest productivity together with smooth acceleration.

Overview MACHINEMATE® Functions (I)

| | | | |
|-------|--|-------|--|
| G 000 | Rapid Traverse | G 025 | Programmable Work Area, Upper Limits |
| G 001 | Linear Interpolation | G 026 | Programmable Work Area "Off" |
| G 002 | Circular Interpolation (clockwise) (circle center) | G 027 | Programmable Work Area "On" |
| G 003 | Circular Interpolation (counterclockwise) | G 033 | Programmable Thread Cutting, Constant Lead |
| G 012 | Circular Interpolation (clockwise) (radius) | G 034 | Thread Cutting, Variable Lead |
| G 013 | Circular Interpolation (counterclockwise) | G 035 | Prepare Oscillation |
| G2/G3 | Helical Interpolation | G 038 | Programmable Mirror Image "On" |
| G 004 | Dwell in Milliseconds | G 039 | Programmable Mirror Image "Off" |
| G 005 | Spline Type | G 040 | Tool Radius Compensation "Off" |
| G 006 | Spline Interpolation (Refer to Specification, p. 29) | G 041 | Tool Radius Compensation Left of Path/Intersection |
| G 007 | Tangent Circle Interpolation | G 042 | Tool Radius Compensation Right of Path/Intersection |
| | Helical Interpolation | G 043 | Tool Radius Compensation Left of Path/Perpendicular |
| | Polygonal Interpolation | G 044 | Tool Radius Compensation Right of Path/Perpendicular |
| | Feedrate Interpolation | G 050 | Scaling |
| G 008 | Ramp at Block Transition | G 051 | Part Rotation; Programming in Degrees |
| | Look Ahead "Off" | G 052 | Part Rotation; Programming in Radians |
| G 009 | No Ramp at Block Transition | G 053 | Zero Offset Cancel |
| | Look Ahead (23 Blocks) | G 054 | Zero Offset 1, Per Axis |
| G 010 | Stop Dynamic Block Pre-Processing | G 055 | Zero Offset 2, Per Axis |
| G 011 | Stop Interpolation During Block Pre-Processing | G 056 | Zero Offset 3, Per Axis |
| G 014 | Polar Coordinate Programming absolute | G 057 | Zero Offset 4, Per Axis |
| G 015 | Polar Coordinate Programming incremental | G 058 | Zero Offset 5, Per Axis |
| G 016 | Definition of Pole | G 059 | Zero Offset 6, Per Axis |
| G 017 | Plane Selection X, Y | G 063 | Feedrate/Spindle Override Deactivated |
| G 018 | Plane Selection Z, X | G 066 | Feedrate/Spindle Override Activated |
| G 019 | Plane Selection Y, Z | G 070 | Inch Format |
| G 020 | Plane Selection, Programmable | G 071 | Metric Format |
| G 021 | Parallel Axes "On" | G 072 | Interpolation with In-Position-Tolerance "Off" |
| G 022 | Parallel Axes "Off" | | |
| G 024 | Programmable Work Area, Lower Limits | | |

Overview MACHINEMATE® Functions (II)

| | | | |
|-------|---|-------|---|
| G 073 | Interpolation with In-Position-Tolerance “On“ | G 105 | Polar Transformation “On“, Polar Axis Letters |
| G 074 | Programmable Referencing | G 106 | Cylinder Transformation “On“, Polar/Cylindrical Coordinates |
| G 075 | Curvature | G 107 | Cylinder Transformation “On“, Polar/Cyl. Coord. with RRC |
| G 078 | Approach to Contour “On“ (With Rotary Axis Orientation) | G 108 | Cylinder Transformation “On“, Polar/Cyl. Coord. w/PO & RRC |
| G 079 | Approach to Contour “Off“ | G 109 | Axis Transf., Programming of Tool Cutting Depth |
| G 080 | Canned Cycle “Off“ | G 110 | Power Control, Axis Selection/Channel 1 |
| G 081 | Canned Cycle “Drilling“ | G 111 | Power Control, Pre-Selection V1, F1, T1/Channel 1 |
| G 082 | Canned Cycle “Facing with Dwell“ | G 112 | Power Control, Pre-Selection V2, F2, T2/Channel 1 |
| G 083 | Canned Cycle “Deep Hole Drilling“ | G 113 | Power Control, Pre-Selection V3, F3, T3/Channel 1 |
| G 084 | Canned Cycle “Tapping with Floating Holder“ | G 114 | Power Control, Pre-Selection T4/Channel 1 |
| G 085 | Canned Cycle “Reaming“ | G 115 | Power Control, Pre-Selection T5/Channel 1 |
| G 086 | Canned Cycle “Boring“ | G 116 | Power Control, Pre-Selection T6/Pulsing Output |
| G 087 | Canned Cycle “Reaming with Stop for Gauging“ | G 117 | Power Control, Pre-Selection T7/Pulsing Output |
| G 088 | Canned Cycle “Boring with Spindle Stop“ | G 120 | Axis Transf.; Change Orient. of Rotary Axis for Linear Intpl. |
| G 089 | Canned Cycle “Boring with Intermediate Stop“ | G 121 | Axis Transf.; Change Orientation In One Plane |
| G 090 | Absolute Programming | G 125 | Electronic Gearbox; Straight Teeth |
| G 091 | Incremental Programming | G 126 | Electronic Gearbox; Slant Teeth, Axial |
| G 092 | Programmable Zero Shift | G 127 | Electronic Gearbox; Slant Teeth, Tangential |
| G 093 | Constant Circumference Speed “On“ (Grinding Wheel) | G 128 | Electronic Gearbox; Slant Teeth, Diagonal |
| G 094 | Feedrate Programming in mm/min | G 130 | Axis Transf.; Progr. Mode of Orientation Change |
| G 095 | Feedrate Programming mm/Spindle Revolution | G 131 | Axis Transf.; Progr. Mode of Orientation Change |
| G 096 | Constant Cutting Speed “On“ | G 132 | Axis Transf.; Progr. Mode of Orientation Change |
| G 097 | Constant Cutting Speed “Off“ | G 133 | Learning Mode Threading without Lag “On“ |
| G 098 | Positioning Axis Signal to PLC | G 134 | Learning Mode Threading without Lag “Off“ |
| G 100 | Polar Transformation “Off“ | G 135 | Distance Control, Axis Selection |
| G 101 | Polar Transformation “On“, Cartesian Axis Letters | G 140 | Axis Transformation; Work piece Coordinates |
| G 102 | Cylinder Transformation “On“, Cart. Coordinate System | G 141 | Axis Transformation; Active Coordinates |
| G 103 | Cylinder Transformation “On“, w/Real Time Radius Comp.(RRC) | | |
| G 104 | Cylinder Transformation w/Profile Offset (PO) and RRC | | |

Overview MACHINEMATE® Functions (III)

| | | | |
|-------|--|-------|---|
| G 160 | Activate ART | G 210 | Power Control, Axis Selection/Channel 2 |
| G 161 | ART Learning Function for Velocity Parameters “On“ | G 211 | Power Control, Pre-Selection V1, F1, T1/Channel 2 |
| G 162 | ART Learning Function “Off“ | G 212 | Power Control, Pre-Selection V2, F2, T2/Channel 2 |
| G 163 | ART Learning Function for Acceleration Parameters “On“ | G 213 | Power Control, Pre-Selection V3, F3, T3/Channel 2 |
| G 164 | ART Learning Function for Acceleration Changes “On“ | G 214 | Power Control, Pre-Selection T4/Channel 2 |
| G 165 | Path Filter “On“ | G 215 | Power Control, Pre-Selection T5/Channel 2 |
| G 166 | Path Filter “Off“ | G 270 | Turning Finish Cycle |
| G 170 | Digital Probing Signals; Block Transfer with Hard Stop - (Stops and Backs Up) | G 271 | Stock Removal in Turning |
| G 171 | Digital Probing Signals; Block Transfer without Hard Stop - (Measures on Fly) | G 272 | Stock Removal in Facing |
| G 172 | Digital Probing Signals; Block Transfer with Soft Stop | G 310 | Power Control, Axis Selection/Channel 3 |
| G 175 | SERCOS Ident Number Write | G 311 | Power Control, Pre-Selection V1, F1, T1/Channel 3 |
| G 176 | SERCOS Ident Number Read | G 312 | Power Control, Pre-Selection V2, F2, T2/Channel 3 |
| G 180 | Axis Transformation “Off“ | G 313 | Power Control, Pre-Selection V3, F3, T3/Channel 3 |
| G 181 | Axis Transf. With Non-Rotated Coordinate System | G 314 | Power Control, Pre-Selection T4/Channel 3 |
| G 182 | Axis Transf. With Rotated/Translated Coordinate System | G 315 | Power Control, Pre-Selection T5/Channel |
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| G 184 | Axis Transf.; Programming Tool Dimensions | | |
| G 186 | Look Ahead; Corner Acceleration, Tolerance on Arc | | |
| G 188 | Activate Positioning Axes | | |
| G 190 | Diameter Programming “Off“ | | |
| G 191 | Diameter Programming “On“ and Display Tangent Point | | |
| G 192 | Diameter Programming Display Tangent Point Diameter | | |
| G 193 | Diameter Programming Display Tangent Point to Center Line | | |
| G 200 | Corner Rounding “Off“ | | |
| G 201 | Corner Rounding “On“ with Defined Radius | | |
| G 202 | Corner Rounding “On“ with Defined Corner Deviation | | |
| G 203 | Corner Rounding “On“ with Defined Radius up to Maximum Deviation | | |

Overview MACHINEMATE® Functions (IV)

| | |
|-------|--|
| M 000 | Unconditional stop |
| M 001 | Conditional stop |
| M 002 | End of program |
| M 003 | Spindle clockwise |
| M 004 | Spindle counterclockwise |
| M 005 | Spindle stop |
| M 006 | Tool change (see Note below) |
| M 019 | Spindle orientation |
| M 020 | Oscillation On |
| M 021 | Oscillation Off |
| M 030 | End of program |
| M 040 | Automatic spindle gear selection |
| M 041 | Spindle gear transmission step 1 |
| M 042 | Spindle gear transmission step 2 |
| M 043 | Spindle gear transmission step 3 |
| M 044 | Spindle gear transmission step 4 |
| M 045 | Spindle gear transmission step 5 |
| M 046 | Spindle gear transmission step 6 |
| M 070 | Spline, beginning and end curve 0 |
| M 071 | Spline, beginning tangential and end curve 0 |
| M 072 | Spline, beginning curve 0 and end tangential |
| M 073 | Spline, beginning and end tangential |
| M 080 | Delete the rest of distance using probe function |

Note: The M-code values for the machine-specific functions, for such features as coolant control, are specified in the PLC application. Their values are not defined by the CNC.

MACHINEMATE[®]

CNC SERIES

SYSTEM SPECIFICATION

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1. INTRODUCTION

Superior Capability in Technology and Productivity

The **MACHINEMATE CNC** provides you with innovative high-performance technology to handle the ever-increasing demands of today's automation industry.

MACHINEMATE's modern and fully open CNC architecture, using a single, powerful Pentium CPU, gives you leading-edge CNC performance and flexibility. With **MACHINEMATE**, you do not sacrifice openness for CNC performance. There are good open architecture controls and good CNC controls on the market; but until **MACHINEMATE**, both did not exist in one single processor control.

The **MACHINEMATE CNC** fulfills all technical requirements from standard to high-tech applications. A variety of performance levels and technology functions is available. A high-performance CNC control does not have to be high-priced anymore. The compact and modular **MACHINEMATE CNC** provides you with the performance you need at an excellent price / performance ratio. Now you can have the openness of a PC in an industrial package that is enclosed in stainless steel with an IP65 rated front panel.

Modularity

To match the **MACHINEMATE CNC** to your requirements, four different performance levels are available as the economy version, the traditional version, the standard version and the plus version. A variety of hardware components such as a 10.4" or 12.1" TFT-display, different I/O components, ASCII drawer keyboard, and Teach-In Panel allow various customized configurations. Digital drives (SERCOS) or standard analog drives can be interfaced to **MACHINEMATE**.

PC Technology

The **MACHINEMATE CNC** is based on standard PC technology, integrated on an industrial level. Through the standard PC motherboard, with the powerful Pentium processor running the standard **Windows 2000** operating system, plus our **Real Time Kernel**, the **MACHINEMATE CNC** is open to the PC components manufactured world wide. This way, a modern **Windows 2000**-based human machine interface was readily incorporated. As an option, a touch screen of 15" TFT color on the 19" rack mount front panel is available. Third party displays can be interfaced also since the front panel display cable is for the standard VGA. Moreover, there is the possibility to have 2 GB or more of NC program memory by means of PC hard disk technology. All types of communications ranging from

simple serial interfaces to a complex network environment are available. Aided by the standard PC operating system, you can integrate your own PC software such as NC programming tools, statistical programs, and visual programs in your control.

A CNC That is Truly OPEN

Based on a truly open architecture (including the CNC kernel), you can integrate, in a very secure and efficient manner, your application-specific knowledge and proprietary software routines written in C++ into the CNC. Your unique CNC functionality can be integrated into the CNC operating system with highly efficient software tools called “Compile Cycles.” In addition to such unique software, third-party PC-based hardware and software can be integrated due to the standard bus system (PCI) used.

Application Experience and Know-how

From two-axes turning, three-axes laser cutting to complex five-axes milling machines, the **MACHINEMATE CNC** fulfills a wide range of application requirements. A long list of standard functionality, including compensations, as well as high-tech functions such as five-axis transformation, make the **MACHINEMATE** an extremely versatile CNC.

High-Speed Machining

An important factor in machine tool productivity is the feedrate. New machine concepts and new tooling technologies require accurate and responsive controls with continuously increasing feedrates. Extremely short block cycle times (up to 2000 blocks/sec.) and specific control algorithms and communication functions are required for high-speed machining. “**Adaptive Look Ahead**” analyzes multiples of up to 1000 NC blocks ahead in real-time and calculates the maximum achievable feedrate for complex machining requirements staying within the programmed parameters and constraints.

Accuracy

The demands for increased productivity, higher accuracy, and better surface finish are continuously increasing. For higher accuracy and better part finish, the productivity of the machine tool should not be sacrificed. The **MACHINEMATE CNC** provides a solution to compensate for the machine kinematics, environmental conditions, and various other factors that cause errors in the machining process. With the **MACHINEMATE** and its software tool “**FACTS**” (**F**ast, **A**ccura**T**e, and **S**mooth), you can achieve an optimum in accuracy, execution speed, and surface finish. “**ART**” (**A**dvanced **R**egulation **T**echnology) assists you in compensating path errors in real-time and reduces machine resonance when the feedrate is changed. During installation, “**ART**” automatically acquires the optimum parameters for each axis and compensates those parameters during the machining process as required.

Human Machine Interface

Using six clearly defined modes of operation and a simple and clean-cut menu-driven operation via soft keys, the machine operator will find the operation of the **MACHINEMATE** easy to learn and use. By means of the common window technology, the information is presented where it is needed on the screen.

2. **MACHINEMATE** ILLUSTRATION



The picture shows the **MACHINEMATE** CNC package, including the CE-rated industrial PC (at the left), the 19" rack-mount IP65-rated front panel (in the middle), the front panel cables (at the lower left), remote IO boxes (at the right) and the complete software package.

3. OPERATIONAL COMPONENTS

- Operator's module
 - ⇒ Color flat TFT screen display 10.4" or 12.1" (See Figure 2.0)
 - ⇒ VGA (640 x 480, 10.4"), SVGA (800 x 600, 12.1")
 - ⇒ Membrane keypad with short stroke keys
 - ⇒ Mode selection keys
 - ⇒ Soft keys
 - ⇒ Alphanumeric keypad
- 15" flat TFT touch screen in 19" rack mount panel (optional)
- Touch add-on to 12.1" display (optional)
- 9" monochrome CRT (optional)

4. OPERATION

The **MACHINEMATE CNC** has six different operating modes that are selected by means of soft keys. Alternatively they may be selected through a pointing device, i.e., a cursor, a mouse, or alternative means.

MANUAL

- Jog Continuously
- Traverse to Reference Point
- Auxiliary Functions
- Jog Incrementally
- Retreat (return to path)
- Jog with Hand Wheel

AUTOMATIC

- Program Selection
- Program Test
- Path Graphics
- Backward
- Program Process 1 (Sequential, Single Block, MDI)
- Program Process 2 (Block Skip /, Optional Halt M01, Initial State)

DATA

- Selection
- Load
- Save
- Edit
- Modify
- Manage

INFORMATION

- Interface Display, CNC / PLC
- Version

- Status Treatment
- Path Graphic of program in simulation (offline test)
- Log Book

SYSTEM

- Display Functions
- Station (Channel) Selection
- Exit
- Operations
- Settings
- Minimize

SETUP

- PLC
- Machine Parameters
- SERCOS Monitor
- I/O Configuration
- Drive Configuration
- Pitch Error Comp
- Gantry Initialize
- Logic Analyzer

5. DISPLAY/DIAGNOSTICS

Display Languages

Two display languages are selectable:

- English
- German
- Other Languages on Request

NC Axis Information

- Position
- Direction
- Output Voltage
- Distance To Go
- Active Offsets
- Velocity
- Lag (Following Error)
- Position Loop Gain
- End Position
- Offset Values

Stored Data Information

- NC Programs
- Radius Compensation
- File Attributes
- PLC Programs
- Tool Length Offsets
- Zero Offsets

Status Information

- Auxiliary Functions
- Active Block

- Active G Codes
- PLC Interface
- Active NC Program Status

- Active Subprogram
- Program Repetition

System Memory

- Memory Size for Both CNC and Windows System
- Memory Space Available

- Number of Part Programs
- Program Size

Interfaces/Data Ports

- CNC ↔ PLC Interface
- Serial Interfaces*
- External Device Definition

- PLC ↔ Machine Interface
- Serial Interface Setup*

*May require additional software.

User Information Box

- Error Messages in Legible Text

- Time and Date Display
- Help Messages in Legible Text

Machine Parameters

- Legible Machine Parameters
- Edit Machine Parameters

- Input/Output of Machine Parameters

6. AXES/AXIS FUNCTIONS

4 Axes Simultaneous Interpolation is standard

Choice of Analog Interface or Digital Interface (SERCOS)

| | Analog | SERCOS |
|--|----------------------------|---------------------------------|
| Measurement Input frequency | 1 MHz (Internal 4 MHz) | Depends on Drive |
| Measurement Resolution | Freely Selectable | Freely Selectable |
| Maximum Feedrate | | Depends on Drive |
| Resolution of 10 μm : 2,400 m/min | | |
| Resolution of 1 μm : 240 m/min | | |
| Resolution of 0.1 μm : 24 m/min | | |
| Output Signal | $\pm 10\text{V DC}$, 5 mA | Digital via Optical Fiber Cable |

6.1 Axis Types

- Parallel axis logic
- Gantry axis logic
- Oscillation axis logic
- Rotary axis reset
- Spindle/rotary axis switchable
- PLC-driven axis

6.2 Transformations

- Five-axis transformation including helical-interpolation
- Four-axis transformation including helical-interpolation
- Three-axis transformation including helical-interpolation
- Polar transformation
- Barrel cam transformation
- Angled wheel transformation

6.3 Distance Control

- 3D distance control

6.4 Path Tracking

- 2D path tracking

- 6.5 Axis Control
 - Velocity override via external analog signal
 - Block processing control via external digital probe signals
 - Adaptive Look Ahead 2½D and 3D
 - Adaptive ART II 2½D and 3D
- 6.6 Axis Dependent Analog Output
 - 3D Power control via axis channel
- 6.7 Electronic Gearbox
- 6.8 Positioning Axis Logic (for PLC-driven axis not a part program axis)
 - Positioning axis logic for 200 NC blocks
 - Positioning axis logic for 600 NC blocks
- 6.9 Spindle Control
 - Without feedback
 - With feedback
 - Automatic gear step selection
- 6.10 Measurement Functions
 - Probe logic (Probing routine available as an option)
 - Software for distance encoded feedback
- 6.11 CNC Stations
 - Up to 8 CNC stations with a maximum of 8 axes in each station

7. MEMORY

- NC Program Memory
 - NC memory (buffered CMOS-RAM) 128 KB up to 872 KB
 - NC programs 200
 - Program number 6 Digits
- Hard Disk Memory
 - Hard disk memory 800 MB Minimum
 - NC programs Unlimited
 - Program number 6 Digits

- Dynamic block buffer 50 Expandable to 1000 blocks
- PLC program memory 64 KB Expandable to 256 KB
- Cycle parameters 1000 Expandable to 9999

8. COMPENSATIONS

- Tool compensation
 - Tool length compensation 128 sets
 - Tool radius compensation 128 sets
- 3D cutter compensation
- Lead screw error compensation 4000, up to 16000 points
- Backlash compensation
- Zero offsets (or part offsets)
- External compensation via PLC
- Access to compensations via cycle programming

9. PROGRAMMING

- Subprograms (up to four levels)
- Automatic syntax checking
- Decimal point programming
- Compensation programming
- Programming simultaneous during program execution
- Teach-In function

9.1 NC Programming

G codes

- G 000 Rapid traverse
- G 001 Linear interpolation with feedrate
- G 002 Circular interpolation (cw)
- G 003 Circular interpolation (ccw)
- G 012 Circular interpolation (cw) with radius
- G 013 Circular interpolation (ccw) with radius
- G2/G3 Helical interpolation
- G 004 Dwell time in millisecond

| | |
|-------|---|
| G 005 | Spline definition |
| G 006 | Spline interpolation |
| G 007 | Tangential circular interpolation Helix interpolation Polygon interpolation Feedrate interpolation |
| G 008 | Ramping function at block transition Look ahead "off" |
| G 009 | No ramping function at block transition Look ahead on (23 blocks) |
| G 010 | Stop dynamic block preprocessing |
| G 011 | Stop interpolation during block preprocessing |
| G 014 | Polar coordinate programming, absolute |
| G 015 | Polar coordinate programming, relative |
| G 016 | Definition of the pole point |
| G 017 | Selection of the X, Y - plane |
| G 018 | Selection of the Z, X - plane |
| G 019 | Selection of the Y, Z – plane |
| G 020 | Selection of a freely definable plane |
| G 021 | Parallel axes "on" |
| G 022 | Parallel axes "off" |
| G 024 | Safe zone programming; lower limit values |
| G 025 | Safe zone programming; upper limit values |
| G 026 | Safe zone programming "off" |
| G 027 | Safe zone programming "on" |
| G 033 | Thread cutting with constant pitch |
| G 034 | Thread cutting with dynamical pitch |
| G 035 | Oscillation activating |
| G 038 | Mirror imaging "on" |
| G 039 | Mirror imaging "off" |
| G 040 | Path compensations "off" |
| G 041 | Path compensation left of the work piece contour |
| G 042 | Path compensation right of the work piece contour |
| G 043 | Path compensation left of the work piece contour with altered approach |
| G 044 | Path compensation right of the work piece contour with altered approach |

| | |
|-------|---|
| G 050 | Scaling |
| G 051 | Part rotation; programming in degrees |
| G 052 | Part rotation; programming in radians |
| G 053 | Zero offset off (also called part offset or fixture offset) |
| G 054 | Zero offset #1 |
| G 055 | Zero offset #2 |
| G 056 | Zero offset #3 |
| G 057 | Zero offset #4 |
| G 058 | Zero offset #5 |
| G 059 | Zero offset #6 |
| G 063 | Feed / spindle override not active |
| G 066 | Feed / spindle override active |
| G 070 | Inch format active |
| G 071 | Metric format active |
| G 072 | Interpolation with precision stop "off" |
| G 073 | Interpolation with precision stop "on" |
| G 074 | Home position |
| G 075 | Curvature |
| G 078 | Normalcy function "on" (rotational axis orientation) |
| G 079 | Normalcy function "off" |
| G 080 | Drilling cycle "off" |
| G 081 | Drilling to final depth |
| G 082 | Spot facing with dwell time |
| G 083 | Deep hole drilling |
| G 084 | Thread cutting with balanced chuck |
| G 085 | Reaming |
| G 086 | Boring |
| G 087 | Reaming with measuring stop |
| G 088 | Boring with spindle stop |
| G 089 | Boring with intermediate stop |
| G 090 | Absolute programming |
| G 091 | Incremental programming |
| G 092 | Position register preset |
| G 093 | Constant tool circumference velocity "on" (grinding wheel) |
| G 094 | Feed in mm / min (or inch / min) |

- G 095 Feed per revolution
- G 096 Constant cutting speed "on"
- G 097 Constant cutting speed "off"
- G 098 Positioning axis signal to PLC
- G 100 Polar transformation "off"
- G 101 Polar transformation "on"
- G 102 Cylinder barrel transformation "on"; cartesian coordinate system
- G 103 Cylinder barrel transformation "on," with real-time-radius compensation (RRC)
- G 104 Cylinder barrel transformation with center line migration (CLM) and RRC
- G 105 Polar transformation "on" with polar axis characters
- G 106 Cylinder barrel transformation "on" polar-/cylinder-coordinates
- G 107 Cylinder barrel transformation "on" polar-/cylinder-coordinates with RRC
- G 108 Cylinder barrel transformation polar-/cylinder-coordinates with CLM and RRC
- G 109 Axis transformation programming of the tool depth
- G 110 Power control axis selection/channel
- G 111 Power control pre-selection V1, F1, T1/channel 1
- G 112 Power control pre-selection V2, F2, T2/channel 1
- G 113 Power control pre-selection V3, F3, T3/channel 1
- G 114 Power control pre-selection T4/channel 1
- G 115 Power control pre-selection T5/channel 1
- G 116 Power control pre-selection T6/pulsing output
- G 117 Power control pre-selection T7/pulsing output
- G 120 Axis transformation; orientation changing of the linear interpolation rotary axis
- G 121 Axis transformation; orientation change in a plane
- G 125 Electronic gear box; plain teeth
- G 126 Electronic gear box; helical gearing, axial
- G 127 Electronic gear box; helical gearing, tangential
- G 128 Electronic gear box; helical gearing, diagonal
- G 130 Axis transformation; programming of the type of the orientation change
- G 131 Axis transformation; programming of the type of the orientation change
- G 132 Axis transformation; programming of the type of the orientation change
- G 133 Zero lag thread cutting "on"
- G 134 Zero lag thread cutting "off"

G 135 Distance control - axis selection
 G 140 Axis transformation; orientation designation work piece fixed coordinates
 G 141 Axis transformation; orientation designation active coordinates
 G 160 ART activation
 G 161 ART learning function for velocity factors "on"
 G 162 ART learning function deactivation
 G 163 ART learning function for acceleration factors
 G 164 ART learning function for acceleration changing
 G 165 Command filter "on"
 G 166 Command filter "off"
 G 170 Digital measuring signals; block transfer with hard stop
 G 171 Digital measuring signals; block transfer without hard stop
 G 172 Digital measuring signals; block transfer with smooth stop
 G 175 SERCOS-identification number "write"
 G 176 SERCOS-identification number "read"
 G 180 Axis transformation "off"
 G 181 Axis transformation "on" with not rotated coordinate system
 G 182 Axis transformation "on" with rotated / displaced coordinate system
 G 183 Axis transformation; definition of the coordinate system
 G 184 Axis transformation; programming tool dimensions
 G 186 Look ahead; corner acceleration; circle tolerance
 G 188 Activation of the positioning axes
 G 190 Diameter programming deactivation
 G 191 Diameter programming "on" and display of the contact point
 G 192 Diameter programming; only display contact point diameter
 G 193 Diameter programming; only display contact point actual axes center point
 G 200 Corner smoothing "off"
 G 201 Corner smoothing "on" with defined radius
 G 202 Corner smoothing "on" with defined corner tolerance
 G 203 Corner smoothing with defined radius up to max. tolerance
 G 210 Power control axis selection/Channel 2
 G 211 Power control pre-selection V1, F1, T1/Channel 2
 G 212 Power control pre-selection V2, F2, T2/Channel 2
 G 213 Power control pre-selection V3, F3, T3/Channel 2
 G 214 Power control pre-selection T4/Channel 2

| | |
|-------|---|
| G 215 | Power control pre-selection T5/Channel 2 |
| G 216 | Power control pre-selection T6/pulsing output/channel 2 |
| G 217 | Power control pre-selection T7/pulsing output/channel 2 |
| G 265 | Distance regulation – axis selection |
| G 270 | Turning finishing cycle |
| G 271 | Stock removal in turning |
| G 272 | Stock removal in facing |
| G 274 | Peck finishing cycle |
| G 275 | Outer diameter / inner diameter turning cycle |
| G 276 | Multiple pass threading cycle |
| G 310 | Power control axes selection /channel 3 |
| G 311 | Power control pre-selection V1, F1, T1/channel 3 |
| G 312 | Power control pre-selection V2, F2, T2/channel 3 |
| G 313 | Power control pre-selection V3, F3, T3/channel 3 |
| G 314 | Power control pre-selection T4/channel 3 |
| G 315 | Power control pre-selection T5/channel 3 |
| G 316 | Power control pre-selection T6/pulsing output/channel 3 |
| G 317 | Power control pre-selection T7/pulsing output/channel 3 |

M codes

| | |
|-------|----------------------------------|
| M 000 | Unconditional stop |
| M 001 | Conditional stop |
| M 002 | End of program |
| M 003 | Spindle clockwise |
| M 004 | Spindle counterclockwise |
| M 005 | Spindle stop |
| M 006 | Tool change (see Note below) |
| M 019 | Spindle orientation |
| M 020 | Oscillation on |
| M 021 | Oscillation off |
| M 030 | End of program |
| M 040 | Automatic spindle gear selection |
| M 041 | Spindle gear transmission step 1 |
| M 042 | Spindle gear transmission step 2 |
| M 043 | Spindle gear transmission step 3 |
| M 044 | Spindle gear transmission step 4 |

| | |
|-------|--|
| M 045 | Spindle gear transmission step 5 |
| M 046 | Spindle gear transmission step 6 |
| M 080 | Delete rest of distance using probe function |
| M 140 | Distance regulation on (configured by G265) |
| M 141 | Distance regulation off |

Note: Other machine functions, like coolant control, have their M-code value specified by the PLC application, not by the CNC software.

- Programmable acceleration
- Tool management

9.2 Cycle Programming

- Programming tool with 1000 (up to 9999) parameters
- Allocation of parameters values with NC addresses
- Execution control of the NC program
- Output signal programming
- Verification of input signals
- Arithmetic and trigonometric functions
- Boolean programming functions
- Jump commands
- Repeat commands

9.3 CAM Software Capability

- Several CAM packages (and their post processors) are already configured to work with **MACHINEMATE**. The part program format follows the standard RS274D (with each field in the NC statement being a letter followed by a number; typical G-code and M-code part programming).

10. INTEGRATED IEC 1131-3 SOFT PLC

| | |
|------------------------------------|--|
| Programming Languages | Structured Text (included in basic) |
| | Ladder Diagram (included in basic) |
| | Function Block Diagram (optional) |
| | Instruction List (optional) |
| | Sequential Flow Chart (optional) |
| Inputs | Up to 792 MACHINEMATE Inputs |
| Outputs | Up to 528 MACHINEMATE Outputs |
| PLC Memory | 64 KB (expandable to 256 KB equiv. to 40,000 lines) |
| Data Memory (non-retentive) | 64 KB (expandable to 256 KB) |
| | Real, Integer, Timer, Boolean Variables |
| Data Memory (retentive) | 4 KB (expandable to 32 KB) |
| Data type definitions | Bit, Byte, Word, DWord, Real, LReal, SInt, USInt, Int, UInt, DInt, UDInt, String, Time, TOD, Date, DT, Arrays, enumeration, structures |
| C++ Routines | Custom Routines Written in C++ May Be Integrated |

I/O Components

The basic OEM **MACHINEMATE** system comes with a number of 24 volt inputs and 24 volt outputs of external I/O. The standard I/O supplied is **MACHINEMATE** Modular I/O, but external PLC I/O (Omron PLC IO but without a PLC processor) can be furnished as an option.

With the MM1 and MM3 models, the control comes with 24 inputs and 16 outputs (i.e., one input module). With the MM5 and MM7 models, the control comes with 48 inputs and 32 outputs (i.e., two input modules).

Field bus I/O (Profibus-DP or Interbus-S) can be used in conjunction with Modular I/O or PLC I/O or can be used exclusively. Either field bus is available as an option.

External **MACHINEMATE** Modular I/O System

| | |
|----------------------|--|
| Module Box: | Holds one or two modules, can be stacked laterally to each other and/or daisy-chained with cables, snaps on DIN rail |
| 24V Discrete Module: | 24 inputs, 16 outputs (1A) 24V DC |
| Relay Module: | 16 relay outputs (N.O.), 24V DC or 110VAC (3A) |
| Analog Module: | 4 analog in 12 bit, 4 analog out 14 bit |
| Encoder Module: | 4 encoder inputs, 4 analog outputs, 4 analog inputs Each encoder input and analog output pair constitutes an analog drive interface (servo axis or spindle). The analog inputs are general purpose. |

Modular I/O system has built in line drivers and receivers for a remote arrangement, up to 115 ft.* (35 m) from the CNC.

*Between control and last I/O module.



4.84" (123) H X 3.95" (100.4) W X 7.1" (181) D
Dimensions: inches (mm)
Dimensions do not include connectors.
(a single 2416 IO module is shown above).

11. INTERNAL **MACHINEMATE** I/O ON SERCOS MODULE
(does not apply to analog servo CNC model)

When using SERCOS drives, an additional 24 DC inputs and 16 DC outputs @ 0.5 amps are available. This I/O capability is in addition to the Modular I/O unit(s) included with the basic **MACHINEMATE** CNC.

12. INTEGRATED PC

- Industrial PC package (IPC)
- Intel processor (speed depends on model; is either Celeron or Pentium 4)
- 1.44 MB, 3.5" system floppy drive (in IPC)
- System hard disk, 2 GB minimum
- Windows 2000
- **MACHINEMATE** Real Time Kernel

13. COMMUNICATION

- **Interface Ports**

 - USB (at least 2)

 - COM 1 and COM 2 (serial ports)

 - Printer or LPT (parallel port)

 - PS/2 Mouse

 - Keyboard

 - CD ROM (IDE) is available internally in the IPC

 - Many standard PC devices could be connected externally via USB

- **Data I/O Simultaneously with Program Execution**

- **LAN-Network (Ethernet) (optional)**

 - Standard PC network card (PCI) is optional

- **Bus Interfaces (options)**

 - InterBus-S

 - Profibus-DP

 - DeviceNet

 - CAN-bus

14. SAFETY FUNCTIONS

Integrated Diagnostic Functions:

- Internal CNC voltage monitoring
- Processor activity
- Battery voltage monitoring for CMOS backup
- Electric noise monitoring
- Processor watchdog timer monitoring
- CMOS memory
- RAM memory
- Hard disk and floppy disk drives
- Bus systems
- Power supply voltage monitoring
- Temperature monitoring
- Operator guidance through soft keys

- Syntax check during NC program inputs
- Checksum test
- Comprehensive CNC status and machine status display via PLC
- Read, write, and clear protection for NC programs
- Protected programs
- Password protection (up to ten levels)
- Software limit switches

15. SYSTEM ACCESS

Via DDE technology

All PLC variables (that can also include references to the CNC variables) can be referenced via a DDE (Dynamic Data Exchange).

- Any program using DDE technology, including many operator interface development applications or even spreadsheet applications such as Microsoft Excel, can access data with the **MACHINEMATE**.
- A 'visualizer' program is also available, called MMVis. Graphical operator displays or windows can be created that access the PLC data in the **MACHINEMATE** using the DDE connection.

Via **MACHINEMATE Compile Cycles** in C++

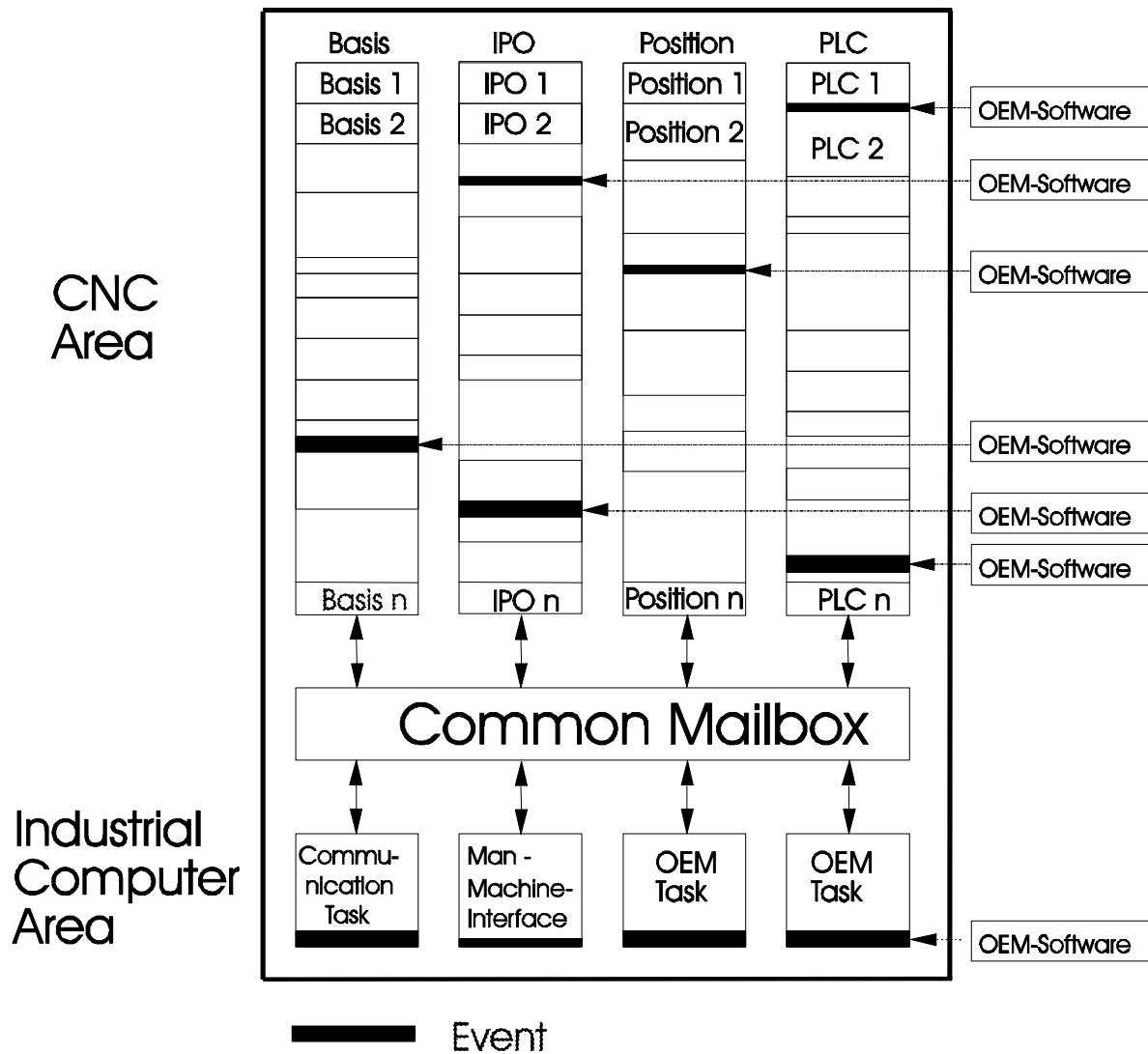
Basic software tools required (standard products from Microsoft, to be purchased by the customer):

- MS C++ Compiler, Visual C++ 6.0

Development set:

- Compile cycle interface definitions

16. **MACHINEMATE** Features

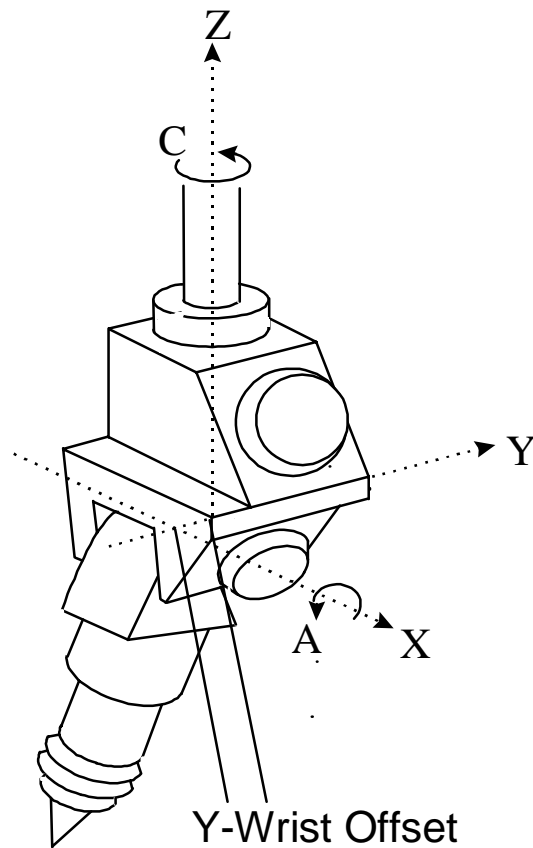


Representation of the Interface to Compile Cycles. Compile Cycles are dlls that are written by the customer; the dll is called by the CNC at specified events to work with the internal CNC data to adapt special algorithms or support special applications.

Note:

- Basis represents the handling of the input NC blocks (i.e., the 'basis' for the subsequent processing)
- IPO represents the CNC kernel's interpolator
- Position is the CNC position loop.
- PLC is the PLC application.

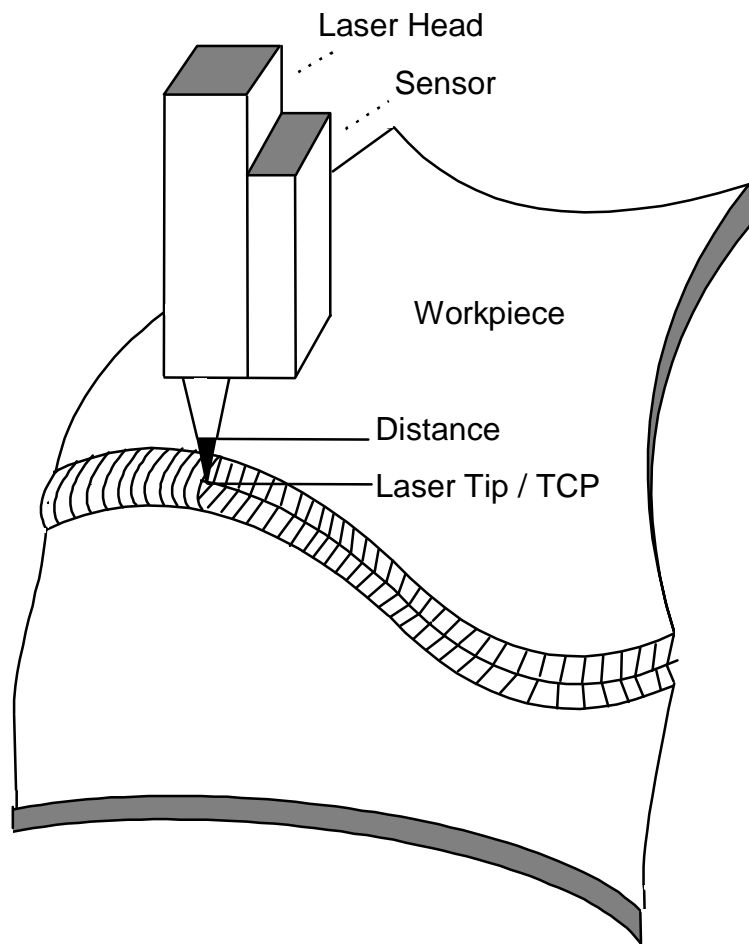
Five-Axis Transformation (Option)



Properties of the Five-Axis Transformation

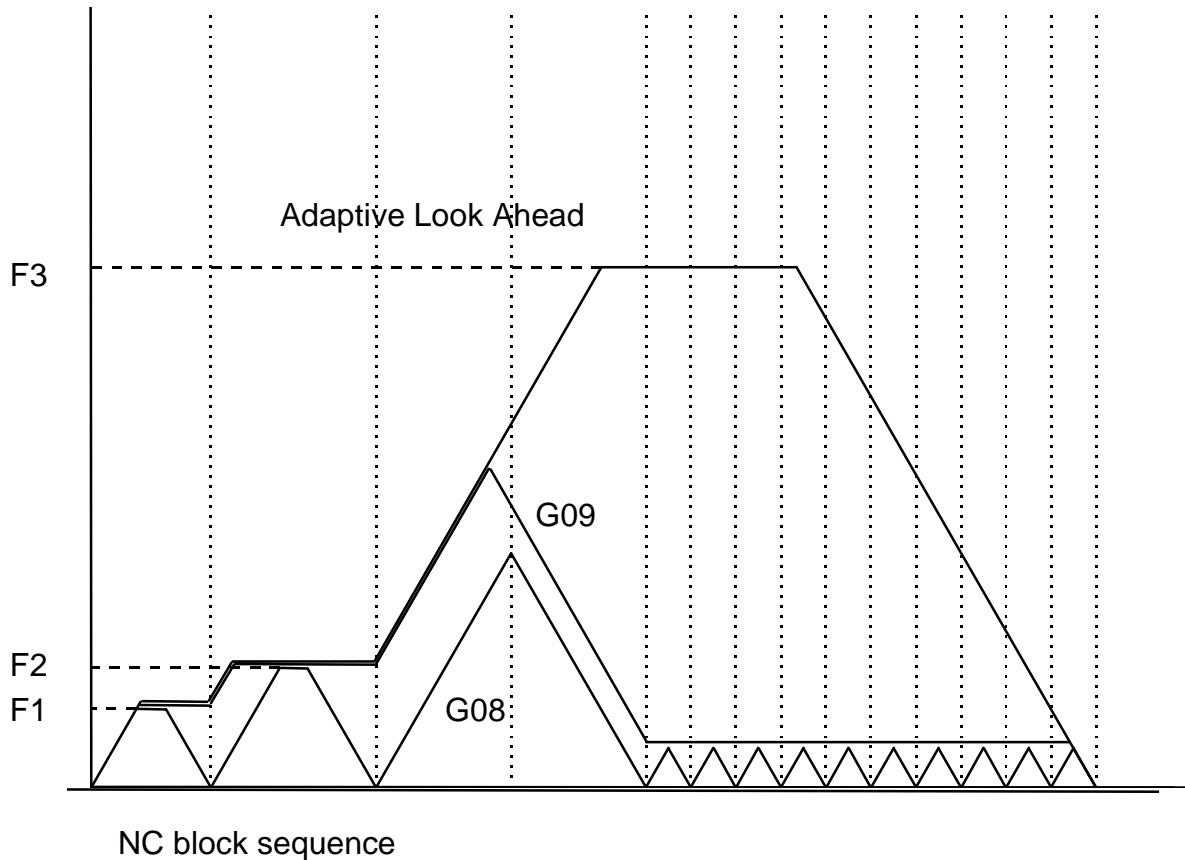
- Definition of tool center point
- Definition of a speed limitation point on the tool
- Programming based on machine coordinate system
- Programming based on user-defined coordinate system
- TCP programming in the original coordinate system
- TCP programming in a rotated and shifted coordinate system
- Linear interpolation A, B, C axes
- Rotation of the tool vector in a plane
- Programming of the tool orientation by rotary axis positions or by vectors

3D DISTANCE CONTROL (Option)



Representation of Distance Control feature for Laser applications

ADAPTIVE LOOK AHEAD



- Adaptive Look Ahead results: Error-free block transitions.
- Adaptive Look Ahead analyzes up to several hundred subsequent NC blocks.
- Adaptive Look Ahead monitors the acceleration and deceleration values set for each axis.
- Adaptive Look Ahead assures that the dynamic limits of the machine will never be exceeded.
- Adaptive Look Ahead recognizes peaks in the velocity profile caused by geometry and F word changes. Acceleration and deceleration over multiple NC blocks.
- Continuous axis movement.
- Adaptive Look Ahead calculates the maximum path velocity with consideration of the programmed F word, the programmed accuracy, and the dynamic machine limits.

ADVANCED REGULATION TECHNOLOGY

1. Even with the most sophisticated feed-forward functions like the one of Machine Mate, Zero Following Error cannot be achieved completely, leaving a minute path error. Using the self-adapting ART function, this error can even be more reduced by automatic fine-tuning of the relevant control parameters.

ART is included with all controls as a standard feature.

2. Below is the results of a machined and measured part that was completed on a Swiss Jig Grinder using circular interpolation.

Excellent accuracies at high speed and small curvature were achieved.

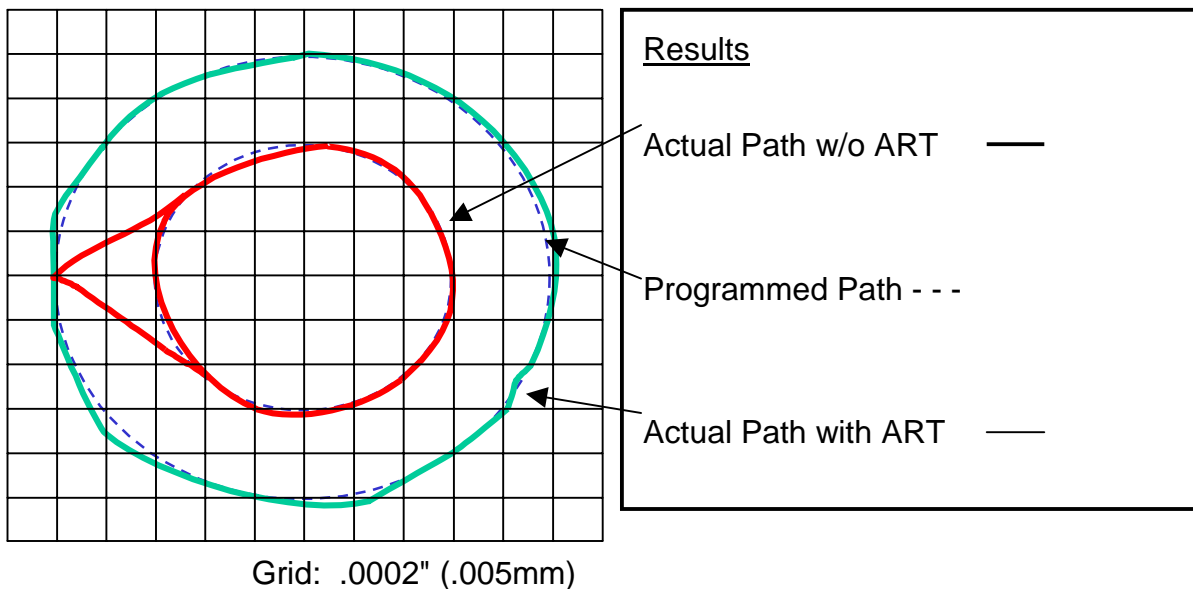
Part dia.: .984" (25 mm)

Contouring velocity: 236 in./min. (5000 mm/min)

Results (see figure below)

Without ART: deviation from programmed circle: .0004" (0.01 mm)

With ART: deviation from programmed circle: .00008" (0.002 mm, five times less error)

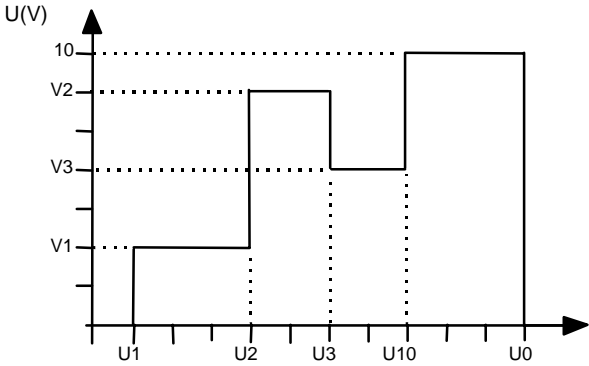


With "Adaptive ART" Contouring without Servo Lag

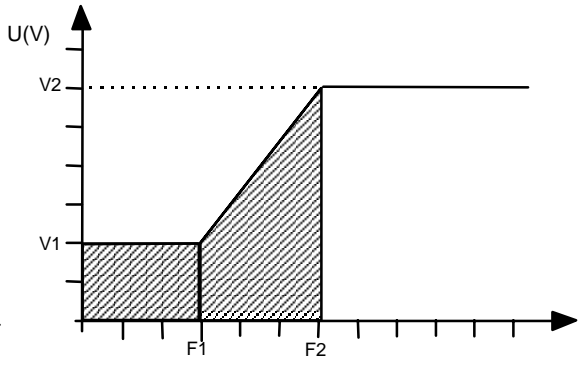
- Adaptive ART learns the characteristics of all axes.
- Adaptive ART learns continuously.
- Adaptive ART supports the gain for movement in both directions.
- Adaptive ART compensates different gains of motors.

- Adaptive ART uses:
 - ⇒ feedrate
 - ⇒ acceleration/deceleration
 - ⇒ acceleration/deceleration changes (jerk)
- Adaptive ART is active during:
 - ⇒ acceleration
 - ⇒ constant speed
 - ⇒ deceleration

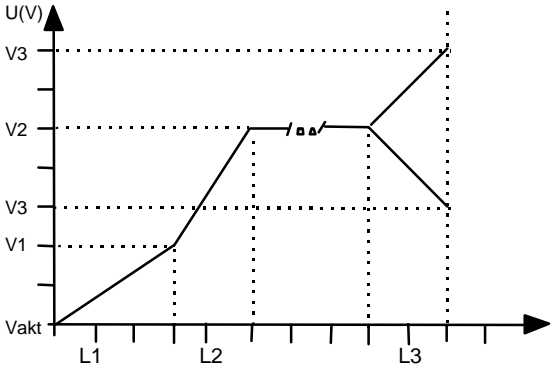
LASER POWER CONTROL



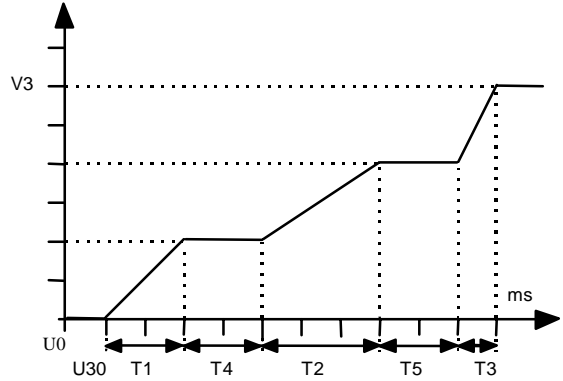
Constant



Velocity



Position

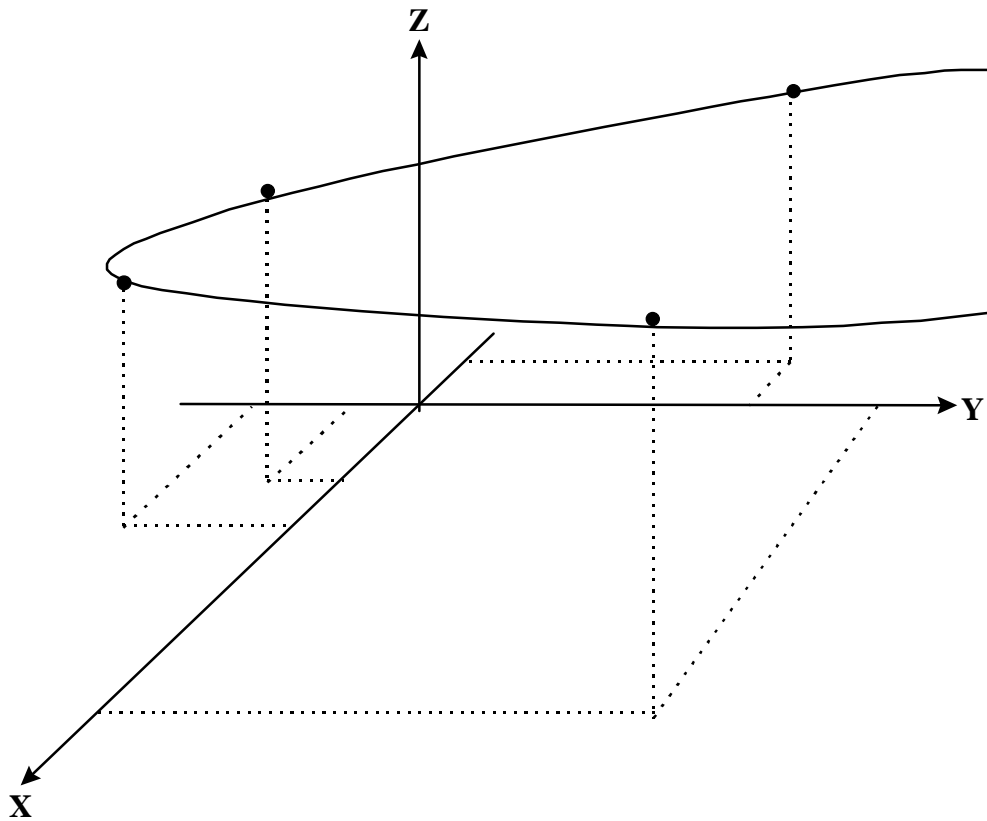


Time

Parameters = U – Constant; F – Velocity; L – Position; T – Time; V – Power

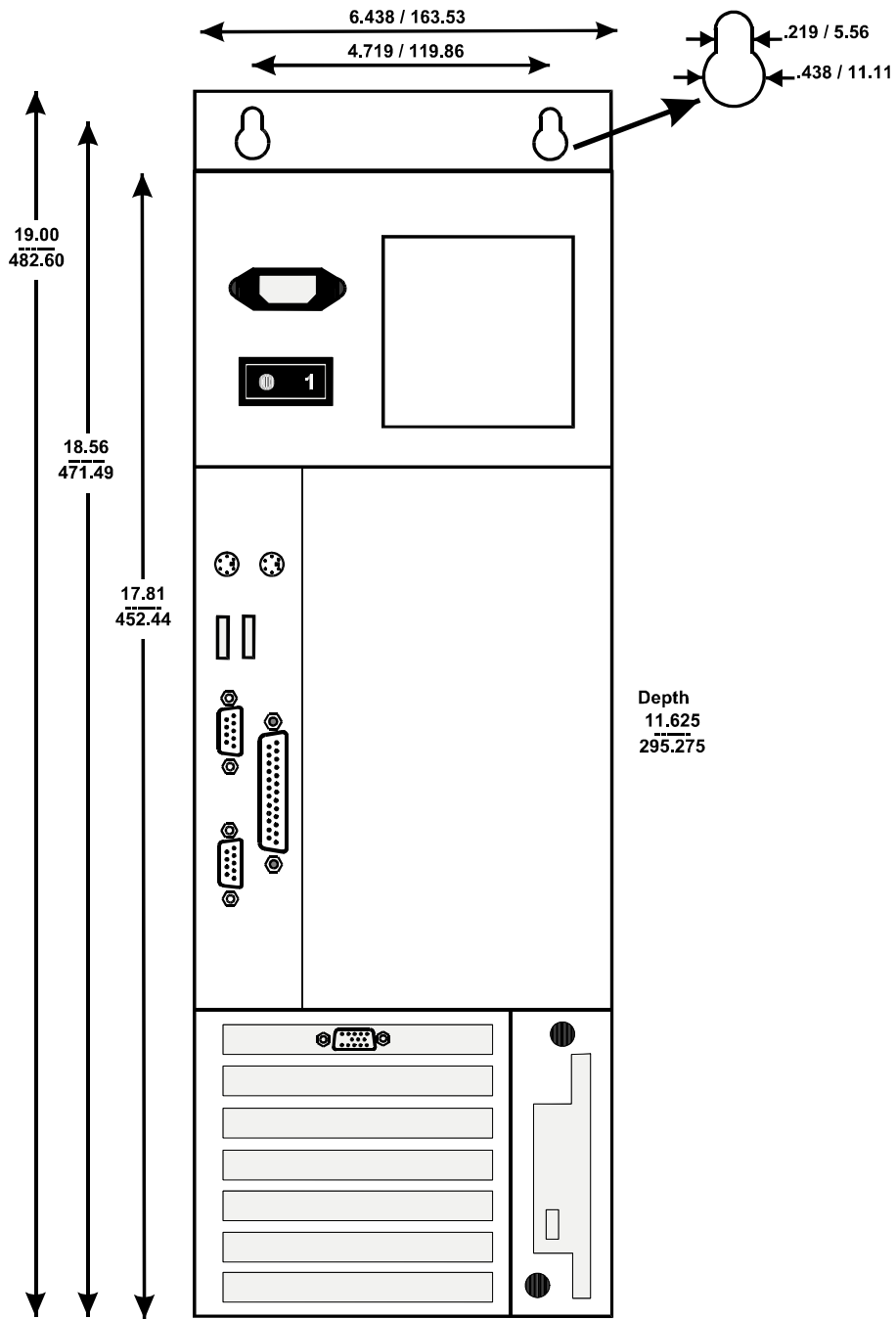
The figure represents different NC programs that select the different types of laser voltage output.

3D SPLINE INTERPOLATION



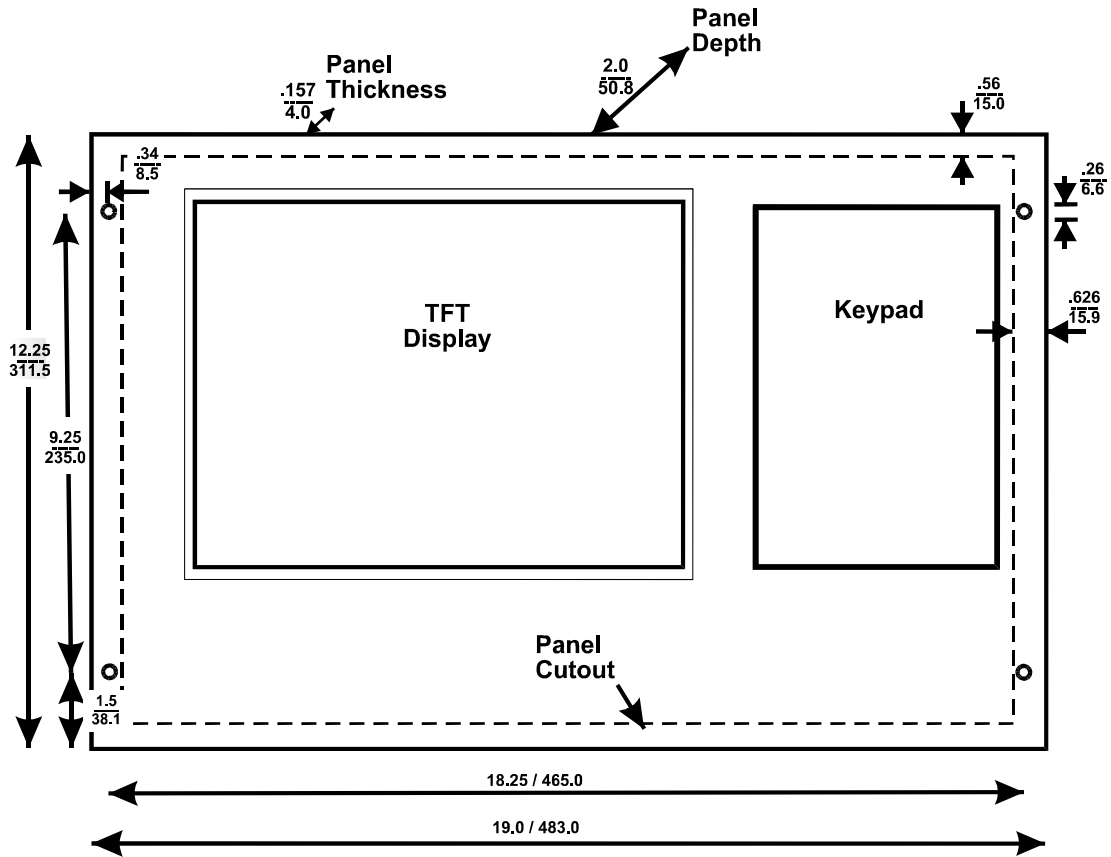
- Real time spline interpolation
- NC data reduction by factor of 3 to 10
- Tangential
- Smooth transitions
- In combination with five-axis transformation
- In combination with five-axis cutter compensation

L2 IPC



The L2 IPC weighs approximately 24.5 lb (11.1 kg).

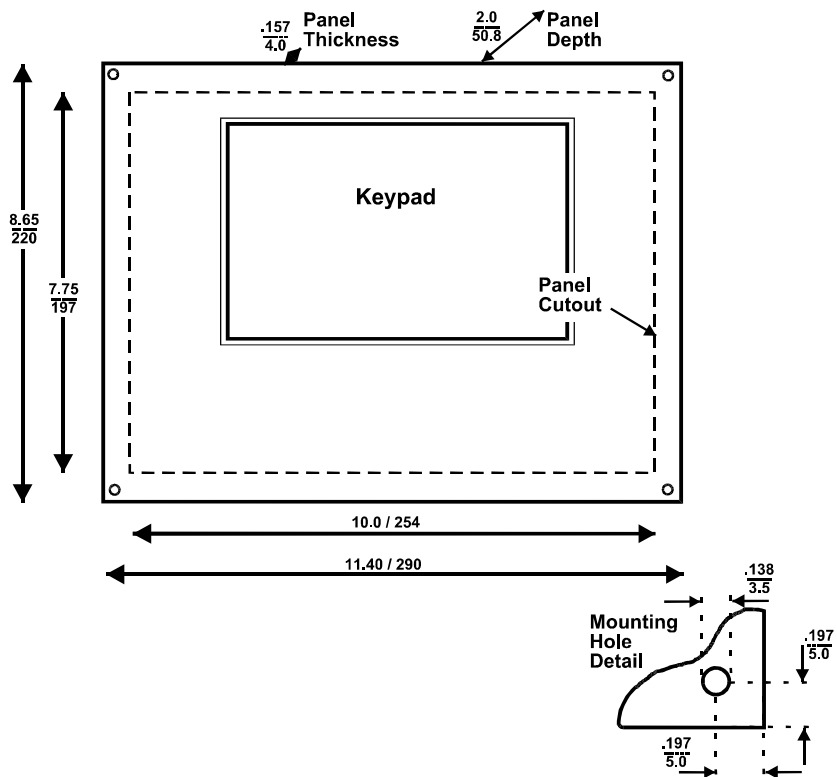
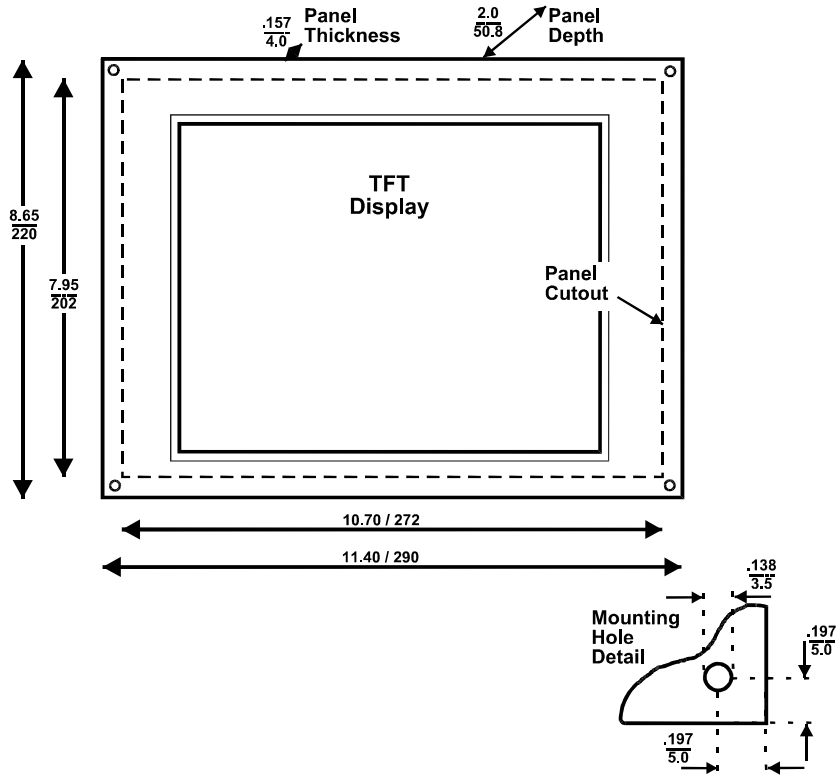
19" rack mount front panel with 12.1" TFT color display



This front panel weighs approximately 11.0 lb (5.0 kg).

The 19" rack mount front panel with the 15" color TFT touch display has the same outer dimensions and hole positions. It weighs 16.0 lb (7.3 kg).

Slim-line operator panel (two piece)



This front panel weighs approximately 8.0 lb (4.0 kg).

18. OPERATING CONDITIONS

- **Space Requirements**

Minimum installation free space is: left 3.2" (80), right 1.2" (30)

- **Power Requirement**

104V AC -132V AC; 95 - 264V AC - 244V AC 47Hz - 63 Hz

- **Maximum Power Required**

150 Watts

- **Temperature**

Storage temperature -4°F to 140°F (-20°C to +60°C)

Operating temperature 41°F to 113°F (5°C to 45°C)

- **Test Conditions**

All **MACHINE**MATE controls are run-in tested for 48 hours by cycling between 41°F and 113°F (5°C and 45°C).

- **Protection**

Operator's panel IP 65

- **Weight**

29.5 lb (13.4 Kg) Basic OEM **MACHINE**MATE L2 with 12.1" TFT display in 19" rack-mount front panel

MACHINEMATE®

SERIES CNC

STANDARD FEATURES

INCLUDED IN THE BASIC OEM PACKAGE

MACHINEMATE BASIC CONFIGURATION

1. OPERATION

The **MACHINEMATE CNC** has six different operating modes that are selected by means of soft keys. Alternatively they may be selected through a pointing device, i.e., a cursor, a mouse, or alternative means.

MANUAL

- Move Continuously
- Traverse to Reference Point
- Auxiliary Functions
- Move Incrementally
- Retreat
- Hand Wheel Function
- Playback

AUTOMATIC

- Program Selection
- Program Test
- Path Graphics
- Backward
- Program Process 1 (Sequential, Single Block, MDI)
- Program Process 2 (Block Skip /, Optional Halt M01, Initial State)

DATA

- Selection
- Load
- Save
- Edit
- Modify
- Manage

INFORMATION

- Interface Display
- Version
- Status Treatment
- Log Book

SYSTEM

- Display Functions
- Station (Channel) Selection
- Exit
- Operations
- Settings
- Minimize

SETUP

- PLC
- Machine Parameters
- SERCOS Monitor
- I/O Configuration
- Drive Configuration
- Pitch Error Comp
- Gantry Initialize
- Logic Analyzer

ZOOM

- Axis positions only are displayed, in much larger characters

2. **DISPLAY/DIAGNOSTICS**

Display Languages

Two display languages are selectable:

- English
- German
- Other Languages on Request

NC Axis Information

- Position
- Direction
- Output Voltage
- Distance To Go
- Active Offsets
- Velocity
- Lag (Following Error)
- Position Loop Gain
- End Position
- Offset Values

Stored Data Information

- NC Programs
- NT/DOS Programs
- Radius Compensation
- File Attributes
- PLC Programs
- Tool Length Offsets
- Zero Offsets

Status Information

- Auxiliary Functions
- Active Block
- Active G Codes
- PLC Interface

- Active NC Program Status
- Active Subprogram

- Program Repetition

System Memory

- Memory Size for Both CNC and Windows System
- Memory Space Available

- Number of Part Programs
- Program Size

Interfaces/Data Ports

- CNC ↔ PLC Interface
- Serial Interfaces*
- External Device Definition

- PLC ↔ Machine Interface
- Serial Interface Setup*

*May require additional software.

User Information Box

- Error Messages in Legible Text

- Time and Date Display
- Help Messages in Legible Text

Machine Parameters

- Legible Machine Parameters
- Edit Machine Parameters

- Input/Output of Machine Parameters

3. AXES/AXIS FUNCTIONS

4 Axes Simultaneous

Choice of Analog Interface or Digital Interface (SERCOS)

| | Analog 4x | SERCOS 8x |
|--|----------------------------|------------------------------------|
| Measurement Input frequency | 1 MHz (Internal 4 MHz) | Depends on Drive |
| Measurement Resolution | Freely Selectable | Freely Selectable |
| Maximum Feedrate | | Depends on Drive |
| Resolution of 10 μm : 2,400 m/min | | |
| Resolution of 1 μm : 240 m/min | | |
| Resolution of 0.1 μm : 24 m/min | | |
| Output Signal | $\pm 10\text{V DC}$, 5 mA | Digital via Optical Fiber Cable |

4. COMPENSATIONS

Tool Compensation

- 128 Radius Compensations
- 128 Length Compensations
- Tool table for management of tool data

Backlash Compensation

Zero Offsets (G54 to G59)

External Compensation via PLC

Access to Compensations via Cycle Programming

5. SPINDLE CONTROL

Through SERCOS or Analog CNC engine

Analog Spindle Control via PLC is also possible (option - analog module)

6. COMMUNICATION

| | |
|------------|--|
| Interfaces | COM 1 Port COM 2 Port LPT 1 Port USB (at least 2 available) VGA external Display Port Keyboard Port CD ROM (IDE) Connector Mouse Port |
| NC Format | ISO (DIN 66025) (standard G-code, M-code programming) |

Data I/O Simultaneously with Program Execution

File Load

Main- and Subprograms Executable From Hard Disk

7. MEMORY

Hard Disk

- Number of NC Programs unlimited (to disk capacity)
- Program Number 6 digits

NC Program Memory

128 KB CMOS RAM

- Number of NC Programs 200
- Program Number 6 digits

(option – increases to 224KB, 400KB or 872KB)

Dynamic Block Buffer 50 blocks

(option – increases to 200 or 1000 blocks)

PLC Program Memory 64 KB

(option – increases to 128KB or 256KB)

Cycle Parameter Memory 1000 parameters

(option – increases in increments of 1000)

8. PROGRAMMING

NC Programming as per ISO (DIN 66025)

- G00 Rapid traverse
- G01 Linear interpolation
- G02/G03 Circular interpolation
- G04 Dwell
- G07 Tangential circle interpolation
- G08/G09 Path control mode (ramp at block transitions)
"Adaptive Look ahead" function
- G10/G11 Block pre-processing control
- G12/G13 Circular interpolation with radius input
- G17-G20 Plane selection
- G33 Thread cutting/rigid tapping
- G38/G39 Mirror image
- G40-G44 Tool radius compensation
- G50 Scaling
- G51/G52 Part rotation
- G53-G59 Zero offsets
- G63/G66 Programmable feed rate/spindle speed override
- G70/G71 Inch/metric switching
- G72/G73 Interpolation with in position stop
- G74 Home position
- G80-G89 Canned cycles
- G90/G91 Absolute/incremental programming
- G92 Position register preset (part reference)
- G94/G95 Feedrate programming
- G186 Programmable tolerance band
- M00 Program stop
- M01 Optional stop
- M02/M30 End of program
- M03/M04/M05 Spindle control
- M06 Tool change
- M19 Spindle orientation

(programming options: see Product Guide section 2 for complete G-code list)

Cycle Programming

- Programming tool with 1000 parameters
- Use of parameter values within NC addresses
- Execution control of the NC program
- Programmable man-machine interface
- Input/output signal programming
- Monitoring of input signals
- Arithmetic and trigonometric functions
- Boolean operators
- Jump commands
- Repeat commands

Subroutines (4 Levels)

Automatic Syntax Check

Decimal Point Programming

Compensation Programming

Programming Parallel to Program Execution

Probing function - Automatic Position Value Acquisition

9. INTEGRATED SOFT PLC AS PER IEC 1131-3

| | |
|----------------|---|
| Languages: | Structured Text (Standard) Ladder Diagram (Standard) |
| PLC Memory | 64 KB (expandable to 256KB, equiv. to 40,000 instr.) |
| Internal Flags | 256 (expandable to 1000) non retentive 256 (expandable to 1000) retentive |
| Timers | 256 (expandable to 1000) non retentive 256 (expandable to 1000) retentive |
| I/O Definition | bit/byte, word, double word |
| C Routines | Custom routines written in C can be integrated via an external object library |

10. INTEGRATED PERSONAL COMPUTER

Integrated Personal Computer

- Intel processor (varies with CNC model – Celeron or Pentium 4)
- 1.44 MB, 3½"-system floppy drive
- TFT display graphics board
- System hard disk
- Microsoft Windows 200 operating system
- **MACHINEMATE** real time kernel

11. SAFETY FUNCTIONS

Following checks are integrated:

- CNC voltage monitoring
- Battery voltage monitoring for CMOS backup
- Processor watchdog timer monitoring
- Feedback supervision (incremental encoder)
- RAM memory
- Bus systems
- Processor activity
- Electrical noise monitoring
- CMOS Memory
- Feedback signal (broken wire detection)
- Hard disk / floppy drive
- Temperature monitoring

Operator Guidance Through Soft Keys

Syntax Check During NC Program Input

Software Limit Switches

CNC Status and Machine Status Display via PLC

Read, Write, Delete and Execution Protection for NC Programs

Protected Programs

Password Protection (up to 10 levels)

The **MACHINEMATE** Milling or Turning application software must be specified at the time of purchase.

Abbreviations in the following list are as follows:

| | | |
|----------|-----------------|------------|
| Package: | | item: |
| M | Milling package | i included |
| T | Turning package | o optional |

When an item is indicated as included for a major group, there is usually at least one option for that category.

CNC STANDARD FEATURES

| | | | |
|--------------------|----------|----------|-----------------|
| <u>DESCRIPTION</u> | <u>M</u> | <u>T</u> | <u>COMMENTS</u> |
|--------------------|----------|----------|-----------------|

1. OPERATION

| | | | |
|--|---|---|--|
| Handwheel Interface | i | i | |
| 250 pulses per rev.; maximum of 3 handwheels | | | |
| (options include operator hardware) | | | |

2. DISPLAY / DIAGNOSTICS

The color displays available are selected through the choice of the basic control type. The 10.4" color (VGA 800x600) flat panel display is standard in the slim line (2-piece front panel), whereas the 12.1" color (VGA 800x600) is standard in the 19" rack mount front panel.

9" monochrome CRT is optional replacement for 10.4" color in slim line front panel.

15" color touch display is optional in the 19" rack mount front panel.

Flat TFT touch screen is available as an option in 12.1" size.

3. AXES / AXIS FUNCTIONS

The basic control comes with 8-axes SERCOS or 4-axes analog (not both). Please specify which drive control interface is desired.

| | | | |
|---|---|---|------------------|
| Digital SERCOS Drive Interface (8 axes) | i | i | Select SERCOS |
| | | | or |
| Analog Axis Interface (4 axes) | i | i | Analog |

(options include more axes and/or more stations – or program paths)

| DESCRIPTION | M | T | COMMENTS |
|---|----------|----------|-----------------|
| Axis Types | | | |
| Parallel Axes Logic | i | i | |
| (options include gantry axes and other axis variations) | | | |
| Adaptive Look Ahead; 2½ D | i | i | |
| Adaptive ART II including Command Filter 2½ D | i | i | |
| Automatic Drift Compensation (analog) | i | i | |
| (options include other transformations, such as full 5-axis, polar, barrel cam, angled wheel; also electronic gear box for gear hobbbers) | | | |
| 4. COMPENSATIONS | | | |
| Lead Screw Error Compensation 1,000 Internal Points | i | i | |
| (options include more points, up to 16000) | | | |
| 5. SPINDLE CONTROL | | | |
| Spindle Control (with or without feedback) | i | i | |
| Automatic Gear Step Selection (analog) | i | i | |
| (options include more spindles) | | | |
| 6. COMMUNICATION | | | |
| Floppy Disk Drive (A:), Front Access | i | i | |
| (options include external floppy drive or network card) | | | |
| 7. MEMORY EXTENSION | | | |
| NC Memory Extension (buffered CMOS RAM) | i | i | |
| (options include more memory) | | | |

| DESCRIPTION | M | T | COMMENTS |
|--------------------|----------|----------|-----------------|
|--------------------|----------|----------|-----------------|

| | | | |
|---|---|---|--|
| 8. PROGRAMMING | | | |
| Cycle Programming | | | |
| Extension to 1000 Parameters | i | i | |
| (options: more available in increments of 1000) | | | |
| NC programming | | | |
| Helical Interpolation | i | o | |
| Spline Interpolation | i | o | |
| Feedrate Interpolation | i | o | |
| Diameter Programming | o | i | |
| Thread Cutting G33/G34 | o | i | |
| Rigid Tapping | i | o | |
| Constant Surface Speed | o | i | |
| Feed Per Revolution | i | i | |
| Polar Coordinate Programming | i | o | |
| Programmable Acceleration | i | o | |
| Safe Zone Programming | i | i | |
| Corner Rounding | i | i | |
| Tool Management | i | i | |
| Extended PLC Interface | i | i | |

(options in most cases above: the optional item is usually associated with either a Milling or Turning application so it does not apply to the other application – making it optional for that type)

(other options include: software for non-servo clutch/brake machines, software for two-axes collinear tracking)

| <i>DESCRIPTION</i> | <i>M</i> | <i>T</i> | <i>COMMENTS</i> |
|---|-----------------|-----------------|------------------------|
| 9. PROBING FUNCTIONS | | | |
| Probing Logic (Probing routine is an option.) | i | i | |
| 10. MACHINEMATE MODULAR I/O* | | | |
| Module Box (for two I/O Modules) | i | i | |
| I/O Module 24-Input/16-Output (1A) 24 VDC | i | i | (qty: see below) |
| (for the L2 for analog drives, two modules are built-in; for all other models these are IO modules are optional) | | | |
| (SERCOS models come with additional 24i/16o connector) | | | |
| (options: Relay Module: 16 relays (N.O. contacts) Analog Module: 4 input channels/4 output channels; Axis Encoder Module: 4 analog axis channels) | | | |
| READY-TO-USE CABLES FOR MODULAR I/O | | | |
| Interconnect Cable - 6.6 ft. (2 m) | i | i | |
| (option: longer cables are available, up to 35m) | | | |
| (option, since the eCNC can be mounted on the back of the 19" rack mount front panel, a short 0.6m cable is available for that arrangement) | | | |
| (options: Fieldbus I/O can be supported as an option in place of or in addition to the Modular IO; available fieldbus PCI cards are: Interbus, Profibus, Canbus and DeviceNet; no Fieldbus IO devices are available other than the interface bus master card for the CNC) | | | |
| 11. PLC DEVELOPMENT ENVIRONMENT | | | |
| PLC IEC1131 Language (Ladder Diagram and Structured Text) | i | i | |
| PLC Development System on CNC | i | i | |
| (options: the other IEC-1131 standard languages: Instruction List (IL), Function Block (FB), and Sequential Flow Chart (SFC), individually) | | | |

12. DOCUMENTATION

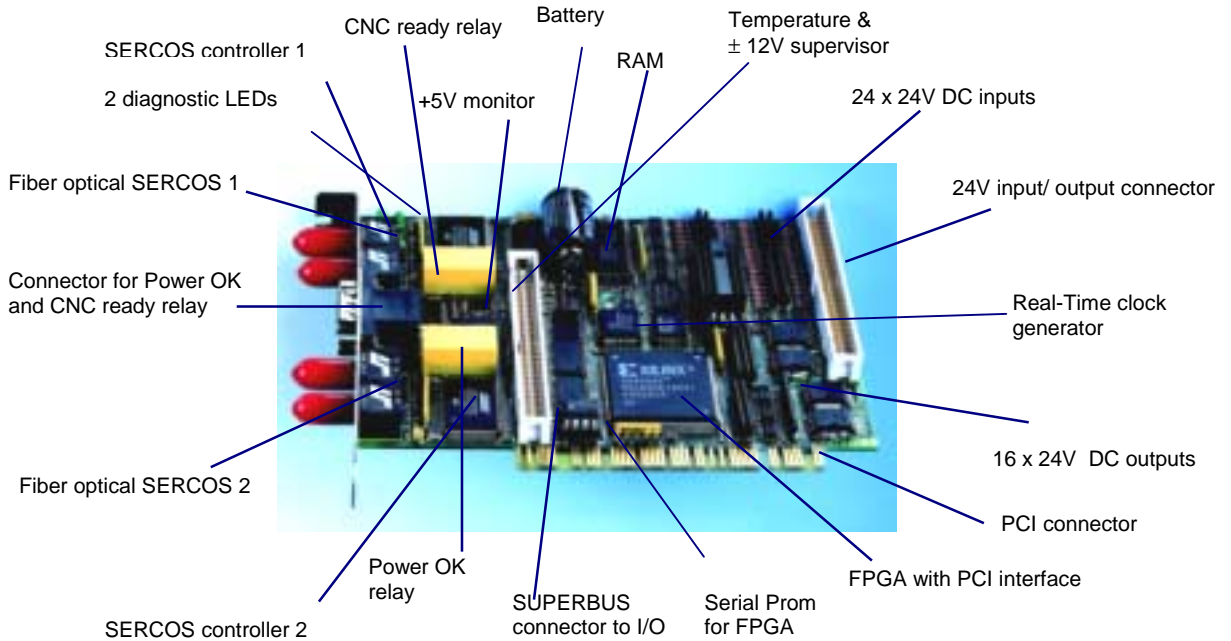
Installation Kit i i
(includes **MACHINEMATE** Manuals on CD)

(options: the printed manuals are available individually or as a set)

The SERCOS CNC-ENGINE board is specially designed to complement the powerful **MACHINEMATE** SERCOS software with the following features:

- ❑ PCI Interface, 33 MHz
- ❑ One or two independent SERCOS interfaces (i.e., 1 or 2 fiber-optic rings and 8 drives per ring, so either 8 or 16 drives per board)
- ❑ Easy installation
- ❑ SUPERBUS I/O Interface to **MACHINEMATE** Modular I/O pack(s)
- ❑ 24 DC Inputs
- ❑ 16 DC Outputs
- ❑ RAM on board (battery buffered)
- ❑ Watchdog (64ms)
- ❑ Voltage Monitor
- ❑ Temperature Supervisor
- ❑ Ready relay
- ❑ Power - OK relay
- ❑ Diagnostic LEDs
- ❑ Real-time clock generator
- ❑ High flexibility through FPGA technology

Technical Data



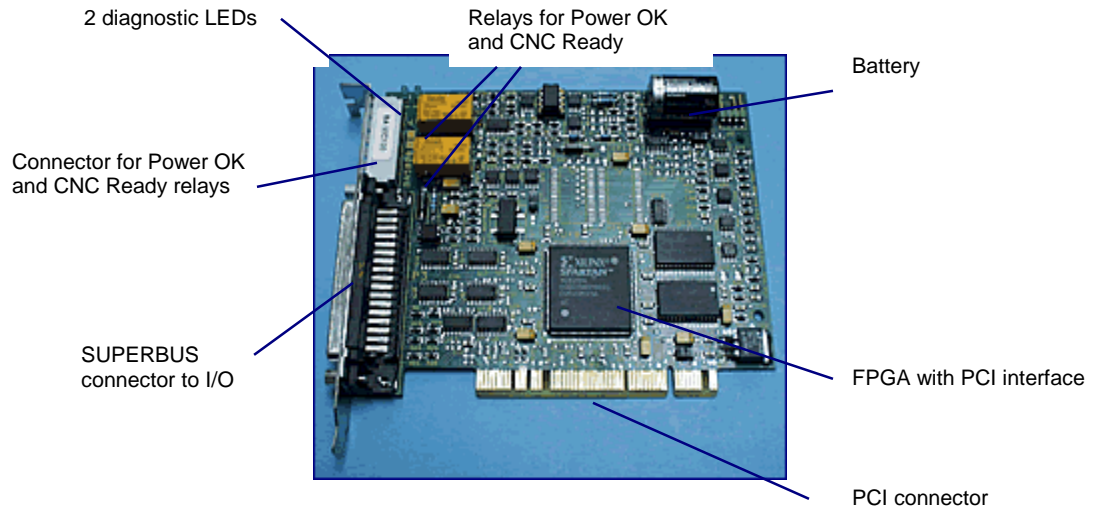
| | |
|-----------------------------|--|
| PCI Interface | 32-bit bus with 33 MHz clock. The PCI interface complies with revision 2.1 of the specification. |
| SERCOS interface(s) | One or two independent SERCOS interfaces. Single chip controller for each SERCOS interface. Dual port RAM with 2048 bytes. Maximum transmission rate of 4 MBaud. Data communication via optical fiber ring. Power modulation of optical transmitter diode. Data transmission is synchronous to on board real-time clock. |
| Real - Time clock generator | Special hardware for real-time kernel. Needed for absolute clock synchronous axis control. |
| Easy installation | The software automatically configures interrupts and the integrated memory. |
| SUPERBUS interface | I/O bus interface with a transfer rate of 4Mbit/s up to a maximum extension of 115' (35m). This interface is to the MachineMate Modular I/O devices. |
| 24V DC inputs | All inputs are opto-isolated. |
| 24V DC outputs | All outputs are opto-isolated source outputs. Output current can be 1A per channel (8A max. for all 16 outputs). Shorted load and over temperature protections. Under voltage shut down. |
| Memory | 256 Kbyte (1 Mbyte opt.) battery buffered static RAM. |
| Battery | On board Li, high capacity. |
| Watchdog | Digital watchdog, programmable up to 64ms. |
| Voltage monitor | + 5V and ± 12V supervisor for under- and over-voltage monitoring. Battery supervisor for under-voltage monitoring. |
| Power OK relay | One 24V / 1A relay, which switches on if both the power and temperature are OK. |
| CNC ready relay | One 24V / 1A relay, which switches on if the control is in the ready state. |
| Relay connector | The two relays are connected to the CNC electrical circuits via this 15-pin connector. |
| Hardware diagnostic LEDs | Two LEDs show the ready and the power OK status. |
| FPGA technology | Third generation Field-Programmable Gate Array. The speed grade is fully PCI compliant. Linear PCI - Local bus interface, no address gaps. FPGA configuration via serial prom. |
| Temperature supervisor | 131°F (55°C) / 140°F (60°C) supervisor for temperature monitoring. |
| Dimensions | 5.315" (135 mm) x 4.21" (107 mm) |

The Superbus IO CNC-ENGINE board is specially designed to complement the powerful **MACHINE****MATE** software with the following features:

- ❑ PCI Interface, 33 MHz
- ❑ Easy installation
- ❑ SUPERBUS I/O Interface to **MACHINE****MATE** Modular I/O pack(s), including the 4ENC4A module for the analog-controlled servo drives
- ❑ RAM on board (battery buffered)
- ❑ Watchdog (64ms)
- ❑ Voltage Monitor
- ❑ Temperature Supervisor
- ❑ Ready relay
- ❑ Power - OK relay
- ❑ Diagnostic LEDs
- ❑ Real-time clock generator
- ❑ High flexibility through FPGA technology

This card is similar to the SERCOS Engine card except it has no fiber-optic ring support and no 24in/16out IO connector. The drives are handled via the MIO 4ENC4A modules and the IO points in the system are handled via the MIO 2416 modules.

Technical Data



| | |
|-----------------------------|--|
| PCI Interface | 32-bit bus with 33 MHz clock. The PCI interface complies with revision 2.1 of the specification. |
| Real - Time clock generator | Special hardware for real-time kernel. Needed for absolute clock synchronous axis control. |
| Easy installation | The software automatically configures interrupts and the integrated memory. |
| SUPERBUS interface | I/O bus interface with a transfer rate of 4Mbit/s up to a maximum extension of 115' (35m). This interface is to the MachineMate Modular I/O devices. The 4ENC4A axis interface module provides the CNC access to the analog-controlled servo drives. |
| Memory | 256 Kbyte (1 Mbyte opt.) battery buffered static RAM. |
| Battery | On board Li, high capacity. |
| Watchdog | Digital watchdog, programmable up to 64ms. |
| Voltage monitor | + 5V and \pm 12V supervisor for under- and over-voltage monitoring. Battery supervisor for under-voltage monitoring. |
| Power OK relay | One 24V / 1A relay, which switches on if both the power and temperature are OK. |
| CNC ready relay | One 24V / 1A relay, which switches on if the control is in the ready state. |
| Relay connector | The two relays are connected to the CNC electrical circuits via this 6-pin connector. |
| Hardware diagnostic LEDs | Two LEDs show the CNC ready and the power OK status. |
| FPGA technology | Third generation Field - Programmable Gate Array. The speed grade is fully PCI compliant. Linear PCI - Local bus interface, no address gaps. FPGA configuration via serial prom. |
| Temperature supervisor | 131°F (55°C) / 140°F (60°C) supervisor for temperature monitoring. |
| Dimensions | 5.315" (135 mm) x 4.21" (107 mm) |



The Handheld Operator Station with handwheel (or MPG) from **MACHINEMATE** INC is specially designed to complement the **MACHINEMATE** control with the following features:

- ❑ Dust and waterproof pendant
- ❑ 3-meter flexible cable (polypropylene insulated, polyurethane jacket) is included, with a 26-pin round connector
- ❑ Emergency stop push button (push in to lock, twist out to release)
- ❑ Handwheel (manual pulse generator or MPG) with 100 counts per revolution, in either a 5V encoder model or a 24V input (signal pair) model
- ❑ Axis selection switch (six positions: X, Y, Z, 4, 5, 6)
- ❑ Feed selection switch (three position: X1, X10, X100)
- ❑ Two general purpose push buttons (illuminated)
- ❑ PLC application template for this MPG available from **MACHINEMATE** INC or from its web site

There are four versions. There are two handwheels (either 5V encoder or a 24VDC signal pair). There are two cable lengths available.

- One version has a 4.26-foot cord, that extends to about 21-feet.
- The other version has a 5.9-foot cord, that extends to about 34-feet.

| | |
|-------------------|--|
| Easy installation | The 3-meter cable comes with a 26-pin round connector for a bulkhead connection. The 24VDC supply and Emergency stop circuit connections are made there. The other pins are connected to a MachineMate I/O module. |
| IO connector | The inputs and outputs are connected to the control via this 26-pin round connector on the end of the 3-meter flexible cable. |
| Cable | 3-meter cable is provided; 4 and 5-meter cables are optional. When fully coiled, the cables are about 1.3-meter, 1.6-meter and 1.8-meter respectively. Each of these cables will actually uncoil well beyond their stated length; the stated cable length is for the usual distance (not the maximum). |
| Dimensions | roughly 7.9" (200 mm) x 3.15" (80 mm) |
| Weight | 22.9 ounces (650 grams) |



The Machine Tool Builder's Panel (MTBP) from **MACHINEMATE** INC is specially designed to complement the **MACHINEMATE** control with the following features:

- ❑ Easy installation – same 19” width as the **MACHINEMATE** 19” rack-mount front panel or the 11.4” width as the slim line front panel
- ❑ 50-pin D-shell connector for easy cabling to the **MACHINEMATE** system (it is also pin-compatible with the SERCOS control X9 connector)
- ❑ 2-meter cable included, 50-pin D-shell connectors on both ends
- ❑ Emergency stop push button (push in to lock, twist out to release)
- ❑ Feed rate and spindle speed override rotary switches
- ❑ Cycle start (green) and cycle stop (red) push buttons (illuminated)
- ❑ Jog + and Jog – push buttons (illuminated)
- ❑ Several general purpose push buttons (illuminated) (six on 19” model; ten on slim line model)
- ❑ All of the small push buttons can have different labels on their backing (buttons with no backing or with blank backing are available)
- ❑ PLC application template for this MTBP available from **MACHINEMATE** INC or from its web site

| | |
|----------------------|--|
| Easy installation | The 19” panel has the same 19” width (standard rack-mount dimension) as the MachineMate control. The slim line model has the same width as the MachineMate slim line operator front panel. The 2-meter cable is pin-compatible with the X9 connector on the MachineMate SERCOS control (its IO connector, separate from the other system IO modules). Alternately, a 50-pin breakout card with terminal strips is available for the electrical connection to the system IO modules. |
| 4-pin terminal block | The power supply (24VDC and ground) is connected to a small terminal block on the panel's circuit card. On the same block, the Emergency stop signals (two pins) are provided to connect the push button to the control's Emergency stop electrical circuit. |
| IO connector | The 24VDC inputs/outputs are connected to CNC via this 50-pin D-shell connector. |
| Dimensions | 19.0” (482 mm) x 4.0” (101.6 mm) or 11.4” x 6”. Allow at least 6” (153 mm) behind the panel for the cable and its bend radius. |



The Auxiliary Panel from **MACHINEMATE** INC is specially designed to complement the **MACHINEMATE** control with the following features:

- ❑ Easy installation – same 19” width as the **MACHINEMATE** control
- ❑ 50-pin D-shell connector for easy cabling to the **MACHINEMATE** system (it is also pin-compatible with the SERCOS control X9 connector)
- ❑ 2-meter cable included, 50-pin D-shell connectors on both ends
- ❑ Handwheel with 100 counts per revolution, in either a 5V encoder model or a 24V input (signal pair) model
- ❑ Sixteen general purpose push buttons (illuminated)
- ❑ All sixteen of the small push buttons can have different labels on their backing (buttons with no backing or with blank backing are available)

| | |
|----------------------|--|
| Easy installation | The panel has the same 19” width (standard rack-mount dimension) as the MachineMate control. The 2-meter cable is pin-compatible with the X9 connector on the MachineMate SERCOS control (its IO connector, separate from the other system IO modules). Alternately, a 50-pin breakout card with terminal strips is available for the electrical connection to the system IO modules. |
| 4-pin terminal block | The power supply (24VDC and ground) and the handwheel's 5V encoder signals are connected to a small terminal block on the panel's circuit card. |
| IO connector | The 24VDC inputs and outputs are connected to the CNC via this 50-pin D-shell connector. |
| Dimensions | 19.0” (482 mm) x 4.0” (101.6 mm) Allow at least 6” (153 mm) behind the panel for the cable and its bend radius. |