MACHINEMATE®

CNC SERIES

SYSTEM SPECIFICATION

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1. INTRODUCTION

Superior Capability in Technology and Productivity

The **MACHINE**MATE **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 **MACHINE**MATE, you do not sacrifice openness for CNC performance. There are good open architecture controls and good CNC controls on the market; but until **MACHINE**MATE, both did not exist in one single processor control.

The **MACHINE**MATE **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 **MACHINE**MATE **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 **MACHINE**MATE **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 **MACHINE**MATE.

PC Technology

The **MACHINE**MATE **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 NT** operating system, plus the **NT Real Time Kernel**, the **MACHINE**MATE **CNC** is open to the PC components manufactured world wide. This way, a modern **Windows NT**-based human machine interface was readily incorporated. As an option, touch screens of 15", 18", and 20.1" can be interfaced just as easily. 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 (ISA and PCI) used.

Application Experience and Know-how

From three-axis laser cutting to complex five-axis 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.

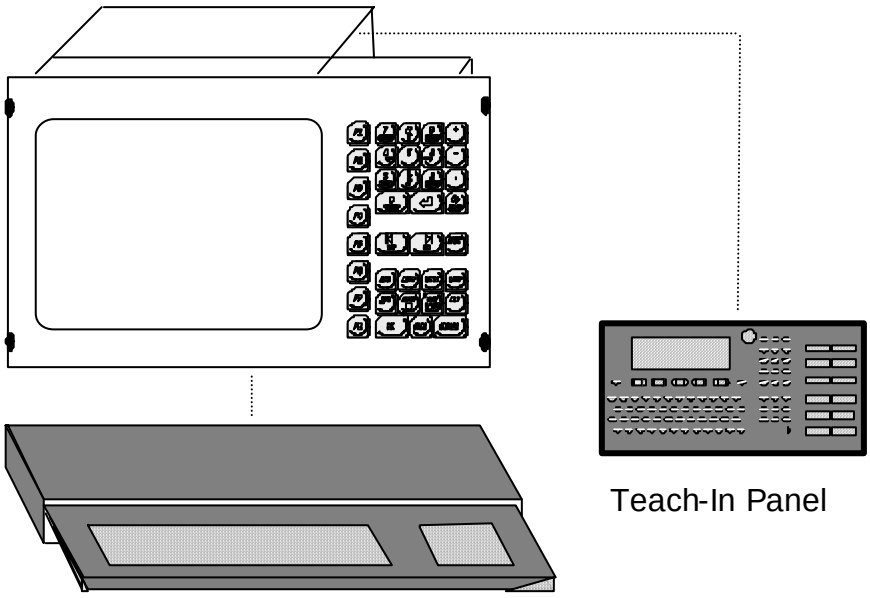
Accuracy

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, **AC**cura**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 **MACHINEM**ATE easy to learn and use. By means of the window technology, the information is presented where it is needed on the screen.

2. **MACHINEM**ATE ILLUSTRATION



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
  - ⇒ Numeric keypad
- Teach-In Panel (See Figure 2.1) (optional)
  - ⇒ LC display
  - ⇒ ASCII keyboard (See Figure 2.1)
  - ⇒ Mode selection keys
  - ⇒ Soft keys
- ASCII drawer keyboard (see Figure 2.1) (optional)
- 10.4", 12.1", 15", 18", 20.1" flat TFT touch screen (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

- 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 (Continuous, Single Block, Manual NC)
- Program Process 2 (Block Read Over, Optional Halt, Parallel Edit, Initial State)

DATA

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

INFORMATION

- Interface Display
- Version
- Status Treatment
- Log Book

SYSTEM

- Display Functions
- Station (Channel) Selection
- Exit
- Operation
- 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
- 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 NT 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

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	±10V 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

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

6.3 Distance Control

- 3D distance control

6.4 Path Tracking

- 2D path tracking

6.5 Axis Control

- Velocity override via external analog or digital signal

- 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

- 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

- <u>NC Program Memory</u>
  - NC memory (buffered CMOS-RAM) 128 KB up to 872 KB
  - NC programs 200
  - Program number 6 Digits
- <u>Hard Disk Memory</u>
  - 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
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 270	Turning finishing cycle
G 271	Stock removal in turning

G 272 Stock removal in facing

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

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 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

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 **MACHINE**MATE.

10. INTEGRATED IEC 1131-3 SOFT PLC

Languages	Structured Text (included in basic)
	Ladder Diagram (included in basic)
	Function Blocks (optional)
	Instruction List (optional)
	Step Sequence (optional)
Inputs	Up to 792/**MACHINE**MATE Inputs
Outputs	Up to 528/**MACHINE**MATE 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)
E/A Definition	Bit/Byte, Word, DWORD
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
Hybrid Discrete Module:	24 inputs, 16 outputs (1A) 24V DC
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 **MACHINE**MATE I/O ON SERCOS MODULE
(does not apply to analog servo module)

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 **MACHINE**MATE CNC.

12. INTEGRATED PC

- Industrial PC package (IPC)
- Pentium processor (speed depends on model
- 1.44 MB, 3.5" system floppy drive (front panel mounted)
- System hard disk, 800 MB minimum
- Windows NT
- **MACHINE**MATE Real Time Kernel

13. COMMUNICATION

- **Interface Ports**

  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 but not externally
- **Data I/O Simultaneously with Program Execution**
- **LAN-Network (Ethernet) (optional)**

  Standard PC network card (ISA or PCI) is optional
- **Bus Interfaces (options)**

  InterBus-S

  Profibus-DP

  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

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 spreadsheet applications such as Microsoft Excel, can access data with the **MACHINE**MATE.
- A 'visualizer' program is also available, called MMVis. Graphical operator displays or windows can be created that access the PLC data in the **MACHINE**MATE using the DDE connection.

Via **MACHINE**MATE **Compile Cycles** in C++

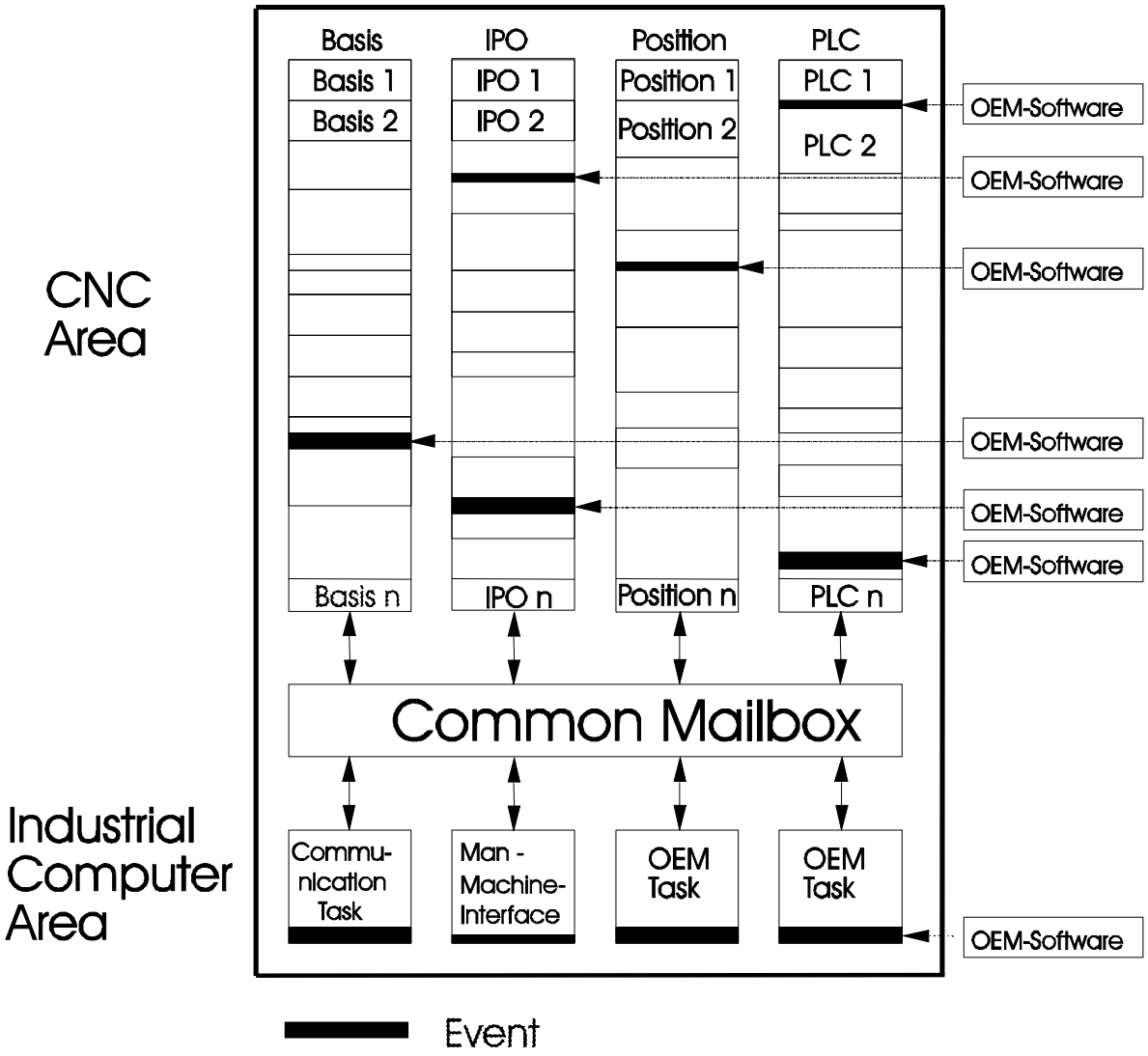
Basic software tools required (standard products from Microsoft, to be purchased by the customer):

- MS C++ Compiler, Visual C++ 5.0

Development set:

- Compile cycle CNC kernel library

16. **MACHINE**MATE Features

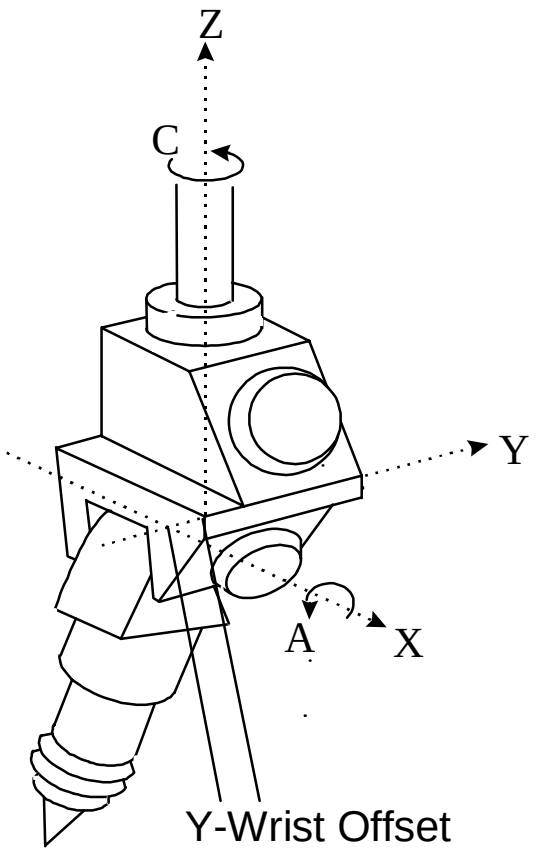


Representation of the Interface to Compile Cycles

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.

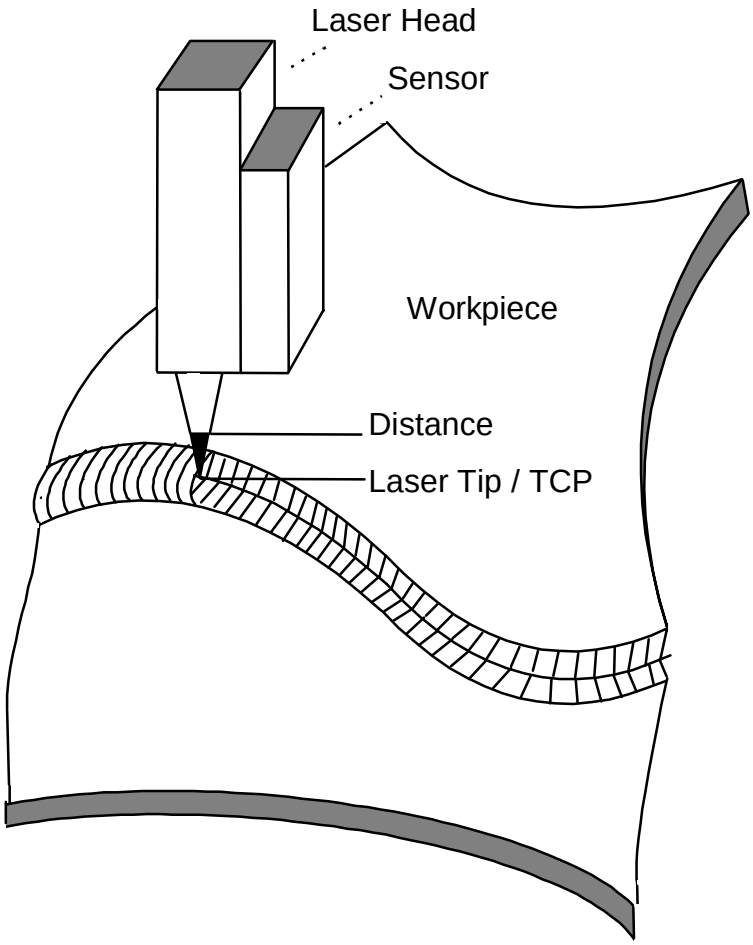
Five-Axis Transformation (Option)



Properties of the Five-AxisTransformation

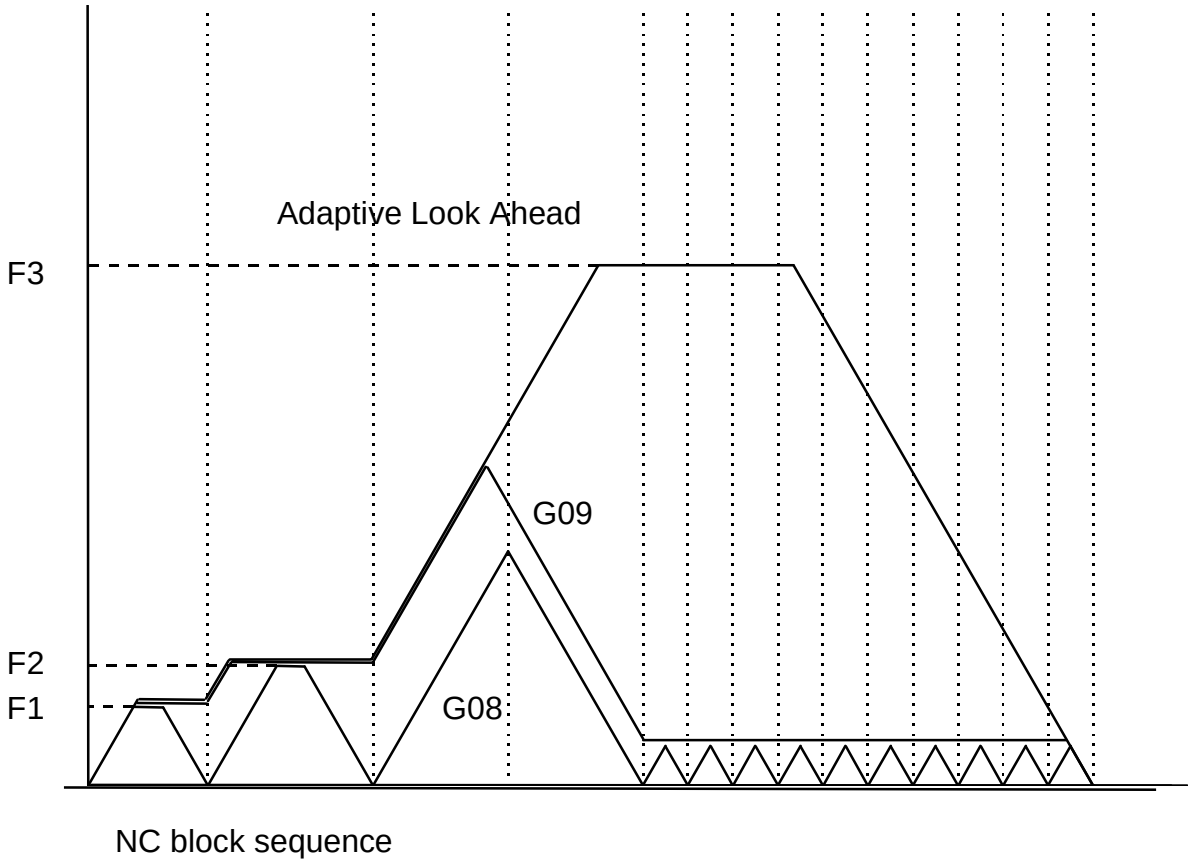
- Definition of tool center point
- Definition of a speed limitation point on the tool
- Programming based on machine coordinate system
- Programming based on user-defined coordinate system
- TCP programming in the original coordinate system
- TCP programming in a rotated and shifted coordinate system
- 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

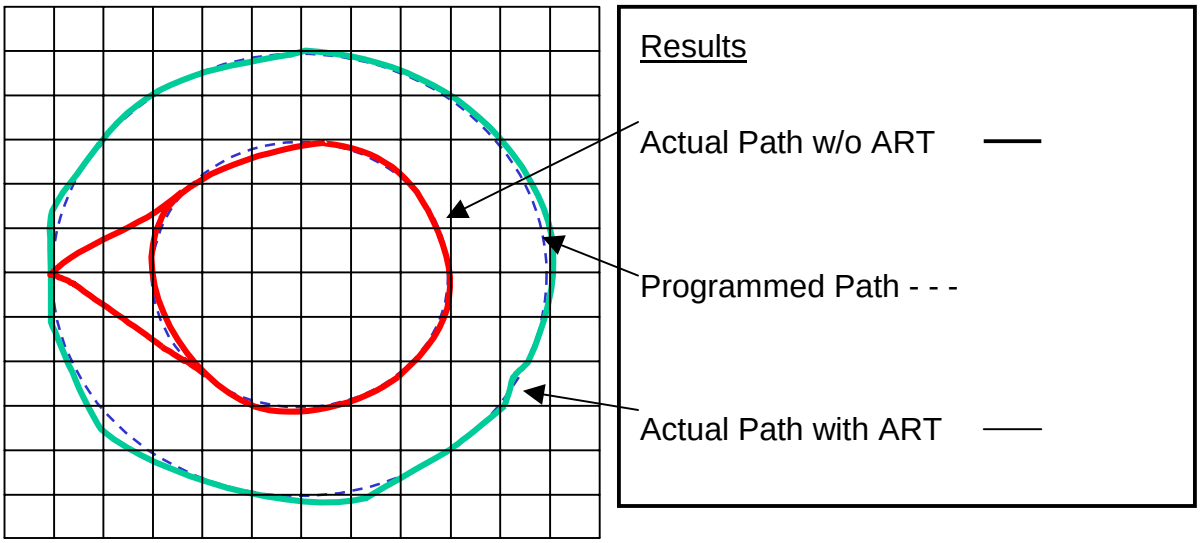
1. Even with the most sophisticated feed-forward functions like the one of Machine Mate, Zero Following Error cannot be achieved completely, leaving a minute path error. Using the self-adapting ART function, this error can even be more reduced by automatic fine-tuning of the relevant control parameters.

   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)



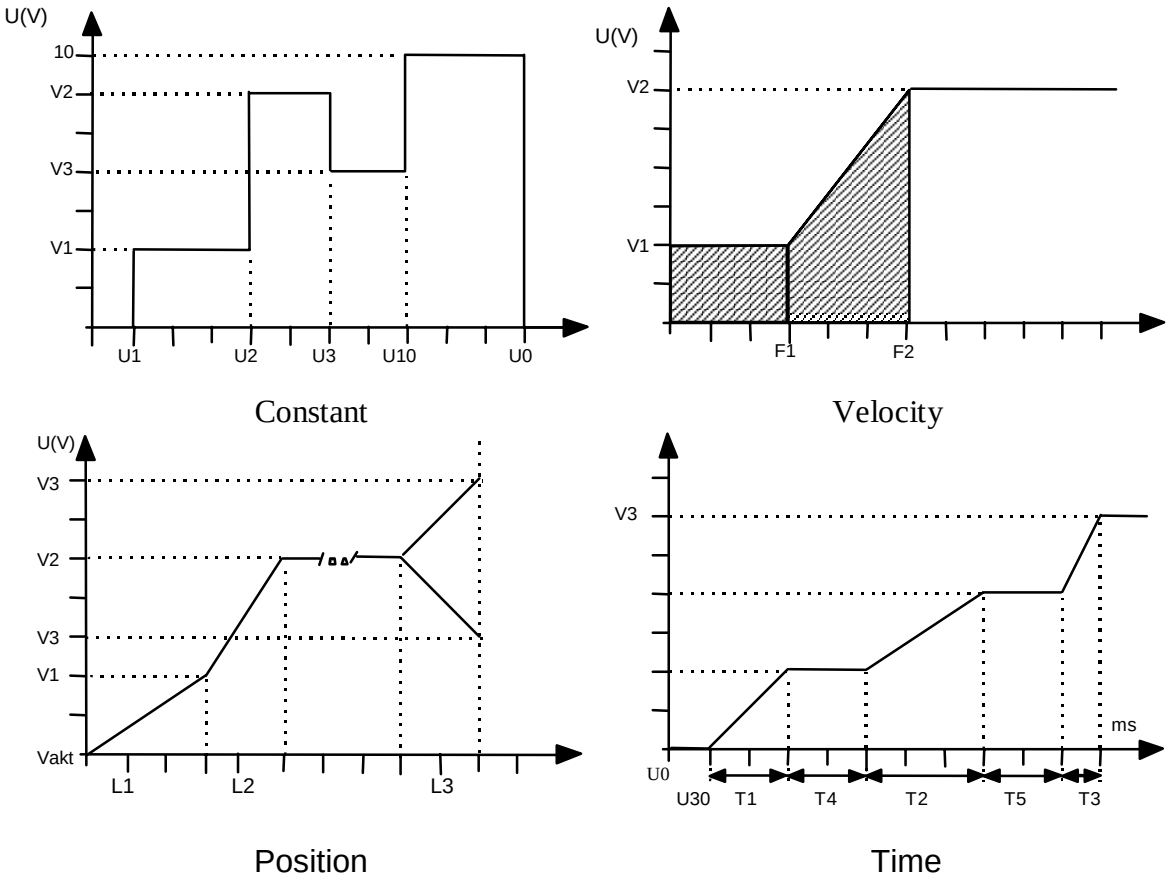
Grid: .0002" (.005mm)

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

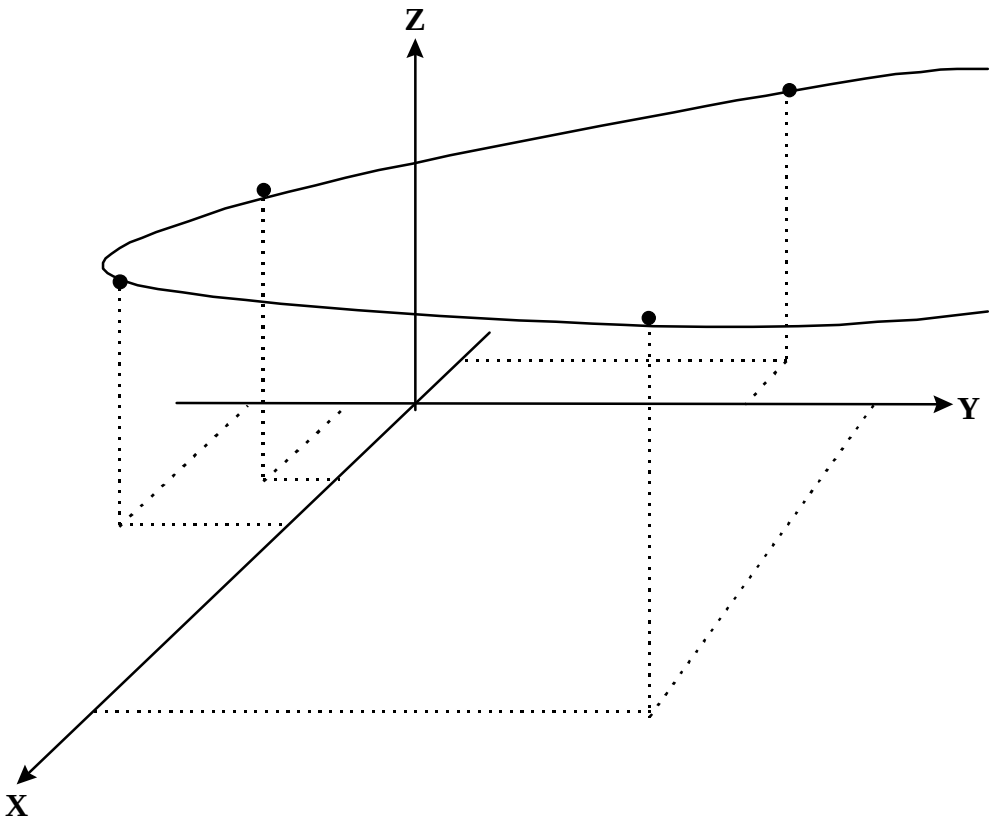
LASER POWER CONTROL



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.

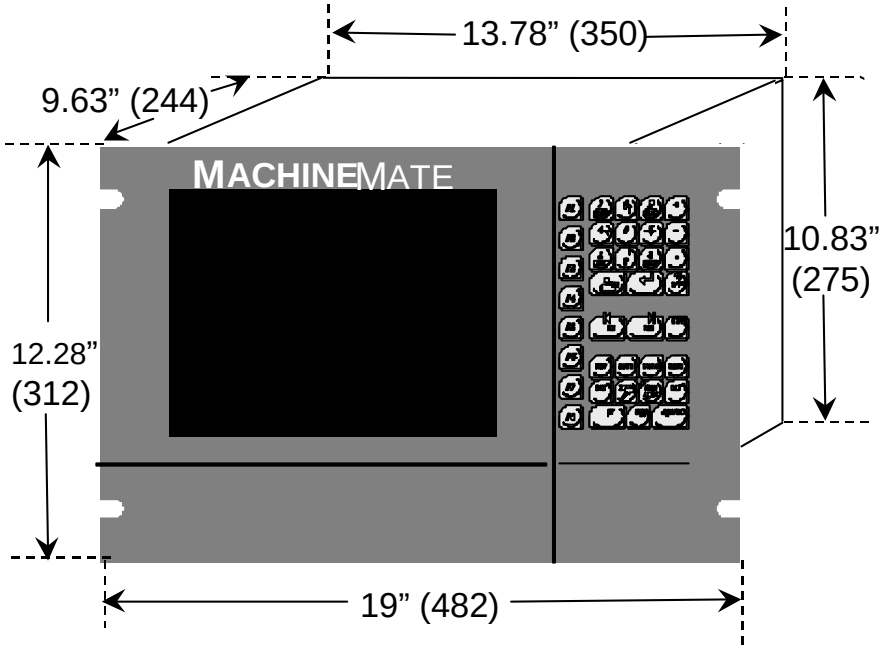
3D SPLINE INTERPOLATION



- 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

17. MECHANICAL OUTLINE

CNC with Operator's Station



All dimensions in inches (mm).

Weight: 31# (14 Kg) with 10.4" TFT screen

NOTE: The flat screen is either a 10.4" or 12.1" (diagonal measure), but this does not affect the overall dimensions.

Teach-In Panel (Option)

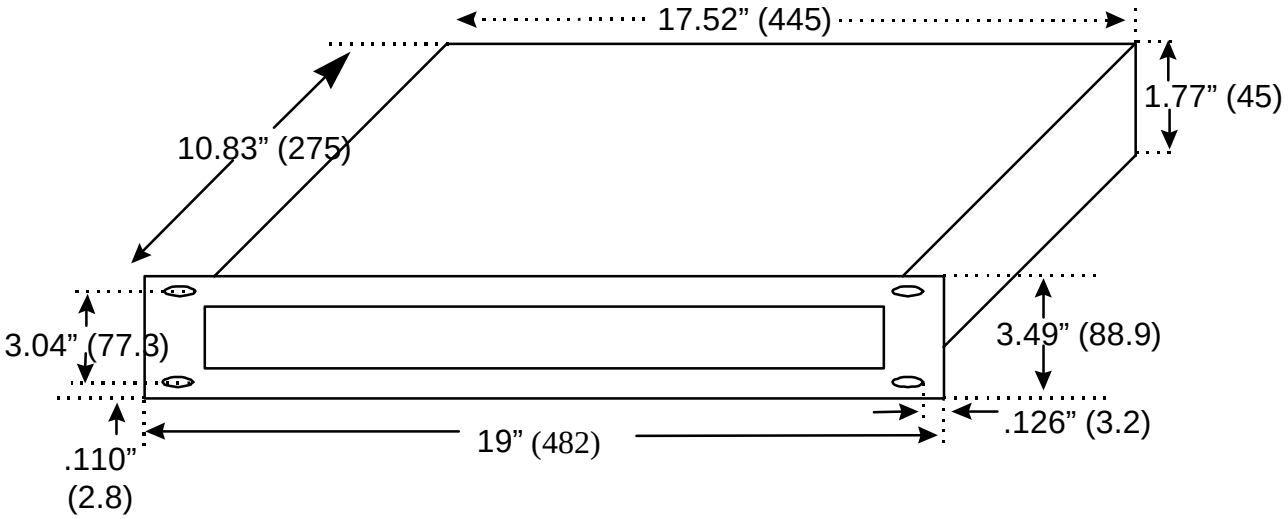
With the MACHINEMATE Teach-In Panel, any teach task can be solved simply and comfortably. The user must keep an eye solely on the path to be taught regardless if the machine has two or five axes. All other tasks are accomplished automatically by the controller. If a new part is to be taught or an already available part is to be changed, the procedure is simple. By moving backward and forward again, an already taught path is examined and corrected if necessary.

This process can be repeated until the path corresponds to the desired requirements. It is possible to temporarily move off of the teach contour and automatically return to the teach contour. Inserting of NC blocks at arbitrary locations in a part's program is possible at any time. The changes are indicated immediately on the display of the Teach-In Panel. All functions necessary for teaching can be called up by the user simply by pressing a button.

Among others these are:

- Display of the new NC program during the teach procedure
- Display of the position of the axes
- Selection of the NC programs
- Input and modification of NC blocks during the teach procedure
- Test run with moving forward and backward
- Aborting of the teach procedure and automatic reset
- Setting of the axes position to zero
- Zero point offset
- Activate transformation

ASCII DRAWER KEYBOARD (Option)



All dimensions in inches (mm).

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**

  100 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 **MACHINEMATE** 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**

  31# (14 Kg) Basic OEM **MACHINEMATE** with 10.4" TFT

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