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Cat. No.
I51E-EN-05

OMRON

Trajexia motion control system

TJ1-MC04, TJ1-MC16, TJ1-ML04, TJ1-ML16, TJ1-PRT, TJ1-DRT, TJ1-CORT, TJ1-FL02
GRT1-ML2

HARDWARE REFERENCE MANUAL

Notice

OMRON products are manufactured for use according to proper procedures by a qualified operator and only for the purposes described in this manual. The following conventions are used to indicate and classify precautions in this manual. Always heed the information provided with them. Failure to heed precautions can result in injury to people or damage to property.

Definition of precautionary information

WARNING
Indicates a potentially hazardous situation, which, if not avoided, could result in death or serious injury.

Caution
Indicates a potentially hazardous situation, which, if not avoided, may result in minor or moderate injury, or property damage.

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About this manual

This manual describes the installation and operation of the Trajexia Motion Control System.
Please read this manual and the related manuals listed in the following table carefully and be sure you understand the information provided before attempting to install or operate the Trajexia Motion Control units. Be sure to read the precautions provided in the following section.

Name	Cat. No.	Contents
Trajexia motion control system QUICK START GUIDE	I50E	Describes how to get quickly familiar with Trajexia, moving a single axis using MECHATROLINK-II, in a test set-up.
Trajexia motion control system HARDWARE REFERENCE MANUAL	I51E	Describes the installation and hardware specification of the Trajexia units, and explains the Trajexia system philosophy.
Trajexia motion control system PROGRAMMING MANUAL	I52E	Describes the BASIC commands to be used for programming Trajexia, communication protocols and Trajexia Studio software, gives practical examples and troubleshooting information.
Sigma-II Servo Driver manual	SIEP S800000 15	Describes the installation and operation of Sigma-II Servo Drivers
Sigma-III with MECHATROLINK interface manual	SIEP S800000 11	Describes the installation and operation of Sigma-III Servo Drivers with MECHATROLINK-II interface
Sigma-V Servo Driver manual	SIEP S800000-44-O-OY SIEP S800000-46-O-OY SIEP S800000-48-O-OY	Describes the installation and operation of Sigma-V Servo Drivers
JUNMA series servo drive manual	TOEP-C71080603 01-OY	Describes the installation and operation of JUNMA Servo Drivers
V7 Inverter	TOEP C71060605 02-OY	Describes the installation and operation of V7 Inverters
F7Z Inverter	TOE S616-55 1-OY	Describes the installation and operation of F7Z Inverters
G7 Inverter	TOE S616-60	Describes the installation and operation of G7 Inverters
JUSP-NS115 manual	SIEP C71080001	Describes the installation and operation of the MECHATROLINK-II application module
SI-T MECHATROLINK interface for the G7 & F7	SIBP-C730600-08	Describes the installation and operation of MECHATROLINK-II interfaces for G7 and F7 Inverters
ST-T/V7 MECHATROLINK interface for the V7	SIBP-C730600-03	Describes the installation and operation of MECHATROLINK-II interfaces for V7 Inverters
MECHATROLINK IO Modules	SIE C887-5	Describes the installation and operation of MECHATROLINK-II input and output modules and the MECHATROLINK-II repeater
SYSMAC CS/CJ Series Communications Commands	W342	Describes FINS communications protocol and FINS commands
Omron Smartslice GRT1-Series, slice I/O units, Operation manual	W455-E1	Describes the installation and operation of Omron slice I/O units
Omron G-series user's manual	I566-E1	Describes the installation and operation of G-series Servo Drivers
Omron Accurax G5 user's manual	I572-E1	Describes the installation and operation of Accurax G5 Servo Drivers
Trajexia Studio user manual	I56E-EN	Describes the use of Trajexia Studio programming software

WARNING
Failure to read and understand the information provided in this manual may result in personal injury or death, damage to the product, or product failure. Please read each section in its entirety and be sure you understand the information provided in the section and related sections before attempting any of the procedures or operations given.

Functions supported by unit versions

During the development of Trajexia new functionality was added to the controller unit after market release.
This functionality is implemented in the firmware, and/or the FPGA of the controller unit.
In the table below, the overview of the applicable functionality is shown related to the firmware and FPGA version of the TJ1-MC__.

Functionality	**TJ1-MC__ Firmware version**	**TJ1-MC__ FPGA version**
Full support TJ1-FL02	V1.6509	21 and higher
Support BASIC commands FINS_COMMS	V1.6509	All versions
Support TJ1-DRT	V1.6509	All versions
Support TJ1-MC04 andTJ1-ML04	V1.6607	21 and higher
Support TJ1-CORT, GRT1-ML2, ModbusTCP, Sigma-V series Servo Drivers (except **DATUM** and **REGIST** BASIC commands) and allow Inverters to be controlled as servo axes	V1.6652	21 and higher
Support for G-series Drivers, full support for Sigma-V series Servo Drivers	V1.6714	21 and higher
Support for Accurax G5 Drivers	V1.6720	21 and higher

Verify the firmware and FPGA versions of the TJ1-MC__

Connect the TJ1-MC__ to Trajexia Studio software. Refer to the Programming Manual.
Open the terminal window and type the following commands:

Type `PRINT VERSION` in the terminal window. The version parameter returns the current firmware version number of the motion controller.
Type `PRINT FPGA_VERSION SLOT(-1)` in the terminal window. The parameter returns the current FPGA version number of the TJ1-MC__.

1 Safety warnings and precautions

1.1 Intended audience

This manual is intended for personnel with knowledge of electrical systems (electrical engineers or the equivalent) who are responsible for the design, installation and management of factory automation systems and facilities.

1.2 General precautions

The user must operate the product according to the performance specifications described in this manual.
Before using the product under conditions which are not described in the manual or applying the product to nuclear control systems, railroad systems, aviation systems, vehicles, safety equipment, petrochemical plants, and other systems, machines and equipment that can have a serious influence on lives and property if used improperly, consult your OMRON representative.

1.3 Safety precautions

WARNING
Do not attempt to take the Unit apart and do not touch any of the internal parts while power is being supplied.
Doing so may result in electrical shock.

WARNING
Do not touch any of the terminals or terminal blocks while power is being supplied.
Doing so may result in electric shock.

WARNING
Never short-circuit the positive and negative terminals of the batteries, charge the batteries, disassemble them, deform them by applying pressure, or throw them into a fire.
The batteries may explode, combust or leak liquid.

WARNING
Fail-safe measures must be taken by the customer to ensure safety in the event of incorrect, missing, or abnormal signals caused by broken signal lines, momentary power interruptions, or other causes.
Not doing so may result in serious accidents.

WARNING
Emergency stop circuits, interlock circuits, limit circuits, and similar safety measures must be provided by the customer as external circuits, i.e., not in the Trajexia motion controller.
Not doing so may result in serious accidents.

WARNING
When the 24 VDC output (I/O power supply to the TJ1) is overloaded or short-circuited, the voltage may drop and result in the outputs being turned off.As a countermeasure for such problems, external safety measures must be provided to ensure safety in the system.

WARNING
The TJ1 outputs will go off due to overload of the output transistors (protection).As a countermeasure for such problems, external safety measures must be provided to ensure safety in the system.

WARNING
The TJ1 will turn off the WDOG when its self-diagnosis function detects any error.As a countermeasure for such errors, external safety measures must be provided to ensure safety in the system.

WARNING
Provide safety measures in external circuits, i.e., not in the Trajexia Motion Controller (referred to as "TJ1"), in order to ensure safety in the system if an abnormality occurs due to malfunction of the TJ1 or another external factor affecting the TJ1 operation.
Not doing so may result in serious accidents.

WARNING
Do not attempt to disassemble, repair, or modify any Units.
Any attempt to do so may result in malfunction, fire, or electric shock.

Caution
Confirm safety at the destination unit before transferring a program to another unit or editing the memory.
Doing either of these without confirming safety may result in injury.

Caution
User programs written to the Motion Control Unit will not be automatically backed up in the TJ1 flash memory (flash memory function).

Caution
Pay careful attention to the polarity (+/-) when wiring the DC power supply.A wrong connection may cause malfunction of the system.

Caution
Tighten the screws on the terminal block of the Power Supply Unit to the torque specified in this manual.
Loose screws may result in burning or malfunction.

1.4 Operating environment precautions

Caution
Do not operate the Unit in any of the following locations.
Doing so may result in malfunction, electric shock, or burning.
- Locations subject to direct sunlight.
- Locations subject to temperatures or humidity outside the range specified in the specifications.
- Locations subject to condensation as the result of severe changes in temperature.
- Locations subject to corrosive or flammable gases.
- Locations subject to dust (especially iron dust) or salts.
- Locations subject to exposure to water, oil, or chemicals.
- Locations subject to shock or vibration.

Caution
Take appropriate and sufficient countermeasures when installing systems in the following locations.
Inappropriate and insufficient measures may result in malfunction.
- Locations subject to static electricity or other forms of noise.
- Locations subject to strong electromagnetic fields.
- Locations subject to possible exposure to radioactivity.
- Locations close to power supplies.

Caution
The operating environment of the TJ1 System can have a large effect on the longevity and reliability of the system.
Improper operating environments can lead to malfunction, failure, and other unforeseeable problems with the TJ1 System.
Make sure that the operating environment is within the specified conditions at installation and remains within the specified conditions during the life of the system.

1.5 Application precautions

WARNING
Do not start the system until you check that the axes are present and of the correct type.
The numbers of the Flexible axes will change if MECHATROLINK-II network errors occur during start-up or if the MECHATROLINK-II network configuration changes.
Not doing so may result in unexpected operation.

WARNING
Check the user program for proper execution before actually running it in the Unit.
Not checking the program may result in an unexpected operation.

Caution
Always use the power supply voltage specified in this manual.
An incorrect voltage may result in malfunction or burning.

Caution
Take appropriate measures to ensure that the specified power with the rated voltage and frequency is supplied. Be particularly careful in places where the power supply is unstable.
An incorrect power supply may result in malfunction.

Caution
Install external breakers and take other safety measures against short-circuiting in external wiring.
Insufficient safety measures against short-circuiting may result in burning.

Caution
Do not apply voltage to the Input Units in excess of the rated input voltage.
Excess voltage may result in burning.

Caution
Do not apply voltage or connect loads to the Output Units in excess of the maximum switching capacity.
Excess voltage or loads may result in burning.

Caution
Disconnect the functional ground terminal when performing withstand voltage tests.
Not disconnecting the functional ground terminal may result in burning.

Caution
Always connect to a class-3 ground (to 100Ω or less) when installing the Units.
Not connecting to a class-3 ground may result in electric shock.

Caution
Always turn off the power supply to the system before attempting any of the following.
Not turning off the power supply may result in malfunction or electric shock.

- Mounting or dismounting expansion Units, CPU Units, or any other Units.
- Assembling the Units.
- Setting dipswitches or rotary switches.
- Connecting or wiring the cables.
- Connecting or disconnecting the connectors.

Caution
Be sure that all mounting screws, terminal screws, and cable connector screws are tightened to the torque specified in this manual.
Incorrect tightening torque may result in malfunction.

Caution
Leave the dust protective label attached to the Unit when wiring.
Removing the dust protective label may result in malfunction.

Caution
Remove the dust protective label after the completion of wiring to ensure proper heat dissipation.
Leaving the dust protective label attached may result in malfunction.

Caution
Use crimp terminals for wiring. Do not connect bare stranded wires directly to terminals.
Connection of bare stranded wires may result in burning.

Caution
Double-check all the wiring before turning on the power supply.
Incorrect wiring may result in burning.

Caution
Wire correctly.
Incorrect wiring may result in burning.

Caution
Mount the Unit only after checking the terminal block completely.

Caution
Be sure that the terminal blocks, expansion cables, and other items with locking devices are properly locked into place.
Improper locking may result in malfunction.

Caution
Confirm that no adverse effect will occur in the system before changing the operating mode of the system.
Not doing so may result in an unexpected operation.

Caution
Resume operation only after transferring to the new CPU Unit the contents of the VR and table memory required for operation.
Not doing so may result in an unexpected operation.

Caution
When replacing parts, be sure to confirm that the rating of a new part is correct.
Not doing so may result in malfunction or burning.

Caution
Do not pull on the cables or bend the cables beyond their natural limit. Doing so may break the cables.

Caution
Before touching the system, be sure to first touch a grounded metallic object in order to discharge any static build-up. Otherwise it might result in a malfunction or damage.

Caution
UTP cables are not shielded. In environments that are subject to noise use a system with shielded twisted-pair (STP) cable and hubs suitable for an FA environment.
Do not install twisted-pair cables with high-voltage lines.
Do not install twisted-pair cables near devices that generate noise.
Do not install twisted-pair cables in locations that are subject to high humidity.
Do not install twisted-pair cables in locations subject to excessive dirt and dust or to oil mist or other contaminants.

Caution
Use the dedicated connecting cables specified in operation manuals to connect the Units.
Using commercially available RS-232C computer cables may cause failures in external devices or the Motion Control Unit.

Caution
Outputs may remain on due to a malfunction in the built-in transistor outputs or other internal circuits.
As a countermeasure for such problems, external safety measures must be provided to ensure the safety of the system.

Caution
The TJ1 will start operating in RUN mode when the power is turned on and if a BASIC program is set to Auto Run mode.

Caution
Always check the “Status-Words” of each GRT1-ML2 coupler. Not doing so can lead to missing or incorrect I/O data.

Caution
Always check the status of the connected MECHATROLINK-II devices in a BASIC program.
Not doing so may result in an unexpected operation.

Caution
The TJ1-CORT unit is developed to exchange I/O data between the Trajexia system and a CANopen network.
The TJ1-CORT is not able to exchange motion commands.
Using the TJ1-CORT to exchange motion commands may result in unexpected operation.

1.6 Unit assembly precautions

Caution
Install the unit properly.
Improper installation of the unit may result in malfunction.

Caution
Be sure to mount the TJ1-TER supplied with the TJ1-MC__ to the right most Unit.
Unless the TJ1-TER is properly mounted, the TJ1 will not function properly.

1.7 Conformance to EC Directives Conformance

1.7.1 Concepts

The concepts for the directives EMC and Low Voltage are as follows:

EMC Directives

OMRON devices that comply with EC Directives also conform to the related EMC standards so that they can be more easily built into other devices or machines. The actual products have been checked for conformity to EMC standards. Whether the products conform to the standards in the system used by the customer, however, must be checked by the customer.
EMC-related performance of the OMRON devices that comply with EC Directives will vary depending on the configuration, wiring, and other conditions of the equipment or control panel in which the OMRON devices are installed. The customer must, therefore, perform final checks to confirm that devices and the over-all machine conform to EMC standards.

Low Voltage Directive

Always ensure that devices operating at voltages of 50 to 1,000 VAC or 75 to 1,500 VDC meet the required safety standards.

1.7.2 Conformance to EC Directives

The Trajexia Motion Controllers comply with EC Directives.
To ensure that the machine or device in which a system is used complies with EC directives, the system must be installed as follows:

1. The system must be installed within a control panel.
2. Reinforced insulation or double insulation must be used for the DC power supplies used for the communications and I/O power supplies.

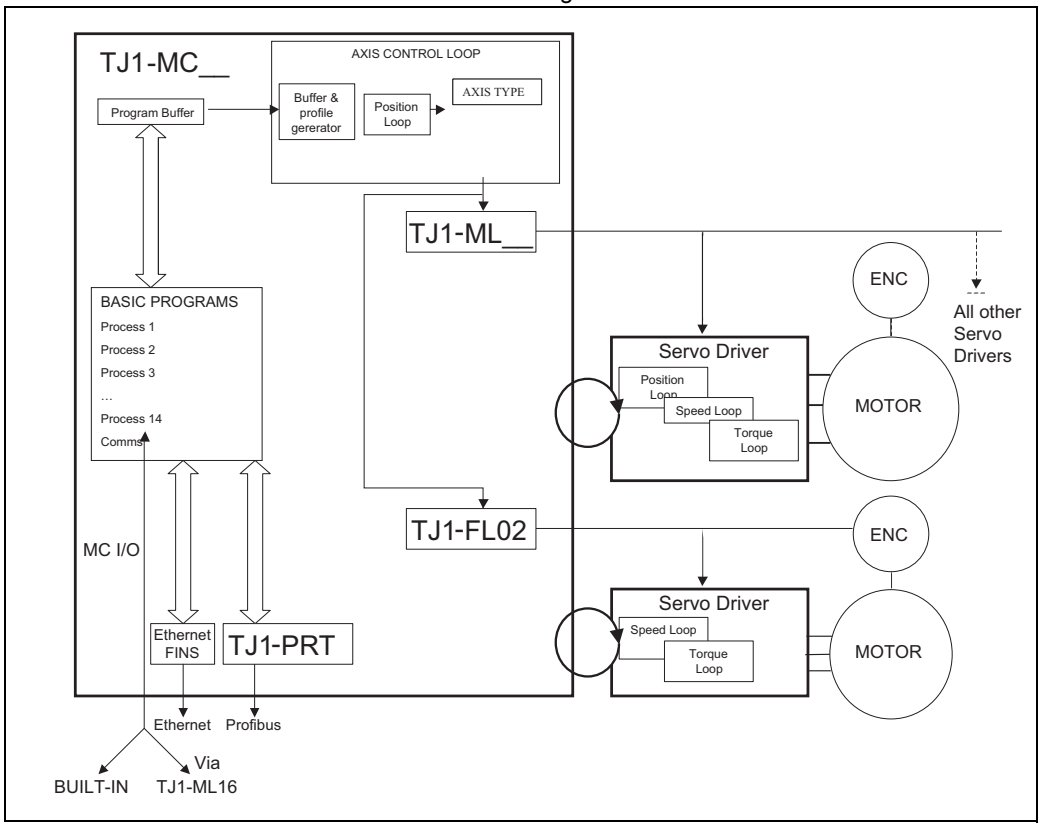
2 System philosophy

2.1 Introduction

The system philosophy is centred around the relationship between:
- System architecture
- Cycle time
- Program control and multi-tasking
- Motion sequence and axes
- Motion buffers

A clear understanding of the relationship between these concepts is necessary to obtain the best results for the Trajexia system.

fig. 1



2.1.1 Glossary

Motion sequence
The Motion Sequence is responsible for controlling the position of the axes.

Servo period
Defines the frequency at which the Motion Sequence is executed. The servo period must be set according to the configuration of the physical axes. The available settings are 0.5ms, 1ms or 2ms.

Cycle time
Is the time needed to execute one complete cycle of operations in the TJ1-MC__. The cycle time is divided in 4 time slices of equal time length, called "CPU Tasks". The cycle time is 1ms if **SERVO_PERIOD**=0.5ms or **SERVO_PERIOD**=1ms and 2ms if the **SERVO_PERIOD**=2ms.

CPU tasks
The operations executed in each CPU task are:

CPU task	Operation
First CPU task	Motion Sequence Low priority process

CPU task	Operation
Second CPU task	High priority process
Third CPU task	Motion Sequence (only if **SERVO_PERIOD**=0.5ms) LED Update High priority process
Fourth CPU task	External Communications

Program
A program is a piece of BASIC code.

Process
Is a program in execution with a certain priority assigned. Process 0 to 12 are Low priority processes and Process 13 and 14 are High priority processes. First the process priority, High or Low, and then the process number, from high to low, will define to which CPU task the process will be assigned.

2.2 Motion control concepts

The TJ1-MC__ offers these types of positioning control operations:
1. Point-to-Point (PTP) control
2. Continuous Path (CP) control
3. Electronic Gearing (EG) control.

This section introduces some of the commands and parameters used in the BASIC programming of the motion control application.

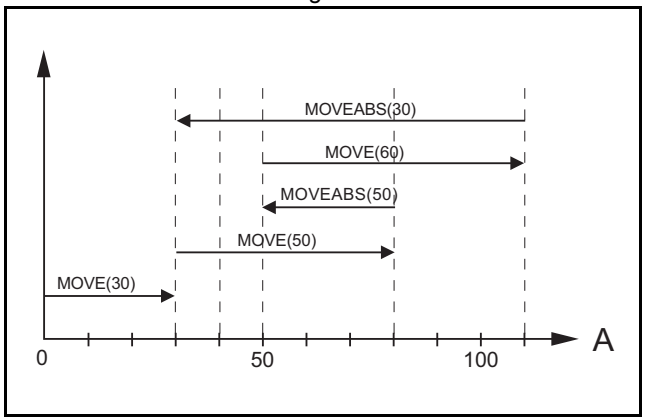
Coordinate system
Positioning operations performed by the TJ1-MC__ are based on an axis coordinate system. The TJ1-MC__ converts the position data from either the connected Servo Driver or the connected encoder into an internal absolute coordinate system.

The engineering unit that specifies the distances of travelling can be freely defined for each axis separately. The conversion is performed through the use of the unit conversion factor, which is defined by the **UNITS** axis

parameter. The origin point of the coordinate system can be determined using the **DEFPOS** command. This command re-defines the current position to zero or any other value.

A move is defined in either absolute or relative terms. An absolute move takes the axis (A) to a specific predefined position with respect to the origin point. A relative move takes the axis from the current position to a position that is defined relative to this current position. The figure shows an example of relative (command **MOVE**) and absolute (command **MOVEABS**) linear moves.

fig. 2



2.2.1 PTP control

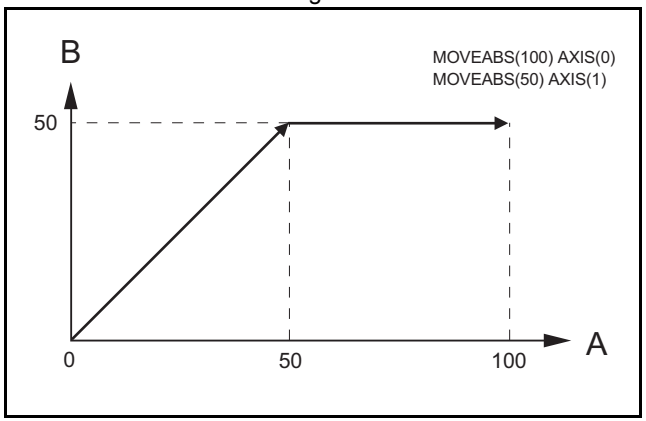
In point-to-point positioning, each axis is moved independently of the other axis. The TJ1-MC__ supports the following operations:

- Relative move
- Absolute move
- Continuous move forward
- Continuous move reverse.

Relative and absolute moves

To move a single axis either the command **MOVE** for a relative move or the command **MOVEABS** for an absolute move is used. Each axis has its own move characteristics, which are defined by the axis parameters.
Suppose a control program is executed to move from the origin to an axis no. 0 (A) coordinate of 100 and axis no. 1 (B) coordinate of 50. If the speed parameter is set to be the same for both axes and the acceleration and deceleration rate are set sufficiently high, the movements for axis 0 and axis 1 will be as shown in the figure.
At start, both the axis 0 and axis 1 moves to a coordinate of 50 over the same duration of time. At this point, axis 1 stops and axis 0 continues to move to a coordinate of 100.

fig. 3



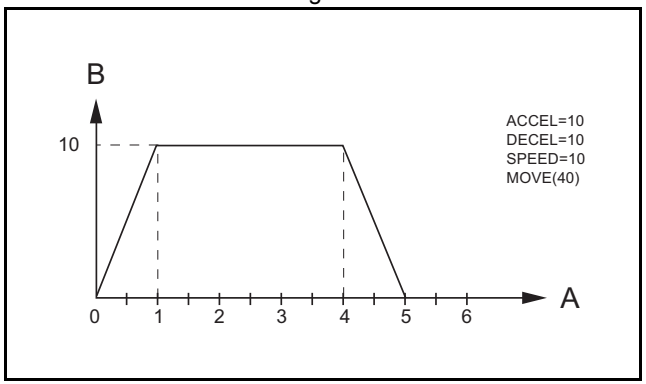
The move of a certain axis is determined by the axis parameters. Some relevant parameters are:

Parameter	Description
UNITS	Unit conversion factor
ACCEL	Acceleration rate of an axis in units/s^2
DECEL	Deceleration rate of an axis in units/s^2
SPEED	Demand speed of an axis in units/s^2

Defining moves

The speed profile in this figure shows a simple **MOVE** operation. Axis A is the time, axis B is the speed. The **UNITS** parameter for this axis has been defined for example as meters. The required maximum speed has been set to 10 m/s. In order to reach this speed in one second and also to decelerate to zero speed again in one second, both the acceleration as the deceleration rate have been set to 10 m/s^2. The total distance travelled is the sum of distances travelled during the acceleration, constant speed and deceleration segments. Suppose the distance moved by the **MOVE** command is 40 m, the speed profile is given by the figure.

fig. 4



The two speed profiles in these figures show the same movement with an acceleration time respectively a deceleration time of 2 seconds. Again, Axis A is the time, axis B is the speed.

fig. 5

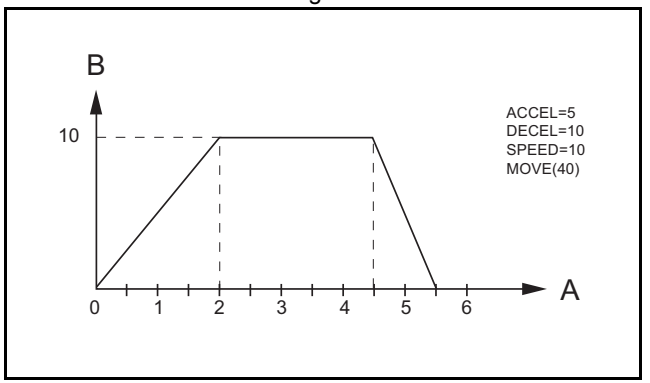
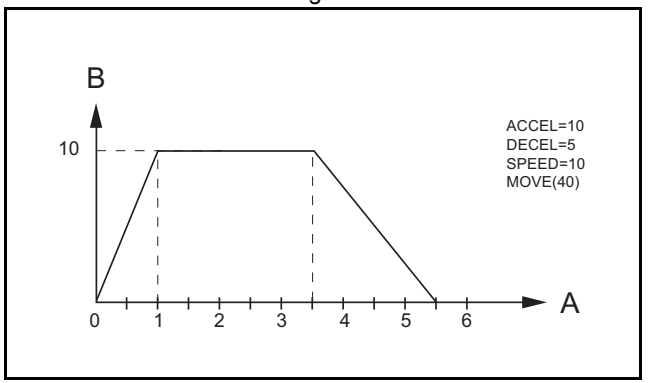


fig. 6



Move calculations

The following equations are used to calculate the total time for the motion of the axes.

- The moved distance for the **MOVE** command is *D*.
- The demand speed is *V*.
- The acceleration rate is *a*.
- The deceleration rate is *d*.

$$\text{Acceleration time} = \frac{V}{a}$$

Acceleration distance = $\frac{V^2}{2a}$

Deceleration time = $\frac{V}{d}$

Deceleration distance = $\frac{V^2}{2d}$

Constant speed distance = $D - \frac{V^2(a+d)}{2ad}$

Total time = $\frac{D}{V} + \frac{V(a+d)}{2ad}$

Continuous moves

The **FORWARD** and **REVERSE** commands can be used to start a continuous movement with constant speed on a certain axis. The **FORWARD** command moves the axis in positive direction and the **REVERSE** command in negative direction. For these commands also the axis parameters **ACCEL** and **SPEED** apply to specify the acceleration rate and demand speed.
Both movements can be cancelled by using either the **CANCEL** or **RAPIDSTOP** command. The **CANCEL** command cancels the move for one axis and **RAPIDSTOP** cancels moves on all axes. The deceleration rate is set by **DECEL**.

2.2.2 CP control

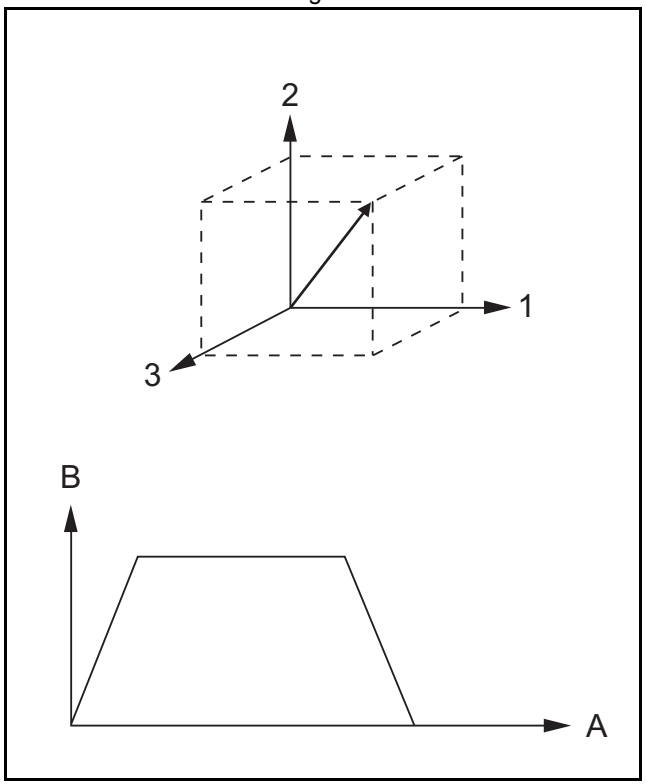
Continuous Path control enables to control a specified path between the start and end position of a movement for one or multiple axes. The TJ1-MC__ supports the following operations:

- Linear interpolation
- Circular interpolation
- CAM control.

Linear interpolation

In applications it can be required for a set of motors to perform a move operation from one position to another in a straight line. Linearly interpolated moves can take place among several axes. The commands **MOVE** and **MOVEABS** are also used for the linear interpolation. In this case the commands will have multiple arguments to specify the relative or absolute move for each axis.
Consider the three axis move in a 3-dimensional plane in the figure. It corresponds to the **MOVE(50,50,50)** command. The speed profile of the motion along the path is given in the diagram. The three parameters **SPEED**, **ACCEL** and **DECEL** that determine the multi axis movement are taken from the corresponding parameters of the base axis. The **MOVE** command computes the various components of speed demand per axis.
A is the time axis, B is the speed axis.

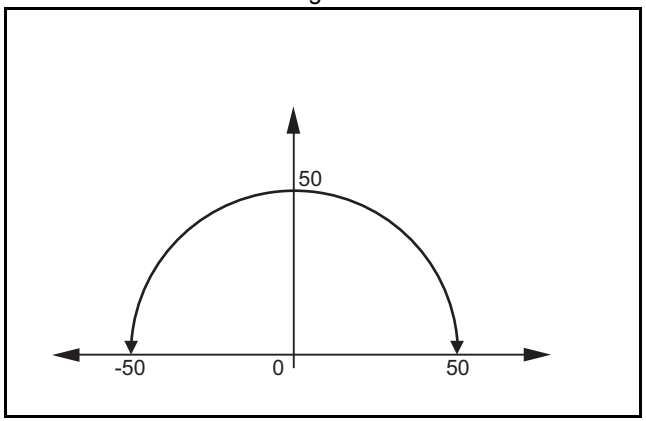
fig. 7



Circular interpolation

It may be required that a tool travels from the starting point to the end point in an arc of a circle. In this instance the motion of two axes is related via a circular interpolated move using the **MOVECIRC** command.
Consider the diagram in the figure. It corresponds to the **MOVECIRC(-100,0,-50,0,0)** command. The centre point and desired end point of the trajectory relative to the start point and the direction of movement are specified. The **MOVECIRC** command computes the radius and the angle of rotation. Like the linearly interpolated **MOVE** command, the **ACCEL**, **DECEL** and **SPEED** variables associated with the base axis determine the speed profile along the circular move.

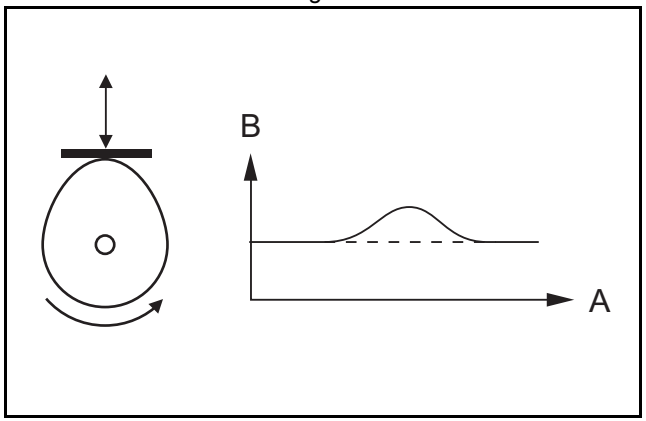
fig. 8



CAM control

Additional to the standard move profiles the TJ1-MC__ also provides a way to define a position profile for the axis to move. The **CAM** command moves an axis according to position values stored in the TJ1-MC__ Table array. The speed of travelling through the profile is determined by the axis parameters of the axis.
The figure corresponds to the command **CAM(0,99,100,20)**. A is the time axis, B is the position axis.

fig. 9



2.2.3 EG control

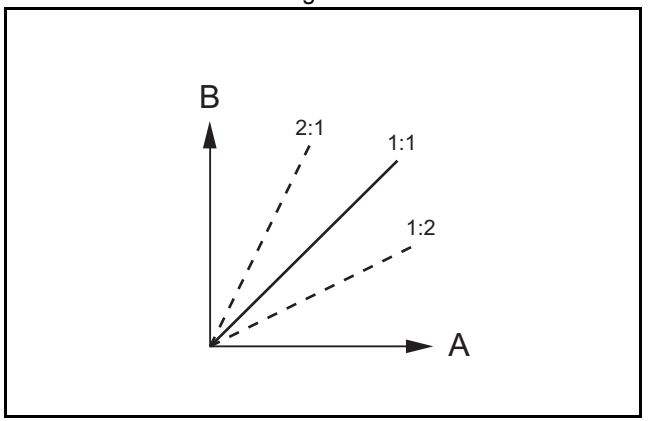
Electronic Gearing control allows you to create a direct gearbox link or a linked move between two axes. The MC Unit supports the following operations.

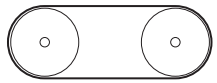
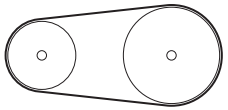
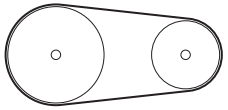
- Electronic gearbox
- Linked CAM
- Linked move
- Adding axes

Electronic gearbox

The TJ1-MC__ is able to have a gearbox link from one axis to another as if there is a physical gearbox connecting them. This can be done using the **CONNECT** command in the program. In the command the ratio and the axis to link to are specified.
In the figure, A is the Master axis, and B is the **CONNECT** axis.

fig. 10

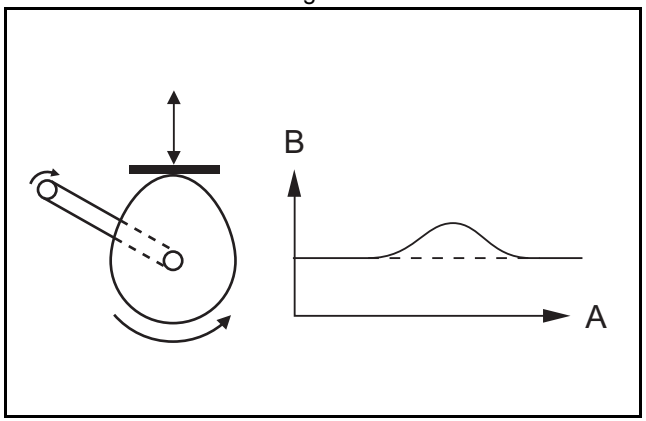


Axes		Ratio	CONNECT command
0	1		
		1:1	**CONNECT(1,0) AXIS(1)**
		2:1	**CONNECT(2,0) AXIS(1)**
		1:2	**CONNECT(0.5,0) AXIS(1)**

Linked CAM control

Next to the standard CAM profiling tool the TJ1-MC__ also provides a tool to link the CAM profile to another axis. The command to create the link is called **CAMBOX**. The travelling speed through the profile is not determined by the axis parameters of the axis but by the position of the linked axis. This is like connecting two axes through a cam.
In the figure, A is the Master axis (0) position, and B is the **CAMBOX** Axis (1) position.

fig. 11

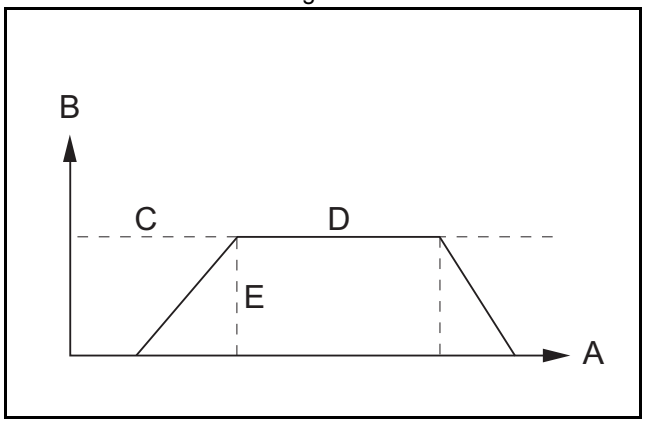


Linked move

The **MOVELINK** command provides a way to link a specified move to a master axis. The move is divided into an acceleration, deceleration and constant speed part and they are specified in master link distances. This can be particularly useful for synchronizing two axes for a fixed period.
The labels in the figure are:

A. Time axis.
B. Speed axis.
C. Master axis (1).
D. Synchronized.
E. **MOVELINK** axis (0).

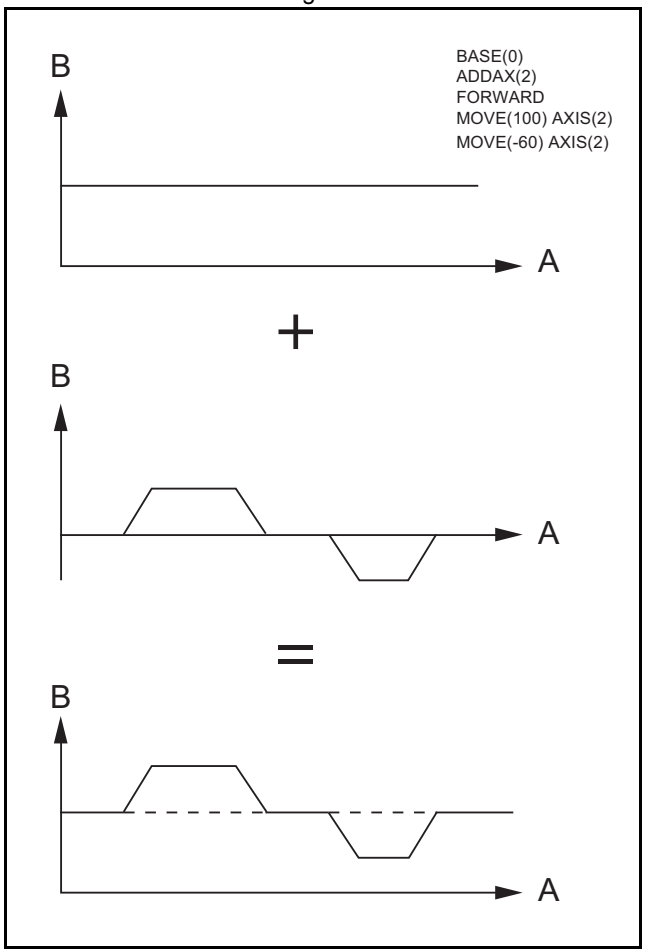
fig. 12



Adding axes

It is very useful to be able to add all movements of one axis to another. One possible application is for instance changing the offset between two axes linked by an electronic gearbox. The TJ1-MC__ provides this possibility by using the **ADDAX** command. The movements of the linked axis will consists of all movements of the actual axis plus the additional movements of the master axis.
In the figure, A is the time axis and B is the speed axis.

fig. 13



2.2.4 Other operations

Cancelling moves

In normal operation or in case of emergency it can be necessary to cancel the current movement from the buffers. When the **CANCEL** or **RAPIDSTOP** commands are given, the selected axis respectively all axes will cancel their current move.

Origin search

The encoder feedback for controlling the position of the motor is incremental. This means that all movement must be defined with respect to an origin point. The **DATUM** command is used to set up a procedure whereby the TJ1-MC__ goes through a sequence and searches for the origin based on digital inputs and/or Z-marker from the encoder signal.

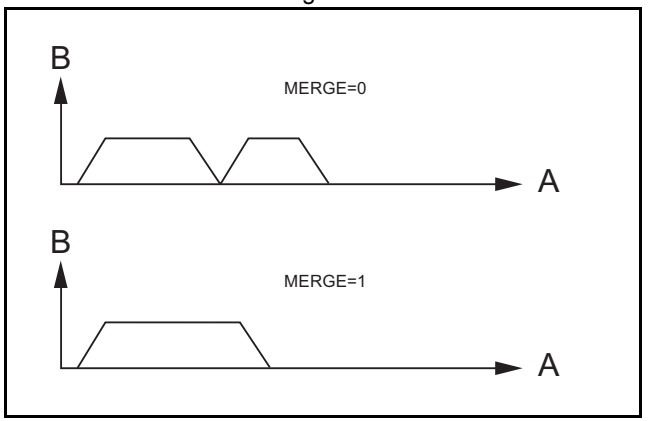
Print registration

The TJ1-MC__ can capture the position of an axis in a register when an event occurs. The event is referred to as the print registration input. On the rising or falling edge of an input signal, which is either the Z-marker or an input, the TJ1-MC__ captures the position of an axis in hardware. This position can then be used to correct possible error between the actual position and the desired position. The print registration is set up by using the **REGIST** command.
The position is captured in hardware, and therefore there is no software overhead and no interrupt service routines, eliminating the need to deal with the associated timing issues.

Merging moves

If the **MERGE** axis parameter is set to 1, a movement is always followed by a subsequent movement without stopping. The figures show the transitions of two moves with **MERGE** value 0 and value 1.
In the figure, A is the time axis and B is the speed axis.

fig. 14



Jogging

Jogging moves the axes at a constant speed forward or reverse by manual operation of the digital inputs. Different speeds are also selectable by input. Refer to the **FWD_JOG**, **REV_JOG** and **FAST_JOG** axis parameters.

2.3 Servo system principles

The servo system used by and the internal operation of the TJ1-MC__ are briefly described in this section.

2.3.1 Semi-closed loop system

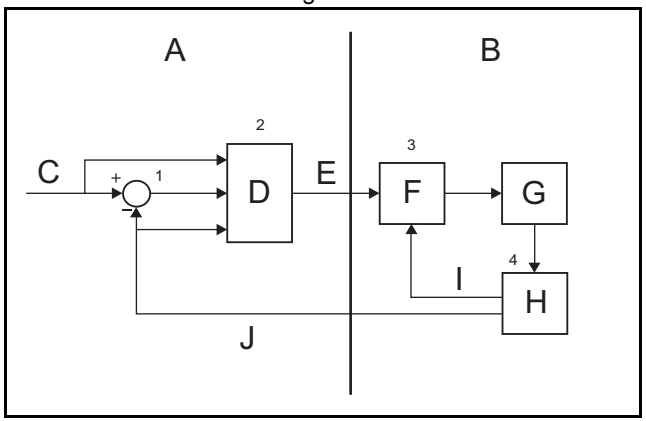
The servo system of the TJ1-MC__ uses a semi-closed or inferred closed loop system. This system detects actual machine movements by the rotation of the motor in relation to a target value. It calculates the error between the target value and actual movement, and reduces the error through feedback.

2.3.2 Internal operation of the TJ1-MC__

Inferred closed loop systems occupy the mainstream in modern servo systems applied to positioning devices for industrial applications. The figure shows the basic principle of the servo system as used in the TJ1-MC__.

1. The TJ1-MC__ performs actual position control. The main input of the controller is the Following Error, which is the calculated difference between the demand position and the actual measured position.
2. The Position Controller calculates the required speed reference output determined by the Following Error and possibly the demanded position and the measured position. The speed reference is provided to the Servo Driver.
3. The Servo Driver controls the rotational speed of the servo motor corresponding to the speed reference. The rotational speed is proportional to the speed reference.
4. The rotary encoder generates the feedback pulses for both the speed feedback within the Servo Driver speed loop and the position feedback within the TJ1-MC__ position loop.

fig. 15



The labels in the figure are:

A. TJ1-MC__.
B. Servo system.
C. Demand position.
D. Position control.
E. Speed reference.
F. Speed control.
G. Motor.
H. Encoder.
I. Measured speed.
J. Measured position.

2.3.3 Motion control algorithm

The servo system controls the motor by continuously adjusting the speed reference to the Servo Driver. The speed reference is calculated by the motion control algorithm of the TJ1-MC__, which is explained in this section.