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 HARD-WARE 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 MECHA-TROLINK-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

Name	Cat. No.	Contents
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 MECHATRO-LINK 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 MECHA-TROLINK 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

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__.

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__.

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__

trajexia

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.

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

fig. 1
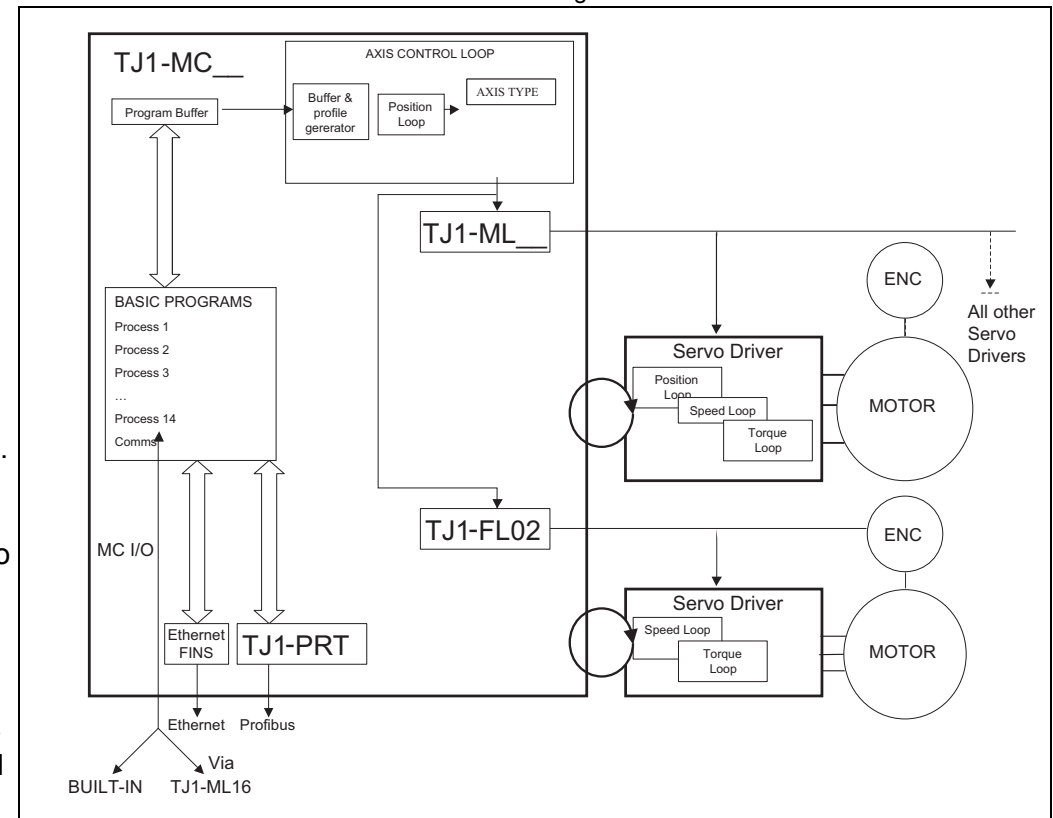
CPU task	Operation
Second CPU task	High priority process
Third CPU task	Motion Sequence (only if **SERVO_PERIOD**=0.5ms) LED Update High priority process
Fourth CPU task	External Communications

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
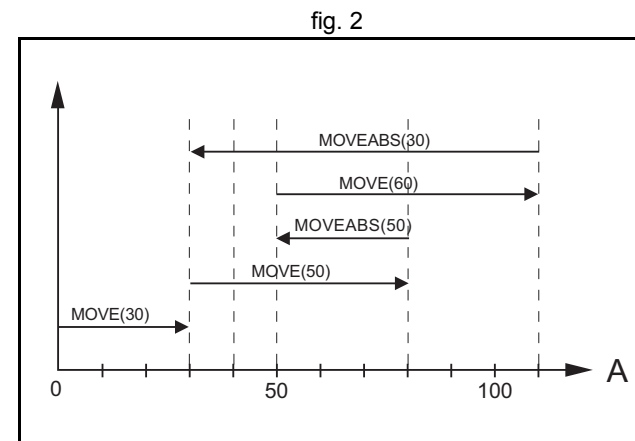
2.2.1 PTP control

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.

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

fig. 3

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.
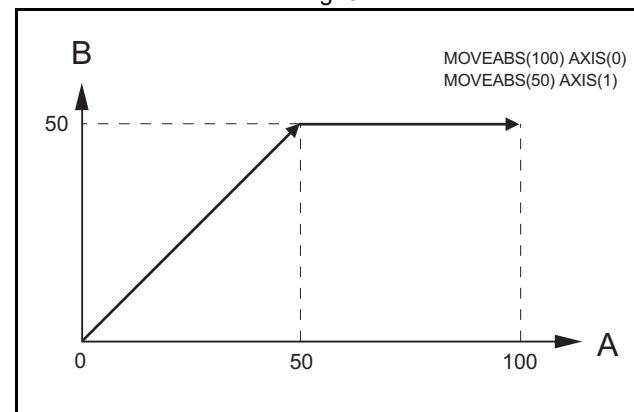
fig. 4
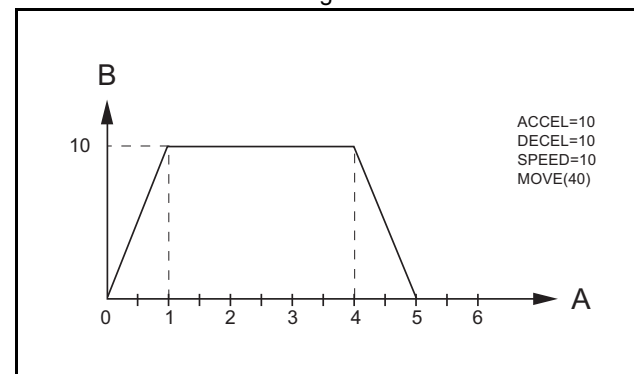
The two speed profiles in these figures show the same movement with an acceleration time respectively a deceleration time of 2 seconds. Again, Axis A is the time, axis B is the speed.

fig. 5


```
ACCEL=5
DECEL=10
SPEED=10
MOVE(40)
```

fig. 6


```
ACCEL=10
DECEL=5
SPEED=10
MOVE(40)
```
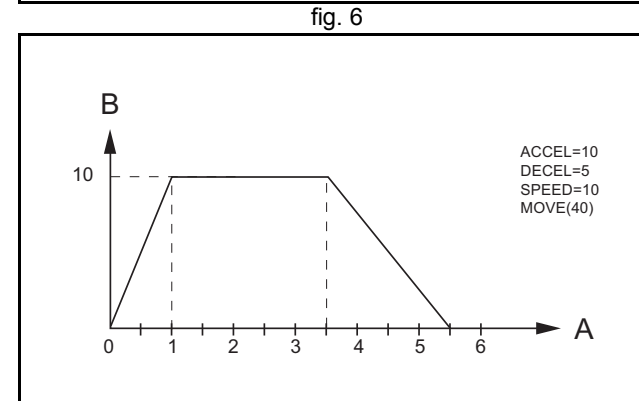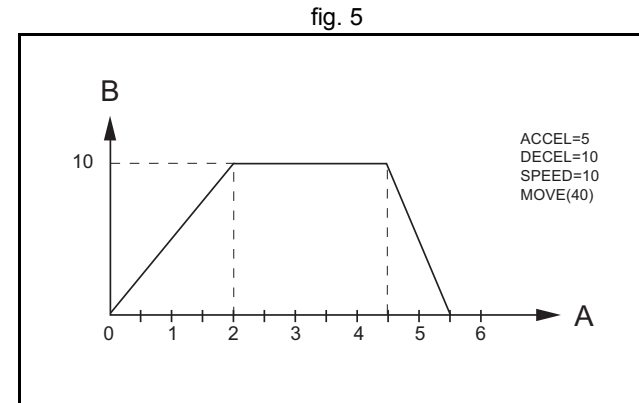
Move calculations

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*.

Acceleration time $\quad = \quad \dfrac{V}{a}$

| Acceleration distance | = | $\dfrac{V^2}{2\,a}$ |

| Deceleration time | = | $\dfrac{V}{d}$ |

| Deceleration distance | = | $\dfrac{V^2}{2\,d}$ |

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

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

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
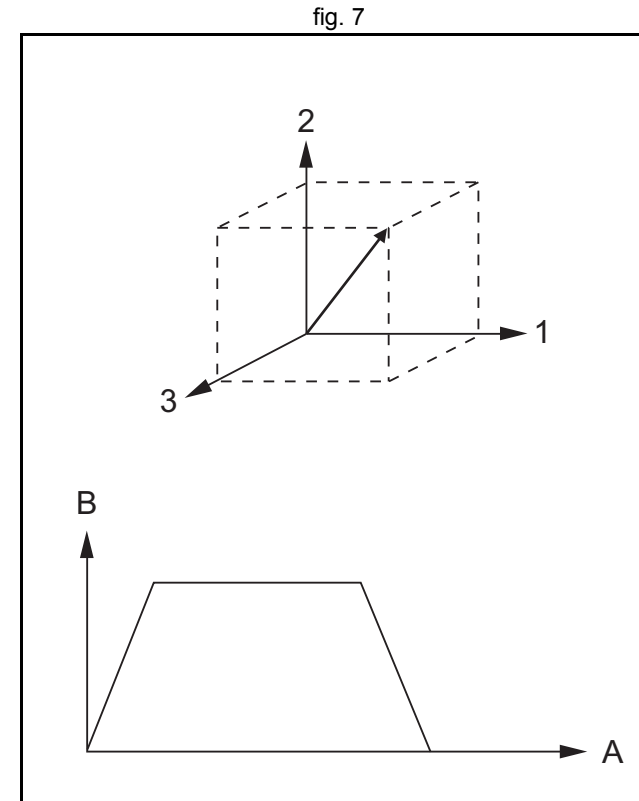
Circular interpolation

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.

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. 8
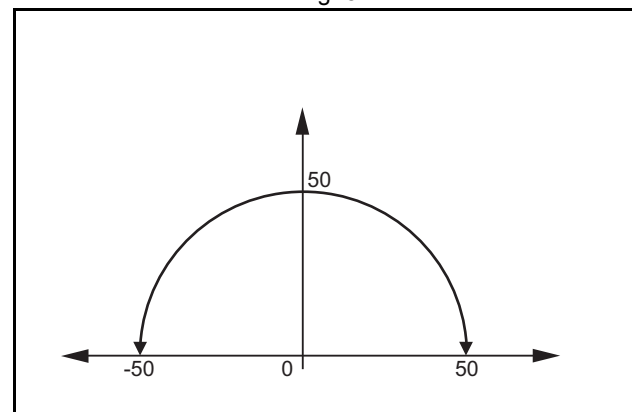
fig. 9
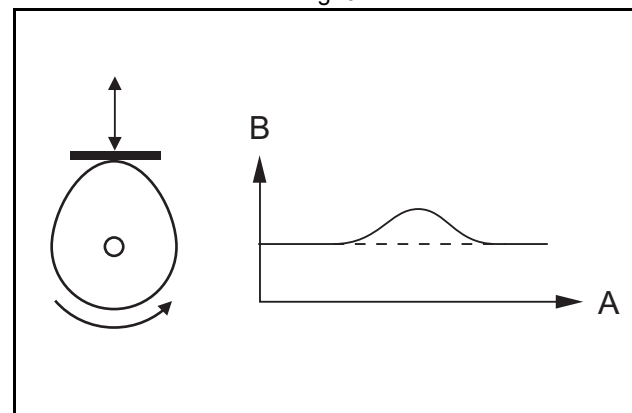
2.2.3 EG control

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)**
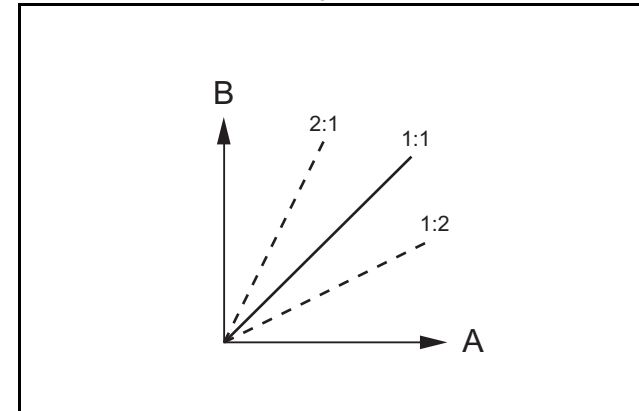
Linked CAM control

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
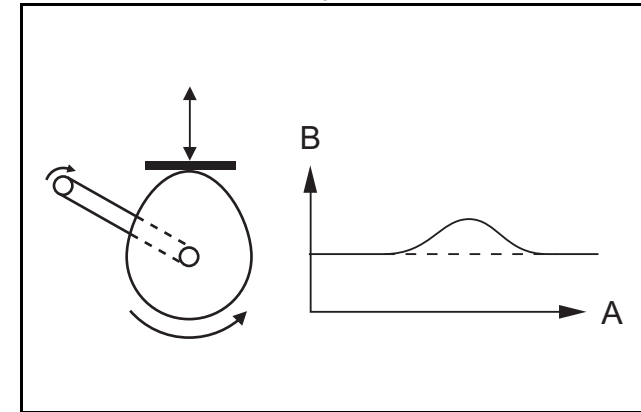
Linked move

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
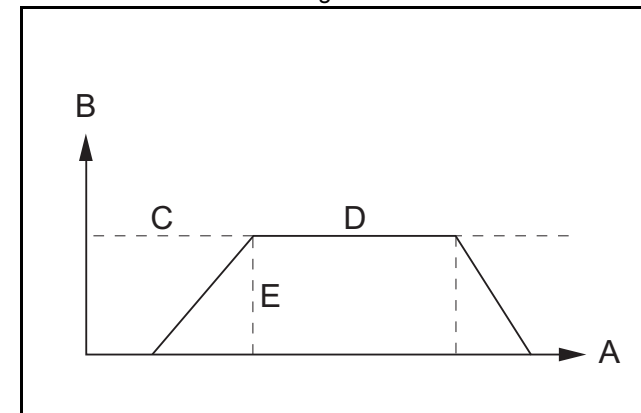
Adding axes

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

```
BASE(0)
ADDAX(2)
FORWARD
MOVE(100) AXIS(2)
MOVE(-60) AXIS(2)
```
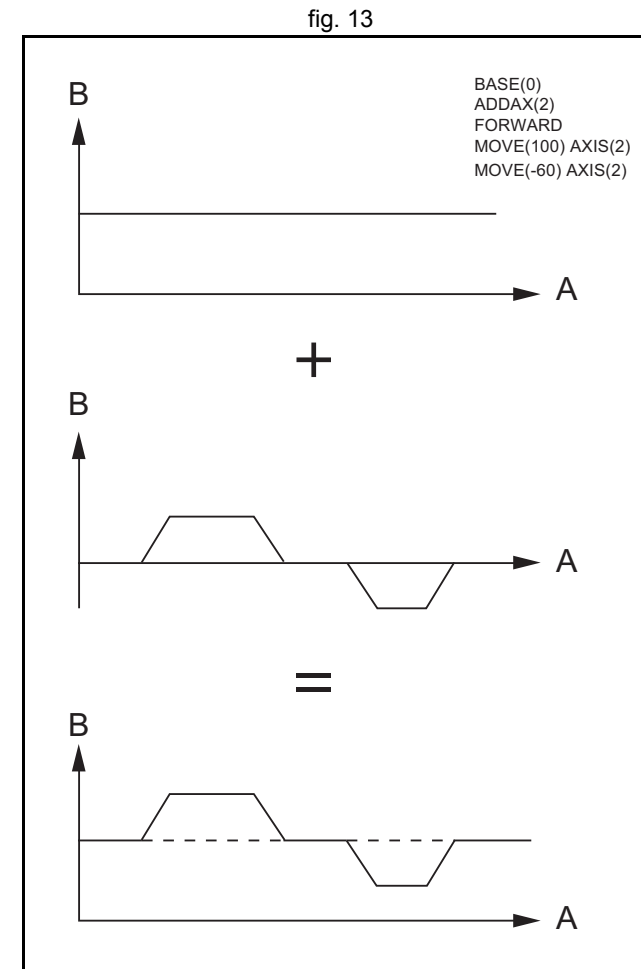
2.2.4 Other operations

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.

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.

fig. 14

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.
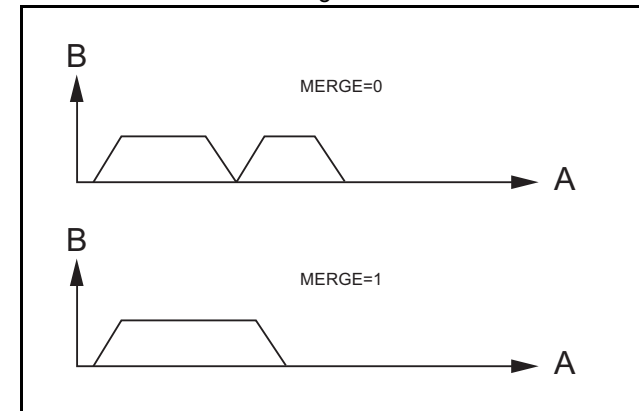
2.3.2 Internal operation of the TJ1-MC__

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.

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.

fig. 15

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.
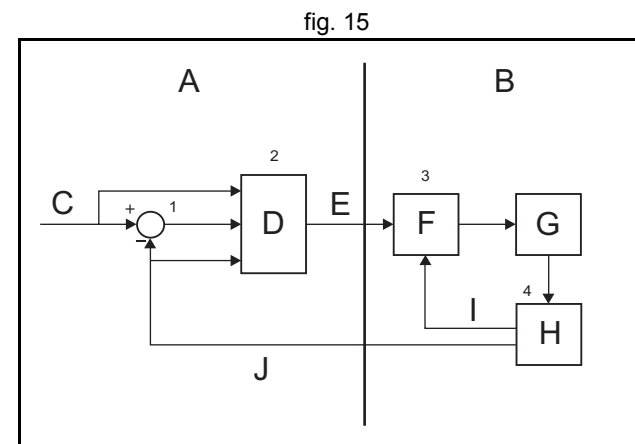
The motion control algorithm uses the demand position (A), the measured position (D) and the Following Error (B) to determine the speed reference. The Following Error is the difference between the demanded and measured position. The demand position, the measured position and the Following Error are represented by the axis parameters **MPOS**, **DPOS** and **FE**. Five gain values have been implemented for the user to be able to configure the correct control operation for each application.

C is the output signal.

- Proportional gain
  The proportional gain K_p creates an output O_p that is proportional to the Following Error E.
  $O_p = K_p \cdot E$
  All practical systems use proportional gain. For many just using this gain parameter alone is sufficient. The proportional gain axis parameter is called **P_GAIN**.

- Integral gain
  The integral gain K_i creates an output O_i that is proportional to the sum of the Following Errors that have occurred during the system operation.
  $O_i = K_i \cdot \Sigma E$
  Integral gain can cause overshoot and so is usually used only on systems working at constant speed or with slow accelerations. The integral gain axis parameter is called **I_GAIN**.

- Derivative gain
  The derivative gain K_d produces an output O_d that is proportional to the change in the Following Error E and speeds up the response to changes in error while maintaining the same relative stability.
  $O_d = K_d \cdot \Delta E$
  Derivative gain may create a smoother response. High values may lead to oscillation. The derivative gain axis parameter is called **D_GAIN**.

- Output speed gain
  The output speed gain K_{ov} produces an output O_{ov} that is proportional to the change in the measured position P_m and increases system damping.
  $O_{ov} = K_{ov} \cdot \Delta P_m$

fig. 16
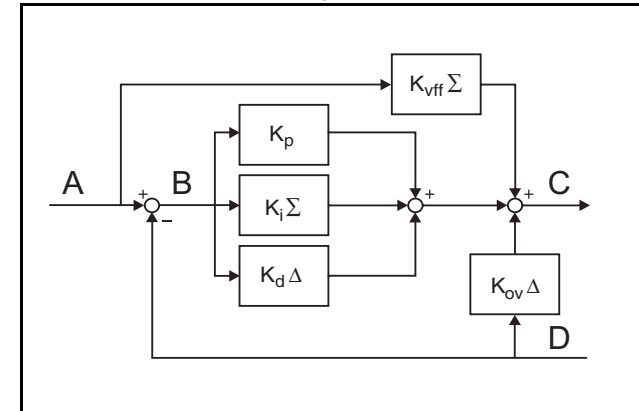
The output speed gain can be useful for smoothing motions but will generate high Following Errors. The output speed gain axis parameter is called **OV_GAIN**.

- Speed feed forward gain
  The speed feedforward gain K_{vff} produces an output O_{vff} that is proportional to the change in demand position P_d and minimizes the Following Error at high speed.
  $O_{vff} = K_{vff} \cdot \Delta P_d$
  The parameter can be set to minimise the Following Error at a constant machine speed after other gains have been set. The speed feed forward gain axis parameter is called **VFF_GAIN**.

The default settings are given in the table along with the resulting profiles. Fractional values are allowed for gain settings.

Gain	Default value
Proportional gain	0.1
Integral gain	0.0
Derivative gain	0.0
Output speed gain	0.0
Speed feedforward gain	0.0

2.4   Trajexia system architecture

The system architecture of the Trajexia is dependant upon these concepts:
- Program control
- Motion Sequence
- Motion buffers
- Communication
- Peripherals

These concepts depend upon the value set in the **SERVO_PERIOD** parameter. The relationship between the value of **SERVO_PERIOD** and the different concepts of the system architecture are describes as follows.

2.4.1   Program control

Programs make the system work in a defined way. The programs are written in a language similar to BASIC and control the application of the axes and modules. 14 Programs can be executed in parallel. The programs can be set to run at system power-up, started and stopped from other programs and executed from Trajexia Tools.
Programs execute commands to move the axes, control inputs and outputs and make communication via BASIC commands.

2.4.2   Motion sequence

The motion sequence controls the position of all 16 axes with the actions as follows:
- Reading the Motion buffer
- Reading the current Measured Position (MPOS)
- Calculating the next Demanded Position (DPOS)
- Executing the Position loop
- Sending the Axis reference
- Error handling

2.4.3   Motion buffers

Motion buffers are the link between the BASIC commands and the Axis control loop. When a BASIC motion command is executed, the command is stored in one of the buffers. During the next motion sequence, the profile generator executes the movement according to the information in the buffer. When the movement is finished, the motion command is removed from the buffer.

2.4.4   Communication

All communication is carried out in the forth CPU task. A set of BASIC communication commands are used to configure the communications. When the Trajexia is a communication slave (as in the PROFIBUS communication) it is only necessary to configure the communication in an

initial task. The values are exchanged from the configured global variables in a transparent way. When the Trajexia is a communications master, the BASIC communication commands are used to write and read.

2.4.5 Peripherals

All inputs and outputs are used with the set of parameters (**IN**, **OP**, **AIN**, **AOUT**). The inputs and outputs are automatically detected and mapped in Trajexia. Inverters are considered a peripheral device and have a set of BASIC commands to control them. Various MECHATROLINK-II input and output modules can be connected to a TJ1-ML__ unit.

2.5 Cycle time

All processes in the Trajexia system are based on the cycle time. The cycle time is divided into four CPU tasks:
- 250μs time intervals for a **SERVO_PERIOD** of 0.5 and 1.0ms
- 500μs time intervals for a **SERVO_PERIOD** of 2.0ms

The processes that can be carried out in each time interval depends on the **SERVO_PERIOD** that is set.
The operations executed in each CPU task are:

CPU task	Operation
First CPU task	Motion Sequence Low priority process
Second CPU task	High priority process
Third CPU task	[1] Motion Sequence (only if **SERVO_PERIOD**=0.5ms) LED Update. High priority process
Fourth CPU task	External Communications

fig. 17

fig. 18

Note

The Motion sequence execution depends on setting of the **SERVO_PERIOD** parameter.
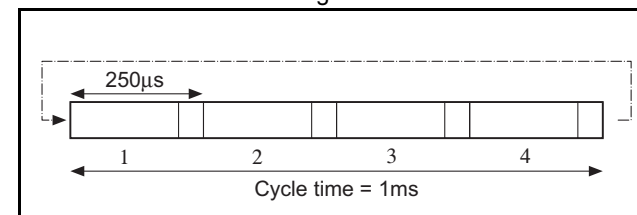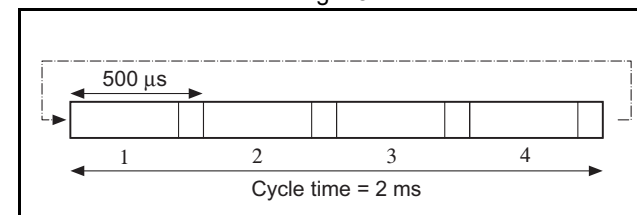
2.5.1 Servo period

The **SERVO_PERIOD** can be set at 0.5, 1 or 2ms. The processes that take place within the cycle time depend on the setting of the **SERVO_PERIOD** parameter. The **SERVO_PERIOD** parameter is a Trajexia parameter that must be set according to the system configuration.
The factory setting is 1ms (**SERVO_PERIOD=1000**). A change is set only after a restart of the TJ1-MC__.

> **Note**
> Only the Sigma-III Servo Driver and the Sigma-V Servo Driver support the 0.5 ms transmission cycle.

Example 1
The **SERVO_PERIOD** has a value of 0.5ms and the motion sequence is executed every 0.5ms.

fig. 19

CPU task 1	**Motion sequence** Low priority task (0,1,2,3...)	
CPU task 2	High priority task (13,14)	
CPU task 3	**Motion sequence** LED refresh High priority task (13,14)	1ms
CPU task 4	Communication	
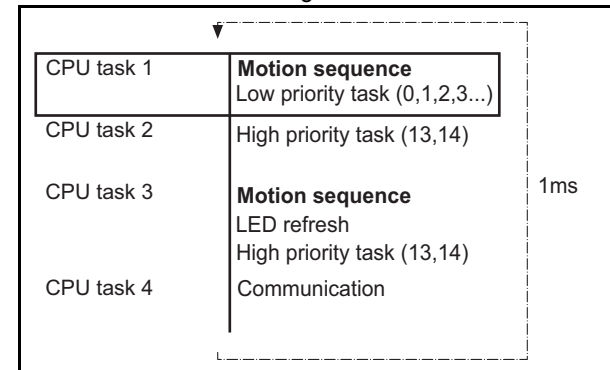
Example 2

The **SERVO_PERIOD** has a value of 1ms and the motion sequence is executed every 1ms. As the motion sequence is not executed during CPU task 3, there is more time for the program execution. High priority programs run faster.

fig. 20

CPU task 1	**Motion sequence** Low priority task (0,1,2,3...)	
CPU task 2	High priority task (13,14)	
CPU task 3	LED refresh High priority task (13,14)	1ms
CPU task 4	Communication	
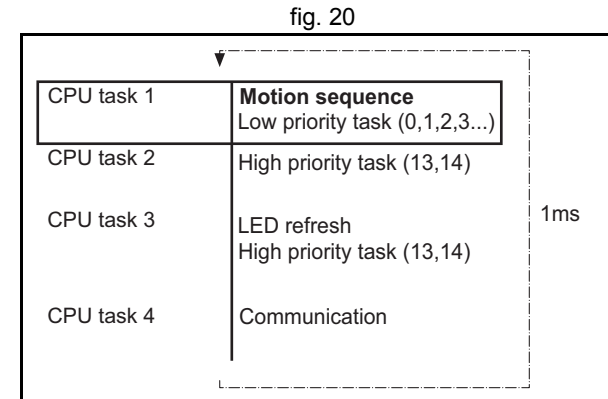
Example 3

The **SERVO_PERIOD** has a value of 2ms and the motion sequence is executed every 2.0ms.

fig. 21

CPU task 1	**Motion sequence** Low priority task (0,1,2,3...)	
CPU task 2	High priority task (13,14)	
CPU task 3	LED refresh High priority task (13,14)	2ms
CPU task 4	Communication	

Servo period rules

The number of axes and MECHATROLINK-II devices in the Trajexia system determines the value of the **SERVO_PERIOD** system parameter.
There are 3 types of MECHATROLINK-II devices that are supported by the TJ1-MC__ units:
- Servo Drivers
  The TJ1-MC__ considers Servo Drivers as axes.
- Inverters
  The TJ1-MC__ does not consider Inverters as axes.
- I/O units and slice bus couplers
  The TJ1-MC__ does not consider I/O units (analog and digital, counter and pulse) and slice bus couplers as axes.

You must obey the most restrictive rules when you set the **SERVO_PERIOD** parameter. An incorrect value of the **SERVO_PERIOD** parameter results in an incorrect detection of the MECHATROLINK-II devices.
The most restrictive rules are given in the tables below. For each unit the table lists the maximum number of devices the unit can control at the given **SERVO_PERIOD** setting.
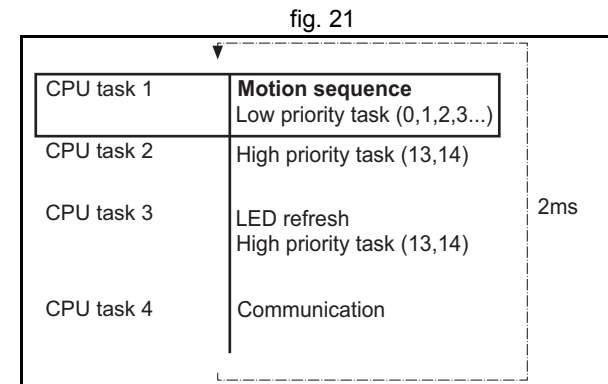
SERVO_PERIOD	TJ1-MC16	TJ1-MC04	TJ1-ML16	TJ1-ML04
0.5 ms	8 axes	5 axes	4 devices	4 devices
	4 non-axis devices	4 non-axis devices		
1.0 ms	16 axes	5 axes	8 devices	4 devices
	8 non-axis devices	8 non-axis devices		
2.0 ms	16 axes	5 axes	16 devices	4 devices
	8 non-axis devices	8 non-axis devices		

Configuration examples

Example 1
- 1x TJ1-MC__
- 1x TJ1-ML__
- 3x Sigma-II Servo Driver
- **SERVO_PERIOD** = 1ms

TJ1-MC__ Supports 0.5ms **SERVO_PERIOD** with 3 axes.
TJ1-MC__ Supports 0.5ms **SERVO_PERIOD** with 3 devices.
Sigma-II supports 1ms **SERVO_PERIOD**. This is the limiting factor.

fig. 22
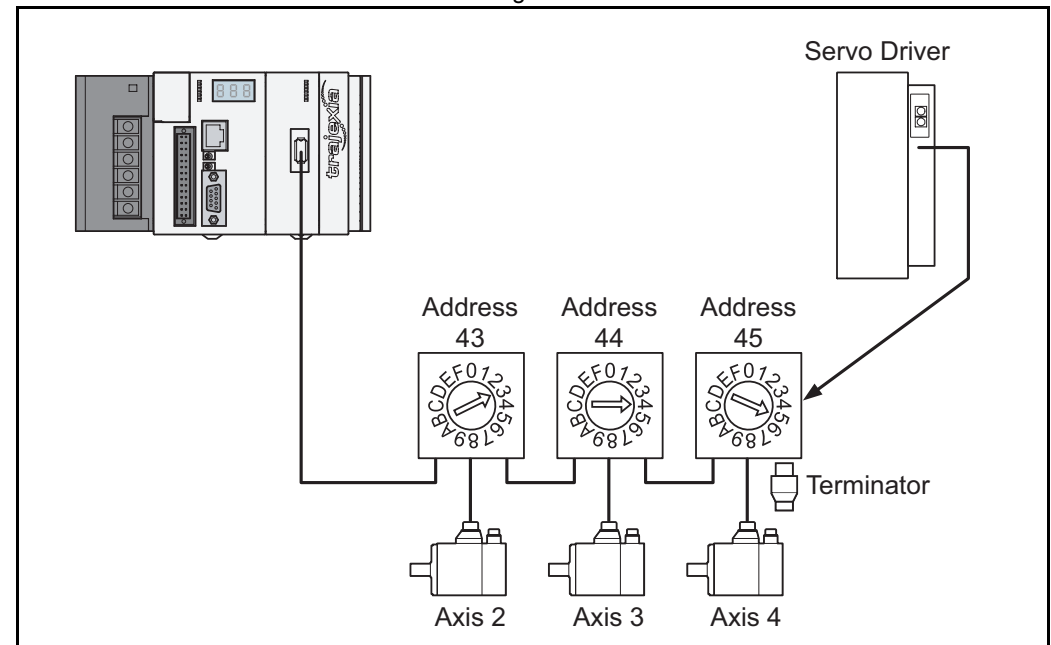
Example 2

- 1x TJ1-MC16
- 2x TJ1-ML16
- 16x Sigma-II Servo Driver
- **SERVO_PERIOD** = 1ms

TJ1-MC16 supports 1ms **SERVO_PERIOD** with 16 axes.
TJ1-ML16 supports 1ms **SERVO_PERIOD** with 8 devices.
Sigma-II supports 1ms **SERVO_PERIOD**.

fig. 23
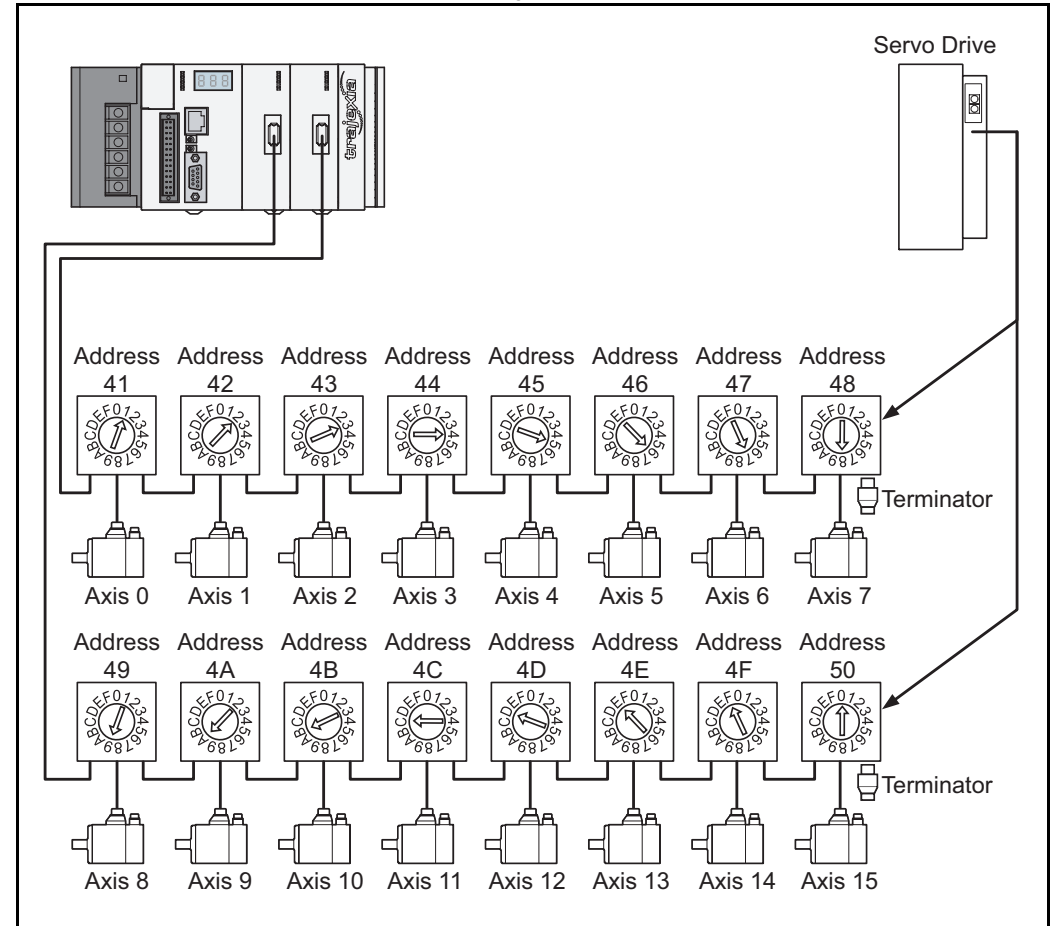
Example 3

- 1x TJ1-MC16
- 1x TJ1-ML16
- 8x Sigma-II Servo Driver
- 1x F7Z Inverter with SI-T interface
- 3x MECHATROLINK-II I/Os
- **SERVO_PERIOD** = 2.0ms

TJ1-ML16 supports 2.0ms **SERVO_PERIOD** with 12 devices. This is the limiting factor.
Sigma-II supports 1.0ms **SERVO_PERIOD**.
SI-T supports 1ms.
MECHATROLINK-II I/Os support 1.0ms.

Example 4

- 1x TJ1-MC16
- 1x TJ1-ML16
- 2x TJ1-FL02
- 1x TJ1-PRT (does not influence in the **SERVO_PERIOD**)
- 5x Sigma-II Servo Driver
- **SERVO_PERIOD** = 1.0ms

TJ1-MC16 supports 1.0ms **SERVO_PERIOD** with 9 axes (5 MECHATROLINK-II servo axes and 4 TJ1-FL02 axes)
TJ1-ML16 supports 1.0ms **SERVO_PERIOD** with 5 devices
TJ1-FL02 supports 0.5ms **SERVO_PERIOD** (2 axes each module)
Sigma-II supports 1.0ms **SERVO_PERIOD**.

fig. 24
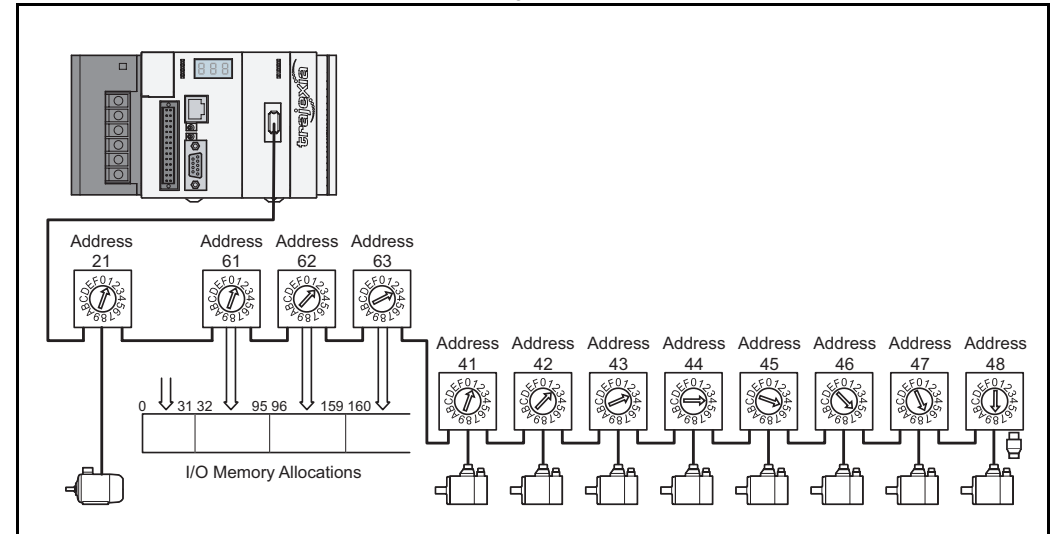
fig. 25
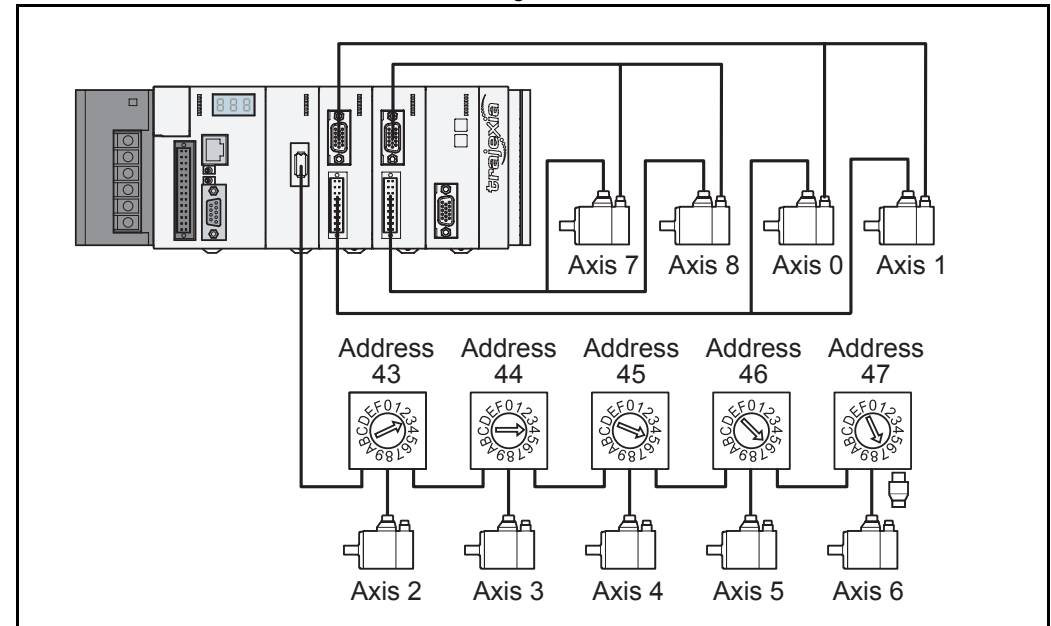
2.6 Program control and multi-tasking

The Trajexia system has program, processes and multi tasking control.

2.6.1 Program control

The Trajexia system can control 14 processes that are written as BASIC programs. When the program is set to run, the program is executed. Processes 1 to 12 are low priority, 13 and 14 are high priority.

2.6.2 Processes

The low-priority process 0 is reserved for the "Terminal Window" of Trajexia Tools. This terminal window is used to write direct BASIC commands to the TJ1-MC__ independent to other programs. These commands are executed after you press the Enter button.

2.6.3 Multi-tasking

Each cycle time is divided into 4 time slices called CPU tasks. Processes run in the first 3 CPU tasks according to the priority of the process.
Motion sequence and low-priority processes (A) are executed in the Low Task (LT) period.
High priority processes (B) are executed in the high Task (HT) periods.

External communication that are not related to the motion network are updated in the communications (COMS) period in the fourth CPU task. Trajexia can control up to 14 programs at the same time.
In contrast to low priority processes, a high priority process is always available for execution during two of the four CPU tasks. The high-priority tasks are executed faster than the low-priority tasks, it is that they have more time available for their execution. All the low-priority tasks must share one slot of time and the high-priority task have their own two slots of time.

fig. 26
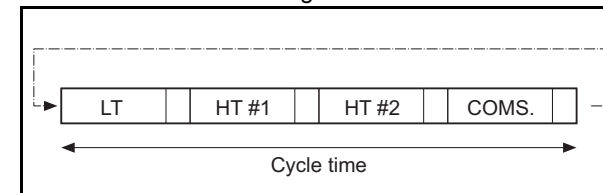
fig. 27
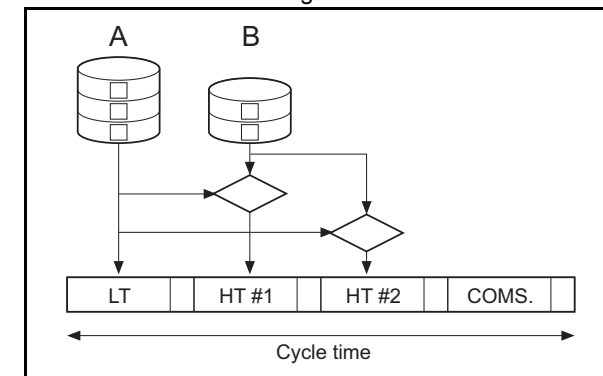
2.6.4 Multi-tasking example

In the example 1, there are two high-priority processes, 13 and 14. The two HT periods are reserved for these processes, one for processes 13 and one for processes 14. The low-priority processes 3, 2, 1 and 0 are executed in the LT period, one process per Cycle time here set to 1.0ms.

In the middle example, there is only one high-priority process, 14. Both HT periods are reserved for this process. The low-priority processes, 3, 2, 1 and 0 are executed in the LT period, one process per cycle time.

In the lower example, there are no high-priority processes. Therefore, the HT periods can be used for the low-priority processes. The LT period is also used for the low-priority processes.

fig. 28
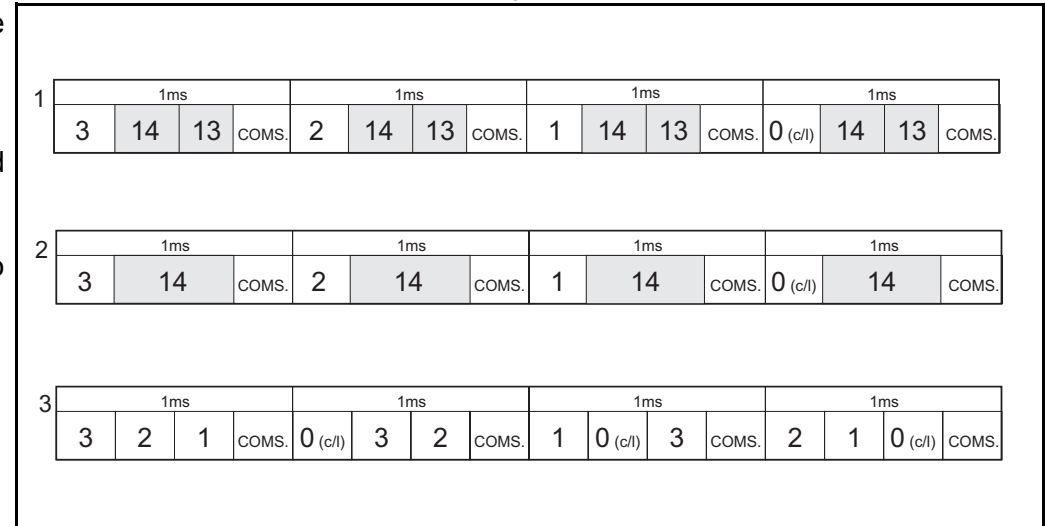
2.7 Motion sequence and axes

Motion sequence is the part of the TJ1-MC__ that controls the axes. The actual way that the motion sequence operates depends on the axis type. The axis type can be set and read by the parameter **ATYPE**. At start-up the Trajexia system automatically detects the configuration of the axes.
- The default value for the parameter **ATYPE** for MECHATROLINK-II axes is 41 (MECHATROLINK-II speed).
- The default value for the parameter **ATYPE** for the TJ1-FL02 axes is 44 (Servo axis with an incremental encoder).

All non allocated axes are set as a virtual axis. The value for the parameter **ATYPE** is 0.
Every axis has the general structure as shown in fig. 29.

The motion sequence which will be executed at the beginning of each servo period will contain the following elements:

fig. 29
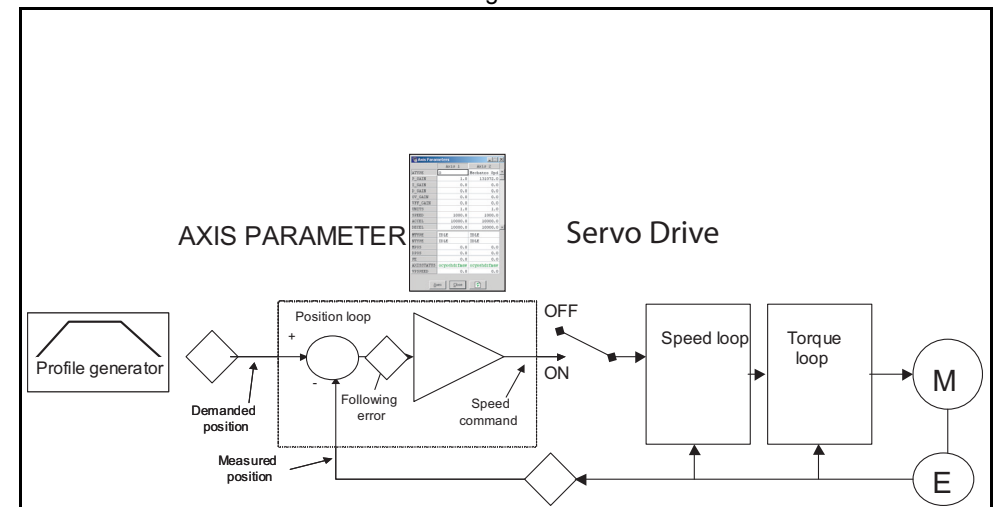
1. Transfer any moves from BASIC process buffers to motion buffers (see section 2.8).
2. Read digital inputs.
3. Load moves. (See note.)
4. Calculate speed profile. (See note.)
5. Calculate axis positions. (See note.)
6. Execute position servo. For axis 0 this also includes the Servo Driver communications. (See note.)
7. Update outputs.

Note
Each of these items will be performed for each axis in turn before moving on to the next item.

2.7.1 Profile generator

The profile generator is the algorithm that calculates the demanded position for each axis. The calculation is made every motion sequence.
The profile is generated according to the motion instructions from the BASIC programs.

fig. 30

2.7.2 Position loop

The position loop is the algorithm that makes sure that there is a minimal deviation between the measured position (**MPOS**) and the demand position (**DPOS**) of the same axis.

2.7.3 Axis sequence

- The motion controller applies motion commands to an axis array that is defined with the **BASE** command. If the motion command concerns one axis, it is applied to the first axis in the **BASE** array. If the motion command concerns more than one axis, and makes an orthogonal
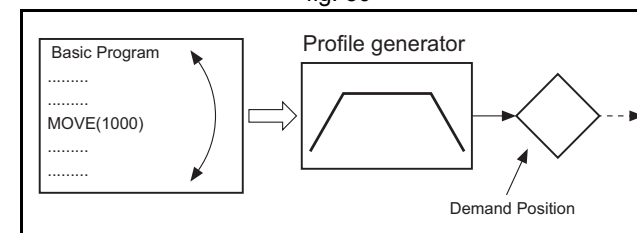
move, the axes are taken from the array in the order defined by the **BASE** command. For more information on the **BASE** command and the definition of the axis sequence in an axis array, refer to the Trajexia Programming Manual, chapter 3 (BASIC commands).

- If **SERVO=OFF** for one axis, the motion commands for that axis are ignored.
- If the Following Error (**FE**) in one axis exceeds the parameter value **FELIMIT**, the next action occurs:
  - **WDOG** is set to **OFF** and all axes stop.
  - **SERVO** for the axis that causes the error goes to **OFF**.
  - The current move is cancelled and removed from the buffer.

2.7.4   Type of axis

ATYPE	Applicable to	Name	Description
0	All axes	Virtual axis	Internal axis with no physical output. It is the only valid setting for non-allocated axes. That is, those that are not MECHATROLINK-II servos or a flexible axis.
40	MECHATRO-LINK-II Servo Drivers connected to a TJ1-ML__	MECHATRO-LINK-II Position	Position loop in the Servo Driver. TJ1-MC__ sends position reference to the Servo Driver via MECHATROLINK-II.
41		MECHATRO-LINK-II Speed (Default)	Position loop in the Trajexia. TJ1-MC__ sends speed reference to the Servo Driver via MECHATROLINK-II.
42		MECHATRO-LINK-II Torque	Position loop in the Trajexia. TJ1-MC__ sends torque reference to the Servo Driver via MECHATROLINK-II.

ATYPE	Applicable to	Name	Description
43	External driver connected to a TJ1-FL02	Stepper output	Pulse and direction outputs. Position loop is in the driver. TJ1-FL02 sends pulses and receives no feed back.
44		Servo axis (Default) Encoder	Analogue servo. Position loop is in the TJ1-MC__. The TJ1-FL02 sends speed reference and receives position from an incremental encoder.
45		Encoder out-put	The same as stepper, but with the phase differ-ential outputs emulating an incremental encoder.
46		Absolute Tam-agawa	The same as servo axis but the feed back is received from a Tamagawa absolute encoder.
47		Absolute EnDat	The same as servo axis but the feed back is received from an EnDat absolute encoder.
48		Absolute SSI	The same as servo axis but the feed back is received from an SSI absolute encoder.
49	ML__	Inverter as axis	Inverters (with built-in encoder interface) are controlled on the MECHATROLINK-II bus as servo axes.

Virtual axis ATYPE=0

You can split a complex profile into two or more simple movements, each assigned to a virtual axis. These movements can be added together with the BASIC command **ADDAX** then assigned to a real axis.

fig. 31
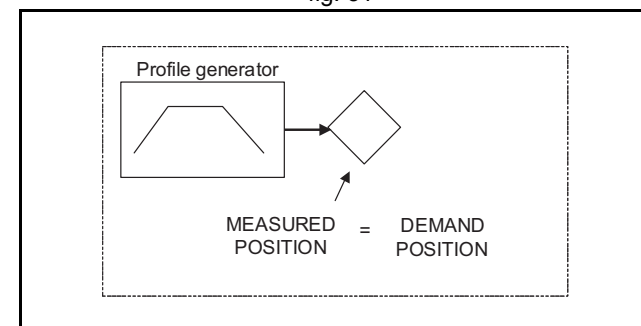
MECHATROLINK-II position ATYPE=40

With **SERVO = ON**, the position loop is closed in the Servo Driver. Gain settings in the TJ1-MC__ have no effect. The position reference is sent to the Servo Driver.

> **Note**
> Although **MPOS** and **FE** are updated, the real value is the value in the Servo Driver. The real Following Error can be monitored by the **DRIVE_MONITOR** parameter by setting **DRIVE_CONTROL = 2**.

> **Note**
> The MECHATROLINK-II position **ATYPE = 40** is the recommended setting to obtain a higher performance of the servo motor.

fig. 32
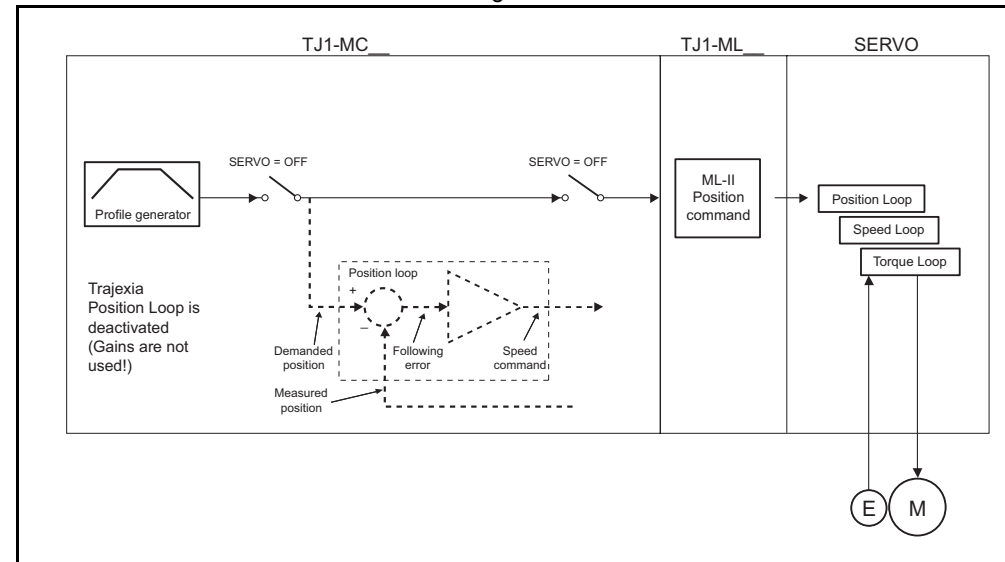
MECHATROLINK-II speed ATYPE=41

With **SERVO = ON**, the speed loop is closed in the TJ1-MC__.
Speed reference is sent to the Servo Driver. This setting is not recommended, since there is one cycle delay in the loop (DPOS(n) is compared with MPOS(n-1)).
With **SERVO = OFF**, the speed reference is sent via **S_REF** command. 0x40000000 means maximum speed of the servomotor. This is the recommended setting.

fig. 33
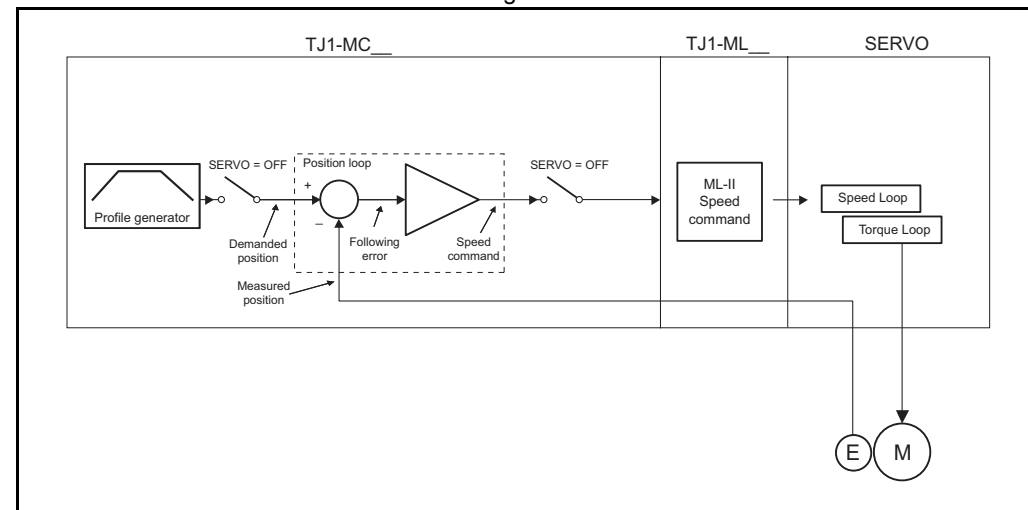
MECHATROLINK-II torque ATYPE=42

With **SERVO = ON**, the torque loop is closed in the TJ1-MC__. The torque reference in the Servo Driver depends on the **FE** and the gain.
With **SERVO = OFF**, the torque reference is sent directly via the **T_REF** command. 0x40000000 is the maximum torque of the servomotor.

Note
To monitor the torque in the servo in **DRIVE_MONITOR**, set **DRIVE_CONTROL=11**.

fig. 34
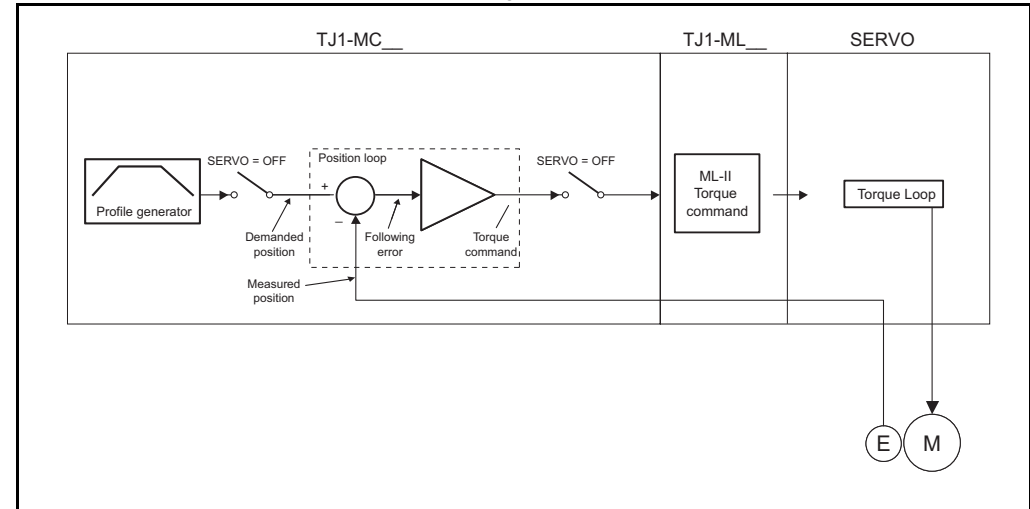
Stepper output ATYPE=43

The position profile is generated and the output from the system is a pulse train and direction signal. This is useful to control a motor via pulses or as a position reference for another motion controller.

Servo axis ATYPE=44

With **SERVO = ON** this is an axis with an analogue speed reference output and incremental encoder feedback input. The position loop is closed in the TJ1-MC__ which sends the resulting speed reference to the axis.

fig. 35

With **SERVO = OFF**, the position of the external incremental encoder is read. The analogue output can be set with BASIC commands only and can be used for general purposes.
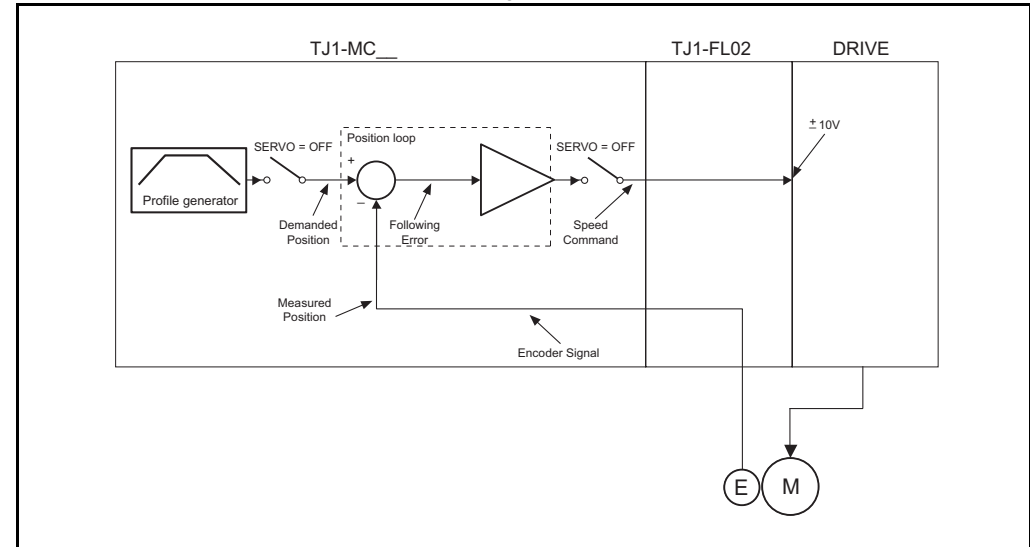
fig. 36
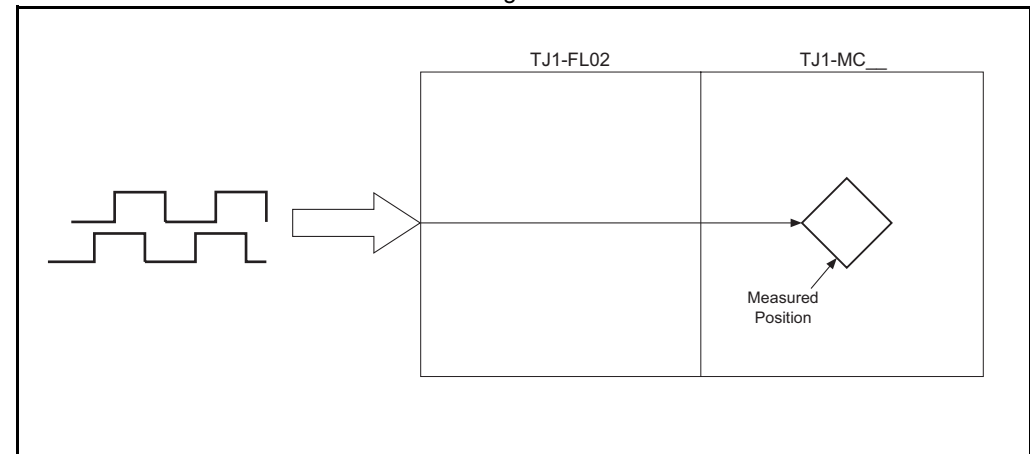
Encoder output ATYPE=45

The position profile is generated and the output from the system is an incremental encoder pulse. This is useful to control a motor via pulses or as a position reference for another motion controller.

fig. 37
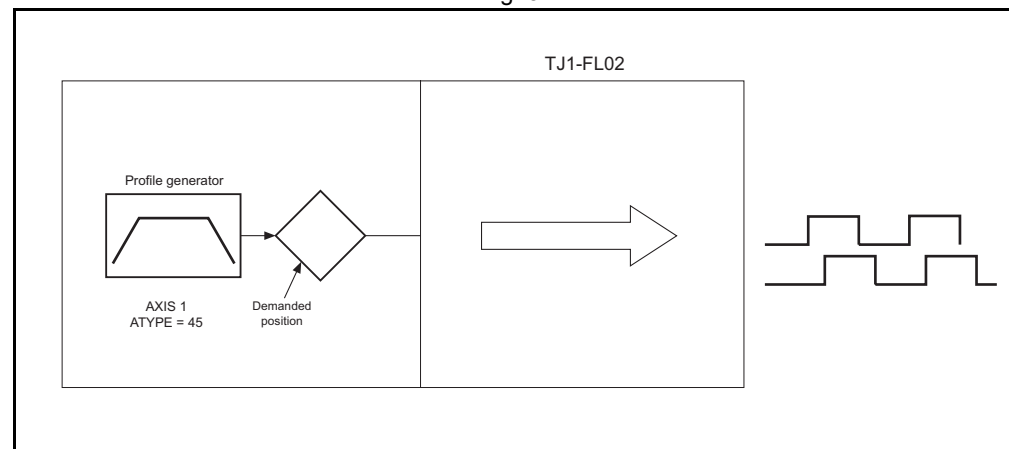
Absolute Tamagawa encoder ATYPE=46

With **SERVO = ON**, this is an axis with analogue speed reference output and absolute Tamagawa encoder feedback. The position loop is closed in the TJ1-MC__ and the resulting speed reference is sent to the axis.
With **SERVO = OFF**, the position of the external absolute Tamagawa encoder is read. The analogue output can be set with BASIC commands only and can be used for general purposes.
See fig. 35 for reference.

Absolute EnDat encoder ATYPE=47

With **SERVO = ON**, this is an axis with analogue speed reference output and absolute EnDat encoder feedback. The position loop is closed in the TJ1-MC__ and the resulting speed reference is sent to the axis.
With **SERVO = OFF**, the position of the external absolute EnDat encoder is read. The analogue output can be set with BASIC commands only and can be used for general purposes.
See fig. 35 for reference.

Absolute SSI encoder ATYPE=48

With **SERVO = ON**, this is an axis with analogue speed reference output and absolute SSI encoder feedback. The position loop is closed in the TJ1-MC__ and the resulting speed reference is sent to the axis.

With **SERVO = OFF**, the position of the external absolute SSI encoder is read. The analogue output can be set with BASIC commands only and can be used for general purposes.

See fig. 35 for reference.

Inverter axis ATYPE=49

This type allows Inverters (with built-in encoder interface) to be controlled on the MECHATROLINK-II bus as servo axes.

From the controller point of view, Inverter axes are handled the same as servo axes in MECHATROLINK-II Speed Mode (**ATYPE=44**).

Unlike the other axis types, this Inverter axis must be defined programmatically with function 8 of the command **INVERTER_COMMAND**.

The Speed command to the Inverter and the feedback from the encoder is refreshed in the Inverter every 5 ms. This is a DPRAM limitation. This means that the use of the Inverter is similar to the use of a Servo Driver, but the performance is lower.

Summary of axis types and control modes

The following table lists the axis types and their recommended modes for speed control, position control and torque control.

fig. 38

ATYPE	SERVO	Mode	Comment
40	OFF	Position (MECHATROLINK-II)	The position loop is closed in the Servo Driver. No new motion command is allowed.
40	ON	Position (MECHATROLINK-II)	Recommended mode for position control with MECHATROLINK-II axes.
41	OFF	Speed (MECHATROLINK-II)	Recommended mode for speed control with MECHATROLINK-II axes. Set the speed with **S_REF**.
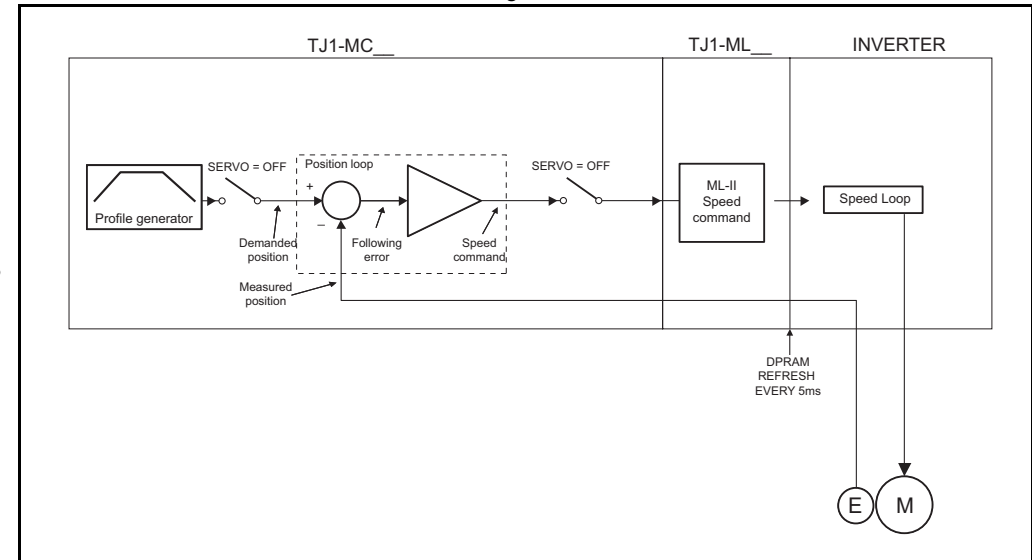
ATYPE	SERVO	Mode	Comment
41	ON	Position (MECHATROLINK-II)	The position loop is closed in Trajexia. This gives lower performance than closing the position loop in the Servo Driver.
42	OFF	Torque (MECHATROLINK-II)	Recommended mode for torque control with MECHATROLINK-II axes. Set the torque with **T_REF**.
42	ON	Position via torque (MECHATROLINK-II)	The position loop is closed in Trajexia. The output of the position loop is sent as the torque reference to the Servo Driver.
44, 46, 47, 48	OFF	Speed (Flexible Axis)	Recommended mode for speed control with Flexible Axis.
44, 46, 47, 48	ON	Position (Flexible Axis)	The position loop is closed in Trajexia. Recommended mode for position control with Flexible Axis.
49	OFF	Speed	Inverter (with built-in encoder interface) controlled on the MECHATROLINK-II bus as a servo axis. Set the speed with **S_REF**.
49	ON	Position	Inverter (with built-in encoder interface) controlled on the MECHATROLINK-II bus as a servo axis. The position loop is closed in Trajexia.

2.8 Motion buffers

The motion buffer is a temporary store of the motion instruction from the BASIC program to the profile generator.
The BASIC program continues while the instruction waits in the buffer.
There are three types of buffer:
- **MTYPE**. The current movement that is being executed. **MTYPE** relates to the axis and not to the process.
- **NTYPE**. The new movement that waits for execution. **NTYPE** relates to the axis and not to the process.
- Process Buffer. The third buffered movement cannot be monitored. The process buffer relates to the process and not to the axis.

It is possible to check if the process buffer is full by checking the **PMOVE** process parameter.

When a motion instruction is executed in the BASIC program, the instruction is loaded into the process buffer and distributed to the corresponding axis buffer in the next motion sequence.
If a fourth motion instruction is executed and the three buffers are full, the BASIC program stops execution until a process buffer is free for use.
Example of buffered instructions:

fig. 39

BASIC PROGRAM
....
MOVE(-500)
....
MOVE(1000)
....
CONNECT(1,1)
....

CONNECT(1,1) AXIS(2)

PROCESS BUFFER

AXIS BUFFER
(one per axis)

NTYPE   Waiting to be executed
MOTION COMMAND

MTYPE   Currently executed
MOTION COMMAND

DEMAND POSITION

Profile generator

fig. 40

Each process has its own "Process Buffer"

Each Axis has its own 2 buffers: **NTYPE** & **MTYPE**

fig. 41

EXAMPLE:

BASIC PROGRAM	BUFFER		

BASIC PROGRAM
....
MOVE(-500) ◄
....
MOVE(1000)
....
DATUM(3)
....
MOVE(200)
....

BUFFER

NTYPE   IDLE

MTYPE   MOVE(-500)
- - - -

MOVE -500

1.- All buffers are empty and a movement is loaded. The movement starts to execute

---

BASIC PROGRAM
....
MOVE(-500)
....
MOVE(1000) ◄
....
DATUM(3)
....
MOVE(200)
....

BUFFER

- - - -

NTYPE   MOVE(1000)

MTYPE   MOVE(-500)

MOVE -500

2.- A second movement is loaded while the first one is not finished. The new movement waits in the second buffer.

BASIC PROGRAM
....
MOVE(-500)
....
MOVE(1000)
....
DATUM(3) ◄
....
MOVE(200)
....

BUFFER

DATUM(3)

NTYPE   MOVE(1000)

MTYPE   MOVE(-500)

MOVE -500

3.- A third movement can still be stored in the process bu If the basic program reaches 'MOVE(200)' it will wait.

BASIC PROGRAM
....
MOVE(-500)
....
MOVE(1000)
....
DATUM(3)
....
MOVE(200) ◄
....

BUFFER

MOVE(200)

NTYPE   DATUM(3)

MTYPE   MOVE(1000)

MOVE -500

MOVE 1000

4.- The first movement has finished. The buffer moves by one position. The next movement starts to execute.

BASIC PROGRAM
....
MOVE(-500)
....
MOVE(1000)
....
DATUM(3)
....
MOVE(200)
....

BUFFER

- - - - - -

NTYPE   MOVE(200)

MTYPE   DATUM(3)

MOVE -500

MOVE 1000

DATUM (3)

5.- As the sent movements are finished, the buffer empties.

BASIC PROGRAM
....
MOVE(-500)
....
MOVE(1000)
....
DATUM(3)
....
MOVE(200)
....

BUFFER

- - - - - -

NTYPE   IDLE

MTYPE   MOVE(200)

MOVE -500

MOVE 1000

DATUM (3) MOVE 200

6.- If no new movements are executed, finally, the buffer will become empty and the profile generator becomes inactive.

2.9 Mechanical system

2.9.1 Inertia ratio

The inertia ratio is a stability criterion. The higher the intertia of the load in relation to the intertia of the motor, the lower the gains you can set in your system before you reach oscillation, and the lower the performance you can reach.
With a ratio of 1:30 for small Servo Drivers and a ratio of 1:5 for big Servo Drivers you can reach the maximum dynamic of the motor-driver combination.

2.9.2 Rigidity

If a machine is more rigid and less elastic, you can set higher gains without vibration, and you can reach higher dynamic and lower Following Error.

2.9.3 Resonant frequency

A mechanical system has at least one resonant frequency. If you excite your mechanical system to the resonant frequency, it starts oscillating. For motion systems, it is best to have mechanical systems with a very high resonant frequency, that is, with low inertia and high rigidity.
The resonant frequency of the mechanical system is the limit for the gain settings.

3 Hardware reference

3.1 Introduction

Trajexia is OMRON's motion platform that offers you the performance and the ease of use of a dedicated motion system.

Trajexia is a stand-alone modular system that allows maximum flexibility and scalability. At the heart of Trajexia lies the TJ1 multi-tasking motion coordinator. Powered by a 32-bit DSP, it can do motion tasks such as e-cam, e-gearbox, registration control and interpolation, all via simple motion commands.

Trajexia offers control of up to 16 axes over a MECHATROLINK-II motion bus or traditional analogue or pulse control with independent position, speed or torque control for every axis. And its powerful motion instruction set makes programming intuitive and easy.

You can select from a wide choice of best-in-class rotary, linear and direct-driver servos as well as Inverters. The system is scalable up to 16 axes and 8 Inverters & I/O modules.

3.1.1 Trajexia High-Lights

The main high-lights of the trajexia system are as follows:

Direct connectivity via Ethernet
Trajexia's Ethernet built-in connector provides direct and fast connectivity to PCs, PLCs, HMIs and other devices while providing full access to the drivers over a MECHATROLINK-II motion bus. It allows explicit messaging over Ethernet and through MECHATROLINK-II to provide full transparency down to the actuator level, and making remote access possible.

Keep your know-how safe
Trajexia's encryption method guarantees complete protection and confidentiality for your valuable know-how.

fig. 1
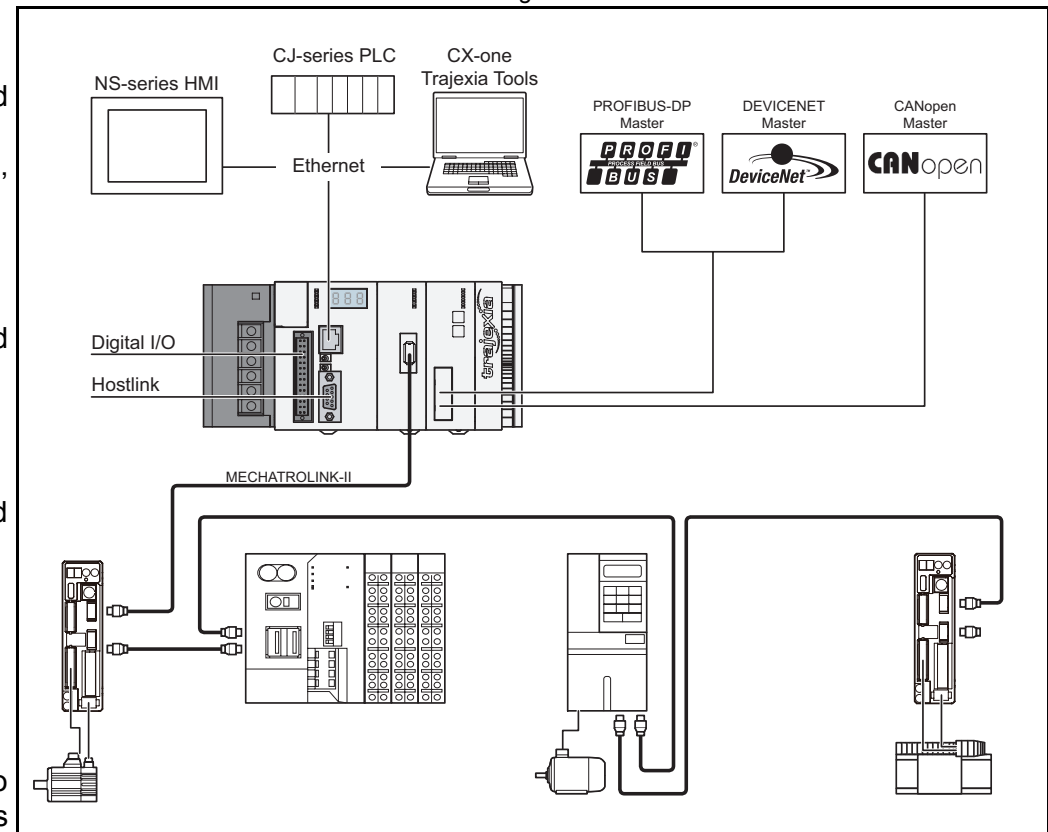
Serial Port and Local I/Os

A serial connector provides direct connectivity with any OMRON PLC, HMIs or any other field device. 16 Inputs and 8 outputs are freely configurable embedded I/Os in the controller to enable you to tailor Trajexia to your machine design.

MECHATROLINK-II Master

The MECHATROLINK-II master performs control of up to 16 servos, Inverters or I/Os while allowing complete transparency across the whole system.MECHATROLINK-II offers the communication speed and time accuracy essential to guarantee perfect motion control of servos. The motion cycle time is selectable between 0.5 ms, 1 ms or 2 ms.

TJ1-FL02 (Flexible Axis Unit)

The TJ1-FL02 allows full control of two actuators via an analogue output or pulse train. The module supports the main absolute encoder protocols allowing the connection of an external encoder to the system.

Drives and Inverters

A wide choice of rotary, linear and direct-driver servos as well as Inverters are available to fit your needs in compactness, performance and reliability. The Inverters connected to the MECHATROLINK-II are driven at the same update cycle time as the Servo Drivers.

Remote I/Os

The I/Os on the MECHATROLINK-II motion bus provide for system expansion while keeping the devices under one motion bus.

PROFIBUS-DP

The PROFIBUS-DP slave allows connectivity to the PROFIBUS network in your machine.

DeviceNet

The DeviceNet slave allows connectivity to the DeviceNet network in your machine.

CANopen

The CANopen master allows connectivity to the CANopen network in your machine.

3.1.2   Trajexia Studio

One software

Trajexia's intuitive and easy programming tool, based on the Motion BASIC instruction set, includes dedicated commands for linking axes, e-cams, e-gearboxes etc. Multi-tasking provides flexibility in application design. The motion commands are "buffered" so the BASIC programs are executed while motion movements are executed.

One connection

The parameters and functions inside the drivers on the MECHATROLINK-II are fully accessible from the Ethernet connection.

One minute

Trajexia Studio includes advanced debugging tools, including trace and oscilloscope functions, to ensure efficient operation and minimum downtime. The servos, Inverters and I/Os connected to the MECHATROLINK-II motion bus are automatically identified and configured, allowing you to set up your system in minutes.

3.1.3   This manual

This Hardware Reference Manual gives the dedicated information for:
- The description, connections and use of the Trajexia units
- The description, connections and use of the MECHATROLINK-II slaves
- A detailed philosophy of the system design to obtain the best results for Trajexia

fig. 2
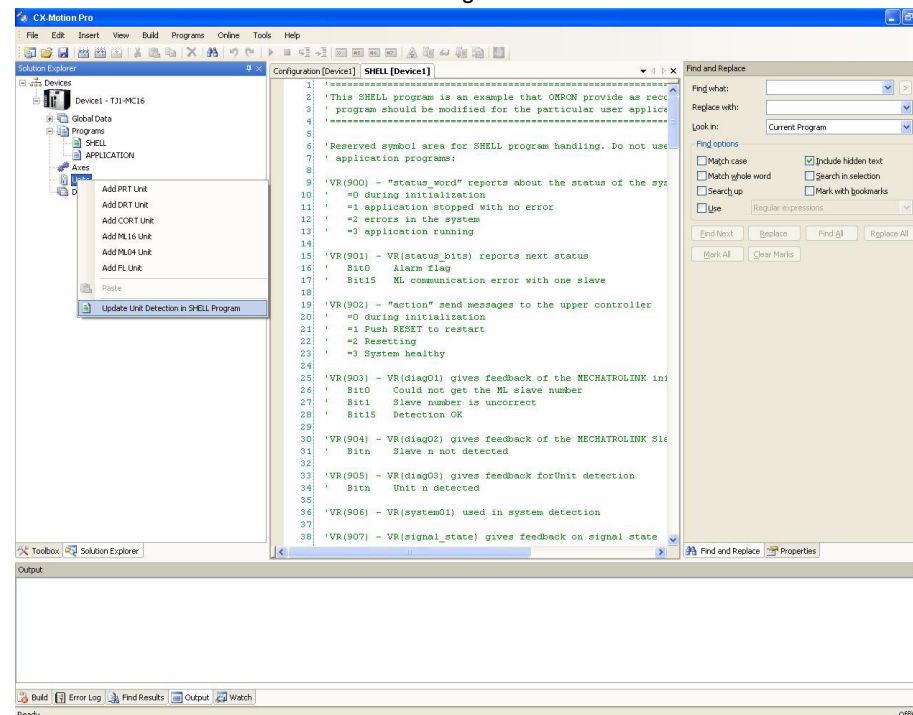
3.2 All units

3.2.1 System installation

A Trajexia system consists of these units:
- A Power Supply Unit.
- A TJ1-MC__ (Motion Controller Unit). This can be one of these:
  - TJ1-MC16. It supports 16 real or virtual axes, and 16 axes in total.
  - TJ1-MC04. It supports 5 real and up to 16 virtual axes, 16 axes in total.
- Up to 7 expansion units.
- A TJ1-TER (Terminator Unit).

The expansion units (unit numbers 0-6) can be arranged in any order. The TJ1-MC__ autodetects all units.

A Trajexia system with a TJ1-MC16 can include:
- 0 to 4 TJ1-ML__ units (MECHATROLINK-II Master Unit).
- 0 to 7 TJ1-FL02 units.
- 0 or 1 TJ1-PRT (PROFIBUS-DP Slave Unit) or TJ1-DRT units (DeviceNet Slave Unit)[1].
- 0 or 1 TJ1-CORT units (CANopen Master Unit).

A Trajexia system with a TJ1-MC04 can include:
- 0 to 4 TJ1-ML__ units.
- 0 to 3 TJ1-FL02 units.
- 0 or 1 TJ1-PRT or TJ1-DRT units[1].
- 0 or 1 TJ1-CORT units.

fig. 3

Unit number: -1   0   1   2   3   4   5   6

---
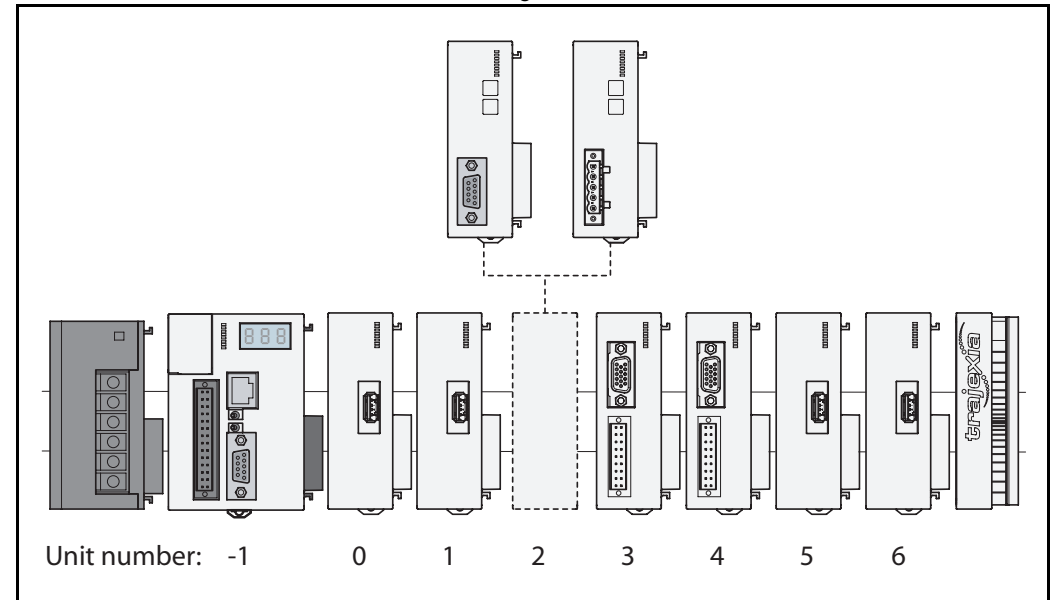
1. Trajexia does not support both a TJ1-PRT and a TJ1-DRT unit in the same system.

The figure is an example of a simple configuration.

A. Power supply
B. TJ1-MC__.
C. TJ1-ML__.
D. Sigma-II Servo Driver
E. NS115 MECHATROLINK-II Interface Unit.
F. Sigma-II servo motor
G. TJ1-TER.

fig. 4
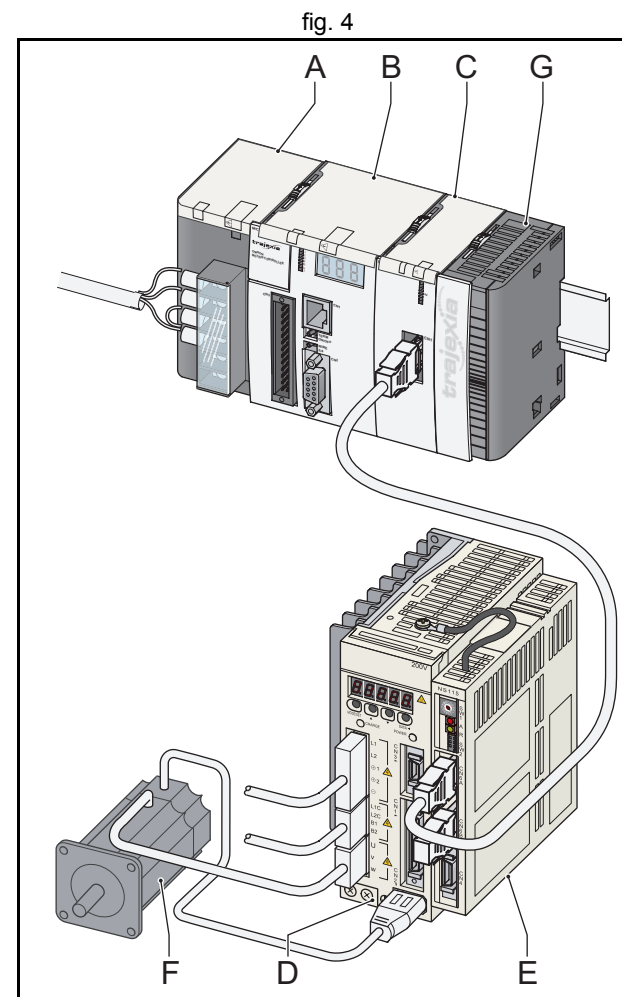
1. Remove all the units from the packaging. Make sure all units are complete.
2. Do not remove the protection labels from the units.
3. To disconnect the TJ1-MC__ and the TJ1-TER, push the clips (A) on top and bottom of the TJ1-TER to the front.
4. Disconnect the TJ1-TER from the TJ1-MC__.

fig. 5

5. Push the clips (A) on top and bottom of all the units to the front.

fig. 6
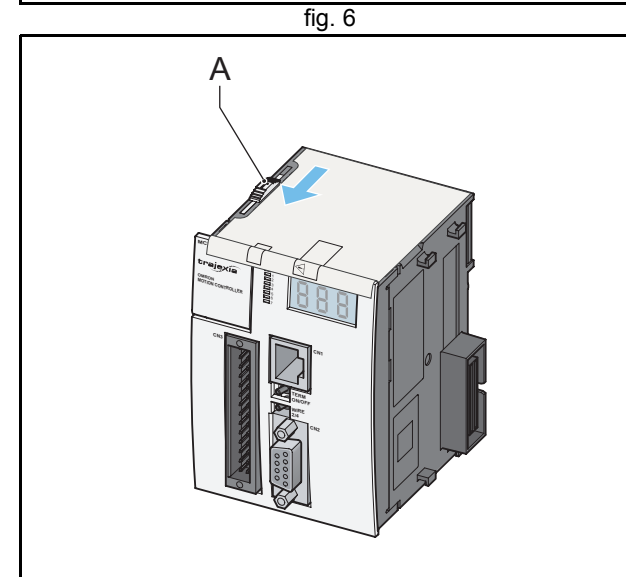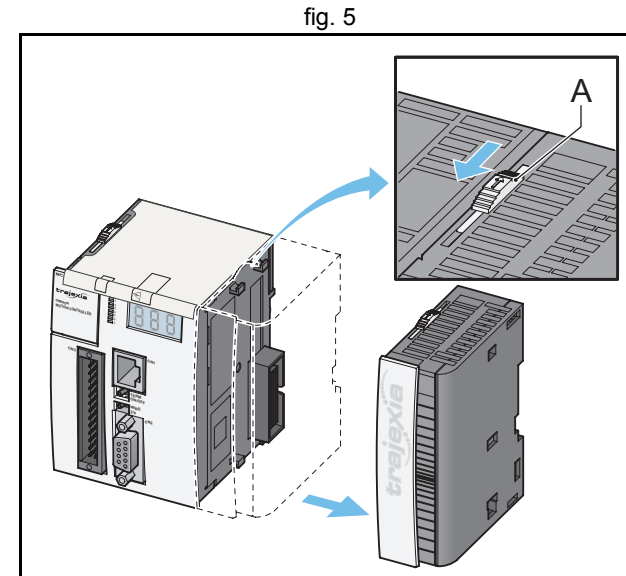
6. Attach the TJ1-MC__ (C) to the Power Supply Unit (B).

fig. 7
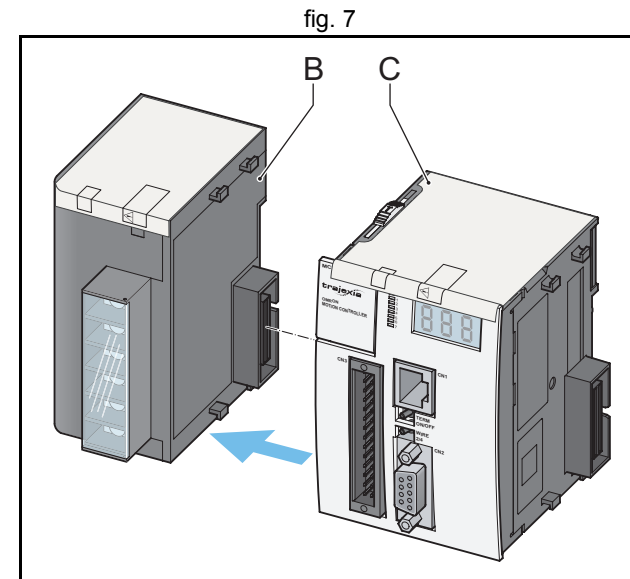
7. Push the clips (A) on top and bottom to the rear.

fig. 8
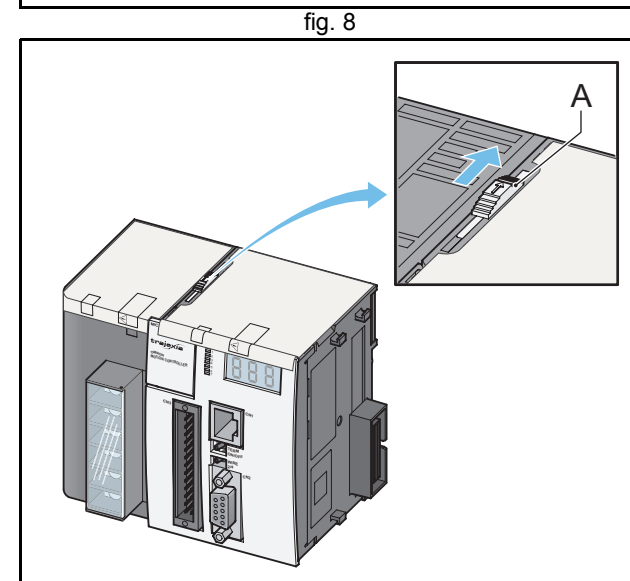
8. Repeat the previous two steps for all other units.
9. Make sure the last unit is the TJ1-TER.

fig. 9

10. Pull down all the clips (D) on all units.
11. Attach the Trajexia system to the DIN rail in an upright position to provide proper cooling. The recommended DIN rail is of type PFP-100N2, PFP-100N or PFP-50N.
12. Push all the clips (D) up on all units.
13. After you complete the wiring of the units, remove the protection labels from the units.
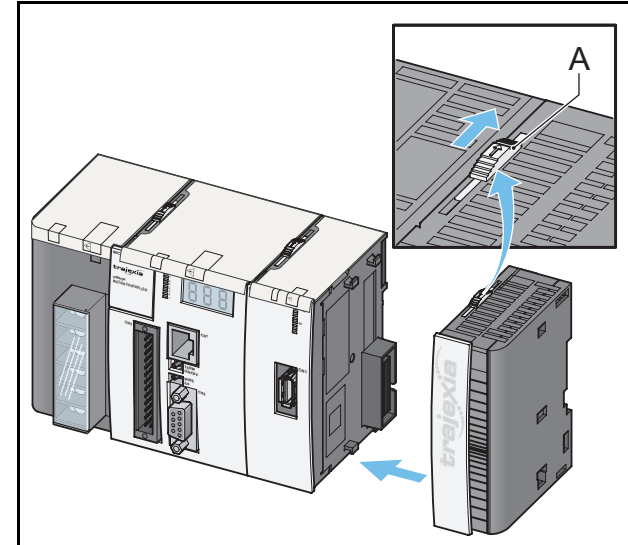
fig. 10
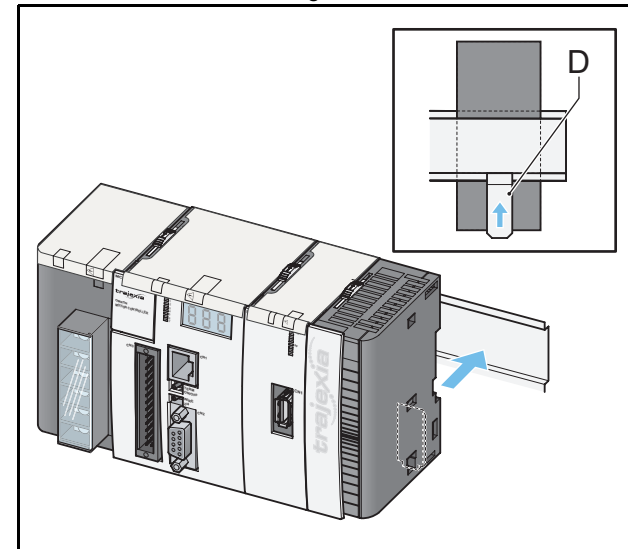
14. Do not install the Trajexia units in one of these positions:
- Upside down.
- With the top side forward.
- With the bottom forward.
- Vertically.

fig. 11
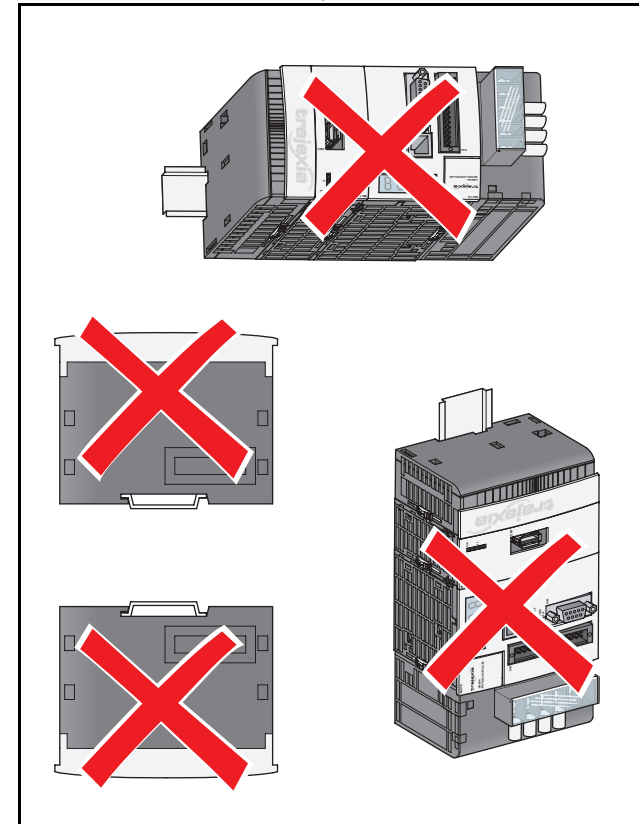
15. When you design a cabinet for the units, make sure that the cabinet allows at least 20 mm of space around the units to provide sufficient airflow. We advise to allow at least 100 mm of space around the units.

fig. 12
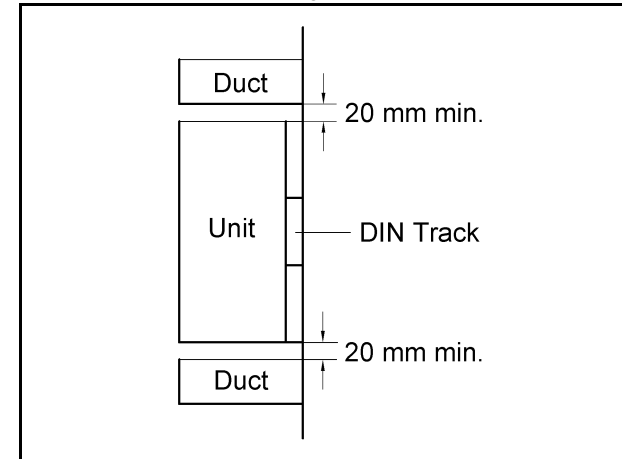
3.2.2 Environmental and storage for all units

Item	Specification
Ambient operating temperature	0 to 55°C
Ambient operating humidity	10 to 90% RH. (with no condensation)
Ambient storage temperature	-20 to 70°C (excluding battery)
Ambient storage humidity	90% max. (with no condensation)
Atmosphere	No corrosive gases
Vibration resistance	10 to 57 Hz: (0.075 mm amplitude): 57 to 100 Hz: Acceleration: 9,8 m/s2, in X, Y and Z directions for 80 minutes
Shock resistance	147 m/s^2, 3 times each X, Y and Z directions
Insulation resistance	20 MΩ
Dielectric strength	500 VAC
Protective structure	IP20
International standards	CE, EN 61131-2, cULus, Lloyds RoHS compliant

3.2.3 Unit dimensions

The dimensions for the units of the Trajexia system are as follows:

Trajexia motion controller
All measurements are in mm.

fig. 13
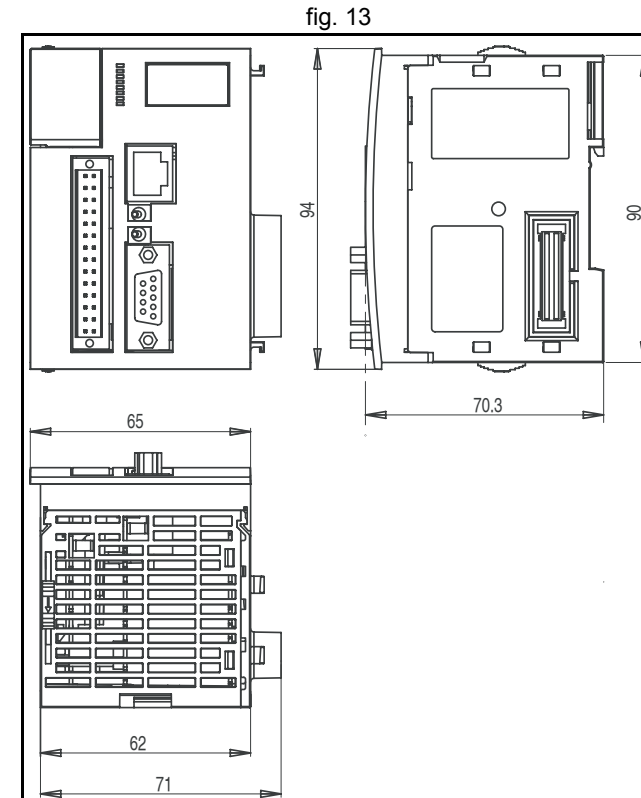
Trajexia units

All measurements are in mm.

fig. 14
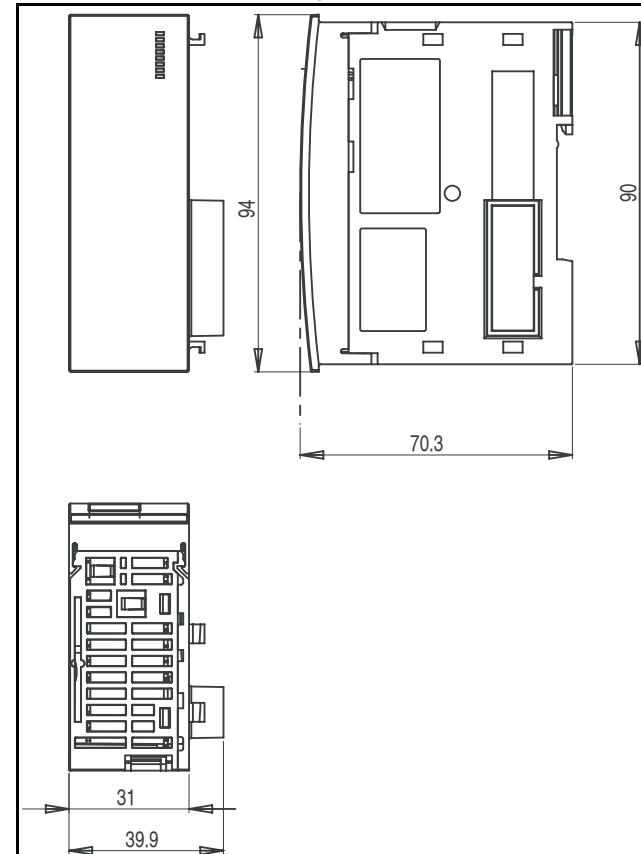
Trajexia system

All measurements are in mm.

fig. 15

The installation depth of the Trajexia system is up to 90 mm, depending on the modules that are mounted. Allow sufficient depth in the control cabinet.
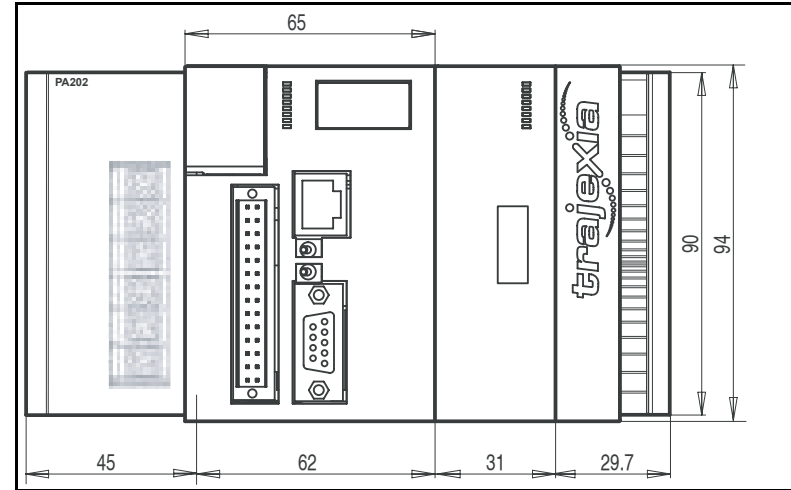
fig. 16
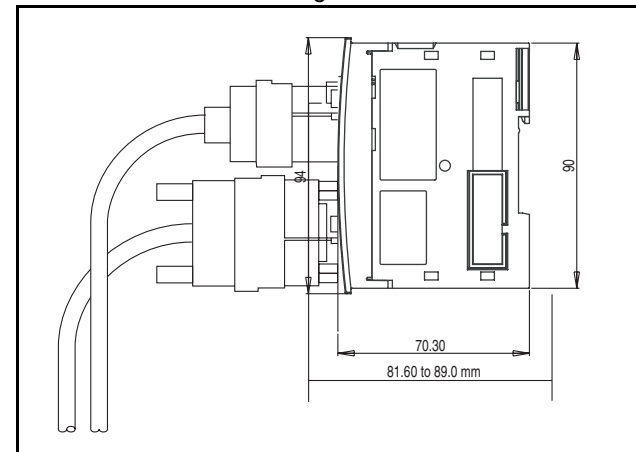
3.2.4   Wire the I/O connectors

To wire the I/O connectors of the TJ1-MC__ and the TJ1-FL02 units, do these steps:

1. Strip the wires.
2. To make it easier to insert the wires, twist them.
3. If necessary, crimp the plain (top) ferrules or the collared (bottom) ferrules.
4. Insert the screwdriver into the inner (square) hole. Push firmly.
5. Insert the wire into the outer (circular) hole.
6. Remove the screwdriver.
7. Make sure that there are no loose strands.

fig. 17
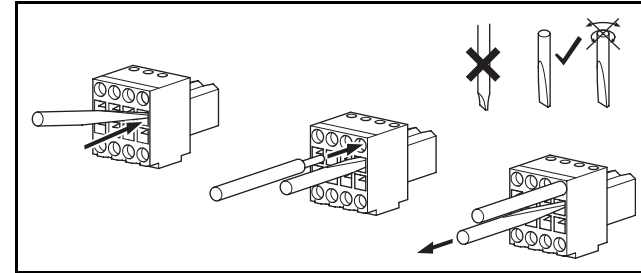
Wiring specifications

Item	Specification
Wire types	$0.14-1.0$ mm^2 Solid, stranded or stranded with ferrule: • Crimp ferrules according to DIN46228/1 • Crimp ferrules wit plastic collar according to DIN46228/4 • With recommended tool Weidmüller PZ6
Insertion tool	2.5 mm flat-bladed screwdriver
Recommended ferrule types	Weidmüller AEH H0,14/12 AEH H0,25/12 AEH H0,34/12
Stripping length	7 mm without ferrules (tolerance: +1 mm, −0 mm) 10 mm with ferrules (tolerance: +1 mm, −0 mm)

Conductor size

Item	Specification
Clamping range	$0.08-1.0$ mm^2
Wires without ferrule	$0.5-1.0$ mm^2
Wires with ferrule	AEH H0,14/12, 0.13 mm^2 AEH H0,25/12, 0.25 mm^2 AEH H0,34/12, 0.34 mm^2

3.3   Power Supply Unit (PSU)

3.3.1   Introduction

The PSU supplies power to the other units in the Trajexia system. You can use three different types of Power Supply Unit with the Trajexia system:

- CJ1W-PA202
- CJ1W-PA205R
- CJ1W-PD025.

3.3.2   PSU Connections

Each Power Supply Unit has six terminals:

fig. 18

Item	CJ1W-PA202	CJ1W-PA205R	CJ1W-PD025
A	110 - 240 VAC input	110 - 240 VAC input	24 VDC input
B	110 - 240 VAC input	110 - 240 VAC input	0 V input
C	Line earth	Line earth	Line earth
D	Earth	Earth	Earth
E	N/C	[1]Wdog relay contact	N/C
F	N/C	Wdog relay contact	N/C

1. Terminals E and F for the CJ1W-PA205R are relay contacts that close when Wdog is enabled. Refer to the BASIC Commands in the Programming manual.

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.
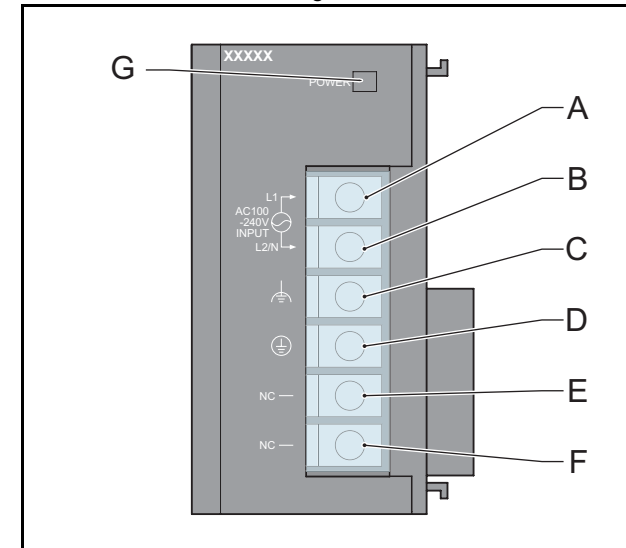
Caution

A ground of 100Ω or less must be installed when shorting the GR and LG terminals on the Power Supply Unit.
Not connecting a ground of 100Ω or less may result in electric shock.

Each Power Supply Unit has one green LED (G). This LED comes on when you connect the Power Supply Unit to the power source.

Caution

Tighten the screws of the power supply terminal block to the torque of 1.2 N·m. Loose screws can result in short-circuit, malfunction or fire.

3.3.3   PSU Specifications

Power Supply Unit	Input voltage	Maximum current consumption		Output power
		5 V group	24 V group	
CJ1W-PA202	110 - 240 VAC	2.8 A	0.4 A	14 W
CJ1W-PA205R	110 - 240 VAC	5.0 A	0.8 A	25 W
CJ1W-PD025	24 VDC	5.0 A	0.8 A	25 W

Caution

The amount of current and power that can be supplied to the system is limited by the capacity of the Power Supply Unit. Refer to this table when designing your system so that the total current consumption of the units in the system does not exceed the maximum current for each voltage group.
The total power consumption must not exceed the maximum for the Power Supply Unit.

3.3.4 PSU box contents

- Safety sheet.
- Power Supply Unit.
- Protection label attached to the top surface of the unit.

3.4 TJ1-MC__

3.4.1 Introduction

The TJ1-MC__ is the heart of the Trajexia system. You can program the
TJ1-MC__ with the BASIC programming language to control the expansion
units and the servo motors attached to the expansion units. Refer to the
Programming Manual.
There are two versions of the TJ1-MC__:
The TJ1-MC04 supports 5 axes (up to 4 axis on MECHATROLINK-II)
The TJ1-MC16 supports 16 axes.
The TJ1-MC__ has these visible parts:

fig. 19

Part	Description
A	LED display
B	I/O LEDs 0 - 7
C	Battery
D	Ethernet connector
E	TERM ON/OFF switch
F	WIRE 2/4 switch
G	Serial connector
H	28-pin I/O connector
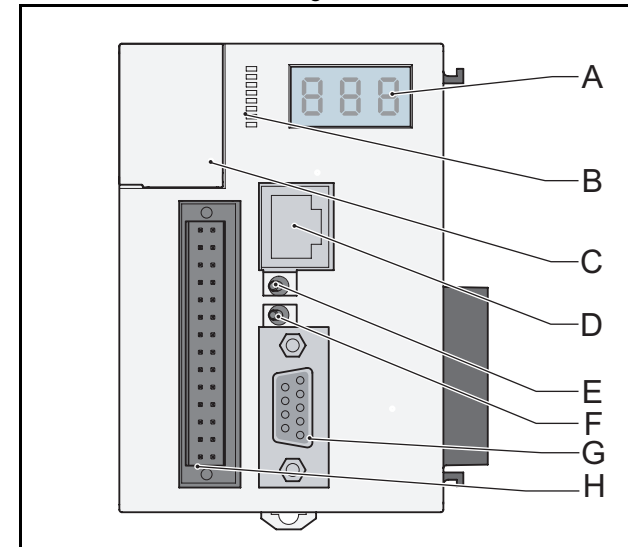
3.4.2 LED Display

The LED display shows the following information:

Information	When
IP address and sub-net mask	Shows 3 times when you connect the Trajexia system to the power supply.
IP address	Shows 4 times when you connect an Ethernet cable to the Ethernet connector of the TJ1-MC__ and to a PC.
RUN	When the TJ1-MC__ operates a Servo Driver.
OFF	When the TJ1-MC__ does not operate a Servo Driver.
ERR + code	When an error occurs in the Trajexia system. The code is the error code. Refer to troubleshooting chapter in the Programming Manual.

fig. 20
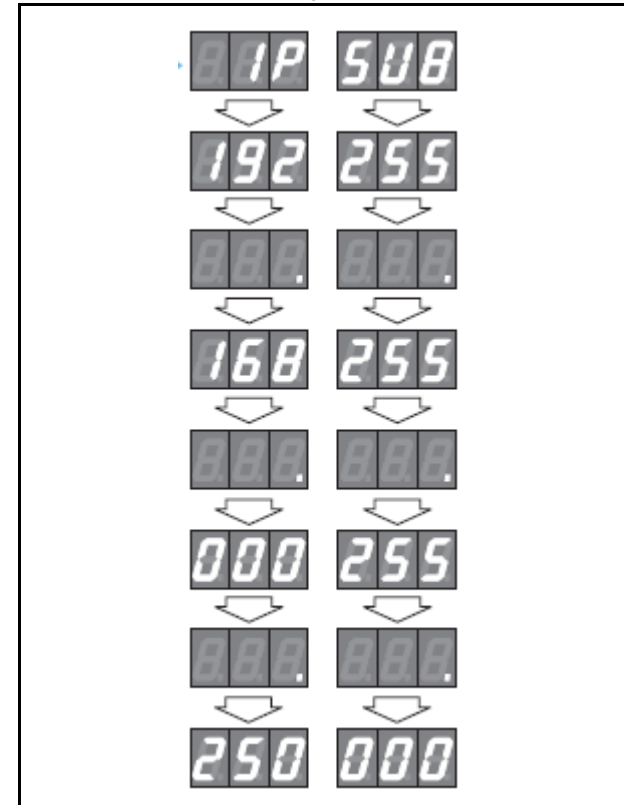
3.4.3 TJ1-MC__ Connections

The TJ1-MC__ comes with these connectors:
- One Ethernet connector, to connect to a PC or Ethernet network (D)
- One serial connector (G).
- One 28-pin I/O connector (H).

The parts for the serial connector and the 28-pin connector are supplied.

Ethernet connector
The Ethernet connector is used to connect the TJ1-MC__ to a PC or Ethernet network. The Ethernet connector is the only connection that can be used to program the system. Use either a crossover or a Ethernet patch cable for this connection. If you connect the PC directly to the TJ1-MC__, and not via a hub or any other network device, the PC must have a fixed IP address.
The TJ1-MC__ automatically detects when a cable is connected to the Ethernet connector.

BASIC installation precautions
Make sure that the Ethernet system is to the IEEE Std 802.3 standard.
Do not install the Ethernet system near a source of noise.

Environmental precautions
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.
Install twisted-pair cables away from high-voltage lines and devices that generate noise.
Install twisted-pair cables in locations that are free of high humidity and excessive dust and contaminates.

fig. 21
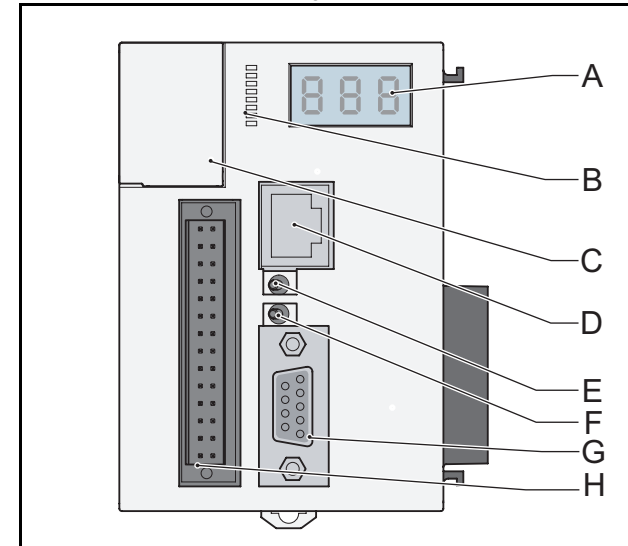
Serial connector

The serial connector allows for three communication standards:

- RS232.
- RS422.
- RS485.

fig. 22

Pin	Communication	Connection
1	RS422/RS485	/Tx
2	RS232	Tx
3	RS232	Rx
4	N/C	N/C
5	N/C	N/C
6	RS422/RS485	/Rx
7	RS422/RS485	Tx
8	RS422/RS485	Rx
9	RS232	0 V
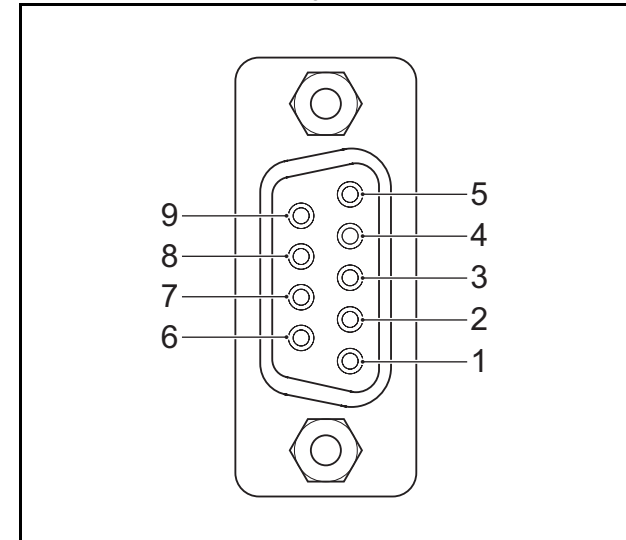
TERM ON/OFF Switch

Sets the termination on/off of the RS422 / 485 serial connection. The setting of the TERM ON/OFF switch depends on the communication standard of the serial connection and the position of the TJ1-MC__ in the network:

Communication standard	Position of the TJ1-MC__	Setting of the TERM ON/OFF switch
RS422 or RS485	First or last	Left (on)
RS422 or RS485	Not the first and not the last	Right (off)

WIRE 2/4 Switch

The WIRE 2/4 switch sets the communication standard for the RS422/485 serial connection. To use one of the communication standards, do this:

Communication standard	How to select it
RS422	Set the WIRE 2/4 switch right
RS485	Set the WIRE 2/4 switch left

Note
In RS485 mode, the transmit pair is connected to the receive pair.

fig. 23
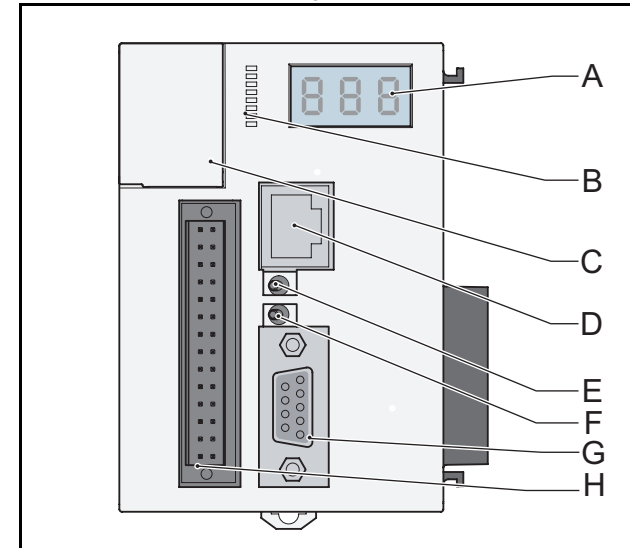
28-Pin I/O connector

The 28 pin connector is a Weidmuller connector designation:
B2L 3.5/28 LH.

Pin	Connection	Pin	Connection
1	0 V input common	2	0 V input common
3	Input 0	4	Input 1
5	Input 2	6	Input 3
7	Input 4	8	Input 5
9	Input 6	10	Input 7
11	Input 8	12	Input 9
13	Input 10	14	Input 11
15	Input 12	16	Input 13
17	Input 14	18	Input 15
19	Output 8	20	Output 9
21	Output 10	22	Output 11
23	Output 12	24	Output 13
25	Output 14	26	Output 15
27	0 V output common	28	24V Power supply Input for the Outputs.

fig. 24

LEDs 0 - 7

The I/O LEDs reflect the activity of the input and outputs. You can use the BASIC **DISPLAY=n** command to set the LEDs.
The table below lists the configuration for LEDs 0 - 7 and the **DISPLAY=n** command where **n** ranges from 0 to 7.

LED label	n=0	n=1	n=2	n=3	n=4	n=5	n=6	n=7
0	IN 0	IN 8	IN 16	IN 24	OUT 0	OUT 8	OUT 16	OUT 24
1	IN 1	IN 9	IN 17	IN 25	OUT 1	OUT 9	OUT 17	OUT 25
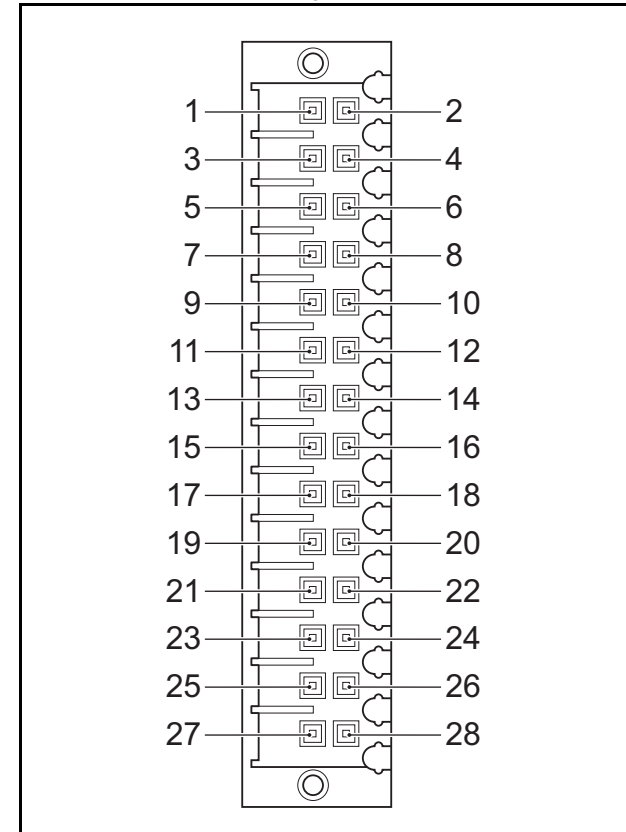
LED label	n=0	n=1	n=2	n=3	n=4	n=5	n=6	n=7
2	IN 2	IN 10	IN 18	IN 26	OUT 2	OUT 10	OUT 18	OUT 26
3	IN 3	IN 11	IN 19	IN 27	OUT 3	OUT 11	OUT 19	OUT 27
4	IN 4	IN 12	IN 20	IN 28	OUT 4	OUT 12	OUT 20	OUT 28
5	IN 5	IN 13	IN 21	IN 29	OUT 5	OUT 13	OUT 21	OUT 29
6	IN 6	IN 14	IN 22	IN 30	OUT 6	OUT 14	OUT 22	OUT 30
7	IN 7	IN 15	IN 23	IN 31	OUT 7	OUT 15	OUT 23	OUT 31

For example, if you use the **DISPLAY=1** command, LED 5 reflects the activity of the input in 13 (pin16) of the 28-pin I/O connector.

Digital inputs

The following table and illustration details the digital input (Input 0 to Input 15) specifications for the I/O:

Item	Specification
Type	PNP/NPN
Maximum voltage	24 VDC + 10%
Input current	5 mA at 24 VDC
ON voltage	14.4 VDC
OFF voltage	5.0 VDC max.

The timings are dependant upon the MC16's servo period, and include physical delays in the input circuit.

Maximum response times of 1250 μs (for servo periods of 0.5 ms or 1.0 ms) or 2500 μs (for a servo period of 2.0 ms) are achieved between a change in the input voltage and a corresponding change in the IN Parameter.

fig. 25
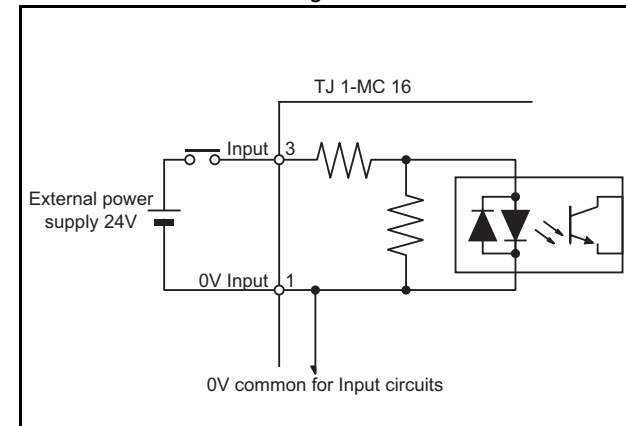
Digital outputs

The following table and illustration details the digital output (O8 to O15) specifications:

Item	Specification
Type	PNP
Maximum voltage	24 VDC + 10%
Current capacity	100 mA each output (800 mA for a group of 8)
Max. Voltage	24 VDC + 10%
Protection	Over current, Over temperature and 2A fuse on Common

The timings are dependant upon the MC16's servo period, and include physical delays in the output circuit.

Maximum response times of 250 μs on and 350 μs off (for servo periods of 0.5 ms or 1.0 ms) or 500 μs on and 600 μs off (for a servo period of 2.0 ms) are achieved between a change in the OP parameter and a corresponding change in the digital output circuit.

fig. 26
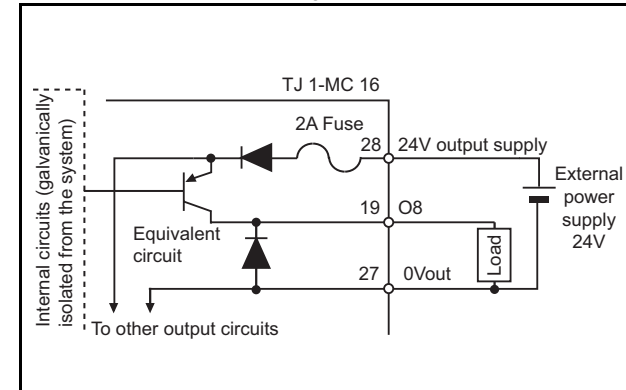
3.4.4 Battery

The backup battery provides power to the RAM, where programs and global variables are stored, and real Time Clock when the power supply is off. You must replace it every five years. The part number of the backup battery is CJ1W-BAT01.

To replace the battery the power must not be off for more than five minutes to ensure no backup memory loss. If the TJ1-MC__ has not been on, set the unit to on for at least five minutes before you replace the battery else the capacitor that gives backup power to the memory is not fully changed and backup memory may be lost before the new battery is inserted.

fig. 27
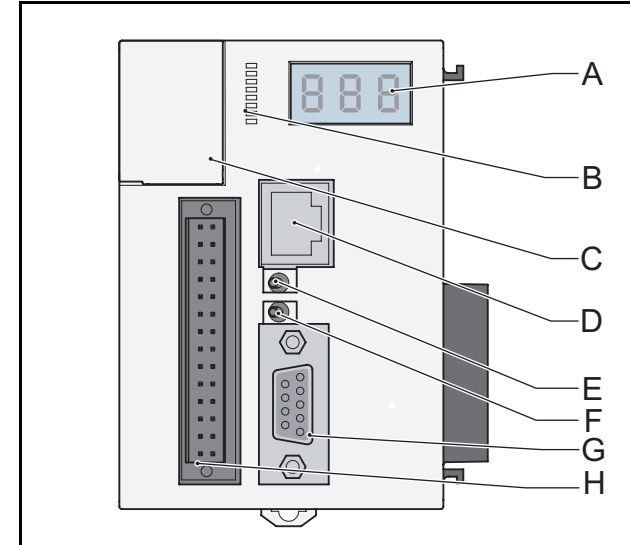
3.4.5 TJ1-MC__ Specification

Item	Specification	
	TJ1-MC04	**TJ1-MC16**
Power supply	5 VDC and 24 VDC (supplied by a Power Supply Unit)	
Total power consumption	3.3 W	
Current consumption	650 mA at 5 VDC	
Approximate weight	230 g	
Number of axes	5 (up to 4 axis on MECHA-TROLINK-II)	16
Number of Inverters and I/Os	Up to 8 on MECHATROLINK-II, depending on the type of TJ1-ML__ in the system.	
Number of TJ1-ML__ units	Up to 4	
Real Time Clock	Yes	

Item	Specification	
	TJ1-MC04	**TJ1-MC16**
Servo period	0.5 ms, 1 ms or 2 ms	
Programming language	BASIC-like motion language	
Multi-tasking	Up to 14 tasks	
Digital I/O	16 digital inputs and 8 digital outputs, freely configurable	
Measurement units	User-definable	
Available memory for user programs	500 kB	
Data storage capacity	Up to 2 MB flash data storage	
Saving program data on the TJ1-MC__	• RAM and flash memory backup • Battery backup	
Saving program data on the PC	Trajexia Tools software manages backups on the hard-disk of the PC	
Communication connectors	• 1 Ethernet connection • 2 serial connections	
Firmware update	Via Trajexia Tools software	
Electrical characteristics of the Ethernet connector	Conforms to IEEE 802.3 (100BaseT)	
Ethernet connector	RJ45	

Serial connectors 1 and 2

Item	Specification
Electrical characteristics	• PORT1: RS232C, non-isolated • PORT2: RS485/RS422A, isolated
Connector	SUB-D9 connector
Baud rate	1200, 2400, 4800, 9600, 19200 and 38400 bps
Transmission format, databit length	7 or 8 bit
Transmission format, stop bit	1 or 2 bit

Item	Specification
Transmission format, parity bit	Even/odd/none
Transmission mode	• RS232C: Point-to-point (1:1) • RS422/485: Point-to-multipoint (1:N)
Transmission protocol	• Host link master protocol • Host link slave protocol • ASCII general purpose
Galvanic isolation	RS422/485 connector only
Communication buffers	254 bytes
Flow control	None
Terminator	Yes, selected by switch
Maximum cable length	• RS232C: 15 m • RS422/485: 100 m

3.4.6 TJ1-TER

The TJ1-TER makes sure that the internal data bus of the Trajexia system functions correctly. A Trajexia system must always contain a TJ1-TER as the last unit.

fig. 28
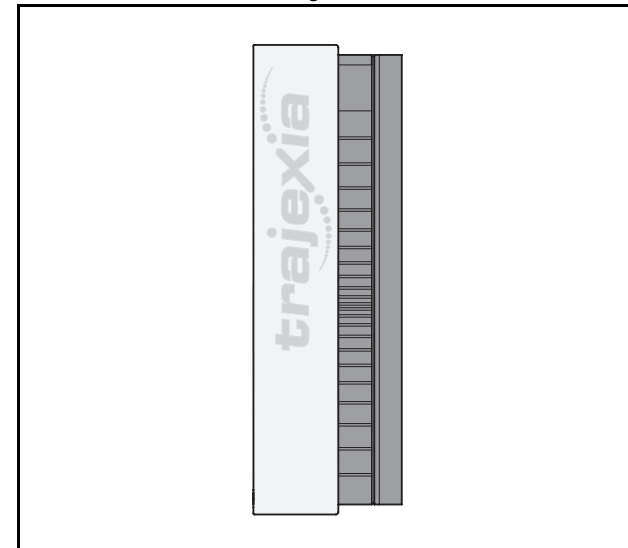
3.4.7   TJ1-MC__ box contents

- Safety sheet.
- TJ1-MC__ (battery included).
- Protection label attached to the top surface of the TJ1-MC__.
- TJ1-TER, attached to the TJ1-MC__.
- Parts for a serial connector.
- Parts for an I/O connector.
- Two metal DIN-rail clips, to prevent the Trajexia system from sliding off the rail.
- White clip, to replace the yellow clip of the Power Supply Unit.

3.5   TJ1-ML__

3.5.1   Introduction

The TJ1-ML__ controls MECHATROLINK-II devices in a cyclic and deterministic way. MECHATROLINK-II devices can be:
- Servo Drivers.
- Inverters.
- I/Os.

The TJ1-ML__ has these visible parts:

Part	Description
A	LED indicators
B	CN1 MECHATROLINK-II bus connector

Together the TJ1-ML__ and its devices form a serial network. The first unit in the network is the TJ1-ML__.
- One TJ1-ML16 can control 16 devices.
- One TJ1-ML04 can control 4 devices.

fig. 29
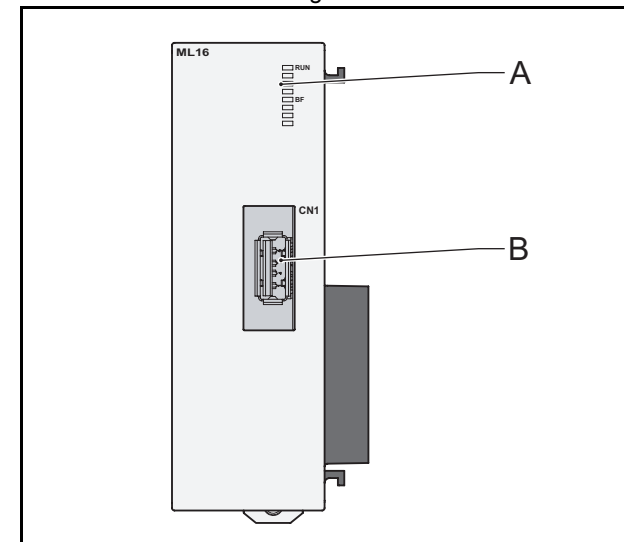
3.5.2 LEDs description

Label	Status	Description
run	off	Start-up test failed. Unit not operational Operation stopped. Fatal error
	on	Start-up test successful. Normal operation
BF	off	Normal operation
	on	A fault in the MECHATROLINK-II bus
-		Reserved

3.5.3 TJ1-ML__ connection

The MECHATROLINK-II bus connector (A) fits a MECHATROLINK-II connector. Use this connector to connect the TJ1-ML__ to a MECHATROLINK-II network.

The MECHATROLINK-II network must always be closed by the MECHATROLINK-II terminator.

fig. 30
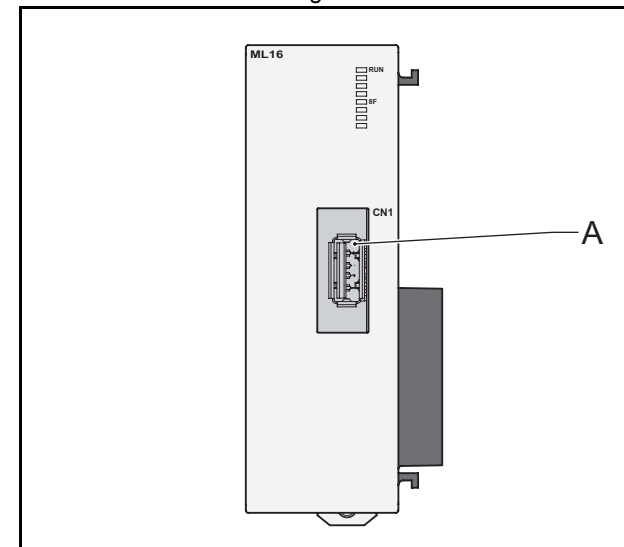
Example connections
Example 1
- 1 x TJ1-MC__
- 1 x TJ1-ML__
- 3 x Sigma-II Servo Driver
- 1 x MECHATROLINK-II terminator

fig. 31
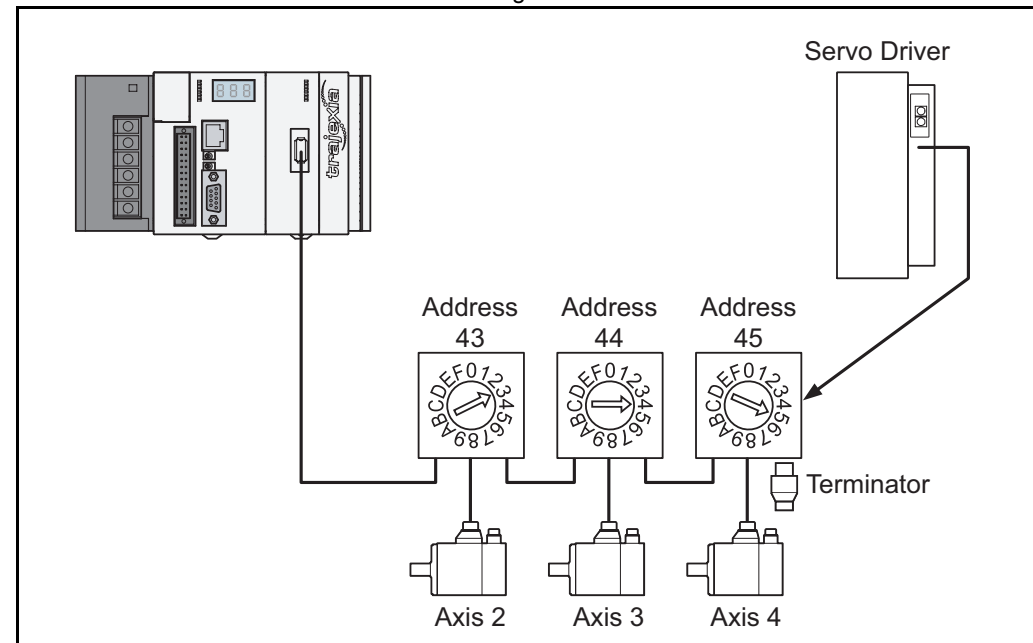
Example 2

- • 1 x TJ1-MC16
- • 2 x TJ1-ML16
- • 16 x Sigma-II Servo Driver
- • 2 x MECHATROLINK-II terminator

fig. 32
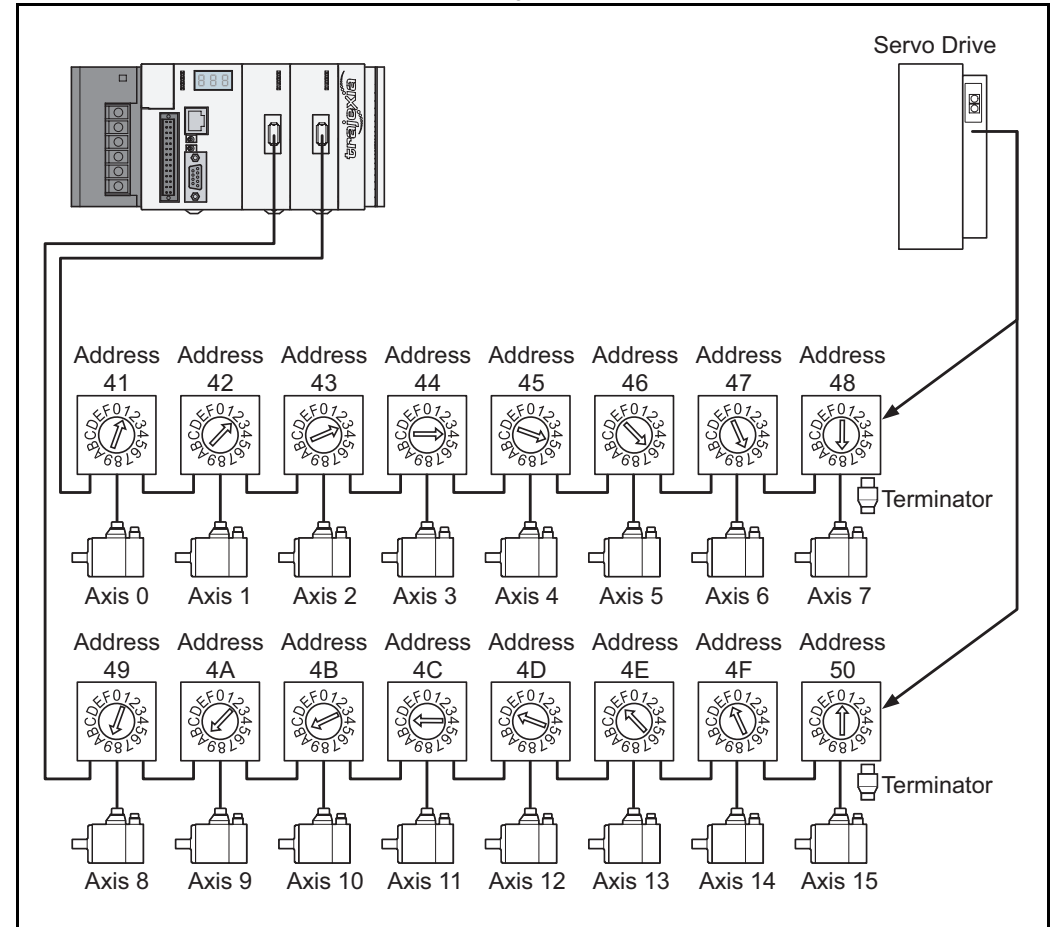
The MECHATROLINK-II Units can control different combinations of axes, Inverters and I/O units.

Example 3

- 1 x TJ1-MC__
- 1 x TJ1-ML16
- 1 x Sigma-II Servo Driver
- 1 x Inverter
- 3 x I/O units
- 1 x MECHATROLINK-II terminator

fig. 33
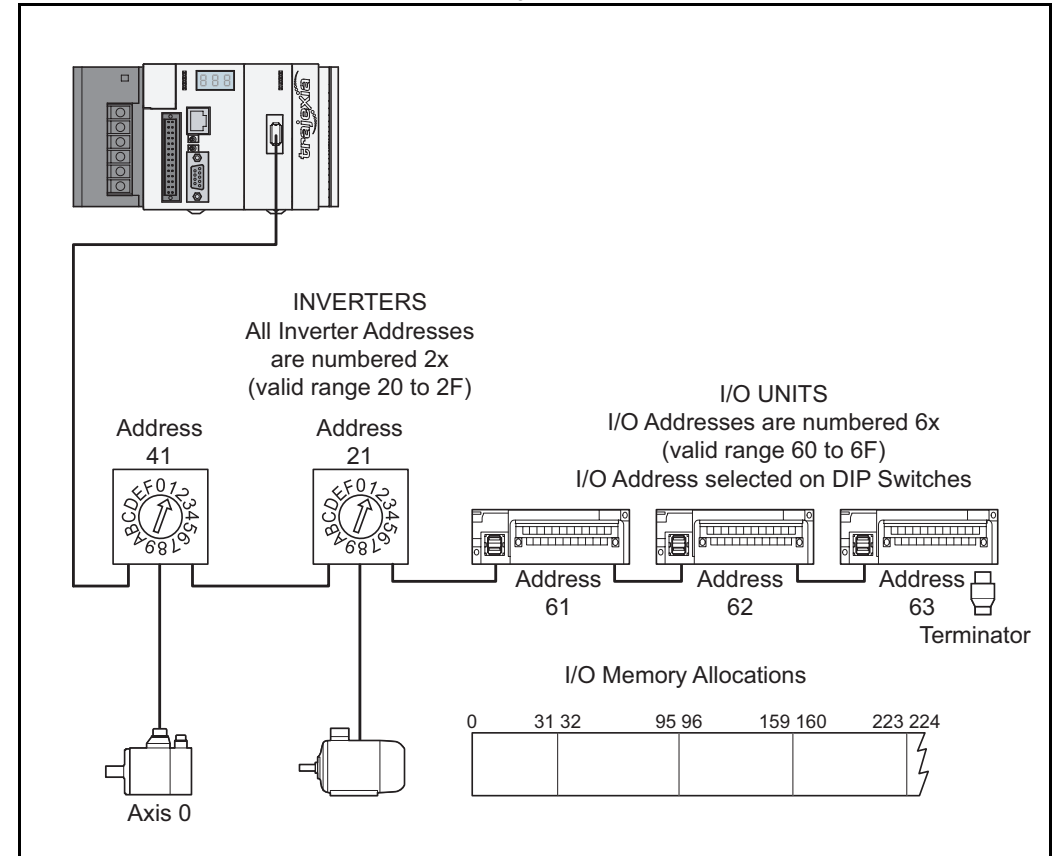
3.5.4 TJ1-ML__ specifications

Item	Specification	
	TJ1-ML04	**TJ1-ML16**
Power supply	5 VDC (supplied by the TJ1-MC__)	
Total power consumption	1.0 W	
Current consumption	200 mA at 5 VDC	

Item	Specification	
	TJ1-ML04	**TJ1-ML16**
Approximate weight	75 g	
Number of controlled devices	4	16
Controlled devices	• Omron G-Series Servo Drivers • Omron Accurax G5 Servo Drivers • Sigma-II, Sigma-V and Junma-ML Servo Drivers • I/Os • V7, F7 and G7 Inverters	
Electrical characteristics	Conforms to MECHATROLINK-II standard	
Communication connection	1 MECHATROLINK-II master connector	
Transmission speed	10 Mbps	
Servo period	0.5 ms, 1 ms or 2 ms	
Transmission distance without a repeater	Up to 50 m	

TJ1-ML__ related devices

Name	Remarks	Model
Distributed I/O modules	MECHATROLINK-II Smartslice coupler	GRT1-ML2
	64-point digital input and 64-point digital output (24 VDC sinking)	JEPMC-IO2310
	64-point digital input and 64-point digital output (24 VDC sourcing)	JEPMC-IO2330
	Analogue input: -10V to +10 V, 4 channels	JEPMC-AN2900
	Analogue output: -10 V to +10 V, 2 channels	JEPMC-AN2910
MECHATROLINK-II cables	0.5 meter	FNY-W6003-A5
	1 meters	FNY-W6003-01
	3 meters	FNY-W6003-03

Name	Remarks	Model
	5 meters	FNY-W6003-05
	10 meters	FNY-W6003-10
	20 meters	FNY-W6003-20
	30 meters	FNY-W6003-30
MECHATROLINK-II terminator	Terminating resistor	FNY-W6022
MECHATROLINK-II interface unit	For Sigma-II series Servo Drivers (firmware version 39 or later)	JUSP-NS115
	For Varispeed V7 Inverter (For the supported version details of the Inverter, contact your OMRON sales office).	SI-T/V7
	For Varispeed F7, G7 Inverter (For the supported version details of the Inverter, contact your OMRON sales office).	SI-T

3.5.5 TJ1-ML__ box contents

MECHATROLINK-II Interface Unit box:
• Safety sheet.
• TJ1-ML__.
• Protection label attached to the top surface of the unit.

3.5.6 Related BASIC commands

The following BASIC commands are related to the TJ1-ML__:
• **ATYPE**
• **MECHATROLINK**

For more information, refer to the Trajexia Programming Manual.

3.5.7   MECHATROLINK-II Servo Drivers

A MECHATROLINK-II Servo Driver is designed to do position control in
Trajexia. In every MECHATROLINK-II cycle, the TJ1-MC__ receives the
position feedback from the Servo Driver via the TJ1-ML__. The TJ1-MC__
sends either the target position, speed or torque to the receiver, depending
on the axis type.
Other functionality of the Servo Driver is available but refreshed at slower
rate.
A Servo Driver is considered an axis by the TJ1-MC__.
When you connect a servo to the Trajexia, the parameter does not change
automatically so, depending on the application, you may have to change
values.

3.5.8   MECHATROLINK-II Servo Drivers Sigma-II series

To connect a Sigma-II Servo Driver to a Trajexia system, a JUSP-NS115
MECHATROLINK-II interface must be connected to the Servo Driver.
For details about the Sigma-II connections refer to the manual.

fig. 34
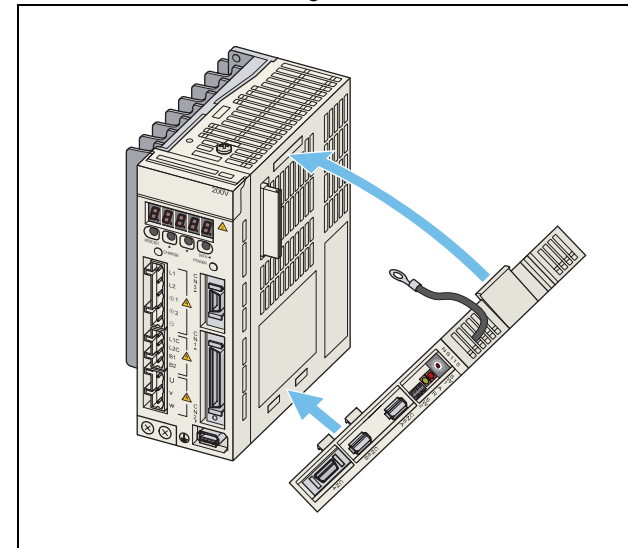
LED indicators on the NS115

LED	Color	Description
Alarm	Red	Lit: an alarm occurred Not lit: no alarm active
Ready	Green	Lit: communication active Not lit: no communication in progress

Address settings (SW1 & SW2)

The dipswitches (B) on the NS115 configure the communication settings.

Dipswitch	Function	Setting	Description
1	Baud rate	on	10 Mbps
2	Data length	on	32-byte data transmission
3	Address range	off	Addresses 40-4F
		on	Addresses 50-5F
4	Maintenance (Reserved)	off	Must always be set to off. on is not used

fig. 35
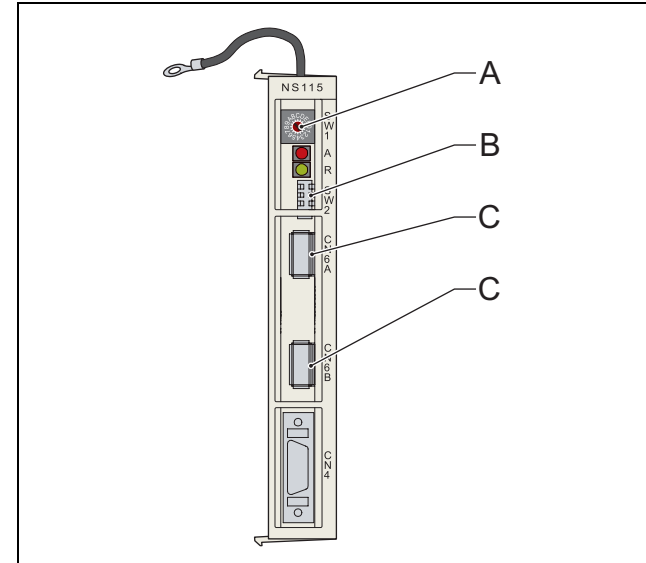
fig. 36
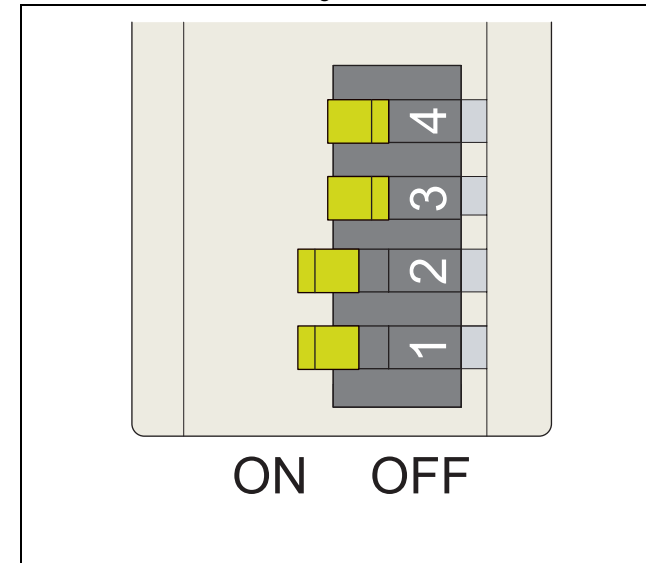
Set the address selector (A, fig 35) of the NS115 to *n* (where *n* ranges from 0 to F) to assign the following address to the NS115:

fig. 37

Rotary switch number	Dipswitch 3	Station address	Axis in motion controller
1	off	41	0
2	off	42	1
3	off	43	2
4	off	44	3
5	off	45	4
6	off	46	5
7	off	47	6
8	off	48	7
9	off	49	8
A	off	4A	9
B	off	4B	10
C	off	4C	11
D	off	4D	12
E	off	4E	13
F	off	4F	14
0	on	50	15

Do not use the addresses 40 and 51-5F. Use only the addresses 41-50.

MECHATROLINK-II connectors (CN1A & CN1B)

Connect to the MECHATROLINK-II network as in the figure using a suitable MECHATROLINK-II cable. Both connectors are parallelled so you can connect both cables to both connectors. Connect a MECHATROLINK-II terminator resistor in one of the connectors if the Servo Driver is the last device in the network.

fig. 38
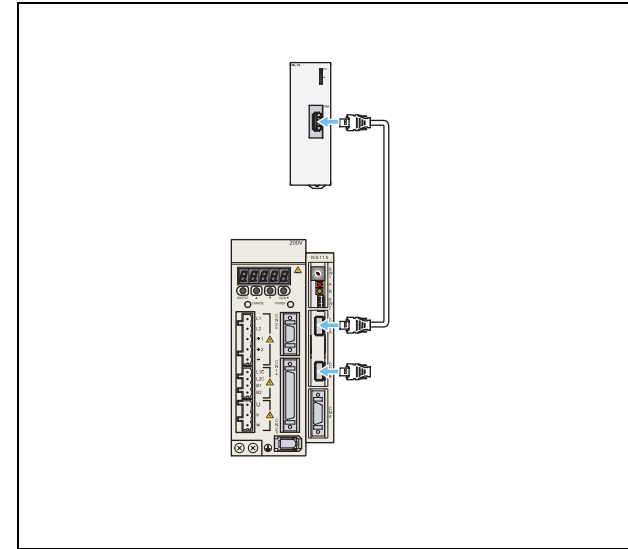
CN4 Full-closed encoder connector

CN4 is for connecting a full-closed encoder, that is, the position is controlled based in one external encoder, and the speed and torque loop based in the motor encoder. This is used when you install the motor in machines where you have to measure directly on the load because either:
- There is slip or backlash in the mechanical transmission.
- The precision required is very high.

The supported encoder is line driver and the pinout is shown in the figure.

The table shows the CN4 connector terminal layout and connector specifications.

1	PG0V	Signal ground
2	PG0V	Signal ground
3	PG0V	Signal ground
4	-	-
5	-	-
6	-	-
7	-	-
8	-	-
9	-	-
10	-	-
11	-	-
12	-	-
13	-	-
14	FC	Phase-C input +
15	/FC	Phase-C input -
16	FA	Phase-A input +
17	/FA	Phase-A input -
18	FB	Phase-B input +
19	/FB	Phase-B input -
20	-	-

fig. 39
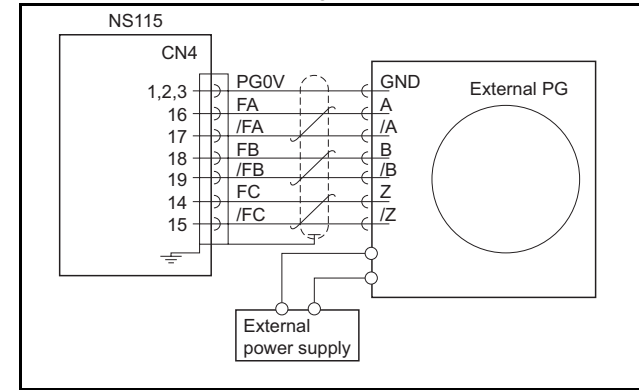
Note

Make sure that shielded cable is used and that the shield is connected to the connector shell.

Relevant servo parameters related with the use of Trajexia:

Encoder gear ratio resolution

These two parameters define the units of the system in combination with UNITS.

- Pn202: Gear ratio numerator. Default is 4, set to 1 to obtain the maximum encoder resolution.
- Pn203: Gear ratio denominator. Default=1.

Absolute encoder

- Pn205= Number of multiturn limit. Default 65535. Set to suitable value in combination with the encoder gear ratio and UNITS.

Full close encoder

- Pn002.3: 0=Disabled, 1=uses without Z, 2=uses with Z, 3=uses without Z reverse rotation, 4= uses with Z reverse rotation.
- Pn206: Number of full-closed encoder pulses per revolution. Default 16384

Using the Servo Driver digital inputs with Trajexia

- Pn50A: Mapping of the forward limit switch (P_OT).
- Pn50B: Mapping of the reverse limit switch (N_OT).
- Pn511: Mapping of the registration inputs and zero point return declaration.
- Pn81E: Mapping of the normal inputs.

For the overview of all possible settings and parameter values to map the input signals from the Servo Driver to Trajexia, refer to the Trajexia Programming manual, chapter "Mapping Servo Driver inputs and outputs". For the rest of the parameters and connections refer to the Sigma-II manual.

Related BASIC commands

The following BASIC commands are related to the MECHATROLINK-II Servo Drivers Sigma-II series:

- **ATYPE**
- **AXIS**
- **AXIS_ENABLE**
- **AXISSTATUS**

- **DRIVE_ALARM**
- **DRIVE_CLEAR**
- **DRIVE_CONTROL**
- **DRIVE_INPUTS**
- **DRIVE_MONITOR**
- **DRIVE_READ**
- **DRIVE_RESET**
- **DRIVE_STATUS**
- **DRIVE_WRITE**

For more information, refer to the Trajexia Programming Manual.

3.5.9   MECHATROLINK-II Servo Drivers Sigma-V series

You can also connect a Sigma-V Servo Driver to a Trajexia system.

Label	Terminal/LED	Description
A	CHARGE	Charge indicator
B	L1, L2, L3	Main circuit power supply terminals
C	L1, L2	Control power supply terminals
D	B1, B2	Regenerative resistor connecting terminals
E	1, 2	DC reactor terminals for harmonic suppression
F	U, V, W	Servo motor terminals
G	+	Ground terminal
H	CN6A/B	MECHATROLINK-II bus connectors
I	CN3	Connector for digital operator
J	CN7	PC connector
K	CN1	I/O signal connector
L	CN8	Connector for safety function devices
M	CN2	Encoder connector
N	SW1	Rotary switch for MECHATROLINK-II address settings
O	SW2	Dipswitches for MECHATROLINK-II communication settings
P		Panel display
Q		MECHATROLINK-II communication LED

fig. 40
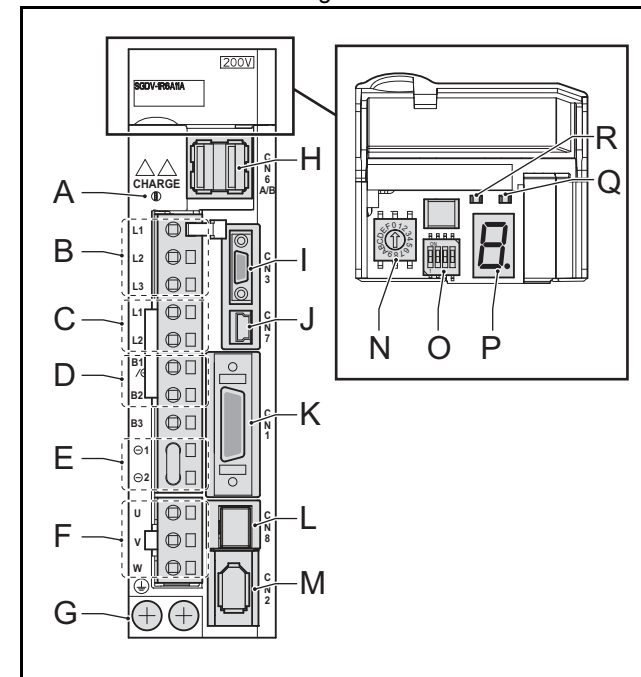
Label	Terminal/LED	Description
R		Power LED

Communication settings (SW2)

The 4 dipswitches configure the communication settings.

fig. 41

Dipswitch	Function	Setting	Description	Factory setting
1	Baud rate	on	10 Mbps	on
2	Data length	on	32-byte data transmission	on
3	Address range	off	Addresses 40-4F	off
		on	Addresses 50-5F	
4	Reserved	off	Must always be set to off. on is not used	off
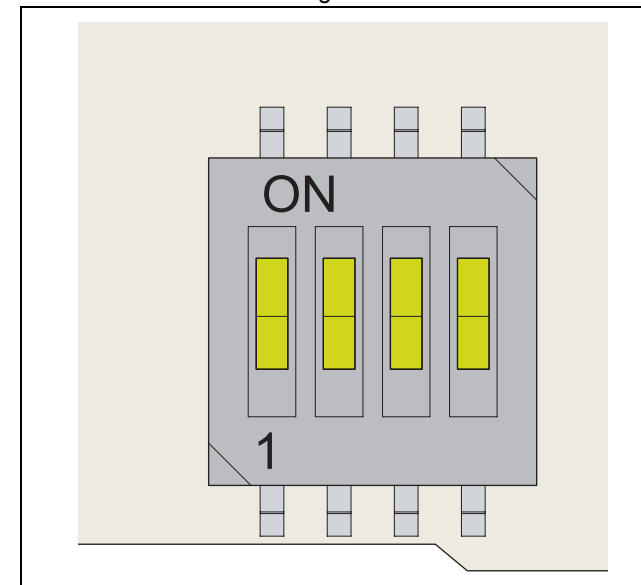
Address settings (SW1)

Set the address selector of the Sigma-V Servo Driver to *n* (where *n* ranges from 0 to F) to assign the following station address to it:

fig. 42

Rotary switch number	Dipswitch 3	Station address	Axis in motion controller
1	off	41	0
2	off	42	1
3	off	43	2
4	off	44	3
5	off	45	4
6	off	46	5
7	off	47	6
8	off	48	7
9	off	49	8
A	off	4A	9
B	off	4B	10
C	off	4C	11
D	off	4D	12
E	off	4E	13
F	off	4F	14
0	on	50	15

Do not use the addresses 40 and 51-5F. Use only the addresses 41-50.

LEDs

LED	Color	Description
Charge indicator	Orange	Lit: main circuit power supply is on or internal capacitor is charged Not lit: no power supply and internal capacitor is not charged
Power LED	Green	Lit: control power is supplied Not lit: no control power
MECHATROLINK-II communication LED	Green	Lit: communication active Not lit: no communication

Panel display

The panel display is a 7-segment LED display. It indicates the status of the Servo Driver.

The panel display has 3 display modes:

- Status display
  The display shows the statuses listed in the table below.

Display	Description	Remark
	Baseblock	Comes on when the motor current is shut off. Does not come on when the Servo Driver is on
	Rotation detection (/TGON)	Comes on when the motor speed is greater than the value set in Pn502
	Reference input	Comes on when a reference is being input
	CONNECT	Comes on during connection

- Alarm/warning
  If an alarm or a warning occurs, the display shows the alarm code or the warning code.
  The figure shows an example of displaying alarm code A.E60.

fig. 43

Status → Unlit → $A.$ → Unlit → $E.$ → Unlit → 6 → Unlit → 0 → Unlit
Display

- Test without motor
  The display shows the sequence given in the figure if a test is executed without a motor.

fig. 44

Status → Unlit → $H.$ → Unlit → $b.$ → Unlit → $b.$ → Unlit → $H.$ → Unlit
Display
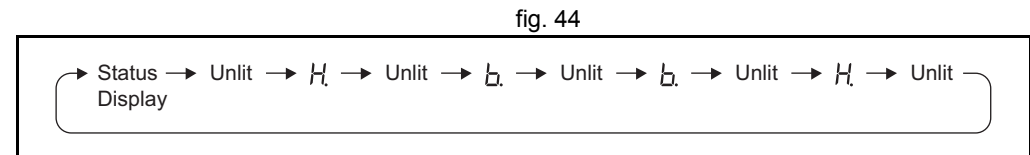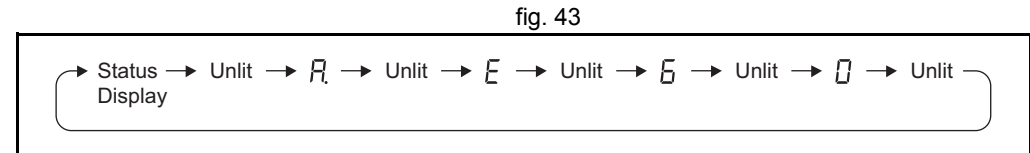
MECHATROLINK-II connectors (CN6A & CN6B)

Connect the Sigma-V Servo Driver to the MECHATROLINK-II network using the CN6A and CN6B connectors. Use one of the MECHATROLINK-II connectors to connect to the previous MECHATROLINK-II device or the TJ1-ML__. Use the other MECHATROLINK-II connector to connect to the next MECHATROLINK-II device, or to connect a MECHATROLINK-II terminator.

CN1 I/O Signal connector

The table below shows the pin layout for the I/O signal connector (CN1).

Pin	I/O	Signal	Signal name
1	Output	/BK+ (/SO1+)	Brake interlock signal
2	Output	/BK- (/SO1-)	Brake interlock signal
3	Output	ALM+	Servo alarm output signal
4	Output	ALM-	Servo alarm output signal
5	N/A	N/A	Not used
6	Input	+24 V IN	Control power supply for sequence signal
7	Input	P-OT	Forward run prohibited
8	Input	N-OT	Reverse run prohibited
9	Input	/DEC	Homing deceleration limit switch
10	Input	/EXT1	External latch signal 1[1]
11	Input	/EXT2	External latch signal 2[1]

Pin	I/O	Signal	Signal name
12	Input	/EXT3	External latch signal 3[1]
13	Input	/SIO	General-purpose input signal
14	N/A	N/A	Not used
15	N/A	N/A	Not used
16	Output	FG	Signal ground
17	N/A	N/A	Not used
18	N/A	N/A	Not used
19	N/A	N/A	Not used
20	N/A	N/A	Not used
21	Input	BAT (+)	Battery (+) input signal
22	Input	BAT (-)	Battery (-) input signal
23	Output	/SO2+	General-purpose output signal
24	Output	/SO2-	General-purpose output signal
25	Output	/SO3+	General-purpose output signal
26	Output	/SO3-	General-purpose output signal

1. NPN only.

For more information, refer to the Sigma-V Series SERVOPACKs manual.

CN2 encoder connector
The tables below shows the pin layout for the Sigma-V encoder connector.

Pin	Signal	Description
1	PG 5 V	PG power supply +5 V
2	PG 0 V	PG power supply 0 V
3	BAT (+)	Battery (+) (For an absolute encoder)
4	BAT (-)	Battery (-) (For an absolute encoder)
5	PS	PG serial signal input (+)

Pin	Signal	Description
6	/PS	PG serial signal input (-)
Shell	Shield	-

Related BASIC commands
The following BASIC commands are related to the MECHATROLINK-II Servo Drivers Sigma-V series:
- **ATYPE**
- **AXIS**
- **AXIS_ENABLE**
- **AXISSTATUS**
- **DRIVE_ALARM**
- **DRIVE_CLEAR**
- **DRIVE_CONTROL**
- **DRIVE_INPUTS**
- **DRIVE_MONITOR**
- **DRIVE_READ**
- **DRIVE_RESET**
- **DRIVE_STATUS**
- **DRIVE_WRITE**

For more information, refer to the Trajexia Programming Manual.

3.5.10 MECHATROLINK-II Servo Drivers Junma series

You can also connect a Junma Servo Driver to a Trajexia system.

fig. 45

Label	Terminal/LED	Description
A	FIL	Rotary switch for reference filter setting
B	CN6A & CN6B	MECHATROLINK-II bus connectors
C	CN1	I/O signal connector
D	CN2	Encoder input connector
E	SW1	Rotary switch for MECHATROLINK-II address settings
F	SW2	Dipswitches for MECHATROLINK-II communication settings
G	RDY	Servo status indicator
H	ALM	Alarm indicator
I	COM	MECHATROLINK-II communication status indicator
J	CNA	Connector for power supply
K	CNB	Connector for servo motor

LED indicators

LED	Description
COM	Lit: MECHATROLINK-II communication in progress Not lit: No MECHATROLINK-II communication
ALM	Lit: An alarm occurred Not lit: no alarm
RDY	Lit: Power is on, standby for establishment of communication Blinking: Servo ON status
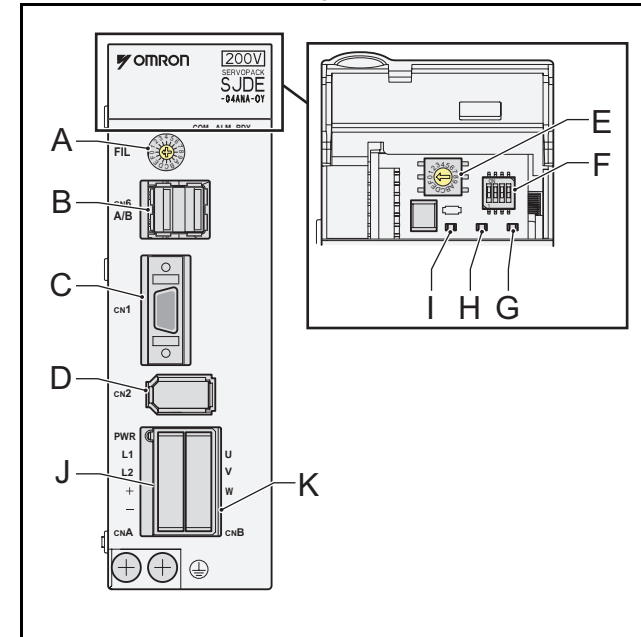
Communication settings (SW2)

The 4 dipswitches configure the communication settings.

Dipswitch	Function	Setting	Description
1	Reserved	ON	Must always be set to ON. OFF is not used
2	Data length	ON	32 bytes
3	Address range	OFF	Addresses 40-4F
		ON	Addresses 50-5F
4	Filter setting	OFF	Set the filter with the FIL rotary switch
		ON	Set the filter with Pn00A

fig. 46
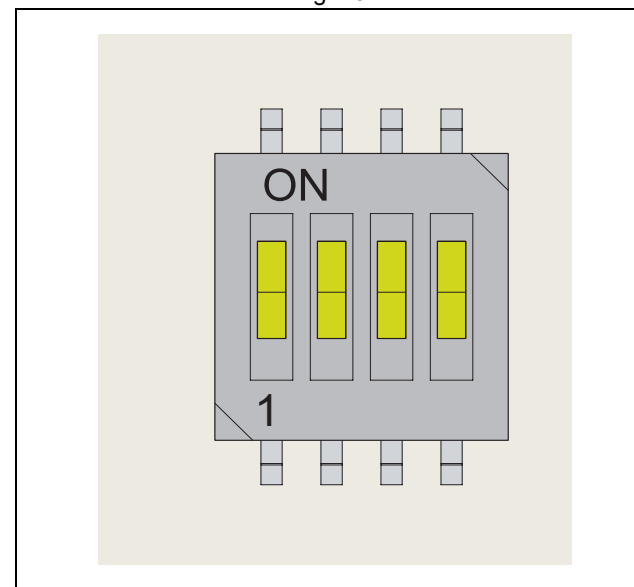
Address settings (SW1)

Set the address selector of the Junma Servo Driver to *n* (where *n* ranges from 0 to F) to assign the following station address to it:

fig. 47

Rotary switch number	Dipswitch 3	Station address	Axis in motion controller
1	off	41	0
2	off	42	1
3	off	43	2
4	off	44	3
5	off	45	4
6	off	46	5
7	off	47	6
8	off	48	7
9	off	49	8
A	off	4A	9
B	off	4B	10
C	off	4C	11
D	off	4D	12
E	off	4E	13
F	off	4F	14
0	on	50	15

Do not use the addresses 40 and 51-5F. Use only the addresses 41-50.

trajexia

CN1 I/O Signal connector

The table below shows the pin layout for the I/O signal connector (CN1).

fig. 48

Pin	I/O	Code	Signal name
1	Input	/EXT1	External latch
2	Input	/DEC	Homing deceleration
3	Input	N_OT	Reverse run prohibit
4	Input	P_OT	Forward run prohibit
5	Input	+24VIN	External input power supply
6	Input	E-STP	Emergency stop
7	Output	SG-COM	Output signal ground
8	N/C		
9	N/C		
10	N/C		
11	N/C		
12	Output	ALM	Servo alarm
13	Output	/BK	Brake
14	N/C		
Shell	-	-	FG
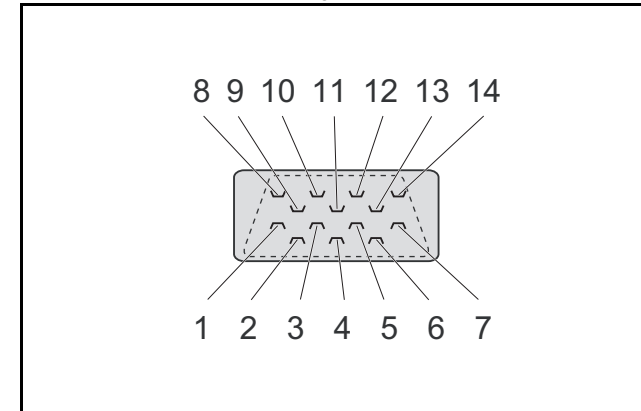
MECHATROLINK-II connectors (CN6A & CN6B)

Connect the Junma Servo Driver to the MECHATROLINK-II network using the CN6A and CN6B connectors. Use one of the MECHATROLINK-II connectors to connect to the previous MECHATROLINK-II device or the TJ1-ML__. Use the other MECHATROLINK-II connector to connect to the next MECHATROLINK-II device, or to connect a MECHATROLINK-II terminator.

CN2 encoder input connector

The tables below shows the pin layout for the Junma Servo Driver encoder connector.

Pin	Signal
1	PG5V
2	PG0V (GND)
3	Phase A (+)
4	Phase A (-)
5	Phase B (+)
6	Phase B (-)
7	Phase /Z
8	Phase U
9	Phase V
10	Phase W
Shell	-

fig. 49
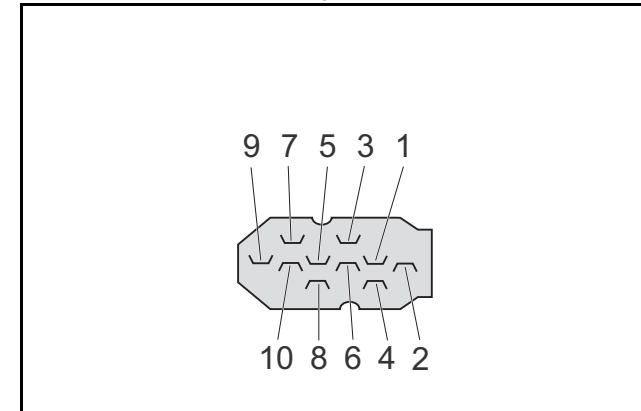
CNA power supply connector

The tables below shows the pin layout for the CNA power supply connector.

Pin	Signal	Name
1	L1	Power supply terminal
2	L2	Power supply terminal
3	+	Regenerative unit connection terminal
4	-	Regenerative unit connection terminal

fig. 50
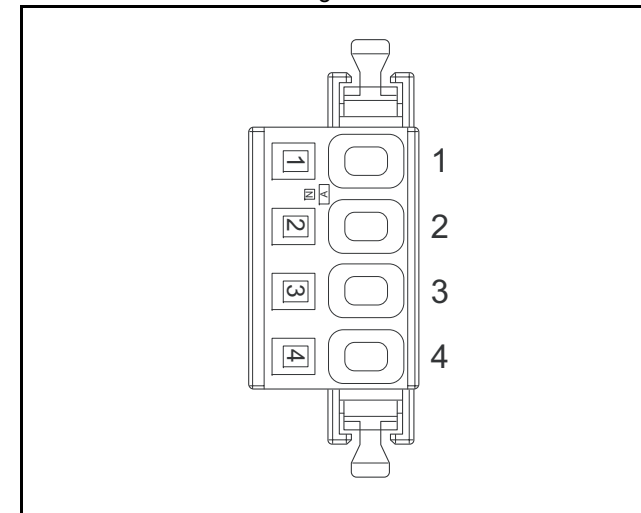
CNB servo motor connector
The tables below shows the pin layout for the CNB servo motor connector.

fig. 51

Pin	Signal	Name
1	U	Phase U
2	V	Phase V
3	W	Phase W
4	N/C	
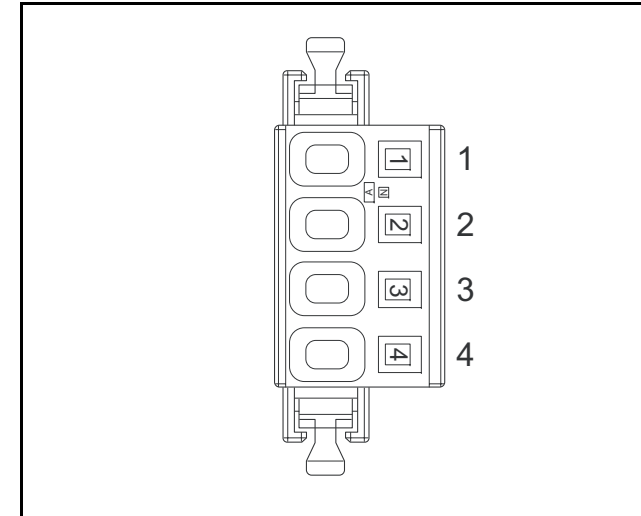
Related BASIC commands
The following BASIC commands are related to the MECHATROLINK-II
Servo Drivers Junma series:
- **ATYPE**
- **AXIS**
- **AXIS_ENABLE**
- **AXISSTATUS**
- **DRIVE_ALARM**
- **DRIVE_CLEAR**
- **DRIVE_CONTROL**
- **DRIVE_INPUTS**
- **DRIVE_MONITOR**
- **DRIVE_READ**
- **DRIVE_RESET**
- **DRIVE_STATUS**
- **DRIVE_WRITE**

For more information, refer to the Trajexia Programming Manual.

3.5.11   MECHATROLINK-II Servo Drivers G-series

You can also connect a G-Series Servo Driver to a Trajexia system.

Label	Terminal/LED	Description
A	SP, IM, G	Analog monitor check pins
B	L1, L2, L3	Main-circuit power terminals
C	L1C, L2C	Control-circuit power terminals
D	B1, B2, B3	External Regeneration Resistor connection terminals
E	U, V, W	Servomotor connection terminals
F	CN2	Protective ground terminals
G	---	Display area
H	---	Rotary switches
I	COM	MECHATROLINK-II communications status LED indicator
J	CN3	RS-232 communications connector
K	CN6A, CN6B	MECHATROLINK-II communications connector
L	CN1	Control I/O connector
M	CN2	Encoder connector

LED indicators

LED	Description
COM	Lit: MECHATROLINK-II communication in progress
	Not lit: No MECHATROLINK-II communication

fig. 52
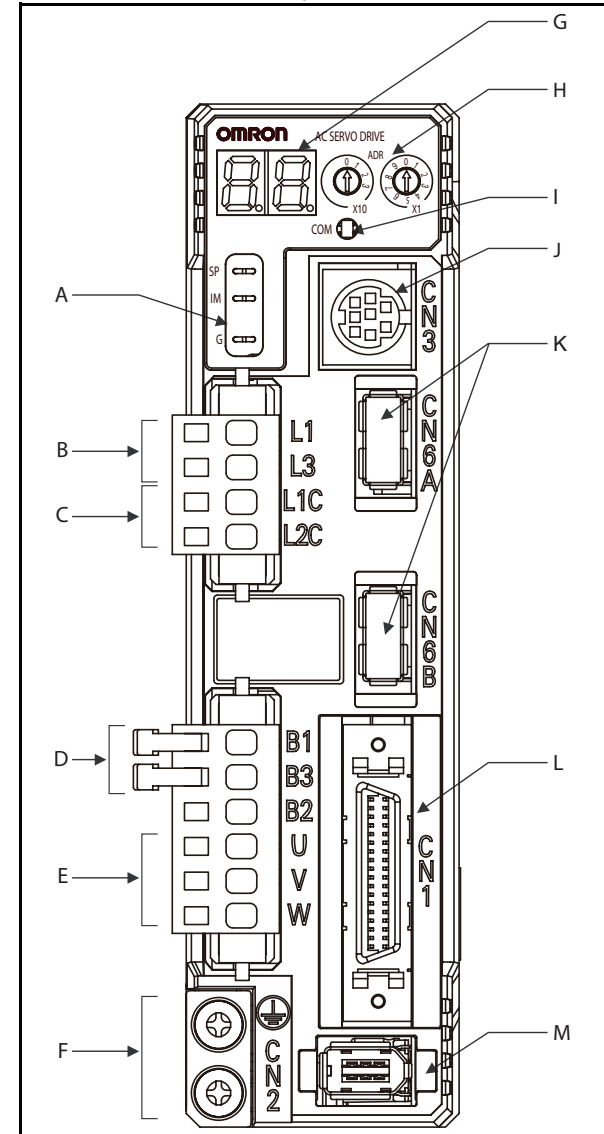
Address settings (SW1)

Set the address selector of the G-series Servo Driver to the required node address by using the X1 (right) and X10 (left) rotary switches.
The setting range for the node address setting rotary switch is 1 to 31. The actual station address used on the network will be the sum of the rotary switch setting and the offset value of 40h. These node addresses correspond to axis numbers 0 (node address = 1) to 15 (node address = 16).

Note
The node address is only loaded once when the control power supply is turned ON. Changes made after turning the power ON will not be applied until the power is turned ON next time. Do not change the rotary switch setting after turning the power ON

Note
If the rotary switch setting is not between 1 and 31, a node address setting error (alarm code 82) will occur.

fig. 53
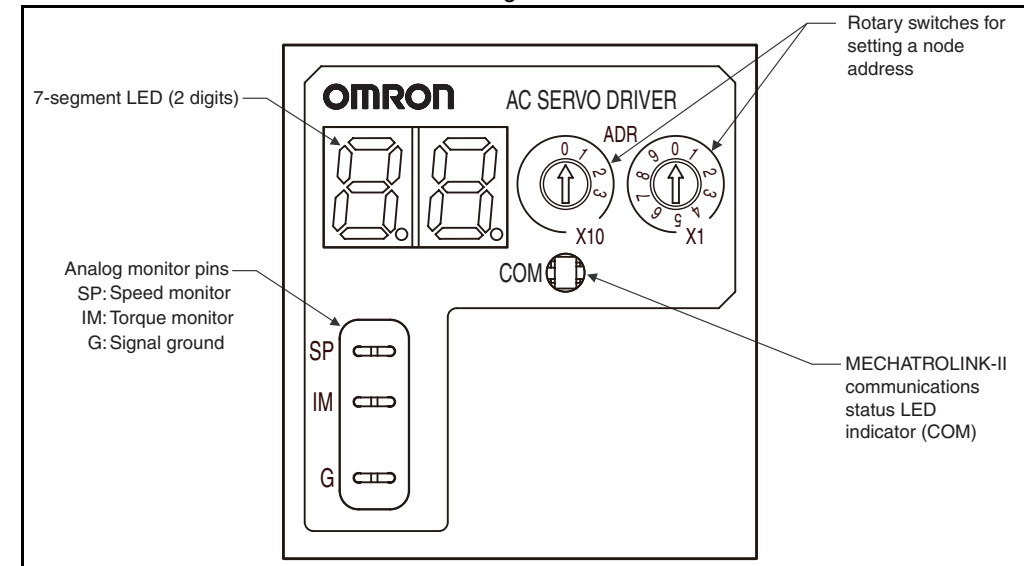
7-segment LED

The display of the 7-segment LED on the front panel is shown below.

When the power is turned ON, the node address set with the rotary switch is displayed, followed by the display content set by the Default Display (Pn001) parameter. When an alarm occurs, the alarm code will be displayed. When a warning occurs, the warning code will be displayed.

fig. 54
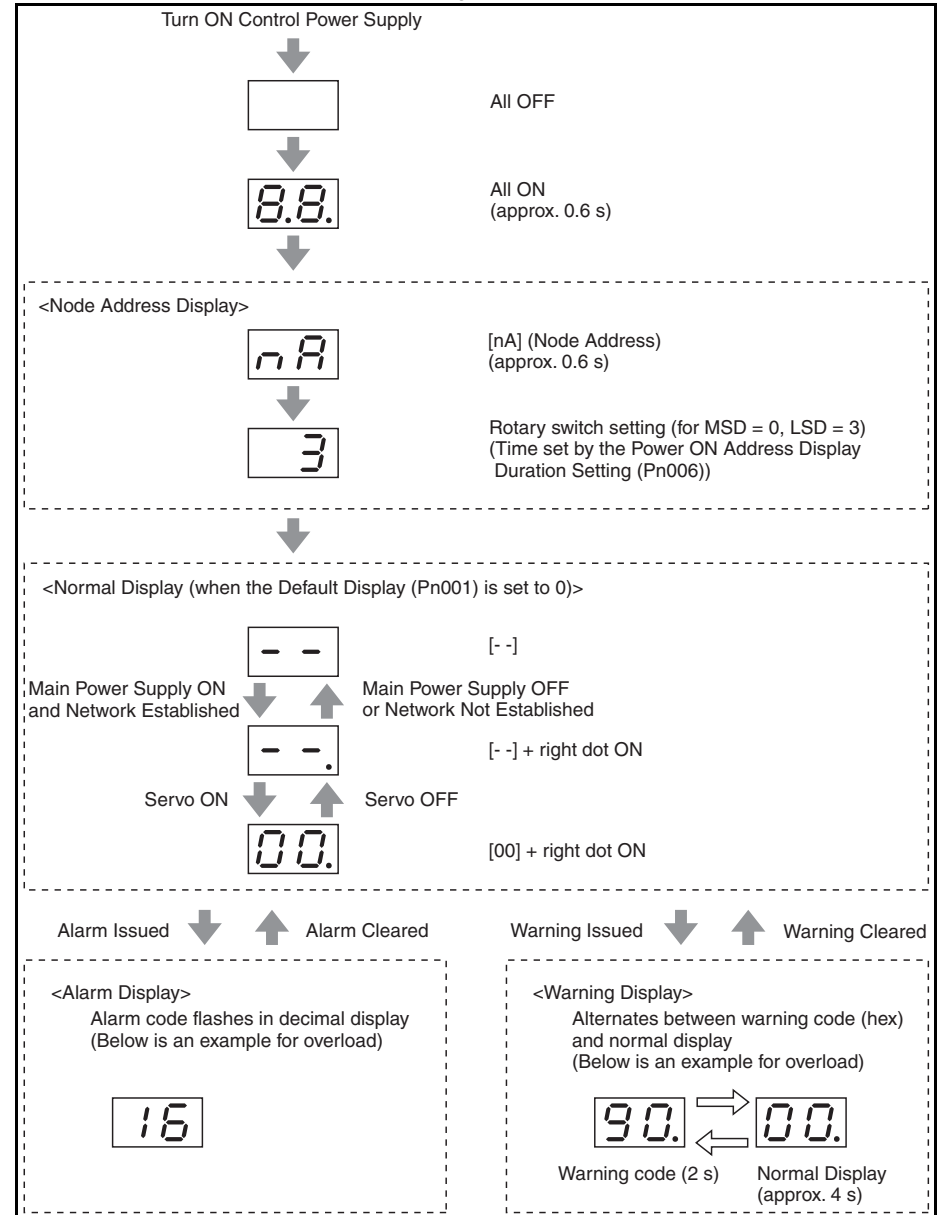
CN1 I/O Signal connector

The table below shows the pin layout for the I/O signal connector (CN1).

fig. 55

Pin	I/O	Code	Signal name
1	Input	+24VIN	12 to 24-VDC Power Supply Input
2	Input	STOP	Emergency Stop Input
3	Input	EXT3	External Latch Signal 3
4	Input	EXT2	External Latch Signal 2
5	Input	EXT1	External Latch Signal 1
6	Input	IN1	External general-purpose Input 1
7	Input	PCL	Forward Torque Limit Input
8	Input	NCL	Reverse Torque Limit Input
19 to 20	Input	POT	Forward Drive Prohibit Input
		NOT	Reverse Drive Prohibit Input
21	Input	DEC	Origin Proximity Input
22	Input	IN0	External general-purpose Input 0
23	Input	IN2	External general-purpose Input 2
11 to 14	Input	---	Spare inputs. Do not connect anything to these inputs.
9 to 10	Input	---	Spare inputs. Do not connect anything to these inputs.
27 to 28	Input	---	Spare inputs. Do not connect anything to these inputs.
34	Input	BAT	Backup Battery Input
33	Input	BATCOM	
17 to 18	Input	---	Spare inputs. Do not connect anything to these inputs.
24 to 26	Input	---	Spare inputs. Do not connect anything to these inputs.

Pin	Code	Signal	Pin	Code	Signal	Pin	Code	Signal
			1	+24VIN	12 to 24-VDC Power Supply Input	19	POT	Forward Drive Prohibit Input
2	STOP	Emergency Stop Input	3	EXT3	External Latch Signal 3	20	NOT	Reverse Drive Prohibit Input
4	EXT2	External Latch Signal 2	5	EXT1	External Latch Signal 1	21	DEC	Origin Proximity Input
6	IN1	External General-purpose Input 1	7	PCL	Forward Torque Limit Input	22	IN0	External General-purpose Input 0
8	NCL	Reverse Torque Limit Input				23	IN2	External General-purpose Input2
10		*	9		*	24		*
12		*	11		*	26		*
14		*	13		*	28		*
16	ALMCOM	Alarm Output	15	/ALM	Alarm Output	30	OUTM2COM	General-purpose Output 2
18		*	17		*	32	OUTM3COM	General-purpose Output 3
						34	BAT	Backup Battery Input
						36	OUTM1	General-purpose Output 1
						25		*
						27		*
						29	OUTM2	General-purpose Output 2
						31	OUTM3	General-purpose Output 3
						33	BATCOM	Backup Battery Input
						35	OUTM1COM	General-purpose Output1

Pin	I/O	Code	Signal name
15	Output	/ALM	Alarm Output
16	Output	ALMCOM	
29	Output	OUTM2	General-purpose Output 2 (READY)
30	Output	OUTM2COM	
31	Output	OUTM3	General-purpose Output 3 (CLIM)
32	Output	OUTM3COM	
36	Output	OUTM1	General-purpose Output 1 (BKIR)
35	Output	OUTM1COM	
Shell	---	---	FG

MECHATROLINK-II connectors (CN6A & CN6B)

Connect the G-series Servo Driver to the MECHATROLINK-II network using the CN6A and CN6B connectors. Use one of the MECHATROLINK-II connectors to connect to the previous MECHATROLINK-II device or the TJ1-ML__. Use the other MECHATROLINK-II connector to connect to the next MECHATROLINK-II device, or to connect a MECHATROLINK-II terminator.

Note
Cable length between nodes (L1, L2, ... Ln) should be 0.5 m or longer.
Total cable length should be L1 + L2 + ... + Ln = 50 m max.

fig. 56

CN2 encoder input connector
The table below shows the pin layout for the encoder connector.

Pin	Signal	Name
1	E5V	Encoder power supply +5 V
2	E0V	Encoder power supply GND
3	BAT+	Battery +
4	BAT-	Battery -
5	PS+	Encoder +phase S input
6	PS-	Encoder -phase S input
Shell	FG	Shield ground

CNA power supply connector
The table below shows the pin layout for the CNA power supply connector.

Pin	Signal	Name
1	L1	Main circuit
2	L2	power supply input
3	L3	
4	L1C	Control circuit
5	L2C	power supply input

CNB servo motor connector

The table below shows the pin layout for the CNB servo motor connector.

Pin	Signal	Name
1	B1	External Regeneration Resistor
2	B2	connection terminals
3	B3	
4	U	Servomotor
5	V	connection
6	W	terminals
7	⏚	
8	⏚	Frame ground

3.5.12 MECHATROLINK-II Servo Drivers Accurax G5

You can also connect an Accurax G5 Servo Driver to a Trajexia system.

fig. 57

Label	Terminal/LED	Description
A	---	Display area
B	CN5	Analog monitor check pins
C	L1, L2, L3	Main-circuit power terminals
D	L1C, L2C	Control-circuit power terminals
E	CHARGE	Charge lamp
F	B1, B2, B3	External Regeneration Resistor connection terminals
G	U, V, W	Servomotor connection terminals
H	---	Protective ground terminals
I	COMM	MECHATROLINK-II communications status LED indicator
J	---	Rotary switches
K	CN6A, CN6B	MECHATROLINK-II communications connector
L	CN7	USB connector
M	CN8	Connector for safety function devices
N	CN1	Control I/O connector
O	CN4	Full-closed encoder connector
P	CN2	Encoder connector
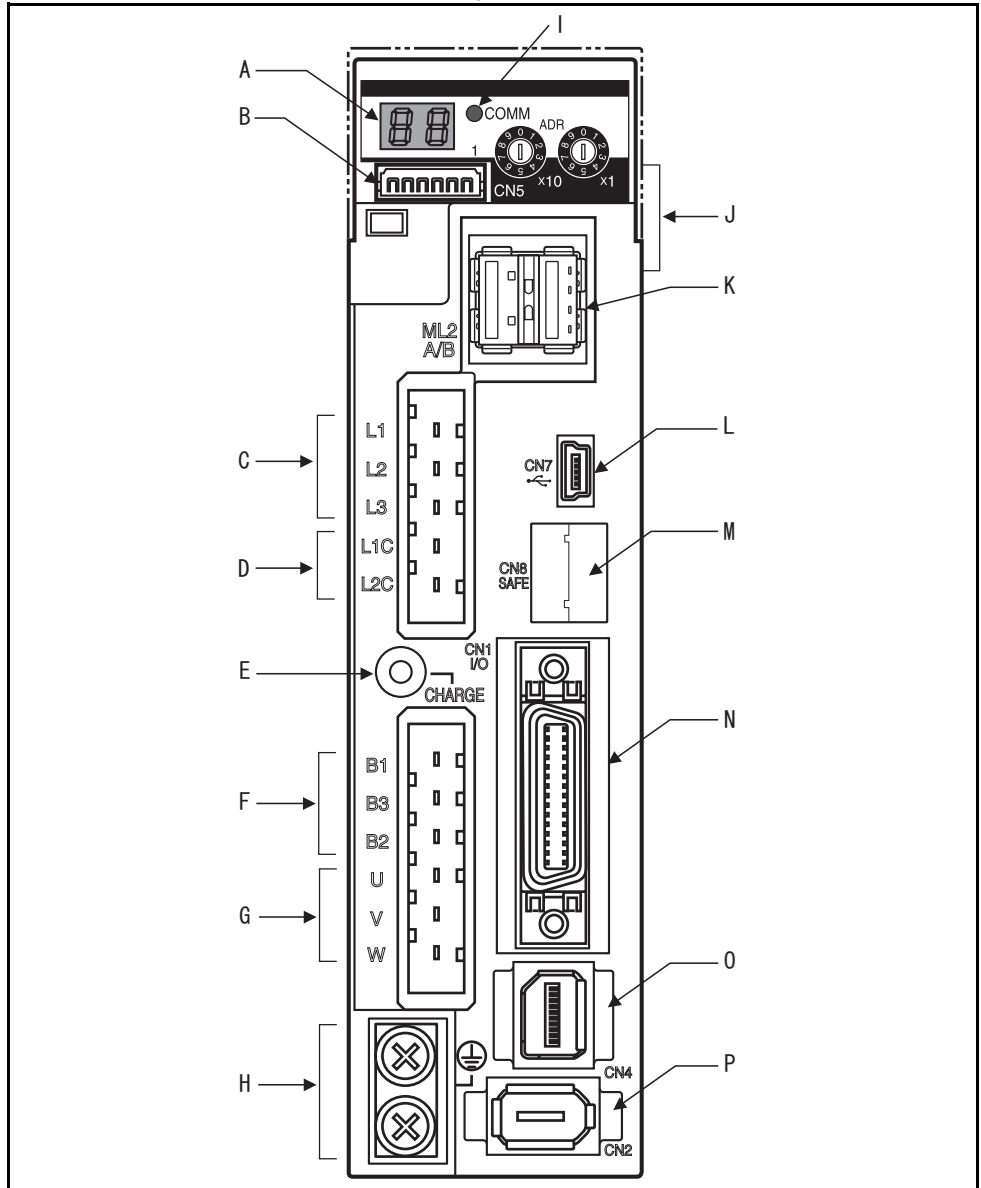
MECHATROLINK-II Communications Status LED Indicator

The table below shows the LED indication status and the corresponding conditions of the communications.

LED status	Communications status
Not lit	No communication is established.
Green Flash	Asynchronous communications is established.
Green Light	Synchronous communications is established.
Red Flash	A clearable error occurred in MECHATROLINK-II communications. • Communications error (Err83.0) • Transmission cycle error (Err84.0) • SSYNC_SET error (Err84.4) • Watchdog data error (Err86.0) • Transmission cycle setting error (Err90.0) • CONNECT error (Err90.1) • SYNC command error (Err91.0)
Red Light	A non-clearable error occurred in MECHATROLINK-II communications. • Node address setting error (Err82.0) • SYNC process error (Err84.3)

Note
If any of communication related error occurs while an error that is not related to MECHATROLINK-II communications happens, the MECHATROLINK-II Communications Status LED Indicator follows the corresponding communications status as shown above.

Address settings (SW1)

Set the address selector of the Accurax G5 Servo Driver to the required node address by using the X1 (right) and X10 (left) rotary switches. The setting range for the node address setting rotary switch is 1 to 31. The actual station address used on the network will be the sum of the rotary switch setting and the offset value of 40h. These node addresses correspond to axis numbers 0 (node address = 1) to 15 (node address = 16).

> **Note**
> The node address set by the rotary switch is read only once when the control power is turned on. Any changes made by the rotary switches after the power-on are not reflected to the Controller. Such changes become effective only after the subsequent power-on following to a power-off. Do not change the rotary switch setting after the power-on.

> **Note**
> The settable range for a node address is between 1 and 31. The node address used over the network is the value obtained by adding the offset 40h to the rotary switch set value. If any value over or under the range is set, the Node address setting error (Err82.0) occurs.

fig. 58
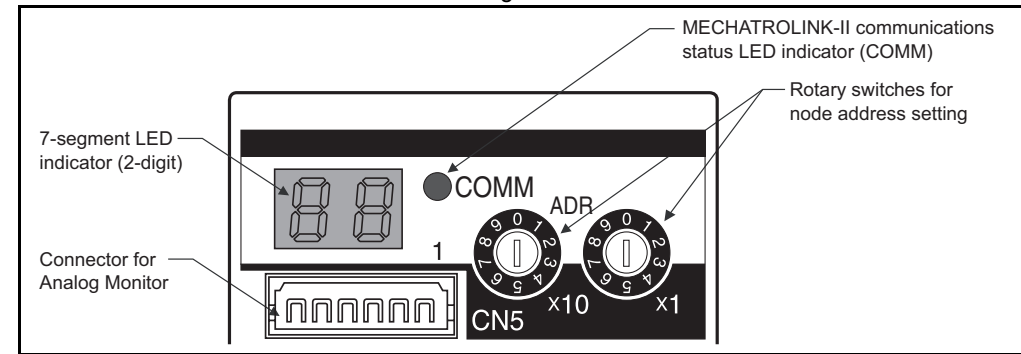
7-segment LED

The 7-segment LED indicator is on the front panel.

When the power is turned on, it shows the node address that is set by the rotary switches. Then the indication changes in accordance with the setting on the Default Display (Pn700). If any alarming error occurs, it indicates the error number (Errxxx) as the alarm code. If any warning situation occurs, it indicates the warning number as the warning code.

fig. 59

Turn ON Control Power Supply

All OFF

8.8. All ON
(approx. 0.6 s)

<Node Address Display>

nA [nA] (Node Address)
(approx. 0.6 s)

3 Rotary switch setting (for MSD = 0, LSD = 3)
(Time set by the Power ON Address Display
Duration Setting (Pn006))

<Normal Display (when the Default Display (Pn001) is set to 0)>

– – [- -]

Main Power Supply ON
and Network Established   Main Power Supply OFF
or Network Not Established

– –. [- -] + right dot ON

Servo ON   Servo OFF

00. [00] + right dot ON

Alarm Issued   Alarm Cleared   Warning Issued   Warning Cleared

<Alarm Display>
Alarm code flashes in decimal display
(Below is an example for overload)

16

<Warning Display>
Alternates between warning code (hex)
and normal display
(Below is an example for overload)

90. ⇄ **00.**

Warning code (2 s)   Normal Display
(approx. 4 s)

CN1 I/O Signal connector

The table below shows the pin layout for the I/O signal connector (CN1).

Pin	I/O	Code	Signal name
6	Input	+24 VIN	12 to 24-VDC Power Supply Input
5	Input	IN1	General-purpose Input 1
7	Input	IN2	General-purpose Input 2
8	Input	IN3	General-purpose Input 3
9	Input	IN4	General-purpose Input 4
10	Input	IN5	General-purpose Input 5
11	Input	IN6	General-purpose Input 6
12	Input	IN7	General-purpose Input 7
13	Input	IN8	General-purpose Input 8
3	Output	/ALM	Alarm output
4	Output	ALMCOM	
1	Output	OUTM1	General-purpose Output 1
2	Output	OUTM1COM	
25	Output	OUTM2	General-purpose Output 2
26	Output	OUTM2COM	
14	---	BAT	Backup Battery Input
15	---	BATGND	
16	---	GND	Signal ground
17 to 24	Input	---	Spare inputs. Do not connect anything to these inputs.
Shell	---	---	FG

fig. 60

Pin	Code	Signal	Pin	Code	Signal	Pin	Code	Signal
1	OUTM1	General-purpose Output 1	14	BAT	Absolute encoder backup battery input	15	BATGND	Absolute encoder backup battery input
2	OUTM1COM	General-purpose Output 1 Common	16	GND	Signal Ground	17		*
3	/ALM	Alarm Output	18		*	19		*
4	ALMCOM	Alarm Output Common	20		*	21		*
5	IN1	General-purpose Input 1	22		*	23		*
6	+24 VIN	12 to 24-VDC power supply input	24		*	25	OUTM2	General-purpose Output 2
7	IN2	General-purpose Input 2	26	OUTM2COM	General-purpose Output 2 Common			
8	IN3	General-purpose Input 3						
9	IN4	General-purpose Input 4						
10	IN5	General-purpose Input 5						
11	IN6	General-purpose Input 6						
12	IN7	General-purpose Input 7						
13	IN8	General-purpose Input 8						

MECHATROLINK-II connectors (CN6A & CN6B)

Connect the G-series Servo Driver to the MECHATROLINK-II network using the CN6A and CN6B connectors. Use one of the MECHATROLINK-II connectors to connect to the previous MECHATROLINK-II device or the TJ1-ML__. Use the other MECHATROLINK-II connector to connect to the next MECHATROLINK-II device, or to connect a MECHATROLINK-II terminator.

Note

Cable length between nodes (L1, L2, ... Ln) should be 0.5 m or longer.

Total cable length should be L1 + L2 + ... + Ln = 50 m max.

fig. 61

CN2 Encoder input connector

The table below shows the pin layout for the encoder connector.

Pin	Signal	Name
1	E5V	Encoder power supply +5 V
2	E0V	Encoder power supply GND
3	BAT+	Battery +
4	BAT-	Battery -
5	PS+	Encoder +phase S input
6	PS-	Encoder -phase S input
Shell	FG	Shield ground

CN4 External encoder connector

The table below shows the pin layout for the external encoder connector.

Pin	Signal	Name
1	E5V	Encoder power supply +5 V
2	E0V	Encoder power supply GND
3	PS+	Encoder +phase S input
4	PS-	Encoder -phase S input
5	EXA+	Encoder +phase A input
6	EXA-	Encoder -phase A input
7	EXB+	Encoder +phase B input
8	EXB-	Encoder -phase B input
9	EXZ+	Encoder +phase Z input
10	EXZ-	Encoder -phase Z input
Shell	FG	Shield ground

CN5 Monitor connector

The table below shows the pin layout for the CN5 monitor connector.

Pin	Signal	Name
1	AM1	Analog monitor output 1
2	AM2	Analog monitor output 2
3	GND	Analog monitor ground
4	---	Reserved: do not connect.
5	---	Reserved: do not connect.
6	---	Reserved: do not connect.

CN7 USB Connector

The table below shows the pin layout for the CN7 USB connector.

Pin	Signal	Name
1	VBUS	
2	D+	USB signal terminal
3	D-	
4	---	Reserved: do not connect.
5	SENGND	Signal ground

CN8 Safety connector

The table below shows the pin layout for the CN8 safety connector.

Pin	Signal	Name
1	---	Reserved: do not connect.
2	---	Reserved: do not connect.
3	SF1-	Safety input 1
4	SF1+	
5	SF2-	Safety input 2
6	SF2+	
7	EDM-	EDM output
8	EDM+	

Pin	Signal	Name
Shell	FG	Shield ground

CNA Power supply connector

The table below shows the pin layout for the CNA power supply connector.

Pin	Signal	Name
1	L1	Main circuit
2	L2	power supply input
3	L3	
4	L1C	Control circuit
5	L2C	power supply input

CNB Servo motor connector

The table below shows the pin layout for the CNB servo motor connector.

Pin	Signal	Name
1	B1	External Regeneration Resistor
2	B2	connection terminals
3	B3	
4	U	Servomotor
5	V	connection
6	W	terminals
7	⏚	
8	⏚	Frame ground

Related BASIC commands

The following BASIC commands are related to the MECHATROLINK-II
Servo Drivers Accurax G5:

- **ATYPE**
- **AXIS**
- **AXIS_ENABLE**
- **AXISSTATUS**
- **DRIVE_ALARM**

- **DRIVE_CLEAR**
- **DRIVE_CONTROL**
- **DRIVE_INPUTS**
- **DRIVE_MONITOR**
- **DRIVE_READ**
- **DRIVE_RESET**
- **DRIVE_STATUS**
- **DRIVE_WRITE**

For more information, refer to the Trajexia Programming Manual.

3.5.13 MECHATROLINK-II Inverter V7

A V7 Inverter with a MECHATROLINK-II interface is designed to make speed and torque control (if the Inverter supports this feature) of an AC induction motor. No position control is supported via MECHATROLINK-II.

By default an Inverter is not considered an axis by the TJ1-MC__. To control an Inverter as a servo axis, this axis must be defined with function 8 of the command **INVERTER_COMMAND**. Refer to section 2.7.4 for more information.

The illustration shows the external appearance of the SI-T/V7 Unit.
A.   LED
B.   Modular plug (CN10)
C.   Optional connector (CN1)
D.   Communications connector (CN2)
E.   Dipswitch
F.   Rotary switch
G.   Ground terminal
H.   Communications connector (CN2)

fig. 62
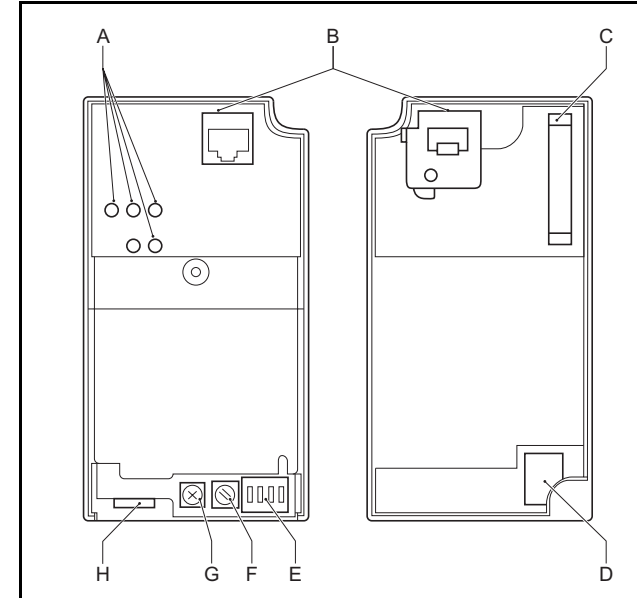
LED indicators

The LED indicators indicate the status of the communications of the
MECHATROLINK-II and the SI-T/V7 Unit.

A. Run
B. TX
C. RX
D. ERR

fig. 63

Name	Display		Explanation
	Color	**Status**	
RUN	Green	Lit	Normal operation
	-	Not lit	Communications CPU stopped, resetting hardware, RAM check error, DPRAM check error, station address setting error or Inverter model code error
ERR	Red	Lit	Watchdog timeout error, communications error or reset-ting hardware
	Red	Flashing	ROM check error (once)*, RAM check error (twice)*, DPRAM check error (3 times)*, communications ASIC self-diagnosis error (4 times)*, ASIC RAM check error (5 times)*, station address setting error (6 times)*, Inverter model code error (7 times)* *: indicates the number of flashes
	-	Not lit	No communication error or self-diagnosis error
TX	Green	Lit	Sending data
	-	Not lit	Sending of data stopped, hardware reset
RX	Green	Lit	Searching for receiving carrier
	-	Not lit	No receiving carrier found, hardware reset

Dipswitch
The following table shows the dipswitch settings of the SI-T/V7 Unit.

Name	Label	Status	Function
Baud rate	S1-1	on	10 Mbps (MECHATROLINK-II)
Data length	S1-2	on	32-byte data transmission (MECHATROLINK-II)
Station address	S1-3	off	Set the 10th digit of the station number to 2. Invalid if the maximum number of units including the S2 of the rotary switch is 20.
		on	Set the 10th digit of the station number to 3. Invalid if the maximum number of units including the S2 of the rotary switch is 3F.
Maintenance	S1-4	off	Normally off[1]
		on	Not used

1. For maintenance. Always leave this switch off.

fig. 64

Rotary switch
The following table shows the rotary switch settings of the SI-T/V7 Unit.

Label	Status	Function	Factory setting
S2	0 to F	Set the 1st digit of the station number. Invalid if the maximum number of units including the S1-3 is 20 or 3F.	1

fig. 65

S1-3	S2	Station number	S1-3	S2	Station number
off	0	Fault	on	0	30
off	1	21	on	1	31
off	2	22	on	2	32
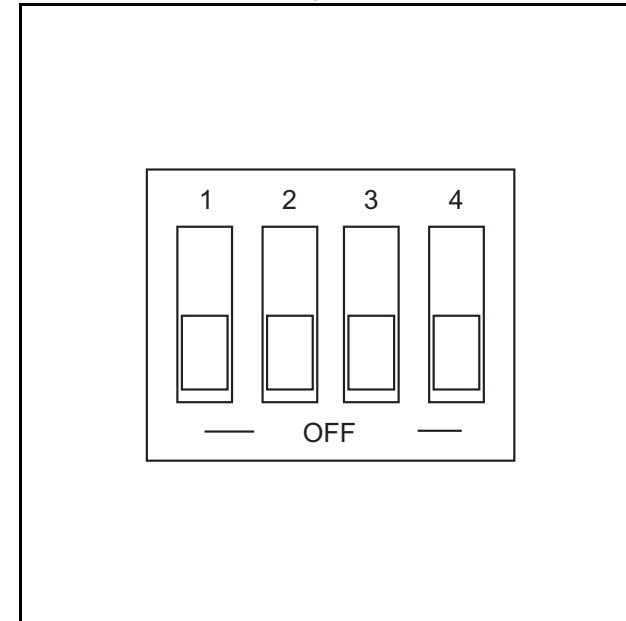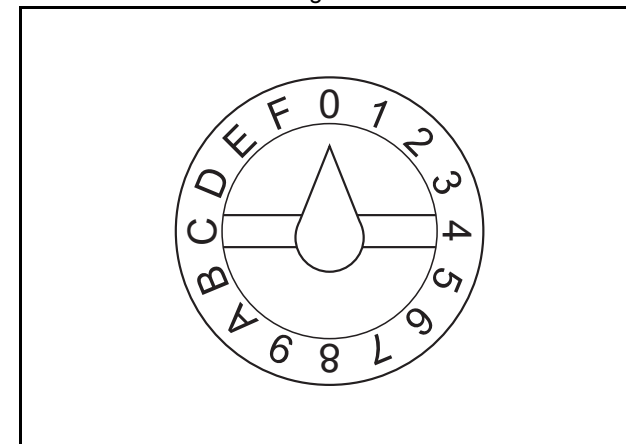
S1-3	S2	Station number	S1-3	S2	Station number
off	3	23	on	3	33
off	4	24	on	4	34
off	5	25	on	5	35
off	6	26	on	6	36
off	7	27	on	7	37
off	8	28	on	8	38
off	9	29	on	9	39
off	A	2A	on	A	3A
off	B	2B	on	B	3B
off	C	2C	on	C	3C
off	D	2D	on	D	3D
off	E	2E	on	E	3E
off	F	2F	on	F	Fault

To use the V7 Inverter with the MECHATROLINK-II interface it is necessary
to make the following settings in the Inverter:
• N3=3 Sequence via MECHATROLINK-II
• N4=9 Reference via MECHATROLINK-II

Check the manual for details about the V7 Inverter.

Related BASIC commands
The following BASIC commands are related to the MECHATROLINK-II
Inverters V7 series:
• **ATYPE (ATYPE=49)**
• **INVERTER_COMMAND**
• **INVERTER_READ**
• **INVERTER_WRITE**

For more information, refer to the Trajexia Programming Manual.

3.5.14 MECHATROLINK-II Inverter F7 and G7

The F7 and G7 Inverters with a MECHATROLINK-II interface are designed to make speed and torque control (if the Inverter supports this feature) of an AC induction motor. No position control is supported via MECHATROLINK-II.

By default an Inverter is not considered an axis by the TJ1-MC__. To control an Inverter as a servo axis, this axis must be defined with function 8 of the command **INVERTER_COMMAND**. Refer to section 2.7.4 for more information

The illustration shows the installation of the SI-T card.
A. SI-T Card
B. Control terminal
C. 3CN: Option D connector
D. Option CN (To secure option C or D)
E. 2CN: Option C connector
F. 4CN: Option A connector

fig. 66
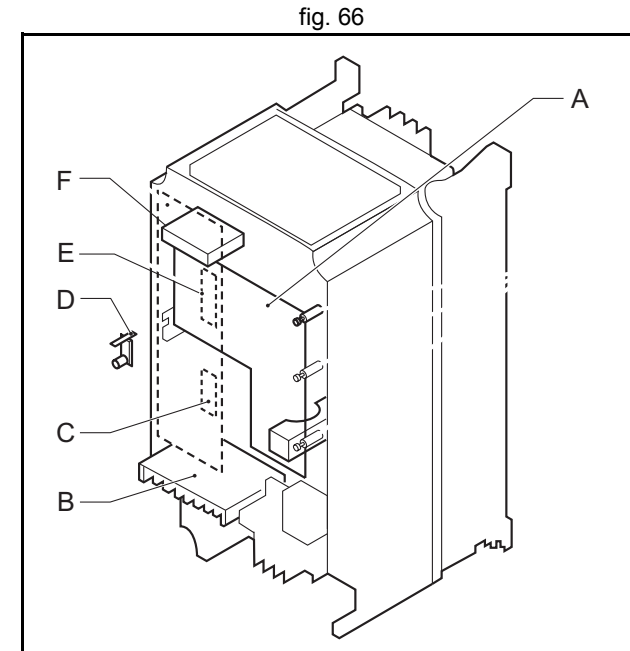
The illustration shows the external appearance of the SI-T Card.
A. LED
B. Rotary switch
C. Dipswitch
D. Communications connector
E. Code No.
F. Type

fig. 67
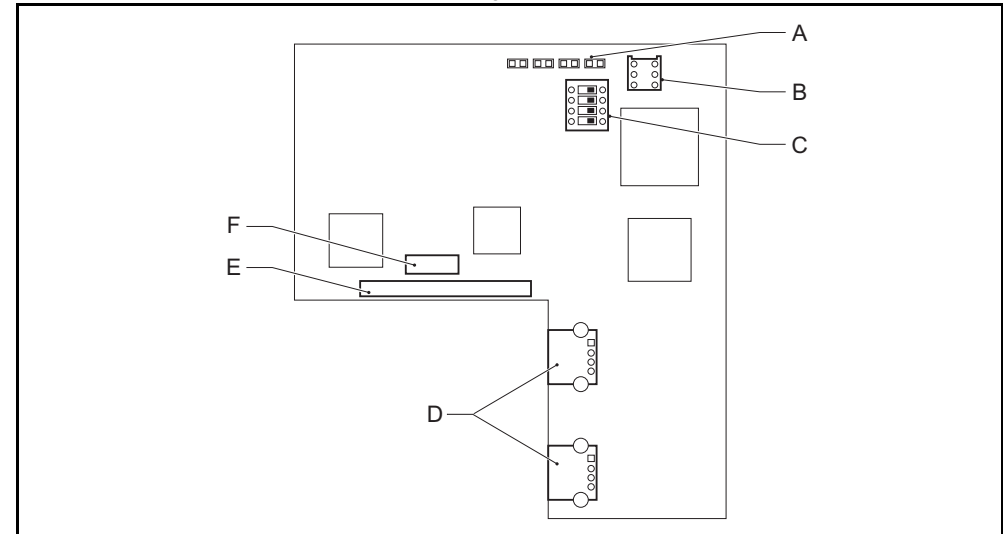
LED indicators
The LED indicators indicate the status of the communications of the
MECHATROLINK-II and the SI-T Card.

Name	Display		Explanation
	Color	**Status**	
RUN	Green	Lit	Normal operation
	-	Not lit	Communication CPU stopped, resetting hardware, RAM check error, DPRAM check error, station address setting error or Inverter model code error

Name	Display		Explanation
	Color	Status	
ERR	Red	Lit	Watchdog timeout error, communication error, diagnosis error or resetting hardware
	Red	Flashing	ROM check error (once)*, RAM check error (twice)*, DPRAM check error (3 times)*, communications ASIC self-diagnosis error (4 times)*, ASIC RAM check error (5 times)*, station address setting error (6 times)*, Inverter model code error (7 times)* *: indicates the number of flashes
	-	Not lit	No communication error or self-diagnosis error
TX	Green	Lit	Sending data
	-	Not lit	Sending of data stopped, hardware reset
RX	Green	Lit	Searching for receiving carrier
	-	Not lit	No receiving carrier found, hardware reset

Dipswitch

The following table shows the dipswitch settings of the SI-T/V7 Unit.

fig. 68

Name	Label	Status	Function
Baud rate	S1-1	on	10 Mbps (MECHATROLINK-II)
Data length	S1-2	on	32-byte data transmission (MECHATROLINK-II)
Station address	S1-3	off	Set the 10th digit of the station number to 2. Invalid if the maximum number of units including the S2 of the rotary switch is 20.
		on	Set the 10th digit of the station number to 3. Invalid if the maximum number of units including the S2 of the rotary switch is 3F.
Maintenance	S1-4	off	Normally off[1]
		on	Not used

1. For maintenance. Always leave this switch off.

Rotary switch

The following table shows the rotary switch settings of the SI-T/V7 Unit.

fig. 69

Label	Status	Function	Factory setting
S2	0 to F	Set the 1st digit of the station number X0H-XFH. Invalid if the maximum number of units including the S1-3 is 20 or 3F.	1

Switch Setting and Station Number:

S1-3	S2	Station number	S1-3	S2	Station number
off	0	Fault	on	0	30
off	1	21	on	1	31
off	2	22	on	2	32
off	3	23	on	3	33
off	4	24	on	4	34
off	5	25	on	5	35
off	6	26	on	6	36
off	7	27	on	7	37
off	8	28	on	8	38
off	9	29	on	9	39
off	A	2A	on	A	3A
off	B	2B	on	B	3B
off	C	2C	on	C	3C
off	D	2D	on	D	3D
off	E	2E	on	E	3E
off	F	2F	on	F	Fault

To use the F7 or G7 Inverter with the MECHATROLINK-II interface it is
necessary to make the following settings in the Inverter:
- B1-01=3 Sequence via MECHATROLINK-II
- B1-02=3 Reference via MECHATROLINK-II

Check the corresponding manual for details about the F7 or G7 Inverter.

Related BASIC commands
The following BASIC commands are related to the MECHATROLINK-II
Inverters F7 and G7 series:
- **ATYPE (ATYPE=49)**
- **INVERTER_COMMAND**
- **INVERTER_READ**
- **INVERTER_WRITE**

For more information, refer to the Trajexia Programming Manual.

3.5.15 MECHATROLINK-II digital I/O slaves

An I/O device allows to integrate in the system remote digital and analogue
inputs and outputs. Those are autodetected and automatically allocated by
the Trajexia system.

Digital I/O module: JEPMC IO2310/IO2330
This is a 64 channel Digital Input and 64 channel Digital Output
MECHATROLINK-II slave unit. The digital inputs and outputs are
automatically allocated by the Trajexia system according to the unit number
and can be read and set by Trajexia starting from IN(32) and OP(32).
Trajexia Inputs and outputs are automatically mapped starting from IN(32)
and OP(32), according to the MECHATROLINK-II node number. In the case
of existing several IO2310 units, the unit with lowest node number
corresponds to IN(32) to IN(95) and OP(32) to OP(95), the next lower to
IN(156) to IN(219) and OP(156) to OP(219).
The value is refreshed every servo period.
A. Input signal connector 1
B. Output signal connector 1
C. Input signal connector 2

fig. 70
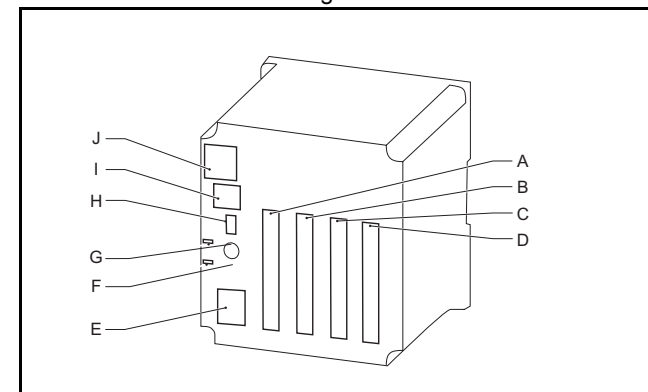
D. Output signal connector 2
E. Power supply terminals
F. I/O indicator switch
G. Station number switch
H. Dipswitch for setting
I. MECHATROLINK-II connector
J. I/O indicators

Connector description

I/O and Status Indicators:

Indicator Name	Indicator Color	Meaning when lit
R	Yellow	Not used, stays lit
ACTIVE	Yellow	Sending data through MECHATROLINK-II
F	Red	Blown fuse
1 to 32	Yellow	Input signal and output signal monitors. The meaning of these indicators depends on the I/O indicator switch setting.

Indicator switch:
Selects which 32 I/O points are monitored by the I/O indicators.
*   IN1: Input signals 1 to 32
*   IN2: Input signals 33 to 64
*   OUT1: Output signals 1 to 32
*   OUT2: Output signals 33 to 64

MECHATROLINK-II Connector:
Connects through a MECHATROLINK-II cable.

fig. 71
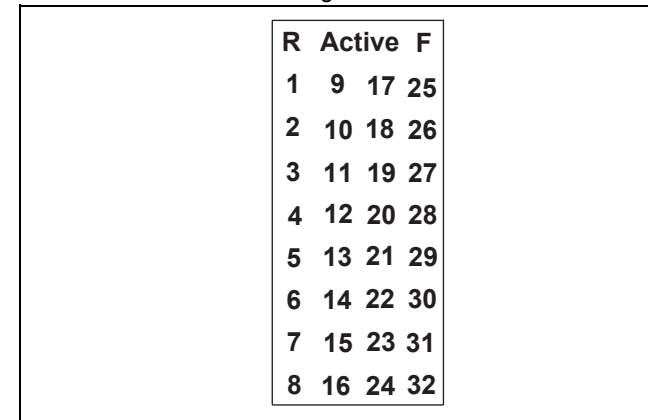
fig. 72
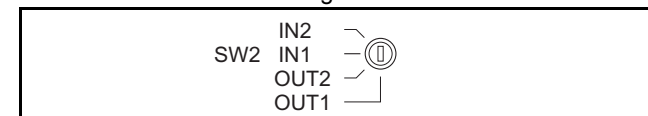
fig. 73
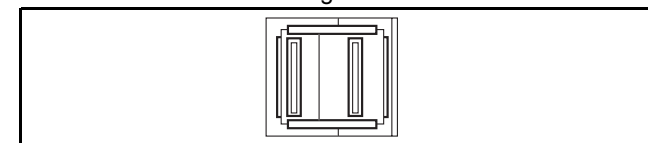
I/O Signal connector:
Connect the I/O Unit with external I/O signals through the I/O Cable.
Number of I/O points: 64 inputs and 64 outputs

fig. 74
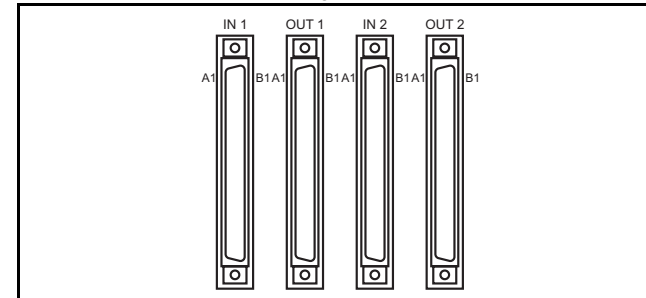
Digital I/O layout
The pin layout of the I/O connectors is the same for the IO2310, and IO2330 modules. The following table shows the pin layout of the IN1 connector.

No.	Signal name	Remarks	No.	Signal name	Remarks
A1	(NC)		B1	(NC)	
A2	+24V_2	24-V power supply 2	B2	+24V_2	24-V power supply 2
A3	IN32	Input 32	B3	IN31	Input 31
A4	IN30	Input 30	B4	IN29	Input 29
A5	IN28	Input 28	B5	IN27	Input 27
A6	IN26	Input 26	B6	IN25	Input 25
A7	IN24	Input 24	B7	IN23	Input 23
A8	IN22	Input 22	B8	IN21	Input 21
A9	IN20	Input 20	B9	IN19	Input 19
A10	IN18	Input 18	B10	IN17	Input 17
A11	IN16	Input 16	B11	IN15	Input 15
A12	IN14	Input 14	B12	IN13	Input 13
A13	IN12	Input 12	B13	IN11	Input 11
A14	IN10	Input 10	B14	IN09	Input 9
A15	IN08	Input 8	B15	IN07	Input 7
A16	IN06	Input 6	B16	IN05	Input 5
A17	IN04	Input 4	B17	IN03	Input 3
A18	IN02	Input 2	B18	IN01	Input 1
A19	(NC)		B19	(NC)	
A20	+24V_1	24-V power supply 1	B20	+24V_1	24-V power supply 1

Note: The +24V_1 is used for IN01 to IN16; +24V_2 is used for IN17 to IN32.

The following table shows the pin layout of the IN2 connector.

No.	Signal name	Remarks	No.	Signal name	Remarks
A1	(NC)		B1	(NC)	
A2	+24V_4	24-V power supply 4	B2	+24V_4	24-V power supply 4
A3	IN64	Input 64	B3	IN63	Input 63
A4	IN62	Input 62	B4	IN61	Input 61
A5	IN60	Input 60	B5	IN59	Input 59
A6	IN58	Input 58	B6	IN57	Input 57
A7	IN56	Input 56	B7	IN55	Input 55
A8	IN54	Input 54	B8	IN53	Input 53
A9	IN52	Input 52	B9	IN51	Input 51
A10	IN50	Input 50	B10	IN49	Input 49
A11	IN48	Input 48	B11	IN47	Input 47
A12	IN46	Input 46	B12	IN45	Input 45
A13	IN44	Input 44	B13	IN43	Input 43
A14	IN42	Input 42	B14	IN41	Input 41
A15	IN40	Input 40	B15	IN39	Input 39
A16	IN38	Input 38	B16	IN37	Input 37
A17	IN36	Input 36	B17	IN35	Input 35
A18	IN34	Input 34	B18	IN33	Input 33
A19	(NC)		B19	(NC)	
A20	+24V_3	24-V power supply 3	B20	+24V_3	24-V power supply 3

Note: The +24V_3 is used for IN33 to IN48; +24V_4 is used for IN49 to IN64.

Revision 5.0

The following table shows the pin layout of the OUT1 connector.

No.	Signal name	Remarks	No.	Signal name	Remarks
A1	024V_6	Common ground 6	B1	024V_6	Common ground 6
A2	+24V_6	24-V power supply 6	B2	+24V_6	24-V power supply 6
A3	OUT32	Output 32	B3	OUT31	Output 31
A4	OUT30	Output 30	B4	OUT29	Output 29
A5	OUT28	Output 28	B5	OUT27	Output 27
A6	OUT26	Output 26	B6	OUT25	Output 25
A7	OUT24	Output 24	B7	OUT23	Output 23
A8	OUT22	Output 22	B8	OUT21	Output 21
A9	OUT20	Output 20	B9	OUT19	Output 19
A10	OUT18	Output 18	B10	OUT17	Output 17
A11	OUT16	Output 16	B11	OUT15	Output 15
A12	OUT14	Output 14	B12	OUT13	Output 13
A13	OUT12	Output 12	B13	OUT11	Output 11
A14	OUT10	Output 10	B14	OUT09	Output 9
A15	OUT08	Output 8	B15	OUT07	Output 7
A16	OUT06	Output 6	B16	OUT05	Output 5
A17	OUT04	Output 4	B17	OUT03	Output 3
A18	OUT02	Output 2	B18	OUT01	Output 1
A19	024V_5	Common ground 5	B19	024V_5	Common ground 5
A20	+24V_5	24-V power supply 5	B20	+24V_5	24-V power supply 5

Note: The +24V_5 and 024V_5 are used for OUT01 to OUT16;
+24V_5 and 024V_6 are used for OUT17 to OUT32.

The following table shows the pin layout of the OUT2 connector.

No.	Signal name	Remarks	No.	Signal name	Remarks
A1	024V_8	Common ground 8	B1	024V_8	Common ground 8
A2	+24V_8	24-V power supply 8	B2	+24V_8	24-V power supply 8
A3	OUT64	Output 64	B3	OUT63	Output 63
A4	OUT62	Output 62	B4	OUT61	Output 61
A5	OUT60	Output 60	B5	OUT59	Output 59
A6	OUT58	Output 58	B6	OUT57	Output 57
A7	OUT56	Output 56	B7	OUT55	Output 55
A8	OUT54	Output 54	B8	OUT53	Output 53
A9	OUT52	Output 52	B9	OUT51	Output 51
A10	OUT50	Output 50	B10	OUT49	Output 49
A11	OUT48	Output 48	B11	OUT47	Output 47
A12	OUT46	Output 46	B12	OUT45	Output 45
A13	OUT44	Output 44	B13	OUT43	Output 43
A14	OUT42	Output 42	B14	OUT41	Output 41
A15	OUT40	Output 40	B15	OUT39	Output 39
A16	OUT38	Output 38	B16	OUT37	Output 37
A17	OUT36	Output 36	B17	OUT35	Output 35
A18	OUT34	Output 34	B18	OUT33	Output 33
A19	024V_7	Common ground 7	B19	024V_7	Common ground 7
A20	+24V_7	24-V power supply 7	B20	+24V_7	24-V power supply 7

Note: The +24V_7 and 024V_7 are used for OUT33 to OUT48;
+24V_8 and 024V_8 are used for OUT49 to OUT64

I/O Cable:
The following table shows the standard I/O cable models. The standard cable is used for both IO2310 and IO2330 modules.

Name	Model	Length (m)
I/O Cable	JEPMC-W5410-05	0.5
	JEPMC-W5410-10	1
	JEPMC-W5410-30	3

fig. 75

Station number and dipswitch settings
Station Number switch sets the station number of the module in the MECHATROLINK-II system. The range is 0 to F.
Use a unique station number for each unit if two or more units are connected.

fig. 76

Dipswitch settings:
The dipswitch sets the communication parameters.

fig. 77

Display (Switch no.)	Name	Status	Function
-	Reserved by system	-	Be sure to turn it off
3	MECHATROLINK-II upperplace address setting	on	7xh
		off	6xh
2	I/O byte setting	on	32-byte mode
1	Baud rate setting	on	10 Mbps

The data in the parentheses indicate the MECHATROLINK-II addresses.
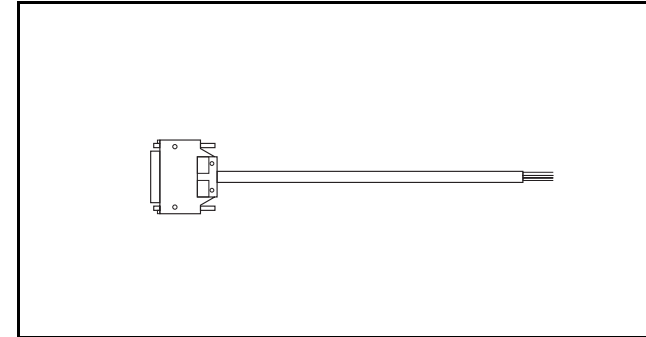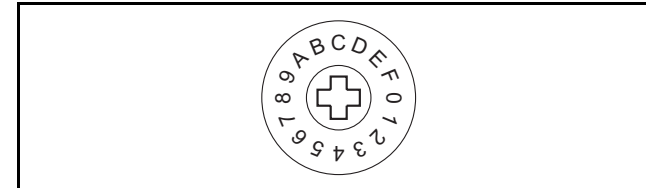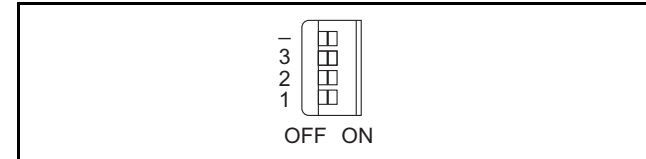
Station Address	Dipswitch 3	Station number switch	Station Address	Dipswitch 3	Station number switch
1(61h)	off	1	16(70h)	on	0
2(62h)	off	2	17(71h)	on	1
3(63h)	off	3	18(72h)	on	2
4(64h)	off	4	19(73h)	on	3
5(65h)	off	5	20(74h)	on	4
6(66h)	off	6	21(75h)	on	5
7(67h)	off	7	22(76h)	on	6
8(68h)	off	8	23(77h)	on	7
9(69h)	off	9	24(78h)	on	8
10(6Ah)	off	A	25(79h)	on	9
11(6Bh)	off	B	26(7Ah)	on	A
12(6Ch)	off	C	27(7Bh)	on	B
13(6Dh)	off	D	28(7Ch)	on	C
14(6Eh)	off	E	29(7Dh)	on	D
15(6Fh)	off	F	Not used	on	E, F

Power supply input
The external wiring terminal supplies 24 VDC to the I/O module.

Terminal name	Function
DC24V	+24 VDC
DC0V	0 VDC
FG	Protective ground terminal

fig. 78
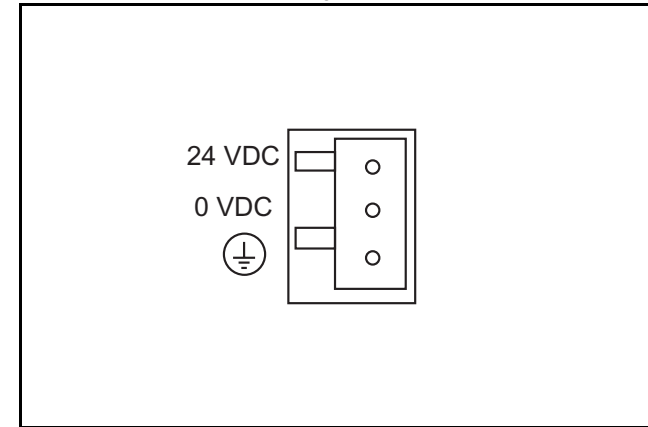
Specification

Input circuit:
The input circuit specifications are shown below. The input circuit is used both for IO2310, and IO2330 modules.

Item	Specifications
Number of input points	64 points (32 points x 2)
Input type	Sinking or sourcing
Isolation method	Photocoupler
Input voltage	24 VDC (20.4 to 28.8 VDC)
Input current	5 mA/point
on voltage/current	9V min./1.6 mA min.
off voltage/current	7V max./1.3 mA max.
on time / off time	on time: 2ms, off time: 3 ms
Output points per common	16 points per common (1 to 16, 17 to 32, 33 to 48, 49 to 64)

fig. 79

Input Circuit

Revision 5.0
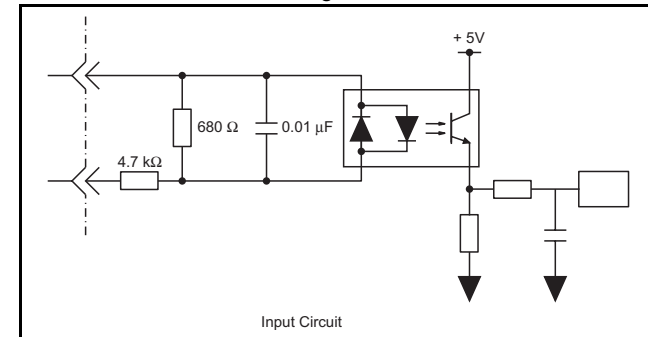
Output circuit:
The output specifications are shown below.

Item	Specifications	
Module	IO2310	IO2330
Number of output points	64 points (32 point x 2)	
Output type	Transistor, open collector or sinking	Transistor, open collector or sourcing
Isolation method	Photocoupler	
Output voltage	24 VDC (20.4 to 28.8 VDC)	
Output current	50 mA/point	
Leakage current when off	0.1 mA max.	
on time / off time	on time: 2 ms max., off time: 4 ms max.	
Output points per common	16 points per common (1 to 16, 17 to 32, 33 to 48, 49 to 64)	
Fuses	A fuse for each common point to prevent fire caused by the output short-circuit	
Error detection	Blown fuse detection	

General specifications:

Item	Specifications
Name	64-point I/O Module
Model description	IO2310/IO2330
Model number	JEPMC-IO2310/JEPMC-IO2330
External power supply	24 VDC (20.4 to 28. 8VDC)
Rated current	0.5 A
Inrush current	1A
Dimensions (mm)	120 x 130 x 105 (W x H x D)

fig. 80
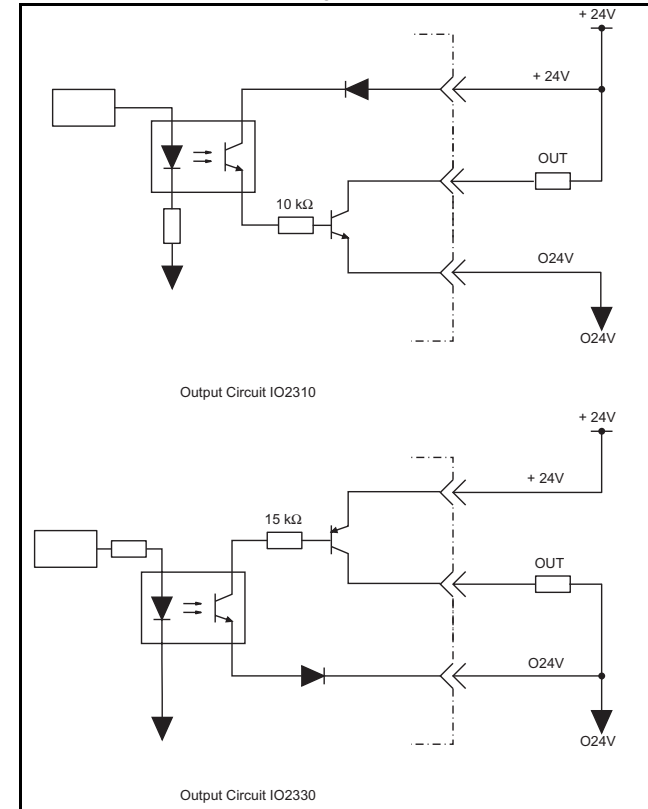
Output Circuit IO2310

Output Circuit IO2330

Related BASIC commands

The following BASIC commands are related to the MECHATROLINK-II
digital I/O module:

- **IN**
- **NIO**
- **OP**

For more information, refer to the Trajexia Programming Manual.

3.5.16 MECHATROLINK-II 4-Channel analogue input module

This is a 4-channel analogue input MECHATROLINK-II slave. The analogue inputs are automatically allocated by the Trajexia system according to the unit number and can be read by Trajexia starting from AIN(0).
The I/Os are automatically mapped in AIN(x) according to the MECHATROLINK-II node number. In the case of existing several AN2900 units, the one with lowest node number corresponds to AIN(0) to AIN(3), the next lowest one to AIN(4) to AIN(7).
The value is refreshed every servo_period.

A. LED indicators
B. Module description (AN2900)
C. Module mounting holes (for M4 screws) for back mounting
D. Module mounting holes (for M4 screws) for bottom mounting
E. Terminal cover
F. Detachable terminal
G. External connector terminals (M3, Phillips-head)
H. Signal label
I. Terminal block mounting screws (two M3.5 screws)
J. MECHATROLINK-II connector
K. Front cover
L. Dipswitch

fig. 81

Connector description

LED Indicators:

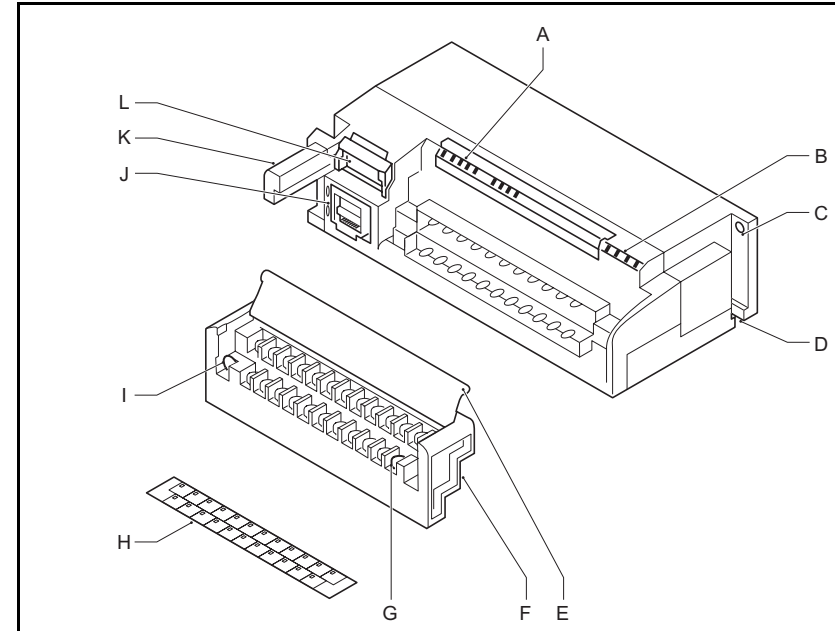| Indicator name	Indicator color	Meaning when lit or flashing	
RDY	Green	Lit	The module is operating normally
		Flashing	The transmission cable is disconnected or the module is waiting for communication with the master
TX	Green	Lit	Sending data
RX	Green	Lit	Receiving data

fig. 82

RDY TX RX ERR FLT   CH1 CH2 Ch3 Ch4
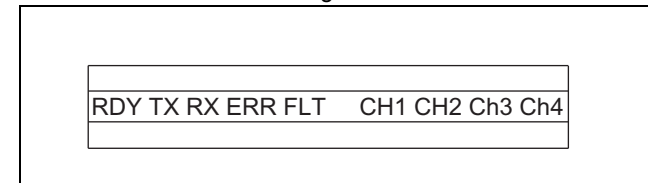
Indicator name	Indicator color	Meaning when lit or flashing	
ERR	Red	Lit	A communication error occurred
FLT	Red	Lit	Offset/gain setting error
		Flashing	Self-diagnostic error
CH1 to CH4	Green	Lit	Each LED indicates that the input is out-of-range for that channel. Out-of-range inputs are as follows: +10.02 V < Channel input signal Channel input signal < -10.02 V

Dipswitch functions:

The dipswitch consists of eight pins. The pins are numbered 1 to 8, as shown in the illustration. Each pin is turned to on when it is moved to the upper position.

The following table shows the function of each switch.

Any switches other than pin 7 become effective when each switch is changed.

fig. 83

Pin no.	Setting	Function
1 to 5	on	Set the slave address of pins 1 through 5. For details, refer to the table below.
	off	
6	on	32-byte data transmission (MECHATROLINK-II).
7	on	Software filter (average is 5 times) is set to "Enabled".
	off	Software filter is set to "Disabled".
8	on	Sets the baud rate to 10 Mbps.

Slave address settings:

Set the slave address with pins 1 to 5 on the dipswitch on the front of the front of the distributed I/O module.

Refer to the following table, and set the slave addresses as required.

Pin No.					Slave address
1	2	3	4	5	
0	0	0	0	0	Not used
1	0	0	0	0	1
0	1	0	0	0	2
1	1	0	0	0	3
0	0	1	0	0	4
1	0	1	0	0	5
0	1	1	0	0	6
1	1	1	0	0	7
0	0	0	1	0	8
1	0	0	1	0	9
0	1	0	1	0	10
1	1	0	1	0	11
0	0	1	1	0	12
1	0	1	1	0	13
0	1	1	1	0	14
1	1	1	1	0	15
0	0	0	0	1	16
1	0	0	0	1	17
0	1	0	0	1	18
1	1	0	0	1	19
0	0	1	0	1	20
1	0	1	0	1	21
0	1	1	0	1	22
1	1	1	0	1	23
0	0	0	1	1	24

Pin No.					Slave address
1	**2**	**3**	**4**	**5**	
1	0	0	1	1	25
0	1	0	1	1	26
1	1	0	1	1	27
0	0	1	1	1	28
1	0	1	1	1	29
0	1	1	1	1	30
1	1	1	1	1	Not used

Specification

The performance specifications of the analogue input module (±10 V, 4 CH) are shown below.

Item	Specifications
Name	Analog input module (-10 V to + 10 V, 4 CH)
Model description	AN2900
Model number	JEPMC-AN2900
Input signal range	-10 to 10V
Special inputs	None
Number of input channels	4 channels, isolated as a group
Input impedance	1 MΩ min.
Maximum allowable overload	-20 to 20 V
Digital resolution	16 bits
Data format	Binary (2s complement) -32,000 to 32,000
Error	±0.5% F.S. (at 25ºC) ±1.0% F.S. (at 0 to 60ºC)
Input delay time	4 ms max.
Sampling interval	Input data is refreshed every communication cycle

Item	Specifications
Input filter characteristics	Software filter
Number of allocated words	5 words/module
Maintenance/diagnostic functions	Watchdog timer
External connections	Removable terminal block with 23 M3 screw terminals

Item		Specifications
Input circuit iso-lation	Isolation method	Photocoupler (There is no isolation between input channels.)
	Dielectric strength	1,500 VAC for 1 minute between input terminals and internal circuits
	Insulation resistance	100 MΩ min. at 500 VDC between input terminals and internal circuits (at room temperature and humidity)
External power supply		Main external power supply: 24 VDC (20.4 to 26.4 VDC), 120 mA max.
Derating conditions		The maximum ambient operating temperature is limited with some mounting directions.
Maximum heating value		2.88 W
Hot swapping		Terminal block: not permitted Communication connector: permitted
weight		Approx. 300 g
Dimensions (mm)		161 x 44 x 79 (W x H x D)

The figure shows the circuit configuration for the analogue input module.
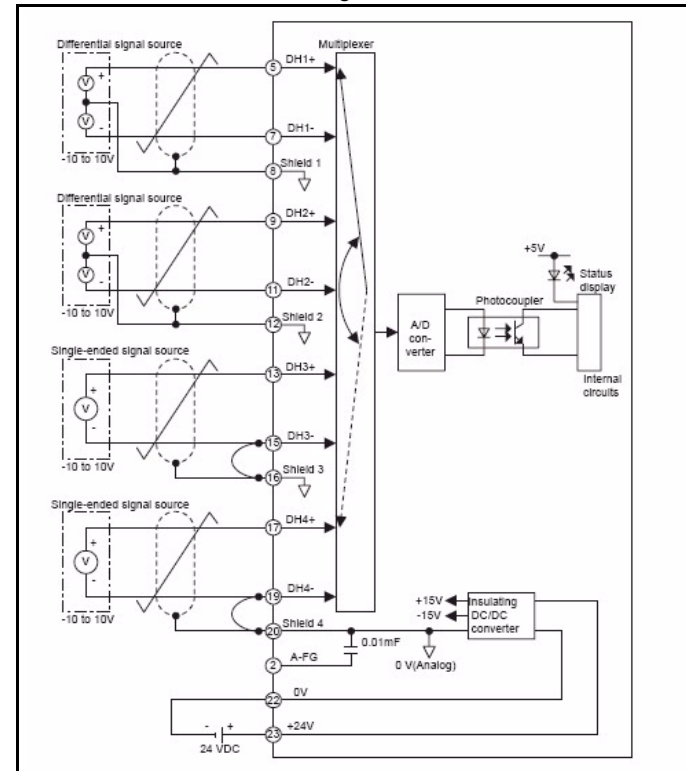
fig. 84

Related BASIC commands
The following BASIC commands are related to the MECHATROLINK-II analogue input module:
- **AIN**
- **NAIO**

For more information, refer to the Trajexia Programming Manual.
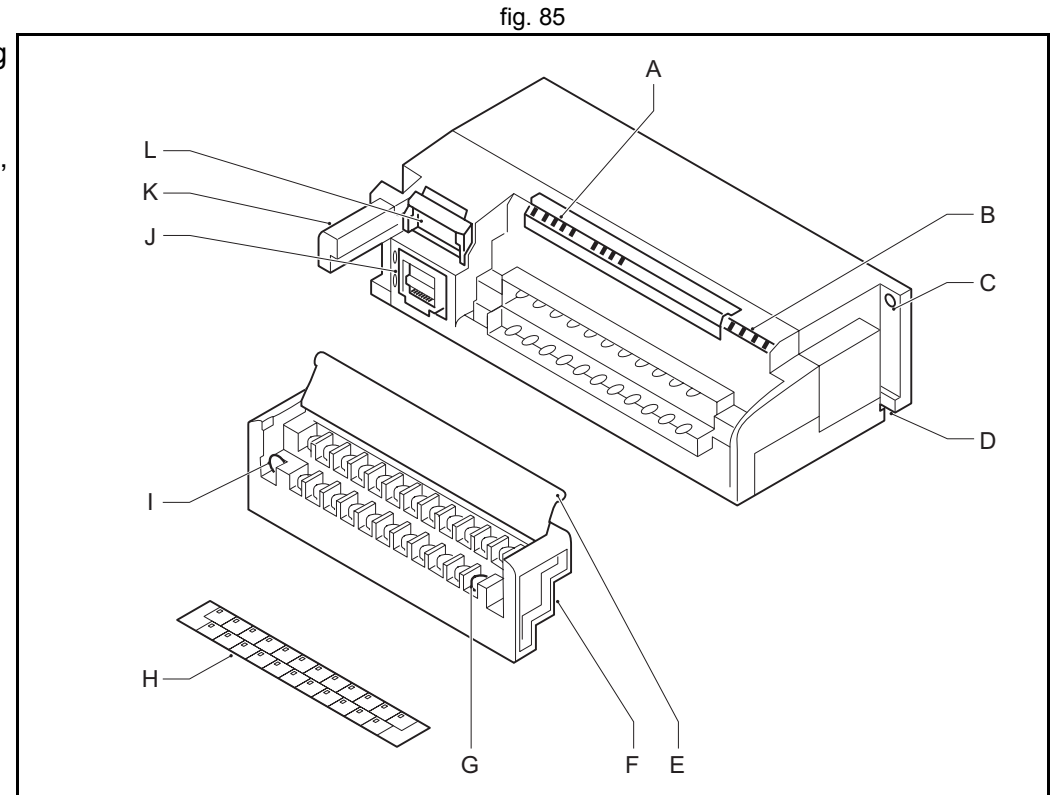
Revision 5.0

3.5.17 MECHATROLINK-II 2-Channel analogue output module

This is a 2-channel analogue output MECHATROLINK-II slave. The analogue output is automatically allocated by the Trajexia system according to the unit number and can be read by Trajexia starting from AOUT(0). The I/Os are automatically mapped in AOUT(x) according to the MECHATROLINK-II node number. In case of existing several AN2910 units, the one with lower node number corresponds to AOUT(0) to AOUT(1), the next one to AOUT(3) to AOUT(4).
The value is refreshed every **SERVO_PERIOD**.

A. LED indicators
B. Module description (AN2910)
C. Module mounting holes (for M4 screws) for back mounting
D. Module mounting holes (for M4 screws) for bottom mounting
E. Terminal cover
F. Detachable terminal
G. External connector terminals (M3, Phillips-head)
H. Signal label
I. Terminal block mounting screws (two M3.5 screws)
J. MECHATROLINK-II connector
K. Front cover
L. Dipswitch

fig. 85

Connector description
LED Indicators:

fig. 86

```
RDY TX RX ERR FLT
```

Indicator name	Indicator color	Meaning when lit or flashing	
RDY	Green	Lit	The module is operating normally
		Flashing	The transmission cable is disconnected or the module is waiting for communication with the master
TX	Green	Lit	Sending data

Indicator name	Indicator color	Meaning when lit or flashing	
RX	Green	Lit	Receiving data
ERR	Red	Lit	A communication error occurred
FLT	Red	Lit	Offset/gain setting error
		Flashing	Self-diagnostic error

Dipswitch functions:
The dipswitch consists of eight pins. The pins are numbered 1 to 8, as shown in the following diagram. Each pin is turned to on when it is moved to the upper position.

The setting of each pin becomes effective as soon as the dipswitch is changed.
The following table shows the functions that correspond to the settings for each pin.

fig. 87

Pin no.	Setting	Function
1 to 5	on	Set the slave address of pins 1 through 5. For details, refer to the table below:
	off	
6	on	32-byte data transmission (MECHATROLINK-II).
7	on	The output when communication stops is set to "data immediately before stop".
	off	The output when communication stops is set to "0".
8	on	Sets the baud rate to 10 Mbps.

Slave address settings:
Set the slave address with pins 1 to 5 on the dipswitch on the front of the distributed I/O module.
Refer to the following table, and set the slave addresses as required.

Pin No.					Slave address
1	**2**	**3**	**4**	**5**	
0	0	0	0	0	Not used
1	0	0	0	0	1
0	1	0	0	0	2
1	1	0	0	0	3
0	0	1	0	0	4
1	0	1	0	0	5
0	1	1	0	0	6
1	1	1	0	0	7
0	0	0	1	0	8
1	0	0	1	0	9
0	1	0	1	0	10
1	1	0	1	0	11
0	0	1	1	0	12
1	0	1	1	0	13
0	1	1	1	0	14
1	1	1	1	0	15
0	0	0	0	1	16
1	0	0	0	1	17
0	1	0	0	1	18
1	1	0	0	1	19
0	0	1	0	1	20
1	0	1	0	1	21
0	1	1	0	1	22
1	1	1	0	1	23
0	0	0	1	1	24

| Pin No.					Slave address
1	**2**	**3**	**4**	**5**	
1	0	0	1	1	25
0	1	0	1	1	26
1	1	0	1	1	27
0	0	1	1	1	28
1	0	1	1	1	29
0	1	1	1	1	30
1	1	1	1	1	Not used

Specification

The performance specifications of the analogue output module (±10 V, 2 CH) are shown below.
The illustration shows the circuit configuration for the analogue input module.

Item	Specifications
Name	Analog output module (-10 V to +10 V, 2 CH)
Model description	AN2910
Model number	JEPMC-AN2910
Input signal range	-10 to 10V
Number of output channels	2 channels
Maximum allowable load current	±5 mA (2 kΩ)
Digital resolution	16 bits
Data format	Binary (2s complement) -32,000 to 32,000
Error	±0.2% F.S. (at 25ºC) ±0.5% F.S. (at 0 to 60ºC)
Output delay time	1 ms
Number of allocated words	2 words/module
Maintenance/diagnostic functions	Watchdog timer

fig. 88
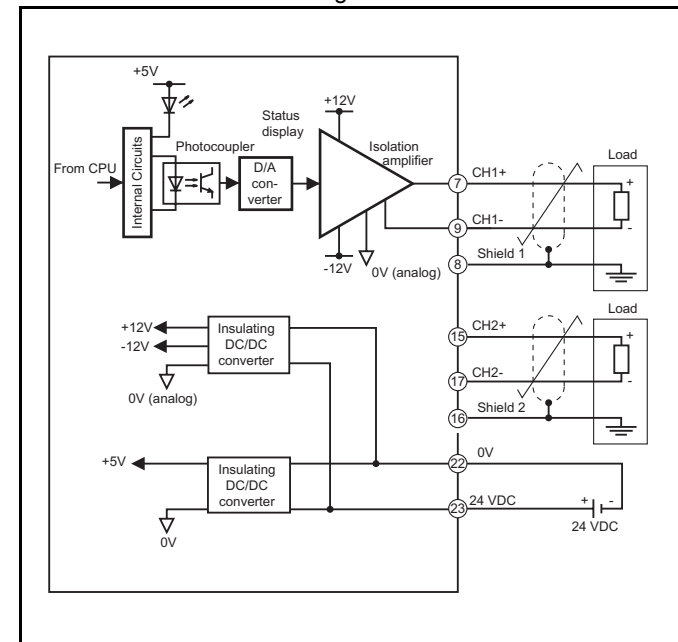
Item		Specifications
Output status when master stops		Mode selected with the dipswitch (SW7): SW7 off: clear outputs (output 0 V) SW7 on: retain prior output status
External connections		Removable terminal block with M3 screw terminals
Output circuit isolation	Isolation method	Photocoupler (There is no isolation between channels.)
	Dielectric strength	1,500 VAC for 1 minute between output terminals and internal circuits
	Insulation resistance	100 MΩ min. at 500 VDC between input terminals and internal circuits (at room temperature and humidity)
External power supply		Main external power supply: 24 VDC (20.4 to 26.4 VDC), 120 mA max.
Derating conditions		The maximum ambient operating temperature is limited with some mounting directions.
Maximum heating value		2.88 W
Hot swapping		Terminal block: not permitted Communication connector: permitted
weight		Approx. 300 g
Dimensions (mm)		161 x 44 x 79 (W x H x D)

Related BASIC commands

The following BASIC commands are related to the MECHATROLINK-II analogue output module:

- **AOUT**

For more information, refer to the Trajexia Programming Manual.

3.5.18 MECHATROLINK-II repeater

The JEPMC-REP2000 is a MECHATROLINK-II repeater. It extends the range and the maximum number of MECHATROLINK-II devices in the MECHATROLINK-II network.

fig. 89

Terminal/LED	Label	Description
A	TX1	CN1 communication indicator
B	TX2	CN2 communication indicator
C	POWER	Power indicator
D	SW	Dipswitch
E	CN1 & CN2	MECHATROLINK-II connectors
F	CN3	Power supply connector

LED indicators

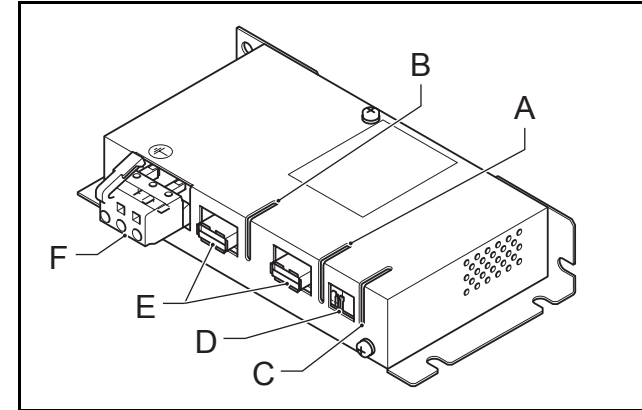| LED	Description
POWER	Lit: Power on Not lit: No power
TX1	Lit: Communication via CN1 Not lit: No communication via CN1
TX2	Lit: Communication via CN2 Not lit: No communication via CN2

MECHATROLINK-II connectors
Use one MECHATROLINK-II connector (CN1 or CN2) to connect the repeater to the master-side network, i.e. the part of the network that had the TJ1-ML__. Use the other connector to connect the repeater to the network extension.
Both connectors have a built-in terminator.

Power supply connector
Connect an external 24 VDC power supply to the power supply connector (CN3).

The table below gives the pin layout for the power supply connector.

Pin	Signal	Description
1	FG	Frame ground
2	0 V	0 VDC input
3	+24 V	24 VDC input

Dipswitch settings (SW)
The dipswitch is for future use. Set all the pins to OFF.

System configuration
The maximum number of MECHATROLINK-II devices that you can connect in the MECHATROLINK-II network with a repeater is set by the MECHATROLINK-II cable length.

Network part	MECHATROLINK-II cable length	Maximum number of MECHATROLINK-II devices[1]
Master-side (B)	Max. 30 m	16
	Max. 50 m	15
Extension (C)	Max. 30 m	16
	Max. 50 m	15

1. The repeater itself is included in the maximum number of MECHATRO-LINK-II devices.

The total number of MECHATROLINK-II devices is set by the TJ1-ML__:
• The TJ1-ML04 can have up to 4 MECHATROLINK-II devices.
• The TJ1-ML16 can have up to 16 MECHATROLINK-II devices.

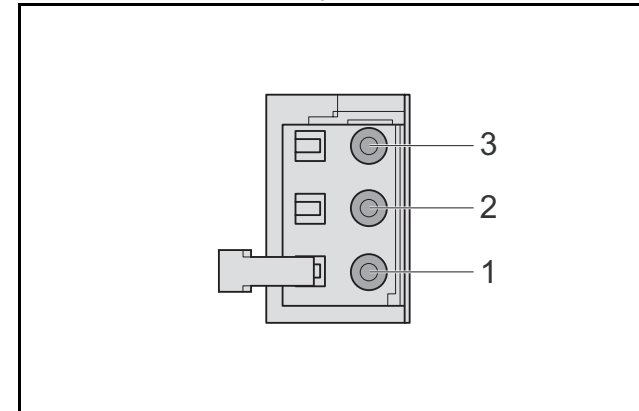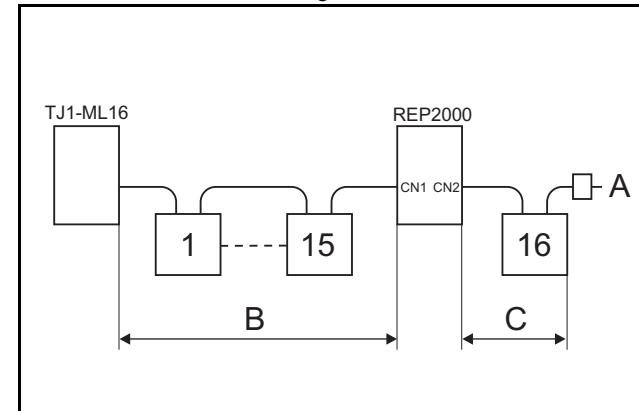Terminate the last MECHATROLINK-II device with a MECHATROLINK-II terminator (A).

fig. 90

fig. 91

3.6 GRT1-ML2

3.6.1 Introduction

The GRT1-ML2 SmartSlice Communication Unit controls data exchange between a TJ1-MC__ Motion Controller Unit (via a connected TJ1-ML__ MECHATROLINK-II Master Unit) and SmartSlice I/O Units over a MECHATROLINK-II network. For more information on SmartSlice I/O Units, refer to the GRT1 Series SmartSlice I/O Units Operation Manual (W455).

Label	Description
A	LED indicators
B	Unit dipswitches
C	Unit power supply terminals
D	I/O power supply terminals
E	MECHATROLINK-II connectors
F	Shielding terminal
G	Rotary switch
H	Communication dipswitches

fig. 92
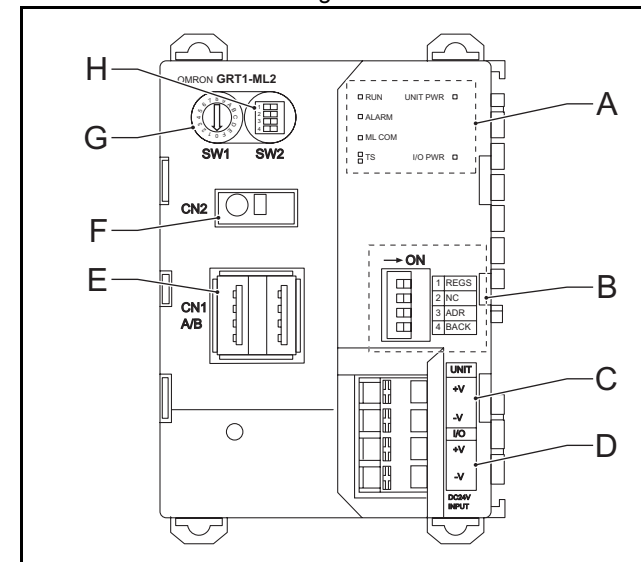
Unit dipswitches

Dipswitch	Function	Setting	Description
REGS	Create/enable registration table	ON	Registered table is enabled
		OFF	Registered table is disabled
		OFF to ON[1]	Register I/O unit table
		ON to OFF[1]	Clear registered I/O unit table
NC	N/A	OFF	Not used, always set to OFF

fig. 93
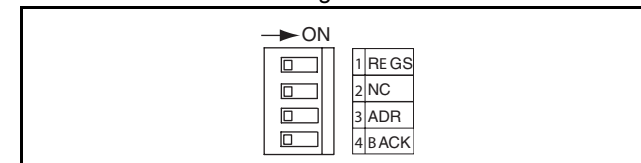
Dipswitch	Function	Setting	Description
ADR	Automatic restore	OFF to ON	When the SmartSlice I/O Units are replaced, the parameter data that was backed up with the BACK dipswitch is automatically restored[2]
		OFF	Automatic restore disabled
BACK	Backup trigger	ON to OFF to ON in 3 s[3]	Parameter data of all connected Smart-Slice I/O Units is backed up[2]

1. When the unit power is on.
2. When dipswitch 1 is set to ON.
3. The setting of dipswitch 4 (BACK) is given in figure 94.

Caution

The Backup and Restore functionality is available in the GRT1-ML2. However, the backed up and restored parameters cannot be accessed via MECHATROLINK-II communication.
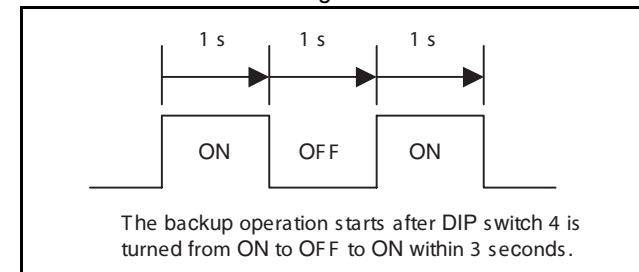
Note

- It is recommended to do a registration of the SmartSlice I/O Units (see the Trajexia Programming Manual).
- It is recommended to set dipswitches 1, 3 and 4 on after this registration.
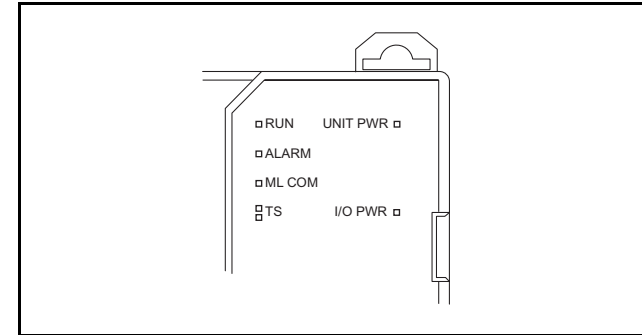
The factory setting of all dipswitches is OFF.

fig. 94

The backup operation starts after DIP switch 4 is turned from ON to OFF to ON within 3 seconds.

LED indicators

LED	Description	Color	Status	Meaning
RUN	Unit status	Green	Not lit	• Startup test failed, unit not operational • Operation stopped due to a fatal error
			Lit	Initialization successful, unit is in normal operation
ALARM	Unit error	Red	Not lit	Unit is in normal operation
			Flashing	A startup error has occurred
			Lit	Unit is in alarm state, or a fatal error has occurred
ML COM	MECHATRO-LINK-II communication	Green	Not lit	No MECHATROLINK-II communication
			Lit	MECHATROLINK-II communication active

fig. 95

LED	Description	Color	Status	Meaning
TS	SmartSlice I/O system communication status	N/A	Not Lit	• No power supply • Communication with SmartSlice I/O Unit has not started • Overcurrent detected
		Green	Flashing (every second)	SmartSlice I/O Unit added to the system
			Flashing (every 0.5 second)	Backup/Restore function operating: • Restoring settings to SmartSlice I/O Unit, backup function operating • Downloading SmartSlice I/O Unit settings
			Lit	Communication with SmartSlice I/O Unit established
		Red	Flashing	Non-fatal communication error occurred. • Communication timeout • Verification error occurred with registered table • Different model unit detected after SmartSlice I/O Unit replacement
			Lit	Fatal communication error occurred.
			Lit for 2 s	Failure occurred while restoring settings to I/O unit or downloading I/O unit settings
UNIT PWR		Green	Not Lit	No power supply to the unit (All LEDs are off)
			Lit	Power supply to the unit
I/O PWR		Green	Not Lit	No power supply to the SmartSlice I/O (No output from the SmartSlice I/O Units, even when they are in operation)
			Lit	Power supply to the SmartSlice I/O

Note

- When the power of the Trajexia system is turned on, the TJ1-MC__ executes its startup sequence before it initializes the MECHATROLINK-II bus. During this startup sequence, the ML COM LED is off.
- When the TJ1-MC__ initializes the MECHATROLINK-II bus with the command **MECHATROLINK(unit,0)**, the ML COM LED goes on.
- When the GRT1-ML2 loses the MECHATROLINK-II communication with the master, or when the command **MECHATROLINK(unit,1)** is executed, the ML COM LED goes off.

Communication dipswitches

Dipswitch	Function	Setting	Description
1	MECHATROLINK-II address range	ON	70 hex – 7F hex
		OFF	60 hex – 6F hex
2	MECHATROLINK-II bus speed	OFF	10 Mbps[1]
3	Frame size	OFF	32 bytes[2]
4	HOLD/CLEAR	ON	HOLD: All outputs hold their values when communication is lost
		OFF	CLEAR: All outputs become 0 when communication is lost

1. Trajexia only supports 10 Mbps bus speed. Therefore always set dipswitch 2 to OFF.
2. Trajexia only supports 32-byte communication. Therefore always set dipswitch 3 to OFF.

Rotary switch

The rotary switch (SW1) sets the MECHATROLINK-II address that identifies
the GRT1-ML2 in the MECHATROLINK-II network. The settings range is
from 0 hex to F hex.
To set the MECHATROLINK-II address of the GRT1-ML2, do these steps:
1. Turn off the Unit power supply of the GRT1-ML2.

Note
The address of the GRT1-ML2 is read only at power on. Setting
the new address when the power is on has no effect.

2. To set the address of the unit, set communication dipswitch 1 and the
    rotary switch as given in the table below.

Dipswitch 1	Rotary switch	Address	Dipswitch 1	Rotary switch	Address
OFF	0	60 hex	ON	0	70
OFF	1	61 hex	ON	1	71
OFF	2	62 hex	ON	2	72
OFF	3	63 hex	ON	3	73
OFF	4	64 hex	ON	4	74
OFF	5	65 hex	ON	5	75
OFF	6	66 hex	ON	6	76
OFF	7	67 hex	ON	7	77
OFF	8	68 hex	ON	8	78
OFF	9	69 hex	ON	9	79
OFF	A	6A hex	ON	A	7A
OFF	B	6B hex	ON	B	7B
OFF	C	6C hex	ON	C	7C
OFF	D	6D hex	ON	D	7D
OFF	E	6E hex	ON	E	7E

Dipswitch 1	Rotary switch	Address	Dipswitch 1	Rotary switch	Address
OFF	F	6F hex	ON	F	7F

> **Note**
> Make sure that the address is unique in the MECHATROLINK-II network. If two or more units have the same MECHATROLINK-II address, they cannot be initialized properly.

3. Turn the power on.

> **Note**
> To make the MECHATROLINK-II address of the unit valid, do one of these steps:
> • Restart the TJ1-MC__.
> • Execute the command **MECHATROLINK(unit,0)**.

Power supply connector

The GRT1-ML2 has 2 24 VDC power supply terminals:

fig. 96

Label	Power supply terminal	Description
A	Unit power supply terminal	Power supply to the internal circuits of the GRT1-ML2 and to the internal circuits of the connected SmartSlice I/O Units (through the SmartSlice bus)
B	External I/O power supply terminal	Power supply to the external I/Os connected to the SmartSlice I/O Units

> **Note**
> The unit power supply and the external I/O power supply are not transferred through the GCN2-100 Turnback cable. The GRT1-TBR units have the same power supply terminals as the GRT1-ML2.
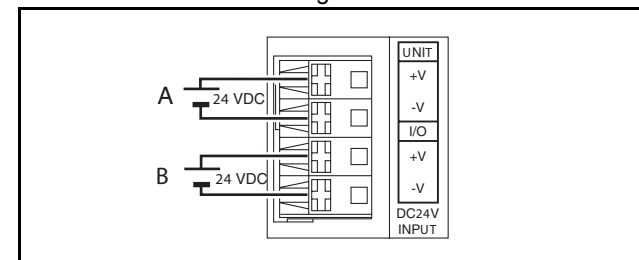
3.6.2   Specifications

Item		Specification
Installation	Unit type	SmartSlice GRT1 series
	Model	GRT1-ML2
	Installation position	On a DIN rail
	Power supply	24 VDC +10% −15% (20.4 to 26.4 VDC)
	Current consumption	110 mA typical at 24 VDC
	Dimensions (W × H × D)	58 × 80 × 70 mm
	Weight	130 g
Environment	Ambient operating temperature	−10 to 55°C (no icing or condensation)
	Ambient operating humidity	25% to 85% Relative humidity
	Storage temperature	−20 to 65°C (no icing or condensation)
	Vibration resistance	10 to 57 Hz, 0.7 mm amplitude 57 to 150 Hz, acceleration: 49 m/s^2
	Shock resistance	150 m/s^2
	Dielectric strength	500 VAC (between isolated circuits)
	Conformance to EMC and electrical safety standards	EN61131-2:2003
	Enclosure rating	IP20

Item		Specification
SmartSlice I/O	Number of connectable SmartSlice I/O Units	64 Units max. Connected directly to the GRT1-ML2 or via Turnback extension units
	Baud rate	3 Mbps
	Communication signal level	RS485
	Communication distance	SmartSlice I/O Units: 64 Units coupled (about 2 m max.) Turnback cable: 2 m max. (2 cables, 1 m each)
	Turnback cable	Length 1 m max., up to 2 cables can be connected
	SmartSlice I/O Unit connections	Building-block style configuration with slide connectors (Units connect with Turnback cables).
	Baseblock power supply	Voltage: 24 VDC Current: 4 A max.
	Event messaging	Supported
MECHATROLINK-II	Baud rate	10 Mbps (MECHATROLINK-II)
	Data length	17-byte and 32-byte data transmission

Supported SmartSlice I/O Units

The GRT1-ML2, in combination with the Trajexia system, supports these SmartSlice I/O Units.

Function	Specification	Model
4 NPN inputs	24 VDC, 6 mA, 3-wire connection	GRT1-ID4
4 PNP inputs	24 VDC, 6 mA, 3-wire connection	GRT1-ID4-1
8 NPN inputs	24 VDC, 4 mA, 1-wire connection + 4xG	GRT1-ID8
8 PNP inputs	24 VDC, 4 mA, 1-wire connection + 4xV	GRT1-ID8-1
4 NPN outputs	24 VDC, 500 mA, 2-wire connection	GRT1-OD4

Function	Specification	Model
4 PNP outputs	24 VDC, 500 mA, 2-wire connection	GRT1-OD4-1
4 PNP outputs with short-circuit protection	24 VDC, 500 mA, 3-wire connection	GRT1-OD4G-1
8 NPN outputs	24 VDC, 500 mA, 1-wire connection + 4xV	GRT1-OD8
8 PNP outputs	24 VDC, 500 mA, 1-wire connection + 4xG	GRT1-OD8-1
8 PNP outputs with short-circuit protection	24 VDC, 500 mA, 1-wire connection + 4xG	GRT1-OD8G-1
2 relay outputs	240 VAC, 2A, normally-open contacts	GRT1-ROS2
2 analog inputs, current/voltage	10 V, 0-10 V, 0-5 V, 1-5 V, 0-20 mA, 4-20 mA	GRT1-AD2
2 analog outputs, voltage	10 V, 0-10 V, 0-5 V, 1-5 V	GRT1-DA2V
2 analog outputs, current	0-20 mA, 4-20 mA	GRT1-DA2C

Dimensions

The external dimensions are in mm.

fig. 97
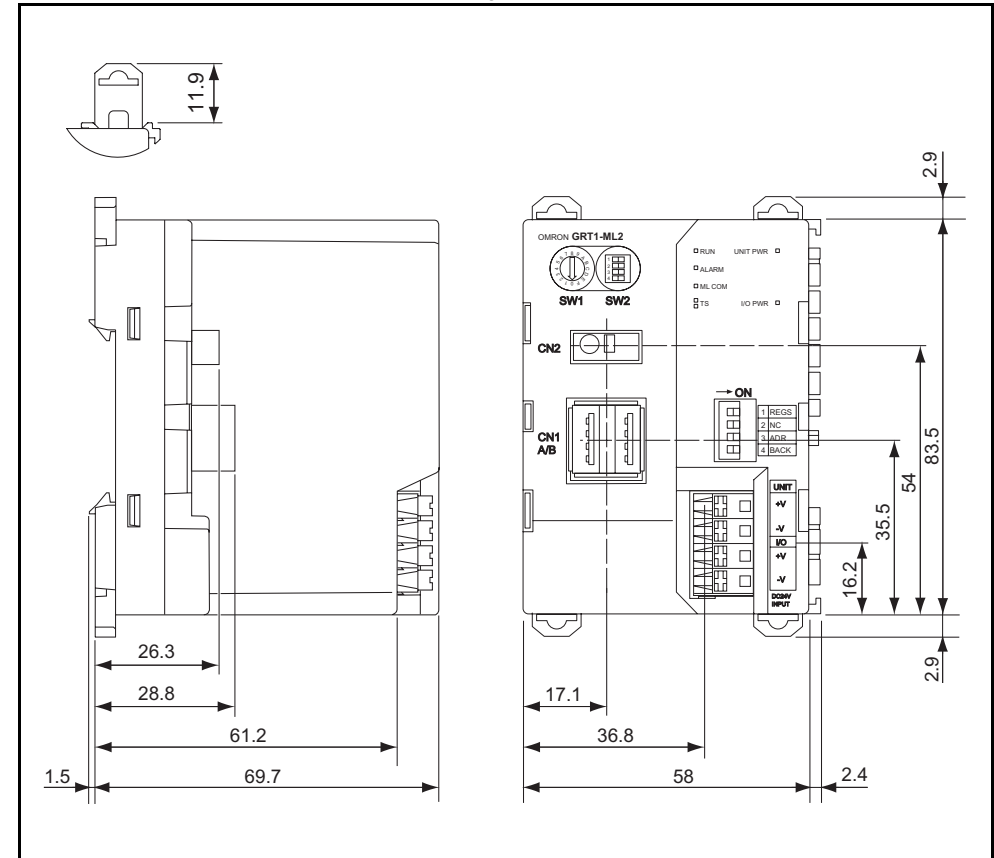
3.6.3   Installation

Follow these rules when installing the GRT1-ML2:

*   Before installing the GRT1-ML2 or connect or disconnect cables, switch off the power of the Trajexia system, the SmartSlice I/O Units and the external I/Os.
*   Make sure that the power supplies of the GRT1-ML2, the SmartSlice I/O Units and the external I/Os are correctly connected.

- Provide separate conduits or ducts for the I/O lines to prevent noise from high-tension lines or power lines.
- It is possible to connect up to 64 SmartSlice I/O Units to 1 GRT1-ML2.
- Install the GRT1-ML2 and the SmartSlice I/O Units on a DIN rail. To install a GRT1-ML2 on the DIN rail, press it onto the DIN track from the front, and press the unit firmly until it clicks. Check that all DIN rail sliders of the unit are locked onto the DIN rail.
- To remove the GRT1-ML2 from the DIN rail, release the sliders from the DIN rail with a screwdriver, and pull the unit straight from the DIN rail.

Connections

Connect the first SmartSlice I/O Unit to the GRT1-ML2:
- Align the sides of the GRT1-ML2 and the SmartSlice I/O Unit.
- Slide the SmartSlice I/O Unit to the rear until it clicks onto the DIN rail.

⚠ **Caution**
Do not touch the connectors on the side of GRT1-ML2 and the SmartSlice I/O Units.

See the GRT1 Series SmartSlice I/O Units Operation Manual for more information on connecting additional SmartSlice I/O Units, Turnback Units, End Units and end plates.
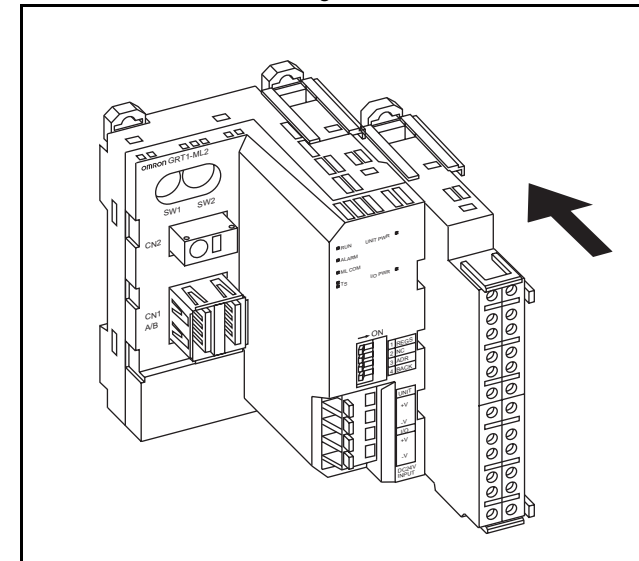
Wiring

The GRT1-ML2 has 2 power supply terminals. Both power supply terminals have screwless clamping-type connections.
To determine the power supply requirements, do the steps below.
The maximum power consumption for SmartSlice I/O Units is 80 W per block.

fig. 98

1. Calculate the power consumption of all SmartSlice I/O Units connected to the GRT1-ML2. Refer to the GRT1 Series SmartSlice I/O Units Operation Manual (W455) for the power value for each SmartSlice I/O Unit.
2. If the power consumption exceeds 80 W, mount a Right Turnback Unit (GRT1-TBR) on the SmartSlice I/O Unit at the point where the power consumption is less than 80 W.
3. Connect the 24 VDC unit power supply to the Left Turnback Unit (GRT1-TBL).

The maximum I/O current consumption is 4 A.

1. Calculate the total current consumption used by all external I/Os of the connected SmartSlice I/O Units (including other units like Turnback Units). Refer to the GRT1 Series SmartSlice I/O Units Operation Manual (W455) for the current value for each SmartSlice I/O Unit.
2. If the current consumption exceeds 4 A or if you want to provide separate systems for inputs and outputs, divide the SmartSlice I/O Units at the desired point with a GRT1-PD_(-1) I/O Power Supply Unit and provide a separate external I/O power supply.

Note
It is also possible to provide a separate external I/O power supply at a Left Turnback Unit (GRT1-TBL).
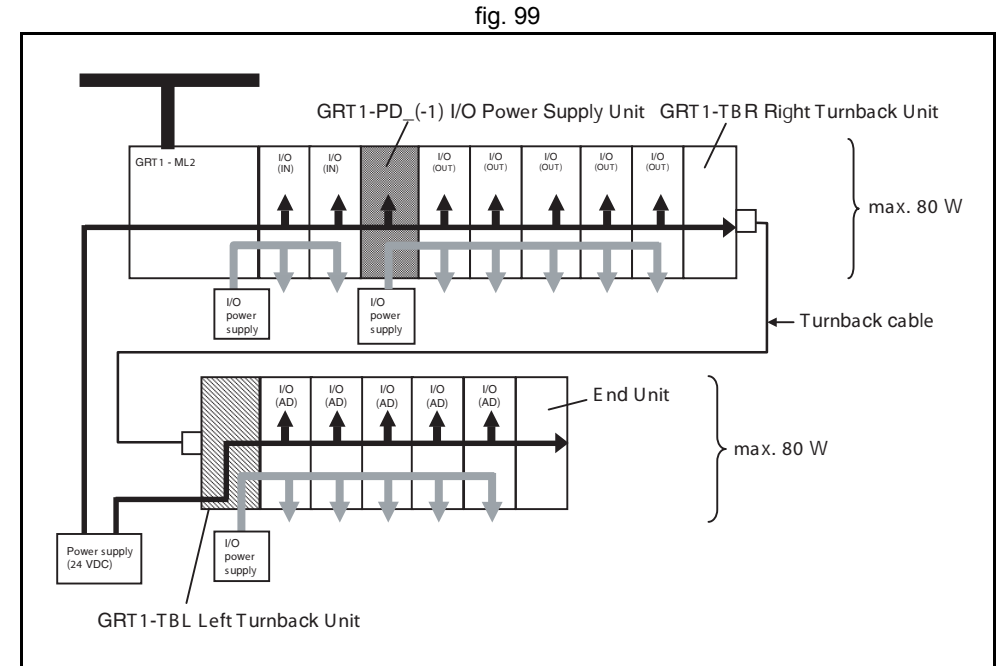
Note
Make sure the power supply is isolated.

Note
The GCN2-100 Turnback cable does not supply power.

The figure gives a wiring example.

To supply power to the units and the I/O devices, connect the power supply wires to the power supply terminals of the GRT1-ML2. If the wire ends have pin terminals, just insert the pin terminals in the power supply terminals.

fig. 99

To remove the wires, press the release button above the terminal hole with a precision screwdriver, and pull out the wire.

It is recommended to use a SELV (Safety Extra Low Voltage) power supply with over-current protection. A SELV power supply has redundant or increased insulation between the I/O, an output voltage of 30 V rms and a 42.4 V peak or maximum of 60 VDC.
Recommended power supplies are:
- S82K-01524 (OMRON)
- S8TS-06024 (OMRON).

fig. 100

It is recommended to use wires with a gauge of 20 AWG to 16 AWG (0.5 to 1.25 mm^2).
Strip the wire between 7 and 10 mm of insulation at the ends of the wires (stranded or solid wire), or use pin terminals with a pin (conductor) length of 8 to 10 mm.
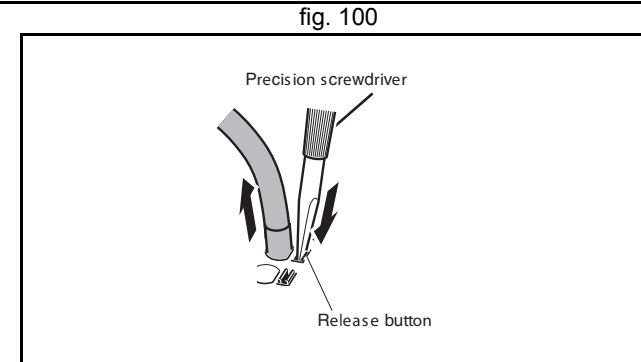
Replace

⚠ **Caution**
The GRT1-ML2 is a unit that is part of a network. If the GRT1-ML2 is damaged, it effects the whole network. Make sure that a damaged GRT1-ML2 is repaired immediately.

To replace the unit, follow these rules:
- Turn off the power before replacing the unit. This includes the power to all master and slave units in the network.
- Make sure that the new unit is not damaged.
- If a poor connection is the probable cause of any malfunctioning, do these steps:
  - Clean the connectors with a clean, soft cloth and industrial-grade alcohol.
  - Remove any lint or threads left from the cloth.
  - Install the unit again.
- When returning a damaged unit to the OMRON dealer, include a detailed damage report with the unit.
- Before reconnecting the new unit, do these steps:
  - Set the MECHATROLINK-II station address to the same address as the old unit.
  - If the table registration function was used for the old unit, create a new registration table for the new unit. See the Trajexia Programming Manual.

3.6.4   Online replacement

It is possible to replace SmartSlice I/O Units connected to a GRT1-ML2 when the power is on. The I/O communication continues while a SmartSlice I/O Unit is removed and replaced.
To replace a SmartSlice I/O Unit online, do these steps:
1. Turn off all power supplies of the SmartSlice I/O Unit. This is the I/O power supply, plus possible external power supplies to the terminal block (for example, a Relay Output Unit).
2. Release the locks on the front of the unit and remove the terminal block. Do not remove the wiring.

3. Remove the main block of the unit. Replace it with a new SmartSlice I/O Unit of the same type.
4. Attach the new unit to the system. Close the locks on the front of the unit.
5. Turn on the power supplies to the unit.

When replacing a SmartSlice I/O Unit online, note the following things:
*   When a unit is removed from the I/O communication, the withdrawn flag of the unit is set on and the TS LED on the GRT1-ML2 flashes red.
*   If I/O power supply of the unit is not turned off, there can be false output signals, false input signals and electrical shocks.
*   Only replace one SmartSlice I/O Unit at a time.
*   If a unit is replaced with a different type of unit, there can be unexpected outputs and the restore operation can be incomplete.
*   If the base block has faults or damage, turn off the power supply and replace the entire unit.

When an online replacement is performed, the status word of the GRT1-ML2 reports an error (missing I/O Unit). When the I/O Unit is replaced or put back, the status word changes to 8000 hex, but the error has already been detected by the TJ1-MC__. To avoid this, it is necessary to mask the errors before the online replacement is performed. To perform the online replacement do the following:
1. Execute **MECHATROLINK(unit,37,station_addr, 0)**. This masks all bits, including errors, in the GRT1-ML2 status word.
2. Replace the I/O Unit.
3. Execute **MECHATROLINK(unit,37,station_addr, $4000)**. This sets the error mask to its default value.

3.6.5 Related BASIC commands

The following BASIC commands are related to the MECHATROLINK-II GRT1-ML2 module:
*   **MECHATROLINK**

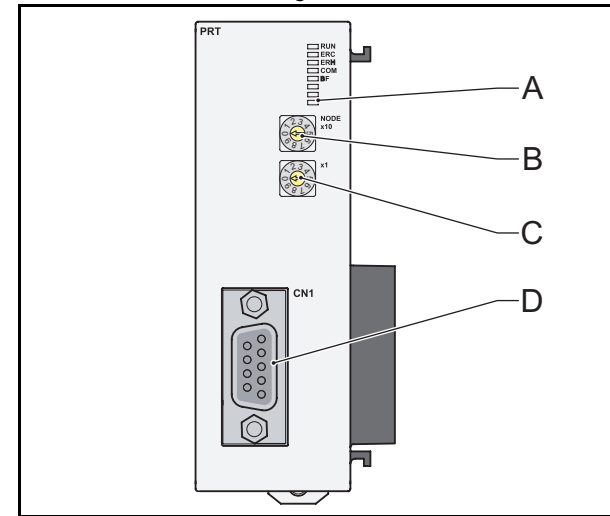For more information, refer to the Trajexia Programming Manual.

3.7   TJ1-PRT

3.7.1   Introduction

The TJ1-PRT is an interface between the Trajexia system and a PROFIBUS network.
The TJ1-PRT has these visible parts.

fig. 101

Part	Description
A	LEDs
B and C	Node number selectors
D	PROFIBUS connector

3.7.2   LEDs description

Label	Status	Description
run	off	Start-up test failed. Unit not operational Operation stopped. Fatal error
	on	Start-up test successful. Normal operation
ERC	off	Normal operation
	flashing	Start-up error
	on	Fatal error in program Error occurred while Reading or Writing error log
ERH	off	Normal operation
	flashing	I/O-size not configured
	on	Error detected in communication with controller

| Label	Status	Description
COM	off	No PROFIBUS data exchange communication
	on	I/O data exchange on PROFIBUS is active
BF	off	No PROFIBUS bus communication errors
	flashing	Parameter values sent by the PROFIBUS master unit are invalid. I/O data exchange is not possible.
	on	No PROFIBUS communication is detected by the unit

3.7.3   Node number selectors

You can use the node number selectors to assign a node number to the TJ1-PRT. This node number identifies the TJ1-PRT in the PROFIBUS network. The upper node number selector sets the tens of the node number. The lower node number selector sets the units of the node number. Both selectors range from 0 to 9. To set a selector to *n*, turn the arrow to point to the label *n*. Refer to the chapter, Communication Protocols in the Programming Manual.

3.7.4　TJ1-PRT Connections

fig. 102

Pin	Signal	Description
1	Shield	Connected to the metal shell
2	N/A	N/A
3	B-line	Data signal
4	RTS	Direction control signal for repeaters
5	DGND	Data 0 Volts
6	VP	Power output for the termination, 5 V, 10 mA
7	N/A	N/A
8	A-line	Data signal
9	N/A	N/A
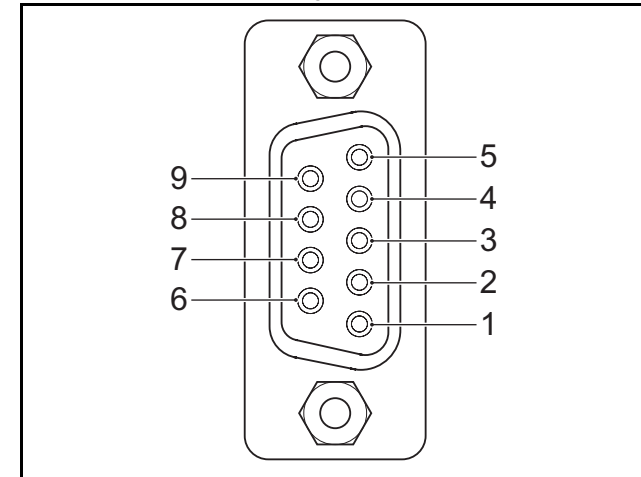
3.7.5　TJ1-PRT Specifications

Item	Specification
Power supply	5 VDC (supplied by the TJ1-MC__)
Power consumption	0.8 W
Current consumption	150 mA at 5 VDC
Approximate weight	100 g
Electrical characteristics	Conforms to PROFIBUS-DP standard EN50170 (DP-V0)
Communication connector	1 PROFIBUS-DP slave connector
Transmission speed	9.6, 19.2, 45.45, 93.75, 187.5, 500, 1500, 3000, 6000 and 12000 Kbps
Node numbers	0 to 99
I/O size	0 to 122 words (16-bit), configurable, for both directions
Galvanic isolation	Yes

3.7.6   TJ1-PRT unit box contents

TJ1-PRT box:
- Safety sheet.
- TJ1-PRT.
- Protection label attached to the top surface of the unit.

3.7.7   Applicable BASIC commands

The following BASIC commands are applicable for the TJ1-PRT:
- **PROFIBUS**

For more information, refer to the Trajexia Programming Manual.

Revision 5.0

3.8   TJ1-DRT

3.8.1   Introduction

The TJ1-DRT is an interface between the Trajexia system and a DeviceNet network.

fig. 103

Part	Description
A	LEDs
B and C	Node number selectors
D	DeviceNet connector

3.8.2   LEDs description

Label	Status	Description
RUN	off	Start-up test failed. Unit not operational Operation stopped. Fatal error
	on	Start-up test successful. Normal operation
ERC	off	Normal operation
	flashing	Start-up error
	on	Fatal error in program Error occurred while Reading or Writing error log
ERH	off	Normal operation
	flashing	I/O-size not configured
	on	Error detected in communication with controller
NOK	off	Baud rate not detected or node address duplication check not completed.
	flashing	Slave not allocated to a DeviceNet master.
	on	Slave is on-line and allocated to a DeviceNet master.
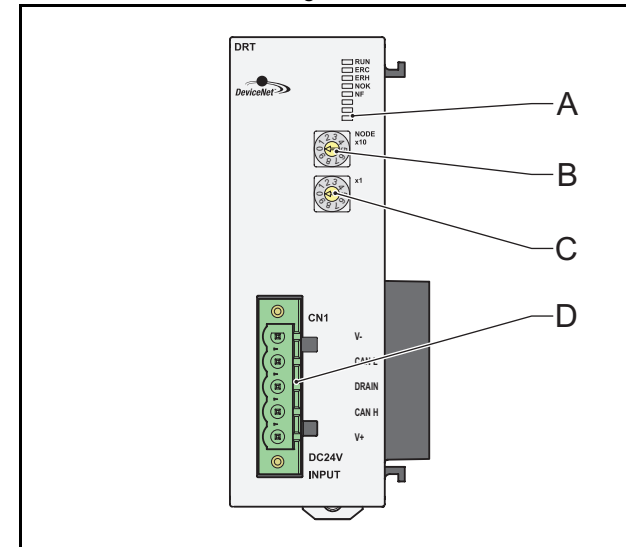
| Label	Status	Description
NF	off	No network error detected.
	flashing	Connection time-out detected for I/O connection with the Device-Net master.
	on	Other device detected with the same node number or severe network error detected.

3.8.3   Node number selectors

You can use the node number selectors to assign a node number to the TJ1-DRT. This node number identifies the TJ1-DRT in the DeviceNet network. The upper node number selector sets the tens of the node number. The lower node number selector sets the units of the node number. Both selectors range from 0 to 9. To set a selector to *n*, turn the arrow to point to the label *n*. Refer to the chapter, Communication Protocols in the Programming Manual.

The DeviceNet node numbers range from 0 to 63. If you select a node number with the node number selectors that exceeds this range, you will select the node number that is set by software. The nodes that enable software settings are 64 to 99.

3.8.4 TJ1-DRT Connections

Pin	Signal	Description
1	V-	Power supply input, negative voltage
2	CAN L	Communication line, low
3	DRAIN	Shield
4	CAN H	Communication line, high
5	V+	Power supply input, positive voltage

fig. 104
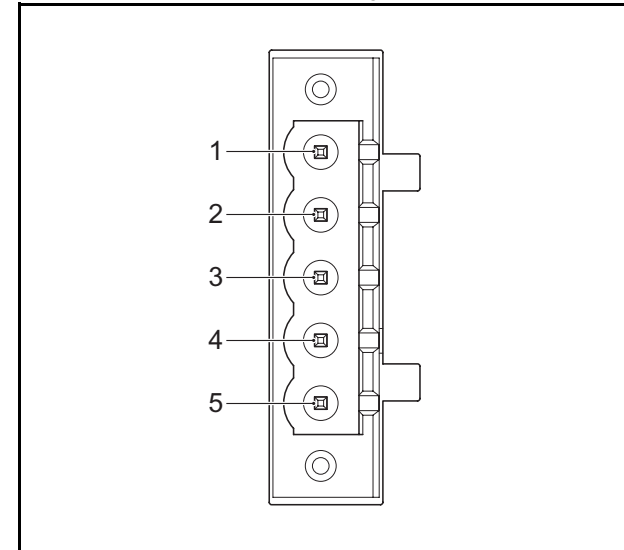
3.8.5 TJ1-DRT Specifications

Item	Specification
Power supply	5 VDC (supplied by the TJ1-MC__)
Power consumption	120 mA at 5 VDC
Network power supply	24 VDC
Network current consumption	15 mA at 24 VDC
Power dissipation	0.6 W
Approximate weight	100 g
Electrical characteristics	Conforms to DeviceNet standard of CIP edition 1.
Communication connector	1 DeviceNet slave connector
Transmission speed	125, 250 and 500 Kbps, auto-detected

Item	Specification
Node numbers	0 to 63
I/O size	0 to 32 words (16-bit), configurable, for both directions
Galvanic isolation	Yes

3.8.6   TJ1-DRT unit box contents

TJ1-DRT box:
- Safety sheet.
- TJ1-DRT.
- DeviceNet connector.
- Protection label attached to the top surface of the unit.

3.8.7   Applicable BASIC commands

The following BASIC commands are applicable for the TJ1-DRT:
- **DEVICENET**

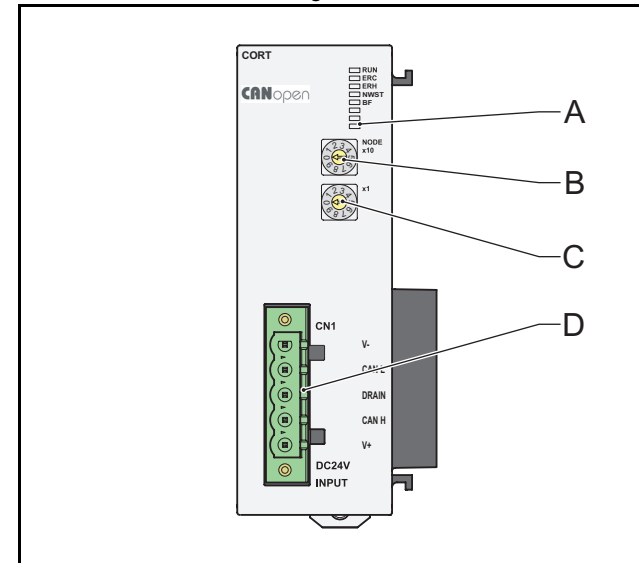For more information, refer to the Trajexia Programming Manual.

3.9   TJ1-CORT

3.9.1   Introduction

The CANopen Master Unit (TJ1-CORT) is an interface between the Trajexia system and a CANopen network.

Part	Description
A	LED indicators
B and C	Node number selectors
D	CANopen port

fig. 105

3.9.2   LEDs description

Label	Status	Description
RUN	off	Start-up test failed. Unit not operational. Operation stopped. Fatal error.
	on	Start-up test successful. Normal operation.
ERC	off	Normal operation
	flashing	Start-up error
	on	Fatal error in program. Error occurred while Reading or Writing error log.

Label	Status	Description
ERH	off	Normal operation.
	flashing	I/O size not configured.
	on	Error detected in communication with controller.
NWST	off	Start-up error or fatal error detected.
	single flash	TJ1-CORT in stopped state.
	flashing	TJ1-CORT in pre-operational state.
	on	TJ1-CORT in operational state.
BF	off	No network error detected.
	single flash[1]	Warning limit reached. At least one of the error counters of the CAN controller has reached or exceeded the warning level (too many errors).
	double flash[2]	A remote error or a heartbeat event has occurred.
	flashing[3]	Invalid configuration.
	on	A duplicate node address has been detected, or the unit is in Bus OFF state.

1. Single flash: one 200ms pulse, followed by 1 second off.
2. Double flash: two 200ms pulses, followed by 1 second off.
3. LED flashing frequency: 2.5 Hz.

3.9.3   Node number selectors

You can use the node number selectors to assign a node number to the TJ1-CORT. This node number identifies the TJ1-CORT in the CANopen network. The upper node number selector sets the tens of the node number. The lower node number selector sets the units of the node number. Both selectors range from 0 to 9. To set a selector to *n*, turn the arrow to point to the label *n*.
The CANopen node number can range from 0 to 127. But the TJ1-CORT only supports node numbers from 1 to 99. The default node number, 0, is invalid. Therefore, the default node number must be changed before the TJ1-CORT is used.

3.9.4   TJ1-CORT connections

Pin	Signal	Description
1	V-	Power supply input, negative voltage
2	CAN L	Communication line, low
3	DRAIN	Shield
4	CAN H	Communication line, high
5	V+	Power supply input, positive voltage

fig. 106
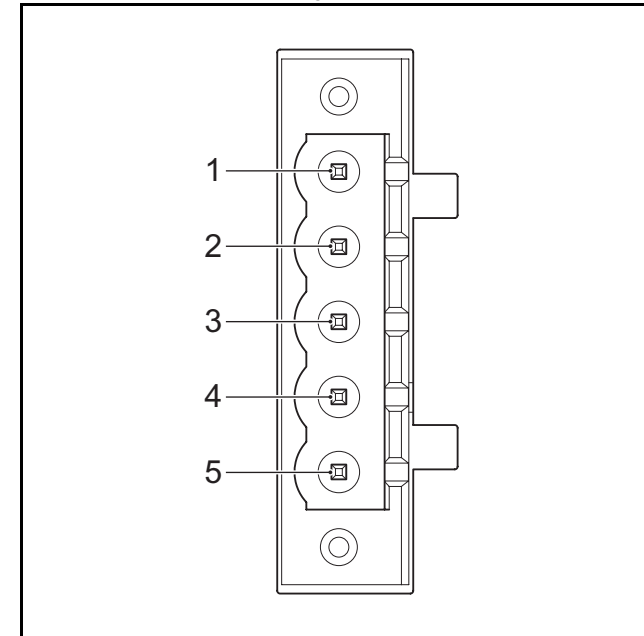
3.9.5   TJ1-CORT specifications

Item	Specification
Power supply	5 VDC (supplied by the TJ1-MC__)
Power consumption	120 mA at 5 VDC
Network power supply	24 VDC
Network current con-sumption	15 mA at 24 VDC
Power dissipation	0.6 W
Approximate weight	100 g
Electrical characteris-tics	Conforms to ISO 11898-1

Item	Specification
Communication ports	1 CAN port
Transmission speed	20, 50, 125 and 500 Kbps
Node numbers	1 to 99
I/O size	8 RPDO and 8 TPDO
Galvanic isolation	Yes
Device profile	DS302: CANopen manager profile Note: This CANopen master does not support motion control features of slaves with the DS401 profile

3.9.6   TJ1-CORT unit box contents

CANopen Master Unit box:
- Safety sheet.
- CANopen Master Unit.
- DeviceNet connector.
- Protection label attached to the top surface of the unit.

3.9.7   Applicable BASIC commands

The following BASIC commands are applicable for the TJ1-CORT:
- **CAN_CORT**

For more information, refer to the Trajexia Programming Manual.

3.10 TJ1-FL02

3.10.1 Introduction

⚠️ **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.

The TJ1-FL02 is an analogue control unit. It controls up to two axes A and B in these modes:
- Analogue speed reference plus encoder feedback.
- Incremental or absolute encoder input.
- Pulse output.

At start up the TJ1-MC__ assigns the TJ1-FL02 to the first 2 free axes in sequence. When multiple TJ1-FL02 units are connected they are assigned in unit sequence 0..6. Any MECHATROLINK-II axes that are assigned (using the driver switches) will not change. The TJ1-MC__ assigns the next free axis.
The TJ1-FL02 has these visible parts:

Part	Description
A	LEDs
B	15-pin connector
C	18-pin connector

fig. 107

3.10.2 LED description

The function of the LEDs is defined by the BASIC command
AXIS_DISPLAY. For more information, refer to the Programming Manual.
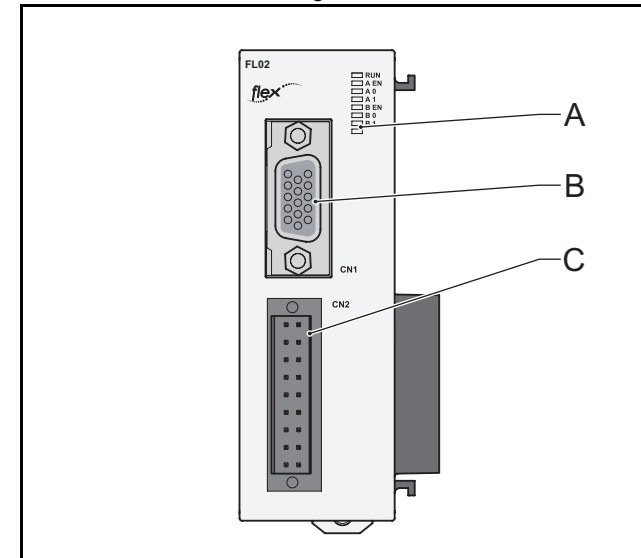
Axis	Label	Status	AXIS_DISPLAY parameter			
			0	1	2	3
All	run	on	The TJ1-MC__ recognises the TJ1-FL02			
A	A EN	on	Axis enabled.			
		flashing	Axis error			
		off	Axis disabled			
	A 0	on	REG 0	AUX	OUT 0	Encoder A
	A 1	on	REG 1	Encoder Z	OUT 1	Encoder B
B	B EN	on	Axis enabled			
		flashing	Axis error			
		off	Axis disabled			
	B 0	on	REG 0	AUX	OUT 0	Encoder A
	B 1	on	REG 1	Encoder Z	OUT 1	Encoder B

3.10.3 TJ1-FL02 connections

The signals of the 15-pin connector depend on the type of interface selected:

15-pin connector

Pin	Axis	Encoder input[1]	Encoder output	Stepper output	SSI/EnDat	Tamagawa
1	A	A+	A+	Step+	Clock+	
2	A	A-	A-	Step-	Clock-	
3	A	B+	B+	Dir+		
4	A	B-	B-	Dir-		
5		GND	GND	GND	GND	GND
6	A	Z+		Enable+	Data+	SD+
7	A	Z-		Enable-	Data-	SD-
8	B	Z+	Enable+	Enable+	Data+	SD+
9	B	Z-	Enable-	Enable-	Data-	SD-
10		+5V out	Do not use	Do not use	Do not use	Do not use
11	B	A+	A+	Step+	Clock+	
12	B	A-	A-	Step-	Clock-	
13	B	B+	B+	Dir+		
14	B	B-	B-	Dir-		
15		GND	GND	GND	GND	GND

fig. 108
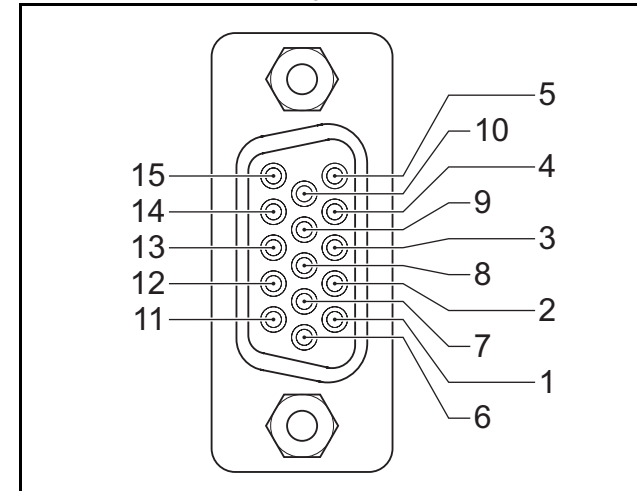
1. With the VERIFY parameter the input type can be changed from phase differential (VERIFY=ON, default) to Step (Channel A) and Direction (Channel B) (VERIFY=OFF).

18-pin connector

Pin	Axis	Signal	Pin	Axis	Signal	Description
1	A	Vout	2	B	Vout	Analog output
3	A	0V	4	B	0V	0V Reference for Vout
5		Wdog-	6		Wdog+	Enable relay contacts
7	A	Reg 0	8	B	Reg 0	24V registration inputs
9	A	Reg 1	10	B	Reg 1	24V registration inputs
11	A	AUX	12	B	AUX	24V auxiliary inputs
13	A	OUT 0	14	B	OUT 0	position switch outputs (HW_PSWITCH)
15	A	OUT 1	16	B	OUT 1	OUT1 Auxiliary outputs
17		I/O 0V Common	18		I/O +24 V	24V Power supply Input for the Outputs.

Digital inputs

The following table and illustration details the digital input specifications:

Item	Specification
Type	PNP
Maximum voltage	24 VDC + 10%
Input current	8 mA at 24 VDC
on voltage	18.5 VDC min
off voltage	5.0 VDC max

Input response time (registration):
- without noise filter: 0.5µs maximum.
- with noise filter 3.5µs maximum.

fig. 109
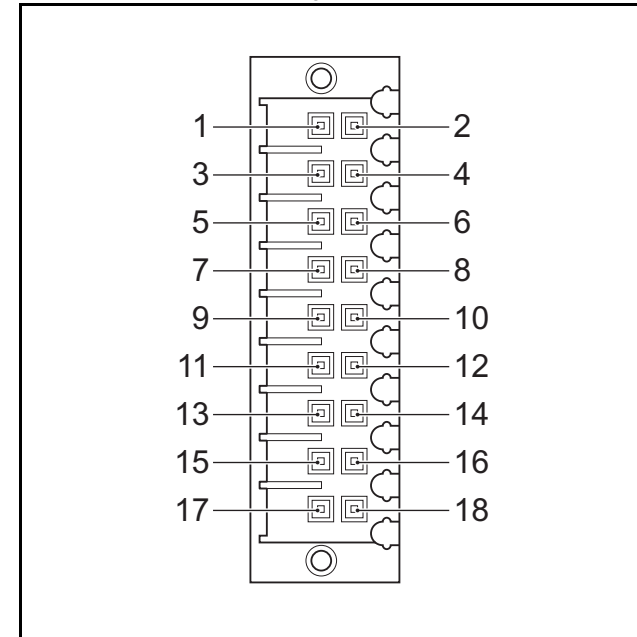
fig. 110
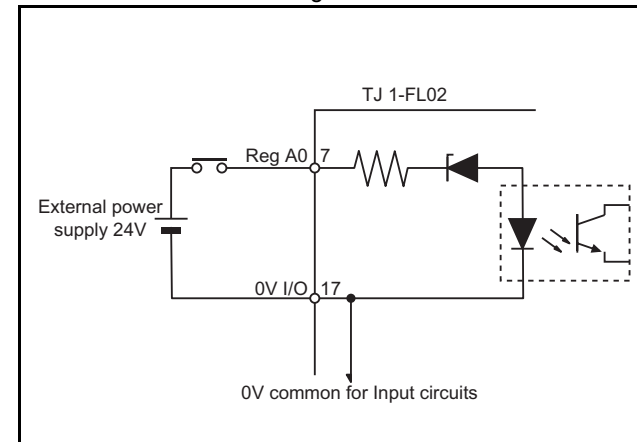
Note

In the case of an incorrect registration due to slow edges or noise, a digital noise filter can be enabled with the **REGIST** command. Refer to the BASIC Commands in the Programming Manual.

Note

A maximum of 4 inputs on is allowed simultaneously.
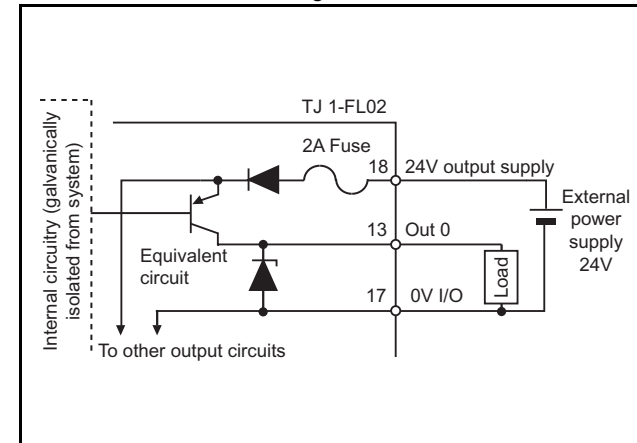
Digital outputs

The following table and illustration details the digital output specifications:

Item	Specification
Type	PNP
Maximum voltage	24 VDC + 10%
Current capacity	100 mA each output (400 mA for a group of 4)
Max. Voltage	24 VDC + 10%
Protection	Over current, Over temperature and 2A fuse on Common

Output response time (PSwitch):

- 140 µs maximum

fig. 111

Analog outputs

The following table and illustration details the analog output specifications:

Item	Specification
Output voltage	-10 to +10 V
Resolution	16 bit
Output impedance	100 Ω
Load impedance	10 k Ω min

fig. 112

Note

The analogue output of one flexible axis is always 0V unless both axes in the TJ1-FL02, axis A & B are enabled, that is:

WDOG=ON
AXIS_ENABLE AXIS(A)=1
AXIS_ENABLE AXIS(B)=1

Wdog relay

The following table and illustration details the Wdog relay:

Item	Specification
Type	Solid state relay
Current capacity	50 mA
on resistance	25 Ω max.
Maximum voltage	24 VDC + 10%
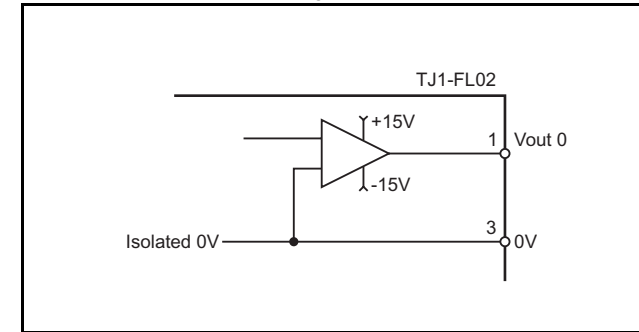
fig. 113
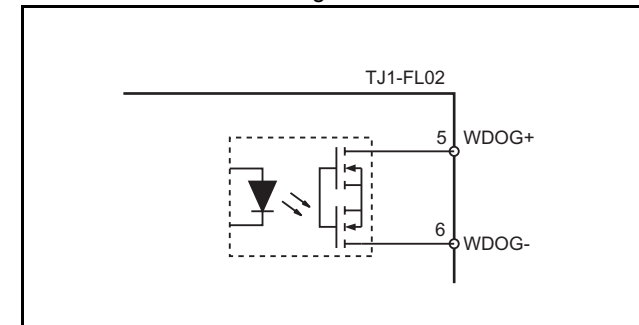
Encoder interface
The following table and illustration details the encoder interface:

Item	Specification
Type	Phase differential incremental encoder
Signal level	EIA RS-422-A Standards (line-driver)
Input impedance	48 kΩ min
Load impedance	220 Ω min
Termination	None

Connection example

fig. 114

The example shows the connections for the TJ1-FL02 to a F7 Inverter for position control.
The encoder from the motor must be connected to the encoder interface (PG-X2) in the Inverter (connector TA1). The encoder signal is forwarded in the connector TA2 of the (PG-X2).
Make the connections for the 18 pin connector on the TJ1-FL02 to the terminal board on the F7 Inverter as follows:

fig. 115

TJ1-FL02 pin number	F7 Inverter TA1	Signal	Description
1	A1	Vout	Analog output
3	AC	0V	0V Reference for Vout
5	S1	Wdog-	Enable relay contacts
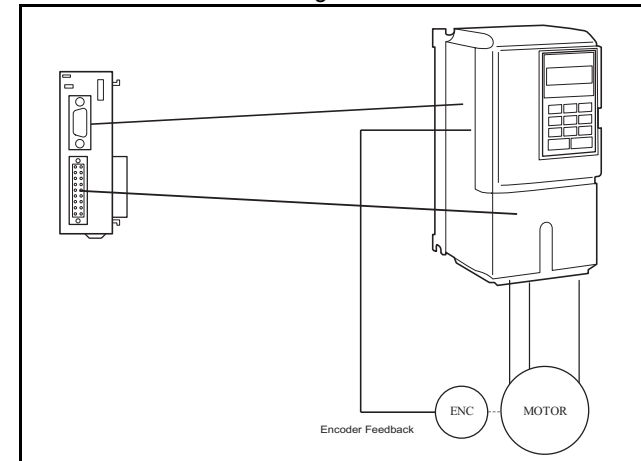
TJ1-FL02 pin number	F7 Inverter TA1	Signal	Description
6	SP	Wdog+	Enable relay contacts

The cable for pins 1 and 3 must be shielded twisted pair.
The cables for pins 5 and 6 are two single strand cables.

Make the connections for the 15 pin connector on the TJ1-FL02 to the PG-X2 option board on the F7 Inverter as follows:

TJ1-FL02 pin number	F7 Inverter TA2	Signal	Description
1	1	A+	Pulse monitor input phase A+
2	2	A-	Pulse monitor input phase A-
3	3	B+	Pulse monitor input phase B+
4	4	B-	Pulse monitor input phase B-
5	7	GND	Isolated controller circuit GND

Note
The cables are twisted pair (A+,A- and B+,B-) and shielded with the shield connected to the shell of the TJ1-FL02 15 pin connector.

3.10.4 TJ1-FL02 specifications

Item	Specification
Power supply	5 VDC and 24 VDC (supplied by the TJ1-MC__)
Total power consumption	3.35 W
Current consumption	190 mA at 5 VDC and 100 mA at 24 VDC
Approximate weight	110 g
Galvanic isolation	• Encoder interface • Analogue outputs • Digital interface
Output power supply	5 VDC, 150 mA Maximum

Item	Specification
Number of axes	2
Control method	• +/- 10 V analogue output in Closed Loop • Pulse Train output in Open Loop
Encoder position/speed feedback	Incremental and absolute
Absolute encoder standards supported	• SSI 200 kHz • EnDat 1 MHz • Tamagawa
Encoder input maximum frequency	6 MHz
Encoder/pulse output maximum frequency	2 MHz
Maximum cable length:	• SSI 200 kHz, 100 m • EnDat 1 MHz, 40 m • Tamagawa, 50 m • Encoder input, 100 m • Encoder/stepper output, 100 m
Auxiliary I/Os	• Two fast registration inputs per axis • Two definable inputs • Two hardware position switch outputs • One enable output • Two definable outputs

Note
The 5 VDC power supply can only be used when both axes are in
SERVO_AXIS mode (**ATYPE=44**).

3.10.5 Applicable BASIC commands

The following BASIC commands are applicable for the TJ1-FL02:
• **ATYPE**
• **AXIS_DISPLAY**
• **DRIVE_CONTROL**
• **DRIVE_STATUS**

BASIC commands applicable for specific encoder types, are listed with the corresponding explanations in the next chapters. For more information of BASIC commands, refer to the Trajexia Programming Manual.

3.10.6 Incremental encoder

An incremental encoder has this phase definition:
- An advanced phase A for forward rotation.
- An advanced phase B for reverse rotation.

By monitoring the relative phase of the 2 signals, you can easily detect the rotation direction. If signal A leads signal B, the movement is clockwise and the counter increments. If channel B leads channel A, the movement is counterclockwise and the counter decrements.
Most rotary encodes also provide an additional Z marker. This Z marker is a reference pulse within each revolution. With these 3 signals, you can determine the direction, the speed and the relative position.

Encoder input

The pulse ratio of the TJ1-MC__ is 1: every encoder edge (i.e., a pulse edge for either phase A or B) is equal to one internal count.
The figure shows phase A (A), phase B (B) and the number of counts (C) for forward or clockwise rotation (D) and reverse or counterclockwise rotation (E).
The signals A, B and Z appear physically as A+ and A-, B+ and B- and Z+ and Z-. They appear as differential signals on twisted-pair wire inputs. This makes sure that common mode noise is rejected.
When you use an encoder from other manufacturers, check the encoder specification for the phase advancement carefully. If the phase definition is different from the phase definition of the standard OMRON equipment, reverse the B-phase wiring between the TJ1-MC__ and the encoder.
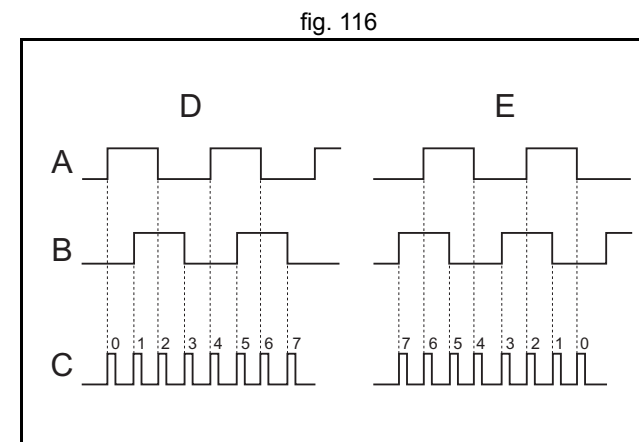
fig. 116

> **Note**
> The TJ1-FL02 does not have a termination inside. In case of long distances or disturbed communication, add an external termination to the TJ1-FL02.

The table below and the figure give an example of how to connect the OMRON E6B2-CWZ1Z encoder to the TJ1-FL02.

Encoder		TJ1-FL02	
Signal	**Wire color**	**Pin**	**Signal**
A+	Black	1	A+
A-	Black/red	2	A-
B+	White	3	B+
B-	White/red	4	B-
Z+	Orange	6	Z+
Z-	Orange/red	7	Z-
0 V (COM)	Blue	5	GND
5 VDC	Brown	10	+ 5V

fig. 117
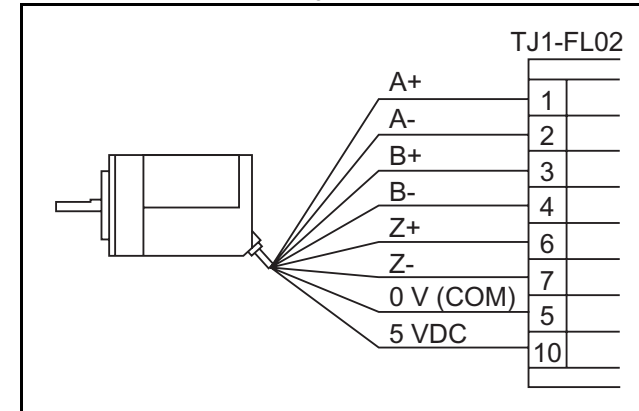
Encoder output

The TJ1-FL02 can generate encoder type pulses. For each internal count (C), the TJ1-FL02 produces one encoder edge for phase A (A) or phase B (B).

Related BASIC commands

The following BASIC commands are related to incremental encoders:
- **ATYPE (ATYPE=44 and ATYPE=45)**
- **ENCODER_RATIO**

For more information, refer to the Trajexia Programming Manual.

fig. 118
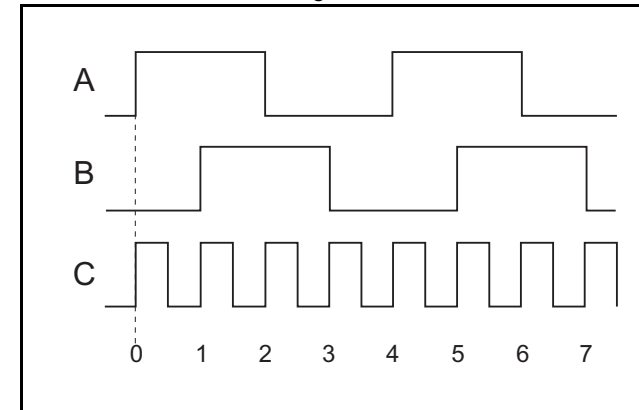
3.10.7 Absolute encoder

SSI

SSI (Synchronous Serial Interface) is a digital system for transferring data in serial form. SSI is the most widely used serial interface between absolute sensors and controllers. SSI uses a pulse train from the controller to clock out the data from the sensor.

The SSI interface of the TJ1-FL02 accepts absolute values from an encoder if the data is in Gray Code format or in binary format and if the resolution is 25 bits or less. The number of bits, and therefore the number of clock pulses sent to the encoder in each frame, is programmable. You set this number with the BASIC command **ENCODER_BITS = n**.

When you have initialized the TJ1-FL02 with the **ENCODER_BITS** command, the TJ1-FL02 continuously sends clock pulses to the encoder. These clock pulses are sent in frames of $n+2$ pulses, where n is the bit count set. The clock rate is fixed at 200 kHz. The clock interval between frames is 32 μs. The resulting maximum cable length between the controller and the sensor is 200 m.
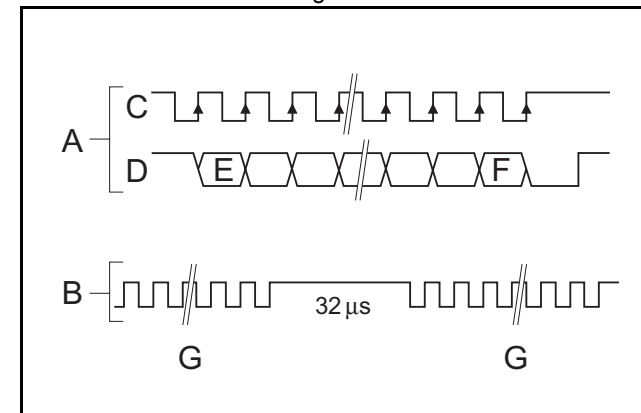
The labels in the figure are:

A. Timing diagram.
B. Clock sequence.
C. Clock.
D. Data.
E. MSB (Most Significant Bit).
F. LSB (Least Significant Bit).
G. Clock frame.

When the data is clocked into the TJ1-MC__, the position value is interpreted. With this position value, it produces a value for **MPOS** and a position error that is used to close the control loop.

The connections for SSI are:

fig. 119

| Encoder signal	Axis A	Axis B
DATA+	6	8
DATA-	7	9
CLOCK+	1	11
CLOCK-	2	12
GND	5 / 15	5 / 15

Note

The TJ1-FL02 does not have a termination inside. In case of long distances or disturbed communication, add an external termination to the TJ1-FL02.

The table below and the figure give an example of how to connect the Stegmann ATM 60-A encoder to the TJ1-FL02.

fig. 120

Encoder			TJ1-FL02	
Pin	Signal	Wire color	Pin	Signal
2	DATA+	White	6	DATA+
10	DATA-	Brown	7	DATA-
3	CLOCK+	Yellow	1	CLOCK+
11	CLOCK-	Lilac	2	CLOCK-
1	GND	Blue	5	GND
8	Us	Red	See footnote [1]	

1. Use an external power supply

Related BASIC commands
The following BASIC commands are related to SSI absolute encoders:
- **ATYPE (ATYPE=48)**
- **ENCODER_BITS**

For more information, refer to the Trajexia Programming Manual.
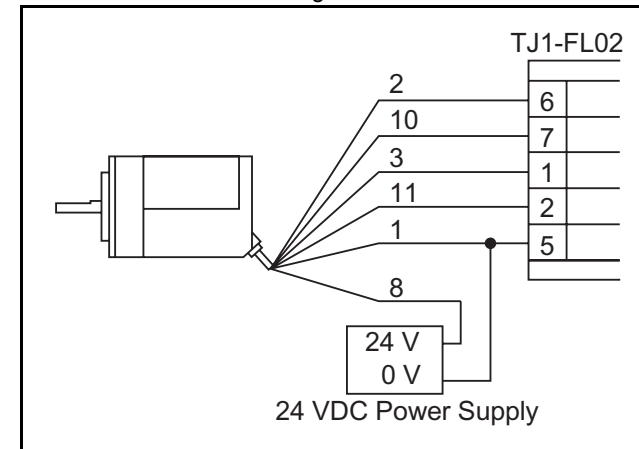
EnDat

You can configure the TJ1-FL02 to interface directly to EnDat absolute encoders. EnDat absolute encoders respond on a dedicated Clock and Data 1 MHz RS485 serial interface when their position is requested by the controller. When you set the encoder to the relevant encoder mode, the axis transmits an information request to the encoder on a fixed 250 μs cycle.

The connections for EnDat are:

Encoder signal	Axis A	Axis B
DATA	6	8
/DATA	7	9
CLOCK	1	11
/CLOCK	2	12
GND	5 / 15	5 / 15

> **Note**
> The TJ1-FL02 does not have a termination inside. In case of long distances or disturbed communication, add an external termination to the TJ1-FL02.

The table below and the figure give an example of how to connect the Heidenhain ROC 425 2048 5XS08-C4 encoder to the TJ1-FL02.

Encoder			TJ1-FL02	
Pin	Signal	Wire color	Pin	Signal
3	DATA	Grey	6	DATA
4	/DATA	Pink	7	/DATA
7	CLOCK	Violet	1	CLOCK
6	/CLOCK	Yellow	2	/CLOCK
5	GND	White/Green	5	GND

fig. 121
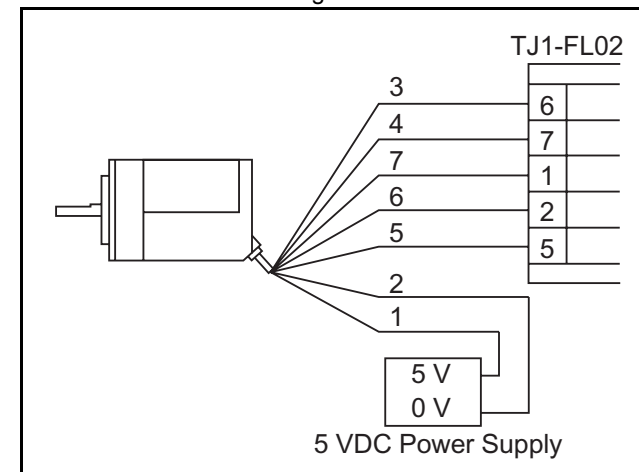
Encoder			TJ1-FL02	
Pin	**Signal**	**Wire color**	**Pin**	**Signal**
2	0 V	White	See footnote [1]	
1	Up	Blue		

1. Use an external power supply

Related BASIC commands
The following BASIC commands are related to EnDat absolute encoders:

- **ATYPE (ATYPE=47)**
- **ENCODER_BITS**
- **ENCODER_CONTROL**
- **ENCODER_READ**
- **ENCODER_TURNS**
- **ENCODER_WRITE**

For more information, refer to the Trajexia Programming Manual.

Tamagawa
In the figure, A is the encoder side, and B is the receiving side.

The TJ1-FL02 can interface directly to Tamagawa "SmartAbs" absolute encoders. Tamagawa encoders respond on a dedicated 2.5 MHz RS485 serial interface when their position is requested by the controller. When you set the encoder to the relevant encoder mode, the axis transmits an information request to the encoder on a fixed 250 µs cycle. The data returned is available to BASIC and you can use it to drive a servo motor.
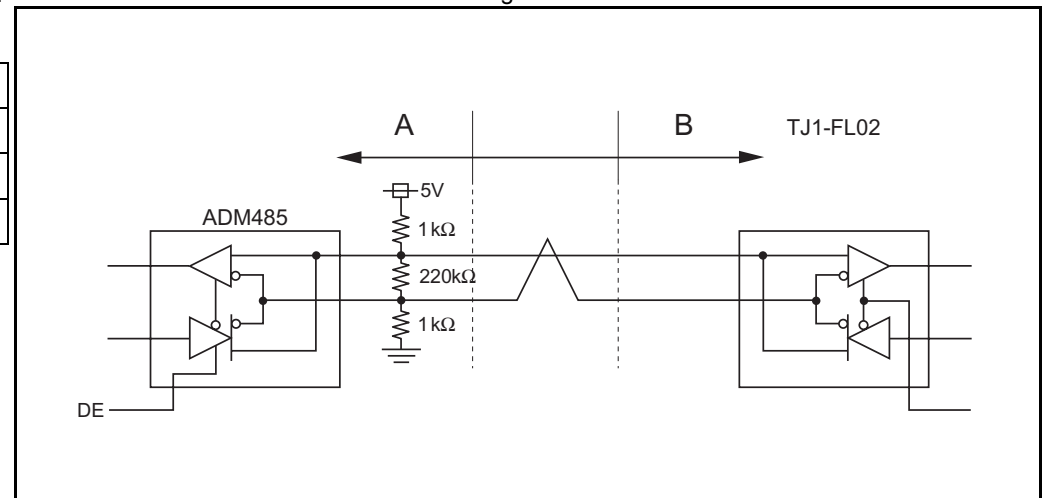The connections for Tamagawa are:

Encoder signal	Axis A	Axis B
SD	6	8
/SD	7	9
GND	5 / 15	5 / 15

Note
The TJ1-FL02 does not have a termination inside. In case of long distances or disturbed communication, add an external termination to the TJ1-FL02.

fig. 122

The table below and the figure give an example of how to connect the Tamagawa TS5667N420 encoder to the TJ1-FL02.

Encoder		TJ1-FL02	
Signal	**Wire color**	**Pin**	**Signal**
SD	Blue	6	SD
/SD	Blue/Black	7	/SD
GND	Black	5	GND
Vcc	Red	Use an external power supply	

Related BASIC commands
The following BASIC commands are related to Tamagawa absolute encoders:
- **ATYPE (ATYPE=46)**
- **ENCODER_ID**
- **ENCODER_STATUS**
- **ENCODER_TURNS**

For more information, refer to the Trajexia Programming Manual.

fig. 123
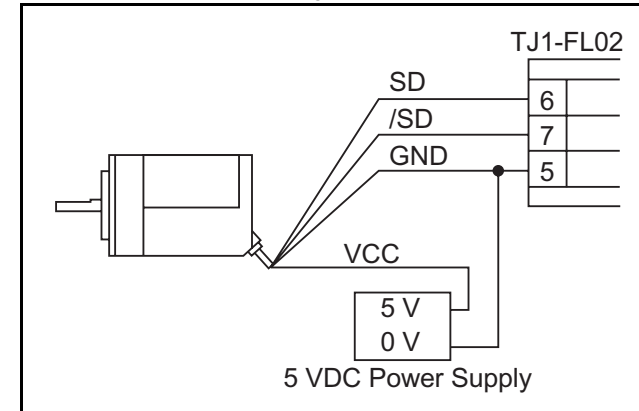
3.10.8 Stepper

The TJ1-FL02 can generate pulses to drive an external stepper motor amplifier. You can use single step, half step and micro-stepping drivers with this interface. Applicable signals:
*   Enable
*   Step
*   Direction.

Related BASIC commands
The following BASIC commands are related to stepper outputs:
*   **ATYPE (ATYPE=43)**
*   **INVERT_STEP**

For more information, refer to the Trajexia Programming Manual.

fig. 124

3.10.9 Registration

The TJ1-FL02 can capture the position of an axis in a register when an event occurs. The event is called the print registration input. On the rising or falling edge of an input signal (either the Z marker or an input), the TJ1-FL02 captures the position of an axis in hardware. You can use this position to correct possible errors between the actual position and the desired position. You set up the print registration with the **REGIST** command.
The position is captured in hardware and therefore there is no software overhead. This eliminates the need to deal with timing issues.
Because the registration inputs are very fast, they are susceptible to noise in combination with slow rising and falling edges. To counter this problem, you can use a digital noise filter. Use of the noise filter increases the response time from $0.5 \, \mu s$ to $3.5 \, \mu s$.
We refer to the **REGIST** command in the Trajexia Programming Manual for more information on using the registration inputs.
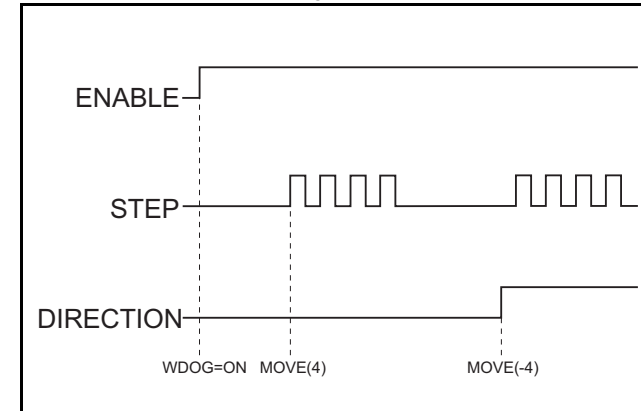
3.10.10 Hardware PSWITCH

The TJ1-FL02 has 2 outputs that you can use as hardware position switches. These outputs go on when the measured position of the predefined axis is reached. They go off when another measured position is reached.
The outputs are driven by hardware only. This means that the response times do not have software delays.
We refer to the **HW_PSWITCH** command in the Trajexia Programming Manual for more information on using the position switches.

3.10.11 TJ1-FL02 box contents

- Safety sheet.
- TJ1-FL02.
- Protection label attached to the top surface of the unit.
- Parts for a 15-pin connector.
- Parts for an 18-pin connector.

A   Differences between Sigma-II and Junma

These are the differences between Sigma-II and Junma Servo Drivers and motors.

1. Motor
    *   The Sigma-II Servo Driver can control a large range of servo motors. These include rotary, DD and Linear motors with different encoders, IP rates, inertias and other electrical and mechanical characteristics.
    *   The Junma can only control Junma motors with a 13-bit incremental encoder. These motors have a low IP rate and medium inertia.
2. Power and voltage range
    *   The output power of Sigma-II Servo Drivers and motors range from 30 W to 15 kW. The input voltages of Sigma-II Servo Drivers and motors are 200 V single phase and 400 V three phase.
    *   The output power of Junma Servo Drivers and motors range from 100W to 800W. The input voltage of Junma Servo Drivers and motors is 200V single phase.
3. Power circuit
    *   Sigma-II always has a breaking chopper. Most models have internal braking resistor too. The voltage supplies for power and control circuits are separate.
    *   Junma has no breaking chopper or resistor. The same voltage supply is used for both power and control circuits.
4. Motion control algorithm
    *   Sigma-II has a traditional PID control algorithm, which in most cases needs adjustments and tuning of parameters. Sometimes adjusting and tuning can be time consuming but the benefit is full coverage of a very wide range of applications regarding mechanical characteristics of the system, such as inertia ratio, rigidity etc.
    *   Junma supports a new and innovative self-tuning control algorithm, which requires no adjustment and tuning from the user. The benefit of this algorithm is that commissioning of the system is very fast and easy. The drawback is a limited range of applications covered. This particularly applies to inertia ratio. Junma Servo Drivers and motors cannot serve applications where the inertia ratio is larger than 1:10 approximately.
5. Control modes

*   Sigma-II can work in all three control modes: position mode (**ATYPE=40**), speed mode (**ATYPE=41**) and torque (force) mode (**ATYPE=42**).
*   Junma can work only in position mode (**ATYPE=40**). Trying to set an axis assigned to a Junma Servo Driver and motor to some other control mode results in an alarm on the driver
6. I/O
    *   Sigma-II has 7 digital inputs and 4 digital outputs. Functionality of these I/Os is very flexible and can be configured using drivers parameters. Analog control is possible (with the TJ1-FL02). There is an encoder output as well, and fully closed encoder configuration is possible.
    *   Junma has 4 digital inputs and 2 digital outputs. They are not flexible, but have fixed functionality. Fully closed encoder configuration is not possible.
7. Operator interface and settings
    *   The Sigma-II Servo Driver has a full operator interface. It consists of a 4-digits display and 4 buttons. The interface can be used to monitor and change parameters, perform tuning etc. Changing parameters by using the CX-Drive software or by sending MECHATROLINK-II commands from Trajexia is also possible.
    *   The Junma Servo Driver has a limited operator interface. It consists of a 1-digit display that shows the driver status and alarms. Monitoring and changing of parameters is only possible by using a separate operator panel, the CX-Drive software or by sending MECHATROLINK-II commands from Trajexia.

For more detailed information on the differences between Sigma-II and Junma Servo Drivers and motors, please see their respective manuals.

Revision history

A manual revision code shows as a suffix to the catalogue number on the front cover of the manual.

Revision code	Date	Revised content
01	August 2006	Original
02	October 2006	DeviceNet update
03	May 2007	Updated with TJ1-MC04, TJ1-ML04, JUNMA series Servo Drivers and the MECHATROLINK-II repeater. Updated with motion control concepts, servo system principles and detailed encoder information.
04	June 2008	Updated with TJ1-CORT, GRT1-ML2, Sigma-V Servo Driver and MECHATROLINK-II functionality (Inverter as an axis)
05	January 2010	Updated with G-Series and Accurax G5 Servo Drivers

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