Cat. No.
I51E-EN-05

OMRON

Trajexia motion control system

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

HARDWARE REFERENCE MANUAL

Manual abstract:

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 Revision 5.0 HARDWARE REFERENCE MANUAL I 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. /i Name Trajexia motion control system QUICK START GUIDE Trajexia motion control system HARDWARE REFERENCE MANUAL Trajexia motion control system PROGRAMMING MANUAL Sigma-II Servo Driver manual Sigma-III with MECHATROLINK interface manual Sigma-V Servo Driver manual JUNMA series servo drive manual Cat. No. I50E Contents Describes how to get quickly familiar with Trajexia, moving a single axis using MECHATROLINK-II, in a test set-up. Describes the installation and hardware specification of the Trajexia units, and explains the Trajexia system philosophy. Name V7 Inverter F7Z Inverter G7 Inverter JUSP-NS115 manual SI-T MECHATROLINK interface for the G7 & F7 ST-T/V7 MECHATROLINK interface for the V7 MECHATROLINK IO Modules Cat. No. Contents TOEP C71060605 02-OY Describes the installation and operation of V7 Inverters TOE S616-55 1-OY TOE S616-60 SIEP C71080001 Describes the installation and operation of F7Z Inverters Describes the installation and operation of G7 Inverters Describes the installation and operation of the MECHATROLINK-II application module Describes the installation and operation of MECHATROLINK-II interfaces for G7 and F7 Inverters Describes the installation and operation of MECHATROLINK-II interfaces for V7 Inverters Describes the installation and operation of MECHATROLINK-II input and output modules and the MECHATROLINK-II repeater Describes FINS communications protocol and FINS commands Describes the installation and operation of Omron slice I/O units SIBP-C730600-08 I51E SIBP-C730600-03 SIE C887-5 I52E Describes the BASIC commands to be used for programming Trajexia, communication protocols and Trajexia Studio software, gives practical examples and troubleshooting information. Describes the installation and operation of Sigma-II Servo Drivers Describes the installation and operation of Sigma-III Servo Drivers with MECHATROLINK-II interface Describes the installation and operation of Sigma-V Servo Drivers SYSMAC CS/CJ Series Communications Commands Omron Smartslice GRT1-Series, slice I/ O units, Operation manual Omron G-series user's manual Omron Accurax G5 user's manual Trajexia Studio user manual W342 SIEP S800000 15 SIEP S800000 11 W455-E1 I566-E1 I572-E1 I56E-EN SIEP S800000-44-O-OY SIEP S800000-46-O-OY SIEP S800000-48-O-OY Describes the installation and operation of G-series Servo Drivers Describes the installation and operation of Accurax G5 Servo Drivers Describes the use of Trajexia Studio programming software TOEP-C71080603 01-OY Describes the installation and operation of JUNMA Servo Drivers Revision 5.0 HARDWARE REFERENCE MANUAL II WARNING Failure to read and understand the information provided in this manual may result in personal injury or death, damage to the product, or product failure.

Please read each section in its entirety and be sure you understand the information provided in the section and related sections before attempting any of the procedures or operations given. 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__. 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__.

/i Functionality Full support TJ1-FL02 Support BASIC commands FINS_COMMS Support TJ1-DRT Support TJ1-MC04 andTJ1-ML04 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 Support for G-series Drivers, full support for Sigma-V series Servo Drivers Support for Accurax G5 Drivers Revision 5.0 TJ1-MC__ Firmware version V1.6509 V1.6509 V1.6509 V1.

6607 V1.6652 TJ1-MC__ FPGA version 21 and higher All versions All versions 21 and higher 21 and higher V1.6714 V1.6720 21 and higher 21 and higher Verify the firmware and FPGA versions of the TJ1-MC__ HARDWARE REFERENCE MANUAL III Contents 1 Safety warnings and precautions..

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....158 TJ1-DRT .
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..esult in electric shock. Revision 5.0 HARDWARE REFERENCE MANUAL 1 Safety warnings and precautions 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.

Revision 5.0 HARDWARE REFERENCE MANUAL 2 Safety warnings and precautions 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. 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 100 or less) when installing the Units. Not connecting to a class-3 ground may result in electric shock. 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 MECHATROLINKII 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.

Revision 5.0 HARDWARE REFERENCE MANUAL 3 Safety warnings and precautions 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.

4 Revision 5.0 HARDWARE REFERENCE MANUAL Safety warnings and precautions 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. 5 Revision 5.0 HARDWARE REFERENCE MANUAL Safety warnings and precautions 1.
7 1.7.1 Conformance to EC Directives Conformance 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. Revision 5.0 HARDWARE REFERENCE MANUAL 6 System philosophy 2 2.1 System philosophy Introduction fig. 1 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. TJ1-MC__ Program Buffer Buffer & profile gererator AXIS CONTROL LOOP AXIS TYPE Position Loop TJ1-ML__ ENC BASIC PROGRAMS Process 1 Process 2 Process 3 2.

1.1 Glossary Servo Driver Position Loop Speed Loop Torque Loop All other Servo Drivers MOTOR Motion sequence The Motion Sequence is responsible for controlling the position of the axes. ... Process 14 Comms 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. MC I/O TJ1-FL02 Servo Driver Ethernet FINS ENC TJ1-PRT Profibus Speed Loop Torque Loop MOTOR Cycle time Is the time needed to execute one complete cycle of operations in the TJ1MC__. 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. Ethernet BUILT-IN Via TJ1-ML16 CPU tasks The operations executed in each CPU task are: CPU task Revision 5.0 Operation Motion Sequence Low priority process First CPU task HARDWARE REFERENCE MANUAL 7 System philosophy CPU task Second CPU task Third CPU task Operation High priority process Motion Sequence (only if SERVO_PERIOD=0.
5ms) LED Update High priority process External Communications Fourth CPU task 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 HARDWARE REFERENCE MANUAL 8 Revision 5.0 System philosophy 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 MOVEABS(30) MOVE(60) MOVEABS(50) MOVE(50) MOVE(30) 0 50 100 A 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.

Revision 5.0 HARDWARE REFERENCE MANUAL 9 System philosophy 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: /i Parameter UNITS ACCEL DECEL SPEED Description Unit conversion factor Acceleration rate of an axis in units/s2 Deceleration rate of an axis in units/s2 Demand speed of an axis in units/s2 fig. 3 B 50 MOVEABS(100) AXIS(0) MOVEABS(50) AXIS(1) 0 50 100 A 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/s2. 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. Revision 5.

0 fig. 4 B 10 ACCEL=10 DECEL=10 SPEED=10 MOVE(40) 0 1 2 3 4 5 6 A HARDWARE REFERENCE MANUAL 10 System philosophy 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. 10 fig. 5 B ACCEL=5 DECEL=10 SPEED=10 MOVE(40) 0 1 2 3 4 5 6 A fig. 6 B 10 ACCEL=10 DECEL=5 SPEED=10 MOVE(40) 0 1 2 3 4 5 6 A 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.

/i Acceleration time = Revision 5.0 HARDWARE REFERENCE MANUAL 11 System philosophy Acceleration distance = Deceleration time = Deceleration distance = Constant speed distance = Total time = 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 TJ1MC__ supports the following operations: · Linear interpolation · Circular interpolation · CAM control. Revision 5.0 HARDWARE REFERENCE MANUAL 12 System philosophy 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 2 1 3 B A Revision 5.0 HARDWARE REFERENCE MANUAL 13 System philosophy Circular interpolation It may be required that a tool travels from the starting point to the end point in an arc of a circle. In this instance the motion of two axes is related via a circular interpolated move using the MOVECIRC command. Consider the diagram in the figure. It corresponds to the MOVECIRC(100,0,-50,0,0) command. The centre point and desired end point of the trajectory relative to the start point and the direction of movement are specified. The MOVECIRC command computes the radius and the angle of rotation.

Like the linearly interpolated MOVE command, the ACCEL, DECEL and SPEED variables associated with the base axis determine the speed profile along the circular move. fig. 8 50 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. -50 0 50 fig. 9 B A 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 HARDWARE REFERENCE MANUAL 14 Revision 5.0 System philosophy 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. /i Axes 0 1 1:1 CONNECT(1,0) AXIS(1) Ratio CONNECT command fig. 10 B 2:1 1:1 1:2 A 2:1 CONNECT(2,0) AXIS(1) 1:2 CONNECT(0.5,0) AXIS(1) Revision 5.

0 HARDWARE REFERENCE MANUAL 15 System philosophy 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 B A 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 B C E D A Revision 5.0 HARDWARE REFERENCE MANUAL 16 System philosophy 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) B A B A B A Revision 5.0 HARDWARE REFERENCE MANUAL 17 System philosophy 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. Revision 5.0 HARDWARE REFERENCE MANUAL 18 System philosophy Merging moves If the MERGE axis parameter is set to 1, a movement is always followed by a subsequent movement without stopping. The figures show the transitions of two moves with MERGE value 0 and value 1. In the figure, A is the time axis and B is the speed axis.

fig. 14 B MERGE=0 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. A B MERGE=1 A 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. Revision 5.0 HARDWARE REFERENCE MANUAL 19 System philosophy 2.3.2 Internal operation of the TJ1-MC__ fig.

15 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. A 2 3 B C 1 D E F I 4 G H J 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. Revision 5.0 HARDWARE REFERENCE MANUAL 20 System philosophy 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 Kp creates an output Op that is proportional to the Following Error E. Op = Kp · 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 Ki creates an output Oi that is proportional to the sum of the Following Errors that have occurred during the system operation. Oi = Ki · 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 Kd produces an output Od 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. Od = Kd · 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 Kov produces an output Oov that is proportional to the change in the measured position Pm and increases system damping.

Oov = Kov · Pm Revision 5.0 fig. 16 Kvff Kp A B Ki Kd Kov C D HARDWARE REFERENCE MANUAL 21 System philosophy · 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 Kvff produces an output Ovff that is proportional to the change in demand position Pd and minimizes the Following Error at high speed.

Ovff = Kvff · Pd 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. 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 default settings are given in the table along with the resulting profiles. Fractional values are allowed for gain settings. /i Gain Proportional gain Integral gain Derivative gain Output speed gain Speed feedforward gain Default value 0.1 0.

0 0.0 0.0 0.0 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 2.4 Trajexia system architecture The system architecture of the Trajexia is dependant upon these concepts: · Program control · Motion Sequence · Motion buffers · Communication · Peripherals Revision 5.0 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 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.

HARDWARE REFERENCE MANUAL 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 22 System philosophy 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 fig. 17 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 First CPU task Second CPU task Third CPU task Operation Motion Sequence Low priority process High priority process 1 250µs 1 2 3 4 Cycle time = 1ms fig. 18 500 µs 1 2 3 4 Motion Sequence (only if SERVO_PERIOD=0.

5ms) LED Update. High priority process External Communications Cycle time = 2 ms Fourth CPU task Note The Motion sequence execution depends on setting of the SERVO_PERIOD parameter. HARDWARE REFERENCE MANUAL 23 Revision 5.0 System philosophy 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. CPU task 1 CPU task 2 CPU task 3 fig. 19 Motion sequence Low priority task (0,1,2,3...

) High priority task (13,14) Motion sequence LED refresh High priority task (13,14) Communication 1ms CPU task 4 Revision 5.0 HARDWARE REFERENCE MANUAL 24 System philosophy 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 CPU task 2 CPU task 3 Motion sequence Low priority task (0,1,2,3...) High priority task (13,14) LED refresh High priority task (13,14) Communication 1ms CPU task 4 Example 3 The SERVO_PERIOD has a value of 2ms and the motion sequence is executed every 2.0ms.

CPU task 1 fig. 21 Motion sequence Low priority task (0,1,2,3...) High priority task (13,14) LED refresh High priority task (13,14) Communication 2ms 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. HARDWARE REFERENCE MANUAL CPU task 2 CPU task 3 CPU task 4 Revision 5.0 25 System philosophy /i SERVO_PERIOD 0.

5 ms TJ1-MC16 8 axes 4 non-axis devices 1.0 ms 16 axes 8 non-axis devices 2.0 ms 16 axes 8 non-axis devices TJ1-MC04 5 axes 4 non-axis devices 5 axes 8 non-axis devices 5 axes 8 non-axis devices 16 devices 4 devices 8 devices 4 devices TJ1-ML16 4 devices TJ1-ML04 4 devices Configuration examples Example 1 · · · · 1x TJ1-MC__ 1x TJ1-ML__ 3x Sigma-II Servo Driver SERVO_PERIOD = 1ms fig. 22 Servo Driver 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. Address 43 Address 44 Address 45 Terminator Revision 5.0 Axis 2 Axis 3 Axis 4 HARDWARE REFERENCE MANUAL 26 System philosophy Example 2 · · · · 1x TJ1-MC16 2x TJ1-ML16 16x Sigma-II Servo Driver SERVO_PERIOD = 1ms fig.

23 Servo Drive TJ1-MC16 supports 1ms SERVO_PERIOD with 16 axes. TJ1-ML16 supports 1ms SERVO_PERIOD with 8 devices. Sigma-II supports 1ms SERVO_PERIOD. Address Address Address Address Address Address Address Address 41 42 43 44 45 46 47 48 Terminator Axis 0 Axis 1 Axis 2 Axis 3 Axis 4 Axis 5 Axis 6 Axis 7 Address Address Address Address Address Address Address Address 49 4A 4B 4C 4D 4E 4F 50 Terminator Axis 8 Axis 9 Axis 10 Axis 11 Axis 12 Axis 13 Axis 14 Axis 15 Revision 5.0 HARDWARE REFERENCE MANUAL 27 System philosophy 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 Address 21 Address Address Address 61 62 63 fig. 24 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. Address Address Address Address Address Address Address Address 41 42 43 44 45 46 47 48 0 31 32 95 96 159 160 Example 4 I/O Memory Allocations · · · · · · 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 fig. 25 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. Axis 7 Address 43 Address 44 Axis 8 Axis 0 Axis 1 Address 45 Address 46 Address 47 Revision 5.0 Axis 2 Axis 3 Axis 4 Axis 5 Axis 6 HARDWARE REFERENCE MANUAL 28 System philosophy 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 fig. 26 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. Revision 5.0 LT HT #1 HT #2 COMS. Cycle time fig. 27 A B LT HT #1 HT #2 Cycle time COMS. HARDWARE REFERENCE MANUAL 29 System philosophy 2.6.4 Multi-tasking example fig. 28 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. 1 In the middle example, there is only one high-priority process, 14. Both HT 3 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 2 HT periods can be used for the low-priority processes. The LT period is also 3 used for the low-priority processes. 1ms 1ms 1ms 1ms COMS. 14 13 COMS.

2 14 13 COMS. 1 14 13 0 (c/l) 14 13 COMS. 1ms 1ms COMS. 1ms COMS. 1ms COMS. 14 2 14 1 14 0 (c/l) 14 COMS. 3 1ms 1ms 1ms 1ms 3 2 1 COMS. 0 (c/l) 3 2 COMS. 1 0 (c/l) 3 COMS. 2 1 0 (c/l) COMS.

2.7 Motion sequence and axes fig. 29 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: Revision 5.0 · · block AXIS PARAMETER Position loop + Servo Drive OFF Speed loop Torque loop Profile generator Demanded position Measured position Following error Speed command ON M E HARDWARE REFERENCE MANUAL 30 System philosophy 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 fig. 30 Basic Program ...
.....
. ....
..... MOVE(1000) .....

....
... 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. Profile generator Demand Position 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 · Revision 5.0 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 31 HARDWARE REFERENCE MANUAL System philosophy · · 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 /i Type of axis Name Virtual axis Description 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. Position loop in the Servo Driver. TJ1-MC__ sends position reference to the Servo Driver via MECHATROLINK-II. ATYPE Applicable to 0 All axes 40 41 MECHATROLINK-II Servo Drivers connected to a TJ1ML__ MECHATROLINK-II Position MECHATRO- Position loop in the Trajexia. TJ1-MC__ sends LINK-II Speed speed reference to the Servo Driver via MECHATROLINK-II. (Default) MECHATRO- Position loop in the Trajexia.
TJ1-MC__ sends LINK-II Torque torque reference to the Servo Driver via MECHATROLINK-II. 42 Revision 5.0 HARDWARE REFERENCE MANUAL 32 System philosophy ATYPE Applicable to 43 External driver connected to a TJ1-FL02 Name Description Stepper output Pulse and direction outputs. Position loop is in the driver. TJ1-FL02 sends pulses and receives no feed back.
Servo axis (Default) Encoder Encoder output Analogue servo. Position loop is in the TJ1MC__. The TJ1-FL02 sends speed reference and receives position from an incremental encoder. The same as stepper, but with the phase differential outputs emulating an incremental encoder. 44 45 46 47 48 49 ML__ Absolute Tam- The same as servo axis but the feed back is agawa received from a Tamagawa absolute encoder.
Absolute EnDat Absolute SSI Inverter as axis The same as servo axis but the feed back is received from an EnDat absolute encoder. The same as servo axis but the feed back is received from an SSI absolute encoder. 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 Profile generator MEASURED POSITION = DEMAND POSITION Revision 5.0 HARDWARE REFERENCE MANUAL 33 System philosophy 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 TJ1-MC__ TJ1-ML__ SERVO SERVO = OFF SERVO = OFF Profile generator ML-II Position command Position Loop Speed Loop Position loop Torque Loop Trajexia Position Loop is deactivated (Gains are not used!) + _ Demanded position Measured position Following error Speed command E M 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 TJ1-MC__ TJ1-ML__ SERVO SERVO = OFF Position loop SERVO = OFF + Profile generator Demanded position Measured position _ Following error Speed command ML-II Speed command Speed Loop Torque Loop E M Revision 5.0 HARDWARE REFERENCE MANUAL 34 System philosophy 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. SERVO = OFF fig. 34 TJ1-MC__ TJ1-ML__ SERVO Position loop SERVO = OFF + Profile generator Demanded position Measured position _ Following error Torque command ML-II Torque command Torque Loop E M 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.
Revision 5.0 HARDWARE REFERENCE MANUAL 35 System philosophy 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 TJ1-MC__ TJ1-FL02 DRIVE _ + 10V SERVO = OFF Position loop SERVO = OFF + Profile generator Demanded Position _ Following Error Speed Command Measured Position Encoder Signal E M 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 TJ1-FL02 TJ1-MC__ Measured Position Revision 5.0 HARDWARE REFERENCE MANUAL 36 System philosophy 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 TJ1-FL02 Profile generator AXIS 1 ATYPE = 45 Demanded position 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 TJ1MC__ 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. Revision 5.0 HARDWARE REFERENCE MANUAL 37 System philosophy 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. Profile generator Demanded position Measured position fig. 38 TJ1-MC__ TJ1-ML__ INVERTER SERVO = OFF Position loop SERVO = OFF + _ Following error Speed command ML-II Speed command Speed Loop 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. /i DPRAM REFRESH EVERY 5ms E M ATYPE SERVO Mode 40 40 41 OFF ON OFF Comment Position The position loop is closed in the Servo Driver. (MECHATROLINK-II) No new motion command is allowed.

Position Recommended mode for position control with (MECHATROLINK-II) MECHATROLINK-II axes. Speed Recommended mode for speed control with (MECHATROLINK-II) MECHATROLINK-II axes. Set the speed with S_REF. Revision 5.0 HARDWARE REFERENCE MANUAL 38 System philosophy ATYPE SERVO Mode 41 ON Comment Position The position loop is closed in Trajexia. This (MECHATROLINK-II) gives lower performance than closing the position loop in the Servo Driver. Torque Recommended mode for torque control with (MECHATROLINK-II) MECHATROLINK-II axes. Set the torque with T_REF. Position via torque The position loop is closed in Trajexia. The out(MECHATROLINK-II) put of the position loop is sent as the torque reference to the Servo Driver.

Speed (Flexible Axis) Position (Flexible Axis) Speed Recommended mode for speed control with Flexible Axis. The position loop is closed in Trajexia. Recommended mode for position control with Flexible Axis. Inverter (with built-in encoder interface) controlled on the MECHATROLINK-II bus as a servo axis. Set the speed with S_REF.

Inverter (with built-in encoder interface) controlled on the MECHATROLINK-II bus as a servo axis. The position loop is closed in Trajexia. 42 OFF 42 ON 44, 46, 47, 48 44, 46, 47, 48 49 OFF ON OFF 49 ON Position Revision 5.0 HARDWARE REFERENCE MANUAL 39 System philosophy 2.8 Motion buffers fig.

39 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. BASIC PROGRAM .... MOVE(-500) .

.....

. MOVE(1000) ....

... CONNECT(1,1) ....

AXIS BUFFER (one per axis) CONNECT(1,1) AXIS(2) PROCESS BUFFER NTYPE MTYPE Waiting to be executed MOTION COMMAND Currently executed MOTION COMMAND DEMAND POSITION Profile generator 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. 40 Process 1 Process 2 Process 3 Process 4 Process 5 Process 6 Process 7 Process Buffer Process Buffer Process Buffer Process Buffer Process Buffer Process Buffer Process Buffer Axis 0 Axis 1 Axis 2 Axis 3 WAITING NTYPE NTYPE NTYPE NTYPE EXECUTING MTYPE MTYPE MTYPE MTYPE Axis 15 Process 14 Program Buffer NTYPE MTYPE Each process has its own "Process Buffer" Revision 5.0 Each Axis has its own 2 buffers: NTYPE & MTYPE HARDWARE REFERENCE MANUAL 40 System philosophy fig. 41 EXAMPLE: BASIC PROGRAM .....

.. MOVE(-500) ...

.... MOVE(1000) .

...... DATUM(3) ....

... MOVE(200) ....

BUFFER --------------------------------NTYPE IDLE --------------------------------MTYPE MOVE(-500) ---- MOVE -500 BASIC PROGRAM .....

.. MOVE(-500) ...

.... MOVE(1000) ......

. DATUM(3) .... MOVE(200) ..

.....

1.- All buffers are empty and a movement is loaded. The movement starts to execute . BUFFER -----------------------------------NTYPE MOVE(1000) -------------------------------MTY PE MOVE(-500) MOVE -500 BASIC PROGRAM ..

..... MOVE(-500) .....

.. MOVE(1000) .... DATUM(3) .

.....
. MOVE(200) ....
... 2.- A second movement is loaded while the first one is not finished. The new movement waits in the second buffer. 3.- A third movement can still be stored in the process bu If the basic program reaches `MOVE(200)' it will wait. BUFFER DATUM(3) --------------------------------NTYPE MOVE(1000) --------------------------------MTYPE MOVE(-500) MOVE -500 BASIC PROGRAM ..

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

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

. MOVE(200) .... 4.- The first movement has finished.
The buffer moves by one position . The next movement starts to execute. BUFFER -------------------------------------NTYPE MOVE(200) --------------------------------MTYPE DATUM(3) DATUM (3) MOVE -500 5.