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You can read the recommendations in the user guide, the technical guide or the installation guide for OMRON R88A-MCW151-E. You'll find the answers to all your questions on the OMRON R88A-MCW151-E in the user manual (information, specifications, safety advice, size, accessories, etc.). Detailed instructions for use are in the User's Guide.

User manual OMRON R88A-MCW151-E
User guide OMRON R88A-MCW151-E
Operating instructions OMRON R88A-MCW151-E
Instructions for use OMRON R88A-MCW151-E
Instruction manual OMRON R88A-MCW151-E

Cat. No. I200-E2-02

R88A-MCW151-E
R88A-MCW151-DRT-E

**Motion Control Option
Board**

OPERATION MANUAL

OMRON



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Manual abstract:

No. @@@@Always heed the information provided with them. @@@@Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury. Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury, or property damage. OMRON Product References All OMRON products are capitalized in this manual. The word "Unit" is also capitalized when it refers to an OMRON product, regardless of whether or not it appears in the proper name of the product. The abbreviation "Ch", which appears in some displays and on some OMRON products, often means "word" and is abbreviated "Wd" in documentation in this sense. The abbreviation "PC" means Programmable Controller and is not used as an abbreviation for anything else. Visual Aids The following headings appear in the left column of the manual to help you locate different types of information. Note Indicates information of particular interest for efficient and convenient operation of the product.

1,2,3... Indicates lists of one sort or another, such as procedures, checklists, etc. Trademarks and Copyrights DeviceNet is a registered trademark of the Open DeviceNet Vendor Association, Inc.

OMRON, 2003 All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form, or by any means, mechanical, electronic, photocopying, recording, or otherwise, without the prior written permission of OMRON. No patent liability is assumed with respect to the use of the information contained herein. Moreover, because OMRON is constantly striving to improve its high-quality products, the information contained in this manual is subject to change without notice. Every precaution has been taken in the preparation of this manual.

Nevertheless, OMRON assumes no responsibility for errors or omissions. Neither is any liability assumed for damages resulting from the use of the information contained in this publication. GNINRAW! n oit uaC! REGNAD! v vi About this Manual: This manual describes the installation and operation of the R88A-MCW151-E and R88A-MCW151DRT-E Motion Control Option Boards (MC Units) and includes the sections described below. 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 MC Unit. Be sure to read the precautions provided in the following section. Name MCW151 Series R88A-MCW151-E R88A-MCW151-DRT-E Operation Manual Cat. No. I203 Contents Describes the installation and operation of the R88A-MCW151-E and MCW151-DRT-E Motion Control Units. (This manual) Describes the installation and operation of the W-series Servo Driver and Servomotor. OMNUC W-series I531 R88M-W (AC Servomotors) R88D-W (AC Servo Drivers) User's manual DeviceNet Operation Manual W267 Describes the configuration and construction of a DeviceNet network, including installation procedures and specifications for cables, connectors, and other connection devices, as well as information on the communications power supply.

Describes the operation of the DeviceNet Configurator to allocate remote I/O areas according to application needs, as well as procedures to set up a DeviceNet network with more than one master. DeviceNet Configurator Operation Manual W328 Precautions provides general precautions for using the MC Unit and related devices. Section 1 describes the features and system configuration of the R88A-MCW151-E and R88AMCW151-DRT-E Motion Control Units and concepts related to their operation. Section 2 describes the MC Unit components and provides the information for installing the MC Unit. Section 3 describes the different Motion Control features of the MCW151. Also the functionality of the Servo Driver related commands are explained. Section 4 describes the communication components of the MCW151-E and MCW151-DRT-E. The functionality of the serial communication protocols and the DeviceNet interface are explained. Section 5 provides an overview of the fundamentals of multitasking BASIC programs and the methods by which programs are managed in the MC Unit. Section 6 describes all commands, functions and parameters required for programing the motion control application using the MC Unit.

Section 7 describes the operation of the Motion Perfect programming software package. Motion Perfect provides the user a tool to program, monitor and debug motion based applications for the MC Unit. Section 8 describes error processing and troubleshooting procedures needed to keep the system operating properly. Section 9 explains the maintenance and inspection procedures that must be followed to keep the MC Unit operating in optimum condition. It also includes proper procedures when replacing an MC Unit.

The Appendices provide the required parameter settings for the Servo Driver, the DeviceNet protocol specification and some general programming examples.

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. GNINRAW! vii TABLE OF CONTENTS PRECAUTIONS . .

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... 255 261 x PRECAUTIONS This section, operation, maintenance, or inspection must be performed by authorized personnel. Not doing so may result in electric shock or injury.

Wiring or inspection must not be performed for at least five minutes after turning OFF the power supply. Doing so may result in electric shock. Do not damage, press, or put excessive stress or heavy objects on the cables. Doing so may result in electric shock, stopping operation of the product, or burning. General Warnings and Safety Precautions 3 Do not touch the rotating parts of the Servomotor in operation. Doing so may result in injury. Do not modify the product. Doing so may result in injury or damage to the product. Provide safety measures in external control circuits (i.e.

, not in the MC Unit) to ensure safety in the system if an abnormality occurs due to malfunction of the MC Unit, incorrect or unintended configuration and programming of the MC Unit or external factors affecting the operation of the MC Unit. Not providing sufficient safety measures may result in serious accidents, or property damage. · The MC Unit outputs may remain ON or OFF due to deposits on or burning of the output relays, or destruction of the output transistors. As a counter-measure for such problems, external safety measures must be provided to ensure safety in the system. · Provide an external emergency stopping device that allows an instantaneous stop of operation and power interruption. Not doing so may result in injury. · Emergency stop

circuits, interlock circuits, limit circuits, and similar safety measures must be provided in external control circuits. · When the 24-VDC output (service power supply to the Unit) 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. It is the nature of high speed motion control and motion control language programming and multi-tasking systems, that it is not always possible for the system to validate the inputs to the functions or to validate the combination of functions.

It is the responsibility of the programmer to ensure that the various BASIC statements are invoked correctly with the correct number of parameters and inputs, that the values are correctly validated prior to the actual calling of the functions, and that the BASIC program(s) provide the desired functionality for the application. Failure to do so may result in unexpected behaviour, loss or damage to the machinery. When the SERVO_PERIOD parameter has been set to change the servo cycle period of the MC Unit, a power down or software reset (using DRV_RESET) must be performed for the complete system. Not doing so may result in undefined behaviour. Use the Servomotors and Servo Drivers in a specified combination.

Using them incorrectly may result in fire or damage to the product. Do not operate the control system in the following locations: · Locations subject to direct sunlight. · Locations subject to temperatures or humidity outside the range specified in the specifications. · Locations subject to condensation due to radical temperature changes. · Locations subject to corrosive or inflammable gases.

· Locations subject to dust (especially iron dust) or salts. · Locations subject to vibration or shock. · Locations subject to exposure to water, oil or chemicals.

Do not touch the Servo Driver radiator, Regeneration Resistor, or Servomotor while the power is being supplied or soon after power is turned OFF. Doing so may result in a skin burn due to the hot surface. GNINRAW! GNINRAW! GNINRAW! GNINRAW! GNINRAW! n oit uaC! n oit uaC! n oit uaC! n oit uaC! xiii

Storage and Transportation Precautions 4 4 Storage and Transportation Precautions Do not hold the product by the cables or motor shaft while transporting it. Doing so may result in injury or malfunction. Do not place any load exceeding the figure indicated on the product. Doing so may result in injury or malfunction. Use the motor eye-bolts only for transporting the Motor.

Using them for transporting the machinery may result in injury or malfunction.



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MCW151-DRT-E MCW151-DRT RUN MS STS NS PORT2 1 2 1 2 I/O I/O 25 26 25 26 + 24 V 0V + 2 4V 0V 1-1-1 Overview The R88A-MCW151 is a 1.5-axis
Motion Control (MC) Unit which is connected to the W-series Servo Driver. The MC Unit provides direct control of the Servo Driver, enables both speed and
torque control and has access to detailed Servo Driver data.

To support a multi-axis control application, the MC Unit features both an encoder input and output connection. There are two types of the MCW151 Motion
Controllers, according to the communication interface which is integrated into the Unit. Communication Interface RS-422A/485 Serial Communication
DeviceNet Model R88A-MCW151-E R88A-MCW151-DRT-E The multi-tasking BASIC motion control language provides an easy to use tool for programming
advanced motion control applications. Three types of motion control are possible: point-to-point, continuous path and electronic gearing. Point-to-point
Control Point-to-point (PTP) control enables positioning independently for each axis. Axis specific parameters and commands are used to determine the paths
for the axes. Continuous path (CP) control enables the user not only to control the start and end positions, but also the path between those points. Possible
multi-axis paths are linear interpolation and circular interpolation. Also user defined paths can be realized with the CAM control. Electronic gearing (EG)
enables controlling an axis as a direct link to another axis.

The MC Units supports electronic gear boxing, linked moves and CAM movements and adding all movements of one axis to another. Continuous Path Control
Electronic Gearing 2 PORT0,1 PORT0,1 Features Section 1-1 1-1-2 Description of Features The MC Unit provides the following features. The direct
connection to the Servo Driver provides a high performance / high precision control system. Operation will be processed in optimal synchronization. ·
Supports both speed and torque control modes of the Servo Driver.

· Supports switching between the modes during operation. · Supports speed limit during torque control using the speed reference. · Selectable MC Unit servo
period cycle which can be set to either 0.5 ms or 1.0 ms.

Apart from the motion control operation with the Servo Driver, the MC Unit provides the following features: · Monitor the detailed Servo Driver alarm status.
· Monitor various monitor signals (rotation speed, command torque). · Monitor the Servo Driver digital inputs and analog input to include in the application.
· Read and write of the Servo Driver Parameters. · Execution of several Driver functions from the MC Unit. Examples are Print Registration, Origin Search,
Driver Alarm Reset and Driver Reset. The multi-task BASIC motion control language is used to program the MC Unit. A total of 14 programs can be held in
the Unit and up to 3 tasks can be run simultaneously. The MC Unit is programmed using a Windows-based application called IMotion Perfect. Motion

Perfect allows extremely flexible programming and debugging.

To achieve a solution for multi-axis applications, the MC Unit is provided with an encoder axis. This axis provides either to have an encoder input for external encoders or to have an encoder output to cascade position data to another MC Unit. The MCW151-DRT-E can be connected easily in an existing DeviceNet network. The DeviceNet network has a maximum communication distance of 500 m, so an MC Unit in a remote location can be controlled from the Master. The MC Unit supports both remote I/O and explicit message communications. · Remote I/O communications Remote I/O communications can exchange data (4 input words and 4 output words max.) with the MC Unit at high speed and without programming, just like regular I/O. · Explicit message communications Large data transfers to and from the MC Unit memory can be performed by sending explicit messages from the Master when required. The MC Unit has three (MCW151-E) or two (MCW151-DRT-E) serial ports for communication to several external devices. Next to the connection to the Personal Computer for configuring, the MC Unit can be connected with PCs, Programming Terminals (PTs) and other MC Units.

The serial ports support the Host Link Master and Slave protocols. By using a Servomotor with absolute encoder, the motor position is updated automatically in the MC Unit at start-up of the system. No origin search sequence will be necessary in the system initiation phase. Motion Control Servo Driver Access Easy Programming with BASIC Motion Control Language Encoder Input and Output DeviceNet Interface (MCW151-DRT-E only) Serial Communications

Absolute Encoder Support 1. Motion Perfect is a product of Trio Motion Technology Limited.

3 Features Virtual Axes Section 1-1 The MC Unit contains a total of 3 axes, of which two can be configured as virtual axis. The virtual axes are internal axes and are used for computational purposes. They act as perfect servo axes and are very useful for creating profiles. They can be linked directly to the servo axes. There is a high-speed registration input for the encoder input and output axis.

On the rising or falling edge of a registration input, the MC Unit will store the current position in a register. The registered position can then be used by the BASIC program as required. The registered positions are captured in hardware. Starting, stopping, limit switching, origin searches and many other functions can be controlled by the MC Unit. The general I/O can have specific functions (such as the registration, limit switches), but also can be freely used. The traditional trapezoidal speed profile is provided to generate smooth starting and stopping.



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The trapezoidal corners can be rounded off to S-curves. Trapezoidal Speed Profile with Square Corners Speed Trapezoidal Speed Profile with S-curve Corners Speed Hardware-based Registration Inputs General-purpose Input and Output Signals Reduced Machine Wear Time Time 4 System Configuration Section 1-2 1-2 System Configuration MCW151 M CW15 1 RUN SD ST S RD Basic Configuration W-series Servo Driver Personal Computer running Motion Perfect Personal Computer PORT0 ,1 1 2 PORT2 1 Typical applicable Units for Serial Comm. Ports PC I/O 2 25 26 + 24 V 0V Programmable Terminal (PT) General-purpose device Typical applicable Actuators for Digital Outputs Typical applicable Sensors for Servo Driver Digital Inputs Relais Print Registration Lamp Limit Switches Typical applicable Sensors for Digital Inputs Power Supply connection Print Registration 24 V Power supply Proximity Sensor Typical applicable Pulse Generators for Encoder Input Typical applicable Units for Encoder Output MCW151 Unit MCW151 Unit Servo Driver Note 1. The RS-422A/485 Serial Port 2 is only available on the MCW151-E Unit.

2. The MC Unit has one encoder axis. Either the encoder input or the encoder output can be used. 5 System Configuration Section 1-2 The equipment and models which can be used in the system configuration are shown in the following table. Device Motion Control Unit Servo Driver (see note) Servomotor Control Devices (using Host Link) Personal Computer (for Motion Perfect) Motion Perfect R88A-MCW151-E R88A-MCW151-DRT-E R88D-WT R88M-W Programmable Terminals CPU Units IBM Personal Computer or 100% compatible Version 2.0 or later Model Note The MC Unit must be used with a Servo Driver with software version 14 or later. The MC Unit cannot be used with software version 8. DeviceNet Configuration (MCW151-DRT-E only) A DeviceNet system can be constructed in two ways: fixed allocation or free allocation. Fixed Allocation A DeviceNet system can be constructed easily without the Configurator. With fixed allocation, predetermined words are allocated to each node for the Slave's I/O.

An OMRON Master must be used in order to perform fixed allocation. Moreover, with fixed allocation only one Master Unit can be used in a DeviceNet network and only one Master Unit may be mounted to a PC. Master Unit CPU Unit Remote I/O communications Slave Slave MC Unit Free Allocation The Configurator can be used to freely allocate the words used by each Slave. With free allocation, more than one Master Unit can be connected in a DeviceNet network and each Master's Slave I/O can be set independently. More than one Master Unit may be mounted to each PC and those Masters can be used independently.

Furthermore, other companies' Masters can be 6 Motion Control Concepts Section 1-3 used. For details, refer to the DeviceNet Configurator Operation Manual (W328). Master Unit Master Unit Master Unit Configurator CPU Unit ISA Board Remote I/O communications Message communications MC Unit Slave Slave MC Unit The following OMRON Master Units can be used. Applicable PC Master Unit model number CS1-DRM21 C200HW-DRM21-V1 Mounting position Max. number of Units With Configurator CPU Rack or Expansion I/O Rack (Classified as Special I/O Units) CPU Rack or Expansion I/O Rack (Classified as Special I/O Units) 16 10 or 16 (see note) Without Configurator 1 1 CS1 Series C200HZ/HX/HG/HE Note Some CPUs can control 16 Master Units and other CPUs can control 10.

1-3 Motion Control Concepts The MC Unit offers the following types positioning control operations. 1. Point-to-point control 2. Continuous Path control 3. Electronic Gearing This section will introduce some of the commands and parameters as used in the BASIC programming of the motion control application. Refer to SECTION 6 BASIC Motion Control Programming Language for details. Coordinate System Positioning operations performed by the MC Unit are based on an axis coordinate system. The MC Unit converts the position data from either the connected Servo Driver or the connected encoder into an internal absolute coordinate system. The engineering unit which 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 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 following diagram shows an exam- 7 Motion Control Concepts Section 1-3 ple of relative (command MOVE) and absolute (command MOVEABS) linear moves. MOVEABS(30) MOVE(60) MOVEABS(50) MOVE(50) MOVE(30) 0 50 100 Axis position 1-3-1 PTP-control In point-to-point positioning, each axis is moved independently of the other axis. The MC Unit 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 coordinate of 100 and axis no. 1 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 illustrated below. Axis 1 50 MOVEABS(100) AXIS(0) MOVEABS(50) AXIS(1) 0 50 100 Axis 0 At start, both the axis 0 and axis 1 will move to a coordinate of 50 over the same duration of time.

At this point, axis 1 will stop and the axis 0 will continue to move to a coordinate of 100. Relevant Axis Parameters As mentioned before the move of a certain axis is determined by the axis parameters. Some relevant parameters are given in the next table. Parameter UNITS ACCEL DECEL SPEED 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/s Description 8 Motion Control Concepts Defining moves Section 1-3 The speed profile below shows a simple MOVE operation. 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.



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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 will be given by the following graph. Speed 10 ACCEL=10 DECEL=10 SPEED=10 MOVE(40) 0 1 2 3 4 5 6 Time The following two speed profiles show the same movement with an acceleration time respectively a deceleration time of 2 seconds. Speed 10 ACCEL=5 DECEL=10 SPEED=10 MOVE(40) 0 1 2 3 4 5 6 Time ACCEL=10 DECEL=5 SPEED=10 MOVE(40) 0 1 2 3 4 5 6 Time

Calculations The following equations are used to calculate the total time for the motion of the axes. Consider the moved distance for the MOVE command as D , the demand speed as V , the acceleration rate a and deceleration rate d .

Section 1-3 = $V - a t$
 $V = -d t$
 $V = -d t = D / (a + d)$
 $2ad D / V(a + d) = \dots + \dots - V 2ad 2$

2 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 will move 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 canceled by using either the CANCEL or RAPIDSTOP command. The CANCEL command will cancel the move for one axis and RAPIDSTOP will cancel moves on all axes. The deceleration rate is set by DECEL.

1-3-2 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 MC Unit 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 following three axis move in a 3-dimensional plane.

MOVE(50,50,50) Axis 2 Speed Axis 1 Time Axis 0

10 Motion Control Concepts Section 1-3 The speed profile of the motion along the path is given in the diagram. The three parameters SPEED, ACCEL and DECEL which 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. **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 following diagram. MOVECIRC(-100,0,-50,0,0) Axis 1 50 -50 0 50 Axis 0

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 MC Unit also provides a way to define a position profile for the axis to move. The CAM command will move an axis according to position values stored in the MC Unit Table array. The speed of travelling through the profile is determined by the axis parameters of the axis. CAM(0,99,100,20) Position Time

1-3-3 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

11 Motion Control Concepts Electronic Gearbox Section 1-3 The MC Unit 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. CONNECT Axis 2:1 1:1 1:2 Master Axis Axes 0 1 Ratio 1:1

CONNECT command 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 MC Unit 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.

CAMBOX(0,99,100,20,0) AXIS(1) CAMBOX Axis (1) Position Master Axis (0) Position 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. MOVELINK(50,60,10,10,1) AXIS(0) Speed Master Axis (1) Synchronized MOVELINK Axis (0) Time

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 MC Unit provides this possibility by using the ADDAX command. The movements of the linked axis will consist of all movements of the actual axis plus the additional movements of the master axis. Speed axis 0* BASE(0) ADDAX(2) FORWARD MOVE(100) AXIS(2) MOVE(-60) AXIS(2) Speed axis 2 += Time Speed axis 0 Time

1-3-4 Other Operations 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.

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 MC Unit goes through a sequence and searches for the origin based on digital inputs and/or Z-marker from the encoder signal. **Canceling Moves Origin Search** 13 Control System Configuration Print Registration

Section 1-4 The MC Unit 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 MC Unit captures the position of an axis in hardware.



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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. If the MERGE axis parameter is set to 1, a movement will always be followed by a subsequent movement without stopping. The following illustrations will show the transitions of two moves with MERGE value 0 and value 1. Speed MERGE=0 Merging Moves Time Speed MERGE=1 Time 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. 1-4 1-4-1 Control System Configuration Servo System Principles The servo system used by and the internal operation of the MC Unit are briefly described in this section.

Refer to 2-4 Servo System Precautions for precautions related to servo system operation. Semi-closed Loop System The servo system of the MC Unit 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. 14 Control System Configuration MC Unit Section 1-4 Servo System 2.3 Demand position + - 1 Position Control Speed reference Speed Control Motor 4 Measured speed Encoder Measured position Internal Operation of the MC Unit 1,2,3... Inferred closed loop systems occupy the mainstream in modern servo systems applied to positioning devices for industrial applications. The following graph shows the basic principle of the Servo System as used in the MC Unit. 1.

The MC Unit 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 Servomotor corresponding to the speed reference. The rotational speed is proportional to the speed reference. 4. The rotary encoder will generate the feedback pulses for both the speed feedback within the Servo Driver speed loop and the position feedback within the MC Unit position loop.

The servo system controls the motor by continuously adjusting the speed reference to the Servo Driver. The speed reference is calculated by the MC Unit's Motion Control algorithm, which is explained in this section. The Motion Control algorithm uses the demand position, the measured position and the following error to determine the speed reference. The following error is the difference between the demanded and measured position. The demand position, measured position and following error are represented by 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. Motion Control Algorithm 15 Control System Configuration Section 1-4 The Motion Control algorithm of the MC Unit is shown in the diagram below. $K_v \ddot{e} + K_p \dot{e} + K_i e + K_{ov} \dot{P}_m + K_{vff} \dot{P}_d$ Demand position + Following error Output - $K_i K_d + +$ signal K_{ov} Measured position Proportional Gain $O_p = K_p e$ The proportional gain following error e . K_p creates an output O_p that is proportional to the 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 e that have occurred during the system operation. 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. $O_d = K_d \dot{e}$ 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. $O_{ov} = K_{ov} \dot{P}_m$ 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 Feedforward 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. $O_{vff} = K_{vff} \dot{P}_d$ 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. 16 $\ddot{O}_i = K_i e$ Control System Configuration Default Values Section 1-4 The default settings are given below along with the resulting profiles.

Fractional values are allowed for gain settings. Gain Proportional Gain Integral Gain Derivative Gain Output Speed Gain Speed Feedforward Gain Default 0.1 0.0 0.0 0.

0 0.0 1-4-2 Encoder Signals Standard OMRON equipment is designed for an advanced phase-A for forward rotation and an advanced phase-B for reverse rotation. For the encoder input and output signals, the MC Unit is designed to comply with this phase definition, allowing the MC Unit to be connected to other equipment without problems. With this arrangement, the direction of rotation can be easily detected by monitoring the relative phase of both signals. If channel A leads channel B, indicating clockwise (CW) movement, the counter will increment. Conversely, if channel B leads channel A, indicating counterclockwise (CCW) movement, the counter will decrement. Typically, rotary encoders also provide an additional Z-marker as a reference pulse within each revolution. By properly decoding and counting these encoder signals, the direction of motion, speed, and relative position can be determined. Encoder input For the MC Unit encoder input, the pulse ratio is 4. Every encoder edge (pulse edge for either A or B phase) is one internal count.

Forward rotation (CW) Phase A Phase B Reverse rotation (CCW) 0 1 2 3 4 5 6 7 7 6 5 4 3 2 1 0 Counts (x4) The signals A, B and Z appear physically as A+ and A-, B+ and B- and Z+ and Z-.



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These appear as differential signals on twisted-pair wire inputs, ensuring that common modes are rejected and that the noise level is kept to a minimum. When using encoders by other makers, check carefully the encoder specification for phase advancement. If the definition differs from the ones given above, reverse the B-phase wiring between the MC Unit and the Servo Driver. In most case, this should resolve the problem. 17 Control System Configuration Encoder output Section 1-4 For encoder output, the pulse ratio is 64. For every 16 internal counts one encoder edge for one of the two phases will be produced. Phase A Phase B Phase Z 0 16 32 48 64 80 96 Internal Counts The Z-phase signal has the following specification: · The Z-marker has a period of 4096 generated edges. · The pulse has a width of a quarter pulse period length (when both phase A and B are low). · The Z-phase signal is active after power-on.

The generated frequency is limited to the maximum allowable frequency. If the internal speed would result in a frequency above this maximum, an axis status flag will be set. See 8-2-1 MC Unit Error Handling for details. 18 Specifications Section 1-5 1-5-1 Specifications General Specifications The MC Unit provides the following general specifications. Item Applicable Servo Driver Servomotors Installation Method Basic Specifications Power Supply Method Type Encoder R88M-W Series Incremental / Absolute Mounted on the CN10 connector on the Servo Driver side.

5 VDC (supplied from the control power supply of the Servo Driver) 24 VDC (supplied from external power supply) Total Power Consumption 4.0 W External Dimensions Approx. Mass Current Consumption Output Power Supply Environment Ambient Operating Temperature Ambient Operating Humidity Ambient Atmosphere 20 x 142 x 128 mm (H x W x D) 200 g 170 mA for 24 VDC 5 VDC, maximum 160 mA (to external encoder) 0 to 55°C 90 % RH or less (non-condensing) Free from corrosive gasses Contents R88D-W Series (software version 14 or later, see note) Ambient Storage Temperature -20 to 75°C Ambient Storage Humidity 90 % RH or less (non-condensing) Vibration Resistance Impact Resistance 4.9 m/s² Acceleration 19.6 m/s² or less (when the impact is applied three times in each X, Y, Z direction) Note The MC Unit cannot be used with software version 8.

1-5-2 Functional Specifications The MC Unit provides the following functional specifications. Item Type of Unit Motion Control Speed Control Contents Optional board for W-series Servo Driver Inferred closed loop with PID, output speed and speed feed forward gains Speed reference (open loop) Possible torque limit operation Torque reference Possible speed limit operation Speed / Torque control switching during operation 3 1 1 2 Selectable to 0.5 ms or 1.0 ms. User definable Torque Control Control Switch Configuration Maximum No. of axes No. of controlled servo axes Maximum No. of encoder in- or output axes Maximum No. of virtual axes Servo Loop Cycle Measurement Units 19 Specifications Item Positioning operations Linear interpolation Circular interpolation CAM profile Electronic gearbox Linked CAM Linked move Adding axes Acceleration/deceleration curves Servo Driver Access Motion Control Contents Section 1-5 Linear interpolation for any number of axes Circular interpolation for any two axes CAM profile movement for any axis Electronic gearbox link between any two axes Linked CAM profile movement for any two axes Linked move for any two axes Adding any two axes Trapezoidal or S-curve Speed Control Torque Control Position Feed-back Driver Enable Driver Print Registration Driver Alarm and Warning Status General Driver Status Driver Digital Input Driver Analogue Input Driver Limit Switches Driver Alarm Reset Driver Reset Read and Write Pn-parameters Read Un parameters Personal Computer with Motion Perfect Programming Software Port 0: Connection to PC (Motion Perfect Software) Port 1: Host Link Master protocol Host Link Slave protocol General-purpose Port 2: Host Link Master protocol Host Link Slave protocol General-purpose Line receiver input; maximum response frequency: 1500 kHz pulses (before multiplication) Pulse multiplication: x4 Line receive output; maximum frequency: 500 kHz pulses Internal counts to output pulse ratio: 64 : 1 Total of 8 digital inputs can be wired and used for instance for limit switches, emergency stop and proximity inputs. Two inputs can be used for registration of the encoder input/output axis.

Total of 6 digital outputs can be wired and used for position dependent switching or other general purposes. Two registration inputs can be used (simultaneously) to capture the position in hardware. DeviceNet settings (MCW151-DRT-E only) General purpose (MCW151-E only) Provided externally Monitoring General Control Parameter Access External connected devices Serial Communications RS-232C RS-422A/485 (MCW151E only) External I/O Encoder Input Encoder Output Digital Inputs Digital Outputs Registration inputs Switch setting Power supply for general and axis I/O 20 Comparison between Firmware Versions Item Task program manage- Programming language ment Number of tasks BASIC Contents Section 1-6 Up to 3 tasks running simultaneously plus the Command Line task 251 (VR) + 8000 (Table) max. Random Access Memory (RAM) and Flash memory backup. (See note) Motion Perfect software manages a backup on the hard disk of the personal computer. Detection of memory corruption via checksum Detection of error counter overrun Max. number of programs 14 Data storage capacity Saving program data MC Unit Personal Computer Self diagnostic functions Note The service life for the flash memory is 100,000 writing operations. 1-5-3 DeviceNet Specifications (MCW151-DRT-E only) The MC Unit provides the following DeviceNet specifications. Item Communications protocol Supported connections (communications) Connection forms (see note) Baud rate Communications media Communications distances 500 kbps DeviceNet Master-Slave: Remote I/O and explicit messages Both conform to DeviceNet specifications Combination of multi-drop and T-branch connections (for trunk or drop lines) 500 kbps, 250 kbps, 125 kbps (switchable) Special 5-wire cables (2 signal lines, 2 power lines, 1 shield line) Network length: 100 m max. (100 m max.

) Drop line length: 6 m max. Total drop line length: 39 m max. Network length: 250 m max. (100 m max.) Drop line length: 6 m max.

Total drop line length: 78 m max. Network length: 500 m max. (100 m max.) Drop line length: 6 m max. Total drop line length: 156 m max.

11 to 25 VDC (Supplied from the communications connector) Contents 250 kbps 125 kbps Parentheses indicate the length when Thin Cables are used.

Communications power supply Note Terminating resistors are required at both ends of trunk line. Refer to the DeviceNet Operation Manual (W267) for other communication specifications, such as communication cycle times.



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1-6 Comparison between Firmware Versions The following table shows a comparison between the two current versions of the R88A-MCW151-E and R88A-MCW151-DRT-E Motion Control Units. The changes are only related to firmware (not hardware) and the firmware is common for both types. Verify the current version of the MC Unit using the VERSION parameter. 21 Comparison between Firmware Versions Section 1-6 The R88A-MCW151-E FW 1.62 is fully backward compatible with the previous version FW 1.61. For the R88A-MCW151-DRT-E FW 1.

62 many DeviceNet implementation changes have been done. For both Units caution must be taken when upgrading. FW 1.61 No. FW 1.62 Yes. Command to enable dual feedback control. Possibly only by Explicit Message command RESET. Commands and instructions DeviceNet (MCW151-DRT-E only) 22 n oit uac! Item ADD_DAC Software reset of MC Unit Possible by either bit in Remote I/O Output word 1 or Explicit Message command RESET. Different maximum transfer amount for read and write.

Explicit messages (read and write) Maximum amount of elements to transfer (read/write) is 39 (three-word format) and 119 (one-word format). See 4-2-2 Explicit DeviceNet Messages. Update of Device objects. See Appendix B Device Protocol (MCW151-DRT-E only). Device objects - SECTION 2 Installation This section describes the MC Unit components and provides the information required for installing the MC Unit.

2-1 2-2 Components and Unit Settings

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... 2-2-1 Installation Conditions ...

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... 2-2-2 Installation Method ...

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..... 2-2-3 Dimensions

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.. 2-3-2 Serial Port Connections ...

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. 2-3-3 DeviceNet Connection

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. 2-3-4 I/O Specifications

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2-3-5 Connection examples

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. Servo System Precautions

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. Wiring Precautions

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24 28 28 29 30 30 31 36 36 38 39 40 2-3 2-4 2-5 23 Components and Unit Settings Section 2-1 2-1 Components and Unit Settings The following diagram shows the main components of the MC Unit. MCW1 51 RUN SD STS RD M CW15 1-DRT Indicators RS-232C Ports Connector RS-422A/485 Port Connector DeviceNet Connector RUN MS STS NS PORT0 ,1 1 2 PORT2 1 2 I/O Connector I/O 25 26 25 26 + 24V 0V + 24V Power Connector 0V Indicators The following table describes the indicators on the front of the MC Unit. s Motion Control Indicator RUN Color Green ON OFF Flashing with STS STS Red ON OFF Status Meaning The MC Unit is operating normally. The MC Unit did not start properly or is not powered on. An error occurred in the communication with the Servo Driver. The axis has been disabled. The Servo Enable is not ON. The axis is enabled. Flashing alone A motion error has occurred. The Servo Driver has been disabled. Flashing with RUN An error occurred in the communication with the Servo Driver. s RS-422A/485 (MCW151-E only) Indicator SD RD Color Green Green ON OFF ON OFF Status Transmitting data. No communication. Receiving data. No communication. Meaning 24 PORT0 ,1 Components and Unit Settings s DeviceNet (MCW151-DRT-E only) Indi Color cator MS Status Definition Meaning Section 2-1 Green ON Device Operational Normal operating status. Reading switch settings. Unit hardware error: Watchdog timer error. Switch settings incorrect. Unit power is not supplied, waiting for initial processing to start, or the Unit is being reset. Network is operating normally (communications established). Network is operating normally, but communications have not yet been established. A fatal communications error has occurred. Network communications are not possible. Communications timeout. Checking for node address duplication on the Master, switch settings are incorrect, or fieldbus power is not supplied. Flashing Device in Standby Red ON Unrecoverable Fault No Unit Power Link OK. Online, Connected. Flashing Minor Fault --NS OFF Green ON Flashing Online, Not connected Red ON Critical Link Failure Flashing Connection Timeout --OFF No Fieldbus Power / Not Online Switch Settings The MCW151 Units are equipped with the following DIP-switches.

s DeviceNet Switch Settings (MCW151-DRT-E only) The external switch settings will set the Slaves' node address setting and baud rate setting. ON 1 2 3 4 5 6 7 8 9 10 NA0 NA1 NA2 NA3 NA4 NA5 MD0 NC DR0 DR1 1 2 3 4 5 6 7 8 9 10 ON Node address The node address of the slave is set with pins 1 through 6 of the DIP switch. Any node address within the setting range can be used as long as it is not already set on another node. 25 Components and Unit Settings DIP switch setting Pin 6 0 0 0 1 1 1 Pin 5 0 0 0 1 1 1 Pin 4 0 0 0 1 1 1 Pin 3 0 0 0 ... 1 1 1 0 1 1 1 0 1 Pin 2 0 0 1 Pin 1 0 1 0 0 (default) 1 2 ... 61 62 63 Section 2-1 Node address 0: OFF, 1: ON Baud rate Pins 9 and 10 are used to set the baud rate as shown in the following table. Pin 10 OFF OFF ON ON Pin 9 OFF ON OFF ON Baud rate 125 kbps (default) 250 kbps 500 kbps Not allowed Note 1. Always turn OFF the MC Unit's power supply (including the communications power supply) before changing the baud rate setting. 2. Set the same baud rate on all of the nodes (master and slaves) in the Network. Other settings Pin 7 is used to select the I/O Slave Messaging mode. This determines the allocation of the I/O Slave Messaging mode area. Pin 7 OFF ON I/O Slave Messaging Mode Mode I (default) Mode II Pin 8 is not used. s General Switch Settings (MCW151-E only) ON 1 2 3 4 5 6 7 8 9 10 SW1 SW2 SW3 SW4 SW5 SW6 SW7 SW8 SW9 SW10 1 2 3 4 5 6 7 8 9 10 ON For the MCW151-E the external DIP switch can be used for general purpose. The value of the switch can be accessed using the SWITCH_STATUS parameter. 26 Components and Unit Settings DIP switch setting Pin 10 0 0 0 1 1 1 Pin 9 0 0 0 1 1 1 Pin 8 0 0 0 1 1 1 Pin 7 0 0 0 1 1 1 Pin 6 0 0 0 1 1 1 Pin 5 0 0 0 . . . 1 1 1 1 1 1 1 1 1 0 1 1 1 0 1 Pin 4 0 0 0 Pin 3 0 0 0 Pin 2 0 0 1 Pin 1 0 1 0 Section 2-1 Parameter value 0 (default) 1 2 ... 1021 1022 1023 0: OFF, 1: ON s Internal Switches SW2 SW2 ON 123 4 ON 12 3 4 SW3 ON 123 4 SW3 ON 12 34 Switch SW2 (MCW151-E only) Pin 1 and 2 select the serial communication for port 2. Pin 2 OFF ON Pin 1 OFF ON RS-485 Selection RS-422A (default) Other not allowed Pin 3 selects the termination resistor between receive pins (RD+ / RD -) for port 2. Pin 3 OFF ON Selection Termination disabled (default) Termination enabled Pin 4 is not used. Switch SW3 Pin 1 through 3 enable

the termination resistor for the encoder channel A, B and Z.



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