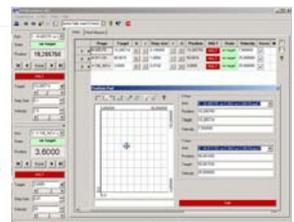**MS77E User Manual**

C-843 Motor Controller Card

Release: 3.0.0   Date: 2009-11-17

This document describes the following product(s):

- **C-843.21**
  Motor Controller Card (PCI), 2 motor axes

- **C-843.41**
  Motor Controller Card (PCI), 4 motor axes

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Declaration of Conformity

according to DIN EN ISO/IEC 17050:2005-01

Manufacturer:	Physik Instrumente (PI) GmbH & Co. KG	CE
Manufacturer´s Address:	Auf der Römerstrasse 1 D-76228 Karlsruhe, Germany	

The manufacturer hereby declares that the product

Product Name: **Motor Controller Card**

Model Numbers: **C-843**

Product Options: **all**

complies with the following European directives:

2006/95/EC, Low voltage directive (LVD)

2004/108/EC, EMC-Directive

The applied standards certifying the conformity are listed below.

Electromagnetic Emission: EN 61000-6-3, EN 55011

Electromagnetic Immunity: EN 61000-6-1

Safety (Low Voltage Directive): EN 61010-1

Electrical equipment which is intended to be integrated in other electrical equipment only conforms to the cited EMC Standards and normative documents, if the user ensures a compliant connection when implementing the total system. Possible necessary measures are installation of the component in a suitable shielded enclosure and usage of suitable connectors.

17 November 2009
Karlsruhe, Germany

Dr. Karl Spanner
President

About this Document

Users of this Manual

This manual is designed to help the reader to install and operate the C-843 Motor Controller Card. It assumes that the reader has a fundamental understanding of basic servo systems, as well as motion control concepts and applicable safety procedures.
The manual describes the physical specifications and dimensions of the C-843 Motor Controller Card as well as the software and hardware installation procedures which are required to put the associated motion system into operation.

Conventions

The notes and symbols used in this manual have the following meanings:

WARNING

Calls attention to a procedure, practice or condition which, if not correctly performed or adhered to, could result in injury or death.

DANGER

Indicates the presence of high voltage (> 50 V). Calls attention to a procedure, practice or condition which, if not correctly performed or adhered to, could result in injury or death.

CAUTION

Calls attention to a procedure, practice, or condition which, if not correctly performed or adhered to, could result in damage to equipment.

NOTE

Provides additional information or application hints.

Related Documents

The software tools and the mechanics which might be mentioned in this document are described in their own manuals. All documents are available as PDF files. Updated releases are available for download at www.pi.ws or via e-mail: contact your Physik Instrumente Sales Engineer or write info@pi.ws.

Related Documents

Manuals for C-843:	Manuals for the motion processor on the C-843 card:
C-843_GCS_Commands_SM149E C-843_GCS_DLL_MS112E C843_GCS_LabVIEW_MS89E PIMikroMoveUserManual_SM148E GCSData_User_SM146E PiStageEditor_SM144E A000T0014_100_UserProfileModeSoftware	MotionProcessor_UsersGuide MotionProcessor_ProgrammersRef MotionProcessor_MC2100_TechnicalSpec

Contents

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1 Introduction

- PCI-bus-compatible PC board

- Analog amplifiers for 5 W motors

- Selectable PWM output (10-bit resolution, 24.5 kHz)

- Full P-I-D motion control

- Multiple trajectory profile generation

- Profile modes: trapezoidal, velocity contouring, S-curve, User Profile mode

- Incremental encoder input (differential)

- Limit switch control

- Motor brake support for each axis

- High-level command language

- TTL input and output channels

- Software DLL for C, C++, Visual Basic

- 32256 points on-board RAM for high-precision, user-specified trajectory profile control and data recording

The C-843 PCI motion controller card drives up to 4 axes of micropositioning equipment. Because there is no need for external servo-amplifiers, this card is a very cost-effective, easy-to-set-up solution.

On-Board Servo-Amplifiers

Unlike other PCI controller cards, the C-843 comes with on-board, low-noise linear amplifiers for the small DC motors used in most compact micropositioning stages and actuators.

In addition, PWM outputs are available to drive more powerful equipment (all direct-drive translation and rotation stages from PI feature the integrated ActiveDrive™ PWM amplifiers, and also connect to the C-843 with no external power amplifiers). The PWM mode and linear amplifier mode can be programmed individually for each of the 4 (or 2) channels.

High-Performance PID Control

The C-843 employs a fast DSP (digital signal processor) providing high-performance PID motion control with many options for trajectory generation and filter settings for superior positioning and tracking accuracy. Position, velocity, acceleration and several other motion parameters can be programmed individually for each axis on-the-fly. High-bandwidth counters (5 MHz) support differential encoder feedback (incremental rotary encoders or linear scales) for fast and accurate positioning.

I/O for Flexible Automation

In addition to 3 TTL inputs per channel for limit and reference signals, up to 24 I/O lines are available for flexible automation tasks (trigger functions, etc.). The C-843 also features motor-brake output lines (e.g. for M-531.DDB stages).

High-Speed Buffering

The integrated trace memory allows online buffering (read and write) at integer multiples of the servo-loop time of up to four independent system variables (e.g. positions, velocities, internal register contents, etc.) This allows the observation of the motion system (data recording) and also performing customized trajectory profiles (User Profile Mode).

PI General Command Set (GCS)

The comprehensive command structure is based on the PI General Command Set (GCS). With GCS the development of custom application programs is simplified, because the commads for all supported devices are identical in syntax and function. PI controllers for nanopositioning systems, for piezomotors and servo or stepper motors can be commanded with GCS.

Software / Programming

In addition to the user software for setup, system optimization and operation, comprehensive LabVIEW and DLL libraries are provided. The user friendly PI MikroMove™ provides a convenient interface for stage operation including tuning tool, joystick operation, terminal and macro editor.

1.1 Prescribed Use

The C-843 Motor Controller card with the included hardware and software drivers is designed to drive DC motors and PI Voice Coil Drives in any combination up to a total power consumption of about 20 watts. Five-watt motors can be driven directly from the integrated amplifiers. More powerful motors need external amplifiers.

The C-843 is based on a fast DSP processor providing high-performance PID motion control with many options for trajectory generation and filter setting. The motors can be controlled as to position, velocity, acceleration and many other motion-relevant parameters.

C-843s are usually operated in closed-loop mode using the position feedback of incremental position sensors (rotary encoders or linear scales). Consult the product specifications of the mechanics with which the C-843 is to be operated to see what kind of position sensor is present.

The C-843 is intended to be installed in a PC with PCI-Bus and Windows operating system (XP, Vista, Windows 7; Linux support is available on request). The number of free PC slots required for installion depends on the C-843 model: one with C-843.21, two with C-843.41 (the second slot is for the bracket with sockets for motor #3 and #4). Access to the digital I/O lines is provided via an additional bracket which requires another free slot. The operator is responsible for the intended installation of the C-843 and any additional equipment and for the training of the users of the board.

C-843s must not be used for applications other than stated in this manual. Observe the safety precautions given in this User Manual.

The verification of the technical specifications by the manufacturer does not imply the validation of complete applications. In fact the operator is responsible for the process validation and the appropriate releases.

The C-843 is a laboratory apparatus as defined by DIN EN 61010. It meets the following minimum specifications for safe operation (any more stringent specifications in the technical data table are, of course, also met):

- Indoor use only

- Altitude up to 2000 m

- Temperature range 5°C to 40°C

- Max. relative humidity 80% for temperatures up to 31°C, decreasing linearly to 50% relative humidity at 40°C

- Line voltage fluctuations not greater than ±10% of the line voltage

- Transient overvoltages as typical for public power supply Note: The nominal level of the transient overvoltage is the standing surge voltage according to the overvoltage category II (IEC 60364-4-443).

- Degree of pollution: 2

1.2 Safety Precautions

Install and operate the C-843 Motor Controller Card only when you have read the operating instruction. Keep the instruction readily available close to the device in a safe place. When the instruction is lost or has become unusable, ask the manufacturer for a new copy. Add all information given by the manufacturer to the instruction, e.g. supplements or Technical Notes.

DANGER

Before opening the host PC, remove the line-voltage connection.

Heed any warnings provided by the manufacturer of the PC or of other add-on cards it may contain.

WARNING

All motion of the connected motors and mechanical stages is software controlled, and software may fail. Be aware that some motorized stages can generate large forces which can cause personal injury or other damage if not properly handled.

CAUTION

!

The C-843 Motor Controller Card is an ESD-sensitive (electrostatic discharge sensitive) device. Observe all precautions against static charge buildup before touching this device.

Avoid touching circuit components, pins and PCB traces. Discharge any static charge you may have on your body by briefly touching a conductive, grounded object before you touch any electronic assembly. Pose PCBs only on conductive surfaces, such as ESD-safe transport containers (envelopes, foam). Electronic subassemblies must always be kept and transported/shipped in conductive packaging.

Make sure that no conductive particles of any kind (metallic dust or shavings, broken pencil leads, loose screws) get on the card or into the PC

Make sure that no electrical contact between the various add-on cards in the PC is possible.

CAUTION

!

DO NOT EXCEED MAXIMUM CURRENTS!

Keep in mind that the total current for the C-843 is supplied from the PC power supply only.

Extreme power peaks will occur when:

- Motors accelerate or decelerate very fast
- Motors are reversed at high speed
- Motors stall
- Stages are driven into the hard stop

The total current may exceed the current capability of the PC power supply. Voltage drops may occur with the risk of PC malfunction or damage to other devices such as hard disks drives.

The C-843 has factory-set output current limitation. Nevertheless the user has to ensure that the total current does not exceed the capability of the PC power supply.

1.3 Model Survey

The C-843 Motor Controller Coard is available in a 2-axis and a 4-axis version:

- ■ **C-843.21** Motor Controller for 2 axes

- ■ **C-843.41** Motor Controller for 4 axes

1.4 Unpacking

!

CAUTION

The C-843 Motor Controller Card is an ESD-sensitive (electrostatic discharge sensitive) device. Observe all precautions against static charge buildup before touching this device.

Avoid touching circuit components, pins and PCB traces. Discharge any static charge you may have on your body by briefly touching a conductive, grounded object before you touch any electronic assembly. Pose PCBs only on conductive surfaces, such as ESD-safe transport containers (envelopes, foam). Electronic subassemblies must always be kept and transported/shipped in conductive packaging.

Unpack the C-843 Motor Controller Card with care. Compare the contents against the sales contract and packing slip.

The following components should be included:

- ■ C-843.x1 Motor Controller Card

- ■ Separate adapter bracket with two sub-D connectors for access to the digital I/O lines (Digital I/O and All-Axes headers on the C-843 board).
  Note that older revisions of the adapter bracket do not provide the sub-D 15-pin connector which gives access to the All-Axes header. If required, contact your PI sales engineer or write info@pi.ws to obtain a new version of the adapter bracket.

- ■ 5.25-inch-style, 4-wire power Y-connector

- ■ With C-843.41 cards only: separate mounting bracket with two 15-conductor sub-D connectors for motors #3 and #4

■ C-843 distribution CD containing host software, hardware driver and all manuals as PDF files (for an overview over the host software see p.29)

■ Standard version of the C-843 User Manual (this document) in printed form

Inspect the contents for signs of damage. If parts are missing or you notice signs of damage contact PI immediately.

Save all packing materials in the event the product needs to be reshipped.

1.5 Additional Components

Depending on your application, you might need the following unincluded items for use with the C-843 Motor Controller Card:

■ C-843.JS option: joystick and sound card with game port

■ C-842.AP1 PWM to analog adapter box, for driving analog stages with high power consumption using an external PWM amplifier

Contact your PI sales engineer or write info@pi.ws, if you need additional components.

1.6 System Requirements

To start working with the C-843 Motor Controller card, your motion system needs to meet the following conditions:

■ A PC with at least one free PCI slot to install the C-843; note that two free slots are necessary with C-843.41 4-axis cards (the second slot is required for the mounting bracket with the connectors for motors #3 and #4). Another free slot is required if you want to install the adapter bracket which provides the digital I/O lines.

■ Windows operating system (XP, Vista, Windows 7; Linux support is provided on request))

■ One or more motorized positioners with incremental encoders (e.g. linear or rotary stages with DC-motor, voice coil stages, DC-Mikes)

■ Cables to connect stage and controller (PI cable order number: C-815.38)

We recommend that you make your first trials with the C-843 using the PIMikroMove™ software. This is the quickest way to verify that your system is connected and operating properly. You can even run simple automation tasks with the PIMikroMove™ host macro functionality. All information about PIMikroMove™ is found in a separate manual which is included on the C-843 CD.

2   Quick Start

With a motion system that meets the requirements listed above, carry out the following steps to put it into operation:

1   Install the card, with the PC powered completely down (see p. 10)

2   Install hardware driver and software on host PC (see p.10)

3   Begin operation (see p. 14)

If C-843 host software is already installed, it must be uninstalled before the new version can be installed. To uninstall, follow the instructions on p. 19.

The PI host software is improved continually. It is therefore recommended that you visit the PI website (www.pi.ws) regularly to see if updated releases of the software are available for download. Updates are accompanied by information (readme files) so that you can decide if updating makes sense for your application. You need a password to see if updates are available and to download them. This password is provided on the C-843 CD in the C-843 Releasenews PDF file in the \Manuals directory. See "Software Updates" on p. 19 for download details.

2.1   How to Install the Card in Host PC

Install the C-843 card in the PC **before** you install hardware driver and software from the C-843 CD.

CAUTION

The C-843 Motor Controller Card is an ESD-sensitive (electrostatic discharge sensitive) device. Observe all precautions against static charge buildup before touching this device.

Avoid touching circuit components, pins and PCB traces. Discharge any static charge you may have on your body by briefly touching a conductive, grounded object before you touch any electronic assembly. Pose PCBs only on conductive surfaces, such as ESD-safe transport containers (envelopes, foam). Electronic subassemblies must always be kept and transported/shipped in conductive packaging.

!

Make sure that no conductive particles of any kind (metallic dust or shavings, broken pencil leads, loose screws) get on the card or into the PC.

Make sure that no electrical contact between the various add-on cards in the PC is possible.
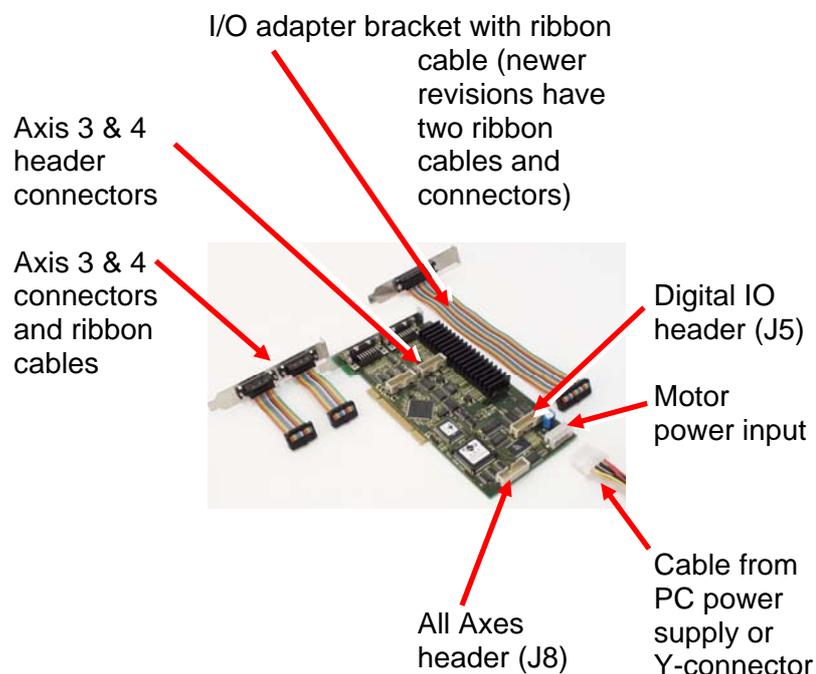
DANGER

Before opening the host PC, remove the line-voltage connection.

Heed any warnings provided by the manufacturer of the PC or of other add-on cards it may contain.

1   Turn off the host PC and unplug the line cord. Then open the PC housing.

2   With C-843.41 only: to use motor axes #3 and #4 of the C-843.41, you must connect the two ribbon cables of the included 2-connector bracket adapter to the corresponding 16-pin header connectors on the C-843.41 board (for component locations see Fig. 1).

3   Optional: to make the digital I/O lines of the C-843 available (see Sections 3.3.4 on p. 25 and 3.3.3 on p. 24), you must connect the ribbon cables of the included I/O adapter bracket to the 26-pin "I/O" header (J5) and to the 16-pin "All-Axe" header (J8) on the C-843 board. For component locations see Fig. 1.

Note that older revisions of the adapter bracket do not contain a connection for the 16-pin "All-Axes" header (J8). If you have such an old version, contact your PI sales engineer or write info@pi.ws if you want to bring these lines out of the PC housing.

4   Remove the slot covers from the positions in the PC which you plan to use.

5   For multiple-card installations: make sure the card numbers are properly configured in EEPROM (see p. 17 before continuing).

6   Install the C-843 card in a free PCI slot; install any adapter brackets you connected in steps 2 and 3 in suitable (neighboring) positions.

7 Screw down the card and any adapter brackets. Otherwise the card may creep out of its connector or the adapters will slip and may cause a short circuit.

8 Connect the C-843 to the PC internal power supply (see Fig. 2 on p. 13).
If there is no free cable of sufficient length from the power supply, use the Y-cable which comes with the card as a splitter or as an extension.

9 Close the PC case.

I/O adapter bracket with ribbon cable (newer revisions have two ribbon cables and connectors)

Axis 3 & 4 header connectors

Axis 3 & 4 connectors and ribbon cables

Digital IO header (J5)

Motor power input

All Axes header (J8)

Cable from PC power supply or Y-connector

Fig. 1: C-843 and connectors

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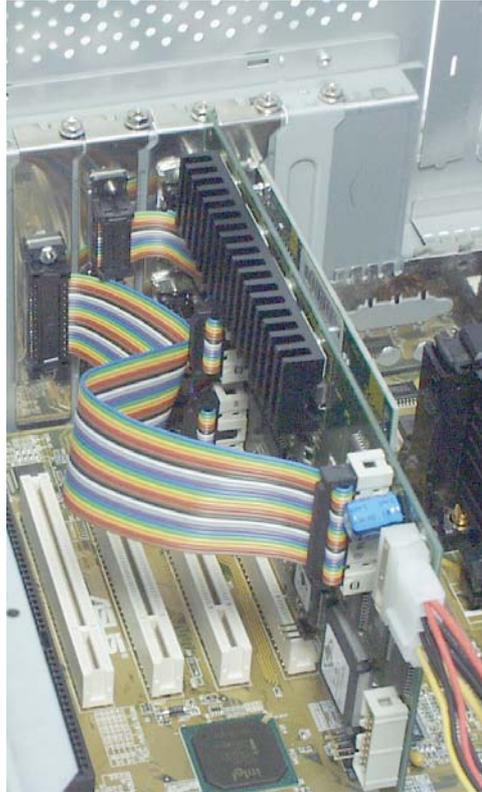
Fig. 2: C-843.41 installed, with power connector at lower right

2.2   How to Install Driver and Software on Host PC

Install hardware driver and software **after** you have installed the C-843 card in the PC. For a short description of the available host software see "Software Overview" on p. 29.

1   Start the host PC. Be sure to log in with administrator privileges.

2   When the *New Hardware Wizard* appears, cancel it.

3   Insert the C-843 CD in the host PC.

4   If the Setup Wizard does not start automatically, start it from the root directory of the CD with the icon.

5   Follow the on-screen instructions. You can choose between "typical" and "custom" installation. Typical components are hardware driver, DLLs, LabView

drivers, PIMikroMove™ and PITerminal. "Typical" is recommended.

2.3   Begin Operation

After you have installed the C-843 card and the hardware driver and software, you should perform some test moves with the stages. For that purpose, you should use PIMikroMove™ (see the PIMikroMove™ Manual for more information).

!

CAUTION

DO NOT EXCEED MAXIMUM CURRENTS!

Keep in mind that the total current for the C-843 is supplied from the PC power supply only.

Extreme power peaks will occur when:

■ Motors accelerate or decelerate very fast

■ Motors are reversed at high speed

■ Motors stall

■ Stages are driven into the hard stop

The total current may exceed the current capability of the PC power supply. Voltage drops may occur with the risk of PC malfunction or damage to other devices such as hard disks drives.

The C-843 has factory-set output current limitation. Nevertheless the user has to ensure that the total current does not exceed the capability of the PC power supply.

1   Connect the stages to the sub-D15 connectors on the mounting bracket(s). It is recommended to note the channel designations. Channel 1 on the bracket corresponds to the first axis in PIMikroMove™, channel 2 to the second axis, etc..

2   Start PIMikroMove™ on the host PC and establish a connection with a C-843 DC Motor Controller Card by selecting the PCI board and pressing *Connect*.

The figure below shows the *Start up controller* screen at the *Connect controller* step. The C-843 card in this example is to be connected as board 2.

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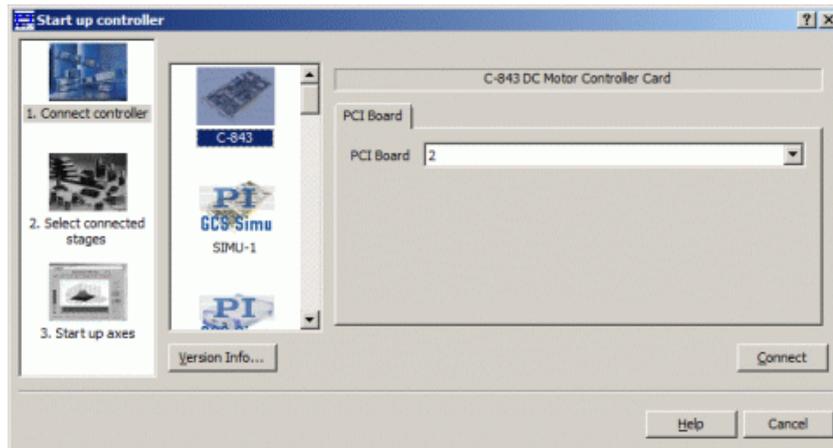
3 Choose the stage type to be connected for the axes of the C-843 card.

Notes:
While choosing the stage type, the parameters for that stage type will be loaded automatically from a stage database on the host PC to the motion processer of the C-843 card. Incorrect stage selection can cause damage to the stage or nonsatisfying performance. Furthermore, make sure that you always have installed the latest version of the PIStages2.dat stage database. See the C-843 GCS Commands manual (SM149E) for details.

If the stage selection dialog does not open automatically, click on the *Select connected stages* entry in the leftmost pane of the *Start up controller* screen. For each axis, select the stage type in the S*tage database entries* list and press the *Assign ->* button. The selected stage types are now visible in the *Controller axes* pane. To accept the selection and close the dialog, press the *OK* button. Note that pressing *OK* also switches the servo on for the axes and resets their reference states to "unreferenced".

The figure below shows the *Start up controller* screen with the *Select connected stages* step.

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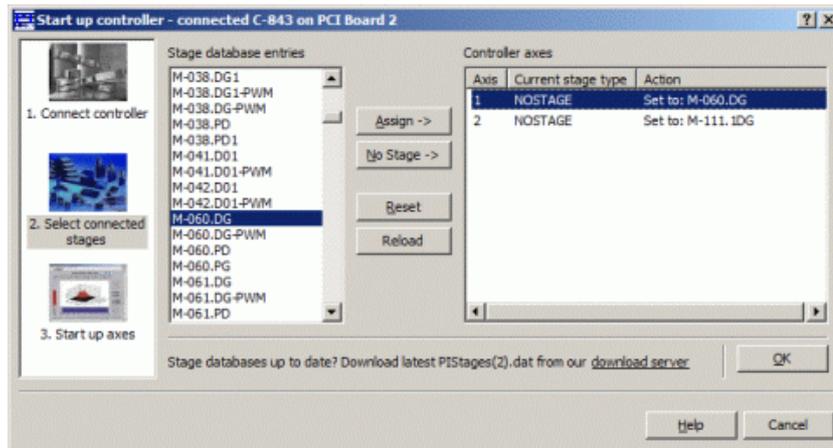
The choice can later be changed with *Select connected stages* on the *C-843* menu in the PIMikroMove™ main window.

4   Start reference moves for the axes.

Due to the nature of the incremental sensors used in the stages, the C-843 cannot know the absolute position of an axis upon startup. Reference and/or limit switches in the stage can be used to obtain absolute position information.

The figures below show the *Start up controller* screen with the *Start up axes* step where reference moves are to be started. When referencing is successfully finished, press the *Close* button. The PIMikroMove™ main window will open.
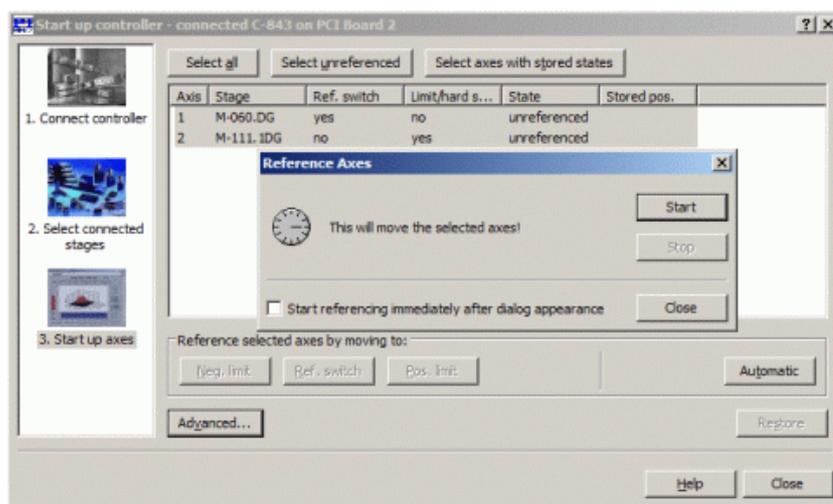
See "Referencing" in the C-843 GCS Commands manual (SM149E) for more information.

5   Start some test moves of the axes:
For example, perform a step of a predefined size by pressing the associated arrow buttons for an axis.

The figure below shows the PIMikroMove™ main window with the *Axes* tab card where you can start axis motion.
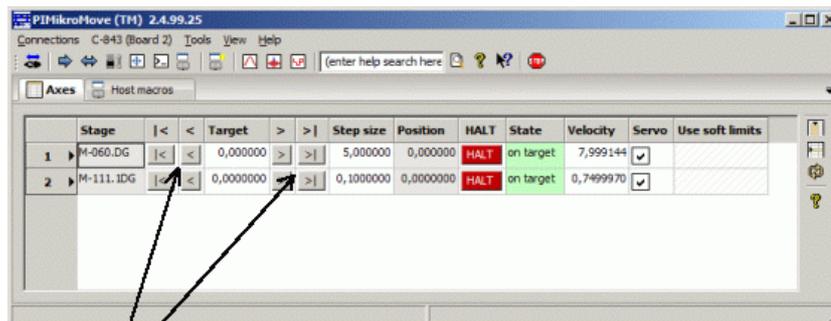
Arrow buttons causing motion

See "Joystick Control" in the C-843 GCS Commands manual for manual control by a joystick connected to the host PC.

2.4   Configuration Settings for Multiple Cards

If you want to use more than one C-843 card (up to 8 cards are possible) in one PC, the cards must be given different board ID settings. The mechanism used is comparable to setting jumpers on an ISA card, but instead of a jumper, a serial EEPROM on the card is used. By default all cards ordered from PI are configured with ID of 1, so card 1 need not be reprogrammed. If you wish to have PI set your card before shipment, please let us know. Otherwise, to reset the EEPROM, the following steps must be performed:

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Avoid touching circuit components, pins and PCB traces. Discharge any static charge you may have on your body by briefly touching a conductive, grounded object before you touch any electronic assembly. Pose PCBs only on conductive surfaces, such as ESD-safe transport containers (envelopes, foam). Electronic subassemblies must always be kept and transported/shipped in conductive packaging.

Make sure that no conductive particles of any kind (metallic dust or shavings, broken pencil leads, loose screws) get on the card or into the PC

Make sure that no electrical contact between the various add-on cards in the PC is possible.

DANGER

Before opening the host PC, remove the line-voltage connection.

Heed any warnings provided by the manufacturer of the PC or of other add-on cards it may contain

1   Place the file EPROM.exe from the EPROM_Tool directory of the C-843 distribution CD on a bootable medium (e.g. USB stick or CD-R).

2   Power down the PC and disconnect it from the AC power.

3   Remove any other C-843 cards currently in the PC and install the card to be reprogrammed. (For programming, only one C-843 at a time may be in the PC).

4   Boot the PC from the bootable medium which contains the EPROM.exe file. It may be necessary to change settings in the BIOS Setup in order to do this.

5   Start EPROM.exe and press a key from 1 to 8 to program the corresponding number as the card number in the EEPROM on the card. The card now has the specified identification number.

6   If you want to program another card, disconnect the PC from the AC power and repeat steps 3 to 6.

> After programming all the cards whose settings need to be changed, disconnect the PC from the AC power and install all the cards.

2.5   Updates

2.5.1 Uninstalling C-843 Software

To uninstall the C-843 host software use the *Start→Settings→Control Panel→Add/Remove Programs (Software)* menu sequence and follow the on-screen instructions.

To update the C-843 host software proceed as follows:

1   If you want to keep any existing configuration files, save them under new names or in a new directory

2   Uninstall the old C-843 host software version using the *Start→Settings→Control Panel→Add/Remove Programs (Software)* menu sequence (This also removes unneeded directories)

3   Install the new C-843 host software version by running the Setup Wizard from your update CD

4   If desired, move back any configuration files you saved in step 1

2.5.2 Software Updates

Updated releases of software and manuals are available for download at www.pi.ws. While the manuals are freely accessible, you need a password for the software download. This password is provided on the C-843 CD in the C-843 Releasenews PDF file in the \Manuals directory.

To download the latest software (complete CD mirror) from the PI Website, proceed as follows:

1   On the www.pi.ws front page, move the cursor to *Manuals, Software, ISO Statements* in the *Service* section on the left.

2   Select *Link to Software Server* from the list that pops up.

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3   On the *PI Download Server* page, enter the Username and the Password which are provided in the C-843 Releasenews xxxxx.pdf on the C-843 CD and click on *Login*

4   Click on the *C Motion Controllers* category.

5   Click on *C-843.*

6   Click on *Software* (if you click on *Documents* you will get the latest manuals).

7   Click the on the latest CD-Mirror (includes the manual versions that were with the release) or on the latest update zip file.

See the C-843 GCS Commands Manual (SM149E) for how to update the PIStages(2).dat stage database which is used by the C843_GCS_DLL and the GCS-based host software from PI.

3 System Description

The C-843 Motor Controller is designed for high-performance motion control based on the *MC2140 (MC2120)* motion processor (for detailed descriptions see the Motion Processor manuals on the C-843 CD). The board is designed as a 32-bit, plug-and-play, PCI-bus card, compatible with main boards with 3.3 V and 5 V PCI bus slots (universal card). Read/Write operations are controlled via the PCI bus and memory-mapped PCI bridge, providing fast data transfer for complex motion control.

The C-843 provides closed-loop digital servo-control for a large variety of servo-motors. It uses incremental encoder position feedback signals. Sophisticated trajectory profile and digital servo capabilities are provided for each axis, resulting in very low position and velocity tracking errors. Axes can be programmed either independently or synchronously to allow advanced multi-axis motion, such as tracing circular and other complex path profiles.

For motor amplifier output the C-843 has one on-board linear amplifier per motor axis; each amplifier is capable of driving a 5 W motor. PWM outputs for external amplifiers are also available.

The volatile memory integrated on the C-843 board allows for high-precision, user-specified trajectory profile control and data recording (online tracing of up to four independent system variables at whole-number multiples of the servo-loop time).

To offer maximum flexibility, software interfaces at different levels are provided and documented. See "Software Overview" on p. 29 for more details.

3.1 Output Current Limitation

!

CAUTION

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Keep in mind that the total current for the C-843 is supplied from the PC power supply only.

Extreme power peaks will occur when:

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■Motors are reversed at high speed

■Motors stall

■Stages are driven into the hard stop

The total current may exceed the current capability of the PC power supply. Voltage drops may occur with the risk of PC malfunction or damage to other devices such as hard disks drives.

The C-843 has factory-set output current limitation. Nevertheless the user has to ensure that the total current does not exceed the capability of the PC power supply.

All output channels have separate current limiting. The factory default output current limit for each channel is 1 A, sufficient to drive a 5 W motor.

It is possible to drive stages with higher power consumption in PWM mode. See section 3.2 on p. 22.

3.2 Motor Output Modes

The motor output mode and thus the amplifier mode can be set by command for each axis separately. Possible modes are "16-bit DAC" (analog mode)[*] and "Sign/Magnitude PWM" (see the Motion Processor Users Guide p. 53 *ff*. for more information). The "50/50 PWM" mode of the motion processor chip is not presently supported by PI stages and thus not recommended. Nor is driving stepper motor stages currently supported.

Use the SPA command (GCS command set) to set the output mode (see C-843 GCS Command Manual, SM149E). Note: When working with the operating software provided on the product CD, the correct motor output mode for the selected stage is automatically loaded from a stage database.

Axes connected to a given C-843 card may be in different modes, so that PWM and analog stages can be run off the same card. When PWM mode is used, the stages are driven by external amplifiers instead of the C-843 on-board amplifiers, thus allowing higher-power stages. PWM mode is required with PI ActiveDrive™ stages (.PD and .DD models).

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[*]In analog mode, commanding the motor to run in positive direction puts a higher voltage on the "MOT+" output than on the "MOT - " output. Commanding the motor to run in negative direction puts a lower voltage on the "MOT+" output than on the "MOT - " output. The maximum differential is 12 V and no particular relationship to ground is guaranteed.

If you want to drive an analog stage whose power consumption might exceed the output current limitation (see Section 3.1 on p. 21) a PWM converter box (C-842.AP1) can be used. The output mode of the appropriate axis must then be set to Sign/Magnitude PWM (or the stage with the "PWM" name suffix must be selected from the appropriate stage database).

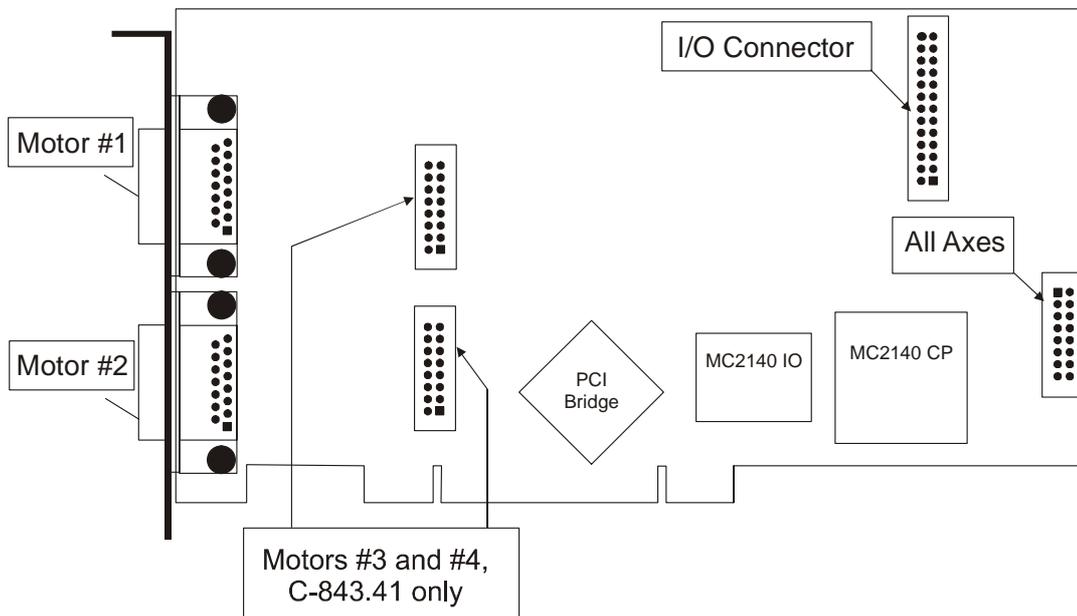## 3.3 Connectors and Pinouts

3.3.1 Connector Locations

Fig. 3: C-843 Board layout

3.3.2 Motor Connector Pinouts

Connectors for Motors #3 & #4 (only on C-843.41) IDC16 header		Connectors for Motors #1 & #2 (on bracket) Sub-D15f		Function
Pin	1	1		Motor Brake
	2		9	Motor (+)
	3	2		Motor (-)
	4		10	GND
	5	3		MAGN
	6		11	SIGN
	7	4		Output + 5 V
	8		12	Negative limit
	9	5		Positive limit
	10		13	REFS
	11	6		GND
	12		14	Encoder A (+)
	13	7		Encoder A (-)
	14		15	Encoder B (+)
	15	8		Encoder B (-)
	16			n.c.

For the C-843.41 an adapter mounting bracket is provided with two sub-D 15 connectors to allow standard-connector access for motors #3 and #4.

3.3.3 All-Axes Connector

The lines of the "All-Axes" connector offer direct access to the motion processor. For using them via the commands of the PI General Command Set (CTO, TRO for output lines, FED for input lines) see the C-843 GCS Commands manual (SM149E). See the Motion Processor User's Guide p. 46 *ff.* for further details on these lines.

These I/O lines can be brought out of the PC housing using the sub-D 15-pin connector (male) on the included adapter bracket. The corresponding ribbon cable connects to the 16-pin "All-Axes" IDC connector (J8) on the C-843 (see Fig. 3 on p. 23). Note that older revisions of the adapter bracket do not provide the sub-D 15-pin connector and the corresponding ribbon cable. If required, contact your PI sales engineer or write info@pi.ws to obtain a new version of the adapter bracket.

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All-Axes Connector on Board IDC16 header	Connector on Bracket Sub-D 15m		Function Axis-In & Axis-Out
Pin 1	1		AOUT1 (AxisOut pin for first axis)
2		9	GND
3	2		AOUT2 (AxisOut pin for second axis)
4		10	GND
5	3		AOUT3 (AxisOut pin for third axis, with 4-axis models only)
6		11	GND
7	4		AOUT4 (AxisOut pin for fourth axis, with 4-axis models only)
8		12	GND
9	5		AIN1 (AxisIn pin for first axis)
10		13	GND
11	6		AIN2 (AxisIn pin for second axis)
12		14	GND
13	7		AIN3 (AxisIn pin for third axis, with 4-axis models only)
14		15	GND
15	8		AIN4 (AxisIn pin for fourth axis, with 4-axis models only)
16			no connection

3.3.4 Digital I/O Connector

Eight input and eight output lines are available on the "I/O" connector of the C-843 card. These lines have no direct connection to the motion processor. For using them via the commands of the PI General Command Set (DIO and DIO?) see the C-843 GCS Commands manual (SM149E). For accessing to them via the commands of the motion processor see "Reading/Writing Digital I/O Lines" on p. 32.

These I/O lines can be brought out of the PC housing using the sub-D 25 connector (female) on the included adapter bracket. The adapter ribbon cable connects to the 26-pin "I/O" IDC connector (J5) on the C-843 (see Fig. 3 on p. 23).

I/O Connector on Board IDC26 header	Connector on Bracket Sub-D 25f		Function
Pin 1	1		GND
2		14	Input #0
3	2		Input #1
4		15	Input #2
5	3		GND
6		16	Input #3
7	4		Input #4
8		17	Input #5
9	5		GND
10		18	Input #6
11	6		Input #7
12		19	n.c.
13	7		GND
14		20	Output #0
15	8		Output #1
16		21	Output #2
17	9		GND
18		22	Output #3
19	10		Output #4
20		23	Output #5
21	11		GND
22		24	Output #6
23	12		Output #7
24		25	n.c.
25	13		GND
26			no connection

NOTE

With some older C-843 hardware models, usage of the volatile memory (data recorder, user-defined motion profiles; see below) and usage of the digital output lines on the 26-pin IDC connector (DIO command of the PI General Command Set) are mutually exclusive. This means that after the C-843 board was connected in the software, only the functionality called first is available. The selection is reset any time the C-843 board is reconnected. If, for example, the digital output lines have been set with DIO before any data-recorder-related command was sent, you can not use the data recorder until you reconnect the C-843.

3.4 On-Board Memory for User-Defined Profiles and Data Recorder

The C-843 card contains 32,256 points of volatile memory which is accessable in real time by the motion processor (referred to as "external RAM" in the MotionProcessor UsersGuide).

This memory is shared by a data recorder and user-defined multi-axis motion profiles ("User Profile Mode"). Both data recorder functionality and the usage of user-defined motion profiles are provided by commands of the PI General Command Set (GCS); see the C-843 GCS Commands manual and the separate Technical Note A000T0014_100_UserProfileModeSoftware for more information.

NOTE

With some older C-843 hardware models, usage of the volatile memory (data recorder, user-defined motion profiles) and usage of the digital output lines on the 26-pin IDC connector (DIO command provided in the GCS) are mutually exclusive. This means that after the C-843 board was connected in the software, only the functionality called first is available. The selection is reset any time the C-843 board is reconnected. If, for example, the digital output lines have been set with DIO before any data-recorder-related command was sent, you can not use the data recorder until you reconnect the C-843.

3.5 Communication

Information you would need to actually access the MC2140 or MC2120 motion processor on the C-843 card directly is contained in the motion processor manuals on the product CD and in "Low-Level Information" on page 32.

The motion processor provides the output signals for the motors. Its I/O address space is mapped to the card's PCI-bus function registers, making it addressable from the PC. Furthermore, the motion processor can be accessed by the lines of of the All-Axes connector (see p. 24).

At the next level, the C-843 is controlled as a PCI card by a driver installed by the C-843 Setup. That driver can read and write the PCI function registers in response to software that wishes to communicate with the device.

At intermediate levels, communications with a C-843 are handled by DLL functions which refer to the card as a standard Windows PCI device. These functions are described in the corresponding DLL manual.

At the application level (LabView, PIMikroMove™, PITerminal etc.), commands are usually input via the mouse and keyboard.

3.6 Command Sets

The PI General Command Set (GCS) is supported by a wide range of PI systems. This command set is well-suited for positioning tasks with one or more axes. The command set itself is independent of the specific hardware (controller or attached stages). GCS commands for the C-843 are provided by the C843_GCS_DLL (Windows Dynamic Link Library) which must be installed on the host PC. You can type GCS commands, for example, in the *Command Entry* window of PIMikroMove™, or in the PITerminal (to which the C-843 card must be connected via the C-843 GCS DLL).

The C-843 GCS DLL is also the software interface recommended for users who program their own applications. It handles communications and relieves the user-programmer of the details of tasks like referencing the connected stages, calculating counts-to-physical-unit ratios or limit checking.

C-843 GCS commands and C-843 GCS DLL are described in their own manuals (SM149E and MS112E) which are on the C-843 CD.

At the low level is the command set of the MC2140 or MC2120 motion processor (also referred to as "QMC" command set). The motion processor programmers' reference and user manuals are included on the C-843 CD. Because of their complexity, successful use of the motion processor commands requires extensive experience. They can be sent via the C-843 GCS DLL as well so that its complete functionality is available to the programmer.

3.7   Software Overview

The table below lists the software tools which are on the C-843 product CD and gives application recommendations.

For more information see the corresponding software manuals.

Software Tool	Purpose	Recommended for
Hardware driver	C-843 device driver for Windows XP, Vista and Window 7; 32-bit and 64-bit versions	Required for all access to the C-843 card from Windows operating systems
C-843 GCS DLL (Windows Dynamic Link Library)	This DLL provides the commands of the PI General Command Set (GCS) for the C-843 card. For programming customized applications we recommend use of the C-843 GCS DLL since all PI controllers understand the PI General Command Set (GCS) and your applications are thus portable between them. The C-843 GCS DLL has also functions for sending the commands of the motion processors command set so that the motion processors complete functionality is available to the programmer.	Needed by PIMikroMove™, the LabVIEW driver set and PITerminal. Recommended for customers who want to use a library for their applications.
PIMikroMove™ operating software	PIMikroMove™ permits you to start your motion system—host PC, controller and stage(s)—immediately without the need to write customized software. It offers motion-control displays and features that in many cases make it unnecessary to deal with ASCII-format commands. It also has a complete command input facility, which represents an easy way to experiment with various GCS commands. PIMikroMove™ uses the GCS DLL described above to command the controller. Note that the program offers comprehensive online support.	Users who want to test the equipment without programming an application
LabVIEW drivers	LabVIEW is a software tool (available separately from National Instruments) for data acquisition and process control. The C-843 LabVIEW software consists of a collection of virtual instrument (VI) drivers for the C-843 card. This driver set supports GCS based on the C-843 GCS DLL. Included are Vis for GCS commands and high-level Vis for various tasks.	Users who want to use LabVIEW for programming their applications based on the GCS.

Software Tool	Purpose	Recommended for
PIStageEditor	GUI tool for adding, removing and editing stages (parameter sets) in the stage database files (DAT-files) used by the GCS DLL and other host software from PI.	Users who want to check or edit the content of the stage databases used by the host software
PITerminal	PITerminal is a Windows GUI which can be used as a simple terminal with almost all PI controllers. The C-843 card must be connected to PITerminal via the C-843 GCS DLL.	Users who want to send GCS commands directly.
Profile Generator DLL (Windows Dynamic Link Library)	The Profile Generator DLL facilitates access to the User Profile Mode where it is possible to specify the motion of one or more axes in great detail. This DLL takes over the work of writing the GCS commands that define a User Profile.	User who want to define their own multi-axis motion profiles
StateViewer	This "online-reading" tool is recommended for testing the correct card installation and for debugging purposes. It reads out motion processor status registers, velocity, acceleration, position and position error, motor mode and motion errors for all axes on all C-843 cards which are installed in the PC.	Users who want to observe the operation of the card while it is being controlled with other software
MC DLL (Windows Dynamic Link Library)	The MC DLL is provided for compatibility and historical reasons only. It provides lower-level access to the C-843 card

Note that separate installation of the MC DLL is not provided by the setup program on the C-843 CD. If you need this DLL for programming, copy it to the PC manually from the MC_DLL directory on the C-843 CD. | Customers who need this lower-level DLL for programming due to compatibility reasons |
| EPROM.exe | If you want to use more than one C-843 card (up to 8 cards are possible) in one PC, the cards must be given different board ID settings. This is to be done using the EPROM tool.

Note that this tool is not installed with the setup program provided on the C-843 CD. If you need to program a C-843 card, copy EPROM.exe from the EPROM_TOOL directory of the C-843 CD to a bootable medium (e.g. USB stick or CD-R). | Users who want to use more than one C-843 card in one PC |

The PI host software is improved continually. It is therefore recommended that you visit the PI website (www.pi.ws) regularly to see if updated releases of the software are available for download. Updates are accompanied by

information (readme files) so that you can decide if updating makes sense for your application. You need a password to see if updates are available and to download them. This password is provided on the C-843 CD in the C-843 Releasenews PDF file in the \Manuals directory. See "Software Updates " (p. 19) for download details.

3.8 Stage Databases for Motion Parameters

Like most motion controllers, the C-843 needs information about the connected stages in order to control them correctly. To keep you from having to enter all these values whenever a new stage is connected, the C843_GCS_DLL and the GCS-based host software from PI uses the following databases for motion parameters of the stages:

- ■ **PIStages2.dat** contains parameter sets for all standard stages from PI and is automatically installed on the host PC with the setup. It cannot be edited; should changes in the file become necessary, you must obtain a new version from PI and install it on your host PC (see "Updating PIStages2.dat" in the C-843 GCS Commands manual (SM149E)).

- ■ **C843UserStages2.dat** allows you to create and save your own stages (see "Editing User DAT Files" in the PIMikroMove™ User Manual). This database is created the first time you connect stages in the host software (i.e. the first time the C843_qVST() or C843_CST() functions of the C843_GCS library are used which is the case, for example, when VST? or CST are sent in PITerminal or the *Select connected stages* startup step is performed in PIMikroMove™).

- ■ **M-xxx.dat** files contain parameter sets for custom stages delivered by PI. Those files are provided by CDs which come with the stages and have to be copied to the host PC according to the accompanying instructions. M-xxx.dat files can not be edited; should changes become necessary, you must obtain a new version from PI.

The PIStages2.dat, C843UserStages2.dat and M-xxx.dat databases are located in the ...\PI\GcsTranslator directory on the host PC. The location of the PI directory is that specified upon installation, usually in C:\Documents and Settings\All Users\Application Data (Windows XP) or C:\ProgramData (Windows Vista). If this directory does not exist, the program that needs the stage databases will look in its own directory. In

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PIMikroMove™, you can use the *Version Info* item in the controller menu or the *Search for controller software* item in the *Connections* menu to identify the GcsTranslator path.

For further details on motion parameters see the C-843 GCS Commands manual (SM149E).

3.9 Low-Level Information

The information given in this section is for programmers who have sufficient knowledge to deal directly with the motion processor of the C-843 card and wish to bypass some or all of the higher-level software provided. For further details regarding the motion processor and its command set, refer to MotionProcessor_ProgrammersRef.pdf and MotionProcessor_UsersGuide.pdf included on the C-843 CD.

3.9.1 Reading/Writing Digital I/O Lines

The digital output and input lines of the 26-pin "I/O" IDC connector on the C-843 card are available on the 8-bit registers at I/O address 0. This address space can be accessed via the *WriteIO* (output lines) and *ReadIO* (input lines) motion processor commands.

3.9.2 Enabling/Disabling Analog Amplifiers and Brakes

Each analog power amplifier can be enabled or disabled independently from the others. The hardware connection to the analog amplifier enable/disable function and brake actuation signals is via the *Write/O* motion processor command with address 1. The four lower bits control the analog amplifiers, the four upper bits the brake signals, motor axes 1-4.

3.9.3 Sense of Limit Switch and Reference Signals

The limit switch and reference signals are inverted by the hardware on the C-843 board before they are connected to the motion processor. This is important to know if the actual signal status is read with the GET_SIGNAL_STATUS motion processor command. The value read is also combined with the signal sense register (SET_SIGNAL_SENSE command) and then returned to the user. For each bit in the signal sense register that is set to 1, the corresponding bit in the GET_SIGNAL_STATUS command will be inverted, so that a low signal is read as 1 and a high signal will be read as 0.

3.9.4 Encoder Signals

Standard quadrature encoder signals can be used with the C-843. The phase of ENCA signals is ENCB +90°. Both inputs have 10 k pull-up resistors.

3.9.5 Index and Home Reference Signals

The motion processor can capture separate *home* and *index* signals, although both inputs are connected to the same line, REFS.

Capturing home can be activated by the "SetCaptureSource A 1" motion processor command (Set Capture Source for axis a to 1). Home position recognition requires any transition from high to low or vice versa at the REFS input. The level of the REFS input can be read on bit 3 of the signal status register.

The command for index pulse capture is "SetCaptureSource A 0" (Set Capture Source to 0). Index pulses are clock-synchronized signals like those that are emitted by special rotary encoders (one signal per revolution). PI software does not use this configuration.

4 Technical Data

Model	C-843.21 / C-843.41
Function	PC plug-in Servo-Motor Controller Board, 32-bit plug-and-play PCI-bus, supported by main boards with 3.3 V and 5 V PCI bus connectors (universal card).
Axes	2 / 4
Servo characteristics	Programmable PID V-ff filter, parameter changes on-the-fly
Profile Modes	Trapezoidal^point-to-point, S-curve point-to-point, velocity contouring, user-defined
Output power	5 watts/channel (analog mode)
Resolution	12-bit D/A converters, PWM 10-bit, 24.5 kHz
Current limitation	1 A per channel (short-circuit proof)
Encoder input	AB (quadrature) differential TTL signal, max. 5×10^6 counts/s
Stall detection	Servo off, triggered by programmable position error
Limit switches	2 TTL per axis (active high/low, programmable)
Reference switches	1 TTL per axis (active high/low, programmable)
Digital I/O	8 TTL inputs, 8 TTL outputs on I/O connector; 1 TTL input and output per axis on All-Axes connector
Motor connectors	15-pin (f) sub-D per channel (2 on board + 2 on bracket for C-843.41)
Interface / Communication	PC PCI bus
Command set	PI General Command Set (GCS)
Dimensions	Standard PCI card, length 20 cm
Weight	230 g ± 10%