

mirao™-52d
deformable mirror

User's Guide

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Manual Revision D DUT 003 b : March 2007

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1 INTRODUCTION

Thank you for buying the mirao52d and putting your trust in Imagine Eyes' technology. We are committed to assuring your complete satisfaction with this high-performance product.

Mirao52d in short

The mirao52d is a mini deformable mirror that allows you to control the phase shape of light beams. This product has been designed to correct a wide range of wavefront aberrations with a very high precision. You may also use mirao52d to generate predefined aberrations and reshape optical beams.

As an OEM device, the mirao52d deformable mirror can be integrated into various optical systems. This purpose is served by its compact optical hardware and developer-friendly software drivers. The integration of mirao52d is particularly straightforward when it is combined with **the HASO line of wavefront sensors and adaptive-optics software**. If you wish to know more about these high-performance products, please contact your mirao52d Seller or Imagine Eyes.

The mirao52d deformable mirror is based on a patented proprietary technology. It uses an array of miniature electromagnetic actuators to locally push or pull a continuous reflecting membrane. You will get more knowledge in the performance and advantages of this unique technology by reading through the pages of the present manual.

About this manual

This User's Guide will help you familiarize with the use of the mirao52d deformable mirror. It is designed as a training and reference manual.

The section [2 WARNINGS AND CAUTIONS](#) contains important security orders concerning the installation and current use of the product. Please read it carefully before using your mirao52d. You will also find other information about security in other sections of this manual, when appropriate.

The information needed to understand the functioning of mirao52d is presented in section [3 PRODUCT OVERVIEW](#). This section also includes descriptions that are useful for the integration of mirao52d into various systems. The detailed technical specifications of mirao52d are listed in section [4 SPECIFICATIONS](#).

To install your product, please follow the guidelines of section [5 INSTALLATION](#). You should read the "Unpacking" instructions of this section as soon as you receive your product.

The section [6 USING MIRA052D](#) teaches you the basic use of the product. If you want to control the deformable mirror using your own-developed software, you should also read section [7 PROGRAMMING MIRA052D](#). In order to ensure the preservation of your product over time, you should adhere to the recommendations of section [8 STORAGE AND MAINTENANCE](#).

In case of trouble with your mirao52d or if you suspect malfunctioning, please read section [9 TROUBLESHOOTING](#) : it will help you to solve some typical problems that you may encounter. If a problem remains unsolved, follow the guidelines of section [10 GETTING SUPPORT](#) to receive help from your mirao52d supplier.

2 WARNINGS AND CAUTIONS

The mirao52d deformable mirror has been designed and manufactured so that it can be operated in full integrity and safety. Please strictly adhere to the following points :

- *Please carefully read this User's Guide before using your device.*
- *Check the product before usage : see instructions in section [5 INSTALLATION](#).*
- *Keep the mirao52d optical component protected with its plastic cover while unpacking.*
- *Do not place the product close to a source of heat.*
- *Do not place the product near an open window : exposure to water could damage the device.*
- *Do not place the product in a dirty or dusty environment.*
- *Make sure that the product cables are placed in a position where they cannot be damaged or stepped on.*
- *Use the threaded holes of the mirao52d optical component to attach it to other pieces of equipment ; do not use any other part of the component to attach it.*
- *Do not use adhesive tape or glue to attach the mirao52d optical component to other pieces of equipment.*
- *Check that your mains electric supply has an earth plug.*
- *Before connecting the electronic unit to the mains supply, check that the voltage is comprised between 100 and 240 V AC and the frequency between 50 and 60 Hz.*
- *Make sure that the mirao52d electronic unit is switched off when you install the product software.*
- *Do not switch on the mirao52d electronic unit before having turned on the driving computer and checked that the computer operating system has opened.*
- *Do not use the product in the presence of flammable or caustic gasses.*
- *Do not expose the product to liquids, dust, vibrations, shocks, excessive heat or high magnetic fields.*
- *Do not cover the ventilation openings of the electronic unit.*
- *Do not touch or put anything in contact with the reflecting surface. The mirror membrane is thin and fragile.*
- *Keep the mirao52d optical component protected with its plastic cover while handling the mirror and when the product is not in use.*
- *Do not connect or disconnect the mirao52d optical component while the electronic unit is switched on.*
- *Do not disconnect any cable of the product while the product is in operation or the electronic unit is turned on.*
- *Do not move the cable that connects the mirao52d optical component to the electronic unit while the product is operating.*
- *Do not install or manipulate the product without being skilled in using optical and electronic systems or being supervised by a person with such skills.*
- *If your device is exposed to a liquid, or suffers a fall, or overheats, please unplug the computer from the mains supply and contact your mirao52d supplier.*
- *Do not open or disassemble any part of the product.*
- *The instrument does not include any repairable parts: for any repairs or if you suspect damage or malfunctioning of the instrument, please contact your mirao52d supplier immediately, both for your personal safety and in keeping with the terms of the warranty.*

- Do not connect any part of the product to a device that is not part of the original product (except for the communication board, which is intended to be plugged into a computer).
- Do not replace any of the product cables by another cable that was not supplied by your mirao52d supplier.
- Make a backup copy of the product software disks.
- Install and maintain reliable antivirus software on the computer that drives your mirao52d.
- If you connect the computer to a network, install and maintain reliable firewall software.

Important notice

Your mirao52d supplier will not be held responsible for the reliability, security and integrity of the product and the product warranty will not apply when :

- assembly, disassembly, repairs or modifications have been made without express written permission by your mirao52d supplier ;
- the serial number has been removed ;
- the product has been used in a manner exceeding its specifications ;
- the product has not been used in accordance with this User's Guide.

Disposal

This product does not contain any environmentally hazardous components. For proper disposal of the equipment, please follow local regulations.

Information on symbols

The following symbols can be found in the product labels :



	<p>Important operating and maintenance instruction must be read in the user's guide</p>
	<p>Date of manufacture</p>

Table 1- Symbols used in the product labels

3 PRODUCT OVERVIEW

The mirao52d is an OEM product. As such, it can be integrated in a variety of systems. This section is intended to give a better understanding of the product and to facilitate its integration.

Hardware overview

The mirao52d product includes the following main hardware parts :

Optical component	the deformable mirror in a rigid mount
Electronic unit	produces the analog currents needed to drive the optical component
PCI-7200 digital I/O board	enables a PC computer to control the electronic unit.
Active digital data cable	connects the electronic unit to the PCI-7200 board.
Analog data cable	connects the optical component to the electronic unit

Table 2 - Hardware list

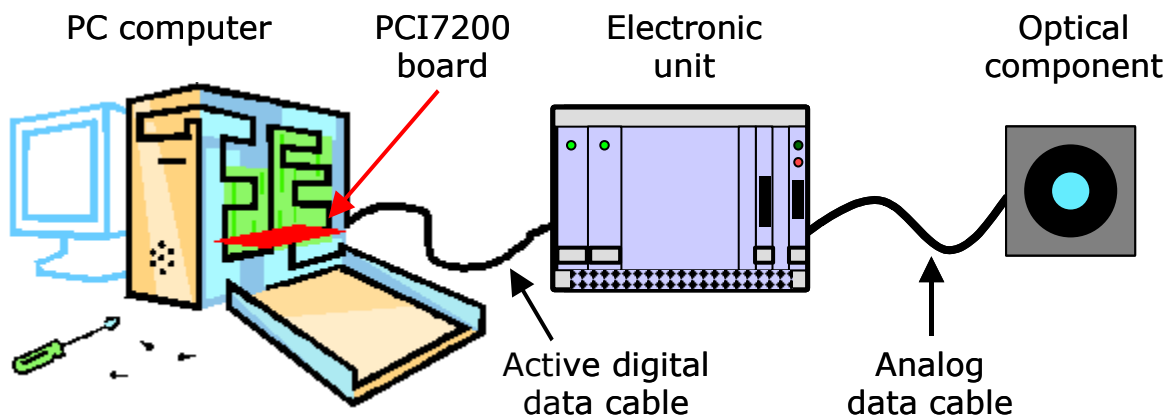


Figure 1 - Representation of the mirao52d hardware configuration

Optical component

The mirao52d optical component includes a high-quality reflecting membrane and 52 miniature actuators assembled in a rigid aluminum housing. When the product is not in use, a removable plastic cover protects the reflecting membrane.

Principle of operation

The principle of the mirao52d technology is very simple. Each actuator couples a miniature magnet with a miniature coil attached to the deformable membrane. The magnet and coil attract or repel each other through the magnetic force. This force directly depends on the current that flows through the coil. Therefore, by varying the coil current provided by the electronic unit, one can adjust the magnetic force and control the local shape of the deformable membrane.

This innovative technology has multiple advantages. To know more about the performance of mirao52d, please read section [4 SPECIFICATIONS](#).

Geometry

When no voltage is applied to the actuators, the reflecting membrane assumes an uncontrolled shape that usually corresponds to a mix of aberrations including significant spherical curvature and astigmatism. The set of voltages able to flatten the mirror is specific to each mirao52d. The optimum values of these "flat mirror" voltages may vary, depending on the ambient conditions.

The convention used in numbering the mirror actuators is explicated in Figure 2. In this figure the optical component is viewed from back (not from the reflecting side), with its connector oriented to the left.

A mechanical drawing of the mirror mount is shown in the Figure 3 below. The rear part of this mount features M3 threaded holes that must be used to attach the mirror to other equipment. The drawing also shows the position of the reflecting surface relative to the mount.

A circular pupil limits the reflecting area. The actuator centers are distributed on a square grid (see the exact dimensions in the zoomed drawing at the bottom-right of Figure 3). As the last ring of actuators is located outside of the pupil aperture, the mirror shape can be fully controlled over the complete pupil area.

Most relevant geometrical data are :

- Pupil diameter : 15.0 mm
- Inter-actuator spacing : 2.5 mm

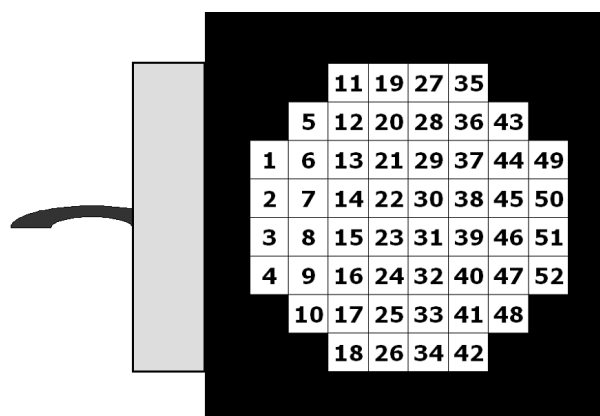


Figure 2 - Actuator numbering (back view)

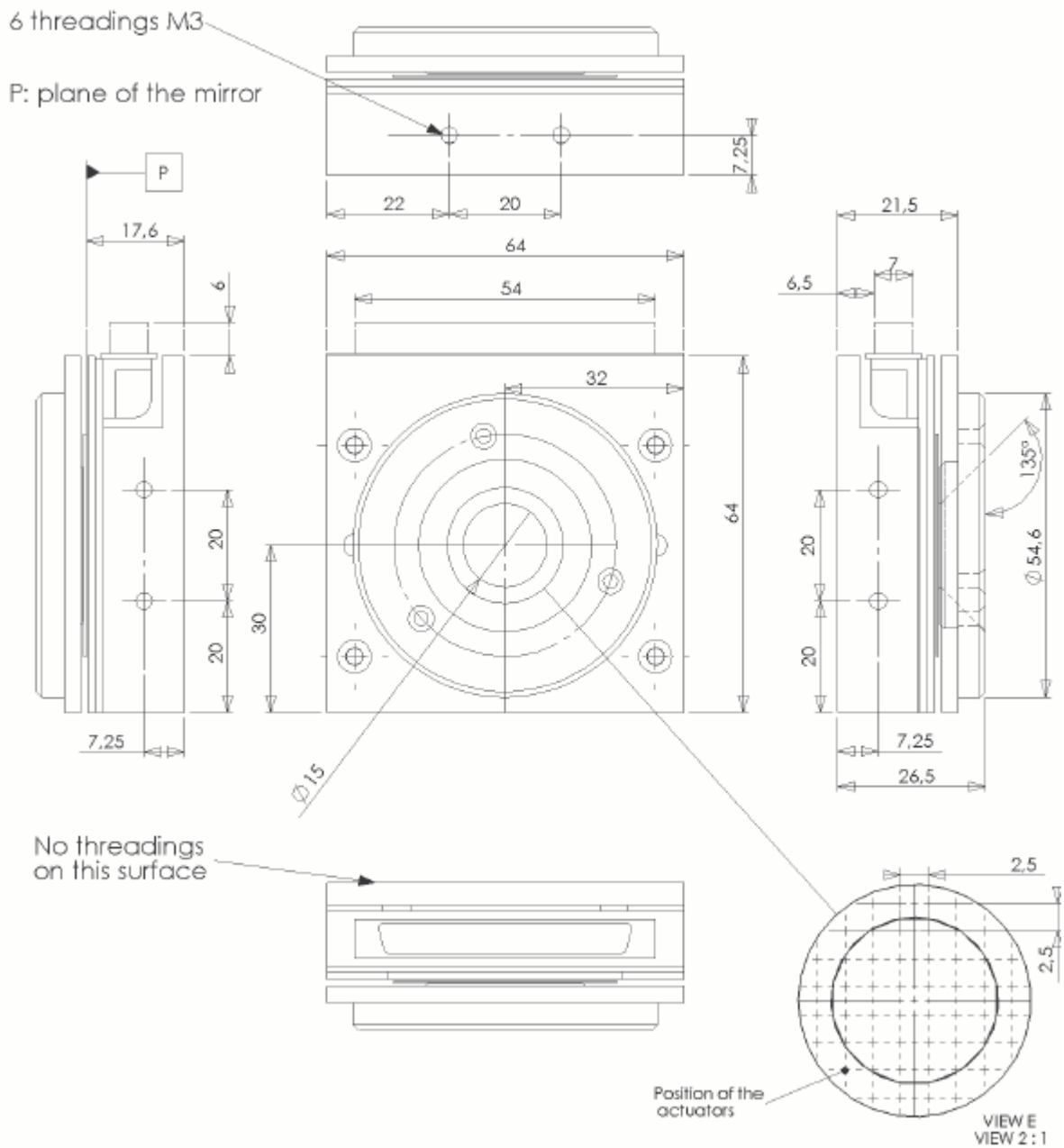


Figure 3 – Mechanical drawing of the mirao52d optical component

Reflective coating

The mirao52d deformable mirror is coated with a protected silver layer. The Figure 4 and Table 3 below show measured reflectivity data that are typical with this coating.

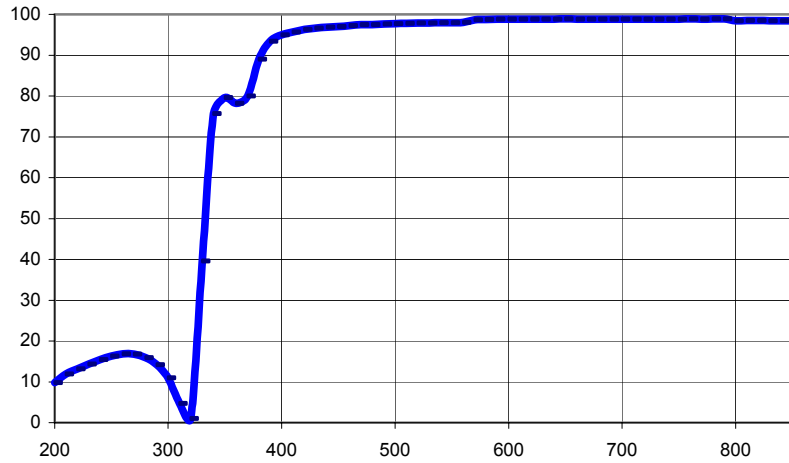


Figure 4 - Typical reflectivity spectrum

Wavelength (nm)	%R	Wavelength (nm)	%R	Wavelength (nm)	%R
200,000	9,8396	420,000	96,2799	640,000	98,8528
210,000	11,8854	430,000	96,6096	650,000	98,8685
220,000	13,2134	440,000	96,8596	660,000	98,8039
230,000	14,3776	450,000	97,0485	670,000	98,8038
240,000	15,4660	460,000	97,2269	680,000	98,8396
250,000	16,2984	470,000	97,4601	690,000	98,8367
260,000	16,8819	480,000	97,5164	700,000	98,8059
270,000	16,8068	490,000	97,6278	710,000	98,8255
280,000	15,9386	500,000	97,7220	720,000	98,8389
290,000	14,2060	510,000	97,7656	730,000	98,8517
300,000	10,9922	520,000	97,8940	740,000	98,8566
310,000	4,7177	530,000	97,8693	750,000	98,8592
320,000	1,0096	540,000	97,9564	760,000	98,8839
330,000	39,6323	550,000	97,9901	770,000	98,8398
340,000	75,7144	560,000	98,0349	780,000	98,8783
350,000	79,5798	570,000	98,6776	790,000	98,8719
360,000	78,2037	580,000	98,7736	800,000	98,4668
370,000	79,9621	590,000	98,8235	810,000	98,4945
380,000	89,0352	600,000	98,8595	820,000	98,4885
390,000	93,4487	610,000	98,8013	830,000	98,4570
400,000	94,9642	620,000	98,8530	840,000	98,4420
410,000	95,7151	630,000	98,8342	850,000	98,4024

Table 3 - Typical reflectivity data

Electronic unit

General description

The mirao52d electronic unit provides the analog currents needed to drive the optical component. This unit includes the following electronic parts rack-mounted together in a robust box :

- Power supply
- Parallel digital interface board (IEEE 1284)
- Digital-to-analog converters (DAC)
- Linear amplifiers :

A schematic representation of the electronic unit is given in the Figure 5 below.

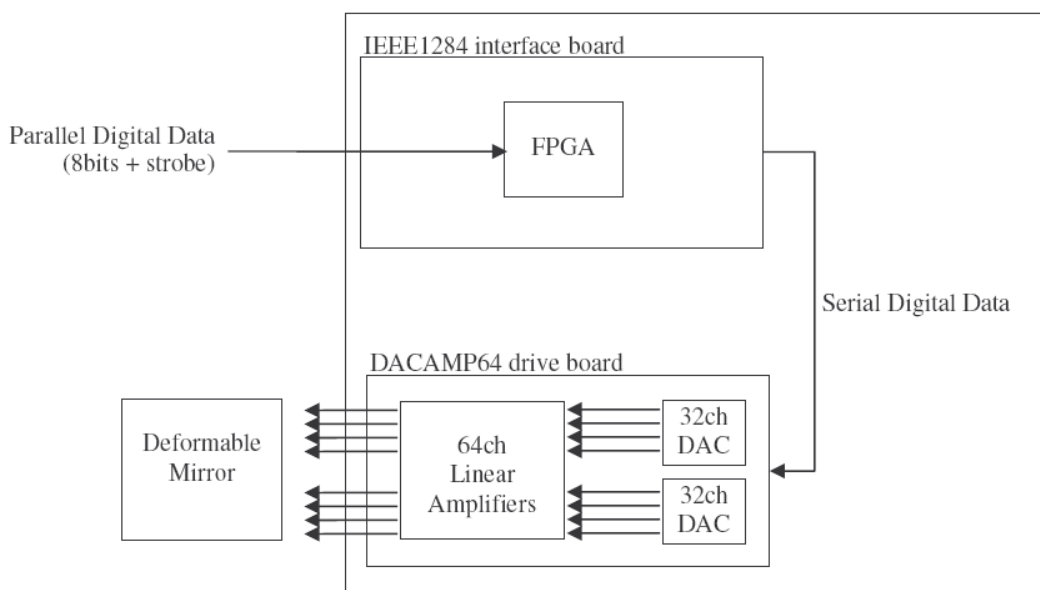


Figure 5 – Schematic layout diagram of the electronic unit

Principle of operation

When it is turned on, the electronic unit needs to be initialized. The initialization enables it to send command voltages to the deformable mirror actuators. This procedure ensures that no unwanted command is sent to the mirror before you are willing to do it. Another procedure allows to “uninitialize” the unit and turn it back to its initial protected state.

When all command voltages reach their range limits, the electronic turns to an auto-protect mode. When this occurs, the unit must be “uninitialized” before it can resume its normal operation.

LED indicators

The front panel of the electronic unit features four LED indicators that monitor its status. The main possible states are : off, not initialized, ready to transmit data (initialized), sending data, blocked in auto-protect mode. More detail on the LED indicators is given in section [6 USING MIRA052D](#).

PCI-7200 digital I/O board

The PCI-7200 is a PCI form factor high-speed digital I/O card manufactured by ADLINK. The mirao52d system uses the PCI-7200 to transfer digital data from the computer to the electronic unit. The card consists of 32 digital input channels, and 32 digital output channels. It performs high-speed data transfers using bus-mastering DMA via 32-bit PCI bus architecture. The maximum data transfer rates can be up to 12MB per second.

The PCI-7200's layout is represented in Figure 6. The board comes equipped with one 37-pin D-Sub connector (CN2) located on the rear mounting plate and one 40-pin female flat cable header connector (CN1). The CN2 is located on the rear mounting plate : it is actually not used in the mirao52d system. The CN1 is on front of the board. It can be bound to a rear panel connector through a flat cable provided in the ADLINK box.

Only the CN1 connector is used in mirao52d because the clock signal needed for the electronic unit is only present on this connector.

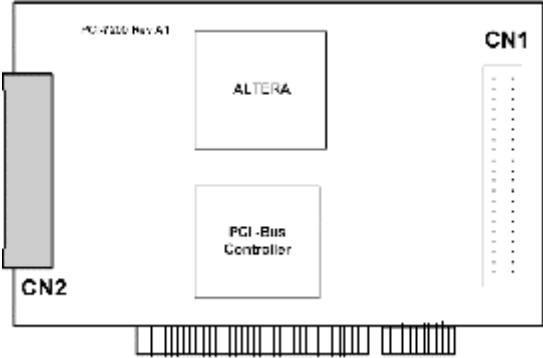


Figure 6 – Layout diagram of the PCI-7200 digital I/O board

Software overview

Your mirao52d product includes the following software items :

Type	Name	Description
Executable application	Mirao52d - Demo	A simple application that allows the user to control the voltage applied to each actuator.
Driver	Mirao52d Labview driver	Allows you to easily control mirao52d from your software developed in National Instrument Labview (7.1 and later versions)
	Mirao52d Visual C++ 2003 driver	Allows you to easily control mirao52d from your software developed in Microsoft Visual C++ (2003 and later versions).
	ADLINK 7200 driver	Is used by the Mirao52d drivers to control the PCI-7200 digital I/O board installed in your PC. Your software does not need to directly interact with the ADLINK 7200 driver.
Example source code	Visual 2003 example	An example project that uses the mirao52d Visual C++ driver.
	Labview 7.1 example	An example program that uses the mirao52d Labview driver.
Data file	FlatCommandSNxxxx.ten	A file that contains an array of command voltages. When this command is applied, the deformable assumes an approximately flat shape. In the file name, SNxxxx is the serial number of your mirao52d optical component.

Table 4 – Software items included in the mirao52d product

4 SPECIFICATIONS

Mirao52d optical component

Dimensions	64 x 64 x 23 mm ³
Weight	0.49 kg
Pupil diameter	15 mm
Number of actuators	52
Inter-actuator spacing	2.5 mm
Actuator input voltage	± 1 V max in each actuator Sum of positive voltages < 18 V Sum of negative voltages > -18 V
Coating	Protected silver ²
Reflectivity	λ in [410 nm, 560 nm] : > 95% λ in [560 nm, 800 nm] : > 98%
Max. admitted light energy in pulsed mode ³	100 mJ / cm ²
Max. admitted light power in continuous mode	5 W / cm ²
Bandwidth	> 200 Hz
Hysteresis	< 2 %
Linearity	> 95 %
Spatial frequency range	Zernike modes up to the 6 th order
Surface quality in active flat configuration	0.006 μm RMS ⁴
Wavefront quality in active flat configuration	0.012 μm RMS
Wavefront quality for any Zernike mode of order <5 using 20% of the dynamic range	0.020 μm RMS
Tip / tilt wavefront range	-50 to +50 μm PV ⁵
Zernike wavefront range	Defocus 35 μm PV Astigmatism 30 μm PV Coma 10 μm PV Trefoil 25 μm PV Spherical aberr. 08 μm PV 4th order astig. 08 μm PV Quadrafoil 15 μm PV

² Other coatings available on request

³ Thresholds are valid for standard silver coating at wavelengths comprised within [600 nm, 800 nm]. At other wavelengths the reflecting surface must not be submitted to high optical energies or powers

⁴ RMS: Root-Mean-Square

⁵ PV: Peak-to-Valley

Mirao52d electronic unit

Dimensions	330 x 240 x 190 mm ³
Weight	5 kg
Mains input voltage	100 to 240 V DC
Mains input frequency	50 to 60 Hz
Power consumption	50 W
Output voltage	± 1V max in each of the 52 channels Sum of positive voltages < 18 V Sum of negative voltages > -18 V
Working temperature	15° to 35° C

PCI-7200 digital I/O board

The specifications of this board are included in the PCI-7200 User Manual, provided on the ADLINK CDROM.

5 INSTALLATION

This section will guide you through the installation of your mirao52d. Please follow the guidelines in the same order as they appear in the following pages.

- *WARNING : this product must be installed in a clean and dry environment, protected from direct sun and excessive heat. The equipment should suffer no shock, deformation or excessive vibration.*
- *WARNING : do not install the hardware supplied with your mirao52d product before having completed the software installation.*

Unpacking

Every component and accessory of the mirao52d deformable mirror has been carefully tested and inspected before packing. On delivery, it is important to check that packages and equipment have not been altered by transportation.

- Please inspect the packages carefully in order to identify possible transportation damage. If so, please contact your supplier immediately.
- If missing or damaged elements can be identified when unpacking, please contact your supplier immediately.
- Keep the original package in order to ensure a safe transportation, if necessary.

Package contents

The mirao52d deformable mirror is usually shipped in a single package that includes the following items :

Optical component: deformable mirror with removable plastic cover
Electronic unit including power supply and control electronics
ADLINK I/O communication board with flat cable
Active digital data cable
Analog data cable
Power supply cable
ADLINK CDROM : communication board software driver
Imagine Eyes CDROM : Mirao52d software drivers, demo application and example programs
User's Guide

Table 5 –Product package contents

Computer configuration

To operate the mirao52d deformable mirror, you must provide a PC-compatible computer. Your PC must be operated by Microsoft Windows 2000 or XP.

Minimum recommended configuration : Pentium III / 1Ghz / 256 Mo RAM / CDROM drive. The PCI system board must provide bus-mastering capability.

The computer must be compatible with the ADLINK PCI-7200 board, which uses one PCI slot in the motherboard and two extension board windows in the PC rear panel. On most PCs, this will require two unused PCI slots.

- Check that your PC motherboard has at least one unused PCI extension slot.
- Check that the rear panel of your PC has at least one additional unused extension board window.

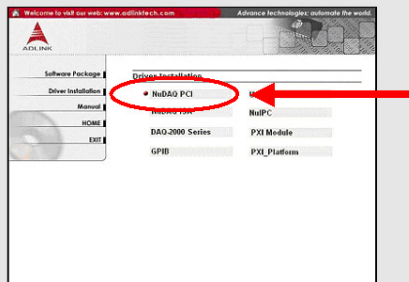
ADLINK software setup

All the product software must be installed before setting up or connecting any part of the mirao52d hardware. Please follow the next guidelines to install the ADLINK PCI-7200 software driver.

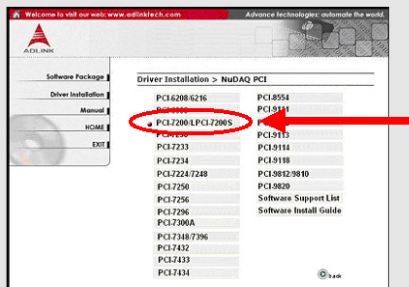
- Turn on the computer
- Insert the "ADLINK ALL-IN-ONE" CDROM
- The auto-executable setup program starts.
- If the installation program does not automatically start, double-click the setup.exe icon at the following location in the ADLINK CDROM :
`\Driver Installation\NuDAQ PCI_cPCI\7200\PCIS-DASK\DISK1\setup.exe`
- In the ADLINK home window, click on "Driver Installation"



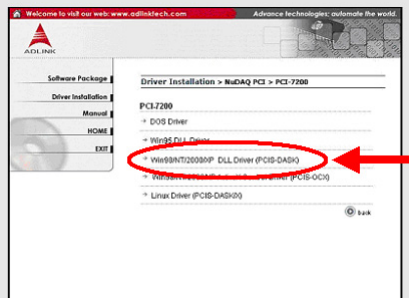
- In the driver installation window, select "NuDAQ PCI"



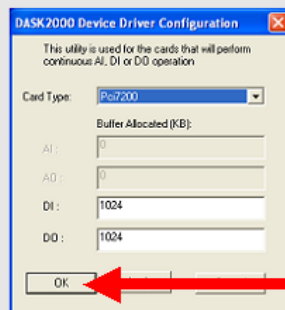
- In the NuDAQ PCI window, select "PCI-7200/LPCI-7200S"



- In the PCI-7200 window, select "Win98/NT/2000/XP DLL Driver (PCIS-DASK)"



- In the DASK2000 configuration window, press "OK" (do not change these settings).



- You have completed the ADLINK driver installation. The driver will be effective after you restart your computer.

Imagine Eyes software setup

The Imagine Eyes drivers, demo application and example programs are installed in a single and straightforward procedure as follows :

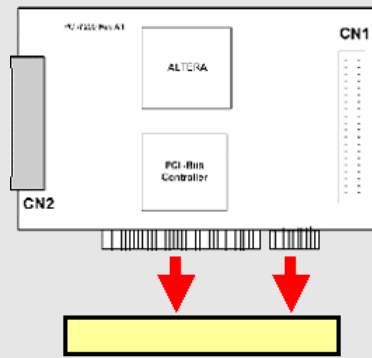
- Turn on the computer
- Insert the "Imagine Eyes mirao52d" CDROM
- Double-click the "Install Mirao 52D V1-00.exe" icon in the CDROM
- The installation program will ask you to confirm the mirao52d directory path. We recommend you to accept the proposed default path.
- Wait until the installation is complete.

PCI-7200 hardware setup

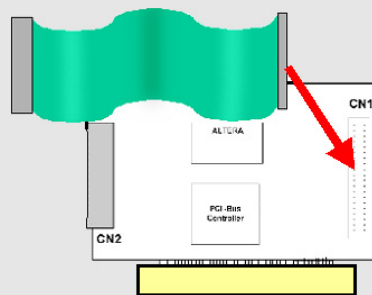
You must install the ADLINK PCI-7200 board inside your computer. Please strictly follow the next guidelines.

- *WARNING : your PCI-7200 card contains sensitive electronic components that can be easily damaged by static electricity. The card should be manipulated on a grounded anti-static mat. The operator should be wearing an anti-static wristband, grounded at the same point the anti-static mat.*
- *WARNING : install the ADLINK software before you install the PCI-7200 board in your computer. Otherwise, the Windows auto-detection system may assign an incorrect driver to the PCI-7200.*

- Turn off your computer
- Turn off all accessories (printer, modem, monitor, etc.) connected to your computer
- Remove the cover from your computer
- Select a 32-bit PCI slot
- Before handling the PCI-7200 card, discharge any static build-up on your body by touching the metal case of the computer. Hold the edge and do not touch the components.
- Position the board into the PCI slot you selected. Do not touch other components in the computer.



- Secure the card in place at the rear panel of the system
- Plug the PCI-7200 flat cable into the CN1 socket located at the front of the card. This flat cable is included in the ADLINK PCI-7200 box.



- Attach the connector at the other end of the flat cable to the rear panel of the system.
- Replace the computer cover

Connecting mirao52d

Once you have installed the product software and the PCI-7200 board, you can easily connect all the mirao52d equipment together.

- *WARNING : do not connect or disconnect the mirao52d optical component while the electronic unit is switched on.*

- Turn off the computer
- Turn off the mirao52d electronic unit
- Connect the active digital data cable to the electronic unit
- Plug the other end of the active digital data cable into the outside CN1 socket of the PCI-7200 board, located at the computer rear panel
- Connect the analog data cable to the electronic unit
- Plug the other end of the analog data cable into the deformable mirror socket
- Connect the electronic unit to the mains supply

6 USING MIRA052D

After you have installed the mirao52d following the guidelines of section [5 INSTALLATION](#), the product is ready to use. Before using it, please make sure that you have read the recommendations of section [2 WARNINGS AND CAUTIONS](#). In case of trouble or if you suspect malfunctioning, please refer to section [9 TROUBLESHOOTING](#).

Starting up

- Turn on the computer
- Wait until the operating system is ready
- Turn on the electronic unit

- *WARNING : do not connect or disconnect the mirao52d optical component while the electronic unit is switched on.*
- *WARNING : do not disconnect any cable while the product is in operation.*

How the electronic unit works

Before being able to send command voltages to the deformable mirror actuators, the electronic unit first needs to be initialized. This requirement protects the device from any undesired commands that could be sent without your control. For the same reason, the electronic must be "uninitialized" when you stop using the mirao52d.

Initialization and "uninitialization" are entirely driven by software : they are usually performed when the software program that controls mirao52d respectively opens and closes. This is easily implemented in your own programs using the mirao52d software driver functions described in section [7 PROGRAMMING MIRA052D](#).

When all command voltages reach their range limit (-1 or +1V), the electronic unit automatically resets all output voltages to zero and remains blocked in the **auto-protect mode**. When this occurs, the unit must be "uninitialized" before it can resume its normal operation.

In summary, the electronic unit may assume the following five states :

- Off
- Not initialized
- Initializing
- Ready to transmit data (initialized)
- Sending data
- Blocked in auto-protect mode.

Understanding LED indicators

The front panel of the mirao52d electronic features four LED indicators as shown in the Figure 7 below.

- Power LEDs : these two green LEDs at the left of the front panel are alight when the electronic unit is ON.
- Data LEDs : the green and red LEDs at the right of the front panel reflect the status of the electronic unit. More detail about the data LEDs is given in the Table 6 below.

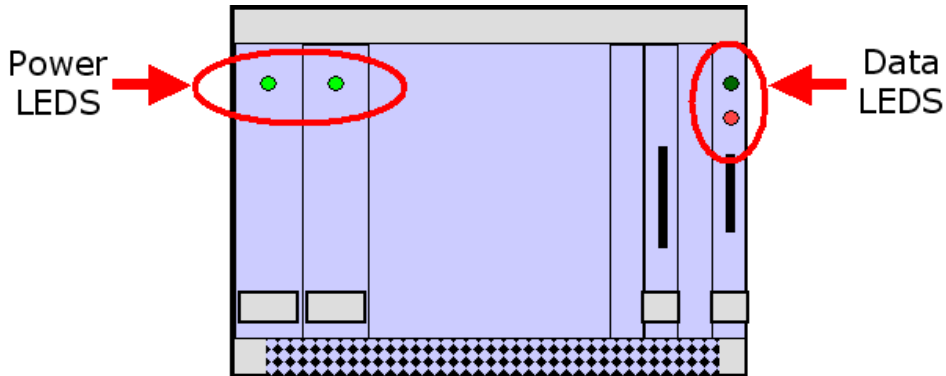


Figure 7 - LED indicators in the electronic unit front panel

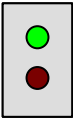
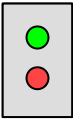
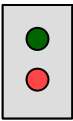
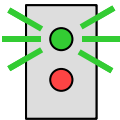
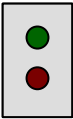
Data LED status	Electronic unit status
 Green ON Red OFF	Not initialized
 Green ON Red ON	Initializing (typically takes 1 or 2 s)
 Green OFF Red ON	Ready to transmit data (initialized)
 Green FLICKERING Red ON	Sending analog data to the mirror (the green LED flickering may be very light)
 Green OFF Red OFF	<u>If the power LEDs are ON</u> : the unit is blocked in auto-protect mode (it needs to be "uninitialized") <u>If the power LEDs are OFF</u> : the unit must be OFF.

Table 6 - Correspondence between data LED status and electronic unit status

Using mirao52D Demo

Mirao52d Demo version : 1.00

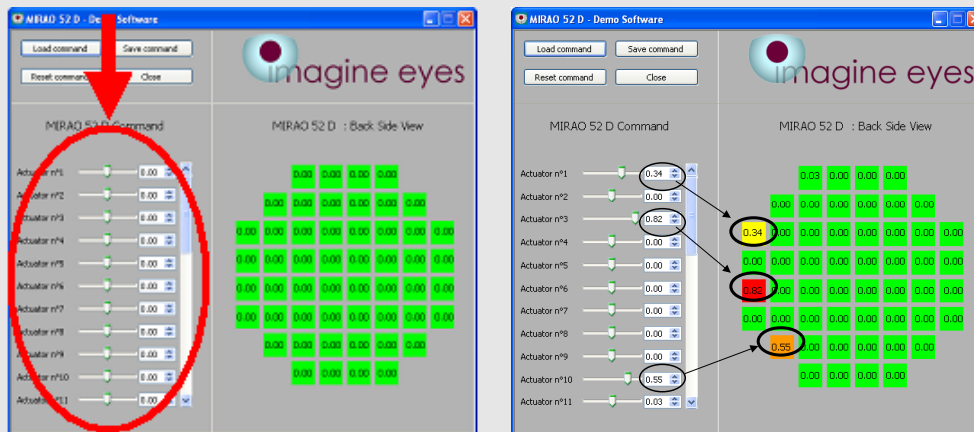
The mirao52d Demo software is a Windows-32 application designed to provide an easy first experience with controlling the deformable mirror. The Demo interface allows you to define command voltages and apply them to the mirror actuators. The acceptable voltage range is $\pm 1.0V$. However, you should avoid applying voltages of more than 0.5V for several minutes of time in order to prevent overheating of the actuator coils.

In the following lines, the computer hard disk directory where your mirao52d software has been installed is referred to as **"install dir"**. The "Mirao 52D - Demo.exe" executable file can be found in the directory :

"install dir"\Mirao 52D Demo

Please follow the next guidelines to use the Demo application :

- Run "Mirao 52 D - Demo.exe" from your PC hard disk drive.
- Wait while the program loads and initializes the electronic unit.
- To modify an actuator voltage : use the corresponding slider control or type a value in the corresponding edit box. The new voltage value can be seen in the graph. The numbering of actuators is explained in Figure 2 (section 3 [PRODUCT OVERVIEW](#)).



- To save the current set of command voltages : click the "Save command" button and answer to the Save dialog window.
- To load a set of command voltages : click the "Load command" button and select a file in the Load dialog window.
- To reset all command voltages : click the "Reset command" button.
- To exit the Demo program, click the "Close" button.
- Wait while the program "uninitializes" the electronic unit and exits.

- *WARNING : in order to comply with the electronic unit specifications, the sum of all positive voltages applied must not exceed 18 V and the sum of all negative voltages in absolute value must not exceed 18 V.*

Error messages

In the event the Demo application issues an error message, please note the message and look for the corresponding guidelines in the error list provided in section [9 TROUBLESHOOTING](#).

Flat mirror command

If you want your mirror to assume an approximately flat shape, please proceed as follows :

- Start the mirao52d Demo application.
- Load the FlatCommandSNxxxx.ten file from the **"install dir"** directory. In this template file name, SNxxxx represents the serial number of your product.

Applying the flat mirror command produces reasonably flat surface shape, which is suitable for alignment purposes. If you need a high-quality flatness, you should use the mirao52d in an adaptive-optics configuration.

Turning off

- Close the software program that currently controls the mirao52d.
- Wait until the electronic unit is "uninitialized"
- Turn off the electronic unit.
- Turn off the computer.
- Put the mirror plastic cover in place.

Reminder : keep the mirao52d optical component protected with its plastic cover while the product is not in use.

7 PROGRAMMING MIRA052D

This section explains how to control mirao52d from a C++ or Labview software of your own design, using the mirao52d drivers. These drivers allow you to initialize and "uninitialize" the electronic unit, and control the voltages applied to the deformable mirror actuators.

In the following pages, the computer hard disk directory where your mirao52d software has been installed is referred to as "**install dir**".

- *WARNING : in order to comply with the electronic unit specifications, the sum of all positive voltages applied must not exceed 18 V and the sum of all negative voltages in absolute value must not exceed 18 V. We recommend to include this limitation in your software.*

Programming in C++

Mirao52d C++ driver version : 1.00

The mirao52d C++ driver was compiled using Microsoft Visual 2003 NET. It is therefore compatible with the 2003 version of this compiler.

C++ driver directory organization

The Visual C++ driver files are located in the directory :

"install dir"\drivers\Visual 2003

This directory includes the following main sub-directories :

"install dir"\drivers\Visual 2003\dll	Dynamic libraries needed to execute the applications that use the driver.
"install dir"\drivers\Visual 2003\include	Headers to be added to your C++ projects.
"install dir"\drivers\Visual 2003\lib	Static libraries to be added to your C++ projects.

Table 7 – Visual C++ driver file directories

Example C++ project

An example Visual 2003 C++ project is located in the directory :

"install dir"\examples\Visual 2003

Before developing your own C++ projects, we recommend you to browse through this example source code. In particular you should examine the contents of the file **Mirao_Test.cpp** located in the directory :

"install dir"\examples\Visual 2003\Mirao_Test.

Follow the next guidelines to compile and run the example program :

- Run Microsoft Visual 2003.
- Open the example project "Mirao_Test.sln".
- Check that the files "mirror_data.xml" and "fichier_cadlink_PCI-7200_driver_setup.xml" are located in the project directory.
- Compile the Mirao_Test project
- Check that the mirao52d electronic unit is ON
- Execute the program : it successively initializes the electronic unit, applies a 0.0V voltage to each actuator and "uninitializes" the electronic unit.

Setting up your own C++ project

Compiler version

You must use Microsoft Visual 2003.

Project files

The following files must explicitly be added to your C++ project :

Type	Name
Header	cmirror.h (other headers will be automatically added to your project)
	ima_op_mirror.lib
Static import libraries	libboost_filesystem-vc71-mt-gd-1_33.lib
	libboost_filesystem-vc71-mt-1_33.lib

Table 8 - Files included in a typical C++ project

Project settings

For a proper use of the driver, you must set the following options in your Visual 2003 NET C++ project :

- Open the "Project Settings" dialog
- Select the "C/C++" -> "Code generation" section of the "Project Settings"
- Change the "runtime library" settings to :
 - multithread DLL (/MD) for the release configuration
 - debug multithread DLL (/MDd) for the debug configuration
- In the include search path field, add the directory path to the driver library header files. This path normally is :
"install dir"\drivers\Visual 2003\include
- Select the linker section of the "Project Settings"
- Indicate path to the import file of library
- In the Additional Library Directories field, add the directory path to the static import library files. This path normally is :
"install dir"\drivers\Visual 2003\lib
- Select the "C/C++" -> "Language" of the "Project Settings".
- Set the "Enable Run-Time Type Info" property to "Yes".

Files needed for execution

When you run your application, the following files must be present in the program execution directory :

Type	Name
Driver DLLs	CADLINK_PCI7200_driver.dll CSLm_driver.dll ima_op.mirror.dll msvc71.dll msvcr71.dll PCI-Dask.dll xerces-c_2_5_0.dll
Configuration data files	mirao_data.xml fichier_cadlink_PCI-7200_driver_setup.xml

Table 9 - Files required by the C++ driver at execution time

Calling the C++ driver from your code

Include directives

To incorporate the C++ driver class definitions and function prototypes into your code, you must include the header file **cmirror.h** located in the directory :

```
"install dir"\drivers\Visual 2003\include\ima_op_mirror
```

The driver functions use C++ Standard Library classes, such as the vector and exception classes. In summary the following compiler directives must be present in your code :

```
#include ""install dir"\drivers\Visual 2003\include\ima_op_mirror\cmirror.h"  
#include <vector>  
#include <utility>  
#include <stdlib.h>
```

Reminder : add the command "using namespace std;" before your code in order to make sure that the Standard Library names are recognized by the compiler.

The CMirror class

All the interactions between your program and the mirao52d are managed by a single instance of the CMirror class.

The CMirror class has four public methods : New, Config, Apply and the ~ class destructor. These methods are described in the following tables.

Function	New
Prototype in class CMirror	static CMirror* New (const std::string& config_file_name);
Description	New is a <u>static method</u> that allocates memory for a CMirror object instance. This method has one input parameter : the string path to the configuration file. This method sets the required variables in memory, checks the configuration consistency and initializes the electronic unit.
Example	CMirror* my_mirror = CMirror:: New ("mirror_data.xml") ... [your code] delete my_mirror;
Remark	The New method returns a pointer to an object allocated on the heap memory. This object must later be deallocated using the CMirror class destructor.

Table 10 - CMirror New method

Function	Config
Prototype in class CMirror	const ns__ConfigMiroir& Config () const
Description	Config returns a reference to a ns__ConfigMiroir structure that contains information about the deformable mirror configuration.
Example	The following line reads the maximum voltage that can be applied to the mirror actuators : Double maxvolt = my_mirror-> Config ().max_command;
Remark	The elements of the ns__ConfigMiroir structure are described in the Table 12 below.

Table 11 - CMirror Config method

The following table describes the elements contained in the ns__ConfigMiroir structure returned by the **Config** method.

Element	Type	Description
Config(). mirror_name	std::string	Mirror name
Config(). mirror_class_name	std::string	Mirror class interface name
Config(). mirror_specific_filename	std::string	Mirror specific filename : contains all the information required to manage the specific PC hardware that commands the mirror electronic unit
Config(). max_command	double	Higher limit of the command voltage range
Config().min_command	double	Lower limit of the command voltage range
Config().Temporization	long	Non zero parameter : defines the time delay observed after applying a voltage vector to the mirao52d electronic unit
Config().nb_commands	long	Number of actuators in the deformable mirror
Config().Valid_Actuators_Array	ns__vectorint	Array of valid actuator indices. More detail on the ns_vectorint type is given below.

Table 12 – Elements of the ns__ConfigMiroir structure used by Cmirror::config()

The Valid_Actuators_Array element of the ns__ConfigMiroir structure is itself a structure of type ns__vectorint. It contains a one-dimension array of integer elements (int). The following examples show how to access the relevant data in this structure :

First array element : **Config**().tab_valid_actionneur.val.m[0]

Pointer to the array : **&Config**().tab_valid_actionneur.val.m[0]

Array size : **Config**().tab_valid_actionneur.val.m.size()

Function	Apply
Prototype in class CMirror	void Apply (const std::vector<double>& commande, std::vector<double>& commande_out);
Description	Apply sends a set of command voltages to the electronic unit. Its first argument (input) is the desired voltage vector. Its second argument (output) is the voltage vector that has actually been applied by the driver. In the output argument, voltage values are limited to the acceptable voltage range.
Example	The following lines build a voltage vector, assign all the vector elements to a value of 0.2 and apply the vector to the mirao52d. <pre>unsigned int nb_command = my_mirror->Config().nb_commandes; vector<double> command(nb_command), command_out(nb_command); for (unsigned int i = 0; i<nb_command; i++) command[i] = 0.2; my_mirror->Apply(command, command_out);</pre>
Remark	Your program should avoid applying voltages of more than 0.5V for several minutes of time in order to prevent overheating of the actuator coils.

Table 13 - CMirror Apply method

Function	~ class destructor
Prototype in class CMirror	~CMirror()
Description	This destructor "uninitializes" the mirao52d electronic unit and frees the memory previously allocated using the New method.
Example	<pre>CMirror* my_mirror = CMirror::New("mirror_data.xml") ... [your code] delete my_mirror;</pre>
Remark	In general, you must explicitly call the ~ class destructor using the "delete" keyword to clean the heap memory previously allocated using the New method. However, explicit destruction is not required if you are using an auto pointer to your CMirror object instance (as shown in the Mirao_Test.cpp example CPP file).

Table 14 - CMirror class destructor

Error management in C++

When it encounters an execution error, the mirao52d C++ driver generates an exception. In order to diagnose errors, your code should therefore be able to catch the C++ Standard Library exceptions. In practice, your program should use the try and catch keywords as shown in the following example :

```
using namespace std;
try
{
    [your code...]
}
catch(const exception& err)
{
    cout << "ERROR\n" << err.what();
}
```

The error message string can be obtained using the what() method provided by the exception class.

A list of the error messages that may be issued by the mirao52d drivers is provided in section [9 TROUBLESHOOTING](#).

Programming in Labview

Mirao52d LabView driver version : 1.00

The mirao52d Labview driver was developed using National Instrument Labview 7.1. If you want to use this driver or the example Labview program installed with your mirao52d software, you must have LabView 7.1 or a later version installed in your computer.

Labview driver directory organization

The Labview driver files are located in the directory :

"install dir"\drivers\LabView

This directory includes the sub-directory :

"install dir"\drivers\LabView\controls

The Labview driver also uses the dynamic libraries located in the C++ driver directory :

"install dir"\drivers\Visual 2003\dll

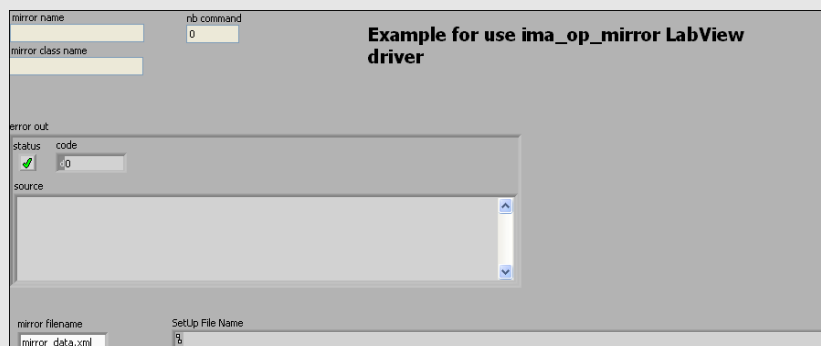
Example LabView program

An example Labview program is located in the directory :

"install dir"\examples\LabView

Before developing your own Labview programs, we recommend you to browse through the source file **Example LabView7-1 DRV_IMA_OP_Mirror.vi**. The block diagram of this program is shown in Figure 8.

- Check that the configuration files "mirror_data.xml" and "fichier_cadlink_PCI-7200_driver_setup.xml" are present in your LabView example directory.
- Open the file "Exemple LabView7-1 DRV_IMA_OP_Mirror.vi" using Labview.
- Execute the program. The following window is displayed :



- The program successively initializes the electronic unit, applies a 0.1V voltage to each actuator and "uninitializes" the electronic unit.

Setting up your own LabView program

LabView version

You must use LabView 7.1 or a later version.

Driver files

The following table lists the VI and Control files of the mirao52d drivers :




Icon	Name	File path
	ControlMirror.ctl	"install dir"\Drivers\LabView 7.1\Controls\ControlMirror.ctl
	ConfigMirror.ctl	"install dir"\Drivers\LabView 7.1\Controls\ConfigMirror.ctl
	DRV_IMA_OP_Mirror.vi	"install dir"\Drivers\LabView 7.1\DRV_IMA_OP_Mirror.vi

Table 15- LabView driver VI and Control list

When you run your LabView program, the following files must also be present in your program directory :

Type	Name
Driver DLLs	CADLINK_PCI7200_driver.dll
	CSLm_driver.dll
	ima_op.mirror.dll
	msvc71.dll
	msvcr71.dll
	PCI-Dask.dll
	xerces-c_2_5_0.dll
Configuration data files	mirao_data.xml
	fichier_cadlink_PCI-7200_driver_setup.xml

Table 16 - Files required by the LabView driver at execution time

Calling the LabView driver from your code

The deformable mirror operation is controlled using two Controls in the driver : **ConfigMirror.ctl** and **ControlMirror.ctl**. An example of a proper use of the driver Controls in shown in Figure 8. The hierarchy between these Controls is illustrated in Figure 9.

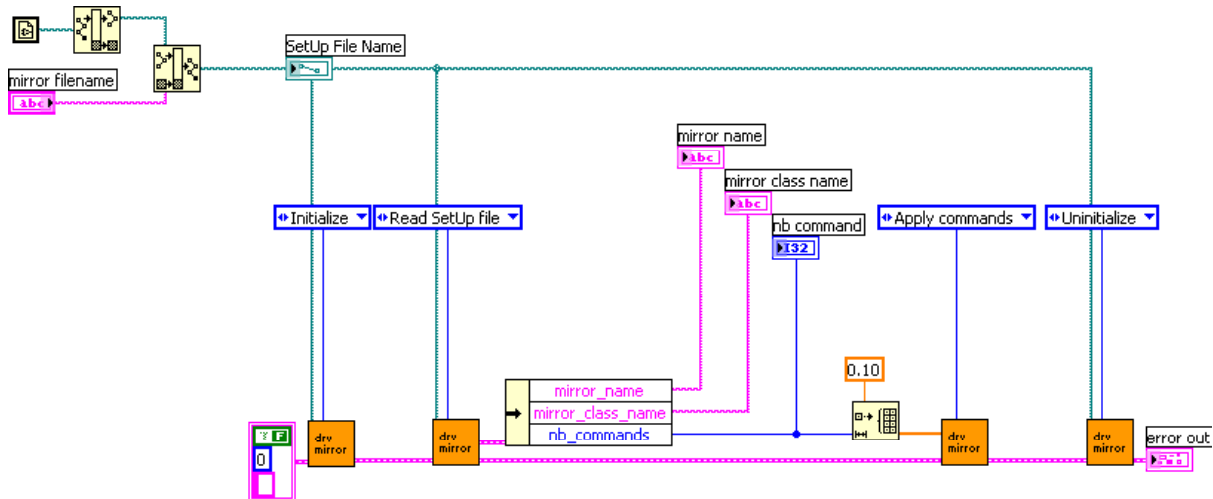


Figure 8- Block diagram of the LabView example program

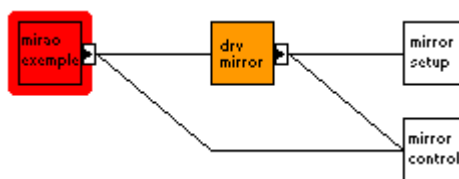


Figure 9 - LabView driver VI and Control hierarchy

The LabView driver Controls are described in more detail in the two following tables :









	mirror_name	Mirror name
	mirror_class_name	Mirror class interface name
	mirror_specific_filename	Mirror specific filename : contains all the information required to manage the specific PC hardware that commands the mirror electronic unit
	max_command	Higher limit of the command voltage range
	min_command	Lower limit of the command voltage range
	temporization	Non zero parameter : defines the time delay observed after applying a voltage vector to the mirao52d electronic unit
	nb_commands	Number of actuators in the deformable mirror
	Valid_Actuators_Array	Array of valid actuators indices

Table 17 –Description of the ConfigMirror Control variables

Write SetUp file	Writes an Mirror SetUp File (ConfigMirror struct)
Read SetUp file	Reads an Mirror SetUp File (ConfigMirror struct)
Initialize	Initializes the LabView Driver and electronic unit
Apply commands	Applies a set of command voltages to the actuators
Uninitialize	“Uninitializes” the electronic unit and LabView Driver

Table 18 - Description of the ControlMirror Control functions

- *WARNING : your program should avoid applying voltages of more than 0.5V for several minutes of time in order to prevent overheating of the actuator coils.*

Error management in LabView

When it encounters an execution error, the mirao52d LabView driver uses the standard LabView error cluster. You can easily read the corresponding error message from this cluster.

A list of the error messages that may be issued by the mirao52d drivers is provided in section [9 TROUBLESHOOTING](#).

8 STORAGE AND MAINTENANCE

Storage

If you need to store the product :

- Put the plastic cover in place on the deformable mirror.
- Place the product it in its original package.
- Respect the environmental conditions indicated in section [4 SPECIFICATIONS](#).

Maintenance

The mirao52d normally requires no specific maintenance. It must be stored and operated in a dry and clean environment. The mirror membrane is thin and fragile : please remind that it must not be touched or put in contact with anything. When the product is not in use, the mirror must be protected by its plastic cover.

- In the event that some dust has contaminated the reflecting surface, it can only be removed using a low-pressure manual air blower. This cleaning must be performed with extreme care.

9 TROUBLESHOOTING

In case of trouble with your mirao52d or if you suspect malfunctioning, please consult the following instructions.

The deformable mirror does not respond

1. Check if the electronic unit switch is on. If not, please exit the software and switch the electronic unit on.
2. With the electronic unit is turned on, check if the two power LEDs on the left of the front panel are alight. If any of the power LEDs is off, please contact your mirao52d supplier.
3. Check all connections. If some items are not properly connected, please switch off the electronic unit and connect them as instructed in section 5 [INSTALLATION](#).
4. Check the data LEDs on the right side of the electronic unit front panel and determine the status of the electronic unit using Table 6 in section 6 [USING MIRA052D](#). The unit may have blocked in the auto-protect mode : if this occurs, the unit needs to be "uninitialized" following the guidelines of section 6, or you may turn the unit successively off and on.
5. Open the MS-Windows Device Manager program and check if your ADLINK PCI-7200 driver is correctly installed (see Figure 10 below). If not, please reinstall your driver as instructed in section 5 [INSTALLATION](#).

One of the actuators does not respond

Check the integrity of the connectors and cable that link the mirror to the electronic unit. Verify that pins are not bent or broken.

No optical signal is detected

Check if the protective plastic cover was removed from the mirror.

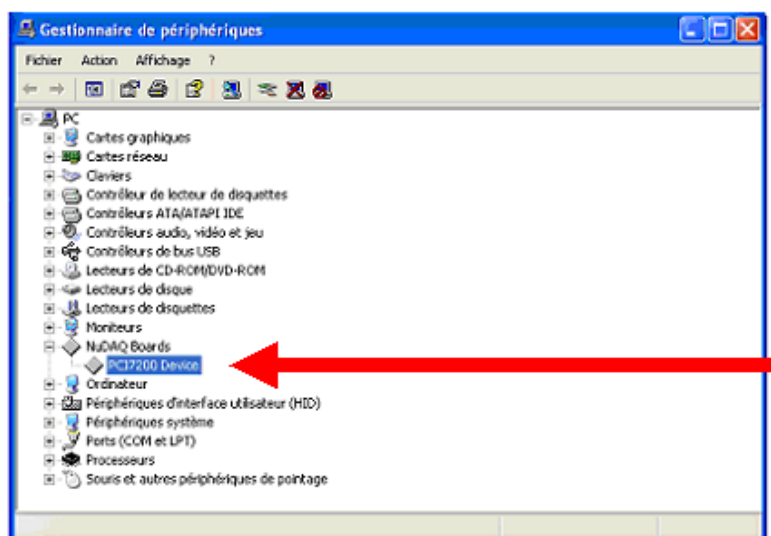


Figure 10 – The ADLINK driver as seen in the MS-Windows Device Manager.

Software driver errors

When used by an application, the mirao52d software drivers may generate errors. Please read in section 7 PROGRAMMING MIRA052D the guidelines to manage these errors in your own software. The following table gives a list of the software driver errors :

Error message	Most likely cause	Corrective action
ERREUR de type class ErreurBase. SOAP FAULT: SOAP-ENV:Client "XML syntax error"	A configuration file was not read correctly	Check the cadlink_pci7200_driver_setup.xml and mirror_data.xml files
ERREUR de type class ErreurFichier	A configuration file was not read correctly or was not found	Check if the cadlink_pci7200_driver_setup.xml and mirror_data.xml files are present in your execution directory
Inconsistent between Look Up Table Size and Actuators Number - Initialization	A configuration file was not read correctly	Check the cadlink_pci7200_driver_setup.xml file
Error in dmInit - Initialization	Problem during the PCI-7200 initialization	Check your PCI7200 board installation
Error in dmSetPower(1) - Initialization	Problem with the data sent from the PCI-7200 Board	Check your PCI7200 board installation
Error in dmSetPower(0) - Uninitialization	Problem with the data sent from the PCI-7200 Board	Check your PCI7200 board installation
Error in dmRelease - Uninitialization	Problem during the PCI-7200 "uninitialization"	Check your PCI7200 board installation
Error in dmSendVolt64	Problem with the data sent from the PCI-7200 Board	Check your PCI7200 board installation

Table 19 – List of software driver errors

10 GETTING SUPPORT

What to do if something goes wrong with your order

Contacting Customer Support Services

In the event that you may need to contact the Customer Support Services of your mirao52d supplier, please use the email address or the fax stated on your Imagine Eyes CDROM package.

My parcel is damaged on arrival

Sign for the parcel as "unchecked". This will make it quicker and easier to process the claim and recover the loss from the carrier. Then, contact the Customer Support Services within 2 days of the delivery date and we will work out the best way to repair the damage.

The quantity of products received does not match the Delivery Note or Invoice

Contact the Customer Support Services within 2 days of the delivery date. We will compare the part number on the delivery note or invoice with the product you have and check with our warehouse to see if an error occurred there. We will arrange for a follow-up order to you.

My product is faulty

All products are sold under the warranty specified below. Contact the Customer Support Services preferably by email. **Please include your product serial number, a clear description of the problem and any error messages that have occurred.** If it is established that your product is faulty, the Customer Support Services will arrange with you the best way this product can be repaired.

My order is late arriving

If your order fails to arrive within the expected time, please contact your mirao52d supplier. We will establish whether the goods have been dispatched or inform you as to why your delivery has been delayed. The goods may be temporarily out of stock or there may be a problem with the method of payment.

Returning Products

Our aim is to provide high quality products along with excellent service. On the rare occasion that a product is in a less than perfect condition, please contact our Customer Support Services. In most cases we will be able to resolve support issues at the client's location. This ensures the shortest downtime for the customer. **Before returning any product, you must obtain a written Product Return Authorization (PRA).** We cannot receive a returned product for which a PRA has not been previously issued. The equipment must be returned postage-prepaid. Package it securely and insure it. You will be charged for parts and labor if you lack proof of date of purchase, or if the warranty period has expired.

Software Returns Policy

We regret that we are unable, under any circumstances to issue a credit note or refund monies for an opened software package, unless it is faulty. By breaking the seal, you have accepted the license agreement between yourself and the software manufacturer. If products are returned to us because of a fault, the product will be tested upon receipt. If no fault is found, the product will be returned to you.

Unwanted Goods Policy

Goods are not sold on a trial basis and unwanted goods can only be returned if they have been declared faulty by your mirao52d supplier's experts and are otherwise in a fully re-saleable condition, subject to a charge for the repairs off the purchase price. We reserve the right to refuse or refund monies for goods bought in error that are not re-saleable. Before returning any product, you must obtain a written Product Return Authorization (PRA). Due to the fast-changing nature of our industry area, prices and specifications are subject to change without notice. Errors and omissions excepted. Your statutory rights are unaffected by any restrictions contained in the present section.

Warranty conditions

Seller warrants that equipment furnished will be free from defects in material and workmanship for a period of one year from the confirmed date of purchase of the original buyer and that upon written notice of any such defect, Seller will, at its option, repair or replace the defective item under the terms of this warranty, subject to the provisions and specific exclusions listed in the present section [10 GETTING SUPPORT](#) of the User's Guide.

This warranty shall not apply to equipment that has been previously repaired or altered outside our plant in any way as to, in the judgment of the manufacturer, affect its reliability. Nor will it apply if the serial number has been removed or if the product has been used in a manner exceeding its specifications or not in accordance with the instructions and recommendations of this User's Manual.

Seller does not assume any liability for consequential damages as a result from our products uses, and in any event our liability shall not exceed the original selling price of the equipment. The equipment warranty shall constitute the sole and exclusive remedy of any Buyer of Seller equipment and the sole and exclusive liability of the Seller, its successors or assigns, in connection with equipment purchased and in lieu of all other warranties expressed implied or statutory, including, but not limited to, any implied warranty of merchant ability or fitness and all other obligations or liabilities of seller, its successors or assigns.

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