# Corvus

high resolution positioning controller

# Manual

# Contents

| About this documentation                              | 7  |
|---|----|
| Symbols in this documentation                         | 8  |
| Chapter -1- Introduction                              | 9  |
| Presentation of the controller                        |    |
| Function survey                                       |    |
| Chapter -2- Installation                              |    |
| Safety notice   | 15 |
| Declaration by the manufacturer                       |    |
| Mains supply  |    |
| Universal input voltage                               |    |
| Mains protection                                      |    |
| Motor connection                                      | 18 |
| Axes designation                                      |    |
| Motor types   |    |
| Motor characteristics                                 |    |
| Commands for the motor adaptation                     |    |
| Measures against system resonances                    | 20 |
| Motor cable   | 21 |
| Endswitches   | 22 |
| Endswitch inputs                                      | 22 |
| Endswitch functions                                   | 22 |
| Endswitch types                                       | 23 |
| Configuration for PNP/NPN/opener/closer               | 23 |
| Endswitch wiring                                      | 24 |
| Joystick mode   | 25 |
| General remarks                                       | 25 |
| Axes assignment                                       | 25 |
| Configuration of the controller for the joystick mode | 26 |
| Important notices for the joystick mode               | 26 |
| Programmed mode                                       | 27 |
| Setting-up operation of the RS-232 connection         | 28 |
| Important notices                                     | 28 |
| RS-232 Interface configuration                        | 29 |

|           | RS-232 Baudrate settings                                      | 29 |
|-----------|---|----|
|           | Closed Loop   | 29 |
|           | Terminal Mode or Host Mode,                                   | 29 |
|           | Test of the RS-232 connection                                 | 30 |
|           | Connection with the Hyperterminal                             | 31 |
|           | Hyperterminal configuration for RS-232 Interface              | 32 |
| Prog      | ramming via the Ethernet Interface                            | 34 |
| · ·       | Notices for the setting-up operation                          |    |
|           | Testing the Ethernet connection                               | 35 |
|           | Ethernet connection with the hyperterminal                    |    |
| 0         |   |    |
| Chapter - | 3- Functions  |    |
| LED-      | diagnostics display   |    |
|           | Functions of the LED-displays                                 |    |
|           | Push-button A and B   | 41 |
| Ends      | witch functions   | 42 |
|           | Working range and coordinate system                           | 42 |
|           | Endswitch inputs  | 42 |
| Prog      | rammed endswitch movement                                     | 43 |
|           | Programmed endswitch movement in detail                       | 44 |
|           | Endswitch movement to the cal-endswitch                       | 45 |
|           | Endswitch movement to the rm-endswitch                        | 45 |
| Ends      | witch movement with the joystick                              | 46 |
|           | Endswitch movement with the Joystick in detail                | 46 |
|           | Working range and coordinate system                           | 46 |
|           | Notices for the endswitch move                                | 47 |
| Ends      | witch wiring  | 48 |
| Posit     | ioning with the joystick                                      | 49 |
|           | Joystick button speed   | 49 |
|           | Configuration of the joystick                                 | 49 |
|           | Notices for the joystick mode                                 | 50 |
| Prog      | rammed positioning  | 51 |
| - 5       | Venus-1 syntax and examples                                   |    |
|           | Axes interpolation  | 53 |
|           | Velocity and acceleration                                     | 53 |
|           | Velocity profile of a linear acceleration function            | 54 |
|           | Movement profile of short distances                           | 54 |
|           | Movement profile of a sin <sup>2</sup> -acceleration function | 55 |
| Digita    | al Inputs / Outputs   | 56 |
| 5         | Input circuit   |    |
|           | -   |    |

| Output circuit                | 57 |
|-------------------------------|----|
| Configuration switch          |    |
| Input / Output functions      | 59 |
| Produce an output signal      | 59 |
| Read an input signal          | 59 |
| Limitation of movement        | 59 |
| Safety device                 | 60 |
| Switching off the motor       | 60 |
| Relay                         | 61 |
| Output Voltage Module         | 62 |
| Function description:         | 62 |
| User output voltages          | 63 |
| Closed-Loop function          | 64 |
| Venus-1 Closed-Loop commands: | 65 |
| Supported measuring systems   | 66 |
| A/B Quadrature input          | 66 |
| SIN/COS Module                | 67 |
| SIN/COS Status LED            | 67 |

### **Chapter -4- Communication**

| Interfaces                               | 68 |
|--|----|
| Interface concept                        | 69 |
| Communication with Terminal or Host Mode | 70 |
| Configuration of Terminal or Host Mode   | 71 |
| RS-232 Interface                         | 72 |
| RS-232 Interface configuration           | 72 |
| Baudrate                                 | 72 |
| Ethernet Interface                       | 73 |
| General informations about Ethernet      | 73 |
| Topology                                 | 73 |
| TCP / IP                                 | 75 |
| Hardware address (MAC-address)           | 76 |
| IP-Address                               | 77 |
| Sub Mask                                 | 77 |
| Port-Address                             | 78 |
| Corvus Ethernet data summary             | 78 |

| Chapter -5- Device concept             | 79  |
|--|-----|
| Components of the controller           | 80  |
| Case variants                          | 81  |
| Table top housing TT                   | 82  |
| Cabinet mounting case CM               | 83  |
| 19" Rack 2 U / 30                      | 84  |
| Controller and motor driver electronic | 85  |
| Parts of the board                     | 85  |
| Diagnostic Display                     | 86  |
| Power supply                           | 87  |
| Operation system and firmware          | 88  |
|  |     |
| Chapter -6- Technical data             | 89  |
| Overview                               | 90  |
|  |     |
| Chapter -7- Connectors                 | 92  |
| Motor Connector                        | 93  |
| Motor wiring                           | 94  |
| Stepper motor with 2-phases            |     |
| Stepper motor with 3-phases            | 94  |
| RS-232 Programming Interface           | 95  |
| RS-232 Service Interface               |     |
| Ethernet Interface                     | 97  |
| Joystick Input                         | 98  |
| Digital Encoder Input                  | 99  |
| SIN/COS Interface (1Vss)               |     |
| Digital Input / Output                 |     |
| Safety device                          |     |
| Voltage Output Module                  | 103 |
|  |     |

### Chapter -8- Releasing an Option/

# About this documentation

This documentation is written for the positioning controller Corvus.

Therein all technical data and functions are described. Information about the IEEE-488 interface and the operation of the Touch Terminal is available in a separate documentation.

#### Symbols in this documentation

To clarify the content following symbols are used.

| Symbol Description        |   |
|---------------------------|---|
| <u>!</u>                  | Warning.<br>The informations must be<br>observed strictly             |
| IMPORTANT                 | Hint.   |
| Option = = = =<br>= = = = | This function can be enabled with a release code.                     |
| Option                    | This function must be installed from the factory personal or experts. |
| Venus-1                   | Venus-1 command   |

Table 1. Symbols

# Chapter 1

# Introduction

### Presentation of the controller

#### Number of axes

Corvus is a complete stepping motor controller for alternatively 2 or 3 axes and torques up to 1.5 Nm.

#### **Power concept**

The controller is offered in several power classes. The power concept "distributed power" provides the opportunity to focus the power output on one axis and with it the advantage that bigger stepping motors can also be controlled with the lowest Corvus power class (50W).

#### Motor controlling concept

With 48V motor voltage Corvus produces enough torque, also at a high number of motor revolutions.

In comparison with the traditional stepping motor controller technology, the motors connected to Corvus cause clearly less power dissipation and as a result of that they remain colder.

#### Resolution, velocity, acceleration

The elaborated controller technology enables a very lownoise positioning and at the same time an extremely high stepping resolution. In the programmable mode positioning resolution of 1,5nm is achieved.

The resolution in the joystick mode is 23.2fm (femtometer).

Due to the high computing power Corvus has a high speed and acceleration dynamic. The minimum speed amounts to 15nm/s, the controller tops 60 revolutions/s.

For all axes Corvus offers linear- or sin<sup>2</sup>-acceleration. The sin<sup>2</sup>-acceleration function is indispensable for the controller technology of vibration sensitive systems which demand a highly dynamic positioning.

#### **Closed Loop function**

The closed-loop mode enables the monitored and controlled positioning for the highest precision demanded. Corvus supports optic and magnetic length measuring systems.

#### Hardware

The complete control logic is space-saving placed on one circuit board, including the power unit.

A 32-bit processor with 133 Mhz has the control and its power capacity is supported by a real-time operating system. With a 8-Mbyte flash store, 2-Mbyte SRAM and up to 32-Mbyte DRAM, Corvus offers a hardware platform in which the future is integrated.

#### **Communication Interfaces**

The communication concept is also progressive. Corvus has several interfaces. A RS-232 interface with up to 115 kbaud, a CAN-bus interface, an IEEE-interface and as a peculiarity a 10 Mbit Ethernet interface with TCP/IP stack.

The Ethernet interface enables the intranet network of an arbitrary number of controller and is the door for the remote control via internet.

#### Diagnostics

Support for the service offers the LED-diagnostics system. 20 light-emitting diodes inform the user about the momentary operating state of the controller.

#### Operation, Programming, Update an Upgrade, Software tools

- For the position display and the operation without any PC or terminal, the controller can be equipped with a touch-display.
- The program controlled operation works via the approved interpreter language Venus-1.

Corvus is nearly 100% software compatible with the predecessor controller multicontrol, mc-compact or mc-3000.

The update of the firmware can be executed on site. That way the controller can always be kept up to date. With the possibility to release functions subsequently, Corvus grows with the standard.

In support of the software developer an API is available. API signifies "application programming interface" and permits the use of a specified amount of system functions of the controller.

## **Function survey**

| F | unctions  | Standard / Option                     |
|---|---|---------------------------------------|
| • | 2 axes  | Standard                              |
| • | 3 axes (additional 3rd. axis)                       | Option / Code                         |
| • | Phase current: until 2.5A                           | <ul> <li>Standard</li> </ul>          |
| • | Max motor revolutions (200 step motor): 45 rev/s    | Standard                              |
| • | Max. motor driver resolution: 1,5nm                 | Standard                              |
| • | Power classes: 50W Table top cabinet                | Standard                              |
| • | 100W Table top cabinet                              | Option                                |
| • | 240W / 500W 19" Rack 2HE / 3HE                      | Option                                |
| • | Joystick operation                                  | <ul> <li>Standard</li> </ul>          |
| • | Programming with ASCII command language             | Standard                              |
| • | Macro execution                                     | <ul> <li>Standard</li> </ul>          |
| • | Terminal operation                                  | Standard                              |
| • | Error correction 1D, open loop, closed loop         | <ul> <li>Standard</li> </ul>          |
| • | Sin <sup>2</sup> - acceleration (S-Curve)           | <ul> <li>Standard</li> </ul>          |
| • | Closed Loop (RS422 digital Encoder input)           | <ul> <li>Option / Code</li> </ul>     |
| • | Closed Loop (Sin/Cos 1Vss input)                    | Option / Hardware                     |
| • | Digital I/O, 3 inputs / 3 Outputs                   | <ul> <li>Option / Code</li> </ul>     |
| • | Digital I/O, 8 inputs / 8 Output                    | Option / Hardware                     |
| • | Analog outputs, 2 outputs, 0-1V, 8Bit               | Option / Hardware                     |
| • | Trigger Out Function, 4 Khz (cycle =250µs)          | <ul> <li>Option/ Code</li> </ul>      |
| • | Switched power output for motor break circuits, 24V | <ul> <li>Option / Hardware</li> </ul> |
| • | Motor enable/disable input                          | Option / Hardware                     |
| • | Display with touch function                         | Option / Hardware                     |
| • | Firmware update via RS-232 line                     | Standard                              |
| • | RS-232 Interface until 115kBaud                     | Standard                              |
| • | CAN-Bus Interface                                   | Option / Hardware                     |
| • | IEEE-Interface (GBIP)                               | Option / Hardware                     |
| • | Ethernet Interface with TCP/IP Stack on Board       | Option / Code                         |
| - |   |                                       |

Table 2. Function survey

Standard:Basic configurationOption / Code:Hardware prepared, releasecode neccessaryOption / Hardware:Additional hardware neccessary



# Chapter 2

# Installation

# Safety notice

#### . . . . . . . . . . . . . . . . . . .



The controller is developed, produced, checked and documented in consideration of the relevant standards.

If it is used according to regulations, there are no dangers for persons and things.

Use according to regulations implies that the device is solely used in the way that is described in here and that the stated safety advices are followed.

#### . . . . . . . . . . . . . . . . . . .

# Declaration by the manufacturer

The company

PI miCos GmbH Freiburger Strasse 30 D-79427 Eschbach

declares that the product:

Corvus

intended use:

#### **Positioning Controller**

meet the following directives and standards:

Directive 73/23/EECDirective 3Electrical ApparatusElectromationLow Voltage DirectiveElectromation

Directive 89/336/EEC Electromag. compatibility

**European Standards:** 

EN61010-1 (08.2002) EN61326-1 EN61000-3-2, EN61000-3-3

Remarks:

Initial operation of the Corvus Controller sold by us is not permitted until it has been assured that the machine/system, in which our Controller is installed, complies with the EU machine guidelines.

1. A molune

Lucius Amelung (Managing Director) Eschbach, 01.03.2003

# Mains supply

#### Universal input voltage

Corvus is in each offered model always ready for mains connection. For the setting-up operation the case has not to be opened.

The integrated power supply unit has a wide range voltage input which adapts itself automatically to the input voltage range of 90-250V.

#### Mains protection

A safety fuse in the mains connector protects the controller. The protection is accessible from the outside.



## **Motor connection**

#### Axes designation

The axes designation is axis-1, axis-2 and axis-3. They consciously were not designated as x-y-z coordinates, be-cause this assignment is determined by the application. Axis-1 and axis-2 belong to the standard equipment of the device.

For the joystick there is the following determination:

| Axis-1 | Х |
|--------|---|
| Axis-2 | Y |
| Axis-3 | Z |

#### Motor types

The motors are connected to the motor connections axis-1 to axis-3.

Two-phase or three-phase stepping motors for bipolar controller technology are supported.

"Motor connection and endswitch" on page 95.



Figure 3: Corvus motor connection

#### **Motor characteristics**

The typical motor characteristics are the holding torque, the step angle, the maximum phase current, the poles and the inductivity. The torque is dependent on the number of revolutions per minute and has to be taken from the motor characteristic line.

Recommended values:

| Phase current | Inductivity | Polepairs     | step angle            |
|---------------|-------------|---------------|-----------------------|
| 1,2A - 2.5A   | 0.8mH - 4mH | 25/50/<br>100 | 3.6° / 1.8° /<br>0.9° |

#### Commands for the motor adaptation

The adaptation of the controller to the motors is done via the programming interface.

The following Venus-1 commands are therefor concerned:

| setumotmin   | The motor setting command umotmin<br>affects the phase current when the<br>motor is holding.<br>As a result it determines holding torque<br>and power consumption. |
|--------------|--|
| setumotgrad  | The motor setting command umotgrad determines the phase current and torque during the motor is moving.   |
| setpolepairs | Adapts controller to polepairs of the<br>different motor types.<br>0.9° Hybridmotor polepairs = 100<br>1.8° Hybridmotor polepairs = 50                             |

You'll find further comments on this commands in the manual *Venus-1 command language*.

#### Measures against system resonances

The combination of a motor and the other motion components are forming a typical spring/mass system.

If the damping of the mechanics is insufficient, resonance appearances are possible. In a worst case situation the stepping motor will stall with a whistling sound.

An effective countermeasure are resonance absorbing elements which are for example installed on the extended motor shaft.

For precision position tasks we always recommend the use of this damping measure.

A cause for resonances are often overdimensioned motors. In this case it can make sense to reduce the torque via the motor parameter resp. by choosing a more suitable motor.



Figure 4: Motor damper

#### Motor cable

Motor cables are by request produced by us according to customized demands.

If the motor cable is in-house produced, cable cross-section, cable length and shielding have to be considered.

The cable cross-section has to be adapted to the phase current. The cable cross-section should be calculated based on the maximum phase current per motor phase.

For cables longer than 4 meters it can be necessary to adapt cable losses by a modified configuration of the motor parameters **setumotmin** and **setumotgrad** or to make up for these losses by an enlarged cross-section.

For the EMC-compatible fitting of the cable a total shielding is prescribed whereby the cable shield is connected to the case. The DSUB-15 motor connector should have a metal case. The fasten nuts of the DSUB connectors of the controller have an UNC4-40 thread.



An incorrect wiring of the motor connection can result in a defect of the controller.



Figure 5: Shielded motor cable with metal connector housing

# Endswitches

#### **Endswitch inputs**

For each axis there are respectively two endswitch inputs available.

The endswitch connections are situated in the respective motor connector. The switch inputs are designated due to their function as cal-endswitch input or as rm-endswitch input. The endswitch functions supported by Corvus are linked to these inputs; no other function can be assigned to them.

#### **Endswitch functions**

There are the following endswitch functions:

• move to the cal-endswitch (Venus-1 command cal)

The controller positions towards negative position values until the cal-endswitch is reached.

• move to the rm-endswitch (Venus-1 command rm) The controller positions towards positive position values until the rm-endswitch is reached.

#### **Endswitch types**

Corvus supports the following endswitch types:

- mechanical switches (opener /closer)
- inductive proximity switches NPN / PNP
- · photo sensors

For the supply of electronic switches, 5V and 12V are available in the motor connector. See "User output voltage" on page 63.

#### Configuration for PNP/NPN/opener/closer

With the changeover switch on the back of the controller Corvus is configured to the NPN or PNP endswitch type.



- NPN = the endswitch closes or opens towards ground
- PNP = the endswitch closes or opens to VCC

The function *opener* or *closer* is determined with the Venus-1 command *setsw* and is saved with *save*.

#### **Endswitch wiring**







Figure 7: PNP endswitch wiring

## Joystick mode

#### **General remarks**



In the joystick mode the positioning is executed independent from a host control unit.

The turning or the deflection of the joystick enables a sensitive and high resolvent positioning of the motors.

The joystick can in addition be equipped with a touch-terminal. In doing so there is the possibility to display the position of all axes and to execute further operation functions.



Figure 8: FJ Joystick with Speed buttons

#### Axes assignment

| Joystick | Axes assignment |
|----------|-----------------|
| х        | Axis-1          |
| Y        | Axis-2          |
| Z        | Axis-3          |

#### Configuration of the controller for the joystick mode

The following configurations have to be executed for the joystick mode:

- · determining the joystick velocity
- · determining the button-speed
- determining the joystick acceleration
- · switching on the joystick mode

So that the made configurations also remain valid after switching off the controller, these parameters have to be saved.



#### Important notices for the joystick mode

• The joystick has to be connected when the controller is switched on.



- The joystick may not be deflected when the controller is switched on.
- For safety reasons an active joystick is always switched off after a "programmed move" and has to be switched on again afterwards.

## **Programmed mode**

For the program controlled operation a control unit (host) has to be connected. The operation can work via the following interfaces:

- RS-232 interface
- Ethernet interface
- IEEE-interface

Command language is named Venus-1. The function of these commands is described in the second

part of this manual.

# Setting-up operation of the RS-232 connection

#### Important notices

- The delivered cable should preferably be used. The correct wiring has to be minded if it is in-house produced.
- See "RS-232 / host interface" on page 96.
- The interface configurations of the control unit have to correspond accurately with the configurations of Corvus.
- If there are problems you have to check if so-called interface adapters, which possibly have falsified the wiring, have been set in.
- The interface of the control unit may not be occupied by other active programs.
- The configuration of the RS-232 operation mode, Host mode or terminal mode, has to be adapted to the application. See "DIP-Switch configuration".
- The Closed Loop mode should not be activated at first setting-up operation. See "DIP-switch configuration".
- For the test of the RS-232 connection the diagnostics display RX/TX on the front should be used.

#### **RS-232 Interface configuration**

| Data bits                     | • 8  |
|-------------------------------|--|
| Stop bits                     | • 1  |
| Parity                        | • no   |
| <ul> <li>Handshake</li> </ul> | • no   |
| Baudrate                      | <ul> <li>*9600,19200, 57600,115200</li> <li>* Factory setting</li> </ul> |

#### **RS-232 Baudrate settings**

ON

OFF



Configuration

| Dip-Switch 1 | Dip-Switch 2 | Baudrate |
|--------------|--------------|----------|
| OFF          | OFF          | • 9600   |
| OFF          | • ON         | • 19200  |
| • ON         | OFF          | • 57600  |
| • ON         | • ON         | • 115200 |

#### **Closed Loop**

|              | ON                   | ON DIP        |
|--------------|----------------------|---------------|
|              | OFF                  | Configuration |
| Dip-Switch 3 | Function             |               |
| • ON         | Closed Loop disabled |               |
| OFF          | Closed Loop enabled  |               |

Terminal Mode or Host Mode,

| Dip-Switch 6 | Function                     |
|--------------|------------------------------|
| • ON         | Terminal Mode after Power On |
| OFF          | Host Mode after Power On     |

#### Test of the RS-232 connection

Below you find some test measures which shall help to test the function of the RS-232 connection.

#### • Testing via the LED-diagnostics display

While receiving and transmitting ASCII signs via the RS-232 interface the displays RxD resp. TxD flash. It must be pointed out that during the transmission of few data the display possibly only flashes short. An attentive observation is therefore necessary.

#### • Testing the transmission with the command reset

If the connection between host and controller works, the controller is restarted with reset. Thereby the diagnostics display is visibly switched off shortly and there is an audible signal at the same time.

#### • Testing with WinPos

WinPos LT is added for free to each controller and is qualified for getting to know all functions of the controller. A test of the RS-232 connection is automatically executed during the connection establishment.

The most important configurations in WinPos:

- · connecting the controller with the PC
- · configuring host mode
- · switching on the controller
- starting WinPos
- configuring interface and baudrate
- "connecting" WinPos
- · opening Venus command line and testing commands

#### **Connection with the Hyperterminal**

A terminal connection via the RS-232 interface or the Ethernet interface can be established with the program Hyperterminal. The controller therefor has to be switched into the Terminal mode. See "Closed Loop / Terminal or Host mode" at page 24.

A complete operation of the controller via the Venus-1 command input is possible with that program.

This program is therefore not only suited for the test of the interface connection but is also suited for operating and configuring the controller with simple means which are available for everybody.

The program Hyperterminal is added to the windows versions 95/98/NT and is normally to be found in:

#### Start>programs>accessories>communication

You can also get the product for free under the following address:

http://www.hilgraeve.com/products/index.html#HyperTerminal Private Edition.

You have to pay attention to the licence agreements.

#### Hyperterminal configuration for RS-232 Interface



- Start Hyperterminal.exe.
- Determining the name of the configuration in which the configurations shall be saved. Example: Corvus.ht

| Scorvus                                   |                  | Anschkassenstelkingen   |   |
|---|------------------|-------------------------|---|
| *   |                  | Bits pro Selvande, 9600 |   |
| Enter details for the phone number that ; | you want to diat | Daterbit: 8             |   |
| Country/region: Deutschland (49)          | ¥                | Paitat Fore             | • |
| Area code: 0049                           |                  | Stoppbilt: 1            | - |
| Phone number:                             |                  | Randevering 200         |   |
| Connect using: COM2                       |                  |                         |   |

- indicating the used interface.
- making interface configurations.
- closing and saving the session.
- switching off Corvus and setting DIP-switch to terminal mode.
- opening hyperterminal with the saved configurations, for example: Corvus.ht.
- switching on the controller. After that a screen mask with position display and command input line is automatically transmitted via the controller to the terminal.

(Continuation see next page)

 the commands are entered in the input line according to the requirements of the Venus-1 manual and are executed with <enter>.





Changes in the interface configurations of the terminal program are only adopted if the program is **offline**.

The configuration local echo is not necessary, the sign echo is transmitted by the controller.

# Programming via the Ethernet Interface

The ethernet interface is an optional function of the controller. The extension is possible per a release code. The command language Venus-1 is also used for the programming and the effect of terminal and host mode is valid as well.

#### Notices for the setting-up operation

To operate the controller via the ethernet, the following requirements have to be fulfilled:

- The option ethernet has to be released. Testing with Venus-1 command getoptions.
- Connection to an existing network via a hub or directly with a network card.
- Determining an IP-address and saving in the controller. Subnetmask is 255.255.255.0

•

- The program for the operation of the controller has to be configured to the protocol "telnet".
- Checking the interface activity. (Attention: you'll also have a display if the function is not released)
- Testing the connection with the function "ping". See following page.



#### **Testing the Ethernet connection**

To test the connection of the controller with the network, Windows offers the test function "ping".

It is normally used to check the performance of a network connection and can also be used as a fundamental function test. This function is executed as follows:

#### Start > programs > accessories > prompt

The command "ping" and the IP-address of the controller are entered in the input line.

Example: Subnetmask: 255.255.255.0 ping 141.51.14.38

If the connection works, the controller delivers the answer below.

| Microsoft(R) Windows 95<br>(C)Copyright Microsoft Corp 1981-1995.  |  |
|--|--|
| C:\WINDOWS>ping 141.51.14.38   |  |
| Pinging 141.51.14.38 with 32 bytes of data:  |  |
| Reply from 141.51.14.38: bytes=32 time<10ms TTL=128<br>Reply from 141.51.14.38: bytes=32 time<10ms TTL=128<br>Reply from 141.51.14.38: bytes=32 time<10ms TTL=128<br>Reply from 141.51.14.38: bytes=32 time<10ms TTL=128 |  |
| C:\WINDOWS>_   |  |
|  |  |

#### Ethernet connection with the hyperterminal

Hyperterminal supports in addition to the RS-232 protocol also TCP/IP and is for this reason qualified for operating Corvus via the ethernet interface.

Instead of the Com interface the IP-address of the controller has to be indicated here.

The further operation does not differ from the RS-232 connection.

| Connect To        | <u>? ×</u>                      |
|-------------------|---------------------------------|
| Corvus 🍋          |                                 |
| Enter details for | the host that you want to call: |
| Host address:     | 192.168.128.41                  |
| Port number:      | 23                              |
| Connect using:    | TCP/IP (Winsock)                |
|                   | OK Cancel                       |
# Chapter 3

# **Functions**

# LED-diagnostics display

By dint of the diagnostics display at the front, important configurations and operation states of the controller can be surveyed at a glance.

Active states are displayed by shining LEDs. Blinking displays give additional tips which are explained in the function explanations.



### Functions of the LED-displays

| At At At | 6 <sup>53</sup> |   |
|----------|-----------------|---|
|          | Axis enabled    | Indicates status of the configuration <i>setaxis</i> .<br>The display flashes if the axis is switched on. The display<br>blinks if the function of the axes is restricted by outside influ-<br>ences.                                       |
|          | Closed-Loop     | Indicates status of the configuration <b>setcloop</b> .<br>The display flashes if the closed-loop function is switched on.<br>The display blinks if a target window has been activated and<br>the position is outside of the target window. |
|          | Endswitch       | Indicates status of the endswitch function.<br>The display flashes if the endswitch is activated.   |
|          | Manual          | Indicates status of the configuration <i>joystick</i> .<br>The display flashes if the joystick is switched on.  |
| ĥ        | TxD             | Indicates status of the RS-232 data transmission.<br>The display flashes if Corvus transmits data.  |
|          | Rx              | Indicates status of the RS-232 data transmission.<br>The display flashes if Corvus receives data.   |
| 1        | Connect         | Indicates status of the ethernet data connection.<br>The display flashes if there is an ethernet connection.<br>Attention:<br>The display also flashes if the ethernet interface is not re-<br>leased.                                      |
| 1        | Activity        | Indicates status of the ethernet data traffic.<br>Here is not only displayed the data traffic of the controller but<br>the whole network traffic.<br>Attention:<br>The display also flashes if the ethernet interface is not re-<br>leased. |

| Error     |  |
|-----------|--|
|           | Error display.<br>The display flashes if an error has occurred.<br>The error code can be read with the command <b>gme</b> or <b>ge</b> .   |
| Stopped   | Indicates status of the command execution.<br>The display flashes if the command interpreter is ready to re-<br>ceive a new command.<br>This display is switched off in the joystick mode. |
| USER LED1 | Indicates status of push-button A. If the LED is switched on, status bit D2 is produced.<br>See command <i>status</i> .  |
| USER LED2 | (no function)  |

### **Push-Button A and B**

Push-button A and push-button B offer switch functions which can be used for controlling purposes in coaction with the application software.

Presently only push-button A is supported.

The switch state of push-button A is displayed from the outside by User LED1. The evaluation by the application software is done via the command *status*.

Remark:

Push-button A is compatible to the function key **"online"** like it was used for the controller MultiControl-2000.



# **Endswitch functions**

### Working range and coordinate system

As a basis for the positioning, each controller needs a coordinate origin and for safety reasons the information of the maximum working range within which the positioning can take place.

The in Corvus implemented endswitch functions calculate the origin and the maximum working range and save those for the period of the operation.

The working range is defined by hard- or soft limits.

The hard limits are endswitches, soft limits are limitations which can be determined program technically.

The endswitches can be registered programmed by command or manually with the joystick.



For safety reasons the coordinate origin and the determined maximum movement range get lost while switching off the controller and have to be recalculated resp. programmed after a restart.

### **Endswitch inputs**

Corvus supports two endswitches per motor axis. The endswitch connections are in the respective motor connector.

These switch inputs are designated due to their function as **cal-** or **rm-** endswitch input.

The endswitch functions are dedicated to these inputs. See "endswitches" on page 17.

# Programmed endswitch movement

With the commands *cal* and *rm* a synchron positioning of all active axes to their endswitches is started. The activation of the axes is done with the command *setaxis*.

Synchron means that the axes are started simultaneously and are driven in the endswitches.

As soon as all endswitches are activated, the axes are again driven simultaneously out of the endswitches. Therewith the endswitch movement is completed.

The endswitch movement can be aborted with the command *Ctrl+c*. During the endswitch movement the interpreter is blocked for all further commands.

A position reply message during the endswitch movement is only received in Terminal Mode. See manual Venus-1.



During the endswitch movement no other commands except the abort command *CtrI+c* can be executed.

The controller can continue to receive data and saves these in the command FIFO. These commands are executed when the endswitch movement is completed.

### Programmed endswitch movement in detail

The fundamental procedure of the programmed endswitch movement is described below.

The endswitch movement is divided in at least two successive positionings:

1. The controller positions until the endswitch is activated and stops immediately.

The endswitch diagnostics LED flashes.

2. The controller positions again out of the endswitch until this one is inactive.

The endswitch diagnostics LED extinguishes.



3. With the command *setcalswdist* an additional distance to the endswitches can be determined.

The endswitches are always outside of the working range and are not again activated by the controller in the regular mode. With the command *getlimit* the registered coordinates are read.



### Endswitch movement to the cal-endswitch



The controller positions all active axes towards negative position values. At the end of the cal-endswitch movement the position is set to zero and the origin is firstly determined there. The positioning of coordinates less than zero is no longer possible. The origin can be changed subsequently with the command *setpos*.

### Endswitch movement to the rm-endswitch



The controller positions all active axes towards positive position values. The position at the end of the rm-endswitch movement is the maximum movement range for the controller. A positioning beyond this point is no longer possible. The limit can subsequently be minimized with the command **setlimit**.



The coordinate configurations are not saved for safety reasons and have to be recalculated after each restart.

# Endswitch movement with the joystick

By the use of the manual positioning with the joystick, the endswitches can also be detected. The procedure resembles the programmed endswitch movement.

### Endswitch movement with the Joystick in detail

The controller is positioned with the joystick in the endswitch until this one is activated. After that it is positioned out of the endswitch until this one is again inactive.

The position before the endswitch is registered as the movement limit and can neither in the manual nor in the programmed mode be run over afterwards.

### Working range and coordinate system

In opposition to the programmed endswitch movement, the controller does not determine an origin during the manual endswitch movement.

The point of origin could be given here already before the endswitch movement by the command.

If an origin is not determined before the manual endswitch move, the mechanic position at switching on the controller is the origin.

A reassignment of the coordinate origin is subsequently possible.



### Notices for the endswitch move



- To calculate the working range and to determine the coordinate system, the origin has to be calculated first (cal). After that the maximum movement range (rm).
- The velocity for the movement to the endswitch has to be chosen that way that within the deceleration distance there will not be a collision with the mechanics. This is first of all valid for the endswitch movement with the joystick.
- To achieve a good reproducibility of the limits, the velocity for the move out of the endswitch should be chosen as small as possible.
- During the endswitch move the command interpreter is blocked for all commands except the abort command Ctrl+c.
   A position reply message is only received in terminal mode.
- For safety reasons the movement range and the configurations of the coordinate system are not saved. They have to be recalculated and determined after each restart.

# **Endswitch wiring**

With the changeover switch at the back of the controller, Corvus is configured to **NPN-** or **PNP-** endswitch type.

- NPN = the endswitch closes or opens towards ground
- PNP = the endswitch closes or opens to VCC

The function *opener* or *closer* is determined with the Venus-1 command *setsw* and is saved with *save*.



# Positioning with the Joystick



The joystick mode allows a very sensitive positioning of all axes via a joystick.

The movement is velocity controlled and is produced by the deflection of the joystick.

The larger the deflection the higher the velocity. In joystick mode the axes can be moved independently. It does not exist an interdependence of the axes in this mode like it exists in the programmed mode.

The position resolution with the joystick is enormous. The internal calculation works with 32 bit and reaches thereby a resolution of theoretically **23.2 fm** (femtometer)!

### Joystick button speed

With the two paralleled push buttons of the joystick, a freely definable second joystick velocity can be activated. This velocity is valid as long as one of these push buttons is pushed.

### Configuration of the joystick

| Command      | Description                                       |
|--------------|---|
| setjoyspeed  | maximum joystick velocity                         |
| setjoybspeed | maximum joystick velocity if button is<br>pressed |
| setmanaccel  | manual acceleration                               |

### Notices for the joystick mode



- During the phase of switching on the controller, the zero position of each axis of the joystick is checked. The joystick may not be deflected during this time. If there is a zero position outside of an internally determined tolerance window, the manual mode for the relevant axis is switched off.
- The zero position is also checked when the joystick shall be switched on during the running mode.
- If the joystick is disconnected during a manual positioning, the axes are immediately stopped. The joystick mode remains active.
- During the programmed positioning the joystick mode is switched off for safety reasons. It has to be switched on again afterwards.

# Programmed positioning

The programmed positioning is run via the RS-232 interface or the ethernet interface. The command language is Venus-1.

The principle of software control is easy:

There are reading and writing commands. Writing commands execute the activities, the configuration resp. the current state is checked with reading commands.

An automatic status reply message can be received by a combination of commands.

During a positioning, the status, the position and the error storage can be read out at the same time.

In the manual **Venus-1** the possibilities of programming are described in detail.

### Venus-1 syntax and examples

The following command groups are distinguished:

- · system commands
- configuration commands
- · positioning commands
- · status commands

### System commands

save parameters: save

restart controller: reset

### **Configuration commands**

[parameter] \_ [axis index] \_ [command] \_

Example: switching on the 2<sup>nd</sup> axis

### 1 2 setaxis

### **Positioning commands**

[axis 1] [axis 2] [axis 3] move

Example: Positioning all three axes to the coordinates below (absolute move)

### 1.204 4.01 3.4 move

### Status commands

System status:

### st

Status of the digital inputs: *getin* 

### **Axes interpolation**

In the programmed positioning mode the axes are linear interpolated, i.e., a so-called *vector move* is executed.

In doing so the involved axes are synchronized that way that the phase of acceleration and the phase of deceleration are equal.

A cross table with the axes x and y executes thereby a straight movement.



### Velocity and acceleration

The indication of the velocity and the acceleration always refers to the axis with the longest moving distance. It is also called the limiting axis.

The velocity of the other axes v is a result of the ratio of the moving distance of these axes to the moving distance of the limiting axis  $s_{lim}$ 

$$v = \frac{s}{s_{lim}} \triangleright v_{lim}$$

The acceleration of the other axes is a result of their maximum velocities.

### Velocity profile of a linear acceleration function

The movement profile of a programmed move which is produced with a linear acceleration function has the form of a trapezium. The area under the curve corresponds to the covered distance s and the pitch of the curve corresponds to the acceleration a.

See v/t graph below.

- 1 = accelerated move
- 2 = continuos move
- 3 = decelerated move



### Movement profile of short distances

The graph below shows the positioning of a short distance. It can not always be guaranteed here that the axis reaches its maximum velocity.

The movement profile has the form of a isosceles triangle.



### Movement profile of a sin<sup>2</sup>-acceleration function

For the sin<sup>2</sup>-acceleration the torque is not provided abruptly but in form of a sine curve. A very soft start and deceleration of the motor is achieved with it.

As the acceleration is raised in the lower to average speed range it <u>does not</u> lead to an extension of the positioning process.



# **Digital Inputs / Outputs**





For individual controlling tasks and special tasks, Corvus has three digital inputs and three digital outputs. These are fed to a 9pol DSUB connector at the front panel.

The input / output functions are supported by the Venus-1 commands *setout, getout, getin* and *getinfunc*.

### Input circuit

The input voltage range of the digital inputs is between 0 to 24V.

The inputs are optically isolated but not DC-isolated.



**Technical data:** 

| Input voltage | Identified as |
|---------------|---------------|
| 0 - 2 V       | 0             |
| 3 - 24 V      | 1             |

### **Output circuit**

The output driver has a darlington circuit with open-collector output which is also qualified for switching inductive loads. The maximum current capacity of each output is 500 mA.





The total current of all outputs should never exceed 1000 mA.

# **Configuration switch**

 ON
 DIP

 1
 2
 3
 4
 5
 6
 7
 8
 9
 10

 .Configuration

| 1 | Switch | Function                  |
|---|--------|---------------------------|
|   | 1      | RS-232 Baudrate           |
|   | 2      | RS-232 Baudrate           |
|   | 3      | Closed Loop On/OFF        |
|   | 4      | no function               |
|   | 5      | no function               |
|   | 6      | Host Mode / Terminal Mode |
|   | 7      | no function               |
|   | 8      | no function               |
|   | 9      | no function               |
|   | 10     | no function               |
|   |        |                           |

TABLE 9. Configuration switch functions

|   |     | 4        | 1/          |   |    |   |
|---|-----|----------|-------------|---|----|---|
| Ľ | 11- | <b>'</b> | <b>1</b> /I | Ρ | IN | Р |

| Setting | Function   |  |
|---------|--|--|
| NPN     | <ul><li>NPN function of endswitches is assumed</li><li>All inputs are closed to GND if active.</li></ul>   |  |
| PNP     | <ul><li>PNP function of endswitches is assumed</li><li>All inputs are switched to VCC if active.</li></ul> |  |

TABLE 10. Endswitch setting with hardware switch NPN/PNP

# Input / Output functions

In the following the functions which can be realised with the digital in- or outputs are described.

### Produce an output signal

The command *setout* switches a signal to the outputs Dout1 - Dout2.

### Read an input signal

The command *getin* reads the binary state of the data inputs Din1 - Din3.

### Limitation of movement

Via an externally produced signal at the digital inputs Din1-Din3 it is possible to block selected axes completely or to restrict their moving range depending on the direction. The function is activated with the Venus-1 command *setinfunc*.

# Safety device





The interface "safety device" enables switching off the motor power stage. In addition there are two floating connections of a relay which can be used for a safety circuit or other controlling tasks.

### Switching off the motor

Switching off the motor affects the hardware of the motor power stage and is independent from the software.

You can switch off the power stage of each single axis. In doing so the signal switches all motor phases of an axis in the high-impedance state.

A switch off is reported as a machine error. See Venus-1 command *gme*.

Switching on the motors again is only possible by a restart of the controller or with the command **reset**.

The inputs are optically isolated but not DC-isolated.



### **Technical data:**

| Input voltage | Status of motor driver   |
|---------------|--------------------------|
| 0 - 2 V       | Motor driver is disabled |
| 3 - 24 V      | Motor driver is active   |

### Relay

The floating contact is closed 2 seconds after switching on the controller.

The contact opens while switching off the controller or if the command *reset* is executed.



# **Voltage Output Module**





With the Voltage Output Module Corvus delivers a floating 24V output voltage which can be switched via the Venus-1 command *setsout*.

This option is i.e. used to support motor brake circuits. The maximum output current is 0.5A. Connector pin assignment see Chapter 7.

### **Function description:**

After switching on the controller, the voltage module is disconnected and 0V is applied to the output. The output voltage is switched on by the command **1 1 setsout** and is switched off by **0 1 setsout**. The status

query is done by **getsout**.



The voltage is also switched off with the command *reset*.

If the Module is used for controlling a motor brake, it is the job of the user to check if therewith a safe operation can be guaranteed.

# User output voltages

For the power supply of external devices, Corvus provides the user-voltages +5V and +12V. These voltages are saved with their nominal current.

The safety elements are self-resetable fuse, i.e., the electric circuit is closed again after removing the overload and after a convalescence.

### **Technical data:**

| User voltage | Max. output current |
|--------------|---------------------|
| 5V           | 1A                  |
| 12V          | 0.3A                |

Option

If more output power is needed to supply the external devices an optional DC-DC module is available.

# **Closed-Loop function**

This function enables the operation of the axes in a closed-loop mode.

At this the actual position measured by a measuring system is delivered to the controller to tune the target position exactly.

Depending on the measuring system there are some advantages for the stepping motor positioning:

- · step monitoring
- · increasing the repeatability
- · improvement of the absolute accuracy
- · load compensation during the move and a standstill
- · improved controlling behavior
- support of fast and highly precise positioning procedures by the "in-window" function
- measuring function realisable

### **Measurement connectors**

The inputs of the measuring system are placed on the backside of the controller.

The connectors are labeled with Enc.Axis-1, Enc.Axis-2 and Enc.Axis-3.



Figure 11: Closed loop inputs are shown

### Venus-1 Closed-Loop commands:

- setcloop
- setscaleinterface
- setclperiode
- setclfactor
- setscaletype
- setclpara
- setref
- refmove

# Supported measuring systems

Corvus supports the following measuring systems:

- A/B Quadrature with RS422 signal output
- SIN/COS, 1Vss

### A/B Quadrature input

| Option = 5 5<br>7 5 5<br>• • • |
|--------------------------------|
|--------------------------------|

The interface supports square wave pulse trains and their inverted pulse trains.

The encoder interface is also provided with a reference signal input.

### **Technical data:**

| Incremental signal input | RS422  |
|--------------------------|--------|
| Reference signal input   | RS422  |
| Max. input frequency     | 10 Mhz |

### **SIN/COS Module**



The SIN/COS module is an independent data interface for sinusoidal encoder signals. The encoder signals are interpolated with a 12 resolution.

For each axis a SIN/COS module is required.

### **Technical data:**

| Input signals        | 1Vss, differential |
|----------------------|--------------------|
| Reference mark       | Supported          |
| Max. input frequency |                    |
| Interpolation        | 12 Bit             |

| Signal period | Resolution  |
|---------------|-------------|
| 20µm          | 0.00155 nm  |
| 2µm           | 0.000155 nm |

### SIN/COS Status LED

| Co os                     |  |  |  |  |  |  |  |
|---------------------------|--|--|--|--|--|--|--|
| Cycle LED Status          |  |  |  |  |  |  |  |
| active Hardware OK        |  |  |  |  |  |  |  |
| not active Hardware error |  |  |  |  |  |  |  |

| Sensor LED | Status    |
|------------|-----------|
| active     | no Sensor |
| not active | Sensor OK |

# Chapter 4

# Communication Interfaces

## Interface concept

Corvus is equipped with the following communication interfaces:

- RS-232
- Ethernet
- IEEE Interface

If more interfaces are available, they can be used at the same time. Data reply messages are always transmitted to the interface from which the data query came.

The IEEE-488 interface is realized with an additional hardware modul.

The function is descriped in a separate document.



Figure 12: Corvus network topology

### **Communication with Terminal or Host Mode**

For communication via RS-232, Ethernet and IEEE-488 Terminal mode or Host mode can be selected.

In the terminal mode Corvus sends automatically data to the host for example a screen mask with position display and Venus-1 command entry.

In the host mode the controller is sending data only if these are queried.

See to "Connection with the hyperterminal" on page 30.



Figure 13: Screen shot of Microsoft Hyperterminal

### **Configuration of Terminal or Host Mode**

The setting terminal or host mode is defined either with DIP-Switch 6 or with the Venus-1 command **0 mode / 1 mode.** 

| ON |   |   |   |   |   |   |   | D | IP |
|----|---|---|---|---|---|---|---|---|----|
| Đ. | 0 | ē | Ē | Đ | 6 | B | ĥ | ß | 8  |
| Ľ  | 2 | 5 | 7 | 5 | 0 | ' | 0 | 3 | 10 |

Configuration

Figure 14: DIP-Switch 6 defines Terminal or Host mode

| Dip-Switch 6 | Function      |
|--------------|---------------|
| ON           | Terminal Mode |
| OFF          | Host Mode     |

The setting of the DIP-Switch is dominant. That means, a stored setting could be overwritten with the Dip-Switch setting.

# **RS-232 Interface**

The RS-232 interface is the standard programming interface of Corvus.

The transmitting rate is variable in four steps and is configured with DIP-Switches which are at the rear of the controller.

### **RS-232 Interface configuration**

| Data bits | 8  |
|-----------|----|
| Stop bits | 1  |
| Parity    | no |
| Protocol  | no |

### Baudrate

| Dip-Switch1 | Dip-Switch 2 | Baudrate |
|-------------|--------------|----------|
| OFF         | OFF          | 9600     |
| OFF         | ON           | 19200    |
| ON          | OFF          | 57600    |
| ON          | ON           | 115200   |

| ON            |   |   |   |   |   |   |   | D | lΡ |
|---------------|---|---|---|---|---|---|---|---|----|
|               |   | 8 | Β | Β | D | Đ | Ð | B | Β  |
| 1             | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Configuration |   |   |   |   |   |   |   |   |    |

Figure 15: DIP-Switch
# **Ethernet Interface**

| Option 🚦 | 2 3<br>5 16<br>100<br>100<br>100<br>100<br>100<br>100<br>100<br>1 |
|----------|---|
|----------|---|

Corvus can be enlarged with a 10-base Ethernet interface, so that the programming is possible via a network. Each Corvus has a network connection, so that the functionality can be activated later.

The Venus-1 command *getoptions* checks the released functions.

#### **General informations about Ethernet**

Ethernet is a widely spread and producer independent technology with which data can be transmitted with a velocity of 10 Mbits/s or 100 Mbits/s in Local Area Network (LAN).

#### Topology

The specification allows different network topologies of which tree and ring topology are shown below:



Figure 16: Ethernet network topology with Corvus



Figure 17: Ethernet loop topology with Corvus

## TCP / IP

Corvus Ethernet interface supports the protocol layers **TCP** and **IP**. They are also known as the so-called TCP/IP stack. Corvus is equipped with the interface of the modern communication technology which has penetrated into all areas of technology and is without doubt part of the industry standard.

The hardware of this technology is cheep and well-tested. This interface is part of all modern software products in the area of data communication or will be part of them in future. The advantage of that is a complete compatibility between hard- and software products. This leads to a considerable improvement of productivity.

The TCP/IP- protocol uses a number of well-known applications which are normally known as the terms below:

- ftp
- telnet
- e-mail
- http

## Hardware address (MAC-address)

Each device in a network which can independently produce data packets needs an unmistakable hardware-address, the so-called MAC-address (Media Acces Control-address).

This address is centrally administered to guarantee that it is only one time distributed worldwide.

MAC-address is programmed in the controller and can not be changed.

The address format consists of 6 byte in Hex-code, divided by a colon.

Example: 00:08:63:01:A2:B3

The Ethernet hardware address of each Corvus can clearly be identified.

The Venus-1 command getmacadr reads out this address.

#### **IP-Address**

If data packets shall be clearly addressed, in the internal network or in the internet, there is another address needed, the IP-address.

Like each telephone-connection can worldwide be clearly identified by its local area code number and telephone number, each device which is connected to a network can also clearly be addressed from the outside.

This address format consists of four numbers between 0 and 255 which are divided by a full stop.

Example: 134.109.72.64

Any IP-address can be stored in Corvus. It is written with the Venus-1 command **setipadr** and **save**, the command **getipadr** reads it back.

Factory setting is: 192.168.128.41

Example: 190 170 12 23 setipadr

The digits are divided by space!



It depends on the address structure of the respective network, which IP-address can be assigned for Corvus and it should be assigned by the responsible network administrator.

#### Sub Mask

Submask adress = 255.255.255.0

At the moment not adjustable.

#### **Port-Address**

The IP-address is not the only information that you need to claim the services of a network participant. Different services can be offered via the TCP/IP-protocol (and that is why it is so widely spread).

The distant computer has to be advised about what the querying computer wants. That happens via the so-called ports. A query is always put to a fixed port number.

By that the distant computer knows what is requested and it can pass the query on to the appropriate program.

This detail is normally hidden for the user, as he mostly works with a fixed program which only claims a fixed service of other computers. Without knowing it he has chosen the port address by choosing the program for using the service and the program knows then, which port address offers the service.

Corvus supports port 23 and with it the service telnet.

| Connector      | RJ45          |
|----------------|---------------|
| Data           | 10 MBit/s     |
| Protocol       | TCP/IP        |
| IP adress      | arbitrary     |
| MAC            | Hardware      |
| Submask adress | 255.255.255.0 |
| Port           | 23            |

#### **Corvus Ethernet data summary**

# Chapter 5

# **Device concept**

# Components of the controller

The controller consists of the following components:

- Case
- Controller and Motor driver electronic
- Diagnostics display
- Power supply
- Operating System and firmware

### **Case variants**

The modular composition of the controller makes possible a flexible case concept which allows different models. The following case variants are offered as standard.

- Table top housing TT
- Cabinet mounted CM
- 19" Rack, 2U / 3U

Custom specific changes are possible.

# Table top housing TT

Chromated aluminum table housing with anodized front and back, is additionally equipped with a durable cover. Punched side plates make the passive ventilation possible. High performance devices receive an fan. Display variants are possible.



Figure 18: Front view of Corvus TT



Figure 19: Rear view of Corvus TT

### Cabinet mounting case CM

This case is designed for the assembly in a cabinet. It is equipped with a larger front panel for mounting possibilities. Other mounting designs are also possible.



Tiefe: 300mm

Figure 20: Rear view of Corvus CM

# 19" Rack 2 U / 3U

Chromated aluminum table housing with anodized front and back panel. The mounting plates are at the front side. 3 U version is not shown.



depth = 301mm

Figure 21: Front view of Corvus 19", 2U



Figure 22: Rear view of Corvus 19", 2U

### Controller and motor driver electronic

The Corvus board is high integrated and equipped with the most modern components. Control part and motor-stages are accommodated on one board.



Figure 23. Corvus electronic board

## Parts of the board

| <ul> <li>CPU (133 Mhz)</li> </ul>      | RS-232 Interface                                 |
|--|--|
| <ul> <li>Dual Port Bus</li> </ul>      | <ul> <li>Analog- / Digital conversion</li> </ul> |
| <ul> <li>Flash Memory</li> </ul>       | Closed Loop RS422 Interface                      |
| DRAM Memory                            | Input/Output                                     |
| <ul> <li>SRAM Memory</li> </ul>        | Temperature measurement                          |
| <ul> <li>Ethernet Interface</li> </ul> | Power distribution                               |
| CAN-Bus Interface                      | Motor current sensing                            |
| SPI-Interface                          | Motor driver circuit                             |

# **Diagnostic Display**

The display- and operate-element at the front is part of the standard equipment of Corvus.

The most important operation states of the controller are shown with 20 LEDs.

Two buttons allow manual input functions.



Figure 24. Diagnostic display

### **Power supply**

Corvus is able to support varying stepper motors with different power classes. Adjustment is also made with the power supply. Standard equipment is 50W.

In the following table all Corvus power classes and case variants are summarized.

| Power   | Case variants                           | Fan                     |
|---------|---|-------------------------|
| • 50 W  | <ul> <li>TT, CM, 19" (2U/3U)</li> </ul> | • no                    |
| • 100W  | <ul> <li>TT, CM, 19" (2U/3U</li> </ul>  | <ul> <li>yes</li> </ul> |
| • 150 W | • 19" (2U, 3U)                          | <ul> <li>yes</li> </ul> |
| • 240 W | • 19" (3U)                              | <ul> <li>yes</li> </ul> |
| • 500 W | • 19" (3U)                              | <ul> <li>yes</li> </ul> |

TT = Table top, CM= cabinet mounted,

19"= Rack 2U or 3 U

### Operation system and firmware

Corvus is equipped with a real-time operating system. This concept allows an extremely fast reaction time of the software and has built up a solid basis for a high-end controller which can combine high resolution positioning, a highly developed communication and efficient special functions.

# Chapter 6

# **Technical data**

# Overview

| Number of axes                         | • 2 or 3  |
|--|---|
| Phase current                          | until 2,5A  |
| velocity max.<br>velocity min.         | <ul><li> 45 rounds/ s</li><li> 15.26 nm/s</li></ul>   |
| acceleration max.<br>acceleration min. | <ul> <li>1m/s<sup>2</sup></li> <li>15.26 nm/s<sup>2</sup></li> </ul>  |
| Motor Power                            | <ul> <li>48V/ 50W (Standard)</li> <li>48V/ 75W</li> <li>48V/ 100W</li> <li>48V/ 500W (only with 2U or 3U Rack)</li> </ul>                   |
| Supported motors                       | Stepper motor, 2-Phases or 3-Phases, bipolar,   |
| Programming                            | <ul> <li>ASCII command language Venus-1</li> <li>Windows user interface</li> <li>Software library (dll)</li> </ul>                          |
| Resolution in program-<br>ming mode    | • 1.526 nm  |
| Resolution in Joystick mode            | • 0.233 nm (233 femto meter)  |
| Positioning modes                      | <ul> <li>Absolute, relative, vector, error correction,<br/>velocity controlled</li> </ul>   |
| Acceleration modes                     | <ul> <li>linear (trapezoid), sin<sup>2</sup> (s-curve)</li> </ul>   |
| Closed Loop<br>(Option)                | Sin-Cos 1Vss or RS422 quadrature  |
| Processor                              | 32 Bit Risc Processor   |
| Operating system                       | Real-Time Operating System  |
| Motor driver                           | Digital MOS-FET   |
| Communication                          | <ul> <li>RS-232 Host or Terminal until 115kBaud.</li> <li>Ethernet, 10BaseT with TCP/IP Stack</li> <li>CAN-Bus</li> <li>IEEE-488</li> </ul> |

| Limits                              | 3 x Limit switch inputs   |
|-------------------------------------|---|
| Inputs / Outputs<br>(Option)        | <ul> <li>3 x Digital inputs</li> <li>3 x Digital outputs</li> <li>2 x Analog inputs 0-10V</li> <li>2 x Analog outputs 0-1V, 8Bit</li> <li>3 x Temperature inputs (-25°C until 100°C)</li> </ul> |
| User Output power                   | <ul> <li>+5V, 1000 mA</li> <li>+12V, 300 mA</li> </ul>  |
| Motor Break function (Option)       | +24V, switchable for motor break device   |
| Increm. Digital Encoder<br>(Option) | <ul> <li>3 x RS422 Quadrature</li> <li>Encoder index pulse consideration</li> <li>Input frequency 10 Mhz.</li> </ul>  |
| Sin-Cos Analog Encoder<br>(Option)  | <ul> <li>3x Sin-Cos 1Vss</li> <li>Encoder index pulse consideration</li> <li>Input frequency</li> </ul>   |
| Safety functions<br>(Option)        | <ul><li>Motor disable</li><li>Relay contacts</li></ul>  |
| Graphik Display<br>(Option)         | Graphic-Display   |
| Frontpanel keys                     | • 2   |
| Diagnostic display                  | • 20 LED  |
| Accessories                         | <ul><li>Joystick, with 2 or 3 axes</li><li>Joystick with graphic display</li><li>Handwheel</li></ul>  |
| Special functions<br>(Option)       | Position Synchronisized Output  |
| Case variants                       | <ul> <li>Table top (TT)</li> <li>Cabinet mounted (CM)</li> <li>2U / 3U (Rack)</li> </ul>  |
| Power supply                        | 90-250V (wide range input)  |
| Standards                           | <ul> <li>IEC 1010-1, EN61010-1, EN55011<br/>EN50082-1</li> </ul>  |

# Chapter 7

# Connectors

# **Motor Connector**

.



| Pin | Name      | Description                          |
|-----|-----------|--------------------------------------|
| 1   | Ph 1A / U | Motor phase 1 A                      |
| 2   | Ph 1B / W | Motor phase 1 B                      |
| 3   | Ph 2A / V | Motor phase 2 A                      |
| 4   | Ph 2B     | Motor phase 2 B                      |
| 5   | Ref       | Reference switch                     |
| 6   | User +5V  | User power output                    |
| 7   | User +12V | User power output                    |
| 8   | Temp In   | Temperature input                    |
| 9   | Ph 1A / U | Motor phase 1 A -> (Pin 1)           |
| 10  | Ph 1B / W | Motor phase 1 B -> (Pin 2)           |
| 11  | Ph 2A / V | Motor phase 2 A -> (Pin 3)           |
| 12  | Ph 2B     | Motor phase 2 B -> (Pin 4)           |
| 13  | cal       | Endswitch input cal<br>(lower limit) |
| 14  | rm        | Endswitch input rm<br>(upper limit)  |
| 15  | GND       | Ground                               |

TABLE 25. Motor connector of one axis

# Motor wiring

The adjustment to the different motor types is accomplished with the following Venus-1 commands:

- setphases
- setumotmin
- setumotgrad
- setpolepairs

## Stepper motor with 2-phases



# Stepper motor with 3-phases



# **RS-232 Programming Interface**



This interface is used for the standard programming mode  $\mathsf{T}$ 

| Pin | Name | Function            |
|-----|------|---------------------|
| 1   | nc   | nc                  |
| 2   | RxD  | Corvus data input   |
| 3   | TxD  | Corvus data output  |
| 4   | DTR  | Connected with Pin6 |
| 5   | GND  | GND                 |
| 6   | DSR  | Connected with Pin4 |
| 7   | RTS  |                     |
| 8   | CTS  |                     |
| 9   |      |                     |

TABLE 26. RS-232 programming interface



The RS-232 interface is working without flow control. The handshake signals RTS and CTS are not supported. DTR and DSR are internal connected.

# **RS-232 Service Interface**

| 0 | 1           |
|---|-------------|
| F | S232 / Host |

This interface is used for the firmware update.

| Pin | Name | Function            |
|-----|------|---------------------|
| 1   | nc   | nc                  |
| 2   | RxD  | Corvus Data input   |
| 3   | TxD  | Corvus Data output  |
| 4   | DTR  | Connected with Pin6 |
| 5   | GND  |                     |
| 6   | DSR  | Connected with Pin4 |
| 7   |      |                     |
| 8   |      |                     |
| 9   |      |                     |

TABLE 27. RS-232 service interface

# **Ethernet Interface**



| Pin | Name | Function           |
|-----|------|--------------------|
| 1   | TxD+ | Corvus data output |
| 2   | TxD- | Corvus data output |
| 3   | RxD+ | Corvus data input  |
| 4   |      |                    |
| 5   |      |                    |
| 6   | RxD- | Corvus data input  |
| 7   |      |                    |
| 8   |      |                    |
| 9   |      |                    |

TABLE 28. Ethernet interface

# **Joystick Input**



| Pin | Name            | Function                     |
|-----|-----------------|------------------------------|
| 1   | Axis-1 (X)      | Analog input 0-3.3V          |
| 2   | Axis-2 (Y)      | Analog input 0-3.3V          |
| 3   | Axis-3 (Z)      | Analog input 0-3.3V          |
| 4   | Joystick enable | Enable input<br>GND = enable |
| 5   | +5V (User)      | User output                  |
| 6   | SW              | Joystick Button              |
| 7   | GND             | GND                          |
| 8   | AGND            | analog GND                   |
| 9   | 3.3V (analog)   | Power                        |

TABLE 29. Joystick input

# **Digital Encoder Input**

Used for Closed Loop control with digital encoders.



| Pin | Name       | Function             |
|-----|------------|----------------------|
| 1   | Ua 1       | Channel A (positive) |
| 2   | Ua 2       | Channel B (positive) |
| 3   | Ua 0       | Reference (positive) |
| 4   | DGND       | GND                  |
| 5   | +5V (User) | User output          |
| 6   | Ua 1-      | Channel A (negative) |
| 7   | Ua 2-      | Channel B (negative) |
| 8   | Ua 0-      | Reference (negative) |
| 9   | Error      | Encoder error        |

TABLE 30. Encoder input

# SIN/COS Interface (1Vss)

Used for Closed Loop control with standard analog measurement systems.



| Pin | Name       | Function             |  |  |
|-----|------------|----------------------|--|--|
| 1   | +5V analog | Analog Vcc           |  |  |
| 2   | Event      | Event                |  |  |
| 3   | Ua 1 +     | sin +                |  |  |
| 4   | Ua 1 -     | sin -                |  |  |
| 5   | Ua 2 +     | cos +                |  |  |
| 6   | Ua 2 -     | cos -                |  |  |
| 7   | Ua 0 +     | Reference (positive) |  |  |
| 8   | Ua 0 -     | Reference (negative) |  |  |
| 9   | AGND       | Analog ground        |  |  |

TABLE 31. SIN/COS Input (1Vss)

# Digital Input / Output



| Pin | Name     | Function         |
|-----|----------|------------------|
| 1   | DGND     | Digital GND      |
| 2   | Input 2  | Input 2 (0-24V)  |
| 3   | User +5V | User output      |
| 4   | Output 2 | Output 2 (0-24V) |
| 5   | SPNG     | SPNG             |
| 6   | Input 1  | Input 1 (0-24V)  |
| 7   | Input 3  | Input 3 (0-24V)  |
| 8   | Output 3 | Output 3 (0-24V) |
| 9   | Output 1 | Output 1 (0-24V) |

TABLE 32. Digital input / output

# Safety device



| Pin | Name      | Function      |
|-----|-----------|---------------|
| 1   | REL1      | Relay Pin1    |
| 2   | DGND      | Digital GND   |
| 3   | User +5V  | User Output   |
| 4   | Enable 3  | Enable Axis-3 |
| 5   | Enable 1  | Enable Axis-1 |
| 6   | REL2      | Relay Pin2    |
| 7   | User GND  | GND           |
| 8   | Enable 2  | Enable Axis-2 |
| 9   | User +12V | User Output   |

TABLE 33. Safety device connector



If the safety device connector is not installed, the motor axes are enabled internally.

# Voltage Output Module



| Pin | Name | Function          |
|-----|------|-------------------|
| 1   | +24V | Output 24V / 0.5A |
| 2   | +24V | Output 24V / 0.5A |
| 3   | nc   | nc                |
| 4   | nc   | nc                |
| 5   | nc   | nc                |
| 6   | GND  | GND               |
| 7   | GND  | GND               |
| 8   | nc   | nc                |
| 9   | nc   | nc                |
| 10  | nc   | nc                |
| 11  | nc   | nc                |
| 12  | nc   | nc                |
| 13  | nc   | nc                |
| 14  | nc   | nc                |
| 15  | nc   | nc                |

TABLE 34. Safety device connector with Output Voltage Module

# Chapter 8

# Releasing an Option/ Firmware Update

# **Releasing options**

Corvus is equipped with a various number of options which can be easily released from the customer via a so called release code.

#### Informations to purchase a release code

To purchase an option following informations are necessary.

#### 1. Serial number of the controller

The number is fit at the bottom side of the Corvus chassis.



#### 2. Momentary released options

The already released options are labeled on the rear side of the controller. The options index can also read out via the command *getoptions* 

Options

- Axis-3
- Ethernet

Closed Loop

- Axis 1
- Axis 2
- Axis 3
- Input/Output

# Form for releasing an option

| Serial nun | ıber:              |     |      |  |
|------------|--------------------|-----|------|--|
| Desired of | otion:             |     |      |  |
| Already re | leased optic       | on: | <br> |  |
|            | Options            |     |      |  |
|            | Axis-3<br>Ethernet |     |      |  |
| C          | losed Loop         |     |      |  |
|            | Axis 1             |     |      |  |
|            | Axis 3             |     |      |  |
|            | Input/Output       |     |      |  |
| getoption  | s index:           |     |      |  |
|            |                    |     |      |  |
| Dato:      |                    |     |      |  |
| Jale.      |                    |     |      |  |
|            |                    |     | <br> |  |

## Installation options with an ASCII Terminal

To install an option the purchased code must be send via the RS-232 line to the controller.

Therefore a standard ASCII Terminal or Terminal Software can be used. (We recommend Microsoft Hyperterminal) To activate the Corvus Terminal Mode, Dip-Switch\_6 must be switched to ON.

In this mode Corvus is sending a Terminal mask with a command input line to the RS-232 line after power up.

|              | ON                | ON DIP                       |  |  |
|--------------|-------------------|------------------------------|--|--|
|              | OFF               | Configuration                |  |  |
| Dip-Switch 6 | Function          |                              |  |  |
| • ON         | Terminal Mode aft | Terminal Mode after power on |  |  |
| • OFF        | Host Mode after p | Host Mode after power on     |  |  |

#### Installing step by step

- Start the Terminal program
- Turn On Corvus -> Terminal mask should be shown
- Input release code with command setcode
- Save release code with command save
- Restart Corvus with command reset
- Verify release with command getoptions
- Mark option at the rear label

Corvus Terminal mask after power up

VENUS-1 (Corvus) Interpreter Version: 3.44 Copyright 2003 by 6 X: 0.00000 6 Y: 0.00000 Command[ 0]:

#### Input release code and following commands

|   | VENUS-1 | (Corvus)   | Interpreter  | Version   | : 3.44 | Copyright | 2003 | Ъj |
|---|---------|------------|--------------|-----------|--------|-----------|------|----|
| 6 | 5 X:    | 0.00000    |              |           |        |           |      |    |
| 6 | 5 У:    | 0.00000    |              |           |        |           |      |    |
|   |         |            |              |           |        |           |      |    |
|   |         |            |              |           |        |           |      |    |
|   | Command | [ 0]: OCA( | 67CC2Eh 01F6 | F6F53h se | etcode | save rese | t    |    |

#### Verify release option with getoptions

```
VENUS-1 (Corvus) Interpreter Version: 3.44 Copyright 2003 by
6 X: 0.00000
6 Y: 0.00000
Command[ 0]: getoptions_
```
#### Installation options with WinPos

The Windows program WinPos LT can also be used to release an option. WinPos LT is the standard user program included in the Corvus delivery.

Before using WinPos, please check if your WinPos Version is able to release options.

WinPos Version 1.1 with venuscom.dat\* dated 14.07.2003 or newer should be used.

\*venuscom.dat is found in the WinPos directory.

#### Installing step by step

- Turn On Corvus
- Start WinPos
- Connect WinPos with Corvus (see manual)
- Open Venus command input line
- Input release code and send it with command setcode
- Input command *save* and send it to store release code
- Input command reset and send it to restart the controller
- Verify released code with command getoptions

| 🔁 WinPos                                  |      |   |       |        |  |
|---|------|---|-------|--------|--|
| File Controller Extras Configuration Help |      |   |       |        |  |
|   |      |   |       |        |  |
| Status Not connecte                       | ed   |   |       |        |  |
| V   | mm/s | A | mm/s² |        |  |
| Pos.(0) X                                 | mm   | Y | mm    | Z      |  |
| Limits X                                  |      | Y |       | Z      |  |
| Connect controller                        |      |   |       | roller |  |

| 🚰 WinPos                                     |      |           |        |           |  |
|--|------|-----------|--------|-----------|--|
| File Controller Extras Configuration Help    |      |           |        |           |  |
| <u>````````````````````````````````````</u>  |      |           |        |           |  |
| Status Ready                                 |      |           |        | getlimit  |  |
| V 10   | mm/s | A 1000    | mm/s²  | Joy.Off [ |  |
| Pos.(0) X 0.00000                            | mm   | Y 0.00000 | mm     | Z         |  |
| Limits X undef. Und                          | ef.  | Y undef.  | undef. | Z         |  |
| Venus-1 command line<br>Controller connected |      |           |        |           |  |
|  |      |           |        |           |  |
|  |      |           |        |           |  |
| 😴 WinPos                                     |      |           |        |           |  |

| 2 WINPOS   |                 |        |                |        |       |   |     |
|--|-----------------|--------|----------------|--------|-------|---|-----|
| File Controller Extras Coni  | figuration Help |        |                |        |       |   |     |
|  |                 |        |                | 32     | , i , | 3 | 9   |
| Status Ready   |                 |        |                |        |       |   | get |
| V 10   | mm/s            | A 100  | 0              | m      | m/s²  |   | Joy |
| Pos.(0) X 0.00000  | mm              | Y 0.00 | 000            | m      | m     | Z |     |
| Limits X undef.  | undef.          | Yund   | ef.            | undef. |       | Z |     |
|  |                 |        |                |        |       |   |     |
| ¥enus command line   |                 |        |                | ×      |       |   |     |
| Venus command<br>97B2D79h 0569B6F70h setcode<br>Execute<br>Release Code<br>with command<br>setcode |                 |        |                |        |       |   |     |
|  | Luie            |        | with conserved | mmand  |       |   |     |

| Venus command line |         | ×     |
|--------------------|---------|-------|
| Venus              | command | Close |
| save               | •       | Help  |
| Ex                 | ecute   |       |

| Venus con | nmand line    | ×     |
|-----------|---------------|-------|
|           | Venus command | Close |
| reset     | •             | Help  |
|           | Execute       |       |

| Yenus command line | ×     |
|--------------------|-------|
| Venus command      | Close |
| getoptions 📃       | Help  |
| Execute            |       |
| Execute            |       |

## **Option index table**

With the command *getoptions* the already released options are replied as a bit coded decimal number from 0 to 1023 as shown in the following table.

| Option             | getoptions<br>Index | Bit |
|--------------------|---------------------|-----|
| 3. Axis            | 1                   | D0  |
| Ethernet Interface | 2                   | D1  |
| not used           | 4                   | D2  |
| Input / Output     | 8                   | D3  |
| Motor enable       | 16                  | D4  |
| Safety device      | 32                  | D5  |
| Closed Loop axis 1 | 64                  | D6  |
| Closed Loop axis 2 | 128                 | D7  |
| Closed Loop axis 3 | 256                 | D8  |
| High Speed         | 512                 | D9  |

Example: Options: 3 rd. Axis, Input/Output

**getoptions** = 8 + 1 = 9

## Troubleshooting

#### After releasing the option doesn't work

Check if option is released. Use command *getoptions*. Before you try again to release the option, please make sure that your release code is correct.

In most cases you got the code via E-mail. It is a reasonable way to copy the number from the E-mail into the clipboard and insert it directly in the Venus command line.

- Don't forget to send command save after **setcode**.
- Don't forget to send command reset after **save**.
- During releasing with WinPos you got the message "unknown command *setcode*"

You are using an older WinPos Version. Ask you dealer for WinPos Version 1.1 with "venuscom.dat" date code: 14.07.2003 or newer.

# Update controller firmware

The Firmware update can be easily accomplished with the ITK Update Tool.

This is a self-explanatory tool that guides you through the process in three steps.

#### Update procedure in three steps

- 1. All controller settings will be read and stored to disk
- 2. New firmware download is performed
- 3. Parameters are reread from disk and stored in controller

### What do you need to update the controller

1. Update Tool with following files:



579 KB Anwendung 6 KB Konfigurationseinst... 5 KB Rich Text Format 727 KB Programmbibliothek

2. New Firmware.bin file This file can be uploaded from the home page of your dealer or is send you via E-mail.

🖻 Corvus3\_4\_4.bin

454 KB BIN-Datei

3. Computer with a 115 kBaud RS-232 interface The update is executed via the RS-232 Service line. The baudrate for parameter upload is selectable. The firmware download is executed with a fixed baudrate of 115kBaud.

4. Socket wrench (5mm) Tool to remove the cover of the D-type connector "RS-232 Service" at the controller.

## Update Tool

