documentation

ppelectronic

motor controller

smc

hardware reference
february 2012

table of contents

symbol description

symbols used within this documentation have the following meaning:

ATTENTION
indicates danger of damaging the equipment with a potential danger of injuries.

DANGER
indicates an immediate hazard for persons.

DANGER
indicates shock hazard due to high voltage.

ATTENTION
ESD warning (Electro-Static Discharge). components may only be touched in an electrostatically protected environment.

safety instructions

please read carefully the following safety instructions before installing and using the powerpack. the intended use of the powerpack is described in this documentation and must be observed.

the smc is designed for the use in industrial facilities. during operation, parts of the equipment carry high voltage which may cause injuries or material damages in case of disregarding the safety regulations.

persons, which are responsible for the equipment must ensure that

-        the equipment will be used in accordance with regulations mentioned in this manual.

-        the equipment will be installed by skilled personnel only (i.e. skilled personnel
         in the sense of VDE 105 or ICE 364).

         national regulations concerning
                - prevention of accidents
                - installation of electrical or mechanical equipment
                - suppression of interference
         must be observed.

-        technical specifications and ambient conditions of the equipment will be observed.

-        will be operated by trained personnel only.

unauthorized modification of the equipment voids warranty.

these safety instructions do not assert the entitlement to completeness. in case of problems or questions, please call pp-electronic gmbh.

equipment and documentation have been checked with a great deal of care. however, pp-electronic GmbH cannot guarantee for total faultlessness.

introduction

please note: the online documentation of the smc is available here:

http://smc.pp-electronic.de

it contains information about the latest hard- and software changes, updates and other useful information. the access to this site is password-protected: username '***user***', password '***smc***'.

this manual contains information about the SMC9300 hardware and how to configure and manually operate your controller. a separate manual 'command reference' contains a description of the command set of the controller and instructions operate the SMC9300 under remote control.

the SMC9300 is an integrated stand-alone motor controller which can drive and control up to 16 axes of motion using any combination of 2-, 3- and 5-phase step motors. the SMC9300 can act as a stand-alone unit and perform positioning tasks stored on an integrated hard disk as well as it allows real-time execution of commands received via computer interface.

it is based on an Intel single-board PC under control of the operating system Windows XP Embedded. compared to its predecessor, the successful SMC9000 series, it has been completely redesigned in order to provide expanded functionality and flexibility.

a powerful command set allows easy and comfortable programming of complex positioning tasks. in order to meet future requirements, the system software can be easily upgraded over a network connection.
except for some minor hardware dependent differences, the command set of the SMC9300 is fully compatible with the command set of the SMC9000.

the controller is available in various configurations and can be equipped with a number of modules and options which will be described within the context of this documentation.

through this flexible concept, the configuration of the SMC9300 can be easily adapted to meet your individual requirements. individual control software modification for special applications is available upon request.

properties of the SMC9300:

|	
number of motor axes:	1 … 16
motor type:	stepper motor and servo/dc motor
processor:	Embedded Intel
operating system:	Microsoft Windows XP Embedded
display & user interface:	6" TFT colour display, touch-screen
hard disk:	standard 2.5" PATA
interfaces:	serial (RS 232), ethernet (TCP/IP), keyboard, mouse
input signals:	end/limit switch, slow down, reference, encoder, 3 channels A/B/I, RS422 signal level (TTL at option).
additional options:	impulse counter 9300.07, filter control 9300.08 and half screen control 9300.09. i/o-port, 16-bit (8 x in, 8 x out), TTL signal level
supported external hardware:	Heidenhain EIB7 encoder counter (ethernet). hand terminal, joystick (wired desktop/wireless)
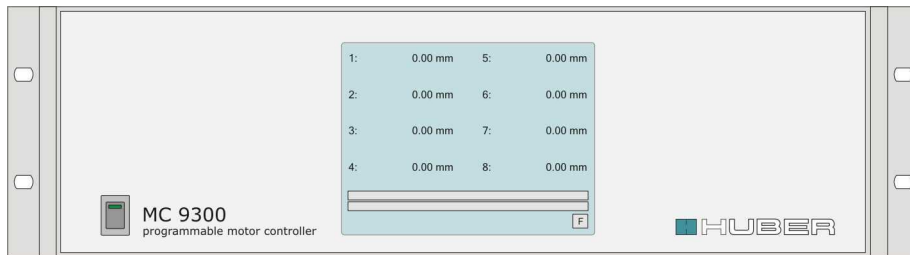
fig.: SMC 9300 front

general

in principle, there is no difference between the operating system Windows XP Embedded and Windows XP Professional, which is used on PC workstations.
the main difference is, that the embedded version provides the possibility to individually compose software modules in order to get an optimized operating system which does not contain unnecessary components and features.

> **ATTENTION:**
> **before you switch the controller OFF, make sure the operating system has been shut down properly.**

installation

please observe the following instructions during installation of the powerpack:

exemplary order of installation steps:

- select cables according to national/international standards.
- connect the motor cables.
- connect signal- encoder- and I/O-port cables.
- assure unimpeded ventilation of the equipment
- inspect the wiring on the basis of the wiring diagram
- assure that all voltage carrying connections are properly secured against touching.
- assure that even unintentional movement of the positioning device will not result in injuries or material damages.
- assure that all installation instructions have been observed.
- connect and switch on mains power.

for better air circulation, it is recommended to remove the top and bottom cover plates of the rack cases when the controller will be mounted into a 19"-rack.

mains power voltage

check the correct AC mains power voltage setting: 240 VAC at 50/60 Hz is the default value. in order to change the mains power voltage, remove the voltage selector of the mains plug socket on the rear panel of the controller and re-insert it with the corresponding setting. if you have a controller with more than two axes, do not forget to change the voltage settings of the powerpack units correspondingly.

> please note:
> some powerpack models do not provide a possibility to change the voltage setting at the mains plug socket. in this case, you have to send the unit back to us in order to change the input voltage.

the fuse cap is integrated in the mains plug socket. always replace fuses corresponding to the individual configuration sheet, which is delivered with your controller.

motor type

it is very important that type and power requirement of the motor you want to connect to the controller is compatible with the configuration of the corresponding axis. especially when you have a 'mixed configuration', i.e. a combination of different motors and/or different power levels, you have to be very careful because mixing up connections may damage motors or motor driver boards permanently.

especially for the correct function of stepper motors, it is very important to adjust the drive current properly. the drive current can be adjusted individually at the corresponding driver board. please consult the driver board documentation for details.

if you received your controller together with positioning devices, this configuration step has been done for you already.

in connection to this you should also read the chapter 'remarks about stepper motors drives' located in the appendix.

motor connection

you will find the motor conectors and the signal connectors on the rear panel of your controller. there are separate sockets for motor power output (female 15-pin d-sub), signal input of limit switches and reference position indicators (female 9-pin d-sub) and encoder signal input (female 15-pin hd d-dub). a corresponding figure is shown later in this section.

controller units with more than 2 axes (9303...9316) usually consist of more than two cases: the controller itself and, depending on number and power consumption of the axes, of one to four additional powerpack power supply units of the motor driver boards.

as already mentioned you must ensure that the type of motor that shall be driven with the powerpack matches type and settings of the motor driver board.

> ⚠ **attention**:
> do not connect/disconnect cables while mains power is switched on. this may permanently damage the driver board.

end/limit switches

for test reasons, the controller can be operated without connected positioning hardware. in this case, it is required to simulate the presence of limit switches because the controller will not execute any positioning command as long as it recognizes active (i.e. disconnected) limit switches. a set of short circuit plugs is provided with the controller in order to simulate the presence of limit switches.

if you want (or have to) run your positioning devices without limit switches, you have to insert these plugs as well.

⚠ **attention**:
driving positioning devices without properly installed and adjusted limit switches may cause serious damage to the positioning hardware in case of collisions.

operation

switch on the controller with the mains power switch on the front panel. the processor starts to boot the operating system.

⚠ **attention**:
the display remains dark for several seconds at the beginning of the boot process. this is normal behaviour. do not switch the controller off during that time. otherwise it may be necessary to attach a keyboard to the controller in order to resume an interrupted boot process.

the control software will start automatically after the boot process is finished. the control software initializes all available axes and executes a self test procedure. finally, the following display will appear:
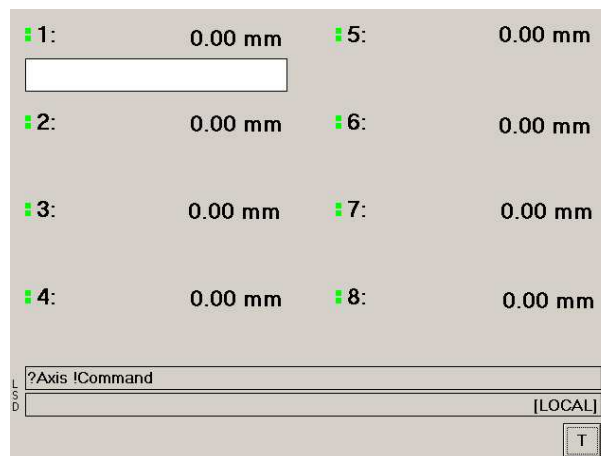
active limit switches are indicated by a red dot next to the axis specifier. the top dot indicates the positive limit switch (el+), the bottom dot indicates the negative limit switch (el-). in case of an active limit switch, the affected axis will not be able to execute a positioning task into the indicated direction.

a reason for an active limit switch could be one of the following:

a)   signal cable not connected
        action: use short circuit plug

b)   positioning device not equipped with limit switch hardware.
        action: use short circuit plug or bridge input signal (see appendix: pin assignment)

c)   cable, cable connection or limit switch faulty.

configuration

prior to starting the first positioning task with your SMC9300, you have to configure every axis by setting a number of parameters which define the properties connected positioning device.

if you received your controller together with your positioning devices, this configuration step has been done for you already in the factory. however, a final check of the configuration would not hurt anyway.


the adjustment of the configuration settings can be done either manually or under remote control from a host computer sending corresponding configuration commands across one of the communication interfaces.

the following section describes the manual adjustment of the hardware configuration settings.

        please note: not all available configuration settings can be adjusted manually,
        i.e. through the user interface. some settings can be changed only by
   commands transferred across the communication

axis configuration

press button [t] located in the lower right corner of the display. the toolbox window will show up immediately. from there, select button [config axis…].
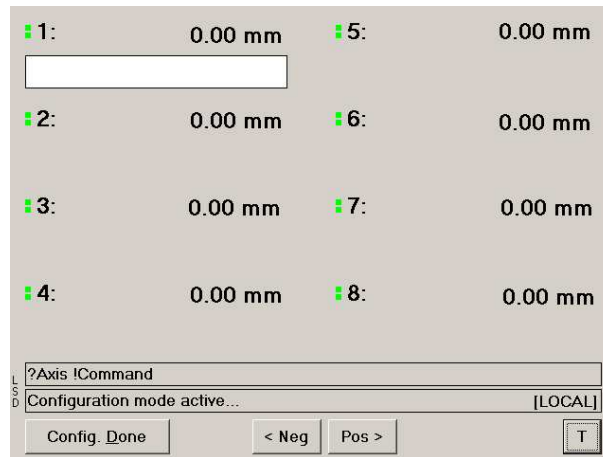
the toolbox window disappears and main screen is visible again. a button [config. done] is visible now and indicates, that the configuration mode is currently active now.

in order to configure a certain axis now, touch the position display of the desired axis. the configuration window will show up. it contains the current settings of the selected axis.
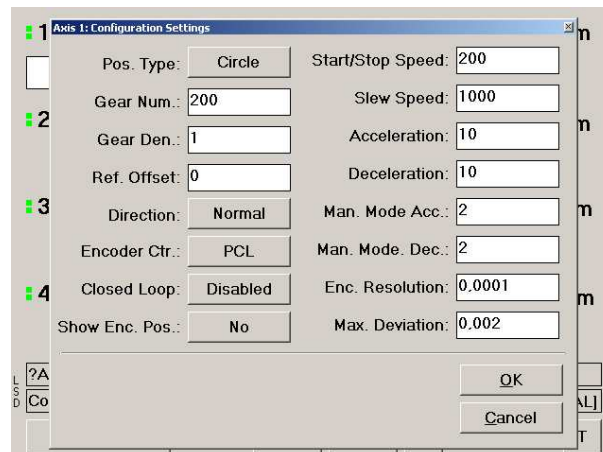
you may now adjust the settings one after the other. in order to enter numbers, just touch the input field and enter the new value using the on-screen keyboard. before you enter a new value, clear the displayed value using the [ce] button.

in order to change option settings, just touch the corresponding button repeatedly until the desired setting is shown.

confirm your changes using [ok]. the new settings will be saved permanently. press [cancel] if you want to exit without saving the changes.

pos. type

a positioning axis can be either defined as a rotation (circle) or a linear motion. touch the button repeatedly until the desired device type is shown. the result of this setting is, that the position value of the selected axis is displayed in [mm] or [deg].

gear num.
gear den.

these two values define the gear factor of the drive. the numerator ([gear num.]) defines the number of increments per distance unit. the denominator ([gear. den.]) defines the distance per numerator value. the denominator is usually set = 1.

according to the example above, we have a circle motion, i. e. [deg] units. [gear. num.] = 200, [gear den.] = 1. in case of a stepper motor drive, this means that 200 motor steps correspond to an angle of 1 deg.

> **please note**:
> for stepper motors, the maximum positioning range is $\pm 2^{24}$-1 motor steps. you have to consider this fact when you enter the gear factor of the positioning device. this may probably limit the range of the absolute position value you can enter for positioning tasks.

ref. offset

this value will be automatically set as the current position value
- after switching on the controller
- after installation of the reference position

setting this value is used in case the reference position is different from the location of the reference position indicator.

example: the reference position (i. e. a position where the display should read '0.00 mm') of a linear table should be in the center of the motion range. due to design reasons, the location of the reference switch must be at a position which is -50 mm away from the desired reference position. in this case, you enter a reference offset value '-50'.

direction

the direction of motion of a step motor depends on the wiring and/or on the configuration of the corresponding driver board (some allow inversion of the direction through switch or jumper setting). when your positioning device moves into the wrong direction, i. e. it runs in negative direction while you press the [pos >] direction button, you may also invert the direction of motion selecting touching this button.

> *attention*
> *it is very important* to check the proper function and the correct assignment of the limit switches. is EL+ really activated when your positioning device moves into positive direction? if not, i. e. with wrong switch assignment, a motion won't be stopped when it moves beyond the limit and may cause a damage or injuries. in this case, you have to change either the wiring of the motor or the wiring of the limit switches.

encoder counter
encoder resolution
closed loop
show enc. pos
max. deviation

'encoder counter' defines the counter hardware for the evaluation of the incremental encoder signal. 'PCL' is the valid setting if you connect an encoder to the SMC9300. settings 'IK220' and 'IK220 E' are reserved and must not be used.

parameter *'encoder resolution'* defines the encoder resolution in [deg] or [mm] units, i. e. the angle- or linear distance per encoder increment.

pre-condition for activation of the *'closed loop'* feature ist of course the presence of an incremental encoder along with the correct rotation sense (wiring of channels A/B; see also command referece: `'edir'`) and the proper setting of parameter *'encoder resolution'*.

if *'closed loop'* is active, the controller moves the motor to the commanded position. then it compares the encoder position with the target position and continues the motion until the target position has been reached with a maximum encoder deviation of *'max. deviation'*.

the encoder position is the small value shown above the axis specifier. you may switch off the encoder position display touching [show enc. pos] until you read 'disabled'. however, you can read out the encoder position value across the communication interfaces anyway.

start/stop speed
slew speed
acceleration
deceleration

these setting define the speed profile, which is used for the execution of positioning tasks. the controller starts moving the motor at *'start/stop-speed'* and accelerates from there at a constant rate (*'acceleration'*) until it runs at *'slew speed'*. upon reaching the target position, the controller reduces the speed again at a constant rate (*'deceleration'*) to *'start/stop-speed'* and stops. values are given in [Hz/ms] units.

Man. Acceleration
Man. Deceleration

acceleration and deceleration settings for manual positioning using [<neg] and [pos>] keys may be changed here.

> **please note:**
> after changing the speed profile, you absolutely have to test the proper function of your positioning device to make sure the hardware can handle the new settings without producing positioning errors.

in order to save the new settings permanently, touch button [ok]. touch [cancel] to quit this configuration screen without saving the changes.

you may now continue with the next axis by touching the corresponding position display. to quit the configuration mode, touch [config. done].

communication interface configuration

within the toolbox window, touch button [config. interface…] in order to configure or change the interface settings:
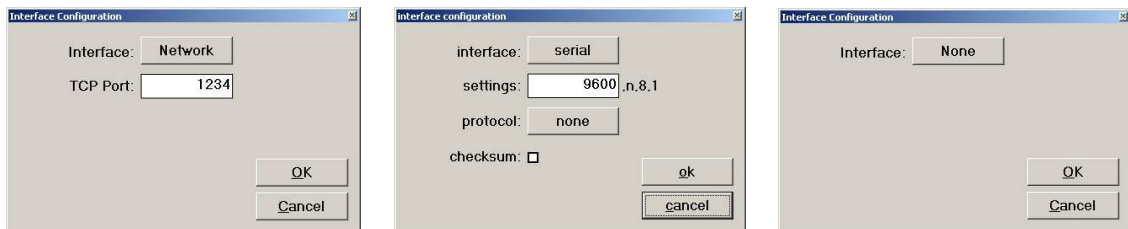
Network

TCP-port, IP-address and netmask are preset to the following default values:

    TCP Port: 1234   (range: 0… 65535)
    IP-address: 192.168.253.200
    net mask: 255.255.255.0

to change IP-address and net mask, quit the smc control program (use [t] - [shutdown] - [exit to os]), start the Windows Control Panel application and change the network settings as desired.

Serial

adjustable parameter: baudrate: 1200, 2400, 4800, 9600, 19200

control parameter are fixed to 'n,8,1', i.e. no parity, 8 data bits and 1 stop bit.
handshaking is currently deactivated, but may be enabled through an entry in the configuration file smc.ini under section [interface]:

[interface]
handshake=<value>

value   handshake-method
0   no handshake
1   XON/XOFF handshake
2   RTS/CTS handshake
3   RTS/CTS and XON/XOFF handshake

e.g.:
[interface]
handshake=2

protocol: [none] or [STX/ETX].
push this button to change the setting. if STX/ETX is selected, the controller will add the character STX (02_{hex}) at the beginning and character ETX (03_{hex}) at the end of transmitted data.

checksum:
when you activate this checkbox, the smc will add a checksum, consisting of two characters, at the end of transmitted data after the delimiter.

by default, each character string transmitted by the controller will be terminated a CR (13_{hex}). you may use direct command 'txdel' (see manual 'command reference') to select LF (10_{hex}) or both CR+LF.

manual operation

select the axis you want to move by touching the corresponding position display line. an empty input line will show up where you can enter a desired target position. in order to de-select an axis, touch the corresponding position display line again.

if at least one axis is selected, you will see two direction buttons [<neg] and [pos>] at the bottom of the display. touch on of the keys in order to move the selected axis manually.

attention:
please note, that **all selected axes will start simultaneously** when you touch one of the direction keys.

if you want to move an axis to a certain target position, you may enter a position value as follows: just touch the input line. thereupon an on-screen keyboard will appear which allows you to enter position values.

before you can enter a number, you have to touch either [a] or [r]. use [a] for 'absolute positioning' and [r] if the controller shall move 'relative' to the current position.

to cancel a position input, you have to clear the input line first using [ce]. touch [cancel] to quit the input mode.

in order to delete a previously entered target position of an axis, just deactivate the corresponding input line by touching ist again. the target position value will be cleared.

the first line below the position displays is used by the controller to provide information about the next possible user action. '?axis' indicates, that you may now select an axis. '!command' indicates, that the controller expects the execution of a command.

the line below serves as a status output line. at the right end of that line, the remote state is indicated, i.e. either [local] or [remote] is visible there. the remote mode can be set by sending a corresponding command across the communication interface.

REMOTE means, the controller is currently under remote control. manual touch screen operation is deactivated **with one exception**: button [stop] is active, if it is visible. positioning tasks in progress can be aborted any time touching [stop].

[stop]

…appears only during active positioning tasks, i.e.while at least one axis is in motion. touch [stop] to abort the execution of any motion immediately. the controller returns to 'ready' state. it is not possible to continue a program that has been interrupted with [stop].

[go!]

…starts **all activated axes**, where a target position has been entered previously. after touching [go!], the button label changes to [stop].
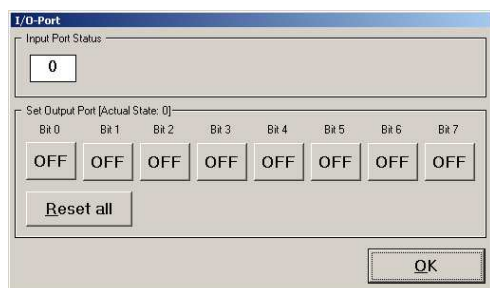
[p]

in the SMC9300 is equipped with more than eight axes, [p] allows to change to position display page two, i.e. to the display of axes 9 to 16. touch [p] again to return to the display page of axes 1 to 8.

[t]

…opens the toolbox window which we've seen already in chapterl 'configuration:
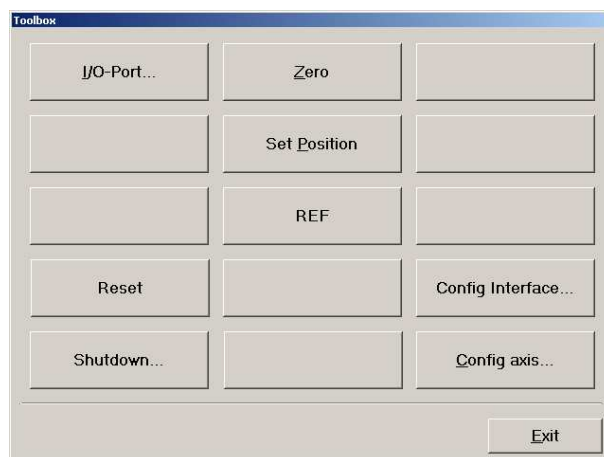
[i/o-port]

if the i/o-port option is installed, a window will show up which allows you to manually control the 16 bit i/o-port.

just touch the desired number button in order to toggle the state of the corresponding output port. touch [reset all] to reset the state of all ports at the same time

[reset]

touch [reset] to reset the controller to power-on state.

[shutdown]

after touching this button, select one of the following option:

[exit to os] terminates the smc control program and returns to the operating system shell. you may now use the controller like any other Windows XP personal computer.

[restart controller] terminates the smc control program and reboots the operting system.

[shutdown controller] prepares the controller for switching off mains power. the smc control program and Windows XP Embedded will be terminated one after the other. you may switch off the controller when you are prompted to do so.

[zero]

the position display of *all selected axes* will be set to 0.00 (or the configured reference offset) by touching this button. this is especially use in case an axis is not equipped with reference indicators. you may install the reference position manually using the positioning keys and clear the position display afterwards.

[set position]

if you need to set the absolute position of an axis to a certain value, proceed as follows: change to the position display window, select the axis, enter the desired value in the position input line, change back to the toolbox window using [t] and touch [set position]. it doesn't matter wether you enter an 'a'bsolute or 'r'elative position value. it's just the number that counts.

[ref]

this button triggers the automatic reference position search procedure **of all active** axes. before this procedure starts, you will be prompted to select the direction of movement.

after touching [<neg] or [pos>], the controller starts searching the reference positions of all active axes one after the other moving into the selected direction.

this functin requires the presence of suitable reference position indicators (optoelectronic switches, mechanical switches, inductive switches). connected to the corresponding signal input connectors (see section 'connections').

the position of axes which are *not* equipped with reference indicators will not perform any motion. the position will of those axes be set to 0.00 or the reference position offset value, if configured.

> **attention**:
> please not, that touching one of the direction buttons triggers the motion **of all selected axes one after the other**. please make sure that the positioning devices of these axes will not collide upon execution of this procedure.
> even the presence limit switches may not be sufficient to avoid hardware collisions.

you will find more information about reference indicators in the corresponding section later in this manual.
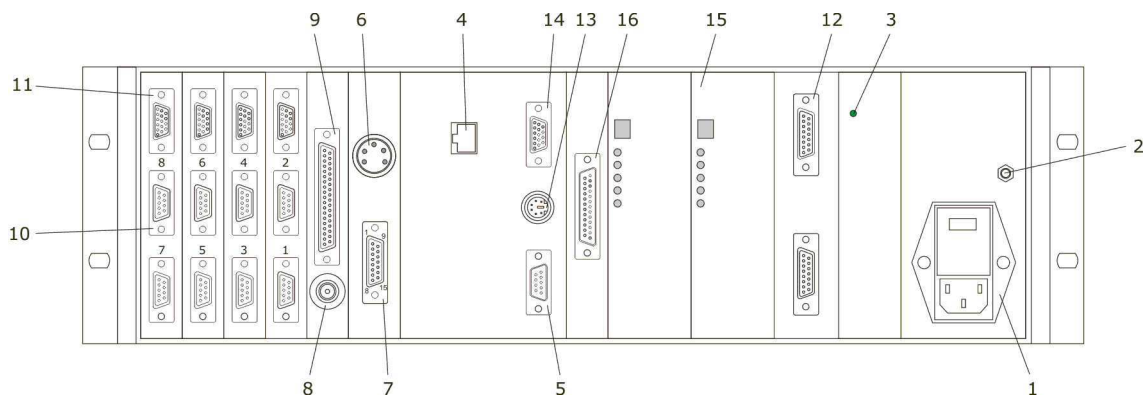
connections

fig.: controller rear view

1 mains power connector and fuse	9 I/O-port (option)
2 ground terminal	10 EL/REF signal input
3 power supply, 'power good' LED	11 encoder signal input
4 ethernet interface	12 motor connectors (1-2 axes)
5 RS232 interface	13 ext. keyboard (PS/2)
6 filter connector (option)	14 ext. monitor
7 half scvreen connector (option)	15 motor driver boards (1-2 axes)
8 impulse counter input (option)	16 motor signals (> 2 axes)

the figure above shows the rear panel connectors of a MC9302, i.e. a controller for two axes of motion. in this case, the motor driver board for the axes are integrated in the controller case. all drive related settings must be adjusted on the rear side of the controller.

controller equipped with more than two axes usually consist of more than one 19" case. controllers MC9303 and up are separated in control unit and one or more motor power supply units (called 'powerpack'). powerpack units allow accessing the motor driver boards through the front panel for convenient configuration of the drive power settings.

input signals for limit switches and reference indicator

the internal wiring of the optocoupled input signal for reference indicator and limit switches have been adapted to the standard components of Huber positioning devices.
each axis is usually equipped with a set of two mechanical microswitches (opener) to limit the positioning range and a sensitive light barrier module to install the reference position.

however, various types of switching components may be used to generate the corresponding input signals. if necessary, the input signal circuits can be adapted to a different signal level and/or signal logic.

limit switches are used in most applications to protect the positioning devices from collisions and corresponding damages. the state of these switches, which are normally closed, will be monitored permanently. when a limit switch event is recognized by the controller, i.e. a motion exceeds its range and opens the switch, the controller immediately stops any motion

of the concerned axis. this is a hardwired function, i.e. it is independent from the control software.

after swiching on the controller, it performs a self-test procedure, where, among other things, the state of the limit switches of all available axes will be checked. the switch state is shown on the display.

if one of the switches of an axis is open, the axis cannot perform any movement into the direction of the active switch. if an axis is not equipped with limit switches, it is required to bridge the signal input using the short circuit plugs delivered with the controller.
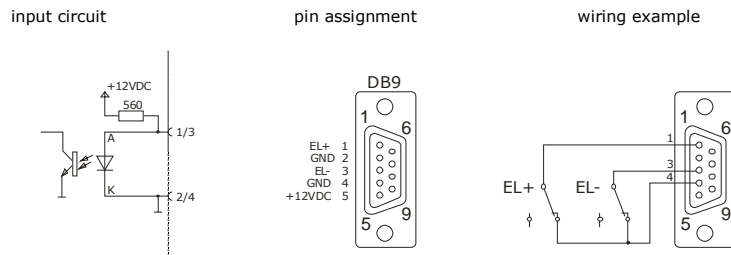

fig.: limit switch input

the switches connected between pins 1-2 and 3-4 generate a 'low' signal level at the signal input of the optocoupler. this enebles the execution of positioning tasks.

reference indicator

during a search-reference-procedure, the controller moves the selected axis with the desired direction of movement and monitors the slow-down (SD) and reference (REF) input signal level. the motion will be executed with the configured positioning speed profile.

when the controller recognizes the SD signal, it automatically reduces the positioning speed. it continues moving at low speed (start-stop speed) until the REF input signal occurs.

finally, the position display of the axis will be set to the configured reference offset position value (which is 0.00 in the most cases). if an axis is not equipped with reference indicators, the axis does not perform any motion. the position display will be set to the reference offset value instantly.
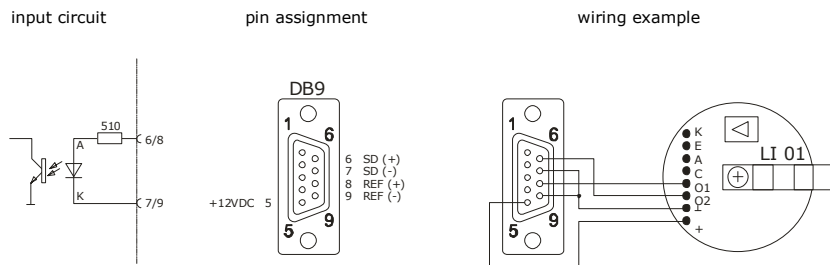

fig.: reference indicator input

the optoelectronic reference position module, which is used in most Huber positioning devices, consists of a set of two light barriers. the first one (signal O1) indicates the slow-down position and triggers the deceleration of the positioning speed. the second light barrier indicates the reference position.
both signals provide a signal level of +12VDC when they are inactive. the signal level drops to 0V when the trigger pin passes the light barrier.

22

encoder signal input

the controller can handle RS422 signals of three-channel incremental encoders. it allows the evaluation of two position signal channels A and B (90° phase shift) and one index channel. the index channel of the encoder may be used as well to install the reference position of a positioning device. this can be done only under remote control. see manual 'command reference' for corresponding control commands.

each of the 15-pin hd d-sub connectors shown below serves for the connection of two incremental encoders.

```
        ┌──────┐
        │  ◯   │
     1  6   11
ws  A0 1 │  ○ ○ ○ │  11 I0   rs    6  B0   ge
br /A0 2 │  ○ ○ ○ │  12 /I0  rt    7  /B0  gr
gn Vcc 3 │  ○ ○ ○ │  13 GND        8  GND  bl
ws  A1 4 │  ○ ○ ○ │  14 I1   rs    9  B1   ge
br /A1 5 │  ○ ○ ○ │  15 /I1  rt   10  /B1  gr
     5  10   15
        │  ◯   │
        └──────┘
        solder
         side
```
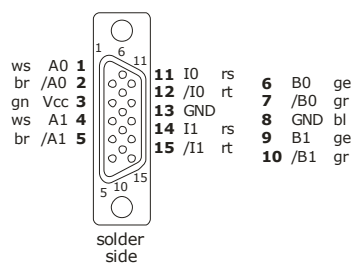
abb.: encoder signaleingang

impulse counter 9300.07

an integrated impulse counter is available at option. signal input level is 5V (TTL) with a maximum input frequency of 200 kHz. counter values can be stored by the SMC9300 and will be transferred to a connected host computer upon request.
if this option is installed, a corresponding BNC connector (8) is available on the rear panel of the controller.

filter device 9000.08

this option has been especially designed for Huber 2- and 4-circle diffractometers used in single-crystal diffractometry. a small filter wheel, equipped with six different filter materials, is driven by a small motor. certain filter position can be selected via control commands in order to move the desired filter into the beam path of the diffractometer.
connect the filter device to diode connector (6).

half screen device 9000.09

this option is likewise designed for single-crytal diffractometry. this device controls a set of four screens which allow the shadowing of the half of a collimated light beam from four sides: top, bottom left and right. this device is extremely helpful for centering a single crystal reflection in a four-circle diffractometer system.

the screen positions can be selected via control commands as well. connect the device to plug socket (7) on the rear panel of the controller.

communication interfaces

the SMC9300 ist equipped with two interfaces: a serial interface (RS232) and a network interface (ethernet, 100 BaseTX). the network interface is active by default.

selection and configuration of the interface settings can be after selection done from the toolbox window by touching [Config. Interface…]. just change the settings to desired values.

RS232 interface

pin assignement of the 9-pin d-sub connector (5):

pin 2   RxD   receive dfata
pin 3   TxD   transmit daten
pin 5   GND   signal ground

pin 9   +5VDC (opt.)

NOTE: the pin assignment of the COM interface may differ from standard in some cases. pin 9 may provide +5VDC and can be used as a power supply for external hardware which uses the serial interface. a corresponding sticker on the rear side of the controller indicates this case.

programs for evaluation and testing the proper function of the interface communication is available on the accompanying software CD-ROM.

ethernet interface

as already mentioned in section 'configuration', the controller is delivered with the following default settings:

IP-address: 192.168.253.200
net mask: 255.255.255.0
TCP-port: 1234

after switching on the controller, it is instantly ready for communication and reacts on querys at the configured TCP-port.

a network communication test program is available on the accompanying CD-ROM as well.

I/O-port

a 16-bit I/O-port (8 x input, 8 x output, optocoupled) is available at option. you may monitor and/or trigger switching events. use the 37-pin d-sub connector (9) on the rear panel of the controller to connect suitable hardware.
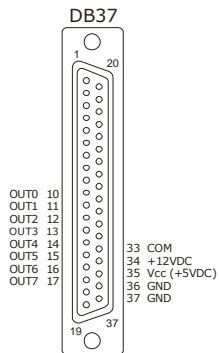
output port

the maximum output current is 100mA. you may either use an external power supply (50 V max.) or the supply voltages at pin 34 (+12VDC) or pin 35 (+5VDC) to provide power for connected hardware.
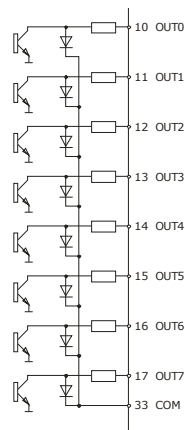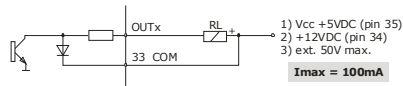
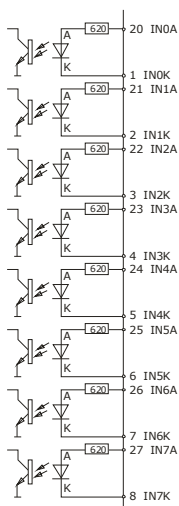circuit diagram | pin assignment | wiring example (control of a relay)

fig.: port output

is COM (pin 33) wired as shown in the example above, a protection diode is connected parallel to the relay coil.

input port
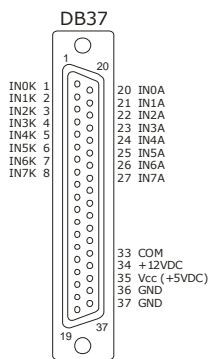
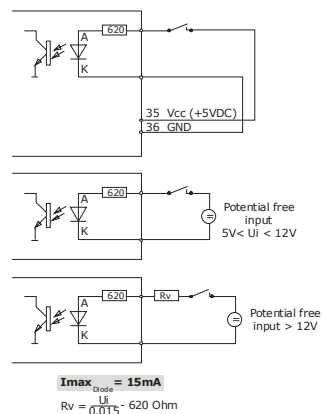the standard signal level of the eight signal inputs is 12VDC.

circuit diagram | pin assignment | wiring examples

$$Imax_{Diode} = 15mA$$

$$Rv = \frac{Ui}{0.015} - 620 \text{ Ohm}$$

fig.: port input

control software update

you can easily update the smc's controller software across the network interface. just connect the smc to your PC using a switch, a hub or a 'crossed' network cable. make sure, the smc's network settings (IP-address and network mask) correspond to the settings of your network.

please follow the instructions, which are available here:

http://smc.pp-electronic.de/howto/fwupd.htm

in order to access to this site, you may need to log in: username '***user***', password '***smc***'.

appendix

remarks about stepper motor drives

nowadays, the technology of stepping motor drives has reached a very high level. however, under certain circumstances, you may encounter positioning errors that could be avoided in most cases if you pay attention to the content of the following paragraphs.

Why problems may arise

positioning errors usually result from a more or less obvious loss of motor steps during positioning. that deviation may drastically increase depending on the number of executions of single positioning tasks. the most extreme case is a total standstill of the positioning device. the reasons for such problems are manifold.

if we assume that the electronic circuit of the step motor drive is working properly, the most frequent reasons for positioning problems are the following:

a) the motor/driver board combination is under-dimensioned for the desired task.
the drive unit of a positioning device may be simply overloaded. especially over time, some mechanic components of positioning devices may increase the required torque due to wear.

b) the motor supply current has not been adjusted properly.
the drive current of step motors needs to be adjusted at the corresponding driver board. if you bought controller and positioning hardware separately, changed positioning devices between controllers or exchanged motor connections, you have to make sure the motor current is set to the correct value before operating it. motors may look similar, but they may need completely different current settings for proper operation.

> **attention**: driving motors at current levels above the specified maximum phase current may cause a permanent damage of the motor.

c) the positioning speed profile is not selected suitably.
each motor owns individual speed limits that depend basically on the drive current, the type of power board and the required torque. a start frequency that is too high, an acceleration/deceleration ramp that is too steep, excessive slew speed or a combination of these may result in positioning errors.

it is hardly possible to give generally applicable rules how to handle this kind of trouble. despite all theoretical considerations on positioning problems like that, the simple 'trial-and-error' method is probably the best and fastest way to solve them.

> **please note**: if positioning devices and controllers have been ordered from as a complete positioning system, the components have been carefully aligned and adjusted at the factory. a corresponding configuration sheet is delivered with the controller.

over time, it may be necessary to check and re-adjust drive parameters. especially under extreme working conditions, e.g. tilted use or increased torque due to heavy and/or unbalanced loads, drive properties may vary.
in some cases, the size of parts or limited space influences the selection of components, i.e. it is unavoidable to drive motors at their, or even above their limits. in this case, even slight changes of the operating conditions may result in positioning errors.

frequencies, currents, resonances

a step motor can follow a continuous train of pulses as long as the load torque is less than the maximum torque available (MTA). of course, but: the mta depends on individual motor properties, the type of circuit used for power supply as well as on the applied frequency.

commonly, the frequency range of a step motor is divided into two parts: the range between zero and the so called 'start-stop frequency' (start frequency range) and the range between start-stop frequency and the maximum motor frequency (acceleration frequency range).

the start frequency range

the start-stop frequency is the theoretical maximum clock frequency, a step motor can execute without acceleration/deceleration ramp without loosing motor steps. as you can imagine, this value strongly depends on most of the parameters mentioned above.

in terms of the mc, the manual run frequency of the mc (i.e. the positioning speed that is used when you press the run key at the front panel) must be set to a value somewhere below the start-stop frequency. the same holds for the selection of the start speed of programmed positioning tasks.

the acceleration frequency range

positioning at frequencies above this imaginary start-stop frequency requires the use of suitable start frequencies and acceleration-/deceleration ramps.
for manual positioning by means of the front panel keyboard, the setting of the manual run frequency additionally serves as the start frequency for the manual fast positioning mode. the acceleration/deceleration ramps for the manual fast mode are calculated from these two values by the controller.
in contrast to that, the acceleration/deceleration ramps (as well as the frequencies of course) for a programmed positioning task can be set individually.

if the theoretical values of these frequency ranges are not available, you have to find out suitable settings by trial-and-error. start at low values (200 Hz) and increase the frequency step by step until you encounter positioning errors. select a value somewhat below the speed where the motor started to show problems.

resonances

a further point that has to be considered, is the mechanical design of positioning devices. to reach the maximum accuracy and repeatability, most of the positioning devices are equipped with some kind of spring loaded drive system, which is more or less susceptible to resonance effects.

there are many and diverse ambient conditions which also have an influence on the extent of the resonance susceptibility: motor type, positioning speed, required torque, type of driver board, applied drive current, mounting position, load, temperature, etc. additionally, if you have a multi-axis system, it may behave different when you move axes separately or simultaneously.

however, if you encounter resonance problems, which are usually clearly discernible by a characteristic rough sound at certain speed ranges during positioning, you should first try to locate the frequency ranges where resonance occurs.

subsequently, you should make sure that you do not use a value from this frequency range as the start- or slew speed of your positioning task. just crossing these resonance ranges

during acceleration or deceleration of a positioning task will usually not result in a positioning error, i.e. in a loss of motor steps.

in order to improve the behavior of your positioning device, try to vary the speed-settings, and/or the steepness of the acceleration ramp. additionally, a variation of the drive current (within the spec's!) of the corresponding motor may improve the resonance behavior as well.

another thing could also be helpful: have a look at your positioning hardware. the aging of lubricants may cause problems. especially positioning devices involved in vacuum applications may drastically change their behavior over time.