SMC hydra

version TT
version CM
version RM

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Version 3.3

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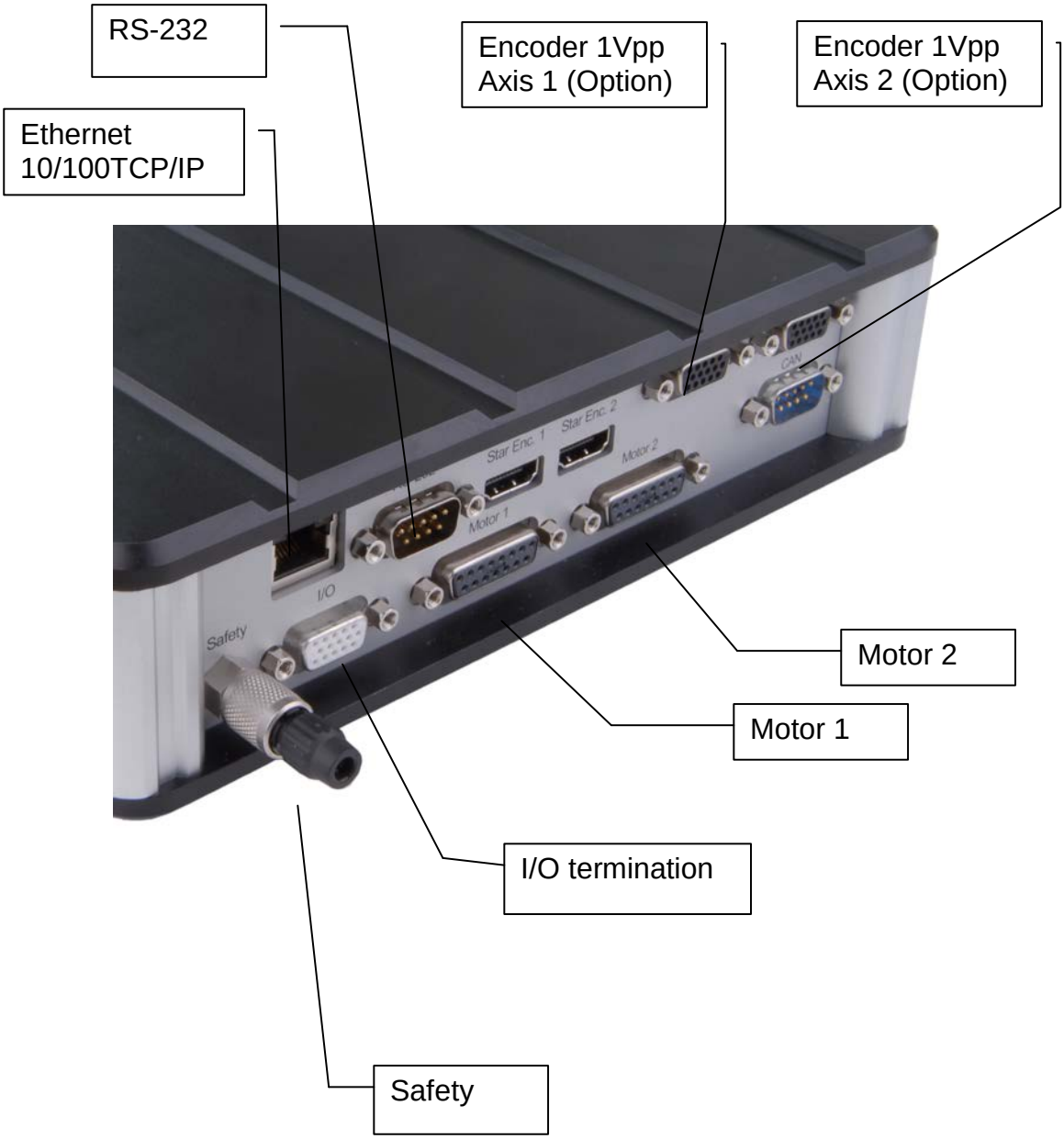
1. Content

2. How to Connect

2.1. Hydra TT



2.2. Hydra CM

24VDC or 48VDC please verify

I/O termination

Ethernet 10/100TCP/IP

RS-232

Encoder 1Vpp Axis 1 (Option)

Absolute Encoder Interface

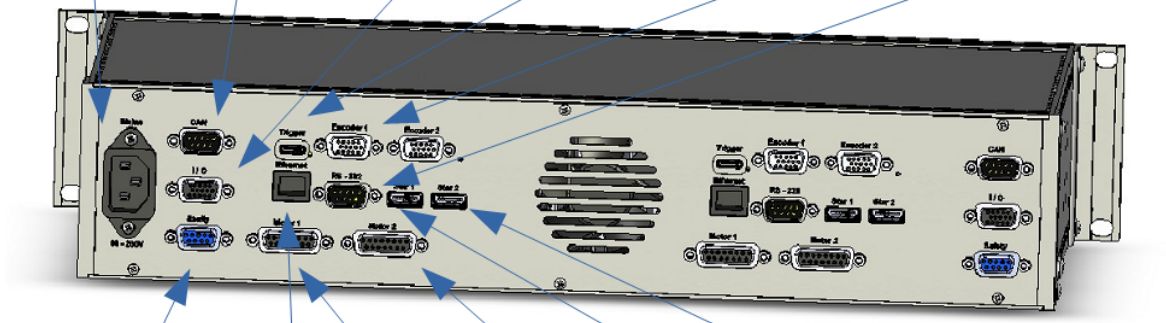
Encoder 1Vpp Axis 2 (Option)

Motor 1

Motor 2

2.3. Hydra-RM

Power 230V/1000W	OUTPUT service/ CAN	digital Input	DeltaStar High Speed Trigger Unit	DeltaStar encoder 1	DeltaStar encoder 2	RS232



4x analog OUT ITK motor bus hardware enable power stage	Ethernet 10/100	motor1 ITK motor Bus/ end switch	motor2 ITK motor Bus/ end switch	star interface 1	star interface 2

According the previous pages, please connect the stages to the controller. The controller is completely configured for the system.

After connecting all components, you can power-up your computer.

The Hydra controller supports Ethernet and RS-232 communication. Daisy-Chain of RS232 is not supported, so each Hydra Controller needs own RS-232 interface.

For multi-controller applications the Ethernet interface is the preferable interface!

The interfaces are actually configured as follows:

3. RS-232 Interface Configuration

Data bits	8
Stop bits	1
Parity	no
Handshake	no
Baudrate	115200 Baud

4. Ethernet Interface Configuration

IP Address	172.20.5.xxx
Port	400 (max.5 handles)
Subnet Mask	255.255.0.0

5. IP-Address change

Please use the RS-232 interface. Send following command-string with any terminal program:

Query Address: 0 getnetpara
Reply "192.168.129.200"

Query Subnet: 1 getnetpara
Reply "255.255.0.0"

New IP address: 172.20.5.202

"172.20.5.202" 0 setnetpara
"255.255.255.0" 1 setnetpara
csave
reset

The new TCP/IP settings are valid after reboot, so the reboot (reset command) is necessary!

6. RS-232 Baudrate change

Send following command-string with any terminal program for example the basic communication tool on CD, JS-terminal.exe and connect with the actual baudrate.

Query : *1 getbaudrate*
Reply 115200

New Baudrate: 57600

Set: *57600 1 setbaudrate*

The baud-rate will immediately be changed, so please close the connection and reconnect with the new baud-rate and store to flash-memory.

csave

Available Baudrates:

9600
19200
38400
57600
115200

7. Connectors

7.1. RS-232-Connector

DB9 male	Function	
1	DCD	bridge to DTR&DSR
2	RxD	Data Input
3	TxD	Data Output
4	DTR	bridge to DCD&DSR
5	GND	Ground
6	DSR	DTR&DCD
7	RTS	bridge to CTS
8	CTS	bridge to RTS
9	5V	optional

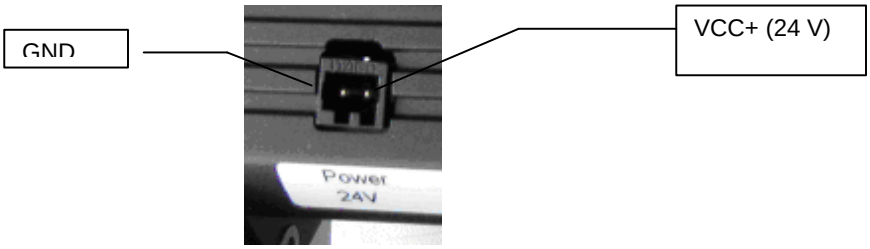
7.2. Ethernet-Connector

RJ45 8 pin	Function	
1	TX+	
2	TX-	
3	RX+	
4		
5		
6	RX-	
7		
8		

LED Function :

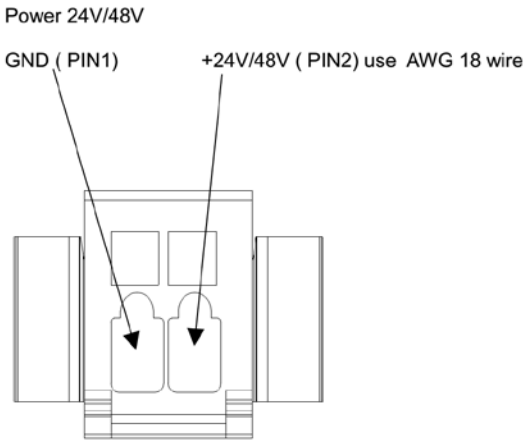
green traffic
yellow 10/100 (lightened if 100Base connected)

7.3. Power-Connector



7.3.1. Mating Connector:

Female Wago Mini , coded 2 pin



7.4. Motor Connector Axis 1

DB15 female	Function	2 Phase Motor	3 Phase Motor
1+9	A+	Motorphase 1+ (A+)	Phase 1 (U)
2+10	A-	Motorphase 1- (A-)	Phase 3 (W)
3+11	B+	Motorphase 2+ (B+)	
4+12	B-	Motorphase 2- (B-)	Phase 2 (V)
6	5V	fused 5V max. 400mA @ 50°C (self resetting polyfuse)	
7	12V	fused12V max. 100mA @ 50°C (self resetting polyfuse)	
8	PGnd	Reference for 12 V Supply, (same as Main-Supply) do not connect to GND otherwise we loose the GND separation between power and logic.	
13	E1 (cal)	Input 5 Limit switch reverse (*cal*)	
14	E2 (rm)	Input 6 Limit switch forward (rm)	
15	GND	Reference for 5 V	

7.5. Motor Connector Axis 2

DB15 female	Function	2 Phase Motor	3 Phase Motor
1+9	A+	Motorphase 1+ (A+)	Phase 1 (U)
2+10	A-	Motorphase 1- (A-)	Phase 3 (W)
3+11	B+	Motorphase 2+ (B+)	
4+12	B-	Motorphase 2- (B-)	Phase 2 (V)
6	5V	fused 5V max. 400mA @ 50°C (self resetting polyfuse)	
7	12V	fused12V max. 100mA @ 50°C (self resetting polyfuse)	
8	PGnd	Reference for 12 V Supply, (same as Main-Supply) do not connect to GND otherwise we loose the GND separation between power and logic.	
13	E1 (cal)	Input 2 Limit switch reverse (*cal*)	
14	E2 (rm)	Input 3 Limit switch forward (rm)	
15	GND	Reference for 5 V	

The Limit switch-inputs are also connected to the Digital-IO-Connector!
We mainly connect the limit-switches to the motor-connector.
Please do not try to connect a additional switch via IO connector, this will not work with normally closed switches!

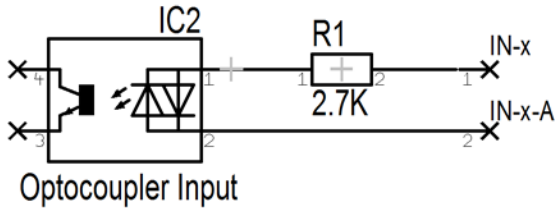
7.6. Digital IO Connector

HB15 female	Function	Definition	Hints
1	5V		fused 5V max. 400mA @ 50°C (self resetting polyfuse)
2	PGnd		Reference for 12 V Supply, (same as Main-Supply) do not connect to GND otherwise we loose the GND separation between power and logic.
3	Input 1	free	5-24 V
4	Input 2	CAL Axis 2	5-24 V (connected internally to Motor 1-Connector)
5	Input 3	RM Axis 2	5-24 V (connected internally to Motor-1-Connector)
6	Input 4	free	5-24 V
7	Input 5	CAL Axis 1	5-24 V(connected internally to Motor-2-Connector)
8	Input 6	RM Axis 1	5-24 V(connected internally to Motor-2-Connector)
9	Input 1A	free	fixed potential Input 1 (termination)
10	Input 2A	CAL Axis 2	fixed potential Input 2 (termination)
11	Input 3A	RM Axis 2	fixed potential Input 3 (termination)
12	Input 4A		fixed potential Input 4 (termination)
13	Input 5A	CAL Axis 1	fixed potential Input 5 (termination)
14	Input 6A	RM Axis 1	fixed potential Input 6 (termination)
15	GND		

7.7. Digital Inputs

The input configuration can be easily adapted to any sensor, all inputs are fitted with bi-directional opto-couplers. The fixed resistance (2.7 kOhm) is designed to work with 5 to 24 VDC signal, minimum High Level 4,25V/1,5mA, maximum High Level 24V/10mA.

	IN-xA termination
Active Sensor 5 V npn	5V
Mechanical Sensor npn	5V
Active Sensor 5 V pnp	GND
Mechanical Sensor pnp	GND
Active sensor 5 < Ub<=24 pnp	PGND



Venus-3-Command : ***getevtst***

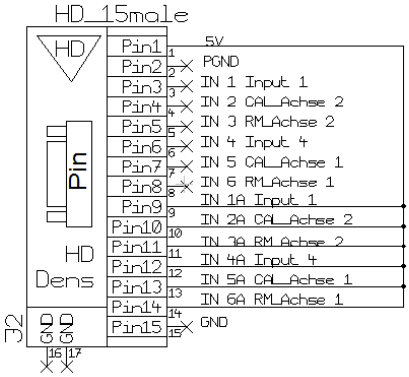
InputId groupindex getevtst inputId = 1 to 6, groupindex = 1 (controller-IO)
returns : 0 = off 1 = on

7.8. Actual IO- Termination

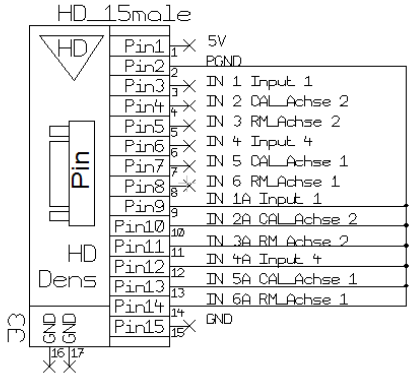
The IO-Termination for the system is documented in the appendix *Configuration.*
The IO-Termination is part of any controller-delivery.
The exact type depends on the stages we deliver with the controller.
If we deliver a controller without stages, the default configuration is NPN.

7.9. Digital Inputs / Termination Schematic

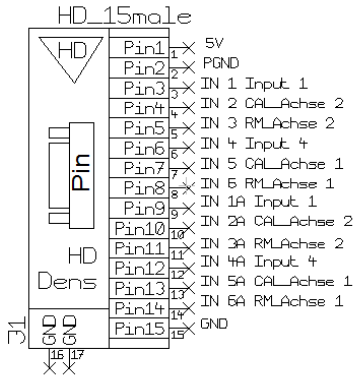
Termination all Inputs for NPN
5 V sensors and mechanical switches



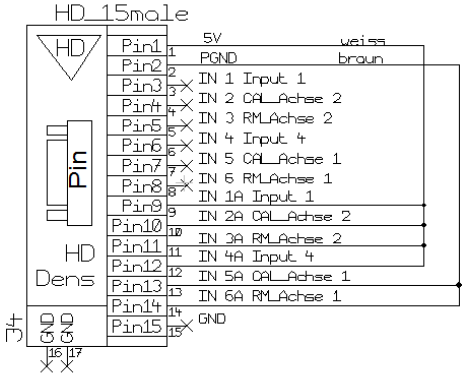
Termination all Inputs for PNP
Vcc >5 V Inductive and mechanical switches



Digital IO Connector



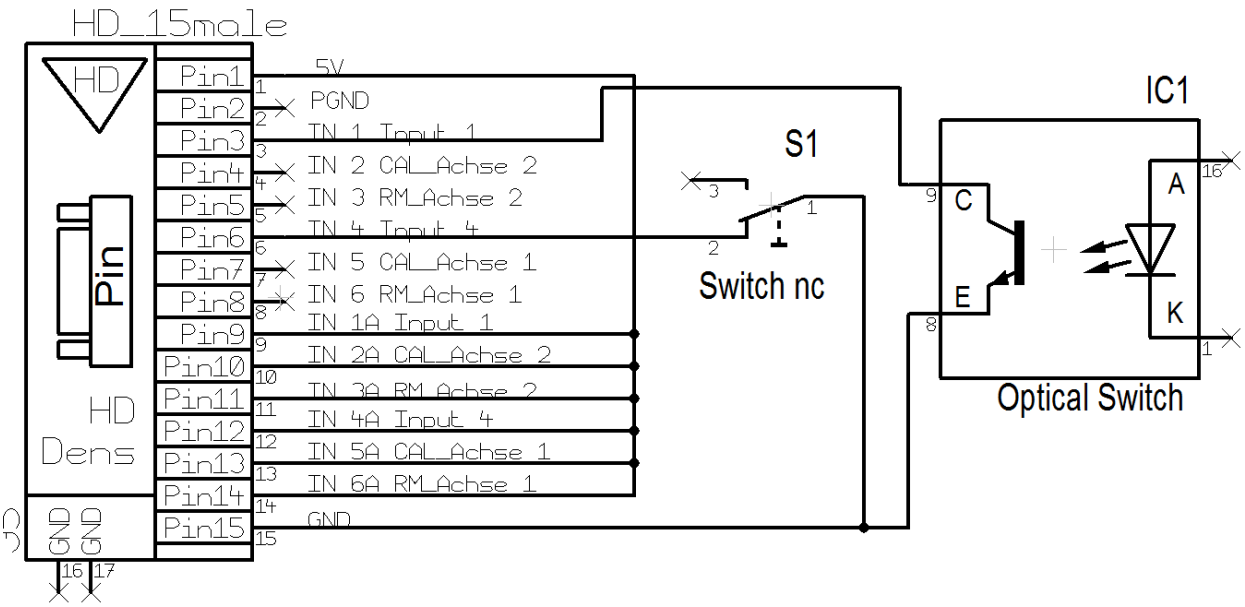
Termination for Axis 1 PNP
Axis 2 and other inputs NPN



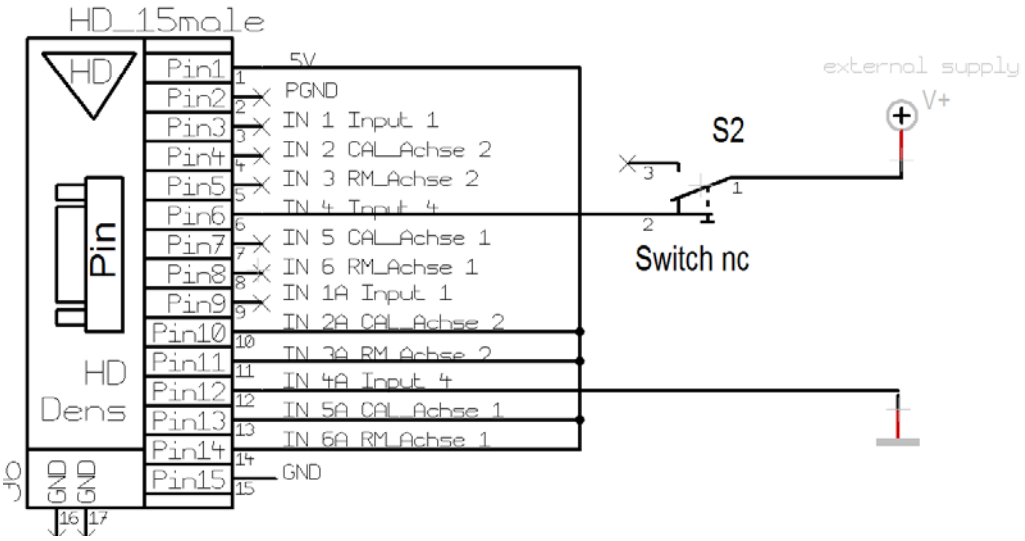
7.10. Additional IO-sensor connection

Example:

The IO termination connector is prepared for npn-Sensors 5 V.
The example shows how to connect two different switch types (npn) to the free inputs.



If the external sensor is a different type or should be galvanically isolated, we need to disconnect the reference Pins IN-1A and IN-4A and do a new connection to the reference-voltage of the external supply.



7.11. Delta-Star Encoder Interface (optional)

For all stages with encoder we need a Delta-Star or Delta-Star-eco interface, without interface the controller is limited to drive only stepper-motors open-loop.!

Delta-Star-eco does not support the FPGA-trigger-interface! All other specs are identical!

- 12Bit A/D converter for optical signal Sin/Cos/Ref 1Vss differential, max. frequency 150 kHz (UA, UB,UREF)
- Converter for TTL signal DIN66259 (RS422, A,B,REF), quadrature encoded, max. frequency 4MHz (16 MHz quad-counts)
- High-speed position trigger unit. Pure hardware implementation of position calculation, interpolation, and compare for highest performance
- Two differential position trigger outputs (TRIG_OUT1_A, TRIG_OUT2_A, RS422 signals)
- Equidistant or arbitrary position trigger definitions possible
- Maximum output trigger frequency: 400kHz, depending on pulse width(s)
- Temporal accuracy: 2µs or better (plus analogue path delays where applicable)
- Differential position capture inputs (TRIG_IN_A, RS422 signal)
- Maximum input trigger frequency: 4 kHz, min. 2.5 µs pulse width
- Programmable pulse widths and delays (0.5µs resolution)
- Programmable signal polarities
- Variety of special functions, for details please refer to software manual
- Trigger units can be associated to each position measurement channel, restrictions are described in the software manual

7.11.1. Encoder Interface Connector

HD-15 female	Function		
1	5V	Sensor V+	fused 5V max. 100mA @ 50°C (self resetting polyfuse)
2	A+	Encoder Signals RS422 quadrature	interpolated quadrature inputs RS-422 standard (differential)
3	A-		
4	B+		
5	B-		
6	REF+ (index+)		
7	REF-(index-)		
8	EN*	Input Select	enables TTL Encoder input if wired to GND (15)
9	Ref+ (index+)	Encoder Signals 1Vpp sin cos	1 Vpp differential inputs for highest interpolation
10	Ref- (index-)		
11	A+		
12	A-		
13	B+		
14	B-		
15	GND	Sensor GND	Supply GND

*Input Select, tie to GND for quadrature inputs, leave open for 1Vpp

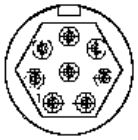
7.11.2. Delta-Star Trigger Interface (optional)

Actually supported is Trigger-Out1_A , Trigger-Out2_A and Trigger-In A

Controller fitted with a Mini-HDMI (Type-C)

Mini-HDMI (controller)	Function	HDMI-Pin	Hint
1	GND	2	
2	+Trig-Out1_A	1	differential RS-422 output
3	-Trig-Out1_A	3	
4	GND	5	
5	+Trig-Out2_A	4	differential RS-422 output
6	-Trig-Out2_A	6	
7			
8			
9			
10			
11			
12			
13			
14			
15	-Trig_In_A	15	differential RS-422 input
16	+Trig_In_A	16	
17	GND	14	
18	5V	18	5 V Output imax = 50 mA
19			

7.12. Safety / Hardware Enable



7.12.1. Hydra TT

Binder 711	Function	
1	5V	fused 5V max. 500mA @ 50°C (self resetting polyfuse)
2	5V	
3		
4		
5	EN	Hardware Enable
6	EN A	Hardware Enable potential
7	GND	Reference for +5 Volt
8	GND	

7.12.2. Hydra CM / RM

DB9 female	Funktion	
1	5V	fused 5V max. 500mA @ 50°C (self resetting polyfuse)
2	RXTX	single wire CAN Bus
3	Dac Out 1	Analog OUT (supported since FW3)
4	Dac Out 2	Analog OUT (supported since FW3)
5	Dac Out 3	Analog OUT (supported since FW3)
6	Dac Out 4	Analog OUT (supported since FW3)
7	EN	Hardware Enable
8	ENA	Hardware Enable potential
9	GND	Reference for DAC , RXTX and +5 Volt

7.12.3. Analog Outputs

The analog outputs are supported since since firmware 3.0

- 0-3V analog output (1024 values)
- Resolution 10 Bits
- relative Accuracy ±4 LSB
- differential non linearity ±0.5 LSB
- Output Voltage Settling Time=9 µs

7.12.4. Input Configuration Safety / Hardware Enable

As the digital inputs, the Hardware-Enable Input can be easily adapted to any sensor or switch which supports a normally closed-contact.

The input is fitted with bi-directional opto-coupler. The fixed resistance is designed to work with 5 to 24 VDC signal.

	ENA, Hardware Enable potential
Active Sensor 5 V npn	5V
Mechanical Sensor npn	5V
Active Sensor 5 V pnp	GND
Mechanical Sensor pnp	GND
Active sensor 5 < Ub<=24 pnp	PGND

The power amplifier is active if current flows through the opto-coupler! So please use a opener contact switch!
By default the emergency input is deactivated (Hydra CM)! To enable the input please use command *1 setemsw* (see manual) and command *csave*

The input "Hardware enable" is not an emergency stop circuit in accordance with the requirements of the professional associations

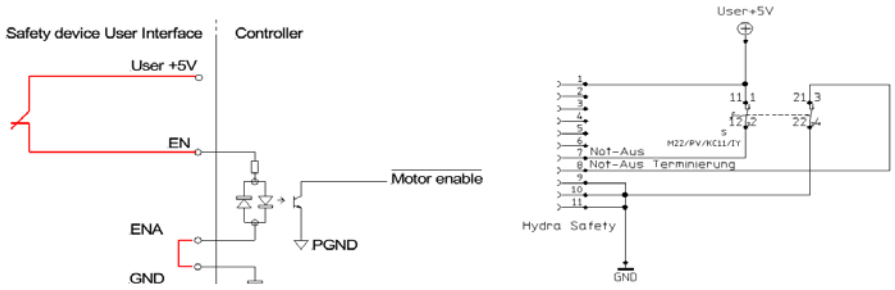
To query the actual setting : *getemsw* 0= deactive | 1 = active

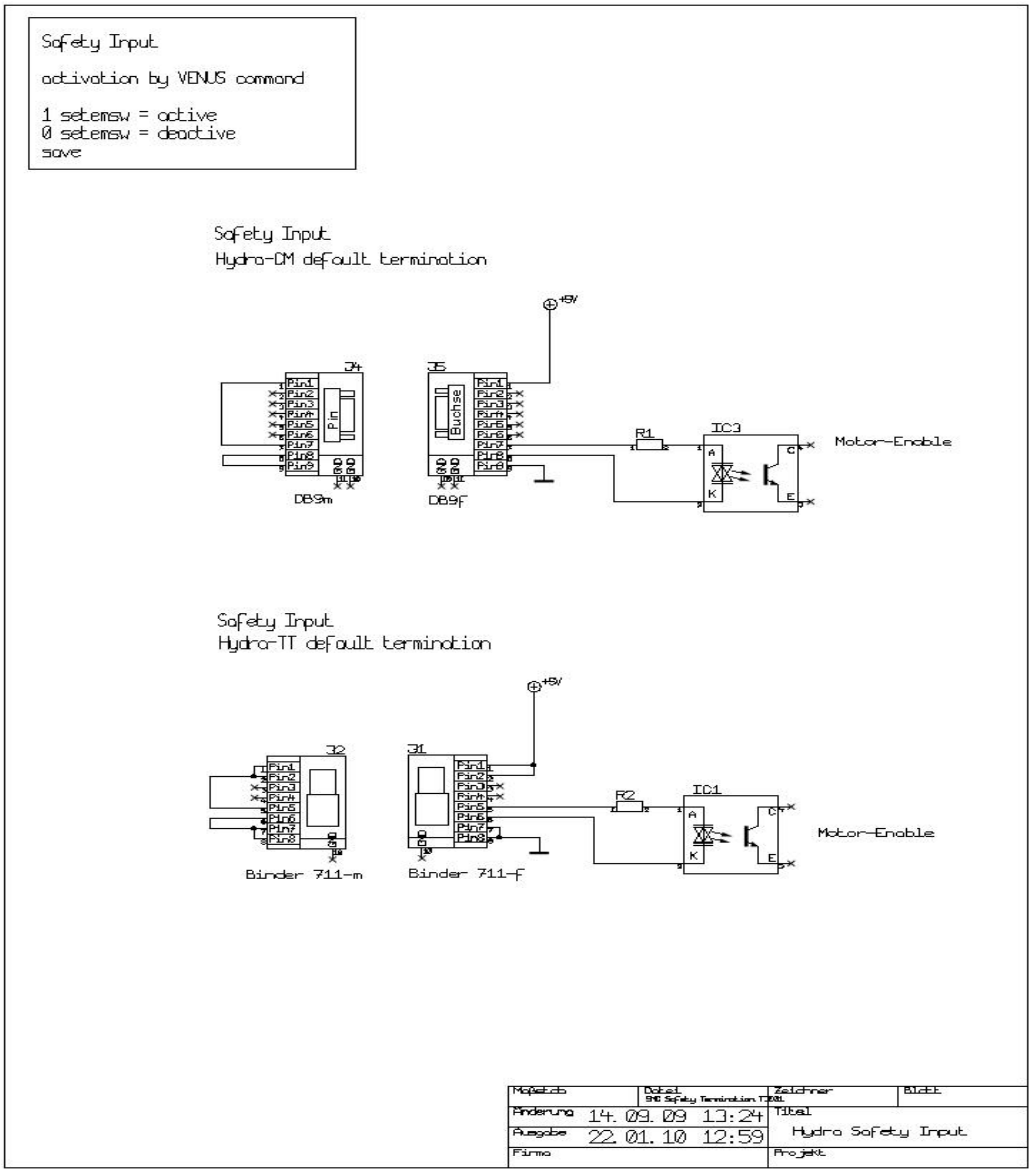
To get the information about the actual status of the input query the status(*st* or *axisid nst*).

Bit 7 : indicates that the system was stopped by emergency input 1= stopped | 0 = ok
Bit 8 : shows the main result, the motor is off 1 = motor off | 1 = on
Bit 9 : shows the actual status of the input , 1 = the input is open→hardware disabled

To re-enable the system, close first the emergency button, after this, send the commands *1 init* to enable axis 1 and *2 init* to enable axis 2.

7.12.5. Emergency / Safety Schematic



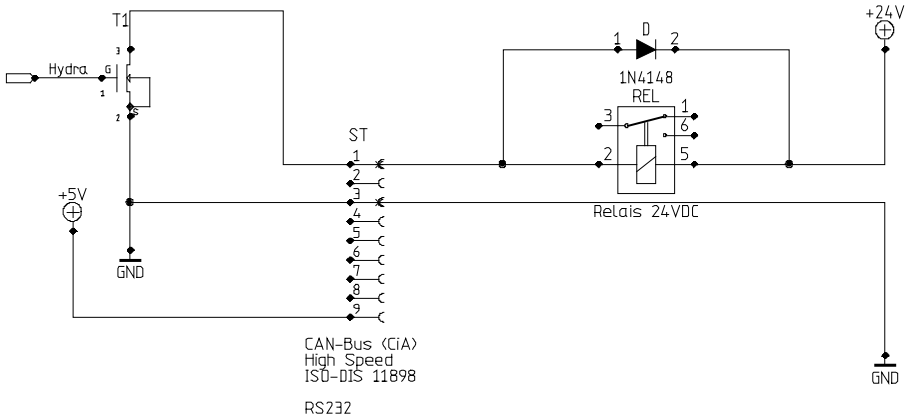


7.13. Service CAN

DB9 male	Funktion	
1	OUT Open Drain	Open Drain Output (Software Index=3)
2	CAN-Bus L	Can Low
3	GND	Ground
4	RxD	Service RS232 RxD
5	Out 1	Out TTL 1 (Software Index=4)
6	Out 2	Out TTL 2 (Software Index=5)
7	CAN-Bus H	CAN High
8	TXD	Service RS232 TxD
9	User 5V	Fused power 5 V/400mA

Output Open Drain: loads max. 24 V 100 mA
TTL-Output: TTL 3.3 V

Example for Open Drain Output:



8. Power-Supply:

8.1. Hydra TT

internal power supply with 2 different bus voltages (must be defined by order)

Voltage	100-250 VAC	
Power	300 W	
Bus Voltage	24 VDC	48 VDC

Using a 48 V supply with a 24V version will cause damage of the controller!
Using a 24 V supply with a 48V version will cause bad performance of the system, but does not cause any damage.

8.2. Hydra CM

External power supply, available in different power and bus-voltage dependant to application.

Version 1: good for standard stepper motors upto NEMA 23 size
and for smaller direct drives (consult factory)
desktop size

	7160-9-626	7160-9-625
Input Voltage	90-264 AC	
Frequency	47-63 Hz	
Output Voltage	24 VDC	48 VDC
Power	120 W	120 W

Version 2: good for standard stepper motors upto NEMA 23 size
but higher current and medium size direct drives (consult factory)
DIN-rail

Input Voltage	85–132 / 187–264 VAC autom. selection	
Frequency	47-63 Hz	
Output Voltage	24 VDC	48 VDC
Power	180 W	192 W

Version 3: good for standard stepper motors upto NEMA 23 size
but higher current and medium to large size direct drives (consult factory)
DIN-rail

	7160-9-621	7160-9-623
Input Voltage	85–132 / 187–264 VAC autom. selection	
Frequency	47-63 Hz	
Output Voltage	24 VDC	48 VDC
Power	360 W	360 W

9. Venus-3 interpreter language

Venus-3 is an interpreter language and combines the languages Venus-1 and Venus-2 Venus-3 commands consist of ASCII-characters which are interpreted in the controller and immediately executed. A software development surrounding to produce the control programs is not needed. The commands can be produced by any host and whatever programming language you are using, on condition that there is an access to the RS-232 interface or Ethernet interface.
In the simplest way the commands are directly transmitted to the controller via an ASCII terminal.

9.1. Blocking and non blocking commands

Hydra has no more blocking commands. All commands are executed immediately are not waiting that the previously
executed command has finished.
One of the consequences is that the target of motion can be changed on the fly!

For more info please refer to the Manual Hydra-Handbook xxx.pdf

9.2. Command Overview

Following commands are actually supported. Detailed description in main-manual *Hydra_Venus_xx.pdf*

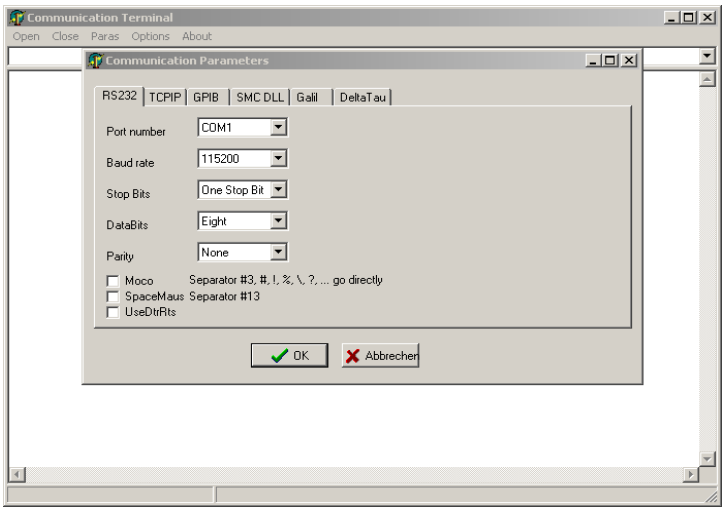
Command	Page	Description	Parameters	R/W	Range	Example
nrmove (nr)		move relative, without query status	*relpos axisid*	w	+/- 1nm .. +-200 m	1.0 1 nr
nmove (nm)		move absolute without query status	*abspos axisid*	w	+/- 1nm .. +-200 m	5.1 1 nm
m		move absolute interpolated	*pos1 pos2 m*	w	+/- 1nm .. +-200 m	12.0 9.0 m
r		move relative interpolated	*pos1 pos2 r*	w	+/- 1nm .. +-200 m	1 1 r
np		returns actual position	*axisid*	r	+/- 1nm .. +-200 m	1 np
p		returns actual position axis 1 & 2	-	r		p
init		**motor restart after failure**	***axisId***	**w**		**1 init**
setnpos		Defines location of position origin relative to its initial location.	*newpos axisid*	w		0.0 1 setnpos
getnpos		Returns current Position origin	*axisid*	r		1 getnpos
nstatus (nst)		returns actual status	*axisid*	r		1 nst
ge		returns actual error number, see table page	-	r		ge
errordecode		returns the error description of the code in a string	*number*	r		2000 errordecode
gme		returns actual error number, see table page 29	-			
merrordecode		returns the error description of the code in a string	*number*			12 merrordecode
nabort		stops a move	*axisid*	w		1 nabort
<CtrlC>		stops move of all connected axes		w		<CTRL-C> hex 3
ncalibrate (ncal)		homing (search limit reverse)	*axisid*	w		1 ncal
nrangemeasure (nrm)		rangemeasure (search limit forward)	*axisid*	w		1 nrm
nrefmove		search index of encoder	*distance axisid*	w		20 1 nrefmove
version		returns the firmware-version		r		version
identify		returns the controller identification		r		identify
getswst		returns the status of limit-inputs	*axisid*	r		1 getswst
getsw		returns the setting of limit-inputs	*axisid*	r		1 getsw
setsw		defines the limit-switch-status	*status 0 axisid* *status 1 axisid*	w	0..2	1 0 1 setsw 1 1 1 setsw
getncalswdist		returns the calswitch-distance	*axisid*	r		1 getncalswdist
setncalswdist		defines the calswitch-distance	*distance axisid*	w	0..1000.0	0.5 1 setncalswdist
getpitch		returns the pitch of the stage	*axisid*	r		1 getpitch
setpitch		defines the pitch of the stage	*pitch axisid*	w	0.001...1000	1.0 1 setpitch
getpolepairs		returns the number of polepairs	*axisid*	r		1 getpolepairs
setpolepairs		defines the number of polepairs	*number axisid*	w	1..100	1 1 setpolepairs
getnvel (gnv)		returns the velocity for move	*vel axisid*	r		1 gnv
setnvel (snv)		defines the velocity for move	*axisid*	w	10 nm/s ..10 m/s	12.0 1 snv
getnaccel (gna)		returns the acceleration for move	*axisid*	r		1 gna
setnaccel (sna)		defines the acceleration for move	*acc axisid*	w	1 µm/s^2 ... 500 m/s^2	120.0 1 sna
getvel (gv)		returns the vector velocity	-	r		gv
getaccel (ga)		returns the vector acceleration		r		ga
setvel (sv)		defines the vector velocity	-	w	10 nm/s ..10 m/s	1.0 sv
setaccel(sa)		defines the vector acceleration		w	1 µm/s^2 ... 500 m/s^2	10 sa
setstopdecel (ssd)		defines the deceleration for a commanded stop or limit-switch activation	*acc axisid*	w	1 µm/s^2 ... 500 m/s^2	20.0 1 ssd
getstopdecel (gsd)		returns the deceleration for a commanded stop or limit-switch activation				
getncalvel		returns the speed for cal-move	*axisid*	r		1 getncalvel
setncalvel		defines the speed for cal-move	*value 1 axisid* *value 2 axisid*	w	10 nm/s ..10 m/s	5.0 1 1 setncalvel 0.1 2 1 setncalvel
getnrefvel		returns the speed for ref-move (encoder index search)	*axisid*	r		1 getrefvel

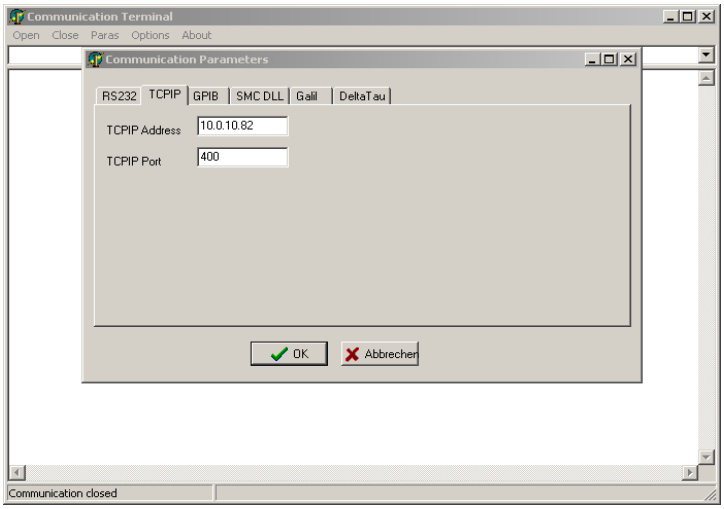
setnrefvel		defines the speed for ref-move (encoder index search)	*value axisid*	w	10 nm/s ..10 m/s	1.0 1 setrefvel
getref		returns the setting for index search	*axisid*	r		1 getref
setref		Defines the mode of operation for encoder index search	*value axisid*	w	0..2	0 1 setref (default)
getrefst		returns the status of the encoder index search	*axisId*	r		1 getrefst
getnrmvel		returns the speed for rm-move	*axisid*	r		1 getnrmvel
setnrmvel		defines the speed for rm-move	*value 1 axisid* *value 2 axisid*	w		50 1 1 setnrmvel 0.1 2 1 setnrmvel
getumotmin		returns the motor-umotmin	*axisid*	r		1 getumotmin
setumotmin		defines the motor-umotmin (*)	*value axisid*	w	see table	2.5 1 setumotmin
getumotgrad		returns the motor-umotgrad	*axisid*	r		1 getumotgrad
setumotgrad		defines the motor-umotgrad (*)	*value axisid*	w	see table	0.2 1 setumotgrad
gi		returns the absolute motor current in Amp	*axisId*	r		1 gi
gc		returns the motor current per phase in Amp	*axisid*	r		1 gc
getnlimit		returns the travel-limits	*axisid*	r		1 getnlimit
setnlimit		defines the travel-limits	*low high axisid*	w	+/- 1nm .. +-200 m	0.0 100.0 1 setnlimit
nsave		save axis parameters in flash-memory	*axisid*	w		1 nsave
save		save controller parameters in flash-memory	-	w		save
gsp		returns the stack-counter	-	r		gsp
clear		clear controllers internal stack	-	w		clear
reset		resets the controller	-	w		reset
getbaudrate		returns the actual baudrate of the serial interface RS232	*index*	r		1 getbaudrate
setbaudrate		defines the baudrate of the serial interface RS232	*rate index*	w		57600 1 setbaudrate
getnetpara		returns the actual settings of the Ethernet interface	*index*	r		0 getnetpara
setnetpara		defines the settings of the Ethernet interface	*string index*	w		“10.0.10.82” 0 setnetpara

10. JS_Terminal.exe

This program allows communication with any devices via RS232 or Ethernet, It's like Hyperterminal, but supports
a editable command-line.

Menu Paras : Configuration of the interface





11. First Steps

Now we play a little with the system, please run the program JS_Terminal.exe or any other terminal-program.

Connect with RS232 or Ethernet.

 After power-up the controller the stage jumps with low energy into a full-step position of the linear-motor. Please do not touch the stage in this phase. After some seconds the stage is in closed-loop.
The system is completely configured for the stage. The settings of the controller are documented in the file appendix *Configuration.*

Command	Reply	Comment
1 np	the actual position	
1 ncal	-	search the home-switch (limit reverse) after this position = 0.00000
10 1 nr	-	stage moves 10 mm relative
-2 1 nr		stage moves –2 mm relative
46 1 nm		stage moves to absolute 46 mm
10 1 nrefmove		searches the index of the encoder
1 np	the actual position	the position at Index
1 nst	the actual status	I
1 gnv	the actual velocity	
10 1 snv		change speed to 10 mm/s
1 gna	the actual acc/deceleration	
50 1 sna		change acc to 50 mm/s/s
0 1 nm		Move to 0-position
0 0 m		Vector move absolute
12 12 r		Vector move relative
gv	the actual vector speed	
ga	the actual vector acceleration	
p	the actual vector position	