MACS5
Quick Hardware Reference:
Connectors & Wiring

MACS5
Multi-axis motion control unit for drive positioning and synchronisation
developped and produced by

zub
machine control AG
www.zub.ch

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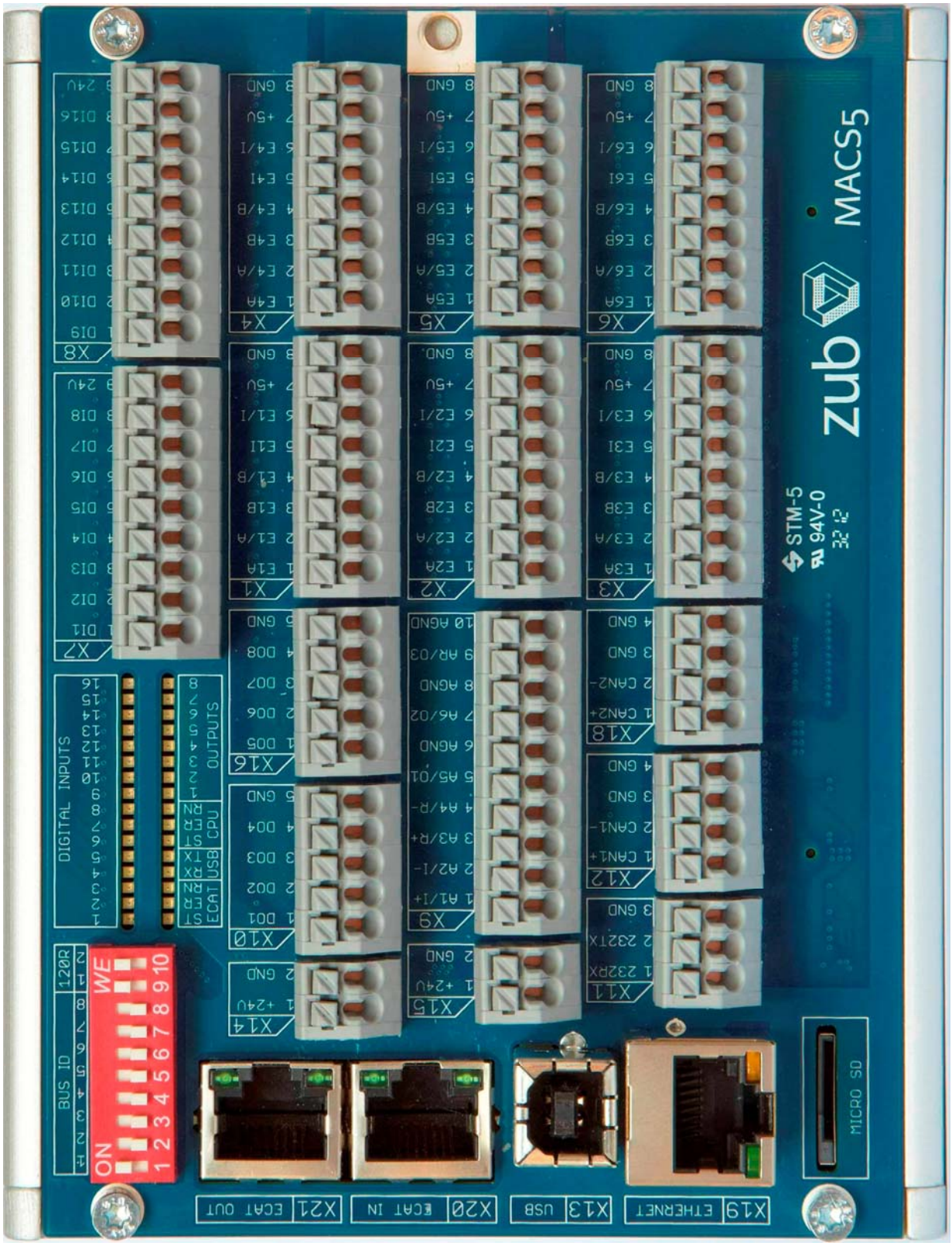
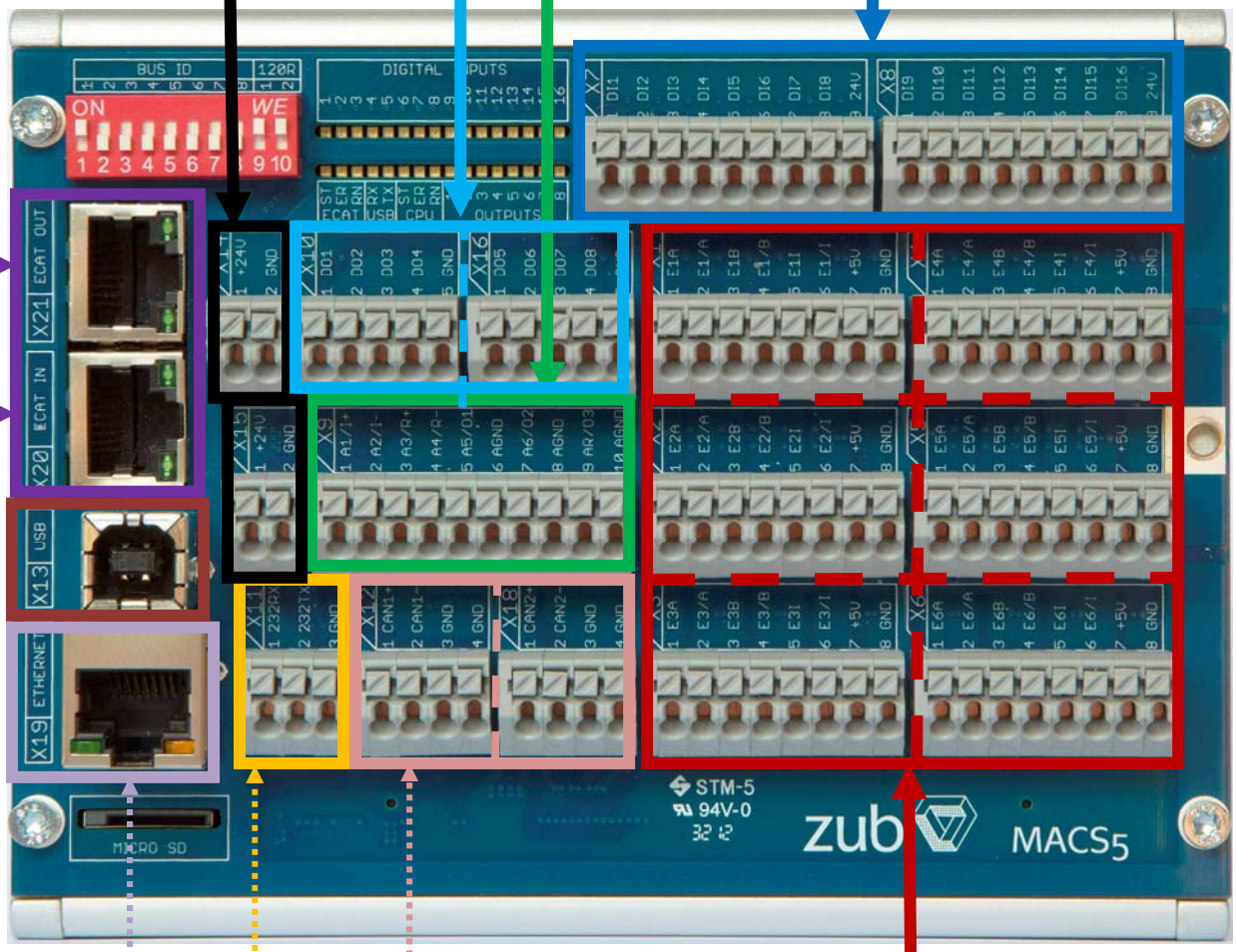
1 MACS5 - A quick glance

1.1 MACS5 - Top View



1.2 MACS5 - Connectors Overview



X20 / X21: EtherCAT Slave

X9: Analog Inputs / Outputs
Pin assigment depends on installed analog I/O-option!

X7 / X8: Digital Inputs 1 - 16
e.g. for limit and reference switches or sensors of process control.

The assigment of an input to a special functionality has to be defined by the MACS application program.

X14 / X15: Supply voltage

X10 / X16: Digital Outputs 1 - 8

X19: Ethernet
Optional: EtherCAT master or Powerlink slave

X12 / 18: 2 x CAN
CANopen slave and / or master

X13: USB

X11: RS232

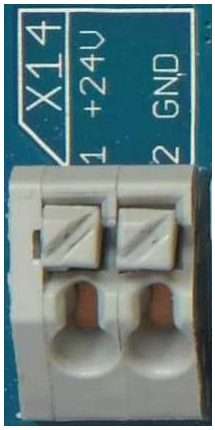
X1 - X6: Encoders Inputs (and virtual Encoder Outputs)
= Feedback signals (RS422, SSI, SinCos) for motor control and master input signals for drive synchronisation or virtual master output signals, depending on configuration.

The functionality, assignment and type of each encoder connector can be configured by the application program.

Default configuration:
X1 - X3: Feedback of drive 1 - 3 for motor control

2 Power Supply

2.1 X14 / X15: Power Supply



Pin	Name	Type	Meaning	Remark
1	+24V	Power Input	Supply voltage for powering the MACS	+24V DC, +/-20%
2	GND	GND	GND of the power supply	

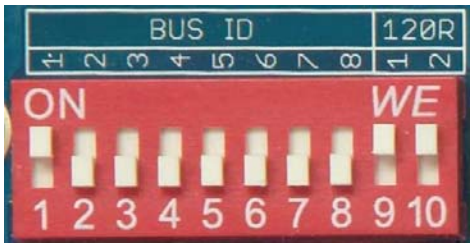
Remarks:

- X14 and X15 are internally linked. Therefore it is possible to link the power supply to just one of the connectors and use the other connector again as a power output for the next MACS or other 24V low-power devices. (Do NOT use one of the connectors as an power output for high-power devices like servo amplifiers !)

Please refer to the MACS5 data sheet or technical manual for more information about the required power supply.

3 Bus and Communication Ports

3.1 DIP switches for CAN and Ethernet configuration



The DIP switches are in use to configure the CAN ID and bus termination, as well as the Ethernet IP address setting, if required.

Configuration of CAN bus:

- The DIP switches 1 - 8 define the CAN node ID of the MACS5,
- The DIP switches 9 and 10 are in use to activate / deactivate the bus termination of CAN bus 1 (-> connector X12) and CAN bus 2 (-> connectorX18).

Find more information about the CAN bus connectors and the pin assignment in chapter 3.6 "X12 / X18: 2 x CAN".

Configuration of Ethernet IP address:

- The default IP address is 172.16.1.xx, where xx corresponds to the setting of the DIP switches 1 - 8. This means, that the last two hex digits of the IP address equal the CAN node ID.
- The global parameters "IPADDRESSMODE" (par.no. 20) and "IPSUBNET" (par.no. 21) can be used to set up the IP address by software without evaluation of the DIP switches. This gives full flexibility to configure the IP address independent of the CAN node ID configuration by the DIP switches.

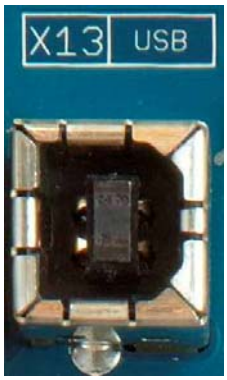
  Meaning of the parameter "IPADDRESSMODE":
  0: The IP Adress is set to IPSUBNET + DIP Switch (default)
  -1: DHCP mode
  1 - 255: The IP address is set to IPSUBNET + n

  The current active IP address can be readout by SDO 0x2209 / 14.

Find more information about the Ethernet connector in chapter 3.4 "X19: Ethernet, or EtherCAT Master, or Powerlink Slave".

Please refer to the APOSS manuals to find more information about related the configuration parameter settings.

3.2 X13: USB



Remarks:

- The MACS5 is a USB slave device. The MACS5 can be connected directly (or by a USB hub) to a PC.
- The MACS5 can not handle other USB slave devices, like cameras, scanners, or bar code readers by its own.

3.3 X11: RS232

Pin	Name	Type	Meaning	Remark
1	232RX	Data	RS232 Receive line	
2	232TX	Data	RS232 Transmit line	
3	GND	GND	RS232 GND	Signal GND

Remarks:

- The RS232 interface can be used to command the MACS5 (as a slave of a PC or any other microcontroller) or to handle devices like bar code scanners directly by the MACS5 application program.
- The functionality of the RS232 interface is compatible with the RS232 interface of former product lines, like MACS3, MACS2 or MOCON.

3.4 X19: Ethernet, or EtherCAT Master, or Powerlink Slave

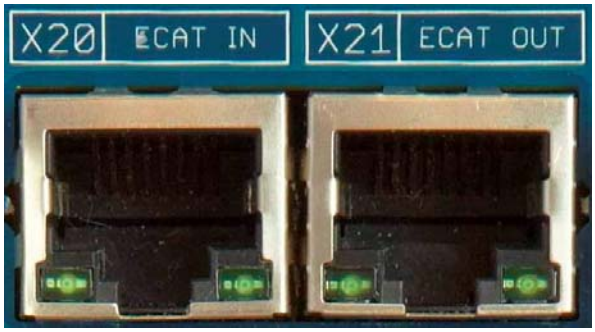
X19 is an Ethernet port by default. There will be special firmware upgrades available in future offering "EtherCAT Master" or "Powerlink Slave" functionality instead of Ethernet.

Remarks:

- The "EtherCAT Master" and "Powerlink Slave" features require a MACS5 firmware upgrade, which disables the "standard" Ethernet based communication. It is not possible anymore to use the Ethernet interface by the APOSS PC software, if "EtherCAT Master" or "Powerlink Slave" functionality is activated.
- The future "EtherCAT Master" functionality can be used to command EtherCAT drives and I/O modules only. There will be no system manager tool (like for PLCs) available to configure the slave device and its PDO mapping. The configuration and PDO mapping has to be part of MACS5 application program code.
- The future "Powerlink Slave" functionality can be used to link the MACS5 to a PLC (= bus master) offering a Powerlink bus.

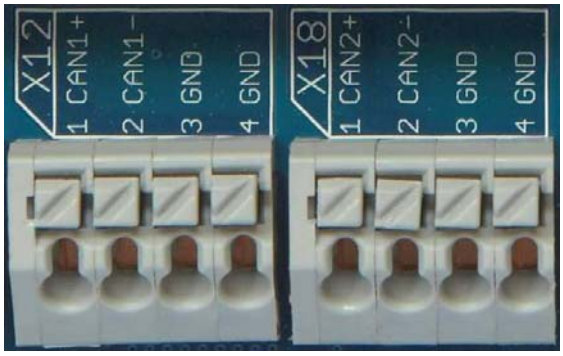
Please find more information about Ethernet IP address configuration in chapter 3.1 "DIP switches for CAN and Ethernet configuration".

3.5 X20 / X21: EtherCAT Slave (Option)



The EtherCAT bus from the PLC (= master) has to be daisy chained to X20 (= EtherCAT In) and X21 (= EtherCAT Out).

3.6 X12 / X18: 2 x CAN



The MACS5 has two CAN bus networks, which can be configured and used independent of each other. Each CAN network can be used as an CANopen slave or CANopen master.

Pin	Name	Type	Meaning	Remark
1	CAN+	Data	CAN High signal line	
2	CAN-	Data	CAN Low signal line	
3	GND	GND	GND	Signal GND
4	GND	GND	GND	

Remarks:

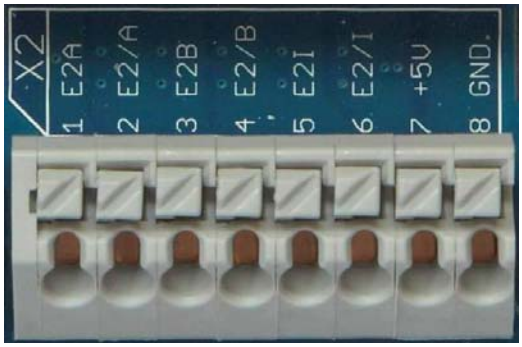
- The CAN node ID has to be configured by the DIP switches 1 - 8.
  The DIP switches 9 - 10 activates / deactivates the bus termination of each CAN bus.

Please find more information about CAN node ID configuration and bus termination in chapter 3.1 "DIP switches for CAN and Ethernet configuration".

4 Encoder Inputs & Outputs

The pin assigment of the encoder connectors X1 - X6 depends on the system configuration and the encoder types in use!

4.1 X1 - X6: Incremental Encoders (RS422)

X1 . . . 

. . . X6

The following wiring information is valid for **incremental encoder signals** only:

Pin	Name	Type	Meaning	Remark
1	A	Input	Encoder channel A	5V signal level only !
2	/A	Input	Inverted A signal	5V signal level only !
3	B	Input	Encoder channel B	5V signal level only !
4	/B	Input	Inverted B signal	5V signal level only !
5	I	Input	Encoder channel Index	5V signal level only !
6	/I	Input	Inverted Index signal	5V signal level only !
7	+5V	Power Output	+5V supply for the encoder	Do NOT link to another 5V supply! e.g. if a servo drive powers the encoder
8	GND	GND	GND	GND of supply voltage and signals common

Remarks:

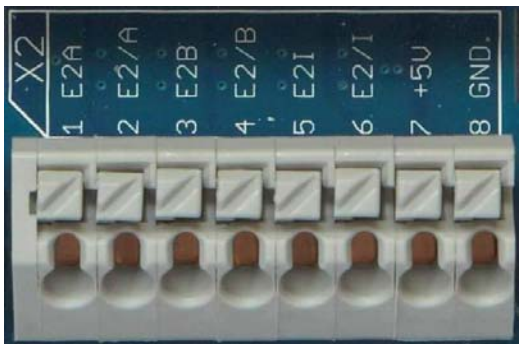
- Due to much better EMC immunity it is strongly recommended to use only encoders with inverted signals, so called differential types (RS422).
- X1 - X3 can also be configured for the use of Heidenhain glass scales with SinCos signals 1Vpp. (see chapter 4.2 "X1 - X3: SinCos-Encoders, e.g. Heidenhain Glass Scales")
- X4 - X6 can also be configured for the use of SSI absolute encoders. (see chapter 4.3 "X4 - X6: SSI Encoders in active mode" and chapter 4.4 "X4 - X6: SSI Encoders in passive mode")

- X4 - X6 can also be configured to output virtual encoder signals.
- Default system configuration:
  - X1 is linked to drive 1
  - X2 is linked to drive 2
  - X3 is linked to drive 3

  It is possible to reconfigure these default parameter settings (-> ENCODERTYPE) completely, so that any encoder input connector can be used for any drive, e.g. X3 for drive 1.
- If the encoder is linked to the MACS5 and a servo amplifier, make sure that the encoder supply voltage (+5V) is just provided by one of the units. Do NOT link the +5V of the MACS5 to the +5V provided by another device.
- If the encoder signals are provided by a servo amplifier (e.g. by an internal resolver to encoder conversion of the servo drive), the +5V supply must NOT be connected!

Please refer to the APOSS manual to learn more about the configuration of related parameters.

4.2 X1 - X3: SinCos-Encoders, e.g. Heidenhain Glass Scales

X1 . . . 

. . . X3

The following wiring information is valid for **SinCos encoders** (e.g. glass scales) only:

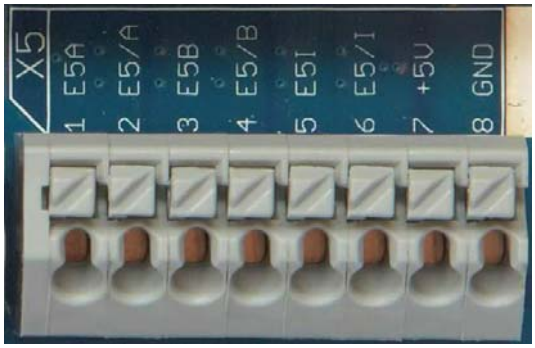
Pin	Name	Type	Meaning	Remark
1	A	Input	Encoder's Sinus signal	1Vpp
2	/A	Input	Inverted Sinus signal	1Vpp
3	B	Input	Encoder's Cosinus signal	1Vpp
4	/B	Input	Inverted Cosinus signal	1Vpp
5	I	Input	Encoder's Index signal	
6	/I	Input	Inverted Index signal	
7	+5V	Power Output	+5V supply for the encoder	Do NOT link to another 5V supply! e.g. if a servo drive powers the encoder
8	GND	GND	GND	GND of supply voltage and signals common

Remarks:

- The encoder inputs X1 - X3 have to be configured by the application program for usage with a SinCos encoder. The default setting is that incremental encoders (RS422) are in use.

Please refer to the APOSS manual to learn more about the configuration of related parameters.

4.3 X4 - X6: SSI Encoders in active mode

X4 . . . 

. . . X6

The following wiring information is valid for **SSI encoders in active mode** only:

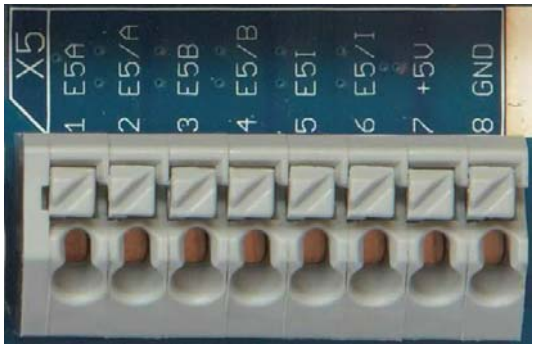
Pin	Name	Type	Meaning	Remark
1	A	Data In	SSI Data In	Data signal of SSI encoder
2	/A	Data In	SSI /Data In	Inverted data signal of SSI encoder
3	B	Clk. Out	SSI Clock Out	Clock signal provided for SSI encoder
4	/B	Clk. Out	SSI /Clock Out	Inverted clock signal for SSI encoder
5				not in use by SSI
6				not in use by SSI
7	+5V	Power Output	+5V supply for the encoder	Do NOT link to another 5V supply! e.g. if a servo drive powers the encoder
8	GND	GND	GND	GND of supply voltage and signals common

Remarks:

- The encoder inputs X4 - X6 have to be configured by the application program for usage with a SSI encoder in active mode. The default setting is that incremental encoders (RS422) are in use.
- X4 - X6 can also be configured to output virtual incremental encoder signals (not SSI).

Please refer to the APOSS manual to learn more about the configuration of related parameters.

4.4 X4 - X6: SSI Encoders in passive mode

X4 . . . 

. . . X6

The following wiring information is valid **for SSI encoders in passive mode** only:

Pin	Name	Type	Meaning	Remark
1	A	Data In	SSI Data In	Data signal from SSI encoder
2	/A	Data In	SSI /Data In	Inverted data signal from SSI encoder
3	B	Clk. In	SSI Clock In	External clock signal in use by SSI encoder
4	/B	Clk. In	SSI /Clock In	Inverted external clock signal in use
5				not in use by SSI
6				not in use by SSI
7	+5V	Power Output	+5V supply for the encoder	Do NOT link to another 5V supply! e.g. if a servo drive powers the encoder
8	GND	GND	GND	GND of supply voltage and signals common

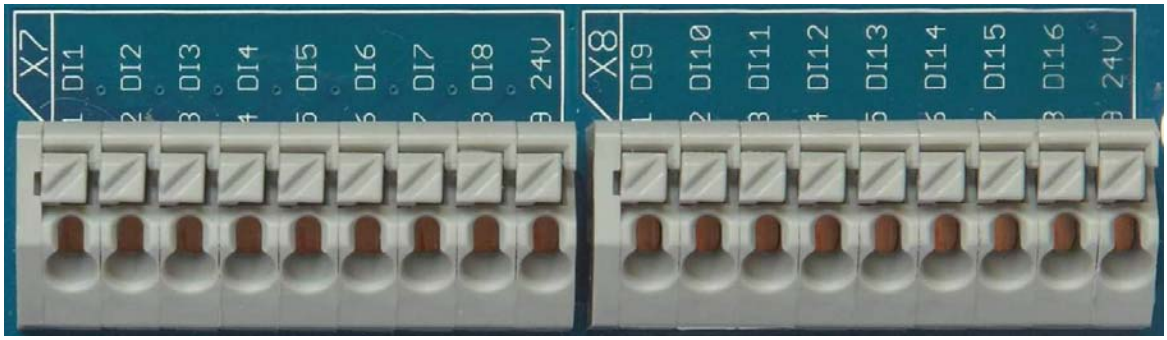
Remarks:

- The encoder inputs X4 - X6 have to be configured by the application program for usage with a SSI encoder in passive mode. The default setting is that incremental encoders (RS422) are in use.
- X4 - X6 can also be configured to output virtual incremental encoder signals (not SSI).

Please refer to the APOSS manual to learn more about the configuration of related parameters.

5 Digital Inputs & Outputs

5.1 X7 / X8: Digital Inputs



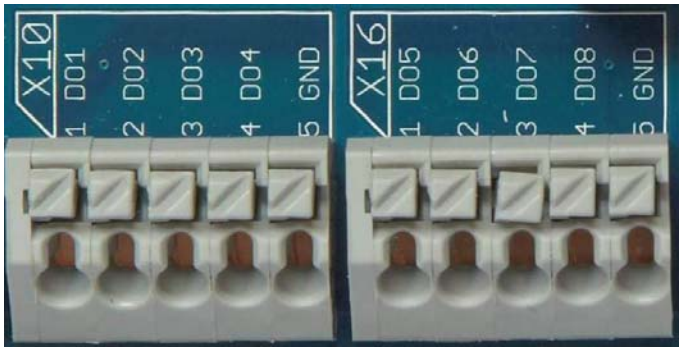
Pin	Name	Type	Meaning	Remark
1 - 8	X7: DI1-8 X8: DI9-DI16	Input	Digital sensor signal inputs	All types of sensors with 24V signal level can be linked to the digital inputs.
9	+24V	Power Output	+24V supply for sensors	Do NOT link to another 24V supply. This is the same power line like provided to the MACS5 by the connectors X14 and X15.

Remarks:

- The functionality and usage of each input is defined by the application program or a global parameter configuration (see -> I_REFSWITCH, I_POSLIMITSW, I_NEGLIMITSW). Therefore it is possible to use any input for any functionality.
- Application specific functionality can be part of the application code and called up by an interrupt handler for example.

Please refer to the MACS5 data sheet or technical manual for more information about the technical data of the digital inputs.

5.2 X10 / X16: Digital Outputs



Pin	Name	Type	Meaning	Remark
1 - 4	X10: DO1-4 X16: DO5-8	Signal Output	Digital outputs	24V DC output signals, max. 100mA each
5	GND	GND	Signal common	

Remarks:

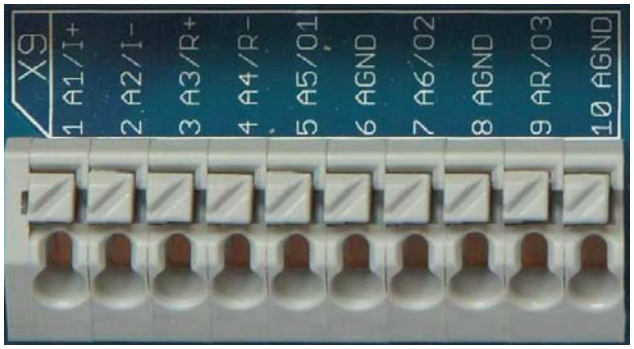
- The assignment of the output lines to a special functionality, like error state messaging or brake control, is NOT pre-configured.
- If a special functionality has to be linked to one or more of the outputs, this has to be done by the MACS parameter settings (-> O_BRAKE, O_AXMOVE, O_ERROR) or directly controlled by the application program. Therefore it is possible to use any output for any information.
- There are no GND pins available on X7/X8. Please use one of the GND pins of the connectors X10/X16 (digital outputs), or X14/X15 (supply) instead.

Please refer to the MACS5 data sheet or technical manual for more information about the technical data of the digital outputs.

6 Analog Inputs & Outputs

The pin assigment of the analog connector X9 depends on the installed analog option card!

6.1 X9: Analog Input / Outputs <u>without</u> an installed analog option card



Pin	Name	Type	Meaning	Remarks (just valid, if no I/O-option is installed!)
1	A1/I+	Input	Analog input 1	0 - 10V, 11 Bit, 280kΩ, 0-50mV dead zone
2	A2/I-	Input	Analog input 2	0 - 10V, 11 Bit, 280kΩ, 0-50mV dead zone
3	A3/R+	Input	Analog input 3	0 - 10V, 11 Bit, 280kΩ, 0-50mV dead zone
4	A4/R-	Input	Analog input 4	0 - 10V, 11 Bit, 280kΩ, 0-50mV dead zone
5	A5/O1	Input	Analog input 5	0 - 10V, 11 Bit, 280kΩ, 0-50mV dead zone
6	AGND	n.c.	not in use	not connected => No special analog GND
7	A6/O2	Input	Analog input 6	0 - 10V, 11 Bit, 280 kΩ, 0-50mV dead zone
8	AGND	n.c.	not in use	not connected => No special analog GND
9	AR/O3	n.c.	not in use	not connected
10	AGND	n.c.	not in use	not connected => No special analog GND

Remarks:

- There is a low end dead zone in the range of 0 - 50mV, i.e. measurements below 50mV are not accurate.
- The internal resolution of the A/D conversion is actually 11.5 Bit. Please check the APOSS manual for the actual bit resolution and scaling in use by the APOSS command INAD.
- If no I/O-option is installed, there are no AGND pins available on X9. Please use one of the GND pins of the connectors X1-X6 (encoders), X10/X16 (digital outputs), or X14/X15 (supply) instead.

6.2 X9: Analog Input / Outputs with option -IO1- (= 1 analog input + 3 analog outputs)

Pin	Name	Type	Meaning	Remarks (just valid, if IO1-option is installed!)
1	A1/I+	Input	Differential analog input	-10V … +10V (pin 1 <-> 2), 12 Bit
2	A2/I-	Input	Differential analog input	-10V … +10V (pin 1 <-> 2), 12 Bit
3	A3/R+	Ref.Out	+10V reference output	Reference only: +10V, +/-2.5%, 15mA
4	A4/R-	Ref.Out	-10V reference output	Reference only: -10V, +/-2.5%, 15mA
5	A5/O1	Output	Set value for drive 1	+/-10V, +/-1%, 12 Bit, set value -> drive 1
6	AGND	AGND	Analog GND	Signal common of drive 1 command
7	A6/O2	Output	Set value for drive 2	+/-10V, +/-1%, 12 Bit, set value -> drive 2
8	AGND	AGND	Analog GND	Signal common of drive 2 command
9	AR/O3	Output	Set value for drive 3	+/-10V, +/-1%, 12 Bit, set value -> drive 3
10	AGND	AGND	Analog GND	Signal common of drive 3 command

Remarks:

- The -IO1- option card is identical with the one in use by the former product MACS4-…-ANA.
- The -IO1- option card consists of a reference voltage source, one differential analog input (+/-10V), and three analog outputs (+/-10V).
- The -IO1- option card is typically in use to command servo amplifiers or frequency converters by +/-10V signals.
- Default system configuration:
  - A5/O1 is linked to drive 1
  - A6/O2 is linked to drive 2
  - AR/O3 is linked to drive 3

  Each analog output provides a +/-10V output signal to command a servo drive or frequency converter.
- If drives are in use, that are commanded by CAN or EtherCAT bus, the corresponding configuration for each drive has to be done by the application program. Please refer to the APOSS manual to learn more about the configuration of related parameters

6.3 X9: Analog Input / Outputs with option -IO2- (= 6 high resolution analog inputs)

Pin	Name	Type	Meaning	Remarks (just valid, if IO2-option is installed!)
1	A1/I+	Input	Analog input 1	0 - 10V, 13 Bit, Ri = 280kΩ
2	A2/I-	Input	Analog input 2	0 - 10V, 13 Bit, Ri = 280kΩ
3	A3/R+	Input	Analog input 3	0 - 10V, 13 Bit, Ri = 280kΩ
4	A4/R-	Input	Analog input 4	0 - 10V, 13 Bit, Ri = 280kΩ
5	A5/O1	Input	Analog input 5	0 - 10V, 13 Bit, Ri = 280kΩ
6	AGND	AGND	Analog GND	Analog signal GND
7	A6/O2	Input	Analog input 6	0 - 10V, 13 Bit, Ri = 280kΩ
8	AGND	AGND	Analog GND	Analog signal GND
9	AR/O3	Ref.Out	+10V reference output	Reference: 10V typ., 13mA, ratiometric
10	AGND	AGND	Analog GND	Analog signal GND

Remarks:

- The -IO2- option card consists of six analog inputs (0-10V), a ratiometric reference voltage and an integrated contact break detection.
- The -IO2- option card offers a higher resolution and a more accurate A/D conversion, than the standard analog inputs (if no analog option card is mounted).
- The -IO2- option card is typically in use, if analog devices (e.g. potentiometers) provide feedback signals, which have to be processed by the motor control loop or position profile generator.

7 Further information

Please refer to the MACS5 data sheet, technical manuals, and the online documentation of the APOSS integrated development enviroment for more detailed information.

If you have any questions or you want to discuss your application and the best way to solve your requirements, please feel free to contact us:

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