General Description

The EASY2504 is an all round very high performance automation system for industrial applications. It is based on the powerful CoDeSys run time system, with several library extensions and enhancements. Furthermore a CANopen run time system is implemented. The system can be configured to run either in CANopen master or CANopen slave mode.

For I/O a total 24 digital inputs, max. 2 analog inputs and 24 digital outputs with several special functions are realized. The digital I/O works with 24V DC.

There are several additional features provided with the I/O pins:

Three pairs of input pins may be used for direct connection of encoders with tracks A and B. The encoder channels may also be configured for hardware event counter functionality.

Two input pins provide hardware event counting features and one input line supports optional interrupt control features.

The opto isolated on board CAN interface allows direct connection to a CAN bus line according to ISO11898. The firmware supports CANopen master as well as slave functionality.

A data bus extension unit gives great flexibility to expand the system with additional peripherals just like LCDs etc. Access from within IEC61131 applications is done with a special library.

A maximum of 3 asynchronous serial interfaces with RS232 or RS485 levels provide flexible communications with several external components, PCs, scanners, machines etc. A special library makes the usage of this interfaces very easy.

The EASY2504 is available in several configurations with optional interfaces.
For realizing operation panels the data bus interface may be connected to a LCD interface and an optional keyboard interface is provided.

Costumer specific features and software libraries are available on request.

As an option the EASY2504 is available with additional wiring boards. This are two additional boards for the supply of sensors, actuators etc. They may be used as a replacement for clamps.

The implemented PLC runtime system is programmable with the (3S) CoDeSys Software. It is one of the most powerful IEC 61131-3 programming tools for controllers' applications for Windows. All five languages of this standard are supported, plus a graphic editor for freehand FBD (function block diagram). CoDeSys produces native machine code for the EASY2504 based Infineon C167CR-CPU.

The communication between the EASY2504 and the CoDeSys programming tools, running on a PC, will be done with the RS232 interface. This allows online debugging, and in circuit programming. Visualization on PC is also possible using this connection.

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Page 1 of 20

Version 1.410 Rev 01
13.02.2009

EASY2504 / IEC 61131 + CANopen Master / Slave

Embedded Automation System / enhanced CoDeSys runtime system

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Features

The following Chapters describe the main features of the EASY2504 PLC core module. Additional features and libraries, especially for OEM versions, are available on request.

PLC features

- **High speed 16 bit CPU kernel (Infineon C167) 2000 commands per millisecond**
- **IEC 61131-3 programmable with CoDeSys development environment**
- **256 kByte PLC application code memory**
- **256 kByte PLC application data memory**
- **optional on board time keeper with up to 128 kBytes non volatile RAM.**
- **24 digital input lines 24V**
- **2 analog input lines 0..10V (10 bit Resolution)**
- **24 digital output lines 24V**

CANopen features

- **CANopen master according to DS301 Version 4 DSP302 Version 3.0 DSP405 Version 2.0**
- **Up to 32 CANopen slaves supported**
- **Slave configuration with EDS files directly with CoDeSys PLC programming tool.**
- **CANopen slave according to DS401 Version 2.1**
- **Up to 250 Transmit PDOs (master mode) Up to 16 Transmit PDOs (slave mode)**
- **Up to 250 Receive PDOs (master mode) Up to 16 Receive PDOs (slave mode)**
- **Dynamic PDO mapping**
- **Variable PDO Identifier**
- **Node guarding, Life guarding, Heartbeat**
- **Sync**
- **Emergency reporting for PLC application**
- **Client SDO transfer for PLC application**
- **Baud rate up to 1 MBaud**
- **CAN bus ISO11898 transceiver 82C251**

Bus Interface

- **Bus Extension unit for additional intelligent peripherals.**
- **2 Chip Select lines for 8 bit peripherals or LCD displays**
- **Built in library for bus access.**

Interrupt features

- **Interrupt processing for IEC61131 tasks**
- **1 interrupt input line**
- **3 programmable priority levels**

Encoder Interface

- **Integrated incremental encoder interface with 3 encoder and additionally 2 event counter channels**
- **Direct connection of 2 track encoder types**
- **Event counter mode optional**
- **32 Bit count values**
- **Built in library for complete encoder control**

Serial Interfaces

- **1 serial programming interface RS232 for connection to the CoDeSys development environment or Visualization tools. 57600 baud, no parity, 8 data bits , 1 stop bit**
- **Max. 3 additional serial RS232 or RS485 interfaces Programmable baud rates up to 57600**
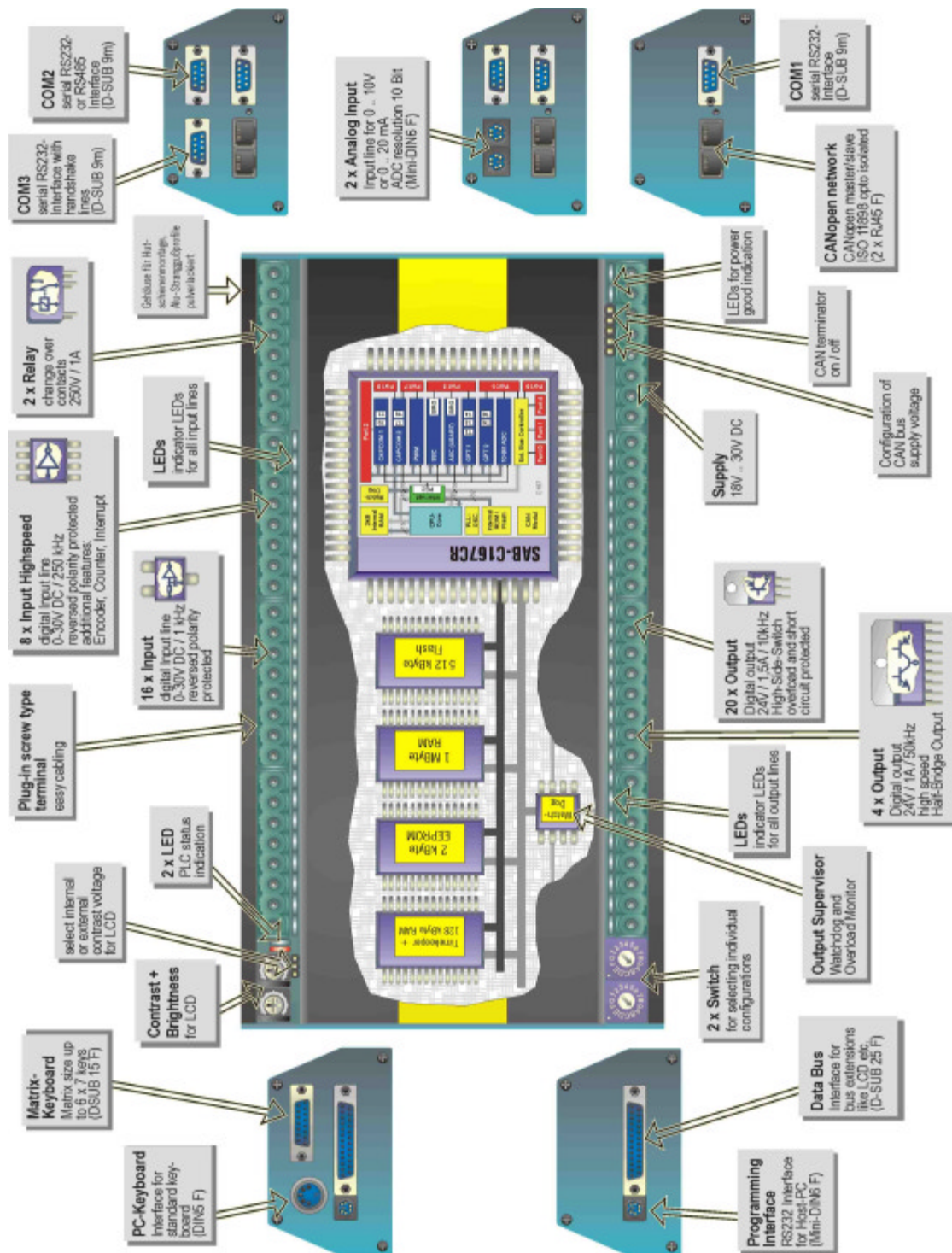
Additional features

- **Temperature range 0°-70° (other on request)**

Customer features

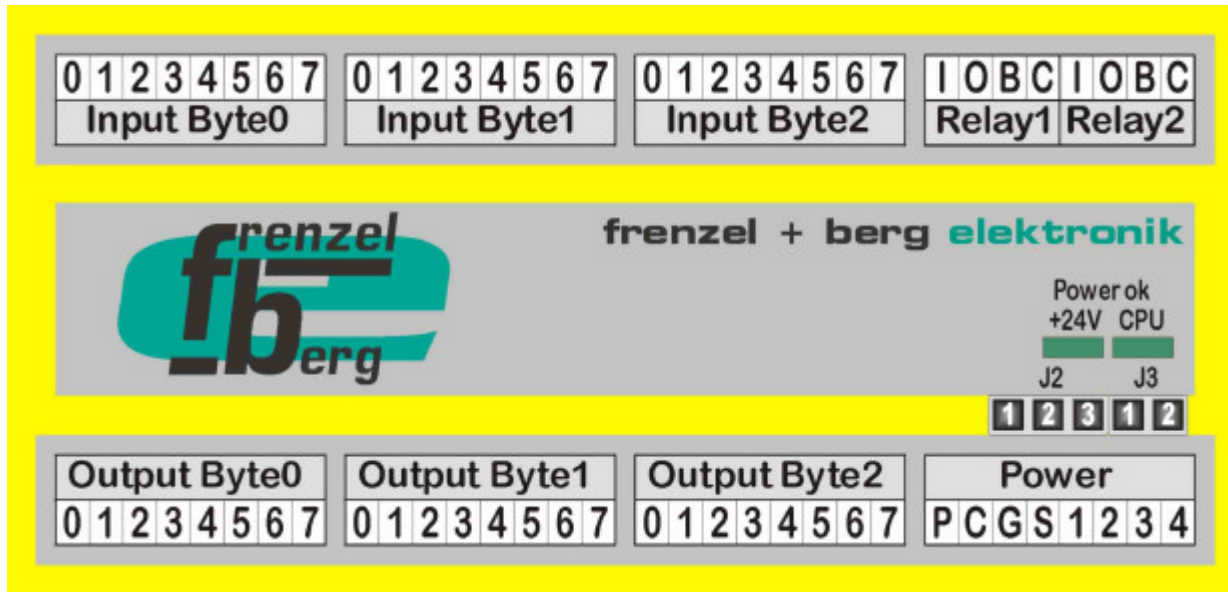Additional library features or OEM versions are available on request

Block Diagram

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Page 3 of 20

Version 1.410 Rev 01
13.02.2009

EASY2504 Version Overview

The EASY2504 is available in various configurations.

EASY-System		System Configuration *1)					
Product-Nr.	EASY-System	COM1	COM2	COM3	A/D	KBD	VE
EZ00000.1202.01	EASY2504CL	✔	-	-	-	-	-
EZ00000.1207.01	EASY2504VL	✔	-	-	-	-	✔
EZ00000.1212.01	EASY2504CK	✔	-	-	-	✔	-
EZ00000.1217.01	EASY2504VK	✔	-	-	-	✔	✔
EZ00000.1222.01	EASY2504CS	✔	✔	✔	-	✔	-
EZ00000.1227.01	EASY2504VS	✔	✔	✔	-	✔	✔
EZ00000.1232.01	EASY2504CA	✔	-	✔	2	✔	-
EZ00000.1237.01	EASY2504VA	✔	-	✔	2	✔	✔

*1) Options			
All EASY-Systems support: Controller SAB-C167CR / 20 MHz CPU-Clock, 256 kByte application program Memory, 256 kByte application data RAM, 2 kByte EEPROM, CANopen Interface opto isolated ISO11898, data bus interface, hex-code-switches, 24 digital input lines, 24 digital output lines, 2 relays and plug in screw type treminals for all I/O connections and power supply.			
COM1..COM3	serielle Interfaces COM1 to COM3	A/D	Analog input chanels 0..10V or 4..20mA
KBD	Interfaces for matrix- and PC-keyboard	VE	Additional Wiring Boards

Options		
Product -No.	Product-Name	Description
EZ00000.1249.01	-T8	Time keeper with real time clock and 8 kByte RAM
EZ00000.1249.02	-T32	Time keeper with real time clock and 32 kByte RAM
EZ00000.1249.03	-T128	Time keeper with real time clock and 128 kByte RAM

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Page 4 of 20

Version 1.410 Rev 01
13.02.2009

Pin Assignment : Screw Type Terminals

Power Connector

The power connector provides independent terminals for the CPU and the output driver power supply. This enables shut down of the output stages in case of emergencies while the CPU may still run.
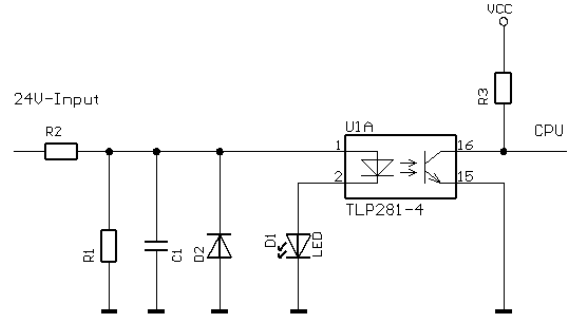
Power		
Pin No.	**Pin Name**	**Function**
P	Power	Supply Input for Power Drivers +24V DC
C	CPU	Supply Input for CPU +24V DC
G	Ground	Ground
S	Shield	Potential for Shield of Connector Housings etc.
1	CPU	Connected to Pin C
2	VCANout	Pin connected to Pin1 of CAN connectors (RJ45) in order to supply the CAN network from CPU voltage
3	Ground	Connected to Pin G
4	CANgnd	CAN-Ground

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Page 5 of 20

Version 1.410 Rev 01
13.02.2009

Digital Input

The EASY2504 provides two different input types. One is a standard input with standard I/O functionality.
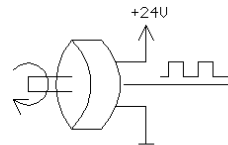
On the other hand there are 8 high speed input lines with extended features such as event counter, encoder or interrupt capabilities. Nevertheless the high speed input lines can be used as standard input line.

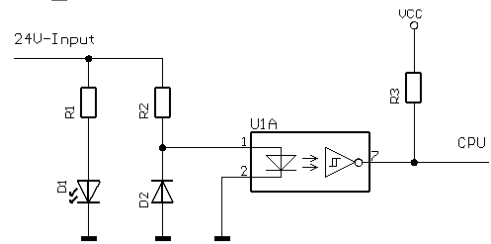All input lines provide indicator LEDs.

Input Byte 0

Pin No.	Pin Name	Function
0 .. 7	INB0.0 .. INB0.7	Digital Input Byte 0 Bit 0 to 7

Input Byte 1

Pin No.	Pin Name	Functions
0 .. 3	INB1.0 .. INB1.3	Digital Input Byte 1 Bit 0 to 3
4	INB1.4	Digital Input Byte 1 Bit 4 Counter Channel 4 Input
5	INB1.5	Digital Input Byte 1 Bit 5 Counter Channel 3 Input
6	INB1.6	Digital Input Byte 1 Bit 6 Encoder Channel 1 Track B
7	INB1.7	Digital Input Byte 1 Bit 7 Encoder Channel 2 Track B

Input Byte 2

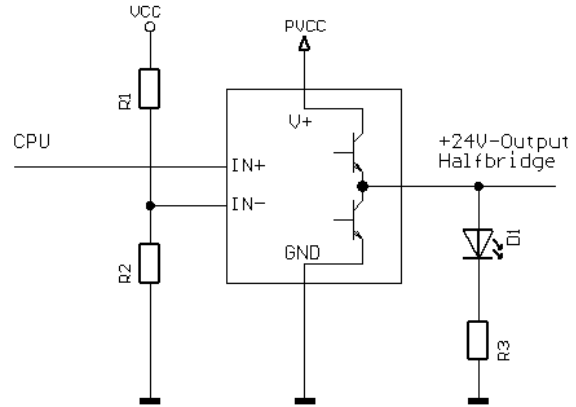| Pin No.	Pin Name	Functions
0, 1, 3	INB2.0 .. INB2.1, INB2.3	Digital Input Byte 2 Bit 0, 1, 3
2	INB2.2	Digital Input Byte 2 Bit 2 Interrupt Input
4	INB2.4	Digital Input Byte 2 Bit 4 Encoder Channel 0 Track B
5	INB2.5	Digital Input Byte 2 Bit 5 Counter Channel 1 Input Encoder Channel 1 Track A
6	INB2.6	Digital Input Byte 2 Bit 6 Counter Channel 0 Input Encoder Channel 0 Track A
7	INB2.7	Digital Input Byte 2 Bit 7 Counter Channel 2 Input Encoder Channel 2 Track A

Schematic of a Standard Input Line

Schematic of High Speed Input

For the programming of the I/O lines and the extended features please refer to additional documentation for the libraries.

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Page 6 of 20

Version 1.410 Rev 01
13.02.2009

Digital Output

The EASY2504 provides two different output types. There are 20 standard output lines realized as high side driver with standard I/O functionality. This output stages are rated for 24V 1,5A, they are overload and short circuit protected.
On the other hand there are 4 high speed output lines realized as half bridge drivers with extended features such as pulse width modulation and DC motor control features. Nevertheless the high speed output lines can also be used as standard output lines. The half bridge output lines are rated 24V / 1,0A.
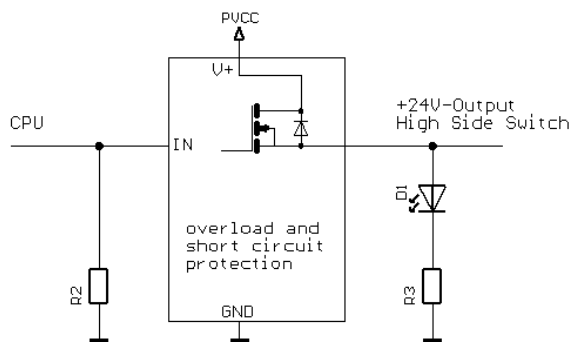
All output lines provide indicator LEDs.

Output Byte 0		
Pin No.	Pin Name	Function
0 .. 7	OutB0.0 .. OutB0.7	Digital Output Byte 0 Bit 0 to 7

Output Byte 1		
Pin No.	Pin Name	Function
0 .. 3	OutB1.0 .. OutB1.7	Digital Output Byte 1 Bit 0 to 3 (Half Bridge Output)
4 .. 7	OutB1.0 .. OutB1.7	Digital Output Byte 1 Bit 4 to 7

Output Byte 2		
Pin No.	Pin Name	Function
0 .. 7	OutB2.0 .. OutB2.7	Digital Output Byte 2 Bit 0 to 7

Schematic of a Standard Output Line

Schematic of a Half Bridge Output Line

Relay

Relay1 / Relay2		
Pin No.	Pin Name	Function
I	Input Coil	Coil Input Voltage (24V DC)
O	no	Relay Contact normally open
B	common	Relay Contact Common
C	nc	Relay Contact normally closed

The relays are completely independent from the output circuit. If relays should be used it is necessary to drive the coil input from a 24V output line.
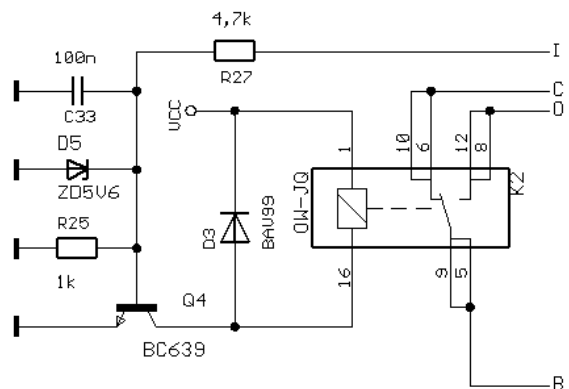

Schematic of Relay Circuit

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Page 7 of 20　　　　Version 1.410 Rev 01
13.02.2009

Analog Input Lines

The EASY2504VA and EASY2504VA versions provide two analog input channels for 0 .. 10V or 0 .. 20 mA with a resolution of 10 bits.

In order to support direct connection of simple potentiometers as input elements to the voltage input channels, supply output pins (output voltage 10V DC @ 5mA max.) are implemented.
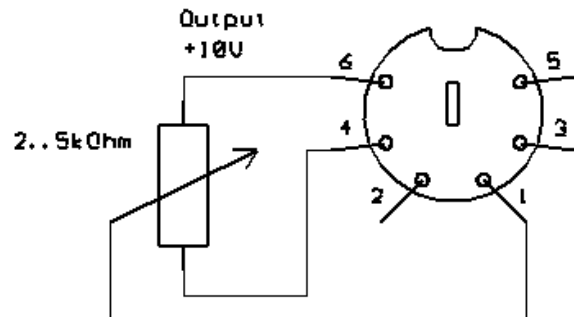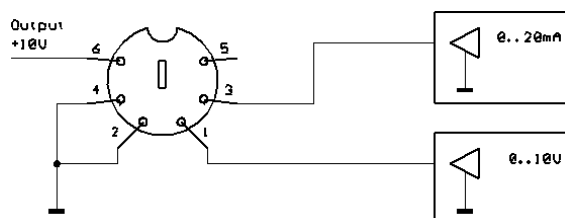

Schematic for connecting a poti to an analog input
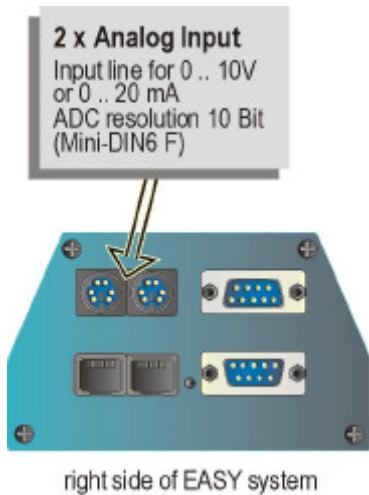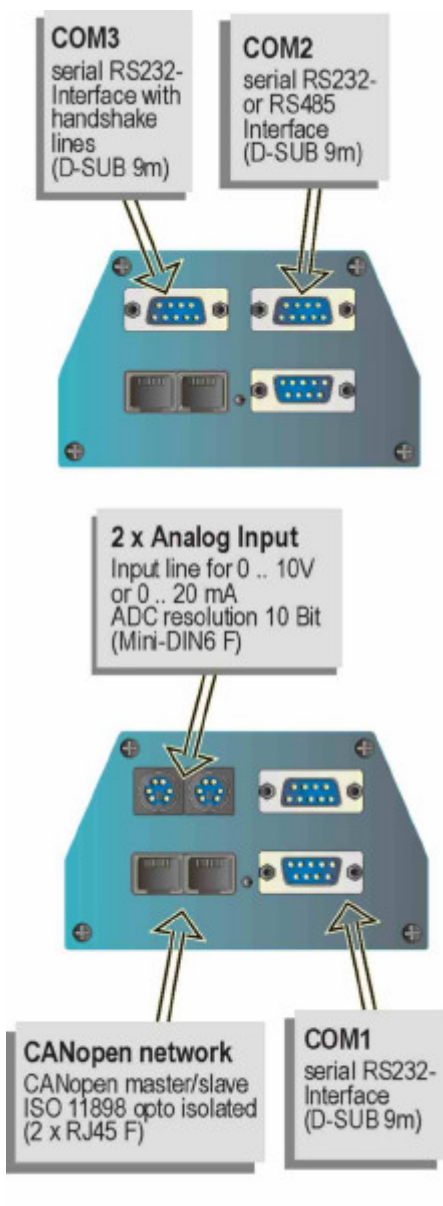

right side of EASY system

Analog Input		
Pin No.	Pin Name	Function
1	INV	Voltage Input (0 .. 10V)
2	GND	Ground
3	INC	Current Input (0 .. 20mA)
4	GND	Ground
5	-	Reserved for future use
6	V+10	Supply Output 10V DC

Principle of analog input

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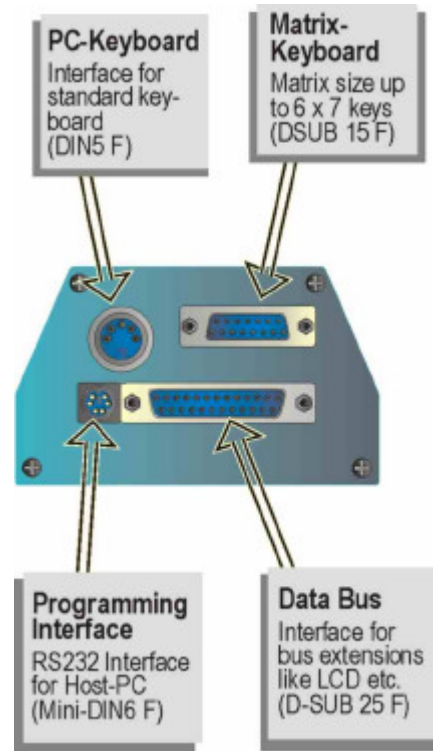
Page 8 of 20

Version 1.410 Rev 01
13.02.2009

Pin Assignment : Interfaces

The interface connectors are placed on the left and on the right side of the EASY housing.
The following drawings show the pin headers of various EASY configurations. The pin header configuration depends on your EASY version.

right side interface connectors

left side interface connectors

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Page 9 of 20

Version 1.410 Rev 01
13.02.2009

Programming Interface

Programming Interface		
Pin No.	Pin Name	Funktion
1	RxD	Serial Receiver (RS232)
2	Res.	Reserved for future use
3	TxD	Serial Transmitter (RS232)
4	GND	Ground
5	Res.	Reserved for future use
6	FWU#	Firmware Update For updating the firmware of the EASY2504, this pin must be forced to Ground. For normal operation this pin should not be connected.

For firmware update procedure, please contact frenzel + berg elektronik.

For programming the EASY2504, the following cable is needed.
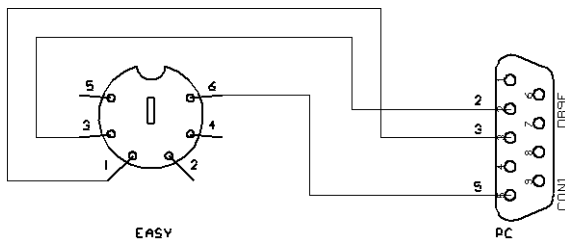
A programming cable is available from frenzel + berg elektronik. (Part No. EZ00000.1099.01)

Data Bus

The data bus connector enables hardware extensions (for example LCD modules etc.) over the micro controllers data bus.

Data Bus
Interface for bus extensions like LCD etc. (D-SUB 25 F)

left side of EASY system
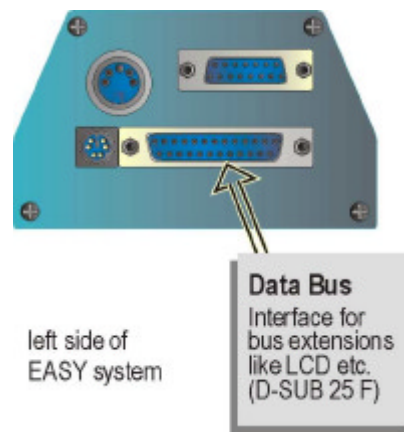
Data Bus		
Pin No.	Pin Name	Funktion
1	GND	Ground
14	VCC	Power supply output +5 V DC from the internal DC/DC regulator.
2	LCDCON	LCD contrast voltage output
15, 3	A0, A1	Address Lines
16	LCDEN	LCD-Enable. Chip Select Line (active high) especially for alpha numeric LCD modules
4,17,5, 18,6,19, 7,20	D0 .. D7	Data Bus
8	LEDV-	LED backlight kathode. (For Displays)
21	CSX12#	Chip Select Line for bus extensions
9	CSX9#	Chip Select Line for bus extensions
10, 23	A2, A3	Address Lines
11	WR#	Write signal for bus cycle
24	dnc	Do not connect
12	RD#	Read signal for bus cycle
25	dnc	Do not connect
13	VnegIn	Negative Voltage Input. The negative Voltage can be used for LCD contrast.

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Page 10 of 20

Version 1.410 Rev 01
13.02.2009

The data bus connector is optimised for connecting alphanumeric or graphic LCD modules with on board controller chips.

Alphanumeric LCD module

The bus can directly interface an alphanumeric LCD module based on the Hitachi HD44780 or compatible display controller.
Most of the displays are compatible with this standard.

A list of possible displays is given in the following table. Please note, this is only a very small example list.

Alphanumeric LCD modules				
Type	Manu-factu-rer	Lines	Char. per Line	Char hight [mm]
EA-D 20040 AR-S	Epson	4	20	4,8
EA-D 16015 AR-S	Epson	1	16	6,5
LM 041L	Hitachi	4	16	4,8
LM 044L	Hitachi	4	20	4,8
BT SBE 42008	Batron	4	20	8,0
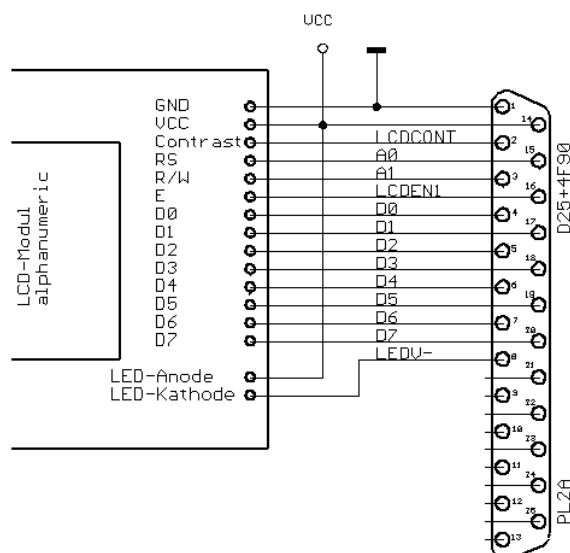
circuit diagram for connecting alphanumeric LCD modules.

For accessing the LCD module, the following addressing scheme must be used.

Addressing Scheme		
LCD Register	Access type	IEC-Address
Command Register	Write	2A0000h
Command Register	Read	2A0002h
Data Register	Write	2A0001h
Data Register	Read	2A0003h

Using other addresses might cause damage to the LCD device.

Graphic LCD module

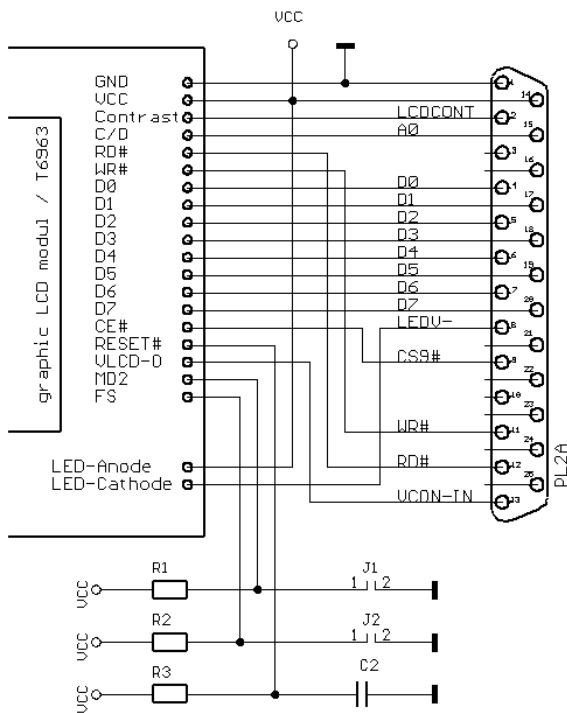The bus can directly interface a graphic LCD module based on the Toshiba T6963C or compatible display controller.

A list of possible displays is given in the following table. Please note, this is only a very small example list.

Graphic LCD modules		
Type	Resolution	Mode
LMG7422 PLFF	240 x 128	B/W transflectiv CFL
DMF-50316	240 x 64	B/W transflectiv CFL
EA P240-7K	240 x 128	CFL transflectiv blue mode

The negative contrast voltage depends on the display type. The EASY2504 system can only generate a contrast voltage down to –5V DC. If lower voltages are required, it must be generated externally.
Several display types provide negative voltage output pins. This display types may use the contrast poti placed on the EASY2504 in order to adjust the contrast.

For accessing the LCD module (see figure), the following addresses must be used.

Addressing Scheme		
LCD Register	Access type	IEC-Address
Data Register	Read/Write	280000h
Command Register	Read/Write	280001h

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Page 11 of 20

Version 1.410 Rev 01
13.02.2009

Circuit diagram for connecting a graphic LCD module based on the Toshiba T6963 display controller with LED backlight.

LED Backlight

The bus interface provides a current sink and can directly drive LED backlights of LCD modules. The backlight output can sink up to 500mA DC current. The backlight intensity can be adjusted at poti P2.
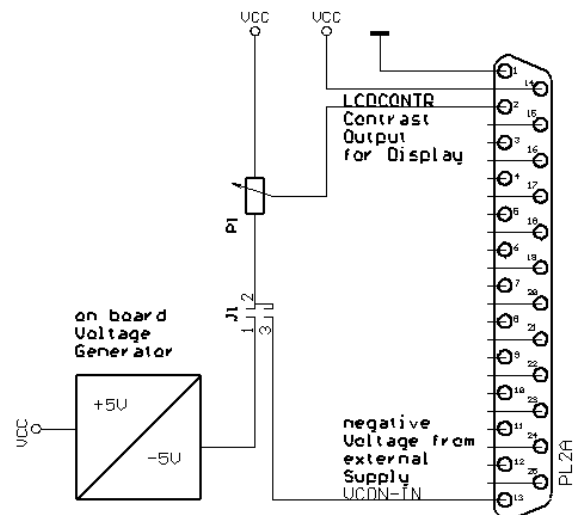
The anode of the backlight LEDs must be connected to VCC (Pin 14 of the Data Bus Connector) and the cathode must be connected to LEDV- (Pin 8 of the Data Bus Connector). No additional resistors or other components are required.

LCD Contrast

The bus interface provides a contrast adjustment circuit. For alphanumeric LCD modules, an on board negative voltage generator is provided. This voltage generator may drive negative contrast voltages up to –5V DC. If other voltages are required, the negative voltage can be supplied from externally.

Jumper J1 selects between internal or external negative voltage generation.

The LCD contrast can be set with poti P1.

Schematic of contrast voltage generation and contrast adjustment.

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Page 12 of 20

Version 1.410 Rev 01
13.02.2009

Keyboard Interface

The EASY2504 provides an interface for a standard PC keyboard and an additional interface for matrix keyboards with up to 6 x 7 keys.

left side of EASY system
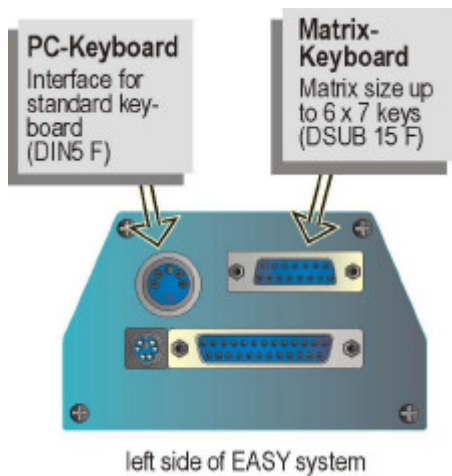
PC Keyboard

The PC keyboard connector is compatible with standard IBM AT compatible keyboard types. For the use of PS2 compatible keyboards an adaptor is required.

PC Keyboard

| Pin No.	Pin Name	Funktion
1	Clock	Clock input
2	Data	Data input
3	Reset	Reset output for keyboard
4	GND	Ground
5	V+Key	Supply voltage for keyboard

Access to the keyboard is done with libraries. See additional documents for further information.

Matrix Keyboard

The matrix keyboard connector supports standard matrix keyboards up to 42 keys arranged in an 6 x 7 matrix.

Matrix Keyboard

Pin No.	Pin Name	Funktion
1 .. 6	SCAN1 .. SCAN6	Keyboard Scan Lines Equivalent to matrix lines.
7, 8	-	Reserved for future use.
9 .. 15	RET1 .. RET 7	Keyboard Return Lines Equivalent to matrix columns.

The keyboard must be connected as follows:
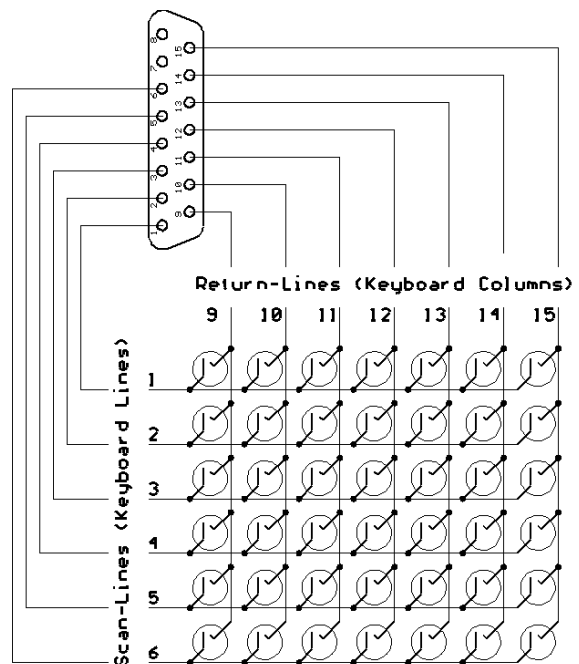
The generated key code is calculated with the following formular:

$$KeyCode = (KeyLine * 8) + KeyColumn + 16\#30$$

KeyLine   Line in with pressed key (0..5)
KeyColumn   Column with pressed key (0..6)

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Page 13 of 20   Version 1.410 Rev 01
13.02.2009

This gives the following key code layout. (Values are given in hexadecimal form)

30	31	32	33	34	35	36
38	39	3A	3B	3C	3D	3E
40	41	42	43	44	45	46
48	49	4A	4B	4C	4D	4E
50	51	52	53	54	55	56
58	59	5A	5B	5C	5D	5E

Access to the keyboard is done with libraries. See additional documents for further information.

Serial Interfaces

There is a maximum of three asynchronous serial interfaces provided on the EASY2504.
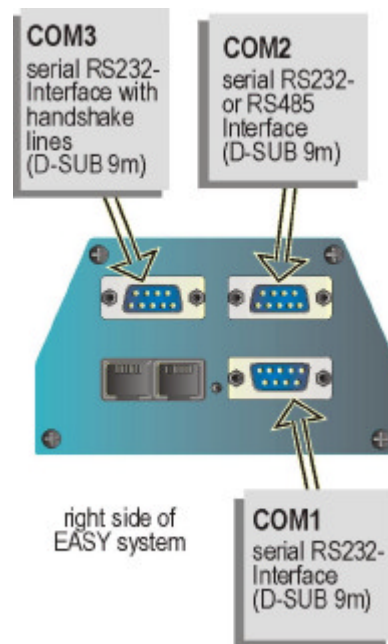
COM1

The serial interface COM1 is a standard RS232 interface. It is provided on all EASY2504 versions.

COM1		
Pin No.	Pin Name	Funktion
2	RxD	Serial Receiver (RS232)
3	TxD	Serial Transmitter (RS232)
5	GND	Ground

Access to the serial interface is done with libraries. See additional documents for further information.

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Page 14 of 20

Version 1.410 Rev 01
13.02.2009

COM2

The serial interface COM2 can be used as standard RS232 interface or as RS485 interface. It is an option and not provided on all EASY2504 versions.

COM3		
Pin No.	Pin Name	Funktion
1	485A	Serial bus line A (RS485)
2	RxD	Serial Receiver (RS232)
3	TxD	Serial Transmitter (RS232)
4	485B	Serial bus line B (RS485)
5	GND	Masse
6	RB1	To add a termination resistor of 120 Ohms to the RS485 bus line (between 485A and 485B), connect pins 6 and pin 7.
7	RB2	
8	MODE	Select Interface Mode: RS232: Pin8 unconnected RS485: Connect pin8 to pin9
9	GND	Ground

Access to the serial interface is done with libraries. See additional documents for further information.

COM3

The serial interface COM3 is a standard RS232 interface but provides all modem control signals. It is an option and not provided on all EASY2504 versions.

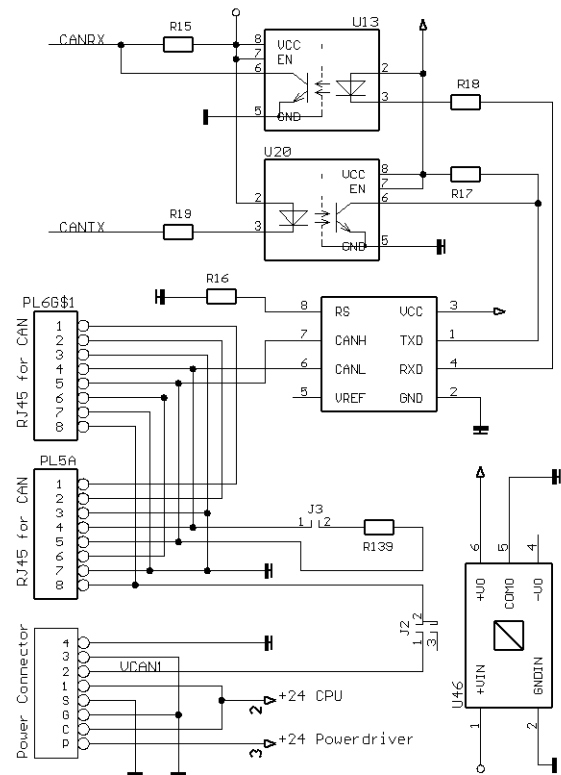| COM2		
Pin No.	Pin Name	Funktion
1	DCD	Data Carrier Detect
2	RxD	Serial Receiver (RS232)
3	TxD	Serial Transmitter (RS232)
4	DTR	Data Terminal Ready
5	GND	Ground
6	DSR	Data Set Ready
7	RTS	Request To Send
8	CTS	Clear To Send
9	RI	Ring Indicator

Access to the serial interface is done with libraries. See additional documents for further information.

CAN Interface

The EASY2504 provides an opto isolated CAN interface. The operating system provides a powerful CANopen driver that supports master mode as well as a CANopen slave mode.

The CAN bus is wired to two RJ45 jacks in parallel.

CAN		
Pin No.	Pin Name	Funktion
1	-	Reserved for future use.
2	-	Reserved for future use.
3	CGND	CAN-Ground
4	CANL	CAN-bus line Low
5	CANH	CAN-bus line High
6	-	Reserviert
7	CGND	CAN-Ground
8	V+out	CAN-Supply output.

Schematic of CAN interface

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Page 15 of 20

Version 1.410 Rev 01
13.02.2009
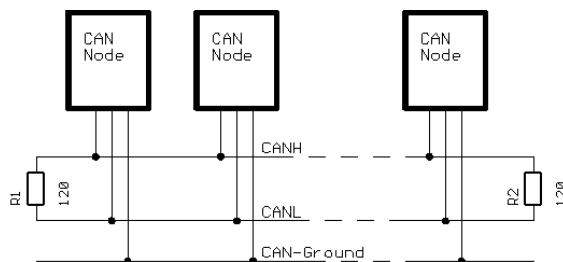
With jumper J3 a termination resistor of 120 Ohms can be activated.

If jumper J2 is set to position a (pin1 and pin2 connected), the voltage that is supplied on pin2 of the power connector is supplied to the CAN network.

In a CAN network all CAN nodes are connected in parallel. At each end of the bus line, a termination resistor is required.

At least the differential bus lines CANH and CANL are connected to each node. Usually also the CAN ground is connected to the nodes.

Memory

The EASY2504 makes a difference between three types of memory.
For programming and placing the retain data to non volatile memory, please refer to the additional documentation concerning the library functions.

Program and Data Memory

The EASY2504 offers 256k byte program code memory and also 256k byte of application data memory.
The code memory keeps the application program and the system configuration data generated from the system configuration window. This system configuration data is filtered from the EASY2504 and only the needed data (for example CAN network, encoder setting etc.) is stored to the code memory. In comparison to other CoDeSys based automation systems, a lot of data overhead is avoided.

The data memory keeps all application data. As an option the retain data can be moved to the non volatile memory.

Non Volatile Memory

As an option the EASY2504 offers a time keeper device with 8, 32 or 128 kbytes of non volatile memory.
As an option the retain data can be moved to the non volatile memory.

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Page 16 of 20

Version 1.410 Rev 01
13.02.2009

Wiring Bords

As an option the EASY2504 is available with two additional boards. This are two additional boards for the supply of sensors, actuators etc. They may be used as a replacement for clamps.

The layout of this boards is as follows:
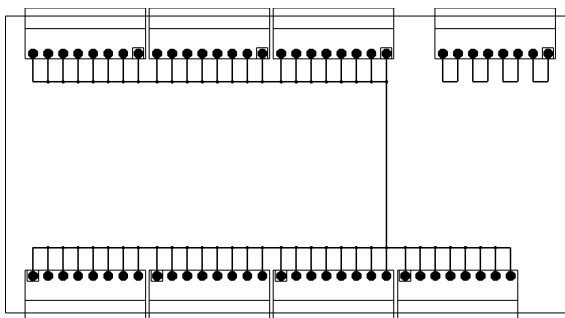
It is recommended to use the upper wiring board for power distribution and the lower board for ground potential.

Development Environment

For software development and software test the CoDeSys programming tool must be connected to the destination hardware via COM-port. Debugging, Tracing and more then can be done online. For such an environment, the following conditions must be met.
For the serial connection the serial interface setup of CoDeSys must use: 57600 baud, no parity, 8 data bits , 1 stop bit

Note: If CoDeSys is already installed on your PC/Notebook start installation with Point 2).

System requirements:
MS Windows 95, Windows NT 4.0 or later
32 MB RAM, Hard disc required: 25MB
CD-ROM drive

1) Installation of CoDeSys development tool on your PC/Notebook.

  - Insert CoDeSys compact disk into the CD-ROM drive.
  - If setup boots not automatically, open CD-drive in the windows explorer. In explorer double-click SETUP.EXE.
  - Follow the instructions that appear on your screen.

2) Install EASY2504 targets and libraries from CD / floppy disk onto your PC / Notebook.

  - Insert compact disk or floppy disk with targets and libraries into CD-ROM drive.
  - With CoDeSys installation the "Install Targets" program was installed.
  - Start "Install Targets" program.
  - Then press button OPEN (öffnen) and open the target information file *.tnf from the directory *Targets* on CD / floppy disk.
  - Target must now shown in the left window.
  - At last select the target in the left window and press button INSTALL (installieren).
  - The right window shows the installed targets.

3) For using EASY2504 stand-alone with CoDeSys development tool, you must connect the programming interface of EASY2504 to a COM-port of the PC. Therefore a programming cable as shown in chapter "Programming Interface" of this manual is required. In addition with a +24V CPU power supply, connected to the Pins C and GND of the power connector, the development environment is ready to start.

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Page 17 of 20

Version 1.410 Rev 01
13.02.2009

Absolute Maximum Ratings

Stresses greater than those listed parameters may cause permanent damage to the device. Functional operation should be restricted to recommended operation conditions. Exposure to absolute maximum rating conditions for extended times may affect reliability.
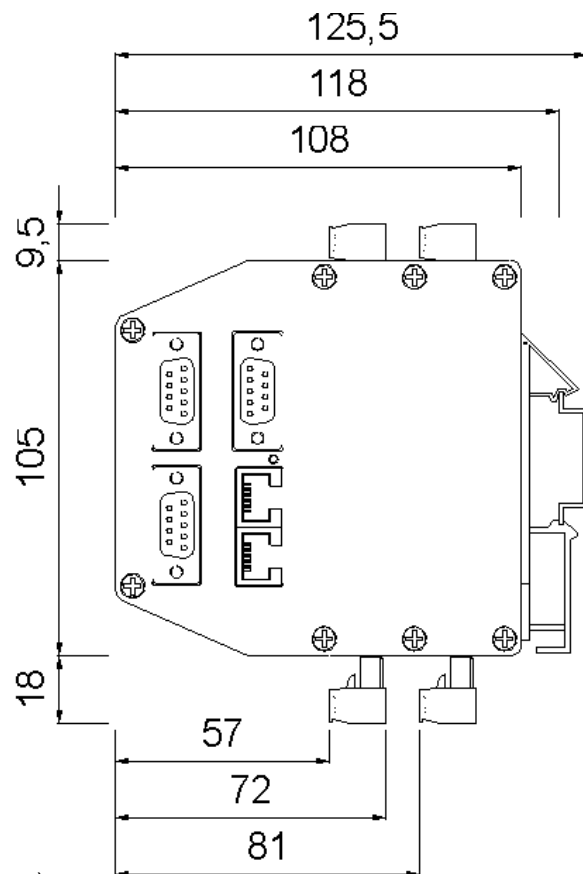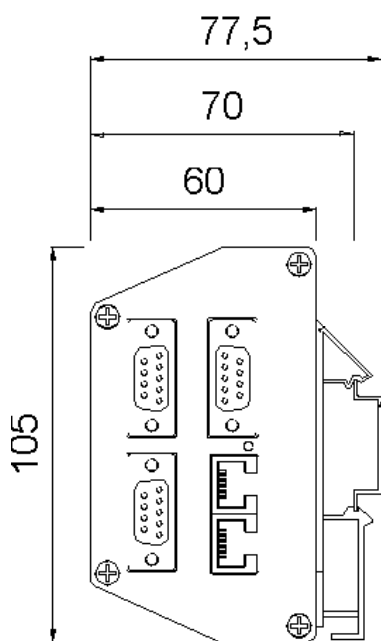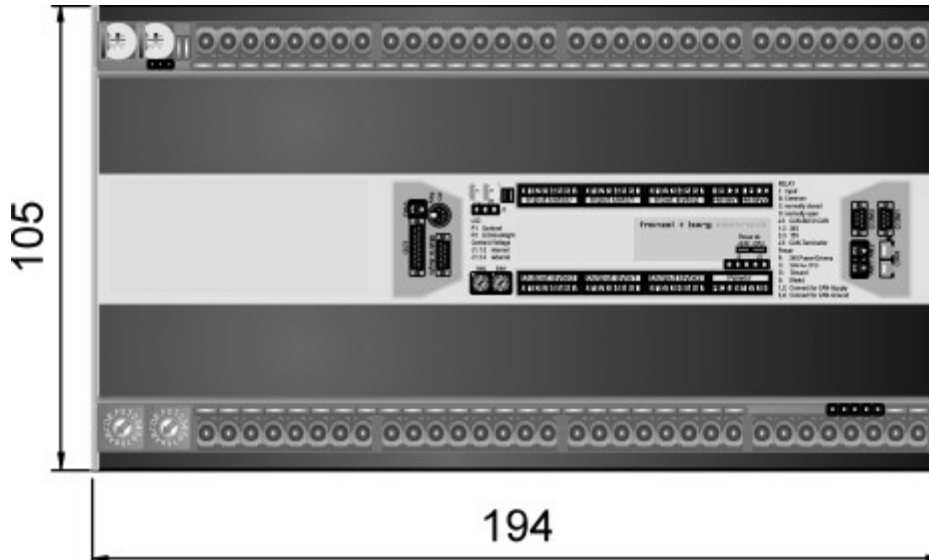
Parameter	Symbol	Rated Value		Units	Remarks
		Min.	Max.		
Power supply voltage	VCC			V	
Analog power supply voltage	AVCC			V	
Analog reference voltage	AVREF			V	
Input voltage	Vi			V	$Vi < VCC + 0.3V$
Output voltage	Vo			V	$Vo < VCC + 0.3V$
L level maximum output current	I_{OLMAX}			mA	Time < 20 msec
L level maximum output current	I_{OL}			mA	
H level maximum output current	I_{OHMAX}			mA	Time < 20 msec
H level maximum output current	I_{OH}			mA	
Maximum Power dissipation	P_{MAX}			mW	
Operating temperature	T_A	0	+50	^oC	
Storing temperature	T_A	-55	+150	^oC	

Recommended Operation Conditions and Characteristics

Functional operation should be restricted to recommended operation conditions.

Parameter	Symbol	Rated Value			Units	Remarks
		Min.	Typ.	Max.		
Power supply voltage	VCC				V	
Analog power supply voltage	AVCC				V	
Analog reference voltage	AVREF				V	
Power supply current	I_{CC}				mA	All inputs V_{IL} or V_{IH} All outputs open
Input H voltage	V_{IH}				V	
Input L voltage	V_{IL}				V	
Output H voltage	V_{OH}				V	$I_{OH} =$
Output L voltage	V_{OL}				V	$I_{OL} =$
Input leakage current	I_{LKC}				uA	
Crystal frequency	f_{osc}				MHz	
Reset pulse width	t_{res}				us	
Power on rise time	t_{RESLH}				ms	
Maximum Power dissipation	P_{MAX}				mW	
Operating temperature	T_A				^oC	Standard Module
	T_A				^oC	On request

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Page 18 of 20

Version 1.410 Rev 01
13.02.2009

Mechanical Dimensions

Side view without and with wiring boards (dimensions in mm)

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Page 19 of 20

Version 1.410 Rev 01
13.02.2009

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Page 20 of 20

Version 1.410 Rev 01
13.02.2009