Hardware Data Sheet

FB1311-014X

EtherCAT **Piggyback Controller Board**

Version 1.1
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BECKHOFF

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ABBREVIATIONS

µController   Microcontroller

as.   Asynchronous

DC   Direct Current

EEPROM   Electrically Erasable Programmable Read Only Memory. Non-volatile memory used to store ESC configuration and description.

ESC   EtherCAT Slave Controller

EtherCAT   Real-time Standard for Industrial Ethernet Control Automation Technology

GND-Earth   Ground-Earth

LED   Light Emitting Diode, used as an indicator

PCB   Printed Circuit Board

PDI   Process Data interface

SPI   Serial Peripheral Interface

RJ45   FCC Registered Jack, standard Ethernet connector (8P8C)

1   Foreword

1.1   Notes on the Documentation

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards. It is essential that the following notes and explanations are followed when installing and commissioning these components.

1.1.1   Liability Conditions

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

The documentation has been prepared with care. The products described are, however, constantly under development. For that reason the documentation is not in every case checked for consistency with performance data, standards or other characteristics. None of the statements of this manual represents a guarantee (Garantie) in the meaning of § 443 BGB of the German Civil Code or a statement about the contractually expected fitness for a particular purpose in the meaning of § 434 par. 1 sentence 1 BGB. In the event that it contains technical or editorial errors, we retain the right to make alterations at any time and without warning. No claims for the modification of products that have already been supplied may be made on the basis of the data, diagrams and descriptions in this documentation.

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1.2   Safety Instructions

1.2.1   Safety Rules

The responsible staff must ensure that the application or use of the products described satisfy all the requirements for safety, including all the relevant laws, regulations, guidelines and standards.

1.2.2   State at Delivery

All the components are supplied in particular hardware and software configurations appropriate for the application. Modifications to hardware or software configurations other than those described in the documentation are not permitted, and nullify the liability of Beckhoff Automation GmbH.

1.2.3   Personnel Qualification

This description is only intended for the use of trained specialists in control and automation engineering who are familiar with the applicable national standards.

1.2.4   Description of Safety Symbols

The following safety symbols are used in this operating manual. They are intended to alert the reader to the associated safety instructions.

Danger   This symbol is intended to highlight risks for the life or health of personnel.

Warning   This symbol is intended to highlight risks for equipment, materials or the environment.

Note   This symbol indicates information that contributes to better understanding.

1.3 Documentation Issue Status

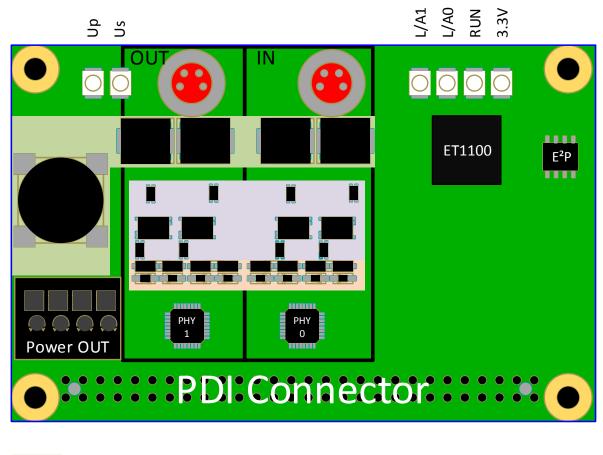| Version	Comment
0.1	First Version
1.0	First Release Version
1.1	Updates related to FB1311-0140 and FB1311-0141

1.4 Licensing

EtherCAT P products require a license, which is available free of charge from Beckhoff Automation.

Please contact licensing@beckhoff.com.

2   Overview

The FB1311-014X EtherCAT P piggyback controller board is designed for EtherCAT P evaluation purposes in combination with the EL9800 evaluation board only. The piggyback controller board is acategory #1 Powered Device (PD) (based on ETG.1030). Two M8P connectors for sourcing and forwarding power are building the electro-mechanical interface to EtherCAT P. The EtherCAT P technology is not only used to power the piggyback controller board itself, but also to provide 24V Us and 24V Up externally utilizing a push button terminal block. The 24V Us shall be used to power the EL9800 EtherCAT Evaluation board. 24V Up can provide power e.g. for external interface integrated circuits.

24V Power Injection and Decoupling

Discrete Ethernet Transformers

Protection Diodes

Figure 1: Overview of the FB1311-014X

Discrete Ethernet transformers are used for galvanic isolation between fieldbus and internal logic. Diodes on the Ethernet transmission signals prevent voltage transients, occurring when accidentally connecting/disconnecting a powered cable with the board, from damaging the PHYs. The PHYs are communicating with the ET1100 via the MII interface. Three different process data interfaces (16/8 bit asynchronous Microcontroller Interface, 32 bit In/Out digital interface, Serial Peripheral Interface (Slave) are provided by the ET1100 for application purposes.

2.1   Indicator LEDs

Six LEDs for information about the device status are available on all three variants of the FB1311-014X. Table 1 is giving an overview over the indicator LEDs on the PCB.

Table 1: Indicator LEDs

LED	Comment
+3.3V	Indicates 3.3V power supply
RUN	RUN indicator (LED) for application state
L/A0	Link/Act Indicator (LED) for port 0
L/A1	Link/Act Indicator (LED) for port 1
Up	24V Up present on the board
Us	24V Us present on the board

2.2   PDI connector

Figure 2: PDI Connector Power Pin Distribution

Figure 2 is showing the top view of the 56 pin PDI connector. Blue marked contacts are GND connections. As the FB1311-014X is powered over EtherCAT P the former power supply pins are not connected (compare FB1111-014X). In comparison to the FB1111-014X the PDI interface is extended by 4 pins. All in- and outputs are 3.3V compatible. Applying higher voltages will cause serious damage to the device.

2.3   Power out connector

Figure 3 Power Output Push-In Connector

Up and Us supply from the EtherCAT P connection is provided as application voltages by the Power output Push In connector.

> **Note** Because the GND contacts on the PDI connector are connected to GNDs, it is mandatory to connect Us/GNDs with the power supply of the EL9800 evaluation board. Up/GNDp shall not be connected with the EL9800 Evaluation board.

2.4   Power Connection between FB1311-014X and EL9800

Figure 4 Power connection between FB1311-014X and EL9800

Figure 4 is showing the power connection between FB1311-014X and the EL9800 EtherCAT evaluation board. Therefore, Us and GNDs from the FB1311-014X power out connector have to be connected with the appropriate contacts of J200 on the EL9800 EtherCAT Evaluation Board.

> **Note** Use AWG20 cable for wiring between FB1311-014X power connector and EL9800 Evaluation board.

2.5 Test pads

Figure 5 Test Pads

Next to the EtherCAT P connectors, test pads for Up and Us supply voltage can be found. Additionally test pads for the ET1100 supply voltages are available on the right side of the board. A DC-DC converter on the bottom side of the PCB provides 3.3V. 2.5V is generated by the internal LDO of the ET1100.

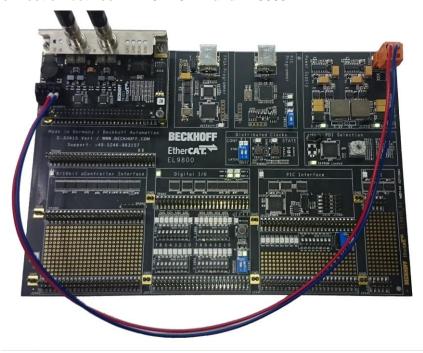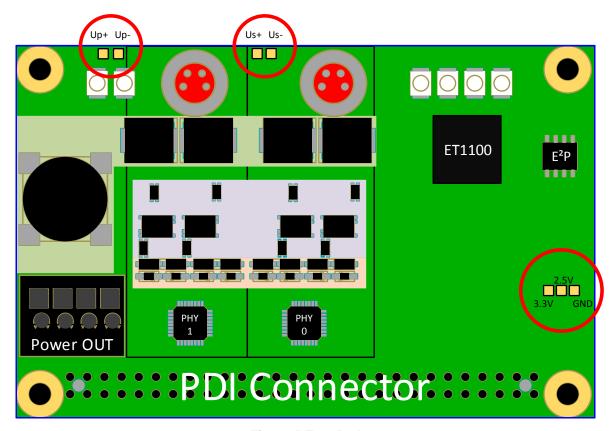⚠️ **Warning** — Users are highly discouraged from connecting any other equipment than measuring equipment to these test pads.

2.6 Variant Differentiation

The three variants of the FB1311-014X are corresponding to three different PDI configurations. The type of PDI interface can be identified by the last position in the product code. In Table 2 the variants of the FB1311-014X are listed with respect to the different PDI interfaces.

Table 2: Variants of the FB1311-014X

Product Code	Sub Code	PDI Interface	Comment
FB1311	0140	µController	16/8 bit asynchronous Microcontroller Interface
FB1311	0141	SPI	Serial Peripheral Interface (Slave)
FB1311	0142	Digital IO	32 bit In/Out digital interface

3   Process Data Interfaces

The ET1100 supports three process data interfaces (PDI) Digital IO, µ-Controller and SPI. Thus, the variants 0140, 0141 and 0142 of the FB1311 reflect the three PDIs. Table 3 is showing the three different pinouts on the PDI connector (Figure 2) of the FB1311 variants.

3.1   Pinout

Table 3: Pinout for different PDI Configurations

Pin number	Port	0142 - 32bit Digital IO	0141 - SPI	0140 - 16bit as. µC
1		GND		
2	PA0	I/O[0]	GPI[6]	A[0]
3	PA1	I/O[1]	GPI[5]	A[1]
4	PA2	I/O[2]	GPI[4]	A[2]
5	PA3	I/O[3]	GPO[7]	A[3]
6	PA4	I/O[4]	GPO[6]	A[4]
7	PA5	I/O[5]	GPO[5]	A[5]
8	PA6	I/O[6]	GPO[4]	A[6]
9	PA7	I/O[7]	GPI[3]	A[7]
10		GND		
11	PB0	I/O[8]	GPI[2]	A[8]
12	PB1	I/O[9]	GPI[1]	A[9]
13	PB2	I/O[10]	GPI[0]	A[10]
14	PB3	I/O[11]	GPO[3]	A[11]
15	PB4	I/O[12]	GPO[2]	A[12]
16	PB5	I/O[13]	EEPROM Loaded	
17	PB6	I/O[14]	GPO[1]	A[13]
18	PB7	I/O[15]	GPI[11]	CPU_CLK_IN
19		GND		
20	PC0	I/O[16]	GPI[7]	D[0]
21	PC1	I/O[17]	GPO[8]	D[1]
22	PC2	I/O[18]	SPI_SEL	D[2]
23	PC3	I/O[19]	GPO[10]	D[3]
24	PC4	I/O[20]	GPO[11]	D[4]
25	PC5	I/O[21]	GPI[8]	D[5]
26	PC6	I/O[22]	SPI_INT	D[6]
27	PC7	I/O[23]	GPI[10]	D[7]
28		GND		
29	PD0	I/O[24]	SPI_D_IN	D[8]
30	PD1	I/O[25]	GPO[13]	D[9]
31	PD2	I/O[26]	SPI_D_OUT	D[10]
32	PD3	I/O[27]	GPO[15]	D[11]
33	PD4	I/O[28]	GPI[12]	D[12]
34	PD5	I/O[29]	GPI[13]	D[13]
35	PD6	I/O[30]	GPI[14]	D[14]
36	PD7	I/O[31]	GPI[15]	D[15]
37		GND		
38	PE0	WD_TRIGGER	SPI_CLK	nCS
39	PE1	OUT_VALID	N.C.	nRD
40	PE2	SOF	N.C.	nWR

Pin number	Port	0142 - 32bit Digital IO	0141 - SPI	0140 - 16bit as. µC
41	PE3	N.C.	N.C.	nBHE
42	PE4	SYNC[0]/LATCH[0]		
43	PE5	SYNC[1]/LATCH[1]		
44	PE6	LATCH_IN	N.C.	nINT
45	PE7	OE	N.C.	nBUSY
46		GND		
47		VCC		
48		N.C.		
49		VCC (5V Input)		
50		3.3V Out		
51	PF0	OE_CONF	GPO[0]	A[14]
52	PF1	CLK25_OUT	N.C.	A[15]

3.2 Using the FB1311-0142 in different PDI modes

The FB1311-0142 supplies all process data signals of the ET1100 on its PDI connector. Therefore, the FB1311-0142 can be configured to operate in digital, SPI- or µC-Mode. The following table (Table 4) shows the signal definitions on the FB1311-0142s PDI connector.

Table 4 Pinout of the FB1311-0142 in Digital, SPI and µC PDI-Mode

Pin number	Port	32 Bit Digital IO	SPI	16bit as. µC
1		GND		
2	PA0	I/O[0]	SPI_CLK	CS
3	PA1	I/O[1]	SPI_SEL	RD
4	PA2	I/O[2]	SPI_DI	WR
5	PA3	I/O[3]	SPI_DO	BUSY
6	PA4	I/O[4]	SPI_IRQ	IRQ
7	PA5	I/O[5]	N.C.	BHE
8	PA6	I/O[6]	EEPROM Loaded	
9	PA7	I/O[7]	N.C.	ADR[15]
10		GND		
11	PB0	I/O[8]	GPO[0]	ADR[14]
12	PB1	I/O[9]	GPO[1]	ADR[13]
13	PB2	I/O[10]	GPO[2]	ADR[12]
14	PB3	I/O[11]	GPO[3]	ADR[11]
15	PB4	I/O[12]	GPI[0]	ADR[10]
16	PB5	I/O[13]	GPI[1]	ADR[9]
17	PB6	I/O[14]	GPI[2]	ADR[8]
18	PB7	I/O[15]	GPI[3]	ADR[7]
19		GND		
20	PC0	I/O[16]	GPO[4]	ADR[6]
21	PC1	I/O[17]	GPO[5]	ADR[5]
22	PC2	I/O[18]	GPO[6]	ADR[4]
23	PC3	I/O[19]	GPO[7]	ADR[3]
24	PC4	I/O[20]	GPI[4]	ADR[2]
25	PC5	I/O[21]	GPI[5]	ADR[1]
26	PC6	I/O[22]	GPI[6]	ADR[0]
27	PC7	I/O[23]	GPI[7]	DATA[0]

Pin number	Port	32 Bit Digital IO	SPI	16bit as. µC
28		GND		
29	PD0	I/O[24]	GPO[8]	DATA[1]
30	PD1	I/O[25]	GPO[9]	DATA[2]
31	PD2	I/O[26]	GPO[10]	DATA[3]
32	PD3	I/O[27]	GPO[11]	DATA[4]
33	PD4	I/O[28]	GPI[8]	DATA[5]
34	PD5	I/O[29]	GPI[9]	DATA[6]
35	PD6	I/O[30]	GPI[10]	DATA[7]
36	PD7	I/O[31]	GPI[11]	CPU_CLK_IN
37		GND		
38	PE0	WD_TRIGGER	GPO[15]	DATA[11]
39	PE1	OUT_VALID	GPO[14]	DATA[10]
40	PE2	SOF	GPO[12]	DATA[8]
41	PE3	N.C.	GPI[14]	DATA[14]
42	PE4	SYNC[0]/LATCH[0]		
43	PE5	SYNC[1]/LATCH[1]		
44	PE6	LATCH_IN	GPI[12]	DATA[12]
45	PE7	OE	GPO[13]	DATA[9]
46		GND		
47		VCC		
48		N.C		
49		N.C.		
50		3.3V Out		
51	PF0	OE_CONF	GPI[13]	DATA[13]
52	PF1	CLK25_OUT	GPI[14]	DATA[15]
53	PF2	RESERVED		
54	PF3	RESERVED		
55	PF4	RESERVED		
56	PF5	RESERVED		

4   EtherCAT P

Detailed information concerning the EtherCAT P technology is given on online presence of the EtherCAT Technology Group (ETG):

www.ethercat.org/ethercatp

For customer specific EtherCAT P implementations an application note with the title

"Beckhoff Application Note: EtherCAT P Implementation Guide for Powered Devices"

is also available on the ETG online presence.

4.1   Supply Voltages

EtherCAT P provides two independent supply voltages Us and Up. Both supply voltages shall be isolated within the device or, if applicable, in any externally connected device.

Nominal supply voltage is 24V DC +20% / -15% according to IEC61131-2. It is recommended to not supply with a voltage below 24V.

Within a segment the voltage may drop below minimal voltage 20.4V.

4.2   System Voltage Us

Us is used to supply EtherCAT P device, externally connected sensors, and inputs.

4.3   Peripheral Voltage Up

Up is used to supply external actuators and outputs.

5 Electrical Specification

5.1 FB1311-014X - Ratings

Table 5: FB1311-014X Typical Ratings

Symbol	Parameter	Condition	Min	Typ	Max	Units
$U_{s\ Board}$	Board Supply Voltage		20.4	24	28.8	V
$I_{S\ Board}$	Board Supply Current	1 Port		60		mA
$\vartheta_{Storage}$	Storage temperature		0		55	°C
$\vartheta_{Ambient}$	Ambient temperature		0		50	°C

> **i** **Note** Additional information about the ratings, operation conditions and DC characteristics can be found in the EtherCAT ET1100 hardware data sheet.
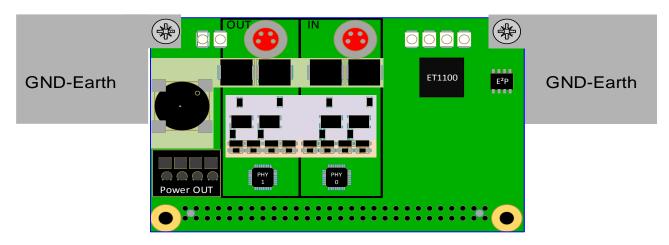
5.2 Power Out Connector - Ratings

Table 6: Power Out Connector Ratings

Symbol	Parameter	Condition	Min	Typ	Max	Units
U_s			20.4	24	28.8	V
I_S					3	A
U_p			20.4	24	28.8	V
I_p					3	A

5.3 EMC – Electro magnetic compatibility

For protection against damage caused by electrostatic discharge, the top left and right mounting holes of the EtherCAT piggyback controller board have to be connected to a massive panel or plate that is connected with GND-Earth. The remaining two holes have to be used for mechanical fixation of the piggyback controller board.

Figure 6 Ground Earth Connection

> **i** **Note** In case of a customer specific application of the FB1311-014X piggyback controller board, the customer has the responsibility to apply all necessary actions to guarantee conformance in terms of EMC requirements of the resulting application.

6   Mechanical Specification

As the FB1311-014X is designed for use with the EL9800 Evaluation Board only, Figure 7 is giving an overview of the board dimensions only.
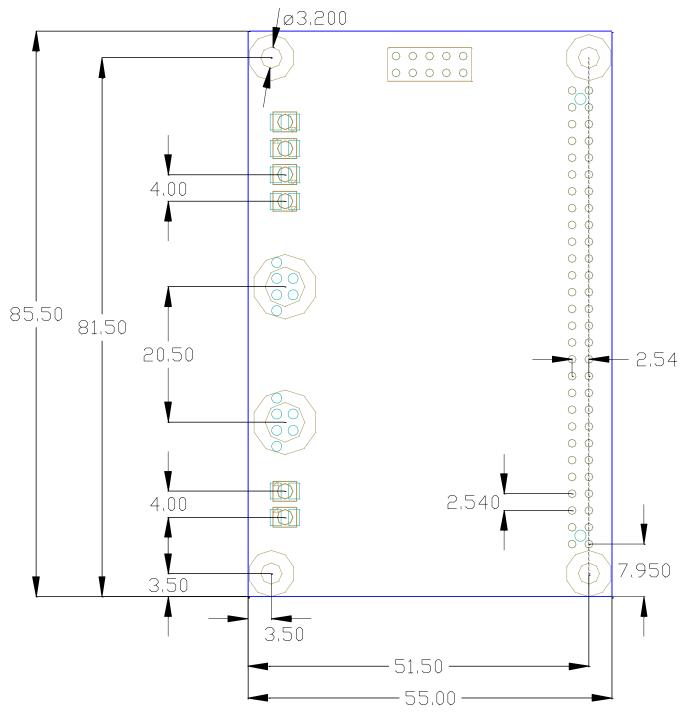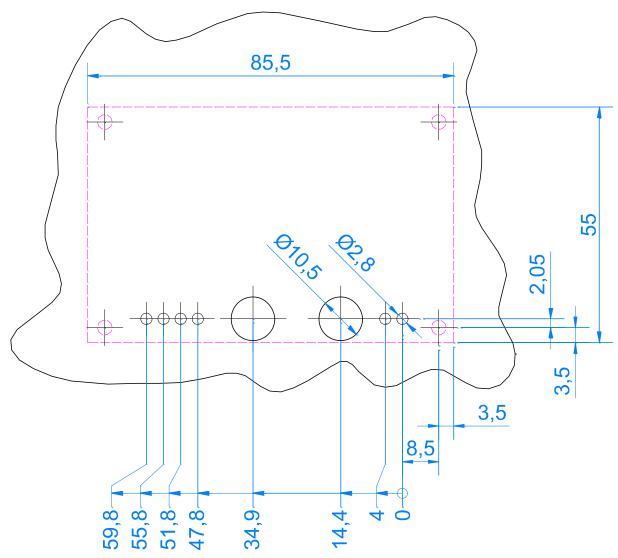
6.1   Board Dimensions

Figure 7 Board dimensions of the FB1311-014X – Top View

6.2   Physical Connector Specification

The PDI connector can be connected as well from the bottom as from the top side of the FB1311-014X. The bottom side low profile socket is equivalent to the *Samtec* (www.samtec.com) product with the manufacturer number CLH-128-L-D-BE-A-P-TR. Insertion depth from top side is 4.7 mm, respectively 3.2 mm from bottom side. A suitable pin header for the low profile socket can also be received from *Samtec*. The TSM series is suitable for the socket. As an example the pin header with the part number TSM-128-02-L-DV can be used to connect the EtherCAT piggyback controller board FB1311-014x.

6.3   Recommended Panel Opening

In Figure 8 a recommended panel opening is given.

Figure 8 Recommended Panel Opening

7 Appendix

7.1 Support and Service

Beckhoff and their partners around the world offer comprehensive support and service, making available fast and competent assistance with all questions related to Beckhoff products and system solutions.

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