20F305-00 E2 • 2018-06-26

F305

Quad Fast Ethernet & Real-Time Ethernet Interface Board

3U CompactPCI

User Manual

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About this Document

This user manual is intended only for system developers and integrators, it is not intended for end users.

It describes the design, functions and connection of the product. The manual does not include detailed information on individual components (data sheets etc.).

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F305 product page with up-to-date information and downloads:
www.men.de/products/f305/

History

Issue	Comments	Date
E1	First issue	2016-09-29
E2	▪ EtherCAT trademark information ▪ Additional information regarding compliances ▪ Minor updates in descriptions and layout	2018-06-26

Conventions

Indicates important information or warnings concerning situations which could result in personal injury, or damage or destruction of the component.

Indicates important information concerning electrostatic discharge which could result in damage or destruction of the component.

Indicates important information or warnings concerning proper functionality of the product described in this document.

The globe icon indicates a hyperlink that links directly to the Internet. When no globe icon is present, the hyperlink links to specific information within this document.

Italics	Folder, file and function names are printed in *italics*.
Comment	Comments embedded into coding examples are shown in green text.
IRQ# /IRQ	Signal names followed by a hashtag "#" or preceded by a forward slash "/" indicate that this signal is either active low or that it becomes active at a falling edge.
In/Out	Signal directions in signal mnemonics tables generally refer to the corresponding board or component, "in" meaning "to the board or component", "out" meaning "from the board or component".
`0xFF`	Hexadecimal numbers are preceded by "`0x`".
`0b1111`	Binary numbers are preceded by "`0b`".

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- Hold components by the edges and try not to touch the IC chips, leads, or circuitry.
- Use a grounded wrist strap before handling computer components.
- Place components on a grounded antistatic pad or on the bag that came with the component whenever the components are separated from the system.
- Only store the product in its original ESD-protected packaging. Retain the original packaging in case you need to return the product to MEN for repair.

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Since July 1, 2006 all MEN standard products comply with RoHS legislation.

Since January 2005 the SMD and manual soldering processes at MEN have already been completely lead-free. Between June 2004 and June 30, 2006 MEN's selected component suppliers have changed delivery to RoHS-compliant parts. During this period any change and status was traceable through the MEN ERP system and the boards gradually became RoHS-compliant.

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Nevertheless, MEN is registered as a manufacturer in Germany. The registration number can be provided on request.

Germany

MEN Mikro Elektronik GmbH
Neuwieder Straße 3-7
90411 Nuremberg
Phone +49-911-99 33 5-0

info@men.de
www.men.de

France

MEN Mikro Elektronik SAS
18, rue René Cassin
ZA de la Châtelaine
74240 Gaillard
Phone +33-450-955-312

info@men-france.fr
www.men-france.fr

USA

MEN Micro Inc.
860 Penllyn Blue Bell Pike
Blue Bell, PA 19422
Phone 215-542-9575

sales@menmicro.com
www.menmicro.com

China

MEN Mikro Elektronik Co., Ltd.
Room 301A,
#971 Dongfang Road
200122 Shanghai
Phone +86-21-5058-0963

sales@men-china.cn
www.men-china.cn

1 Product Overview

1.1 Product Description

Fast Ethernet for Railway Applications

The F305 is a 3U CompactPCI 100-Mbit/s networking controller with a strong focus on railway applications. It comes in a compact 4 HP, one-slot width even with its rugged M12 connectors.

The card provides four Fast Ethernet channels, supporting full-duplex or half-duplex with 10BASE-T and 100BASE-TX physical layers for distances up to 100 m.

As an assembly option, the board is available with or without a real-time Ethernet controller and extended connectivity, making it scalable to system requirements.

Real-Time Ethernet for menTCS

The F305 has a special function as the real-time Ethernet component inside the controller of the MEN Modular Train Control System. menTCS is a platform to perform safe control functions, for example in rolling stock applications like Automated Train Operation (ATO) or Automated Train Protection (ATP). It usually consists of the MH50C menTCS controller system and safe remote I/O boxes.

Ring Topology

The distributed menTCS subsystems are connected via RT Ethernet in ring topology, which tolerates single failures. For example, in case of a broken cable, the entire system is still fully operational, as all menTCS subsystems can still be reached from the other end of the ring. The F305 offers the capability of short-connecting two front channels via software.

See Chapter 3.3.1 menTCS Ring Topology on page 23 and Chapter 3.2.4.1 Loop Function on page 21.

Access to System-Internal menTCS I/O Cards

In menTCS systems the F305 has a direct link to I/O cards on the same backplane, using the menTCS EBUS, power supply, and address lines. As the F305 itself has no special safety mechanisms and certification, the board must be considered as a black channel.

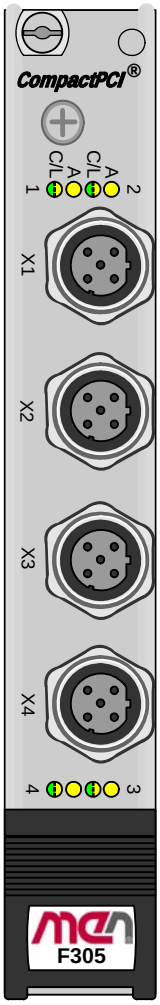
EN 50155 Rolling Stock and EN 50121-4 / EN 50125-3 Wayside Compliance

The F305 was fully designed to meet the requirements both for vehicle and wayside applications. Its operating temperature complies with the class TX specifications of -40 to +70 °C (10 minutes up to +85 °C). Standard boards include conformal coating.

Along with its railway standard compliance and long-term availability of a minimum 10 years, the F305 is a rail-ready component, saving time to market and costs.

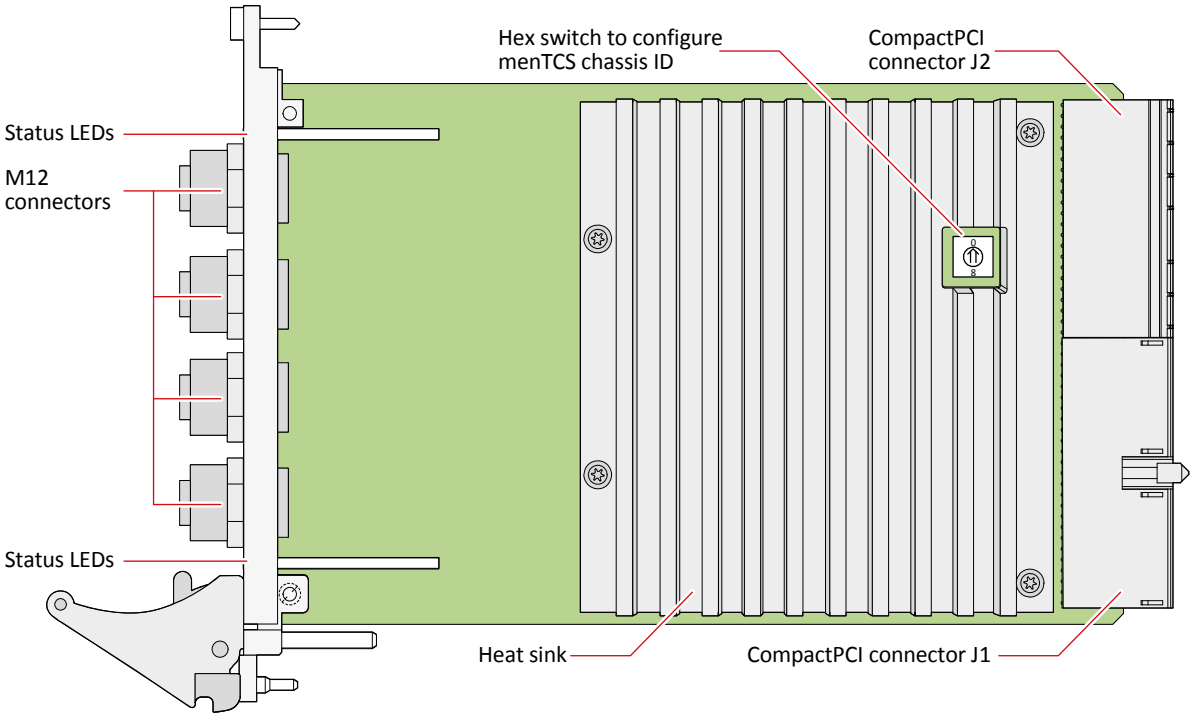
1.2 External Interfaces

Figure 1. Front interfaces



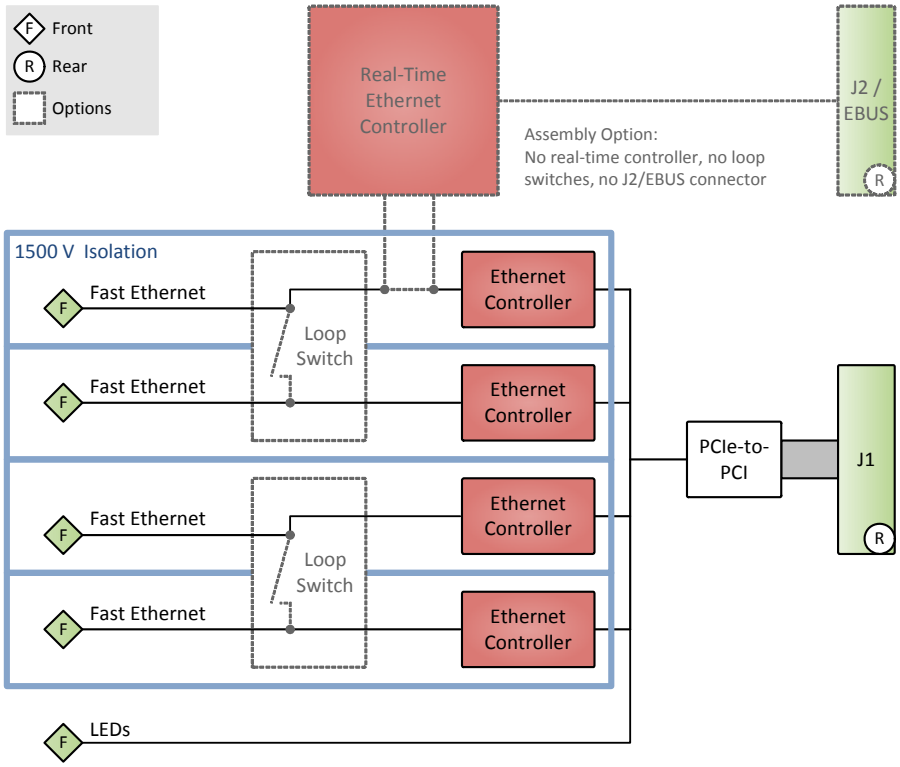
1.3 Board Layout

Figure 2. Board layout – top view



1.4 Block Diagram

Figure 3. Block diagram



1.5 Technical Data

Front Interfaces

- Ethernet
  - Four M12 connectors, 100BASE-T
  - Two link and activity LEDs per channel
  - Channel 1/2 and channel 3/4 can be software-switched to form a loop; optional

Rear Interfaces

- EBUS; optional
  - Two real-time Ethernet channels, ETG.1000
- menTCS; optional
  - Chassis ID

Backplane Standard

- CompactPCI Core Specification PICMG 2.0 R3.0
  - Peripheral slot
  - 32-bit/33-MHz CompactPCI bus
  - V(I/O): +3.3 V (+5 V tolerant)
- ETG.1000 EBUS; optional

Electrical Specifications

- Supply voltages
  - +5 V (-5%/+5%)
  - +3.3 V (-5%/+5%)
- Power consumption
  - +5 V: 0.7 A typ. (model 02F305-00)
  - +3.3 V: 1.24 A typ. (model 02F305-00)
- Isolation voltage
  - 1500 V AC

Mechanical Specifications

- Dimensions: 3U, 4 HP
- Weight: 294 g (model 02F305-00)

Environmental Specifications

- Classification for railway applications
  - EN 50155: Rolling stock, vehicle body
  - EN 50125-3: Wayside, at least 3 m off the track inside a switch box
- Temperature range (operation):
  - -40°C to +85°C (qualified components) (EN 50155, class TX; EN 50125-3, low temp. class T2, high temp. class TX)
- Cooling concept
  - Air-cooled, natural convection
- Temperature range (storage): -40°C to +85°C

- Humidity
  - EN 50155: Rolling stock, vehicle body
  - EN 50125-3: Wayside, at least 3 m off the track inside switch box
- Vibration/Shock
  - EN 50155: Rolling stock, vehicle body class B
  - EN 50125-3: Wayside, at least 3 m off the track
- Altitude: -300 m to +3000 m
- Pollution Degree: PD 2
- Useful Life: 20 years

Reliability

- MTBF: 756 598 h @ 40°C according to IEC/TR 62380 (RDF 2000) (model 02F305-00)

Safety

- Electrical Safety
  - EN 50155: Rolling stock, vehicle body
  - EN 50121-4: Wayside, at least 3 m off the track
- Flammability
  - UL 94V-0
- Fire Protection
  - EN 45545

EMC

- EN 50155: Rolling stock, vehicle body
- EN 50121-4: Wayside at least 3 m off the track

Software Support

- Windows
- Linux
- QNX

See the MEN website for supported operating system versions and drivers:
www.men.de/products/f305/#downl

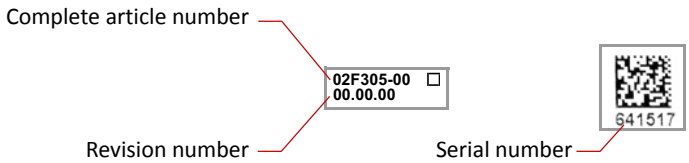
1.6 Product Identification

MEN user documentation may describe several different models and/or design revisions of the F305. You can find information on the article number, the design revision and the serial number on two labels affixed to the board.

- **Article number:** Indicates the product family and model. This is also MEN's ordering number. To be complete it must have 9 characters.
- **Revision number:** Indicates the design revision of the product.
- **Serial number:** Unique identification assigned during production.

If you need support, you should communicate these numbers to MEN.

Figure 4. Product labels



2 Getting Started

2.1 Connecting and Starting

You can use the following check list when installing the board in a system for the first time and with minimum configuration.

- » Power down the system.
- » Insert the F305 into a peripheral slot of your CompactPCI system, making sure that the backplane connectors are properly aligned.

Note: The peripheral slots of every CompactPCI system are marked by a circle on the backplane and/or at the front panel.

- » Power up the system.

2.1.1 Configuring the UEFI Firmware in MEN F21P, F22P and F23P CPU Boards

If you are using the F305 in a CompactPCI system controlled by an MEN F21P, F22P or F23P CPU board, you must apply a specific setting in the CPU board firmware for the two boards to function together properly:

- » Enter the CPU board's UEFI firmware setup menu by hitting the <F2> key at system start-up.
- » In the setup menu, go to sub-menu *Advanced* > *Peripheral Configuration*.
- » Set option *Workaround for MEN F223* to *Enabled*.

Note: This workaround applies to a number of MEN CompactPCI peripheral boards that use a specific PCIe-to-PCI bridge and ensures correct PCI detection.

2.2 Installing Driver Software

For a detailed description on how to install driver software, please refer to the respective documentation of the software package to be installed.

See the MEN website for all available software:
www.men.de/products/f305/#downl

2.3 Using the F305 under Linux

This chapter describes how to use Linux software together with the F305. A detailed step-by-step description is given where needed.

2.3.1 Configuring the F305 Loop Mode

Note: The F305 with its real-time Ethernet option is designed for usage in a menTCS system. In this context, it is controlled using Linux. Operation of F305 using a different operating system is not likely. If you need to configure the loop mode under a different OS, however, this can be done in the same way as under Linux, by direct access to the Control Register as described below.

To configure the F305 loop mode, you have to set bits directly in the Channel Loop Control Register implemented in the PCIe-to-PCI bridge.

» On the CompactPCI system CPU where the F305 is plugged in, open a Linux command line and log in as a root user.

» Use the *lspci -nn* command to display the PCI slot address, vendor and device ID. As there can be several bridges of the same type in your system, especially with an F75P CPU board, take care to locate the right bridge device. The F305's network interfaces are always located directly below the F305 PCI bridge.

```
$ lspci -nn

[...]
There are two identical PCI bridges:
03:00.0 PCI bridge [0604]: Pericom Semiconductor PI7C9X110 PCI Express
to PCI bridge [12d8:e110] (rev 04)
04:0f.0 PCI bridge [0604]: Pericom Semiconductor PI7C9X110 PCI Express
to PCI bridge [12d8:e110] (rev 04)
The second bridge is followed by network interfaces:
05:00.0 PCI bridge [0604]: PLX Technology, Inc. PEX 8606 6 Lane, 6
Port PCI Express Gen 2 (5.0 GT/s) Switch [10b5:8606] (rev ba)
06:01.0 PCI bridge [0604]: PLX Technology, Inc. PEX 8606 6 Lane, 6
Port PCI Express Gen 2 (5.0 GT/s) Switch [10b5:8606] (rev ba)
06:05.0 PCI bridge [0604]: PLX Technology, Inc. PEX 8606 6 Lane, 6
Port PCI Express Gen 2 (5.0 GT/s) Switch [10b5:8606] (rev ba)
06:07.0 PCI bridge [0604]: PLX Technology, Inc. PEX 8606 6 Lane, 6
Port PCI Express Gen 2 (5.0 GT/s) Switch [10b5:8606] (rev ba)
06:09.0 PCI bridge [0604]: PLX Technology, Inc. PEX 8606 6 Lane, 6
Port PCI Express Gen 2 (5.0 GT/s) Switch [10b5:8606] (rev ba)
07:00.0 Ethernet controller [0200]: Intel Corporation I211 Gigabit
Network Connection [8086:1539] (rev 03)
08:00.0 Ethernet controller [0200]: Intel Corporation I211 Gigabit
Network Connection [8086:1539] (rev 03)
09:00.0 Ethernet controller [0200]: Intel Corporation I211 Gigabit
Network Connection [8086:1539] (rev 03)
[...]
```

In our example, this is the lower of the two identical bridge devices, i.e. the F305 is located on '`04:0F.0`' on the CompactPCI bus.

Using the slot address and the Channel Loop Control Register's offset address, `0x78`, you can directly access the register to write the respective command to configure the loop mode, or to read back the setting.

Setting the Channel Loop Mode

*Table 1. Channel loop mode commands for Channel Loop Control Register (**0x78**)*

Hex Command	Channel 1 and 2	Channel 3 and 4
0x00505000	Loop operation (reset state)	Loop operation (reset state)
0x01010000	Normal operation	No change
0x04040000	No change	Normal operation
0x00101000	Loop operation	No change
0x00404000	No change	Loop operation
0x05050000	Normal operation	Normal operation

» For example, configure all channels from loop mode to normal, unlooped operation:

```
$ setpci -s 04:0f.0 0x78.L=0x05050000
```

Reading Back the Channel Loop Mode Configuration

You can read back the last command setting from the Channel Loop Control Register. The first digit reflects the channel loop mode setting.

» Read out the channel mode configuration:

```
$ setpci -s 04:0f.0 0x78.L
```

Table 2. Channel loop mode read-back values

Read-Back Value	Channel 1 and 2	Channel 3 and 4
0x0xxxxxxx	Loop operation (reset state)	Loop operation (reset state)
0x3xxxxxxx	Normal operation	Loop operation
0xCxxxxxxx	Loop operation	Normal operation
0xFxxxxxxx	Normal operation	Normal operation

3 Functional Description

3.1 Power Supply

The F305 is supplied via the backplane.

3.2 Ethernet

The F305 supports:

- Half-duplex operation
- Full-duplex operation

3.2.1 Front Connection

Table 3. Connector types – 4-pin M12 D-coded

Connector	Type
On F305	4-pin M12 receptacle, D-coded (Phoenix Contact SACC-CI-M12FSD-4CON-L90 – 1440708)
Mating	4-pin M12 plug D-coded

Table 4. Pin assignment – Ethernet (4-pin M12)

1	TX+
2	RX+
3	TX-
4	RX-

Note: Although five pins are visible at the front, the connector only uses four pins.

Table 5. Signal mnemonics – Ethernet

Signal	Direction	Function
RX+/-	in	Differential pair of receive data lines for 10BASE-T or 100BASE-T
TX+/-	out	Differential pair of transmit data lines for 10BASE-T or 100BASE-T

3.2.2 Ethernet MAC Addresses

The naming of the interfaces may differ depending on the operating system. The MAC addresses on F305 are:

Table 6. Ethernet MAC addresses

Interface	Position	Base Address
X1	Upper front	`0x 00 C0 3A AE 61 00`
X2	Front	`0x 00 C0 3A AE 63 00`
X3	Front	`0x 00 C0 3A AE 65 00`
X4	Lower front	`0x 00 C0 3A AE 67 00`

"00 C0 3A" is the MEN vendor code. The last six digits form the unique MAC address for each board. The serial number is added by the last two digits in the range:

Serial number 42 (X1): `0x6100 + 0x002A = 0x612A.`

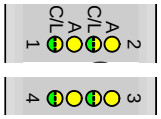
See Figure 1, Front interfaces on page 10.

3.2.3 Ethernet Status LEDs

Bicolor LEDs are used to indicate either the Ethernet link status or the loop status of the Ethernet channels.

See Figure 1, Front interfaces on page 10 for the position of the LEDs.

Table 7. Ethernet status LEDs

Appearance	Label	Color	Function
	C/L [1:4]	Green	Indicates the link status ▪ On: Link up ▪ Off: No link ▪ Blinking: n/a
		Yellow	Indicates the loop status ▪ On: Closed loop between Ethernet channels 1 and 2, or 3 and 4 ▪ Off: No link, no loop ▪ Blinking: n/a
	A [1:4]	Yellow	Indicates Ethernet activity ▪ On: n/a ▪ Off: No activity ▪ Blinking: Transmit/Receive activity

3.2.4 Real-Time Ethernet (Optional)

As an assembly option, the board is also available with a real-time Ethernet controller, loop function and a CompactPCI J2 connector for menTCS MEN Train Control System connectivity.

See Chapter 3.3 menTCS System Integration on page 23 for more information on functional integration in menTCS systems.

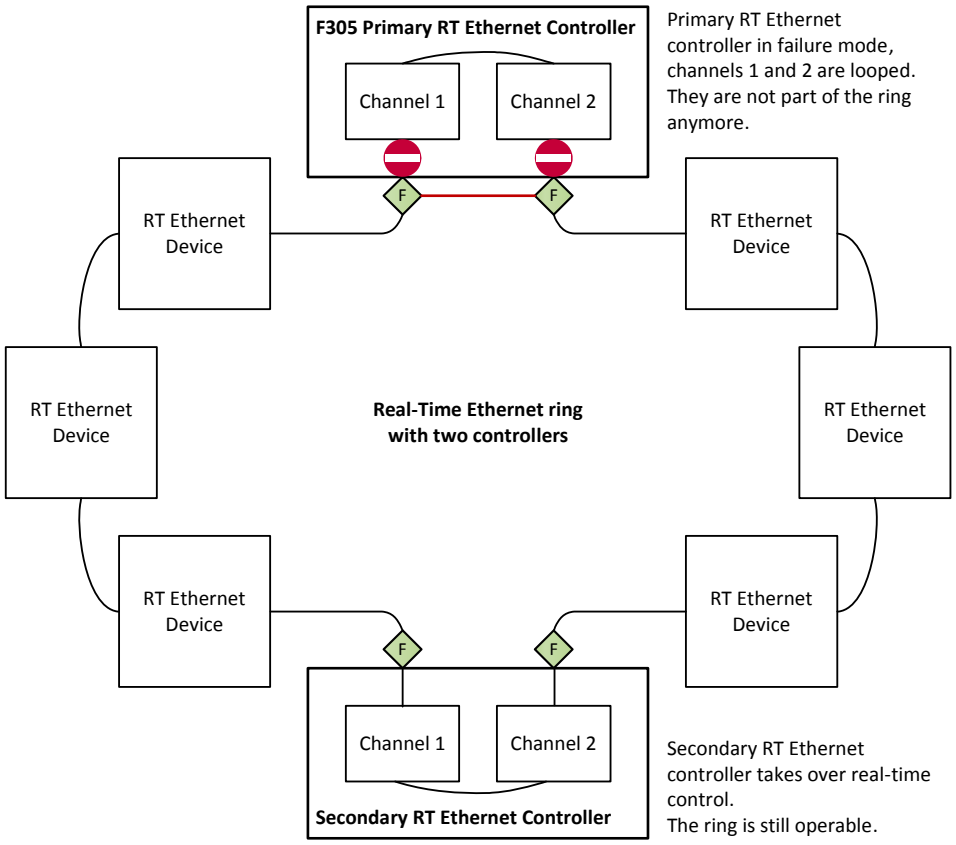
3.2.4.1 Loop Function

Models with real-time (RT) Ethernet offer the capability of short-connecting, or looping, front channels 1 and 2, and front channels 3 and 4. This allows to exclude the looped channels from the ring in case of a failure, leaving the ring intact for the other devices. This increases availability in ring topologies with at least two RT Ethernet controllers.

The loop setting is software-configurable. By default the F305 loops both channel pairs.

See Chapter 2.3.1 Configuring the F305 Loop Mode on page 17.

Figure 5. Real-time Ethernet ring topology with F305 channel 1 and 2 in loop mode



See Chapter 3.3.1 menTCS Ring Topology on page 23 for implementation in menTCS systems.

3.2.5 Isolation between Ethernet Channels

All four Ethernet channels are isolated from each other and support an isolation voltage of 1500 V AC.

In real-time Ethernet configuration, channels 1 and 2 as well as 3 and 4 can be looped. In this case, there is no isolation between channel 1 and 2, and between channel 3 and 4.

3.3 menTCS System Integration

F305 can be a part of a menTCS controller system.

A menTCS system is an EtherCAT network, consisting of the following components:

- menTCS controller, e.g., MH50C: EtherCAT Master
- menTCS remote I/O, e.g., KT8: EtherCAT Slave

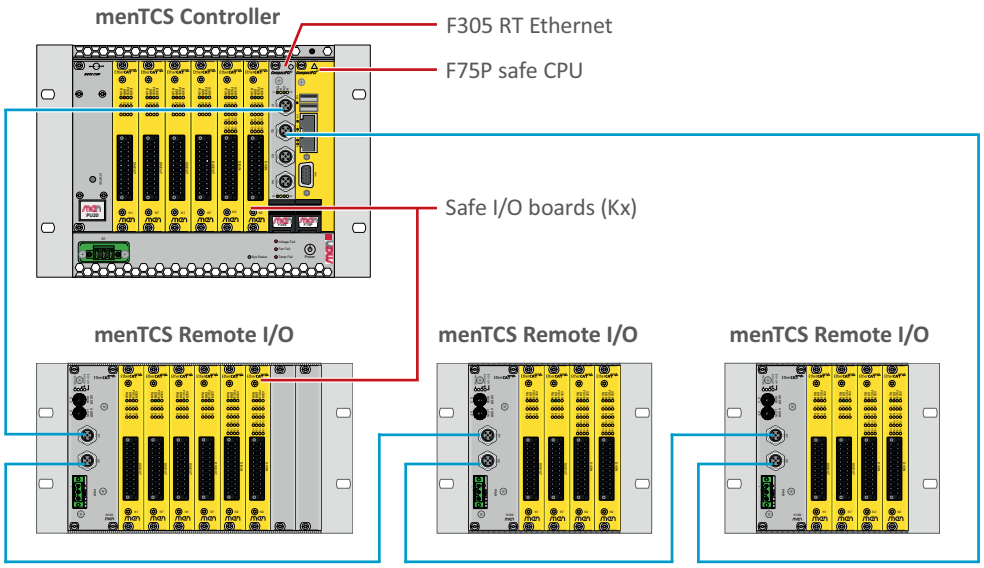
- See the menTCS System Manual for details on implementation of menTCS components with regard to different SIL requirements, use cases and a detailed description of software and start-up procedures.
- See the Downloads section on the MEN website for a complete list of menTCS related literature.

3.3.1 menTCS Ring Topology

The distributed menTCS subsystems are connected via EtherCAT real-time Ethernet in ring topology, which tolerates single failures. For example, in case of a broken cable, the entire system is still fully operational, as all menTCS subsystems can still be reached from the other end of the ring.

The F305 EtherCAT component inside the menTCS controller provides a communication interface between the safe CPU board and the I/O boards inside the chassis, and between a menTCS controller system and menTCS safe remote I/O boxes.

Figure 6. menTCS ring topology with system controller and remote I/O boxes



The upper two Ethernet front interfaces of F305 are used to close an RT Ethernet ring. They connect to menTCS remote I/O boxes. Channel 1 also makes a connection to the I/O cards located inside the MH50C menTCS controller system, using EtherCAT over the chassis backplane.

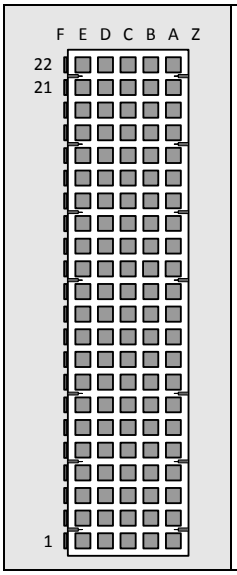
The lower two Ethernet front interfaces of F305 can be used for general-purpose Ethernet traffic or for a second RT Ethernet ring.

3.3.2 menTCS Backplane Connections

In menTCS systems the EtherCAT controller and safe I/O cards are directly linked via the backplane, using the menTCS ETG.1000 EBUS and the chassis ID. This allows the safe CPU board inside the menTCS controller system to communicate with the menTCS I/O cards.

The F305 implements this menTCS backplane connection using CompactPCI connector J2. It provides two EBUS ports between the F305's EtherCAT controller, connected to Ethernet channel 1, and connector J2.

Table 8. Pin assignment – CompactPCI J2



	F	E	D	C	B	A	Z
22	GND	-	-	-	-	-	GND
21	GND	EB3_RX+	-	EB2_RX+	-	-	GND
20	GND	EB3_RX-	-	EB2_RX-	-	-	GND
19	GND	EB3_TX+	-	EB2_TX+	-	-	GND
18	GND	EB3_TX-	-	EB2_TX-	-	-	GND
17	GND	CHASSIS_ID_SDAT	-	-	-	-	GND
16	GND	CHASSIS_ID_SCLK	-	-	-	-	GND
15 – 1	GND	-	-	-	-	-	GND

Table 9. Signal mnemonics – CompactPCI J2

Signal	Direction	Function
CHASSIS_ID_SCLK	out	Chassis ID clock line, for chassis identification
CHASSIS_ID_SDAT	out	Chassis ID data line, for chassis identification
EB2_RX+/-	in	EBUS upstream port, receive data lines
EB3_TX+/-	out	EBUS downstream port, transmit data lines
GND	-	Ground

3.3.2.1 menTCS Chassis ID

All menTCS boxes, i.e. chassis, inside a system have a unique chassis ID to be identifiable in an EtherCAT network.

As there can be up to two menTCS controller boxes inside a system, the chassis ID of the controller box is permanently defined by the F305 real-time Ethernet card. This ensures that even if there is a second Ethernet master in the menTCS system, each master system box has its own unique EtherCAT address.

The F305 has an onboard hex switch to set the menTCS chassis ID either to `0x00` or `0x01`.

Table 10. Hex switch positions to set menTCS Controller chassis ID via F305

Hex Switch Position	Chassis ID (Hex Address)	Hex Switch Position	Chassis ID (Hex Address)
0	`0x00`	1	`0x01`
2		3	
4		5	
6		7	
8		9	
A		B	
C		D	
E		F	

Every system box within a menTCS system must have a unique chassis ID. If by mistake two or more identical chassis IDs were hardware-configured or were entered in the PACY configuration, the related boxes will be non-operational.
The menTCS controller box must have a chassis ID of either `0x00` or `0x01`.

3.4 CompactPCI

3.4.1 J1

The pin assignment of rear connector J1 complies with the CompactPCI specification.

CompactPCI Specification PICMG 2.0 R3.0:
1999; PCI Industrial Computers Manufacturers Group (PICMG)
www.picmg.org

3.4.2 J2 (Optional)

F305 models with real-time Ethernet also include a CompactPCI J2 connector for board communication inside a menTCS system.

See Chapter 3.3.2 menTCS Backplane Connections on page 24.

4 Hardware/Software Interface

This chapter is intended for software developers or board integrators who need deeper knowledge of the implementation details of the F305 interfaces and its internal connections.

4.1 PCI Identification

The F305 has the following IDs on the PCI bus:

- PCI Device ID: `0xE110` (PCIe-to-PCI bridge)
- PCI Vendor ID: `0x12D8` (Pericom)