User Manual

PU5/PU6/PU8 – 3U 12HP wide-range PSUs for 19" systems

110, 24 or 36 VDC nom.

PU5 - 3U 12 HP Power Supply Unit PSU, 110 VDC, 100 W

The PU5 is a plug-in power supply unit for 19" systems (e.g. VMEbus, CompactPCI®) and is especially designed for computer systems in public transport vehicles, being fully compliant with EN 50155.

The PU5 has a nominal input voltage of 110 VDC with a wide input range of 77..137.5 V and a max. input voltage range of 66..154 V (according to EN50155). The otherwise identical PSU models PU6 and PU8 are available for the nominal input voltages of 24 VDC and 36 VDC respectively.

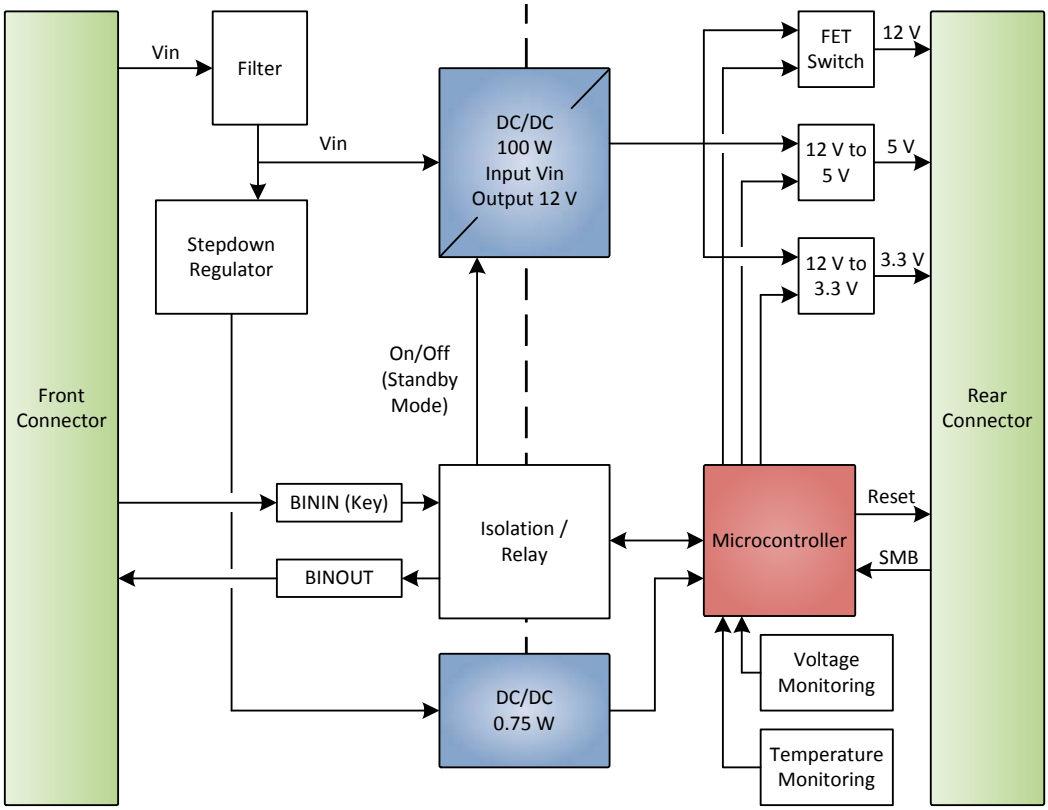
It is controlled by a microprocessor which supervises the voltage and the temperature as well as one external input (for its key input function) and one output.

Thanks to the onboard intelligence the PSU can also act as an SMBus slave and communicate with the CPU board via the backplane. This allows the PSU to power on the system at a programmed date and enables the CPU to make status polls with regard to, e.g., error messages, time-out or on/off.

The PSU provides a DC/DC converter to generate the isolated 12 V from the input voltage. Two regulators generate 5 V and 3.3 V from the 12 V isolated side. The maximum power at full load is 100 W, minimum power is 5 W. The microprocessor is supplied with power independently and can turn off the main DC/DC converter to switch the unit into standby mode (power consumption less than 6 W).

The subassembly is conformally coated, and components are secured against vibration. The PSU operates in -40 to +85°C environmental temperature. The thermal stress is extremely low due to integrated heat sinks and diversion of dissipated heat over the mounting surface.

Diagram


Front Connector
Vin
Filter
Vin
Stepdown Regulator
DC/DC 100 W Input Vin Output 12 V
On/Off (Standby Mode)
BININ (Key)
BINOUT
Isolation / Relay
DC/DC 0.75 W
FET Switch
12 V
12 V to 5 V
5 V
12 V to 3.3 V
3.3 V
Microcontroller
Reset
SMB
Voltage Monitoring
Temperature Monitoring
Rear Connector

Technical Data

Microcontroller

- Output voltage and temperature supervision (readable via SMBus)
- Overtemperature and overvoltage shutdown
- Communication with CPU
- Watchdog functionality
- Independent power supply for operation during standby mode (power consumption less than 1 W)

SMBus

- Signals on back connector
- Voltage level 3.3V
- Controlled by CPU
- Communication between the power supply unit and the CPU

Binary I/O

- 1 binary input
  - Voltage level according to external power supply input voltage (max. 154 VDC)
  - Electrically isolated
  - External switch (key) with binary input
  - Switch-on by key input or wake on time
  - Switch-off by key input or software
  - Status of binary inputs readable via SMBus
- 1 binary output
  - Voltage level according to external power supply input voltage
  - Isolated by relays
  - User-specific functionality (controllable via SMBus)
  - Maximum switching power: 60W (example 110V/0.5A)

Miscellaneous

- DC/DC Converter
  - Fuse-protected
- Two status LEDs on front panel
  - Green LED indicates correct input voltage
  - Yellow LED indicates correct output voltage
- Alternative power supply at the backplane for use as redundant PSU
- Short circuit protection
- Reverse polarity protection by internal protector

Input Characteristics

- Nominal voltage input: 110 VDC

- Wide input range: 0.7 x nominal voltage < nominal voltage < 1.25 x nominal voltage (according to EN50155)
  - 77..137.5 VDC
- Max. input voltage range: 0.6 x nominal voltage < nominal voltage < 1.4 x nominal voltage with full functionality for 0.1 s, no damage for 1 s (according to EN50155)
  - 66..154 VDC
- No load input power: < 5.8 W in standby mode

Output Characteristics

- Output power (max.): 100W
- Output power (min.): 5W
- 12V tolerance/overvoltage protection: ±5%
- 5V tolerance/overvoltage protection: +5%/-3%
- 3.3V tolerance/overvoltage protection: ±3%
- Overtemperature shutdown: 50×..90×(adjustable by SMBus command)
- Holdup time according to EN50155 Class S2

Connection

- Input and output via DIN 41612 plug connector, type H15

Electrical Specifications

- Isolation (according to EN50155)
  - Input/output: 1500VDC/1000V eff
  - Input/shield: 1500VDC/1000V eff
  - Output/shield: 1500VDC/1000V eff
  - Ground/shield: 1500VDC/1000V eff

Mechanical Specifications

- Dimensions: 3U, 12HP, 128.4mm height
- Integrated heat sink
- Weight: 1.1 kg

Environmental Specifications

- Temperature range (operation): -40..+85°C (no derating)
- Temperature range (storage): -40..+85°C
- Airflow: min. 10m³/h
- Shock: according to EN60068-2-27
- Continuous shock: according to EN60068-2-29
- Vibration: according to EN60068-2-6
- Protection
  - Class of protection: Class II, EN 60950
  - Degree of protection: IP20 (insert in rack), EN60529

MTBF

- 190,000+ h @ 40°C according to IEC/TR 62380 (RDF 2000)

EMC

- Tested according to EN55022 (radio disturbance), EN61000-4-2 (ESD), EN61000-4-4 (burst) and EN61000-4-5 (surge)

Software Support

- Driver software for SMB communication for Windows®, Linux, VxWorks®

For more information on supported operating system versions and drivers, please see the online data sheet.

Configuration Options

Mechanical Specifications

- 8HP model with smaller heat sink and derating tbd.

Please note that some of these options may only be available for large volumes. Please ask our sales staff for more information.

For available standard configurations see the online data sheet.

Product Safety

Electrostatic Discharge (ESD)

Computer boards and components contain electrostatic sensitive devices. Electrostatic discharge (ESD) can damage components. To protect the board and other components against damage from static electricity, you should follow some precautions whenever you work on your computer.

- Power down and unplug your computer system when working on the inside.
- 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 board in its original ESD-protected packaging. Retain the original packaging in case you need to return the board to MEN for repair.

About this Document

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

It describes the hardware functions of the board, connection of peripheral devices and integration into a system. It also provides additional information for special applications and configurations of the board.

The manual does not include detailed information on individual components (data sheets etc.). A list of literature is given in the appendix.

History

Issue	Comments	Date
E1	First edition	2009-06-30
E2	Updated standard width to 12HP, new cover photo PU8 added to PSU models covered by this manual Added more detailed information regarding input voltage range Corrected "no load input power" in technical data Cosmetics	2010-06-24
E3	Corrected pin assignment: removed SD_INT signals and alternate power inputs (not relevant for standard models), clarified pin assignment regarding binary outputs, updated block diagram accordingly Added connection example figure Added figure to binary output sub-chapter Added information regarding use in a redundant system with multiple PUx models connected in parallel Cosmetics	2010-12-20
E4	Corrected current rating of fuses	2014-10-22

Conventions

Indicates important information or warnings concerning the use of voltages that could lead to a hazardous situation which could result in personal injury, or 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, where the latest updated information is available.

When no globe icon is present, the hyperlink links to specific elements and information within this document.

italics	Folder, file and function names are printed in *italics*.
bold	**Bold** type is used for emphasis.
`mono`	A `monospaced` font type is used for hexadecimal numbers, listings, C function descriptions or wherever appropriate. Hexadecimal numbers are preceded by `"0x"`.
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 it the board or component".
	Blue vertical lines in the outer margin indicate sections where changes have been made to this version of the document.

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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.

WEEE Application

The WEEE directive does not apply to fixed industrial plants and tools. The compliance is the responsibility of the company which puts the product on the market, as defined in the directive; components and sub-assemblies are not subject to product compliance.

In other words: Since MEN does not deliver ready-made products to end users, the WEEE directive is not applicable for MEN. Users are nevertheless recommended to properly recycle all electronic boards which have passed their life cycle.

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

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Contents

1 Getting Started 16
1.1 Map of the Board 16
1.2 Integrating the Board into a System 16
1.3 Installing Driver Software 16
2 Connecting the PSU 17
2.1 Using the PSU in a Redundant Configuration 18
3 Functional Description 19
3.1 Microcontroller 19
3.2 Power Up 20
3.3 Power Down 20
3.4 Binary I/O 20
3.4.1 Binary Input 20
3.4.2 Binary Output 21
3.5 Status LEDs 22
3.6 SMBus 22
3.6.1 General 22
3.6.2 SMBus Interface 22
3.6.3 Wake On Time 23
3.6.4 Watchdog 23
3.6.5 Status of Binary Input and Output 25
3.6.6 Key Input 26
3.6.7 Shutdown 27
3.6.8 Voltage and Current Supervision 31
3.6.9 Temperature Supervision 32
3.6.10 PSU ID and Firmware Revision Number 33
3.7 DC/DC Converter 34
3.7.1 Fuse Protection 34
4 Appendix 35
4.1 Literature and Web Resources 35
4.2 Finding out the Board's Article Number, Revision and Serial Number 35

Figures

Figure 1. Map of the board – front panel and top view 16
Figure 2. Connection example 18
Figure 3. Microcontroller block diagram 19
Figure 4. Power up by key input 20
Figure 5. Binary output relay 21
Figure 6. Shutdown sequence 30
Figure 7. Position of fuse for DC/DC converter protection 34
Figure 8. Labels giving the board's article number, revision and serial number. 35

Tables

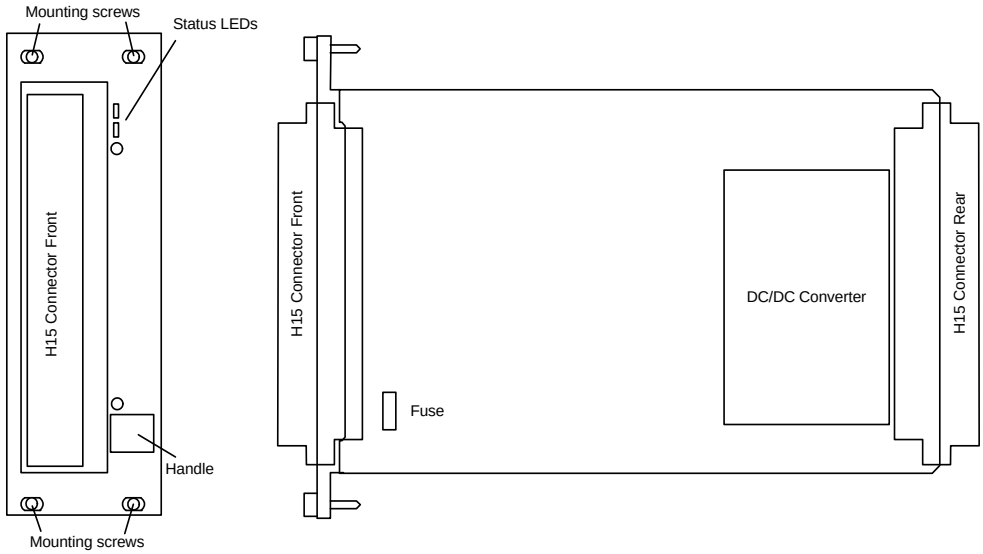
Table 1. Pin assignment of H15 PSU connector (front) 17
Table 2. Pin assignment of H15 PSU connector (rear) 17
Table 3. Signal mnemonics of PSU interfaces 17
Table 4. Status LEDs on the front panel 22
Table 5. SMBus commands for wake on time function 23
Table 6. SMBus commands AD78C_WOT_L/ AD78C_WOT_H 23
Table 7. SMBus commands for watchdog function 24
Table 8. SMBus command AD78C_WDOG_TOUT 24
Table 9. SMBus commands for binary input/output status 25
Table 10. SMBus commands for on acknowledge function 26
Table 11. SMBus on acknowledge timer modes 27
Table 12. SMBus command for shutdown by software function 27
Table 13. SMBus commands for shutdown delay 28
Table 14. SMBus command AD78C_STATUS 28
Table 15. SMBus command AD78C_DOWN_DELAY 28
Table 16. SMBus command for off delay function 29
Table 17. SMBus command AD78C_OFF_DELAY 29
Table 18. SMBus command for off acknowledge function 29
Table 19. MDIS Channels for the PU5/PU6/PU8 31
Table 20. SMBus voltage supervision commands 31
Table 21. SMBus commands for temperature supervision 32
Table 22. SMBus command AD78C_TEMP_HIGH 32
Table 23. SMBus commands for PSU ID and firmware revision number 33

1 Getting Started

This chapter gives an overview of the board and some hints for first installation in a system.

1.1 Map of the Board

Figure 1. *Map of the board – front panel and top view*



1.2 Integrating the Board into a System

This chapter gives important information on first installation of the PU5/PU6/PU8.

- Power down the system before installing or removing the PU5/PU6/PU8.
- Only operate the PU5/PU6/PU8 in a suitable housing, i.e. in such a way that no parts of the PU5/PU6/PU8 except the front panel can be touched.
- Make sure that enough airflow is provided.
- Do not remove any covers or other mechanical parts.
- The guiderails should be made of synthetic material and not touch any components.

1.3 Installing Driver Software

For a detailed description on how to install driver software please refer to the respective documentation.

You can find any driver software available for download on MEN's website.

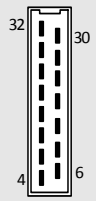
2 Connecting the PSU

The PU5/PU6/PU8 can be connected via two H15 connectors at the front and at the rear side.

Connector types:

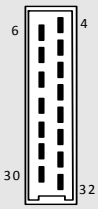
- 15-pin H15 receptacle according to IEC 60603-2
- Mating connector: 15-pin H15 plug according to IEC 60603-2

Table 1. *Pin assignment of H15 PSU connector (front)*



32	GND(I/O)	30	-
28	-	26	-
24	-	22	-
20	-	18	BINOUT RC2
16	-	14	BINOUT RC1
12	BININ	10	V_{in}-
8	-	6	V_{in}+
4	SHIELD		

Table 2. *Pin assignment of H15 PSU connector (rear)*



6	V_{out} 5V	4	GND_{out}
10	-	8	-
14	V_{out} 12V	12	V_{out} 3.3V
18	SMB CLK	16	CPCI_RST
22	SENSE 5V-	20	SMB DATA
26	SENSE 3.3V-	24	SENSE 5V+
30	SENSE 3.3V+	28	-
		32	SHIELD

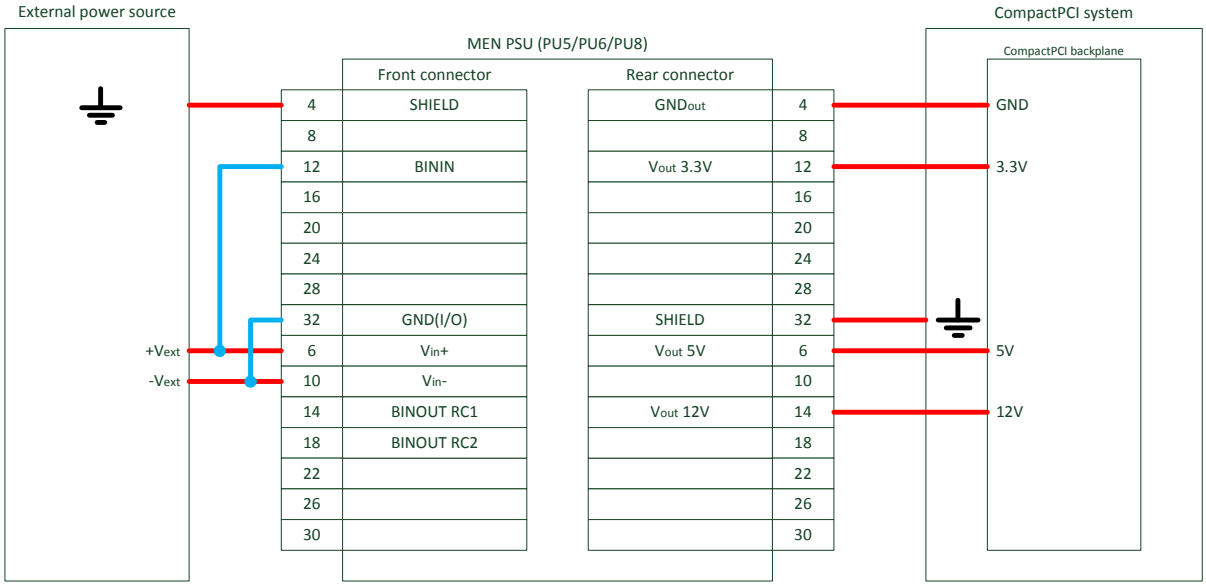
Note: Pin 32 is longer than the other pins.

Table 3. *Signal mnemonics of PSU interfaces*

Signal	Function
SHIELD	Connection to cable shield
V_{in}+	Supply input voltage
V_{in}-	Supply input voltage
BININ	Key input
BINOUT RC1	Binary output relay contact 1
BINOUT RC2	Binary output relay contact 2
GND(I/O)	Key input ground
GND_{out}	Ground for system
V_{out} 5V	5V supply for system

Signal	Function
V_{out} 3.3V	3.3V supply for system
V_{out} 12V	12V supply for system
CPCI_RST	Pushbutton reset
SMB CLK	SMBus clock
SMB DATA	SMBus data (handshake between CPU and PSU)
SENSE 5V-	External sense connection for 5V for a better voltage regulation with different loads
SENSE 5V+	External sense connection for 5V
SENSE 3.3V-	External sense connection for 3.3V
SENSE 3.3V+	External sense connection for 3.3V

Figure 2. *Connection example*



2.1 Using the PSU in a Redundant Configuration

The PU5/PU6/PU8 can be used in parallel with other PSUs of the same type for increased availability. There are a few limitations to such a configuration, though:

- It does not increase the maximum load.
- A failed PSU will not be able to sense that it has failed.
- Both PSUs operate at the same address, so do not use SMBus commands!

3 Functional Description

The functions described in the following chapter depend on the firmware. This user manual describes the functions realized in the current MEN standard firmware.

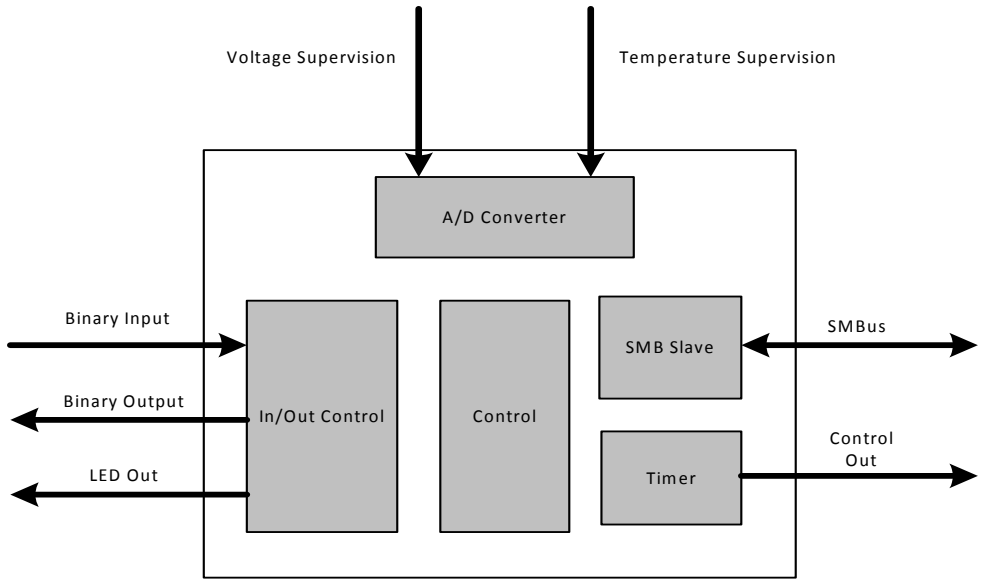
3.1 Microcontroller

The microcontroller is used as a control and supervision device of the DC/DC converter and of the binary inputs and outputs of the PSU. Additionally it is used as a watchdog for the CPU and the microcontroller itself. The microcontroller is connected to the SMBus of the CompactPCI system. It controls the binary output and is able to read the binary input. It is able to keep the power supply active, even if the external on/off-signal goes inactive.

The microcontroller controls the CompactPCI reset signal to be able to reset the complete CompactPCI bus. If a reset shall be performed the CompactPCI reset signal is asserted for 250 ms.

Note: An operating system like Windows needs a controlled power down sequence. The power supply of the CPU can be kept active via the SMBus even when the external on/off signal of the PU5/PU6/PU8 is inactive so that a controlled power down of the operating system is possible. For further information see Chapter 3.6.7.4 Off Delay on page 29.

Figure 3. *Microcontroller block diagram*

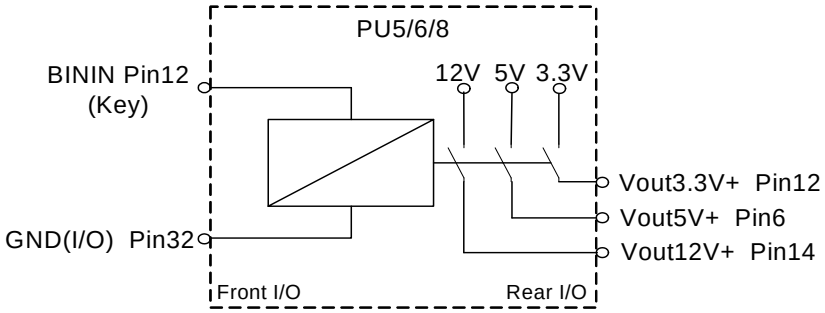


3.2 Power Up

The PU5/PU6/PU8 can be switched on in the following two ways:

- Key input (ignition key) via isolated binary input (see Chapter 3.6.6 Key Input on page 26).

Figure 4. *Power up by key input*



- Wake on time via the SMBus interface (see Chapter 3.6.3 Wake On Time on page 23).

Note: If the key input function is not needed, simply connect the respective binary input and GND(I/O) to the external power source. That way the PU5/PU6/PU8 will be switched on as soon as it is supplied with power.

3.3 Power Down

The PU5/PU6/PU8 can be switched off in the following three ways:

- Disconnecting or switching off the external power source
- Key input (ignition key) via isolated binary input (see Chapter 3.6.7.2 Shutdown by Key Input on page 27).
- Shutdown by application software: the shutdown can be signaled via an SMBus command from application to host (see Chapter 3.6.7.1 Shutdown by Software on page 27).

3.4 Binary I/O

3.4.1 Binary Input

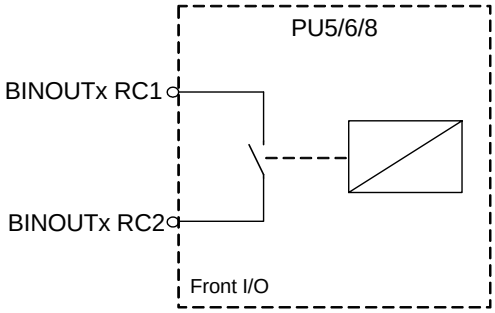
The PU5/PU6/PU8 provides one binary input. It is isolated from the system ground. The input voltage range is 0 V up to the input voltage. The nominal switching level is 9 V. The current is 5 mA. This value is independent of the input voltage.

The isolated binary input is led to the microcontroller and can be used for user specific functionality dependent on the firmware. The state of the binary input can be read via the SMBus interface. See Chapter 3.6.5 Status of Binary Input and Output on page 25.

3.4.2 Binary Output

The power supply unit provides one binary output. It is controlled by the microcontroller and its state is controllable via SMBus.

Figure 5. *Binary output relay*



The binary output is isolated by relays between isolated system ground. The default setting of "BINOUT RC1" and "BINOUT RC2" is open.

The maximum switching power is 60 W.

The state of the binary output can be read via the SMBus interface. See Chapter 3.6.5 Status of Binary Input and Output on page 25.

3.5 Status LEDs

The PU5/PU6/PU8 provides two status LEDs at the front panel. The green LED is on when the input voltage is in the correct range, the yellow LED is on when the output voltage is in the correct range. The yellow LED blinks when the PU5/PU6/PU8 is switched to error state off. See Chapter 3.6.4.1 Error Off State on page 24.

Table 4. *Status LEDs on the front panel*

LED	Function
Green LED	On: input voltage in correct range
Yellow LED	On: output voltage in correct range Blinking: error state off

3.6 SMBus

3.6.1 General

The System Management Bus (SMBus) is a two-wire interface through which various system component chips can communicate with each other and with the rest of the system. It is based on the principles of operation of I²C.

SMBus provides a control bus for system and power management related tasks. A system may use SMBus to pass messages to and from devices instead of tripping individual control lines. Removing the individual control lines reduces pin count. Accepting messages ensures future expandability.

With System Management Bus, a device can provide manufacturer information, tell the system what its model/part number is, save its state for a suspend event, report different types of errors, accept control parameters, and return its status.

3.6.2 SMBus Interface

The microcontroller firmware supports SMBus slave device functionality. The SMBus address of the PU5/PU6/PU8 is `0x12`. The microcontroller behaves according to the SMBus Specification Version 2.0 (see Chapter 4.1 Literature and Web Resources on page 35), but it only supports the write-byte and the read-byte protocol without PEC. The supported SMBus commands and their functions are explained in the following chapters. The commands are listed by their unique name. Column "Data Range" lists the valid range of the data byte for the specific command code. Column "Type" specifies the data direction for the specific command. 'r' specifies that the host can read the data using the SMBus read-byte protocol. 'w' means the host can write data using the SMBus write-byte protocol.

Note: Most of the SMBus commands start with AD78_ because the firmware of the PU5/PU6/PU8 is based on that of earlier PSU models (sometimes referred to as the AD78 models, now officially called PU2, PU3 and PU4) to enable software compatibility. Only a few selected commands are exclusive to this new model, they are listed in Chapter 3.6.8 Voltage and Current Supervision on page 31.

3.6.3 Wake On Time

The PU5/PU6/PU8 can be switched on/off by a programmable timer. The timer is included in the microcontroller and is programmable by the CPU via SMBus commands (see Table 5, SMBus commands for wake on time function, on page 23).

The behavior after power up by wake on time is identical to the behavior after power up by key input. After the first wake on time event the wake on time feature is disabled.

Note: For the timer functionality it is necessary that the DC/DC converter and the microcontroller are active.

Table 5. *SMBus commands for wake on time function*

Name	Command Code	Data Range	Type	Description
AD78C_WOT_L	0x00	0x00.. 0xFF	r/w	Wake on time low byte
AD78C_WOT_H	0x01	0x00.. 0xFF	r/w	Wake on time high byte

The wake on time delay can be configured via SMBus in a 16 bit counter to provide the range according to the following table:

Table 6. *SMBus commands AD78C_WOT_L/ AD78C_WOT_H*

Minimum	Maximum	Description
0 (OFF) (default)	65,535 min	*AD78C_WOT_L* and *AD78C_WOT_H* build a 16 bit value which represents the time in minutes

3.6.4 Watchdog

The microcontroller is also used as a watchdog for the CompactPCI system.

It is possible to enable/disable the watchdog by the SMBus command *AD78C_WDOG_STATE*. After the *AD78C_STATUS* byte (see Table 13, SMBus commands for shutdown delay, on page 28) signaled a shutdown the watchdog is disabled by the firmware. The watchdog is triggered by cyclic SMBus commands (*AD78C_WDOG_TRIG*) from the CPU. The time interval between trigger commands is configurable via SMBus command *AD78C_WDOG_TOUT* (see Table 8, SMBus command AD78C_WDOG_TOUT, on page 24). The time interval is set to its maximum value after PU5/PU6/PU8 power up and the watchdog is disabled. In case of missing trigger, the microcontroller firmware resets the complete system. The number of missing SMBus trigger command exceptions is incremented and can be read via the SMBus command *AD78C_WDOG_ERR*.

After five exceptions the microcontroller firmware switches off the power output (V_{out}) and switches to error off state (see Chapter 3.6.4.1 Error Off State on page 24). After a watchdog reset the firmware waits for the SMBus on acknowledge signal before it restarts the watchdog timer. Care must be taken if the SMBus on acknowledge feature is not used and the system is not able to start within the watchdog timeout time. In this case a deadlock situation occurs and after several watchdog exceptions the system will fall into the error off state.

Table 7. *SMBus commands for watchdog function*

Name	Command Code	Data Range	Type	Description
AD78C_ONACK	0x02	0	w	On acknowledge
AD78C_ONACK_TOUT	0x03	0x00.. 0x0B	r/w	On acknowledge timeout
AD78C_ONACK_ERR	0x04	0x00.. 0xFF	r	Number of missing on acknowledges
AD78C_WDOG_STATE	0x05	0x00, 0x01	r/w	Watchdog state
AD78C_WDOG_TRIG	0x06	0	w	Watchdog trigger signal
AD78C_WDOG_TOUT	0x07	0x01.. 0xFF	r/w	Watchdog timeout in 100ms steps
AD78C_WDOG_ERR	0x08	0x00.. 0xFF	r	Number of missing on watchdog trigger signals

Table 8. *SMBus command AD78C_WDOG_TOUT*

Value	Watchdog Timeout
1	100 ms
2	200 ms
3	300 ms
...	
255	25.5 s (default)

3.6.4.1 Error Off State

If five watchdog or SMBus on acknowledge exceptions have occurred the microcontroller firmware switches to an error off state. This state is also reached if an overtemperature or overvoltage condition has occurred. Upon entering this state V_{out} is immediately deactivated. In this state it is not possible to switch on the system in any way. To leave this state the power of the PSU must be disconnected (power on reset of the PU5/PU6/PU8). This state is signaled via blinking of the yellow LED.

3.6.5 Status of Binary Input and Output

The status of the binary input and output is also signaled via SMBus commands. See Table 9, SMBus commands for binary input/output status, on page 25.

Table 9. *SMBus commands for binary input/output status*

Name	Command Code	Data Range	Type	Description
AD78C_IN	0x0E	0x00.. 0xFF	r	State of binary input
AD78C_IN_MASK	0x0F	0x00.. 0x0F	r	Signal if binary input is usable from application
AD78C_OUT	0x10	0x00.. 0x0F	r/w	State of binary output
AD78C_OUT_MASK	0x11	0x00.. 0x0F	r	Signal if binary output is usable from application

3.6.6 Key Input

3.6.6.1 Key Input On

The firmware switches on the output power (V_{out}) whenever the debounced state of the binary input used as key switches from low to high state (on event). The firmware debounces the key input in the following way: if the input is stable for 250ms the input state is interpreted.

3.6.6.2 SMBus On Acknowledge

The firmware provides an SMBus on acknowledge feature. This feature is enabled by using mode 1 to 11 according to Table 11, SMBus on acknowledge timer modes, on page 27. Default mode is 0 (feature disabled, no SMBus acknowledge required). If enabled and the microcontroller does not receive a SMBus on acknowledge during the configurable SMBus on acknowledge delay, the microcontroller firmware resets the complete system by activating the CompactPCI reset output. The number of missing SMBus acknowledge exceptions are incremented and can be read via SMBus command *AD78C_ONACK_ERR*.

After reset is released, the acknowledge timer is restarted and the microcontroller firmware waits for SMBus acknowledge. After five exceptions the microcontroller firmware disables the power output V_{out} (see Chapter 3.6.4.1 Error Off State on page 24). After a power up of the PU5/PU6/PU8 the on acknowledge configuration is reset.

Table 10. *SMBus commands for on acknowledge function*

Name	Command Code	Data Range	Type	Description
AD78C_ONACK	0x02	0	w	On acknowledge
AD78C_ONACK_TOUT	0x03	0x00.. 0x0B	r/w	On acknowledge timeout
AD78C_ONACK_ERR	0x04	0x00.. 0xFF	r	Number of missing on acknowledges

Table 11. *SMBus on acknowledge timer modes*

Mode	SMBus On Acknowledge
0	Feature disabled = no acknowledge required (default)
1	1 s
2	2 s
3	4 s
4	8 s
5	16 s
6	32 s
7	64 s
8	128 s
9	256 s
10	512 s
11	1024 s

3.6.7 Shutdown

3.6.7.1 Shutdown by Software

At any time it is possible to shut down the power supply by software via SMBus command *AD78C_SWOFF*. A shutdown by software follows the shutdown sequence.

Table 12. *SMBus command for shutdown by software function*

Name	Command Code	Data Range	Type	Description
AD78C_SWOFF	0x09	0	w	Signal a software power off from application

3.6.7.2 Shutdown by Key Input

One of the binary inputs can be used as an on/off input. When this signal is passive (open) during power up of the input voltage, the system is not supplied with power. When this signals goes active, the microcontroller switches the power supply to provide the system with power. Nevertheless the DC/DC converter and the microcontroller are supplied when the input voltage is connected.

It is possible at any time to shut down the power supply by switching off the key input. A shutdown by key input follows the shutdown sequence.

3.6.7.3 Shutdown Delay

During the shutdown sequence the microcontroller firmware provides a programmable shutdown delay. The default state of the shutdown delay after power up of the PU5/PU6/PU8 is 0 (disabled). The shutdown delay is configurable via the SMBus command *AD78C_DOWN_DELAY*, see Table 13, SMBus commands for shutdown delay, on page 28 and Table 15, SMBus command AD78C_DOWN_DELAY, on page 28. The shutdown delay timer is started after shutdown event. At any time during the shutdown delay the shutdown sequence can be stopped by an on event (key input on). The system is in running state then and the shutdown delay timer is cleared. After timeout of the shutdown delay the microcontroller firmware signals the shutdown event to the CPU by setting a bit in the status register, which can be read using the SMBus command *AD78C_STATUS* (see Table 13, SMBus commands for shutdown delay, on page 28 and Table 14, SMBus command AD78C_STATUS, on page 28).

Table 13. *SMBus commands for shutdown delay*

Name	Command Code	Data Range	Type	Description
AD78C_DOWN_DELAY	0x0B	0x00.. 0x07	r/w	Shutdown delay
AD78C_STATUS	0x0D	0x00, 0x01	r	Signal PSU status to application

Table 14. *SMBus command AD78C_STATUS*

Bit	Value	Description
0	0	Shutdown event not signaled
	1	Signal shutdown event
1..7	0	Reserved

Table 15. *SMBus command AD78C_DOWN_DELAY*

Value	Shutdown Delay
0	0 min
1	1 min
2	2 min
3	4 min
4	8 min
5	16 min
6	32 min
7	64 min

3.6.7.4 Off Delay

During the shutdown sequence the microcontroller firmware provides a programmable off delay. As default this feature is not enabled (mode 0). In this case there will be no off delay, the supply will be switched off immediately. When enabled (mode 1…5) the firmware starts the off delay timer after signaling the shutdown event to the CPU. After timeout the microcontroller firmware switches off the supply voltage (V_{out}). V_{out} is kept disabled for at least 1 s, even if an immediate on event occurs. This guarantees a proper power on reset of the supplied system. The off delay can be programmed using the SMBus command *AD78C_OFF_DELAY*, for details see Table 16, SMBus command for off delay function, on page 29 and Table 17, SMBus command AD78C_OFF_DELAY, on page 29.

Table 16. *SMBus command for off delay function*

Name	Command Code	Data Range	Type	Description
AD78C_OFF_DELAY	0x0C	0x00.. 0x05	r/w	Off delay

Table 17. *SMBus command AD78C_OFF_DELAY*

Mode value	Off Delay
0	Feature off (no OFF delay: default)
1	1 min
2	2 min
3	4 min
4	8 min
5	16 min

3.6.7.5 Off Acknowledge

The microcontroller firmware enables acknowledging the shutdown. It is possible at any time during off delay to shut down the power supply by the SMBus command *AD78C_OFFACK*.

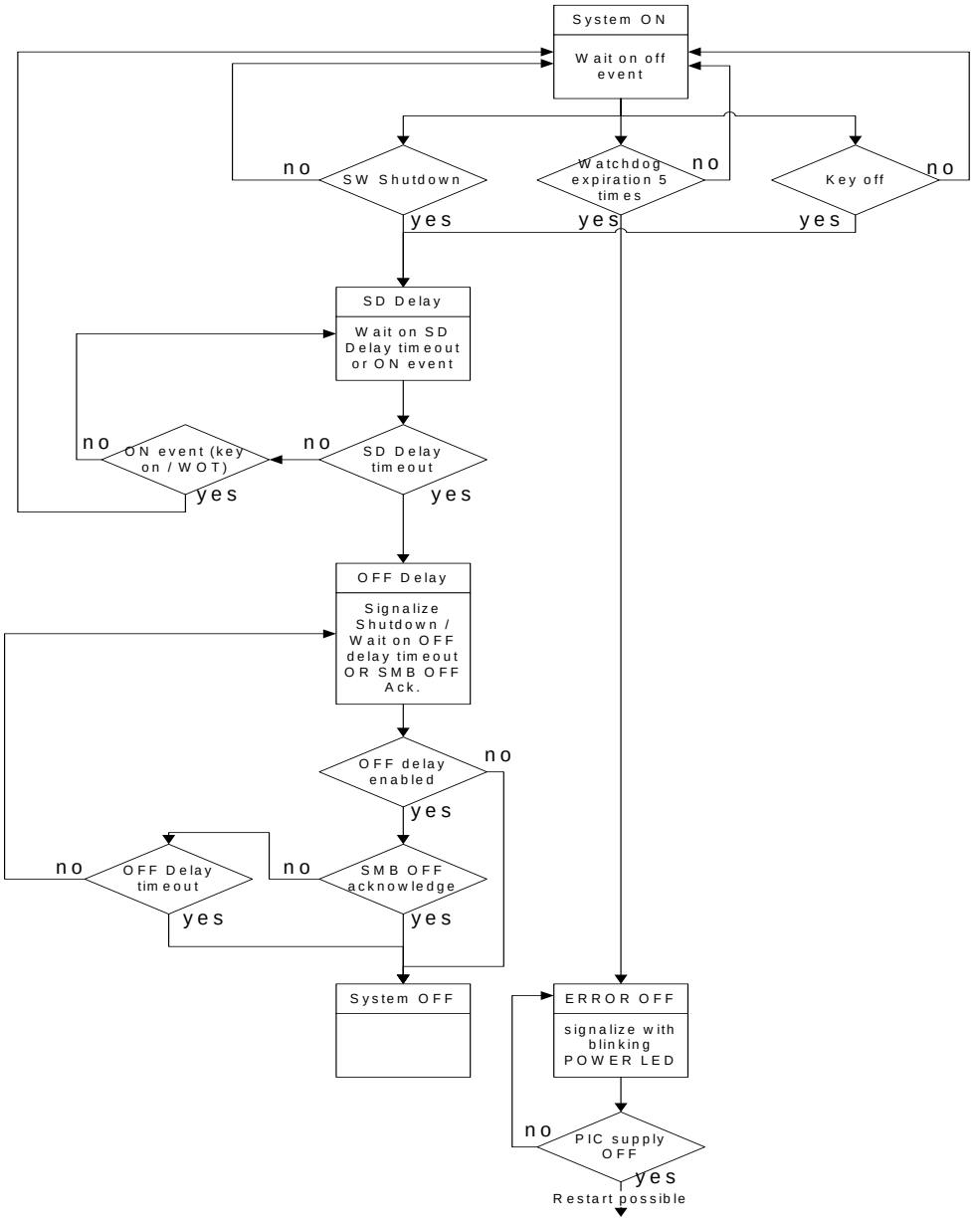
Table 18. *SMBus command for off acknowledge function*

Name	Command Code	Data Range	Type	Description
AD78C_OFFACK	0x0A	0	w	Signal off acknowledge

3.6.7.6 Shutdown Sequence

Any shutdown by software or key input is carried out according to the following sequence:

Figure 6. *Shutdown sequence*



3.6.8 Voltage and Current Supervision

For voltage and current supervision, the PU5/PU6/PU8 PSUs offer a few SMBus commands exclusive to these new PU models.

Before the limits of an output rail can be set, the output rail must be selected through the MDIS driver 13AD78-06 first. The PU5/PU6/PU8 contains 3 output rails which are interpreted as channels 0..2 by MDIS:

Table 19. *MDIS Channels for the PU5/PU6/PU8*

Channel	selects
Channel 0	3.3V rail
Channel 1	5V rail
Channel 2	12V rail

You can find for more information about MDIS on MEN's website.

Input and output voltage are supervised by the microcontroller. The status of the input and output is shown by two LEDs at the front panel (see Chapter 3.5 Status LEDs on page 22).

The microcontroller firmware supervises the 12V, 5V and 3.3V output voltages of the PU5/PU6/PU8. When the voltage is outside the configured range, the microcontroller switches off all its three power rails. The output voltage is measured using the microcontroller internal ADC function. The ADC value which represents the output voltage can be read via the SMBus command *PU5_VOLT* (see Table 20, SMBus voltage supervision commands, on page 31. The voltage values are specified through their corresponding ADC value. The read ADC values correspond to the voltage value according to the following formula:

$$U = \frac{6 \cdot ADCValue}{255} V$$

Table 20. *SMBus voltage supervision commands*

Name	Command Code	Data Range	Type	Description
PU05_CURR	0x20	0x00.. max mA	r	Current drawn on selected rail [mA] (estimated if no load on other 2 rails)
PU05_VOLT	0x21	0x00.. max mV	r	Voltage on selected rail [mV]
PU05_VOLT_LOW	0x22	0x00.. 0xFF	r/w	low voltage limit for selected rail [mV]
PU05_VOLT_HIGH	0x23	0x00.. 0xFF	r/w	high voltage limit for selected rail [mV]

PU05_CURR_LOW	0x24	0x00.. 0xFF	r/w	low current limit for selected rail [mA]
PU05_CURR_HIGH	0x25	0x00.. 0xFF	r/w	high current limit for selected rail [mA]

Its possible to set maximum current values such that the total power would exceed what the PU5/PU6/PU8 is capable of delivering. If an overall power consumption of 90W is exceeded, the unit is switched off regardless of the set limit values.

The values 0x00..0xFF in Table 20, SMBus voltage supervision commands, on page 31 represent the raw ADC values that result from the analog-to-digital conversion. To minimize calculation effort in the microcontroller these values are converted to physical values in the 13AD78-06 driver.

3.6.9 Temperature Supervision

The microcontroller is able to determine the PSU temperature. The temperature can be read via the SMBus command *AD78C_TEMP* and sent to the CPU.

The temperature supervision is carried out by the temperature sensor LM62. The LM62 is a precision integrated-circuit temperature sensor that can sense a 0°C to +90°C temperature range while operating from a single +3.0 V supply.

The microcontroller reads the output voltage of the LM62 with A/D input.

When the temperature is over the *AD78C_TEMP_HIGH* level the microcontroller switches off the output power and changes to the error off state.

Table 21. *SMBus commands for temperature supervision*

Name	Command Code	Data Range	Type	Description
AD78C_TEMP	0x12	0x00.. 0xFF	r	Current PSU temperature
AD78C_TEMP_HIGH	0x13	0x00.. 0xFF	r/w	Temperature alarm limit (shut down/ switching to error off state)

The level *AD78C_TEMP_HIGH* can be configured via the SMBus between 50°C and 90°C, see Table 22, SMBus command AD78C_TEMP_HIGH, on page 32.

Table 22. *SMBus command AD78C_TEMP_HIGH*

Minimum	Maximum	Description
0x6B (50°C)	0xA0 (90°C) (default)	Temperature alarm level

3.6.10 PSU ID and Firmware Revision Number

The ID of the PU5/PU6/PU8 and the firmware revision number can also be read via SMBus commands. See Table 23, SMBus commands for PSU ID and firmware revision number, on page 33.

Table 23. *SMBus commands for PSU ID and firmware revision number*

Name	Command Code	Data Range	Type	Description
AD78C_ID	0xFE	0x78, 0x05, 0x06, 0x8	r	ID of PSU 0x78 = PU2/3/4 0x05 = PU5 0x06 = PU6 0x08 = PU8
AD78C_REV	0xFF	0x00.. 0xFF	r	Firmware revision of PSU

3.7 DC/DC Converter

The power supply unit provides a DC/DC converter to generate isolated 12 V (±5%) with 7 A from the input voltage. The regulator generates 5 V (+5%/-3%) and 3.3 V (± 3%) from the 12 V isolated side. The maximum power with full load is 100 W. The minimum power is 5 W.

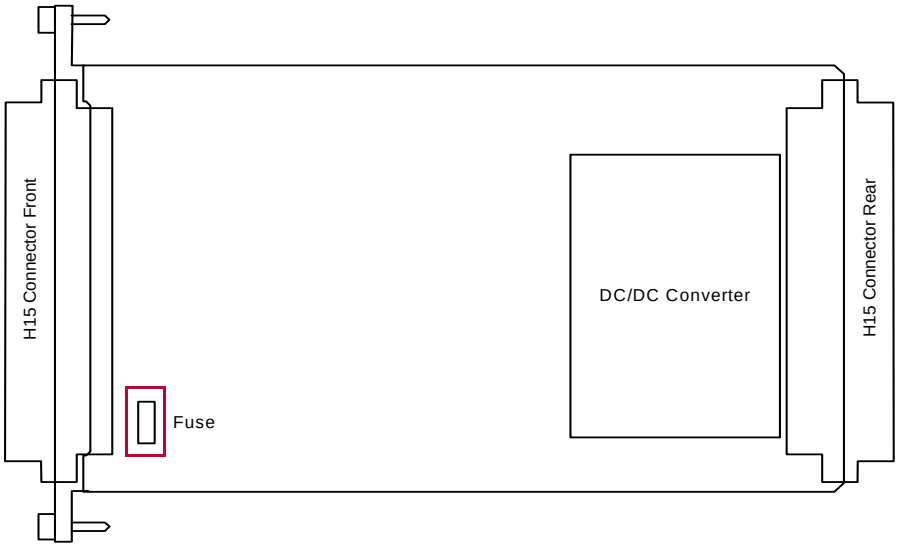
Note: The DC/DC converter is on while the input voltage is connected. The maximum (no load) input power is less than 1 W. The maximum output current of 12 V is 8.3 A, (5 V and 3.3 V: 15 A). For output voltage tolerance the minimum power must be 5 W.

3.7.1 Fuse Protection

The DC/DC converter is protected by a glass fuse.

- Current rating:
- 2.5A for the PU5
- 8A for the PU6
- 6.3A for the PU8
- Size: 5 x 20 mm
- The fuse is located on the top side of the PU5/PU6/PU8.

Figure 7. *Position of fuse for DC/DC converter protection*



4 Appendix

4.1 Literature and Web Resources

- PU5 data sheet with up-to-date information and documentation: www.men.de/products/17pu05-.html
- PU6 data sheet with up-to-date information and documentation: www.men.de/products/17pu06-.html
- PU8 data sheet with up-to-date information and documentation: www.men.de/products/17pu08-.html

4.2 Finding out the Board's Article Number, Revision and Serial Number

MEN user documentation may describe several different models and/or hardware revisions of the PU5/PU6/PU8. You can find information on the article number, the board revision and the serial number on two labels attached to the board.

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

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

Figure 8. *Labels giving the board's article number, revision and serial number*