Janich & Klass Computertechnik GmbH

J&K EMBEDDED

BoxPC S3

Technical description

Version: **1.0**

Date: **06.02.2024**

Numbers:

BoxPC S3 Celeron:	377.751302.100 8
BoxPC S3 i5:	377.751302.150 8

Documentname: BoxPC3-technical-description-1.0.docx

TABLE OF CONTENTS

1 OVERVIEW 5

1.1 THE TECHNICAL DATA IN A NUTSHELL: 5
1.2 CASE 6
1.3 CONNECTION SIDE 7

2 COMPONENTS OF THE BOXPC 8

2.1 CPU MODULE 8
2.2 CENTRAL MEMORY 8
2.3 GIGABIT ETHERNET CONTROLLER 8
2.3.1 PXE Boot 9
2.3.2 Sercos 9
2.4 SUPER-I/O CONTROLLER 10
2.5 HARDWARE-MONITOR 10
2.6 POWER FAILURE DETECTION 10
2.7 CFAST 11
2.8 SLOT FOR PCIE MINI CARD / MINI-SATA 12
2.9 BATTERY 12
2.10 EEPROM 12

3 JUMPERS AND LEDS 13

3.1 JUMPER 13
3.2 LEDS 14

4 INTERFACES 16

4.1 USB INTERFACES 16
4.2 RS232 INTERFACE COM1 17
4.3 MONITOR 17
4.4 SATA INTERFACE 17
4.5 FAN 17
4.6 POWERING THE BOXPC 18

Copyright

Trademark

All product names and logos are trademarks or registered trademarks of their respective owners.

Disclaimer

The contents of this manual have been checked for conformity with the product described. Nevertheless, deviations cannot be ruled out, so that we do not assume any liability for complete conformity. However, the information in this manual is regularly reviewed. Necessary corrections are contained in the following editions. We are grateful for suggestions for improvement.

JANICH & KLASS COMPUTERTECHNIK GMBH ASSUMES NO LIABILITY WHATSOEVER FOR DEFECTS CAUSED DIRECTLY OR INDIRECTLY BY ERRORS IN THIS MANUAL, OMISSION OF INFORMATION OR BY INCONSISTENCIES BETWEEN THE MANUAL AND THE PRODUCT.

Safety

- This device may not be used in any other way than as stated in this Technical Description.
- Installation, commissioning and maintenance of this device may only be carried out by qualified personnel. This personnel must be familiar with the warnings and instructions in this manual.
- For the purposes of this manual, qualified personnel are persons who are familiar with the installation, installation, commissioning and operation of this equipment and who have the qualifications appropriate to their activities, such as:
  - Training and instruction or authorization to switch circuits and assemblies or systems on and off, to ground and mark them in accordance with the current standards of safety technology.
  - Training and instruction in accordance with the current standards of safety technology in the care and use of appropriate safety equipment.
  - First aid training.
- Before connecting this device to the power supply, you must check that the supplied voltage is within the limits of the permissible voltage range printed on the nameplate.
- The device must be properly grounded via the terminal(s) marked with .
- Before opening the device, always disconnect from the power supply to ensure that the device is not energized.
- The device contains electrostatically endangered components. Electrostatic discharges by the human body or similar must therefore be avoided at all costs, e.g. by using a grounded wristband. This is especially true before changing assemblies.
- Protect this device from moisture. Under no circumstances should conductive objects or liquids enter the device.
- The ventilation holes in the side walls must remain free at all times.
- Do not operate the appliance at higher or lower temperatures than those indicated in this description.
- Connected cables must not be subjected to tensile loads.
- In the event of a defective fuse, be sure to install a new one of the same type, otherwise there is a risk of fire.

- This assembly contains a lithium battery. **ATTENTION!** Risk of explosion in case of improper replacement of the battery. The battery may only be replaced with the same type or one recommended by Janich & Klass. Used batteries must be disposed of in accordance with the applicable legal provisions.
- If there is visible damage to the housing, please return the complete device to Janich & Klass for repair. (Any unauthorized repair may void the warranty.)
- Do not attempt to repair this device yourself. For any repairs, please contact Janich & Klass directly.
- Warranty repairs must be carried out directly by Janich & Klass.

History

Version	Date	Name	Changes	HW-Revision
0.1	11.02.2022	c.k.	Document Created	1.2
1.0	14.06.2022	s.h.	Minor fixes	1.2

1 Overview

The BoxPC is a modular industrial computer. It is designed for installation in control cabinets, all connections are plugged in from the front for easy installation.

The BoxPC is delivered in a stainlesssteel case.

A Celeron dual-core processor with a clock speed of 1.6GHz from the Intel "Haswell" family (TDP 15W) is used. Alternatively, Intel Core i3/i5/i7 with clock speeds of up to 1.7GHz are available. All processors are from Intel's embedded product line, which guarantees long-term availability of 5 years or more.

The BoxPC offers the possibility to implement a redundant Sercos master controller without the use of special connection modules or FPGAs. This is made possible by the combination of two Gigabit Ethernet controllers i210 from Intel and the open source project "Sercos SoftMaster". This allows cycle times of 125µs to be achieved. The two interfaces can be used either as two separate Sercos lines or as a redundant ring structure to increase availability.

The well-thought-out cooling concept allows exclusively passive cooling of all components at a wide operating temperature range of -15 - 55°C, maintenance-prone fans are not used.

1.1 The technical data in a nutshell:

- Version in stainless steel housing for installation in control cabinets, protection class IP20, passive cooling, dimensions over all (W x H x D): approx. 301 x 85 x 210mm
- External connections are plugged in on the front
- CPU module H1 with the following features:
  - Firmly soldered Intel® Celeron® dual-core processor 2980U (Haswell), clock speed 1.6GHz
  - Alternatively available are Intel® Core® i3/i5/i7 dual-core processors (Haswell), clock speeds 1.7GHz... 1.9GHz
  - 4GB soldered DDR3-SDRAM, DDR3-1600
  - SODIMM socket for DDR3-SDRAM up to 4GB, DDR3-1600
  - Intel HD Graphics 4400 graphics controller with 200MHz clock speed
- One Intel i218V Gigabit Ethernet controller with RJ45 jack on the port side
- Two synchronizable Intel i210 Gigabit Ethernet controllers with RJ45 sockets on the connector side, intended for Serco's SoftMaster
- Another Intel i210 Gigabit Ethernet controller with RJ45 jack on the port side
- On-board CFast socket, memory module can be replaced from the outside
- Slot for a PCIe Mini Card Module or for a Mini-SATA Module
- Serial interface COM1 as RS232 (Rx, Tx, #RTS and #CTS only)
- Two USB 3.0 ports with up to 5GB/s on the port side
- Two USB 2.0 ports with up to 480MB/s on the port side
- Digital monitor can be connected to HDMI socket
- Nuvoton Super-IO NCT6779D (with internal hardware monitor to monitor temperatures and supply voltages)

- Power failure detection with separate microcontroller, can trigger NMI or interrupts
- LED indicators on the connection side: "Power", "HDD", "RUN", 8 LEDs for Ethernet, "GP" LED
- Buffer battery CR2477 can be replaced from the outside
- Power supply input 230V AC to Combicon plug
- Operating temperature 5 - 55 °C (short-term 70°) relative humidity 10-95% non-condensing
- Tests: CE (UL and ATEX optional)

1.2 Case

The BoxPC is housed in a sturdy, multi-part housing made of stainless steel. The enclosure is designed to be installed in a control cabinet, but it can also be installed in any other enclosure.

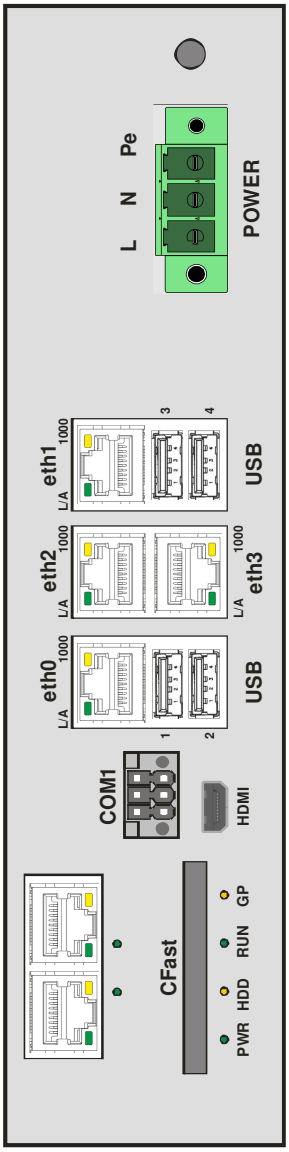
The case of the BoxPC is composed of several individual parts: It consists of a base plate and the electronic frame and heat sink attached to it. A mounting plate is attached to the back.

The electronics frame is closed at the back with a generously dimensioned heat sink. The frame is multi-perforated on the sides and on the front.

All external plugs are connected to the front of the electronics frame. This makes the electrical connection very easy to carry out.

1.3 Connection side

The following drawing shows the position of the connectors on the connection side of the BoxPC:



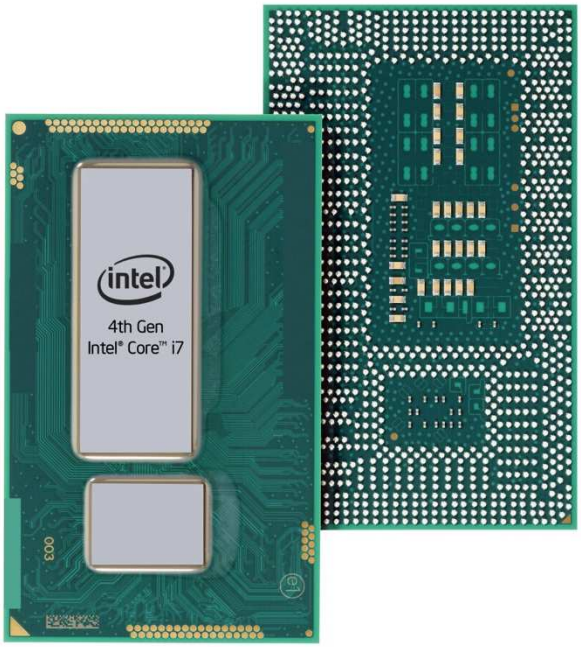
The following table shows the importance of each interface:

Designation	Interface	Remark
CFast	Memory card	
HDMI	Digitalmonitor	HDMI
COM1	RS232	
USB1, USB2	2 x USB 3.0	
NET1, NET4	Gigabit-Ethernet	1x i218V, 1x i210
NET2, NET3	Gigabit-Ethernet	2 x i210 for Sercos (synchronizable)
USB3, USB4	2 x USB 2.0	
Power	Power supply	230VAC (50Hz)

2 Components of the BoxPC

2.1 CPU Module

The central component of the BoxPC is the replaceable CPU module H1. Among other things, the soldered processor, the main memory and the Intel HD graphics controller are located on it. In this way, the BoxPC can be precisely adapted to the requirements of the respective application by selecting a suitable CPU module. There are currently four dual-core processors from the Intel "Haswell" family to choose from: Celeron with 1.6GHz clock speed, Core i3 with 1.7GHz clock speed, Core i5 with 1.9GHz clock speed and Core i7 with 1.7GHz clock speed.



Processor	Clock frequencies	Cores	L2 Cache	Central memory	Power consumption
Core i7-4650U	1.7GHz/3.3GHz	2	4MB	4GB DDR3	15W
Core i5-4300U	1.9GHz/2.9GHz	2	3MB	4GB DDR3	15W
Core i3-4010U	1.7GHz	2	3MB	4GB DDR3	15W
Celeron 2980U	1.6GHz	2	2MB	4GB DDR3	15W

2.2 Central memory

The CPU module H1 already has 4GB of DDR3-SDRAM soldered on. For applications with higher memory requirements, a socket for a 204-pin DDR3 SODIMM module (1.5V) is available, so memory sizes of up to 8GB can be realized. The transfer rate of the main memory is 800MT/s, so PC3-12800 modules can be used.

Attention: Only modules with eight memory chips of 4GBit technology may be used! Modules with more than eight memory chips cannot be used.

2.3 Gigabit Ethernet Controller

The BoxPC is equipped with four Intel i218V and Intel i210 Gigabit Ethernet controllers. With these controllers, four independent, IEEE 802.3ab compliant 10/100/1000Base-T network ports are available. The RJ45 sockets for connecting standard twisted-pair network cables (Cat.5e or better) are accessible in the connection area of the BoxPC.

General Features:

- Gigabit Ethernet Controller
- IEEE 802.3ab compliant PHY for 10/100/1000Base-T-Interface
- Meet IEEE/ANSI 802.3x requirements
- IEEE 1588/802.1AS Precision Time Synchronization (i210)
- 6KByte (i218V) or 48KByte (i210) internal FIFOs for Rx and Tx
- 2 LEDs on the RJ45 socket to control network activity

Status LEDs:

The Gigabit Ethernet controllers control 2 LEDs each "SP" (orange/green) and "L/A" (green), which are located directly in the RJ45 sockets NET1 on the connection side. NET4. These LEDs provide information about the status and activity of the respective network and controller:

SP: "Speed" - this LED glows green when the controller is operating in Gigabit mode and orange when operating in 100Base-TX mode. If this LED is not lit, the controller is in 10Base-T mode. The detection and switching to the present network type is automatic.

L/A: "Link/Activity" - this LED is lit as long as there is a good network connection. During network activities, this LED goes out in the rhythm of the data packets sent or received.

2.3.1 PXE Boot

The BoxPC offers the possibility to boot the operating system from a PXE server over the network instead of from a local drive. For this purpose, the BIOS of the BoxPC is equipped with a PXE BIOS extension. In order to be able to boot the system from the network, the boot order must be set appropriately in the BIOS setup. **Attention:** Booting over the network is only possible with the controller i218V, the corresponding RJ45 socket is marked with NET1 (left socket). For the i210 controllers, the PXE boot function is not available.

2.3.2 Sercos

The BoxPC offers the possibility to implement a redundant Sercos master controller without the use of special power modules or FPGAs. The two network ports NET2 and NET3 are provided for this purpose. The associated i210 Gigabit Ethernet controllers support the Precision Time Protocol (PTP) in accordance with IEEE 1588. They can be synchronized via their respective SDP pins, and the two controllers are powered from a common clock source to avoid drift effects.

In combination with the open source project "Sercos SoftMaster", cycle times of 125µs can be achieved on the Sercos bus. The two interfaces NET2 and NET3 can be used either as two separate Sercos lines or as a redundant ring structure to increase availability.

If the Sercos Master functionality is not required, the NET2 and NET3 connectors can of course also be used for general network connections.

2.4 Super-I/O Controller

The BoxPC's Super I/O Controller NCT6779D provides two serial ports, a parallel interface, a PS/2 keyboard and mouse controller, a hardware monitor, and numerous GPIO pins. However, the parallel interface is not used on the BoxPC.

2.5 Hardware-Monitor

To monitor the supply voltages, temperatures and fans, a hardware monitor is integrated into the Super I/O chip on the BoxPC. The measured values displayed in the BIOS setup in the "PC Health Status" menu are read from this module.

The following metrics can be retrieved:

- Supply voltages:CPU-Core-Spannung, 0.675V, 0.93V, 1.05V, 1.5V, 1.8V, 3.3V, 5V, 12V and the RTC battery voltage
- Temperatures:CPU Temperature and Ambient Temperature
- Fan:System Fan Speed

The hardware monitor can be accessed via special I/O addresses (via LPC bus) or via the SMBus. The following table summarizes the ways to access the Hardware Monitor:

Bus	Address	Description	Remarks
LPC	2Eh/2Fh	Super I/O Configuration Registry	Index/Data
LPC	295h/296h (1)	Hardware Monitor Configuration Register	Index/Data
SMB	01011011b write01011010b read (2)	Hardware Monitor Configuration Register	

Notes:

(1) The I/O address can be set via the Super I/O configuration register CR60/CR61 of logical device B.

(2) The SMB address can be set via the hardware monitor configuration register 48h.

A detailed description of all the registers of the hardware monitor can be found in the data sheet NCT6779D of the manufacturer Nuvoton: http://www.nuvoton.com

2.6 Power failure detection

The BoxPC is equipped with a power failure detection, which is controlled by an Atmel microcontroller (ATmega8L). The microcontroller continuously monitors the supply voltage of the power supply. If the network fails for an adjustable number of half-waves, the controller triggers either an interrupt or an NMI on the CPU module. The main processor then has about 100ms before the final shutdown to perform very specific actions. For example, a drive could be stopped in a controlled manner or important operating data could be backed up to the CFast memory card.

The microcontroller also has a 2KByte non-volatile FRAM memory. This is where data is stored, which can be used to monitor the proper functioning of the power failure detection system the next time it is switched on.

A detailed explanation of the functions of the microcontroller can be found in the document "Panel-PC S3 Power Failure Detection"

2.7 CFast

The BoxPC has a slot for a CFast memory card. These are memory cards in the previous CompactFlash format, but with the much faster SATA interface. The slot is accessible in the connection area of the BoxPC, so the card can be changed without opening the case.

Inserting the CFast card:

For easier handling of the CFast card, it is inserted with the back facing up , see the following picture. As a result, the handle edge is at the top, so that an inserted card can be easily pulled out on this protruding edge.

Attention: The CFast card may only be inserted in the way described here without significant effort! Forcible, twisted or tilted insertion will damage the CFast socket!

2.8 Slot for PCIe Mini Card / mini-SATA

The **S18** slot is intended for an optional PCIe Mini Card (29.8mm x 50.8mm), which can be used to equip a WLAN module or a network controller, for example.

Alternatively, a mini-SATA solid-state drive (full size) can be equipped on this slot, the switching between PCIe Mini Card and mini-SATA is automatic. If the automatic switching fails, the map type can also be set manually via the Jumper S13:

Jumperstellung S13	Card
1 - 2	Automatic switching
2 - 3	PCIe Mini Card
no jumper	mini-SATA SSD

Attention: Solid-state drives with the designation "PCIe Mini Card" are also commercially available. However, these modules are much longer (29.8mm x 70mm) and therefore do not fit in this slot.

2.9 Battery

To ensure that the real-time clock continues to run even when switched off, the BoxPC is equipped with a lithium battery. It is a CR2477 lithium coin cell with a nominal voltage of 3.0V and a typical capacity of 1000mAh.

The durability of the lithium battery is highly dependent on the type of use of the BoxPC, the ambient temperature and the component tolerances. The following table gives a rough overview of the expected battery life:

Ambient temperature	Type of use	Calculated service life
25°C	permanently switched off	12 years
0...55°C		8 years
0...55°C	50% ON	10 years
0...55°C	Constantly switched on	13 years old

The current voltage of the battery can be queried via the hardware monitor, it should be replaced at the latest when the voltage drops below 2.0V.

To replace the lithium battery, open the cover of the battery compartment on the upper side wall of the device. With the help of the angled tab of the cover plate, the button cell can now be pulled out and replaced by a similar one.

Attention: Only lithium manganese dioxide button cells of type CR2477 (24mm ∅ x 7.7mm) with a nominal voltage of 3.0V may be used!

2.10 EEPROM

On the BoxPC there is a 512 byte EEPROM at the user's disposal. Data can be stored here, which should be retained even after the system is switched off. This EEPROM is controlled by four GPIO pins of the Super I/O controller.

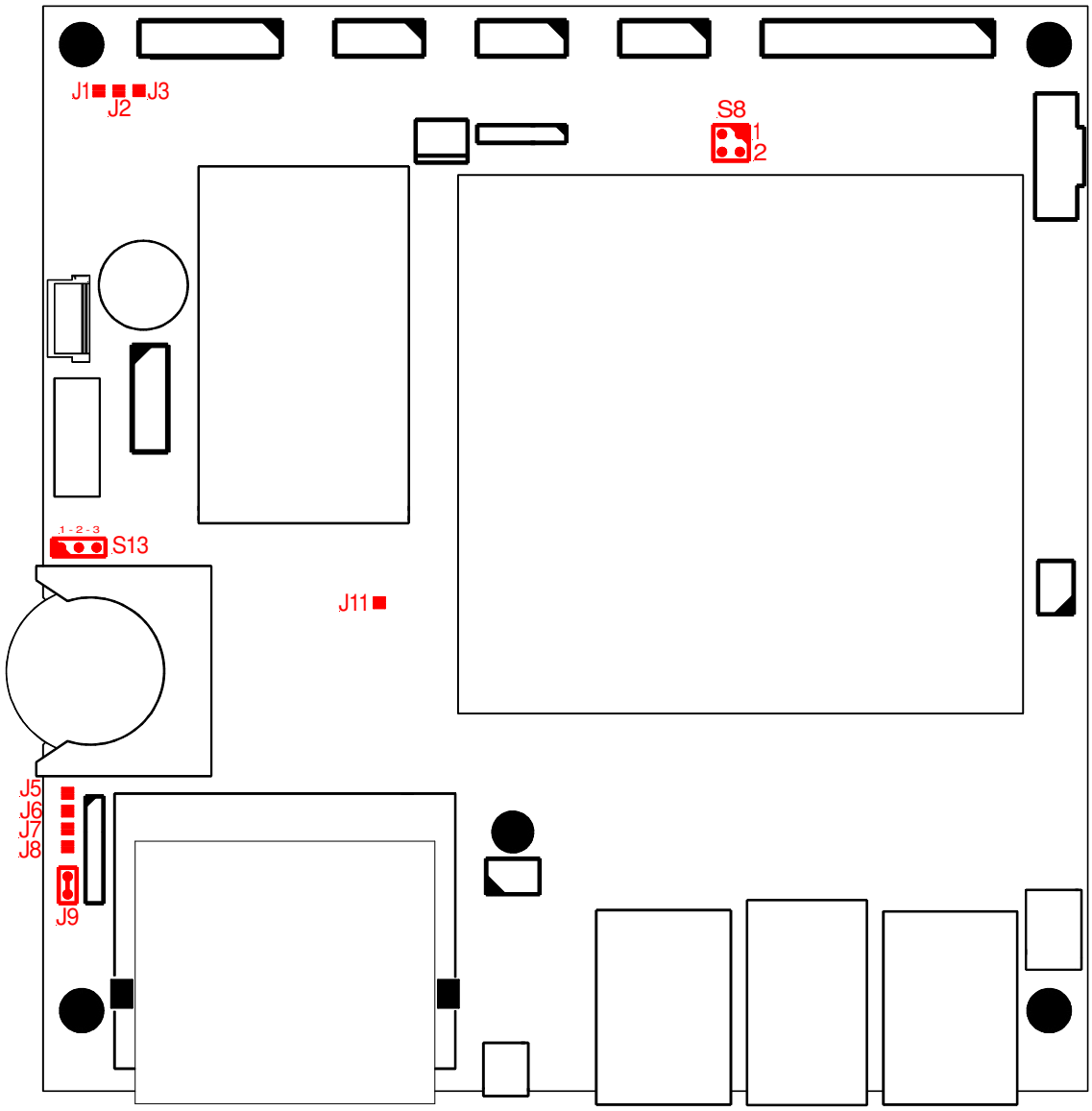
3 Jumpers and LEDs

3.1 Jumper

There are various solder and jumpers on the BoxPC, with the help of which the system can be adapted to different configurations. The following table shows an overview of the existing jumpers:

Jumper	Function	Description
J1 / J2	Touchcontroller	reserved for future expansions
J3	4/5 Wire Touch	Jumper must remain closed
J5	CFast write protect	CFast memory card read-only when closed
J7	GP-Jumper1	Universal jumper on the GP62 pin of the Super I/O:open: GP62 is high-closed: GP62 is low
J6	GP-Jumper2	Universal jumper on the GP63 pin of the Super I/O:open: GP63 is high-closed: GP63 is low
J8	Clear CMOS	A short bridge of this jumper (1...2s) clears the CMOS RAM
J9	CPU Module	Flash Descriptor Security Override
J11	Super I/O	closed: port 80h outputs via COM1
S8	Microcontroller	
S13	PCIe Mini Card	Selecting the Card Type in the PCIe Mini Card Slot:1 - 2: automatic switching2 - 3: PCIe Mini Cardopen: mini-SATA SSD

Jumper map:



3.2 LEDs

In addition to the LEDs on the network sockets and the LEDs of the RS485/422 interfaces, there are four other LEDs in the connection area of the BoxPC, the meaning of which is explained below:

PWR (green): This LED indicates an applied supply voltage.

RUN (green): This LED provides information about the progress of booting the system.

HDD (yellow): This LED indicates access to the CFast memory card.

GP (yellow): The term GP stands for "General Purpose". The function of this LED is controlled by the GP71 pin of the Super I/O controller.

The following table shows the functions of these four LEDs from turning on the device to starting the operating system:

Operating status	PWR	RUN	HDD	GP
Mains voltage ok, 3.3V from DC/DC converter ok, internal voltages not yet stable, reset active	ON	OFF	OFF	OFF
Internal voltages stable, reset still active	ON	OFF	OFF	ON
Internal voltages stable, reset inactive	ON	ON	OFF	ON
Chipset and Super I/O are initialized	ON	Flashes	OFF	ON
Power-On-Self-Test (POST) completed without error, operating system starts	ON	ON blinkt *1	flashesonAccess	OFF ON *2

(*1):The RUN LED flashes at 2Hz when the battery voltage has dropped below 2.7V.

(*2): The GP LED lights up when GP71 of the Super I/O controller is set to 0.

In addition, various light-emitting diodes are available on the base board of the BoxPC for diagnostic purposes. The following list gives an overview of the individual LEDs and their meaning:

LED	Color	Function	Designation	lights up when
D1	yellow	Touch Controller	Diag	flashes 3x after reset, then continuous lights
D7	yellow	System	Sleep LAN	GbLAN in sleep mode
D8	yellow		Sleep S3	System im Sleepmodus S3
D15	green	Microcontroller		
D16	yellow			
D17	green	LVDS-Display	Backlight 12V enable	LVDS display turned on
D18	green		Display 3,3V enable	

4 Interfaces

4.1 USB Interfaces

The BoxPC has two USB 3.0 and two USB 2.0 ports on the connection side for connecting peripheral devices. The USB interfaces comply with USB specification 3.0 and 2.0 and thus allow transferrates of 5 Gbit/s and 480 Mbit/s respectively. USB devices are "hot-pluggable", i.e. they can be plugged in or unplugged into the BoxPC during operation.

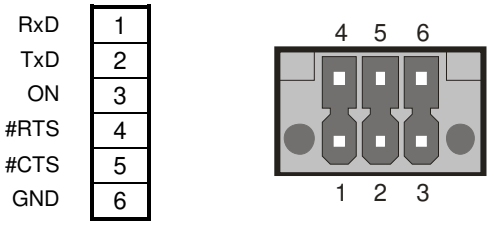
To protect the device, the power output is limited with all USB interfaces. The two USB 3.0 ports on the port side can be loaded with a maximum of 1A in total, as well as the two USB 2.0 interfaces. This allows the use of up to four USB devices, each with a current consumption of 500mA, or alternatively, two USB devices, each with a current consumption of up to 1A.

Interface	Current	Notes
USB1	< 1A in Summe	Common overcurrent error message
USB2		
USB3	< 1A in Summe	Common overcurrent error message
USB4		

4.2 RS232 interface COM1

The BoxPC has two serial ports, each with 16Byte FIFO (16550 compatible). The first interface COM1 is fixed as RS232C (Rx, Tx, #RTS and #CTS only), the second interface is reserved for special applications.

6" Combicon-Stecker **COM1**



The Combicon connector used is type DMC 1.5/3-G1F-3.5 (Phoenix Contact), a suitable mating connector is, for example, the type DFMC 1.5/3-STF-3.5.

4.3 Monitor

A digital monitor can be connected to the BoxPC via the HDMI socket . The following table shows the pinout:

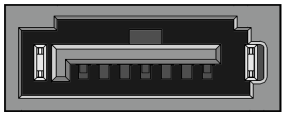
19pol. Micro-HDMI-Buchse HDMI

Pin	Signal	Pin	Signal	Pin	Signal
1	TMDS Data 2+	8	TMDS Data 0 Screen	15	SCL
2	TMDS Data 2 Screen	9	TMDS Data 0-	16	SDA
3	TMDS Data 2-	10	TMDS Clock +	17	GND for +5V
4	TMDS Data 1+	11	TMDS Clock Schirm	18	+5V, max. 0,3A
5	TMDS Data 1 Screen	12	TMDS Clock -	19	Hot-Plug Detection
6	TMDS Data 1-	13			
7	TMDS Data 0+	14			

4.4 SATA Interface

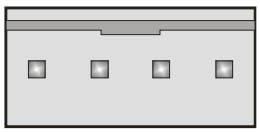
To connect a CDROM or DVD drive, the SATA interface S15 is optionally available on the BoxPC. The drive is powered by the S14 **connector**.

10000000000000



+5V GND GND +12V

Power S14



4.5 Fan

The **J4 connector** is designed to connect an optional 12V system fan. The speed of the fan can be controlled and also monitored by the hardware monitor of the Super I/O chip.

Connector J4

Signalname	
FAN_GND	1
FAN_12V	2
FAN_RPM	3

FAN_12V: Switched 12V supply, with a maximum load capacity of 0.1A!
FAN_RPM: Speedometer signal from the fan

4.6 Powering the BoxPC

The BoxPC can be powered from the following power source:

Variant	Input voltage	max. power consumption
Input range	230VAC 50Hz	60W

The power supply is galvanically isolated from PE (protective earth) and from all electrical connections of the BoxPC. The supply voltage is supplied via the Phoenix Combicon connector **POWER** (PC 4/3-G-7.62). To ensure proper grounding of the case, the BoxPC must also be grounded via the existing 6mm grounding bolt. A suitable mating plug for the power supply is, for example, the type PC 4/3-STF-7.62.

Janich & Klass Computertechnik GmbHZum Alten Zollhaus 24D-42281 WuppertalGermanyTel.: +49 (0)202 2708-0Fax: +49 (0)202 700 625
http://www.janichklass.com