

KBox A-230-LS

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 KBOX A-230-LS – USER GUIDE

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⚠ CAUTION

Handling and operation of the product is permitted only for trained personnel within a work place that is access controlled. Please follow the "General Safety Instructions for IT Equipment" supplied with the system.

Revision History

Revision	Brief Description of Changes	Date of Issue	Author/ Editor
0.1	Initial Issue	2019-May-22	HJS
0.2	TSN chapter added, update	2020-July-15	HJS
0.3	revision from 21.07., DIN rail	2020-July-23	HJS

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Symbols

The following symbols may be used in this user guide

⚠ DANGER

DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

NOTICE

NOTICE indicates a property damage message.

⚠ CAUTION

CAUTION indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.



Electric Shock!

This symbol and title warn of hazards due to electrical shocks (> 60 V) when touching products or parts of products. Failure to observe the precautions indicated and/or prescribed by the law may endanger your life/health and/or result in damage to your material.



ESD Sensitive Device!

This symbol and title inform that the electronic boards and their components are sensitive to static electricity. Care must therefore be taken during all handling operations and inspections of this product in order to ensure product integrity at all times.



HOT Surface!

Do NOT touch! Allow to cool before servicing.



Laser!

This symbol inform of the risk of exposure to laser beam and light emitting devices (LEDs) from an electrical device. Eye protection per manufacturer notice shall review before servicing.



This symbol indicates general information about the product and the user guide.

This symbol also indicates detail information about the specific product configuration.



This symbol precedes helpful hints and tips for daily use.

For Your Safety

Your new Kontron product was developed and tested carefully to provide all features necessary to ensure its compliance with electrical safety requirements. It was also designed for a long fault-free life. However, the life expectancy of your product can be drastically reduced by improper treatment during unpacking and installation. Therefore, in the interest of your own safety and of the correct operation of your new Kontron product, you are requested to conform with the following guidelines.

High Voltage Safety Instructions

As a precaution and in case of danger, the power connector must be easily accessible. The power connector is the product's main disconnect device.

CAUTION

Warning

All operations on this product must be carried out by sufficiently skilled personnel only.

CAUTION



Electric Shock!

Before installing a non hot-swappable Kontron product into a system always ensure that your mains power is switched off. This also applies to the installation of piggybacks. Serious electrical shock hazards can exist during all installation, repair, and maintenance operations on this product. Therefore, always unplug the power cable and any other cables which provide external voltages before performing any work on this product.

Earth ground connection to vehicle's chassis or a central grounding point shall remain connected. The earth ground cable shall be the last cable to be disconnected or the first cable to be connected when performing installation or removal procedures on this product.

Special Handling and Unpacking Instruction

NOTICE



ESD Sensitive Device!

Electronic boards and their components are sensitive to static electricity. Therefore, care must be taken during all handling operations and inspections of this product, in order to ensure product integrity at all times.

Do not handle this product out of its protective enclosure while it is not used for operational purposes unless it is otherwise protected.

Whenever possible, unpack or pack this product only at EOS/ESD safe work stations. Where a safe work station is not guaranteed, it is important for the user to be electrically discharged before touching the product with his/her hands or tools. This is most easily done by touching a metal part of your system housing.

It is particularly important to observe standard anti-static precautions when changing piggybacks, ROM devices, jumper settings etc. If the product contains batteries for RTC or memory backup, ensure that the product is not placed on conductive surfaces, including anti-static plastics or sponges. They can cause short circuits and damage the batteries or conductive circuits on the product.

General Instructions on Usage

In order to maintain Kontron's product warranty, this product must not be altered or modified in any way. Changes or modifications to the product, that are not explicitly approved by Kontron and described in this user guide or received from Kontron Support as a special handling instruction, will void your warranty.

This product should only be installed in or connected to systems that fulfill all necessary technical and specific environmental requirements. This also applies to the operational temperature range of the specific board version that must not be exceeded. If batteries are present, their temperature restrictions must be taken into account.

In performing all necessary installation and application operations, only follow the instructions supplied by the present user guide.

Keep all the original packaging material for future storage or warranty shipments. If it is necessary to store or ship the product then re-pack it in the same manner as it was delivered.

Special care is necessary when handling or unpacking the product. See Special Handling and Unpacking Instruction.

Quality and Environmental Management

Kontron aims to deliver reliable high-end products designed and built for quality, and aims to complying with environmental laws, regulations, and other environmentally oriented requirements. For more information regarding Kontron's quality and environmental responsibilities, visit <http://www.kontron.com/about-kontron/corporate-responsibility/quality-management>.

Disposal and Recycling

Kontron's products are manufactured to satisfy environmental protection requirements where possible. Many of the components used are capable of being recycled. Final disposal of this product after its service life must be accomplished in accordance with applicable country, state, or local laws or regulations.

WEEE Compliance

The Waste Electrical and Electronic Equipment (WEEE) Directive aims to:

- ▶ Reduce waste arising from electrical and electronic equipment (EEE)
- ▶ Make producers of EEE responsible for the environmental impact of their products, especially when the product become waste
- ▶ Encourage separate collection and subsequent treatment, reuse, recovery, recycling and sound environmental disposal of EEE
- ▶ Improve the environmental performance of all those involved during the lifecycle of EEE



Environmental protection is a high priority with Kontron.

Kontron follows the WEEE directive

You are encouraged to return our products for proper disposal.

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1/ General Safety Instructions for IT Equipment

▲WARNING



Please read this chapter carefully and take careful note of the instructions, which have been compiled for your safety and to ensure to apply in accordance with intended regulations. If the following general safety instructions are not observed, it could lead to injuries to the operator and/or damage of the product; in cases of nonobservance of the instructions Kontron is exempt from accident liability, this also applies during the warranty period.

The product has been built and tested according to the basic safety requirements for low voltage (LVD) applications and has left the manufacturer in safety-related, flawless condition. To maintain this condition and also to ensure safe operation, the operator must not only observe the correct operating conditions for the product but also the following general safety instructions:

- ▶ The product must be used as specified in the product documentation, in which the instructions for safety for the product and for the operator are described. These contain guidelines for setting up, installation and assembly, maintenance, transport or storage.
- ▶ The on-site electrical installation must meet the requirements of the country's specific local regulations.
- ▶ If a power cable comes with the product, only this cable should be used. Do not use an extension cable to connect the product.
- ▶ To guarantee that sufficient air circulation is available to cool the product, please ensure that the ventilation openings are not covered or blocked. If an air filter is provided, this should be cleaned regularly. Do not place the system close to heat sources or damp places. Make sure the system is well ventilated.
- ▶ Only devices or parts which fulfill the requirements of SELV circuits (Safety Extra Low Voltage) as stipulated by IEC 60950-1 may be connected to the available interfaces.
- ▶ Before opening the device, make sure that the device is disconnected from the mains.
- ▶ Switching off the device by its power button does not disconnect it from the mains. Complete disconnection is only possible if the power cable is removed from the wall plug or from the device. Ensure that there is free and easy access to enable disconnection.
- ▶ The device may only be opened for the insertion or removal of add-on cards (depending on the configuration of the system). This may only be carried out by qualified operators.
- ▶ If extensions are being carried out, the following must be observed:
 - ▶ All effective legal regulations and all technical data are adhered to.
 - ▶ The power consumption of any add-on card does not exceed the specified limitations.
 - ▶ The current consumption of the system does not exceed the value stated on the product label.
- ▶ Only original accessories that have been approved by Kontron can be used.
- ▶ Please note: safe operation is no longer possible when any of the following applies:
 - ▶ The device has visible damages.
 - ▶ The device is no longer functioning.

In this case the device must be switched off and it must be ensured that the device can no longer be operated.

Additional safety instructions for DC power supply circuits

- ▶ To guarantee safe operation of devices with DC power supply voltages larger than 60 volts DC or a power consumption larger than 240 VA, please observe that:
 - ▶ the device is set up, installed and operated in a room or enclosure marked with "RESTRICTED ACCESS", if there are no safety messages on product as safety signs and labels on the device itself.
 - ▶ no cables or parts without insulation in electrical circuits with dangerous voltage or power should be touched directly or indirectly
 - ▶ a reliable protective earthing connection is provided
 - ▶ a suitable, easily accessible disconnecting device is used in the application (e.g. overcurrent protective device), if the device itself is not disconnectable
 - ▶ a disconnect device, if provided in or as part of the equipment, shall disconnect both poles simultaneously
 - ▶ interconnecting power circuits of different devices cause no electrical hazards
- ▶ A sufficient dimensioning of the power cable wires must be selected – according to the maximum electrical specifications on the product label – as stipulated by EN60950-1 or VDE0100 or EN60204 or UL508 regulations.
- ▶ The devices do not generally fulfill the requirements for "centralized DC power systems" (UL 60950-1, Annex NAB; D2) and therefore may not be connected to such devices!

NOTICE

If any of the supply voltages drops below the allowed operating level longer than the specified hold-up time, all the supply voltages should be shut down and left OFF for a time long enough to allow the internal board voltages to discharge sufficiently.

If the OFF time is not observed, parts of the board or attached peripherals may work incorrectly or even suffer a reduction of MTBF.

The minimum OFF time depends on the implemented PSU model and other electrical factors and needs to be measured individually for each case.

1.1. Electrostatic Discharge (ESD)



A sudden discharge of electrostatic electricity can destroy static-sensitive devices or micro-circuitry.

Therefore proper packaging and grounding techniques are necessary precautions to prevent damage. Always take the following precautions:

1. Transport boards in ESD-safe containers such as boxes or bags.
2. Keep electrostatic sensitive parts in their containers until they arrive at the ESD-safe workplace.
3. Always be properly grounded when touching a sensitive board, component, or assembly.
4. Store electrostatic-sensitive boards in protective packaging or on antistatic mats.

1.1.1. Grounding Methods

By adhering to the guidelines below, electrostatic damage to the device can be avoided:

1. Cover workstations with approved antistatic material. Always wear a wrist strap connected to workplace. Always use properly grounded tools and equipment.
2. Use antistatic mats, heel straps, or air ionizers for more protection.
3. Always handle electrostatically sensitive components by their edge or by their casing.
4. Avoid contact with pins, leads, or circuitry.

5. Turn off power and input signals before inserting and removing connectors or connecting test equipment.
6. Keep work area free of non-conductive materials such as ordinary plastic assembly aids and Styrofoam.
7. Use only field service tools which are conductive, such as cutters, screwdrivers, and vacuum cleaners.
8. Always place drives and boards PCB-assembly-side down on the foam.

2/ Electromagnetic Compatibility

For detailed information refer to section 10.3.

2.1. Electromagnetic Compatibility (EU)

This product is intended only for use in industrial areas. The most recent version of the EMC guidelines (EMC Directive 2014/30/EU) and/or the German EMC laws apply. If the user modifies and/or adds to the equipment (e.g. installation of add-on cards) the prerequisites for the CE conformity declaration (safety requirements) may no longer apply.

3/ Introduction

Kontron's KBox A-230-LS, based on the NXP Dual Cortex processor LS1028A, is an industrial box PC with TSN (Time Sensitive Networking) functionality. This KBox is equipped with a SMARC module and has five TSN-capable 1 GByte Ethernet ports which meet IEEE 802.1 TSN specifications. The A-230-LS is maintenance-free with no battery and no fan. It supports Kontron APPROTECT security solution based on Wibu-Systems CodeMeter®.

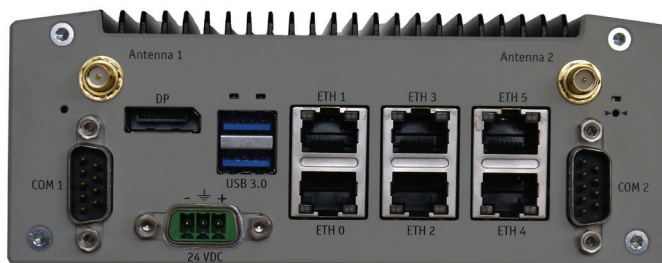
General KBox A-230-LS features are:

- ▶ Based on NXP Dual Cortex A72 LS1028A
- ▶ 6x GbE (5x TSN capable, 1x GbE)
- ▶ Optional APPROTECT (security chip) support on request
- ▶ Maintenance-free: no moving parts, battery-free

The KBox A-230-LS is intended for 24/7 continuous operation and longtime industrial applications. All components are selected to ensure a long lifetime.

This user guide describes the KBox A-230-LS. New users are recommended to study the installation instructions within this user guide before switching on the power.

Figure 1: KBox A-230-LS



The KBox A-230-LS is factory configured to meet customer requirements. Kontron does not recommend opening the system as this may cause damage to internal components..

4/ Shipment and Unpacking

4.1. Packaging

All parts are delivered together in a product specific cardboard package designed to provide adequate protection to absorb shock. Kontron recommends keeping the packaging to store or transport the product.

4.2. Unpacking

Proceed as follows to unpack the unit:

1. Remove packaging.
2. Do not discard the original packaging. Keep it for future relocation.
3. Check the delivery for completeness by comparing it with your order.
4. Please keep the associated paperwork. It contains important information for handling the unit.
5. Check the contents for visible shipping damage.
6. If you notice any shipping damage or inconsistencies between the contents and your order, contact Kontron for help and information.

4.3. Scope of Delivery

Check that your delivery is complete, and contains the items below (according to the ordered unit configuration). If you discover damaged or missing items, contact your dealer.

Table 1: Scope of Delivery

Part	Qty.	Remark
KBox A-230-LS	1	
AC power supply	1	option – order separately
AC power cord	1	option – order separately
Phoenix power connector	1	
Safety Instructions	1	in user guide

4.4. Accessories

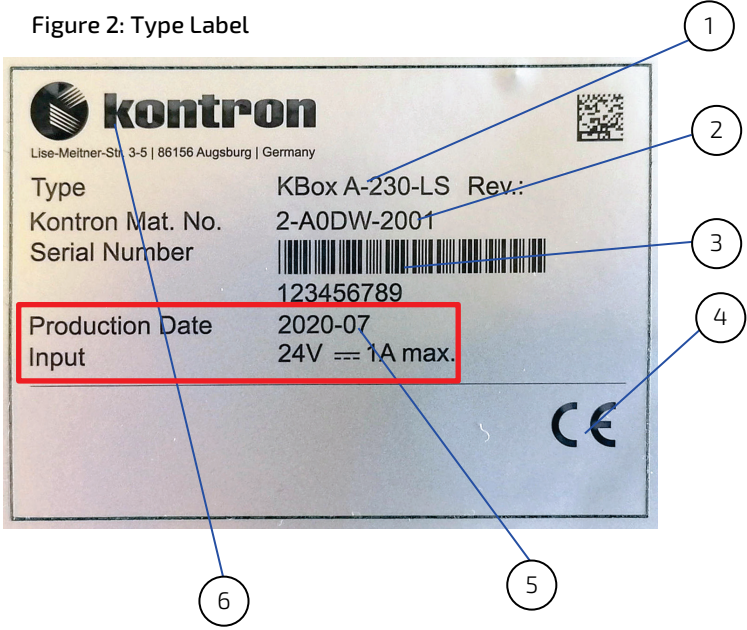
Table 2: Accessories

Part	Part Description
Power Supply	External power supply
Power Cord	230 V power Cord

4.5. Type Label and Product Identification

The type label is position on the side of the chassis.

Figure 2: Type Label

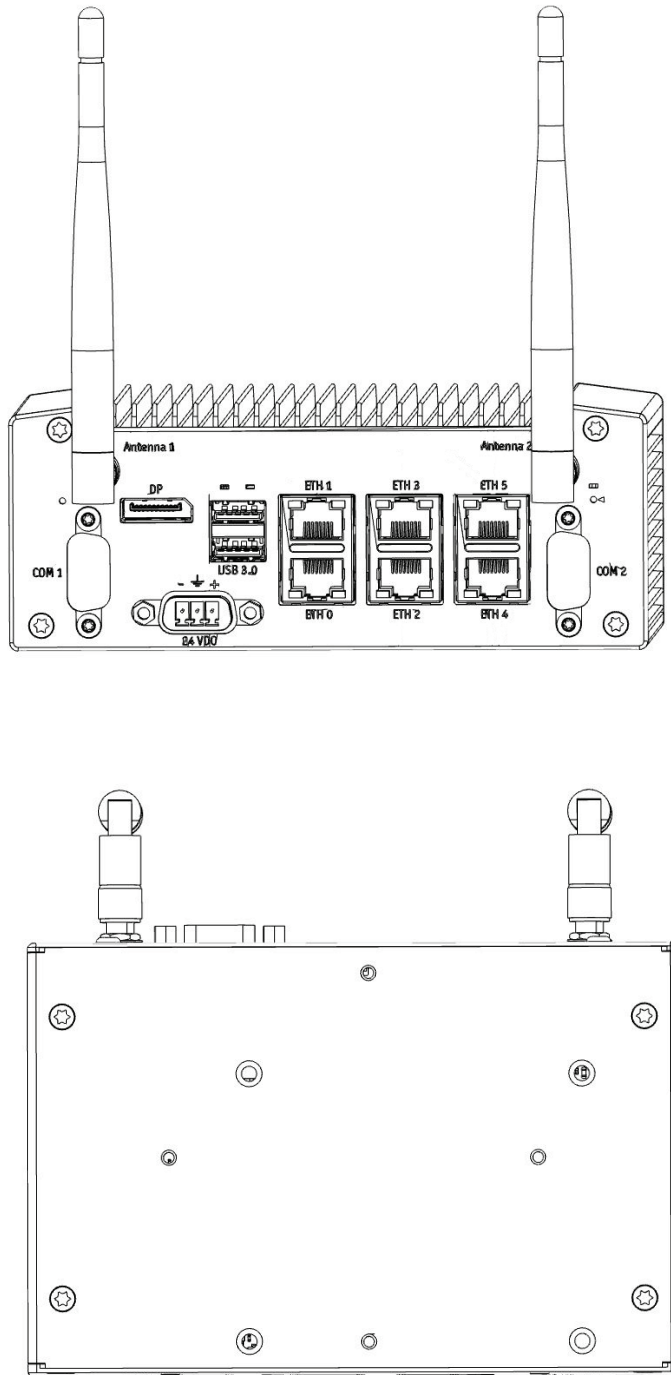


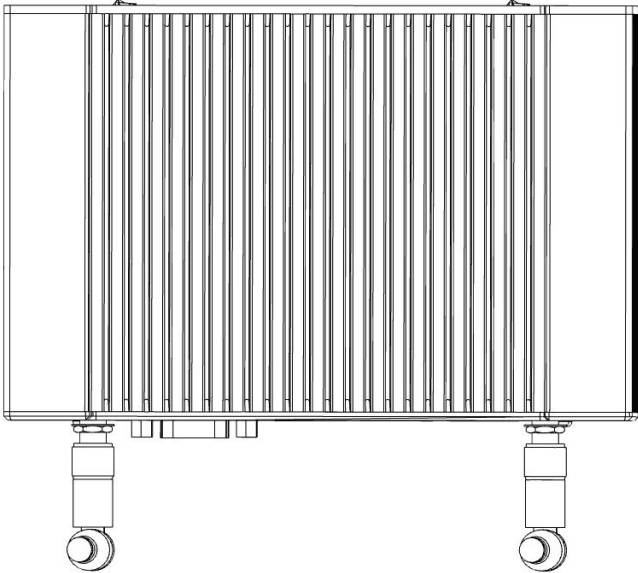
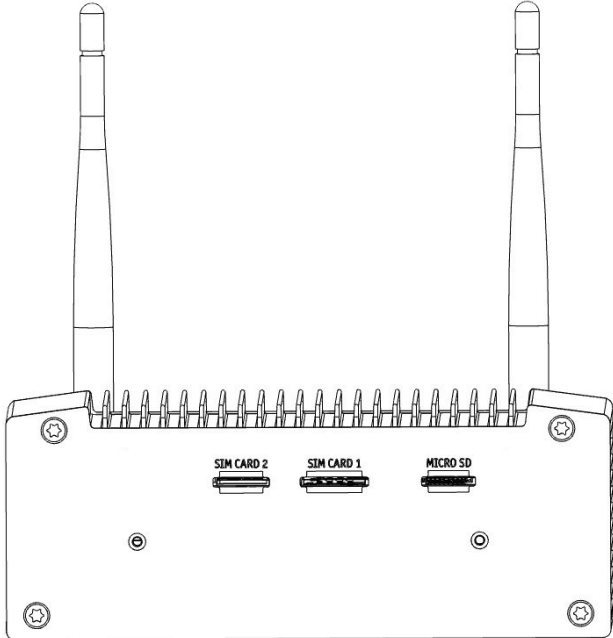
- 1. Product name (KBox A-230-LS)
- 2. Model number
- 3. Serial Number (S/N) with barcode
- 4. Certification information
- 5. Technical data (red frame)
- 6. Manufacturer/Address

5/ Product Overview

The KBox A-230-LS is based on the industrial grade box PC with ARM processor. The KBox A-230-LS is a fanless device with passive cooling. Standard Operating system is Linux Yocto.

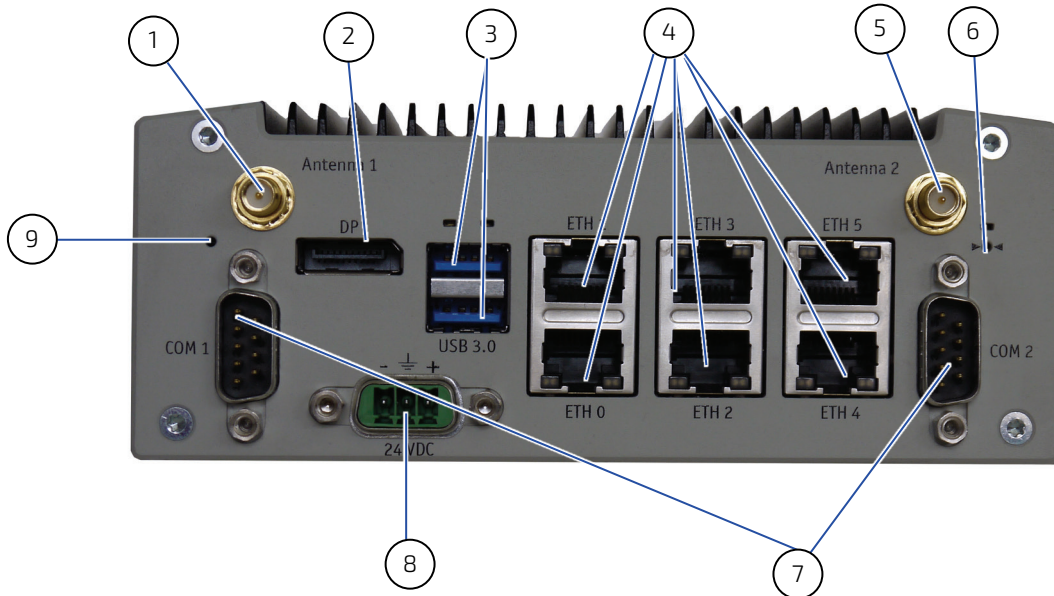
Figure 3: KBox A-230-LS Overview





5.1. Front View

Figure 4: Front View



- | | | | |
|---|------------------------|---|-----------------|
| 1 | WLAN Antenna | 7 | 2x COM |
| 2 | DisplayPort | 8 | Power Connector |
| 3 | 1x USB 3.0, 1x USB 2.0 | 9 | Power Button |
| 4 | 6x GbE | | |
| 5 | WLAN Antenna | | |
| 6 | Reset Button | | |

5.1.1. Power Connector (PWR)

There is one 3-pin Phoenix power connector on the front panel supporting an input DC voltage range of 9 VDC to 30 VDC, see Figure 4 (pos. 8). The required mating connector, to connect the power connector to a DC main power source, is supplied with the KBox A-230-LS.

5.1.2. Display Port (DP)

There is one DP graphics port for video only solutions, see Figure 4 (pos. 2).

5.1.3. Ethernet (ETH0, ETH1, ETH2, ETH3, ETH4, ETH5)

There are six LAN ports ETH0, ETH1, ETH2, ETH3, ETH4 and ETH5 supporting 10/100/1000 Mbit Ethernet, see Figure 4 (pos. 4).

5.1.4. USB 3.0 Ports (USB0, USB1)

There are two USB 3.0 ports allowing the connection of a USB 3.0/USB 2.0 compatible device, see Figure 4 (pos. 3).

5.1.5. Power/Reset Button

A power button is available on the front panel, see Figure 4 (pos. 6). The power button (pos. 9) performs an orderly system shut down with no loss of data and then reapplies power to resume operation.

NOTICE

The reset button does a hard reset, the board reboots directly. With the Power Button (pressed for 4 seconds) the payload power is switched off. Pressed for 0.5 seconds the power restarts.

5.1.6. Serial Port (COM1, COM2)

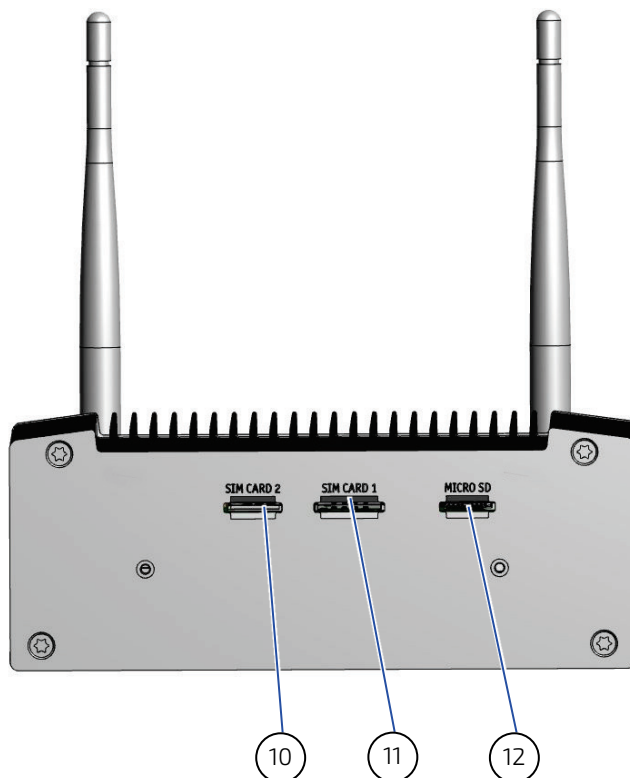
There are two serial ports COM1 and COM2 both supporting RS232/422/485, see Figure 4(pos. 7).

5.1.7. WLAN Antennas (WLAN1, WLAN2)

There are two serial ports WLAN1 and WLAN2, see Figure 4 (pos. 5).

5.2. Rear View

Figure 5: Rear View



- 10. SIM-Card2
- 11. SIM-Card1
- 12. Micro-SD

6/ System Extension



The KBox A-230-LS is factory configured to meet customer requirements. Kontron does not recommend opening the system as this may cause damage to internal components.

6.1. Storage

6.1.1. Internal mSATA SSD

To expand storage memory an Internal mSATA SSD of up to 512 GB can be installed. Kontron recommends the use of Kontron reference SSDs from 32 GB to 512 GB.

6.2. Expansion Cards –mPCIe

There is one internal mini PCIe V 1.2 expansion socket (MPCIE1). For information regarding the pin assignment of MPCIE1, refer Chapter 14.3.

7/ Accessing Components

This chapter contains important information that users must read before accessing components. Follow these procedures properly when accessing or installing component to extend the system.



The KBox A-230-LS is factory configured to meet customer requirements. Kontron does not recommend opening the system as this may cause damage to internal components. There is a protection label on the KBox A-230-LS. If the product is opened within the warranty period, the warranty is lost.

WARNING

The installation/removal of system components may only be performed by a qualified persons. Observe the "General Safety Instructions for IT-Equipment" and the "installation instructions" contained within this user guide.



ESD Sensitive

Follow the safety instructions for components that are sensitive to electrostatic discharge (ESD). Failure to observe this warning notice may result in damage to the product or/and internal components.



Because of the limited predetermined lifespan of expansion devices, Kontron recommends checking the condition of installed expansion devices regularly and to pay attention to the manufacturer specifications for lifespan.

7.1. Accessing External Components

7.2. Accessing Internal Components

7.2.1. Opening the Chassis

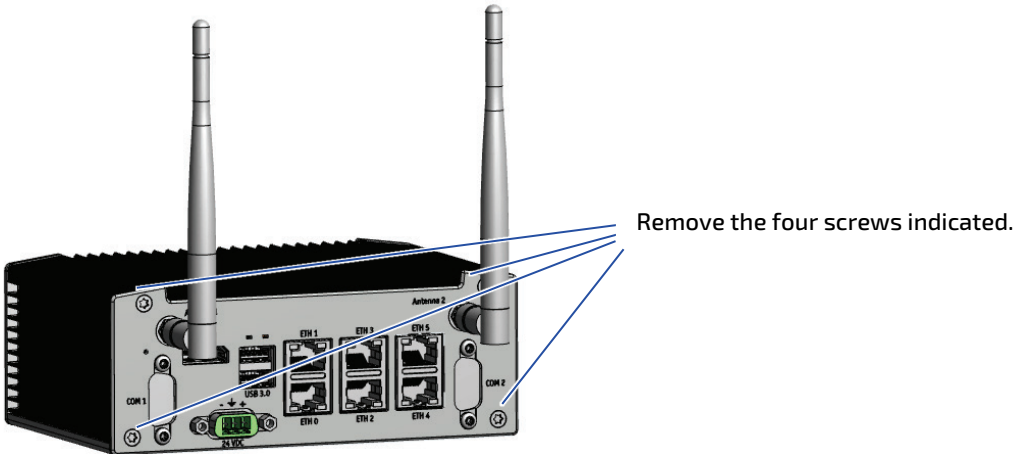
To access the internal components open the KBox A-230-LS chassis by following the step below:



The KBox A-230-LS is factory configured to meet customer requirements. Kontron does not recommend opening the system as this may cause damage to internal components.

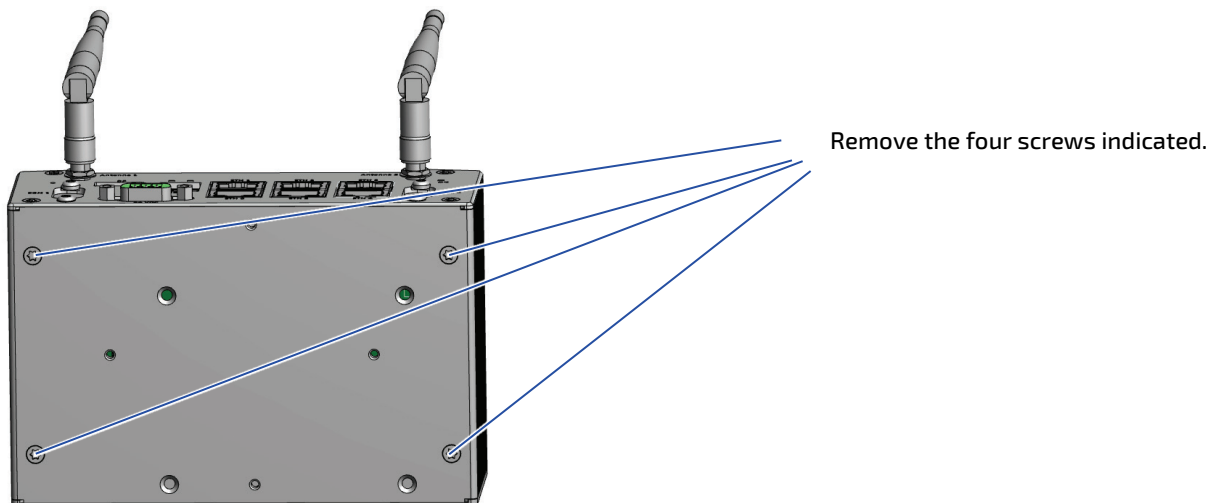
1. Close all applications. Shut down the system properly and disconnect the power cord from the power source. Disconnect all peripherals.
1. Place the KBox A-230-LS on a flat, clean and ESD-safe surface.
2. Remove the screws of the front panel.

Figure 6: Front Panel Fastening Screws



- 3. Remove the screws from the bottom side of the chassis.

Figure 7: Bottom Side fastening screws



4. Carefully slide the cover of the chassis
5. To close the KBox A-230-LS, proceed in the reverse order. Align the front panel with the main chassis and push backwards (towards the rear side of the chassis) while making sure that the front panel remains aligned and goes back as far as it will go. Secure the cover with the screws removed in step 4 and step 3.

7.2.2. Installing and Removing mPCIe Expansion Cards



The KBox A-230-LS is factory configured to meet customer requirements. Kontron does not recommend opening the system as this may cause damage to internal components.

To install a mini PCIe cards follow the steps below:

1. Close all applications; shut down the system properly and disconnect the connection to the power source.
2. Disconnect all peripherals.
3. Open the device as described in the Chapter 7.2.1: (step 1-5).
4. Locate the mini PCIe card socket and the corresponding fixing clips.
5. Insert the mini PCIe card into the socket at an angle of approx. 45° and push it down until the fixing holes of the card are aligned with the fixing clips.
6. Press the mini PCIe card down (on the side with the fixing holes) until the card snaps in the fixing clips.
7. In order to close the KBox A-230-LS, proceed in reverse order (step 6) of Chapter 7.2.1.

To remove a mini PCIe card follow the steps below:

1. Close all applications; shut down the system properly and disconnect the connection to the power source. Disconnect all peripherals.
2. Open the device as described in the Chapter 7.2.1 Opening the Chassis(step 1-5).
3. Locate the mini PCIe card installed into your system.

4. Slide the fixing clips outwards in order to release the mini PCIe card. The mini PCIe card springs up at an angle of approx. 45° on the fixing clips side.
5. Gently pull the mini PCIe card out of the socket.
6. In order to close the KBox A-230-LS, proceed in reverse order (step 6) of Chapter 7.2.1 Opening the Chassis.

8/ Installation Instructions

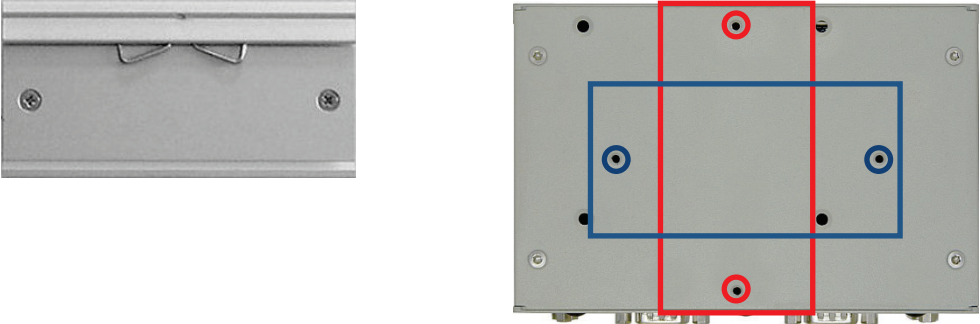
8.1. DIN Rail Clip (Option)

For DIN Rail mounting of the KBox A-203 a DIN Rail clip can be ordered. If ordered, you can adopt your system for mounting to a DIN rail.

8.1.1. Mounting the DIN Rail Clip to the Access Cover

Tapped holes are provided on the access cover for mounting the optional DIN Rail clip in vertical or horizontal orientation.

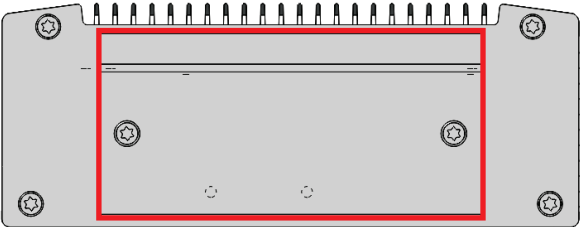
Figure 8: DIN rail clip mounted to the access cover



8.1.2. Mounting the DIN Rail Clip to the Rear Plate

Tapped holes are provided on the rear plate for mounting the optional DIN Rail clip in horizontal orientation.

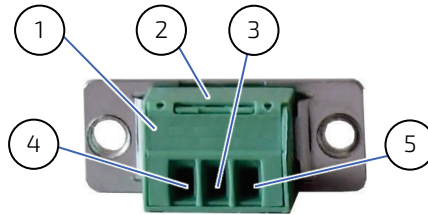
Figure 9: DIN rail clip mounted to the rear plate



8.2. Power Connector

The KBox A-230-LS is connected by the Input power connector on the front panel to a DC power source via a DC power supply wiring consisting of the Phoenix power mating connector (3 pin Phoenix PSC 1,5/ 3-F) delivered with the KBox A-230-LS and the assembled wires. For information on how to assemble the wires, see Chapter 8.2.1.

Figure 10: Phoenix Power Mating Connector



- | | | | |
|---|--|---|--------------------------------------|
| 1 | 3-pin Phoenix plug terminal | 4 | Location for inserting the 0 V wire |
| 2 | Cover over the slotted pan head screws | 5 | Location for inserting the 24 V wire |
| 3 | Location for inserting the functional earth wire | | |

8.2.1. Wiring the DC Mating Power Connector

To wire the supplied 3 pin Phoenix PSC 1,5/ 3-F power mating connector, following the step below.

1. Cut three (1 mm²) AWG18 isolated wires to the required length and strip each end 5 mm – 7 mm.
2. Twist the striped wire-ends and provide them with ferrules.
3. Access the slotted pan head screws by opening the Phoenix Power Mating Connector cover (Figure 10, pos. 2).
4. Loosen the slotted pan head screws of the Phoenix power mating connector far enough so that you can insert the end of the prepared wires.
5. Insert the wires into the corresponding clamp of the Phoenix power mating connector. Make sure that you have the right polarity of the connection.
6. Fasten the screws to secure the wires into the Phoenix power mating connector's clamps.
7. Close the Phoenix Power Mating Connector cover (Figure 10, pos. 2).



The wires used for power connections must be clearly marked (+/-/functional earth) to ensure proper connection to the front panel input power connector and to the main power source. In addition, the cables must have some form of support to minimize the strain on the unit's connectors.

9/ Starting Up

Before using your system, become familiar with the system components and follow the startup instructions below.

9.1. Connecting to Power Supply

The KBox A-230-LS connects to a DC main power supply via a Phoenix power connector on the KBox A-230-LS's front panel and corresponding power cable.



When starting the KBox A-230-LS, the functional earth connection must always be made first and disconnected last. Kontron recommended that the last connections attached to the system should be the power cable. Following a proper cabling procedure will prevent a false power-on condition, which could result in an operational failure.

CAUTION

The KBox A-230-LS must be connected to a DC mains power supply complying with the SELV (Safety Extra Low Voltage) requirements of EN 60950-1 standard. It must be observed that wiring and short-circuit/overcurrent protection is performed according to the applicable standards, regulations and respect to the electrical specification of the KBox A-230-LS. The disconnecting device (fuse/circuit breaker) rating must be in accordance with the KBox A-230-LS's wire cross-section.

To start the KBox A-230-LS follow the steps below:

1. Ensure that the DC power source is switched off via a disconnecting device (circuit breaker), in order to ensure that no power is flowing from the external DC power source during the connection procedure.
2. Connect the ground pin to an appropriate common earth connection point.
3. Connect the supplied Phoenix PSC 1,5/3-F power connector with wiring (refer to Chapter 0:

4. Power Connector and Chapter 8.2.1: Wiring the DC Mating Power Connector) to the Input power connector located on the front panel, see Figure 4 (pos. 8). Pay attention to the polarity of the connections.
5. Connect the other end of the DC power cable to the DC main power supply.
6. Switch on the disconnecting device (circuit breaker) in order to apply voltage to the KBox A-230-LS.

9.1.1. Power Button

A power button is available on the front panel, see Figure 4 (pos.5). The power button performs an orderly system shut down with no loss of data and then reapplies power to resume operation.

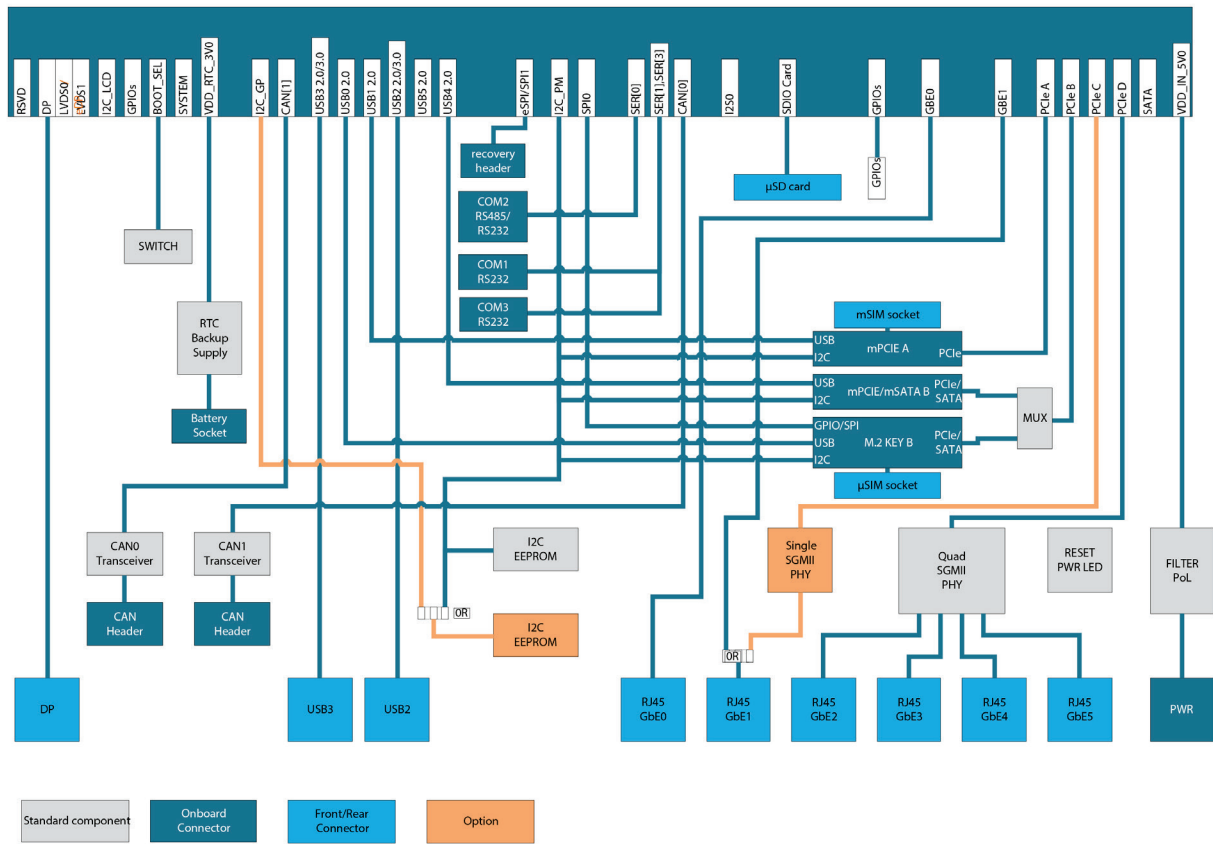
NOTICE

**Do not disconnect the power while KBox A-230-LS is powered up!
Performing a forced shutdown can lead to loss of data or other undesirable effects!**

10/ Technical Data

10.1. Block Diagram

Figure 11: Block Diagram



10.2. Technical Specification

Table 3: Technical Data

Designation	KBox A-230-LS	
Processor	CPU	NXP Dual Cortex A72 LS1028A with 2x 1.3 GHz
	BIOS	U-Boot
Memory	Technology	DDR3L with ECC
	Max. Capacity	4 GB
Interfaces	Graphics Ports	1x Display Port
	USB	1x USB 3.0, 1x USB 2.0
	Ethernet	6x 10/100/1000
	Serial Ports	COM1 RS232, Optional COM2 as RS232/RS485 or CAN
Storage	SD Card	1x mSD
	Flash	up to 64 GByte onboard flash (eMMC)
	MSATA	1x mSATA on mPCIe
	M.2	1x M.2 SSD on Key B socket for 2242/3042 or 2260/3060 module
Expansion	Mini PCIe	1x miniPCIe socket full/half-size modules with miniSIM Card support 1x miniPCIe/mSATA socket full/half-size modules
Software Support	Linux	Yocto
Power	Input Voltage Range	24 VDC (+/- 20 %)
Mechanical	Construction	Aluminum housing
	Mounting	DIN Rail, Desktop, Wall, Cabinet
	Dimensions (HxWxD)	58 x 150 x 100 mm (2.23" x 5.91" x 3.94")
	Weight	1.0 kg
Environment	Cooling	Fanless passiv
	Operating Temperature	0 °C to 60 °C
	Relative Humidity	93 % @ 40 °C, non condensing
Approvals	Certifications	CE, FCC CB scheme, UL61010-1, UL61010-2-201

10.3. Environmental Specification

Table 4: Environmental Specification

Temperature (Operating)	0 °C to +60 °C (32 °F to 140 °F)
Temperature (Storage)	-40 °C to +85 °C (-40 °F to 185 °F)
Relative Humidity (Operating)	93% @ 40°C non condensing
Operating Vibration	acc. IEC 60068-2-6, 5 -500 Hz, 1G
Operating Shock	acc. IEC 60068-2-27, half sine, 15 g, 11 ms
EMC	CE, FCC

Safety Certifications	CB scheme, UL61010-1, UL61010-2-201
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10.4. Mechanical Specification

Table 5: Mechanical Specification

Dimensions	KBox A-230-LS
Width	150.00 mm
Depth	100.00 mm
Height	58.00 mm
Chassis	RAL 7035 (front)/RAL7043 (housing) powder coated

For more detailed mechanical information, refer to the outline dimensions drawings within this chapter. Each dimension drawing shows the main external mechanical features such as the position and size of mounting holes for the DIN rail retaining clamp.

Figure 12: Dimension Bottom Side

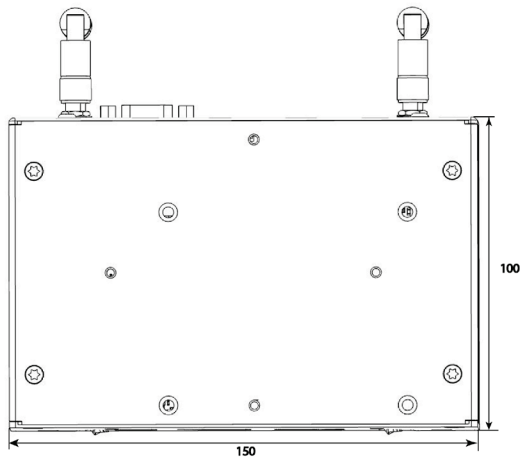
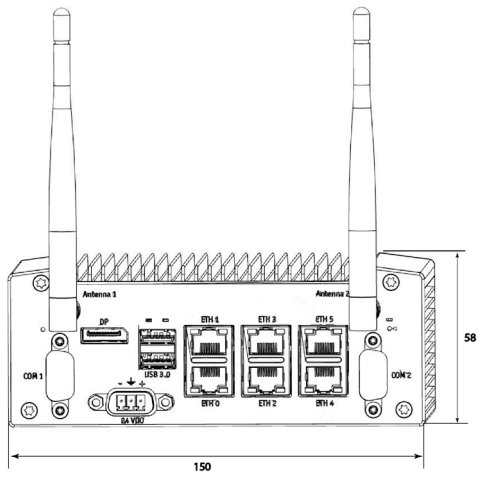


Figure 13: Dimensions Front Side



10.5. Power Specification

The KBox A-230-LS has no internal power supply and is powered by a 3-pin DC connector on the front panel. The standard PSU voltage is 24 V DC which is converted using an internal 24 VDC to 12 VDC converter to supply the mainboard with +12 V DC.

NOTICE

Hot Plugging the power supply is not supported. Hot plugging might damage the board.

Table 6: Power Specification

Nominal Input Voltage	24 V DC +/- 20 %
Input Voltage Range	9 V DC to 30 V DC
Input Power Connector	3- pin Phoenix PSC 1.5/3-M

10.5.1. Power Consumption

The power consumption of the KBox A-230-LS is specified for a device with Windows 7 Professional (64bit), 4 GB RAM and 60 GB mSATA.

Table 7: Power Consumption at 60°C Environment Temperature

Parameter	Vin nom	Vin min	Vin max
Input voltage [V]	23.724	7.918	28.675
Input current [A]	0.815	2.611	0.679
Input power [W]	19.336	20.67	19.472

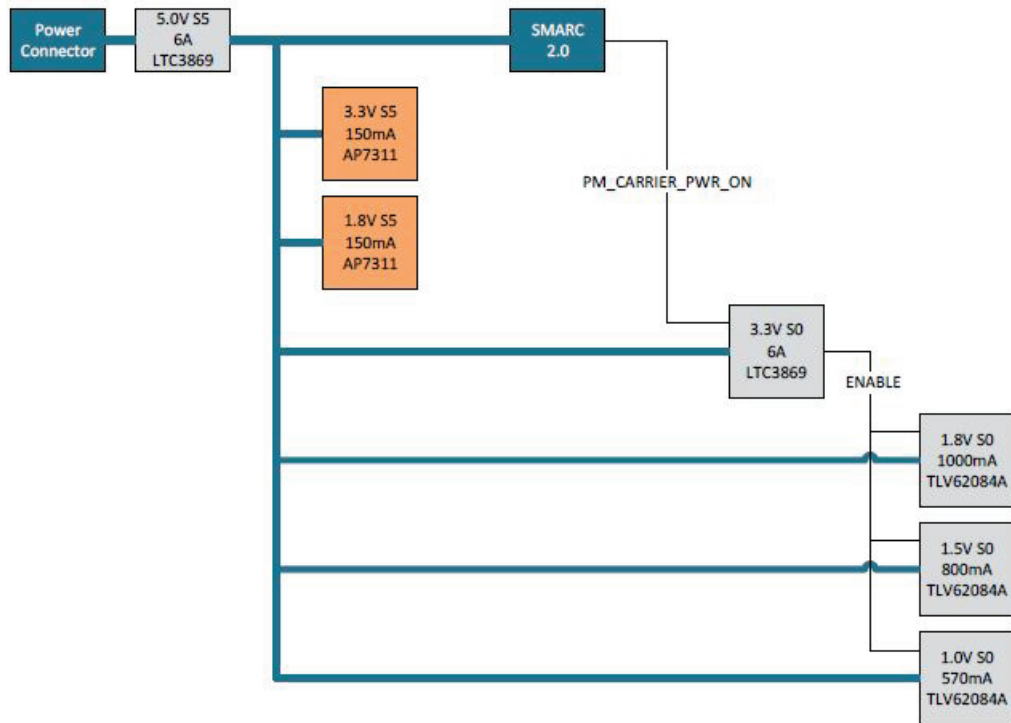
Table 8: Power Consumption at -40°C Environment Temperature

Parameter	Vin nom	Vin min	Vin max
Input voltage [V]	23.724	7.92	28.674
Input current [A]	0.74	2.338	0.622
Input power [W]	17.558	18.518	17.836

10.5.2. Power Distribution

The S1914 input voltage is 24VDC nominal. The KBox A-230-LS is qualified from 19.2 V to 28.8 V (+/-20%), while the 24V to 5V DCDC converter would allow 4V to 38V max. The 5.0V S5 is enabled if the 24V input voltage is above 6.0 V typical.

Figure 14: Power Distribution



NOTICE

If any of the supply voltages drops below the allowed operating level longer than the specified hold-up time, all the supply voltages should be shut down and left OFF for a time long enough to allow the internal board voltages to discharge sufficiently.

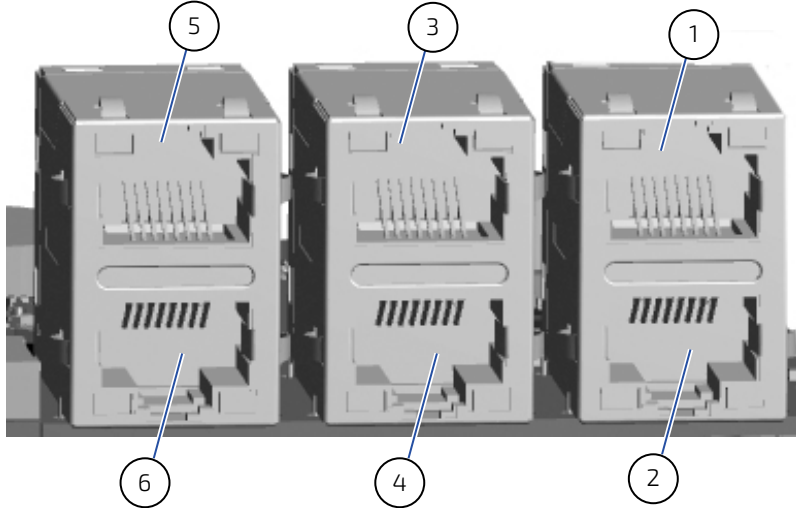
If the OFF time is not observed, parts of the board or attached peripherals may work incorrectly or even suffer a reduction of MTBF.

The minimum OFF time depends on the implemented PSU model and other electrical factors and needs to be measured individually for each case.

11/Interface Pin Assignments

11.1. GBE LAN RJ45 Connector (GBE0, GBE1, GBE2, GBE3, GBE4, GBE5)

Figure 15: Stacked 2x1 RJ45 Array (J6/J7/J8)



1. GBE0 (J6)
2. GBE1 (J6)
3. GBE2 (J7)
4. GBE3 (J7)
5. GBE4 (J8)
6. GBE5 (J8)

Table 9: LED activity

Left LED: Activity/Link		Right LED: Link Speed	
Off	No LAN connectivity	Off	no activity
Green	100Base-TX Link	Green blinking	activity
Yellow	1000Base-TX		

Table 10: GBE2 to GBE5

Interface	BCM54140 Port	PHY Address
GBE2	0	0x7
GBE3	1	0x8
GBE4	2	0x9
GBE5	3	0xa

Table 11: GBE0 driven by SMARC 2.0 GBE0 module

Pin	Signal
U1	GBE0_CT, SMARC 2.0 GBE0_CREF center tap reference voltage.

U2	GBE0_MDI0_CON+, SMARC 2.0 GBE0 MDI
U3	GBE0_MDI0_CON-, SMARC 2.0 GBE0 MDI
U4	GBE0_MDI1_CON +, SMARC 2.0 GBE0 MDI
U7	GBE0_MDI1_CON -, SMARC 2.0 GBE0 MDI
U5	GBE0_MDI2_CON -, SMARC 2.0 GBE0 MDI
U6	GBE0_MDI2_CON -, SMARC 2.0 GBE0 MDI
U8	GBE0_MDI3_CON +, SMARC 2.0 GBE0 MDI
U9	GBE0_MDI3_CON -, SMARC 2.0 GBE0 MDI
U10	NC
U11	GBE0_LINK100_G, SMARC 2.0 GBE0_LINK100# inverted LED signal.
U12	GBE0_LINK1000_Y, SMARC 2.0 GBE0_LINK1000# inverted LED signal.
U13	GBE0_ACT_CON_3V3_R#, filtered 3.3V S0
U14	GBE0_ACT_CON_R#, SMARC 2.0 GBE0_ACT# led signal

Table 12: GBE1, driven by local PHY (Option a) or GBE1 SMARC 2.0 module (Option b)

Pin	Signal
D1	a. NC b. GBE1_CT, SMARC 2.0 GBE1_CREF center tap reference voltage.
D2	a. GBE1_MDI0+ b. GBE1_MDI0_CON+, SMARC 2.0 GBE1 MDI
D3	a. GBE1_MDI0- b. GBE1_MDI0_CON-, SMARC 2.0 GBE1 MDI
D4	a. GBE1_MDI1+ b. GBE1_MDI1_CON +, SMARC 2.0 GBE1 MDI
D7	a. GBE1_MDI1- b. GBE1_MDI1_CON -, SMARC 2.0 GBE1 MDI
D5	a. GBE1_MDI2+ b. GBE1_MDI2_CON +, SMARC 2.0 GBE1 MDI
D6	a. GBE1_MDI2- b. GBE1_MDI2_CON -, SMARC 2.0 GBE1 MDI
D8	a. GBE1_MDI3+ b. GBE1_MDI3_CON +, SMARC 2.0 GBE1 MDI
D9	a. GBE1_MDI3- b. GBE1_MDI3_CON -, SMARC 2.0 GBE1 MDI
D10	NC
D11	a. GBE1_LINK100_G b. GBE1_LINK100_G, SMARC 2.0 GBE1_LINK100# inverted LED signal.
D12	a. GBE1_LINK1000_Y b. GBE1_LINK1000_Y, SMARC 2.0 GBE1_LINK1000# inverted LED signal.
D13	a. GBE1_ACT# b. GBE1_ACT_3V3_R#, filtered 3.3V S0
D14	a. GBE1_ACT# b. GBE1_ACT_CON_R#, SMARC 2.0 GBE1_ACT# led signal

Table 13: GBE2, driven by QSGMII PHY Port 0, PHY address 0x7

Pin	Signal
U1	NC
U2	GBE2_MDIO+
U3	GBE2_MDIO-
U4	GBE2_MDI1+
U7	GBE2_MDI1-
U5	GBE2_MDI2+
U6	GBE2_MDI2-
U8	GBE2_MDI3+
U9	GBE2_MDI3-
U10	NC
U11	GBE2_LINK1000_R#, driven by PHY LED_PO_1#
U12	GBE2_LINK100_R#, driven by PHY LED_PO_2#
U13	GBE2_ACT_CON_3V3_R#, filtered 3.3V S0
U14	GBE2_ACT_R#, driven by PHY LED_PO_3#

Table 14: GBE3, driven by QSGMII PHY Port 1, PHY address 0x8

Pin	Signal
D1	NC
D2	GBE3_MDIO+
D3	GBE3_MDIO-
D4	GBE3_MDI1+
D7	GBE3_MDI1-
D5	GBE3_MDI2+
D6	GBE3_MDI2-
D8	GBE3_MDI3+
D9	GBE3_MDI3-
D10	NC
D11	GBE3_LINK1000_R#, driven by PHY LED_P1_1#
D12	GBE3_LINK100_R#, driven by PHY LED_P1_2#
D13	GBE3_ACT_CON_3V3_R#, filtered 3.3V S0
D14	GBE3_ACT_R#, driven by PHY LED_P1_3#

Table 15: GBE4, driven by QSGMII PHY Port 2, PHY address 0x9

Pin	Signal
U1	NC
U2	GBE4_MDIO+
U3	GBE4_MDIO-
U4	GBE4_MDI1+
U7	GBE4_MDI1-

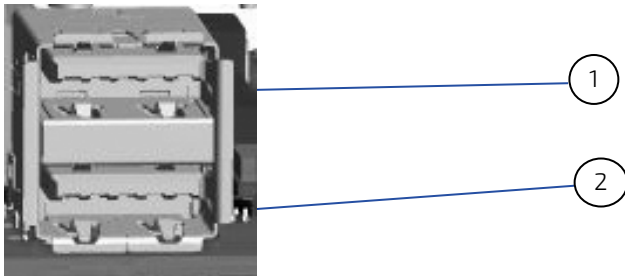
Pin	Signal
U5	GBE4_MDI2+
U6	GBE4_MDI2-
U8	GBE4_MDI3+
U9	GBE4_MDI3-
U10	NC
U11	GBE4_LINK1000_R#, driven by PHY LED_P2_1#
U12	GBE4_LINK100_ R#, driven by PHY LED_P2_2#
U13	GBE4_ACT_CON_3V3_R#, filtered 3.3V S0
U14	GBE4_ACT_R#, driven by PHY LED_P2_3#

Table 16: GBE5, driven by QSGMII PHY Port 3, PHY address 0xa

Pin	Signal
D1	NC
D2	GBE5_MDI0+
D3	GBE5_MDI0-
D4	GBE5_MDI1+
D7	GBE5_MDI1-
D5	GBE5_MDI2+
D6	GBE5_MDI2-
D8	GBE5_MDI3+
D9	GBE5_MDI3-
D10	NC
D11	GBE5_LINK1000_R#, driven by PHY LED_P3_1#
D12	GBE5_LINK100_ R#, driven by PHY LED_P3_2#
D13	GBE5_ACT_CON_3V3_R#, filtered 3.3V S0
D14	GBE5_ACT_R#, driven by PHY LED_P3_3#

11.2. Dual USB 2.0/3.0 (J2)

Figure 16:USB 2.0/3.0



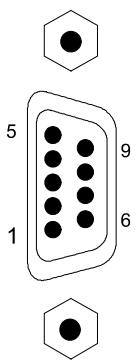
- 1. USB 2.0
- 2. USB 3.0

Table 17: USB 2.0/3.0 Port

USB 2.0/3.0 Port	Pin	Signal Name	Pin	Signal Name
	1	VBUS_BOT	11	USB_TOP_D-
	2	USB_BOT_D-	12	USB_TOP_D+
	3	USB_BOT_D+	13	GND_TOP
	4	GND_BOT	14	USB_TOP_SSRX-
	5	USB_BOT_SSRX-	15	USB_TOP_SSRX+
	6	USB_BOT_SSRX+	16	GND_DRAIN_TOP
	7	GND_DRAIN_BOT	17	USB_TOP_SSTX-
	8	USB_BOT_SSTX-	18	USB_TOP_SSTX+
	9	USB_BOT_SSTX+		
	10	VBUS_TOP		

11.3. COM1, COM2 Connectors (J3/J5)

Table 18: Serial Port

Serial port	Pin	RS232
	1	RX
	2	TX
	3	GND
	4	GND
	5	RTS#
	6	CTS#

11.4. Input Power Connector (PWR)

Figure 17: Input Power



Figure 18: Mating Connector



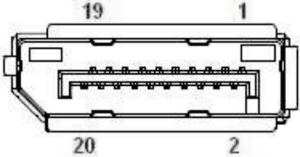
Manufacturer: Phoenix Contact

Product: PSC 1,5/ 3-F

Order#: 1841909

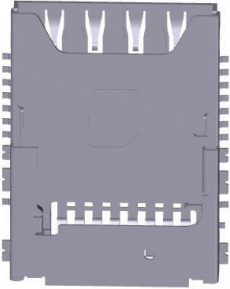
11.5. DisplayPort Connector (J1)

Table 19: DisplayPort

DisplayPort	Pin	Signal	Pin	Signal
	1	SRC0+	11	GND
	2	GND	12	SRC3-
	3	SRC0-	13	CONFIG1
	4	SRC1+	14	CONFIG2
	5	GND	15	AUX+
	6	SRC1-	16	GND
	7	SRC2+	17	AUX-
	8	GND	18	HPD
	9	SRC2-	19	RETURN
	10	SRC3+	20	DP_PWR

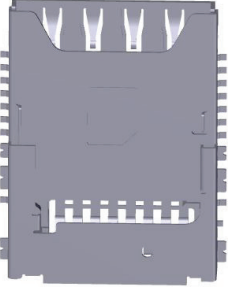
11.6. Micro SIM Card Holder (J26)

Table 20: Micro SIM Card Holder

Micro SIM Card Holder	Pin	Connector Signal	Direction	Function
	P1	SHELL	Ground	Signal Ground
	P2	C5_GND	Ground	Signal Ground
	P3	C1_VCC	Bidirectional	M2_UIM_PWR
	P4	C6_VPP	Power	M2_UIM_VPP (Test Point)
	P5	C2_RST	Output	M2_UIM_RST
	P6	C4_DETECT_CD	Ground	M2_SIM_DETECT
	P7	C7_IO	Bidirectional	M2_UIM_DATA
	P8	C8_CLK	Bidirectional	M2_UIM_CLK


11.7. Mini SIM Card Holder (J25)

Table 21: Mini SIM Card Holder

Mini SIM Card Holder	Pin	Connector Signal	Direction	Function
	C1	VCC	Bidirectional	UIM_PWR
	C2	RST	Output	UIM_RST
	C3	CLK	Bidirectional	UIM_CLK
	C4	RFU_C4	Bidirectional	UM_D+
	C5	GND	Ground	Signal Ground
	C6	VPP	Power	UIM_SPU
	C7	IO	Bidirectional	UIM_DATA
	C8	RFU_C8	Bidirectional	UM_D-
	CD	CD	Output	NC

11.8. Micro SD Card Holder (J27)

Table 22: Micro SD Card Holder

Micro SD Card Holder	Pin	Connector Signal	Direction	Function
	P1	DAT2	Bidirectional	SD Data 2, SMARC 2.0 SDIO_D2
	P2	CD/DAT3	Bidirectional	SD Data 3, Card detect, SMARC 2.0 SDIO_D3
	P3	CMD	Bidirectional	SD Command, SMARC 2.0 SDIO_CMD
	P4	VDD	Power	SD Power Supply 3.3V S0, enabled by module, SMARC 2.0 SDIO_PWR_EN
	P5	CLK	Output	SD Clock, SMARC 2.0 SDIO_CK
	P6	VSS	Ground	Ground
	P7	DAT0	Bidirectional	SD Data 0, SMARC 2.0 SDIO_D0
	P8	DAT1	Bidirectional	SD Data 1, SMARC 2.0 SDIO_D1
	S	Detection	Input	Low – Card is ejected Open – Card is inserted Signal is inverted on carrier and distributed to module, SMARC 2.0 SDIO_CD#
	G	GND	Ground	Ground

12/ Bootloader Operation

12.1. Copyrights and Licensing of U-Boot

U-Boot is free Software. It is copyrighted by Wolfgang Denk and many others who contributed code. U-Boot can be redistributed and modified under the terms of version 2 of the GNU General Public (GPL V2) License as published by the Free Software Foundation.

Actual source code of mainline U-Boot and authors of the source can be obtained from the git repository at

▶ [git://git.denx.de/u-boot.git](https://git.denx.de/u-boot.git)

SMARC-sAL28 bootloader sources are derived work from a dedicated version of mainline U-Boot, e.g v2017.03. As bootloader evolves, the root of the derived work might change to a later version.

NOTICE

The source code of U-Boot will be delivered with the standard software package. Additionally the software can be downloaded from Kontron GitHub repository for SMARC-sAL28: <https://github.com/kontron/u-boot-smarc-sal28>

12.2. Bootloader Quickstart

The SMARC-sAL28 board comes with U-Boot preinstalled on the QSPI flash device. Follow the steps below to gain access to the bootloader command line (CLI) on your host PC.

- ▶ Connect your host machine to the carrier port connected with the edge connector SER1 port of the module. On Kontron SMARC 2.0 carrier this port is named SER1.
- ▶ Start a suitable terminal program on your host and attach it to the port connected with the board's serial interface. Configure the serial line using **115200 baud, 8 data bits, 1 stop bit, no parity**.
- ▶ Connect power supply to the carrier and power up.
- ▶ When boot messages appear, press any key to stop automatic boot sequence.

After power on, bootloader boot messages will appear as shown below. There is a 2 second boot delay counter that will try to boot linux OS automatically after expiration. Pressing any key will stop the boot delay counter and enter the bootloader CLI

```

U-Boot SPL 2018.09-g3b96286ea1 (Oct 01 2019 - 00:05:46 +0000)
Initializing DDR...using raw memory timing
SPI boot
Trying to boot from SPI
U-Boot 2018.09-g3b96286ea1 (Oct 01 2019 - 00:05:46 +0000), Build: 401
SoC: LS1028A Rev1.0 (0x870b0110)
Clock Configuration:
CPU0(A72):1300 MHz CPU1(A72):1300 MHz
Bus: 400 MHz DDR: 1600 MT/s
Reset Configuration Word (RCW):
00000000: 34004010 00000030 00000000 00000000
00000010: 00000000 008f0000 0030c000 00000000
00000020: 06200000 00002580 00000000 00019016
00000030: 00000000 00000048 00000000 00000000
00000040: 00000000 00000000 00000000 00000000
00000050: 00000000 00000000 00000000 00000000
00000060: 00000103 00000000 100e7026 00000000
00000070: bb580000 00020000
Model: Kontron SMARC-sAL28 Board
Hardware Variant: Single PHY (3)
RCW: sl28-3-11_q.bin
DRAM: Detected UDIMM Fixed DDR on board

```

```

3.9 GiB
DDR 3.9 GiB (DDR3, 32-bit, CL=11, ECC on)
Using SERDES1 Protocol: 47960 (0xbb58)
PCIe0: pcie@3400000 Root Complex: x1 gen2
PCIe1: pcie@3500000 Root Complex: x1 gen3
CPLD: v17
Waking secondary cores to start from fbd38000
All (2) cores are up.
MMC: FSL_SDHC: 0, FSL_SDHC: 1
Loading Environment from SPI Flash... SF: Detected w25q32dw with page size 256 Bytes, erase size 64 KiB, total 4 MiB
OK
In: serial
Out: serial
Err: serial
VPD: Using device 0x50 on I2C Bus 2
Net: eth0: enetc#0, eth2: enetc#1, eth8: netc_mdio
Hit any key to stop autoboot: 0

```

12.3. Bootloader Commands

The bootloader CLI provides a bunch of powerful commands to control the board, which basically can be grouped into

- ▶ Information Commands
- ▶ Memory Commands
- ▶ Flash Memory Commands
- ▶ Execution Control Commands
- ▶ Download Commands
- ▶ Environment Control Commands
- ▶ Flattened Device Tree Support Commands
- ▶ Storage Device Control Commands
- ▶ File System Support Commands
- ▶ Kontron Command Extensions



Typing "help" at the bootloader command line prompt will show up a list of the commands available. Typing "help <command>" will show specific command help. Further help can be found under <https://www.denx.de/wiki/view/DULG/UBoot>

On the SMARC_sAL28 bootloader, the powerful hush shell is enabled, which is similar to Bourne shell and provides features similar to a linux shell:

- ▶ Control structures (if ... then ... else ... fi etc.)
- ▶ Command line completion
- ▶ Command line editing
- ▶ Command line history up to 20 entries
- ▶ Local environment variables

12.4. Kontron Bootloader Command Extensions

Kontron's implementation of U-Boot includes certain enhancements to provide board specific functions. They are not part of standard U-Boot as maintained by DENX. The following table provides a complete listing of all Kontron command extensions.

Table 23: Bootloader Command Extensions

Command	Description
kboardinfo	Kontron Board Information - Displays a summary of board and configuration information
md5sum	Creates or checks the md5 message digest over a memory area
watchdog	Start and control i.MX7 CPU watchdog

12.5. kboardinfo - Kontron Board Information

The "kboardinfo" command shows a summary of board serialization data gathered from the system EEPROM.

```
=> kboardinfo
Manufacturer: Kontron Europe GmbH
Product name: SMARC-sAL28
Material number: 51011-0408-13-2-3
Serial number: USD0C0001
MAC0 (ethaddr): 00:a0:a5:5c:6b:3a
MAC1 (eth1addr): 00:a0:a5:5c:6b:3b
MAC2 (eth2addr): 00:a0:a5:5c:6b:3c
MAC3 (eth3addr): 00:a0:a5:5c:6b:3d
MAC4 (eth4addr): 00:a0:a5:5c:6b:3e
MAC5 (eth5addr): 00:a0:a5:5c:6b:3f
MAC6 (eth6addr): 00:a0:a5:5c:6b:40
MAC7 (eth7addr): 00:a0:a5:5c:6b:41
Manufacturer Date: 08/26/2019
Revision: A00
Boot Counter: 3362
```

12.6. md5sum - MD5 Message Digest

The "md5sum" command is already part of standard U-Boot implementation. However Kontron provides the "-a" extension (ASCII) that allows to check MD5 checksum of a given memory area (e.g. a binary image copied into memory) against the checksum that has been copied into an ASCII file on an external linux host. To achieve this, the ASCII string in the file representing the checksum is converted into hexadecimal values and compared against the calculated one.

Syntax:

```
=> help md5sum
md5sum - compute MD5 message digest

Usage:
md5sum address count [[*]sum]
  - compute MD5 message digest [save to sum]
md5sum -v address count [*]sum
  - verify md5sum of memory area
md5sum -a address count [*]sum
  - verify md5sum given in ASCII format
```

Example:

Calculate MD5 checksum of a given binary using the md5sum command on linux host and redirect output messages into a file:

```
# md5sum image.bin >image.md5
```

Copy both image file and checksum file to USB thumb device with EXT2/3/4 or FAT partition. Connect the USB device to the module carrier.

The following sequence shows how to load both image file and image checksum file into SMARC_sAL28 memory and compare them. In case of success, the "md5sum -a" command will have no output messages as this extensions is meant to be used in automatic update scripts to check the binary images against their MD5 checksum.

```
usb start
load usb 0:1 88000000 <image.bin>
load usb 0:1 8a000000 <image.md5>
if md5sum -a 88000000 $ubootsz *88a00000; then
  echo 'CRC check passed'
else
  echo 'CRC check failed'
fi
```

12.7. Watchdog – CPU Watchdog Control

The "watchdog" command is used to control the i.MX7 CPU internal watchdog. After watchdog has been started using "watchdog start", the watchdog is kicked periodically by U-Boot to prevent expiration.



Watchdog timeout can be changed at any time. However, it is not possible to stop watchdog once it has been started.

Syntax:

```
=> help watchdog
watchdog - start/stop/kick IMX watchdog
```

Usage:

```
watchdog <timeout> - kick watchdog and set timeout (0 = disable kicking)
watchdog start <timeout> - start watchdog and set timeout
```

Example:

Start watchdog with 5 seconds timeout and stop kicking watchdog some time later. Board will reset after watchdog has been expired.

```
=> watchdog 5
=> watchdog 0
```

12.8. Bootloader Environment

The bootloader environment is used to control bootloader and OS startup behavior. Environment variables can be used to control boot timing (e.g. bootdelay), interface properties (e.g. baudrate, ethact) or they define memory locations where OS images are stored before boot (e.g. loadaddr, fdt_addr). In addition, bootloader shell commands can be combined to environment scripts.

The redundant bootloader environment is permanently stored in the QSPI flash device at offset 0x0C0000 and 0x0C8000. During bootloader operation, the environment is held in RAM memory and can be modified and written back to persistent storage.

Bootloader commands to modify the environment are summed up under the "env" command group:

- ▶ env default [-f] -a [forcibly] reset default environment
- ▶ env default [-f] var [...] [forcibly] reset variable(s) to their default values
- ▶ env delete [-f] var [...] [forcibly] delete variable(s)
- ▶ env edit name edit environment variable
- ▶ env exists name tests for existence of variable
- ▶ env print [-a | name ...] print environment
- ▶ env run var [...] run commands in an environment variable
- ▶ env save save environment
- ▶ env set [-f] name [arg ...]

However, the legacy commands for environment handling are still available:

- ▶ "setenv",
- ▶ "editenv",
- ▶ "printenv"
- ▶ "saveenv".

U-Boot standard environment variables are set up for the SMARC_sAL28 module as shown below.

Table 24: Standard Environment Variables

Variable	Value	Description
baudrate	115200	Serial line baudrate
bootcmd	Run mmcboot run sdboot run usbboot run netboot run bootfailed	Try booting (in this order) from eMMC, SD card, USB, network
bootdelay	3	Wait 3 seconds before executing bootcmd
ethprime	FEC0	Use Ethernet port FEC0 as default
loadaddr	0x80800000	Default memory location for OS boot

A typical user modification would be to set the variable "bootcmd" to change OS boot commands.

12.9. Bootloader Environment Update

On the SMARC-sAL28 it is possible to update the U-Boot environment separately.

This enables the user to either update from a previous version of the official Kontron sAL28 U-Boot environment (default U-Boot settings), or restore the default in case of problems.

Update procedure:

- ▶ Download the official sAL28 U-Boot environment from the Kontron EMD Customer Section.
- ▶ For Release R10 of the sAL28 U-Boot, the file is called 'NXP LS1028-env-r10.bin'.
- ▶ Put the file into the root directory of a FAT or EXT formatted USB drive.
- ▶ Start the sAL28 system and stop the boot process at the U-Boot prompt.
- ▶ Run the following commands to load the file and flash it into the correct flash memory address (example for R10):


```
usb start && load usb 0:1 $loadaddr NXP LS1028-env-r10.bin
sf probe && sf update $loadaddr 0x0c0000 $filesize
```
- ▶ After reset the updated environment will be active.

12.10. Kontron Bootloader Environment Extensions

To support SMARC_sAL28 board properly, Kontron adds some environment variables to the standard set of variables provided by mainline U-Boot. These variables are shown below.

Table 25: Bootloader Environment Extensions

Variable	Value	Description
boot_sel	Depends on BOOT_SEL lines	BOOT_SEL lines from carrier are evaluated during startup and boot_sel is set appropriately. See chapter 12.19 Bootloader Boot Source for more detail
core_variant	d s	Set to "s" for i.MX7S module, "d" for i.MX7D module.
eth1addr	From EEPROM	Ethernet port FEC1 MAC address
ethaddr	From EEPROM	Ethernet port FEC0 MAC address
fdt_addr	0x83000000	Memory location for device tree blob
panel	Default: ld101	Describes the panel type attached to the module. It is used to select the appropriate device tree file

Variable	Value	Description
pcie_a_prsnt	yes	Enable/disable PCIE_A PRSNT line to reduce power consumption
pcie_b_prsnt	yes	Enable/disable PCIE_B PRSNT line to reduce power consumption
pcie_c_prsnt	yes	Enable/disable PCIE_C PRSNT line to reduce power consumption
pwm_out_disable	yes	Enable/disable PWM_OUT signal. When disabled, GPIO5 pin on SMARC edge connector is used as GPIO.
serial#	From EEPROM	Module serial number



Variables from the table above marked in bold are set automatically each time U-Boot starts. They will override different settings possibly stored in persistent environment.

12.11. Bootloader Mass Storage Support

U-Boot provides support to read and write from mass storage devices like

- ▶ QSPI flash
- ▶ eMMC device
- ▶ SD card
- ▶ USB thumb device

12.12. QSPI flash

QSPI flash is accessed using the "sf" command

Example: Load one sector (64K) from SPI flash

```
=> sf probe 0
=> sf read ${loadaddr} 0 10000
```

12.13. SD Card and eMMC Devices

eMMC and SD card are accessed using the "mmc" command

Example: Load 256 blocks from eMMC

```
=> mmc dev 1
=> mmc read ${loadaddr} 0 100
```

12.14. eMMC SLC mode

Following script adjusts eMMC from MLC mode to pSLC mode:

```
mmc raw_ecsd init 2;
if mmc raw_ecsd cmp A0 3 || mmc raw_ecsd cmp A0 7; then
if mmc raw_ecsd cmp 9B 0; then
mmc raw_ecsd write AF 1
mmc raw_ecsd read 9D
setenv val_tmp1 $raw_ecsd_tmp
mmc raw_ecsd read 9E
setenv val_tmp2 $raw_ecsd_tmp
mmc raw_ecsd read 9F
setenv val_tmp3 $raw_ecsd_tmp
mmc raw_ecsd write 88 0
mmc raw_ecsd write 89 0
mmc raw_ecsd write 8A 0
mmc raw_ecsd write 8B 0
mmc raw_ecsd write 8C $val_tmp1
```

```

mmc raw_ecsd write 8D $val_tmp2
mmc raw_ecsd write 8E $val_tmp3
mmc raw_ecsd write 9C 1
mmc raw_ecsd write 9B 1
setenv val_tmp1
setenv val_tmp2
setenv val_tmp3
setenv raw_ecsd_tmp
echo PASS: eMMC configured;
else
echo PASS: eMMC already configured;
fi;
else
echo FAIL: eMMC cannot be configured;
fi;

```

12.15. USB Storage Device

USB storage devices are accessed using "usb" command

Example: Load bootloader update file from USB thumb device

```

=> usb start
=> usb dev 0
=> fatload usb 0:1 update_NXP LS1028_spl/u-boot-NXP LS1028_spl.bin

```

12.16. Bootloader File System Support

U-Boot for the SMARC_sAL28 provides support for FAT and EXT4 file systems. EXT4 support also includes EXT2 and EXT3 formatted file systems. There are file system specific commands available to list file system contents (ext2ls, fatls) and load a given file into board memory (ext2load, fatload). However, U-Boot also provides generic commands ("ls" and "load"), that will detect the file system on the device and use appropriate file system functions automatically.

Example: Show/boot folder contents from SD card file system

```

=> ls mmc 0:1 /boot
<DIR> 4096 .
<DIR> 4096 ..
<SYM> 48 imx7d-sAL28-ld101-m4.dtb
44034 devicetree-zImage-imx7d-sAL28-ld101-m4.dtb
43986 devicetree-zImage-imx7d-sAL28-ld101.dtb
<SYM> 33 zImage
<SYM> 45 imx7d-sAL28-ld101.dtb
<SYM> 45 imx7s-sAL28-ld101.dtb
6376512 zImage-4.1.29-fslc+g59b38c3
43998 devicetree-zImage-imx7s-sAL28-ld101.dtb

=> load mmc 0:1 ${loadaddr} /boot/zImage
6376512 bytes read in 536 ms (11.3 MiB/s)

```

12.17. EXT4 File System Write Support

There is even support available to write a given memory area into ext4 formatted file systems. However, the implementation is not bullet proof und should be used with care, as this could lead to file system corruption.



Writing to symbolic links in an ext4 filesystem does not work from u-boot!
Do not create new files in ext4 filesystem as this could cause problems.

12.18. Bootloader Network Support

U-Boot provides support for both onboard Ethernet interfaces. The current interface can be selected by setting "ethact" environment variable to either "FECO" or "FEC1".

Board specific MAC addresses are read from EEPROM during startup and environment variables are set automatically. In case EEPROM contents is missing or corrupted, a "random" MAC address will be set to "ethaddr"

In case that the current network interface is attached to a network providing a DHCP server, an IP address can be gathered using "bootp" or "dhcp" commands.

After that, a file from a tftp server can be copied to memory using the "tftpboot" command.

Example:

```
=> bootp
=> tftpboot ${loadaddr} <filename>
```

12.19. Bootloader Boot Source Support

The SMARC v2.0 Specification defines three boot select signals BOOT_SEL[0:2]# that allows the user to select from eight possible boot devices. On the SMARC_sAL28, U-Boot detects the BOOT_SEL signals from the carrier and sets the environment variable "boot_sel" as shown below.

Table 26: Environment Variables for "boot_sel"

	Carrier Connection			Boot Source	Supported on KBox A-230LS
	BOOT_SEL2#	BOOT_SEL1#	BOOT_SEL0#		
0	GND	GND	GND	Carrier SATA	No
1	GND	GND	Float	Carrier SD Card	From U-Boot
2	GND	Float	GND	Carrier eSPI (CS0#)	From U-Boot
3	GND	Float	Float	Carrier SPI (CS0#)	From U-Boot
4	Float	GND	GND	Module device (NAND, NOR)	No
5	Float	GND	Float	Remote boot (GBE, serial)	From U-Boot
6	Float	Float	GND	Module eMMC Flash	From u-boot
7	Float	Float	Float	Module SPI	From u-boot

Bootloader environment scripts can use the boot_sel environment variable to select the source where the dedicated OS image can be loaded. As an example, the bootloader environment of the SMARC_sAL28 implements some small scripts that will load a linux system from the boot source as defined by the BOOT_SEL pins.

```
bootset_boot=echo BOOT_SEL ${boot_sel} selected && run ${boot_sel}_boot
module_mmc_boot=run mmcboot
module_spi_boot=run mmcboot
```

Running the "run bootset_boot" script will load a linux system from MMC if BOOT_SEL pins define the module MMC Flash or the Module SPI as boot source. Depending on application, the script variables in environment can be adapted.



The bootloader is always booted from the boot source defined by fuse settings, which is normally the QSPI flash device. The BOOT_SEL pins only define boot source for the OS.

12.20. Bootloader Boot Counter

The module EEPROM device contents implements a SMBIOS Running-time data block (type 161) as defined in the KEU EEPROM Specification Rev. 1.4. The running-time data block structure implements a 64bit boot counter. U-Boot on the SMARC_sAL28 module will read the current boot counter value and increment it on every boot cycle. Current boot counter is shown as part of the information shown by the "kboardinfo" command (see description of kboardinfo).

12.21. Bootloader Update

Bootloader update on SMARC_sAL28 is using an update script containing all necessary checks and installation commands. It is provided by Kontron on a USB thumb device containing the scriptfile and update images in the dedicated "update_NXP LS1028_spl" folder.

As an alternative it is possible to perform bootloader update from network. To achieve this, the "update_NXP LS1028_spl" folder mentioned above must have been copied to the server path of the TFTP server machine.

Given these prerequisites are met, update can be done from bootloader CLI using the predefined "update" script:

```
=> run update
```

Or, in case of network update

```
=> run updNet
```



It is recommended to use only the update script for bootloader update. This ensures that all necessary installation images are checksum controlled and copied to the appropriate location in QSPI flash.

12.22. U-boot Files for the KBox A-230-LS on Github.com

You can find the last program code under <https://github.com/kontron/u-boot-smarc-sAL28>.

13/ TSN Support

13.1. Time Sensitive Networking overview

Time Sensitive Networking (TSN) is a set of international standards (IEEE-802.1 TSN), that provides new features to standard Ethernet. This includes time synchronization and deterministic network communication over standard Ethernet, allowing operations networks to leverage the advantages of traditional Ethernet while meeting the timing and control needs of control and measurement applications. By converging time-critical and best-effort data within standard Ethernet, TSN delivers cost savings and improved interoperability.

Under the given challenges, e.g. of IIoT and Industry 4.0 it is essential that the process data information from the production field (edge) into the local server landscape (fog) to the cloud will be implemented smoothly. Today's challenges are tied to the interfaces from the production floor, which is typically dominated by a scattered landscape of real time capable fieldbus networks, into the IT level. Realized by gateways, these interfaces create enhanced complexity, cost and management overhead.

As part of the Ethernet standard, TSN also benefits from continuing improvements in Ethernet security, bandwidth, and other capabilities and provides numerous advantages over today's standard Ethernet protocols.

The Kontron KBox A-230-LS with the integrated SMARC-sAl28 Module provides Time Sensitive Networking support and can be used to connect to time sensitive (deterministic) networks according to IEEE-802.1 TSN.

Based on standard Ethernet according to IEEE-802.3, the quad network interfaces with switching function can be used to build deterministic control applications in converged networks from the production floor to the IT level.

The integrated Ethernet 4-port switch matrix can be configured by regular Linux tools, like "route", "ipconfig", "vconfig" or "bridge vlan add". Please read through the corresponding manual pages or linux documentation for help.

In order to configure the TSN relevant parameters. either local tools like

- ▶ tsntool tool providing management objects for the switch
- ▶ or external management via netconf using Yang models can be used.

13.2. Time Synchronization

13.2.1. Precision Time Protocol (PTP)

To use the system for TSN traffic, a precise synchronization to the TSN network is required. This will be achieved by using gPTP according to IEEE802.1AS.

The IEEE 802.1AS, a profile of IEEE 1588v2 Precision Time Protocol is used to synchronize clocks throughout an Ethernet network to accuracies in the sub-microsecond range, designed for applications including networked measurement and control systems, audio/video and more.. PTP specifies a precise clock synchronization protocol that relies on time-stamped packets. The PTP protocol is applicable to distributed systems consisting of one or more nodes communicating over some set of communication media.

The distribution of synchronous time information is done in a hierarchical manner with a grandmaster clock at the root of the hierarchy. The grandmaster provides a common and precise time reference for one or more slave devices by periodically exchanging timing information. All slave devices synchronize their clocks with the grandmaster clock. The slave devices can, in-turn, act as master devices for further hierarchical layers of slave

In an IEEE 802.1AS time domain, all devices must be time aware devices, as specified in IEEE 802.1AS . Each time aware device determines regularly the actual time delay on the data path to all of its directly connected neighbours, using two-step peer-to-peer delay measurements. These values, together with time information received via Sync- and FollowUp Messages, as well as with other values like local latencies and local frequency drift, are used to determine the exact local offset to the grandmasters time.

To be able to use the PTP stack, the Operating system running on the corresponding LS1028A has to be enabled for PTP usage,

For Linux, the linuxptp package (ptp4l) is used. The package is part of all recent distributions, but requires configuration in the build tool to be part of kernel and RootFS.

PTP4L provides the following features:

- Supports hardware and software time stamping via the Linux SO_TIMESTAMPING socket option
- Supports the Linux PTP Hardware Clock (PHC) subsystem by using the clock_gettime family of calls, including the new clock_adjtimex system call
- Implements Boundary Clock (BC) and Ordinary Clock (OC)
- Transport over UDP/IPv4, UDP/IPv6, and raw Ethernet (Layer 2)
- Supports IEEE 802.1AS-2011 as end station, Time aware bridge mode will be made available via update
- IEEE 802.1AS-rev will be provided once standard will be released
- Modular design allowing smooth addition of new transports and clock servos.

Using the ptp4l daemon, the -i switch together with the network interface (e.g. eth0) is the only required parameter to ptp4l. Other useful parameters are -f to select configuration file, -m to print messages on the display and -s to select slave-only mode.

PTP can be used over all Switch interfaces.

13.3. TSN Network Configuration Basics

The overall process to model a TSN network includes the following steps

1. Define a communication profile (End-to-end use case)
2. Calculate schedules for deterministic traffic (TSN)
3. Write schedule to the corresponding device

First step is to define the communication profile, that is a mix of different traffic patterns that shall coexist on a single network

Given the multiple use cases for converged networks, including both OT as well as IT traffic, different traffic patterns are defined, that can be differentiated by their characteristics, e.g.

- ▶ Data Transmission Periodicity
- ▶ Period
- ▶ Application synchronized to network
- ▶ Application data size
- ▶ Data delivery guarantee
- ▶ Tolerance to interference
- ▶ Tolerance to loss
- ▶ Criticality

Given a list of traffic patterns, the following matrix can be aggregated.

Table 27: Summary of traffic pattern and corresponding characteristics (Reference: IIC)

Pattern	Periodicity	Period	Application Synchronized to network	Application data size	Data delivery guarantee	Tolerance to Interference	Tolerance to loss	Criticality
Isochronous	Periodic	100us - 2ms	Yes	Fixed, 30 - 100Bytes	Deadline	No	No	High
Cyclic	Periodic	2 - 20ms	No	Fixed, 50 - 1000 Bytes	Latency	Yes	1-4 Frames	High
Alarms & Events	Sporadic	-	No	Variable, 50 - 1500 Bytes	Latency/	N/A	yes	High/Medium
Config & Diagnostics	Sporadic	-	No	Variable, 0,5 - 1.5kB	Bandwidth	N/A	yes	Medium
Network Control	Periodic	50ms - 1s	No	Variable, 50 - 500 Bytes	Bandwidth	Yes	yes	High
Best effort	Sporadic	-	No	Variable, 30 - 1500 Bytes	None	N/A	yes	Low
Video*	Sporadic	-	No	Variable, 1 - 1.5kB	Latency	N/A	yes	Low
Audio/Voice*	Sporadic	-	No	Variable, 1 - 1.5kB	Latency	N/A	yes	Low

*Video/audio characteristics given here are for standard end user traffic, no special requirements

For isochronous, deterministic traffic, as mentioned in the list above, a corresponding TSN traffic path has to be provisioned in order to ensure the appropriate stream properties.

Besides the possibility to manually configure stream priorities and schedules in each network element, the IEEE 802.1Qcc standard provides protocol based options to automatically configure the network.

There are three models to configure TSN

- Point to point
- Hybrid
- Fully centralized

When using 802.1Qbv, a fully centralized model according to IEEE 802.1Qcc can be used. 802.1Qcc provides specification of protocols, procedures and managed objects used for TSN.

This manual describes manual configuration, Kontron plans to provide Netconf (and corresponding Yang Models) in upcoming releases.

13.3.1. Manual TSN Schedule Configuration

The following chapter describes in detail how to configure TSN schedules locally on your KBox A-230-LS, according to IEEE802.1Qbv.

IEEE 802.1Qbv is used for transmission of TSN traffic with real-time guarantees. It specifies guarantee bounded latency and small jitter for TSN traffic.

IEEE802.1Qbv makes it possible to periodically give egress queues prioritized wire access, so it can also be used to provide bandwidth guarantees.

To configure the scheduling, the tsntool is used.

13.3.2. TSNtool Usage

The following table lists the TSN tool commands and their description.

Table 28: TSNtool Commands and their Description

Command	Description
Help	Lists commands support
Version	Shows software version
Verbose	Debug on/off for tsntool
Quit	Quit prompt mode
Qbvset	Set time gate scheduling config for <ifname>
Qbvget	Get time scheduling entrys for <ifname>
Cbstreamidset	Set stream identify table
Cbstreamidget	Get stream identify table and counters
Qcisfiset	Set stream filter instance
Qcisfiget	Get stream filter instance
Qcisgiset	Set stream gate instance
Qcisgiget	Get stream gate instance
Qcisficounterget	Get stream filter counters
Qcifmiset	Set flow metering instance
Qcifmiget	Get flow metering instance
Cbsset	Set TCs credit-based shaper configure
Cbsget	Get TCs credit-based shaper status
Qbuset	Set one 8-bits vector showing the preemptable traffic class
Qbudgetstatus	Not supported.
Tsdset	Not supported
Tsdget	Not supported
Ctset	Set cut through queue status (specific for ls1028 switch)
Cbgen	Set sequence generate configure (specific for ls1028 switch)
Cbrec	Set sequence recover configure (specific for ls1028 switch)
Pcpmap	Set queues map to PCP tag (specific for ls1028 switch)
Sendpkt	Not supported
Regtool	Register read/write of bar0 of PFs (specific for ls1028 enetc)
Ptptool	Not supported

13.3.2.1. Tsntool Commands and Parameters

This section lists the tsntool commands along with the parameters and arguments, with which they can be used.

Table 29: Parameter qbvset

parameter <argument>	Description
--device <ifname>	interface like eth0/sw0p0
--entryfile <filename>	A file script to input gatelist format. It has the following arguments: # 'NUMBER' 'GATE_VALUE' 'TIME_LONG' ▶ NUMBER: # 't' or 'T' head. Plus entry number. Duplicate entry number will result in an error.

parameter <argument>	Description
	<ul style="list-style-type: none"> ▶ GATE_VALUE: # format: xxxxxxxxb . # The MSB corresponds to traffic class 7. The LSB, corresponds to traffic class 0. # A bit value of 0 indicates closed, whereas, a bit value of 1, indicates open. ▶ TIME_LONG: # nanoseconds. Do not input 0 time long. t0 11101111b 10000 t1 11011111b10000 <p>NOTE: Entryfile parameter must be set. If not set, there will be a vi text editor prompt, "require to input the gate list".</p>
--basetime <value>	AdminBaseTime
--cycletime <value>	AdminCycleTime
--cycleextend <value>	AdminCycleTimeExtension
--enable --disable	enable: enables the qbv for this port • disable: disables the qbv for this port Default is set to enable, if no enable or disable input
--maxsdu <value>	queueMaxSDU
--initgate <value>	AdminGateStates
--configchange	ConfigChange. Default set to 1.
--configchangetime <value>	ConfigChangeTime

Table 30: Parameter qbvget

Parameter <argument>	Description
--device <ifname>	An interface such as eth0/sw0p0

Table 31: Parameter cbstreamidset

Parameter <argument>	Description
--enable --disable	<ul style="list-style-type: none"> ▶ enable: Enables the entry for this index ▶ disable: Disables the entry for this index. Default is set to enable if no enable or disable input
--index <value>	index entry number in this controller. Mandatory parameter.
--device <string>	Interface such as eth0/sw0p0
--streamhandle <value>	tsnStreamIdHandle
--infacoutport <value>	tsnStreamIdInFacOutputPortList
--outfacoutport <value>	tsnStreamIdOutFacOutputPortList
--infacinport <value>	tsnStreamIdInFacInputPortList
--outfacinport <value>	tsnStreamIdOutFacInputPortList
--nullstreamid --sourcemacvid --destmacvid --ipstreamid	tsnStreamIdIdentificationType: <ul style="list-style-type: none"> ▶ nullstreamid: Null Stream identification• ▶ sourcemacvid: Source MAC and VLAN Stream identification• ▶ destmacvid: not supported• ▶ ipstreamid: not supported
--nullmac <value>	tsnCpeNullDownDestMac
--nulltagged <value>	tsnCpeNullDownTagged
--nullvid <value>	tsnCpeNullDownVlan

Parameter <argument>	Description
--sourcemac <value>	tsnCpeSmacVlanDownSrcMac
--sourcetagged <value>	tsnCpeSmacVlanDownTagged
--sourcevid <value>	tsnCpeSmacVlanDownVlan

Table 32: Parameter cbstreamidset

parameter <argument>	Description
--device <ifname>	Interface like eth0/sw0p0
--index <value>	Index entry number in this controller. Mandatory to have.

Table 33: Parameter qcisfiset

parameter <argument>	Description
--device <ifname>	Interface like eth0/sw0p0
--enable --disable	<ul style="list-style-type: none"> • enable: enable the entry for this index • disable: disable the entry for this index • default to set enable if no enable or disable input
--maxsdu <value>	Maximum SDU size.
--flowmeterid <value>	Flow meter instance identifier index number.
--index <value>	StreamFilterInstance. index entry number in this controller.
--streamhandle <value>	StreamHandleSpec This value corresponds to "tsnStreamIdHandle" of "cbstreamidset" command.
--priority <value>	PrioritySpec
--gateid <value>	StreamGateInstanceID
--oversizeenable	StreamBlockedDueToOversizeFrameEnable
--oversize	StreamBlockedDueToOversizeFrame

Table 34: Parameter qcisfiget

parameter <argument>	Description
--device <ifname>	Interface like eth0/sw0p0
--index <value>	Index entry number in this controller. Mandatory to have.

Table 35: Parameter qcisgiset

parameter <argument>	Description
--device <ifname>	Interface like eth0/sw0p0
--index <value>	Index entry number in this controller. Mandatory to have.
--enable --disable	<ul style="list-style-type: none"> • enable: enable the entry for this index. PSFPGateEnabled • disable: disable the entry for this index • default to set enable if no enable or disable input
--configchange	configchange
--enblkinvrx	PSFPGateClosedDueToInvalidRxEnable
--blkinvrx	PSFPGateClosedDueToInvalidRx

parameter <argument>	Description
--initgate	PSFPAdminGateStates
--initipv	AdminIPV
--cycletime	default not set. Get by gatelistfile.
--cycletimeext	PSFPAdminCycleTimeExtension
--basetime	PSFPAdminBaseTime
--gatelistfile	PSFPAdminControlList. A file input the gate list: 'NUMBER' 'GATE_VLAUE' 'IPV' 'TIME_LONG' 'OCTET_MAX' • NUMBER: # 't' or 'T' head. Plus entry number. Duplicate entry number will result in an error. • GATE_VALUE: format: xb: The MSB corresponds to traffic class 7. The LSB corresponds to traffic class 0. A bit value of 0 indicates closed, A bit value of 1 indicates open. • IPV: # 0~7 • TIME_LONG: in nanoseconds. Do not input time long as 0. • OCTET_MAX: The maximum number of octets that are permitted to pass the gate. If zero, there is no maximum. t0 1b -1 50000 10

Table 36: Parameter qcisgiget

parameter <argument>	Description
--device <ifname>	Interface like eth0/sw0p0
--index <value>	Index entry number in this controller. Mandatory to have.

Table 37: Parameter qcifmiset

parameter <argument>	Description
--device <ifname>	Interface like eth0/sw0p0
--index <value>	Index entry number in this controller. Must have.
--disable	If not set disable, then to be set enable.
--cir <value>	cir. kbit/s.
--cbs <value>	cbs. octets.
--eir <value>	eir.kbit/s.
--ebs <value>	ebs.octets.
--cf	cf. couple flag.
--cm	cm. color mode.
--dropyellow	drop yellow.
--markred enable	mark red enable.
--markred	mark red.

Table 38: Parameter qcifmiget

parameter <argument>	Description
--device <ifname>	Interface like eth0/sw0p0
--index <value>	Index entry number in this controller. Mandatory to have.

Table 39: Parameter qbuset

parameter <argument>	Description
--device <ifname>	Interface like eth0/sw0p0
--preemptable <value>	8-bit hex value. Example: 0xfe The MS bit corresponds to traffic class 7. The LS bit to traffic class 0. A bit value of 0 indicates express. A bit value of 1 indicates preemptable.

Table 40: Command cbsset

parameter <argument>	Description
--device <ifname>	Interface like eth0/sw0p0
--tc <value>	Traffic class number.
--percentage <value>	Set percentage of tc limitation.
--all <tc-percent:tc-percent.	Not supported.

Table 41: Command cbsget

parameter <argument>	Description
--device <ifname>	Interface like eth0/sw0p0
--tc <value>	Traffic class number. Usage: regtool { pf number } { offset } [data] pf number: pf number for the pci resource to act on, offset : offset into pci memory region to act upon data : data to be written

Table 42: Command ctset

parameter <argument>	Description
--device <ifname>	Interface like eth0/sw0p0
--queue_stat <value>	Specifies which priority queues have to be processed in cut-through mode of operation. Bit 0 corresponds to priority 0, Bit 1 corresponds to priority 1 so-on.

Table 43: Command cbgen

parameter <argument>	Description
--device <ifname>	Interface like eth0/sw0p0
--index <value>	Index entry number in this controller. Mandatory to have. This value corresponds to "tsnStreamIdHandle" of "cbstreamidset" command.
--iport_mask <value>	INPUT_PORT_MASK: If the packet is from input port belonging to this port mask, then it's a known stream and Sequence generation parameters can be applied
--split_mask <value>	SPLIT_MASK: Port mask used to add redundant paths (or ports). If split is enabled (STREAM_SPLIT) for a stream. This is OR'ed with the final port mask determined by the forwarding engine.
--seq_len <value>	SEQ_SPACE_LOG2: Minimum value is 1 and maximum value is 28. tsnSeqGenSpace = 2**SEQ_SPACE_LOG2 For example, if this value is 12, then valid sequence numbers are from 0x0 to 0xFFFF.
--seq_num <value>	GEN_REC_SEQ_NUM: The sequence number to be used for outgoing packet passed to SEQ_GEN function. Note: Only lower 16-bits are sent in RED_TAG.

Table 44: Command cbrec

parameter <argument>	Description
--device <ifname>	Interface like eth0/sw0p0
--index <value>	Index entry number in this controller. Mandatory to have. This value corresponds to "tsnStreamIdHandle" of "cbstreamidset" command.
--seq_len <value>	SEQ_SPACE_LOG2:Min value is 1 and maximum value is 28. $tsnSeqRecSeqSpace = 2^{**}SEQ_REC_SPACE_LOG2$ For example, if this value is 12, then valid sequence numbers are from 0x0 to 0xFFF.
--his_len <value>	SEQ_HISTORY_LEN: Refer to SEQ_HISTORY, Min 1 and Max 32.
--rtag_pop_en	REDTAG_POP: If True, then the redundancy tag is popped by rewriter.

Table 45: Command pcpmap

parameter <argument>	Description
--device <ifname>	Interface like eth0/sw0p0
--enable	Enable pcp to traffic class for frames.

13.4. Basic TSN Configuration Examples on ENETC

The tsntool is an application configuration tool to configure the TSN capability. You can find the file, /usr/bin/tsntool and /usr/lib/libtsn.so in the rootfs. Run tsntool to start the setting shell. The following sections describe the TSN configuration examples on the ENETC ethernet driver interfaces.

13.4.1. Linuxptp Test

To test 1588 synchronization on ENETC interfaces, use the following procedure:

1. Connect ENETC interfaces on two boards in a back-to-back manner. (For example, eth0 to eth0.)

The linux booting log is as follows:

```
...
pps pps0: new PPS source ptp0
...
```

2. Check PTP clock and timestamping capability:

```
# ethtool -T eth0
Time stamping parameters for eth0:
Capabilities:
hardware-transmit (SOF_TIMESTAMPING_TX_HARDWARE)
hardware-receive (SOF_TIMESTAMPING_RX_HARDWARE)
hardware-raw-clock (SOF_TIMESTAMPING_RAW_HARDWARE)
PTP Hardware Clock: 0
Hardware Transmit Timestamp Modes:
off (HWTSTAMP_TX_OFF)
on (HWTSTAMP_TX_ON)Hardware Receive Filter Modes:
none (HWTSTAMP_FILTER_NONE)
all (HWTSTAMP_FILTER_ALL)
```

3. Configure the IP address and run ptp4l on two boards:

```
# ifconfig eth0 <ip_addr>
# ptp4l -i eth0 -p /dev/ptp0 -m
```

4. After running, one board would be automatically selected as the master, and the slave board would print synchronization messages.

5. For 802.1AS testing, just use the configuration file gPTP.cfg in linuxptp source. Run the below commands on the boards, instead.

```
# ptp4l -i eth0 -p /dev/ptp0 -f gPTP.cfg -m
```


13.4.2. IEEE 802.1Qbv Test Scenario

The objective here is to test whether the DUT does correct time synchronization as well as handle a given schedule correctly. The basic idea is to have a continuous stream of ethernet frames going to one port of the DUT and precisely measure the time when frames exit the DUT. Given these timestamps one can deduce the opening and closing of the gates, which then can be verified against the schedule of the DUT.

To be able to take precise timestamps on the test host one has to use hardware timestamping on the receiving interface. Thus the PHC of this interface has to be synchronized to the DUT's clock responsible for the gate schedule. We use IEEE 802.1as to achieve this, as the DUT already has to have support for it. Because of only a small amount of systems in the synchronization domain, one can usually achieve accuracy in the nanoseconds range (like +/- 50ns). Please note, that a working IEEE 802.1as setup is crucial for having valid results of this test scenario.

This test includes the Basic gates closing test, Basetime test, and the Qbv performance test. These are described in the following sections.

13.4.2.1. Basic Gates Closing

The commands below describe the steps for closing the basic gates:

```
cat > qbv0.txt << EOF
t0 00000000b 20000
EOF

#Explanation:
# 'NUMBER' : t0
# 'GATE_VALUE' : 00000000b
# 'TIME_LONG' : 20000 ns

cp libtsn.so /lib
./tsntool
tsntool> verbose
tsntool> qbvset --device eth0 --entryfile ./qbv0.txt
ethtool -S eth0
ping 192.168.0.2 -c 1 #Should not pass any frame since gates are all off.
```

13.4.2.2. Basetime Test

Base on case 1 qbv1.txt gate list.

```
#create 1s gate
cat > qbv1.txt << EOF
t0 11111111b 10000
t1 00000000b 99990000
EOF

tsntool> regtool 0 0x18
tsntool> regtool 0 0x1c

#Read the current time and add 0x2000000000, about 2 minutes, for example, 0x2000011234 as a result.
tsntool> qbvset --device eth0 --entryfile qbv1.txt --basetime 0x2000011234
tsntool> qbvget --device eth0 #You can check configchange time
tsntool> regtool 0 0x11a10 #Check pending status, 0x1 means time gate is working

#Waiting to change state, ping remote computer
ping 192.168.0.2 -A -s 1000

#The reply time will be about 100 ms
```

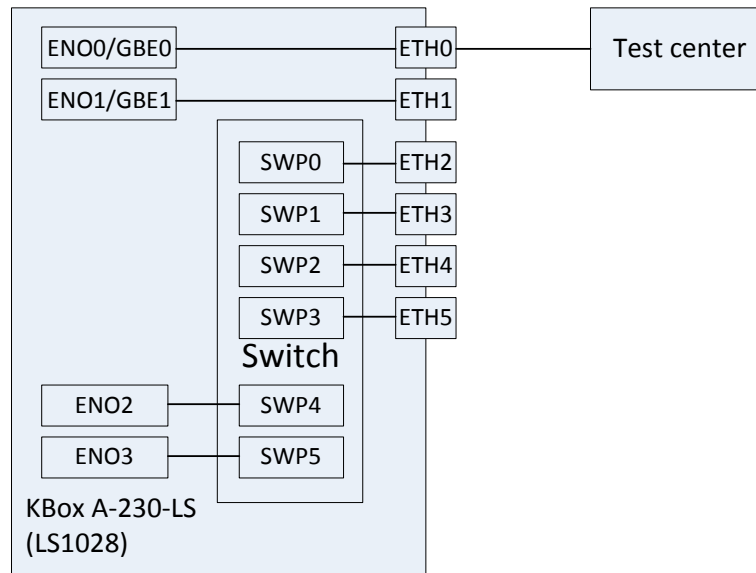
Since 10000 ns is the maximum limit for package size 1250 B.

```
ping 192.168.0.2 -c 1 -s 1300 #frame should not pass
```

13.4.2.3. Qbv Performance Test

Use the setup described in the figure below for testing ENETC port0 (ETH0).

Figure 19: Setup for Testing ENO0 (ETH0)



```
cat > qbv5.txt << EOF
t0 11111111b 1000000
t1 00000000b 1000000
EOF
```

```
qbvset --device eth0 --entryfile qbv5.txt
./pktgen/pktgen_twoqueue.sh -i eth0 -q 3 -n 0
```

#The stream would get about half line rate

13.4.3. IEEE 802.1Qbu Test Scenario

IEEE 802.1Qbu operates on the MAC layer and fiddles with the start of frame delimiter (SFD) of the ethernet frame. Due to this only IEEE 802.1Qbu-enabled MACs are able to send and receive these frames. Normal network cards discard preemptible traffic as jabber because the SFD is incorrect.

Because we don't have specialized test equipment, this scenario involves two DUTs, one which sends the fragments and one which reassembles them. All we can do is to look at the counters of both DUTs and make sure, that the frames are received correctly on the test host.

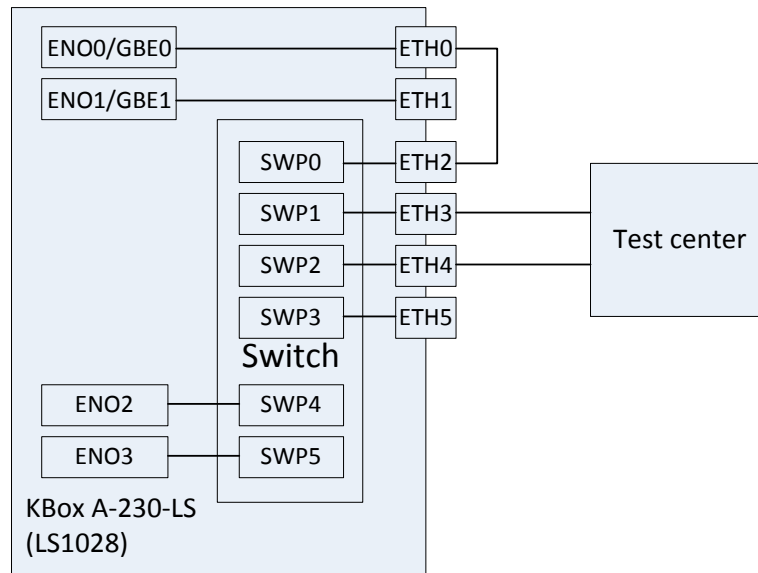
To reduce the number of tests interfaces needed there is a trick how you can use just one test interface to trigger frame interruption. This only works if the switch does store-and-forward. You send one large frame immediately followed by a small frame. Because the preemption happens on the egress side, the small frame will be received on the ingress interface when the large frame is still being sent. If the large frame is on a preemptible queue, it will be interrupted by the small frame.

The test host sends exactly two frames, a large (1518 bytes) one immediately followed by a small (64 bytes) one. The large one has a VLAN header and its PCP set to 1. The positive test has the corresponding queue on the DUT marked as preemptible. The test expects that the small frame is received before the large one. That means that the large one was preempted. Additionally, the fragment counters of the egress interface of the first DUT and the reassembly counters of the ingress interface of the second DUT are checked. For the negative test, the DUT has all queues set to non-preemptible. The preemption counters on the DUT are checked that they do not change and the two frames must be received in the same order as they are sent.

13.4.3.1. Qbu Test

Set the frame path from eth0 to external by linking enetc MAC0 – SWP0. Use the setup as shown in the following figure for the

Figure 20: Qbu Test



Note:

0x11f10 Port MAC Merge Frame Assembly OK Count Register
 0x11f18 Port MAC Merge Fragment Count TX Register (MAC_MERGE_MMFCTXR)

For linking the ENO0 (ETH0) to SWP0 (ETH2), use the steps below:

1. Make sure link speed is 1 Gbps by using the command:

```
ethtool eth0
```

2. If it is not 1Gbps, set it to 1Gbps by using the command:

```
ethtool -s eth0 speed 1000 duplex full autoneg on
```

3. Set the switch to enable merge:

```
devmem 0x1fc100048 32 0x111 #DEV_GMII:MM_CONFIG:ENABLE_CONFIG
```

4. Use the below ENETC port setting:

```
ip link set eth0 address 90:e2:ba:ff:ff:ff
tsntool> qbuset --device eth0 --preemptable 0xfe
./pktgen/pktgen_twoqueue.sh -i eth0 -q 0 -s 100 -n 2000 -m 90:e2:ba:ff:ff:ff
```

5. Check the tx merge counter, if it has a non-zero value, it indicates that the Qbu is working.

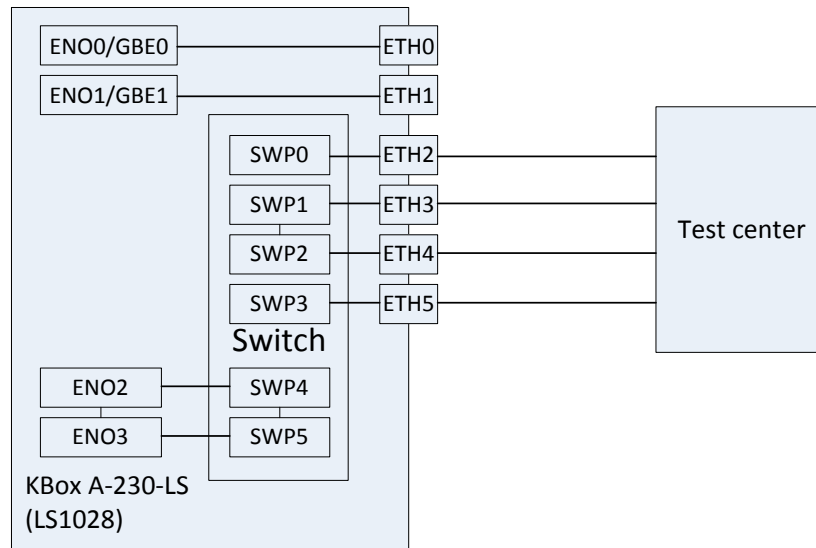
```
tsntool> regtool 0 0x11f18
```

13.5. Basic TSN configuration examples on the switch

The following sections describe examples for the basic configuration of TSN switch.

13.5.1. Switch Configuration

Figure 21: TSN Switch Configuration



Use the following commands for configuring the switch on LS1028ARDB:

```
ls /sys/bus/pci/devices/0000:00:00.5/net/
```

Get switch device interfaces: eth3 eth4 eth5 eth6 eth7 eth8>

```
ip link add name switch type bridge
ip link set switch up
ip link set eno3 master switch && ip link set eno3 up
ip link set swp0 master switch && ip link set swp0 up
ip link set swp1 master switch && ip link set swp1 up
ip link set swp2 master switch && ip link set swp2 up
ip link set swp3 master switch && ip link set swp3 up
ip link set swp5 master switch && ip link set swp5 up
```

13.5.2. Enabling Timestamp on Switch

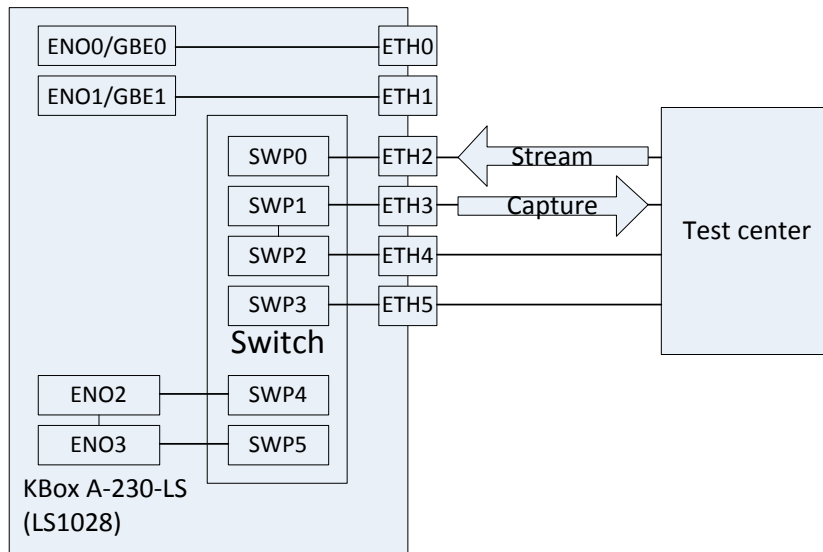
For enabling timestamping on the switch, use the following commands:

```
#Init PTP:
devmem 0x1fc0900a0 w 0x00000004
#Get PTP real time(second):
devmem 0x1fc0900c4
```

13.5.3. Qbv Test

The following figure describes the setup for Qbv test on the KBox A-230-LS.

Figure 22: Qbv Test



13.5.3.1. Closing basic Gates

Use the set of commands below for basic gate closing.

```
echo "t0 00000000b 20000" > qbv0.txt
#Explanation:
# 'NUMBER' : t0
# 'GATE_VALUE' : 00000000b
# 'TIME_LONG' : 20000 ns

cp libtsn.so /lib
./tsntool
tsntool> verbose
tsntool> qbvset --device SWP1 --entryfile ./qbv0.txt

#Send one broadcast frame to SWP0 from TestCenter.
ethtool -S SWP1
#Should not get any frame from SWP1 on TestCenter.

echo "t0 11111111b 20000" > qbv0.txt
tsntool> qbvset --device SWP1 --entryfile ./qbv0.txt

#Send one broadcast frame to SWP0 on TestCenter.
ethtool -S SWP1
#Should get one frame from SWP1 on TestCenter.
```

13.5.3.2. Basetime Test

For the basetime test, first get the current second time:

```
devmem 0x1fc0900c4
tsntool> qbvset --device SWP1 --entryfile ./qbv0.txt --basetime 0x205100000000
# 'basetime' : (current_second_time+offset)<<32 + current_nsecond_time
```

#Send one broadcast frame to SWP0 on the Test Center.

#Frame could not pass SWP1 until time offset.

13.5.3.3. Gate Time Limitation

Use the following commands for testing the gate time limitation:

```
echo "t0 00000000b 20000" > qbv0.txt
echo "t1 11111111b 100" >> qbv0.txt
tsntool> qbvset --device SWP1 --entryfile ./qbv0.txt
tsntool> qbuset --device SWP1 --preemptable 0xff
```

#Send one broadcast frame (frame size = 1500) to SWP0 on Test Center.

#Frame could not pass SWP1.

We can get one fragment frame (frame size less than 1500) from SWP1 on Test Center.

13.5.3.4. Qbv Performance Test

Use the following commands for the QBv performance test:

```
cat > qbv5.txt << EOF
t0 11111111b 1000000
t1 00000000b 1000000
EOF
qbvset --device SWP1 --entryfile qbv5.txt
```

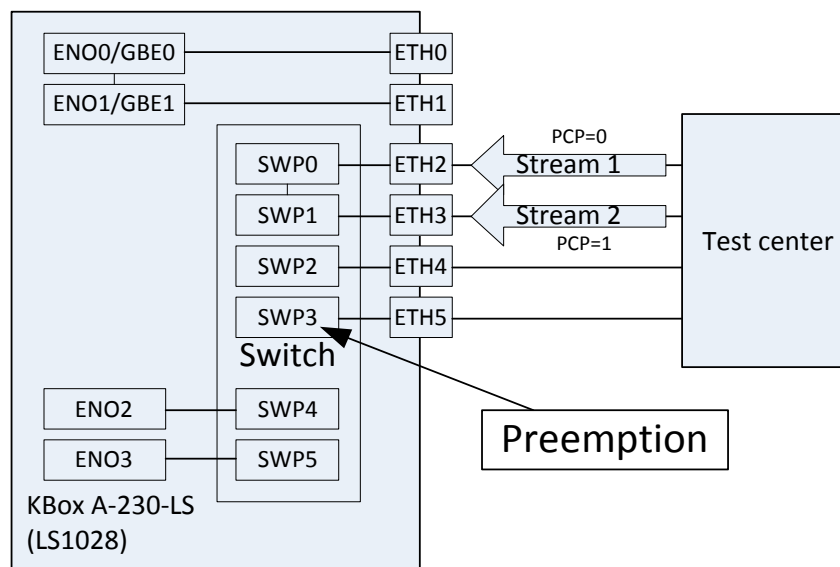
#Send 1G rate stream to SWP0 on TestCenter.

#The stream would get about half line rate from SWP1.

13.5.4. Qbu Test

The figure below illustrates the setup for performing the Qbu test using the TSN switch.

Figure 23: Qbu Test on Switch



1. Map PCP value of VLAN to queues on Switch port 0.

```
tsntool>pcpmap --device SWP0 --enable
```

2. Next, map PCP value of VLAN to queues on Switch port 1.

```
tsntool>pcpmap --device SWP1 --enable
```

3. Set queue 1 to be preemptible.

```
tsntool> qbuset --device SWP3 --preemptable 0x02
```

4. Send two streams from TestCenter, then check the number of additional mPackets transmitted by PMAC:
`devmem 0x1fc010e48 32 0x3 && devmem 0x1fc010280`

14/ Storage, Transportation and Maintenance

14.1. Storage

If the product is not in use for an extended period time, disconnect the power plug from the AC outlet .If it is necessary to store the product then re-pack the product as originally delivered to avoid damage. The storage facility must meet the products environmental storage requirements as stated within this user guide. Kontron recommends keeping the original packaging material for future storage or warranty shipments.

14.2. Transportation

To ship the product use the original packaging, designed to withstand impact and adequately protect the product. When packing or unpacking products always take shock and ESD protection into consideration and use an EOS/ESD safe working area.

14.3. Maintenance

Maintenance or repair on the open product may only be carried out by qualified personnel authorized by Kontron. Equipment from Kontron Europe requires only minimum servicing and maintenance for problem-free operation.

Cleaning

- ▶ For light soiling, clean the product with a dry cloth. Carefully remove dust from the surface of the cooling fins of the chassis using a clean, soft brush.
- ▶ Stubborn dirt should be removed using a mild detergent and a soft cloth

15/ Warranty

Kontron defines product warranty in accordance with regional warranty definitions. Claims are at Kontron's discretion and limited to the defect being of a material nature. To find out more about the warranty conditions and the defined warranty period for your region, following the steps below:

1. Visit Kontron's Term and Conditions webpage.
<http://www.kontron.com/terms-and-conditions>
2. Click on your region's General Terms and Conditions of Sale.

Limitation/Exemption from Warranty Obligation

In general, Kontron shall not be required to honor the warranty, even during the warranty period, and shall be exempted from the statutory accident liability obligations in the event of damage caused to the product due to failure to observe the following:

- ▶ General safety instructions for IT equipment within this user guide
- ▶ Warning labels on the product and warning symbols within this user guide
- ▶ Information and hints within this user guide

Additionally, alterations or modifications to the product that are not explicitly approved by Kontron, described in this user guide, or received from Kontron Support as a special handling instruction will void your warranty.

Due to their limited service life, parts which by their nature are subject to a particularly high degree of wear (wearing parts) are excluded from the warranty beyond that provided by law.

16/ Disposal

Final disposal of this product after the product's service life must be accomplished in accordance with the applicable country, state, or local laws or regulations.



Kontron manufactures products to satisfy environmental protection requirements where possible. Many of the components used are capable of being recycled.

Kontron follows the Waste Electrical and Electronic Equipment (WEEE) Directive that aims to reduce waste arising from Electrical and Electronic waste and therefore encourages customers to return Kontron products for proper disposal. For more information regarding WEEE compliance, see the Disposal and Recycling section at the start of this user guide.

17/ Technical Support

For technical support contact our Support department:

- ▶ E-mail: support@kontron.com
- ▶ Phone: +49-821-4086-888

Make sure you have the following information available when you call:

- ▶ Product ID Number (PN),
- ▶ Serial Number (SN)



The serial number can be found on the Type Label, located on the product's rear side.

Be ready to explain the nature of your problem to the service technician.

17.1. Returning Defective Merchandise

All equipment returned to Kontron must have a Return of Material Authorization (RMA) number assigned exclusively by Kontron. Kontron cannot be held responsible for any loss or damage caused to the equipment received without an RMA number. The buyer accepts responsibility for all freight charges for the return of goods to Kontron's designated facility. Kontron will pay the return freight charges back to the buyer's location in the event that the equipment is repaired or replaced within the stipulated warranty period. Follow these steps before returning any product to Kontron.

1. Visit the RMA Information website:
<http://www.kontron.com/support-and-services/support/rma-information>

Download the RMA Request sheet for **Kontron Europe GmbH** and fill out the form. Take care to include a short detailed description of the observed problem or failure and to include the product identification Information (Name of product, Product number and Serial number). If a delivery includes more than one product, fill out the above information in the RMA Request form for each product.

2. Send the completed RMA-Request form to the fax or email address given below at Kontron Europe GmbH. Kontron will provide an RMA-Number.

Kontron Europe GmbH
RMA Support
Phone: +49 (0) 821 4086-0
Fax: +49 (0) 821 4086 111
Email: service@kontron.com

3. The goods for repair must be packed properly for shipping, considering shock and ESD protection.



Goods returned to Kontron Europe GmbH in non-proper packaging will be considered as customer caused faults and cannot be accepted as warranty repairs.

4. Include the RMA-Number with the shipping paperwork and send the product to the delivery address provided in the RMA form or received from Kontron RMA Support.

Appendix A: List of Acronyms

Table 46: List of Acronyms

API	Application Programming Interface
BMC	Base Management Controller
CLI	Command-Line Interface
COM	Computer-on-Module
ECC	Error Checking and Correction
FRU	Field Replaceable Unit
GPU	Graphics Processing Unit
HD/HDD	Hard Disk /Drive
HPM	PICMG Hardware Platform Management specification family
IOL	IPMI-Over-LAN
IOT	Internet of Things
IPMI	Intelligent Platform Management Interface
KCS	Keyboard Controller Style
KVM	Keyboard Video Mouse
MEI	Management Engine Interface

PCIe	PCI-Express
PECI	Platform Environment Control Interface
PICMG®	PCI Industrial Computer Manufacturers Group
RTC	Real Time Clock
SEL	System Event Log
ShMC	Shelf Management Controller
SMBus	System Management Bus
SMWI	System Monitor Web Interface
SOL	Serial Over LAN
SSH	Secure Shell
TPM	Trusted Platform Module
UEFI	Unified Extensible Firmware Interface
VLP	Very Low Profile



About Kontron

Kontron is a global leader in embedded computing technology (ECT). As a part of technology group S&T, Kontron offers a combined portfolio of secure hardware, middleware and services for Internet of Things (IoT) and Industry 4.0 applications. With its standard products and tailor-made solutions based on highly reliable state-of-the-art embedded technologies, Kontron provides secure and innovative applications for a variety of industries. As a result, customers benefit from accelerated time-to-market, reduced total cost of ownership, product longevity and the best fully integrated applications overall. For more information, please visit: www.kontron.com



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