MBa93xxLA-MINI
Preliminary User's Manual

MBa93xxLA-MINI UM 0001
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REVISION HISTORY

Rev.	Date	Name	Pos.	Modification
0001	06.11.2025	Kreuzer		First edition

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1.6 Tips on safety

Improper or incorrect handling of the product can substantially reduce its life span.

1.7 Symbols and typographic conventions

Table 1: Terms and conventions

Symbol	Meaning
	This symbol represents the handling of electrostatic-sensitive modules and / or components. These components are often damaged / destroyed by the transmission of a voltage higher than about 50 V. A human body usually only experiences electrostatic discharges above approximately 3,000 V.
	This symbol indicates the possible use of voltages higher than 24 V. Please note the relevant statutory regulations in this regard. Non-compliance with these regulations can lead to serious damage to your health and cause damage / destruction of the component.
	This symbol indicates a possible source of danger. Acting against the procedure described can lead to possible damage to your health and / or cause damage / destruction of the material used.
	This symbol represents important details or aspects for working with TQ-products.
`Command`	A font with fixed-width is used to denote commands, file names, or menu items.

1.8 Handling and ESD tips

General handling of your TQ-products

	The TQ-product may only be used and serviced by certified personnel who have taken note of the information, the safety regulations in this document and all related rules and regulations. A general rule is not to touch the TQ-product during operation. This is especially important when switching on, changing jumper settings or connecting other devices without ensuring beforehand that the power supply of the system has been switched off. Violation of this guideline may result in damage / destruction of the MBa93xxLA-MINI and be dangerous to your health. Improper handling of your TQ-product would render the guarantee invalid.

Proper ESD handling

	The electronic components of your TQ-product are sensitive to electrostatic discharge (ESD). Always wear antistatic clothing, use ESD-safe tools, packing materials etc., and operate your TQ-product in an ESD-safe environment. Especially when you switch modules on, change jumper settings, or connect other devices.

1.9 Naming of signals

A hash mark (#) at the end of the signal name indicates a low-active signal.
Example: RESET#

If a signal can switch between two functions and if this is noted in the name of the signal, the low-active function is marked with a hash mark and shown at the end.
Example: C / D#

If a signal has multiple functions, the individual functions are separated by slashes when they are important for the wiring.
The identification of the individual functions follows the above conventions.
Example: WE2# / OE#

1.10 Further applicable documents / presumed knowledge

- **Specifications and manual of the modules used:**
  These documents describe the service, functionality and special characteristics of the module used (incl. BIOS).
- **Specifications of the components used:**
  The manufacturer's specifications of the components used, for example CompactFlash cards, are to be taken note of. They contain, if applicable, additional information that must be taken note of for safe and reliable operation. These documents are stored at TQ-Systems GmbH.
- **Chip errata:**
  It is the user's responsibility to make sure all errata published by the manufacturer of each component are taken note of. The manufacturer's advice should be followed.
- **Software behaviour:**
  No warranty can be given, nor responsibility taken for any unexpected software behaviour due to deficient components.
- **General expertise:**
  Expertise in electrical engineering / computer engineering is required for the installation and the use of the device.

The following documents are required for full comprehension of this Preliminary User's Manual:

- MBa93xxLA-MINI schematics
- TQMa93xxLA Preliminary User's Manual
- i.MX 93 Data Sheet
- i.MX 93 Reference Manual
- U-Boot documentation: www.denx.de/wiki/U-Boot/Documentation
- Yocto documentation: www.yoctoproject.org/docs/
- TQ-Support Wiki: https://support.tq-group.com/en/arm/tqma93xxLA

2. BRIEF DESCRIPTION

This Preliminary User's Manual describes the hardware of the MBa93xxLA-MINI as of revision 01xx.

The MBa93xxLA-MINI is designed as a carrier board for the TQMa93xxLA. The TQMa93xxLA is directly soldered on the MBa93xxLA-MINI.

Core of the MBa93xxLA-MINI is the TQMa93xxLA with an NXP i.MX 93 CPU based on a Single or Dual Cortex®-A55.

The TQMa93xxLA connects all peripheral components. In addition to the standard communication interfaces such as USB, Ethernet, SD card, etc., most other available TQMa93xxLA signals are routed on 100 mil pin headers on the MBa93xxLA-MINI.

CPU features and interface can be evaluated, software development for a TQMa93xxLA-based project can start immediately.

Currently two i.MX 93 derivatives are supported:

1) i.MX 93x1 (Single Cortex®-A55)
2) i.MX 93x2 (Dual Cortex®-A55)

2.1 MBa93xxLA-MINI block diagram

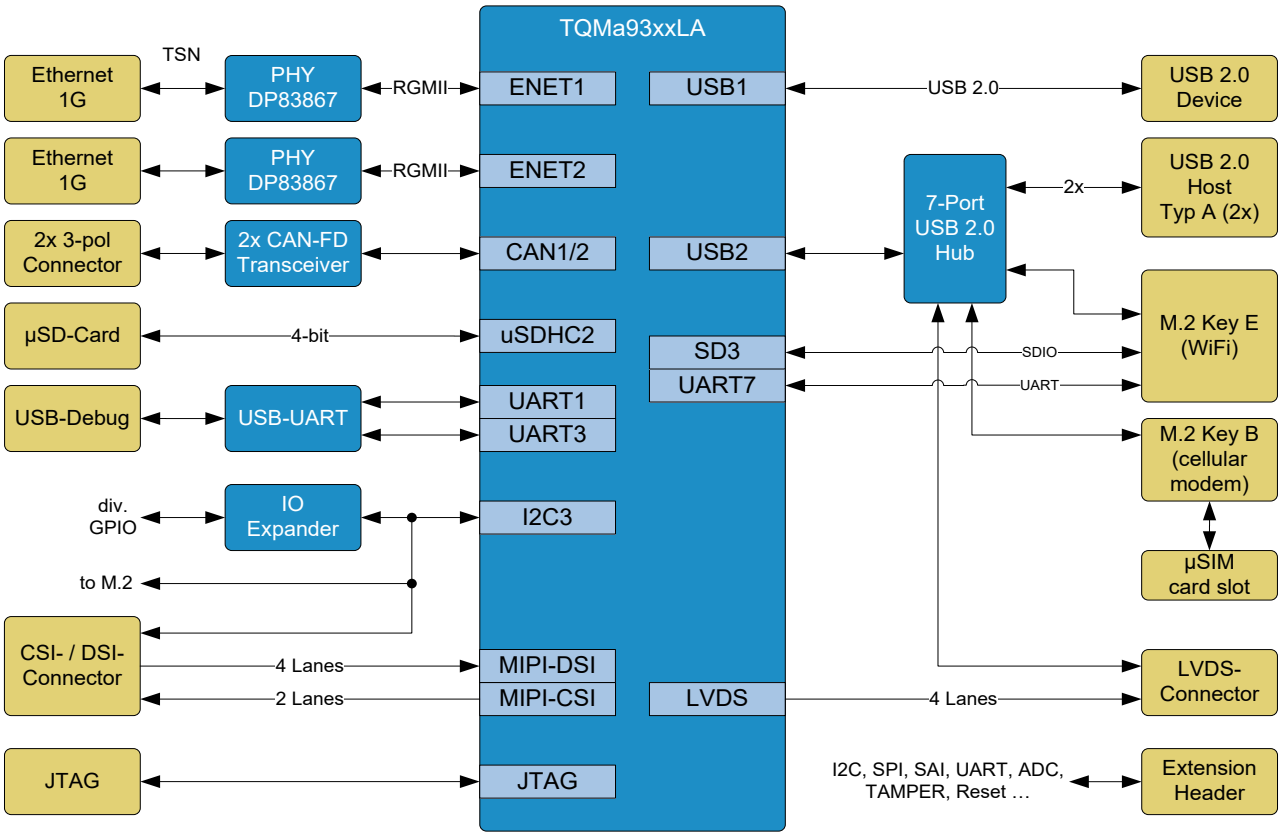

Figure 1: Block diagram MBa93xxLA-MINI

2.2 MBa93xxLA-MINI interfaces, overview

The following interfaces/functions and user interfaces are available on the MBa93xxLA-MINI:

Table 2: Data interfaces

Interface	Connector	Type	Remark
CAN	X6, X7	Phoenix Contact MC 1,5/ 3-G-3,5	
Eth. 1000 Base-T	X5	Dual-RJ45	
Extension	X1, X2	Fischer Elektronik SL-11-SMD-052-20-G-BTR	20-pin, 100 mil pin header
JTAG	X16	Samtec FTSH-105-01-L-DV-P-TR	10-pin, 50 mil pin header
LVDS CMD	X11	Hirose DF19G-14P-1H(52)	14-pin
LVDS Data	X10	Hirose DF19G-20P-1H(52)	20-pin
MIPI-CSI/DSI	X17	TE Connectivity 5177986-2	
M.2 Key B	X13		For WWAN / LTE
M.2 Key E	X12		For WiFi / WPAN
SD card	X3	Micro-SD	
SIM Card	X14	Micro SIM	
USB 2.0 Host	X4	Stacked Type A	Host 1, Host 2
USB Debug	X9	Micro-AB	UART1, UART3
USB Device/Serial Downloader	X8	Micro-AB	USB 2.0

The MBa93xxLA-MINI provides the following diagnostic and user interfaces:

Table 3: Diagnostic and user interfaces

Interface	Reference	Component	Remark
Status LEDs		1 x Red/Green/Orange LED	Power & Reset
		4 x Green/Yellow LED	Ethernet link / activity
Power / Reset	S2 S3	2 x Pushbutton	Reset CPU-ON/OFF
Boot-Mode	S1	1 × 4-fold DIP switch	Boot Device selection
CAN Termination	S4 S5	2 x 2-fold DIP switch	Bus termination CAN1 Bus termination CAN2

3. ELECTRONICS

3.1 MBa93xxLA-MINI functional groups

The following chapters describe the interfaces of the MBa93xxLA-MINI in connection with a TQMa93xxLA.

3.1.1 TQMa93xxLA overview

The MBa93xxLA-MINI provides all power supplies and configurations required for the operation of the TQMa93xxLA.
The TQMa93xxLA is the central system on the MBa93xxLA-MINI. It provides LPDDR4 SDRAM, eMMC, NOR flash, RTC, an EEPROM, power supply and power management functionality. All TQMa93xxLA internal voltages are derived from the 5 V supply voltage. All functionally relevant pins of the i.MX 93 are routed to the TQMa93xxLA connectors or LGA pads. This enables to use the TQMa93xxLA with all the freedom that comes with a customer-specific design-in solution. Further information can be found in the TQMa93xxLA User's Manual.
On the MBa93xxLA-MINI the standard interfaces like USB, Ethernet, etc., provided by the TQMa93xxLA are routed to industry standard connectors. Most other relevant signals and buses provided by the TQMa93xxLA are routed to 100 mil pin headers on the MBa93xxLA-MINI.
The boot behaviour of the TQMa93xxLA can be controlled. The boot mode configuration is set with a DIP switch on the MBa93xxLA-MINI.

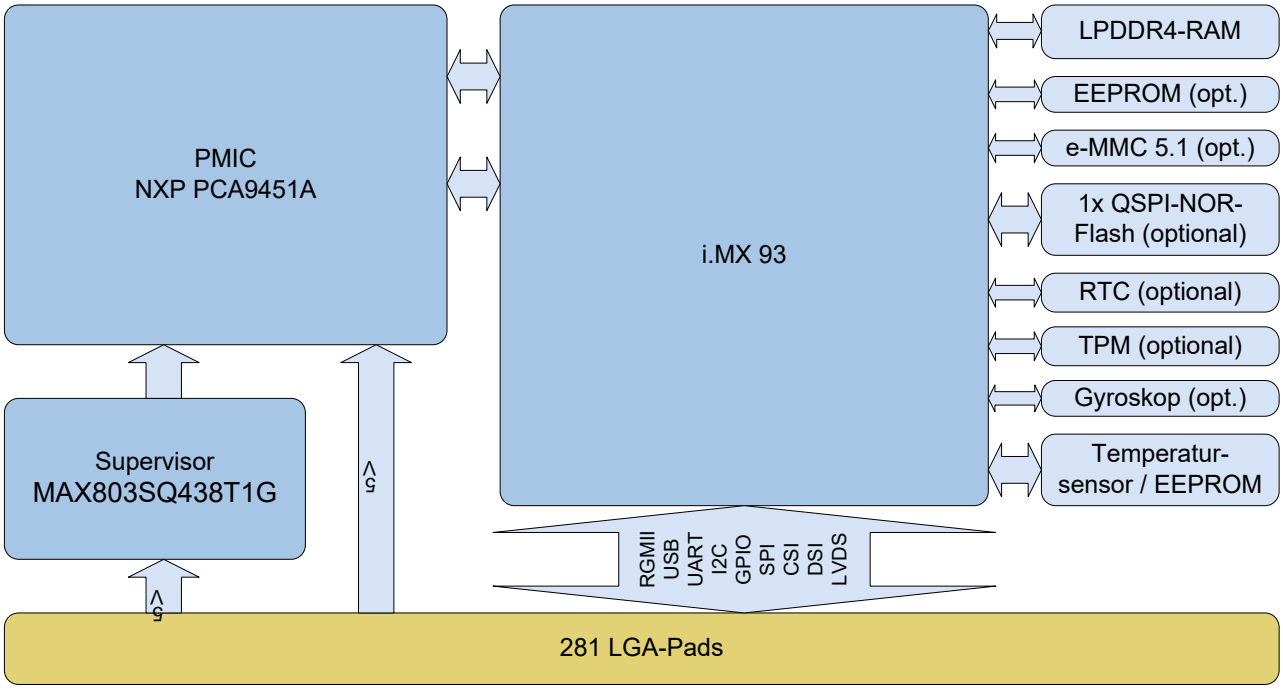

Figure 2: Block diagram TQMa93xxLA

3.1.2 TQMa93xxLA pinout

The most relevant TQMa93xxLA signals that are not already used are routed out to a header on the MBa93xxLA-MINI.

Note: Available interfaces	
	Depending on the TQMa93xxLA derivative, not all interfaces are available. More information about available interfaces can be found in the TQMa93xxLA User's Manual and pinout tables.

3.1.3 I²C devices, address mapping

The TQMa93xxLA provides two I²C buses. Of these, only I2C3 is provided on a pin header X2. All other buses are used by different components on the module or the mainboard.

The following table shows the addresses used on the TQMa93xxLA and the MBa93xxLA-MINI.

Table 4: I²C devices, address mapping on TQMa93xxLA and MBa93xxLA-MINI

Location	Device	Bus	7-bit address	Remark
TQMa93xxLA	PMIC	I2C1	0x25 / 010 0101b	
	Temperature sensor		0x1B / 001 1011b	
	Temperature sensor		0x53 / 101 0011b	
	Temperature sensor		0x33 / 011 0011b	
	EEPROM (memory array)		0x57 / 101 0111b	
	EEPROM (identification page)		0x5F / 101 1111b	
	RTC		0x51 / 101 0001b	
	TPM		0x48 / 100 1000b	
	Gyroscope		0x6A / 110 1010b	
	Extension Header	I2C3	N/A	
	M.2 Key E		N/A	
	M.2 Key B		N/A	
	Port-Expander #1		0x70 / 111 0000b	
	Port-Expander #2		0x71 / 111 0001b	
	MIPI-DSI/CSI		N/A	

3.1.4 IO-Expander

Due to the limited number of GPIO pins available on the TQMa93xxLA, IO expanders are required to provide the necessary signals. Two I2C IO expanders with 8 ports each are used on the MBa93xxLA-MINI. IO signals that must be processed directly by the CPU (e.g. interrupts, timer IOs, PWM signals) are applied directly to the TQMa93xxLA. All other control signals are connected to the IO expanders or free GPIOs of the CPU.

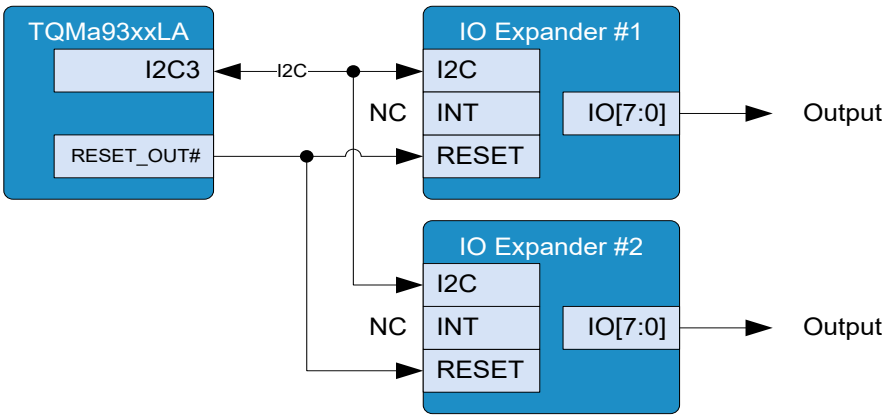

Figure 3: Block diagram IO Expander

Both expanders only contain output signals, which means that their interrupt signals can be saved. The IO expanders used have a reset input, which is connected to RESET_OUT#. This resets all signals when the CPU is reset (High-Z).

3.1.5 RTC backup

The TQMa93xxLA has an optional RTC. This is powered via the V_LICELL pin by a rechargeable battery or battery. A corresponding holder is used for this.

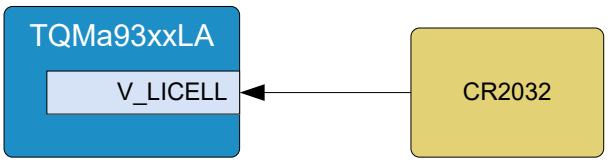

Figure 4: Block diagram RTC backup

3.1.6 Reset

Two reset options are provided by the MBa93xxLA-MINI.

A reset is triggered by the signal PMIC_RST# via pushbutton S2. By default, the PMIC is configured to trigger a cold reset upon activation.

The ONOFF pushbutton S3 offers three reaction possibilities. If it is pressed for more than 5 s, the CPU enters OFF mode. If the button is briefly pushed in OFF mode, the CPU switches back to ON mode. A short push in ON mode triggers an interrupt.

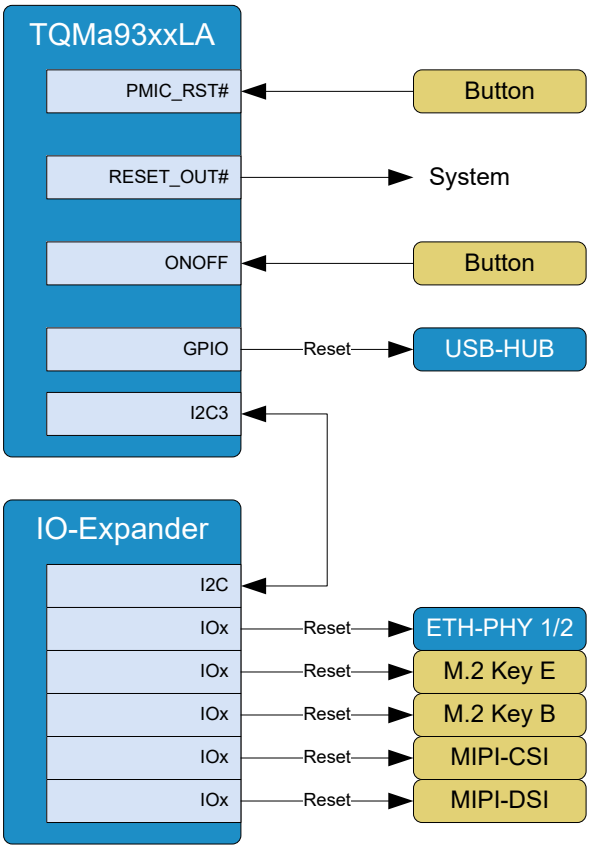

Figure 5: Block diagram MBa93xxLA-MINI Reset & Config

The RESET_OUT# signal of the TQMa93xxLA is available on the MBa93xxLA-MINI.

Attention: RESET_OUT# / PMIC_RST#	
	Attention: The signal RESET_OUT# is designed as a reset triggering signal. To feed a reset signal into the system, it is mandatory to use the signal PMIC_RST#.

Table 5: Reset & Config signals

Signal	Dir.	Level	Remark
PMIC_RST#	I	1.8 VMBa93xxLA-MINI	• Activates RESET of the PMIC (low-active) • Programmable PMIC response (see data sheet) • No pull-up on carrier board required • Connect to GND to activate (push-button)
RESET_OUT#	O	-	• Open drain output (low-active) • Activates RESET of mainboard components • Requires pull-up on mainboard (max. 5.5 V)
ONOFF	I	1.8 V	• ON/OFF function; see i.MX 93 data sheet (1) • No pull-up on carrier board required • Connect to GND to activate (push-button)

LED V1 on the MBa93xxLA-MINI indicates the conditions:

- Green --> Power ON
- Red --> Reset active while Power OFF
- Orange --> Reset active while Power ON

3.2 Power supply

At X15, the MBa93xxLA-MINI has to be supplied with 24 V (16 V to 32 V). All other voltages required on the MBa93xxLA-MINI are derived from this supply voltage with the exception of V_1V8 (max. 0.5 A), which is provided by theTQMa93xxLA. The realistic maximum total power consumption of MBa93xxLA-MINI is approximately 56 W, of which approximately 14 W is provided as power output on pin headers, LVDS or CSI (including 85 % efficiency). With a minimum supply voltage of 16 V, the input current is 3.51 A. It must be ensured that the permissible limit values of the input circuitry are not exceeded.

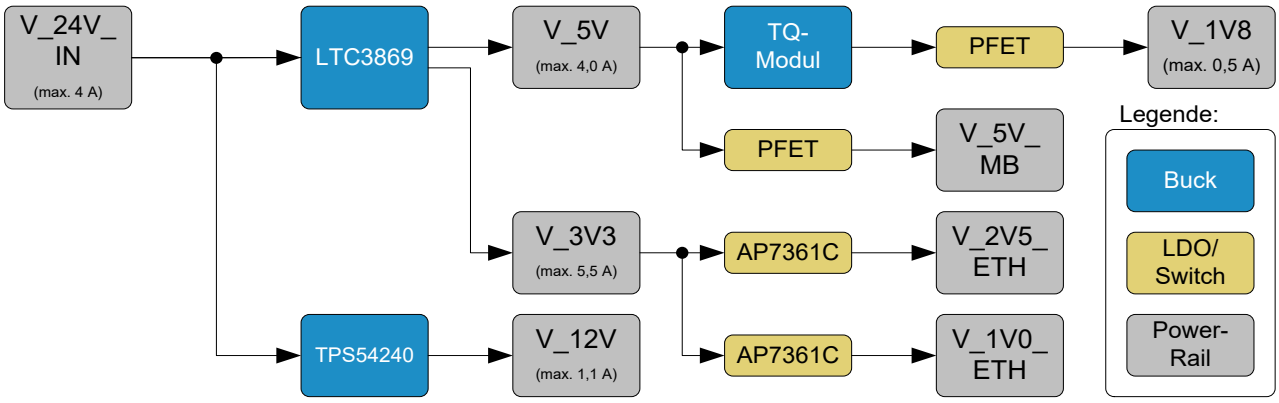

Figure 6: Block diagram power supply MBa93xxLA-MINI

3.2.1 Protective circuitry

The protective circuit features the following characteristics:

- Overcurrent protection by fuse 4 A, Slow Blow
- Overvoltage protection
- PI filter
- Reverse polarity protection
- Capacitors for voltage smoothing

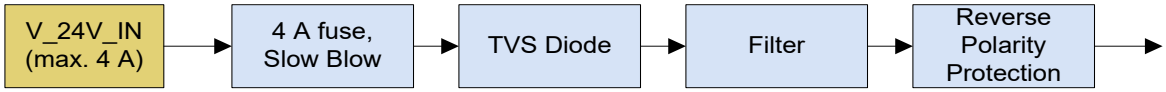

Figure 7: MBa93xxLA-MINI protective circuit

3.2.2 Shared power budgets

Ensure maximum listed power budget for IO interfaces is not exceeded.
Observe maximum current rating on the individual connectors.

Attention: Maximum current of 3.3 V and 5 V rails	
	The currents load of the 3.3 V and 5 V rails add up to the current consumption of the MBa93xxLA-MINI. The additional power required must be provided by the power supply of the MBa93xxLA-MINI. The maximum load of the fuse must be observed.

3.3 Communication interfaces

3.3.1 Ethernet 1000 Base-T (RGMII)

The i.MX 93 processor has two independent RGMII interfaces. On the MBa93xxLA-MINI both interfaces are used to provide two Gigabit Ethernet ports.
The ENET1 interface (ENET QOS) of the CPU provides Time Sensitive Network (TSN) features. The ENET2 interface does not support TSN.

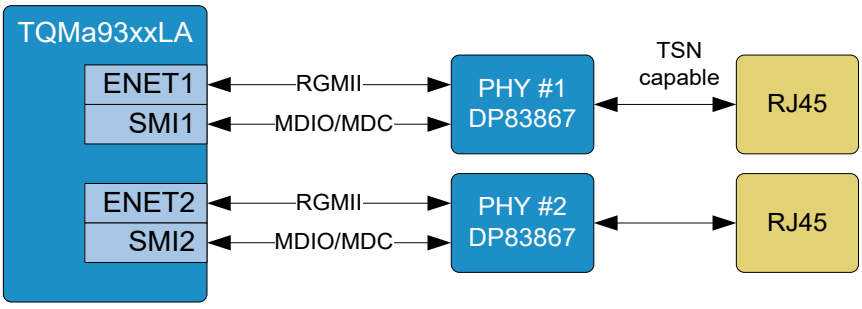

Figure 8: Block diagram Ethernet

3.3.2 SD card interface

The micro SD card slot is connected directly to the uSDHC2 interface of the TQMa93xxLA. A 4-bit wide data interface is used.

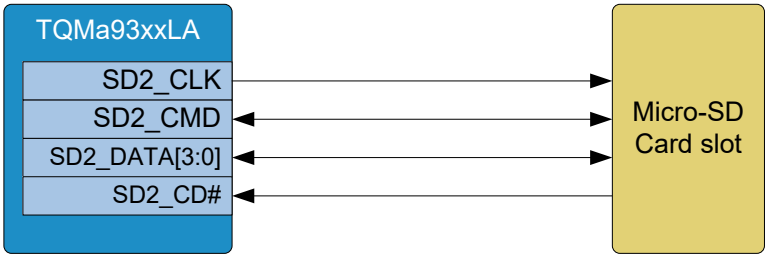

Figure 9: Block diagram SD card interface on MBa93xxLA-MINI

The uSDHC controller in the i.MX93 supports UHS-I mode. The IO voltage is switched by the module's internal signal SD2_VSELECT. The SD card is supplied with V_3V3_SD, which is provided by the TQMa93xxLA. This avoids hang-ups during booting after a soft reset.

3.3.3 M.2 Interfaces

The signal assignment of the M.2 interfaces is standard-compliant. The Key E slot is designed for the 2230 form factor, the Key B slot for the 3042 form factor.

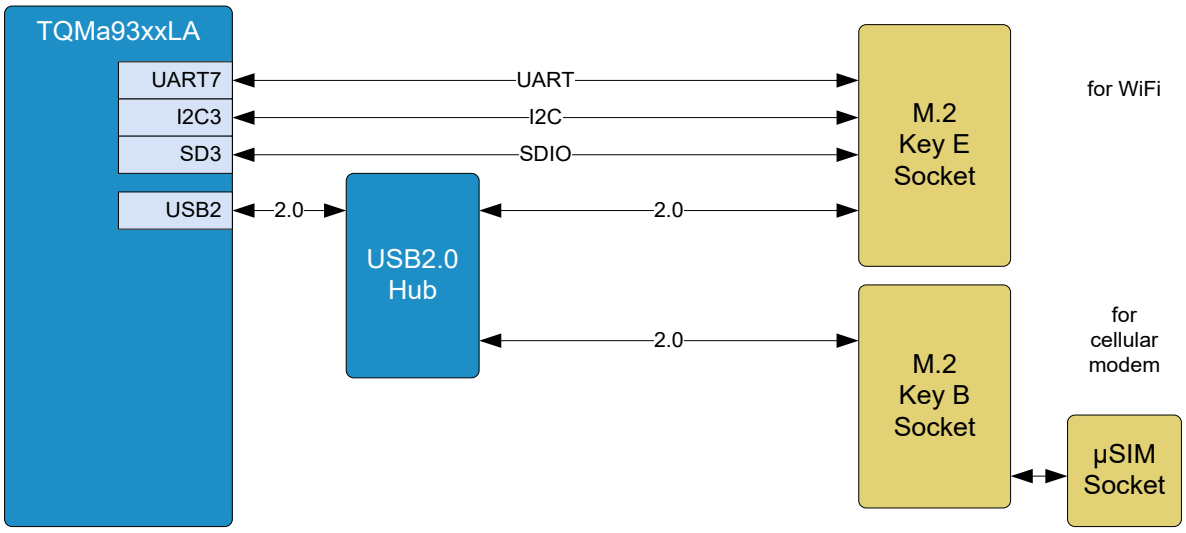

Figure 10: Block diagram M.2 interfaces

Other control signals, which are not shown on the block diagram, are connected either to the GPIO pins of the TQMa93xxLA or via an I2C port expander. Note that the SDIO interface can only be used with a variant of the TQMa93xxLA that does not have an SPI-NOR flash.

3.3.4 USB host

A 7-port USB 2.0 hub USB2517 from Microchip is used to provide the USB interfaces on the USB host sockets as well as for M.2 slots and LVDS connectors.

The USB hub is connected to the USB2 port of the processor. A GPIO signal (provided by an expander) controls the voltage at VBUS Detection of the processor and hub for energy management functions.

VBUS with max. 500 mA each is provided at the stacked USB type A host sockets. The current limit is set internally to typ. 0.8 A.

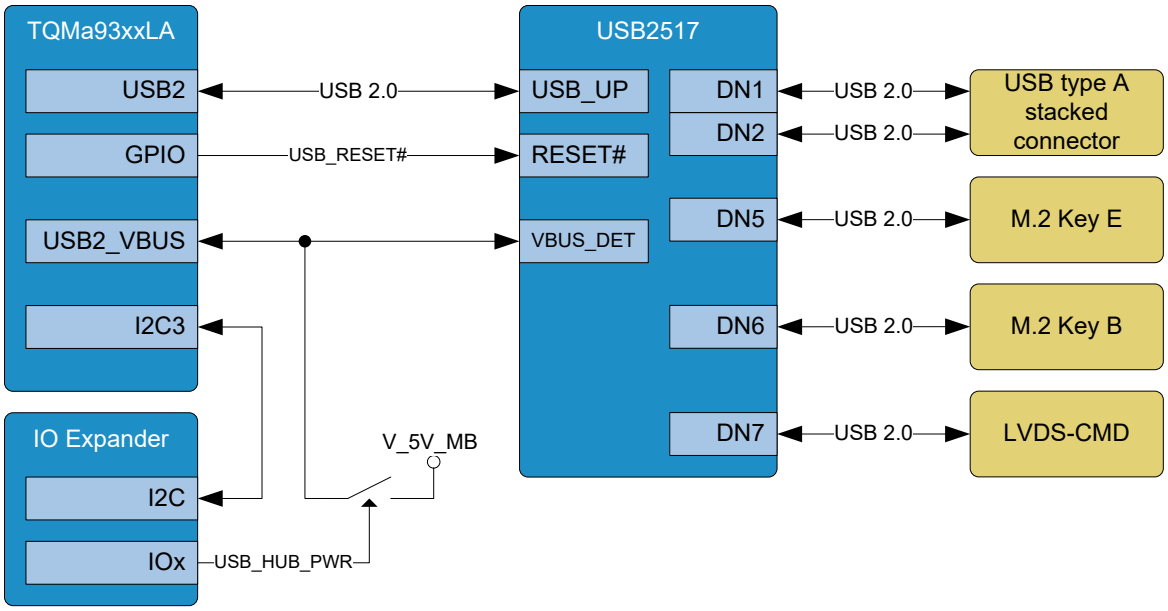

Figure 11: Block diagram USB host

3.3.5 USB device / Serial Downloader

To provide a USB device interface and the processors serial downloader functionality, the USB1 interface is connected to a Micro USB socket.

Figure 12: Block diagram USB device

3.3.6 Debug-USB / UART

For debug functionalities UART1 and UART3 are provided as virtual COM ports via USB. UART1 can be multiplexed to both the Cortex-A55 and -M33 cores of the i.MX 93. However, UART3 can only be multiplexed to the A55 core. Therefore, one UART is available for each core.

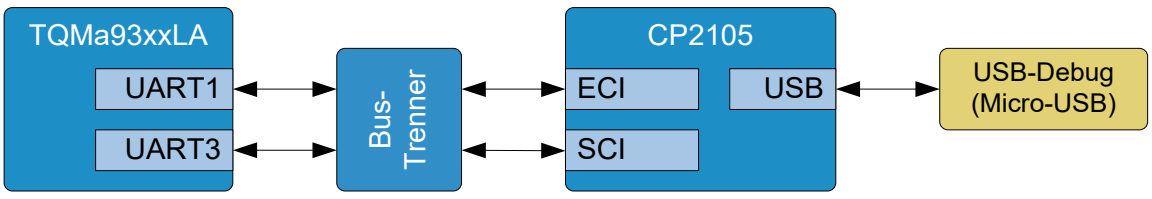

Figure 13: Block diagram UARTs

3.3.7 CAN FD

Two CAN interfaces are implemented on the MBa93xxLA-MINI in accordance with the ISO-11898 standard. The signals are each made available on a 3-pin socket.

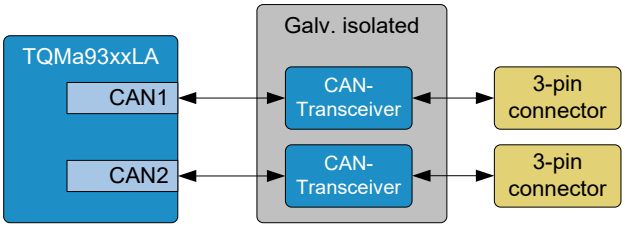

Figure 14: Block diagram CAN

The interfaces are galvanically isolated with an isolation voltage of 1 kV. However, the two CAN interfaces are not isolated from each other. CAN termination is achieved via a DIP switch.

3.3.8 MIPI-CSI / -DSI

The i.MX 93 processor has a MIPI-CSI interface with two lanes and a MIPI-DSI interface with four lanes. These are made available on the MBa93xxLA-MINI via a common connector (TE 5177986-2).

A reset signal and a freely available GPIO signal are provided for DSI. All control signals are implemented with a level of 1.8 V. In addition to the data lines for signal transmission, the supply voltage of 5 V and the I2C bus are also provided on the connector. 1.8 V and 3.3 V are also applied via a placement option.

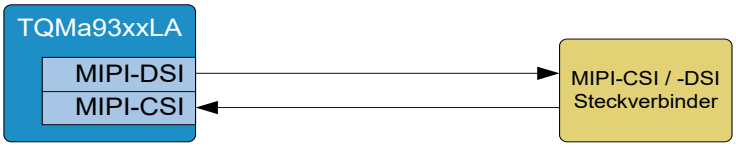

Figure 15: Block diagram MIPI-CSI / -DSI

Table 6: Pinout MIPI-CSI / -DSI, X17

Signal	Pin		Signal
GND	1	2	GND
CAM_PWR#	3	4	DSI_GPIO
CAM_RST#	5	6	DSI_RST#
CAM_TRIGGER	7	8	NC
CAM_SYNC	9	10	NC
NC	11	12	NC
GND	13	14	GND
NC	15	16	MIPI_DSI_DATA3-
NC	17	18	MIPI_DSI_DATA3+
GND	19	20	GND
NC	21	22	MIPI_DSI_DATA2-
NC	23	24	MIPI_DSI_DATA2+
GND	25	26	GND
MIPI_CSI_DATA1-	27	28	MIPI_DSI_DATA1-
MIPI_CSI_DATA1+	29	30	MIPI_DSI_DATA1+
GND	31	32	GND
MIPI_CSI_DATA0-	33	34	MIPI_DSI_DATA0-
MIPI_CSI_DATA0+	35	36	MIPI_DSI_DATA0+
GND	37	38	GND
MIPI_CSI_CLOCK-	39	40	MIPI_DSI_CLOCK-
MIPI_CSI_CLOCK+	41	42	MIPI_DSI_CLOCK+
GND	43	44	GND
I2C3_1V8_SDA	45	46	I2C3_1V8_SDA
I2C3_1V8_SCL	47	48	I2C3_1V8_SCL
GND	49	50	GND
CAM_MCLK	51	52	NC
GND	53	54	GND
V_1V8 (optional)	55	56	V_5V_MB
V_3V3 (optional)	57	58	
	59	60	

3.3.9 LVDS

The i.MX 93 has an LVDS interface with four lanes. These are available on the MBa93xxLA-MINI on a connector (Hirose DF19G-20P-1H(52)). In addition, a CMD connector (Hirose DF19G-14P-1H(52)) is integrated on the MBa93xxLA-MINI, on which supply voltages, a USB interface and display or backlight control signals are available.

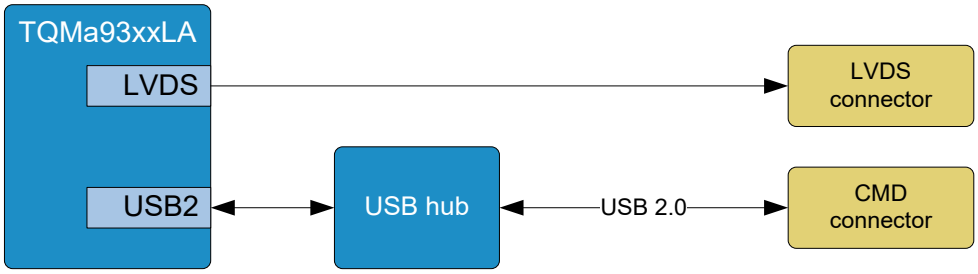

Figure 16: Block diagram LVDS

Table 7: Pinout LVDS data, X10

Pin	Signal	Remark
1	LVDS_D0_N	–
2	LVDS_D0_P	–
3	LVDS_D1_N	–
4	LVDS_D1_P	–
5	LVDS_D2_N	–
6	LVDS_D2_P	–
7	GND	–
8	LVDS_CLK_N	–
9	LVDS_CLK_P	–
10	LVDS_D3_N	–
11	LVDS_D3_P	–
12	GND	–
13		
14		
15	V_5V_LVDS	max. 1.0 A
16		
17		
18	V_3V3_LVDS	max. 1.0 A
19		
20		

Table 8: Pinout LVDS control, X11

Pin	Signal	Remark
1	V_12V	max. 1.0 A
2		
3	GND	–
4	V_5V_MB	max. 0.5 A
5	GND	–
6	V_VBUS_H7	–
7	GND	–
8	USB_LVDS_DN	–
9	USB_LVDS_DP	–
10	GND	–
11	LVDS_RESET#	–
12	LVDS_BLT_EN	–
13	LVDS_PWR_EN	–
14	LVDS_PWM	–

3.3.10 Extension Header

The MBa93xxLA-MINI has two 20-pin headers, through which some signals and interfaces are made available.

Table 9: Extension Header X1

Signal	Pin		Signal
V_5V_MB	1	2	V_3V3
GND	3	4	GND
SAI3_TX_SYNC	5	6	UART8_TX
SAI3_TX_DATA0	7	8	UART8_RX
SAI3_TX_BCLK	9	10	GND
SAI3_RX_SYNC	11	12	SPI6_PCS0#
SAI3_RX_DATA0	13	14	SPI6_SIN
SAI3_RX_BCLK	15	16	SPI6_SOUT
GND	17	18	GND
SAI3_MCLK	19	20	SPI6_SCK

Table 10: Extension Header X2

Signal	Pin		Signal
V_1V8	1	2	V_3V3
GND	3	4	RESET_OUT#
ADC_IN0	5	6	PMIC_RST#
ADC_IN1	7	8	TEMP_EVENT_MOD# (can be bridged to GPIO1_IO11)
ADC_IN2	9	10	GND
ADC_IN3	11	12	M33_NMI
TAMPER0	13	14	I2C3_SDA
TAMPER1	15	16	I2C3_SCL
GND	17	18	GND
CLKIN1	19	20	CLKIN2

In addition to the signals, voltages of 1.8 V, 3.3 V and 5 V are available at these pin headers. The maximum current is shared between all the pins on the header and the LVDS and MIPI connectors. The end customer must ensure that the total current consumption is within the required limits when connecting external components. There is no current monitoring, please regard the following table:

Table 11: Shared Power Out budget

Rail	Max. current	on connectors
V_5V_MB	1.5 A	X1 (Extension Header), X10 (LVDS Data), X11(LVDS CMD), X17 (MIPI-DSI/CSI)
V_3V3	1 A	X1 (Extension Header), X2 (Extension Header) , X11 (LVDS CMD), X17 (MIPI-DSI/CSI)
V_1V8	250 mA	X2 (Extension Header), X17 (MIPI-DSI/CSI)

3.4 User interfaces and diagnostic

3.4.1 Boot Mode configuration

The Boot Mode is set with the 4-fold DIP switch S1 at the four i.MX 93 Boot_Mode[3:0].
Information on the boot configuration of the i.MX 9 can be found in the i.MX 93 documentation.

Table 12: Boot Source options TQMa93xxLA

Boot Mode[3:0]	Boot Source
0 0 0 0	Boot from Internal Fuses
0 0 0 1	Serial Downloader (USB1)
0 0 1 0	uSDHC1 8-bit eMMC 5.1
0 0 1 1	uSDHC2 4-bit SD 3.0
0 1 0 0	FlexSPI Serial NOR
1 0 0 0	LPB: Boot from Internal Fuses
1 0 0 1	LPB: Serial Downloader (USB1)
1 0 1 0	LPB: uSDHC1 8-bit eMMC 5.1
1 0 1 1	LPB: uSDHC2 4-bit SD 3.0
1 1 0 0	LPB: FlexSPI Serial NOR

3.4.2 Reset buttons

More information can be found in chapter 3.1.6

3.4.3 JTAG®

The JTAG® port of the i.MX 93 is routed to a standard ARM® 10-pin JTAG® connector on the MBa93xxLA-MINI.
The pull-up voltage and supply voltage at the plug connector are both 1.8 V.

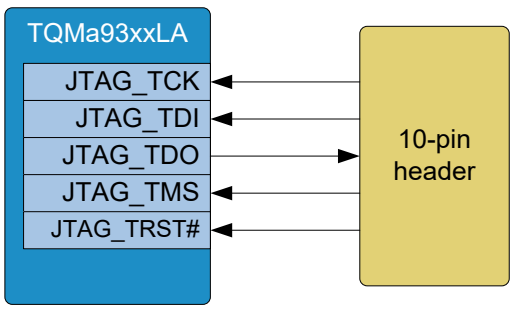

Figure 17: Block diagram JTAG

The following table shows the JTAG® connector pinout.

Table 13: Pinout JTAG® pin header

Pin	Signal	Remark
1	V_{ref} / VCC	1.8 V
2	JTAG_TMS	–
3	GND	–
4	JTAG_TCK	–
5	GND	–
6	JTAG_TDO	–
7	Key	(NC)
8	JTAG_TDI	–
9	GND_DETECT	10 kΩ PD
10	JTAG_SRST#	RESET_IN#, 10 kΩ PU

4. SOFTWARE

No software is required for the MBa93xxLA-MINI. Suitable software is only required on the TQMa93xxLA and is not a part of this Preliminary User's Manual. More information can be found in the TQ-Support Wiki for the TQMa93xxL.

5. MECHANICS

5.1 MBa93xxLA-MINI dimensions

The MBa93xxLA-MINI has overall dimensions (length × width) of 100 mm × 100 mm.
The height without heatspreader and heatsink is approximately TBD mm.
The MBa93xxLA-MINI including TQMa93xxLA weighs approximately TBD grams.

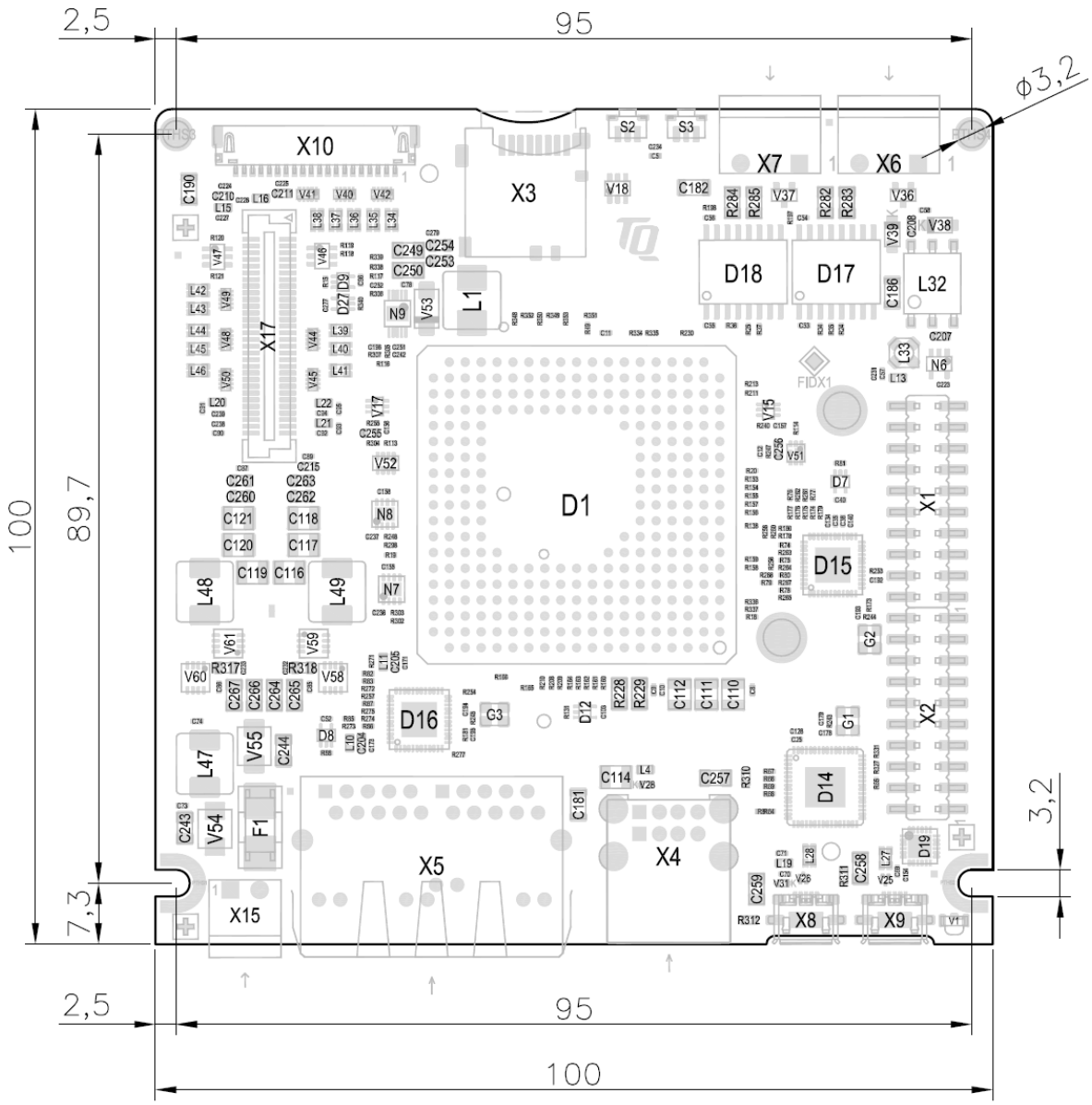

Figure 18: Dimensions MBa93xxLA-MINI

5.2 Embedding in the overall system

The MBa93xxLA-MINI serves as a design base for customer products, as well as a platform to support during development.

5.3 Thermal management

The combination of MBa93xxLA-MINI and TQMa93xxLA has a power consumption of approximately TBD watts.
Further power consumption occurs mainly at externally connected devices.

Attention: TQMa93xxLA heat dissipation	
	The i.MX 93 belongs to a performance category in which a cooling system is essential. It is the user's sole responsibility to define a suitable heat sink (weight and mounting position) depending on the specific mode of operation (e.g., dependence on clock frequency, stack height, airflow, and software). Particularly the tolerance chain (PCB thickness, board warpage, BGA balls, BGA package, thermal pad, heatsink) as well as the maximum pressure on the TQMa93xxLA must be taken into consideration when connecting the heat sink. The TQMa93xxLA is not the highest component. Inadequate cooling connections can lead to overheating of the TQMa93xxLA or the MBa93xxLA-MINI and thus malfunction, deterioration or destruction.

5.4 Component placement

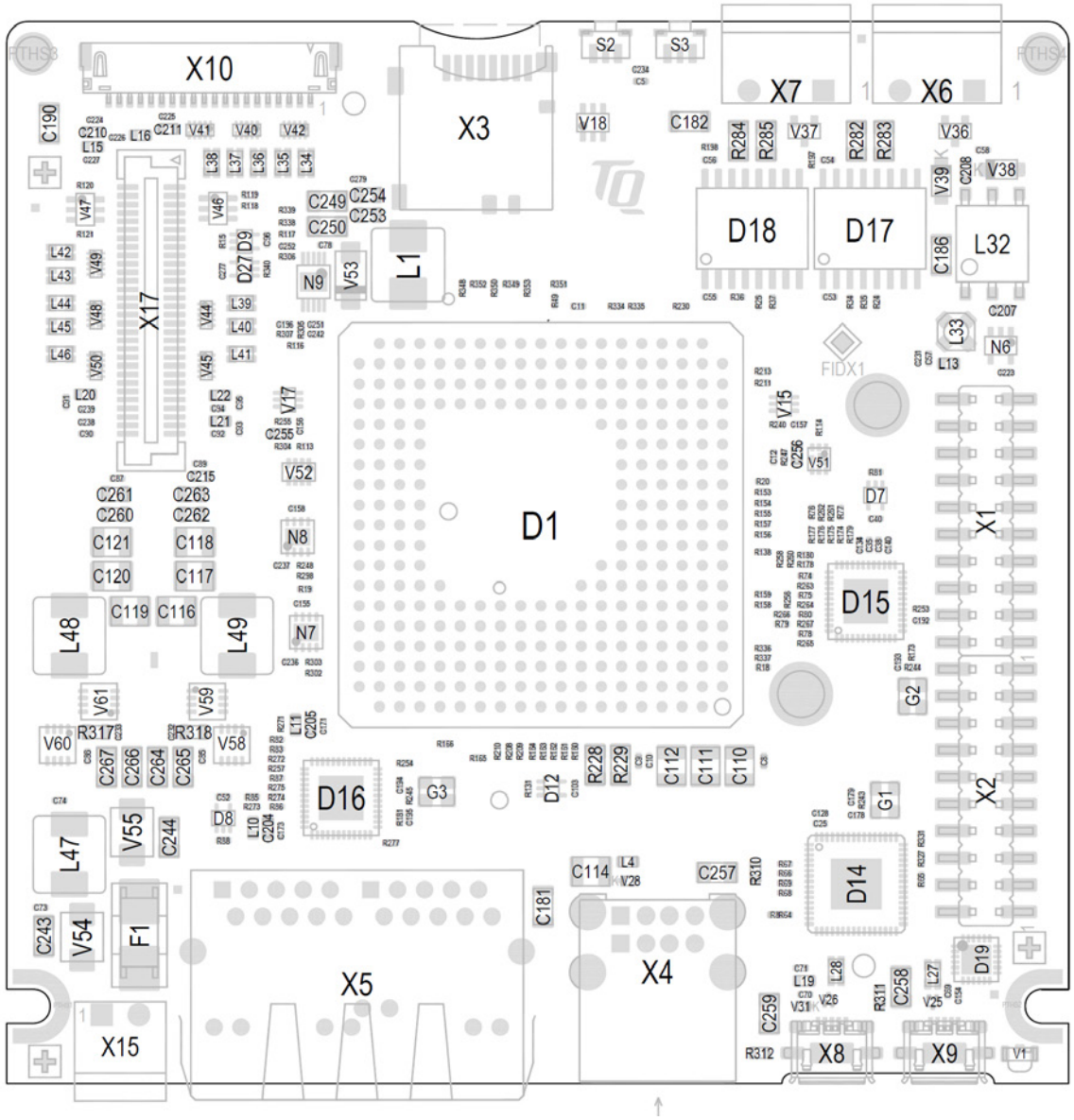

Figure 19: MBa93xxLA-MINI component placement top

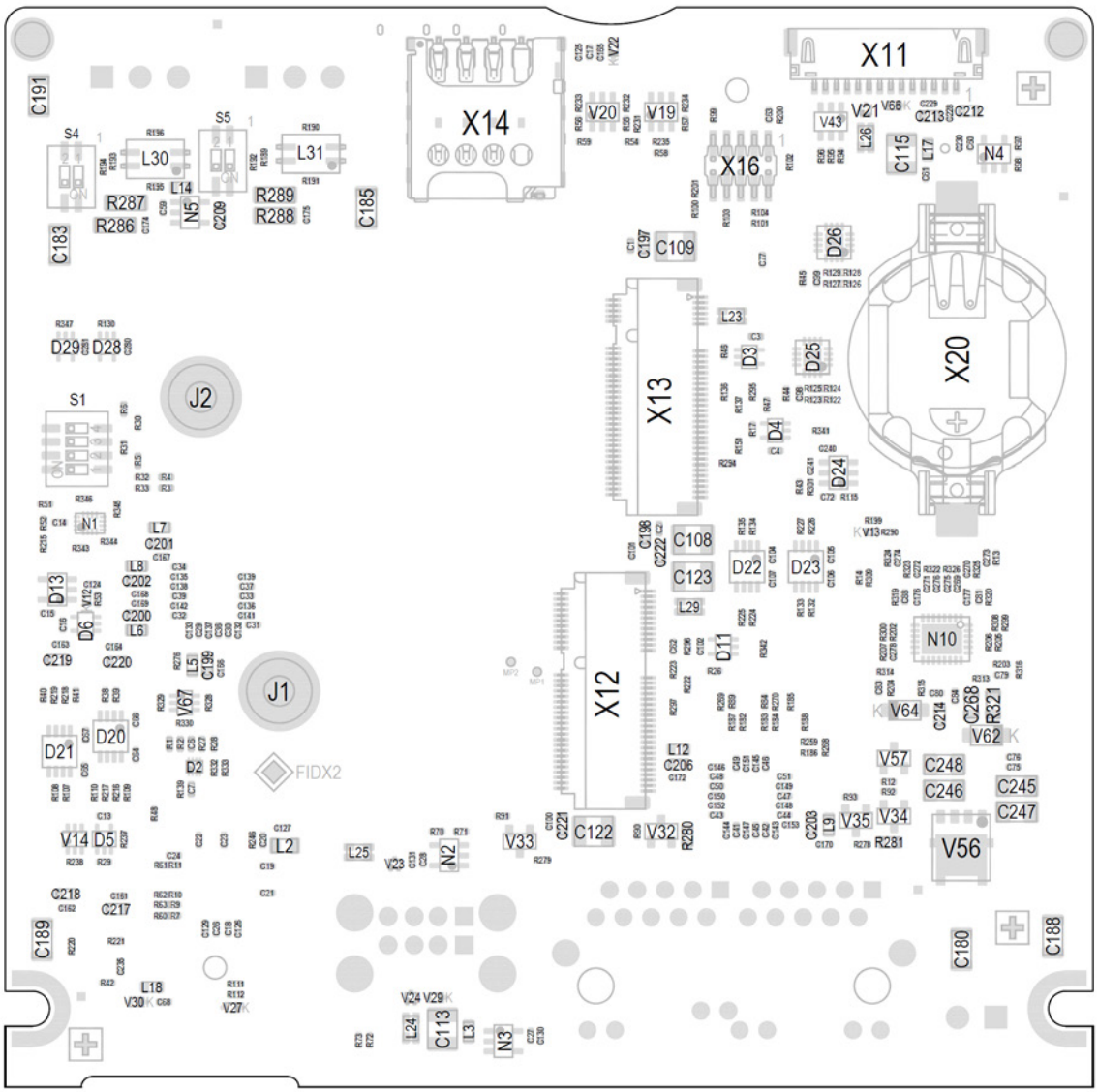

Figure 20: MBa93xxLA-MINI component placement bottom

6. SAFETY REQUIREMENTS AND PROTECTIVE REGULATIONS

6.1 EMC

Since the MBa93xxLA-MINI is a development platform, no EMC tests have been performed.

6.2 ESD

Most interfaces provide ESD protection. Details are to be taken from the MBa93xxLA-MINI schematics.

6.3 Operational safety and personal security

Tests for operational safety and personal protection were not carried out due to the voltages ≤30 V DC.

6.4 Cyber Security

A Threat Analysis and Risk Assessment (TARA) must always be performed by the customer for their individual end application, as the MBa93xxLA-MINI is only a sub-component of an overall system.

6.5 Export Control and Sanctions Compliance

The customer is responsible for ensuring that the product purchased from TQ is not subject to any national or international export/import restrictions. If any part of the purchased product or the product itself is subject to said restrictions, the customer must procure the required export/import licenses at its own expense. In the case of breaches of export or import limitations, the customer indemnifies TQ against all liability and accountability in the external relationship, irrespective of the legal grounds. If there is a transgression or violation, the customer will also be held accountable for any losses, damages or fines sustained by TQ. TQ is not liable for any delivery delays due to national or international export restrictions or for the inability to make a delivery as a result of those restrictions. Any compensation or damages will not be provided by TQ in such instances.

The classification according to the European Foreign Trade Regulations (export list number of Reg. No. 2021/821 for dual-use-goods) as well as the classification according to the U.S. Export Administration Regulations in case of US products (ECCN according to the U.S. Commerce Control List) are stated on TQ´s invoices or can be requested at any time. Also listed is the Commodity code (HS) in accordance with the current commodity classification for foreign trade statistics as well as the country of origin of the goods requested/ordered.

6.6 Warranty

TQ-Systems GmbH warrants that the product, when used in accordance with the contract, fulfills the respective contractually agreed specifications and functionalities and corresponds to the recognized state of the art.
The warranty is limited to material, manufacturing and processing defects. The manufacturer's liability is void in the following cases:

- Original parts have been replaced by non-original parts.
- Improper installation, commissioning or repairs.
- Improper installation, commissioning or repair due to lack of special equipment.
- Incorrect operation
- Improper handling
- Use of force
- Normal wear and tear

7. CLIMATIC AND OPERATIONAL CONDITIONS

In general reliable operation is given when the following conditions are met:

Table 14: Climatic and operational conditions MBa93xxLA-MINI

Parameter	Range	Remark
Ambient temperature	-25…85 °C	Measured ambient temperature of the printed circuit board
Extended ambient temperature	-40…85 °C	
Storage temperature	-40…100 °C	
Relative humidity (operation / storing)	10…90 %	Not condensing

Attention: TQMa93xxLA heat dissipation	
	The i.MX 93 belongs to a performance category in which a cooling system is essential. It is the user's sole responsibility to define a suitable heat sink (weight and mounting position) depending on the specific mode of operation (e.g., dependence on clock frequency, stack height, airflow, and software). Particularly the tolerance chain (PCB thickness, board warpage, BGA balls, BGA package, thermal pad, heatsink) as well as the maximum pressure on the TQMa93xxLA must be taken into consideration when connecting the heat sink. The TQMa93xxLA is not the highest component. Inadequate cooling connections can lead to overheating of the TQMa93xxLA or the MBa93xxLA-MINI and thus malfunction, deterioration or destruction.

7.1 Protection against external effects

Protection class IP00 was defined for the MBa93xxLA-MINI. There is no protection against foreign objects, touch or humidity.

7.2 Reliability and service life

No detailed MTBF calculation has been done for the MBa93xxLA-MINI.
The MBa93xxLA-MINI is designed to be insensitive to vibration and impact.

8. ENVIRONMENT PROTECTION

8.1 RoHS

The MBa93xxLA-MINI is manufactured RoHS compliant. All components, assemblies and soldering processes are RoHS compliant.

8.2 WEEE®

The final distributor is responsible for compliance with the WEEE® regulation.
Within the scope of the technical possibilities, the MBa93xxLA-MINI was designed to be recyclable and easy to repair.

8.3 REACH®

The EU-chemical regulation 1907/2006 (REACH® regulation) stands for registration, evaluation, certification and restriction of substances SVHC (Substances of very high concern, e.g., carcinogen, mutagen and/or persistent, bio accumulative and toxic).
Within the scope of this juridical liability, TQ-Systems GmbH meets the information duty within the supply chain with regard to the SVHC substances, insofar as suppliers inform TQ-Systems GmbH accordingly.

8.4 EuP

The Ecodesign Directive, also Energy using Products (EuP), is applicable to products for the end user with an annual quantity >200,000. The MBa93xxLA-MINI must therefore always be seen in conjunction with the complete device. The available standby and sleep modes of the components on the MBa93xxLA-MINI enable compliance with EuP requirements for the MBa93xxLA-MINI.

8.5 Statement on California Proposition 65

California Proposition 65, formerly known as the Safe Drinking Water and Toxic Enforcement Act of 1986, was enacted as a ballot initiative in November 1986. The proposition helps protect the state's drinking water sources from contamination by approximately 1,000 chemicals known to cause cancer, birth defects, or other reproductive harm ("Proposition 65 Substances") and requires businesses to inform Californians about exposure to Proposition 65 Substances.
The TQ device or product is not designed or manufactured or distributed as consumer product or for any contact with end-consumers. Consumer products are defined as products intended for a consumer's personal use, consumption, or enjoyment. Therefore, our products or devices are not subject to this regulation and no warning label is required on the assembly.
Individual components of the assembly may contain substances that may require a warning under California Proposition 65. However, it should be noted that the Intended Use of our products will not result in the release of these substances or direct human contact with these substances. Therefore you must take care through your product design that consumers cannot touch the product at all and specify that issue in your own product related documentation.
TQ reserves the right to update and modify this notice as it deems necessary or appropriate.

8.6 Packaging

The MBa93xxLA-MINI is delivered in reusable packaging.

8.7 Batteries

8.7.1 General notes

Due to technical reasons a battery is necessary for the MBa93xxLA-MINI. Batteries containing mercury (Hg), cadmium (Cd) or lead (Pb) are not used.
If this is for technical reasons unavoidable, the device is marked with the corresponding hazard note.
To allow a separate disposal, batteries are generally only mounted in sockets.

8.7.2 Lithium batteries

The requirements concerning special provision 188 of the ADR (chapter 3.3) are complied with for Lithium batteries.
There is therefore no classification as dangerous goods:

- Basic lithium content per cell not more than 1 grams (except for lithium ion and lithium polymer cells for which a lithium content of not more than 1.5 g per cell applies (equals 5 Ah)).
- Basic lithium content per battery not more than 2grams (except for lithium ion batteries for which a lithium content of not more than 8 grams per cell applies (equals 26 Ah)).
- Lithium cells and batteries are examined according to UN document ST/SG/AC.10-1.

During transport a short circuit or discharging of the socketed lithium battery is prevented by extricable insulating foils or by other suitable insulating measures

8.8 Other entries

By environmentally friendly processes, production equipment and products, we contribute to the protection of our environment. To be able to reuse the MBa93xxLA-MINI, it is produced in such a way (a modular construction) that it can be easily repaired and disassembled. The energy consumption of the MBa93xxLA-MINI is minimised by suitable measures.
Because currently there is still no technical equivalent alternative for printed circuit boards with bromine-containing flame protection (FR-4 material), such printed circuit boards are still used. No use of PCB containing capacitors and transformers (polychlorinated biphenyls).
These points are an essential part of the following laws:

- The law to encourage the circular flow economy and assurance of the environmentally acceptable removal of waste as at 27.9.94
  (Source of information: BGBl I 1994, 2705)
- Regulation with respect to the utilization and proof removal as at 1.9.96
  (Source of information: BGBl I 1996, 1382, (1997, 2860))
- Regulation with respect to the avoidance and utilization of packaging waste as at 21.8.98
  (Source of information: BGBl I 1998, 2379)
- Regulation with respect to the European Waste Directory as at 1.12.01
  (Source of information: BGBl I 2001, 3379)

This information is to be seen as notes. Tests or certifications were not carried out in this respect.

9. APPENDIX

9.1 Acronyms and definitions

The following acronyms and abbreviations are used in this document:

Table 15: Acronyms

Acronym	Meaning
ADC	Analog/Digital Converter
AI	Artificial Intelligence
ARM®	Advanced RISC Machine
BGA	Ball Grid Array
BIOS	Basic Input/Output System
CAN	Controller Area Network
CAN FD	Controller Area Network Flexible Data-Rate
CCM	Clock Control Module
CPU	Central Processing Unit
CSI	Camera Serial Interface
DIP	Dual In-line Package
DNC	Do Not Connect
DP	DisplayPort
DSI	Display Serial Interface
eCSPI	enhanced Capability Serial Peripheral Interface
eDP	embedded DisplayPort
EEPROM	Electrically Erasable Programmable Read-Only Memory
EMC	Electromagnetic Compatibility
eMMC	embedded Multimedia Card (Flash)
ESD	Electrostatic Discharge
EU	European Union
EuP	Energy using Products
FPS	Frames Per Second
FR-4	Flame Retardant 4
GP	General Purpose
GPIO	General Purpose Input/Output
GPT	General Purpose Timer
HD	High Density (graphics)
HDMI	High-Definition Multimedia Interface
HSS	High-Side Switch
I	Input
I/O	Input/Output
I^2C	Inter-Integrated Circuit
IEEE®	Institute of Electrical and Electronics Engineers
IP00	Ingress Protection 00
JTAG®	Joint Test Action Group
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LGA	Land Grid Array
LPDDR4	Low-Power DDR4
LVDS	Low Voltage Differential Signal

9.1 Acronyms and definitions (continued)

Table 15: Acronyms (continued)

Acronym	Meaning
MAC	Media Access Controller
MIC	Microphone
MIPI	Mobile Industry Processor Interface
ML	Machine Learning
MTBF	Mean operating Time Between Failures
NAND	Not-And (flash memory)
NC	Not Connected
NMI	Non-Maskable Interrupt
NOR	Not-Or
NP	Not Placed
O	Output
OTG	On-The-Go
P	Power
PCB	Printed Circuit Board
PCIe	Peripheral Component Interconnect express
PCMCIA	People Can't Memorize Computer Industry Acronyms
PD	Pull-Down
PHY	Physical (layer of the OSI model)
PMIC	Power Management Integrated Circuit
PU	Pull-Up
PWM	Pulse-Width Modulation
QSPI	Quad Serial Peripheral Interface
REACH®	Registration, Evaluation, Authorisation (and restriction of) Chemicals
RGMII	Reduced Gigabit Media-Independent Interface
RJ45	Registered Jack 45
RoHS	Restriction of (the use of certain) Hazardous Substances
RPM	Revolutions Per Minute
RTC	Real-Time Clock
SAI	Serial Audio Interface
SD	Secure Digital
SDHC	Secure Digital High Capacity
SDRAM	Synchronous Dynamic Random Access Memory
SIM	Subscriber Identification Module
SPDIF	Sony-Philips Digital Interface Format
SVHC	Substances of Very High Concern
TSE	Trust Secure Element
UART	Universal Asynchronous Receiver/Transmitter
UHS	Ultra-High Speed
UM	User's Manual
UN	United Nations
USB	Universal Serial Bus
uSDHC	Ultra-Secured Digital Host Controller
WEEE®	Waste Electrical and Electronic Equipment
ZIF	Zero Insertion Force

9.2 References

Table 16: Further applicable documents

No.	Name	Rev. / Date	Company
(1)	i.MX 93 Industrial Application Processors Data Sheet	Rev. 6 / 06/2025	NXP
(2)	i.MX 93 Hardware Design Guide	Rev. 2.3 / 05/2025	NXP
(3)	Mask Set Errata i.MX 93	– current –	NXP
(4)	TQMa93xxLA User's Manual	– current –	TQ-Systems
(5)	TQMa93xxLA Support Wiki	– current –	TQ-Systems

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