MBa6ULxL
User's Manual

MBa6ULxL UM 0103
08.12.2022

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TABLE DIRECTORY

FIGURE DIRECTORY

REVISION HISTORY

Rev.	Date	Name	Pos.	Modification
0100	06.06.2018	Petz		Initial release
0101	26.10.2018	Petz	Table 28 9	“Package temperature” replaced with “Case temperature” Chapter reworked
0102	10.01.2022	Petz Kreuzer	All Figure 10, Figure 19, Figure 20 Table 28 Chapter 3.4 Table 27	Non-functional changes, formatting, structure Link to Yocto documentation added, links updated “PCIe” corrected to “Mini PCIe” Updated Added Power connector corrected to X21 X21 pin assignment added
0103	08.12.2022	Kreuzer	Table 4 Figure 4	Switch configuration corrected updated

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1.5 Tips on safety

Improper or incorrect handling of the MBa6ULxL can substantially reduce its life span.

1.6 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 also 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 the MBa6ULxL.
`Command`	A font with fixed-width is used to denote commands, file names, or menu items.

1.7 Handling and ESD tips

General handling of the MBa6ULxL:

	The MBa6ULxL 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: do not touch the MBa6ULxL 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 MBa6ULxL and be dangerous to your health. Improper handling of your MBa6ULxL would render the guarantee invalid.

Proper ESD handling:

	The electronic components of the MBa6ULxL are sensitive to electrostatic discharge (ESD). Always wear antistatic clothing, use ESD-safe tools, packing materials etc., and operate the MBa6ULxL in an ESD-safe environment. Especially when you switch modules on, change jumper settings, or connect other devices.

1.8 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#

1.9 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 to fully comprehend the following contents:

- MBa6ULxL circuit diagram
- TQMa6ULxL User's Manual
- IMX6ULRM Reference Manual
- U-Boot documentation: www.denx.de/wiki/U-Boot/Documentation
- PTXdist documentation: www.ptxdist.de
- Yocto documentation: www.yoctoproject.org/docs/
- TQ-Support Wiki: Support-Wiki TQMa6ULx

2. BRIEF DESCRIPTION

This User's Manual describes the hardware of the MBa6ULxL, revision 02xx. The MBa6ULxL is designed as a carrier board for the LGA version of the TQMa6ULxL. The figures in this User's Manual also refer to the TQMa6ULxL.
In addition the standard interfaces routed to the user's connectors, more interfaces like CAN, UART, RS-232, GPIO, I^2C and SPI interfaces are routed to headers on the MBa6ULxL. The characteristics of the i.MX6ULx can be evaluated, and therefore the software development can start immediately.
Currently the MBa6ULxL supports TQMa6ULxL modules with NXP i.MX6UL CPU derivatives MCIMX6G2CVM05AA, MCIMX6G3CVM05AA and MCIMX6Y2CVM05AB.

2.1 System architecture and functionality

2.1.1 MBa6ULxL block diagram

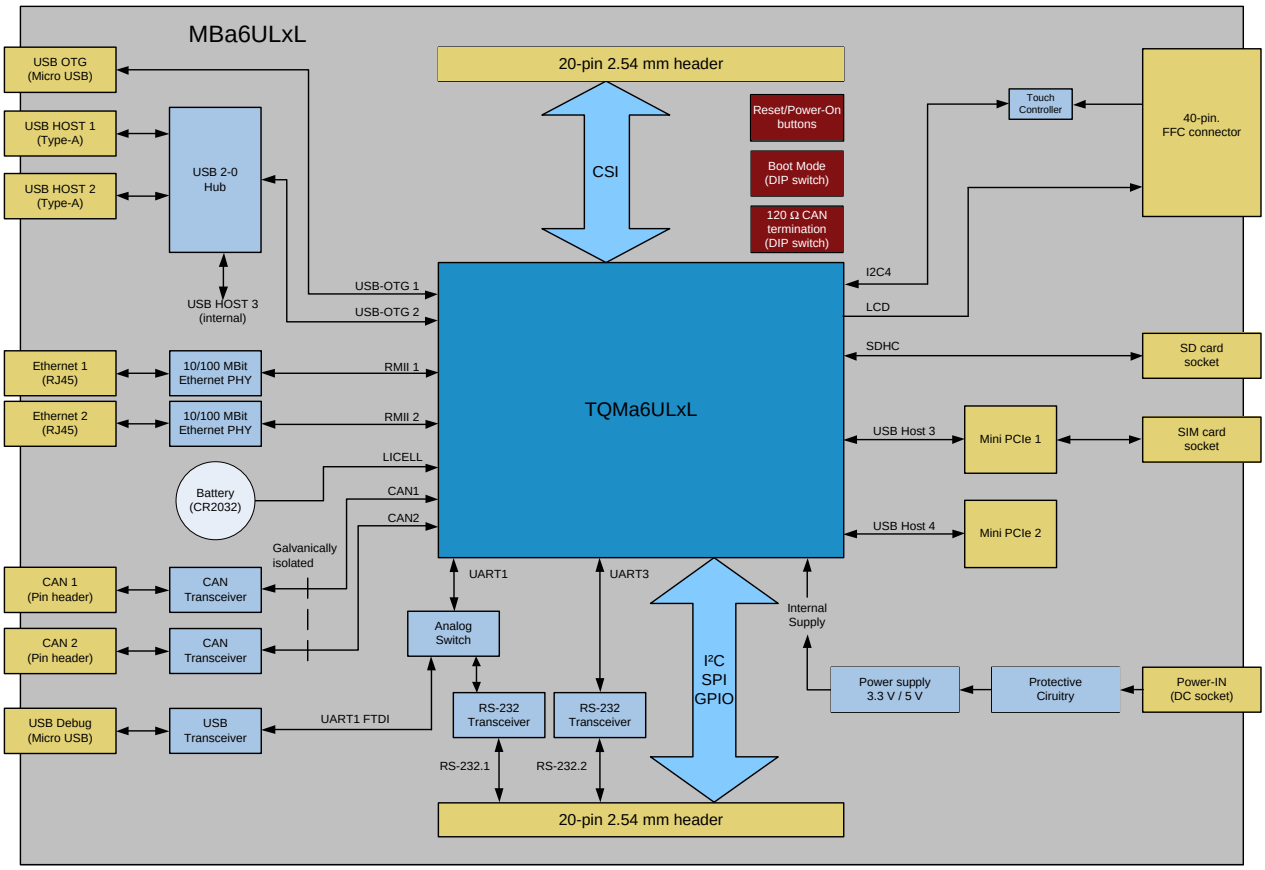


Figure 1: Block diagram MBa6ULxL

2.1.2 Functionality

Core of the MBa6ULxL is the TQMa6ULxL, which is based on an NXP i.MX6ULx CPU. In addition to the standard communication interfaces like USB, Ethernet, RS-232, etc. other signals and interfaces are routed to two 20-pin 2.54 mm headers.

The MBa6ULxL provides the following interfaces and functions:

Table 2: Overview interfaces

Connector	Interface	Type of connector	Remark
X1, X2	CAN 2.0B	Phoenix contact, MC1.5/3-G-3.5	CAN transceiver, galvanically separated
X10	USB / RS-232	Single USB receptacle Micro-AB	RS-232 debug interface (via FTDI as USB)
X12	SIM card	SIM card socket	–
X13	SD card	Micro SD card connector	–
X14	Ethernet	RJ45 receptacle	10/100BASE-T, double RJ45 with integrated magnetics
X15	USB-OTG	Single USB receptacle Micro-AB	USB OTG
X16	USB Host	Stacked USB receptacle Type-A	USB Host 1 / 2
X19	Graphics	40-pin FFC, 0.5 mm	Meets EDT platform concept, for displays with PCT or RT
X21	Power	Phoenix contact, MC1,5/2-G-3,5	Power supply 6.5 V to 30 V
X22	GPIOs	20-pin header, 2.54 mm pitch	I2C4, SPI2, RS-232.1, RS-232.2, PWM, Ext-Wakeup, 2 x ADC, 3.3 V, 5.0 V
X23	GPIOs	20-pin header, 2.54 mm pitch	GPIOS, I2C2, UART6, 3.3 V, 5.0 V
X24	Mini PCIe	Mini PCIe connector	LoRa (assembly option)
X25	Mini PCIe	Mini PCIe connector	Mini PCIe (only USB), with SIM card socket (assembly option)
G2	Battery	SMTU2032	Battery / GoldCap for RTC

3. ELECTRONICS

3.1 MBa6ULxL functional groups

3.1.1 TQMa6ULxL

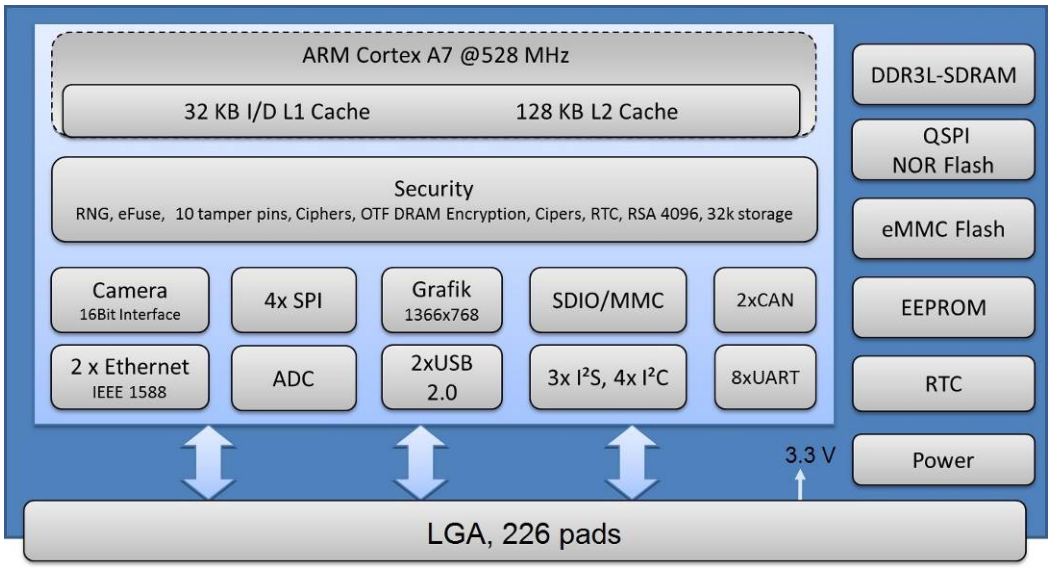


Figure 2: Block diagram TQMa6ULxL

The TQMa6ULxL with the i.MX6ULx CPU is the central system component. It provides DDR3L SDRAM, eMMC, NOR flash and EEPROM memory. All voltages required by the TQMa6ULxL are derived from the supply voltage. More information is to be taken from the accompanying User's Manual of the TQMa6ULxL (7).

The boot behaviour of the TQMa6ULxL can be customised. The required Boot-Mode configuration can be set with DIP switches on the MBa6ULxL, see chapter 3.1.2.

3.1.2 Boot-Mode configuration

The TQMa6ULxL can boot from different media:

- eMMC (on TQMa6ULxL)
- QSPI NOR flash
- SD card

The settings of DIP switches S13 and S16 determine, which device is selected to boot from.

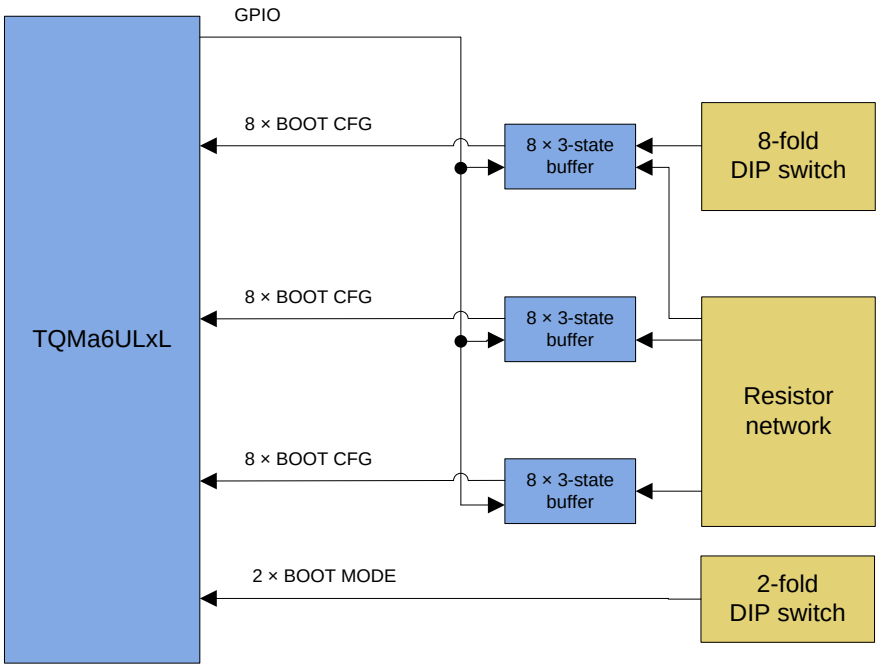


Figure 3: Block diagram Boot Mode

Attention:	Flickering display
	During the boot process, the LCD_DATA signals are not separated from the display. It may therefore be necessary to deactivate the display at system start-up. This can be implemented by appropriate software adaptation via the Data Enable Input.

3.1.2 Boot-Mode configuration (continued)

The following tables describe the DIP switch settings for each boot source.
Further settings such as transfer modes and CPU clock are to be taken from the TQMa6ULxL User's Manual (7).

Table 3: Boot-Mode configuration

Boot-Mode	S13-1	S13-2
Boot from eFuses	OFF	OFF
Serial Downloader	ON	OFF
Internal Boot	OFF	ON
Reserved	ON	ON

Table 4: Boot-Mode configuration DIP switches – S13, S16

DIP switch		eMMC	SD card	QSPI NOR	Serial-Downloader
S13	1	OFF	OFF	OFF	ON
	2	ON	ON	ON	OFF
S16	1	X	X	X	X
	2	OFF	ON	X	X
	3	ON	OFF	X	X
	4	OFF	ON	X	X
	5	OFF	ON	ON	X
	6	OFF	OFF	ON	X
	7	ON	OFF	ON	X
	8	ON	ON	OFF	X

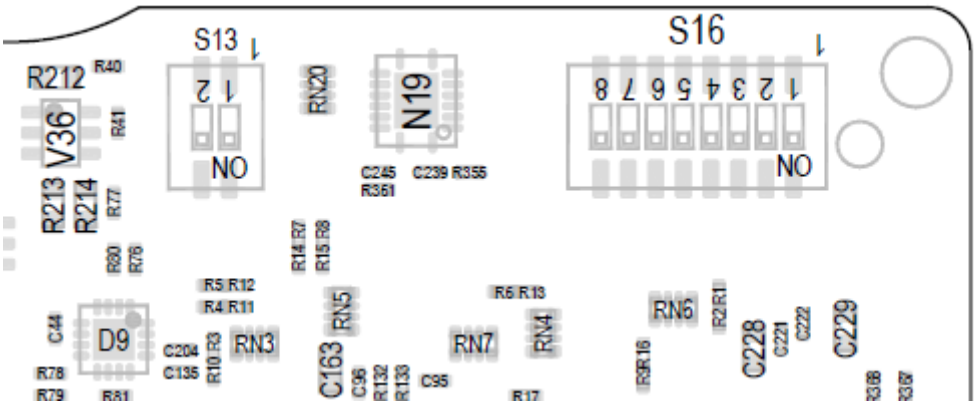


Figure 4: Position of Boot-Mode configuration DIP switches – S13, S16

3.1.3 I²C address mapping

A port replicator and the I²C touch screen controller can be addressed via I2C4 on the MBa6ULxL.
Table 5 shows the addresses used on the TQMa6ULxL and the MBa6ULxL. The I2C4 bus is also routed to header X22.
The following table shows the address assignment of TQMa6ULxL and MBa6ULxL.

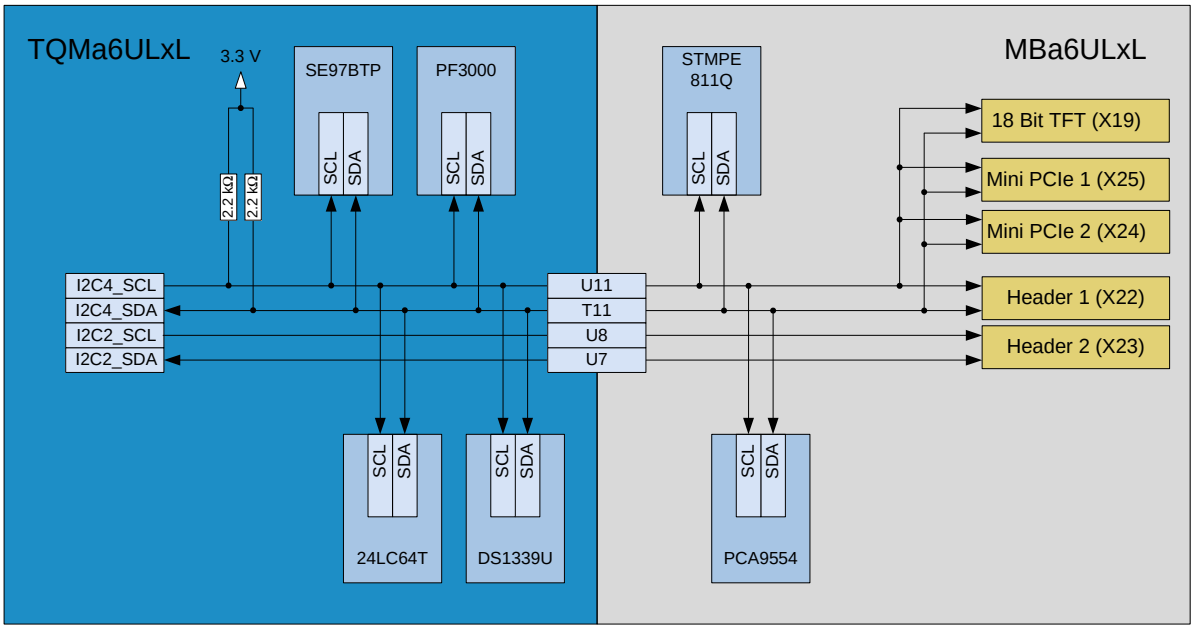


Figure 5: Block diagram I²C busses

Table 5: I2C4 address assignment

Component	Ref ID	7-bit address	Location
Port replicator (PCA9554BS)	D20	0x22 / 010 0010b	MBa6ULxL
I²C Touch Screen Controller (STMPE811Q)	D9	0x41 / 100 0001b	
PMIC (PF3000/3001)	–	0x08 / 000 1000b	TQMa6ULxL
Temperature sensor (SE97BTP)	–	0x1A / 001 1010b	
EEPROM (SE97BTP) Protected Mode (PWP)	–	0x32 / 011 0010b	
EEPROM (24LC64T-I_MC)	–	0x50 / 101 0000b	
EEPROM (SE97BTP) Normal Mode (RWP)	–	0x52 / 101 0010b	
RTC (DS1339U-33)	–	0x68 / 110 1000b	

3.1.4 Port replicator PCA9554BS signals

The port replicator PCA9554BS with I²C address 0x22 provides the following signals:

Table 6: Port replicator PCA9554BS signals

I/O port	Direction	Function	Remark
IO0	O	ENET1_RST#	–
IO1	O	ENET2_RST#	–
IO2	O	BOOT_CFG_EN#	–
IO3	O	PWR_EN_3V3_DISPLAY	Default
	I	ENET1_INT#	Alternative
IO4	O	PWR_EN_1V5	Default
	I	ENET2_INT#	Alternative
IO5	O	LCD.PWRCTRL	–
IO6	O	LCD.WAKE	–
IO7	O	PCIE_1.DIS#	Alternative: PCIE_2.DIS#

Attention:	I2C4 bus
	Attention when using I2C4. Since the PMIC can be addressed via I2C4, errors on the bus can lead to instabilities of the MBa6ULxL!

3.1.5 Temperature sensor / SPD EEPROM

Since there is already a temperature sensor SE97BTP on the TQMa6ULxL, no temperature sensor is provided on the MBa6ULxL.

3.1.6 RTC supply

The TQMa6ULxL provides a discrete RTC. Another RTC is provided by the i.MX6ULx on the TQMa6ULxL.
Both RTCs are supplied via the LICELL.
A lithium battery type CR2032 with very low self-discharge is provided on the MBa6ULxL as a backup supply for both RTCs.

The increased current consumption must be considered, if the i.MX6ULx RTC is used.
This leads to a fast battery discharge. More information can be found in the User's Manual of the TQMa6ULxL.
For the RTCs installed on the MBa6ULxL the following applies:

Table 7: RTC supply, components

Parameter	Value	Temperature range
Coin cell	2.1 V to 3.7 V, typical 3.0 V, 220 mAh	–20 °C to +60 °C
Current consumption RTC	See TQMa6ULxL User's Manual	Depends on RTC used

3.1.7 Reset and Power

The MBa6ULxL provides a power and a reset button. Signal RESET_OUT# resets all components on the MBa6ULxL. The following table shows the signals.

Table 8: TQMa6ULxL Reset and power-on signals

Push button	Signal	TQMa6ULxL pad	Direction	Remark
S1	RESET_IN#	T14	I	10 kΩ PU to 3.3 V on MBa6ULxL
S2	PMIC_PWRON	U16	I	10 kΩ PU to 3.3 V on MBa6ULxL
–	RESET_OUT#	U15	O	Resets all components on MBa6ULxL

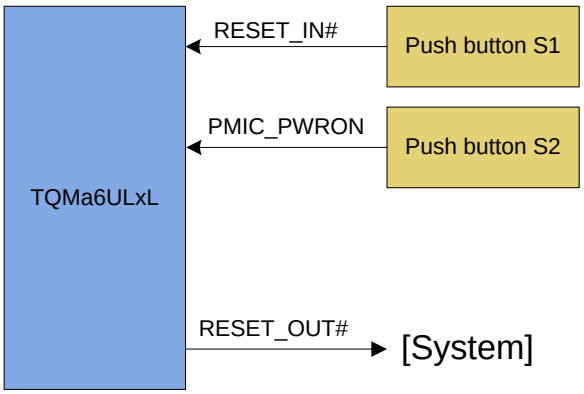


Figure 6: Reset and Power button – S1, S2

3.1.8 Status LED

The MBa6ULxL provides a status LED. The LED shines green during normal operation and orange during reset.

3.2 Communication interfaces

3.2.1 USB 2.0 Hi-Speed Host

The MBa6ULxL provides two USB 2.0 Host (double stack USB Type-A) and USB 2.0 Host interfaces at both Mini PCIe connectors.

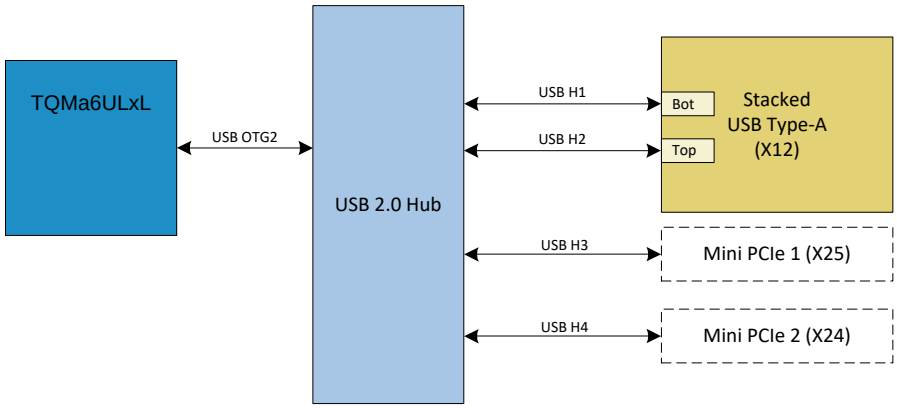


Figure 7: Block diagram USB Host interfaces

The following tables show the pinout of the connectors used.

Table 9: Pinout USB Host 1 & 2, stacked USB Type-A – X12

Pin	Pin name	Signal	Direction	Remark
1A	VBUS	USB_H1_VBUS	P	100 µF to DGND + EMI Filter
2A	D–	USB_H1_D_N	I/O	Common Mode Choke in series
3A	D+	USB_H1_D_P	I/O	Common Mode Choke in series
4A	DGND	DGND	P	–
1B	VBUS	USB_H2_VBUS	P	100 µF to DGND + EMI Filter
2B	D–	USB_H2_D_N	I/O	Common Mode Choke in series
3B	D+	USB_H2_D_P	I/O	Common Mode Choke in series
4B	DGND	DGND	P	–
M1 – M4	DGND	DGND	P	–

Table 10: Pinout USB Host 3, Mini PCIe 1 – X25

Pin	Pin name	Signal	Direction	Remark
36	D–	USB_H3_D_N	I/O	Common Mode Choke in series
38	D+	USB_H3_D_P	I/O	Common Mode Choke in series

Table 11: Pinout USB Host 4, Mini PCIe 2 – X24

Pin	Pin name	Signal	Direction	Remark
36	D–	USB_H4_D_N	I/O	Common Mode Choke in series
38	D+	USB_H4_D_P	I/O	Common Mode Choke in series

The USB host port of the TQMa6ULxL provides a theoretical data rate of 480 Mbit/s. The data rate is shared amongst the connected ports. The data rates of the ports can significantly deviate depending on the hardware and software used.

Table 12: Characteristics USB

Parameter	Min.	Typ.	Max.	Unit	Remark
Voltage	4.75	5	5.25	V	–
Current	–	500	900	mA	–
Read	–	15.7	–	Mbyte/s	USB stick at port 1: 100 Mbyte file, 10 Mbyte block size
Write	–	7.4	–	Mbyte/s	USB stick at port 1: 100 Mbyte file, 10 Mbyte block size

3.2.2 USB 2.0 Hi-Speed OTG

Both USB-OTG interfaces of the TQMa6ULxL are provided on the MBa6ULxL.
USB-OTG1 is provided at a 5-pin Micro-AB receptacle. USB-OTG2 is connected to the USB hub controller, see 3.2.1.
Both OTG interfaces operate in host mode only.
An OTG or device function is not implemented in software except for the serial downloader.

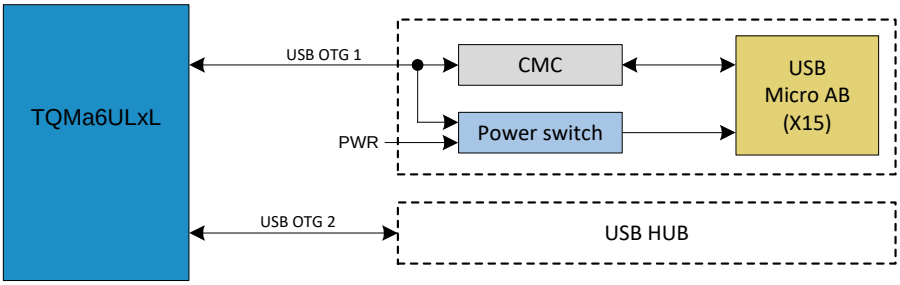


Figure 8: Block diagram USB 2.0 Hi-Speed OTG

The following table shows the pinout of the connector used.

Table 13: Pinout USB-Host OTG – X15

Pin	Pin name	Signal	Direction	Remark
1	VBUS	USB_OTG2_VBUS	P	100 µF to DGND; EMI filter, I_{max} = 100 mA
2	D–	USB_OTG2_D_N	I/O	Common mode choke in series
3	D+	USB_OTG2_D_P	I/O	Common mode choke in series
4	ID	USB_OTG2.ID	I	–
5	DGND	DGND	P	–
M1 – M6	DGND	DGND	P	–

The interface can serve as Client or Host. To use this feature, appropriate software support is necessary, however.
The OTG ports of the TQMa6ULxL provide a theoretical data rate of 480 Mbit/s. The data rate can significantly deviate depending on the hardware and software used.

Table 14: Characteristics USB 2.0 Hi-Speed OTG

Parameter	Min.	Typ.	Max.	Unit	Remark
Voltage	4.75	5	5.25	V	–
Current	–	500	900	mA	–
Read	–	20.4	–	Mbyte/s	USB 2.0 stick: 100 Mbyte file, 10 Mbyte block size
Write	–	8.0	–	Mbyte/s	USB 2.0 stick: 100 Mbyte file, 10 Mbyte block size

3.2.3 Ethernet

Both i.MX6ULx MACs are provided on the MBa6ULxL via two SMSC PHYs LAN8720Ai. The PHYs are connected via RMII. The implementation is shown in the following block diagram.

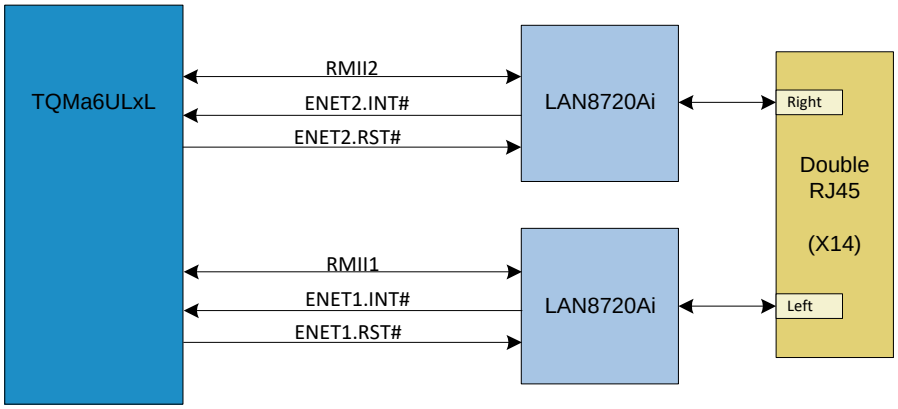


Figure 9: Block diagram Ethernet 100 BASE-T

Both RJ45 jacks contain integrated magnetics and two status LEDs.
The following tables show the pinout of the RJ45 receptacles.

Table 15: Pinout Ethernet 1 – X14, left

Pin	Pin name	Signal	Direction
1	TX+	ETH1_MDI_TX_P	I/O
2	TX–	ETH1_MDI_TX_N	I/O
3	RX+	ETH1_MDI_RX_P	I/O
4	–	NC	–
5	–	NC	–
6	RX–	ETH1_MDI_RX_N	I/O
7	–	NC	–
8	–	NC	–

Table 16: Pinout Ethernet 2 – X14, right

Pin	Pin name	Signal	Direction
1	TX+	ETH2_MDI_TX_P	I/O
2	TX–	ETH2_MDI_TX_N	I/O
3	RX+	ETH2_MDI_RX_P	I/O
4	–	NC	–
5	–	NC	–
6	RX–	ETH2_MDI_RX_N	I/O
7	–	NC	–
8	–	NC	–

The possible data throughput is influenced by the system load and the software platform used.

3.2.4 CAN

The MBa6ULxL provides two CAN interfaces. CAN1 is routed to X1, CAN2 is optionally available at X2.
Both interfaces are galvanically separated. The CAN interfaces are not separated galvanically among themselves.
The CAN signals can be terminated with 120 Ω using DIP switches S15 and S14.

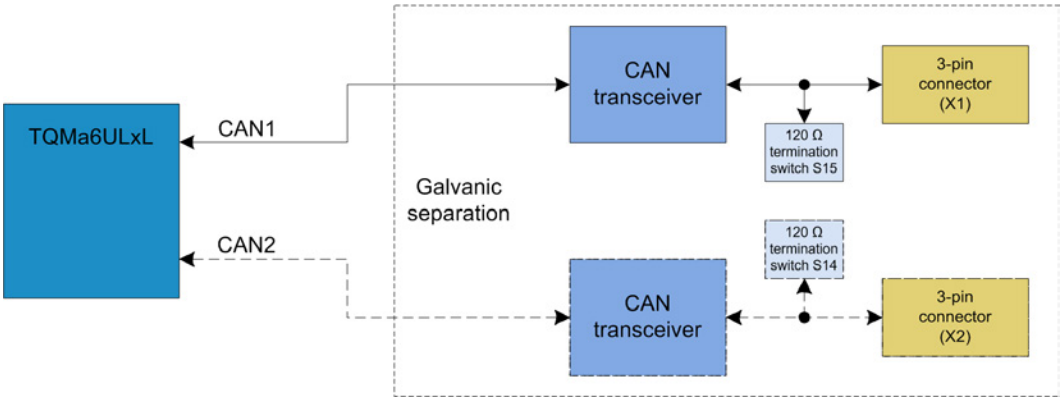


Figure 10: Block diagram CAN

Table 17: Pinout CAN1, CAN2 – X1, X2

Connector	Pin	Pin name	Signal	Direction	Termination	Remark
X1	1	CAN_H	CAN2_P	I/O	S15-2	Assembled
	2	CAN_L	CAN2_N	I/O	S15-1	
	3	DGND	DGND_CAN	P	–	
X2	1	CAN_H	CAN1_P	I/O	S14-2	Assembly option
	2	CAN_L	CAN1_N	I/O	S14-1	
	3	DGND	DGND_CAN	P	–	

3.2.5 Display interface

The i.MX6ULx provides an Enhanced LCD interface (eLCDIF), which is routed to X19 on the MBa6ULxL. The eLCDIF consists of 24 data and 5 control signals and supports different video formats like RGB, VSYNC, ITU-R BT.656, or 4:2:2 YCbCr.
The following block diagram shows the display interface:

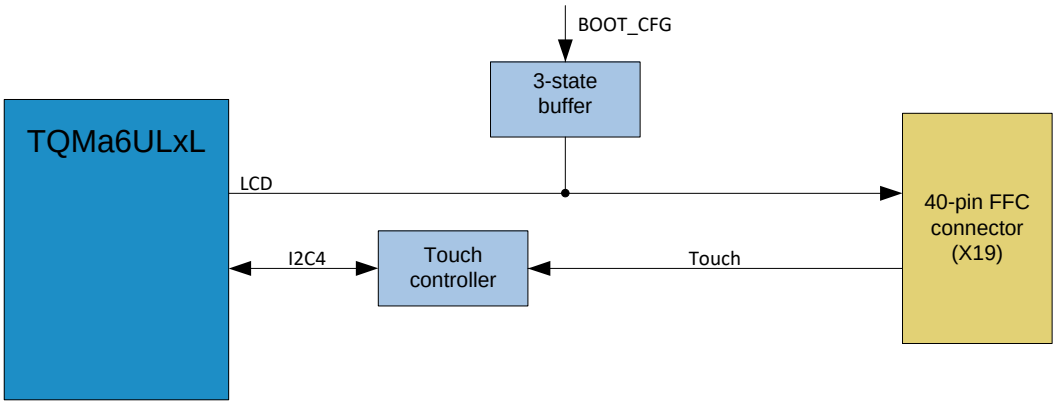


Figure 11: Block diagram display interface, X19

3.1.2 Boot-Mode configuration (continued)

The following table shows the pinout of connector X19.

Table 18: Pinout LCD interface, X19

Pin	Signal	TQMa6ULxL	LCD channel	RGB	Remark
1	TOUCH_X–	–	–		–
2	TOUCH_Y–	–	–		Optional I2C4 SDA
3	TOUCH_X+	–	–		–
4	TOUCH_Y+	–	–		Optional I2C4 CLK
5	LED_CTRL	–	–		–
6	TOUCH_INT#	–	–		–
7	VCC3V3	–	–		Backlight VCC
8	VCC3V3	–	–		Backlight VCC
9	GND	–	–		–
10	GND	–	–		–
11	VCC3V3	–	–		Digital VDD
12	LCD_PWR_CTRL	–	–		3.3 V
13	LCD_ENABLE	U2	–		3.3 V
14	LCD_VSYNC	U4	–		3.3 V
15	LCD_HSYNC	U3	–		3.3 V
16	LCD_WAKE	–	–		3.3 V
17	LCD_CLK	T1	–		3.3 V
18	GND	–	–		–
19	LCD_DATA18	K3	R2 (LSB)		–
20	LCD_DATA19	K4	R3		–
21	LCD_DATA20	J1	R4		–
22	LCD_DATA21	J2	R5		–
23	LCD_DATA22	J3	R6		–
24	LCD_DATA23	J4	R7 (MSB)		–
25	GND	–	–		–
26	LCD_DATA10	M1	G2 (LSB)		–
27	LCD_DATA11	M3	G3		–
28	LCD_DATA12	M4	G4		–
29	LCD_DATA13	L1	G5		–
30	LCD_DATA14	L2	G6		–
31	LCD_DATA15	L3	G7 (MSB)		–
32	GND	–	–		–
33	LCD_DATA2	R3	B2 (LSB)		–
34	LCD_DATA3	P1	B3		–
35	LCD_DATA4	P3	B4		–
36	LCD_DATA5	P4	B5		–
37	LCD_DATA6	N1	B6		–
38	LCD_DATA7	N2	B7 (MSB)		–
39	LCD_RESET#	T4	–		3.3 V
40	LCD.RESET#	–	–		Not connected, optional

FFC connector type Hirose FH12A-40S-0.5SH (55) is assembled on the MBa6ULxL.

3.2.6 Touch controller

The i.MX6ULx Touch Screen Controller (TSC) signals are used for USB OTG. Therefore a separate TSC STMPE811 is assembled on the MBa6ULxL. The STMPE811 is connected to I2C4 using address `0x41`.

3.2.7 Backlight control

Attention, TBD: The display brightness can be controlled at pin X19-5 with PWM signal PWM4 (TQMa6ULxL, pad H15).

3.2.8 Micro SD card connector

The Micro SD card connector is connected to the USDHC1 controller on the TQMa6ULxL with a 4-bit wide data interface.
3.3 V are provided at the Micro SD card connector. All data lines provide ESD protection.
All signals except CLK are pulled-up to 3.3 V with 10 kΩ. Write Protection (WP) is not available.
Booting from Micro SD card is possible (see chapter 3.1.2).

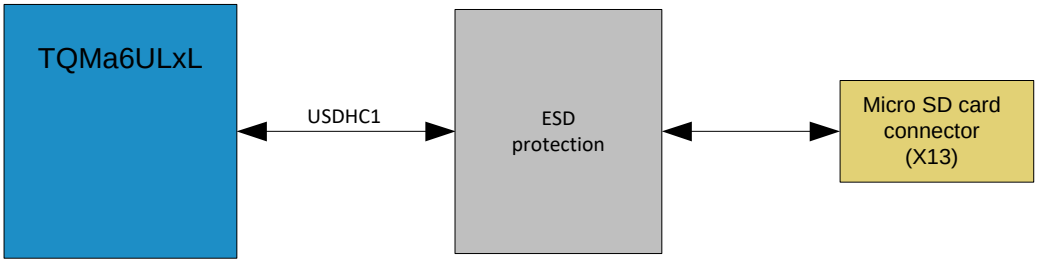


Figure 12: Block diagram Micro SD card socket – X13

The read and write speeds of the Micro SD card interface depend on the Micro SD card used.

The following table shows the pinout of Micro SD card connector X13:

Table 19: Pinout Micro SD card socket – X13

Pin	Signal	Remark
1	USDHC1.DAT2	10 kΩ Pull-Up to VCC3V3 + ESD protection
2	USDHC1.DAT3	10 kΩ Pull-Up to VCC3V3 + ESD protection
3	USDHC1.CMD	10 kΩ Pull-Up to VCC3V3 + ESD protection
4	VDD	3.3 V
5	USDHC1.CLK	ESD protection
6	DGND	Ground
7	USDHC1.DAT0	10 kΩ Pull-Up to VCC3V3 + ESD protection
8	USDHC1.DAT1	10 kΩ Pull-Up to VCC3V3 + ESD protection
SW1	USDHC1.CD#	10 kΩ Pull-Up to VCC3V3 + ESD protection
M1, M2, M3, M4	DGND	SHIELD

3.2.9 Mini PCIe and SIM card socket

Two Mini PCIe connectors for full-size Mini PCIe cards (50.95 × 30 mm) are provided on the MBa6ULxL.
Every standard Mini PCIe card can be used [1]. USB_H3, USB_H4, and I2C4 are routed to the connectors, see Table 21.
A SIM card socket to connect an UMTS / GSM modem is available.

The following block diagram shows the interfaces to Mini PCIe 1 and Mini PCIe 2.

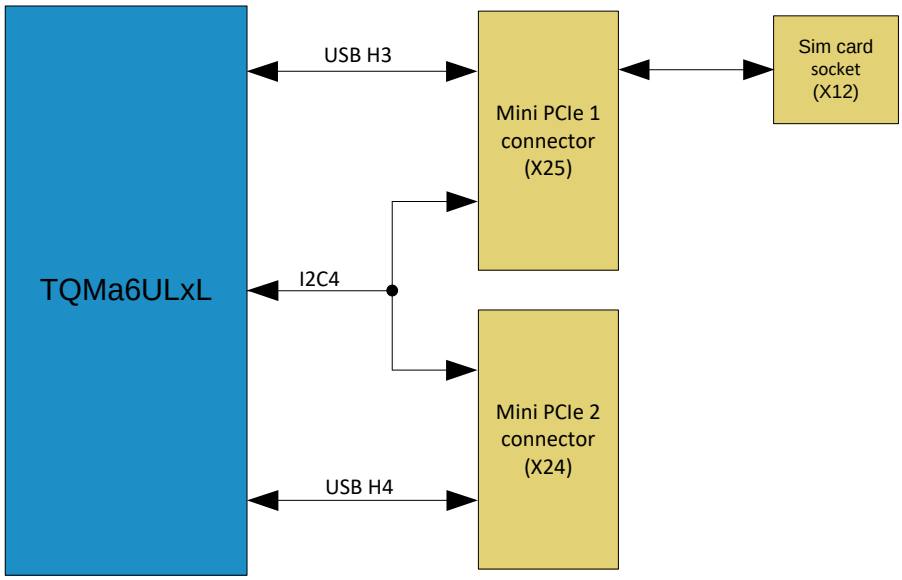


Figure 13: Block diagram Mini PCIe

The maximum load on the voltages provided for the Mini PCIe card is given in the following table.

Table 20: Current load Mini PCIe

Parameter	I_{max} Mini PCIe 1	I_{max} Mini PCIe 2	Remark
Current @ 1.5 V	0.375 A	0.375 A	–
Current @ 3.3 V	1.1 A	1.1 A	Default
Current @ 5 V	0.8 A	2.0 A	Assembly option

Note:	5 V SIM card
	SIM cards, which require a 5 V supply, are only supported by assembly option.

Note:	Space between PCB and Mini PCIe card
	The space between PCB and Mini PCIe card has to be taken into account!

1: If suitable Mini PCIe card driver software is provided.

3.2.9 Mini PCIe and SIM card socket3.1.2 (continued)

The following table shows the pinout of Mini PCIe connectors and SIM card socket.

Table 21: Pinout Mini PCIe – X24, X25; SIM card socket – X12

Mini PCIe pin	Mini PCIe 2, X24	Mini PCIe 1, X25	SIM card, X12	Remark
1	NC	NC	–	–
2	VCC_MPCIE2	VCC_MPCIE1	–	Default 3.3 V, optional 5 V, see Table 20
3	NC	NC	–	–
4	DGND	DGND	–	–
5	NC	NC	–	–
6	VCC1V5	VCC1V5	–	See Table 20
7	NC	NC	–	–
8	NC	SIM_PWR	SIM_PWR	X12-C1, see Table 22
9	DGND	DGND	–	–
10	NC	SIM_DATA	SIM_DATA	X12-C7, see Table 22
11	NC	NC	–	–
12	NC	SIM_CLK	SIM_CLK	X12-C3, see Table 22
13	NC	NC	–	–
14	NC	SIM_RST	SIM_RST	X12-C2, see Table 22
15	DGND	DGND	–	–
16	NC	SIM_VPP	SIM_VPP	X12-C6, see Table 22
17	NC	NC	–	–
18	DGND	DGND	–	–
19	NC	NC	–	–
20	PCIE_2.DIS#	PCIE_1.DIS#	–	–
21	DGND	DGND	–	–
22	PCIE_RST#	PCIE_RST#	–	–
23	NC, optional 5 V	NC	–	–
24	VCC_MPCIE2	VCC_MPCIE1	–	Default 3.3 V, optional 5 V, see Table 20
25	NC, optional 5 V	NC	–	–
26	DGND	DGND	–	–
27	DGND	DGND	–	–
28	VCC1V5	VCC1V5	–	See Table 20
29	DGND	DGND	–	–
30	I242.SCL	I242.SCL	–	–
31	NC	NC	–	–
32	I2C4.SDA	I2C4.SDA	–	For I2C4 address mapping see Table 5
33	NC	NC	–	–
34	DGND	DGND	–	–
35	DGND	DGND	–	–
36	USB_H4_D_N	USB_H3_D_N	–	Common mode choke in series
37	DGND	DGND	–	–
38	USB_H4_D_P	USB_H3_D_P	–	Common mode choke in series
39	VCC_MPCIE2	VCC_MPCIE1	–	Default 3.3 V, optional 5 V, see Table 20
40	DGND	DGND	–	–
41	VCC_MPCIE2	VCC_MPCIE1	–	Default 3.3 V, optional 5 V, see Table 20
42	NC	NC	–	–
43	DGND	DGND	–	–
44	NC	NC	–	–
45	NC	NC	–	–
46	NC	NC	–	–
47	NC	NC	–	–
48	VCC1V5	VCC1V5	–	See Table 20
49	NC	NC	–	–
50	DGND	DGND	–	–
51	NC	NC	–	–
52	VCC_MPCIE2	VCC_MPCIE1	–	Default 3.3 V, optional 5 V, see Table 20

3.2.10 SIM card socket

The following table shows the pinout of the SIM card socket.

Table 22: Pinout SIM card socket – X12

Pin	Signal	Remark
C1	SIM_PWR	–
C2	SIM_RST	–
C3	SIM_CLK	–
C4	NC	Reserved
C5	DGND	–
C6	SIM_VPP	–
C7	SIM_DATA	–
C8	NC	Reserved
DC	NC	D-Contact
DS	NC	D-Spring
GND	Ground	–

3.2.11 20-pin headers

The MBa6ULxL is equipped with two 20-pin headers with 2.54 mm pitch.

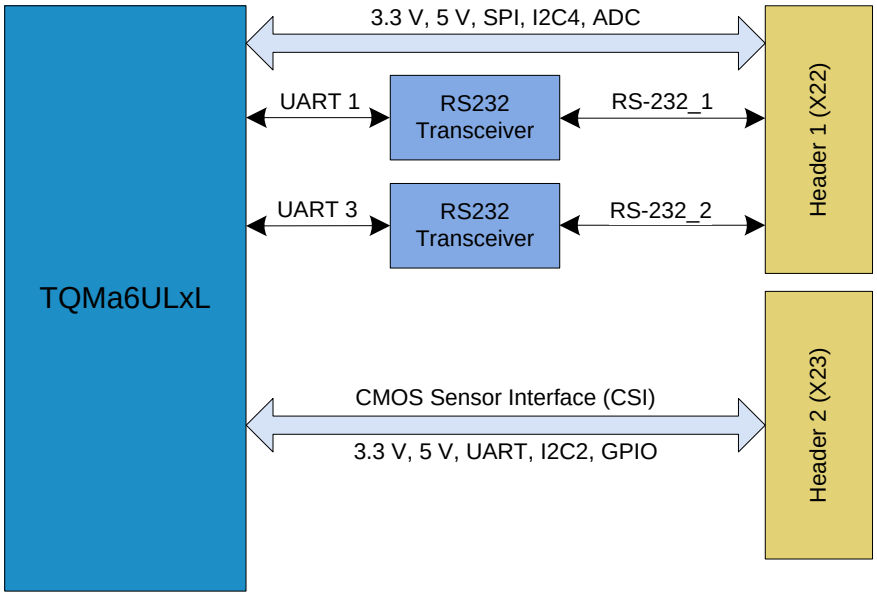


Figure 14: Block diagram of Starterkit headers – X22, X23

Table 23: Pinout header 1 – X22

Alternative	Default	Pin		Default	Alternative
5 V		1	2	3.3 V	
GND		3	4	GND	
UART4_TX	SPI2_SCLK	5	6	I2C4_SCL	–
UART4_RX	SPI2_SS0#	7	8	I2C4_SDA	–
UART5_RX	SPI2_MISO	9	10	TOUCH_INT#	ADC_1
UART5_TX	SPI2_MOSI	11	12	GPIO1_IO02	ADC_2
GND		13	14	GND	
–	RS-232_1_TX	15	16	RS-232_2_TX	–
–	RS-232_1_RX	17	18	RS-232_2_RX	–
LCD_DATA17	EXT_WAKEUP	19	20	PWM2	GPIO1_IO09

Table 24: Pinout header 2 – X23

Alternative	Default	Pin		Default	Alternative
5 V		1	2	3.3 V	
GND		3	4	GND	
CSI_DATA04	GPIO4_IO25	5	6	GPIO4_IO21	CSI_DATA00
CSI_DATA05	GPIO4_IO26	7	8	GPIO4_IO22	CSI_DATA01
CSI_DATA06	GPIO4_IO27	9	10	GPIO4_IO23	CSI_DATA02
CSI_DATA07	GPIO4_IO28	11	12	GPIO4_IO24	CSI_DATA03
GND		13	14	GND	
CSI_MCLK	UART6_TX	15	16	I2C2_SCL	CSI_HSYNC / UART6_CTS
CSI_PIXCLK	UART6_RX	17	18	I2C2_SDA	CSI_VSYNC / UART6_RTS
GND		19	20	GND	

3.3 Diagnostic- and user interfaces

3.3.1 Power-On and Reset-button

See chapter 3.1.7.

3.3.2 CAN termination

See chapter 3.2.4.

3.3.3 Debug interfaces RS-232 / USB

Debug interfaces are available as RS-232 and USB device interface on the MBa6ULxL.
In both cases, the UART1 interface of the TQMa6ULxL is used. No software configuration is required.
DIP switch S16-1 selects the debug interface, see Table 26.

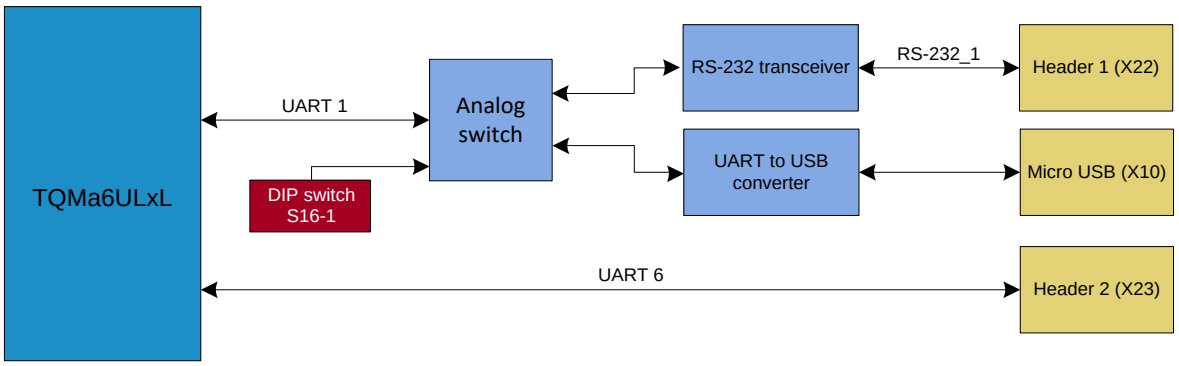


Figure 15: Block diagram debug interfaces RS-232 / USB

Table 23 shows the pinout of the RS-232 signals. The following table shows the pinout of debug Micro USB connector X10.

Table 25: Pinout debug USB – X10

Pin	Pin name	Signal	Direction	Remark
1	VBUS_SENSE	VBUS_SENSE	–	–
2	USB_D_N	USB_RS-232_D_N	I/O	–
3	USB_D_P	USB_RS-232_D_P	I/O	–
4	–	NC	–	Not used
5	DGND	DGND	P	–
M1 – M6	Shield	DGND	P	–

Table 26: Debug interface selection – S16-1

DIP switch	On	Off
S16-1	Debug interface RS-232 at X22	Debug interface USB device at X10

3.4 Power supply

The MBa6ULxL is supplied with 6.5 to 30 V via X21. All other voltages are generated on the MBa6ULxL.
Additionally, 3.3 V and 5 V are available at headers X22 and X23.
The Mini PCIe connectors X24 and X25 are supplied with 1.5 V and 3.3 V.
A 5 V supply instead of 3.3 V is possible as assembly option.

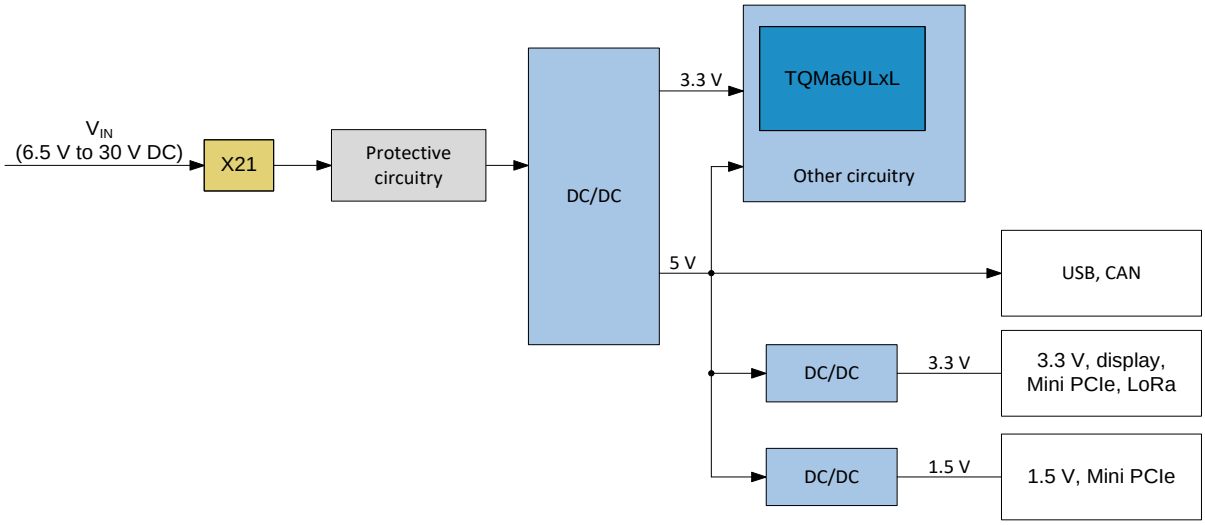
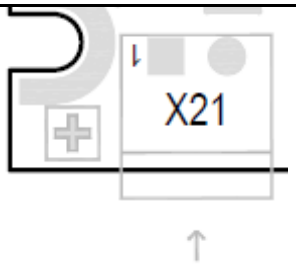


Figure 16: Block diagram power supply

Table 27: Pinout X21

X21 Pin assignment	
X21_1	V_PWR_IN
X21_2	DGND



3.4.1 Protective circuitry

The MBa6ULxL can be supplied with 6.5 V to 30 V DC. The protective circuit has the following characteristics:

- Slow blow fuse 5 A
- Excess voltage protection diode
- PI filter
- Inverse-polarity protection

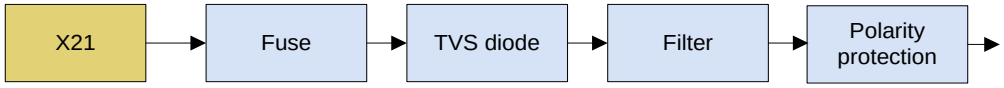


Figure 17: Block diagram input protection

3.4.2 Power consumption

The typical power consumption of the MBa6ULxL without display is approximately 3 ~ 4 watts.
If however a display is powered by the MBa6ULxL, the power consumption depends on the display connected.

3.4.3 Power supply connector

A 2-pin Phoenix connector type MC 1,5/2-G-3,5 is assembled on the MBa6ULxL.
Suitable mating connectors are e.g., Phoenix Contact

- Part Number 1840366 (Screw Terminals)
- Part Number 1952267 (Push-In Spring)

4. SOFTWARE

The following table provides an overview of the implemented software interfaces:

Table 28: Software interfaces

Device	Function	Supported	Linux
i.MX6UL	Display	Resolutions: from 800 × 480 Colour depth: 24 bit, 24 bit RGB interface HDMI (standard monitor) Resolutions: TBD	Yes
i.MX6UL	Backlight	TBD	Yes
i.MX6UL	I²C Port - ADC Touch	Preset default calibration data Calibration tool Wake-up on touch event	Yes
i.MX6UL	DDR3L	Bus width: 16 bit	Yes
i.MX6UL	SPI NOR flash	Bootable: yes	Yes
i.MX6UL	eMMC Flash	Bootable: yes	Yes
i.MX6UL	COM ports	UARTx (RS-232) Baud rates: 9600 to 115200 Baud Parameters: 8 N 1 Flow Control: Software & Hardware Debug / Bootloader	Yes
i.MX6UL	I²C Ports	EEPROM (24LC64T)	Yes
i.MX6UL	I²C Ports	RTC	Yes
i.MX6UL	I²C Ports	Temp (LM73CIMK-0)	Yes
i.MX6UL	RTC	TBD if applicable external	Yes
i.MX6UL	SD/SDIO	SD card interface Hot Plug: yes Bootable: yes	Yes
i.MX6UL	USB 1 Host Hi Speed	HID-Support: Keyboard, Mouse Mass-Storage-Support: USB-Sticks & -Hard disks	Yes
i.MX6UL	USB OTG Hi Speed / FS	As USB Host HID-Support: Keyboard, Mouse Mass-Storage-Support: USB-Sticks & -Hard disks	Yes
–	Audio	Line-out (optional)	No
–	Audio	Line-in (optional)	No
–	Audio	MIC (optional)	No
–	Audio	Mixer (optional)	No
i.MX6UL	Ethernet 1 /2 10/100 Mbit	Speeds: 10/100 Mbit/s Duplex-Modes: Half- & Full-Duplex Auto-Negotiation: Yes Manual Configuration: Yes Protocols: IP, TCP, UDP, ICMP, IEEE1588 Misc.: DHCP-Client	Yes
i.MX6UL	CAN	2 × CAN interface Driver: Socket-CAN Baud rates: TBD Protocol-Stacks: TBD (e.g., CANopen)	Yes
i.MX6UL	SPI	As generic interface	No
i.MX6UL	Basic Power Management	Power Modes: WAIT, STOP	No

5. MECHANICS

5.1 Dimensions

The design of the MBa6ULxL is based on the Mini-ITX form factor (100 × 100 mm²). The MBa6ULxL provides for 4.3 mm mounting holes. The Intel® specifications of the NUC form factor were also taken into account. The MBa6ULxL has a maximum height of approximately 22 mm and weighs approximately 94 grams, including CR2032 battery.

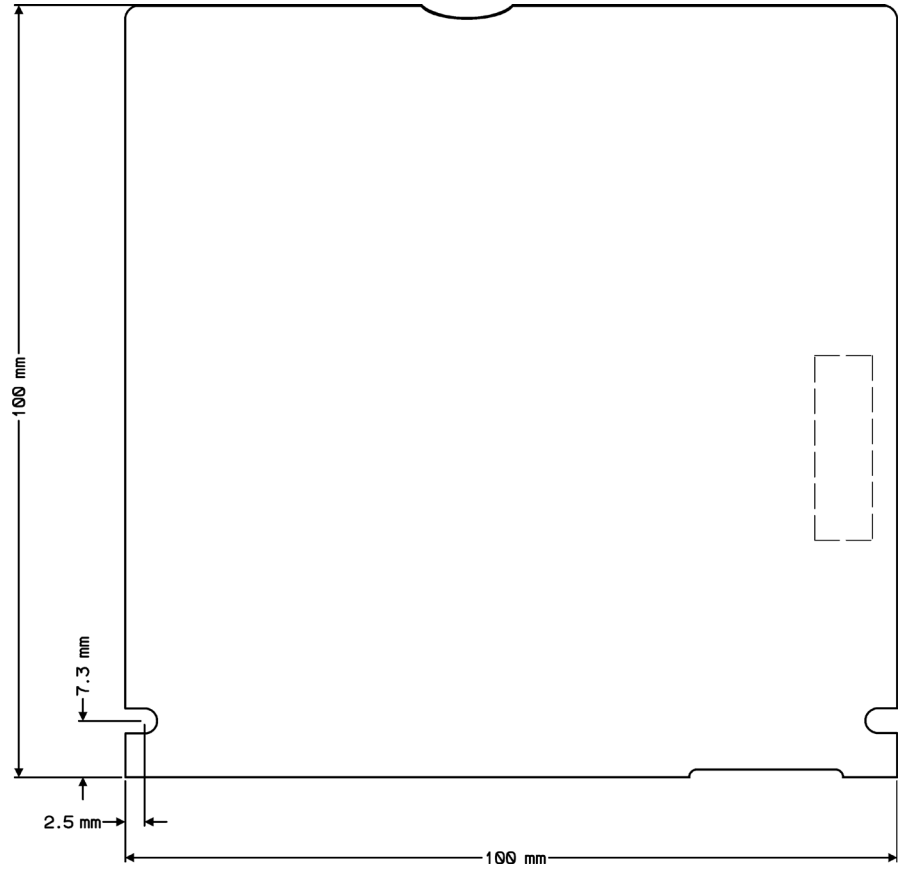


Figure 18: MBa6ULxL dimensions

5.2 Thermal management

No special precautions were taken concerning the thermal management of the MBa6ULxL. A maximum of 5 watts, including TQMa6x, have to be dissipated. More information is to be taken from the TQMa6ULxL User's Manual.

Attention:	Destruction or malfunction, TQMa6ULxL heat dissipation
	The i.MX6ULx belongs to a performance category in which a cooling system is essential in most applications. It is the sole responsibility of the user to define a suitable cooling method 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 curvature, BGA balls, BGA package, thermal pad, heatsink) must be ensured when connecting the heat sink. The i.MX6ULx is not necessarily the highest component. Inadequate cooling connections can lead to overheating of the TQMa6ULxL and thus malfunction, deterioration or destruction.

5.3 Assembly

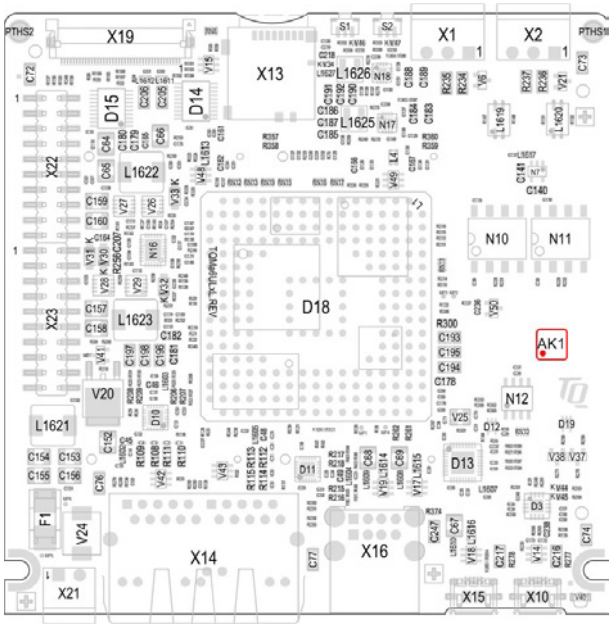


Figure 19: MBa6ULxL, component placement top

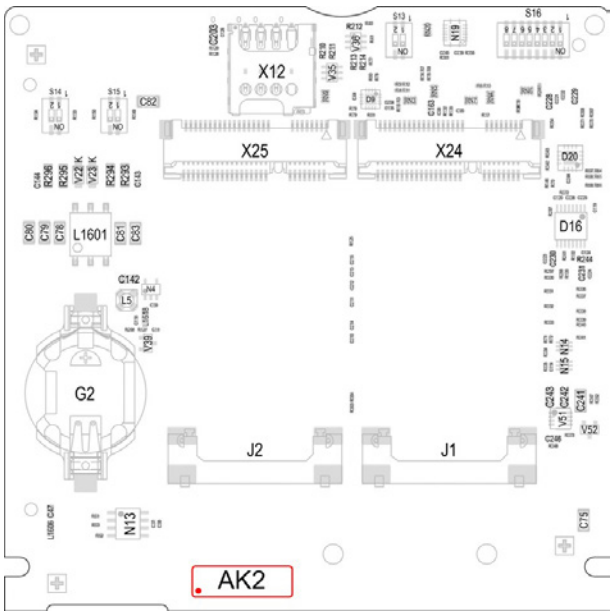


Figure 20: MBa6ULxL, component placement bot

Table 29: Labels on MBa6ULxL

Label	Content
AK1	Serial number
AK2	MBa6ULxL version and revision, tests performed

6. SAFETY REQUIREMENTS AND PROTECTIVE REGULATIONS

6.1 EMC

An EMC test of the board alone is not intended, as it is not meaningful for the customer's application, as the passing of these tests is essentially determined by the installation situation, wiring, operating state, design of the housing, etc.

During development, however, care was taken to avoid or filter potential sources of interference on the TQMa6ULxL as far as possible.

6.2 ESD

Most of the interfaces on the MBa6ULxL are protected against electrostatic discharge.

6.3 Operational safety and personal security

Due to the occurring voltages (≤30 V DC), tests with respect to the operational and personal safety have not been carried out.

The superior overall system in connection with the MBa6ULxL is defined by the end customer.

7. CLIMATIC AND OPERATIONAL CONDITIONS

The MBa6ULxL is designed as an industrial single-board PC that meets all industry standards. Special attention was paid to the temperature range from –40 °C to +85 °C. The possible temperature range strongly depends on the installation situation (heat dissipation via the housing), so no fixed value can be specified for the MBa6ULxL. A cooling system is essential in most applications. 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). Inadequate cooling connections can lead to overheating of the MBa6ULxL and thus malfunction, deterioration or destruction.

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

Table 30: Climatic and operational conditions MBa6ULxL, extended temperature range

Parameter	Range	Remark
Chip temperature i.MX6	–40 °C to +95 °C	Without Lithium battery CR2032
Case temperature other ICs	–40 °C to +85 °C	Without Lithium battery CR2032
Case temperature DDR3L SDRAM	–40 °C to +95 °C	Without Lithium battery CR2032
Relative humidity (operation / storing)	10 % to 90 %	Not condensing

7.1 Protection against external effects

Protection class IP00 was defined for the MBa6ULxL. There is no protection against foreign objects, touch or humidity.

7.2 Reliability and service life

No detailed MTBF calculation was performed for the MBa6ULxL.

The MBa6ULxL is maintenance-free.

It is designed for a service life of 10 years and also to be insensitive to shock and vibration.

8. ENVIRONMENT PROTECTION

8.1 RoHS

The MBa6ULxL 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 MBa6ULxL 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 MBa6ULxL must therefore always be seen in conjunction with the complete device.
The available standby and sleep modes of the components on the MBa6ULxL enable compliance with EuP requirements for the MBa6ULxL.

8.5 Packaging

The MBa6ULxL is delivered in reusable packaging.

8.6 Batteries

8.6.1 General notes

Due to technical reasons a battery is necessary for the MBa6ULxL. 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.

8.6.2 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.

8.7 Other entries

By environmentally friendly processes, production equipment and products, we contribute to the protection of our environment. To be able to reuse the MBa6ULxL, it is produced in such a way (a modular construction) that it can be easily repaired and disassembled. The energy consumption of the MBa6ULxL 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 31: Acronyms

Acronym	Meaning
ADC	Analog/Digital Converter
BGA	Ball Grid Array
BIOS	Basic Input/Output System
CAN	Controller Area Network
CPU	Central Processing Unit
DDR3L	Double Data Rate 3 Low voltage
DHCP	Dynamic Host Configuration Protocol
DIP	Dual In-line Package
EDT	Emerging Display Technology
EEPROM	Electrically Erasable Programmable Read-only Memory
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
eMMC	embedded Multimedia Card
ESD	Electrostatic Discharge
EuP	Energy using Products
FFC	Flat Flex Cable
FR-4	Flame Retardant 4
FS	Full Speed (USB: 12 Mbit/s)
FTDI	Future Technology Devices International
GPIO	General-Purpose Input/Output
GSM	Global System for Mobile Communications (Groupe Spécial Mobile)
HDMI	High Definition Multimedia Interface
HID	Human Interface Devices
HSYNC	Horizontal Synchronisation
I	Input
I/O	Input/Output
I^2C	Inter-Integrated Circuit
ICMP	Internet Control Message Protocol [Novell]
IEEE	Institute of Electrical and Electronics Engineers
IP	Internet Protocol
IP00	Ingress Protection 00
ITU-R	International Telecommunication Union-Recommendation
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LGA	Land Grid Array
LoRa	Long Range
LSB	Least Significant Bit
MAC	Media Access Control
MSB	Most Significant Bit
MTBF	Mean (operating) Time Between Failures
NC	Not Connected
NOR	Not-Or
NUC	Next Unit of Computing

9.1 Acronyms and definitions (continued)

Table 30: Acronyms (continued)

Acronym	Meaning
O	Output
OTG	On-The-Go
P	Power
PC	Personal Computer
PCB	Printed Circuit Board
PCIe	Peripheral Component Interconnect Express
PCMCIA	People Can't Memorize Computer Industry Acronyms
PCT	Projected Capacitive Touch
PHY	Physical (layer of the OSI model)
PMIC	Power Management Integrated Circuit
PU	Pull-Up
PWM	Pulse-Width Modulation
PWP	Permanent Write Protected
QSPI	Quad Serial Peripheral Interface
REACH®	Registration, Evaluation, Authorisation (and restriction of) Chemicals
RGB	Red Green Blue
RJ45	Registered Jack 45
RMII	Reduced Media-Independent Interface
RoHS	Restriction of (the use of certain) Hazardous Substances
RS-232	Recommended Standard (serial interface)
RT	Resistive Touch
RTC	Real-Time Clock
RWP	Reversible Write Protected
SD	Secure Digital
SDA	Serial Data
SDIO	Secure Digital Input/Output
SDRAM	Synchronous Dynamic Random Access Memory
SIM	Subscriber Identity Module
SPD	Serial Presence Detect
SPI	Serial Peripheral Interface
SVHC	Substances of Very High Concern
TBD	To Be Determined
TCP	Transmission Control Protocol
UART	Universal Asynchronous Receiver / Transmitter
UDP	User Datagram Protocol
UM	User's Manual
UMTS	Universal Mobile Telecommunications System
UN	United Nations
USB	Universal Serial Bus
USDHC	Ultra-Secured Digital Host Controller
VSYNC	Vertical Synchronisation
WEEE®	Waste Electrical and Electronic Equipment
WP	Write-Protection

9.2 References

Table 32: Further applicable documents

No.	Name	Rev., Date	Company
(1)	i.MX 6UltraLite Applications Processor Reference Manual	Rev. 2, 11 Mar 2019	NXP
(2)	i.MX 6UltraLite Data Sheet	Rev. 2.2, 30 May 2017	NXP
(3)	PF3000, PMIC	Rev. 9, Aug 2017	NXP
(4)	AN5170, i.MX 6UltraLite Power Consumption Measurement	Rev. 2, 08 May 2016	NXP
(5)	Chip Errata for the i.MX 6UltraLite	Rev. 3, 30 Jul 2020	NXP
(6)	Hardware Development Guide for the i.MX 6UltraLite Applications Processor	Rev. 3, 04 Sep 2018	NXP
(7)	TQMa6ULxL User's Manual	– current –	TQ-Systems
(8)	TQMa6ULxL Support-Wiki	– current –	TQ-Systems

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