MBLS1028A-IND (Industrial Version) User's Manual

MBLS1028A-IND UM 0102
04.12.2023

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FIGURE DIRECTORY

REVISION HISTORY

Rev.	Date	Name	Pos.	Modification
0001	16.02.2020	Petz		First issue
0002	25.02.2020	Petz	Figure 3 Table 5, Table 6 Table 7	Caption corrected Pin names corrected Simplified
0100	23.11.2020	Petz	All 4.3.3, Table 10 Table 5, Table 6 Table 6 Table 23	Typo and formatting, non-functional changes M.2 B-Key reference corrected (X5 ⇨ X35) Pinout of RJ-45 connector removed Simplified Column headers corrected
0101	20.09.2022	Kreuzer	Table 5: Pinout Power-in connector X45 Figure 7: DC Power Supply Connector	Add (power connector X45) Add (power connector X45)
0102	4.12.2023	Kreuzer	Table 22 7.4 7.5 7.6 9.5	Typo Pin 10 corrected Chapter add Chapter add Chapter add Chapter add

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1.5 Tips on safety

Improper or incorrect handling of the product 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 TQ-products.
`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 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: do not 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 MBLS1028A-IND 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.

1.8 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:

- MBLS1028A-IND circuit diagram
- TQMLS1028A User's Manual
- LS1028A Data Sheet
- U-Boot documentation: www.denx.de/wiki/U-Boot/Documentation
- Yocto documentation: www.yoctoproject.org/docs/
- TQ-Support Wiki: Support-Wiki TQMLS1028A

2. BRIEF DESCRIPTION

This User's Manual describes the hardware of the MBLS1028A-IND from revision 01xx.

The MBLS1028A-IND is designed as a carrier board for the TQMLS1028A.

All TQMLS1028A interfaces, which can be used, are available on the MBLS1028A-IND, thus the features of the CPU LS1028A can be evaluated and software development for a TQMLS1028A-based project can be started directly.

The MBLS1028A-IND supports TQMLS1028A modules with an LS1017A, LS1027A, LS1018A or LS1028A CPU.

3. TECHNICAL DATA

3.1 System architecture and functionality

3.1.1 Block diagram MBLS1028A-IND

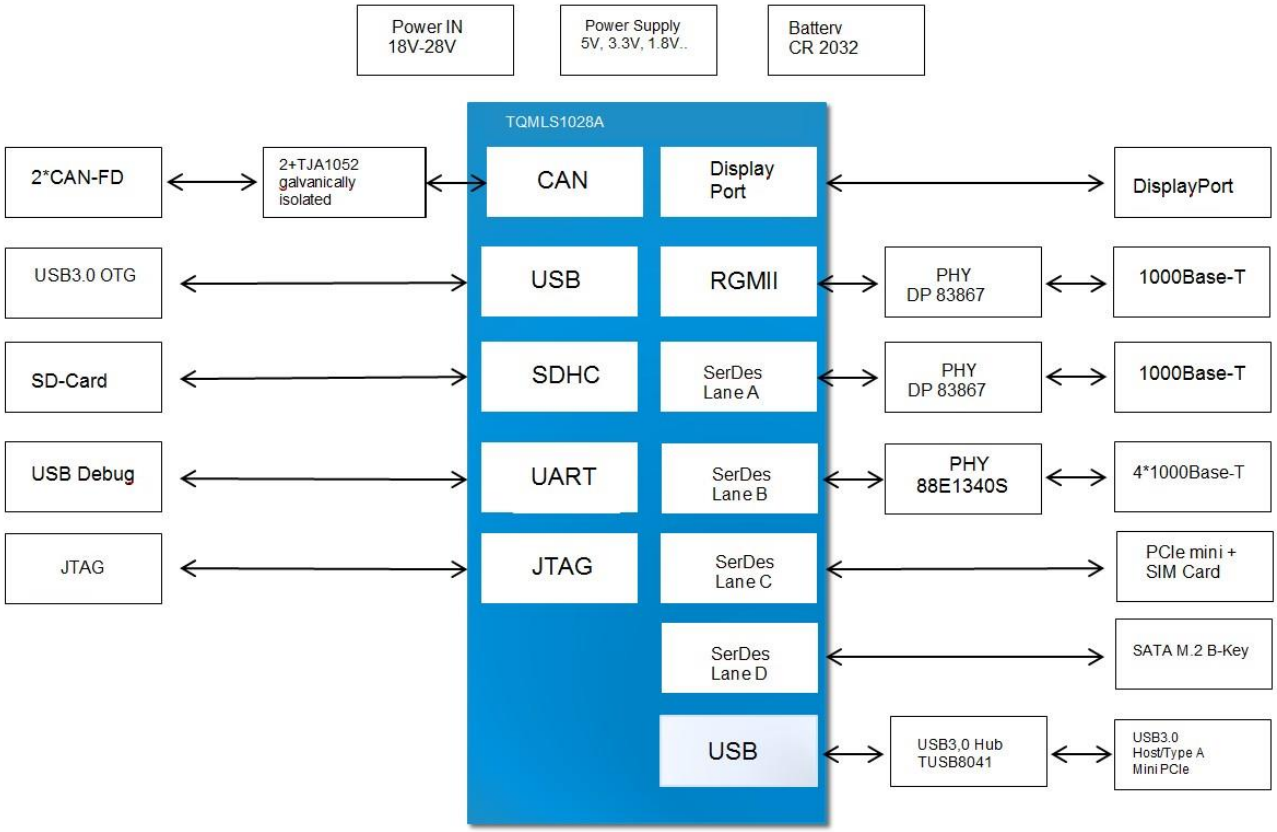

Figure 1: Block diagram MBLS1028A-IND

4. ELECTRONICS

The TQMLS1028A with its LS1028A CPU is the central system component. It provides DDR4 SDRAM, eMMC, NOR flash and EEPROM memory. All voltages required by the TQMLS1028A are derived from the supply voltage of 5 V.

The available signals are routed to two connectors on the MBLS1028A-IND. More detailed information is to be taken from the TQMLS1028A User's Manual (4). The boot behaviour of the TQMLS1028A can be customised.

The required boot-mode configuration can be set with DIP switches on the MBLS1028A-IND, see chapter 4.1.2.

Note: Available interfaces	
	Depending on the TQMLS1028A derivative not all interfaces are available. Refer to the TQMLS1028A User's Manual and the TQMLS1028A pinout table to see which interfaces are available.

4.1 System components

4.1.1 TQMLS1028A

The TQMLS1028A with its LS1028A CPU is the central system component. It provides DDR4 SDRAM, eMMC, NOR flash and an EEPROM. All TQMLS1028A internal voltages are derived from the 5 V supply voltage. Further information can be found in the TQMLS1028A User's Manual. The available signals are routed to the MBLS1028A-IND via two connectors. On the MBLS1028A-IND the interfaces provided by the TQMLS1028A are routed to industry standard connectors. Furthermore the MBLS1028A-IND provides all power supplies and configurations required for the operation of the TQMLS1028A. The MBLS1028A-IND supports TQMLS1028A modules with an LS1017A, LS1027A, LS1018A or LS1028A CPU.

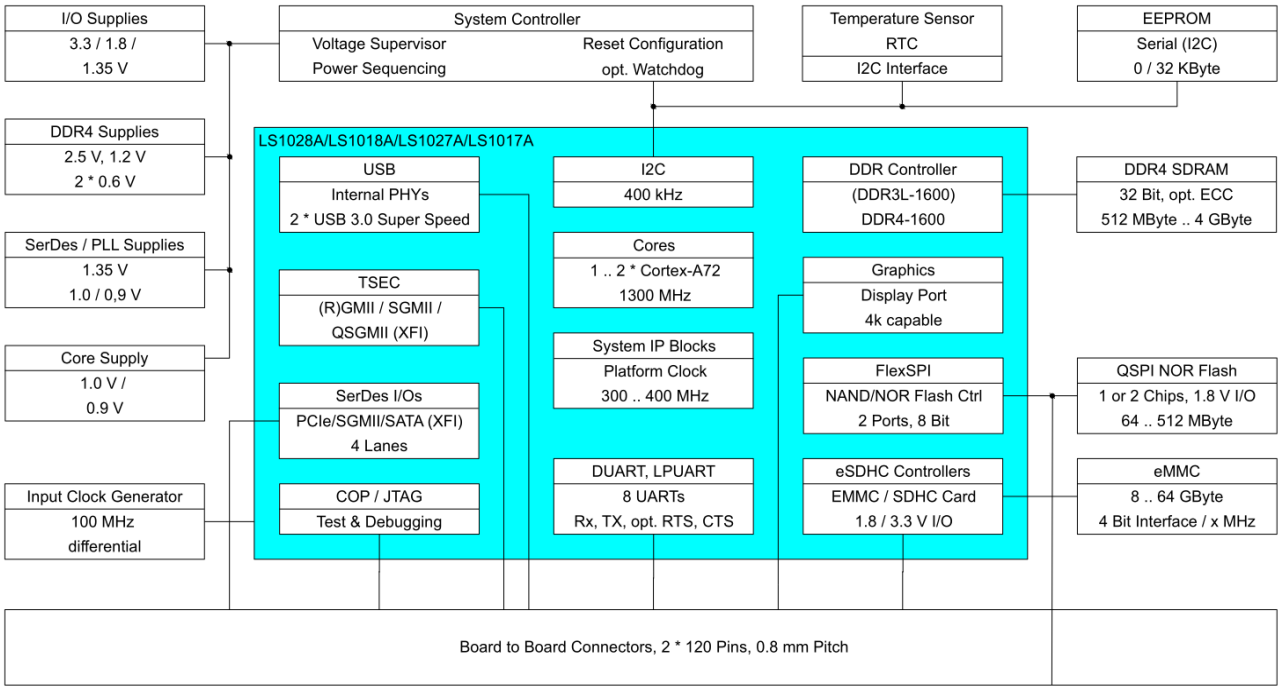

Figure 2: Block diagram TQMLS1028A

4.1.2 Boot configuration

The boot mode of the TQMLS1028A is determined by the signal RCW_SRC_SEL.
The boot mode defines the boot device and specific configurations. The boot mode is set with DIP switches.

The following table shows the possible Boot Mode settings:

Table 2: Boot Mode configuration, DIP switch S9

Boot Mode	S9-1	S9-2	S9-3	S9-4	Remark
SD card (SDHC1)	1	1	1	1	–
eMMC (SDHC2)	0	1	1	1	–
NOR flash	1	0	1	1	–
Hard Coded RCW	1	1	0	1	–
I²C EEPROM	1	1	1	0	I2C1 (2-byte addressing)

4.1.3 Battery

In case of power failure a lithium battery type CR2032 on the MBLS1028A-IND supplies the RTC on the TQMLS1028A.

4.1.4 Clock generation

The following Figure shows, which clocks are required on the TQMLS1028A and how they are generated.

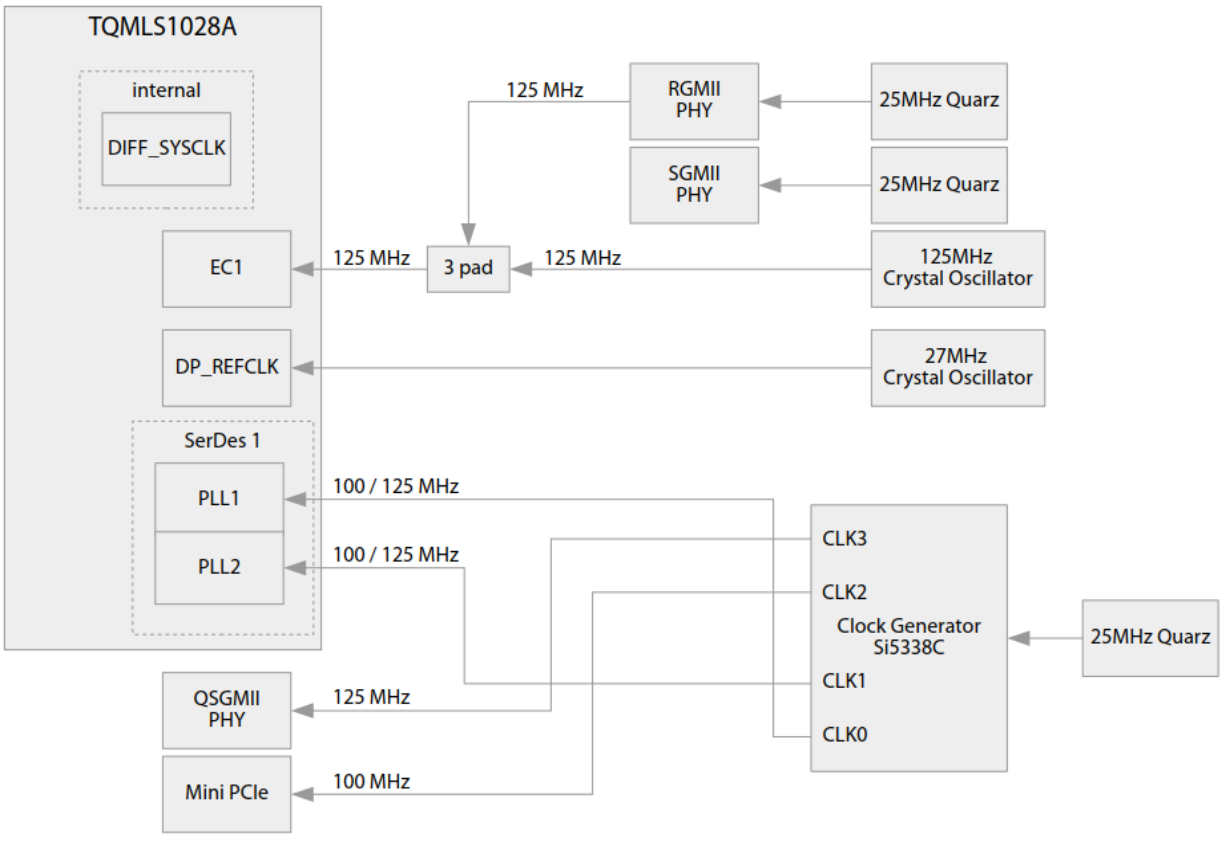

Figure 3: Block diagram clock generation on MBLS1028A-IND

4.1.5 Reset structure

The reset structure is designed in such a way that the TQMLS1028A and the Reset button on the MBLS1028A-IND are the control center. This ensures that the Reset is enabled at the right time during power-up. Corresponding reset delays are handled by the TQMLS1028A. The remaining PHYs, hub and other reset-capable components on the module are controlled by the I^2C expander.

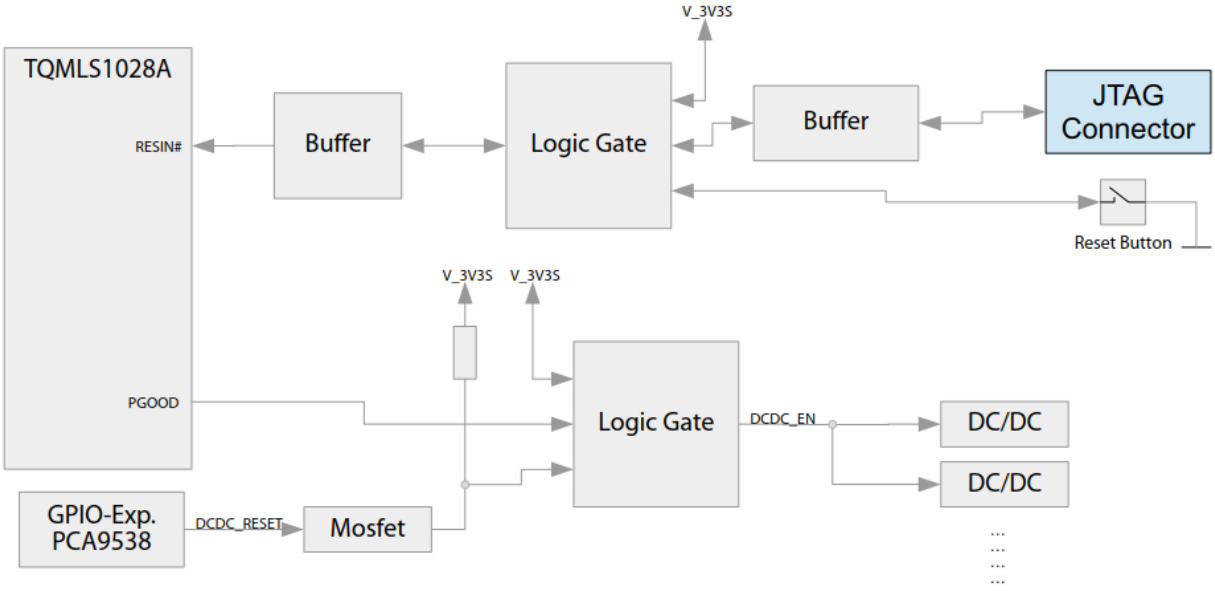

Figure 4: Block diagram Reset structure

4.1.6 I²C devices

The TQMLS1028A provides various I²C buses, of which only IIC5 and IIC6 are used on the MBLS1028A-IND.
The following block diagram shows the I²C bus structure.

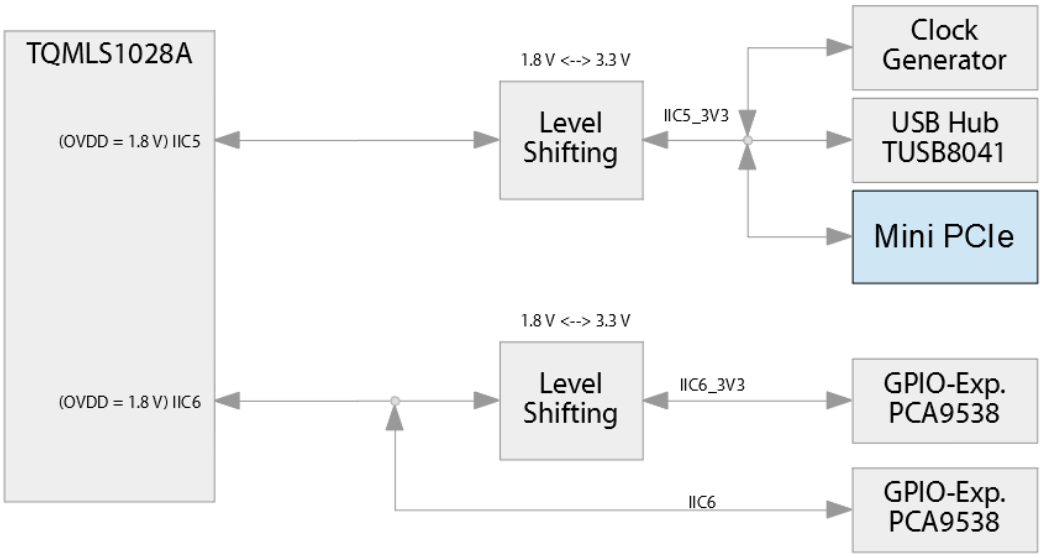

Figure 5: Block diagram I²C bus

On the TQMLS1028A further I²C devices are used, therefore the already assigned I²C addresses were taken into account.
The voltage (OVDD at IIC6) is fixed at 1.8 V and therefore requires a level shifter to 3.3 V.

The following table shows the I²C address mapping on TQMLS1028A and MBLS1028A-IND.

Table 3: I²C devices, address mapping on TQMLS1028A and MBLS1028A-IND

Location	I²C bus	Device	Function	7-bit address	Remark
MBLS1028A-IND	IIC5	SI5338C	Clock Generator	0x70 / 111 0000b	Optional, not connected
		TUSB8041	USB 3.0 Hub	0x44 / 100 0100b	Optional, not connected
		–	mPCIe slot	–	Defined by customer, X12
		–	Header 1	–	Defined by customer, X48
	IIC6	PCA9538	Port expander	0x71 / 111 0001b	Device D68, 3.3 V
		PCA9538	Port expander	0x70 / 111 0000b	Device D69, 1.8 V
TQMLS1028A	IIC1	MKL04Z16	System Controller	0x11 / 001 0001b	Should not be altered
		SE97B	Temp. Sensor	0x18 / 001 1000b	Access to temperature registers
			EEPROM	0x50 / 101 0000b	Normal Mode (RWP)
				0x30 / 011 0000b	Protected Mode (PWP)
		24LC256T	EEPROM	0x57 / 101 0111b	–
		SA56004EDP	Temp. Sensor	0x4C / 100 1100b	–
		PCF85063	RTC	0x51 / 101 0001b	–

4.1.6.1 Temperature sensor

There is no temperature sensor on the MBLS1028A-IND, but a temperature sensor SE97BTP is provided on the TQMLS1028A.

4.1.6.2 GPIO port expander

To control several components on the MBLS1028A-IND, two port expanders PCA9538 with 8 ports each are assembled. Among the controlled components are USB 3.0 Hub, SGMII as well as QSGMII and mPCIe.

Both port expanders are controlled via IIC6. The addresses of the port expanders can be changed by reassembling resistors.

When changing the address, care must be taken to avoid address conflicts with existing I²C devices. The assembly options are documented in the circuit diagram.

In the initial state, after power-up, all ports are set as input and the connected component is thus deactivated.

The following table shows the signals controlled by the port expanders.

Table 4: Function of Port Expanders

Port	Signal	Dir.	Remark
8-port Expander PCA9538, D68, I²C address 0x71 / 111 0001b			
IO_0	CLK_INT#	I	–
IO_1	USB_RST#	O	–
IO_2	MPCIE_WAKE#	O	–
IO_3	MPCIE_DIS#	O	–
IO_4	MPCIE_RST#	O	–
IO_5	SIM_CARD_DETECT	I	–
IO_6	SATA_PERST#	O	–
IO_7	DCDC_RESET	O	–
8-port Expander, PCA9538, D69, I²C address 0x70 / 111 0000b			
IO_0	EC1_INT#	I	–
IO_1	EC1_RESET#	O	–
IO_2	SGMII_INT#	I	–
IO_3	SGMII_RESET#	O	–
IO_4	QSGMII_INT#	I	–
IO_5	QSGMII_RESET#	O	–
IO_6	–	–	(not used)
IO_7	–	–	(not used)

4.2 Power supply

The MBLS1028A-IND has to be supplied with 18 V to 28 V at X45. The typical supply voltage is 24 V.

The following figure shows all voltages (rails) on the MBLS1028A-IND, which are supplied from the two 5 V and 3.3 V main rails of an LM25119. These supply the biggest loads (TQMLS1028A, USB supply, SATA supply with up to 2500 mA). The power supply structure is designed in such a way that the 5 V voltage is always activated.

Furthermore the design allows power sequencing of all voltage levels used. All voltages are powered up after the boot process of the TQMLS1028A.

At the two headers X48 and X49 on the MBLS1028A-IND 1.8 V, 3.3 V and 5 V are available, at header X50, 3.3 V and 5 V are available. The three connectors share the available total power of the individual voltage rails.

The current drawn must be added to the input current. It has to be ensured that the permissible limit values of the input circuit are not exceeded.

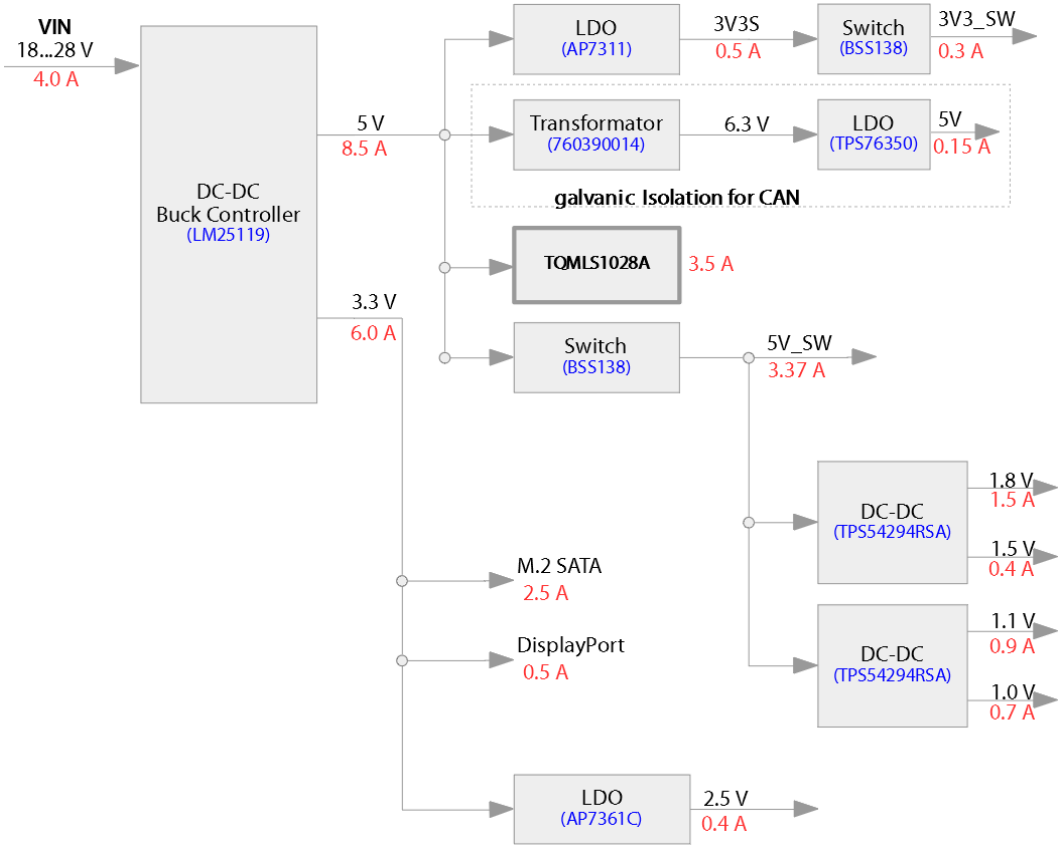

Figure 6: Block diagram power supply

Table 5: Pinout Power-in connector X45

Pin	Signal	Remark
1	12 V	Fused
2	GND	–

Figure 7: DC Power Supply Connector

4.2.1 Protective circuitry

The protection circuit (see Figure 8) features the following characteristics:

- Overcurrent protection by fuse 5 A, slow blow
- Overvoltage protection diode
- PI filter
- Reverse polarity protection by MOSFET

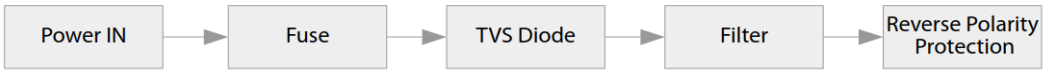

Figure 8: Block diagram protective circuit

4.3 Communication interfaces

4.3.1 Ethernet

4.3.1.1 RGMII

The LS1028A provides an RGMII Ethernet controller (EC1 – port 1). On the MBLS1028A-IND the interface provides a Gigabit Ethernet port. The PHY supports IEEE® 802.3 10BASE-T, 100BASE-T, and 1000BASE-T.

The 125 MHz reference clock for the MAC of the CPU is generated by a quartz oscillator.

The RGMII interface contains PHY reset and interrupt signals.
When looking at X43 from outside, the PHY signals are routed to the left RJ45 port.

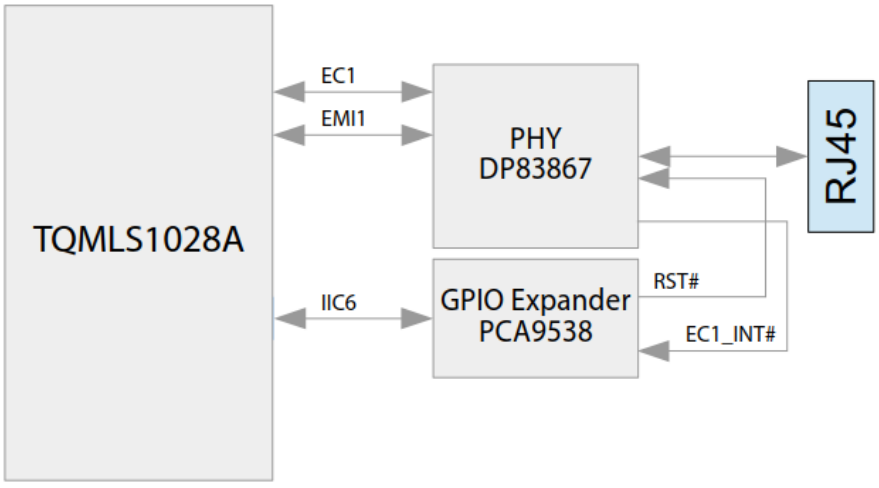

Figure 9: Block diagram Ethernet RGMII

4.3.1.2 SGMII

The LS1028A provides an Ethernet controller (SGMII – port 0), which is used as SGMII interface via SerDes. SerDes Lane 0 is used for this purpose. On the MBLS1028A-IND the interface provides a Gigabit Ethernet port.

The SGMII interface contains PHY reset and interrupt signals.

When looking at X43 from outside, the PHY signals are routed to the right RJ45 port.

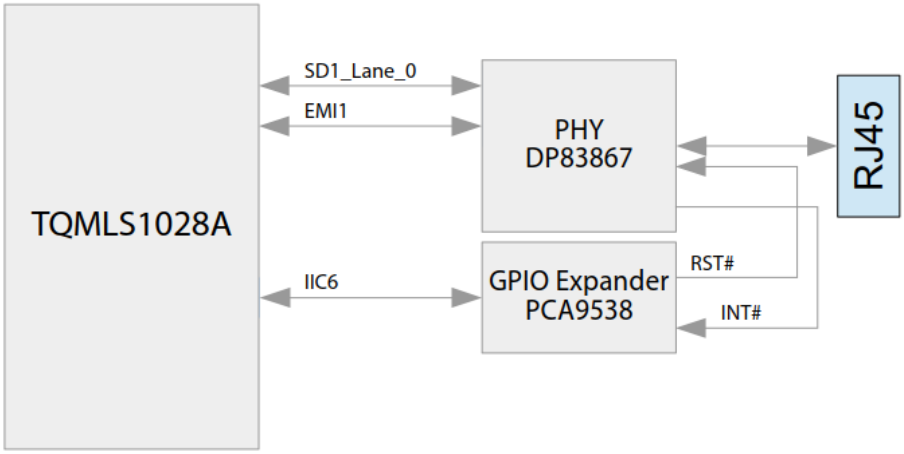

Figure 10: Block diagram Ethernet SGMII

4.3.1.3 QSGMII

In addition to the Ethernet Controller (ENETC), the LS1028A CPU offers a TSN switch (Time-Sensitive Networking Switch) that operates four external ports via SerDes. The TSN switch is not routed via the Ethernet controller but via SerDes and is implemented as QSGMII.

The QSGMII interface includes PHY reset and interrupt signals.

When looking at the MBLS1028A-IND from outside, X8 is on the left, X9 is on the right.

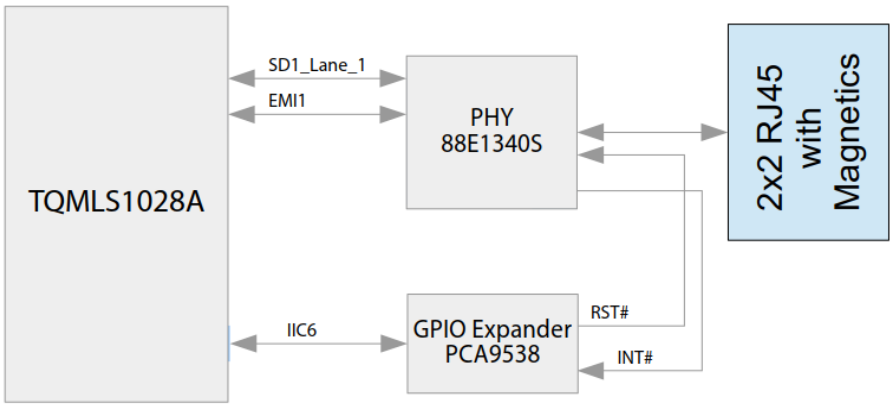

Figure 11: Block diagram Ethernet QSGMII

The following table shows the pinout of the Ethernet connectors X8, and X9.

Table 6: Pinout Ethernet QSGMII, RJ-45 connectors X8, X9

RJ45	X8		X9	
	Left	Right	Left	Right
Interface	P0_MDI	P1_MDI	P2_MDI	P3_MDI

4.3.2 Mini PCIe plus SIM card socket

The MBLS1028A-IND provides a Mini PCIe slot for full-size cards (50.95 mm x 30 mm).
Any standard compliant Mini PCIe card can be used. A SIM card holder is also provided.

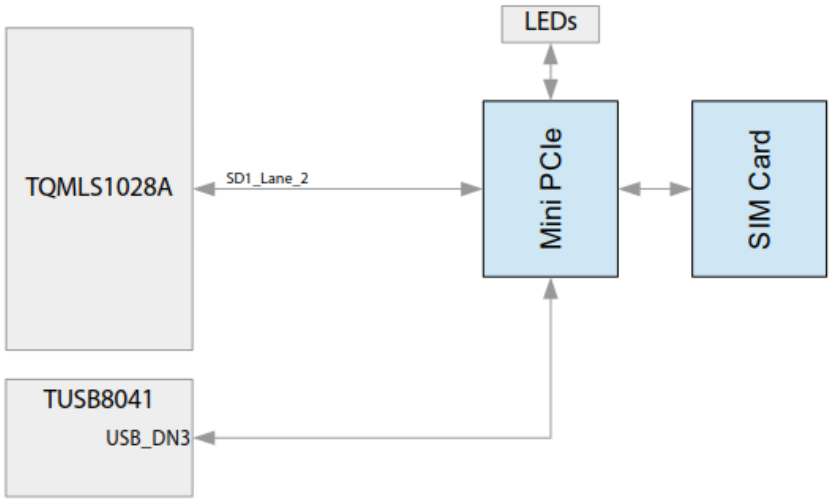

Figure 12: Block diagram Mini PCIe, SIM card

The voltages provided for the Mini PCIe card must not exceed the currents specified in the following table.

Table 7: Maximum permitted currents Mini PCIe, X12

Voltage	Nominal value	I_{max}
V_3V3_PCIE	3.3 V	1.1 A
V_1V5_PCIE	1.5 V	0.375 A

4.3.2 Mini PCIe plus SIM card socket (continued)

Table 8: Pinout Mini PCIe, X12

Remark	Signal	Pin		Signal	Remark
–	PCIE_WAKE#	1	2	V_3V3_MPCIE	–
–	NC	3	4	DGND	–
–	NC	5	6	V_1V5_MPCIE	–
–	NC	7	8	SIM_VCC	–
–	DGND	9	10	SIM_DATA	–
Signal comes from Clock Generator	MPCIE_CLK_N	11	12	SIM_CLK	–
Signal comes from Clock Generator	MPCIE_CLK_P	13	14	SIM_RST	–
–	DGND	15	16	SIM_VPP	–
Key notch					
–	NC	17	18	DGND	–
–	NC	19	20	MPCIE_DIS#	10 kΩ PU/PD. Default: 10 kΩ PU
–	DGND	21	22	MPCIE_RST#	Global Reset from Reset circuitry
0 Ω serial termination	SD1_RX2_N	23	24	V_3V3_MPCIE	–
0 Ω serial termination	SD1_RX2_P	25	26	DGND	–
–	DGND	27	28	V_1V5_MPCIE	–
–	DGND	29	30	IIC5_SCL_3V3	–
100 nF in series	SD1_TX2_N	31	32	IIC5_SDA_3V3	I^2C addresses used, see Table 3
100 nF in series	SD1_TX2_P	33	34	DGND	–
–	DGND	35	36	USB_DN3_D–	–
–	DGND	37	38	USB_DN3_D+	–
–	V_3V3_MPCIE	39	40	DGND	–
–	V_3V3_MPCIE	41	42	WWAN-LED	–
–	DGND	43	44	WLAN-LED	–
–	NC	45	46	WPAN-LED	–
–	NC	47	48	V_1V5_MPCIE	–
–	NC	49	50	DGND	–
–	NC	51	52	V_3V3_MPCIE	–

Table 9: Pinout SIM card connector, X13

Pin	Signal
C1	SIM_VCC
C2	UIM_RST
C3	UIM_CLK
C4	(NA)
C5	DGND
C6	SIM_VPP
C7	SIM_DATA
DL	SIM_CARD_DETECT
DS	DGND

4.3.3 M.2 B-Key (SSD SATA)

The LS1028A provides a SATA 3.0 AHCI interface via SerDes, which is routed from the TQMLS1028A to an M.2 connector on the MBLS1028A-IND to provide an interface for mass storage.

Transfer rates of 1.5 Gb/s (Gen I), 3 Gb/s (Gen II) and 6 Gb/s (Gen III) are possible.

An M.2 slot with B-coding is used on the MBLS1028A-IND. The MBLS1028A-IND supports M.2 sizes 2242, 2260 and 2280.

The standard mounting is for type 2280.

The SATA interface of the LS1028A and a 3.3 V power supply are routed to X35.

According to the M.2 specification, the power budget of the MBLS1028A-IND includes 2.5 A for a SATA SSD.

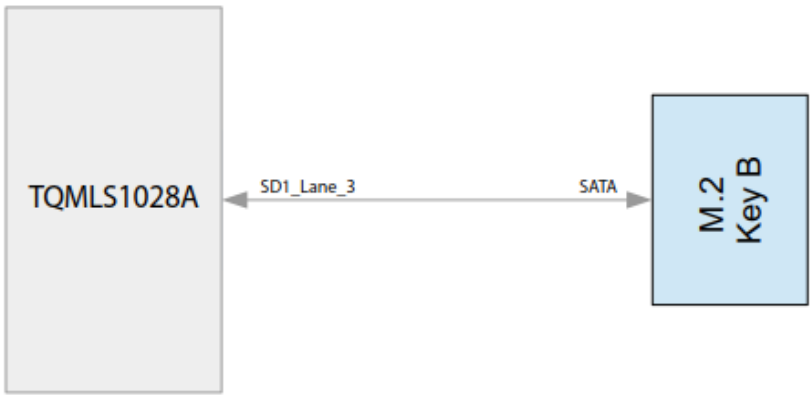

Figure 13: Block diagram M.2 (SSD SATA)

4.3.3 M.2 B-Key (SSD SATA) (continued)

Table 10: Pinout M.2 B-Key, X35

Remark	Signal	Pin		Signal	Remark
Assembly option: 10 kΩ Pull-Up	M2_CONFIG3	1			
–	DGND	3	2	V_3V3	–
–	DGND	5	4	V_3V3	–
–	NC	7	6	NC	–
–	NC	9	8	NC	–
–	DGND	11	10	LED	Activity LED at 3.3 V
Key notch (B-Key)					
Assembly option: 10 kΩ Pull-Up	M2_CONFIG0	21	20	NC	–
–	NC	23	22	NC	–
–	NC	25	24	NC	–
–	DGND	27	26	NC	–
–	NC	29	28	NC	–
–	NC	31	30	NC	–
–	DGND	33	32	NC	–
–	NC	35	34	NC	–
–	NC	37	36	NC	–
–	DGND	39	38	NC	–
10 nF AC from TQMLS1028A	SD1_RX3_P	41	40	NC	–
10 nF AC from TQMLS1028A	SD1_RX3_N	43	42	NC	–
–	DGND	45	44	NC	–
–	SD1_TX3_N	47	46	NC	–
–	SD1_TX3_P	49	48	NC	–
–	DGND	51	50	PERST#	Assembly option: PU/PD default: NP
–	NC	53	52	NC	–
–	NC	55	54	NC	–
–	DGND	57	56	NC	–
–	NC	59	58	NC	–
–	NC	61	60	NC	–
–	NC	63	62	NC	–
–	NC	65	64	NC	–
–	NC	67	66	NC	–
Assembly option: 10 kΩ Pull-Up	M2_CONFIG1	69	68	NC	–
–	DGND	71	70	V_3V3	–
–	DGND	73	72	V_3V3	–
Assembly option: 10 kΩ Pull-Up	M2_CONFIG2	75	74	V_3V3	–

M1	DGND	–
M2	DGND	–

4.3.4 SD card

The SD card socket is directly connected via a 4-bit data interface to the uSDHC controller of the TQMLS1028A.
The uSDHC controller in the TQMLS1028A supports UHS-I mode.
The USDHC1 signals are supplied by EVDD (10 kΩ PU to 1.8 V or 3.3 V).
The I/O voltage is switched by the TQMLS1028A signal SDHC1_VSEL.
The SD card supply is fixed at 3.3V. The signal lines have PUs to 3.3 V. This ensures that the pull-up voltage is at the correct level after automatic switching to UHS-I mode. All data lines are ESD protected.
It is possible to boot from SD card.

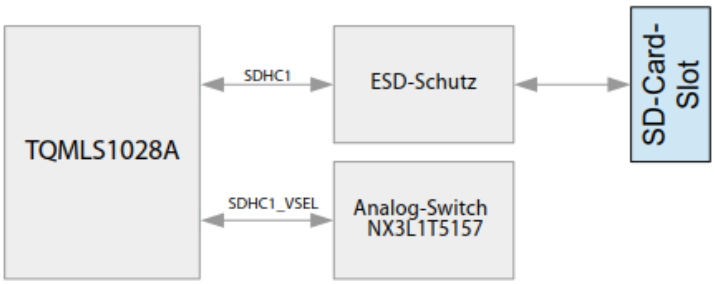

Figure 14: Block diagram SD card

Table 11: Pinout SD card, X16

Pin	Signal	Remark
1	SDHC1_DATA2_R	10 kΩ PU to 3.3 V + ESD protection
2	SDHC1_DATA3_R	10 kΩ PU to 3.3 V + ESD protection
3	SDHC1_CMD_R	10 kΩ PU to 3.3 V + ESD protection
4	VCC3V3	Optional: 1.8 V or 3.3 V
5	SDHC1_CLK	ESD protection
6	DGND	–
7	SDHC1_DATA0_R	10 kΩ PU to 3.3 V + ESD protection
8	SDHC1_DATA1_R	10 kΩ PU to 3.3 V + ESD protection
SW1	SDHC1_CD#	10 kΩ PU to 1.8 V + ESD protection
SW2	DGND	–
M1 … M4	SHIELD	Shield

Note: SD card supply voltage	
	SD cards always start with 3.3 V I/O voltage after power-up. For the modes with 1.8 V I/O voltage they are switched by software. When rebooting or resetting the MBLS1028A-IND, the SD card remains at the last used I/O voltage because it does not have a separate reset signal; the SDHC controller, on the other hand, returns to 3.3 V I/O voltage. Therefore, the supplied BSP is limited to the 3.3 V modes.

4.3.5 USB 3.0 Hub

The TI USB 3.0 Hub TUSB8041 connected to the USB 3.0 OTG port (USB2) of the TQMLS1028A provides three USB HOST ports. Two ports are routed as USB 3.0 interfaces to a stacked connector (X10), the third port is routed as USB 2.0 interface to the mPCIe connector X12. The USB 3.0 Hub TUSB8041 can be programmed via I^2C, the address is 0x44 / 100 0100b, see also Table 3.

A power distribution switch provides 5 V for the USB connectors. The current is monitored and can be switched off in case of an overload and/or overheating.

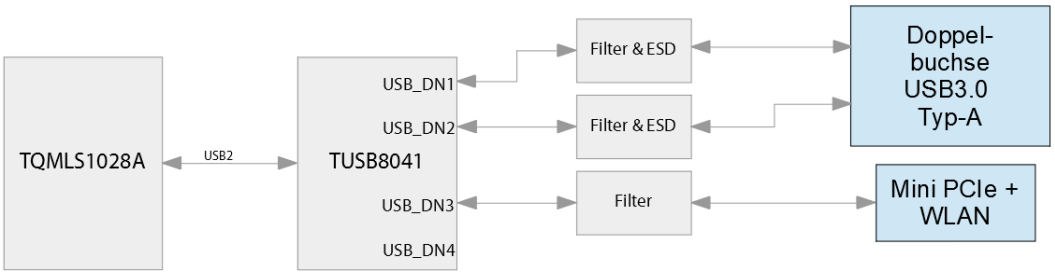

Figure 15: Block diagram USB

The USB host port of the TQMLS1028A provides a theoretical data rate of 5 Gbit/s. This is divided among the connected ports. Depending on the software and hardware used, the effective read and write rates of the ports may vary.

The following table shows the pinout of the stacked connector X10.

Table 12: Pinout USB Host 1 & 2, X10

Pin	Pin name	Signal	Remark
1	VBUS_2	V_VBUS_DN2	100 µF to DGND + EMI filter
2	USB_DN2_D–	USB2_H2_D_N	Common Mode Choke in series
3	USB_DN2_D+	USB2_H2_D_P	Common Mode Choke in series
4	GND_2	DGND	–
5	USB_DN2_RX–	USB3_H2_RX_D_N	Common Mode Choke in series
6	USB_DN2_RX+	USB3_H2_RX_D_P	Common Mode Choke in series
7	GND-DRAIN_2	DGND	–
8	SSTX–_2	USB3_H2_TX_D_N	Common Mode Choke in series + 100 nF AC coupling capacitor
9	SSTX+_2	USB3_H2_PX_D_P	Common Mode Choke in series + 100 nF AC coupling capacitor
10	VBUS_1	V_BUS_DN1	100 µF to DGND + EMI filter
11	USB_DN1_D–	USB2_H1_D_N	Common Mode Choke in series
12	USB_DN1_D+	USB2_H1_D_P	Common Mode Choke in series
13	GND_1	DGND	–
14	USB_DN1_RX–	USB3_H1_RX_D_N	Common Mode Choke in series
15	USB_DN1_RX+	USB3_H1_RX_D_P	Common Mode Choke in series
16	GND-DRAIN_1	DGND	–
17	USB_DN1_TX–	USB3_H1_TX_D_N	Common Mode Choke in series + 100 nF AC coupling capacitor
18	USB_DN1_TX+	USB3_H1_PX_D_P	Common Mode Choke in series + 100 nF AC coupling capacitor
M1 … M4	Shield	DGND	–

Table 13: Pinout USB Host 3, mPCIe connector, X12

Pin	Pin name	Signal	Remark
36	D–	USB_DN3_D–	Common Mode Choke in series
38	D+	USB_DN3_D+	Common Mode Choke in series

4.3.6 USB 3.0 OTG

The LS1028A has two USB3.0 controllers with integrated PHY. USB1 is used as OTG interface.
A Micro USB 3.0 TYPE B connector is assembled on the MBLS1028A-IND. In order to use the interface as Host/Device, a suitable adapter comes with the MBLS1028A-IND.

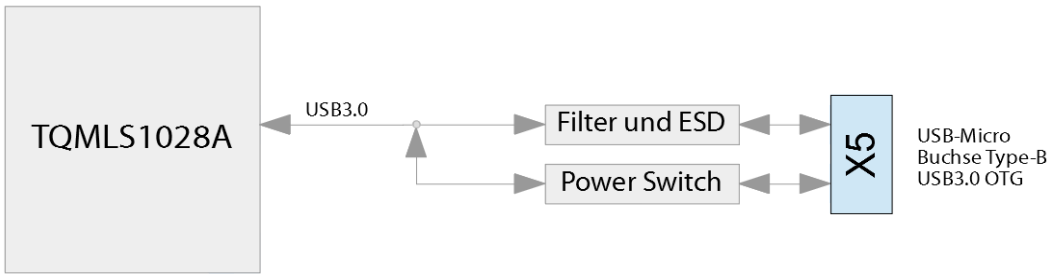

Figure 16: Block diagram USB

The USB1 port of the TQMLS1028A provides a theoretical data rate of 5 Gbit/s.
Depending on the software and hardware used, the effective read and write rates of the ports may vary.

The following table shows the pinout of USB OTG connector X5.

Table 14: Pinout USB OTG, X5

Pin	Pin name	Signal	Dir.	Remark
1	VBUS	V_BUS_USB1	P	100 µF to DGND + EMI filter
2	D–	USB1_D_M	I/O	Common Mode Choke in series
3	D+	USB1_D_P	I/O	Common Mode Choke in series
4	ID	USB1_ID	I	–
5	GND	DGND	P	–
6	SSTX–	USB1_TX_M	I/O	Common Mode Choke in series
7	SSTX+	USB1_TX_P	I/O	Common Mode Choke in series
8	GND_DRAIN	DGND	P	–
9	SSRX–	USB1_RX_M	I/O	Common Mode Choke in series + 100 nF AC coupling capacitor
10	SSRX+	USB1_RX_P	I/O	Common Mode Choke in series + 100 nF AC coupling capacitor
M1 … M10	Shield	DGND	P	–

4.3.7 CAN

Two ISO-11898 compliant CAN interfaces are provided on the MBLS1028A-IND.
The signals are each connected to a 3-pin connector.
The interfaces are galvanically isolated, but not among each other.
The High-Speed Mode supports data rates of up to 5 Mbit/s.

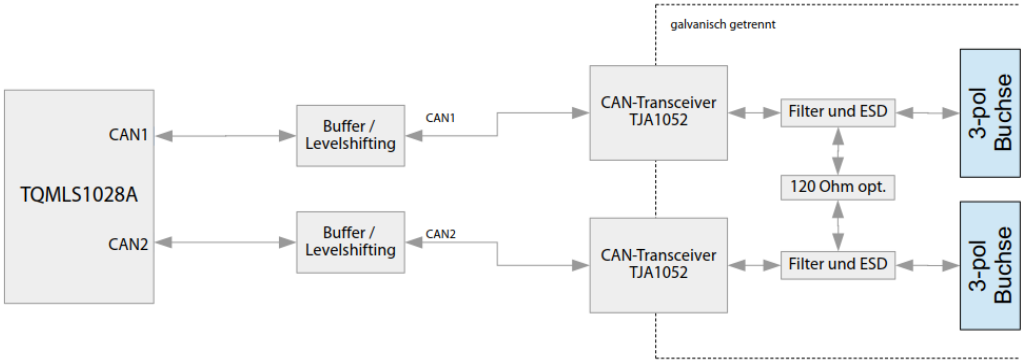

Figure 17: Block diagram CAN

The following table shows the pinout of the CAN connectors.

Table 15: Pinout CAN1 (X17), CAN2 (X29)

Pin	Signal	Direction	Remark
1	CAN_H	I/O	Galvanically separated
2	CAN_L	I/O	
3	GND_CAN	P	

The CAN signals can be terminated with 120 Ω using the DIP switches S11-1 & S11-2, or S11-3 & S11-4.

Table 16: DIP switch S11, CAN termination

DIP switch	Interface	ON	OFF
S11-1 & S11-2	CAN1	CAN1 terminated with 120 Ω	CAN1 not terminated
S11-3 & S11-4	CAN2	CAN2 terminated with 120 Ω	CAN2 not terminated

All other combinations of S11 (e.g., S11-1 ON & S11-2 OFF) are not permitted.

4.4 User and diagnostic interfaces

4.4.1 Display port

The LS1028A provides a GPU with an integrated LCD controller that supports DisplayPort 1.3 and eDP 1.4.
DisplayPort is implemented on the MBLS1028A-IND.
The DisplayPort connector X15 provides 3.3 V, which may be loaded with max. 500 mA. All signals provide ESD protection.

➢ Due to different electrical specifications of DisplayPort and eDP,
it may be necessary to correct the voltage swing or pre-emphasis level via software.

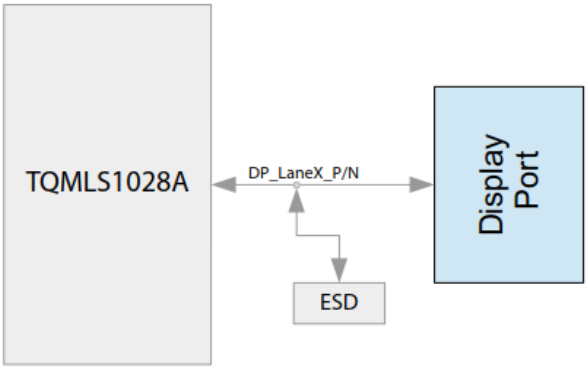

Figure 18: Block diagram display port

Table 17: Pinout display port, X15

Pin	Signal	Remark
1	DP_ML0+	ESD protection + 100 nF in series
2	DGND	–
3	DP_ML0–	ESD protection + 100 nF in series
4	DP_ML1+	ESD protection + 100 nF in series
5	DGND	–
6	DP_ML1–	ESD protection + 100 nF in series
7	DP_ML2+	ESD protection + 100 nF in series
8	DGND	–
9	DP_ML2–	ESD protection + 100 nF in series
10	DP_ML3+	ESD protection + 100 nF in series
11	DGND	–
12	DP_ML3–	ESD protection + 100 nF in series
13	DP_CFG1	1MΩ to DGND
14	DP_CFG2	1MΩ to DGND
15	DP_AUX_CH+	ESD protection + 100 nF in series
16	DGND	–
17	DP_AUX_CH–	ESD protection + 100 nF in series
18	DP_HPD_R	51 kΩ in series
19	DGND	–
20	V_3V3_DP	V_3V3
M1 … M4	DGND	–

4.4.2 Headers

The MBLS1028A-IND provides three 20-pin, 100 mil headers. On these headers all unused signals and those which should be easy to reach are provided. At the two headers X48 and X49 on the MBLS1028A-IND 1.8 V, 3.3 V and 5 V are available, at header X50, 3.3 V and 5 V are available. The maximum current load of all three voltage rails is 3 A each. The three headers share the available total power of the three respective voltage rails.

Table 18: Pinout Header 1, X48

Level	Group	Signal	Pin		Signal	Group	Level
5 V	Power	V_5V0_SW	1	2	V_3V3	Power	3.3 V
1.8 V	Power	V_1V8	3	4	DGND	Power	0 V
1.8 V	XSPI	XSPI1_A_DATA0	5	6	XSPI1_A_CS0#	XSPI	1.8 V
1.8 V	XSPI	XSPI1_A_DATA1	7	8	XSPI1_A_DQS	XSPI	1.8 V
1.8 V	XSPI	XSPI1_A_DATA2	9	10	XSPI1_A_SCK	XSPI	1.8 V
1.8 V	XSPI	XSPI1_A_DATA3	11	12	DGND	Power	0 V
0 V	Power	DGND	13	14	IIC5_SCL_3V3	I²C	3.3 V
1.8 V	Reset	PORESET#	15	16	IIC5_SDA_3V3	I²C	3.3 V
0 V	Reset	HRESET#	17	18	IIC6_SCL_3V3	I²C	3.3 V
1.8 V	Reset	RESET_REQ#	19	20	IIC6_SDA_3V3	I²C	3.3 V

Table 19: Pinout Header 2, X49

Level	Group	Signal	Pin		Signal	Group	Level
5 V	Power	V_5V0_SW	1	2	V_3V3	Power	3.3 V
1.8 V	Power	V_1V8	3	4	DGND	Power	0 V
1.8 V	SDHC	SDHC2_DS	5	6	SDHC2_DAT4	SDHC	1.8 V
1.8 V	SDHC	SDHC2_CMD	7	8	SDHC2_DAT5	SDHC	1.8 V
1.8 V	SDHC	SDHC2_CLK	9	10	SDHC2_DAT6	SDHC	1.8 V
0 V	Power	DGND	11	12	SDHC2_DAT7	SDHC	1.8 V
1.8 V	SDHC	SDHC2_DAT0	13	14	DGND	Power	0 V
1.8 V	SDHC	SDHC2_DAT1	15	16	SCAN_MODE#	System	1.8 V
1.8 V	SDHC	SDHC2_DAT2	17	18	TEST_SEL#	System	1.8 V
1.8 V	SDHC	SDHC2_DAT3	19	20	TBSCAN_EN#	System	1.8 V

Table 20: Pinout Header 3, X50

Level	Group	Signal	Pin		Signal	Group	Level
5 V	Power	V_5V0_SW	1	2	V_3V3	Power	3.3 V
3.3 V	SPI	SPI3_SCK_3V3	3	4	CLK_OUT	System	VBAT
3.3 V	SPI	SPI3_SOUT_3V3	5	6	ASLEEP	Debug	1.8 V
3.3 V	SPI	SPI3_SIN_3V3	7	8	TA_TMP_DETECT#	Trust	1.8 V
3.3 V	SPI	SPI3_PCS0_3V3	9	10	TA_BB_TMP_DETECT#	Trust	1.8 V
0 V	Power	DGND	11	12	DGND	Power	0 V
3.3 V	UART	UART2_SOUT_3V3	13	14	PROG_MTR	Factory Test	–
3.3 V	UART	UART2_SIN_3V3	15	16	FA_VL	Factory Test	–
5 V (OC)	System	RTC_INT_OUT#	17	18	TA_PROG_SFP	Factory Test	–
VBAT	System	RTC_CLKOUT	19	20	TA_BB_VDD	Power	(VDD)

4.4.2 Headers (continued)

Attention: Power drawn from 1.8 V, 3.3 V, and 5 V	
	The current drawn from 1.8 V, 3.3 V, and 5 V is added to the current consumption of MBLS1028A-IND and TQMLS1028A. Any additional power required at the voltage input of the MBLS1028A-IND has to be taken into account. The maximum current load of the fuse has to be observed.

Table 21: X48, X49, X50, type of headers

Manufacturer / part number	Description
SAMTEC / TSM-117-02-L-DV-A-P-TR	SMD header, 100 mil pitch, 2 × 10 pins

4.4.3 Reset Push button

A reset button (S10) is provided on the MBLS1028A-IND.

4.4.4 JTAG®

The JTAG® port of the TQMLS1028A is routed to a standard ARM® 10-pin JTAG® connector.
During normal operation, the JTAG® test reset pin (TRST#) must be grounded simultaneously with PORESET#.
If a boundary scan is to be performed, both signals must be controlled accordingly.
A Lauterbach debugger is intended for programming the modules.

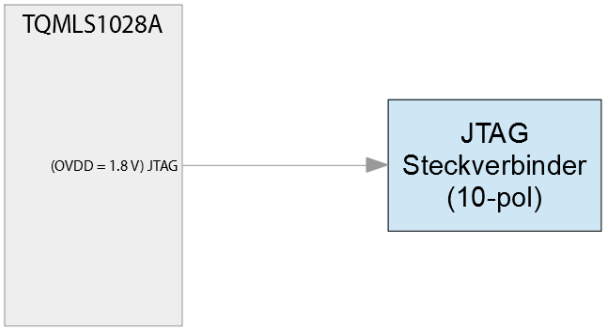

Figure 19: Block diagram JTAG®

The JTAG® interface is not protected against ESD.
The following table shows the pin assignment of the JTAG® connector.

Table 22: Pinout JTAG® header, X47

Pin	Signal	Remark
1	JTAG_VREF	100 Ω Pull-Up to 1.8 V, use only as reference
2	JTAG_TMS	10 kΩ Pull-Up to 1.8 V
3	DGND	–
4	JTAG_TCLK	–
5	DGND	–
6	JTAG_TDO	–
7	NC	–
8	JTAG_TDI	10 kΩ Pull-Up to 1.8 V
9	DGND	10 kΩ to DGND
10	JTAG_TRST#	10 kΩ Pull-Up to 1.8 V. Optional Open-Drain at JTAG_TRST#

4.4.5 USB Debug

A debug interface is available via UART1 of the TQMLS1028A. This UART is converted to USB via FTDI.

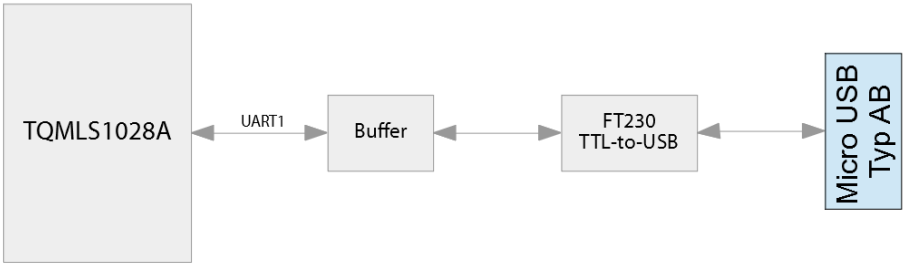

Figure 20: Block diagram Debug

Table 23: Pinout Debug USB, X44

Pin	Signal
1	V_USB_DBG_VBUS
2	USB_DBG_D–
3	USB_DBG_D+
4	NC
5	DGND
M1 … M6	DGND

5. SOFTWARE

No software is required for the MBLS1028A-IND.
Suitable software is only required on the TQMLS1028A and is not a part of this specification.
More information can be found in the Support Wiki for the TQMLS1028A.

6. MECHANICS

6.1 TQMLS1028A and MBLS1028A-IND dimensions

The MBLS1028A-IND has overall dimensions (length × width) of 160 × 100 mm².
The MBLS1028A-IND has a maximum height of approximately 26.4 mm.
The MBLS1028A-IND has six 4.3 mm mounting holes for the housing, and four 3.2 mm mounting holes for a heat sink.
The MBLS1028A-IND weighs approximately 156 grams without TQMLS1028A.

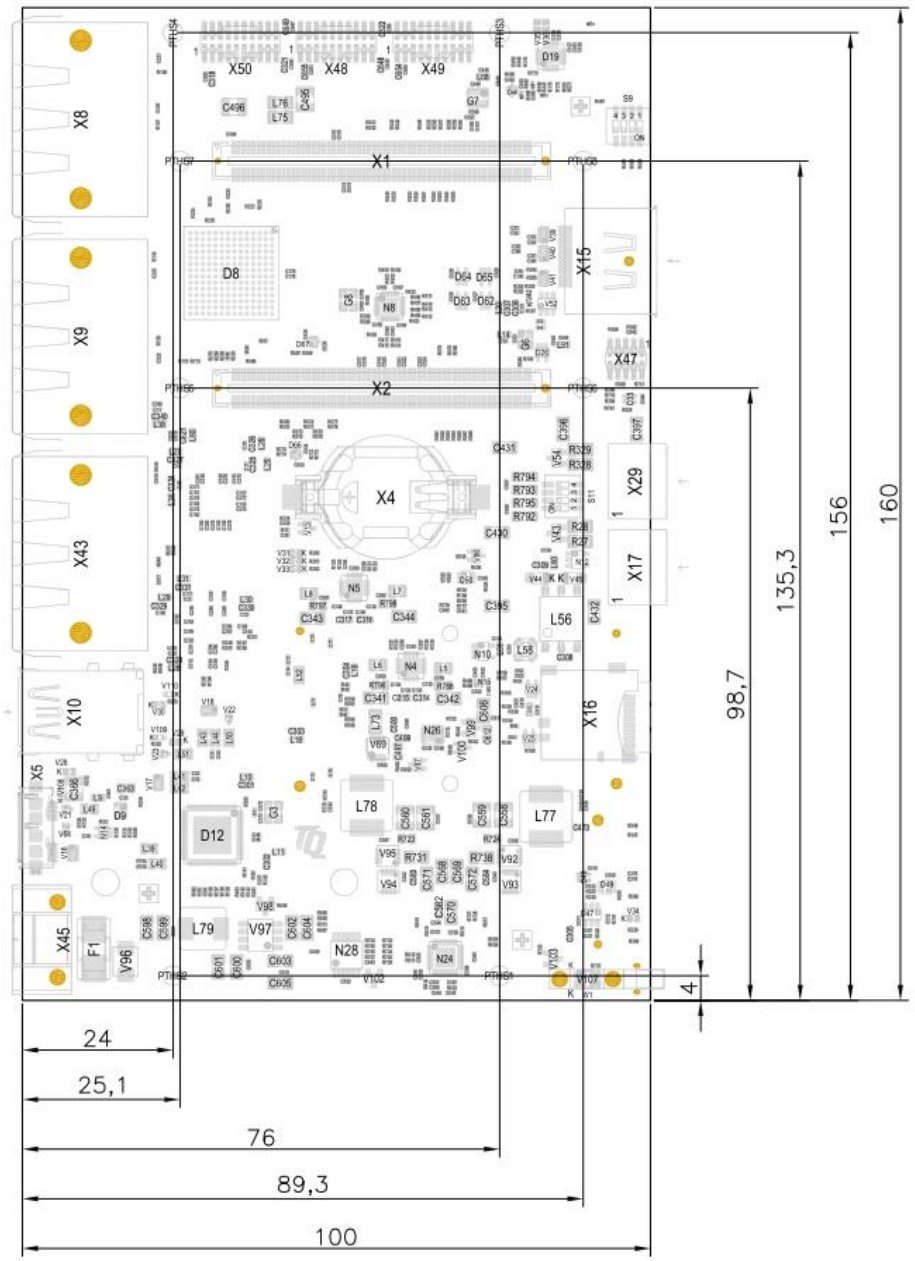

Figure 21: MBLS1028A-IND dimensions

6.2 Notes of treatment

The TQMLS1028A is held in its mating connectors with a retention force of approximately 24 N.

To avoid damage caused by mechanical stress, the TQMLS1028A may only be extracted from the MBLS1028A-IND by using the extraction tool MOZI8XX that can be obtained separately.

Note: Component placement on carrier board	
	2.5 mm should be kept free on the carrier board, on both long sides of the MBLS1028A-IND for the extraction tool MOZI8XX.

6.3 Embedding in the overall system

The MBLS1028A-IND serves as a design base for customer products, as well as a platform to support during development.

6.4 Housing

The form factor and the mounting holes of the MBLS1028A-IND are designed for installation in a standard EURO housing.

6.5 Thermal management

The MBLS1028A-IND has a maximum peak power consumption of approximately 3 watts. Further power loss occurs mainly at externally connected devices.

Attention: TQMLS1028A heat dissipation	
	The LS1028A CPU 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 TQMLS1028A must be taken into consideration when connecting the heat sink. The TQMLS1028A is not the highest component. Inadequate cooling connections can lead to overheating of the TQMLS1028A or the MBLS1028A-IND and thus malfunction, deterioration or destruction.

6.6 Assembly

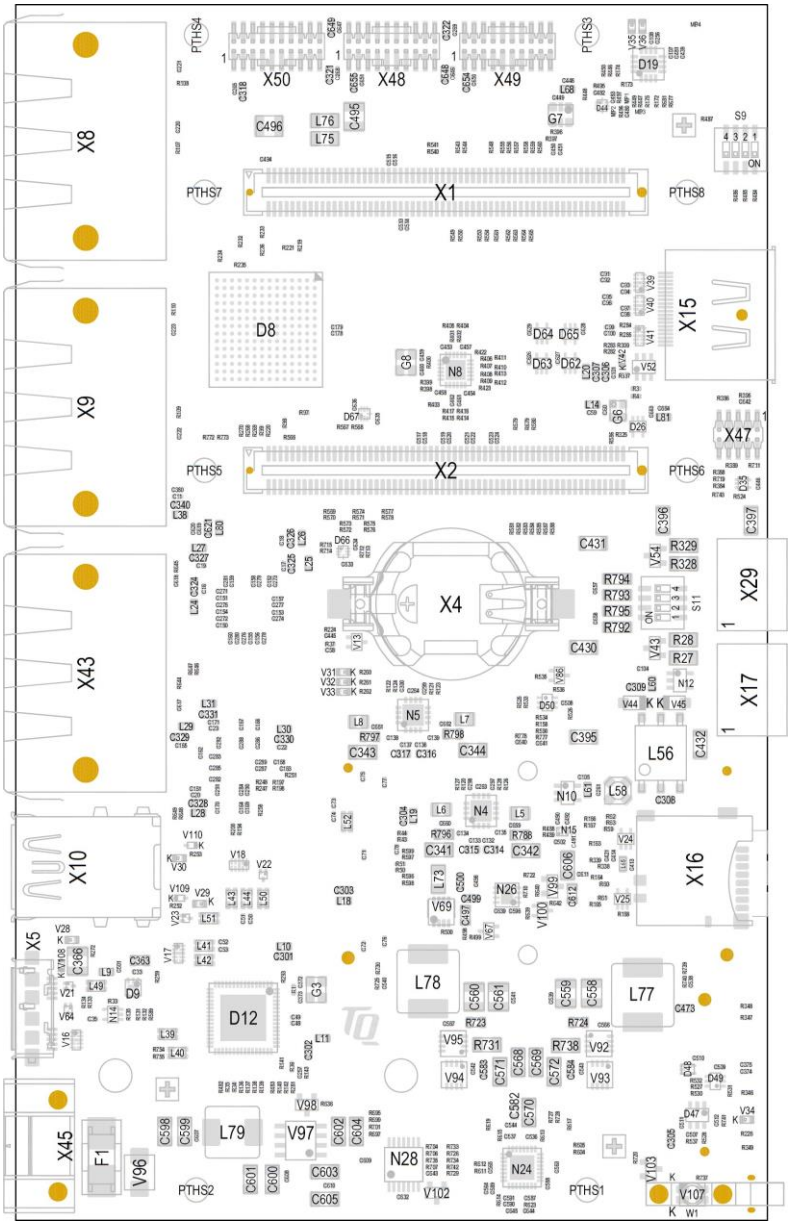

Figure 22: MBLS1028A-IND component placement top

6.6 Assembly (continued)

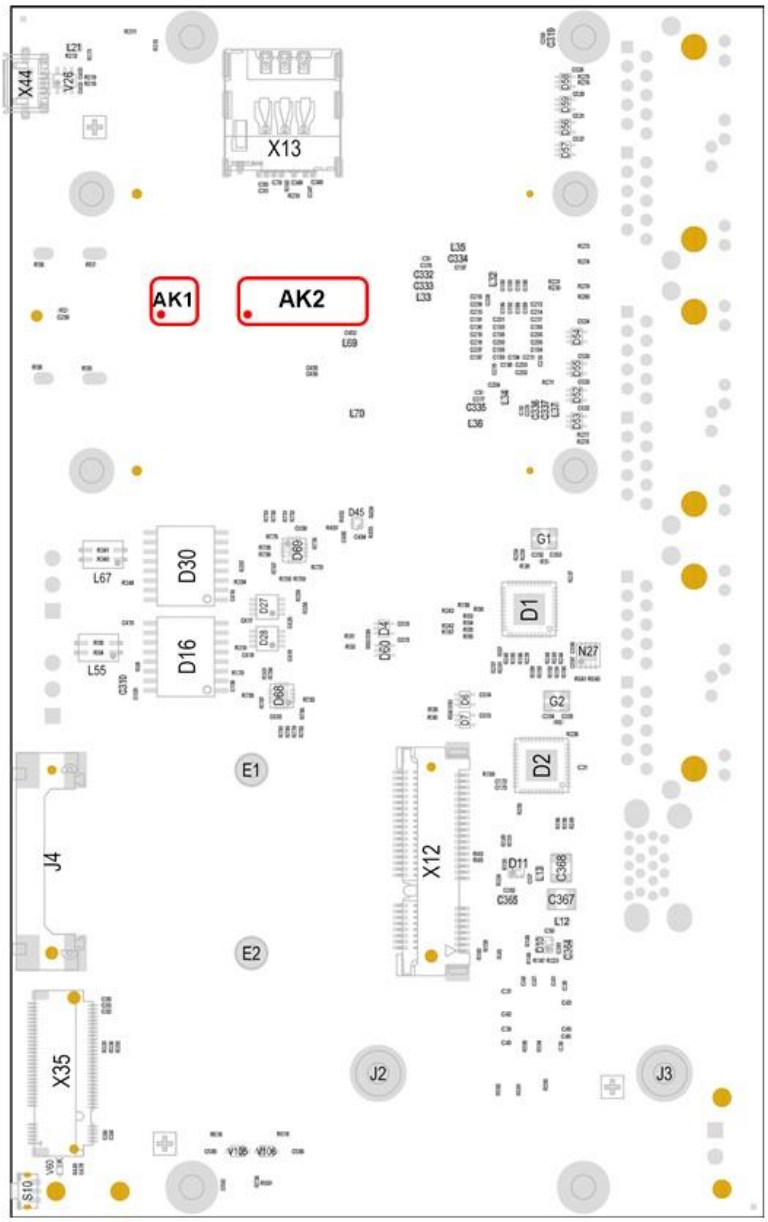

Figure 23: MBLS1028A-IND component placement bottom

The labels on the MBLS1028A-IND revision 01xx show the following information:

Table 24: Labels on MBLS1028A-IND revision 01xx

Label	Text
AK1	Serial number
AK2	MBLS1028A-IND version and revision, tests performed

7. SAFETY REQUIREMENTS AND PROTECTIVE REGULATIONS

7.1 EMC

Since the MBLS1028A-IND is a development platform, no EMC tests have been performed.

7.2 ESD

ESD protection is provided on most interfaces of the MBLS1028A-IND.
The circuit diagram shows which interfaces provide ESD protection.

7.3 Operational safety and personal security

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

7.4 Intended Use

TQ DEVICES, PRODUCTS AND ASSOCIATED SOFTWARE ARE NOT DESIGNED, MANUFACTURED OR INTENDED FOR USE OR RESALE FOR THE OPERATION IN NUCLEAR FACILITIES, AIRCRAFT OR OTHER TRANSPORTATION NAVIGATION OR COMMUNICATION SYSTEMS, AIR TRAFFIC CONTROL SYSTEMS, LIFE SUPPORT MACHINES, WEAPONS SYSTEMS, OR ANY OTHER EQUIPMENT OR APPLICATION REQUIRING FAIL-SAFE PERFORMANCE OR IN WHICH THE FAILURE OF TQ PRODUCTS COULD LEAD TO DEATH, PERSONAL INJURY, OR SEVERE PHYSICAL OR ENVIRONMENTAL DAMAGE. (COLLECTIVELY, "HIGH RISK APPLICATIONS")

You understand and agree that your use of TQ products or devices as a component in your applications are solely at your own risk. To minimize the risks associated with your products, devices and applications, you should take appropriate operational and design related protective measures.

You are solely responsible for complying with all legal, regulatory, safety and security requirements relating to your products. You are responsible for ensuring that your systems (and any TQ hardware or software components incorporated into your systems or products) comply with all applicable requirements. Unless otherwise explicitly stated in our product related documentation, TQ devices are not designed with fault tolerance capabilities or features and therefore cannot be considered as being designed, manufactured or otherwise set up to be compliant for any implementation or resale as a device in high risk applications. All application and safety information in this document (including application descriptions, suggested safety precautions, recommended TQ products or any other materials) is for reference only. Only trained personnel in a suitable work area are permitted to handle and operate TQ products and devices. Please follow the general IT security guidelines applicable to the country or location in which you intend to use the equipment.

7.5 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.

7.6 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

8. CLIMATIC AND OPERATIONAL CONDITIONS

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

Table 25: Climatic and operational conditions MBLS1028A-IND

Parameter	Range	Remark
Ambient temperature	0 °C to +60 °C	With Lithium battery
Ambient temperature	0 °C to +70 °C	Without Lithium battery
Storage temperature	–10 °C to +60 °C	With Lithium battery
Relative humidity (operation / storing)	10 % to 90 %	Not condensing

Attention: TQMLS1028A heat dissipation	
	The LS1028A CPU 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 TQMLS1028A must be taken into consideration when connecting the heat sink. The TQMLS1028A is not the highest component. Inadequate cooling connections can lead to overheating of the TQMLS1028A and thus malfunction, deterioration or destruction.

8.1 Protection against external effects

Protection class IP00 was defined for the MBLS1028A-IND. There is no protection against foreign objects, touch or humidity.

8.2 Reliability and service life

No detailed MTBF calculation was performed for the MBLS1028A-IND.

The MBLS1028A-IND is designed to be insensitive to vibration and impact.

9. ENVIRONMENT PROTECTION

9.1 RoHS

The MBLS1028A-IND is manufactured RoHS compliant.

- All components and assemblies are RoHS compliant
- The soldering processes are RoHS compliant

9.2 WEEE®

The final distributor is responsible for compliance with the WEEE® regulation.
Within the scope of the technical possibilities, the MBLS1028A-IND was designed to be recyclable and easy to repair.

9.3 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.

9.4 EuP

The Ecodesign Directive, also Energy using Products (EuP), is applicable to products for the end user with an annual quantity >200,000. The MBLS1028A-IND must therefore always be seen in conjunction with the complete device. The available standby and sleep modes of the components on the MBLS1028A-IND enable compliance with EuP requirements for the MBLS1028A-IND.

9.5 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.

9.6 Packaging

By environmentally friendly processes, production equipment and products, we contribute to the protection of our environment. To be able to reuse the MBLS1028A-IND, it is produced in such a way (a modular construction) that it can be easily repaired and disassembled. The energy consumption of this subassembly is minimised by suitable measures. The MBLS1028A-IND is delivered in reusable packaging.

9.7 Batteries

9.7.1 General notes

Due to technical reasons a battery is necessary for the MBLS1028A-IND. 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.

9.7.2 Lithium batteries

The requirements concerning special provision 188 of the ADR (section 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.

9.8 Other entries

By environmentally friendly processes, production equipment and products, we contribute to the protection of our environment.
To be able to reuse the MBLS1028A-IND, it is produced in such a way, that it can be easily repaired and disassembled. The energy consumption of this subassembly is minimised by suitable measures. Due to the fact that at the moment 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 of 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.

10. APPENDIX

10.1 Acronyms and definitions

The following acronyms and abbreviations are used in this document:

Table 26: Acronyms

Acronym	Meaning
AC	Alternating Current
ADC	Analog/Digital Converter
AHCI	Advanced Host Controller Interface
ARM®	Advanced RISC Machine
BGA	Ball Grid Array
BIOS	Basic Input/Output System
BSP	Board Support Package
CAN	Controller Area Network
CEC	Consumer Electronics Control
CPI	CEC Programming Interface (Silicon Image)
CPLD	Complex Programmable Logic Device
CPU	Central Processing Unit
DC	Direct Current
DDR4	Double Data Rate 4
DIP	Dual In-line Package
EDID	Extended Display Identification Data
eDP	Embedded Display Port
EEPROM	Electrically Erasable Programmable Read-Only Memory
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
eMMC	embedded Multimedia Card (flash)
ESD	Electrostatic Discharge
EuP	Energy using Products
FFC	Flat Flex Cable
FR-4	Flame Retardant 4
FTDI	Future Technology Devices International
GMII	Gigabit Media-Independent Interface
GPIO	General Purpose Input/Output
GPU	Graphics Processing Unit
GSM	Global System for Mobile Communications (Groupe Spécial Mobile)
HDMI	High Definition Multimedia Interface
I	Input
I/O	Input/Output
I²C	Inter-Integrated Circuit
IEEE®	Institute of Electrical and Electronics Engineers
IFC	Integrated Flash-Controller
IIC	Inter-Integrated Circuit
IP00	Ingress Protection 00
JTAG®	Joint Test Action Group
LCD	Liquid Crystal Display
LDO	Low Drop-Out
LED	Light Emitting Diode
LVDS	Low Voltage Differential Signalling
MAC	Media Access Controller
MOSFET	Metal-Oxide-Semiconductor Field-Effect Transistor
MOZI	Modulzieher (module extractor)
mPCIe	Mini Peripheral Component Interconnect Express
MTBF	Mean (operating) Time Between Failures
NA	Not Available
NC	Not Connected
NP	Not Placed
O	Output
OpenSDA	Serial and Debug Adapter (NXP)
OSI	Open Systems Interconnection

10.1 Acronyms and definitions (continued)

Table 26: Acronyms (continued)

Acronym	Meaning
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)
PMC	Power Management Controller
PMIC	Power Management Integrated Circuit
POR	Power-On Reset
PU	Pull-Up
PWM	Pulse-Width Modulation
PWP	Permanent Write Protected
QSGMII	Quad Serial Gigabit Media-Independent Interface
QSPI	Quad Serial Peripheral Interface
R/W	Read/Write
RCW	Reset Configuration Word
REACH®	Registration, Evaluation, Authorisation (and restriction of) Chemicals
RGB	Red Green Blue
RGMII	Reduced Gigabit Media Independent Interface
RISC	Reduced Instruction Set Computing
RJ-45	Registered Jack 45
RoHS	Restriction of (the use of certain) Hazardous Substances
RS-232, RS-485	Recommended Standard (serial interface)
RTC	Real-Time Clock
RWP	Reversible Write Protected
SAI	Serial Audio Interface
SATA	Serial Advanced Technology Attachment
SD	Secure Digital
SD/MMC	Secure Digital Multimedia Card
SDHC	Secure Digital High Capacity
SDR	Single Data Rate
SDRAM	Synchronous Dynamic Random Access Memory
SerDes	Serializer/Deserializer
SGMII	Serial Gigabit Media Independent Interface
SIM	Subscriber Identification Module
SMBUS	System Management Bus
SMD	Surface Mounted Device
SPI	Serial Peripheral Interface
SS	Super Speed
SSD	Solid-State Disk
SVHC	Substances of Very High Concern
TDM	Time-Division Multiplexing
TSN	Time Sensitive Networking
UART	Universal Asynchronous Receiver/Transmitter
UCC	Unified Communications Controller
UHS-I	Ultra High-Speed (Speed Grades I, II, III)
UM	User's Manual
UMTS	Universal Mobile Telecommunications System
UN	United Nations
USB	Universal Serial Bus
uSDHC	Ultra-Secured Digital Host Controller
WEEE®	Waste Electrical and Electronic Equipment
WLAN	Wireless Local Area Network
WPAN	Wireless Personal Area Network
WWAN	Wireless Wide Area Network
XSPI	Expanded Serial Peripheral Interface

10.2 References

Table 27: Further applicable documents

No.	Name	Rev., Date	Company
(1)	QorIQ® LS1028A Data Sheet	Rev. 0, 12/2019	NXP
(2)	QorIQ® LS1028A Reference Manual	Rev. 0, 12/2019	NXP
(3)	QorIQ® LS1028A Design Checklist, AN12028	Rev. 0, 12/2019	NXP
(4)	TQMLS1028A User's Manual	– current –	TQ-Systems
(5)	TQMLS1028A Support Wiki	– current –	TQ-Systems

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