TQMx50UC
User's Manual

TQMx50UC UM 0101

2018-09-26

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE DIRECTORY

ILLUSTRATION DIRECTORY

REVISION HISTORY

Rev.	Date	Name	Pos.	Modification
0100	2015-12-16	FP		First edition
0101	2017-07-04	FP	All 3.5.1, 3.5.2 3.7.2 6.5.2	Typo Information clarified Errors corrected Updated
0102	2018-09-26	FP	2.1 3.4.4.3 3.5.1, 3.5.2 7	"Memory": Type of EEPROM corrected "Peripheral interfaces": PCIe lane assignment clarified; Size and type of EEPROM corrected PCIe lane assignment clarified Reworked

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1.6   Tips on Safety

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

1.7   Symbols and Typographic Conventions

Table 1:   Terms and Conventions

Symbol	Meaning
⚠ (ESD symbol)	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.
⚠ (high voltage symbol)	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.
⚠ (warning symbol)	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.
⚠ (info symbol)	This symbol represents important details or aspects for working with TQ-products.
`Command`	A font with fixed-width is used to denote commands, contents, file names, or menu items.

1.8   Handling and ESD Tips

General handling of your TQ-products

⚠ (high voltage symbol)	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 TQMx50UC and be dangerous to your health. Improper handling of your TQ-product would render the guarantee invalid.

Proper ESD handling

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

1.9   Naming of Signals

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

Example: RESET#

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

Example: C / D#

If a signal has multiple functions, the individual functions are separated by slashes when they are important for the wiring.

The identification of the individual functions follows the above conventions.

Example: WE2# / OE#

1.10   Further Applicable Documents / Presumed Knowledge

- **Specifications and manual of the modules used:**
  These documents describe the service, functionality and special characteristics of the module used.

- **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.

Implementation information for the carrier board design is provided in the COM Express™ Design Guide (5) maintained by the PICMG®. This Carrier Design Guide includes a very good guideline to design a COM Express™ carrier board.

It includes detailed information with schematics and detailed layout guidelines.

Further information can be found in the official PICMG® documentation (4).

2.   INTRODUCTION

Based on the internationally established PICMG® standard COM Express™ (COM.0 R2.1), Compact, the TQMx50UC enables the design of not only powerful but also economical x86 based systems. The user has access to all essential interfaces of the CPU at the Type 6 compliant pin out connector. Hence all features of the 5th Generation Intel® Core™ processor can be used. The direct access to all interfaces gives the user the freedom to use the features of the CPU in the most suitable way for his application.

The compact and robust design as well as the option of conformal coating extends the use cases to applications within rugged industry, railway and aviation environments. Based on the very low-power consumption and the extended temperature support it is also possible to realize outdoor applications in an easy and reliable way.

2.1   Functional Overview

The following key functions are implemented on the TQMx50UC:

Processor:
- 5th Generation Intel® Core™ 5000U series ("Broadwell-U")
- Intel® Core™   i7-5650U: 2 × 2.2 GHz / 3.2 GHz Turbo, 4 MB Cache, HD6000
- Intel® Core™   i5-5350U: 2 × 1.8 GHz / 2.9 GHz Turbo, 3 MB Cache, HD6000
- Intel® Core™   i3-5010U: 2 × 2.1 GHz, 3 MB Cache, HD5500
- Intel® Celeron®   3765U: 2 × 1.7 GHz, 2 MB Cache, HD
- Hyper-Threading and Virtualization support
- 15 W TDP max. (configurable down to 9.5 / 10 W)

Memory:
- DDR3L-1600 dual channel: 4 Gbyte and 8 Gbyte memory down configuration
- EEPROM: 32 kbit (24AA32)

Graphics:
- Three independent display outputs:
- 2 × Digital Display Interface / DP++ with up to 4K; DisplayPort 1.2a with support for Multi-Stream Transport (MST)
- LVDS Interface (18/24 bit, single/dual channel); optional eDP 1.3 with 4 lanes

System interfaces:
- 1 × Gigabit Ethernet (Intel® i218)
- 2 × USB 3.0 (with USB 2.0 backward compatibility)
- 8 × USB 2.0 (incl. USB 3.0 ports)

Peripheral interfaces:
- 4 × SATA Gen3 (up to 6 Gb/s)
- 4 × PCIe 2.0 (×1) (up to 5 Gb/s), (4 (×1), 2 (×2) or 1 (×4))
- 4 × PCIe 2.0 PEG port (×1) (up to 5 Gb/s), (+1 additional PCIe 2.0 PEG port (×1), if no Ethernet)
- 1 × LPC bus
- 1 × Intel® HD audio (HDA)
- 1 × I²C, (2nd I²C optional) (master/slave capable)
- 1 × SMBus
- 1 × SPI (for external uEFI BIOS flash)
- 2 × Serial port (Rx/Tx, legacy compatible), 4-wire optional through TQ-flexiCFG
- 8 × GPIO through TQ-flexiCFG

Security components:
- TPM (SLB9660 TPM 1.2, alternatively SLB9665 TPM 2.0)

Others:
- TQMx86 board controller with Watchdog and TQ-flexiCFG
- Industrial real time clock (iRTC) (option)
- Hardware monitor

Power supply:
- Voltage: 8.5 V to 20 V, 5 V Standby (optional)
  3 V Battery for RTC (GoldCap option with iRTC)

Environment:
- Standard Temperature: 0 °C to +60 °C
- Extended temperature: −40 °C to +85 °C (on request)

Form factor / dimensions:
- COM Express™ Compact, Type 6, 95 × 95 mm²

2.2   Specification Compliance

The TQMx50UC is compliant to the PICMG$^®$ COM Express™ Module Base Specification (COM.0 R2.1) Compact, Type 6, 95 × 95 mm².

2.3   Versions

The TQMx50UC is available in several standard configurations.

- **TQMx50UC-AC ("Premium")**
  Intel$^®$ Core™ i7-5650U (2 × 2.2 GHz / 3.2 GHz Turbo, 4 MB Cache, HD6000 Gfx),
  8GB DDR3L-1600, TPM, Standard-Temp. 0 to +60 ℃

- **TQMx50UC-AB ("Mainstream")**
  Intel$^®$ Core™ i5-5350U (2 × 1.8 GHz / 2.9 GHz Turbo, 3 MB Cache, HD6000 Gfx),
  4GB DDR3L-1600, TPM, Standard-Temp. 0 to +60 ℃

- **TQMx50UC-AA ("Entry Level")**
  Intel$^®$ Core™ i3-5010U (2 × 2.1 GHz, 3 MB Cache, HD5500 Gfx),
  4GB DDR3L-1600, Standard-Temp. 0 to +60 ℃

- **TQMx50UC-AD ("Basic")**
  Intel$^®$ Celeron$^®$ 3765U (2 × 1.7 GHz, 2 MB Cache, HD Gfx),
  4GB DDR3L-1600, Standard-Temp. 0 to +60 ℃

Please visit to TQ-Group/TQMx50UC for a complete list of standard versions.
Other configurations are available on request.

Standard configuration features are:
- CPU version
- Memory configuration
- TPM
- Temperature range

Optional hardware and software configuration features:
- Conformal coating can be offered as a customer specific add-on
- Custom specific GPIO configuration through TQ-flexiCFG
- 4 (×1) PCIe lanes on PCI Express PEG port
- LVDS / eDP configuration
- iRTC
- Custom specific BIOS configuration

For further information regarding other versions, please contact TQ-Support.

2.4   Accessories

- **TQMx50UC-HSP (TQMx50UC-HSP-11-M-5083-BL)**
  Heat spreader for TQMx50UC according to the COM Express™ specification.

- **Evaluation platform MB-COME6-1**
  Mainboard for COM Express™ Compact Modules, Type 6.
  Interfaces: 2 × DP, LVDS, 2 × Gbit Ethernet, 4 × USB, 3 × COM, audio, mini PCIe, mSATA, 2.5″ SSD, SD card, riser extension with PCIe and USB, fan, debug.
  Dimensions: 170 × 170 mm².

3.   FUNCTIONAL SPECIFICATION

3.1   Block Diagram

The following illustration shows the block diagram of the TQMx50UC.
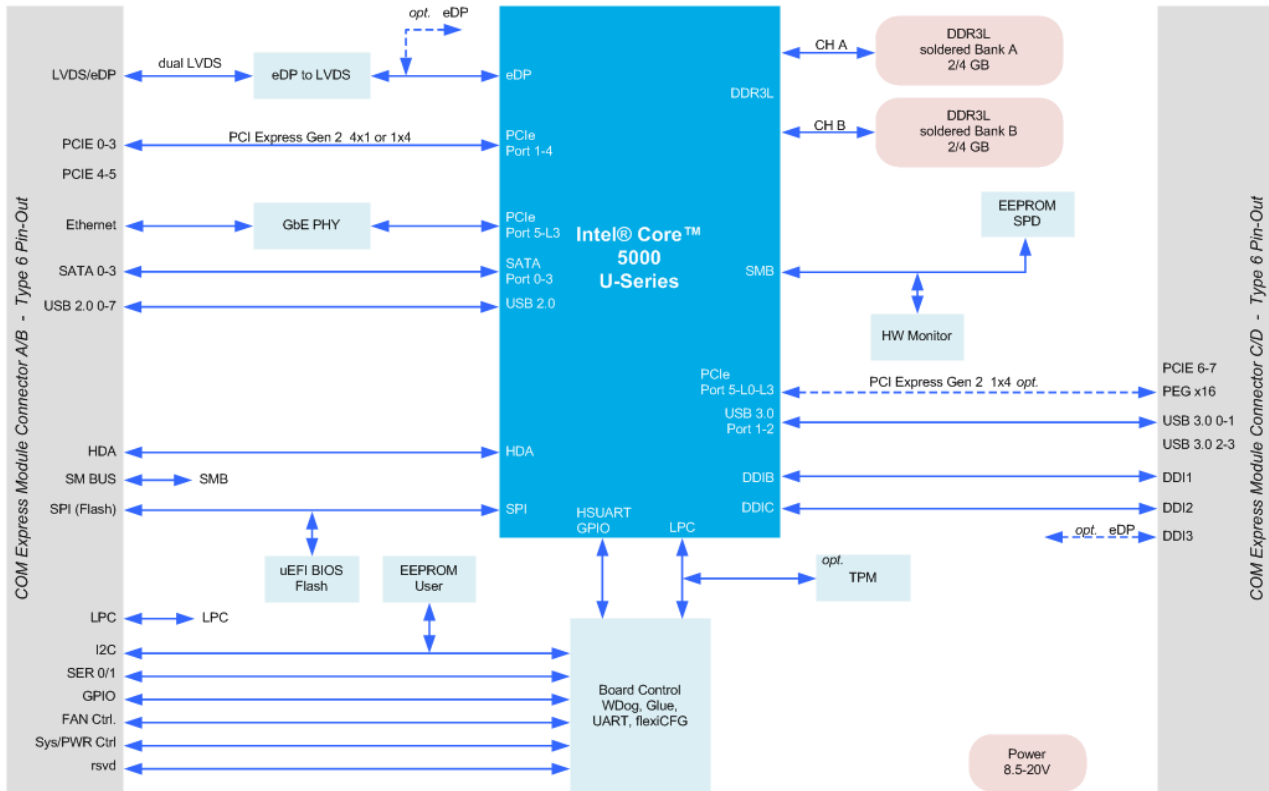
Illustration 1:   Block Diagram TQMx50UC

3.2   Electrical Specification

3.2.1   Supply Voltage Characteristics

The TQMx50UC supports a wide-range voltage input from 8.5 V to 20 V.

The following supply voltages are specified at the COM Express™ connector:

Wide input:	8.5 V to 20 V	maximum input ripple:	±100 mV
VCC_5V_SBY:	4.75 V to 5.25 V	maximum input ripple:	±50 mV
VCC_RTC:	2.0 V to 3.3 V	maximum input ripple:	±20 mV

The input voltages shall rise from 10 % of nominal to 90 % of nominal within 0.1 ms to 20 ms (0.1 ms ≤ Rise Time ≤ 20 ms).

There must be a smooth and continuous increase of each DC output voltage from 10 % to 90 % of its final set point within the regulation range.

Note: Power source
For single supply operations, the 5 V Standby voltage is not required. VCC_5V_SBY can be left open.

3.2.2   Power Consumption Specification

The power consumption values below show the voltage and power specifications of the TQMx50UC.

The values were measured with two power supplies; one for the TQMx50UC and the other one for the MB-COME6-1 COM Express™ carrier board.

The power consumption of each TQMx50UC was measured under Windows® 7, 64-bit.

All measurements were done at a temperature of +25 °C.

The power consumption of the TQMx50UC depends on the application, the mode of operation and the operating system.

The power consumption was measured under the following test modes:

- Windows® 7, 64-bit, idle state:
  Desktop idle state, Ethernet port is disconnected.
- Windows® 7, 64-bit, maximum workload (cTDP down mode enabled)
  These values show the maximum cTDP down power consumption using the Intel® stress test tool to stress the processor and graphic engine. Ethernet port is connected (1,000 Mbps Speed).
- Windows® 7, 64-bit, maximum workload:
  These values show the maximum worst case power consumption using the Intel® stress test tool to stress the processor and graphic engine. Ethernet port is connected (1,000 Mbps Speed).
- Suspend mode:
  The system is in S5/S4 state, Ethernet port is disconnected.
- Green ECO-Off state:
  The system is in Green ECO-Off state, all DC/DC power supplies on the TQMx50UC are switched off.

The following table shows the power consumption with different processor configurations.

Table 2:   TQMx50UC Power Consumption

TQMx50UC	Mode				
	Standby 5 V		Wide input 12 V		
	Green ECO-Off state	Suspend	Win7, 64 bit idle	Win7, 64 bit cTDP down max. load	Win7, 64 bit max. load
i7-5650U with 4 / 8 Gbyte DDR3L (TQMx50UC-AC)	4.0 mW	190.0 mW	3.5 W	11.4 W	16.5 W
i5-5350U with 4 / 8 Gbyte DDR3L (TQMx50UC-AB)	4.0 mW	190.0 mW	3.5 W	11.4 W	16.5 W
i3-5010U with 4 / 8 Gbyte DDR3L (TQMx50UC-AA)	4.0 mW	190.0 mW	3.6 W	11.8 W	16.3 W
Celeron 3765U with 4 / 8 Gbyte DDR3L (TQMx50UC-AD)	4.0 mW	190.0 mW	3.6 W	11.9 W	16.3 W

Note: Power requirement
The power supplies on the carrier board for the TQMx50UC must be designed with enough reserve. The carrier board should be able to provide at least twice the maximum workload power of the TQMx50UC. The TQMx50UC supports several low-power states. The power supply of the carrier board has to be stable even with no load.

3.2.3   Real Time Clock Current Specification

The RTC (VCC_RTC) current consumption is shown below.

The values were measured at +25 °C under battery operating conditions.

Table 3:   RTC Current Consumption

Mode	Voltage	Current
5th Generation Intel® Core™ 5000U series integrated RTC	3.0 V	3 µA
With iRTC option	3.0 V	300 nA

The current consumption of the RTC in the 5th Generation Intel® Core™ 5000U series processor Product Family Datasheet is specified with 6 µA in average, but the values measured on several TQMx50UC were lower.

3.3 Environmental Specification

- Temperature operating Standard: 0 °C to +60 °C
- Temperature operating Extended: −40 °C to +85 °C
- Temperature storage: −40 °C to +85 °C
- Relative humidity (operating / storage):   10 % to 90 % (not condensing)

Attention: Maximum operating temperature	
⚠	Do not operate the TQMx50UC if it is not attached properly to a heat spreader and a heat sink!

3.4 System Components

3.4.1 Processor

The TQMx50UC supports the 5th Generation Intel® Core™ 5000U series.
The following list illustrates some key features of the 5th Generation Intel® Core™ 5000U series processor:

- Ultra low-power, maximum 15 W
- Single, dual processor cores
- Intel® Hyper-Threading Technology (Intel® HT Technology)
- Intel® Streaming SIMD Extensions 4.2 (Intel® SSE4.2)
- Intel® Advanced Vector Extensions 2.0 (Intel® AVX2)
- Intel® 64 Architecture
- Intel® Turbo Boost Technology 2.0
- Intel® Configurable Thermal Design Power (Intel® cTDP)
- Intel® Enhanced Intel® SpeedStep® technology
- Up to 4 Mbyte cache
- Intel® HD Graphics
- Triple independent displays

Table 4:   Processor Specifications

Mode	i7-5650U	i5-5350U	i3-5010U	Celeron-3765U
Processor Cores / Threads	2 / 4	2 / 4	2 / 4	2 / 2
Cache	4 Mbyte	3 Mbyte	3 Mbyte	2 Mbyte
Core Base frequency	2.2 GHz	1.8 GHz	2.1 GHz	1.7 GHz
Core Turbo Single Core frequency	3.2 GHz	2.9 GHz	–	–
Core Turbo Dual Core frequency	3.1 GHz	2.7 GHz	–	–
Temperature T$_{junction}$	0 °C to +105 °C	0 °C to +105 °C	0 °C to +105 °C	0 °C to +105 °C
Memory speed	1,600 MT/s	1,600 MT/s	1,600 MT/s	1,600 MT/s
Max. memory	8 Gbyte	8 Gbyte	8 Gbyte	8 Gbyte
Memory configuration	Dual, no ECC	Dual, no ECC	Dual, no ECC	Dual, no ECC
Graphics	Intel® HD Graphics HD6000 (GT3)	Intel® HD Graphics HD6000 (GT3)	Intel® HD Graphics HD5500 (GT2)	Intel® HD Graphics HD (GT1)
Graphics Execution Units	48	48	24	12
Graphics Base frequency	0.3 GHz	0.3 GHz	0.3 GHz	0.1 GHz
Graphics Turbo frequency	1.0 GHz	1.0 GHz	0.9 GHz	0.8 GHz
Thermal Design Power (TDP)	15 W	15 W	15 W	15 W
Configurable Thermal Design Power (cTDP)	9.5 W	9.5 W	10 W	10 W

3.4.1.1 Intel® Turbo Boost Technology

Intel® Turbo Boost Technology accelerates processor and graphics performance for peak loads, automatically allowing processor cores to run faster than the rated operating frequency if they are operating below power, current, and temperature specification limits. Whether the processor enters into Intel® Turbo Boost Technology and the amount of time the processor spends in that state depends on the workload and operating environment.

The Intel® Turbo Boost Technology allows the processor to operate at a power level that is higher than its Thermal Design Power (TDP) configuration for short durations to maximize performance.

The Intel® Turbo Boost Technology can be configured in the uEFI BIOS, the default setting is "enabled".

Only the Intel® Core™ i7 and i5 processors support Intel® Turbo Boost Technology.

3.4.1.2 Intel® Configurable Thermal Design Power

The Intel® Configurable Thermal Design Power (cTDP) feature allows adjustment of the processor power consumption.

The cTDP down mode specifies a lower processor power consumption and lower guaranteed frequency versus the nominal mode. This mode can be selected for ultra low-power applications, e.g. systems with passive cooling solutions.

The cTDP can be configured in the uEFI BIOS, the default setting is "nominal".

3.4.2 Graphics

The 5th Generation Intel® Core™ 5000U processor series includes an integrated Intel® HD graphics accelerator. It provides excellent 2D / 3D graphics performance with triple simultaneous display support.

The following list illustrates some key features of the 5th Generation Intel® Core™ 5000U series processor:

- Graphics Technology GT3 with 48 Execution Units (HD6000)
- Graphics Technology GT2 with 24 Execution Units (HD5500)
- Graphics Technology GT1 with 12 Execution Units (HD)
- DirectX* 11.1, DirectX* 11.1+, DirectX* 11, DirectX* 10.1, DirectX* 10, DirectX* 9 support
- OpenGL* 4.0, OpenGL* 4.2 support

The TQMx50UC supports two Digital Display Interfaces (DDI0 and DDI1) and one dual LVDS interface at the COM Express™ connector.

Table 5:   Maximum Resolution in Dual Display Configuration

Display 1	Display 2	Display 3	Display 1 Max. resolution	Display 2 Max. resolution	Display 3 Max. resolution
HDMI	HDMI	dual LVDS	4096 × 2304 @ 24 Hz	4096 × 2304 @ 24 Hz	1920 × 1200 @ 60 Hz
HDMI	DP	dual LVDS	4096 × 2304 @ 24 Hz	3840 × 2160 @ 60 Hz	1920 × 1200 @ 60 Hz
DP	DP	dual LVDS	3840 × 2160 @ 60 Hz	3840 × 2160 @ 60 Hz	1920 × 1200 @ 60 Hz
HDMI	HDMI	eDP	4096 × 2304 @ 24 Hz	4096 × 2304 @ 24 Hz	3840 × 2160 @ 60 Hz
HDMI	DP	eDP	4096 × 2304 @ 24 Hz	3840 × 2160 @ 60 Hz	3840 × 2160 @ 60 Hz
DP	DP	eDP	3840 × 2160 @ 60 Hz	3840 × 2160 @ 60 Hz	3840 × 2160 @ 60 Hz

3.4.3 Chipset

The TQMx50UC provides the Intel® 9 Series PCH-LP integrated in the Multi-Chip package.

3.4.4   Memory

3.4.4.1   DDR3L SDRAM

The TQMx50UC supports a memory-down dual-channel DDR3L configuration without error-correcting code (ECC), running at up to 1600 MT/s. The maximum memory size is 8 Gbyte. The available memory configuration can be either 4 Gbyte or 8 Gbyte.

3.4.4.2   SPI Boot Flash

The TQMx50UC provides a 128 Mbit SPI boot flash. It includes the Intel® Management Engine (Intel® ME) and the uEFI BIOS. An external SPI boot flash can be used instead of the on-board SPI boot flash. The uEFI BIOS supports the following 3.3 V SPI flash devices on the carrier board:

- Winbond W25Q128FV
- Macronix MX25L12835F

3.4.4.3   EEPROM

The TQMx50UC provides an EEPROM. The 32 kbit (24AA32) EEPROM is connected to the general purpose I²C interface (COM Express™ pins I2C_DAT and I2C_CK).

3.4.5   Real Time Clock

The TQMx50UC provides a standard RTC (Motorola MC146818B) integrated in the 5th Generation Intel® Core™ 5000U processor series and a high accuracy, ultra-low-power industrial RTC (iRTC) as an assembly option.
The following list illustrates some key features of the iRTC:

- Lowest current consumption (typ. 240 nA)
- Optimized for GoldCap® capacitor backup
- Temperature compensation: –40 °C to +85 °C
- Time deviation ±0.26 s/day / ±3.0 ppm
- Time keeping voltage down to 1.5 V

Please contact TQ-Support for further information about the iRTC.

3.4.6   Trusted Platform Module

The TQMx50UC has been designed to support the Trusted Platform Module (TPM) 1.2 (Infineon SLB9660).
The TPM 2.0 configuration is available on request.

3.4.7   Hardware Monitor

The TQMx50UC provides an integrated Hardware Monitor to monitor the on-board and processor die temperature, board voltages and manage the fan control of the COM Express™ interface (FAN_PWMOUT and FAN_TACHOIN).

3.4.8   TQ Flexible I/O Configuration (TQ-flexiCFG)

The TQMx50UC provides a flexible I/O configuration feature, TQ-flexiCFG.
Using the TQ-flexiCFG, several COM Express™ I/O interfaces and functions can be configured via a programmable FPGA.
This feature enables the user to integrate special embedded features and configuration options in the TQMx50UC to reduce the carrier board design effort.
Here are some examples of the flexible I/O configuration:

- GPIO interrupt configuration
- Interrupt configuration via LPC Serial IRQ
- Serial port handshake signals via GPIOs
- Integrate additional I/O functions, e.g. additional Serial, CAN, I²C, PWM controller or special power management configurations

Please contact TQ-Support for further information about the TQ-flexiCFG.

3.4.9 Ultra Deep Power State Green ECO-Off

The TQMx50UC supports the ultra-deep power state Green ECO-Off. In this configuration all DC/DC power supplies on the TQMx50UC are switched off. This results in lowest power consumption.

The Green ECO-Off mode can be configured in the uEFI BIOS setup.

To wake up the system from the Green ECO-Off mode the power button signal must be pulled low for a minimum of 100 ms.

3.5 Interfaces

3.5.1 PCI Express

The TQMx50UC supports up to four PCI Express Gen2 ports (4 PCIe (×1) or 1 PCIe (×4)) at COM Express™ connector (Port 0 – 3).

The default configuration for the PCI Express lanes is 4 (×1).

PCI Express lane configurations 1 (×1), 1 (×2), or 1 (×4), can be configured with a customized BIOS.

3.5.2 PCI Express Graphics (PEG)

The TQMx50UC supports one optional PCI Express Gen2 port at the COM Express™ connector (PEG interface, 1 × PCIe (×4)).

Since this interface is routed to PCIe port 5 lanes 0 – 3, the Ethernet PHY at PCIe port 5 lane 3 has to be removed.
See also Illustration 1. Please contact TQ-Support for further information.

3.5.3 Gigabit Ethernet

The TQMx50UC provides the Intel® i218 Ethernet controller with 10/100/1000 Mbps speed.

3.5.4 Serial ATA

The TQMx50UC supports four SATA Gen 3.0 (6 Gbit/s) interfaces.

The integrated SATA host controller supports AHCI mode and it also supports RAID mode. The SATA controller no longer supports legacy IDE mode using I/O space.

The RAID capability provides high-performance RAID 0, 1, 5, and 10 functionality on up to 4 SATA ports of the SATA host controller. Matrix RAID support is provided to allow multiple RAID levels to be combined on a single set of hard drives, such as RAID 0 and RAID 1 on two disks. Other RAID features include hot spare support, SMART alerting, and RAID 0 auto replace.

Please contact TQ-Support for further information about the SATA RAID configuration.

3.5.5 Digital Display Interface

The TQMx50UC supports two Digital Display Interfaces (DDI0 and DDI1) at the COM Express™ connector DDI1 and DDI2.

The Digital Display Interface supports Display Port (DP), High Definition Multimedia Interface (HDMI) and Digital Visual Interface (DVI). On both DDI ports the maximum display resolutions are:

- DisplayPort 1.2a resolution up to 3840 × 2160 @ 60 Hz
- HDMI 1.4 up to 4096 × 2304 @ 24 Hz
- DVI up to 4096 × 2304 @ 24 Hz (HDMI without Audio)

3.5.6 LVDS Interface

The TQMx50UC supports a LVDS interface at the COM Express™ connector. The LVDS interface is provided through an on-board eDP to LVDS bridge.

The eDP to LVDS bridge supports single or dual bus LVDS signalling with colour depths of 18 bits per pixel or 24 bits per pixel up to 112 MHz and a resolution up to 1920 × 1200 @ 60 Hz in dual LVDS mode. The LVDS data packing can be configured either in VESA or JEIDA format.

To support panels without EDID ROM, the eDP to LVDS bridge can emulate EDID ROM behaviour avoiding specific changes in system video BIOS.

Please contact TQ-Support for further information about the LVDS configuration.

3.5.7 USB 2.0 Interfaces

The TQMx50UC supports eight USB 2.0 ports at the COM Express™ connector.

3.5.8   USB 3.0 Interfaces

The TQMx50UC supports two USB 3.0 port at the COM Express™ connector.

Table 6:   USB 3.0 COM Express™ Port Mapping

COM Express™	TQMx50UC
USB 0	USB 0
USB 1	USB 1

Note: USB Port Mapping	
	The USB 2.0 port 0 must be paired with USB 3.0 SuperSpeed port 0. The USB 2.0 port 1 must be paired with USB 3.0 SuperSpeed port 1.

3.5.9   General Purpose Input / Output

The TQMx50UC provides eight GPIO signals at the COM Express™ connector. The GPIO signals are shared with the SD card signals.

The GPIO signals are integrated in the TQ-flexiCFG block and can be configured flexibly. The signals can also be used for special functions (see 3.4.8).

3.5.10   High Definition Audio Interface

The TQMx50UC provides a High Definition Audio (HDA) interface, which supports two audio codecs at the COM Express™ connector. The HDA_SDIN2 signal at the COM Express™ is not connected.

3.5.11   LPC Bus

The TQMx50UC supports a Low Pin Count (LPC) legacy bus for I/O expansion.
The LPC bus Direct Memory Access (DMA) is not supported.

3.5.12   I²C Bus

The TQMx50UC supports a general purpose I²C port via a dedicated LPC to I²C controller integrated in the TQ-flexiCFG block. The I²C host controller supports a transfer rate of up to 400 kHz and can be configured independently.

3.5.13   SMBus

The TQMx50UC provides a System Management Bus (SMBus).

3.5.14   Serial Peripheral Interface

The TQMx50UC provides a Serial Peripheral Interface (SPI) interface.
The SPI interface can only be used for SPI boot Flash devices.

3.5.15 Serial Ports

The TQMx50UC offers a dual Universal Asynchronous Receiver and Transmitter (UART) controller. The register set is based on the industry standard 16550 UART. The UART operates with standard serial port drivers without requiring a custom driver to be installed. The 16 byte transmit and receive FIFOs reduce CPU overhead and minimize the risk of buffer overflow and data loss.

With the TQ-flexiCFG feature the serial ports can be configured to route the handshake signals to free pins at the COM Express™ connector.

Table 7:   Serial Port COM Express™ Port Mapping

COM Express™ Signal	COM Express™ Pin	TQMx50UC	Remark
SER0_TX	A98	SER0_TX	3.3 V output (without protection)
SER0_RX	A99	SER0_RX	3.3 V input (without protection)
SER1_TX	A101	SER1_TX	3.3 V output (without protection)
SER1_RX	A102	SER1_RX	3.3 V input (without protection)
SER0_RTS#	B98	SER0_RTS#	3.3 V output
SER0_CTS#	B99	SER0_CTS#	3.3 V input
SER1_RTS#	D24	SER1_RTS#	3.3 V output
SER1_CTS#	D25	SER1_CTS#	3.3 V input

Note: Protection circuits	
⚠ℹ	In Revision 2.0 of the COM Express™ specification the signals A98, A99, A101 and A102 have been reclaimed from the VCC_12V pool. Therefore protection on the TQMx50UC and on the carrier board is necessary to avoid damage to those when accidentally exposed to 12 V. The implementation of this circuitry causes lower transfer rates on the two serial ports. On the TQMx50UC the protection circuit is removed by default and the serial ports provide transfer rates of up to 115 kbaud. Therefore the TQMx50UC can only be used in a COM.0 Revision 2.0 Type 6 pinout carrier board.

3.5.16 Watchdog Timer

The TQMx50UC supports an independently programmable two stage Watchdog timer integrated in the TQ-flexiCFG block.

There are four operation modes available for the Watchdog timer:

- Dual-stage mode
- Interrupt mode
- Reset mode
- Timer mode

The Watchdog timer timeout ranges from 125 ms to 1 h.

The COM Express™ Specification does not support external hardware triggering of the Watchdog. An external Watchdog Trigger can be configured to GPIO pins at the COM Express™ connector with the TQ-flexiCFG feature.

3.6 Connectors

3.6.1 COM Express™ Connector

Two 220-pin 0.5 mm pitch receptacle connectors are used to interface the TQMx50UC on the carrier board.

On the carrier board two 220-pin 0.5 mm pitch plug connectors must be used. There are two versions with 5 mm and 8 mm stack height available.

3.6.2 Debug Header

The TQMx50UC provides a 14-pin flat cable connector to connect an external debug module (TQ specific) providing BIOS post code information, debug LEDs and a JTAG interface for on-board FPGA.
This header is for TQ internal use only.

Please contact TQ-Support for more details about the external debug module.

3.6.3 Debug Module LED

The TQMx50UC provides a dual colour LED providing boot and BIOS information.
The following table illustrates some LED boot messages:

Table 8:   LED boot messages

Red LED	Green LED	Remark
ON	OFF	Power supply error
ON	ON	S4/S5 state
BLINKING	BLINKING	S3 state
OFF	BLINKING	uEFI BIOS is booting
OFF	ON	uEFI BIOS boot is finished

3.7 COM Express™ Connector Pinout List

This section describes the TQMx50UC COM Express™ connector pin assignment, which is compliant with COMR.0 R2.1 Type 6 pinout definitions.

3.7.1 Signal Assignment Abbreviations

The following table lists the abbreviations used within this chapter:

Table 9:   Signal Assignment Abbreviations

Abbreviation	Description
GND	Ground
PWR	Power
I	Input
I PU	Input with pull-up resistor
I PD	Input with pull-down resistor
O	Output
OD	Open drain output
I/O	Bi-directional

Note: Unused signals on the carrier board
If the input signals at the COM Express™ connector are not used, these signals can be left open on the carrier board, since these signals have a termination on the TQMx50UC.

3.7.2   COM Express™ Connector Pin Assignment

Table 10:   COM Express™ Connector Pin Assignment

Pin	Pin-Signal	Description	Type	Remark
A1	GND(FIXED)	Ground	GND	
A2	GBE0_MDI3−	Gigabit Ethernet Controller 0: Media Dependent Interface	I/O	
A3	GBE0_MDI3+	Gigabit Ethernet Controller 0: Media Dependent Interface	I/O	
A4	GBE0_LINK100#	Gigabit Ethernet Controller 0 100 Mbit / sec link indicator	OD	
A5	GBE0_LINK1000#	Gigabit Ethernet Controller 0 1000 Mbit / sec link indicator	OD	
A6	GBE0_MDI2−	Gigabit Ethernet Controller 0: Media Dependent Interface	I/O	
A7	GBE0_MDI2+	Gigabit Ethernet Controller 0: Media Dependent Interface	I/O	
A8	GBE0_LINK#	Gigabit Ethernet Controller 0 link indicator	OD	
A9	GBE0_MDI1−	Gigabit Ethernet Controller 0: Media Dependent Interface	I/O	
A10	GBE0_MDI1+	Gigabit Ethernet Controller 0: Media Dependent Interface	I/O	
A11	GND(FIXED)	Ground	GND	
A12	GBE0_MDI0−	Gigabit Ethernet Controller 0: Media Dependent Interface	I/O	
A13	GBE0_MDI0+	Gigabit Ethernet Controller 0: Media Dependent Interface	I/O	
A14	GBE0_CTREF	Reference voltage for Carrier Board Ethernet channel 0	Power	
A15	SUS_S3#	Indicates system is in Suspend to RAM state. Active low output.	O PD	TQ-flexiCFG
A16	SATA0_TX+	SATA differential transmit pairs	O	
A17	SATA0_TX−	SATA differential transmit pairs	O	
A18	SUS_S4#	Indicates system is in Suspend to Disk state. Active low output.	O PD	TQ-flexiCFG
A19	SATA0_RX+	SATA differential receive pairs	I	
A20	SATA0_RX−	SATA differential receive pairs	I	
A21	GND(FIXED)	Ground	GND	
A22	SATA2_TX+	SATA differential transmit pairs	O	
A23	SATA2_TX−	SATA differential transmit pairs	O	
A24	SUS_S5#	Indicates system is in Soft Off state. Active low output.	O PD	TQ-flexiCFG
A25	SATA2_RX+	SATA differential receive pairs	I	
A26	SATA2_RX−	SATA differential receive pairs	I	
A27	BATLOW#	Indicates that external battery is low	I PU	
A28	(S)ATA_ACT#	SATA activity indicator	O	
A29	AC/HDA_SYNC	Sample-synchronization signal to the CODEC(s)	O	
A30	AC/HDA_RST#	Reset output to CODEC, active low.	O	
A31	GND(FIXED)	Ground	GND	
A32	AC/HDA_BITCLK	Serial data clock generated by the external CODEC(s)	I/O	
A33	AC/HDA_SDOUT	Serial TDM data output to the CODEC	O	
A34	BIOS_DIS0#	Selection straps to determine the BIOS boot device	I PU	
A35	THRMTRIP#	indicating that the CPU has entered thermal shutdown	O	
A36	USB6−	USB differential pairs	I/O	
A37	USB6+	USB differential pairs	I/O	
A38	USB_6_7_OC#	USB over-current sense, USB channels 6 and 7	I PU	
A39	USB4−	USB differential pairs	I/O	
A40	USB4+	USB differential pairs	I/O	
A41	GND(FIXED)	Ground	GND	
A42	USB2−	USB differential pairs	I/O	
A43	USB2+	USB differential pairs	I/O	
A44	USB_2_3_OC#	USB over-current sense, USB channels 2 and 3	I PU	
A45	USB0−	USB differential pairs	I/O	
A46	USB0+	USB differential pairs	I/O	
A47	VCC_RTC	Real-time clock circuit-power input. Nominal +3.0 V	Power	
A48	EXCD0_PERST#	PCI ExpressCard: reset, active low, one per card	O	TQ-flexiCFG
A49	EXCD0_CPPE#	PCI ExpressCard: PCI Express capable card request, active low	I PU	TQ-flexiCFG
A50	LPC_SERIRQ	LPC serial interrupt	I/O	TQ-flexiCFG
A51	GND(FIXED)	Ground	GND	
A52	PCIE_TX5+	PCI Express differential transmit pairs	O	N/A
A53	PCIE_TX5−	PCI Express differential transmit pairs	O	N/A
A54	GPI0/SD_DATA0	GPI0 / SDIO Data lines	I PU	TQ-flexiCFG
A55	PCIE_TX4+	PCI Express differential transmit pairs	O	N/A

Table 10:   COM Express™ Connector Pin Assignment (continued)

Pin	Pin-Signal	Description	Type	Remark
A56	PCIE_TX4–	PCI Express differential transmit pairs	O	N/A
A57	GND	Ground	GND	
A58	PCIE_TX3+	PCI Express differential transmit pairs	O	
A59	PCIE_TX3–	PCI Express differential transmit pairs	O	
A60	GND(FIXED)	Ground	GND	
A61	PCIE_TX2+	PCI Express differential transmit pairs	O	
A62	PCIE_TX2–	PCI Express differential transmit pairs	O	
A63	GPI1/SD_DATA1	GPI1 / SDIO Data lines	I PU	TQ-flexiCFG
A64	PCIE_TX1+	PCI Express differential transmit pairs	O	
A65	PCIE_TX1–	PCI Express differential transmit pairs	O	
A66	GND	Ground	GND	
A67	GPI2/SD_DATA2	GPI2 / SDIO Data lines	I PU	TQ-flexiCFG
A68	PCIE_TX0+	PCI Express differential transmit pairs	O	
A69	PCIE_TX0–	PCI Express differential transmit pairs	O	
A70	GND(FIXED)	Ground	GND	
A71	LVDS_A0+	LVDS Channel A differential pairs 0	O	
A72	LVDS_A0–	LVDS Channel A differential pairs 0	O	
A73	LVDS_A1+	LVDS Channel A differential pairs 1	O	
A74	LVDS_A1–	LVDS Channel A differential pairs 1	O	
A75	LVDS_A2+	LVDS Channel A differential pairs 2	O	
A76	LVDS_A2–	LVDS Channel A differential pairs 2	O	
A77	LVDS_VDD_EN	LVDS eDP panel power enable	O	
A78	LVDS_A3+	LVDS Channel A differential pairs 3	O	
A79	LVDS_A3–	LVDS Channel A differential pairs 3	O	
A80	GND(FIXED)	Ground	GND	
A81	LVDS_A_CK+	LVDS Channel A differential clock	O	
A82	LVDS_A_CK–	LVDS Channel A differential clock	O	
A83	LVDS_I2C_CK	I²C clock output for LVDS display	I/O	
A84	LVDS_I2C_DAT	I²C data line for LVDS display	I/O	
A85	GPI3/SD_DATA3	GPI3 / SD_DATA3	I/O	TQ-flexiCFG
A86	RSVD18	Reserved	NC	
A87	eDP_HPD	eDP Detection of Hot Plug	I PD	optional eDP
A88	PCIE_CLK_REF+	Reference clock output for all PCI Express lanes	O	
A89	PCIE_CLK_REF–	Reference clock output for all PCI Express lanes	O	
A90	GND(FIXED)	Ground	GND	
A91	SPI_POWER	Power supply for Carrier Board SPI	PWR	
A92	SPI_MISO	Data in to TQMx50UC from Carrier SPI	I PU	
A93	GPO0/SD_CLK	GPO0 / SDIO Clock	O PD	TQ-flexiCFG
A94	SPI_CLK	Clock from TQMx50UC to Carrier SPI	O	
A95	SPI_MOSI	Data out from TQMx50UC to Carrier SPI	O	
A96	TPM_PP	Trusted Platform Module (TPM) Physical Presence pin	I PD	TQ-flexiCFG
A97	TYPE10#	Type 10 Module indication (NC)	NC	
A98	SER0_TX	Serial port 0 transmitter	O 3V3	without protection
A99	SER0_RX	Serial port 0 receiver	I 3V3	without protection
A100	GND(FIXED)	Ground	GND	
A101	SER1_TX	Serial port 1 transmitter	O 3V3	without protection
A102	SER1_RX	Serial port 1 receiver	I 3V3	without protection
A103	LID#	LID switch	I PU	
A104	VCC_12V	Primary wide power input	PWR	
A105	VCC_12V	Primary wide power input	PWR	
A106	VCC_12V	Primary wide power input	PWR	
A107	VCC_12V	Primary wide power input	PWR	
A108	VCC_12V	Primary wide power input	PWR	
A109	VCC_12V	Primary wide power input	PWR	
A110	GND(FIXED)	Ground	GND	

Table 10:   COM Express™ Connector Pin Assignment (continued)

Pin	Pin-Signal	Description	Type	Remark
B1	GND(FIXED)	Ground	GND	
B2	GBE0_ACT#	Gigabit Ethernet Controller 0 active indicator	OD	
B3	LPC_FRAME#	LPC frame indicates the start of an LPC cycle	I/O	
B4	LPC_AD0	LPC multiplexed address, command and data bus	I/O	
B5	LPC_AD1	LPC multiplexed address, command and data bus	I/O	
B6	LPC_AD2	LPC multiplexed address, command and data bus	I/O	
B7	LPC_AD3	LPC multiplexed address, command and data bus	I/O	
B8	(LPC_DRQ0#) GPIO	LPC serial DMA request	I/O	N/A TQ-flexiCFG
B9	(LPC_DRQ1#) GPIO	LPC serial DMA request	I/O	N/A TQ-flexiCFG
B10	LPC_CLK	LPC clock output	O	
B11	GND(FIXED)	Ground	GND	
B12	PWRBTN#	Power button input	I PU	TQ-flexiCFG
B13	SMB_CK	System Management Bus bidirectional clock line	I/O	
B14	SMB_DAT	System Management Bus bidirectional data line	I/O	
B15	SMB_ALERT#	System Management Bus Alert	I PU	
B16	SATA1_TX+	SATA differential transmit pairs	O	
B17	SATA1_TX−	SATA differential transmit pairs	O	
B18	SUS_STAT#	Indicates imminent suspend operation	O	
B19	SATA1_RX+	SATA differential receive pairs	I	
B20	SATA1_RX−	SATA differential receive pairs	I	
B21	GND(FIXED)	Ground	GND	
B22	SATA3_TX+	SATA differential transmit pairs	O	
B23	SATA3_TX−	SATA differential transmit pairs	O	
B24	PWR_OK	Power OK from main power supply	I PU	TQ-flexiCFG
B25	SATA3_RX+	SATA differential receive pairs	I	
B26	SATA3_RX−	SATA differential receive pairs	I	
B27	WDT	watchdog time-out	O	TQ-flexiCFG
B28	AC/HDA_SDIN2	Serial TDM data input	I PU	N/A
B29	AC/HDA_SDIN1	Serial TDM data input	I PU	
B30	AC/HDA_SDIN0	Serial TDM data input	I PU	
B31	GND(FIXED)	Ground	GND	
B32	SPKR	PC Audio Speaker output	O	
B33	I2C_CK	General purpose I²C port clock output	I/O	TQ-flexiCFG
B34	I2C_DAT	General purpose I²C port data I/O line	I/O	TQ-flexiCFG
B35	THRM#	Input from carrier temperature sensor	I PU	
B36	USB7−	USB differential pairs	I/O	
B37	USB7+	USB differential pairs	I/O	
B38	USB_4_5_OC#	USB over-current sense, USB channels 4 and 5	I PU	
B39	USB5−	USB differential pairs	I/O	
B40	USB5+	USB differential pairs	I/O	
B41	GND(FIXED)	Ground	GND	
B42	USB3−	USB differential pairs	I/O	
B43	USB3+	USB differential pairs	I/O	
B44	USB_0_1_OC#	USB over-current sense, USB channels 0 and 1	I PU	
B45	USB1−	USB differential pairs	I/O	
B46	USB1+	USB differential pairs	I/O	
B47	EXCD1_PERST#	PCI ExpressCard: reset, active low, one per card	O	TQ-flexiCFG
B48	EXCD1_CPPE#	PCI ExpressCard: PCI Express capable card request, active low	I PU	TQ-flexiCFG
B49	SYS_RESET#	Reset button input	I PU	TQ-flexiCFG
B50	CB_RESET#	Reset output from TQMx50UC to Carrier Board	O	TQ-flexiCFG
B51	GND(FIXED)	Ground	GND	
B52	PCIE_RX5+	PCI Express differential receive pairs	I	N/A
B53	PCIE_RX5−	PCI Express differential receive pairs	I	N/A
B54	GPO1/SD_CMD	GPO1 / SDIO Command	O PD	TQ-flexiCFG
B55	PCIE_RX4+	PCI Express differential receive pairs	I	N/A

Table 10:   COM Express™ Connector Pin Assignment (continued)

Pin	Pin-Signal	Description	Type	Remark
B56	PCIE_RX4–	PCI Express differential receive pairs	I	N/A
B57	GPO2 / SD_WP	GPO2 / SDIO Write Protect	O PD	TQ-flexiCFG
B58	PCIE_RX3+	PCI Express differential receive pairs	I	
B59	PCIE_RX3–	PCI Express differential receive pairs	I	
B60	GND(FIXED)	Ground	GND	
B61	PCIE_RX2+	PCI Express differential receive pairs	I	
B62	PCIE_RX2–	PCI Express differential receive pairs	I	
B63	GPO3/SD_CD#	GPO3 / SDIO Card Detect	O PD	TQ-flexiCFG
B64	PCIE_RX1+	PCI Express differential receive pairs	I	
B65	PCIE_RX1–	PCI Express differential receive pairs	I	
B66	WAKE0#	PCI Express wake up signal	I PU	TQ-flexiCFG
B67	WAKE1#	General purpose wake up signal	I PU	TQ-flexiCFG
B68	PCIE_RX0+	PCI Express differential receive pairs	I	
B69	PCIE_RX0–	PCI Express differential receive pairs	I	
B70	GND(FIXED)	Ground	GND	
B71	LVDS_B0+	LVDS Channel B differential pairs 0	O	
B72	LVDS_B0–	LVDS Channel B differential pairs 0	O	
B73	LVDS_B1+	LVDS Channel B differential pairs 1	O	
B74	LVDS_B1–	LVDS Channel B differential pairs 1	O	
B75	LVDS_B2+	LVDS Channel B differential pairs 2	O	
B76	LVDS_B2–	LVDS Channel B differential pairs 2	O	
B77	LVDS_B3+	LVDS Channel B differential pairs 3	O	
B78	LVDS_B3–	LVDS Channel B differential pairs 3	O	
B79	LVDS_BKLT_EN	LVDS panel backlight enable	O	
B80	GND(FIXED)	Ground	GND	
B81	LVDS_B_CK+	LVDS Channel B differential clock	O	
B82	LVDS_B_CK–	LVDS Channel B differential clock	O	
B83	LVDS_BKLT_CTRL	LVDS panel backlight brightness control	O	
B84	VCC_5V_SBY	Standby power input: +5.0 V nominal	PWR	
B85	VCC_5V_SBY	Standby power input: +5.0 V nominal	PWR	
B86	VCC_5V_SBY	Standby power input: +5.0 V nominal	PWR	
B87	VCC_5V_SBY	Standby power input: +5.0 V nominal	PWR	
B88	BIOS_DIS1#	Selection straps to determine the BIOS boot device	I PU	
B89	VGA_RED	Red for monitor	O	N/A
B90	GND(FIXED)	Ground	GND	
B91	VGA_GRN	Green for monitor	O	N/A
B92	VGA_BLU	Blue for monitor	O	N/A
B93	VGA_HSYNC	Horizontal sync output to VGA monitor	O	N/A
B94	VGA_VSYNC	Vertical sync output to VGA monitor	O	N/A
B95	VGA_I2C_CK	DDC clock line	O	N/A
B96	VGA_I2C_DAT	DDC data line	I/O	N/A
B97	SPI_CS#	Chip select for Carrier Board SPI	O	
B98	(RSVD) SER0_RTS#	Serial port 0 Request To Send	O	TQ-flexiCFG
B99	(RSVD) SER0_CTS#	Serial port 0 Clear To Send	I PU	TQ-flexiCFG
B100	GND(FIXED)	Ground	GND	
B101	FAN_PWMOUT	Fan Pulse Width Modulation speed control output	O	
B102	FAN_TACHIN	Fan tachometer input	I PU	
B103	SLEEP#	Sleep button	I PU	
B104	VCC_12V	Primary wide power input	PWR	
B105	VCC_12V	Primary wide power input	PWR	
B106	VCC_12V	Primary wide power input	PWR	
B107	VCC_12V	Primary wide power input	PWR	
B108	VCC_12V	Primary wide power input	PWR	
B109	VCC_12V	Primary wide power input	PWR	
B110	GND(FIXED)	Ground	GND	

Table 10:   COM Express™ Connector Pin Assignment (continued)

Pin	Pin-Signal	Description	Type	Remark
C1	GND(FIXED)	Ground	GND	
C2	GND	Ground	GND	
C3	USB_SSRX0−	SuperSpeed USB3.0 differential receive pairs	I	
C4	USB_SSRX0+	SuperSpeed USB3.0 differentia receive pairs	I	
C5	GND	Ground	GND	
C6	USB_SSRX1−	SuperSpeed USB3.0 differentia receive pairs	I	
C7	USB_SSRX1+	SuperSpeed USB3.0 differentia receive pairs	I	
C8	GND	Ground	GND	
C9	USB_SSRX2−	SuperSpeed USB3.0 differentia receive pairs	I	N/A
C10	USB_SSRX2+	SuperSpeed USB3.0 differentia receive pairs	I	N/A
C11	GND(FIXED)	Ground	GND	
C12	USB_SSRX3−	SuperSpeed USB3.0 differentia receive pairs	I	N/A
C13	USB_SSRX3+	SuperSpeed USB3.0 differentia receive pairs	I	N/A
C14	GND	Ground	GND	
C15	DDI1_PAIR6+	DDI1 DP / HDMI / DVI differential pairs 6	O	N/A
C16	DDI1_PAIR6−	DDI1 DP / HDMI / DVI differential pairs 6	O	N/A
C17	RSVD18	Reserved	NC	
C18	RSVD18	Reserved	NC	
C19	PCIE_RX6+	PCI Express differential receive pairs	I	N/A
C20	PCIE_RX6−	PCI Express differential receive pairs	I	N/A
C21	GND(FIXED)	Ground	GND	
C22	PCIE_RX7+	PCI Express differential receive pairs	I	N/A
C23	PCIE_RX7−	PCI Express differential receive pairs	I	N/A
C24	DDI1_HPD	DDI1 Detection of Hot Plug	I PD	
C25	DDI1_PAIR4+	DDI1 DP / HDMI / DVI differential pairs 4	O	N/A
C26	DDI1_PAIR4−	DDI1 DP / HDMI / DVI differential pairs 4	O	N/A
C27	RSVD18	Reserved	NC	
C28	RSVD18	Reserved	NC	
C29	DDI1_PAIR5+	DDI1 DP / HDMI / DVI differential pairs 5	O	N/A
C30	DDI1_PAIR5−	DDI1 DP / HDMI / DVI differential pairs 5	O	N/A
C31	GND(FIXED)	Ground	GND	
C32	DDI2_CTRLCLK_AUX+	DDI2_CTRLCLK_AUX+ signal DP AUX, HDMI / DVI CLK	I/O	
C33	DDI2_CTRLDATA_AUX−	DDI2_CTRLDATA_AUX− signal DP AUX, HDMI / DVI DATA	I/O	
C34	DDI2_DDC_AUX_SEL	Selects the function of DDI2_CTRLxAUX+/− Signals	I PD	
C35	RSVD18	Reserved	NC	
C36	DDI3_CTRLCLK_AUX+	DDI3_CTRLCLK_AUX+ signal DP AUX, HDMI / DVI CLK	I/O	N/A
C37	DDI3_CTRLDATA_AUX−	DDI3_CTRLDATA_AUX− signal DP AUX, HDMI / DVI DATA	I/O	N/A
C38	DDI3_DDC_AUX_SEL	Selects the function of DDI3_CTRLxAUX+/− Signals	I PU	N/A
C39	DDI3_PAIR0+	DDI3 DP / HDMI / DVI differential pairs 3	O	N/A
C40	DDI3_PAIR0−	DDI3 DP / HDMI / DVI differential pairs 3	O	N/A
C41	GND(FIXED)	Ground	GND	
C42	DDI3_PAIR1+	DDI3 DP / HDMI / DVI differential pairs 1	O	N/A
C43	DDI3_PAIR1−	DDI3 DP / HDMI / DVI differential pairs 1	O	N/A
C44	DDI3_HPD	DDI3 Detection of Hot Plug	I PD	N/A
C45	RSVD18	Reserved	NC	
C46	DDI3_PAIR2+	DDI3 DP / HDMI / DVI differential pairs 2	O	N/A
C47	DDI3_PAIR2−	DDI3 DP / HDMI / DVI differential pairs 2	O	N/A
C48	RSVD18	Reserved	NC	
C49	DDI3_PAIR3+	DDI3 DP / HDMI / DVI differential pairs 3	O	N/A
C50	DDI3_PAIR3−	DDI3 DP / HDMI / DVI differential pairs 3	O	N/A
C51	GND(FIXED)	Ground	GND	
C52	PEG_RX0+	PCI Express differential receive pairs	I	N/A PCIe on request
C53	PEG_RX0−	PCI Express differential receive pairs	I	N/A PCIe on request
C54	TYPE0#	Type 0 Module indication (NC)	NC	
C55	PEG_RX1+	PCI Express differential receive pairs	I	N/A PCIe on request

Table 10:   COM Express™ Connector Pin Assignment (continued)

Pin	Pin-Signal	Description	Type	Remark
C56	PEG_RX1–	PCI Express differential receive pairs	I	N/A PCIe on request
C57	TYPE1#	Type 1 Module indication (NC)		
C58	PEG_RX2+	PCI Express differential receive pairs	I	N/A PCIe on request
C59	PEG_RX2–	PCI Express differential receive pairs	I	N/A PCIe on request
C60	GND(FIXED)	Ground	GND	
C61	PEG_RX3+	PCI Express differential receive pairs	I	N/A PCIe on request
C62	PEG_RX3–	PCI Express differential receive pairs	I	N/A PCIe on request
C63	RSVD18	Reserved	NC	
C64	RSVD18	Reserved	NC	
C65	PEG_RX4+	PCI Express differential receive pairs	I	N/A
C66	PEG_RX4–	PCI Express differential receive pairs	I	N/A
C67	RSVD18	Reserved	NC	
C68	PEG_RX5+	PCI Express differential receive pairs	I	N/A
C69	PEG_RX5–	PCI Express differential receive pairs	I	N/A
C70	GND(FIXED)	Ground	GND	
C71	PEG_RX6+	PCI Express differential receive pairs	I	N/A
C72	PEG_RX6–	PCI Express differential receive pairs	I	N/A
C73	GND	Ground	GND	
C74	PEG_RX7+	PCI Express differential receive pairs	I	N/A
C75	PEG_RX7–	PCI Express differential receive pairs	I	N/A
C76	GND	Ground	GND	
C77	RSVD18	Reserved	NC	
C78	PEG_RX8+	PCI Express differential receive pairs	I	N/A
C79	PEG_RX8–	PCI Express differential receive pairs	I	N/A
C80	GND(FIXED)	Ground	GND	
C81	PEG_RX9+	PCI Express differential receive pairs	I	N/A
C82	PEG_RX9–	PCI Express differential receive pairs	I	N/A
C83	RSVD18	Reserved	NC	
C84	GND	Ground	GND	
C85	PEG_RX10+	PCI Express differential receive pairs	I	N/A
C86	PEG_RX10–	PCI Express differential receive pairs	I	N/A
C87	GND	Ground	GND	
C88	PEG_RX11+	PCI Express differential receive pairs	I	N/A
C89	PEG_RX11–	PCI Express differential receive pairs	I	N/A
C90	GND(FIXED)	Ground	GND	
C91	PEG_RX12+	PCI Express differential receive pairs	I	N/A
C92	PEG_RX12–	PCI Express differential receive pairs	I	N/A
C93	GND	Ground	GND	
C94	PEG_RX13+	PCI Express differential receive pairs	I	N/A
C95	PEG_RX13–	PCI Express differential receive pairs	I	N/A
C96	GND	Ground	GND	
C97	RSVD18	Reserved	NC	
C98	PEG_RX14+	PCI Express differential receive pairs	I	N/A
C99	PEG_RX14–	PCI Express differential receive pairs	I	N/A
C100	GND(FIXED)	Ground	GND	
C101	PEG_RX15+	PCI Express differential receive pairs	I	N/A
C102	PEG_RX15–	PCI Express differential receive pairs	I	N/A
C103	GND	Ground	GND	
C104	VCC_12V	Primary wide power input	PWR	
C105	VCC_12V	Primary wide power input	PWR	
C106	VCC_12V	Primary wide power input	PWR	
C107	VCC_12V	Primary wide power input	PWR	
C108	VCC_12V	Primary wide power input	PWR	
C109	VCC_12V	Primary wide power input	PWR	
C110	GND(FIXED)	Ground	GND	

Table 10:   COM Express™ Connector Pin Assignment (continued)

Pin	Pin-Signal	Description	Type	Remark
D1	GND(FIXED)	Ground	GND	
D2	GND	Ground	GND	
D3	USB_SSTX0–	SuperSpeed USB3.0 differential transmit pairs	O	
D4	USB_SSTX0+	SuperSpeed USB3.0 differential transmit pairs	O	
D5	GND	Ground	GND	
D6	USB_SSTX1–	SuperSpeed USB3.0 differential transmit pairs	O	
D7	USB_SSTX1+	SuperSpeed USB3.0 differential transmit pairs	O	
D8	GND	Ground	GND	
D9	USB_SSTX2–	SuperSpeed USB3.0 differential transmit pairs	O	N/A
D10	USB_SSTX2+	SuperSpeed USB3.0 differential transmit pairs	O	N/A
D11	GND(FIXED)	Ground	GND	
D12	USB_SSTX3–	SuperSpeed USB3.0 differential transmit pairs	O	N/A
D13	USB_SSTX3+	SuperSpeed USB3.0 differential transmit pairs	O	N/A
D14	GND	Ground	GND	
D15	DDI1_CTRLCLK_AUX+	DDI1_CTRLCLK_AUX+ signal DP AUX, HDMI / DVI CLK	I/O	
D16	DDI1_CTRLDATA_AUX–	DDI1_CTRLDATA_AUX– signal DP AUX, HDMI / DVI DATA	I/O	
D17	RSVD18	Reserved	NC	
D18	RSVD18	Reserved	NC	
D19	PCIE_TX6+	PCI Express differential transmit pairs	O	N/A
D20	PCIE_TX6–	PCI Express differential transmit pairs	O	N/A
D21	GND(FIXED)	Ground	GND	
D22	PCIE_TX7+	PCI Express differential transmit pairs	O	N/A
D23	PCIE_TX7–	PCI Express differential transmit pairs	O	N/A
D24	(RSVD) SER1_RTS#	Serial port 1 Request To Send	O	TQ-flexiCFG
D25	(RSVD) SER1_CTS#	Serial port 1 Clear To Send	I PU	TQ-flexiCFG
D26	DDI1_PAIR0+	DDI1 DP / HDMI / DVI differential pairs 0	O	
D27	DDI1_PAIR0–	DDI1 DP / HDMI / DVI differential pairs 0	O	
D28	RSVD18	Reserved	NC	
D29	DDI1_PAIR1+	DDI1 DP / HDMI / DVI differential pairs 1	O	
D30	DDI1_PAIR1–	DDI1 DP / HDMI / DVI differential pairs 1	O	
D31	GND(FIXED)	Ground	GND	
D32	DDI1_PAIR2+	DDI1 DP / HDMI / DVI differential pairs 2	O	
D33	DDI1_PAIR2–	DDI1 DP / HDMI / DVI differential pairs 2	O	
D34	DDI1_DDC_AUX_SEL	Selects the function of DDI1_CTRLxAUX+/– Signals	I PD	
D35	RSVD18	Reserved	NC	
D36	DDI1_PAIR3+	DDI1 DP / HDMI / DVI differential pairs 3	O	
D37	DDI1_PAIR3–	DDI1 DP / HDMI / DVI differential pairs 3	O	
D38	RSVD18	Reserved	NC	
D39	DDI2_PAIR0+	DDI2 DP / HDMI / DVI differential pairs 0	O	
D40	DDI2_PAIR0–	DDI2 DP / HDMI / DVI differential pairs 0	O	
D41	GND(FIXED)	Ground	GND	
D42	DDI2_PAIR1+	DDI2 DP / HDMI / DVI differential pairs 1	O	
D43	DDI2_PAIR1–	DDI2 DP / HDMI / DVI differential pairs 1	O	
D44	DDI2_HPD	DDI2 Detection of Hot Plug	I PD	
D45	RSVD18	Reserved	NC	
D46	DDI2_PAIR2+	DDI2 DP / HDMI / DVI differential pairs 2	O	
D47	DDI2_PAIR2–	DDI2 DP / HDMI / DVI differential pairs 2	O	
D48	RSVD18	Reserved	NC	
D49	DDI2_PAIR3+	DDI2 DP / HDMI / DVI differential pairs 3	O	
D50	DDI2_PAIR3–	DDI2 DP / HDMI / DVI differential pairs 3	O	
D51	GND(FIXED)	Ground	GND	
D52	PEG_TX0+	PCI Express differential transmit pairs	O	N/A, PCIe on request
D53	PEG_TX0–	PCI Express differential transmit pairs	O	N/A, PCIe on request
D54	PEG_LANE_RV#	PCI Express Graphics lane reversal input strap	I PU	N/A
D55	PEG_TX1+	PCI Express differential transmit pairs	O	N/A, PCIe on request

Table 10:   COM Express™ Connector Pin Assignment (continued)

Pin	Pin-Signal	Description	Type	Remark
D56	PEG_TX1–	PCI Express differential transmit pairs	O	N/A PCIe on request
D57	TYPE2#	Type 2 Module indication (GND)	O	
D58	PEG_TX2+	PCI Express differential transmit pairs	O	N/A PCIe on request
D59	PEG_TX2–	PCI Express differential transmit pairs	O	N/A PCIe on request
D60	GND(FIXED)	Ground	GND	
D61	PEG_TX3+	PCI Express differential transmit pairs	O	N/A PCIe on request
D62	PEG_TX3–	PCI Express differential transmit pairs	O	N/A PCIe on request
D63	RSVD18	Reserved	NC	
D64	RSVD18	Reserved	NC	
D65	PEG_TX4+	PCI Express differential transmit pairs	O	N/A
D66	PEG_TX4–	PCI Express differential transmit pairs	O	N/A
D67	GND	Ground	GND	
D68	PEG_TX5+	PCI Express differential transmit pairs	O	N/A
D69	PEG_TX5–	PCI Express differential transmit pairs	O	N/A
D70	GND(FIXED)	Ground	GND	
D71	PEG_TX6+	PCI Express differential transmit pairs	O	N/A
D72	PEG_TX6–	PCI Express differential transmit pairs	O	N/A
D73	GND	Ground	GND	
D74	PEG_TX7+	PCI Express differential transmit pairs	O	N/A
D75	PEG_TX7–	PCI Express differential transmit pairs	O	N/A
D76	GND	Ground	GND	
D77	RSVD18	Reserved	NC	
D78	PEG_TX8+	PCI Express differential transmit pairs	O	N/A
D79	PEG_TX8–	PCI Express differential transmit pairs	O	N/A
D80	GND(FIXED)	Ground	GND	
D81	PEG_TX9+	PCI Express differential transmit pairs	O	N/A
D82	PEG_TX9–	PCI Express differential transmit pairs	O	N/A
D83	RSVD18	Reserved	NC	
D84	GND	Ground	GND	
D85	PEG_TX10+	PCI Express differential transmit pairs	O	N/A
D86	PEG_TX10–	PCI Express differential transmit pairs	O	N/A
D87	GND	Ground	GND	
D88	PEG_TX11+	PCI Express differential transmit pairs	O	N/A
D89	PEG_TX11–	PCI Express differential transmit pairs	O	N/A
D90	GND(FIXED)	Ground	GND	
D91	PEG_TX12+	PCI Express differential transmit pairs	O	N/A
D92	PEG_TX12–	PCI Express differential transmit pairs	O	N/A
D93	GND	Ground	GND	
D94	PEG_TX13+	PCI Express differential transmit pairs	O	N/A
D95	PEG_TX13–	PCI Express differential transmit pairs	O	N/A
D96	GND	Ground	GND	
D97	RSVD18	Reserved	NC	
D98	PEG_TX14+	PCI Express differential transmit pairs	O	N/A
D99	PEG_TX14–	PCI Express differential transmit pairs	O	N/A
D100	GND(FIXED)	Ground	GND	
D101	PEG_TX15+	PCI Express differential transmit pairs	O	N/A
D102	PEG_TX15–	PCI Express differential transmit pairs	O	N/A
D103	GND	Ground	GND	
D104	VCC_12V	Primary wide power input	PWR	
D105	VCC_12V	Primary wide power input	PWR	
D106	VCC_12V	Primary wide power input	PWR	
D107	VCC_12V	Primary wide power input	PWR	
D108	VCC_12V	Primary wide power input	PWR	
D109	VCC_12V	Primary wide power input	PWR	
D110	GND(FIXED)	Ground	GND	

4.   MECHANICS

4.1   TQMx50UC Dimensions

The dimensions of the TQMx50UC are 95 × 95 mm² (±0.2 mm).
The following illustration shows the Three View Drawing of the TQMx50UC.
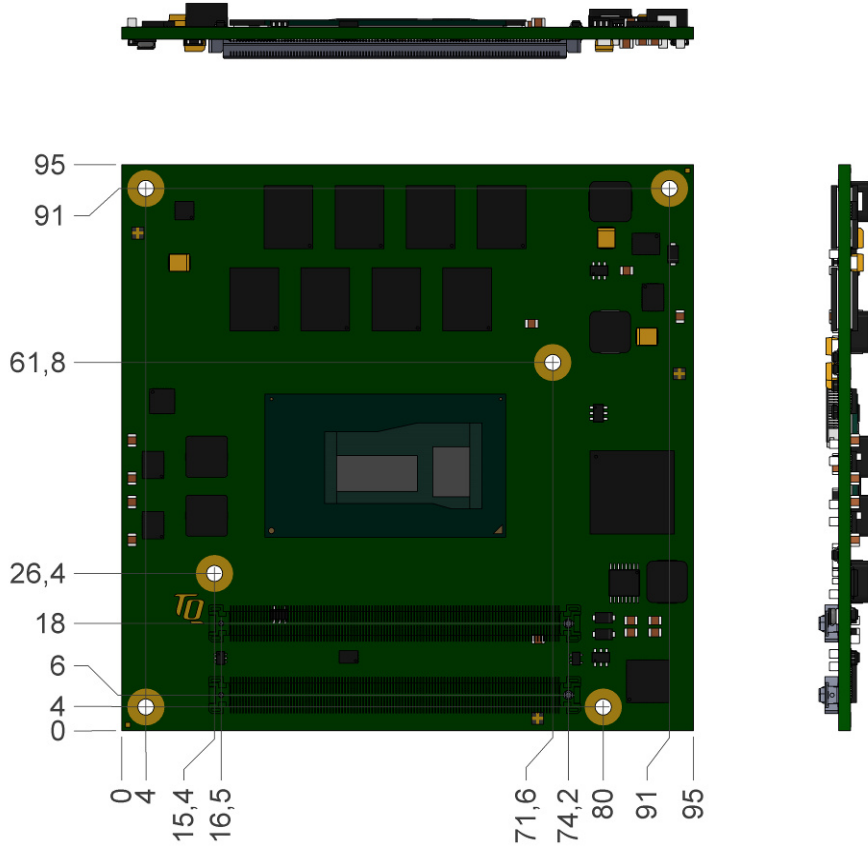

Illustration 2:   Three view drawing TQMx50UC

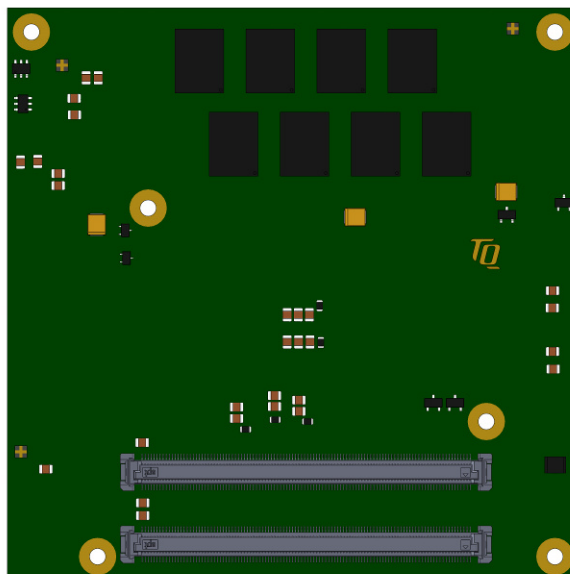The following illustration shows the bottom view of the TQMx50UC.

Illustration 3:   Bottom view drawing TQMx50UC

4.2 Heat Spreader Dimensions

The TQMx50UC supports two different heights of heat spreaders:

- Standard: TQMx50UC-HSP (TQMx50UC-HSP-11-M-…)
  The standard version is compliant to the COM Express™ specification with 13 mm (±0.2 mm) (including PCB).
- Low-Profile: TQMx50UC-HSP-LP (TQMx50UC-HSP-6-M-…)
  The low-profile version focuses on low-profile applications: Height reduced to 8 mm (±0.2 mm) (including PCB).
  The low-profile heat spreader version is available on request.

The following illustration shows the standard heat spreader (TQMx50UC-HSP) for the TQMx50UC.
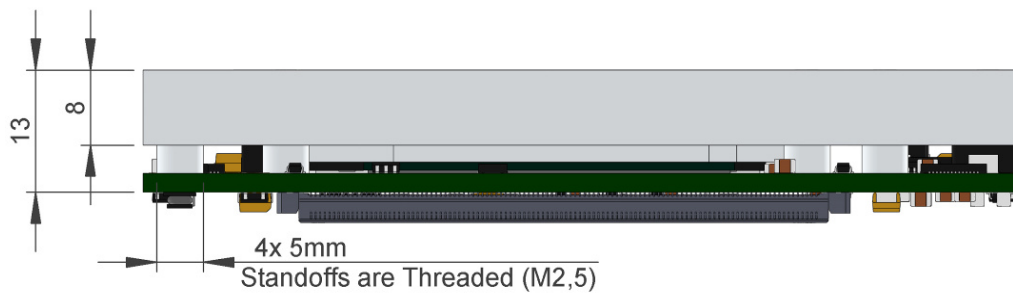

Illustration 4:   Standard Heat Spreader "TQMx50UC-HSP"

Please contact TQ-Support for more details about 2D/3D Step models.

4.3 Mechanical and Thermal Aspects

The TQMx50UC is designed to operate within a wide range of thermal environments.

An important factor for each system integration is the thermal design. The heat spreader acts as a thermal coupling device to the TQMx50UC. The heat spreader is thermally coupled to the processor and provides optimal heat transfer from the TQMx50UC to the heat spreader. The heat spreader itself is not an appropriate heat sink.

System designers can implement different passive and active cooling systems through the thermal connection to the heat spreader.

Attention: Thermal Considerations
⚠️   Do not operate the TQMx50UC without properly attached heat spreader or heat sink!

If a special cooling solution must be implemented an extensive thermal design analysis and verification has to be performed. TQ-Systems GmbH offers thermal analysis and simulation as a service.

Please contact TQ-Support for more information about the thermal configuration.

4.4 Protection Against External Effects

The TQMx50UC itself is not protected against dust, external impact and contact (IP00).
Adequate protection has to be guaranteed by the surrounding system and carrier board.
Conformal coating can be offered for applications in harsh environments.

Please contact TQ-Support for further details.

5. SOFTWARE

5.1 System Resources

5.1.1 I²C Bus

The TQMx50UC provides a general purpose I²C port via a dedicated LPC to I²C controller in the TQ-flexiCFG block.

The following table shows the I²C address mapping for the COM Express™ I²C port.

Table 11:   I²C address mapping COM Express™ I²C port

8-bit Address	Function	Remark
0xA0	TQMx50UC EEPROM	–
0xAE	Carrier board EEPROM	Embedded EEPROM configuration not supported

5.1.2 SMBus

The TQMx50UC provides a System Management Bus (SMBus).

The following table shows the I²C address mapping for the COM Express™ SMBus port.

Table 12:   I²C address mapping COM Express™ SMBus port

8-bit Address	Function	Remark
0xA0, 0xA4	SPD EEPROMs	Only accessed by the BIOS
0x30, 0x34	Thermal Sensors	–
0x58	Hardware Monitor	–
0x64	Reserved for iRTC	–

5.1.3 Memory Map

The TQMx50UC supports the standard PC system memory and I/O memory map.

Please contact TQ-Support for further information about the memory map.

5.1.4 IRQ Map

The TQMx50UC supports the standard PC Interrupt routing. The integrated legacy devices (COM1, COM2) can be configured via the BIOS to IRQ3 and IRQ4.

Please contact TQ-Support for further information about the Interrupt configuration.

5.2 Operating Systems

5.2.1 Supported Operating Systems

The TQMx50UC supports various Operating Systems:

- Microsoft® Windows® 10 (IoT)
- Microsoft® Windows® 8.1 / Microsoft® Windows® Embedded Standard 8 (WES8)
- Microsoft® Windows® 7 / Microsoft® Windows® Embedded Standard 7 (WES7)
- Linux (i.e. Ubuntu 14.10 or later)

Other Operating Systems are supported on request.

Please contact TQ-Support for further information about supported Operating Systems.

5.2.2 Driver Download

The TQMx50UC is well supported by the Standard Operating Systems, which already include most of the required drivers. The use of the latest Intel® drivers to optimize performance and the full feature set of the TQMx50UC is recommended.

Drivers for Graphics can be downloaded at this Intel® page:

http://www.intel.com/content/www/us/en/embedded/products/broadwell-u/overview.html?wapkw=5th+generation+intel+core+processors

Drivers for Chipset Components in the Device Manager can be downloaded at this Intel® page:

https://downloadcenter.intel.com/download/20775/Intel-Chipset-Device-Software-INF-Update-Utility

The Intel® Driver Update Utility is a tool that analyses the system drivers on your computer. The utility reports if any new drivers are available, and provides the download files for the driver updates so you can install them quickly and easily.

https://downloadcenter.intel.com/download/24345/Intel-Driver-Update-Utility

Drivers for the Intel® i218 Gigabit Ethernet controller can be downloaded at this Intel® page:

https://downloadcenter.intel.com/product/71307/Intel-Ethernet-Connection-I218-LM

Please contact TQ-Support for further driver download assistance.

5.3 BIOS

The TQMx50UC uses a 64-bit uEFI BIOS with a legacy Compatibility Support Module (CSM).
This additional functionality enables the loading of a traditional OS or the use of a traditional OpROM.

5.3.1 Enter BIOS Setup

To enter the BIOS setup, turn on the computer, then press <ESC> and select the SCU menu.

5.4 Software Tools

Please contact TQ-Support for further information about available software tools.

6. SAFETY REQUIREMENTS AND PROTECTIVE REGULATIONS

6.1 EMC

The TQMx50UC was developed according to the requirements of electromagnetic compatibility (EMC). Depending on the target system, anti-interference measures may still be necessary to guarantee the adherence to the limits for the overall system.

6.2 ESD

In order to avoid interspersion on the signal path from the input to the protection circuit in the system, the protection against electrostatic discharge should be arranged directly at the inputs of a system. As these measures always have to be implemented on the carrier board, no special preventive measures were done on the TQMx50UC.

6.3 Shock & Vibration

The TQMx50UC is designed to be insensitive to shock and vibration and impact.
The design avoids additional connectors like SO-DIMM sockets to support applications also in harsh environments.

6.4 Operational Safety and Personal Security

Due to the occurring voltages (≤20 V DC), tests with respect to the operational and personal safety haven't been carried out.

6.5 Reliability and Service Life

The MTBF according to MIL-HDBK-217F N2 is approximately 344,858 h, Ground Benign, @ +40 °C.

7. ENVIRONMENT PROTECTION

7.1 RoHS

The TQMx50UC is manufactured RoHS compliant.
- All components and assemblies are RoHS compliant
- The soldering processes are RoHS compliant

7.2 WEEE®

The final distributor is responsible for compliance with the WEEE® regulation.

Within the scope of the technical possibilities, the TQMx50UC was designed to be recyclable and easy to repair.

7.3 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.

7.4 EUP

The Ecodesign Directive, also Energy using Products (EuP), is applicable to products for the end user with an annual quantity >200,000. The TQMx50UC must therefore always be seen in conjunction with the complete device.

The available standby and sleep modes of the components on the TQMx50UC enable compliance with EuP requirements for the TQMx50UC.

7.5 Battery

No batteries are assembled on the TQMx50UC.

7.6 Packaging

By environmentally friendly processes, production equipment and products, we contribute to the protection of our environment. To be able to reuse the TQMx50UC, 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 TQMx50UC is delivered in reusable packaging.

7.7 Other Entries

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 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.

8. APPENDIX

8.1 Acronyms and Definitions

The following acronyms and abbreviations are used in this document.

Table 13: Acronyms

Acronym	Meaning
ATA	AT Attachment
BIOS	Basic Input/Output System
CAN	Controller Area Network
CODEC	Code/Decode
COM	Computer-On-Module
CPU	Central Processing Unit
CSM	Compatibility Support Module
cTDP	Configurable Thermal Design Power
DC	Direct Current
DDC	Display Data Channel
DDI	Digital Display Interface
DDR3L	DDR3 Low Voltage
DMA	Direct Memory Access
DP	DisplayPort
DVI	Digital Visual Interface
ECC	Error-Correcting Code
eDP	embedded DisplayPort
EEPROM	Electrically Erasable Programmable Read-Only Memory
EMC	Electromagnetic Compatibility
eSATA	external Serial ATA
ESD	Electrostatic Discharge
FAE	Field Application Engineer
FIFO	First In First Out
flexiCFG	Flexible Configuration
FPGA	Field Programmable Gate-Array
FR-4	Flame Retardant 4
GND	Ground
GPIO	General Purpose Input/Output
HD	High Definition
HDA	High Definition Audio
HDMI	High Definition Multimedia Interface
HSP	Heat Spreader
I	Input
I PD	Input with internal Pull-Down resistor
I PU	Input with internal Pull-Up resistor
I/O	Input/Output
I^2C	Inter-Integrated Circuit
IEEE®	Institute of Electrical and Electronics Engineers
IoT	Internet of Things
IP	Ingress Protection
IRQ	Interrupt Request
iRTC	Industrial Real Time Clock
JTAG®	Joint Test Action Group
LED	Light Emitting Diode
LP	Low-Profile
LPC	Low Pin Count
LVDS	Low Voltage Differential Signal

Table 13:   Acronyms (continued)

Acronym	Meaning
MMC	Multimedia Card
mSATA	Mini-SATA
MTBF	Mean operating Time Between Failures
N/A	Not Available
NC	Not Connected
O	Output
OD	Open drain output
OpROM	Option ROM
OS	Operating System
PC	Personal Computer
PCB	Printed Circuit Board
PCI	Peripheral Component Interconnect
PCIe	Peripheral Component Interconnect express
PCMCIA	People Can't Memorize Computer Industry Acronyms
PD	Pull-Down
PICMG®	PCI Industrial Computer Manufacturers Group
PU	Pull-Up
PWM	Pulse-Width Modulation
PWR	Power
RAM	Random Access Memory
RMA	Return Merchandise Authorization
RoHS	Restriction of (the use of certain) Hazardous Substances
RSVD	Reserved
RTC	Real-Time Clock
SATA	Serial ATA
SCU	System Control Unit
SD	Secure Digital
SD/MMC	Secure Digital Multimedia Card
SDRAM	Synchronous Dynamic Random Access Memory
SMB	System Management Bus
SO-DIMM	Small Outline Dual In-Line Memory Module
SPD	Serial Presence Detect
SPI	Serial Peripheral Interface
SPKR	Speaker
SSD	Solid-State Drive
TDM	Time-Division Multiplexing
TDP	Thermal Design Power
TPM	Trusted Platform Module
UART	Universal Asynchronous Receiver/Transmitter
uEFI	Unified Extensible Firmware Interface
USB	Universal Serial Bus
WDT	Watchdog Timer
WEEE®	Waste Electrical and Electronic Equipment
WES	Microsoft® Windows® Embedded Standard

8.2　References

Table 14:　　Further Applicable Documents and Links

No.	Name	Rev., Date	Company
(1)	5th Generation Intel® Core™ 5000U series ("Broadwell-U"):: Overview http://www.intel.com/content/www/us/en/embedded/products/broadwell-u/5th-gen-core-mobile-u-processor-platform-brief.html		Intel®
(2)	5th Generation Intel® Core™ 5000U series ("Broadwell-U"):: Software and Drivers download http://www.intel.com/content/www/us/en/embedded/products/broadwell-u/overview.html?wapkw=5th+generation+intel+core+processors https://downloadcenter.intel.com/download/20775/Intel-Chipset-Device-Software-INF-Update-Utility https://downloadcenter.intel.com/download/24345/Intel-Driver-Update-Utility		Intel®
(3)	5th Generation Intel® Core™ 5000U series ("Broadwell-U"): Documentation http://www.intel.com/content/www/us/en/embedded/products/broadwell-u/documentation.html Including Datasheets, Specification Updates and User Guides		Intel®
(4)	PICMG® COM0 COM Express™ Module Base Specification	Rev. 2.1, May 14, 2014	PICMG®
(5)	PICMG® COM Express™ Carrier Design Guide (available for public download) https://www.picmg.org/wp-content/uploads/PICMG_COMDG_2.0-RELEASED-2013-12-061.pdf	Rev. 2.0, Dec. 6, 2013	PICMG®
(6)	Intel® Download Center: Intel® Ethernet Controller i218 Series https://downloadcenter.intel.com/product/71307/Intel-Ethernet-Connection-I218-LM		Intel®

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