



96Boards IoT Edition

Low Cost Hardware Platform Specification

Version 1.0, September 2016

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Background

The 96Boards IoT Edition (IE) platform is designed to support development in the Internet of Things (IoT) space. The 96Boards IE hardware platform key features are:

- Low cost and small footprint suitable for edge device prototyping as well as other embedded products with size and cost constraints
- SoC independent hardware implementation
- Platform support for ARM Cortex-A/R/M SoCs
- Open Source mainline upstream Software development support
- Standard IoT development platform with consistent software stack across devices in different form factors and across Cortex-A/R/M SoC families

Target use case(s) include but are not restricted to:

- Intelligent sensors and controls
- IoT Edge devices
- Low cost gateway

The target design and distribution goals for IE board are:

1. To be able to achieve a retail price at less than \$10 with Cortex-A, -R or -M SoCs for the minimum specified feature set
2. Easy to design with off-the-shelf parts
3. Easy to purchase globally

There are two profiles being defined in 96Boards IE specification, depending on the ARM core used by the SoC

1. Cortex-A Profile
2. Cortex-R/M Profile

There are two defined form factors

1. IE Standard 60 x 30 x 9mm
2. IE Extended 85 x 54 x 12mm

One of the key design objectives is to keep the cost and size of IE boards to a minimum, without mandating a large set of onboard components. The 96Boards IE specification is designed to encourage modular design of IoT devices, enabling an ecosystem to evolve that will support multiple SoCs over a period of years.

The specification is completely free to implement - that is anyone may build a board to the specification without payment of any fees or any licensing requirements.

The 96Boards IE Certification Program is optional for board developers and will provide hardware and software certification, a community site and software support provided by Linaro for 96Boards IE certified boards. Participation is not required in order to build a board to the specification.

96Boards IoT Edition (IE)

Hardware

96Boards IE Minimum Hardware Features

1. A minimum IE configuration may be built on a 2-4 layer PCB depending on design requirements
2. One of the two form factors shall be implemented
 - a. Standard Micro board form factor 60 x 30 x 9mm
 - b. Extended form factor 85 x 54 x 12mm
The Extended form factor is the same as the 96Boards CE Standard footprint.
3. SoC independent (32 or 64 bit SoCs) with two profiles defined
 - a. ARM Cortex-A Profile
 - b. ARM Cortex-R/M Profile
4. On board Connectors and expansion I/O
 - a. For all profiles, the 96Boards standard low profile expansion IO connector **shall** be implemented with optional functionality specified depending on the Profile (see below)
 - b. One microUSB or Type C USB port **shall** be provided for 5V power and host/slave serial communication
 - c. A second microUSB or Type C USB port is **optional** for FTDI style UART bringup/debug console. This is **recommended** if the power port is a full USB implementation as opposed to serial to USB interface.
The Board designer **may** instead bring out the bringup/debug console onto the 1.8V UART1 port on the LS expansion connector.
The Board designer **may** instead bring out the bringup/debug console onto a normally unpopulated 3 pin 0.1" header. In this case the following pinout **shall** be used with PIN 1 and the designer should specify the voltage levels in the board documentation.

Pin 1	TxD (output from MCU)
Pin 2	RxD (input to MCU)
Pin 3	GND

5. Auto-Start
The board shall be able to auto-start from power up. The board shall also be capable of a restart initiated by the CPU.
6. Power Supply
The maximum board power consumption (including attached Mezzanines) shall not

exceed the capability of the selected USB connector (default configuration) and **shall** be specified by the board manufacturer.

The Mezzanine +5V line **shall** be able to supply a minimum of 0.2A (1W)

For the 3.3V 0.1" expansion connector the Mezzanine +3.3V line shall be able to supply a minimum of 0.1A (0.33W).

For the 1.8V 2mm expansion connector the Mezzanine +1.8V line shall be able to supply a minimum of 0.1A (0.18W)

The 96Boards IE edition **may** be powered from the +5V Mezzanine line. The board designer **shall** document any restrictions if a user attempts to power the board from both the USB connector and the Mezzanine.

Any Mezzanine boards designed to utilize the 12V CE power supply will not operate on a 96Boards IE base board.

Cortex-A Profile

7A. SoC

- a. 32 bits: Cortex-A series - for example A5/A7/A9
Note that previous ARM processors (eg ARM11) are not recommended for new designs, and may not have support from the 96Boards IE software platform
- b. 64 bits: Cortex-A series - for example A35/A53
- c. Speed is not specified; the IE specification permits high speed (1GHz+) SoCs

8A. RAM

For Cortex-A SoCs, a minimum of 512MB RAM is **strongly recommended**

For low cost solutions simple board layout and low layer count PCBs may be achieved by using PoP mounted RAM on the SoC, thereby avoiding high speed PCB signal routing

9A. Flash memory

For Cortex-A SoCs, a minimum of on board 512MB bootable eMMC is **strongly recommended**

Cortex-R/M Profile

7M. RAM

For Cortex-R/M SoCs, a minimum of 32KB RAM is **strongly recommended**. This may be on-SoC memory.

8M. Flash memory

For Cortex-R/M SoCs, a minimum of 128KB of bootable flash memory is **strongly recommended**. This may be on-SoC memory.

96Boards IE Strongly Recommended Hardware Features

1. A minimum of one low power wireless interface (e.g. Zigbee, Bluetooth LE), including interfaces supporting protocols such as 6LowPAN, LoRaWAN.

and/or

2. An additional Type A (or Type C) USB port capable of supporting off-the-shelf

wireless USB dongles.

96Boards IE Optional Hardware Features

The 96Boards Specifications define a minimum level of functionality. Board designers are free to add additional functionality including, but not limited to, sensors, controllers, wireless interfaces, and other industrial network interfaces.

NOTE: The implementation of some optional features may require additional board layers (for example using high speed signals) that mean the retail board cost exceeds the target \$10 price point. This is at the designer's discretion.

Hardware Feature Details

96Boards IE Physical Footprint

The 96Boards IE defines a standard footprint for boards implementing the minimum hardware features. This **shall** be IE Standard board form factor 60 (L) x 30 (W) x 9 (H) mm.

An alternative larger IE Extended footprint **shall** be the same as 96Boards CE form factor 85 (L) x 54 (W) x 12 (H) mm.

The IE Standard board height shall be defined as follows:

Component height above PCB	Max 6.5mm (7.0mm if Type A USB is used)
PCB thickness	Max 1.0mm
Component height below PCB	Max 1.0mm

The IE Extended board height shall be defined as follows:

Component height above PCB	Max 7.0mm
PCB thickness	Min 1.0mm, recommended 1.575mm (62 mil) nominal
Component height below PCB	Max 3.4mm

Refer to the drawings below for additional height restrictions in certain board areas. See below for considerations relating to an RJ45 network connector if required.

USB Ports

One microUSB port or Type C USB port **shall** be used for power supply and host/slave serial or USB communications. This **shall** be in the specified location (USB 0).

A debug UART **shall** be provided. This UART shall be used as the startup bootloader/OS console. It is **strongly recommended** that this UART be interfaced to a microUSB port or Type C USB port using a TI TUSB3410, FTDI FT230X or equivalent part. If present, the connector **shall** be located in the specified position (USB 1).

The specification also permits the UART to be implemented on the expansion port UART1 interface (see above).

Low Speed Expansion Connector

The specification caters for 2 types of Expansion Connector. All boards **shall** provide one of the specified connector types.

For 1.8V devices it is **recommended** that the standard 96Boards CE 2x20 pin 2mm female

header connector be provided. Note that signals are specified at 1.8V logic levels.

Interfaces **shall** be available except where specified as optional:

- UART0
- UART1 (optional)
- SPI bus
- I²C x2 (1 mandatory and 1 optional)
- I²S (optional)
- GPIO x12
- Reset and Power button

For 3.3V devices, the alternate 2x15 pins with 0.1" (2.54 mm) pitch female header connector **shall** be used. The pin out is specified in the Appendix. Note that signals are specified at 3.3V logic levels. It shall be implemented at the same location.

Height Exceedance

Some designs may require an Ethernet (RJ45) or other interface where the connector height exceeds the 96Boards IE height requirements. Designers who wish to implement such functionality should understand that this will provide serious limitations on interoperability with standard mezzanine boards.

If Ethernet is required one RJ45 connector **shall** be mounted on the top of the board in the specified location. A low height part ($\leq 12.0\text{mm}$) shall be used. The connector shall be the type fitted with 2 LED indicators.

If other interfaces are used with connectors that exceed the standard height requirement of 7.0mm maximum above the board **may** still achieve 96Boards IE compliance with a variance statement provided in the board documentation.

LEDs

All boards **shall** include a Power LED (Green Type: 0603 SMD).

At least one User LEDs (Green Type: 0603 SMD) **shall** be present on the board, which **shall** be directly programmable from the SoC.

The following LEDs **shall** be provided if the relevant radio(s) are present.

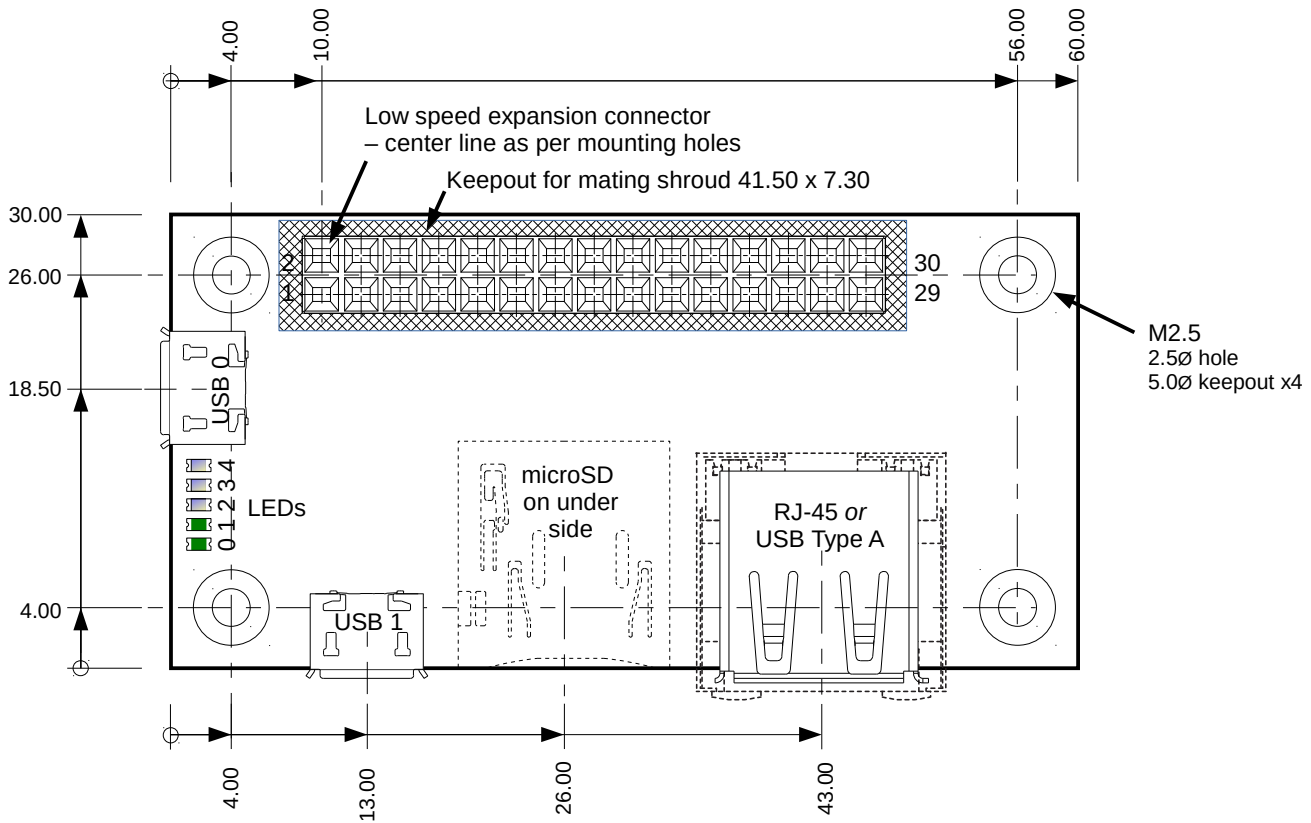
- WiFi activity LED Yellow Type: 0603 SMD
- Bluetooth activity LED Blue Type: 0603 SMD
- ZigBee activity LED Orange Type: 0603 SMD

microSDHC



If implemented, a microSDHC card socket **shall** be fitted in the specified location on the board. If provided, the system **is strongly recommended** to be capable of booting from the microSDHC card at power up.

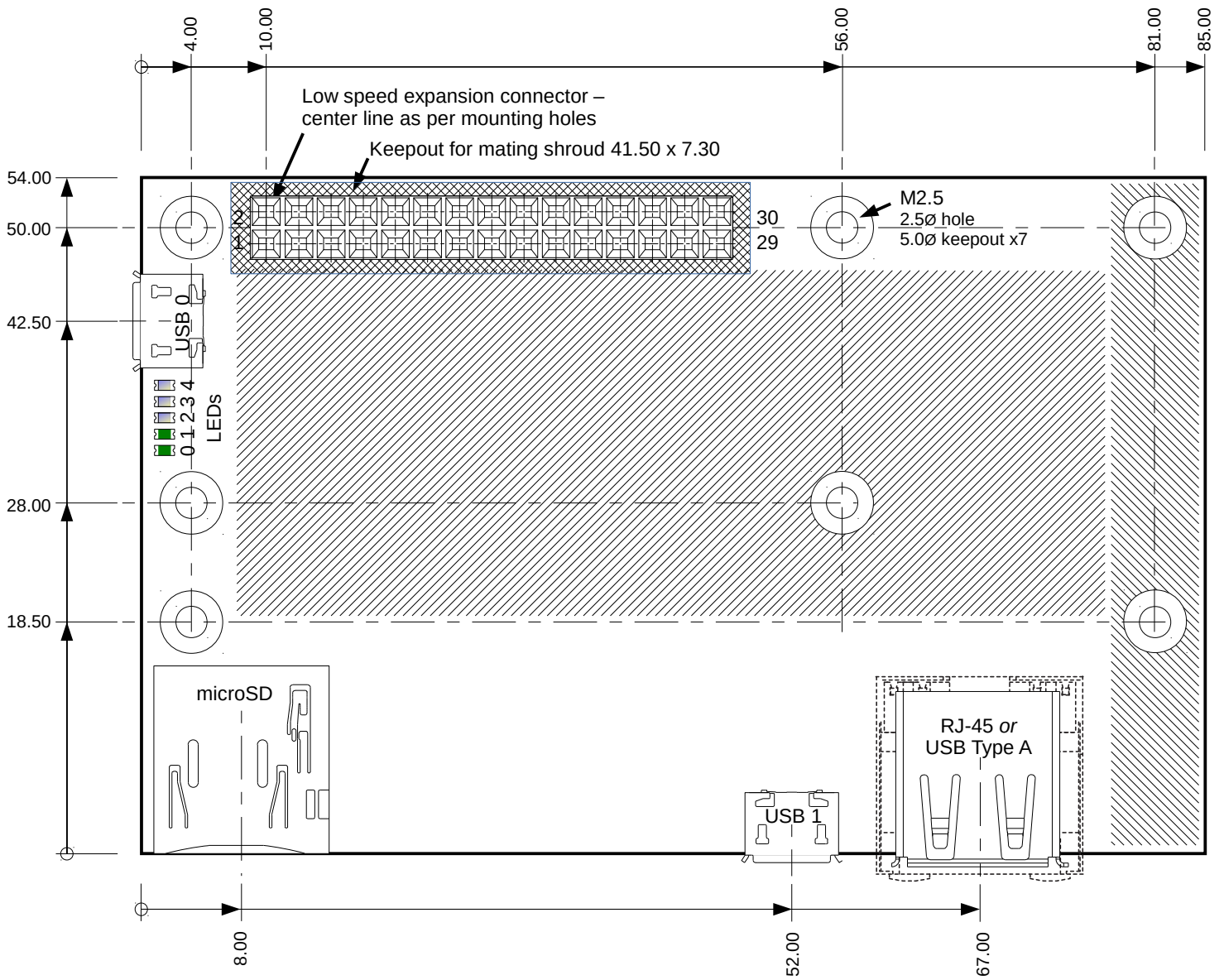
Camera

If a CSI camera is supported the interface shall be a 30 pin FFC with a 0.5mm pin pitch size with pinout compliant to 96Boards CE Camera Module Interface Addendum.



□ General Top
component max
height = 6.5mm,
except Type A
USB connectors
 ≤ 7.0 mm and
RJ-45 ≤ 12.0 mm

		
TITLE 96Boards IoT Edition Standard (3.3V)		
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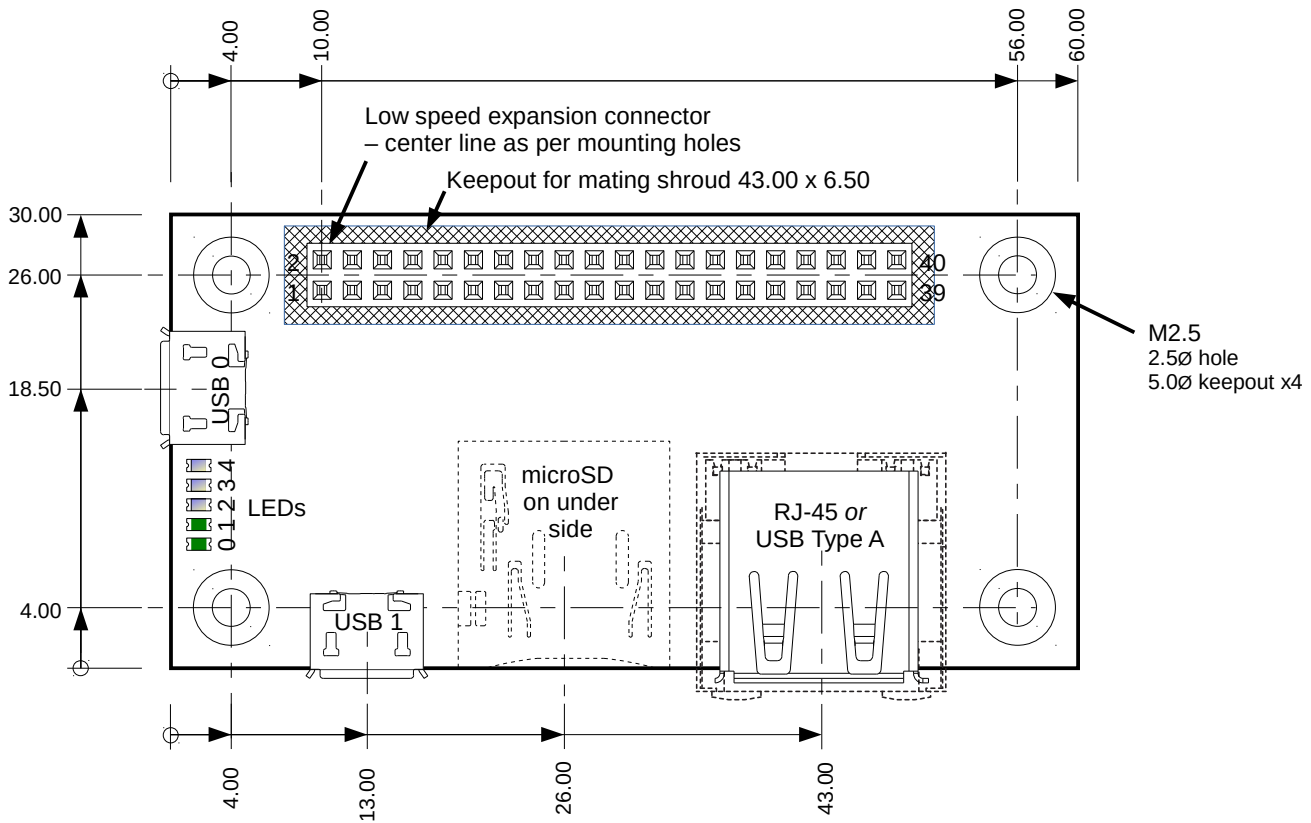


□ General Top component max height = 6.5mm, except Type A USB connectors $\leq 7.0\text{mm}$ and RJ-45 $\leq 12.0\text{mm}$

▨ PCB/Chip WiFi antenna on top or bottom. Follow antenna specification keepout areas.

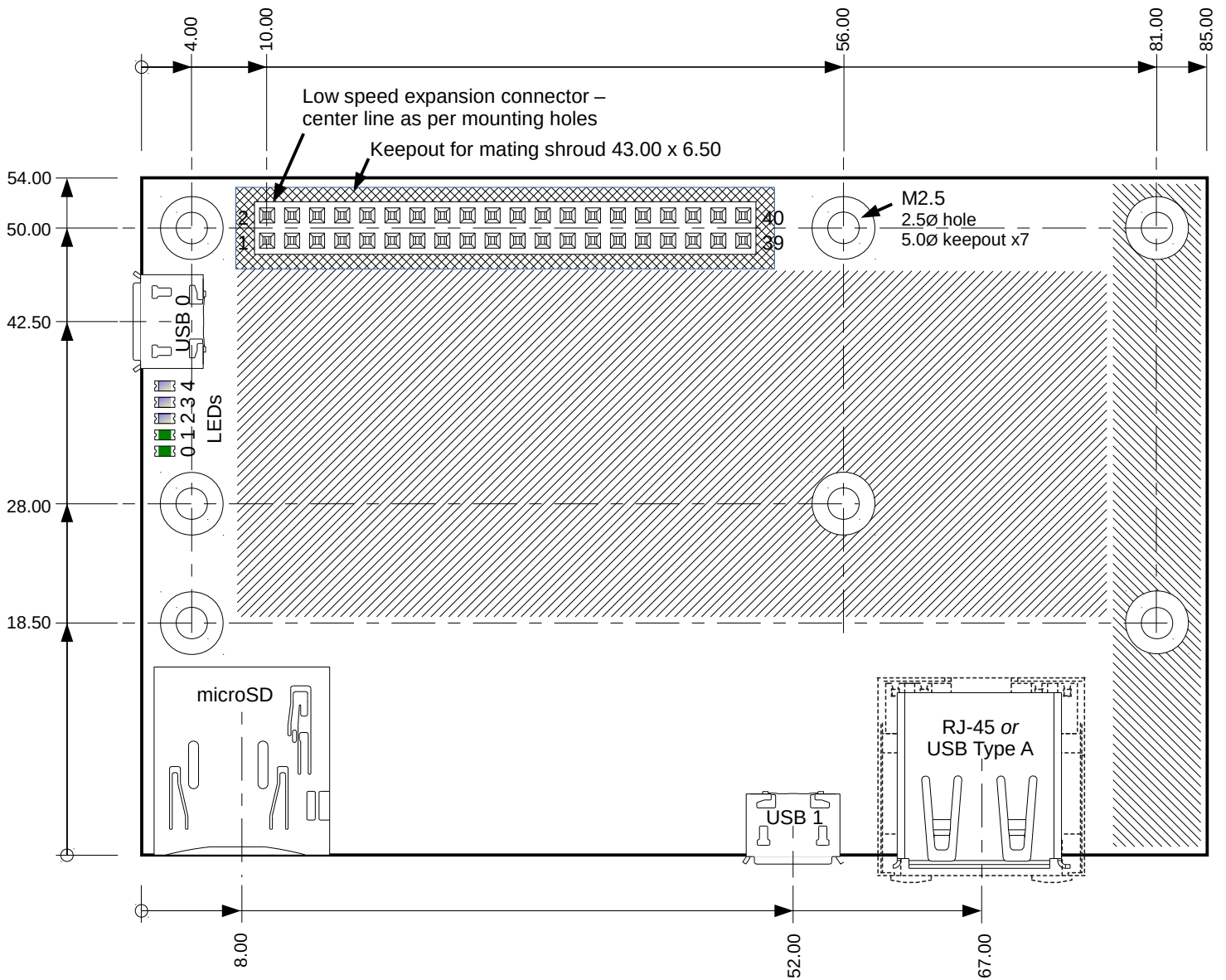
▨ Top component max height = 4.0mm except user link headers and thermal management such as fan/heatsink $\leq 6.5\text{mm}$


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□ General Top
component max
height = 6.5mm,
except Type A
USB connectors
≤ 7.0mm and
RJ-45 ≤ 12.0mm



TITLE 96Boards IoT Edition Standard (1.8V)		
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 General Top component max height = 6.5mm, except Type A USB connectors $\leq 7.0\text{mm}$ and RJ-45 $\leq 12.0\text{mm}$

 PCB/Chip WiFi antenna on top or bottom. Follow antenna specification keepout areas.

 Top component max height = 4.0mm except user link headers and thermal management such as fan/heatsink $\leq 6.5\text{mm}$

		
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96Boards IoT Edition Extended (1.8V)		
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Appendix

Low Speed Expansion Connector Signal Description

For Cortex-A type boards, the expansion connector may use the same as specified in 96Boards CE Specification with pin layout as below:

GND	Pin 1
UART0_CTS	Pin 3
UART0_TxD	Pin 5
UART0_RxD	Pin 7
UART0_RTS	Pin 9
UART1_TxD (O)	Pin 11
UART1_Rx (O)	Pin 13
I2C0_SCL	Pin 15
I2C0_SDA	Pin 17
I2C1_SCL	Pin 19
I2C1_SDA	Pin 21
GPIO-A	Pin 23
GPIO-C	Pin 25
GPIO-E	Pin 27
GPIO-G	Pin 29
GPIO-I	Pin 31
GPIO-K	Pin 33
+1V8	Pin 35
+5V	Pin 37
GND	Pin 39

Pin 2	GND
Pin 4	PWR_BTN_N
Pin 6	RST_BTN_N
Pin 8	SPI0_SCLK
Pin 10	SPI0_DIN
Pin 12	SPI0_CS
Pin 14	SPI0_DOUT
Pin 16	PCM_FS
Pin 18	PCM_CLK
Pin 20	PCM_DO
Pin 22	PCM_DI
Pin 24	GPIO-B
Pin 26	GPIO-D
Pin 28	GPIO-F
Pin 30	GPIO-H
Pin 32	GPIO-J
Pin 34	GPIO-L
Pin 36	NC
Pin 38	NC
Pin 40	GND

Note that Pins 36 and 38 are specified as No Connect as the 12V power supply is not used on the 96Boards IE so that Mezzanines designed to utilize the 12V CE power supply will not operate on a 96Boards IE card.

For Cortex-R/M profile boards with 1.8V power supply, the same expansion connector may be used with the same pin out with optional pins noted below (O) based on availability from the SoC:

GND	Pin 1
UART0_CTS	Pin 3
UART0_TxD	Pin 5
UART0_RxD	Pin 7
UART0_RTS	Pin 9
UART1_TxD (O)	Pin 11
UART1_RxD (O)	Pin 13
I2C0_SCL	Pin 15
I2C0_SDA	Pin 17
I2C1_SCL (O)	Pin 19
I2C1_SDA (O)	Pin 21
GPIO-A	Pin 23
GPIO-C	Pin 25
GPIO-E	Pin 27
GPIO-G	Pin 29
GPIO-I	Pin 31
GPIO-K	Pin 33
+1V8	Pin 35
+5V	Pin 37
GND	Pin 39

Pin 2	GND
Pin 4	PWR_BTN_N
Pin 6	RST_BTN_N
Pin 8	SPI0_SCLK
Pin 10	SPI0_DIN
Pin 12	SPI0_CS
Pin 14	SPI0_DOUT
Pin 16	PCM_FS (O)
Pin 18	PCM_CLK (O)
Pin 20	PCM_DO (O)
Pin 22	PCM_DI (O)
Pin 24	GPIO-B
Pin 26	GPIO-D
Pin 28	GPIO-F
Pin 30	GPIO-H
Pin 32	GPIO-J
Pin 34	GPIO-L
Pin 36	NC
Pin 38	NC
Pin 40	GND

For 3.3V Cortex- A/M IoT boards, the alternate 2x15 pins 0.1” female header connector may be used, with the pin out as specified below.

UART0_CTS	Pin 1	Pin 2	SPI0_CS (O)
UART0_TxD	Pin 3	Pin 4	SPI0_DOUT(O)
UART0_RxD	Pin 5	Pin 6	SPI0_DIN(O)
UART0_RTS	Pin 7	Pin 8	SPI0_SCLK(O)
GND	Pin 9	Pin 10	GND
+5V	Pin 11	Pin 12	+3V3 V _{I/O}
GPIO-A	Pin 13	Pin 14	GPIO-B
GPIO-C	Pin 15	Pin 16	GPIO-D
GPIO-E	Pin 17	Pin 18	GPIO-F
GPIO-G	Pin 19	Pin 20	GPIO-H
UART1_TxD (O)	Pin 21	Pin 22	I2C0_SCL
UART1_RxD (O)	Pin 23	Pin 24	I2C0_SDA
PWM0 (O)	Pin 25	Pin 26	ADC_IN0 (O)
PWM1 (O)	Pin 27	Pin 28	ADC_IN1 (O)
RST_BTN_N	Pin 29	Pin 30	POR* (O)

* POR stands for Power on Reset. It could be optionally included to guarantee that the analog and digital blocks initialize in a known state after the power supply is applied. Once the supply reaches a given threshold voltage, the POR circuit releases the internal reset signal from LOW to HIGH and the state machine initializes the device. Until initialization is complete, the device should ignore external signals, including transmitted data except RST_BTN_N reset pin.

-----SPECIFICATION ENDS-----