Techship

MU201 - M.2 key B to USB3 Adapter Hardware Guide

Revision 1.6 - 2023-02-17

APPLICABLE MODELS

Article Nr	Model	Description
11318	**MU201**	Techship M.2 key B to USB3 type A adapter (dual SIM holder version)

DOCUMENT REVISIONS

Version	Date	Comment	Author
R1.0	2022-01-14	Initial release	Jörgen Storvist
R1.1	2022-02-09	Added information about external power supply connector parts	Jörgen Storvist
R1.2	2022-02-24	Fixed typo regarding Telit SIM card hot swap	Simon Lindh
R1.3	2022-04-11	Added details about power supply and polarity note	Jörgen Storvist
R1.4	2022-06-28	Corrected typo in power supply chapter	Jörgen Storvist
R1.5	2022-12-23	Added configuration info for new generation 5G data cards	Jörgen Storvist
R1.6	2023-02-17	Added chapter about status LEDs on PCB	Jörgen Storvist

HARDWARE REVISIONS

Version	Date	Comment
PCB V1.0 (11318 001)	2021-04	Initial sample version
PCB V1.1 (11318 002)	2021-11	1. Modified external power supply to use jumper for source select. 2. Modified SIM interfaces, SIM detect signal high when SIM present. 3. Adjusted card length to enable assembly in chassis with module installed.
PCB V1.1 (11318 003)	2022-02	Mass-production version

CONTACT DETAILS

Website:
https://techship.com/

Product page and technical documentation:
https://techship.com/products/techship-mu201-adapter-m-2-key-b-to-usb3-type-a-dual-sim/

Technical support:
https://techship.com/page/support/technical_support/

RMA request:
https://techship.com/page/support/rma_requests/

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DOCUMENT CONTENTS

1 INTRODUCTION

This document describes the Techship M.2 key B to USB3 adapters mechanical and electrical specifications. The latest product descriptions, datasheets and hardware guides are available on Techship.com product pages.

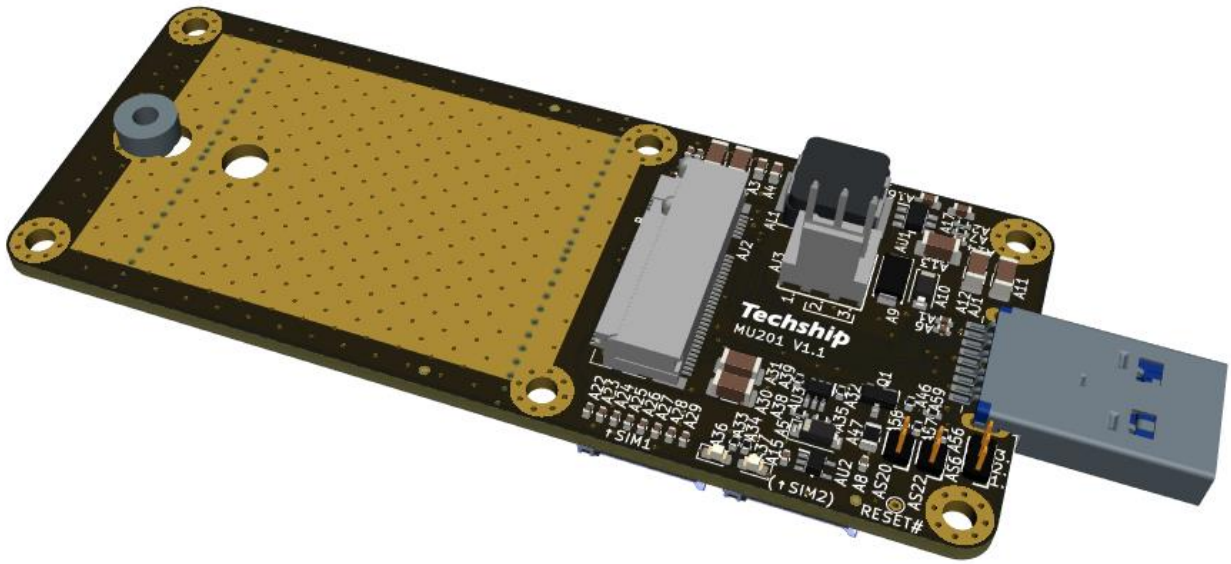
2 PRODUCT DESCRIPTION

The Techship M.2 key B to USB3 adapter is designed with the goal to ease the first steps for customers evaluating, testing, and integrating M.2 key B cellular data cards. It can be used as a known good platform to cross check functionality during troubleshooting, or for firmware updates and diagnostics log capturing in other host system environments/architectures. The adapter can also be used for integration in customer products, for example to add cellular data connectivity to existing generic hardware platforms.

Cross compatibility between vendor design differences, while trying to meet the design requirements for most of first generation 5G cellular data cards have been emphasized. For example:

- On-board pin-headers available for selecting active data interface with jumpers.
- Exposed PCB ground planes where thermal pads can be added between cellular data card and adapter PCB for improved heat dissipation from the cellular data card.
- Ceramic capacitors on power supply input side and output side for improved voltage stability and interference filtering.
- Oversized power supply voltage stepdown circuitry design.
- Adapter compatible with most cellular data cards with card lengths 42, 50 and 52mm.

It implements 4FF nano SIM card holder type for primary SIM card signals, and additionally (variant depending) a SIM card holder for the secondary SIM card signals in the M.2 socket.



3 MECHANICAL SPECIFICATION

3.1 Package contents

The adapter packaging includes the following content:

Description	Amount
Techship MU20x adapter board (in ESD protective bag)	1pcs
Distance M3x2.5mm	1pcs
Screw M3x2.0mm	2pcs
Jumper shunt 2.54mm	1pcs
Jumper shunt 1.27mm	3pcs

3.2 Environmental

Adapter operational temperature range: -20°C to +75°C

3.3 Assembly

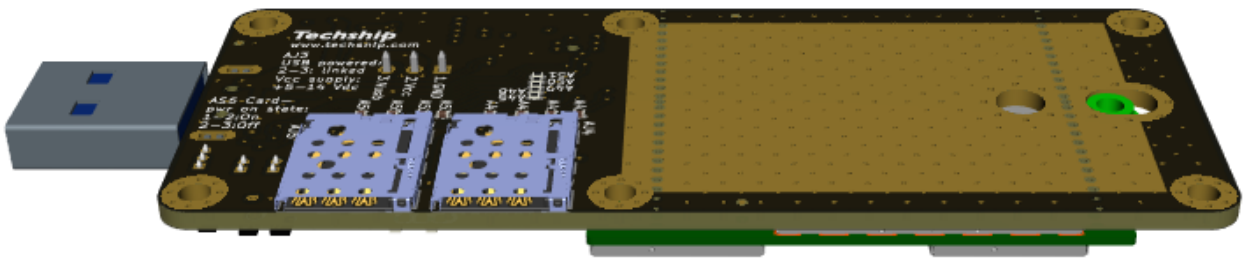
Assemble the included M3x2.5mm steel distance in the PCB slot matching your cellular data card length at either 42, 50 or 52mm distance from the M.2 socket. Use one of the included M3x2.0mm screws to fasten the distance at bottom side of the adapter PCB.

Install the cellular data card in the adapters M.2 socket at an angle and fold down the card to rest on the steel distance. Use the other included M3x2.0mm screw to fasten the cellular data card to the adapter.

ATTENTION – It is recommended to use thermal pads in the gap between the cellular data card and adapter PCB to improve the thermal heat dissipation from the cellular data card.

Mobile broadband data cards capable of high data throughputs generate a considerable amount of heat during high loads and full Tx power which can trigger the data cards internal thermal protection unless the thermal energy is sufficiently dissipated from the data card.
Refer to the cellular data card vendors product hardware guide for their thermal management recommendations.

The unmasked ground plane on bottom side of the adapter PCB can be used to dissipate heat further away from adapter to a chassis, heatsink or casing.



3.3.1 Thermal dissipation accessories at Techship.com

Silicone thermal pads, 6W/mK, 3.0mm thickness:

- 11767 Thermal pad, 6W/mK, 40x28x3.0mm
  https://techship.com/products/thermal-pad-telit-fn990-42x28x3mm

- 12488 Thermal pad, 6W/mK, 20x28x3.0mm
  https://techship.com/products/thermal-pad-6w-mk-20x28x30mm

- 11723 Thermal pad, 6W/mK, 10x28x3.0mm
  https://techship.com/products/thermal-pad-telit-fn980-11x28x3mm

Silicone thermal pads, 6W/mK, 1.5mm thickness:

- 12487 Thermal pad, 6W/mK, 40x28x1.5mm
  https://techship.com/products/thermal-pad-6w-mk-40x28x15mm

- 11724 Thermal pad, 6W/mK, 20x28x1.5mm
  https://techship.com/products/thermal-pad-6-w-m-k-20x28x1-5mm

- 12489 Thermal pad, 6W/mK, 10x28x1.5mm
  https://techship.com/products/thermal-pad-6w-mk-10x28x15mm

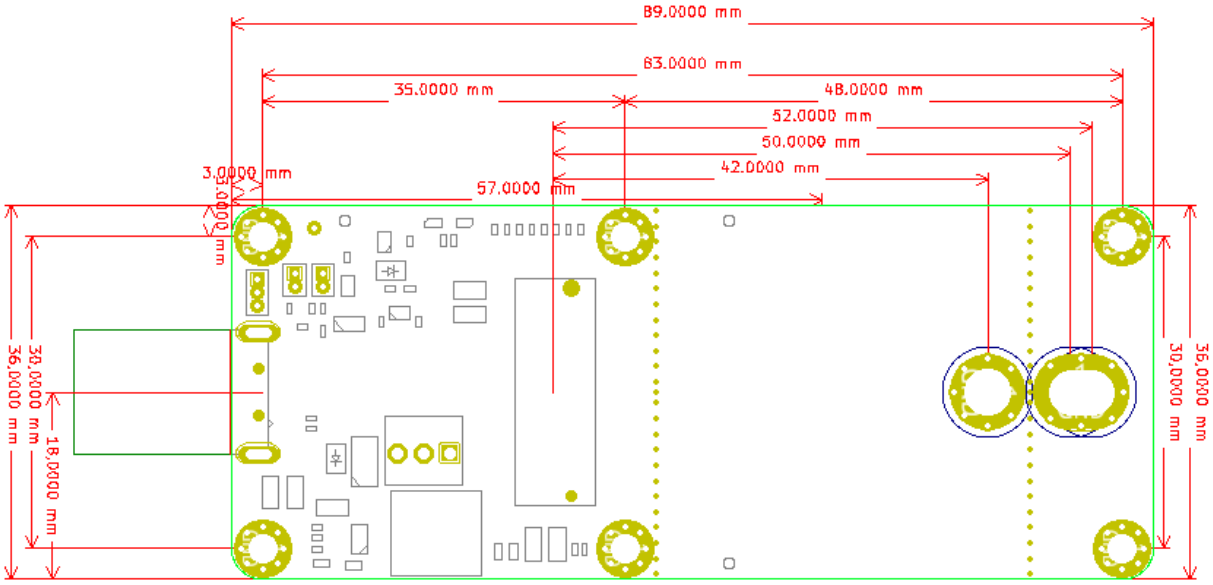
3.4 Dimensions

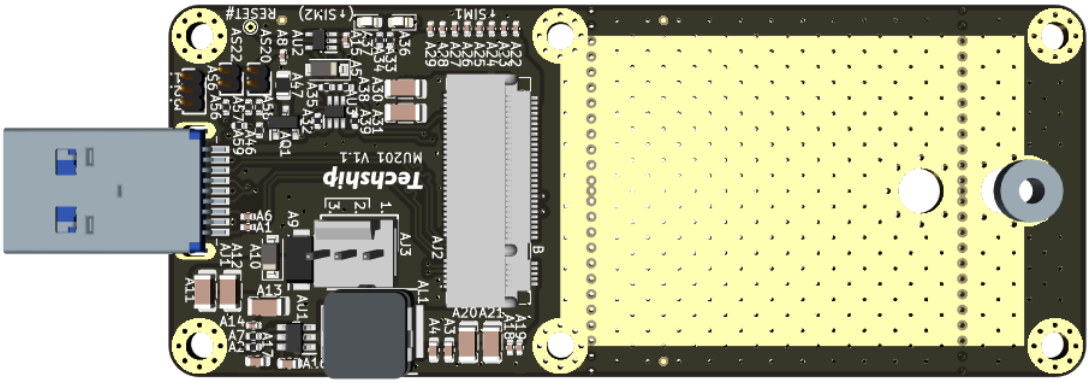
Height, overall, with pin-header, jumpers: approx. 14.0 mm

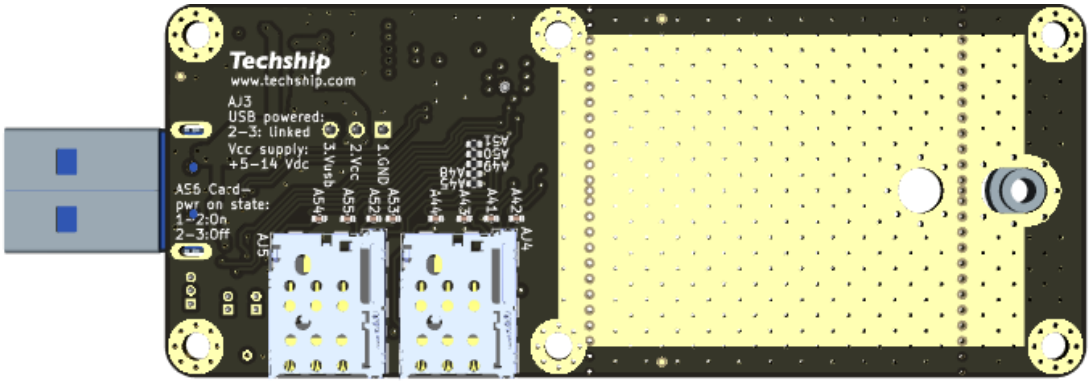
- PCB top side components: approx. 11.3 mm
- PCB thickness: 1.6mm
- PCB bottom side components: approx. 1.5 mm

- M.2 socket slot-in card rise height above adapter PCB top side: 2.5mm
- M.2 screw distance rise height over adapter PCB top side: 2.5mm

Length: 89 mm
Width: 36 mm





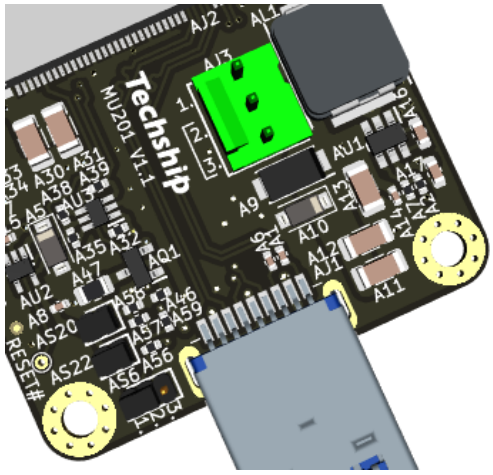


4 ELECTRICAL SPECIFICATION

4.1 Power supply

The adapter is designed with a sturdy switching voltage step-down power supply circuitry providing a fixed output voltage at approx. +3.46V DC for loads up to 4000mA when an external input power supply is used and up to approximately 2300mA when power supply is conducted via the USB plug and capable host port. The output voltage level is at the upper edge of what PCI-SIG M.2 specification allow.

The recommended external supply voltage range is between +5V to +14V DC while absolute minimum and maximum range is between +4.5V to +14.8V DC.



Ceramic capacitors with a combined capacitance of approximately 120uF on input side, and 450uF on output side have been added for improved voltage stability during high current load peaks to prevent voltage drops. The power supply design includes a set of capacitors for cancelling common high frequency interferences created by cellular data cards during RF transmissions at certain radio frequencies.
The adapter has an onboard +1.8V DC low-dropout step-down voltage regulator for pin-header control signals.

Pin-out number mapping for AJ3 / DJ3 referenced PCB header socket:

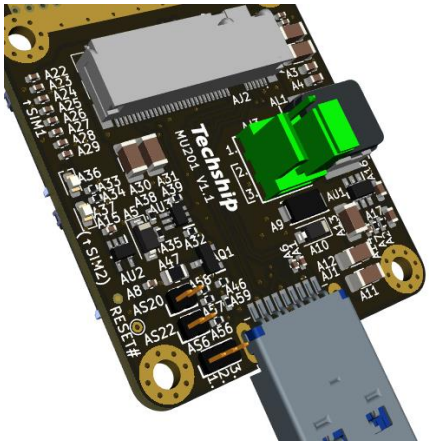
PCB pin number	Description
1	Ground
2	Vcc input (recommended voltage range between +5 to +14V DC)
3	Vusb output (+5V DC supply from the USB3 type A plug)

ATTENTION – Ensure that your host system can provide stable voltage and sufficient power supply even during momentary high peak loads typical for cellular data cards. Refer to the cellular data card vendors hardware guide for specific details concerning their hardware.

ATTENTION – Incorrect polarity or overvoltage may permanently damage the adapters and assembled data cards.

4.1.1 Power supply through the USB3 type A plug

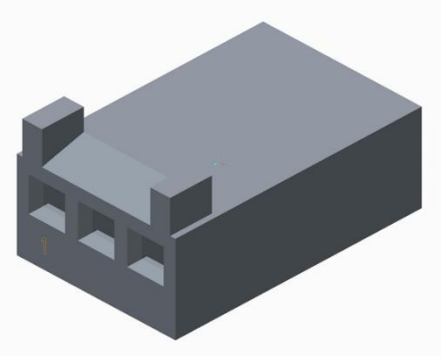
Use the 2.54mm jumper shunt on pin header socket AJ3/DJ3 between pin 2 and 3 (pin numbering marked on top side of PCB) to power supply the adapter through the USB3 type A plug.



NOTE – The maximum allowed electrical rating for the USB3 type A plug is 5V DC and 1800mA. The USB3 standard defines that a USB3 ports should be capable of providing up to 900mA loads at 5V DC while USB2 standard define support for current loads up to 500mA at 5V DC.

4.1.2 External power supply through the Molex KK254 PCB socket header

The adapter has an onboard 3-pin Molex KK254 2695 series PCB header (P/N: 22236035) with friction lock and polarizing rib for external power supply input. The recommended input voltage range is between +5 to +14V DC and absolute minimum and maximum range is between +4.5V to +14.8V DC.



Typical external power adapter is rated between 9-12V DC and up to 16W capable output.

Connect the negative wire to ground at pin 1 and the positive power supply wire to pin 2 in the crimp housing.
Leave the pin 3 slot empty and not populated since it is internally connected to Vusb and only used when no external power supply is in use.

ATTENTION – Incorrect polarity or overvoltage on the external power supply input pins will permanently damage the adapters voltage step-down IC and possibly assembled data cards.

Suitable KK254 wire housing is P/N: 22013037 with pre-crimped wires and terminals of P/N: 797580015 or only the crimp terminals e.g. of type P/N: 08500113.
More details available at Molex product family webpages:
https://www.molex.com/molex/products/family/kk_254_rpc_connector_system

NOTE – When external power supply is used, the Vusb voltage from the USB3 type A plug will still be used for enable/activation signal to the power supply circuitry and adapter will not function without it.

4.1.3 Power supply accessories at Techship.com

11674 Power Supply Cable, KK254 3-pin to Tinned Wire Ends, 0.3m
https://techship.com/products/power-supply-cable-kk-254-3-pin-to-tinned-wire-ends-0-3m

11712 Power Supply Cable, KK254 3-pin to DC Jack, 0.3m
https://techship.com/products/power-cable-kk254-3-pin-to-dc-jack-03m

11720 AC Power Adapter, US Plug, 12VDC, 2.5/5.5mm DC Jack
https://techship.com/products/ac-power-adapter-us-12v-dc-2a-25-55mm-center-positive

11721 AC Power Adapter, EU Plug, 12VDC, 2.5/5.5mm DC Jack
https://techship.com/products/ac-power-adapter-eu-12v-dc-2a

4.2 Status LEDs

The adapter has two LEDs, A36 (blue), A37 (green) on the PCB left hand side.

The blue LED (A36) indicates WWAN activity and controlled by the LED_WWAN# signal in the M.2 socket pin 10. It is an active low signal, so the LED is on when the M.2 pin 10 is pulled to ground.

NOTE – Please refer to the data card vendors documentations to identify the behaviour of the blue indicator LED.

The green LED (A37) is controlled by the power supply circuitry and indicates that the DC supply voltage is available in the M.2 data cards socket.

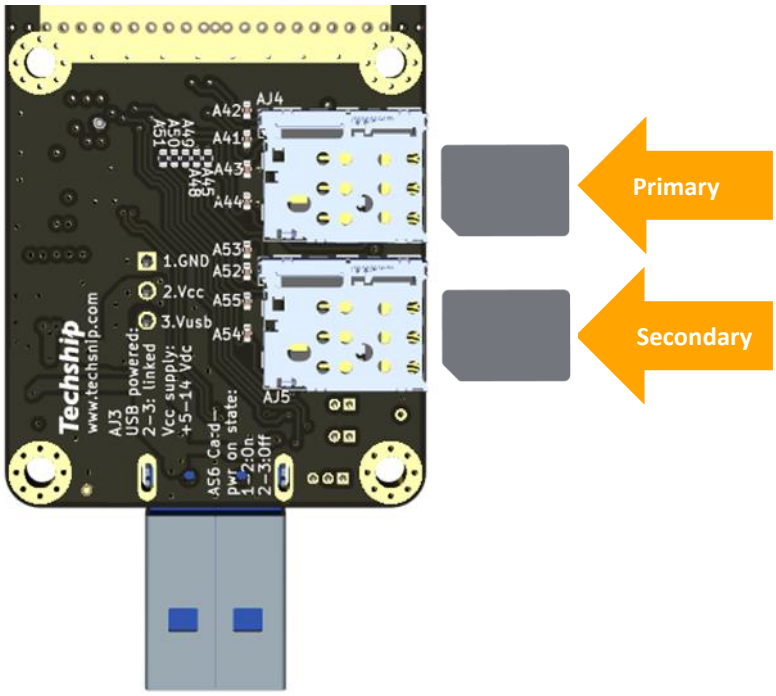
NOTE – When using external power supply, the USB type A cable must still provide +5VDC supply. It controls the enable signal for the DC step down circuitry and the discharge circuitry.

4.3 SIM card interface

The adapter implements 4FF (nano) sized SIM card holder type with SIM card detect signal switch, located on the bottom side of adapter PCB. Depending on adapter variant there is either a single SIM card holder available for primary SIM interface only, or two SIM card holder variant with support for secondary SIM interface also.

The primary SIM1 card holder is connected to the primary SIM interface in the M.2 key B socket and the secondary SIM2 card holder to the secondary SIM interface.

NOTE – Not all cellular M.2 data cards support a secondary SIM card interface, therefore verify support with your cellular data cards hardware guide if you intend to use the secondary SIM interface.



4.3.1 SIM card hot-swap detection signal

The adapter will indicate SIM card presence to the cellular data card in M.2 socket as following:

Primary SIM card holder	Pin	SIM detect signal	Remark
Card inserted	66	SIM1_DET: High, 1.8V	Pull-up to 1.8V through 10k resistor on PCB
Card not inserted	66	SIM1_DET: Low, ground	

Secondary SIM card holder	Pin	SIM detect signal	Remark
Card inserted	40	SIM2_DET: High, 1.8V	Pull-up to 1.8V through 10k resistor on PCB
Card not inserted	40	SIM2_DET: Low, ground	

NOTE – Secondary SIM holder detect signal SIM2_DET is connected via a 10k resistor to avoid short circuit if pin 40 is used for other purposes by cellular data card.

NOTE – Adjust the SIM card hot-swap setting in the cellular module firmware/software accordingly to have high SIM detect signal state indicate SIM card presence. The default configuration varies between cellular data card vendors. If no SIM card detected is reported from device, please first ensure correct configuration of the SIM hot swap detect signal in device software/firmware.

Example on how to enable and configure the SIM hot-swap feature for primary SIM holder among different 5G data card vendors:

Cellular module	Configuration
Telit FN982m	No configuration needed
Sierra Wireless EM91, EM76, EM74, EM75 series	No configuration needed
Fibocom FM150 series, NL668, L850, L860	No configuration needed
Simcom SIM8200, SIM8202 series	No configuration needed
Telit FN990, FN980, LN920 series	Configure the SIM interface with AT commands below: AT#SIMDET=0 AT#HSEN=1,0 AT#SIMINCFG=1,1 AT#REBOOT
Quectel RM500Q	Configure SIM interface with AT commands: AT+QUIMSLOT=1 AT+QSIMDET=1,1

4.4 Pin-out mapping for the on-board M.2 key B socket

4.4.1 M.2 key B pin number locations

4.4.2 M.2 key B top side contact pads (odd numbers)

Pin	Signal	Remark
1		
3	Ground	
5	Ground	
7	USB2_D+	
9	USB2_D-	
11	Ground	
13-19	(Mechanical M.2 key B notch)	
21-25		
27	Ground	
29	HOST_USB3_RX-	
31	HOST_USB3_RX+	
33	Ground	
35	HOST_USB3_TX-	
37	HOST_USB3_TX+	
39	Ground	
41		
43		
45	Ground	
47		
49		
51	Ground	
53		
55		
57	Ground	
59-65		
67	RESET#	Connected to RESET# test point
69		
71	Ground	
73	Ground	
75		

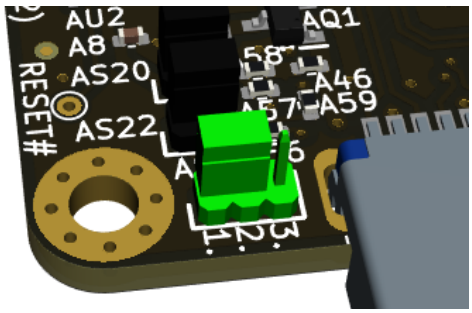
4.4.3 M.2 key B bottom side contact pads (even numbers)

Pin	Signal	Remark
2	VCC	
4	VCC	
6	POWER_OFF#	Connected through 10Kohm to AS6/DS6 pin header
8	W_DISABLE#	
10	LED_WWAN#	Connected to blue signal led
12-18	(Mechanical M.2 key B notch)	
20	(PCIE_DIS)	Connected through 10Kohm to AS20/DS20 pin header
22	(VBUS_SENSE)	Connected through 10Kohm to AS22/DS22 pin header
24-28		
30	SIM1-RESET	
32	SIM1-CLK	
34	SIM1-DATA	
36	SIM1-PWR	
38		
40	SIM2_DET	Connected via 10k resistor (dual SIM holder variant)
42	SIM2-DATA	Connected via zero ohm resistor (dual SIM holder variant)
44	SIM2-CLK	Connected via zero ohm resistor (dual SIM holder variant)
46	SIM2-RESET	Connected via zero ohm resistor (dual SIM holder variant)
48	SIM2-PWR	Connected via zero ohm resistor (dual SIM holder variant)
50-64		
66	SIM1_DET	
68		
70	VCC	
72	VCC	
74	VCC	

4.5 Signal pin-header jumpers

4.5.1 Full card power off# signal

The full_card_power_off# signal controls the operational state of the cellular data card, refer to the cellular data card vendors hardware documentation for details and operational states related to the signal. Use pin-header AS6/DS6 with 1.27mm header jumper to control the signal state.

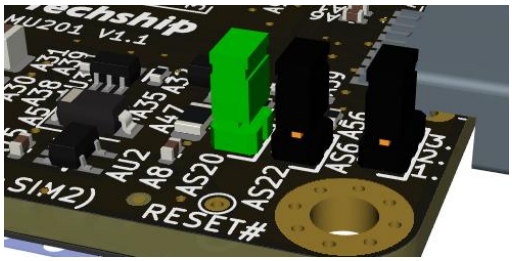


Pin header	M.2 pin	Signal name	Electrical state	Typical operational state
1-2 linked	6	FULL_CARD_POWER_OFF#	High, 1.8V	Data card power on state
2-3 linked	6	FULL_CARD_POWER_OFF#	Low, ground	Data card power off state

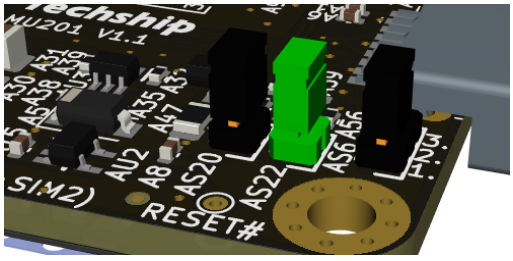
4.5.2 Active data interface selection (vendor dependent)

M.2 cellular data card from certain vendors use select signals in the M.2 socket to select the active data interface used between the host system and the cellular modules. Normally USB2 or USB3 have been the primary data interface for cellular data cards, but since introduction of 5G cellular data cards some vendors primarily defaults to using PCI Express data interface instead of USB. Use the onboard jumpers described below to control the commonly used select signal pins in M.2 socket.

- AS20/DS20 – pin-header, use 1.27mm jumper to pull M.2 socket pin 20 signal high with 1.8V DC, otherwise pulled to ground.



- AS22/DS22 – pin-header, use 1.27mm jumper to pull M.2 socket pin 22 signal high with 1.8V DC.



NOTE – Sierra Wireless EM9190, EM9191, EM7690 and EM9291 defaults to PCI Express data interface. To activate usage of USB2/USB3 data interface instead, assemble jumpers on pin 20 and pin 22 signal pin-headers.

NOTE – Telit FN990, FN980 HW rev. 2.1 and FN980m uses pin 20 to select data interface. To activate USB2/USB3 data interface instead of PCI Express, assemble a jumper on pin 20 signal pin-header to pull the signal high instead of low.

4.6 Compatible M.2 cellular data cards

The M.2 form factor is standardized by PCI-SIG, but cellular data card vendors do sometime implement vendor specific features that do not entirely follow the standard. Example of such could be that some signal pins are used for different purposes compared to what is specified by the standard, or a higher input voltage supply is required. This is seen on some 5G cellular data cards where new features have been introduced in the products. Such things can be mmWave control signals, data interface selection signals, etc.

Our design aim to support the general functionalities for most M.2 cellular data cards while vendor specific functions might not be supported.

Basic functionality and hardware compatibility tested on the following cellular data cards:

Cellular data card	Remark
Telit FN980	Single, primary SIM interface supported
Telit FN990, LN920 series, FN982m	Dual SIM interfaces supported
Sierra Wireless EM91, EM76 series	Single, primary SIM interface supported
Sierra Wireless EM74, EM75 series	Dual SIM interfaces supported
Fibocom FM150 series	Dual SIM interfaces supported
Fibocom NL668, L850, L860	Single, primary SIM interface supported
Simcom SIM8200, SIM8202 series	Dual SIM interfaces supported
Quectel RM500Q	Dual SIM interfaces supported