Techship

M.2 key B to USB3 C Adapter Series Hardware Guide

Revision 1.0 - 2023-05-16

APPLICABLE MODELS

Article Nr	Model	Description
11822	MC201	Techship M.2 key B to USB3 type C adapter with GPIO header

DOCUMENT REVISIONS

Version	Date	Comment	Author
R1.0	2023-05-16	Initial Release	Oscar Berglund

HARDWARE REVISIONS

Version	Date	Comment
PCB V1.0 (11822)	2023-05	Mass-production version

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DOCUMENT CONTENTS

1 INTRODUCTION

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

A quick start guide can be found on the product pages for a fast set-up, but it is recommended to also read the hardware guide so that the users are aware of all features and limitations.

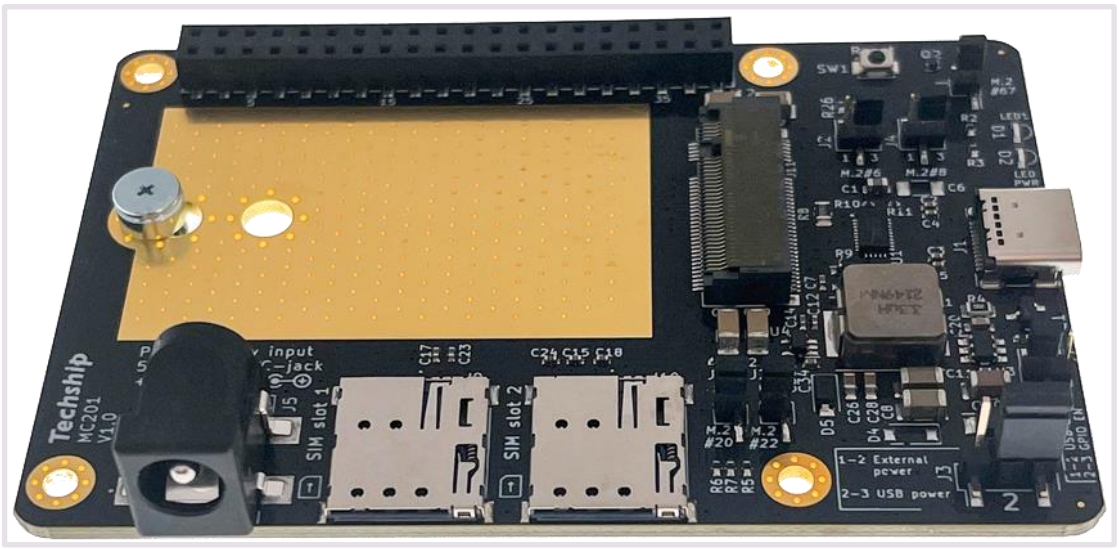
2 PRODUCT DESCRIPTION

The Techship M.2 key B to USB3 type C adapter, MC201, is designed to enable a quick and easy IoT transition. For example, the adapter can be integrated into existing generic hardware platforms co add cellular data connectivity. Additionally, it can ease the first development steps for customers evaluating, testing, and integrating M.2 key B cellular data cards.

A one-size-fits-all design is emphasized, ensuring compatibility with various cellular module design differences while maintaining a single PCB design. For example, the adapter includes:

- On-board pin-headers and jumpers for selecting active data interface.
- Exposed PCB ground planes to add thermal pads between cellular data cards and adapter PCB for improved heat dissipation.
- 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 M.2 cellular data cards with card lengths 42, 50 and 52 mm.

Two type 4FF nano SIM card holders are included for primary and secondary SIM card signals. Support for a secondary SIM is dependent on the modules that support multiple SIM cards.



3 MECHANICAL SPECIFICATION

3.1 Package contents

The adapter packaging includes the following content:

Description	MC201
Techship MC201 adapter board (in ESD protective bag)	1 pcs
Distance M3x2.5 mm	1 pcs
Screw M3x2.0 mm	2 pcs
Jumper shunt 2.54 mm	1 pcs
Jumper shunt 1.27 mm	6 pcs

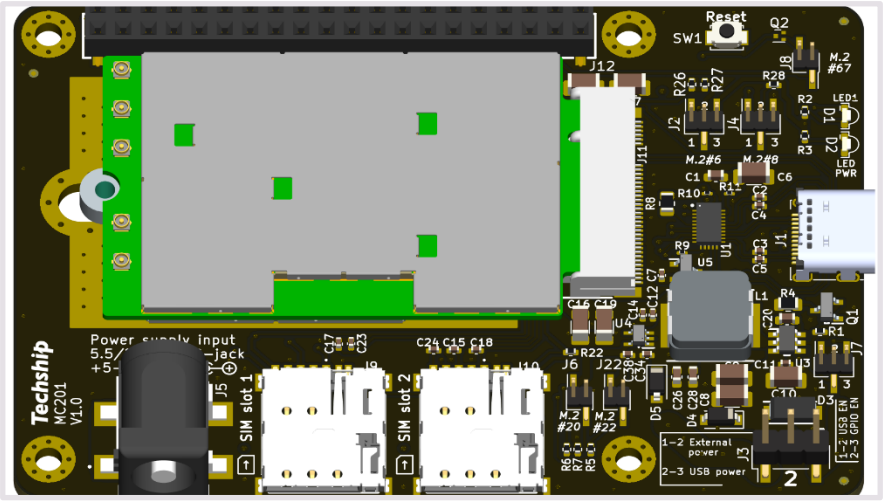
3.2 Environmental

Operational temperature range: -20°C to +75°C.

3.3 Assembly

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

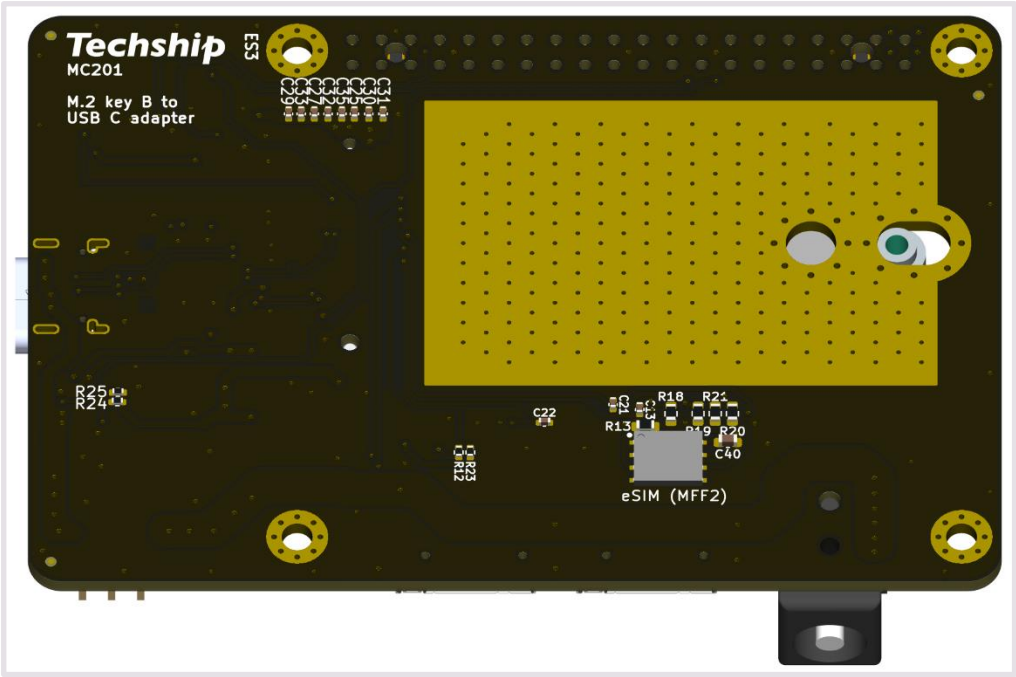
Install the cellular data card in the adapter's M.2 socket at an angle and fold down the card to rest on the steel distance. Use the other included M3x2 mm screw to fasten the cellular data card to the adapter.



ATTENTION – It is recommended to use thermal pads in the gap between the cellular data card and the 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. This can trigger a data card's internal thermal protection settings unless the thermal energy is sufficiently dissipated from the data card. Refer to the cellular data card vendor's product hardware guide for their thermal management recommendations.

The unmasked ground plane on the bottom side of the adapter PCB can be used to dissipate heat further away from the 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

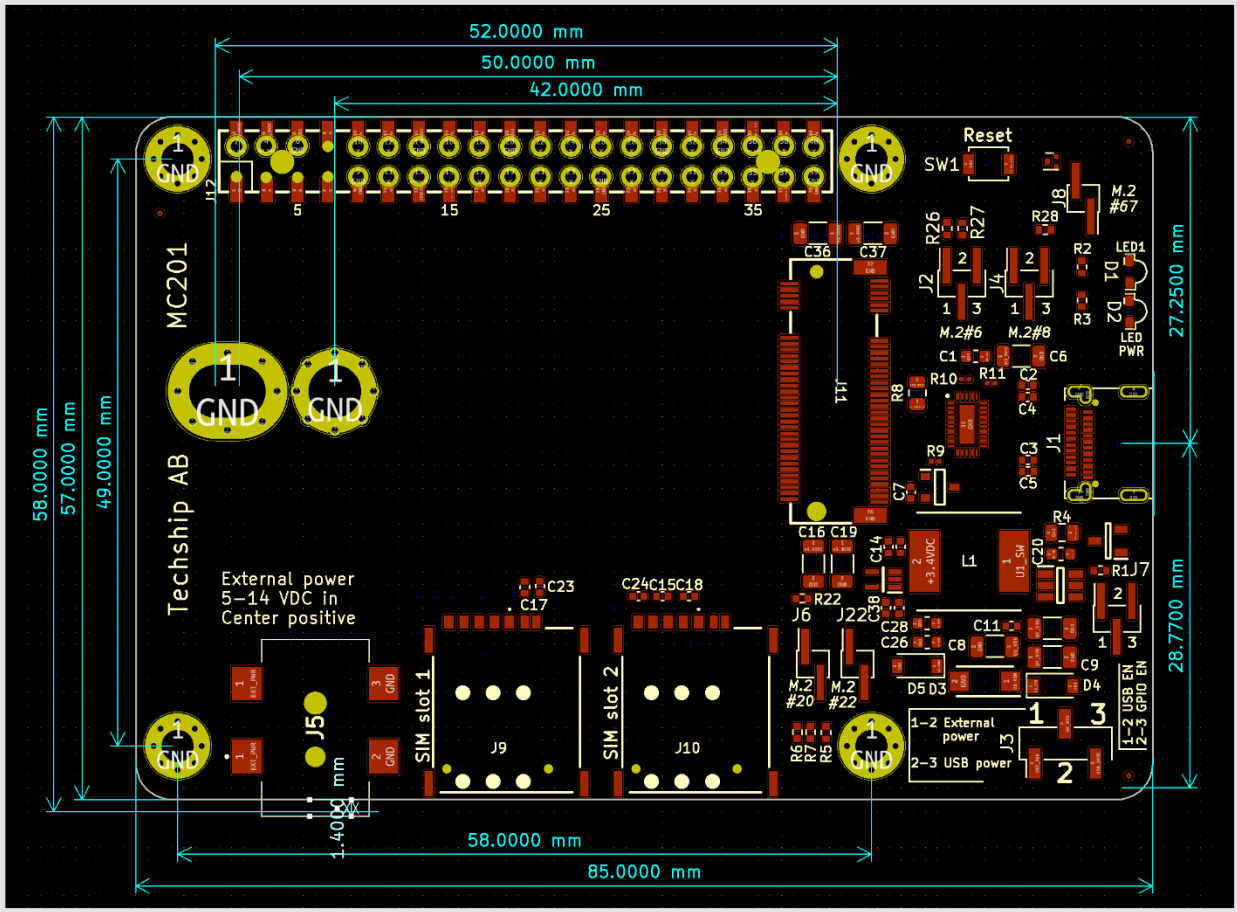
- 12489 Thermal pad, 6W/mK, 10x28x1.5mm
  https://techship.com/products/thermal-pad-6w-mk-10x28x15mm

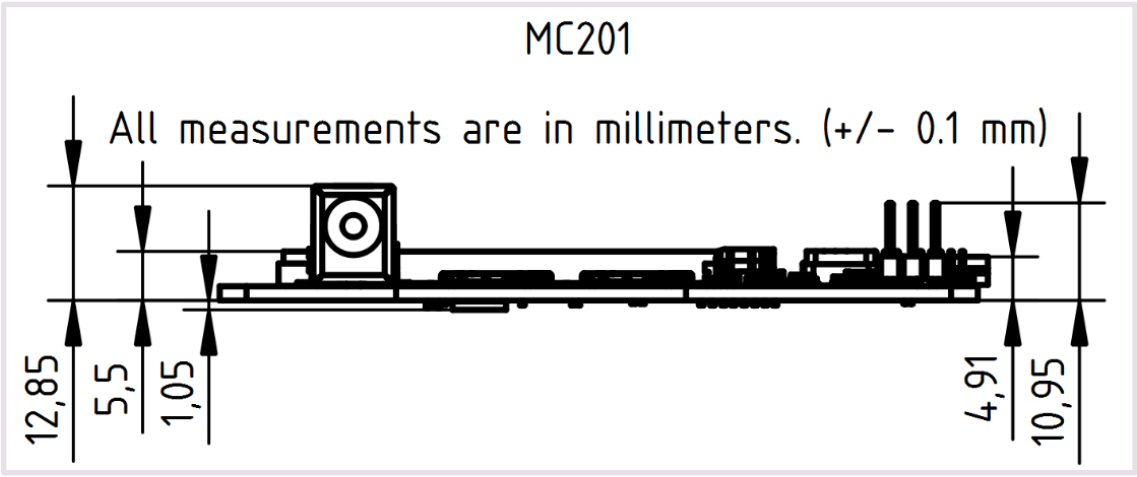
3.4 Dimensions

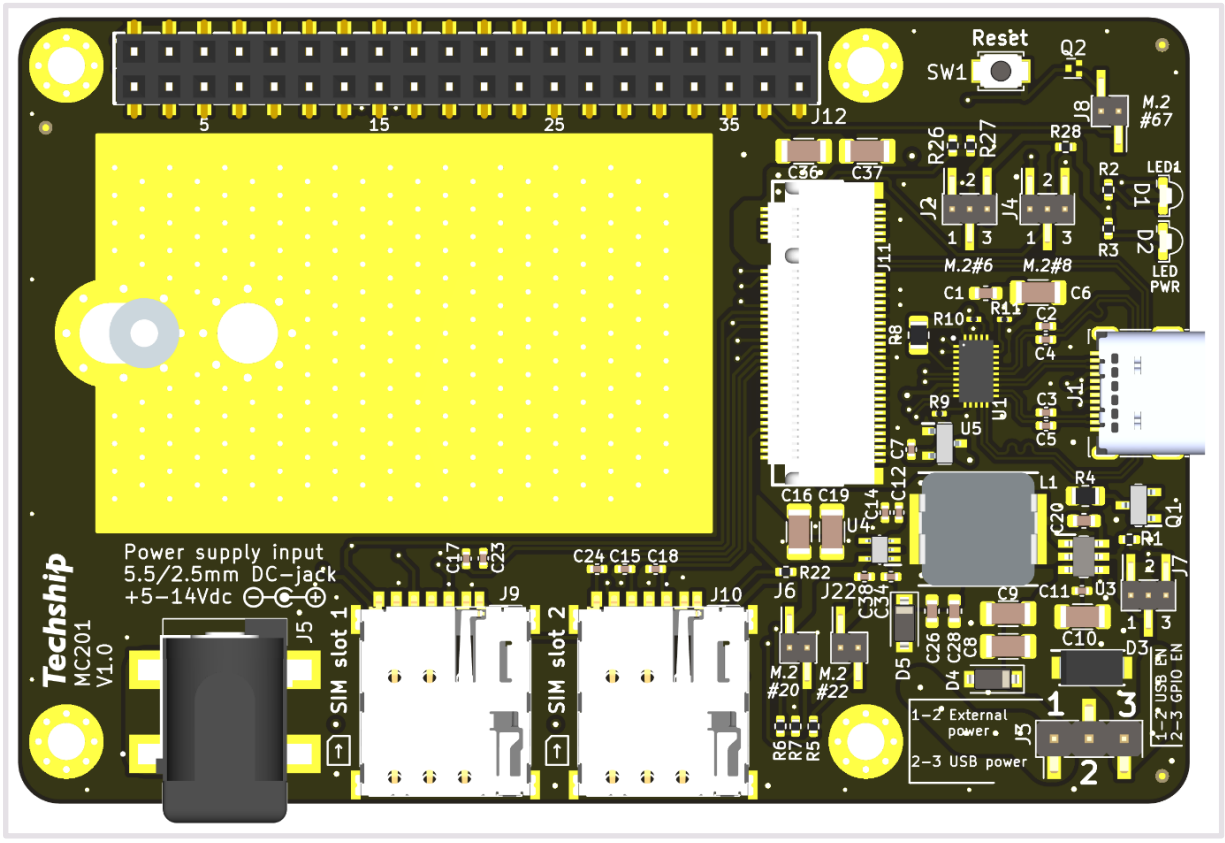
Height, overall, with pin-header, jumpers: approx. 14.6 mm

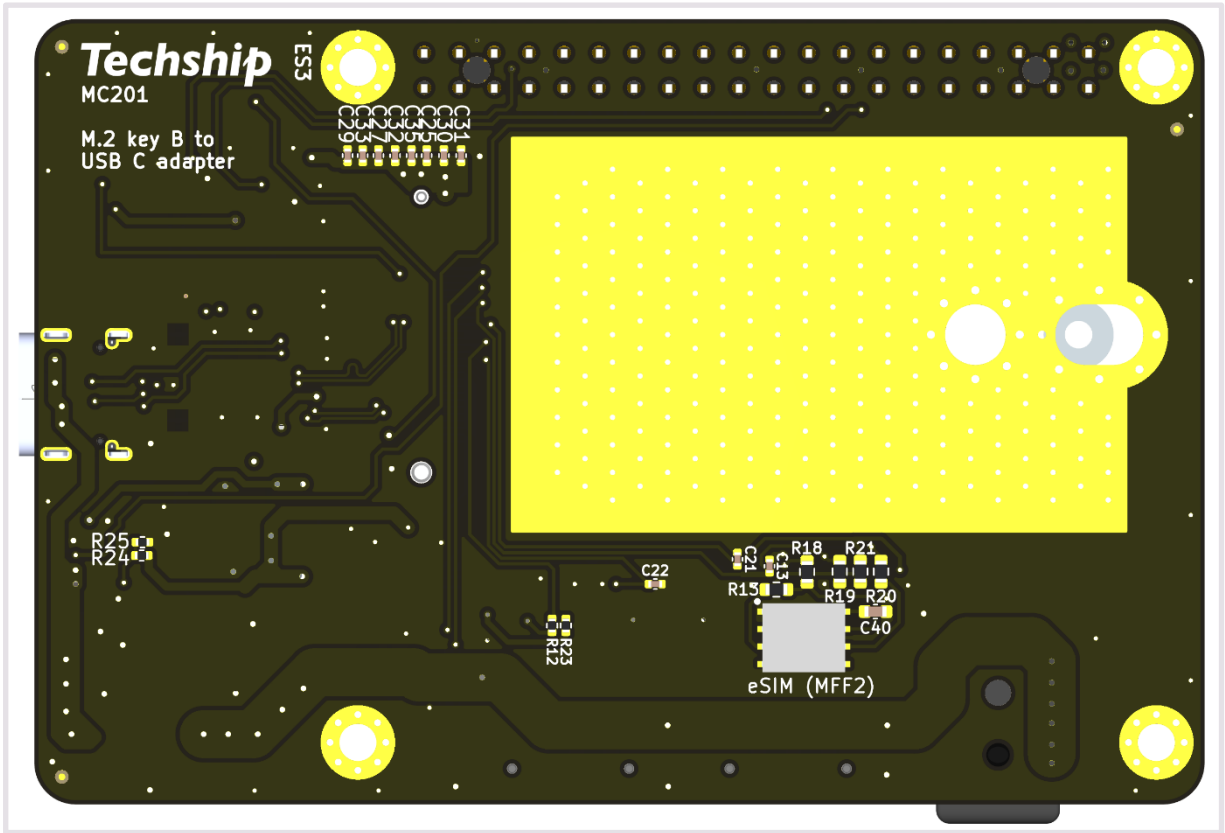
- PCB top side components: approx. 11 mm
- PCB thickness: 1.6 mm
- PCB bottom side components: approx. 2 mm
- M.2 socket slot-in card rise height above adapter PCB top side: 2.5 mm
- M.2 screw distance rise height over adapter PCB top side: 2.5 mm

Length: 86 mm (USB C extends 1 mm from PCB, PCB is 85 mm)
Width: 57 mm (DC jack extends 1 mm, thus total width at DC jack is 58 mm)






Reset
SW1
Q2
J12
M.2 #67
J8
R26
R27
R28
C36
C37
J2
J4
R2
LED1
D1
D2
R3
LED PWR
M.2#6
M.2#8
C1
C6
R10
R11
C2
C4
R8
U1
J1
R9
U5
C3
C5
C7
C12
L1
R4
C16
C19
U4
C14
C20
Q1
R1
J7
R22
J6
J22
C38
C34
C9
C11
Q3
C10
D3
C26
C28
C8
D5
D4
M.2 #20
M.2 #22
R6
R7
R5
1-2 External power
2-3 USB power
J5
1-2 USB EN
2-3 GPIO EN
Power supply input
5.5/2.5mm DC-jack
+5-14Vdc
J5
C17
C23
C24
C15
C18
J9
J10
SIM slot 1
SIM slot 2
Techship
MC201
V1.0


Techship
MC201
M.2 key B to
USB C adapter
ESD
R25
R24
C22
R18
R21
C21
C13
R15
R19
R20
C40
R12
R23
eSIM (MFF2)

4 ELECTRICAL SPECIFICATION

This chapter describes the electrical specifications of the MC201 including pinouts, jumpers, and voltage levels.

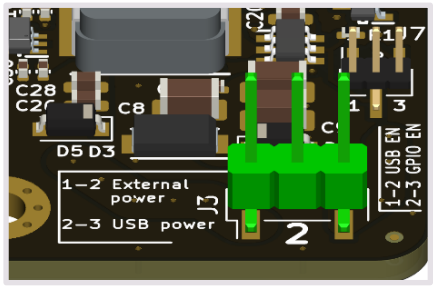
4.1 Power supply

The adapter is designed with a sturdy switching voltage step-down power supply circuitry providing a fixed output voltage at approximately +3.46 V DC for loads up to 3000 mA when an external input power supply is used and up to approximately 2300 mA when power supply is conducted via the USB plug and capable host port. The output voltage level is at the upper edge of what the official PCI-SIG M.2 specification allows.

The recommended external supply voltage range is between +5 V to +14 V DC while the absolute minimum and maximum range is between +4.5 V to +16.0 V DC.

Ceramic capacitors with a combined capacitance of approximately 120 uF on the input side and 450 uF on the 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 filtering capacitors for cancelling common high frequency interferences created by cellular data cards during full power RF transmissions at certain radio frequencies.

The adapter has an onboard +1.8 V DC low-dropout step-down voltage regulator for pin-header control signals.

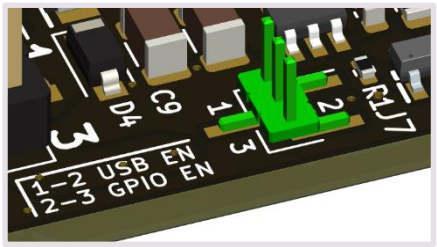


Pin-out number mapping for J3 referenced PCB header socket:

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

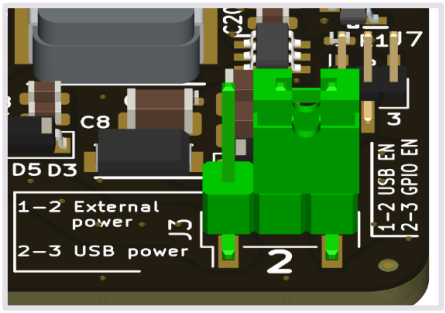
ATTENTION – Ensure that your host system can provide stable voltage and sufficient power supply even during momentary high peak loads typical for cellular data cards. Refer to the cellular data card vendor's hardware guide for specific details concerning their hardware.

The "enable" signal for the 3.46 V DC power supply can be controlled either by a GPIO signal or by being tied to the 5V supply. Pin out number mapping for DS1 is referenced below for the PCB header socket:



PCB pin number	Description
1	USB powered (5 V DC)
2	Vcc enable
3	GPIO powered (3.3 V DC) via pin 27

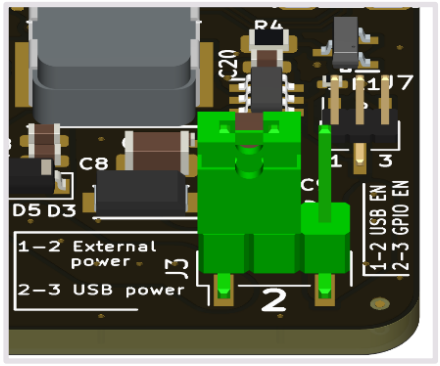
4.1.1 Power supply through the USB3 type A plug



Use the 2.54 mm jumper shunt on pin header socket J3 between pin 2 and 3 (pin numbering marked on top side of PCB) to supply power to the adapter through the USB3 type C plug.

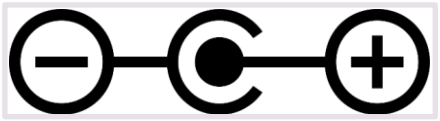
NOTE – The maximum allowed electrical rating for the USB3 type C plug is 3000 mA. The USB3 standard defines that USB3 type A ports should be capable of providing up to 900 mA loads at 5V DC while the USB2 standard defines support for current loads up to 500 mA at 5V DC.

4.1.2 External power supply through the DC jack



Alternatively, an external power supply is possible via the adapter's DC jack. Use the 2.54 mm jumper shunt on pin header socket J3 between pin 1 and 2 (pin numbering marked on top side of PCB) to power supply the adapter through the DC jack.

The recommended input voltage range is between +5 V to +14 V DC and the absolute minimum and maximum range is between +4.5 V to +16.0 V DC.



The DC jack is made to mate with a DC plug with outer diameter 5.5 mm and inner diameter 2.5 mm. The DC jack is centre positive.

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

ATTENTION – The adapter has no polarity protective diode in the power supply circuitry design to protect against incorrect assembly. This is intentionally omitted to support a lower input supply voltage. Therefore, connecting incorrect polarity on the voltage supply input pins will permanently damage the adapters switching voltage step-down IC.

NOTE – When external power supply is used for the MC201, the Vusb voltage from the USB3 type C plug will still be used for enable/activation signal to the power supply circuitry and adapter will not function without it. For MC201 attached to a GPIO header that supplies 5V DC via the GPIO signals the enable/activation signal to the power supply circuitry will still be activated.

4.1.3 Power supply accessories at Techship.com

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

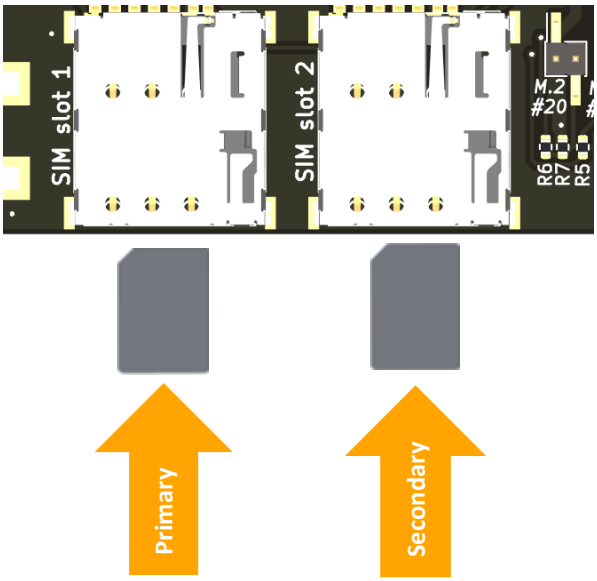
4.2 SIM card interface

The adapter implements 4FF (nano) sized SIM card holder types with a SIM card signal detect switch. The adapter is equipped with two SIM slots, one for the primary SIM and one for the secondary SIM for modules that support dual SIM support.

The primary “SIM slot 1” card holder is connected to the primary SIM interface in the M.2 key B socket and the secondary “SIM slot 2” 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.

On the bottom side of the adapter there is room for an eSIM. This is not populated for the first generation of the MC201 but can be easily mounted for future generations.



4.2.1 SIM card hot-swap detection signal

The adapter will indicate the presence of a SIM card 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, 1.8 V	Pull-up to 1.8 V through 10 k 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 1.8 V through 10 k resistor on PCB
Card not inserted	40	SIM2_DET: Low, ground	

NOTE – Secondary SIM holder detect signal SIM2_DET is connected via a 10 kOhm 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 the device's software/firmware.

The following lists some examples of enabling and configuring the SIM hot-swap feature for the 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 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

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

4.3.1 M.2 key B pin number locations

4.3.2 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 DS5 jumper and Reset button
69		
71	Ground	
73	Ground	
75		

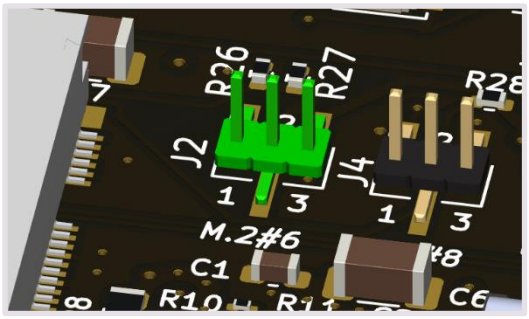
4.3.3 M.2 key B bottom side contact pads (even numbers)

Pin	Signal	Remark
2	VCC	
4	VCC	
6	POWER_OFF#	Connected through a 5kOhm resistor to DS6 pinheader
8	W_DISABLE#	
10	LED_WWAN#	Connected to blue signal LED
12-18	(Mechanical M.2 key B notch)	
20	(PCIE_DIS)	Connected through 5kOhm to DS20 pin header
22	(VBUS_SENSE)	Connected through 10kOhm to DS22 pin header
24-28		
30	SIM1-RESET	
32	SIM1-CLK	
34	SIM1-DATA	
36	SIM1-PWR	
38		
40	SIM2_DET	
42	SIM2-DATA	
44	SIM2-CLK	
46	SIM2-RESET	
48	SIM2-PWR	
50-64		
66	SIM1_DET	
68		
70	VCC	
72	VCC	
74	VCC	

4.4 Signal pin-header jumpers

4.4.1 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 vendor's hardware documentation for details and operational states related to the signal. Use pin-header J2 with a 1.27 mm header jumper to control the signal state.



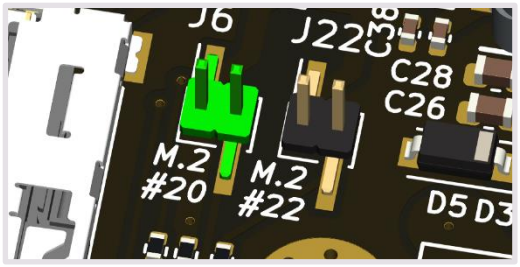
Pin header	M.2 pin	Signal name	Electrical state	Typical operational state
1-2 linked	6	FULL_CARD_POWER_OFF#	GPIO#22	Depending on GPIO pin 22
2-3 linked	6	FULL_CARD_POWER_OFF#	High, 3.4 V	Data card power on state
NC	6	FULL_CARD_POWER_OFF#	GND	Data card power off

4.4.2 Active data interface selection (vendor dependent)

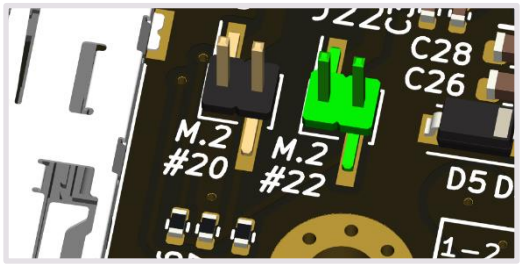
M.2 cellular data card from certain vendors use select signals in the M.2 socket to select the active data interface used between the host system and the cellular modules. Normally, USB2 or USB3 have been the primary data interface for cellular data cards. However, since the introduction of 5G cellular data cards, some vendors default to using the 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.

- J6 – pin-header, use 1.27 mm jumper to pull M.2 socket pin 20 signal high with 1.8 V DC, otherwise pulled to ground.



- J22 – pin-header, use 1.27 mm jumper to pull M.2 socket pin 22 signal high with 1.8 V DC.



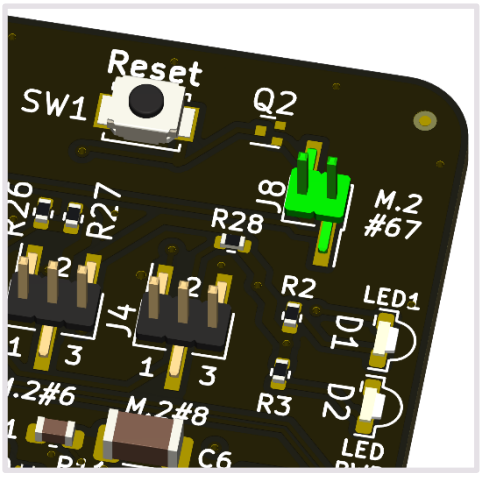
NOTE – Sierra Wireless EM9190, EM9191, EM7690 data cards default to the PCI Express data interface. To activate usage of the USB2/USB3 data interface instead, assemble jumpers on pin 20 and pin 22 signal pin-headers.

4.4.3 Reset# signal

The reset signal controls the operational state of the cellular data card. Refer to the cellular data card vendor's hardware documentation for details and operational states related to the signal.

Use pin-header J8 with 1.27 mm header jumper to control the signal state using GPIO pin 26.

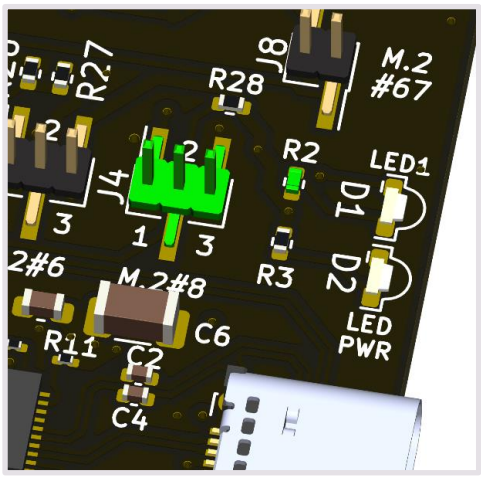
The push button can also be used to pull the signal to ground and thus resetting the module. The reset button can be used whether the DS5 header jumper is connected or not.



4.4.4 W_disable# signal

The W_disable signal controls the WWAN 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 J4 with 1.27 mm header jumper to control the signal state using GPIO pin 16.



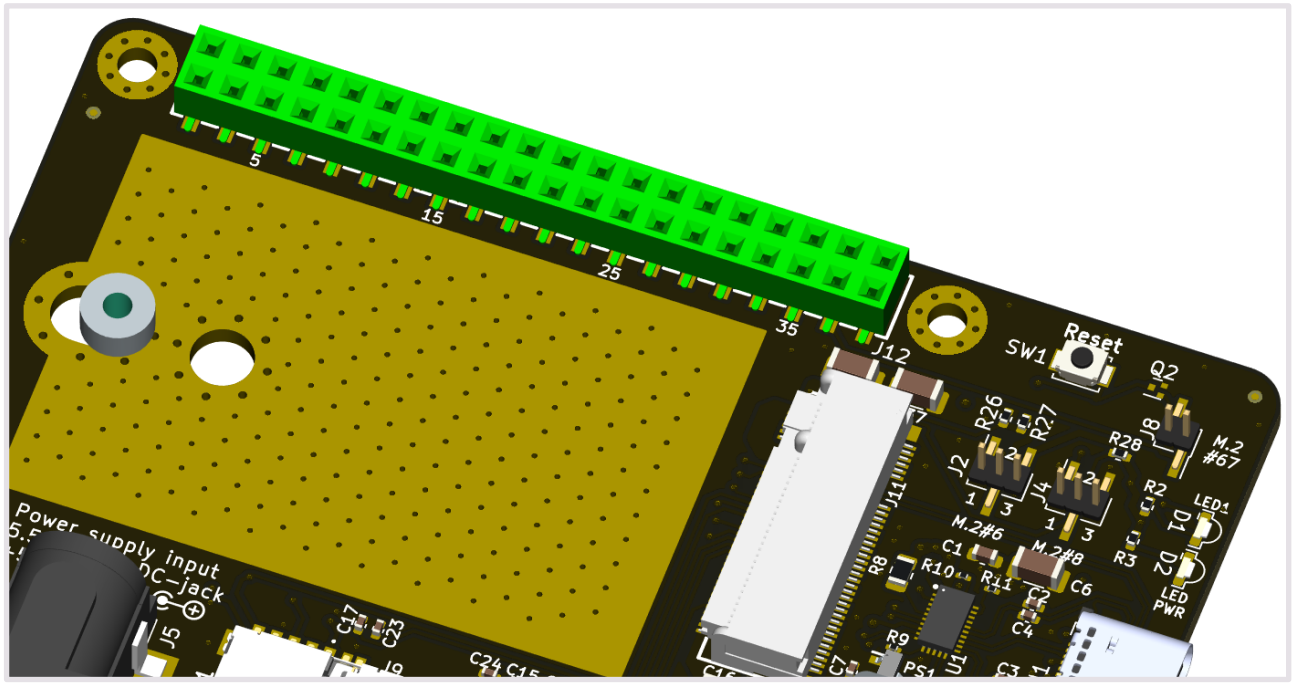
Pin header	M.2 pin	Signal name	Electrical state	Typical operational state
1-2 linked	8	W_DISABLE#	GPIO#16	Depending on GPIO pin 16
2-3 linked	8	W_DISABLE#	GND	Airplane mode
NC	8	W_DISABLE#	Pulled high	Normal mode

4.5 Raspberry Pi Pin Header Socket

The MC201 is equipped with a pin header made to mate with the pin array on a Raspberry Pi 3 Model B+ or Raspberry Pi 4 Model B.
Below is a table that showcases what pins are used on the MC201 (Pin 1 is lower left side of the connector, and pin 2 is the top left.):

Socket Pin Header	Raspberry Pi Pin	MC201 Function
2, 4	5V Supply	USB 5V Supply rail connected to Raspberry Pi
6, 9, 14, 20, 25, 30, 34, 39	Ground	GND
13	GPIO 27	GPIO-controlled Enable signal (See bottom of p.8 for details)
15	GPIO 22	GPIO-controlled Full card power off signal (See 4.4.1 for details)
36	GPIO 16	GPIO-controlled Disable signal (See 4.4.4 for details)
37	GPIO 26	GPIO-controlled Reset signal (See 4.4.3 for details)

NOTE - All other pins are NC.



4.6 LEDs

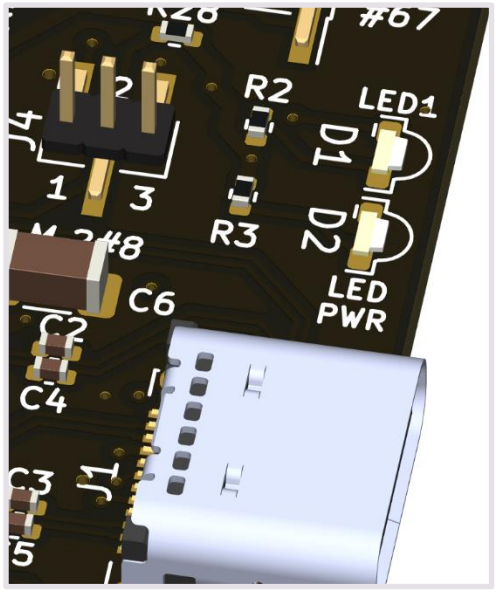
The adapter has two LEDs on the left side of the PCB: D1 (blue) and D2 (green).

The blue LED (D1) indicates WWAN activity and is 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 vendor's documentation to identify the behaviour of the blue indicator LED.

The green LED (D2) is controlled by the power supply circuitry and indicates that the DC supply voltage is available in the M.2 data card's socket.

NOTE – When using external power supply, the USB type A cable must still provide +5VD



4.7 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 deviation could be that some signal pins are used for different purposes compared to what is specified by the standard, or perhaps 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 is to support the general functionalities for most M.2 cellular data cards and be flexible enough to support some vendor-specific functions. However, some vendor specific functions might not be feasible to support in a single adapter.

Basic functionality and hardware compatibility has been listed on the following cellular data cards:

Cellular data card	Remark
Telit FN990A series	Dual SIM interfaces supported
Telit FN980	Single, primary SIM interface supported
Telit 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, FM160 series	Dual SIM interfaces supported
Fibocom NL668, L850, L860	Single, primary SIM interface supported
SIMCom SIM82xx series	Dual SIM interfaces supported
Quectel RM500Q	Dual SIM interfaces supported

4.8 Jumper settings for basic operation with common modems

This is a quick guide on the different jumper settings on common modems. Please note that these settings are intended as a quick start-up point, and some functions might be missed that you require in your situation. Please see your modem's hardware and software guides alongside this hardware guide when choosing jumper settings.

Cellular data card	M.2 Pin 6	M.2 Pin 8	M.2 Pin 20	M.2 Pin 22
Telit FN990A28	2-3 LINK	NC	LINK	NC
Telit FN990A40	2-3 LINK	NC	LINK	NC
Telit FN980	2-3 LINK	NC	LINK	NC
Telit LN920	2-3 LINK	NC	NC	NC
Sierra Wireless EM7565	2-3 LINK	NC	NC	NC
Sierra Wireless EM7421	2-3 LINK	NC	NC	NC
Sierra Wireless EM7455	2-3 LINK	NC	NC	NC
Sierra Wireless EM9191	2-3 LINK	NC	LINK	LINK
Sierra Wireless EM9291	2-3 LINK	NC	LINK	LINK
Fibocom FM150	2-3 LINK	NC	NC	NC
Fibocom FM160	2-3 LINK	NC	NC	NC
Simcom SIM8202	2-3 LINK	NC	NC	NC
Quectel RM500Q	2-3 LINK	NC	NC	NC