Monitor One Datasheet

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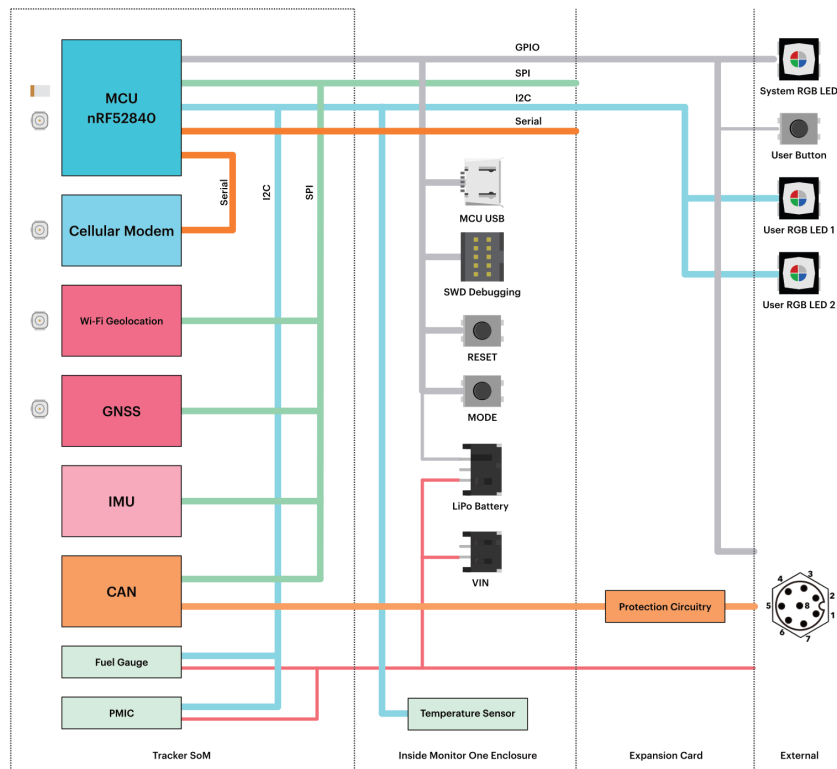This is an preliminary pre-release datasheet and the contents are subject to change.

The pictures in this preliminary datasheet are of a pre-release unit. The production units will be a different color, and may have other minor differences.

The Monitor One is an off-the-shelf complete design, like the Tracker One. The Monitor One is in a larger IP67 waterproof enclosure with room inside for expansion cards and additional connectors, allowing it to be used in more custom scenarios than the Tracker One.

- **Ready to go** with IP67-rated enclosure.
- **Flexible power supply** to easily add asset tracking to most devices with a 6 - 90 VDC power input.
- **Internal or external antennas** for cellular and GNSS.
- **Temperature sensors** within the enclosure, and also a battery pack temperature sensor.
- **Expansion cards** allow for custom features.
- **RGB LEDs** for system status, and two user RGB LEDs for your own use, visible from outside the enclosure.
- **User button**, waterproof and accessible from outside the enclosure.

Block diagram

Tracker SoM

- MCU nRF52840
- Cellular Modem
- Wi-Fi Geolocation
- GNSS
- IMU
- CAN
- Fuel Gauge
- PMIC

Serial — I2C — SPI

Inside Monitor One Enclosure

- MCU USB
- SWD Debugging
- RESET
- MODE
- LiPo Battery
- VIN
- Temperature Sensor

GPIO — SPI — I2C — Serial

Expansion Card

- Protection Circuitry

External

- System RGB LED
- User Button
- User RGB LED 1
- User RGB LED 2

Details about the Tracker SoM that is contained within the Monitor One can be found in the
Tracker SoM Datasheet.

External features

Label	Feature
1	System RGB LED
2	GNSS antenna (internal)
3	Cellular antenna (internal)
4	External connectors (on bottom)
5	Magnetic or bolt-down mounting bracket
6	User RGB LEDs (2)
7	User button (externally accessible)
8	Wi-Fi geolocation antenna (internal)

USER BUTTON

A waterproof button is available from the outside of the enclosure.

- Long press (10 seconds) resets the device (as if the RESET button was pressed)
- Shorter press and multiple press can be handled by your user firmware for your own features

USER LEDS (2)

- There are two small RGB LEDs visible from the outside on the side of the unit, next to the user button.
- You can program custom colors, blinking, and fade effects for each LED from your user firmware.
- LEDs are controlled by a ADP8866 I2C LED controller.

CONNECTORS

The bottom plate of the Monitor One can be customized with different connectors for your application.

| Label	Feature
1	Cellular antenna (SMA)
2	M12 connector (8-pin)
3	M12 connector (4-pin)
4	GNSS antenna (SMA)
5	Mounting plate attachment screw

By default the Monitor One uses the internal cellular and GNSS antennas, but can be switched to using the external connectors inside the enclosure.

Mounting

The Monitor One is intended to be mounted in the orientation shown at the top of the page, with the connectors facing down. You can also mount it with the mounting plate facing down as the GNSS antenna is angled to allow it to work in either orientation.

When using external cellular and GNSS antennas you can orient the Monitor One in any direction.

The mounting plate contains two magnets that allow it to be easily mounted on a metal surface, or to a metal plate affixed to a non-metal surface, such as the wood post shown above.
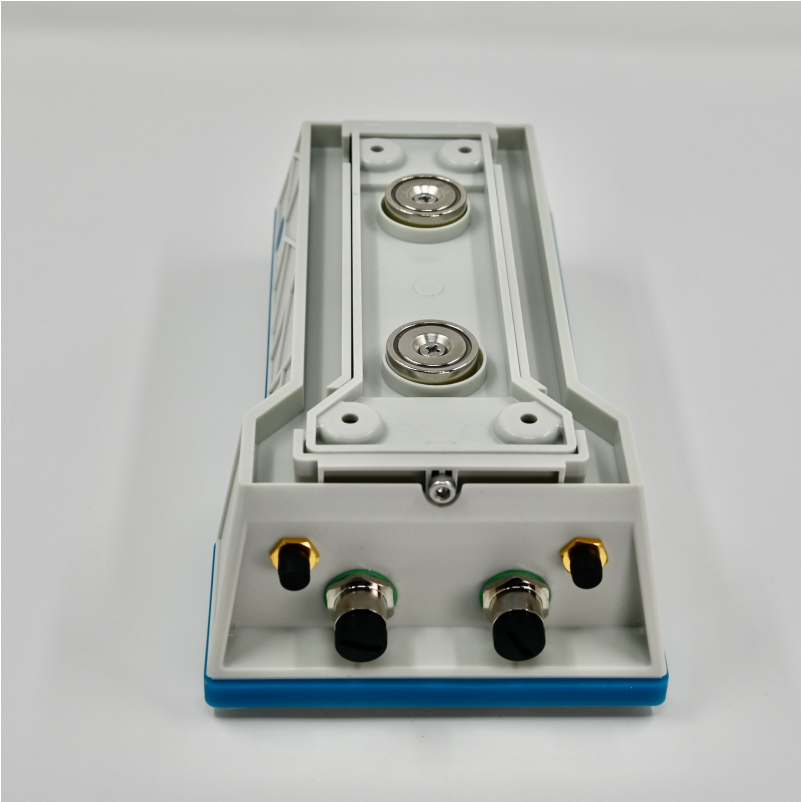
The mounting plate is removable from the back of the unit after removing the screw on the bottom, near the expansion connectors.

Once removed, you can screw or bolt the mounting plate to a surface and reattach the Monitor One. This is good for rough conditions and to help prevent theft.

Dimensions	Metric	SAE
Top, width between mounting holes	28 mm	1 3/32"
Bottom, width between mounting holes	46 mm	1 13/16"
Height between mounting holes	140 mm	5 1/2"

Dimensions	Metric	SAE
Bolt/screw head hole diameter	12.46 mm	31/64"
Bolt/screw head maximum height	4.0 mm	5/32"
Bolt/screw hole diameter	4.33 mm	11/64"
Bolt/screw shaft to surface	3.65 mm	9/64"
Recommended bolt	M4	#8
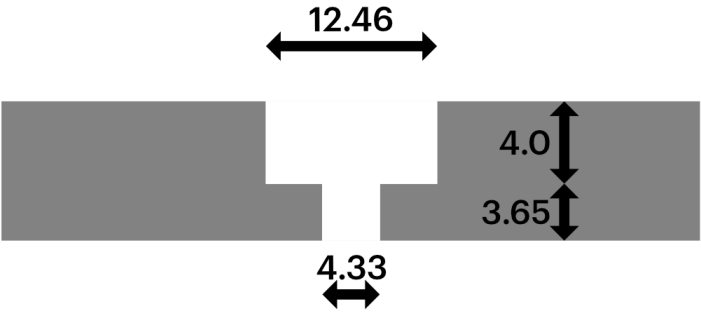
Internal features
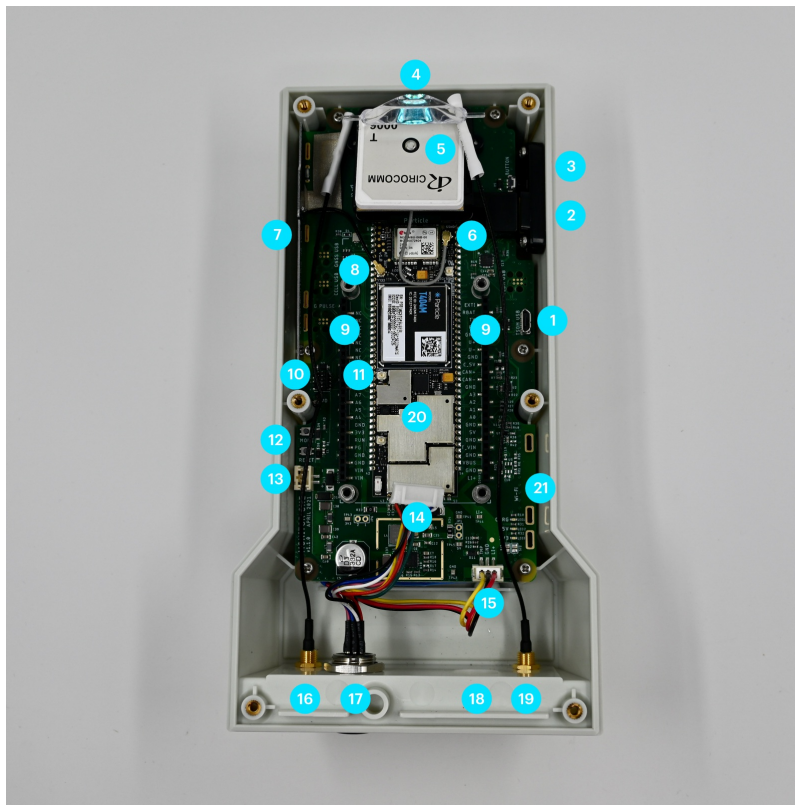
Label	Feature
1	MCU USB Connector (Micro B)
2	User RGB LEDs (2, externally visible)
3	User Button (externally accessible)
4	System RGB LED (externally visible)
5	GNSS antenna (internal, optional)
6	GNSS antenna U.FL connector
7	Cellular antenna (internal)
8	Cellular antenna U.FL connector
9	Expansion card headers (2)
10	SWD debugging connector
11	Wi-Fi geolocation antenna U.FL connector
12	MODE and SETUP buttons
13	VIN connector
14	Expansion card to external connector cable
15	LiPo battery connector
16	Cellular antenna SMA connector (external)
17	Expansion card external connector #1 (M12, 8-pin)
18	Expansion card external connector #2 (M12)
19	GNSS antenna SMA connector (external)
20	Tracker SoM module
21	Wi-Fi geolocation antenna (internal, not pictured)

Expansion card interface

Tracker M is designed with easy-to-use expansion headers and an enclosure with sufficient space inside for an expansion card, and for additional expansion connector through the wall of enclosure.

- Expansion card size: 50mm x 90mm (approximately 2" x 3.5")
- Connectors: 24-pin 0.1" headers (two, one on each long side)
- Male header pins on the bottom of expansion card
- Attachment: 4 screws to standoffs (M3 screw recommended)
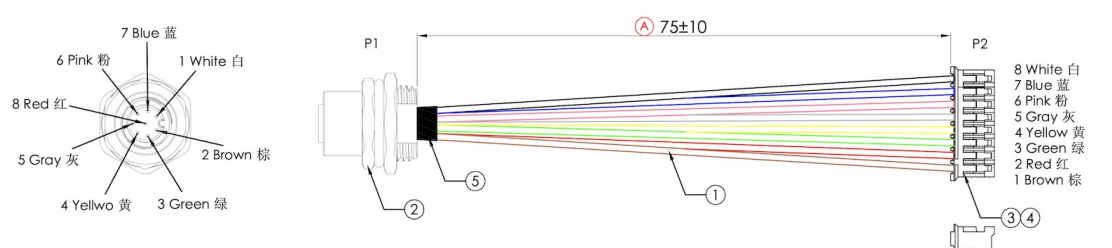
Pre-built expansion cards will be available, including a prototyping breadboard expansion card. You can also design and fabricate your own.
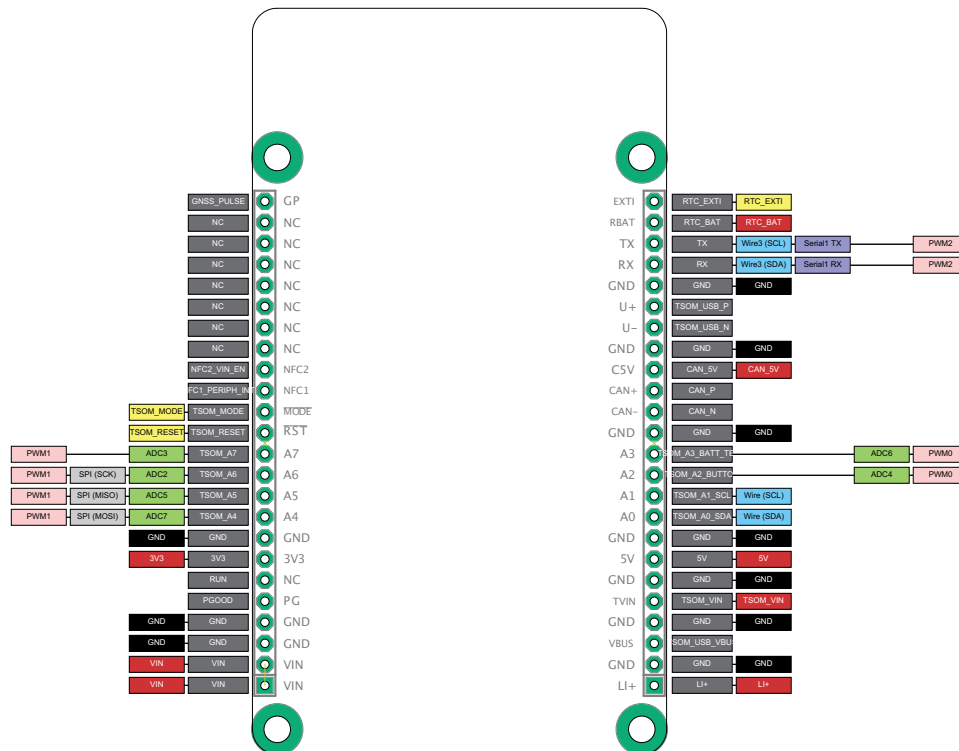
EXPANSION CARD DIMENSIONS

Dimensions in mm

EXPANSION CARD LOCATION

Label	Feature
14	Expansion card to external connector cable (M8 to PHR8)
17	Expansion card external connector #1 (M12, 8-pin)
22	Location of expansion card (green outline)

The enclosure typically has a panel-mount M12 8 pin female connector in location 17 in the picture above. This is connected via a short cable to a PHR-8 female connector that attaches to your expansion card. The picture above shows the cable but a board is not installed in the picture.

The functions of the pins on the M12 8-pin connector are dependent on your base board, but the following pinouts are recommended:

Conn P1 (M12)	Conn P2 (PHR-8)	Function
1	8	
2	1	VIN
3	3	CAN_P
4	4	CAN_N
5	5	
6	6	
7	7	
8	2	Ground
Round	Rectangular	
Enclosure	Expansion Card	

Note: wire color may vary from this graphic.

- Cable length: 75mm
- Wire gauge: 24 AWG

GPIO

Pin Name	Description	SoM Pin	MCU
TSOM_A7 / D7	A7 Analog in, GPIO D7, PWM, SPI SS, WKP	38	P0.05
TSOM_A6 / D6	A6 Analog in, GPIO D6, PWM, SPI (SCK)	39	P0.04
TSOM_A5 / D5	A5 Analog in, GPIO D5, PWM, SPI MISO	40	P0.29
TSOM_A4 / D4	A4 Analog in, GPIO D4, PWM, SPI MOSI	41	P0.29
TSOM_A2_BUTTON / D2	External user button, A2 Analog in, GPIO D2, PWM	57	P0.28
TSOM_A3_BATT_TEMP / D3	Battery temperature sensor, A3 Analog in, GPIO D3, PWM	58	P0.30
RX / D9	Serial1 RX, GPIO D9, PWM, Wire3 SDA	71	P0.08
TX / D8	Serial1 TX, GPIO D8, PWM, Wire3 SCL	72	P0.06

- On the Monitor One, pins A0 and A1 are used in I2C mode by the user RGB LED temperature sensor. Pins A0 and A1 cannot be used as GPIO.
- On the Monitor One, you should not use A2 and A3 as GPIO or analog inputs as they are used by the external user button and battery temperature thermistor.
- All GPIO are 3.3V and are not 5V tolerant.

ADC

Pin Name	Description	Interface	SoM Pin	MCU
TSOM_A7 / D7	A7 Analog in, GPIO D7, PWM, SPI SS, WKP	ADC3	38	P0.05

TSOM_A6 / D6	A6 Analog in, GPIO D6, PWM, SPI (SCK)	ADC2	39	P0.04
TSOM_A5 / D5	A5 Analog in, GPIO D5, PWM, SPI MISO	ADC5	40	P0.29
TSOM_A4 / D4	A4 Analog in, GPIO D4, PWM, SPI MOSI	ADC7	41	P0.29
TSOM_A2_BUTTON / D2	External user button, A2 Analog in, GPIO D2, PWM	ADC4	57	P0.28
TSOM_A3_BATT_TEMP / D3	Battery temperature sensor, A3 Analog in, GPIO D3, PWM	ADC6	58	P0.30

- On the Monitor One, you should not use A2 and A3 as analog inputs as they are used by the external user button and battery temperature thermistor.

SPI

Pin Name	Description	Interface	SoM Pin	MCU
TSOM_A6 / D6	A6 Analog in, GPIO D6, PWM, SPI (SCK)	SPI (SCK)	39	P0.04
TSOM_A5 / D5	A5 Analog in, GPIO D5, PWM, SPI MISO	SPI (MISO)	40	P0.29
TSOM_A4 / D4	A4 Analog in, GPIO D4, PWM, SPI MOSI	SPI (MOSI)	41	P0.29

- Any available GPIO can be used as a SPI CS/SS pin.

I2C

Pin Name	Description	Interface	SoM Pin	MCU
TSOM_A0_SDA / D0	Wire SDA	Wire (SDA)	55	P0.03
TSOM_A1_SCL / D1	Wire SCL	Wire (SCL)	56	P0.02
RX / D9	Serial1 RX, GPIO D9, PWM, Wire3 SDA	Wire3 (SDA)	71	P0.08
TX / D8	Serial1 TX, GPIO D8, PWM, Wire3 SCL	Wire3 (SCL)	72	P0.06

- On the Monitor One, pins A0 and A1 are used in I2C mode by the user RGB LED and temperature sensor. Pins A0 and A1 cannot be used as GPIO.
- On the Monitor One (and Tracker SoM), `Wire` and `Wire3` are two different I2C peripherals and can be used at the same time.
- On the Monitor One (and Tracker SoM), `Wire3` and `Serial1` share the same pins and only one can be used at a time.
- I2C is 3.3V only and is not 5V tolerant.
- There are 4.7K pull-up resistors on `TSOM_A0_SDA` and `TSOM_A1_SCL` to 3.3V on the base board.

SERIAL (UART)

Pin Name	Description	Interface	SoM Pin	MCU
RX / D9	Serial1 RX, GPIO D9, PWM, Wire3 SDA	Serial1 RX	71	P0.08
TX / D8	Serial1 TX, GPIO D8, PWM, Wire3 SCL	Serial1 TX	72	P0.06

- On the Monitor One (and Tracker SoM), `Wire3` and `Serial1` share the same pins and only one can be used at a time.
- Hardware flow control is not available on the Monitor One.
- Serial pins are 3.3V only and are not 5V tolerant.
- Additional interface chips are required for other serial standards such as RS232 and RS485.

PWM

Pin Name	Description	Interface	SoM Pin	MCU
TSOM_A7 / D7	A7 Analog in, GPIO D7, PWM, SPI SS, WKP	PWM1	38	P0.05
TSOM_A6 / D6	A6 Analog in, GPIO D6, PWM, SPI (SCK)	PWM1	39	P0.04
TSOM_A5 / D5	A5 Analog in, GPIO D5, PWM, SPI MISO	PWM1	40	P0.29
TSOM_A4 / D4	A4 Analog in, GPIO D4, PWM, SPI MOSI	PWM1	41	P0.29
TSOM_A2_BUTTON / D2	External user button, A2 Analog in, GPIO D2, PWM	PWM0	57	P0.28
TSOM_A3_BATT_TEMP / D3	Battery temperature sensor, A3 Analog in, GPIO D3, PWM	PWM0	58	P0.30
RX / D9	Serial1 RX, GPIO D9, PWM, Wire3 SDA	PWM2	71	P0.08
TX / D8	Serial1 TX, GPIO D8, PWM, Wire3 SCL	PWM2	72	P0.06

- On the Monitor One, you should not use A2 and A3 as PWM outputs as they are used by the external user button and battery temperature thermistor.
- All pins on the same hardware timer (PWM0, PWM1, or PWM2) must share the same frequency but can have different duty cycles.

CAN

Pin Name	Description	Interface	SoM Pin
CAN_N	CAN Data- or CANL	CAN_N	64
CAN_P	CAN Data+ or CANH	CAN_P	65
CAN_5V	5V power out, 0.8A maximum. Can be controlled by software.	CAN_5V	66

The CAN transceiver is included on the Tracker SoM. However if you implement CAN on your expansion card, you will probably want to add protection circuitry. This circuit is present on the Monitor One CAN expansion card and also on the Tracker One.
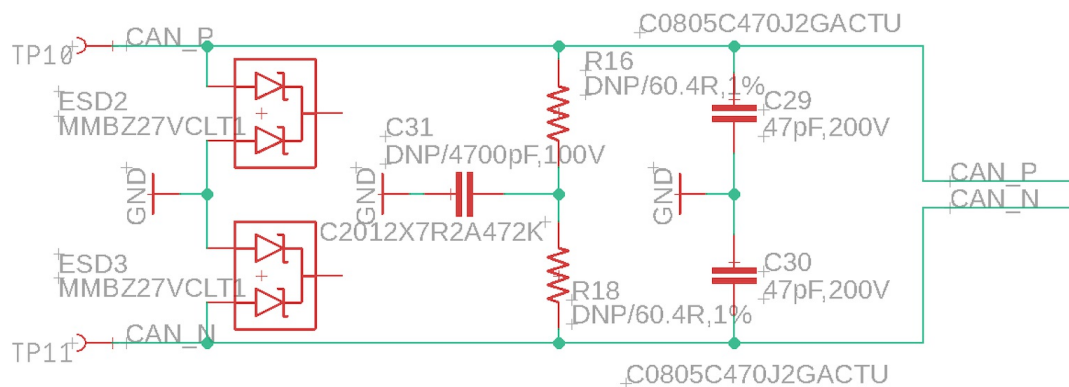
Note that the two 60.4 ohm resistors are DNP (do not populate). If populated, these provide the 120 ohm CAN termination, if you need it in your design.

ALL EXPANSION CARD PINS

Pin	Pin Name	Description	MCU
1	GNSS_PULSE	GNSS time pulse output. Can be used for a GPS fix LED.	
2	NC		
3	NC		
4	NC		
5	NC		

6	NC		
7	NC		
8	NC		
9	NFC2_VIN_EN	VIN enable	P0.10
10	NFC1_PERIPH_INT	Peripheral interrupt (active low)	P0.09
11	TSOM_MODE	MODE button (active low)	P1.13
12	TSOM_RESET	RESET button (active low)	P0.08
13	TSOM_A7 / D7	A7 Analog in, GPIO D7, PWM, SPI SS, WKP	P0.05
14	TSOM_A6 / D6	A6 Analog in, GPIO D6, PWM, SPI (SCK)	P0.04
15	TSOM_A5 / D5	A5 Analog in, GPIO D5, PWM, SPI MISO	P0.29
16	TSOM_A4 / D4	A4 Analog in, GPIO D4, PWM, SPI MOSI	P0.29
17	GND	Ground.	
18	3V3	3.3V out, 1000 mA maximum including nRF52 and other peripherals.	
19	RUN	Pull low to disable LTC7103 regulator. Has 100K pull-up to VIN.	
20	PGOOD	LTC7103 regulator open drain power good output. Pulled low when regulator is not in regulation.	
21	GND	Ground.	
22	GND	Ground.	
23	VIN	Power input, 6 - 90 VDC	
24	VIN	Power input, 6 - 90 VDC	
25	LI+	Connect to Li-Po battery. Can power the device or be recharged by VIN or VBUS.	
26	GND	Ground.	
27	TSOM_USB_VBUS	nRF52 USB power input. Can be used as a 5V power supply instead of VIN.	
28	GND	Ground.	
29	TSOM_VIN	Tracker SoM power input 5V-12V DC.	
30	GND	Ground.	
31	5V	5V power output when powered by VIN or USB	
32	GND	Ground.	
33	TSOM_A0_SDA / D0	Wire SDA	P0.03
34	TSOM_A1_SCL / D1	Wire SCL	P0.02
35	TSOM_A2_BUTTON / D2	External user button, A2 Analog in, GPIO D2, PWM	P0.28
36	TSOM_A3_BATT_TEMP / D3	Battery temperature sensor, A3 Analog in, GPIO D3, PWM	P0.30
37	GND	Ground.	
38	CAN_N	CAN Data- or CANL	
39	CAN_P	CAN Data+ or CANH	
40	CAN_5V	5V power out, 0.8A maximum. Can be controlled by software.	
41	GND	Ground.	
42	TSOM_USB_N	nRF52 MCU USB interface D-.	
43	TSOM_USB_P	nRF52 MCU USB interface D+.	
44	GND	Ground.	
45	RX / D9	Serial1 RX, GPIO D9, PWM, Wire3 SDA	P0.08
46	TX / D8	Serial1 TX, GPIO D8, PWM, Wire3 SCL	P0.06
47	RTC_BAT	RTC/Watchdog battery +. Connect to GND if not using.	

| 48 | RTC_EXTI | | RTC EXTI. Can use as a wake button. Has 100K weak pull-up to 3V3. | | | | |

I/O CHARACTERISTICS

The GPIO pins on the expansion connector have the following specifications, from the nRF52840 datasheet:

Symbol	Parameter	Min	Typ	Max	Unit
VIH	Input high voltage	0.7 xVDD		VDD	V
VIL	Input low voltage	VSS		0.3 xVDD	V
VOH,SD	Output high voltage, standard drive, 0.5 mA, VDD ≥1.7	VDD - 0.4		VDD	V
VOH,HDH	Output high voltage, high drive, 5 mA, VDD >= 2.7 V	VDD - 0.4		VDD	V
VOH,HDL	Output high voltage, high drive, 3 mA, VDD >= 1.7 V	VDD - 0.4		VDD	V
VOL,SD	Output low voltage, standard drive, 0.5 mA, VDD ≥1.7	VSS		VSS + 0.4	V
VOL,HDH	Output low voltage, high drive, 5 mA, VDD >= 2.7 V	VSS		VSS + 0.4	V
VOL,HDL	Output low voltage, high drive,3 mA, VDD >= 1.7 V	VSS		VSS + 0.4	V
IOL,SD	Current at VSS+0.4 V, output set low, standard drive, VDD≥1.7	1	2	4	mA
IOL,HDH	Current at VSS+0.4 V, output set low, high drive, VDD >= 2.7V	6	10	15	mA
IOL,HDL	Current at VSS+0.4 V, output set low, high drive, VDD >= 1.7V	3			mA
IOH,SD	Current at VDD-0.4 V, output set high, standard drive, VDD≥1.7	1	2	4	mA
IOH,HDH	Current at VDD-0.4 V, output set high, high drive, VDD >= 2.7V	6	9	14	mA
IOH,HDL	Current at VDD-0.4 V, output set high, high drive, VDD >= 1.7V	3			mA
RPU	Pull-up resistance	11	13	16	kΩ
RPD	Pull-down resistance	11	13	16	kΩ

- GPIO default to standard drive (2mA) but can be reconfigured to high drive (9mA) in Device OS 2.0.0 and later using the `pinSetDriveStrength()` function.

GPIO AND PORT LEAKAGE CURRENT WARNING

Be careful when you are connecting GPIO or ports such as serial that may have power when the Monitor One is not powered, such as when using shipping mode.

If you have current flowing into GPIO or ports of the nRF52840 when it is powered down, it can cause it to enter a state where it cannot be reawaked without removing all power from it, including the internal LiPo battery. This may be difficult if you've sealed your Monitor One enclosure.

The Tracker One has a TI TS3A5018 Quad SPDT Analog Switch on the three GPIO pins (A3, D9/RX/SDA, D8/TX/SCL) to prevent this. The switch is normally open, and is closed when the `CAN_5V` is powered. By default, Tracker Edge enables `CAN_5V` when in normal operating mode and turns it off during sleep, however this behavior can be changed by using `enableIoCanPower()` and `enableIoCanPowerSleep()` in the `TrackerConfiguration` object.

The Tracker One circuit looks like this, and you may want to implement something similar if you are in a scenario where you have externally powered peripherals.
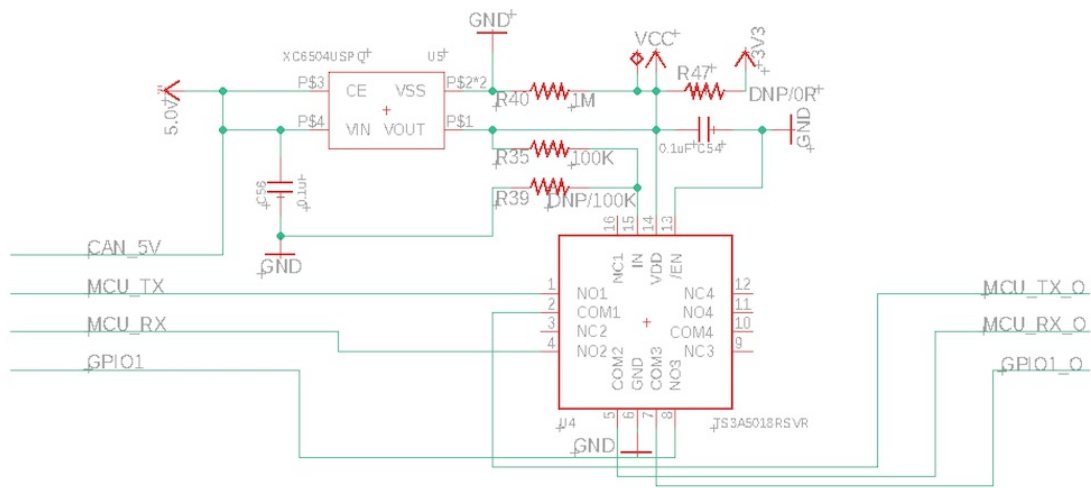
This is not necessary if your external peripherals are powered by 3V3 or CAN_5V.

GPIO AND PORTS VS. TRACKER ONE

Pin	Monitor One	Tracker One
A0	I2C SDA[1]	Internal Thermistor
A1	I2C SCL[1]	User Button (not accessible)
A2	External Button	GNSS lock indicator
A3	Battery Temperature	M8 Analog in, GPIO
A4	Analog in, GPIO, PWM, SPI MOSI[1]	Not available
A5	Analog in, GPIO, PWM, SPI MISO[1]	Not available
A6	Analog in, GPIO, PWM, SPI SCK[1]	Not available
A7	Analog in, GPIO, PWM, SPI SS, WKP	Not available
TX	MCU serial TX, GPIO D8, Wire3 SCL[1]	MCU serial TX, GPIO D8, Wire3 SCL
RX	MCU serial RX, GPIO D9, Wire3 SDA[1]	MCU serial RX, GPIO D9, Wire3 SDA

[1]Available on expansion card connector (internal)

- On the Monitor One, the expansion card connector allows the use the I2C, Serial, and SPI at the same time
- On the Tracker One, you must choose between using the M8 for either serial or I2C. SPI is not available.

Tracker feature comparison

	Tracker SoM	Tracker M	Tracker One	Monitor One
Style	SMD Module	Module	All-in-one	All-in-one
Enclosure	Your design	Your design	Included	Included
MCU	nRF52840	RTL8721DM	nRF52840	nRF52840
CPU Speed	60 MHz	200 MHz	64 MHz	64 MHz
Maximum user binary	256 KB	2 MB	256 KB	256 KB
Flash file system[6]	4 MB	2 MB	4 MB	4 MB
Base board	Your design	Included	Included	Included
Expansion connector	Your design	8-pin	M8 8-pin	Multiple options
GNSS Antenna	Your design	Int/Ext[2]	Internal	Int/Ext[2]
Cellular Antenna	Your design	Int/Ext[2]	Internal	Int/Ext[2]
Wi-Fi geolocation antenna	Your design	Int/Ext[5]	Internal	Internal
BLE Antenna	Your design	Int/Ext[5]	Internal	Internal[4]
NFC Tag	Your design	n/a	Included	n/a
USB Connector	Your design	Micro B	USB C	Micro B (Int)[3]
System RGB LED	Your design	Included	Included	Included
External user button	n/a	n/a		✓
User RGB LEDs				2
SETUP and MODE buttons	Your design	On board	Inside Enclosure	Inside Enclosure
External power	3.9 - 17 VDC	6 - 90 VDC	6 - 30 VDC	6 - 90 VDC
SPI	✓	Expansion card	n/a	Expansion card
I2C	✓	Expansion card	M8	Expansion card
Serial	✓	Expansion card	M8	Expansion card
Internal temperature sensor	Your design	✓	✓	✓
Battery temperature sensor	n/a	✓	n/a	✓
Controlling charging by temperature	Your design	In hardware	In software	In software

[1]On the Tracker One, the M8 can be configured for GPIO, I2C (SDA and SCL), or Serial (RX and TX) on two pins.

[2]Both internal and external GNSS and cellular are supported by physically changing the antenna connector inside the enclosure.

[3]There is no external MCU USB connector on the Monitor One.

[4]The Monitor One uses the Tracker SoM BLE chip antenna on the board and does not include a separate BLE antenna, but one could be added using the BLE U.FL connector.

[5]The Tracker M uses a shared antenna for BLE and Wi-Fi geolocation. You can use the built-in trace antenna or an external 2.4 GHz/5 GHz dual-band antenna, selectable in software.

[6]A small portion of the flash file system is used by the system, and a configurable portion can be used for store and forward, to optionally allow location publishes to be saved when the device is offline to be uploaded later. The remainder of the flash file system can be used by user applications.
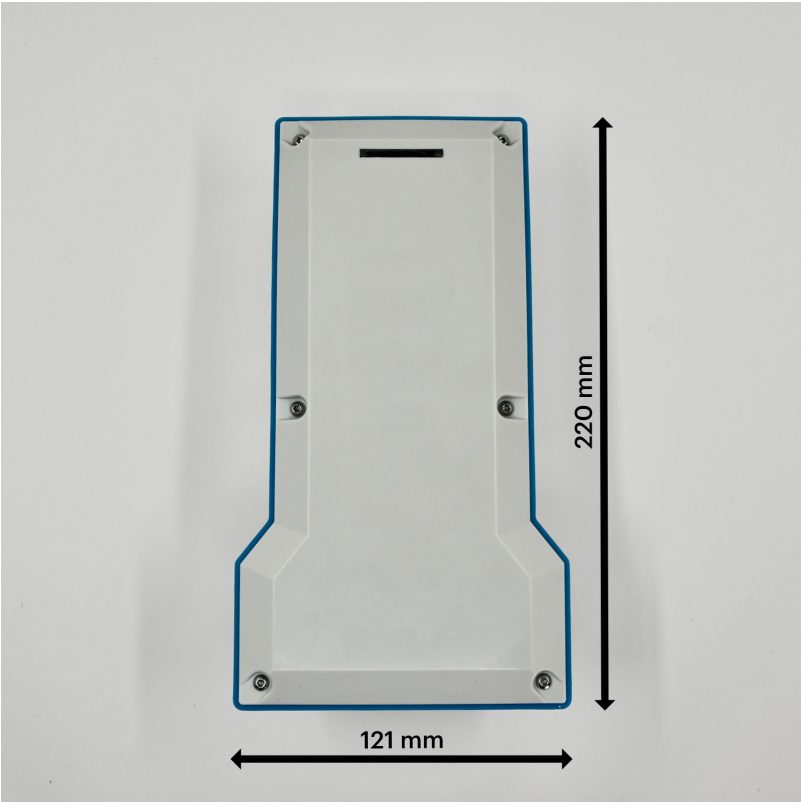
Mechanical specifications

OPERATING TEMPERATURE

To be provided at a later date.

DIMENSIONS AND WEIGHT

Dimensions	Metric	SAE
Width	121 mm	4 3/4"
Height	220 mm	8 5/8"
Depth	69 mm	2 11/16"
Weight	775 g	27.3 oz

69 mm

POWER CONSUMPTION

To be provided at a later date.

Country compatibility

To be provided at a later date.

Ordering Information

To be provided at a later date.

Certification

To be provided at a later date.

Product Handling

ESD PRECAUTIONS

The Monitor One contains highly sensitive electronic circuitry and is an Electrostatic Sensitive Device (ESD). Handling an module without proper ESD protection may destroy or damage it permanently. Proper ESD handling and packaging procedures must be applied throughout the processing, handling and operation of any application that incorporates the module. ESD precautions should be implemented on the application board where the B series is mounted. Failure to observe these precautions can result in severe damage to the module!

BATTERY WARNING

CAUTION

RISK OF EXPLOSION IF BATTERY IS REPLACED BY AN INCORRECT TYPE. DISPOSE OF USED BATTERIES ACCORDING TO THE INSTRUCTIONS.

DISPOSAL

This device must be treated as Waste Electrical & Electronic Equipment (WEEE) when disposed of.

Any WEEE marked waste products must not be mixed with general household waste, but kept separate for the treatment, recovery and recycling of the materials used. For proper treatment, recovery and recycling; please take all WEEE marked waste to your Local Authority Civic waste site, where it will be accepted free of charge. If all consumers dispose of Waste Electrical & Electronic Equipment correctly, they will be helping to save valuable resources and preventing any potential negative effects upon human health and the environment of any hazardous materials that the waste may contain.

Revision history

Date	Author	Comments
2022-10-24	RK	For internal review only