Vision-RTK 2 Positioning Sensor
Datasheet

Product summary

The Vision-RTK 2 positioning sensor comes with two multi-band GNSS receivers, an embedded camera, and an IMU, and outputs position, velocity, and orientation information. Fixposition's unique sensor fusion enables high accuracy positioning and highly reliable performance, even in areas with limited GNSS coverage. This combination of technologies significantly increases reliability and expands the availability of precise positioning in a compact module. With dimensions of 113 x 130 x 30 mm^3 and a weight of 420 g, it is compatible with platforms of many sizes, from small outdoor AV systems and asset-tracking devices to mid-and large-sized ground robots.

Document Information

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Engineering sample	Data based on early testing. Revised and supplementary data will be published later.

Contents

1 Sensor fusion engine

Vision-RTK 2 incorporates the following sensors:

- Multi-band RTK GNSS Receiver (2x)
- Camera
- Accelerometer
- Gyroscope
- Wheel odometry

The embedded fusion engine makes use of the listed sensors to estimate position, velocity, acceleration and orientation at specific update rates. Figure 1 summarizes the main components of the sensor:

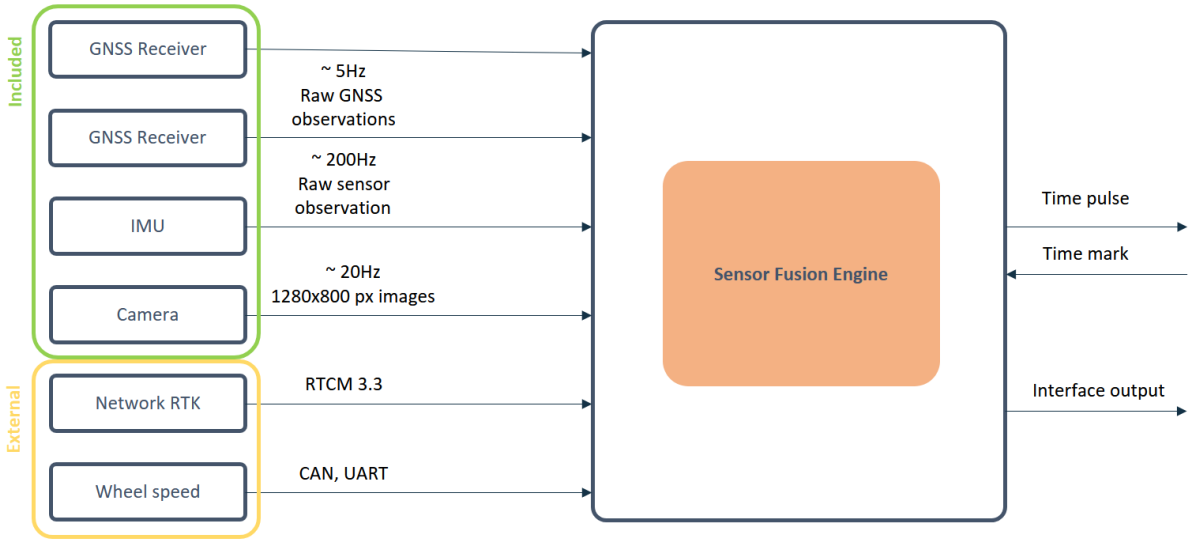

Figure 1 Sensor fusion engine schematic

2 Positioning performance specification

Parameters	Condition	Value
Solution latency	-	50 ms
Horizontal position accuracy	At maximum performance	1.0 cm + 1 ppm
Vertical position accuracy	At maximum performance	1.0 cm + 1 ppm
Velocity accuracy	-	±0.1 m/s
Velocity with GNSS signal	Maximum operational	500 m/s
Velocity in GNSS outages	Maximum operational	20 m/s
Attitude accuracy[1]	-	< 0.4°
Acquisition time[2]	Cold start Hot start/reacquisition Aided start	25 s 2 s 2 s
GNSS outage position offset[3]	Described as a percentage of distance travelled, without wheel speed data	2%[4]
GNSS outage position offset[3]	Described as a percentage of distance travelled, with wheel speed data	0.75%[4]
Velocity accuracy[4]	Average of GNSS outage and non-outage	0.1 m/s

Table 1 Positioning performance of the sensor fusion engine

3 GNSS specifications

The Vision-RTK 2 module includes two multiband GNSS receivers. All four major GNSS constellations (GPS, GLONASS, Galileo and BeiDou) plus QZSS satellites can be received concurrently on both receivers. The RTK positioning output is available when combining GNSS correction data and the received satellite signals.

GPS/QZSS	L1C/A, L2C
GLONASS	L1OF, L2OF
Galileo	E1B/C, E5b
BeiDou	B1I, B2I
SBAS	L1C/A

Table 2 Available GNSS constellation and signals

[1] Setup with 1m antenna baseline.
[2] All satellites at -130 dBm.
[3] Position/heading offset with respect to distance travelled.
[4] Average values taken from random datasets of thousands of kilometers of test data. This data is under the condition of a properly and rigidly mounted setup with proper initialization and calibration, as well as, very accurate extrensics. Furthermore, this data assumes the camera has a good unobstructed view and the lighting conditions are sufficient for features to be apparent. The probability of an error below 5% is 99% with wheelspeed and 98% without, the probability of an error below 2% is 98% with wheelspeed and 79% without, the probability of an error below 1% is 78% with wheelspeed and 52% without. These numbers assume a correct implementation of the sensor.

4 Camera specifications

MIPI camera interface

The Vision-RTK 2 incorporates an image sensor for visual navigation with a 10-bit 1280x800 resolution image array. In addition, the Auto Exposure Control (AEC) and Auto Gain Control (AGC) are constantly enabled to maintain the image quality regardless of the lighting changes in the scene.

Parameter	Value
Active array size	1280 × 800 px
Shutter type	Global Shutter
Sensor type	CMOS
Mono/color	Monochrome
Diagonal field of view	125°
Max. cable length	15 cm

Table 3 Camera specifications

5 Inertial measurement unit

The Vision-RTK 2 incorporates an inertial measurement unit (IMU) that combines a 3-axis gyroscope and 3-axis accelerometer.

Parameter	Value
Gyroscope full scale range	±2000 °/s
Gyroscope sensitivity scale factor	16.4 LSB/°/s
Gyroscope noise density	0.0028 °/s /√Hz
Accelerometer full scale range	±16 g
Accelerometer sensitivity scale factor	2048 LSB/g
Accelerometer noise density	65 µg/√Hz

Table 4 IMU specifications

6 Electrical specifications

6.1 Absolute maximum ratings

Parameter	Symbol	Min	Max	Units
Power supply voltage[5]	V_{CC}	-14	40	V
Digital IO pin voltage	V_{IO}	-0.3	3.7	V
USB VBUS supply voltage	V_{USB}	-14	29	V
CAN bus voltage (CAN_H or CAN_L)	V_{CAN}	-14	14	V
Output current of GNSS antenna	I_{CC_RF}	-	50	mA
Output power of GNSS antenna	P_{IN_RF}	-	10	dBm
GNSS backup voltage	V_{BCKP_GPS}	-0.5	3.6	V
Digital IO ESD Withstand Voltage (IEC 61000-4-2 air discharge)	V_{PP_AIR}	-25	25	kV
Digital IO ESD Withstand Voltage (IEC 61000-4-2 contact discharge)	V_{PP_CON}	-12	12	kV
Output supply voltage	V_{+5V1}	-	5.3	V
Output supply current	I_{+5V1}	-	200	mA
Storage temperature range	T_{STG}	-40	85	°C
Operating temperature range (non-condensing)	T_{ST}	-30	85	°C
Performance guarantee temperature range	T_{STP}	0	50	°C

Table 5 Absolute minimum and maximum ratings[6]

6.2 Recommended operating conditions

All typical measurements are performed with V_{CC} = 5.0 V, V_{IO} = 3.3 V and T = 25 °C, unless otherwise indicated.

Parameter	Conditions	Symbol	Min	Typical	Max	Units
Supply voltage	-	V_{CC}	4.5	5.0	36	V
Supply current[7]	Suspend mode	I_{CC}	-	200	-	mA
	GNSS acquisition	I_{CC}	-	800	-	mA
	GNSS acquisition and sensor fusion	I_{CC}	-	1500	2000	mA
Input voltage at USB-C connector	Device mode	$V_{USB\_VBUS\_IN}$	4.5[8]	5.0	20	V
Start-up threshold input voltage at USB-C connector	Device mode	$V_{USB\_VBUS\_IN\_START}$	-	4.75	-	V
Input current at power input connector	-	$I_{V\_IN\_EXT}$	-	-	5.1	A

[5] Reverse polarities protected (P6SMAJ20ADF Zener diode).

Input current at USB-C connector	Device mode	$I_{USB\_VBUS\_IN}$	-	-	3.3	A
Output voltage at USB-C connector	Host mode	$V_{USB\_VBUS\_OUT}$	-	5.1	-	V
Output current at USB-C connector	Host mode	$I_{USB\_VBUS\_OUT}$	-	-	1.5	A
Input pin voltage range	-	V_{IN}	0	-	3.3	V
Digital IO pin high level input voltage	-	V_{IH}	2.45	-	3.6	V
Digital IO pin low level input voltage	-	V_{IL}	0	-	0.8	V
Digital IO pin high level output voltage	-	V_{OH}	2.8	-	-	V
Digital IO pin low level output voltage	-	V_{OL}	-	-	0.7	V
GNSS antenna voltage	-	V_{CC_RF}	-	3.2	-	V
Receiver chain noise figure[9]	-	NF_{TOT}	-	9.5	-	dB
Output current for camera serializer/deserializer[10]	-	I_{CAM_SERDES}	-	-	0.5	A
Output current for cooling fan	-	I_{FAN_5V}	-	-	0.2	A
Output current at external IMU pin	-	I_{EXT_IMU}	-	-	0.1	A
Output current at wheel tick pin		I_{EXT_WT}	-	-	0.1	A
GNSS backup voltage	-	V_{BCKP_GPS}	1.65	-	3.6	V
GNSS backup current	-	I_{BCKP_GPS}		40		µA
Real-time clock backup battery voltage[11]	-	$V_{V\_BCKP\_RTC}$	1.2	3.0	5.5	V
Real-time clock backup battery current	$V_{V\_BCKP\_RTC}$ = 3.0 V	$I_{V\_BCKP\_RTC}$	-	40	-	nA
CAN Common Mode Range: normal and silent modes	-	V_{CM}	-12	-	12	V
Time pulse voltage	-	V_{TM_PLS}	-	3.3	-	V
Time mark voltage	-	V_{TM_MRK}	-	3.3	-	V
Reset voltage	Drive high to shutdown	V_{PWR_SHDN}	-	3.0	-	V

Table 6 Electrical specifications

[6] Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under Operating Conditions is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
[7] The listed power requirements can vary depending on the firmware version, external circuitry, and operating conditions.
[8] Undervoltage lockout threshold, start-up requires VUSB_VBUS_5V_IN ≥ VUSB_VBUS_5V_IN_START.
[9] Only valid for the GPS L1 band.
[10] Runtime-enabled 5.1V output on CSI D3 signals.
[11] Internal trickle charger allows recharging (for rechargeable 3V Lithium cells only).

7 Interfaces

The following interface communication options are possible: UART, Wi-Fi, USB-C, Ethernet, CAN, time pulse and time mark. All the digital IOs have internal pull-down resistors in normal operation compliant with ESD (IEC 61000-4-2 level 4).

7.1 Time pulse

The time pulse function provides a one pulse per second (pps) signal. Once the sensor has received any GNSS signals information, the 1 pps signal will adjust itself to each second in time. The raised edge of each pulse will be aligned to the top of GPS time seconds. The duty cycle is 10 %, meaning that the pulse width is 100 ms. The message is available in the raw GNSS1 output on port 20010.

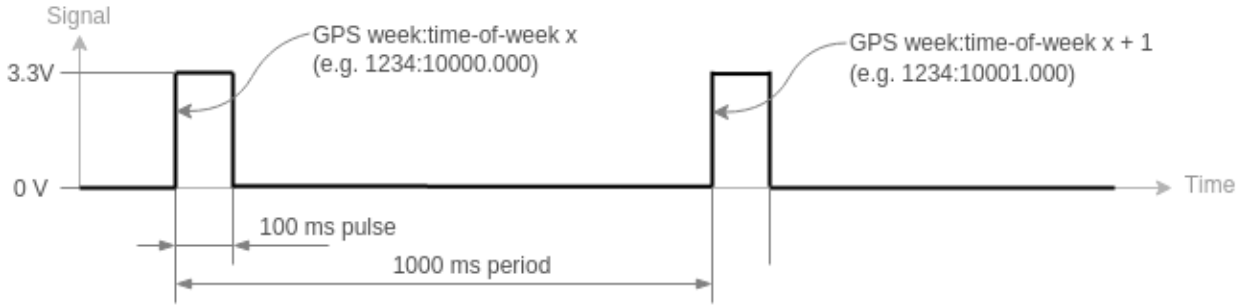

Figure 2 Time pulse signal

7.2 Time mark

The time mark provides an accurate measurement of the time at which a pulse is detected on the port 20010. The maximum time mark frequency is 5 Hz, that is at most one mark per 200 ms interval.

7.3 UART

Parameter	Symbol	Min	Max	Units
Baud rate	F_{baud_rate}	9600	4000000	bit/s
Transmit bit time	t_{Tbit}	$1/F_{baud\_rate} - T_{ref\_clk}$	$1/F_{baud\_rate} + T_{ref\_clk}$	-
Receive bit time	t_{Rbit}	$1/F_{baud\_rate} - 1/(16xT_{ref\_clk})$	$1/F_{baud\_rate} + 1/(16xT_{ref\_clk})$	-

Table 7 Vision-RTK 2 UART specifications

7.4 Ethernet

The Ethernet MAC interface is provided via a RJ45 connector. The AR8033 Ethernet transceiver supports IEEE 802.3az standard.

Parameter	Condition
IP setup	Static and Dynamic
Speed	10BASE-Te/100BASE-TX/1000BASE-T IEEE 802.3
Communication	Full-duplex
Cable Discharge Event	±6 kV CDE protection
Operation	Limited to 140 meters of CAT5 cable
Default IP address	10.0.2.1

Table 8 Vision-RTK 2 Ethernet specification

7.5 USB

A USB2.0 interface is provided via a USB Type C connector. Not recommended as a power supply.

7.6 Wi-Fi

Parameter	Condition
Operation mode	IEEE 802.11 ac/a/b/g/n
Band support	Dual band 2.4/5 GHz
Default IP address	10.0.1.1
Mode	Station and access point

Table 9 Vision-RTK 2 Wi-Fi specifications

7.7 I/O sensor

The following connected interfaces can be used:

Interface	Measurement	Specification
OBD-II	Wheel speed	500000 bitrate
CAN	Wheel speed	500000 bitrate
Serial	Wheel speed	50 Hz

Table 10 Supported interfaces

7.8 Default interface settings

Interface	Direction	Function
UART1	Output	Baud rate 115200, 8 bits, no parity, 1 stop bit Fixposition messages are output by default
	Input	Configurable serial wheel speed RTCM3 correction data input
TCP/IP network (Wi-Fi, Ethernet)	Output	Port 21000, Fixposition messages are output by default.
	Output	Port 20010, raw GNSS receiver 1 output (read-only). The configuration of the receiver cannot be changed.
	Output	Port 20020, raw GNSS receiver 2 output (read-only). The configuration of the receiver cannot be changed.
	Output	Port 23010, raw NTRIP data stream (read-only)
	Input/Output	Port 80 (HTTP) configuration and logging interface
Time Pulse	Output	Port 20010, 1 Hz 10% duty cycle, 3.3 V, the configuration cannot be changed.
Time Mark	Input	Time signal
CAN	Input	Configurable wheel speed

Table 11 Default interface parameters

7.9 Fixposition ASCII messages

Message structure

The Fixposition ASCII messages use the following framing format and general structure. Note that all the fields are separated by an ASCII 44 character ",".

$FP,msg_type,msg_version,field$_3$,field$_4$,…,field$_N$*CC\r\n	
$	Start character (ASCII 36).
FP	Fixposition ASCII message identifier (ASCII 70 + 80).
(field$_1$)	Message type, all capital letters (ASCII 65–90).
(field$_2$)	Message version, decimal number (numbers 0–9, ASCI 48–57).
field$_3$	The structure of the message data is defined by the msg_type and msg_version fields. Each field can contain all printable 7-bit ASCII characters (ASCII 32–126), excluding the reserved characters '!' (ASCII 33), '$' (ASCII 36), '*' (ASCII 42), ',' (ASCII 44), '\' (ASCII 92) and '~' (ASCII 126). Fields can be null (the empty string) to indicate absence or unavailability of data.
field$_4$	
…	
field$_N$	
*CC	Checksum value obtained by applying XOR to all characters in the message. The value starts with a * (ASCII 42) and is followed by the checksum value in capital hexadecimal notation (numbers 0– 9 and letters A–F, ASCI 48–57 and 65–70).
\r\n	Message termination characters, CR an LF (ASCII 13 and 10).

Table 12 Fixposition ASCII message structure

The data fields can be of the following type:

Type	Description
Numeric	Decimal integer number, one of more digits (0–9) and optional leading '-' sign.
Float (.*x*)	Decimal floating-point number with *x* digits fraction part. One or more digits (0–9) , with fractional part separated by a dot ('.') and optional leading '-' sign.
Float (*x*)	Decimal floating point with *x* significant digits. One or more digits (0–9) with optional fractional part separated by a dot ('.') and optional leading '-' sign.
String	String consisting of allowed field characters.

Table 13 Fixposition ASCII message field types

8 Physical connectors

8.1 Connectors

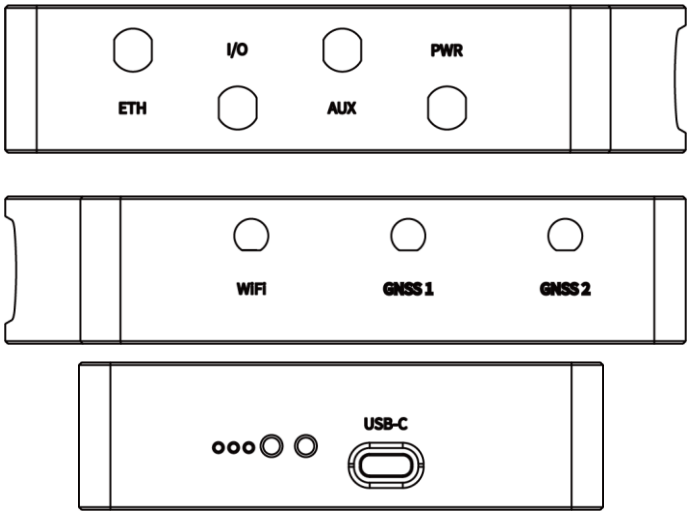

Figure 3 Vision-RTK 2 connectors overview

8.2 Ethernet

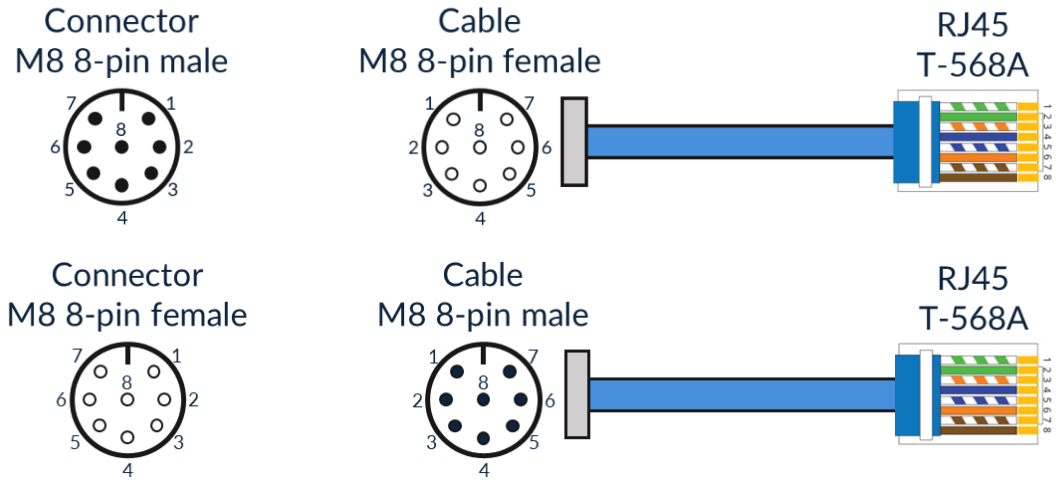

Figure 4 Ethernet connector and cable

The Vision-RTK 2 exists in 2 variants. Variants manufactured before October 2022 are equipped with male connectors on the sensor, future sensors are equipped with female connectors.

8.3 I/O connector

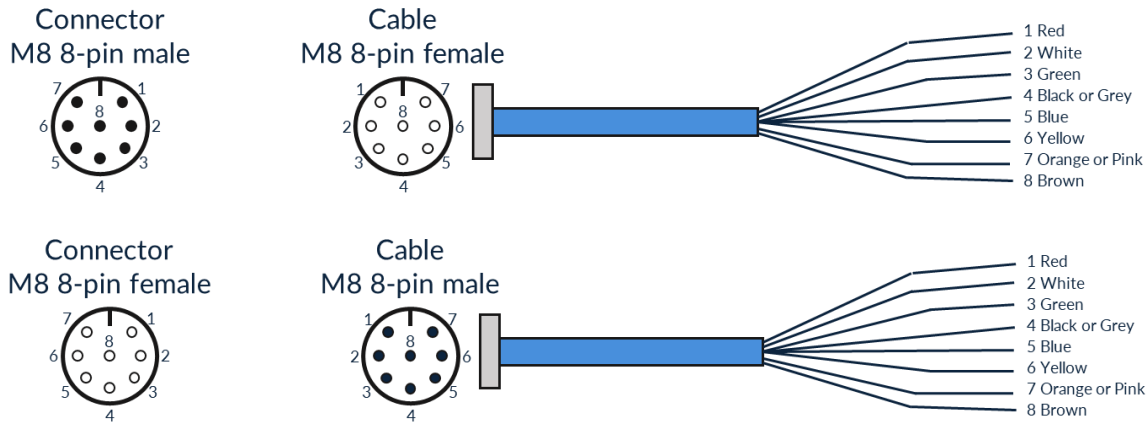

Figure 5 I/O connector pin overview

The Vision-RTK 2 exists in 2 variants. Variants manufactured before October 2022 are equipped with male connectors on the sensor, future sensors are equipped with female connectors.

Pin	Wire color	Symbol	Description
1	Red	CANH	CAN High
2	White	CANL	CAN Low
3	Green	MAIN_RST	Reset pin
4	Black or Grey	GND	Signal ground
5	Blue	TM_PLS	GNSS1 receiver time pulse
6	Yellow	TM_MRK	GNSS1 receiver time mark
7	Orange or Pink	UART1_RX	UART receiver input 1
8	Brown	UART1_TX	UART transmitter output 1

Table 14 I/O pin definition

8.4 AUX connector

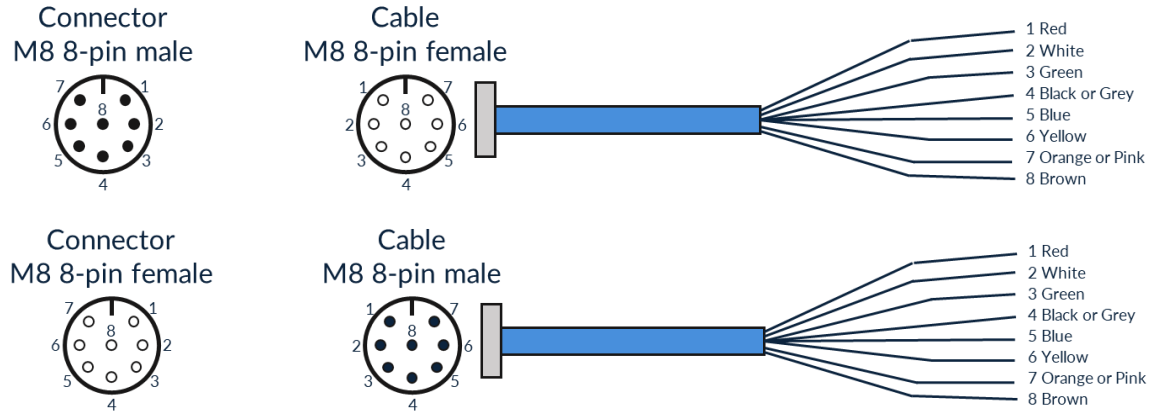

Figure 6 AUX connector pin overview

The Vision-RTK 2 exists in 2 variants. Variants manufactured before October 2022 are equipped with male connectors on the sensor, future sensors are equipped with female connectors.

Pin	Wire color	Symbol	Description
1	Red	+5V1	Voltage supply output of 5V
2	White	UART2_RX	UART receiver input 2
3	Green	UART2_TX	UART transmitter output 2
4	Black or Grey	GND	Signal ground
5	Blue	EXT_WT2	Wheel tick Interrupt 1
6	Yellow	EXT_WT1	Wheel tick Interrupt 2
7	Orange or Pink	Reserved	Reserved
8	Brown	Reserved	Reserved

Table 15 AUX pin definition

8.5 Power connector

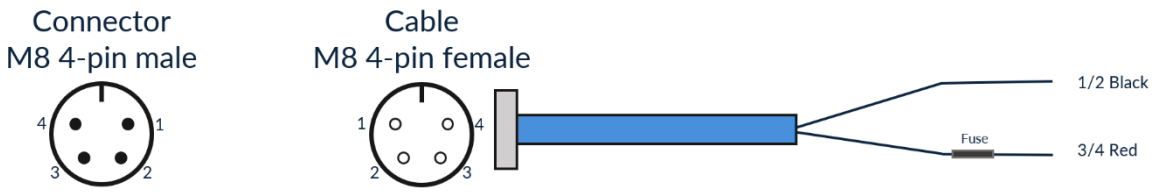

Figure 7 Power connector pin overview

Pin	Wire color	Symbol	Description
1/2	Black	GND	Power ground
3/4	Red	VCC	Main power input

Table 16 Power pin definition

8.6 GNSS connectors

The Vision-RTK 2 is equipped with two GNSS receivers which can be connected to antennas via the female SMA connectors labelled GNSS 1 and GNSS 2

8.7 WiFi connector

The Vision-RTK 2 can have Wi-Fi range significantly increased by connecting a Wi-Fi antenna to the female RP-SMA connector labelled WiFi.

The Wi-Fi has a range of about 0.5m when no antenna is connected. The Wi-Fi can be disabled in the configurations.

8.8 USB-C connector

Label: USB-C
Connector type: USB Type-C female mid mount

9 Mechanical Specifications

9.1 Enclosure dimensions

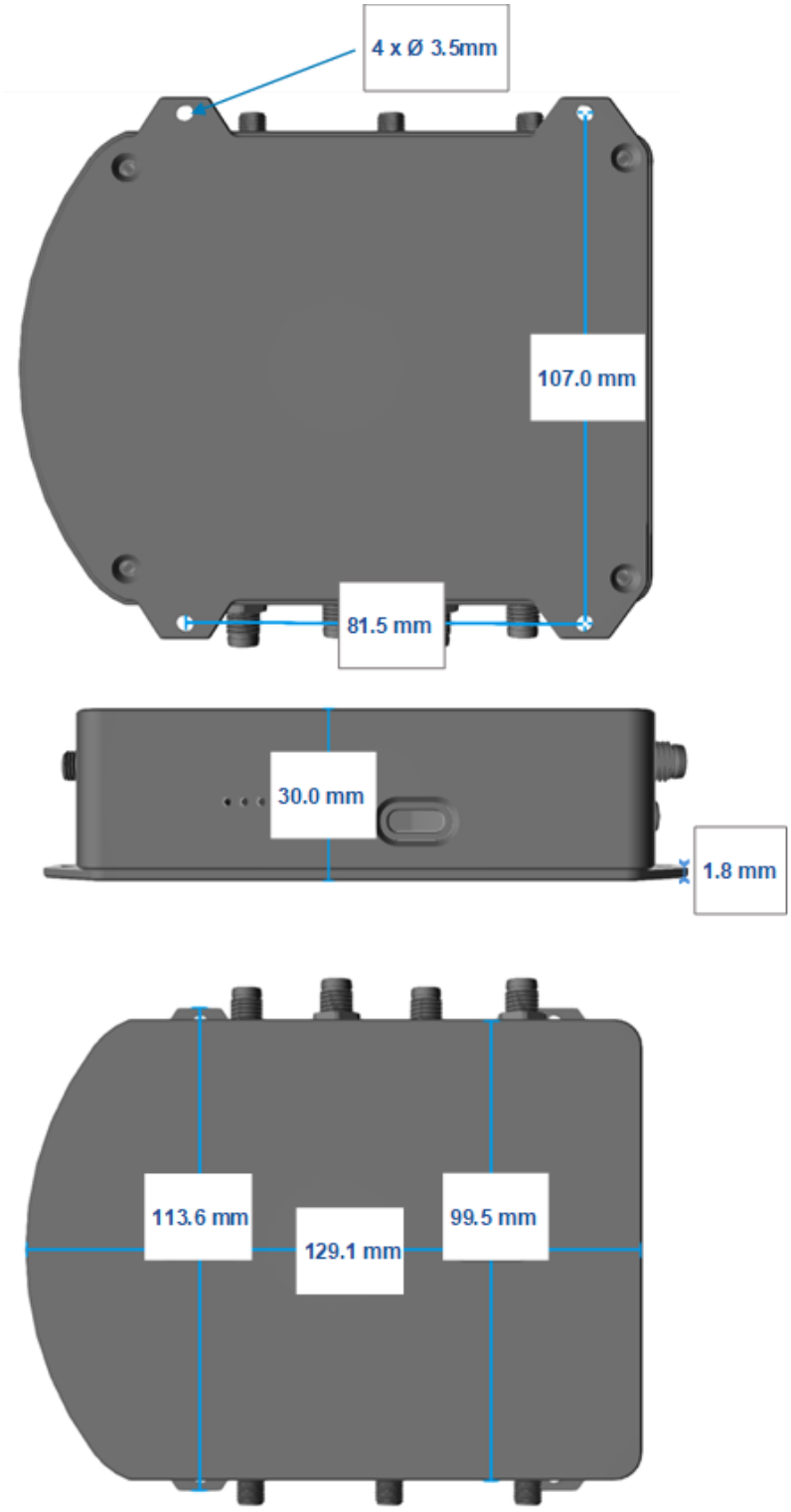

Figure 8 Vision-RTK 2 outer dimensions

Mechanical characteristics	
Weight	420 g
Dimensions without camera	113 mm x 130 mm x 30 mm

Table 18 Vision-RTK 2 weight and dimensions

9.2 Sensor Frame

The origin of the sensor's reference frame is located in the Fixposition logo. The reference frame components are shown in the picture below. Note that all the functionalities and messages of the sensor use this as their default reference frame.

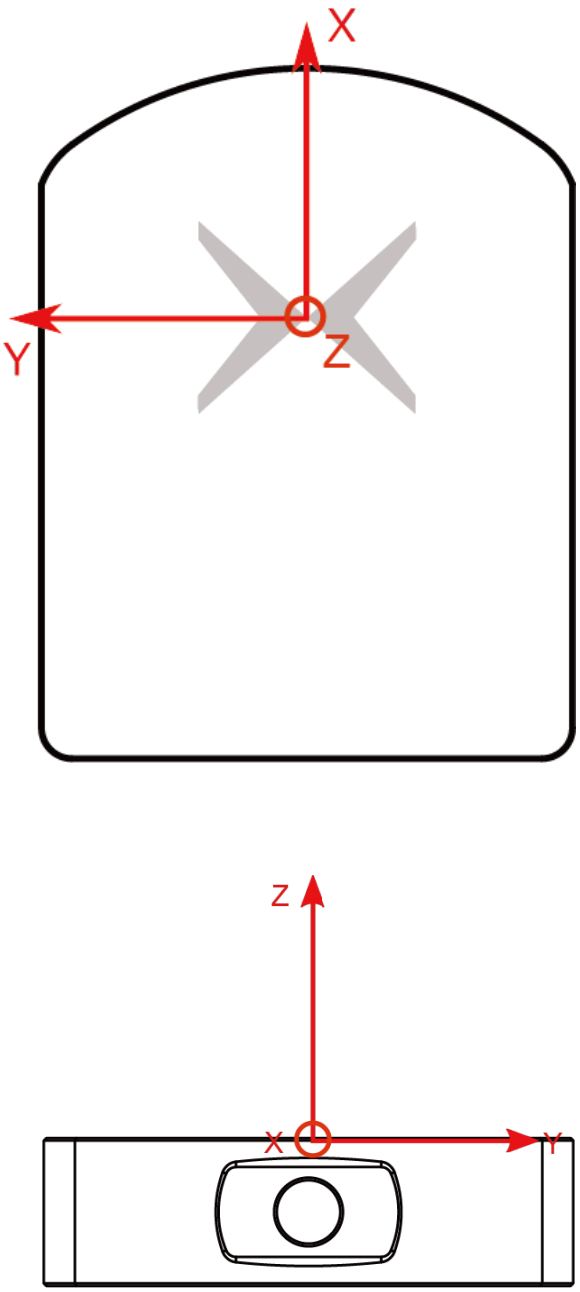

Figure 9 Vision-RTK 2 sensor frame

10 Related Documents

1. Vision-RTK 2 integration manual
2. Vision-RTK 2 product flyer.
3. Quick start guide.

11 Disclaimer

Absolutely confidential, Fixposition proprietary information. All information declared herein are intended as indicative only. Only non-guaranteed, target specifications are listed. The Vision-RTK 2 item is not a qualified engineering part, and is provided “as is”. Any express or implied warranties, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose are disclaimed. In no event shall Fixposition be liable for any direct, indirect, incidental, special, exemplary or consequential damages or injuries (including, but not limited to, procurement of substitute goods or services, loss of use, data, profits or business interruption) however caused and on any theory of liability, whether in contract, strict liability or tort (including negligence or otherwise) arising in any way of the use of the Vision-RTK 2, even if advised of the possibility of such damage. Use under own responsibility.

12 Contact

Further information on the product and its application can be obtained by contacting a Fixposition representative or visiting the webpage: https://www.fixposition.com/

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