



EQU RTK Tracking System for Horse Racing

Hardware Manual

Version 1.1 | June 2021

Caution and safety precautions

- Never use any other charger than the supplied or a type approved by Swiss Timing. This could destroy the battery, cause damage to unit, and possibly cause personal injury due to fire or/and electrical shock.
- Never bypass a power cord ground lead by breaking off the ground pin, or by using inappropriate extension cords or adapters.
- Never plug a power cord into the AC power source until you have made sure that all installation, cabling and power levels, are proper, and that the applicable procedures in this manual have been followed.
- Never use the device if it is damaged or insecure.
- Verify the selection of the power distribution.
- Verify that the voltage quoted on the rating plate is the same as your voltage. Connect the appliance only to power sockets with protective earth. The use of incorrect connection voids warranty.
- This program may be modified at any time without prior notification.
- Do not open the housing of any device.
- During the transport of all Swiss Timing equipment delivered with a reusable carry case, the said case should be used at all times. This is imperative to limit the damage, such as shocks or vibration that can be caused to the units during transport.
- The same cases should also be used when returning equipment to Swiss Timing for repair. Swiss Timing reserves the right to refuse all guarantees if this condition is not fulfilled.
- If the installation includes a horn, be sure to maintain a sufficient security distance from the public.

FCC

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

- (1) this device may not cause harmful interference, and
- (2) this device must accept any interference received, including interference that may cause undesired operation.

No changes shall be made to the equipment without the manufacturer's permission as this may void the user's authority to operate the equipment

This equipment complies with FCC RF radiation exposure limits set forth for an uncontrolled environment.

The EQ Tracker complies with the safety requirements for RF exposure in accordance with FCC Part 2.1093 for portable use conditions. The GPS Radio must be installed with a separation distance of at least 20cm from all persons.

Documentation Updates

Swiss Timing SP reserves the right to make improvements in the products described in this documentation at any time without prior notice. Furthermore, Swiss Timing SP reserves the right to revise this documentation in its content at any time and without any obligation to notify any person or organization of such revision.

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Environment



This symbol indicates that this product should not be disposed with household waste. It has to be returned to a local authorized collection system. By following this procedure you will contribute to the protection of the environment and human health. The recycling of the materials will help to conserve natural resources.

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1 INTRODUCTION

About This Document

This document serves as a hardware manual for the **RTK EQU Tracking System** for horse racing. It is intended to give guidance on the setup and the commissioning of all mobile components of the system. This document is not intended as an operation manual for hardware or software components of the system.

Audience

Information in this document are intended for skilled personnel only, such as system operators, track personnel and persons responsible for setting up the mobile components of system.

About the System

RTK Tracking for horse racing is a complete solution intended for accurate GNSS-based tracking of horses in Horse racing. It incorporates the use of real-time kinematic (RTK) correction through a number of hardware and software components. The system is not intended for consumer markets and only applicable in the Horse Racing sector.

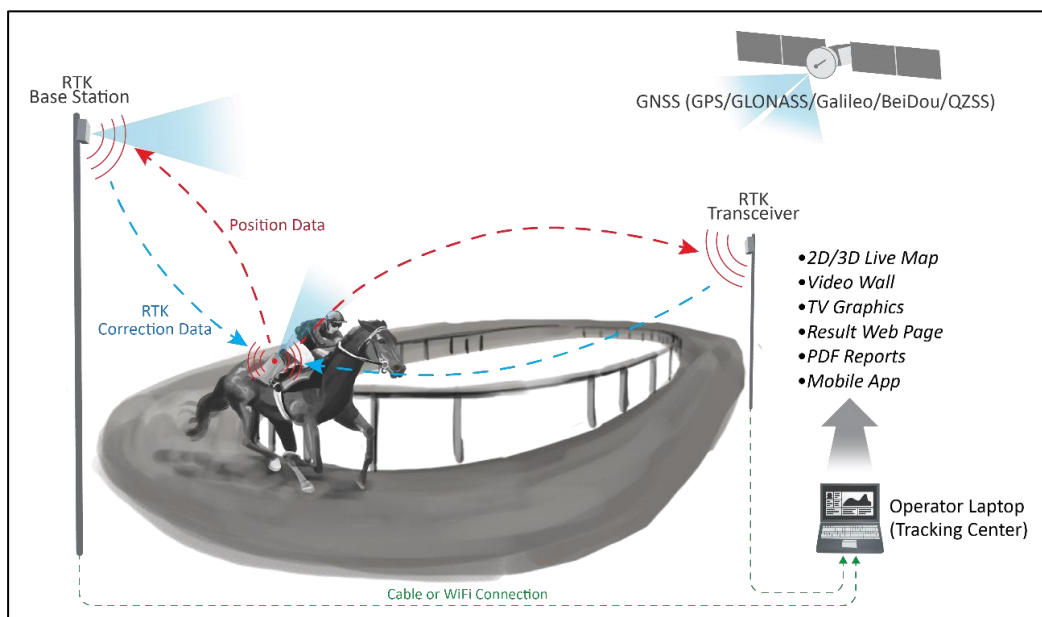


Figure 1: System Overview

Nomenclature

Within this manual, the system components of the RTK EQU Tracking System will be named according to their user terms. However, there might be situations in which the technical term for a component is being used instead.

User term	Technical term
EQTracker	EQTrackerV4
RTK Base Station	GPSRadio32V2
RTK Transceiver	GPSRadio32V2
RTK EQU Charging Case	ChargingCaseEQTrackerV4
RTK EQU Tracking System	RTKEQUSystem

2 SCOPE OF SUPPLY

2.1 Standard Scope

The following components are part of the RTK EQU Tracking System for horse racing. Their individual installation and mounting procedures will be covered within the following sections of this document.

- 1x GPSRadio32V2 designated as RTK Base Station
- Up to 4x GPSRadio32V2 designated as RTK Transceiver
- 60x EQTrackerV4 (per standard)
- 2x RTK EQU Charging Case (one charging case for 30 EQTrackerV4 each)
- Required cables and antennas

2.2 Optional Parts

The standard scope can be extended by a GPS TIMEsync. This device adds a valid GPS timestamp to an incoming starting. Detailed information about this can be found in chapter 8.

2.3 Purchased Parts

The following parts are absolutely necessary for a proper operation. But these parts must be purchased separately. They are not produced by our company. But the parts belong to the scope of supply and are provided by Swiss Timing. The following documents are the technical instructions of the external suppliers:

- Operator Laptop with EQTracker Software

3 COMPONENT ARRANGEMENT

The following scheme outlines a basic arrangement of components at a horse racing track.

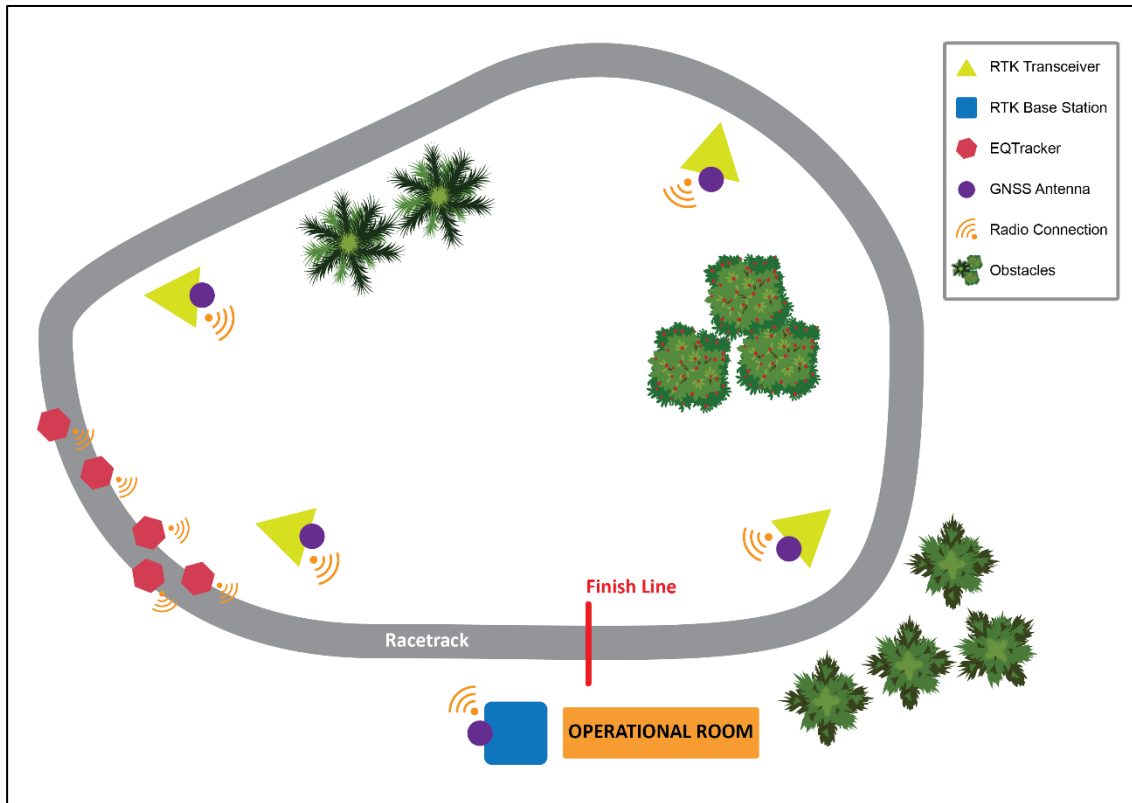


Figure 2: System components (example)

4 RTK BASE STATION

CAUTION

Keep the RTK Base Station and its power supply out of the range of children.

The main function of the RTK Base Station is the calculation and transmission of the GNSS correction data to the EQTracker devices. The GNSS antenna requires an uninterrupted view to the sky in order to achieve optimal positioning results.



Figure 3: RTK Base Station

4.1 Specification

Attribute	Value
Power supply	12-24 VDC; 1.2 A
GNSS standards	GPS, GLONASS, GALILEO, BEIDOU
GNSS band	Multiband
Sample/Measurement rate (RTK)	5 Hz
Measurement accuracy	+/- 1 cm (relative, outdoor)
Effective range	Max. 500 m radius
Required distance	Between GNSS antenna and people: > 20 cm
Radio transmission	ISM / SRD (country specific settings): 868.3 MHz (EU) 917.5 MHz (AUS)
Dimensions (WxHxD)	183x109x34 mm
Weight	~450 g
Mounting	Tripods, masts, rails
Housing	Metal, weatherproof

Note: RTK Base Station can be powered through alternative supplies, for example by a battery pack. In any case, make sure that the power supply current meets the requirements of the RTK Base Station. A protective fast fuse (10A) is mandatory for the external power supply

4.2 Connectors

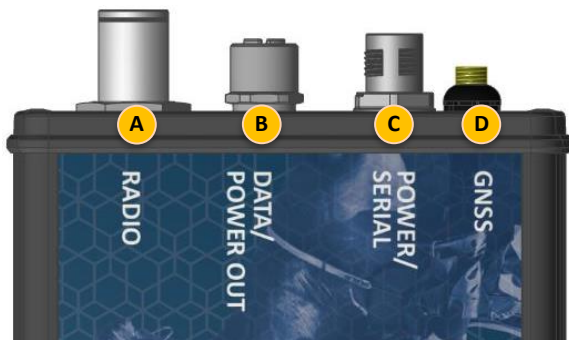


Figure 4: Connectors RTK Base Station


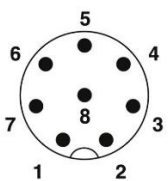
#	Label	Type	Function
A	RADIO	N-type	Antenna connector for ISM or SRD radio transmission
B	DATA/POWER OUT	M12 (X-Coded)	Data connection, PoE (passive, 12-24 VDC, same as input voltage) (see section 4.3 for details)
C	POWER/SERIAL	M12	Power supply (12-24 VDC) and debugging interface (see section 4.3 for details)
D	GNSS	SMA	Antenna connector for satellite signal reception

4.3 Electrical Specification

⚠ CAUTION

Make sure that your intended power supply for the RTK Base Station does not exceed the voltage limits of 12 – 24 VDC in order to prevent malfunction or damage to the device.

Pinouts and voltage ratings for the POWER/SERIAL and DATA/POWER OUT connectors are set out in the table below.

CONNECTOR NAME	CONNECTOR REFERENCE	PIN ID	SIGNAL DESCRIPTION
DATA/POWER OUT	M12 8pFT-X 	1 2 3 4 5 6 7 8	Ethernet: TX+ Ethernet: TX- Ethernet: RX+ Ethernet: RX- Power supply: 12 – 24 VDC Power supply: 12 – 24 VDC Power supply: GND Power supply: GND
POWER/SERIAL	M12 8pMT-A 	1 2 3 4 5 6 7 8	RS422: RX+ RS422: RX- Power supply: GND RS422: TX+ RS422: TX- Power supply: GND Power supply: 12 – 24 VDC Power supply: 12 – 24 VDC

4.4 LED Status

The device is equipped with two status LEDs. The blue LED illuminates when the device is properly supplied with power. The green LED flashes during GNSS signal acquisition and fully illuminates as soon as it has a proper GNSS fix. The device is fully operational when both status LEDs are light up.



Figure 5: Status LEDs on the RTK Base Station

5 RTK TRANSCEIVER

CAUTION

Keep the RTK Base Station and its power supply out of the range of children.

The RTK Transceiver's main purpose is transmitting the correction data to the EQTracker devices and forwarding the GNSS positions from the EQTrackers to the operation room. There are up to four RTK Transceiver provided. These RTK Transceivers must be placed strategically around the racecourse.



Figure 6: RTK Transceiver

5.1 Specification

Attribute	Value
Power supply	12-24 VDC; 1.2 A
GNSS standards	GPS, GLONASS, GALILEO, BEIDOU
GNSS band	multiband
Effective range	Max. 500 m radius
Radio transmission	ISM / SRD (country specific): 868.3 MHz (EU) 917.5 MHz (AUS)
Dimensions (WxHxD)	183x109x34 mm
Weight	~450 g
Mounting	Tripods, masts, rails
Housing	Metal, weatherproof

5.2 Connectors


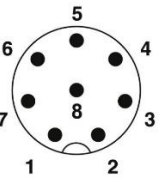
Connectors are similar to the RTK Base Station. See section 4.2 for information on the connectors.

5.3 Electrical Specification

⚠ CAUTION

Make sure that your intended power supply for the RTK Transceiver does not exceed the voltage limits of 12 – 24 VDC in order to prevent malfunction or damage to the device. A protective fast fuse (10A) is mandatory for the external power supply.

Pinouts and voltage ratings for the POWER/SERIAL and DATA/POWER OUT connectors are set out in the table below.

CONNECTOR NAME	CONNECTOR REFERENCE	PIN ID	SIGNAL DESCRIPTION
DATA/POWER OUT	M12 8pFT-X 	1 2 3 4 5 6 7 8	Ethernet: TX+ Ethernet: TX- Ethernet: RX+ Ethernet: RX- Power supply: 12 – 24 VDC Power supply: 12 – 24 VDC Power supply: GND Power supply: GND
POWER/SERIAL	M12 8pMT-A 	1 2 3 4 5 6 7 8	RS422: RX+ RS422: RX- Power supply: GND RS422: TX+ RS422: TX- Power supply: GND Power supply: 12 – 24 VDC Power supply: 12 – 24 VDC

	PARAMETERS	SYM	MIN	TYP	MAX	UNITS
	DC Input Supply Voltage	V_{in}	12	24	-	V
	DC Output Supply Voltage	V_{out}		$V_{in}-0.5$		V
	Input Supply Current	I_{in}	0.2	-	1.2	A
	Output Supply Current*	I_{out}	-	-	1.0	A

*supplied current for devices powered by GPSRadio32V2

5.4 LED Status

The "Power" LED lights up when device is connected to a 12 – 24 VDC power supply and is blinking periodically when device is fully operational.

The "GPS" LED lights up when device is powered and GNSS antenna acquires a GPS fix condition. It is blinking periodically when device is fully operational.

6 EQTRACKER

⚠ CAUTION

Keep the EQTracker out of the hands of children and make sure children cannot access the battery of the device.

⚠ CAUTION

The internal battery of the EQTracker must only be replaced by skilled personnel. Do not open the device unless you are explicitly authorized and trained to do so.

The portable EQTracker devices are used for GNSS positioning of the horses during a race. Each device features both, an internal antenna for GNSS position data acquisition and a radio antenna for correction data exchange with the RTK Transceiver or RTK Base Station. A single status LED is used to indicate the current operation mode. Each EQTracker is equipped with an internal battery that is being recharged using the supplied charging case (see chapter 7).

The charging voltage for the EQTracker's internal battery is 5 VDC at max. 500 mA (see section 7.1).

Note: The front design can be customized by the ordering contractor and printed with a logo or lettering, for example.



Figure 7: EQTracker

6.1 Specification

Attribute	Value
Battery	Internal lithium-polymer battery, 1200mAh, 3.7VDC, rechargeable
Battery Runtime	~6h (fully charged)
GNSS standards	GPS, GLONASS, GALILEO, BEIDOU
GNSS band	Multiband
IMU	9D-IMU
Sample/Measurement rate (RTK)	5Hz
Measurement accuracy	+/- 1cm (relative, outdoor)
Effective range	Max. 500 m radius
Required distance	Between EQTracker and Jockey: ≥ 4 cm

Radio transmission	ISM / SRD (country specific): 868.3 MHz (EU) 917.5 MHz (AUS)
Dimensions (WxHxD)	58x24x90 mm
Weight	~120 g
Mounting	Typically saddle cloth
Housing	weatherproof

Note: The EQTracker are preconfigured per default, which means that you don't have to manually switch on the EQTracker prior to an event.

6.2 Charging

An EQTracker is powered off when put into a charging slot in the RTK EQU Charging Case via magnetic contact. It will charge automatically when the case is connected to a suitable power supply. When an EQTracker is removed from a charging slot, it will automatically switch on. Once operational, the green status LED starts to flash periodically.

Note: Charging for about three hours will result in a charging level of approximately 95 percent.

⚠ CAUTION

The power supply for EQTracker must meet the requirements of ES1/PS1

⚠ CAUTION

Mechanical damage to the housing can cause shorts circuits in the internal battery which entail the risk of excessive overheating and burn injuries.
Never deploy or charge EQTracker that appears to be mechanically damaged.

6.3 Deployment

The EQTracker has no separate power button. The EQTracker is automatically ready for operation as soon as it is removed from a slot in the RTK EQU Charging Case. Furthermore, every EQTracker is preconfigured to "standby mode" per default, which means that you don't have to manually switch on an EQTracker prior to an event or after a full discharge.

⚠ CAUTION

EQTracker must only be used in a maximum height of 2 meters above the ground. An accidental dropping of the device from heights above 2 meters entails a risk for injuries, especially to the head.

To ensure maximum safety during the race, observe the following precautions:

- Do not deploy a EQTracker that seems broken or damaged
- Make sure that the EQTracker body is firmly attached to the saddle cloth
- After the race, check all EQTrackers for visible damages.
- Replace these EQTrackers if a damage is found or may be suspected
- Always store EQTrackers in a dedicated RTK EQU Charging Case, in order to avoid damages

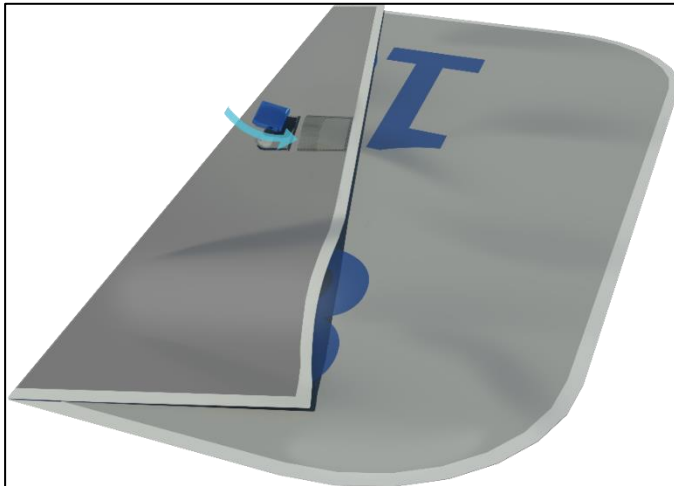


Figure 8: Saddlecloth with EQTracker

Note: The LED on the EQTracker, which is inside the pocket of the saddlecloth, must point outwards.

Note: Make sure to do a function test of each device prior to the race day.

6.4 LED Status

The status LED on each EQTracker indicates its current operation mode. The possible devices statuses are set out in the table below:

LED Status	Description
Illuminating red	Device is being charged in charging case
Illuminating green	Device is fully charged in charging case
Blinking green	Device is healthy and can be deployed
Blinking red	Device has issues and should not be deployed (if longer than 2 min after taken from charging case)

7 RTK EQU CHARGING CASE

The RTK EQU Charging Case is provided for transporting, storing and simultaneously charging of up to 30 EQTracker. For this reason, the case is equipped with 30 charging slots. Each EQTracker needs to be charged for approx. 3 hours. When the RTK EQU Charging Case is connected to a suitable power, its red status LED illuminates.

If the RTK EQU Charging Case is stored over a long time period (e.g. between racing seasons), it should always be disconnected from the power source. If it is not possible to disconnect the power supply via the power cable, the fuse can be unscrewed and removed. The fuse is located between the plug for the power cable and the LED light, directly on the case.



Figure 9: EQU RTK Charging Case

7.1 Specification

Attribute	Value
Input voltage	90 – 250 VAC
Output voltage (per charging slot)	5 VDC, isolated
Protection	IP 54
Dimensions (WxHxD)	48.6 x 35.7 x 17.6 cm
Weight	6.0 kg (empty) / 9.8 kg (fully equipped)
Housing	watertight, crushproof, dustproof

8 OPTIONAL PARTS

8.1 GPSTIMEsync

The GPSTIMEsync adds a valid GPS timestamp to an incoming starting impulse (i.e. starting signal of a race). The resulting information is forwarded to both application notebooks via Ethernet (standard solution) or via USB.

Since the device must acquire a GPS signal, it has to be installed in a location with a free sight to the sky (e.g. near a window in the operational room).



Figure 10: GPS TIMEsync (top)

8.1.1 Connectors

The following scheme shows the device's connectors (Left connector panel and right connector panel) as required during installation:

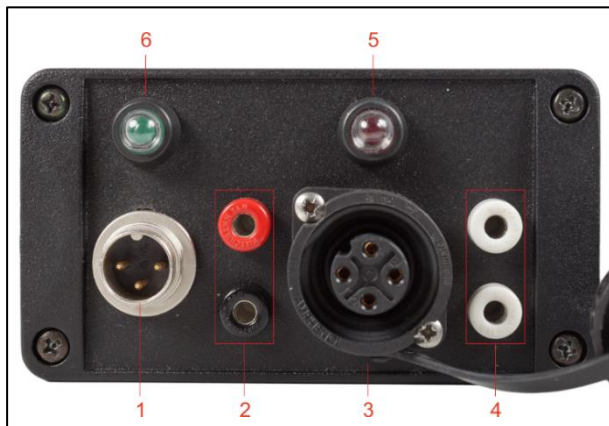


Figure 11: GPS TIMEsync connectors (left)

#	Element	Target / Description
1	Power connector	Power supply (only used when not powered via PoE)
2	Starting signal input 1 (banana plugs)	Connection with the starting signal provided through the local timing
3	Starting signal input 2	Optional starting signal input
4	Starting signal output	Output for the starting signal
5	Starting signal LED (red)	Shortly flashes when a starting signal is detected
6	Power status LED (green)	Illuminates when the device is powered

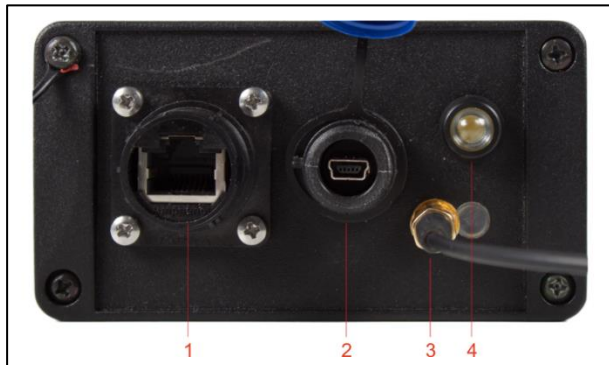


Figure 12: GPS TIMEsync (right)

#	Element	Target / Description
1	Network connector (with active PoE)	Network connection (device can be powered using a suitable PoE injector / switch)
2	USB connector	Data output (optional to Ethernet/Network connector)
3	GPS antenna socket	Connector for GPS antenna
4	GPS status LED (yellow)	Flashes when the device has a GPS fix

8.1.2 Requirements

The starting signal must be available in form of an electronic impulse (12V normally closed) which needs to be supplied via banana plugs.

A network connection (min. 100Mbit/s) between timing and operation room is required.

Furthermore, a GPS signal must be acquired at the designated location of the GPS TIMEsync device.

8.1.3 Placement and Connections

Proceed as follows:

1. Place the GPS TIMEsync device in or near the operation room (where the starting signal can be supplied).
2. Connect the supplied GPS antenna to the GPS TIMEsync.
3. Place the GPS antenna at a location with the best possible visibility of the sky (e.g. near a window).
4. Connect the starting signal to the banana plugs on the GPS TIMEsync. Mind the color coding or respectively polarization of the starting signal input.
5. Connect the GPS TIMEsync via network cable (or over an available dedicated network).

9 INSTALLATION AND OPERATION

The power supply for GPSRadio32V2 must meet the following requirements:

⚠ CAUTION

- (a.) ES1/PS1 for PoE-Devices (Powered Devices) with max. 10W
- (b.) ES1/PS2 for PoE-Devices (Powered Devices) with max. 24W

⚠ WARNING

GPSRadio32V2 must only be used in a maximum height of 2 meters above ground. An accidental dropping of the device from heights above 2 meters entails a risk for serious injuries, especially to the head.

The RTK Base Station as well as RTK Transceivers must be installed in an elevated position with a clear line of sight to the EQTracker devices moving within the racing area. Any existing infrastructure (e.g. light poles) can be used to attach the GNSS antenna and the device. Typically, it is installed near the operation room on a roof.

When installing, ensure that there is an unobstructed view to the sky. No trees or other obstacles may obstruct especially the GNSS antennas sky sight. For the RTK Base Station's GNSS antenna it is also important, that no pole swaying or other movements at the place of mounting occur. A fixed position is mandatory for an accurate device calibration, EQTracker positioning and operational usage of correction data.

Proceed as follows, after physically mounting an RTK Base Station or RTK Transceiver in its intended location:

6. Connect the dual-band GNSS antenna to the "GNSS" connector.
7. Connect the supplied radio antenna to the "RADIO" connector
8. Connect the M12-to-Ethernet cable to "DATA/POWER OUT" connector
9. Connect the M12-to-Power cable to the "POWER/SERIAL" connector. Remember to use an appropriate power supply (12-24 VDC; max. 1.2 A).

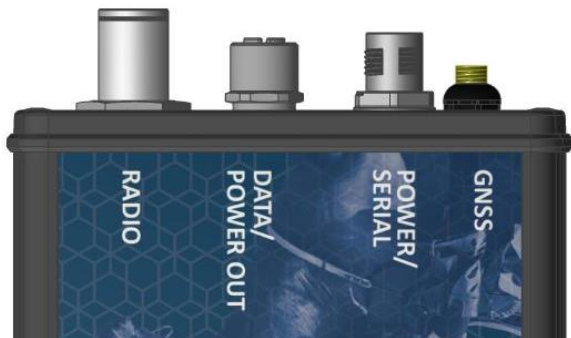


Figure 13: Connectors of the GPSRadio32V2 (RTK Base Station/RTK Transceiver)

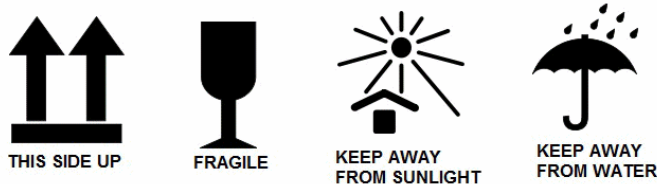
10 TRANSPORT AND STORAGE

Keep in mind that all mobile components of the **RTK EQU Tracking System** for horse racing are sensitive to stress from impact and compressive stress. To avoid physical damage to the equipment, it is particularly important to store and transport all components in a suitable case or box.

Observe the following precautions when storing the components:

- Store the components in a dry place
- Prevent exposing the components to temperatures that exceed 40°C
- Use a suitable case for storing the equipment
- EQTracker can be store directly in the charging case.
- Observe the additional instructions for battery-powered devices as set out below (see chapter 10.1)

For transportation it is recommended to appropriately label the appointed carrying cases with packaging symbols similar to the following pictures.



10.1 Battery Care and Storage

The EQTracker contain a Li-ion battery pack and should be stored in a cool, dry and well-ventilated area, and should be far from the fire and the high temperature. Choose a location with a fire extinguisher in direct reach. This is strongly advised since all lithium-polymer batteries have a potential risk to overheat and even ignite when physically damaged or short-circuited.

The best storage temperature is 25±5 °C. The best humidity is 60±15 %. The battery should be stored within room temperature and charged to 40 % till 60 % electric quantity (3.85 V).

In order to avoid over-discharge, we suggest charge and discharge the batteries every three months. Then charge to 40 % till 60 % electric quantity (3.85 V).

11 CLEANING AND MAINTENANCE

General Notes on Cleaning System Components

- Always unplug a device before you clean it
- Never immerse a device in water or any other liquid
- Never use abrasive, aggressive, or flammable cleaning agents such as bleach or alcohol to clean any part of the device
- Never open or disassemble any of the system components for cleaning

Cleaning Notes for the Charging Case

General maintenance is limited to keep the slots and the connection pads clear from dust and other dirt with a mild soap lotion. Be sure to disconnect the power supply before you start cleaning.

12 APPENDIX

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12.2 Version history

Version	Date	Modifications since last version
1.0	01.09.2020	Initial version
1.1	01.06.2021	Minor changes, added FCC information



NOTES: