airelectronics

UAV AUTOPILOTS

U-Antenna Tracker Manual

V 1.02

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Table of Contents

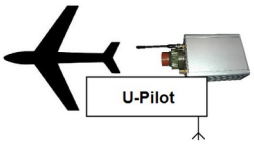
1 General System Introduction

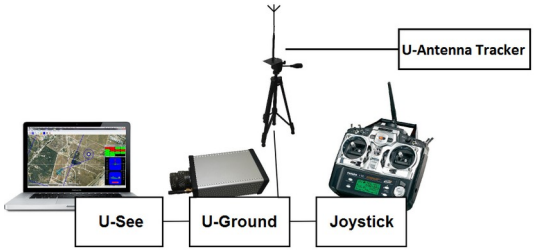
The U-Antenna Tracker system developed by Airelectronics allows the directional antennas attached to the U-Ground or U-Station to track the UAV and keep communications quality at a maximum automatically. Only an antenna set or a single antenna installation onto its mechanical structure is needed.

U-Antenna Tracker manages and controls the tracking of the UAV from take-off to landing thank to U-Ground feedback data. Hence, communications between aircraft and ground station will be granted over the flight plan with nobody getting involved.

1.1 Concept of system operation

The system consists of a U-Ground connected to the U-Antenna Tracker through a TTL serial port in order to relay data to each other. The tracker, in turn, is connected to the rotator and an electrical network (230 VAC). In addition, a single directional antenna or a set of them connected to the U-Ground or any video system will be installed onto the rotator in order to receive UAV transmitted signals (such as telemetry, video, etc.) as the tracker executes its workflow.





U-Ground is continuously calculating the position where the antenna should be, this is, azimuth and elevation for the antenna to point the current UAV position. In automatic mode, the tracker will point the azimuth resulting of this calculation.

Although this system is mainly oriented to be used as an automated one, the user is allowed to command the tracker manually, through the U-See software installed on a personal computer connected to the U-Ground. Also, U-See will display feedback of the tracker (for more information about the command and report interface, please refer to U-See User Manual).

The user will be also allowed to set a local orientation on the tracker, based on these compass points: North, East, South or West.

2 U-Antenna Tracker

As we aforementioned earlier on this document, U-Antenna Tracker is the hardware which allows permanent communication between the aircraft and the U-Ground by focusing a directional antenna straight to the UAV.

U-Ground allocates UAV position thank to its own GPS and the UAV telemetry data and then, let the tracker know which azimuth should point to track the UAV. Then, U-Antenna Tracker sends feedback to the U-Ground in order to display relevant information to the user on U-See. However, the user could command the tracker system manually, so the GPS signal would be ignored and the rotator would move as the user pleased (given some rotator limitations, described later on this document).

The tracker subsystem is based on two parts: the mechanical structure and the electronic system.

2.1 Mechanical Structure

As shown in the previous figure, the mechanical structure consists of a strong, hardy tower with a motor inside which allows a 450 degrees pan rotation, parallel to the horizontal plane. The rotor is mounted to the tripod with an adapter, go to appendix C for more information.

The tower is strong enough to hold a pole-mounted antenna (up to 10 kg) or a tower-mounted set of antennas (based on “K” coefficient, explained later on this document) on it and keep rotating with no speed rate losses, at all. This model of rotator works at unique speed rate of 0.1 rad/s, which means the rotator will spin around 360 degrees in 63 seconds for a 50 Hz

supply network, approximately. For any extra feature desired, please contact with Airelectronics.

It's worth noting the rotator is able to spin around 450 degrees, so a 90 degrees overlap is allowed distributed into 45 degrees at left hand and 45 degrees at right hand. This means the tracker will be able to rotate within a maximum [-225,+225] degrees pan span. Given this information, the user will decide how the rotator will be oriented in order to fit the flight plan and avoid any possible crash against the rotator dead zone. If the angle is beyond this dead zone, the tracker is forced to spin on the other way around in order to track back the aircraft, with the possibility of losing communications meanwhile.

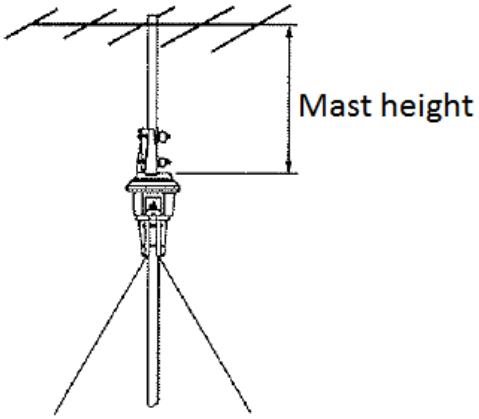
Full rotator specifications are displayed on the U-Antenna Tracker specifications sheet, please refer to Airelectronics website.

2.1.1 Pole-Mounted Antennas

The attached antenna must have a mounted weight (combined weight of antenna and attached mast) of **10 kg or less**[1] and the result of multiplying the "antenna wind loading area (m^2)" by the height of antenna mast (m)" must be 0.25 or less. Hence:

(Antenna weight) + (Mast weight) ≤ 10 kg

(Antenna wind loading area) x (Height of antenna mast) ≤ 0.25



The picture above shows an example of a pole-mounted 5-element Yagi antenna on the rotator. Mast weight added to antenna weight must not exceed 10 kg.

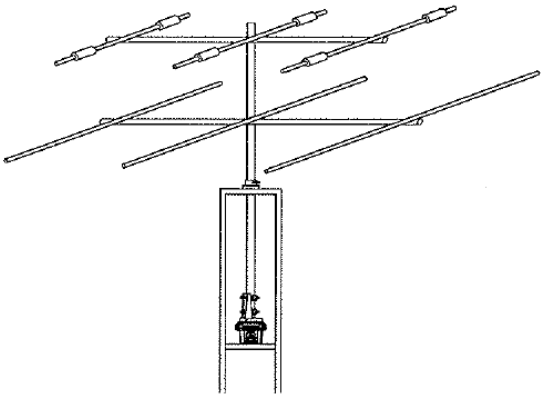
2.1.2 Tower-Mounted Antennas

The antenna wind loading area must be less than 1 m^2 and the aforementioned antenna "K" coefficient **must not exceed 100 units**[2]. "K" is calculated by this given expression:

K = Antenna rotation radius (m) x Total antenna weight (including mast) (kg) ≤ 100

Use the antenna rotation radius and weight values provided by the antenna manufacturer.

1 Although the rotator is capable of holding such weight, Airelectronics provides a tripod within the Installation Kit which sets a limitation of 5 kg for pole-mounted antennas installed onto the rotator. A stronger tripod is provided separately.
2 Although the rotator is capable of holding such weight, Airelectronics provides a tripod within the Installation Kit which sets a limitation of K = 50 units for tower-mounted antennas installed onto the rotator. A stronger tripod is provided separately.



On the picture above there is an example of tower mounted two 3-element antennas set. To calculate the “K” coefficient would be necessary to calculate every single “K” involved (N “K” coefficients for N antennas mounted, so every antenna has a single “K” coefficient). Then, the addition of all “K” coefficients will give “K_{TOTAL}” as a result. This “K_{TOTAL}” value must be less than 100 units. Hence, in this given example:

K_1 = Antenna_1 Rotation radius (m) x (Total antenna_N weight + Mast weight / 2) (kg)

K_2 = Antenna_2 Rotation radius (m) x (Total antenna_N weight + Mast weight / 2) (kg)

$K_{TOTAL} = K_1 + K_2$

It's worth noting we divided mast weight by 2 as the antennas are attached to the same mast, so the weight is distributed between them. Hence, we could update “K” coefficient as:

K_N = Antenna_N Rotation radius (m) x (Total antenna_N weight + Mast weight / N) (kg)

$K_{TOTAL} = K_1 + K_2 + \ldots + K_N$

2.2 Electronic System

U-Antenna Tracker hosts an embedded software which allows the system to track the UAV motion based on the data reported by U-Ground through the TTL serial port. Meanwhile, the rotator spins and current pan angle are monitored all the time by some sensors allocated on the board. Given this information, this embedded software makes all the geometric calculations needed for the rotator to focus the UAV with 1 degree resolution, as well as keep the rotator under control over the system normal execution.

Motor states (stopped, spin left, spin right) are commanded by 2 relays during the whole execution.

2.3 Power supply

U-Antenna Tracker accepts AC voltages in a range from 220 to 240 VAC, 50-60 Hz. Power electronics is connected to an electrical network to feed the rotator thanks to a transformer working inside the tracker box.

The transformer output is linked to a 3A fuse to make sure the rotator electrical circuit will be safe against any current peak.

CAUTION: Powering U-Antenna Tracker at a voltage OUT of range can cause IRREVERSIBLE DAMAGE to the transformer. If so, the rotator would be out of operation.

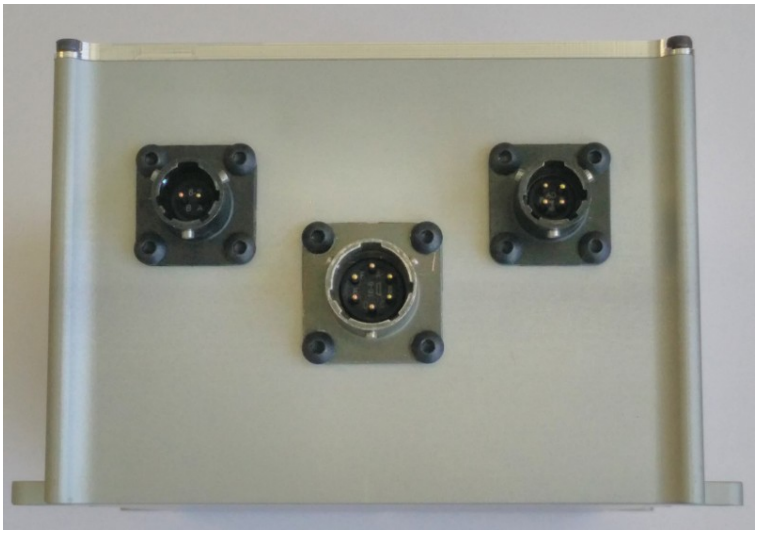
Please read carefully this manual and do not hesitate to contact Airelectronics in case of doubt.

Control electronics is fed by U-Ground through the 4-pin aerial port, described later on this document. Hence, a proper voltage applied to the U-Ground (Please, refer to U-Ground User Manual) is needed for the Tracker to operate safely.

2.4 U-Antenna Tracker Connections

This section provides the required information about U-Antenna Tracker connections, including:

- Tracker to electrical network connection.
- Tracker to U-Ground connections.
- Tracker to rotator connections.



The U-Antenna Tracker box includes 3 aerial connectors which purpose will be detailed further on this section.

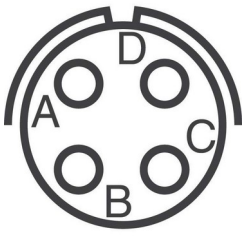
2.4.1 Tracker to electrical network connection

A connection to a 220-240 VAC (50-60 Hz) power source is needed for the transformer to feed the rotator. This connection is made through the 2-pin aerial connector seen in the previous figure.

The cable and connectors needed for this connection is supplied in the Installation Kit.

2.4.2 Tracker to U-Ground connections

U-Antenna Tracker and U-Ground are connected through the 4-pin aerial connector also seen in the previous figure:

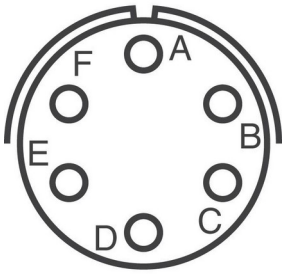


These all 4 pines are connected to U-Ground in this order:

PIN	I/O	Function	U-Ground Connection
A	Input	3.3V TTL Rx	Pin 28
B	Output	3.3V TTL Tx	Pin 16
C	Input	Vin	VBat
D	GND	Ground	GND

2.4.3 Tracker to rotator connections

U-Antenna Tracker and rotator are connected through the 6-pin aerial connector:

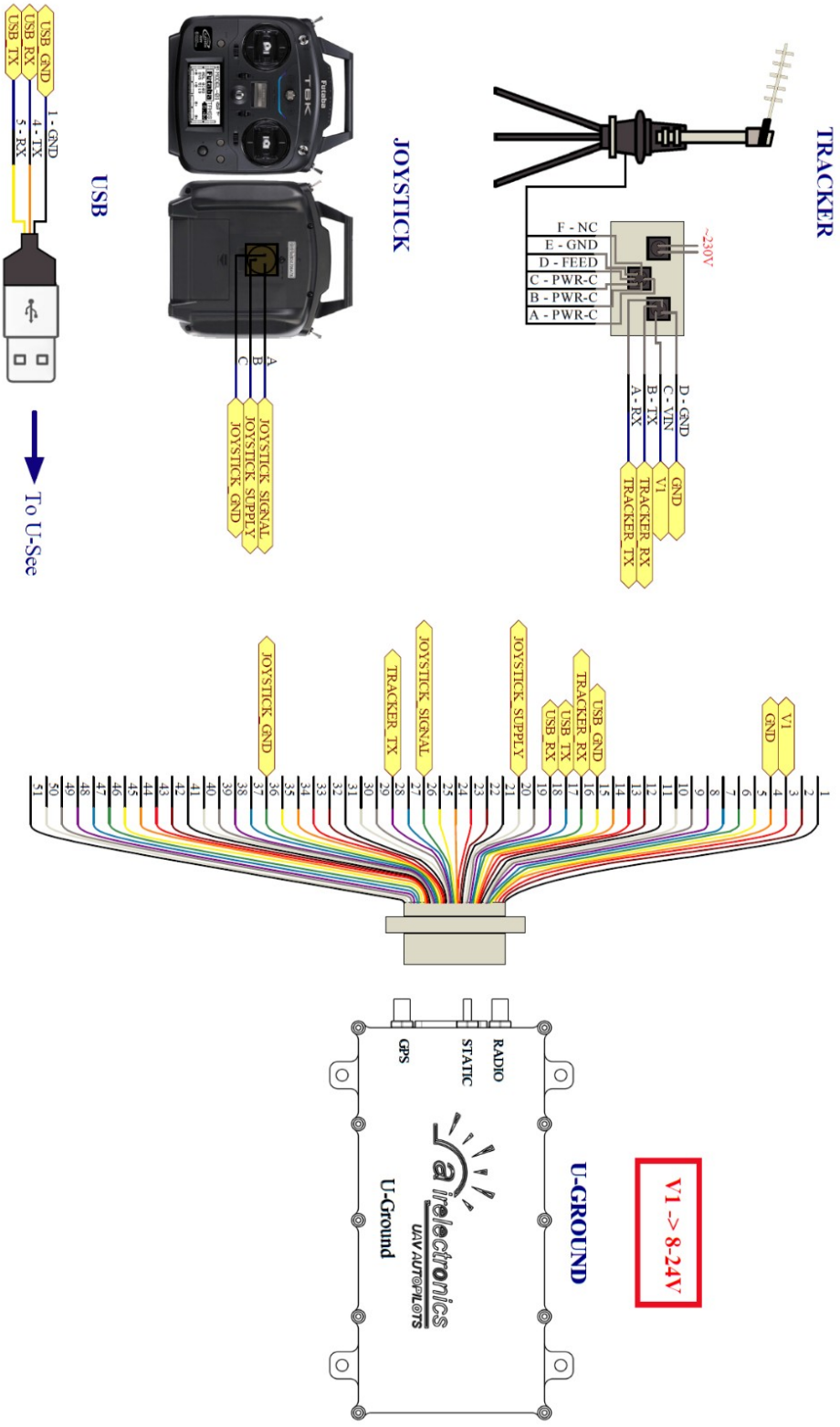


These all 6 pines are connected to rotator in this order:

PIN	I/O	Function
A	Output	Power Circuit
B	Output	Power Circuit
C	Output	Power Circuit
D	Input	Feedback Analog
E	GND	Ground
F	NC	NC

2.4.4 Typical ground connection schematics

A typical connection between the main components in the ground segment is shown below. Keep in mind that all these connections are already done with the wires supplied with the Installation Kit for each device.


TRACKER
F - NC
E - GND
D - FEED
C - PWR-C
B - PWR-C
A - PWR-C
~230V
D - GND
C - VIN
B - TX
A - RX
GND
V1
TRACKER RX
TRACKER TX
JOYSTICK
A
B
C
JOYSTICK_SIGNAL
JOYSTICK_SUPPLY
JOYSTICK_GND
USB
USB_GND
USB_RX
USB_TX
1 - GND
4 - TX
5 - RX
To U-See
JOYSTICK_GND
TRACKER_TX
JOYSTICK_SIGNAL
JOYSTICK_SUPPLY
USB_TX
USB_RX
TRACKER_RX
USB_GND
V1
GND
GPS
STATIC
RADIO
U-Ground
U-GROUND
V1 -> 8-24V

3 Communications

Communications between U-Ground and U-Antenna Tracker is done through a TTL serial interface. U-Ground sends commands while U-Antenna Tracker relays back telemetry data regularly to the U-Ground to display it on U-See, so the user can check its performance every time.

In order to configure and calibrate U-Antenna Tracker, it is required to enter in Direct Config Mode in U-Ground. In this mode, it is possible to set the calibration table for the rotator and the feedback is received at an increased speed from the tracker.

U-Pilot and U-Ground communicate to each other by radio-frequency.

4 Operation

Please, read carefully the section ***2.11.5.1 U-Antenna Tracker specific options***, in the U-See software manual, for more information about the Manual and Auto operation mode, the management of the dead zone associated to the U-Antenna Tracker and other considerations. Please, **do not operate the U-Antenna Tracker before reading the U-See software manual and the indicated section**.

4.1 In-Field orientation

The tracker has a reference mark in the Rotator-tripod adapter (the round metal base) that marks the 0 angle of the tracker. This is the reference used to orient the tracker and for the tracking to be proper it has to be aligned to one of the four cardinal points (N,W,S,E) so the tracker can convert physical azimuths to rotator movement.

The rotator has a range of 450°, 225° per side from the 0. This means that if an aircraft crosses from one side to the other across the limits of the range the rotator will have to rotate all the way around to avoid tangling the cables.

Because of this the relative position of the dead zone should be placed strategically.

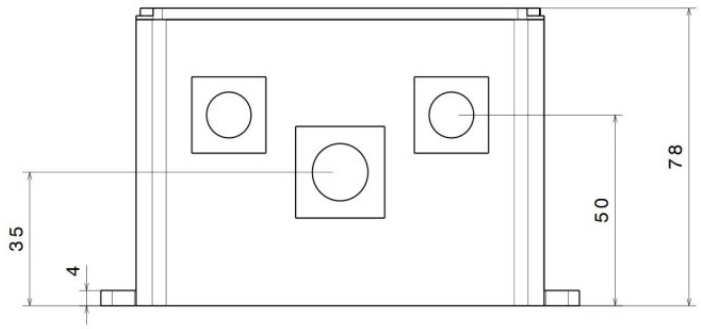
Any one of the four cardinal points is valid and must be set in the U-See software so the antenna pointing is valid.

The reference point of the tracker should be set in the general direction of the expected operations zone.

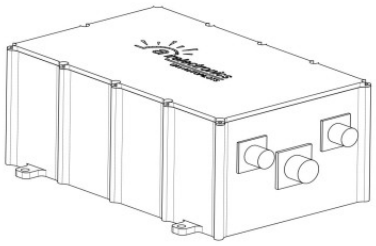
For example, for an operation taking place at the west of your position the tracker should be oriented towards west. This leaves the dead zone towards the East avoiding the necessity to turn around all the way down while the operation is in progress.

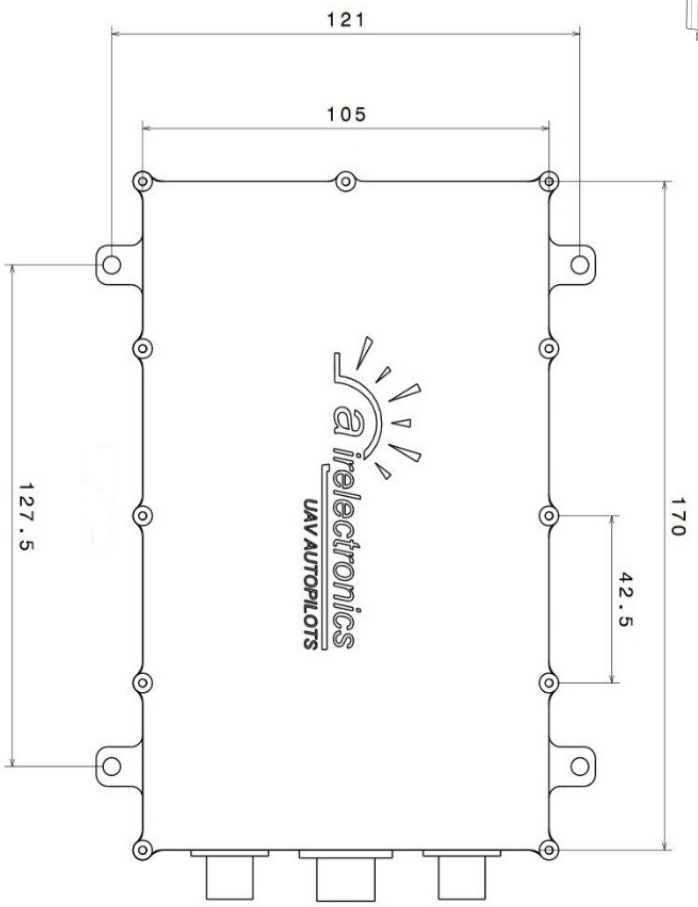
For the best performance the tracker should be installed in a horizontal surface so the axis of the rotator is perfectly vertical. If this is not possible, use the adjustable legs of the tripod to put the rotator axis as close as vertical as possible.

Appendix A Box Mechanical Drawing



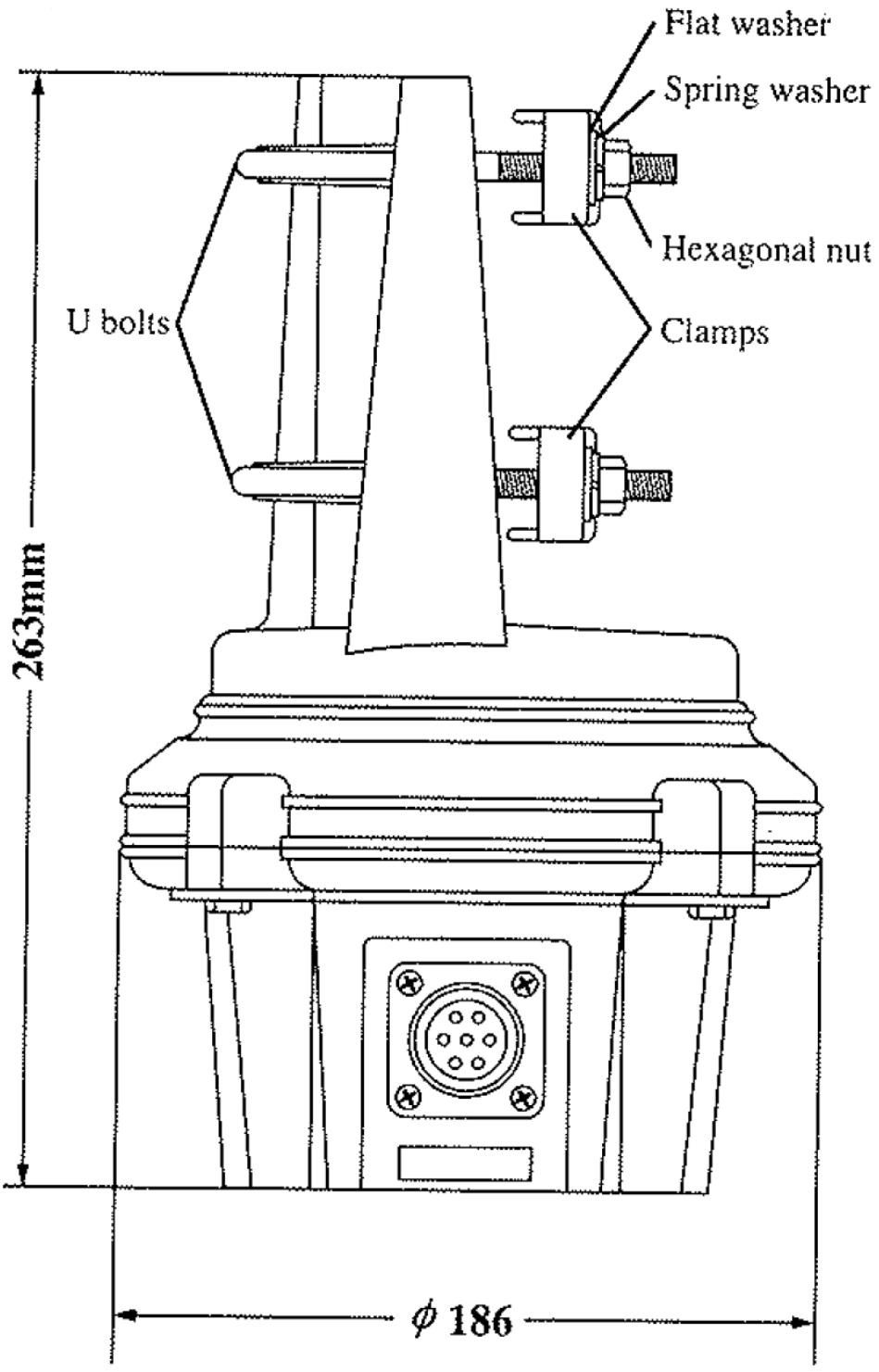
Front View



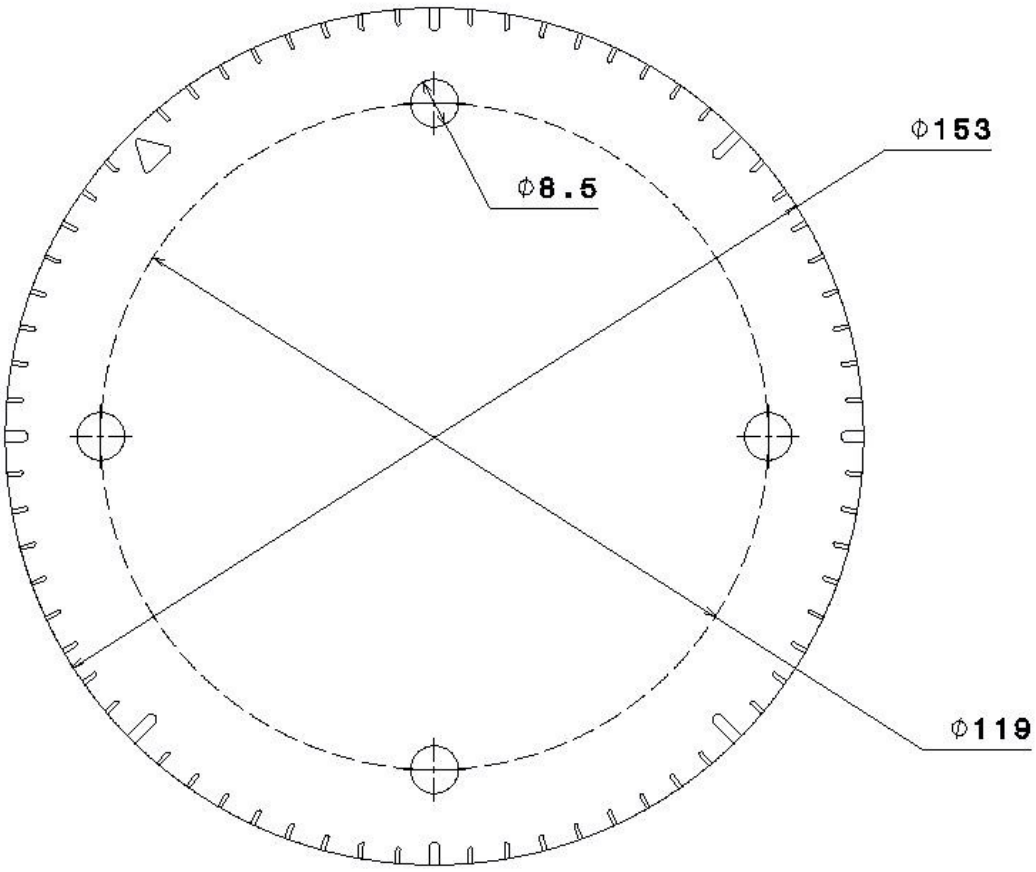


Top View

Appendix B Rotator Mechanical Drawing



Appendix C Rotator-Tripod Adapter Drawing



Front view

Appendix D Changelog

Date	Changes
2020/12/01	• Added ‘Operation’ section • Added schematics about connection between ground devices
2018/06/06	• Document version up to 1.01 • Added rotator-tripod adapter mechanical drawings
2018/04/26	• First Document Version