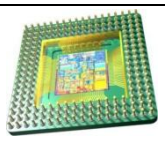
Elektroline

VETRA tram-to-wayside communication system

Technical conditions

Short-range tram-to-wayside communication system VETRA produced by Elektroline ensures reliable bidirectional data transmission between trams and wayside systems based on 2.4 GHz radio transmission.



FLEXIBLE, CUSTOMIZED DESIGN

EMC CERTIFIED

EMC

DESIGNED ESPECIALLY FOR TRAMWAYS

RELIABLE

Revision 1.02 (18.1.2012)

Introduction

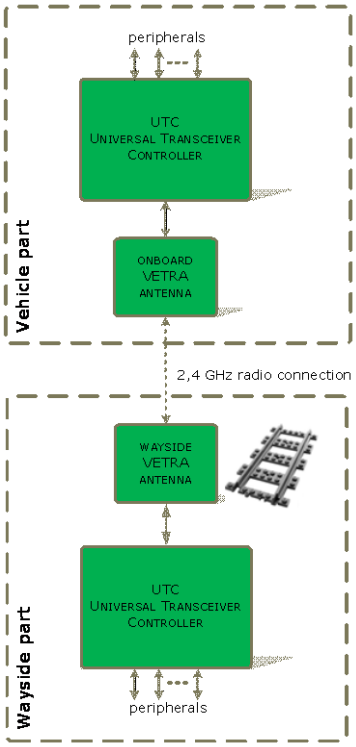
Reliable fast data communication

Elektroline tram to wayside communication system VETRA is modern sophisticated system for local transmission of data between trams and wayside systems.

It is intended for data communication between any onboard equipment and any wayside equipment. Onboard equipment can be any onboard computer or Human Machine Interface (HMI).

Bidirectional 2,4 GHz radio communication is used. That ensures high communication speed for tram speed up to 100 km/h.

VETRA communication system offers many flexible applications such as automatic commanding of switch points, automatic control system for tram depots, tram priority systems for traffic lights, tram localizations, passenger information systems, automatic speed-limit checking system and many others.



System Highlights

- **No crosstalk -**Nearby antennas does not interfere
- **Fast and reliable** bidirectional data communication
- **Automatically sends commands** to wayside control systems
- **Easy-to-install,** suitable for all trams
- **Can be installed on** steel reinforcement
- For tram **speed up to 100 km/h**
- **Small dimensions** of the system components
- **Your are data safe,** all transferred data are encrypted
- **No interference** with low-frequency inductive vehicle-communication systems

Content

Onboard VETRA equipment

VETRA onboard communication unit UTC

installed onboard the tram

onboard VETRA antenna

installed under the floor of the tram

VETRA onboard touch screen

installed on the driver's dashboard

Onboard VETRA cabling

Cable connecting the VETRA OCU and onboard VETRA antenna

Wayside VETRA equipment

VETRA wayside communication unit UTC

installed in a wayside control cabinet

ground VETRA antenna

installed in the track in order to communicate with the onboard VETRA antennae

Wayside VETRA cabling

cables for connecting the ground VETRA antennae with the VETRA WCU

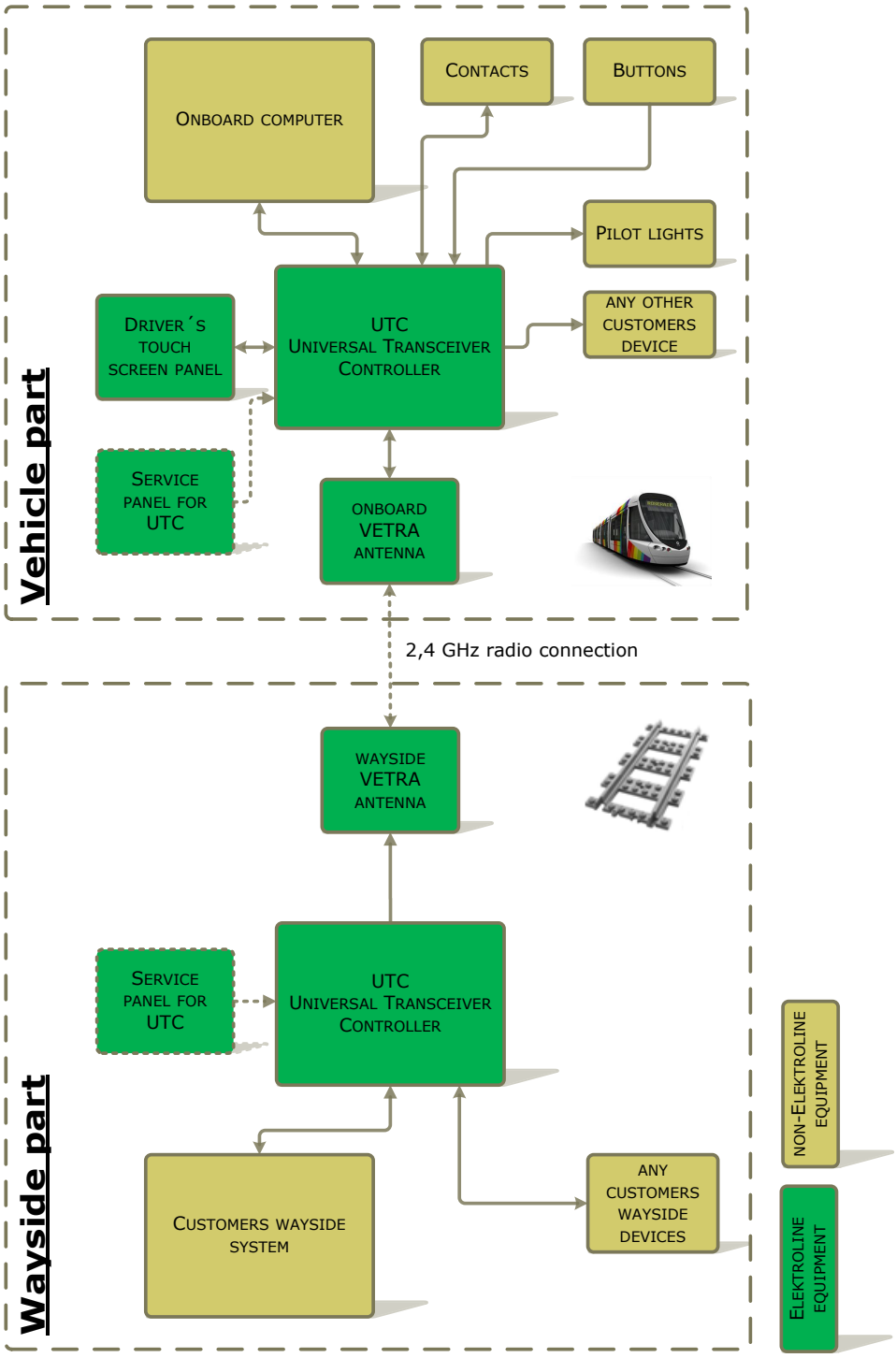
Additional

UTC service panel

Optional/additional only for service use

Block description

Following picture shows schematic layout of system parts.

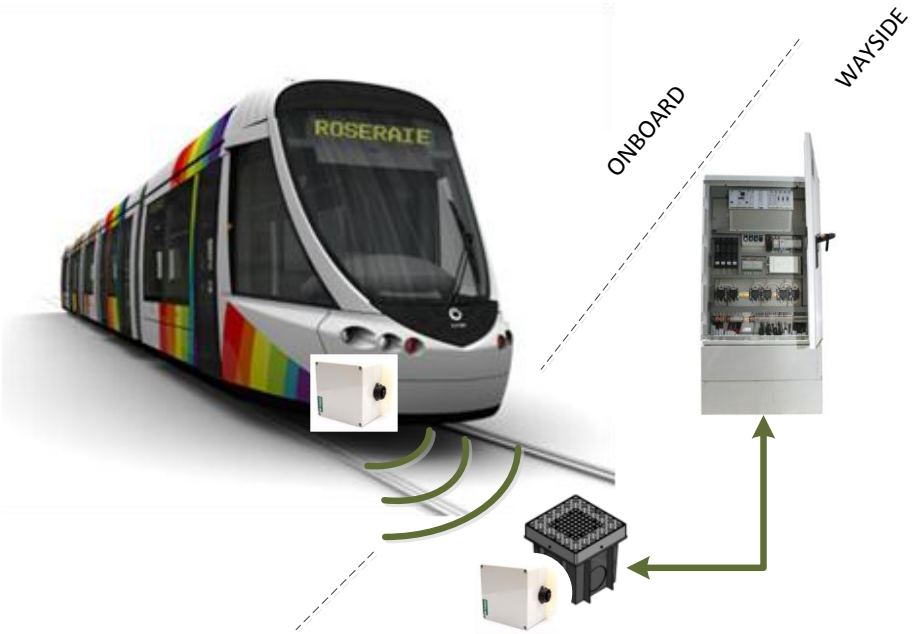


Component description

This chapter is dedicated to describe each part of the VETRA tram-to-wayside communication system. One by one of the mentioned parts will be described together with brief description of their installation.

Components can be separated into two categories

- Onboard parts
- Wayside parts



Onboard parts

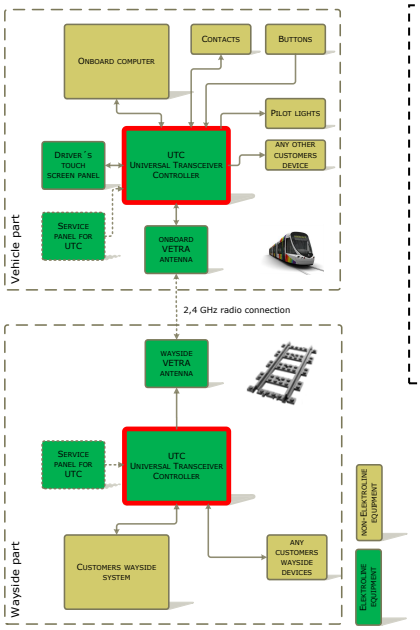
Equipment mounted on the vehicle.

VETRA onboard communication unit UTC

Universal Transceiver Controller

Universal Transceiver Controller (UTC) is multifunctional unit intended for connecting all parts of equipment such as onboard computer, touch screen panel etc. together.

As we can see from the picture, one UTC is mounted onboard, one is part of wayside equipment and is usually installed in the wayside control cabinet.



- ✓ **Automatically sends commands** to wayside control systems
- ✓ **Small dimensions**
- ✓ **Your data safe** all transferred data encrypted
- ✓ **Customer choice** of bytes (bits) meaning and behaviour
- ✓ **Software change** via RS485 without necessity of dismounting the unit

UTC communicates with touch screen panel, onboard computer and any other customer´s device on one side. On the other side there is communication witch VETRA antenna. In case of onboard part it is onboard VETRA antenna, in case of wayside equipment, it is wayside VETRA antenna.

UTC communicates with onboard computer and with VETRA antenna over RS485 serial line.

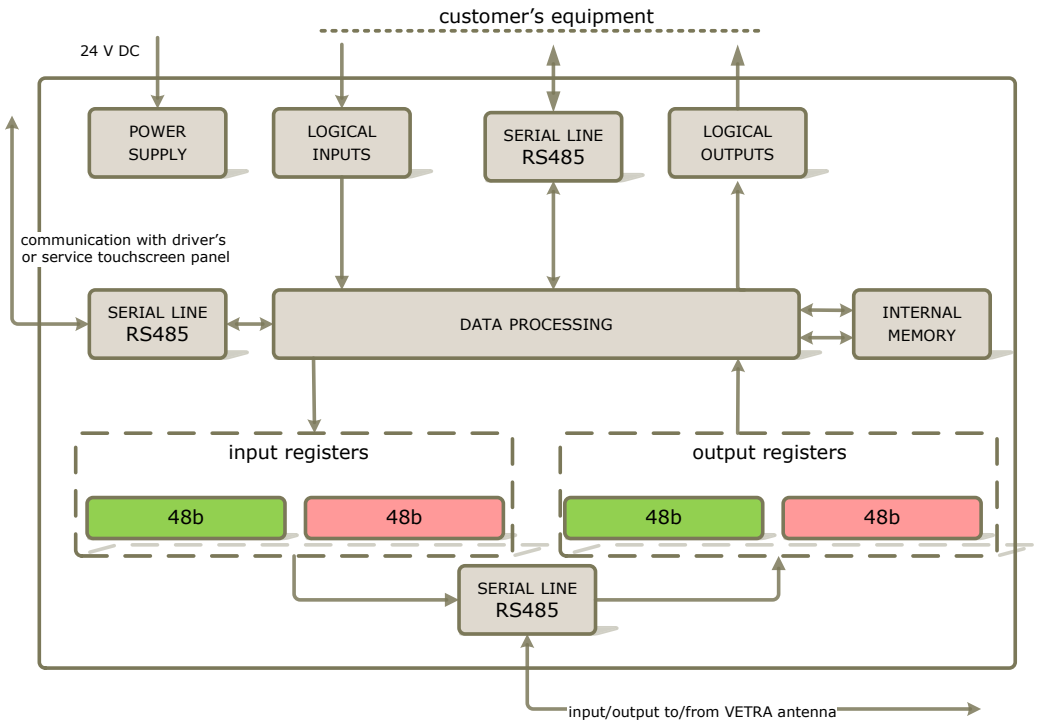
Feeding voltage:	24 V DC	
Power consumption:	50 mA	UTC unit itself
	350 mA	UTC unit + LCD panel
	400 mA	UTC unit + LCD panel + VETRA transceiver

UTC data operation

Data flow in Universal Transceiver Controller shown at the following picture describes at large how does the inner logic organisation work.

VETRA antennas (transceivers) provide data transfer between input and output registers of vehicle UTC and ground station UTC.

Customer's equipment in the vehicle can be onboard computer connected via RS485 and some push buttons, switches or vehicle 24 V signals connected via logical inputs and outputs.



Customers equipment in the ground station can be rail or trolleybus point control system or a public transportation preference system connected via logical inputs and outputs or via RS485.

LCD touch screen panel can be connected permanently (e.g. driver's LCD touch screen on the dashboard) or only for service, monitoring and configuration purposes (service touch screen).

User can define data processing for user configurable data (colored pink).

Therefore half of data flow can be used by customer for his own purpose. It is whole one data frame of 6 bytes (48 bits).

Bytes description

Byte Nr. (8 bits each)	Byte	For
1	{b⁷ b⁶ b⁵ b⁴ b³ b² b¹ b⁰}	Used by Elektroline devices for necessary data communication
2	{b⁷ b⁶ b⁵ b⁴ b³ b² b¹ b⁰}	
3	{b⁷ b⁶ b⁵ b⁴ b³ b² b¹ b⁰}	
4	{b⁷ b⁶ b⁵ b⁴ b³ b² b¹ b⁰}	
5	{b⁷ b⁶ b⁵ b⁴ b³ b² b¹ b⁰}	
6	{b⁷ b⁶ b⁵ b⁴ b³ b² b¹ b⁰}	
7	{b⁷ b⁶ b⁵ b⁴ b³ b² b¹ b⁰}	Customers data (customer can choose meaning and purpose of these bytes)
8	{b⁷ b⁶ b⁵ b⁴ b³ b² b¹ b⁰}	
9	{b⁷ b⁶ b⁵ b⁴ b³ b² b¹ b⁰}	
10	{b⁷ b⁶ b⁵ b⁴ b³ b² b¹ b⁰}	
11	{b⁷ b⁶ b⁵ b⁴ b³ b² b¹ b⁰}	
12	{b⁷ b⁶ b⁵ b⁴ b³ b² b¹ b⁰}	

✓ **Customer´s choice** of higher bytes

Specification of UTC electronic unit:

Mechanical dimensions / W x H x D / :

UTC LIGHT / basic unit / 27 x 80 x 80 mm

UTC FULL / extended unit / 55 x 80 x 80 mm

Power: 24V DC 100 mA max /18....32V acceptable

Logical inputs : 24V DC 6 mA non isolated , active High, common GND 24V

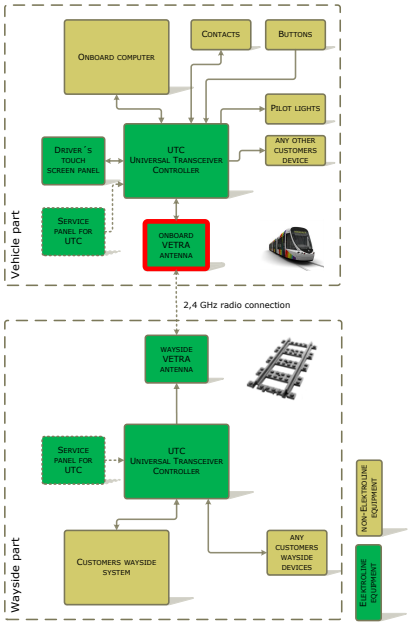
Logical outputs: 24V 50mA max. non isolated , active High, common GND 24V

Serial communication ports: RS 485

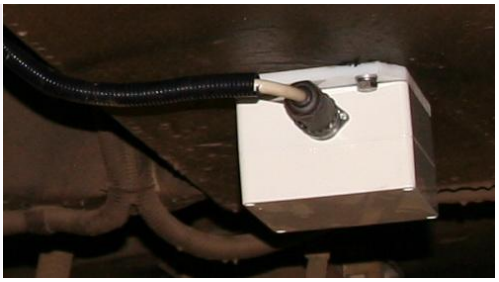
HW	Serial ports	Log. inputs	Log. Outputs / inputs /
UTC LIGHT	**3**	**4**	**4**
UTC FULL	**5**	**12**	**10**

Vehicle VETRA antenna block

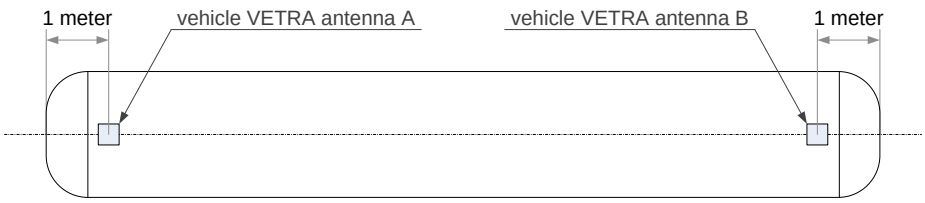
The vehicle VETRA antenna block is installed under the floor of the tram at such location that a visibility between the antenna and the ground is guaranteed. Within a 45° angle from the vehicle VETRA antenna towards the ground, no metal objects are allowed to be placed. One vehicle VETRA antenna is installed at each end of the tram so that each terminal keyboard has its own antenna.



- ✓ **No crosstalk** Nearby transceivers do not interfere
- ✓ **Fast and reliable** bidirectional data communication
- ✓ **Up to 100 km/h** tram speed passage



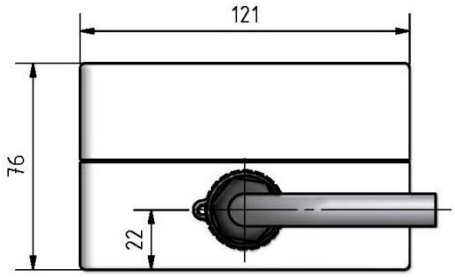
The recommended location of the vehicle antenna is in the centre line of the tram on distance of 1 meter from the end of the tram:

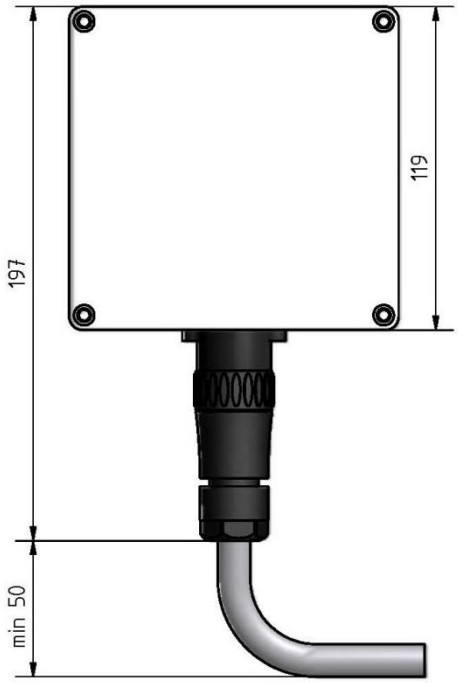


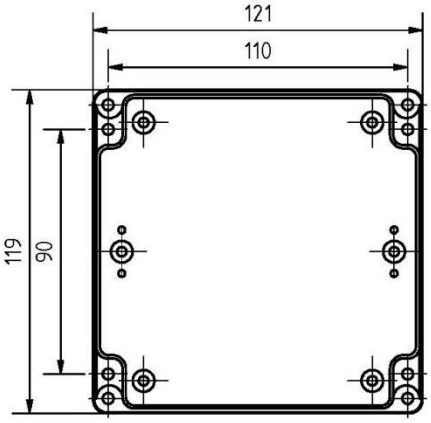
Above described location of vehicle VETRA antennas is only a proposal. We would like you to consider this proposed location on tram and to let us know whether it is convenient for customer´s type of tram or whether we should suggest different location.

If the exact location cannot be achieved, the antenna has to be installed as close as possible to the optimal location.

Following drawing shows mechanical dimensions of the vehicle VETRA antenna:







✓ **Small and compact** design

Wayside equipment parts

Equipment installed in the track and on the street or just next to the track.

VETRA wayside communication unit UTC

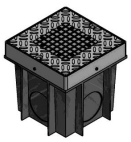
Universal Transceiver Controller

Universal Transceiver Controller (UTC) is multifunctional unit intended for connecting all parts of equipment such as customer's wayside device, wayside customer's system, wayside VETRA antenna and eventually UTC service panel together.

VETRA Onboard Communication Unit and Wayside Communication Unit are identical hardware with the same or different software with different configuration settings. Software in the unit can be exchanged by user in the future, only a PC or notebook and USB/RS485 converter is needed. Advantage is that the UTC hardware need not to be opened or dismounted from the vehicle. Software change is done via accessible RS485.

For more information about Universal Transceiver Controller please see chapter "VETRA onboard communication unit UTC" describing onboard parts of the system.

- ✓ **Automatically sends commands** to wayside control systems
- ✓ **Small dimensions**
- ✓ **Your data safe** all transferred data encrypted
- ✓ **Customer choice** of bytes (bits) meaning and behaviour
- ✓ **Software change** via RS485 without necessity of dismounting the unit

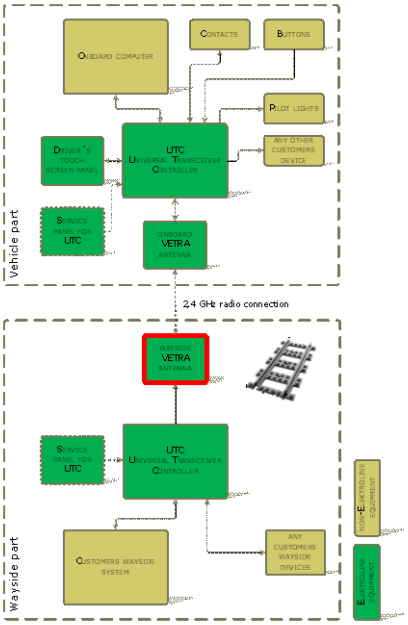


Wayside VETRA antenna

VETRA antenna is transmitting signal between onboard VETRA antenna and any wayside equipment.

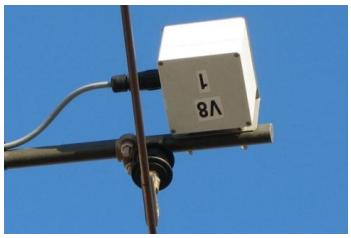
Basic functions and characteristics:

Travel speed up to 100 km/h



- ✓ **No crosstalk** Nearby transceivers do not interfere
- ✓ **Fast and reliable** bidirectional data communication
- ✓ **Up to 100 km/h** tram speed passage

The wayside VETRA antenna is connected with a wayside system using a special RS485 serial line cable dedicated for data communication.



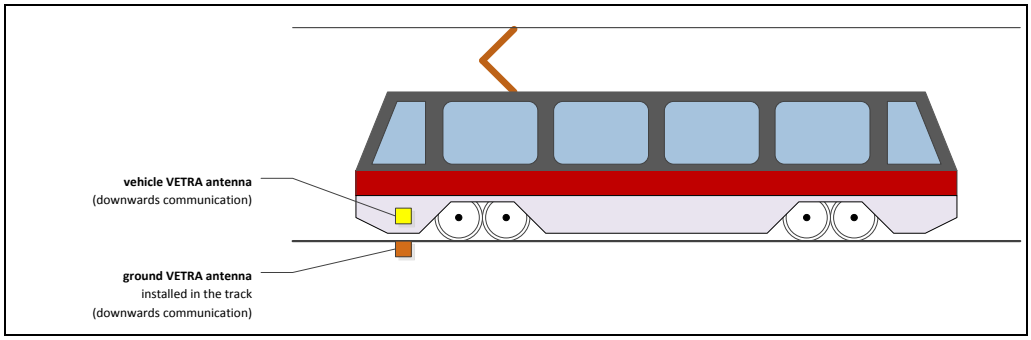
- ***Wayside VETRA antenna*** can be installed in one of the two possible ways:

1) in the track so that the communication is realized downwards from the tram
2) on the overhead contact line so that the communication is realized upwards from the tram

Ground VETRA antenna

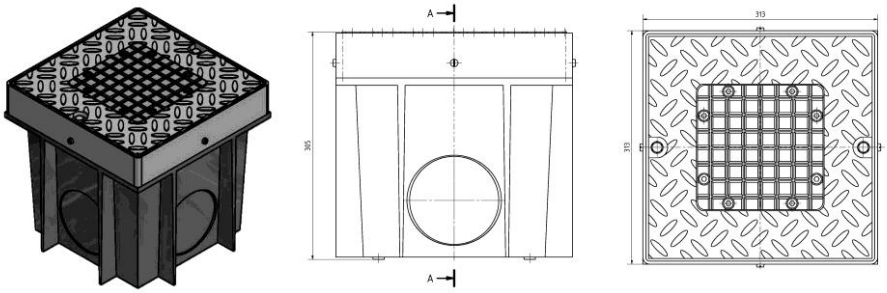
type of wayside VETRA antenna installed in the track

The ground VETRA antenna is installed in the track in order to receive signal from onboard VETRA antennae and send information to them. It can be used only for the downwards VETRA communication as it communicates with onboard VETRA antenna installed under the tram floor.



The main part of the ground VETRA antenna is the same hardware as is used in the trams as vehicle VETRA antenna. The difference is only in the way how the equipment is installed and what kind of mounting and protective material is delivered with it.

The ground VETRA antenna is installed in a ***protective ground shaft*** at locations where communication between trams and ground systems is required. The ground VETRA antenna is delivered including a protective ground shaft with special adaptations in order to enable easy installation of the ground VETRA antenna into the ground shaft.



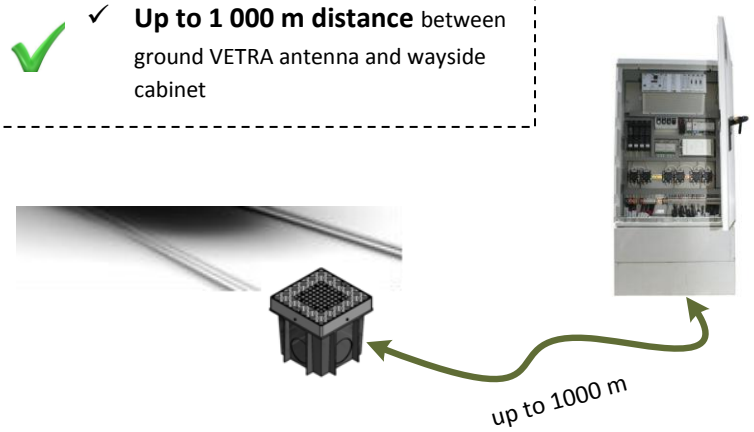
The cover of the ground shaft is made of strong steel with a strong plastic part in the middle through which the radio signal can easily pass. The ground shaft offers four possible entries for protective cable ducts where the incoming cable can be placed. It is recommended that the ground shaft is connected to a water drainage system. The ground shaft can be installed in a ballast track as well as in an encapsulated paved or concreted track.

- ✓ **High mechanical protection** strong shaft with metal cover
- ✓ **Plastic middle part** ensures that no radio signal is lost

Ground VETRA antenna has a special connector in order to connect RS 485 serial line cable to connect the ground VETRA antenna with a wayside system (UTC). This is a special watertight connector that prevents water from getting into the box of the VETRA antenna.

Used serial communication allows the ground antennae to be installed even very far from the wayside control system where a VETRA interface is installed. As the RS485 cable provides both data communication with the ground VETRA antenna and power supply for it, maximum distance of the cable is approximately 1 000 meters. Longer distances can be achieved by special arrangements of the communication and can be done on special request.

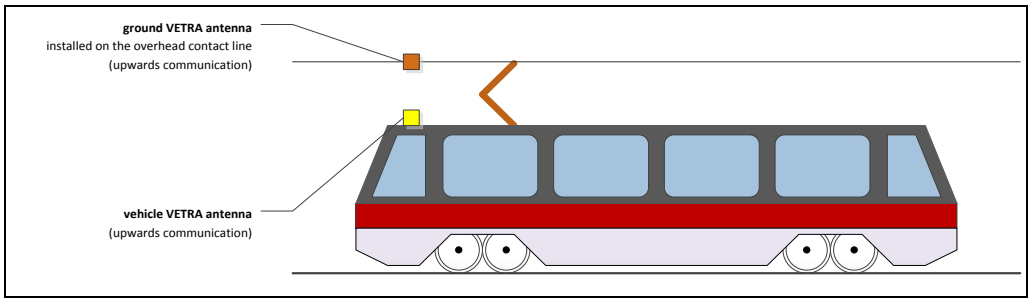
- ✓ **Up to 1 000 m distance** between ground VETRA antenna and wayside cabinet



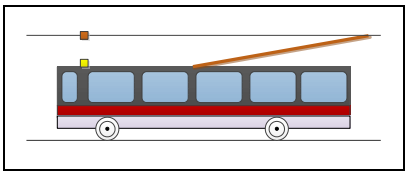
Overhead VETRA antenna

type of wayside VETRA antenna

The overhead VETRA antenna is installed on the overhead contact line close to the longitudinal axis of the track in order to receive signal from onboard VETRA antenna and send information to them. It can be used only for the upwards VETRA communication as it communicates with onboard VETRA antenna installed on the roof of the tram.



- ✓ **Universal**
- ✓ **Trolley-buses** can use the same system

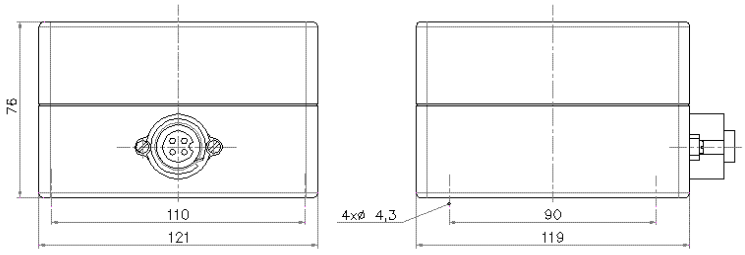


trolley-bus usage

transceiver on the roof

1.1.1.1

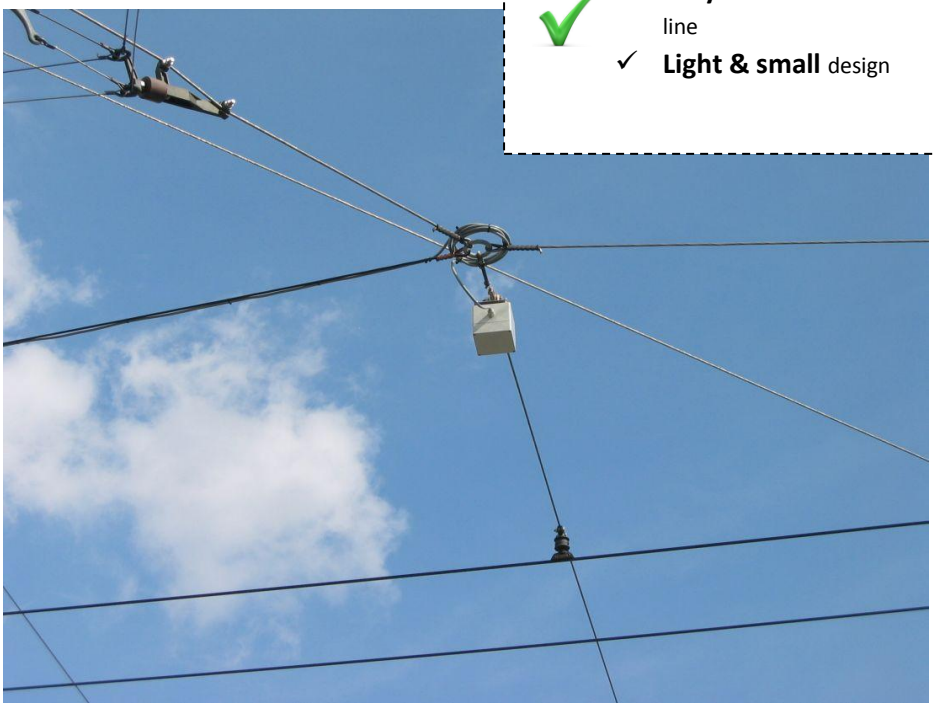
The main part of the overhead VETRA antenna is the same hardware as is used in the trams as vehicle VETRA antenna. The difference is only in the way how the equipment is installed and what kind of mounting and protective material is delivered with it.



Elektroline offers various systems of fixing the overhead VETRA antennae on the overhead contact wire; the most common system is using a fiberglass bar installed between two contact wires. When this solution is not possible, we can install the overhead VETRA antennae also on a cross-wire, cantilever, etc. Installation of the overhead VETRA antennae on the overhead contact line is always matter of customized solution for specific location.

The overhead VETRA antenna is usually delivered including necessary material for fixing it on the overhead contact wire

- ✓ **Easy to install** on overhead contact line
- ✓ **Light & small** design



Interfaces

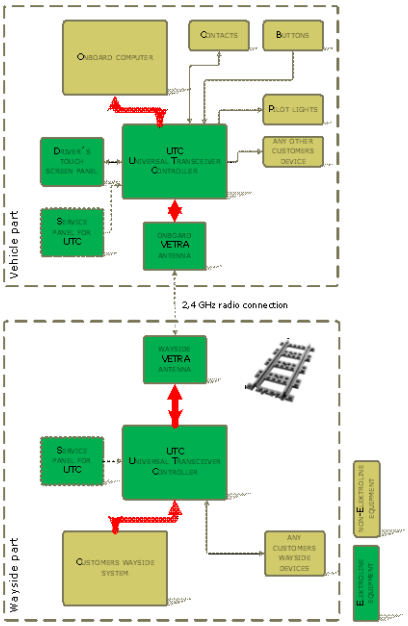
This chapter describe interfaces used by the UTC. One of many advantage of VETRA tram-to-wayside communication system is using common interfaces to communicate with other equipments.

Serial line RS485

Connecting UTC and VETRA antenna

Via RS485 is also connected onboard computer and drive's touch screen panel.

Standard	EIA RS-485
Physical Media	Twisted pair
Maximum Devices	32 drivers or receivers
Maximum Distance	1000 metres
Mode of Operation	Differential signalling
Baud Rate	57.2 kBd
Available Signals	D+ D- (Half Duplex)



RF signal

Connecting the VETRA antennas

Minimum RF signal level needed to establish communication. Transmition power can be precisely set in the device configuration.

Radio bidirectional communication is based on MASTER – SLAVE concept. Usually the vehicle is master transmitting the radio packet each 8 ms. So there is guarantee that communication will run even in high speed. Whenever the slave wayside unit receive a data packet with RF signal level higher than the limit then the slave transmits data packet to the master.

Necessary cables for connecting the antenna

These cables are delivered together with the vehicle VETRA equipment for a bidirectional tram.

- Cable 1: Serial line RS485 communication cable to be connected between vehicle VETRA antenna and UTC. Cables are delivered including connector. Cable has 4 wires – 2 for power, 2 for data.
- Cable 2: Connecting cable to be connected between the driver's touch screen panel an UTC. Cables are delivered including both connectors.

Technical condition

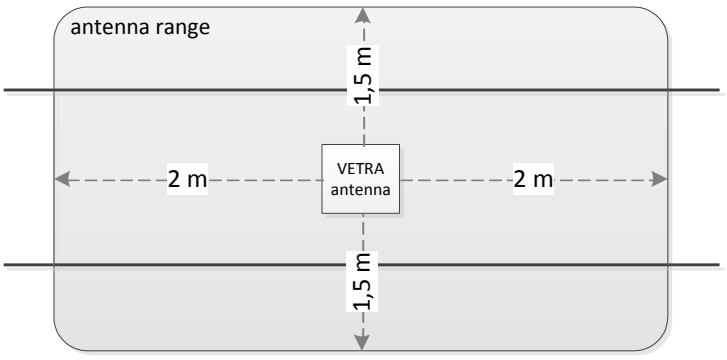
Few technical conditions have to be fulfilled to ensure smooth functioning. This chapter inscribe these conditions.

Most technical condition of installation result from the fact that VETRA tram-to-wayside communication system uses 2,4 GHz radio communication. This radio signal connects onboard and wayside VETRA antenna.

As described in chapters above, VETRA antenna can be installed either in the track (ground VETRA antenna) or on overhead contact line (overhead VETRA antenna). The electronic part of antenna is the same in both cases. It differs only in mounting/fixing. Following pictures and pictograms show some information on ground VETRA antenna that are though valid even for overhead VETRA antenna.

Picture above shows ground VETRA installed in the shaft. In the middle part of the cover you can see plastic part necessary for signal to go through.

Following picture is layout of VETRA antenna range. You can see that nearby tracks cannot interfere with each other due to “narrow” shape of antenna range.



Picture of tram describe how the onboard VETRA antenna should /should not/ be installed. Metal part around antenna could influence it´s range.