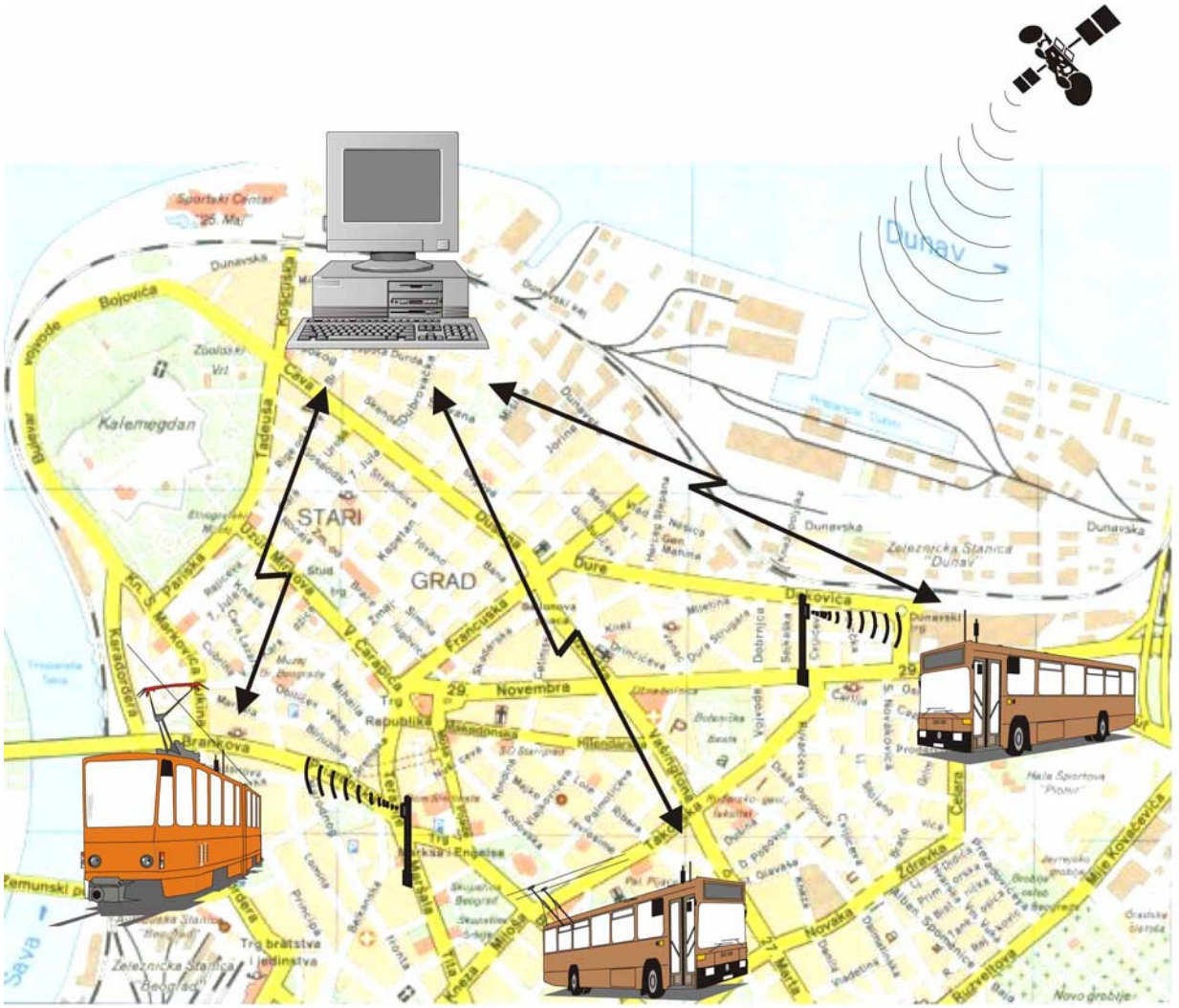
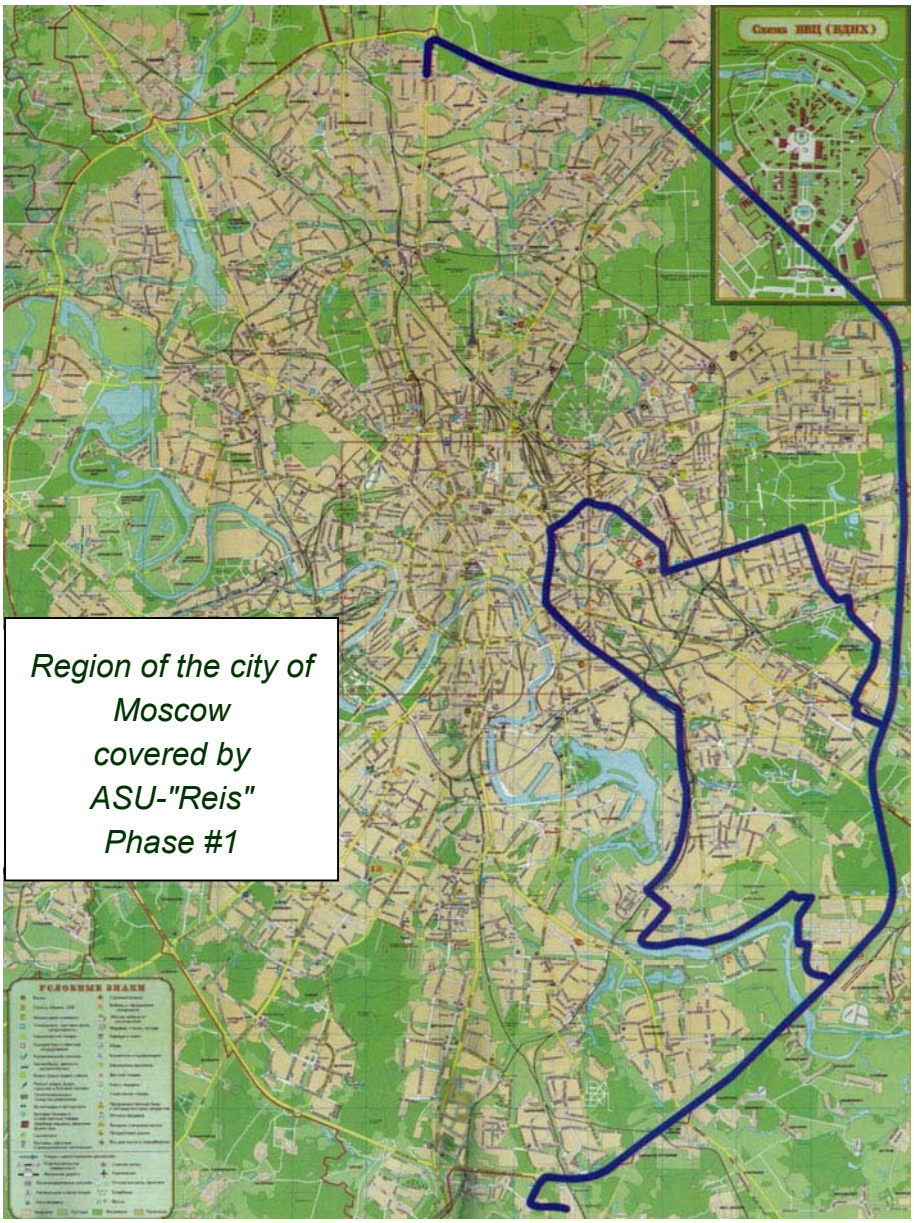
ASU-2000

AUTOMATED SYSTEM FOR URBAN PUBLIC TRANSPORT FLOW MANAGEMENT





BRK-610 installed on board of a MAZ bus (2-nd Bus garage, Moscow, RF)

INTRODUCTION

ASU-2000 represents computerised control and information system for optimizing management of mobile fleet (buses, street-cars, trolleys) flow in urban public transport.

The main objective for mplementation of the Automated system for flow management (ASFM) is to ensure the optimum level of service with the available resources and under existing traffic conditions. The objective could be set to reduce the number of vehicles for the same job as prior the system implementation, as well.

Functioning of urban public transport is based on primary, planned time-tables. Time-table deviations are very frequent, due to:

- weather conditions;
- obstructions of traffic lines and delays at traffic-lights;
- overcrowding and delays in peak periods (rush-hours);
- accidents and various traffic and road incidents;
- mobile units defects;
- drivers' lack of discipline.

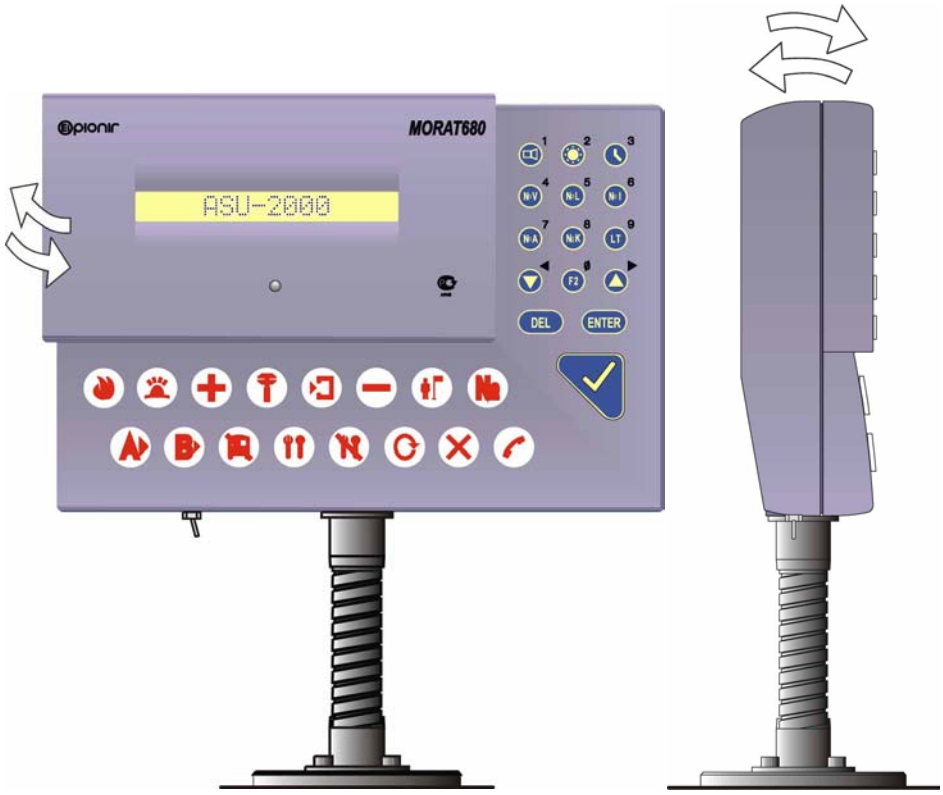
Primary tasks of ASFM are:

- mobile fleet flow management on traffic lines;
- operational time-table corrections depending on conditions and availability of resources;
- operational reallocation of mobile fleet resources;
- traffic control under unusual circumstances - transport organization in case of defects, closures of streets or blocks of streets, maximum loads on specific lines on special occasions (sports events etc.).

ASFM implementation benefits comprise:

- increase of traffic flow regularity;
- improvement of passengers service quality;
- providing an uninterrupted transport;
- increase of mobile fleet utilisation factor;
- increase of passengers' and drivers' safety;
- automation of line transport reporting documentation preparation;
- support and transport planning improvement;
- decrease of dispatcher staff number.

NOTE: The System has been in use in Moscow (Russia) for more than 10 years under the name of ***АСУ-"Рейс"*** (ASU-Reis). It has been developed in cooperation with "МосгортрансНИИпроект" Institute, Moscow. Contemporary equipment, highly modernized, replaces the initial one and provides new possibilities for public transport control, facility in exploitation, top-level technical performances and high reliability.



Indication-control device MORAT-680

SYSTEM STRUCTURE AND EQUIPMENT

Control-information system core consists of: Central Computer (CCP) in the Control Center (CC) and Micro-computer Vehicle Equipment (MVE), installed in Mobile Units (MUs). Central computer establishes successive connections, through UHF-FM radio-channel, with equipment in individual MUs. On the other side, MVE continuously collects data from on-board sensors, processes it and then sends it to CC, on its request. Central computer processes received data and prepares the message for MU regarding the current traffic flow on a particular line i.e. time-table deviation, and sends the appropriate instructions to the MU driver.

Computer software in CCP, based on the processed data, displays operational messages on the dispatchers' screens and writes collected data on memory disk (HD) for further analysis or for printing messages on dispatcher's request. This way dispatchers in CC are constantly appraised of time-table execution by the MUs under their control and can send messages to drivers to improve the quality of service.

Fast exchange of messages between Central computer and vehicle equipment (min. 600 MUs/sec) enables efficient urban public transport flow regulation. If needed, driver and dispatcher can establish voice connection, through a separate radio channel, without disturbing data exchange between CCP and other MUs.

Driver can send appropriate requests and reports to CC, by pressing one of sixteen keys on the functional keypad. Some reports have priority status (fire, police, ambulance, technical support) and they appear immediatelly on dispatcher's screen, indicating the MU location on traffic line.

The System is designed for centralized traffic flow regulation in urban ground public transport. It enables traffic control on all levels: individual MUs, specific traffic line, group of lines, depot and finally the entire city.

Exchange of voice messages between CC and MU is carried out through duplex radio channel in dispatcher's type network "dispatcher - driver": bilateral connection is available only between CC and MU. For data transmission, exchange of messages is carried out through semiduplex radio channel while base station is in constant carrier state.

System equipment is installed:

- **In Control Center;**
- **On Base station site;**
- **In MU vehicles;**
- **Along traffic lines.**

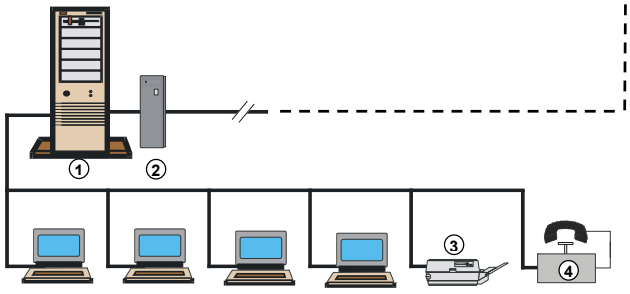
Control Center consists of the following equipment:

- Standalone PC-Pentium or local area network (1) with special software;
- Communication front-end processor with incorporated synchronous FFSK modem 1200/2400 B/s (2);
- Printer (3);
- Voice connection console (4).

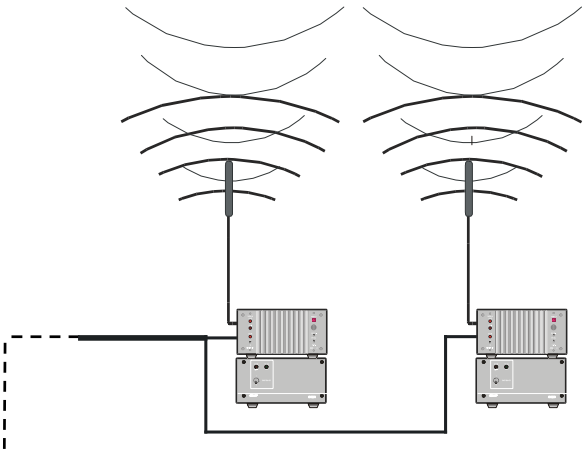
Control of a larger number of vehicles within the mobile fleet requires more than one dispatcher. Therefore local area network (*LAN*), which implies a server and the necessary number of PC's, appears as a standard configuration in CC. Databases containing traffic line numbers, MU addresses, drivers' numbers, time-tables and other necessary informations reside on the server.

Communication front end processor is connected with Base station site over duplex (4-w) connection, which is realized through telephone wires or over microwave link.

Voice connection console enables all dispatchers to connect directly with drivers. It is also used for inspection and control of fixed transceiver at Base station site.



Base station site is equiped with the following facilities:



- Two Fixed Transceivers - SRS (1): one for data transmission and reception, one for voice connection;
- Stabilized power supplies (2);
- Fixed antennas (3).

Both transceivers are identical - each may be used for data transmission or voice connection. SRS contains a FFSK1200 modem for connection with CC, enabling inspection and control over Voice connection console.

To achieve the largest possible service zone and reliable radio covering, Base station site should be as high as possible, on a tall building or a tower.

If needed, Base station antenna system radiation diagram can be tailored to the specific service zone, which is accomplished with the phasing method or by use of reflectors.

Vehicle equipment BRK-610 consists of the following devices and accessories:

- Indication-control device - MObile RAdio Terminal MORAT (1) on flexible support ;
- Mobile duplex UHF transceiver (2) with incorporated radio beacon receiver;
- Power supply 24/12 V (3);
- Connection box (4);
- Microphone (5) on flexible "gooseneck" support;
- Loudspeaker (6);
- Transceiver's antenna (7);
- Radio-beacon receiver's antenna (8).

Built-in sensors and special detectors - for distance crossed (odometer), for number of stations served (door O/C), for fullness of the vehicle (weight), for number of entering and exiting passengers - are connected to transceiver inputs (Det) and (Od).

Loudspeaker and microphone are connected to vehicle equipment through connection box. There is anticipated possibility on the box (connector and switch) for using BRK microphone with built-in public address system, as well.

Power supply provides stabilized voltage +13,5V for supplying Transceiver and MORAT from 12 or 24V electrical installation in vehicle.

On customer's request, Navigational Block (NB) for use in line traffic (not AVL) can be added to vehicle equipment. It contains satellite navigation receiver - GPS (*Global Positioning System*) or combined receiver - GPS+ГЛОНАСС (*ГЛОбальная НАви-гационная Спутникоая Система*). NB is connected to MORAT.

Satellite navigation receiver (GPS) is also available with differential correction (DGPS), which ensures more accurate positioning of the MU on the line. This option requires the use of special DGPS central station.

When NB is used, radio beacon receiver is not installed into transceiver.

Equipment along traffic lines:

Radio beacons - UHF transmitters with low output power (0,2 to 10 mW), and integrated circular polarization antenna. They are installed on posts or buildings along traffic lines, 1 to 3km appart.

Information tables for passengers - for displayng messages with expected time of MU arrival - are installed in the stations.

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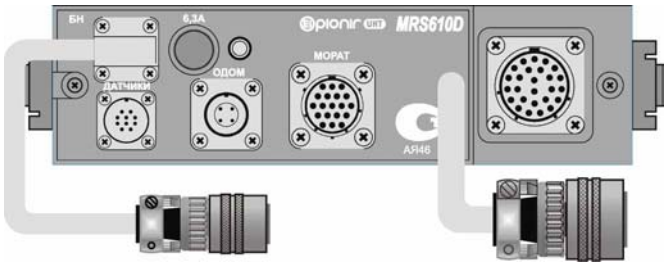
Radio beacon



SYSTEM FUNCTIONING DESCRIPTION

MORAT , an on-vehicle microcomputer, through local interface on vehicle MU continuously collects and analyses data from incorporated sensors and detectors as well as from navigational receiver (satellite or radio beacon), diplays informations received from CC on LCD screen, checks the accuracy of vital modules in BRK-610, including transceiver. Through incorporated FFSK modem (1200/2400 B/s) and duplex transceiver MORAT exchanges data with the computer in CC.

Central computer executes cyclic polling of all MUs in mobile fleet which are under control, sends requests and commands to driver (or to on-vehicle equipment) through radio channel and receives relevant informations from them. In addition, CCP processes data from MU, displays informations on dispatcher's screen, prints reports on request, stores data on memory disk (HD).

In basic operation mode CCP sends time-table deviation to MU (with +/- sign). Polling is cyclical, according to a predeterminated schedule of MUs on traffic lines. Equipment on vehicle MU, in answer to data concerning deviation, sends new data for accurate location calculation - radio beacon address or co-ordinate data from satellite receiver, together with number of pulses from odometer. During next connection CCP sends time-table deviation to MU, according to data from the previous one. Equipment on vehicle displays informations about quantity and sign of deviation on LCD.

In addition to above mentioned information , it is possible to exchange variety of messages between CC and mobile fleet. In this way, outside of basic operation mode, CC can send, for instance:

- answers to drivers' inquiries;
- commands about changes in time-table;
- information about: drive beginning from one or the other terminal, end of shift, beginning and end of a break, waiting on stand-by, accurate time, etc.;
- commands to MORAT: send exact data collected on vehicle MU, change working channel in transceiver, etc.;
- commands to driver: enter data - № of exit from garage, № of line, personal driver's № ;
- call for driver to establish voice connection with dispatcher.

Equipment in vehicle , beside the data automatically sent on CC request, enables the driver to send the following reports or requests to CC, by pressing one of 16 available keys:

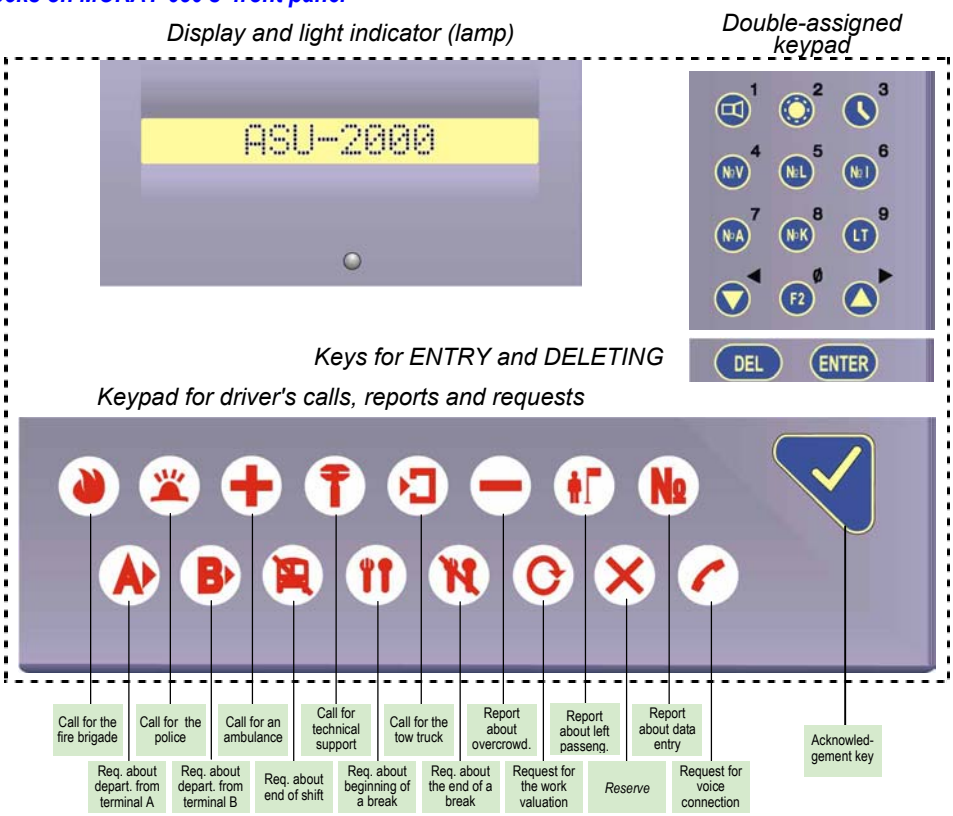
- urgent calls: fire brigade, police, ambulance;
- call for technical support - tow truck for return to depot, tyre change;
- inquiry about: departure from terminal A,from terminal B, end of shift, beginning of a break, end of a break;
- inquiry about quality of work;
- reports about: data entry (numbers), a large number of passengers left on station;
- request for voice connection with dispatcher.

A variety of possible warnings about equipment defects, which are automatically displayed to driver, as well as "archive" which contains 32 last messages, ensure comfortable use of ASFM Vehicle completion for a driver.

On customer's request it is possible to provide connection of other built-in sensors/detectors to the Vehicle set, such as: engine temperature, oil temperature, reserve of fuel (buses) or existence of voltage on contact network (trolleys, street-cars), functioning of a breaking system. All of the information can be transmitted out of basic operational mode, on CC's request.

Polling cycle time is defined by Central Computer Software in CC, depending on number of MUs and special customer's requests.

Functional blocks on MORAT-680's front panel



BASIC TECHNICAL DATA

System performances

★ Type of communication between CC and Vehicle equipment - cyclical polling, time multiplex;

★ Data transmission - serial, synchronous, data rate 1200 or 2400B/s FFSK or 1200B/s DPSK, algorithm for error detection and correction, message length - fixed;

★ Radio connection - full duplex at 300-350MHz or 430-470 MHz band, FM, emission class: 13K2C2D, 16KOF3E;

★ System capacity - 4096 different MUs on same radio channel;

★ Data exchange time CC⇒MU⇒CC: 2x66/2x33 ms (1200/2400B/s);

★ One polling cycle effective time for 500 MUs, including 30% MUs with request repetition: 50s/25s (1200/2400B/s). *This velocity is achieved with special solutions in mobile transceiver.*

Central Computer Software

★ Customized, adaptive for execution of defined tasks, system capacity enhacement, expanding of functional demands.

Equipment in Control Center (*Hardware*)

★ Central computer: standalone *PC Pentium* or local area network (LAN).

★ Radio communication front end processor: Computer with synchronous serial ports (2-6) and external FFSK modem 1200/2400 and/or DPSK1200 (2-6);

Radio communication equipment

★ Base station BRS-610/n - Fixed duplex transceiver (min. 3 pcs.) in completion: SRS-610D - 10 channels, 20/30W; Stabilized power supply SI-600/10; Fixed antenna - vertical array of collinear dipoles with +4,5 dBd;

★ Radio navigational vehicle set BRK-610 - Full duplex transceiver MRS-610D 10/20W with incorporated radio-beacon receiver (800-900MHz) or with external Navigational Block BSN-600; quarter-wave flexible whip (permits passing through automatic bus-laundry); universal Power Supply for 12 and 24V electrical installation in vehicle, BN-24/12-10.

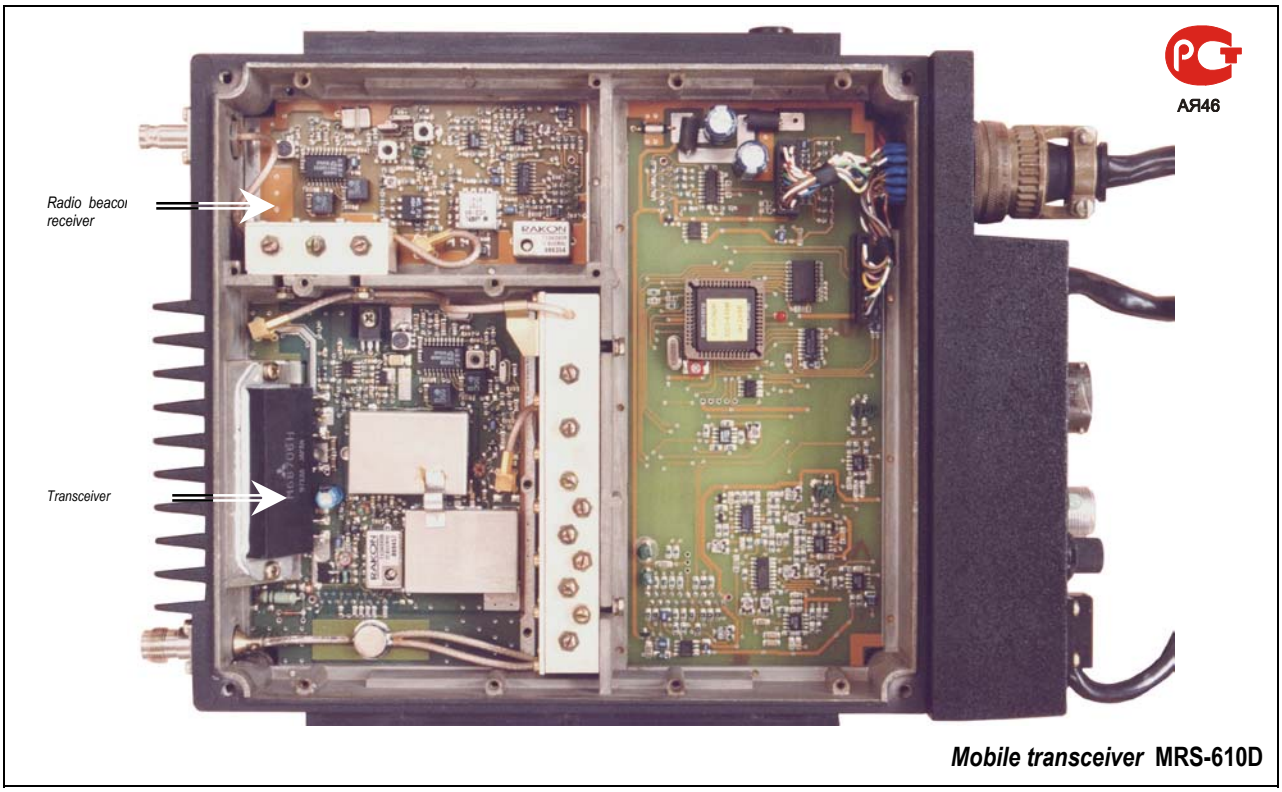
★ Radio beacon RM-603 - low power UHF transmitter 0,5-10 mW (800-900MHz), emission class 13K2C2D, integrated circular polarization antenna.

Operational temperature range

Vehicle and Base station equipment: -25/+55°C; equipment along traffic lines: -40/+55°C; equipment in CC: 0/+55°C.

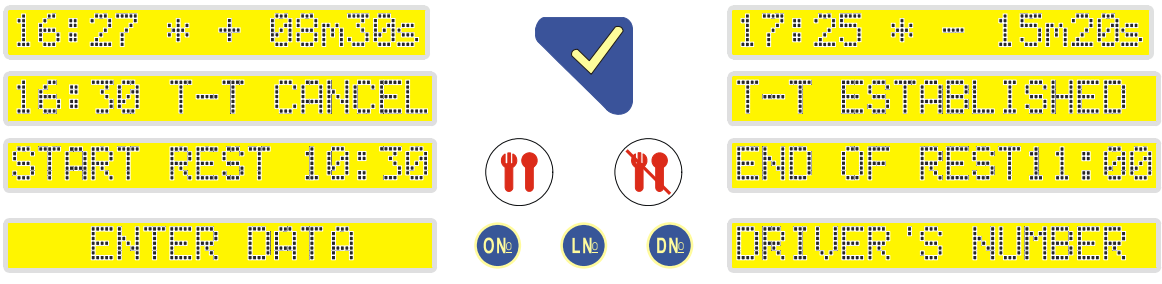
Technology

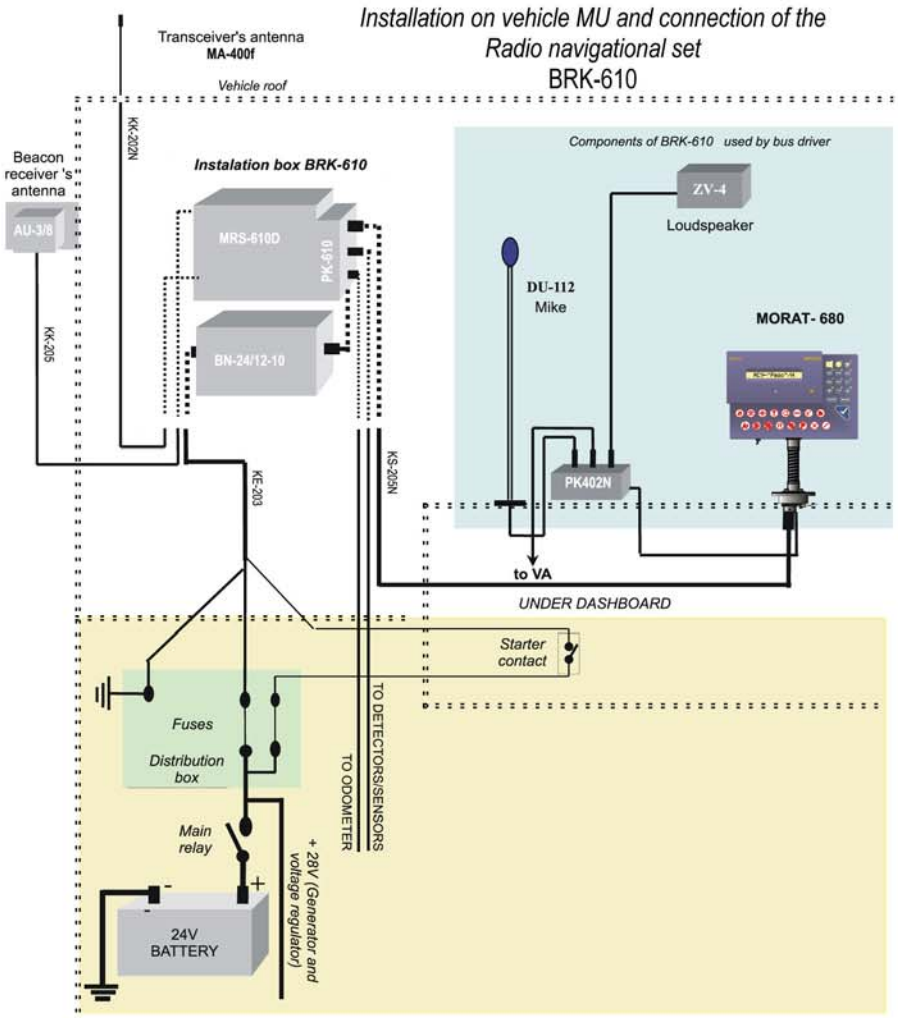
All radio modules are produced in surface mount technology with multilayer printed circuit boards; *very fast frequency synthesizers* - with digital PLLs and temperature compensated reference oscillators (TCXOs); multiprocessor's control of all Vehicle set functions.



Mobile transceiver **MRS-610D**

Examples of messages on MORAT's LCD





Cabinet for installing Transceiver and Power Supply

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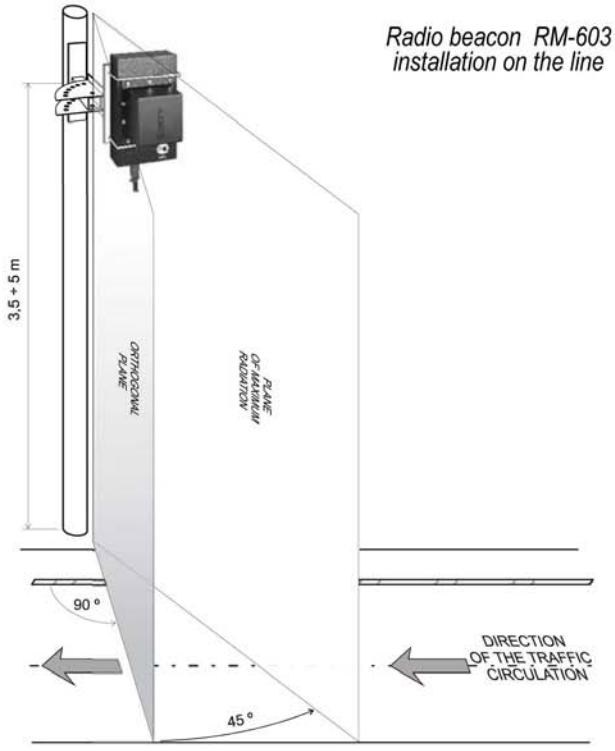

Factory **Ei Pionir UKT d.o.o. -** *Land Mobile Radio OEM & System Engineering*
Batajnički put 23, 11080 Zemun/Belgrade, Serbia and Montenegro; Phone: (++ 381 11),199 601, 198 703, 199 038
Fax: (++ 381 11) 195 988; e-mail: *eipioukt@EUnet.yu;* **www.eipionirukt.co.yu**