

HIGH TECHNOLOGIC SYSTEMS FOR CONTROL AND MANAGEMENT OF THE TRAIN TRAFFIC OF LINE 3 OF THE SOFIA METRO

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Abstract. Features of the newest Sofia Metro line are shown. In a general way, the systems for control and management the movement of trains on this line, as well as the interrelationships between the individual systems, are examined. The technical possibilities for future extension and development of this line have been examined.

Keywords: Sofia metro, line three, control and management systems, train traffic, automation level, safety level, platform screen doors, centralization, Trackguard Westrace Mk II, Clearguard ACM, Controlguide, Trainguard MT, Airlink.

1. GENERAL INFORMATION OF LINE 3 OF THE SOFIA METRO

Currently, the third line of the metro in the city of Sofia consists of twelve metro stations, an independent depot and a control center. The line was put into operation in two stages: eight stations at the end of August 2020 and four stations in April 2021. The management and control of trains on this line is characterized by the use of advanced technology, reflecting the latest trends in the development of railway insurance technology. The control and management of train traffic on the third metro line is characterized by safety level SIL4, according to standard EN61508 and automation level GoA3. Transition from automation level GoA3 to level GoA4 is only possible through a software upgrade. I.e. the available system hardware (road and train equipment) is fully sufficient for the highest level of automation (GoA4).

In the control and management of train traffic, continuous communication is used between the rolling stock and the control center, which makes it possible to use the principle of separating the trains by a “moving block” section. This allows maximum convergence of the trains, their movement in an energy-efficient mode and the achievement of a track following interval of 90 s. This

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technology allows for automatic targeted stopping of station platforms (with an accuracy of up to 30 cm), as well as the realization of automatic self-turning at end stations. The maximum driving speed is 5 km/h in the depot and 80 km/h on the main line.

A characteristic feature of the third metro line is the lack of signals (traffic lights) along the main line. The only signals on the line are those for entering the depot. All train movements in the depot are carried out according to signal readings of two- or three-light traffic lights.

The trains for the third line, as well as the control and management systems for train traffic, are produced by the company “Siemens” AG. Three wagon sets with overhead current collection (trains with pantograph) are used. To control road clearance, the depot is equipped with a FAdC[®]R2 axle counter system, manufactured by Frauscher company. The “Clearguard ACM 200” axle counting system manufactured by “Siemens” AG is used on the main line.

On line three hydraulic turnbuckles are used, part of the assortment of the company “Voestalpine Signaling” Germany. Due to the specifics of the track development and the use of “tram” type rails, the “UNISTAR CSV 24” model SAO (turning device) is used in the depot. On the main line, hydraulic SOA model “UNISTAR HR” is used.

Eurobalises with fixed data are used as an additional means of communication between the road and rolling stock. They are passive devices and implement a one-way transmission of information from the roadside equipment to the train.

There are passenger information system (PIS) boards installed at each station. Through them, information is transmitted both about the time remaining until the arrival of the next train, as well as alphanumeric information of varying volume, which is entered from a workplace in the control center.

A characteristic feature of the third line is that the dispatch center is fully booked by a workplace in the depot. At any time, all control of the third line (both shunting movements in the depot and movements on the main line) can be handed over to either the duty manager in the depot or the train dispatcher in the central control room. Normally, the train dispatcher is involved in the train movement on the main line, while the duty supervisor at the depot is responsible for the shunting activity in the depot area. An automatic entry from the main line to the depot has been implemented.

Another feature is the presence of platform partition doors at the stations of the third line. They are 1.5m high and completely close the station platforms. In this way, they prevent passengers from falling onto the railway track and

reduce the piston effect of an approaching train.

Regardless of the fact that currently the third line has only three-car sets, the platform partition doors are completed and can work with four wagon sets as well. Thus, in the future, both three-car and four-car trains could run along the third line. A mixed mode of movement is also possible - simultaneous movement of trains with three and four cars.

2. CONTROL AND MANAGEMENT SYSTEMS OF TRAIN TRAFFIC ON THE THIRD LINE

The control and management of train traffic on the third metro is possible thanks to the following systems:

- IXL (Centralization for the third metro line) – includes Trackguard Westrace Mk II computer centralization and Clearguard ACM system for reporting road clearance;
- ATS – system for dispatch control and management Controlguide[®];
- ATC – Trainguard MT automatic train control system, consisting of automatic train protection (ATP) and automatic train movement control (ATO);
- DCS – data transmission system consisting of roadside communication network and Airlink[®] radio communication system;
- PPV – platform barrier door system.

3. IXL SYSTEM (CENTRALIZATION FOR THIRD METRO LINE)

The IXL system consists of:

- Trackguard Westrace Mk II – modern computer centralization with safety level SIL4. Through the Trackguard Westrace Mk II, the remote control and management of switches, ordering of routes and issuing of permits for the movement of trains is carried out in compliance with all safety conditions.
- Clearguard ACM – is used to control the freedom of the switches, in order to more quickly set routes through them, as well as for the faster restoration of the system in the event of a deteriorated operating mode and/or in the case of a damaged train.



Fig. 1. Equipment of Trackguard Westrace Mk II

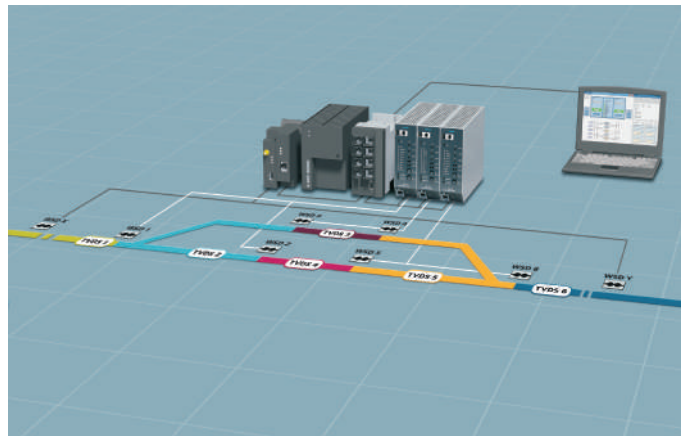


Fig. 2. Clearguard ACM Subsystem

4. ATS SYSTEM (CONTROLGUIDE®)

Controlguide® provides dispatch control and management of the main line and depot. The more important tasks solved by the ATS system are:

- provides the graphical user interface for the operators;
- ensures the automatic movement of the trains according to the timetable or evenly distributed to the trains along the route when moving in a time interval;
- ensures the movement of the trains in an energy-efficient mode;
- supports dispatchers by automating standard operator actions;
- provides interfaces to external systems.



Fig. 3. Picture of the video wall for the train dispatcher for the first working section of line 3 (from Hadzhi Dimitar metro station to Krasno Selo metro station)

5. ATC SYSTEM (TRAINGUARD MT)

The Trainguard MT system implements the automatic and safe control of trains on the main line. It consists of a safety-related subsystem: the ATP subsystem and a secondary (non-safety-related) subsystem: the ATO subsystem.

Some of the more important functions implemented by the ATP subsystem are:

- continuous control of the train speed with protection against exceeding the speed set in the specific section; – maintaining the necessary safe distance between trains; – activation of the emergency stop of a train/trains in case of violation of the conditions for safe movement; – controlling the direction of movement and backward movement; opening the doors at the stations upon reaching the stopping point;
- introduction and removal of temporary speed limits. Part of the tasks of the ATO subsystem are:
 - automatic control of traction and brake operation; control and management of train doors; – control of platform partition doors (PPV);
 - submission of information to the on-board passenger information system;
 - generation of energy-saving speed profiles in accordance with the schedule (motion by inertia and movement at economical speed); ensuring automatic movement of the covers.

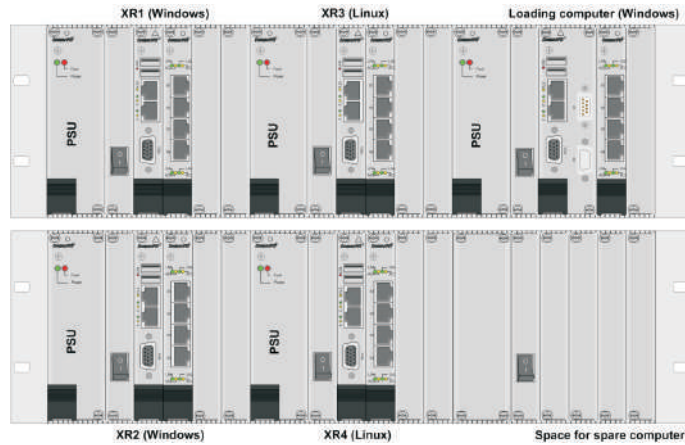


Fig. 4. Trainguard MT system equipment

6. DCS SYSTEM (AIRLINK)

The data transmission system realizes the two-way continuous communication between the rolling stock and the road equipment. The system includes serially produced products and components customized to the specific requirements of the project. Airlink's modular design, combined with the use of standard telecommunications products, make the system easy to maintain and upgrade.



Fig. 5. Airlink system antenna

7. PLATFORM PARTITION DOORS (PPV)

PPVs communicate directly with the IXL system. When a door is open or when there is no control of any of the 16 doors on the platform, a signal is sent to the Trackguard system, which in turn stops the trains approaching the station. PPVs are mandatory at automation level GoA4. This is one of the prerequisites for the third metro line in Sofia to be completely ready, as hardware, for the transition to the highest level of automation.



Fig. 6. Platform partition doors of metro station “NDK-2”

CONCLUSION

During the construction of the systems for control and management of train traffic on line three of the metro in the city of Sofia, high-tech modern solutions were used. The modular and scalable architecture of the individual systems makes it possible to include new stations in the composition of the line just by changing their configuration files, without adding new hardware on the trains or in the control center. The future use of four-car sets, the possibility of running trains in mixed mode, in combination with the possible transition from automation level GoA3 to GoA4, make a third metro line ready for the challenges of the 21st century.

REFERENCES

- [1] SIEMENS MOBILITY, Cleanguard ACM200 Axle Counting System (2016).
- [2] H. OMSTEDT, Introduction to Trainguard®MT. Presentation training, part 1–3 (2019).
- [3] SIEMENS MOBILITY, ATS System Overview, (2019).
- [4] SIEMENS MOBILITY, Train Traffic Control Telecommunication (CBTC) system including passenger information system. Technical documentation (2020).
- [5] SIEMENS MOBILITY, Radio system Airlink, metro line 3 of the Sofia Metro. Presentation training (2020).
- [6] “METROPOLITEN” JSC, Internal documents.

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