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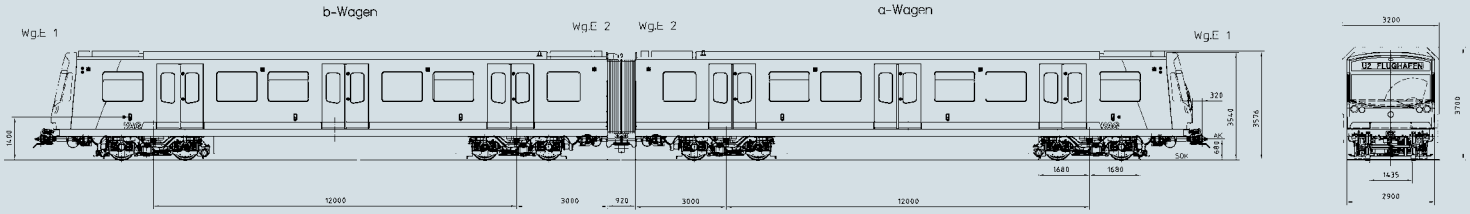
Driverless metro in Nuremberg, Germany

32 DT3 two-car trainsets + 14 DT3-F two-car trainsets

In November 2001, VAG Verkehrs-Aktiengesellschaft Nürnberg awarded Siemens AG an order for equipping the metro lines U2 and U3 for driverless operation and for the delivery of 30 fully automated two-car trainsets of type DT3. VAG Nürnberg also took an option for two additional DT3 trains for an extension of the U3 line.
The first driverless subway line in Germany went into operation on June 14, 2008. For the extension of the U3 and for the replacement of old DT1 trains, VAG also ordered another 14 trains of type DT3-F. These are largely identical in design to the series DT3 trains but are equipped with fully ergonomic, air-conditioned driver's cabs.

During the introductory phase of this project, which ran under the name "RUBIN" (acronym for "Realisation of a fully automated subway in Nuremberg" in German), fully automated trains and conventional trains were deployed on the same line section for the first time in the world. VAG Nürnberg received the Germany Industry Silver Award for Innovation in 2009 for the fully automatic subway in Nuremberg.

Technical Data	DT3	DT3-F
Vehicle type	Two-car trainsets for driverless operation (GoA4)	Two-car trainsets for driverless (GoA4) and conventional operation
Train configuration	M-M	Mc-Mc
Wheel arrangement	Bo'Bo'+Bo'Bo'	
Car body material	Aluminum	
Track gauge	1,435 mm	
Length over couplers	38,360 mm	
Width of car	2,900 mm	
Floor height above top of rail	1,050 mm	
Wheel diameter max. / min.	850 / 770 mm	
Max. axle load	12.6 t	
Seats (of which tip-up seats)	82 (12)	72 (16)
Vehicle capacity (at 4 Passengers/m^2)	238	216
Passenger doors per car	2 x 3	
Minimum curve radius	100 m	
Maximum gradient	5 %	
Maximum speed (operational)	80 km/h	
Max. starting acceleration	1.3 m/s^2	
Mean deceleration service brake (operating brake / emergency brake)	1.1 m/s^2 / 1.3m/s^2	
Power supply	750 V DC / 3rd rail	



Implementation program for fully automatic operation

Phase 0 of the automation program began with equipping the test track at the depot and comprehensive test operation in the customer's network.
In phase 1 of the implementation program, mixed operation was introduced on lines U2 and U3 in the inner city area between Rothenburger Strasse and Rathenauplatz stations. For the first time anywhere in the world, fully automated trains were deployed alongside conventional trains of types DT1 and DT2 on this mainline section of a subway system. After automation of line U2 in phase 2, this mixed operation was discontinued.
Phase 2, which followed until fall of 2009, comprised the conversion of line U2 for fully automatic, driverless operation.
In phase 3, the two branches of line U3 are being extended as far as their outer terminus stations, Nordwestring in the north and Gebersdorf to the southwest.

General information

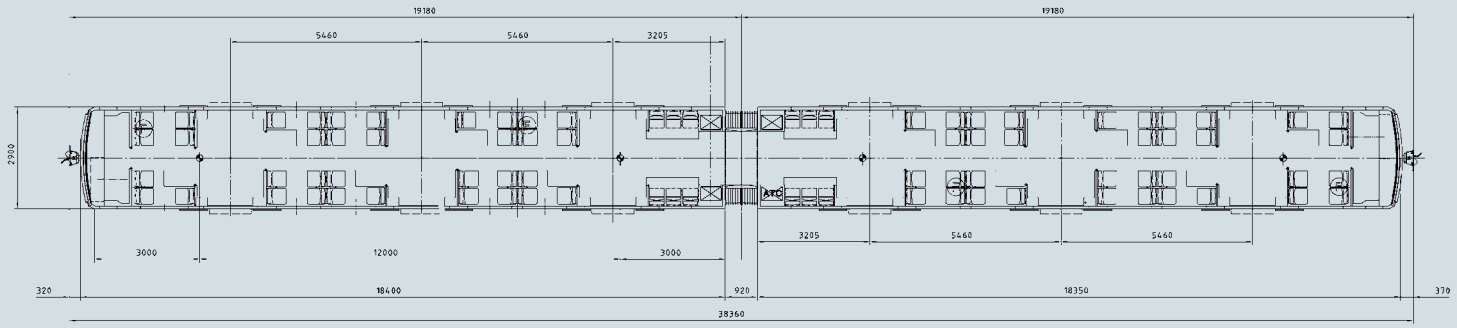
The smallest operating unit of the vehicles consists of two semi-permanently coupled railcars as married pairs. The two cars of a married pair are connected by a wide, open passageway to allow passengers unhindered passage between cars. If necessary, two married pairs can be coupled for passenger operation.
All trains operate fully automatically without drivers or conductors. The vehicles of type DT3 are equipped with emergency driving consoles at their front ends. Type DT3-F is equipped with an air-conditioned, ergonomically designed, and fully equipped driver's cab. This means that the vehicle can also be operated on the conventional driver-operated line U1.
The rear wall of the driver's cab, the driver's seat, and the conventional driver's console can be dismantled to allow conversion to fully automatic operation and to enable the area of the driver's cab to be used by passengers. The DT3 trains can carry a total of 238 passengers (at 4 Passengers/m^2) and provide 41 seats per car (including six tip-up seats). The DT3-F series is equipped with a driver's cab at each end of the train, which reduces its passenger carrying capacity to a total of 216, with 36 seats per car (including eight tip-up seats).

Carbody

The trains are of lightweight construction, using modular structural components. All materials were selected with environmental compatibility and improved recyclability in mind.
The carbody is a lightweight structure made of welded aluminum sections with integrated C-rails.
Its collision-proof construction ensures that all energy released in a collision at 15 km/h is absorbed through the couplings, without causing any damage to the structure. The exterior surface of the carshell is painted.

Doors

All cars are equipped with three electrically operated double-leave sliding-plug doors on each side. The clear width of the doors is 1,300 mm. All doors have sliding steps that completely bridge the gap between train and platform.



Passenger information and communication system
The passenger information system provides visual as well as acoustic information inside and outside the trains. This includes train destination displays at the front end of the train as well as displays and loudspeakers inside and outside of the cars. The interior displays indicate the next station and on which side the doors open at the next stop. In an emergency, passengers can communicate with the driver (DT3-F) or directly with the control center via emergency intercom stations installed in every entrance area of the train.

Heating / ventilation / air-conditioning
All vehicles are equipped with a heating / ventilation system for the passenger compartment. Heating is provided via heating elements that enable a large proportion of the dynamically generated braking energy to be stored thermally. In addition, the DT3-F trains have separate air conditioning for the driver's cab.

Traction system
The trains are driven electrically, with 750 V DC power supplied via a third rail. Each train car train is motorized, and all bogies are equipped with two self-ventilated traction motors from the well-proven 1TB20 series. The four traction motors on each car are controlled by one traction converter. The traction system allows electrodynamic braking down to standstill. This feature offers the advantage of operational braking without wear under normal conditions, and, in particular, increases stopping accuracy at stations.

Bogies
The SF 1000 bogie was developed for modern metro trains with running speeds of up to 90 km/h and for axle loads up to 13.5 t. The bogie frames are fabricated from low-alloy, high-strength steel. The traction motors are installed transversally and fully suspended on the bogie frames. Each axle is equipped with a disk brake and a compact brake caliper unit. The bogies are equipped with spring-loaded brakes that act as holding brakes. Air springs are used for the secondary suspension and helical steel springs for the primary suspension. The trains' end bogies are equipped with current collectors.

Automatic operation
Vehicles of both DT3 and DT3-F types are designed for fully automated, driverless and conductorless operation (GoA4). A state-of-the-art automation system is integrated in the vehicle to ensure reliable operation with high availability. The fully automated system offers considerable advantages for passengers and operator alike. For example, fully automated operation makes it possible to shorten train headways, thereby reducing waiting times for passengers and increasing the overall capacity of the metro system. In addition, married-pairs can be automatically coupled to four-car trains during operation and separated again as required. This flexibility, along with shortening of the headways by putting additional trains into operation, makes it possible to react rapidly to changing capacity requirements. This helps to avoid overcrowded trains as well as to optimize operating costs because trains are only deployed when actually needed and overcapacities are avoided.

Safety systems
Sensors in the doors' closing edges are capable of detecting even thin objects like dog leashes trapped in doors, thus making boarding and disembarking safer for passengers. The sliding steps at the doors also allow safe and unimpeded access for wheelchair users or passengers with baby carriages.
A video surveillance system (CCTV) is installed in the passenger compartments to provide extra security for passengers. The images are transmitted live to the control center and are also stored on board of the train.
Moreover, additional systems guarantee safe operation of the trains: The vehicles are equipped, for example, with obstruction detectors on the end bogies, a system for detecting derailment, and a fire alarm system based on optical smoke detectors and thermo switches.
These are supplemented by a monitoring system on the station platforms. People or large objects that fall into the track area are detected by this system and approaching trains are stopped immediately. A newly developed on-board sensor system has been implemented in order to guarantee monitoring of the coupling area between two coupled DT3-F type married-pairs in manned operation.

Train control system
The train is controlled via an MVB bus on the basis of the proven Sibas® 32 system.
All diagnostic data is transmitted to a database server via WLAN where it then becomes available to the workshop. Selected train status information such as the door status is transmitted via the automation system directly to the control center for monitoring of the system status.

Highlights

- Fully automatic driverless train control system for safe and efficient operation
- Variant DT3-F with removable driver's cab for fully automatic operation and manned operation
- Mixed operation with conventional rolling stock
- Derailment- and obstruction-detection systems and fire alarm system
- All doors are equipped with sliding steps and with sensitive door edges
- Video data transmission to the control center during operation
- Transmission of diagnostic data via WLAN during operation
- All axles are driven
- Electrodynamic braking down to standstill
- Energy-efficient thermal storage heating supplied by dynamic braking energy

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