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Tram System – Combino Plus, Budapest, Hungary

40 Six-Section Units

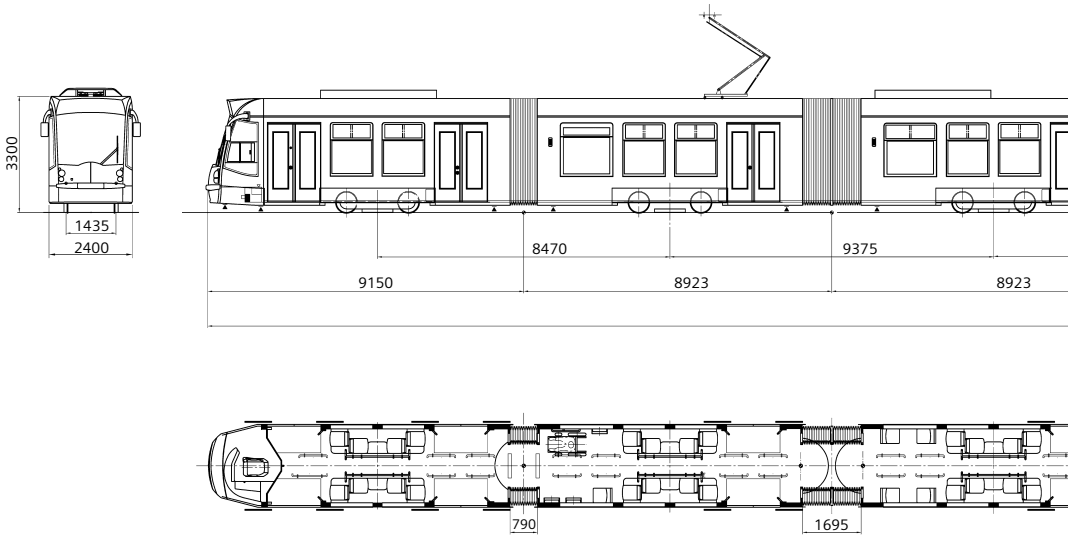
Siemens is one of the few providers for mass transit systems.

The Budapest Transport Company (BKV Zrt.) ordered 40 low-floor Combino Plus® tramcars from Siemens to modernize its old fleet on Lines 4 and 6 serving the Grand Boulevard, one of the most heavily frequented tramlines in the world.

The engineering process for this vehicle started in September 2004. Eleven months later, in August 2005, bodyshell production started at the Siemens plant in Vienna. The first vehicle was delivered to Budapest in March 2006 for testing and certification purposes and started passenger service on July 1st, 2006. The last tram entered into revenue service on May 30th, 2007. The trams have become inherent part of the everyday life in Budapest with up to 38 trams in daily service with a headway of two minutes.

The high availability of the trams is the result of the efficient cooperation between the operations, led by Budapest Transport Company (BKV Zrt.), and the maintenance, which has been contracted to Siemens.

Technical Data	
Type of vehicle	Six-section, low-floor articulated, power car for bi-directional operation
Traction adhesion	66 %
Wheel arrangement	Bo'2'Bo'Bo'2'Bo
Track gauge	1,435 mm
Vehicle length	53,990 mm
Vehicle width	2,400 mm
Vehicle height	3,639 mm over top of rail (pantograph lowered)
Max. axle load	< 10 t
Vehicle capacity 4 pers./m^2	352, including 58 seats / 6 folding seats
Maximum speed (design speed)	70 km/h
Max. speed (operational)	60 km/h
Max. starting acceleration	1.3 m/s^2
Mean service deceleration	1.1 m/s^2
Line voltage	(600 V DC) +20 % / –33 % via overhead contact wire
Traction motors (nominal operating point)	8 x 100 kW at 1,580 rpm
Wheel diameter new / worn	600 mm / 520 mm
Low-floor percentage	100 %
Floor height	350 mm
Entrance height	320 mm



Project Data	
Customer	Budapesti Közlekedési Zártkörűen Működő Részvénytársaság (BKV Zrt.)
Line	4 & 6, Grand Boulevard
Delivery period	March 2006 – May 2007
Number of units	40 tramcars
Scope of supply	Rolling stock, depot equipment, spare part and special tools package
Test	Extensive test procedure at Siemens Test Center in Wegberg-Wildenrath, Germany, and parallel on track in Budapest (10,000-km test run, 1,000-km overload test run etc.)

General Arrangement
This modern and attractive tramcar design is based on typical Combino elements as the front mask and many approved technical features as the traction technology. Each end of the car is equipped with driver's cabs to permit bi-directional operation.

Each vehicle comprises six sections (or modules) of the same length and features six bogies, four of which are powered. The bogies are arranged in the centre of each module. These modules are linked by articulation joints and inter-car gangways to create a completely open and bright interior.

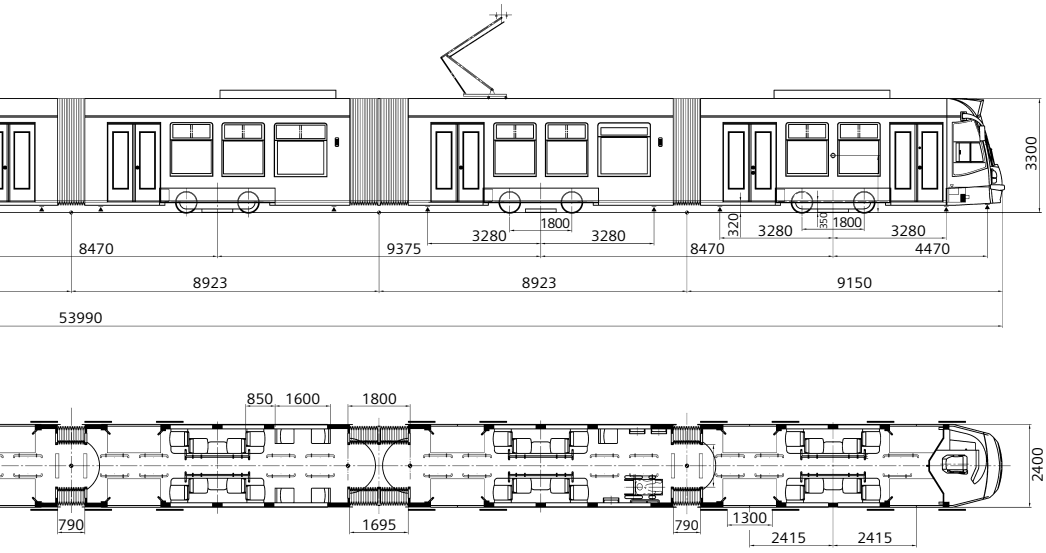
The tramcar is equipped with three hydraulically operated ride stabilization systems, each linking two modules. This system improves the ride quality of the vehicle and ensures an optimum envelope under all operating conditions.

Combino Plus Budapest is capable of carrying a total of 352 passengers, with seating for 58 and standing room for 294. Additionally, the trams are equipped with six folding seats and two large areas for disabled people or passengers with baby carriages.

The tramcar is designed for operation with a high passenger volume of about 10,000 persons per hour and per direction, which is equivalent to metro operation. Budapest Transport Ltd. consequently operates the trams in peak hours at two-minute intervals. To ensure quick and convenient passenger flows, the door concept envisions eight double-leaf doors on each side with a clear width of 1,300 mm and a convenient allocation over the whole length of the tramcar. Seating and handrail arrangements are optimal matched to the specific customer requirements.

Sliding windows and an air conditioning system, with separate units for the driver's cab and the passenger area, provide for a good climate inside the tram.

For emergencies the passenger compartment is equipped with six emergency intercommunication terminals, allowing the passengers to talk with the driver.



Car Body
The car body is a welded stainless-steel construction and makes use of a special corrosion-resistant steel for the middle section of the underframe.

Traction Equipment
The electrical equipment is concentrated in containers which are integrated into the roof structure of the car body.

Four modern IGBT pulse-width-modulated inverters, low-wear three-phase asynchronous motors and a 32-bit traction control unit (Sibas® 32) are used as traction equipment. The traction system also allows power recovery.

The vehicle's control equipment is based on a vehicle data bus system backed up by a wired control lines for essential train control functions.

For the auxiliary and secondary equipment, low-wear and low-maintenance components are used throughout the vehicle.

Brake System
The Combino Plus Budapest features four separate and independent brake systems:

- electrodynamic brake on powered running gear
- hydraulically passive spring-loaded brake on powered running gear
- hydraulically active disk brake on non-powered running gear
- electromagnetic track brake on all running gears

Design and brake performance conforms to the German standard BOStrab.

Bogies
The powered bogies with their two longitudinally arranged drives are characterized by their low center of gravity, minimized unsprung masses, and running characteristics which, due to mechanical coupling of the wheels in the longitudinal direction, have been improved over those of conventional 100 % low-floor running gear. Moreover, mechanical decoupling of the opposing wheel pairs rules out the inherent, additional longitudinal slip that causes wear when the vehicle travels through curves.


Interior


Motorized bogie


Traction unit

Driver's cab

Large spaces for baby carriages
or wheelchairs for disabled passengers

Technical Features / Highlights

- spacious and light-colored interior design
- safety during vehicle movement: sufficient arrangement of horizontal and vertical hand rails
- easy to clean due to smooth surfaces inside and outside
- easy to enter: the door height is 2,100 mm, width 1,300 mm
- swing plug sliding doors: eight double-leaf doors per side
- two large spaces reserved for baby carriages or wheelchairs for disabled passengers
- unobstructed view: the absence of electronics cabinets affords an unobstructed view through the entire tramcar
- air conditioning system, with separate units for the driver's cab
- impact buffers with energy absorption device
- large, easy-to-read destination and station displays
- four electrically adjustable exterior mirrors

Combino Plus Powered Bogie	
Track gauge	1,435 mm
Distance between wheel pairs	1,800 mm
Min. negotiable curve radius	20 m

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Printed in Germany
TH 325-130538 DS 06130.5
Dispo 21720 c4bs 1432
Order No.: A19100-V520-B416-V3-7600