

The Siemens logo is displayed in a bold, teal, sans-serif font.

*Ingenuity for life*

A photograph of a white and red Velaro D (Class 407) high-speed train at a station platform. The train is sleek and aerodynamic, with a prominent red stripe and the DB logo. In the background, a red regional train is visible, and several people are standing on the platform under a large glass and steel station roof.

# Velaro D (Class 407)

## High-Speed Trainset

Deutsche Bahn awarded Siemens the contract for 17 interoperable eight-car type Veraro D high-speed trains for national and international use.

The Velaro train for Germany (Class 407) is based on the Velaro platform, which is one of the fastest operational high-speed trains in the world. High-speed trains of this type are already operating reliably in Spain, China and Russia.

The Velaro D, a version that is the result of further development work, was delivered to Deutsche Bahn starting in December 2013, and has been

successfully transporting passengers ever since. As multi-system trains, they can be used in Germany and France – on the new high-speed Rhine-Rhône line.

### **Trainset with astounding efficiency – flexible and comfortable**

The Velaro D is a multiple-unit trainset in which the traction and all the technical modules are distributed under-floor over the length of the train. Thus, the full length of the train is available to the passengers, offering 20% more room than other train concepts.

The interior of the Velaro D has a modular design; its fixtures, fittings and equipment can be altered quickly and flexibly. In future, it will be possible to integrate additional baggage racks or supplementary face-to-face table arrangements overnight. This enables compliance with any altered requirements resulting from the operating situation.

## Technical Data

Maximum speed	320 km/h
Train length	200 m
Voltage	15 / 25 kV AC and 1.5 / 3 kV DC
Traction power	8,000 kW
Brake systems	Generator, eddy current brakes, pneumatic
Number of axles	32 (16 driven)
Wheel arrangement	Bo'Bo'+2'2'+Bo'Bo'+2'2'+2'2'+ Bo'Bo'+2'2'+Bo'Bo'
Number of bogies	16
Max. axle load	17 t
Number of cars per train	8
Number of seats	(total / 1st / 2nd / Bistro) 460 / 111 / 333 / 16
Operating temperature range	-25 °C to +45 °C
Signaling systems	ETCS, PZB, LZB, KVB, TVM, MEMOR, TBL, ATB

### Exemplary energy efficiency

Aerodynamics has been collected and evaluated systematically from Velaro trains operating in Germany, Spain and China. New aerodynamic design features were tested in the wind tunnel and tried on the Velaro in China. This led to a refinement of the Velaro platform, visible for the first time on the new Velaro D in the form of panel covers for the roof-mounted equipment, bogies and intercar gangways that reduce power consumption. A high roof that starts in the middle of the end car reduces the sonic boom during movement through tunnels, lowers running resistance and reduces exterior noise. Roof-mounted equipment, such as pantographs and air-conditioning units, are completely covered by panels.

The spoiler, nose and front section have been aerodynamically optimized. The brake system of the Velaro is also energy-efficient – since the early 1990s, its electric brake has made it possible to feed braking energy back into the supply network.

The bottom line: 10% energy savings and reduced mechanical wear.

The intelligent energy manager in the Velaro D ensures that the train operates with optimum efficiency. This results in a reduced equivalent CO<sub>2</sub> emission of 14 g/person-km, while an aircraft with similar loading has an average CO<sub>2</sub> emission of 136 g/person-km.

### The clear advantage:

#### Optimized performance characteristics

The trainset concept is characterized by the following operational advantages:

- Better leverage of the adhesion (coefficient) during acceleration as 50% of the axles are driven.
- Ability to run on steeper line sections with gradients of up to 40 per mille.
- The evenly distributed weight over the entire trainset leads to lower individual axle loads. Due to this uniform distribution (of weight) over the entire multiple-unit train, the individual wheelsets have to bear less weight. This reduces track wear and maintenance requirements of the running gear. The axle load per wheelset is below the internationally stipulated maximum of 17 t.





### **Additional benefits: Comfortable ride**

The evenly distributed weight also improves the running characteristics and, therefore, travel comfort.

- The selected train length of 200 m is ideal with regard to the regulations of the Technical Specification of Interoperability (TSI), since it allows for the train to be driven with double heading at a total length of 400 m.
- For example, the Velaro D can run on a section of track initially as a double train and then be split up into two trains for different final destinations.

### **Impressive traction**

The Velaro D has four identical, independent traction converter units. This principle generates clear advantages in continuous operation:

- Any failure of one converter will not affect the remaining units. This enables the train to safely reach its destination with 75% of its maximum rated traction power.
- Low-maintenance three-phase asynchronous motors with cage rotors ensure a high level of availability.

### **The result**

A concept of space economy that ensures pleasant traveling for the passengers and maximum freedom of movement at the same time – in both car classes.

### **Continuously informed**

The passenger information system is based on previous experiences and incorporates advanced technologies. All car classes feature video screens that are clearly visible from every seat and provide information on the train route.

### **Perfect control**

The Train Communication Network (TCN), consisting of the train bus (WTB) and the vehicle bus (MVB), ensures smooth and reliable data transfer between the traction units of a train as well as between two coupled trains. A state-of-the-art diagnostic system reports data to maintenance via radio.

The fully redundant design of the TCN system provides additional advantages:

- Significant improvement of the availability of the communications paths
- Savings in respect of hardware, installation dimensions, weight and lifecycle costs
- Increased data transparency and shorter data propagation delays due to reduction in the number of interfaces and sub-systems

### **Efficient onboard power supply system**

Maximum passenger comfort requires an especially efficient electric system.

Busbars installed throughout the train ensure a reliable power supply for:

- Air-conditioning, ventilation and heating
- Fans and pumps
- Restaurant operation
- Lighting





### Proven safety

The bogies are further refinements of the type used on the ICE 3 of Deutsche Bahn AG, and contribute to the exemplary lateral guidance performance of the Velaro D. They also ensure maximum stability and thus an excellent ride.

Even more important than rapid acceleration is rapid deceleration. The electric brake of the Velaro D enables automatic distribution of the braking effort among the pneumatic and the regenerative brake systems. In order to reduce lifecycle costs, the wear-free regenerative feedback system and the eddy-current brake are used preferentially. Experience gained from the ICE 3 and Velaro trainsets and leads to quickly and reliably deployable systems.

Of course, the optimized bodyshell and train concept meets the standard EN 15227:2008 standard for collision safety.

### Summary

The Velaro D in its advanced state of development, unifies the knowledge gained from fleets presently in service, it meets the current requirements of our customers and serves as a multiple-unit train that can be operated anywhere in Europe.

With its capacity advantages, the high level of development of its systems in terms of reliability and lifecycle costs, plus the experience of the people building it, it represents the state-of-the-art benchmark for high-speed trains with distributed traction.

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