

SIEMENS



[siemens.com/mobility](https://www.siemens.com/mobility)

Velaro. Top performance for high speed.

Top performance for high speed

More people. More goods. Fewer resources. There's no end to the number of challenges facing rail operators today. And providing fast, reliable connections between urban centers across borders calls for a future-ready alternative to the airplane and the automobile. So why not get on board a mature high-performance connection. One that is setting new standards daily and at high speed: Welcome to Velaro.



Expertise ten years ahead of its time

High speed – a key factor to economic success and quality of life across entire regions. But Velaro's more than ten-year technological edge did not come overnight. The revolutionary move away from all-traction equipment concentrated in a power car operating in push-pull mode to a distributed traction arrangement was made by Siemens in the 1990s. As a result, the first trainset – the ICE 3® – went into service in time for Expo 2000. And developments have continued ever since. The ongoing evolution of Velaro® is based on our experience in design, production, service and preventive maintenance in

day-to-day international service. You can check out the successes for yourself by riding on a Velaro in Spain, Russia, or China. Its technology, flexibility, comfort, and cost-effectiveness are sure to impress you.

Variety with a family connection

Be it a high-class solution for discriminating travelers, a trainset with outstanding riding comfort, or a very economical transportation system for large numbers of passengers: The Velaro family outgrew the concept stage long ago. Today, you have an innovative high-speed trainset at your disposal that is way ahead of the rest. The Velaro family is as proven as it is

versatile: Completely different variants can be configured from one standard platform. It can be customized in terms of capacity, comfort, and service. The platform is so mature that a Velaro can be rapidly integrated into your operations – today and in the future. A perfect base for increasing your market share and an attractive concept – confirmed by Eurostar International's recent selection of Eurostar e320.







Perfecting performance

When it comes to reliability, Velaro pulls no punches. Behind the highly aesthetic exterior lies rock-solid functionality. Pioneering innovations, first-class materials, and the intelligent integration of reliable electrical and mechanical systems pave the way for this superior integrated concept worldwide.

Performance – 24/7

Meet a versatile top performer: The Velaro reaches speeds of up to 360 km/h. Two car body widths, two track gauges, and a flexible number of cars in various configurations have been built and – typical of Velaro – are already in service. Traveling well over 1,000,000 kilometers a year and with punctuality exceeding 99%, Velaro is far ahead of the rest.

Pioneering multiple-unit concept

Velaro is strictly a multiple-unit trainset: The traction system is distributed over the entire train, and all traction components are arranged underfloor. Consequently, the entire length of 200 m above the floor is available for use without space being taken up by a power car. That means maximum room for your passengers. The multiple-unit concept also guarantees optimized performance, improved running characteristics, and a high degree of riding comfort. 50% of all the axles are driven. The result is safe operation under all outdoor conditions. Velaro is not phased by low adhesive coefficients and can take gradients as steep as 40‰ in its stride. The even distribution of weight also reduces the load on individual axles. This lowers the burden on the track and the maintenance requirements for the bogies.

Worked out down to the last detail

Velaro's level of innovation is evident in the smallest detail: While passengers benefit from the extraordinarily comfortable bogie suspension, an autopilot helps the driver make an energy-saving journey. A state-of-the-art diagnostic system reports data to preventive maintenance via a wireless link. Available options such as a high-performance eddy-current brake ensures for wear-free braking, permanent-magnet synchronous machines for higher energy efficiency and air-cycle air conditioning for environmentally compatible and agreeable temperatures. And it goes without saying that Velaro complies with the European safety standards and regulations (TSI, EN, and so forth).



Creating space

Experience shows that a state-of-the-art train just has to cater to different passenger and baggage loadings and provide different levels of comfort. The Velaro family does this, and that's why it is the most versatile and comfortable high-speed platform of its kind.

A balanced combination of direct and indirect lighting provides a uniquely comfortable atmosphere. As an option, individual lighting conditions can be provided via LEDs.



Thanks to compartments for large bags in the center of the car and roomy overhead luggage racks above the seats, bags are always visible and within reach.



Handholds on the seats, a tactile guidance system with seat numbering in Braille, and strips on the vehicle floor ensure passenger safety and guidance when boarding and while the train is underway.



Convenient catering on board: A timeless contemporary Bistro with snacks and beverages offers passengers relaxation and refreshment.



The most options

Spacious, bright, and exceptionally comfortable: Want a benchmark for passenger satisfaction? Then take a journey on board the Velaro. It's in a class of its own. No annoying noise, no check-ins, no traffic congestion – but full air conditioning in hot weather. The multiple-unit concept, with two bogies per car, offers maximum useful space in the interior in all train configurations. The results are clear advantages in terms of capacity and plenty of scope for designing interiors.

Exceptional comfort

Comfort and capacity are not at odds in Velaro. Before the train leaves the station, you will notice the large vestibules and spacious baggage racks. The barrier-free design philosophy makes traveling easier for older people, passengers in wheelchairs, and families with baby

carriages and a lot of baggage. Relax and enjoy your journey in very comfortable seats. Upholstery, armrests, and legroom can be customized to your needs. Even rotatable seats are available if required. This allows all passengers to enjoy the panoramic view while facing the direction of travel.

Appealing infotainment and more

While audio and video entertainment is provided for the passengers, a state-of-the-art information system keeps them up to date. For instance, power outlets for laptops and a W-LAN are available so that passengers can combine business with pleasure. You can have it all on board if you want it. A GSM repeater permits interference-free mobile phone reception on the train. And, naturally, a CCTV surveillance system for passenger areas ensures utmost security.

Changing flexibly with the seasons

The vacation season is here – and with it lots of baggage. But where is it all going to be stowed? The answer is to adapt to seasonal changes and demands flexibly. The Velaro interior is modular in design: Its furnishings can be altered to suit your needs. Other modules, such as baggage racks, and small galleys with trolley storage space, are also available. You can upgrade to cars with shallower seat pitches, or change from first to second class with ease. We can supply Velaro with the UIC vehicle clearance envelope as well as with wider cars for higher seating capacity. Unlike double-deck designs with their stairs and low ceilings, Velaro retains its high degree of passenger comfort.



Preserving resources

An integral approach is essential when optimizing the cost efficiency of modern rail systems. In addition to next-generation technology and comfort, short amortization periods and environmental compatibility are among Velaro's top qualities. Minimum service and maintenance costs play a prominent role in vehicle design. So it is not surprising that life cycle costs are equally low.

Optimized maintenance

All Velaro systems are the object of continuous development. This effort leads to reductions in maintenance costs. Trains are also monitored in daily service. Useful information from the field flows back into the engineering process. Improved component accessibility, continually updated maintenance schedules reflecting experience gained in the field, and the

high reliability of the Velaro family, all add up to reduced maintenance costs.

A model of energy efficiency

ICE 3 and Velaro E already offered optimized aerodynamics. Masked roof-mounted equipment, the bogies, and the intercar gangways cut energy consumption. Further aerodynamic measures were tested for the Velaro CN. Today's Velaro family integrates

all acquired field knowledge and refines it. For example, a roof section elevated from the middle of the last car reduces sonic boom in tunnels. Roof-mounted equipment such HVAC units and braking resistors are fully encased. Spoiler, nose and front section have been aerodynamically optimized. An energy-efficient brake system is also a priority for Velaro. Since the early 1990s, the train's electric brake



Equivalent gasoline consumption:

only 0.33l per person and 100 km

Wind-tunnel-tested and aerodynamically optimized: Thanks to a 20% reduction in the equivalent air resistance surface, the most recent generation of Velaro train-sets saves even more energy.



has been feeding surplus braking energy back into the power grid. The result is a 10% saving in energy, and a similar reduction in mechanical wear. All in all, this is equivalent to a gasoline consumption of 0.33 liters per person and 100 kilometers. And that's impressive!

Significant transport efficiency

Make room for your business expansion plans: Eight cars with two bogies each offer maximum seating capacity over a length of 200m. Up to 510 seats are possible with classic 1+2 seating in first class, 2+2 seating in second class and a first-class component of approximately 20%. And there's enough room for around 600 passengers in the high-density arrange-

ment with 2+2 seating and a reduced seat pitch also in first class. In contrast to articulated trains, Velaro with its 16 bogies has considerably more reserve capacity. Thus, two more persons per square meter standing room can be accommodated and carried during peak times.

Cost-effectiveness thanks to maximum seating capacity



Building on success

The Velaro family was developed for the international market. It has the attributes of global versatility and a broad service spectrum. Reliable, configured to suit national and international requirements, and always based on a service-proven platform. So put your trust in our global experience. After all, 195 high-speed trains sold speak for themselves.

Globally adaptable

From Spain to Russia and as far as China: The high-performance Velaro family is operating in four climatic zones, and also demonstrating its adaptability to different track gauges. The Spanish and Chinese versions are based on Europe's 1,435-mm standard gauge, while Velaro Russia is built for that country's 1,520-mm broad gauge.

Powering across borders

Velaro is designed as a four-system trainset. This means that it can run on conventional line voltage systems. So you benefit from its border-crossing capability. In Spain, Portugal, France, Italy, Germany, the UK, Switzerland, Belgium, the Netherlands, Russia, and China – you might as well say all over the world. As experts in the international certification of high-speed trains, we ensure compatibility with the infrastructure, global standards, and smooth integration of state-of-the-art and next-generation train protection and communication systems.



Velaro E

High speed under the Spanish sun
 Breakfast in Madrid, business lunch in Barcelona: What are you waiting for? Velaro E will speed you to your destination in less than 2½ hours. The eight-section, 200-m-long trainsets reach a top speed of 350 km/h with a traction power rating of 8,800 kW. The 625-km run passes not only quickly but also at pleasant temperatures. Velaro E is specially equipped for service in the heat of Spain: Its approximately 25% more powerful, redundant air-conditioning system with separate, dedicated air-conditioning unit for the driver's cab is designed for outside temperatures as high as 50°C.

Traveling with class
 Club, Preferente, and Turista – these three classes and four service areas offer a lot of room to move around for 405 passengers. The Club class is fitted out with leather and premium class comfort, and the Preferente class has a high-quality interior and individual service at business class level. The cafeteria car marks the transition to the Turista class with customer service center and rooms for train crews and unattended baggage. Turista class passengers can enjoy an unobstructed view of the track ahead in a front lounge.



Relaxing in comfort
 Like to sit facing the direction of travel? Thanks to rotatable seats, Velaro E provides this type of seating in all three classes. And when you've seen enough of the passing panorama, you can relax and watch the big video screen. Passenger information is provided via multi-lingual LED screens inside and outside. More Siemens systems look after your safety during the journey: the state-of-the-art European signal system ETCS Level 2 and the reliable continuous ATC system (LZB).

26 Velaro E
Contracting party: Spanish National Railways RENFE
Order placed: 2001 / 16 trains, December 2005 / 10 trains
Delivery: 2005 – 2006
World's fastest series production trainset: 403.7 km/h without modifications
Highest passenger approval: Market share rose to 50% from 2008 to 2010



60 Velaro CN

Contracting party:
Chinese Ministry of
Railways MOR

Order placed:
November 2005

Delivery:
2008

Follow-up:
component delivery
for 180 more trains

Forerunner for more:
Ready for the 20,000 km
of high-speed tracks

Velaro CN

New capacity for China

Highly comfortable ride, large seating capacities: Welcome to Velaro CN! The 8- and 16-car, 200- and 400-m-long trainsets are specially tailored for the large numbers of passengers in China. Velaro CN has 30-cm-wider cars and 2+3 seating arrangements to accommodate the transport capacity of 601 and 1,060 passengers respectively. With a traction power rating of 18,400 kW and at a maximum speed of 350 km/h, the Velaro CN is in operation on the Beijing–Shanghai and the Guangzhou–Wuhan routes.



En route in comfort

Two different classes with catering services are available on Velaro CN. First class has a lounge with rotatable seats facing the direction of travel at both ends of the train. There's lots to see here as well: A glass partition between the lounge and driver's cab offers an unobstructed view of the track ahead. First-class passengers can also enjoy exclusive entertainment via video and audio entertainment system.

Tracking customization

Fancy a cup of tea? A hot water dispenser is available in every car. Or how about a bite to eat in the Bistro? The Bistro offers small snacks and beverages and also accommodates the customer service center. You can get the latest news: Information is provided in English or Chinese on LED screens both inside and outside. The automatic train control and signaling systems for Velaro CN are geared to meet the Chinese requirements. The operations control system specially developed by Siemens for the Chinese market is based on the European standard ETCS.



Velaro RUS

High availability for Russia

Snow, ice and subzero temperatures: Russia has an extreme climate indeed. Nonetheless, as of 2009, Velaro RUS will start providing reliable service: 650 kilometers from Moscow to St. Petersburg in only 3.5 hours. It has specially adapted components and systems to cope with the harsh operating conditions in Russia and is backed up by a 30-year maintenance contract.

Capacity meets flexibility

The ten-car trainset accommodates 604 passengers over a length of 250 m and a carbody that is 30 cm wider than the UIC profile. With a traction power rating of 8,000 kW, it reaches a maximum speed of 250 km/h and can be upgraded to 300 km/h. Velaro RUS can be deployed universally. This is due to its two-variant design: as a single-system train for 3 kV DC and as a dual-system train for 3 kV DC and 25 kV AC. Train protection is based on the Russian operations control system Klub U.

High performance at low temperatures

Velaro RUS is made for climatic challenges, such as temperatures ranging from minus 40°C to plus 40°C. This is evident from the extra insulation of the car and its specially adapted ventilation and cooling system. Its air intake is on the roof to avoid the hazards of drifting snow, and a more powerful heating system in the interior makes for agreeable temperatures. All the more reason to expand service to the Moscow – Nizhniy Novgorod line.



16 Velaro RUS

Contracting party:
Russian Railways RZD

Order placed:
May 2006, December 2011

Delivery:
2008, beginning in January 2014

Russian record:
281 km/h

Greatest consistency:
99% operating availability



16 Velaro D

Contracting party:
Deutsche Bahn AG

Order placed:
December 2008

Delivery:
2012

Energy-saving aerodynamics:
drag-generating surfaces
decreased by 20%

Seamless integration:
can be coupled to the
existing ICE 3 fleet

Velaro D

A competitive edge for Europe

Attractive reliability and low life cycle costs – for usage in Germany, as well as in France, Belgium, and Switzerland. The Velaro D is already equipped for cross-border operation in Europe's liberalized rail network. Designed as a four-system-capable, eight-unit trainset, it achieves a top speed of 320 km/h with a traction power rating of 8,000 kW.

Attractive flexibility

The Velaro D optimally meets a wide range of mobility requirements. It has a capacity for 460 passengers over its 200-m length. During peak hours, there is a standing room capacity of two people per square meter. Supplementary baggage racks and face-to-

face table arrangements can be integrated overnight. Naturally, Velaro takes the needs of passengers with reduced mobility fully into account. Not only can wheelchair users reach their locations safely and independently via wide entries and aisles, but they can also make their way to the adjacent dining car.

Reliable frugality

An intelligent brake control unit distributes the braking power between the pneumatic and generator-type brake systems. As a result, the Velaro D can not only accelerate rapidly, but also decelerate just as quickly and safely. And while wear-free regenerative feedback systems and eddy-current brakes lower life cycle costs, the aerodynamic concept of the new generation reduces energy consumption. It was thus possible to reduce train resistance by around 8% despite the large amount of roof-mounted equipment.





Eurostar e320

Expertise for the Eurotunnel

A 50-km-long tunnel, of which 38 km are undersea and up to 75 m below sea level: The Eurostar e320 once again pushes our most configurable vehicle platform worldwide into new, challenging realms. Used on the London – Paris – Brussels route, the Eurostar e320 will supplement the existing fleet that runs through the Eurotunnel. With a traction power of 16,000 kW, the 400-m-long multi-system train reaches a top speed of 320 km/h.

Trendsetting safety

Resistant to both fire and water: The Eurostar e320 is especially tailored to meet the strict standards and design requirements for tunnel operations. In the event of a fire, the train can still be operated for an additional 30 minutes. Given the tunnel's ambient conditions of up to 100% humidity and 25°C temperature throughout the year, all components are reliably protected against condensation.



10 Eurostar e320

Contracting party:
Eurostar International Ltd.

Order placed:
December 2010

Delivery:
2014

Suited for tunnels:
optimized to operate
in the Eurotunnel

Fastest data transmission:
train-wide communications network

Shaping the future



To get maximum performance, you need a partner at your side from the initial decision, through planning and realization, all the way to competent after-sales service. Siemens has been gaining experience and know-how in project management for 160 years. The corporate knowledge acquired and refined in all those years benefits the Velaro as well.



Integrated service

Even the most trendsetting vehicles are only as good as their well-planned integration into the infrastructure and service network. For this reason, we at Siemens offer you comprehensive support ranging from technical care to customized service and diagnosis on up to economical financing and leasing models. And, on top of all that, we will contractually agree to assume overall responsibility for the construction and maintenance of entire

rail systems – from tracks to stations and trains. Our aim is to ensure highly available trains and smooth running operations at all times.

Seamless testing

Intensive tests are a matter of course for us. Your trains are thoroughly checked and tested under realistic operating conditions at our test and validation center for rail systems in Wegberg-Wildenrath, a test center certified by the German

Federal Railway Authority (EBA). Be it static or dynamic testing, system change and ATP tests, acoustics or leakage tests: Our seamless investigations guarantee maximum investment security and availability right from the start. We test from the first prototype up to the series production train. Why do we do this? Because we love rail-based transportation systems!

Advancing technology

Bogies

The tried-and-tested SF 500 bogies of the Velaro family are put through their paces at speeds up to 403.7 km/h and are therefore suitable for running speeds up to 360 km/h. They provide perfect guidance, maximum stability, and outstanding riding comfort – all this has been verified on high-speed routes in Germany, Belgium, France, Spain, the Netherlands, and China.

Traction equipment

The Velaro family has a sophisticated drive system with scalable ratings from 8 to 11 MW. Four identical, independent traction units provide outstanding redundancy: The failure of one unit has no impact on the remaining units. And, while the bogie or axle-selective drive unit gives you clear benefits in terms of maintenance and repairs, maintenance-free, proven three-phase squirrel-cage asynchronous motors assure high availability. Or, as an alternative, a permanent-

magnet synchronous machine combining a higher degree of efficiency with a better power-weight ratio can also be used.

The latest IGBT technology allows easy operation in all power systems. The traction converters can be easily fitted with additional braking resistors, regenerative brake or eddy-current brake.

Vehicle control system

The safe and smooth exchange of data between traction units and between two coupled trains is made possible via the Train Communication Network (TCN). The TCN system is fully redundant and has a reduced number of interfaces and subsystems. This increases the availability of the data communication paths and data transparency, reduces data propagation delays, and saves not only hardware, installation dimensions and weight but also life cycle costs.

Key vehicle features

- Trainset with distributed under-floor traction equipment
- Tested vehicle design with a high level of customization
- Internationally deployable
- Variable configuration concept: 7-, 8-, 10-, 12- and 16-car
- Standard version: 8-car, 510 seats, 200 m long, capable of double-running with a total length of 400 m, coupling and separation in minimum time
- Variable passenger capacities and interior furnishings: 460 to 1,243 seats
- European standards (TSI, UIC, EN)

Low life cycle costs

- High energy efficiency
- Optimized service and maintenance costs
- Low refurbishment expenditures after 10-year or 20-year periods of operation thanks to its flexible and modular design



Technical Data

	Standard	Options
Number of cars	8-car	7-, 10-, 12-, 16-car
Passenger capacity	Standard: 510 seats / 304 standing room	Additional 1st class, high-density 8-car: 596 seats, high-density 16-car: 1,243 seats, more possible
Maximum speed	320 km/h AC, 250 km/h DC	360 km/h AC
Train control system	ETCS and 1 national system	3 other national systems
Traction power	8 MW	depends on configuration
Length	200 m	depends on configuration
Bogies	16 (8 driven)	depends on configuration
Line voltages	Two-system train: 1 x DC, 1 x AC	Four-system train: 1.5 kV DC, 3 kV DC, 15 kV AC, 25 kV AC
Brakes	Air brake with extra regenerative brake	Track brake as electromagnetic track brake or eddy-current brake; electric brake with braking resistor
Multiple running	Multiple unit operation of 2 Velaro 8-car trains, mechanical coupling with ICE 3 or TGV	Functional coupling with existing fleets



Image:

p. 4, Spanish National Railways RENFE

ICE 3® is a registered trademark of
German Rail (DB AG)

Velaro® is a registered trademark of
Siemens AG

Siemens AG
Infrastructure & Cities Sector
Rail Systems Division
P.O. Box 32 40
13629 Berlin
Germany

© Siemens AG 2012

Printed in Germany
HL 12077175 176803 WS 08121.0
Dispo 21704 c4bs 1420
Order no. A19100-V800-B796-V3-7600

The information in this document contains general descriptions of the technical options available, which do not always have to be present in individual cases. The required features should therefore be specified in each individual case at the time of closing the contract.

www.siemens.com