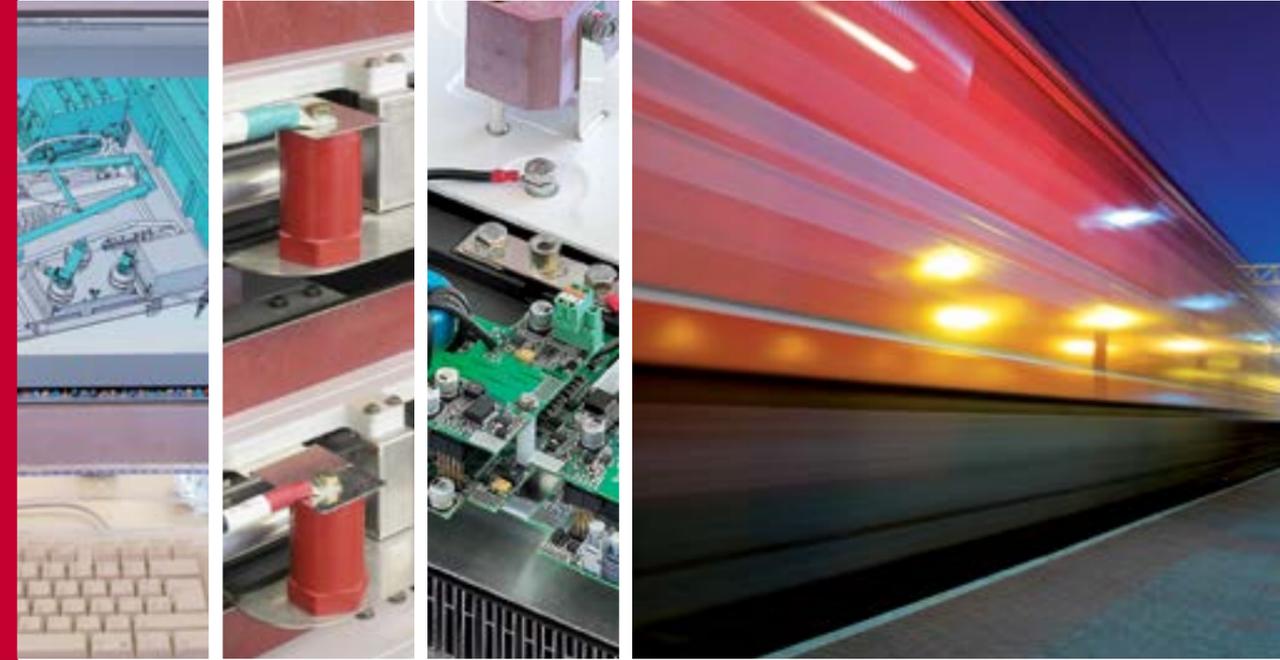


**Ingeteam**

## Traction Systems



GC01DTR01\_C 08/2013

**Ingeteam**



Vehicle control unit (VCU)



Human machine interface (HMI)



Traction converter

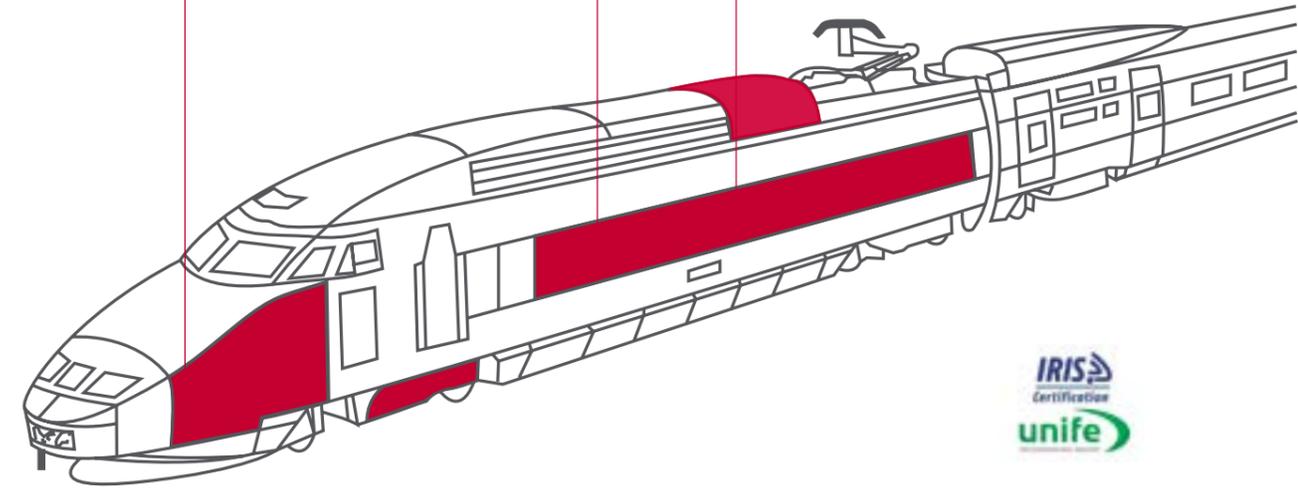


Auxiliary converter

**INGETEAM Traction designs and supplies complete traction, control and auxiliary systems for trams, EMUs, locomotives and high-speed trains**, based on in-house technological developments in the field of control and power electronics, with the goal of maximizing the availability and performance of trains, as well as offering comfort and safety.

Cooperation with our clients ranges from vehicle definition, design and engineering to the “turnkey” supply of on-board electrical solutions, for both new rolling stock projects and fleet modernization.

Our capabilities and experience in the railway sector allow us to offer **advanced solutions** that contribute towards significant improvements in railway operation, focusing in particular on operating costs, reliability, availability, maintenance and energy consumption.



ELF



UT 3000



UT 200



Bilbao Tram



GAMA



ED 74



TD 2000



# Philosophy

*Ingeteam is a market leader specialized in **power and control electronics** (frequency converters, automation and process control), **electrical equipment, electrical engineering and power plants**, seeking to optimise energy consumption while maximising generating efficiency.*



## R&D

Our strategy is based on ongoing investment into research and development in the electro-technical field, focusing on power and control systems, plus the use of exclusive technologies and the application of in-house processes.

Our qualified team has a in-depth knowledge of the demands of the railway market and works in one of the finest electrical/technical laboratories in Europe. Also, our testing facilities have the most advanced simulation tools available on the market.

In the field of control systems, our R&D activity has grown from the first automation units developed in 1982 to the current distributed systems that have been incorporated into some of the most advanced projects in the railway market.



## Experience

Ingeteam's presence in the railway sector is backed by mastery when it comes to combining our extensive experience in the development and supply of electronic power and control equipment with our knowledge of rolling stock engineering and railway operations.

## Quality

The excellence of our products and services is our reason for existing, as well as the goal behind all our production processes and the tasks that our contributors perform. We therefore demand the highest levels of quality from our approved suppliers and cooperate with them on incorporating the most advanced and reliable components into our products.

Our management system has IRIS and ISO 9001 and 14001 certification.



## Engineering

Our vocation is to work side-by-side with our customers, from the beginning of the project, by contributing with our experience in analysing the performance of the systems, starting with the original system in the case of renovations, until a final optimal solution is attained, from the standpoint of performance and costs.

Throughout this process, all the simulations required to guarantee the correct specification of all the embedded electrical components, traction system, control, auxiliary supply, communications, signalling, safety and control are carried out to integrate said systems in the train's engineering.



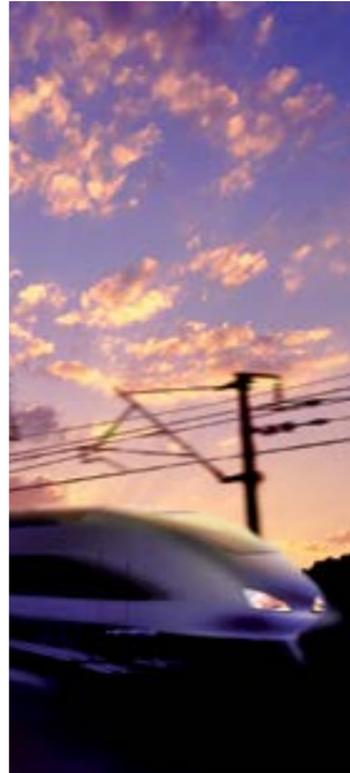
## Service

We consider that keeping in close contact with our clients and meeting their needs are a fundamental part of the success of each project; therefore, we maintain a significant geographical presence and a flexible organizational structure.

One major feature of our business model is to offer competitive advantages for products and projects, and our commitment is to meet our customer's expectations.



## Traction systems



*We design and manufacture comprehensive traction systems using in-house technology and know-how to offer very high energy performance, maximum reliability and reduced maintenance costs, to fit our clients' requirements and their need to minimize the life cycle costs (LCC) of their rolling stock.*

This approach allows us not only to pay special attention to offering availability, reliability and reduced maintenance costs, but also to maximizing the use of space and reducing the weight for each rolling stock design.

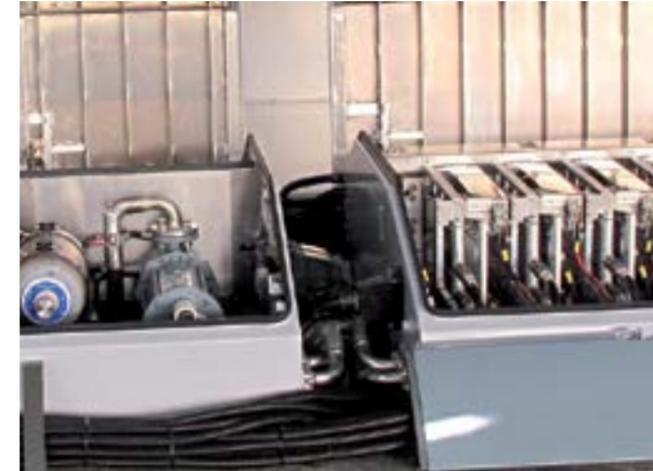
We apply the latest advances in the field of power semiconductors. We maintain a policy of cooperation and preferential agreements with the major suppliers of semiconductors and other critical components, in order to incorporate state-of-the-art components into our products and ensure the supply chain.

Finally, in cooperation with our suppliers' design departments, we also specify and integrate auxiliary elements for the traction system, such as pantographs and transformers.

- ▶▶ Entire range of catenary voltages : 750 Vdc, 1,500 Vdc, 3,000 Vdc, 15 kVac, 25 kVac and powers.
- ▶▶ Modularity and a high degree of standardization are key aspects, allowing us to offer high rates of reliability and reduced maintenance costs.
- ▶▶ Different cooling systems: water, air, anti-freeze liquids.
- ▶▶ Electronic control unit developed in-house, featuring new functions such as preventive maintenance, self-diagnosis and thermal analysis of semi-conductors.

Traction systems proven in trams, EMUs, locomotives and high-speed trains

## Auxiliary power supply systems



*Our auxiliary systems are designed to offer highly reliable and efficient power supply. Ingeteam designs and manufactures light, compact and redundant auxiliary power supply systems in the entire range of catenary voltages, which can be integrated into the traction converter. Our portfolio includes battery chargers and head-end power equipment.*

Right from the initial design phase of these systems, we focus on obtaining the best energy performance, as well as modular construction and the minimization of life cycle costs.

- ▶▶ Solutions for all types of catenary systems: continuous voltage catenary for 750-, 1,500- or 3,000-Vdc networks, as well as 1,000 or 1,500 Vac 16 2/3 Hz or 2500Vac 50 Hz for AC catenary systems
- ▶▶ Equipment for different power ranges
- ▶▶ Easy maintenance, thanks to the modular design of the equipment. Communication with the control system via TCN, CAN, RS-85 and other communication buses.
- ▶▶ The power circuit switching devices are state-of-the-art, traction-specific IGBTs.
- ▶▶ The cooling of the auxiliary converter is by forced-air ventilation or water, depending on the output power and the client's preferences.

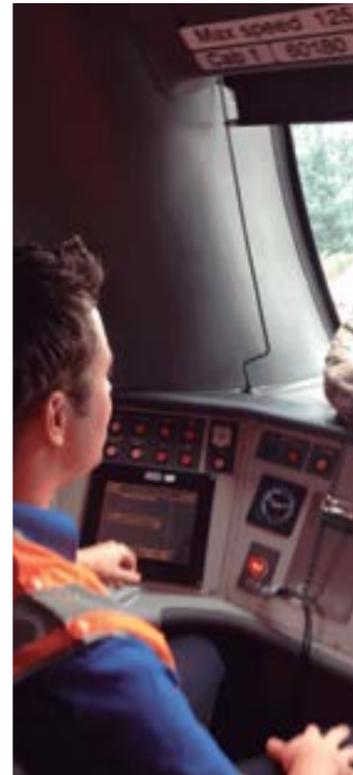
Our product range includes battery chargers based on resonant circuits or high-frequency circuits to minimize the space required and weight, and to be integrated into the auxiliary converter itself.

Reliability, modularity and availability

## Train control management system



*Ingeteam's experience in the development and manufacture of control solutions for application in different sectors makes it a leader in the design and manufacture of vehicle control systems and man-machine interfaces. These solutions are based on in-house control electronics platforms that allow for programming in open languages in accordance with IEC Standard 1131-3.*



These systems are conceived for use in distributed configurations, minimizing the wiring, and may be connected both by means of the TCN protocol in accordance with IEC 61.375-X: MVB, CCN, ECN, WTB, ETB, and other bus protocols.

The concept behind the vehicle control electronics (VCU) fulfils the requirements demanded by railway standards and covers all control, monitoring and communications needs for any type of rolling stock, from LRVs, EMUs and locomotives to high-speed locomotives.

The following are some of the main needs:

- ▶▶ Control of train propulsion and braking.
- ▶▶ Control of auxiliary converters and battery chargers.
- ▶▶ Monitoring and driver-assistance systems.
- ▶▶ Management of the train's on-board systems and their communication with the ground station.
- ▶▶ Maintenance diagnostics and assistance system.
- ▶▶ Integration of the signalling systems required for vehicle operation (ERTMS, etc.) and the communication elements (GSM-R, etc.) so as to provide a comprehensive control system for the vehicle.

Design and development of comprehensive control systems

## On-board electrical system engineering



*Our aim is to work with the client throughout the various phases of the project. In the initial phase, we apply our experience to the analysis of the system's performance, starting with the original system in the case of renovations, going right through to the final phase, in order to offer optimal solutions in terms of both performance and cost.*



In this process, all necessary simulations are carried out to guarantee the proper power specification for the traction system, in keeping with the track profiles, vehicle aerodynamics and acceleration requirements.

We also execute the specifications for all the on-board electrical components, traction system, control, auxiliary power supply, communications, signalling, security and comfort, integrating these systems into the engineering of the train.

- ▶▶ System Design: Vehicle subsystems and integration
- ▶▶ System Definition: electrical schematics, electrical cabinet design, mechanical integration of equipment and software development

In the final phases our engineers program the vehicle's various control systems and its commissioning and subsequent approval, thus supplying a "turnkey" project.

As part of our comprehensive offering, we are committed to providing the best service during operation. We provide highly qualified, experienced teams and the resources needed to maintain the on-board electrical systems, to ensure compliance with the specified reliability and availability ratios.

Engineering experience to tackle complex projects

## Comprehensive solutions for new vehicles



*As part of our collaboration with our clients, both rolling stock manufacturers and operators, our capabilities allow us to offer a comprehensive traction and control system for new rolling stock. From specifications and engineering, the integration of the different elements offered by Ingeteam and the remaining subsystems necessary for rolling stock operation, we work side by side with our clients to obtain the appropriate approval certificates and cooperate on maintenance.*



### Design of the optimal configuration

Our engineers collaborate in the specification of equipment and systems so that they meet all the dynamic requirements of the rolling stock.

### Calculation of energy consumption

Our experience in the field of power electronics, as applied to energy, enables us to design and supply systems that minimize energy consumption.

### Maximum safety

Our engineering takes into account the criteria needed to minimize the risk of accidents, both during operation and maintenance stoppages, by implementing appropriate safety measures, such as interlocking.

### Maximum reliability and improvement of maintenance conditions

Our systems are designed with ease of maintenance

firmly in mind. We also offer a modern diagnostic system that allows for incidents to be located quickly. These factors, along with low energy consumption, allow our solutions to reduce the life cycle cost (LCC) of the project.

### Interoperability criteria

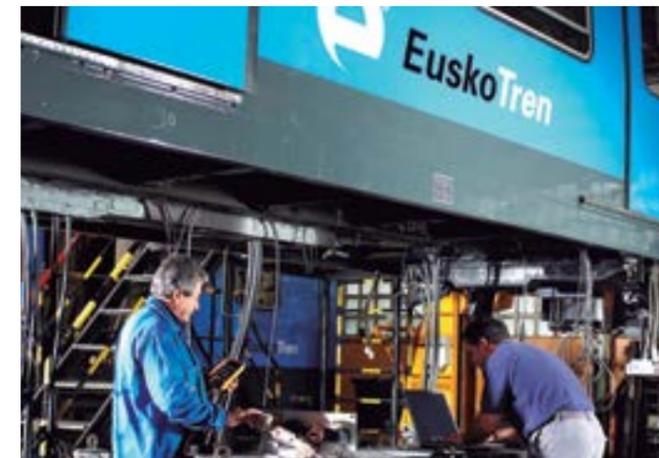
The design and engineering of our equipment takes interoperability criteria into consideration, to allow for the use of the vehicle by different operators.

### Interior comfort through multimedia technologies

As part of the rolling stock engineering, we integrate the most modern multimedia systems to provide the highest quality interior equipment and the greatest comfort for the passengers.

Minimization of energy consumption and maintenance

## Modernization of rolling stock



*Ingeteam offers operators the possibility of renovating the electrical traction and control system of their rolling stock, to obtain the advantages provided by our modern traction systems, but with less investment and a reduced project execution time.*

*This includes a modernization solution based on a DC Chopper (based on IGBT-s), DC motors and microprocessor-based control.*



These solutions are especially appropriate when the mechanical components of the fleet are in good condition and only require conditioning or cleanup.

The advantages obtained in this type of project are:

### Greater availability

The new alternate-current traction systems offer greater reliability than traditional direct-current systems. Greater reliability, plus the smaller number of necessary electromechanical elements, allows for greater fleet availability, improving the returns on the investment in rolling stock.

### Lower maintenance costs

Alternate-current systems, especially asynchronous ones, require less maintenance since they present no problems with brushes, collectors, camshafts, contactors and electromechanical parts in general. This situation, together with the lower cost of replacement parts for alternate-current systems, leads to a significant reduction in fleet maintenance costs.

### Lower energy consumption

The possibility of catenary regenerative electrical braking means important savings in operating costs, especially taking into account the evolution of energy costs.

### Greater comfort

The precision traction control offered by the new traction systems contributes to jerk control, leading to improved passenger comfort. This advantage therefore adds to the user's perception of improved service.

### Improvement of dynamic performance

The dynamic performance of rolling stock is improved thanks to the remodelling of the traction system, facilitating the use of the rolling stock on lines with higher demand or a reduction in operating times, given that the new alternate-current systems allow for greater performance in the same space.

### Extension of the stock's useful life

Renovating the traction system means that the useful life of the rolling stock is extended, thereby optimizing the entire existing fleet.

Reduction of life cycle cost (LCC). Improved disponibility