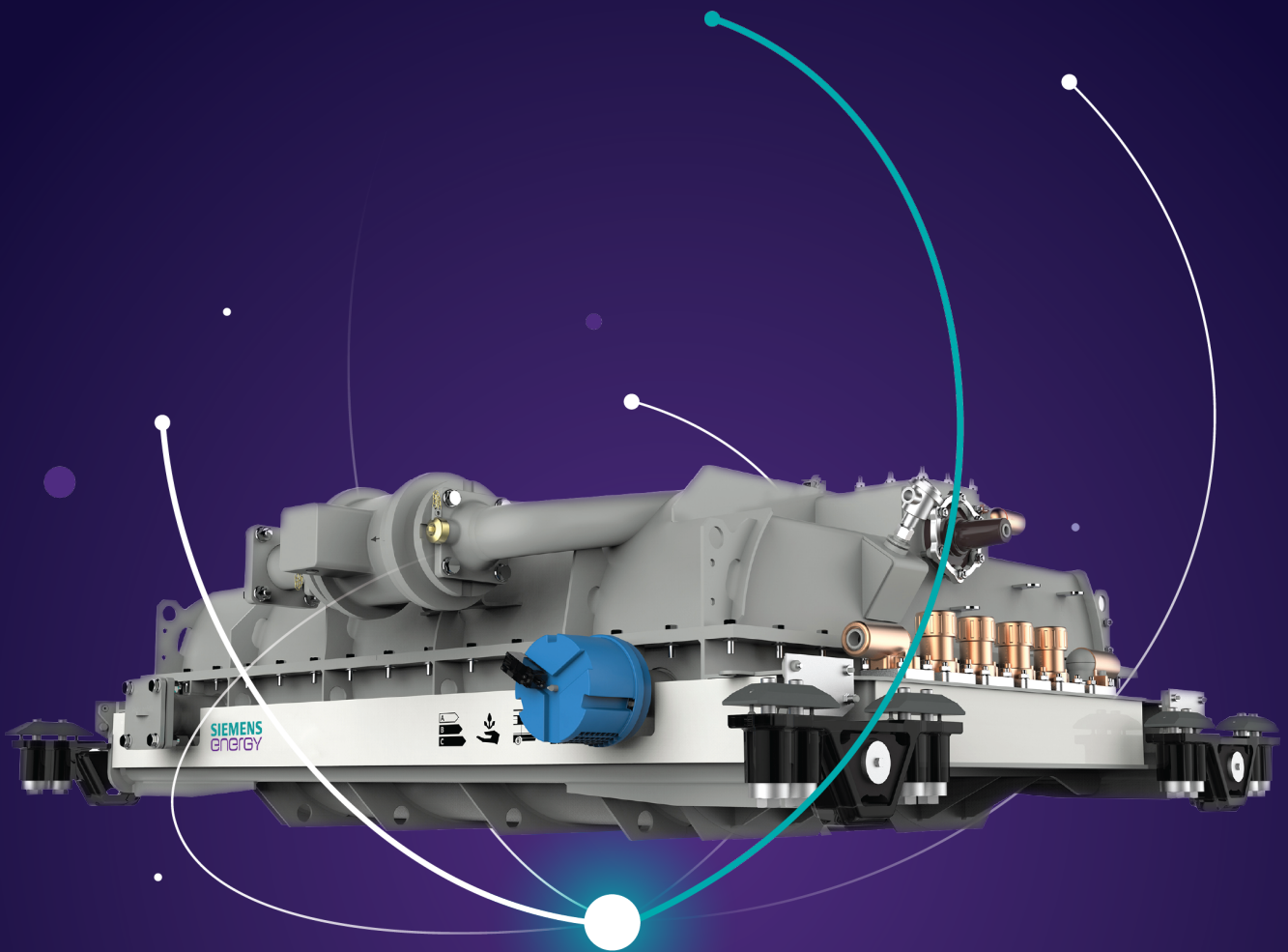
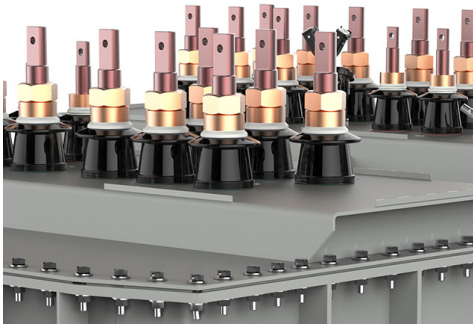


Tractronic®

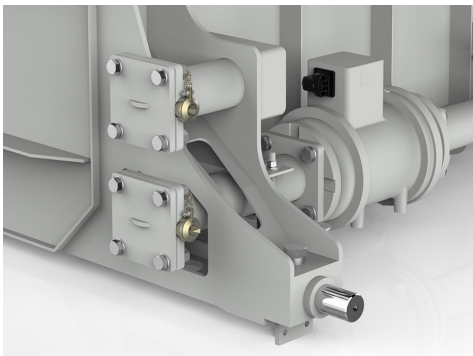
Turning energy into speed with traction transformers from Siemens Energy



Tractronic® – the on-board traction transformer sets the bar for quality and versatility



Low-voltage bushings for multiple-system locomotives



Customized mechanical connection to meet project specific requirements

In a class of their own

Siemens Energy offers Tractronic® traction transformers of all capacity ranges for rail-based vehicles. The long product lifecycle means that the focus is on maximum reliability, economic efficiency, and safety – perfectly aligned with our customers' requirements. This is reflected in a variety of designs based on the following parameters:

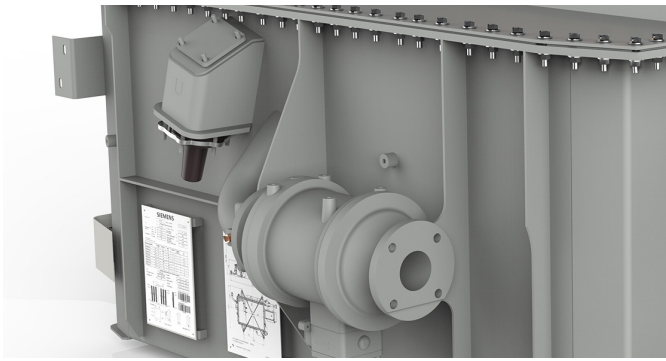
- Power ratings – frequency, capacity, and voltage
- Dimensions, weight, and place of installation
- Dissipation and short-circuit voltages
- Driving patterns and medium-frequency performance
- Losses and impedance voltage characteristics
- Materials and technologies to meet environmental requirements (e.g. ester coolant)

Proven technology

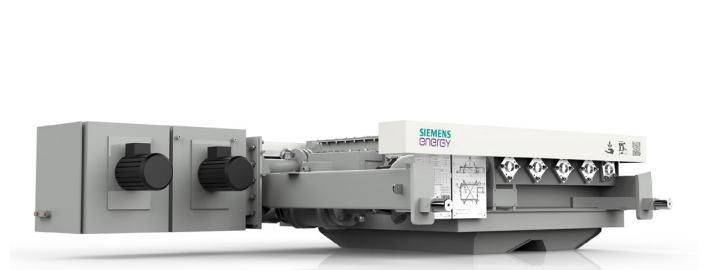
Tractronic® traction transformers from Siemens Energy are a state-of-the-art platform solution already proven in different classes and validated in different rail applications:

- In locomotive platforms around the world, which means that Tractronic® traction transformers are deployed in all types of climatic conditions for heavy-duty transportation purposes.
- In high-speed long-distance rail applications in Europe, China, and Turkey, which means that Tractronic® traction transformers are designed for high levels of safety and security, availability, and reliability as well as environmental friendliness.
- In Electric Multiple Units (EMU) operating in commuter and suburban rail networks around the world, which means that Tractronic® traction transformers are sustainable products that stand the test of time by operating efficiently for decades to come.

Siemens Energy designs and manufactures Tractronic® traction transformers for rail operators and train manufacturers worldwide, that increase train efficiency and performance, handle maximum ratings in a minimum of space, serve local content demands for worldwide applications, and ensure maximum reliability and flexibility.



High-voltage bushing and cooling fluid circulation pump



Cooling unit combined with the transformer

Certified and awarded

Siemens Energy Tractronic® traction transformers are setting standards of quality and versatility around the world. Close cooperations with international standards committees ensure compliance with the specific requirements and standards.

Besides being awarded Q-1 supplier status for the German railway company Deutsche Bahn AG, Siemens Energy also holds the following certifications:

- ISO 9001
- ISO 14001
- ISO 45001
- ISO 22163 (IRIS)
- Welding qualification EN 15085-2

Comprehensive range of services

From a technical perspective, Siemens Energy Tractronic® traction transformers cover every need. In all capacity ranges up to 15 MVA and – on request – even above, Siemens Energy offers single-phase and multi-phase transformers for machine rooms, under-floor and low-floor applications, and for on-roof installation – which provides maximum flexibility for the train's design.

Siemens Energy can design and customize the cooling unit to suit customer preferences, either integrated in the transformer in the full frame or as a separate component, entirely in accordance with the specific space requirements. Flexibility is also the order of the day when it comes to selecting cooling fluids. We have solutions for all capacity ranges that use oil, silicon, or an ester-based fluid (e.g. MIDEL 7131) that is very kind on the environment.

An internationally reliable partner

With over a century of experience in transformer technology, Siemens Energy is one of the world's leading suppliers for customized, state-of-the-art Tractronic® traction transformers. The basis for Siemens Energy's great track record is a worldwide manufacturing and service network with a refined system of global logistics, internationally binding quality standards, highly trained skilled workers and specialization resulting in the following customer benefits:

- Timely responses to inquiries
- Short processing time on spare parts orders
- Fast access to services directly on-site
- Components and services anywhere and any time

Uniform, IRIS-compliant quality standards are binding for manufacturing at all our production locations.

Technical performance

- Frequencies from 16⅔ to 60 Hz
- Operating voltages: 1.5 kV DC, 3 kV DC, 11.5 kV AC, 15 kV AC, 25 kV AC, and other special voltage levels
- Single- or multi-system versions
- Integrated smoothing and filter reactors
- Auxiliary and heating windings depending on customer specifications
- Traction windings as network filter reactors



Full speed ahead – the right Tractronic® transformer for every application

On-board Tractronic® traction transformers turn energy into speed that moves passengers and freight. As part of the traction chain, they are crucial to the performance of train and operator services. Siemens Energy designs and builds Tractronic® traction transformers in different specification profiles. Every traction transformer type is designed and optimized for a special type of train following the specific customer requirements:

- Frequency, rating and voltage
- Required dimensions and weights
- Losses and impedance voltage characteristics
- Operational cycles and frequency response behavior
- Environmental requirements

Ultra-light Thinity® transformers



Tractronic® AC and DC transformers for electric locomotive applications



Tractronic® AUX transformers for diesel locomotive applications



Tractronic® transformers for high-speed applications



Tractronic® transformers for EMU applications



Tractronic® transformers for tram trains applications



Selected References

Ultra-light Thinity® design



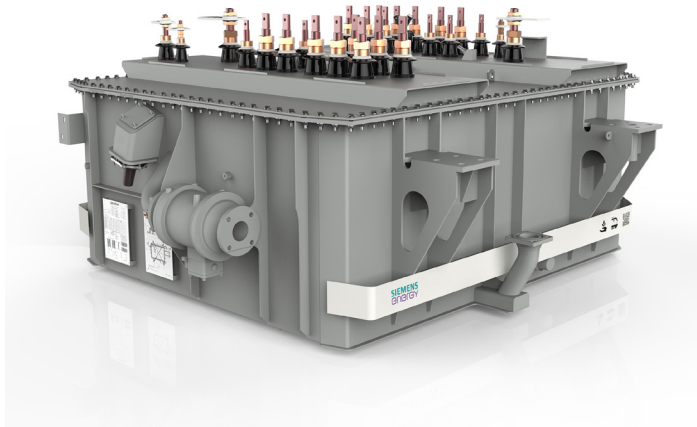
Transformer data (example)

Rated power	2.716 MVA
Frequency	16 $\frac{2}{3}$ Hz
Voltage	Primary: 15 kV Traction: 4 x 961 V Filter: 1 x 511 V
Power	Traction: 4 x 679 kVA Filter: 1 x 25 kVA
Weight	4,450 kg
Features	<ul style="list-style-type: none"> • The Thinity® design reduces the transformer's weight by up to 25% • Flexible installation: rooftop as well as under-floor installation • Systematic tank shape • Adaptable to different types of trains

Selected references	Country/Region	Rated power [MVA]	Rated voltage [kV]	Rated frequency [Hz]	Cooling medium
1	World	2.716	15/25/4 x 0.961/0.963)	16 $\frac{2}{3}$ / 50	Ester
2	Germany	1.68	15/25/2 x 1.062	16 $\frac{2}{3}$ / 50	Ester

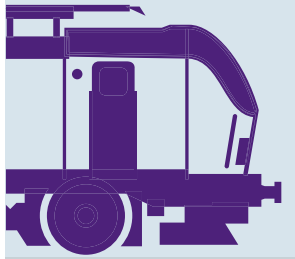


AC locomotives



Transformer data (example)

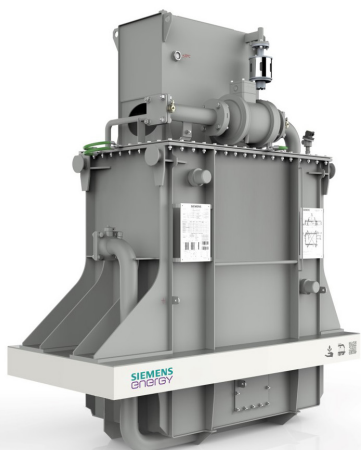
Rated power	5.8 MVA
Frequency	16 2/3 Hz/50 Hz
Voltage	Primary: 15 kV/25 kV Traction: 4 x 1.935 V/4 x 1.928 V Tertiary: 1 x 998 V/1 x 1.496 V
Power	Traction: 4 x 1.300 kVA Tertiary: 1 x 600 kVA
Weight	12,500 kg
Features	<ul style="list-style-type: none"> • Ester cooling and insulation liquids ensure maximum environmental compliance • Can be used with 25/15 kV AC voltages and 1.5/3 kV DC voltages • Weight-optimized design



Selected references	Country/Region	Rated power [MVA]	Rated voltage [kV]	Rated frequency [Hz]	Cooling medium
1	Australia	4.726	25/6 x 0.99	50	Mineral oil
2	Belgium	6.3	25/4 x 1.849	50	Ester
3	World	5.8	15/25/4 x 1.94	16 2/3 / 50	Ester
4	USA	6.2	25/4 x 1.957	60	Ester
5	World	5.8	15/25/4 x 1.5	60	Ester
6	World	2.3	15/4 x 1.063	16 2/3	Ester
7*	Russia	2.6	25/2 x 1.0	50	Mineral oil
8*	Russia	5.75	25/4 x 0.99	50	Mineral oil

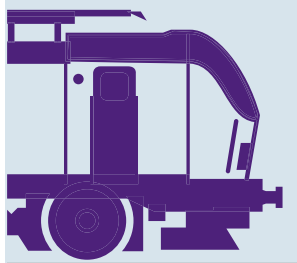
* Delivered to Russia before February 2022

DC locomotives



Transformer data (example)

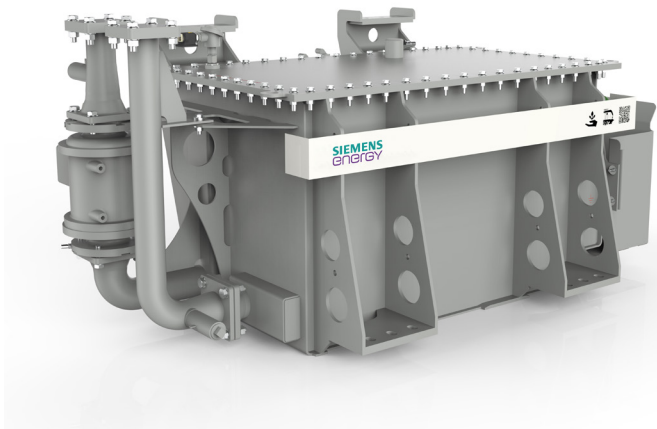
Rated Voltage	3 kV
Inductance	39 + 3.15 mH
Rated current	790 A
Weight	4,150 kg
Features	<ul style="list-style-type: none"> • Installed half under floor and half in machine room • Version for lowest ambient temperature –50° Celsius



Selected references	Country/Region	Rated voltage [kV]	Cooling medium
1	Germany	3 DC	Ester
2*	Russia	3 DC	Mineral oil

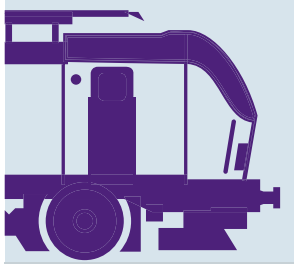
* Delivered to Russia before February 2022

Diesel locomotives



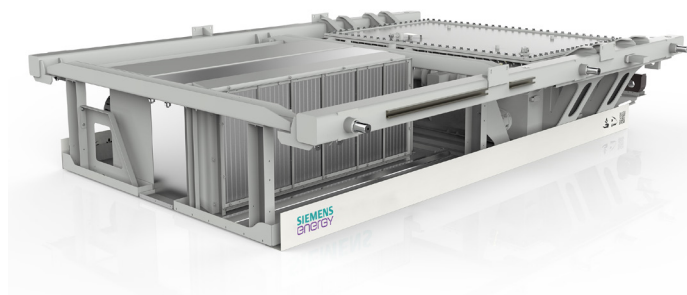
Transformer data (example)

Rated power	1,130 kVA
Frequency	60 Hz
Voltage	Primary: 3 x 528 V Secondary: 3 x 480 V
Weight	1,920 kg
Features	<ul style="list-style-type: none"> • High-quality ready-to-use transformer • Sealed version for 30-year lifespan



Selected references	Country/Region	Rated power [MVA]	Rated voltage [kV]	Rated frequency [Hz]	Cooling medium
1	USA	0.756	3 x 0.528	60	Ester
2	USA	1.130	3 x 0.635	60	Ester

High-speed trains



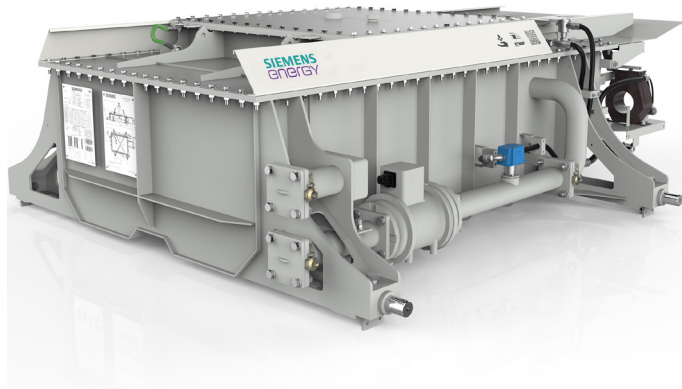
Transformer data (example)

Rated power	5.848 MVA
Frequency	50 Hz
Voltage	Primary: 20 kV Traction: 4 x 1.844 V
Power	Traction: 4 x 1.462 kVA
Weight	6,200 kg
Features	<ul style="list-style-type: none"> • Nomex insulation for maximum energy density • Integrated design of transformers and cooling systems • Pfisterer plug connection for fast and easy installation

Selected references	Country/Region	Rated power [MVA]	Rated voltage [kV]	Rated frequency [Hz]	Cooling medium
1*	Russia	5.52	25/4 x 1.55	50	Mineral oil
2	China	5.848	25/4 x 1.850	50	Mineral oil
3	China	3	25/0.899	50	Mineral oil
4	United Kingdom	4.804	25/4 x 1.848	50	Ester
5	Germany	4.6	15/4 x 1.103	16 ² / ₃	Ester
6	Europe	4.6	15/25/4 x 1.103	16 ² / ₃ / 50	Ester

* Delivered to Russia before February 2022

Electric multiple units



Transformer data (example)

Rated power	1.816 MVA
Frequency	50 Hz
Voltage	Primary: 25 kV Traction: 4 x 1.853 V Filter: 1 x 461 V
Power	Traction: 4 x 448 kVA Filter: 1 x 24 kVA
Weight	2,900 kg
Features	<ul style="list-style-type: none"> • Integrated expansion vessel • 2 redundant pumps • Ester cooling and insulation liquids ensure maximum environmental compliance

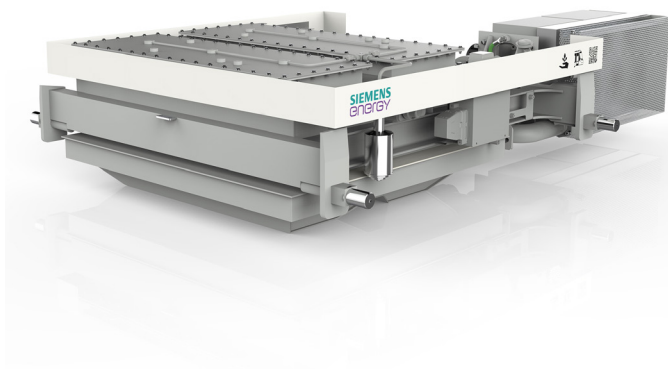


Selected references	Country/Region	Rated power [MVA]	Rated voltage [kV]	Rated frequency [Hz]	Cooling medium
1	Europe	1.816	25/4 x 1.853	50	Ester
2	India	1.25	25/0.855	50	Mineral oil
3	Malaysia	1.932	25/4 x 0.951	50	Mineral oil
4	Europe	1.28	25/2 x 0.640	50	Ester
5	Switzerland	2.64	15/4 x 0.660	16 $\frac{2}{3}$	Ester
6	United Kingdom	2.204	25/6 x 0.449	50	Ester
7	Europe	1.972	15/4 x 0.980	16 $\frac{2}{3}$	Ester
8	Germany	2.2	15/2 x 0.95	16 $\frac{2}{3}$	Ester
9	Europe	2.2	25/4 x 0.55	50	Ester
10*	Russia	1.65	25/2 x 0.86	50	Mineral oil
11	Europe	1.3	25/2 x 1.88	50	Ester
12*	Russia		3.0	DC	Mineral oil

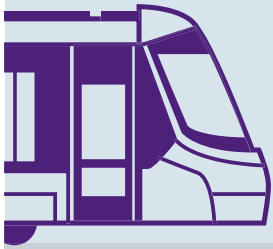
* Delivered to Russia before February 2022

Tram trains

Transformer data (example)

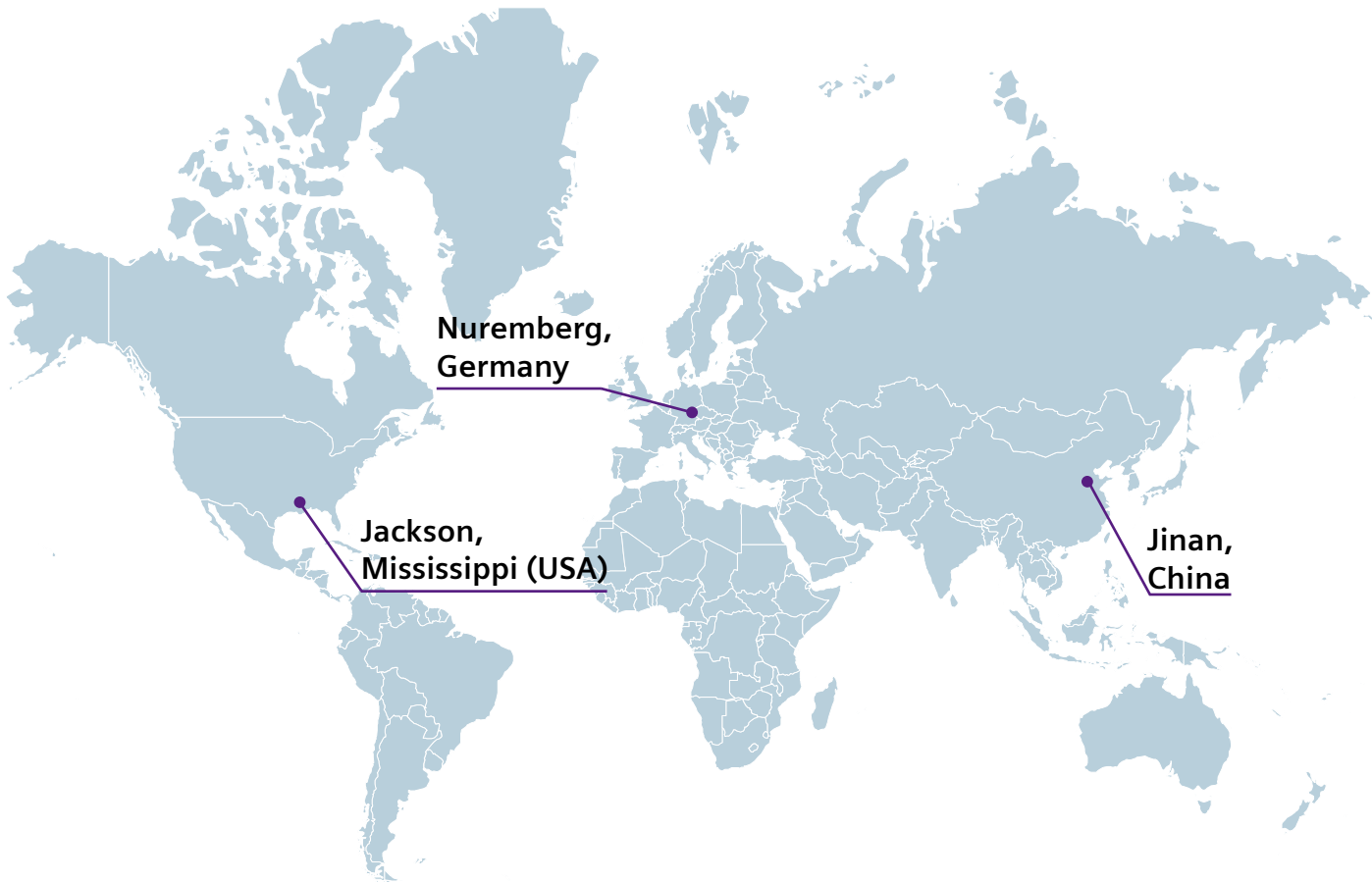


Rated power	690 MVA
Frequency	50 Hz
Voltage	Primary: 25 kV Traction: 2 x 420 V
Power	Traction: 2 x 345 kVA
Weight	2,150 kg
Features	<ul style="list-style-type: none"> • Extremely low production tolerance • Roof mounted



Selected references	Country/Region	Rated power [MVA]	Rated voltage [kV]	Rated frequency [Hz]	Cooling medium
1	Germany	0.585	15/0.996	16⅔	Silicon
2	France	0.585	25/2 x 0.42	50	Mineral oil

100% reliable all over the world – our Tractronic® traction transformer factory network



Siemens Energy operates a worldwide manufacturing and service network to serve customers all over the world. All factories implement the same high quality standards our customers expect. This approach also allows us to easily satisfy all local content requirements.

Tractronic® traction transformer developments are typically designed in the Center of Competence in Nuremberg, Germany, where close collaboration between engineering and production in the prototype stage ensures that products are perfectly prepared for serial production at our factories in Germany, China, and USA.



Nuremberg, Germany

In 2009, the Tractronic® traction transformer manufacturing was relocated from the historical power transformer factory in central Nuremberg to the north of Nuremberg to expand the production facility and manufacture traction transformers only. This location is now the main factory for the complete portfolio of Tractronic® traction transformers and also the global Center of Competence for Siemens Energy traction transformers business:

- Global sales and key account management
- Electrical and mechanical design
- Strategic procurement
- Quality management

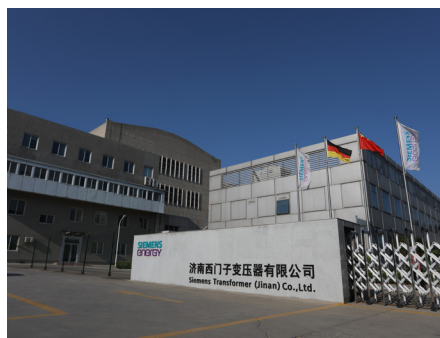
The advanced lean management processes and methods used in the production of the Tractronic® traction transformers ensure high product quality, short engineering processes, and fast delivery lead times.

Engineering departments for electrical and mechanical design are located right next to the transformer production plant to facilitate direct interactions.

The factory is also main repair center for all types of Tractronic® traction transformers.

Certificates

- ISO 9001
- ISO 14001
- ISO 50001
- ISO 45001
- ISO 22163 (IRIS)
- Welding qualification to EN 15085-2



Jinan, China

Siemens Energy Co., Ltd. is one of the major Siemens Energy transformer factories worldwide, and produces oil-immersed power transformers up to 750 MVA/750 kV, generator transformers, traction transformers, ester oil distribution transformer, line feeders, and prefabricated substations while also providing transformer lifecycle management and services.

Established in 2008, the factory delivers localized solutions based on the latest Siemens Energy transformer technology.

The factory provides Tractronic® traction transformers for locomotives, high-speed trains and electrical multiple units (EMU) for the local market, but also for several projects across the globe.

The factory also offers Tractronic® traction transformer repairs for the local market.

Certificates

- ISO 9001
- ISO 14001
- ISO 45001
- ISO 22163 (IRIS)
- Welding qualification to EN 15085-2



Jackson, Mississippi, USA

The team at the Siemens Energy facility in Jackson, Mississippi, views their customers as the sole reason for their existence. Their customers' success is the factory's success. The reliable products manufactured here not only meet the standards set by the IEEE but also set the bar for all other manufacturers with regard to product design, durability, and lifecycle management.

The traction transformer team strives for people excellence across all businesses and believes that the best workforce is a motivated and diverse one – and that's the key to maintaining their competitive edge.

Using local knowledge and leveraging global reach, the factory is able to incorporate the very best components into transformer products while successfully managing costs.

This is ensured by a strict code of conduct that commits vendors to the promise that their business drivers support delivering products and services that are cost-effective, high-quality, and produced in a manner consistent with Siemens Energy's business ethics guidelines.

Certificates

- ISO 9001
- ISO 14001
- OHSAS
- ISO 45001
- ISO 27001

Highest quality secured by stringent testing procedures



Siemens Energy uses the most advanced and comprehensive routine tests, type tests and special tests for maximized product reliability and customer satisfaction. Siemens Energy Tractronic® traction transformers are tested essentially in the same way as power transformers to ensure maximum safety and quality. The routine and type test are in full compliance with IEC 60310:

Routine tests

- Measurement of winding resistance
- Measurement of voltage ratios
- Measurement of no-load primary current and losses
- Separate source voltage withstand test
- Induced voltage withstand test
- Measurement of impedance voltages
- Determination of load losses

Type tests

Depending on customer requirements, type tests examine a variety of performance parameters:

- Measurement of winding resistances
- Measurement of voltage ratios
- Measurement of no-load primary current and losses

- Lightning impulse voltage withstand test
- Separate source voltage withstand test
- Induced voltage withstand test
- Measurement of impedance voltages
- Determination of total losses
- Determination of load losses
- Temperature-rise test
- Measurement of power consumption of cooling unit
- Oil-gas analysis acc. to IEC 1181

Special tests

- Measurement of magnetic field strength at different distances from the tank wall in three orthogonal directions
- Noise measurements
- Partial-discharge measurement
- Mathematical proofs of sudden short-circuit resistance; at the customer's request, a test may also be performed in an accredited third-party laboratory
- Shock and vibration tests

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