SE Rapid
Traction Power System DC Switchgear
GE

GE is a diversified organization covering a myriad of market segments, including infrastructure, finance and media. From energy, water, transportation and health to access to money and information, GE serves customers in more than 100 countries and employs more than 300,000 people worldwide.

The company traces its beginnings from Thomas A. Edison, who established the Edison Electric Light Company in 1878. In 1892, a merger of Edison General Electric Company and Thomson-Houston Electric Company created the General Electric Company. GE is the only company listed in the Dow Jones Industrial Index today that was also included in the original index in 1896.

Industrial Solutions

GE Industrial Solutions, a division of GE Energy Management, is a global leading provider in power distribution, offering a wide range of products which include medium and low voltage power distribution equipment and components, and motor & control systems that are safe, reliable and offer high performance. Its innovative solutions can improve energy efficiency and environmental impact in power plants, power grids, oil & gas, mining, data center, overseas EPC, industrial manufacturing, rail transportation, commercial buildings, residential houses, renewable energy and many other industries.

GE is one of the worldwide partners of the Olympic Games. In 2008, GE assisted Beijing with this tremendous event, which was unprecedented in scale and first-class in its use of science and technology, offering a series of innovative solutions and products for around 400 Olympic infrastructure projects, covering fields in electricity distribution, lighting, security, water processing, benefiting some 37 Olympic venues and 168 commercial buildings. GE also brought its experiences to the 2010 Expo in Shanghai, Asia Games in Guangzhou, Vancouver Olympic Games and continued through to the London 2012 Olympic Games.

Fortune 2011 World’s Most Admired Companies

Interbrand 2011 Best Global Brand

Financial Times 2008 World’s Most Respected Companies

BusinessWeek 2010 World’s Most Innovative Companies

Barron’s 2009 World’s Most Respected Companies

World’s Best R&D Companies 2007 World’s Best R&D Companies
General introduction

SE Rapid traction power system DC switchgear developed by GE is a complete power distribution system with feeder protection and control for the DC traction power system in railway transportation.

SE Rapid consists of incoming cubicle, feeder cubicle, negative cubicle, shunt trip cubicle and over voltage limiting cubicle etc.

With the latest US made digital relay and the modern high-speed DC breaker (Gerapid) from GE, SE Rapid satisfies the needs of DC traction power supply for metro and rail transit all over the world.

SE Rapid offers a system solution in a compact and robust framework. It complies with international standards EN50123/IEC60439-1 for application of low-voltage switchgear. The rated current of the switchgear is up to 6000A.
Features

Safety and Reliability

• Equipped with Gerapid, the high-speed DC breaker with large capacity and high reliability
• Compliance with international standards EN 50123 and IEC60439-1/ IEC61992
• GE's Digital Relay MPR-32 provides all the protection and monitoring functions for DC feeder systems of metro
Reliable protection performance

- Protection module is separated from trolley with only sampling module installed.
- Relay communication network
- Electromagnetic trip and static trip
- Comprehensive protection with multi-level operating authority
- Reliable electromagnetic interlock to prevent wrong operation
- Using fault simulation CPU board to simulate all over-current protection.
Powerful Communication Function

- TCP/IP, MODBUS communication
- RS485, RS232, Ethernet ports, and PC communication
- Transmission rate up to 10M/100M
- Optical fiber communication, anti-electromagnetic interference
Flexible and Easy Operation

- Friendly user-interface in Chinese and English
- Easy installation assisted by smooth-moving trolley
- The trolley suitable for all feeder cubicles makes operation effortless.
- Flexible parameter configuration and easy operation. All configuration parameters can be set up remotely
- A compact framework with high stabilization
- A secondary connector for optical fiber communication inside the cubicle
Typical Applications

DC traction power-systems for urban railway transportation system like metro, light rail and trolleybus

Traction Power Station with complete offer from GE
**SE Rapid Application in Traction Power Station**

DC 1500V rectified from high AC voltage (e.g. 35kV) is supplied to the third rail or overhead line through DC switchgear in traction power station.

SE Rapid series DC Switchgear complies with standard EN 50123 (Railway applications. Fixed installations. D.C. switchgear) and consists of following four types cubicles:

- **Incoming cubicle**: shall be installed between the positive pole of rectifier and DC 1500V positive busbar to control the feeding from rectifiers to DC 1500V busbar.

- **Feeder cubicle**: shall be installed between the positive busbar and the disconnector going to the overhead line. It controls and protects the feeding from DC 1500V positive busbar to feeder line.

- **Negative cubicle**: shall be installed between negative pole of the rectifier and the return rail to control the return current from feeder line.

- **Electronic ground fault protection**: is connected with the negative rail and the earth of public station to measure the voltage between rail and earth. It keeps the safety of people walking on the rail.
Control and Protection for Traction Power System

High-speed DC breaker (Gerapid) and the microcomputer relay MPR are integrated in SE Rapid DC switchgear, which provides the highest-level control and protection function for traction power system.

SE Rapid provides the most reliable basic protection

- Di/dt and △I protection (Rising rate and current increment protection)
- Protection function based on measure of current: The frame current leakage, electromagnetic/static trip, overcurrent, reverse current and etc.
- Protection function based on measure of voltage: The frame voltage leakage, low level voltage protection, rail voltage limiting protection

SE Rapid also provides more advanced protection

- Multi-language selection (Chinese/English), customized according to requirement
- Intelligent internal and external interlock, safe-operation protection
- Control and protection parameter configuration switching freely (Alarm, trip, interlock) by remote SCADA control center or local PC
- Bidirectional low current ground faults, time overcurrent, inverse time overcurrent, and extreme inverse overcurrent protection
- Cable thermal overload protection
- Intertip protection
Structure and Installation

- The switchgear assembly has the type-C material modular construction with self-threading screws joint the frame and components. The frame and enclosure have adequate strength and the rigidity to bear mechanical stress and electrodynamics force during short circuit and components installation.

- Cubicle dimensions (Could be customized) (mm)

<table>
<thead>
<tr>
<th>Cubicle type</th>
<th>Height</th>
<th>Width</th>
<th>Depth</th>
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<tr>
<td>Feeder cubicle</td>
<td>2260</td>
<td>500/800</td>
<td>1500</td>
</tr>
<tr>
<td>Incoming cubicle</td>
<td>2260</td>
<td>500/800</td>
<td>1500</td>
</tr>
<tr>
<td>Negative cubicle</td>
<td>2260</td>
<td>1200</td>
<td>1200</td>
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<tr>
<td>OHL DS cubicle</td>
<td>2260</td>
<td>500/800</td>
<td>1500</td>
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<tr>
<td>OA DS cubicle</td>
<td>2260</td>
<td>500/800</td>
<td>1500</td>
</tr>
</tbody>
</table>

- Protection degree:
  Trolley compartment: IP2X
  Low voltage compartment: IP4X
Layout

Primary System Diagram

DC1500V+

DC1500V-

Operation Conditions

Normal operation conditions

- Ambient temperature: -5°C~+40°C; average temperature within 24h is less than +35°C
- Atmosphere conditions: clean air; ambient relative humidity shall not exceed 50% when the highest temperature is +40°C. When the temperature is low, it allows higher humidity
- Altitude: ≤1400m

Pollution degree

- III
Technical Description

Electrical Data

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<thead>
<tr>
<th>Electrical Data</th>
<th>Value</th>
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<tr>
<td>Nominal voltage $U_n$</td>
<td>1500V DC</td>
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<tr>
<td>Rated insulation voltage $U_{inz}$</td>
<td>3000V DC</td>
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<tr>
<td>Rated voltage $U_{ins}$</td>
<td>1800V DC</td>
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<tr>
<td>Impulse withstand voltage $U_{imp}$ primary circuit 1.2/50 μs Between main circuit and earth</td>
<td>15kV</td>
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<td>Across the isolating distance</td>
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<tr>
<td>Power frequency withstand voltage $U_{pf}$ Main circuit 50HZ/1min Between main circuit and earth</td>
<td>6.9kV</td>
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<td>Across isolating distance</td>
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<tr>
<td>Power frequency withstand voltage $U_{pf}$ Auxiliary circuit 50HZ/1min Between main circuit and frame</td>
<td>2.0kV</td>
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<tr>
<td>Main busbar conventional thermal current $I_{th1}$</td>
<td>6000A</td>
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<tr>
<td>Feeder conventional thermal current $I_{th2}$</td>
<td>4000A</td>
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<tr>
<td>Frame rated earth fault current $I_{ncwe}$</td>
<td>31.5kA</td>
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<tr>
<td>Main busbars rated short-time withstand current $I_{thwe}$ [250ms]</td>
<td>70kA</td>
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<tr>
<td>Main busbar rated peak withstand current $I_{pk}$</td>
<td>100kA</td>
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<tr>
<td>CB rated short-circuit restraint current $I_{rss}$ [250ms]</td>
<td>70kA</td>
</tr>
<tr>
<td>CB rated short-circuit peak current $I_{ps}$</td>
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<tr>
<td>Over voltage category</td>
<td>III</td>
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<tr>
<td>Material category</td>
<td>I and II</td>
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<tr>
<td>Protection level</td>
<td>IP2X/IP4X</td>
</tr>
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</table>

Main Components

- **Breaker**
  - Incoming cubicle: High-speed breaker 4000A auxiliary power supply (APS) DC.220V
  - Feeder cubicle: High-speed breaker 4000A auxiliary power supply (APS) DC.220V

- **Disconnector**
  - Incoming cubicle: Electric disconnector 4000A auxiliary power supply (APS) DC.220V
  - Negative cubicle: Manual disconnector 4000A auxiliary power supply (APS) DC.220V

- **Current divider**
  - Incoming cubicle: 4000A/60mV
  - Feeder cubicle: 4000A/60mV
  - Negative cubicle: 800-10000A/60mV

- **Lightning arrester:**
  - Incoming cubicle: 3EB2 020-7D Rated voltage 2000V (Optional)
  - Negative cubicle (Optional): 3EB2 020-7D Rated voltage 2000V (Optional)
Partition and Shutter

- Partition separates the equipment into busbar compartment, trolley compartment, low voltage control compartment. It prevents neighbor live units from touching each other. It also avoids other object moving from one compartment to another.

- Partition is made of zinc coated metal plate or insulation board. The zinc coated metal plate is connected to protection conductor.

- The partition in the compartment will not be damaged or permanently distorted by pressure of electric arc or free gas produced from short-circuit breaking.

- When the trolley is moved out, the insulated shutter will keep trolley compartment and busbar compartment apart.

Protective Earthing

SE Rapid not only compliances with IEC60439-1, but also provides more advanced earthing protection.

Protection:

- The switchgear has an earthing bar across the whole switchboard. All the frame of electrical components inside the equipment are connected to the cubicle frame by the earthing bar.

- The trolley is connected to the cubicle frame through the sliding contact mechanism.

Earthing:

- All the metal partitions used to separate the live conductor and metal handle of electrical components are earthed effectively.

Racking Mechanism

- Drive shaft
- Clockwise: Test position to service position
- Counter clockwise: Service position to test position
Interlock

- Interlocking system is applied to prevent operator errors.
- The trolley has both mechanical and electrical interlock
- Trolley can be moved out only when DC breaker is open
- Disconnector can be operated only when related breaker is open.

Trolley

- The trolley located in the trolley compartment consists of the cart, high-speed breaker, measuring unit, latch mechanism, interlocker and main circuit contact.
- With idler wheels on both sides, the trolley has guiding function to facilitate the movement into or out the compartment.
- The electric and mechanic interlocking ensures that the high-speed breaker is always open when the trolley moves between test and service position.
- Both side of the trolley have sliding contact mechanism for reliable earthing.
- The main busbar and contactor are visible, with the transparent partition between breaker compartment and busbar compartment made from fire-retardant insulation material.

Window

- The window has the same protection degree as the equipment. It uses transparent self-extinguishing insulation material with the same mechanical robustness of the cubicle.
Cubicle Description

SE Rapid DC switchgear includes incoming cubicle, feeder cubicle, negative cubicle and Electronic Ground Fault Protection

Incoming Cubicle

The incoming cubicle, as the isolation between the positive pole of rectifier and busbar of DC feeder, is installed between two feeder cubicles

- Transparent partition separates the busbar compartment from disconnector-operating compartment, which ensures the safety of operators
- Low voltage control compartment segregated by partition to reduce electrical interference and ensure operator safety.

- Equipped with one set of high quality electromotion disconnector STOL-4000L
- One set of voltage meter to measure the voltage of main busbar
- Earth fault detecting device for control circuits
- DC/DC power supply converter
- Two surge arrestors
- Electric interlocking with feeder cubicles and negative cubicles to prevent wrong operation
Feeder Cubicle

The cubicle consists of low voltage control compartment, trolley compartment and busbar compartment

Low voltage control compartment
- Equipped with digital relay MPR-32 to satisfy requirements of control and protection

Trolley compartment
- Equipped with GE high quality high-speed DC breaker Gerapid
- The trolley equipped with high performance DC circuit breaker, sensor and digital sampling module
- Electrically and mechanically interlocked with feeder cubicles to guarantee safety
- Smooth and easy trolley operation by drive shaft mechanism

Busbar Compartment
- Busbar is located in the rear of the feeder, and outgoing cable is at the bottom
  The transparent shutter between busbar compartment and trolley compartment, ensures entire segregation but clear visibility when the trolley is removed out of the cubicle.
Negative Cubicle

The negative cubicle is installed between two rectifier cubicles, as isolation between the negative pole of the rectifier and rails

- Two high quality manual disconnectors STOL-4000A
- Use one ammeter to measure the total return current, and several ammeters to measure each branch return current
- The frame current leakage protection, detects the current between the frame and the protection earth
- The frame voltage leakage protection detects the voltage between the frame and the negative pole of traction system
- Lightning arrester (Optional)
- Electrically interlocked with feeder cubicles and incoming cubicles to prevent wrong operation
Electronic Ground Fault Protection

- When frame leakage or short circuit between feeder line and overhead earthing line happens, the protection panel will operate according to EN50122-1 standard to guarantee personnel safety.
- The worst fault condition is frame leakage or short circuit between feeder line and overhead earthing line. The equipment bears the maximum short circuit current for longest time.
- It is recommended to disable the voltage component in the protection when using thyristor contactor type protection to prevent unintended tripping.

EZZ Electronic Ground Fault Protection in Traction Power Station

- Anti-shock protection
- Trip on all the ground faults
- Trip the traction substation in case of current return cable broken
- Limit irregular current

<table>
<thead>
<tr>
<th>Construction parameters</th>
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<td>Operation temperature</td>
<td>from 5°C to 45°C</td>
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<tr>
<td>Weight</td>
<td>150-180kg</td>
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<tr>
<td>Dimensions (height x width x depth)</td>
<td>2260x600x600 [mm]</td>
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</tbody>
</table>

Busbar Diagram

- Electronic ground fault protection
- Feeder (breaker) cubicle
- Incoming (disconnecter) cubicle
Introduction of Components

High-speed breaker Gerapid 4207

- Compact design based on modular concept
- GE six-sigma quality control
- High breaking capacity and excellent insulation character

Typical short-circuit oscillogram

Gerapid 4207 with arc chute type 2x2

![Oscillogram](image)

Test voltage: 1600V
Prospective breaking current: 114kA
Time constant: 12 ms

Product Characters

- Compact modular design
- 2 stage contact system
- Driving-mechanic locking device without auxiliary power supply
- Electromagnetic drive integrated with control unit
- Variable wiring terminals
- Complete accessories

Standard Certification

- IEC60947-2
- EN50123
- GB140482 and win CCC certification

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<tr>
<th>Technical Data of Gerapid 4207</th>
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<tr>
<td>Type of Arc chute</td>
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<td>Max breaking capacity kA</td>
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<tr>
<td>Rated voltage V</td>
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<tr>
<td>Rated current A</td>
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<td>Short time withstand current A</td>
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<tr>
<td>Short time withstand current A</td>
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<td>Short time withstand current A</td>
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<td>Mechanical endurance (minimal maintenance)</td>
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### Gerapid High-speed Breaker Reference List (Part)

<table>
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<tr>
<th>Projects</th>
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<tr>
<td>Shanghai Metro line 1 extension</td>
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<td>Shenzhen Metro line 1</td>
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<td>Beijing Airport Metro Line</td>
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<td>BART (retrofit)</td>
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<tr>
<td>Long Island Rail Road-Shea Stadium (SMC)</td>
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</table>
Digital Relay MPR-32

As the market leader in digital relay, MPR-32 integrates control, protection, monitoring and communication for the DC feeder systems in metro applications.

Features

- Powerful communication, including Ethernet, RS485, RS232, transmission rate up to 10M/100M
- 6 levels of authority for safety control
- 32-bit high performance DSP
- High operation reliability (No error codes or wrong operation)
- Local and remote parameter setting
- Systematic fault analysis
- 8 pieces of oscillograph records, 200 pieces of warning and events records
- 22 DI and 32 DO

Control and communication diagram

Protection Functions

- Instantaneous Overcurrent (dual) (Inst)
- Inverse time overcurrent protection (Inv)
- Reverse Overcurrent (Rev)
- Timed Inverse Overcurrent (TOC)
- Cable thermal overload (Lng)
- Rate of rise (ROR)
- Contact Rail Potential Low Voltage (CRP)
- Low Level current Fault (LLF)
- Extreme Inverse Overcurrent (Xinv)
- Load Impedance Measuring/Reclosing
<table>
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<tr>
<th>Metro Operating Companies</th>
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<tr>
<td>SHANGHAI METRO</td>
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<td>LIRR</td>
<td>Long Island, New York,</td>
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<td>WMATA</td>
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Appendix

Product Certification/Standard

- IEC60439-1,1999. Low-voltage whole set of switchgear and controlgear assemblies Part 1: Type-tested and partially type-tested assemblies