STATE OF THE ART DESIGN AND ENGINEERING

Dynapower Company is the world’s largest independent manufacturer of High Power Rectifier Systems. We design, manufacture and test integrated high power transformer-rectifier systems for use in many heavy industrial processes such as electrowinning, electrochemical, electorefining, electroplating and other specialized applications. With experience in power conversion since the commercialization of the thyristor, Dynapower has designs that cover all the topologies and also has exclusive rights to all the products previously designed & manufactured by Rapid Power Technologies for a significant number of large mining applications worldwide.

Dynapower’s High Power Rectifier Systems are engineered, designed, manufactured and tested to internationally recognized standards including ANSI, IEEE, IEC, NEMA, UL, CSA, JEC, etc. Our design capabilities include the complete High Power Transformer Rectifier System – inclusive of fully integrated operator interfaces and control systems for a single unit or entire multi-unit SCADA network. We can evaluate the impact of the rectifier system on the incoming power grid and design power factor correction and harmonic filtering as required. With the latest techniques in all rectifier technologies, application engineers can recommend the optimum rectifier configuration for your project.
THYRISTOR & IGBT CHOPPER RECTIFIERS

Dynapower designs and manufacturers thyristor rectifiers and fast switching IGBT chopper rectifiers for large applications. These are available in 6, 12, 18 and 24 pulse sets with higher order combined systems available. Each multi-pulse arrangement is in an ANSI configuration that is selected for the voltage/current values of the application. The multi-pulse criteria is selected to reduce the supply side harmonic content, reduce output DC ripple, and provide improved regulation.

BOTH RECTIFIER TECHNOLOGIES FEATURE:

- Conservative design margins
- Electrolytic pure Copper bus work
- Heavy gauge construction
- Sub-system integration
- High reliability and maintainability
- Deep hole drilled copper heat sink (water cooled systems)

Our system designs may also be provided with auxiliary equipment as required by the specification, including switchgear, power factor correction and harmonic filters, heat exchangers and free-standing cooling systems.
CHOPPER RECTIFIERS
The copper rectifier designs consist of high frequency switching technology in a modular design package that converts the secondary AC voltage to a regulated output DC voltage.

Larger power systems are constructed of multiple chopper modules to obtain the specified current requirements. Each section of modules has a separate set of sensing and protection and receives directions from the main chopper controller. This chopper conversion process has minimal effect on the incoming power system and a high power factor is maintained at the level of a fixed diode converter.

The transformer section is configured to optimize the harmonics. The total module count results in a 12 pulse configuration as seen by the utility. The load sees a very smooth low ripple DC over the total range due to compact high frequency output filtering. Dynapower designs and manufactures all the water cooled IGBT power modules used in our chopper rectifiers. A full control metering, monitoring, and fast protection scheme is integral to all Dynapower chopper rectifiers.

System shown is 30,000 amp with 2x 15kA choppers — Arizona USA.
**ADDITIONAL FEATURES FOR THE CHOPPER:**

- High power factor over full range
- Low output DC ripple
- Low input AC harmonic distortion
- Dynamic response to input line changes, load set point changes and fault conditions
- Modular construction

---

**DRIVERS**
Dedicated fiber optic gate driver for each IGBT.

**CURRENT SENSING**
Independent IGBT current sensing.

**BUSWORK**
Laminated copper bus designed to maintain a low bus impedance and low voltage overshoot.

**HEAT SINKS**
Water cooled copper for cooling the isolated modules to maintain low junction temperature.

**DEVICE COOLING**
Module heat sink plates are direct cooled by means of inner loop circulated water.

**FLOW PROTECTION**
System is complete with flow detectors.

**TEMPERATURE SENSORS**
Modules each have heat sink over-temperature protection.

**NUMBER OF MODULES**
Conservative design margins with multiple parallel modules per section.

**PARALLEL DEVICES**
Symmetrical assemblies result in current balance controlled within +5%.

**REDUNDANCY**
N-1 power module configuration is supplied.

**DEVICE FUSES**
Each IGBT has a coordinated semiconductor fuse with visual indication of the activated fuse.

**FUSE FAILURE**
First IGBT fuse failure will alarm and failure of a second will result in automatic current reduction or a trip signal being generated.

---

*Four Channel IGBT Power Module rated 2000ADC.*
TRANSFORMERS
Dynapower’s transformer products are custom designed to suit your overall system needs and include Liquid Filled, Dry Type Epoxy Cast Coil and Dry Type Vacuum Pressure Impregnated (VPI). We design and manufacture complete transformer systems in-house. All of our transformers are manufactured using copper conductors and grain oriented silicon core steel. All transformers are designed, manufactured, and tested in accordance with ANSI and IEEE standards, but other standards can also be considered as required by individual customers.

Dry Type Epoxy Cast Transformer features:
- Individual transformer ratings to 12,000 kVA
- All ANSI circuits available
- Primary voltages: 480Vac to 34.5 kVac; 50 or 60Hz
- Class H – 220°C insulation system
- Temperature rise 80°C, 115°C
- ULTRACAST® Copper windings encased in epoxy resin
- Enclosures NEMA 1, 3R and 4 or integrated into the rectifier section of your system
- Cooling-convection, forced air, direct water or via a heat exchanger system

Liquid Filled Transformer Features:
- Ratings to 25,000 kVA
- All ANSI circuits available
- Primary voltages to 38 kV
- Temperature rise 55°C or 65°C
- Mineral oil with options for Silicone fluid and Rtemp
- Copper windings
- Cooling - OA, OFAF, OFWF

Dry Type VPI Transformer Features:
- Individual transformer ratings to 7,500 kVA
- All ANSI circuits available
- Primary voltages: 200Vac to 15kVac; 50 or 60 Hz
- Class H – 220°C insulation system
- Temperature rise designs available 80°C, 115°C and 150°C (Standard)
- Copper windings
- Enclosures NEMA 1, 3R and 4 or integrated with the rectifier section of your system
- Cooling-convection, forced air, direct water or via a heat exchanger system
RECTIFIER CONTROLS
Dynapower designs and manufactures the complete rectifier control systems for use in our high power rectifier systems including the main semiconductor controller, gate drivers and base conversion process control. The integration of this control with commercially available Programmable Logic Controllers (PLC) and Personal Computers (PC) is used to produce a wide range of power rectifier system designs capable of analog or digital control via a variety of serial protocols. The communication network and operator interface may be designed to meet you system control and monitoring requirements.

Remote supervisory system and interface features:

- Email triggered by preset events or conditions such as process milestones like cycle completion, alarms, or faults with the logged information attached for analysis. Milestone, alarm or fault information can be instantaneously supplied to the customer to any email address.
- System and user defined web page for monitoring.
- Data acquisition using various communication protocols.
- Data logging into and internal database.
- Data retrieval from an internal database on the remote monitoring storage system via FTP link.
COOLING SYSTEMS
Dynapower rectifier systems may be designed to be cooled by a variety of cooling methods including forced air, direct water, or a combination of closed loop heat exchanger systems integral to the cabinet or free standing for installation external to the rectifier.

HIGH VOLTAGE SWITCHGEAR
Dynapower manufactures high power rectifier systems up to 38kV and integrates commercially available medium and high voltage components into the systems. We coordinate the AC switchgear for complete system integration and safety.

DC DISCONNECT SWITCH
Dynapower has extensive experience integrating commercially available DC disconnect switches into our systems as required.

DC CURRENT MEASUREMENT
Dynapower rectifiers use precision current DC shunts for the internal control regulation and for the current measurement of our high power systems. Commercially available current measurement systems for outer loop monitoring can be incorporated in accordance with the specifications of the project.

DC BUS WORK
Dynapower uses electrically pure copper bus work exclusively in our rectifier systems. Bus work with plated, bolted joints and flexible connections are designed to minimize bus losses and to match the clients’ application requirements.
FACTORY TESTING
Dynapower has an established high current test facility for the testing of high power transformer/rectifier systems. Complete line up of transformers and rectifiers are tested at rated current and rated voltage with total power levels dictated by our test area capacity.

FIELD TESTING
Dynapower’s Field Service Engineers have extensive experience traveling worldwide to field test, commission and start up major high power rectifier systems. Our field service technicians and system engineers are available at your request for start-ups, preventative maintenance, emergency service and hands-on training with new equipment.

SERVICE & TECHNICAL SUPPORT
Dynapower offers an extensive portfolio of Engineering Services and Power System Services. Dynapower can assure exceptional coverage of your system requirements with single source capability, worldwide resources, local coverage, and rapid response. For more information on our Service capabilities visit us at www.dynapower.com.

AVAILABLE 24/7
- 24-hour technical service line. Call 1-800-332-1111 to speak with a Technical Support Specialist.
- On-site or phone support for all brands of rectifiers.
- Domestic and International on-site service within 48 hours. Same day emergency service also available.
GLOBAL RESOURCES

Dynapower’s team of rectifier power experts is strategically positioned globally. We have service technicians located in North America, Africa, and Latin America to assure exceptional coverage of your power system requirements. Our team of customer service, sales, and engineering professionals are prepared to assist you no matter your location.

Photos 1 & 2: 210 VDC, 50,000 amp electrowinning installation in Arizona, USA.

Photos 3 & 4: 322 VDC, 68,000 amp electrowinning installation in DR Congo, Africa.

Photos 5 & 6: 280 VDC, 30,000 amp electrowinning installation in Sonora, Mexico.
Dynapower designs, manufactures and tests our power rectifiers and transformers in accordance with the prevailing specifications and the following codes and standards.

### ANSI STANDARDS
- C34.2-1968: Practices and requirements for semiconductor power rectifiers.
- C57-12.00 & 12.01: Standards for liquid and dry transformers
- C57-18.10: Standard for rectifier transformers

### IEC STANDARDS
- IEC 76: Power transformers
- IEC 146: Semiconductor converters
- IEC 147: Essential ratings and characteristics of semiconductor devices and general principles of measuring methods.
- IEC 148: Letter symbols for semiconductor devices

### IEEE RECOMMENDED STANDARDS
- IEEE 519 - 1992: IEEE recommended practices and requirements for harmonic control in electrical power systems

### NEMA STANDARDS
- NEMA R1: Safety code for semiconductor rectifiers
- NEMA R16: Electrochemical processing semiconductor rectifier requirements

### NFPA STANDARDS
- 70: National Electric Code

---

200 VDC, 45,000 amp electrowinning installation in Senora, Mexico.