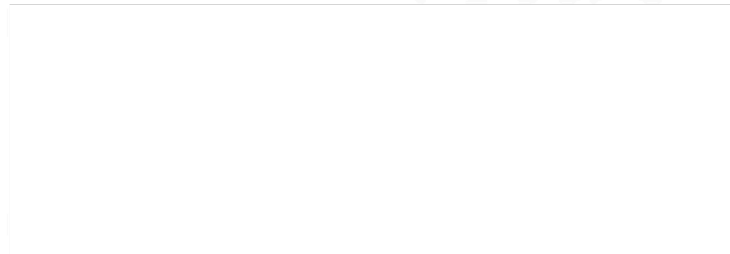
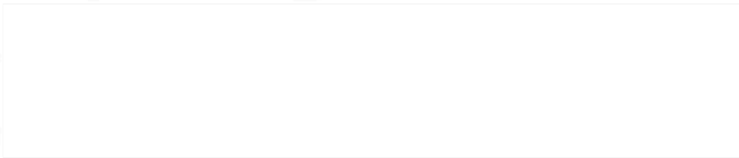


DATE: July 8, 2022



Thank you for your interest in Dynapower's DC Power Supplies. We are grateful for the opportunity to provide you with the following quotation. Please review our proposal and contact me if you have any questions or need any further information. We look forward to working with you.

Thank you,



SPECIFICATIONS AND PRICING

<p>SWITCHMODE POWER SUPPLY</p> <ul style="list-style-type: none"> • Cooling: Direct Water • AC Input: 480 Volts, 3 Phase, 60Hz • DC Output: 12 Volts, 6000 Amperes • Ripple: Filtered. The proposed rectifier will maintain imposed AC RMS ripple to less than 2% of full scale voltage output through the rectifier's entire operating range (10-100% output) • Controls: Integral console with Dynapower's exclusive Touchpad controller (see Technical Description for full functionality) • Interface: Connections for reference and feedback of voltage and current via digital signals over Ethernet • Enclosure Rating: NEMA 4X • Regulation: +/-1% • Warranty: 3 years • 34" W x 40"H x 16" D • 475-500lbs. 			
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TECHNICAL SPECIFICATIONS

Electrical

Input Voltage:	480V _{AC} , 3PH
Frequency:	60Hz
Output Voltage:	Up to 36V _{DC} (see matrix below)
Output Amps:	Up to 6,000A _{DC} (see matrix below)
Ripple:	≤2% from 10-100% of unit output
Regulation Range:	10-100% of rated output
Control Precision:	Voltage/current at +/- 1%
Duty Cycle:	Designed for continuous operation at rated load

Environmental

Cooling:	Direct Water
Enclosure:	NEMA 4X
Max Ambient:	40°C

Communications Interface

Analog (4-20mA and 0-10V)
Ethernet IP
Modbus TCP

Protection Features

Over-Current
Over-Voltage
Over-Temperature
Short Circuit
IGBT Failure (results in unit shutdown)

Standard Configurations Options

VOLTS	AMPS									
	100	250	500	750	1000	1500	2000	2500	3000	
8										
9										
12										
15										
18										
24										
30										
36										

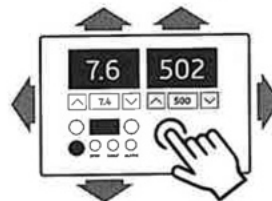
Controls

Standard Controller:	Integrated Touchpad
Control Settings:	Custom Recipe Storage Pulse Ramp & Cycle Timer Set Current Set Voltage ON / OFF Start / Stop Stand by / Run Amp Hours
Control Outputs:	Onscreen Diagnostics Current and Voltage Feedback On Signal Run Signal Actual Amp Hours Actual Run Time Diagnostic Alarms

Control Options



Touchpad Controller: Flexible, reliable, and user-friendly programmable controller with precision digital controls and intuitive recipe storage.



Multi-Unit Touchscreen Controller: Control up to 10 rectifiers from a single intuitive touchscreen interface.



PC-Based Process Controller: Graphical interface PC application designed for process control of 1 to 10 rectifiers.

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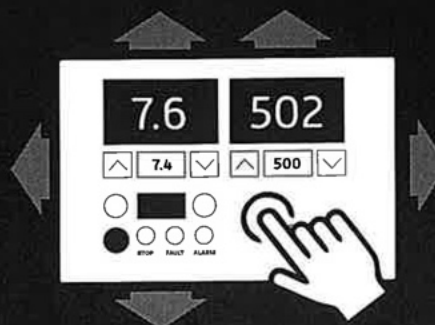
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Multi-Unit Controller

Control up to ten units from one interface

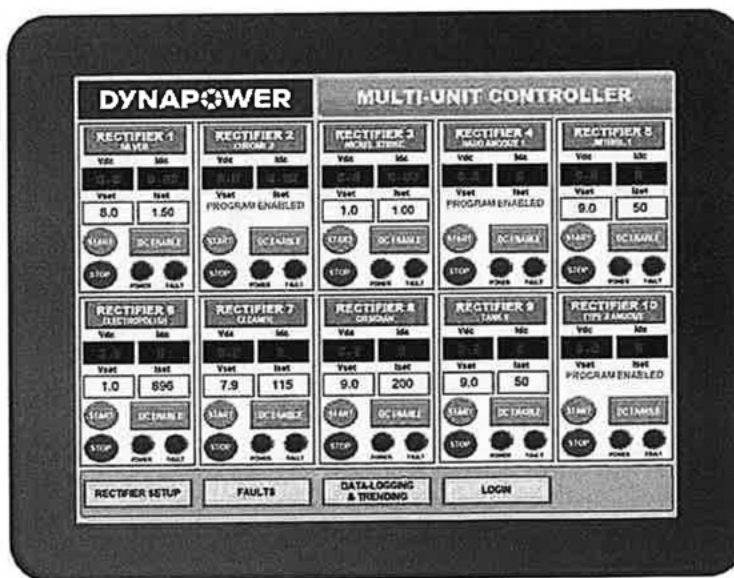


Our Multi-Unit Rectifier Controller offers convenience and efficiency by controlling multiple rectifiers from a single user-friendly touchscreen that can be centrally located in any facility.

Compatible with both SCR and switchmode rectifiers — which may include a combination of up to 10 power supplies of varying sizes — this controller saves valuable time with the automation of recipes, fault diagnostics, and data logging of all connected rectifiers from a central control interface.

With the Multi-Unit Controller, you can create and store up to 12 custom recipes to suit any process, ensuring your process is completed the same way every time. Recipe steps include ramp, dwell, pulse, amp-hour, and cycle functions.

To ensure all audit requirements are satisfied, the Multi-Unit Rectifier Controller features data logging for objective evidence. The data logging feature saves detailed DC voltage and current feedback & setpoint data and reports upon the completion of every successful finishing cycle. All history is easily accessible for download and review for record keeping.



The Multi-unit controller comes built into a standard remote console, allowing for flexible controller placement. Custom control placement options are also available on request. This controller can also be retrofitted to existing Dynapower rectifiers to modernize the control of your power supplies.

Multi-Unit Controller

Features

12.1" Touchscreen interface (1024 x 768) for easy control

Graphic display for viewing unit output, set-point reference levels, status indication, setup, and special operating modes

Voltage and Current set-point adjust

Amp-hour totalizer with 9-digit resolution

Amp-hour count dousing cycle. Can program digital output to change state after 'X' Amp hours is reached and program output to stay energized for 't' seconds.

Status screen showing all input and fault states

In depth active fault and history reports to quickly identify and diagnose faults

DC voltage and current feedback and setpoint trend display with cycle-based **data logging**

Polarity reversal function (when applicable rectifier hardware present)

Selection for **customer remote interface** (AUTO MODE) via Ethernet TCP/IP, Modbus TCP or Remote Analog (4-20mA/0-10VDC)

Temperature monitoring readback/fault capability (Contact Dynapower for more information on hardware requirements)

Basic Functions

Ramp rate set-point adjust for both voltage and current modes

Amp-hour cycle-limit adjust

Pulse set-point adjust for both voltage and current modes

End of cycle indication

Cycle timer/voltage cycle limit adjust

Program Functions

Store up to **12 multi-step programs** per rectifier

Each program contains up to **8 steps** that include **ramp, dwell, pulse, amp-hour, and cycle functions, step repeat/jump functions**

Selectable time-base of milliseconds, seconds, minutes, or hours for all timers

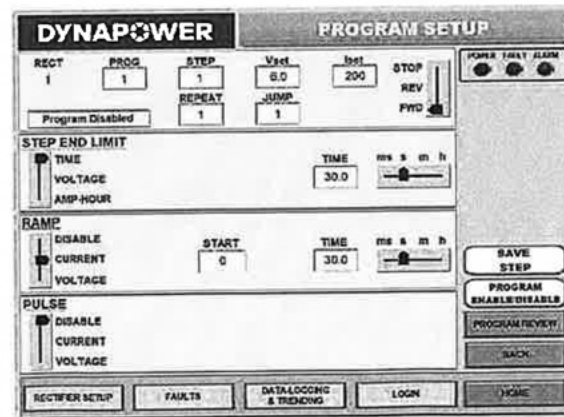
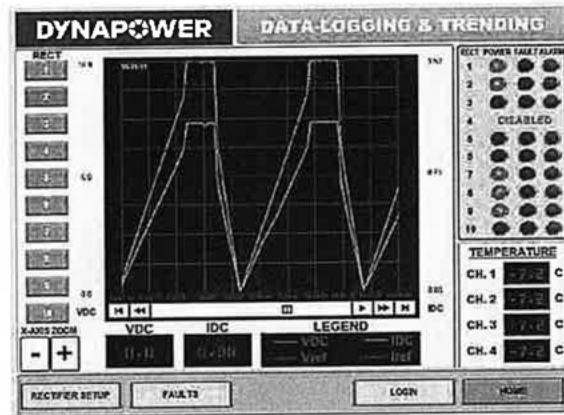
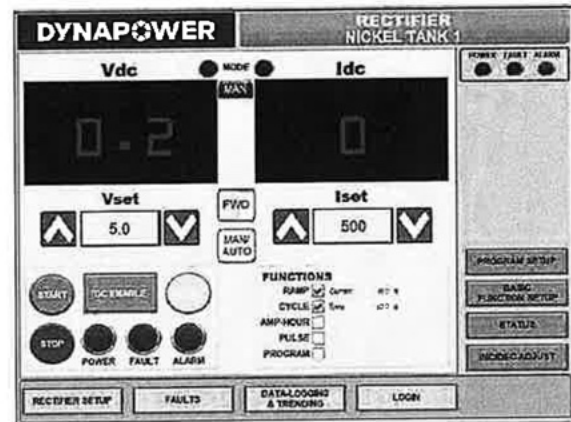
Intuitive and **visual interface to set up and review programs**

Step repeat/jump parameters to allow for complex waveforms

Ability to **copy and delete full programs**

Programs and set-points **automatically restored** upon power-up

End of program indication



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WATER & WATER QUALITY REQUIREMENTS (WATER-COOLED UNITS)

Water Requirements

Following are the water requirements for water-cooled units:

- Water Temperature: Above dew point up to 30°C/86°F to avoid condensation
- Pressure Differential: 25-30 PSI across the inlet to outlet
- Maximum Water Pressure: 65 PSI
- Approximate ΔT : 10°C/50°F
- Approximate Flow Rate: 1.5GPM per Circuit

As a standard, the solenoid valve controls cooling water in accordance with the position of the main contactor to prevent the flow of water when the rectifier is de-energized.

Water Quality Requirements

The cooling water, if required, shall have the following quality:

- A neutral or slightly alkaline reaction (i.e., a PH between 7.0 and 9.0)
- A chloride content of not more than 20 parts per million
- A nitrate content of not more than 10 parts per million
- A sulfate content of not more than 100 parts per million (Switchmode Power Supplies) or 250 parts per million (Silicon Controlled Rectifiers)
- A total solids content of not more than 250 parts per million
- A total hardness, as calcium carbonate, of not more than 250 parts per million
- For Silicon Controlled Rectifiers, conductivity should not exceed 100 uS/cm
- For Switchmode Power Supplies, conductivity should not exceed 1000 uS/cm

Condensation

Cooling water temperature should be adjusted properly to avoid condensation on water-cooled metallic surfaces and electrical insulation. Ordinarily, this is not an issue if the cooling water temperature is at or above 25°C/77°F. If the cooling water temperature is below 25°C/77°F, humidity control may be necessary to stop condensation. When power thyristors are placed in operation, all surface moisture must be eliminated before voltage is applied. Do not allow thyristors to come into contact with water. Condensation must be wiped off to avoid damage to the thyristor.

Special Instructions for Winterizing Water-Cooled Equipment

Water cooled equipment contains water lines and coils that may be subject to freezing if the temperature of the enclosure goes below 1°C/33°F. The expansion of such water in the system may cause the system to leak. Liquid is removed from all water-cooled units before shipping. If the unit is shipped between September 15 and April 15, any small amounts of liquid remaining are an anti-freeze mixture. If water cooled equipment is purchased during the warm part of the year, or is put into use and then placed into storage, it will be necessary for the customer to flush the cooling system with glycol if the units are stored at lower than 1°C/33°F.

Dynapower uses 20% mixture of propylene glycol (good for -7°C/18°F.) If colder temperature is expected, use the chart below.

PROPYLENE GLYCOL (UNINHIBITED)

Percent Glycol By Volume	Freezing Point	
	Degree C	Degree F
1.25	-3.9	25
17.0	-6.7	20
25.0	-12.2	10
32.5	-17.8	0
38.5	-23.3	-10
44.0	-28.9	-20
49.0	-34.4	-30
52.5	-40.0	-40

INSTALLATION NOTICE

Please note that a water strainer is included as a loose part with the rectifier. The strainer must be installed on the intake line ahead of the solenoid valve. For further details about water cooling quality requirements, please see the O & M manual.

WATER-COOLED SWITCHMODE POWER SUPPLY TECHNICAL DESCRIPTION

RATING

All units are rated at 100% continuous full load output.

OPERATING CONDITIONS

Equipment is designed for operation in a 30°C/86°F average, 40°C/104°F maximum ambient and a maximum altitude of 3,300 feet. Please consult the factory if water cooled units are intended to be stored or operated near or below freezing temperatures, or if any equipment is expected to be subjected to temperatures below 5°C/41°F.

HEAT SINKS

Thyristors and diodes, when applicable, are mounted on cooling surfaces designed to remove heat from these devices while in operation. Water cooled heat sinks are manufactured in-house from copper bus bar which is deep hole drilled to form water passages. Individual clamping structure is laid out for each device to maintain proper compression and allow for individual device maintenance. Our conservative design results in substantially greater cooling than other methods which minimizes semiconductor junction temperatures.

TRANSFORMER

Dynapower transformers are conservatively designed to provide an efficient, transformer that offers the customer optimum performance. These transformers, which form the heart of any rectifier, are manufactured in the following manner:

- **Design:** IGBTs convert the rectified 60Hz AC line frequency to a 25 kHz primary frequency allowing the transformer to be made in a much more compact package than a rectifier of other construction technologies.
- **Winding Material:** Electrolytically pure copper.
- **Core Material:** Multi-part ferrite magnetic steel.
- **Insulation Material:** Class 220°C insulation is employed within and between primary and secondary windings.
- **Water Cooling:** Water is directed through heat sink assemblies on which the transformer secondary windings and other components are mounted.
- **Coils:** All coils are wound for stress distribution under fault conditions to provide superior mechanical strength.

DIODES

These devices are selected to be operated at an extremely conservative utilization level requiring only a fraction of the device rating. This conservative design, coupled with an oversized cooling system, ensures low junction temperatures on the semiconductor devices and provides long-term, reliable operation.

ELECTRONIC CONTROLS

Dynapower designs and manufactures its own electronic printed circuit control boards. Our quality assurance program includes complete testing and "burn in" of every board prior to installation. The latest CMOS integrated circuits insure reliable and efficient performance. All Dynapower rectifiers have the following standard features:

- **Automatic Current Control (ACC):** Continuous output control, from 10% to 100% of the power supply current rating is provided. Regulation of $\pm 1\%$ of system nameplate rating is supplied from 10% to 100% of the power supply current rating. Automatic crossover to Automatic Voltage Control is provided.
- **Automatic Voltage Control (AVC):** Continuous output control, from 10% to 100% of the power supply voltage rating is provided. Regulation of $\pm 1\%$ of the system nameplate rating is supplied from 10% to 100% of power supply voltage rating. Automatic crossover to Automatic Current Control is provided.
- **Inhibit Circuit:** A dry contact closure will clamp the electronic output and prevent conduction thus reducing the output of the power supply to zero. This feature is useful for line interlocking and interfacing with automation.

TOUCHPAD CONTROLLER

The following functionality is available with Dynapower's exclusive Touchpad interface controller mounted on the front panel of the unit or on an optional remote control enclosure:

- 4 digit digital setpoint and run display of DC Volts and DC Amperes
- Precision voltage and current pushbuttons with setpoint displays
- Start, stop, reset, manual/auto
- 2 line fault and operational status display
- Ramp setpoint adjust and run display
- Ramp in voltage or current modes
- Ramp to a setpoint
- End of cycle alarm
- Selectable time base of milliseconds, seconds, minutes or hours
- Time resolution of 00.0 sec/min/hr
- Amp-hour setpoint and run display
- Totalizer with 8 digit resolution
- Pulse Setpoint adjust and run display
- 10 millisecond on/off pulse time capability
- Pulse in current or voltage mode
- Consult factory for faster pulse waveforms
- Create, edit and store custom programs
- 12 multi-step program capability, with 8 steps per program
- Setpoints and program parameters are automatically restored upon power-up

- Operating modes run concurrently, allowing complex waveforms & reversing profiles

ENCLOSURE

The design will consist of a NEMA 4X stainless steel enclosure. The stainless steel material allows it to operate in extremely caustic environments, and its compact design is ideal for limited space applications. Our Switchmode Power Supply can be mounted where a standard remote control console might otherwise be located

PROTECTION

All Dynapower rectifiers have a multi layered protection scheme, which includes:

- Thermal Overload Protection
- Electrical Overload Protection
- "Fault" Indicator
- "Power On" Indicator

COOLING

Dynapower's attention to detail in the design and construction of the cooling systems ensure that heat generated during normal operation is removed from each component. Our conservative design approach substantially increases the reliability providing our customers with rectifying systems that are virtually maintenance free. Direct water cooling is employed to maintain semiconductor and transformer temperatures well within manufacturers' ratings.

OPTIONAL FEATURES

Depending on ratings the following functionality may be available with the proposed products. Please consult with your sales engineer to confirm availability and pricing:

- Solid State reversing
- Mounting of control interface on an external remote control console