

TRANSFORMER RECTIFIERS & CONTROLS 1.6.1

OPTIONS:

AVAILABLE TYPES

Indoor or outdoor. Oil filled or dry type (air-cooled). Wall, pole, or base mounting.

SUPPLY

Single or three phase input, voltage to customer requirements. All **BAC** rectifiers are dual frequency 50/60 Hz.

OUTPUTS

Preferred ratings:

DC Volts: 12, 16, 24, 48, 75, 100V

DC Amps: 5, 10, 15, 25, 50, 100, 150, 200, 250, 300, 400, 500, 600A.

CLIMATIC CONDITIONS

BAC rectifiers can be manufactured for operation in the severest of climatic conditions. Standard outdoor units are designed to operate in ambient temperatures of up to 50°C in the shade, with a degree of protection against dust and water ingress to IP55.

TRANSFORMERS

All transformers are manufactured and tested according to BS171, IEC76. Magnetic cores are constructed from low-loss, grain oriented materials. Coils are wound using high temperature (180°C) insulated high conductivity copper, though temperatures are restricted to a maximum hot spot temperature of 100°C. Double wound transformers are also fitted with an earthed screen between windings.

Auxiliaries

All auxiliary and control circuits are protected by HRC fuses.

All fuses are to BS88 and are installed in suitable fuseholders or, with semiconductor fuses, on suitable mounting pillars.

RECTIFIERS

Three types of rectifier elements are available:

- a) Silicon diode
- b) Selenium
- c) Thyristor (SCR)
- d) Switch Mode

BAC rectifiers use full wave rectification circuits of the following types:

Single phase bridge
Three phase bridge
Double star

Most cathodic protection rectifiers use either single or three phase bridge circuits. However, by using the double star circuit, low voltage (up to 48V dc) equipment with current ratings of more than 100A dc can be used. This results in considerable savings in both capital and operating costs.

All rectifier assemblies are generously rated for voltage and are designed to operate well below manufacturers recommended rated operating temperatures.

PROTECTION

Input

Depending on customer requirements and type of equipment, one or more of the following devices are connected on the input side of the rectifier.

- a) Switch fuse
- b) Moulded case circuit breaker
- c) Miniature circuit breaker
- d) RCCB (earth leakage circuit breaker)

Rectifier

Silicon diodes and thyristors are protected by high speed semiconductor fuses and metal oxide or selenium transient voltage surge protectors. Selenium rectifiers are protected by HRC fuses.



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METERS

Meters fitted as standard to BAC rectifiers are of the moving coil type to BS89 class 1.5. DIN pattern meters of the 72mm or 96mm case size will be fitted.

Ammeter shunts, where fitted, will be of the brass-ended type to BS89 class 1.0.

Voltmeters are protected by fuses.

At the customer's option, standard meters can be replaced by hermetically sealed types to DEF STAN 66-7 or digital (LED) instruments.

ENCLOSURES**Oil Filled Equipment**

Oil tank and integral control instrument enclosure are fabricated from 3.00mm thick steel.

Access to controls, terminals, etc., is via a hinged cover closing on a positive sealing gasket. The cover is fitted with a minimum of two stainless steel quick release toggle catches, which incorporate a padlocking facility.

Meters are viewed through a 4mm polycarbonate (Lexan R) window.

All external fittings such as hinges, screw fixings, etc., are of stainless steel.

Dry Type Equipment

Several types of enclosures are available depending on size and type of equipment. These include glass-reinforced polyester, aluminium and steel.

These can be supplied as ventilated units for clean indoor environments or protected to IP55 or IP56 for more severe conditions.

All oil filled equipment is supplied complete with the following:

Oil drain, oil sight gauge, oil filler, thermometer pocket, lifting lugs, silica gel breather, and sunshades where required.

FINISH

All external surfaces and internal surfaces of air filled chambers:

Shot blast to SA 2½, Zinc flame spray 100 microns prime, undercoat, topcoat stove enamel dark grey. Total 100 microns dry film thickness.

Internal surfaces of oil tanks are thoroughly cleaned, degreased and painted.

CONTROL

All of the generally accepted methods for the output control of cathodic protection rectifiers are available from BAC and these include:

Manual Control Systems

- a) Off-load control of output voltage by tappings on the rectifier transformer secondary winding. The preferred number of steps is 25 for voltage control from 0% to 100% by adjustment of coarse and fine tappings. Other combinations are available to suit individual requirements.
- b) On-load control by tappings on the transformer secondary winding. This is restricted to 15 steps from either 0% or 20% to 100% of dc volts by use of coarse and fine switches. This is available only on rectifiers of up to 50A dc for single phase or 100A dc for three phase units.
- c) On-load control by multi-tapped auto transformer providing control of output from 0% or 20% to 100% in 63 steps by use of coarse medium and fine selector switches.
- d) On-load variation of output voltage by stepless autotransformer connected in main transformer primary. Control range is from 0% to 100%.

Automatic Control Systems:**a) Constant Current Control:**

Using a Thyristor rectifier, this system enables the operator to set the required dc output current rating of the equipment. Once set, this value will be maintained within close limits (typically $\pm 1\%$ maximum rating of the rectifier) irrespective of changes in load resistance or supply voltage variations $\pm 10\%$. The equipment will operate into a short circuit without damage.

An additional facility on this equipment is that the dc output voltage can be adjusted to any value up to maximum. This will act as a voltage limit to prevent damage to any load, which may be sensitive to excessive voltage.

b) Automatic Potential Control (APC)

Using thyristor control as in the constant current equipment, the APC rectifier will control dc output from the rectifier in response to a signal from a permanent reference electrode and will maintain the pre-set protection



potential to close limits (typically +10mV depending on type of structure).

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The **BAC** APC rectifier may be used in its automatic mode with variable voltage and current limits. As a manually controlled system operation can be in either a constant voltage with current limit mode, or constant current with voltage limit.

c) Modular Control System (MCS)

This type of control system is normally only applicable for the cathodic protection of power station cooling water systems and other complex structures. **BAC** MCS rectifiers are individually designed using standard control modules to suit the particular installation.

The equipment comprises a main transformer rectifier, which provides the total dc capacity to protect the structure.

This total capacity is then divided into several outputs, which are individually controlled by using transistorised automatic potential control modules.

The outputs from these modules are again divided and fed via suitable current balancing resistors and monitoring shunts, to the individual impressed current anodes of cathodic protection system.

A rectifier of this type may have to supply over one hundred anodes with various alarm facilities.

OPTIONAL EQUIPMENT

The following optional items and features are available for most of the range for **BAC** Cathodic Protection Rectifiers.

Dial Type Thermometers:

2½" diameter bimetallic thermometer for measurement of top oil temperatures.

Anode Junction Boxes:

Provided to split dc output from the rectifier to supply several anodes. Anode junction boxes can be supplied complete with adjustable resistors for current balancing, shunts, and ammeter for monitoring individual anode currents.

Cycle Timer:

Two main types of ON/OFF cyclic timers are available:

- Electronic type with on and off times variable from 5 to 200 seconds.
- Synchronous motor type with on and off times variable in steps of approximately 30 seconds.

All equipment fitted with cyclic timers also incorporate a switch to select either continuous or timed output. All but the smallest rectifiers also have a contactor to provide the load switching.

Potential Meters:

A millivoltmeter for measurement of protection potentials is often required and three types are available for installation in rectifiers.

- Moving coil, high impedance voltmeter (up to 100,000 ohms/volt). This instrument can be used with supply to equipment turned off.
- Moving coil voltmeter of lower impedance than a) but fitted with unity gain amplifier giving actual impedance of 1 megohm/volt minimum.
- Digital (LED) voltmeter with high input impedance of 1 megohm/volt minimum.

Items b) and c) are normally supplied from the rectifier input and cannot be used with equipment turned off.

Kilowatt Hour Meter:

Supplied connected to ac input to record power consumption of equipment.

Hours Run Meter:

Supplied connected to ac input to record total hours of equipment operation.

Ampere/Hour Meter:

Connected to dc output this instrument records total ampere/hours supplied by equipment.



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ALARM

Current Alarm:

Gives indication of high and low levels dc currents supplied by equipment. Alarm trip levels for both high and low currents are available and indication is normally by warning lamps.

Potential Alarm:

Gives indication of low, normal and high protection potentials. Primarily intended for use with **BAC** APC rectifiers but it can be used in any cathodic protection installation, which includes permanent reference electrodes.

As with the current alarm trip levels are variable with indication by warning lamps and volt free contacts for remote indication can be supplied.

Lightning Protection:

Surge Arrestors, normally of the Bowthorpe EMP LTXZ80 or LTP290 type are available at the customer's option for fitting to ac input and dc output of rectifiers.