Twickenham
Scientific Instruments

Superconducting Magnet Controller

Twickenham's SMC range of Superconducting Magnet Controllers - proven high technology at the service of superconducting systems.

Special features of the SMC range include:

Modular design, allowing master-slave operation for higher current models;

Many single module units can have integral electronic reversing switch option fitted - external reversing switches are available for other systems;

Each module is independently fail safe protected, air cooled and has an internal high stability shunt for greater accuracy;

RS232 operation with short-form codes for ease of automatic computer operation and confirmation of the operational status shown by a backlit liquid crystal display on the front panel;

Adjustable output for depersisting switch heater and input for accessory or safety trip signal;

The SMC fully configurable from the front panel.

Proven computer control

The SMC is supplied with an optically isolated RS232 interface giving the advantages of computer control without the risk of earth loop burn-outs. This enables the SMC to perform sequences of magnet energisations and sweeps either by interactive operation or from a computer program controlling the SMC as one of many instruments within a complex experiment.

Computer control of the SMC provides the additional benefit of proven unattended operation on a round-the-clock basis. The SMC will run locally or over long distances via fibre optic or modem links to the control computer, making it ideal for today's large scale experiments.

The SMC's capacity for unattended computer controlled operation naturally includes fail safe protection against unforseen events such as quenches, loss of helium or mains failure. In addition, a safety trip signal can be used to provide a rapid or a controlled de-energisation of the magnet system in the event of another monitor system providing a signal.

The SMC interface commands consist of short form ASCII codes which provide a comprehensive instruction set to control the unit. The SMC series only talks in response to a command issued from the control computer. Details of critical events, such as a quench, are recorded and stored for later interrogation. The interface bus is therefore not dominated by unwanted, unnecessary ASCII characters.

Dual ramp mode

The SMC has an integral digital ramp generator for constant current ramps lasting from a few seconds to well over a day. Ramp rates are selected from one of the 65 preset values spread logarithmically over four orders of magnitude, or the selected ramp rate can be entered via the front panel numeric keys or through the interface.

Alternatively the ramp generator can operate in constant voltage mode, which takes over if the selected ramp rate demands a terminal voltage in excess of the pre-set limit.

The ramp generator can be indefinitely paused via the 'Pause' button or through the interface.

Fundamental and Operational Parameters

The SMC allows the setting of all the operational parameters either via the front panel controls (with the use of the numeric functions of the keys) or via the interface.

The fundamental system parameters are stored in NOVRAM, together with the latest operational parameters entered by the user or computer, such as ramp rate, voltage limit, Lower and Upper set points.

The two set points, (L)ower and (U)pper, can be set to 0.002% resolution either through the interface or via the front panel numeric buttons.

Fail safe Magnet and SMC Protection

The SMC is fully protected against the problems of quenches, helium loss and power failure.

The output stage quench protection uses a combination of passive and active devices to achieve full protection, even in the event of a power failure, to the control electronics.

The SMC also has a thermal limit trip which will stop a ramp in a controlled manner should the output stage temperature exceed a safe limit. This avoids the possibility of inducing a magnet quench. Such a condition may occur if the supply of cooling air to the instrument has been obstructed.

In the case of mains failure, the SMC will slowly ramp down the magnet, should it not be in persistent mode, despite the lack of power.

Full system protection can be provided by using the SMC in conjunction with a helium level gauge, such as the Helium Depth Indicator (HDI) with the Control option (C) option. The HDI can be used to detect a loss of helium and activate an alarm signal which, coupled to the SMC's external trip input, will then safely de-energise the magnet.

An SMC450-20 system in operation. This master with two slave system operates a 1 m clear-bore superconducting magnet, enclosed in the yellow iron yoke (partly in the background) in a large scale industrial application. *With permission of Outokumpu Technology Ltd (Carpco division), whose logo appears on these units.*

Status Indication

A backlit alphanumeric liquid crystal display provides a comprehensive visual indication of the SMC's status. All information is represented via a series of messages appearing directly on the display. Current output, readout and settings can be in Amps or Tesla, as the user selects.

In normal operation, the display will continuously show the terminal voltage, the target output, the actual output, and an indication that the SMC is ramping to, or has hit a voltage limit. Other information, such as the status of the switch heater, or whether the ramp generator has been paused by the user, is provided by LED illumination built into the relivent front panel switches.

Further options

The modular design of the SMC allows multiple units to be strung together in a 'master-slave' arrangement in order to achieve higher output currents at an affordable cost.

The standard units are able to charge and discharge magnets with $\pm$ 5 V terminal voltage, but high voltage options are available, either $\pm$ 10 V, $\pm$ 15 V or $\pm$ 20 V for fast charging/discharging of large magnet systems.

The ECS reversing switch option is used to allow reversal of the current direction in the superconducting magnet - necessary for measurements such as magnetic hysteresis. For single module systems, the ECS is built into the module, but for larger units, or master-slave systems, it is a separate unit controlled from an input/output port interface of the SMC.

Physical size

All SMC units have the same width and depth. Smaller units are 4U (177 mm) high, while units with the ECS option fitted and/or larger output units are fitted in a 5U (223 mm) high case. Occasionally, as shown in the photograph above, even larger case sizes are used, but that will be for exceptional units only.

Physical and Electrical Specifications

Physical

Size per module 483 w x 177 h x 450 d (19" x 4U case)

483 w x 223 h x 450 d (19" x 5U case)

Front handles add extra 50 mm to overall depth.

Support tray required for 19" rack mounting.

Bench mounting feet add another 15 mm to the height.

Weight per module 20 - 32 kg depending on model.

Clearance Allow 150 mm behind the SMC for cables; Free air access to both sides, bench or rack mounting, for cooling air.

Front Panel

Display 4 row x 20 character alphanumeric backlit liquid crystal display. Display gives full details of the current status of the controller.

Switches 12 momentary make switches (7 with LED illuminators) for control of all functions and setting of parameters with direct front panel numeric input.

Mains switch Illuminated rocker type.

Back Panel

Mains input Filtered IEC CEE22 connector.

Current output M12 studs, with supplied nuts.

DVM output Differential via two 4 mm sockets. 300 Ω source resistance. Nominal 2 mV/A output, calibrated to 0.03%, stable to 10 ppm/°C or better.

Interface Optically isolated RS232 interface with standard DB9-F connector.

Depersisting switch heater output Constant current source, 0 - 255 mA, compliance voltage 18 V, galvanically isolated from main current supply.

Input/Output ports

External trip: An externally supplied signal from for example the HDI control outputs cause the SMC to ramp down an energised magnet. This can be used for system protection.

Reversing switch (when required) Input/output signals for control of reversing switches, such as the ECS reversing switch.

Electrical Specifications

Values quoted at room temperature after 20 minutes warm up.

Output current: 0 to rated maximum.

Setting resolution: Can be set to 1 part in 2^{16} maximum; resolution limit of 0.001A via front panel.

Accuracy: 0.015% of rated output.

Stability: 15 ppm/ °C or better.

Readout resolution: 0.05 A on front panel display; 0.001 A via interface.

Voltage limit Setting: 0 – rated voltage output, in 0.1 V steps. Accuracy: 2 % of rated output.

Digital Ramp Generator

Setting range 10 – 100,000 s, 0 to full output.

Setting resolution 65 values, spread logarithmically over 4 orders of magnitude.

Accuracy 0.1% of set rate.

Environmental

Ambient temperature 10 – 40 °C; SMC will suspend ramp if the output stage temperature exceeds 90 °C.

Mains input is protected by a thermal overload switch.

Humidity: 85% maximum non-condensing.

Stray field: 0.001 T (10 Gauss) maximum at the SMC.

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