



## Introduction to Thyristor Stacks from Caledon

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### GENERAL

Caledon Controls have been manufacturing thyristor stacks for OEMs for several years, and the latest designs incorporate the benefits of considerable applications and design experience. The company currently produces two standard ranges of Thyristor stacks for heating applications; the SRC series for resistive loads and the STA series for transformer coupled loads. These have been specifically designed to meet the requirements of the European EMC and Low Voltage Directives.

The SRC range supersedes the SR range, offering more compact dimensions and simpler mounting. A new range of 3-phase stacks, the STC range is shortly to be introduced. These stacks operate in phase angle or soft start burst fire mode, and offer multiple feedback options and current limit, making them suitable for use with complex loads. The phase angle mode of operation does however generate conducted radio frequency emissions and harmonic currents.

This information sheet is intended to provide a brief overview of the SRC and STA models, and their applications. If you have any further queries, please contact us and we shall be pleased to assist. We are also able to consider special applications, or applications not covered here, and welcome any enquiries.

Both the SRC and the STA series use the burst fire control technique. This eliminates the RFI and waveform distortion associated with phase angle control. Combined with careful driver design and integrated capacitive filters using the latest X1 capacitors from BC Components (formerly Philips), ensures an exceptionally low level of radio frequency emissions, and enables system compliance with the European EMC directive without the need for any additional filters.

The standard ranges cover current ratings from 63A to 800A, using isolated base thyristor modules. The driver cards are suitable for other current ratings, and we can supply units rated up to 1000A on short lead times. The SRC series (resistive load) are available as standard in 2 or 3-phase models up to 200A, and in 1, 2 or 3 -phase models from 250 to 800A. The STA series (transformer load) are available in 1 or 2-phase models for all current ratings. 2-phase models are intended for controlling 3-phase loads, but only switch 2 of the 3 supply lines. They are suitable for 3-phase 3-wire loads, either star or delta connected, and reduce size, cost and heat dissipation. The 2-phase SRC range can also be used to control two independent single phase loads.

The designs incorporate many features to ensure long term reliability. They are conservatively rated, with large heatsinks, and the full current rating is available up to a 50°C ambient temperature. All units are fully protected against voltage spikes with snubbers and MOVs, and are fitted with integral semiconductor fuses for protection against short circuits. The cooling fans are fitted with long life ball bearings. In the event that replacement should become necessary, the printed circuit cards can be changed in a few minutes, and a straight forward mechanical design ensures that the isolated base thyristor modules can also be changed quickly in situ with a minimum of specialist knowledge.

The standard units are designed for incorporation into switchgear or transformer cabinets. The depth of the resistive load stacks enables them to fit in 300mm deep cabinets, and the transformer load units will fit in 400mm deep cabinets. A clear polycarbonate cover prevents accidental contact with live parts, and adequate room is allowed within the cover for crimped cable terminal lugs.

The insulation characteristics are designed in conformance with European standards EN 61010-1 (Safety requirements for electrical equipment for measurement, control and laboratory use), and EN 50178 (Electronic equipment for use in power installations), for use in an environment of pollution category 2. This precludes operation in the presence of conductive pollution or condensation within the cabinet in which the units are installed. The rated impulse withstand voltage is 4kV, which is recommended for operation on supplies up to 300V line to earth, installation category 3. This covers supplies up to 520V line to line with earthed neutral (Nominal supplies up to 480V). Reinforced insulation is provided between control circuits and mains circuits, with 3,700V RMS isolation. Isolation from control circuits to earth, is 1,000V RMS. Operation on supplies above 520V is possible, but it may be necessary to take precautions to limit the maximum impulse voltage the units will encounter, to comply fully with the above standards. Ultimately the impulse withstand voltage is limited by the insulation to earth of the isolated thyristor modules, which have been in use on supplies up to 660V for many years.

A separate information sheet provides more detailed information on the requirements of the European EMC and Low Voltage Directives, and how these apply to systems incorporating thyristor stacks.

### SRC SERIES FOR RESISTIVE LOAD

These units use an economical and versatile high voltage MOSFET driver, with opto-coupled logic input (<2V input = off; >6V = on). Switch on is automatically synchronised to zero voltage of the mains cycle (fig 2a). An LED indicates when the stack is calling for current to flow. Loads may be connected as shown in figure 1a to 1f. In all cases the auxiliary connection supplies the small current needed by the driver, and also serves to connect the rfi filter capacitors. If required, a 4-20mA driver unit is available (supplied mounted in the stack) which converts a 4-20mA signal to logic pulses, with a cycle period of approximately 1 second. This driver requires no power supply, but requires the current drive to be capable of supplying 10V minimum; ie to be capable of driving 20mA into 500 ohms. Other analogue drivers are available with more comprehensive inputs, powered from 24V AC / DC or 115 / 230V AC. All apart from the 63A and 80A unit are fan cooled, and the fan(s) will

require a power supply of either 115 or 230V AC 50/60 Hz.

Outputs which are compatible with 24V DC relay logic or plcs, are provided as standard to indicate failure of the semiconductor fuses. If the 115 / 230V powered analogue driver card is fitted, this is provided with volt free relay contacts which will interface the fuse failure signal to higher voltage logic.

### STA SERIES FOR TRANSFORMER COUPLED LOADS

These units, which represent the cumulation of several years experience with this type of load, are available for single phase loads, or 2-phase control of 3-phase loads (fig 1a, b, c). They can also be configured for control of open delta 3-phase to 1-phase transformer connection (please enquire).

All units use a microprocessor based driver board, requiring a 115 or 230V supply. This need not be phase related to the main load supply. This driver accepts either a logic or 1-5V (4-20mA with 250 ohm burden resistor) input signal, and provides a logic output signal to slave drive other units if required. A separate enable input is also provided. Power supplies and fuses are electronically monitored, and their status displayed on a series of LEDs. An alarm relay is provided for remote indication.

The delayed start angle burst fire technique is employed (figure 2b) to minimise transformer inrush. This technique depends on transformer theory, in which it can be proved that inrush is reduced to zero if switch on occurs at the peak of the voltage waveform. In practice the optimum point is generally just before the peak, if switch off is at the zero on the opposite half cycle. This type of control can be very reliable, and provides the minimum waveform distortion and rfi generation possible when switching transformer coupled loads. It is not however suitable for loads where current limiting is required. The cycle period for 1-5V analogue drive is set at 15 seconds, which is generally suitable for furnace applications. Please consult us if your application requires a different period. A minimum on and off time of 1 second is also preset, to avoid short cycling under logic control, or if the analogue signal changes very rapidly. To ensure correct operation it is important that the switch off, as well as the switch on is correctly synchronised to the mains cycles. To this end the operation is constantly monitored by the microprocessor, and in the event of failure of a supply when the stack is conducting, or reversal of the supply rotation or frequency, indicating that the plant has been disconnected, the next 'on' cycle of the stack is started in phase angle mode, ramped up over 10 cycles, to demagnetise the transformer.

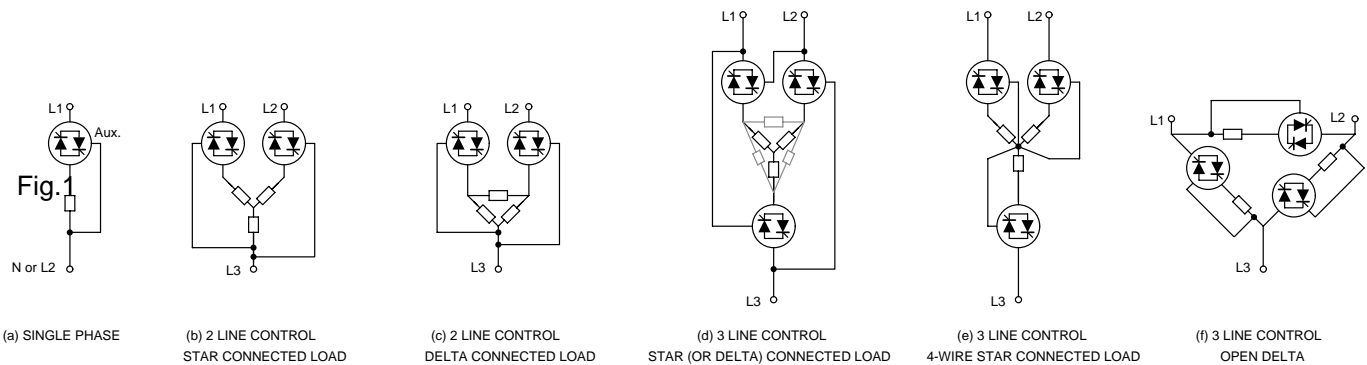
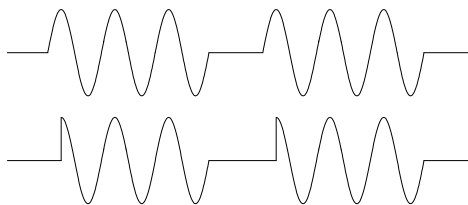


Fig.2



(Fig.2a) Resistive load burst fire

(Fig.2b) Transformer load burst fire