# Pulse-Current Source

The TeachSpin SIM called 'Pulse Current Source' is an electronic module designed to deliver pulses, of controlled duration and stabilized current-value, to an external floating resistive load. The pulse duration can be set in the range ¼ s to 128 s, and the current can be set in the range 20 mA to 320 mA. The current-controlled output has a voltage compliance of about 20 V, so that the full current can be delivered to loads of resistance up to 60 Ω. The potential difference arising across the load can be measured, in real time during the pulse, by a 4-wire method.

## Features:

This SIM requires power from a SIM mainframe or 'crate' (or from TeachSpin's substitute power supply), and it derives all its power from that supply.

This SIM permits the pulsed operation of a constant-current source, stabilizing the output current to a chosen value for a chosen duration.

This SIM is designed for use with a floating resistive load, and permits 4-wire connections to it, so the actual potential difference across the load can be measured in real time.

The pulse may be triggered manually or by external pulse command; the module can also be set to 'c.w.' or continuous-current operation.

## Layout:

Front panel features:

10-position rotary switch: permits choice of pulse duration, from ¼ s to 128 s, by binary steps.

8-position rotary switch: permits choice of stabilized-current output, in steps from 20 mA to 320 mA.

3-position toggle switch: permits choice of triggering mode. 'CW' position gives a (non-pulsed) steady stabilized current; 'Ext Trig' position permits a single current pulse upon back-panel digital command; spring-depressed 'On' position yields a single pulse, upon manual depression.

Voltage Monitor BNC connector: gives a ground-referenced voltage output, a buffered copy of the potential difference developed across the load.

Rear panel features:

DB-9 (female) connector: Accepts a DB-9 male connector, for connection of the SIM to the TeachSpin Cryostat Interface Box (or other interface to load resistor). See Connections (below) for pin assignments.

## Operation:

This SIM provides a way to deliver constant currents, to an external resistive load, for a fixed and chosen duration. The external (resistive) load might be a heater, intended to deliver an accurately-quantifiable heat-pulse to the object to which it's attached. The device does not assume that the heater's resistance is stable with time or temperature, but accommodates variations in that resistance between, or even during, pulses.

The SIM provides for '4-wire connection' to the load-resistor acting as heater. Two leads, here labelled $I_+$ and $I_-$, carry the actual current, and any heat developed in these leads is not included in the quantification. Two more leads, here labelled $R_+$ and $R_-$, and also attached to the two ends of the resistor-as-load, permit the measurement of the potential difference across the load itself. Notice that neither resistance of the current leads, nor any resistance of the voltage-monitoring leads, affect the computability of the energy delivered to the load itself.

### Connections:

This SIM uses a back-panel DB-9 connector to make all its connection to the load.

Use pins 4 and 5 for the current leads to the load.

Use pins 8 and 9 for the voltage connections to the load.

Use pin 1 for logic ground, and pin 2 for digital trigger input.

Use pin 7 for current monitor, and/or pin 3 for voltage monitor.

Note that the low-potential end of the load resistor is *not* at ground potential during the pulse. Hence the load resistor needs to be isolated from ground (ie., 'floating') for proper operation.

### Power:

This SIM derives all its power from the SIM crate (or substitute power supply) into which it is plugged. At maximum current (0.32 A) and maximum output voltage (about 20 V), the output power of this SIM is under 7 W. As the SRS crate can supply up to 70 W to all the modules installed, there ought always to be enough power to operate this SIM.

### Settings:

For manually- or digitally-triggered operation, the 'Time Sec.' rotary switch selects the duration of the 'square-edged' current pulse that will be delivered. The pulse durations, of 0.25 s to 128 s, are controlled by an internal digital clock.

The current, which will be held constant during the pulse, is stabilized at a value selected by the 'Current mA' rotary switch. The SIM will vary the voltage applied to the load (up to about +20 V) so as to servo-stabilize the current to the chosen value, even if the load resistance varies during the pulse.

The potential difference across the load is the third variable which determines the energy delivered per pulse. This is *not* servo-stabilized, nor is it necessarily constant, during a pulse; but its instantaneous value can be monitored, during a pulse, at the 'Voltage Monitor' BNC output. This provides a buffered and ground-referenced copy of the potential difference across the load, as sensed by the $R_+$ and $R_-$ connections to the load.

The SIM's mode of operation is set by a 3-way toggle switch.

> For a one-time pulse operation under manual control, depress the spring-loaded toggle switch from its central, to its lower, position.
>
> For one-time pulse operation under rear-panel digital command, set this switch to its central 'Ext Trig' position, and apply a $0 \rightarrow +5$ V rising edge at the back-panel EXT TRIG input pin.
>
> For steady (non-pulsed) output current at the chosen current level, raise this toggle switch to its upper 'CW' position.

Activation:

The whole SIM is activated as you've as you've energized the SIM crate or equivalent that is powering it. The device can only deliver current if an external load is connected (to back-panel DB-9 pins 4 and 5); loads need to be unconnected to ground, and may be a short circuit, or a load of resistance up to 60 Ω.

Monitor Outputs:

There are three monitor outputs in this SIM; each presents a ground-referenced voltage output.

Front-panel 'Voltage Monitor': this front-panel BNC output is a buffered copy of the actual potential difference that arises across the external load, as measured by the connections-to-load labelled $R_+$ and $R_-$.

Rear-panel '$I_{mon}$' output: pin 7 of the DB-9 connector provides a voltage given by $I \times 10.0\ \Omega$, which may be used to verify that the current $I$ is actually flowing, or may be used as a surrogate ammeter to measure the current actually flowing, during a pulse.

Rear-panel '$V/R_{mon}$' output: pin 3 of the DB-9 connector provides a back-panel copy of the front-panel 'Voltage Monitor' output.

## Application:

This current-source was designed to make possible the delivery of accurately-quantifiable pulses of energy to a load-resistor acting as heater. The energy delivered will be an integral of power × time, so the time-duration of the current pulse is accordingly controlled digitally. The instantaneous power will be given by the current × the potential difference, so the current during the pulse is servo-stabilized to a chosen value. The potential difference might vary with the

temperature of the resistor, and might even vary during the duration of the pulse, so the design provides for the instantaneous potential difference to be measured and recorded (for example, with an oscilloscope) and then to be time-averaged after the fact.