The Claims defining the invention are as follows:

1. A fail-safe programmable solid-state relay comprising:

a base module;

a configuration module;

a control voltage module comprising at least one energy storage device;

a controller module having at least two electrically isolated microcontrollers operating in parallel, each microcontroller comprising an internal EEPROM memory and at least one digital timer; and

at least one switch module comprising at least one switching circuit,

wherein the at least one switching circuit has two switches;

wherein the control voltage module is adapted to receive an applied control voltage or current and to permit pre-selection of an activation voltage or current level and a de-activation voltage or current level;

wherein the at least one switching circuit is placed in a state which is selected from at least one normally open switch, or at least one normally closed switch, or a combination thereof;

wherein determination of a state of the control voltage or current operates independently of a voltage or current of the at least one switching circuit; and

wherein the state of the at least one switching circuit is selected from one of: up to sixteen sets of two normally open switches in series; up to sixteen sets of two normally closed switches connected in parallel; and up to sixteen sets of a combination of two normally open switches in series and two normally closed switches in parallel.

2. The fail-safe programmable solid-state relay according to claim 1, wherein, when the applied control voltage or current exceeds the pre-selected activation voltage or current level, a response to a polarity of the applied control voltage or current is generated and the at least one switching circuit is set to at least one individually pre-determined first state and the at least one digital timer is loaded with a pre-determined value, whereafter the at least one digital timer is started to initiate at least one time delay, an expiry of which sets the at least one switching circuit to at least one individually pre-determined subsequent state; and

wherein, when the applied control voltage or current decreases to the pre-selected de-activation voltage or current level, a response is generated whereby the at least one digital timer is started to initiate at least one time delay, an expiry of which sets the at least one switching circuit to at least one individually pre-determined subsequent state.

3. The fail-safe programmable solid-state relay according to claim 1, wherein when a first applied control voltage or current exceeds the pre-selected activation voltage or current level, a response to a polarity of the applied control voltage or current is generated and the at least one switching circuit is set to at least one individually pre-determined first state and the at least one digital timer is loaded with a pre-determined value, whereafter the at least one digital timer is started to initiate at least one time delay, an expiry of which sets the at least one switching circuit to at least one individually pre-determined subsequent state; and

wherein when a second control voltage or current is applied, the at least one digital timer is loaded with at least one pre-determined time value, an expiry of which sets the at least one switching circuit to at least one individually pre-determined subsequent state.

4. The fail-safe programmable solid-state relay according to claim 9, wherein the at least one switching circuit is placed in a state which is selected from at least one normally open switch, or at least one normally closed switch, or a combination thereof; and

wherein determination of a state of the control voltage or current operates independently of a voltage or current of the at least one switching circuit.

5. The fail-safe programmable solid-state relay according to claim 4, wherein the state of the at least one switching circuit comprises at least two normally open switches connected in series.

6. The fail-safe programmable solid-state relay according to claim 4, wherein the state of the at least one switching circuit comprises at least two normally closed switches connected in parallel.

7. The fail-safe programmable solid-state relay according to claim 4, wherein the state of the at least one switching circuit comprises a first set of at least two normally closed switches connected in series being connected in parallel to a second set of at least two normally closed switches connected in series.

8. The fail-safe programmable solid-state relay according to claim 4, wherein the state of the at least one switching circuit is selected from one of: up to sixteen sets of two normally open switches in series; up to sixteen sets of two normally closed switches connected in parallel; and up to sixteen sets of a combination of two normally open switches in series and two normally closed switches in parallel.

9. A fail-safe programmable solid-state relay comprising:

a base module;

a configuration module;

a control voltage module comprising at least one energy storage device;

a controller module having at least two electrically isolated microcontrollers operating in parallel, each microcontroller comprising an internal EEPROM memory and at least one digital timer; and

at least one switch module comprising at least one switching circuit,

wherein the at least one switching circuit has two switches;

wherein the control voltage module is adapted to receive an applied control voltage or current and to permit pre-selection of an activation voltage or current level and a de-activation voltage or current level;

wherein the at least one switching circuit is placed in a state which is selected from at least one normally open switch, or at least one normally closed switch, or a combination thereof;

wherein determination of a state of the control voltage or current operates independently of a voltage or current of the at least one switching circuit; and

wherein the energy storage device provides sufficient power to a portion of the at least two microcontrollers, whereby when the applied control voltage or current decreases to a minimum voltage or current level, an ability of the at least two microcontrollers to control the state

of the at least one normally open switch, the at least one normally closed switch, or a combination thereof is substantially maintained.

10. A fail-safe programmable solid-state relay comprising:

a base module;

a configuration module;

a control voltage module comprising at least one energy storage device;

a controller module having at least two electrically isolated microcontrollers operating in parallel, each microcontroller comprising an internal EEPROM memory and at least one digital timer; and

at least one switch module comprising at least one switching circuit,

wherein the at least one switching circuit has two switches;

wherein the control voltage module is adapted to receive an applied control voltage or current and to permit pre-selection of an activation voltage or current level and a de-activation voltage or current level; and

wherein the controller module further comprises at least one Ferroelectric Random Access Memory (FRAM) device associated with each microcontroller, wherein upon initialization of a software program used to control the relay, contents of the at least one internal EEPROM memory are copied to the FRAM device and substituted therefor during one or more subsequent operations of the software program.

11. The fail-safe programmable solid-state relay according claim 1, further comprising a display module.

12. The fail-safe programmable solid-state relay according to claim 11, wherein the display module comprises at least one visual indicator selected from at least one light emitting diode, at least one multi-segmented display, at least one liquid crystal display, or combinations thereof.

13. The fail-safe programmable solid-state relay according to claim 11, wherein the display module displays a state of the at least one switching circuit, a level of the applied

control voltage or current, remaining time in the at least one digital timer, an overall state of the relay, or any combination thereof.

14. The fail-safe programmable solid-state relay according to claim 13, wherein the applied control voltage or current is selected from DC or AC.

15. A fail-safe programmable solid-state relay comprising:

a base module;

a configuration module;

a control voltage module comprising at least one energy storage device;

a controller module having at least two electrically isolated microcontrollers operating in parallel, each microcontroller comprising an internal EEPROM memory and at least one digital timer; and

at least one switch module comprising at least one switching circuit,

wherein the at least one switching circuit has two switches;

wherein the control voltage module is adapted to receive an applied control voltage or current and to permit pre-selection of an activation voltage or current level and a de-activation voltage or current level;

wherein, when the applied control voltage or current exceeds the pre-selected activation voltage or current level, a response to a polarity of the applied control voltage or current is generated and the at least one switching circuit is set to at least one individually pre-determined first state and the at least one digital timer is loaded with a pre-determined value, whereafter the at least one digital timer is started to initiate at least one time delay, an expiry of which sets the at least one switching circuit to at least one individually pre-determined subsequent state;

wherein, when the applied control voltage or current decreases to the pre-selected de-activation voltage or current level, a response is generated whereby the at least one digital timer is started to initiate at least one time delay, an expiry of which sets the at least one switching circuit to at least one individually pre-determined subsequent state; and

wherein the polarity of the applied control voltage or current is pre-selectable between polarity sensitive and polarity insensitive and wherein when the polarity is sensitive, a biased relay is provided and when the polarity is insensitive, an unbiased relay is provided.

16. A fail-safe programmable solid-state relay comprising:

a base module;

a configuration module;

a control voltage module comprising at least one energy storage device;

a controller module having at least two electrically isolated microcontrollers operating in parallel, each microcontroller comprising an internal EEPROM memory and at least one digital timer;

at least one switch module comprising at least one switching circuit; and

a unique pin code installed in the base module, wherein each pin is received in a matching pattern of three receptacles provided in a suitably compatible plugboard, whereby installation of the relay into an incorrect plugboard is substantially prevented;

wherein the at least one switching circuit has two switches; and

wherein the control voltage module is adapted to receive an applied control voltage or current and to permit pre-selection of an activation voltage or current level and a de-activation voltage or current level.

17. The fail-safe programmable solid-state relay according to claim 1, further comprising a delayed release function, wherein when the applied control voltage or current decreases to the selected de-activation voltage or current level, a resetting of the at least one switching circuit to individually pre-determined first states is delayed by corresponding pre-determined time values.

18. The fail-safe programmable solid-state relay according to claim 1, wherein at least one of the at least two microcontrollers further comprises an external communication device, whereby the relay transmits data to an external device or service.

19. The fail-safe programmable solid-state relay according to claim 1, further comprising a switch latching function, whereby a state of the at least one switching circuit, once established in the active state, is retained in the active state for an indefinite length of time or until specified pre-requisite conditions are satisfied.

20. A system comprising:

the fail-safe programmable solid-state relay of claim 1; and

a slave device,

wherein the slave device is selected from a relay, a computer, a motor, a bell, or combinations thereof.

21. A method of installing the fail-safe programmable solid-state relay according to claim 1 in a signaling and switching application, comprising:

initially selecting at least two or more of the following variables:

(i) at least one pair of suitable connections on the base module to supply the control voltage or current;

(ii) a desired number and combination of normally open and normally closed switches;

(iii) a value of the activation voltage or current level;

(iv) a value of the de-activation voltage or current level;

(v) a sensitivity of the relay to a polarity of an activation voltage or current;

(vi) an ability of the at least one switching circuit to retain its existing state upon removal of the activation voltage or current; and/or

(vii) a value of at least one time delay; and

pre-setting one or more levels of the at least two selected variables prior to removably attaching the relay to a plugboard.

22. A method of operation using an installed software program of the fail-safe programmable solid-state relay according to claim 1 comprising the steps of:

(i) reading and/or measuring an analog level of the applied control voltage or current and converting it into a digital value;

(ii) periodically and continuously monitoring the digital value of the control voltage or current and comparing it to one or more pre-set levels of the control voltage or current; and

(iii) modifying the at least one switching circuit according to at least one of:

i) the measured value of the activation control voltage or current as required;

ii) an ability of the at least one switching circuit to retain its existing state upon removal of the activation voltage or current or when the activation or current voltage decreases below a minimum voltage or current level; and/or

iii) an instantaneous value of any time delay,

whereby an unsafe state of the relay is substantially prevented.