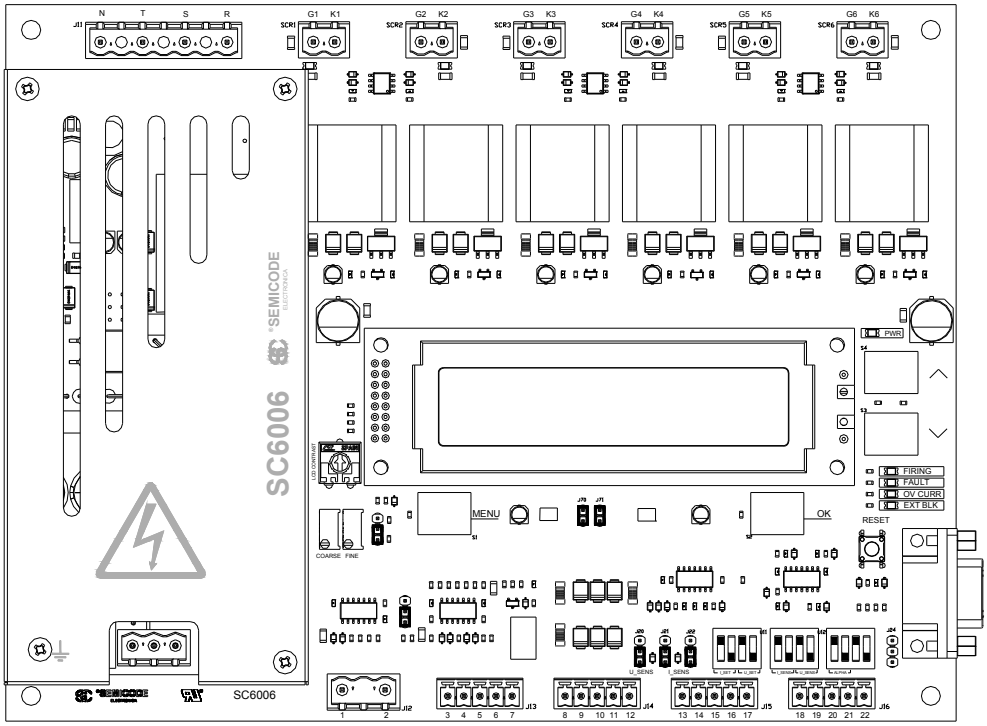
SEMICODE
ELECTRONICA

SC6006: Operation Manual



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1 GENERAL

These operation instructions describe the configuration and functions of the SC6006 and are designed to enable qualified personnel to perform the planning, commissioning and maintenance of this equipment.

These operation instructions comply with the current technical specifications of the device at the time of publication. The contents do not constitute a subject matter of the contract, but serve for information purposes only.

We reserve the right to alter any specification given in these operating instructions, especially with regard to technical data and operation. SEMICODE reserves the right to make modifications with regard to the content and technical data in these operation instructions.

Versatility and ruggedness are the main features of SC6006 providing a lot of regulation options and a great performance in many different applications and environments.

SC6006 is designed to adapt to most common rectification and control schemes, like W3C, B6C, M6C and M3.2C. Optionally can also be applied to W3H, B6H and M3C. The power adjustment can be made by current or voltage through potentiometers or by external analog signals. SC6006 also has protection against current peaks, soft start up ramp, inhibit input by external relay, possibility of a shunt terminal + or -, current transformer direct input, etc.

The SC6006 is also a communication-capable thyristor power controller. It can be used wherever alternating voltages, alternating currents or outputs in thermal process technology e.g. need to be controlled. Main applications for this circuit are those where is needed a safe control for large currents through thyristors, for example thermal process, surfaced treatments, electrolytic process, ovens, lightning, etc.

1.1 Special Features

- Wide voltage range for supply the entire system up to 480 V_{AC}.
- High SCR voltage applications up to 700 V_{AC}.
- Soft start and soft stop .
- Autoset mode. Automatic sync, rotation and output assignation.
- Operating modes: phase regulation, burst regulation,relay mode or 6 independent SCR drivers.
- Open-loop or closed-loop with U and I control modes.
- Connectivity and system control through RS-232 interface.

1.2 Warranty

In the event of any claims in connection with the SC6006, please contact us quoting:

- Fabrication number / serial number.
- Reason for the complaint.
- Environmental conditions of the device.
- Operating mode.
- Period of use.

Goods and services are subject to the general conditions of supply for products of the electrical industry, and our general sales conditions.

Claims in connection with supplied goods must be submitted within one week of receip, along with the delivery note. SEMICODE Will rescind all obligations such as warranty agreements, service contacts, etc. entered into by SEMICODE Or its representatives without prior notice if maintenance and repair work is carried out using anything other than original SEMICODE spare parts or spare parts purchased from SEMICODE

2 SAFETY INSTRUCTIONS

The safety instructions and operating manual are to be carefully read prior to installation and commissioning

2.1 Operator and personnel requirements

The operator must ensure the following:

- The safety regulations of the operating instructions are observed.
- The accident prevention regulations valid in the respective country of use and general, national and regional safety regulations are observed.
- The operating conditions and restrictions resulting from the technical data are observed.
- Only qualified electro-technical personnel who are familiar with the pertinent safety and installation regulations may perform the connection installation testing and operation of the device.
- This operating instructions must be read carefully prior to the installation and initial start-up.

2.2 Proper and intended use

- SC6006 SCR power controller is a component which may only be used for control and regulation of electrical energy.
- It is not permitted to make any unauthorized modifications to the unit or to use any spare parts or replacements parts not approved by SEMICODE, or to use the unit for any other purpose.
- The device is a component that cannot function alone.
- The Thyristor Power Controller may at most be operated between the maximum admissible ranges specified by its datasheet.
- The Thyristor Power Controller may only be operated in connection with a suitable and series connected power supply disconnecting device.
- As a component, the SC6006 SCR controller is unable to operate alone and must be projected for its intended use to minimize residual risks.
- Despite proper use, it is possible in the event of fault, that the device will not control the currents, voltages and power in the load circuit, the following reactions are possible: current interrupted, half wave operation, permanent flow of power.

2.3 Use and operation of the device

- Only power on the mains voltage at the device when there is no danger to persons, system or load.
- Protect the device against dust and damp.
- Install the device in a upright or flat position and ensure a minimum ventilation distance between surroundings.
- If mounted in a cabinet ensure sufficient ventilation.
- Observe minimum spacing (clearance: 150 mm above and below).
- Ground the device in accordance with local regulations.
- Connect the device with the power stack and load in accordance with the connection diagrams.
- The device is configured and calibrated when delivered with standard parameters. Check default settings and adjust them to the application conditions if necessary (e.g. operating mode, control mode, monitoring, faults, etc.)

3 FUNCTIONS

In order to adapt as best as possible to a wide range of applications SC6006 has numerous functions which had to be properly configured before its use along with a SCR power stack. All the functions available and its proper configuration are described in the following chapter.

3.1 Topology configuration

SC6006 has 2 topology configurations: B6C and W3C. The topology must be configured according the application and the SCRs power stack topology which will be used.

This option enables or disables a 30º shift in output firing control signal of the SCRs with regard the input mains phase sync signal in order to properly fire the topology in use. For W3C schemes no phase delay between the input phase and the triggering pulse is needed, for B6C schemes it is needed a 30º delay to correctly fire the SCRs.

System firing topology can be configured by software, please refer to chapter 4.3.2.1 in page 25 for a more detailed explanation for the procedure and check on chapter 7 the topology which must be set on each case regarding the converter in use.

3.2 Operating modes

SC6006 has 4 different operating modes: PSA (Phase-Shift Angle mode) working as a phase delay switch controller, FWS (Full Wave Switch mode) working as proportional ON/OFF controller, RLY (Relay mode) working as 3 independent zero-cross static relays and DRV (Independent multidriver firing mode) working as 6 direct SCR switching drivers.

- Phase-shift angle controller mode (PSA)

In this operating mode, the firing phase of the sinus wave of the mains voltage is shifted. The shift depends on the setpoint value. In phase angle firing mode the controller fires over a variable portion of the incoming AC cycle in response to the control input signal. Characteristic of this operating mode are the high control dynamics but when phase-shift angle control PS is used, harmonics of the mains voltage should be expected as drawback.

The following image (figure 1) shows an example of PSA waveform according the alpha setpoint going from 0 to full wave switch.

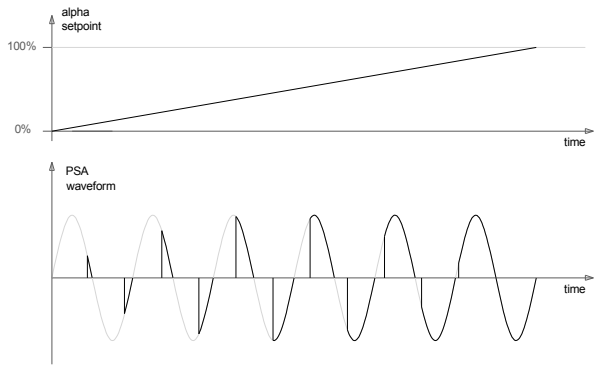


figure 1: PSA waveform example versus alpha setpoint.

- Full wave switch mode (FWS)

In FWS operating mode, the mains voltage is switched periodically firing in burst packets of AC waves, relative to the defined setpoint. Integer multiples of the mains periods are switched to avoid D.C. components. The operating mode full wave switch principle FWS is particularly suited for loads with a high thermal inertia.

This mode only works along with alpha set input J15[p12]-ALPHA_INP or `D_ALPHA_REG[M011]` software register in open loop and switches packets of 100 semi periods in the zero-cross of the mains, proportionally to the value of alpha set.

In figure 2 is shown a FWS waveform example according the alpha setpoint. In this image and for sake of simplicity the wave packets are of 5 periods.

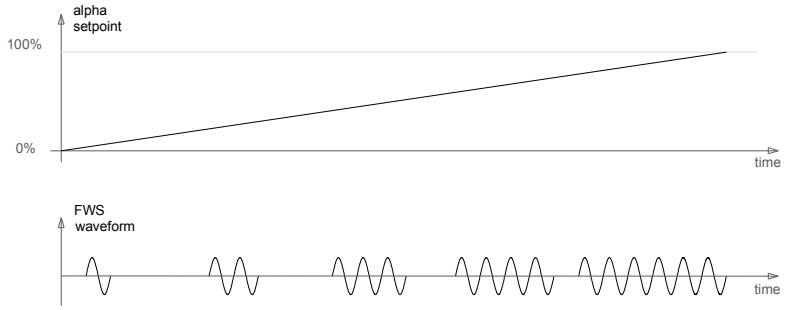


figure 2: FWS waveform example versus alpha setpoint.

When using this mode it is also possible to define a number of periods in which PSA will be applied as an initializing slope on each packet. Please read a more detailed description of this option on chapter 3.7 -Soft power ON and soft power OFF.

- Relay mode (RLY)

Relay mode switches the outputs in the next zero-cross event after a triggering signal. When a switching signal is applied to card's input control, the SCRs will switch when the voltage across its terminals crosses the 0 V. The switch off is produced naturally when the control signal is off and the direct current flowing through SCRs extinguishes.

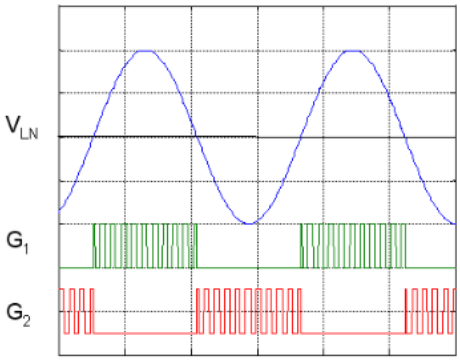


figure 3: Example of picket fence gate driving.

Using all 6 firing outputs it is possible to implement up to 3 static relays driving an antiparallel SCR power scheme each. There are available 3 different static relays (one for each phase.) You can configure which outputs will fire. This mode works as a switch controller for 3 static relays with a W3C topology or as 3 independent static relay firing W1C.

Working as a relay mode the inputs voltage setpoint (J15[p15]-U_SETPOINT), current setpoint (J15[p14]-I_SETPOINT) and alpha setpoint (J16[p21]-ALPHA_INP) works as digital triggering inputs (according to its configuration: TTL, 0-10 V, 0-20 mA or 4-20mA) and firing the outputs SCR1 & SCR2, SCR3 & SCR4, SCR5 & SCR6 respectively.

System mode of operation can be configured by software, please refer to chapter 4.3.2.2 on page 26 for a more detailed explanation.

- Independent multidriver firing mode (DRV)

Independent multidrive mode switches the outputs according 6 independent triggering signals. When a switching signal is applied to card's input control, SC6006 will switch ON the corresponding SCRs gate.

In this mode SC6006 will not sense the mains synchronism and acts just like 6 independent SCR drivers.

Fault signaling due synchronization and overcurrent will be disabled automatically in this operation mode as well as the inhibit signal working as a source for Halt fault.

In independent multidriver firing mode the inputs current setpoint (J15[p14]-I_SETPOINT), voltage setpoint (J15[p15]-I_SETPOINT), current measure (J16[p19]-I_SENS), voltage measure(J16[p20]-U_SENS) and alpha setpoint (J16[p21]-ALPHA_INP) works as digital firing inputs (according to its configuration: TTL, 0-10 V, 0-20 mA or 4-20mA) and firing the outputs SCR1,SCR2, SCR4, SCR5, SCR6 respectively.

Inhibit input (J15[p16]-INHIBIT) works as digital firing CMOS level input for SCR3.

System mode of operation can be configured by software, please refer to chapter 4.3.2.2 on page 26 for a more detailed explanation. An example of connection is given at chapter 7.4 on page 46.

3.3 Setpoint signals processing

There are 3 different analog input setpoints available: voltage setpoint (J15[p15]-U_SETPOINT), current setpoint (J15[p14]-I_SETPOINT) and alpha setpoint (J16[p21]-ALPHA_INP), this signals works as external references which should be provided by the operator or PLC to the controller (SC6006) giving the corresponding setpoint when regulating the ouptut voltage of the converter, the output current of the converter or the firing phase angle of the converter respectively.

As mentioned before all these input setpoint signals can be configured to work as 0-5 V or 0-10 V and also 0-20 mA and live input 4-20 mA. This configurations are made using the PCB DIP switches and LCD screen.

Furthermore all this inputs can be digitally overrode. There are 3 software setpoint registers which can be set by the operator through LCD and push-buttons on board or by using the serial communication port.

3.3.1 Analog or digital references / setpoints

Input signals of current setpoint, voltage setpoint and alpha setpoint for the open or closed loop control can be configured, independently, as a digital reference or analog reference.

If an input reference is set as digital, its value must be set through software using the on-board LCD menu or through RS-232 serial communications interface, the following are the corresponding software registers:

alpha_setpoint: `D_ALPHA_REG[M011]`

u_setpoint: `D_VOLTAGE_REG[M034]`

i_setpoint: `D_CURRENT_REG[M035]`

All the digital setpoint are 10 bits registers and can be set with decimal values from 0 to 1023.

Please refer to chapter 5-SERIAL COMMUNICATION for further explanation regarding the communications interface and communications protocol of the system if it is needed to change this registers remotely.

If an input reference is set as analog the corresponding value is obtained by his assigned PCB input:

alpha_setpoint: J16[p21]-ALPHA_INP

u_setpoint: J15[p15]-U_SETPOINT

i_setpoint: J15[p14]-I_SETPOINT

Note:
All analog setpoint input signals can be configured to work as 0-5 V or 0-10 V and also 0-20 mA. Additionally they can be interfaced connecting a potentiometer (2 included). The recommended value of this potentiometers is 4.7 kΩ.

Configuration are made using the PCB DIP switches. Please refer to chapter 4.4.2 on page 31 for the DIP-switches configurations.

Also all inputs can be configured as 4-20 mA (Live Input). The Live Input is enabled through software. Please refer to chapter 4.3.2.4 on page 26.

3.3.2 Setpoints signal processing diagrams

This chapter provides several simplified diagrams and blocks regarding the different sources of setpoints available with the aim of clarify the way this setpoints are processed and routed or selected by SC6006.

This diagrams depicts, when necessary, the input impedance or resistive charge for the input signal, the filtering (low pass) and shaping modules (live input shaping) as well the hardware and software setting which selects or switchs one or other signal path depending on selected signal source by the operator.

Please take them as a guidance planned for the sake of a more in-depth and comprehensive scheme of the SC6006 signal path and setpoint signal process.

Alpha setpoint signal processing.

In figure 4 is shown the diagram for acquisition and setting of alpha setpoint.

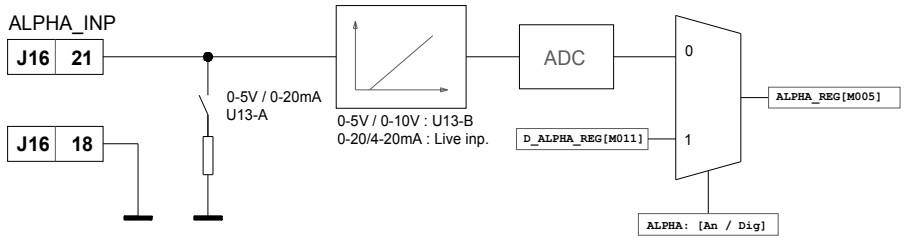


figure 4: alpha setpoint signal processing diagram.

By default SC6006 takes the alpha setpoint from the analog ALPHA_INP input configured as 0-5 V_{DC}.

Voltage setpoint signal processing.

In figure 5 is shown the diagram of acquisition and setting of voltage setpoint.

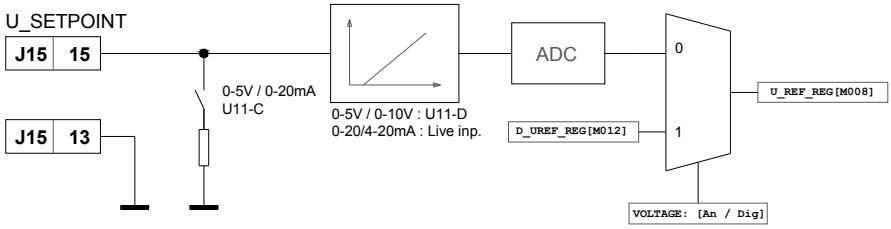


figure 5: Voltage setpoint signal processing diagram.

By default SC6006 takes the voltage setpoint from the analog U_SETPOINT input configured as 0-5 V_{DC}.

Current setpoint signal processing.

In figure 6 is shown the diagram of acquisition and setting of current setpoint.

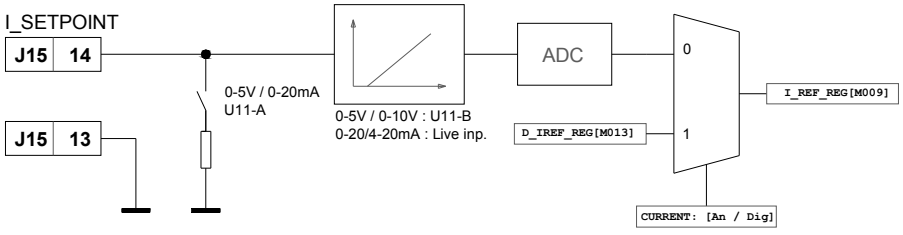


figure 6: Current setpoint signal processing diagram.

By default SC6006 takes the current setpoint from the analog I_SETPOINT input configured as 0-5 V_{DC}.

3.4 Feedback signals processing

SC6006 have 2 independent feedback signals: current feedback signal and voltage feedback signal. This signals are used when a closed loop control is needed.

As on the previous chapter, following, simplified diagrams are provided regarding the different sources of feedback signals available with the aim of clarify the way this feedback signals are processed and routed or selected by SC6006.

Current feedback signal processing.

There are 3 different analogic sources available for the current feedback signal:

- Current transformers: AC currents. The current feedback signal can be obtained directly from standard 200 mA AC current transformers (J14[p9..11]-I_AUX).
- Shunt: DC currents. By interfacing a standard 60 mV shunt (J14[p12]-I_SHUNT) .
- Analog configurable input: current feedback signal also can be obtained with an analog (0-5 V , 0-10 V, 0-20 mA or 4-20 mA) current signal (J16[p19]-I_SENS).

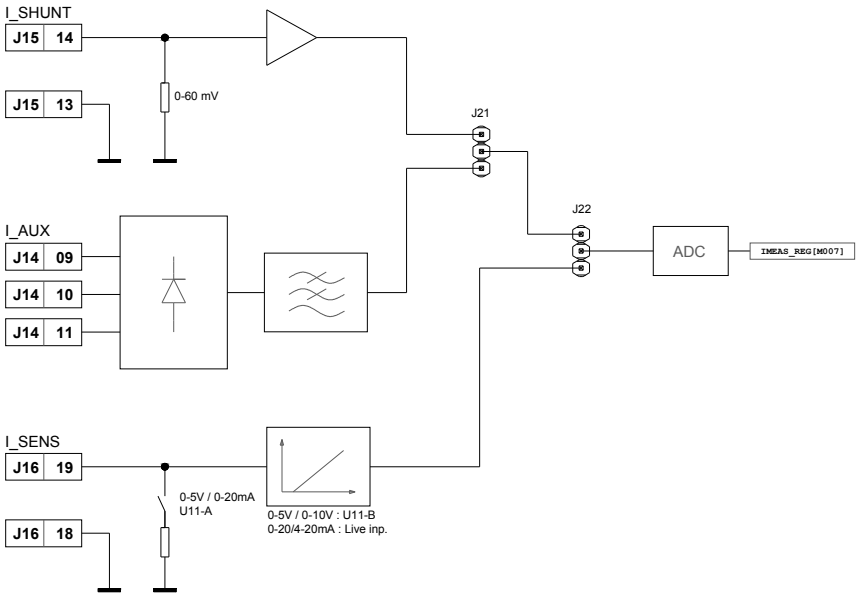


figure 7: Current feedback signal processing diagram.

The operator must choose and configure which source for current and voltage feedback signal wants to work with according the application, the configuration of current feedback signal processing, filters and selection or routing is as shown in figure 7.

By default SC6006 takes the current feedback signal from the analog I_SENS input configured as 0-5 V signal.

Voltage feedback signal processing.

The voltage feedback signal can be obtained with direct output voltage connection (J12[p1]-V_REAL) or with an analog (0-5 V or 0-10 V and also 0-20 mA or 4-20 mA) voltage signal (J16[p20]-U_SENS). The operator must ensure and configure which source for voltage feedback signal wants to be used in his application as shown in figure 8.

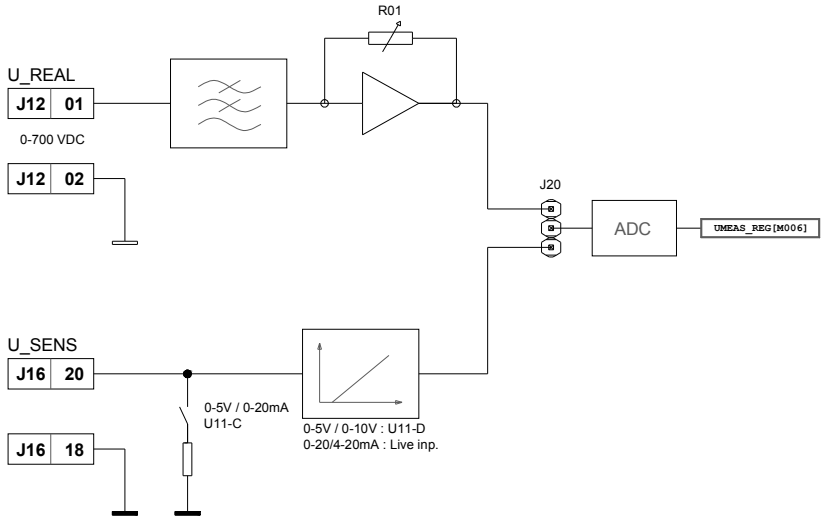


figure 8: Voltage feedback signal processing diagram.

By default SC6006 takes the voltage feedback signal from the analog U_SENS input configured as 0-5 V.

3.5 Setpoints and feedback live input signals configuration

All inputs, setpoints and feedback signals, can be configured to work as 0-5 V or 0-10 V and also 0-20 mA. This configuration is made using the PCB DIP switches (chapter 4.4.2 on page 31).

Also all setpoint and feedback inputs can be configured as 4-20 mA (Live Input). The *Live Input* mode is enabled through software. How to set this option it is explained at chapter 4.3.2.4 on page 26.

3.6 Control Modes

The system can work with all its regulating operating modes (PSA and FWS) as open loop scheme setting the output direct with alpha reference.

In PSA mode it is also possible to make a voltage and current regulation through a PID closed loop scheme. SC6006 has different control modes:

- **OL**: Open Loop control mode. Direct regulation of the output according alpha setpoint.
- **V**: Voltage feedback control. Voltage regulation of the output according voltage setpoint.
- **I**: Current feedback control. Current regulation of the output according current setpoint.
- **IV**: Both current and voltage feedback control. Voltage and current regulation of the output according the most restrictive between current and voltage setpoints.

The control mode is set by software, please refer to chapter 4.3.2.5 on page 26 for further information about how to set the working control mode of the system.

3.7 Soft power ON and soft power OFF

- **Soft init slope and soft turn off slope for phase-shift mode (PSA)**

When working in PSA mode SC6006 can operate making a soft power ON and soft power OFF. When soft power ON is set and the unit is started, the phase delay will be gradually decreased until it reaches the setpoint. The soft power ON time can also be set by software.

Same way, when soft power off is set and the unit is being stop, the phase delay will be gradually increased from the actual setpoint until it reaches the off state.

In the image is shown a soft power on from 0 to 100%.

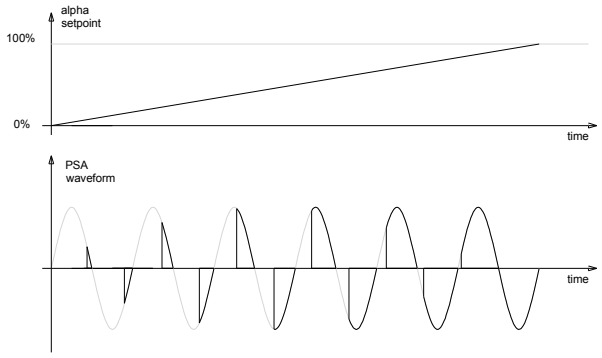


figure 9: PSA soft power on waveform example.

The power on and the power off times can be set by software varying from 1 to 30 seconds, how to set the soft power on and off and the timings is further explained in chapter 4.3.2.6 on page 26.

- **Soft init slope and soft turn off slope for proportional mode (FWS). Avoiding transformer inrush current.**

It is recommended to use this configuration in order to reduce the inrush current when controlling a transformer primary driving resistive loads on its secondary on proportional mode. When a transformer is first energized a high transient current can flow for several cycles due core saturation. Usually the worst case inrush happens when the primary winding is connected at an instant around the zero-crossing of the primary voltage as it occurs every starting period on each mains wave packet when operating in FWS mode.

The inrush current is greater than the nominal operating current of transformer and the ratio can vary from a few percent up to many times the operating current, this can blow up fuses and trip circuit breaker it also causes causes harmonics which can excite system resonances and cause dynamic overvoltage, all this effects may lead to the breakdown of the power equipment.

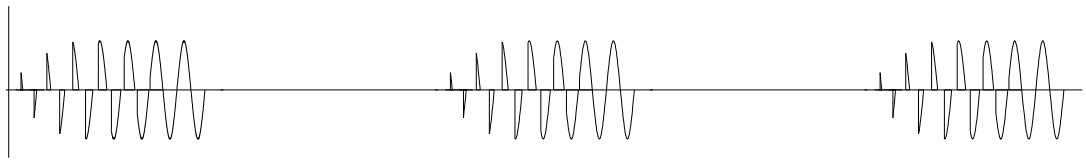


figure 10: Pulse train example with a soft init on FWS mode.

In many cases a single period (1st period of the pulse train) fired at 90º will suffice to reduce to its minimum the inrush peak. In other cases a specific number periods of soft on would reduce at its maximum the initial inrush current. A recommendation would be to initially set a single cycle of soft turn on, monitorize the initial peak current and compare it with different number of cycles and select the most suitable for the application.

On figure 10 is depicted as example the initial transient on each packet working with FWS with 5 cycles of PSA soft init. In this image and for sake of simplicity the wave packets are of 7 periods.

You can find more information regarding the procedure to configure SC6006 to operate with this firing mode in chapter 4.3.2.6 Soft ON/OFF ramps submenu on page 26 of this manual.

3.8 Fault sources and pulse inhibition

When the system is in ON state, the output pulse inhibition it is produced when an enabled fault source in working condition occurs.

There are 3 different sources that triggers a fault: incorrect mains sync or rotation, external blocking signal through an external logic inhibit signal or contact block signal and overcurrrent condition.

All this fault conditions can be masked through software or some of them modified. The triggering of fault signal is made as it is shown in diagram on figure 11.

Sync signal: When unmasked, it is triggered when the phase rotation of mains is reversed than the configured one or triggered when mains is out of sync, for example by its disconnection or by the disconnection or out of phasing of one of its phases.

Halt signal: When unmasked, it is triggered when inhibition input (J15[p16]-INHIBIT) or block input (J13[p6]-BLK) switches on activation state given by signals *en_inh* and en*_ext_blq* set by software (chapter 4.3.2.7 on page 27).

OvCurr signal: When unmasked, it is triggered when the measured feedback current exceeds the maximum set by `OV_CURRENT_REG[M036]`.

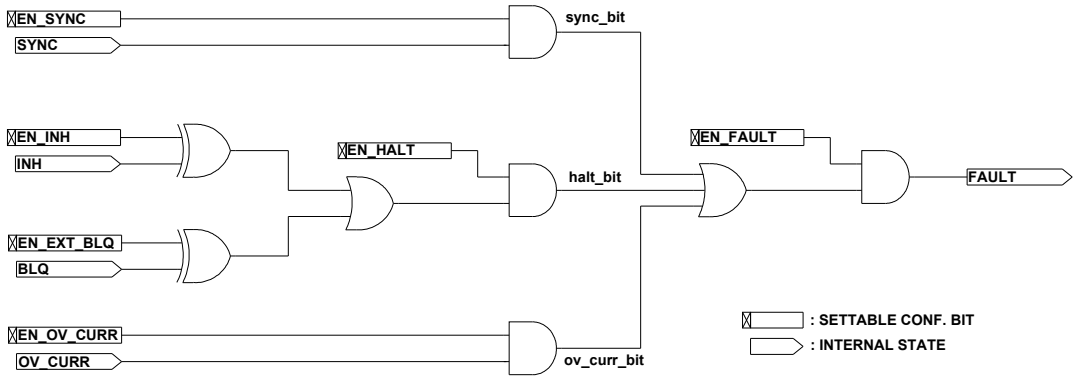


figure 11: Logic diagram for fault signal.

When any of this 3 fault signals is triggered and fault generation is enabled, a fault condition will occur and will stop (if it is in working state) the system and set the fault fault flags, those are visible in main menu of on-board display and with signaling LEDs.

The fault condition will be reset when all fault signals returns to OFF state. Then the system can be triggered ON again or, if it is set this way, it will resume its previous operation mode.

Output fault dry relay

When fault condition occurs and sets fault signal the output dry relay will be triggered ON following the fault signal. User can use this output to externally detect and properly set its PLC or uP control system to act according when a fault is produced.

Fault interlock

SC6006 can interlock a fault condition by using its interlock function. When fault interlock mode is enabled (see chapter 4.3.2.7 in page 27.) any fault signal will stop the firing mode, and the system will not resume its previous working and release the fault state mode until all the fault sources are deactivated again and the system put on OFF state by pressing [OK] push-button on the main menu.

3.9 Start up mode

Using the start up setting SC6006 can be configured to, when powered on, start in ON mode, OFF mode or remembering the last state before it was powered down. By default the unit is configured to start up with the last system state. This option is software set (chapter 4.3.2.8 on page 27).

3.10 Autoset function

Autoset function SC6006 automatically checks the mains frequency mode, the SCR output assignation and the phase rotation. By default Autoset function is executed automatically every SC6006 startup, but user can mask or unmask which properties will set up this function. All its options can be software configured. Also, Autoset function can be triggered by software in any moment with no need to turn on and off the system. See chapter 4.3.2.9 on page 28.

Note:
When powered on, SC6006 automatically starts the autoset function before initialize all the system. So, in order to work properly all the power system must be connected and powered on at the same time or before power on the SC6006. Otherwise the Autoset function would be unable to determine the frequency of mains or rotation or output assignation and will be configured in a default mode or with the previous detected configuration.

Mains frequency configuration:

By default every time the board is powered up checks the mains frequency mode (50 Hz or 60 Hz) and then it can automatically configure itself to work at the corresponding mains frequency. The operator can also mask this option and manually set through software the frequency of operation.

Mains frequency autodetect option can be masked and configured by software:

```
SUBMENU 1.8: AUTOSET > AC freq > [Auto/50Hz/60Hz]
```

If the mains *frequency autoset* is enabled but during the autoset process the system cannot determine it, the working frequency will be set the same as the last time used.

Phase rotation autoset:

SC6006 can autodetect and correct a change in phase rotation. This occurs when, in the mains, 2 phases were swapped (e.g.: S and T swaps yelding R-S-T → R-T-S).

Phase rotation autodetect option can be masked and configured by software:

```
SUBMENU 1.8: AUTOSET > Rotation > [Auto/CW/ACW]
```

By default *phase rotation autoset* is executed automatically every SC6006 startup and checks if there is any change since the last configuration. If there is any change the system autoconfigures itself. This autoconfiguration can also be masked.

If the *phase rotation autoset* is enabled but during the autoset process the system cannot determine it, the phase rotation will be set the same as the last time used.

SCRs automatic output assignation:

SC6006 can autodetect how the SCRs has been connected to the PCB and autoconfigure correctly the corresponding output signals.

The SCRs automatic assignation detects and corrects the output signal assignation scheme in the following cases:

- A swap between the SCRs in a same branch (W3C or B6C) or module. e.g. : SCR1 ↔ SCR2.
- A swap between 2 pairs of SCRs of different branches or between 2 modules. E. g. : SCR1 ↔ SCR3 and SCR2 ↔ SCR4.

If the operator wants to use this option SC6006 must be connected to a resistive load in B6C scheme, and in a delta or wye resistive load in W3C. It is also recommended to connect the neutral.

In some cases outputs autoset may be unable to find the correct outputs assignation and, by default will disable all the outputs (0). The user can override the automatic configuration by manually setting up the output assignation.

SCRs output assignation option can be disabled and configured by software:

```
SUBMENU 1.8: AUTOSET > Outputs > [No/Auto]
```

By default *outputs autoset* is disabled. Can be useful to use this function when installing the power stack the first time to get a quick and easy configuration and, then, save the configuration and disabling the outputs *autoset* mode.

If the automatic outputs detection in *autoset* is enabled but during the *autoset* process the system cannot determine it, the outputs assignation will be the same as the last time was saved in EEPROM.

Note:
The SCRs automatic assignation option works only for W3C and B6C schemes with resistive loads. For other topologies the user must leave disabled the outputs autoset option and configure the system according the SCRs connection scheme through `SUBMENU 1.9: OUTPUTS`.

3.11 Output assignation option

Each output of the SC6006 can be software set independently to operate according R, S, or T phase and for the positive semi-cycle (r,s,t) or the negative semi-cycle (r',s',t'). Also can be permanently disabled (0).

The output assignation option is found at:

```
SUBMENU 1.9: OUTPUTS
```

Please refer to chapter 7 on page 41 for the standard topologies and its corresponding outputs configuration.

3.12 Saving all the changes and configurations

When the operator has made some settings change or properly configured all the options of the system the new configuration must be saved in the internal EEPROM through:

```
SUBMENU 1.11: SAVE > [OK]
```

All changes not properly saved in the EEPROM will be lost during a power down and the previous EEPROM saved configuration will be restored in the next power up of the system.

Note:
Remember to save the configurations to the internal EEPROM every time a change is made or all the changes will be lost when system is powered off.

3.13 Restore default configurations

The factory default software configurations of the system can be restored at any moment using the menu option:

```
SUBMENU 1.12: RESTORE > [OK]
```

When restored, the system will be automatically rebooted and all software configurations back to default factory set.

4 SETTINGS AND OPERATION

In this chapter is given a complete device overview, with a description of all available input/output signals and connections available and a brief description of all software options and on-board hardware configurations made by jumpers and DIP-switches.

4.1 PCB connectors overview

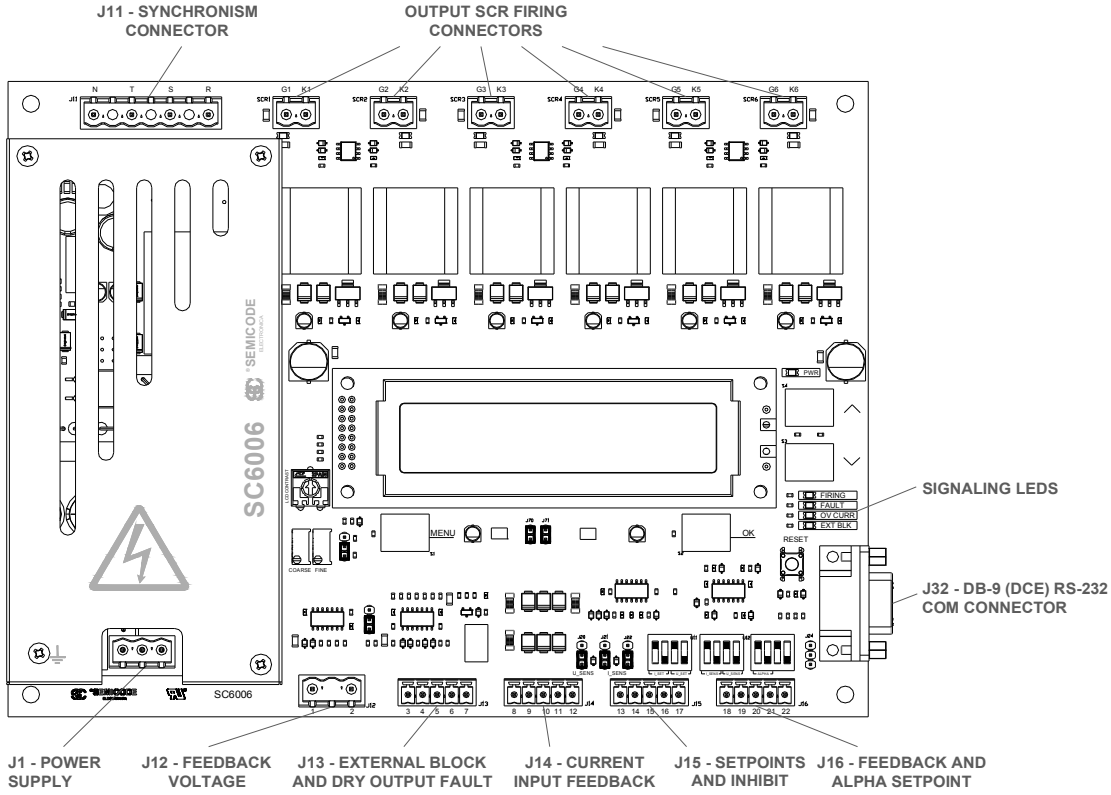


figure 12: Connectors PCB overview.

Terminal		Name	Description
J1		AC_IN1	AC / DC power supply input.
		AC_IN2	AC / DC power supply input.
J11	R	R_SYNCH	Mains R phase input.
	S	S_SYNCH	Mains S phase input.
	T	T_SYNCH	Mains T phase input.
	N	NEUTRAL	Mains neutral input.
J12	1	V_REAL	Direct voltage input feedback.
	2	GND	Signal ground.
J13	3	K1_NC	Output dry relay N/C contact.
	4	K1_COM	Output dry relay COM contact.
	5	K1_NO	Output dry relay N/O contact.
	6	BLK	Blocking signal input.
	7	VDD	+15 VDC from SC6006.

Terminal		Name	Description
J14	8	GND	Signal ground.
	9	AUX_I_R	R phase input for CT.
	10	AUX_I_S	S phase input for CT.
	11	AUX_I_T	T phase input for CT
	12	I_SHUNT	Shunt input terminal.
J15	13	GND	Signal ground.
	14	I_SETPOINT	Input current setpoint.
	15	U_SETPOINT	Input voltage setpoint.
	16	INHIBIT	inhibit input signal.
	17	VCC	+5 VDC output reference.
J16	18	GND	Signal ground.
	19	I_SENS	Input current feedback.
	20	U_SENS	Input voltage feedback.
	21	ALPHA_INP	Input alpha setpoint.
	22	VDD	+15 VDC from SC6006.

table 1: List of connectors and pinning.

4.2 Connectors

Following is listed and described every connector and every output/input signal available of the SC6006.

4.2.1 Power supply connector (J1)

Connector J1 is the input mains supply connection for the switched mode power supply on board.

The system can be powered with AC (or DC) power source from 195 V_{AC} to 480 V_{AC}. For more technical details or maximum and recommended values and parameters please refer to chapter: 10-TECHNICAL SPECIFICATIONS.

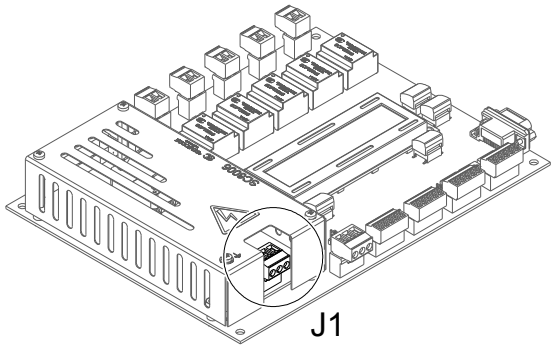


figure 13: Detail of mains supply input connector.

The connector type is a MSTBVA series (or equivalent) from Phoenix Contact (ref. MSTBVA2,5/3-G-5,08). The board is also provided with the matching plug connector (ref. MSTB2,5/3-ST-5,08).

4.2.2 Synchronism connector (J11)

Synchronism connector is labelled (PCB silkscreen) indicating the three phases **R**, **S**, **T** and neutral **N.** Mains connection must guarantee concordance with the SCRs to get sure that the synchronism and phase rotation is correct.
If the concordance is wrong this can be fixed without reconnecting the SCRs by means *Autoset function* or manually assigning the correct outputs by software.
In case the phase rotation is wrong the PCB can autodetect and solve it using the *Autoset function* or, if it is enabled *phase rotation autoset* during the power on, just by reset the system.

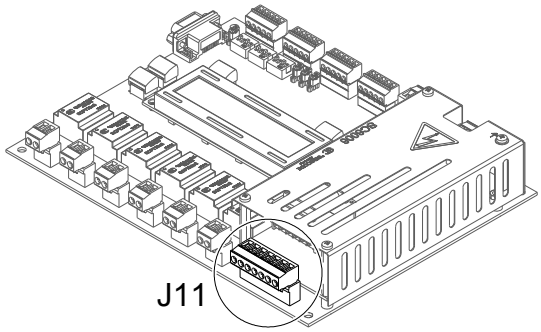


figure 14: Detail of sync input connector.

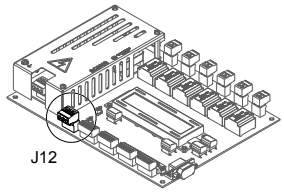
The connector type is an MSTBA series (or equivalent) from Phoenix Contact (ref. MSTBA 2,5/7-G-5,08). The board is also provided with the matching plug connector (ref. MSTB 2,5/7-ST-5,08).

4.2.3 Feedback voltage signal connector (J12)

Direct voltage feedback input is made on J12 connector. Please note that in those cases where control board is controlled by external equipments, like PLC, microcontrollers, etc, without isolated outputs, it must be considered to have all the feedback elements isolated. Using elements like shunts to close the current loop, and voltage feedback could not be done directly if galvanic isolation is required.
There are available isolated feedback modules designed to work with this control board. Please see chapter 8 -AVAILABLE ACCESSORIES on page 50 for a list and explanation of suitable accessories for SC6006.

- J12 PINOUT:

- **Terminal 1 (V_REAL)**: Direct voltage input feedback signal.
- **Terminal 2 (GND)**: PCB signal ground.



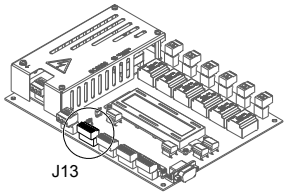
The connector type is an MSTBVA series (or equivalent) from Phoenix Contact (ref. MSTBVA2,5/3-G-5,08). The board is also provided with the matching plug connector (ref. MSTB2,5/3-ST-5,08).

4.2.4 External block and dry output fault connector (J13)

The external block connector and dry output fault connector provides the user an input blocking signal (using for example an external contactor or switch) and an output dry relay for fault signaling.

- J13 PINOUT:

- **Terminal 3 (K_NC)**: Output dry relay N/C contact.
- **Terminal 4 (K_COM)**: Output dry relay COM contact.
- **Terminal 5 (K_NO)**: Output dry relay N/O contact.
- **Terminal 6 (BLQ):** Input terminal of the blocking signal.
- **Terminal 7 (VDD):** Positive terminal blocking signal (15 V_{DC}).(*)



(*) please do not use this terminal to power other external devices. Refer to ELECTRICAL CHARACTERISTICS TABLE for further information.

Terminal 6 (BLQ) must be shortcircuited with Terminal 7 (VDD) for trigger ON the input blocking signal.

Terminals 3-5 are those corresponding to the dry output fault relay. Relay switches ON (Terminal 4 connected with Terminal 5) when fault occurs. Otherwise, if there is no fault, relay switchs OFF (Terminal 4 connected with Terminal 3). Please see the connection diagram for J13 in figure 15.

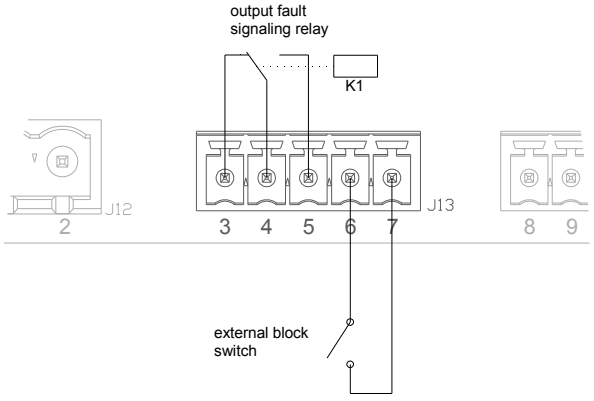


figure 15: Connection example diagram for J13.

The J13 connector type is an MCV series (or equivalent) from Phoenix Contact (ref. 1803442). SC6006 is also provided with the matching plug connector (ref. 1803604).

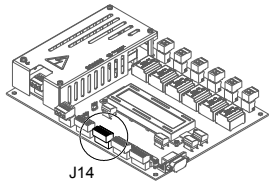
Note:
By default SC6006 is configured to operate with a normally-off blocking contactor. To work without the blocking mode or with a normally-on contact you must set this option through software. Please see chapter 4.3.2.7 in page 27.

4.2.5 Current input feedback connector (J14)

When necessary AC/DC current measurement can be achieved by using current transformers (CT) or shunt respectively. J14 interfaces those feedback current signals.

- J14 PINOUT:

- **Terminal 8 (GND)**: Ground connection
- **Terminal 9 (AUX_I_R)**: R phase input for auxiliary CT feedback.
- **Terminal 10 (AUX_I_S)**: S phase input for auxiliary CT feedback.
- **Terminal 11 (AUX_I_T)**: T phase input for auxiliary CT feedback.
- **Terminal 12 (I_SHUNT)**: Shunt input terminal.



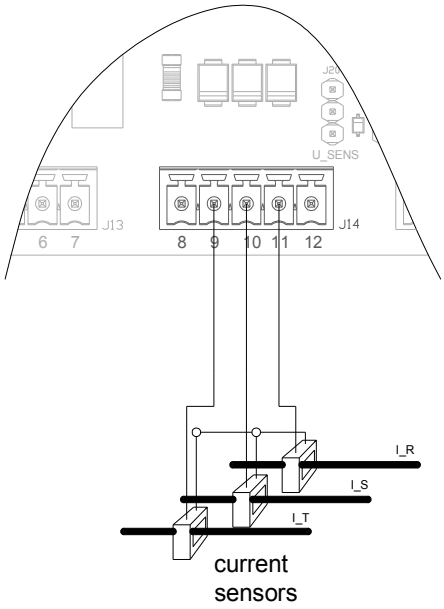


figure 16: Connection diagram example for J14.

The J14 connector type is an MCV series (or equivalent) from Phoenix Contact (ref. 1803442). The board is also provided with the matching plug connector (ref. 1803604).

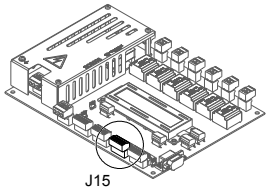
Note:
Auxiliary feedback uses the signal from a current transformer (200 mA output), in order to be able to regulate AC currents. Below are indicated our recommended current transformers:

Current Transformers	
TTS017 25-50-100A/0.2A	Input current: 25, 50 or 100 A
TTS040 200-300-400/0.2A	Input current: 200, 300 or 400 A
TTS040 600/0.2A	Input current: 600 A

4.2.6 Setpoints and inhibit connector (J15)

Voltage and current setpoints and inhibit signal are interfaced with this connector. It also provides a 5 V reference in case setpoint potentiometers are used.

- J15 PINOUT:



- **Terminal 13 (GND)**: Negative terminal from the regulator potentiometers or GND reference.
- **Terminal 14 (I_SETPOINT)**: Adjustment terminal from the current regulator potentiometer or current setpoint input.
- **Terminal 15 (U_SETPOINT)**: Adjustment terminal from the voltage regulator potentiometer or voltage setpoint input.
- **Terminal 16 (INHIBIT)**: Inhibit input signal.
- **Terminal 17 (VCC):** Positive terminal from the regulator potentiometers or 5 V reference(*).

(*) please do not use this terminal to power other external devices. Refer to ELECTRICAL CHARACTERISTICS TABLE for further information.

The J15 connector type is an MCV series (or equivalent) from Phoenix Contact (ref. 1803442). The board is also provided with the matching plug connector (ref. 1803604).

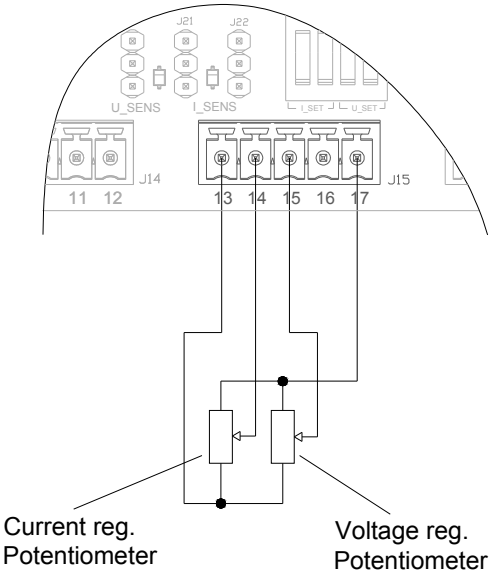


figure 17: Connection diagram example for J15.

Notes:

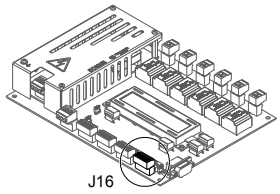
- Inputs can be driven by potentiometers. This potentiometers can be any type, but with a recommended value of 4.7 kΩ.
- When the adjustment cursor of the potentiometer is situated to the positive side, the supplying voltage is at the maximum level.
- It is also possible to control the inputs with 0-5 V, 0-10 V, 0-20 mA or 4-20 mA signals applied to the adjustment terminals (referred to ground).

4.2.7 Feedback and alpha setpoint input connector (J16)

Voltage and current feedback signals and alpha setpoint signal are interfaced with this connector.

- J16 PINOUT:

- **Terminal 18 (GND)**: Negative terminal from the regulator potentiometers or GND reference.
- **Terminal 19 (I_SENS)**: Current feedback signal input.
- **Terminal 20 (U_SENS)**: Voltage feedback signal input.
- **Terminal 21 (ALPHA_INP)**: Alpha reference input.
- **Terminal 22 (VDD):** Positive terminal from 15 V reference(*).



(*) please do not use this terminal to power other external devices. Refer to ELECTRICAL CHARACTERISTICS TABLE for further information.

The J16 connector type is an MCV series (or equivalent) from Phoenix Contact (ref. 1803442). The board is also provided with the matching plug connector (ref. 1803604).

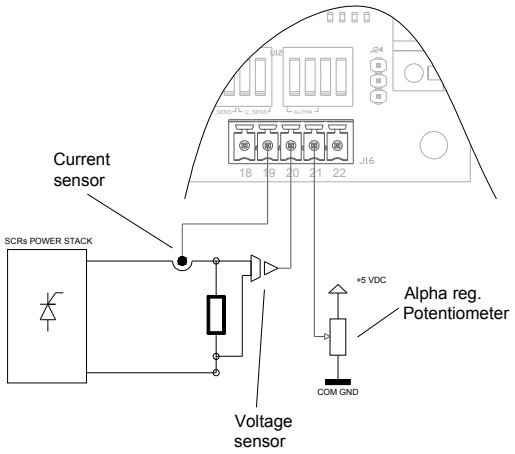


figure 18: Connection diagram example for J16.

Notes:

- ALPHA_INP setpoint can be driven by a potentiometer. This potentiometer can be any type, but with a recommended value of 4.7 kΩ. If a potentiometer is used its positive +5 V_{DC} reference can be wired to J15:17 (VCC) and GND reference to J16:18 (GND).

I_SENS, U_SENS and ALPHA_INP can work with 0-5 V, 0-10 V, 0-20 mA or 4-20 mA signals level.

4.2.8 Output SCR firing connectors (SCR1-SCR6)

The output SCR firing connectors are labelled (PCB silkscreen) indicating the six outputs **SCR1** to **SCR6** and its correspondent **G** and **K** connections, please see figure 19. Mains connection must guarantee concordance with the SCRs to get sure that the synchronism and phase rotation is correct.
If the concordance is wrong this can be fixed without reconnecting the SCRs by means *Autoset function* or manually assigning the correct outputs by software.
In case the phase rotation is wrong the PCB can autodetect and solve it using the *Autoset function* or, if it is enabled *phase rotation autoset* during the power on, just by reset the system.

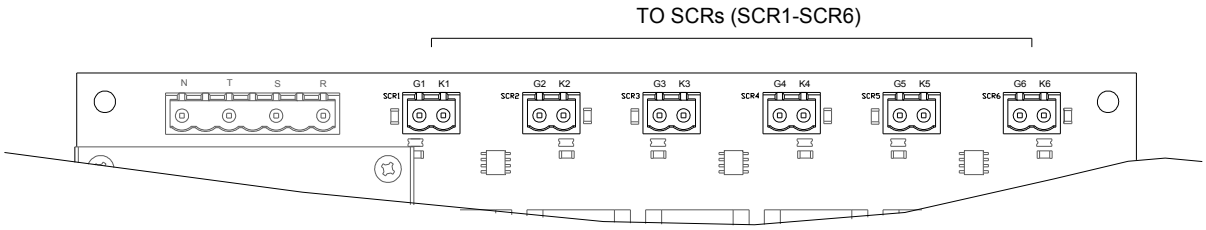
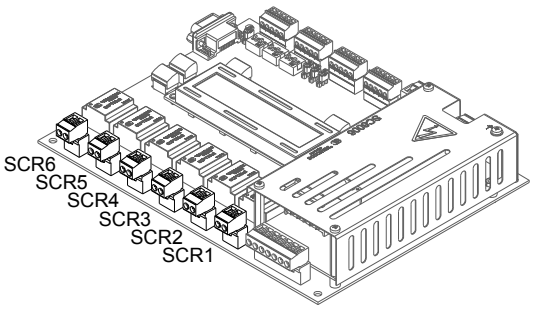


figure 19: Detail of output SCR firing connectors.

Connector	Gate	Cathode
SCR1	G1	K1
SCR2	G2	K2
SCR3	G3	K3
SCR4	G4	K4
SCR5	G5	K5
SCR6	G6	K6



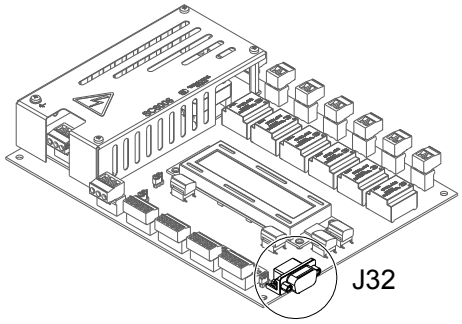
The connectors type is an MSTBVA series (or equivalent) from Phoenix Contact (ref. 1755736). The board is also provided with the matching plug connectors (ref. 1757019).

Notes:
- For thyristor connection, see chapter 7 where there are the most typical circuits. And please read the mounting recommendations on page 48,
- Avoid long cables in the firing system, and always use twisted or shielded cables (preferred).

4.2.9 Serial communications DB-9 connector (J32)

The connector type is a specific DB-9 male (DTE) connector. Can be interfaced to a standard PC serial port or PLC RS232 port.

Please check chapter 5 -SERIAL COMMUNICATION on page for a more detailed information regarding te use of the SC6006 serial communication port.



4.3 LCD menu settings and navigation

SC6006 has an on-board integrated alphanumeric LCD that provides an user interface to easy set up and monitor every configuration or setting of the system.
When initializes SC6006 starts on main menu as is shown in figure 20 and there are a total of 3 menus. The main menu (on top of the figure), settings menu, and registers menu. User can go cyclically through this menus clicking the [MENU] push-button.

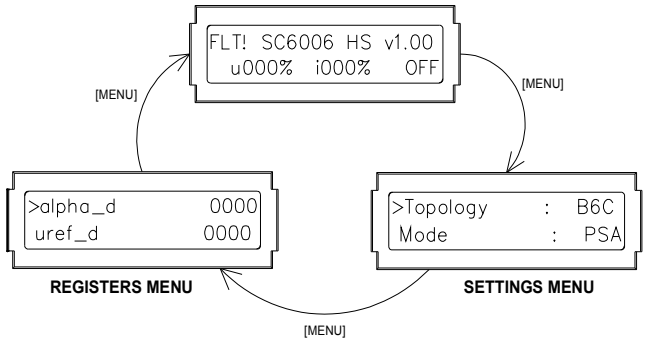


figure 20: menu sequence of SC6006.

The [OK] push button triggers ON the SCR controller when its pushed at main menu and accepts the introduced changes or access to the submenus when it's pressed in the other menus.
The [UP] an [DOWN] push buttons move up and down in the menus and, when selected, increases or decreases the settings variables.

4.3.1 Main Menu:

In the main menu you can see in a glimpse the actual state of the system.

- Faults: If there is any fault condition it will appear “FLT!” at the left LCD corner.
- ON/OFF system status. At the right LCD corner.
- Halt (H), sync (S) and overcurrent (I) fault flags.
- Voltage and current setpoint references or alpha reference.
- Voltage and current measurements.
- Firmware version.

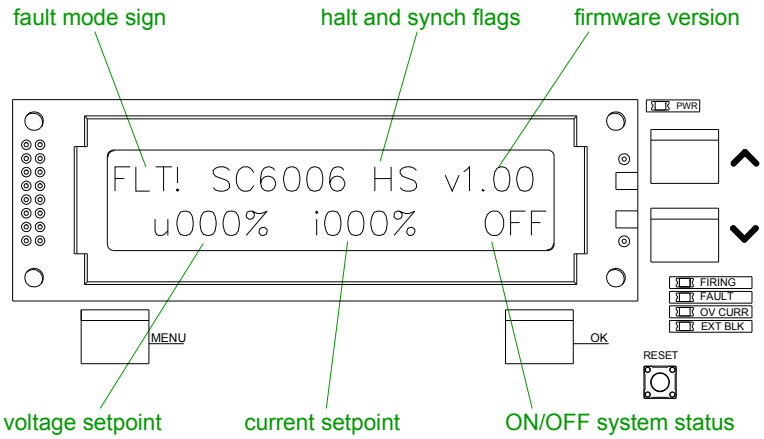


figure 21: Detail of main menu in LCD display.

By default SC6006 will show in the first line of main menu its version and if there is any fault. In the second line the values (in %) of the reference inputs (current and voltage).
By pressing the push-button [UP] the first line of main menu will switch to the default information to show the

actual values (in %) of the sensed current and voltage. If the SC6006 is in fault mode then the first line always will show the default information.
By pressing the push-button [DOWN] the second line of the main menu will switch to the default information to show the actual value (in %) of the alpha reference.
When during the initialization SC6006 could not determine the phase-rotation, frequency or output assignation and its default configuration it is ben made a "!" character will be shown on the fist position of the second line.

4.3.1.1 LCD contrast adjusting potentiometer

By means the potentiometer P5 (see figure 22) operator or user can readjust the contrast of LCD in case more or less contrast is needed according the environmental light or visual conditions.
The contrast is in factory adjusted for an optimal LCD reading.

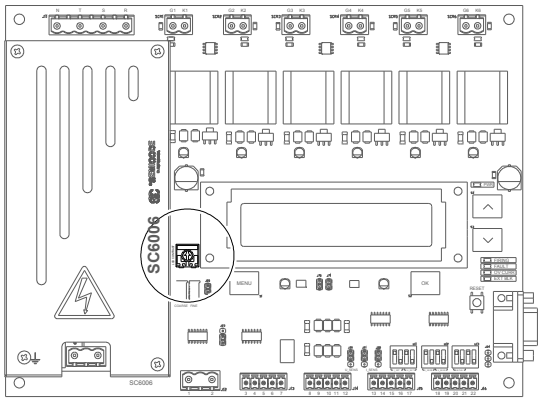


figure 22: P5 LCD contrast adjusting potentiometer

4.3.1.2 LCD backlight

When SC6006 is in the main menu you can switch the LCD backlight OFF by pressing and hold for a second the push-button [DW].
The LCD backlight can be turned ON again by pressing and hold for a second the push-button [UP].
By default LCD backlight is ON.

Note:
All the changes of visualization, information and backlight state introduced in the main menu can be saved in EEPROM by submenu 1.11 (submenu save).

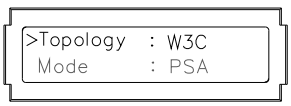
4.3.2 Settings menu

In settings menu it is possible to change all the internal characteristics and modes of operation of the system. We can access this menu pressing [MENU] push-button when we are in main menu.

SETTINGS MENU

4.3.2.1 Topology option

MENU 1: SETTINGS > Topology > [B6C / **W3C**]



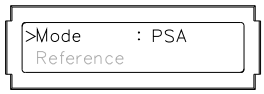
TOPOLOGY OPTION

By pressing [OK] button we can change between B6C topology and W3C topology operation.

By default SC6006 is configured in W3C topology.

4.3.2.2 Mode option

MENU 1: SETTINGS > Mode > [**PSA** / FWS / RLY / DRV]



MODE OPTION

By pressing [OK] button we can change between PSA, FWS, RLY and DRV modes of operation.

By default SC6006 is configured in PSA mode.

4.3.2.3 Reference submenu

SUBMENU 1.2: REFERENCE > alpha > [**An** / Dig]
> voltage > [**An** / Dig]
> current > [**An** / Dig]

REFERENCE SUBMENU

By pressing [OK] button we access to the *Reference* submenu. In this submenu we can change the references which SC6006 uses to calculate the setpoint. It is possible to choose between analog references for alpha, voltage and current or use the digital registers for this setpoints .

By default SC6006 is configured with all of its inputs as analog references.

4.3.2.4 Live-zero input submenu

SUBMENU 1.3: INPUTS > i_ref > [**0 mA**/ 4 mA]
> i_meas > [**0 mA**/ 4 mA]
> u_ref > [**0 mA**/ 4 mA]
> u_meas > [**0 mA**/ 4 mA]
> alpha_inp > [**0 mA**/ 4 mA]

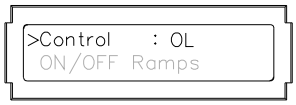
LIVE INPUT SUBMENU

By pressing [OK] button we access to the *Live-inputs* submenu. In this submenu we can set each input working as a normal input or as live input (4-20 mA). Please note that the DIP-Switches configuration must be set according the voltage or current levels required.

By default all inputs in SC6006 are configured in zero mode (no live-input).

4.3.2.5 Control option

MENU 1: SETTINGS > Control > [**OL** / I / V / IV]



CONTROL OPTION

By pressing [OK] button system changes between "OL" (open loop), "I" (current regulation), "V" (voltage regulation) or "IV" (both current and voltage regulation).

By default SC6006 is configured in OL mode.

4.3.2.6 Soft ON/OFF ramps submenu

SUBMENU 1.6: ON/OFF Ramps > Soft ON > [**OFF** / ON]
> Time ON > [1..30]s/c(+ -)
> Soft OFF > [**OFF** / ON]
> Time OFF > [1..30]s/c(+ -)

ON/OFF RAMPS SUBMENU

- **When SC6006 is operating on PSA Mode:**

By pressing [OK] button it access to the *Soft ON/OFF ramps* submenu. In this submenu you can activate or deactivate the soft turn on and soft turn off and set up the both times.

By default SC6006 is configured with 10 seconds (both UP and DOWN) ramps but with soft on and off options disabled.

- ***When SC6006 is operating on FWS Mode:***

By pressing [OK] button it access to the *Soft ON/OFF ramps* submenu. In this submenu you can activate or deactivate the soft turn on and soft turn off on FWS mode and set up the both number of cycles in which PSA will be used.

By default SC6006 is configured with 10 cycles (both UP and DOWN) ramps but with soft on and off options disabled.

Note:
On cases where a determinated number of cycles of turn on is set, the minimum firing packet will be this number of cycles A. On those cases where a determinated number of cycles B of turn off where set the minimum firing packet will be B. On those cases where turn on and turn off is set with A and B cycles respectively the minimum firing packet will be A+B cycles. Additionally, if alpha setpoint is set to 0% SC6006 will not fire, alternatively if alpha setpoint is set to 100% the board will be permanently activated ignoring turn on and turn off clycles.

4.3.2.7 Faults submenu

SUBMENU 1.7: Faults	> Blq	> [**N.OFF** / N.ON]
	> Inh	> [**N.OFF** / N.ON]
	> Halt	> [**En** / Dis]
	> Sync	> [**En** / Dis]
	> OvCurr	> [**En** / Dis]
	> Fault	> [**En** / Dis]
	> Interlock	> [En / **Dis**]

FAULTS SUBMENU

In this submenu we can enable or disable each one of the sources of fault (Halt, Sync and OvCurr) and even the fault signal itself (Fault). We also can set if the signals block and inhibit works as a normally-on or normally-off signals. Besides, the last option in submenu (Lock fault) interlocks the fault signal in case of fault event and stops the system and blocks it until all faults are gone and the SC6006 is in OFF mode by pressing [OK] push button in main menu.

By default SC6006 is configured with all the faults enabled and block and inhibit signals normally off. Interlock fault disabled.

4.3.2.8 Start up option

MENU 1: SETTINGS	> StartUp	> [OFF / ON / **Last**]

START UP OPTION

By pressing [OK] button we can change between ON, OFF or Last state.
Mode “ON” enables the firing every time the system is powered up. Mode “OFF” starts always SC6006 stopped. In “Last state” mode starts the system maintaining the last state when it was powered down.

By default SC6006 is configured with LAST state when start up the system.

4.3.2.9 Autoset options submenu

SUBMENU 1.9: Autoset

> AC Freq > [**50Hz** / 60Hz / Auto]
> Outputs > [**No** / Auto]
> Rotation > [No / **Auto**]
> Autoset?

AUTOSET SUBMENU

By pressing [OK] button we access to the *Autoset* submenu. In this submenu we can configure the mains frequency (50 or 60 Hz) or leave the SC6006 finds by itself the working frequency. Also SC6006 can set up by itself the outputs configuration and the phase rotation.
With the last option the SC6006 will start the autoset procedure.
The autoset is launched every time the system is powered on autosetting the enabled configurations.

By default SC6006 is configured as 50 Hz mains frequency with the outputs detect disabled and automatic rotation enabled.

4.3.2.10 Outputs assignation submenu

SUBMENU 1.10: Outputs

> SCR1 > [0 / **r** / r' / s / s' / t / t' / 1] (+ -)
> SCR2 > [0 / r / **r'** / s / s' / t / t' / 1] (+ -)
> SCR3 > [0 / r / r' / **s** / s' / t / t' / 1] (+ -)
> SCR4 > [0 / r / r' / s / **s'** / t / t' / 1] (+ -)
> SCR5 > [0 / r / r' / s / s' / **t** / t' / 1] (+ -)
> SCR6 > [0 / r / r' / s / s' / t / **t'** / 1] (+ -)

By pressing [UP] and [DOWN] we can select the SCRs outputs phase assignation. Pressing [OK] and then UP] and [DOWN] we can move through each phase and assign the output SCR.

By default SC6006 outputs are configured as: r – r ' – s – s' – t – t'.
***r:** meaning this output will switch during the positive semi-cycle of R-phase.*
***r':** meaning its output will switch during the negative semi-cycle of R-phase, and similarly for the other phases.*

4.3.2.11 Communications submenu

SUBMENU 1.9: COM

> RS232 > [**En** / Dis]
> Remote > [En / **Dis**]

COMMUNICATIONS SUBMENU

By pressing [OK] in “RS232” option we can activate or deactivate the serial communication of the unit.

By pressing [OK] in “Remote” option we can activate or deactivate the serial communication of the unit when operating with a SCRP6006 remote panel please read on chapter 8.1 - SCRP6006 for further information.

By default SC6006 is configured with its serial port activated and the communication with a SCRP6006 deactivated.

4.3.2.12 Save changes option

SUBMENU 1.10: Save all?

SAVE CHANGES

By pressing [OK] in “Save all?” a warning message will be displayed and then, if we push another time [OK]

all changes introduced will be saved in the internal EEPROM. By pressing [MENU] we will return to previous menu.

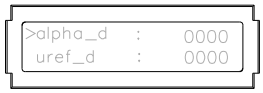
4.3.2.13 Restore option

SUBMENU 1.10: Restore?

RESTORE CHANGES

By pressing [OK] in “Restore?” a warning message will be displayed and then, if we push another time [OK] all configurations will be restored to the factory settings and then the controller rebooted.

4.3.3 Registers menu



REGISTERS MENU

In this menu it is possible to read and change some of the internal registers as digital setpoints or frequency and duty cycle of the train pulse of the SCRs.
The registers can be highlighted with [UP] and [DOWN] push-buttons, selected by pressing [OK] and then using [UP] and [DOWN] we can adjust, manually, its values.
Next will be briefly explained each of this set registers.

Digital setpoints registers

> alpha_d: This is the corresponding digital register to adjust the alpha setpoint when the unit is configurated to operate with the digital alpha setpoint register.
This is a 10 bit register and can be set from 0 (0%) to 1023 (100%).

> uref_d: This is the corresponding digital register to adjust the voltage setpoint when the unit is configurated to operate with the digital voltage setpoint register.
This is a 10 bit register and can be set from 0 (0%) to 1023 (100%).

> iref_d: This is the corresponding digital register to adjust the current setpoint when the unit is configurated to operate with the digital current setpoint register.
This is a 10 bit register and can be set from 0 (0%) to 1023 (100%).

By default all digital setpoints registers are set to 0.

Overcurrent threshold register

> o_curr: This register adjust the maximum rate of overcurrent when the overcurrent fault signal is triggered.
The o_curr register can be manually set from 50% to 300% of the measured input current with steps of 50%.

By default overcurrent register is set to 200%.

Output pulse gate train registers

> fsw: This register adjust the switching frequency for the output pulse gate train. Can be set from 1 to 25 kHz and by default it is set for a frequency of 12 kHz.

> duty: This register adjust the duty cycle for the output pulse gate train. Can be set from 5% to 30% and by default it is set for a duty of 25%.

Topology sync delay registers

> dly1: This register adjust the firing delay when W3C topology is used. It is, by default, configured to adjust the firing signal to the mains signal and normally there is no need to change its value.

> dly2: This register adjust the firing delay when B6C topology is used. It is, by default, configured to adjust the firing signal to the mains signal and normally there is no need to change its value.

4.3.4 Debug menu

If, when power on the SC6006, we maintain pressed the [UP] push-button we will enter in debug mode. In this mode we can access to another menu called debug menu. In this menu we can see with the on board LCD the values of many internal registers of the system. This mode is intended only for debug purposes.

Note: *All configuration changes introduced by user must be saved before power down or resetting the equipment or all changes will be lost.*

4.4 Jumpers and DIP Switches configurations

There are some configurations that can not set in software and must be set using the jumpers and DIP switches of the board. Following you will find an explanation of all the configurations set by jumpers and DIP switches.

4.4.1 Jumpers J7 and J20 to J24

Jumpers allow to configure the different input options of the control board. In table below, there are indicated the possible jumper configuration options.

Jumper	*Description*
J7	Used to control the gain of the direct voltage feedback input. Further description in 4.4.3.
JP20	Used to change the source of voltage feedback signal between direct voltage feedback input and analog input voltage signal input.
JP21	Used to select between auxiliary current transformers or shunt.
JP22	Used to change the source of current feedback signal between auxiliary current transformers or shunt and analog input current signal input.
JP23	It will be used for feedback with shunt in positive terminal and inverted voltage feedback. See chapter 7.3.2 on page 44.
JP24	Do not use this jumper, leave all its pins unconnected.

Notes:
In case of using an isolated sensor for the DC current feedback with J16[p19]-I_SENS, please double check the measuring direction of the sensor. Current feedback signal must be always positive.

In the following table can find the correct jumper configuration for common application schemes.

APPLICATION	*JP20*	*JP21*	*JP22*	*JP23*
Rectifier (shunt + controlled)	UP	UP	UP	UP
Rectifier (shunt - controlled)	UP	UP	UP	DW
AC control (aux. feedback)	UP	DW	UP	DW
External voltage and current control	**DW**	**DW**	**DW**	**DW**
Feedback by SCCAVO2 OA	UP	DW	DW	DW

Warning notes:
- Make sure and double check the position of the plugging connectors (jumpers), following previous indications.
- JP70 and JP71 are reserved, do not use them, they always must be connected.
- Do not let any jumper unconnected except for the J24 jumper.

4.4.2 DIP Switches

DIP switches sets the type of signal input for current and voltage references (I_SET, U_SET, voltage and current references (I_SENS, U_SENS) and alpha reference (ALPHA).

All this signals can be configured with DIP switches to work as 0-5 V, 0-10 V and 0-20 mA. For live input (4-20 mA) the configuration is made through software.

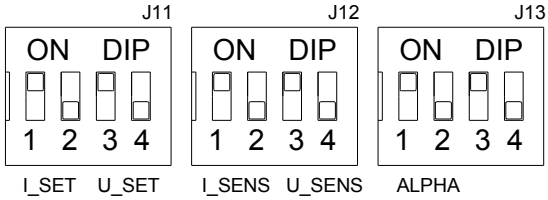
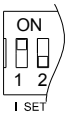


figure 23: Detail of the default configuration of DIP switches.

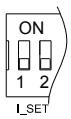
There are 2 switches assigned to each input as we can see in figure 23. In this figure is shown the default configuration of the switches. With this configuration all inputs are set to work as 0-5 V signals.

0-5 V mode (ON-OFF):



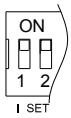
If we want to adjust I_SET (e.g.) input for 0-5 V mode the 2 correspondig switches must be set as follows: first switch ON (up position) and second switch OFF (down position). Same way for the other input signals.

0-10 V mode (OFF-OFF):



If we want to adjust I_SET (e.g.) input for 0-10V mode the 2 corresponding switches must be set as OFF (down position). Same way for the other input signals.

0-20 mA / 4-20 mA mode (ON-ON):



If we want to adjust I_SET (e.g.) input for 0-20 mA / 4-20 mA mode the 2 corresponding switches must be ON (up position). Same way for the other input signals.

Warning note:
Please double check if the configuration set by the DIP switches corresponds to the input signals you use. And avoid by all means the OFF-ON configuration.

4.4.3 Setting the gain for direct voltage feedback input

Voltage input feedback gain for J12[p1]-V_REAL input can be precisely adjusted for work correctly sensing a wide range of load voltages (see technical specification and maximum rated values). The gain of direct voltage feedback is adjusted by regulating R01 resistance using a pair of potentiometers (R01C and R01F) and a jumper on board (J7).

- How to adjust R01

The voltage input feedback gain is adjusted by setting the R01 resistor. This resistance can be adjusted setting the potentiometers R01C (coarse) and R01F (fine). With a multimeter the user can measure the R01 resistance value measuring between the points A and B of the figure 24 with all the system powered OFF.
Jumper J7 adds 2.2 kΩ when down and 220 kΩ when up in order to adjust more widely the total resistance value.

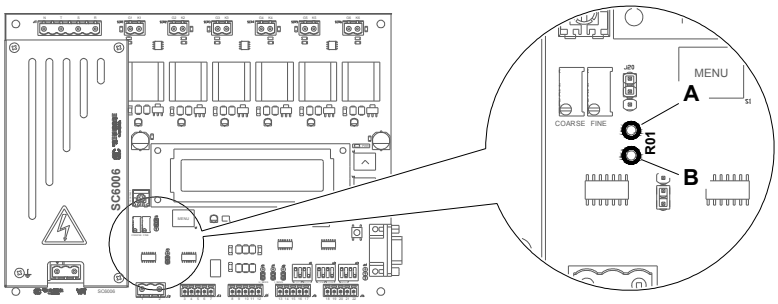


figure 24: Detail of test points for R01.

R01 resistance for the maximum voltage regulation, it must be calculated and regulated with R01C and R01F potentiometers following the indications below:

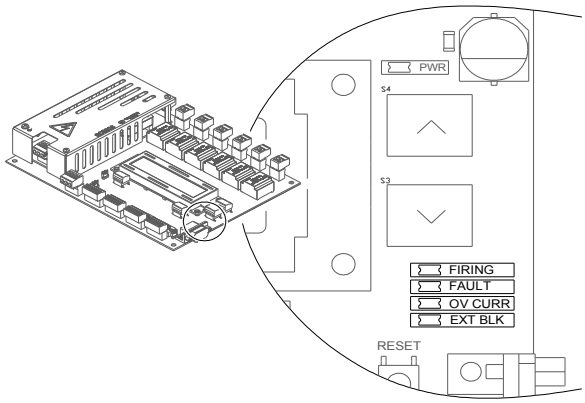
For direct feedback (without galvanic isolation): R01=2230/Vr
R01=[kΩ], Vr=[V] (rectifier bridge maximum output voltage or DC maximum input voltage)

For feedback through SCCAV02-OA (galvanically isolated): R01=220 kΩ

Note: When gain is properly regulated according the input voltage, the signal present in the upper pin of J20 must go from 0 to 5 V when input voltage go from 0 to 100%.
In case R01 has been set but the output regulation do not reach the 100% try to decrease gradually the gain voltage feedback to the point where the unit regulation go from 0 to 100%.

By default SC6006 is factory calibrated for measurement of 400 V_{AC} through bridge rectifier input (565 V_{DC} input).

4.5 LED Indications



There are a total of 5 LEDs in the PCB that shows the state of the system. If it is firing, in fault mode or there is an overcurrent or blocking event:

PWR LED: (Green) it indicates when the system is powered.
FIRING LED: (Orange) it indicates the system is in ON state and firing.
FAULT LED: (Red) it indicates there are a fault signal active and the outputs disabled.
OV CURR LED: (Red) indicates the situation of over current.
EXT BLK LED: (Red) indicates, when enabled, if there is an external blocking signal.

5 SERIAL COMMUNICATION

SC6006 has a serial communication port (J32) to make basic operations of control and configuration of the system through a RS232 interface with, for example, a remote PC or a PLC.

The default configuration of the serial link is as follows:

Baud rate: 9600bps

Parity bit: none

Stop: 1 bit

Flow control: none

To interface it with a standard RS-232 serial communication port, you will need a specific DB-9 null modem cable. You can, additionally, order the cable with the SC6006 board.

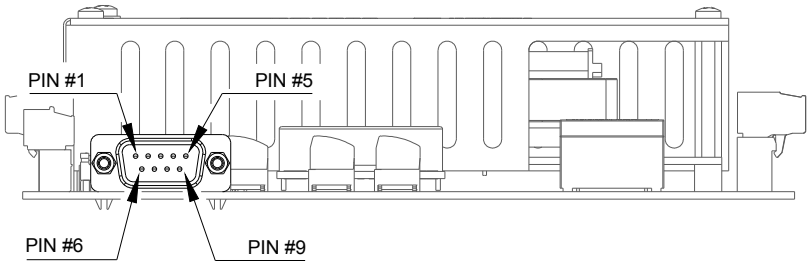


figure 25: J32 Connector (male D-SUB9) pinning detail. SC6006 lateral view.

Pin No.	Name	Dir	Notes / Description
1	VAUX	OUT	Do not use.
2	TD	OUT	Transmit serial data from SC6006.
3	RD	IN	Received serial data from remote DTE.
4	DTR	OUT	Data Terminal Ready. Loopback with DSR, internally connected.
5	SGND	-	Signal ground (SC6006).
6	DSR	IN	Data Set Ready. Loopback with DTR, internally connected.
7	RTS	OUT	Not connected.
8	CTS	IN	Not connected.
9	RI	IN	Not connected.

When powered on SC6006 sends a welcome message and awaits for the user instructions. If we interface SC6006 with a PC with HyperTerminal (e.g.) when system is power up we will see the following:

```
SC6006 - Command line

>
```

Then the communication it has been correctly established.

5.1 Overview available command set

SC6006 has 4 different types of instructions:

- Query instructions (?).
- Signal instructions (*).
- Memory read instructions (R).
- Memory write instructions (S).

To send any instruction to SC6006 and for being processed this instruction must end with a 0x10[“NL”] character (or an enter pulsation if HyperTerminal is used).

All the sent instructions will return back to the user (at least) the 0x10[“NL”] character plus the character of waiting for a new instruction: 0x3E[“>”]. This 2 characters will always be sent back even when the echo mode is deactivated.

5.2 Query instruction set

The query instructions which starts with 0x3F[“?”] character, gives the user a fast read of usual registers as voltage feedback register, current feedback register, alpha register, etc. And also get information about the software version installed in the system and its serial number.

5.2.1 “?ver” query version command

Returns the version of the firmware and hardware of the unit.

```
>?ver
PCB:v1.0 firmware:v1.28
```

5.2.2 “?S” query status register

Returns the value of the status register. This register is described in chapter 6.1.1 on page 37. This instruction is equivalent to read the register M000.

5.2.3 “?A” query alpha register

Returns the value of the alpha register. This instruction is equivalent to read the register M005.

5.2.4 “?U” query voltage register

Returns the value of the current register. This instruction is equivalent to read the register M008.

5.2.5 “?I” query current register

Returns the value of the status register. This instruction is equivalent to read the register M009.

5.3 Signal instruction set

The signal instructions starts with the 0x2A[“*”] character; this instructions makes a change in the system or sends a signal. Allowing to send a remote push-button signal, remote reset signal, etc. This instructions returns no value response but the 0x10[“NL”] and 0x03[“>”] when the instruction has been processed.

5.3.1 “*OK” signal command

Sends a remote pulsation of the [OK] push-button.

5.3.2 “*MENU” signal command

Sends a remote pulsation of the [MENU] push-button.

5.3.3 “*UP” signal command

Sends a remote pulsation of the [UP] push-button.

5.3.4 “*DW” signal command

Sends a remote pulsation of the [DW] push-button.

5.3.5 “*RMT” signal command

Enables or disables the remote mode for the SC6006 in order to use it with a remote control LCD as SCRP6006, this command activates a new set of reserved instructions less verbose and more M2M oriented. The description of this additional instruction set is out of the scope of this manual.

5.3.6 “*ECHO” signal command

Enables or disables the echo in serial communication.

When the echoing option is enabled, SC6006 transmits (echoes) data characters it receives back to the sender. When the echoing option is disabled, SC6006 will not echo the characters back to the sender; this, of course, does not prevent SC6006 from responding to data characters received.

This option is intended for a more man-machine friendly interface, for M2M communications disabling echo mode reduces the redundant information sent.

Echo mode is, by default, activated.

5.3.7 “*HOME” signal command

Returns the on-board LCD displayed menu to the main menu.

5.3.8 “*RST” signal command

Sends a reset signal to the unit. SC6006 will restart itself.

5.3.9 “*SV” signal command

Sends a save signal to the unit. SC6006 will save all the configuration changes introduced.

5.4 Memory read instruction

The memory read instructions starts with 0x4D[“M”] character followed by 3 numeric characters which specifies the memory address to read through communications port.

This instruction returns the decimal value of the specified register.

```
>M001
SC6006: 65460d
```

Note:
The table 2 in page 37 shows the a list of available registers to read with its corresponding brief description.

5.5 Memory write instruction

The memory write instruction starts with “S” character followed by 5 numeric characters which specifies the value (in decimal) which will be overwritten in the previously read memory. All the writable registers are 16 bits long, so the maximum allowed decimal value is 65,536.

For example, if we want to set the digital alpha setpoint from scratch to a decimal value of 128, first we must send a read instruction to register 011-d_alpha_reg (“M011”) and then overwrite its value using the instruction “S00128”. If then we want to change once again the same register we only need to send again the write instruction “S00000”. If we would change another different register we must proceed the same way from the beginning. Please see the following example.

```
>M011
SC6006: 00000d
>S00128
SC6006: 00128d
>S00000
SC6006: 00000d
```

Note:
The table 8 in page 40 shows a list of available registers to write with its corresponding brief description.

6 INTERNAL MEMORY AND REGISTERS

Following you will find a list of some important internal software registers of SC6006 and its description. Most of the features of SC6006 can be set using the on-board LCD menu but the operator/installer can also access or set a great deal of internal configurations making use of RS-232 communications port described in last chapter.

6.1 Readable registers

SC6006 can provide to the unit operator some information about its internal parameters, and settings. Operator can access some of this registers from registers menu with the LCD (on chapter 4.3.3) but also can access to all this registers by using the communications port, in table 2 appears the list of available-to-read SC6006 internal registers:

Register	*Name*	*Description*
M000	status0	System status register 0.
M001	status1	System status register 1.
M002	p_status0	System status register 2.
M003	p_status1	System status register 3.
M004	p_status2	System status register 4.
M005	alpha_reg	Phase angle register.
M006	u_meas_reg	Voltage feedback measure register.
M007	i_meas_reg	Current measure register.
M008	u_ref_reg	Voltage setpoint register.
M009	i_ref_reg	Current setpoint register.
M010	alpha_ext_reg	Alpha setpoint register.
M011	d_alpha_reg	Digital alpha setpoint register.
M016	autoconf_reg	Autoconfiguration status bits.
M017	freq_reg	Switching freqüency of SCR gates register.
M018	duty_reg	Duty cycle of SCRs gates register.
M021	f_meas_reg	Measured mains frequency register.
M022	enh_curr_reg	Enhanced current measure register.
M023	delay1_reg	delay for W3C mode register.
M024	delay2_reg	delay for B6C mode register.
M031	autoset_reg	Enable register for autoconfiguration.
M032	rmp_timeon_reg	Time to on register.
M033	rmp_timeoff_reg	Time to stop register.
M034	d_voltage_reg	Digital voltage setpoint register.
M035	d_current_reg	Digital current setpoint register.

table 2: List of readable registers.

6.1.1 status registers

The internal registers `STATUS0[M000]` and `STATUS1[M001]` are read-only registers. This registers are internal status bits with some of the actual state or system settings as all the fault signals, ON/OFF firing state of the unit and so on.

Following the tables with the description of some of the control bits contained in this registers.

M000: STATUS0 register

bit	Name	Description
0	on	system status. ON(1)/OFF(0)
1	fault	system status. Fault bit signal
2	halt	halt bit signal
3	inh	inhibit bit signal
4	ext_blq	external block bit signal
5	sync	system status. Sync bit signal
6	ov_curr	system status. Overcurrent bit signal
7	*N/A*	
8	*N/A*	
9	*N/A*	
10	*N/A*	
11	*N/A*	
12	*N/A*	
13	*N/A*	
14	*N/A*	
15	*N/A*	

table 3: bit list for status0 register.

M001: STATUS1 register

bit	Name	Description
0	on_rmp	on ramp activated bit
1	off_rmp	off ramp activated bit
2	*N/A*	
3	*N/A*	
4	rotation	phase rotation bit. 0 for CW.
5	mains_f	mains freq. 0 for 50Hz
6	on_led	ON LED bit signal
7	*N/A*	
8	*N/A*	
9	*N/A*	
10	*N/A*	
11	*N/A*	
12	*N/A*	
13	*N/A*	
14	*N/A*	
15	*N/A*	

table 4: bit list for status1 register.

6.1.2 p_status registers

The internal registers `P_STATUS0[M002]`, `P_STATUS1[M003]` and `P_STATUS2[M004]` are read/write configuration registers. This registers had the masking and enable bits for many system configurations. For example; comparison bits for normally-ON or normally-OFF blocking input signals, fault signals masking bits, mode of operation bits, topology and live zero bits, etc.

The below tables gives a brief description of this status bit registers.

M002: P_STATUS0 register

bit	Name	Description
0	en_on	enable ON (firing) mode
1	en_fault	enable fault signal
2	en_halt	enable halt signal
3	en_inh	enable inhibit signal
4	en_ext_blq	enable external block signal
5	en_sync	enable sync fault signal
6	en_ovcurr	enable overcurrent fault signal
7	sw_fault	enable interlock fault
8	*N/A*	
9	*N/A*	
10	topo0	topology bit. B6C=0, W3C=1
11	*N/A*	
12	*N/A*	
13	backlight	enable LCD backlight
14	*N/A*	
15	*N/A*	

table 5: bit list for p_status0 register.

M003: P_STATUS1 register

bit	Name	Description
0	en_on_rmp	enable soft on bit
1	en_off_rmp	enable soft off bit
2	en_auto_pw ron	enable startup bit
3	en_last_state	enable last state start up bit
4	*N/A*	
5	u_meas_lz	voltage feedback live zero
6	i_meas_lz	current feedback live zero
7	u_ref_lz	voltage setpoint live zero
8	i_ref_lz	current setpoint live zero
9	alpha_lz	alpha setpoint live zero
10	*N/A*	
11	*N/A*	
12	*N/A*	
13	*N/A*	
14	*N/A*	
15	*N/A*	

table 6: bit list for p_status1 register.

M004: P_STATUS2 register

bit	Name	Description
0	u_ref_src	voltage setpoint reference bit
1	i_ref_src	current setpoint reference bit
2	*N/A*	
3	*N/A*	
4	alpha_ref_src	alpha setpoint reference bit
5	*N/A*	
6	*N/A*	
7	echo	comm. echo mode
8	mode0	mode0 bit. PSA=0 FWS=1
9	mode1	mode1 bit. RLY=1
10	*N/A*	
11	*N/A*	
12	fb0	feedback mode bits:
13	fb1	00:I, 01:V, 10:IV, 11:OL
14	*N/A*	
15	*N/A*	

table 7: bit list for p_status2 register.

Warning note:
Take special care when attempting to change any of the configuration bits of p_status registers, if accidentally a wrong value is written the system can stop working or malfunction.

6.2 Writable registers

In table 8 appears the list of available-to-write SC6006 internal settings registers and its brief description. It is also specified the valid value range (decimal integer) for each register.

Register	Name	Description	Range
M002	p_status0	System status register 2.	N/A
M003	p_status1	System status register 3.	N/A
M004	p_status2	System status register 4.	N/A
M011	d_alpha_reg	Digital alpha setpoint register.	[0..1023]
M017	freq_reg	Switching freqüency of SCR gates register.	[10..20]
M018	duty_reg	Duty cycle of SCRs gates register.	[10..30]
M023	delay1_reg	delay for W3C mode register.	[0..400]
M024	delay2_reg	delay for B6C mode register.	[0..400]
M032	rmp_timeon_reg	Time to on register.	[1..30]
M033	rmp_timeoff_reg	Time to stop register.	[1..30]
M034	d_voltage_reg	Digital voltage setpoint register.	[0..1023]
M035	d_current_reg	Digital current setpoint register.	[0..1023]
M036	ov_current_reg	Maximum overcurrent reference.	[50..300]

table 8: list of writable registers.

Warning note:
Please do not attempt to make a writing in a register not appearing in table 8.And do not write to a register a value out of the defined range.

7 INSTALLATION

In the following chapter it is given a walk-through for the most common configurations and topologies where a SC6006 can be used, and examples on how to properly connect the SCR scheme or how the feedback loop (V/I) can be set. Also is given some mounting recommendations.

7.1 Typical application circuits

Below there are some schematics of the most common applications (different combinations of rectifiers and antiparallel thyristors), as well as feedback connections by shunt, transformer, etc.

The following descriptions are made separately for what concerns the firing and feedback, because they can combine in different ways (for example, it can be done an antiparallel control (AC) taking the feedback from a rectifier (DC), a typical application of this example would be the primary control of a transformer of a surface treatment).

In the application examples SCR are labeled with concordance with standard output software configuration (r-r'-s-s'-t-t').

At the end of this descriptions some advice as mounting recommendations are given, with the aim to improve the working security and prevent possible external problems along the installation process.

7.2 Control AC/AC applications.

In AC/AC control application, SC6006 controls a three-phase group of antiparallel thyristors.

The most common cases are:

- Control in the primary:

SC6006 card controls the voltage in the primary of a transformer. Feedbacks can be for current or voltage in the transformer primary or in the load connected in the secondary. In some cases, with applications based in microcontrollers, PLC, etc, it's necessary to have isolated sensors to proceed with the feedback loop.

- Direct control:

It is applied to motor start up, heating through resistor, dynamics compensation of reactive, etc.

7.2.1 W3C topology connection example

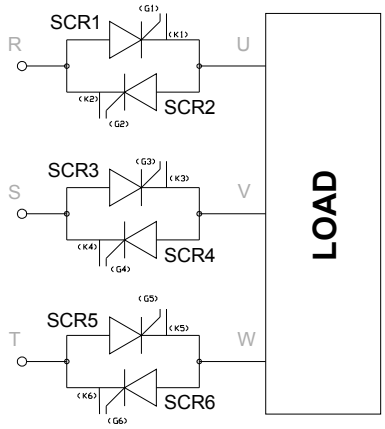


figure 26: W3C circuit connection example.

7.2.2 W3C current and voltage feedback scheme

In figure 27 is shown a typical feedback connection for a W3C scheme. Current feedback made with current transformers and voltage feedback using an auxiliar rectifier. Please note that if we use this configuration with an auxiliary bridge connected to J12[p1]-V_REAL it not provides a galvanic isolation.

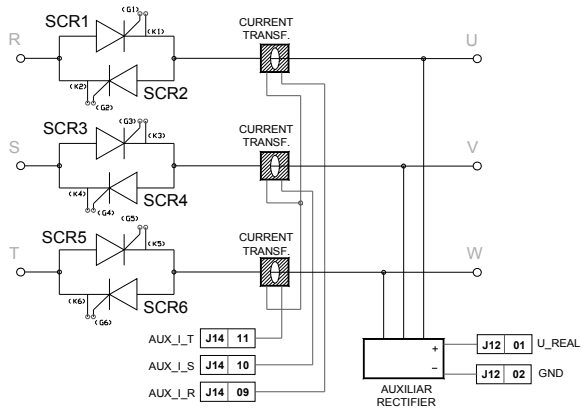


figure 27: Feedback connection W3C example.

7.2.3 Load connection types for W3C scheme

- Loads in wye connection:

To control loads in wye connection, see figure 28, the card must be synchronized with the voltages phase – neutral, *so it is very important to connect the neutral from the net to the neutral of the card* (J11[pN]-NEUTRAL).

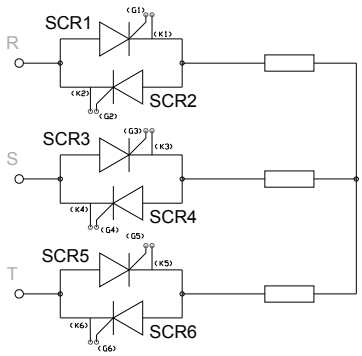


figure 28: Load in wye circuit.

- Loads in delta circuit:

To control loads in delta connection, *in case of the antiparallel thyristors are in the line*, see figure, the card must be synchronisated with the voltages phase-neutral, *so it is very important to connect the neutral from the net to the neutral of the card* (J11[pN]-NEUTRAL).

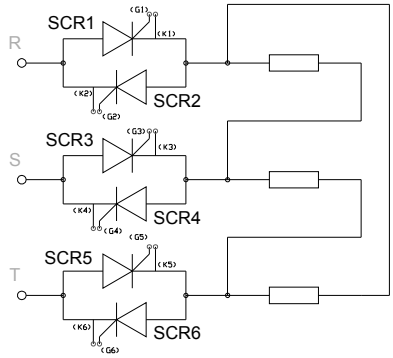


figure 29: Load in delta circuit.

- Loads inside delta circuit or open delta circuit:

In case of the antiparallel thyristors would be connected "inside" the delta circuit, see figure 30, the card will be configured as B6C topology.

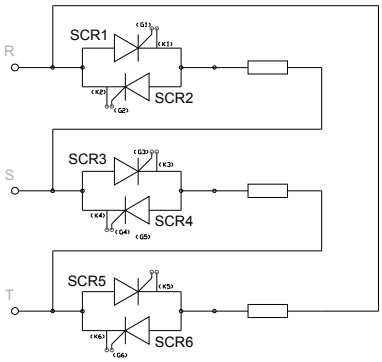


figure 30: Load in open delta circuit.

7.2.4 M6CK and M3.2CK schemes of connection

When configuring M6CK or M3.2CK topology it is necessary to follow the diagrams of figure 31. In both cases software output assignation is the assignation by default (r-r'-s-s'-t-t').

For M6CK configuration SC6006 must be set to work as B6C topology mode, and connect the SCR power stack as specified in the diagram below.

For M3.2CK configuration SC6006 must be set to work as W3C topology mode, and connect the SCR power stack as specified in the diagram below.

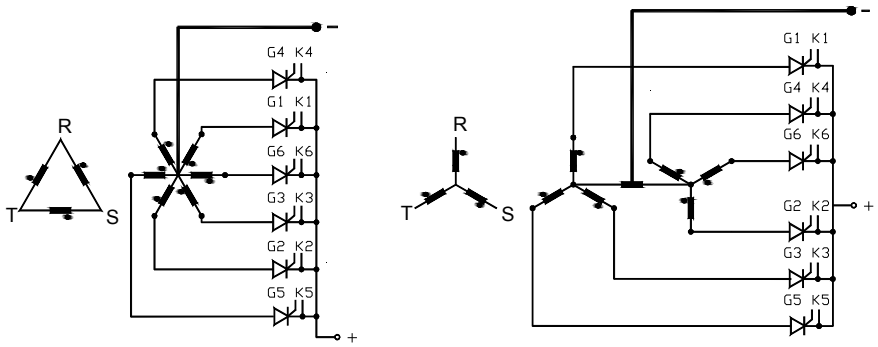


figure 31: M6CK and M3.2CK connection schemes.

Note:
Autoset function will not be capable to determine the output connection for this topologies due its common cathode connection. The user must check the concordance between the software output phase assignation and the wiring to the SCRs.

7.3 Control AC/DC applications. B6C scheme.

In AC/DC control application, SC6006 controls a three-phase thyristors bridge. They have a wide range of applications from electro-chemical processes, traction equipment, controlled power supplies, etc.

7.3.1 B6C topology connection example

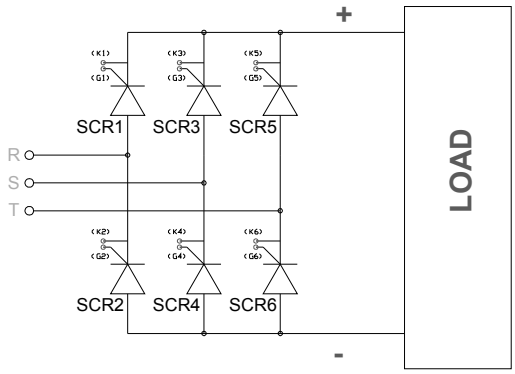


figure 32: B6C topology connection example.

7.3.2 DC current sense feedback using a shunt

If a shunt is used to sense the output current in a AC/DC topology then it must be checked, or decided, if the shunt is placed on the positive ouptut terminal or on the negative one. Then the controller board should be configured according this configuration and wired (the connections for current and voltage feedback signals) following the next specifications.

- Shunt on positive terminal

When a shunt is used on the positive output terminal and the voltage feedback measure is done with direct voltage input feedback J12[p1]-V_REAL, shunt negative reference must be connected to J14[p8]-GND and its positive sensing terminal to J14[p12]-I_SHUNT. Jumper JP23 must be set in UP position as specified in chapter 4.4.1 on page 30. So, if a current measure through shunt and a direct voltage measurement is done, voltage and current measures must be connected as is shown in figure 33.

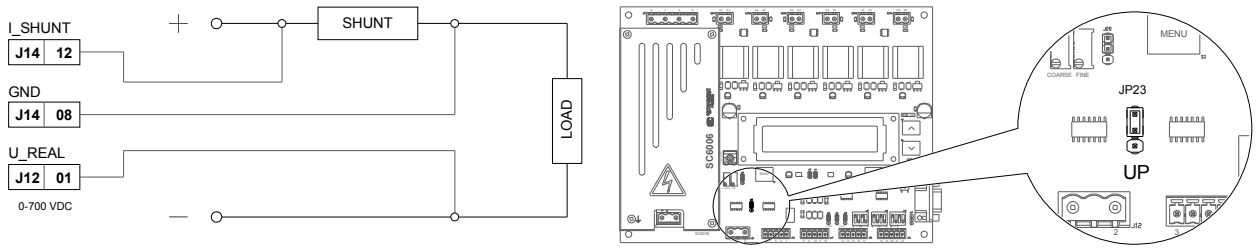


figure 33: Example of connection for shunt on positive terminal.

- Shunt in negative terminal

When a shunt is used on the negative output terminal and also a direct voltage input feedback is wired, SC6006 must be connected as is shown in figure 34.

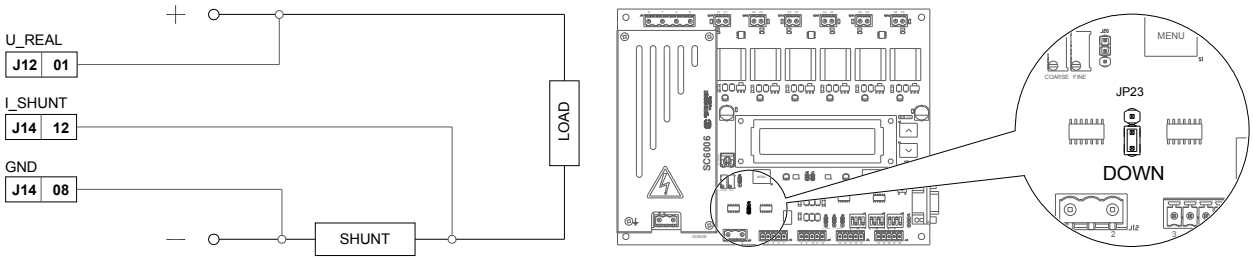


figure 34: Example of connection for shunt on negative terminal.

Warning note:
By default jumper JP23 is in DW configuration. Only change it to UP position when using a shunt in positive terminal and direct voltage input feedback.

7.3.3 Feedback using a current and voltage isolated sensors

Here is an example of a feedback scheme for an AC-DC application using a current isolated sensor (LA55-P) and a voltage optoisolated sensor (SCCAVOA) from transformer in primary side and with sensor signal outputs meeting the specifications of SC6006.

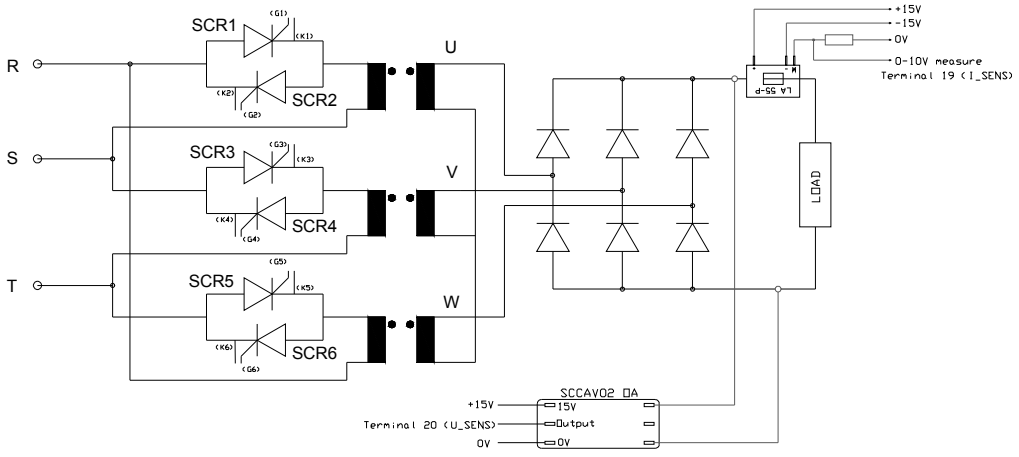


figure 35: AC/DC converter example with current and voltage feedback from transformer in primary side.

For this example circuit U_SENS and I_SENS inputs must be set through DIP-switches as 0-10 V inputs.

7.4 Direct drive mode with block signal

When SC6006 is operated in 'DRV' mode please note overcurrent fault and synchronism fault are automatically disabled, and also the inhibition signal is no longer a source for halt fault.

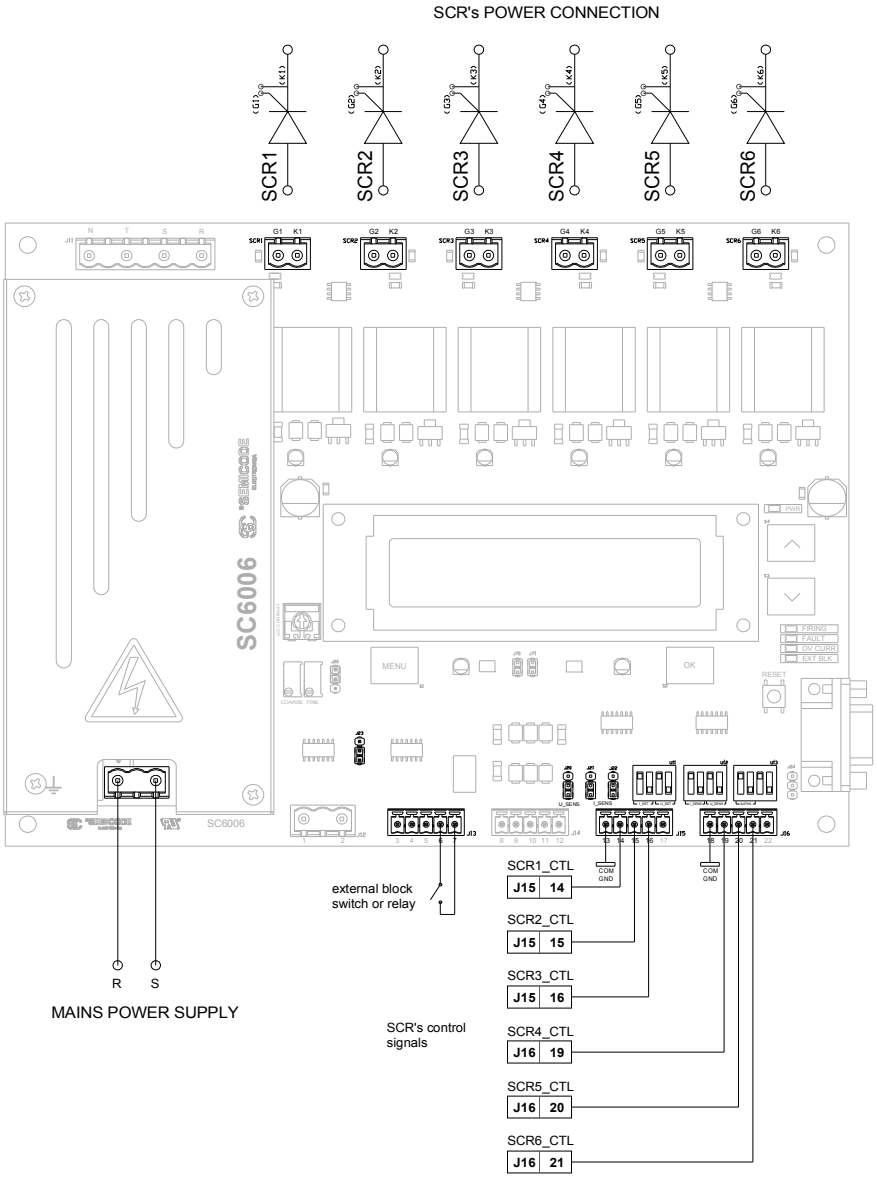


figure 36: 'DRV' mode recommended application circuit.

Following you will find a walkthrough to set up this operation mode according the circuit example given at figure 36.

- DIRECT DRIVE MODE SETUP WALKTHROUGH:

1. **Previous SC6006 operation mode configuration.**
   a) Power ON the board without any power connection or SCR connected to the board, just the power supply (J1).
   b) Make sure the PCA is in its default factory values. Go to submenu "`Restore?`" and restore the default values and wait until SC6006 reinitializes.
   c) Power OFF the board.

2. **Hardware test connection and configuration.**
   a) Connect all input signals but do not connect any SCR output power connectors.
   b) Set jumpers as follows:

JP20	*JP21*	*JP22*	*JP23*
DW	DW	DW	DW

   c) Set on-board DIP-switches as follows:

3. **Operation mode configuration.**
   a) Set and check that all logic inputs to 0 V and BLQ contact closed.
   b) Power ON the board.
   c) Go to "`Mode`" submenu and change to "`DRV`" mode.
   d) Go to "Reference" and check that "`Alpha`", "`Voltage`" and "`Current`" are set to "`An`" (Analog).
   e) Go to "`Live Inp.`" submenu and check that all inputs are set to "`0 mA`".
   f) Go to "`Start up`" submenu and check it is in "`Last`" mode.
   g) In "`Autoset`" submenu check value in option "`Outputs`" set as "`No`".
   h) Go to "`Outputs`" submenu and check that combination is: "` r - r' - s - s' - t - t' `".
   i) Go to Main Menu and set SC6006 in ON state.
   j) At this point FAULT LED and HALT LED must be ON, the rest OFF.

4. **Test correct operation.**
   a) Open BLQ contact. SC6006 resets FAULT and FIRING LED ON.
   b) Set SCR1_CTL input (J15[p14]) to 5 V.
   c) Check that SCR1 LED (D71) changes to ON following SCR1_CTL signal.
   d) Repeat b) and c) points for each SCR control input.
   e) Save all your software configurations: "Save all?".

5. **Hardware final set up.**
   a) Power OFF the SC6006 and connect all SCR output power connectors as shown in figure 36.
   b) Now the board is ready to work as 6 independent multidriver mode with a block signal.

7.5 Mounting recommendations

7.5.1 General mounting recommendations

1- Avoid long cables in the firing system, or use twisted or shielded cables. Apply it also for the potentiometer cables.

2- Ground the device in accordance with local regulations.

3- Make sure that the board is not in environments of strong magnetic fields, for example, high power transformers, or apply it a conductive envelop connected to ground.

3- For use it in inductive or capacitive loads, with regular connection cycles, it's recommended to use a fixed resistive load (with low value), in order to avoid any kind of error during the start up process (this is valid for all assemblies).

4- Is convenient to realize working tests with small loads (for example, bulbs or resistors), in this way if there is any connection error will be detected without further consequences. It's important to know that the feedback susceptibility couldn't be enough with loads which consumes very low current, thus, the control operation can be wrong.

5- In AC current control applications with voltage regulation, it must be added the auxiliary rectifier module SCCAV02, knowing that the galvanic isolation disappears with the net, otherwise use the isolated version SCCAV02 OA.

6- Shunt elements doesn't provide galvanic isolation in current feedback power stage. If galvanic isolation is a requirement, it must be used isolated current sensors (Hall sensors).

7- In applications with presence of variable loads, parasitic in the net, regulations with minimums voltage and currents, can cause non desired oscillation regulations. For this cases, please contact to our technical department.

8- Install the device in a upright or flat position and ensure a minimum ventilation distance between surroundings. If mounted in a cabinet ensure sufficient ventilation and always observe minimum spacing (clearance: 150 mm above and below).

8- For specific applications, there is the possibility to realize customized software and hardware adaptations and include auxiliary control modules, so please, don't hesitate to ask about your application.

7.5.2 Recommended start up procedure

CAUTION:
Before plugging the supply voltage for the control unit, be sure that the card is locked or will be start up in OFF mode and set the regulation potentiometers to the minimum level.

1- Lock the card through external blocking switch.

2- Regulate to the minimum level all the voltage and current or alpha potentiometers or setpoints.

3- If *Autoset mode* is configured for check and set the mains frequency operation, the phase rotation or outputs assignation, it will be done when the control board is powered up. Then SC6006 must be powered after or at the same time as the power stack.

4- Check operation and configuration settings are correct for your application.

7.5.3 Notes about the control card in systems controlled by microcontrollers or PLC

In those cases SC6006 is controlled by a external system, microcontroller, PLC, etc, it's essential to guaranty galvanic isolation between control signals and power circuits. The lack of isolation may cause a current circulation between the power stage and the power control circuits, thus, most cases the control elements get damaged.

The personal in charge of the design of this system should be qualified enough to manage isolation tests.

In case of doubt, please contact to our technical department where we can look for the best option.

8 AVAILABLE ACCESSORIES

There are available several accessories to work with the SC6006 which will be briefly described in this section, those accessories are normally used in applications with the firing board to enhance or complete its integration in a power converter.

8.1 SCRP6006

SCRP6006 (datasheet) is specially designed to interface our SC6006 SCR digital firing board. It provides a neat and easy way to remotely monitor and set up SC6006 SCR controller board using its serial interface. This panel expands the on-board LCD screen, buttons and status LEDs for mounting in a cabinet door. Additionally provides an extension to SC6006 serial link communication port.

Typical application

8.1.1 Interfacing SC6006 with remote panel SCRP6006.

To use a remote panel interfacing SC6006 for a door cabinet e.g. on figure 37 is shown how to connect it with SC6006. An standard DB-9 cable M to F is needed and on SC6006 the jumper 24 must be set on down position and configure, through LCD on board, the communication with the remote panel.

SUBMENU 1.9: COM > Remote > [**En** / Dis]

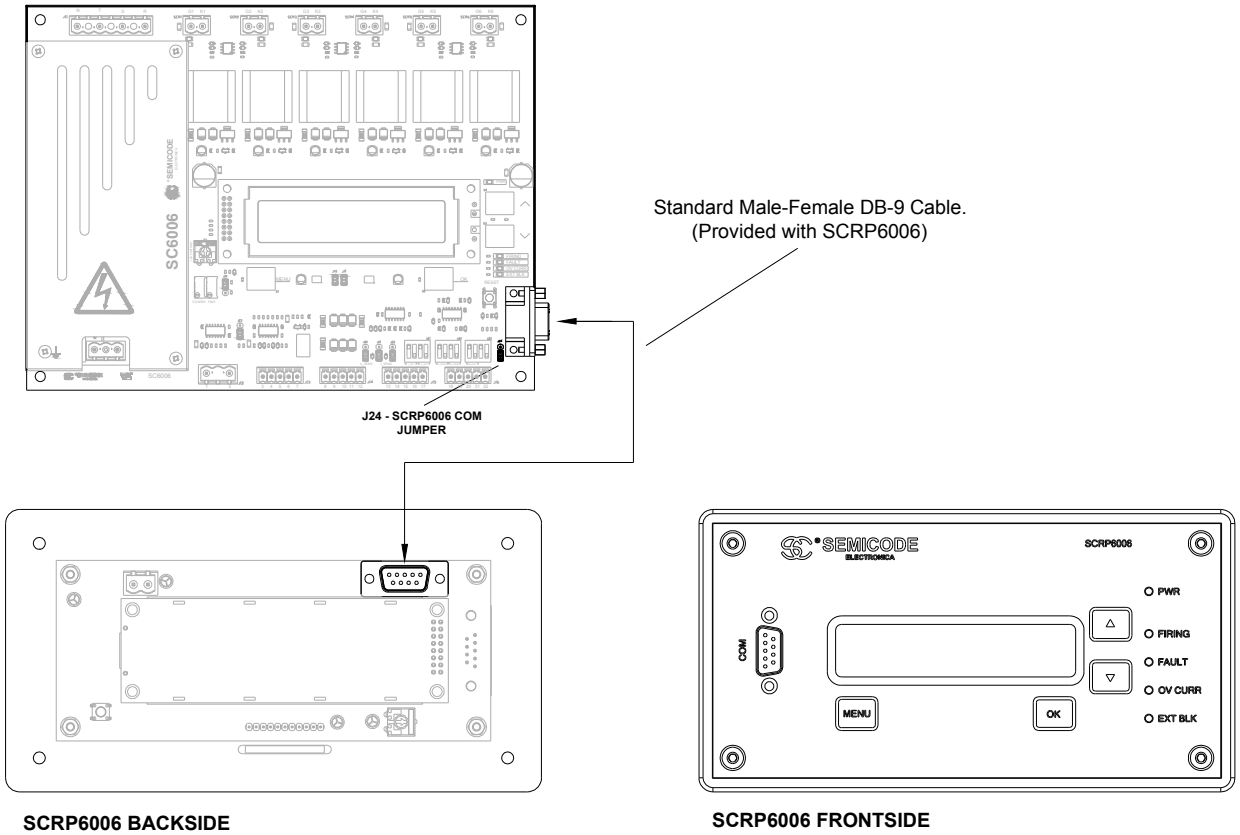


figure 37: Example of connection between SC6006 and SCRP6006.

8.2 SCGI24

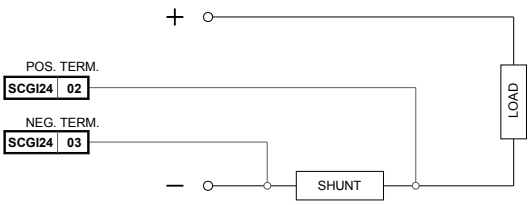
SCGI24 (datasheet) is a single-channel universal galvanical isolator well suited to interface standard 60 mV shunt current loops and direct voltage feedback signaling with a great input range (up to 700 V).

Typical applications

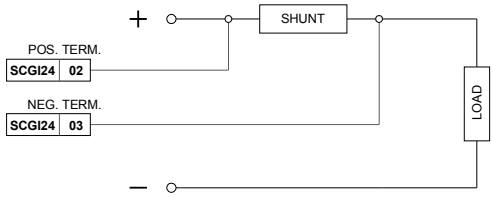
8.2.1 Galvanically isolated current loop with shunt using SCGI24.

Using SCGI24 with SC6006 to provide galvanic isolation on those applications with current loop made through a shunt. On figure 38 is depicted the scheme for a shunt mounted on positive or negative terminal (for a B6C application e.g.) using a 4-20 mA signal for the current loop connection between SCGI24 and SC6006.

SHUNT ON NEGATIVE TERMINAL



SHUNT ON POSITIVE TERMINAL



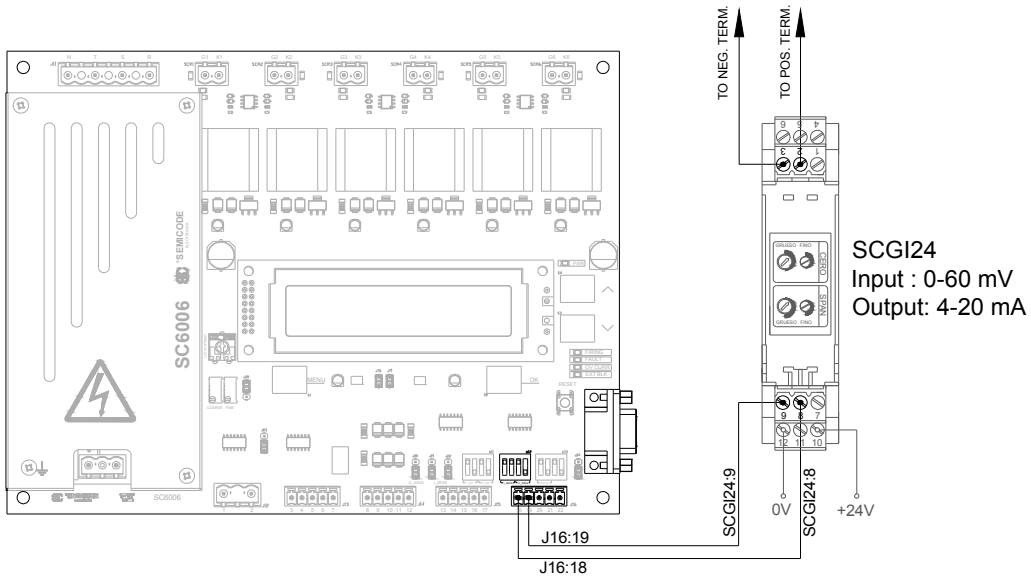


figure 38: Interfacing 60 mV shunt application with SCGI24 and 4-20 mA current loop signal.

8.3 SCST700

SCST700 (datasheet) is a 3-phase signal transformer for synchronism signaling which also provides a neutral signal to the controller card in installations without neutral take which is necessary to acquire a good synchronizing signal for SC6006. It is recommended to use it in those cases neutral connection is not available on the installation.

Typical applications

8.3.1 Obtaining a neutral reference using SCST700 for improved synchronism aquisition.

In those cases a neutral connection is not available or in cases the amplitude of the mains voltage where the SC6006 card is taking the reference synchronism is under 50 V_{AC}, it is very recommended to use SCST700 to improve synchronism acquisition for SC6006.

On figure 39 and figure 40 are represented two cases of typical connection for SCST700 where no neutral connection available on mains. For up-to-date and more in-depth and complete information please read SCST700 datasheet.

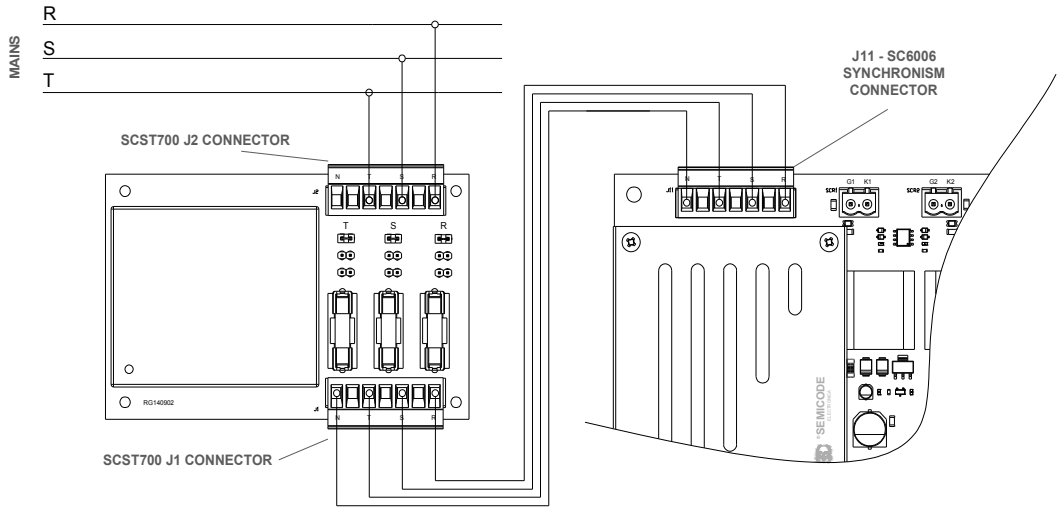


figure 39: Interfacing SC6006 with mains voltage from 200 to 700 V_{AC}.

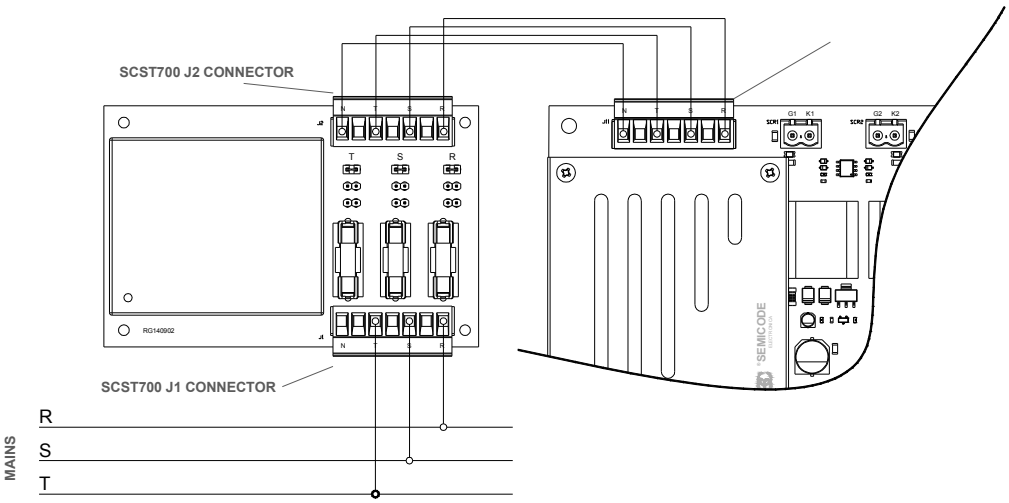


figure 40: Interfacing SC6006 with mains voltage from 65 to 200 V_{AC}.

9 FIRMWARE REVISIONS

Changes introduced on each firmware version of SC6006 along the initial serial number from each firmware revision has been released are listed in the following table and described in detail below.

Please note that is possible to upgrade an old control card with the newest revision available on request.

Firmware	*Date*	*Initial S/N*	*Changes Introduced*
v1.00	2013-03-20	123979	● First firmware version released.
v1.05	2013-06-25	126553	● Added a new mode of operation called "DRV" giving the option of fire each of the 6 channels independently from the rest and from synchronism.
v1.20	2014-01-13	129519	● Added Interlock function, an over current event interlocks the system until current drops below threshold current limit and SC6006 switches from ON state to OFF. ● Block and inhibit ON/OFF signal mode. Block and inhibit can work as board's ON/OFF signals. ● Remote mode introduced. Enables the comunication between SC6006 and SCRP6006 remote panel.
v1.25	2015-04-10	138426	● Improved outputs assignation algorithm. ● Saving last correct outputs assignation for use when the board is unable to autoset outputs. ● Improved given on-screen information for autoset and autoconf. ● Added new instruction set for enhancing comunication with SCRP6006 remote panel adding new remote funcionalities.
v1.28	2016-02-11	138440	● With FWS mode now it is possible to make a PSA ramp specifying on the time ramp the number of periods. ● Rugged behaviour on FWS with slope in for temperature treatments with resistors controlled on primary. ● Other minor internal firmware changes introduced.

10 TECHNICAL SPECIFICATIONS

TECHNICAL SPECIFICATIONS

Description	Symbol	Notes / Test Conditions	Min	Typ	Max	Units
Input supply voltage	$V_{IN\ RMS}$	*50Hz - 60Hz*	195	230	480	V_{RMS}
Input AC voltage (sync)	V_{sync}		10		700	V_{RMS}
Direct input voltage sense	V_{REAL}		10		700	V_{DC}
Thyristor triggering current	I_{OUT}	*Vout = 5V*			600	mA
Working frequency	f_w			50 / 60		Hz
Load		Delta / wye				
Topologies		W3C, B6C, M6C, M3.2C, W3H, B6H, M3C…				
Working modes		Phase angle modulation, Full wave switch and relay mode				
Protection degree				IP-00		
Pollution degree				III		
Humidity		50% Rh @ 35ºC / 70% Rh @ 20ºC				
Power-to-control isolation voltage	V_{ISOp-c}	*50 Hz @1min*		5300		V_{AC}

SUPPLY SPECIFICATIONS

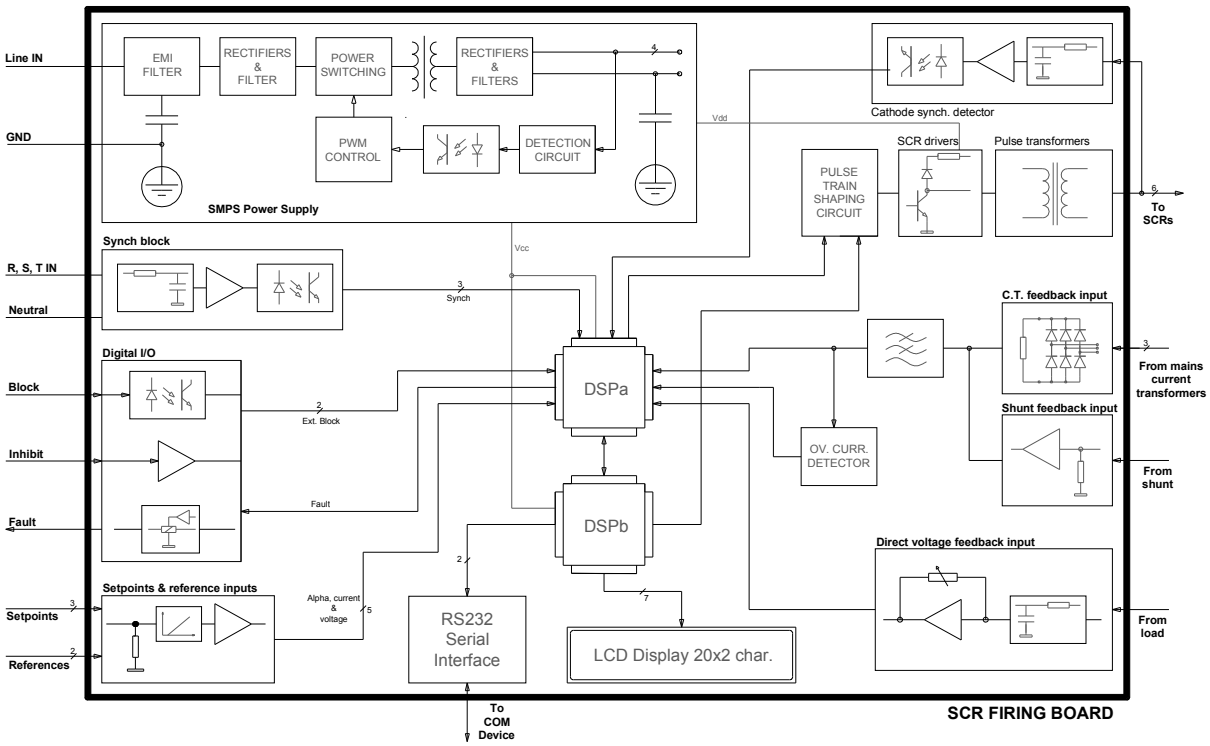
Description	Symbol	Notes / Test Conditions	Min	Typ	Max	Units
Line voltage	$V_{IN\ RMS}$	*±10%*	195	230	480	V_{RMS}
Frequency range	f_w		47		63	Hz
Power output	P_{out}			25		W
Typical input current		*Full load @ 230$V_{AC\ IN}$*		180		mA
		Full load @ 400 $V_{AC\ IN}$		130		mA
Inrush current limiting		*@ 230$V_{AC\ IN}$*		11,5		A
		@ 400 $V_{AC\ IN}$		20		A
Isolation between mains and output		*@ 1min*		4000		V_{RMS}
Isolation between secondaries		*@ 1min*		4000		V_{RMS}
Power supply starting time					1.5	s
System start up time		*without sync signals*			5	s

Data at T_a = 25 °C, V_{IN} = 230 V_{AC} and rated values, unless otherwise indicated

BOARD CONNECTIONS AND CONFIGURATIONS

Description	Notes / Test Conditions	Units
Board configuration	Jumpers, DIP switches & software configurations	
Supply, control & trigger signals	Plug connectors, with screw	

BLOCK DIAGRAM



INPUT REFERENCE AND FEEDBACK SIGNALS

Description	*Symbol*	*Notes / Test Conditions*	*Min*	*Typ*	*Max*	*Units*
Voltage setpoint	$V_{IN\ ref}$	depending of the on board DIP-switches configuration and software settings.	0		20	mA
Current setpoint	$I_{IN\ ref}$		4		20	mA
Alpha setpoint	$\alpha_{IN\ ref}$		0		10	V
Voltage feedback signal	$V_{IN\ fb}$		0		5	V
Current feedback signal [1]	$I_{IN\ fb}$					
Voltage direct feedback	$V_{IN\ dfb}$		10		700	V_{peak}
Current feedback (from curr. Trans.) [1]	$I_{IN\ trf}$		0		200	mA
Current feedback (from shunt.)	$I_{IN\ shunt}$		0		60	mV
External lock		*NO/NC software configurable*		External relay		
Inhibit		*NO/NC software configurable*		5		V
Output fault dry relay current	I_{K2}				1.5	A
Output fault dry relay voltage	V_{K2}			250		V_{RMS}

[1] Current inputs allows a peak input 3 times the maximum nominal current sensing.

PROTECTIONS AND TIMMINGS

Description	*Symbol*	*Notes / Test Conditions*	*Min*	*Typ*	*Max*	*Units*
Phase loss, sync or rotation fault						
External block signal		Disables thyristor firing				
Overcurrent fault		Fault auto-reset softw are configurable				
Max. time detect and stop phase loss	t_{ph_dly}		50	60		ms
Maximum time ext. Block to stop	t_{blk_dly}			0.25		ms
Maximum time to response RS232 op.	t_{RS232_dly}			0.2		ms
Time to get mains sync	t_{sync}			50		cycles

SOFTWARE ADJUSTMENTS

Description	*Notes / Test Conditions*
Maximum/minimum voltage limit	0 – 100%
Maximum/minimum current limit	0 – 100%
Soft start and stop time	1 – 30 s (independently adjustable)
Overcurrent	0 – 300%

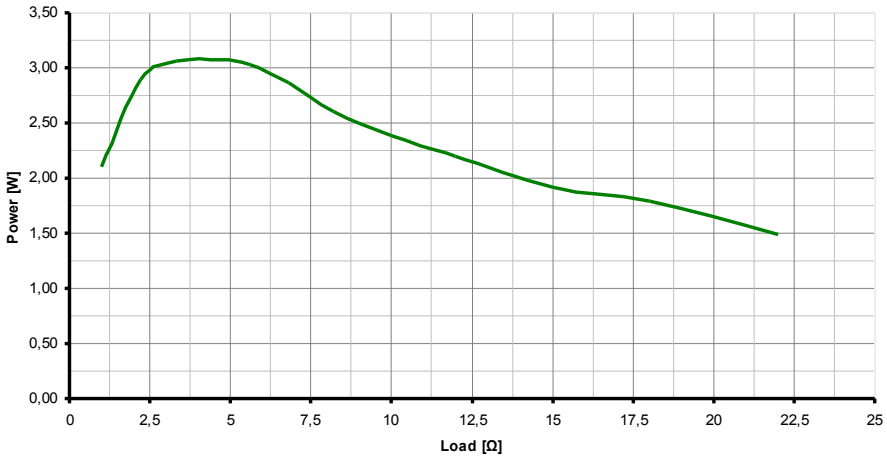
LCD ON-BOARD SIGNAL & COM MONITORIZATION

Description	
Voltage setpoint	
Current setpoint	All signals monitorized at on-board LCD
Alpha setpoint	and through serial communications port
Voltage feedback signal	
Current feedback signal	

OUTPUT FIRING PULSE TRAIN

Description	Symbol	Notes/Test conditions	Min	Typ	Max	Units
Thyristor triggering current	I_{OUT}	*Vout = 5V*			600	mA
Maximum output voltage	$V_{OUT\ max}$				7.5	V
Max transferred power to load	$P_{OUT\ max}$				3	W
Output firing train frequency	f_{OUT}		1	12	25	kHz
Output firing train duty cycle	Dc_{OUT}		5	25	30	%

OUTPUT POWER vs. LOAD



CONFORMALS

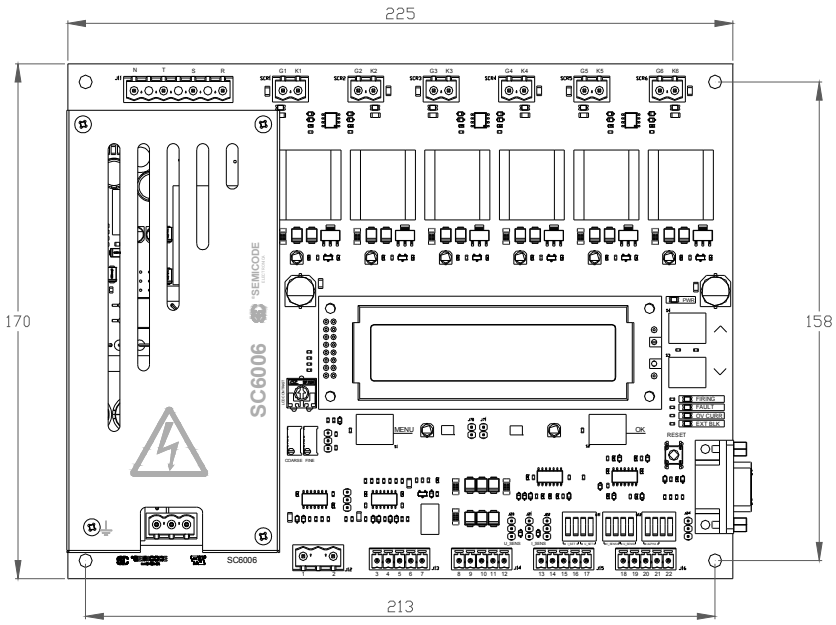
Conformal coating	MIL-1-46058, Type UR
Security	EN60950-1, UL60950-1

EMC DIRECTIVE

This Thyristor power controller is intended to work as part of an industrial fixed installation and is not for itself a functional unit destined to an end user. According 2004/108/CE directive, CE marking for this device not apply.

10.1 Mechanical dimensions

Description	Notes/Test conditions		Units
Board		225 x 170 x 45	mm
Fixations	*fixation holes diameter*	4.5	mm
Weight (aprox)		700	gr



(All dimensions in mm)

10.2 Connectors overview

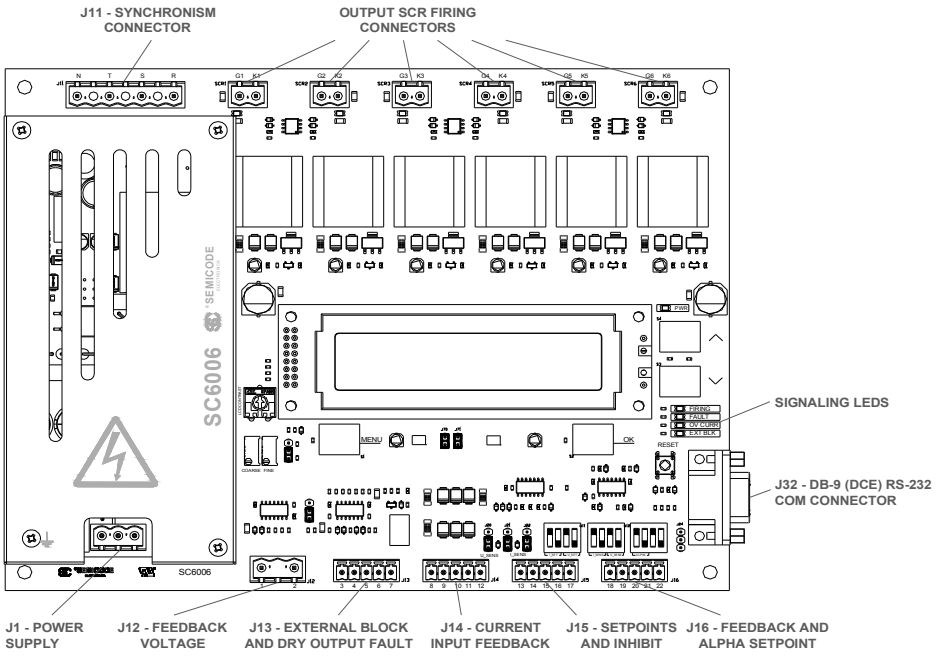


figure 41: Connectors overview of SC6006.

Cost Effective Products

SEMICODE ELECTRONICA

Offers to the market a comprehensive range of products from recognized manufacturers at the best price/quality relationship, this products are provided with a basic reference code that allows maintaining the same product reference even if the original device manufacturer is replaced. SEMICODE product reference has to be considered as a generic brand.

Seeking the market needs and trends, we are constantly increasing the product portfolio with new products and suppliers, please ask for the updated information available to our local contacts.

SEMICODE products include semiconductors, passive components and accessories focused in power electronics market.

Datasheet Annotations:

SEMICODE ELECTRONICA annotate datasheets in the top left hard corner of the front page, to indicate product status. The annotations are as follows:
Tentative information: This is the most tentative form of information and represents a very preliminary specification. No actual design work on the product has been started.
Preliminary Information: The product is in design and development. The datasheet represents the product as it is understood but details may change.
Advance Information: The product design is complete and final characterisation for volume production is well in hand.
No Annotation: The product parameters are fixed and the product is available to datasheet specification.

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