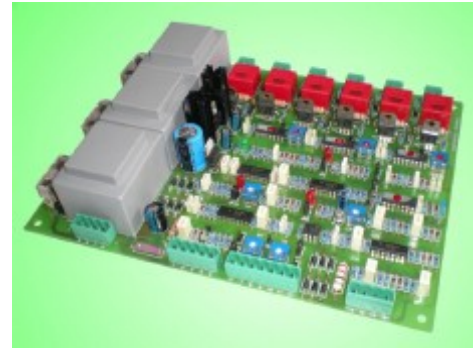


PRELIMINARY TECHNICAL INFORMATION
HIGHLIGHTS

- Two supply voltages 230 V_{AC} or 400 V_{AC}
- External inhibit input
- Wide range of application allowed



non-contractual photo

OVERVIEW

The main feature of this circuit is its versatility, because of it allows different regulation options to work in several applications.

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

Main applications for this circuit are those where you need a safe control for large currents trough thyristors, for example surfaced treatments, electrolytic process, ovens, lightening, etc.

GENERAL DATA

Supply voltage	230/400 V _{RMS} 42 to 63 Hz
Load connections allowed	Delta/ star (with neutral)
Application topologies	W3C; B6C; M6C; M3.2C
Optional application topologies	W3H; B6H; M3C

CONTROL OPTIONS

Control of voltage	External potentiometer 4k7 Ω
	Analog signal 0 to 10 V _{DC}
Control of current	External potentiometer 4k7 Ω
	Analog signal 0 to 10 V _{DC}
Phase control (direct control)	Analog signal 0 to 10 V _{DC}
External lock	External relay (open contact)

INTERNAL ADJUSTMENTS

Voltage limit	Resistor R1 (see documentation)
Maximum output voltage adjustment	Internal board potentiometer ±10%
Maximum output current adjustment	Internal board potentiometer ±10%
Instantaneous overcurrent allowed	Internal board potentiometer (0 to 600%)
Startup ramp	Internal board potentiometer (1 to 90 s)

111215 Rev.:1

INDICATIONS

Synchronism phase error (or phase rotated)	Red LED
Instantaneous overcurrent	Red LED
External lock	Red LED
Board supplied	Green LED

FEEDBACK (INPUTS)

Current feedback	Standard 60 mV shunt (on positive output)
	Standard 60 mV shunt (on negative output)
	Current transformer (ratio $x/200$ mA)
Voltage feedback	Hall effect sensor
	DC voltage up to 300 V_{PK}

PROTECTIONS

General	Fast fuses (3x 1 A)
Phase failure	Thyristor firing pulses instantaneous suppression
Synchronism phase failure detected	
Wrong phase rotation	
Instantaneous overcurrent	
Starting	Board supplied (auto-reset)

TRIGGER

Minimum trigger current (pulse train)	200 mA ⁽¹⁾
Maximum trigger voltage (pulse train)	24 V
Maximum working voltage (pulse transformers)	500 V_{RMS}

(1) measured with 20 Ω load

CONNECTIONS

Board configuration	Jumpers in the board
Supply, control & trigger signals	Plug connectors (with screw)

ENVIRONMENTAL ESPECIFICATIONS

Protection degree	IP-00
Maximum humidity	50% Rh @ 35°C / 70% RH @ 20°C
Pollution degree	III
Electrical isolation	2500 $V_{RMS}/1$ min

DIMENSIONS

Mechanical dimensions of the board

225x170x45 mm

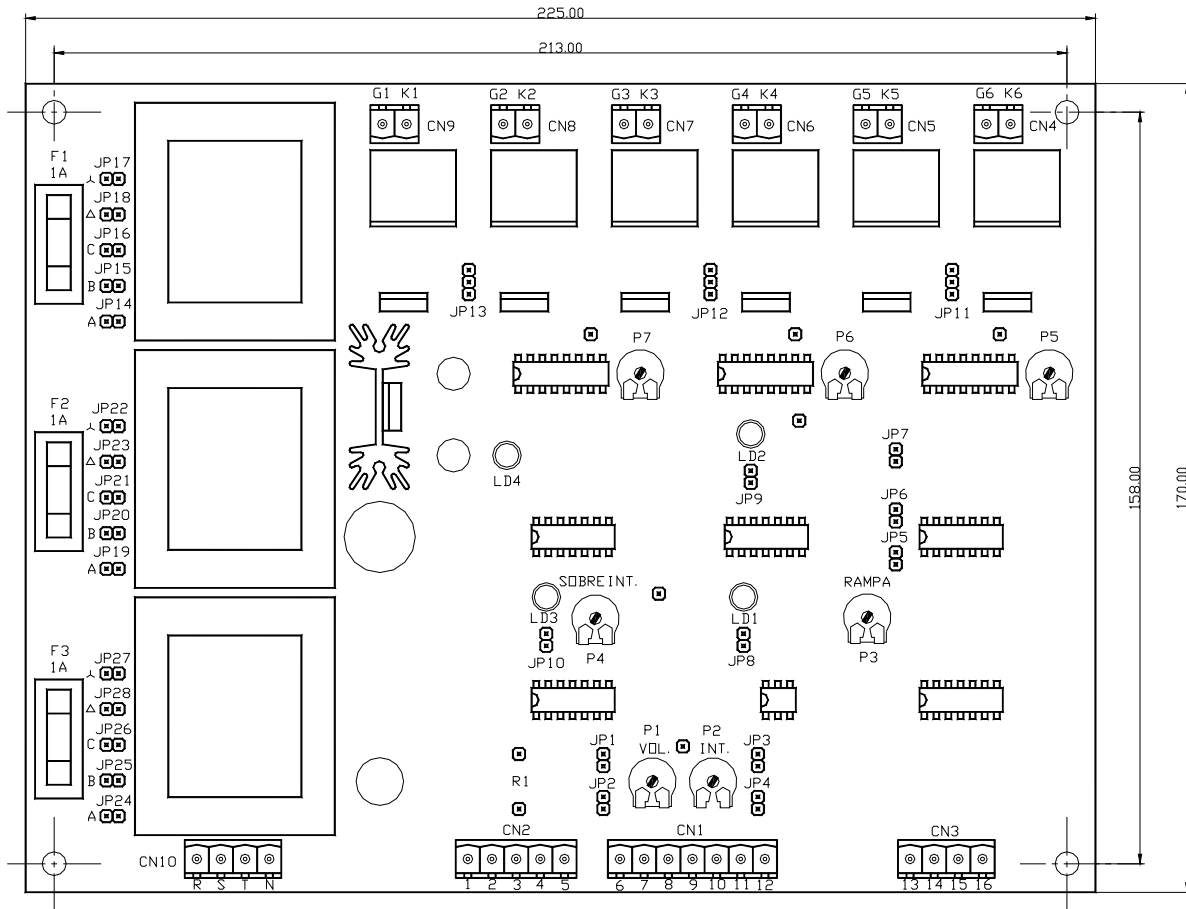
Fixation

4x hole Ø4,2 mm

Weight

1350 gr.

MECHANICAL DIMENSIONS



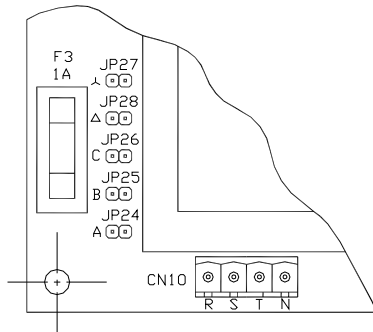
All dimensions are in millimeters

POWER SUPPLY CONNECTIONS:

Protection fuses: Three units, one for each phase, fast type 5x20, 1 A

Jumpers group **JP14** to **JP28**

Voltage supply and synchronism selection, according to the indications below:



- **Star connection supply 230 V:** Jumper to **Y** and to letter **C**.
- **Delta connection supply 230 V:** Jumper to **D** and to letter **B**.
- **Star connection supply 400 V:** Jumper to **Y** and to letter **B**.
- **Delta connection supply 400 V:** Jumper to **D** and to letter **A**.

In the table of page 7 there are indicated this selection modes regarding to jumpers numeration (JP14 to JP28).

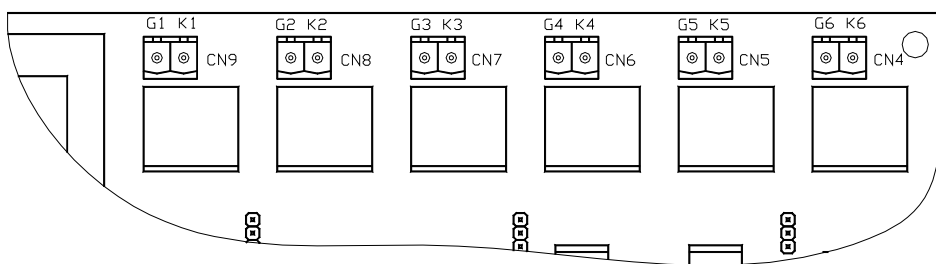
CN10

Input mains supply connection. In the board there are indicated the three phases **R, S, T** and neutral (**N**). Mains connection must guaranty concordance with the thyristors to get sure that the synchronism is correct.

Notes:

- For star connection, although apparently there isn't the need, the connection to the neutral conductor always must be done.
- It is very important to be sure about the mains supply configuration, in case of any error, it will work badly and can appear important malfunctions to the control board.

FIRING CONNECTIONS:



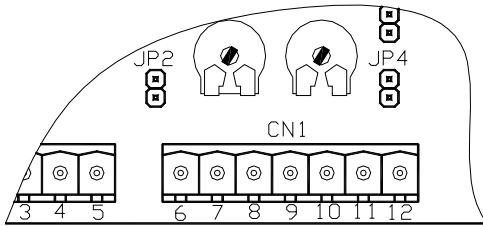
CONNECTOR	GATE	CATHODE
CN9	G1	K1
CN8	G2	K2
CN7	G3	K3
CN6	G4	K4
CN5	G5	K5
CN4	G6	K6

Note:

For thyristor connection, see “TYPICAL APPLICATION CIRCUITS” and annex 1, where it’s indicated the most typical circuits.

CONTROL AND FEEDBACK CONNECTIONS:

CN1



Terminal 6: Positive terminal from the voltage regulator potentiometer.

Terminal 7: Adjustment terminal from the voltage regulator potentiometer.

Terminal 8: Negative terminal from the voltage regulator potentiometer.

Terminal 9: Positive terminal from the current regulator potentiometer.

Terminal 10: Adjustment terminal from the current regulator potentiometer.

Terminal 11: Negative terminal from the voltage regulator potentiometer.

Negative connection to the external control signal 0 to 10 V.

Terminal 12: Positive connection to the external control signal 0 to 10 V.

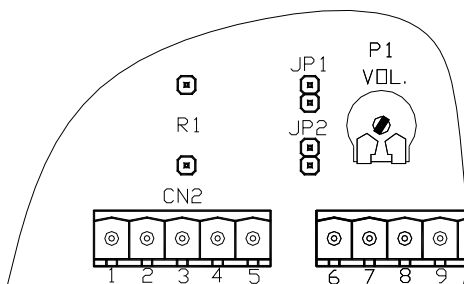
Notes:

- Potentiometers can be any type, but with a value of 4k7 Ω.
- When the adjustment part of the potentiometer is situated to the positive side, the supplying voltage is at the maximum level.
- It’s possible to control the inputs with 0 to 10 V signals applied to the adjustment potentiometer terminals (referring to ground).

CN2

Supply and blocking signals are located to CN2. In 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. So its forbidden to use elements like “shunts” to close the current loop, and voltage feedback it can’t be done directly.

For this cases, there is available isolated feedback modules, designed to work with the control board.



Terminal 1: Voltage input feedback signal.

Terminal 2: Input for feedback with a standard 60 mV shunt. In cases where it’s necessary galvanic isolation, its recommended to use an isolated sensor, hall effect, and an adaptation to the output signal to 0-60 mV range will be needed.

Terminal 3: Ground, voltage and current feedback common point.

Terminal 4: Positive terminal of the blocking signal. This terminal has an output of 24 V for sensor supply.

Terminal 5: Negative terminal for the blocking signal.

Note: To work without the blocking mode, the contact must be normally-off (a bridge can be added between both terminals), the blocking mode will be done opening the circuit by a switch, thermostat, microfuse, etc.

R1 resistor:

Reference resistor for the maximum voltage regulation, it must be calculated following the indications below:

Rectifier bridge control feedback

For direct feedback (without galvanic isolation): $R1=1500/Vr$
 $R1=[k\Omega]$, $Vr=[V]$ (rectifier bridge maximum output voltage)

For feedback through SCCAV02-OA (galvanic isolated): $R1=82\text{ k}\Omega$

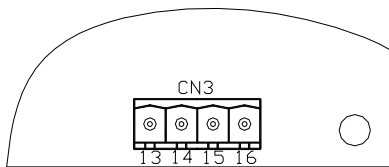
Feedback for ac-ac control

Feedback through SCCAV02 (non galvanic isolation): $R1=2000/Vr$
 $R1=[k\Omega]$, $Vr=[V]$ (ac-ac converter maximum output voltage)

For feedback through SCCAV02-OA (galvanic isolated): $R1=82\text{ k}\Omega$

CN3

If it's necessary AC current measurement by current transformers, CN3 lets the feedback current.



Terminal 13: R phase input for auxiliary feedback.

Terminal 14: S phase input for auxiliary feedback.

Terminal 15: T phase input for auxiliary feedback.

Terminal 16: Ground connection (for special applications, normally not used).

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 the recommended values for this application:

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

PLUGGING CONNECTORS (JUMPERS) JP1 to JP13

Jumpers allow to configure the different options of the control board, in table below, it's indicated the possible configuration options.

JUMPER	use
JP1	It will be used for feedback with shunt in terminal -. In case of using the module SCCAV02OA, this jumper must be always used.
JP2	Used for feedback with shunt in + terminal.
JP3	Used for DC feedback or with shunt or isolated sensor.
JP4	Used for auxiliary feedback .
JP5	Used for external feedback (direct control over the conduction angle) with control signal from 0 to 10 V.
JP6	Used for internal feedback (current and voltage control).
JP7	Used for internal feedback (current and voltage control).
JP8	Its disconnection disallow the blocking for external contact. It is recommended not to disable it for normal operation.
JP9	Its disconnection disallow the blocking for synchronism error. It is recommended not to disable it for normal operation
JP10	Its disconnection disallow the blocking for overcurrent. It is recommended not to disable it for normal operation
JP11	Output signal for firing of T phase (control) for special applications
JP12	Output signal for firing of S phase (control) for special applications
JP13	Output signal for firing of R phase (control) for special applications

Notes:

In case of using an isolated sensor for the DC current feedback, double check the measuring direction of the sensor. Current feedback signal must be positive (see examples in annex 1).

- If you use module SCCAV02 OA, set JP1.

APPLICATION	JP1	JP2	JP3	JP4	JP5	JP6	JP7	JP8	JP9	JP10	JP11	JP12	JP13
Rectifier (shunt + controlled)													
Rectifier (shunt - controlled)													
AC control (aux. feedback)													
External control 0-10V													
Feedback by SCCAV02 OA													

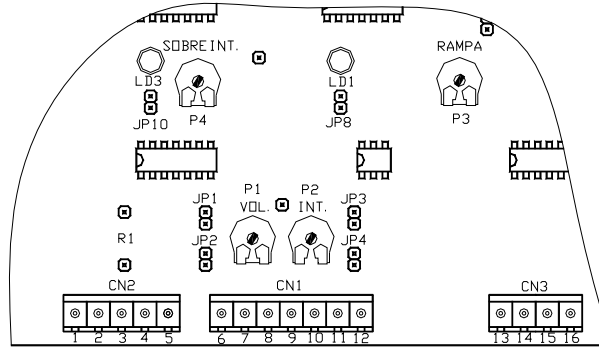
BOARD SUPPLY	JP14	JP15	JP16	JP17	JP18	JP19	JP20	JP21	JP22	JP23	JP24	JP25	JP26	JP27	JP28
230 V star connection															
230 V delta connection															
400 V star connection															
400 V delta connection															

Jumper plugged	
Jumper unplugged	

Notes:

- Make sure the position of the plugging connectors (jumpers), following previous indications.
- JP11, JP12 and JP13 are reserved, do not use them.

AVAILABLE ADJUSTMENTS



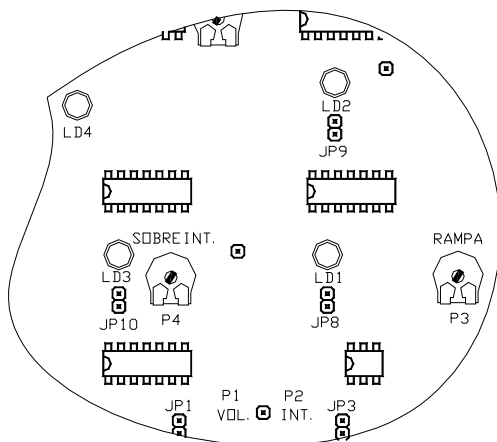
OVERCURRENT: Instantaneous overcurrent potentiometer, it detects the current peaks (for example, shortcircuits), causing a blocking state in the control and a new start up by a ramp. For normal applications, this potentiometer is situated in a medium position.

VOL: Maximum voltage adjustment potentiometer (it limits the voltage, when the cursor of the voltage regulating potentiometer it's in the maximum position).

INT.: Maximum current adjustment potentiometer (it limits the current, when the cursor of the current regulating potentiometer it's in the maximum position).

RAMPA: Ramp adjustment potentiometer (standard timing: minimum <0.1; maximum >20 s).

INDICATIONS:



LD1: Red led, it indicates the situation of blocking for external contact.

LD2: Red led, it indicates the situation of blocking for synchronism error, incorrect rotation or error presence one phase.

LD3: Red led, it indicates the situation of blocking for overcurrent.

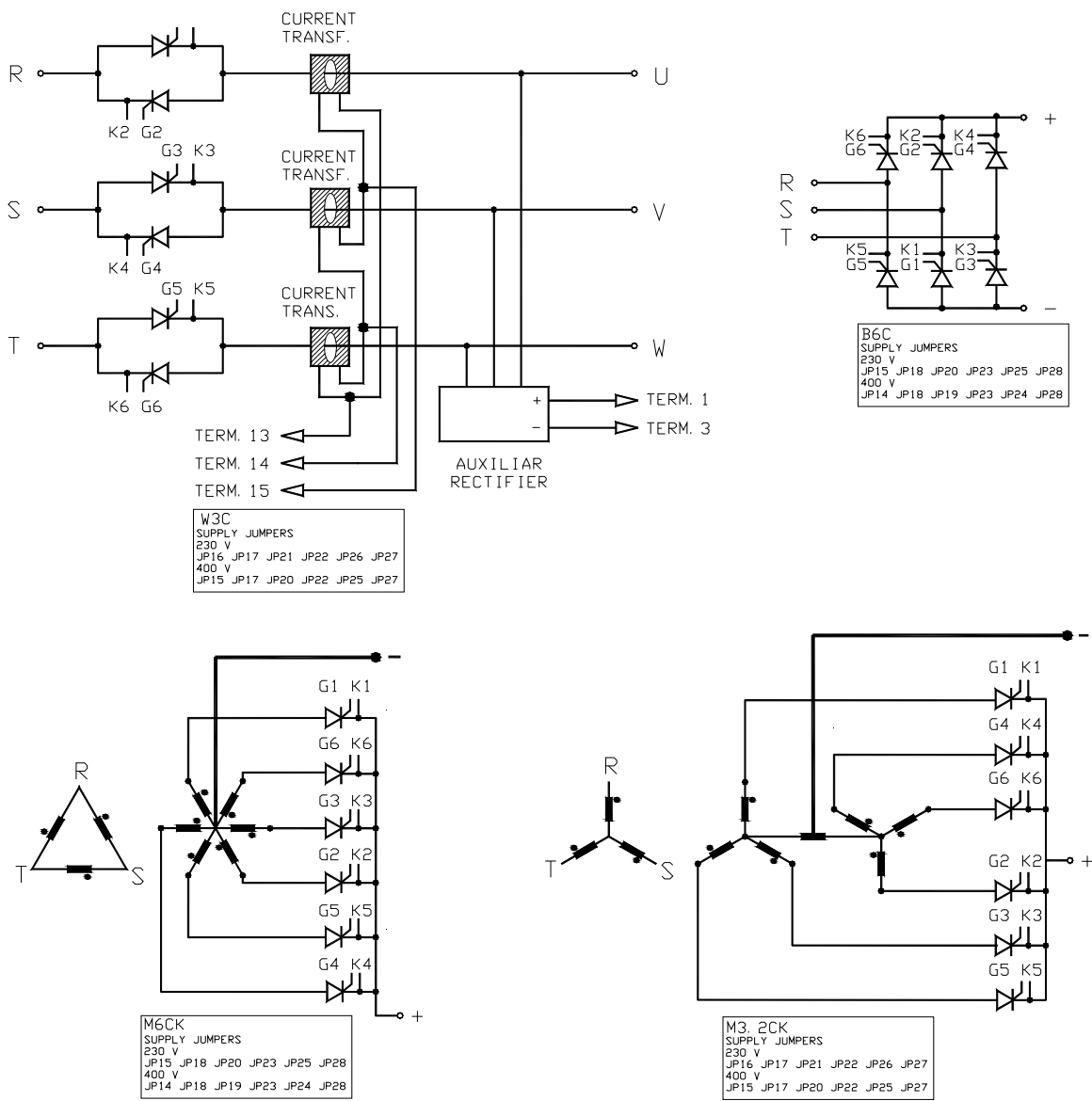
LD4: Green led, it indicates that there's supply signal.

TYPICAL APPLICATION CIRCUITS:

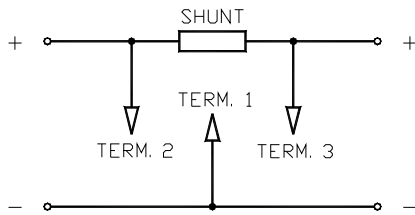
Below there are some schematics of the most common applications (different combinations of rectifiers and antiparallel thyristors), as well as feedback connections by shunt, transformer, etc.

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 antiparalel 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).

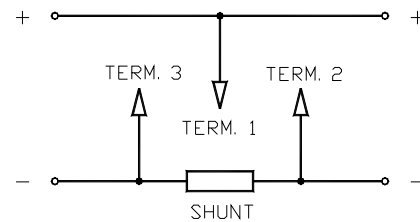
At the end of this descriptions are given some advice about how to mount, in this way it's improved the working security and prevent possible external problems.



FEEDBACK SCHEMES (for D.C. applications)



POSITIVE SHUNT APPLICATION



NEGATIVE SHUNT APPLICATION

MOUNTING RECOMMENDATIONS:

- 1- Avoid long cables in the firing system, or use twisted or shielded cables. Apply it also for the potentiometer cables.
- 2- 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- For specific applications, there is the possibility to realize adaptations and include auxiliary control modules, so please, don't hesitate to ask about your application.

Notes about the control card in systems controlled by microcontrollers:

When the RG6000 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 causes 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.

ANNEX 1

NOTES AND APPLICATION EXAMPLES

Applications of secondary rectification.

To control a three phase rectifier bridge, connected in the secondary of a transformer where the voltage is a non normalized value, the control board should get the supply voltage from the available net. To connect the board to the net and the thyristor gate connections depends on the connection type of the transformer. *This is the most complicated application case and it's recommended to have experience in how to manage thyristor converters.*

There are 24 three phase connections which can form four groups: star-delta (Yd), star-star (Yy), delta-star (Dy) and delta-delta (Dd). For each type there are six possible variations differentiated by numbers. In the table from page 13 there is indicated the correct configuration for the SC6000 for each possible connection of the transformer.

For a correct configuration, it's necessary to know exactly the number and the type of the transformer connection, on the other hand, it's necessary to try one by one all the possible configurations of the table.

If you know the number but not the connection type, you should try one by one of the six possibilities.

Below you can find some examples. In all cases it has been used modules with galvanic isolation feedback.

Example 1

There is a transformer in connection D-Y, transformation ratio 380/18 V and it has to be mounted a rectifier controlled in the secondary, with the voltage and current control and with an isolated feedback.

If you don't know the connection number of the transformer, there is the need to try one by one of the six possibilities for the star-delta case.

For example, it can be started for the Dy5 connection which is illustrated in the scheme in the page 13.

Connections:

- 1- Connect R, S, T and N from the connector CN10 from the board to the net (R, S, T, and N). It's very important to connect the neutral to the N connector from CN10.
- 2- Connect the thyristor gate and cathode cables to CN4-CN9 indicated on the table (page 4) and the schemes A1.1 and A1.2.
- 3- Configure the jumpers JP1, JP3, JP6, JP7, JP8, JP9 and JP10 corresponding to the voltage and current control.
- 4- Connect the voltage and current control potentiometers.
- 5- Connect the blocking switch.
- 6- Connect the current feedback signal 0-60 mV to the terminal 2, CN2.
- 7- Connect the voltage feedback signal (SCCAV02-OA output) to terminal 1, CN2.
- 8- Connect the feedback common signal to the terminal 3, CN2.

Start up.

CAUTION: Before plugging the supply voltage, be sure that the card is locked and the regulation potentiometers to the minimum level.

- 1- Lock the card through the blocking switch.
- 2- Regulate to the minimum level all the voltage and current potentiometers.
- 3- Connect the supply voltage to the R,S,T and N from the card.
- 4- Check operation.

When the board operation it's correct, voltage must vary in a stable and continuous mode, between zero and a maximum value of $1.35 V_{RMS}$ between the supply phases of the rectifier bridge. In the case of this example, rectifier bridge voltage supply is 18 V, thus maximum output voltage will be 24 V. Being a low voltage, due to the diode forward voltage the real maximum voltage will be 22 V.

In case of detecting working anomalies, and after being sure that there connections are correct, proceed to change the connection settings according to the table connections in page 13.

Transformer connection	Thyristors connection	Supply Jumpers configuration
Yd11		230V _{RMS}
Dy11		JP16,JP17,JP21,JP22,JP26,JP27
Yy10		400V _{RMS}
Dd10		JP15,JP17,JP21,JP22,JP25,JP27
Yd5		230V _{RMS}
Dy5		JP16,JP17,JP21,JP22,JP26,JP27
Yy4		400V _{RMS}
Dd4		JP15,JP17,JP21,JP22,JP25,JP27
Yd3		230V _{RMS}
Dy3		JP16,JP17,JP21,JP22,JP26,JP27
Yy2		400V _{RMS}
Dd2		JP15,JP17,JP21,JP22,JP25,JP27
Yd9		230V _{RMS}
Dy9		JP16,JP17,JP21,JP22,JP26,JP27
Yy8		400V _{RMS}
Dd8		JP15,JP17,JP21,JP22,JP25,JP27
Yd7		230V _{RMS}
Dy7		JP16,JP17,JP21,JP22,JP26,JP27
Yy6		400V _{RMS}
Dd6		JP15,JP17,JP21,JP22,JP25,JP27
Yd1		230V _{RMS}
Dy1		JP16,JP17,JP21,JP22,JP26,JP27
Yy0		400V _{RMS}
Dd0		JP15,JP17,JP21,JP22,JP25,JP27
		230V _{RMS}
		JP15,JP18,JP20,JP23,JP25,JP28
		400V _{RMS}
		JP14,JP18,JP19,JP23,JP24,JP28

Figure A1.1
Controlled rectifier bridge on secondary of the three-phase transformer (Dy5)

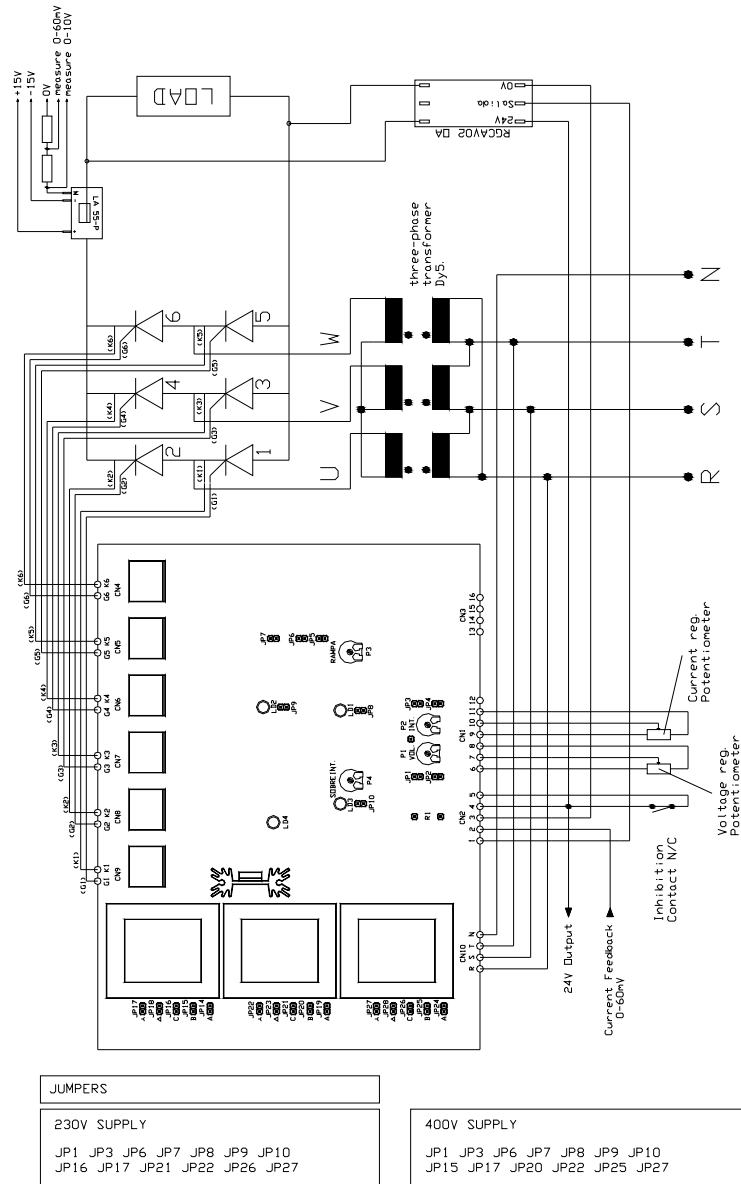
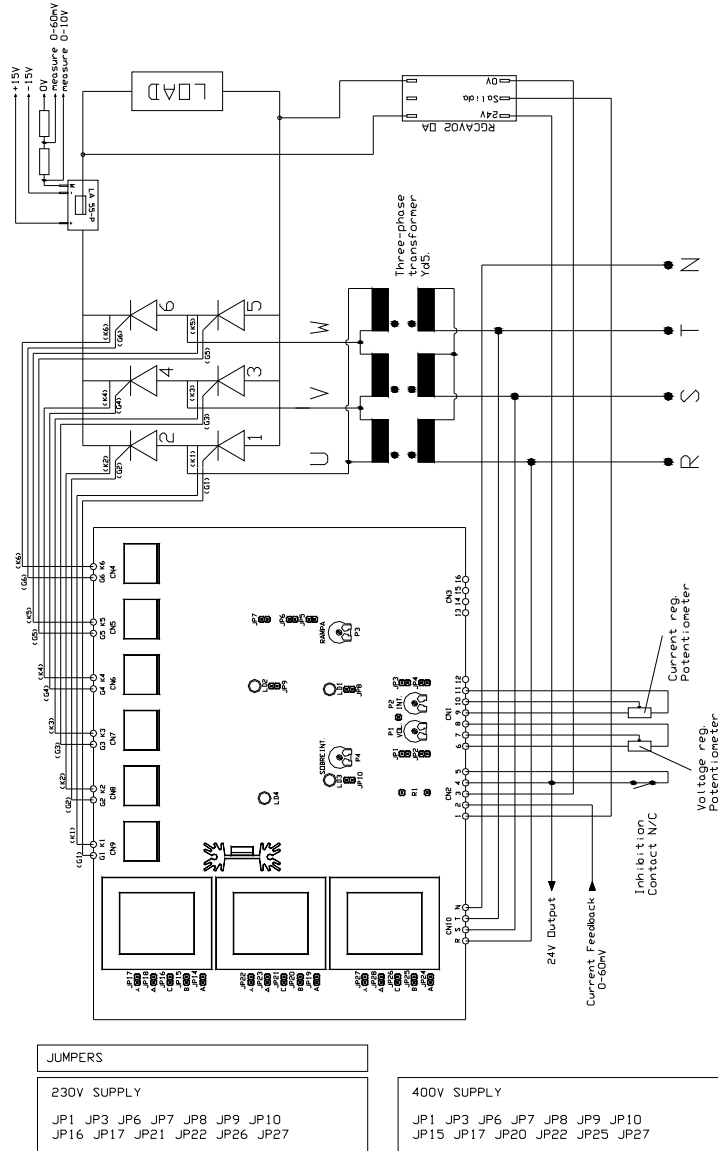


Figure A1.2
Controlled rectifier bridge on secondary of the three-phase transformer (Yd5)



Control AC-AC applications:

In AC-AC control application, SC6000 controls a three-phase group of antiparallel thyristors.

The most common cases are:

- Control in the primary:

SC6000 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.

Notes:

- Loads in star connection:

To control loads in star connection, see figure A1.3.a, the card must be configured to be synchronized with the voltages phase – neutral, so it's very important to connect the neutral from the net to the neutral of the card (terminal N, CN10). Configuration jumpers of the supply voltage will be configured as star connection, see figure A.1.4. and A.1.5.

- Loads in delta connection:

To control loads in delta connection, in case of the antiparallel thyristors are in the line, see figure A.1.3.b, the card must be configured to be synchronisated with the voltages phase-neutral, so it's very important to connect the neutral from the net to the neutral of the card (terminal N, CN10).

In case of the antiparallel thyristors would be connected "inside" the delta, see figure A.1.3.c, the card will be configured to be synchronized with the voltages phase – neutral, in this case it's not necessary to connect the neutral to the card. Configuration jumpers of the supply voltage will be configured as delta connection, see figure A.1.3. and A.1.6.

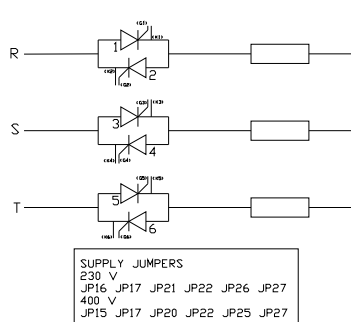


Figure A1.3a
load in star connection

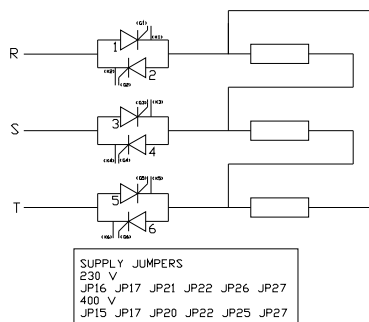


Figure A1.3b
load in delta connection

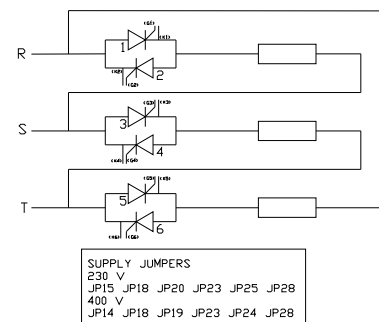


Figure A1.3c
switch inside delta connection

Figure A1.4
AC-AC converter with current and voltage feedback from transformer primary side

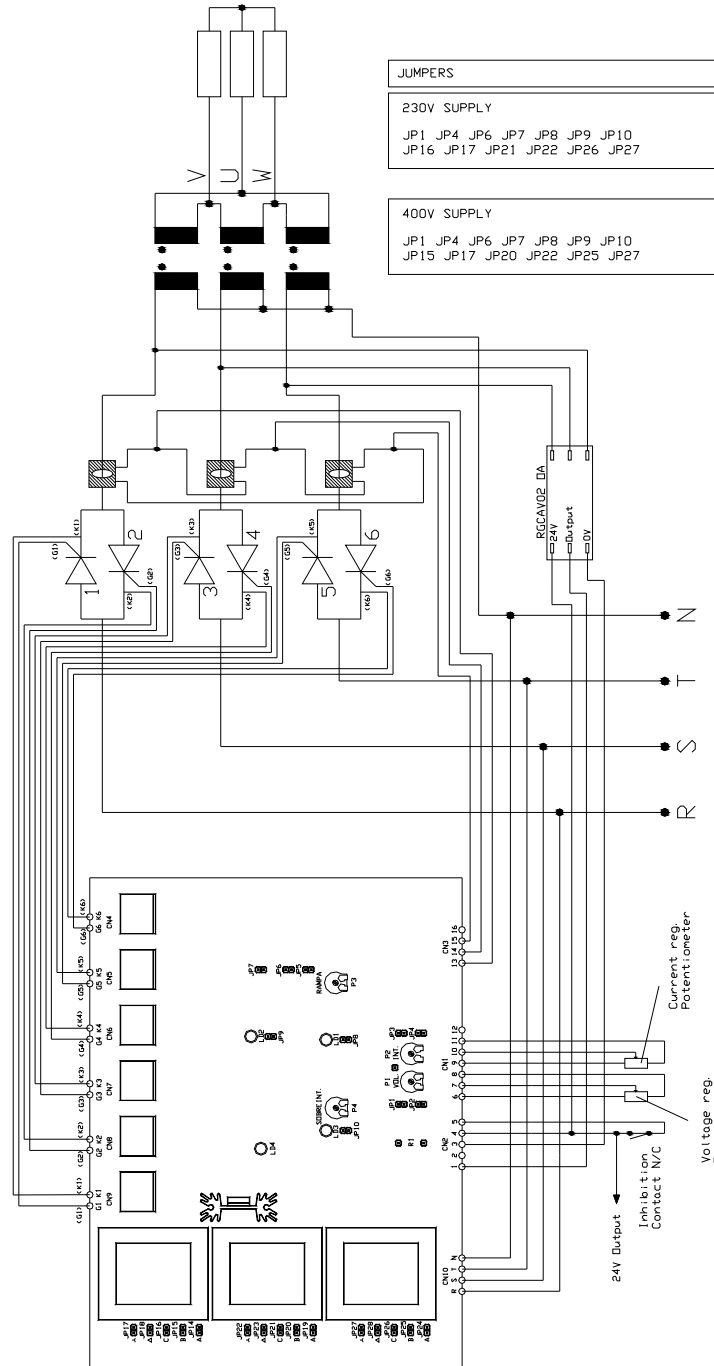
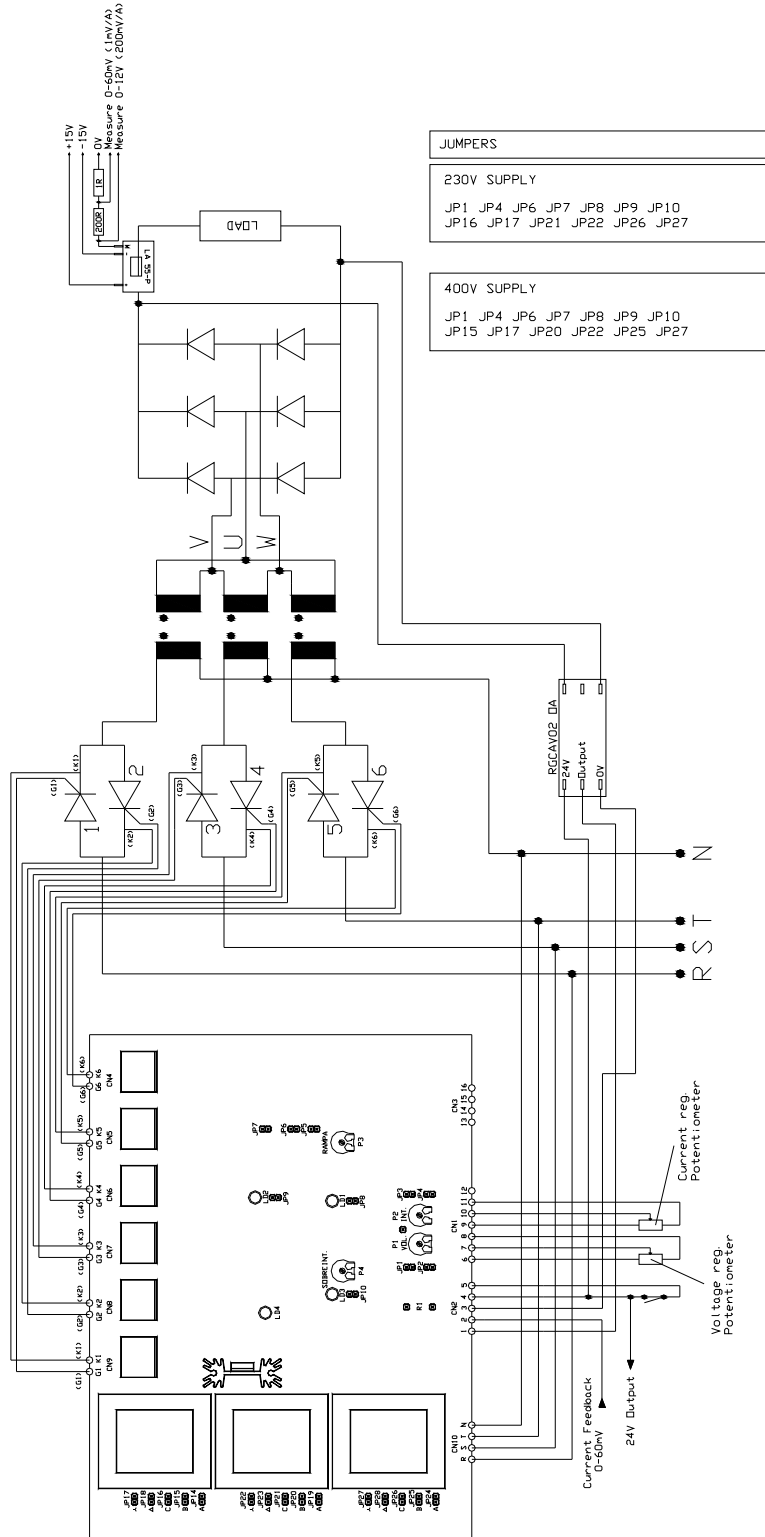


Figure A1.5

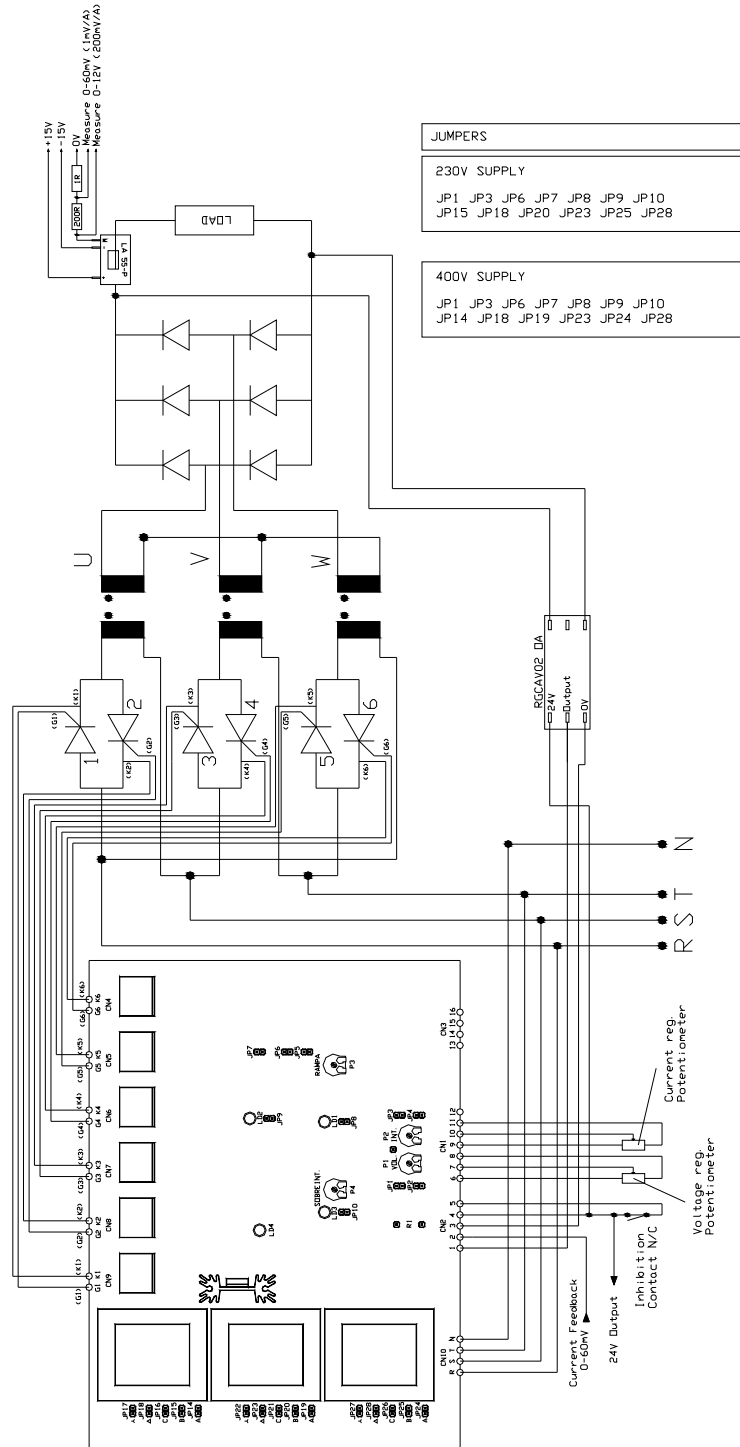
Uncontrolled rectifier (primary side controlled), with current and voltage feedback from DC output (star-delta transformer)



Reserves the right to change limits, test conditions and dimensions given in this data sheet at any time without previous notice.

Figure A1.6

Uncontrolled rectifier (primary side controlled), with current and voltage feedback from DC output (delta-star transformer)



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