SIRIO 2000

2 KW FM POWER AMPLIFIER

1 GENERAL DESCRIPTION

The SIRIO 2000 is a highly integrated broadband solid-state Mos-Fet FM amplifier of 2000W rated power, fitted in a 16 unit 19" rack, which provides room either for the exciter and some spare equipment

Its compact size, high efficiency, wide mains range acceptance, low maintenance requirements and broadband construction, make this amplifier ideal in medium power repeaters, in unattended posts, in N+1 systems and as a reserve.

Its sturdy, modular mechanical and electrical construction guarantees a high MTBF and an easy maintenance. The modules are easily identifiable and inspectable with few interconnections each with the other, through multi-pole connectors.

The nominal RF output power is obtained over the full FM range with a mere 12W drive and is particularly stable against time, temperature and frequency variations being ALC regulated, with a front panel adjustment. The output power may be varied from a minimum level to the nominal level and the frequency varied over the full FM range, without retouching the drive power or any other adjustment than the ALC control.

The output stage has a reverse intermodulation figure, which is lower than standard bipolar construction, due to the all Mos-Fet design and approaches that of tube equipment.

A particularly complete metering and alarm section completes the amplifier, permitting an easy check of the functioning with unambiguous readings. All main parameters and alarms are externally available on a remote I/O port, which permits as well to command stand-by/on-the-air operating mode, with a fraction of a second reaction time. A suitable external controller may be supplied on request to permit full remote control of the apparatus from the studio or another service centre. Mains absorption in stand-by mode is <10W.

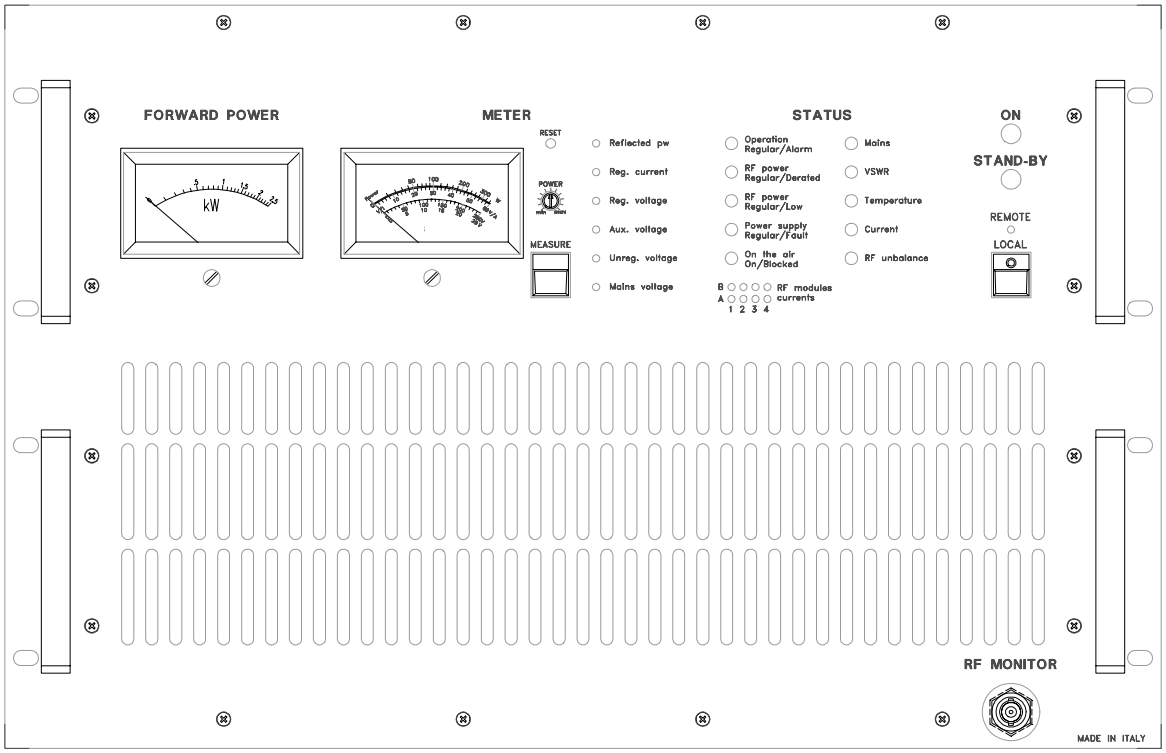
All the input and output ports are fitted on the rear. The exhaust air too is conveyed on the rear: an optional flanged outlet may be optionally mounted to provide a connection to an external ventilation system.

The whole assembly is designed in accordance with the CCIR, FCC and tighter international norms and conforms to the recent, strict CE requirements for EMI susceptance and emission.

This Equipment complies with and EISI 300.384 requirements.

2 TECHNICAL FEATURES

2.1 FRONT PANEL COMMANDS AND SIGNALLING



The front control panel carries all the metering facilities, with a fixed RF power meter, a switchable one, a "*STATUS / ALARM*" section and the "*ON / STAND-BY*" control and signalling section.

The switchable meter permits the reading of the reflected power (340W f.s.), the regulated current and voltage (60Adc and 60Vdc f.s.), the auxiliary regulated voltage (25Vdc f.s.), the unregulated voltage and the mains voltage (250Vdc and 250 Vac f.s.).

The switching between the various measures is commanded by pushing on the "MEASURE" switch, which is sensitive to the time being pushed. The time to pass from the first measure, reflected power, to the second one is 3 times as long as the others and this measure is the default reading at the turn-on.

The "*STATUS*" section signals regular or alarm modes: the first led column on the left must be always on with green light during regular "*on the air*" operation and becomes red in case of warning. The second column lights on with red light only in case of failure.

LED	GREEN	RED
OPERATION	Regular functionment	Alarm
RF POWER reg./der.	Regular	RF reduced for any internal safety reason
RF POWER reg./low	Regular	RF lower than approx. -3dB (»500 W)
POWER SUPPLY	Regular	Low regulated voltage (<»42 Vdc)
ON THE AIR	Regular	Blocked for any continuous safety reason Needs manual reset
MAINS HIGH		High input mains voltage (> 250 Vac)
MAINS LOW		Low input mains voltage (< 190 Vac)
VSWR		High RF output refl. power (> 100 W)
TEMPERATURE		High internal temperature
CURRENT		High current absorbtion (> 80 A)

Table 1: Status led meaning

The meaning of the various led is summarised on table 1.

The "ON" and "STAND-BY" led on the last section unambiguously signals the corresponding operating mode. Note that "on" do not means "on-the-air", but simply that the amplifier is completely powered and ready to deliver power if correctly driven.

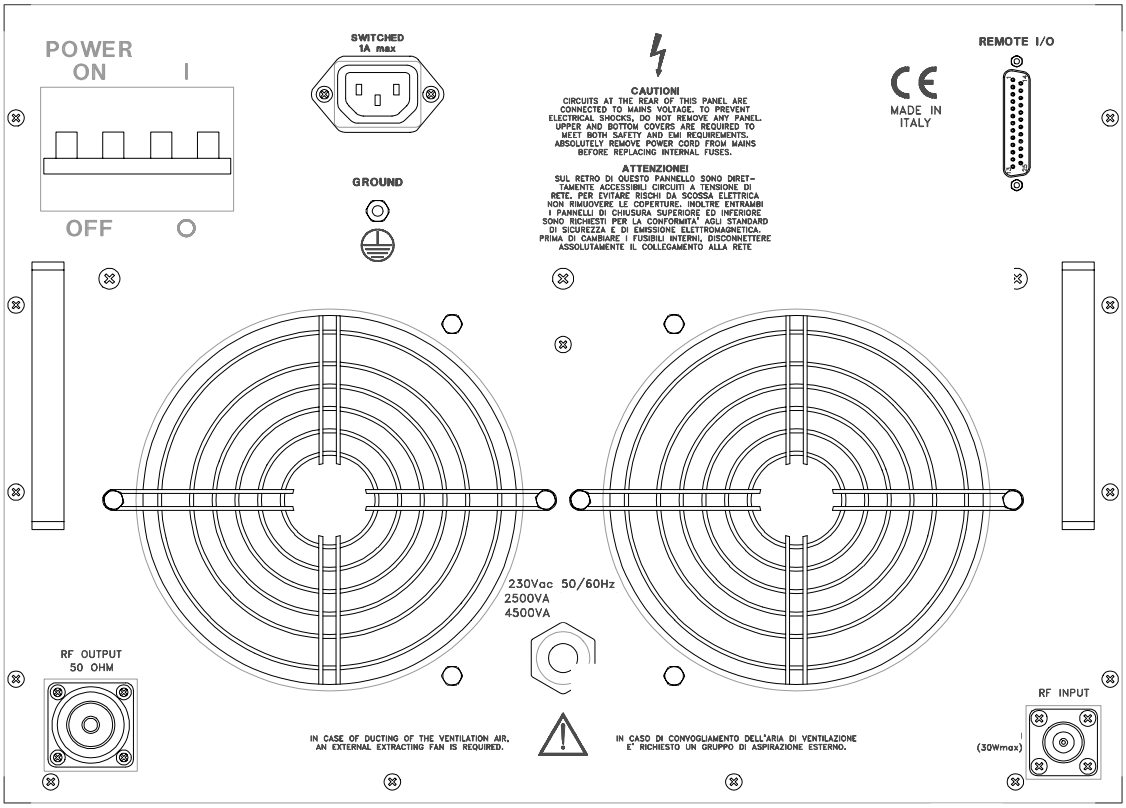
The "on" state is the default state when the SIRIO 2000 is switched on by the general switch and turns to "stand-by" by pushing on the "local" switch, which will light. Remotely commanding stand-by mode will do the same, and the remote control is signalised by its small yellow led. Local and remote commands both acts in parallel to force the equipment in stand-by.

During stand-by only the command interface section is active, the auxiliary regulated voltage is on, and the main regulated power supply and all the fans are off.

The RF output power may be adjusted by the front panel trimmer without retouching the drive power, which is usually set at 20W, i.e. a value which is only slightly higher than that needed to drive the amplifier at full power. RF Output range in this condition is comprised between 1/5 and full power. If needed, very low power operation, down to zero, may be achieved slightly reducing the input power.

A recessed reset snap switch may be operated, if needed, with a small pointed object, through a hole in the panel. This alarm-reset pushbutton must be manually pushed if the module is blocked for any reason, for repeated or prolonged action of any protection, mainly for very high VSWR or high input power. The reset may be remotely applied too, through the remote I/O port.

2.2 THE REAR PANEL AND THE CONNECTIONS



The rear panel allocates all the RF and the I/O ports in addition to the mains power cord, the earthling screw and the on/off switch.

The Antenna output is brought out on a 7/16" connector, while the input connector is a "N" type. At the RF monitor output, BNC type, a sample of the output power is available, which is attenuated 54 dB typically (i.e. +6 dBm @ 2.0 kW output). Even if this output is fairly flat vs. frequency, it is not suggested to use this for accurate harmonica analysis.

Through this panel it passes the mains power cord, which is not removable. If it is required a longer cable than that provided in the factory (roughly 2 meters long), a suitable 3x 2.5 mm sq. power cord may easily replace the original one.

Directly on the panel are fixed the remote I/O port (SUBD 25 poles, female) and the exhaust air output opening.

Wide room must be provided during installation to permit ventilation air flux, which must not be obstructed. It is not permitted to insert the equipment in a closed rack without a suitable external air extraction system. An optional exhaust air flanged outlet may be required and mounted to easy the connection to an external ventilation system

An auxiliary IEC-320 female type mains outlet is provided, which is powered only when the amplifier is on (enabled), i.e. not in stand-by mode. The exciter is usually connected to this outlet, so being powered only when the apparatus is fully on. A separate power connection may be used if the exciter may be switched in stand-by/operation by the logic signal available on the I/O remote connector (see later), so avoiding any delay to lock in frequency nor delivering power to the amplifier during stand-by.

No fuses other than the general fuses (16A) are inserted on this line. Limit the power absorption from this outlet to low levels, i.e. 100W / 1A max.

To gain access to the inner in the event of changing the internal fuses, the top covering must be removed. Be sure to remove the power cord from mains to avoid direct exposure to hazardous mains voltage, which are always present on the fuses and the input board, even with power on switch in the off position.

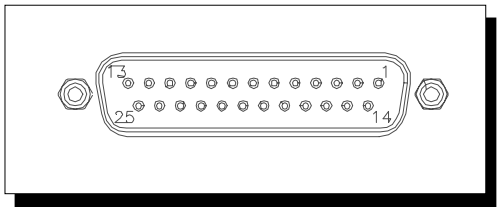
2.3 I/O REMOTE CONTROL SPECIFICATIONS

The remote I/O DB25 female connector, located on the rear panel, makes available several analog and digital lines to permit remote control and surveillance of the equipment. The assigned lines to each connector pin follows:

Pin	Line	Range/use
1	ground	common
2	Stand-by	connect to ground to stand-by
3	n.c. / ground	
4	Regular/Alarm	+12V when Alarm (Cmos out)
5	RF Derate	+12V when RF power derated on protection (Cmos out)
6	VSWR Alarm	+12V when high VSWR on antenna line (Cmos out)
7	Current Alarm	+12V when dc Current too high (Cmos out)
8	Block Alarm	closed to ground when regular (100mA/24Vmax relay contact)
9	Reflected Power	0¸5V vs. 0¸340Wout (Op-Amp out, Zo=156W) (2.71 V typ. @ 100W)
10	Forward Power	0¸5V vs. 0¸2.5kWout (Op-Amp out, Zo=156W) (3.16 V typ. @ 1000W / 3.87 V typ. @ 1500W)
11	ground	signal ground
12, 24	Aux. supply out	+12.5Vdc / 100mAout, protected by fuse
13, 25	ground	power ground
14	Reset	Close to ground to reset Block Alarm for T>0.2 sec
15	Enable out	open/close an internally programmable relay contact to ground
16	ground	signal ground
17	RF low	+12V when RF low, i.e. < »700Wout (Cmos out)
18	P. Supply Alarm	+12V on Power Supply Regulator alarm (Cmos out)
19	Temper. Alarm	+12V when too high Temperature (Cmos out)
20	Mains alarm	+12.5V when Mains line is out of range (Cmos out)
21	n.c. / ground	future option
22	Regulated Volt.	0¸5V vs. 0¸50V out on Power Supply Regulator (Zo»300W)
23	Regulated Cur.	0¸5V vs. 0¸100A out from P. S. Regulator (Op-Amp out, Zo=156W)

WARNING: Never connect anything to the Remote I/O connector with power supply on. Damage or overload to any buffered line may cause improper function or measure on the equipment.

The remote I/O signal and control DB25 female connector, on the rear panel



2.4 TECHNICAL SPECIFICATIONS

@ 1kW RF output

- Frequency range:	87.5 ÷ 108 MHz
- RF input power	20 W nom., 25 W max
- RF output power	1000 W ±0.5 dB
- RF input/output impedance:	50 W
- RF input connector:	N
- RF output connector:	7/16"
- RF monitor connector:	BNC
- Harmonic and spurious emissions:	< -70 dBc
- RF monitor attenuation:	54 dB, typ.
- Max total current handling capability on the auxiliary sockets:	1A @ 230 Vac, 100Wmax, not fused
- Mains supply requirements:	90÷265V c.a. 50/60Hz<3800W (5000VA) 340÷460V c.a. 50/60Hz<3800W (4000VA)
- Operating temperature range:	0 ÷ +35 °C recommended, -10 ÷ +45 °C max
- Dimensions, not including the handles:	483 x 310 x 570 mm (H x W x L) See drawings
- Weight, not including the exciter:	47 kg, approx.
REMOTE CONTROLS:	Stand-by, Alarm Reset, Exciter enable
REMOTE SIGNALS:	Alarm, Power derating, Power low, High VSWR, Power supply fault, Current alarm, Temperature alarm, Mains alarm, System block
REMOTE MEASURES:	Forward and Reflected power, Regulated Power Supply current and voltage

3 INSTALLATION AND USE

3.1 FOREWORD TO INSTALLATION

Although in most cases no special instruments are required, have skilled personnel install the apparatus. To make best use of the apparatus's capabilities and prevent damage to the unit, comply with the recommendations throughout this manual.

When in doubt, or if any technical problems should arise during the installation procedure, AEV strongly recommend the apparatus not be tampered with in any way by unskilled personnel and will be glad to supply qualified after-sale service.

As a rule, the user should not have access to the inside of the apparatus for normal installation and use. Tampering with the factory settings makes the guarantee null and void and might also affect apparatus' performance, causing costly damage.

NO ADJUSTMENT OR INTERNAL PRESETTING IS REQUIRED FOR NORMAL OPERATIONS. THE APPARATUS SHALL BE PROPERLY EARTHED AND BE OPERATED WITH ALL THE COVERS CLOSED TO PREVENT ELECTRICAL HAZARDS IN OPERATION AND FULLY COMPLY WITH CE EMI AND SAFETY REQUIREMENTS.

NEVER TOUCH THE INSIDE OF THE APPARATUS WITHOUT FIRST DISCONNECTING IT FROM THE MAINS. DANGEROUS AC, DC AND RADIO-FREQUENCY VOLTAGES ARE PRESENT INSIDE AND BECOME ACCESSIBLE WHEN THE COVERS ARE REMOVED.

—— MAINS VOLTAGE MAY KILL ——

3.2 PLACING THE APPARATUS

Install apparatus in a dry, sheltered but well-ventilated room away from dust, moisture, insects and vermin (mice).

Place apparatus as close as possible to the antenna to prevent excessive power loss in the cables. If this is not feasible, use antenna cables of suitable cross-section.

Room size shall be such that the apparatus can be placed in an upright position and that technical personnel can easily carry out routine or extraordinary maintenance. The minimum recommended size is 2.5m x 2m, and 2.2m high when there is no other broadcasting or support equipment nearby.

The room must be ventilated to ensure that the inside temperature never exceeds 35°C. Even if 45°C is the max. allowed temperature: it is anyway suggested not to approach to this limit.

This condition cannot generally be met when the exhaust cooling air is not pushed outside and is fed back into the room. This is even truer if more than one apparatus is installed in the same location. An efficient ventilation system is thus required in the room. Air exchange in the room shall have a minimum flow-rate of 500 metres cubed per hour or more.

If the apparatus is fitted in a rack system, the back door of the rack cannot usually be fixed in place. If a completely closed assembly is needed, a suitable ventilation extraction unit must equip the system. To aid air ducting, an optional flange may be retrofitted on the ventilation outlet to which a duct can be attached to convey hot air outside. In this case remember that the SIRIO 2000 internal fans are low-pressure units: some sort of external air extraction blower is than imperative on the exhaust air duct.

Vents in the walls and any other openings shall be fitted with a metal grating to keep rodents out, and with a dust filter. Make absolutely certain that no water can seep through the vents or the air exhaust duct or antenna-cable grommet, and that the floor cannot be flooded during heavy rainfall.

Moisture and/or dust, when contained in the air or in the room in excessive quantity, may cause condensation build-up in the amplifier. When the system is periodically switched on and off, this can trigger destructive electric arcs and short circuits and thus cause damage that is not covered by the guarantee.

3.3 WIRING INTO THE MAINS

The SIRIO 2000 is powered by a single-phase line. Mains capacity must be at least 5kVA and the nominal voltage is 230 Vac.

Whilst the power supply regulator accepts a wide input voltage (190 ÷ 250 Vac), operation near the lower input voltage on high impedance lines must be avoided: if the line drops more than 6 volt at full load, the low line sense circuitry may trigger an oscillating turn-on / turn-off cycle, which is very dangerous. In this cases adopt an external line stabiliser.

The nominal mains input range (190 ÷ 265 Vac) is achieved when the primary side of the main transformer is wired to the 230 V tap. Two other taps, the first one slightly lower (220 V), the second higher (240 V), are available to adjust the input voltage range of ±10 V. In countries were a stable 240V is the norm, it is important to set this tap on the transformer. In this case the allowed voltage range window must be shifted higher to avoid nuisance trip at occasional higher mains voltage. See proper section in the service section of this manual.

To ensure proper operation and comply with the safety regulations, efficient earthling is required. Use the yellow/green lead in the power cable. The cable's neutral lead is blue. Never connect the earth to the mains' neutral lead.

The cable connecting the SIRIO 2000 mains input terminal block to the external board should consist of leads of adequate cross-section. Recommended values are 2.5 to 4 mm squared.

Do never switch the apparatus on without antenna connection, even when no RF drive is on.

3.4 ANTENNA CONNECTION

A 7/16" output connector is fitted at the back of the amplifier module. It is very important to check that the antenna, the connecting cables and the connectors are suitable for 2.0 kW.
The antenna coupler too, should be capable of adequate power; its input connector shall be 7/16" or 7/8" or larger.

The cable connecting the amplifier and antenna will generally be of the corrugated, spongy-dielectric type, such as a 1/2" or 7/8" celflex or flexwell. Smaller cables as RG214, cannot be used.

The antenna shall be earthen via a copper braid of adequate cross-section to prevent lightning reaching the amplifier via the antenna cable.

3.5 LF CONNECTION

To maximally avoid earth loops, wire the modulation signal line directly on the exciter, with high quality shielded and preferably balanced cable. Earth the shield only on the exciter LF input

If balanced lines are not feasible, use the highest available level: the suggested EXC22 or EXC23 exciters may easily accommodate signals at +6 or +10 dBm.

3.6 OTHER RECOMMENDATIONS

The ambient temperature shall range between -5°C and +30°C (35°C max. peak). It is advisable to hang a min.-max thermometer on the wall to display any variation.

Air conditioning at 20 ÷ 25°C would obviously be the best solution, but installation and operating costs are generally excessive. Thermal isolation and efficient ventilation with a thermostat-controlled blower are generally the most advantageous solution.

Mains fluctuation and electric discharges due to the weather or nearby industrial machinery may cause significant trouble, especially in mountain areas and in places close to industrial areas.
In such cases, it is advisable if not indispensable, to install a protector, and insulating transformer or possibly an electromechanical mains voltage regulator. AEV can provide all these accessories on request.

Since the total cost of the plant, inclusive of broadcasting equipment, antenna system and installation, is rather high, a certain percentage of the budget should be estimated for buying and installing suitable protection and conditioning facilities as described above.

Depending on location, the share of total cost should be around 10 ÷ 20%; with this expenditure, however, the machinery will operate under optimum conditions, its useful lifespan will increase and, above all, the incidence of accidental breakdowns due to ambient or mains trouble will be reduced.

3.7 IMPORTANT NOTE TO VENTILATION

It is mandatory to provide adequate ventilation to the apparatus to maintain its internal temperature as low as possible, in the recommended range 5 ÷ 25°C. Even if the apparatus may sustain 45°C, and occasionally slightly higher temperatures, his life expectancy will be impaired by high temperature.

As general rule the life expectancy may be halved by each 10°C increase in ambient temperature, over 30°C.

3.8 OPERATION

Check that the antenna or a suitable dummy load is connected to the amplifier RF output, and control that its power cord is connected to the proper auxiliary mains outlet, as explained in the previous section "REAR PANEL AND CONNECTIONS". Check that the exciter output signal is fed to amplifier input and the correct frequency is set, then:

1) Reduce to zero the exciter power.

2) Reduce to the minimum the amplifier power set by completely rotating the proper trimmer on the amplifier module's panel.

3) Push down the control panel "LOCAL" switch: it must hold down.

4) Switch-on the rear power-on switch. The SIRIO 2000 will turn-on in stand-by mode.
   - Some leds will light in green on the control panel, i.e. OPERATION, RF POWER reg./ derated, ON THE AIR.
   - Some leds will light in red, i.e. RF POWER reg./low, POWER SUPPLY.
   - The measure module will start in "reflected power" position.

5) Push down the "LOCAL" switch to release it: the SIRIO 2000 will turn to "ON" state.
   - The POWER SUPPLY led must turn to green.
   - Internal blowers will start.
   - The exciter must switch-on (if not, control its power switch!) and must lock in frequency after some seconds.
   - No RF output power.

6) Raise the drive power to the required level, usually 20 W at the input of the amplifier.
   - The RF output power can rise from zero to 100 ÷ 200 Watt.

7) Slowly increase the preset power by the proper trimmer on the amplifier front panel, until reaching the required output power, not higher than 2050 W.
   - Roughly at 700 W, the RF POWER led on the control panel will change to green
   - At the same time the green RF REGULAR led on the amplifier module will light.

8) Control and note for future reference the correct reading of the operating parameters through the internal instrumentation, which must indicate the following values:

- FORWARD POWER: up to 2050W
- REFLECTED POWER: < 50 W
- REGULATED CURRENT: < 75 A
- REGULATED VOLTAGE: 48 V
- AUXILIARY VOLTAGE: 12.5 V

- UNREGULATED VOLTAGE: 120 ¸ 170 V
- MAINS VOLTAGE: 200 ¸ 245 V

The installation of the amplifier is thereby completed. A spectrum analysis is now advisable to assure no spurious products due to internal or external causes (i.e. reverse intermodulation on the final stage) are generated.

AEV wishes you success in your work and remind you that they are always available for further information or to tackle any specific problem.

OPERATION WITHOUT THE ANTENNA OR WITH A FAULTY ANTENNA CONNECTION MAY CAUSE DEGRADATION AND POSSIBLE DESTRUCTION OF THE FINAL STAGE. THIS FAILURE IS NOT COVERED BY THE GUARANTEE.

4 SERVICE AND MAINTENANCE

Since the SIRIO 2000 is cooled by air, it is subject to clogging by dust. Because of the high-quality materials used in their manufacture, if it is installed as set forth under "INSTALLATION AND USE," it will not require special maintenance for quite some time.

A regular service routine, mainly to remove internal dust is suggested over a 6 month to a year rate. Take present that 90% of the air circulation is restricted to the main internal ventilation channel and do not affect the components. Regularly change the ventilation fan, especially in higher temperature environments. A 2-year rate may be prudential: always use the same high quality, ball bearing fan type.

After a few years of continuous service, it is recommended that the apparatus be overhauled in the factory or in a specialised laboratory, where the characteristics can be checked against the initial ones and recalibration can be made when needed.

It is also especially important that the power supply be over-hauled when the apparatus has been working at high temperatures, over 30 ÷ 35°C.

Never change or cause the original settings to be changed when the necessary, complex testing equipment and standard calibration procedure are not available.

5 GUARANTEE

Like all AEV's solid state equipment, the SIRIO 2000 carries a one-year guarantee on all its components with the exclusion of the final RF power module, which may be damaged by faulty output connections.

This guarantee is null and void if the apparatus is tampered with or if failure is due to improper use, wrong installation or external causes, such as mains overvoltage.

This guarantee covers work done exclusively in our laboratories and in those of our agreed representatives.

The goods shall be delivered carriage prepaid to the laboratory and shall be returned freight forward.

This guarantee does not cover any consequential damage due to non-operation or faulty operation.

6 SERVICE MANUAL

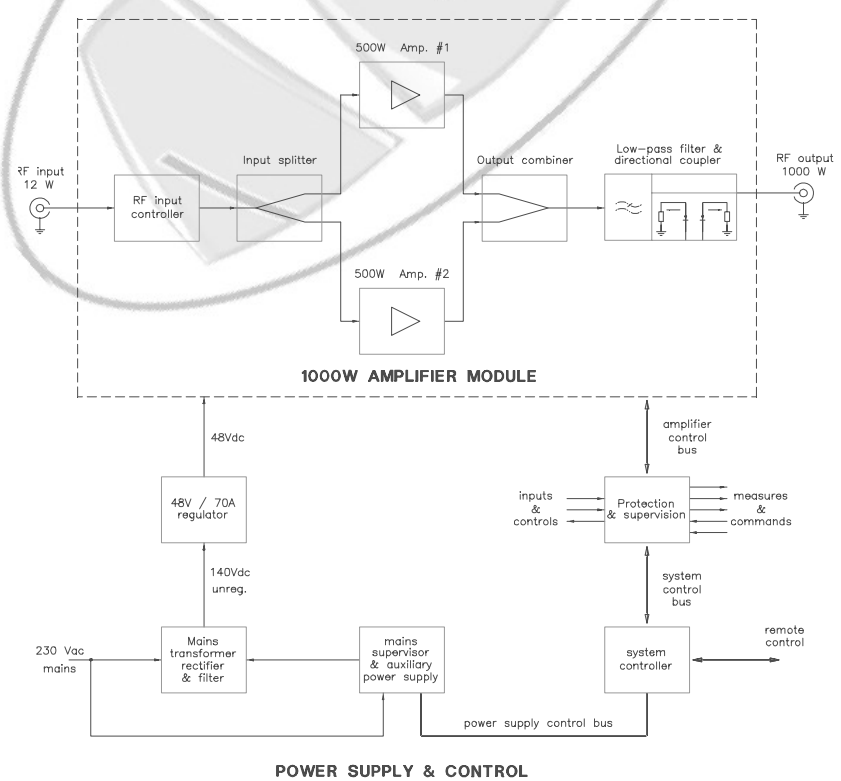
6.1 SYSTEM DESCRIPTION

3 basic sections compose the RFB2001: the RF amplifier box, the power supply and the control and metering section.

The RF section comprises 4 x 500W amplifier modules connected through strip-line combiners. All the RF transistors are Mos-Fet type. A low-pass filter with directional coupler completes the section, which is completely screened by a metal box, to comply with EMI requirements. A fully planar design permits an immediate access and inspection to the 4 internal modules.

The power supply comprises a mains input screened transformer, whose output is rectified and filtered and a highly efficient Switch-Mode Power Supply regulator. A separate power supply controller provides input filtering and voltage range check.

The control section is built of two boards. The first one performs full RF AGC and protection control; the other provides metering and an interface to the external I/O port. All main parameters as Voltages, Currents, Direct and Reflected Power and protections are displayed and provided at the Remote I/O port. Through this port is possible as well to command the stand-by / on-the-air operating mode.



SIRIO 2000: Block diagram

6.2 INTERNAL DESCRIPTION

The SIRIO 2000 amplifier comprises 8 internal different modules/boards plus some spare components, as can be seen in the drawing of the inner contents and in the "General wiring diagram"; both comprised in this manual:

-The power supply transformer, rectifiers and capacitor(s)
-The Switch Mode Power Supply regulator
-The power supply controller and ac filter
-The controls and measures board
-The control, interface and protection board
-The current sensing board
-The input RF power splitter
-The 500W RF power amplifier modules
-The output RF combiner, Low-Pass Filter and coupler

For the detailed description of each module on the following pages, always refer to the corresponding electrical diagram, in the relevant section of the manual.

THIS SECTION IS ONLY AIMED TO GENERAL KNOWLEDGE OF THE APPARATUS AND FOR SERVICE PURPOSE BY SKILLED PERSONNEL. AS EXPLAINED IN THE PREVIOUS SECTIONS, INTERNAL ADJUSTMENTS ARE NOT REQUIRED DURING NORMAL OPERATION. TAMPERING WITH INTERNAL SETTINGS VOIDS THE WARRANTY, MAY HARM THE APPARATUS AND JEOPARDIZE THE GUARANTEED PERFORMANCE.

IN ADDITION, MANY MODULES ARE TOO MUCH SPECIALIZED AND DIFFICULT TO REPAIR EVEN BY SKILLED TECHNICIANS AND MUST BE REPLACED IN CASE OF NEED BY BRAND NEW ONES AND POSSIBLY RETURNED BACK TO FACTORY TO VERIFY IF THEY CAN BE REPAIRED.

All modules are easy to be accessed and substituted with minimum or no adjustment and in most cases, no need of the soldering iron.

ANY ISPECTION ON THE MODULES DESCRIBED ABOVE MUST BE EXECUTED WITH THE TOP COVER REMOVED AND OFTEN WITH THE OPERATING APPARATUS CONNECTED TO THE MAINS. ALTHOUGH MOSTLY OF THE PARTS UNDER VOLTAGE ARE INSULATED AND ARE NOT EASILY ACCESSIBLE, THIS EXPOSES TO THE RISK OF ACCIDENTAL CONTACT WITH THE MAINS VOLTAGE.

TO AVOID IT, ALWAYS USE INSULATED TOOLS AND NEVER TOUCH THE SUPPLY TRANSFORMER, THE MAINS SWITCH OR THE MAINS SOCKET WITH MAINS CONNECTED. NEVER OPERATE THE EQUIPMENT WITH THE COVERS REMOVED. REMOVAL OF THE BOTTOM COVER MAY LEAD TO IMPROPER FUNCTIONING OF ANY ELECTRONIC MEASURING METER DUE TO HIGH RF FIELD.

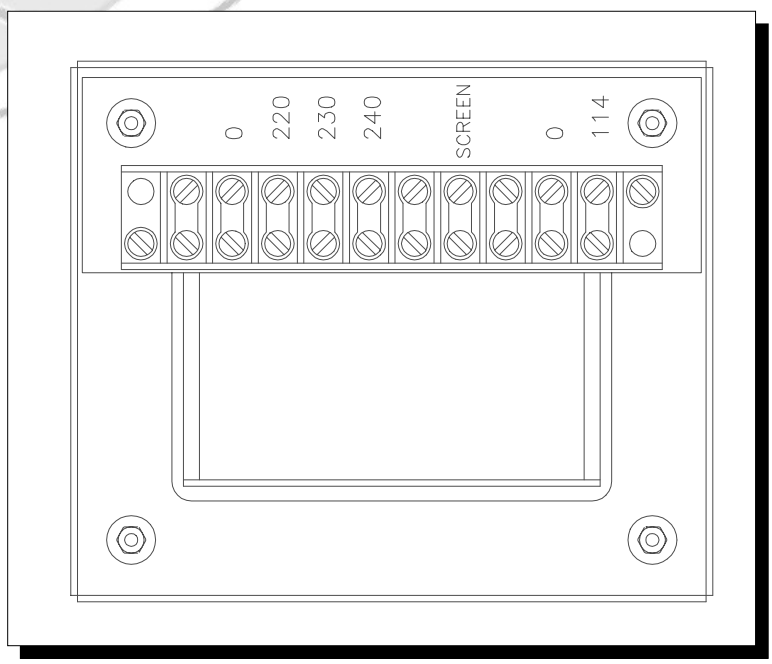
--- MAINS VOLTAGE MAY KILL! ---

6.3 The power supply components

The power supply components, other the boards below described, are very few: the power transformer, 2 bridge rectifiers and a power capacitor, which delivers the raw rectified dc power to the SMPS regulator module.

The unregulated dc voltage, nominally 140 Vdc, may range 120 ÷ 170 V. The primary tap on the power transformer is factory set on the 230V input, allowing a mains range approximately 200 ÷ 250 Vac. Should the mains voltage be 240Vac nominally, it is suggested to change the transformer tap to that voltage. If the mains voltage is a stable 215 ÷ 225 Vac, the transformer tap may be left as factory set. Only if there are frequent occasional drops of mains input below 195V and consequent system stops, it is suggested to lower the input tap to 220V.

To do that, the power cord must be disconnected from the mains, the top cover must be removed and the transformer voltage terminals may be accessed.



SIRIO 2000:
The power transformer

6.4 The Switch Mode Power Supply regulator

This module performs an efficient regulation of the raw dc input, nominally 140V ±15% to a lower 48V ±1%. Being its efficiency very high, very little heat is produced in the regulation process. The nominal current capability of the regulator is much higher than requested, and approaches 70A @ 48V.

A control I/O connector on an upper daughter board permits a remote control of the regulator by the apparatus controller, i.e. output on/stand-by, current and voltage monitoring, status prompting and alert.

A fast 80A semiconductor-grade protection fuse is screwed on the board: it may be fused by the crowbar protection in case of switching transistor damage. If this happens a first attempt to replace the fuse may be accomplished, after having verified the integrity of the power transistors. Usually something is broken so causing the fuse blow-up.

Reparation of this module in the field is very difficult if any component other than the fuse and/or a power transistor failed. It is suggested to substitute the module with a new one and send back the damaged unit to the factory for inspection and possible reparation.

6.5 The power supply controller

The power supply controller accomplishes several tasks:

- Provides line filtering for EMI compliance
- Carries line power fuses
- Carries the power relay and the anti-surge devices in series to the power transformer
- Supports an auxiliary power supply, which feeds all the internal circuitry but the RF stages
- Controls the allowed range of the input mains, consequently enabling the main regulator
- Discharges the power filter capacitor, when the main power supply is turned off

The first tasks are self-explanatory. The auxiliary power supply is another, IC based, switching-type regulator, preceded by an isolation/step-down transformer. The raw filtered dc voltage, in the range 20V ±15%, is regulated to 12.5 ±0.5 Vdc

Two separately rectified dc taps drive the power relay and an average filter (R7, R8, C17, C18). RT1 regulates the sensitivity of the rectifier and must be set to provide 20mV/Vac-in on TP2, i.e. 4.60 Vdc @ 230 Vac-in. IC2a and IC2b performs a window comparator on the mains input, disabling the main transformer for voltage outside approx. 190 ¸ 255 Vac, when RT2 is adjusted to have 5.16 ±0.02 Vdc on TP1.

Note that this voltage may be set to 4.96 and 5.36 Vdc in case of occasional protection trip-on, when the primary side of the main transformer is changed to 220 or 240 Vac input. If

this do not happen, RT2 may be left as factory preset for 230 V.

TR2, driven by the opto-insulator IC7, inserts the resistor chain R40 ¸ R43 in parallel to the power dc filter capacitor, to discharge it in few seconds, when the apparatus is turned off. Note that the discharge time is not very fast: it may need some 10 seconds and even more to lower the raw dc voltage to a safe level. Even so there may be enough energy in the power storage capacitors to destroy some delicate component or performing hazardous electrical arcs, if accidentally short circuited by some metal tool.

Look at the system meter in the "Unregulated Power" position, to have an idea of the time needed to reach a safe dc level, after having switched the apparatus in the stand-by position.

Note that the resistor chain R40 ¸ R43 become very hot during the turn-off process and that repeated turn-off cycling in little time (i.e. more than 2-3 times in a minute) may overheat, scorch the external body of the resistors and even destroy them.

6.6 The controls and measure board

This board accommodates the stand-by/operation switch, the system metering section and the I/O interface to the remote I/O connector.

The Stand-by switch generates a disable logic low signal, which is processed by the power supply controller, when in the high state, generating a "Enabled" signal which turns on the RL1 relay. This component enables the RF control / interface board, through the "Enable_amp" line.

All the measure lines coming from the control/interface and the power supply controller boards but the forward power, are processed by the Cmos switch IC3 and amplified by IC4a, then applied to the meter M1. A separate meter, M2, is always connected to the forward power line.

An oscillator built around IC1, is triggered by the measure range switch SW2 and the digital output of the internal divider drive both IC1 and IC2. The only function of IC2 is to light a corresponding led to the meter range, in parallel with IC1. The position of the range switch depends on the time-length it is pushed the pushbutton SW2.

This board carries the output RF adjustment trimmer RT5, which is externally accessible through a hole in the front panel. An internal trimmer, RT4, is adjusted to limit the maximum output power to 2050W, for safety purpose.

6.7 The control, interface and protection board

This is quite a complicate board and carries all the circuitry to regulate and protect the RF amplifier stage. Let us consider its various loops.

An internal regulator, IC13, feeds al the internal circuitry with a regulated +12 Vdc, derived by an unregulated dc input of some +20V.

The Forward power line drives the IC2b buffer, which isolates the input, with unity gain. The subsequent IC3b op-amp is the forward power loop amplifier and compares the sense line with the preset level at the line "5" (TP8). Its output drives the gate command line of T5 and T6, which generate the AGC signal at their drains, on the line "VB", i.e. the bias of the RF amplifier modules. IC14 limits the maximum output power set.
An auxiliary op-amp IC4a, compare the forward sense voltage with a preset value, to detect if the output power is lower than a fixed threshold (approx. 700W), in this case generating a warning alarm on line "6".

The reflected power line is amplified and buffered by IC2a. IC3a is the reflected control loop amplifier and compares the reflected sense signal to a preset threshold, which approximates 100W, i.e. 3V on TP5. The output of IC3 adds on T5/6 gate command line to control the AGC. This circuit performs a soft reflected power protection; a hard protection is managed by IC1b, which trips at a 30% higher level than IC3a, but it is much speeder and more effective. In fact, while the soft IC3a circuit simply decreases the output power to the level, which determines the maximum allowed reflected power, IC1b triggers the monostable circuit IC8 that completely disables the RF line for as much as some 5 seconds.

The input RF sense voltage is applied on IC1a, which trips at the maximum allowed RF input drive level, exciting IC7, which disables the RF line in the same manner than the previous circuit.

A similar circuit based on IC5b, IC5a and IC9 buffers the current sense line and trips if the SMPS regulator current exceeds a preset value.

The circuit built around D11, D12, D13, D14 and IC10b perform a logical Or on any of the SMPS warning lines, to advice of a fault.

The temperature protection is performed by IC6a, which trips when the Temperature Detect line crosses its preset threshold, diminishing or completely disabling the RF output. IC6b trips at a lower level, so possibly starting (or increase the rotation speed) a dc ventilation fan, before to reach the warning level. Nevertheless this part of circuit is not always present on the SIRIO 2000.

The last parametric protection is built around IC4b and it Or'ed lines through D15, D16, D17, D18 and D33, on which is applied a voltage proportional to the current flowing on each

of the RF modules, with a sensitivity of 0.25V/A on the main power lines. If any line exceeds some 5V at any input, i.e. approx. 20A, IC4b decreases the RF power gain and trips the warning current alarm.

The last circuit, built around IC11, trips after many repeated alarms positively triggering the bi-stable relay RL1, which needs a manual reset from the control panel of the apparatus, even if the apparatus is turned off and on again. IC11 looses the memory of the counted alarm when the apparatus is completely turned off, i.e. not simply in stand-by mode, or reset.

6.8 The current sensing board

This small board is allocated very near to the SMPS regulator and its current input line, which is a solid brass profiled sheet, is screwed on its positive terminal, to reduce the line loss.

Each current monitor line passes through a very low-ohmic precision power resistor (R46, R37, etc.) which develops a small proportional voltage at its ends. The subsequent operational amplifier senses this voltage and generates a similarly proportional current upon the paired resistors R49, R40, etc. The PNP transistors T6, T5, etc. transfer this currents to ground, where they develop a proportional voltage on the loading resistors R51, R43, etc.

The output voltage proportionality on these outputs is usually 250 mV/A, i.e. 5V/20A.

Note that only 4 sensors are used on RFB2001: the board has room for more identical sections, which are mounted in other apparatuses.

6.9 The input RF power splitter

The purpose of this simple board is mainly to divide the input RF drive power in two identical signals, one for each power amplifier module, providing a good insulation between each output port (>20 dB, typ. 23 dB minimum on the whole FM band).

This is done by a Wilkinson type printed coupler, followed by the balancing resistor array R21 ¸ R24.

A directional coupler senses the input RF level and RT1 is regulated to provide the overdrive protection circuit trip at the right maximum input level. The board supports also the direct (or forward) and reflected detector sensitivity trimmers, whose input comes from the output board.

Two additional lines support the RF module bias (or AGC) line and the temperature sensing PTC thermistor.

6.10 The RF power amplifier modules

These modules are built around a couple of "Gemini type" Mos-fet transistors each one forming a 300W push-pull amplifier.

Discrete Wilkinson-type couplers equip both the input and the output module section, doing the job of dividing and recombining the input and output signals, providing a suitable insulation between the transistors.

A small balancing resistor R1 is mounted on the input splitter, while a much bigger resistor R14 is mounted in the output combiner.

A group of C, R and L RF decoupler and dampening components are mounted on the positive supply line of each amplifier, plus a small value resistor, R12 and R13, for possible separate current detection of each supply leg.

The gate bias is separately adjusted through R15 and R16 on each section. Do not tamper the factory bias preset values!

The full power output of the whole module exceeds 600W, to provide some room for coupling losses on the combining stages of higher power amplifiers, like the same SIRIO 2000.

6.11 The output RF power combiner, LPF and coupler

This module is symmetric to the input power splitter and is another printed Wilkinson coupler, whose power management capability is obviously much higher than the input board. In this case the power balancing resistors are high power devices, whose centre connection is referred to ground through an inductor, which discharges any static electricity on the antenna up to a relevant amount of power.

The power combiner is followed by a printed low-pass filter, which attenuates the harmonic products generated by the amplifiers.

3 directional sample lines derive two rectified voltages proportional to the direct and reflected output power and a RF signal for external monitoring purposes.

7 REPAIR AND REPLACEMENT OF DAMAGED MODULES

The SIRIO 2000 is a high reliability apparatus, as much effort was done in the design and development stage to assure the maximum reasonable working margin for each part. Nevertheless, as all apparatus which works 24 hours a day for years, some failures are possible, especially in those environments which over-stress the apparatus, like hot or dusty or moist places, or subjected to wide mains fluctuations or static discharges and things like that.

In the event of any failure an appropriate analysis must be done to avoid subsequent failures due to faulty ambient conditions. A often underestimate cause of failure is simply a too high ambient temperature or insufficient ventilation. Improving the ambient and system ventilation as suggested in the installation paragraph of this manual, usually fix the problem.

Other obvious causes may be dust clogging and ventilator fan failure. A regular service and maintenance routine will avoid these sources of problems and it is suggested to change the ventilator each two years, even if no damage is still visible, especially at high ambient temperature.

No air pipe must be attached to the ventilator fan output for air ducting, if an external extacting fan is not installed in that system.

In any case, if the amplifier fails, some work must be done on the apparatus to fix the problem. With the appropriate spare parts, most of repairing work may be done on site, without need of special tools and often without need of any solder joint.

Practically 95% of any reported failure in similar equipment applies to the power managing modules, i.e. the RF power amplifiers module (65 ¸ 70% of the failures), the RF output combiner (»10%), which may be consequent to an amplifier module failure and the SMPS regulator, accounting for another 10 ¸ 15% of the failures. All the other components and boards are responsible for the remaining 5% of problems!

Not much needs to be said about the general boards and components changing: virtually all of them may be changed in few minutes, without retouching the adjustments. Most of them are immediately accessible or needs a minimum of dislocation of other components and plates. Only the RF boards need a deeper look.

RF boards are delicate modules, which contains some parts as flanged power transistors and resistors which must separately be screwed on the supporting heatsink and may be easily damaged by improper handling. These boards are the 500 W power amplifier modules and the RF output combiner.

Repairs of these modules are usually made in the factory or in a specialised laboratory, if possible at all. If the p.c. board is damaged perhaps only the costly RF active devices may be recovered. Nevertheless, very often this is worthless because, in case of major damages, these

parts are internally electrically damaged or degraded.

Repair of the RF modules requires too, at the end of the reparation, a full check of the module's working parameters in a dummy fixture or in a test assembly which are not available even in most specialised laboratories. For these reasons repairs of the modules, specially the higher power amplifiers, is discouraged at the most and the broken one must be replaced by new parts with the same identical characteristics, fully tested at the factory.

To replace the modules avoiding as much as possible to damage the new part or the old transistors, if not already broken, carefully follow the subsequent steps:

1) Remove the amplifier cabinet from the rack, after having disconnected from its rear connectors the RF input and output cables, the power supply and the control cables. Disconnect also the ground cable from its screw.

2) To investigate on the damaged parts or to test the reparation, it may be required to externally connect the removed cables and the RF output load to the amplifier assembly in manner to permit inner inspection of the top and bottom of the apparatus. If the latter is placed on a small stand aside of the main rack, the internal cables are usually long enough to permit the connections, avoiding extension cables.

3) Open the bottom cover of the cabinet and remove the screen from the damaged module(s), if any.

4) If the damage is not immediately visible, it may be helpful to measure the currents sunk by each 300W sub-module amplifier. To this aim a low ohmic value shunt resistor is inserted in series to the 48V power supply of the module's subsections (R12 and R13, 10mW).
To measure the current sunk, the amplifier assembly must be completely connected and powered with and without RF. A sensitive, RF proof, digital voltmeter must be used to measure the voltage across the shunt resistors, which vary from nearly 1 mV at no load to 100 mV at full power.
Take care: most of low quality digital or analog meters are not able to do this reading, because they are affected by the high RF field and their reading is completely meaningless!
WARNING: great care must be paid not to accidentally short-circuit the resistor leads to the ground with the voltmeter probe tips, during the measurements!

5) When properly functioning at full power, each module 300W subsection will sink 8 ÷ 10 Amperes, i.e. 80 ÷ 100 mV across the shunt resistor. The absorption must be balanced ±10% around the mean value on each amplifier. A lower or higher value may mean a module failure.

6) Remove the power supply cable screwed on a centre terminal in the board and the small bias cable.

7) Unscrew the input and output RF connections, at the module opposite sides.

8) Carefully unscrew the RF transistor flanges from the heatsink base-plate. This operation, if not properly done, may mechanically over-stress the transistor, cracking the internal delicate beryllium-oxide ceramic which supports the active silicon dies and determine unrecoverable damage of the device.
CAUTION: beryllium-oxide is toxic and must not be thrown with domestic refuse but in specialised toxic material disposals. No special handling precaution must be paid when the transistors or power resistors are not mechanically broken, apart those deriving from the handling of mechanically fragile (and very costly) devices. If the transistor or resistor flange is broken, avoid to get in touch with it and the brittle white exposed internal ceramic or inhaling dust of it. Dispose the transistor or the entire broken module as previously described.

9) Make a note of the position and the length and remove the threaded screen spacers and the board fixing screws.

10) Remove the broken module and clean the supporting heatsink base-plate before mounting the new one.

11) Smear thin heat-conductive silicon grease below the flanges of the power transistors and resistors of the new module, before mounting it.

12) Position the new module, placing the threaded spacers and screws over the p.c. board avoiding to tighten them. When all the screws are placed, control the correct alignment of the transistors and resistors fixing holes and tighten the screws and spacers.

13) Insert the proper screws and washers, if any, across the transistors and resistors and carefully tighten them in several, alternate steps.

14) Reconnect the power supply and bias cables to the module.

15) Turn-on the whole amplifier fully connected to the supporting power and control rack without RF power, with RF load connected and driver exciter off. Enable the equipment, with the exciter still off.

16) Measure the bias current of the two transistors on the module, as explained on previous paragraphs 4 and 5. They were factory adjusted to 100 mA (1mV).

17) If the currents are off the range 50 ÷ 200 mA (0.5 ÷ 2 mV), carefully retouch the bias trimmers on the board. A small clockwise rotation increases the bias current.

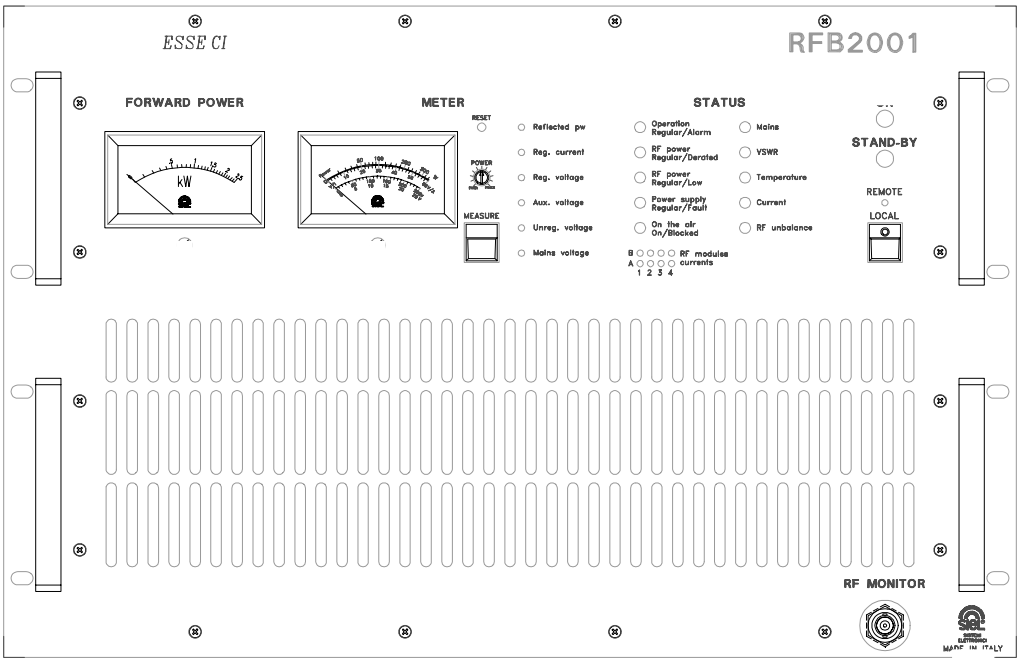
18) Reduce the output set power to a low value, acting on the front panel power set trimmer and turn on the exciter power.

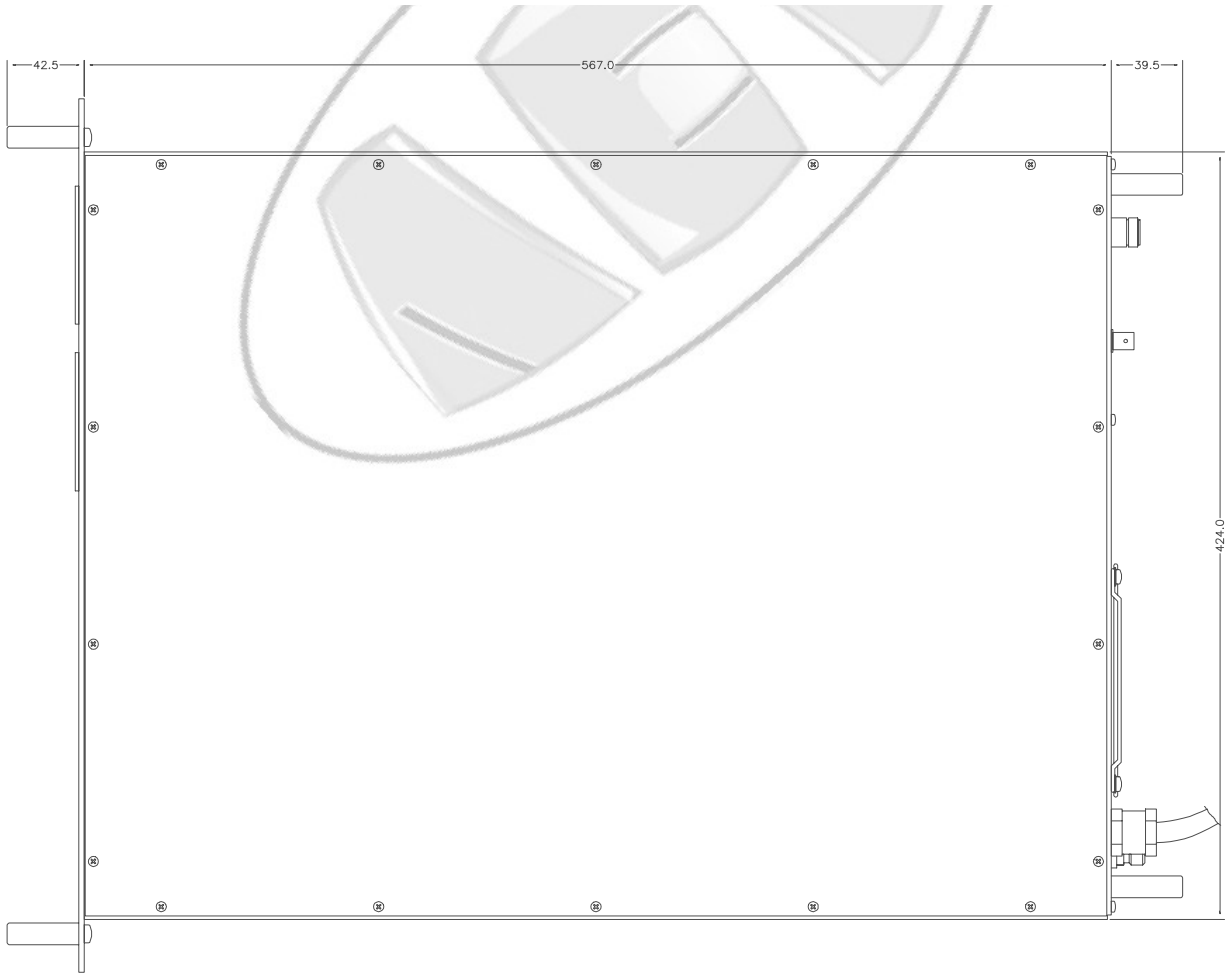
19) Slowly increase the power-set and measure the balance of the current drained by each module at half level and at full power. Verify the limits written in paragraph 5.

20) Turn off the equipment, reassemble the screening covers and the bottom panel of the apparatus and reposition it in its working location with full connections.

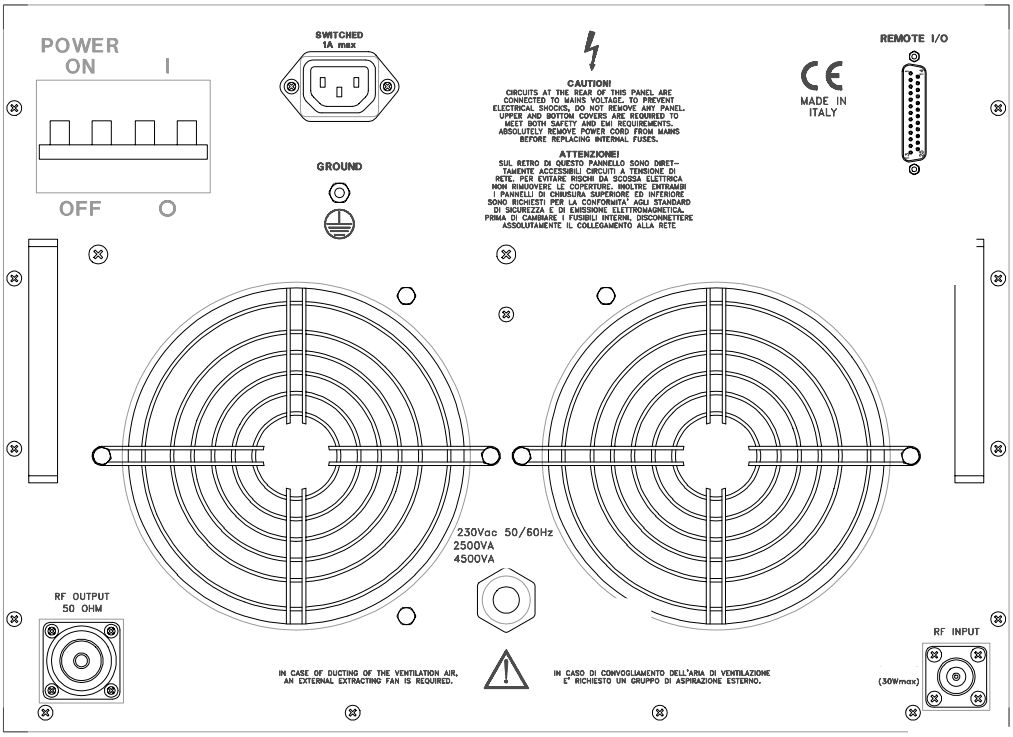
21) Perform a limited period of test at full power, i.e. 2050 ¸ 2100 W and then reduce power at maximum nominal working level, i.e. no more than 2000 W.

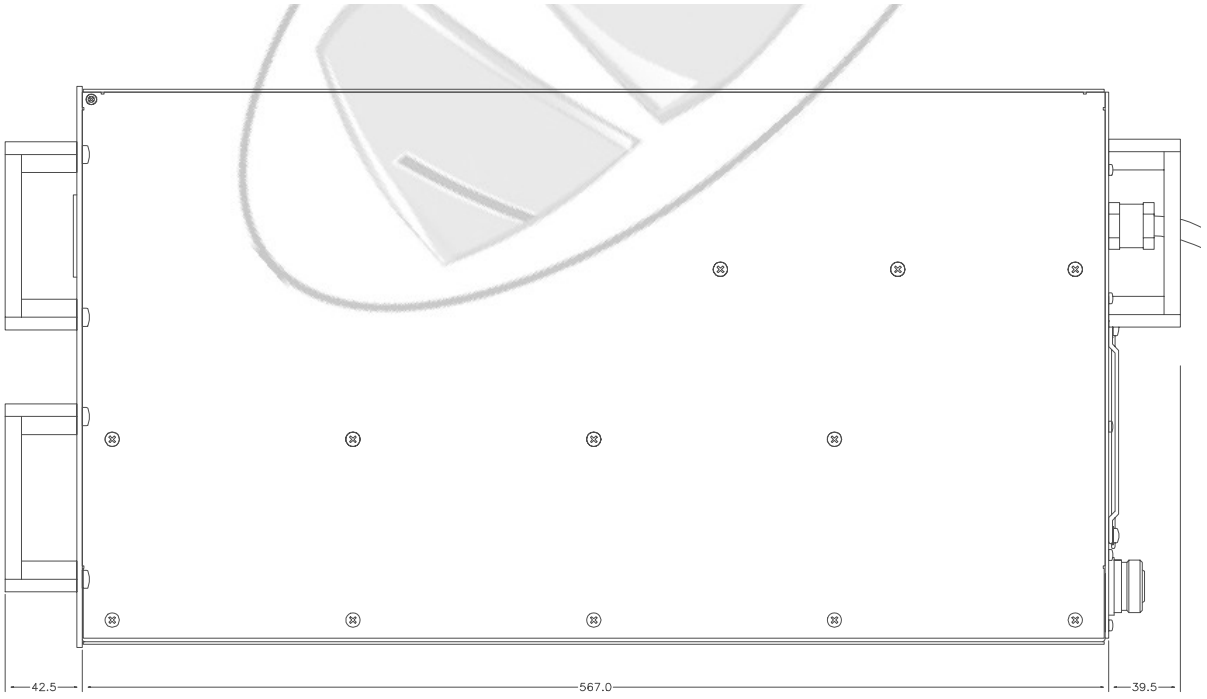
SIRIO 2000 AMPLIFIER - VISTA FRONTALE E DALL' ALTO



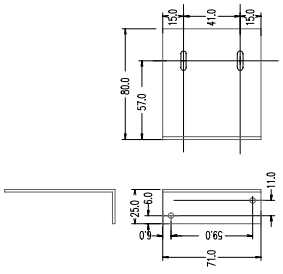


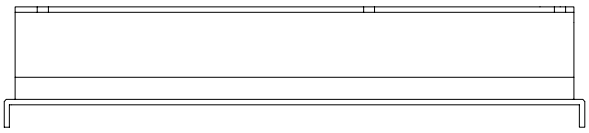
SIRIO 2000 AMPLIFIER - REAR & SIDE VIEW

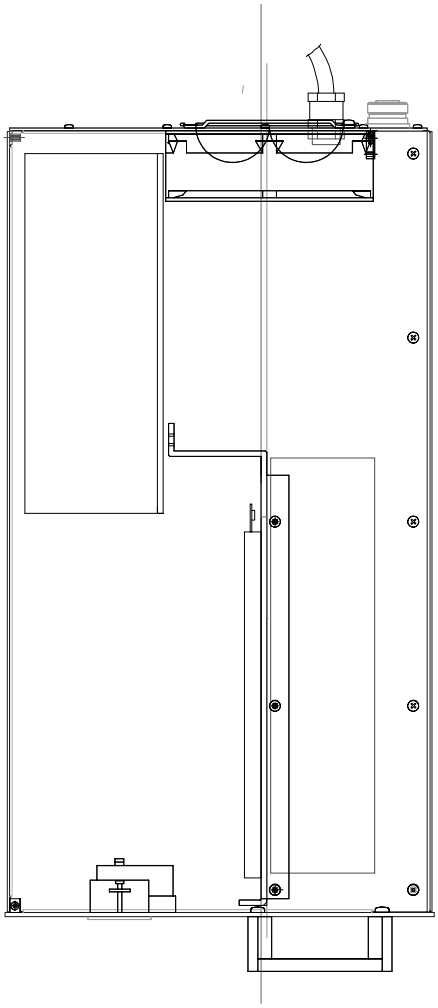


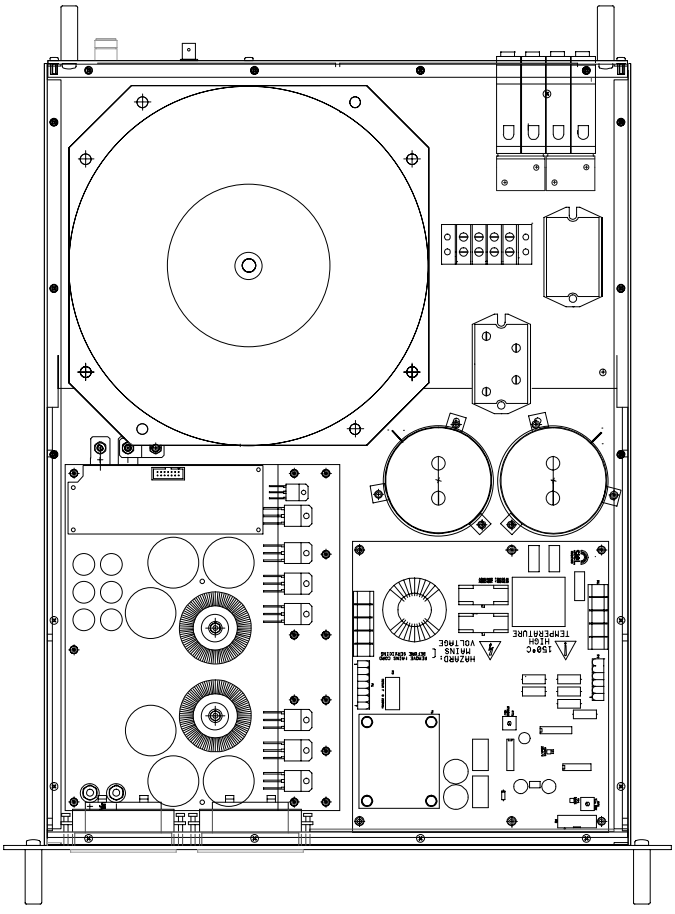


SIRIO 2000 AMPLIFIER - TOP INTERNAL ASSEMBLY VIEW



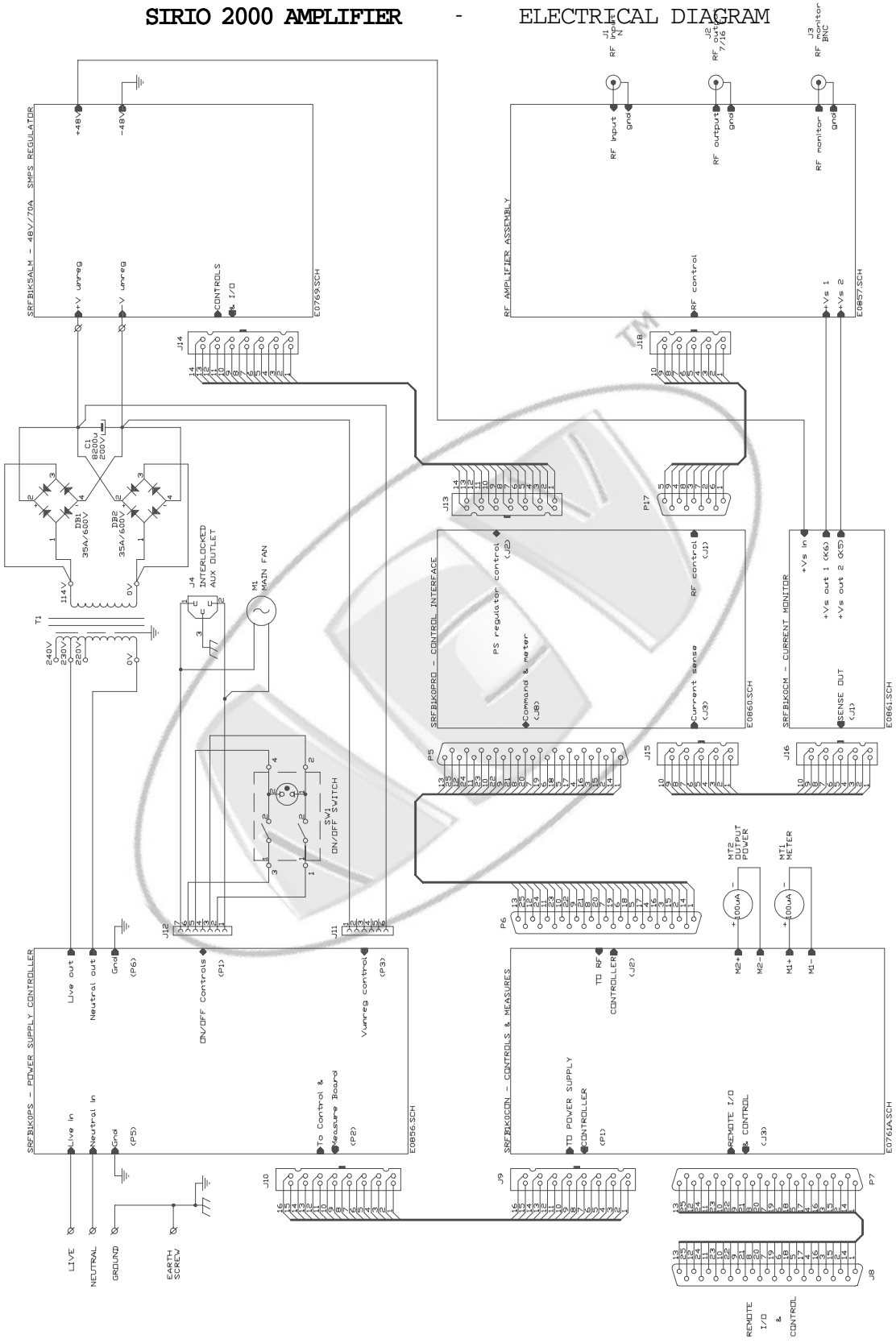




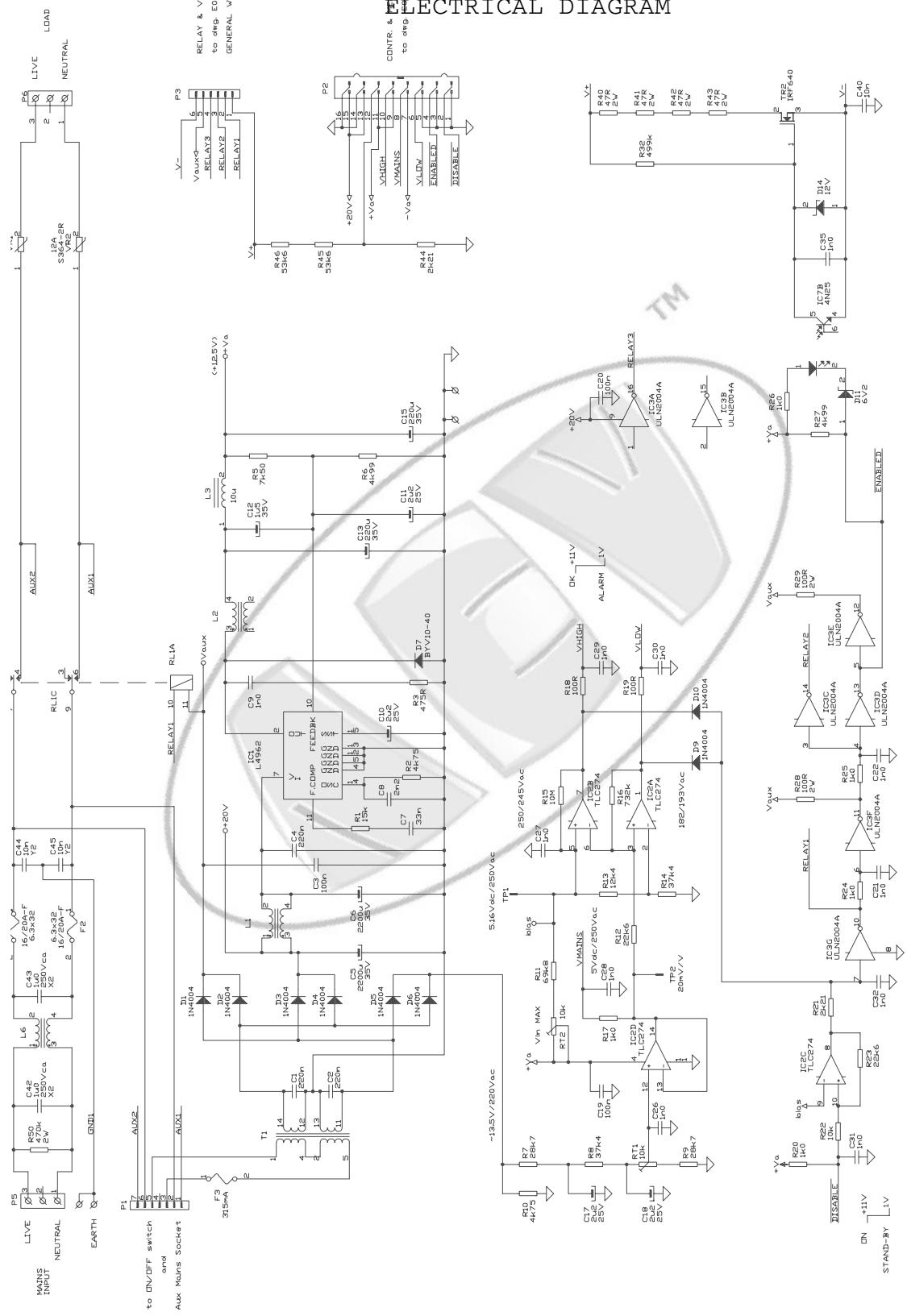


SIRIO 2000 AMPLIFIER - BOTTOM INTERNAL ASSEMBLY VIEW

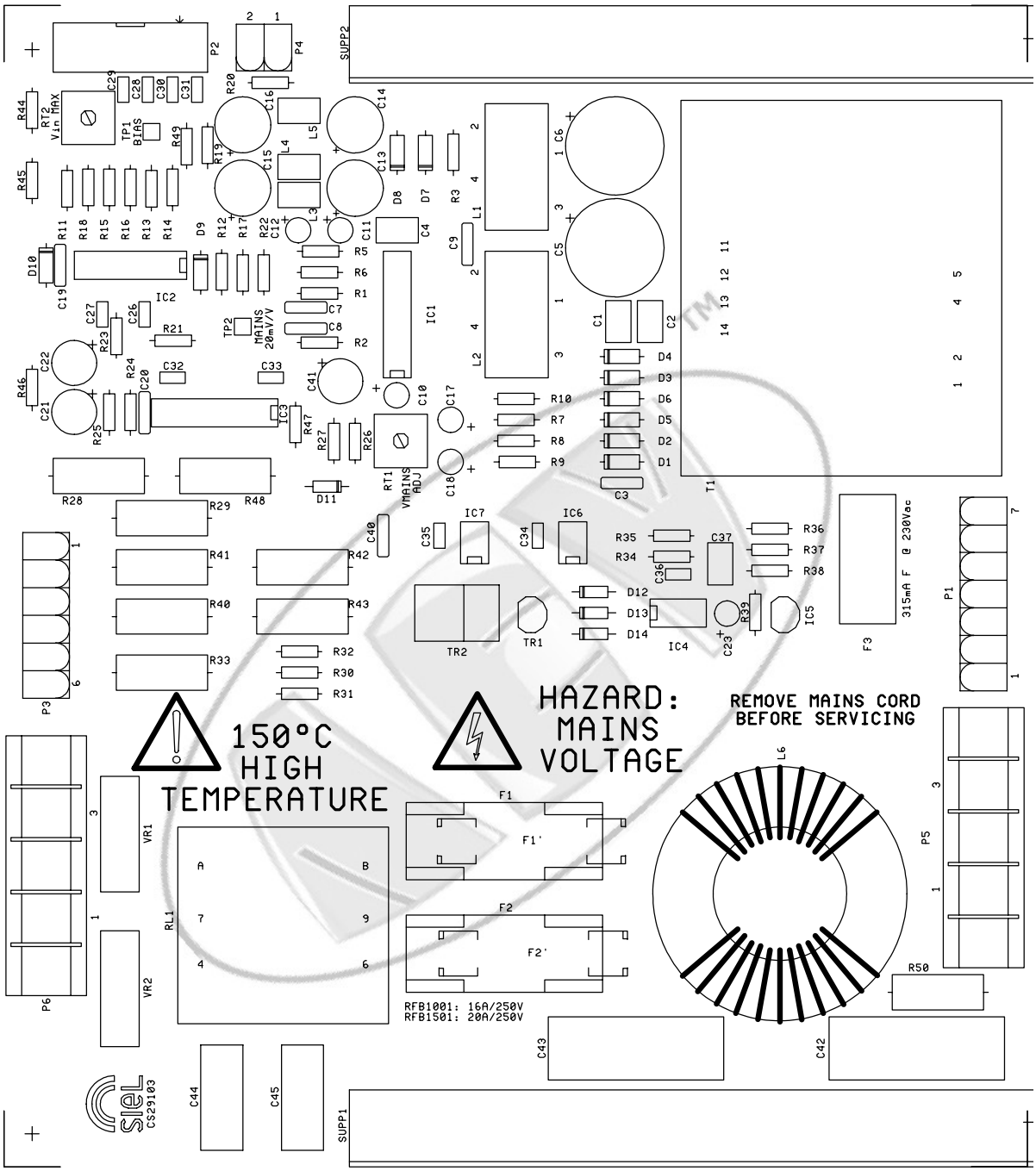
SIRIO 2000 AMPLIFIER - ELECTRICAL DIAGRAM



SRFB1K0PS - POWER SUPPLY CONTROLLER BOARD
ELECTRICAL DIAGRAM

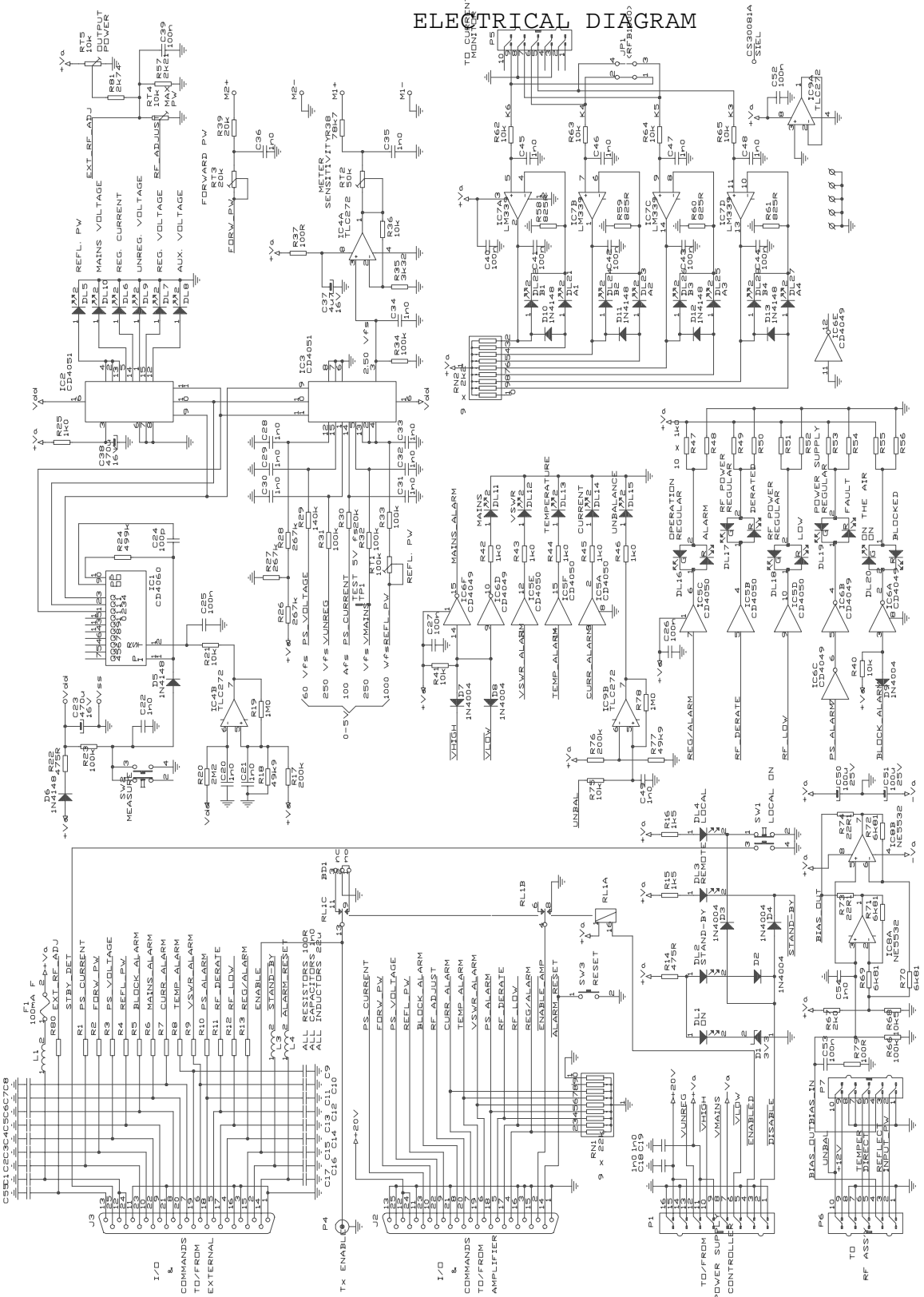


SRFB1K0PS - POWER SUPPLY CONTROLLER BOARD
COMPONENT LAYOUT



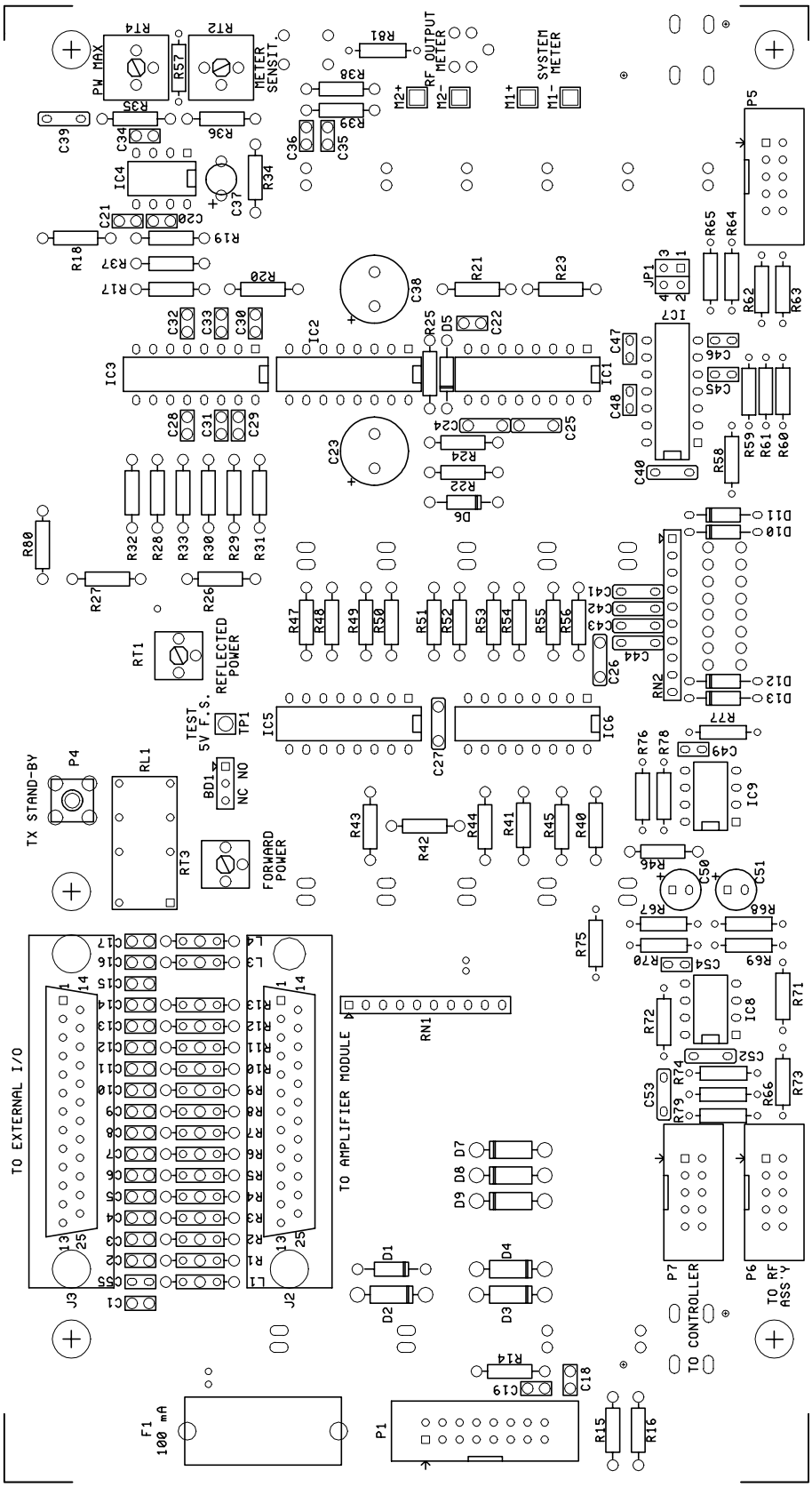
SRFB1K0CON - CONTROLS & MEASURES BOARD

ELECTRICAL DIAGRAM



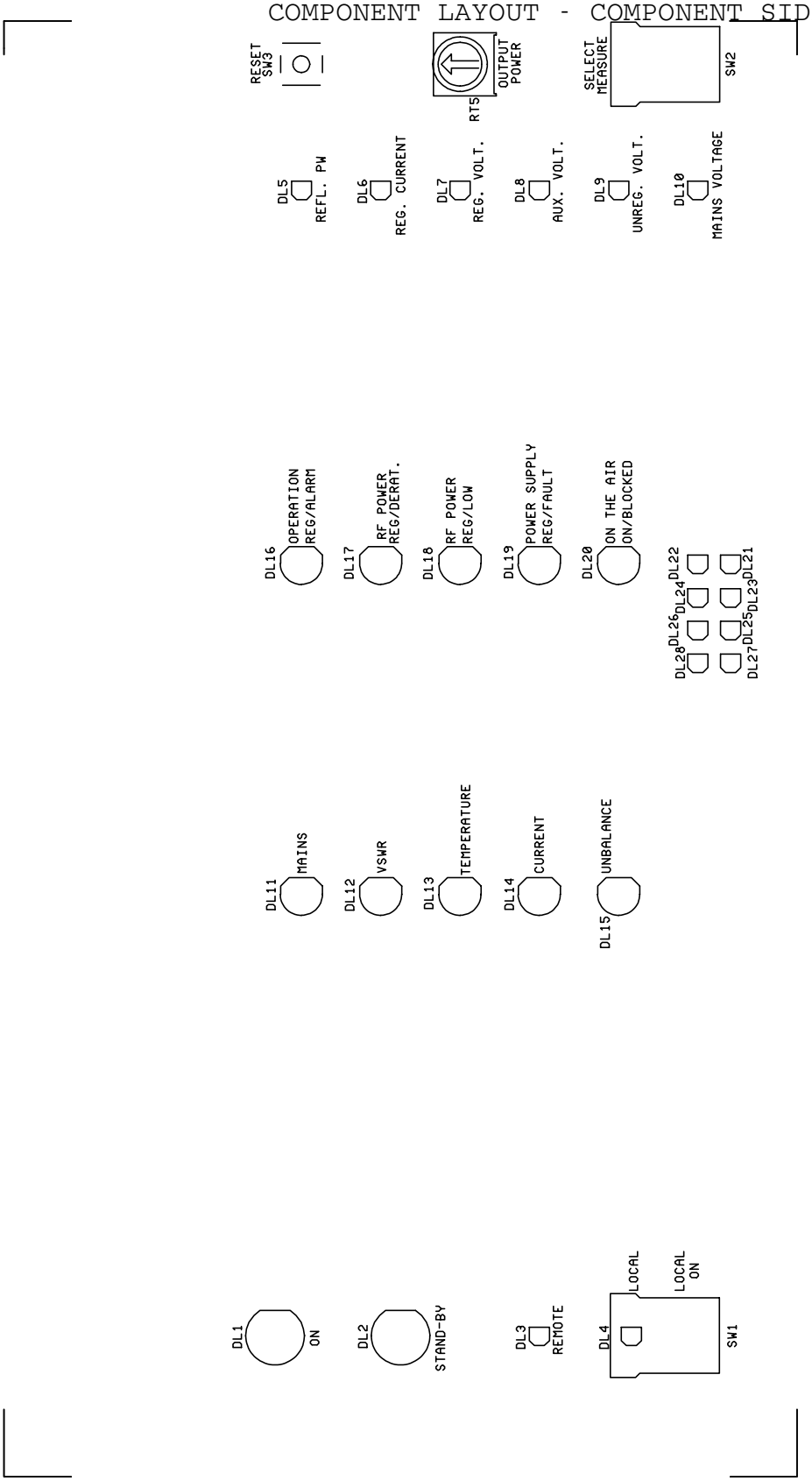
SRFB1K0CON - CONTROLS & MEASURES BOARD

COMPONENT LAYOUT - COMPONENT SIDE

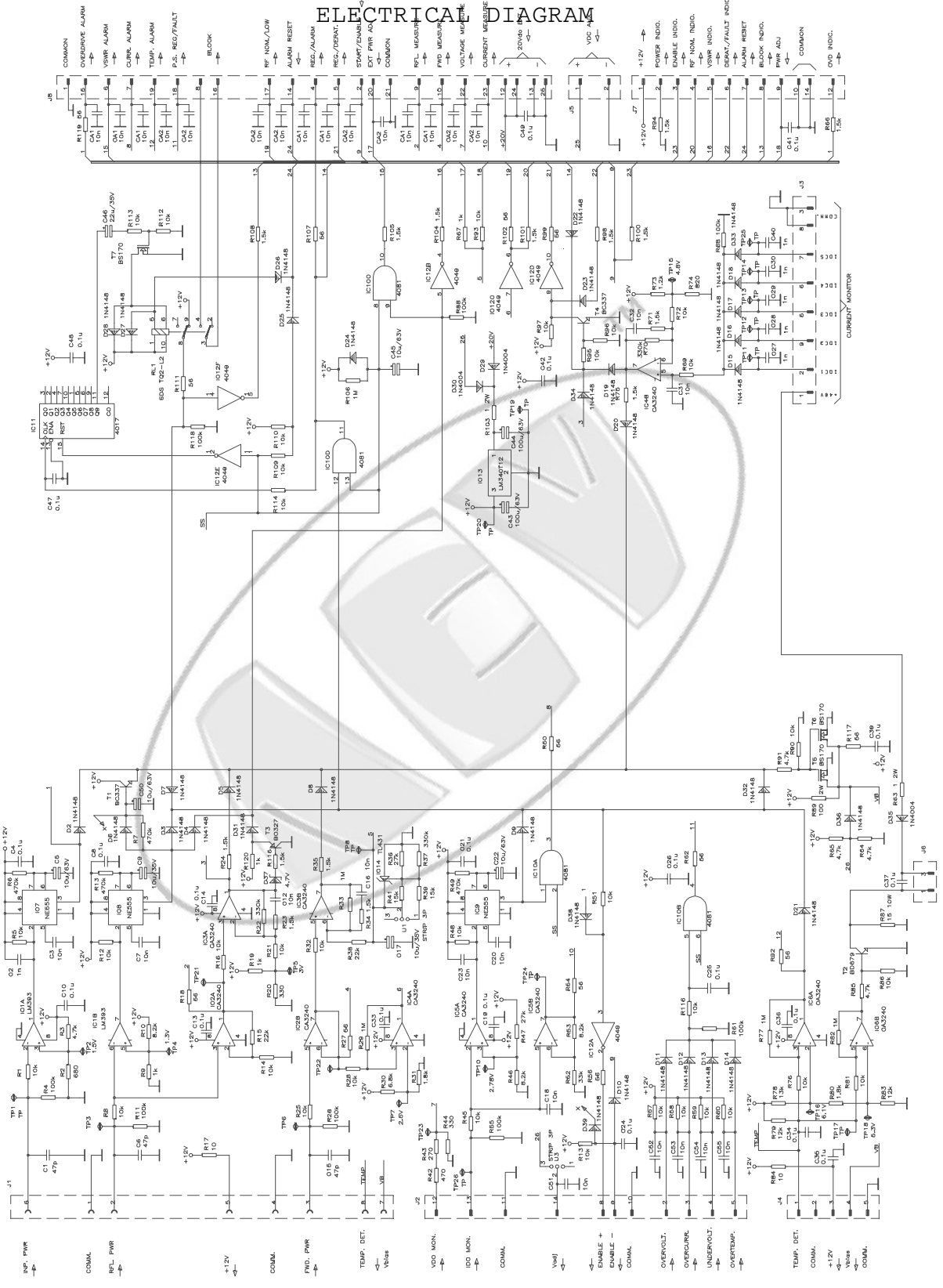


SRFB1K0CON - CONTROLS & MEASURES BOARD

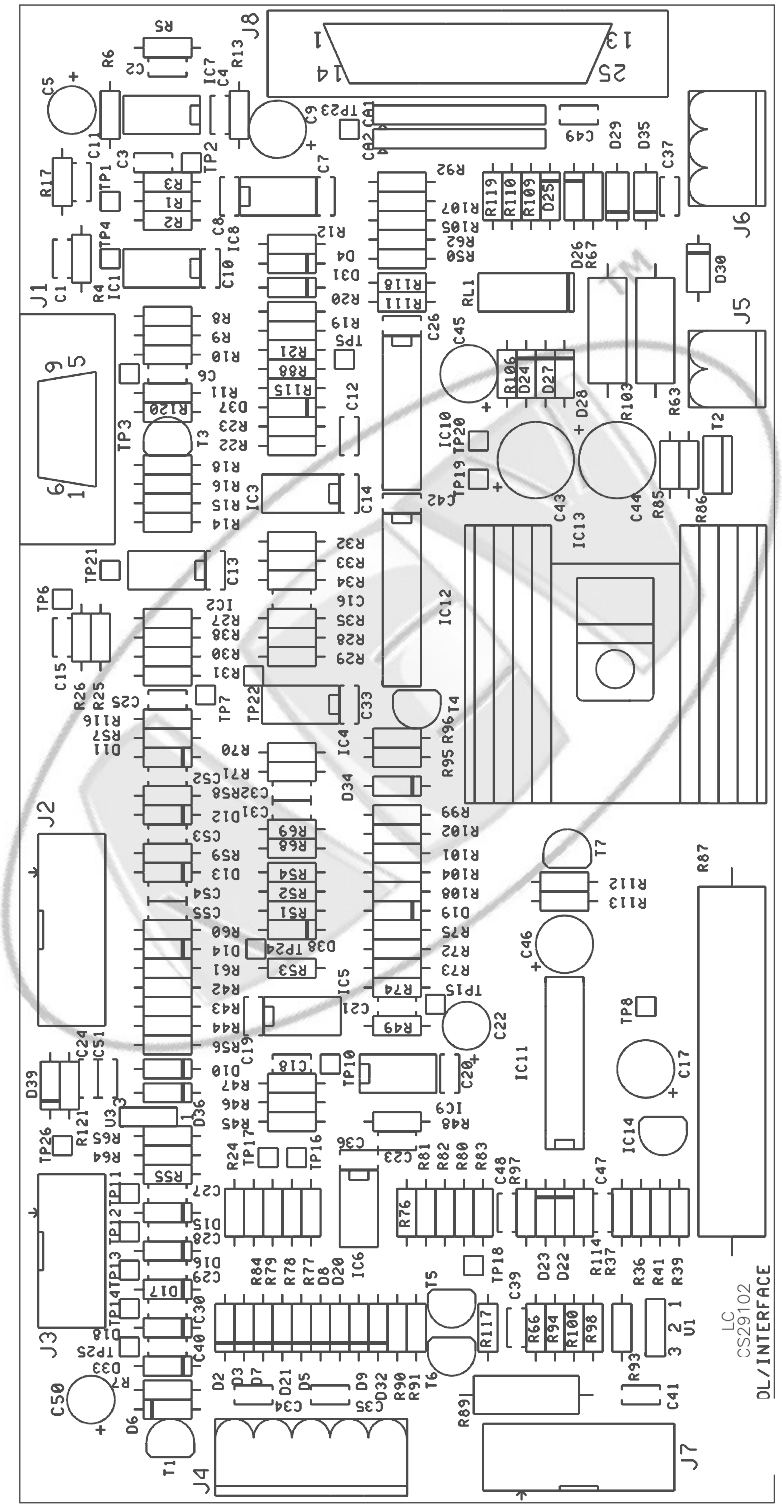
COMPONENT LAYOUT - COMPONENT SIDE



SRFB1K0PRO - CONTROL, INTERFACE & PROTECTIONS BOARD ELECTRICAL DIAGRAM

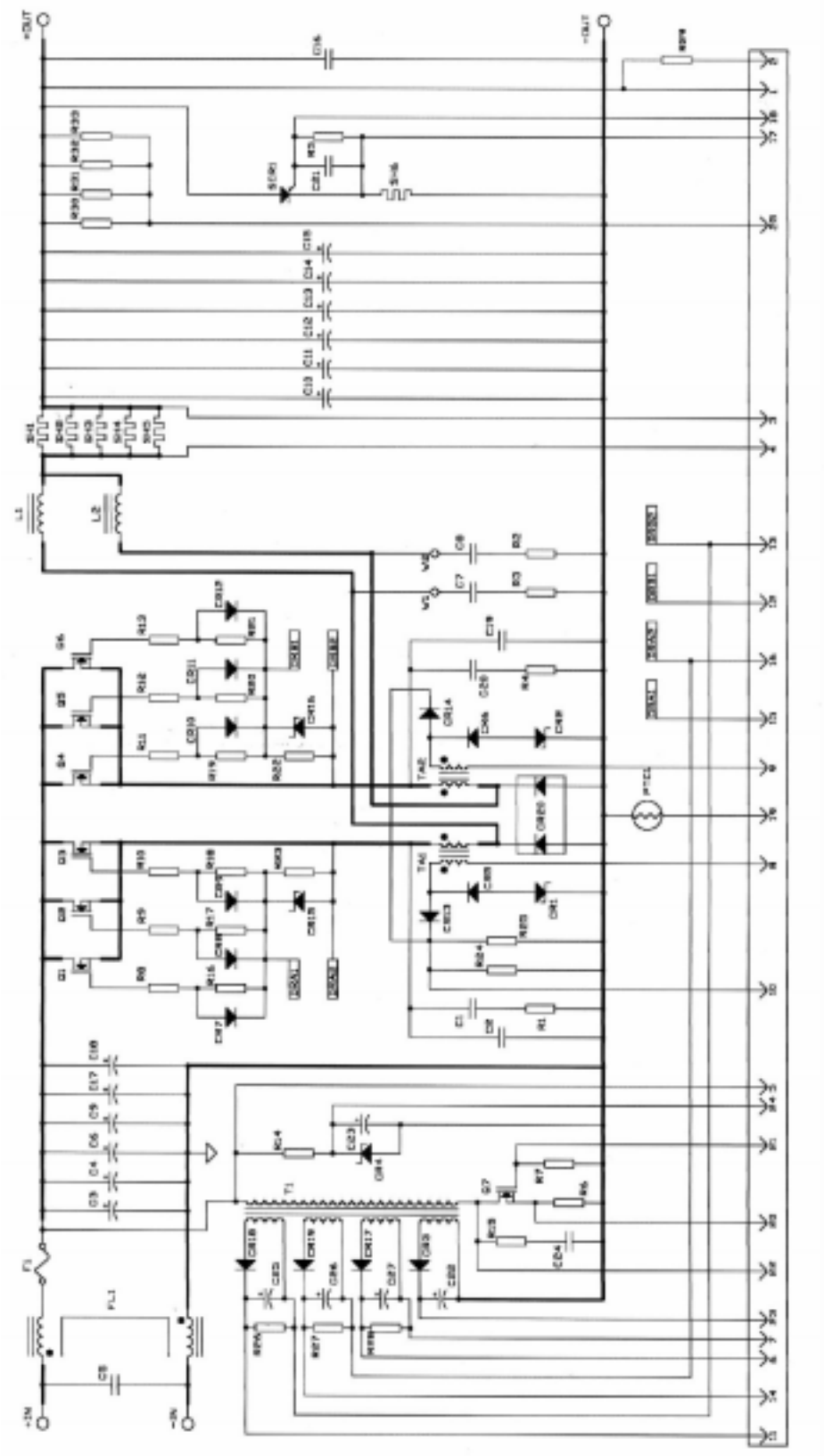


SRFB1K0PRO - CONTROL, INTERFACE & PROTECTIONS BOARD
COMPONENT LAYOUT



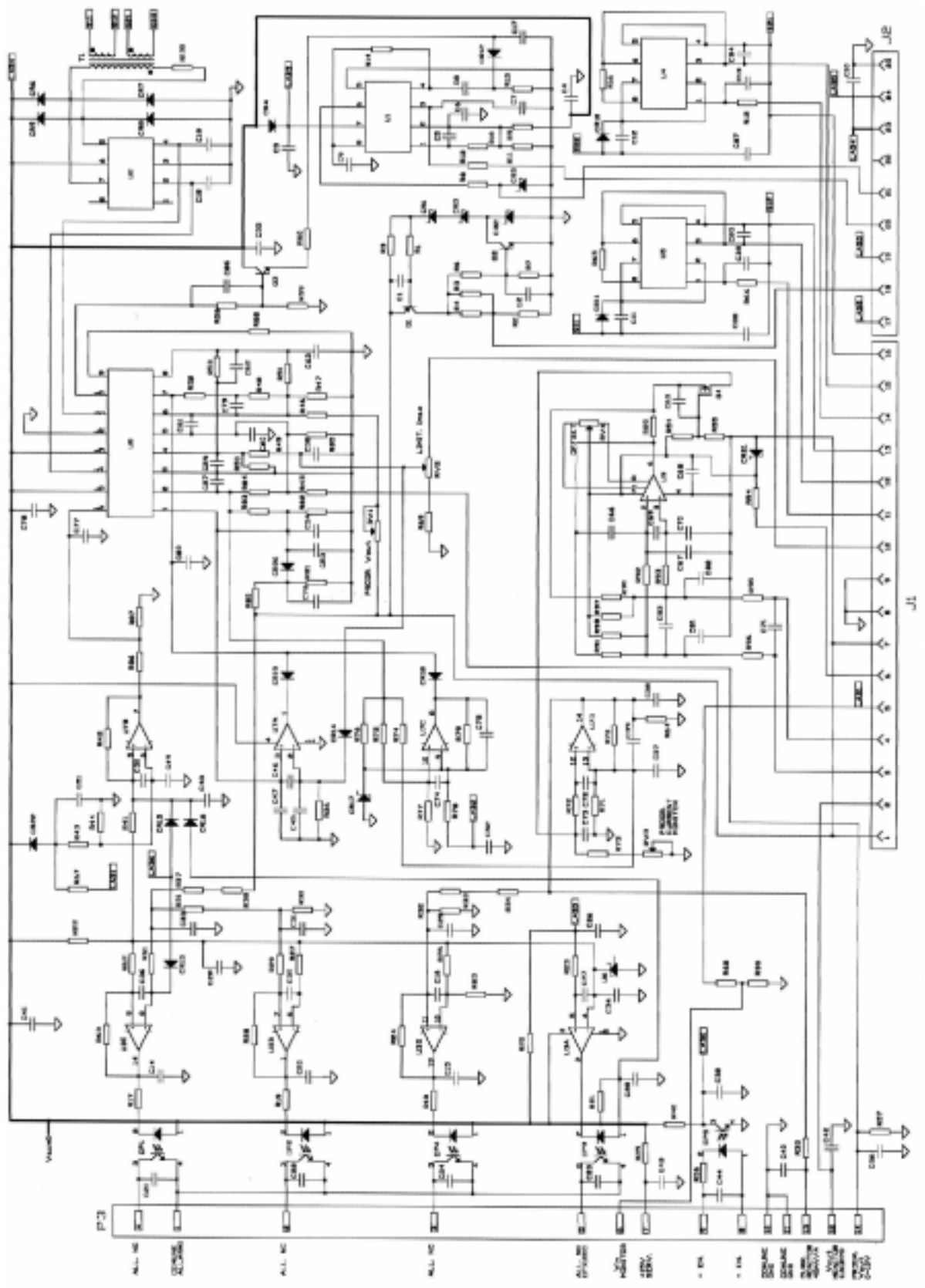
SRFB1K5ALM - 48V/70A SMPS REGULATOR

ELECTRICAL DIAGRAM - POWER SECTION



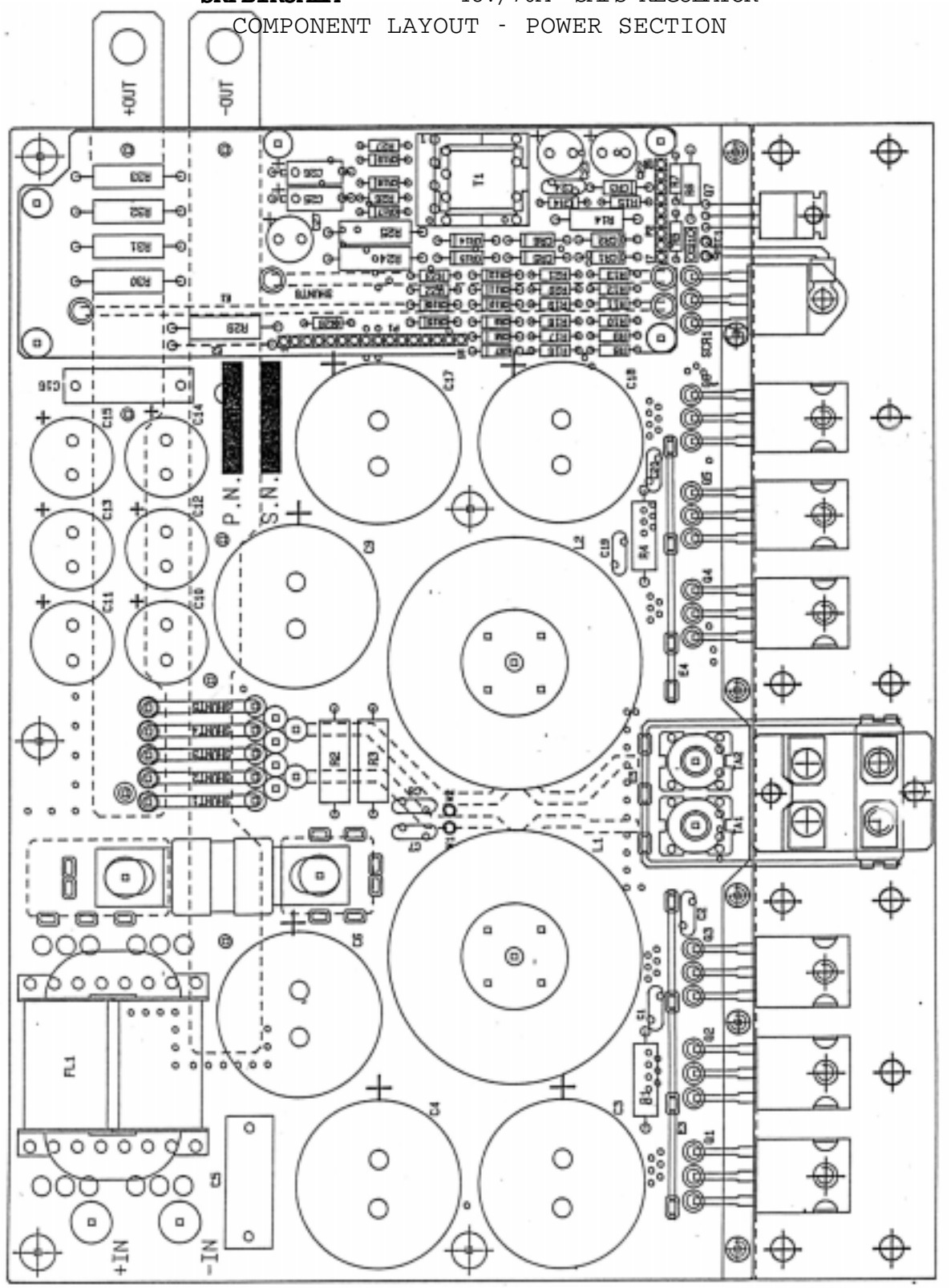
SRFB1K5ALM - 48V/70A SMPS REGULATOR

ELECTRICAL DIAGRAM - CONTROL SECTION

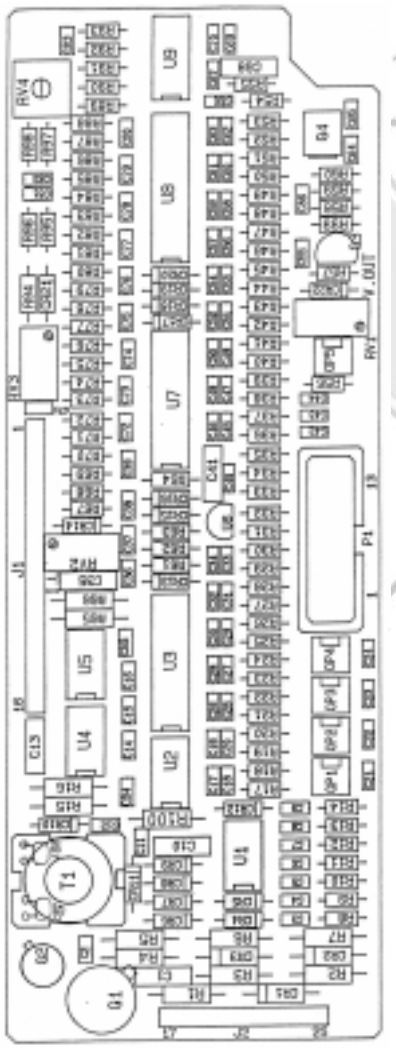


SRFB1K5ALM - 48V/70A SMPS REGULATOR

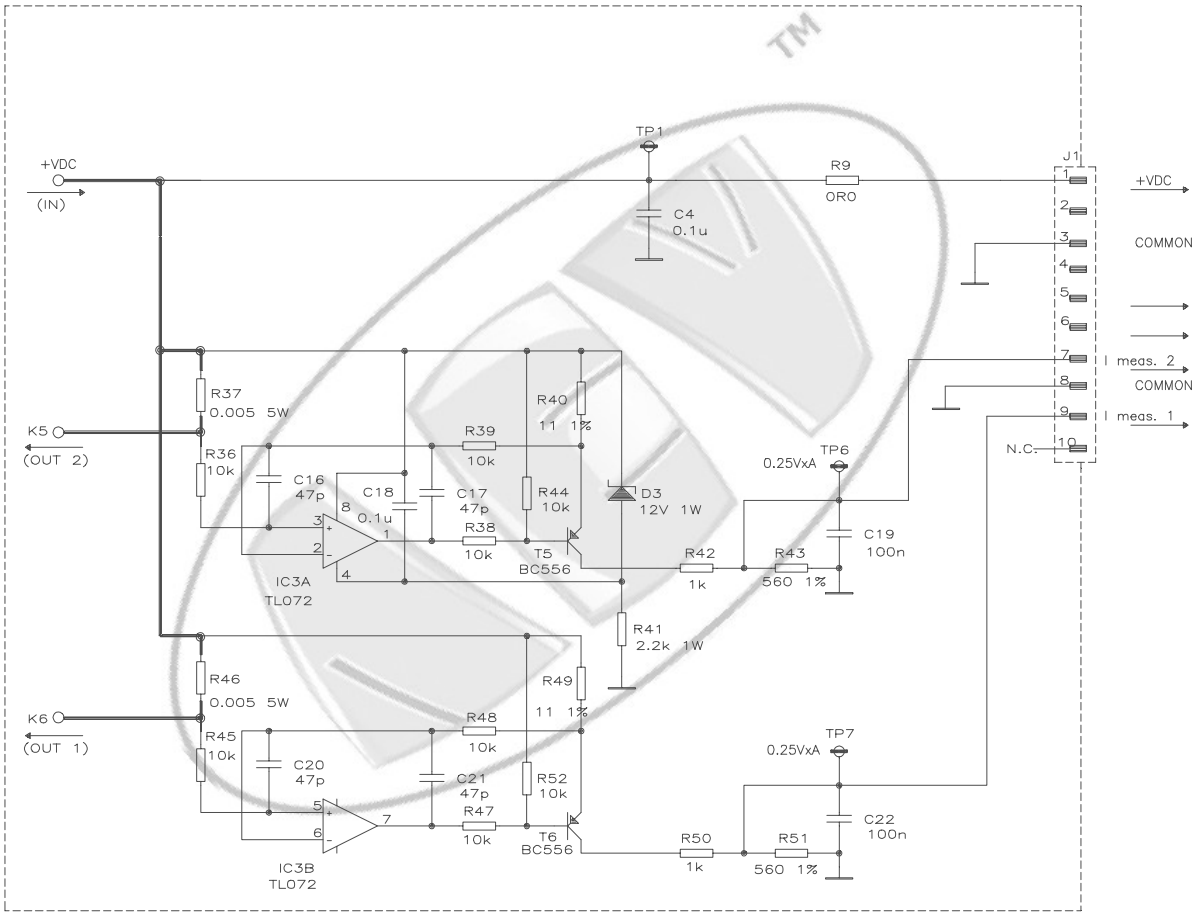
COMPONENT LAYOUT - POWER SECTION



SRFB1K5ALM - 48V/70A SMPS REGULATOR
COMPONENT LAYOUT - CONTROL SECTION

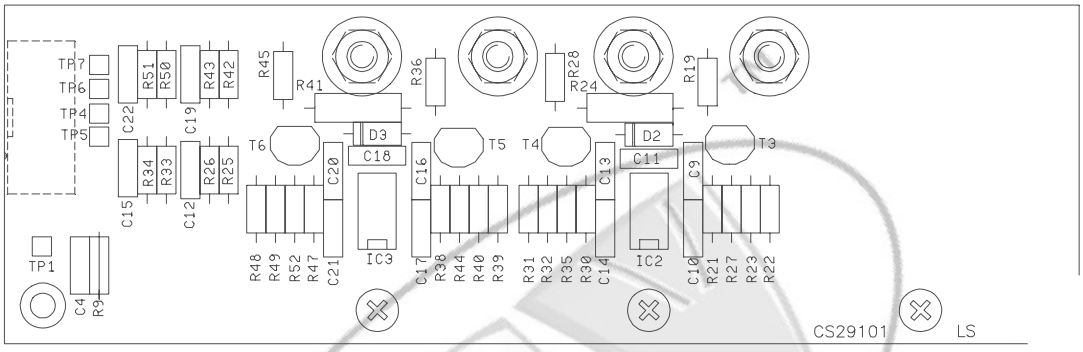


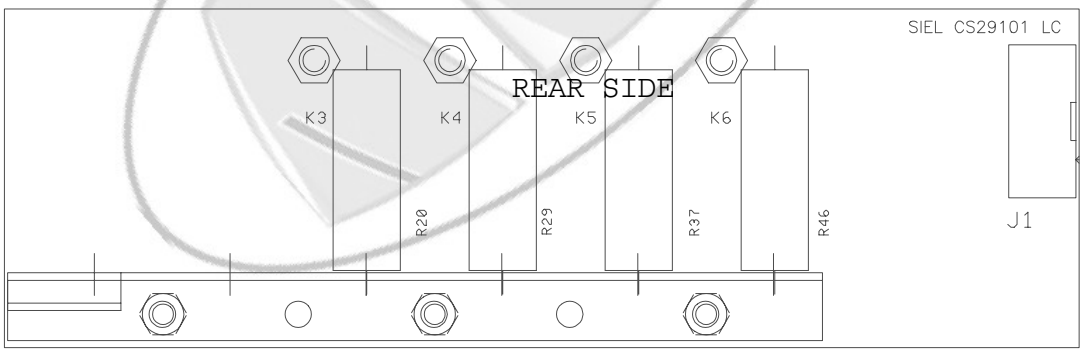
SRFB1K0CM - CURRENT MONITOR BOARD
ELECTRICAL DIAGRAM



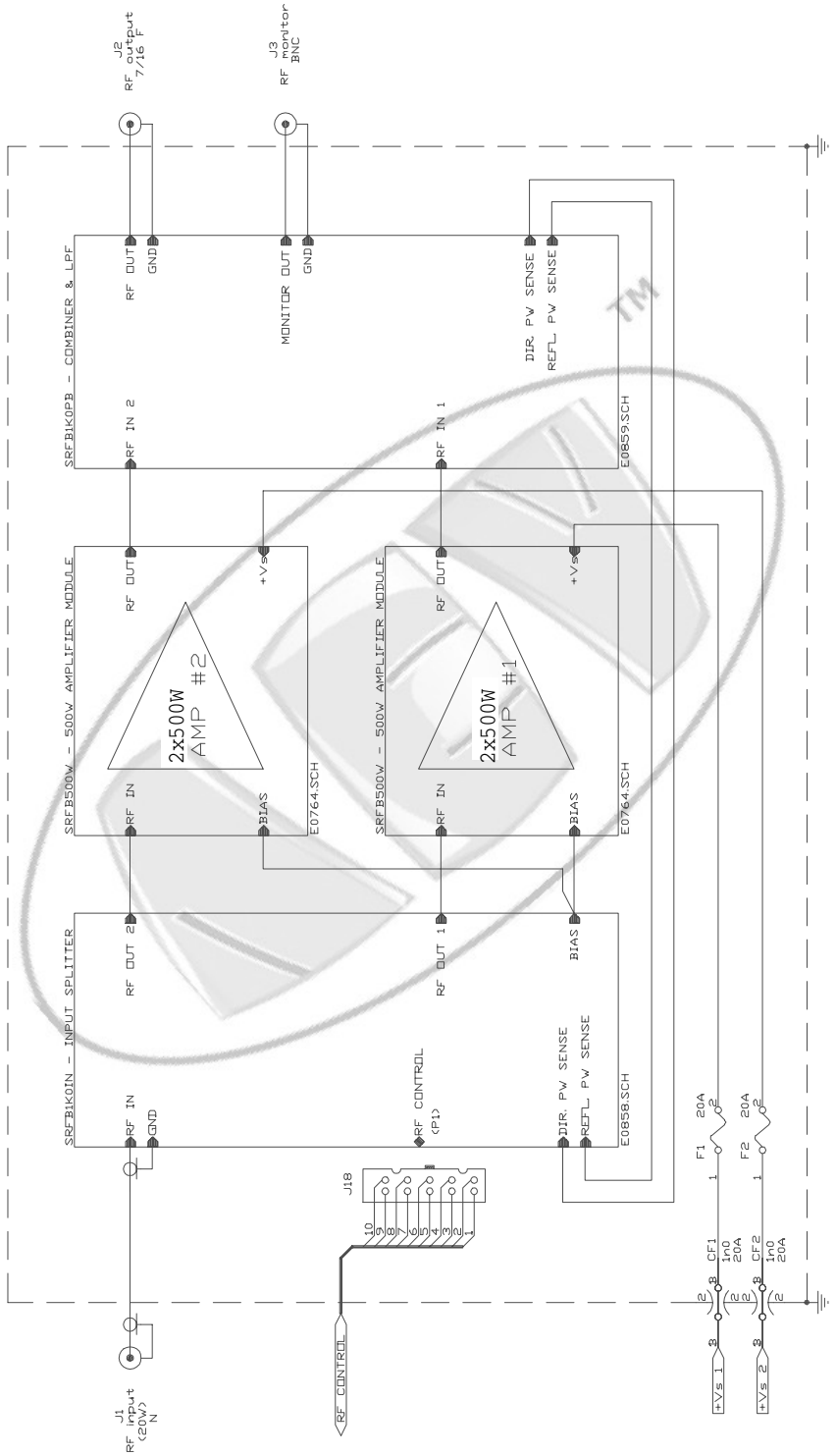
SRFB1K0CM - CURRENT MONITOR BOARD
COMPONENT LAYOUT

FRONT SIDE

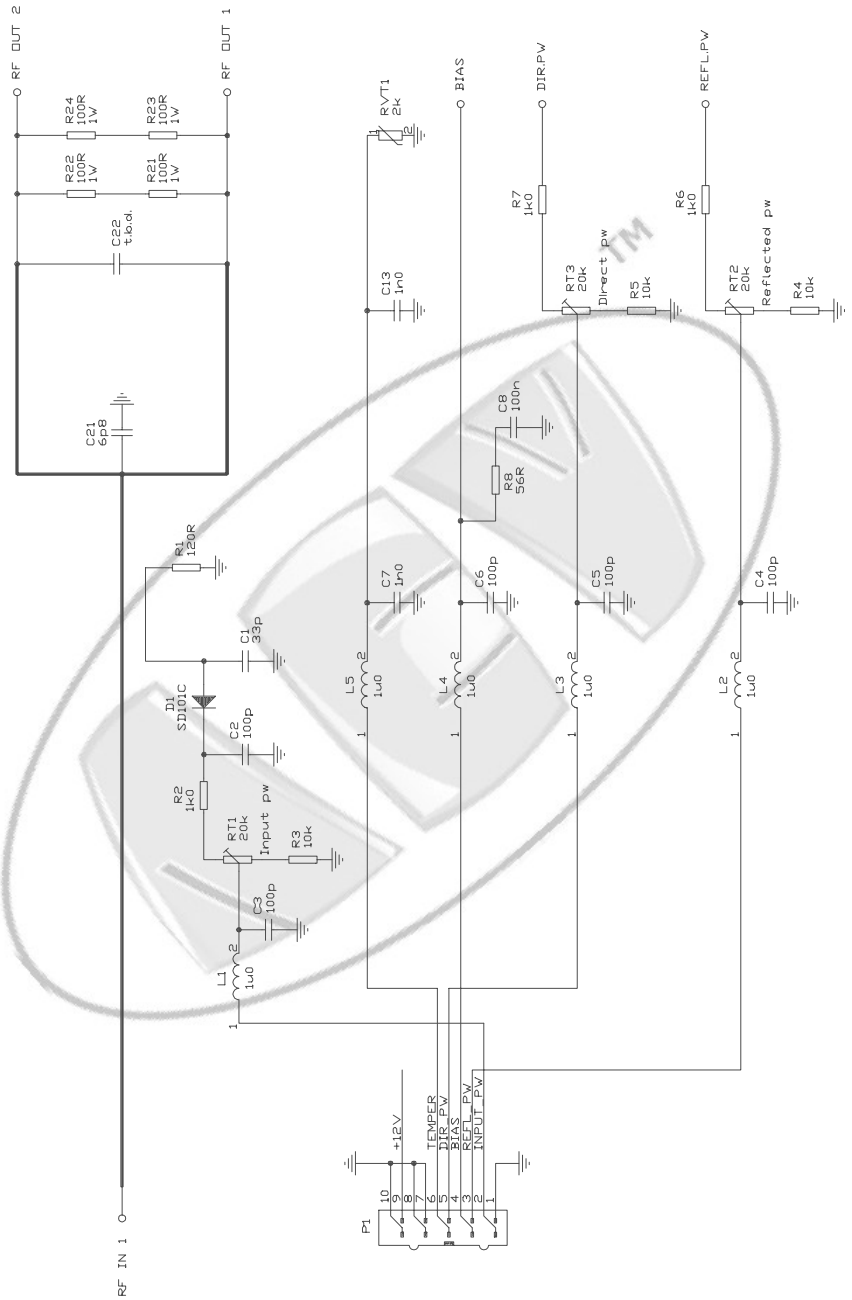




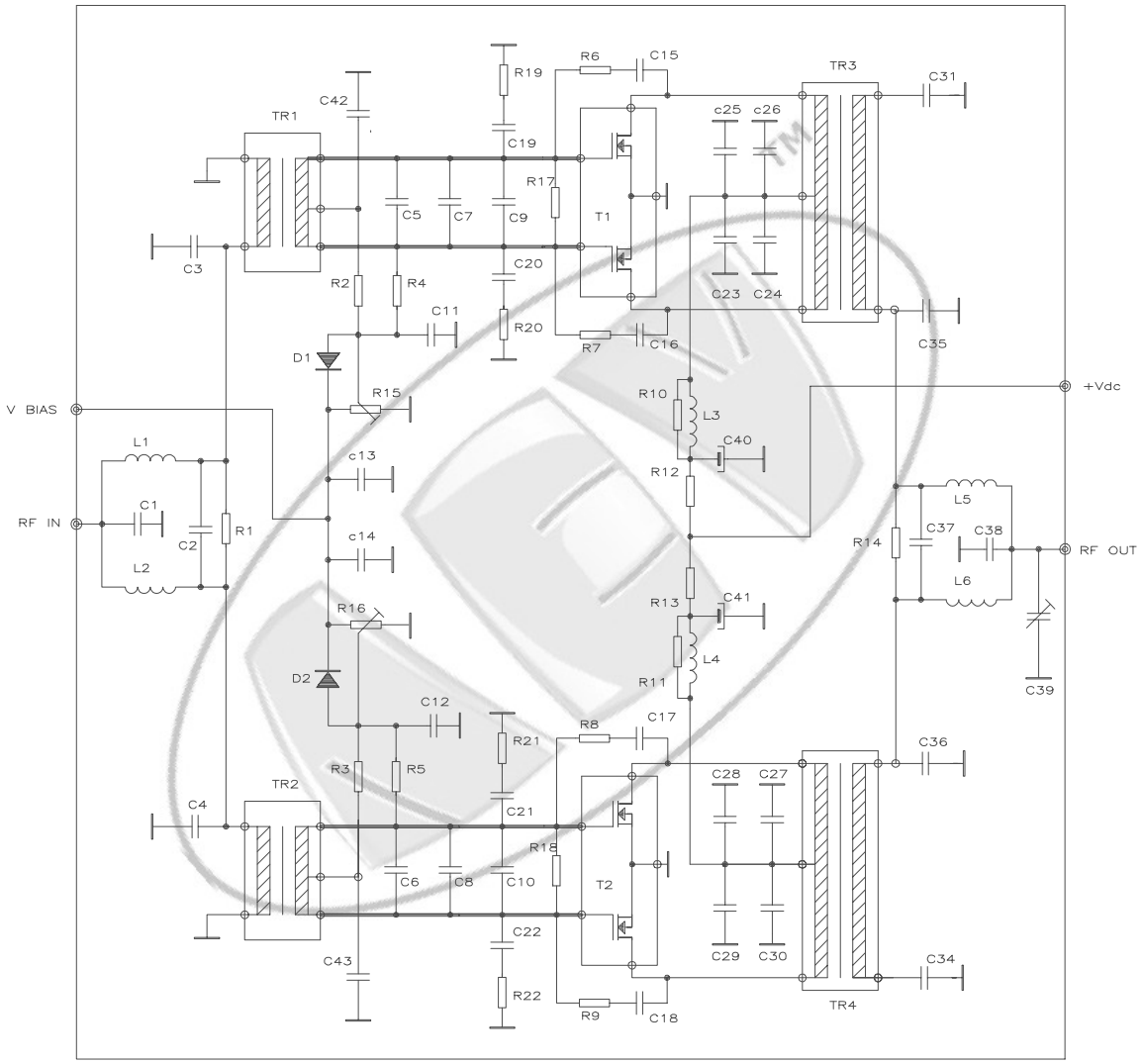
SIRIO 2000 RF AMPLIFIER ASSEMBLY - ELECTRICAL DIAGRAM



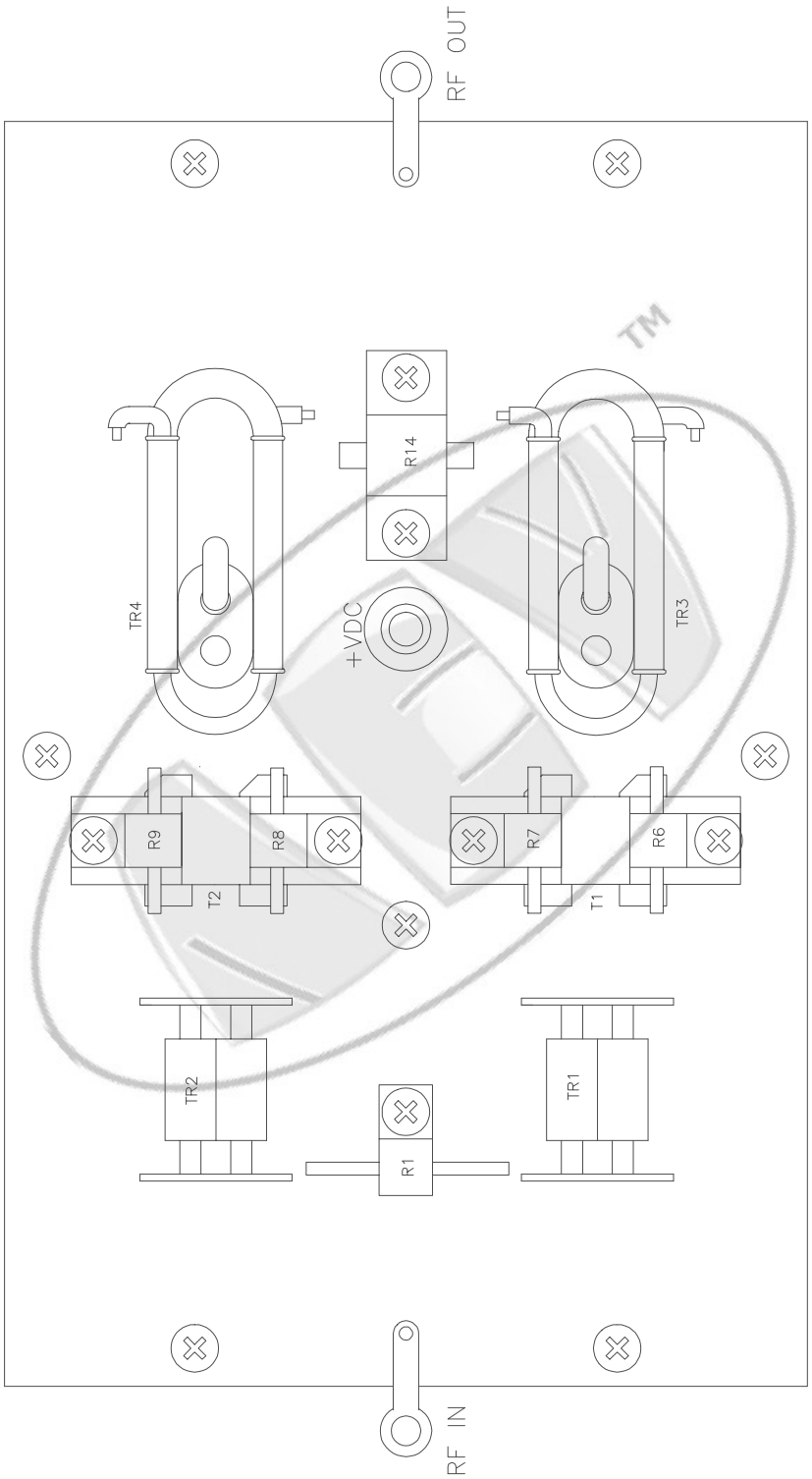
SRFB1K0IN - 2-PORT RF INPUT SPLITTER
ELECTRICAL DIAGRAM



SRFB500W - 500W AMPLIFIER MODULE
ELECTRICAL DIAGRAM

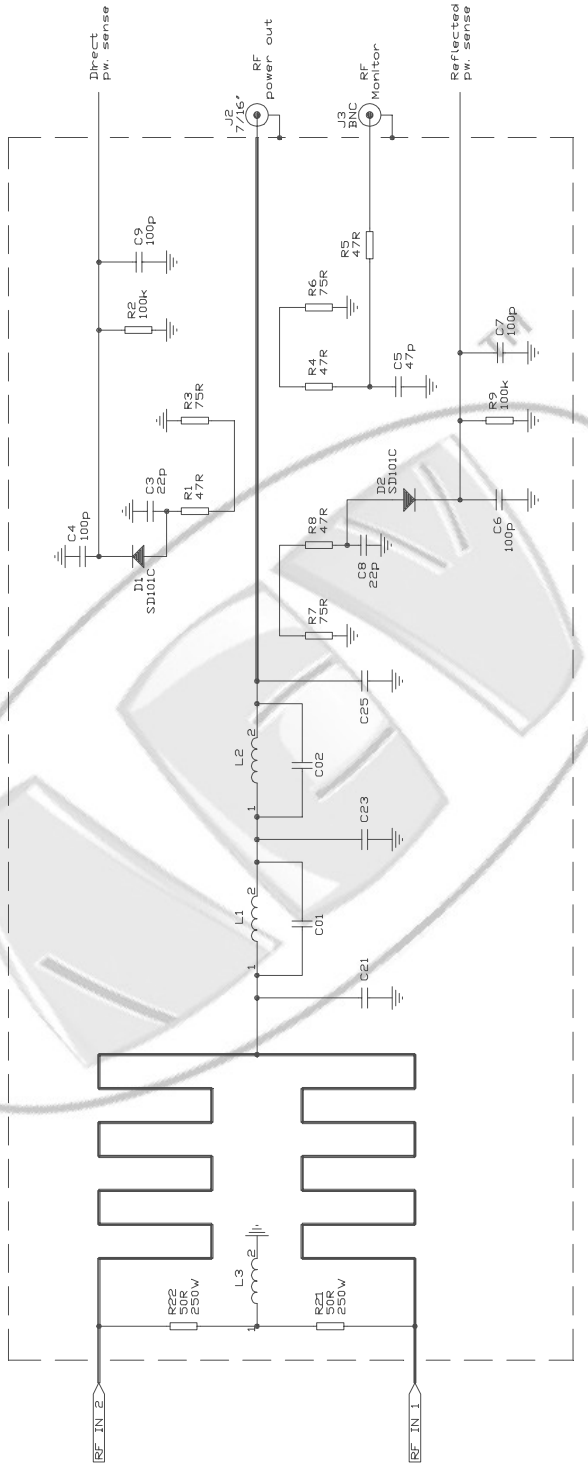


SRFB500W - 500W AMPLIFIER MODULE
COMPONENT LAYOUT



SRFB1K0PB - 2-PORT RF OUTPUT COMBINER & LPF

ELECTRICAL DIAGRAM



COMPONENTS VALUES SHOWN ARE PURELY INDICATIVE AND MAY VARY IN PRODUCTION