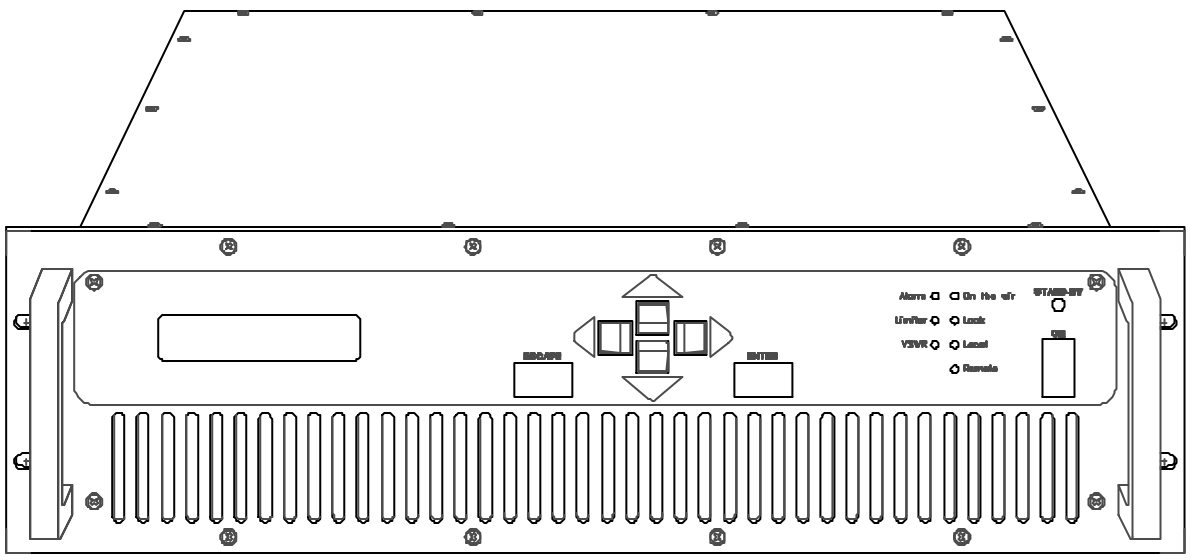
EXB300

87.5 ÷ 108 MHz FM 300W TRANSMITTER

USER AND MAINTENANCE MANUAL



SOFRATEC BROADCAST EQUIPMENT
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CONTENTS

1 INTRODUCTION 3

2 GENERAL DESCRIPTION 4

3 TECHNICAL FEATURES 5

4 TECHNICAL SPECIFICATIONS 7

5 INSTALLATION AND USE 8
5.1 FOREWORD TO INSTALLATION 8
5.2 SYSTEM CONNECTION 8
5.3 LF CONNECTION AND PRESETS 10
5.4 OPERATION 15

6 COMMANDS AND PROGRAMMING 18
6.1 PASSWORD ORGANISATION 18
6.2 FACTORY DEFAULT PASSWORDS 19
6.3 MENU AND COMMANDS DESCRIPTION 19

7 SERVICE AND MAINTENANCE 30

8 GUARANTEE 30

9 SERVICE MANUAL 31
9.1 INTERNAL DESCRIPTION 31

DRAWINGS

A.1 EXB300, top, front & rear assembly view
A.2 EXB300, general electric diagram (E0901)
SEXC25CON, cpu controller and display board (E0838)
SEXC25MB, lf and rf control mainboard (E0837)
SEXC25MOD FM exciter board (E0839)
ASEXC101AMP FM 100W power amplifier (E0514A)
SEXC23COD2 stereo encoder board (E0868)
ASEXB300AL power supply regulator assembly (E0913)

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EXB300

87.5 ÷ 108 MHz FM 100W TRANSMITTER

INTRODUCTION

The EXB300 series transmitters are the result of experience gained by SOFRATEC during years of producing FM broadcast equipment, transmitters, stl and stereo encoders.

These transmitters were specifically designed to comply with the latest international standards and the requirements of advanced broadcasters, meeting tighter specifications than usually required, at an affordable cost.

Great care went into producing a Hi-Fi-quality modulated signal, with low residual noise and distortion. The RF signal is also free from spurious and harmonic components to a higher degree than required by CCIR, European, USA and most other national standards.

To obtain this outstanding performance, SOFRATEC strongly recommend to rely on qualified personnel to install and verify the equipment which makes up the radio station, i.e. the transmitter, the possible stl and power amplifier, the corresponding antennas, cables and connectors. This will assure to achieve the best performance and stability in time.

To this aim, SOFRATEC especially recommend that their equipment should not be tampered with by unskilled personnel and its after-sale service is available to customers for any technical problem. Before proceeding to installation, please carefully read at least the general installation part of this manual, to gain confidence with the equipment.

The transmitters are very stable and changes to the internal pre-setting other than frequency and few other options are not usually required but, if they are, once again they must be done by skilled personnel, with proper instrumentation and service documentation. Improperly tampering with the settings may harm the apparatus or jeopardize the guaranteed performance.

THIS EQUIPMENT COMPLIES WITH ALL RELEVANT CE EMI/EMC AND SAFETY REQUIREMENTS, ETSI EN300384, ETS300447 AND EN60215 STANDARDS.

NO INTERNAL ADJUSTMENT OR PRESETTING IS REQUIRED DURING NORMAL OPERATIONS. THE APPARATUS SHALL BE PROPERLY EARTHED AND BE OPERATED WITH ALL THE COVERS CLOSED TO PREVENT ELECTRICAL HAZARDS AND COMPLY WITH EMC STANDARDS.

——— MAINS VOLTAGE MAY KILL ———

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GENERAL DESCRIPTION

The EXB300 is a 300W rated, direct-synthesis, FM-modulated transmitter. Being digitally controlled, it is extensively on field programmable by front panel or remotely in every respect: frequency, power, channel sensitivity, preemphasis, functioning mode (mono, stereo, external mpx), clock and date and many other parameters without adjusting or substituting any part. A powerful 3-levels password management permits a very high degree of security and privacy as may be required in different situations. The apparatus requires little o no maintenance and its simple modular layout facilitates stage testing and servicing.

As imposed by various national standards, these transmitters incorporate sophisticated low-pass audio filters on mono and stereo channels, and a sharp acting modulation limiter, which is usually set at a peak deviation slightly higher than 75 kHz. Its intervention may nevertheless be avoided, if required, pre-setting its threshold at a deviation higher than 150 kHz.

Output frequency is phase-locked to a temperature-compensated crystal oscillator, which ensures superior precision and stability. A very low noise, low distortion VCO produces a harmonic-free, spurious-free signal. A lock control circuit inhibits the presence of power on the output until the apparatus is on the right frequency, when turning on.

To lower the noise threshold further, the low-frequency inputs are fitted with balanced input circuitry. The input level is precisely adjustable over a broad range, by means of a 0.5dB stepwise variable attenuators. The transmitter has an auxiliary input, specifically designed for RDS and SCA encoders. A modulation output permits to control other transmitters or STL's with the same internally processed high-quality mpx signal.

The alphanumeric display permits easy and accurate metering, adjustment and continuous monitoring of modulation levels, power, operation and internal parameters. All these information may be externally available on the same RS232 I/O port that may be used to remotely control the transmitter. In addition to the serial I/O, some signals (RF power, On the air state, Disable line) are available on a parallel I/O socket for easy interfacing with others analog controllers or supervisory systems.

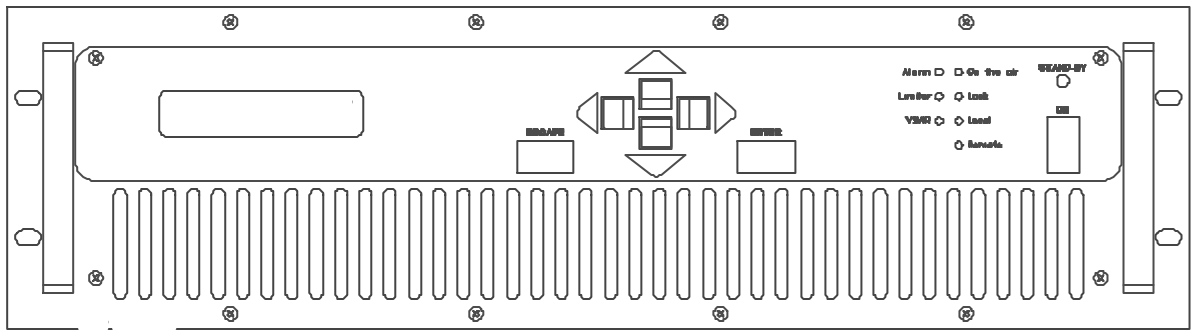
A top-quality stereo encoder may be factory installed as option and even retrofitted in the field in a second time, requiring minimum technical skill. The powerful internal software and monitoring functions recognise its presence and enable its functions.

The RF power amplifier employs a broadband design and has plenty of reserve: the output power is feedback controlled for increased stability till higher than nominal level. High reflected power is limited to prevent output stage degradation; direct power is accordingly continuously reduced so as not to exceed the reflected power safety level. A sturdy telecom-grade high efficiency switch-mode power supply permits operation in a very wide and noisy mains environment.

The temperature alarm circuitry reduce the output power in case of high internal or ambient temperature, trying to continue to stay on the air in spite of the adverse conditions.

TECHNICAL FEATURES

FRONT PANEL COMMANDS AND SIGNALLING



The EXB300 front panel is clean and easy to control. The wide alphanumeric display and the control keyboard permit a simple self-explanatory menu-driven navigation through the various options.

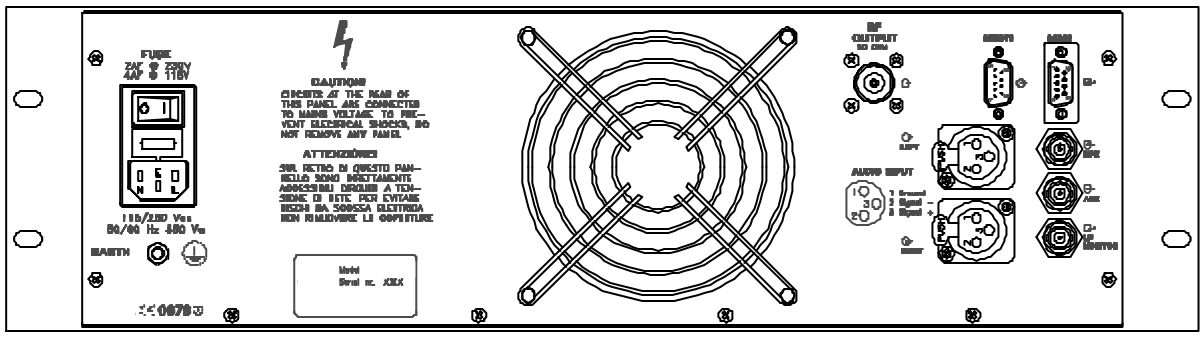
Great care was taken in the design of the software to allow natural feeling with the controls to permit operation and programming in every respect of the apparatus without needing to extensively read the user-manual.

The password management, hides some functions and prevents tampering with the most critical options and data to unauthorised people.

The on/stand-by key do not power off the apparatus, which is still locked on frequency and ready to transmit as soon the key is pushed or a remote command is sent.

Some leds signal at a glance proper functioning and warning states.

REAR PANEL CONNECTORS



All transmitter inputs and outputs are allocated on the rear panel. They are:

- The audio channels input sockets on balanced female XLR-type connectors
- The wide-band external processed / stereo or composite signal input on a grounded unbalanced BNC connector
- The frequency limited (20k÷ 100kHz) auxiliary channel input on a grounded, unbalanced BNC connector
- The lf modulation output for monitoring, RDS external synchronisation or re-broadcasting purpose, BNC-type
- The inverted wired RS232 DB9 female remote serial control port
- The parallel control port, DB9 male type
- The RF antenna connector, N-type

Note that:

- The hot centre-pin on the "EXTERNAL" BNC input is physically in parallel with the signal + input (pin 3) on the mono/right channel XLR socket. For this reason both connectors cannot be used at the same time.

On the left side of the panel it is located the mains supply IEC320-type outlet and an earth screw for system earthing in addition to the ground pin on mains socket. On the same socket it is located the mains switch and the fuses.

Please note that the transmitter is usually factory pre-set for 220-240 Vac nominal mains voltage. If requested, 110-120 Vac range must be internally set on the mains tranformer.

TECHNICAL SPECIFICATIONS

- Frequency range: 87.5÷108 MHz
- Modulation: FM, 75 kHz peak dev.
  180kF3E mono
  256kF3E stereo
- Synthesis step: 10/100 kHz

- Frequency error: <200 Hz
- Frequency drift: <250 Hz over temperature
  <100 Hz/year

- RF output power: 10 ÷ 100W
- Max allowable reflected power: 10W
- RF harmonic products: <-67 dBc, -72 dBc typ.
- RF spurious products: <-85 dBc, -95 dBc typ.
- RF output impedance: 50 ohm on N connector

- Audio/mpx input level: -3.5 ÷ +12.5 dBm
  @ ±75 kHz deviation

- Audio/mpx input impedance: 10 k ohm / 600 ohm
  bal/unbalanced, select.

- Common mode input rejection:
  >50 dB >60 typ. (20 ÷ 15000 Hz)

- Audio input connectors: female XLR type

- Aux channel input level:
  -12.5 ÷ +3.5 dBm @ ±7.5 kHz dev.
  -24 ÷ -8 dBm @ ±2 kHz dev.

- Aux channel input impedance: 10 k ohm

- Linear and aux input connectors: BNC

- Mpx output level: 0 ÷ +10 dBm @ ±75 kHz dev.

- Preemphasis time constant: 0 / 50 / 75 µs ±2%

- S/N ratio, mono:
  ≥76 dB 86 typ.(30÷20000Hz)
  ≥75 dB 81 typ.(CCIR)
- S/N ratio, stereo: ≥72 dB 77 typ. (30÷20000Hz)
  ≥68 dB 72 typ. CCIR
- Modulation distortion:
  <0.05% 0.02% typ. @ 75 kHz dev.
  <0.2% ≤0.05% typ. @ 150 kHz dev.
  (limiter threshold > 150 kHz)
- Stereo crosstalk:
  <-50 dB with external encoder
  <-60 dB (100 ÷ 5000 Hz)
  <-50 dB (30 ÷ 15000 Hz)
  with internal encoder

- Audio channel freq. response:
  30 Hz ÷ 15 kHz ±0.1dB

- Out of band filter reject.: >50 dB @ F≥19 kHz

- Deviation limiter: adjust. between 0 and > +7 dB

- Composite input freq. response:
  10 Hz ÷ 100 kHz ±0.1dB
- Aux input frequency response:
  10 ÷ 100 kHz ±0.2 dB

- I/O lines: RF disable, Direct pw, On the air, Alarm
  RS232 for monitoring and control

- Mains supply requirements:
  115 / 230 Vac ±15% 50/60 Hz
  320 VA / 220W @ 100 Wout

- Operating temperature range: 0 ÷ 35 °C recomm.
  -10 ÷ 45 °C max

- Dimensions without handles: 19" 3 un. std. rack
  483 x 132.5 x 360mm

CHECK, PROTECTION AND CONTROL SYSTEMS

Block against emission on spurious frequencies
Reflected power
Modulation limiter
High internal or external temperature
Real-time clock and date, with battery back-up

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INSTALLATION AND USE

FOREWORD TO INSTALLATION

Before proceeding further, make sure that mains voltage corresponds to the factory-set value (usually 220/240 Vac). In case it differs, a proper jumper must be internally set on the mains supply regulator board of the apparatus. This must be done by skilled technicians.

In case the voltage selection is changed to 110/120 Vac, the fuses must be substituted with others of double current capacity, compared to those for the higher voltage.

Install the transmitter in a dry, aerated and dust-free environment, so that it will operate in the +10 ÷ +35 °C temperature range.

Wire the transmitter to the antenna and audio source using suitable cables and connectors, which should be periodically inspected.

The EXB300 has many features of a hi-fi apparatus and should be installed and audio-wired with the same care, avoiding earth loops as much as possible. When these conditions are met, the transmitter performs superbly.

The transmitter is adequately shielded and could be installed close to the production studio without fear that it will affect the audio equipment. This arrangement has the advantage that the audio level, deviation and power parameters can be continually monitored. Nevertless the transmitter is usually installed away from the studio and connected with several metres of LF co-axial cables with no adverse effect on modulation quality. A remote installation, far from the studio, usually requires a STL (Studio to Transmission Link).

As the final modulation performance is dependent on the whole system arrangement, carefully consider the whole system planning. Some advice is given on the appropriate paragraph in this manual.

SYSTEM CONNECTION

1) Connect the N-type output connector, marked “RF OUT” to the antenna or successive RF amplifier with top-grade 50-ohm shielded cable.
   Note that although practically any 50-ohm specified cable has enough power management capability, its power attenuation can be too high and may excessively lower the power available to the antenna. For this reason only low-attenuation type cable must be used for direct antenna connection: in this case we suggest Celflex or similar 1/2" cable.
   In some applications, where the power is over-dimensioned or the cable length is small, RG213 cable will do. RG58 is adequate only for connection to a subsequent amplifier, little apart.

2) Connect the LF inputs as required for operation and detailed in the following chapters for various situations. If needed wire the serial and/or parallel remote control I/O ports as required, or jump this step to a subsequent moment.

3) Switch-off the mains rear switch and connect the transmitter to mains and ground system.

4) Before turning on the transmitter in the system, pre-set if possible frequency and power separately on a dummy load, to avoid system problems at the first turn-on of the equipment. If this cannot be done, check that the transmitter's maximum output power does not harm the downstream amplifier stage (if any).
If a proper dummy load is not available and the state of the apparatus (frequency and set power) is not note, it may be possible for low-power (<100W) SOFRATEC transmitters to operate for reduced time without any load, to permit setting the transmission parameters. In this case the transmitter will limit its output power to the maximum permitted with infinite VSWR, i.e. few watts. When turn-on without any load, immediately reduce output power to 1W or less, to reduce the overload to the output stage and damage risks. Then set the appropriate frequency as required. Refer to the appropriate programming section of this manual for the procedure, if not known.

5) Turn-on the rear panel mains switch, then push-on the front panel on/stand-by switch to operate the transmitter and check that:

- All leds and the display briefly light on and off for the initial check.
- The yellow "STAND-BY" led turns off, correspondingly turning on the "ON" green led on the cap of the stand-by switch.
- The green "Local" led must light immediately and the upper green “Lock” led must also light up after some seconds, when the frequency is locked.
- When locked the RF power will rapidly increase to the pre-set level in a mild ramped mode
- When the preset power is reached, the "On the air" led will light completely, if the power is set >5W. Till that moment it will turn off and on, signalling the RF power is on but not correct.

The apparatus is now functioning in the pre-set mode, delivers power and can be accessed to be programmed or simply to monitor its functions with the keyboard and the front panel display.

The first request at the turn-on will be entering the password for the required level of authorisation/ security. The apparatus is factory pre-set with the first 2 levels disabled: this will permit to set most of the operating parameters, including power, frequency, input levels, clock and date. Some more critical parameters will require the upper 3rd level: be sure to know it if you need this access.

In case the passwords are disabled as factory preset, repeatedly press "ESCAPE" key to access to keyboard functions

WARNING !

THE TRANSMITTER WILL ALWAYS TURN-ON IN THE SAME STATE AS IT WAS IN THE LAST TIME IT WAS TURNED OFF FROM MAINS, I.E. POWER, FREQUENCY AND EVEN ON OR STAND-BY CONDITION. AS SOON YOU TURN-ON THE REAR PANEL MAINS SWITCH BE PROMPT TO THAT, EVEN WHEN JUST FACTORY DELIVERED.

6) The first task to manage when turning on the apparatus as factory delivered is to set-up the passwords. At least the 3rd (the highest) level must be **immediately** changed: if any unauthorised people change it or you loose it, there is no way to change it for security reasons and the apparatus may become unmanageable. **Gaining again access to the apparatus will require factory reprogramming or changing of the internal CPU**.
   For this reason be sure to write down and keep it **immediately** in a secure place: **there is no way to read it** after you have programmed down and confirmed.
   For practically any parameters that may require some setting in the field, the 2nd level password is enough and may be used for any standard service requirement. The main purpose of the existence of the 3rd level is a security assurance for the user if he looses control on the lower password levels.

7) If not already done, adjust frequency and RF power as required and check reflected power on the transmitter display. To this aim search for RF power menu and read the corresponding value of direct and reflected output power.
   For proper operation, the reflected power reading should typically be less than 10% of the direct power value, 10sW max. Any higher reading may indicate that the antenna is not properly connected or the subsequent amplifier input needs to be tuned.

8) Check and/or set clock and data and all transmission parameters as required, i.e. channel sensitivity and deviation, mono/stereo, preemphasis etc. Refer to the appropriate section of the manual.

LF CONNECTION AND PRESETS

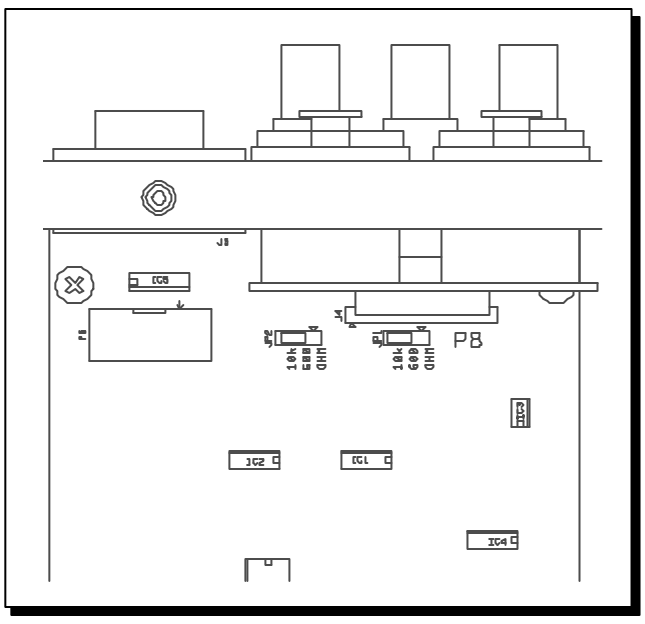
LF wiring and impedance selection

EXB300 supports balanced or unbalanced signals with selectable input impedance.

The audio inputs are basically balanced and have selectable 600/10k ohm resistive impedance, factory pre-set at 10k ohm. They can be connected to the balanced output of a professional mixer or to the unbalanced one of a cheaper unit without appreciable degradation.

Selection of the input impedance is one of the very few pre-sets that may be done only internally. For this purpose you must gain internal access by removing the upper cover. While no risk is involved, remove mains connection before doing it. As many as 14 Phillips screws must be unscrewed to remove the cover. Be sure to put them in place again when done, for EMI/EMC compliance.

Preset of input impedance is easily done by accordingly selecting the jumpers JP1 and JP2 located on the input board, shown to the right, just on the rear of the input connectors. Impedance selection is silk-screened on the component mask of the board.



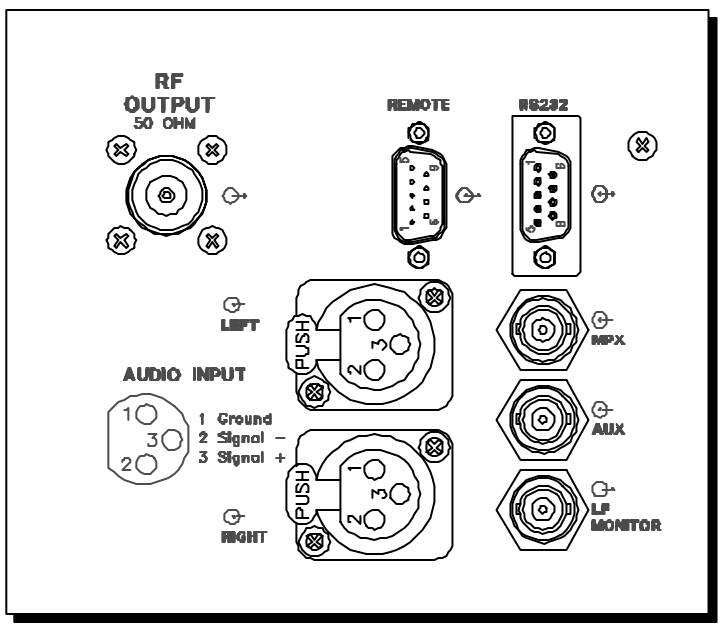
Input board with impedance jumpers

LF audio mono or stereo inputs are "XLR" female connectors. They should be connected to the output of the mixing table, or of any audio-processor that drives it, by a balanced coaxial cable connected to pin 3 (+) and pin 2 (-). The cable shield, connected to the ground of the driving equipment, has to be connected to pin 1.

In case of unbalanced drive, input pin 2 shall be short-circuited with ground and shield on pin 1, while the signal shall be available on pin 3. Higher impedance selection, in this case, will be 5 kohm instead of 10 kohm.

With balanced driving signals, the connecting cables to the audio source may be well more than 100-m long.

Mpx or an externally processed signal, usually an unbalanced signal, can be supplied to the female BNC connector, marked "MPX", which is internally parallel wired with the "RIGHT" channel connector: for this reason it is not possible to connect signals to these two connectors at the same time. Higher impedance position is 5 kohm in this case too.



LF, RF & control input / output connector ports

Connect this input with a 50-ohm (RG58) cable for a few metres' distance; if the distance exceeds several tens of metres, use 75-ohm (RG59) or 92-ohm (RG62) cables.

The auxiliary-channel connector is also of the grounded BNC female type. Use 50-ohm (RG58) or 75-ohm (RG59) cables to connect to the driver. The same applies to the monitor "MODULATION" output, if needed

Pre-emphasis setting

Low frequency mono and stereo channel signals have to be adequately "pre-emphasised". Standard preemphasis time constant is 50 and 75µs, the former being usually factory pre-set. Check whether this is correct for your country (it is usually correct for any European country and most of the Pacific and South American areas). It is not correct for USA standards, which require 75µs.

If above correction is needed, simply set it on the "mode" frame of the transmitter menu, which also includes mono/stereo operation and frequency. See appropriate section further on in this manual.

LF input level range, setting and requirements

In the following paragraph we will refer to 0 dBm as the audio signal which produce 1mW on 600 ohm, i.e. a 775 mVrms / 2200 mVpp sine. Irrespective of the impedance and the non-sinus form of the signal, we will continue to assume 0 dBm as a LF signal whose peak is + (or -) 1100 mV.

In the same way, when talking of the modulation, we will generally assume 0 dB as the signal which produces 100% maximum allowed modulation, i.e. 75 kHz deviation.

There is no absolute worldwide standard regarding LF peak level as modulation signal for a transmitter, nor for the mean deviation. Many Broadcasters use 0 or +6 dBm as LF peak level for 100% modulation, USA often uses +10 dBm.

Many European countries specify +6dBm for 40 kHz deviation (which is assumed to be a "mean" modulation). This allows for 5.5 dB headroom to 75 kHz (max) deviation, i.e. +11.5 dBm for 100% modulation.

A higher level minimise system and ambient noise. A level too high may over-stress the input circuitry of the transmitter, reducing the dynamic distortion-free range over the nominal level (headroom). It may also be costly to produce with the required quality.

For this reason SOFRATEC recommend, whenever possible, to adopt +6 ÷ +11.5 dBm as nominal peak level for audio modulation purpose.

EXB300 transmitter allows an input LF level on the main channel/s ranging -3.5 ÷ +12.5 dBm to be set for 100% modulation, with almost no difference in modulation performances, if high quality signal is provided. Even at the higher level, at least +6 dB headroom is additionally allowed: i.e. up to 150 kHz deviation, with no distortion. Obviously this deviation is not allowed by any broadcast standard and the limiter threshold in this case should be set at its maximum to permit undistorted performance.

The auxiliary channel's level ranges -12 ÷ +4 dBm to produce 10% modulation, i.e. 7.5kHz deviation. Consequently typical input levels for an SCA-type signal (10% max. admissible deviation) are 0.2 ÷ 1.0 V_{rms} / 566 ÷ 2830 mV_{pp}, when the input is set between -11.5 and +2.5 dB. All the same, an RDS-type signal could be accommodated in the 0.052 ÷ 0.33 V_{rms} / 150 ÷ 930 mV_{pp} level range, to produce the standard peak deviation of 2 kHz, as above. In case a higher deviation is required for RDS (some broadcast authorities set it to 3 or even 4 kHz deviation instead of 2kHz standard) a higher signal level or sensitivity preset is needed.

Regulating the nominal input level for 0 dB modulation on the transmitter is an easy task. From the proper menu field it may be seen varying the modulation in real-time with the level adjustment, in 0,5dB steps. The modulation is reported as deviation in kHz and in dB, referred to 75kHz.

In this field, the reported deviation includes any other auxiliary signal as pilot tone, when in stereo, and RDS or SCA signals contemporary applied. To measure only the audio channel signal, go to the Left/Right level menu

The auxiliary channel level is equally easy to set, being measured in dB and in kHz. Remember that, in this case, 0dB corresponds to 7.5kHz deviation, i.e. 10% max allowed total modulation. The typical level for RDS so being -11.5dB for 2 kHz deviation. This menu field accounts only for deviation due to auxiliary signal. To see the added effect on the total deviation, go to the MPX menu.

Due to the inherent characteristics of the RDS signal and the measuring sampling, the reading is slow to stabilise in case of sudden level variarions and tends sometimes to slightly flicker in few tenths of a dB. Allow enough time to stabilise and take the higher deviation reported as the right one.

The transmitter's internal limiter is of the peak-clipping type; this means that as soon at it cuts in, modulation distortion increases sharply. For this reason, the modulation signal should be kept under control to prevent intervention of the limiter. Do not over-estimate this problem: occasional action of the limiter is mostly unperceivable.

The cut-in limiter threshold, when enabled, is factory pre-set to +2.5 dB (100 kHz peak value). It may be set from 0 dB (75 kHz) up to +7.1 dB (170 kHz). This threshold value is mostly specified in the various national standards, and tolerance to short over-modulating peaks varies from country to country. Some countries do not permit the user to disable the limiter or change the level. Note that the limiter action begins slightly after the pre-set level, with no action at all till that. The difference between the threshold level and hard clipping is some 0.5dB.

In any case, the modulation peak value that is internationally admitted for FM is 75 kHz for peaks that are not extremely short. For this reason, the limiter's cut-in threshold should never be too high.

It is highly recommended to use an external multi-band limiter to optimise modulation, with higher tolerance for any audio-signal peaks. Such devices momentarily reduce the amplifier circuits' gain if the threshold is exceeded and prevent severe, significant distortion.

Any external compressor, limiter or audio meter must be frequency compensated with the same time constant of the pre-emphasis to modulate or monitor deviation properly.

Therefore the audio level shall be constantly and correctly monitored and adjusted to prevent, as much as possible, the internal limiter from cutting in. On the other hand, the audio level should be as high as possible, to achieve the best signal/noise ratio on reception.

The tendency to over-process audio signals is common in many local broadcasting stations: some sort of processing is advisable and we recommend using a top grade multiband compressor, but not to compress the signal too much as this impairs the original dynamics.

The audio response of the EXB300 transmitter is extremely flat, without any perceivable loss on low and high audio frequency: for this reason large frequency alterations of the audio signal supplied by using a so-called "frequency equaliser," are not advisable. An increase of the low and high frequency contents of the audio signal by more than a few dB can cause general degradation of modulation dynamics and improper functioning of the limiter.

RS232 port

The RS232 port manages only Tx, Rx and Return data signals, with no handshake. Being the two former signals inverted wired to the port, it needs a simple straight wired serial cable with appropriate connectors to connect to a PC. Usually a female DB9 or DB25 female goes to the PC port and a male DB9 connector at the transmitter end. Appropriate software is needed for communication. Do not connect the cable with either transmitter or PC on.

Parallel REMOTE port

This port accommodates some lines for simple direct control / monitor on a DB9 male connector. They are:

- Pin 1, 5, 8 *Ground*.
- Pin 2, *On The Air*: a +12V/10kΩ signals that the transmitter deliver subtantial RF power.
- Pin 3, *Direct power*: a signal proportional to direct power is present, with a pseudo square law. Range is 0-5Vdc / 1kΩ impedance. On EXB300 5V stands for 150W.
- Pin 6, *RF enable*: a shorted circuit to ground disables RF. signal level ≈ +10V/1mA.
- Pin 7, *Alarm*: logic low signal means alarm. Correct functioning is signalled by +12V/10kΩ. Maximum current sinking capability <10mA.

OPERATION

Mono Broadcasting, from a monophonic audio source through main mono channel:

1) Wire the “right” (or mono) input connector to the corresponding audio source as described in the "system connection" section. No connection to the "left" channel input is needed. The signal runs through the channel processor and is 15-kHz filtered and pre-emphasised.

2) Select the "MODE" command menu (cf. relevant section on the manual) and select "MONO R" operating mode. Confirm or change also 50 or 75µs preemphasis as required.

Mono Broadcasting, from a stereophonic audio source through the optional internal stereo-encoder:

1) Wire both the "left" and “right” input connector to the corresponding audio source as required for stereo transmission. The audio signals will run through the channel processors and will be 15-kHz filtered and pre-emphasised on both channels. The internal stereo-encoder will blend the stereo input source to transmit in mono. In this case the transmitter is already preset for stereo operation if needed, simply reversing transmission mode to "stereo".

2) Select the "MODE" command menu and select "MONO L+R" operating mode. Confirm or change also 50 or 75µs preemphasis as required.

Note that it is possible, acting on the internal stereo-encoder, to blend the left and right channel or select only one of them, without changing the modulation sensitivity. Refer to the stereo-encoder description to do that.

Mono or Stereo Broadcasting from a Radio-Link Receiver or an External Encoder:

1) In this case, the signal is already multiplexed and pre-emphasised. Use the “MPX” lf input. The signal skips the coding and filtering stage and therefore is not pre-emphasised.

2) Select the "MODE" command menu and select "EXT MPX" operating mode. While it is anyway advisable to select the proper preemphasis time-constant as required for your country, in this position this selection is not influent.

Stereo Broadcasting from a stereophonic audio source through the optional internal stereo-encoder:

1) Wire the XLR-type modulation input connectors, marked “Left” (channel) and “Right” (channel), to the output of the two channels from the mixer or stereo source. They will be internally 15-kHz

filtered and pre-emphasised

2) Select the "MODE" command menu and select "STEREO" operating mode. Confirm or change 50 or 75µs preemphasis as required.

Operation with a RDS or SCA Encoder:

1) Wire the BNC-type “Aux” connector to the output of the RDS or SCA Encoder. If the internal optional stereo-encoder is used, wire the "MODULATION" BNC output to the pilot-tone synchronisation input of the RDS encoder, if present.

2) Select the "AUX" command menu and push "ENTER" to vary the channel sensitivity. Adjust both transmitter sensitivity and/or the level of the external generator for the deviation required, as explained in the previous manual sections. Consider that 0dB modulation reading (not the input level) in this field means 10% total modulation or 7.5kHz deviation, i.e. the standard setting for a SCA auxiliary channel. In the case of RDS, a reading of -11.5dB or 2kHz is the correct value of modulation.

3) Total modulation and deviation may be read in the "MPX" display field, with the addition of any other composite signal contemporary present.

Modulation Adjustment with broadcast signal:

Check the overall modulation level for adequacy, as follows:

1) Select the display menu field "MPX": the total modulation will be displayed, both in dB and as deviation in kHz. An analog moving bar and a digital peak reading are contemporary shown.

2) Send a sufficiently constant musical signal to modulator input, check that the measure hovers around 0 dBm and moves higher during signal peak only and by no more than 1 or 2 dB. For any other reading, adjust the mixer’s “MASTER” volume until the above conditions are obtained. The red “Limiter” alarm LED should never or rarely light up, as this would indicate distortion.

If the limiter is set just above 75 kHz, the red LED will light up above 0dB and the modulation measured will never show a much greater value. Factory pre-set is 100 kHz (+2.5 dB).

Check of Pilot tone on Stereophonic Transmission:

In case of internal stereo-encoder, no allowance is externally provided to change the pilot tone level, which is internally pre-set for 9-10% of modulation, i.e. -21 ÷ -20dB or 7 ÷ 7.5kHz deviation. In case the stereo multiplex signal it is provided by a separate external stereo-encoder, it must be measured in

absence of audio modulation and any other auxiliary signal as below described:

1) Disconnect any signal from the external stereo-encoder input and any RDS or SCA signal.

2) Select the display menu field "MPX" and check the pilot tone, which must be now the only signal present. The standard level is that previously stated, i.e. 9-10% or -21 ÷ -20dB, and may be adjusted accordingly on the external stereo-encoder to suit the request.

3) Reconnect any previously disconnected signal as done.

Very low power level transmission:

EXB300 transmitter is not suggested for use at power levels less than 25W and definitely not specified at <10 Watt, as with some power and frequency combinations (usually at less than 2 Watt), some sub-harmonic and/or spurious signals may be generated and the power level stability is not so good as at higher power. In addition it may be dangerous to use a transmitter which may generate a very higher power level if improperly set.

So were low power level transmission was imperative, preset it very carefully and pre-set also the maximum output power which may be adjusted by main regulation: the software permits to adjust the max RF output level (cfr. relevant section in the manual). Carefully verify with a spectrum analiser that the transmitter is correctly functioning at and just below the operating power.

The installation of the transmitter is thereby completed. Many other monitoring and control facilities are provided by the internal display and software and are remotely accessible. Navigation through the menu driven software is suggested and encouraged to gain confidence with the options: no extensive training is needed for the most common options. Neverthless some options are hidden for security purpose and require always the password. Read the relevant section of the manual to know all possible functions which are provided and presettable.

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

WARNING !

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.

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COMMANDS AND PROGRAMMING

The transmitter permits exhaustive control of all transmission parameters and complete programmability and monitoring facilities through the various software controls via the front panel keyboard and display. The same functions are remotely addressable with proper software, which is not included as a standard option other than some simple demo programs.

For a description of remote capability see the proper section on the manual. In this section we will examine the front panel menu-driven operational capability.

PASSWORD ORGANISATION

The password organisation is set in 3 security levels, each with its own password. A higher level permits to change the lower levels authorisations and passwords.

The password is composed by 4 alphanumeric characters, including extended capital and lower case ones and several special symbols. We suggest using a wide range of characters as the security level raises, to increase the possible combinations. No password is ever shown: it is always masked by dummy characters as "...." or "****". Nevertheless it may be always changed with the higher level authorisation. Here is the purpose of each level:

Level 1: Lower security level. It is needed to access to most of the monitoring and control menu fields, not permitting to alter or programming any operating parameter. It is set to "off" state as default, permitting to anybody to navigate freely through transmitter's monitoring menu information. SOFRATEC suggests leaving it in this state if a high privacy level is not needed. If set to "on" it will show the default menu field #00 (c.r. menu tree), requiring password for any other information or pre-set. Failure to insert a correct password of any level will impede any other access to the commands for the time-out length (usually 3 minutes).
No change to the functioning mode is done in case of incorrect password input. No information is available on the display regarding the transmitter functioning.

Level 2: Service level. This password is needed for any functioning set-up as frequency and power, sensitivities, clock and date etc. Its use is reserved to service technicians who need wide access to the transmitter presets and functions.
While the default factory state is "off", SOFRATEC suggests changing the default state and password immediately at the first power on, to prevent to unauthorised people to tamper with transmitter commands, if the default word is known or the state is set to "off".

Level 3: Highest security level. It is always "on" by default and reset anyway to "on" after the display time-out, for security purpose. Its knowledge is deserved only to **very few** people and must be immediately registered after setup and kept in a secure place: **there is no way to read it** after you have setup and confirmed on the transmitter.
This password must be **immediately** changed at the first pre-set of the apparatus: if any

unauthorised people tampers with it or you loose it, there is no way to change it if you do not know the correct word for security reasons and the apparatus may become unmanageable. **Gaining again access to the apparatus will require factory reprogramming or changing the internal CPU**.
For practically any parameters that may require some setting in the field, the 2nd level password is enough and may be used for any standard service requirement. The main purpose of the existence of the 3rd level is a security assurance for the user if he looses control on the lower password levels.
Only very few critical parameters, like limiter permission or control require this password, as in some countries this functions are not allowed to be freely chosen.

FACTORY DEFAULT PASSWORDS

These are the factory default password:

Level 1: **P001**

Level 2: **P002**

Level 3: **ABCD**

For what previously said, be sure to change at least the 3rd and possibly the 2nd level as soon as you receive and turn on the apparatus.

For security purpose the 3rd level password may be factory changed from the default value before the transmitter is shipped, in consequence of a specific final customer request.

MENU AND COMMANDS DESCRIPTION

The hierarchical tree of the menu is depicted in the following table, with a small number near the left side of each field for easy reference. In the following pages we will examine each menu field and option.

All of the first column fields require the first level password authorisation to be navigated. Similarly practically all the second column fields require the second level authorisation, as some in the third column. The third level is required only by some functions in this last column.

Navigation through the menu fields is quite straightforward and natural, with the direction key. "Up" and "down" key vertically scroll the fields, while the "left" and "right" key horizzontally scroll the menu. Moving to the right may be impeded by the password permission, while returning to left is always possible.

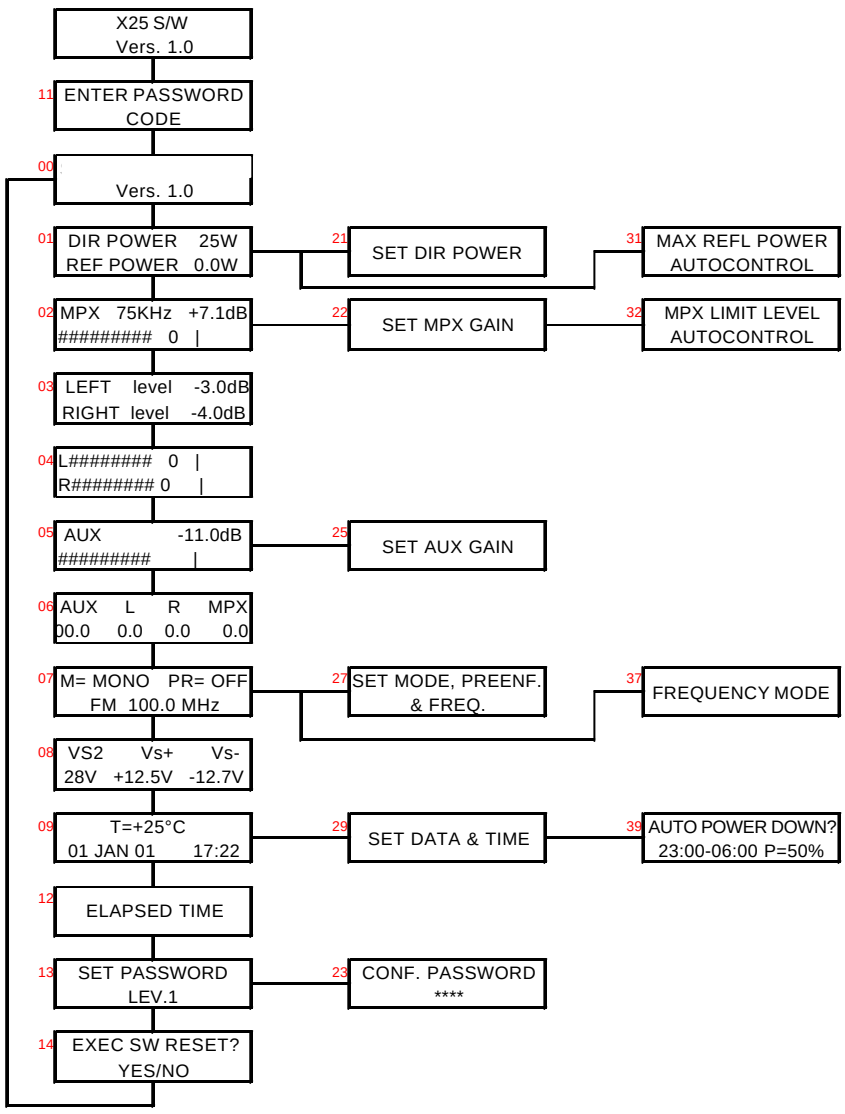
The "enter" key changes from scrolling to programming mode, if allowed in the field. Another push

on the "enter" key will confirm the input data. When in program mode, the up and down keys will change the character, while the left and right key will move the cursor on the field. Pushing on the "escape" key will abort the input while repeated escape commands will reset the menu field to the default one (#00).

A local input time-out will automatically escape the command mode resetting input data if this is not confirmed in 60 seconds after the last variation.

Few minutes of experiments will enable most users to gain confidence with control keys and menu and to be able to access all main features of the transmitter, without any previous training.

Anyway it is impossible to discover hidden functions without the proper password permission.



Hierarchical menu tree

Start menu

The start menu field is the unnumbered one on the top of the menu tree. It is shown only when the apparatus is turned on from mains or software reset. It will show the software version and the initialization step, when all the leds and the display will be turned on and off for testing purpose. Any subsequent key input will turn this menu field to the next, which requests a valid password code.

Menu #11: Initial Password

```
ENTER PASSWORD
....
```

This field requests to input a valid password code. When the input is confirmed by the "enter" key, the word will be compared with the memorised passwords table and, if recognised, the corresponding security level will be allowed. If the password is incorrect or the input is terminated by an "escape", the password will be signalised as invalid and the security level allowed will be that actually in memory, i.e. 0 (no permission at all), 1 or 2.

If the security level is pre-set to "off" for the 1st and the 2nd level as factory pre-set, there is no need to input any password to freely navigate in the menu tree and to change most parameters.

When the password is recognised as valid and the corresponding level is displayed, press on escape key will turn on the default menu field #00.

Menu #00: Default Message

```
SOFRATEC - NICE -FRANCE
 X25 SW  rev. 1.0
```

This field shows the default message and the software release. It is the field that will be initially set or to which it will return back after repeated escape commands.

If authorised by the 3rd level permission, going in the command mode pushing "enter", will permit to edit the first row of this field with a custom 20 characters long message e.g. the following organisation name:

```
NORTH-WEST RADIO
X25 SW  rev. 1.0
```

Menu #01: Direct & Reflected Power

```
Dir   Power:    25.0  W
Refl  Power:     0.0  W
```

This field shows the direct and reflected power actually delivered.

Going in the command mode, with the 2nd level password authorisation, will permit to set a new direct RF output power. See menu #21.

Menu #02: Multiplex Signal Level (Output Modulation)

```
MPX   75.0kHz  +  0.0dB
#############  0|
```

This field shows the actual peak modulation in dB referred to 75kHz and as deviation in kHz. A pseudo-analog moving bar will contemporary change according with the modulation, leaving a peak mark at its end for 1 or 2 seconds. A vertical bar (|) on this line marks the 0dB position.

Command mode, with the 2nd level password authorization, permits to set LF input channel sensitivity. See menu #22.

Right key instead permits to access to limiter setup and threshold. See menu #32.

Menu #03: Left & Right Signal Level in dB

```
  LEFT  level  -  3.0dB
 RIGHT  level  -  4.5dB
```

This field shows the actual left and right peak modulation in dB referred to 75kHz.

The reading is adequately accurate with real audio signals. Some steady state test tone especially at very low audio frequency may beat with the discrete ADC conversion sometimes producing reading uncertainty (*aliasing*). In this case the MPX level reading will anyway produce correct overall modulation measure.

Menu #04: Left & Right Signal Level as analog moving bar

```
L##########  0    |
R#########   0    |
```

This field shows the actual left and right peak modulation as two moving bars. A vertical line marks 0dB position and the same considerations as in the previous menu are still valid.

Menu #05: Auxiliary Signal Level Modulation (SCA, RDS)

```
AUX   2.0kHz   -11.2dB
#########0        |
```

This field shows the actual modulation due to an auxiliary SCA or RDS signal in dB referred to 7.5kHz or 10% of max peak modulation. Usual level for SCA signal is 0dB (7.5kHz) while standard RDS modulation needs to be set at -11.5dB (2kHz).

Command mode, with the 2nd level password authorization, permits to set auxiliary input channel sensitivity. See menu #25.

Menu #06: Aux, Left, Right and Mpx level in dB

```
 AUX     L     R    MPX
-11.2  -3.0  -4.5  +0.0
```

This field contemporary summarise the actual modulation in dB due auxiliary, left, right and multiplex signal as seen in their own menu fields.

Menu #07: Transmission Modes and Frequency

```
STEREO        PR=50us
  FM   102.43 MHz
```

This field shows the transmission mode, i.e. "EXT MPX", "MONO R", "STEREO", "MONO L+R", t he latter 2 modes allowed and automatically recognised only if the optional stereo-encoder board is internally present. It also displays the preemphasis time constant and the transmission frequency.

Entering in command mode, with the 2nd level password authorisation, permits to set every of this transmission parameters. See menu #27.

Pushing "right" key will allow access to change the frequency step between 10 and 100kHz. See menu #37.

Menu #08: Internal Voltages

```
 Vs2     Vs+     Vs-
+27.7V  +12.4V  -13.2V
```

This field shows the internal regulated voltages. In the EXB300 Vs2 is comprised between +18 and +28V, depending on output power. Vs+ is +12.5 ±0.3V, Vs- is -13.0V (+1/-3V). A marked difference from these values, may indicate mis-fuctioning or very low mains voltage.

Menu #09: Temperature, Data and Clock

```
T(A/H):  +30°C   +36°C
01 JAN 02    17:22:10
```

This field shows the internal temperature, the actual data and clock. To set data and clock it is required to go in command mode, with the 2nd level password authorisation. See menu #29.

Two temperature sensors read the ambient (A) and the output stage heatsink (H) temperature. The ambient temperature is really that of the exhaust ventilation air and it is taken just behind the front panel. It is always 7 - 12 °C higher than the external temperature at full output power: i.e. nearly +55 °C assuming an external temperature of +45 °C (the maximum allowed).

The heatsink temperature is usually 5-10°C higher than the ambient, at maximum power.

Being the maximum allowed temperature limit +45°C, the transmitter progressively reduces its output power when the ambient temperature is reported higher than 57°C or the heathsink is higher than 70°C. There is 5°C overtemperature range in which the equipment is allowed to work at reduced performance. In addition, the equipment may reliably work in an ambient which is even 10°C higher than the maximum nominal range, at less than maximum output power or for reduced lengths of time.

Take present that the higher the ambient tamperature, the lower the MTBF. As rule of thumb the life is halved each 10 °C the temperature is increased. Assuming 10 years operating life at +25°C, which is not unrealistic, it may become 2.5 years at +45°C.

Menu #12: Elapsed Time

```
ELAPSED TIME
000356 HOURS
```

This field shows the elapsed time whether the transmitter is on the air or in stand-by with the mains applied. There is no way to change the reading.

Menu #13: Password Management

```
  PASSWORD  LEVEL X
code=****  status=OFF
```

This field shows the password status and permits to change the code and/or the status in command mode, when in possession of the necessary level authorisation for that level or a higher one. No code is ever shown and no access is permitted to a level higher than the current authorisation.

If the password is unknown, lost or tamperers changed it, it is possible to change status and code when in possession of the higher password. In this case the lower level password code must be changed and confirmed: no possibility still being to know what was the old password. This means that it is always possible to change the 1st or 2nd level password, even if they are unknown, if respectively the 2nd or 3rd level password are correctly set.

If the code or the status is changed, it is always required to confirm the correct password for that level.

In case a lower password permission is actually set in regard to the needed action, it is possible to input the higher level password either performing a software reset, if permitted, or turning off and on the mains voltage through the rear mains switch or an external switch.

The 3rd level authorisation, when set, will stay valid only till a display time-out is performed, i.e. usually 3 minutes after the last command. Simply navigating through the menu or performing some action will prolong the time-out.

If the password status is set to on for the level 1, a hung-up follows after the time-out. This is intentional to prevent unauthorised people from browsing the transmitter parameter. Transmitter performance will be unaffected by this condition. Any attempt to access the transmitter will cause the password request: if an invalid password is entered, it needs to wait for the time-out to permit a new attempt or to remove the mains power to the apparatus, causing a hardware reset. Even in this case, the first request will be a valid password input.

Menu #14: Software Reset

```
EXEC  SOFTWARE  RESET?
          NO
```

This field permits to execute a software reset if in possession at least of level 1 password authorisation. The main purpose of this reset is permitting to input a new password level; its action is similar to turning off and on the mains to the apparatus. A software reset will lead to a small interruption of the RF output power which will be re-established in 1-2 seconds, while lock on frequency will not be lost. No transmission or sensitivity parameter is lost in consequence of software or hardware reset.

To execute a software reset the "ENTER" key must be pressed twice

Menu #21: Output Power Set

```
Dir   Power:    25.0 W
Refl  Power:     0.0 W
```

This field derives from #01, in command mode. The direct power value blinks and acting on up and down keys the numeric value varies. The output power will vary in real time. Confirming the final value with an "enter" will write the new setting in the non-volatile memory of the apparatus. Escaping will abort the change. A local time-out will automatically escape the input if not confirmed in 30s from the last change.

Menu #22: Multiplex, Left & Right Input Level Set

```
MPX  75.0kHz  +  0.0dB
Nom.input  =  +  6.0dBm
```

This field in command mode, with the 2nd level password authorisation, permits to set LF input channels sensitivity, i.e. multiplex, left and right channel. Take present that the multiplex and the right signals share the same channel and the sensitivity is set to the same value for both right (or multiplex) and left channel, with a differential error <0.2dB at any level. Allowed range is -3.5 ÷ +12.5 dBm.

The first line of the display shows the actual modulation, while the bottom line shows the input level for 100% modulation. Increasing the nominal input level will accordingly decrease the modulation.

Menu #23: Password Confirmation

```
   CONFIRM  PASSWORD
         ....
```

This field is displayed when password code or mode is changed on menu #13. It requires to input the same password code as in the current level which is to be changed. Failure to do so will show the following message:

```
  INVALID  PASSWORD!
         ....
```

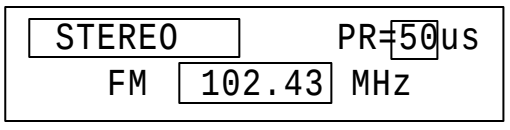
This display stops input mode for 5 second and than permits to exit (and possibly to try again) with the escape key.

Menu #25: Auxiliary channel Input Level Set

```
 AUX           -41.0dB
Nom.input  =  +  0.0dBm
```

This field in command mode, with the 2nd level password authorisation, permits to set the auxiliary channels input sensitivity. Allowed range is -12 ÷ +4 dBm to produce 10% modulation, i.e. 7.5kHz deviation or 0dB in the upper line of the display.

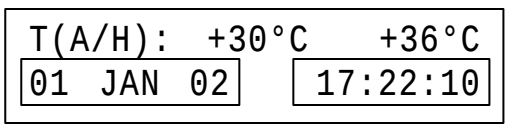
Menu #27: Mode, Preemphasis and Frequency Set



In this field it is possible to set the transmission "modes" (MONO R, STEREO, MONO L+R, EXT MPX), the preemphasis time-constant (0, 25, 50 & 75 µs) and the frequency in step of 10 or 100kHz as pre-set on the menu #37. The access to this last menu is performed directly from the main frequency menu #07, pressing the "right" key.

Left and right keys change the input fields whilst the up and down keys change the various options or increase/decrease the frequency.

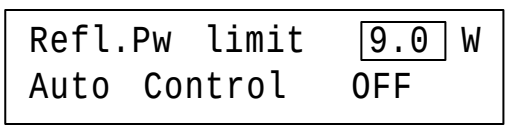
Menu #29: Data and Time Set



This field is the command mode display of menu #09, with the 2nd level password authorisation and permits to set data and time.

As in the last menu, the left and right keys change the input fields while the up and down keys increase/ decrease the date and time.

Menu #31: Maximum Reflected Power Set



This field permits to set the maximum reflected power level. Default value is 10W and in any case this power is hardware limited to 12 or 15W for security reason.

Auto Control on the lower line is not operative and could be absent in other software releases.

Menu #32: Limiter Set

```
MPX   limit   + 7.1dB
Auto  Control   OFF
```

This field, with the 2nd level authorisation, permits to set the limiter action. The right/left keys toggle limiter on and off. The up/down keys vary the threshold level.

Auto Control on the lower line is not operative in some software releases. When it is, it will dynamically reduce the input sensitivity to allow distorsionless limiting if pre-set to ON. Even in this case it will be wise not to exceed the limiter threshold to avoid "pumping" effect on the modulation.

Menu #37: Frequency mode

```
   FREQUENCY   MODE
  100kHz / STEP
```

This field, with the 3rd level authorisation, permits to set the frequency step variation between 100 and 10kHz.

Menu #39: Power-down setup

```
 AUTO  POWER-DOWN  OFF
 23:00--06:00  P=50%
```

This field, with the 2nd level authorisation, permits to preset the "power-down" mode.

If this mode is on, the output power will be automatically decreased to the pre-set percentage in the time period set on the bottom line. The scaled power is approximate and must be tested and/or adjusted before final setup, if critical.

SERVICE AND MAINTENANCE

Since the EXB300 is forced-air cooled by an internal low-pressure fan, it is subjected to clogging by dust.

It is therefore recommended to install the apparatus in rooms that are not excessively dusty and sheltered from dust. Place apparatus above floor level on a stable stand/rack, in such a way to permit good ventilation. Depending on the environment it is suggested to internally clean the equipment with a soft brush or compressed air at fixed time intervals, from 6 to 12 months.

Other than this, 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.

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 re-calibration can be done when needed.

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

Never change the internal calibrations to avoid altering the transmitter declared performances.

GUARANTEE

Like all SOFRATEC's solid state equipment, the EXB300 carries a one-year guarantee on all their components with the exclusion of the final RF power transistor, 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 or excessive moisture in the environment.

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.

SOFRATEC BROADCAST EQUIPMENT
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SERVICE MANUAL

INTERNAL DESCRIPTION

The EXB300 transmitter comprise 5 or 6 internal modules, as can be seen in the drawing “General view” and in the "General wiring diagram", both comprised in this manual:

-The LF and RF control main-board
-The CPU controller and display board
-The stereo-encoder module (optional)
-The FM synthesiser module
-The RF power amplifier
-The regulated power supply

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.

WARNING !

THIS SECTION IS ONLY AIMED TO GENERAL EXPLANATION, REFERENCE AND 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. COMPONENT VALUES SHOWN MAY VARY FOR PRODUCTION REQUIREMENTS.

DUE TO THE TECHNOLOGY USED, MOST MODULES AND ESPECIALLY THOSE IN SMT ARE NOT INTENDED TO BE REPAIRED IN CASE OF FAILURE AND MUST BE REPLACED WITH NEW ONES.

THE LF AND RF CONTROL AND PROCESS MAIN-BOARD

This is the most complex board in the transmitter and supports the LF input processing, with level adjustment, audio-pass filtering and limiting. It also carries the RF control section and the I/O interfaces and interconnects the various transmitter modules with flat-cables.

Its electrical diagram is splitted in two sheets for clarity purpose: they will be examined in sequence.

In the first diagram sheet are allocated the I/O interfaces, both the audio and the digital ports and the analog RF control. Let's start to briefly consider each block diagram.

In the upper left side of the diagram are located the audio channels amplifier/buffers made with 6 op-amp sections of IC1 and IC2. Two impedance selector jumpers for the audio channels leads the pack and a protection network made by resistors and diodes protects the inputs from occasional static discharges, as required for **CE** compliance. Four unity-gain active buffers follow and than two balanced to unbalanced signal converters, which drive the electronic attenuator in the 2nd sheet.

The last op-amp in IC2 (d), amplify the auxiliary channel input with a -0.1dB upper corner band >>200 kHz and drives the third channel of the electronic attenuator.

On the lower left of the diagram are the RS232 interface (IC5) and the parallel remote I/O active interface with its protection network, built around TR1, TR2 and TR3. A wired or pull-up makes the logic levels <1V as 0 and 10-12V for 1.

On the lower right section of the diagram it is located the RF power controller.

The RF direct and reflected power signals coming from the output directional coupler are amplified by IC3 in two symmetrical circuits.

The direct-power control circuit, built around IC4a continuously drives the RF output stage gain, varying the supply voltage to the RF driver transistor and the regulated voltage of the output transistor. The reflected-power limiting circuit IC4b only acts on the same loop when the IC3b output voltage is greater than the threshold set by the voltage on the R49/R50 network. A third and fourth section of IC4 filter and buffer the signal coming from the CPU and set the reference level for the output power loop. TR4 disable the RF output when the synthesiser is not locked on the correct frequency.

In the upper right section of the sheet it is shown the control bus connector to the CPU, which carries the digital control lines on the lower pins and the analog lines on the upper ones. From this connector comes the power supply too: only +12.5V and -12.5V are used in the board.

Let's now go to the second sheet of this diagram.

Beginning from the upper left side, we find IC8, which makes a 3-channel digitally controlled attenuator. It separately manages left, right and auxiliary channel, while the external multiplex signal is

processed in the same channel as the right one. 3 buffers/amplifier follow each channel: IC7a, IC8a and IC12a. The output of the first two amplifiers drive the pre-emphasis stages, whose time constants can be digitally set at 0, 50 and 75µs, through the analog gates of IC9. A limiter stage follows, built around D8 and D9 diodes acting as clippers. By varying the limiter's reference voltage driven by the CPU though IC13a, the limiter threshold level +Vl & -Vl can be adjusted. RT4, if present, impose a ceiling to the limiter.

The signal is then sent to the stereo-encoder circuit's input sections if present. Contemporary the signal the signal on the mono right channel path is sent to a low-pass filter, consisting of the section built around IC10 and IC11, which attenuates the frequencies above 15 kHz, for operation in mono.

The switch IC14 selects the signal issuing from the non-pre-emphasised input section through R124 or from the pre-emphasis-and-filter section through R128 or from the stereo-encoder through R131. IC12b buffers the chosen signal and mix it with that issuing from the auxiliary channel. When required the diode D17 further limits the resulting total signal. The latter is then sent to the FM modulating/exciting circuit via IC12c buffer circuit and adjusted in level by RT6 as required. A separate section of IC12 separately buffers the modulation signal for monitoring purpose, and sends it to the modulation output connector.

IC15 deserialise the digital signal sent by the CPU to control the transmission channels with IC14 and preemphasis action with IC9. Two output lines from IC15 are used to latch the remote output lines "Failure" and "On the air".

THE STEREO-ENCODER MODULE

The encoding circuit uses an 8-step switching technique, which ensures excellent performance with a relatively simple circuit. In addition, by this technique, the first harmonics that are associated with the resulting stereo multiplex signal are the 7th and 9th (266 and 342 kHz); this simplifies the design of the low-pass filter on this signal.

The audio signal is filtered beyond 15 kHz by the two precision active low-pass filters built around IC1 ÷ IC4. It is then buffered by IC3d and IC4c and applied to the encoding circuit comprised in IC8. Another higher frequency low-pass filter follows to remove higher order harmonic products. This filter too is made with highly precise active circuitry built around IC5 and IC6a, b. The latter section (c) of IC6 performs phase equalisation. The four analog switches comprised in IC7 permits to select the mono or the stereo-encoded signal and to slightly vary the encoder gain to adjust for the 90% audio modulation in stereo vs. 100% in mono. Two jumpers on BD1 permit to select either Left or Right or Left+Right channel for mono operation, with no output level change. As factory configured, both jumpers are installed, to mix Left and Right channel for "MONO L+R" operation.

Circuits IC10, IC11 make the encoder's time base; IC9 synthesizes the 19kHz pilot frequency, which is filtered and buffered by IC5a. A separate 1Vpp output is provided on J2 to drive carrier synchronisation on a possible external RDS generator.

THE SYNTHESISED OSCILLATOR

It's a classical phase-locked-loop circuit with 10-kHz step synthesis across the entire FM band.

The very low-noise, fundamental-frequency VCO consists of a FET-oscillator transistor TR5, modulated by the varactor diode set D4÷D7, which also sets the operating frequency. The circuit is sensitivity compensated vs. carrier frequency variation so that its modulation gain varies less then 0.5 dB across the entire operating range.

Modulation distortion is typically lower than 0.03% with over 90 dB S/N ratio in the mono mode in the 30 - 20,000 Hz band.

The RF signal is buffered and amplified by three successive transistors TR6 ÷ TR8, from which is derived the feedback signal to the PLL and the drive signal for the output RF stage. This latter is composed by two small mosfet transistors TR9 and TR10 and attains some 900 mW output level (+29 dBm) over the full FM range. To correctly operate TR9 and TR10 require a gate bias voltage, which is factory pre-set by RT1.

The digital PLL circuit is entirely comprised in IC2, whose frequency reference is derived by a highly precise temperature compensated oscillator (TCXO1) running at 12.8MHz.

To correctly operate on the chosen frequency, IC2 must be serially programmed with complex data. This task is done by the transmitter CPU through 3 control lines.

IC1 either performs loop filtering from IC2 frequency comparator output to the varactor diodes and lock detection. Note that bias voltage is removed from output transistors through TR4 and TR3 to turn-off RF when the PLL is not locked on the right frequency. The control loop was designed to ensure that cross-talk added to stereo-composite signal is below -55 dB at 30 Hz, and is virtually not influent at just slightly higher frequencies.

THE RF POWER AMPLIFIER

This stage is designed with two sequential RF power transistors.

A resistive input attenuator (R1, R2, R3) enhances matching with the preceding stage and contributes to insulate the two stages.

After that, two RF broad-band amplifier stage and a filter which attenuates the harmonics to a value lower than -70 dBc, follows.

A directional coupler on the output generates a dc signal, which is proportional to the direct and reflected RF power.

The driver-stage supply voltage is varied by the power management circuit, in a closed loop driven by the output sense circuitry. This will accordingly vary the output power to obtain the preset value and cope with alarm and start-up conditions. To achieve an higher efficiency at reduced output power, even the output transistor power supply is varied by the gain control in a limited range (18 - 28V).

The output transistor is a rugged device which could easily pass the nominal output power. Nevertheless SOFRATEC suggest never to exceed 100 ÷ 110W output power, even when the transmitter could generate more than this.

THE CPU CONTROLLER AND DISPLAY

This circuit board is basically simple. It contains the CPU, the keyboard and few other circuits which we will briefly discuss.

The CPU has 3 digital 8-bit ports and an analog one. This latter is the interface with the analog signals that must be measured in the transmitter. A fast peak rectifier built around IC4 drives one of these analog lines. All audio or lf modulation plus some steady state signals are multiplexed to its input by IC3, so requiring only one peak rectifier and increasing the number of the analog channels. One analog channel reads the internal temperature through the TR3 sensor.

The simple specialised IC6 performs clock and date functions as a stand-alone unit, backed-up by a battery which keeps circuit active for a long time when the power is removed.

The keyboard switch array is sequentially scanned one hundred times in a second to determine if a key was pushed. IC5, a serial to parallel converter, drives the front-panel leds and the display backlighting with TR2.

The alphanumeric display is a separate module, connected to the board by a small flat-cable. 11 digital lines from the CPU drive this module. The internal board trimmer RT1 regulate the LCD contrast and may be used to change it for different situations. A separate power supply current for the backlight leds is provided by R41 and R42: these resistors become quite hot when the display is full on and their heat someway influence the internal temperature read by TR3.

No other regulation is provided on the board. The precision of the measurements is guaranteed by design by the precision of the components and the reference voltage source IC1.

THE POWER SUPPLY REGULATOR

The power supply regulator is a high-efficiency, low-voltage switch-mode type.

The external mains transformer galvanically insulates the 220/230 Vac mains, delivering some 33 Vac to the power supply rectifier. The transformer's primary winding is equipped with a 110/120 Vac tap, with internal setting.

The DB1 diode bridge and C7 ÷ C9 power capacitors rectify and filter the input voltage to a value between 33 and 50 Vdc, in operating conditions in the allowed mains range.

The power switch-mode regulator is buit around IC1, which controls the conduction duty-cycle of its internal series-pass power MOSFET to obtain a variable 18 - 28.0Vdc regulated voltage. The actual output voltage is controlled by the ALC input. The oscillation frequency is fixed, nearly 200 kHz.

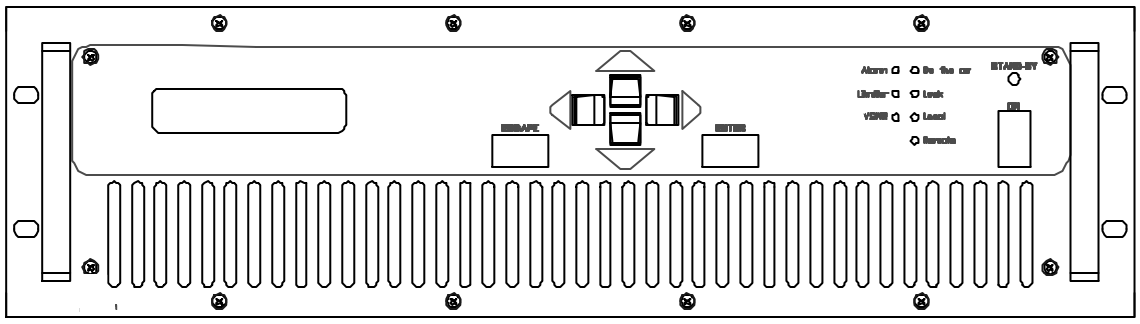
L1 and C23-C26 forms the main integration cell, which averages the pulsed voltage on IC1 output. A second filtering cell, L2 / C27 further removes high frequency noise contents from the main regulated output.

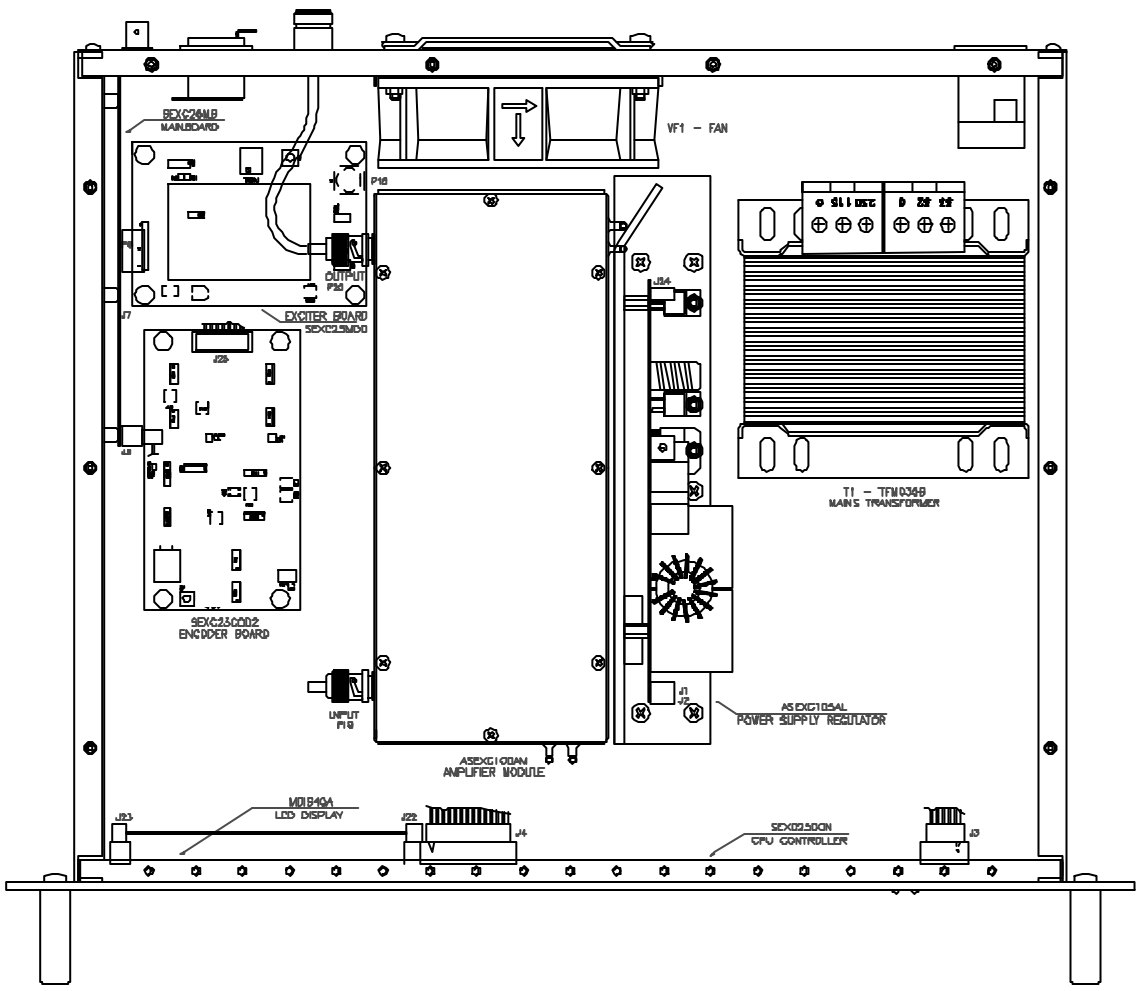
A lower power switch-mode IC regulator derives the auxiliary regulated +12.5V voltage (±0.5V/ 0.5A, average) and a losely regulated -12.5 ±1V

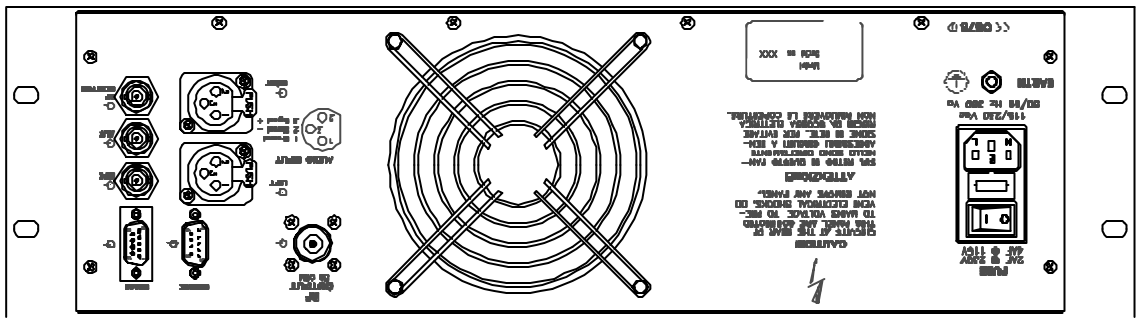
The efficiency of the whole circuitry is very high and manages a substantial amount of power versus mains voltage changes, dissipating little energy, so keeping overall temperature low with no extensive heatsinking, required by linear regulators.

Two separate sections, driven by the ALC input voltage either interface the RF driver transistor supply, by IC3b / TR2 / TR3 and the dc ventilation fan, by IC3c and TR4.

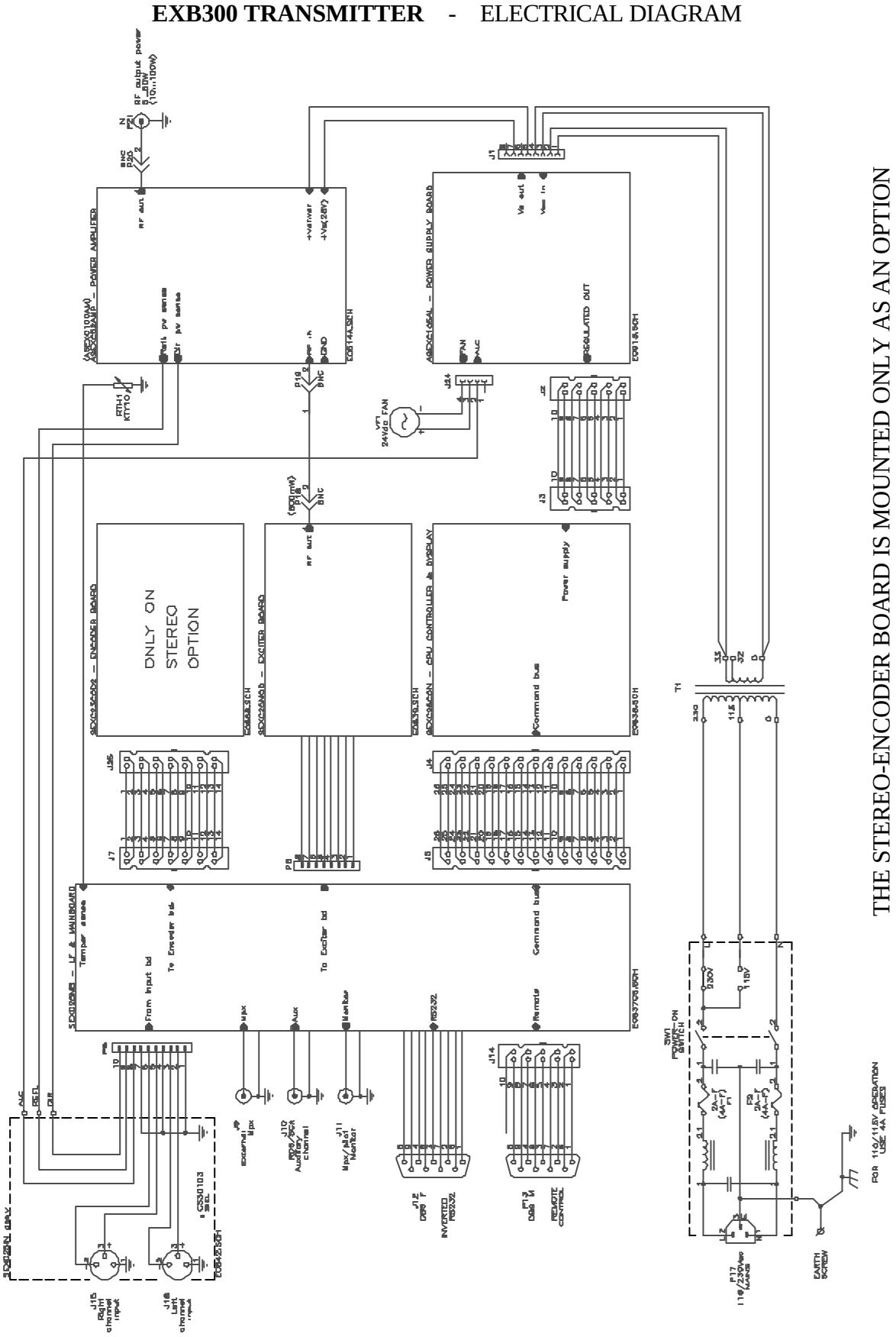
EXB300 TRANSMITTER - TOP, FRONT & REAR ASSEMBLY VIEW



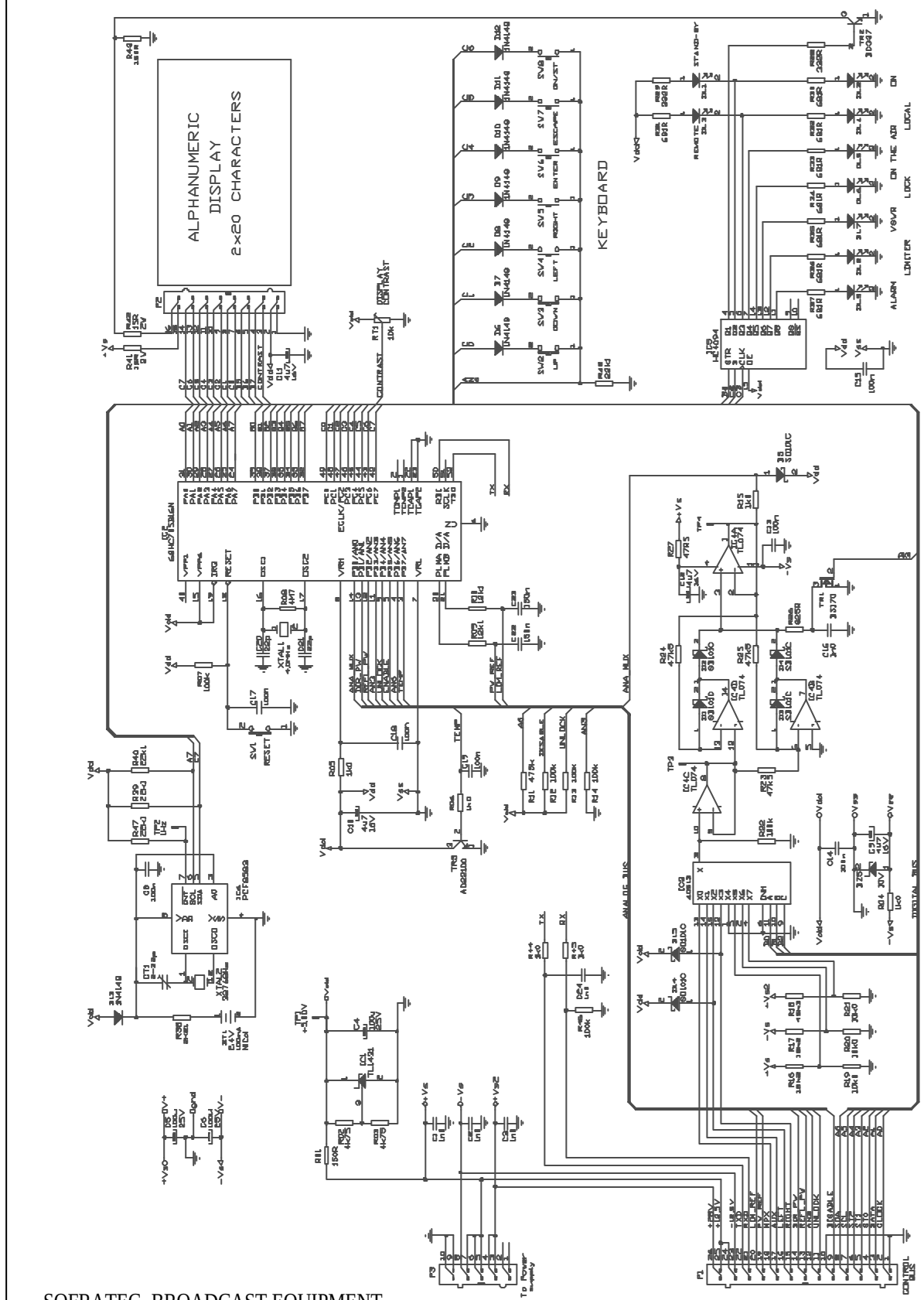




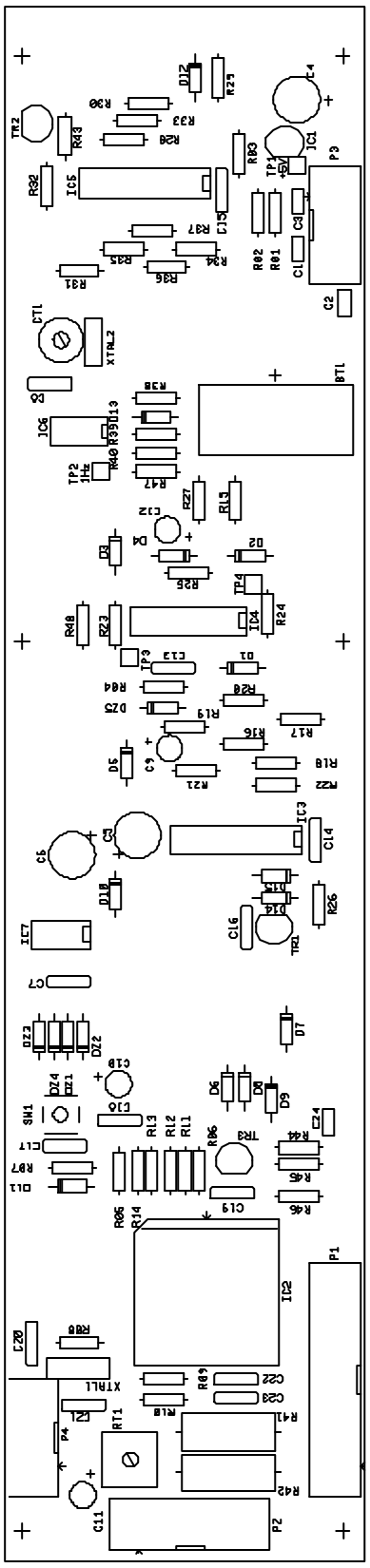
EXB300 TRANSMITTER - ELECTRICAL DIAGRAM



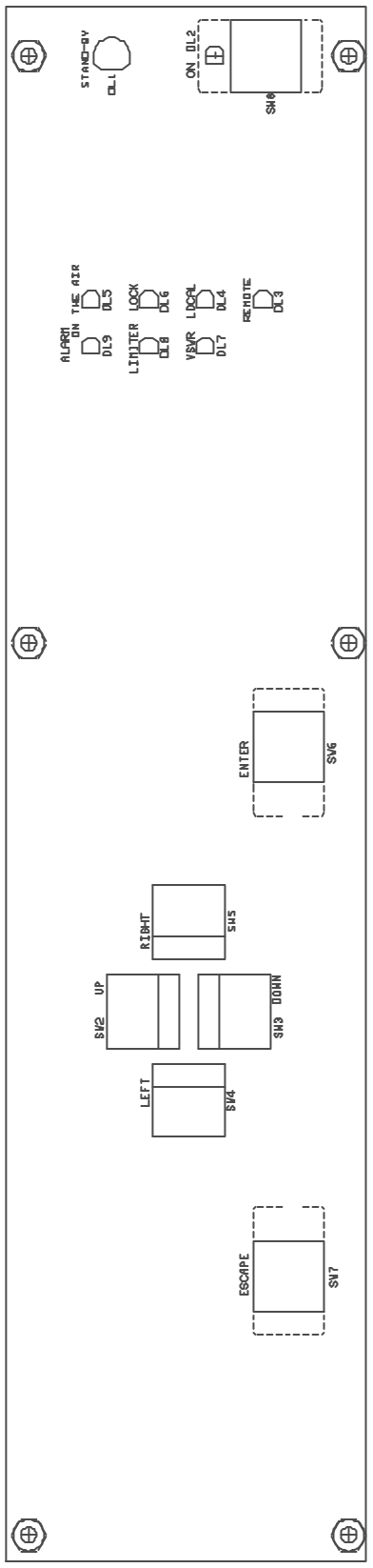
SEXC25CON - CPU CONTROLLER & DISPLAY BOARD
ELECTRICAL DIAGRAM



SEXC25CON - CPU CONTROLLER & DISPLAY BOARD
COMPONENTS LAYOUT

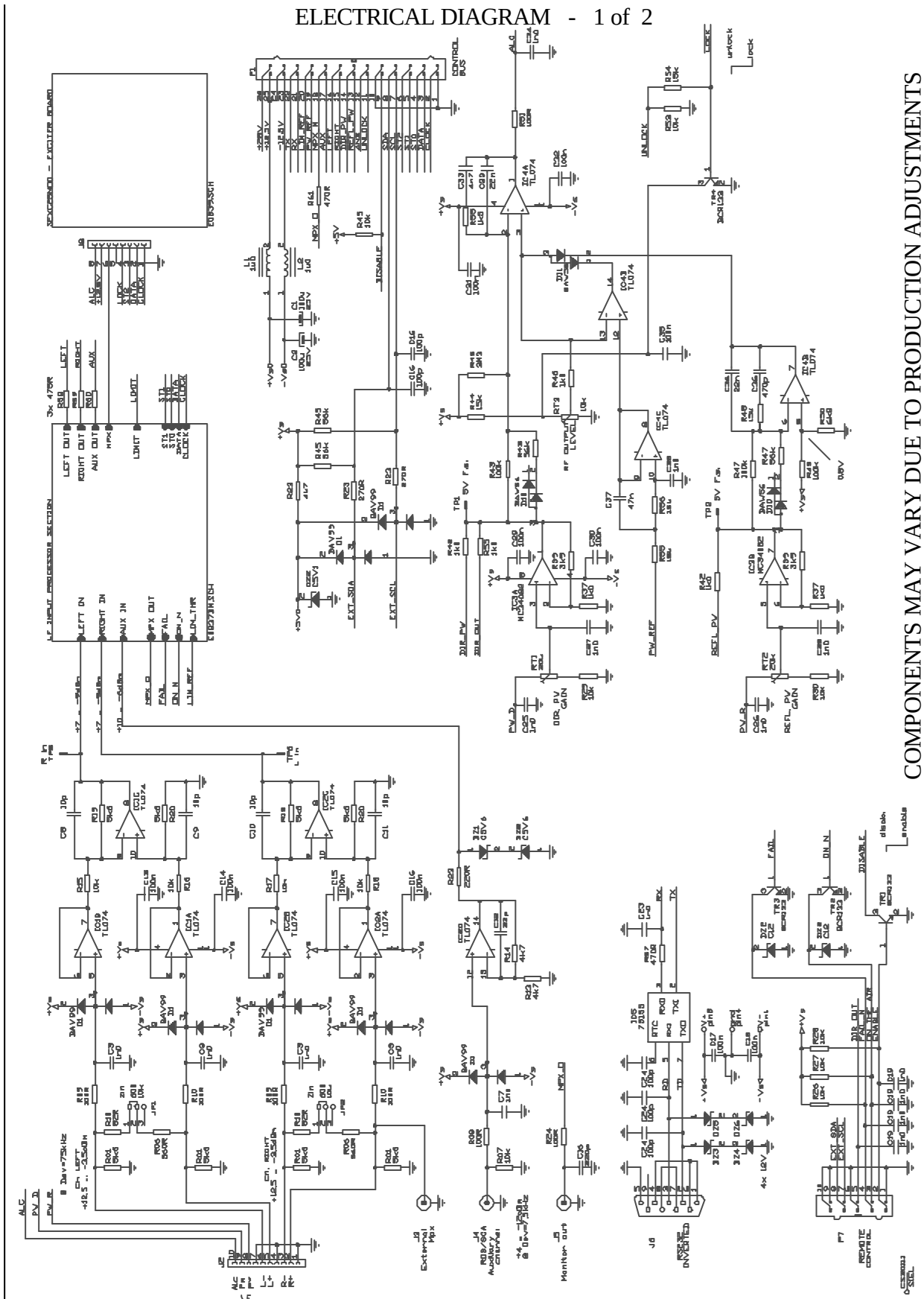


COMPONENT SIDE



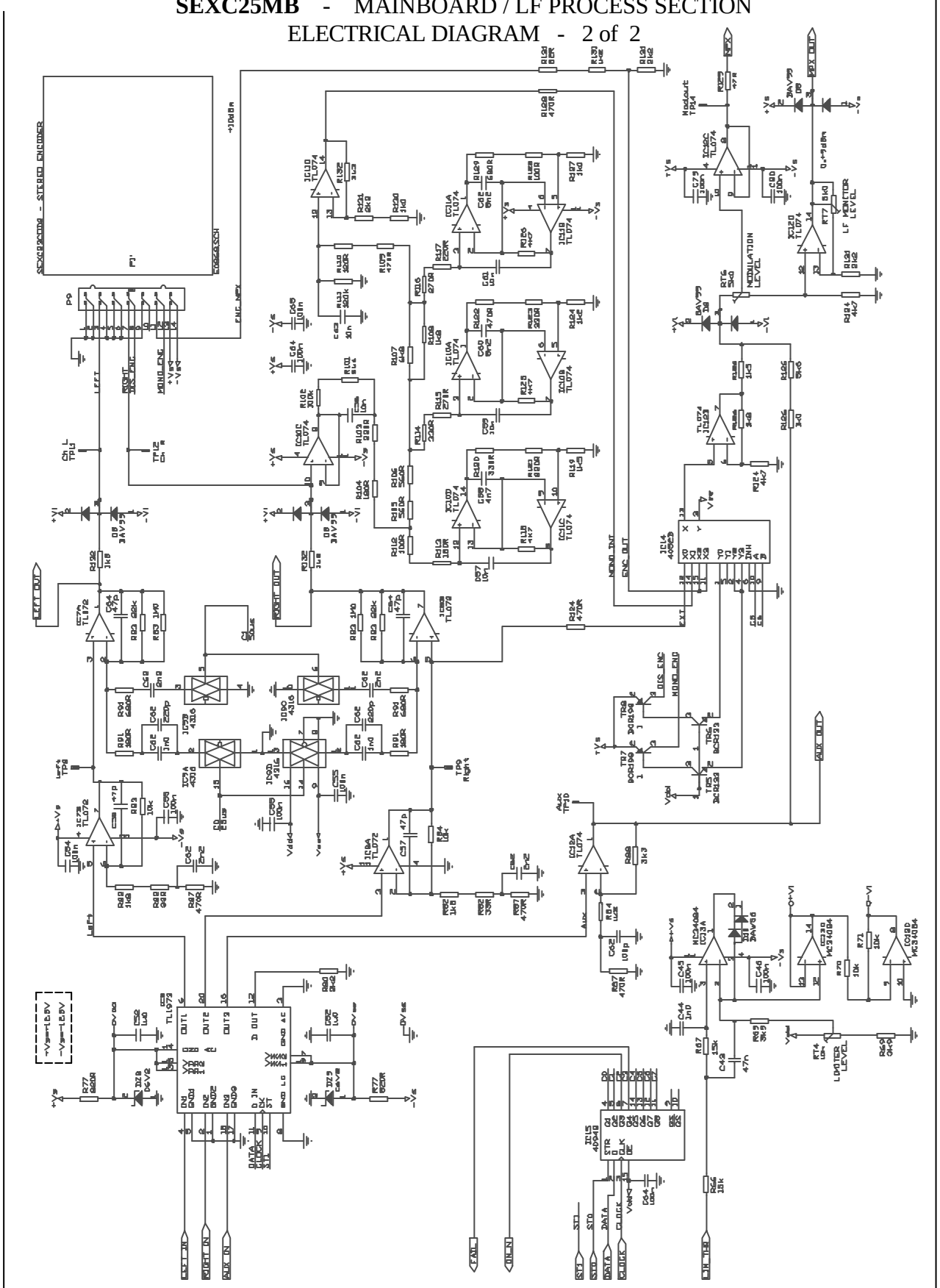
SOLDER SIDE

SEXC25MB - MAINBOARD / I/O & RF CONTROL SECTION
ELECTRICAL DIAGRAM - 1 of 2

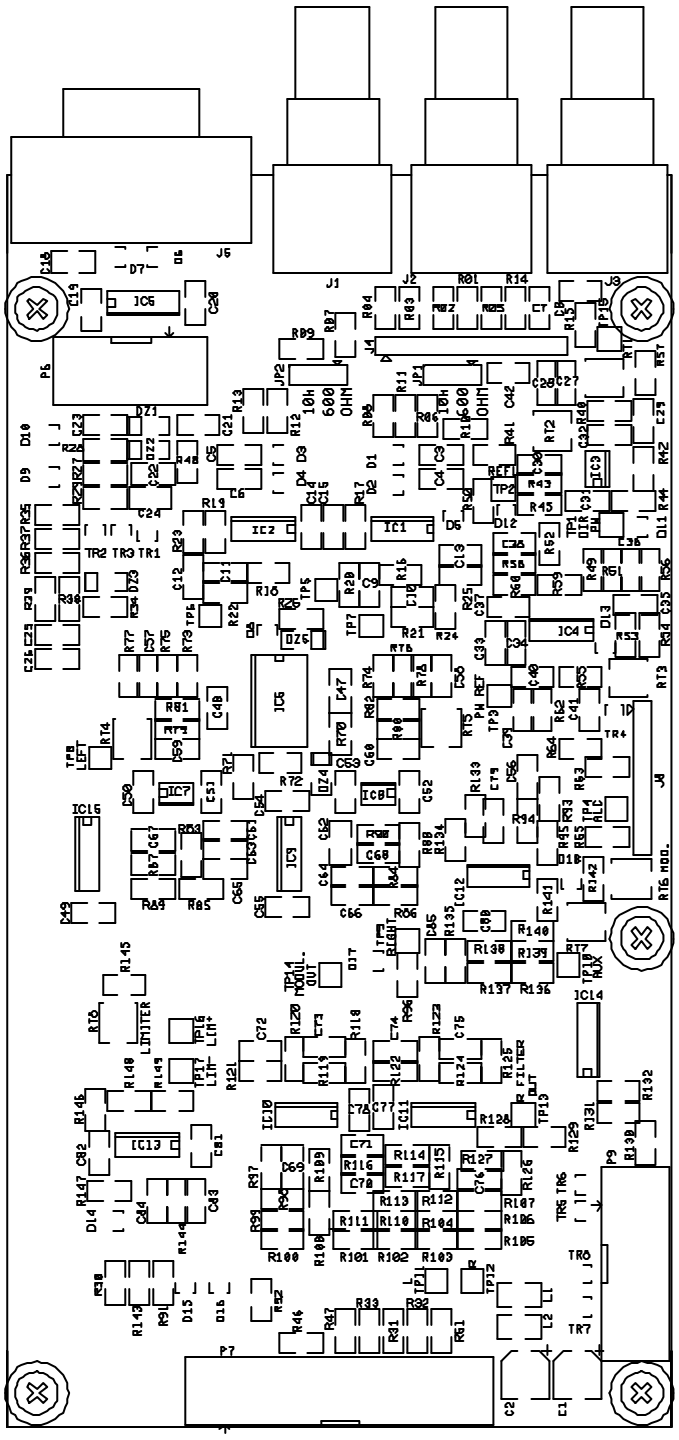


COMPONENTS MAY VARY DUE TO PRODUCTION ADJUSTMENTS

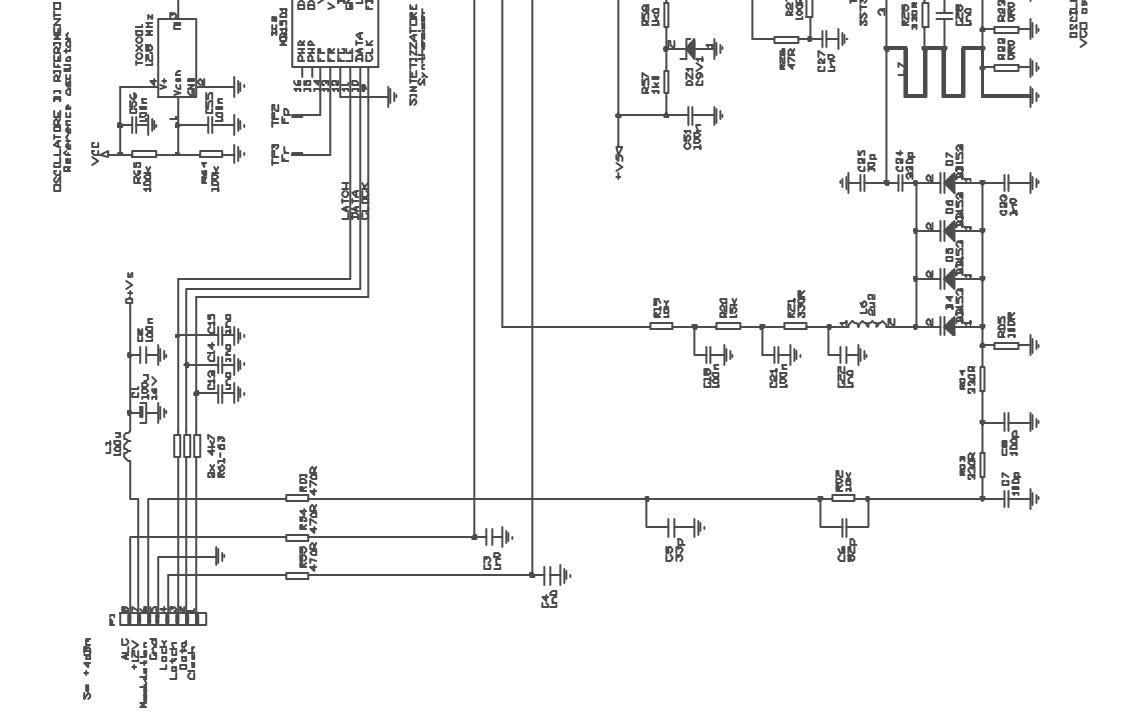
SEXC25MB - MAINBOARD / LF PROCESS SECTION
ELECTRICAL DIAGRAM - 2 of 2



SEXC25MB - MAINBOARD
COMPONENT LAYOUT

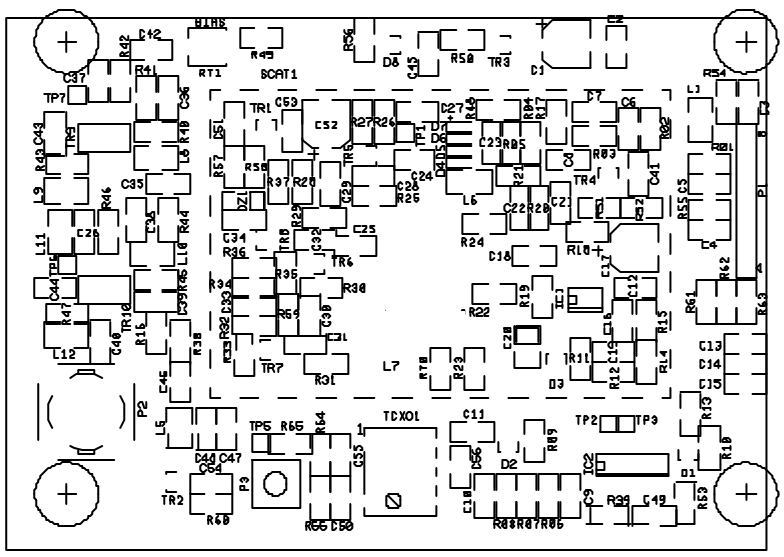


SEXC25MOD - FM EXCITER BOARD - ELECTRICAL DIAGRAM

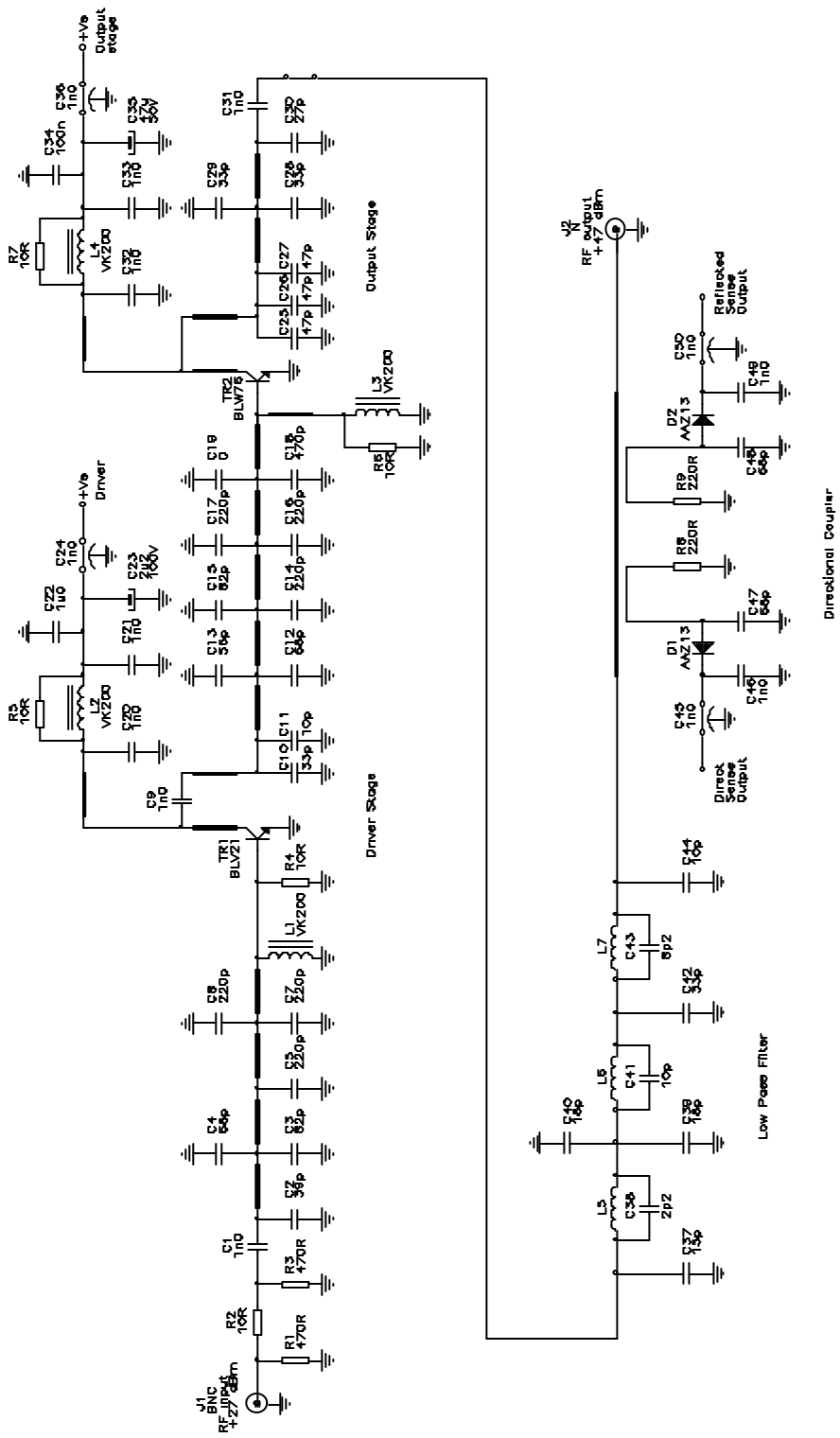


COMPONENTS MAY VARY DUE TO PRODUCTION ADJUSTMENTS

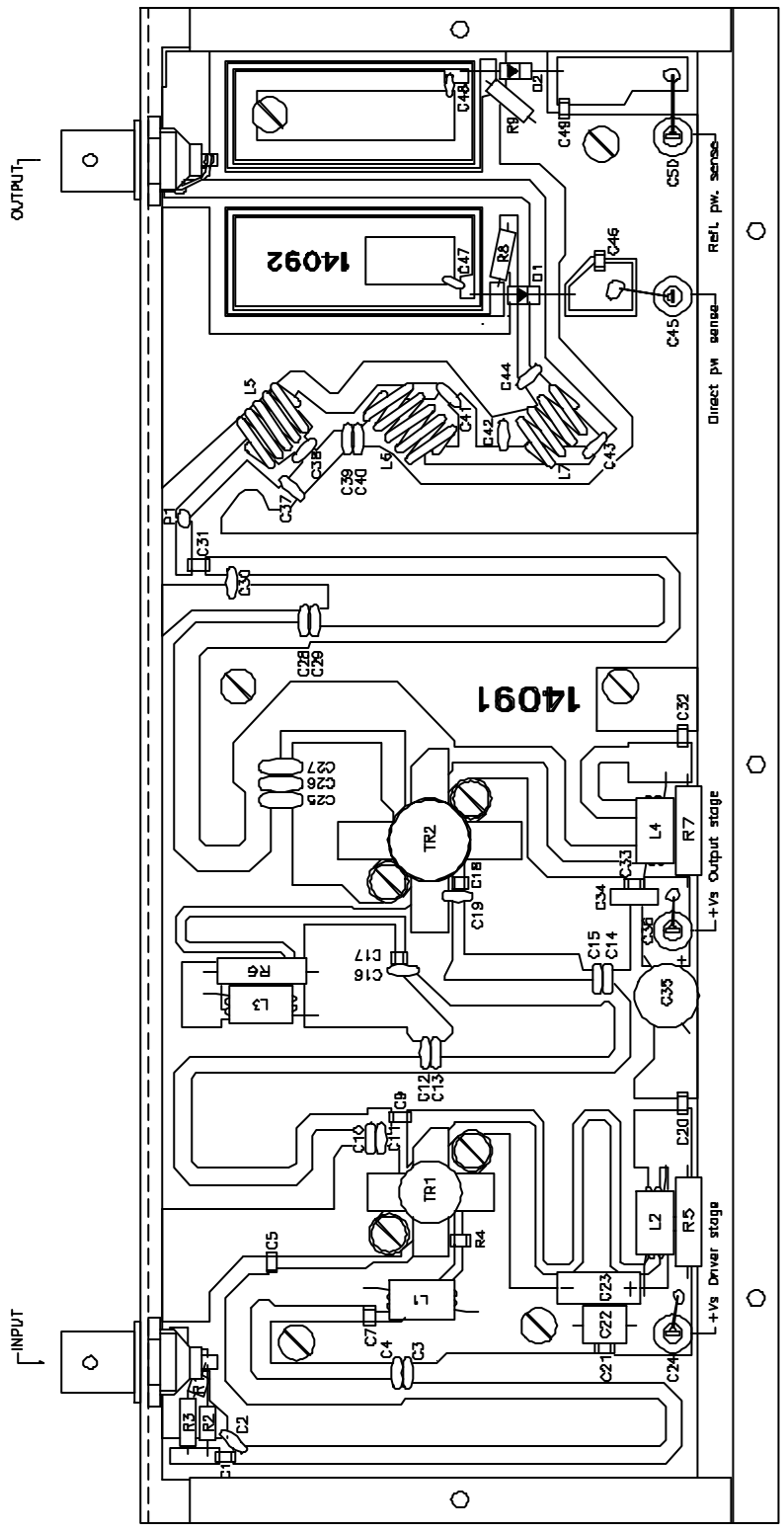
SEXC25MOD - FM EXCITER BOARD - COMPONENT LAYOUT



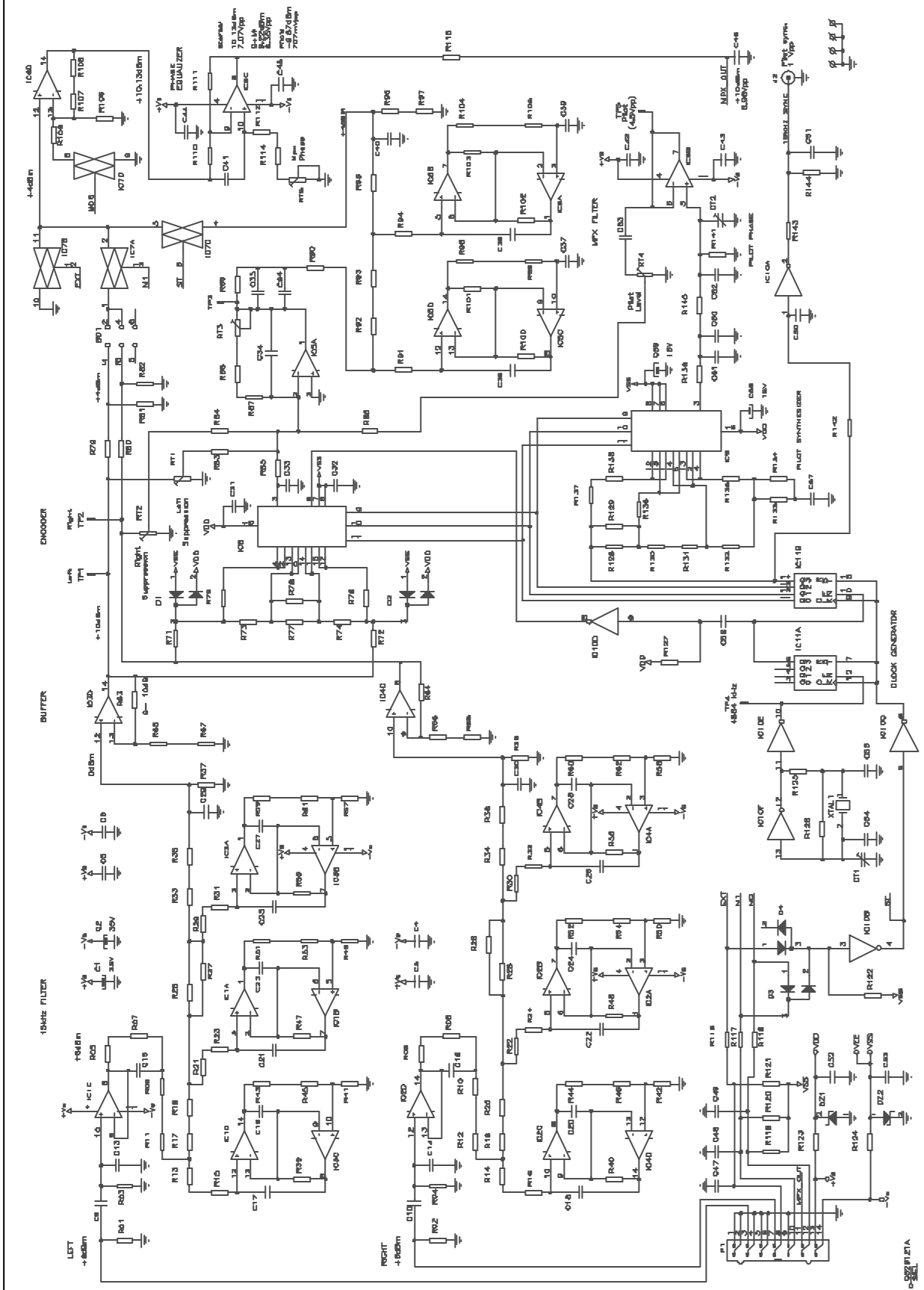
ASEXC101AMP - FM 50W POWER AMPLIFIER
ELECTRICAL DIAGRAM



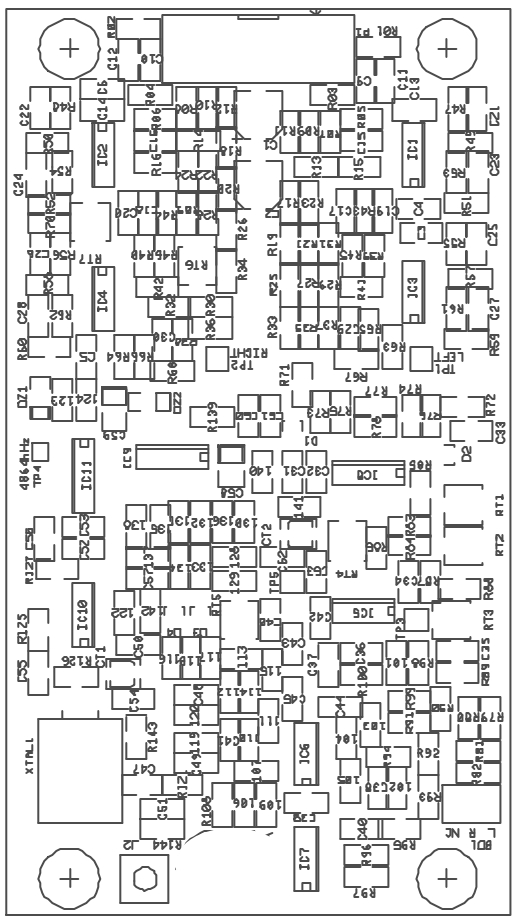
ASEXC101AMP - FM 100W POWER AMPLIFIER
COMPONENT LAYOUT



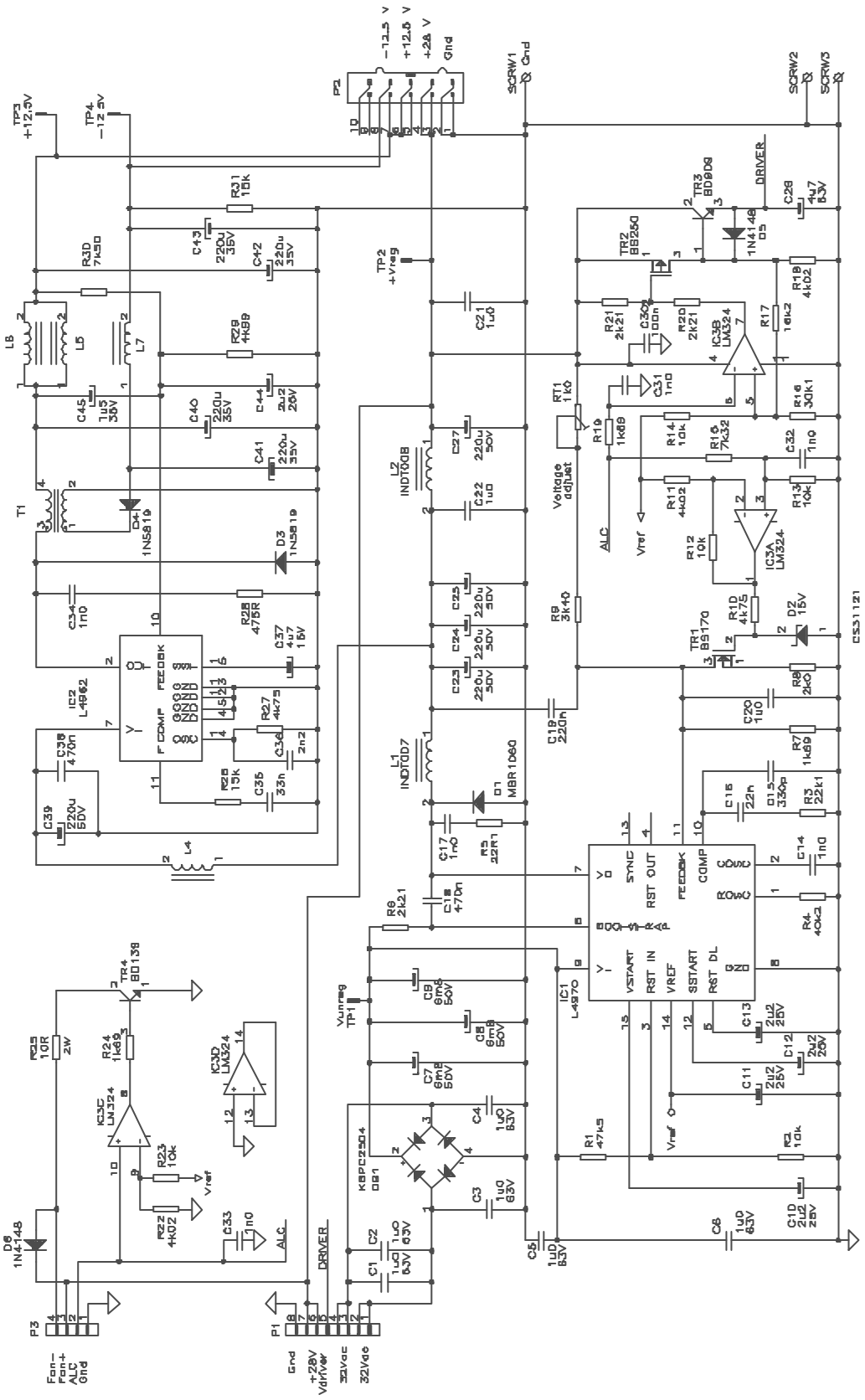
SEXC23COD2 - STEREO ENCODER BOARD - ELECTRICAL DIAGRAM



SEXC23COD2 - STEREO ENCODER BOARD
COMPONENT LAYOUT



ASEXB300AL - POWER SUPPLY REGULATOR - ELECTRICAL DIAGRAM



ASEXB300AL - POWER SUPPLY REGULATOR - COMPONENTS LAYOUT