



TX FM1 /S/R/A

**VHF FM Broadcast Exciter/Transmitter
with Integral 5-band Audio Processor, Stereo Encoder, RDS Encoder
and Remote RDS TA (Traffic Announcement) DTMF Controller**

Technical Manual

No part of this document may be reproduced or transmitted, in any form, by any means, without prior written consent of the directors of TX Techniques Limited, Harrogate, UK.

TX Techniques Ltd shall not be liable for any direct, indirect, incidental, consequential or other damage or loss alleged in connection with the supply or use of this product.

The information contained in this document is subject to change without notice. TX Techniques Ltd makes no warranty of any kind with respect to this information. TX Techniques Ltd specifically disclaims the implied warranty of merchantability and fitness for a particular purpose.

TX Techniques Ltd shall not be liable for any direct, indirect, incidental, consequential or other damage or loss alleged in connection with the furnishing or use of this information.

Index

| | | |
|------|--|----|
| 1. | Introduction | |
| 1.1 | General | 1 |
| 1.2 | RDS Encoder | 1 |
| 1.3 | Stereo Encoder | 1 |
| 1.4 | Audio Processor | 2 |
| 2. | Safety information | |
| 2.1 | General Safety Information | 3 |
| 2.2 | Before Operating this unit | 4 |
| 3. | Controls and Connectors | |
| 3.1 | Front Panel Controls and Connectors | 6 |
| 3.2 | Back Panel Connectors | 6 |
| 4. | Installation | |
| 4.1 | Connections | 7 |
| 4.2 | Switching On | 7 |
| 4.3 | Settings | 7 |
| 4.4 | Audio Processor | 8 |
| 4.5 | Remote TA Controller | 9 |
| 5. | Internal Adjustments | |
| 5.1 | Carrier Frequency Setting | 10 |
| 5.2 | Carrier Frequency Fine Tuning | 10 |
| 5.3 | RF Output Power | 10 |
| 5.4 | Audio Processor Input Level | 10 |
| 5.5 | Audio Processor Individual Band Adjustment | 10 |
| 5.6 | Audio Processor Overall Density Level | 10 |
| 5.7 | 19 KHz, 38 KHz, & 57 KHz Frequency Trim | 11 |
| 5.8 | RDS Injection Level | 11 |
| 5.9 | RDS Subcarrier Level | 11 |
| 5.10 | MPX Output Level | 11 |
| 5.11 | MPX Pilot Injection Level | 11 |
| 5.12 | MPX Subcarrier Null | 11 |
| 5.13 | MPX Separation Level | 11 |
| 5.14 | Composite Clipping Level | 11 |
| 6. | Circuitry | |
| 6.1 | Switch Mode PSU | 12 |
| 6.2 | ALC | 12 |
| 6.3 | Audio Processor | 12 |
| 6.4 | Stereo Encoder & RDS Encoder | 13 |
| 6.5 | Modulator | 13 |
| 6.6 | LCD Control Panel | 13 |
| 6.7 | RF Amplifier | 14 |
| 6.8 | RF Measurement | 14 |

| | | |
|-----|---------------------------|----|
| 7. | Block Diagrams | |
| 7.1 | Switch Mode PSU | 15 |
| 7.2 | FM1-EXCI PCB | 15 |
| 7.3 | FM1-ALC PCB | 16 |
| 7.4 | FM1-AP PCB | 16 |
| 7.5 | FM1-RDS PCB | 17 |
| 7.6 | FM1-PA PCB | 17 |
| 7.7 | FM1-RF PCB | 18 |
| 7.8 | FM1-LCD PCB | 18 |
| 8. | Wiring | |
| 8.1 | Wiring Diagram | 19 |
| 9. | Circuit Diagrams | |
| 9.1 | FM1-EXCI PCB | 20 |
| 9.2 | FM1-ALC (L) PCB | 21 |
| 9.3 | FM1-ALC (R) PCB | 22 |
| 9.4 | FM1-AP PCB | 23 |
| 9.5 | FM1-RDS PCB | 24 |
| 9.6 | FM1-PA PCB | 25 |
| 9.7 | FM1-RF PCB | 26 |
| 9.8 | FM1-LCD PCB | 27 |
| 10. | Declaration of Conformity | 28 |
| 11. | Technical Specification | 29 |

1. Introduction

1.1 General

The TX-FM1/S/R/A is a 30W VHF FM Broadcast Exciter Transmitter with integral stereo encoder, RDS encoder and multiband audio processor (with ALC and clipping).

At the heart of the TX-FM1/S/R/A is a high quality modulator, which employs proprietary 'Complimentary Varicap Compensation' for linear characteristics and constant modulation levels across the entire FM band. Carrier frequency is selectable via internal rotary dial switches, with a trimmer provided for output power adjustment from 10 to 30W. The efficient MOSFET RF power amplifier includes a 7-pole Chebyshev output filter and uses high power rated metal clad mica capacitors and large air-wound coils for exceptional ruggedness.

Traditional slow acting needle meters have been replaced by the latest analogue to digital measurement technology, with menu driven LCD screens for monitoring and adjustments.

SWR cut back, and both audible and visual alarms activate in the event of mismatches in the antenna system.

Careful design and layout of internal circuitry results in low board space, no wire jumper or 'zero ohm' links. Every connection to every PCB is pluggable, allowing fast servicing. The use of 'through-hole' components means components can be replaced easily by engineers using traditional methods.

The TX-FM1/S/R/A is designed to operate continually for many years without maintenance. There are no cooling fans to replace and the carefully specified, quality components ensure ultimate reliability.

1.2 RDS Encoder

The RDS Encoder broadcasts most RDS data types (excluding EON information), and includes dynamic switching of the TA flag using DTMF signalling via programme audio.

1.3 Stereo Encoder

The Stereo Encoder is part of the above RDS option board but is available without RDS by means of reduced component population. The pilot tone and subcarrier are generated from a single clock source for perfect phase correlation, and a high quality DSSC modulation technique is employed for high quality results. Stereo operation can be defeated using the LCD menu control. Composite clipping is applied to Coder output.

1.4 Audio Processor

The 5-band audio processor provides optimum loudness, within tight deviation limits and, together with the ALC section, ensures a constant level during both short term and long term fluctuations. A 'noise gate' prevents noise on landline feeds or STL's rising during long pauses, by returning the ALC section to 0dB gain.

The five independent compressors on each channel feature wide filter bands for natural sound and a non-linear compression curve characteristic, which prevents the unnatural amplification of very low level sounds and noise. Multiple peak limiting stages provide the control needed to ensure that final clipping circuitry operates with negligible distortion or audible effect, across all kinds of programme material. This analogue multi-band audio processor is the result of over three years of development and achieves a spectral density and loudness similar to digital products costing many thousands of pounds. Two boards are fitted for stereo operation.

2. Safety Information

2.1 General Safety Information

Use of this device into a radiating antenna requires a valid Wireless and Telegraphy licence.

Never operate this device without a suitable 50 ohm load connected to the RF OUTPUT socket, or without a suitable antenna.

Use of this device as part of a transmission system, or combined transmission system not specified by the manufacturer, may require further testing to ensure that it remains compliant with the essential requirements and other relevant provisions of Directive 1999/5/EC. Approval from a 'Notified Body' and clearance from the Spectrum Management Authority may also be required.

Never allow audio, or audio peaks, in excess of +8dB enter the AUDIO IN LEFT and/or AUDIO IN RIGHT input sockets, as this may lead to overmodulation of the carrier. Always use an external audio limiter in cases where audio levels may exceed +6dBu. FAILURE TO COMPLY MAY INVALIDATE ANY WARRANTIES OR APPROVALS GIVEN TO THIS PRODUCT.

RISK OF FIRE! High power RF (Radio Frequency) energy could cause ignition of combustible surfaces during fault conditions. Installation should be left to qualified personnel. RF can cause severe burns to skin. Ensure antenna systems and feeder cables are not situated near – or could fall onto – any combustible surface.

Installation must adhere to safety regulations and the requirements of the relevant authorities. We recommend that at least two people are present during installation. Keep a file containing installation instructions and plans, including details of the transmission system (antennae, feeders, filters, etc) and operating instructions for all equipment at the transmission site at all times. Display posters detailing first aid treatment and treatment for electrical shock, along with telephone numbers for contacting the emergency services in the event of personal injury.

BERYLLIUM OXIDE IS LETHAL. Some components inside this appliance contain the highly dangerous TOXIC substance Beryllium Oxide. In case of damage contact the manufacturer or its Agent immediately. Seek advice from the local authority when discarding this appliance.

To reduce the risk of electrical shock, do not remove the cover, or any screws. NO user serviceable parts inside; refer servicing to qualified personnel.

To reduce the risk of fire or electrical shock, do not expose this appliance to rain or moisture.

To reduce the risk of fire, always replace fuses with the same type and rating.

Do not operate this appliance without a suitable 50 ohm dummy load or a suitable, matched antenna connected to the RF OUTPUT socket on this apparatus. Although the output devices used in this appliance are intended to be open and short circuit tolerant, MIS-OPERATION MAY RESULT IN DAMAGE NOT COVERED BY ANY WARRANTY.

The heatsink at the rear of this appliance may become very warm under normal operating conditions.

2.2 Before Operating This Unit

These instructions should be read in full before the transmitter is operated.

The safety and operating instructions should be retained for future reference.

All warnings on the transmitter and in the operating instructions should be adhered to.

All operation and user instructions should be followed.

The transmitter should not be used near water.

The transmitter should be mounted into a well ventilated standard 19 inch equipment rack. It should be situated so that its location or position does not interfere with its proper ventilation. Particular attention should be paid to the bottom ventilation holes, and convection of the rear heatsink, which can be impeded if the unit is placed on a flat surface.

The transmitter should be situated away from heat sources.

The transmitter should be connected to a power supply only of the type described in the operating instructions or as marked on the unit.

Precautions should be taken so that the grounding or polarisation means of an appliance is not defeated.

Power supply cords should be routed so that they are not likely to be walked on or pinched by items placed upon or against them, paying particular attention to cords and plugs and the point where they exit from the transmitter.

The unit should be cleaned only as recommended by the manufacturer.

The power cord of the transmitter should be unplugged from the outlet when left unused for a long period of time.

Care should be taken so that objects do not fall and liquids are not spilled into the enclosure through openings.

The transmitter should be serviced by qualified service personnel when: - The power supply cord or the plug has been damaged; or - Objects have fallen, or liquid has been spilled into it; or - The transmitter has been exposed to rain; or - The transmitter does not appear to operate normally or exhibits a marked change in performance; or - The transmitter has been dropped, or the enclosure damaged.

The user should not attempt to service the transmitter beyond that which is described in the Operating Instructions. All other servicing should be referred to qualified service personnel.

3. Controls & Connections

3.1 Front Panel Controls and Connectors

AF (Audio Frequency) Monitor BNC. For monitoring of the input to the modulator (AF spectrum, including MPX and RDS subcarriers). 1k Ω 1V p-p (max).

RF (Radio Frequency) Monitor BNC. Allows monitoring of the RF output. Output level will be the output power attenuated by approximately 40dB. 50 Ω .

SoftKeys. These keys correspond to selections indicated on the adjacent LCD.

Menu 'Shuttle' Controller. Turn this control clockwise or counter-clockwise to navigate forward or backward through the LCD menu screens.

The initial "SELECT" menu allows the "SETTINGS" or "METER" screens to be displayed. Under the settings menu, RF OUTPUT, MPX, DTMF and PIN settings can be changed. Under the meter menu, selecting "RF" provides monitoring of forward ("RF FWD") and reflected ("RF REF") power measurements. "AF" provides a graphical PPM meter showing the sum of the LEFT and RIGHT audio inputs. Please note that this is NOT a deviation meter. Because the internal limiting always ensures that deviation is +/- 75KHz, or less, a deviation meter is unnecessary.

Please note: Pressing the Softkey corresponding to "EXIT" will always take the TX-FM1/S/R/A to the "ENTER PIN" screen, as an anti-tamper feature.

3.2 Rear Panel Connectors

AC POWER. Connect a power lead with an IEC connector (and a 5 Amp fuse in the plug or at the distribution panel) to this socket.

AUDIO IN (LEFT) XLR. Electronically balanced audio input. Apply a +4dB balanced audio feed to this socket.

AUDIO IN (RIGHT) XLR. Electronically balanced audio input. Apply a +4dB (max) balanced audio feed to this socket.

RF OUTPUT 'N' Socket. Connect a matched, pre-tested antenna system (using suitably rated feeder cable), with a return loss of ≤ 20 dB, to this socket.

4. Installation

4.1 Connections

Connect a matched, pre-tested antenna system (which complies with the regulations of the license) to the RF OUPUT socket on the rear of the unit.

Connect a balanced +4dB (max) audio feed to the AUDIO IN (LEFT) and AUDIO IN (RIGHT) XLR sockets.

Connect the transmitter to a suitable power source using the supplied IEC connector power lead. Ensure that the appliance is protected by a 13A fuse either at the supply plug or at the distribution panel.

4.2 Switching On

Ensure a suitable load is connected to the RF OUPUT socket before connecting the unit to mains power.

Upon power-up, the display will show the unit's firmware release number. After a few seconds, it will prompt for the PIN to be entered (or may go straight to the "SELECT" menu if the PIN function is not enabled).

Enter the correct PIN.

Please note: If an incorrect frequency (eg. Below 87.5MHz or above 108.0MHz) has been selected on the internal frequency setting switches, the unit will not initialise. Instead it will display "ALARM: SYSTEM ERROR" after a short while. Disconnect the mains supply, select a valid frequency internally, and then power-up the unit once again.

4.3 Settings

The following options can be accessed via the "SETTINGS" menu:

RF OUTPUT. Selecting 'Disable' on this menu function mutes the RF output, putting the unit into a 'hot standby' mode.

MPX. Disabling this setting will defeat the MPX Encoder, resulting in a monophonic signal being transmitted .

DTMF. Disabling this option prevents DTMF tones from activating the TA flag.

PIN. Disabling this option prevents the transmitter from requesting a PIN code, upon power-up before output. Please note that if the PIN setting is set to ON, the RF output will not resume following a power outage, without the intervention of an operator (entering the PIN code), in order to protect the unit against theft. If continual supply cannot be guaranteed and transmission is required to automatically re-commence following a power outage, the PIN setting must be disabled (note that this will not, however, afford any anti-theft protection).

4.4 Audio Processor

Audio Processing parameters are set at board level during manufacture, using carefully selected component values.

When listening off-air, slow variations in loudness may not be apparent due to the action of the internal ALC, which amplifies or attenuates a wide range of audio levels, to a single, optimum level.

A +4dB (maximum audio level) test tone will result in roughly 50% modulation level, due to the nature of the internal Audio Processor, when monitoring off-air using a Modulation Meter or Analyser. Normal program (music and/or speech) will show full $\pm 75\text{kHz}$ deviation.

PPMs – including the TX-FM1/S/R/A's graphical one – exhibit a fast response and slow decay, and may not appear to represent music or speech in a predictable manner. Also remember that meters that indicate the output of a radio station may be connected to an off-air monitor receiver and will not respond in the same way as the one on the transmitter (which is ahead of any processing). The graphical PPM is the sum of both Left and Right channels and is for indication only. It is not intended to be an accurate measurement of the audio level entering the unit.

By nature, multi-band audio processors greatly amplify any distortion present on certain elements of source material (a particular instrument, for example), even if it is not evident when previewed without audio processing. Also, CD recordings mastered at very high levels, often drive many CD players reproduction circuitry into 'clipping' (distortion). If, after ensuring that audio levels are correctly set, objectionable distortion is heard, try alternative programme material and/or source equipment, before suspecting that the transmitter or its audio processor is at fault. Audio processing may also accentuate the distortion effect of microphone Voice Processors.

The addition of an audio limiter in the audio feed, before the TX-FM1/S/R/A, with the onset of limiting set at slightly above +4dB, is recommended.

Additional (external) audio processing normally has little effect on the sound, because the internal processing counteracts any external processing. However, experimentation is encouraged, and 'mix enhancement' products with 'stereo widening' often yield excellent results in conjunction with the TX-FM1/S/R/A's internal processor.

It is strongly advised that the audio applied to the TX-FM1/S/R/A has little or no 'EQ' applied. The integral 5-band Audio Processor, acts like a 'dynamic graphic equaliser', optimising the tonal quality of the programme source. It is likely that this will counteract any external tone equalisation. The point at which any additional EQ would become noticeable on the received transmission, would be under extreme levels of applied EQ. This would cause unpleasant sound, degradation of the audio and possibly even overmodulation if DC or square waves (ie. distorted or clipped) audio is applied.

4.5 Remote 'TA' Controller

The DTMF remote controller may be used to dynamically switch the RDS TA (Traffic Announcement) 'flag'. The short burst of 'RDS ON' tones are used to activate the RDS TA 'flag'. Ensure that the tones are clearly audible.

Music and/or voices played at the same time could prevent the tones from working. If, after the TA mode has been activated, the 'RDS OFF' tones are not received within 4 minutes, the TX-FM1/S/R/A will automatically cancel the TA mode. Abuse of this system may incur penalties from the broadcasting Authorities.

It is important that the level of audio entering the TX-FM1/S/R/A, and therefore the level of the RDS tones is around +4dB. Whilst the DTMF detector has its own ALC circuitry, it is 'ahead' the ALC and Audio Processor circuitry. If the signal is too low, it may not activate the DTMF detector. Similarly, if the level is too high, it may be distorted, and will not be correctly decoded by the DTMF circuitry.

5. Internal Adjustments

5.1 Carrier Frequency Setting

Select the desired carrier frequency on SW1,2,3 & 4 on “FM1-EXCI” PCB. For example, to set the unit to operate on 98.4, turn SW1 to “0”, SW2 to “9”, SW3 to “8” and SW4 to “4”. The new frequency will take effect when the unit is next powered-up.

5.2 Carrier Frequency (Fine Tuning)

Connect a frequency meter connected via the front panel “RF” BNC socket. Adjust VC1 on “FM1-EXCI” PCB.

5.3 RF Output Power

With the front panel LCD set to display forward RF power, turn VR1 on “FM1-EXCI” PCB to achieve the desired output power. To set the power accurately, use an external calibrated RF power meter (with a suitable RF test load) connected to the “ANTENNA” socket on the rear panel.

5.4 Audio Processor - Input Level

This board-level setting is factory set using a specific component value. R31 (right audio channel) and R32 (left audio channel) on the “FM1-ALC” board determines the overall level entering the multiband audio processor.

| | | |
|-----------|--------|-----------|
| Decrease | Normal | Increase |
| 1K5 (min) | 2K2 | 4K7 (max) |

Use of values other than the default values fitted during manufacture may result in a deterioration of the broadcast sound quality.

5.5 Audio Processor - Individual Band Adjustments

These board-level settings are factory set, using specific component values. Values below 47K or above 100K are not recommended. Use of values other than the default values fitted during manufacture may result in a deterioration of the broadcast sound quality.

| | | | | |
|----------|-----------|-----------|------------|------------|
| 80Hz LPF | 200Hz BPF | 650Hz BPF | 2100Hz BPF | 5000Hz HPF |
| R4 | R6 | R19 | R20 | R32 |

| | | |
|--------------------------|--------|---------------------------|
| Increase | Normal | Decrease |
| Decrease value (47K min) | 68K | Increase value (100K max) |

5.6 Audio Processor Overall Density Level

This board-level setting is factory set, during manufacture, using a specific component value. R42 sets the overall density level. Use of values other than the default value fitted during manufacture may result in a deterioration of the broadcast sound quality.

5.7 19kHz, 38kHz and 57kHz Frequency Trim

Using a frequency meter, monitor Pin 7 of IC6 and adjust VC1 for 19,000Hz. This will also, in turn, adjust the 38kHz and 57kHz subcarrier frequencies.

5.8 RDS Injection Level

The RDS injection level can be adjusted using VR5 on the "FM1-RDS" PCB.

5.9 RDS Subcarrier Null

The DSSC generation of the RDS signal requires the 57kHz carrier to be nulled, for correct operation. VR1 on "FM1-RDS" PCB controls this setting, and requires the use of a spectrum analyser connected to the front panel "AF" monitor BNC socket

5.10 MPX Output Level

The overall MPX level (ie. audio, pilot and subcarrier) can be altered using VR6 on the "FM1-RDS" PCB. This setting requires the use of a modulation monitor connected to the front panel "AF" monitor BNC socket

5.11 MPX Pilot Injection Level

The level of pilot present in the stereo broadcast can be varied, independently of the overall MPX setting, by adjusting VR4 on the "FM1-RDS" PCB. This setting requires the use of a modulation monitor connected to the front panel "AF" monitor BNC socket

5.12 MPX Subcarrier Null

The DSSC generation of the stereo multiplex signal requires that the 38kHz carrier is nulled, for correct operation. VR2 on "FM1-RDS" PCB controls this setting. This setting requires the use of a spectrum analyser connected to the "AF" monitor BNC socket.

5.13 MPX Separation Level

VR1 on "FM1-RDS" PCB controls stereo separation, which should be set using an oscilloscope connected to the front panel "AF" monitor BNC socket and a 1kHz tone connected to either the left or right audio input only. Setting the RDS injection and MPX pilots levels to minimum will improve clarity of the displayed waveform. Maximum separation is achieved when the waveform exhibits a flat baseline.

5.14 Composite Clipping Level

VR7 and VR8 on the "FM1-RDS" PCB adjust the amount of clipping applied to each polarity of the MPX waveform. A digital storage oscilloscope is required for this adjustment. Both trimmers should be adjusted for exact symmetry, and so that overshoots (above and below the average limited/clipped audio levels) are removed.

6. Circuitry

6.1 Switch Mode PSU

The Switch Mode PSU provide a single +28VDC 6.5A output from a wide range of input voltage supplies (90 – 264VAC 47-63Hz, or 120 – 370VDC). It features power factor correction and compliance to generic EMC standards. A version capable of Level 2 surge immunity (as defined by ETS 300 447 standard) can be supplied if specifically requested at the time of ordering. The SMPSU is over voltage and short circuit protected, and is a self-contained unit for fast, easy replacement.

6.2 ALC

The left and right circuits are identical. The following component references relate to the left audio channel only.

This board also incorporates a switching regulator, which provides a +/- 12V supply for this, and other boards, via PL4 (which also includes a +24V supply rail).

XLR balanced audio passes through an RF filter (FB1, FB2 and C1,C2) and is converted to unbalanced audio by IC1 (Balanced Line Receiver).

IC2 buffers the Left and Right audio channels which are then bridged and presented to the LCD meter and the DTMF TA controller as a mono source, via socket PL5.

The audio passes through IC3(A), the gain of which is controlled by OR1 in its feedback path. The output of IC4 (precision rectifier) and IC5 (mute control) feeds OR1. High audio levels are gradually reduced, or long term low levels boosted. Extended periods of silence result in the ALC slowly returning to an overall 0dB gain level, thus reducing noise on landlines or STL feeds.

Op-amp IC6 is configured as an amplifier enabling the ALC output level to be adjusted (by changing the value of R31) . This will increase/decrease the input level for the audio processor.

6.3 Audio Processor

Dual op-amps IC1, IC3 and IC5 dual op-amps form the band filtering. IC2, IC4 and IC6 are dual VCAs set to perform a limiting/leveling action on each band. Their outputs are combined by IC5b. LED3 and 4 provide 'brick wall' limiting. IC6b performs an overall 'sliding pre-emphasis' limiting action. LED1 and LED2 further clip the waveform ahead of FILTER 1, which is a sharp 15kHz low pass filter. Since the input and output impedance have to be carefully matched for this filter to work correctly, R47, R48, R49, R44 are used to ensure the correct drive and load impedances.

6.4 Stereo Encoder/RDS Encoder

IC6 contains outputs a 19kHz, 38kHz and 57kHz clock from a single crystal, XTAL 4. RC filtering converts the digital pulses into sine waves.

IC7 creates the MPX signal with a suppressed carrier, the output of which is switched by IC5. The 19kHz pilot signal is also switched by IC5 and then mixed to the multiplex signal by IC8, a quad op-amp.

IC4 monitors the bridged (mono) audio from the ALC board for DTMF tones and outputs serial data representing the decoded tones. IC3 is the main RDS processor; a powerful 8-bit microcontroller capable of executing 5 million instructions every second. It not only calculates and outputs the RDS data stream and the associated Cyclic Redundancy Code in real time, but also contains an algorithm to decipher the DTMF code validity, and sets the TA flag accordingly. The serial RDS data stream is clocked out of IC3 by IC2 which digitally synthesises the RDS pulses. IC1 creates the RDS signal with a suppressed carrier.

6.5 Modulator

The MPX signal modulates VCD1. The RF carrier frequency is tuned by a PLL voltage across VCD3 and VCD4. The amount of capacitance effect the modulation varicap has on the tuned circuit (VCD3, VCD4 and L1) is controlled by VCD2 in order to introduce more modulation at one end of the tuning range. This has the effect of maintaining a constant modulation level across the entire FM band. TR2 and TR3 form a 'Cascode' oscillator, which is buffered by TR4, and switched by TR5. This allows the exciter output to be muted via the front panel LCD menu settings, during tuning, and under output mismatch conditions.

An RF transformer T1 matches the buffer to the modulator output transistor TR6 which provides an efficient 2W (nominal) output.

IC2 provides the PLL tuning function, and is controlled by serial data from the host microcontroller, IC3, which also continually monitors the PLL for a locked condition, creating a logic output signal accordingly. An op-amp PLL filter is used based on designs in the PLL IC manufacturer's datasheet and application notes.

A voltage sample, proportional to the RF output power, is connected to PL3. This controls the base of TR1. The more positive its base, the more OR1 reduces the resistance on the VADJ pin of regulator VREG1. This lowers the voltage to TR4 and TR6, lowering the modulator board's output, thus forming an ALC function, the threshold of which is controlled by VR1.

6.6 LCD Control Panel

IC1 is a microcontroller containing proprietary firmware to perform all metering, system monitoring and set-up functions. D1, D2, R1 and C15 form a simple passive rectifier with a time constant which creates a voltage proportional to the peak of the bridged (mono) audio feed at PL3. This voltage is sampled by an on-chip D to A converter in IC1.

5V logic control signals for TA function and MPX settings (on or off) are provided on PL1.

A 5V logic signal from “FM1-EXCI” arrives at PL2 when the PLL is locked . The RF on/off control signal is sent back to the modulator board via the same connector.

Voltages proportional to the forward and reflected RF levels present on the “FM1-RF” board arrive at PL4. These voltages are sampled by an on-chip D to A converter in IC1.

R2 and ZD1 create a reference voltage for IC1 from the 5V supply rail which is smoothed by C10.

IC1 directly drives sounder S1, and performs the decoding for the front panel encoder ENC1 and the push button switches SW1 and SW2.

6.7 RF Amplifier

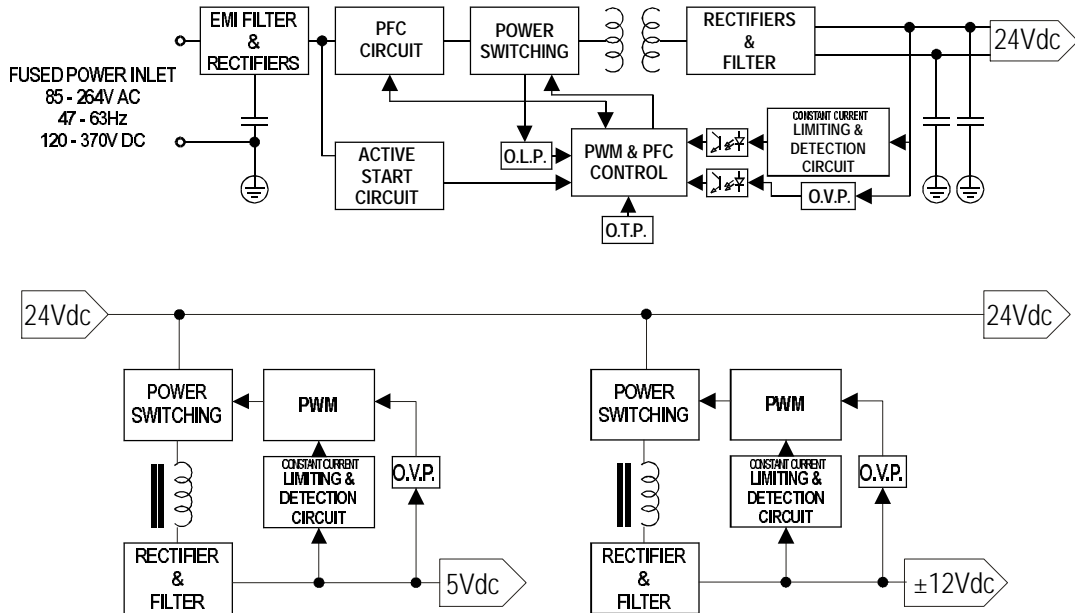
The RF amplifier design uses a Motorola RF MOSFET device. C1, L1, C2, and L2 form an input matching circuit. ZD1 rectifies the RF forming a bias for TR1 and R1, in conjunction with the board circuit pad presents the correct input impedance to TR1. L5,C4,L5,C5 form an output matching circuit for TR1 and C7, L7, C8, L8, C9, L9, C10, L10 and C11 form a 7-pole Chebyshev RF output filter.

6.8 RF Measurement

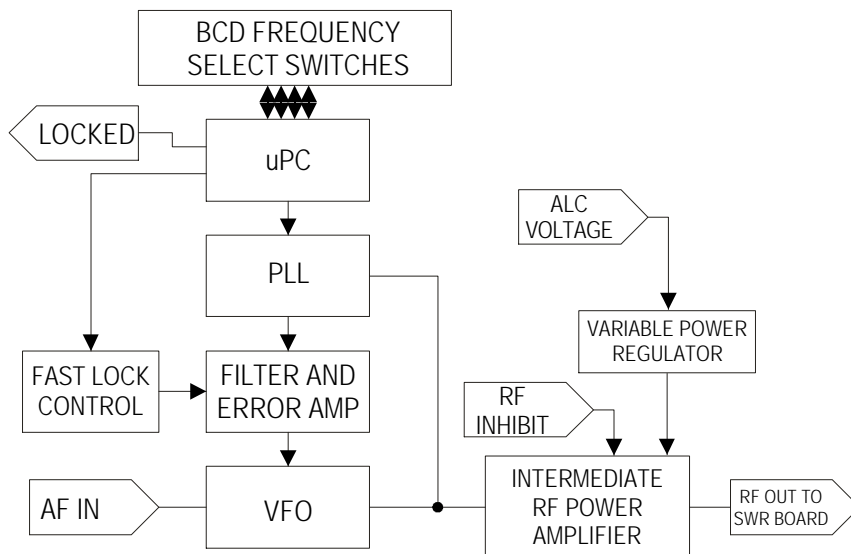
C3, C4, R4 and R5 create a decoupled -40dB sample of the coaxial output line. C1, C2, T1 together with R1, R2, D1 and D2 provide voltages proportional to the forward and reverse RF power levels. The ‘reflected’ voltage is nulled by VR1 which is connected to the RF output via R3. IC1 and IC2 buffer the forward and reflected voltages, which are kept below 5V, under all conditions, by ZD1 and ZD2.

7. Block Diagrams

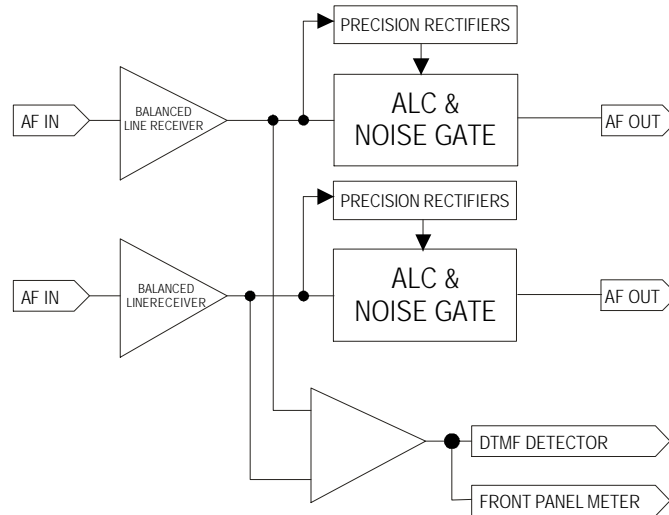
7.1 Switch Mode Power Supply



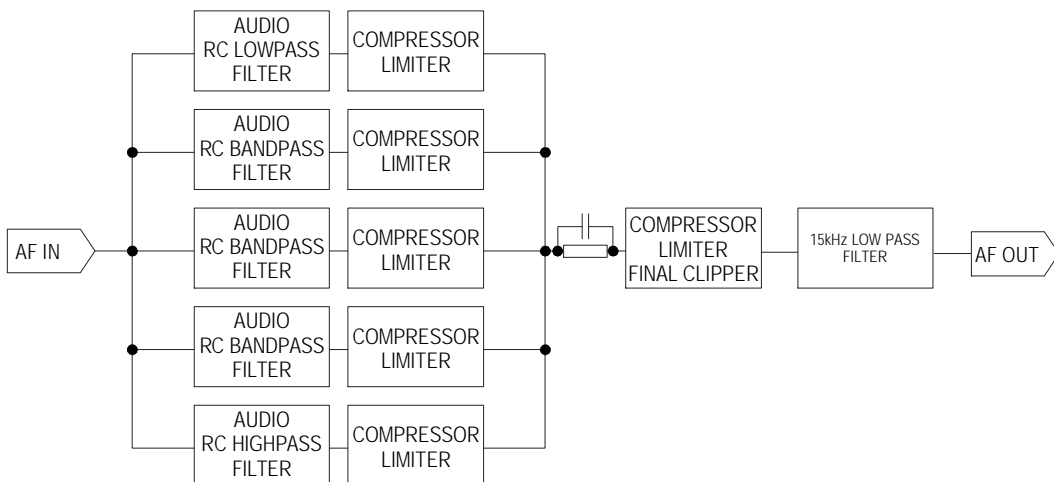
7.2 FM1-EXCI PCB



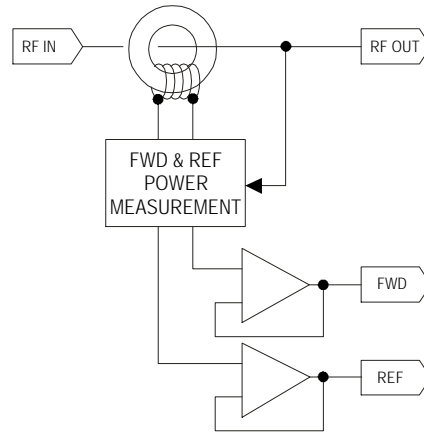
7.3 FM1-ALC PCB



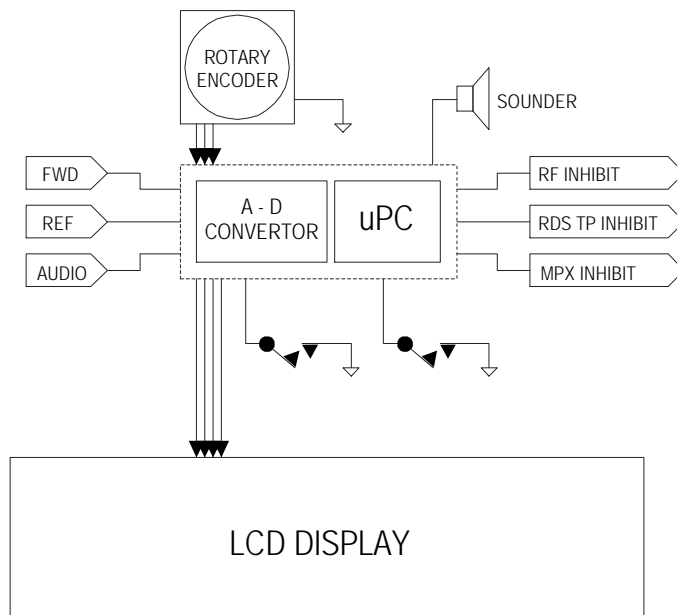
7.4 FM1-AP PCB



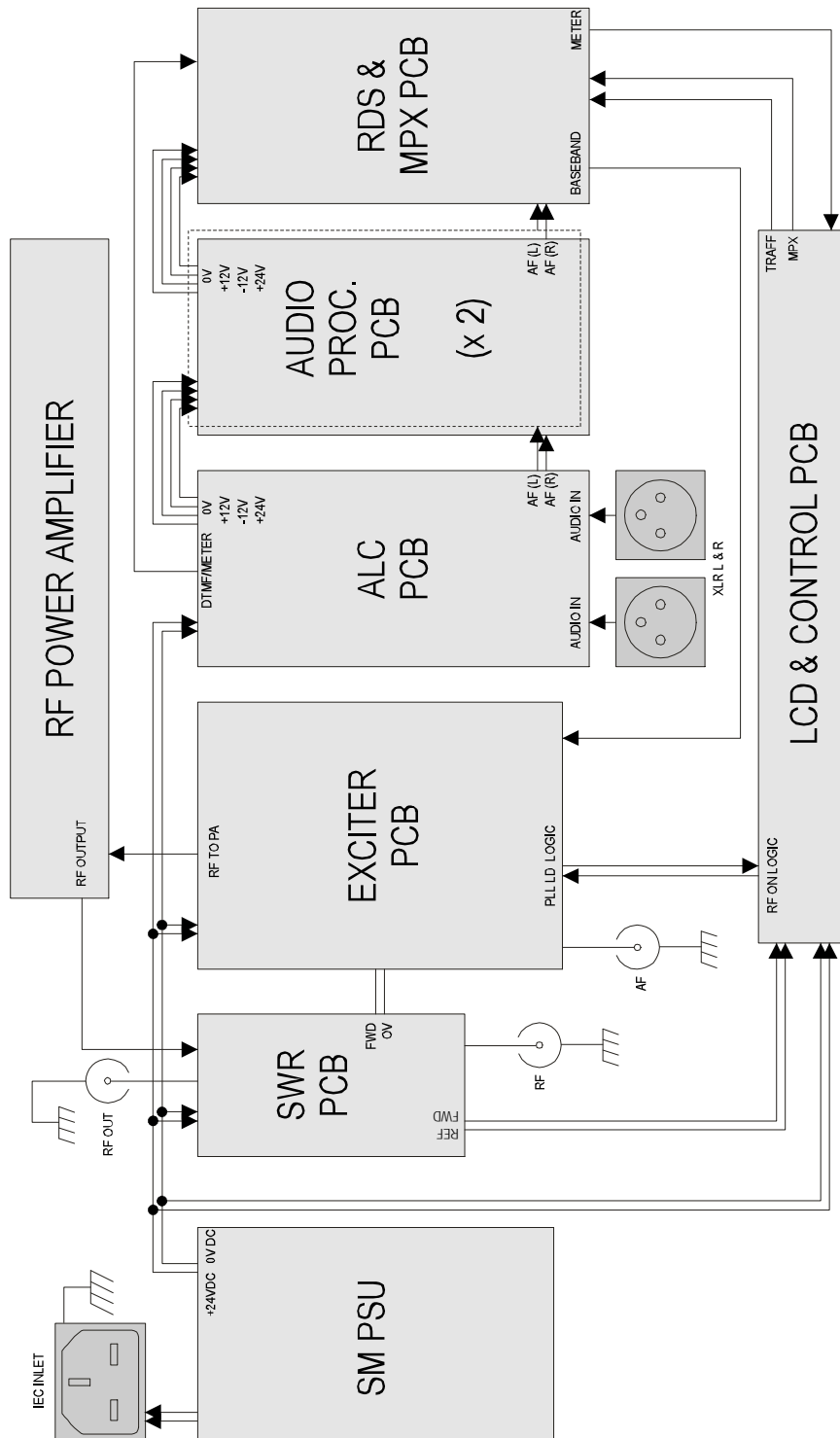
7.7 FM1-RF PCB



7.8 FM1-LCD PCB

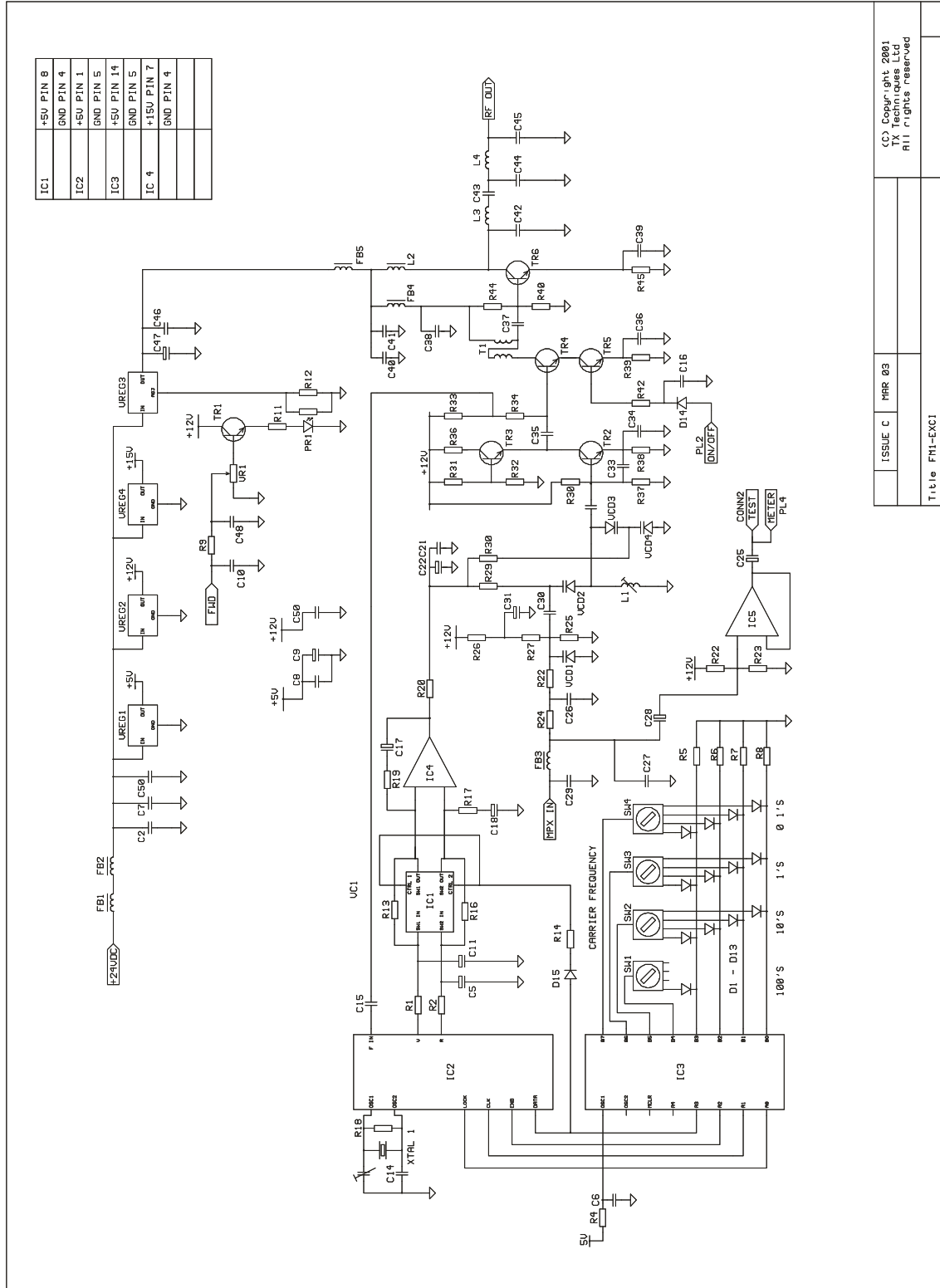


8. Wiring Diagram



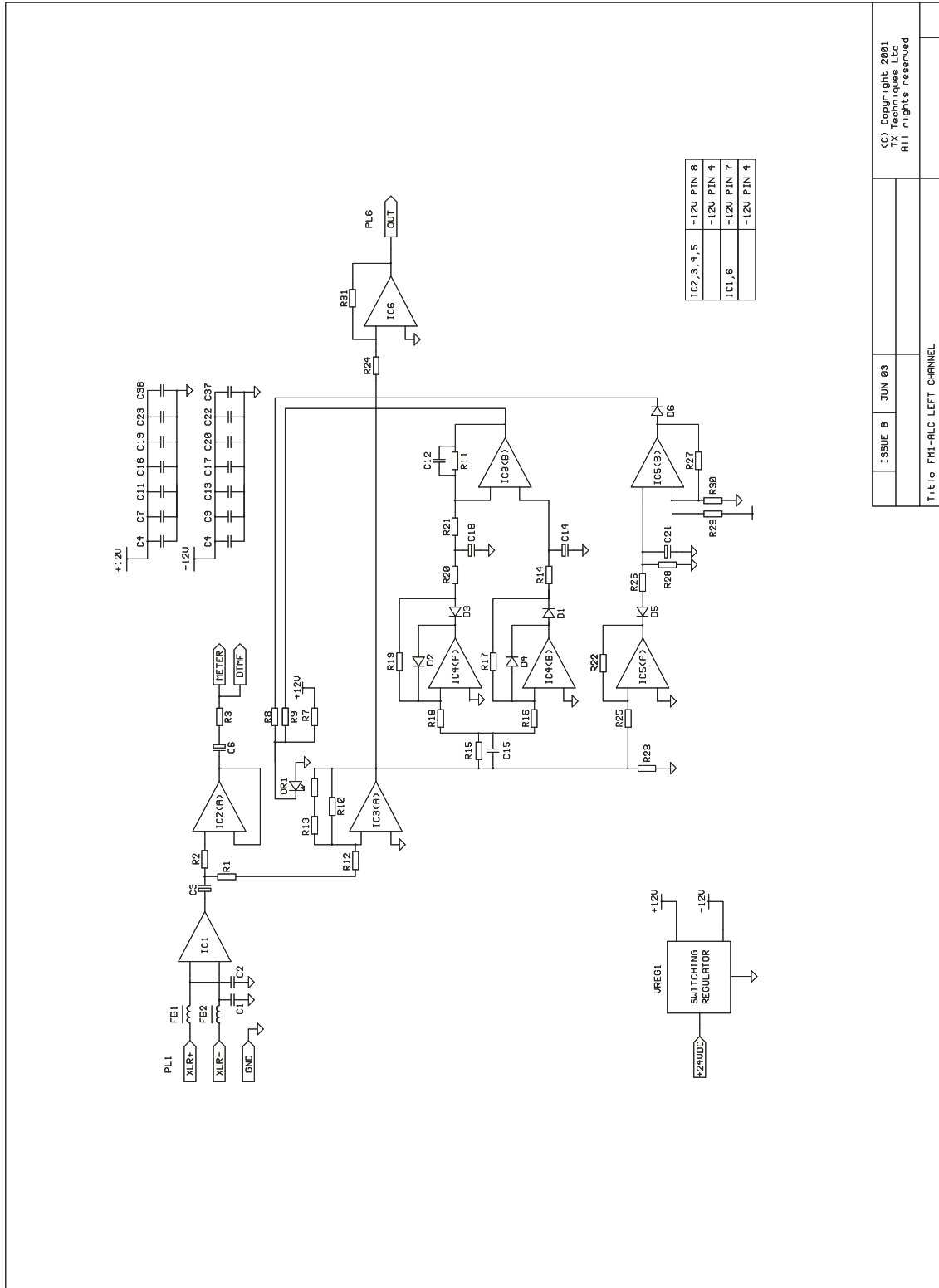
9. Circuit Diagrams

9.1 FM1-EXCI



Copyright 2001
 All rights reserved
 Title FM1-EXCI

9.2 FM1-ALC (Left Audio Channel)

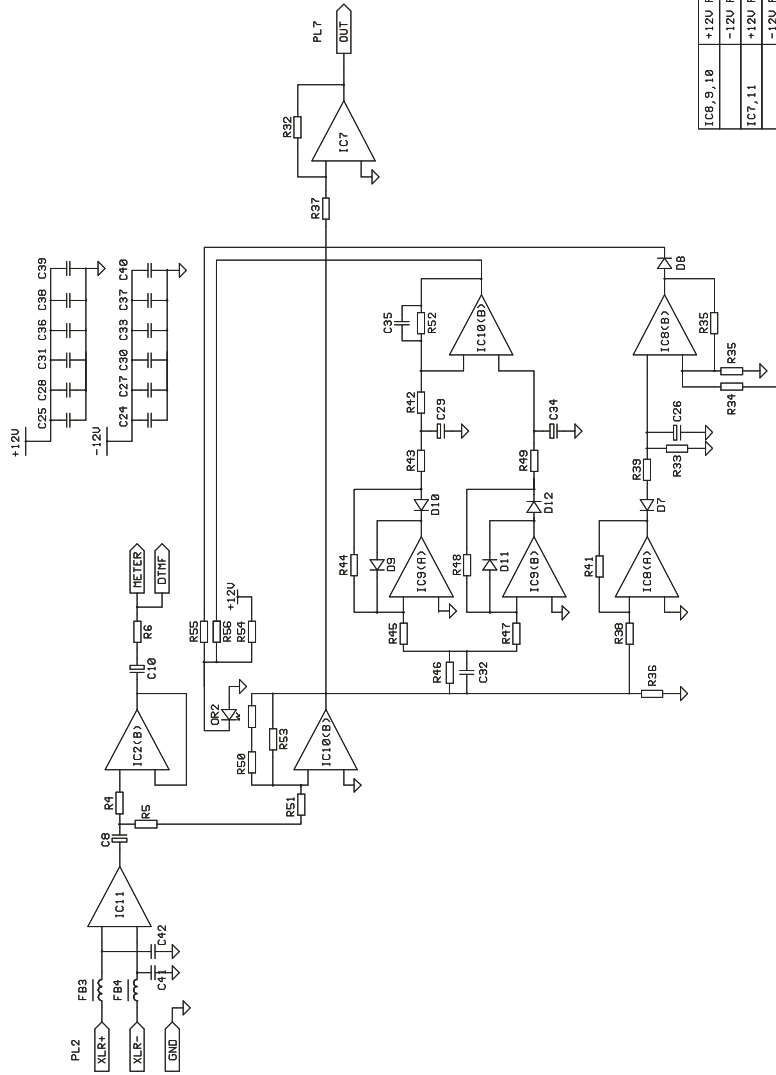


(C) Copyright 2001
TX Technique Ltd
All rights reserved

ISSUE B JUN 03

Title FM1-ALC LEFT CHANNEL

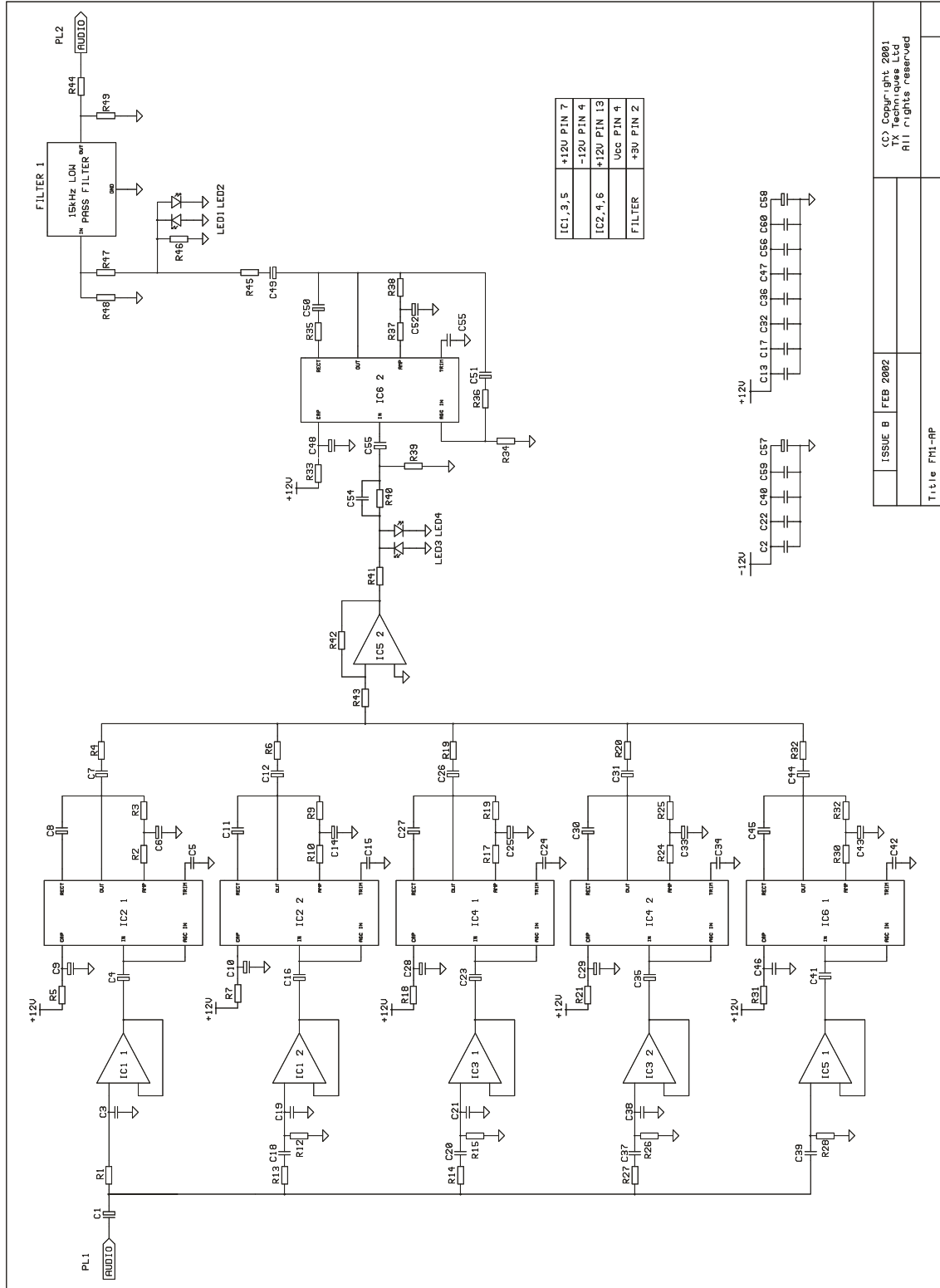
9.3 FM1-ALC (Right Audio Channel)



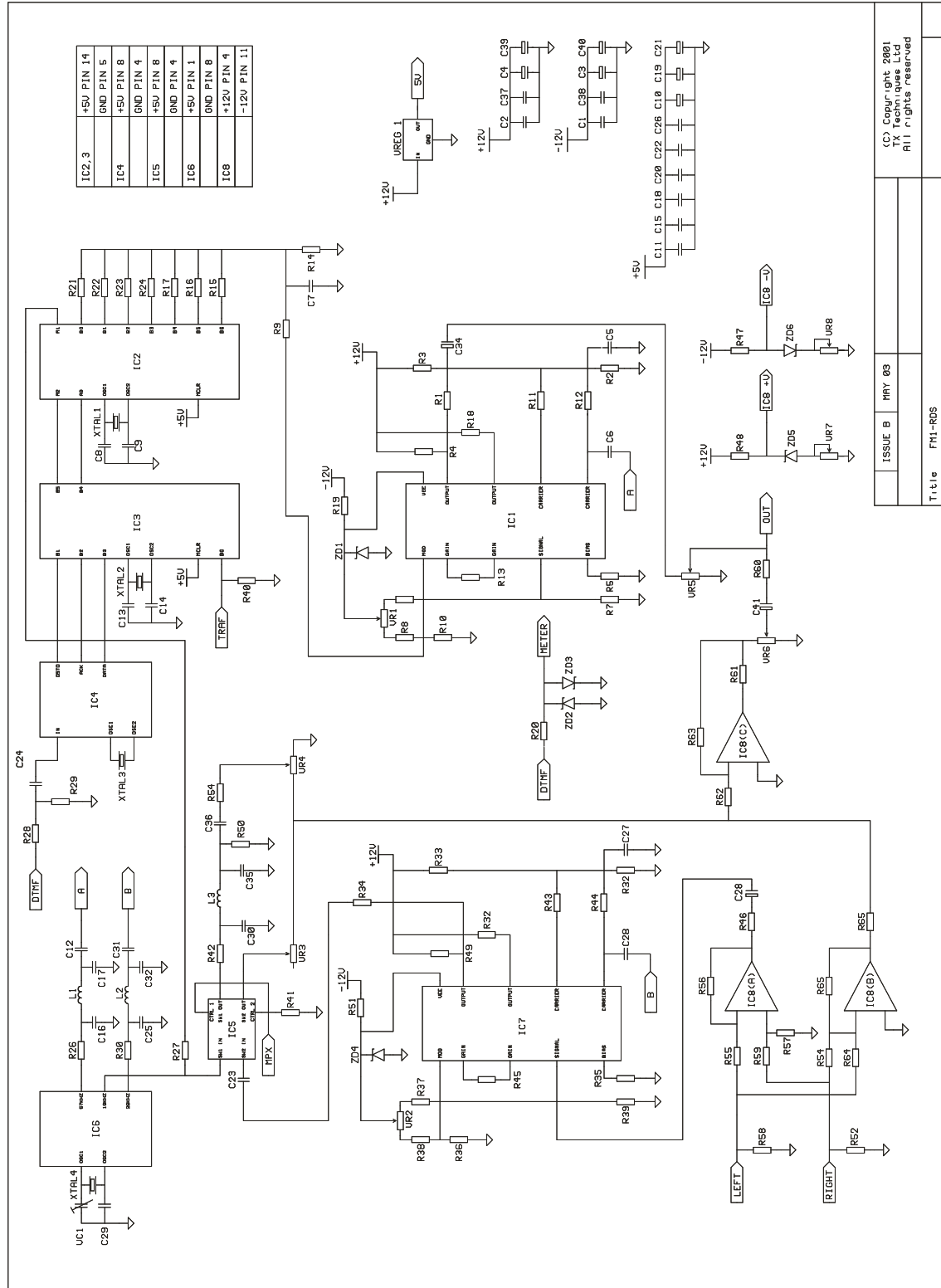
| | |
|------------|------------|
| IC6, S, 10 | +12V PIN 8 |
| IC7, 11 | -12V PIN 4 |
| | +12V PIN 7 |
| | -12V PIN 4 |

| | | |
|-----------------------------|--------|--|
| ISSUE B | JUN 03 | (C) Copyright 2001 TX Techniques Ltd All rights reserved |
| Title FM1-ALC RIGHT CHANNEL | | |

9.4 FM1-AP



9.5 FM1-RDS

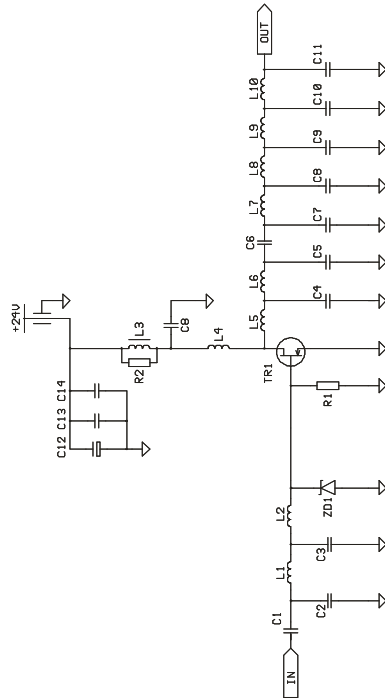


(C) Copyright 2001
TX Techniques Ltd
All rights reserved

ISSUE B MAY 03

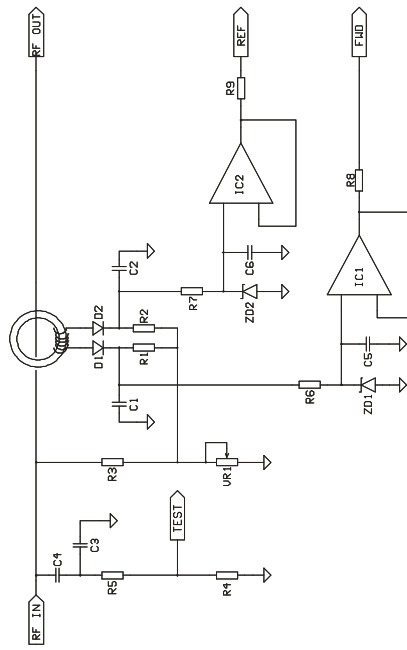
Title FM1-RDS

9.6 FM1-PA



| | | |
|--------------|--------|--|
| ISSUE C | AUG 03 | (C) Copyright 2001 TX Techniques Ltd All rights reserved |
| Title FM1-PA | | |

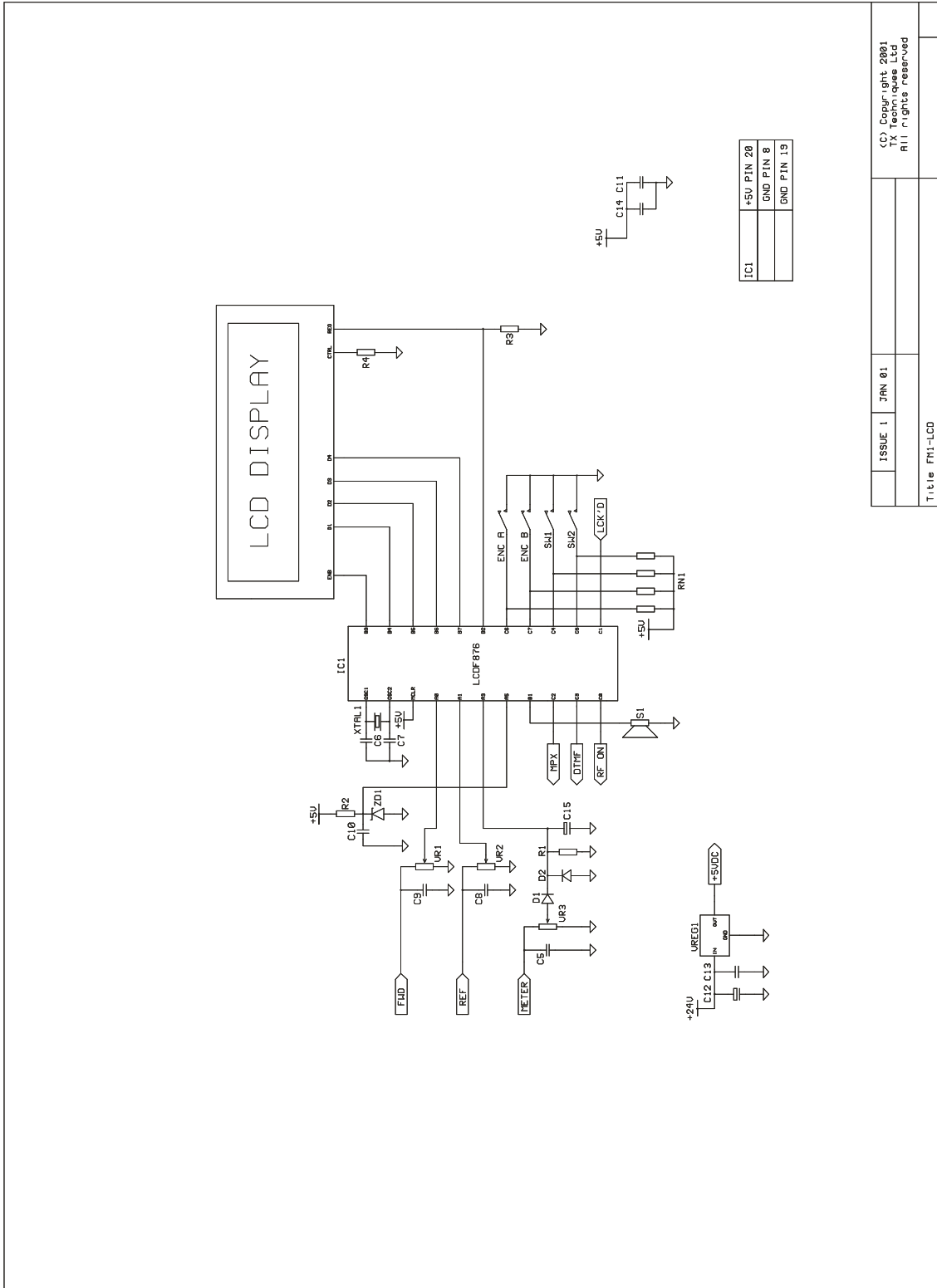
9.7 FM1-RF



| | |
|-------|------------|
| IC1,2 | +24V PIN 7 |
| | 0V0 PIN 4 |

| | | |
|--------------|--------|---|
| ISSUE A | JRN 01 | (C) Copyright 2001 TX Technique Ltd All rights reserved |
| Title FM1-RF | | |

9.8 FM1-LCD



| | |
|-----|------------|
| IC1 | +5V PIN 28 |
| | GND PIN 6 |
| | GND PIN 19 |

| | | |
|---------------|--------|--|
| ISSUE 1 | JAN 01 | (C) Copyright 2001 TX Techniques Ltd All rights reserved |
| Title FM1-LCD | | |

10. Declaration Of Conformity

EC Declaration of Conformity to R&TTE Directive 1999/5/EC

We, TX Techniques Ltd
Transmission House
PO Box 150
Harrogate
HG2 8UX

hereby take sole responsibility to confirm that the product:

TX-FM1 /S/R/A

and variants: TX-FM1 /R/A TX-FM1 /LR
TX-FM1 /W
TX-FM1 /RBRX

which this declaration refers to, conforms to all applicable requirements of EU Directive 1999/5/EC and is CE marked accordingly:

LVD 73/23/EEC:

EN60215 (and amendments where applicable)

EMC Directive 89/336/EEC:

| | |
|-----------------|-------------|
| EN55022 Class 2 | EN61000-4-2 |
| EN61000-4-3 | EN61000-4-4 |
| EN61000-4-5 | EN61000-4-6 |
| EN61000-4-11 | |

R&TTE Conformity was assessed via Annex IV, using a technical construction file examined by notified body 0885, CTMS Ltd. Standard used to show compliance to the essential requirements of:

ETS 300 384 : 1995

The following operation conditions and installation arrangements have to be presumed:

- (i) According to Operating Instruction Manual
- (ii) EN-61000-4-5 Level I immunity (meets generic standard). For Level II immunity, specify at time of ordering. Retrofit option also available.

TX TECHNIQUES LTD
Transmission House
PO Box 150
Harrogate
HG2 8UX
United Kingdom
Tel +44 (0) 1423 886422
Fax +44(0) 1423 886423

N. Lewis, Director

31 October 2001

11. Technical Specifications

Audio:

| | |
|--------------|-------------------------|
| Inputs XLR | Electronically balanced |
| Input Level | +4dBu |
| Pre-emphasis | 50uS (75uS on request) |

RF:

| | |
|-----------------------------------|--------------------------------------|
| Frequency (selectable internally) | 87.50 to 108.00MHz |
| Frequency stability | Better than ± 200 Hz |
| Output Power | 10 - 30W max (adjustable internally) |
| Type | MOSFET Class AB |
| Power flatness | ALC governed |
| Harmonics: | -70dBc or better |
| Spurii | -75dBc or better |

Stereo Encoder:

| | |
|-----------------|------------------|
| Separation | Better than 42dB |
| Subcarrier null | Better than 50dB |
| Pilot stability | 2Hz typical |

RDS Encoder:

| | |
|---------------------|------------------------------------|
| Blocks handled | 0B & 2A |
| Features | PI, PTY, AF, PS, RadioTEXT, TP, TA |
| TA remote switching | DTMF tones |

Power Supply:

| | |
|-------------|--------------------------|
| Input AC | 85V to 264V (47 - 63 Hz) |
| Input DC | 120V to 370V |
| Consumption | 170W (max) |

Mechanical:

| | |
|-------------|-------------------------------|
| Size (mm) | 132(H) x 483(W) x 394(D) |
| Weight | 8.2kg |
| Temperature | -10°C to +45°C* |
| Humidity | 95% (relative non-condensing) |

Standards:

| | |
|------------------------------|--------------------------------------|
| Approved by UK Notified Body | No. 0885 |
| Radio Performance | ETS 300 384 (Essential requirements) |
| EMC | ETS 300 447 |
| Safety | EN60215 |

* Liquid crystal in LCD may exhibit some abnormalities at extreme temperatures.

We reserve the right to alter specifications without notice.

TX Techniques Ltd
Unit 25 Claro Court Business Centre
Claro Road
Harrogate
HG1 4BA

Tel +44 (0) 1423 565394
Fax: +44 (0) 1423 520996
engineering@txtechniques.co.uk