

ALAN HP-425/-425K SERVICE MANUAL

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SPECIFICATION

TEST METHODS

- ETS 300-086
- ETS 300-113
- IEC 529 IP54
- MIL STD 810 C/D/E

GENERAL

- Frequency Bands UHF 440÷470 MHz
- Number of Channels..... 280
- Frequency Control..... Synthetiser
- Modulation System F3E / G3E
- Channel spacing..... 12,5 / 20 / 25KHz
- Temperature Range operative -25 / +55 °C,
- Temperature Range storage..... -40 / +80 °C
- Humidity 90% not condensing @ -15 / +55°C
- Power Supply 7.2 Vdc (battery NiMH 1200mA/h)
- RF Impedance 50Ω
- Antenna socket MX type
- Frequency Stability better than ±2.5ppm

TRANSMITTER

- RF Output Power 5W programm. (programmable Hi/Low channel dependent)
- Modulation System FM (F3E) / PM (G3E)
- Maximum Deviation ±2.5 KHz 12.5KHz, ±4 KHz 20KHz, ±5 KHz 25KHz
- Adjacent Channel Power..... < -60dB
- Spurious Emissions < 0.25μW 9KHz÷1GHz, <1μW 1÷4GHz
- Switching Bandwidth full band
- Tx attack time max 25ms
- Tx release time..... max 20ms

RECEIVER

- **Circuit Type** Double Conversion
- **Intermediate Frequencies**..... I 45 MHz, II 455 KHz
- **Sensitivity** < 0.25 μ V @ 12 dB SINAD
- **Distortion**..... < 3%
- **Co-channel Rejection** < -6dB 12.5KHz, < -4dB 25/20KHz
- **Adjacent Channel Selectivity** > 60dB 12.5KHz, 70dB 25/20KHz
- **Spurious Response Rejection** > 70dB
- **Intermodulation Resp. Rejection** > 65dB
- **Blocking**..... > 85dB
- **Switching Bandwidth** full band
- **Rx opening delay** max 15ms
- **Carrier sense delay** max 10ms
- **Squelch threshold** 0.18 μ V
- **Squelch hysteresis**..... < 2dB

AF & signalling

- **audio power**..... > 500mW
- **CTCSS decode sensitivity** < 6dB Sinad
- **CTCSS decode selectivity** accept tones $\pm 0,5\%$
- **Selcall decode sensibility** > 99% @ 12 dB sinad
> 97% @ 10 dB sinad
- **Selcall decode selectivity**..... accept tones $\pm 1,5\%$
reject tones $\pm 3\%$

Mechanical Specs

- **Dimensions**..... 148 x 36 x 60 mm (with battery pack)
- **Weight**..... 385 gr (with battery pack)
- **display** 2 x 12 char alphanumeric & backlighted
- **keyboard** 12 + 3 function keys + UP/DOWN/MENU
keys and Emergency Call button
- **battery**..... Back slide battery
- **accessory connector** Hirose 10 pins connector and mono Jack
- **radio and key paint**..... grease resistant
- **shock resistant** follow MIL STD 810
- **water & dust**..... IEC529 IP54

ALIGNMENT & REPAIR

ALIGNMENT

ALAN HP-425/-425K is full bandwidth radio: adjustments are not necessary. A factory adjustment assures that:

- RF power output is stable for the full bandwidth;
- Main modulation is equalized for the full bandwidth with or without CTCSS;
- CTCSS modulation is equalized for the full frequency bandwidth and for the full subtones frequency range.

User can readjust RF power output and modulation according to his specific needs.

For Power output and Main/CTCSS modulation adjustment, pls refer to the programming manual.

CIRCUIT DESCRIPTION

This series of radios are comprised of an RF PCB and a Control PCB. The RF PCB contains the Frequency Synthetiser, Transmitter and First IF Receiver circuits. The Control PCB contains the Second IF Receiver circuits, microcontroller, audio processor and associated digital circuits.

UHF RF PCB - FREQUENCY SYNTHETISER

With data received from the Eeprom IC119 (24LC66ISM) via a dedicated Bus the frequency synthetiser circuit controls and produces the RF carrier frequency for the transmitter during transmit and the local oscillator frequency for the receiver. The frequency synthetiser circuit is comprised of:

- Voltage Controlled Oscillator (VCO) module
- Charge Pump and Loop Filter
- PLL Frequency Synthetiser

Voltage Controlled Oscillator (VCO) module

The module contains two VCOs. One for producing carrier frequencies during transmit (TX VCO) and one for producing the local oscillator frequency during receive (RX VCO). The module also has RX and TX powerline filters.

RX and TX powerline filters

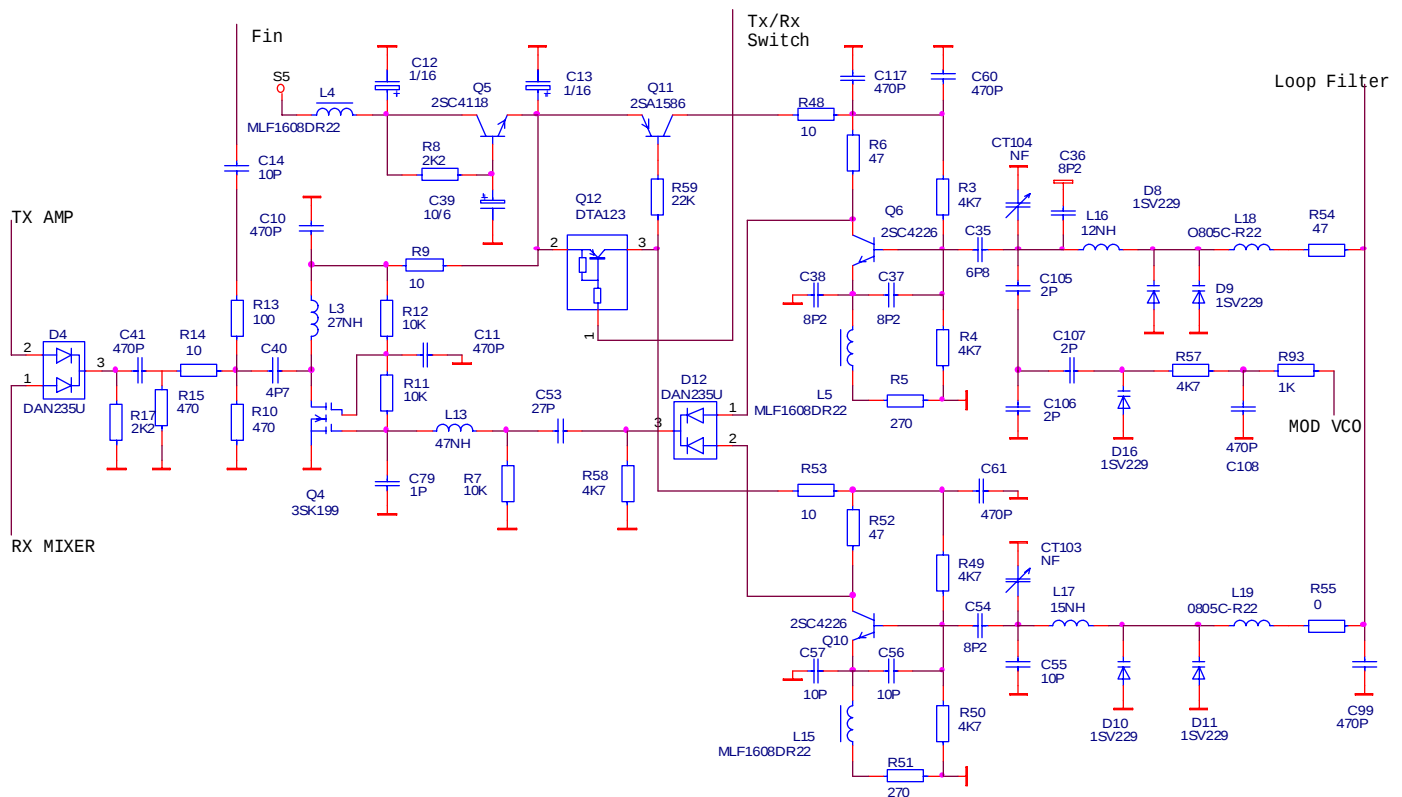
Transistor Q5 is configured as a 5V power supply ripple filter. The filter reduces the noise on the carrier and local oscillator signals.

RX VCO

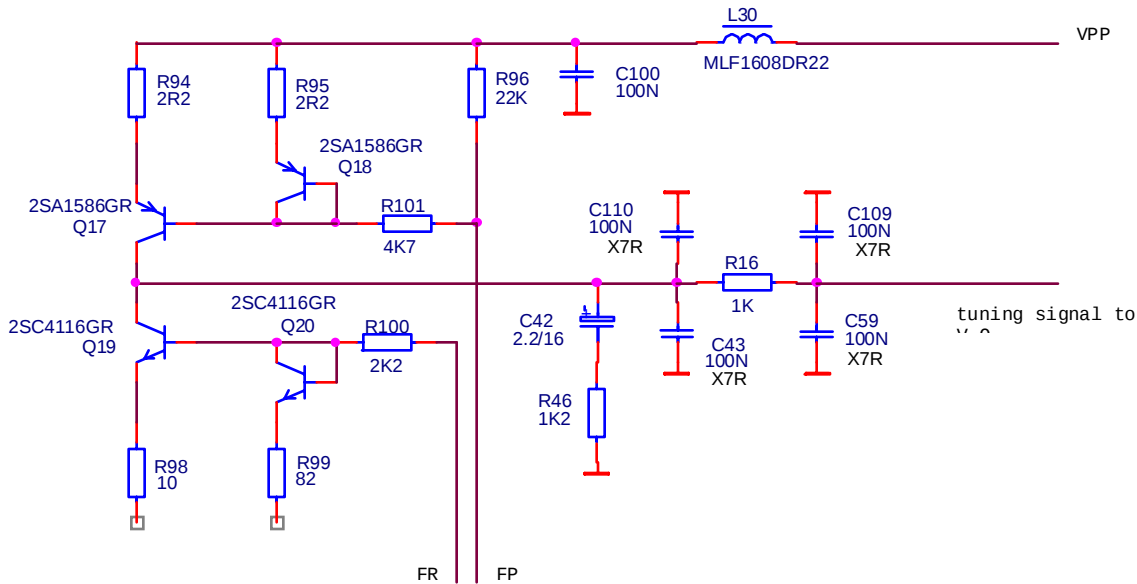
The RX VCO comprises transistors Q10, coil L15 and varactors D10 and D11. It is configured as a Colpitts oscillator. Its complexity comes from the balance between wide band and low noise needs. The resonant circuit produces a different frequency with a change in DC voltage controlled by the tuning voltage signal present at the cathode of D10 and D11. The local oscillator signal is applied to the buffer/amplifier Q4. D4 is a dual diode, when 1 of the 2 is reverse biased the other one is forward biased. Due to D4, the LO signal is applied to the mixer.

TX VCO

The TX VCO comprises transistors Q6, coil L5 and varactors D8, D9, and D16. It is configured as a Colpitts oscillator. The resonant circuit produces a different frequency with a change in DC voltage controlled by the tuning voltage signal present at the cathode of D8 and D9. The AF signal at connector X1 pin13 is applied to the cathode of D16 to produce FM modulation. The signal is applied to the buffer/amplifier Q4. D4 is a dual diode, when 1 of the 2 is reverse biased the other one is forward biased. Due to D4, the RF signal is passed to the power amplifier via Q13 and Q9.



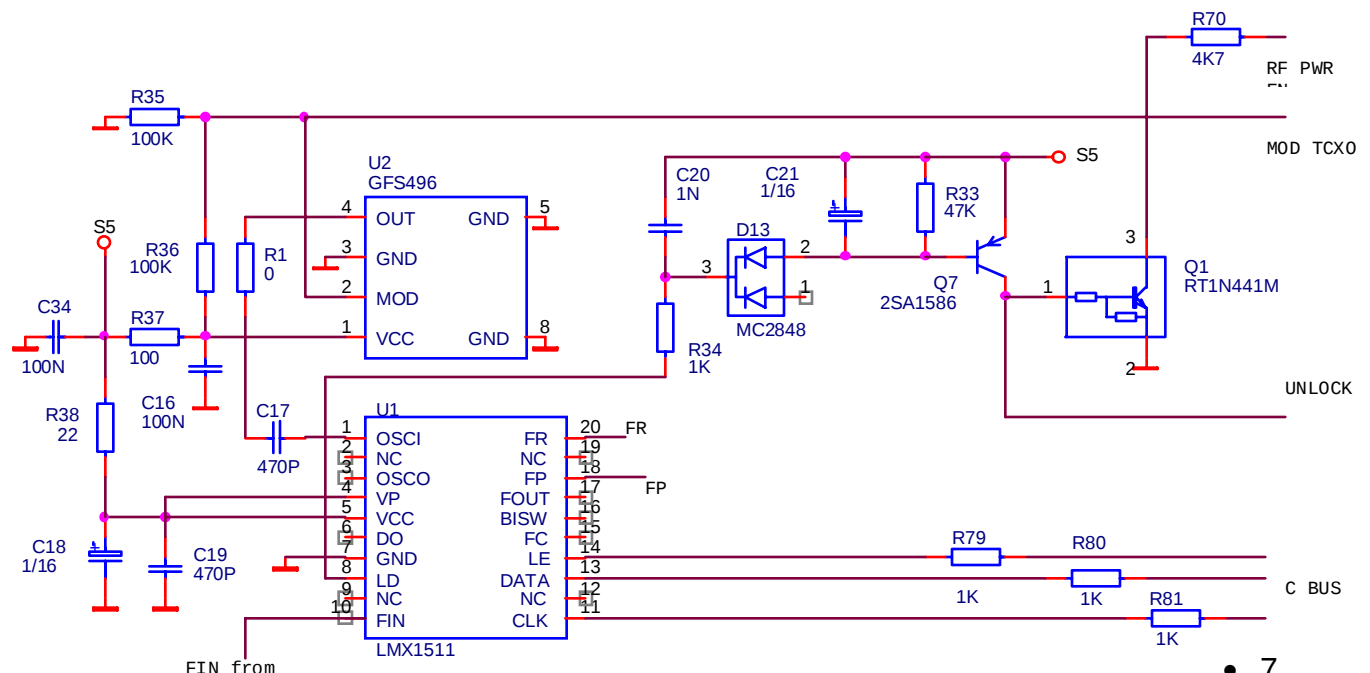
Charge pump and loop filter



Transistors Q17-Q20 and R94-R101 form the charge pump. The associated R-C form the loop filter. The signals ϕ_p and ϕ_r correspond to the phase detector outputs of the LMX1511 frequency synthesiser. These logic signals are converted into current pulses, using the circuitry Q17-Q20/R94-R101 form, to enable either charging or discharging of the loop filter components to control the output frequency of the PLL. The tuning signal is filtered by the loop filter (R16-R46/C42-C43-C59-C109-C110) to remove any residual reference frequency harmonics from the signal. After filtering the signal is applied to the VCO and to the receiver front end.

PLL frequency synthesiser

The PLL frequency synthesiser U1 LMX1511 contains prescaler, phase comparator with lock detector, internal dividers, internal charge pump and analog switch. An external TCXO assures that the frequency remains stable across the temperature range (typically ± 2.5 ppm). Besides TCXO offers a modulation port for the 2 port modulation system.



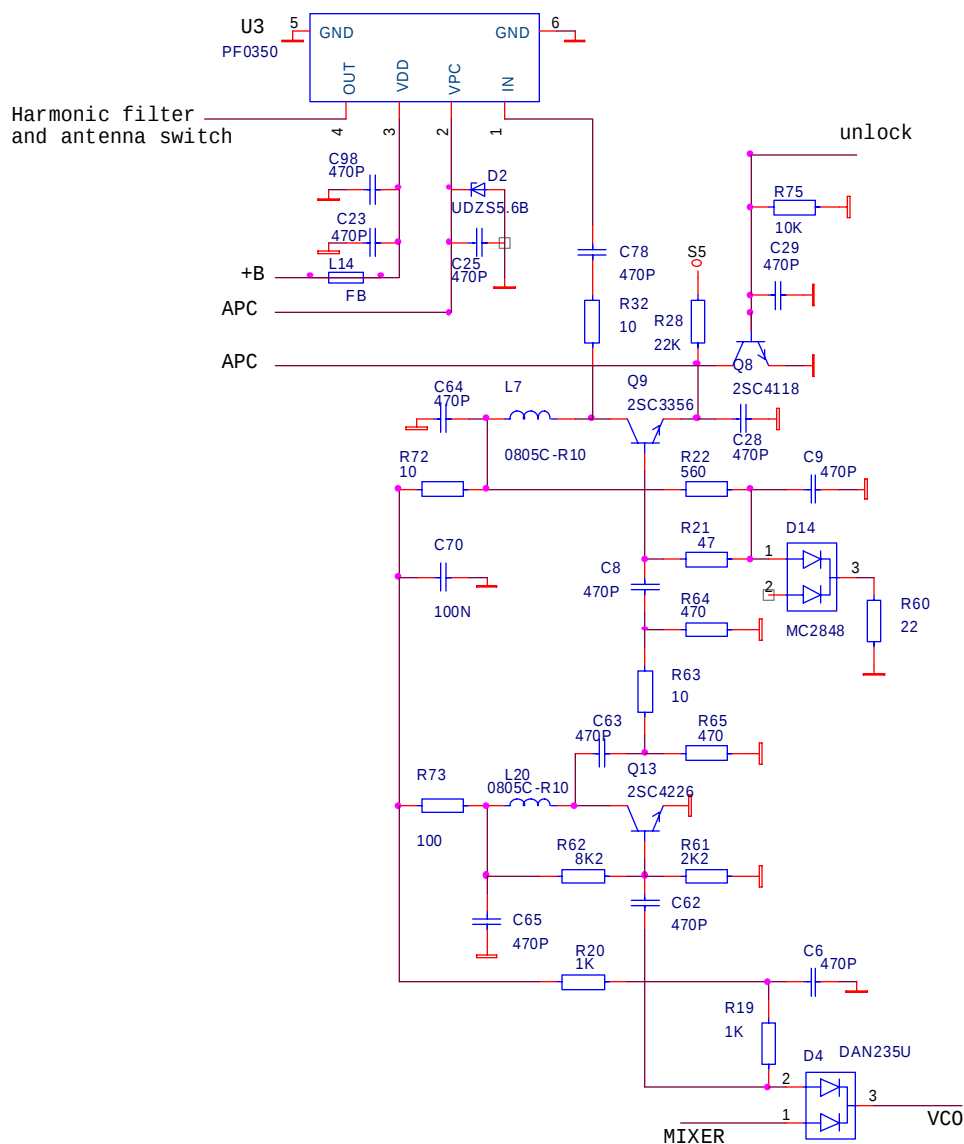
UHF RF PCB - TRANSMITTER

The Transmitter is comprised of:

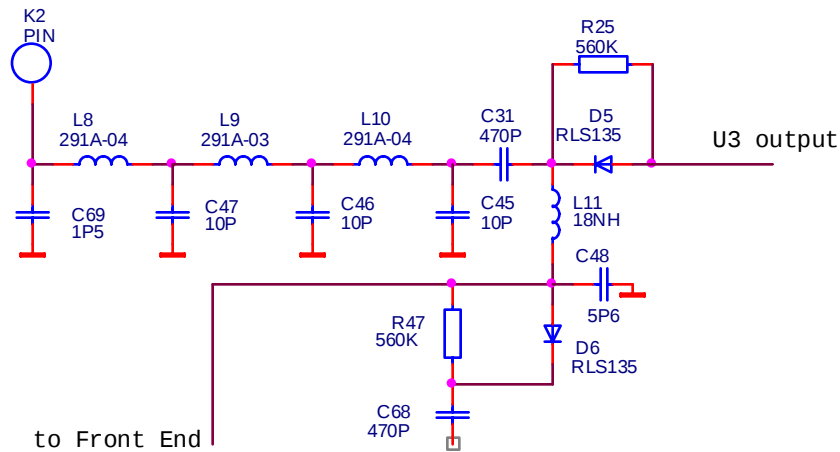
- Power Amplifier
- Harmonic Filter
- Automatic Power Control

Power amplifier

The power amplifier contains transistors Q13, Q9 and U3 and associated inductors, capacitors and resistors. When the radio is in transmit mode, the dual diode D4 enables the modulated RF signal from the VCO to pass to the buffer/preamplifier Q13 and Q9. Q8 enables Q9, so as to avoid unwanted transmission (i.e. Q8 does not enable Q9 in case of PLL UNLOCK). The output signal is passed from Q9 to U3 via a matching network consisting of L7 and C78. The signal is then amplified for transmission by U3 Hitachi PF0350.

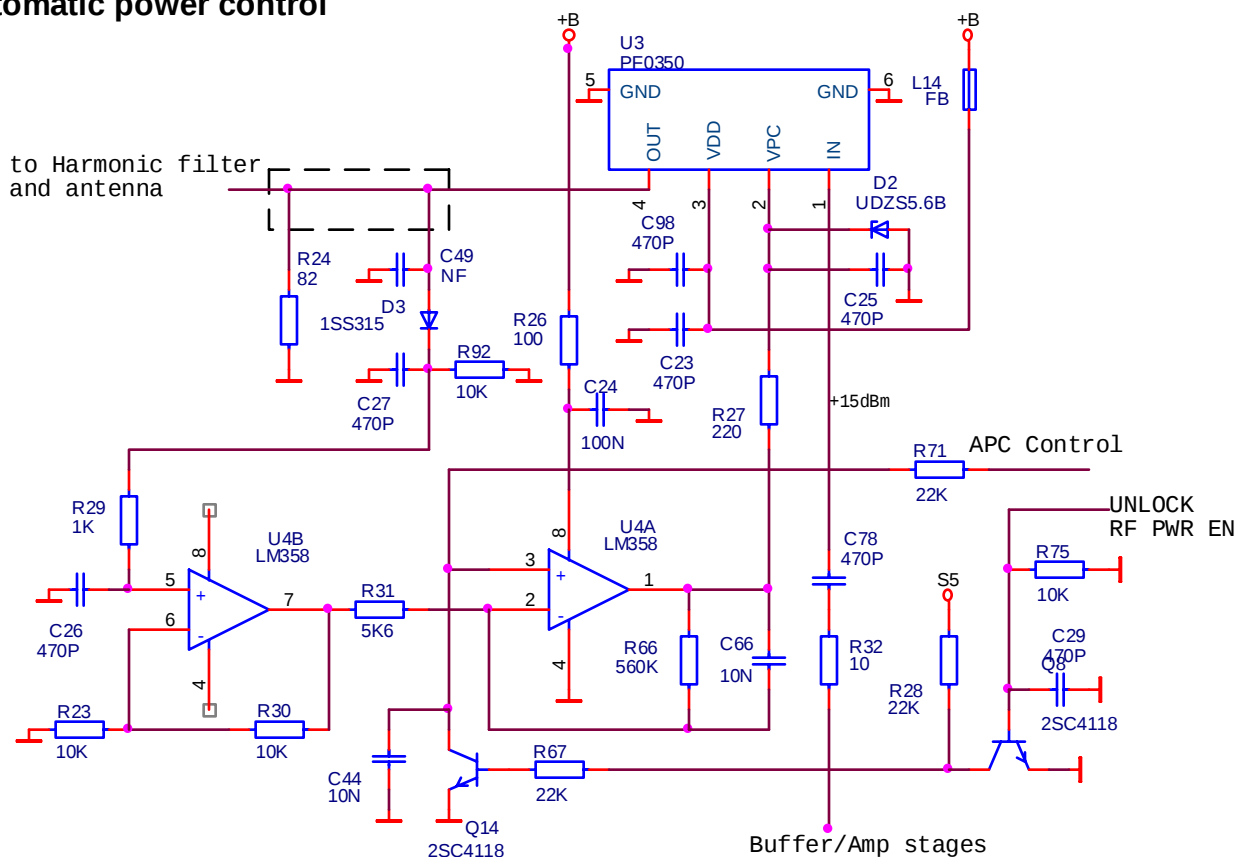


Harmonic filter



The amplified RF signal is passed to the harmonic low pass filter, comprising L10 to L8 and C31 to C69 and then to the antenna connector. Diode D6 is forward biased causing L11 to look like an open circuit to the transmitter inhibiting the TX signal through the receiver stage.

Automatic power control



The RF signal is rectified by D3 to produce a DC voltage. U4A is a differential amplifier. In transmit mode a reference level for U4A is supplied, depending on customer programming power output level, by microcontroller (PWM output pin 54). The reference level and the detected level are compared and a difference signal is produced. The

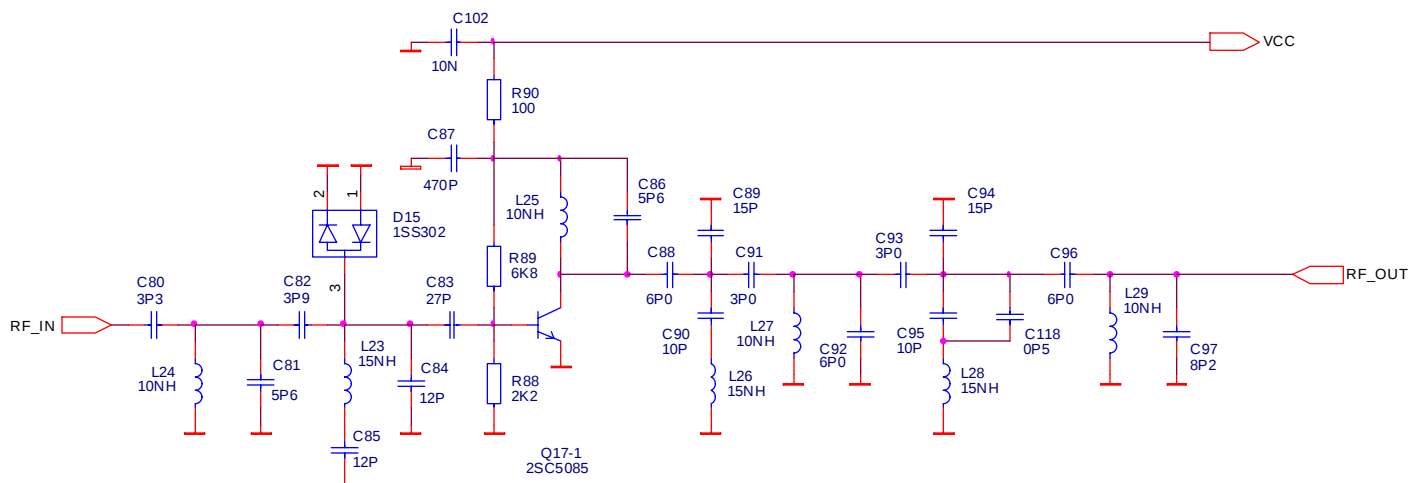
difference signal controls the supply voltage to the first amplifier stage in U3. This control loop produces a constant power output at the antenna connector.

UHF RF PCB - RECEIVER

The Receiver is comprised of:

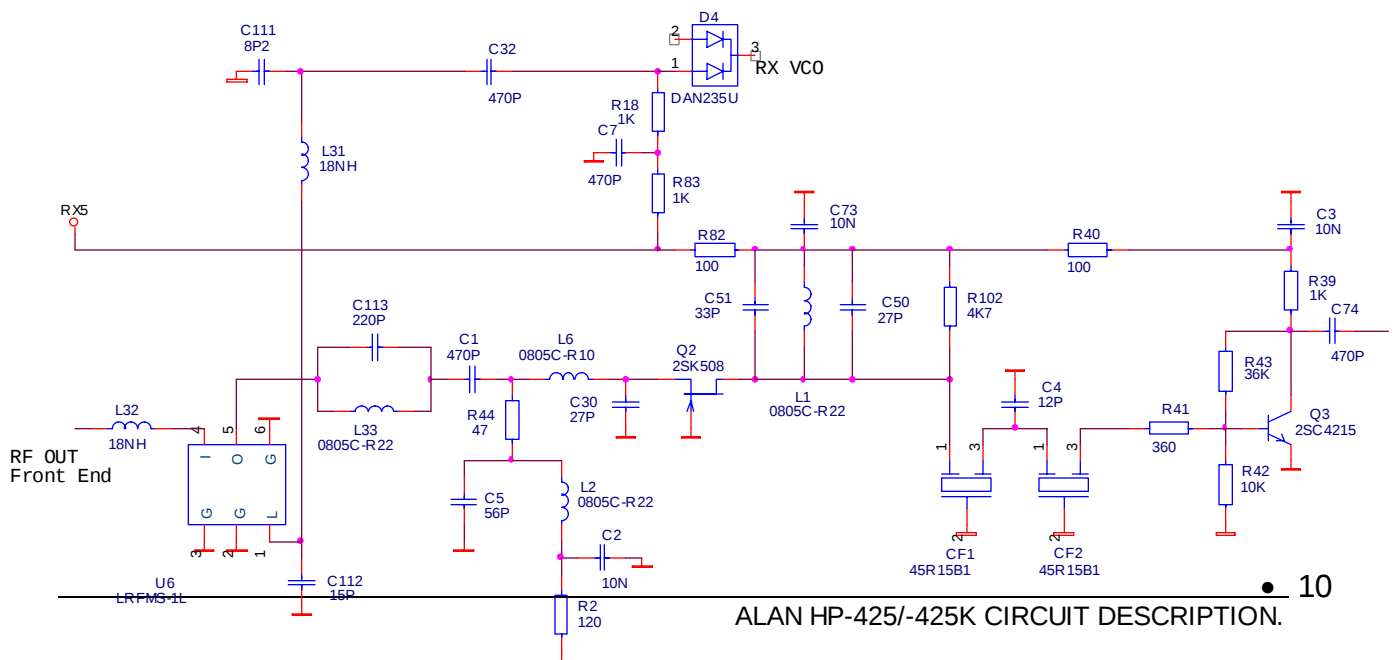
- Front end filter/amplifier
- First mixer and first IF filter/amplifier

Front end filter/amplifier



The receive front end contains 2 stages of filtering and an amplifier Q17. The module filters out the unwanted frequencies and provides a gain for the wanted frequencies. The wanted RF signal at the operating frequency is passed to the first mixer.

First mixer and first IF filter/amplifier



U6, 2-pole crystal filters CF1-CF2 and associated L-C components, and Q3 form the first mixer and first IF filter and amplifier. The wanted RF signal at the operating frequency from the receiver front end (at pin 4) and the VCO local oscillator signal (at pin1) are passed to the mixer U6. It produces a difference frequency of 45MHz at pin 5. The 45MHz difference frequency is filtered by the crystal filters CF1-CF2. The associated L-C components provide matching of the crystal filters to assure a good pass-band response and selectivity. The first IF signal is amplified by Q3 and passed to the second mixer on the control pcb.

Second mixer, second IF filter/amplifier and FM detector

Placed on logic board, IC117 is a single conversion FM receiver integrated chip, and contains the second mixer, second IF amplifier and FM detector. The second local oscillator frequency is determined by the crystal X105 connected to pin 1 of IC117. The first IF signal is received at pin 16 of IC117 and is applied to the mixer. The output of the second mixer, a frequency of 455KHz, is the difference between the IF signal and second local oscillator. The 455KHz passes via pin 3 and is applied to a 455KHz band pass filter, FL101 12.5KHz channel spacing or FL102 20/25KHz channel spacing. The selection of the 2 filters is accomplished by diodes D110-D111 whose bias is controlled by software. The output is passed via pin 5 to a high gain IF amplifier coupled to the adjustable quadrature detector L107 at pin 10. Any detected signal is produced at pin 9 of IC117 to the receiver audio circuit and the mute circuit.

Receiver audio circuit

The signal is passed to the audio processors IC114/IC110, which contain high and low pass voiceband filters with high CTCSS rejection properties. The audio signal from pin 21 IC110 is fed to the audio amplifier IC103. The amplified audio signal is applied to the internal speaker.

Mute circuit

The squelch circuit switches off the audio power amplifier in absence of audio signal (and of course of other signalling systems). The squelch circuit comprises a 20KHz band pass filter formed by R240-R181-R189-R168-C201-C115. The noise in the 20KHz band is accepted, frequencies in the voice frequency band are rejected. Any noise present at the output of the filter is applied to the noise detect circuit via pin 8 IC117. The noise is detected and amplified in IC117 and passed via pin 14 IC117 to pin 2 IC108 microcontroller via the filter R165-R171-C178-C177 (which provides the squelch hysteresis of max 3dB). Microcontroller sets the squelch trigger on frequency and channel spacing basis.

CONTROL PCB

The Control PCB performs the following main functions:

- Second mixer, second IF filter/amplifier and FM detector;
- Audio Processing;
- Signalling Systems;
- Radio control and data storage.

The operation and function of the control board centres around 5 integrated circuits. these are:

H8F3644 IC108, 8 bit single chip microcontroller with the addition of 32K of flash ROM and 1K bytes of RAM.

FX828 IC114, a low voltage signal processor for CTCSS-DCS-Selective Calling generation and decoding. It is also used as an alert generator. Its internal high and low pass filters form an RX voiceband filter with high CTCSS rejection properties.

FX829 IC110, a low voltage audio processor for audio processing, DTMF generation and FFSK generation and decoding. It contains high and low pass voiceband filters and an amplitude limiter. Path bandwidth is switchable for use in both 12.5 and 25KHz channel spacing applications.

Three variable attenuation blocks are available to set both RX volume and TX modulation levels. The TX modulation outputs provide two-point modulation drives.

LC7385 IC115, a low voltage signal processor for DTMF decoding.

24LC65I/SM IC119, it is a “smart” 8K x 8bit EEprom addressed over the dedicated bus and implemented by the microcontroller. It stores all the programmable parameters for the operation of the radio.