6 TECHNICAL DESCRIPTION

6.1 Introduction

The transmitter consists of 4 printed circuit boards.

- RF-board (X-99040). This board contains the transmitter power amplifier chain, antenna relay, directional couplers, and voltage regulators.
- LF-board (X-99035). This board contains all the audio processing - amplifiers and filters, user and remote interface, microcontroller that controls the synthesiser and BITE. In addition the synthesiser unit is mounted on this board.
- Front panel board (X-99038). This board holds the display and the push buttons on the front panel.
- Synthesiser unit (X-99107). The synthesiser unit includes the VCO, buffer amplifier, reference oscillator and synthesiser.

Most components used are of SMD type (surface mount) except some higher power devices in the power supply and in the power amplifier.

6.2 RF-board (X-99040)

The RF board can be divided into three main sections:

- RF amplifier.
- Directional couplers and filter
- Voltage regulators.

The RF board is connected to the LF board via a ribbon cable.

6.2.1 RF amplifier

The RF amplifier is a 4-stage broad band amplifier. This transmitter uses low level modulation and no high power audio amplifier for modulation is needed.

A RF signal (app. +10 dBm) from the synthesiser module (located on the LF board) is fed into PL101 on the RF board.

The signal is attenuated in the network consisting of R108/R113/R116 to achieve a good matching for the output of the synthesiser.

Q101 is the first amplifier. The gain in this amplifier is controlled by the modulation control consisting of IC103 and Q102. IC103A compares the signal received from the

directional coupler at the transmitter output with the modulation signal generated on the LF-board and adjusts the drive of Q102 to minimise the error between the two signals. In this way a RF signal with very low distortion is achieved at the transmitter output.

A 4:1 impedance transformer matches the signal to the input of the predriver transistor, Q103. Q103 is of MOSFET type, and the bias voltage is also modulated to achieve high dynamic range. The output is taken trough a 4:1 impedance transformer and fed to the input of the driver transistor Q108. Q108 is also of MOSFET type.

Q108 drives the output stage Q111 trough a single ended 4:1 impedance transformer, and a 9:1 balanced impedance transformer. Q111 is a "gemini" transistor set wich operates as a push-pull amplifier. The output is impedance transformed and converted to single ended by transformer T105.

All the power stages are operated as class C amplifiers. This increases the overall efficiency of the transmitter and is possible since low level modulation is used.
All RF stages are enclosed in a shielded box to avoid excessive RF interference on the surrounding circuitry.

6.2.2 Directional couplers and filter

From the output of the final amplifier the signal is fed via the output transformer into a 5-section lowpass filter consisting of L105/107/109/106/108 and C172/176/177/173/178/174. The lowpass filter ensures excellent attenuation of the harmonics from the output stage.

A directional coupler is the last element in the signal path. It plays a vital role in the modulation process, and is a critical part for obtaining good modulation characteristics.
Both forward and reflected power is detected in the directional coupler. D110 detects the reflected power and D109 detects the forward power. Both signals are fed to the LF-board for monitoring purposes.

The forward detector is the most critical part in this construction. To linearize the detection, D109 and D110 are biased by a diode, D111. This assures that temperature drift in the detector diodes is minimised, since the temperature on all the diodes is approximately the same.

The signal out of D109 consists of a DC level, proportional to the power level, and an AC level, proportional to the modulation level. This signal is fed to the amplifier IC103. The signal is compared with the modulation signal from the LF board. The resulting signal controls the current in Q101.

6.2.3 Voltage regulators

The internal voltage regulators of the transmitter are placed on the cooling profile and connected to the RF board.
IC106 supplies 5V for the front LED display.
IC107 supplies 12V for the LF-board and RF board.
IC105 and IC104 is the fan control circuit. A NTC resistor mounted on the cooling tunnel senses the temperature of the cooling tunnel and the speed of the fan is regulated according to the measured temperature.
The main supply for the RF amplifier is regulated with IC104A and Q109. This regulator is keyed with the key signal from the LF board. Q109 is a very low on resistance NFET and acts as a switch when the input voltage goes below the wanted output voltage.

The relay RL101 is the main switch and also acts as a reverse polarity protection thanks to D107. IC106 supplies app. 35V (input voltage + 8.2V) to the main regulator.

Current measurement is done with IC109. There is also a current limiter (IC102B) which reduces supply voltage if current consumption is too high.

6.3 LF Board (X-99035)

The LF Board can be divided into the following sections:

- Synthesiser (X-99033)
- Audio circuits
- Control circuits

The LF board is connected to the RF board via PL4 and a ribbon cable. The front board is plugged directly into PL1.

6.3.1 Synthesiser.

The synthesiser is located inside a separate screened box on the PCB. Q206 is the oscillator transistor. The output frequency is controlled by the varicaps D209, D210, D211 and D212.

The signal is tapped on the lower side of the tank coil to ensure as high Q as possible. The signal is buffered by the emitter follower Q205, and then feed to the synthesiser (IC203) and an ECL divider (IC201).

The signal from the divider circuit is amplified by Q203 and is then put through a tunable bandpass filter. This filter reduce wide band noise, as well as spurious frequencies from the synthesiser. The filter is tuned with the loop voltage, buffered by IC207.

The synthesiser has a built in dual modulus prescaler. IC204 is the reference oscillator, it operates at 12.8MHz and is a high quality VCTCXO type to achieve excellent stability versus temperature and time. It has a voltage input to enable tuning of the center frequency. This tuning is software controllable, and frequency adjustement is available from the front panel of the transmitter.

The output from the phasecomparator is filtered in a passive loopfilter to minimise noise in the output signal.

Q204 and surrounding components act as a low noise voltage regulator, filtering the supply voltage for the VCO.

The frequency is programmed by the microcontroller via a SPI bus.

6.3.2 Audio circuits

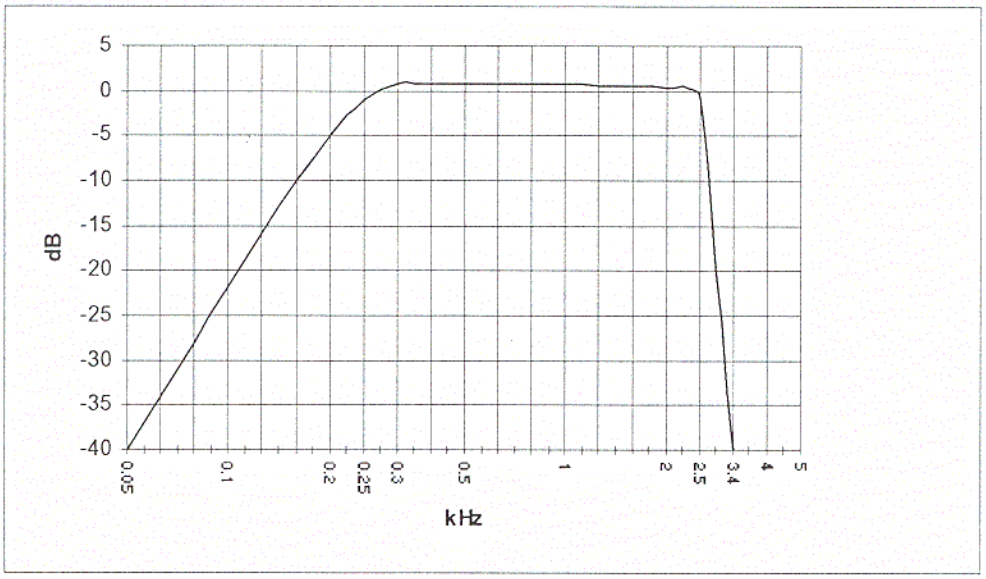
The microphone amplifier has symmetrical input with the inverting input normally connected to ground. IC6 is the input stage. The signal from this amplifier is fed into the CMOS switch IC9. This switch selects between the Mic input or the Line input. From IC5 the signal goes into an AGC controlled amplifier consisting basically of IC5 and Q2.
The output level from this amplifier is controlled with output op-amp IC10A, which is dependent of the voltage of the transmitter power supply.

Q3 is used to mute the amplifier. If the input level is below the set level, adjusted with R87, Q2 will short-circuit the signal to ground. The mute facility can be switched off from the front panel (see chapter 5, Operating instructions).

IC4B, IC4C and Q4 act as a limiter. This circuit is used to prevent overmodulation of the transmitter during transients.

From the output of 4D the signal enters the audio filter which is of switched capacitor type.

Figure F, Typical audio response



The cut off frequency can be changed between 3.4 kHz and 2.5 kHz dependent on wether a 25 kHz or an 8.33 kHz channel is used. Changing the clock frequency of the filter changes the cut off frequency. IC15 and resonators Y1 and Y2 generate clock.

Further the signal is amplified and DC-offset in amplifier IC10C and IC10D. The reference voltage of this amplifier is the supply voltage of the RF output stage. This is to reduce the modulation signal if the input voltage of the transmitter drops.

From IC10D the signal is fed through the IC8C potentiometer. This potentiometer is used to set the different output power levels and is controlled by the microcontroller. The output from the potentiometer is fed through the CMOS switch (IC9) and into the final audio amplifier IC11A. Reference level for the low power setting is set with the IC8A potentiometer
R106 is used to adjust the output power in the initial testing of the radio, but should not be adjusted at a later stage. The modulation is pre-set with IC8B, and is available from the front panel (see chapter 5, Operating instructions).

In remote mode the audio enters trough line transformer TR2 and is fed through a buffer amplifier IC6B, and then to IC8D, the line sensitivity adjustment potentiometer, and then to the CMOS switch IC9C. From there the signal path is identical to the one described for local operation.

The termination of the line can be changed between high impedance and 600Ω. This can be usefull if more than on transmitter is connected to the same line, e.g. in a main standby cofiguration. (See chapter 5, Operating instructions).

6.3.3 Control circuits

The microcontroller sets up the synthesiser and controls several functions in the transmitter.

It also has a built in ADC with multiplexer which is used to measure the most important parameters in the transmitter, and the self-check (BITE) functions is handled by this circuit.

An external EEPROM is used to store all channel and setup information.
There are separate voltage regulators for audio/RF, synthesiser and logic circuits.

Serial communication is performed with RS-485 or RS-232. Selection of serial communication type and speed (1200b/s or 9600 b/s) is available from the front panel.

All input and output signals are protected with surge arrestors.

6.4 Front panel board (X-99038)

The front board contains the LED display and the push buttons visible on the front panel. The board is connected directly to the LF-board with PL1.