M760REM-01-0

Airband VHF Transceiver
Declaration of Design Performance

Table of Contents

1.0 Introduction

The M760REM-DDP lists and describes the performance of the transceiver. Where necessary, the performance items are referenced to RTCA standards, which define the performance items and the method of measurement.

All performance measurements for this document are made at Microair's factory at Bundaberg Australia, under standard environmental conditions.

2.0 Development History

The M760REM is a development of the Microair M760 Airband Transceiver. This development replaces the human interface display assembly, with a serial data interface.

The M760REM retains the serial data SL30 interface from the M760, for control over the active frequency, standby frequency, and dual monitor mode.

The serial data interface replaces all controls normally accessible from the display assembly, with serial command codes. A third party control unit can use these commands to maintain full control and operation of the M760REM.

Existing controls and interfaces such as the microphone audio in, headphone audio out, and PTT line remain unchanged from the original M760.

3.0 Product Description

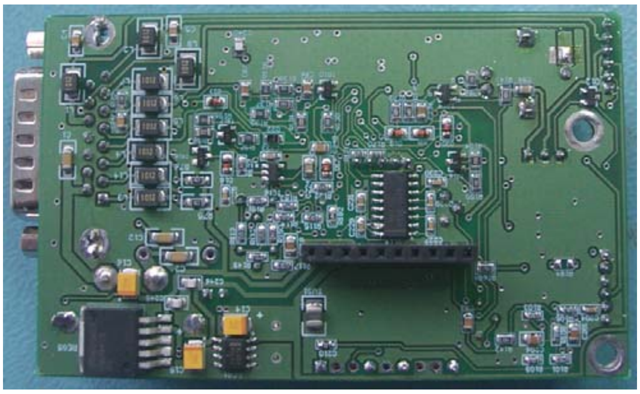
The M760REM consist of three major sub assemblies:

- AF Board (p/n M760_AF_01R18-6A)
- RF Board (p/n M760_RF_01R19-2)
- Micro Board (p/n M760UAV_MICRO_01R1-0)

3.1 AF Board

The AF (Audio Frequency) board holds the following systems:

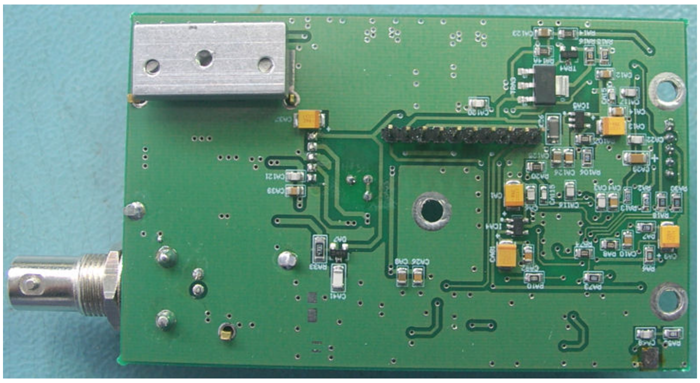
- IF filter, three stage strip, & Detector
- AGC
- Mute
- Microphone input and audio compression
- PTT switching
- Audio PA
- DB15 electrical connector
- RS232 line driver
- 9.5V regulator
- 5V regulator

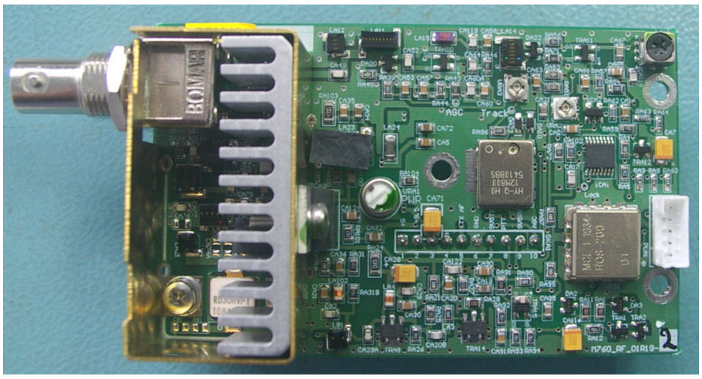


3.2 RF Board

The RF (Radio Frequency) board holds the following systems:

- TCXO
- PLL/VCO
- Receiver front end & LP filter
- Transmitter & PA
- Modulator

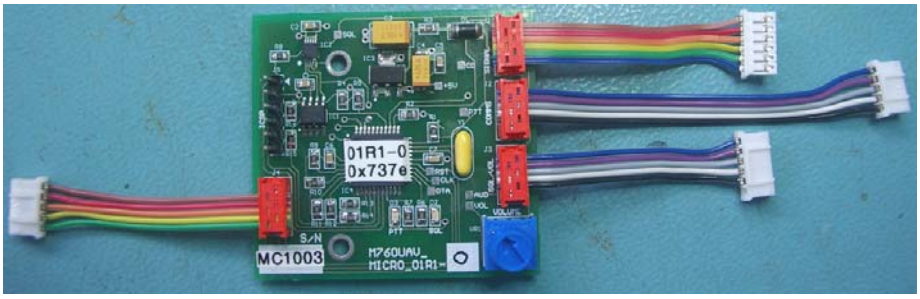


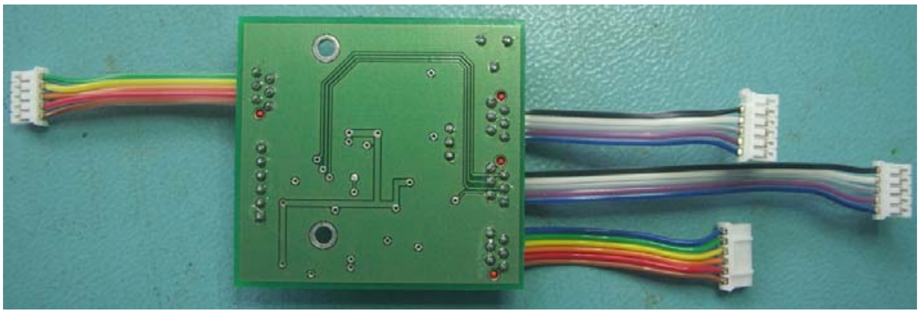


3.3 Micro Board

The Micro Board holds the following systems:

- Microcontroller
- Squelch adjust
- Headphone audio adjust
- 5V regulator

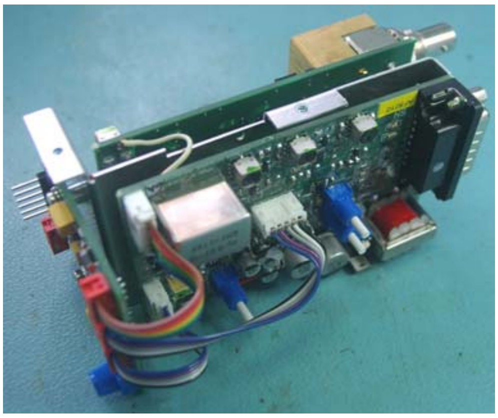


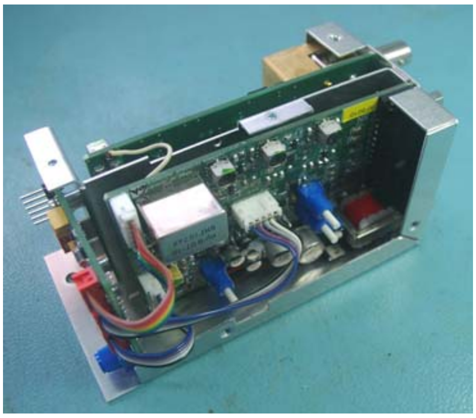


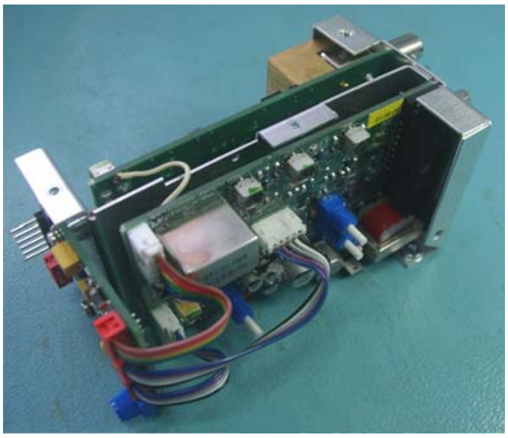
3.4 Chassis

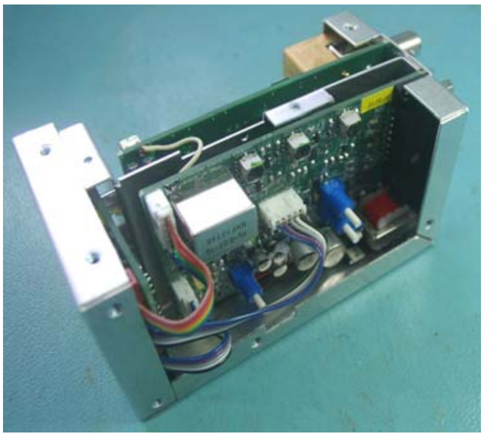
The M760REM has a sheet aluminium chassis with a divider plate in the centre, to which the AF and RF boards are fixed. The MICRO board is fixed to the front of the divider plate. Harnessing from the MICRO board connects the AF and RF boards.

The chassis is completed by a base plate, front plate, back plate, and top cover. The top cover features mounting flanges, to facilitate installation.









4.0 Frequency Tuning

The M760REM frequency control is via the SL30 command interface. Upon receipt of a valid "set active" or set standby" command, the microcontroller will decode the frequency value and pass it to the PLL via an SPI interface.

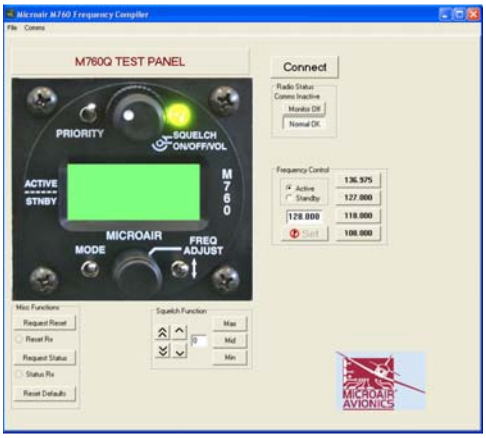
The PLL will set the control volts for the VCO, which in turn provides the signal source to the transceiver.

5.0 PC Emulation

Microair provides a PC application to emulate a standard M760 display.

The emulator interfaces to the M760REM via the PC's serial port, and used the SL30 command set.

All functions can be tested, and the application provides a communications window to confirm the command traffic.



6.0 Transmitter Function

M760 Transmitter

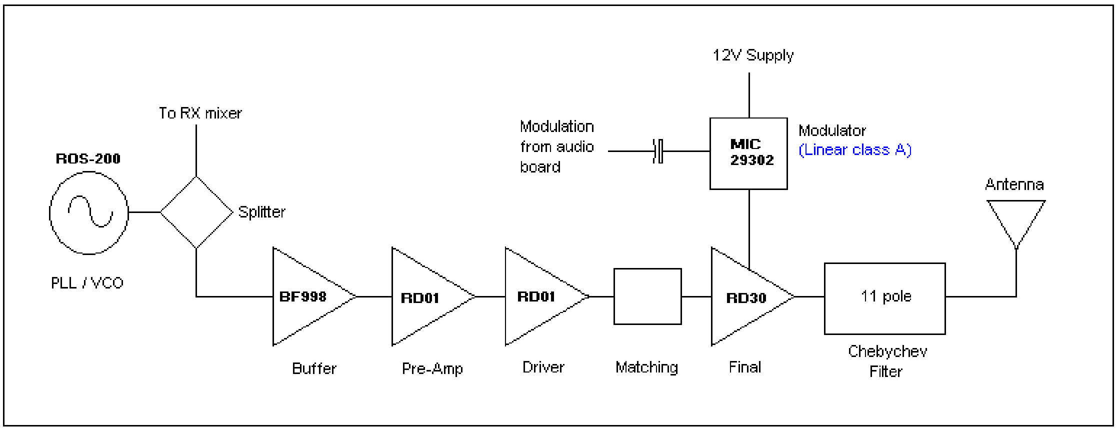


Figure 1

The above figure shows the basic layout of the transmitter in block diagram. The VHF fundamental frequency is generated by the PLL / VCO pair, both of which are separately supplied by their own individual low noise voltage regulators. The VCO is an integrated module that also encapsulates its own 50 ohm buffer. The VCO output level is +10 dBm (10mW). This energy is fed through a -6dB resistive splitter that provides a constant 50 ohm load across the air band.

Approximately -3 to -4dBm of RF is then presented to the buffer amplifier. Virtually no gain is obtained from this stage. Its job is to isolate the rest of the transmitter chain from the VCO and to impedance match to the pre-amplifier.

The rest of the transmitter chain consists of two RD01 MOSFETs and the PA RD30. All three transistors are very conservatively rated for power dissipation. The RD01 transistors are rated at 1 watt each with no heat sinking and with thermal bonding to PCB ground plane can easily dissipate in excess of two watts each.

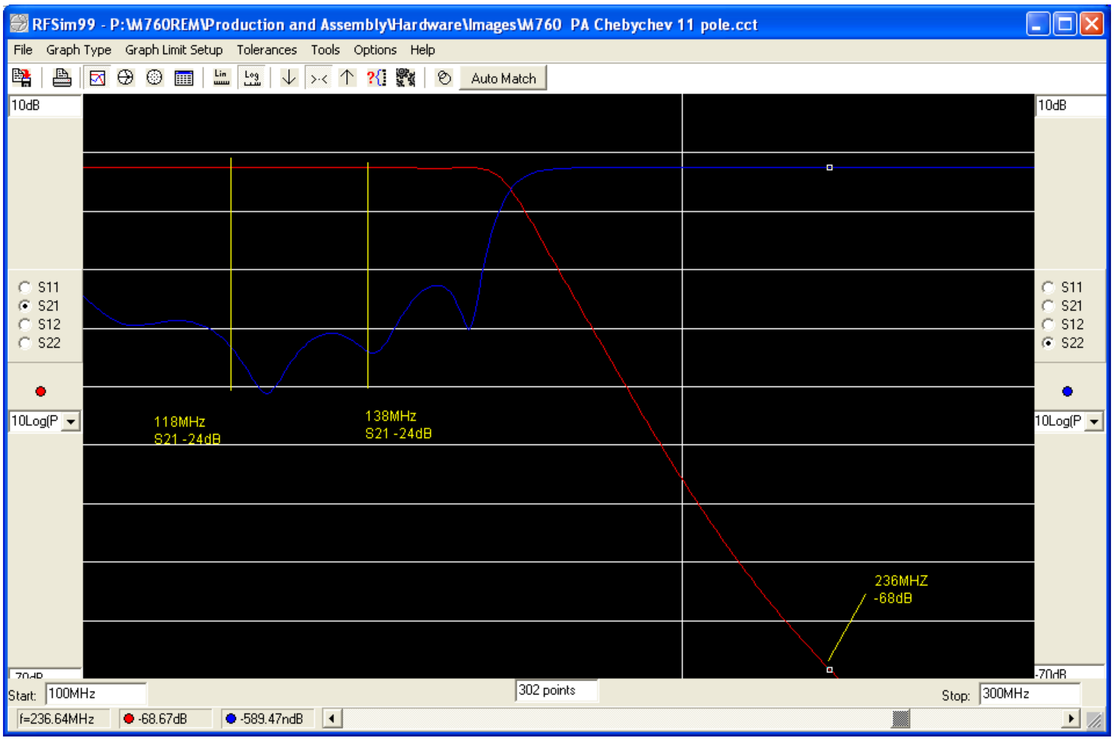
The PA (RD30) is a 30W MOSFET and with direct source bonding to the aluminium chassis can easily dissipate double this figure. The first RD01 generates +14dBm (25mW) of RF to drive the second RD01. The driver RD01 is tasked with providing +24dBm (250mW) average power to the PA and up to 500mW of instantaneous peak power on modulation peaks.

Because of the very low input impedance of the final PA (~ 3 ohms) and an output impedance of ~ 65 ohms at the drain of the driver, a matching network was required. The best solution proved to be a high pass /low pass / strip line combination. This circuit is a band pass with 3dB points at 90MHz and 165MHz.

For best broad band performance (118 to 138 MHz) and repeatability no inter-stage LC matching was used in the low power preceding stages.

The output (PA) stage has approximately 15dB of gain and produces 5W carrier with a Vdd of 6 volts. The output impedance in this configuration is approximately 8 ohms. The main reason to choose such an over rated transistor is the need to provide 4 times average power (PEP) on the modulation peaks when the modulator voltage will drive Vdd to about 11 volts and still remain linear. This device will tolerate a 20:1 VSWR indefinitely, 30V on the drain and 75W of dissipation. In this role it is virtually indestructible. The native biasing of the RD30 is class AB1 which was deemed good enough as this allowed for the source grounding tabs to be bonded directly to the chassis.

With correct output matching the PA proved to be exceptionally free on harmonic content. The output to the antenna is a classic 11 pole Chebychev low pass designed to ramp the impedance gently up to 50 ohms. Chebychev was chosen over Butterworth because 60dB of attenuation was achievable at 236MHz (twice the lowest transmit frequency) at the cost of a small amount of band-pass ripple. That is, the carrier power fluctuates from 4.8 to 5.1 watts across the 20MHz tuning range but the harmonic suppression remains better than 60dBc. The Chebychev cutoff frequency is 160MHz.



All stages from VCO to the driver are biased linear class A. The PA is biased linear class AB1. This makes for a very inefficient transmitter in terms of DC power draw (20 watts drawn from the battery to produces 5 watts of RF at the antenna) but makes for a very clean low harmonic output.

The modulator makes use of a linear low drop out 3A voltage regulator. It is configured to provide just under 6 volts on PTT to the drain of the PA. A 500 mV pk-pk audio signal applied to the programming pin of this IC will drive the output voltage from 1V to 11V in a faithful linear reproduction of the applied audio.

The M760 strategy to avoid adjacent channel "splatter" is to limit the amplitude of the modulation signal. To this end the audio amplitude is constrained by a 10:1 compressor on the audio board and does not vary within the range of 200mV pk-pk to 2000mV pk-pk of applied external microphone audio.

With a typical 13.8 volts supply the modulation is adjusted to 70%. This allows for battery operation at 12V when the modulation will rise to approximately 90%.
Modulation will not intercept 100% until the battery voltage falls to 11V by which time the battery is expended in any case.

The audio modulation bandwidth is controlled by the audio processing on the audio board. It has sharp band pass characteristics with 3dB points at 300Hz and 3 KHz and corner frequencies of 400 Hz – 2.7 KHz.

The modulator is also class A with all the attendant inefficiencies. A large finned heatsink is installed to distribute the waste heat.

7.0 Receiver Function

The M760REM has a superhetrodyne receiver with an IF frequency of 10.7MHz. The receiver's mixer is "high side" tuned (eg for 127.000MHz the VCO is tuned to 137.700MHz.

The M760REM is also fitted with a dual monitor function, where the PLL is rapidly switched between the active and standby frequencies. If carrier is detected, the switching process is locked to receive that signal. When carrier is no longer present the M760REM will return to rapid switching between the active and standby.

If the M760 is receiving on the standby frequency, it will regularly resample the active for the presence of carrier. If carrier is detected on the active, the M760REM will switch back to the active frequency.

The M760 can be pout into or out of dual monitor by setting the applicable bit in either the set active or set standby commands.

8.0 Specification

Radio Type	Amplitude Modulation (AM) Aircraft Transceiver	
Channels	760 channels - 25KHz spacing	TX: 118.000 – 136.975MHz RX: 108.000 – 139.975MHz
Receiver	RTCA/DO-186B Class D	
Transmitter	RTCA/DO-186B Class 4	
TX Frequency Stability	0.4 ppm (0.00004%)	
Frequency Control	Microprocessor controlled: phase lock loop / voltage controlled oscillator	
Memories	99 programmable memories Active & Standby channels with Dual RX monitoring function	
Priority Key	Fast access to memory 25 (typically 121.500MHz)	
Power consumption	Receive (no signal) 100 mA Transmit 1.8 A	
Input Voltage	10.7 – 16.0 Volts dc Minimum operation 10.7V (receive only)	
Power output	5.0 – 5.5 Watts carrier – no modulation	
Modulation	70% (nominal)	
VSWR Tolerance	< 5:1	
Receiver sensitivity	>20dB SINAD @ 1.0uV	
Receiver Selectivity	± 3.75KHz @ 3dB ± 8.75KHz @ 90dB	
Microphone Types	Electret or Amplified Dynamic	
Headset volume output	Adjustable: up to 100mW output into 600 ohms	
Temperature range	-20 - +55 degrees Celsius	
Dimensions	W-87mm H-64mm D-119mm (plus 35mm for harness) W-3.4” H-2.5” D-4.7” (plus 1.5” for harness)	
Weight	338 grams 13 ounces	

9.0 Non-Interference Testing

In accordance with the requirements of RTCA/DO-186B:

Section 2.3.7(c) Emission of Radio Frequency Energy

Harmonic emission products shall be at least 60dB below the rated output power, ie minus 60dBc. Harmonic emission products in ICAO Global Navigation Satellite Systems (GNSS) band extending from 1559 to 1610MHz shall be no greater than minus 60dBm.

Testing for compliance with RTCA/DO-1686B Section 2.3.7(c) has been carried out in accordance with RTCA/DO-186B Section 3.2.2 Note 2 for spurious emissions greater than -40dBc and emission products greater than -60dBm.

9.1 Table of Testing

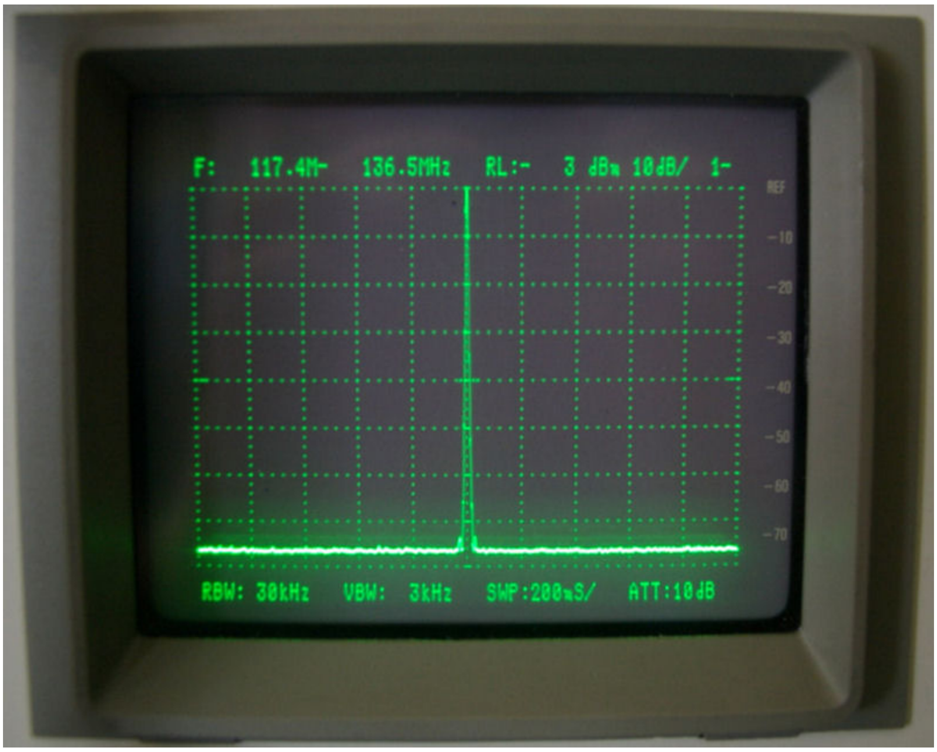
Fc	**Harmonic**	**Fh**	**Level**
MHz		**MHz**	**dBm**
130.625	12	1567.500	<-70dBm
131.275	12	1575.300	<-70dBm
134.150	12	1609.800	<-70dBm
120.925	13	1572.025	<-70dBm
121.175	13	1575.275	<-70dBm
123.825	13	1609.725	<-70dBm

Where
Fc = Carrier frequency
Fh = Harmonic frequency

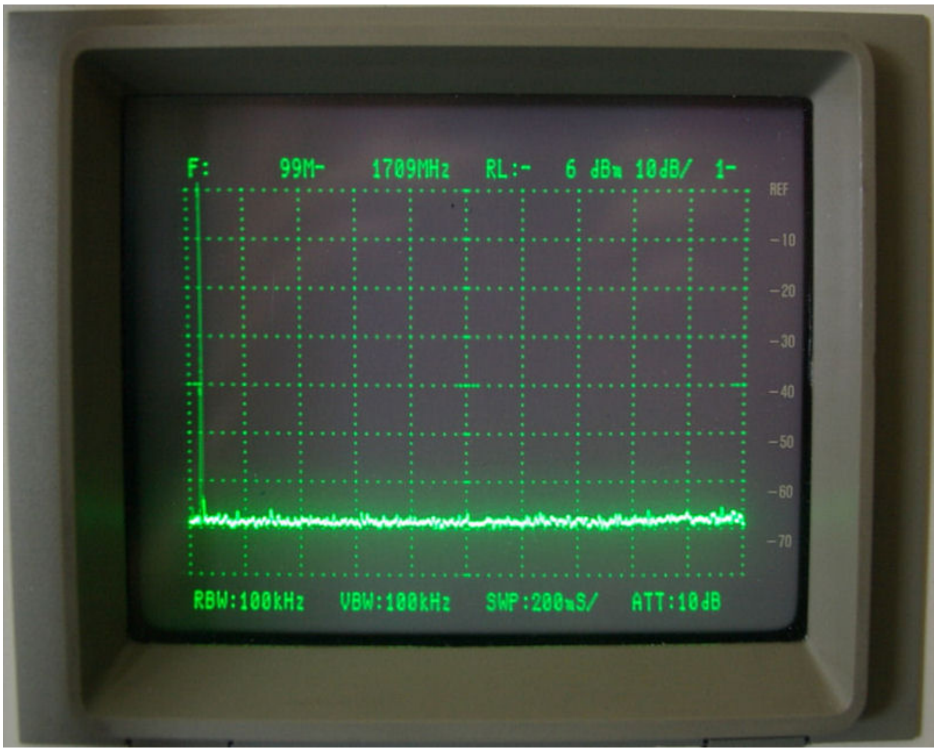
9.2 Test Equipment

Motorola R2600B Communications Analyser
Anritsu MS710E Spectrum Analyser

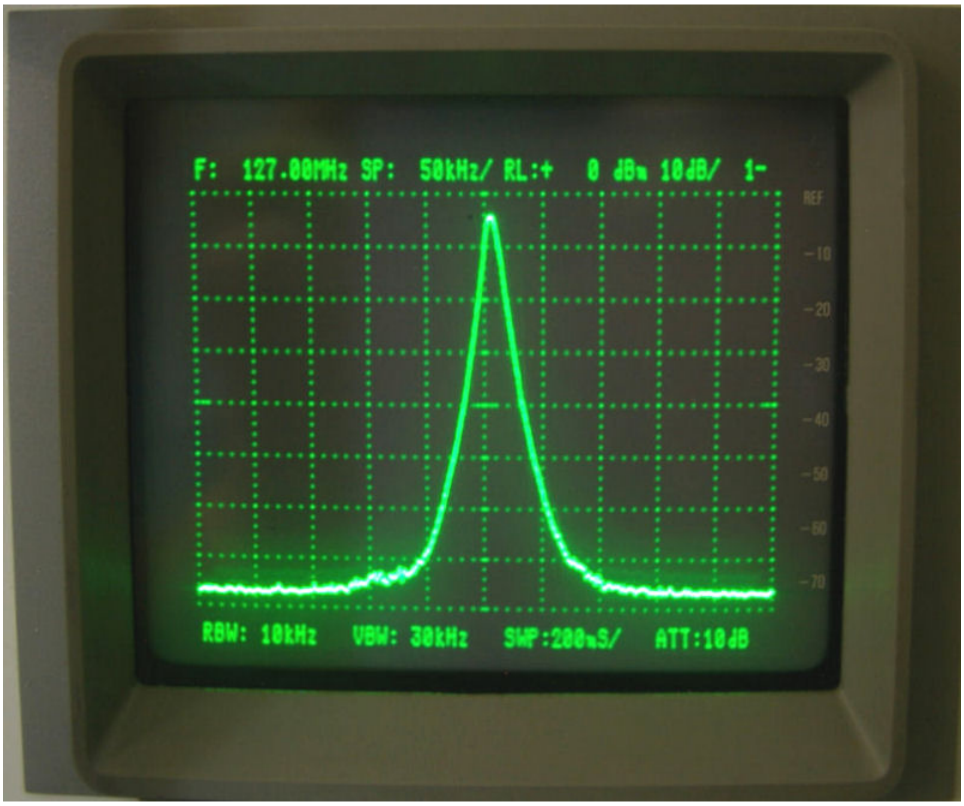
10.0 Supporting Data



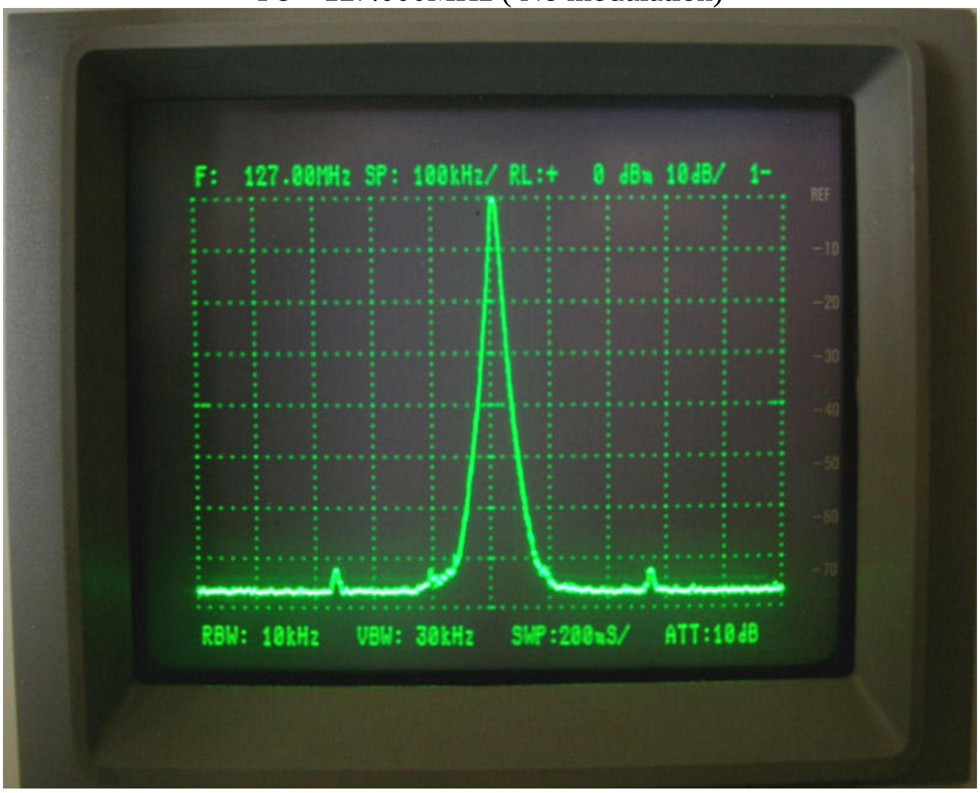
Fc = 127.000MHz



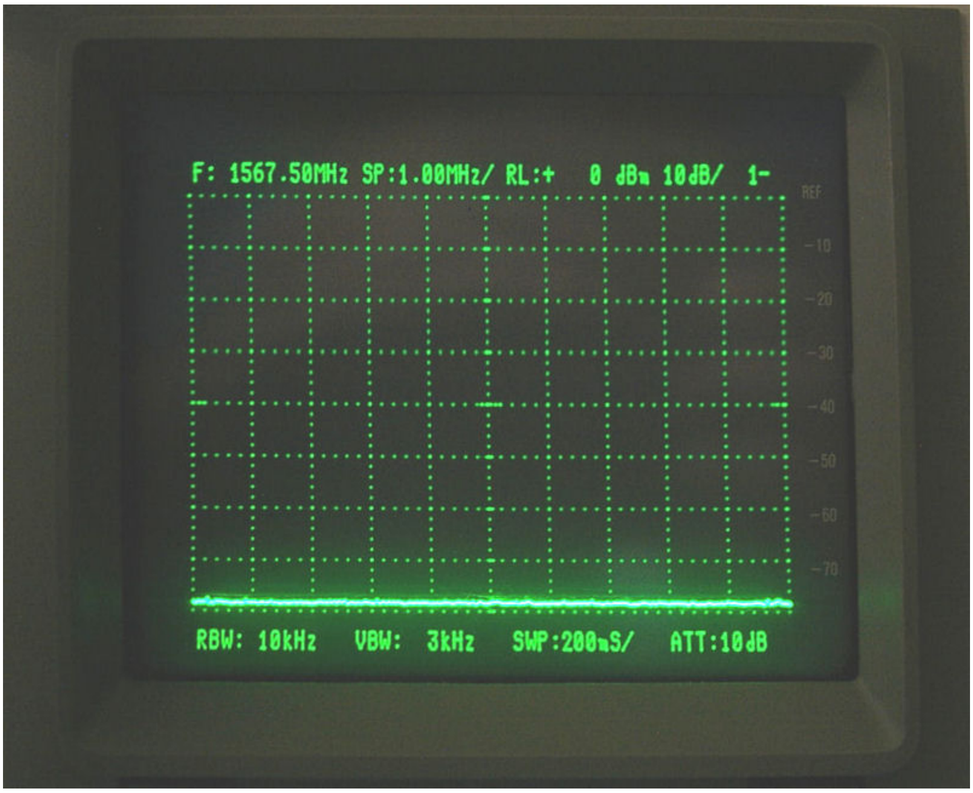
Fc = 127.000MHz



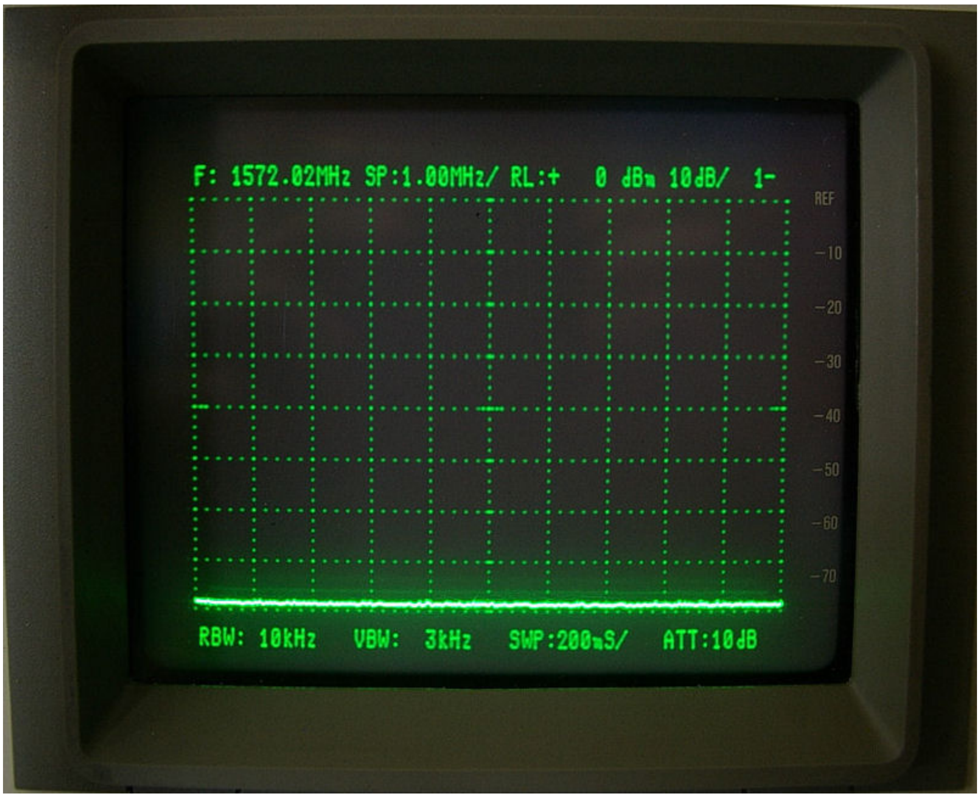
Fc = 127.000MHz (No modulation)



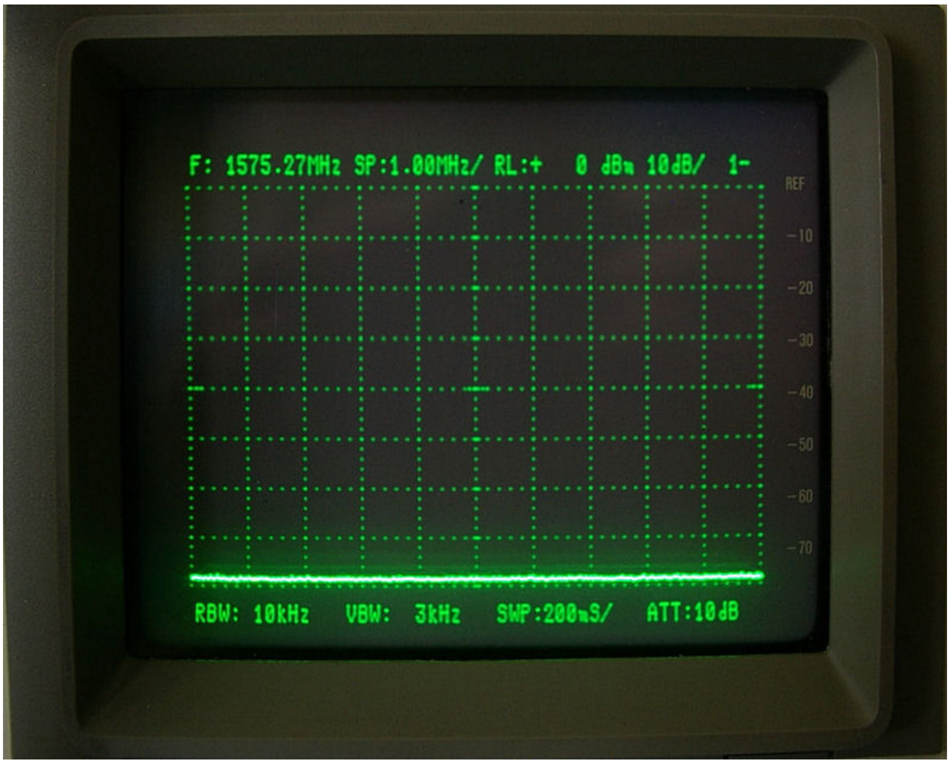
Fc = 127.000MHz (70% modulation)



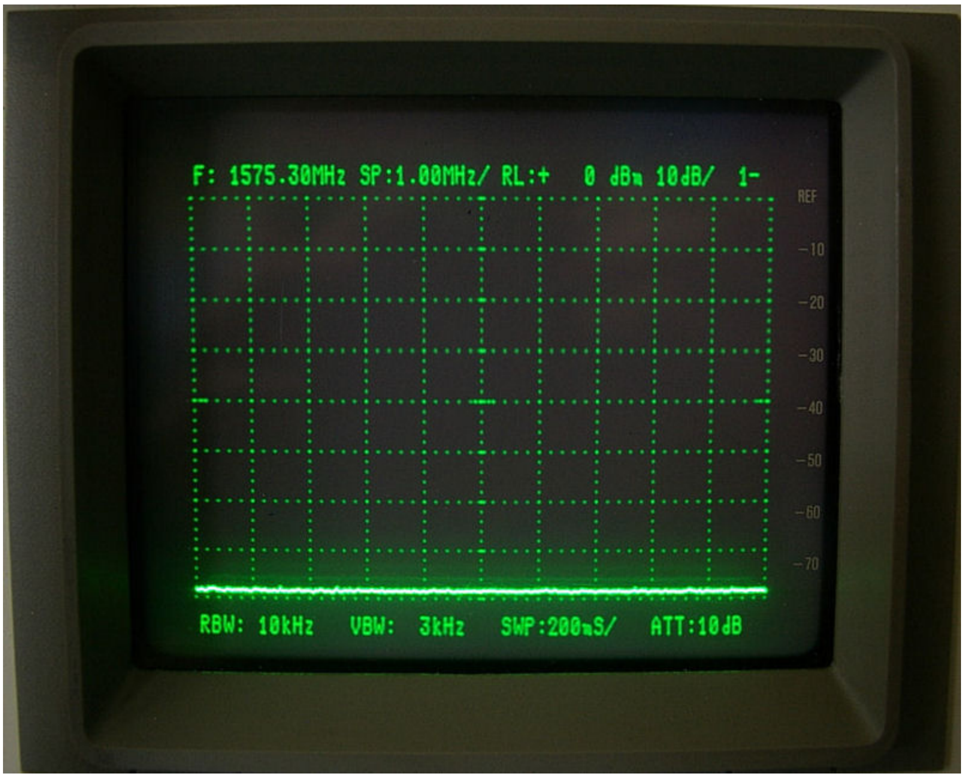
Fc = 130.625MHz



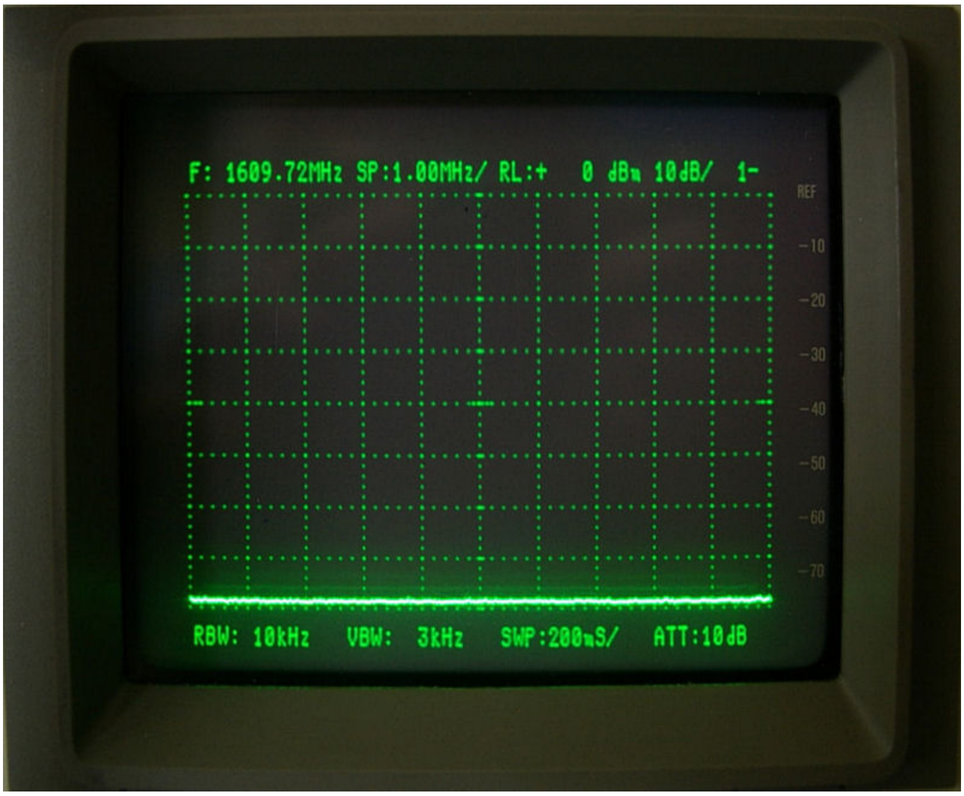
Fc = 120.925MHz



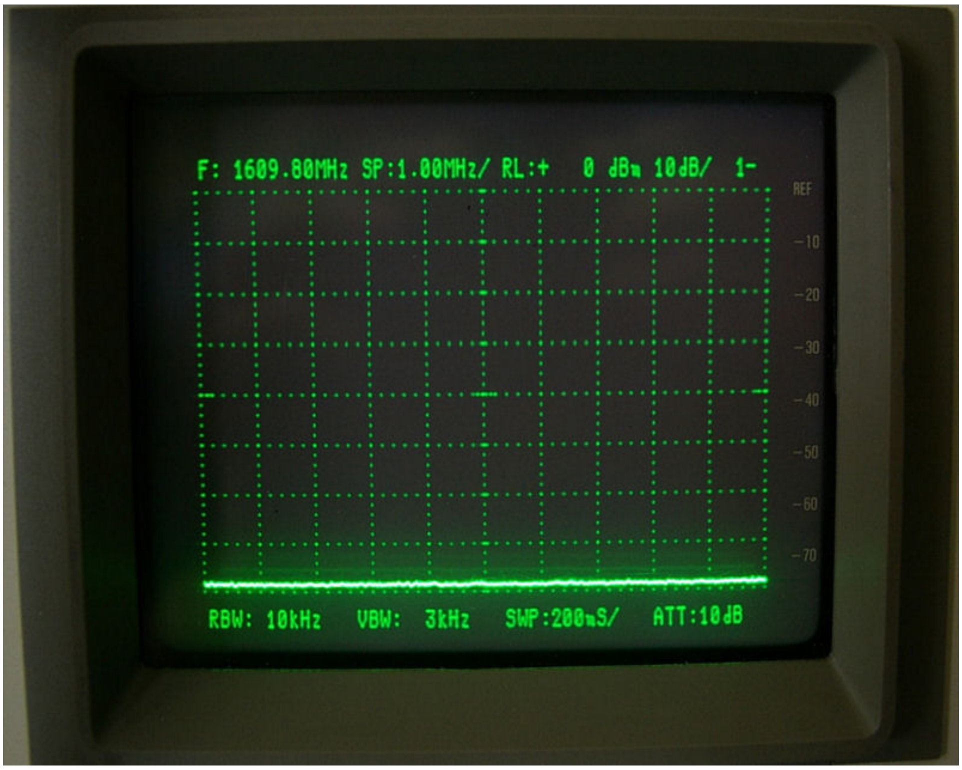
Fc = 121.175MHz



Fc = 131.275MHz

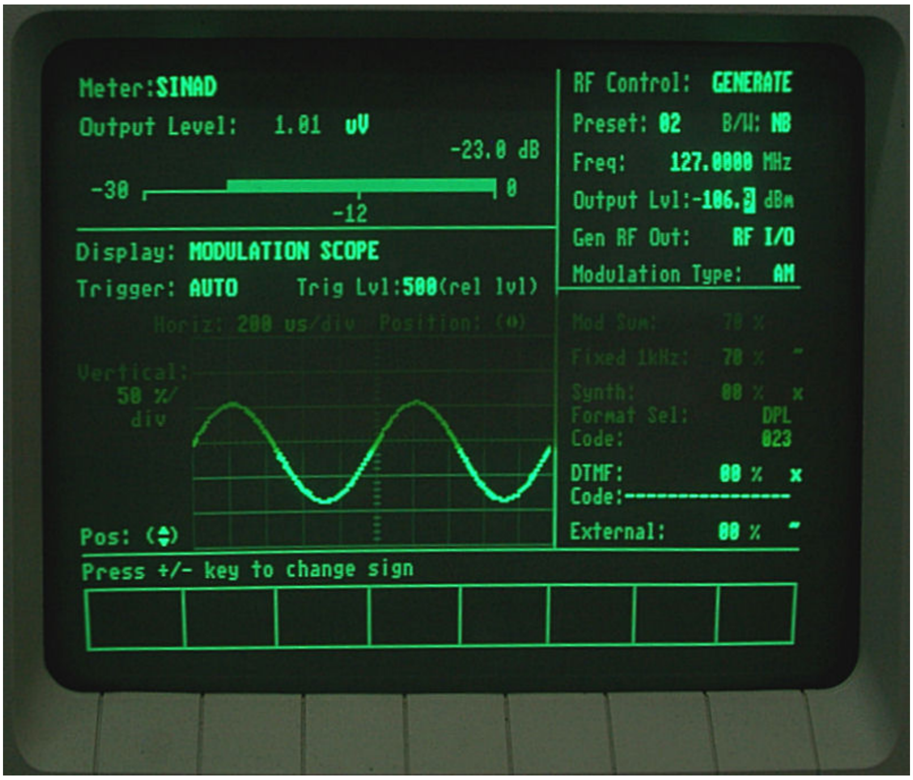


Fc = 123.825MHz



Fc = 134.150MHz

Fc = 127.000MHz



FC = 127.000MHz

11.0 Technical Drawing