DMR Portable Hardware Training

Kirisun Communications Co., Ltd.
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Technical Specifications

General	
Frequency Range	400-470MHz
Channel Capacity	1024
Channel Spacing	25/12.5 KHz (Analog) 12.5KHz(Digital)
Operating Voltage	7.4V (rated)
Battery	2000mAh (Li-Ion)
Battery Life (5-5-90 Duty Cycle, High TX Power) standard 2000mAh Li-ion Battery	Analog: Above 11 Hours Digital: Above 12 Hours
Frequency Stability	±1.5ppm

Environmental Specifications	
Operating Temperature	-30℃ ~ +60℃
Storage Temperature	-40℃ ~ +85℃
Dust & Water Intrusion	IP67 Standard
GPS	
Accuracy specification applies to long-term tracking	
TTFF (Time To First Fix) Cold Boot	<60 seconds
TTFF (Time To First Fix) Hot Boot	<10 seconds
Horizontal Accuracy	<10 meters

Technical Specifications -- Analog

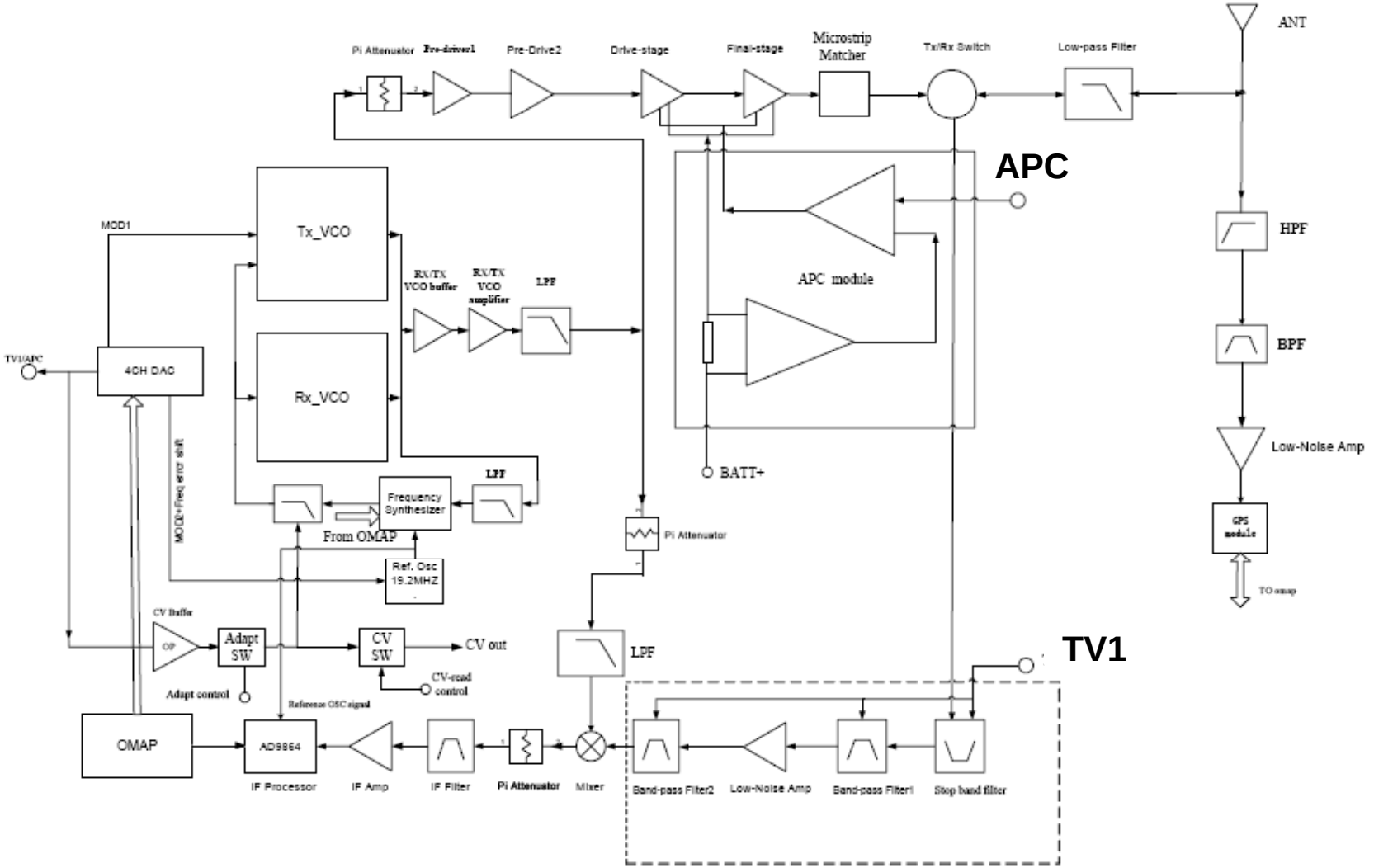
Transmitter (DC 7.4V)	
RF Power Output (H/L)	4.0W±0.2W/ 1.0W±0.2W (UHF)
RF Transmit Current (H/L)	<1.8A / <1A
Modulation Limiting	±2.5kHz@12.5 kHz ±5.0kHz@25 kHz
Adjacent channel power	≤-60 dB@12.5 kHz ≤-70 dB@25 kHz
Audio Distortion	≤3%
FM hum&noise	≤-40 dB@12.5 kHz ; ≤-45 dB@25 kHz
Conducted/radiated emission	<-36dBm(<1GHz); <-30dBm(>1GHz)
Receiver	
Sensitivity	≤ -118dBm (typical) (12dB SINAD)
Adjacent channel selectivity	≤-60dB@12.5 kHz; ≤-70dB@25 kHz
Rated Audio Power Output	>1W (16Ω Load)
Rated Audio Distortion	≤3%
Intermodulation rejection	≤-65dB@12.5 kHz ; ≤-70dB@25 kHz

Technical Specifications -- Digital

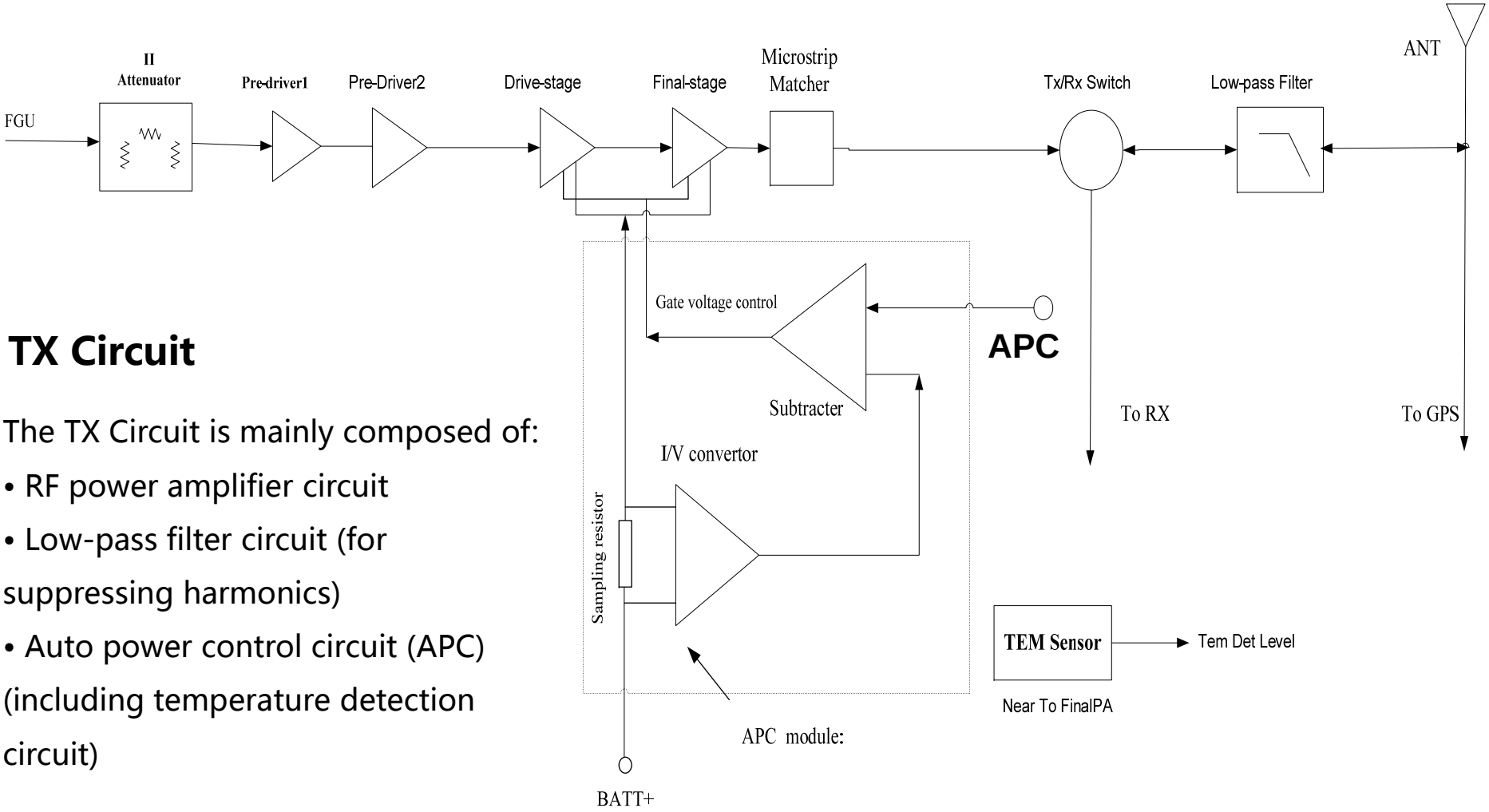
Transmitter	
TX Power(Slot1/Slot2)	4.0W±0.2W/ 1.0W±0.2W
4FSK Error	≤5%
Magnitude Error	≤1%

Receiver	
Receiving Sensitivity(BER5%)	≤0.22μV/-120dBm
Rated Audio Output Power	1W
Rated Audio Distortion	≤ 3%

Circuit Elements Introduction -- RF Part Block Drawing



Circuit Elements Introduction -- RF Tx Part

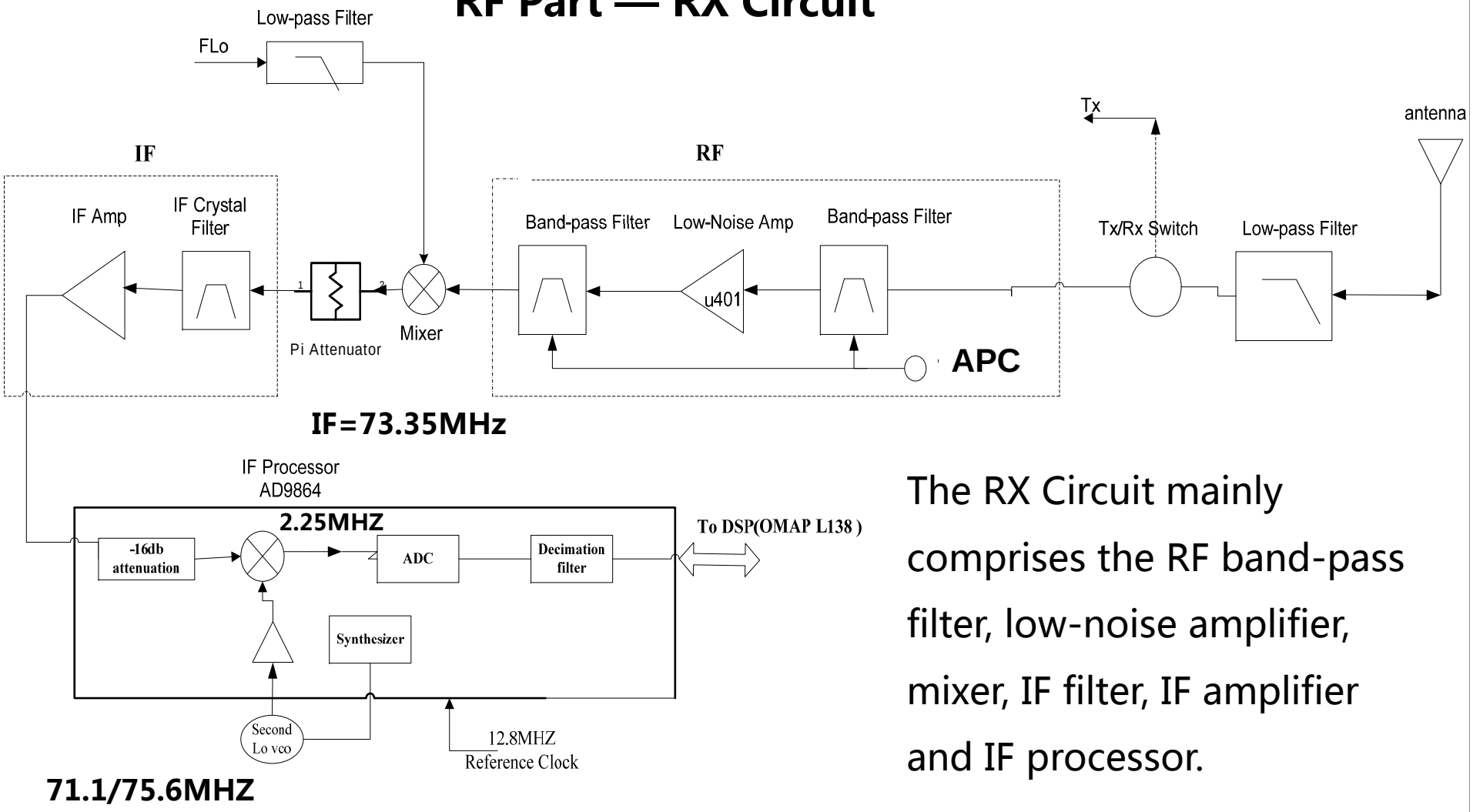


TX Circuit

The TX Circuit is mainly composed of:

- RF power amplifier circuit
- Low-pass filter circuit (for suppressing harmonics)
- Auto power control circuit (APC) (including temperature detection circuit)

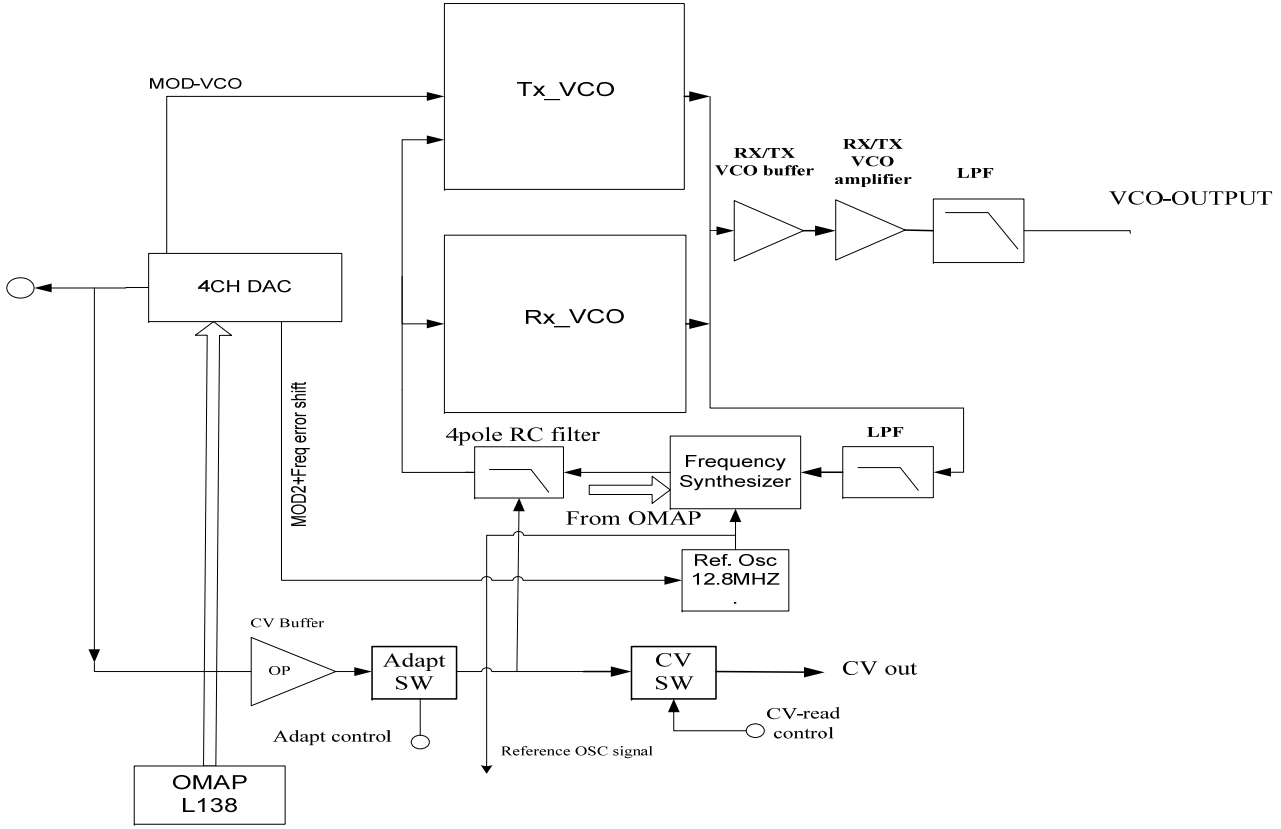
RF Part — RX Circuit



The RX Circuit mainly comprises the RF band-pass filter, low-noise amplifier, mixer, IF filter, IF amplifier and IF processor.

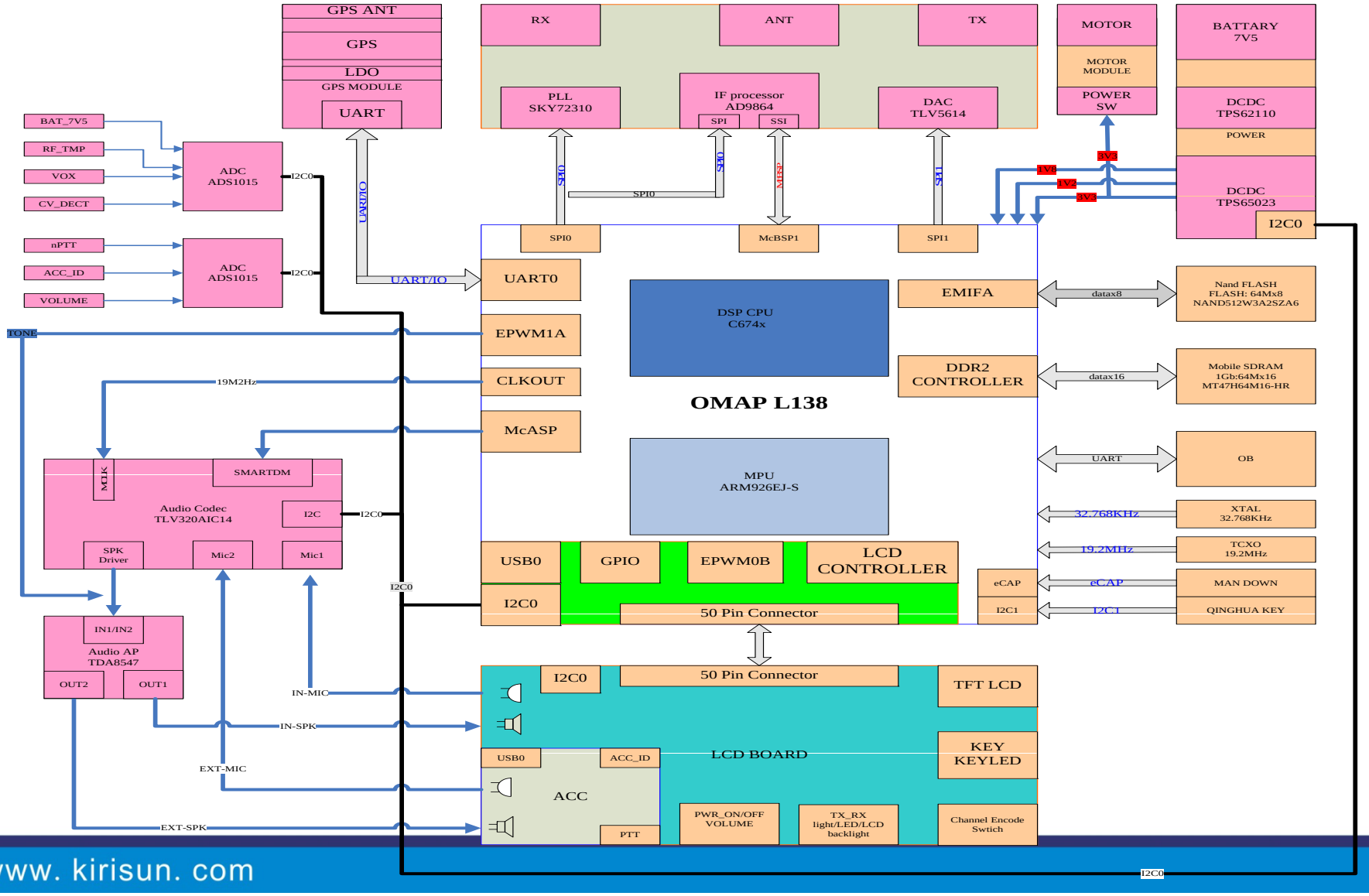
RF Part — Frequency Generation Unit (FGU)

The FGU is composed of VCO and PLL. It is the core module of the whole TX-RX system. This circuit provides accurate carrier frequency during transmission, and stable LO signal during reception,. It has a direct influence on the performance of the system.



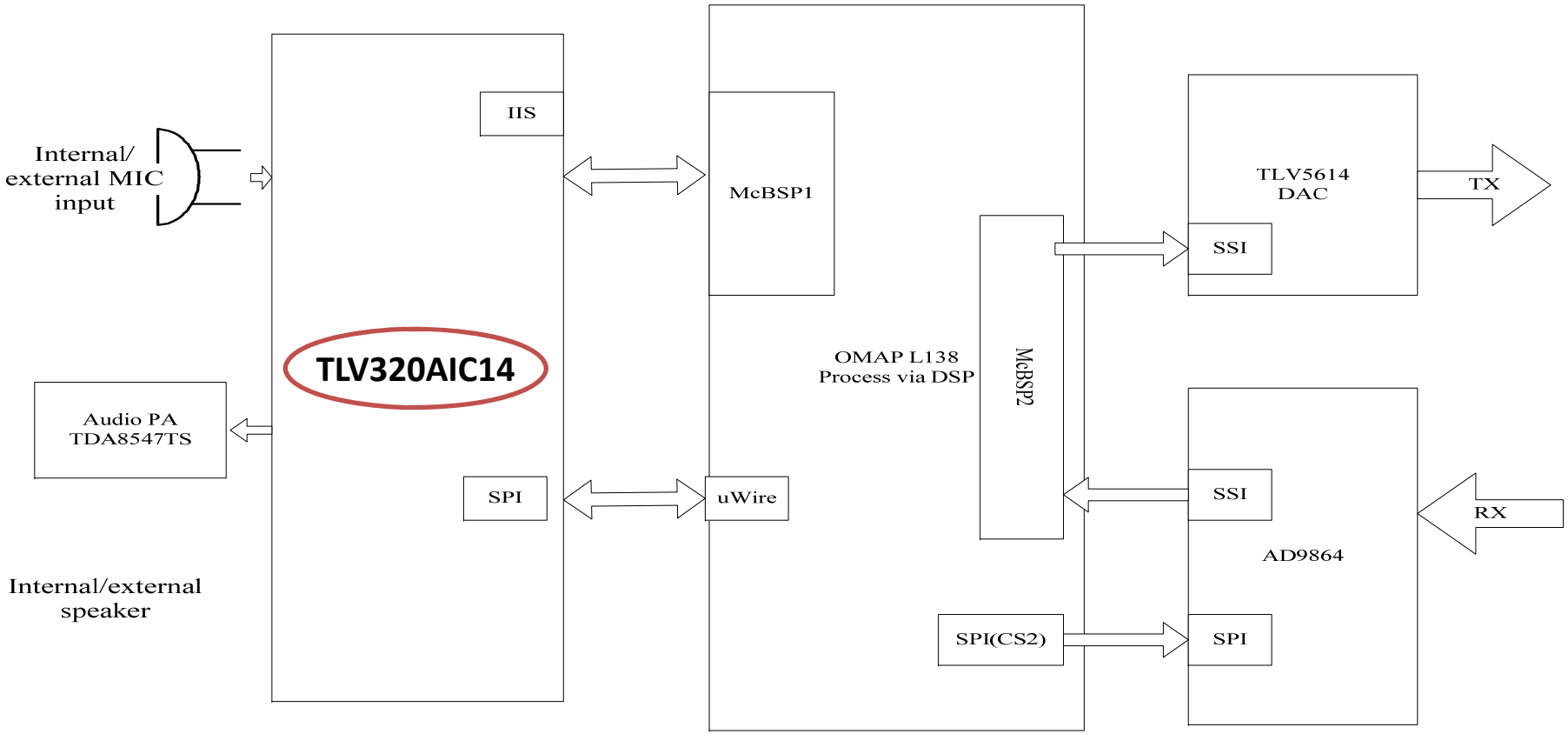
Circuit Elements Introduction -- Baseband Circuit

Sepura DMR terminals uses the dual-core processor OMAP L138 (DSP+ARM) for modulation/demodulation and voice encoding/decoding.

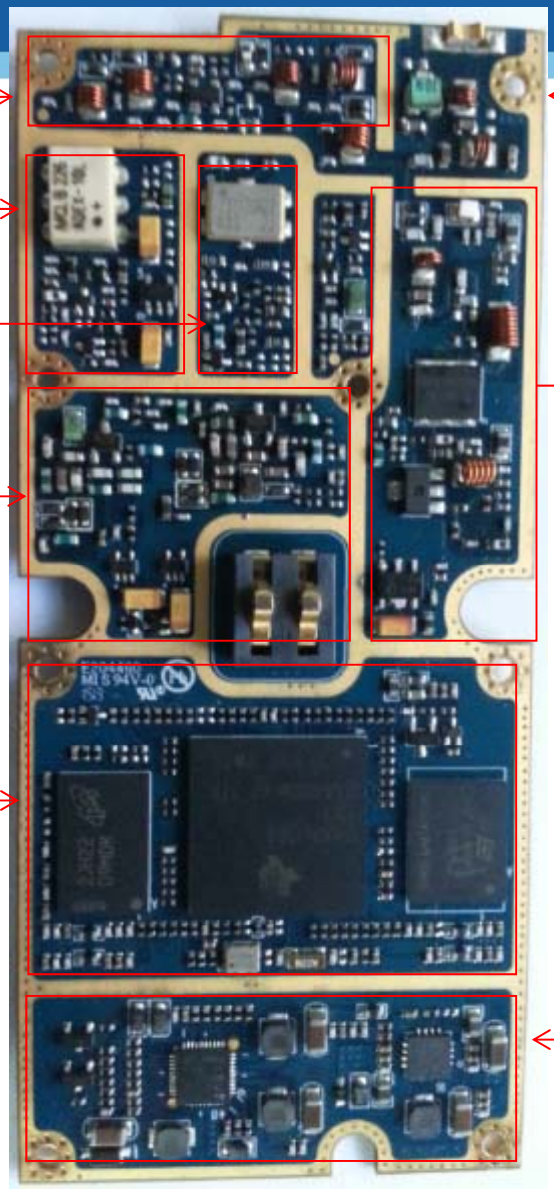


Channel code/decode and audio processing unit

The module is mainly for channel code/decode and audio process . The key parts are including TLV320AIC29 audio codec, the audio amplifier TDA8547TS , omap L138, IF processor AD9864, DAC5614.



PCB Layout Introduction -- Top Side



Band-pass Filter and LNA

Mixer Circuit

IF Crystal filter

RX VCO + TX VCO Circuit

OMAP L138 + SDRAM + Flash Circuit

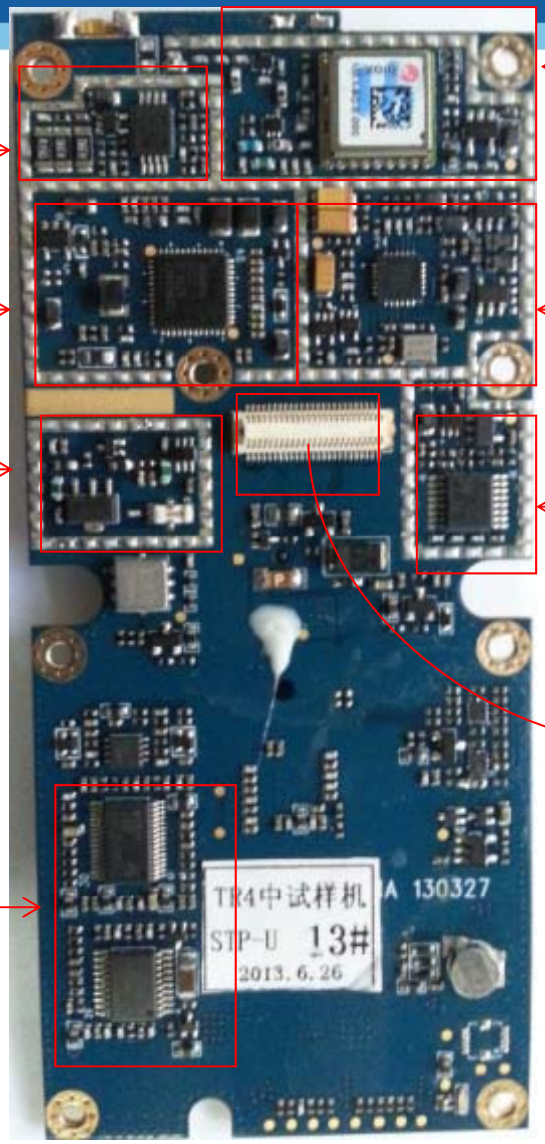
Antenna LPF

RD07 Final Power Amplifier

RD01 Drive amplifier

PMU CIRCUIT

PCB Layout Introduction -- Bottom Side



Auto power control

IF processor AD9864

TX drive amplifier

Codec TLV320 + audio amplifier TDA8547

GPS BPF+LNA+ GPS Module

PLL circuits Sky72310

DAC circuit TLV5614

50 pin connector

Contents

1. How to test analog specification of DMR radio through HP8921A
2. How to test Digital specification of DMR radio though IFR3920

Analog Analyzer
HP8921A
Manufacturer: HP

Digital Analyzer IFR3920 with DMR option
Manufacturer: Aeroflex

Test Methods

Brief Introduction about following 2 Analyzers

HP8921A	IFR3920
We can use this analyzer to test DMR analog specifications and it works with Sepura DMR tuner software, we can use HP8921A to tune DMR analog specifications.	We can use this analyzer to test DMR analog specifications & digital specifications.
Analog specifications 1. Tx Frequency 2. Tx Frequency Error 3. FM Deviation 4. Tx Power 5. Tx SNR 6. Tx Audio Distortion 7. Tx CTCSS/CDCSS 8. Rx CTCSS/CDCSS 9. Squelch On/Off Sensitivity 10. Rx Audio Distortion 11. Rx SNR 12. Rx SINAD	**Digital Specifications** 1. Tx 4 FSK Error 2. Magnitude Error 3. Tx Power 4. Tx Bit Error

The Channels we use in this course

In following slides, we use Sepura DMR portable as a sample to run the test.

Channels	Frequency	Channel Spacing	Others	Note
Analog Channel A1	400.25MHz	25KHz	CTCSS - 71.9Hz	
Analog Channel A2	410.25MHz	12.5KHz	CDCSS-031	
Analog Channel A3	420MHz	25KHz	None	For audio specs like distortion & SINAD& SNR
Digital Channel D1	443.735MHz	12.5KHz		

Test Methods

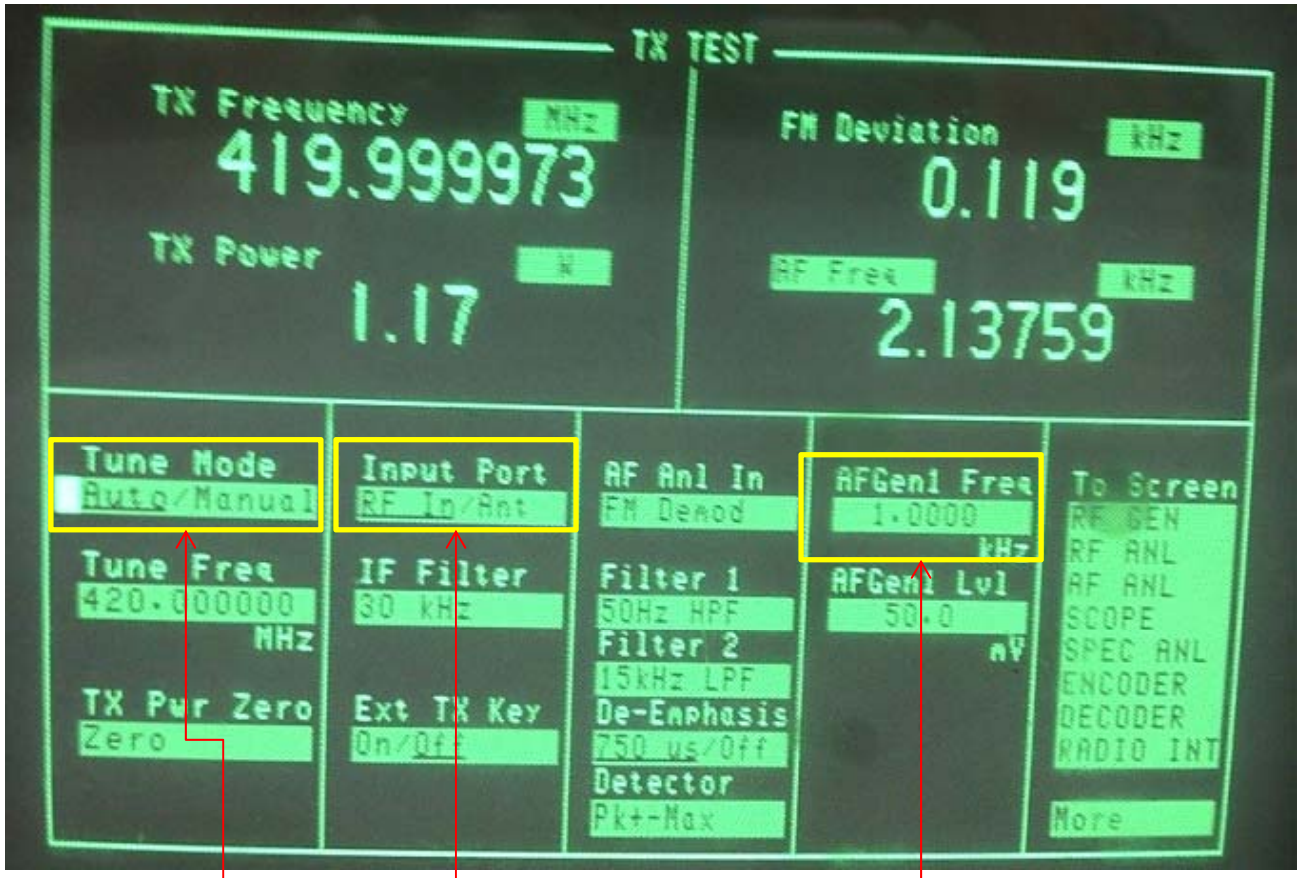
Portable(DC7.4V)	Conditions	Specs
Tx Power	Hi Power	4.0±0.2W
	Low Power	1.0±0.2W
Tx Frequency Error	±100Hz	
FM Deviation	25KHz	≤5KHz
	20KHz	≤4KHz
	12.5KHz	≤2.5KHz
Tx SNR	25KHz	≥ 45dB
	20KHz	≥ 43dB
	12.5KHz	≥ 40dB
Tx Audio distortion	≤3%	
Squelch On/Off Sensitivity	20/25KHz	-121±2dBm
	12.5KHz	-120±2dBm
Rx SNR	25KHz	≥ 45dB
	20KHz	≥ 43dB
	12.5KHz	≥ 40dB
Rx SINAD	≥14dB	
Rx Audio Distortion	≤3%	

Analog Specification of DMR portable radio we need during test

Temperature: 20-35ºC Relative Humidity: 45%-75% Atmospheric Pressure: 86kPa-106kPa
Antenna Load: 50Ω
Note: for distortion/SNR specs, must test them under one channel without CTCSS/CDCSS

Test Methods

Tx Power/Tx Frequency/FM Distortion



1. Choose Tx Test.
2. Press PTT to transmit.
3. The Tx Freq and Tx Power are on the left of TX Test window, the FM deviation is on the right of the window. You can speak to radio's Mic to observe the status of FM Deviation.

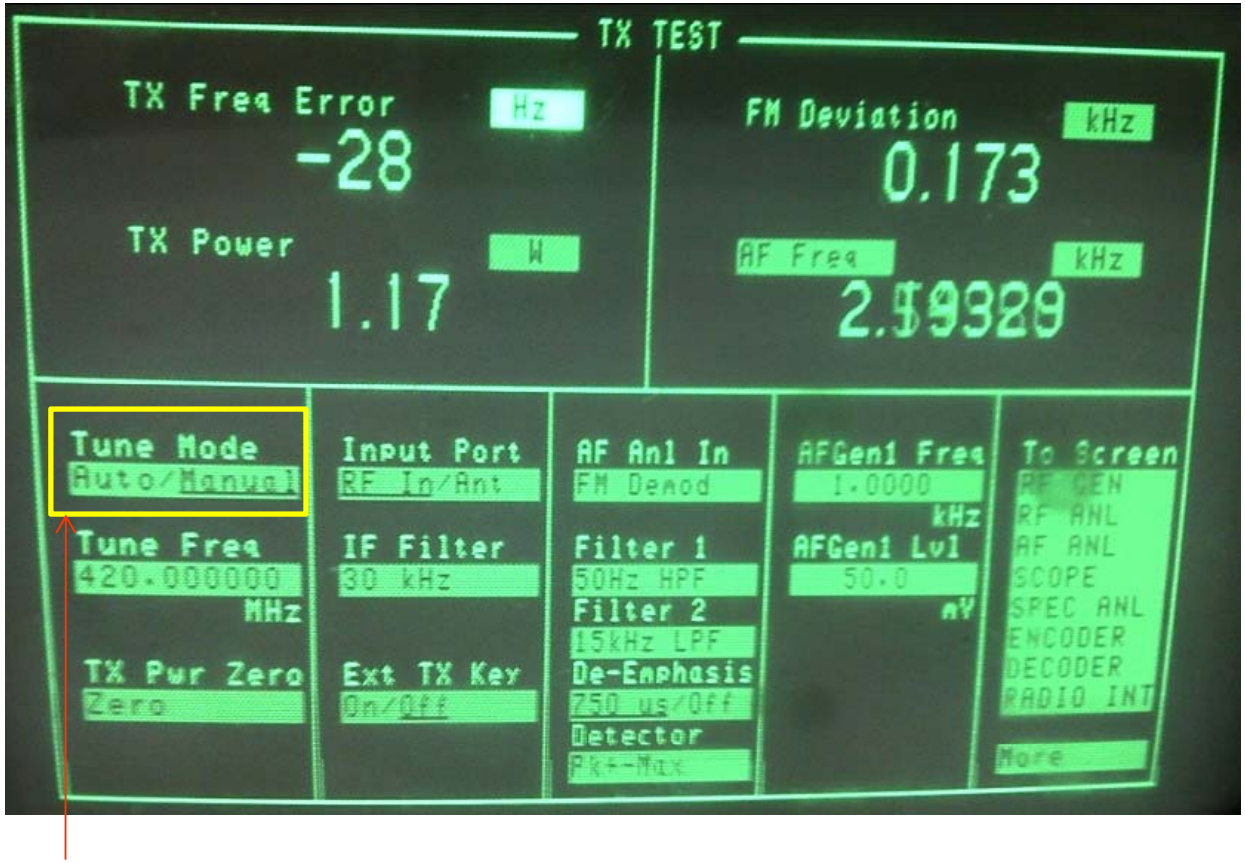
FM Deviation	25KHz	≤5KHz
	20KHz	≤4KHz
	12.5KHz	≤2.5KHz

AFGenl Freq:1KHz
(The audio freq range: 300Hz-3KHz)

Input Port: RF In

Tune Mode : Auto

Tx Frequency Error

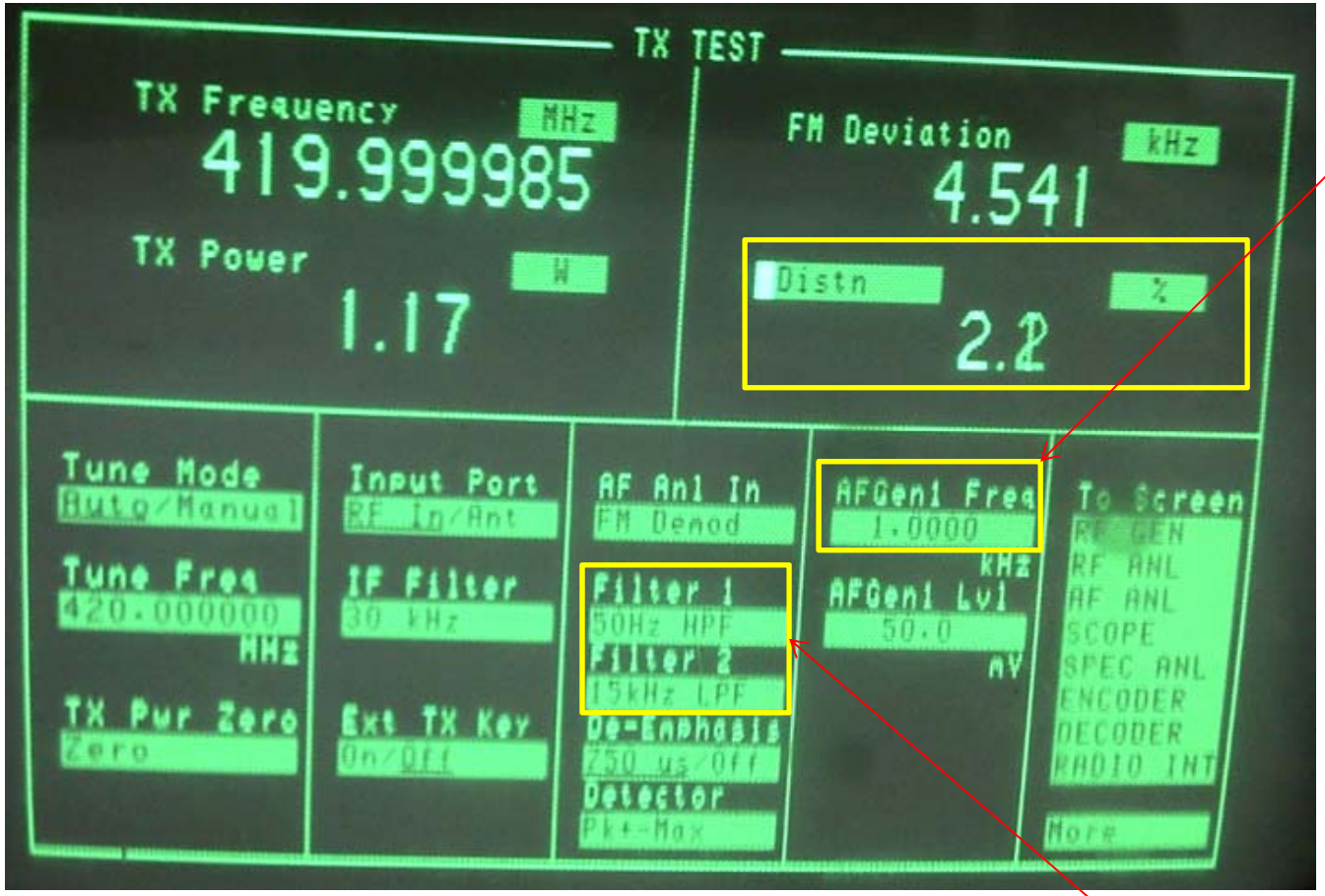


Tune Mode: Manual

1. Choose Tx Test.
2. Switch from Auto to Manual under Tune Mode, the Tx Freq Error appears.
3. Press PTT to transmit.
4. The Tx Freq Error is on the left of TX Test Window.

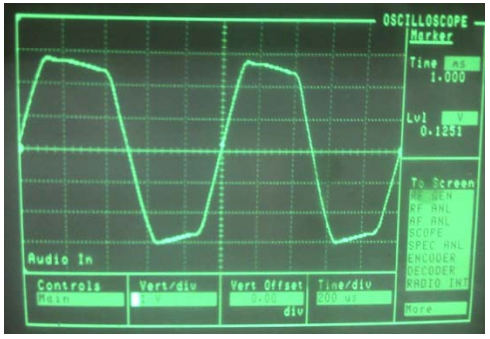
Tx Frequency Error	±100Hz

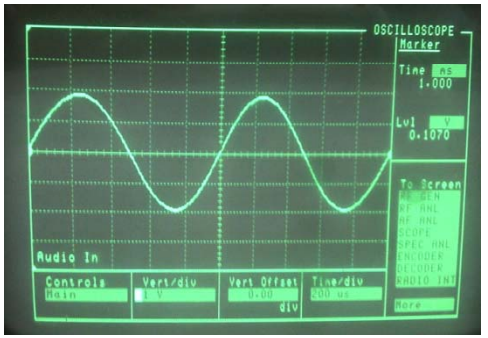
Tx Audio Distortion



1. Choose Tx Test.
2. Switch from AF Freq to Distn.
3. Press PTT to transmit.

AF Genl Freq: 1KHz





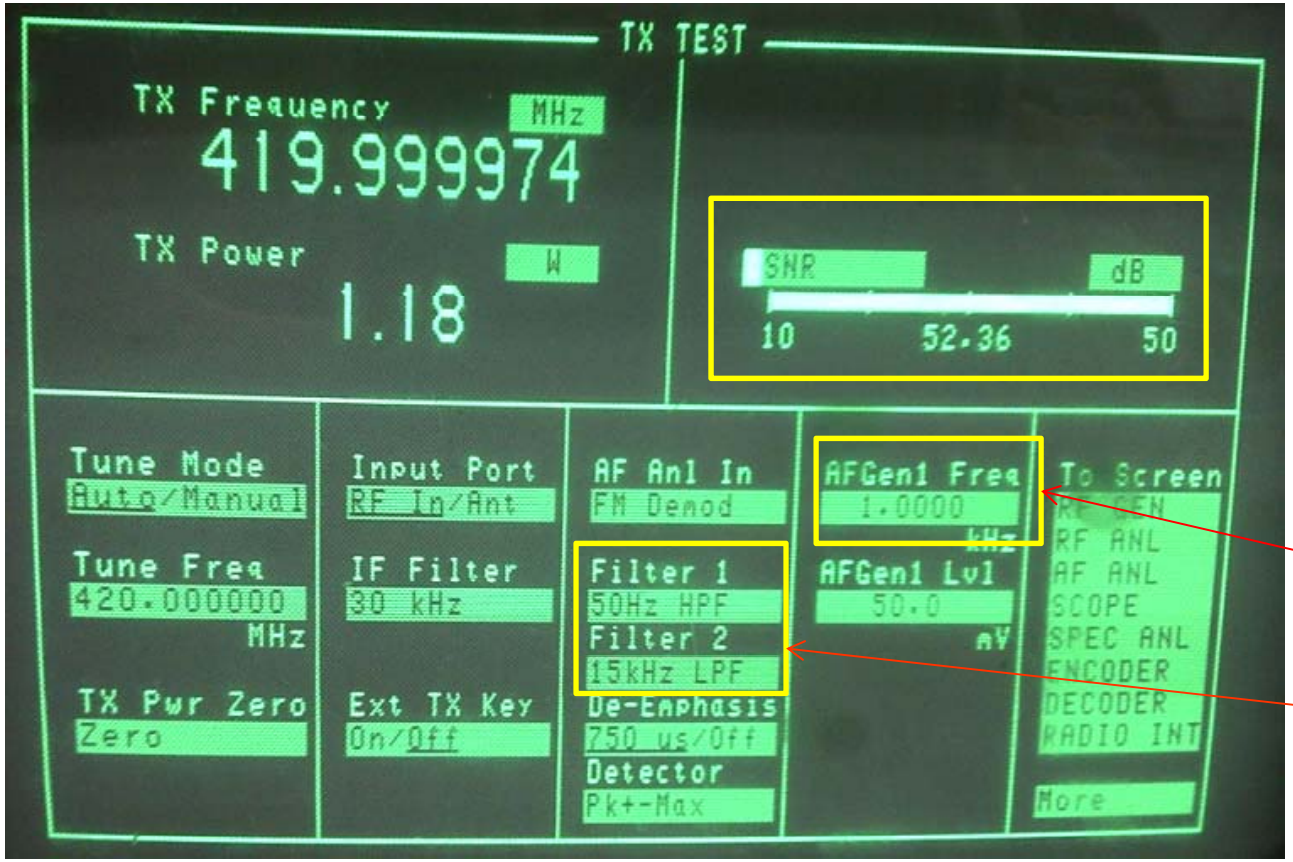
Tx Audio distortion	**≤3%**

Filter 1:50Hz HPF
Filter 2: 15KHz LPF

Note: for distortion/SNR specs, must test them under one channel without CTCSS/CDCSS. The audio cable (Speaker or Mic) must be connected. When test cable is connected, please always use the cable PTT to transmit.

Test Methods

Tx SNR



1. Choose Tx Test.
2. Switch from AF Freq to SNR.
3. Press PTT to transmit.
4. You can hear the beep sound comes from the HP8921A.

Tx SNR	25KHz	≥ 45dB
	20KHz	≥ 43dB
	12.5KHz	≥ 40dB

AF Genl Freq: 1KHz

Filter 1:50Hz HPF

Filter 2: 15KHz LPF

Note: for distortion/SNR specs, must test them under one channel without CTCSS/CDCSS. The audio cable (Speaker or Mic) must be connected. When test cable is connected, please always use the cable PTT to transmit.

Tx CTCSS

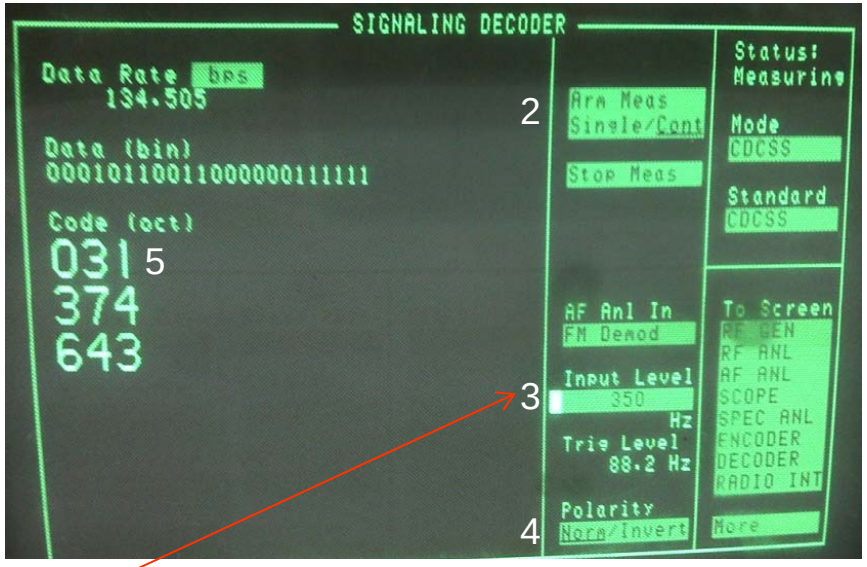
1. Choose Tx Test.
2. Filter 1 choose <20Hz HPF.
3. Filter 2 Choose 300Hz LPF.
4. Press PTT to transmit.
5. The Number under AF Freq is Tx CTCSS.

Filter 1: <20Hz HPF

Filter 2:300Hz LPF

Test Methods

Tx CDCSS



1. Choose Tx Test.
2. To Screen choose DECODER.

Channel Spacing	Input Level
Narrow Band	350Hz
Wide Band	750Hz

1. Mode : choose CDCSS.
2. Arm Meas: choose Cont.
3. Input Level: Narrow band 350Hz /Wide Band 750Hz.
4. Polarity: if normal CDCSS choose Norm, otherwise choose invert.
5. The first number under code is the Tx CDCSS. Here it is 031.

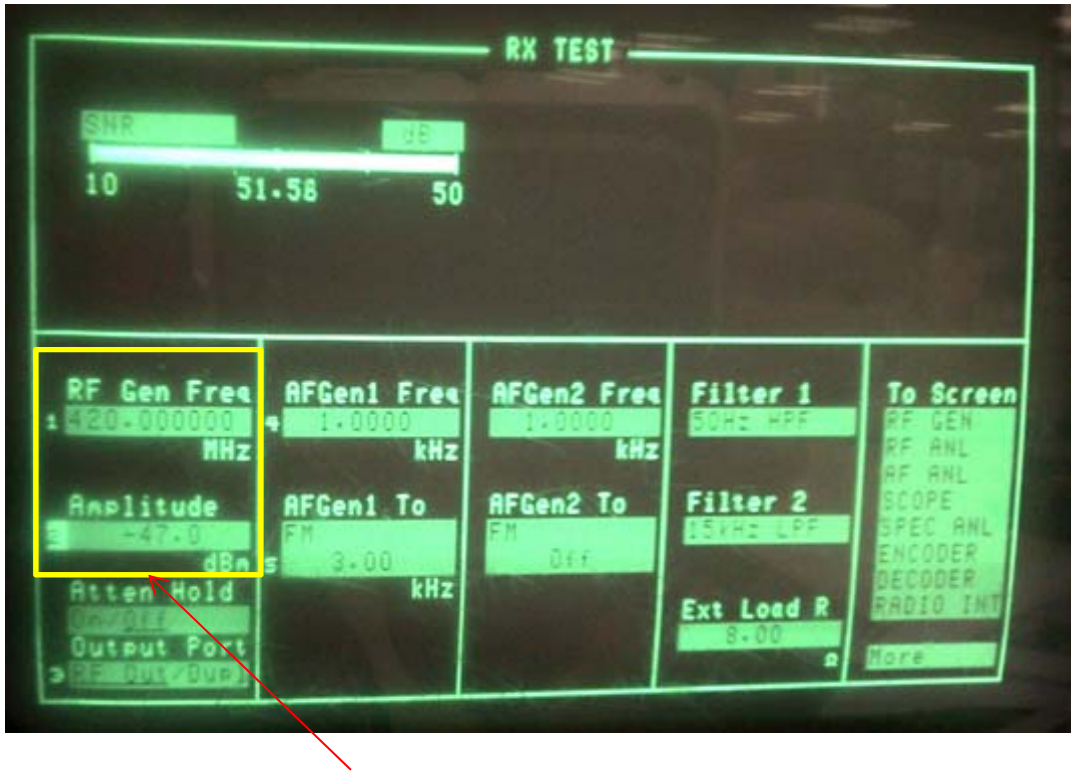
Squelch On/Off Sensitivity

1. Choose Rx Test.
2. Input the correct frequency at RF Gen Freq.
3. Amplitude: adjust the knob of HP8921A to decrease the signal level, observe the open/off audio status of radio speaker.
4. Listen and observe the audio voice comes from the speaker.

Squelch On/Off Sensitivity	20/25KHz	-121±2dBm
	12.5KHz	-120±2dBm

Test Methods

Rx SNR



RF Gen Freq: Input correct Frequency
Amplitude: input -47dbm

1. Choose Rx Test.
2. Input the correct frequency at RF Gen Freq.
3. Input -47dBm signal at Amplitude.
4. Adjust the volume knob of the radio until the AC Level around 1.3V.
5. The Rx SNR specs will show on the left.

Rx SNR	25KHz	≥ 45dB
	20KHz	≥ 43dB
	12.5KHz	≥ 40dB

Note:

for distortion/SNR specs, must test them under one channel without CTCSS/CDCSS. The audio cable (Speaker or Mic) must be connected. When test cable is connected, please always use the cable PTT to transmit.

Rx Audio Distortion

1. Choose Rx Test.
2. Input the correct frequency at RF Gen Freq.
3. Input -47dBm signal at Amplitude.
4. Adjust the volume knob of the radio until the AC Level around 1.3V.
5. The Distn specs will show on the left.

Rx Audio Distortion	**≤3%**

Note: for distortion/SNR specs, must test them under one channel without CTCSS/CDCSS. The audio cable (Speaker or Mic) must be connected. When test cable is connected, please always use the cable PTT to transmit.

Test Methods

Rx SINAD

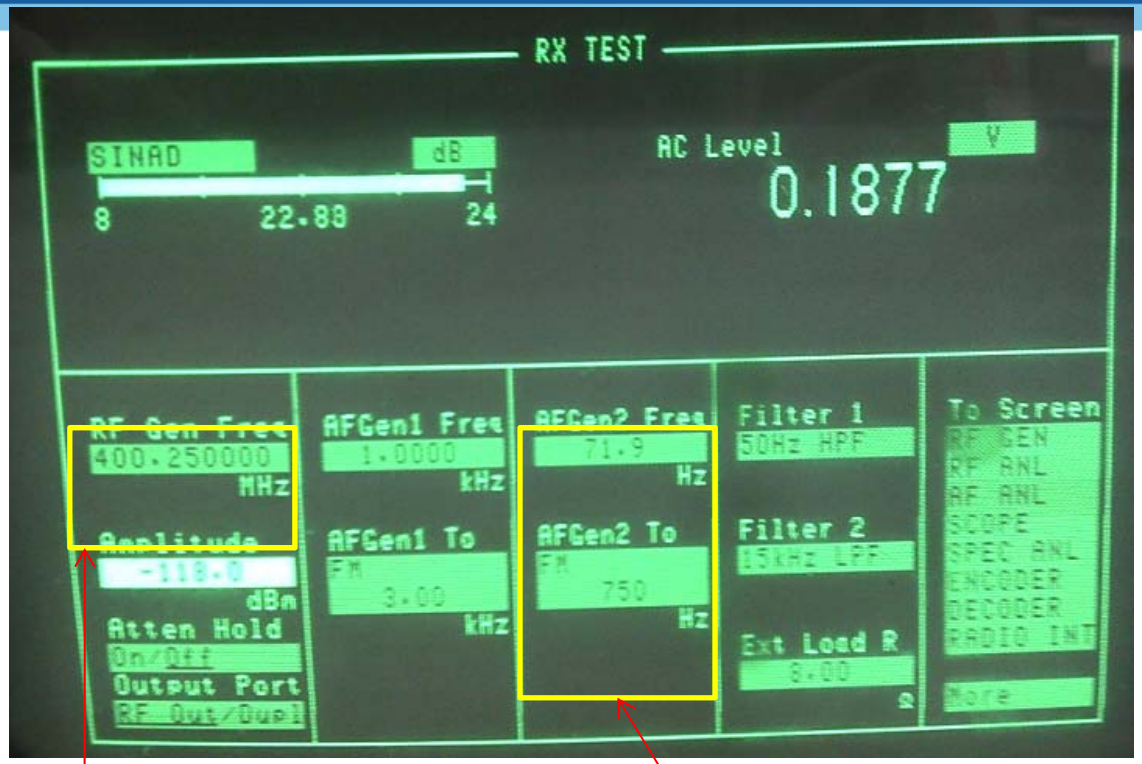
1. Choose Rx Test.
2. Input the correct frequency at RF Gen Freq.
3. Input -118dBm signal at Amplitude.
4. Adjust the volume knob of the radio until the AC Level around 1.3V.
5. The SNR specs will show on the left.

Rx SINAD	**≥14dB**

Note: for distortion/SNR specs, must test them under one channel without CTCSS/CDCSS. The audio cable (Speaker or Mic) must be connected. When test cable is connected, please always use the cable PTT to transmit.

Test Methods

Rx CTCSS



1. Choose Rx Test.
2. AF Gen 2 Freq: Input the correct CTCSS.
3. AF Gen 2 To: Wideband input 750Hz, narrowband input 350Hz.
4. Amplitude: adjust the knob of HP8921A to decrease the signal level, observe the open/off status of radio speaker.

RF Gen Freq: Input correct frequency, here it is 400.25MHz

AF Gen2 Freq: input correct CTCSS here it is 71.9Hz

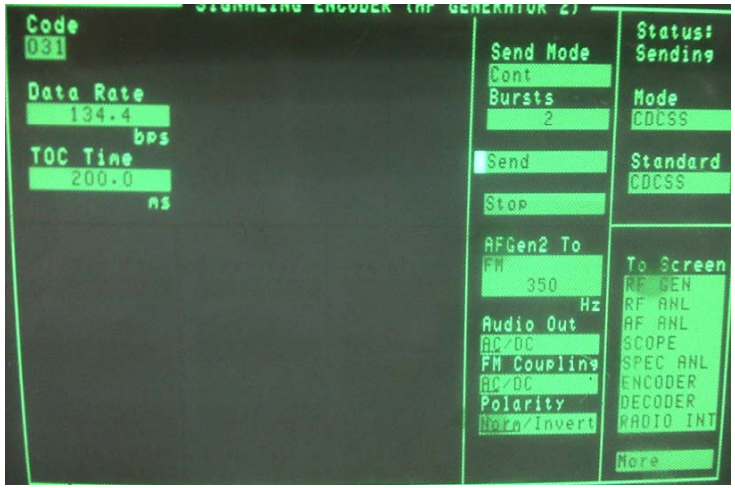
AF Gen2 To: input correct frequency, you can refer following table

Channel Spacing	AFGen2 to
Narrow Band	350Hz
Wide Band	750Hz

Test Methods

Rx CDCSS

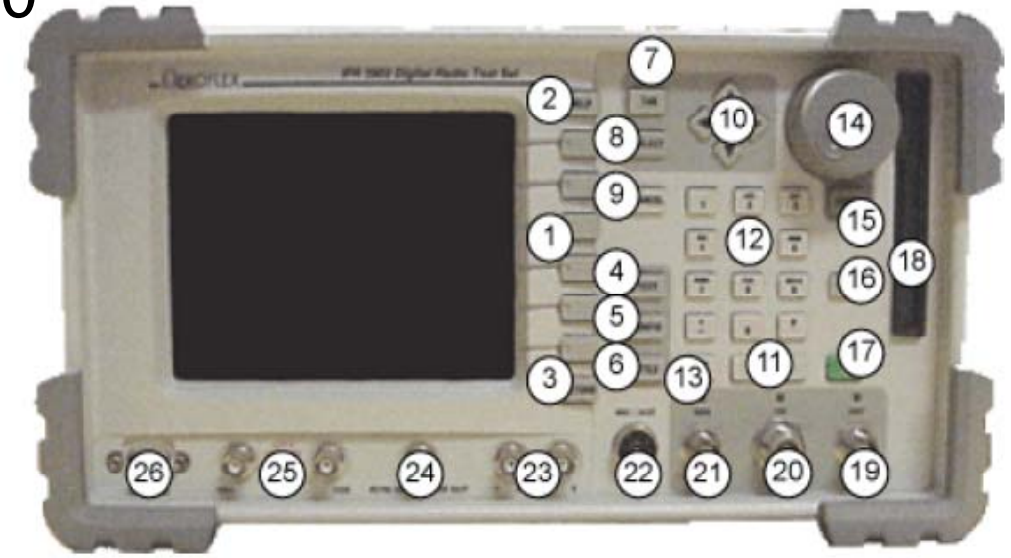
1. Choose Rx Test.
2. To Screen choose ENCODER.



1. Mode : choose CDCSS.
2. Send Mode: choose Cont.
3. AF Gen2 To: Narrow band 350Hz /Wide Band 750Hz.
4. Input the CDCSS Code. Here is 031.
5. Polarity: if normal CDCSS choose Norm, otherwise choose invert.
6. Click Send to send the Rx CDCSS.
7. Go back to Rx test window, send/stop the CDCSS, adjust the knob of HP8921A to decrease the signal level of amplitude, observe the open/off status of radio speaker.

Getting to Know IFR3920

Front Panel

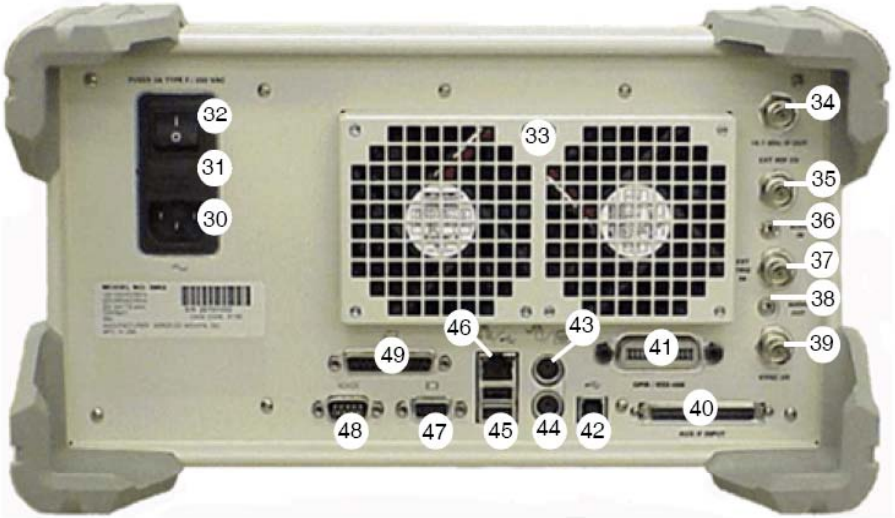


Keys

1	Soft Key	8	SELECT Key	15	ASSIGN Key	22	MIC/ACC Connector
2	HELP Key	9	CANCEL Key	16	Display Hold Key	23	Audio 1 and 2 IN Connectors
3	RETURN Key	10	Cursor Key	17	On/Standby Key	24	FCTN GEN/DEMOD Connector
4	TEST Key	11	ENTER Key	18	3.5 inch Floppy Disk Drive	25	Scope CH1/CH2 Connector
5	CONFIG Key	12	Data Input Key	19	ANT Connector10dbm	26	Test Connector
6	UTILS Key	13	BSKP Key	20	T/R Connector 125W		
7	TAB Key	14	Rotary Control Knob	21	GEN Connector		

Getting to Know IFR3920

Rear Panel



Keys

30	AC Power Connector	37	External Trigger Signal Connector	44	Keyboard Interface Connector
31	AC Power Fuse	38	Audio Output Connector	45	USB Connector
32	AC Power Supply Switch	39	Synchronization Signal Input or Output Connector	46	Ethernet Connector
33	Rear Cooling Outlets	40	Auxiliary IF Input Connector	47	VGA Monitor Output Connector
34	IF Output Signal Connector	41	GPIB-IEEE-488 Interface Connection	48	RS-232 Connector
35	Ext Ref I/O External Interface	42	Standard USB Client Connector	49	Parallel Printer Output Connector
36	Audio Output Connector	43	PS/2 Mouse Interface Connector		

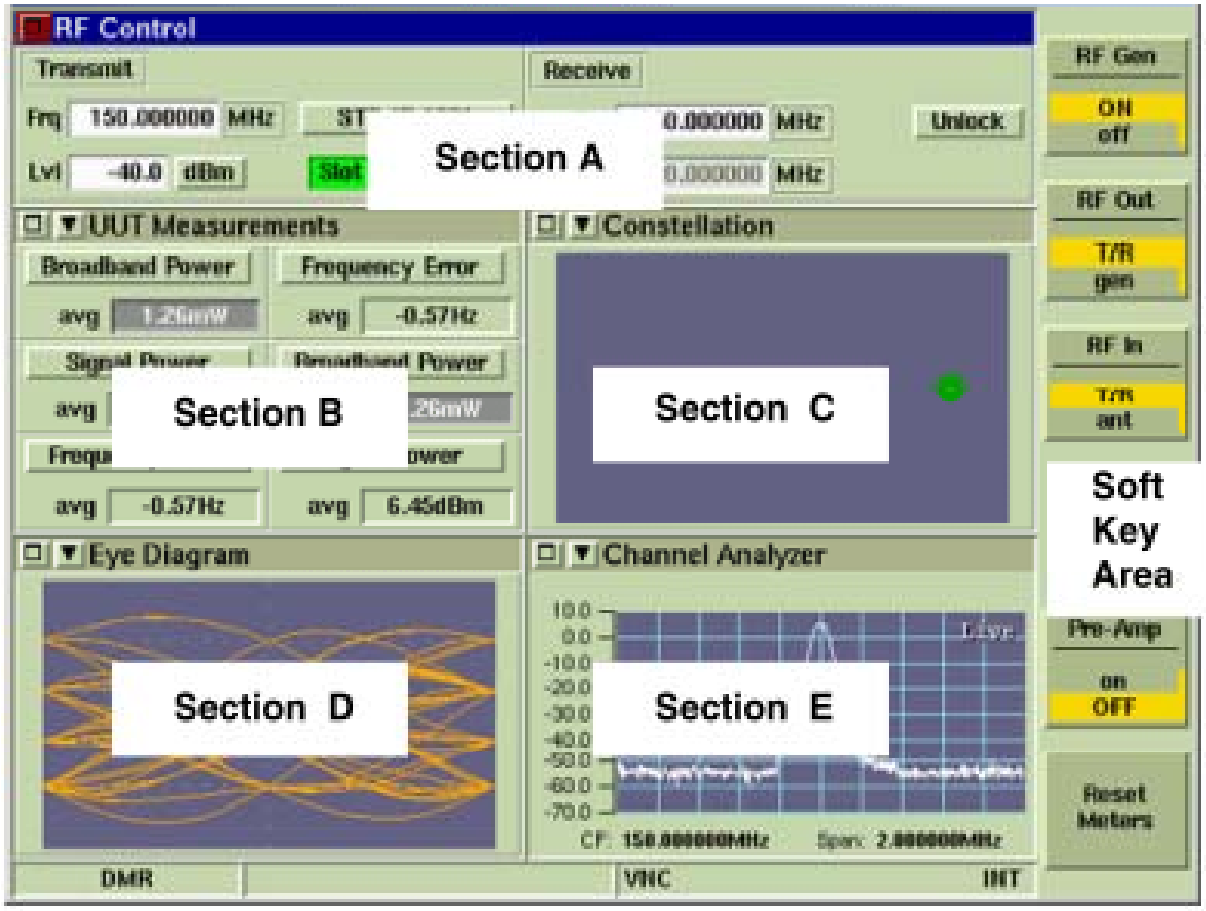
Digital Specifications

Portable (DC7.4V)	Specs
Tx Power	High Power 4.0W±0.2W /Low Power 1.0W±0.2W
4 FSK Error	≤5%
Magnitude Error	≤1%

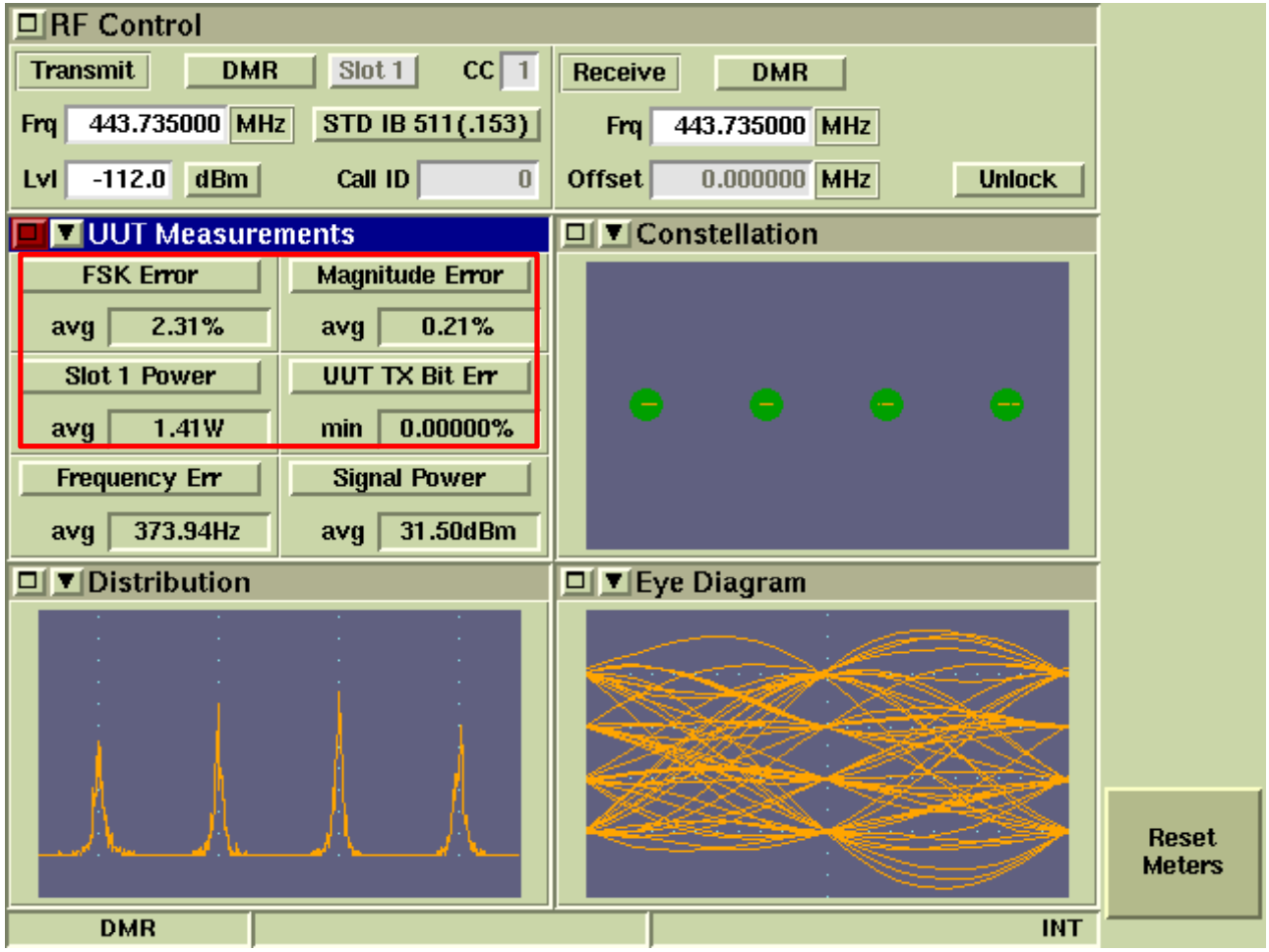
Temperature: 20-35ºC Relative Humidity: 45%-75% Atmospheric Pressure: 86kPa-106kPa Antenna Load: 50Ω

Test Methods

Intro of DMR Test Screen



Digital Parameter Test



1. Press Config button twice, then choose the DMR menu to enter this screen.
2. In primary course, we only need to test the FSK Error, Magnitude Error&Power.

Tx Power	
4 FSK Error	≤5%
Magnitude Error	≤1%

Thank you !