



# **AN1218.01**

## **Application Note**

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***VHF FM Radio Receiver based on the  
XE1218 single chip FM 230MHz***

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## Introduction

This reference design reports on how the RD1218.01 VHF FM Radio Receiver demonstrates the use of a highly integrated single chip audio receiver from antenna to loudspeaker for voice transmission applications. For details about the Single Chip FM 230MHz Receiver, refer to XE1218 Data sheet.

Traditionally, FM Receiver includes a high complexity design simplified by the use of a highly integrated single chip receiver.

XEMICS XE1218 FM Receiver has an ultra low voltage operation down to 1 volt and ultra low power consumption, 2mA. The sensitivity has been designed in order to obtain  $-107\text{dBm}$  with 6kHz audio bandwidth.

The XE1218 circuit includes a RF receiver section, demodulator and a directly connecting audio amplifier that fits to an external earpiece. It uses analog narrow-band FM modulation.

Based on low power-IF architecture, the XE1218 VHF receiver is designed with an on-chip channel filter and a delay line type demodulator. Moreover, a crystal oscillator generates the Local Oscillator frequency that can therefore be fixed between 130MHz-230MHz.

## XE1218 Benefits

The use of the XE1218 VHF FM Receiver in audio RF application offers the following advantages:

- Low power consumption
- Highly integrated
- High sensitivity
- 6kHz audio bandwidth
- Integrated audio amplifier
- Very few external components

## Overview

The FMX Electronic module is a VHF FM radio receiver. It provides a cost-effective circuit enabling it to receive an audio signal from a walky-talky.

The system operates in the low power band 200MHz for short-range devices. It is a fixed frequency one-channel receiver. Its receiving frequency is defined by a quartz, which is soldered on the module. It can be chosen in the 173-225MHz band.

In Europe, the 173-225MHz band (formerly TV "VHF-II") has recently been assigned to short range radio communication equipment using a low power transmitter (for more information refer to norm ETS300422).

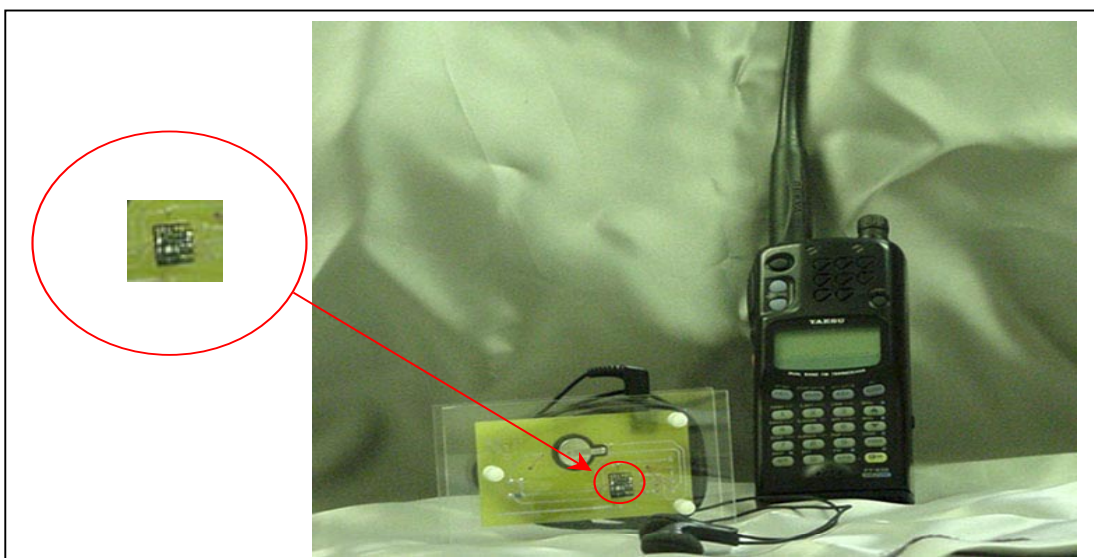
Typical applications using the XE1218 design are tour guide systems, wireless phone headsets, FM broadcasting miniature receivers, local/wide area voice paging and toys.

In the USA, the 216-217MHz band was freed in 1996 for a new Low Power Radio Service (LPRS) which includes auditory assistance devices, health care assistance devices and law enforcement tracking systems. The maximum allowable transmitter power is 100mW.

The FMX is an electronic module that allows the construction of a miniaturized radio receiver. It is supplied by a single 1.3V battery and has a low current consumption (1.5mA-3mA, depending on its mode).

## Key Features

- Low complexity hardware
- Small size
- A short wire printed antenna
- Direct connection with a loudspeaker
- Stand by mode  $<50\mu\text{A}$ .



## System Overview

The RD1218.01 Reference Design describes how to develop a cost effective and fully integrated FM Receiver. Using the XE1218, this application performs RF signal reception and Audio processing (antenna in, loudspeaker out).

This Reference Design is limited to receive only one frequency, which is fixed by a quartz (see design modification to change the LO frequency).

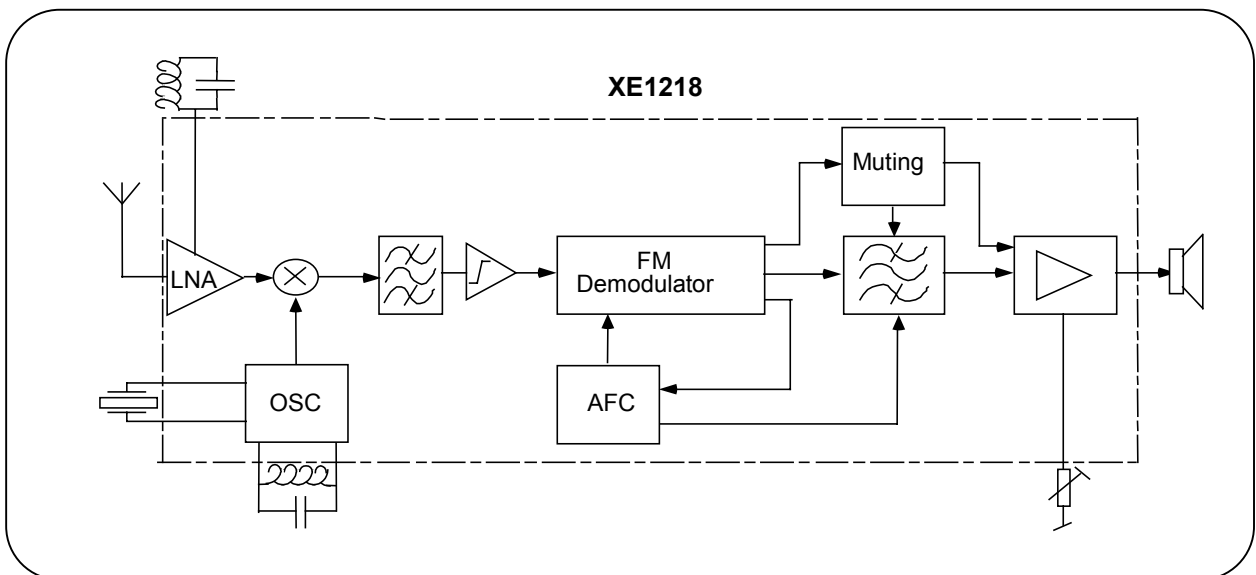
The Ultra Low Power VHF FM receiver, XE1218, is composed of the following main functional blocks:

- Receiver Chain including the audio output stage
- The Local Oscillator block
- The control and service blocks.

The receiver is implemented with the following blocks:

- A low noise amplifier
- A mixer used as a down converter to transfer the signal from VHF band to an intermediate frequency (IF) of 25kHz.

- An offset cancellation block used to attenuate the DC.
- An IF Filter chain used to amplify and filter the IF signal.
- A limiter providing the demodulator with fully digital signals.
- A digital delay line FM demodulator that converts the signal from limiter into a pulse width modulated signal at twice the IF frequency. This block also generates AFC and MUTE signals; the AFC signal is used inside the demodulator in order to track the clock frequency of the IF frequency.
- An audio stage used to filter the input PWM signal and to provide volume control and output buffering. The block uses the MUTE signal generated by the demodulator to switch on/off the output buffer driving the EAR output.



## System Details

The receiving frequency of the FMX is determined by the quartz frequency. The receiver XE1218 is a super-heterodyne receiver having an IF of 25kHz. It has two receiving frequencies that are +25kHz offset with respect to the quartz frequency.

The image frequency is not rejected, this simplification has been made in order to achieve the lowest current consumption. The image frequency is located very close to the receiving frequency, therefore the probability of interference, on this image, by other low power transmitters remains low.

The antenna circuitry has to be adjusted (Trimmer on the module), because it depends on the chosen antenna type.

### Power Supply

A single 1.0-1.6V battery supplies the receiver. The battery shall be connected between +Vdd and GND.

### Audio Outputs

The module FMX has 3 outputs each of which serving different purposes:

- OUTL and OUTH (not accessible with demonstrator) are low-level outputs for connection to loudspeaker input.
- EAR is a high level output. It is the output of a class A amplifier and can be directly connected to an earphone.

Audio Pad	Output Level	Output Impedance	Recommended Load Impedance
OUTL	10mVrms ±3dB	<100Ω, serie 4.7μF	>1kΩ
OUTH	40mVrms ±3dB	10kΩ ±25%, serie 1μF	Any
EAR	250mVrms ±3dB	Vbias=0.3V ±100mV	Rdc (earphone)>200 Ω

### Audio Output Level Control

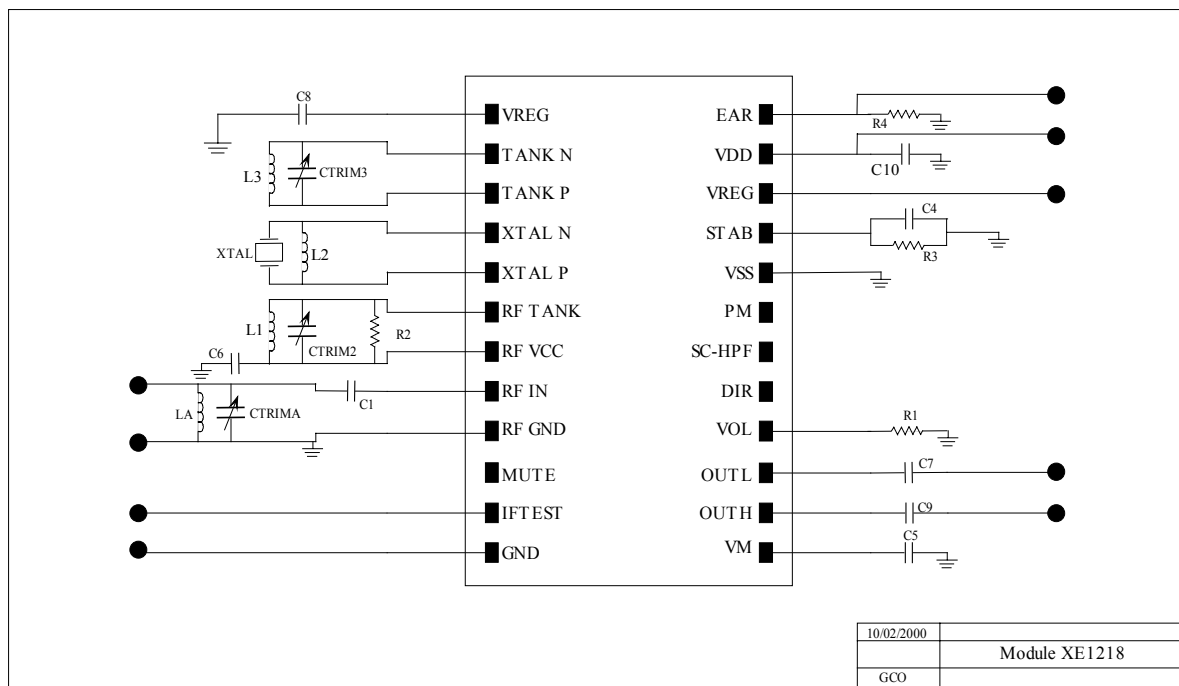
The Audio output level depends on the value of the resistor R1 (see fig). The default value is 470kOhm.

### Antenna Circuit

The simplest receiving antenna is a short wire of length 4cm (electrical antenna)

It is possible to use a magnetic LOOP antenna with a 2 square centimeter area. In that case, the SMD coil LA must be removed and CT1 again bring the whole antenna circuitry at resonance on the frequency. The magnetic antenna is less sensitive to de-tuning by the proximity of the body than the electrical antenna.

## Electrical Schematic of the Module

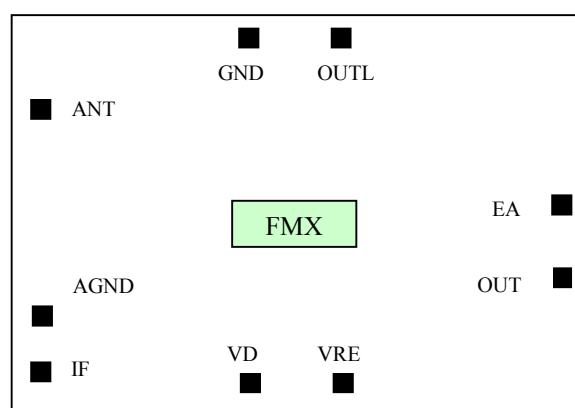


## General Specification

Parameter	Specification
Type of Modulation	FM, $\Delta f_{dev}=5\text{kHz}$ max.
Alignment Range	173-225MHz
Switching Range	One channel receiver, (quartz controlled)
Sensitivity	SINAD>10dB @ Pin=-105dBm, $f_{mod}=1\text{kHz}$ , $\Delta f_{dev}=3\text{kHz}$
Channel Selectivity	>50dB (@200kHz channel spacing)
Current Consumption	Stand-by mode<50 $\mu$ A Squelch or active mode:1.5mA-2.1mA
Operating Temperature Range	-10 $^{\circ}$ to +55 $^{\circ}$ C (extreme)
Audio Signal Frequency Range	100Hz – 6kHz
SNR	45dB
THD	<3% ( $f_{mod}=1\text{kHz}$ , $\Delta f_{dev}=5\text{kHz}$ )
Spurious Emissions	Far below –57dBm ERP

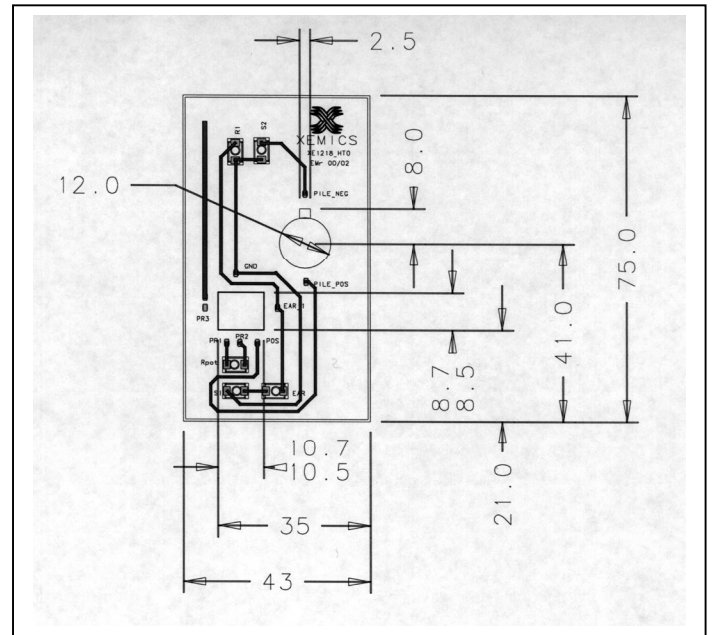
## Symbol and List of the connection

PAD	Description
GND	Negative Supply (GND)
VDD	Positive Supply
VREG	Sense Input for the standby modus
EAR	Earphone Output or high level audio output
OUTL	Low Impedance Output for hearing aids
OUTH	High Impedance output for hearing aids
IF	Test pad
ANT	Antenna input
AGND	Antenna ground



## Bill of Material

Components	Type	Value
Xtal 1	Overtone crystal, Serial resonance	Ex, F=171.525 Cs=0.17fF, Rs<120Ω Q>40000 Cp=3,2pF
L1		0.15uH
L2		0.18uH
L3		0.18uH
C1		1pF
Ctrim1		10pF
Ctrim2		2.5pF
Ctrim3		3.2pF
C4,C5,C6		10pF
C7		4.7uF
C8		4.7uF
C9		10uF
R1		0-100kΩ
R2		
R3		2.2MΩ
R4		45kΩ



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