AN1201A.03
Application Note

The XM1201A module Reference Board for XE1201A

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Introduction

This application note describes the XM1201A module, vers. 3.0, which constitutes a reference module for the XEMICS XE1201A single chip transceiver. Targeted for high volume manufacturing, this UHF board has been optimized for performance and cost.

This module is an excellent starting point for users needing additional on-board features such as a microcontroller.

The module includes the RF IC XE1201A with its associated external RF circuitry and printed loop antenna.

Performances

Typical performance is at 19.2 Kbits/s is +7.5dBm output power and -107dBm sensitivity.

How to use this document

The reference board described here is a reference module for the XEMICS XE1201A single chip transceiver. Click here to download the full set of the XM1201A Gerber files, or download information on the XE1200 series at XEMICS' website, http://www.xemics.com/xe1200/

Information contained within this document, as well as in the XM1201A Gerber files are for reference and information only.

If you need to develop your personalized UHF board, you can start from this design and then make the necessary upgrade to match your requirements.

To access the XE1201A Datasheet, simply download it from XEMICS' website:
http://www.xemics.com/download/

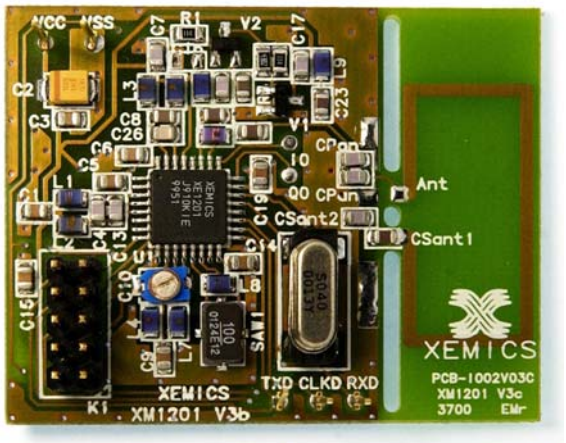
Board

The XE1201A Reference Board allows the user to program the XE1201A in any configuration. A 10-pin connector can be used to connect the XM1201A directly to a microcontroller board or to the XEMICS Interface board. This enables the utilization of the XE1201A Evaluation kit Software.

Moreover, a loop antenna on board has been designed for a "Quick Start Transmission". For users wishing to connect a spectrum analyzer or another antenna other than the antenna designed for this board, the loop antenna can be easily removed from the board.

Furthermore, an external power amplifier has been added to increase the data range. This design optimizes the increase of output power without sensitivity loss. In addition, this external power amplifier produces the "antenna switch" thereby reducing the number of external components and in turn the overall costs.

To enable complete cost reduction and better production, all tuning element on the board have been removed. Only one trimmer capacitor has been inserted to fix the value of the Local Oscillator. Final applications can be built without any tuning component.



XM1201A Reference Board

I/O Lines

An Overview of I/O lines is given in Figure 2.

Connector 10 pins:

- "RXTX Line": Receive / transmit is activated when the control bit (A13) is set to zero. In this mode, the module can be set to the transmitter or receiver mode.

RXTX	Mode
0	Transmit Mode
1	Receive Mode

- "EN Line": Chip "enable" is activated when the control mode bit (A13) is set to zero. In this mode, the XE1201A can be switched on or off.

EN	Mode
0	Chip disabled
1	Chip enabled

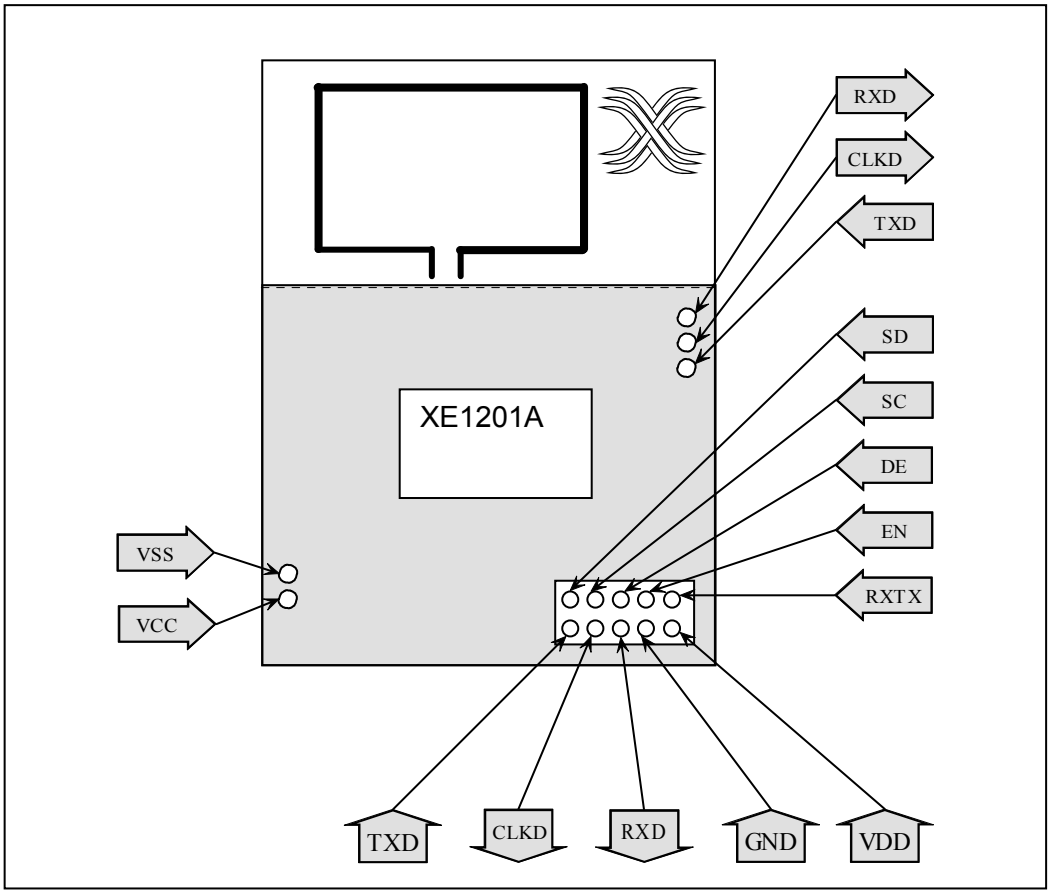
- "DE, SC, SD Lines": The XE1201A is controlled via the 3-wire serial bus and by a microcontroller that addresses the 3 wires (SD-Serial Data, SC-Serial Clock, DE- Data Enable). For more information refer to the XE1201A datasheet
- "TXD Line": Transmit Data Line
- "CLKD LINE": Clock Data Line. This signal is generated by the bit synchronizer block that provides glitch free data. This allows the received data signal to be directly read by a low complexity microcontroller.
- "RXD": Line Receive data Line
- "VDD Line": Connect to a 3 V power-supply.
- "GND Line": Ground

Probe-pad:

- "TXD Line": Transmit Data Line
- "CLKD LINE": Clock Data Line. "RXD": Line Receive data Line

Power supply:

- The XM1201A Module can be powered in two different ways. The first uses the two externals VSS and VCC and the second uses the 10 pins connector.



Performances

Output Power and Current consumption
The performances of the XM1201A Module are listed below. These measures have been made with a typical configuration, frequency deviation at 125kHz, power supply at 3 V, temperature at 25°C, a data rate at 16 kbit/s and the output power register set at the maximum power available (5dBm).

In transmitter mode:
Set up configuration:
- A13=0
- EN=1
- RxTx=0

Output Power at the antenna connector
- P_{out} = 7.5dBm

Total current consumption
- I_{tot}= 16.1mA

Current consumption with the external Power amplifier Off
- I_{min}=8.47mA

In receiver mode:
Set up configuration:
- A13=0
- EN=1
- RxTx=1

Sensitivity
- Sens = -107dBm

Current consumption
- I_{rx} = 6.46mA

Stand by mode
Set up configuration:
- A13=0
- EN=0
- RxTx=X

Current consumption
- I_{sby} = 60µA

Sensitivity
To achieve a RF transmission, two parameters need to be defined: The output power and the sensitivity.
In order to obtain the maximum data range a compromise needs to be made between these two values.

The value of the bit rate can also influence the receiver sensitivity. Figure 1 shows the measure of the sensitivity with a bit error rates less than 10E-2 versus the data rate. This measure is based on a calculation of frequency deviation at 125kHz and supply voltage at 3 V.

The frequency deviation can also influence the receiver sensitivity. Figure 3 shows that the sensitivity is optimum 50kHz and 250kHz and maximum 125kHz. This is due to the receiver Base-band filter, for more information refer to XE1201A Application information chapter II-3-4.

Spectrum waveforms
To calculate these measures, the capacitor C15 has been removed so as to obtain an impedance equal at 50 Ohm (input impedance of the Spectrum Analyzer).

Figure 3 shows the spectrum of the FSK signal for 1 transmit (Flo + Fdev). The output power, in static mode, is more than +7.5dBm and the attenuation of the spurious at the 3rd harmonic of Fdev is better than 40dBc.
The frequency image (Flo – Fdev) is measured at 30dBc.

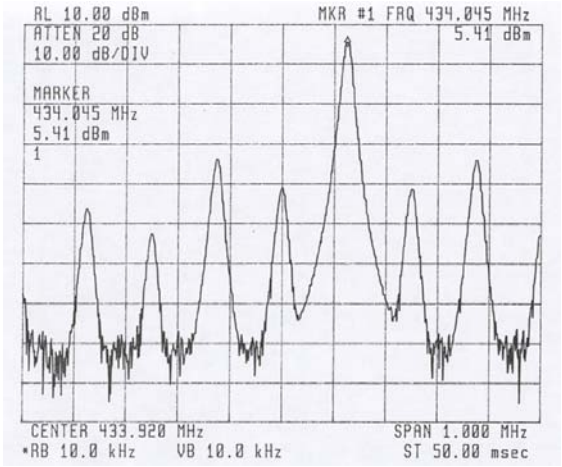


Figure 3: Spectrum of a “1” transmission

Figure 4 shows the spectrum of the FSK signal for 0 transmit (Flo -Fdev). The output power in static mode is more than +7.5dBm and the attenuation of the frequency image and the spurious at the 3rd harmonic gives the same result as that for a 1 transmit.

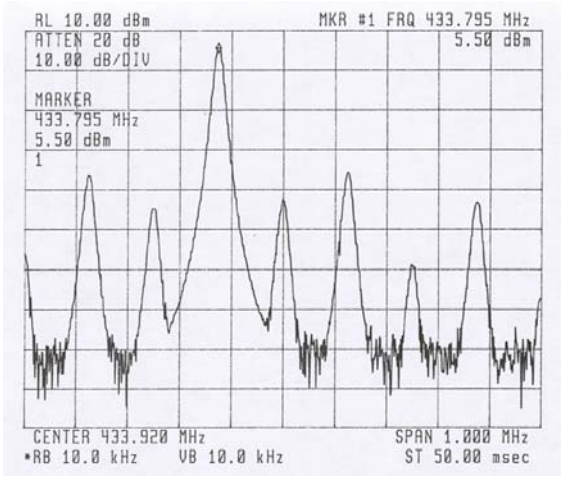


Figure 4: Spectrum of a “0” transmission

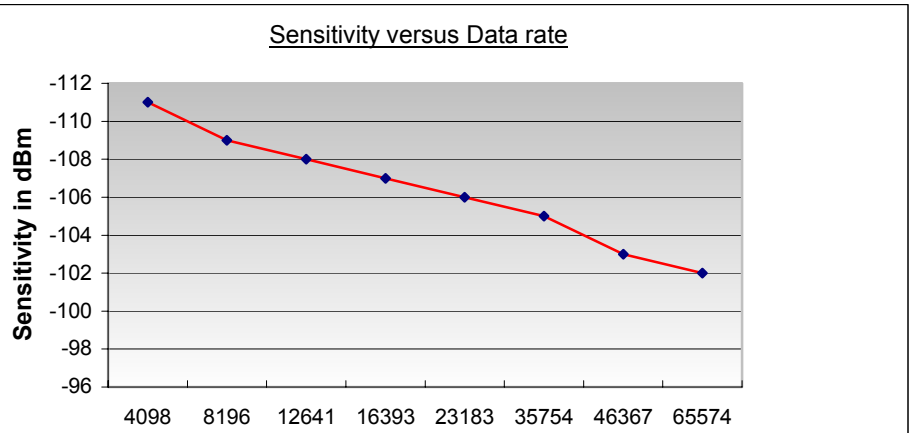


Figure 1

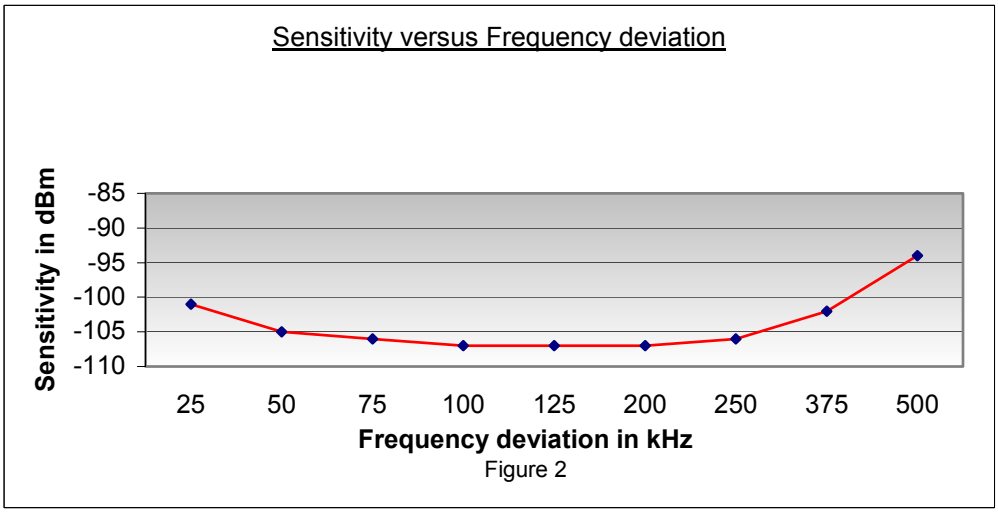


Figure 2

Loop Antenna

A loop antenna has been designed for this board. The performances are not optimal. The performances are 250 meters in free space and more than 50 meters indoor.

If the final application needs more data range then the other antenna structure needs to be implemented as a wipe antenna. The maximum performance of the antenna requires two conditions: Resonance and Matching.

Resonance: This is obtained at the centered frequency once the characteristic impedance is strictly resistive. The minimum reactive part should be observed at the considered frequency (Figure 5: Smith's chart)

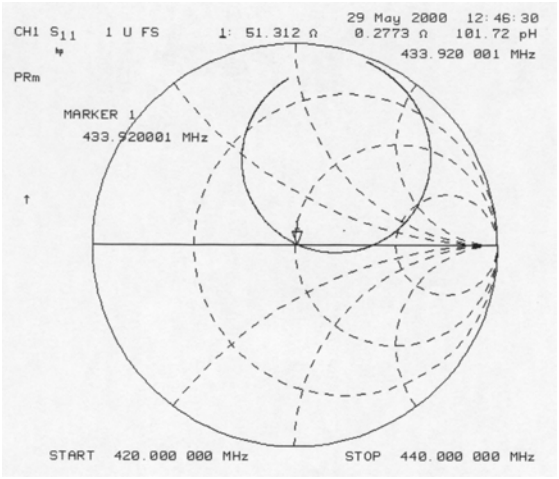


Figure 5: Smith chart

Matching: A proper matching of the antenna to the feed point implies that both impedance is identical. This condition ensures that all the energy delivered by the feed point is converted in an electromagnetic field. In the case of mismatch, a Standing Wave appears and part of its energy returns to the transmitter.

The SWR (Standing Waves Ratio) determines the amount of energy that is not converted by the antenna into an electromagnetic energy. (Figure 6)

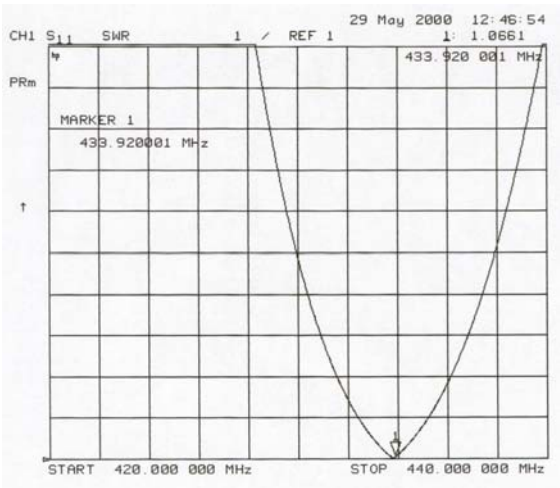


Figure 6: SWR

The loop antenna's main advantage is the cost (Figure 7), being directly included in the cost of the PC board. The fixed capacitors Cloop1 and Cloop2 may be replaced by a tuning capacitor in order to optimize the antenna adaptation. The capacitor's values of depend on the application and of the PC board location.

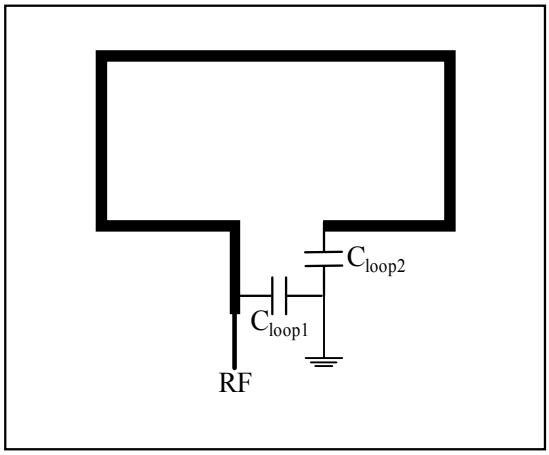


Figure 7: Printed Loop Antenna

The loop antenna is a good solution for portable instruments, which are not demanding in terms of range. Beware of attenuation and directivity caused by body effect. For the antenna in this application note, make sure to place it well within proximity of the body.

How to use

The XM1201A Module has been designed for "Quick Start Transmission". It can be used in two different ways

- With the XEMICS interface board and software or
- In stand alone with a microcontroller board

XEMICS Interface board

The XM1201A Module can be interfaced directly with the XEMICS interface board via the 10 pins connector (Figure 8). In this case, the XE1201A software can program the XM1201A Module. To download the XE1201A software, go to XEMICS' website at
http://www.xemics.com/download/

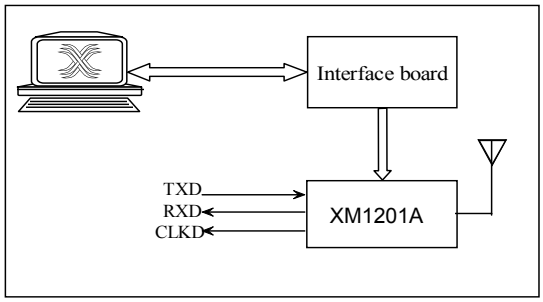


Figure 8: XM1201A with Xemics interface board

Application board

The XM1201A can be directly inserted in the final application (Figure 9). For that, the motherboard needs to be connected to the module via the 10 pins connector in order to:

- program the XE1201A (SD, SC,DE),
- manage the communication (EN,RxTx),
- transmit/receive data via (TXD, RXD, CLKD)

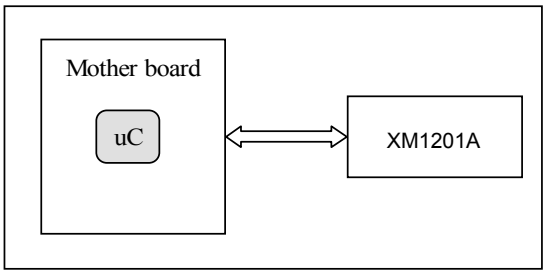


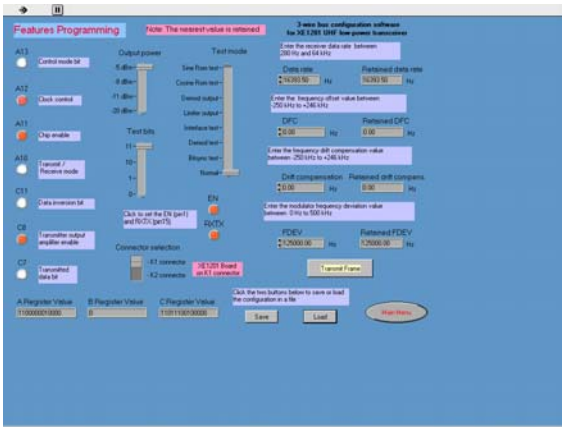
Figure 9: XM1201A with Motherboard

Programmation

The XM1201A is configured with two different blocks: the XE1201A and the external power amplifier. For using both blocks, the user needs either to switch to receiver mode, transmitter mode or stand-by mode.

Receiver mode configuration

- ➢ Control mode bit A13=0
- ➢ Enable pin EN=1
- ➢ Receive/transmit RxTx=1

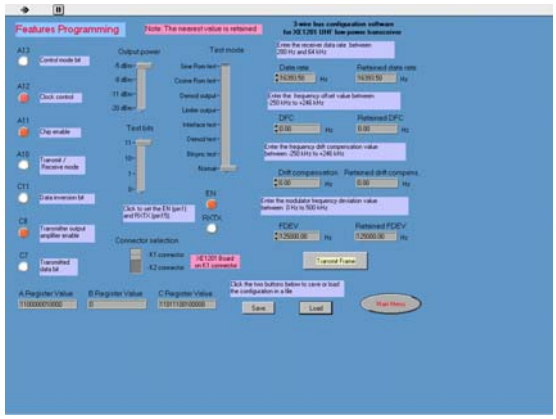


- ⇨ External PA Switch Off
- ⇨ XE1201A in receiver mode

Transmitter mode

- ➢ Control mode bit A13=0
- ➢ Enable pin EN=1
- ➢ Receive/transmit RxTx=0

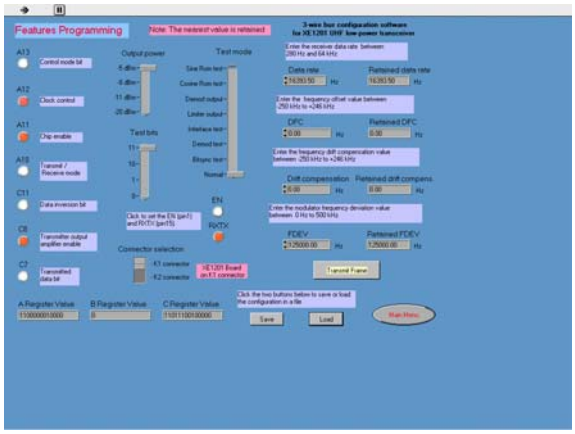
- ⇨ External PA Switch On
- ⇨ XE1201A in transmitter mode



Stand-by mode

- ➢ Control mode bit A13=0
- ➢ Enable pin EN=0
- ➢ Receive/transmit RxTx=1

- ⇨ External PA Switch Off
- ⇨ XE1201A in stand by mode



PCB issues

We strongly recommend the use of a PCB similar to the one as described here in Figures 10 and 11. Moreover, do not forget that the XE1201A circuit is a Direct Conversion Receiver. As such, the local oscillator is operating at the carrier frequency. To avoid self-mixing and DC bias, maximum insulation between the LO section (tank, SAW resonator) and the receiver antenna is essential.

Decoupling components should be placed as close as possible to the XE1201A circuit. They should not be connected through vias.

Components

Below is a reference list of components, this describes the types and references of the various selected components. When selecting an equivalent device, one should make sure performances such as tolerances and Q-factor is equal to or above those indicated.

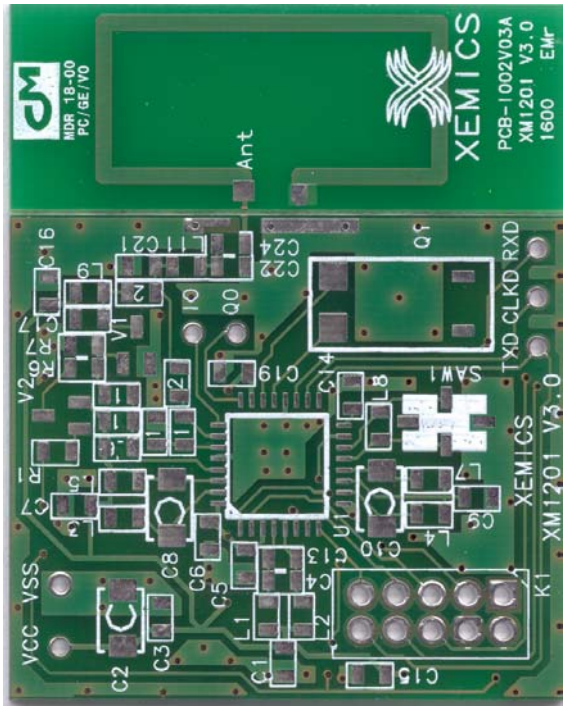


Figure 10: XM1201A Top view

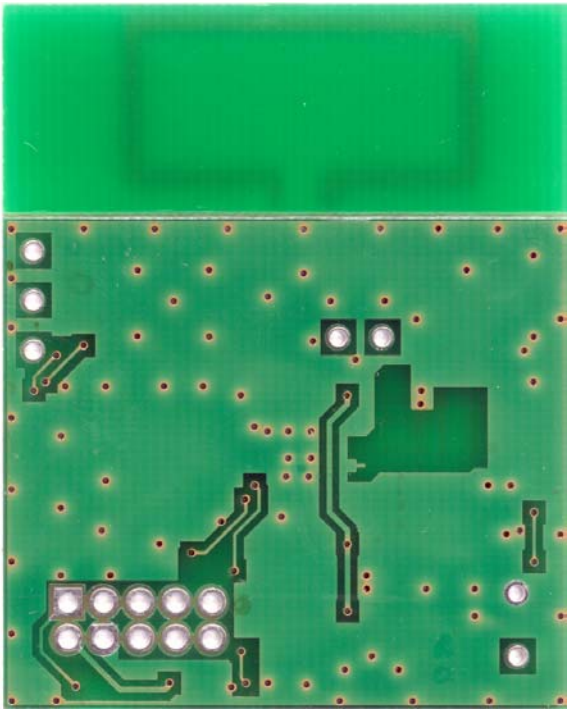


Figure 11: XM1201A Bottom view

Exhibit I: Board diagram

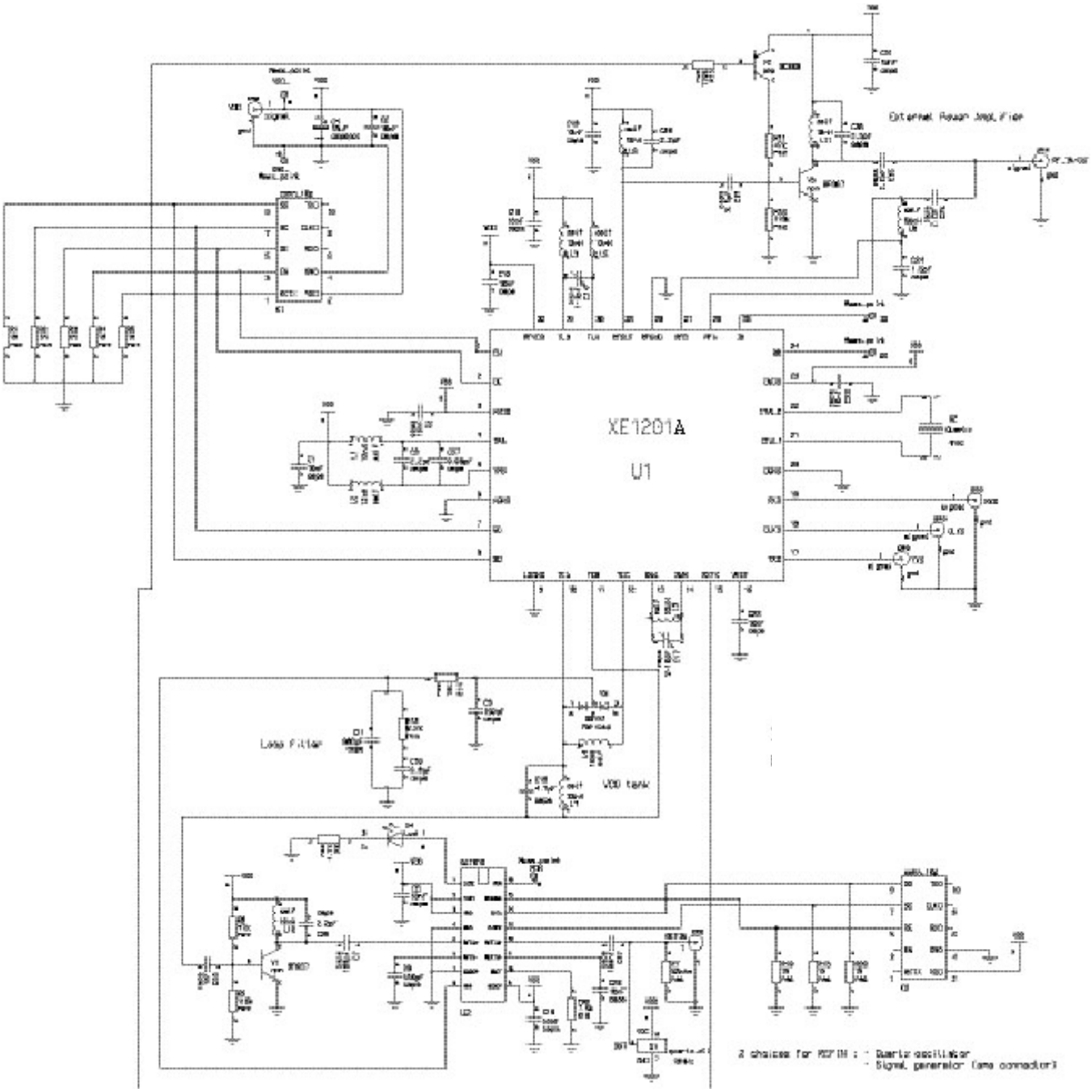


Exhibit II: List of Components, references

Name	Type	Reference	Value	Form	Quantity
U1	XE1201A Transceiver IC	XE1201A-T		TQFP32	1
Q1	XTAL Quartz	S0409745	4.00MHz	-	1
T1	NPN Transistor	BFQ67		Sot23	1
T2	PNP Transistor	BC808		Sot23	1
SAW1	SAW Resonator	RO-2101A	433.92MHz	SM-2	1
C2	Decoupling capacitor		10uF		1
C1, C3, C5, C6, C7, C9, C14, C16,C19	Capacitor 0805	805 NPO Ni, +/-0.25pF, 50v	10nF	SMD0805	9
C26	Capacitor 0805	805 NPO Ni, +/-0.25pF, 50v	0.68pF	SMD0805	1
C4,C11,C13,C17,C27	Capacitor 0805	805 NPO Ni, +/-0.25pF, 50v	1.5pF	SMD0805	5
C8,C18,C23	Capacitor 0805	805 NPO Ni, +/-0.25pF, 50v	2.2pF	SMD0805	3
C24	Capacitor 0805	805 NPO Ni, +/-0.25pF, 50v	2.7pF	SMD0805	1
C12,C20	Capacitor 0805	805 NPO Ni, +/-0.25pF, 50v	4.7pF	SMD0805	2
C22	Capacitor 0805	805 NPO Ni, +/-0.25pF, 50v	10pF	SMD0805	1
C25	Capacitor 0805	805 NPO Ni, +/-0.25pF, 50v	33pF	SMD0805	1
C21	Capacitor 0805	805 NPO Ni, +/-0.25pF, 50v	22pF	SMD0805	1
C15	Capacitor 0805	805 NPO Ni, +/-0.25pF, 50v	100nF	SMD0805	1
C10	Trim-Capacitor	TZC03Z060A110	2 to 6pF	SMD0805	1
L1, L2, L3, L4, L5, L7	self	0805 CS-120-X JBC 5%	12nH	SMD0805	6
L6, L8, L9	self	0805 CS-180-X JBC 5%	18nH	SMD0805	3
L10	self	0805 CS-560-X JBC 5%	56nH	SMD0805	1
R6	Pola resistor	any	43k	SMD1206	1
R1,R7	Pola resistor	any	110k	SMD1206	2