

How to Connect C51 Microcontroller to ATR2406

This application note describes how to control an ATR2406 with a C51 microcontroller (AT89C5130A for example).

ATR2406 is a single chip RF-transceiver intended for applications in the 2.4 GHz to 2.5 GHz ISM band.

AT89C5131A is a high-performance Flash version of the 80C51 single-chip 8-bit microcontrollers with full speed USB functions. It is available in low pin count with 18 IOs and high pin count with 34 IOs. It also has a 32K Flash and mask ROM variants.

The result is a RF/USB gateway. A wide domain of applications is proposed:

- **High-tech toys**
- **Telemetry**
- **Wireless Audio...**

References

- AT89C5131A data sheet (available on www.atmel.com)
- ATR2406 data sheet (available on www.atmel.com)

Acronyms

- **USB:** Universal Serial Bus
- **ISM:** Industrial, Scientific and Medical (radio spectrum)



**8051
Microcontrollers**

Application Note



ATR2406 Overview

ATR2406 is a single chip RF-transceiver intended for applications in the 2.4 GHz ISM band.

ATR2406 is a complete transceiver including image rejection, mixer, low IF filter, FM demodulator, RSSI, TX preamplifier, power-ramping generator for external power amplifier, integrated synthesizer, and a fully integrated VCO and TX filter.

No mechanical adjustment is necessary in production.

ATR2406 supports baudrates from 72kBits/s to 1152kBits/s. For 1152 kBit/s data rate, the receiver has an on-chip clock recovery function.

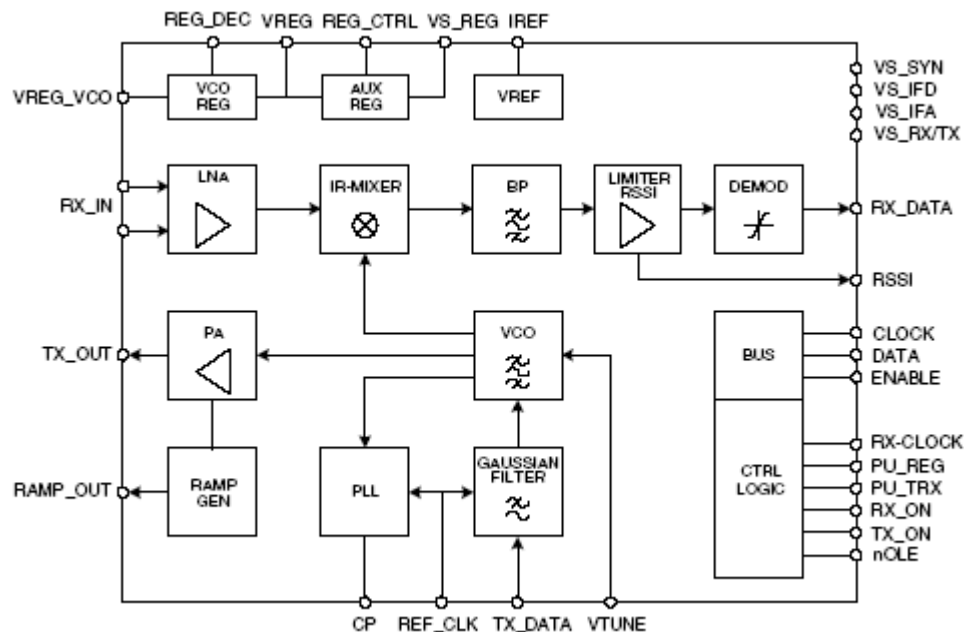
The PLL allows two reference frequency values:

- 10,368 MHz
- 13,824 MHz

The transceiver is programmed by the SPI (CLOCK, DATA, ENABLE).

The power supply voltage range is from 2.9V to 3.6V.

Figure 1. ATR2406 Block diagram



AT89C5130 Overview

AT89C5131A is a high-performance Flash version of the 80C51 single-chip 8-bit micro controllers with full speed USB functions.

AT89C5131A features a full-speed USB module compatible with the USB specifications Version 1.1 and 2.0.

AT89C5131A retains the features of the Atmel 80C52 with extended Flash capacity (16/32 Kbyte), 256 bytes of internal RAM, a 4-level interrupt system, two 16-bit timer/counters (T0/T1), a full duplex enhanced UART (EUSART) and an on-chip oscillator.

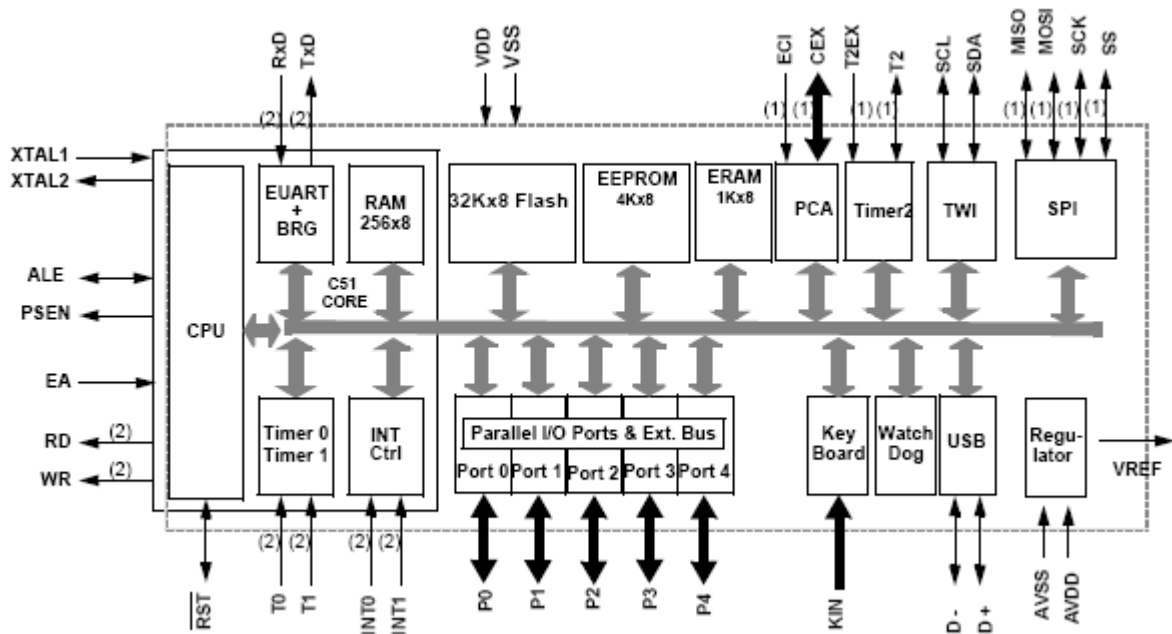
In addition, AT89C5131A has an on-chip expanded RAM of 1024 bytes (ERAM), a dual data pointer, a 16-bit up/down Timer (T2), a Programmable Counter Array (PCA), up to 4 programmable LED current sources, a programmable hardware watchdog and a power-on reset.

AT89C5131A has an hardware SPI block.

A PLL provides the 48 MHz for USB from a crystal oscillator.

The power supply voltage range is from 3V to 3.6V.

Figure 2. Block diagram



Hardware Connections

ATR2406 has two data inputs and one output:

- DATA: This input is used to program the transceiver. The programming is done by a 16 bits (or 25 bits) data word with a SPI bus (CLOCK, DATA, ENABLE).
- Tx_DATA: After configuration of the transceiver, the input data on Tx_DATA are transmitted on RF.
- Rx_DATA: This pin outputs the asynchronous serial data.

AT89C5131A hardware SPI bus is used to configure ATR2406.

AT89C5131A hardware UART is used to send/receive data to/from ATR2406.

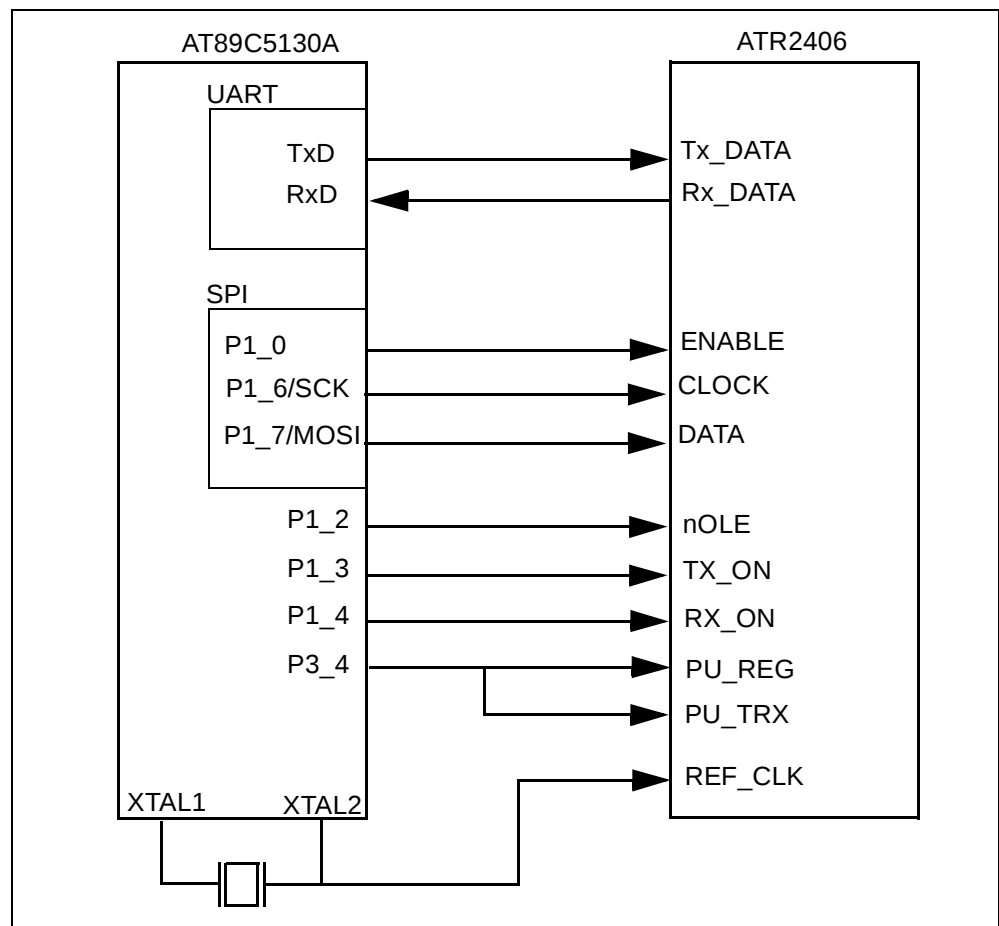
The transceiver and receiver hardware connections are identical.

In the figure below, the recovery clock function pin is not connected.

For the receiver, AT89C5131A starter kit is connected on USB bus. The power supply of the starter kit comes from USB (5V). The starter kit has a regulator to provide 3.3V to AT89C5131A (and ATR2406).

A 3 to 5V battery is used to power the transceiver.

Figure 3. AT89C5131A and ATR2406



ATR2406 and USB Communication Problem

The major issue to solve is the selection of the crystal frequency.

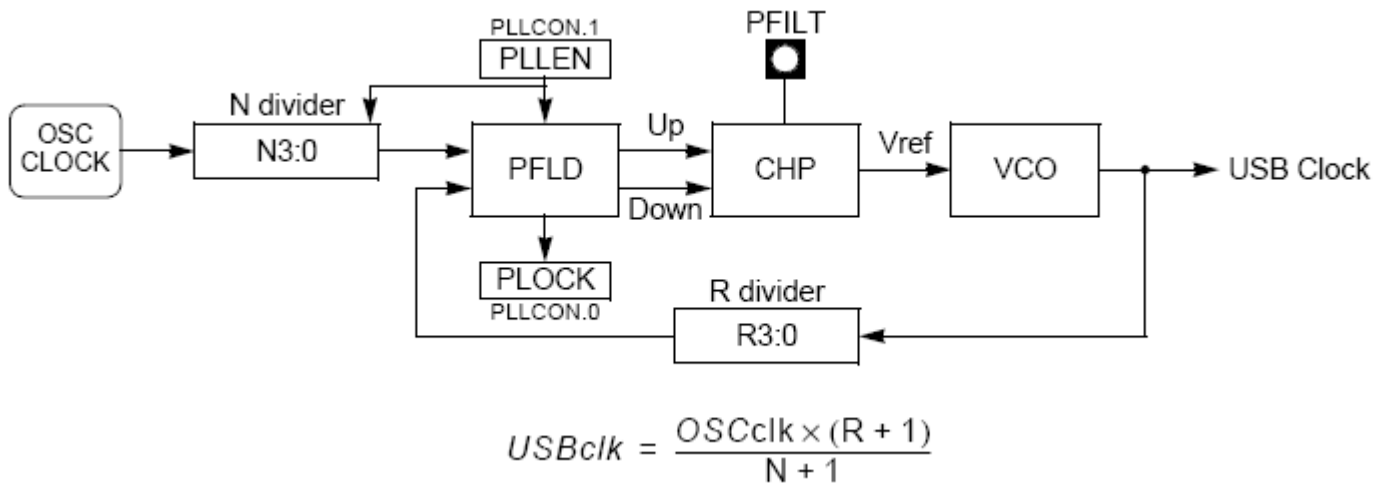
ATR2406 allows two frequencies:

- 10,368 MHz
- 13,824 MHz.

AT89C5131A needs a 48 MHz for the USB. The 48 MHz comes from a PLL with a prescaler multiplying the input frequency, see Figure 4.

AT89C5131A prescaler cannot provide 48 MHz with 10,368 MHz or 13,824 MHz.

Figure 4. AT89C5131A PLL block diagram



Crystal Selection

A crystal value of 13.714 MHz is selected.

The crystal is provided by:

- Taitien Electronic, i.e. XRFBCC-NANL, 10ppm, SMD

Distributor: <http://www.taitien.com>

AT89C5131A prescaler values are:

USB clk = 13.714 * 7/2 = 48 MHz (with R=6 and N=1)

ATR2406 nominal frequency of 13.824 MHz is near 13.714 MHz and the effect of changing frequency is given in section "channel description".

The results on baudrates and channels are described in the next paragraphs.

Remark on Bootloader

AT89C5131A default Atmel bootloader does not support the value of 7/2 for the clock prescaler. A software modification of the bootloader is needed to load a program in Flash memory with a 13.714 MHz oscillator frequency. See also, application notes for programming a customized boot loader.

Channel Description

ATR2406 operates in the 2.4 GHz to 2.5 GHz frequency band.

ATR2406 proposes 95 channels without overlap in this band. Each bandwidth is equal to 800kHz (modulation deviation).

There is a formula to calculate the antenna frequency in transmission mode and a formula for reception mode (from ATR2406 datasheet):

TX mode: $F_{ant} = 864 \text{ kHz} * (32 * SMC + SSC + 1)$

RX mode: $F_{ant} = 864 \text{ kHz} * (32 * SMC + SSC)$

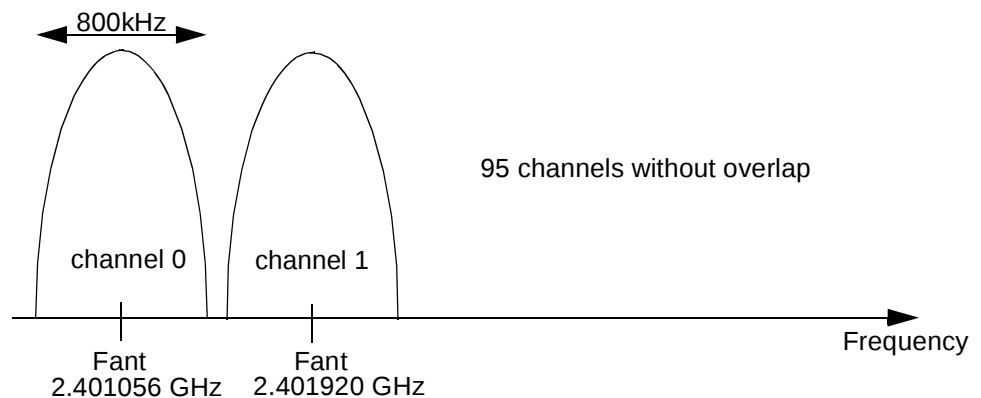
Table 1. Channel description in Tx mode

Channel	Antenna frequency (GHz)	SMC	SSC
C0	2.401056	86	27
C1	2.401920	86	28
.....			
C93	2.482272	89	24
C94	2.482272	89	25

Table 2. Channel description in Rx mode

Channel	Antenna frequency (GHz)	SMC	SSC
C0	2.401056	86	28
C1	2.401920	86	29
.....			
C93	2.482272	89	25
C94	2.482272	89	26

Figure 5. Bandwidth description



List of Channels with 13.714 MHz Crystal

Due to the 13.714 MHz frequency, the number of channels in the ISM band is limited to 79.

At the 13,714 MHz frequency, the ATR2406 formula are changed to:

TX mode: $\text{Fant} = 857,125 \text{ kHz} * (32 * \text{SMC} + \text{SSC} + 1)$

RX mode: $\text{Fant} = 857,125 \text{ kHz} * (32 * \text{SMC} + \text{SSC})$

The antenna frequencies are modified and few channels are going out of the 2.4 GHz to 2.5 GHz band. Seventy nine channels are available in this band, which is sufficient to avoid interference with other systems like Bluetooth[®], and WLAN.

Table 3. Channel description in Tx mode

Channel	Antenna frequency (GHz)	SMC	SSC
C0	2.400807	87	16
.....			
C78	2.467662	89	30

Table 4. Channel description in Rx mode

Channel	Antenna frequency (GHz)	SMC	SSC
C0	2.400807	87	17
.....			
C78	2.467662	89	31

ATR2406 Nominal Baud Rates

The ATR2406 baud rate values available with a 13.824 MHz crystal are:

- 72 kBit/s (13,824 / 192)
- 144 kBit/s (13,824 / 96)
- 288 kBit/s (13,824 / 48)
- 576 kBit/s (13,824 / 24)
- 1152 kBit/s (13,824 / 12)

List of Baud Rates with a 13,714 MHz Crystal

The corresponding baud rate values with 13,714 MHz are:

- 71,42 kBit/s (13,714 / 192)
- 142,85 kBit/s (13,714 / 96)
- 285,70 kBit/s (13,714 / 48)
- 571,41 kBit/s (13,714 / 24)
- 1142,83 kBit/s (13,714 / 12)

The AT89C5131A UART formula to calculate baud rates is:

$$\text{Baudrate} = \frac{2^{\text{SMOD1}} \times \text{Fclk_periph}}{2 \times 6^{(1-\text{SPD})} \times 16 \times [256 - \text{BRL}]}$$

With a 13.714 MHz oscillator, the Fclk_periph values are:

- 13.714 MHz if X2 bit = 1
- 6.857 MHz if X2 bit = 0

Table 5. Available Baud rates on AT89C5130 UART

F clk_periph	X2	SMOD1	SPD	BRL	Baud rate
6,857 MHz	0	1	1	250	71,42 kBit/s
13,714 MHz	1	1	1	244	71,42 kBit/s
6,857 MHz	0	1	1	253	142,85 kBit/s
13,714 MHz	1	1	1	250	142,85 kBit/s
13,714 MHz	1	1	1	253	285,70 kBit/s

The available baud rates on AT89C5131A UART with a 13.714 MHz crystal are:

- 71,42 kBit/s
- 142,85 kBit/s
- 285,7 kBits/s



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