XTR-903-A8 radio transceiver represents a simple and economic solution to the problem of wireless data transmission: the employment of an **embedded microprocessor** allows a transparent TTL RS-232 throughput without any need of packaging and data encoding, avoiding user to write complex software routines for the transmission management.
It's possible to set up input serial speed (9600-19200-38400 bps) by means of two input lines (SP1 e SP2) and it is automatically assigned a different degree of redundancy and protection on the forwarded RF packet depending on the selected speed: Hamming+Manchester at 9600 bps, Manchester at 19200 bps and Scrambling at 38400 bps.
Module is a multichannel transceiver which enables up to **7 channels**.
Channel selecting is highly straightforward and takes place through easy AT commands, as well as emitted power selection (from –8 dBm to +10 dBm) and monitoring of channel occupation.
The device works using frequency modulation (FSK) that guarantees a better immunity to noise than amplitude modulation: it's possible to cover 200 m in open air with omni directional antennas.
Module looks very compact, keeping the same small dimensions of its predecessor XTR (33 x 23 mm).
Timing guarantees a max delay of 20 ms between data sending and its real reception: this minimum delay includes the necessary time for the device to switch from RX to TX and transmit a synchronization header.
Supply voltage is 3V stabilized and it is provided for the transceiver to switch to power down mode, reducing current consumption to less than 10 µA. Even in that state, the device keeps valid interface levels towards user application.

Features

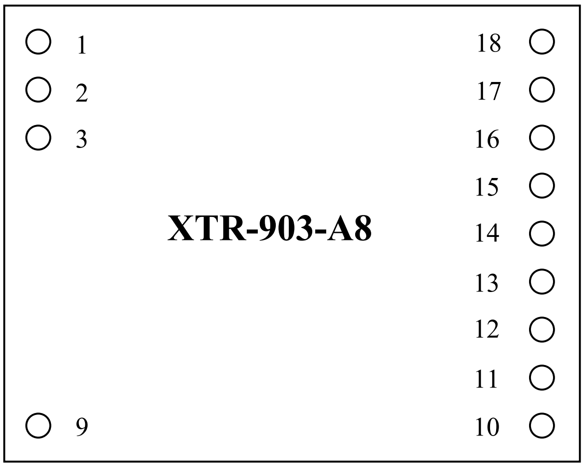
- **Transparent throughput of RS-232signals**
- **No data encoding and no preamble required**
- **No data packaging**
- **Easy AT commands for channel selection, emitted power level and monitoring of channel occupation**
- **HyperTerminal* compatible**
- **Channels: 7 at 868-870 MHz,**
- **Embedded microprocessor**
- **Small size (23x33 mm)**
- **Bit rate: 9600, 19200 o 38400 bps**
- **Emitted power: max 10 mW**
- **Supply voltage: 3V**
- **Covering range: 200 m**

Applications

- **Wireless hands free**
- **Home automation**
- **Telemetry**
- **Access control**
- **Instruments monitoring**
- **Data acquisition**
- **POS terminals**

* Trademark registered by Hilgraeve

Pin Description



Pin No.	Nome Pin
Pin 1-3	**RF GND**
Pin 2	**ANT**
Pin 9-10-18	**GND**
Pin 11	**SP1**
Pin 12	**RSRX**
Pin 13	**485EN**
Pin 14	**RSTX**
Pin 15	**SP2**
Pin 16	**PWRDN**
Pin 17	**Vcc**

RF GND – pin 1,3

RF ground plane connection.

ANT – pin 2

Antenna terminal, 50 ohm impedance.

GND – pin 9,10,18

Ground (0V).

SP1, SP2 – pin 11,15

These pins allow selection of input/output serial data speed.. Setting up them, it is possible to select one of the three enabled speed, from 9600 bps to 38400 bps. Table 1 illustrates how to set up the desired value:

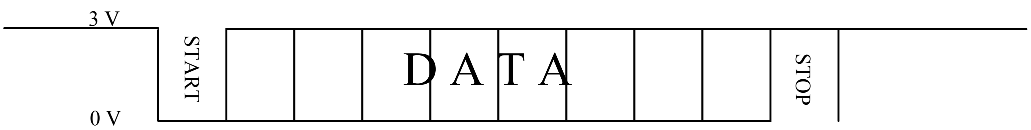
SP1	SP2	Speed
GND	Vcc	9600
Vcc	Vcc	19200
Vcc	GND	38400

Table 1 – Set up of serial data speed

A different degree of redundancy and protection is associated to the RF packet according to the selected speed: this means that slower speed involves an higher level of reliability and/or further distances.

RSRX – pin 12

Data output of the receiver in TTL RS-232 logic levels with 1 start bit (0V), 8 data bits and 1 stop bit (3V). Output is normally high (3V).



485EN – pin 13

Enable pin to drive external RS-485 transceiver.

RSTX – pin 14

Data input to the transmitter in TTL RS-232 logic levels with 1 start bit (0V), 8 data bits and 1 stop bit (3V). Input is normally high (3V).

PWRDN – pin 16

Enable pin to switch on or off the power-saving feature. By supplying 3V the module moves to Power Down mode, switching off all active circuitry and reducing consumption to less than 10 µA: even in that state the logical levels of input/output data lines are being kept to high levels (3V). By supplying 0V the device works in operational mode.

Vcc – pin 17

Positive supply voltage (3V).

Absolute Limits

Work Temperature range	-20 °C ÷ +70 °C
Storage Temperature range	-40 °C ÷ +100 °C
Max Supply Voltage	+6V
Input pin Voltage	-1.0 ÷ Vcc + 0.3V
Output pin Voltage	-1.0 ÷ Vcc + 0.3V

Technical Characteristics

	Min.	Tip.	Max.	Units
DC values				
Supply Voltage	2.7	3	3.3	V
(rx mode) Current		26		mA
(tx mode @ -8 dBm) Current		20		mA
(tx mode @ 10 dBm) Current		31		mA
(stand-by mode) Current		8	10	µA
Input/output Logical 1 Level	0.7xVcc		Vcc	V
Input/output Logical 0 Level	0		0.3xVcc	V
RF				
Modulation		FSK		
Rx Sensitivity		-105		dBm
Tx Max Power Output	-8		10	dBm
Performance				
Input Bit Rate[1]	9600, 19200 e 38400			bps
Outdoor range		200		m
Available Channels			7	
Timing				
PWRDN → RX		7		ms
PWRDN → TX		5		ms
TX → RX		3		ms
RX → TX		3		ms
CH #X → CH #Y		3		ms
Default Values (NO programming)[2]				
Channel frequency		868.88		MHz
Tx Output Power		4		dBm

[1] Input signal is made of 1 start bit, 8 data bits and 1 stop bit, no parity.

[2] Default values are intended as available with no need of AT commands.

Usage Conditions

Implementation of an embedded powerful microprocessor spares to user the trouble of implementing a synchronization protocol between the sending and receiving unit, thus significantly reducing the design cycle times of any system that requires RF data transfer.
The XTR-903-A8 transceiver allows the transfer of data in RS232-TTL logic as they are coming out from a microprocessor or from a PC serial port (with electrical level conversion), with no need of any further coding. In this way the radio transmission will be completely transparent, allowing the radio transfer of data packets of any length* and with a time shift not longer then 20 ms between the data delivery and the actual reception: this time is needed to "open" the connection and, then, the data transfer is carried on at the real serial port speed (9600, 19200 or 38400 bps).

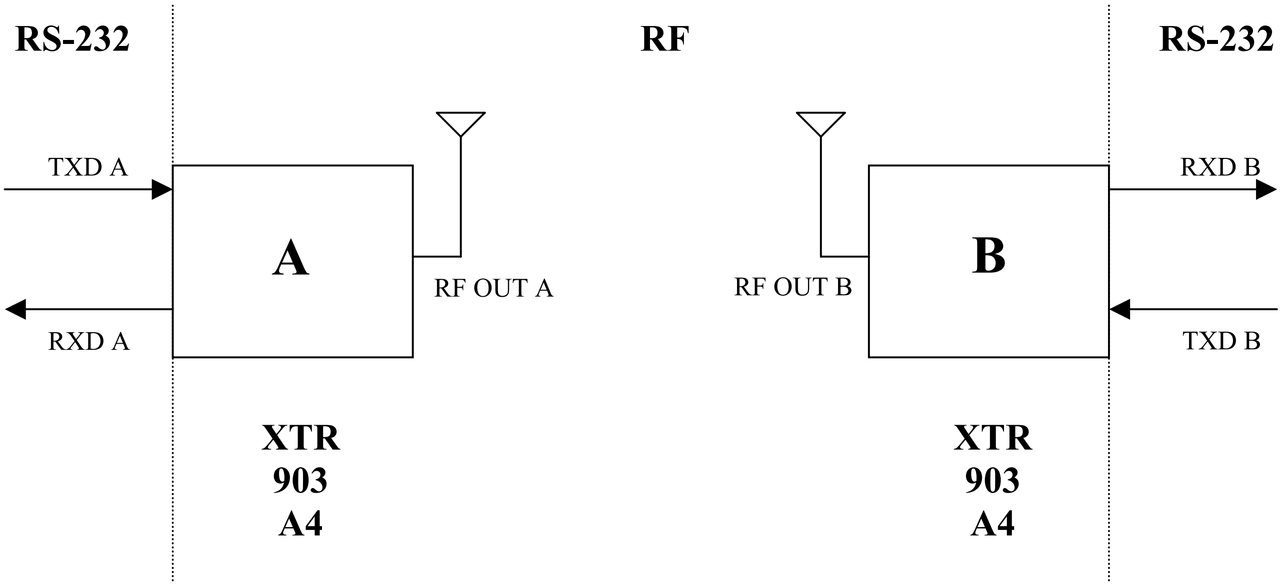
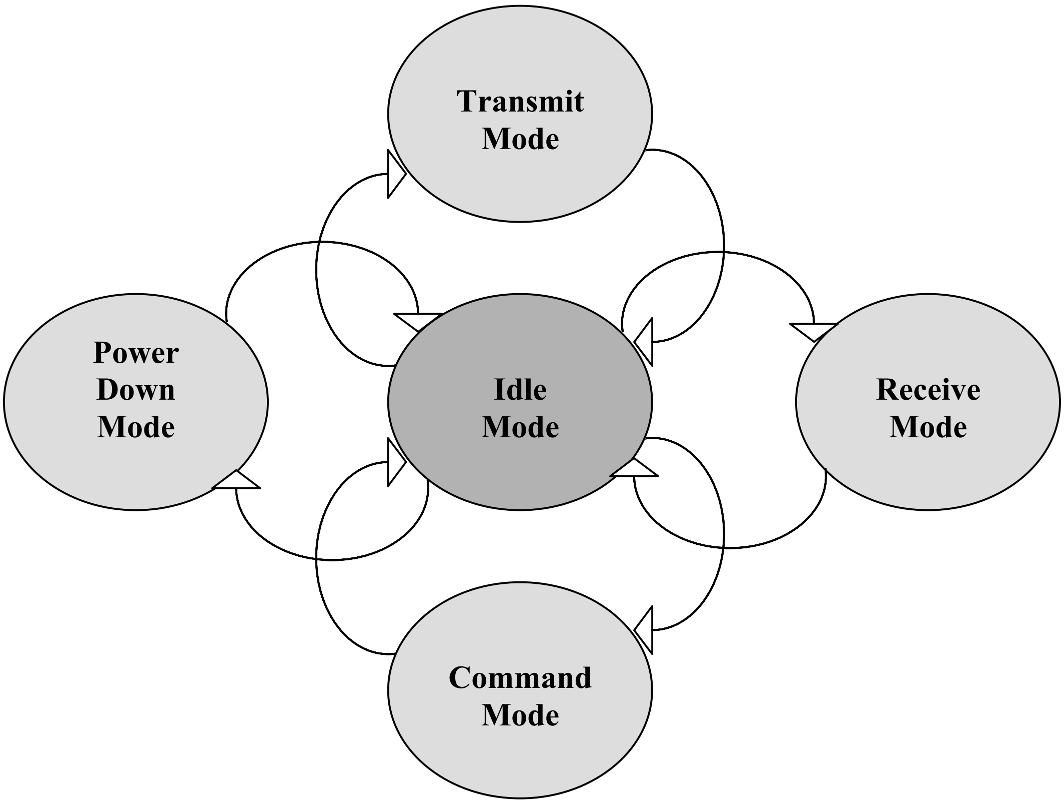


Fig.1 – Two XTR-903-A8's in connection.

XTR-903-A8 status can be summarized as follows:

- **Idle mode**
- **Transmit mode**
- **Receive mode**
- **Command mode**
- **Power Down mode**

*Max input packet length is dependant from signal precision of bit rate. Typically it results higher than 16KBytes



Idle mode

This is the rest status of the transceiver, as soon as it is turned on: in this mode the transceiver will be "listening" for everything is present in radio frequency, waiting for both RF synchronization sequence or data presence on the serial line input. If any of the two occurrence will happen, the transceiver will leave Idle mode, switching to the new proper status.

Transmit mode

From the resting status of Idle mode, the transceiver will automatically go to transmission status (Transmit mode) as soon as on the serial data input line (pin 14) a start bit is sensed.
RF data transfer is transparent to user, and the data packet will be delivered without any buffering, with no limit on packet length. No checksum or CRC is foreseen: the responsibility to properly handle discrimination between well received packets and possible corrupted data packets is left to User.

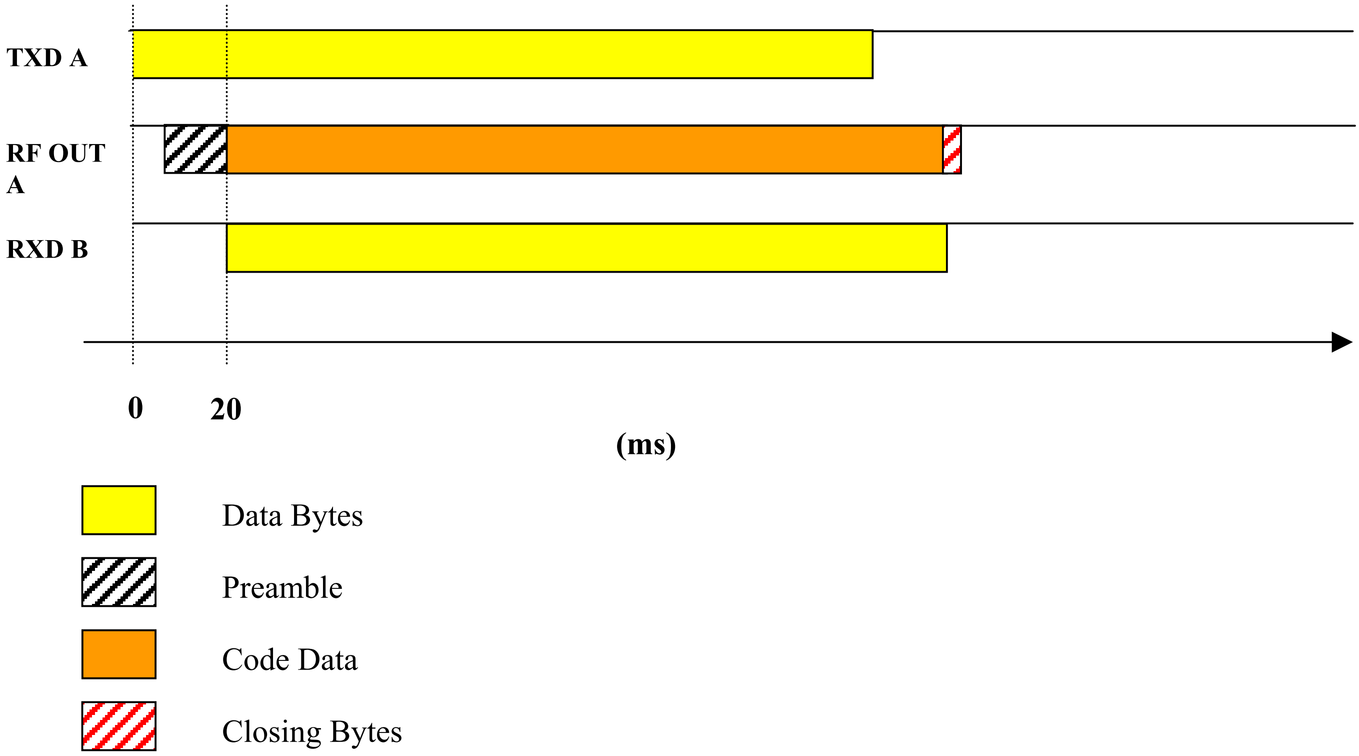


Fig. 3 – Timing Diagram of a data packet transmission

As shown in above Timing Diagram (Fig. 3), from the starting time (0 time), when the first data start to flow to the sending module input, to the moment when the same first data is received on the remote unit, about 20 milliSec. are elapsed. This delay accounts for the preamble transmission that the sending unit automatically places before to the packet of data to be sent: this is made to wake up and synchronize the receiver at the remote unit.
On the other end, as a tail to the data packet a closing sequence of bytes is automatically added and transmitted.
Possible data speed to the sending unit transmitter (TXD, pin 14), 9600 bps, 19200 bps and 38400 bps, is settable via pin SP1 (pin 11) and SP2 (pin 15), in accordance to Table 1.
For each of the selectable serial speeds, a different level of redundancy will be added, while it is transmitted at RF. This variety can be helpful to find the best suitable configuration of the complete system according to all the possible conditions that can affect Radio Frequency propagation.

Speed	RF Data Coding
38400	Any single byte of the data packet to be sent is affected with pseudo-random balancing. There is no assurance that data received at remote module was not corrupted during radio transmission.
19200	Any single byte of the data packet to be sent is balanced with the same number of ‘0’ and ‘1’ (Manchester). The system can recognize any single error per data bit and, when this is happening, will force a stop to the transfer, on the data line of the receiving unit, of the RF data.

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9600	Manchester + Hamming: Hamming code allows correction of any single error occurring in any data nibble. This is the most safe speed to send data, as it set the system for error detection and correction.

Table 2 – Redundancy possibilities vs. serial data speed

Receive mode

Transfer from Idle to Receive mode will happen as soon as the module recognizes, on the incoming RF, the synchronization preamble. From this point the transceiver will stay in Receive mode up to the reception of packet closing sequence.
Any data in input from the serial line will be discarded while the module is in Receive mode.

Command mode

Command mode allows User to configure the main parameters to change the device work conditions, such as parameters to select a new work channel or to set emitted RF power to desired value. This allows a high flexibility degree to personalize design and application.
Programming is carried out via simple AT commands. To force Command mode, from Idle mode, the following string must be sent via serial line

- 3 ASCII characters immediately followed from 3 plus charact. (+++)

The module will answer with **OK<CR>** string to confirm its new setting in Command mode (<CR> is intended as ASCII 10, Carriage Return).
Registers available for programming, where the parameters are stored, are 16 (from 1 to 16), some of them are available only for read operations, others will be read/write.
Syntax to read a valued stored in a register is as follows:

ATSx<CR> (x= 1, ..., 16)

Assuming that the command was correctly issued, answer to this command is the value of the content of the register. For a command issued with errors, answer is given back as: **ERROR<CR>**.
To change the value of parameter in a register, the following syntax is used:

ATSx=Y<CR> (x= 1, ..., 16) , Y= value to be inserted

with a back answer made of the string **OK<CR>** if command was correctly performed, or **ERROR<CR>** if a syntax error was made or if the value that was entered to be written is unacceptable as parameter for that register.
All the values written into registers are temporary valid and will be lost when the module will be turned off (Power voltage removed), unless they were previously forced saved into the EEPROM memory available in the embedded microprocessor : only in this case, the modified values will be still active when the module will be turned again on.
The command to force saving off ALL the values in register is:

ATWR<CR>

To exit Command Mode, going back to the normal operating status of transceiver, the command to be issued is:

ATCC<CR>

When in Command mode, it is possible to concatenate more instructions in one command line, separating each command by comma (,) operator. With following command line, for example, register 3 is set to value 2, the change is permanently saved and the Command Mode is left:

Example: ats3=2,wr,cc<cr>
OK<CR>

As shown above, the prefix -at- is just used once in the first command of line, while is not used for the following ones.
Command chaining is possible only for write operations, while it will receive an error answer if used in read operations.

Example: ats1,cc
ERROR<CR>

Commands are <u>not</u> case sensitive, so there is not problem to use both capital and small letters.

To have meaning of each register and the possible configuration values, please see **Appendix A**.

Power Down mode

Setting to high value (+3V) pin 16 (PWRDN), the transceiver will fall in a power saving mode, limiting its consumption to less than 10 µA: in this mode the transceiver is not in a condition to receive or transmit: to bring it back to an operating status (Idle Mode), pin 16 must be forced again to low voltage value (0V).
Also with most of circuits not under power, even when in Power Down Mode, the module will keep to the outside word interface lines at logical consistent values: for example, the received data line (RXD) will keep the high logical value (+3V) associated to stop bit.

Applications

Fig.3 shows a typical XTR-903-A8 application, with the transceiver connected to a microprocessor that, in addition to data reception and transmission on the input and output lines (TXD e RXD), is also controlling two lines dedicated to serial interface speed selection (SP1 e SP2) plus PWRDN line.

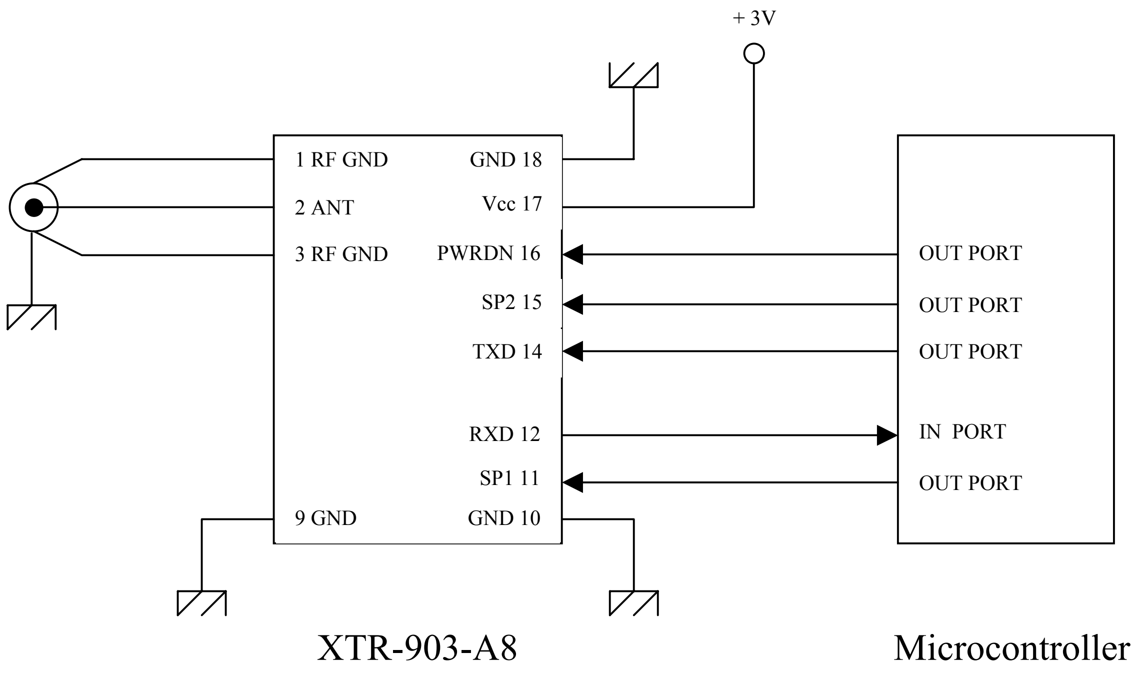


Fig.3 – Example of connection between XTR-903-A8 and microcontroller.

In Fig.4, a sample connection between XTR-903-A8 module and PC serial port is shown: The integrate component between the transceiver and the RS232 port is only used to convert the electrical level voltages from RS-232 and TTL logic.
Working with the RTS line (pin 7 of DB9 connector) it is possible to drive the PWRDN line, while the serial data speed selection is set to 19200 bps.

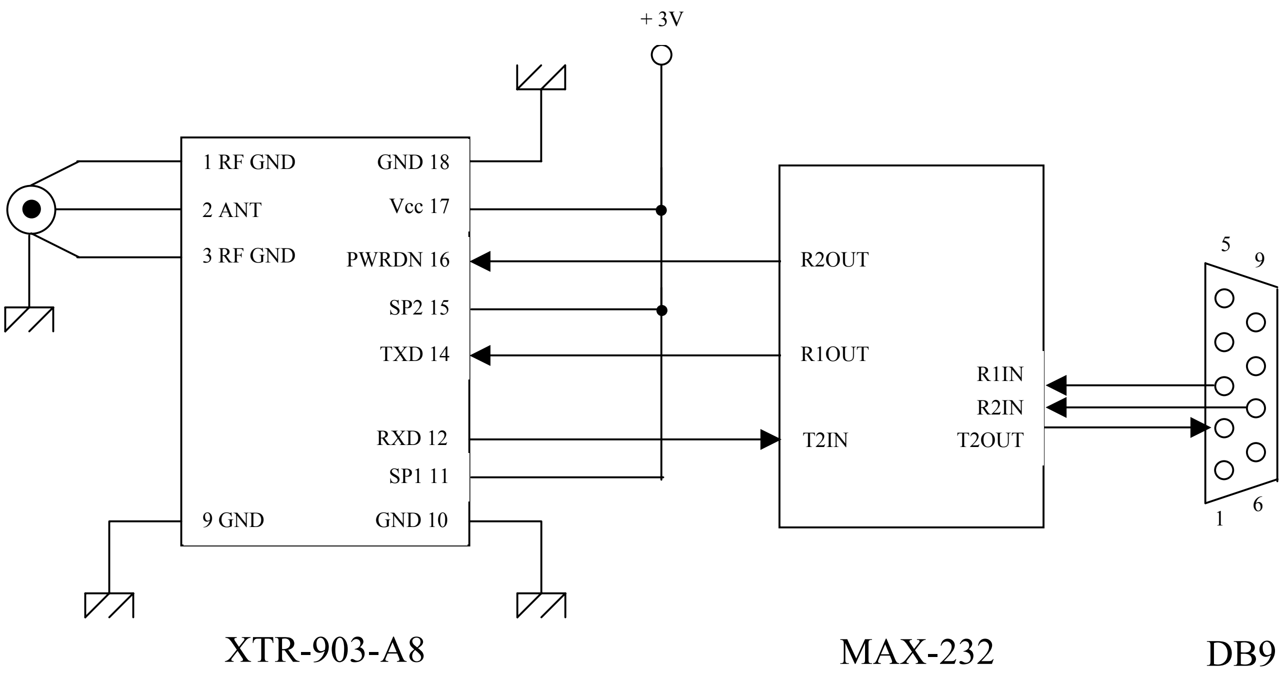
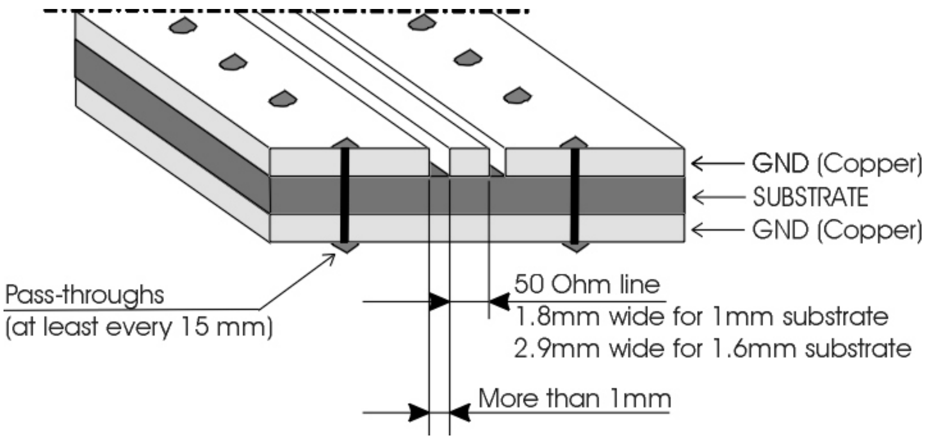


Fig.4 – Example of connection XTR-903-A8 and RS-232 serial port at 19200 bps.

Usage suggestions

Ground circuitry

1. Must cover all area around the module. Circuit should be etched on two side PCB, with sides connected every 15 mm (at least)
2. Ground must be present around the antenna output area



50 Ohm lines (connection between pin 2 and Antenna):

1. Should be as short as possible
2. Wide 1.8 mm for FR4 PCBs (1 mm thick) and 2.9 mm for FR6 (1.6 mm thick). Distance from surrounding GND is more than 1 mm (2 mm is better).
3. On reverse side of PCB, should have a rather large GND area

Antenna connection:

1. Can be used to directly connect a radiating stylus (85 mm straight wire)
2. Can be used to connect the central conductor of a coaxial cable to remote antenna. The cable out braid must be connected to GND near the antenna connection.

Antenna:

1. At transceiver antenna pin a proper antenna must be connected: a 8.5 cm stylus is suggested, made of copper or brass of 1 mm diameter. the body of the antenna must be as straight as possible and should be free from any other circuit or metallic body (at least 5 cm are suggested) Antenna can be used both vertically or horizontally, with suggestion to use a lot of ground circuit around the feed connection point.

Note: as an alternative to a. m. antennas, any of the antenna proposed from AUREL can be used. Please see Data Sheets and Application Notes).
Usage of antennas different from the suggested ones do not guaranty the adherence to CE Homologation measurements.

Other components:

1. Keep AUREL module as far as possible from other circuit components (min. 5 mm)
2. Keep as far as possible microprocessor and clock circuitry. Apply GND shields
3. Do not install components around the 50 Ohm line(s). Keep at least 10 mm clearance
4. If antenna is directly connected to PCB antenna connection point (see above) keep a 50 mm radius area with no components, but adequate GND. If antenna connection point is used for coax cable connection, it is possible to move components up to 5 mm.

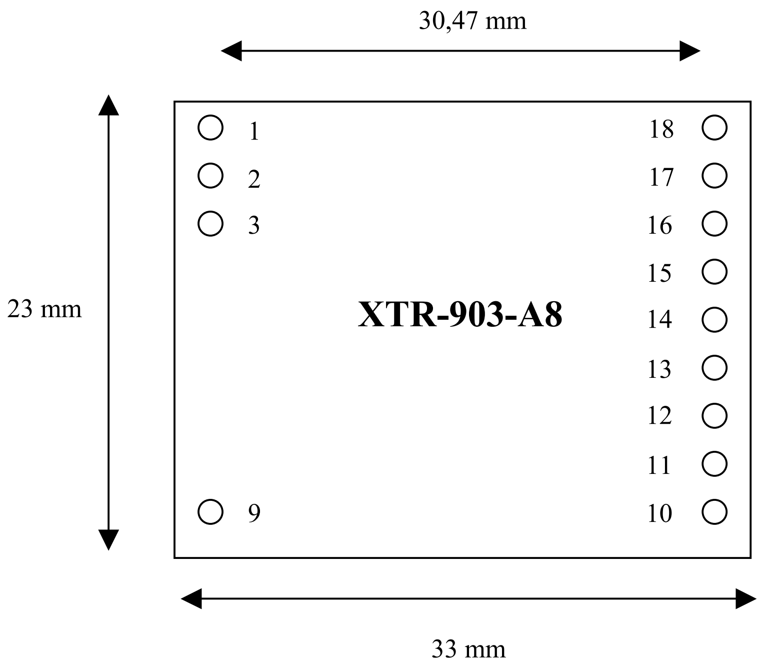
Reference Rules

The XTR-903-A8 transceiver is EC certified and in particular it complies with the European Rules **EN 300 220-3** and **EN 301 489**. The product has been tested according to rule **EN 60950** and it can be utilized inside a special insulated housing that assures the compliance with the above mentioned rule. The transceiver must be supplied by a very low voltage safety source, protected against short circuits.
The use of the transceiver module is foreseen inside housings that assure the overcoming of the rule **EN 61000-4-2** not directly applicable to the module itself. In particular, it is at the user' s care the insulation of the external antenna connection and of the antenna itself, since the RF output of the transceiver is not built to directly bear the electrostatic charges foreseen by the a.m. rule.

CEPT 70-03 Recommendations

In order to comply with such rule, the device (strictly for what it concerns the transmission phase) must be used only for a 1% of an hourly duty-cycle (that means 0.6 minutes of utilization over 60) for channels 0, 1 and 2.
Max admitted duty cycle is 0.1% for channels 4, 5 and 6.
Only for channel eleven a full 100% duty cycle is allowed.

Mechanical dimensions



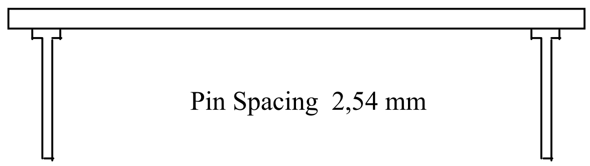


Fig.5 – Micro Embedded Transceiver.

Appendix A – Register Programming

Different work performances of the transceiver, such as RF channel selection, RF emitted power, etc..., can be programmed from User with setting of special parameters: this will be made by programming 16 available registers. Following are the meaning and the programming possibilities for each register.
At this very moment, only 4 out of 16 registers are used and documented (registers 1, 2, 3, 16), While the remaining will be used for future enhancements.

Register 1 - FREQUENCY BAND

This register is READ ONLY and will supply info related to the operational RF band used by transceiver (XTR-903-a is available in different models also for 433 and 915 Mhz bands).

Command	Values	Readable (R)/ Writable (W)
ATS1	**0 = 433-434 MHz** **1 = 868-870 MHz** **2 = 902-928 MHz**	**R**

Example 1: Module set up to operate on the 868-870 MHz band

+++OK<CR>
ATS1<CR>
1

Example 2: Syntax Error: This register is available for read only!

+++OK<CR>
ATS1=2<CR>
ERROR<CR>

Register 2 – RF CHANNEL

This register is available for read and write operations. It allows to get feed backs of the RF frequency (channel) setting for both receiving and transmitting circuits. Makes it possible to "write" a different frequency (channel).

Command	Values	Readable (R)/ Writable (W)
ATS2	**0 = 868.19 MHz** **1 = 868.34 MHz** **2 = 868.49 MHz** **4 = 868.80 MHz** **5 = 868.95 MHz** **6 = 869.11 MHz** **11 = 869.88 MHz**	**R/W**

Example 1: Reading RF frequency (869.88 MHz)

+++OK<CR>
ATS2<CR>
11

Example 2: Selecting channel 1 as work frequency (868.34 MHz)

+++OK<CR>
ATS2=1<CR>
OK<CR>

Register 3 – EMITTED RF POWER

This register is available for read and write operations. It allows to get feed backs of the RF output power emitted from the transmitting circuits. Makes it possible to "write" a different level of emitted power.

Command	Values	Readable (R)/ Writable (W)
ATS3	0 = - 8 dBm 1 = - 2 dBm 2 = + 4 dBm 3 = + 10 dBm	R/W

Example 1: Reading the RF emitted power (-2 dBm)

+++OK<CR>
ATS3<CR>
1

Example 2: Setting emitted RF power to max available value (+10 dBm)

+++OK<CR>
ATS2=3<CR>
OK<CR>

Registers 4 to 15 – RESERVED FOR FUTURE ENHANCEMENTS

Register 16 – RSSI (Received Strength Signal Indicator)

The register is read only and will supply a digital value proportional to RF field Strength senses from the receiving circuitry. Possible values readable from register are 0 to 9.

Command	Values	Readable (R)/ Writable (W)
ATS16	**0 = Min Field Strengh** **1** **2** **3** **4** **5** **6** **7** **8** **9 = Max Field Strenght**	**R**

Example 1: Reading Field Strenght (Very good received signal)

+++OK<CR>
ATS16<CR>
9

Example 2: Reading Field Strength (Very poor, inexistent received signal)

+++OK<CR>
ATS16<CR>
0

Example 3: Syntax Error: register is read only!

+++OK<CR>
ATS16=3<CR>
ERROR<CR>

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