Timings related to data transfer by means of XTR-7020A-4 and XTR-903A-x modules

The XTR-7020A-4 transceiver transmits serial data by the "*store & forward*" compared with "*transparent*" for the XTR-903A-x family, with consequently different timings. This document will compare the values relating to the data transfer time in function of the modules' different features. It will be shown how, under appropriate hypothesis, the performance of a transceiver family is comparable with that of the other family and even ameliorative.

Data transfer timings

The microcontroller integrated in the transceiver converts the input signals in RS232-TTL logic (from other microcontroller or PC, before translation of the electrical levels), with no need to assemble them in packets suitable for their RF transmission. The max. dimension of the data packets accepted at the input is 240 Bytes. However smaller amounts of data (32 or 64 bytes), are quite sufficient for the typical applications of the module (telemetry, etc.).
The end of the accepted data at the XTR-7020A-4 module's input is decided by means of a Timeout (function of the data's serial speed), at whose expiry the transceiver will enter no more data until the RF transmission, of those already inside its transmission buffer, is ended.

The transmission time $T_{SER}[ms]$ of the serial data packet (speed function) is:

$$T_{SER}[ms] = \frac{N_{bit}}{V_{SER}[bps]} \cdot 1000 = \frac{10 \cdot N_{byte}}{V_{SER}[bps]} \cdot 1000 = \frac{10000 \cdot N_{byte}}{V_{SER}[bps]} \qquad [1]$$

The time required by the RF data sending is given by the sum of a fix component $Tf[s]$, which takes into consideration the different constant components such as Timeout about the serial data reception, the packeting, etc. and a variable time $Tv[s]$ function of the number of data at the input:

$$T_{RF}[ms] = Tf[ms] + Tv(N_{byte})[ms]$$

with

$$Tf[ms] = 3.1$$
$$Tv[ms] = 0.139 \cdot N_{byte}$$

from which it derives:

$$T_{RF}[ms] = 3.1 + 0.139 \cdot N_{byte}$$

On the whole, therefore, the use of the microcontroller for the serial data reception and RF transmission operations, derives from:

$$T_{TOT}[ms] = T_{SER}[ms] + T_{RF}[ms] = \frac{10000 \cdot N_{byte}}{V_{SER}[bps]} + 3.1 + 0.139 \cdot N_{byte}$$

If we consider the connection between two XTR-7020A-4 modules XTR_1 and XTR_2, the total time $T_C[ms]$ employed by the system to transfer N_{byte} is given by:

$$T_C[ms] = T_{SER1}[ms] + T_{RF}[ms] + T_{SER2}[ms] \qquad [2]$$

where $T_{SER1}[ms]$ e $T_{SER2}[ms]$ are given by [1] in relation with the serial speeds V_{SER1} and V_{SER2} of the XTR_1 and XTR_2 modules.

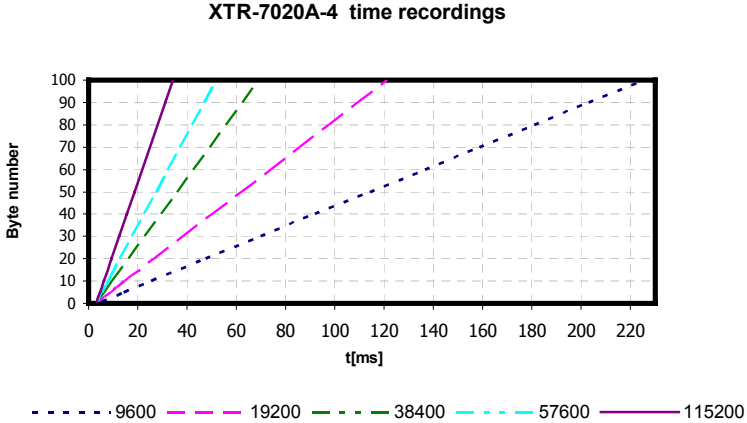
Comparison between the time recordings of the XTR-7020A-4 and XTR-903A-4 modules

As far as the XTR-903A-4 module is concerned we remember that the data transmission 'transparent' mode inserts only a fixed delay between the instant when the first datum enters the microcontroller and when it is retransmitted by the unit's serial port, after the radio link. The serial speeds of the XTR_1 and XTR_2 modules, for the XTR-903A-4 features, must coincide.
The formula that shows this time interval is the following:

$$T_{C903}[ms] = 21 + \frac{10000 \cdot (N_{byte} + 1)}{V_{SER}[bps]} \qquad [3]$$

We can compare the $T_{C903}[ms]$ and $T_{C7020}[ms]$ values, by considering equal the serial speeds of the two XTR_1 and XTR_2 modules, in function of the allowed different serial speeds and N_{byte} being equal:

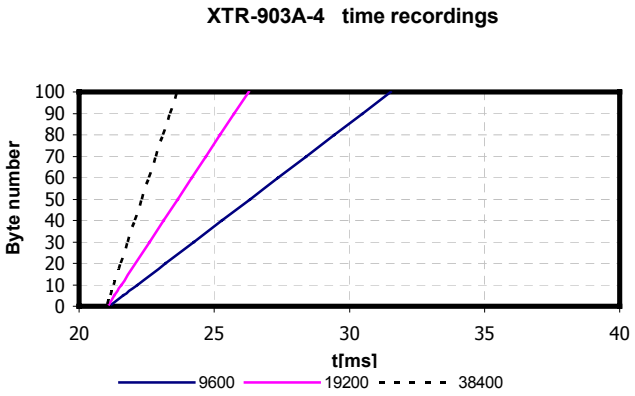
N_{byte}	$T_{C7020}[ms]$				
	9600	**19200**	**38400**	**57600**	**115200**
1	5,32	4,28	3,76	3,59	3,41
5	14,21	9,00	6,40	5,53	4,66
10	25,32	14,91	9,70	7,96	6,23
20	47,55	26,71	16,30	12,82	9,35
30	69,77	38,52	22,90	17,69	12,48
40	91,99	50,33	29,49	22,55	15,60
50	114,22	62,13	36,09	27,41	18,73
60	136,44	73,94	42,69	32,27	21,86
70	158,66	85,75	49,29	37,14	24,98
80	180,89	97,55	55,89	42,00	28,11
90	203,11	109,36	62,49	46,86	31,24



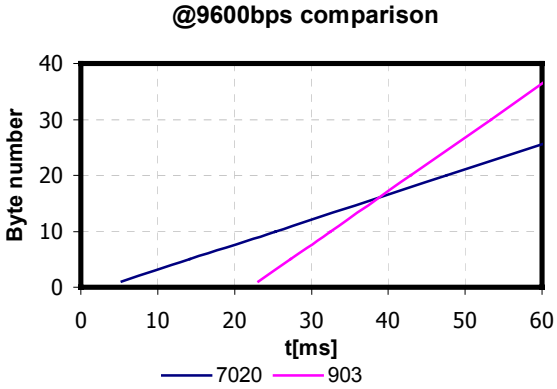
Timings related to data transfer by means of XTR-7020A-4 and XTR-903A-x modules

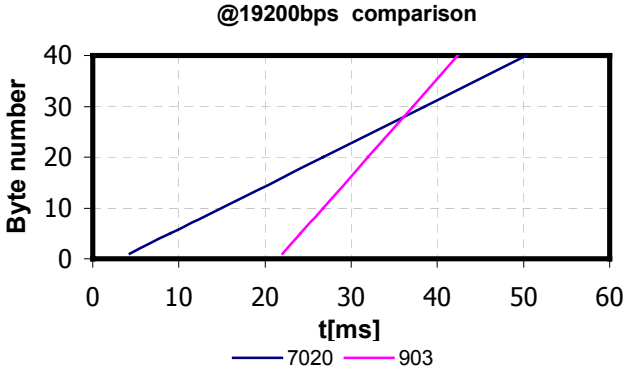
100	225,33	121,17	69,08	51,72	34,36
150	336,45	180,20	102,08	76,03	49,99
200	447,57	239,23	135,07	100,34	65,62

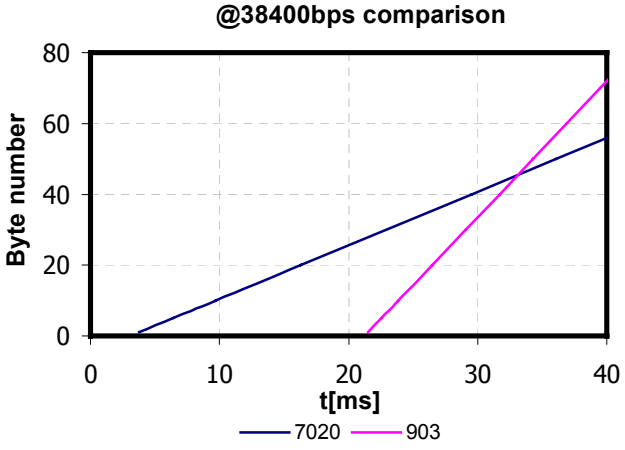
N_{byte}	$T_{C903}[ms]$		
	9600	**19200**	**38400**
1	23,08	22,04	21,52
5	27,25	24,13	22,56
10	32,46	26,73	23,86
20	42,88	31,94	26,47
30	53,29	37,15	29,07
40	63,71	42,35	31,68
50	74,13	47,56	34,28
60	84,54	52,77	36,89
70	94,96	57,98	39,49
80	105,38	63,19	42,09
90	115,79	68,40	44,70
100	126,21	73,60	47,30
150	178,29	99,65	60,32
200	230,38	125,69	73,34



We will compare the following speeds 9600, 19200, 38400 bps only, as the 57600 and 115200 bps speeds are not available for the 903A-4 model. We can obtain the following graphics for which the N_{byte} values are enhanced and for which we have performance equality:







The meeting point of the curves is obtained by solving a system composed by the equations [2 – with equivalent serial speeds] and [3].
The equalisation value $\overline{N}_{byte}$ is obtained :

$$\overline{N}_{byte} = \frac{17.9 \cdot V_{SER} + 10000}{0.139 \cdot V_{SER} + 10000} \qquad [4]$$

and its value, in function of V_{SER} shall be:

$\overline{N}_{byte|9600} \approx 16$

$\overline{N}_{byte|19200} \approx 28$

$\overline{N}_{byte|38400} \approx 45$

If we want to replace an XTR-903A-4 module @38400bps connection by an XTR-7020A-4 module @115200bps, an equivalence is obtained for $\overline{N}_{byte} \approx 348$, while no $\overline{N}_{byte}$ value can be calculated in case the XTR-903A-4 connection is @9600bps.

In conclusion, the transmission's whole delay, in case of an XTR-7020A-4 module with appropriate serial speed selections and packet's length, comes out to be compatible, if not ameliorative, compared to the equivalent delay inserted by the XTR-903A-4 module, thanks to the reduced length of the preamble and to the high speed RF transmission.