

Application Note Interrogation Unit WR-XXXX RS232 Digital Communication Protocol

The communication protocol is designed to support sensors with multiple resonances, multiple antennas or multiples sensor chips. The number N of resonances is dependent on the number of physical quantities. In the case of a temperature sensor, N=2 and one of the resonance frequencies exhibits a turnover around room temperature while the other resonance frequency exhibits a turnover at very low temperature, out of the measurement range. Hence, the resonance frequency difference is bijective with the temperature.

The communication protocol is based on an asynchronous protocol at 57600 baud, N81. The communication medium might be either a serial (RS232) port or an USB adapter which converts RS232 sentences to USB. The sentences are in ASCII format and are displayed using Hyperterminal under MS-Windows

(http://www.softhypermarket.com/HyperTerminal-Private-Edition-download_14740.html)
or minicom under unix.

The structure of each sentence is as follows:

```
2 433841476 2837 27 65 434458836 2912 23 128 00020591 00116
2 433841444 2846 27 44 434458804 2932 23 139 00020591 00116
2 433841332 2847 27 54 434459124 2922 23 152 00020588 00116
2 433841332 2835 27 48 434458964 2925 23 133 00020591 00116
2 433841268 2836 27 65 434459012 2907 23 86 00020589 00118
2 433841204 2832 27 72 434458980 2909 23 199 00020589 00117
```

All fields are space-separated, and each sentence finishes with CRLF. The first value is always the total number N of resonances to be measured. This value is followed by N sets of 4 values:

1/ the resonance frequency, in Hz, for example here 433.841268 MHz,

2/ the received power as a 12-bit value, between 0 and 4095. An automatic feedback control running on the embedded hardware aims at keeping the received power around 3000. This value must be above 200 and below 4000 to be usable and avoid saturation. In this example, the received power is around 2836,

3/ the emitted power, between 0 and 31. A value of 31 means the emitted power is 10 dBm, and each unit is equal to 1 dB, so that a value of 0 means the emitted power is -21 dBm. In this example, the emitted power is 27,

4/ the measurement variance, in units consistent with the internal representation of the frequency within the embedded software.

This value is converted to a standard deviation in Hz by taking the square root of this value (in bits) and multiplying by 47.7. In this example, a variance of 65 or 72 bits induces a standard deviation of 385 to 405 Hz.

These 4 fields are repeated N times, providing the characteristics of the N resonances. The last two fields are an indication of the microprocessor temperature (raw output of the ADuC7026 analog to digital converter connected to the internal temperature sensor) and an information of the number of measurements used to identify each resonance frequency.

This last field requires some understanding of the interrogation mechanism.

Each measurement provided to the user is the result of some averaging, in this case 16 averages. In the best situation, the requested number of samples for averaging is obtained, and the returned value is the number of frequency sweeps needed to reach the required number of samples, to which 100 is added. In this example, the returned value is 116, which means that 16 frequency sweeps were needed to accumulate 16 samples for averaging. In the worst case, a timeout of 160-measurements is reached, and the returned value in this last field provides the number of samples successfully acquired until this timeout was reached.

Once these sentences have been acquired, the computational steps for the conversion to a physical quantity is depend on each sensor configuration.

In the particular case of the temperature sensor, calibration coefficients A0, A1 and A2 are provided by SENSeOR and will be used in the conversion formula

$$\text{quantity} = A0 + \text{sqrt}(A1 + A2 \times (f2 - f1))$$

The calibration coefficients provided by SENSeOR assume the frequencies (here two frequencies for a temperature sensor, f1 and f2) are provided in Hz.

For any additional detail, contact us at: contact@senseor.com , www.senseor.com