



RF transmission protocol

of

**Auriol H13726
Ventus WS155,
Hama EWS 1500,
Meteoscan W155/W160**

wireless weather stations

v2.0

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1 RF transmission

1.1 Modulation and bit timing

The data from the sensors is transmitted on 433.92 MHz with OOK (on/off keying) modulation. The bits are coded by the duration of the off keying intervals between the ~0.5 msec on keying pulses as follows:

- **sync** bit ~9 msec,
- **1** data bit ~4 msec,
- **0** data bit ~2 msec.

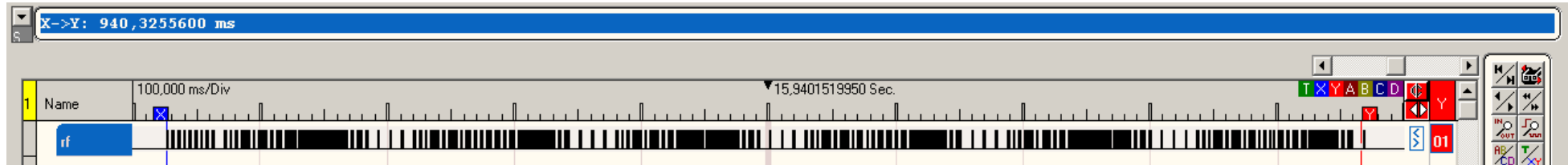
Note, that timings are approximates, they depend on the receiver characteristic.

1.2 Transmission bursts

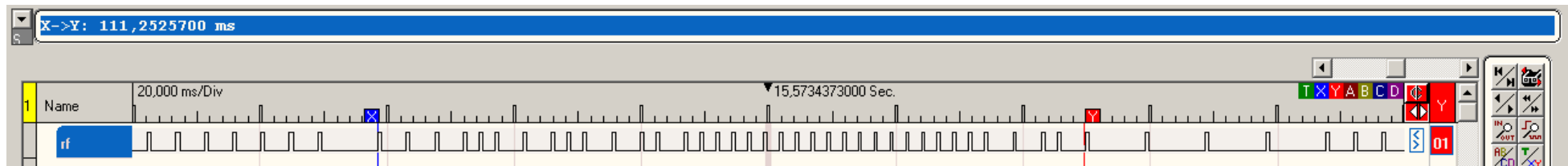
The transmissions take place in bursts. One burst consist of some **sync** bit separated data packets, that contain 36 data bits each. These bursts are then repeated in specified time intervals. The two sensors have a slightly different burst format, more on that later.

1.3 Samples

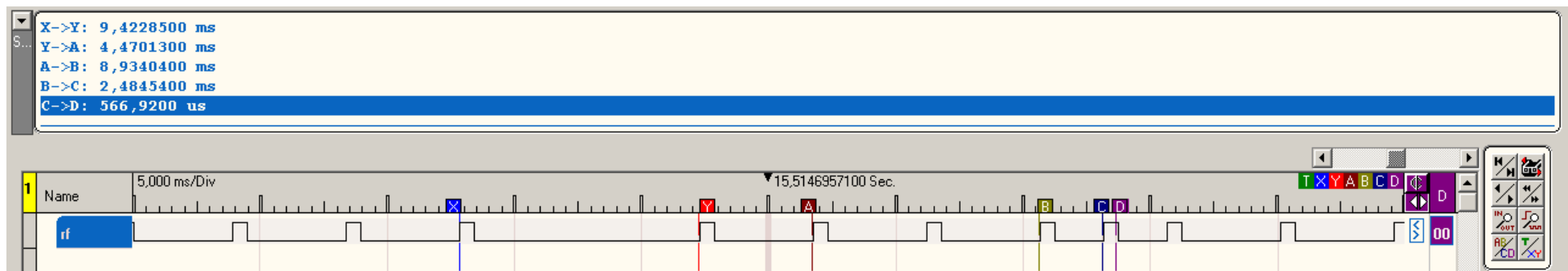
For better understanding the physical layer of the protocol here are some samples captured with a logic analyzer:



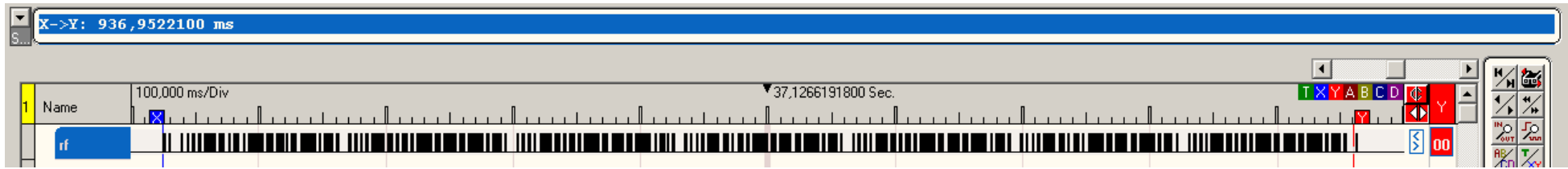
Combined sensor: transmission burst



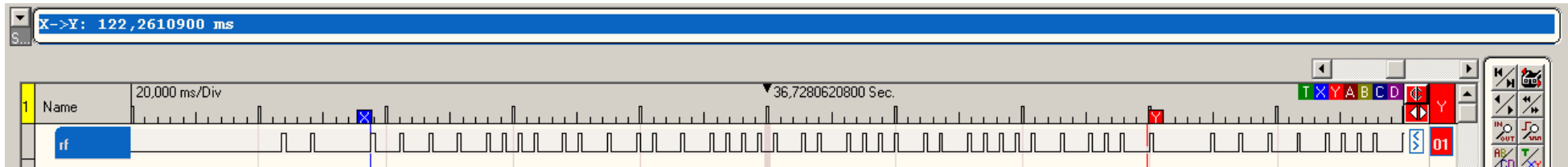
Combined sensor: first packet of the burst above



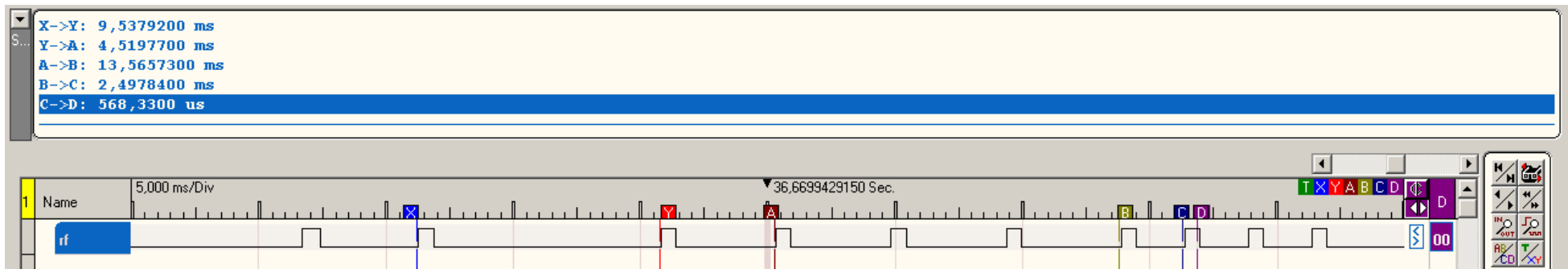
Combined sensor: bit timing



Rain gauge: transmission burst



Rain gauge: first packet of the burst above



Rain gauge: bit timing

1.4 General packet format

Each data packet contains 36 bits, that form 9 4 bit (LSB first) nibbles namely n_0 to n_8 . The first two and the last nibbles have the same meaning for each type of packets, the others carry the sensor specific payload data.

n_0				n_1				n_2				n_3				n_4				n_5				n_6				n_7				n_8				
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
r_0	r_1	r_2	r_3	r_4	r_5	r_6	r_7																									c_0	c_1	c_2	c_3	
<i>random id</i>								v	<i>payload</i>																								<i>checksum</i>			

- *random id* At power up (when the batteries are inserted) the sensor selects a random number, that will use as a (hopefully) unique identifier to avoid interference with similar sensors in the base unit's receiving range. After collecting a lot of random ids it seems, that r_4 is always 0, the others are truly randoms.
- v 0: Sensor's battery voltage is normal.
1: Battery voltage is below ~ 2.6 V.
- *checksum* This field is used to validate the data integrity of a packet. The two sensors use different formulas to compute this field, see the details there.

2 Combined sensor

2.1 Transmission schedule

The combined sensor sends all of its data in the following burst format:

- 8 **1** bits preamble to prepare the receiver circuitry,
- 1 **sync** bit,
- 36 bits data packets repeated 6 times, 4 **sync** bits between each packet,
- 1 **sync** bit.

Typical transmitting period is 31 seconds.

2.2 Temperature and relative humidity data

This packet is repeated six times within a transmission burst. Only one of six consecutive transmission bursts contains this type of data.

n ₀				n ₁				n ₂				n ₃				n ₄				n ₅				n ₆				n ₇				n ₈			
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
r ₀	r ₁	r ₂	r ₃	r ₄	r ₅	r ₆	r ₇		x ₀	x ₁		t ₀	t ₁	t ₂	t ₃	t ₄	t ₅	t ₆	t ₇	t ₈	t ₉	t ₁₀	t ₁₁	h ₀₀	h ₀₁	h ₀₂	h ₀₃	h _{t0}	h _{t1}	h _{t2}	h _{t3}	c ₀	c ₁	c ₂	c ₃
<i>random id</i>								v	X	bt.	<i>temperature [0.1 °C]</i>												<i>rh ones</i>				<i>rh tens</i>				<i>checksum</i>				

- *temperature*

This 12 bits wide 2's complement signed binary number represents the actual temperature value in 0.1 °C units.

- *rh ones, rh tens*

Two BCD digits, that shows the actual relative humidity in %.

- *bt.*

0: Scheduled transmission.

1: The transmission was initiated by pressing the button inside the sensor unit.

- *X*

x_1	x_0	
0	0	Valid temperature/humidity data was seen with all of these three values. Their meaning is unknown.
0	1	
1	0	
1	1	Non temperature/humidity data. All other type data packets have this value in this field.

- *checksum*

The formula is used in all types of packets sent by the combined sensor:

$$n_8 = (0xf - n_0 - n_1 - n_2 - n_3 - n_4 - n_5 - n_6 - n_7) \& 0xf$$

2.3 Wind speed and direction data

These two packets are sent in pairs repeated three times within a transmission burst. Five of six consecutive transmission bursts contain this type of data.

n_0				n_1				n_2				n_3				n_4				n_5				n_6				n_7				n_8				
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	
r_0	r_1	r_2	r_3	r_4	r_5	r_6	r_7		x_0	x_1														s_0	s_1	s_2	s_3	s_4	s_5	s_6	s_7	c_0	c_1	c_2	c_3	
<i>random id</i>								v	1	1	<i>bt.</i>	1	0	0	0	0	0	0	0	0	0	0	0	0	<i>average wind speed [0.2 m/s]</i>								<i>checksum</i>			

n_0				n_1				n_2				n_3				n_4				n_5				n_6				n_7				n_8			
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
r_0	r_1	r_2	r_3	r_4	r_5	r_6	r_7		x_0	x_1					d_0	d_1	d_2	d_3	d_4	d_5	d_6	d_7	d_8	g_0	g_1	g_2	g_3	g_4	g_5	g_6	g_7	c_0	c_1	c_2	c_3
<i>random id</i>								v	1	1	<i>bt.</i>	1	1	1	<i>wind direction [°]</i>								<i>wind gust [0.2 m/s]</i>								<i>checksum</i>				

- *average wind speed, wind gust*

Both fields are a 8 bits wide unsigned binary numbers, that describe the corresponding wind speed values in 0.2 m/s units.

- *wind direction*

This 9 bits wide unsigned binary number shows the wind direction in degrees.

Only these values were seen:

0 (N), 45 (NE), 90 (E), 135 (SE), 180 (S), 225 (SW), 270 (W), 315 (NW).

Other values - that are sometimes shown on the base unit's LCD screen - seems to be interpolated animations only.

- *bt.*

0: scheduled transmission.

1: the transmission was initiated by pressing the button inside the sensor unit.

3 Rain gauge

3.1 Transmission schedule

The rain gauge's burst format:

- 1 **1** bit preamble to prepare the receiver circuitry,
- 1 **sync** bit,
- 36 bits data packets repeated 7 times, 1 **sync** bit between each packet,
- 1 **sync** bit.

Typical transmitting period is 2 minutes 28 seconds, that may be shorter if there is a change in the measured value.

3.2 Rain data

Each 7 packet in a burst contain the same data.

n ₀				n ₁				n ₂				n ₃				n ₄				n ₅				n ₆				n ₇				n ₈			
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35
r ₀	r ₁	r ₂	r ₃	r ₄	r ₅	r ₆	r ₇		x ₀	x ₁					r ₀	r ₁	r ₂	r ₃	r ₄	r ₅	r ₆	r ₇	r ₈	r ₉	r ₁₀	r ₁₁	r ₁₂	r ₁₃	r ₁₄	r ₁₅	c ₀	c ₁	c ₂	c ₃	
<i>random id</i>								v	1	1	0	1	1	0	0	<i>rain [0.25 mm]</i>																<i>checksum</i>			

- *rain* This 16 bits wide unsigned binary number represents the accumulated (since power on) rain data in 0.25 mm units. Usually each tipping of a bucket means 0.5 mm, that causes this number incremented by 2, but in some cases the least significant bit is also used.
- *checksum* Computed with the following formula: $n_8 = (0x7 + n_0 + n_1 + n_2 + n_3 + n_4 + n_5 + n_6 + n_7) \& 0xf$

4 Revision history

v 2.0	2011-01-25	<ul style="list-style-type: none">- In the modulation and bit timing section the inverted keying polarity was corrected,- and some logic analyzer captured samples of RF transmissions were added.- Battery voltage bit found.- Negative temperature value representation specified.- Rain gauge data details were added,- the above required also some rearrangements.
v 1.0	2011-01-18	Initial release.