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D A T V-Development: The Next Generation

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Here is some more information on the Powerpoint slides :

slide 5: Due to the limited bandwidth of the Helical filters (ca. 20 MHz) only a part of the 23cm and 13cm band can be covered by change of the crystal. We made 50 23cm up-converters, all are sold out.

slide 6: Our DVB-T exciter we showed 3 years ago at Hamradio, output frequency is 36 MHz, it features 2k, 4k, 8k and 16k carriers, too expensive for amateur use at that time.

slide 7: 70cm GMSK receiver (rf-part), two crystal controlled frequencies in the 70cm band can be received, two 44 MHz IF parts with 2,5 MHz and 6 MHz SAW filter, respectively, outputs the FM-demodulated GMSK (eye diagram) and also in case of QPSK it outputs 44 MHz . 14 pieces are built.

slide 8: Digital part of the GMSK receiver, the input eye-diagram is digitized (50 MHz, 12 Bit), clock recovery, bit slicing, deinterleaving, Viterbi decoding, Reed/Solomon decoding are carried out in the FPGA, when the software RS-decoder is ready the FPGA will output the MPEG data in parallel format.

Currently the sliced GMSK bit stream is remodulated into a standard DVB-S signal on 1100 MHz (upper left box), this signal can be decoded by a cheap digital satellite set-top box. In case of QPSK reception on 70cm, eg. via down converter from a GHz band the 44 MHz output signal of the rf-part is mixed to 1144 MHz and can also be decoded by the set-top box.

4 digital parts are working, 10 more are currently stuffed and tested.

slide 11: instead of a crystal oscillator with frequency multiplier a synthesizer is used controlled by a joystick and a small LCD, the whole 23 cm band and the whole 13cm band are covered, the step size can be chosen from 1 MHz to 10 MHz by pushing the joystick. Ceramic low pass and high pass filters are used rather than helical filters.

The 0dBm 70cm signal input is at he upper left, the 23 cm (13cm) output at the upper right, 0dBm and -10dBm via a directional coupler e.g. to monitor the output spectrum during transmission.

The PCBs for 23cm and 13cm are fully identical just stuffed with different components. We have one model each working.

The 9cm up-converter is realized using a 23cm up-converter and heterodyning the output signal to 9cm using the same PCB with the synthesizer used as LO programmed to a fixed frequency and just stuffed with the mixer and the amplifiers, ceramic low pass and high pass filters.

This trick is done since the synthesizer does not reach a high frequency enough for a direct conversion (we use the Analog Devices ADF4360 series with 2750 MHz maximum).

This converter is not stuffed and tested due too a lack of manpower and lower priority.

slide 12: A sampling process produces replicas all containing the same information as has the baseband signal. In general the high frequency replicas are suppressed by a low pass filter following the DAC thus recovering the baseband signal.

High frequency replicas can also be separated by a band pass filter and used for transmission provided the S/N is good enough (we found it is).

Using a clock frequency of 320 MHz on the DAC and some digital interpolation techniques allow to generate the digitally modulated signal between 110 MHz and 120 MHz with a useful replica between 430 MHz and 440 MHz.

slide 13: Shows a first test generating the digitally modulated signal on 44 MHz, using a clock frequency of 390 MHz with a replica on 434 MHz.

slide 14: Trough 16: show an alternative 70cm to GHz up-converter using a SSB I/Q-modulator. 23cm, 13cm and 9cm can be covered by joystick and LCD control, east/west movement of the joystick switches between the bands, north/south increments/decrements the channels within the bands with the step size between 1 and 10 MHz.

One student currently is working on this up-converter full time, preliminary tests look promising.

slide 17 Shows our new MPEG encoder with MPEG input for multiplexing

slide 20: We have combined the functions of the 3rd generation MPEG encoder and exciter on one PCB using modern and more compact components. Adding more features like 2 USB connectors one intended for USB mass memories like a USB hard disk or a USB stick to record incoming MPEG streams and replay and transmit them later and further more MPEG inputs for multiplexing into one transport stream, the other USB can be connected to a laptop for menu driven controls.

All digital modulation schemes can be programmed from GMSK to DVB-T and the American ATSC standard.

I have one student working on this project full time, the schematic diagram is ready, the key components are chosen and he just started with the layout of the PCB. This will be most likely 100mm x 220mm and probably needs 6 or 8 layers, the FPGA has a BGA case. The board is also intended as platform for experimental purposes with enough memory and computing power. (in the meantime the mono-board is ready for stuffing and testing)

Since the mono-board solution might become somewhat expensive and perhaps will be slightly overdone for most of the amateurs, we are also busy to make "cheap" versions of a MPEG encoder (see slide 17 showing the working encoder) and a 70cm-exciter, connector- and signal compatible to those of the 3rd generation for direct replacement (see also slide 10).

The schematic of the new exciter is ready waiting for the boards, the exciter features 2 USB connectors and will be controlled by joystick and LCD or by laptop, respectively. The sampling method up-version from 110 MHz to 430 MHz will be used, by means of the joystick all frequencies within the 70cm band can be chosen (Direct Digital Synthesizer within the FPGA). All digital modulation schemes are possible including DVB-T.

The hardware development is one part the other is the software development, we can use a great deal of software from previous projects since everything is written in VHDL.

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