EDGES MEMO #029

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To: EDGES Group

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Subject: New inexpensive approach to EDGES and SRT spectrometers

The current EDGES spectrometer (now being used for MWA tile tests) is limited by systems associated with the interaction of the high speed digital electronics with the analog sampling and conversion to digital. The problem is described in memo #27 . While direct sampling is clearly the way of the future the commercially available spectrometers are still very expensive and many applications are not adversely affected by the spurious signals and systematics.

The new approach being studied is a return to the use of a scanning system similar to that of the use of a scanning system similar to that of a modern spectrum analyzer. The proposed receiver would consist of a LNA, amplifier, image reject mixer (or an up down converter) followed by a lowpass filter. The "video" output of the low pass filter is then passed to a narrow band digital spectrometer with FFT and spectral accumulation in software.

Tentative characteristics:

Local oscillator tuning range	95-200 MHz (1350-1750)
Local oscillator frequency step	< 100 kHz
Local oscillator lock time	< 1ms
LNA noise	<20 K (< 50K)
Image rejection	> 26 dB
Video bandwidth	4 MHz
Analog gain	~65 dB
Gain stability	< 0.01 dB/^{o}C
ADC (SAA7113H)	9 bit
ADC sample rate	13.5 Ms/s
Computer interface (EM2820) for data	USB 2.0
Computer interface for L.O. (Stamp)	USB
Power consumption of SAA7113+EM2820	170 ma @ 5v
Total power consumption	< 450 ma @ 5v

Note: SRT characteristics in ( )

Packaging:

LNA + L.O. + video	Hammond cast aluminum box
Input	SMA female

Video out	SMA female
Power + 3 wire L.O. control	USB A connector
PC board	2 sided. SM + ground plane
Laptop + digital for EDGES	Closed box vented through R.F. tight mesh

Dual function:

The receiver PC board could serve both EDGES and SRT with only a change of the oscillator chip and a fewer other components with the same SMT footprint. The digital "backend" provided by the USB video frame grabber and laptop could also serve both projects.

Parts cost:

Excluding the laptop the parts cost estimate for the receiver is about $150 plus $50 for the USB video frame grabber which contains the digital electronics (SAA7113H + EM2820). No power supplies are required as the proposed design should draw less than 500 ma at 5v which is within the limit of power available to a USB powered device.

Function:

The scanning spectrometer has a spectral integration efficiency of about 1%, but even with this low value the noise in a 12 hour integration with 1 MHz resolution will be about 50 mK in a 1000 K system. A low cost system could be replicated and made available to hams, teachers and students in remote locations. The SRT version with Yagi antennas could provide a teacher an inexpensive means to demonstrate the galactic hydrogen line emission and to construct a simple adding interferometer.