

# Radio JOVE SUG SDR Design Specifications

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This outline lists the desired specifications for an SDR to be used by the Radio JOVE Spectrograph Users Group (SUG). Dual receivers sampled coherently allow orthogonally polarized signals to be processed for scientific analysis. These specifications support measurement and characterization of Jovian and Solar radio emission along with investigation of ionospheric and magnetospheric radio phenomena.

## ➤ Polarization

- One linear (or circular) polarized antenna signal input per receiver
  - Inputs signals may be assumed orthogonal regardless of polarization (i.e., two linear inputs or two circular inputs)
- In-phase signals obtained direct from RF inputs
- Quadrature signals formed in RF hardware (wideband 90° phase shifters) or DSP (FPGA)
- Circular (or linear) polarization formed in RF hardware (wideband 90° hybrid ring) or DSP (FPGA)

## ➤ RF Section

- Number of receivers: 2
- Front end passband: 15 to 35 MHz
- Input impedance: 50 ohms
- AGC: none, or the capability to turn AGC off
- Noise figure:  $\leq 5$  dB
- Internally-generated spurious signal (spur) amplitude limits in terms of equivalent noise temperature with 50 $\Omega$  resistors at the receiver inputs:
  - No spurs  $> 9$  dB above the receiver noise floor
  - One spur permissible  $6 \text{ dB} < T_{\text{spur}} \leq 9 \text{ dB}$  above the receiver noise floor
  - Two spurs permissible  $3 \text{ dB} < T_{\text{spur}} \leq 6 \text{ dB}$  above the receiver noise floor
  - Four spurs permissible  $\leq 3 \text{ dB}$  above the receiver noise floor
- Received signal harmonic spur amplitude limit in terms of carrier amplitude equivalent noise temperature referenced to the receiver input:
  - $T_{\text{spur}} \leq -80 \text{ dBc}$
- Gain stability: FFT outputs shall exhibit an amplitude change in 12 hours of  $\leq 3\sigma$  of the background thermal noise when the receivers are terminated with constant temperature 50 $\Omega$  resistors at the receiver inputs

## ➤ DSP / FFT (FPGA) Section

- Sampling method: Direct sampling (no frequency conversion)
- Sample rate:  $\geq 40$  Msamp/s IQ pairs per receiver ( $\geq 80$  Msamp/s total for both receivers)
- ADC bit depth: 14 bits
- Demodulation: none (this is a “total power receiver” or “radiometer”)
- FFT Block Size: user adjustable, in the range of  $2^8$  to  $2^{16}$  (~1.8 kHz minimum FFT bin width @ 122 Msamp/sec)
- FFT Windowing: user selectable, selections must include a choice of no windowing

- FFT Output: user selectable as vector magnitude or complex
- FFT Output Averaging (FFT Integration over time, aka decimation): user configurable from 1 (no averaging) to  $2^{16}$ 
  - applies only when vector magnitude output is selected
- FFT Vector Magnitude Output Scaling: selectable linear and log scaling, configurable post-FFT amplitude offset & gain (to keep range of FFT output bin values within the limits acceptable to Radio Sky Spectrograph (RSS) software – i.e.,  $2^0$  to  $2^{14}-1$ )
- User-selectable dual FFT output modes, two user choices:
  - Output data in terms of RCP and LCP (right and left circular polarization), or
  - Output data in terms of X and Y (orthogonal linear polarizations)
- Capability to perform calculation of Stokes parameters via DSP (FPGA)
- User-selectable single FFT output modes, two user choices:
  - Output data in terms of Stokes V for circular polarization, or
  - Output data in terms of Stokes Q for linear polarization

➤ **Communications**

- Method: Ethernet, user choice of static IP address or DHCP (dynamic)
- Time stamping: once each FFT output block (or averaged output block), UTC, 1 ms accuracy or better, 8-byte date-time data type