The ATNF S2 Data Acquisition System

Preface to FTP File

This document is a summary of a paper presented at the fourth Asia-Pacific Telescope meeting and workshop in December 1995, and has been submitted for inclusion in the Proceedings thereof.

While accurate at the time it is now somewhat dated, as development has continued at the finer level. For example, 2-bit data may now be coded in AT (sign & magnitude), VLBA (offset binary) or NASA SERC (ternary) formats, and 64MHz and 32+32MHz 1-bit data may be recorded.

The contents should not be interpreted as a technical specification for the final product but as a general introduction to the style and capabilities of the DAS.

Beware that Figure 2 on page 4 may take some time to display, and readers may find it expedient to set 'Tools.Options.View.Show text with.Picture Place holders' while reading, then print the file in order to see the graphics.

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The ATNF S2 Data Acquisition System

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Abstract

The DAS provides two independent signal channels with broadband inputs at IF, and outputs in S2 and correlator formats. One or two passbands may be assigned to each channel. Bandwidths range from 32MHz down to 62.5kHz in factors of two. Passbands below 16MHz may be tuned in 1Hz steps. All processing is based on digital filter technology.

Background

- Very different receiver systems at each telescope in the LBA.
- Telescopes spend only a small percentage of time on VLBI.
- Autocorrelators available at six out of eight LBA telescopes in the near future.
- DAS design provides fully featured narrowband backend for single dish operation.

Configuration (Fig. 1.)

- Two channel system, eg LCP + RCP.
- Independent bandwidth selection.
- One or two passbands per channel.
- Fine tuning for bandwidths less than 16MHz.
- Two-bit digitisation at output with integral statistics normalisation.
- Correlator Port formats 1) AT (2-bit / 4-level)
2) NASA SERC (2-bit / 3-level)
3) high resolution (10-bit / 1024-level).
- S2 Port : direct connection to C1 cable.
- Analog Ports : signal reconstructed from high resolution data for spectrum monitor, special backends etc.
- Full computer control and monitoring.
- No manual run-time controls.
- Example control software provided for PC in ANSI C.

Hardware (Fig. 2.)

- Fully contained in 5U 19" rack bin.
- N2 + N3 module for each channel, D3 computer interface, N4 power.
- RS485/422 and RS232 computer interfaces.
- 115/240V, 50-60Hz mains power.
- Internal cable compensation for 1PPS and 5MHz reference.

Signal Path (Fig. 3.)

- Broadband IF input; 80-112Hz used for outputs.
- Alternative prefiltered inputs at 0-64MHz or 64-128MHz where available.
- Alternative 64MHz BW digital data input where available, eg. AT Tied Array.
- AGC amplifier compensates for more than +/- 3dB changes in IF input level.
- Unlike analog systems, 'sampler' is an 8-bit ADC, and precedes the filters.
- 5MHz reference frequency provides 128MHz for the ADC and 32MHz for the processor clock.
- 1PPs synchronises output data and allows phase-continuous frequency switching.

- Raw ADC output, (up to 64MHz BW,) is available at the correlator formatter only.
- Bandpass filtered data 32MHz BW and down is available at the correlator, S2 and analog ports.
- Single Passband Mode: 32MHz down to 1MHz BW, all centred on the middle of the input band.
- Dual Passband "BBC" Mode: adjacent USB+LSB pairs, 16+16MHz down to 1+1MHz, "DC" at midband.
- Tuned Passbands: additional filters, single or dual passband mode, tuned across any fixed band <= 16MHz.

  Output BW is 1/2 down to 1/16 of the tuner input BW.

  Narrowest bandwidth is 62.5kHz.

  Tuning resolution is 1Hz across the input band.

  Frequency switching is phase continuous and synchronised to 1PPS.
- Mixed Passband Mode: one ('broad') fixed passband and one ('narrow') tuned passband.
- Dual Split Bands (Fig. 4.): non contiguous passbands in many forms may be programmed if required.
- Spectrum inversion at will for any output data stream.

Recorder/Passband Options..(Fig. 3., Table 1.)

- Some common modes not exceeding 128Mbps (S2 capacity) and their applications.
- Telescopes providing 64MHz prefiltered inputs may see 64MHz at the correlator port.

Why *Digital* Filters?

- **Engineering:** Completely deterministic.
- No : Component selection

  Signal balancing

  Elaborate alignment procedures
- Instead : Easy design

  Exact modelling

  Precise performance
- **Astronomy:** Stability, performance.
- Amplitude, phase and group delay responses as stable as the hydrogen-maser standard derived clock signal!
- Wider, flatter passbands.
- Near-perfect passband matching between systems.
- Nil dispersion/group delay distortion across the band.
- Common sampler eases calibration problems in multiple band continuum correlations.
- Flexibility allows many different functions from common hardware.
- Cost effective for high performance multiple response systems.

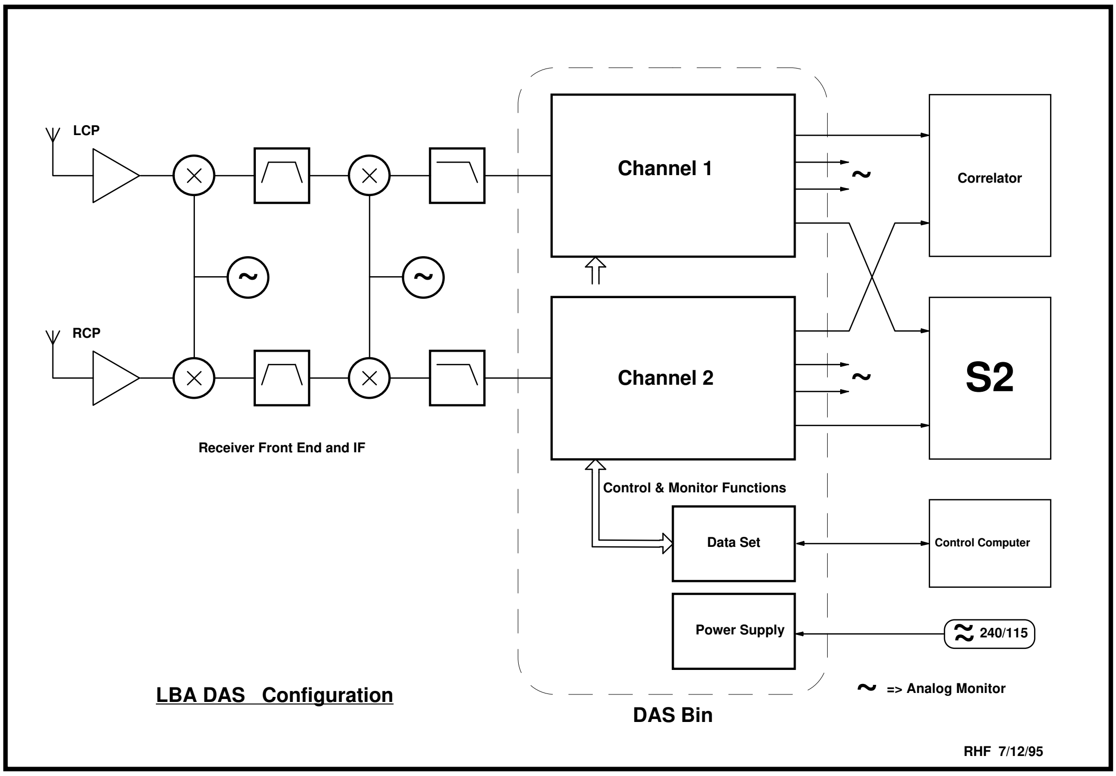


Figure 1.

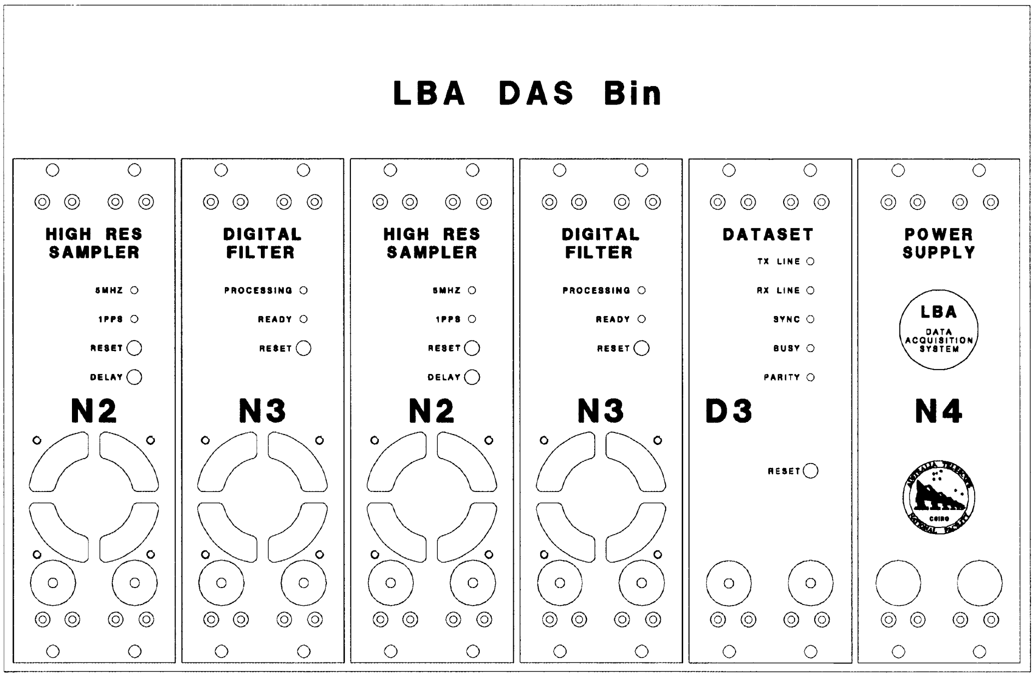
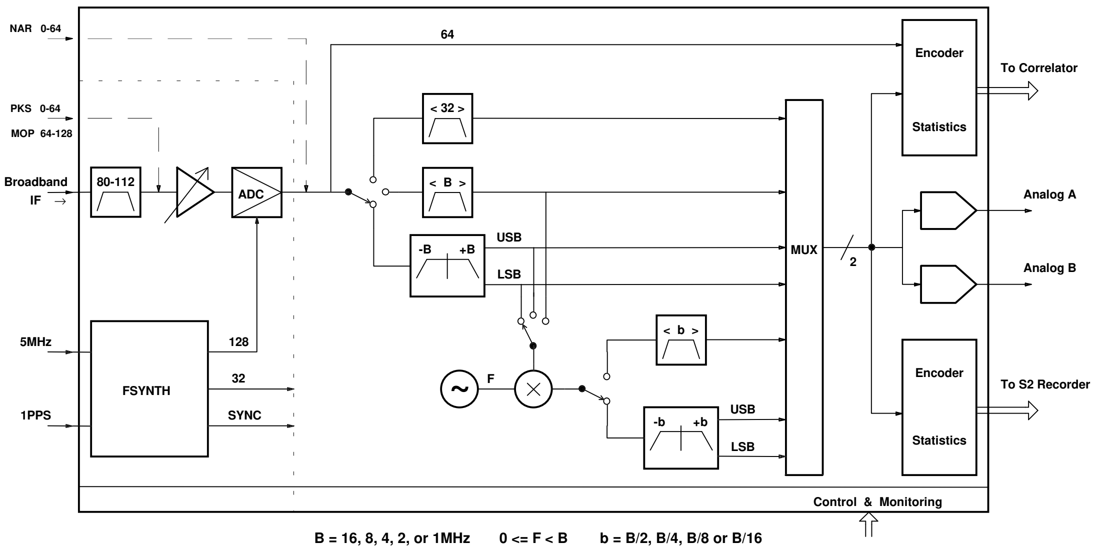


Figure 2.



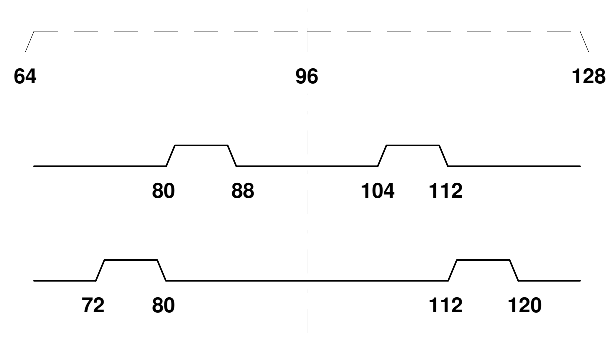
B = 16, 8, 4, 2, or 1MHz   0 <= F < B   b = B/2, B/4, B/8 or B/16

LBA DAS Signal Path

(One Channel)

RHF 7/12/95

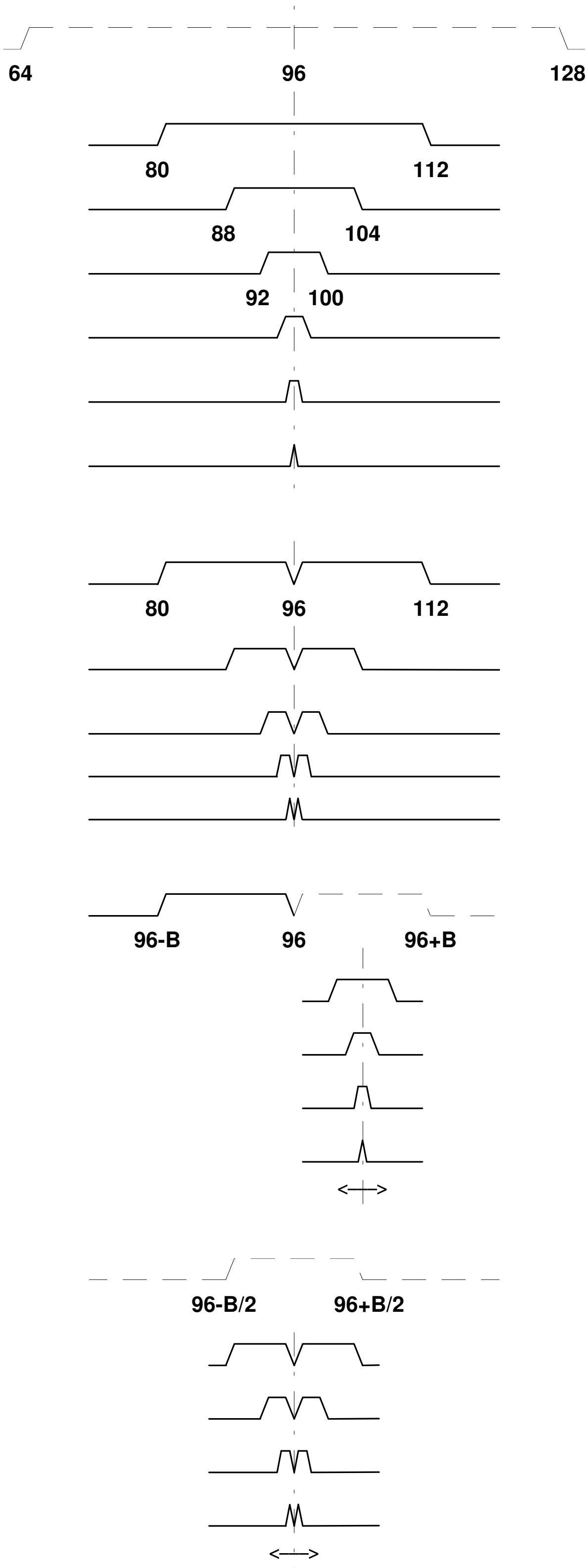
Figure 3.



Non-Contiguous Passbands

Figure 4.

LBA DAS Output Options (Incomplete)



Filter Response	Mode/Data for 2 IFs	Data for 1 IF
	64MHz baseband input #1	
	n.a.	VSOP 32MHz @ 2bit
	LBA continuum 16MHz @ 2bit	16MHz @ 2bit
	8MHz @ 2bit	8MHz @ 2bit
	4MHz @ 2bit	4MHz @ 2bit
	2MHz @ 2bit	2MHz @ 2bit
	1MHz @ 2bit	1MHz @ 2bit
	n.a.	VSOP 2 * 16MHz @ 2bit
	RadioAstron & VLBA 2 * 8MHz @ 2bit	2 * 8MHz @ 2bit
	RadioAstron, VLBA & MkIIIA 2 * 4, 2, 1MHz @ 2bit	2 * 4,2,1MHz @ 2bit
	Line plus continuum #2 2 * BMHz @ 2bit #4	2 * BMHz @ 2bit
	b = B/2MHz tunable	=
	B/4MHz tunable	=
	B/8MHz tunable	=
	B/16MHz tunable	=
	VLBA, MkIII & RadioAstron #2	
	2 * B/2MHz @ 2bit #3	=
	2 * B/4MHz @ 2bit tunable	=
	2 * B/8MHz @ 2bit tunable	=
	2 * B/16MHz @ 2bit tunable	=

#1 64MHz data is available on the correlator port only.
#2 The BMHz subbands may be interchanged at will.
#3 At most +/- 0.5MHz tuning is possible.
#4 B < 16MHz only.