4 OPERATION

The DAS signal paths are configured by assigning values to each of about 70 soft switches or ***parameters*** in each IFP by means of a control program running on a small computer. They may be set interactively, loaded from files, or both. The program also displays signal levels and a number of status variables but otherwise plays no part in the operation of the hardware. A small number of essentially permanent options concerning serial communications and clock sources are set by jumpers on the back-plane and matching soft switches in the control program. These are described in sections 2 **Installation** and 5 **Control Software** respectively.

The DAS synchronises to station time and frequency standards, and provides derivative clock signals on its outputs such as the S2 port, but provides no interlock or handshake facilities for associated systems. Any such must operate independently and rely on their own control and synchronisation facilities to maintain compatible operation.

A number of hardware design functions are optimised for 'standard' astronomical conditions, namely near-stationary 'noise' signals with Gaussian amplitude distributions which are subsequently subjected to integration times of a second or longer. Non-standard observations in this sense, or operation in the presence of impulsive or coherent interference, may require special configurations to optimise performance.

4.1 IFP Configuration

Each IFP has an identical set of parameters and is programmed independently. The parameters conveniently divide into Default, Input, Output and Correlator groups as described below. Parameter values for the Input and Correlator groups configure interfaces to associated equipment in a particular *station*, and may be regarded as local defaults. The Output controls determine bandwidth, tuning, encoding etc. peculiar to each *observation* and are usually common to all DAS's participating in an interferometry experiment.

The information in this section presumes 'standard' conditions as above and adoption of the convention described in 4.1.3. Familiarity with concepts of the IFP signal path described in Section 3 is highly recommended.

4.1.1 Notation

Individual parameters are conventionally denoted "**<nn> name**", where the number "**nn**" uniquely identifies the parameter and "**name**" is a brief descriptor. Eg. **<13> LO Sync Source**. Note that some early documentation and control software may use different (and varying!) descriptors but the numbers are immutable. On screen displays some particularly cryptic descriptors may be replaced by more fulsome 'User-Mode' names.

DSB filter responses, or sometimes the hardware nodes from which they emerge, are designated **BL**, **BU**, **FL** and **FU**, where **B***/**F*** refer to Band Splitter/Fine Tuner

outputs, and ***L**/***U** refer to lower and upper sideband responses respectively. A lower/upper sideband is a passband below/above the frequency of a notional carrier or median frequency. The **Natural** state for the lower of a DSB pair of contiguous passbands (eg. B2 Group filters) is for the sense of its spectrum to be *inverted*, whereas the USB spectrum sense is *normal*. With non-contiguous DSB pairs the situation is the same for even orders of sidebands, but reversed for odd orders. Thus for B4 Group filters the **Natural** spectrum of **BL** is *normal* and **BU** is *inverted*, while B6 Group responses are similar to B2s. Where DAS options to reverse a response spectrum are enabled the signal is described as **Flipped**.

4.1.2 Default Settings

Comprising some 40% of all IFP parameters these normally assume the value specified in the following tables. Once loaded they may be ignored except that a small number may be required for special setups as described in a later section.

4.1.3 Input Settings

These provide for specific receivers or signal sources connected to the IFP. Once determined at a particular station each set can be saved and reloaded when required.

<1> Image Filter is set **Out** if the IF input is suitably band-limited already, or **In** if the input is broad-band, in which case the effective input range becomes 144-172MHz.

<2> I/P Data Format is normally **8bit**, but may be either **8bit** or **4bit** as appropriate when predigitised data is connected directly to the back-plane.

<3> I/P Spectrum. It is necessary to determine for a particular receiver whether the combined effect of its conversion chain and the sampler's aliasing if any, leaves the spectrum normal or inverted at baseband. If inverted, set **Flipped** in order to restore the spectrum to its normal sense, otherwise **Natural**. While this procedure is not strictly necessary, it is a useful *convention* that provides for consistent operation of many following features, as well as uniform operation across a station network. Note that this control does not affect the S0*64 spectrum.

4.1.4 Output Controls

These determine the final signal characteristics of bandwidth, frequency, encoding etc. plus the mapping of signals or encoded data streams to each output port. For network observations this set can be prepared by the PI and attached to the observation schedule file for all stations to use.

Options Available:

Unfiltered sampler output "64MHz" S0*64 response:

Spectrum Inversion

Band Splitter:

Filter Configuration

Spectrum Inversion(s)
Analog Monitor Source

Fine Tuner:
Input Source
LO Frequency
Filter Configuration
Spectrum Inversion(s)
Analog Monitor Source
Digital Monitor Source

Magnitude Statistics (all outputs):
4-level/3-level

S2 Port:
Data Source(s)
Code Format

Correlator Port:
Data Source(s)

Filter Configurations

Each IFP may be set up to produce signals from up to five simultaneous filter responses. Whereas the S0*64 response is always available, the Band Splitter and Fine Tuner responses are configured by many parameters, often with strong interdependencies. These have been separately tabulated in Section 4.3 Filter Configurations. The degree with which one has to deal with all or any of them depends on the nature of the control software.

Spectrum Inversion

Individual controls allow each response to be obtained in either its **Natural** or **Flipped** state. All manifestations of a response are affected by its control in the same way. Beware the effect on frequency and sense of the Fine Tuner outputs when it takes an inverted spectrum for its input.

<30> 64M O/P controls the sense of the S0*64 spectrum. It is normally set the same as **<3>** q.v. for the same reasons. It does not affect any other response.

<11> BU O/P Spectrum & **<12> BL O/P Spectrum**. With B2, B4 or B6 filter configurations these may **Flip** their respective responses. In the case of B1 or B1S configurations *either* will **Flip** the single response, setting *both* reverts to the **Natural** state. For example the standard VSOP mode is produced by configuring B2*16 and **Flipping BL** so that only one IFP is required to produce the specified outputs.

<53> FU O/P Spectrum & **<54> FL O/P Spectrum**. Similar to **<11>** & **<12>** above for F2, F1 and F1S responses in the Fine Tuner.

Analog Monitors

<17> BS Monitor Ctrl, <18> BS Mon BandSel. With B1 and B1S configurations set, **<17>** ***must*** **be** set to **Auto**, in which case **<18>** is ineffective and the signal appears at the BS Monitor connector. For B2, B4 and B6 configurations **<17>** may be set to **Man** in which case **<18>** selects the band mapped to the port. If simultaneous monitoring of the other response is required it should be selected as the Fine Tuner source, then with F0 configured it will appear at the FT Monitor connector.

<57> FT Monitor Ctrl, <58> FT Mon BandSel. With F1 and F1S configurations set, **<57>** ***must*** **be** set to **Auto**, in which case **<58>** is ineffective and the signal appears at the FT Monitor connector. For the F2 configuration **<57>** may be set to **Man** in which case **<58>** selects the band mapped to the port.

Fine Tuner Input

<15> FT I/P Data Ctrl, <16> FT I/P BandSel. With B1 and B1S configurations set, **<15>** ***must*** **be** set to **Auto**, in which case **<16>** is ineffective and the signal is connected to the FI input. For B2, B4 and B6 configurations **<15>** may be set to **Man** in which case **<16>** selects the band mapped to the FT.

Fine Tuner LO

<41> LO Frequency defines the centre frequency of F1 responses, or the common band edge of F2 responses. Resolution is 1Hz. Usually **<47> LO Phase Correct** is **Off** unless the control software makes the facility easy to use.

Digital Monitor

<55> DIG PORT Ctrl, <56> D_PORT BandSel. With F1 and F1S configurations set, **<55>** ***must*** **be** set to **Auto**, in which case **<56>** is ineffective and the signal appears at the DIGITAL PORT connector. For the F2 configuration **<55>** may be set to **Man** in which case **<56>** selects the band mapped to the port. If F0 is configured the Band Splitter response connected to the Fine Tuner is mapped directly to the port.

Magnitude Statistics

<31> Magnitude Stats sets all 2-bit data coders in the DAS to operate at the 4-level (34.6%) or 3-level (54.1%) magnitude statistics level.

S2 Port

Each IFP provides four 1-bit or two 2-bit data streams to the S2 C1 connector: IFP1 drives C1-channels 0..3 and IFP2 channels 4..7. For 2-bit data these channels are referred to in pairs, Lo Chans signifying 0&1 in IFP1 or 4&5 in IFP2. The lower/even numbered channel always carries the sign or most significant bit. The mapping options between DAS configurations and S2 record **Modes** are described in the section "DAS to S2 Interface".

<70> S2 Data Source, **<71> S2 Lo Chans Data** and **<72> S2 Hi Chans Data** comprise a two-level multiplexer. At any time **<70>** may select **64M** (S0*64 data, sign bit only) or **64Mm** (magnitude bit, for test purposes). If B1*32(S) is configured **<70>** ***must*** be set to **32M,** otherwise it may be set to **BxFx** in which case **<71>** and

<72> become active. **<71>** is connected to C1-channels 0&1 in IFP1 and 4&5 in IFP2.

When narrow (ie <= 16MHz) bands are recorded any combination of **BU, BL, FU** and **FL** is permitted. Differing bandwidths are accommodated by setting the **S2** record **Mode** according to the higher data rate.

When B1 or B1S SSB filters <=16MHz wide are configured, nodes **BU** and **BL** carry the same data so either may act as S2 source. Similarly F0, F1 and F1S filters put identical data on **FU** and **FL**.

<73> S2 Lo Chans Fmat and **<74> S2 Hi Chans Fmat** allow narrowband data to be recorded in **VLBA** format (4-level offset binary) rather than **AT** format (4-level sign & magnitude). Multibeam format data (3-level) is recorded in AT mode.

Correlator Port

<76> Corr Data Source selects the source for the correlator port, or if Multibeam format is selected (see 4.1.5) possibly the first of two sources. Option **64M** is not valid for AT format. If **Multibeam** is selected and **<76>** is one **of BU, BL, FU** or **FL, then <79> MB Corr Source 2** may select another data stream of the *same* bandwidth.

Note that when B1 or B1S SSB filters <=16MHz wide are configured, nodes **BU** and **BL** carry the same data so either may act as S2 source. Similarly F0, F1 and F1S put identical data on **FU** and **FL**.

4.1.5 Correlator Settings

<75> CORR OUT Fmat selects the data format on the CORR OUT connector.

<76> AT Corr Clk Delay provides four different data phases at 16ns intervals to allow for timing differences between the DAS and the AT Delay Unit. See the Delay Unit NB/In Port documentation for details. Once set this parameter should not need adjustment unless the time and frequency distribution around the station is disturbed. Corresponding adjustments for Multibeam correlators must be done at the correlator end, according to the Multibeam Correlator documentation.

4.2 IFP Parameter Lists

The full parameter set is presented in two tables. In the first they are selected into functional groups and then sorted (generally) to match the signal path. In the second table they are simply presented in numerical order.

These parameter descriptions may be correlated with the original set by matching the parameter number in the first column. In many cases the purely numeric value ranges have been replaced by symbolic lists. Their equivalent numeric values are 0 for the first symbol, 1 for the second etc.

4.3 Filter Configurations

pto.

4.4 Displays and Readouts

4.4.1 N2 HIGH RES SAMPLER Module

Normal Operation

The 5MHZ and 1PPS lamps flash green together once per second. At power-on either may latch red until either the RESET button is pushed or (more usually) a reset signal is sent by the control computer as the DAS is reconfigured.

The RESET button must be held in until the next 1PPS pulse arrives in order to have effect on either indicator.

Malfunctions

The 1PPS lamp will latch red if more than 1200ms passes without another 1PPS pulse.

The 5MHZ lamp will latch red if either the 5MHz reference signal fails completely or there is a shift of about 50ns or more between the 1PPS and 5MHz signals. A weak (below specification) 5MHz signal level is *not* detected by this system.

Both circuits raise error flags visible to the control program. Failure of either kind often provokes additional error indications from the N3 module and the S2 data recorder.

4.4.2 N3 DIGITAL FILTER Module

Normal Operation

PROCESSING lamp continuous orange. READY lamp continuous green.

While the IFP is being reconfigured the PROCESSING lamp will go off to indicate a break in the data flow. It will come on again synchronous with 1PPS when processing resumes.

Malfunctions

The READY lamp will not light if internal power-on reset functions fail to reprogram the Xilinx chips correctly.

PROCESSING will remain off if reconfiguration is interrupted, usually by the absence of 1PPS signals.

4.5 D3 DATA SET Module

Normal Operation

The top four lamps shine continuously or flash together (orange, orange, yellow, yellow) with each monitor cycle. The bottom PARITY lamp (red) stays off.

If the control program is not operating, briefly pushing RESET will cause SYNC, BUSY and PARITY to flash together.

Indications

TX LINE turns on when the Tx line is in the SPACE state (the rest state is MARK). It normally indicates activity on the Data Set Bus.

SYNC reports the detection of a SYNC symbol marking the head of a request packet from the control computer.

RX LINE indicates that this Data Set detected its own address in the packet and is responding to the control computer.

BUSY indicates that a valid request was decoded from the incoming packet and is being performed.

PARITY indicates the detection of a parity error or other signalling protocol in the incoming request packet.

4.6 Monitor Display

Normal Operation

All graphic indicators on-scale and stable. There is no particular virtue about mid-scale. On the numeric display most signal parameters fluctuate about one count around their mean.

Module temperatures typically stabilise 10 to 15 degrees C above ambient.