WBDC-2 IF Switching

Background

Les White has 16+ coaxial 6x1 switches. The goal is to design a switching scheme that will allow the 40 WBDC-2 IF outputs to be connected to signal processing equipment with 16 optical fibers in such a way as to meet the needs of various anticipated research projects. The accompanying spreadsheet explores possible switch configurations using 6x1 switches.

Summary

To meet the needs of some projects, it is desirable to process 20 IF signals. With only 16 IF paths, there cannot be full simultaneous frequency coverage with high sensitivity for some projects. It will be necessary to limit the observations in some way, either by leaving out a band, or observing some bands in only one polarization. A 16-IF configuration also demands more switch matrix configurations, limiting the number of additional configurations we might add in the future.

The spreadsheet has two pages. One explores what can be done with 5 ROACH boards and 20 IFs, the other using the nominal 4 ROACH boards and 16 IFs. On these sheets, green and blue text indicate alternate choices. On the '5 ROACH', gray indicates additional signals enabled by four more IF paths.

In the cases where two bands share the same signal processing equipment, the band selection may be important to the various projects and so alternative arrangements should be considered.

On can easily assess the number of additional configurations possible by looking at the last digit of the code in the right-most columns. '5' means that there is only one possible use of that switch left.

Assumptions

1. At sufficiently low spectral resolution (e.g. pulsars and transient studies) one ROACH can process four IF inputs.
2. At very high spectral resolution (e.g. 32K channels) a ROACH can handle only one IF input with full spectral coverage.
3. With a sufficiently small number of channels, using some form of decimation for high spectral resolution, a ROACH can handle two IF inputs.

Use Cases

1. **One feed, both pols, both sidebands**. This provides full frequency coverage, high sensitivity with optional polarization characterization.
    1. Examples would be pulsar studies and diagnostic surveys of molecular clouds. The second feed is not needed because pulsars have their own intrinsic 'signal off' state and molecular clouds are large enough that the second feed does not provide an 'off source' signal.
    2. For complete frequency coverage this can be done all at once with 20 signal processor inputs. With 16 signals inputs, one ROACH must be configured to be able to process either of two bands. Cloud surveys would not generally need all bands at once so one ROACH can be assigned to the two least interesting bands.
2. **Two feeds, one pol, both sidebands**. This provides maximum frequency coverage for

unpolarized point sources.
1. An example would be an unbiased survey of spectral lines in molecule rich regions like Orion KL and Sgr B2, which are effectively point sources for this purpose.
2. Note 1.2. applies here as well.
3. **One feed, one pol, both sidebands**. This configuration trades sensitivity in favour of spectral resolution .
4. **Any two complete bands, both feeds, both pols**. Searching for high-Z distributed molecular lines with low spectral resolution, i.e. wide CO lines but not narrow H_2O lines.
5. **Half band, ultra-high freq. res., both feeds, both pols**. Searching for extra-galactic H_2O (and other kinds of) masers.

Configuration Rules

1. A signal source is defined by BAND-FEED-POL-SB:
   1. BAND is one of 17-19, 19-21, 21-23, 23-25, 25-27.
   2. FEEDs are numbered 1 and 2
   3. POLs are labelled 'a' and 'b', which might be linear or circular depending on whether the polarization hybrid is used.
   4. SBs are labelled U and L but this may represent I and Q also, depending on the state of the band-separating hybrids.
2. A signal destination is defined by three numbers of the form ROACH-ADC-PORT:
   1. ROACH boards are numbered 1 through 4 (or 5).
   2. ADCs are numbered 1 through 4, representing ZDOC 0 input I through ZDOC 1 input Q respectively.
   3. Each ADC input is fed from a 6x1 switch. The switch input ports are numbered 1-6.
3. A switch state defines a unique mapping from a down-converter output port to a ROACH ADC input.
4. A 'configuration' is a set of switch states. Configurations are numbered sequentially.
5. A given switch state (and IF output to switch input mapping) may be used by multiple configurations. In the configuration table, this means that a configuration may appear in multiple columns but only the same row.
6. An IF output will generally need a 1-to-N power splitter, where N≤6.