WASP2 Spectrometer Overview and Interfaces

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1 Overview

This document describes the physical interfaces (timing, microwave, data link, electrical, and mechanical) interfaces for the WASP2 spectrometer, its signal processor, and external synchronization signals. It also provides a brief overview of internal microwave and digital signal processing components.

The WASP2 spectrometer is a analog lag correlator with 128 total lags and approximately 4 GHz bandwidth. It can be configured as either an auto- or a cross-correlator. As described in section 5, internal signal processing accepts a nominal 4-8 GHz input band at approximately –10 dBm power level, shifts this to the correlator's native baseband to 4 GHz band, and provides gain and computer-controlled attenuation. WASP2 contains an internal microcontroller for data acquisition and instrument control (sections 6 and 3). Detailed information on the correlator is in *Rev. Sci. Inst.* 72, 1531—1538 (2001) and is available at www.astro.umd.edu/~harris/spectrom.html.

2 Microwave inputs

2.1 Input band
4.5 to 7.5 GHz

2.2 Input power level
–10 dBm nominal, range –13 to –3 dBm. Band flatness degrades as input power increases.

2.3 Signal dynamic range
Signal dynamic range from nominal input power is minus 0 dBm, plus 3 dBm. Larger signal swings require compensation with input attenuation.

2.4 Band flatness
±1.5 dB from nominal slope across 4.5 to 7.5 GHz of:
1. Maximum rolloff with increasing frequency of 0 dB.
2. Maximum rollup (preferred) with increasing frequency of 3 dB.

2.5 Mechanical
SMA female.

3 Data links

3.1 Signal processor to host computer
RS-232 serial link, 19.2 kBd, 8 bits, one stop bit, no parity.

3.2 Signal processor to external synchronization signals
Trigger on the rising edge of a TTL-compatible pulse with minimum width 50 ms.

3.3 Host computer to calibration microwave synthesizer

A computer-controlled microwave synthesizer with a IEE-488 (GPIB) interface is necessary for occasional spectrometer calibration. The preferred interface is a GPIB card within the host computer. If necessary, the interface could be a second serial link with a serial-GPIB converter.

4 Electrical power

4.1 Spectrometer module

Power supply requirements inside the spectrometer; note that if the backplane voltage falls below 4.75 VDC the microcontroller will shut down:

+5 VDC @ 4.5 A (analog and digital for correlator board and microcontroller)
–5 VDC @ 2.6 A (analog for correlator board)
+15 VDC @ 0.85 A (microwave amplifiers, oscillator)
+28 VDC @ 1 A (for driving external microwave relays, if needed)

4.2 Power dissipation

48 W total, of which 26 W from correlator, 9 W from digital electronics, and 13 W from microwave electronics.

5 WASP2 internal microwave processing modules

5.1 Block diagram
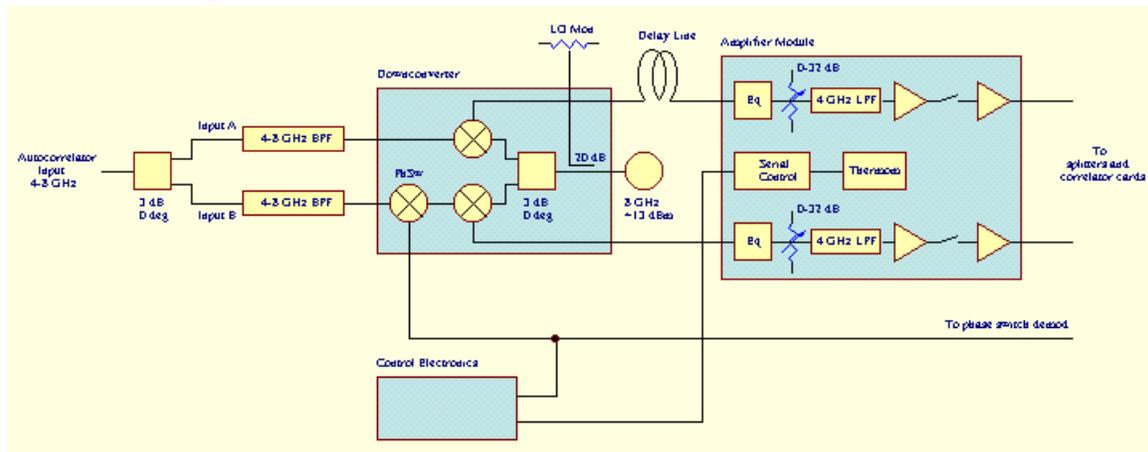
5.2 Descriptive overview

5.2.1 Signal division, anti-aliasing filtering, and compensating delay

WASP2 is fundamentally a cross-correlator. For autocorrelation mode, a 3 dB 0º splitter at the input feeds both inputs with the same signal. Since the autocorrelation function is even only positive or negative lags are needed. Adding a compensating delay line between the downconverter and amplifier modules brings the zero lag near one end of the correlator string. Leaving the delay in place is useful for cross-correlation when the cor-

relator is used for either the real or the imaginary part of the signal, or if the system as a whole is calibrated so all signals are real. Matched 4-8 GHz filters define the input band to prevent aliasing by correlator sampling or sideband folding.

5.2.2   Dual downconverter module

This module contains a 3 dB 0º LO splitter that feeds two mixers to convert the 4-8 GHz band to the correlator modules' 0-4 GHz native input band. A biphase modulator for internal phase modulation precedes one mixer. A 20 dB coupler samples the LO signal for frequency and power monitoring. The LO source is an external 8 GHz DRO with 5 ppm/ºC stability. Phase stability is unimportant since the signal is split between the two mixers.

5.2.3   Dual amplifier module

This module contains two strings consisting of a gain equalizer, 0-31 dB step attenuator, printed circuit 4 GHz low-pass anti-aliasing filter, and two amplifiers with a 70 dB minimum isolation switch between the two. The output from the second amplifier feeds the correlator card splitters. The module contains a serial interface for computer control of the attenuators and the switch; both chains receive the same control signals. A thermometer monitors the module temperature.

6   Internal signal processing, timing and synchronization

6.1   Internal microcontroller

An internal Intel 80C251SB microcontroller provides spectrometer control and handles all real-time spectrometer tasks including data accumulation during integrations and synchronization to external signals. The microcontroller communicates with a host computer with a RS-232 serial link. The microcontroller code resides in nonvolatile flash memory on the microcontroller board.

6.2   Basic internal timing

All of WASP2's integration times are multiples of its basic correlator readout time of 11.52 ms (86.81 Hz). This is also the time granularity for response to external signals. An internal signal processor microcontroller accumulates data during the integration and then transmits the result on a request from the host computer.

6.3   Synchronization for total power, chopping, and nodding

The internal microcontroller can generate or read hardware synchronization signals that initiate total power, chop side, and nod side readouts. TTL-level compatible synchronization signals are distributed in parallel to 15-pin D connectors on all spectrometer rear panels. Details are in the *Microcontroller Command Reference* available at www.astro.umd.edu/~harris/spectrom.html.

7   Mechanical

7.1   Spectrometer chassis dimensions

Standard chassis for 19" relay rack mounting, 4 U high, 410 mm deep. Chassis body dimensions are 17 5/8" wide, 7" high, and 16" deep.

7.2   Mass

10 kg without water cooling system.

7.3   Connectors, controls, and indicators

7.3.1   Front Panel

2 ea. SMA female connectors for microwave input
Power indicator lamp (LED)
Manual microcontroller reset pushbutton

7.3.2   Rear Panel

Power connector, AMP MS multi-pin screw connector
2 ea. DB-15 female connectors for hardware synchronization signals
DB-9 female connector for RS-232 serial interface.
Connectors for water cooling (TBD).

7.3.3   Internal (signal processor)

Indicator lamps (LED) for synchronization and phase switch signals
Pushbuttons for microcontroller reset, flash memory loader

8   Environmental

8.1   Thermal operating limits

The temperature inside the spectrometer should be between 10 and 40º C. Several temperature sensors are built into the system and can be read with a command to the microcontroller. Active cooling may be necessary if the spectrometer operates in a warm room. Passive chilled water cooling of the amplifier module and the air within the chassis is recommended if cooling is necessary. Forced air cooling causes a loss in stability and is not recommended.

8.2   Temperature stability

Astronomical data should be taken with components within ± 2º C of temperature during phase calibration.