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Near infrared polarimeter for extended sources

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Abstract. A state of art near IR polarimeter was designed and developed at Physical Research Laboratory, Ahmedabad and the polarimeter is operational for the last three years. During the last one year a new mode of operation has been implemented to measure polarization of extended sources. The modulation of incoming light signal is generated by fast rotating half wave plate (10 revolution/sec which generates 40 Hz modulation of polarized light). The fast modulation takes care of sky background variation. The technical details are discussed in this paper.

1. Introduction

An Infrared polarimeter for Astronomical Observations in 1 to 3 micron wavelength region was fabricated and is operational since 1995 (Joshi et al., 1996, 1997).

In the first version of this instrument, the $\lambda/2$ plate rotates slowly at the rate of one revolution of 96 steps in 48 seconds (Joshi et al., 1996, 1997). The chopper mirror oscillates at 20 Hz with chopping throw limited to 15 arcsec. This is okay for point sources, but for extended sources, 'sky' much away from the extended object is to be sampled and subtracted from the 'source+sky' signal for extracting the 'source data. At the same time, a fast modulating technique for polarized light is needed to take care of the variations in the 'sky'. In the modified version a speed of 10 revolutions per second (600 steps per second) of the $\lambda/2$ plate has been incorporated. So the polarizer controller of the chopper mirror, $\lambda/2$ plate and the data sampling, was redesigned to accommodate the new requirement and was successfully lab-tested. The modified instrument is functioning very satisfactorily. In the following discussion the emphasis is given to the implementation of Polarizer Controller.

2. Instrumentation

The incoming light from the telescope is passed through a rotating $\lambda/2$ plate, foster prism, and chopper mirror which also deflect the beam by 90° to the detector through the cold aperture and infrared filter. In the modified version of the Polarizer controller a fast mode of 10 revolutions per second of the polarizer plate is incorporated with 60 steps per revolution. In this mode the Chopper modulator is not oscillated but positioned to acquire either the 'sky' signal or the 'source+sky' signal data. The acquired data is then filtered through a 40 Hz band pass filter with a preset constant gain to separate the polarizer modulated signal (in this

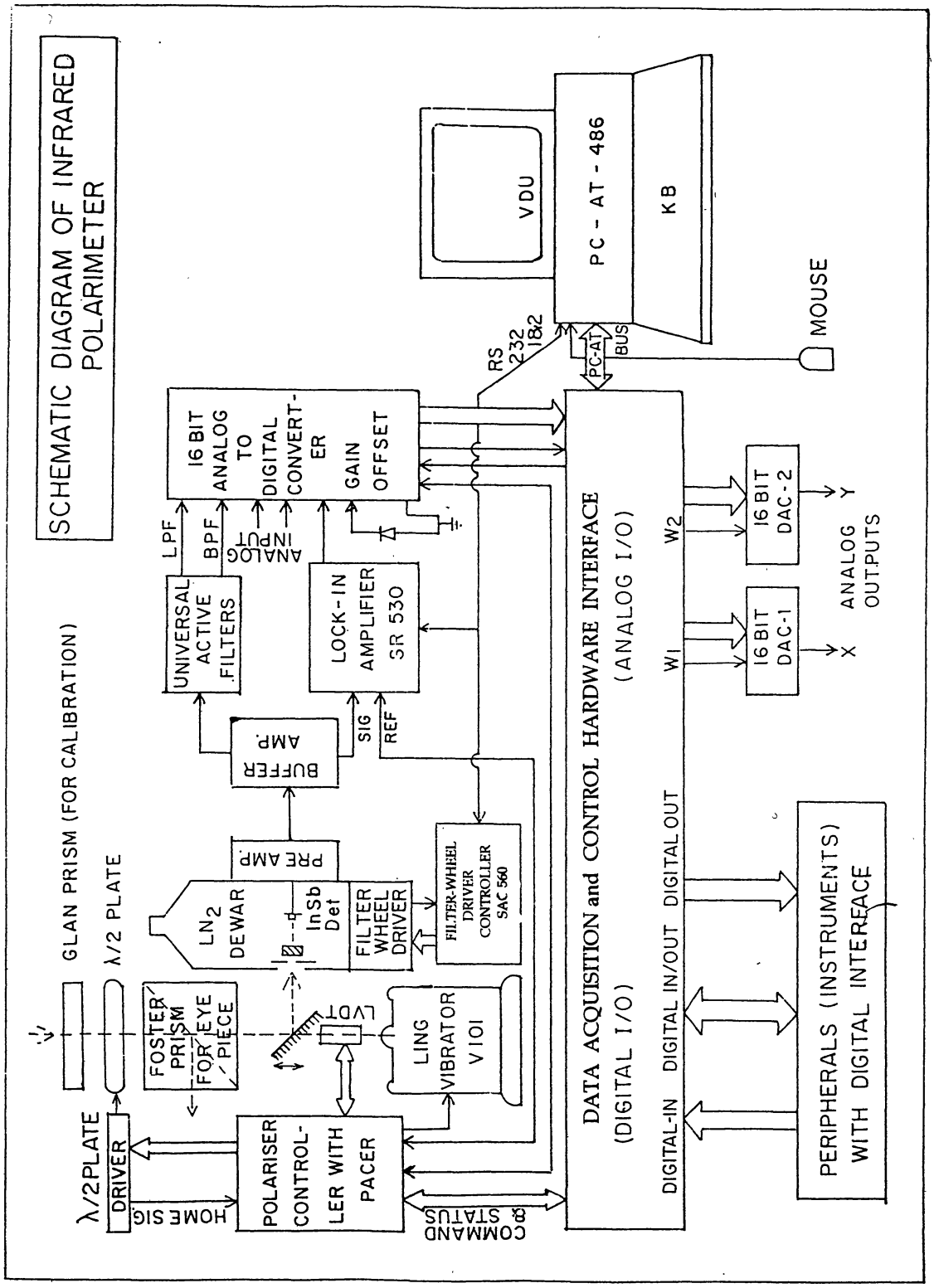

Figure 1.

case 40 Hz modulation of polarized light) and a low pass filter to get the clean total intensity signal. These two separated-signals are fed to the data acquisition and control system for recording, etc.

The data acquisition and control system digitizes the input analog signal into 16-bit data, which is then fed to the computer along with the system gain and offset information for instrumental correction during signal processing.

The band-passed polarised light signal is then sampled for each step of the λ/2 plate movement (60 steps) and at the end of one full rotation of the λ/2 plate the total intensity signal is sampled. Thus a data array of 61 points is created for every revolution of the λ/2 plate rotation with the home signal as the pointer for the starting point of the array. The data arrays created by multiple rotation of the λ/2 plate are coherently added to improve the S/N ration. The integrated data array is then processed to obtain polarization and position angle.

The infrared filters in the Dewar assembly are selected by computer command utilizing the RS232C serial port and the filter information is stored with the data. The general schematic diagram of the IR Polarimeter, DAC (Data Acquisition and Control) interface and the controlling PC is shown in Figure 1.

3. The polarizer controller

The polarizer controller has the important function in acquiring data in slow or fast mode operation. It controls an optical chopper and half wave plate driver movements either by manual or by software controls to do the operations, which are shown in Figure 2.

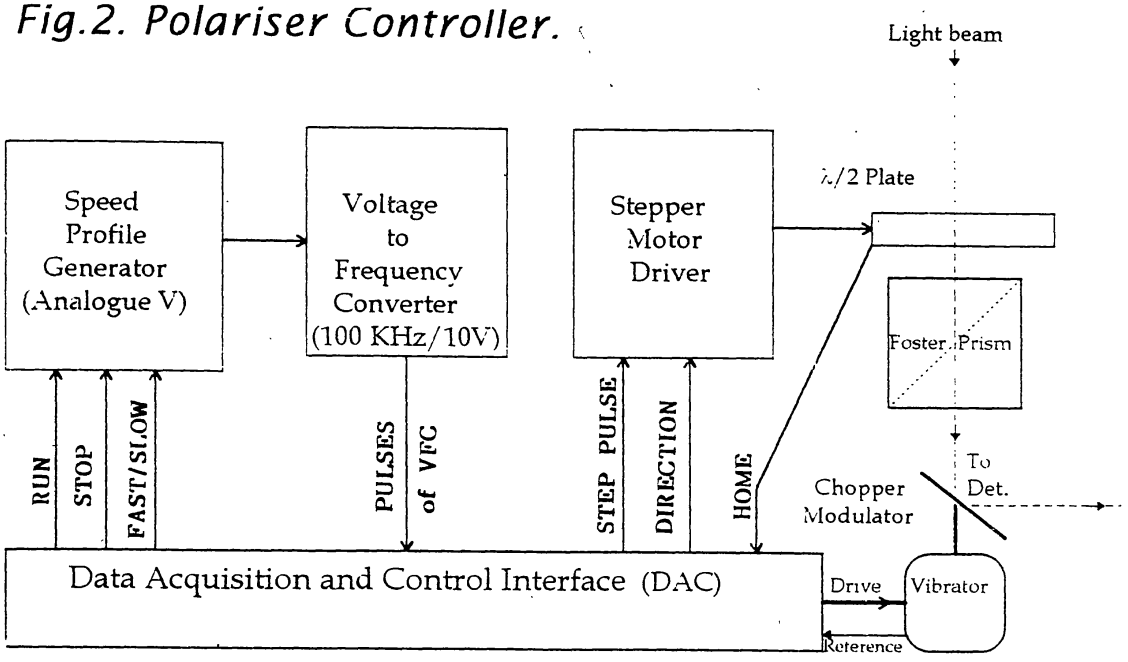

Figure 2. Polariser controller

In the slow scan mode the λ/2 plate is rotated once every 30 seconds and the chopper modulator is oscillated at 20 Hz. In the fast mode, the chopper mirror is set either to 'star + sky' or 'sky' position and the λ/2 plate is rotated 10 times per second. For each revolution of the λ/2 plate 60 data sampling points with a reference 'Home' signal are generated. The controller has the status and command hand shake with the computer, to do the above functions.

The built in oscillator gives the necessary clock pulses for the chopper mirror driver as well as the stepper-motor driver of the λ/2 plate. Ramp up oscillations are given to the stepper motor to turn 10 times per second in the fast mode.

The preliminary test runs in the laboratory were carried out successfully and the performance of the instrument is found to be very satisfactory.

Acknowledgements

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