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CRaTER

Analog to Digital Subsystem

Electrical Interface Control Document

Drawing Number: **32-02052**

Revision 01

1. Scope

This document specifies the electrical interface between the Analog Processing Board and the Digital Processing Board within the CRaTER electronics box. This document does not describe the interface between the Detector Telescope and the Analog Processing Board, although references are made to the Detector Boards inside the Telescope as appropriate.

2. Applicable Documents

32-01205	CRaTER Level 2 Mission Requirements Document
32-02001	Spacecraft to CRaTER Data ICD
32-02002	Spacecraft to CRaTER Electrical ICD
32-10201	Analog PCB Outline Drawing
32-10202	Digital PCB Outline Drawing

3. Functional Description

The Analog Processing Board (APB) will be located inside the electronics box in an conductively shielded enclosure. The Digital Processing Board (DPB) will also reside in the same box and will interface to the APB with two connectors, one for power and one for signals. A high-level functional interface block diagram is shown in Figure 1.

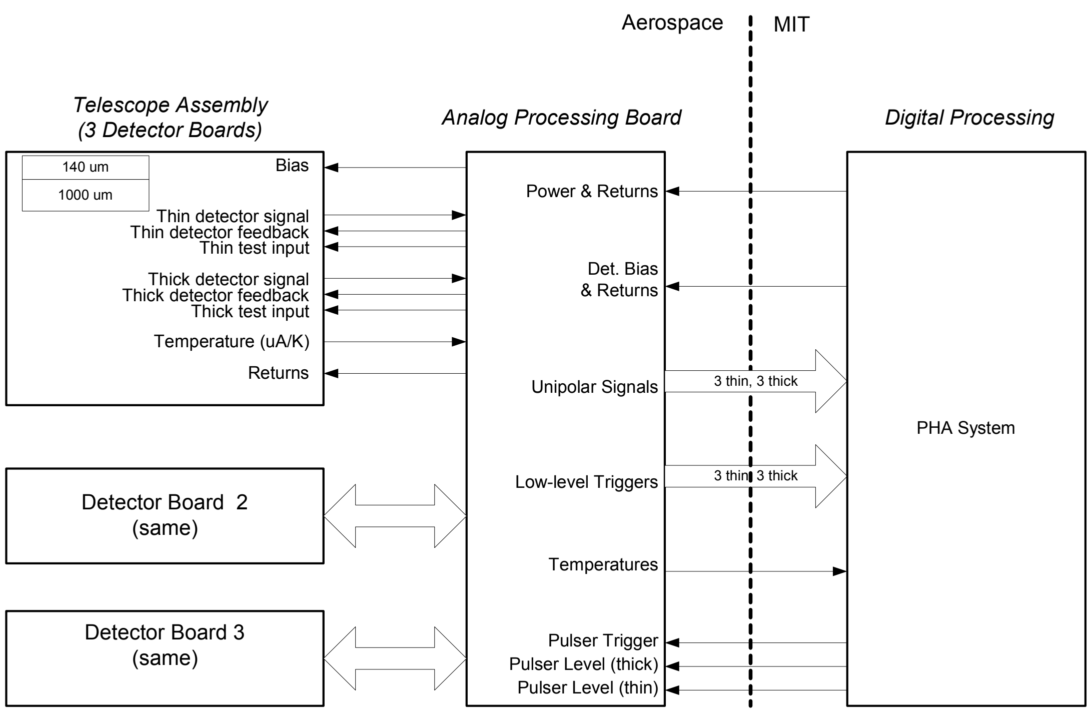

Figure 1: Analog Interface Block Diagram Concept

3.1. Analog Processsing Board

The APB provides a linear transfer function of output signal amplitude to detector energy deposit for three thin detectors and three thick detectors. A functional block diagram of a single amplifier string is shown in Figure 2. The shape of each output pulse is Gaussian and scaled in amplitude to achieve the full dynamic range of the DPB A/D subsystem. An amplified signal with low-level digital trigger is provided on the interface to aid ground testing of the analog front-end. It also functions as an early event trigger that may be used for coincidence timing or for gating a peak-hold detector on the DPB.

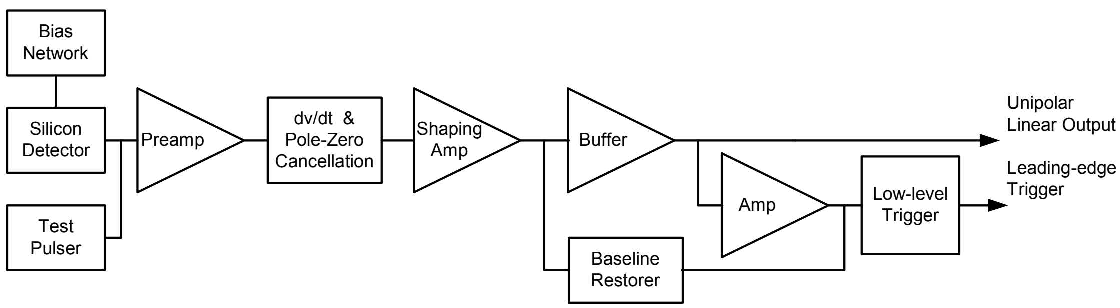

Figure 2: Single Amplifier String Block Diagram

3.2. Digital Processing Board

The DPB function is to determine event validity through the use of a stacked detector coincidence scheme, digitize the pulse-heights of the APB output signals, provide control of the APB test pulser, supply power and detector bias, and provide the command and telemetry interface to the spacecraft.

4. Detector Signal Interfaces

Detector signals are amplified and filtered versions of the detector charge. There are three thin detector signals and three thick detector signals. Correspondingly, there are three thin and three thick low-level trigger signals.

4.1. Thin Detector Signal

The thin detector signal is a pulse whose peak voltage is proportional to the charge deposited in a thin detector. The source of the thin detector signal is the APB and the destination is the DPB. There are three thin detector signals each corresponding to one of three thin detectors.

4.1.1. Voltage Range

The thin detector signal shall be a positive unipolar pulse with a linear range of 0V to +3V. Input protection of the ADC system shall be implemented on the DPB to protect against signals outside this range. There will be no limiting on the APB, except the power supply rails.

4.1.2. Peaking Time

The thin detector signal shall be a Gaussian shaped pulse with a peaking time of 1 usec +/- 10%.

4.1.3. Noise

The thin detector noise voltage shall be less than 1.5 mVrms (i.e., ~ 0.5 bit).

4.1.4. Transfer Function

The thin detector transfer function shall be nominally 3 mV/MeV into 1 Meg-ohm. The actual transfer function will be determined during electrical calibration of the APB with the DPB.

4.1.5. Output Impedance

The thin detector signal output impedance shall be less than 100 ohms.

4.2. Thick Detector Signal

The thick detector signal is a pulse whose peak voltage is proportional to the charge deposited in a thick detector. The source of the thick detector signal is the APB and the destination is the DPB. There are three thick detector signals each corresponding to one of three thick detectors.

4.2.1. Voltage Range

The thick detector signal shall be a positive unipolar pulse with a linear range of 0V to +3V. Input protection of the ADC system shall be implemented on the DPB to protect against signals outside this range. There will be no limiting on the APB, except the power supply rails.

4.2.2. Peaking Time

The thick detector signal shall be a Gaussian shaped pulse with a peaking time of 1 usec +/- 10%.

4.2.3. Noise

The thick detector noise voltage shall be less than 1.5 mVrms (i.e., ~ 0.5 bit).

4.2.4. Transfer Function

The thick detector transfer function shall be nominally 30 mV/MeV into 1 Meg-ohm. The actual transfer function will be determined during electrical calibration of the APB with the DPB.

4.2.5. Output Impedance

The thick detector signal output impedance shall be less than 100 ohms.

4.3. Thin Detector Low-level Trigger

The thin detector low-level trigger is a CMOS digital signal giving early indication of the arrival of the thin detector signal. The source of this signal is the APB and the destination is the DPB.

4.3.1. Voltage Range

Logic 0 corresponds to 0-volts and logic 1 corresponds to 5-volts. The pulse width shall be 5 usecs +/- 10%.

4.3.2. Timing

The rising edge indicates the arrival of a thin detector signal and shall occur no less than 300ns before the peak amplitude is reached. The rising edge of this signal shall be less than 25 nsecs into 1-MegOhm and 10pF.

4.4. Thick Detector Low-level Trigger

The thick detector low-level trigger is a CMOS digital signal giving early indication of the arrival of the thick detector signal. The source of this signal is the APB and the destination is the DPB.

4.4.1. Voltage Range

Logic 0 corresponds to 0-volts and logic 1 corresponds to 5-volts. The pulse width shall be 5 usecs +/- 10%.

4.4.2. Timing

The rising edge indicates the arrival of a thick detector signal and shall occur no less than 300ns before the peak amplitude is reached. The rising edge of this signal shall be less than 25 nsecs into 1-MegOhm and 10pF.

5. Test Pulser Interfaces

The test pulser function is used during ground test phases and on-orbit to monitor the transfer function stability with time. The test pulser injects a known charge into the front of each preamplifier at a known rate. The DPB will supply two separately controlled voltage levels for the thin and thick detectors and a common trigger. The APB will convert these signals into a charge injection into the detector preamplifiers.

5.1. Thin Detector Pulser Level

The thin detector pulser shall cover the full dynamic range of the thin detector signal from below threshold to full-scale. The source of this signal is the DPB and the destination is the APB.

5.1.1. Voltage Range

The thin detector pulser level is a DC analog voltage. The linear range is from 0 to 5-volts. Input protection of the circuitry shall be implemented on the APB to protect against signals outside this range. There will be no limiting on the DPB, except the power supply rails.

5.1.2. Resolution

The resolution for level settings shall be 8-bits.

5.1.3. Output Impedance

The output impedance shall be less than 100 ohms.

5.2. Thick Detector Pulser Level

The thick detector pulser shall cover the full dynamic range of the thick detector signal from below threshold to full-scale. The source of this signal is the DPB and the destination is the APB.

5.2.1. Voltage Range

The thick detector pulser level is a DC analog voltage. The linear range is from 0 to 5-volts. Input protection of the circuitry shall be implemented on the APB to protect against signals outside this range. There will be no limiting on the DPB, except the power supply rails.

5.2.2. Resolution

The resolution for programmable level settings shall be 8-bits.

5.2.3. Output Impedance

The output impedance shall be less than 100 ohms.

5.3. Test Pulser Trigger

The test pulser trigger is a clock whose frequency corresponds to the rate of charge injection into the preamplifiers. The source of this signal is the DPB and the destination is the APB. This signal will be used for both thin and thick detector strings.

5.3.1. Voltage Range

The test pulser trigger is a CMOS digital signal with 0-volts corresponding to logic 0 and 5-volts corresponding to logic 1. A logic 0 triggers the test pulser circuit on the APB to inject charge into the front of both the thin and thick detector preamps. The amount of charge injected is determined by the test pulser level signals.

5.3.2. Timing

The logic 0 pulse width shall be fixed and no less than 50 usec. The logic 1 pulse width shall be determined by the low and high rate selections on the DPB.

6. Housekeeping Signal Interfaces

6.1. Telescope Temperature

The telescope temperature signal is a DC analog signal in the range 0 to +3 volts corresponding to a linear function of temperature from –50C to +60C, respectively. The source of this signal is the APB, however the temperature will actually be monitored in the Telescope. The output impedance shall be less than 100 ohms.

6.2. Analog Processing Board Temperature

The APB temperature signal is a DC analog signal in the range 0 to +3 volts corresponding to a linear function of temperature from –50C to +60C, respectively. The source of this signal is the APB, however the temperature will actually be monitored in the Telescope. The output impedance shall be less than 100 ohms.

7. Detector Bias Supply

7.1. Thin Detector Bias

The thin detector bias is supplied by the power system through the DPB.

7.1.1. Output Voltage

The thin detector bias is a stable negative DC voltage of -100V +/- 2%. This voltage will be tuned on the APB/Detector Board to meet the bias requirements of the thin detector using a resistive divider.

7.1.2. Load

The detector leakage current in addition to the resistive divider current creates the total load on the bias supply. The total current drawn by the thin detector bias supply (i.e., sum of all three thin detectors) shall not exceed 50 uA.

7.1.3. Ripple

The ripple on this bias shall be less than 1-volt peak-to-peak at a frequency greater than 1 KHz at the maximum load plus margin.

7.2. Thick Detector Bias

The thick detector bias is supplied to the APB/Detector Board by the power system through the DPB.

7.2.1. Output Voltage

The thick detector bias is a stable negative DC voltage of -300V +/- 2%. This voltage will be tuned on the APB/Detector Board to meet the bias requirements of the thick detector using a resistive divider.

7.2.2. Load

The detector leakage current in addition to the resistive divider current creates the total load on the bias supply. The total current drawn by the thick detector bias supply (i.e., sum of all three thin detectors) shall not exceed 100 uA.

7.2.3. Ripple

The ripple on this bias shall be less than 3-volt peak-to-peak at a frequency greater than 1 KHz at the maximum load plus margin.

8. Power Supply Interfaces

8.1. +6V Analog Power

The DPB/Power system will supply a positive power supply for the analog electronics. The APB and Detector Boards will use this supply for the detector signal processing.

8.1.1. Output Voltage

The DPB/Power system shall provide positive regulated power of +6V +/- 5%.

8.1.2. Load

The APB/Telescope shall draw no more than 110 mA from the +6V supply.

8.1.3. Ripple

The ripple shall not exceed 60mV peak-to-peak at a frequency greater than 100 KHz.

8.2. –6V Analog Power

The DPB/Power system will supply a negative power supply for the analog electronics. The APB and Detector Boards will use this supply for the detector signal processing.

8.2.1. Output Voltage

The DPB/Power system shall provide negative regulated power of -6V +/- 5%.

8.2.2. Load

The APB/Telescope shall draw no more than 75 mA from the -6V supply.

8.2.3. Ripple

The ripple shall not exceed 60mV peak-to-peak at a frequency greater than 100 KHz.

8.3. +5V Digital Power

The DPB/Power system will supply a positive power supply for digital electronics. The APB will use this supply voltage for the low-level trigger and test pulser.

8.3.1. Output Voltage

The DPB/Power system shall provide positive regulated power of +5V +/- 10%.

8.3.2. Load

The APB/Telescope shall draw no more than 5 mA from the +5V supply.

8.3.3. Ripple

The ripple shall not exceed 200mV peak-to-peak at a frequency greater than 100 KHz.

8.4. Power Returns

The analog +/- 6V return shall be connected to the digital +5V return at the input to the A/D converters on the DPB, and nowhere else unless a board jumper is provided that can be removed if necessary.

8.5. Chassis Grounding

The detector housing shall be connected to the detector ground inside the telescope assembly, and nowhere else unless a jumper is provided that can be removed if necessary.

The detector housing shall be electrically isolated from the electronics box in order to prevent noise coupling from the spacecraft into the detector front-end. The detector ground shall be routed through the interface connector to the electronics box APB where it will join the analog power return.

9. Connector Pin Assignments

TBD.