Anode Front End Board AD16_F

User manual

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Prepared by Nikolay Bondar (e-mail: bondar@fnal.gov)

AFEB/p option  AFEB/s option

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Introduction

The Anode Front End Board (AFEB) AD16_F was designed for amplifying and discriminating anode signals from the Cathode Strip Chambers (CSC). The board is optimized for the CSC of the Endcap Muon system of the CMS detector. The essential feature of the board is excellent time resolution (RMS less then 1 ns). The board is intended for use in a limited maintenance environment.

AD16_F is the production version of the AD16 board.

Construction

The AD16_F module consists of a printed board assembled with all its components. The board’s top cover has a thermo-conductive pad between the ASIC and the cover which serves two functions – it protects the board and provides heat dissipation. The input and output connectors are located on opposite sides of the board to minimize input-output cross talk.

The input connector is a SAMTEC 19X2 socket, modified to match the standard 17X2 IDC header. The top row of the input connector is a ground connection; the bottom row has input contacts.

The output connector (3M 20X3 Header) has two parts. The first one (pins 1 – 32) is the output signal contacts. The second part is an amplifier service part. This part has power supply pin 37, power control pin 35, threshold control pin 36, and test pulse pin 39. These two parts are divided with two ground pins, 33 and 34.

There are two mechanical options for the board. The first and the main option is the AFEB/p option. This option is for direct connection to the chamber. The second option is the AFEB/s option. This option is for connecting the board to the chamber with a short cable jumper. This option may be used for small chamber size (less than 1 m) and for small detector capacitance (less than 50 pf).

Circuit diagram

The AFEB AD16_F consists of the ASIC CMP16G, an ASIC input protection network and ASIC serving networks. The input protection network for each channel consists of two limiter diodes and a decoupling capacitor.

To provide stable characteristics to the boards, a power voltage regulator, TK112, is used. The regulator has a current overflow protection, overheating protection and a power on/off control feature (standby mode). Minimum 3.5 V is a “Power-ON” signal. The input power voltage range is 5.5 V - 6.0 V. The output voltage of the regulator is 5.0 V +/-0.05 V.

There are three bias voltage sources and one current source on the board to provide the normal operational regime of the ASIC.

Vgi = 1.59 V +/-0.02 V – internal reference voltage (artificial ground); Voff=1.94 V +/-0.02 V – additional reference voltage; Vbp=3.36 V +/-0.03 V – PMOS bias voltage; Ide=0.1 ma – discriminator current.

The discriminator threshold voltage comes from outside via the output connector. The threshold control voltage range is from 0 V to 1.5 V. The threshold control voltage is applied to all channels of the board.

The board has an internal test feature. Using the input test pulse, all channels of the board fire simultaneously.

The AD16_F output signals are LVDS compatible (bipolar output current 1.5 ma).

Application note

Inasmuch as the AD16_F has one output cable with two functions (signal transmission and power supplying), it is very important to be sure that the power voltage is OFF before connect or disconnect the cable.

Troubleshooting

All boards after production are carefully tested and certified. All information is on the WEB page
http://www-hep.phys.cmu.edu/cms/

In case of problems:
- Check the power voltage (5.5V – 6.0V)
- Check the “Power ON” signal (3.5 V – 5.5 V)
- Check the threshold voltage on the board
- Check the test pulse on the board (negative pulse)

If all signals are normal, try to watch the output pulse with an oscilloscope (use high impedance probe).

If there is no output pulse on the board, the board needs maintenance.
AD16_F specification

General

Size 2.8” x 3.1”
Number of channels 16
Input connector 19X2 socket SAMTEC SSQ-1-19-02-T-D-RA (modified)
Input connector specification 1,3,5,...,33–GND, 2–not connected, 4,6,8,...,34–INP16-INP1.
Output connector 20 x2 header 3M 3432-5002
Installation fixture Two options for installation.

Power characteristics

Power voltage +5.5 V - +6.0 V
Current 0.1 A
On board power protection fully protected power regulator
Remote power switch +3.5 V – power “ON”

Input characteristics:

Input impedance 40 Ohm equivalent
Input DC connection Capacitor decoupled
Sparkle protection One stage diode protection
Minimum input signal 10 fC
Maximum input signal 1 pC
Maximum overflow signal 100 pC
Maximum detector capacitance 250 pF

Transfer characteristics

* Amplifier gain 8 mV/fC
* Shaping time 30 ns
* Detector tail cancellation Two exponents cancellation circuit
* Amplifier noise Cin=0 0.8 fC
* Cin=200 pF 1.8 fC
* Threshold control
  Threshold control voltage 0 V – 1.2 V
  Minimum threshold 7 fC
  Maximum threshold 150 fC
  Signal propagation time 100 ns
* Slewing time 3 ns @ (50 fC - 500 fC)
* Time resolution 0.8 ns @ 80 fC
** Dead time 80 ns
*** Recovery time @ 10 pC 500 ns
*** @ 100 pC 60 us
Maximum test pulse frequency 16 MHz
Output pulse
  Signal levels LVDS compatible 1.5 mA
  Output driver capability 110 Ohm load
  Output pulse width Input pulse width over the threshold
  Leading edge 6 ns
  Trailing edge 6 ns
  Cross talk level -50 dB

Test Pulse parameters

Amplifier is triggered by the negative transition of the test pulse.
Termination 110 Ohm
Minimum amplitude 10 mV
Maximum amplitude 500 mV
Leading edge 20 ns
Trailing edge 20 ns
Pulse width minimum 500 ns
Internal injection capacitance ~0.25 pF

Note:
*) Parameters are tested for each board. Results are on the WEB page:
**) Dead time definition: Threshold – 20 fC; First pulse amplitude – 100 fC; Second pulse amplitude – 40 fC.
***) Recovery time defined for the second pulse amplitude – 100 fC.
AD16_F top view.

- Input Power Voltage contact.
- Power regulator
- "On board" power voltage contact.
- Input connector.

AD16_F bottom view

- Output connector
- Pin 1
- ASIC test channel output.
- ASIC test channel input.
- Pin 1
- Input connector.
- ASIC test channel output.
- ASIC test channel input.
- Power "ON" signal
- Input Power Voltage.
- Threshold control voltage contact.
- Test Pulse contact.