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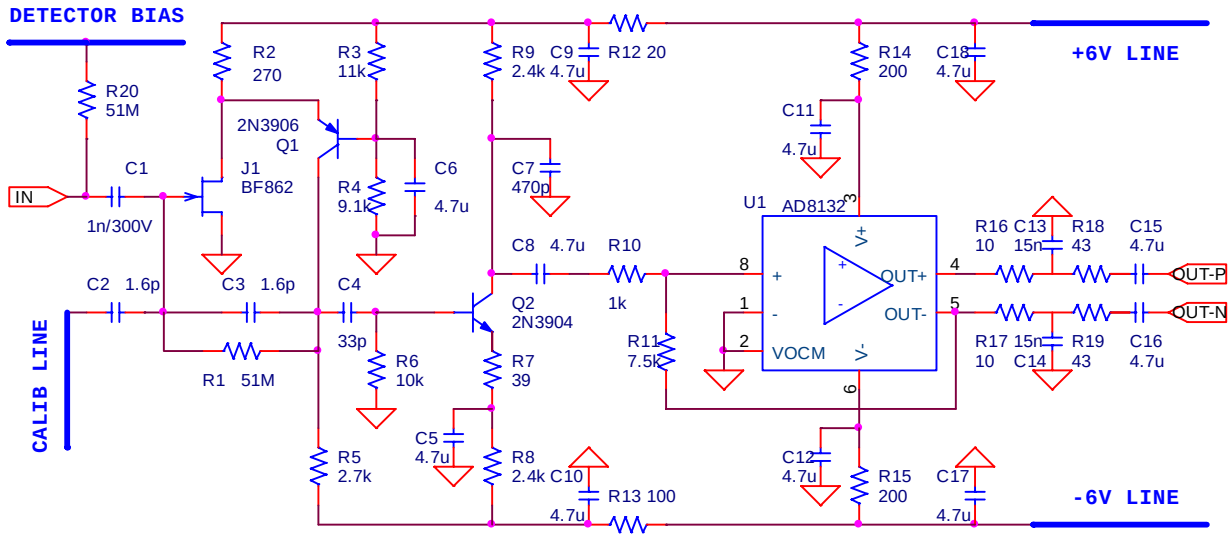
TRINAT Amplifier-Shaper for Silicon Detector (TASS)

1. General description

Preamplifier-shaper for TRINAT Si detector (Micron model BB1) is charge-sensitive amplifier followed by semi-gaussian shaper and differential amplifier driving output line. The single-channel schematics is shown below.

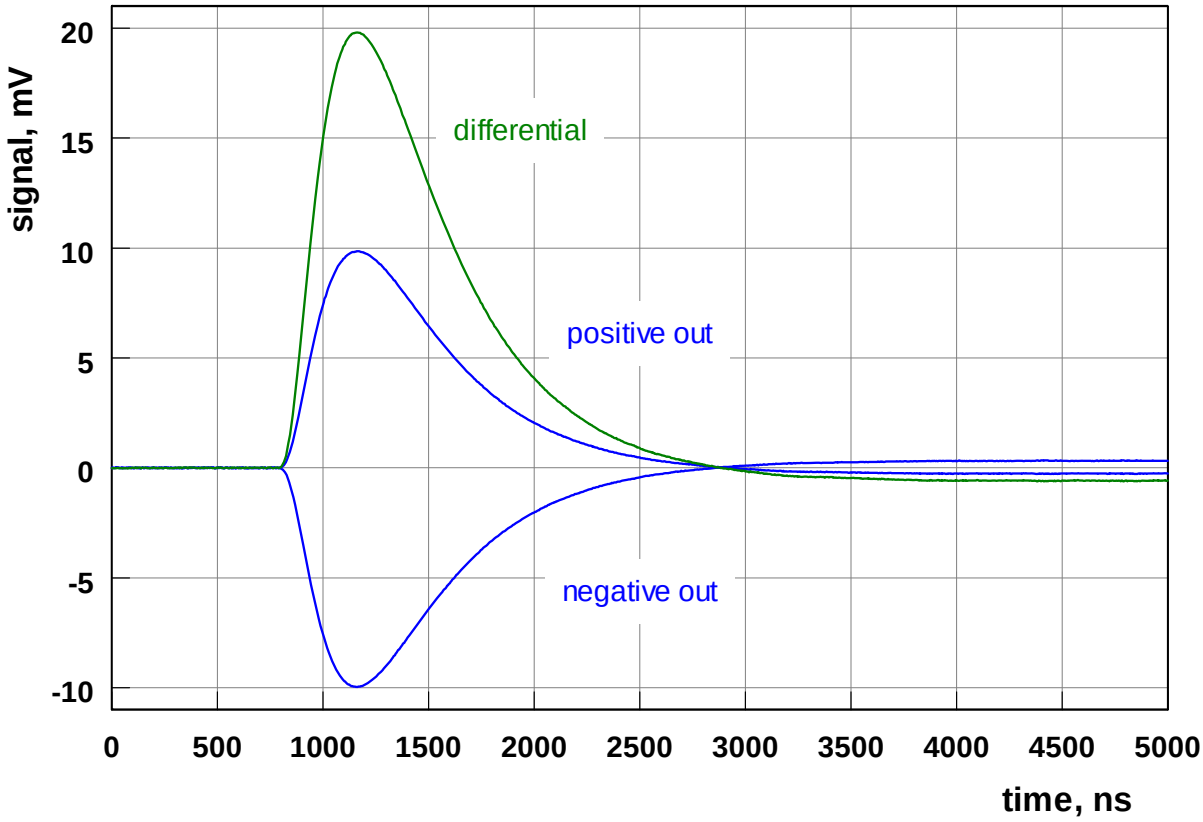


The BB1 is double sided DC coupled design which requires bias and decoupling from amplifier side. R20 and C1 provide these functions. J1 and Q1 form cascode with charge sensitive feedback R1-C3. Q2 with input differentiation in C4-R6 and integration in C7-R9/R10 provides RC-CR shaping and additional gain defined by R7. The final gain adjusted by U1 feedback loop R10-R11. Additional integration, mainly to filter-out U1 noise, is implemented at its output with R10-C13 and R17-C14.

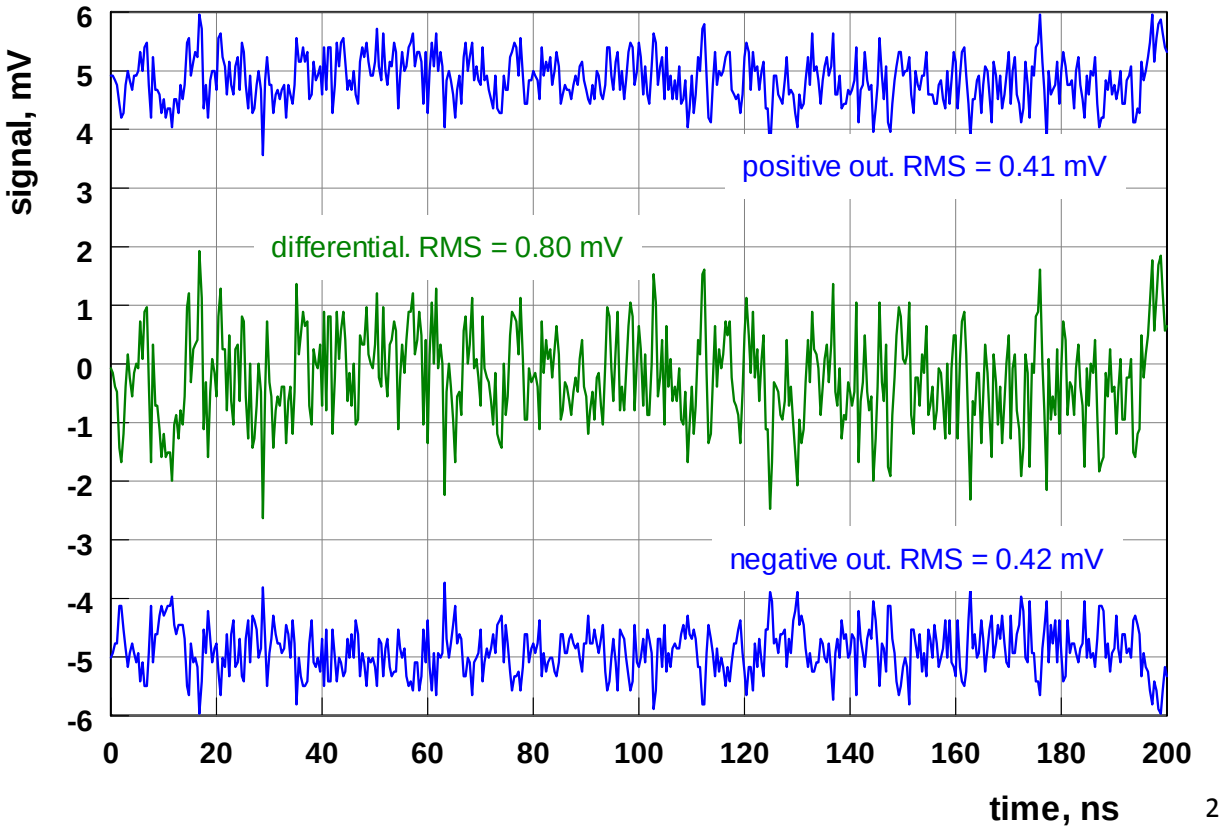
The values of resistors and capacitors are optimized with single-channel prototype described in the next section.

2. TASS prototype

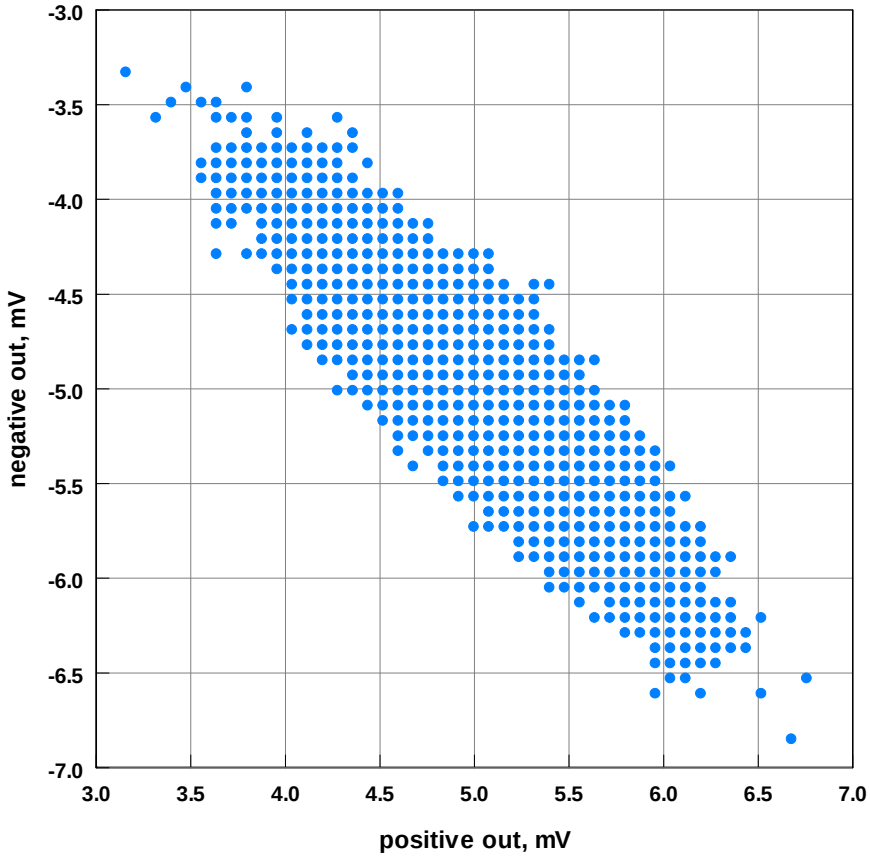
Measured pulse response is shown in the next plot. OUT-P and OUT-N are connected to 50-Ω oscilloscope input with 50-Ω coaxial cables. The differential response is calculated as a difference of two measured output waveforms. The injected charge was 3.2 fC or 20 kel. The circuit is adjusted to differential gain of 6.25 mV/fC or 1 mV/kel. The input load was 40-cm of coaxial cable representing 20 pF of detector strip and 20 cm of input cable.



The noise traces (a small part of actual data) measured with the same input load are shown below. The differential noise of 0.8 mV is equivalent to input charge of 800 electrons or 2.9 keV of deposited energy.

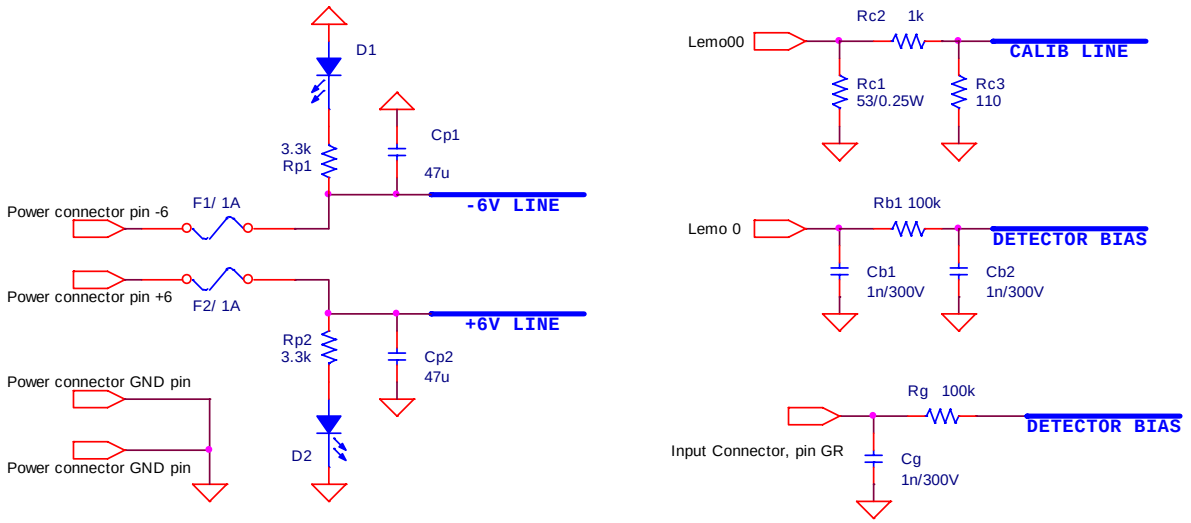


The next scatter plot, drawn from the noise traces shown in the previous Fig., demonstrates that opamp noise contribution is negligible.



3. TASS schematics and layout

TASS board houses 20 amplifier-shaper channels, power distribution, detector bias line and calibration line. The schematic diagram is shown below.



Rg and Cg are not installed by default

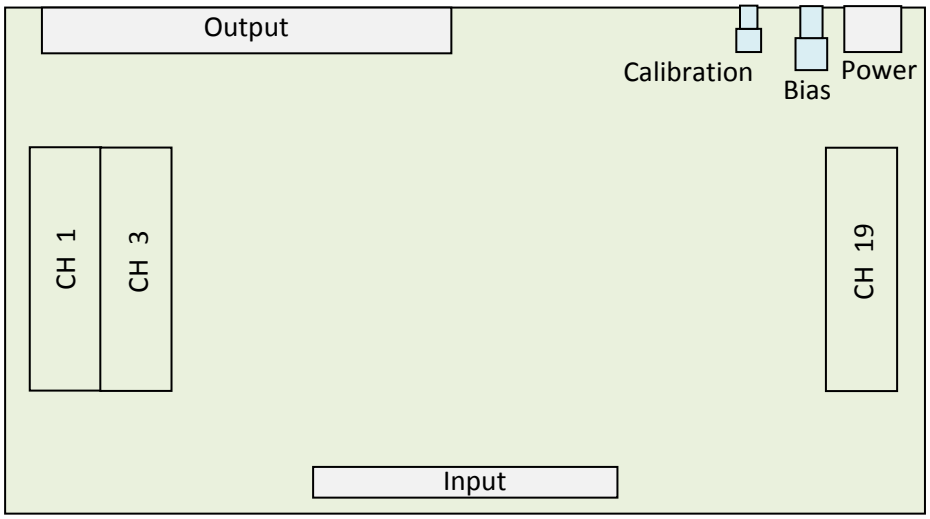
10 amplifier channels are located on each PCB side in one row. In order to avoid crosstalk between channels all traces from input connector and those to output connector must be surrounded by ground lines. In order to reduce EMI interference, empty area on all layers must be filld with ground plane. Since amplifier has high gain and low noise, the input traces must be routed on a separate layer. Detector bias line holds up to 50V, the minimum distance from this line to all other electrodes is 1 mm. A tentative layer assignment is shown in the table below.

Layer	**Traces**
1 (top)	10 amplifiers with all interconnections, their output traces. GND in empty space
2	+6V line. The rest filled with GND
3	20 input traces. The rest filled with GND
4	-6V line. The rest filled with GND
5	Detector bias line. Calibration line
6 (bottom)	10 amplifiers with all interconnections, their output traces

Board must be equipped with 12 standoffs, 6 on each side, to hold top and bottom shielding plates. LED indicators must be visible from back side of module. The input connector located on the front side of module and all other connectors – on the back side. Suggested connector types are shown in the next table.

Connector	**Type**
Input	SFMC-126-01-S-D-K. See comments below
Power	Single row, 4 pins, RA. Pinout not critical
Detector bias	LEMO-0 PCB mount, RA
Calibration	LEMO-00 PCB mount, RA
Output	Male, 0.1” pitch, 2 rows x 20 pins, either RA or card edge

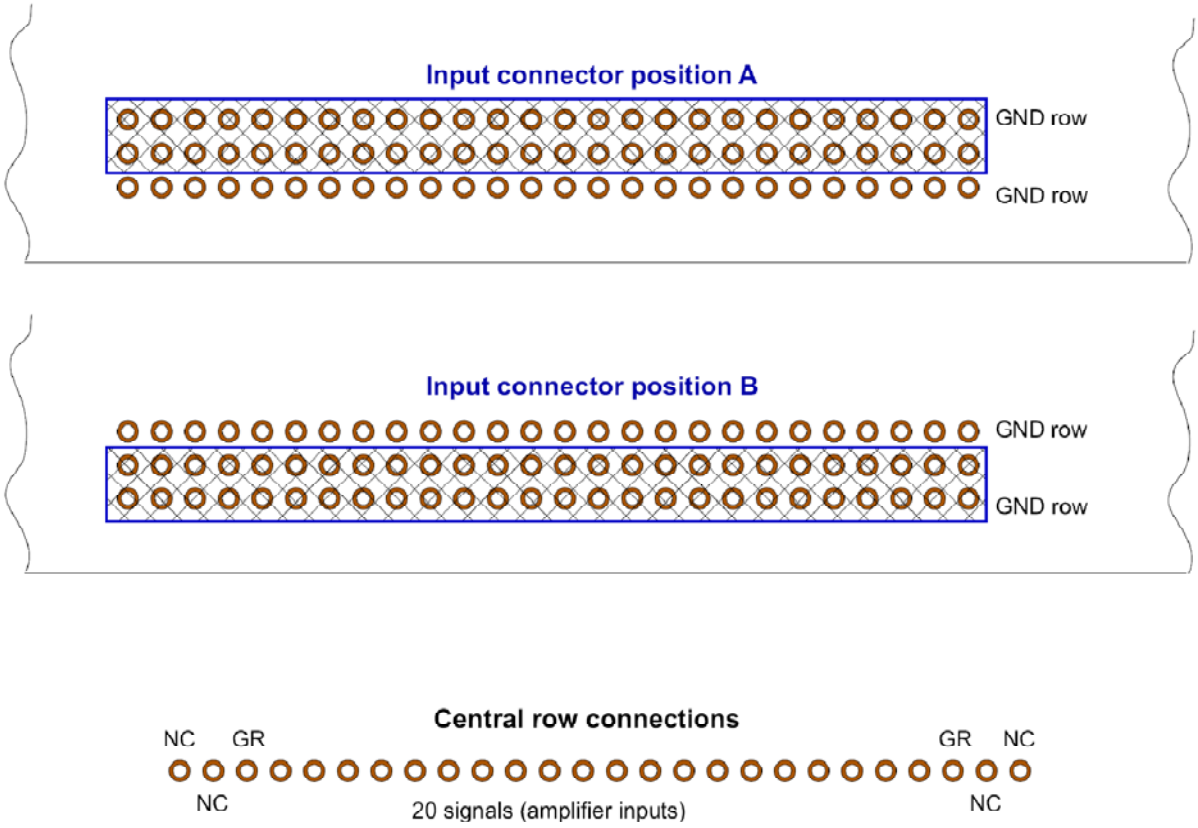
All connectors are placed on top side of PCB as shown in the sketch.



4. Input connector

Input connector is 2-row 0.05” pitch female with 26 positions per row. It can be either through hole (as in Tab above, SFMC-126-01-S-D-K) or surface mount (SFMC-126-02-S-D-K). There are four flex cables from BB1 detector carrying signals from 20 strips each. All four have different pin-out of FTSH-125 male connector. In order to use the same amplifier PCB for these four options, the PCB has three rows of 26 vias (or pads) for 2-row connector. The positioning of input connector will be of two types as shown in the figure below. A half of the boards will be assembled according to type A and another have – according to type B.

Schematic diagram of GR pin connection is shown in p.3, left bottom. The GR pins serve detector guard rings and by default are floating. The powering of guard rings as in the diagram might be needed in the case of leaky or noisy strips and will be done individually for each guard ring by user.



Total production volume 8-10 boards, 4-5 of each type.