

This note describes the known changes to the LArIAT TPC front end electronics since the ORC review prior to Run 1.

This is a summary of changes up to February 9, 2016.

This is version 1 of this document.

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List of changes

- 1) The 19" rack-mountable power pan supplying the electronics on the top of the cryostat has been moved and the mains power is now coming from a different building outlet.
- 2) The analog input sections on the D2S cards have been modified.
- 3) The amplifier feedback networks on the WRD cards have been modified.
- 4) The digital control section of the WRD cards has been modified.
- 5) The cable tray carrying the analog signals and the ground braid away from the cryostat has been replaced.

Details of the changes

1: Description

The 19" rack-mountable power pan that supplies power to the WRD cards has been moved. The original location was in the equipment rack that also houses the D2S card file, the D2S power supply, and the CAEN digitizers. The new location is either directly under the TPC cryostat or in a rack very close to the location. Additionally, the mains power cord for this unit now passes through a large inductor to reduce the amount of common-mode noise that can enter from the electrical mains.

1: Reasoning

This power pan was moved in efforts to reduce the electrical noise entering the cryostat and the readout electronics.

1: Safety implications

This move of the power supply was already reviewed by Steve Chappa in consultation with Carl Bromberg.

2: Description

The analog input sections of the D2S cards have been modified. The original input sections were terminated with 1820 ohms differential impedance. The modified input sections are terminated with 150 ohms differential impedance which matches the impedance of the WRD-to-D2S signal cabling. The gain of the D2S amplifiers was increased to compensate for the reduction of the input amplitude caused by the termination. To accomplish these changes one resistor was added and two resistors were changed in every analog channel.

2: Reasoning

This change to the D2S cards was implemented during the diagnosis of sporadic 200 MHz oscillations in the readout chain. It was reasoned that the sporadic 200 MHz oscillations may have been supported by reflections in the 25-foot long signal cabling, and that terminations would work against these

possible reflections. These changes do not affect the shape of the analog signals.

2: Safety implications:

None are apparent.

3: Description:

The analog feedback networks on the WRD cards were modified by the removal of a pair of 100 pF capacitors.

3: Reasoning:

These 100 pF capacitors were included in the design to provide one pole of low-pass filtering with a corner frequency of 320 kHz. The goal was to attenuate frequencies beyond those of interest for the TPC readout. However, the resulting amplifier channels were marginally stable and could oscillate at ~200 MHz. These oscillations are probably supported by a combination of amplifier characteristics and the parasitic circuit elements. Removal of the 100 pF capacitors prevented the high-frequency oscillations.

3: Safety implications:

None are apparent.

4: Description

The digital signals to configure the ASICs inside the cryostat are generated on the WRD cards. These signals pass through series resistances. The values of the series resistance was changed from 500 ohms to 45 ohms.

4: Reasoning

During LArIAT Run 1 there were several instances of corruption of the ASIC parameters. It is believed that these corruptions are due to noise spikes originating somewhere in the overall LArIAT system. The series resistance of the digital control lines was reduced to attenuate any noise that may couple onto the digital control lines.

4: Safety implications:

None are apparent. The digital control lines can supply a maximum of 1.8 VDC. With the 45 ohm series resistance a maximum current of 40 mA can flow in the signal cabling during a short-circuit fault. The signal cabling is 30 AWG copper.

5: Description

The cable tray that carries signal cabling and the building ground braid was replaced.

5: Reasoning

The previous cable tray interfered with the removal/installation of the main flanges of the TPC cryostat. The cabling was removed, the cable tray was replaced, and the cabling was re-installed.

5: Safety implications:

None are apparent. The connections of the ground braid should be verified at both ends. At the TPC the ground braid should be attached to the copper back plate of the WRD crate. The other end should be attached to the building ground plate located behind the readout equipment rack.