BaBar SVT Earthing and Shielding Specifications

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Introduction

The BaBar Silicon Vertex Tracker is an independent electrical structure, which is connected to its environment at one point. There are 5 electrical sub-structures within the SVT. The topological exterior electrical system is the shield, which contains the electrical information system, the power system, and part of the SVT monitor system. The fifth system is the earth system, which connects the SVT to its environment at the power supplies, and distributes the earth connection to each multiplexer rack, in a forked configuration.

SVT System Architecture

The primary architectural principle being followed is that the SVT Earthing structure follows the shielding structure, which follows the power structure, which follows the electrical information structure. The electrical information structure must be in the form of a fork. Consequently, none of the fore mentioned structures, contain topological loops. Nor should inadvertent coupling between these systems create topological loops.

A corollary to this is that all electrical systems except the shield itself and the Earth connection system must be either completely inside the shield, or completely outside the shield.

Due to the limited space requirement that causes the SVT to be read out in both the forward and backward direction, coupled with the requirement that the entire SVT detector have a continuous shield around it, the shield structure could violate the fork principle, and form a large 3 legged donut surrounding the entire SVT system. In the baseline connection configuration, the shield loop is broken at the power supplies

Definitions

Earth: Refers to the electrical connection of the SVT to its environment. May refer to the electrical potential of the environment, or the physical environment itself

Common: Refers to the electrical connections and potential of the HV center taps, the Mux center common and the HDI Temperature and Radiation monitor system common.

Shield: Refers to the electrical faraday cage structure which surrounds the entire SVT system, including cable shields, and the conductive foil surrounding the detector.

Earth Baseline Design

The SVT system is tied to earth at one point at the power supply racks, on top of the electronics house.

Three heavy cables run along with the power cables from the power supply racks to the three sets of multiplexer racks around the detector which are locally floating.

The cases of all modules which reside in the power supply and Mux racks, including the power modules, the Mux modules the HDI temperature and radiation monitor modules, are all tied to Earth by being in contact with the crates which are in contact with the racks.

The electronics in all modules are isolated from their cases and thus isolated from Earth.

Options

Optional jumpers are provided in all modules for strapping via a jumper, or a resistor with protection diodes, the internal electronics common to Earth.

Baseline connections

The baseline connection installed during fabrication is to tie the internal electronics common to the case (Earth) via a 10k resistors and protection diodes in all modules.

Common Baseline Design

The commons of all modules are insulated from their cases.

The common of each multi-source power supply is the center tap of the high voltage.

The common of each single-source power supply (Mux Supply), can be either the positive or negative power bus depending on its connection in the Mux modules.

The common of the "front-end" drivers and receivers in the HDI Link module is tied to its associated multi-source power supply common via its power cables. (Mux module front-end common) . The common of the "back-end" circuitry in the HDI and DAQ Link module is tied to its associated single-source power supplies via its power cables. (Mux module back-end common)

The Commons of the HDI Temperature and Radiation monitor power supplies residing in the Mux rack are tied to the rest of the SVT system by the Mux Common interconnect bus on the back plane in each Mux crate.

Options

Optional jumpers are provided in all modules for strapping via a jumper, or a resistor with protection diodes, the internal electronics common to pins on the back plane or connectors on their back panel as in the power supply modules.

The front and backend commons of the Mux modules can be strapping via a jumper or a capacitor and resistor with protection diodes

Baseline connections

For all modules, the baseline connection installed during fabrication is to tie the internal electronics to the common connectors on their back panel of back plane.

Shield Baseline Design

The shield is an electrical faraday cage structure which surrounds the SVT system. It is AC coupled by (optional) capacitors on all matching cards to the analog 2 volt supplies which are the reference for the chip inputs. The DC potential is provided by strapping the shield to the multi-source power supply common, both at the power supplies and in the HDI link card Mux.

The shield around the detector is made of copper coated Kapton with the conductive side facing inward. On the "outside" of the detector the Kapton surrounds the entire structure out past the cable connectors of the matching cards. Another layer of Kapton runs between the beam pipe and detector, changes to a copper mesh running up the topside of the support cones making contact with the cooling rings and proceeding past the cable connectors on the matching cards.

Both the "inside" and "outside" Kapton shields are electrically tied to all the cable shields leaving the detector via the M-card supports.

The shields of the cables running to the Mux system enter the Mux modules via a pin, and are insulated from the connector shells and case. Within each module, the shield continues through to the power supply cable shields in a similar manner. The shields of each Mux assembly in a crate are collected via the shield. As are the shields of the HDI temperature and radiation modules

The shields of the cables running to the power system enter the power modules via a pin, and are insulated from the connector shells and case. In the baseline connection installed during fabrication, the shields are tied to the power supply common in the power supply modules.

The shields of the cables running to the HDI Temperature and Radiation monitor system enter the modules via a pin, and are insulated from the connector shells and case. The shields are strapped to Common in the temperature and radiation monitor modules.

Options

Optional jumpers are provided in all modules for strapping via a jumper, or a resistor with protection diodes, the internal electronics common to the shield entering via pins on all connectors.

In the Mux and monitor modules, a jumper is provided to connect the shield to the Shield Interconnect Bus.

Baseline connections

The shield is capacitivly coupled to the n and p side analog 2 volt supply lines at the M-cards and HDI link Mux modules.

The shield is tied to the multi-source power supply common in the power supply modules and in the HDI link Mux modules.

The shield is tied to the Shield Interconnect Bus in the Mux and monitor modules.

Implementation Requirements List

This list specifies the implementation features for each sub component of the SVT system relevant to Earth, Common and Shield.

HDI

The HDI must incorporate the ability to strap or couple, using a capacitor, the Analog and Digital Commons together.

Matching Card

The Matching card must incorporate the ability to strap or couple, using a capacitor, the Analog and Digital Commons together.

The Matching card must incorporate the ability to couple the analog 2 volt line on each side to the mounting flange which is connected to the shield, using a capacitor of at least .5uf @ 100v.

Mux System

The Mux System must pass the cable shields through to the inside circuitry, without connection to the case which is connected to earth via the racks.

The HDI Link Mux Modules must provide a jumper option to connect their front-end common to their back-end common with a jumper, capacitor, or resistor with protection diodes.

The HDI Link Mux Modules must provide a jumper option to connect their front-end common to the Earth Interconnect bus on the back plane with a jumper or a resistor with protection diodes.

The HDI Link Mux Modules must provide a jumper option to connect their front-end common to the Mux Common Interconnect bus on the back plane with a jumper or a resistor with protection diodes.

The HDI Link Mux Modules must provide a jumper option to connect their front-end common to the Shield Interconnect bus on the back plane with a jumper or a resistor with protection diodes.

Power Supplies

All connections to systems outside the SVT shield must be electrically isolated.

The power modules must pass the cable shields through to the inside circuitry, without connection to the case which is connected to earth via the racks.

The power modules must provide a jumper option to connect their common to their case (earth) with a jumper or a resistor with protection diodes.

The power modules must provide a jumper option to connect their common to the shield with a jumper or a resistor with protection diodes.

The power modules must provide a jumper option to connect their common to the two parallel SVT Common connectors on their back panel with a jumper or a resistor with protection diodes.

Monitoring system

All connections to systems outside the SVT shield must be electrically isolated.

The HDI Temperature and Radiation monitor modules must pass the cable shields through to the inside circuitry, without connection to the case which is connected to earth via the racks.

The HDI Temperature, Radiation, and Abort monitor modules must provide a jumper option to connect their common to the Earth Interconnect bus on the back plane with a jumper or a resistor with protection diodes.

The HDI Temperature, Radiation, and Abort monitor modules must provide a jumper option to connect their common to the Mux Common Interconnect bus on the back plane with a jumper or a resistor with protection diodes.

The HDI Temperature, Radiation, and Abort monitor modules must provide a jumper option to connect their common to the Shield Interconnect bus on the back plane with a jumper or a resistor with protection diodes.

Baseline Connections

Installed during fabrication

HDI

The analog and digital commons are tied together

Matching Cards

The shield is capacitively coupled to every analog 2 volt supply on the matching cards.

Mux Modules

The shield is capacitively coupled to every analog 2 volt supply on the HDI Link card Mux module

The shield is tied to the multi-source power supply common in the HDI link Mux modules and the Mux Shield Interconnect bus on the back plane.

The Front-end Mux module common is strapped to the Mux Common Interconnect bus on the back plane.

The Back-end Mux common is coupled to the Front-end Mux module common via 10uf capacitor and a 10k resistor with protection diodes.

The front and back Mux commons are tied to the Earth interconnect buss via 10k resistors with protection diodes.

Power Modules

The Shield is strapped to the supply common in each multi- source power module.

The Supply Common in each power module, are strapped to the Common back panel connectors.

The Supply Common in each power module, are tied via a 10k resistor with protection diodes to Earth via their case which is in contact with the racks.

Monitor Modules

The Shield is strapped to the HDI Temperature and Radiation monitor module commons.

The Shield is strapped to the Shield Interconnect Bus on the back plane.

The common is strapped to the Mux Common Interconnect Bus on the back plane.
The common is tied to the Earth Interconnect Bus via 10k resistors with protection diodes.