LCLS Interface Control Document #	**# DOC HERE**	**System Here**	**Name**	**Revision 0**

Interim Machine Protection System

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Brief Summary: The Machine Protection System (MPS) is an interlock system to turn off or reduce the rate of the beam in response to fault conditions that may either damage or cause unwanted activation of machine parts. Many systems provide input to the MPS.

Change History Log

Rev Number	Revision Date	Sections Affected	Description of Change
000	May 1, 2006	All	Initial Version

Stephen Schuh Section 2	Signature	Date
Sheng Peng Sections 3 to 9	Signature	Date
Tim Montagne Section 10	Signature	Date
Michael Cecere Sections 11 to 12	Signature	Date
Stephen Norum Section 13	Signature	Date
Arturo Alarcon Section 13	Signature	Date
Section 14	Signature	Date
Section 15	Signature	Date
Section 16	Signature	Date
Anthony Tilghman Sections 17 to 20	Signature	Date
Bill White Sections 21 to 22	Signature	Date

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Contents

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Section 1 Introduction

The Machine Protection System (MPS) is an interlock system to turn off or reduce the rate of the beam in response to fault conditions that may either damage or cause unwanted activation of machine parts. The three active devices in the LCLS MPS are an abort kicker that is able to kick a single electron bunch, and a Pockels cell and mechanical shutter that block the laser light.

This document discusses the interface of the MPS and its connections to other systems. Input signals refer to signals that originate from non-MPS devices and are sent to the MPS. Output signals refer to signals that originate from the MPS and are sent to non-MPS devices.

1.1 LDIM Signals

LDIM and LDIM compatible signals refer to signals compatible with the Latching Digital Input Modules' (LDIM) High Threshold Mode. Where a signal between -30V and +9V is interpreted as logic 0, +11V to +30V is interpreted as logic 1, and +9V to +11V is undefined. See Chapter 19 of the SLC Control System Hardware Manual for more information (`http://www.slac.stanford.edu/grp/cd/soft/wwwman/hard.www/chapter19.html`).

1.2 LDIM/Device Connections

Signals input to the LDIM are passed up to the SLC MPG.

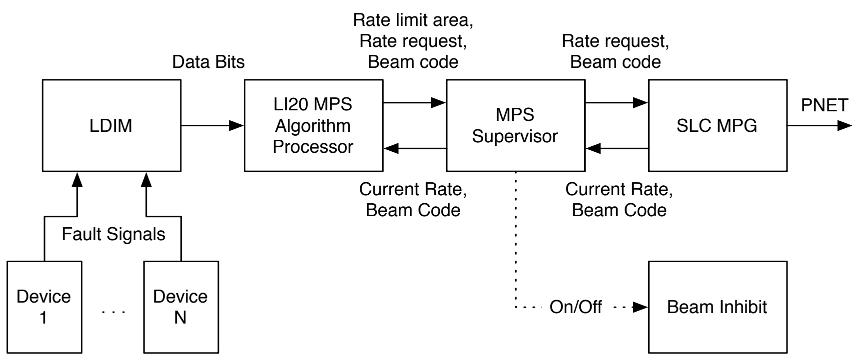

Figure 1.1. Generic Signal Flow of Interim MPS

Section 2 Vacuum System

Status of all pneumatic and manual beam line valves is sent to the MPS so that the MPS can prevent the electron beam from striking a valve. See Vacuum Controls Requirements (ESD 1.1-326), Section 2.4.1.

Status of the gun waveguide vacuum interlock is sent to the MPS so that the MPS can zero rate the electron beam when the waveguide vacuum pressure is elevated.

2.1 Input Signals

Table 2.1 lists interlock signals sent to the MPS from the Vacuum System.

Table 2.1. Vacuum System Signals

Signal	Format	OK Condition	Fault Condition
VVPG IN20 BL435 (VV02) Position	LDIM Signal	Opened	Not opened
VVPG IN20 BL545 (VV03) Position	LDIM Signal	Opened	Not opened
VVPG IN20 BL635 (VV04) Position	LDIM Signal	Opened	Not opened
VVPG IN20 BL915 (VVS1) Position	LDIM Signal	Opened	Not opened
VVMG LI21 BL175 (VVX1) Position	LDIM Signal	Opened	Not opened
VVMG LI21 BL195 (VVX2) Position	LDIM Signal	Opened	Not opened
VVWG IN20 WG558 Position	LDIM Signal	Opened	Not opened
VVWG IN20 WG560 Position	LDIM Signal	Opened	Not opened
20-6 Waveguide Vacuum Summary	LDIM Signal	OK	Faulted

Table 2.2. Vacuum System States

Input	State
0	Not Opened/Faulted
1	Opened/OK

2.2 Wiring

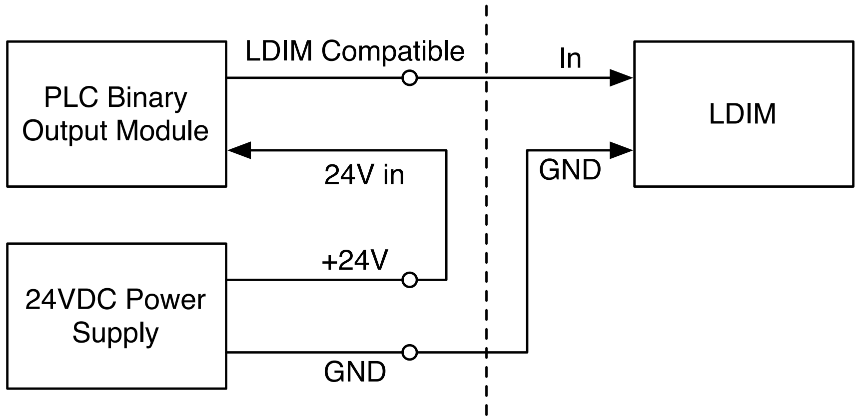

Figure 2.1. Wiring Diagram for Vacuum System to MPS

Section 3 Profile Monitors

Profile monitors provide their limit switch status to the MPS as two LDIM compatible signals. One LDIM signal is given for the Out limit switch, and another LDIM signal is given for the In limit switch.

3.1 Input Signals

Table 3.1. Profile Monitor Signals

Signal	Format	State 1	State 2	State 3	State 4
YAG01 Position	Two LDIM Signals	Out	In	Moving	Broken
YAG02 Position	Two LDIM Signals	Out	In	Moving	Broken
YAG03 Position	Two LDIM Signals	Out	In	Moving	Broken
YAG04 Position	Two LDIM Signals	Out	In	Moving	Broken
YAGG1 Position	Two LDIM Signals	Out	In	Moving	Broken
YAGS1 Position	Two LDIM Signals	Out	In	Moving	Broken
YAGS2 Position	Two LDIM Signals	Out	In	Moving	Broken
OTR1 Position	Two LDIM Signals	Out	In	Moving	Broken
OTR2 Position	Two LDIM Signals	Out	In	Moving	Broken
OTR3 Position	Two LDIM Signals	Out	In	Moving	Broken
OTR4 Position	Two LDIM Signals	Out	In	Moving	Broken
OTRS1 Position	Two LDIM Signals	Out	In	Moving	Broken
OTR11 Position	Two LDIM Signals	Out	In	Moving	Broken
OTR12 Position	Two LDIM Signals	Out	In	Moving	Broken

Table 3.2. Profile Monitor States

Data 2	Data 1	State
0	0	Moving
0	1	In
1	0	Out
1	1	Broken

3.2 Wiring

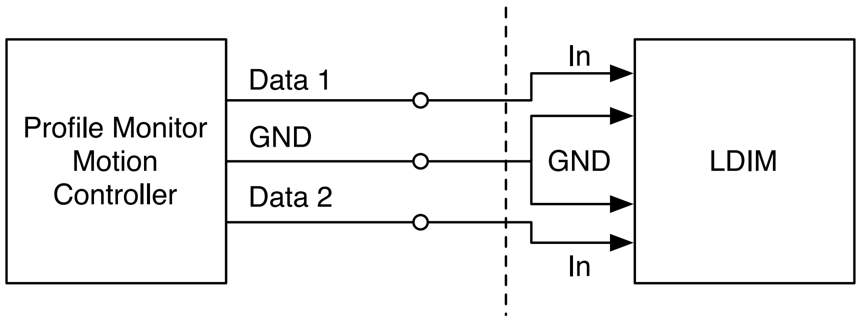

Figure 3.1. Wiring Diagram for Profile Monitor Limit Switches to MPS

Section 4 Faraday Cup

The Faraday Cup provides its limit switch status to the MPS as two LDIM signals. One LDIM signal is given for the Out limit switch, and another LDIM signal is given for the In limit switch.

4.1 Input Signals

Table 4.1. Faraday Cup Signals

Signal	Format	State 1	State 2	State 3	State 4
FC01 Position	Two LDIM Signals	Out	In	Moving	Broken

Table 4.2. Faraday Cup States

Data 2	Data 1	State
0	0	Moving
0	1	In
1	0	Out
1	1	Broken

4.2 Wiring

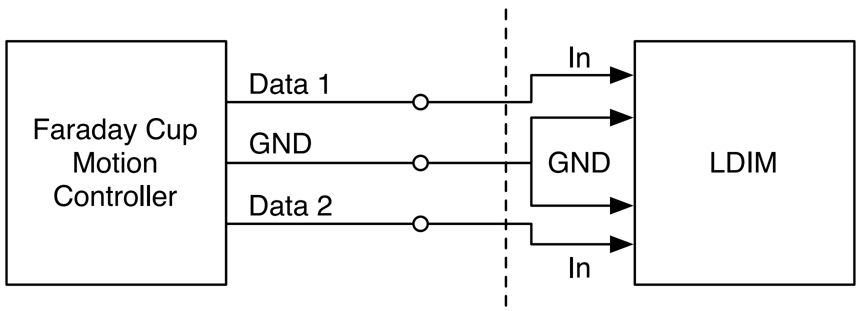

Figure 4.1. Wiring Diagram for Faraday Cup Limit Switches to MPS

Section 5 Alignment Mirror

The Alignment Mirror, AM01, has a single limit switch providing the mirror's Out status as an LDIM signal.

5.1 Input Signals

Table 5.1. Alignment Mirror Signal

Signal	Format	State 1	State 2
AM01	LDIM Signal	Out	Not Out

Table 5.2. Alignment Mirror States

Input	State
0	Not Out
1	Out

5.2 Wiring

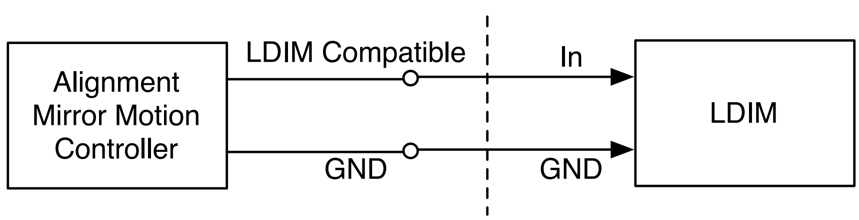

Figure 5.1. Wiring Diagram for Alignment Mirror Limit Switch to MPS

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Section 6 Wakefield Shield

The wakefield shield provides its limit switch status to the MPS as two LDIM signals. One LDIM signal is given for the Out limit switch, and another LDIM signal is given for the In limit switch.

6.1 Input Signals

Table 6.1. Wakefield Shield Signals

Signal	Format	State 1	State 2	State 3	State 4
Wakefield Shield Position	Two LDIM Signals	Out	In	Moving	Broken

Table 6.2. Wakefield Shield States

Data 2	Data 1	State
0	0	Moving
0	1	In
1	0	Out
1	1	Broken

6.2 Wiring

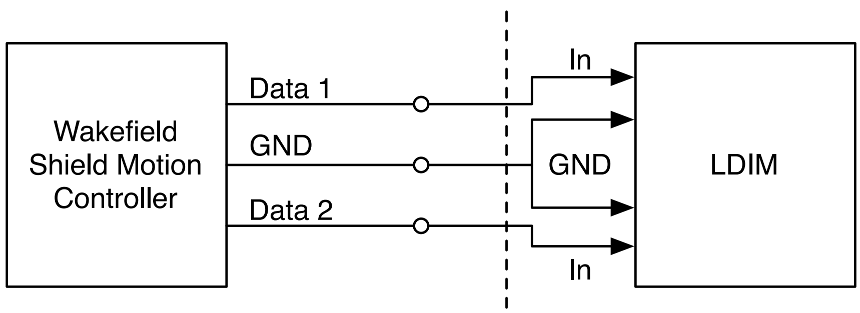

Figure 6.1. Wiring Diagram for Wakefield Shield Limit Switches to MPS

Section 7 Cerenkov Radiator

Cerenkov radiators provide their limit switch status to the MPS as two LDIM signals. One LDIM signal is given for the Out limit switch, and another LDIM signal is given for the In limit switch.

7.1 Input Signals

Table 7.1. Cerenkov Radiator Signals

Signal	Format	State 1	State 2	State 3	State 4
CR01 Position	Two LDIM Signals	Out	In	Moving	Broken
CRG1 Position	Two LDIM Signals	Out	In	Moving	Broken

Table 7.2. Cerenkov Radiator States

Data 2	Data 1	State
0	0	Moving
0	1	In
1	0	Out
1	1	Broken

7.2 Wiring

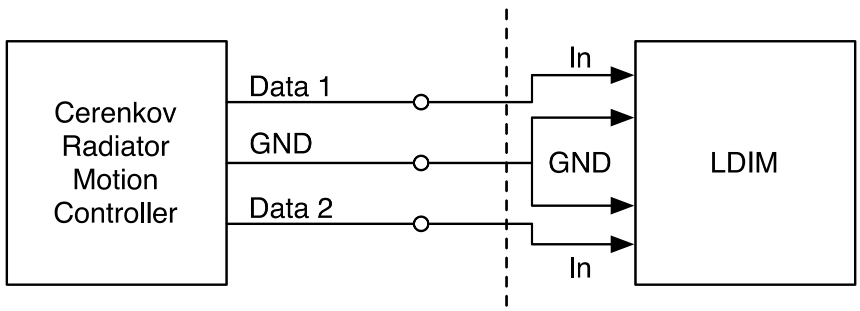

Figure 7.1. Wiring Diagram for Cerenkov Radiator to MPS

Section 8 BL11 Mirror

The BL11 Mirror provides its limit switch status to the MPS as two LDIM signals. One LDIM signal is given for the Out limit switch, and another LDIM signal is given for the In limit switch.

8.1 Input Signals

Table 8.1. BL11 Mirror Limit Switch Signals

Signal	Format	State 1	State 2	State 3	State 4
BL11 Position	Two LDIM Signals	Out	In	Moving	Broken

Table 8.2. BL11 Mirror States

Data 2	Data 1	State
0	0	Moving
0	1	In
1	0	Out
1	1	Broken

8.2 Wiring

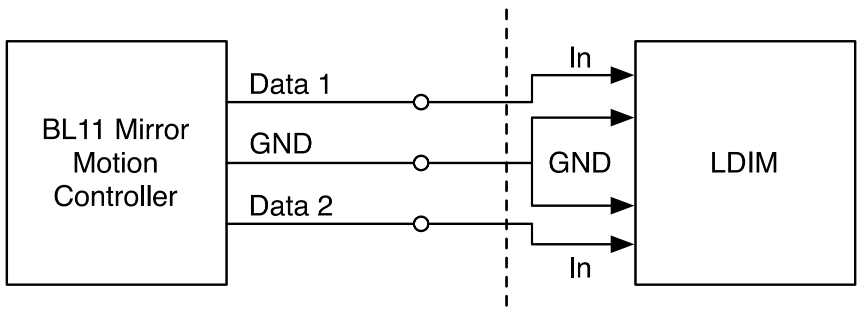

Figure 8.1. Wiring Diagram of BL11 Mirror to MPS

Section 9 Joule Meter

The Joule Meter provides its status as a single LDIM signal to the MPS.

9.1 Input Signals

Table 9.1. Joule Meter Signal

Signal	Format	State 1	State 2
Joule Meter	LDIM Signal	OK	Fault

Table 9.2. Joule Meter States

Input	State
0	Fault
1	OK

9.2 Wiring

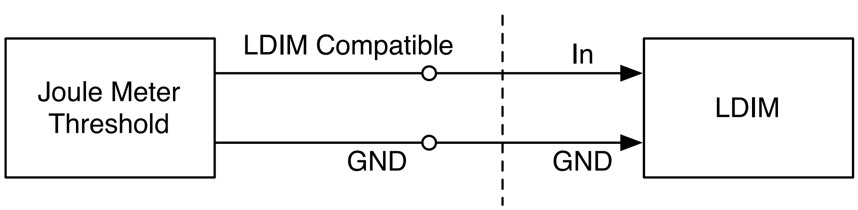

Figure 9.1. Wiring Diagram of Joule Meter to MPS

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Section 10 Flow Switch

The flow switch from TD11 has a single signal giving the water's flow status as an LDIM compatible signal.

10.1 Input Signals

Table 10.1. Flow Meter Signals

Signal	Format	State 1	State 2
TD11	LDIM Signal	OK	Fault

Table 10.2. Flow Meter States

Input	State
0	Fault
1	OK

10.2 Wiring

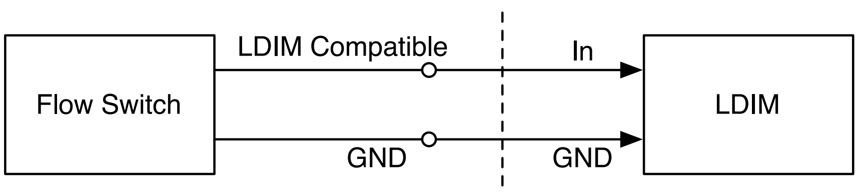

Figure 10.1. Wiring Diagram for Flow Switches to MPS

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Section 11 Toroid

The only toroid that provides a fault signal without comparison to another toroid is IM01. Its electronics give the MPS an LDIM fault signal. 0V and 24V are used for logic 0 and logic 1 respectively.

11.1 Input Signals

Table 11.1. Toroids

Signal	Format	State 1	State 2
IM01	LDIM Signal	OK	Passed Threshold 1

Table 11.2. Toroid Signals

Toroid Signal	State
0	Passed Threshold 1/Fault
1	OK

11.2 Wiring

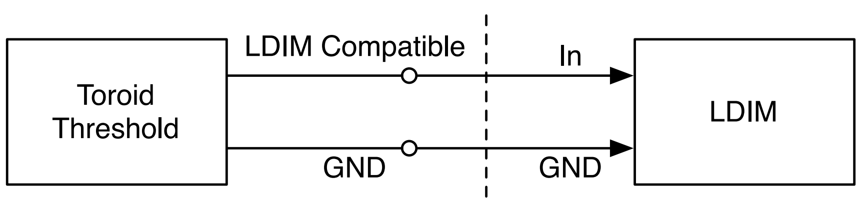

Figure 11.1. Wiring Diagram for Toroid Threshold to MPS

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Section 12 Toroid Comparator

The toroid comparator electronics give two LDIM signals each to the MPS to supply the beam loss information. 0V and 24V are used for logic 0 and logic 1 respectively.

12.1 Input Signals

Table 12.1. Toroid Comparators

Toroids	Format	State 1	State 2	State 3	State 4
IM02/IM03	Two LDIM Signals	OK	>Threshold 1	>Threshold 2	Invalid
IM02/IMS1	Two LDIM Signals	OK	>Threshold 1	>Threshold 2	Invalid
IMBC1I/IMBC1O	Two LDIM Signals	OK	>Threshold 1	>Threshold 2	Invalid

Table 12.2. Toroid Comparator Signals

Data 2	Data 1	State
0	0	Invalid/Fault
0	1	>Threshold 1
1	0	>Threshold 2
1	1	OK

12.2 Wiring

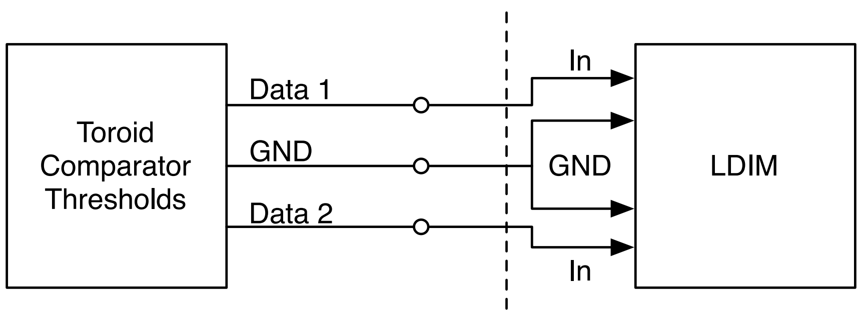

Figure 12.1. Wiring Diagram for Toroid Comparator Thresholds to MPS

Section 13 Magnets

Magnet signals originate from EPICS PVs and are converted to LDIM signals for the MPS by an IOC. The IOC generates a heartbeat signal. The heartbeat signal is high while the IOC is operating correctly and goes low when the IOC has a critical error.

13.1 Input Signals

Table 13.1. Magnet Signals

Signal	Format	State 1	State 2
BXG	LDIM Signal	OK	Fault
BX01	LDIM Signal	OK	Fault
BX02	LDIM Signal	OK	Fault
BXS	LDIM Signal	OK	Fault
BX11 to BX14	LDIM Signal	OK	Fault
IOC Heartbeat	LDIM Signal	OK	Fault

Table 13.2. Magnet States

Input	State
0	Fault
1	OK

13.2 Wiring

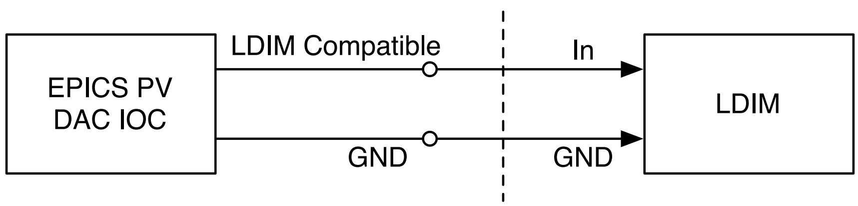

Figure 13.1. Wiring Diagram for Magnet's EPICS PV to LDIM IOC to MPS

Section 14 Tune-up Dump

The TD11 Tune-up Dump provides its limit switch status to the MPS as two LDIM signals. One LDIM signal is given for the Out limit switch, and another LDIM signal is given for the In limit switch.

14.1 Input Signals

Table 14.1. Tune-up Dump Limit Switch Signals

Signal	Format	State 1	State 2	State 3	State 4
TD11 Position	Two LDIM Signals	Out	In	Moving	Broken

Table 14.2. Tune-up Dump States

Data 2	Data 1	State
0	0	Moving
0	1	In
1	0	Out
1	1	Broken

14.2 Wiring

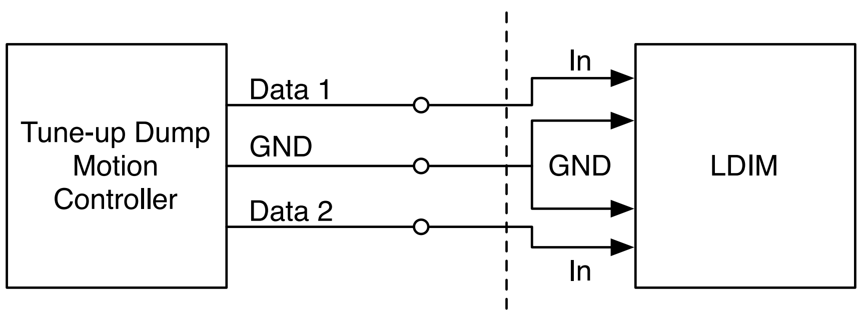

Figure 14.1. Wiring Diagram of Tune-up Dump Limit Switches to MPS

Section 15 Backward Beam Stopper

The Backward Beam Stopper, RST1, has a single limit switch providing the mirror's "out" status as an LDIM signal.

15.1 Input Signals

Table 15.1. Backward Beam Stopper Signal

Signal	Format	State 1	State 2
RST1	LDIM Signal	Out	Not Out

Table 15.2. Backward Beam Stopper States

Input	State
0	Not Out
1	Out

15.2 Wiring

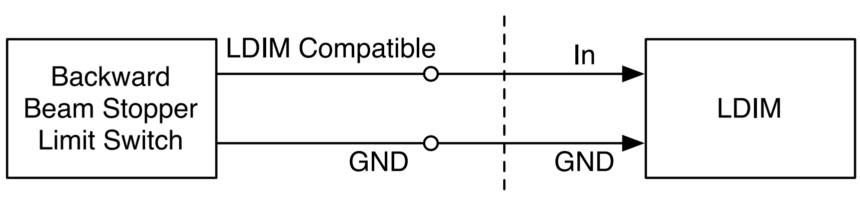

Figure 15.1. Wiring Diagram for Backward Beam Stopper Limit Switch to MPS

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Section 16 Event Generator

An Event Generator (EVG) Watchdog will provide the fault status of the EVG to the MPS as an LDIM signal.

16.1 Input Signals

Table 16.1. Event Generator Watchdog Signal

Signal	Format	State 1	State 2
EVG Watchdog	LDIM Signal	OK	Fault

Table 16.2. Event Generator Watchdog States

Input	State
0	Fault
1	OK

16.2 Wiring

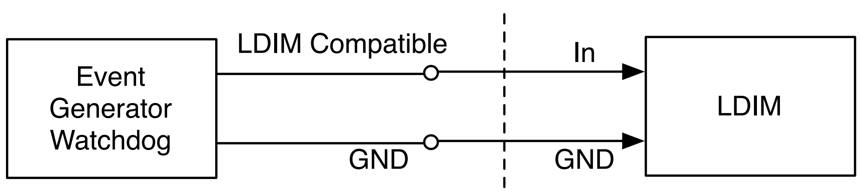

Figure 16.1. Wiring Diagram of Event Generator's Watchdog to MPS

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Section 17 Tone Interrupt (TIU) Summary

A summary of Tone Interrupt Units' (TIU) signals from sector 21 to MCC will be given to the MPS as a single LDIM signal.

17.1 Input Signals

Table 17.1. TIU Summary Signals

Signal	Format	State 1	State 2
TIU Summary	LDIM Signal	OK	Fault

Table 17.2. TIU Summary States

Input	State
0	Fault
1	OK

17.2 Wiring

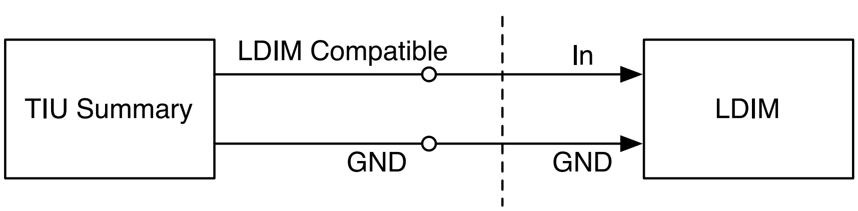

Figure 17.1. Wiring Diagram for TIU Summary Signal to MPS

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Section 18 Protection Ion Chambers

Protection Ion Chamber (PIC) signals are fed through a Protection Ion Chamber Processor (PICP), also known as a PIC Module, to make the data available to the MPS. The PICP is connected to the MPS via a 1553 Transceiver VME Module.

18.1 Input Signals

Table 18.1. Protection Ion Chamber Signals

PIC	Format	State 1	State 2	State 3	State 4
Near BX01	PIC Signal	Out	Level 1	Level 2	Level 3
Near BX02	PIC Signal	Out	Level 1	Level 2	Level 3
Near BXS	PIC Signal	Out	Level 1	Level 2	Level 3
Near Linac-X	PIC Signal	Out	Level 1	Level 2	Level 3
Near BC12	PIC Signal	Out	Level 1	Level 2	Level 3
Near BC13	PIC Signal	Out	Level 1	Level 2	Level 3

18.2 Wiring

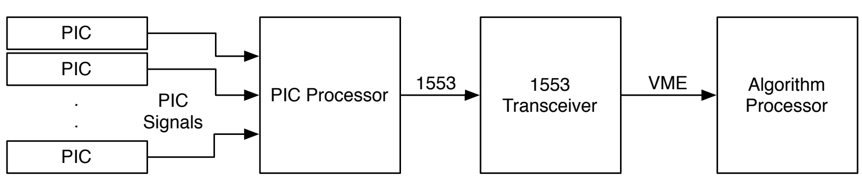

Figure 18.1. Wiring Diagram of PICs to MPS

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Section 19 Panofsky Long Ion Chamber

Panofsky Long Ion Chamber (PIC) signals are fed through a Protection Ion Chamber Processor (PICP), also known as a PIC Module, to make the data available to the MPS. The PICP is connected to the MPS via a 1553 Transceiver VME Module.

19.1 Input Signals

Table 19.1. Panofsky Long Ion Chamber Signals

PIC	Format	State 1	State 2	State 3	State 4
Injector PLIC 1	PLIC Signal	Out	Level 1	Level 2	Level 3
Injector PLIC 2	PLIC Signal	Out	Level 1	Level 2	Level 3

19.2 Wiring

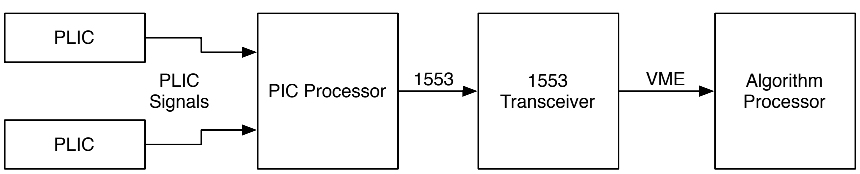

Figure 19.1. Wiring Diagram of PLICs to MPS

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Section 20 Linac PLIC

The linac PLIC hardware is already in place. The LCLS relevant signals are gated out and input to the MPS by...

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Section 21 Injector Mechanical Shutter

The Injector Mechanical Shutter provides its open/closed state to the MPS as an LDIM signal.

The MPS controls the Injector Mechanical Shutter with a TTL level output signal (0V and +5V for logic 0 and 1 respectively) triggered by events from the SLC MPG.

21.1 Input Signals

Table 21.1. Injector Mechanical Shutter Input Signal

Signal	Format	State 1	State 2
Shutter Open State	LDIM Signal	Open	Closed

Table 21.2. Injector Mechanical Shutter Input States

Input	State
0	Open
1	Closed

21.2 Output Signals

Table 21.3. Injector Mechanical Shutter Output Signal

Signal	Format	State 1	State 2
Shutter Control	TTL Output	Open	Close

Table 21.4. Injector Mechanical Shutter Output States

Output	State
0	Close
1	Open

21.3 Wiring

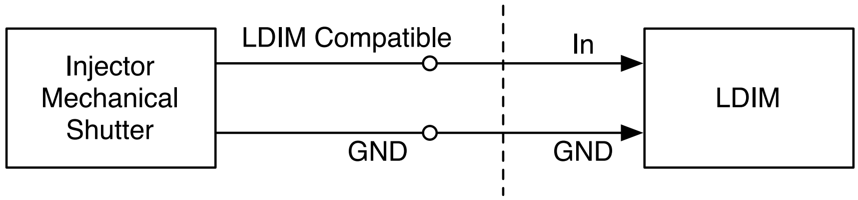

Figure 21.1. Wiring Diagram for Injector Mechanical Shutter Input Signal to MPS

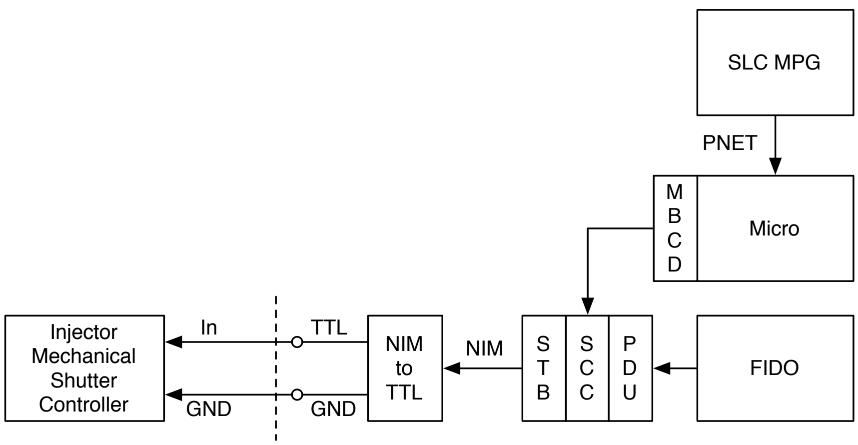

Figure 21.2. Wiring Diagram for MPS Injector Mechanical Shutter Control

Check the LCLS Project website to verify that this is the correct version prior to use.

Section 22 Pockels Cell

The Pockels Cell requires a TTL level trigger from the MPS to open. A TTL level output signal (0V and +5V for logic 0 and 1 respectively) is triggered by events from the SLC MPG.

22.1 Output Signals

Table 22.1. Pockels Cell Output Signal

Signal	Format	State 1	State 2
Pockels Cell Control	TTL Output	Open	Close

Table 22.2. Pockels Cell Output States

Output	State
0	Close
1	Open

22.2 Wiring

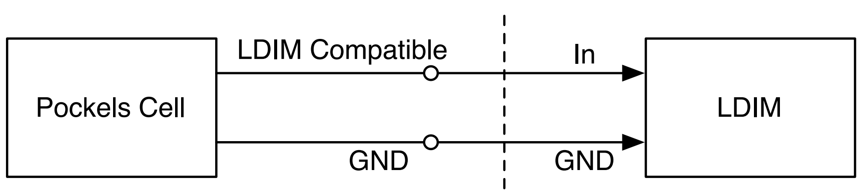

Figure 22.1. Wiring Diagram for MPS Pockels Cell Control