LCLS SXR Three Letter Acronym (TLA) Interface Control Document

**Document Approval** (signature/date)

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**Brief Summary**

This document describes the interface between the XES photon beam controls system and the general set of end stations which will be used on the SXR Instrument. It can be used as a template for any endstation needing integration to the SXR controls system.

**Table of Content**

1 Introduction 5

1.1 Scope 5

1.2 Areas of responsibility 5

2 SXR End Station Devices 6

2.1 Vacuum Systems 6

2.2 Motion Systems 8

2.3 Vision Systems 10

2.5 Misc Controls 12

***2.4*** ***VME - V976*** 13

2.6 DAQ Systems 13

3 Interface connction system (patch panel) 14

#  Introduction

This document defines the systems which are commonly used on the SXR End Stations. These systems have been developed by the Photon Controls and Data Systems group at LCLS. This list is general and thus not intended for one specific end station. End station builders can start from this document when writing the ICD (Interface Control Document) which is specific to their endstation. This will both prevent duplication, but also improve efficiency.

Because the end stations will change frequently it is important that standard interface point between the controls systems and the components is defined. Cables from the end stations may be patched to a nearby and easily accessible set of interface connetors on the south side of the end station area.

##  Scope

This document establishes the areas of responsibility for SXR Instrument and XES Photon Controls and defines the interface components. This includes all components for Vacuum, Motion, Vision, DAQ, and Power as well as interfaces to other services including MPS, networking, and timing systems.

Each of the endstations will develop its own ICD to controls and DAQ. Included in this document are a general suite of components which can accommodate for most of the needs of a typical end station. To differentiate between the SXR beamline (instrument) and the endstations the numbering of pumps, valves, gauges, motors, etc. will start over with the endstations.

##  Areas of responsibility

The end station builders are responsible for specifying their control needs and supplying and supporting all hardware which will not be used by other end stations or other collaborators. The SXR instrument scientist team is responsible for specifying all of the facility provided general components included in this document. The SXR instrument team is also responsible for defining the cabling between the end station and the interface connection system. The Photon Controls and Data Systems Group is responsible for all cabling from the Controls Interface Location connector to the controlling hardware (rack based), and is responsible for the acquisition and installation of all controls hardware. The Photon Controls Group will also design, purchase and install a patch panel system.



# SXR End Station Devices

The following list of components are provided in Hutch 2 for the user supplied end stations.

##  Vacuum Systems

SXR User end stations will operate in a variety of vacuum conditions. Users are often anticipated to provide their own vacuum components, but an effort will be made to ensure that backup systems are available. See the ([SXR Provided Capabilities (Hardware and Controls) (PUBLIC)](http://tinyurl.com/sxrcap)) document, which lists all of the available equipment.

**Vacuum Interlock (Preliminary)**

If users wish to read the status of or control gate valves, a panel of dry contacts controllable by EPICS process variables will be provided.

Opening the gate valve between the end station and the beamline vacuum requires that the following conditions be met.

1. A closed contact provided by the user indicating proper pump speeds, pressure set points and valve states are present. The contact must open once any of these conditions (which are specified in the vacuum guidelines) are no longer met.
2. Unless they are overridden by a hardware toggle, one or two of the cold cathode gauges must be connected to the chamber and reading a vacuum level below the pressure set point.

Eight channels have a dry contact output with a low voltage that is returned to the input. If the voltage is returned the channel reports a logical 1. All of the channels have a logical and relationship such that all must be closed for the valve to open and the MPS to report okay. The channels can be included or excluded by a hardware toggle switch at the contacts. To exclude the channel the toggle shorts the contacts. The cold cathode gauges can be implemented in the same way. An EPICS PV for the state (open, closed) and case (included, excluded) would be nice, but is not a priority and should not interfere with the hardware implementation.

**Patch Cable Note**: All of these components should interface to the end stations at the patch panel.

The controlled components of the vacuum system are listed in Table 2.2.1.

 **Table 2.2.1: Vacuum System Devices**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Device** | **EPICS Name** | **Purchaser**  | **Manufacture** | **Model Number** | **Connector Type** | **Functional Description** |
| Isolation Valve | SXR-EXP-VGC-01 | User |  |  |  |  |
| Cold Cathode Gauge 1 | SXR-EXP-GCC-01 | SXR Ops | MKS  | Series 422 | 5kV SHV+BNC | 2.75 CF flange. To be on a fast response card |
| Pirani Gauge 1 | SXR-EXP-GPI-01 | SXR Ops | MKS  | Series 317 | DB9 | Mounted with SXR-EXP-GCC-01 to interlock the Cold Cathode HV at high pressure. Part of MPS when toggled.  |
| Cold Cathode Gauge 2 | SXR-EXP-GCC-02 | SXR Ops | MKS | Series 422 | 5kV SHV+BNC | 2.75 CF flange. To be on a fast response card |
| Pirani Gauge 2 | SXR-EXP-GPI-02 | SXR Ops | MKS | Series 317 | DB9 | Mounted with SXR-EXP-GCC-02 to interlock the Cold Cathode HV at high pressure. Part of MPS when toggled. |
| Cold Cathode Gauge 3 | SXR-EXP-GCC-03 | SXR Ops | MKS | Series 422 | 5kV SHV+BNC | 2.75 CF flange. To be on a fast response card |
| Pirani Gauge 3 | SXR-EXP-GPI-03 | SXR Ops | MKS | Series 317 | DB9 | Mounted with SXR-EXP-GCC-03 to interlock the Cold Cathode HV at high pressure. Part of MPS when toggled. |
| Foreline Thermocouple Gauge 1 | SXR-EXP-GTC-01 | SXR Ops | ??? |  | DB9 |  |
| Foreline Thermocouple Gauge 2 | SXR-EXP-GTC-02 | SXR Ops | ??? |  | DB9 |  |
| Vacuum interlock points 8 channels (see description above)  |  | PCDS | SLAC |  |  | Low voltage DC on dry contacts where users closed connection indicates vacuum system is ready. Open contact closes isolation valve with MPS. This can be triggered with the toggle selected Cold Cathode Gauges.  |
| Varian Turbo Pump | SXR-EXP-PTM-01-03 | SXR | Varian |  |  | These will be spares for the user systems.  |

**Table 2.2.2: Vacuum System Controllers**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Device** | **EPICS Name** | **Purchaser**  | **Manufacture** | **Model Number** | **Connector Type** | **Functional Description** |
| Ion Pump Controller 1 | SXR-EXP-PCI-01 | PCDS | Gamma Vacuum  | Digital Mutli-Pump Controller | 10kV SHV | Pumps provided by users with 10kV Star Cell Connector. Patch panel should have standard 10kV connector and extra star cell to 10kV patch cables should be made.  |
| Gate Valve Controller PLC (8 channels) | SXR-EXP-VGC-0X | PCDS | SLAC |  |  | 8 Channels to Read Status and Actuate user gate valves with EPICS PV. Not part of M PS. Valve status can report for MPS in the toggle switch logic system below.  |
| Turbo Pump Controller |  | SXR Ops | Varian | V81 |  |  |
| Terminal Server 16 Serial Channels |  | PCDS | Digi |  |  |  |

##  Motion Systems

The perfered motion system is the IMS SmartMotors, but “dumb” stepper motors can be accommodated. Contact the instrument staff for a detailed description of the IMS motor integration. Some facility provided manipulators will be motorized and can be changed between end stations. A manipulator will have up to six motors which will have a cable bundle containing the power supply and signal cables. These cables will run to a patch panel. The connector type at the patch panel will be RJ45 for signal and PHX for power. A red LED will be mounted on the panel which will indicate when the power supply is on and thus that cables should not disconnected or connected.

The controlled components of the motion systems are listed in Table 2.3.1.

**Patch Cable note:** The signal and power cables will be bundled. Once side will connect to the mezenine board and the other will connect to the patch panel with RJ45 and a PHX connector.

**Table 2.3.1: Motion System Devices**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Device**  | **EPICS Name** | **Purchaser** | **Manufacture** | **Model Number** | **Connector Type**  | **Functional Description** |
| Chamber Positioning | SXR-EXP-MMS-01 | SXR Opts | IMS |  | Sigmal: RJ45 power: PHX |  |
| Chamber Positioning | SXR-EXP-MMS-02 | SXR Opts | IMS |  | Sigmal: RJ45 power: PHX |  |
| Chamber Positioning | SXR-EXP-MMS-03 | SXR Opts | IMS |  | Sigmal: RJ45 power: PHX |  |
| Chamber Positioning | SXR-EXP-MMS-04 | SXR Opts | IMS |  | Sigmal: RJ45 power: PHX |  |
| Chamber Positioning | SXR-EXP-MMS-05 | SXR Opts | IMS |  | Sigmal: RJ45 power: PHX |  |
| Chamber Positioning | SXR-EXP-MMS-06 | SXR Opts | IMS |  | Sigmal: RJ45 power: PHX |  |
| Manipulator 1 motors  | SXR-EXP-MMS-07 | SXR Opts | IMS |  | Sigmal: RJ45 power: PHX |  |
| Manipulator 1 motors  | SXR-EXP-MMS-08 | SXR Opts | IMS |  | Sigmal: RJ45 power: PHX |  |
| Manipulator 1 motors | SXR-EXP-MMS-09 | SXR Opts | IMS |  | Sigmal: RJ45 power: PHX |  |
| Manipulator 2 motors | SXR-EXP-MMS-10 | SXR Opts | IMS |  | Sigmal: RJ45 power: PHX |  |
| Manipulator 2 motors | SXR-EXP-MMS-11 | SXR Opts | IMS |  | Sigmal: RJ45 power: PHX |  |
| Manipulator 2 motors | SXR-EXP-MSS-12 | SXR Opts | IMS |  | Sigmal: RJ45 power: PHX |  |
| Manipulator 3 motors | SXR-EXP-MSS-13 | SXR Opts | IMS |  | Sigmal: RJ45 power: PHX |  |
| Manipulator 3 motors | SXR-EXP-MSS-14 | SXR Opts | IMS |  | Sigmal: RJ45 power: PHX |  |
| Manipulator 3 motors | SXR-EXP-MSS-15 | SXR Opts | IMS |  | Sigmal: RJ45 power: PHX |  |
| Backup motor | SXR-EXP-MSS-16 | SXR Opts | IMS |  | Sigmal: RJ45 power: PHX |  |
|  |  |  |  |  |  |  |

**Table 2.3.2: Motion System Controllers**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Device** | **EPICS Name** | **Budget** | **Purchaser** | **Manufacture** | **Model Number** | **Connector Type**  | **Functional Description** |
| Power Supply (16 channels) |  | SXR Opts  | PCDS | SLAC |  | PHX |  |
| Terminal Server (16 Channels) |  | SXR Opts  | PCDS | Digi |  | RJ45 |  |

##  Vision Systems

The Ademic Opal 1000 cameras are used for full frame rate data acquisition on the end station. The Uniq camera and Gigi camera will primarily be used for monitoring sample positions and thus do not need shot to shot readout. Finally, the web cameras serve two purposes. One will be to provide surveillance of the hutch and thus should be permanently mounted with motorized position and lens. The second application for the web cams will be to monitor specific end station components. For example they may look at bellows while moving a chamber. They may also provide a status of a component which is not integrated to the control interface, but needs to communicate to the operator. For example, a pump with an LED message screen. Finally all of these systems should be integrated at the patch panel with the appropriate connectors.

**Patch note**: A standard camera bundled cable will be used for all DAQ and controls cameras. This will include: signal over fiber with a LC Duplex connector on both sides, power with use PHX5 on both sides, trigger will use Lemo on both sides and the LED illuminator will connect with PHX2 to the patch panel and BNC or PHX2 at the LED for the camera. The web cams will run with power of Ethernet and will also include a power cable for the LED with a PHX2 connector.

**Table 2.4.1: Vision System Devices**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Device** | **EPICS Name** | **Purchaser** | **Manufacture** | **Model Number** | **Connector Type** | **Functional Description** |
| Endstation Sample Position, Data Camera, Opal or Pulnix | SXR-EXP-CVD-01  | SXR PO# | Opal | Opal 1000 MQ | Sig: LC DuplexPower:PHX5Trig: LemoLED: PHX2 | Second DAQ camera which can be mounted to any end station. Triggerable.  |
| Endstation Sample Position, Data Camera, Opal or Pulnix | SXR-EXP-CVD-02  | SXR  | Opal | Opal 1000 MQ | Sig: LC DuplexPower:PHX5Trig: LemoLED: PHX2 | Second DAQ camera which can be mounted to any end station. Triggerable.  |
| End Station Monitor Camera 2 | SXR-EXP-CVV-02 | SXR  | Uniq | UP-900CL -12B | Sig: LC DuplexPower:PHX5Trig: LemoLED: PHX2 | Can be mounted anywhere on end station. To be used to look at sample and other internal equipment. TriggerableLED illumination channel |
| End Station Monitor Camera 3 | SXR-EXP-CVV-03 | SXR  | Uniq | UP-900CL -12B | Sig: LC DuplexPower:PHX5Trig: LemoLED: PHX2 | Can be mounted anywhere on end station. To be used to look at sample and other internal equipment. TriggerableLED illumination channel |
| End Station Monitor Camera 4 | SXR-EXP-CVV-04 | SXR  | Uniq | UP-900CL -12B | Sig: LC DuplexPower:PHX5Trig: LemoLED: PHX2 | Can be mounted anywhere on end station. To be used to look at sample and other internal equipment. TriggerableLED illumination channel |
| End Station Monitor Camera 5  | SXR-EXP-CVV-05 | SXR  | Uniq | UP-900CL -12B | Sig: LC DuplexPower:PHX5Trig: LemoLED: PHX2 | Can be mounted anywhere on end station. To be used to look at sample and other internal equipment. TriggerableLED illumination channel |
| End Station Webcam | SXR-EXP-CWB-02 | SXR  | Axis | Axis 210A | RJ45 PoELED: PHX2 | Should be mountable anywhere on the end station |
| End Station Webcam | SXR-EXP-CWB-03 | SXR  | Axis | Axis 210A | RJ45 PoELED: PHX2 | Should be mountable anywhere on the end station |
| End Station Webcam | SXR-EXP-CWB-04 | SXR  | Axis | Axis 210A | RJ45 PoELED: PHX2 | Should be mountable anywhere on the end station |
| Hutch Webcam | SXR-WAL-CWB-01 | PCDS | Axis | Axis 213 PTZ | RJ45 Power: | To be mounted overhead on gimble and used for surveillance. Use magnetic mount for relocation on cable trays.  |
| Hutch Webcam | SXR-WAL-CWB-02 | PCDS | Axis | Axis 213 PTZ | RJ45 Power: | To be mounted overhead on gimble and used for surveillance. Use magnetic mount for relocation on cable trays. |
| Hutch Webcam | SXR-WAL-CWB-03 | PCDS | Axis | Axis 213 PTZ | RJ45 Power: | To be mounted overhead on gimble and used for surveillance. Use magnetic mount for relocation on cable trays. |
| Hutch Webcam | SXR-WAL-CWB-04 | PCDS | Axis | Axis 213 PTZ | RJ45 Power: | To be mounted overhead on gimble and used for surveillance. Use magnetic mount for relocation on cable trays. |

**Table 2.5.1: Misc System Devices**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Device** | **EPICS Name** | **Purchaser** | **Manufacture** | **Model Number** | **Connector Type** | **Functional Description** |
| Thermocouple Readout 8- Channel | SXR-EXP-STC-01-06 | PCDS | Beckhoff | EL3314 (Type K) | Type K | Thermocouple readout for users. Thermocouple sockets should be provided at patch panel such that users only need to connect standard K type thermocouple sensors into the system.  |
| Analog Signal Output8-channel | SXR-EXP-AOT-01 | PCDS | Beckhoff | +/- 10V with current less than 2mA | BNC | This may be used as a signal generator, but also to manipulate the states of other components.  |
| Triggering Module 4 channels | SXR-EXP-CCC-01 | PCDS | SLAC | TTL over 50 Ohm coaxial | BNC | This should be in close proximity to the chamber. Signals may be directly coupled to delay generator boxes. |
| Delay Generator (2 boxes and 4 boxes funding permitted) | SXR-EXP-CCC-01 -04 | PCDS | SRS | DG645 | BNC | These boxes are used to generate arbitrary delay for trigger signals. IS there a driver for them yet? They would also need an input (maybe two) and an output)  |
| 0-24V DC Power Supply (8 channels) | SXR-EXP-SLV-01-08 | PCDS |  | Constant Current up to 1AConstant Voltage up to 20V | PHX  |  |
| 0-250V DC Power Supply (8 channels) | SXR-EXP-PSV-01 - 08  | PCDS | iSeg | 4005 P | 5kV SHV | For biasing diodes and MCPS |
| 5kV Power Supply 4 Channel  | SXR-EXP-PSV-09 - 12 | PCDS | iSeg | 4050 P | 5kV SHV |  |
| +2kV Power Supply 4 Channels | SXR-EXP- PSV-13 - 16 | PCDS | iSeg | 4020 P | 5kV SHV |  |
| - 2kV Power Supply 4 Channels | SXR-EXP- PSV-17 - 21 | PCDS | iSeg | 4020 N | 5kV SHV |  |
| High Current bi –poler operational amplifying power supply  | SXR-EXP-CCC- | SXR Opts | Kepco | BOP 50-8ML | No patch | This is for driving magnets. It is an opAmp so it can be driven the signal generator. EPICs control integration should be discussed.  |
| Temperature Controller  | SXR-EXP-CCC- | SXR Opts | Lakeshore | 331 | No patch | A driver will be need |
| Fiber Trunk for USB + Firewire expansion | SXR-EXP-CCC- | PCDS | S.I Tech | 21722563 | Fiber at patch panel  | This will patch from fiber at the patch panel to the control room. The modulator/demodulator boxes will be connected via fiber patch to keep the USB/Firewire cable runs as short as possible on both the experiment and in the control room.  |

## DAQ Systems

**Patch Note:** The Aquiris system has SMA connectors. At the patch panel type-N connectors are used typically in conjunction with a N-SMA adaptor. Heliax cable with a 3-dB cutoff at 20GHz is run between the Acqiris and the patch panel.

**Table 2.6.1: DAQ System Devices**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Device** | **EPICS Name** | **Purchaser** | **Manufacture** | **Model Number** | **Connector Type** | **Functional Description** |
| Fast Digitizer 1 | SXR-EXP-AIN-01 | PCDS | Acqiris | DC282 | SMA  | 2 GHz digitizer to connect to any fast detector (SMA) on the chamber. Single channel to be read a full speed. Also leave slots open for expansion. |
| Fast Digitizer 2 | SXR-EXP-AIN-02 | PCDS | Acqiris | DC282 | SMA | 2 GHz digitizer to connect to any fast detector (SMA) on the chamber. Single channel to be read a full speed. Also leave slots open for expansion. |
| Fast Digitizer 3 (funds permitted)  | SXR-EXP-AIN-03 | PCDS | Acqiris | DC282 | SMA | 2 GHz digitizer to connect to any fast detector (SMA) on the chamber. Single channel to be read a full speed. Also leave slots open for expansion. |
| Fast Digitizer 4 (funds permitted)  | SXR-EXP-AIN-04 | PCDS | Acqiris | DC282 | SMA | 2 GHz digitizer to connect to any fast detector (SMA) on the chamber. Single channel to be read a full speed. Also leave slots open for expansion. |
| Digital Real Time Scope | SXR-EXP-CCC-01 | Schlotter | LeCroy | Waverunner 13 | SMA  | The scope is not in the DAQ  |
| A/D shot rate 8 channel | SXR-EXP-AIN-03 | PCDS | Beckoff |  | BNC | This is for various user supplied signals. Should be in rack with easy access for users It only needed to sample one single voltage on each channel per event. Traces will be handled with the ACQIRIS |
| IPIMB (1-8 channels) | SXR-EXP-IPM-08🡪 -16 | PCDS | SLAC |  |  | These are for reading out fast user signals such as diodes. They should be close to end station. |
|  |  |  |  |  |  |  |

# Interface connction system (patch panel)

Rapid experimental changeover is important for SXR. To best leverage the commen equipment used by of the end stations and augment the efficiency a standard interface system is provided. Two identical interface conection systems are located in the NEH setup lab and in the NEH Hutch #2. The setup lab hosts a rack with control systems similar to Hutch #2. Each end station can be setup in the setup room before moving to the hutch. By having identical interface connection systems the cables can be trunked and organized to minimize the risk of misconnecting or damaging cables and connectors. This will also improve the speed and ease of installing the experiment in the hutch.

**Modular**: The patch panels will be 19 inches wide and two rack units tall. They will be mounted slightly above the floor between aluminum profile beams. This allows for a sparse cable density. Additionally the cables can be easily protected by placing a protective cover over the cabling which can be stepped on and used to provide better access to the experimental chamber.

**Change History Log**

|  |  |  |  |
| --- | --- | --- | --- |
| **Rev Number** | **Revision Date** | **Sections Affected** | **Description of Change** |
| 000 | 10/19/2009 | All | DRAFT 1 Version |
| 000 | 12/03/2009 | All | DRAFT 4 Version |
| 000 N | 12/08/2009 | All | DRAFT 7Version |
| 000 | 1/26/2010 | All | DRAFT 8 Now with Document Control Number |
| 000 | 5/28/2012 | All | DRAFT 9 Includes text for adaptation to other end station systems.  |
| 000 | 6/24/2012 | All | Reformated. Updated text for most sections.  |