LCLS Control System -- VME Crate Specification

Rev 1.2

0. Introduction:
This document outlines the overall requirements for a VMEbus Crate (also known as a subrack) for the LCLS Control System. The LCLS control system backbone is based on VMEbus and implements many mission-critical subsystems including Beam Controls (LLRF, Magnets), Diagnostics (BPMs, Toroids, OTR/YAG, etc.) and Protection (MPS, BCS) systems. The continued function and well-being of the LCLS machine is dependent upon the its control system, which in turn, is dependent upon its individual components. -- with one of these being the VME crates.

This specification defines the requirements for VME crates destined to be installed into the *production* LCLS machine environment.

A VME crate purchased from a vendor must satisfy, at the minimum, the requirements set forth in this document. Any deviations from the requirements set forth here must be approved, prior to placing an order.

1.0 Features:
The VME crate shall have, as a minimum, the following features:

1.1 Provide a system for the insertion of VME modules and their associated cabling as well as support for Power, Communication, Cooling and Diagnostics.

1.2 Support the VME protocol for module intercommunication.

1.3 Provide a sturdy mechanical enclosure for stability and protection of the installed VME modules.

1.4 Contain a mechanism for the remote monitoring of temperature and power supply levels.

1.5 Design for serviceability of DC power supply and cooling subsystem components.

1.6 Accept standard 6U x 160mm form-factor VME modules.

1.7 Contain a maximum of 21 slots or a specified subset (e.g. 8, 4, 2, etc.), depending upon our requirements.

2.0 Backplane:
The backplane shall support the VME64X Specification as outlined in VITA 1-1994 and VITA 1.1-1997 Specifications. This shall include the 5-Row PI & P2 connectors as well as the P0 connector. The backplane shall support automatic IACK* and Data Transfer Arbitration Bus (BGxIN* & BGxOUT*) daisy-chaining. The backplane shall accommodate Rear Transition Module interconnect via the P2 and P0 connectors. The user-defined I/O pins on these connectors should be left as uncommitted and have a connection between the front and back connectors of a given slot.

<u>2.1 Protocols</u>:
The VME-64X backplane shall support the following protocols:

- VME-32
- VME-64
- VME-64x

- 2eVME-SST
- MBLT
- MD32

Additional protocols are not required at this time. However, it is allowable to have a backplane that supports additional protocols as long as compatibility with the above-listed protocols is maintained.

3.0 Remote Monitoring and Control:

The Crate shall provide the capability, at the minimum, to remotely monitor (via ethernet) the crate's power supply voltages and currents as well as the temperature(s) of the crate. The controller shall provide the capability of remotely power cycling the crate as well as issuing VME SYSRESET*.

The ethernet interface shall communicate using (TCP, UDP or SNMP) protocol. It is advantageous to provide driver source code to SLAC to facilitate the development of our own custom software (EPICS) to integrate the crate controls within our control system.

4.0 Mechanical Specifications:

4.1 Overall Crate Mechanical

The VME Crate shall conform to the mechanical standards set forth in IEEE Specifications 1101.1 & 1101.10 for compatibility; as well as VITA 1-1994. In addition, the crate shall be mechanically sound, providing ease in rack installation and serviceability. VME Module installation/extraction shall be consistent mechanically across all slots of the crate. Provision shall be made to accept standard as well as 1101.10 module ejector handles and module keying. The front slots shall accept standard B-size 160mm, 6U VME modules. Slot orientation: for crates with 8, 7, 4, 2, etc. slots, it is preferred that the VME modules mount in a horizontal orientation; this is to save rack space. The 21 slot unit is expected to have all of its VME modules mount vertically.

4.2 Rear Transition Modules

The VME crate shall support 6U 80mm rear transition modules across all slots including slot 0. The mechanical specifications shall conform to IEEE Specifications 1101.10 & 1101.11. Provision shall be made to accept standard as well as 1101.10 module ejector handles. Provision in the rear of the crate should be made to facilitate the routing of cables to and from the front panel connectors of the rear transition modules.

4.3 EMI Shielding

There is no stringent requirement for EMI Shielding. Therefore EMI shielding provided on a standard product from a typical VME crate vendor is acceptable. Any shielding above this is also acceptable, but not required. The crate should be able to accept modules with EMC gasket hardware.

4.4 Cooling

The crate shall provide adequate forced air cooling of the modules. At a minimum, the airflow should accommodate a minimum of 45 Watts per slot of power dissipation. The cooling system must include an air filter to prevent particles from the external environment from entering the crate. This air filter must be removable for ease of service. In addition, the crate fans should be designed for maintainability. That is, the fan assembly(s) should be easily removed and replaced. The maximum temperature rise from intake to exhaust for a fully-loaded crate should be 10 degrees Celsius.

5.0 Crate Power System

5.1 AC Power Source
The crates are power by AC line voltage: The AC power is 120V at 60Hz, with a standard US 3-wire (Hot, Neutral, GND) power receptacle.

5.2 DC Power
The crate shall provide the following voltages at the following current levels. Note that the currents are specified on a per slot basis. The total power required for a given crate is based on the number of slots plus a reasonable operating margin for headroom. Note that the currents specified below are the absolute maximum requirements.

Voltage Rail (Volts DC)	Current Per Slot (Amperes)
+5.0V	10.0A (max)
+3.3V	10.0A (max)
+12.0V	1.0A (max)
-12.0V	1.0A (max)

The power supply voltages and currents shall be reported to the remote monitoring and control system to allow supply health to be monitored remotely.

5.3 Power supply DC turn-on characteristics
The power supply must provide a monotonic ramp-up characteristic on all DC voltages, with minimal overshoot and undershoot when turned on. It is desirable, though not absolutely required, that the DC supply voltages reach their final values at the same time (sequenced) and within 10ms. This is to ensure that certain modules and components will power-up correctly.

5.4 Power Supply Ripple
The DC power supplied to each slot shall have a ripple content of less than 50 mV peak-to-peak at frequencies of less than 10MHz. This is consistent with the VME specification, and must be followed.

6.0 Serviceability:
It is desirable that the DC power system be modular in nature to facilitate fast and easy service. An added desire, though not absolutely necessary, is the provision for dual-redundant power supplies with hot-swap capability.

In addition, the cooling system components should be easily serviceable, with a minimum impact to system downtime during maintenance. Therefore the air filter should be easily replaceable and the cooling fan assembly should be easily serviceable (see section 11.1).

7.0 Reliability:
The Mean Time Between Failures for the DC power supply and cooling fans should be in excess of 60K Hours.

8.0 Protection:
The Crate shall provide protection from overvoltges, overcurrents and excessive temperatures in the following manner:

8.1 AC Protection
The input AC Voltage shall have an overcurrent protection device (fuse or circuit breaker). The power supply should have provision for AC surge protection in case of an overvoltage on the AC mains. Note that only the Hot or Line side of the AC input shall be fused or otherwise (circuit breaker) protected. The Neutral side shall NOT be fused.

8.2 DC Protection
The crate must provide overvoltage and overcurrent protection for all of the DC voltages. In the case of a DC fault, the power supply should shut down.

8.3 Over Temperature Protection
In the case of an overtemperature condition, defined nominally as being at or in excess of 50 degrees Celsius, the crate power supply should shut-off.

8.4 Stalled Cooling Fan Protection
In the case of a stalled fan, this condition should be reported by the remote monitor and the crate power supply should shut-off.

9.0 Front Panel:
The crate front panel shall provide at a minimum the following:

9.1 AC Power Switch (mounting on rear panel is acceptable)

9.2 Indicator Lights for all DC power supply voltages

10.0 Additional Features:
The following features are desired, but not required:

10.1 Front panel display showing supply voltage and current levels, fan speed, etc. Note that if provided, the DC voltage indicator light requirement can be waived.

10.2 Remote monitoring of fan speed

10.3 Dynamic adjustment of fan speed based on thermal load

11.0 Additional Notes:

11.1 Definition of “easily serviceable”:
This phrase should be taken to mean that the affected components should be designed in such a way that such components can be removed and replaced with a minimum amount of work. Both mechanically (removal of screws, mounting brackets & etc.) and electrically (e.g. the fan should have connectors for the power).

In addition, it is very preferable that the easily serviceable components (power supply, cooling fan assembly, air filter assembly) be modular in nature. Complimentary to this is that they should be replaceable in such a way that the crate does not have to be removed from the rack to service them.

12.0 Document Revision History:

Change History		
Version	**Date**	**Changes**
1.0	7-23-2007	- Original version
1.1	8-1-2007	- Added section 11.0
1.2	10-2-2007	- Updated section 8.1 & added 8.4