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LIGO CDS VME Mainframe Specification

Jay Heefner

Distribution of this draft:

California Institute of Technology
LIGO Project - MS 51-33
Pasadena CA 91125
Phone (818) 395-2129
Fax (818) 304-9834
E-mail: info@ligo.caltech.edu

Massachusetts Institute of Technology
LIGO Project - MS 20B-145
Cambridge, MA 01239
Phone (617) 253-4824
Fax (617) 253-7014
E-mail: info@ligo.mit.edu

WWW: http://www.ligo.caltech.edu/

1 INTRODUCTION

This specification establishes the performance, design, development and test requirements for the LIGO Control and Data System (CDS) VMEbus mainframe. This specification describes and defines additions to the VMEbus IEEE 1014 specification.

This specification cover the rules for a “B-size” VMEbus mainframe. The bus rules for modules are not included except where they effect the VME backplane, power supply, cooling and mechanical definitions for the VMEbus mainframe.

The principle tasks under this subcontract will include multiple efforts required to design, develop, fabricate, prepare drawings, manuals and test procedures for a VMEbus rack mount powered and ventilated mainframe. The contractor shall provide all personnel, equipment, facilities, materials and services necessary to deliver VMEbus rack mountable powered and ventilated mainframes.

Vendor supplied quotes shall include design documentation, parts lists, schematics, wiring diagrams and mechanical drawings. The documentation shall be sufficient to evaluate whether the requirements given in this specification have been satisfied.

1.1. Definitions

1. “B-size”: B-Size refers to a circuit board size of 160x233 mm (6.3”x9.2”). This term is used interchangeably with “double height” and “6U”.
2. “B-size Mainframe”: A rigid framework that provides mechanical support for modules inserted into the backplane, ensuring that the connectors mate properly and that adjacent modules do not contact each other. Air cooling is also guided through the system. Modules shall not disengage from the backplane due to vibration or shock. The mainframe also contains a power supply.
3. J1, J2, P1, P2: Naming convention which defines the backplane connection location (J1, J2) and connections to VME single wide double height modules (P1, P2).
4. PARD: Periodic and Random Deviation. The variation in current (voltage) which is the sum of the current (voltage) deviations cause by frequency variations, phase imbalance, transient spikes, hum, and noise with all other operational and environmental parameters held constant.
5. VME Backplane: A printed circuit board with two 96 pin connectors per slot (J1, J2) and signal paths that connect to corresponding connector pins. The circuit board is monolithic and provides power and ground to corresponding connector pins.

1.2. Acronyms

A - Ampere

CDS - Control and Data System

dBA - Decibels Absolute

Hz - Hertz

IEC - International Electrotechnical Commission

kV - kilovolt

LED - Light Emitting Diode

mA - milliampere

MTBF - Mean Time Between Failure

mm - millimeters

MTTR - Mean Time to Repair

RH - Relative Humidity

VAC - volts AC

VDC - volts DC

W - watts

2 APPLICABLE DOCUMENTS

The following documents form part of this specification to the extent specified herein. The issue in effect on the date of request or proposal shall be used. In the event of conflict between the documents referenced herein and the contents of this specification, the contents of this specification shall be considered a superseding requirement.

Copies of LIGO documents required by suppliers in conjunction with specified procurement functions should be obtained from the LIGO procurement office or as directed by the LIGO subcontracting officer. Procurement of all other military, federal government, and industrial governing documents are the responsibility of the supplier.

2.1. Non-LIGO Documents

6. IEEE STD 1014 VMEbus Specification
7. MIL-HDBK-217F Reliability Prediction for Electronic Equipment
8. VDE 871 Specifications for Far Field Radiated Emissions

2.2. Source of Documents

Any difficulty in obtaining the applicable documents should be referred to the LIGO Subcontract Manager. The documents may be obtained from the following:

2.2.1. Government Documents

Federal Handbooks

Superintendent of Documents

U.S. Government Printing Office

Washington, D.C. 20402

2.2.2. Industry and Society Documents

Copies can be obtained from the appropriate professional organization referenced. Reference copies of technical society and association documents are generally available from libraries.

2.2.3. LIGO Documents

California Institute of Technology

LIGO Project

51-33 Bridge Laboratory

Pasadena, CA 91125

Attn: Tina Lowenthal

3 REQUIREMENTS

3.1. VMEbus Mainframe Specifications

3.1.1. Power Monitor

The power monitor is a VMEbus function which shall assert the SYSRESET* line at power on and asserts both the ACFAIL* and SYSRESET* lines immediately prior to power removal. The VMEbus mainframe shall provide power monitoring.

The mainframe chassis shall have an externally accessible connector on the back of the mainframe which provides voltage levels for each supply, ACFAIL*, SYSRESET*, fan (cooling) status and remote On/Standby function.

The voltage outputs shall be protected against short circuits and remote On/Standby input shall be provided by isolated contacts.

3.1.2. P1 and P2 Electrical Specifications

All conductors on P1 and P2 shall meet the requirements of IEE 1014. P1 and P2 shall support VME64 as defined in IEEE, Rev. D.

3.1.3. ACFAIL*

The power supply shall have a monitor circuit which provides power up and power down timing for ACFAIL*

3.1.4. SYSRESET*

The power supply shall have a monitor circuit which provides power up and power down timing for SYSRESET*.

3.1.5. SYSFAIL*

The power supply shall have a monitor circuit which provides power up and power down timing for SYSFAIL.

3.2. Input Power Requirements

The power supply shall be designed to operate from a 120 volt single phase, 60 Hz source having the following characteristics:

Voltage: 120 VAC, +/- 10%

Frequency: 57 - 63 Hz

3.3. Input Power Switch

The input power switch shall be mounted on the front panel of the VMEbus mainframe. The front panel power switch shall incorporate a cover or other means of preventing accidental activation or deactivation. The input power connection shall be a IEC three conductor socket located on the rear of the mainframe. The input power shall include circuit breaker and line filters to attenuate noise interference.

3.4. Indicators

The VMEbus mainframe shall have (minimum) the indicators described in Table 1, “Indicator Lights”. The LED indicators shall be visible from the front. A green illumination shall indicate an active or “OK” condition. A red illumination shall indicate a fault condition. All LEDs shall be off when main power is off. A voltage fault condition shall be indicated when the voltage exceeds the range listed in Table 1, “Indicator Lights”.

Table 1: Indicator Lights

System Status	*Range*	*Indication*
120 VAC	120 VAC +/- 12 VAC	green = “OK”
+12 VDC	-360 mV/+600 mV	green = “OK” red = “fault”
12 VDC	-600 mV/ +360 mV	green = “OK” red = “fault”
+5 VDC	-125 mV/ +250 mV	green = “OK” red = “fault”
Fans/Cooling	Over Temp./Low Flow	green = “OK” red = “fault”

A cooling air flow fault condition shall be indicated when fan(s) failure(s) occur or the temperature exceeds the operating range listed in Table 3, “Environmental Performance Characteristics”.

3.5. Mainframe Power System

3.5.1. DC Voltage Specifications

The mainframe power supply shall comply with the maximum allowed variation and maximum allowed DC Load Ripple/Noise in Table 2, “VME mainframe Power Supply Specifications” up to the maximum rated current.

DC Load Ripple/Noise is the maximum Periodic and Random Deviation (PARD) generated by the power supply under all DC load conditions up to the mainframe peak current, measured as the peak to peak voltage in the DC to 10 MHz bandwidth.

Induced Ripple/Noise is the additional peak to peak ripple that may exist on the backplane power supply pins due to injected current from operational modules.

Table 2: VME mainframe Power Supply Specifications

Voltage	*Current Minimum*	*Description*	*Maximum Deviation*	*DC Load Ripple/Noise*	*Induced Ripple/Noise*
+5 V	100 A	+5 VDC	+250 mV/ -125 mV	50 mV p-p	50 mV p-p
+12 V	10 A	+12 VDC	+600 mV/ -360 mV	50 mV p-p	50 mV p-p
-12 V	10 A	-12 VDC	+360 mV/ -600 mV	50 mV p-p	50 mV p-p

3.5.2. Power Supplies

Power Supplies provide power to the modules and shall not be used to sink current other than transient current protection circuits.

3.5.3. Voltage/Current Marking

The mainframe shall be marked with the current ratings of all voltages listed in Table 2, “VME mainframe Power Supply Specifications”. The markings shall be located on the rear panel of the mainframe.

3.5.4. Power Supply Outputs - Remote Sense (Compensation)

The power supply shall be able to compensate for up to 250 mV total line drop. The power supplies shall include open lead protection.

3.5.5. Power Supply Stability

Stability of the power supply output voltages during any 8 hour period shall be 0.1%. Under constant loading conditions for 6 months the stability shall be better than 1%, over the temperature range specified in Table 3, “Environmental Performance Characteristics”.

3.5.6. Power Supply Transient Response

The power supply output voltage(s) shall return to within 1% of the nominal setting in less than 500 microseconds for a 50% load change. Peak transients shall not exceed 5% of required output voltage specified in section 3.5.1.

3.5.7. Power Supply Overload Protection

All power supply output voltages shall be protected against overload conditions. After the overload is removed, the power supply shall automatically recover.

3.5.8. Power Supply Overvoltage Protection

All power supply output voltages shall be protected from overvoltage fault conditions. Overvoltage trip level shall be set to 125% of nominal output voltage levels. If an overload condition is detected, the power supply shall turn off within 5 milliseconds.

3.5.9. Power Supply Thermal Protection

The power supply shall have thermal protection switches which shut off power supply outputs automatically after an over-temperature fault is detected. After a thermal overload condition, the power supply shall automatically recover when operating conditions return to within the range specified in section 3.5.1.

3.5.10. Power Supply Temperature Range

The mainframe power supplies shall operate continuously in ambient air per Table 3, “Environmental Performance Characteristics” at 100% rated load.

3.5.11. Power Supply Efficiency

The mainframe power supplies shall have a minimum 70% efficiency at 100% output load at 25 degrees C.

3.5.12. Power Supply Isolation

All power Supply outputs shall be internally isolated from ground with a minimum breakdown potential of 50 VDC.

3.5.13. Power Supply Cooling

If required, the power supply cooling fan(s) shall be wired separately from the mainframe cooling fans

3.5.14. Power Supply Reliability (MTBF)

MTBF shall be calculated using the MIL HDBK 217F as a guide. MTBF shall be 80,000 hours minimum. The MTBF calculation shall include air cooling system components and use the temperature specifications in section 3.10.1.

3.5.15. Backplane Termination Resistors

Backplane termination resistor networks shall be derated so the maximum power dissipation under worst case logic level conditions on all pins simultaneously does not exceed 50% of the manufacturer's rated package power dissipation.

3.5.16. Radiated Emissions

The mainframe shall comply with VDE 871 for radiated emissions.

3.6. Miscellaneous Electrical Construction Details

3.6.1. Wiring

For ease of servicing, all wires and terminals shall be clearly marked and shall correspond to those shown on the drawings and schematics. The 120 VAC mains wiring shall be kept separate from all other wiring.

Bolted bus power supply connections shall be tinned and shall not rely on threaded surfaces to carry current.

3.6.2. Power Supply Construction

The power supply shall be an interchangeable and easily removable subassembly on the rear of the mainframe to provide the maximum flexibility of use and a minimum of time loss for repair or replacement.

3.6.3. Indicator Lights

Indicator lights on the front of the mainframe shall be accessible and replaceable.

3.7. VME Backplane

3.7.1. Backplane Construction

Each backplane shall be of single monolithic board construction.

3.7.2. Split Backplane Option

The mainframe shall include an option for the backplane to be split into 2 separate 10 slot VME-bus backplanes. Each 10 slot backplane shall be independent, with the exception of common power supplies, and shall meet all other specifications outlined in this document. The split backplane option shall be implemented by replacing the nominal 20 slot backplane with two 10 slot backplanes.

3.7.3. Backplane Connectors

Forty (20 slots, two connectors each) backplane connectors shall be positioned as shown in Rule 7.37 of the VME specification.

3.7.4. J1 and J2 Connector Type

J1 and J2 connectors shall be female 96 pin 603-2-IEC Class 2 type connectors. In addition, the J2 connectors shall have male 96 pin locking shroud type connectors on the back side of the back-plane to mate with transition cables.

3.7.5. J1 Bus Interrupt Acknowledge Jumpering

The J1 bus shall have a provision for jumpering the interrupt acknowledge and bus grant daisy chains when boards are not installed into a slot. Jumpering shall be automatic when boards are removed from each slot.

3.7.6. Backplane Crosstalk

Crosstalk between any two signal traces on the VMEbus backplane shall be less than 6%. The measurement shall be performed with a signal generator which injects a square wave function with an amplitude of three volts (3 V) and rise and fall times a maximum of 1 nanosecond (10-90%). The pulse width shall be no greater than 10 nanoseconds. The induced voltage on any other signal trace shall be measured with an oscilloscope (300 MHz bandwidth).

3.7.7. Front Panel Chassis Ground

All mainframes shall provide chassis ground to the module front panels in the area of the front panel mounting screws.

3.8. Construction Details

3.8.1. Injector/Ejector Interface

The mainframes shall not interfere with VME “B-size” module injector/ejector systems.

3.8.2. Front Panel Module Slots

The mainframe front panel shall provide for 20 or 21 slots for VME modules. The slots shall provide screw receptacles to secure modules to the frame and top and bottom guide rails (card guides) installed in each slot.

3.8.3. Rear Transition Module Slots

The mainframe rear panel shall a minimum of 6 slots for VME transition modules.

3.8.4. Rear Transition Module Card Guides and Rails

The mainframe shall provide card guides and rails for each of the transition module slots.

3.8.5. Mainframe Dimensions

External dimension shall not exceed 14 inches high, by 26 deep. The depth measurement shall include all rear connectors and required cables.

3.8.6. Rack Mounting of Mainframe

The mainframe shall be designed to be mounted in a standard 19 inch rack. Mounting pieces shall be designed to support the weight of the mainframe and a full set of VME modules in the front and rear slots.

3.9. Cooling and Environmental

3.9.1. Cooling Air Supply

The mainframe shall provide adequate cooling to each slot to dissipate 55 watts.

3.9.2. Cooling Air Exhaust

The mainframe shall provide space for exhausted cooling air to exit each slot. The mainframes may provide for additional cooling air entry and exhaust in areas outside those specified.

3.9.3. Cooling Air Specifications

The mainframe shall be designed to operate continuously at full rated output power in the temperature environment specified in Table 3, “Environmental Performance Characteristics”.

3.10. Physical Characteristics

3.10.1. Environmental Conditions

3.10.1.1 Natural Environment

The mainframe may be used, transported in and exposed to uncontrolled conditions as described below.

3.10.1.1.1 *Temperature and Humidity*

Table 3: Environmental Performance Characteristics

Operating	***Non-operating (storage)***	***Transport***
+0 C to +50 C, 0-90%RH	-40 C to +70 C, 0-90% RH	-40 C to +70 C, 0-90% RH

3.10.1.1.2 Atmospheric Pressure

The mainframe design must accommodate atmospheric pressure change from a maximum of 15.2 psia to a minimum of 14.2 psia.

3.10.2. Acoustic Noise

The mainframe acoustic noise sound pressure level, independent of module loading, shall be less than 35 dBA measured at a distance of 1 meter. The 35 dBA shall be measured using an A-weighting network.