PIP-II DAQ/XRM First Article Acceptance Test Plan

Overview

This Acceptance Test Plan (ATP) is developed to validate the XRM device's compliance with the technical requirements specified in document ED0013500-V2. The test plan ensures that all specifications, functionality, and performance requirements are met before deployment in the PIP-II accelerator environment.

Objectives

1. Verify the XRM meets all physical, environmental, and electrical specifications.
2. Verify the XRM performs under the expected operational conditions.
3. Verify the XRM meets all functional and software requirements outlined.
4. Verify the XRM interfaces comply with the standards for connectivity and synchronization.
5. Assess the XRM documentation, usability, and solicit stakeholder feedback.

Resources Required

1. XRM, new in box from vendor, with complete documentation package.
2. Test computer with USB and network access.
3. Appropriate power and signal harness cabling.
4. Appropriate power and signal harness test circuitry.
5. Four or more function generator channels (Minimum 10MHz)
6. Four or more oscilloscope readback channels (Minimum 10MHz)
7. Vendor provided software suite.
8. Fermilab provided testing suite.
9. Surface for drop testing.
10. Environmental chamber for HALT testing.
11. (Optional) Externally validated compliance test report.

Acceptance Criteria

Each test category has specific pass/fail criteria detailed in the following sections. The XRM must meet or exceed all specified thresholds to pass.

Deliverables

1. Detailed test reports for each category
2. Issues log with resolutions
3. Final acceptance sign-off sheet
4. Base test procedure for all XRM's delivered

First Article Acceptance Test Procedure

1. Documentation Review
   1.1. Performance Agreement
      ☐ Has the Performance Agreement been reviewed and agreed upon by all parties?

   1.2. Vendor supplied documentation
      1.2.1. Reference the vendor supplied installation and maintenance procedure
         ☐ Does the procedure contain sufficient information for installation?
         ☐ Does the procedure contain relevant safety information?
         ☐ Does the documentation require any routine maintenance?
      1.2.2. Reference the vendor supplied user manual
         ☐ Does the manual contain sufficient information to log into the device?
         ☐ Does the manual contain an overview of all accessible PV's and settings?
         ☐ Does the manual contain an overview of the vendor supplied engineering page?
         ☐ Does the manual have comprehensive electrical specifications for all modules?

2. Physical, Environmental, and Electrical Compliance
   2.1. Environmental Verification (Part 1)
      2.1.1. With the XRM removed from packaging, drop the unit from a height of 80mm onto a wooden surface from all sides. Utilize blocking to ensure rack flanges are not struck.
         ☐ Is the XRM free from mechanical failures?
   2.2. Form Factor / Usability Verification
      2.2.1. If the order quantity was greater than ten, observe the XRM.
         ☐ Is the XRM blue?
         ☐ Are vendor and Fermilab markings clearly present?
      2.2.2. Install the XRM in the EIA-310 compliant 19" test fixture.
         ☐ Is the XRM of correct depth (<27")?
         ☐ Does the XRM physically install without interference?
         ☐ Are all screw holes in the correct location?
      2.2.3. Connect the PPS, CLK, CYC, and PMT lines to the function generator.
         ☐ Are the connectors accessible?
         ☐ Are the connectors clearly identifiable?
         ☐ Do all connectors mate correctly?
      2.2.4. Connect the DB-37 and coaxial connectors to the signal harness.
         ☐ Are the connectors accessible?
         ☐ Are the connectors clearly identified?
         ☐ Do all connectors mate correctly?
      2.2.5. Connect the power, diagnostic, and internet ports.
         ☐ Are the connectors accessible?

☐ Are the connectors clearly identified?
☐ Do all connectors mate correctly?
☐ Is a fuse present near the power input port?

2.2.6. Rapidly power cycle the device 5 times using the switch on the back of the unit. Then rapidly press the reset switch (for less than 1s) on the front of the unit 5 times.
☐ Does the unit power on successfully?

2.2.7. Hold the reset switch on the front of the unit for 5 seconds.
☐ Does the unit turn off?

Power off the device using the switch on the back of the unit for the next step.

2.3. Electrical Verification (Part 1)

2.3.1. For each module, reference the 'partial schematic' provided by the vendor.
☐ Are the correct voltage suppression components present?
☐ Are the components rated for the specified operating range?

2.3.2. For each module, reference the specifications provided by the vendor.
☐ Do the ADC/DAC/GPIO performance specifications match Fermilab specifications?
☐ Is the pinout compliant with those specified in the requirements document?
☐ Are the ports clearly labeled for their function?
☐ Is the power conversion stage UL listed, and Category II rated?

2.3.3. Measure the chassis between exposed metal, and the grounding terminal
☐ Is the XRM chassis connected to ground with an impedance < 1Ω?

2.3.4. Other electrical (EMI/Discharge) tests must be completed by an independent party.
☐ Have these tests been performed with satisfactory results?

2.4. Environmental Verification (Part 2)

2.4.1. With the XRM powered on, observe the direction of fan airflow.
☐ Does the air move from the front to the back of the unit?

2.4.2. Place the connected XRM in a 40°C environmental chamber for a period of one hour.
☐ Does the unit remain operational (the green light is on, and software is responsive).
☐ Does the XRM display zero temperature alarms through software?

Power on the XRM in the environmental chamber for the remainder of this testing.

3. Functional Validation

The following tests are to be performed after 1 hour at 40°C, and after 48 hours at 40°C.

3.1. Vendor Software Verification

3.1.1. With the XRM connected to the network, observe the startup sequence.
☐ Does the XRM boot automatically to the correct configuration?
☐ Does the XRM load corresponding scripts, and launch its IOC?
☐ Is the XRM accessible immediately via the diagnostic port?

☐ Is the XRM accessible to other network devices within 5 minutes of startup?
☐ Are the network signal indicators active?

3.1.2. Connect to the XRM utilizing the vendor provided engineering display.
☐ Are basic PV's accessible?
☐ Are basic PV's correctly identified?
☐ Are basic PV's modifiable without system re-boot?

3.2. Interim Electrical Validation (Part 2)

3.2.1. Configure the signal harness per the following specifications:

	Signal	Source	Freq (Hz)	Range	Term. (Ω)
Signal Gen.	PPS	CH1	1	5V	50R
	CYC Trig.	CH3	20	5V	50R
	ADC Clk.	CH2	2M	5V	50R
	ADC Inp.	CH4	See Table	See Table	~1M
Scope	Permit	CH1	-	5V	50R
	GPIO	CH4	See Table	5V	50R
	DAC	CH2	See Table	See Table	1K
	ADC Inp.	CH3	See Table	See Table	1M

3.2.2. For each module (Row), configure the harness for the following:

Unit			Configuration				Test Scenario		
Type	Rate (Sps)	Range	Voltage	Rate (Sps)	Window	Rep Rate	SQ. (Width)	SIN (Hz)	SIN (Hz)
GPIO	1M	5V (TTL)	5V (TTL)	100K Int.	Cont.	20Hz	10ms	-	-
Relay	20	5V	5V	1	Cont.	20Hz	250ms	-	-
DAC	100K	±10V	±8V	100K Int.	Cont.	20Hz	10ms	20Hz	5760
ADC	100K	±10V	±8V	100K Int.	Cont.	20Hz	10ms	5760	60K
ADC	100K	±5V	±4V	100K Int.	Cont.	20Hz	10ms	5760	60K
ADC	100K	±2.5V	±2V	100K Int.	Cont.	20Hz	10ms	5760	60K
ADC	2M	±10V	±8V	2M Ext.	1ms	20Hz	10uS	300K	600K
ADC	2M	±2.5V	±4V	2M Ext.	1ms	20Hz	10uS	300K	600K
ADC	2M	±1V	±2V	2M Ext.	1ms	20Hz	10uS	300K	600K

3.2.3. Check the PPS, Cycle Trigger, Clock, and Permit Signals are active
☐ Does the Cycle Trigger indicator on the front of the unit blink?
☐ Do PV's from each device begin updating on a per-cycle basis?
☐ Does the XRM's timestamp match wall time within 1uS?

3.2.4. Run the square wave validation (Scenario 1).
☐ Does the module respond with a waveform of appropriate voltage and rate?
☐ Does the unit respond at the appropriate update rate (continuous or 10ms window)
3.2.5. Run the sine wave validation (Scenario 2).
☐ Does the module respond with a waveform of appropriate voltage and rate?
☐ Does the unit respond at the appropriate update rate (continuous or 10ms window)
3.2.6. Run the sine wave validation (Scenario 3).
NOTE! The voltage in this scenario should be < half the voltage recorded above.
☐ Does the module respond with a waveform of appropriate voltage and rate?
☐ Does the unit respond at the appropriate update rate (continuous or 10ms window)

3.3. Software Validation
The following requires a full software test suite, to be finalized after vendor selection.
3.3.1. Load the Fermilab base configuration script for the XRM, and test for the following:
3.3.1.1. Waveform readback
3.3.1.2. Waveform playout
3.3.1.3. Full bandwidth readback
3.3.1.4. GPIO testing
3.3.1.5. Permit testing
3.3.1.6. Sample and hold testing
3.3.1.7. Analytic variable testing
3.3.1.8. Postmortem testing
3.3.1.9. Multicast testing
3.3.1.10. Save restore functionality

4. Stakeholder Review
4.1. Review the test results above with designated stakeholders.
☐ Are the test results satisfactory for their given application?
☐ Do they wish to perform additional signal validation, with dedicated instruments?
☐ If so, provide the test unit to the external party. Testing to be completed in under 1 week.
4.2. Formally record stakeholder approval in line with the test results for future reference.