ALP LAB

E1M-X V2N-M1 EMC Pre-Compliance Assessment

Standards, test plan & emitter risk assessment

Document Number: EM-V2NM1-001 **Revision:** 0.4 **Date:** November 2026 **Status:** Preliminary

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1 Purpose & Status

The E1M-X V2N-M1 is a **System-on-Module (a component)**. Under the EMC Directive (2014/30/EU) and equivalents, **EMC compliance is demonstrated on the final host product**. This document de-risks that test: it identifies the module's likely emission sources from the design and gives integrators a ready test plan; it will carry Alp Lab's pre-compliance bench results once measured.

What this document can and cannot contain: The standards, test plan and emitter risk assessment (Section 4) are netlist-derived and complete. The **measured** emission/immunity results (Section 6) depend on the host board, cabling and enclosure and can only be obtained on an EMC bench. This document is not a Declaration of Conformity to the EMC Directive.

2 Applicable Standards

Aspect	Industrial	IT / multimedia
Emissions	EN IEC 61000-6-4	EN 55032 (CISPR 32)
Immunity	EN IEC 61000-6-2	EN 55035 (CISPR 35)
Radio (Wi-Fi/BLE)	EN 300 328 / EN 301 893 + EN 301 489 (RED)	same
North America	FCC Part 15 B + 15.247/15.407 (Wi-Fi)	same

Table 1 Candidate EMC standards (host-product dependent)

Note: The on-module **Murata LBEE5HY2FY** Wi-Fi/BLE radio is an intentional radiator carrying its own **modular FCC/IC/RED approval**; the integrator inherits it subject to the module's antenna and integration conditions. The unintentional-emitter assessment below excludes the radio's transmissions.

3 Pre-Compliance Test Plan

Test	Method	Setup notes
Radiated emissions	CISPR 32 / 61000-6-4, 30 MHz–6 GHz	Upper limit ≥6 GHz: high-speed LPDDR4 + GbE + 5 GHz Wi-Fi. Near-field probe scan first.
Conducted emissions	CISPR 32 / 61000-6-4, 150 kHz–30 MHz	On the DC input and host I/O; the dense multi-rail DC-DC section is the main source.
ESD immunity	IEC 61000-4-2, ±4 kV contact / ±8 kV air	Exposed connectors / host surfaces; TVS diodes present on external lines.
Radiated RF immunity	IEC 61000-4-3, 3 V/m (10 V/m industrial)	Watch Ethernet, PCIe-to-DeepX, and analog paths.
EFT / burst	IEC 61000-4-4	DC power + signal ports.
Surge	IEC 61000-4-5	Host-level on external ports.
Conducted RF immunity	IEC 61000-4-6, 3 V (10 V industrial)	Cabled ports.

Table 2 Pre-compliance test plan (host-representative fixture)

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4 Emitter Risk Assessment (from netlist)

Ranked by likely contribution to radiated emissions, from the V2N-M1 clock tree and power architecture. This module has a **denser, higher-risk emitter profile** than a simple SoM — many switching rails, two GbE PHYs, high-speed memory, and a PCIe link to the DeepX accelerator.

Source	Risk	Character & mitigation
Multi-rail DC-DC (5 × TPS628640 + DA9292 + ACT88760)	High	Many switching fundamentals + broadband harmonics on planes. Tight hot loops, input/output filtering (38 ferrite beads present), guard SW nodes.
LPDDR4 / 4X interfaces (3 devices)	High	Wide high-edge-rate buses ⟶ broadband to >1 GHz. Controlled impedance, fly-by/length match, minimise stubs.
Dual GbE: 2 × RTL8211 + 25 MHz XOs	High	25 MHz spurs + harmonics, differential TX/RX. Guard XOs; magnetics with common-mode chokes at host RJ45s.
PCIe to DeepX DX-M1 (on-module PCIe lane switches) [M1]	Med-High	Gbit serial; well-contained if matched, a radiator on imbalance/stubs. M1-variant-specific.
eMMC / OSPI NOR / SPI NAND buses	Medium	Fast memory edges; series termination + controlled routing.
SoC + DeepX core clocks	Medium	Core-clock harmonics; extensive MLCC decoupling present.
USB / display / camera high-speed lanes	Low-Med	Common-mode chokes at host ports; matched differential routing.
32.768 kHz RTC ×2	Low	Low frequency/energy; negligible radiator.

Table 3 Unintentional-emitter risk ranking

> **Note:** **Highest-leverage targets:** the dense multi-rail DC-DC section, the LPDDR4 interfaces, and the two 25 MHz Ethernet clocks dominate. A near-field probe pass over the power section + memory + PHY clocks is the fastest early read before booking chamber time.

5 Integrator Mitigation Checklist

1. **Power entry:** filter the DC input at the host connector (π-filter / ferrite); the module's MLCCs + beads handle local decoupling, not host-cable common mode.
2. **Ethernet (×2):** magnetics/MagJack with integrated common-mode chokes; keep the 25 MHz XOs away from board edges and connectors.
3. **Enclosure:** a conductive enclosure or shield can over the power + memory + DeepX region is the most effective radiated fix if the near-field scan flags it.
4. **Cabling:** common-mode chokes on every high-speed and power cable leaving the box.
5. **Wi-Fi:** respect the Murata module's antenna/keep-out conditions to retain the modular radio approval.

6 Measured Pre-Compliance Results

> **Note:** **Pending bench characterisation.** Radiated/conducted emission limit-line plots, immunity pass/fail, and margins to the selected class limits are inserted here after a pre-compliance scan on a host-representative fixture.

7 Limitations

1. **Module, not product** — formal EMC compliance is the host's responsibility.
2. **Predicted, not measured (§4–5)** — only a bench scan produces compliance evidence.

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3. **Host-dependent** — emissions depend on carrier board, cabling, enclosure, software.
4. **Radio handled separately** — intentional Wi-Fi/BLE follows the module's modular approval.

8 Revision History

Revision	Changes	Date
0.1	• Initial pre-compliance scaffold: standards, test plan, and netlist-derived emitter risk assessment (dense multi-rail DC-DC + LPDDR4 + dual 25 MHz Ethernet clocks dominant; PCIe-to-DeepX M1-specific). • Measured results pending bench characterisation.	June 2026
0.2	• Release history: every entry formatted as a bullet list.	October 2026
0.3	• Table of Contents: each entry links to its section; the front-matter lists are set tighter.	October 2026
0.4	• Product name on page 1 links to the product page on alplab.ai. • On-module parts named by function; component designators removed.	November 2026

Table 4 Document revision history

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