ALP LAB

# E1M-X V2N EMC Pre-Compliance Assessment

Standards, test plan & emitter risk assessment

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# 1 Purpose & Status

The E1M-X V2N 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 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 clock tree and power architecture. This module has a **denser, higher-risk emitter profile** than a simple SoM — many switching rails, two GbE PHYs, and high-speed memory.

| 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 interface (main DRAM) | High | Wide high-edge-rate bus ⟶ 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. |
| eMMC / OSPI NOR / SPI NAND buses | Medium | Fast memory edges; series termination + controlled routing. |
| SoC 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 interface, 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 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.
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.

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# 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).<br>• 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. | November 2026 |

**Table 4** Document revision history

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