LF12 Floating Format and Coheron Word Specification

Technical Description for Reproducible Wave-Based Computation

Coheron Research Draft

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Abstract

This document specifies the LF12 (Low-Float-12) numerical format and the structure and semantics of Coheron Words, a 4096-bit wave-oriented data structure designed for coherent, low-entropy, high-throughput computation. The purpose of this specification is to enable independent implementations that reproduce the same numerical behavior, wave dynamics, and structural properties as the reference system. The specification defines the bit layout, encoding rules, clamping behavior, wave operations, temporal echo, optional vertical coupling, and deterministic requirements for reproducibility.

1 Introduction

LF12 is a compact 12-bit floating-like scalar format designed for wave-based computation. It is not intended as a general-purpose floating-point format, but as a bounded, symmetric, low-entropy carrier for coherent wave evolution. LF12 values are arranged into Coheron Words, each consisting of 340 LF12 lanes plus a 16-bit CRC, totaling 4096 bits.

The Coheron Word is the fundamental unit of computation in the Coheron wave engine. Wave operations are applied lane-wise and across lanes, enabling spatial mixing, temporal echo, and optional vertical coupling across words. This document defines the format and semantics required for reproducible implementations.

2 LF12 Format Specification

2.1 Bit Layout

LF12 is a 12-bit format with the following structure:

Bit 11	Bits 10–6	Bits 5–0
Sign (S)	Exponent (E)	Mantissa (M)

2.2 Sign Bit

The sign bit is defined as:

$$S = 0 \Rightarrow \text{positive}, \qquad S = 1 \Rightarrow \text{negative}.$$

2.3 Exponent Field

The exponent field consists of 5 bits with a bias of 15. The unbiased exponent is:

$$e = E - 15.$$

The representable exponent range is:

$$-15 \le e \le 16.$$

2.4 Mantissa Field

The mantissa field consists of 6 bits. LF12 uses an implicit leading 1, so the effective mantissa is:

$$m = 1 + \frac{M}{64}.$$

2.5 Value Reconstruction

For any non-zero LF12 value:

$$x = (-1)^S \cdot m \cdot 2^{(E-15)}.$$

2.6 Zero Representation

Zero is represented by all bits set to zero. Negative zero is not permitted.

2.7 Special Values

LF12 does not encode NaN, Infinity, or subnormal numbers. Any out-of-range value must be clamped.

2.8 Clamping Rules

All implementations must clamp values to the operational range:

$$-3.0 \leq x \leq 3.0.$$

This ensures bounded energy and stable wave propagation.

2.9 Rounding Rules

Mantissa rounding must use round-to-nearest, ties-to-even. This ensures deterministic behavior across implementations.

3 Coheron Word Structure

A Coheron Word is a 4096-bit structure composed of 340 LF12 lanes and a 16-bit CRC.

3.1 Layout

$$\underbrace{\text{LF12}_0, \text{LF12}_1, \ldots, \text{LF12}_{339}}_{340 \text{ lanes}} \quad \| \quad \underbrace{\text{CRC}_{16}}_{\text{integrity}}$$

3.2 CRC Requirements

The CRC must be:

- 16 bits,
- deterministic,
- computed over all LF12 lanes,
- updated after all wave operations.

The polynomial is implementation-defined but must be documented.

4 Wave Operations

This section defines the semantic behavior of wave operations. Implementations must preserve the order and meaning of these operations.

4.1 LUT Transform

Each LF12 lane is mapped through a nonlinear lookup table:

$$y_i = \text{LUT}(x_i).$$

The LUT input index is the raw 12-bit LF12 value. The LUT output is a real number that must be re-encoded into LF12.

4.2 Spatial Wave Mixing

Each lane interacts with its immediate neighbors:

$$y_i = \alpha x_i + \beta(x_{i-1} + x_{i+1}),$$

with circular indexing.

The constants α and β must remain fixed for the duration of a run.

4.3 Temporal Echo

Each lane blends with its previous value:

$$y_i = \gamma \cdot x_i^{(t)} + (1 - \gamma) \cdot x_i^{(t-1)}.$$

The parameter γ must remain constant during a run.

4.4 Optional Vertical Coupling

If enabled, vertical coupling mixes lanes across adjacent Coheron Words:

$$y_{i,j} = \lambda \cdot x_{i-1,j} + (1 - \lambda) \cdot x_{i,j}.$$

This produces two-dimensional wave behavior.

5 Deterministic Requirements

To ensure reproducibility:

- All operations must be deterministic.

- LF12 encoding and decoding must be bit-exact.

- Clamping and rounding rules must be followed precisely.

- Wave operations must occur in the order:

$$\text{LUT} \rightarrow \text{Spatial Mixing} \rightarrow \text{Temporal Echo} \rightarrow \text{Vertical Coupling.}$$

- CRC must be computed after all transforms.

6 Use Cases

LF12 and Coheron Words are suitable for:

- wave simulation,

- coherent field propagation,

- temporal stability tracking,

- low-precision signal processing,

- inference scrambling,

- context diffusion,

- reaction–diffusion systems,

- synthetic correlators,

- fluid-like dynamics.

7 Reference Behavior

A correct implementation must reproduce:

- stable low-entropy fields in conservative mode,

- turbulent structured fields in enhanced mode,

- coherence index near 1.0 in stable mode,

- entropy growth in enhanced mode,

- reproducible CRC evolution.

8 Conclusion

This specification defines the LF12 format and Coheron Word semantics required for reproducible wave-based computation. Implementations adhering to this document will produce compatible numerical behavior and wave dynamics suitable for scientific comparison, publication, and further research.