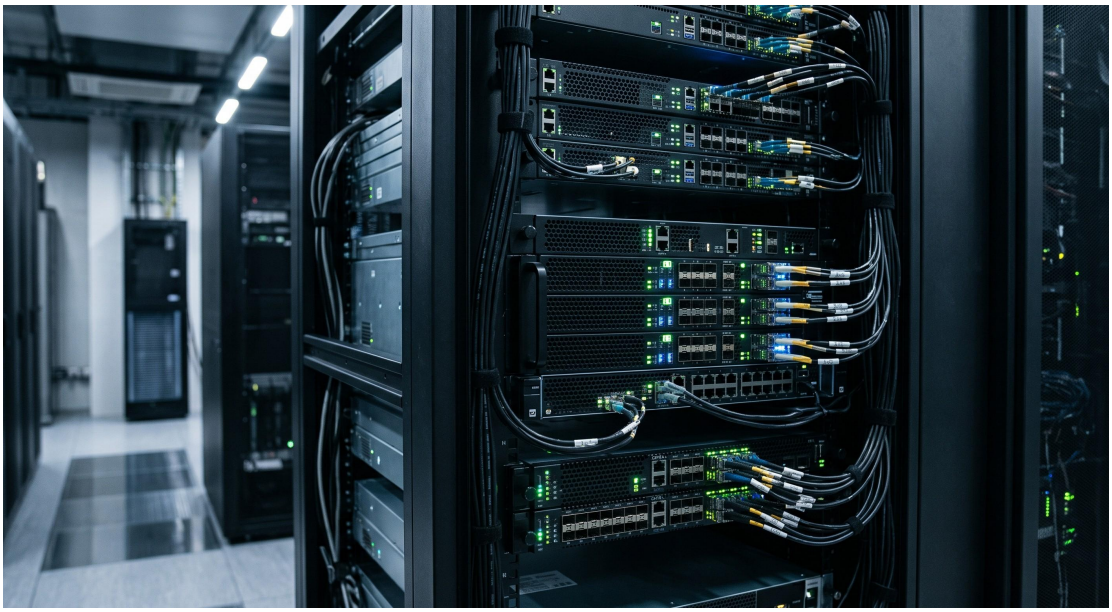
Optical Router Interface SyncE (Synchronous Ethernet) Jitter and Wander Tolerances - Official Technical Overview & Hardware Datasheet

EXECUTIVE SUMMARY

The Optical Router Interface SyncE (Synchronous Ethernet) Jitter and Wander Tolerances platform represents a definitive advancement in carrier-grade timing distribution for next-generation optical routing infrastructure. As service providers migrate toward 5G transport, fixed-mobile convergence, and time-sensitive enterprise services, the integrity of frequency synchronization across packet-switched networks becomes paramount. This document specifies the hardware architecture, silicon-level timing subsystem, and standards compliance profile of the Optical Router Interface SyncE implementation, delivering unparalleled jitter and wander performance that meets and exceeds ITU-T G.8262, G.8262.1, and G.8273.2 boundary clock requirements. The interface integrates a dedicated SyncE timing ASIC with a high-stability oven-controlled crystal oscillator (OCXO) or rubidium holdover module, ensuring sub-nanosecond phase alignment across line cards and chassis. This datasheet provides detailed technical specifications for pre-sales engineering evaluation, network design validation, and procurement assessment.



HARDWARE ARCHITECTURE & SILICON

The Optical Router Interface SyncE subsystem is architected around a dual-stage timing engine. The first stage resides in the physical layer (PHY) and MAC devices, where incoming Ethernet frames are used to recover the reference clock directly from the bitstream. This recovered clock is then forwarded to a centralized Synchronization Equipment Clock (SEC) module on the control plane. The SEC module employs a digital phase-locked loop (DPLL) with programmable bandwidth and a high-resolution time-to-digital converter (TDC) to filter packet delay variation (PDV) and network jitter. The second stage distributes the cleansed clock to all line cards and forwarding ASICs via a dedicated backplane clock bus, ensuring deterministic phase alignment. The SyncE interface supports both EEC Option 1 (G.8262) and EEC Option 2 (G.8262.1) performance levels, with selectable loop bandwidths ranging from

0.1 Hz to 10 Hz. Hardware-based wander filtering is complemented by an integrated holdover algorithm that leverages temperature-compensated crystal oscillator (TCXO) or OCXO stability of ±4.6 ppb over the operational temperature range. The router interface provides per-port SyncE status, QL (Quality Level) messaging, and Ethernet Synchronization Messaging Channel (ESMC) support in accordance with ITU-T G.8264.

KEY FEATURES & ROUTING LOGIC

- Synchronous Ethernet (SyncE) per ITU-T G.8261, G.8262, and G.8262.1: Full compliance for EEC Option 1 and Option 2, enabling frequency synchronization traceable to a primary reference clock (PRC).
- Jitter Tolerance: Meets ITU-T G.8251 and G.8262 jitter tolerance masks, with sinusoidal jitter tolerance exceeding 1.5 UIpp at frequencies from 10 Hz to 100 kHz.
- Wander Tolerance: Complies with ITU-T G.8262 wander generation, transfer, and tolerance requirements, including MTIE and TDEV masks for both EEC Option 1 and Option 2.
- ESMC and QL Messaging: Supports Ethernet Synchronization Messaging Channel (ESMC) per G.8264, with automatic quality level (QL) processing and holdover performance monitoring.
- Hitless Reference Switching: Hardware-based hitless switching between SyncE,

external BITS/SETS, and internal holdover references, with switchover time less than 1 ms.

- Integrated Timing ASIC: Dedicated SyncE timing engine with DPLL, TDC, and programmable loop filters for PDV mitigation.

- High-Stability Holdover: Optional OCXO or rubidium module providing holdover stability of ±4.6 ppb (OCXO) or ±0.05 ppb (rubidium) over 24 hours.

- Per-Port SyncE Status: Real-time monitoring of SyncE link state, QL, and SSM (Synchronization Status Message) via CLI, SNMP, and NETCONF/YANG.

- Boundary Clock and Transparent Clock Support: Integrated PTP (IEEE 1588v2) boundary clock and transparent clock capabilities for combined frequency and phase synchronization.

COMPLIANCE & STANDARDS

The Optical Router Interface SyncE platform is engineered to meet the most stringent international and regional synchronization standards. Compliance is validated through independent third-party testing and internal conformance test suites.

- ITU-T G.8261: Timing and synchronization aspects in packet networks.

- ITU-T G.8262: Timing characteristics of synchronous Ethernet equipment slave clocks (EEC Option 1).

- ITU-T G.8262.1: Enhanced timing characteristics for synchronous Ethernet equipment slave clocks (EEC Option 2).

- ITU-T G.8264: Distribution of timing information through packet networks (ESMC).

- ITU-T G.8251: The control of jitter and wander within the optical transport network (OTN).

- ITU-T G.8273.2: Timing characteristics of telecom boundary clocks and telecom time slave clocks.

- IEEE 1588v2: Precision Time Protocol (PTP) for frequency, phase, and time synchronization.

- MEF 22.1: Mobile backhaul synchronization requirements.

- Telcordia GR-1244-CORE: Clocks for the synchronization of telecommunications networks.

- Telcordia GR-253-CORE: Synchronous Optical Network (SONET) transport systems.

TECHNICAL SPECIFICATIONS

The following table summarizes the key hardware and performance parameters of the Optical Router Interface SyncE subsystem. These specifications are applicable to the line card and chassis platforms equipped with the SyncE timing module.

Parameter	Specification
Form Factor	Integrated line card or modular timing module for 1RU/2RU/Modular Chassis
SyncE Standard Compliance	ITU-T G.8262 (EEC Option 1), G.8262.1 (EEC Option 2)
Jitter Tolerance	Meets G.8262 and G.8251 masks; >1.5 UIpp sinusoidal jitter, 10 Hz to 100 kHz
Wander Tolerance	Meets G.8262 MTIE and TDEV masks for EEC Option 1 and Option 2
Holdover Stability	± 4.6 ppb (OCXO) or ± 0.05 ppb (Rubidium) over 24 hours at constant temperature
Loop Bandwidth	Programmable 0.1 Hz to 10 Hz
Reference Inputs	SyncE recovered clock, BITS/SETS (T1/E1), 1PPS, 10 MHz, PTP
Reference Switching	Hitless, <1 ms switchover between SyncE, BITS, and holdover
ESMC Support	Yes, per ITU-T G.8264, with QL processing and SSM
PTP Support	IEEE 1588v2 boundary clock and transparent clock

Management	CLI, SNMPv3, NETCONF/YANG, RESTCONF
Power Supply	Dual hot-swappable redundant AC/DC
Operating Temperature	-5°C to +55°C (commercial), -40°C to +65°C (hardened)
MTBF	> 500,000 hours (Telcordia SR-332)

ORDERING SKU INFORMATION

The Optical Router Interface SyncE capability is available as an integrated feature on select line cards and as a modular timing module for chassis-based routers. Ordering options include:

- SYNCE-LC-10G-24: 24-port 10 Gigabit Ethernet line card with integrated SyncE EEC Option 1/2 and PTP boundary clock.
- SYNCE-LC-100G-12: 12-port 100 Gigabit Ethernet line card with integrated SyncE EEC Option 2 and high-stability OCXO.
- SYNCE-TM-OCXO: Modular SyncE timing module with OCXO holdover for chassis-based platforms.
- SYNCE-TM-RB: Modular SyncE timing module with rubidium holdover for mission-critical synchronization.

- SYNCE-SW-LIC: Software license for enabling SyncE and ESMC on supported platforms.

