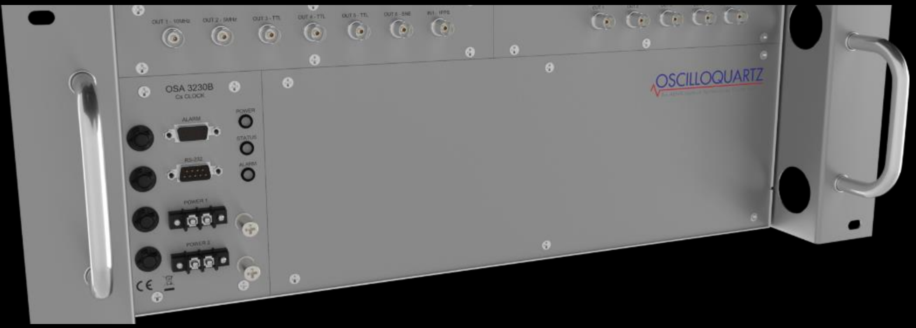
OSCILLOQUARTZ
A division of Adtran

75 YEARS
TIMING EXCELLENCE



OSA 323xB Cesium Clock

introduction

Rev D

OSA 323xB Cesium Clock

introduction

Oscilloquartz Magnetic Cesium Clock family

- ENHANCED WITH NEW **EUROPEAN CESIUM** TUBE TECHNOLOGY

OSA 3230B

- **exhaustive solution for telecom networks**
- frequency accuracy ±1x10-12
- ETSI and ANSI 19''
- ITU-T G.811 / ST1
- 2 direct outputs 5 & 10 MHz
- 4 auxiliary programable outputs
- 1PPS input
- 4 telecom outputs (optional)

OSA 3235B

- **Primary reference for labs and metrology with premium performance**
- frequency accuracy ±1x10-12
- ANSI 19''
- 2 direct outputs 5 & 10 MHz
- 4 auxiliary programable outputs
- 1 PPS input
- ultra low noise outputs
- 4 telecom outputs (optional)
- internal battery (optional)

OSA 3230B is available in version ePRC-A compatible G811.1

OSA 323xB Cesium Clock
introduction

OSA 32XXB is a magnetic atomic Cesium clock suitable as timing source for a Primary Reference Clock for telecommunications networks, laboratory, metrology or defence.

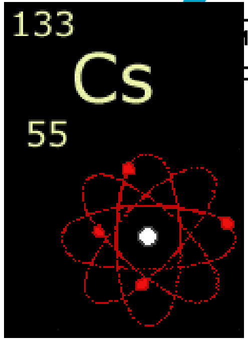
- generates a timing signal of a quality exceeding ITU-T Rec. G.811, using an atomic Cesium oscillator.
- provides a 10 MHz low phase noise signal derived from the atomic Cesium oscillator.
- provides additional programmable AC-MOS output (1, 5 or 10 MHz)
- displays equipment alarms on front panel LED and send them on relay contacts
- is manageable by a CMSW (Configuration & Monitoring Software) through a RS 232 port.
  - optional remote management can be installed through a “Universal Management Interface” (UMI 2)

functions of the OSA 323xB family

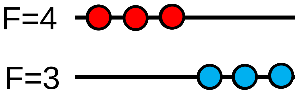
OSA 323xB Cesium Clock
introduction

Time and Cesium

- **it's all about time:**
  - need to define a Time scale:
  - **absolute time (initial sync of all clocks)**
  - time interval (1 second) to maintain time right in all clocks (frequency)



- **UTC defines the second as a property of the Cesium atom**
  - Cs atom change their energy state from level F=3 up to F=4 when excited
  - by a microwave at 9’192’631’770 Hz
  - this property is absolutely repeatable (in any condition and at any time)



$\nu_{RF} = 9.192$ GHz

- **definition of the SECOND : 9’192’631’770 periods of the Cesium F3/F4 transition**

- **maintaining Time ACURATELY → Cesium clock is the only way**

Cesium 133 is not radioactive

OSA 323xB Cesium Clock
introduction

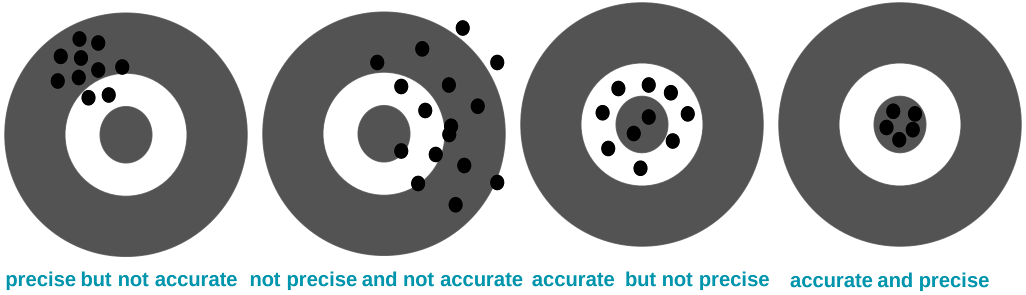
accuracy, precision and stability

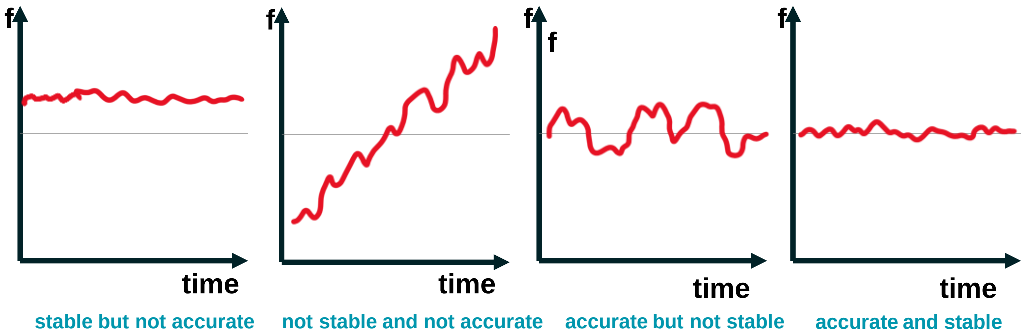
- **stable but not accurate:**
  example: a cesium clock not correctly calibrated to UTC

- **not stable and not accurate:**
  example: a SDH equipment or a cell site in holdover

- **accurate but not stable:**
  example: E1 signal at the end point of a network and affected by wander

- **Stable and accurate:**
- The best case. For example, the output 10Mhz of a cesium clock.





OSA 323xB Cesium Clock

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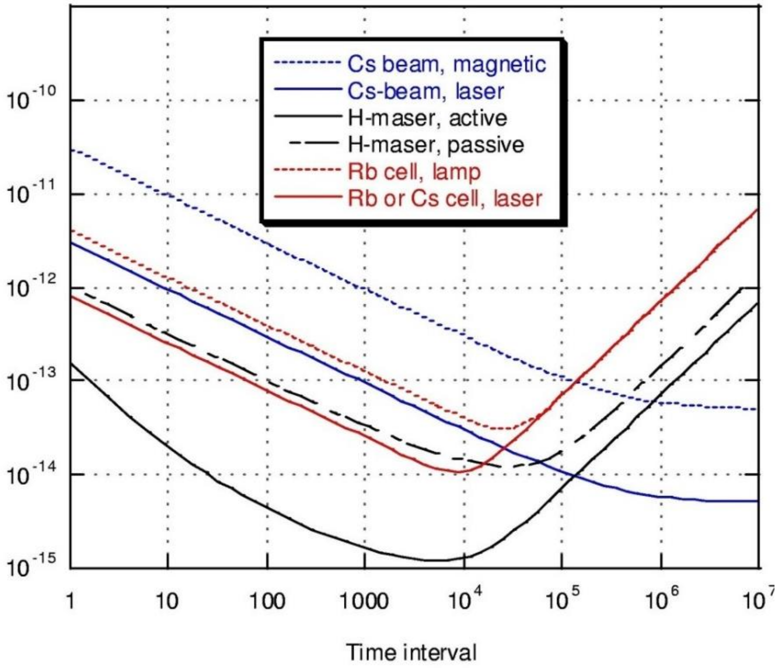


- **ADEV (Allan Deviation)** expresses
  - the clock frequency instability vs. the observation time
  - the lower the **ADEV** curve is the better the stability is

- **different atomic clock** exist:
- **Rb cell clock**
  - for good short-term stability and compactness
- **H-maser cell clock**
  - for best short and mid-term stability but bulky instrument
- **Cs beam clock**
  - for best long-term stability due to absence of atomic collisions

Why Cs atomic beam clock ?

OSA 323xB Cesium Clock
introduction

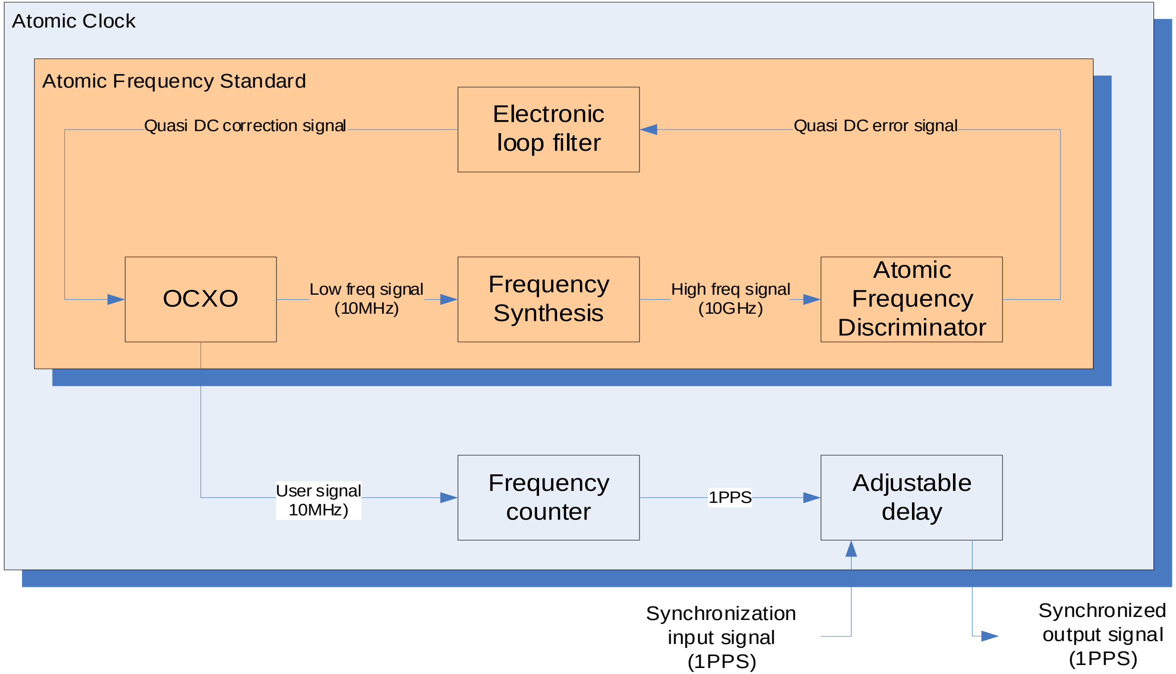
Cesium Clock contains:

- quartz oscillator whose frequency is locked to the hyperfine transition frequency (clock transition) of the cesium atom
- cesium atomic beam resonator (cesium tube)
- control circuits, driven by the quartz oscillator frequency, delivers an interrogation signal to the atomic generator
  - the response of the resonator is a resonance signal whose amplitude is maximum when the interrogation signal frequency
    is equal to the clock transition frequency
- servo loop circuits, fed by the tube output signal, which control the quartz oscillator frequency so that the interrogation frequency is locked to the clock transition
- power supplies

Principles of Operation

OSA 323xB Cesium Clock

introduction



What is an atomic clock / frequency standard ?

OSA 323xB Cesium Clock

introduction

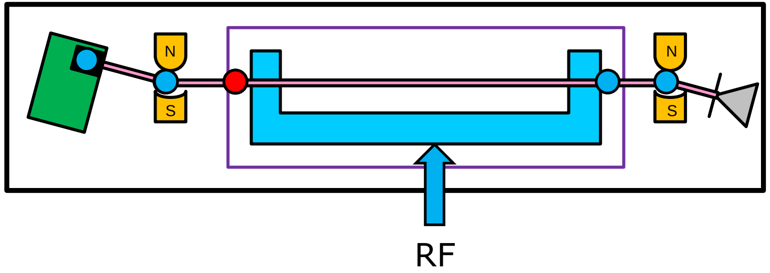
- magnetic cesium beam tube is working under vacuum
- in case of a long storage period, it is necessary to power on the tube regularly in order to maintain this vacuum

view of a magnetic cesium tube

OSA 323xB Cesium Clock

introduction

- in a cesium clock, cesium is heated to a gaseous state in an oven
- a hole in the oven allows the atoms to escape at high speed
- magnets separate the atoms to exclude the impurities

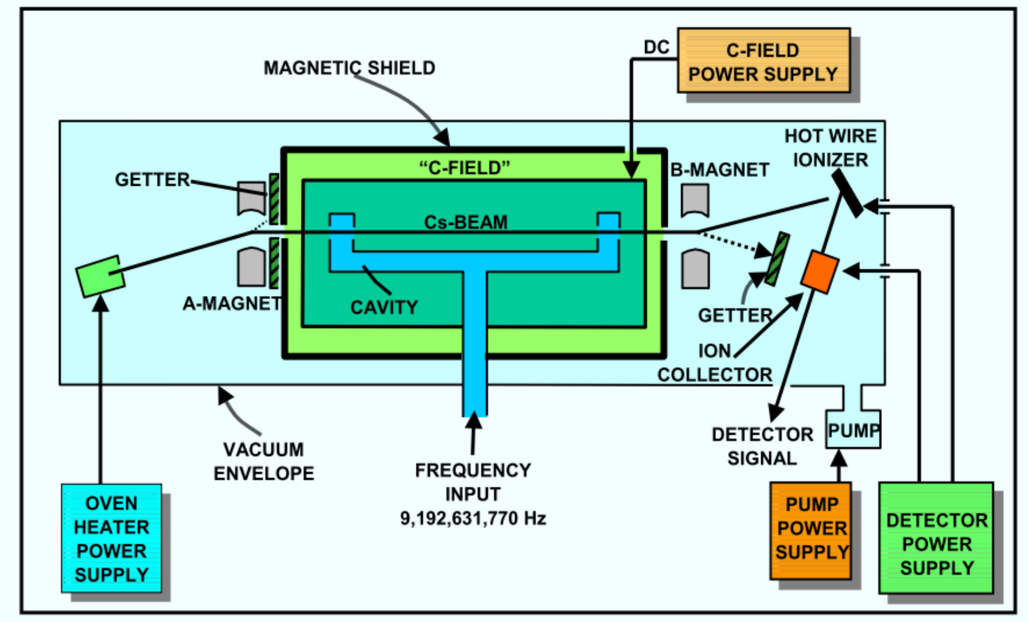


Cs beam atomic resonator 1/3

OSA 323xB Cesium Clock

introduction

- the atoms that can absorb energy are directed through a microwave cavity where they are exposed to radiation with a frequency very close to 9,192,631,770 cycles per second, which is given by the Quartz Oscillator
- these atoms are then pushed by another set of magnets toward a detector

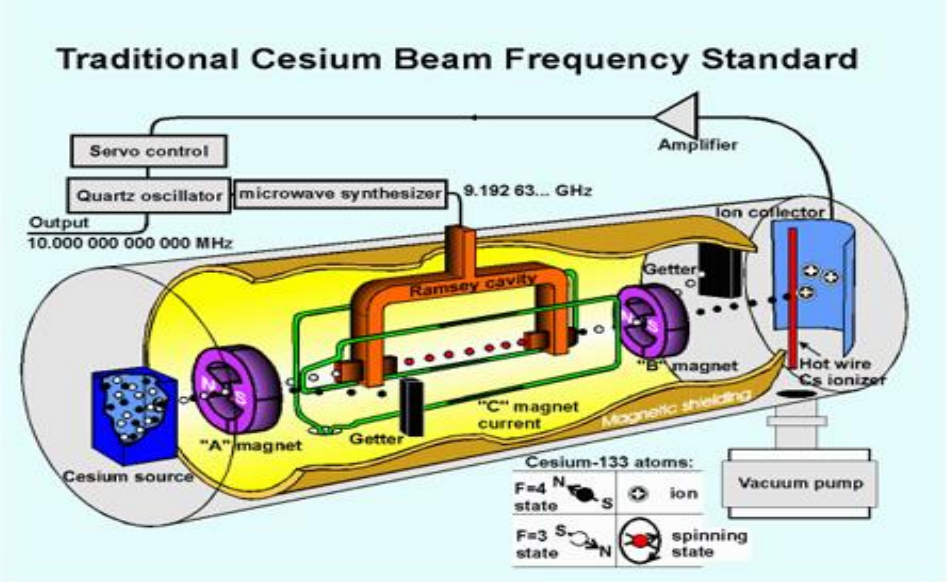


Cs beam atomic resonator 2/3

OSA 323xB Cesium Clock

introduction

- this feedback tunes the microwave frequency until it exactly matches the radiation frequency of the cesium atoms, maximizing the number of atoms that reach the detector
- once the microwave frequency is locked into the cesium atoms' frequency, it is then divided down to a frequency that can be used to mark time accurately to a few billionths of a second

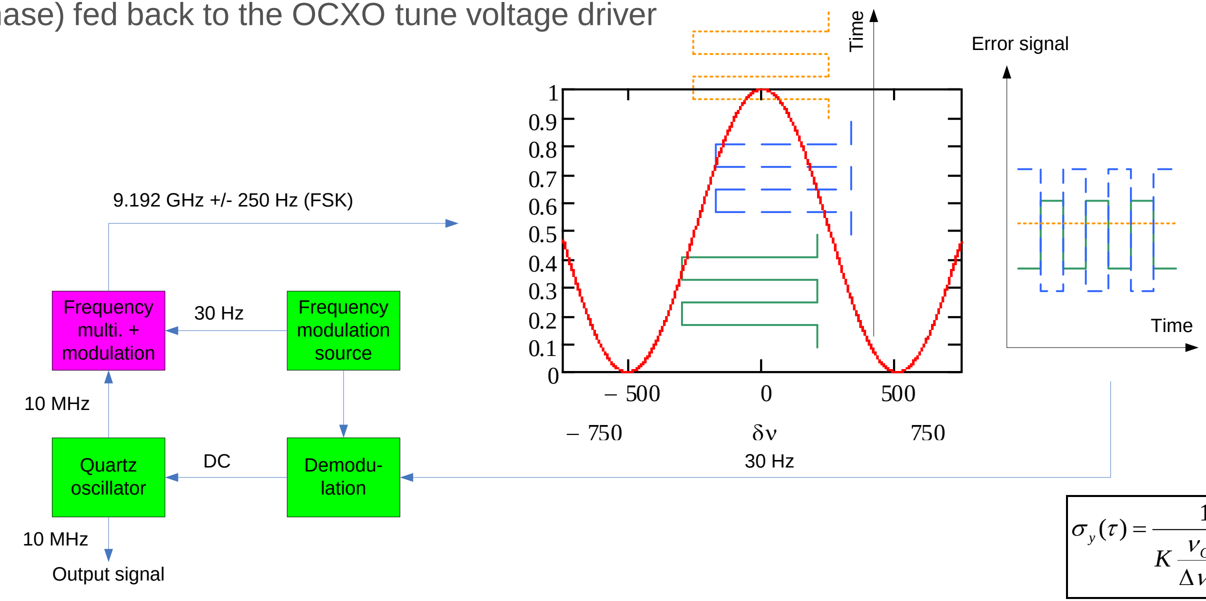


Cs beam atomic resonator 3/3

OSA 323xB Cesium Clock

introduction

- **RF square modulation** through DDS frequency modulation (10-30Hz)
- **synchronous detection** of atomic current (locking amplifier)
- **error signal** (ampl. and phase) fed back to the OCXO tune voltage driver



$$\sigma_y(\tau) = \frac{1}{K \dfrac{\nu_{Cs}}{\Delta\nu_{Cs}} \dfrac{S}{N}} \frac{1}{\sqrt{\tau}}$$

operation principle: OCXO locking

OSA 323xB Cesium Clock

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19'' version

ETSI version

OSA 3230B Views

OSA 323xB Cesium Clock

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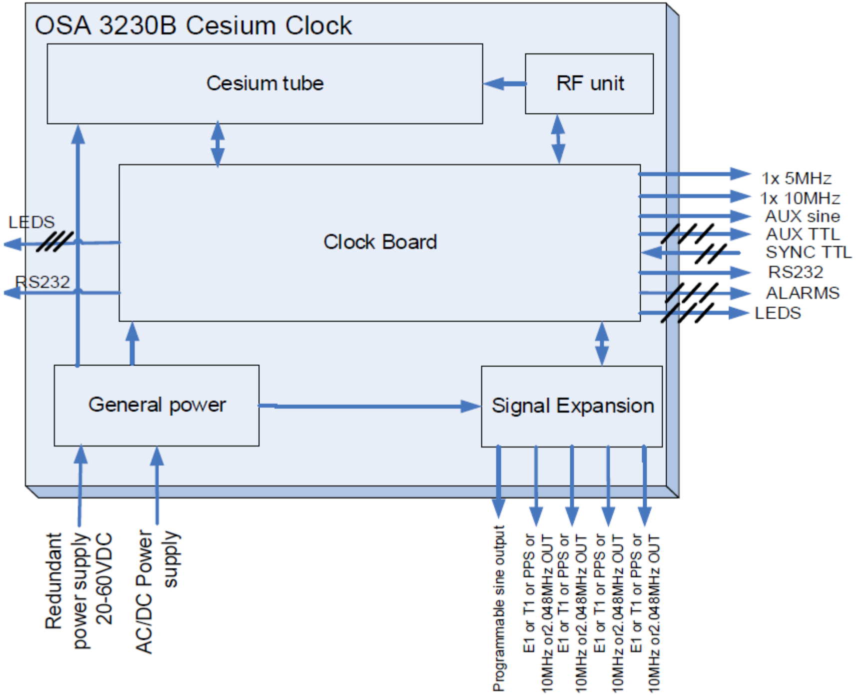

OSA 3230B Block Diagram

OSA 323xB Cesium Clock

introduction

19'' version, no ETSI version for the 3235B

OSA 3235B view

OSA 323xB Cesium Clock

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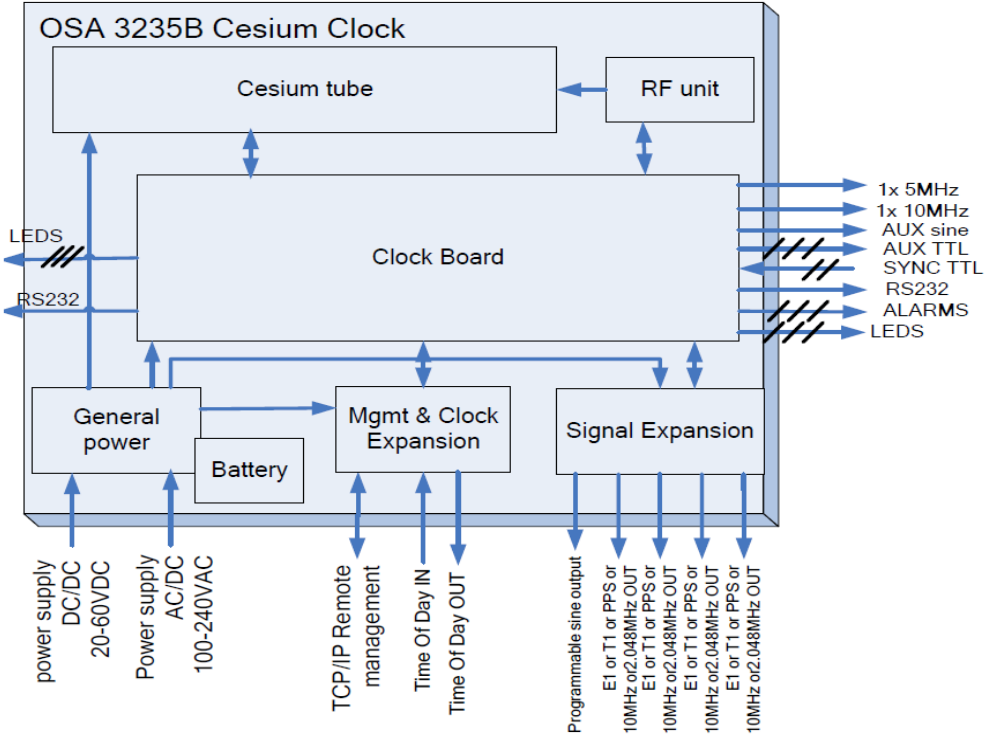

OSA 3235 Block Diagram

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75 YEARS

TIMING EXCELLENCE