

LOCATE · CONNECT · CONSERVE

Tracking, Telematics & Embedded Positioning

Frequency-control and RF-filtering guidance for embedded GNSS in vehicles, assets, cargo, industrial IoT, wearables and portable terminals, where power, size, cost, start-up time and RF sensitivity must be balanced.

Fast Acquisition + RF Sensitivity + Low Duty-Cycle Power + Compact Integration

Vehicle Telematics

Asset Tracking

Cargo & Cold Chain

Industrial IoT

Wearables

Portable Terminals

Engineering Focus

Begin with the externally accessible function: GNSS RF path, receiver reference, always-on RTC, host MCU, cellular or short-range radio, vehicle interface or regional sub-GHz link.

Architecture Consideration

Battery life and TTFF are system outcomes. Clock current, stability and RF selectivity should be allocated together with antenna efficiency, assisted data, receiver power modes, modem duty cycle, coexistence and firmware behavior.

26 MHz

Common published GNSS reference class.

32.768 kHz

Always-on RTC and wake domain.

1210

Miniature crystal package class.

1176-1602 MHz

Embedded multi-band GNSS RF region.

01

Application Scope & System Architecture

Tracking, Telematics & Embedded Positioning covers compact products that acquire GNSS position and time, add device or vehicle data, and report location through cellular, Wi-Fi, Bluetooth, LPWAN or wired interfaces under tight power, size and cost constraints.

Representative Equipment

Vehicle & Fleet Telematics

- TCUs, OBD and insurance dongles
- Fleet, rental and trailer trackers
- eCall and recovery terminals
- CAN / Ethernet location gateways

Asset, Cargo & Industrial IoT

- Containers, pallets and returnables
- Cold-chain and condition loggers
- Tools, equipment and livestock tags
- Remote industrial monitoring nodes

Personal & Portable Positioning

- Wearables and safety devices
- Handheld data terminals
- Outdoor and sports products
- Portable navigation and locator units

Representative Embedded Positioning Chain

Antenna & GNSS RF

Antenna · LNA · SAW · coexistence



Position & Time

GNSS receiver · local reference · 1PPS



Host & Power

MCU · sensors · RTC · duty-cycle control



Connectivity & Service

Cellular · BLE / Wi-Fi · LPWAN · cloud

Acquisition & Sensitivity

Preserve the weak-signal RF path and the reference conditions required by the selected GNSS receiver.

Sleep & Wake Power

Maintain time and ephemeris-support functions with the current budget defined for each power mode.

Size & Integration

Use a discrete component only where the module, SiP or host device exposes an external clock or RF position.

Coexistence & Environment

Validate cellular, Wi-Fi and LPWAN transmit conditions together with temperature, shock and supply events.

FCom Solution Scope

FCom supports compact GNSS TCXO references, miniature 32.768 kHz crystals and ultra-low-current oscillators, rugged MCU / PHY crystals, GNSS SAW filtering and frequency-specific sub-GHz filters for defined regional radio plans.

System-Level Performance

FCom components support the RF and timebase design. Sensitivity, TTFF, location availability and battery life remain complete-system results determined by antenna, receiver, power architecture, firmware, network and operating profile.

02

Select by System Node First

A frequency used by the GNSS receiver may be unrelated to the RTC, host MCU, cellular modem or vehicle interface. Define the node, integration boundary and electrical interface before selecting a device family.

NODE 1 · GNSS MEASUREMENT PATH

RF Filtering & Receiver Reference

Function: acquire single- or dual-band GNSS signals and maintain the local reference used by the receiver tracking engine.

Define: signal families, passband / rejection mask, antenna / LNA topology, exact reference frequency, waveform, supply, phase noise and temperature.

Selection direction: evaluate a discrete TCXO or SAW only where the receiver design exposes that position; do not derive the local oscillator frequency from the RF carrier.

NODE 2 · ALWAYS-ON TIME & POWER DOMAIN

RTC, Wake Scheduling & Retained State

Function: retain time through GNSS-off, modem-off, shipment, parking or deep-sleep intervals and schedule the next acquisition or report.

Common family: 32.768 kHz crystal loop or low-current CMOS oscillator input, subject to the PMIC, MCU or GNSS device.

Selection direction: compare total sleep current, start-up margin, CL / ESR, drift over the longest sleep interval and host input compatibility.

NODE 3 · HOST MCU, SENSORS & VEHICLE INTERFACE

Application Clock Roots

Function: clock the host MCU, sensor hub, event logger, security device, CAN / Ethernet interface and local processing.

Common families: 16 / 25 / 32 / 40 MHz external references; 48 / 64 MHz values are often internally synthesized CPU or bus clocks.

Selection direction: choose crystal or CMOS XO from the host clock-input topology; confirm CL / ESR or logic level / load, start-up and temperature.

NODE 4 · WIDE-AREA & SHORT-RANGE CONNECTIVITY

Cellular, Wi-Fi / BLE, LPWAN & Sub-GHz

Function: upload location and sensor data while limiting transmit noise coupled into the GNSS antenna and power rails.

Common families: 26 / 32 / 38.4 / 40 MHz platform references; regional 433 / 868 / 915 MHz RF paths where the radio architecture requires an external filter.

Selection direction: follow the selected modem or transceiver reference input. For SAW filtering, region, channel bandwidth, impedance and rejection zones are mandatory.

1PPS / Timepulse

A pulse output can align timestamps or discipline a host timebase, but it is not a continuous oscillator and does not eliminate the RTC or local clocks needed between GNSS fixes and through sleep.

Integration Boundary

Many GNSS modules, cellular SiPs and wireless modules integrate their crystal, TCXO or SAW. FCom selection begins only after confirming that the relevant board-level component remains externally accessible.

03

Frequency & Component Placement Matrix

The frequencies below recur in publicly documented embedded GNSS and telematics platforms. Final selection is matched to the exact receiver, host, PMIC, modem, PHY or RF path used in the customer design.

Frequency / Signal	Common Placement	Engineering Meaning	FCom Selection Direction	Qualification Note
32.768 kHz	RTC, wake, retained-time and event-log domain	Low-power timekeeping through PSM, parking, shipment or deep sleep	Tuning-fork crystal or ultra-low-current 32 kHz XO class	Match host topology, CL, ESR, drive, start-up and current budget
16 MHz	Module MCU, host controller and sensor hub	Published controller reference in selected telematics modules; not universal	Miniature crystal or CMOS XO if the clock is external	Confirm whether the value is a board reference or internal domain
25 MHz	Ethernet / 100BASE-T1 PHY and vehicle gateway	Common external PHY reference distinct from network line rate	AEC crystal or wide-temperature CMOS XO class	Follow PHY input mode, loading, start-up and qualification needs
26 MHz	GNSS receiver and selected cellular / wireless platforms	Common published local-reference value; exact need remains chipset-specific	Compact clipped-sine TCXO where the receiver exposes an input	Match supply, amplitude / load, stability, phase noise and temperature
32 / 38.4 / 40 MHz	MCU, cellular, Wi-Fi / Bluetooth and LPWAN platform	Chipset-defined clock family independent of the GNSS RF carrier	Crystal, TCXO or CMOS XO according to the actual IC	Specify one exact value, waveform, voltage and integration boundary
48 / 64 MHz	USB, CPU or radio internal clock domain	Frequently generated by an internal PLL; not automatically an external BOM item	No discrete recommendation until the external reference input is confirmed	Separate processor speed or internal domain from board reference
1176.45 / 1207.14 / 1227.60 / 1268.52 MHz	Dual-band GNSS lower RF paths	L5 / E5 / B2, L2 and BeiDou B3 signal families used by advanced trackers	Signal-specific or combined lower-band SAW selection	Validate signal set, bandwidth, loss, group delay and rejection mask
1561.098 / 1575.42 MHz	BeiDou B1I and GPS L1 / Galileo E1 / BeiDou B1C RF paths	Primary embedded GNSS acquisition and tracking region	Wide upper-band or separate B1I / L1-family SAW path	Confirm antenna / LNA topology and required constellation coverage
1602 MHz region	GLONASS G1 RF path	Channelized upper-band coverage beyond a narrow 1575.42 MHz path	Dedicated or verified wideband SAW architecture	Validate the complete channel range and coexistence requirements
1 PPS / Timepulse	GNSS-to-host timestamp alignment	Epoch marker used with the local RTC and host clock domains	Interface and timebase integration, not an oscillator product	Validate pulse level, latency, availability and sleep behavior

RF Carrier vs Clock

1176-1602 MHz values define GNSS RF-filter placement. The TCXO, crystal or integrated reference used by the receiver is defined separately.

Internal vs External

A module block diagram may show a clock domain without exposing a replaceable component. The module hardware design remains the authority for board-level selection.

Configuration Note

This matrix identifies the applicable product class. FCom confirms frequency-specific electrical options and final ordering codes through application review.

04

Representative Platform & Architecture Matrix

Four publicly documented platforms illustrate how clock and RF responsibilities shift across a compact GNSS module, a multi-radio asset-tracking reference design, a highly integrated cellular IoT device and a vehicle dead-reckoning module.

QUECTEL

LG77L(C) Compact GNSS Module

01

The public LG77L hardware architecture places an L1 SAW and LNA ahead of the receiver, with a 26 MHz TCXO, 32.768 kHz crystal, backup supply and 1PPS output inside a 7 × 7 × 2 mm module. Public documentation reports -163 dBm tracking sensitivity, 6 µA backup current and 50 ns RMS 1PPS accuracy.

Antenna + L1 SAW / LNA → 26 MHz GNSS Engine → UART / 1PPS + Backup

Design focus: the module integrates its oscillator and RF filtering. In designs using an integrated module, FCom selection applies only to separately exposed host-clock, RTC or discrete-receiver positions.

STMICROELECTRONICS

SL-ASTRA1B / STEVAL-ASTRA1B

02

The public asset-tracking reference design combines a Teseo-LIV3F GNSS module with STM32WB5MMG Bluetooth, STM32WL55 sub-GHz / LoRa, environmental and motion sensors, NFC, security, power management and a rechargeable battery. The GNSS module architecture includes a 26 MHz TCXO and 32 kHz RTC domain.

GNSS + Sensors → BLE / Sub-GHz MCU → Gateway / Cloud

Design focus: treat GNSS, Bluetooth and sub-GHz references as separate clock domains. FCom selection applies where the chosen implementation exposes an external clock or regional RF-filter position.

NORDIC SEMICONDUCTOR

Nordic Thingy:91 X

03

The cellular IoT prototyping platform combines an nRF9151 LTE-M / NB-IoT / NR+ / GNSS SiP, nRF7002 Wi-Fi location, nRF5340 Bluetooth / USB processing, sensors, PMIC and battery. Nordic documents high- and low-frequency oscillator domains for the nRF9151, with the SiP integration boundary containing the associated crystal function.

GNSS + Cellular SiP → Wi-Fi / BLE + Sensors → nRF Cloud Services

Design focus: an integrated SiP clock domain does not require a separate board-level oscillator. Review only the external hosts, peripherals, RTCs or filters exposed by the board architecture.

QUECTEL

LG69T(AP) Vehicle Telematics Module

04

The published dual-band architecture supports L1 / L5-family GNSS through two LNA / SAW paths and combines a 26 MHz TCXO, 16 MHz MCU crystal, two 32.768 kHz domains, a six-axis IMU, wheel-tick / CAN inputs and UART / USB. Public product information identifies dead reckoning, RTK support, 10 Hz operation and AEC-Q100 qualification.

Dual-Band GNSS RF → GNSS + IMU / DR → CAN / Wheel Tick / Host

Design focus: dual-band RF, receiver reference, MCU clock and always-on domains must be allocated separately. The module integrates these functions; a discrete design may expose equivalent positions.

How to use these examples: the public platforms illustrate representative system architectures and potential clock locations. Component use, qualification and exact frequencies remain specific to each customer design; no third-party endorsement or existing FCom design-in is implied.

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FCom Selection Guidance by Critical Function

The four representative FCom options below focus on positions that materially affect embedded GNSS, sleep current, host clocking or RF coverage. Each evaluation begins with confirmation of the integration boundary and electrical interface.

Decision 1 • Exposed GNSS Receiver Reference

FVT-6S • 26.000 MHz configuration

Compact clipped-sine TCXO class for a receiver that explicitly requires an external 26 MHz reference. Evaluate this option only when the selected GNSS device exposes a compatible clock input.

Series window: 2016 • 10-52 MHz • clipped sine
Stability / temp.: ± 0.5 ppm option • -40 to +85°C
Supply options: 1.8 / 2.5 / 2.8 / 3.0 / 3.3 V
Phase-noise ref.: -115 / -135 / -148 dBc/Hz @ 100 Hz / 1 kHz / 10 kHz
Confirm: Input amplitude / load • enable • phase-noise mask • dynamics

Decision 2 • Low-Current CMOS Timebase

FCO-6K-UC • 32.768 kHz

Ultra-low-current CMOS oscillator for a PMIC, MCU or host that accepts an active 32.768 kHz clock. It provides a defined clock output without relying on the host crystal loop.

Package / output: 2016 • CMOS
Supply: 1.5 / 1.8 V
Stability / temp.: ± 20 ppm • -40 to +105°C
Current reference: 1.4-1.8 μ A across listed supply options
Confirm: Host clock-input level • enable behavior • total sleep-current budget

Decision 3 • Rugged Host / PHY Crystal

FCX-1S-A

Miniature passive crystal for an exposed MCU or PHY oscillator loop in vehicle or industrial trackers. An external CMOS oscillator should be evaluated when the host requires a driven clock input.

Selection window: 1210 • 24-76.8 MHz • AEC-Q200
Tolerance / stability: ± 10 ppm option • ± 50 ppm option
Temperature: -40 to +125°C
Load / ESR: 18 pF or specify • 60-100 Ω frequency-dependent range
Confirm: Exact frequency • CL • C0 • drive • negative resistance

Decision 4 • Primary GNSS RF Path

FSF3030-1575M42-32M736-1.4-30

Upper-band SAW reference for the L1 / E1 / B1C path. L2, L5 / E5 and BeiDou B3 are treated as separate RF channels and matched to the receiver band plan.

Center / bandwidth: 1575.42 MHz • 32.736 MHz
Reference values: 1.4 dB insertion loss • 30 dB stopband value
Selection relevance: Directly affects supported constellations and RF coexistence
Application inputs: Full rejection mask • matching • S-parameters • B11 / GLONASS coverage

Passive RTC Option • 32.768 kHz Crystal Class

1210 • 32.768 kHz • ± 5 ppm option • -40 to +125°C • CL 6-12.5 pF • ESR 70-90 k Ω . Evaluate only with a host crystal loop and verify start-up margin.

Dual-Band GNSS • 1176.45 MHz L5 / E5a / B2a Path

1176.45 MHz • 20 MHz bandwidth • 1.4 dB insertion-loss reference • 40 dB stopband value. Consider only when the receiver exposes an L5 / E5a / B2a RF path.

Regional Sub-GHz • 915 MHz RF Path

915 MHz • 26 MHz bandwidth • 1.5 dB insertion-loss reference • 50 dB stopband value. Confirm region, channel plan, impedance, power and full rejection mask.

Selection note: the references above are application starting points. Frequency-specific oscillator ordering codes are confirmed after supply, waveform, stability, load, temperature and package review. VCXO, OCXO and crystal-filter families are considered only when the architecture defines a tunable loop, quantified holdover requirement or narrowband IF.

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Primary Technical & Public Architecture References

Platform and frequency statements are based on official semiconductor, module and equipment-manufacturer publications. FCom product specifications reflect the current portfolio information used for this guide.

COMPACT GNSS MODULE

Quectel LG77L Series

Official product and hardware-design sources for package, sensitivity, backup current, L1 RF path, 26 MHz TCXO, 32.768 kHz crystal and 1PPS.

quectel.com · LG77L series

[quectel.com · LG77L hardware design PDF](#)

ASSET-TRACKING REFERENCE DESIGN

ST SL-ASTRA1B

Official architecture for GNSS, BLE, sub-GHz / LoRa, sensors, NFC, security, power management, mobile application and cloud connectivity.

st.com · SL-ASTRA1B

GNSS MODULE CLOCK DOMAIN

ST Teseo-LIV3F

Official module information supporting the 26 MHz TCXO and dedicated 32 kHz RTC-domain example used in the ASTRA architecture.

st.com · Teseo-LIV3F

CELLULAR IOT PLATFORM

Nordic Thingy:91 X

Official platform architecture for nRF9151 GNSS / cellular, nRF7002 Wi-Fi location, nRF5340 Bluetooth / USB, sensors, PMIC and battery.

nordicsemi.com · Thingy:91 X

SiP INTEGRATION BOUNDARY

Nordic nRF9151 Oscillators

Official description of high- and low-frequency oscillator domains used to distinguish integrated SiP timing from an external board-level component.

docs.nordicsemi.com · nRF9151 oscillators

VEHICLE DR / RTK MODULE

Quectel LG69T Series

Official product and hardware-design sources for dual-band GNSS, 26 MHz TCXO, 16 MHz MCU crystal, 32.768 kHz domains, IMU, CAN and wheel tick.

quectel.com · LG69T series

[quectel.com · LG69T hardware design PDF](#)

40 MHZ CONNECTIVITY EXAMPLE

Espressif ESP32-S3

Official hardware-design guidance documenting the external 40 MHz crystal requirements for a widely used Wi-Fi / Bluetooth host platform.

docs.espressif.com · ESP32-S3 schematic checklist

25 MHZ VEHICLE PHY EXAMPLE

TI DP83TC812S-Q1

Official 100BASE-T1 PHY information supporting the 25 MHz vehicle-network reference example and -40 to +125°C operating range.

ti.com · DP83TC812S-Q1

Reference note: public sources establish representative architectures, interfaces and clock / RF positions. A clock shown inside a module or SiP is not assumed to be externally replaceable. Third-party names are included for technical reference and do not imply endorsement, qualification, commercial affiliation or an existing FCom design-in.

07

Minimum Information for an Engineering RFQ

For an accurate recommendation, please provide one requirement set for each GNSS, RTC, host, vehicle-interface or radio function rather than only a general tracker description.

1 • Product & Functional Node

- Vehicle, asset, cargo, industrial, wearable or portable product
- GNSS RF, receiver reference, RTC, host, PHY or radio node
- Selected module / chipset and externally replaceable component position
- Prototype / production architecture and expected product lifetime

2 • GNSS & RF Plan

- Required constellations and exact single- / dual-band signals
- Antenna type, gain, cable and active / passive topology
- SAW-before-LNA or LNA-before-SAW architecture and matching
- Cellular / Wi-Fi / LPWAN coexistence frequencies and transmit power

3 • Clock Electrical Interface

- Exact frequency and crystal / XO / TCXO function
- Passive crystal loop, clipped-sine or CMOS clock input
- Supply, load / termination, amplitude and enable behavior
- For a crystal: CL, ESR, C0, drive level and negative resistance

4 • Power Modes & Time Budget

- Cold / warm / hot start and assisted-GNSS strategy
- Tracking, acquisition, backup, PSM, shipment and off intervals
- Maximum retained-time error over the longest sleep interval
- Wake schedule, 1PPS use and host timestamp requirement

5 • Mechanical & Environmental Profile

- Operating / storage temperature and thermal-gradient profile
- Vibration spectrum, shock, mounting orientation and board resonance
- Package, height, footprint and keep-out constraints
- Power interruption, brownout and controlled-shutdown behavior

6 • Qualification & Program Data

- AEC / industrial qualification and PPAP expectations
- Prototype quantity, validation stage and required sample date
- Annual volume, lifetime and change-control requirements
- Required compliance, reliability and traceability documentation

Acquisition Validation

Measure TTFF, sensitivity and position availability with the production antenna, enclosure, temperature profile, motion and representative sky conditions.

Power Validation

Record current and timing in every acquisition, tracking, modem transmit, PSM, backup and wake state—not only a data-sheet sleep figure.

Coexistence Validation

Test GNSS during cellular, Wi-Fi, BLE and LPWAN transmit events, supply transients and worst-case antenna / cable configurations.

Send one RFQ line per clock or RF-filter function. FCom Engineering will identify the most relevant product series and an efficient validation path. Technical Review →

08

Tracking, Telematics & Embedded Positioning FAQ

Does a tighter TCXO directly guarantee a more sensitive tracker?

No. Sensitivity depends on the antenna, RF loss, filtering, LNA and noise figure, interference, receiver, power mode and firmware. The TCXO must meet the selected receiver reference specification.

Is 1575.42 MHz the GNSS receiver oscillator frequency?

No. It is an RF carrier frequency for the L1 / E1 / B1C family. The receiver local reference is a much lower chipset-specific frequency, commonly within the tens-of-megahertz range.

Does every embedded GNSS platform need an external 26 MHz TCXO?

No. Many modules and SiPs integrate the reference. A discrete TCXO is selected only when the receiver or board architecture exposes a compatible clock input.

Should a 32.768 kHz XO replace every RTC crystal?

No. An ultra-low-current 32.768 kHz XO may be evaluated when the host accepts an active CMOS clock. A host with a crystal loop requires a passive crystal selected for CL, ESR, drive and start-up margin.

Does a 1PPS output eliminate the RTC?

No. 1PPS marks GNSS epochs while available. The local RTC or host clock maintains time through GNSS-off and sleep intervals and schedules future acquisitions.

Will an OCXO improve a battery tracker by default?

Usually not. Size, power and warm-up are difficult to justify unless the architecture provides a compatible input and a quantified holdover requirement that smaller references cannot meet.

Can one 1575.42 MHz SAW cover every GNSS design?

No. Coverage depends on GPS / Galileo / BeiDou / GLONASS signals, bandwidth, insertion loss, group delay, matching and coexistence rejection. Dual-band designs need a separately defined lower path.

Does an automotive-qualified component make the system automotive-qualified?

No. Component qualification supports the design, but system qualification also requires schematic, PCB, thermal, EMC, safety, manufacturing and vehicle-level validation.

Selection principle: define the integration boundary, operating modes and RF / clock interface first; then select frequency, waveform, current, bandwidth, stability, temperature, package and qualification. Public platform names illustrate architecture and do not constitute cross-reference or replacement approval.

09

Convert the Architecture into a Qualified Selection

FCom Engineering reviews each clock or RF-filter function within the complete tracking, telematics or embedded-positioning architecture before confirming a frequency-specific configuration.

01 · Define the Boundary

Identify the GNSS, RTC, host, PHY or radio function and confirm whether the component is externally replaceable.

02 · Define the Interface

Provide the exact frequency, signal family, waveform, supply, load / matching and component location.

03 · Apply the Budget

Allocate current, stability, phase noise, RF loss / rejection, sleep drift, temperature, aging and shock.

04 · Validate the Product

Confirm TTFF, sensitivity, battery life and reporting behavior in the final antenna, RF, enclosure and firmware design.

What to Send

- System block diagram or relevant schematic section
- Selected GNSS, PMIC, MCU, modem, transceiver or vehicle PHY
- GNSS bands, antenna chain and RF rejection requirements
- Clock frequency, waveform, load, stability and current budget
- Power modes, environment, qualification, schedule and annual volume

What FCom Provides

- Representative product series or SAW ordering-code recommendation
- Matched electrical, RF and environmental configuration
- Loading, matching, termination and layout considerations
- Recommended validation checkpoints and documentation scope
- Sample / production feasibility and delivery discussion

Typical Review Outcomes

Defined Function	Recommended Product Class	Information Required for Final Selection
Exposed 26 MHz GNSS receiver reference	Clipped-sine TCXO	Supply, amplitude / load, stability, phase-noise mask, enable, temperature and dynamics
Always-on 32.768 kHz timebase	Ultra-low-current active XO or passive RTC crystal	Host input topology, sleep-current budget, CL / ESR or logic level, start-up and drift interval
Vehicle MCU / PHY crystal loop	AEC crystal or wide-temperature CMOS XO	Exact frequency, CL, ESR, C0, drive, negative resistance and qualification
Single- or dual-band GNSS RF path	Frequency-specific GNSS SAW filter	Signal set, passband, insertion loss, group delay, rejection zones, impedance and RF environment

Discuss Your Tracking or Telematics Architecture

Send the selected chipset, integration boundary, GNSS bands, antenna / RF path, power modes, exact clock or filter requirement, temperature, package and qualification needs. FCom will identify a relevant product direction and validation path for review.

[General Inquiry](#)
[Technical Support](#)

Product-data note: the specifications shown in this guide reflect the current FCom portfolio information. Frequency availability, final guaranteed limits and complete ordering codes are confirmed through application review and the applicable product documentation.