

TIMING & RF FILTERING FOR CONNECTED DEVICES

Smart Home, Security & Connected IoT

This guide supports board-level timing and RF-filter selection for connected hubs, security cameras, video doorbells, sensors, alarm and access-control equipment, IoT nodes and trackers.

Wireless Reference + Always-On RTC + Camera / Network Timing + Conditional Sub-GHz, 2.4 GHz & GNSS Filtering

Smart Home Hub

IP Camera

Video Doorbell

Smart Sensor

Alarm / Access Control

IoT Node

Tracker

Application Scope

Platforms combining an MCU or application processor with Wi-Fi, Bluetooth / BLE, Zigbee, Thread, Matter, Sub-GHz radio, Ethernet, GNSS, camera and always-on control functions.

Selection Philosophy

Selection begins with the system node and receiving interface. A passive crystal is evaluated for documented XTAL pins, a driven clock for a supported CLKIN mode, and an RF filter only where the complete antenna-to-radio design provides a defined insertion point.

Low-Power

32.768 kHz RTC, wake scheduling and retained-time reference.

Wireless

MHz reference for Wi-Fi, BLE, Thread, Zigbee or multi-band radio.

Camera / Network

Processor, image-sensor interface and optional Ethernet PHY timing.

RF / GNSS

Conditional SAW filtering at documented Sub-GHz, 2.4 GHz or L1 nodes.

Battery Sensor Priority

Minimize standby current and startup energy while maintaining the required reference accuracy and predictable wake timing.

Camera / Doorbell Priority

Coordinate wireless, video-processing and network-clock domains without assuming that every derived high-speed clock requires an external oscillator.

Gateway Priority

Treat each radio, host and Ethernet clock interface independently; module-integrated references remain inside the module boundary.

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Application Scope & Engineering Domains

Connected devices span ultra-low-power sensor nodes, video platforms, multi-radio gateways and location-aware trackers.

Timing and RF filtering address different system requirements. A clock source establishes the frequency or time reference at an oscillator or CLKIN node. A SAW or crystal filter provides RF / IF selectivity and is selected against the complete channel, loss, impedance and interference requirements.

Typical Equipment

Connected Control

Smart Home Hub
Alarm Panel
Access Controller
Home-Automation Bridge
Multi-Protocol Gateway

Video Security

IP Camera
Security Camera
Video Doorbell
Battery Camera
Camera-Enabled Intercom

Distributed IoT

Smart Sensor
Asset Tracker
Environmental Node
Connected Lock
Wireless Detector

Six Engineering Domains

MCU / SoC

Processor and baseband reference at passive XTAL or driven-clock pins.

RTC / Sleep

Always-on time, wake interval and retained state across low-power modes.

2.4 / 5 GHz

Wi-Fi and BLE / 802.15.4 timing; conditional external RF selectivity.

Sub-GHz

433 / 868 / 915 MHz regional or proprietary radio paths.

GNSS

Tracker receive path and optional high-accuracy reference in chip-down designs.

Camera / Ethernet

Video-processing and wired-network reference domains where exposed.

Passive Crystal Path

Receiver XTAL pins → exact frequency → CL / ESR → drive and startup → tolerance / stability → package.

Driven Clock Path

Supported CLKIN / bypass mode → VDD and waveform → load / OE → accuracy, phase noise and power.

RF Filter Path

Antenna topology → insertion point → passband / stopband → loss → impedance / matching → RF power.

Power State

Active · idle · standby · deep sleep · wake latency.

Integration

Chip-down IC · certified module · carrier board · sensor module.

Environment

Temperature · vibration · aging · enclosure detuning.

Validation

Oscillation margin · frequency offset · RF loss · coexistence · EMC.

Architecture boundary: a reference already integrated in a wireless, GNSS or camera module is not normally duplicated on the host PCB. A board-level FCom component may be evaluated only where the design provides a customer-selectable clock or filter position.

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Select by System Node First

Selection should begin with the target IC documentation and schematic interface before frequency, device class or package is considered.

System Node	Clock / RF Role	Representative Frequency	Typical Device	Selection Focus
Always-On RTC	Retained time and wake scheduling	32.768 kHz	Tuning-fork crystal / low-current XO	XTAL vs CLKIN · CL / ESR · current · startup
BLE / 802.15.4 Host	Radio and system reference	32 MHz class	Miniature MHz crystal	SoC oscillator limits · RF accuracy · package
Wi-Fi / Connected MCU	RF synthesizer and processor reference	37.4 / 40 MHz class	MHz crystal / supported TCXO	platform-specific frequency · CL · ESR · ppm
Multi-Band Sub-GHz MCU	MCU and radio calibration reference	48 MHz class	MHz crystal	radio requires HF XO · CL / ESR · startup margin
Ethernet PHY	Wired-network reference	25 MHz; 50 MHz CLKIN on selected PHYs	MHz crystal / CMOS clock	crystal mode vs RMI clock input · jitter · load
GNSS Receiver	Receiver local reference	Device-specific MHz reference	Crystal / TCXO / module-internal source	chip-down interface · accuracy · waveform · power
External RF Front End	Channel or coexistence selectivity	433.92 / 868 / 915 / 2437 MHz class	SAW filter	full mask · loss · impedance · matching · RF power
GNSS L1 Receive Path	Out-of-band blocking ahead of LNA / receiver	1575.42 MHz	SAW filter	pre- or post-LNA position · noise figure · ESD / power

1 · Identify the Receiver

Record the exact MCU, wireless IC, Ethernet PHY, GNSS receiver, camera processor or module and the relevant pins.

2 · Define the Interface

Confirm passive XTAL, driven CLKIN, module-integrated reference or RF filter insertion point before assigning a product family.

3 · Apply the Limits

Use CL / ESR / drive for crystals; VDD / waveform / load for XOs; and the complete loss / attenuation / impedance mask for filters.

Documented XTAL Pins

Evaluate a passive crystal at the exact frequency and verify oscillator margin across PCB parasitics, voltage, temperature and production spread.

Representative FCom options: FCX / FCT crystal families

Documented CLKIN / Bypass

Consider a driven source only when the receiver specifies the input amplitude, common mode or logic levels, loading and enable sequence.

Representative FCom options: FCO / FVT families

Documented RF Insertion Point

Evaluate a SAW or narrowband IF filter against the full RF chain, channel plan, matching network and coexistence target.

Representative FCom options: FSF; conditional FCF

Recommended sequence: system node → integration boundary → electrical interface → frequency → component class → accuracy / loss → power and temperature → package → board-level validation.

Protocol name alone is not a sufficient selection basis: Wi-Fi, BLE or Matter platforms may use different reference frequencies and oscillator interfaces. Matter is an application layer; clock selection follows the underlying Wi-Fi, Thread / 802.15.4, BLE and host hardware.

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Frequency & Component Placement Matrix

The frequencies below represent external positions documented in public platforms or common interface specifications; they are not interchangeable.

Frequency	Representative System Position	Applicability	Selection Interpretation
32.768 kHz	RTC, sleep timer, retained time, radio low-frequency clock	Optional / Always-On	Passive crystal at LF XTAL pins or a microamp-class XO at a documented low-frequency CLKIN.
25 MHz / 50 MHz	Ethernet PHY crystal or selected RMII clock-input architecture	Wired Network	25 MHz is a common PHY crystal / clock input; selected PHYs use a 50 MHz input for RMII. Follow the exact PHY mode.
32 MHz	BLE / 802.15.4 host or multiprotocol wireless SoC	Wireless HFXO	Miniature passive crystal on chip-down implementations; confirm CL, ESR and radio-accuracy budget.
37.4 MHz	Selected Wi-Fi / BLE connected MCU system reference	Platform-Specific	Public CYW55913 architecture example; not a generic Wi-Fi frequency and often integrated on a carrier or module.
40 MHz	ESP32-S3 chip-down reference; nRF7002 Wi-Fi companion	Common Wi-Fi Class	Match the receiving IC limits. The Nordic reference BOM, for example, specifies 1612, CL 8 pF and ESR ≤100 Ω.
48 MHz	CC1352P7 multi-band wireless MCU HFXO	Sub-GHz + 2.4 GHz	This public platform requires the external HFXO for radio operation; the optional 32.768 kHz source remains a separate low-frequency domain.
433.92 / 868 / 915 MHz	Regional or proprietary Sub-GHz RF filter path	RF Filter — Not a Clock	Center frequency and bandwidth are RF parameters. Select only from the complete channel plan and front-end mask.
2437 MHz class / 1575.42 MHz	Conditional 2.4 GHz coexistence filter / GNSS L1 receive filter	RF Filter — Not a Clock	Validate usable passband, insertion loss, source / load impedance, matching and location relative to the LNA or switch.

Always-On

32.768 kHz for retained-time and low-power clock domains.

Wireless HFXO

32 / 37.4 / 40 / 48 MHz according to the exact chip-down device.

Wired Network

25 MHz crystal / clock or selected 50 MHz RMII input.

RF Selectivity

Sub-GHz, 2.4 GHz and GNSS L1 are filter-center frequencies.

Three-way cross-check: confirm the exact frequency range, the exact electrical interface and the exact RF mask. A nominal frequency match alone does not establish drop-in compatibility.

Derived clocks: CPU, camera pixel, CSI / DVP, USB and internal peripheral clocks are often PLL- or divider-derived. An external oscillator should be considered only where the system schematic and receiving device expose a suitable reference input.

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Representative Platform & Architecture Matrix

Four public platforms illustrate multi-radio gateways, camera-enabled connected devices, Sub-GHz sensor nodes and module-integrated Wi-Fi / BLE timing.

NORDIC SEMICONDUCTOR

nRF7002 DK · Wi-Fi 6 + BLE / Thread Host

1

Architecture: an nRF5340 host provides BLE / 802.15.4 processing while the nRF7002 companion provides dual-band Wi-Fi 6 connectivity.

Timing evidence: nRF5340 uses a 32 MHz HFXO and optional 32.768 kHz LFXO. nRF7002 uses a 40 MHz crystal or supported external TCXO; its public reference BOM specifies 1612, CL 8 pF and ESR $\leq 100 \Omega$.

32 MHz + 32.768 kHz → nRF5340 Host → 40 MHz · nRF7002

Representative FCom options: FCX-1M at 32 / 40 MHz and FCT-1M at 32.768 kHz. Exact CL / ESR and oscillator margin require confirmation on the target PCB.

ESPRESSIF SYSTEMS

ESP32-S3-EYE · Connected Vision Endpoint

2

Architecture: an ESP32-S3-WROOM-1 module interfaces to the OV2640 camera, digital microphone and LCD for vision, voice and Wi-Fi / BLE applications.

Timing evidence: ESP32-S3 chip-down hardware uses a 40 MHz main crystal with a ± 10 ppm crystal requirement; 32.768 kHz is optional for the RTC domain. On the EYE board, the module contains the main reference.

40 MHz · Chip-Down → ESP32-S3 → Camera / Wi-Fi / BLE

Representative FCom options: FCX-1M or FCX-1S at 40 MHz, with an optional FCT for a chip-down implementation. A host-board crystal would not normally be added when the selected module already integrates the reference.

TEXAS INSTRUMENTS

LP-CC1352P7-1 / -4 · Multi-Band Sensor & Alarm Node

3

Architecture: the CC1352P7 combines a low-power MCU, sensor controller, Sub-1 GHz radio and 2.4 GHz multiprotocol radio for Thread, Zigbee, Matter, BLE and proprietary systems.

Timing evidence: the device exposes 48 MHz crystal pins and optional 32.768 kHz crystal pins. TI specifies that radio operation requires the external 48 MHz crystal.

48 MHz HFXO → CC1352P7 → 433 / 868 / 915 + 2.4

Representative FCom options: FCX-1M / FCX-1S at 48 MHz and optional FCT at 32.768 kHz; regional FSF filters may be evaluated only where a custom RF front end provides the required insertion point.

INFINEON TECHNOLOGIES

CYW955913EVK-01 · Wi-Fi 6E + BLE Connected MCU

4

Architecture: the CYW55913 evaluation platform uses an M.2 carrier with Wi-Fi / BLE RF switching, band-pass filtering, matching and external memory.

Timing evidence: the carrier has a 37.4 MHz system crystal and supports an internal low-power oscillator or an external 32.768 kHz crystal / reference for higher accuracy.

37.4 MHz → CYW55913 → Wi-Fi 6E / BLE

Representative FCom options: FCX-1M at 37.4 MHz and FCT-1M at 32.768 kHz may be considered for chip-down or custom-module designs. The evaluation carrier already integrates its references and RF filtering.

Use of public platforms: these examples are presented solely to illustrate representative clock positions and integration boundaries. They do not imply qualification, endorsement or drop-in compatibility. Final selection should follow the latest target-device documentation and board-level validation.

Independent Clock Loops

A gateway may require separate references for the host, Wi-Fi companion, low-frequency domain and Ethernet PHY. Similar frequencies do not make the loops interchangeable.

Module Integration Boundary

ESP32-S3-EYE and CYW955913EVK-01 illustrate how a module or carrier may already contain its reference. The host PCB would not normally duplicate it.

RF Path Boundary

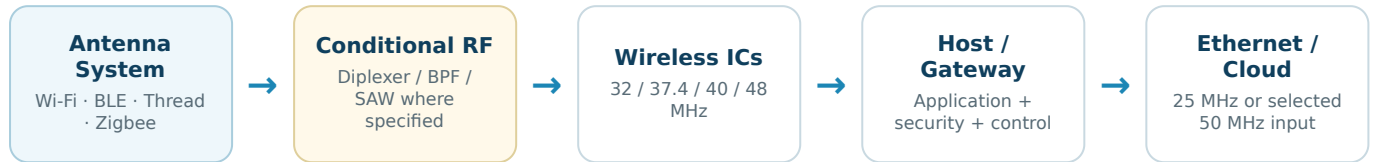
The public boards also show that RF switching, diplexing, matching or filtering may be integrated. An additional SAW should be considered only for a defined custom front end.

Purpose of the platform matrix: the examples help identify transferable clock positions and integration constraints before an FCom series is evaluated. The matrix should not be used as a component cross-reference or approved-vendor list for the named platforms.

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Smart Hub / Multi-Protocol Gateway Architecture

A gateway can contain several independent timing loops; each is selected from its own receiving interface and integration boundary.



Host Wireless HFXO

A passive MHz crystal may be used at the documented host oscillator pins; 32 and 48 MHz are public platform examples.

Representative FCom options: FCX-1M / FCX-1S

Wi-Fi Companion HFXO

A Wi-Fi companion may require its own 40 MHz loop even when the host uses a separate 32 MHz reference.

Representative FCom option: FCX-1M at 40 MHz

Always-On Domain

An optional 32.768 kHz crystal may support retained time and low-power radio or wake scheduling where documented.

Representative FCom option: FCT-1M

Ethernet PHY

Evaluate the PHY-specified 25 MHz crystal / clock or a supported 50 MHz RMII input; the required reference should not be inferred from line rate.

Representative FCom options: FCX-1M or FCO-6C

Driven External Clock

A CMOS source may be considered only for a supported CLKIN / bypass mode with compatible VDD, waveform and load.

Representative FCom option: FCO-6C

2.4 GHz RF Selectivity

Evaluate an external filter only when the radio reference design and regional channel plan match its usable passband and attenuation mask.

Conditional FCom option: FSF1109-2437M-69M-1.1-30

MHz XTAL Compact HFXO

Selection role

Chip-down host, Wi-Fi companion or Ethernet PHY using passive oscillator pins.

Published capability

FCX-1M · 1612 4-SMD · 24–60 MHz · tolerance to ± 5 ppm · stability to ± 10 ppm · -40 to $+125^{\circ}\text{C}$ · CL specified · ESR 30–60 Ω .

Application interpretation

Frequency, CL, ESR, drive and oscillator margin remain configuration- and receiver-specific; the complete ordering code is confirmed during application review and quotation.

32 KHz XTAL RTC / Sleep

Selection role

Optional always-on crystal where the receiving IC exposes low-frequency XTAL pins.

Published capability

FCT-1M · 1610 2-SMD · 32.768 kHz · tolerance to ± 5 ppm · -40 to $+125^{\circ}\text{C}$ · CL 6–12.5 pF · ESR 70–90 k Ω .

Application interpretation

Confirm the receiver ESR ceiling, effective PCB load, drive level, startup and the actual sleep-current benefit.

RF SAW Conditional 2.4

Selection role

External 2.4 GHz receive / coexistence filter at a documented 50 Ω insertion point.

Published capability

FSF1109-2437M-69M-1.1-30 · CSP1109 · center 2437 MHz · bandwidth 69 MHz · insertion loss 1.1 dB · stopband attenuation 30 dB.

Application interpretation

The complete part number is shown; usable channel coverage, loss and attenuation remain subject to the system mask and RF validation.

Reference-sharing consideration: a reference should not be shared between unrelated oscillator loops unless both receiving devices explicitly support the topology. Separate clocks may simplify startup, power-state control and RF-frequency budgeting.

Validation sequence: verify passive-crystal startup and frequency offset first, then confirm wireless sensitivity / EVM, Ethernet link performance, sleep-current impact and coexistence in the final enclosure.

06 Camera, Sensor, Alarm & Tracker Architectures

Three endpoint patterns show where timing is normally required and where RF filtering remains conditional.

IP Camera / Video Doorbell

A 40 MHz-class wireless reference may serve a chip-down Wi-Fi SoC. Camera pixel and video clocks are commonly supplied or synthesized by the processor and should not be treated as automatic external XO positions.

Representative FCom options: **FCX-1M / FCX-1S; optional FCT**

Sub-GHz Sensor / Alarm

A 48 MHz-class HFXO may serve the MCU / radio, with an optional 32.768 kHz source for the low-power domain. A 433 / 868 / 915 MHz SAW should be considered only within a defined custom antenna-to-radio path.

Representative FCom options: **FCX / FCT; conditional FSF**

GNSS / BLE Tracker

The GNSS module may integrate its own reference and RF filtering. In a chip-down receiver, an L1 SAW and a documented crystal / TCXO input may provide customer-selectable positions.

Conditional FCom options: **FSF L1 + FVT where supported**



Representative Complete FCom SAW Part Numbers

RF Position	Complete FCom Part Number	Published Matrix Parameters	Application Check
433.92 MHz Sub-GHz	FSF3030-433M92-1M71-2.5-50	SMD3030 · BW 1.71 MHz · IL 2.5 dB · stopband 50 dB	regional channel plan · mask · matching
868 MHz Sub-GHz	FSF3030-868M-10M-1.9-40	SMD3030 · BW 10 MHz · IL 1.9 dB · stopband 40 dB	usable passband · blocker profile · RF power
915 MHz Sub-GHz	FSF1109-915M-26M-1.5-50	CSP1109 · BW 26 MHz · IL 1.5 dB · stopband 50 dB	band edge · impedance · layout / matching
1575.42 MHz GNSS L1	FSF3030-1575M42-32M736-1.4-30	SMD3030 · BW 32.736 MHz · IL 1.4 dB · stopband 30 dB	pre- / post-LNA position · noise figure · ESD

PRECISION REF

Conditional TCXO

Selection role

Chip-down GNSS receiver or wireless IC with a documented clipped-sine TCXO input and an accuracy requirement beyond a standard crystal.

Published capability

FVT-6S · 2016 6-SMD · 10-52 MHz · 1.8 / 2.5 / 2.8 / 3.0 / 3.3 V · stability to ±0.5 ppm · -40 to +85°C · clipped sine.

Application interpretation

Confirm exact frequency, input amplitude, current, enable strategy and startup. A module-internal reference would not normally be replaced at host-board level.

Endpoint Validation Focus

Camera: wireless frequency offset, video streaming load and conducted / radiated coexistence.

Sensor: HFXO startup, sleep / wake energy, RTC drift and packet timing.

Sub-GHz: usable passband, sensitivity, blockers, harmonics and regional compliance.

Tracker: GNSS noise figure, cold start, LNA linearity, BLE coexistence and enclosure loss.

Narrowband IF application: an FCF crystal filter may be considered only for a defined narrowband IF architecture. The FCF-7M series / 45MQ15A type requires a 45 MHz receiver design with matching bandwidth, insertion-loss, termination and attenuation requirements.

07

FCom Selection Guidance by Design Condition

The options below are limited to architectural or specification choices that materially affect the application.

RTC / Sleep

Passive 32.768 kHz crystal or a driven low-current clock where supported.

Wireless / Network

Miniature MHz crystal or CMOS clock selected from the receiver interface.

Precision Reference

Conditional TCXO for a documented high-accuracy clipped-sine input.

RF Selectivity

An exact SAW P/N is evaluated only after the full front-end mask and insertion point are defined.

Design Condition	Representative FCom Option	Published Capability / Selection Value	Key Check Before RFQ
Minimum-area passive RTC crystal	FCT-1S	1210 2-SMD · 32.768 kHz · tolerance to ± 5 ppm · -40 to $+125^{\circ}\text{C}$ · CL 6–12.5 pF · ESR 70–90 k Ω .	LF XTAL mode · CL · ESR ceiling · startup
Compact 24–60 MHz wireless / network XTAL	FCX-1M FCX-1S where 1210 area is required	FCX-1M: 1612, 24–60 MHz, ESR 30–60 Ω . FCX-1S: 1210, 24–76.8 MHz, ESR 60–100 Ω . Both offer tolerance to ± 5 ppm, stability to ± 10 ppm and -40 to $+125^{\circ}\text{C}$.	frequency · CL · ESR · drive · negative resistance
Driven 32.768 kHz with microamp-class current	FCO-6K-UC	2016 4-SMD · 32.768 kHz · 1.5 / 1.8 V · ± 20 ppm · -40 to $+105^{\circ}\text{C}$ · CMOS · 1.4–1.8 μA .	CLKIN support · amplitude · current · OE / startup
Driven 1.5–50 MHz CMOS reference	FCO-6C	2016 4-SMD · 1.5–50 MHz · 1.8 / 2.5 / 3.3 V · ± 20 ppm · -40 to $+125^{\circ}\text{C}$ · CMOS · 7–15 mA.	bypass mode · VDD / logic · load · enable sequence
Documented precision clipped-sine input	FVT-6S	2016 6-SMD · 10–52 MHz · 1.8–3.3 V options · stability to ± 0.5 ppm · -40 to $+85^{\circ}\text{C}$ · clipped sine · ± 5 ppm pull option.	exact frequency · amplitude · current · TCXO / VCTCXO mode
Regional Sub-GHz external filter	FSF3030-433M92-1M71-2.5-50 FSF3030-868M-10M-1.9-40 FSF1109-915M-26M-1.5-50	Complete P/Ns at 433.92 / 868 / 915 MHz. Published bandwidth, insertion-loss and stopband values differ by device and are listed on the preceding page.	band plan · full mask · impedance · matching · RF power
2.4 GHz or GNSS L1 external filter	FSF1109-2437M-69M-1.1-30 FSF3030-1575M42-32M736-1.4-30	Complete P/Ns. 2437 MHz: CSP1109, 69 MHz BW, 1.1 dB IL, 30 dB stopband. 1575.42 MHz: SMD3030, 32.736 MHz BW, 1.4 dB IL, 30 dB stopband.	usable passband · LNA position · NF · ESD / coexistence
Special proprietary narrowband IF	FCF-7M series / 45MQ15A type	7050 6-SMD crystal-filter configuration at 45 MHz. Consider only where the defined IF, bandwidth, termination and attenuation requirements match.	IF architecture · bandwidth · insertion · termination

Ordering configuration: FCT, FCX, FCO, FVT and FCF entries are shown at series or series / type level because frequency, CL, voltage, output and option suffixes determine the complete ordering code. FCom confirms the final code against the applicable specification during application review and quotation. The FSF entries above are complete part numbers and remain subject to system-level RF validation.

ENGINEERING SELECTION SUPPORT

Request a Smart Home / Connected IoT Review

For an application review, provide the target MCU, wireless IC, Ethernet PHY, GNSS receiver or module, together with the clock pins, frequency, CL / ESR or supply / waveform, RF insertion point, full filter mask, package and project stage.

[Start Engineering Review →](#)

08

Engineering Validation & Minimum RFQ

Clock and RF selections should be based on the receiving interface, operating states, environment and complete front-end requirements—not frequency alone.

Passive Crystal

- Exact IC and XTAL pins
- Frequency and tolerance / stability budget
- CL, ESR, C0 and drive level
- negative-resistance / startup margin
- layout parasitics and temperature range

Driven XO / TCXO

- Supported CLKIN or bypass mode
- VDD, waveform, amplitude and load
- OE behavior and power sequence
- current in each operating state
- accuracy, jitter or phase-noise requirement

SAW / IF Filter

- Antenna-to-radio block diagram
- insertion point and source / load impedance
- full passband / stopband mask
- allowed insertion loss and group delay
- RF power, ESD and coexistence blockers

System Conditions

- active, standby and deep-sleep states
- startup / wake latency target
- voltage and temperature range
- package and placement constraints
- certification, lifetime and compliance needs

Minimum RFQ Information

Information Category	What to Provide
Application / System Node	Hub, camera, doorbell, sensor, alarm, access control, tracker or IoT node; identify the exact clock or RF-filter location.
Target Device / Module	Exact MCU, Wi-Fi / BLE / 802.15.4 / Sub-GHz IC, Ethernet PHY, GNSS receiver or module part number and schematic pins.
Clock Requirements	Frequency, interface type, CL / ESR / drive or VDD / waveform / load, accuracy, startup, power state and temperature.
RF Requirements	Center frequency, usable passband, complete attenuation mask, insertion loss, impedance, matching, RF power and LNA / switch position.
Mechanical / Reliability	Package, height, assembly process, board environment, shock / vibration, aging, lifecycle and required qualification documents.
Program Requirements	Prototype quantity, sample date, annual volume, manufacturing location, certification plan and production release schedule.

Oscillation Validation

Measure startup and frequency offset, confirm negative-resistance margin and retune load capacitance on the production PCB.

Power-State Validation

Verify reference startup, enable sequencing and average current across connect, transmit, standby, sleep and wake cycles.

RF Validation

Measure insertion loss, return loss, sensitivity, blocker performance, coexistence and radiated behavior in the final layout and enclosure.

Selection confirmation: complete ordering information can be issued once the target interface and configuration are defined. Board-level results remain the final basis for approving a timing or filter component for production.

Application-review deliverables: an FCom review identifies candidate series or complete SAW part numbers, configuration assumptions, open technical items and the board-level checks required before release.

09

Engineering FAQ & Application Review

Common Smart Home and Connected IoT questions, representative public references and the information required for FCom engineering review.

Does every connected node need a 32.768 kHz crystal?

No. Some devices use an internal RC or synthesized clock. An external crystal may be considered when accuracy, standby-energy or protocol requirements justify it.

Can a 40 MHz crystal be used for any Wi-Fi design?

No. 40 MHz is common in selected platforms, but the exact frequency, CL, ESR and accuracy follow the receiving IC and implementation.

Can a CMOS XO replace a passive crystal?

Only when the target device provides a supported external-clock / bypass mode with compatible voltage, waveform and amplitude limits.

Does a wireless module need another host-board crystal?

Normally no. A host-board crystal is applicable only if the module exposes a documented reference input or the design moves to chip-down integration.

Does every 433 / 868 / 915 MHz radio need a SAW filter?

No. Use depends on the radio reference design, antenna topology, regulatory band, blocker environment and required front-end selectivity.

Is a 2.4 GHz SAW the Bluetooth or Wi-Fi clock?

No. It is an RF filter. The carrier is synthesized from a lower-frequency MHz reference.

Where should a GNSS L1 filter be placed?

The correct position is architecture-specific. Pre- and post-LNA placement create different noise-figure, linearity, ESD and blocking trade-offs.

When is an MCF appropriate?

An MCF may be considered for a defined narrowband IF receiver with matching center frequency, bandwidth, attenuation and termination; it is not a general-purpose IoT filter.

Representative Public Technical References

1. **Nordic Semiconductor:** nRF7002 product specification — 40 MHz crystal / TCXO pins and 1612 reference-BOM requirements.
2. **Nordic Semiconductor:** nRF5340 oscillator control — 32 MHz HFXO and 32.768 kHz LFXO.
3. **Espressif Systems:** ESP32-S3 hardware guidelines — 40 MHz main crystal and optional 32.768 kHz RTC crystal.
4. **Espressif Systems:** ESP32-S3-EYE guide — connected-camera platform and module boundary.
5. **Texas Instruments:** CC1352P7 datasheet — 48 MHz HFXO, optional 32.768 kHz clock and multi-band radio architecture.
6. **Infineon Technologies:** CYW955913EVK-01 user guide — 37.4 MHz system crystal and low-power clock options.
7. **Analog Devices:** ADIN1300 product information — 25 MHz crystal / clock input and selected 50 MHz RMII clock input.
8. **FCom Fuji Crystal:** timing and RF product information and application-engineering contact.

FCom product specification note: this guide presents product information at series, series / type or complete SAW part-number level, as indicated. Guaranteed limits, complete ordering codes and availability are confirmed in the applicable FCom specification and quotation.

ENGINEERING REVIEW

Smart Home, Security & Connected IoT Review

Share the system block diagram, exact IC / module, clock pins, frequency and electrical requirements, together with the RF insertion point and full filter mask. FCom application engineering can then identify candidate devices for board-level validation.

[Request Engineering Review →](#)
[FCom Solutions](#)

This guide provides representative application and product-selection guidance. Final device selection should be confirmed against the latest target-device documentation and applicable FCom product specification, followed by validation on the complete PCB and system. RF performance, EMC, battery life, functional safety, cybersecurity and regulatory compliance remain system-level responsibilities of the equipment manufacturer.