APPLICATION NOTE

Accelerating Wireless Coexistence Testing for Medical Devices

Achieving Repeatable, Realistic Validation with Automation and Multi-Interference Simulation

KEYSIGHT

Faster, Repeatable, More Realistic Validation

Wireless connectivity is fundamental to modern medical devices, enabling real-time monitoring and data exchange. However, operation in congested RF environments, such as hospitals, introduces persistent coexistence challenges where interference is no longer exceptional but expected.

Standards such as ANSI C63.27 provide structured methodologies to evaluate coexistence performance. However, manufacturers still face key challenges in expanding test coverage, maintaining repeatability, and meeting increasingly compressed development timelines.

Accelerating coexistence testing is not simply about executing tests faster, but about reducing the overall validation effort by minimizing redundant scenarios, enabling realistic interference conditions, and ensuring repeatability and traceability of results, to keep pace with modern medical device development cycles.

Conventional Test Approaches

Traditional approaches often rely on manually configuring individual interferers and executing tests sequentially. This leads to:

- Redundant test cycles across similar conditions
- Limited test scenario coverage due to time constraints
- Inefficient reproduction of real-world RF density

In addition, coexistence validation often depends on external test houses for lab-based interference testing. This further constrains validation efficiency by introducing:

- Long lead times from test booking to execution
- Limited flexibility for iterative debugging
- Multiple re-test cycles when devices fail initial validation

As a result, validation cycles become prolonged while still failing to fully capture realistic interference behavior.

Accelerating Coexistence Validation: Beyond Basic Automation

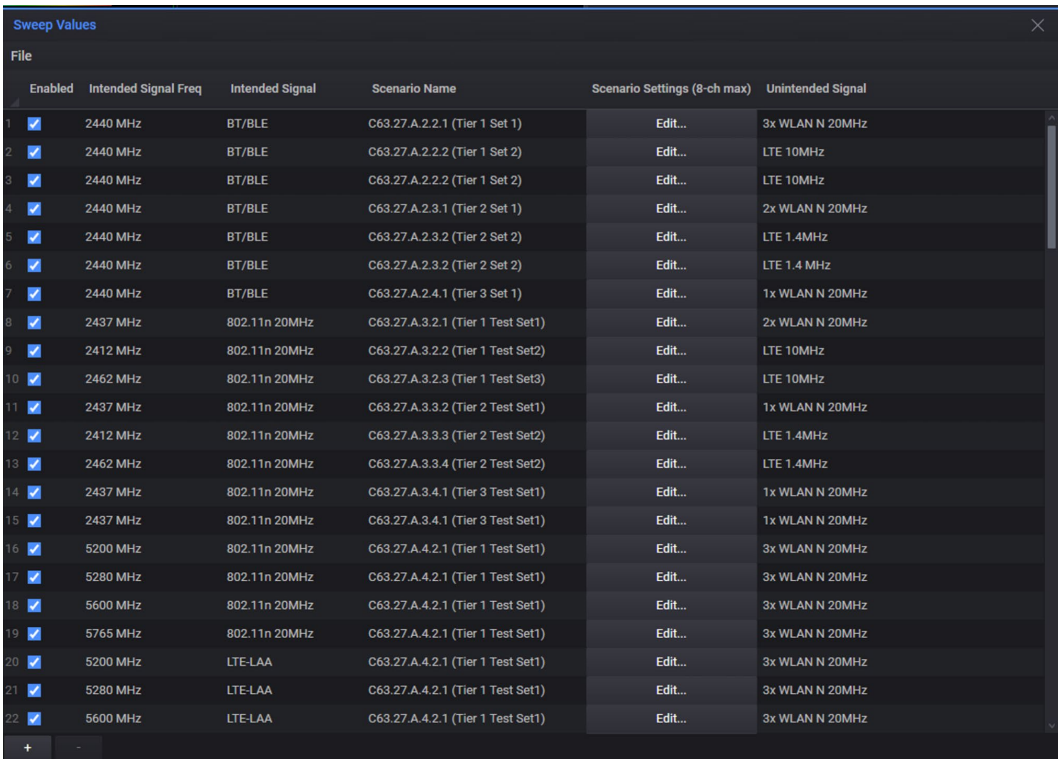
Test automation is widely adopted and plays a critical role in improving efficiency and ensuring consistency in test execution.

However, in wireless coexistence testing, accelerating the testing is not simply about executing tests faster, but about reducing the overall validation effort by minimizing redundant scenarios, enabling realistic environments, and identifying issues earlier in the design cycle.

Automation: The Foundation for Repeatable and Efficient Validation

Automation transforms wireless coexistence testing into deterministic workflow, where instrument, DUT behavior and measurements are fully coordinated. By eliminating manual intervention and enforcing structured test sequences, it ensures consistent and efficient execution of complex test matrices, which brings:

- **Faster validation cycles** through reduced setup time, high-throughput execution, and support for unattended operation
- **Consistent and repeatable results** with controlled test conditions, minimizing operator variability and ensuring reproducibility across runs and sites
- **Improved debug and reporting efficiency** with automated KPI capture, traceability, and faster transition from failure detection to root-cause analysis



	Enabled	Intended Signal Freq	Intended Signal	Scenario Name	Scenario Settings (8-ch max)	Unintended Signal
1	☑	2440 MHz	BT/BLE	C63.27.A.2.2.1 (Tier 1 Set 1)	Edit...	3x WLAN N 20MHz
2	☑	2440 MHz	BT/BLE	C63.27.A.2.2.2 (Tier 1 Set 2)	Edit...	LTE 10MHz
3	☑	2440 MHz	BT/BLE	C63.27.A.2.2.2 (Tier 1 Set 2)	Edit...	LTE 10MHz
4	☑	2440 MHz	BT/BLE	C63.27.A.2.3.1 (Tier 2 Set 1)	Edit...	2x WLAN N 20MHz
5	☑	2440 MHz	BT/BLE	C63.27.A.2.3.2 (Tier 2 Set 2)	Edit...	LTE 1.4MHz
6	☑	2440 MHz	BT/BLE	C63.27.A.2.3.2 (Tier 2 Set 2)	Edit...	LTE 1.4 MHz
7	☑	2440 MHz	BT/BLE	C63.27.A.2.4.1 (Tier 3 Set 1)	Edit...	1x WLAN N 20MHz
8	☑	2437 MHz	802.11n 20MHz	C63.27.A.3.2.1 (Tier 1 Test Set1)	Edit...	2x WLAN N 20MHz
9	☑	2412 MHz	802.11n 20MHz	C63.27.A.3.2.2 (Tier 1 Test Set2)	Edit...	LTE 10MHz
10	☑	2462 MHz	802.11n 20MHz	C63.27.A.3.2.3 (Tier 1 Test Set3)	Edit...	LTE 10MHz
11	☑	2437 MHz	802.11n 20MHz	C63.27.A.3.3.2 (Tier 2 Test Set1)	Edit...	1x WLAN N 20MHz
12	☑	2412 MHz	802.11n 20MHz	C63.27.A.3.3.3 (Tier 2 Test Set2)	Edit...	LTE 1.4MHz
13	☑	2462 MHz	802.11n 20MHz	C63.27.A.3.3.4 (Tier 2 Test Set2)	Edit...	LTE 1.4MHz
14	☑	2437 MHz	802.11n 20MHz	C63.27.A.3.4.1 (Tier 3 Test Set1)	Edit...	1x WLAN N 20MHz
15	☑	2437 MHz	802.11n 20MHz	C63.27.A.3.4.1 (Tier 3 Test Set1)	Edit...	1x WLAN N 20MHz
16	☑	5200 MHz	802.11n 20MHz	C63.27.A.4.2.1 (Tier 1 Test Set1)	Edit...	3x WLAN N 20MHz
17	☑	5280 MHz	802.11n 20MHz	C63.27.A.4.2.1 (Tier 1 Test Set1)	Edit...	3x WLAN N 20MHz
18	☑	5600 MHz	802.11n 20MHz	C63.27.A.4.2.1 (Tier 1 Test Set1)	Edit...	3x WLAN N 20MHz
19	☑	5765 MHz	802.11n 20MHz	C63.27.A.4.2.1 (Tier 1 Test Set1)	Edit...	3x WLAN N 20MHz
20	☑	5200 MHz	LTE-LAA	C63.27.A.4.2.1 (Tier 1 Test Set1)	Edit...	3x WLAN N 20MHz
21	☑	5280 MHz	LTE-LAA	C63.27.A.4.2.1 (Tier 1 Test Set1)	Edit...	3x WLAN N 20MHz
22	☑	5600 MHz	LTE-LAA	C63.27.A.4.2.1 (Tier 1 Test Set1)	Edit...	3x WLAN N 20MHz

Figure-1: Keysight solution provides a built-in library of ~100 predefined ANSI C63.27-aligned test scenarios, further simplify setup, enabling rapid configuration of multi-interference environment.

Advanced Multi-Interference Simulation: Enabling Realistic and Scalable Testing

Conventional coexistence testing often evaluates interference scenarios sequentially, where each interferer is configured and tested independently. While this component-level approach remains essential for isolating performance impacts and supporting root-cause analysis, it is time-consuming and does not fully reflect real-world RF environments, where multiple wireless systems operate simultaneously.

To bridge this gap, the advanced multi-interference simulation enables the concurrent generation and control of multiple interference signals within a single test scenario, supporting realistic emulation of congested RF environments involving Wi-Fi, Bluetooth, LTE, and other wireless technologies, delivering several practical advantages:

- **More realistic coexistence conditions** by emulating simultaneous multi-technology interference as encountered in real deployments
- **Reduced total test iterations** by combining multiple interferers into a single execution, minimizing repetitive scenario testing
- **Accelerated validation cycles** through more efficient scenario execution while maintaining coverage of critical interference conditions

Effective validation therefore requires seamless integration of component-level and composite scenario testing. They form a complementary validation strategy where component-level scenarios provide the diagnostic depth required for root-cause analysis, while composite scenarios deliver the realistic system-level behavior under simultaneous interference conditions. Together with automation, they enable comprehensive coexistence coverage across a broad range of interference conditions while minimizing manual effort.

#	Scenario	Interferer Type	Power Level	# of Concurrent Interferers
1	Baseline (no interference)	N/A	N/A	-
2	Co-channel 802.11n AP	IEEE 802.11n, 20MHz, Ch 40	-20 dBm	1
3	Lower Adjacent-channel 802.11n	IEEE 802.11n, 20MHz, Ch 36	-20 dBm	1
4	Upper Adjacent-channel 802.11n	IEEE 802.11n, 20Mhz, Ch 44	-20 dBm	1
5	C63.27 5GHz Tier-1 Set-1: High-density AP environment	3x 802.11n 20MHz, Ch 36,40,44	-20 dBm	3
6	C63.27 5GHz Tier-1 Set-2: LTE-LAA Co + Lower Adjacent	LTE-LAA 20MHz, EARFCN 47290, 47090	-20 dBm	2
7	C63.27 5GHz Tier-1 Set-2: LTE-LAA Co + Upper Adjacent	LTE-LAA 20MHz, EARFCN 47290, 47490	-20 dBm	2
8	Worst-case aggregate load	3× 802.11n 2x LTE-LAA	Iterates across -23, -20 and -17dBm	5

Table 1. An example of typical tier-1 test scenarios set for a 5GHz Wi-Fi enabled ambulatory infusion pump

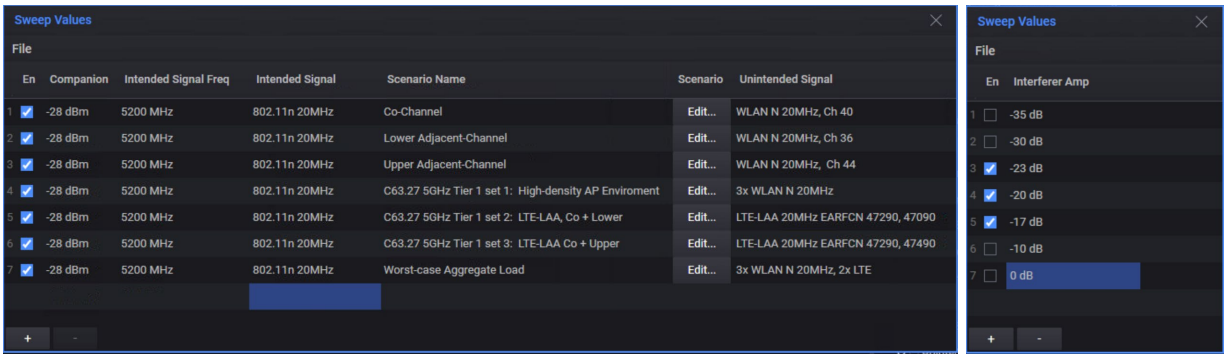


Figure-2: Automated iteration of coexistence test scenarios, including component-level and composite scenarios, with configurable interference sources and power levels using the Keysight Wireless Coexistence Test solution, enabling efficient, repeatable validation and scalable execution across a broad range of test conditions.

Early-Stage Coexistence Validation

An effective strategy for accelerating wireless coexistence validation is to shift validation earlier in the design cycle while leveraging automation to efficiently evaluate a broader range of interference conditions. By automating the creation and execution of both component-level and composite test scenarios, engineers can assess device coexistence performance:

- Before the system reaches full maturity, reducing the risk of late-stage surprise.
- In controlled lab conditions prior to field testing, enabling early issue detection when fixes are less costly.
- Through pre-compliance validation performed internally e-validation before engaging external test houses, allowing iterative debugging and design refinement without lab scheduling constraints or costly re-test cycles.

The result is a faster, more confident path to market. With coexistence issues identified and resolved under controlled lab conditions, rather than discovered during field testing or regulatory submission, teams reduce dependency on external facilities, shorten overall timelines, and enter compliance testing with much greater assurance of success.

Manual vs. Keysight Automated Solution

Comparison of typical conventional manual test bench approaches against Keysight automated solution for a Wi-Fi infusion pump Tier-1 coexistence testing.

Item	Typical Conventional Manual Test	Keysight Wireless Coexistence Solution Automated Test
Test Setup Time	2-4 hours: manual connection and configuration of multiple instruments; manual path loss calibration	<30 minutes: SW automated instrument configuration and path loss calibration. Seamless transition between conducted and radiated in single setup
Scenario Construction	Each scenario built manually from ANSI C63.27 tables: frequency calculation, power level setting, modulation selection — high error risk.	~100 pre-built scenarios auto loaded for selection; Ability to create and play component and composite scenarios.
Multi-Signal Generation	Requires one signal generator per interferer; separate hardware combiner; power calibration for each combination.	Up to 8 simultaneous interference signals from a single instrument; composite waveform managed in software.
KPI Measurement	Manual logging of each KPI per scenario; typically requires a separate measurement script or spreadsheet; error-prone.	Fully automated KPI capture, real-time dashboard, automated pass/fail evaluation per scenario.
Repeatability	Low — power levels, timing, and measurement intervals vary between runs and operators.	High — identical conditions enforced by software; results reproducible across sites and engineers.
Time per 10-Scenario Campaign	Estimated 3–5 days including setup, execution, manual data collation, and report drafting.	Estimated < 1 day including setup, execution, automated report generation, and first failure re-run.
Risk of Non-Compliance	High — scenario parameter errors, missing test cases, and inconsistent measurement conditions are common failure modes.	Low — pre-defined scenarios ensure standards alignment.
Suitability for Pre-compliance	Low — setup overhead makes iterative pre-compliance runs impractical during development.	High — rapid scenario execution supports daily pre-compliance runs throughout development cycle.

Conclusion

Accelerating wireless coexistence testing requires more than simply increasing execution speed. It demands a shift toward efficient, scalable, and realistic validation approach. Keysight's Wireless Coexistence Test Solution enables this transformation by providing:

- Automated, standards-aligned test workflows
- Scalable multi-signal generation and simulation
- Efficient evaluation of complex RF coexistence scenarios

Together, these capabilities help manufacturers to reduce validation time, improve test coverage, and ensure reliable device performance in increasingly congested wireless environments, ultimately supporting faster regulatory approval and safer deployment of connected medical devices.

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