RWC5070M BLE Tester

Operating Manual



Software Version 1.000
(Cross-Platform Release)

Oct. 2026

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1. General Information

This chapter covers general precautions regarding the equipment, warranty information, software licenses, and more.

1.1 Warranty
1.2 Safety Considerations
1.3 Power Requirement
1.4 Operating Environment
1.5 Software License & Warranty

1.1 Warranty

RedwoodComm Warrants that this product will be free from defects in materials and workmanship for a period of two(2) years from the date of shipment. During the warranty period, RedwoodComm Company will, at its option, either repair or replace products that prove to be defective.
For warranty service or repair, customers must notify RedwoodComm of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customers shall be responsible for packaging and shipping the defective product to the service center designated by RedwoodComm. Customers shall prepay shipping charge to RedwoodComm designated service center and RedwoodComm shall pay shipping charge to return the product to customer. Customer is responsible for all shipping charges including freight, taxes, and any other charge if the product is returned for service to RedwoodComm, if the customer is located outside of Korea.

LIMITATION OF WARRANTY
The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, accident or abnormal conditions of operations.
RedwoodComm responsibility to repair or replace defective products is the sole and exclusive remedy provided to the customer for breach of this warranty. RedwoodComm will not be liable for any indirect, special, incidental, or consequential damages irrespective of whether RedwoodComm has advance notice of the possibility of such damages.

1.2 Safety Considerations

Review the following safety precautions to avoid injury and prevent damage to this product or any product connected to it.

1.2.1 Injury Precautions

Use Proper Power Cord
To avoid fire hazard, use only the power cord specified for this product.

Avoid Electric Overload
To avoid electric shock or fire hazard, do not apply a voltage to a terminal that exceeds the specified range

Ground the Product
This product is grounded through the grounding conductor of the power cord. In case no ground is available at the power outlet, it is recommended to provide a separate grounding path to the instrument by connecting a wire between the instrument ground terminal and an earth ground to avoid electric shock or instrument damage. Before making connections to the input or output terminals of the product, ensure that the product is properly grounded.

Do Not Operate Without Covers
To avoid electric shock or product damage, do not operate this product with protective covers removed.

Do Not Operate in Wet/Damp Conditions

To avoid injury or fire hazard, do not operate this product in wet or damp conditions.

Do not use in a manner not specified by the manufacturer

1.2.2 Product Damage Precautions

Use Proper Power Source

Do not operate this product from a power source that applies more than the voltage specified. Main supply voltage fluctuations should not exceed ± 10% of the nominal voltage.

Provided Proper Ventilation

To prevent product overheating, provide proper ventilation.

Do Not Operate With Suspected Failures

If there is damage to this product, have it inspected by qualified service personnel.

Environmental Conditions

Refrain from using this equipment in a place subject to much vibration, direct sunlight, outdoor and where the surface is not level. Also, do not use it where the ambient temperature is outside 5 °C to 40 °C, and altitude is more than 2000m. The maximum relative humidity is 80% for temperatures up to 31 °C, decreasing linearity to 50% relative humidity at 40 °C. Over voltage Installation Category II for mains supply. Pollution Degree 2

1.2.3 Safety Symbols and Terms

Symbols on the Product

The following symbols may appear on the product



Close

Open



ATTENTION



Indicates earth (ground) terminal

WARNING

Warning statements identify conditions or practices that could result in injury or loss of life.

CAUTION

Caution statements identify conditions or practices that could result in damage to this product or other property.

1.3 Power Requirement

This Tester is a portable instrument and requires no physical installation other than connection to a power source. The manufacturer does not take any responsibility for problems that occur when the adapter provided with the product is not used.

Items	Specifications
Input voltage	12V/3A VDC
Input current	1.50A
Power Consumption	Less than 20 watt

CAUTION:
If AC power is beyond the range of operation, the equipment may malfunction or could be permanently damaged. Main supply voltage fluctuations should be not to exceed ±10% of the nominal voltage.

1.4 Operating Environment

Refrain from using this equipment in a place subject to much vibration, direct sunlight, outdoor and where the surface is not level. Also, do not use it where the ambient temperature is outside 5 °C to 40 °C, and altitude is more than 2000m.

The maximum relative humidity is 80% for temperatures up to 31 °C decreasing linearity to 50% relative humidity at 40 °C. Over voltage Installation Category II for mains supply. Pollution Degree 2.

The storage temperature range for this equipment is –20 °C to 70 °C. When this equipment is not used for a long period of time, store it in a dry place away from direct sunlight, covered with vinyl or placed in a cardboard box.

1.5 Software License & Warranty

RedwoodComm provides the RWC5070M PC Application program as an integrated software suite for controlling RWC5070M BLE Tester hardware. The software is protected by copyright laws and international intellectual property treaties.

RedwoodComm warrants that the software will perform substantially in accordance with the accompanying documentation for a period of one(1) year from the release date. RedwoodComm continuously provides software updates, bug fixes, and Bluetooth Core Specification enhancements through the official RedwoodComm customer support portal.

2. Basic Operation

This section covers the basics of operating the RWC5070M and the necessary software preparations.

2.1 Exterior
2.2 Screen Layout
2.3 Firmware Update
2.4 Operating System & PC Requirements
2.5 Software Installation Guide

2.1 Exterior

2.1.1 Front Panel View

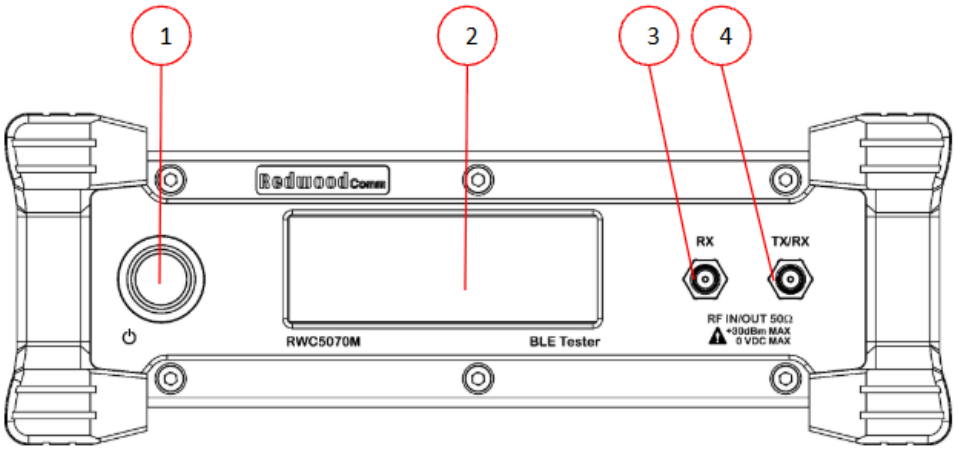


Fig. 2-1 RWC5070M Front Panel View

1. POWER ON/OFF SWITCH
2. 2.79” Color Graphic LCD
3. SMA-type RF RX Port
4. SMA-type RF TX/RX Port

2.1.2 Rear Panel View

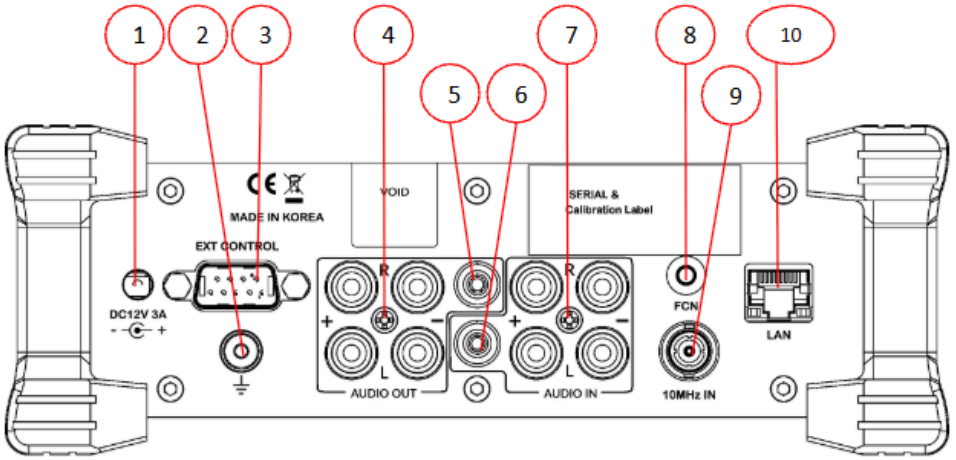


Fig. 2-2 RWC5070M Rear Panel View

1. 12V DC power input
2. GND Terminal
3. RS232 male connector

4. Audio Out (RCA L+/L-/R+/R-)
5. Audio Out (AUX)
6. Audio In (AUX)
7. Audio In (RCA L+/L-/R+/R-)
8. Function button
9. 10MHz input BNC
10. RJ45 connector

2.2 Screen Layout

The main screen of the RWC5070M is broadly divided into two sections: the settings screens for the device's transmitter and receiver. Indicates the currently set value.



Fig. 2-3 Screen Layout

- IP Address Indication: Shows the local IPv4 address assigned to the tester. Preceding character indicates allocation mode:
  - 'S' Static IPv4 address assignment (e.g., S: 192.168.0.25).
  - 'D' Dynamic IPv4 address assignment allocated via DHCP server.
- FCN Button Navigation: Pressing the physical rear FCN button cycles the active LCD screen modes, revealing detailed views including active network configuration, dynamic hardware temperature, and current RF port allocations.
- Active RF Parameters: Real-time display showing:
  - TX Frequency (MHz) and calibrated Output Power (dBm).
  - RX Frequency (MHz) and input gain state.
  - Active Physical Layer (PHY) selection (1M, 2M, Coded S2, Coded S8).
  - Selected Active RF Port (TX/RX Port vs RX Port).

2.3 Firmware Upgrade

As RWC5070M adapted Flash Memory, it is available to upgrade easily by using the PC without changing the Hardware. For upgrading, RWC5070M Application Program shall be used. The program is provided together with the product and it is available to download the upgrade data from RedwoodComm Website or provide it via post-mail. The information for upgrading shall be kept in providing to the user via email or website.

2.3.1 Normal Firmware Upgrade

Setup Ethernet connection between RW5070M and RWC_upgrader.exe. The download sequence is as follows. For the next processing, click the NEXT button.

1. Establish a direct Ethernet connection between the host PC and the RWC5070M.
2. Launch the RWC_upgrader.exe executable on the host PC.
3. Enter the active target IPv4 address displayed on the tester's LCD screen into the network address bar.
4. Click Connect. The utility will verify hardware handshaking and display the current running firmware build version.
5. Click Browse and select the validated firmware binary file (.bin).
6. Click Execute Upgrade. The system will flash the internal non-volatile memory, displaying a progress bar. Upon reaching 100%, the tester automatically reboots into its updated operational state.

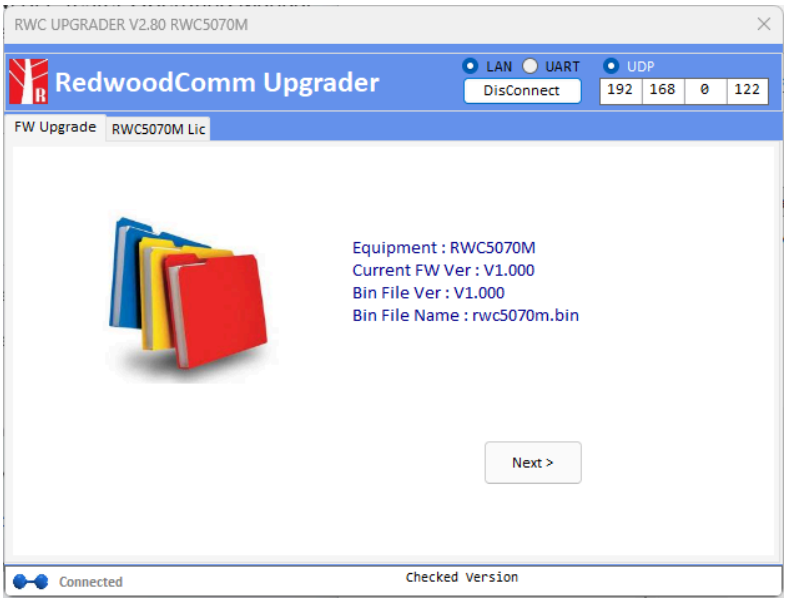


Fig. 2-4 RWC UPGRADER Screen

2.3.2 Emergency Upgrade Mode

If an error occurs in the normal program, RWC5070M will enter 'emergency upgrade' mode. Users can also manually trigger this mode by pressing and holding the FCN key while powering on the RWC5070M. The device will then enter a standby state, awaiting a firmware upgrade. Once the firmware has been updated using the RWC upgrader, the device will be able to boot normally.

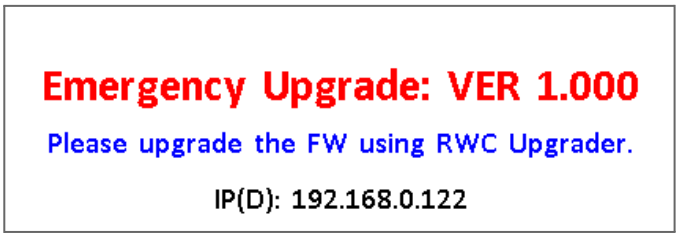


Fig. 2-5 Emergency upgrade mode screen

1. Power off the RWC5070M using the main power switch.
2. Press and hold the rear panel FCN button continuously while applying power via the power switch.
3. Hold the FCN button for 5 seconds until the LCD displays the recovery screen.
4. The LCD will display [Emergency Upgrade] and fallback to the IP(ex: 192.168.0.122).
5. Open RWC_upgrader.exe, connect to 192.168.0.122, upload the correct rwc5070m.bin file, and press Upgrade to restore device functionality.

2.4 Operating System & PC Requirements

To ensure real-time RF measurement stream processing and smooth 60fps graph rendering, the host computer should satisfy the following minimum and recommended system requirements.

Component	Minimum Requirement	Recommended Specification
Operating System	Windows 10 64-bit	Windows 11 64-bit
Processor (CPU)	Intel Core i3 / AMD Ryzen 3 (Quad Co	Intel Core i5/i7 (8th Gen+) or AMD Ryzen 5/7
System Memory	4 GB RAM	8 GB RAM or higher
Storage	1 GB free disk space (SSD)	SSD with 5 GB+ (for test logs and reports)
Display Resolution	1366 × 768 pixels	1920 × 1080 (Full HD) or higher
Network Interface	100Base-TX Ethernet Port	Gigabit Ethernet NIC (RJ45 direct o LAN switch)
DUT Serial Interface	USB 2.0 Port	FTDI / CP210x USB-to-UART bridge driver

2.5 Software Installation Guide

This chapter details the installation procedures for the RWC5070M PC software, required device drivers for DUT communication, host Ethernet static IP configuration, and firewall rules.

2.5.1 Host Application Installation

The RWC5070M PC application is distributed as a standalone installation package for Microsoft Windows 64-bit systems. Follow the instructions below to complete installation:

- Download Installer: Obtain the official installation package RWC5070M_Setup_vX.X.exe from the RedwoodComm customer portal or distributed USB drive.
- Execute Setup: Double-click the installer executable. If prompted by Windows User Account Control (UAC), click [Yes] to grant administrator privileges.
- Select Installation Path: Follow the on-screen setup wizard to choose the target directory (default: C:\Program Files\RedwoodComm\RWC5070M\).
- Complete Setup: Click [Finish]. The installer automatically creates a desktop shortcut and registers application file associations.

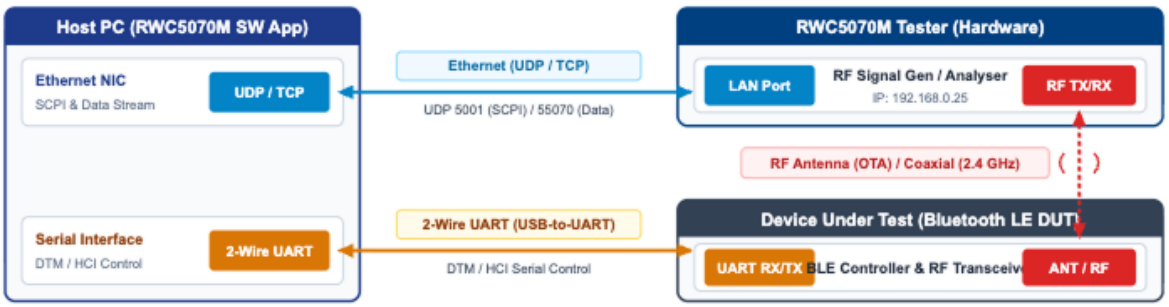


Fig. 2-6 RF & DTM Test Setup Architecture Block Diagram

2.5.2 USB Driver Setup (DUT Communication)

During automated Direct Test Mode (DTM) or HCI testing, the host PC communicates with the target Bluetooth DUT through a USB-to-UART bridge:

- Virtual COM Port (VCP) Drivers: Ensure official chipset drivers are installed for your USB bridge controller (e.g. FTDI FT232R, Silicon Labs CP210x, or Prolific PL2303).
- Device Manager Verification: Connect the DUT cable and open Windows Device Manager > Ports (COM & LPT) to confirm the assigned port number (e.g., COM3).
- Port Exclusivity: Close any external terminal tools (PuTTY, TeraTerm) before launching RWC5070M to prevent serial port access conflicts.

2.5.3 Network Configuration & Firewall Exceptions

The PC communicates with the RWC5070M tester over standard Ethernet UDP sockets. Correct host network settings are required for seamless communication:

- Ethernet IP Configuration: Set the host PC Ethernet adapter to a static IPv4 address in the 192.168.0.x subnet (e.g., IP: 192.168.0.10, Subnet Mask: 255.255.255.0). The default tester IP is 192.168.0.201.
- Windows Firewall Exception: Add inbound and outbound firewall allowance rules for UDP Port 5001 (SCPI Command / Query) and UDP Port 55070 (JsonData & Async Event streams).

3. User Interface & Getting Started

This chapter introduces the application workspace, menu navigation, real-time status banners, and initial instrument connection setup.

3.1 Application Workspace Layout
3.2 Instrument Connection Setup
3.3 Project Explorer & DUT Management
3.4 Settings (Preference & Diagnostics)

3.1 Application Workspace Layout

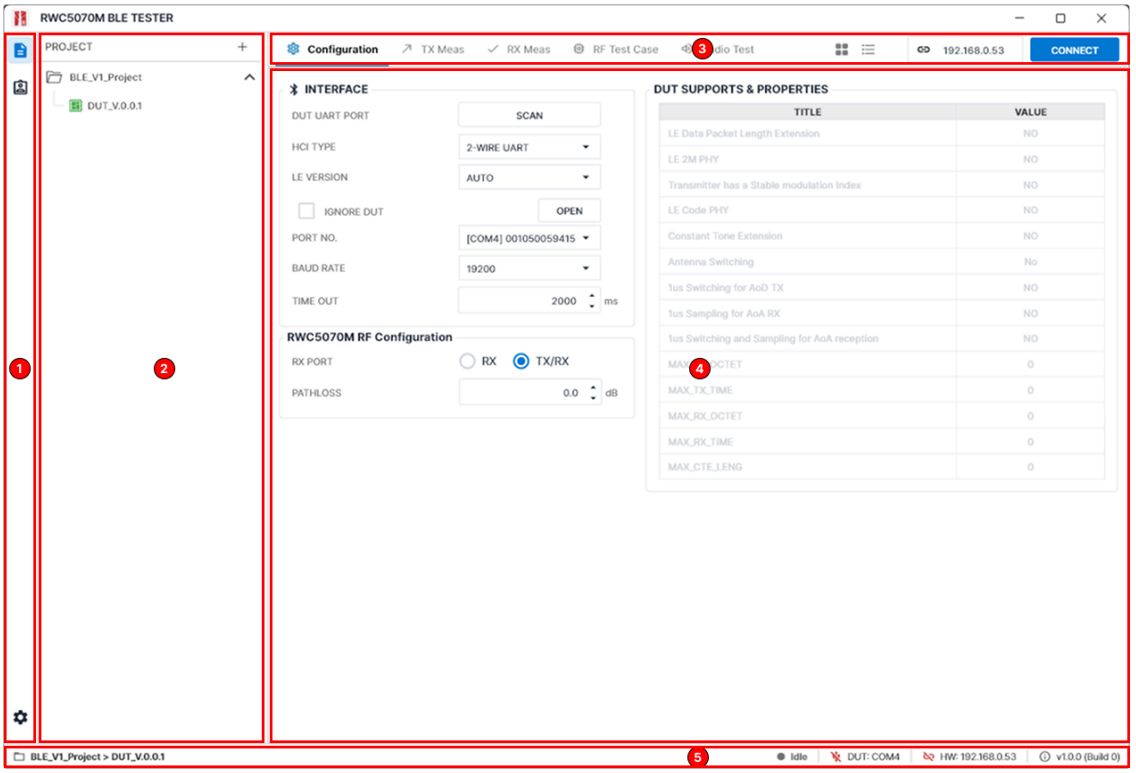


Fig. 3-1 Application Workspace Layout

The control software is divided into functional sectors to simplify test execution and parameter configuration.

3.1.1 Top Header & Connection Controls

The top header provides global view options and hardware connection controls:

- Layout Switch Toggle: Alternates the active workspace view between multi-window Tiled view and consolidated List view.
- IP Address Field: Configurable IPv4 input box (Default string: 192.168.0.25).
- CONNECT / DISCONNECT Toggle Button: Initiates or breaks the socket control link between host software and tester hardware.

3.1.2 Status Bar Indicators

Located along the bottom edge of the software interface, providing real-time hardware feedback:

- Activity Bar: Vertical icon bar on the far left used to switch between different management views, including Project Explorer, Report Explorer, and System Settings.
- Side View Panel (View Container): Displays the view selected from the Activity Bar, dynamically toggling between tree management interfaces such as the Project & DUT Explorer or the Report Explorer.
- Top Navigation & Connection Bar: Houses mode selection tabs (Configuration, TX Meas, RX Meas, RF Test Case) and instrument network connection controls ([CONNECT] button & IP display).
- Main Configuration & Work Stage: Primary interactive area displaying DUT communication interface setup, RF path loss configuration, and test measurement screens.
- Bottom Status Bar: Real-time system status bar displaying the active project/DUT name, test execution state (Idle/Running), hardware connection IP, and software version.

3.2 Instrument Connection Setup

Click [CONNECT] in the top header or Activity Bar to Settings > Connection to configure network communication with the RWC5070M instrument:

- Connection Socket parameter
  - Socket type: UDP
  - Port Number: 5001 for commands
  - Port Number: 55070 for data dump

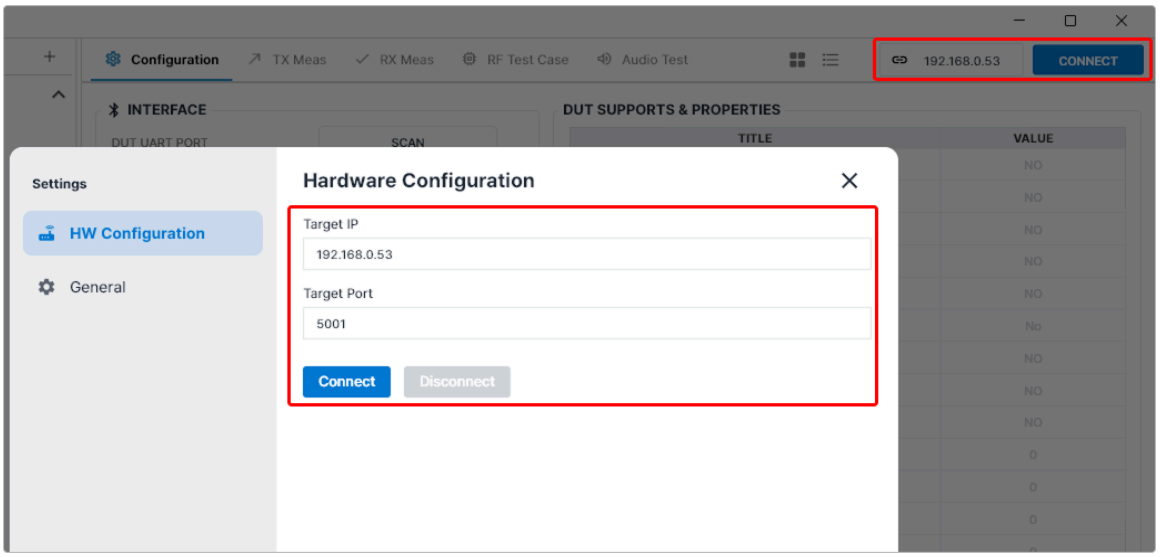


Fig. 3-2 Instrument Connection Setup Dialog

3.3 Project Explorer & DUT Management

All test measurements, parameter profiles, and exported reports in RWC5070M are organized hierarchically under Project > DUT entities managed inside the local database.

3.3.1 Mandatory Prerequisite: Active DUT Selection

To ensure test configuration integrity, selecting an active DUT is strictly required before using the software. Upon launching the application, users must select or double-click the target DUT in the Project Explorer tree. Until a DUT is actively selected, the entire main workspace remains locked under a semi-transparent overlay, disabling all measurement triggers (TX, RX, and RF Test Cases) and parameter modifications.

3.3.2 Right-Click Context Menu Operations

Right-clicking on any node within the Project Explorer tree opens a context menu for managing project containers and device profiles:

- Project Node Right-Click:
  - NEW PROJECT: Creates a new top-level project container.
  - RENAME PROJECT: Renames the selected project title.
  - DELETE PROJECT: Deletes the project and all associated configurations (prevented if containing opened DUTs).
  - NEW DUT: Creates a new Device Under Test (DUT) profile under this project.

- DUT Node Right-Click:
  - RENAME: Modifies the display name of the selected DUT profile.
  - DELETE: Removes the selected DUT profile (prevented if currently opened/active to safeguard ongoing test data).

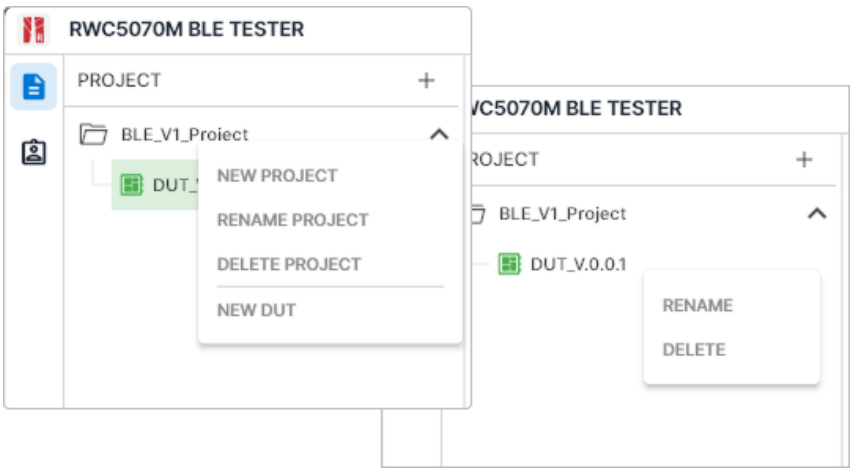


Fig. 3-3 Project Explorer Tree & DUT Device Profile Management

3.4 Settings (Preferences & Diagnostics)

Click the Gear icon (**Settings**) on the far-left Activity Bar to access comprehensive software preferences and diagnostic tools:

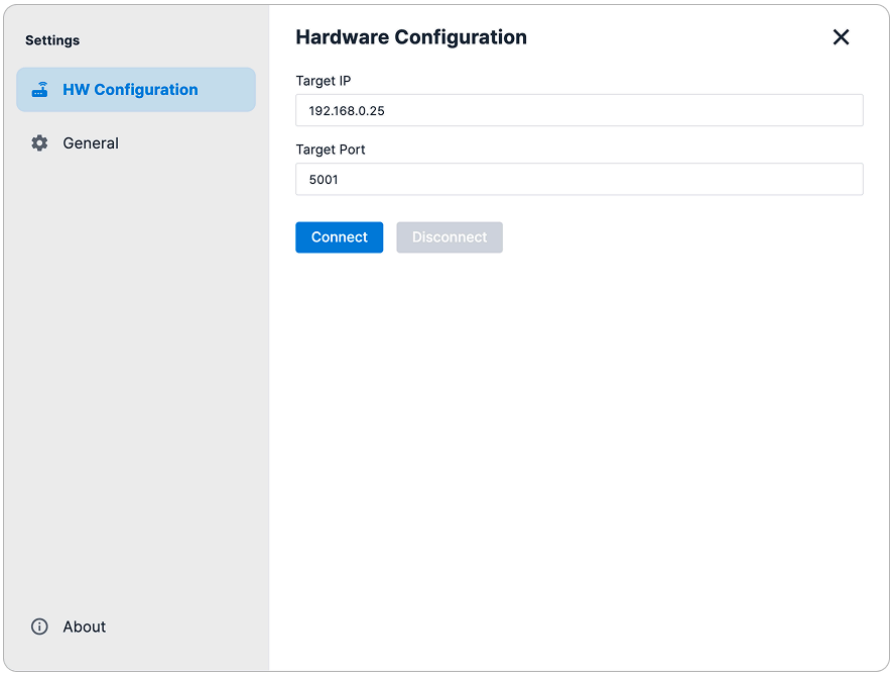


Fig. 3-4 HW Configuration Dialog

- HW Configuration: Secondary access point for tester IP/Port settings and socket connect/disconnect state controls.

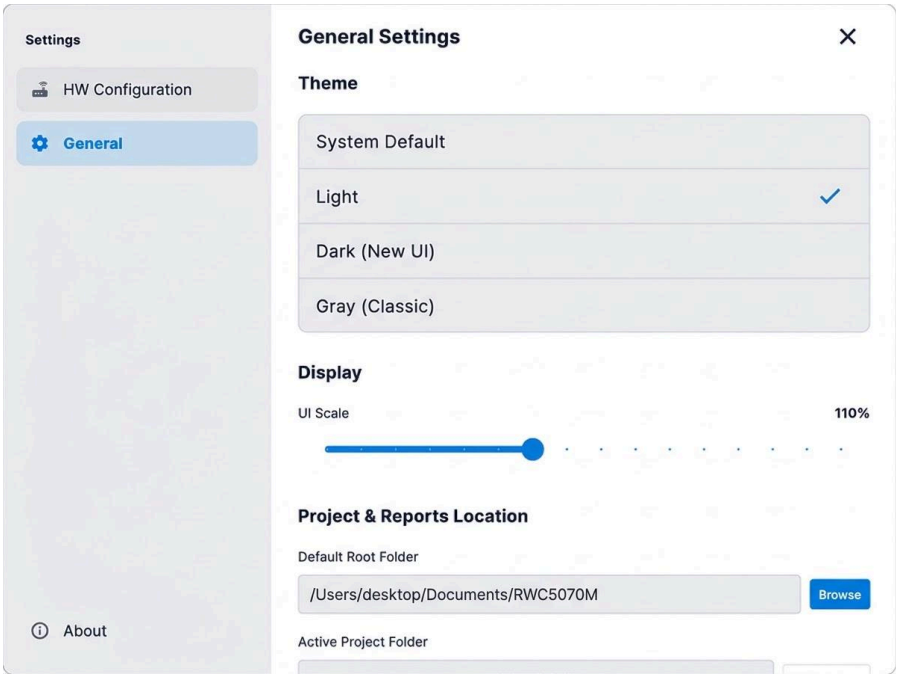


Fig. 3-5 General Settings Dialog

- General Settings:
  - Theme (Appearance): Switch dynamically between System (matches OS theme), Light, Dart, and Gray styles.
  - Display (UI Scale): Adjust overall workspace scaling from 50% to 200% via the interactive slider to fit diverse monitor resolutions.
  - Project Root Folder: Configures the default root directory where project databases and test records are saved ([Open Folder] action).

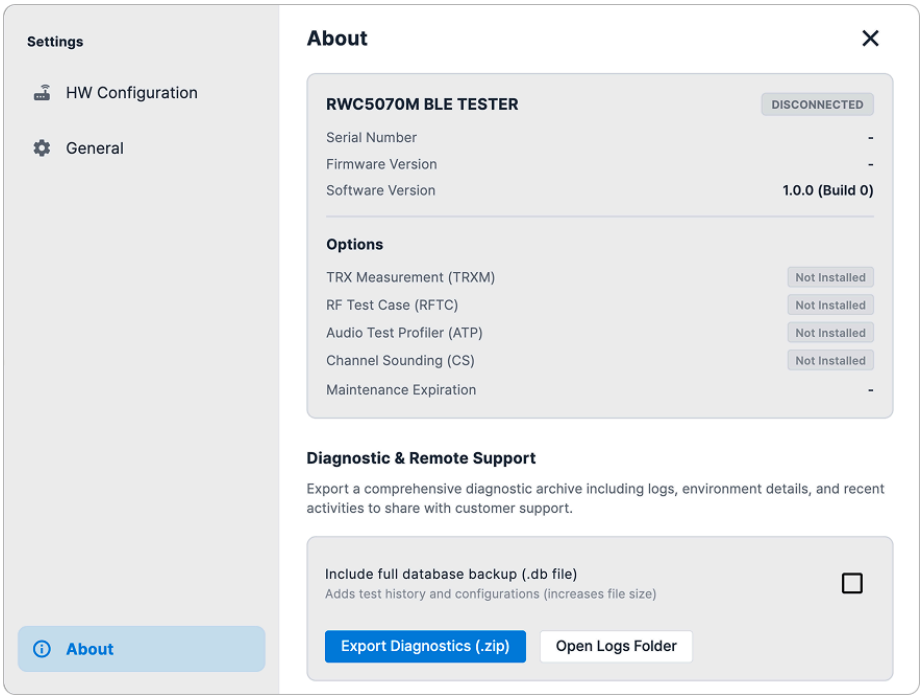


Fig. 3-6 About Dialog

- About:
  - Device Info: Displays HW serial number, firmware version, and software version.
  - License Info: Display licensed options (TRXM, RFTC, ATP, CS) and maintenance expiration date.
  - Export Diagnostics (.zip): Packages execution logs, environment profiles, and optional database snapshots into a single zip archive for technical support.
  - Open Logs Folders: Opens the local directory containing daily runtime execution logs (app_log_YYYY-MM-DD.log).

4. Configuration

This chapter details the configuration of the Device Under Test (DUT) communication interface, RWC5070M RF hardware parameters, real-time automated verification of DUT-supported features, and manual DTM command operations.

4.1 Configuration Screen
4.2 DUT Interface
4.3 RWC5070M RF Configuration
4.4 DUT Support & Properties Verification
4.5 Manual DUT command Control Utility

4.1 Configuration Screen

The Configuration screen (Configuration tab) is structured into two main operational columns designed for intuitive pre-test hardware calibration:

- Left Column (DUT Interface & Instrument Environment): Houses the INTERFACE panel for establishing serial/network DTM links to the DUT and the RWC5070M ENVIRONMENT panel for configuring RF port routing and coaxial path loss offsets.
- Right Column (DUT Supports & Properties): Displays a comprehensive, real-time table of Bluetooth SIG physical layer capabilities, packet boundaries, and Direction Finding (AoA/AoD) features queried directly from the DUT controller.

4.2 DUT Interface

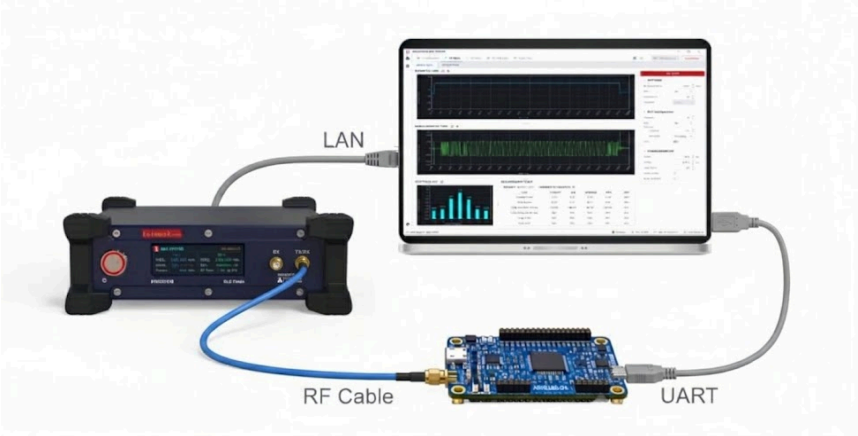


Fig. 4-1 Example of LE test setup

Automated Bluetooth RF conformance testing requires the host PC to control the DUT using standard Bluetooth SIG Direct Test Mode (DTM) or HCI protocol commands over a 2-Wire UART or TCP socket connection:

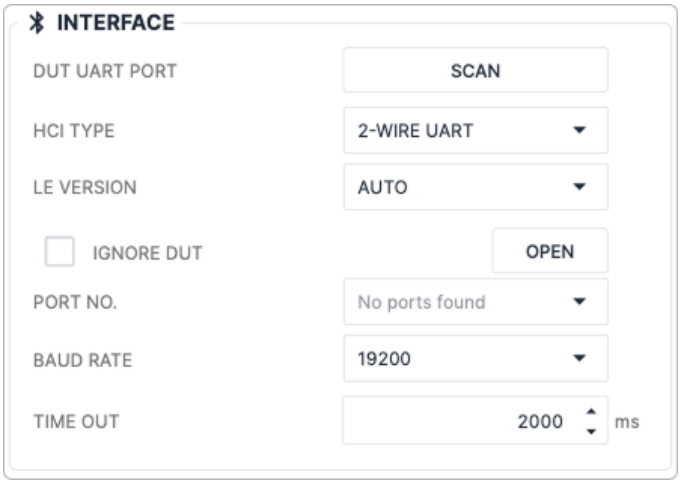


Fig. 4-2 DUT Interface

UI PARAMETER	DEFAULT / OPTIONS	DESCRIPTION & OPERATIONAL BEHAVIOR
DUT UART PORT [SCAN]	Action Button	Scans available host COM/serial ports and updates the port selection list with detected USB-to-UART chipset information and serial numbers.
HCI TYPE	2-WIRE UART | NONE	Selects the control protocol. Set to 2-WIRE UART for automated DTM test sequences, or NONE for manual/non-signaling RF testing.
LE VERSION	AUTO, < Ver 4.2, > Ver 5.0	Defines DTM protocol command formatting. AUTO negotiates automatically; > Ver 5.0 unlocks LE 2M, Coded PHY, and 255-octet DLE commands.
IGNORE DUT	Checkbox (Default: Off)	When checked, bypasses DUT response timeouts or query errors, allowing automated test loops to proceed even if DUT responses are unacknowledged.
[OPEN] / [CLOSE]	Toggle Button	Opens the selected port and triggers an automated feature query sequence (Opcode 0x04 and 0x05) to populate DUT properties; [CLOSE] safely releases port locks.
PORT NO. & BAUD RATE	115,200 (9.6k ~ 115.2k)	Specifies the virtual COM port and communication baud rate matched to the DUT bootloader/application firmware.
TIME OUT (ms)	2000 ms (500 ~ 5000 ms)	Maximum response wait duration for DUT DTM query commands (adjustable in 100 ms increments).

4.3 RWC5070M RF Configuration

Calibrating the RF link between the tester and DUT is critical for accurate power measurements and sensitivity evaluation:

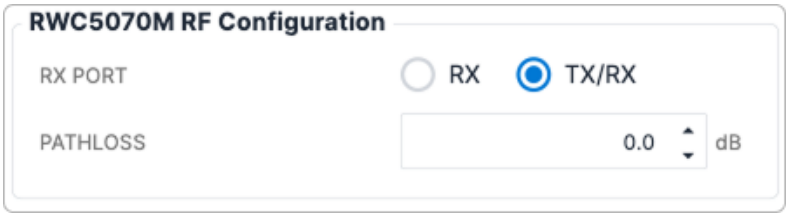


Fig. 4-3 RF Configuration

- **RX PORT:** Select **RX** when using dedicated dual-coaxial cables (DUT TX into tester RX, and tester TX into DUT RX). Select **TX/RX (TRX)** for single-cable bidirectional test setups.
- **PATHLOSS:** Enter the total calibrated attenuation of the RF coaxial cable, fixtures, and shielding

box attenuators.

- **TX Measurements:** Actual DUT Output Power = Measured Power + Path Loss.
- **RX Measurements:** Delivered Power at DUT = RWC5070M Output Power − Path Loss.
- Range: 0 - 50 dB

4.4 DUT Supports & Properties Verification

Upon clicking [OPEN], the software interrogates the DUT by transmitting standard read feature mask commands (0x04, 0x00) and read maximum operational limit commands (0x05, 0x00 ~ 0x10). The detected feature set is displayed in the properties matrix:

FEATURE / TITLE	VALUE / STATUS	LIMIT PARAMETER	SUPPORTED VALUE
LE Data Packet Length Extension	YES / NO	MAX_TX_OCTET	e.g. 255 Octets
LE 2M PHY	YES / NO	MAX_TX_TIME	e.g. 17,040 µs
Stable Modulation Index	YES / NO	MAX_RX_OCTET	e.g. 255 Octets
LE Coded PHY (S=2, S=8)	YES / NO	MAX_RX_TIME	e.g. 17,040 µs
Constant Tone Extension (CTE)	YES / NO	MAX_CTE_LENG	e.g. 160 µs (20 × 8µs)
Antenna Switching (AoA/AoD)	YES / NO	1µs Switching for AoD TX	YES / NO
1µs Sampling for AoA RX	YES / NO	1µs Switch & Sample (AoA)	YES / NO

4.5 Manual DUT Command Control Utility

Click the grid icon (DUT Command) on the top navigation bar to open the floating manual DTM control utility. This panel enables interactive testing and single-shot command transmission without running full automated test suites, supporting four primary Direct Test Mode (DTM) command types:

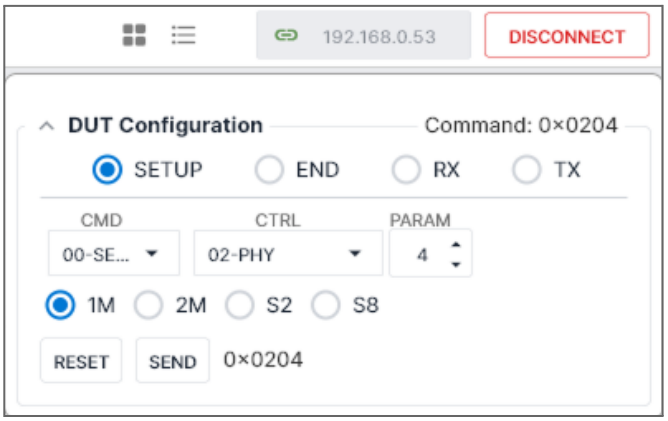


Fig. 4-4 DUT Command Configuration

[SETUP]

Configures fundamental operating parameters, PHY layers, and modulation parameters prior to initiating test transmissions or receptions:

- **00-RESET:** Resets the DUT DTM test state machine and clears all internal packet counters to default state.
- **01-POWER:** Sets transmission output power level (PARAM specifies target power level index).
- **02-PHY:** Selects physical layer transmission mode via sub-radio options [1M (Uncoded 1 Mbps, value 0x04), 2M (Uncoded 2 Mbps, value 0x08), S2 (LE Coded 500 kbps, value 0x10), or S8 (LE Coded 125 kbps, value 0x0C)].
- **03-MODULATION:** Selects transmitter modulation index characteristic between STANDARD (standard index, 0.28 ~ 0.35) and STABLE (stable index, 0.495 ~ 0.505).
- **06-CTE:** Configures Constant Tone Extension for AoA/AoD Direction Finding testing. Enable the CTE checkbox and set CTE Time from 2 to 20 (in 8 µs units, up to 160 µs duration).
- **PARAM (Hex):** Directly input hexadecimal parameter values (0x00 to 0xFF) passed to the selected CTRL opcode.

[TRANSMITTER (CMD: 10b)]

Commands the DUT to begin transmitting RF test packets continuously on the designated RF channel

- **FREQ (Channel Index):** Specifies RF test channel from 0 to 39 (2402 MHz to 2480 MHz, Frequency = 2402 + 2 × N MHz)
- **LENG (Payload Length):** Sets test packet payload length from 0 to 255 bytes (octets), supporting standard Bluetooth Data Length Extension (DLE).
- **PKT (Payload Pattern):** Selects payload bit sequence pattern:
  - PRBS9: Pseudo-Random Binary Sequence (9-bit sequence, $x^9 + x^5 + 1$) for general RF-PHY conformance..
  - 11110000b: Alternating 4-bit repeating nibbles for modulation drift and frequency offset verification.
  - 10101010b: Alternating single-bit pattern for maximum frequency deviation (Δf2) testing.
  - 11111111b: Constant all-ones pattern.

[RECEIVER (CMD: 01b)]

Puts the DUT receiver into continuous listening mode on a designated RF channel to measure packet reception and evaluate Packet Error Rate (PER):

- **FREQ (Channel Index):** Sets the target RF reception channel from 0 to 39 (2402 MHz to 2480

MHz).

[END (CMD: 11b)]

Halts the currently active transmission or reception test mode and queries the DUT packet reception results

- **Packet Counter Query:** Stops active test execution and reports the total count of successfully received packets accumulated during RECEIVER mode.
- **[RESET] Action Button:** Transmits an immediate software reset command to restore the DUT controller to normal idle state.
- **[SEND] Action Button & Hex Display:** Builds the 16-bit DTM opcode (e.g. 0x0000, 0x8021, 0xC000) and transmits it to the DUT via UART, displaying the real-time command hex value.

[Hex Command Display & SEND]

Displays the raw 2-byte hexadecimal opcode (e.g. 0x0000, 0x8021) and provides immediate single-shot command transmission.

5. TX Measurement

TX Measurement analyzes transmitter RF characteristics of the Bluetooth Low Energy DUT across power vs. time, modulation vs. time, and spectrum adjacent channel power.

RFPHY testing supports three types of graphs, while ADVERTISING testing displays all graphs except for the Spectrum ACP graph. Clicking the 'detail' icon on each graph allows you to access more in-depth settings and a detailed view of the graph.

5.1 Measurement Configuration
5.2 Time-axis Analysis
5.3 Frequency-axis Analysis
5.4 Measurement Table
5.5 Advertising Packet Measurement

5.1 Measurement Configuration

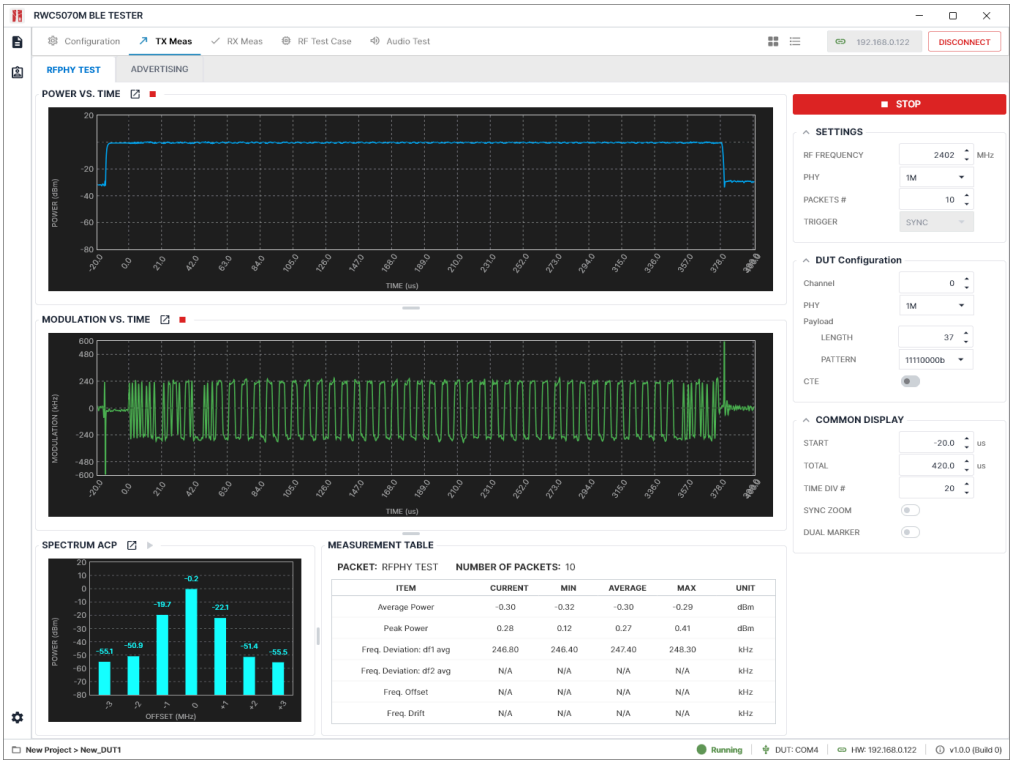


Fig. 5-1 TX Measurement Screen

5.1.1 Settings

This section describes the core parameters required to set up the RF physical layer test.

- **RF FREQUENCY** (MHz): Sets the center frequency of the target RF signal in MHz. You can adjust this value using the up/down arrows or by typing the desired frequency directly. Range
  - Range : 2400 ~ 2500 MHz
- **PHY**: Selects the Physical Layer data rate for the Bluetooth Low Energy signal. You can choose the appropriate PHY variant (e.g., 1M) from the dropdown menu.
  - Selection : 1M, 2M, S8, S2
- **PACKETS #**: Defines the total number of packets to be captured and analyzed during a single measurement cycle.
  - Range : 1 ~ 20
- **TRIGGER:** Specifies the trigger condition for signal capture. The available modes operate as follows:
  - **OFF:** Operates in a free-running mode without synchronizing to a specific packet structure.
  - **SYNC:** Detects the sync word of the LE packet to accurately identify the exact start of the packet. The START time configured in the COMMON DISPLAY is applied relative to this sync point.
  - **Limit Triggers (Other options):** Functions similarly to SYNC by detecting the packet start, but automatically halts the measurement if a parameter falls outside the user-defined limit values. It then captures and displays the graph and measurement data specifically for that out-of-limit packet. Selecting this item will cause a limit value settings field to appear in the bottom-right corner.

- P_AVG : This is a trigger used to determine whether the average power falls outside the specified limits.
- DF1_AVG : This is a trigger used to determine whether the average df1 falls outside the specified limits.
- DF2_AVG : This is a trigger used to determine whether the average df2 falls outside the specified limits.
- FREQ_OFFSET : This is a trigger used to determine whether the frequency offset falls outside the specified limits.
- FREQ_DRIFT : This is a trigger used to determine whether the frequency drift falls outside the specified limits.

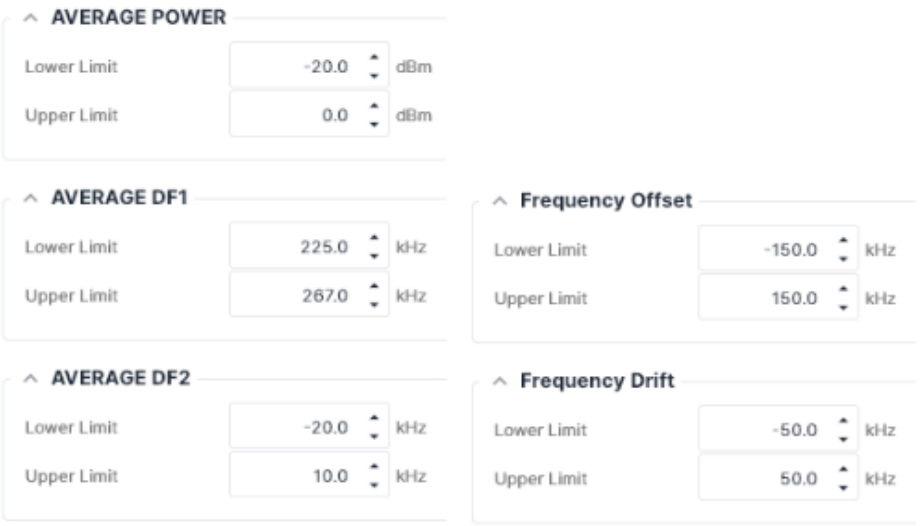


Fig. 5-2 Fields for setting the limit value in Limit Triggers

5.1.2 DUT Configuration

This panel is used to configure a Device Under Test (DUT) that supports Direct Test Mode (DTM). It establishes the DUT's transmission (TX) parameters, dictating the conditions under which the equipment conducts its measurements. If the connected DUT does not support DTM, this entire configuration area will be disabled. For additional comprehensive information, refer to the operational description provided in Section 4.5.

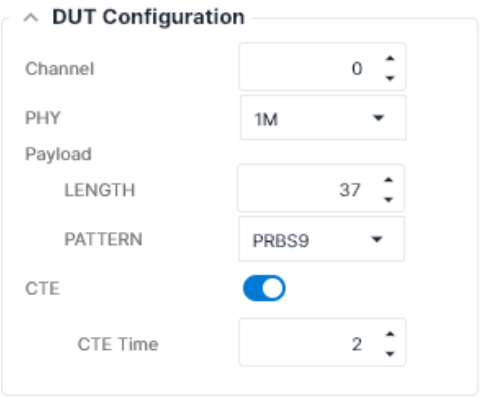


Fig. 5-3 DUT Configuration screen when CTE is enabled

- **Channel**: Specifies the LE RF channel index for the DTM test. (0~39)
- **PHY**: Configures the physical layer data rate for the DUT's transmission.
- **Payload**
  - **LENGTH**: Defines the byte length of the data payload in the test packet.
  - **PATTERN**: Selects the specific bit pattern used in the payload for modulation testing.
- **CTE**: A toggle switch to enable or disable the Constant Tone Extension (CTE) configuration.
  - **CTE Time**: The length of the Constant Tone Extension in 8 µs units (2 ~ 20)

5.2 Time-axis Analysis

The RWC5070M measures the output and modulation characteristics of a DUT in the time domain and generates graphs for these parameters. Clicking the 'Start' button simultaneously activates the power and modulation functions, allowing you to view the measurement results.

5.2.1 Time-Axis Parameters

This section describes how to configure the time-axis for time-domain measurements, such as POWER VS. TIME and MODULATION VS. TIME. By setting the 'start time' and 'total time' parameters, users can examine in detail the power variations that occur at the beginning and end of a packet. Furthermore, they can analyze the composition of an LE packet based on precise timing settings.

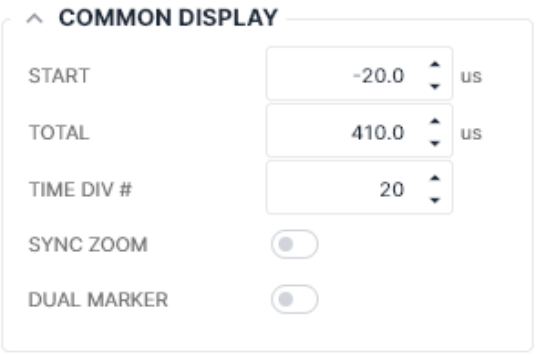


Fig. 5-4 Common Display screen

- **START (us):** Sets the starting point of the time axis (X-axis). A value of 0 indicates the exact start of the packet. You can use negative values (e.g., -20.0 us) to observe the signal state immediately preceding the packet transmission.
- **TOTAL (us):** Defines the total time duration displayed on the graph. Adjusting this value allows you to zoom in on a specific segment of the packet or zoom out to view the entire waveform.
- **TIME DIV #:** Specifies the number of grid divisions along the X-axis. For instance, setting this to `20` divides the total displayed time into 20 equal segments, making it easier to read specific time intervals.
- **SYNC ZOOM:** A toggle switch that, when enabled, synchronizes the time scale across all time-domain graphs. Zooming or panning in one graph will automatically apply the same time-axis adjustments to the others.
- **DUAL MARKER:** Enables two vertical reference markers on the graph. Users can click on two desired points in time, which will then be automatically marked and their values displayed. This is useful for measuring the exact time difference (delta) and specific values between two points on the signal.

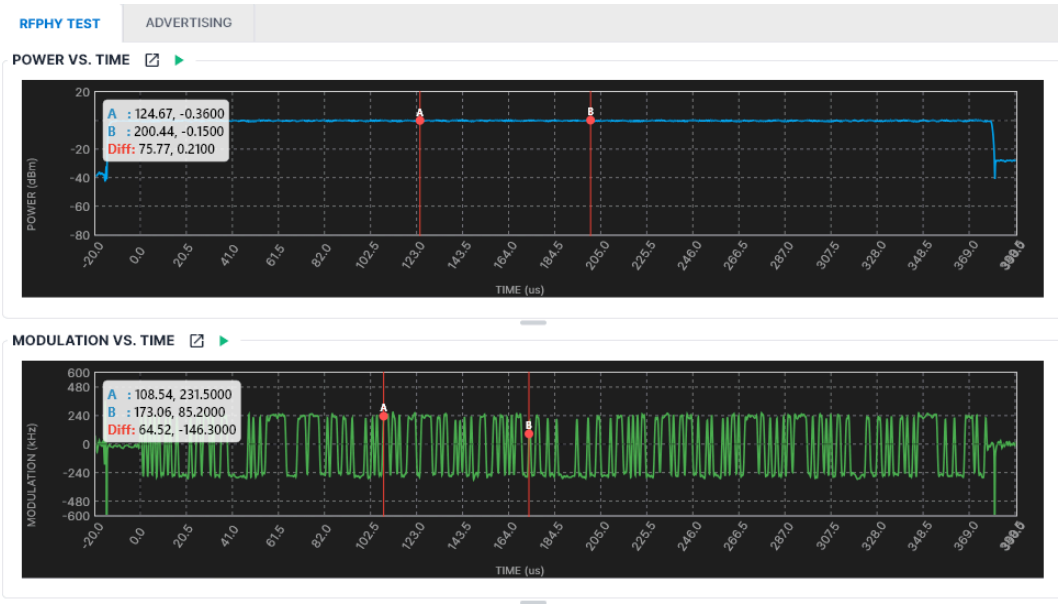


Fig. 5-5 TX Measurement screen when dual marker is enabled

5.2.2 Power vs. Time

The 'Power vs. Time' screen measures the 'burst power' of consecutively received BLE packets, and calculates and displays the average, minimum, and maximum values for a specified number of packets.

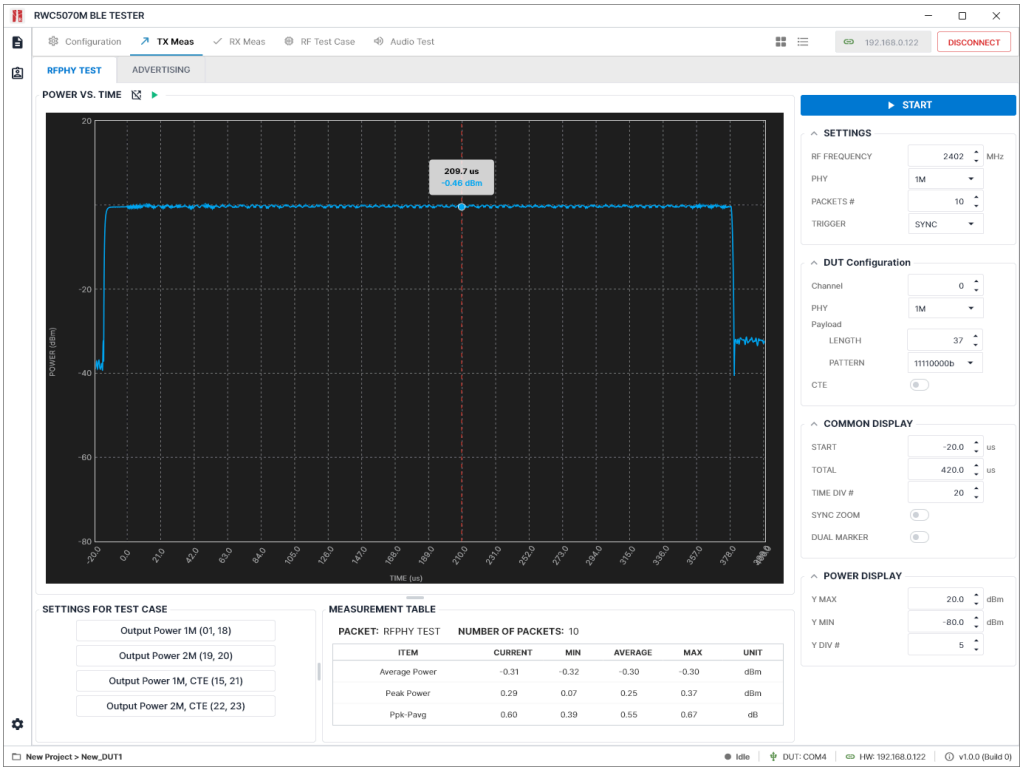


Fig. 5-6 POWER VS. TIME

If you wish to modify the graph settings for Power vs. time, please configure the "Power Display" area located in the bottom-right corner.

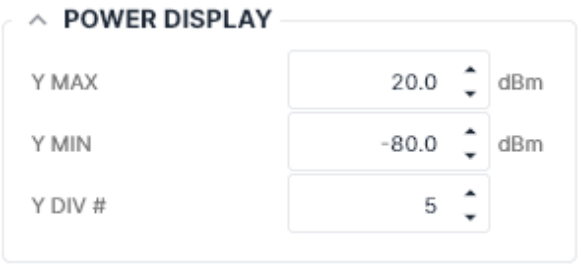


Fig. 5-7 Settings for Power vs. time

- Y MAX: Set the maximum value for the y-axis of the graph
- Y MIN: Set the minimum value for the y-axis of the graph
- Y DIV #: Number of divisions of the graph's y-axis

The "Settings for test case" feature automatically configures the parameters by retrieving the default values defined for "output power" in the RF test case, and then displays the measurement results. This allows for testing under the exact same conditions as the specified test case, with the added capability to view the results in graphical format.

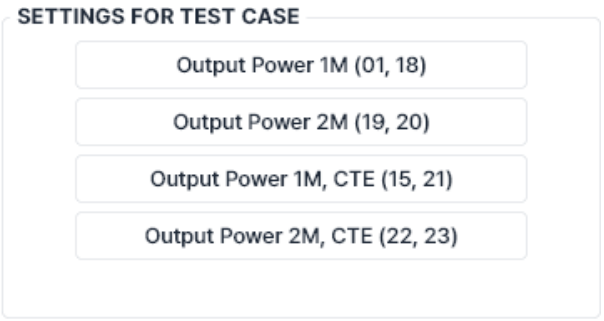


Fig. 5-8 Settings for test case in Power vs. time

5.2.3 Modulation vs. Time

The 'Modulation vs. Time' screen measures the GFSK characteristics of consecutively received BLE packets and calculates and displays key measurement results for the Modulation Characteristics and Carrier Frequency Offset and Drift parameters. The measurement table contains a total of four items, with calculated values corresponding to the number of packets presented in a tabular format.

If you wish to modify the graph settings for Modulation vs. time, please configure the "Modulation Display" area located in the bottom-right corner.

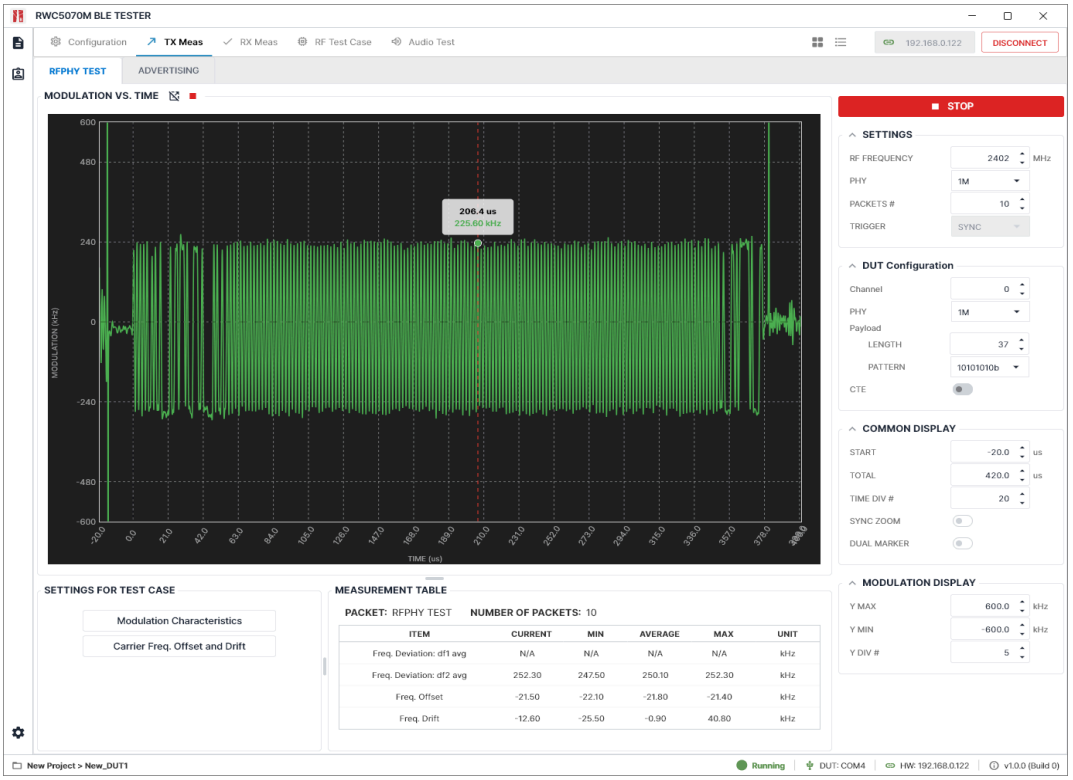


Fig. 5-9 MODULATION VS. TIME



Fig. 5-10 Settings for Modulation vs. time

- Y MAX: Set the maximum value for the y-axis of the graph
- Y MIN: Set the minimum value for the y-axis of the graph
- Y DIV #: Number of divisions of the graph's y-axis

The "Settings for test case" feature automatically configures the parameters by retrieving the default values defined for "output power" in the RF test case, and then displays the measurement results. This allows for testing under the exact same conditions as the specified test case, with the added capability to view the results in graphical format.

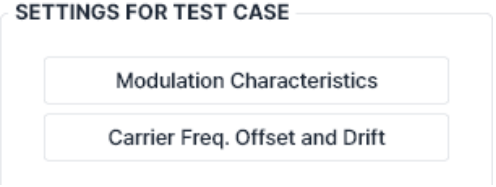


Fig. 5-11 Settings for test case in Modulation vs. time

5.3 Frequency-axis Analysis

5.3.1 Spectrum ACP

This panel displays a bar graph representing the channel power of the center channel and three adjacent channels on both the upper and lower sides (Offsets from -3 MHz to +3 MHz). Spectrum Adjacent Channel Power(ACP) operates independently, separate from time-axis analysis. The measured channel power values are displayed above each bar in the bar graph.

- In-Band Emissions Verification: This measurement is highly useful for indirectly verifying the in-band emissions of the RF signal. However, for precise, formal compliance results, it is recommended to execute the dedicated RF Test Case.
- Automatic Triggering: Please note that during the Spectrum ACP operation, the user-configured TRIGGER mode in the SETTINGS panel is ignored. The tester automatically configures an internal trigger setting optimized specifically for this measurement.

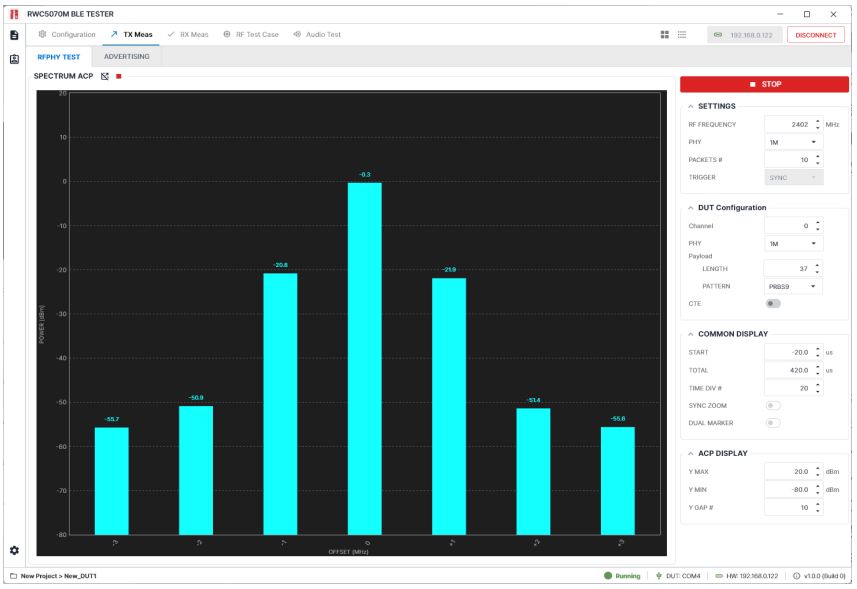


Fig. 5-12 Spectrum ACP

If you wish to modify the graph settings for Spectrum ACP, please configure the "ACP Display" area located in the bottom-right corner.



Fig. 5-13 Settings for Spectrum ACP

- Y MAX: Set the maximum value for the y-axis of the graph
- Y MIN: Set the minimum value for the y-axis of the graph
- Y GAP #: Number of divisions of the graph's y-axis

5.4 Measurement Table

This section provides a numerical summary of the RF physical layer test results. It displays statistical data calculated over the total number of packets specified in the SETTINGS panel.

- **Power parameter**
  - Average power : The average transmission power measured over the duration of the packet.
  - Peak Power : The highest (maximum) power level detected during the packet transmission.
- **Modulation parameter**
  - df_{1_avg} : The average frequency deviation measured when transmitting the 11110000b or 00001111b payload pattern. *(Note: This shows as* N/A *if the corresponding pattern is not selected in the DUT Configuration)*
  - df_{2_avg} : The average frequency deviation measured when transmitting the 10101010b or 01010101b payload pattern. *(Note: This shows as* N/A *if the corresponding pattern is not selected in the DUT Configuration)*
  - Frequency offset : The frequency difference between the ideal center frequency and the actual measured center frequency of the DUT.
  - Frequency drift : The amount of frequency change (drift) that occurs over the duration of the packet's payload.

5.5 Advertising Packet Measurement

Similarly, this device receives advertising packets and displays power and modulation graphs. At the same time, it calculates key measurement parameters and presents them in a single table. Because the intervals between advertising packets are long, the measurement process can take a significant amount of time.

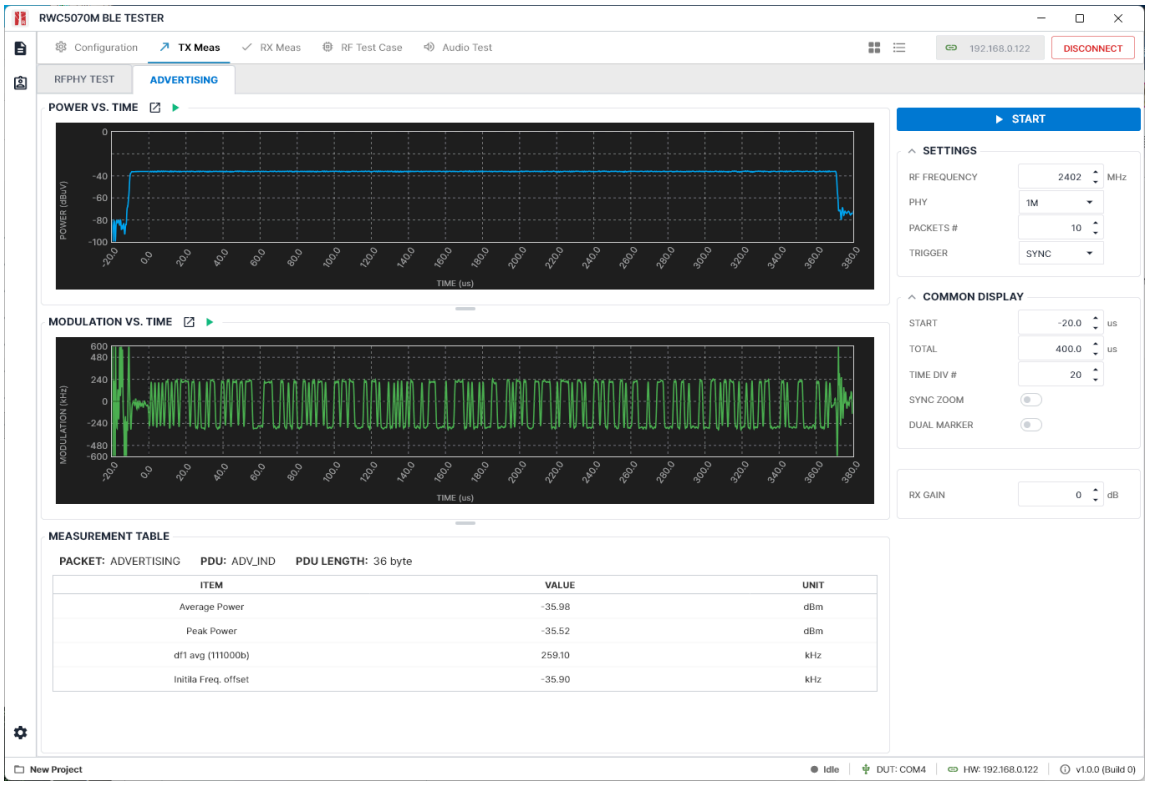


Fig. 5-14 TX Measurement of Advertising Packet

6. RX Measurement

The RX measurement mode evaluates the reception sensitivity of a DUT (Device Under Test) by varying the transmit power and modulation characteristics of the RWC5070M. Additionally, the 'Signal Generator' tab allows for the generation and output of LE test packets or continuous wave (CW) signals. Both frequency and power levels can be adjusted, and in LE mode, packet information can be configured according to user-defined parameters.

6.1 Packet Error Rate(PER) Sensitivity Measurement
6.2 RF Signal Generator

6.1 Packet Error Rate(PER) Sensitivity Measurement

6.1.1 PER Measurement Principle

In the "Measure PER" tab, you can measure LE test packets, while in the "OTA Measure PER" tab, you can measure advertising packets. Both allow for the measurement and analysis of the DUT's (Device Under Test) reception sensitivity. Users can adjust the power range of the equipment and set power increments using the "step power" function. Additionally, they can configure various parameters for the packets to be generated, including PHY settings, packet length, payload type, and "dirty transmission" options.
For LE test packets, the device must be set to 'Direct Test Mode' to measure the PER, and the number of received packets can be verified via a wired connection. Conversely, in the case of advertising packets, it is possible to count received packets by tracking the "ping-pong" (back-and-forth exchange) of specific packets within an OTA (over-the-air) environment. The formula for calculating PER is as follows:

PER (%) = [(Transmitted Packets − Received Packets) / Transmitted Packets] × 100

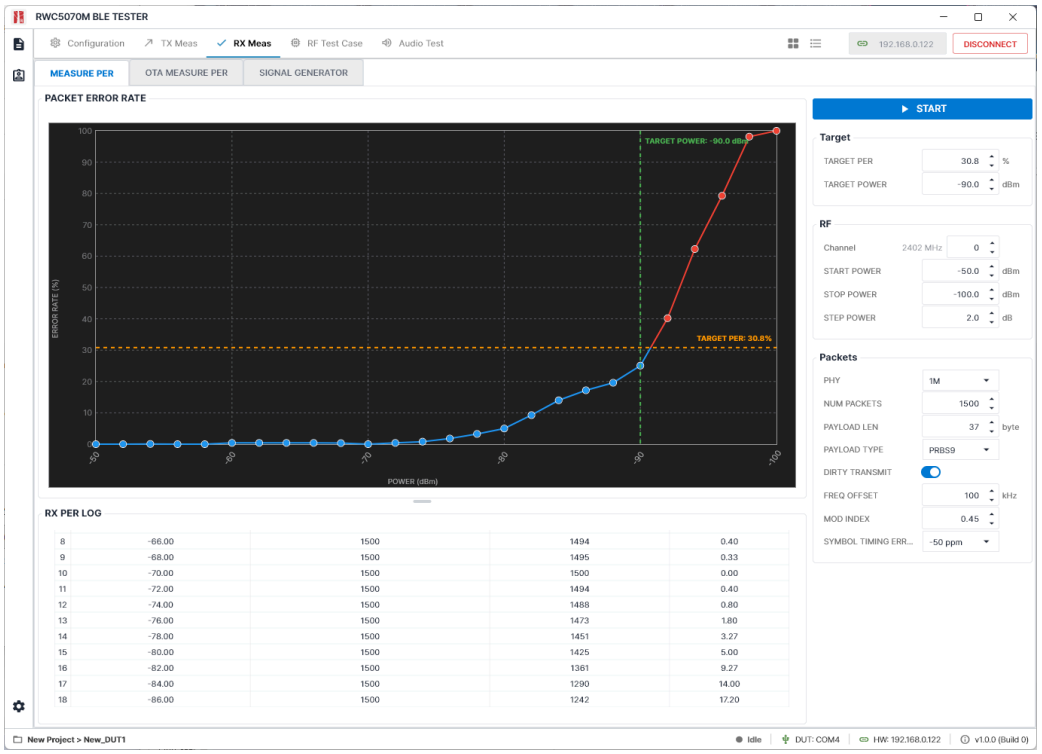


Fig. 6-1 Packet Error Rate (PER) Measurement Screen

6.1.2 Parameters

[**TARGET**]
Configures the sensitivity search termination conditions and reference threshold limits.

- **TARGET PER**: Sets the threshold packet error rate for sensitivity evaluation (Default: 30.8%, compliant with Bluetooth SIG RF-PHY specifications; Range: 0.0% to 100.0%, 0.1% resolution).
- **TARGET POWER**: Specifies the target RF input power level delivered to the DUT antenna port to verify whether the DUT meets the target PER criteria(Range: -110.0 dBm to -5.0 dBm) .

[**RF**]
Controls RF carrier frequency, attenuation offset, and sweep power levels.

- **CHANNEL**: Selects the BLE RF operating channel for the test (Channels 0 to 39, corresponding to 2402 MHz to 2480 MHz in 2 MHz steps).
- **START/STOP POWER**: Defines the power sweep boundary for automated sensitivity searching (Range: -110.0 dBm to -5.0 dBm). The sweep begins at START POWER and steps down sequentially toward STOP POWER.
- **STEP POWER**: Sets the power decrement step per measurement iteration in dB.

[**PACKETS**]
Defines the structure and stress conditions of the transmitted test signal.

- **PHY**: Sets the LE physical layer. 1M, 2M, Coded S=2, Coded S=8
- **NUM PACKETS**: Specifies the total number of packets transmitted per power step (Range: 1 to 20,000; Recommended: 1,500 packets to satisfy standard statistical confidence for 30.8% PER).
- **PAYLOAD LEN**: Sets the data payload length in bytes (Range: 0 to 255 bytes; Default: 37 bytes per Bluetooth SIG test specification).
- **PAYLOAD TYPE**:
    - PRBS9: Pseudo-Random Binary Sequence (x^9 + x^5 + 1) for general sensitivity evaluation.
    - 11110000b (0xF0) / 10101010b (0xAA) / 11111111b (0xFF): Fixed repeating patterns for specific demodulator stress tests.
- **DIRTY TRANSMIT**:A toggle switch that enables the injection of standardized worst-case transmitter impairments
    - **FREQ OFFSET**: Sets the frequency offset value in kHz.
    - **MOD INDEX**: Adjusts the frequency modulation index between standard stress limits (Range: 0.40 to 0.60).
    - **SYMBOL TIMING ERROR**: Selects clock timing drift into the transmitted symbols (0 ppm, -50 ppm, +50 ppm).

6.2 RF Signal Generator

The RWC5070M integrates a versatile, software-controlled RF signal generator supporting two operational modes: Continuous Wave (CW) mode for general purpose, and Standard LE Packet Generation mode for receiver sensitivity evaluation, and Over-The-Air (OTA) functional verification.

6.2.1 Standard LE Test Packet Generation

In LE mode, you can configure the packet structure details—as specified in the standard—on an individual basis, and you can also set the output to be continuous or limited to a specific number of transmissions. The interval between LE packets conforms to the specification and is a multiple of 625 µs. There are currently four supported PHYs: 1M, 2M, Coded S=2, and Coded S=8. The definition of LE test packets can be found in detail under the 'LE test packet definition' section in the Core Specification, Vol. 6, Part F, Chapter 4.

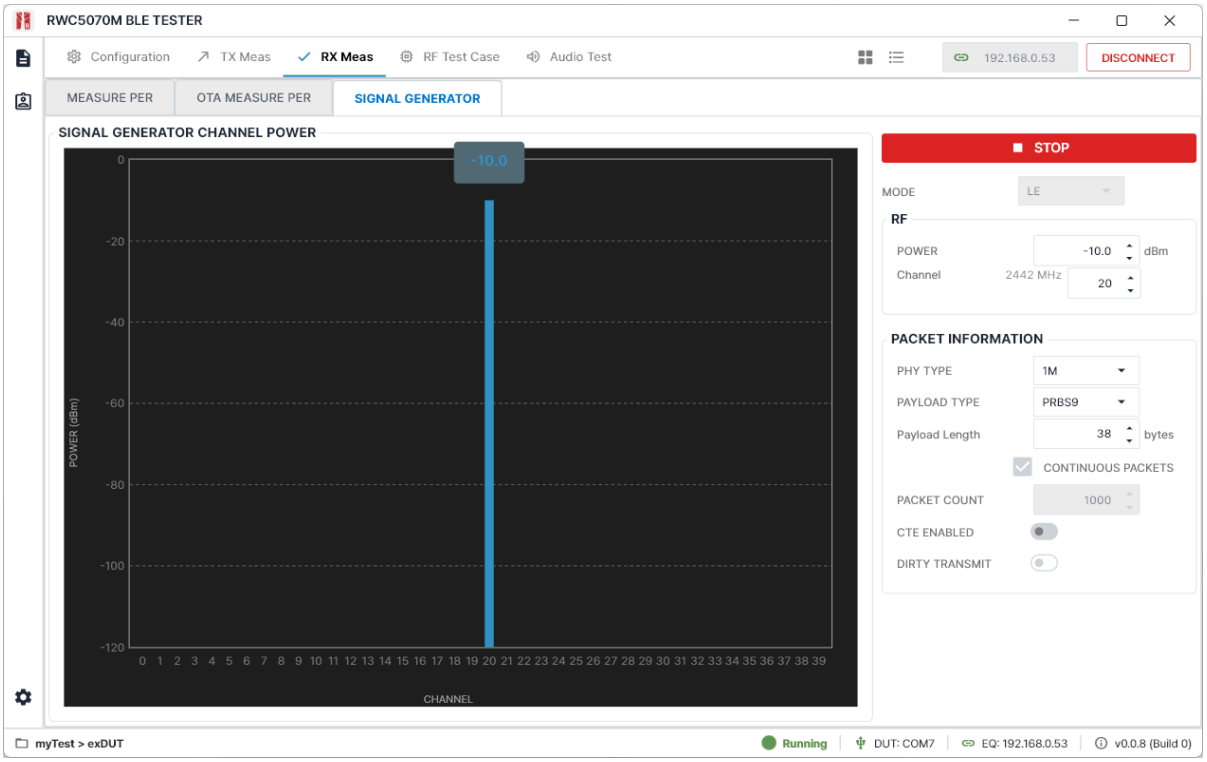


Fig. 6-1 Signal Generator

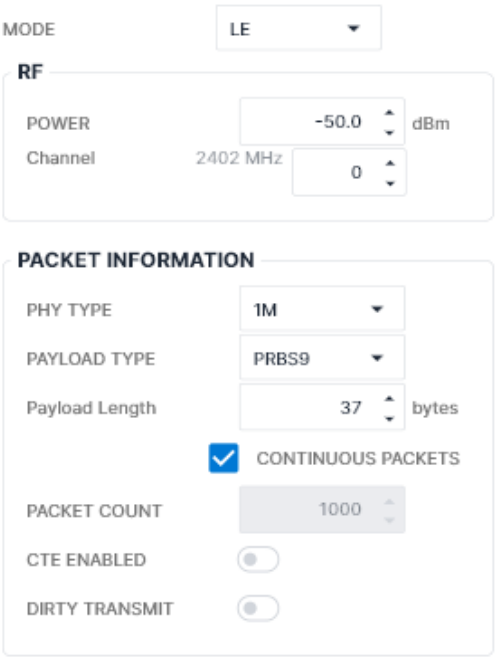


Fig. 6-2 LE Packet Information

[RF]

- **POWER**: Specifies the output transmission power. Users can input the desired level in dBm.
- **CHANNEL**: Selects the target BLE channel index (0 to 39). The system automatically displays the corresponding center frequency in MHz(e.g., 2440 MHz for channel 19).

[PACKET INFORMATION]

- **PHY TYPE**: Selects the physical layer modulation and symbol rate:
  - 1M: Standard LE 1 Mbps GFSK (BT = 0.5).
  - 2M: High-rate LE 2 Mbps GFSK (BT = 0.5).
  - Coded S=2: Long-range 500 kbps coded PHY
  - Coded S=8: Long-range 125 kbps coded PHY
- **PAYLOAD TYPE**: Selects the standard payload bit sequence pattern:
  - PRBS9: Pseudo-Random Binary Sequence (x^9 + x^5 + 1) for general receiver characterization.
  - 11110000b (0xF0): Repeating nibbles for frequency drift and stability analysis.
  - 10101010b (0xAA): Alternating bit pattern for maximum frequency deviation (Delta f_2) testing.
  - 11111111b (0xFF): Constant all-ones pattern.
- **PAYLOAD LENGTH**: Sets the PDU payload size in bytes.
  - Range: 0 to 255 bytes (Default: 37 bytes; supports LE Data Length Extension up to 255 bytes).
- **CONTINUOUS PACKETS:** When checked, the generator transmits test packets continuously until manually halted with STOP.
  - When unchecked, PACKET COUNT is enabled.
- **PACKET COUNT:** Specifies an exact number of packets to transmit (e.g., 1000). This input field is disabled if "CONTINUOUS PACKETS" is checked.
- **CTE ENABLED:** Toggle switch enabling Constant Tone Extension appended to the packet for Bluetooth 5.1+ Direction Finding (AoA/AoD) receiver testing.
  - CTE Time: Adjustable from 16us to 160us in 8us increments (2 to 20 units).



Fig. 6-3 CTE Information

- **DIRTY TRANSMIT**:Applies standard non-ideal transmitter impairments to test receiver sensitivity and demodulator tracking under worst-case conditions.
  - **FREQ OFFSET**: Sets the frequency offset value in kHz.
  - **MOD INDEX**:Adjusts the GFSK modulation index between 0.40 and 0.60.
  - **SYMBOL TIMING ERROR**: Selects clock symbol rate offset selectable between 0 ppm, -50 ppm, or +50 ppm.

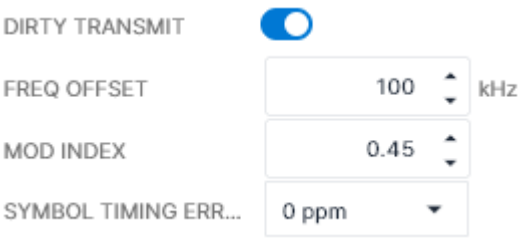


Fig. 6-4 Dirty transmit parameters

6.2.2 Continuous Wave (CW) Output Mode

Generates and outputs a CW signal capable of FM modulation.
Clicking START begins the continuous transmission of signals.



Fig. 6-5 Settings for CW mode

- **POWER (dBm)**: Specifies the RF output level at the RF port.
  - Range: -110.0 dBm to -5.0dBm (Resolution: 0.1dB, Accuracy: 1.0dB).
- **FREQUENCY**: Sets the center frequency of the target RF signal in MHz.
- **FM DEVIATION**: Sets the deviation value for FM modulation.
  - Range: $0.0kHz$ (pure CW, unmodulated) to $250.0kHz$.

6.2.3 Graphic Display

The main graphic display provides an intuitive, real-time visual representation of the active RF carrier being generated across the 2.4 GHz ISM band. It allows operators to instantly verify the active transmission channel, carrier frequency, and delivered output power level.

- **X-axis (CHANNEL/FREQUENCY)**
  - Displays the 40 standard Bluetooth LE RF channels (0 to 39).
  - Directly corresponds to carrier frequencies from 2402 MHz to 2480 MHz (f = 2402 + 2 x k MHz in 2 MHz channel spacing).
- **Y-axis (POWER):**
  - Scales the calibrated signal output power from 0 dBm down to -120 dBm.
  - Reflects the net output level factoring in the configured RF path loss (calibrated level at the DUT terminal).
- **Signal Indicator:**
  - A highlighted blue vertical bar appears dynamically at the active channel index, visually extending to the configured output power level.
  - Numerical Data Tooltip / Badge: Displays the exact configured RF power and frequency above the indicator bar (e.g., -10.0 dBm @ 2442 MHz (Ch 20)).
  - Transmission State Feedback: The indicator bar illuminates distinctly in blue when RF transmission is actively running (START), and dims or indicates an idle state when signal generation is halted (STOP).

7. RF Test Case

Automated batch testing against Bluetooth Core Specification RF-PHY test suites for compliance verification and manufacturing line quality control.

7.1 Supported Test Cases & Standards
7.2 Test Setup & Parameter Configuration
7.3 Execution & Batch Testing
7.4 Test Result Analysis & Troubleshooting
7.5 Protocol Sequence & Message Diagnostics
7.6 Test Report & Export

7.1 Supported Test Cases & Standards

You can sort the test items by group using the checkboxes (TRM, PS, ASI, RCV, IQC, IQDR) located at the top right corner of the application. Based on the DUT-supported features listed in the 'Configuration' tab, only the relevant items are enabled, while all others are automatically disabled. For each item, the execution time and judgment result for each channel are displayed next to the item's full name. During execution, an animated progress modal displays real-time step results, measured values, limit thresholds, and verdict badges.

Table 7-1. Bluetooth LE RF-PHY Supported Test Suite Summary

Category	Test Case Number	Test Case Name	Purpose & Verification Limits
TRM	01, 18, 19, 20, 15, 21, 22, 23	Output Power	Measures peak and average output power.
TRM	03, 08	In-Band Emissions	Verifies transmit spectrum ACP and emissions within the 2.4 GHz ISM band.
TRM	05, 09, 10, 11, 13	Modulation Characteristics	Evaluates frequency deviations (Δf_1, Δf_2) using 11110000b and 10101010b patterns. For LE Coded (S=8), the payload consists of a repetitive sequence of 0xFF octets (11111111b).
TRM	06, 12, 14	Carrier Frequency Offset and Drift	Measures carrier center frequency offset and drift using 10101010b patterns For LE Coded (S=8), the payload consists of a repetitive sequence of 0xFF octets (11111111b).
TRM	16, 17	Carrier Frequency Offset & Drift, Constant Tone Extension	Measures carrier frequency offset and carrier drift of the transmitted Constant Tone Extension portion in a transmitted signal with uncoded data are within specified limits at normal operating conditions.

RCV	01, 08, 14, 20,26, 27, 32, 33	Receiver Sensitivity	Verify that the receiver sensitivity is within limits for non-ideal signals at normal operating conditions when receiving a signal.
RCV	06, 12, 18,24	Maximum Input Signal Level	Verify that the receiver is able to demodulate a wanted signal at high signal input levels.
RCV	07, 13, 19, 25, 30, 31, 36, 37	PER Report Integrity	Verify that the DUT PER report mechanism reports the correct number of received packets to the Lower Tester.

7.2 Test Setup & Parameter Configuration

Before executing automated RF-PHY test suites, the test environment, RF channels, packet parameters, and conformance pass/fail limits must be verified or customized. Selecting an item from the RF TEST CASE list automatically populates the **TEST PARAMETERS** and **REQUIREMENTS** panels with default settings compliant with the Bluetooth SIG RF-PHY specifications.

TEST PARAMETERS is used to configure the specific test settings (e.g., Frequency, Number of Packets, Payload Length) required for each item. You can configure up to three channels for execution, categorized as low, medium, and high. REQUIREMENTS defines the reference criteria for Pass/Fail judgments. These limits strictly comply with the LE RF-PHY Test specifications.

7.2.1 Test Parameters

Standard Bluetooth RF-PHY test cases mandate performance evaluation across the operating band using three designated frequency channels: Low, Medium, and High.

- **LOW Channel (Default: Ch 0, 2402 MHz)**: Evaluates band-edge characteristics and lower frequency boundary performance.
- **MID Channel (Default: Ch 19, 2440 MHz)**: Evaluates nominal in-band operating performance at the center of the 2.4 GHz ISM band.
- **HIGH Channel (Default: Ch 39, 2480 MHz)**: Evaluates upper band-edge emissions and adjacent band interference limits.
- **Selective Channel Execution**: Checkboxes allow users to execute single-channel sweeps (e.g., debugging an issue observed only on Channel 39) or run the full three-channel sequence required for compliance verification.
- **Custom Channel Override**: While standard test suites enforce 0, 19, and 39, engineers can

manually select intermediate channels (0 to 39) to troubleshoot localized spur issues or PCB trace resonance.

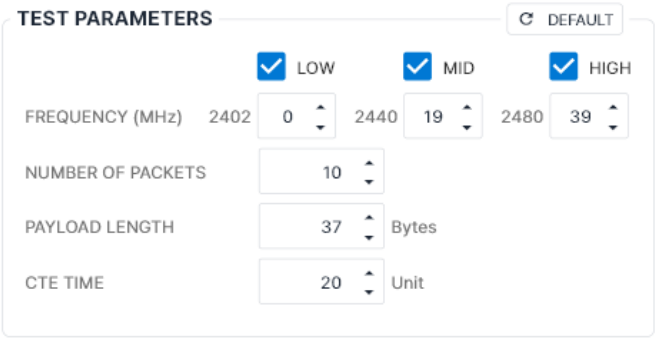


Fig. 7-1 Test Parameters for RF Test Case

7.2.2 Requirements & Limit Thresholds (Pass/Fail Criteria)

The REQUIREMENTS panel outlines the numerical boundary limits used to calculate the final Verdict (PASS / FAIL).

The default limits are configured according to the applicable Bluetooth LE RF-PHY Test Specification. These limits may vary depending on the selected test case, PHY mode, and test conditions.
The following are examples of commonly used acceptance criteria:

- Transmitter Output Power: Verifies that the measured average and peak output power satisfy the applicable transmitter power requirements.
- Modulation Characteristics: Evaluates frequency deviation and modulation ratio against the specified limits for the selected PHY.
- Carrier Frequency Offset and Drift: Verifies carrier frequency accuracy, maximum drift, and drift rate during packet transmission.
- Receiver Sensitivity: Evaluates Packet Error Rate (PER) against the specified threshold, typically 30.8%, at the required input signal level for the selected PHY.

7.3 Execution & Batch Testing

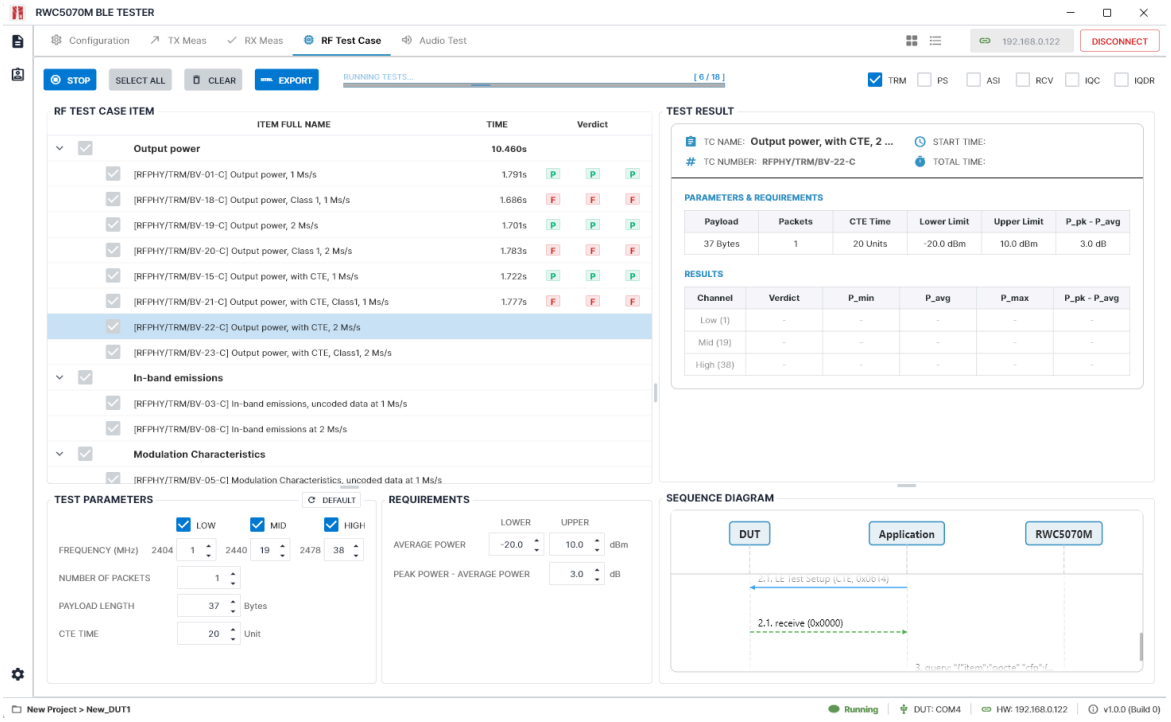


Fig. 7-2 Automated EF Test Case Execution Overlay with Real-time Verdict Badges

7.3.1 Category Filters & Test Selection



The acronyms correspond to the official RF PHY test suite definitions (for example, TRM filters for Transmitter tests, and RCV filters for Receiver tests). When a checkbox is selected, the main list dynamically updates to show.

These checkboxes function as sorting and filtering tools for the RF TEST CASE ITEM list.
By checking or unchecking these boxes, you can filter the test list to display only the items that belong to specific LE RF test case specification categories. This allows you to quickly isolate the exact types of tests you want to run. Only the test cases associated with that specific keyword.

- **TRM (Transmitter):** Transmitter RF performance tests, including output power, in-band emissions, modulation characteristics, and carrier frequency offset and drift.
- **PS (Power Stability):** Tests related to transmitter power stability.
- **ASI:** Application-specific category; its definition and supported test cases should be verified.
- **RCV (Receiver):** Receiver RF performance tests, including sensitivity, interference tolerance, maximum input signal level, and packet error rate reporting.
- **IQC (IQ Samples Coherency):** Direction Finding receiver tests that evaluate the phase coherency of I/Q samples during CTE reception.
- **IQDR (IQ Samples Dynamic Range):** Direction Finding receiver tests that evaluate I/Q sample performance over the specified received signal dynamic range.

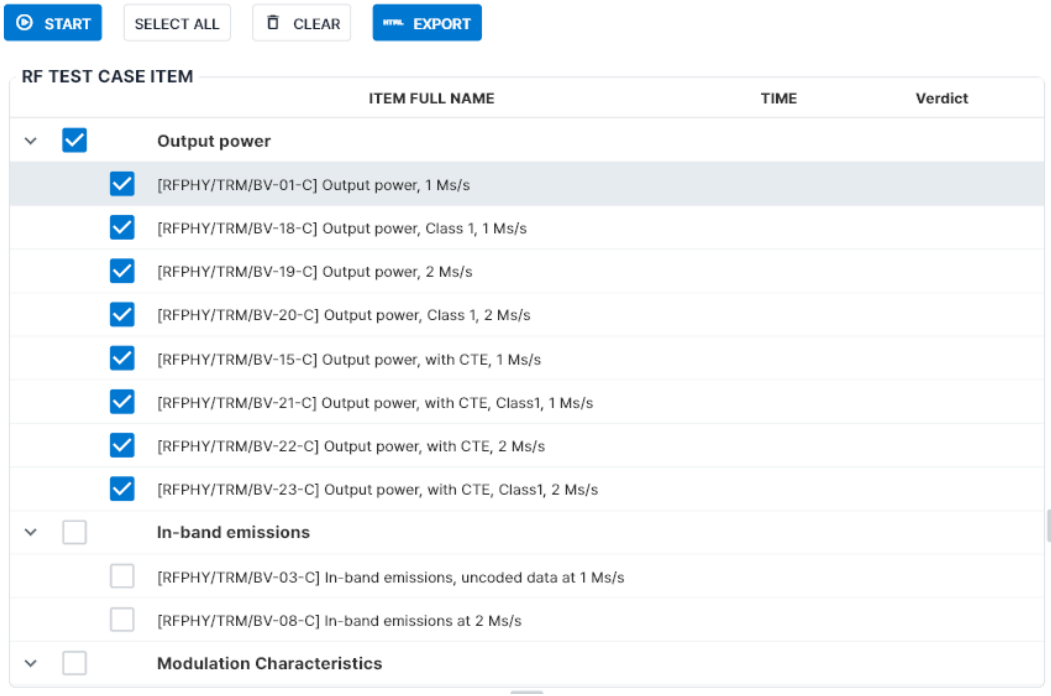


Fig. 7-3 RF Test Case Item list according to the category filter selection

7.3.2 Execution Controls



- **START**: Initiates the testing process for all currently checked items in the "RF TEST CASE ITEM" list.
- **SELECT ALL**: Automatically selects and checks all available test cases in the list, allowing you to easily run a complete batch test without clicking each item individually.
- **CLEAR**: Deletes the measured execution **TIME** and the **Verdict** results (such as Pass or Fail) for the currently selected test items, resetting them so they are ready for a fresh test run.
- **EXPORT**: Exports the completed test results and configurations into a report file (indicated by the HTML icon) for external documentation, sharing, or further analysis.

7.4 Test Result Analysis & Troubleshooting

Once the test for each item is completed, the final data and verdicts are displayed in this panel. The test results provide a summary of the parameters and requirements set by the user, and also include the test items and the time taken for the test.

7.4.1 Result Frame

The screen is divided into three main sections: Test Information, Parameters & Requirements, and Results.

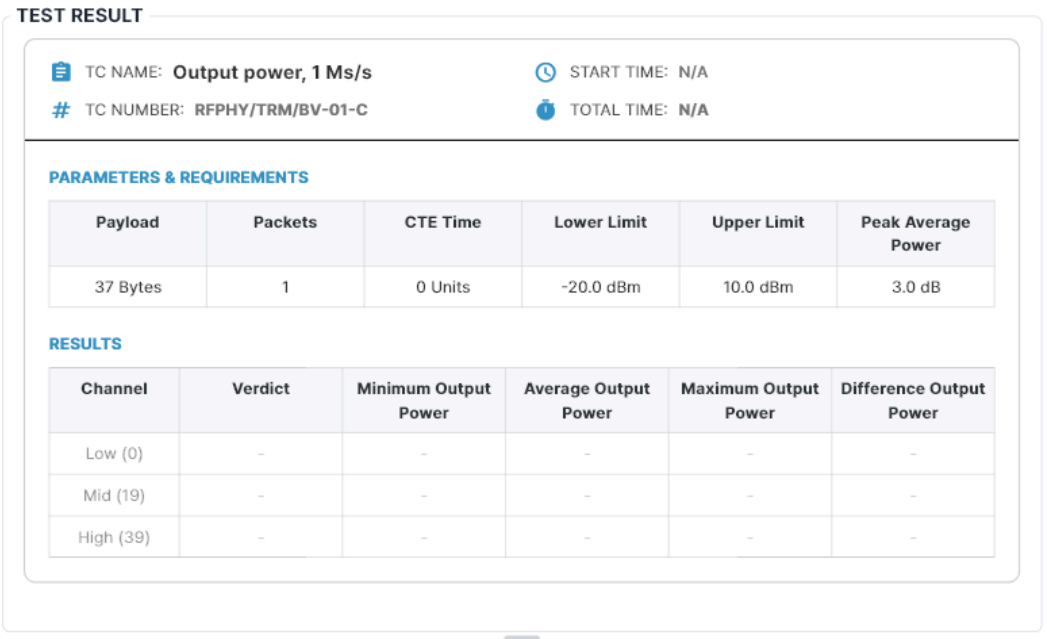


Fig. 7-4 Test Result of Rf_PHY Test

[Test Information]

This top section displays the general metadata for the executed test case.

- **TC NAME** (Test Case Name): Specifies the name of the test performed. In this example, it is "Output power, Class 1, 1 Ms/s", which measures the transmission power of a Class 1 LE device operating at 1 Megasymbol per second.
- **TC NUMBER**: The official specification code for the test case. Here, "RFPHY/TRM/BV-18-C" refers to a standard Bluetooth RF-PHY Transmitter test.
- **START TIME**: The exact date and time the test was initiated (e.g., 2026-11-04 16:43:15).
- **TOTAL TIME**: The total duration it took to complete the test execution (e.g., 1.686 seconds).

[Parameters & Requirements]

This section outlines the configured test conditions and the passing criteria limits that the device under test (DUT) must meet. Provides a summary of the settings configured in 7.1.

[Results]

This section provides the measured data across different frequency channels and determines the final pass/fail status.

7.4.2 Troubleshooting note based on result

In the results table, 'PASS' is displayed in green and 'FAIL' in red, allowing users to easily check the status of each item. For example, the device failed the test because its transmission power (P_avg ranges from -0.75 to -0.23 dBm) is well below the Class 1 requirement of 10.0 dBm to 20.0 dBm. Please refer to the image below.

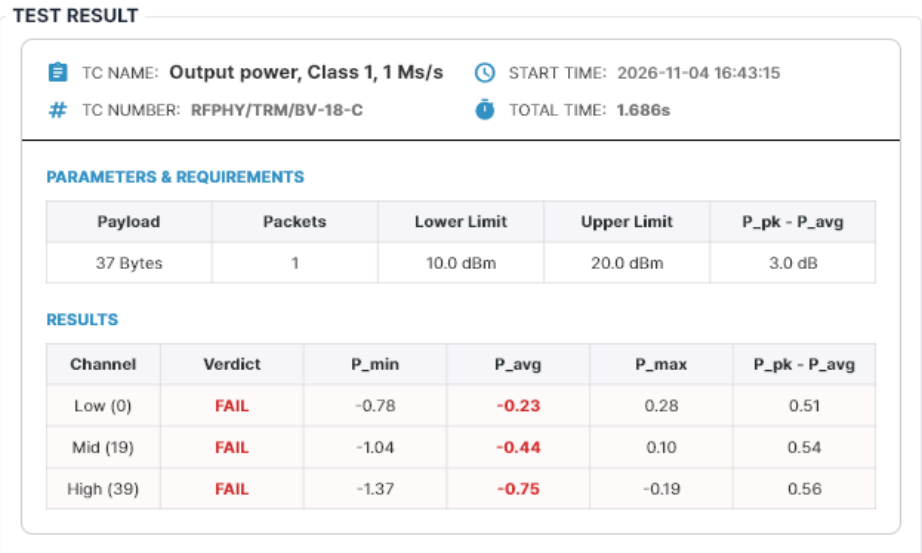


Fig. 7-5 An example of a FAIL judgement in the test results table

7.5 Protocol Sequence & Message Diagnostics

This section provides a visual timeline of the communication flow between the testing system and your hardware. It is primarily used for debugging test execution and verifying that commands are sent and acknowledged in the correct order.

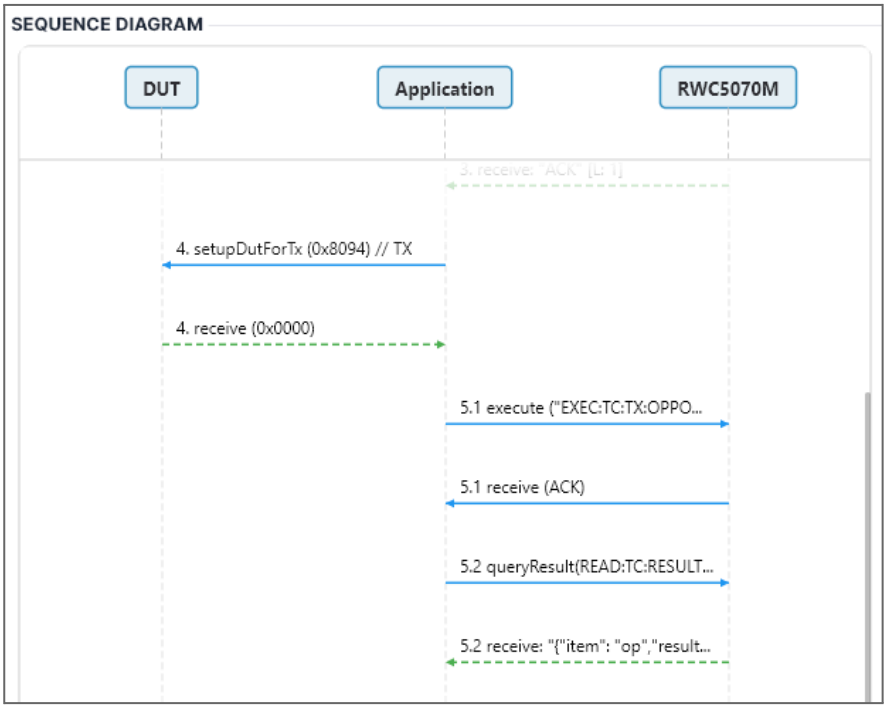


Fig. 7-6 An example of sequence diagram

- The Entities (Top boxes): The test involves three main components: the DUT (Device Under Test), the Application (the PC software controlling the automation), and the RWC5070M (the BLE tester instrument).
- Communication Flow (Arrows): The directional arrows track the chronological exchange of messages from top to bottom.
- Specific Commands: Text above the arrows shows the exact commands, data packets, and responses being passed. For example, the diagram shows the Application sending an command (0x8094) tp the DUT and receiving code(0x0000) from DUT. Subsequently, the application sends an execution command ("EXEC:TC:TX:OPPOW") to the RWC5070M; once the tester returns an acknowledgment (ACK), the application then requests data (via "READ:TC:RESULT?").

Clicking on a message line in a sequence diagram displays detailed raw data in a pop-up window, which can be useful for actual debugging tasks.

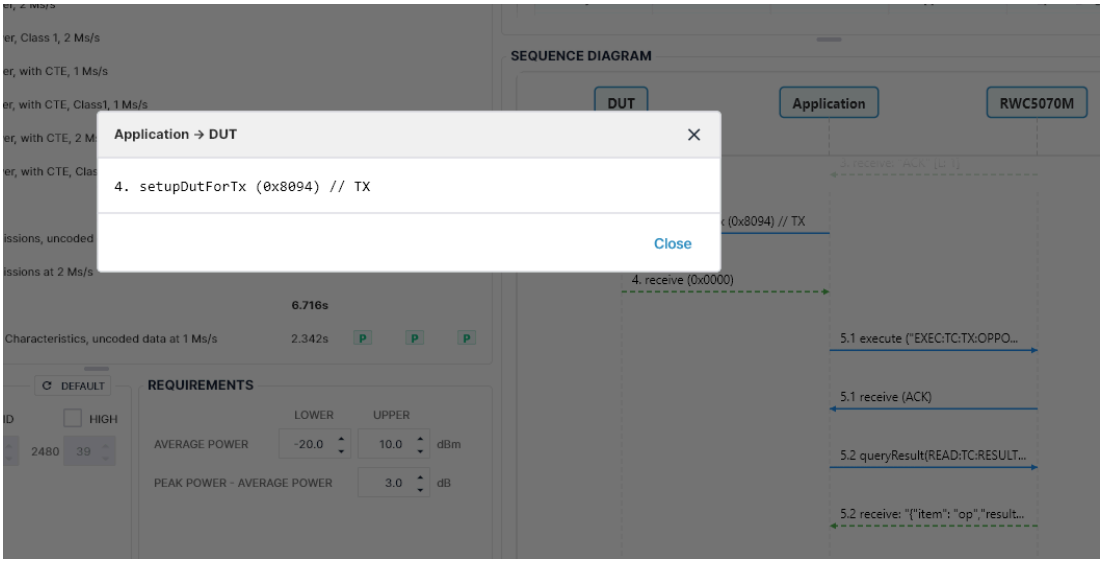


Fig. 7-7 An example of the detail message in the sequence diagram

7.6 Test Report & Export

When you click the EXPORT button on the main screen, the Select Export Format dialog box will appear. This prompt allows you to choose how the test reports will be structured when saved to your local drive.

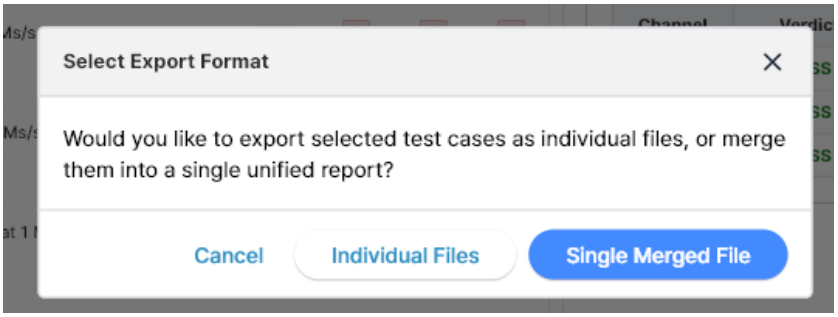


Fig. 7-8 The pop-up window for export

- **Individual Files**: Select this option to save each selected test case as its own separate report file. This is useful if you need to isolate specific test results to share with different teams.
- **Single Merged File**: Select this option to combine the results of all selected test cases into one comprehensive, unified report document. This is ideal for archiving a complete test run or submitting a final summary.
- **Cancel**: Closes the popup window and aborts the export process without saving any files.

7.6.1 Merged Report

After completing the export process, the generated document will open in a new Merged Report viewer window. The cover page of the RF TEST CASE REPORT displays key identifying metadata, including the Project name, the DUT (Device Under Test) identifier, and the exact Date and time the report was generated. Below the cover page, you can scroll through the Table of Contents to navigate the specific test results.

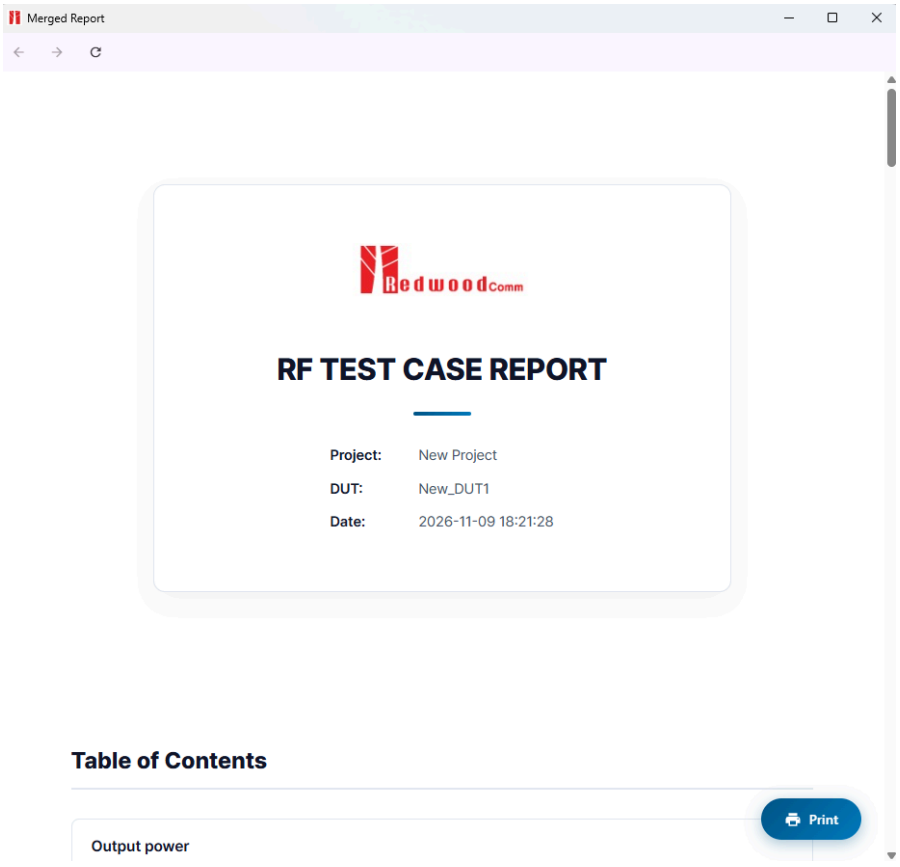


Fig. 7-9 An example of merged report

How to Print or Save as a PDF:

- **Locate the Print Button**: Find the blue Print button floating in the bottom right corner of the report screen.
- **Physical Print**: Click the Print button to open your operating system's standard print dialog menu. Select your local or network printer from the destination list to print a physical hard copy.
- **Save as PDF**: To export the document as a digital PDF file, click the Print button. When the system

print dialog appears, change the destination or printer selection to "Save as PDF" (or "Microsoft Print to PDF" on Windows). Click 'Save' or 'Print' to choose a folder on your computer to store the PDF.

7.6.2 Interactive HTML Report

The HtmlReportService generates completely self-contained, publication-ready HTML reports for any completed test sequence:

- **Zero Dependency Standalone Document**: All charts, styling, and test data are embedded directly into a single HTML file. No external internet or server connection is needed to view the report.
- **Integrated In-App WebView**: Reports can be previewed immediately inside the RWC5070M application window without launching external browsers.

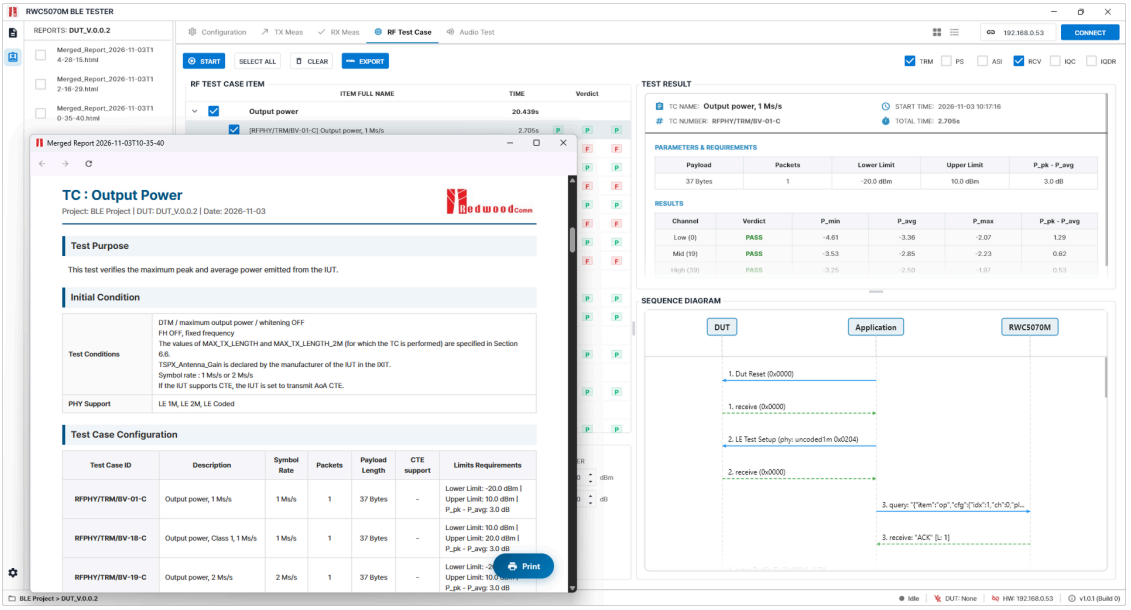


Fig. 7-10 Standalone Interactive HTML Test Report Output

The Reports tab, accessible via the left-side navigation menu (indicated by the highlighted document/badge icon), serves as the built-in file manager for your exported test results.

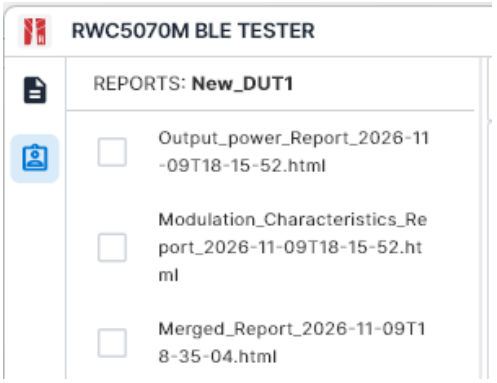


Fig. 7-11 Report file list

8. Audio Test

The Audio Test module provides high-precision analog audio signal generation and analysis via physical AUX (3.5mm unbalanced) and RCA (balanced) ports. It enables real-time oscilloscope waveform capture, FFT spectral power density distribution, and comprehensive electroacoustic distortion metrics (SINAD, THD, SNR, channel separation) for audio equipment, line-level outputs, and earphone signals.

8.1 Audio Test Getting Started Guide
8.2 Audio Generator
8.3 Audio Analyzer

8.1 Audio Test Getting Started Guide

8.1.1 System Architecture

The RWC5070M operates as an integrated Stimulus-Response analog audio test station. All signal generation and measurements are performed directly via the physical hardware analog interfaces (AUX 3.5mm and Balanced RCA). The internal Audio Generator synthesizes calibrated analog test signals (pure sine tones or continuous frequency sweeps) to stimulate the Device Under Test (DUT). Concurrently, the incoming analog audio signal from the DUT is acquired through the Audio In ports into the high-precision Audio Analyser ADC, calculating real-time time-domain waveforms, FFT spectral power distribution, and electroacoustic distortion metrics.

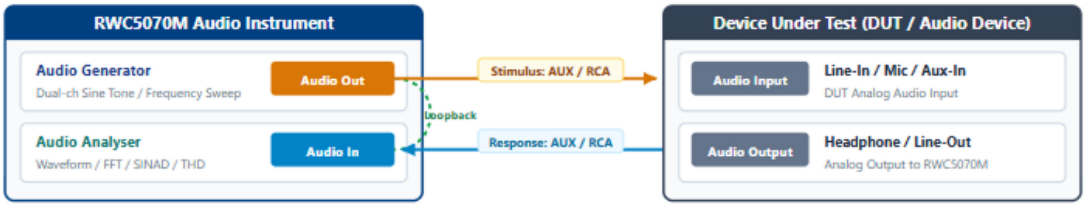


Fig. 8-1 System Block Diagram

8.1.2 Physical Wiring by Test Scenario

- **Direct Audio Signal Analysis (DUT Output Evaluation)**: Connect the analog audio output of the DUT (e.g., 3.5mm headphone jack, earphone output, or line-out) directly to RWC5070M Audio In (AUX or RCA). The Analyser continuously evaluates real-time waveform voltages, FFT spectrum, and distortion metrics. *(Note: When evaluating wireless audio receivers or earbuds, pair and stream audio to the DUT using an external source device such as a smartphone or PC; the RWC5070M analyzes the analog sound output by the DUT).*
- **Stimulus-Response Testing (Audio Out → DUT → Audio In)**: Connect RWC5070M Audio Out to the DUT analog audio input (Line-In/Mic), and connect the DUT analog output back to RWC5070M Audio In. Use Tone or Sweep mode to measure gain, frequency response, and harmonic distortion across the audio band.
- **RLoopback Calibration (Self-Verification)**: Connect RWC5070M Audio Out directly to Audio In using a 3.5mm stereo cable or RCA jumper cables. Enable a 1.00 kHz tone (0.0 dBu) to verify the instrument baseline floor (THD < 0.01%, SINAD > 80 dB) before testing devices.
- **Interface Selection:** Use RCA (Balanced) for professional line-level differential signals (+4 dBu nominal, superior common-mode noise rejection) and AUX (Unbalanced 3.5mm) for consumer mobile/earphone line-in/out (-10 dBV nominal).

8.2 Audio Generator

The built-in dual-channel Audio Generator outputs calibrated reference test signals to stimulus audio receivers or DUT audio inputs for end-to-end electroacoustic verification.

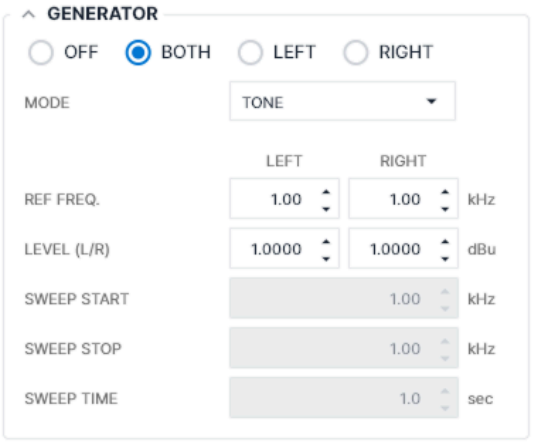


Fig. 8-2 Audio Generator Controls

8.2.1 Channel Output Mode & Level Control

- **Channel Output Mode (Type)**: Select active output channels via the radio selector [OFF (disable generator), BOTH (stereo output), LEFT, or RIGHT]. The test signal is output immediately upon selecting a channel (selecting OFF immediately disables generator output).
- **Level L/R (dBu)**: Output voltage level from -40.0 dBu to +10.0 dBu.

8.2.2 Fixed Tone Mode

- **TONE Mode (Fixed Frequency Sine Wave)**: Generates pure audio tones for SINAD and harmonic distortion tests.
- **Ref Freq (kHz)**: Left and Right independent tone frequencies from 0.02 kHz to 20.00 kHz (default: 1.00 kHz).

8.2.3 Frequency Sweep Mode

- **SWEEP Mode (Frequency Sweep)**: Automatically sweeps frequency across a designated band for frequency response characterization.
- **Sweep Start (kHz)**: Sweep start frequency from 0.02 kHz to 20.00 kHz.
- **Sweep Stop (kHz)**: Sweep stop frequency from 0.02 kHz to 20.00 kHz.
- **Sweep Time (sec)**: Duration for one complete frequency sweep cycle, adjustable from 0.5 sec to 50.0 sec.

8.3 Audio Analyzer

The Audio Analyser performs comprehensive multi-domain signal analysis on incoming analog audio signals received via the AUX or RCA input ports, providing real-time oscilloscope time-domain waveforms, FFT spectral distribution, and automated audio quality metrics.

8.3.1 Audio Waveform

The Audio Waveform screen displays real-time time-domain audio voltages for Left and Right channels. Clicking the **START** button initiates continuous audio signal acquisition from the hardware interface.

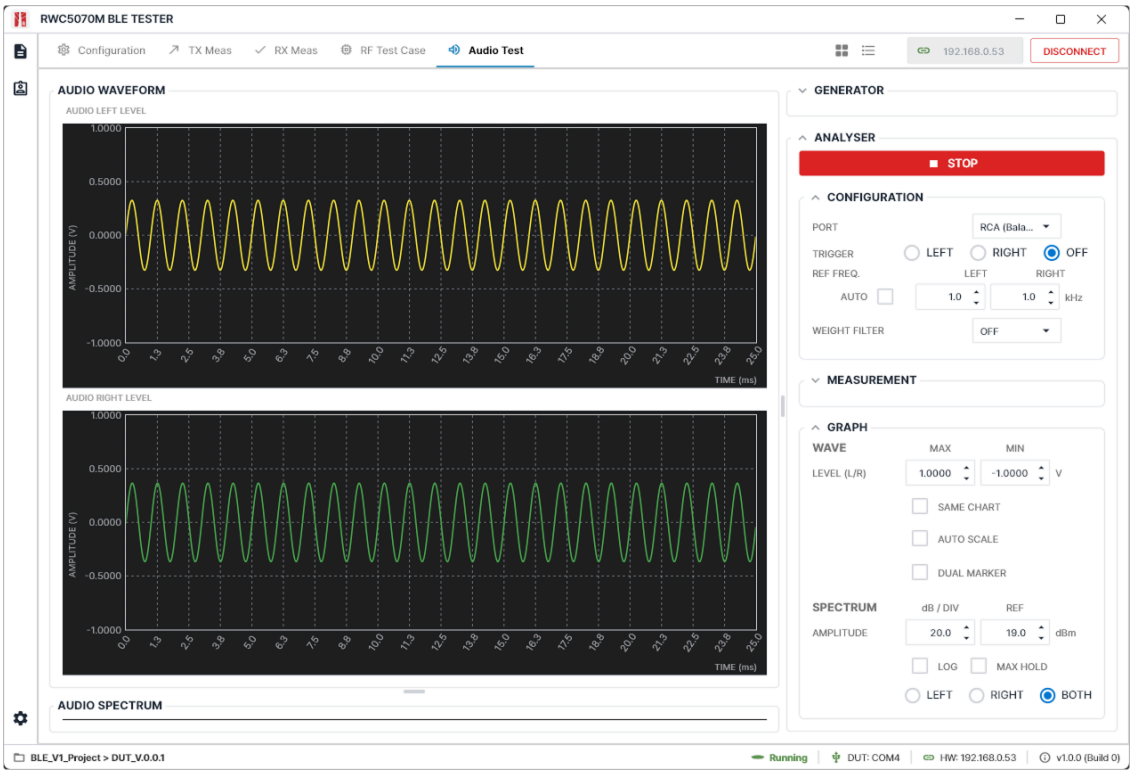


Fig. 8-3 Audio Waveform - Configuration & Graph Controls

8.3.1.1 Configuration Controls

- **Audio Port**: Select the physical hardware input interface between RCA (Balanced) and AUX (Unbalanced).
- **Trigger**: Choose oscilloscope synchronization trigger source between LEFT, RIGHT, or OFF (free-run).
- **Ref Freq. (kHz)**: Enable Auto for automatic fundamental frequency estimation, or uncheck to manually set Left and Right reference frequencies (0.40 kHz to 4.00kHz).
- **Weight Filter:** Apply psychoacoustic weighting filter [OFF, A_WEIGHT, C_WEIGHT, or CCIR]. The A and C weighting filters follow the ANSI S1.42 and IEC 61672-1 standards, and the CCIR filter follows ITU-R 468:
  - OFF: Flat frequency response across 20 Hz to 20 kHz for unweighted raw electrical voltage and wideband distortion (THD/SINAD) measurement.
  - A_WEIGHT (ANSI S1.42 / IEC 61672-1): Emulates human auditory perception at moderate sound levels (40 phon curve), attenuating low and high frequencies; standard for general audio SNR and idle noise evaluation.
  - C_WEIGHT (ANSI S1.42 / IEC 61672-1): Broad, flat response across 31.5 Hz to 8 kHz simulating ear response at high acoustic levels (80 phon); ideal for peak power, clipping headroom, and rumble analysis.
  - CCIR (ITU-R 468): Standardized broadcast weighting with quasi-peak detection, emphasizing noise annoyance around 6.3 kHz.

8.3.1.2 Graph Controls

- **Level L/R (V)**: Manually specify the Y-axis voltage limits (Max/Min Limit between -5.0 V and +5.0 V).
- **Same Chart**: Overlay Left (Blue) and Right (Orange) signals on a unified chart, or separates them into two stacked independent charts.
- **Auto Scale**: Automatically fits Y-axis voltage scale to peak input signal amplitudes.
- **Dual Marker**: When checked, click on the chart to place time/voltage markers (T1, T2) to measure ΔTime, 1/ΔTime (frequency), and ΔVoltage.
- **Interactive Zoom & Pan**: Scroll mouse wheel to zoom time/voltage axes, drag to pan along the time axis, and inspect buffer navigation in the mini-map.

8.3.2 Audio Spectrum

The Audio Spectrum screen computes and renders high-resolution Fast Fourier Transform (FFT) spectral power density across the 20 Hz to 20 kHz audio band.

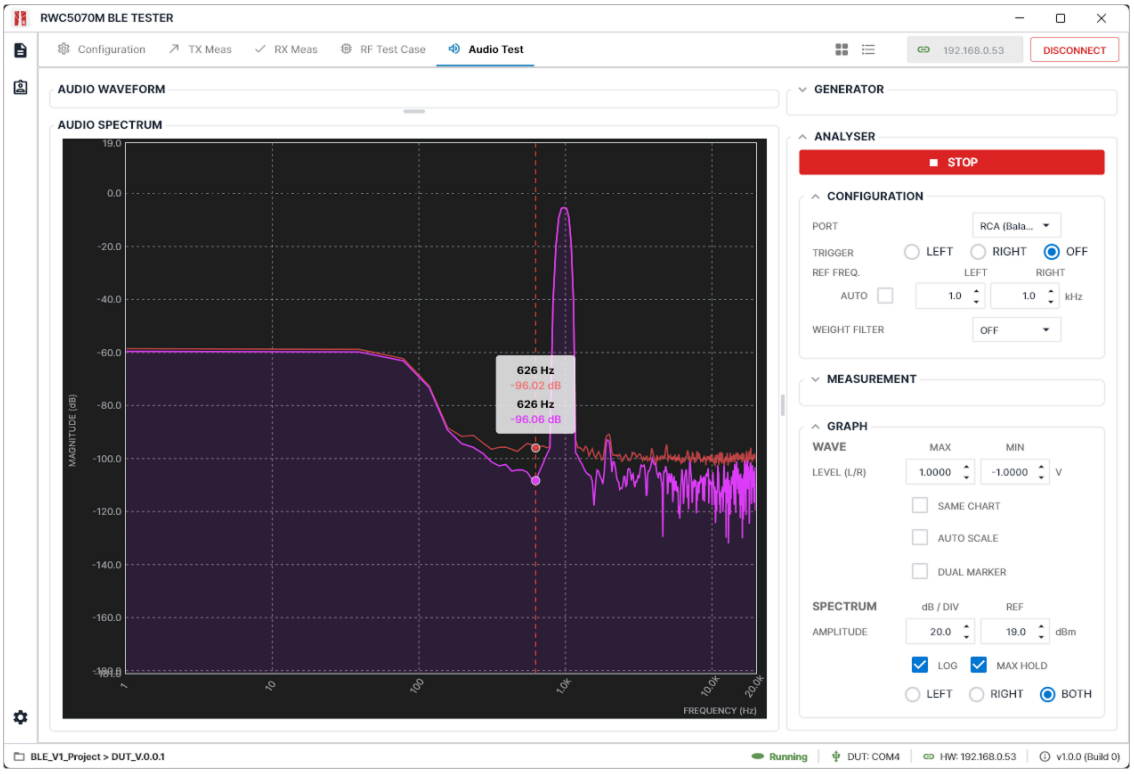


Fig. 8-4 Audio Spectrum - Configuration & Graph Controls

8.3.2.1 Configuration Controls

- Operates synchronously with input port selection and weight filtering defined in the Configuration panel to ensure precise acoustic calibration.

8.3.2.2 Graph Controls

- **Amplitude**: Set Y-axis scale interval (dB/DIV: 1 to 20 dB) and reference power level (Ref: -140 dBm to +150 dBm).
- **Log Scale**: Toggle the X-axis between standard logarithmic frequency representation (20 Hz to 20 kHz) and linear frequency display.
- **Max Hold**: Enable peak hold overlay trace to capture transient distortion spurs and harmonic peaks

across consecutive FFT sweeps.

- **Channel Selector**: Select displayed spectrum channel between LEFT, RIGHT, or BOTH.
- **Interactive Inspection**: Hover cursor over spectrum peaks to view exact frequency (Hz) and power level (dBm) tooltips.

8.3.3 Audio Measurement Parameters

The Measurement panel calculates ten fundamental audio performance metrics simultaneously for Left and Right channels from demodulated PCM streams in real time:

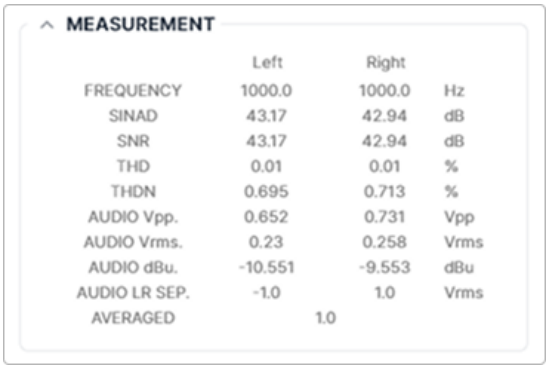


Fig. 8-5 Audio Measurement Parameters

PARAMETER	UNIT	DESCRIPTION & TECHNICAL DEFINITION
Frequency	Hz	Measured fundamental tone frequency of the decoded audio signal.
SINAD	dB	Signal-to-Noise and Distortion ratio: evaluates overall audio purity by measuring total signal power against noise and spurious harmonics.
SNR	dB	Signal-to-Noise Ratio: fundamental signal power relative to background noise floor excluding harmonic spurs.
THD	%	Total Harmonic Distortion: ratio of the sum of harmonic powers to fundamental tone power, expressed in percentage.
THD+N	%	Total Harmonic Distortion plus Noise: comprehensive distortion metric across the entire audio bandwidth.
Level Vpp.	Vpp	Peak-to-Peak output voltage for verifying dynamic swing and clipping limits.
Level Vrms.	Vrms	Root-Mean-Square output voltage for evaluating effective audio output level.
Level dBu.	dBu	Logarithmic voltage ratio referenced to 0.775 Vrms: 20 × log10(Vrms / 0.775).
L/R Sep.	Vrms	Channel separation (crosstalk): measures unwanted signal leakage between Left and Right channels.
Averaged	Count	Number of consecutive measurement cycles accumulated in the running average calculation.

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