

LENOVO DIAGNOSTICS for ARM V1.7.3 **USER GUIDE**

LSBD - Laboratório de Sistemas e Banco de Dados

LENOVO DIAGNOSTICS FOR ARM **USER GUIDE**

Title: Lenovo Diagnostics for ARM User Guide
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REVISION HISTORY

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LENOVO DIAGNOSTICS for ARM V1.7.3

USER GUIDE

1. LENOVO DIAGNOSTICS OVERVIEW

Lenovo Diagnostics for ARM is a diagnostic tool that diagnosis different components in Lenovo computers providing feedback to the users about their machine’s health.

Lenovo Diagnostics for ARM is composed of Modules that allows performing diagnostics for a group of devices and provides Tools to assist in checking devices information, checking previous diagnostics executions, as well creating, and running custom diagnostics.

1.1 Data Collection

Lenovo Diagnostics for ARM collects anonymous data regarding tests execution for the purpose of improving Hardware’s diagnostics. You can enable or disable that function according to your preferences.

By opening the Lenovo Diagnostics tool for the first time, the application will display a message asking if you agree or not with Lenovo Product Privacy Statement.

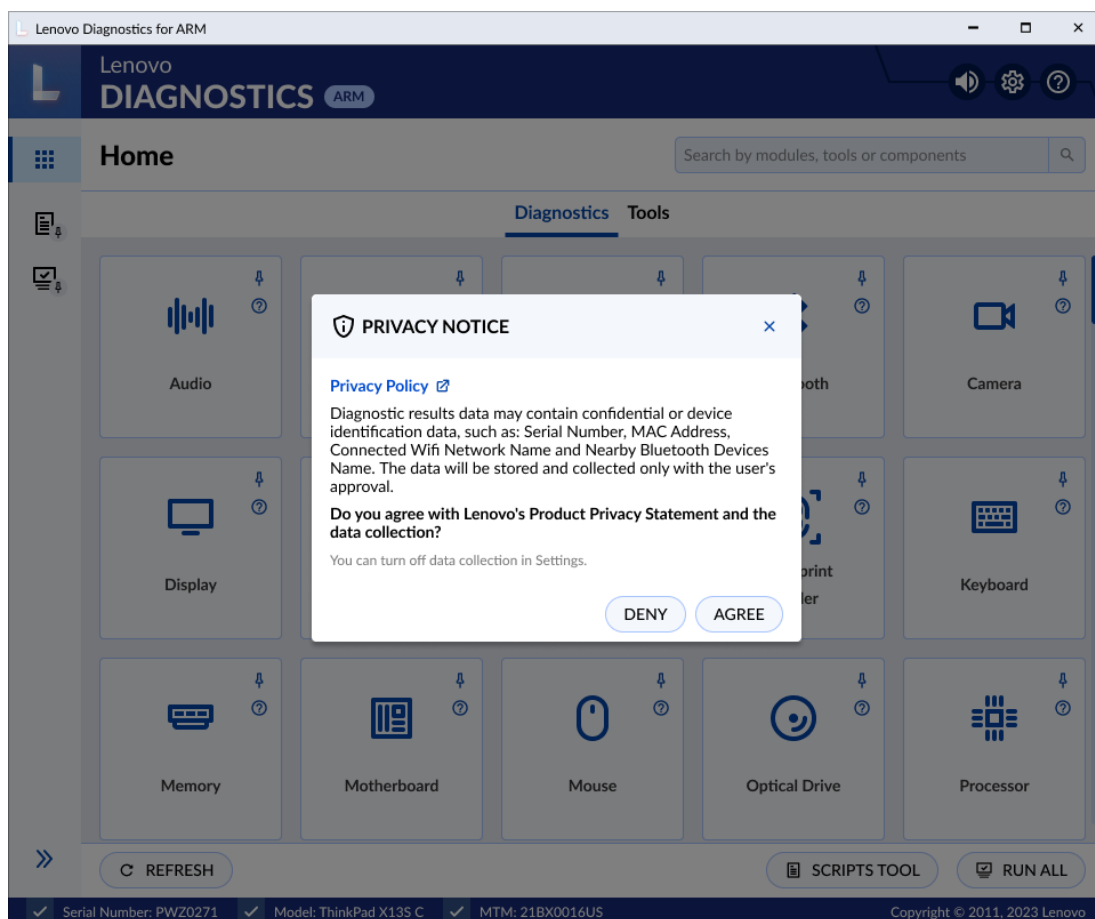



Figure 1: Lenovo Privacy Statement Pop-up

You also may change this option at any time by clicking on the Settings icon 

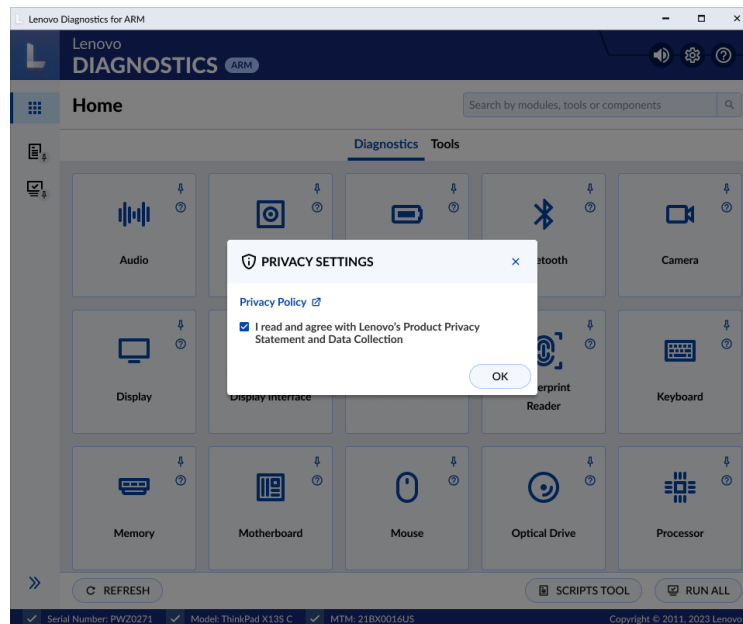
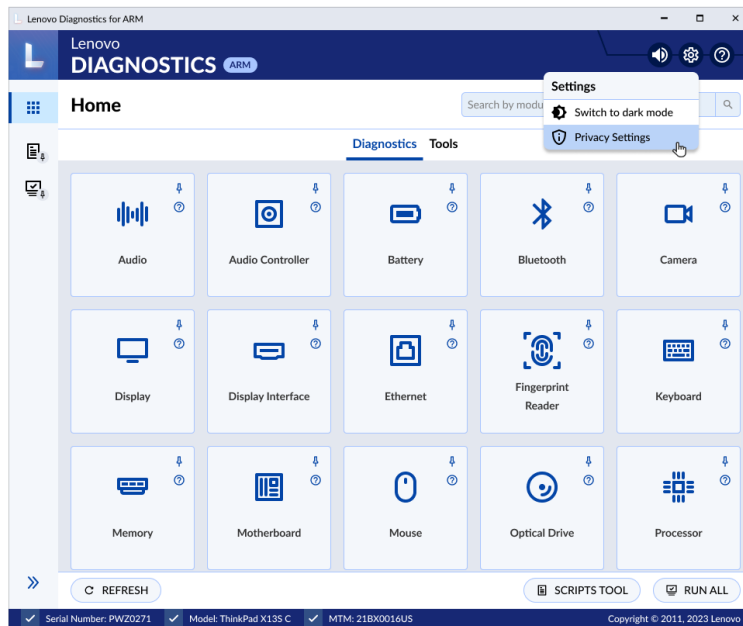


Figure 2: Lenovo Privacy Statement Settings

2. APPLICATION INTERFACE

2.1 Lenovo Diagnostics for ARM Main screen

By opening the Lenovo Diagnostics for ARM, you will see the main screen containing the following items:

- Top bar with icons for enabling/disabling Sound Notice, change Settings, access Help Menu.
- Sidebar with home screen icon and following tools pinned by default, Script tool, and Run All.
- Footer with the buttons: Refresh, Scripts Tool, and Run All.

On this screen, you can also see the search field and the tabs Diagnostics and Tools.

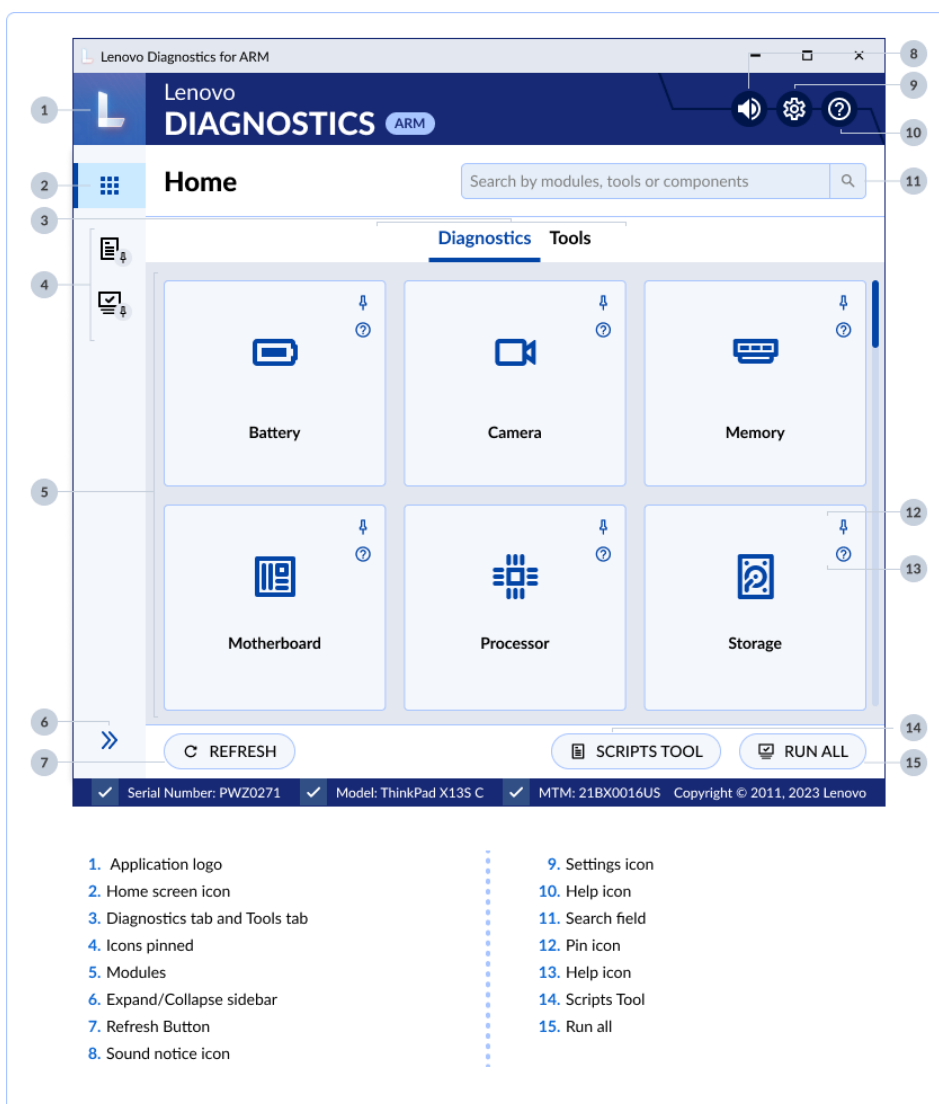


Figure 3: Home Screen

Application logo

The application logo is displayed in the upper left corner of the screen.

Home screen icon

The home screen icon is located in the sidebar. You can access the home screen at any time from other tools or modules.

Diagnostics tab and Tools tab

- **Tab Diagnostics**

You can see the modules provided by Lenovo Diagnostics for ARM and select one of them to perform tests. The modules will not be enabled if no device is supported by the module.

- **Tab Tools**

Through this tab you can access tools that can help you in the diagnostic process, such as creating custom executions (Script Tool), to see detailed information about each device (System Information), to consult and export result log tests performed in a machine (Log History).

Icons pinned

In the sidebar, you can add a shortcut to modules and tools by clicking on each card's pin icon on the Home Screen or by clicking the pin icon located on the sidebar elements, which is displayed when you hover over it.

Modules

On the home screen, all application modules are shown. A module contains a set of tests that can be performed for a type of device. It is enabled in the application only if the tested machine has at least one device supported by the module. When the module is not supported, the module card is grayed out, and with the label "Not Available".

Refresh Button

You can refresh the Home Screen after plugging or unplugging any device by clicking on the Refresh button displayed at the lower-left corner of the screen.

Expand/Collapse sidebar

By clicking on the Collapse/Expand icon, you can collapse or expand the sidebar.

If the sidebar is collapsed, only the home screen icon and pinned or open elements are displayed. You can also pin or unpin sidebar elements by clicking the pin icon displayed on each of those elements.

If the sidebar is expanded, the icons and name of the elements will be displayed, and if a tool or module is open, you can close them via the X icon.

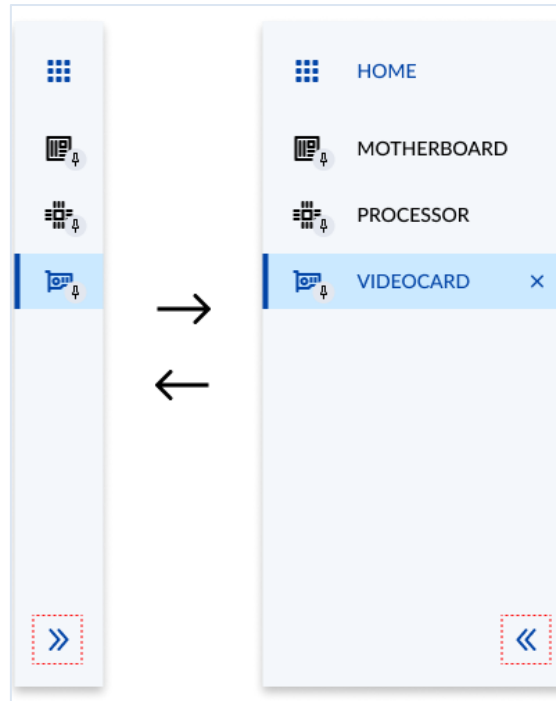


Figure 4: Sidebar

Sound notice icon

When the execution is finished, the application plays a sound notice, where two short 0.5 second beeps mean that no test has returned a failed status and a long 1-second beep means that at least 1 test has returned failed status. You can enable/disable this sound notice by clicking on the sound notice icon located at the top of the application.

Settings icon

By clicking on the Settings icon, you will see the following options:

- Switch to the dark mode or switch to standard mode;
- Enable or disable the Lenovo Product Privacy Statement and Data Collection.

Help icon

By clicking on the Help icon, you will see the following options:

- See About
- See User Guide

Search field

You can search by module or tool name, or by components and the application will return related results as shown in the example below.

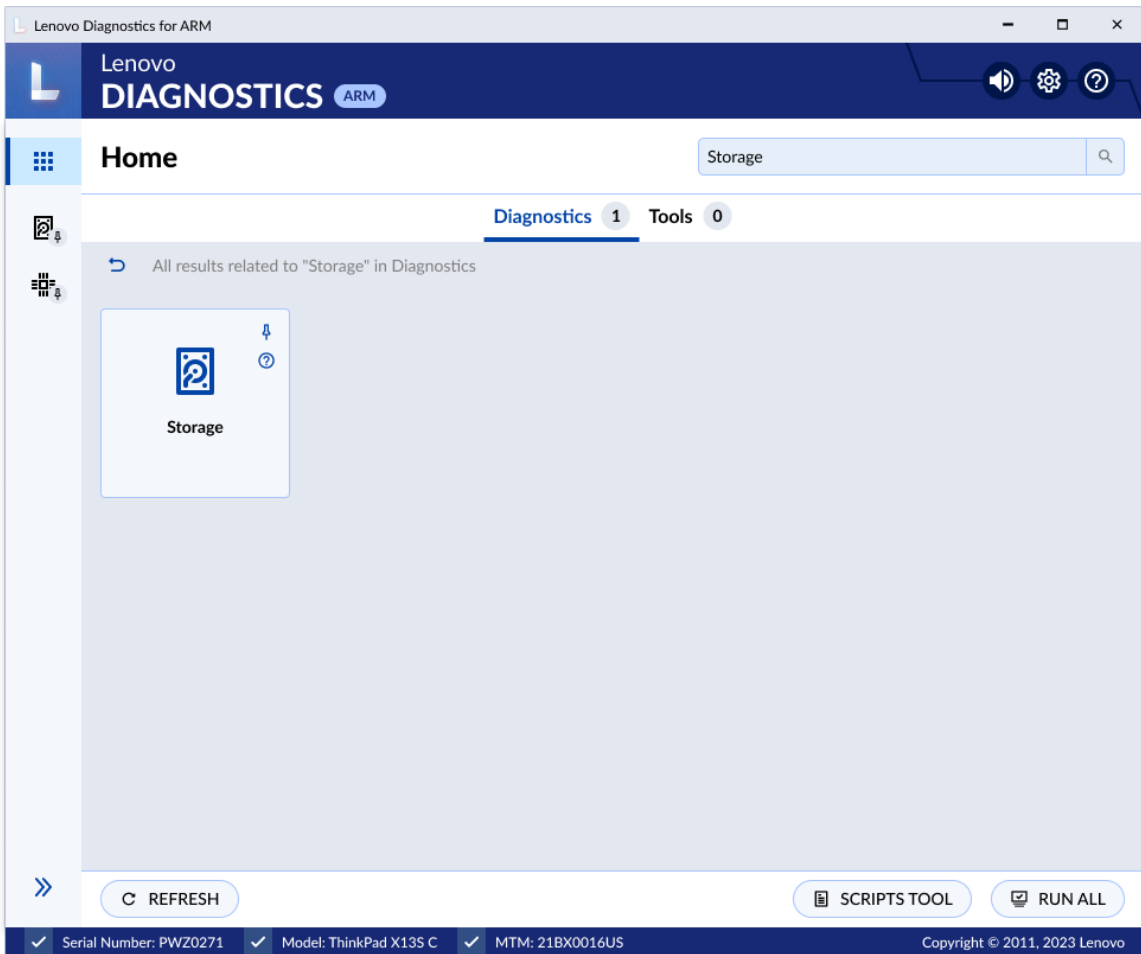


Figure 5: Search Field Example

Pin icon


The pin icon  will allow you to pin modules and tools to the sidebar, which means that the module can be accessed from any screen you are on, as it will always be visible on the sidebar. In the image below, the user is viewing the Processor module but can access the Run All or Scripts Tool at any time, as it is pinned in the sidebar.



Figure 6: Sidebar Example

Help icon

By clicking in the Help icon (?) of each card, you can see a brief description of the respective element.

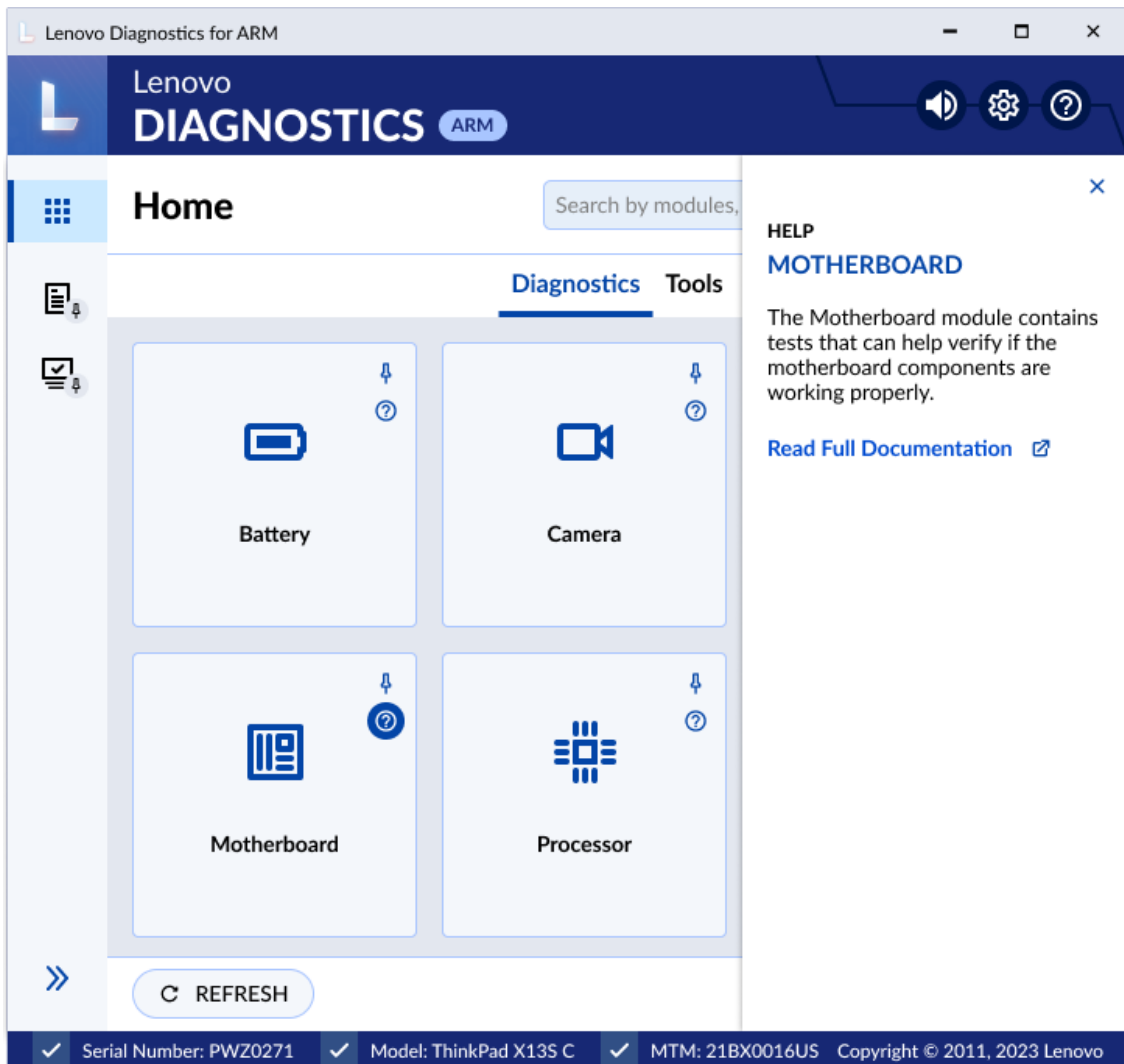


Figure 7: Module's Help

Scripts Tool

You can access the Scripts Tool by clicking on the Scripts Tool button located at the bottom of the screen on the right side.

Run All

You can access the Run All by clicking on the Run All button located at the lower-right corner of the screen.

3. PERFORMING DIAGNOSTICS IN LENOVO DIAGNOSTICS FOR ARM

3.1 Understanding the diagnostics

Each module contains tests that may be performed under one or more devices, resulting in a diagnostic. This structure is displayed in the image below:

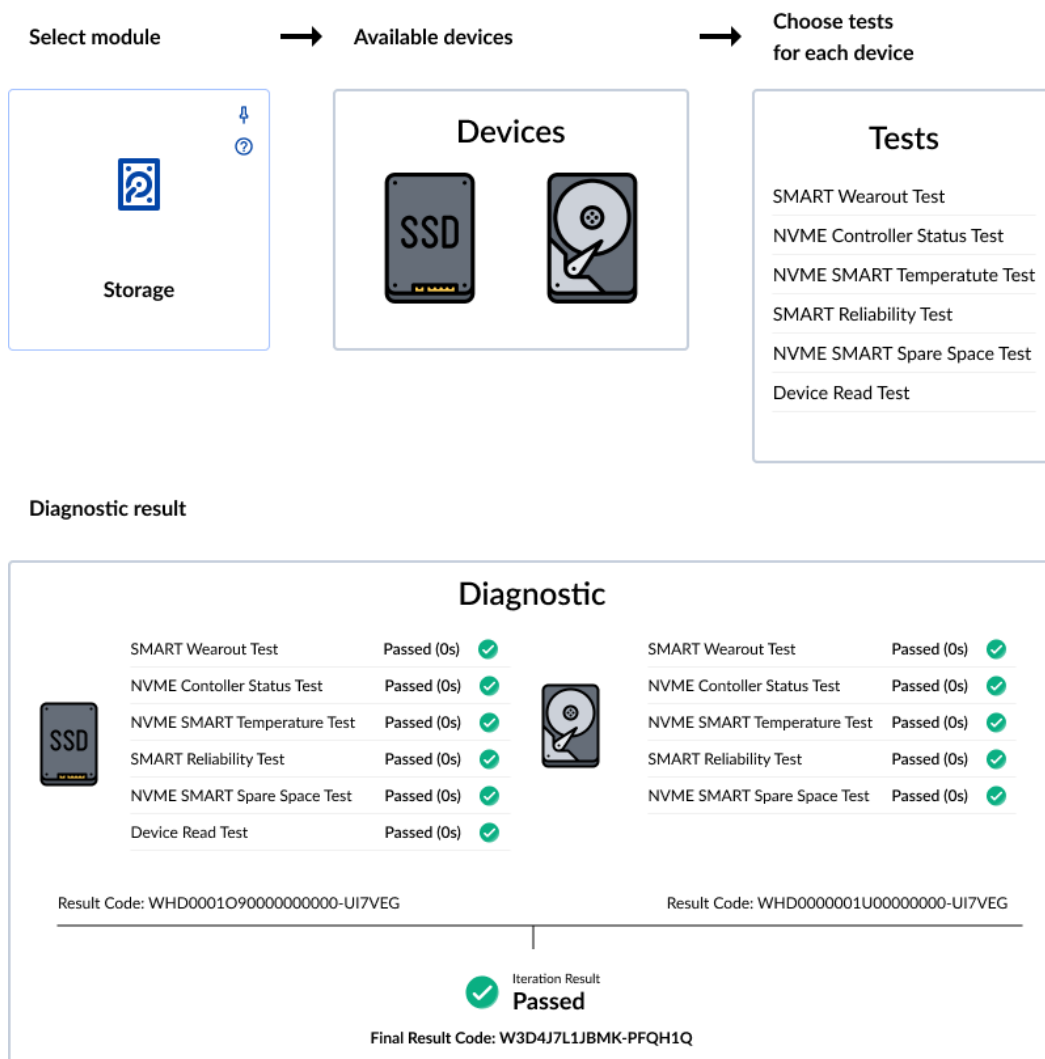







Figure 8: Diagnostics Flow

When a diagnostic is finished, Lenovo Diagnostics displays the results for each performed test and creates two codes to resume the test execution: Result Code and Final Result Code.

Result Code	Contains information about the machine serial number, system platform, and test execution status and date. This code is generated for each tested device.
Final Result Code	Contains information about the machine serial number, system platform, and execution date. This code reports also the module where the tests were performed and the tests with failed status.

The tests on Lenovo Diagnostics may have the following status:

 Passed	When the test algorithm is executed, and no failure is found.
 Failed	When the test identifies the diagnosed device as defective.
 Warning	When the test indicates the diagnosed device may have some defect, but the result is not conclusive.
 Canceled	When the test is canceled in the middle of test execution.
 Not Applicable	When the test is not applicable to the selected device, for example, the device does not meet some minimum requirement for the test to be performed.

3.2 Performing diagnostics

The diagnostic for a module in Lenovo Diagnostics for ARM is based on the following steps:

3.2.1 Select Devices and Tests

By selecting a module in the Diagnostics tab, you will be redirected to a screen where you can select which devices and tests will be performed.

On this step, all devices and tests supported by the selected module are displayed and you may select one or more of them to perform the tests.

Iterations: It is also possible to select the number of times to run the set of tests in a range from 1 to 999 times.

Estimated time: You can see an estimate for the diagnostic run time. The time is based on previous simulations on devices with similar specifications.

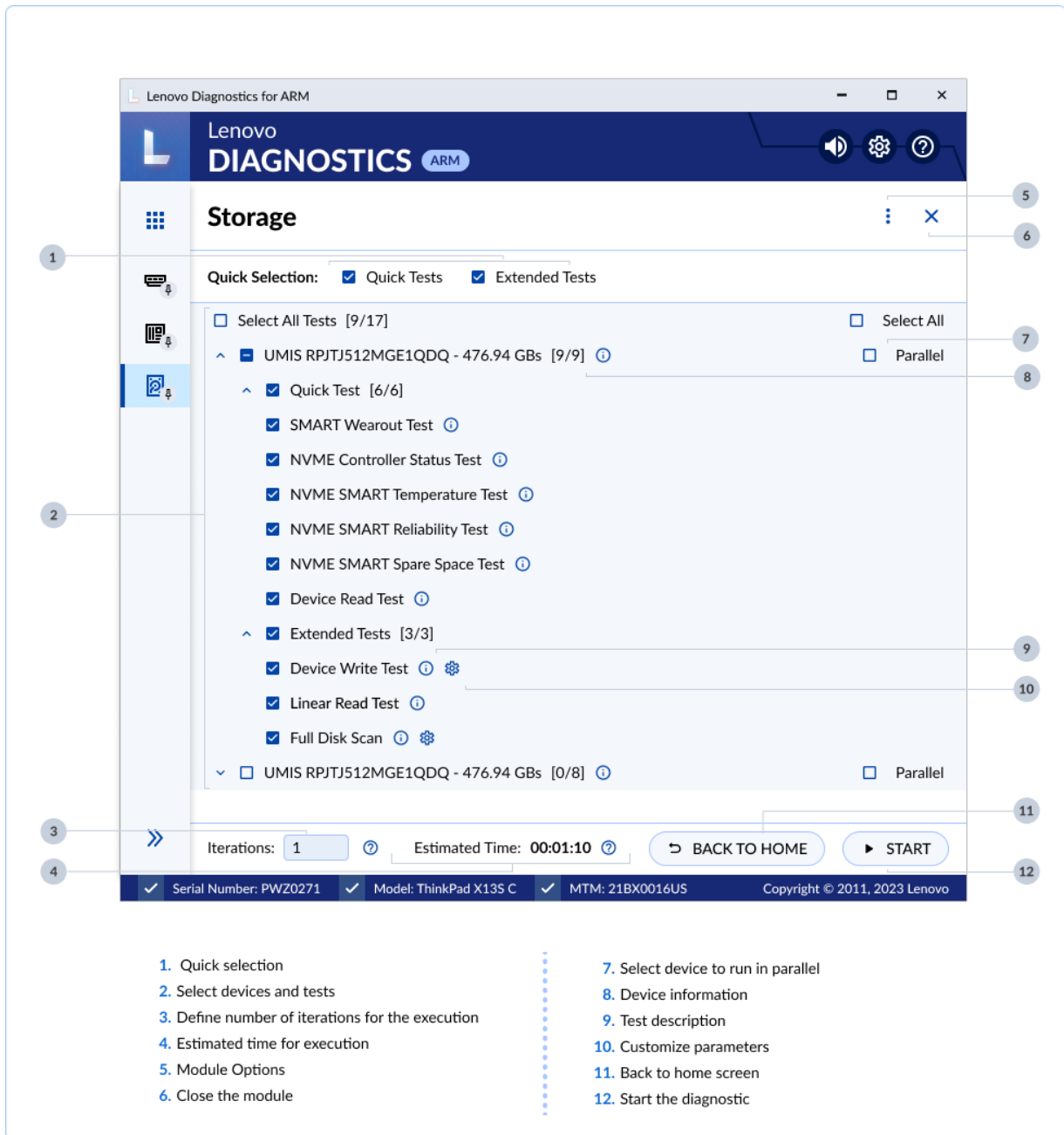


Figure 9: Devices and Tests Selection Screen

By clicking to see **Device Information**, you can view detailed information about the device. The properties displayed depend on the selected module.

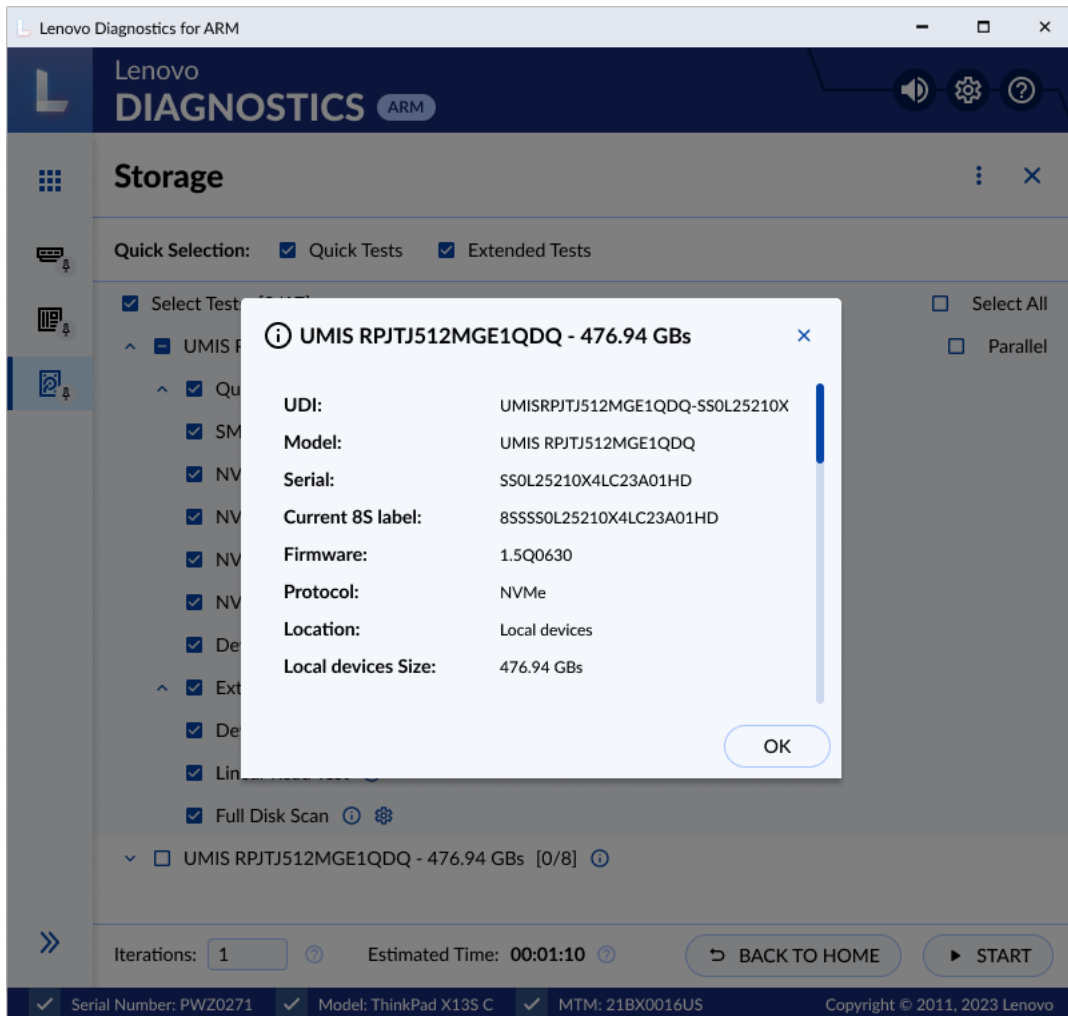


Figure 10: Device Information

By clicking to see the **Test Description**, you can view a brief description of the test and the estimated time to run the test, like the screen below.

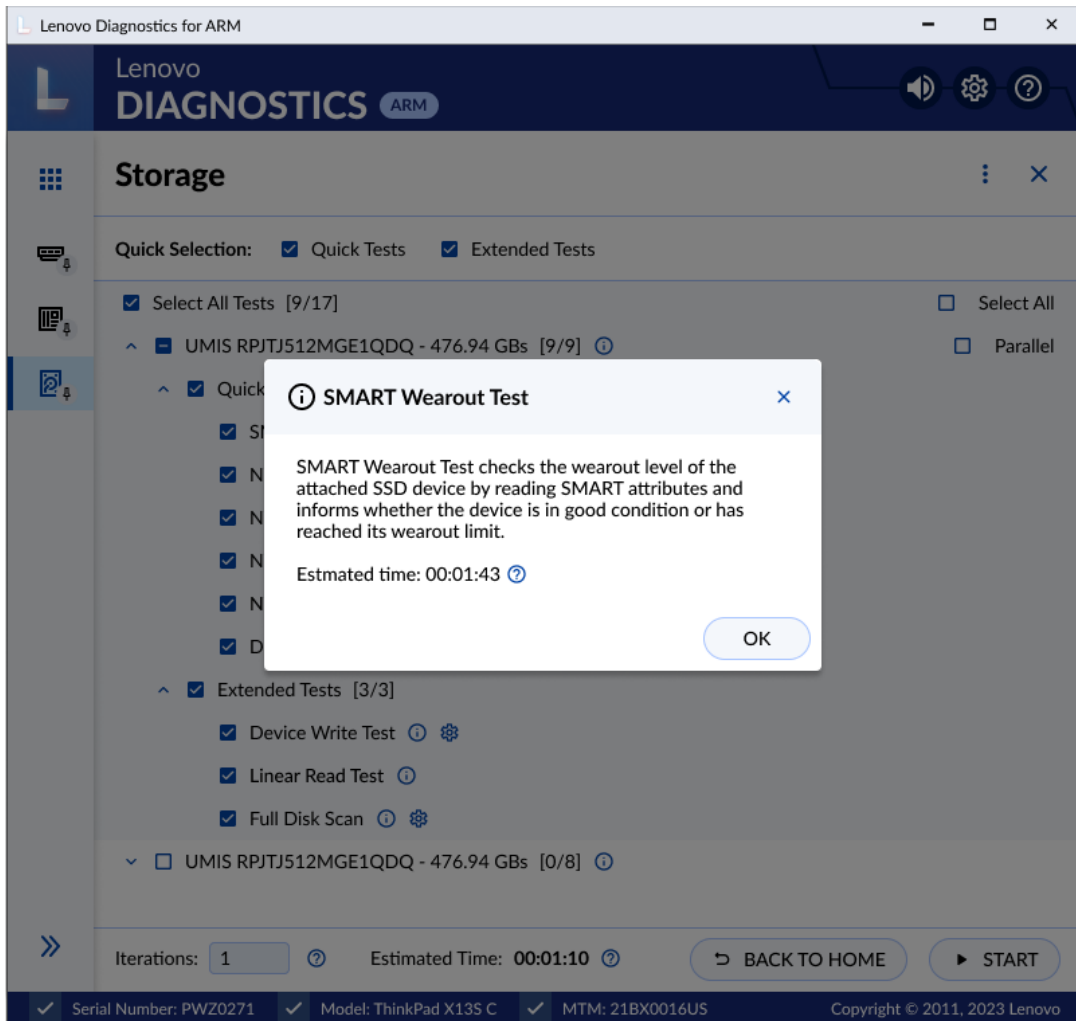


Figure 11: Test Description

By clicking to see the **Module Options**, you can view the following options: Pin/Unpin from the sidebar, and Help.

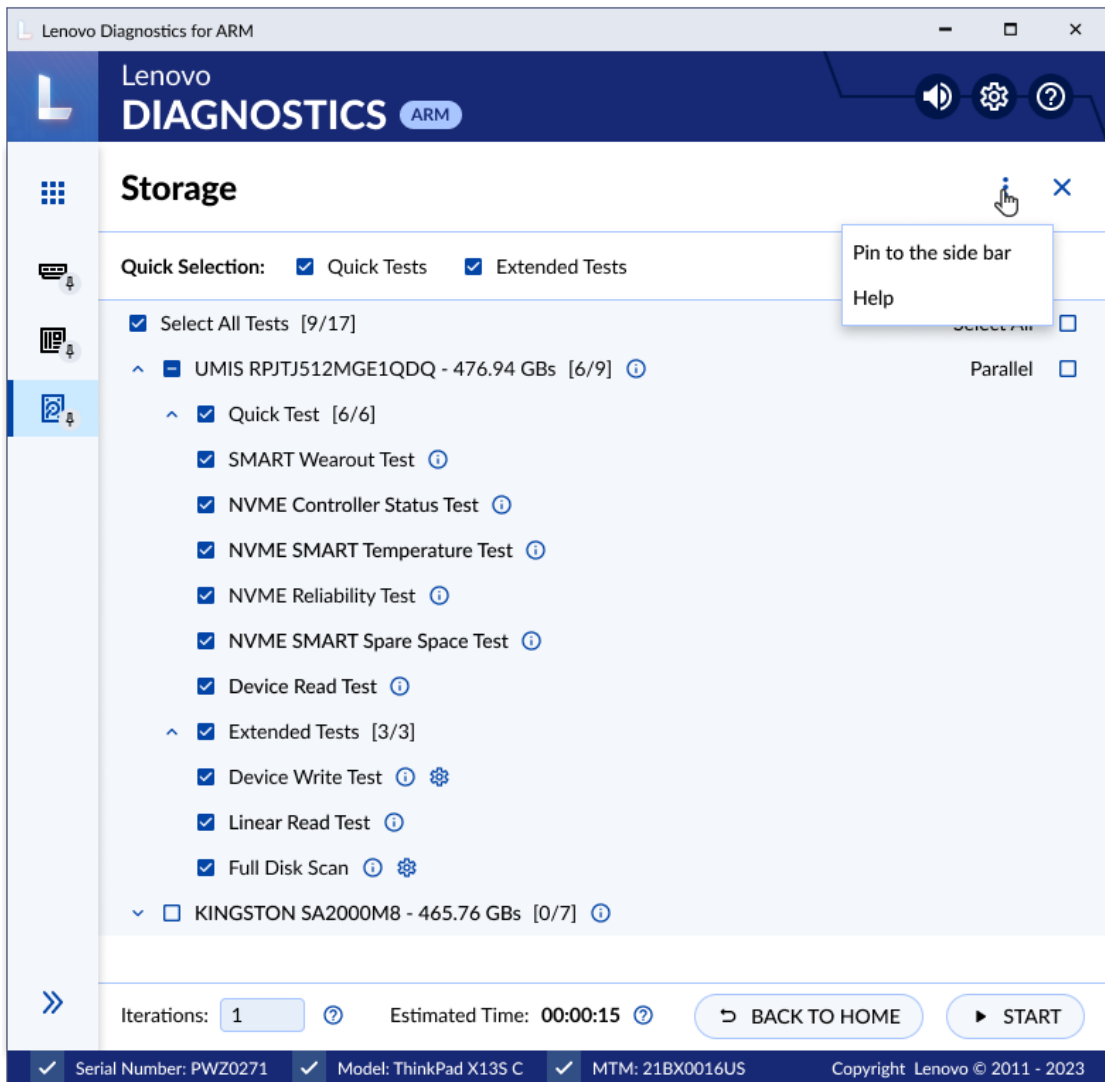


Figure 12: Modules Option

You also can close the module by clicking on “X” located next to the module options. When you close a module, you will be returned to the home screen.

3.2.2 Run Test

After configuring the execution of the tests and clicking Start, you will be directed to the Execution screen.

See in the image below that all devices selected in the previous steps are displayed with their respective tests.

You can follow each test execution by tracking the individual test progress, seeing the test status of each one, the overall test progress, and the time that reports the progress for all devices and tests selected. You also can see in real-time the number of tests for each status and the current status of the iteration.

The screenshot displays the 'Execution Overview' for a 'Storage' diagnostic. It shows an estimated time of 00:00:15 and a run time of 00:00:09. The progress is at 23% with 2/6 tests completed. A summary bar indicates 4 tests are currently executing, 2 have passed, and others are failed, warned, canceled, or not applicable. Below, a table lists individual tests: SMART Wearout Test (Passed 5s), NVME Controller Status Test (Passed 5s), NVME SMART Temperature Test (23% progress), and NVME Reliability Test (Pending). At the bottom, there are 'BACK' and 'ABORT' buttons. A footer shows system information like Serial Number, Model, and MTM.

Test Name	Time	Status	Progress
SMART Wearout Test	05/05/2023, 11:12: 41 AM	Passed (5s)	100%
NVME Controller Status Test	05/05/2023, 11:12: 43 AM	Passed (5s)	100%
NVME SMART Temperature Test	05/05/2023, 11:12: 45 AM	In Progress	23%
NVME Reliability Test	05/05/2023, 11:12: 47 AM	Pending...	0%

- | | |
|--|---|
| <ul style="list-style-type: none"> 1. Estimated time for execution 2. Run time of the execution 3. Iteration overall progress 4. Execution summary 5. More details about the summary 6. Module name 7. Device Name 8. Test in Progress | <ul style="list-style-type: none"> 9. Current iteration / Total iteration 10. Preview of the iterations overall status 11. Number of executed tests / Total of tests 12. Test Status 13. Test progress 14. Back to test selection screen 15. Abort the execution 16. Enable auto-scroll |
|--|---|

Figure 13: Execution Screen

Execution summary: You can see the tests according to the status during the execution, just by clicking on the tab that represents the status you want to see. The image below displays all tests that returned “passed” status.

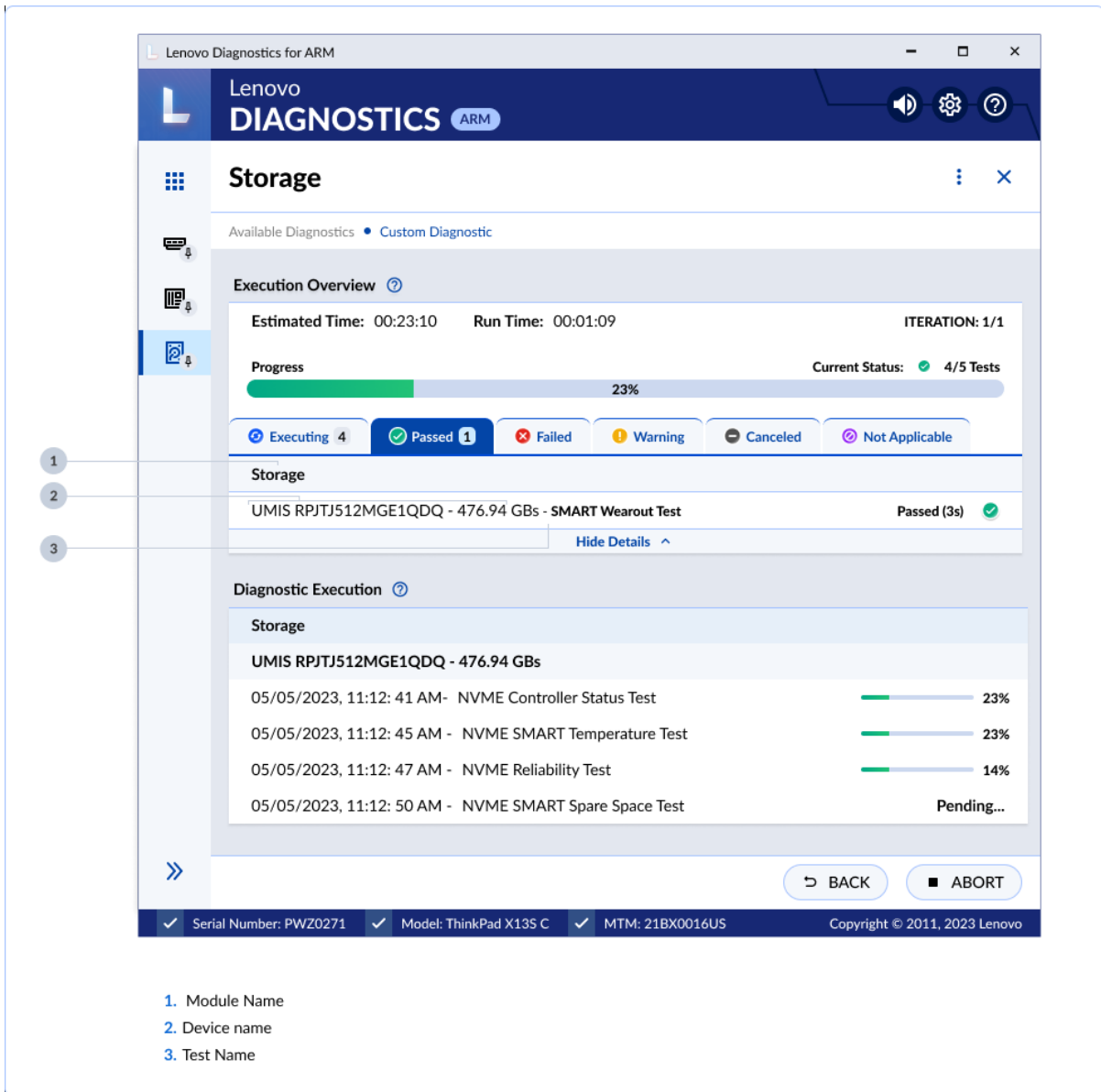


Figure 14: Show Details Example

If you want to abort the whole test execution, you can click on Abort. In this case, the current test and all tests waiting for execution are canceled, including those from the next iterations. In the same way, the overall status for the current iteration and all next iterations will be changed to Canceled.

After all tests to being finished, the Lenovo Diagnostics for ARM generates a log with detailed information about the devices and their test results.

This log is composed of the following sections:

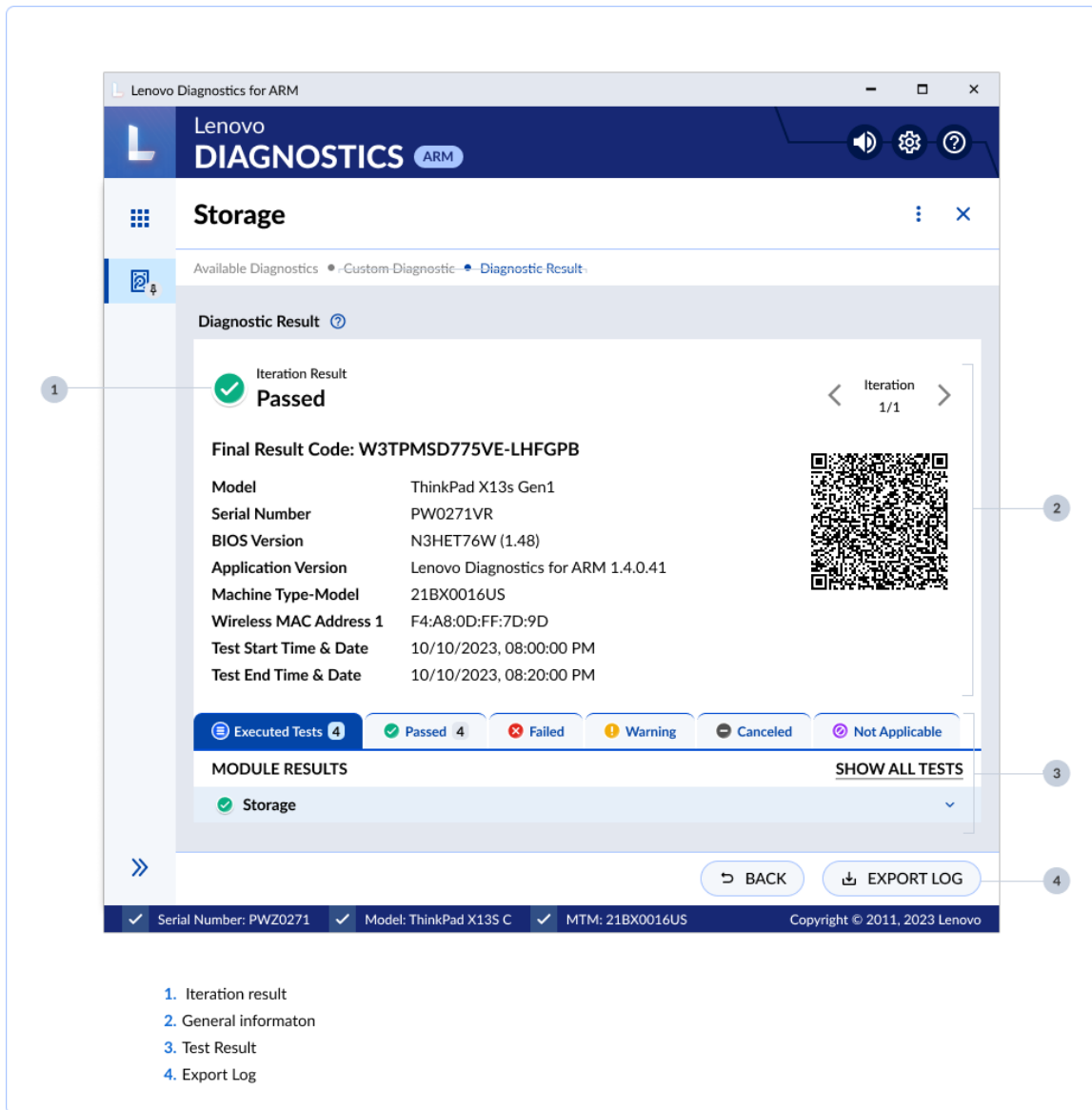



Figure 15: Diagnostic Result Screen

General information: contains information about the machine, test date, and final result. This section also displays a QR Code containing that information.

 Iteration Result
Passed

Iteration
1/1

Final Result Code: WHD3O90000000-UJ7Z2G

Model	ThinkPad X13s Gen1
Serial Number	PW0271VR
BIOS Version	N3HET76W (1.48)
Application Version	Lenovo Diagnostics for ARM 1.4.0.41
Machine Type-Model	21BX0016US
Wireless MAC Address 1	F4:A8:0D:FF:7D:9D
Test Start Time & Date	10/10/2023, 08:00:00 PM
Test End Time & Date	10/10/2023, 08:20:00 PM




Figure 16: General Information Example

Test Results: displays the results and execution time of each performed test. To see the test results, you need to click on **SHOW ALL TESTS**.

The screenshot illustrates the process of viewing detailed test results. The top section shows a summary of executed tests (6 total) with 4 passed, 0 failed, 0 warnings, 0 canceled, and 0 not applicable. A 'SHOW ALL TESTS' button is highlighted with a red dashed box. An arrow points down to the detailed view, where the 'Storage' module is selected. This view shows the device information (UMIS RPJTJ512MGE1QDQ - 476.94 GBs) and a list of six tests, all of which passed successfully.

Test Name	Result	Execution Time
05/03/2023, 11:11:41 PM - SMART Wearout Test	Passed (2s)	2s
05/03/2023, 11:11:42 PM - NVME Controller Status Test	Passed (2s)	2s
05/03/2023, 11:11:44 PM - NVME SMART Temperature Test	Passed (1s)	1s
05/03/2023, 11:11:45 PM - NVME Reliability Test	Passed (1s)	1s
05/03/2023, 11:11:46 PM - NVME SMART Spare Space Test	Passed (1s)	1s
05/03/2023, 11:11:47 PM - Device Read Test	Passed (1s)	1s

Figure 17: Show All Tests Example

Device Information: once the test results are being displayed, you can click to **SHOW DEVICE INFORMATION**. Device information is the technical details of each tested device.

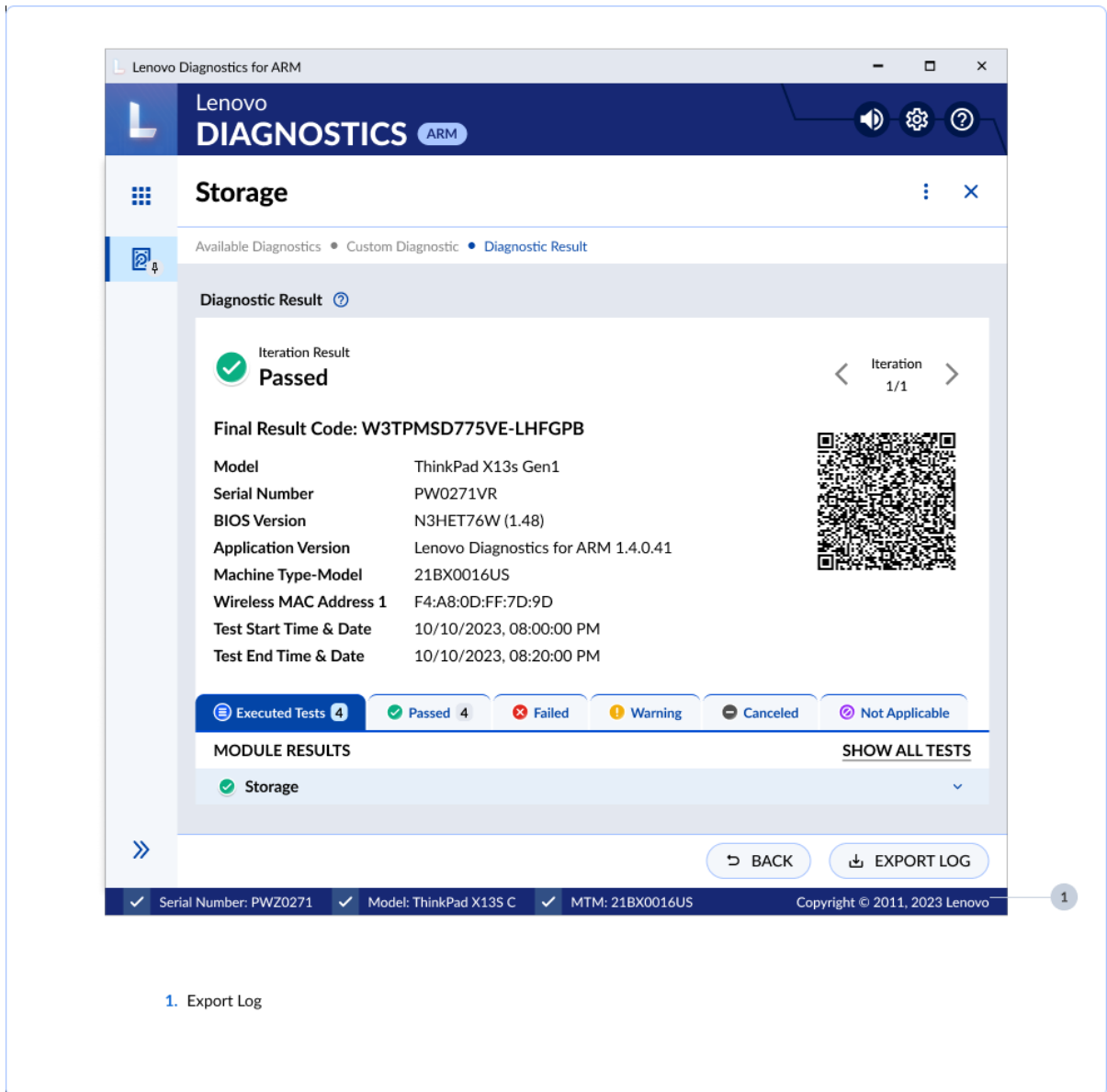
Executed 5		Passed 5	Failed	Warning	Cancel	Not App >
MODULE RESULTS		SHOW DEVICE INFORMATION		HIDE ALL TESTS		
Storage						
KINGSTON SA400S37480G - 447.13 GBs		Result Code: WAC0000700000-UO7V0D				
10/10/2022 11:55:58 - Targeted Read Test						Passed (3s)
10/10/2022 12:15:50 - Random Seek Test						Passed (52s)
10/10/2022 12:15:57 - Stress test						Passed (236s)
10/10/2022 12:15:57 - SMART Wearout Test						Passed (236s)
10/10/2022 12:16:04 - SMART Short Self Test						Passed (3s)



Executed 5		Passed 5	Failed	Warning	Cancel	Not App >
MODULE RESULTS		HIDE DEVICE INFORMATION		HIDE ALL TESTS		
Storage						
KINGSTON SA400S37480G - 447.13 GBs		Result Code: WAC0000700000-UO7V0D				
Model	KINGSTON SA400S37480G					
Manufacturer	KINGSTON					
Driver Version	10.019041789					
Firmware	2BA30002					
Serial	S0026b782DEFD77					
Mount Points	E:\ , D:\					
Logical Sectors	93770388					
Logical Sectors Size	512					
Physical Sector Size	512					
Protocol	ATA					
10/10/2022 11:55:58 - Targeted Read Test						Passed (3s)
10/10/2022 12:15:50 - Random Seek Test						Passed (52s)
10/10/2022 12:15:57 - Stress test						Passed (236s)
10/10/2022 12:15:57 - SMART Wearout Test						Passed (236s)
10/10/2022 12:16:04 - SMART Short Self Test						Passed (3s)

Figure 18: Show Device Information Example

Export Log: you can export the results to an HTML or PDF file. Just click the Export Log button.



1. Export Log

Figure 19: Export Log Example

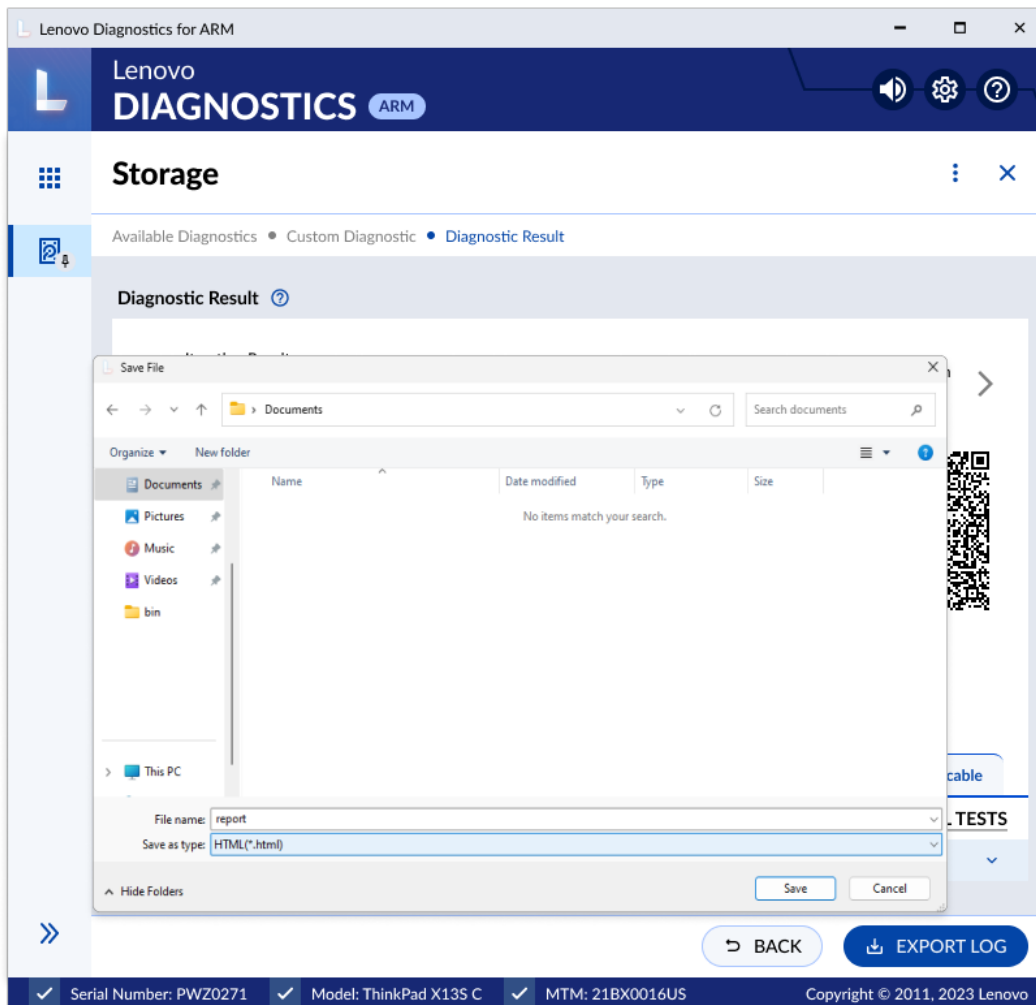


Figure 20: Save the File Example

3.3 Parallelism

Lenovo Diagnostics for ARM application allows modules and devices to run in parallel with each other. By enabling parallelism, the user can take advantage of faster execution as diagnostics occur simultaneously on different components. There are two different types of parallelism available: parallelism among module and parallelism among devices.

3.3.1 Types of Parallelism

Lenovo Diagnostics for ARM has two types of parallelism: parallelism among modules and parallelism among devices.

Parallelism execution among modules: Multiple modules can be executed at the same time.

Some modules cannot run in parallel with others due the architecture limitations.

Below you can check an example of an execution among modules via Run All screen. In this case, Processor and Video Card modules are running in parallel.

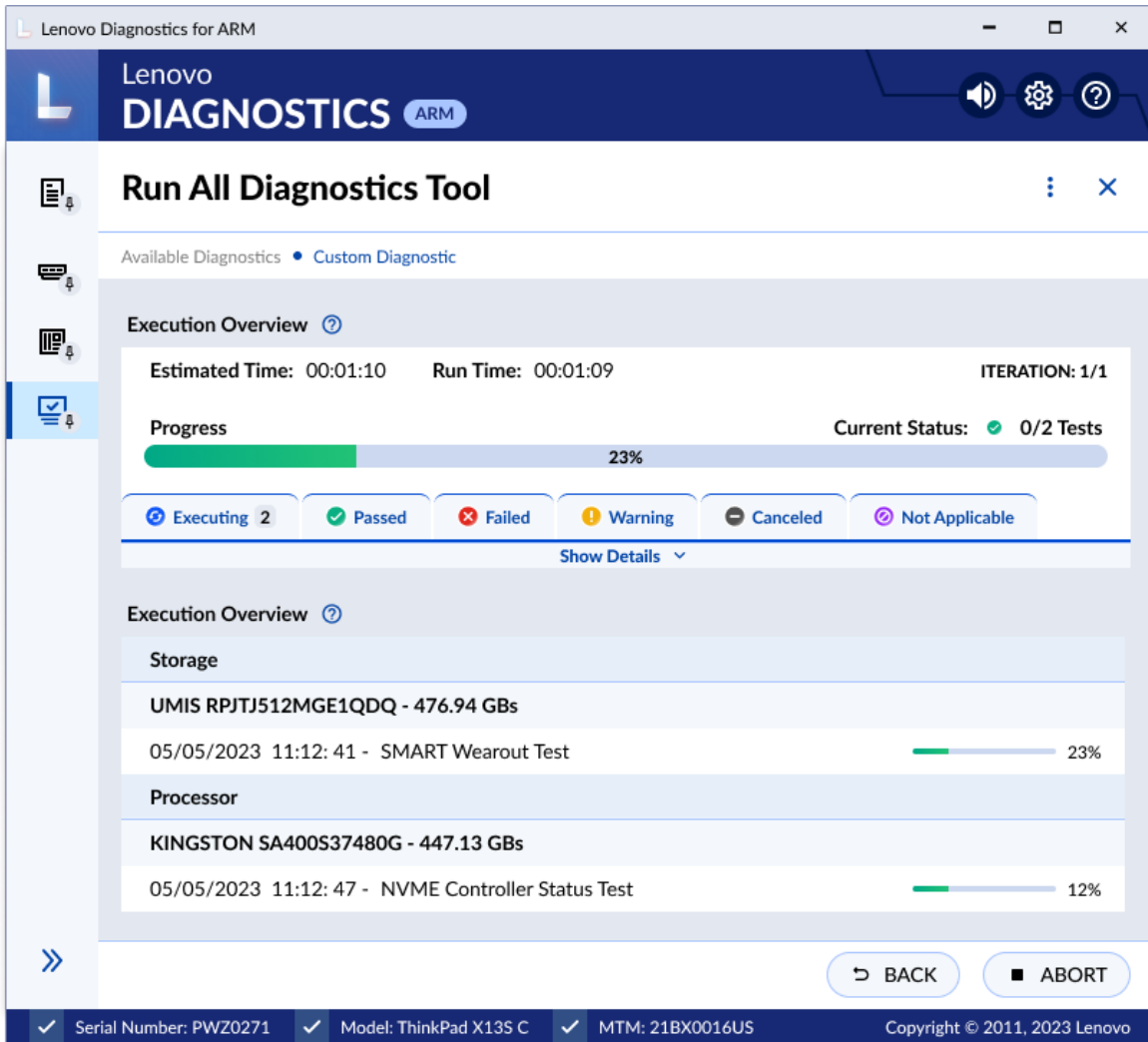


Figure 21: Parallelism among modules

Parallelism execution among devices: Multiple devices from a module can be executed at the same time. For example, on the storage module, you can select to run a full disk scan test in an HDD device and in an NVME device at the same time. Some modules doesn't have multiple device, thus, the Parallelism isn't supported. All restrictions can be found in the Parallelism Rules section.

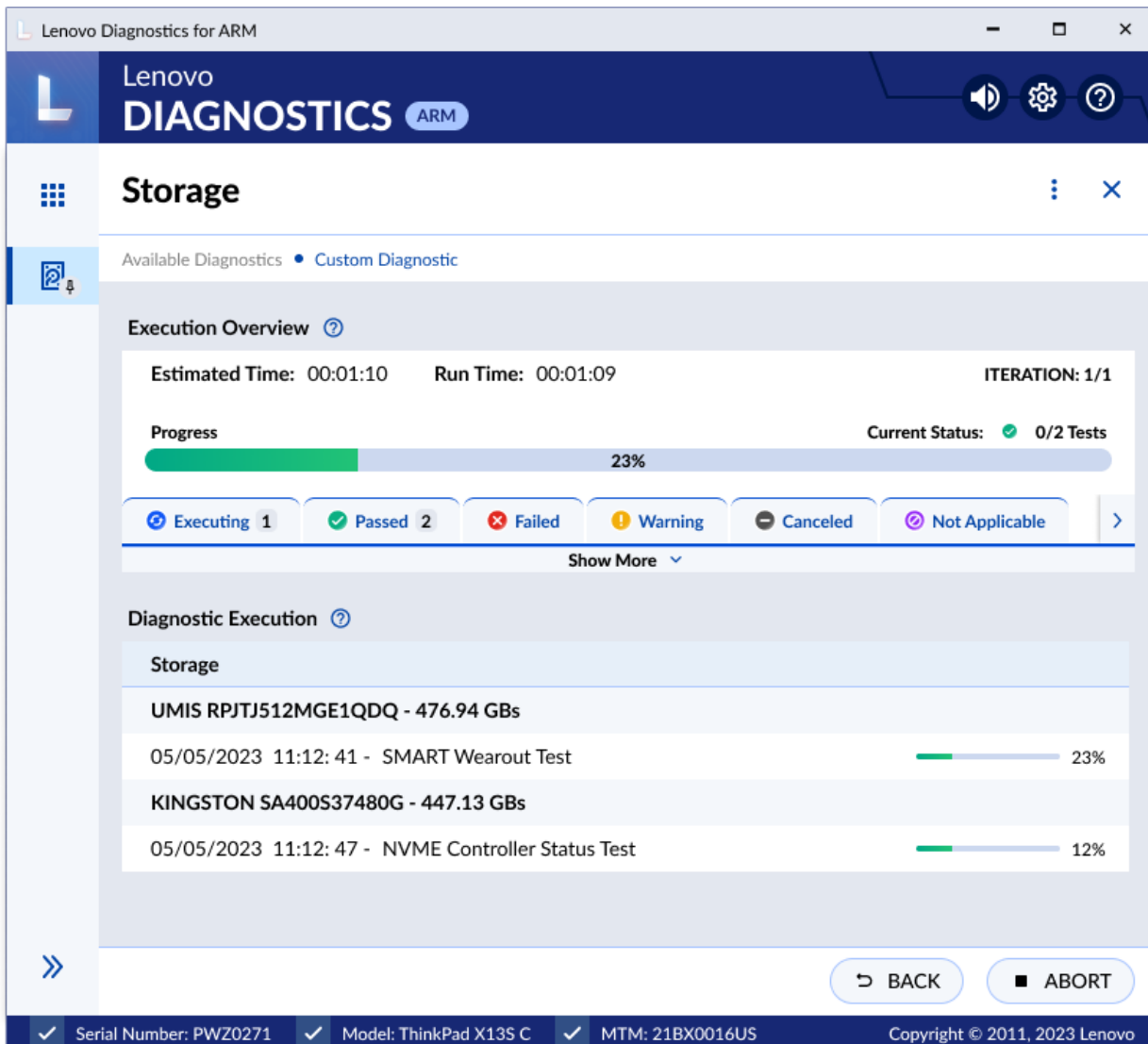


Figure 22: Parallelism among devices

3.3.2 How to Enable and Disable Parallelism

The user must be able to enable and disable the parallel execution during the selection of the tests. By default, the parallel execution is disabled.

The parallel execution among modules and devices can be configured on the following flows: **Run All**, **Scripts Tool**, and **Via Module**.

Run All

The screenshot displays the 'Run All Diagnostics Tool' window. At the top, there are window controls and system icons. Below the title bar, the 'Run All Diagnostics Tool' header is visible. The main content area is divided into 'Preset Diagnostics' and 'Custom Diagnostics'. Under 'Preset Diagnostics', there are two options: 'QUICK DIAGNOSTIC' (0 - 30 minutes) and 'FULL DIAGNOSTIC' (1 - 9 Hours). A 'Settings' section includes checkboxes for 'Only Unattended' and 'Parallel Execution'. The 'Custom Diagnostics' section has a 'Filter only unattended tests' toggle and 'Quick Selection' options for 'Quick Tests' and 'Extended Tests'. A list of modules is shown with checkboxes for selection and a 'Parallel' checkbox for each. The 'Battery' module is expanded, showing 'Battery Health Test', 'Battery Discharge Test', and 'Battery Charge Test'. At the bottom, there is an 'Iterations' field set to 1, an 'Estimated Time' of 00:32:35, and a 'START' button. A 'REFRESH' button and a 'BACK TO HOME' button are also present. The footer bar contains system information: Serial Number: PWZ0271, Model: ThinkPad X13S C, MTM: 21BX0016US, and Copyright © 2011, 2023 Lenovo.

1. Select this option to run Quick and Full Diagnostics in parallel
2. Selected Modules
3. Select the parallel option to run modules in parallel

Figure 23: Parallelism on Run All Screen

Scripts

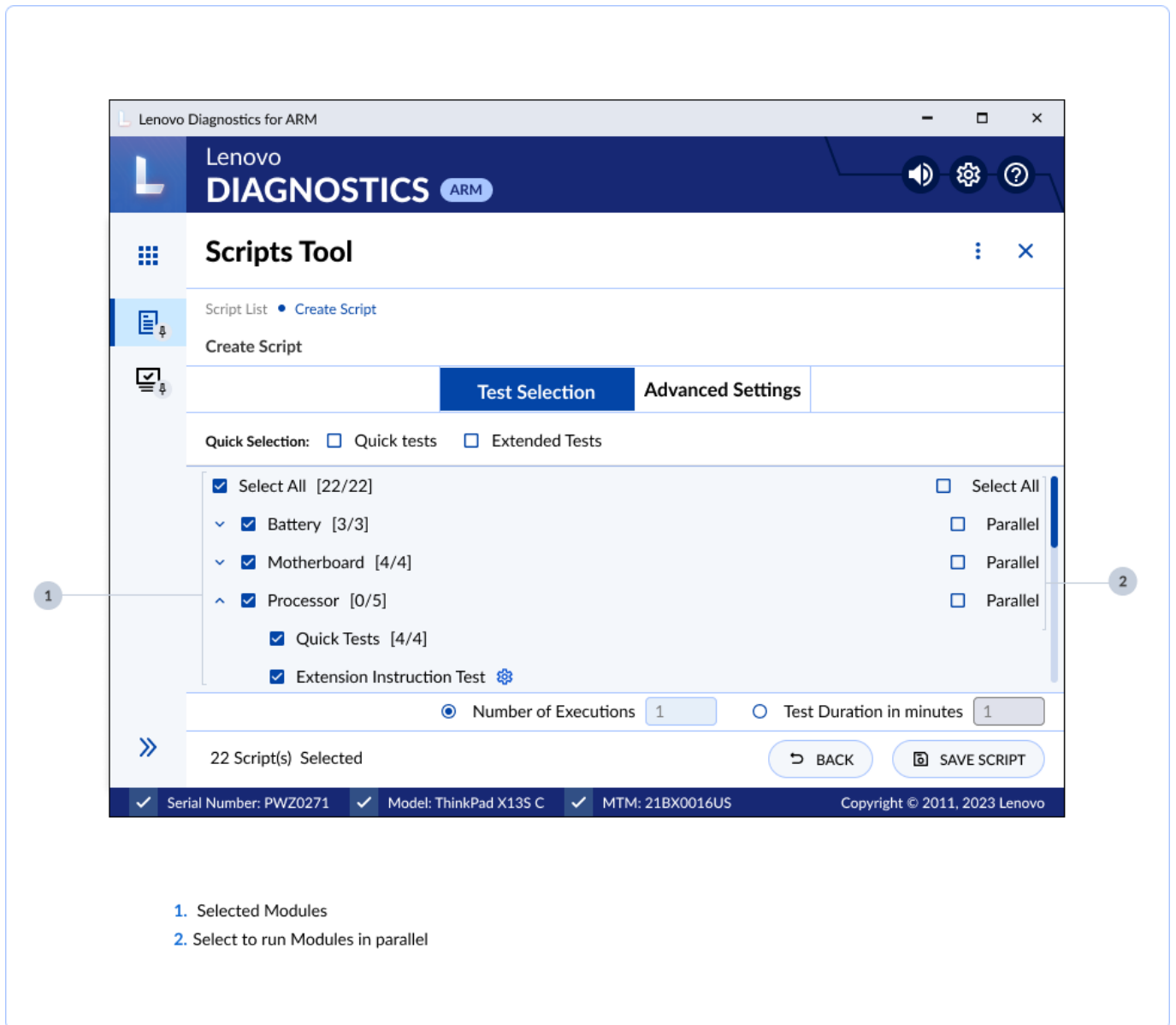


Figure 24: Parallelism on Scripts Screen

Module Screen

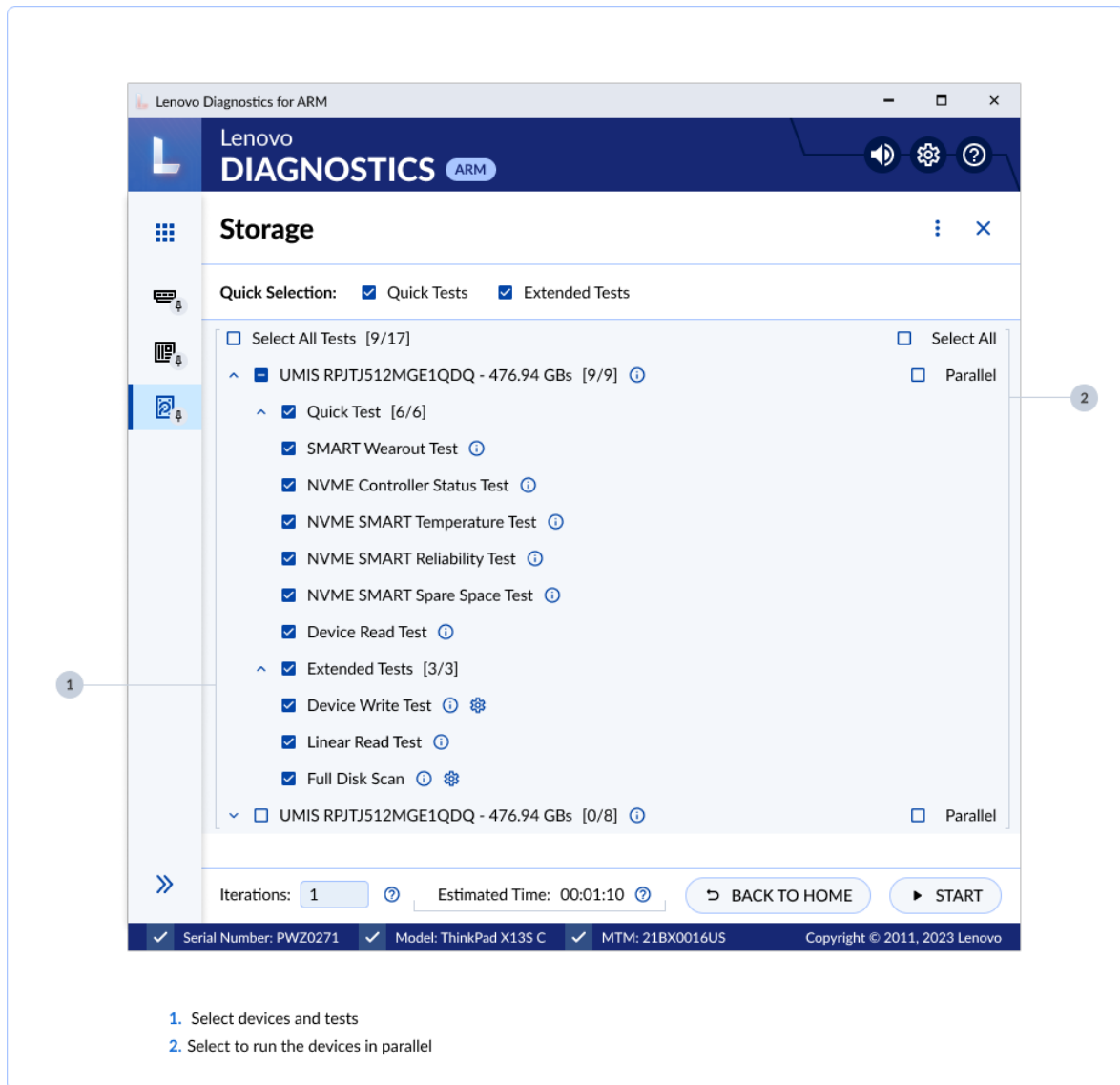


Figure 25: Parallelism on Module Screen

3.3.3 Parallelism Rules

The parallelism cannot be enabled for all modules and devices due architecture limitations. Below you may check all the rules that defines the parallelism support:

- The parallelism among modules is only available if the module contains at least one unattended test supported.
- The parallelism among modules is not supported if the module has at least one attended selected.
- The parallelism among devices it's only supported on Video Card and Storage module.
- The parallelism among modules and devices is not supported for Motherboard and Memory modules.

4. LENOVO DIAGNOSTICS for ARM **MODULES AND TESTS**

This section provides information about all modules available in Lenovo Diagnostics for ARM and their respective tests. Here, you will understand the approach implemented by each test and how these tests should be performed to assure the correct diagnostic of your machine.

4.1 Audio

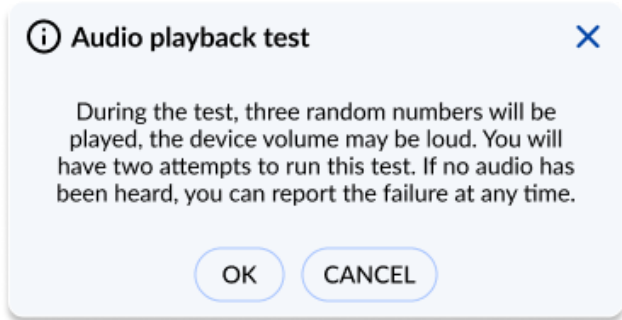
The Audio module contains tests that can help verify that the speaker and microphone devices are working properly.

The Audio module is composed of the following tests:

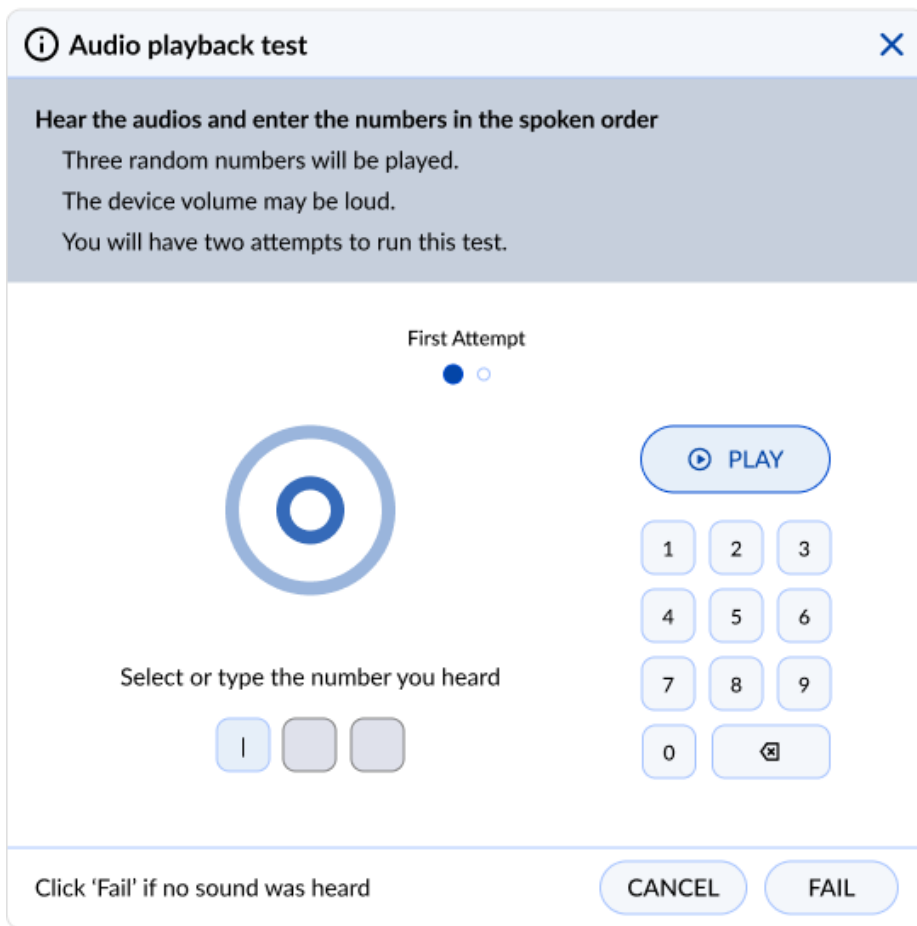
Test	Test type	Attendance
Audio Playback Test	Quick	Attended
Microphone Interactive Test	Quick	Attended

Audio Playback Test

The audio playback test tries to play random numbers through the audio hardware and asks for you in what order the numbers were played.



The application warns that the device volume may be loud during execution



The application plays three random numbers and asks for you what order the numbers were played

Figure 26: Audio Playback Test

Microphone Interactive Test

This test helps to identify if the microphone is capable of capturing sound properly.

The microphone interactive test is performed according to the following workflow:

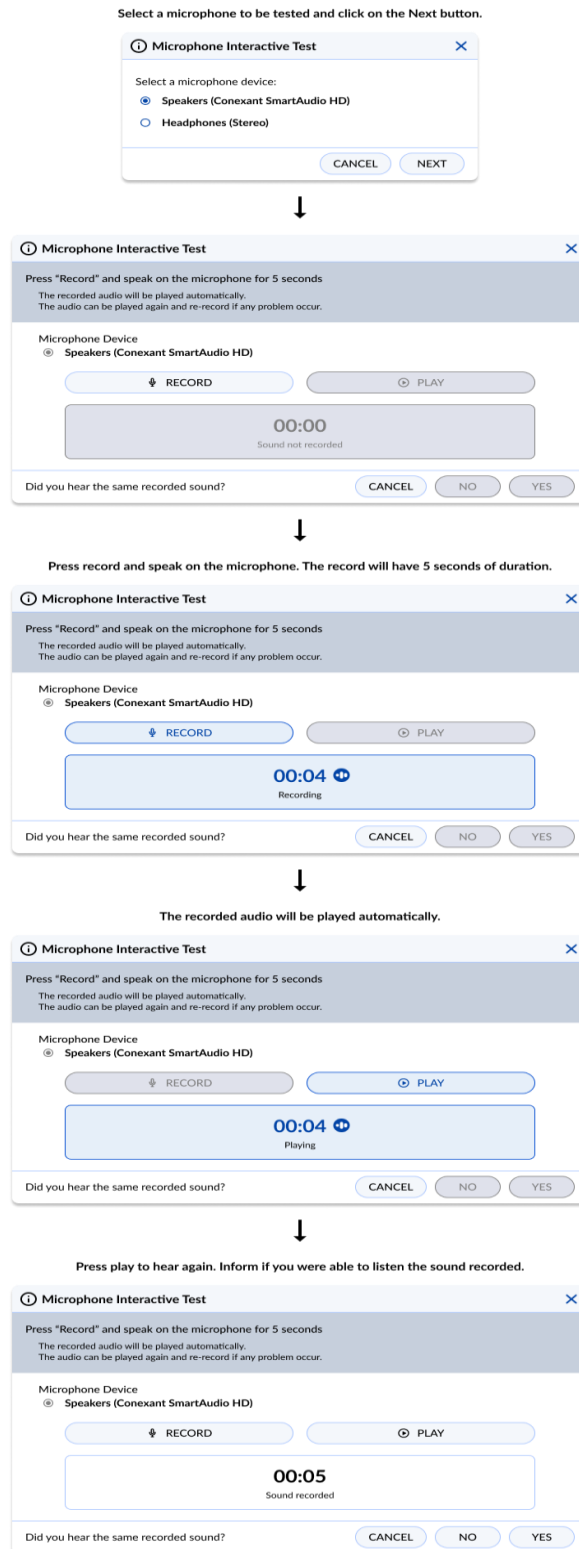


Figure 27: Microphone Interactive Test Flow

4.2 Battery

The Battery module contains tests that help verify that the battery devices are working properly.

The Battery module is composed of the following tests:

Test	Test type	Attendance
Battery Health Test	Quick	Unattended
Battery Discharge Test	Extended	Attended
Battery Charge Test	Extended	Attended

Battery Health Test

Battery Health Test checks the device charge capacity and other important battery properties to evaluate the device's health.

Battery Discharge Test

Battery Discharge Test checks the device charge capacity and other important battery properties to evaluate the device's health. If there is an AC cable plugged in, you must unplug it before proceeding to the test as displayed below.

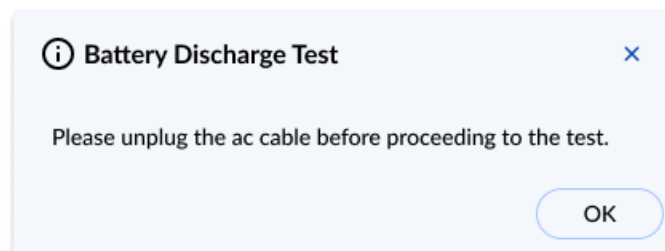


Figure 28: Battery Discharge Test Pop-up

Before starting the test, you can change the duration of the test by clicking on the settings icon next to the test name, according to the image below:

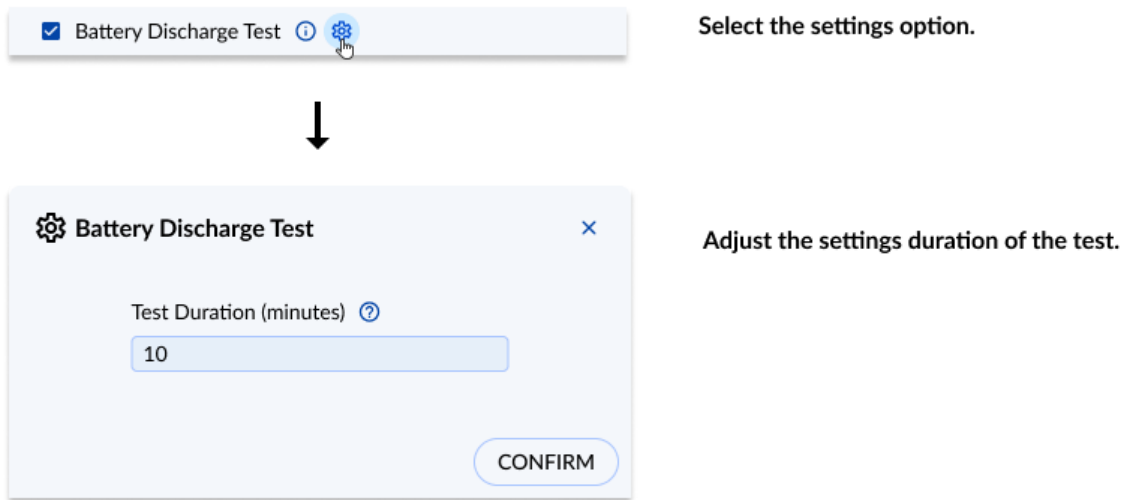


Figure 29: Customizable Parameter for the Battery Discharge Test

Note: This test requires the remaining battery charge must be greater than 20%.

Battery Charge Test

The test checks if the battery charge increases while the AC cable is connected. If there is no AC cable plugged you should connect it before proceeding to the test.

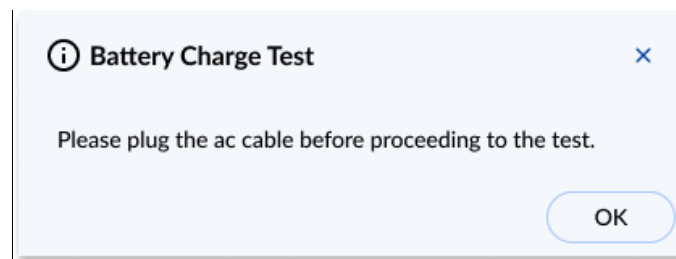


Figure 30: Battery Charge Test Pop-up

Before starting the test, you can change the duration of the test by clicking on the settings icon next to the test name, according to the image below:

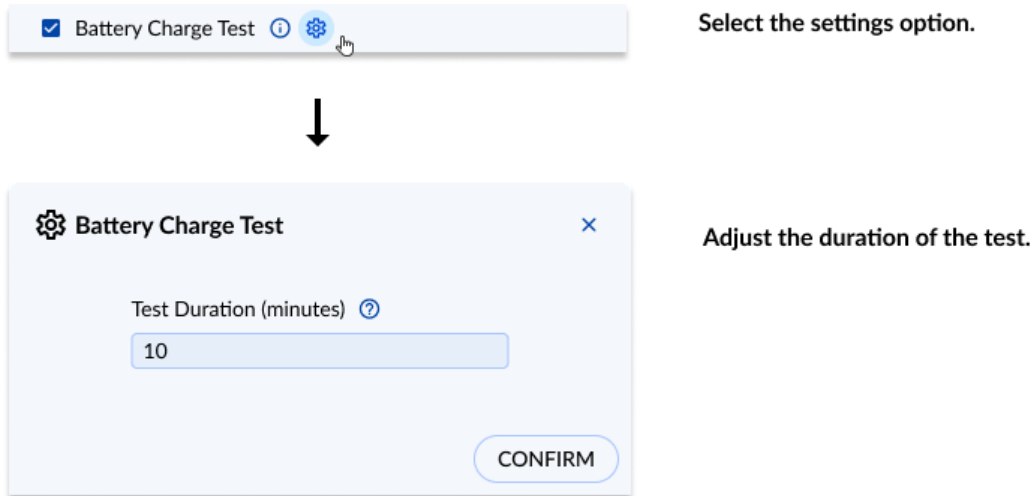


Figure 31: Customizable Parameter for the Battery Charge Test

Note: This test requires the battery charge must be less than or equal to 93%.

4.3 Bluetooth

The Bluetooth module contains tests that can verify that the Bluetooth is working properly.

The Bluetooth module is composed of the following test:

Test	Test type	Attendance
Scan Test	Quick	Unattended

Scan Test

Scan for nearby active Bluetooth devices.

The test starts by asking you to make sure the Bluetooth device is enabled and there is another Bluetooth close and active.

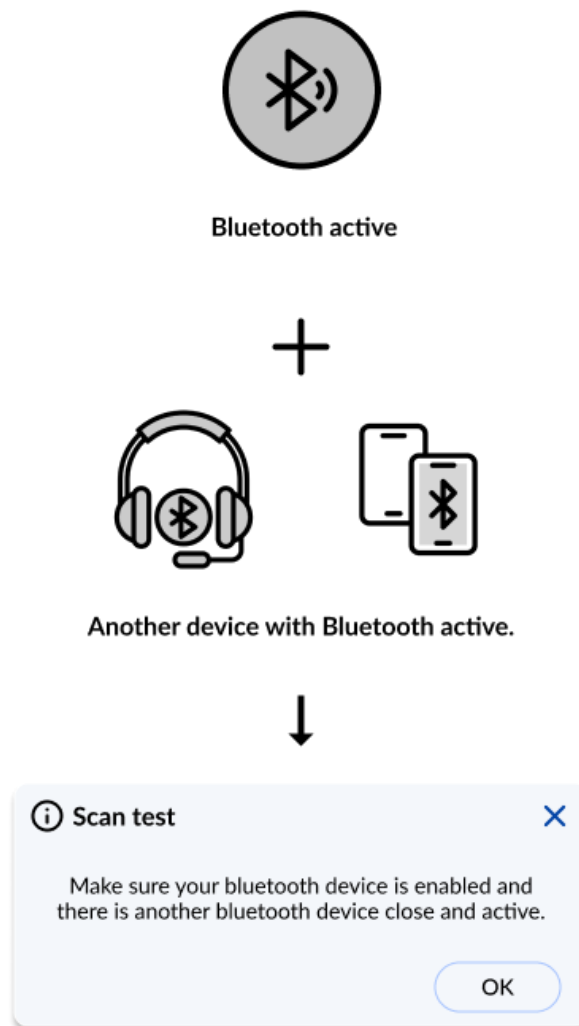


Figure 32: Scan Test

4.4 Camera

The Camera module contains tests that can help verify that the camera devices are working properly.

The Camera module is composed of the following test:

Test	Test type	Attendance
Camera Capture Test	Quick	Attended
Camera Barcode Test	Quick	Attended

Camera Capture Test

Verify if the camera device is working properly based on your feedback for the captured images. This test is performed according to the following workflow:

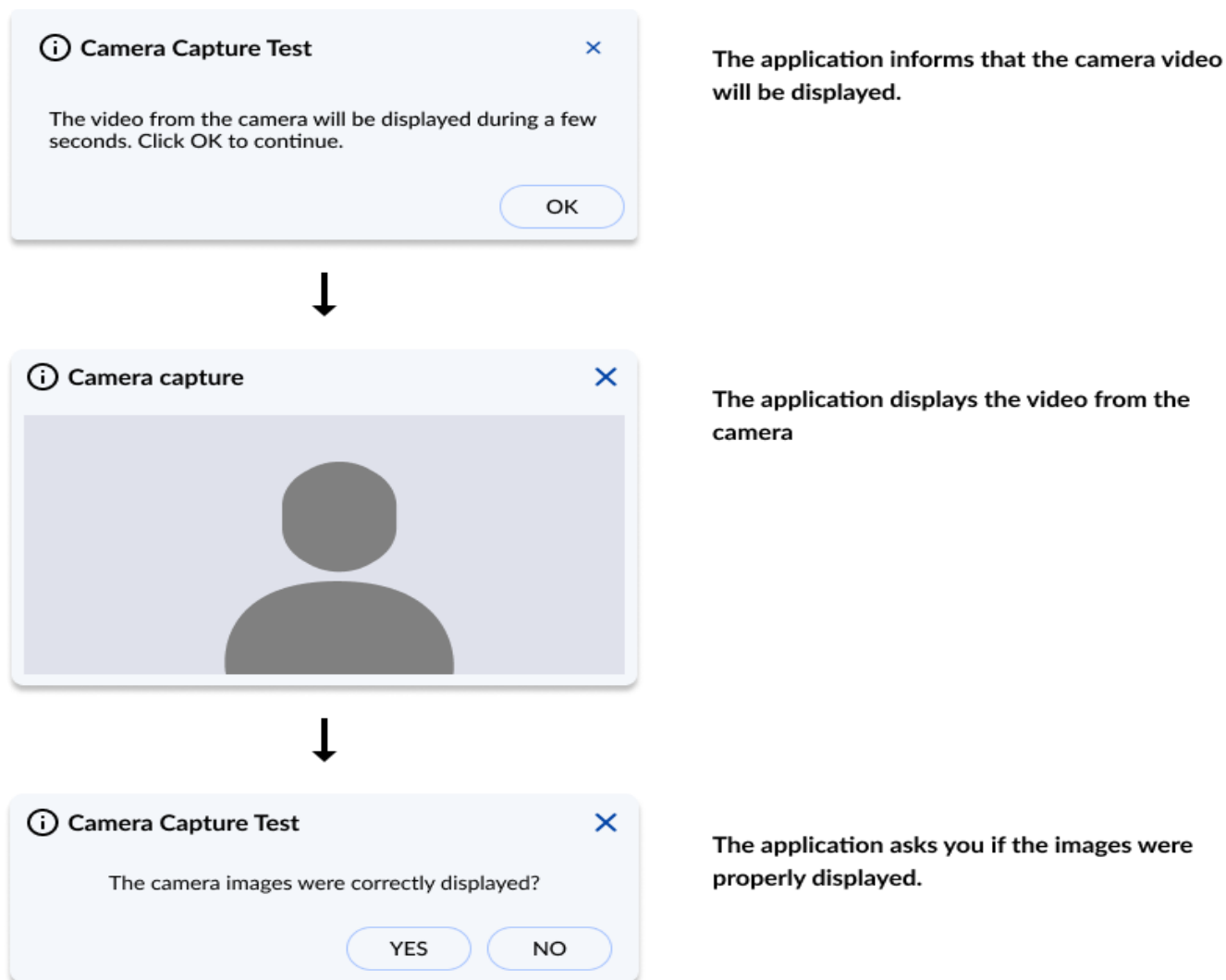


Figure 33: Camera Capture Test

Camera Barcode Test

Verifies if the camera device is properly working by checking if it can read a barcode. The test starts by asking you to point a QR code or a barcode to the camera.

For the test to be successfully completed, the Barcode/QR Code content must contain a maximum of 60 characters and be composed of only letters and numbers.

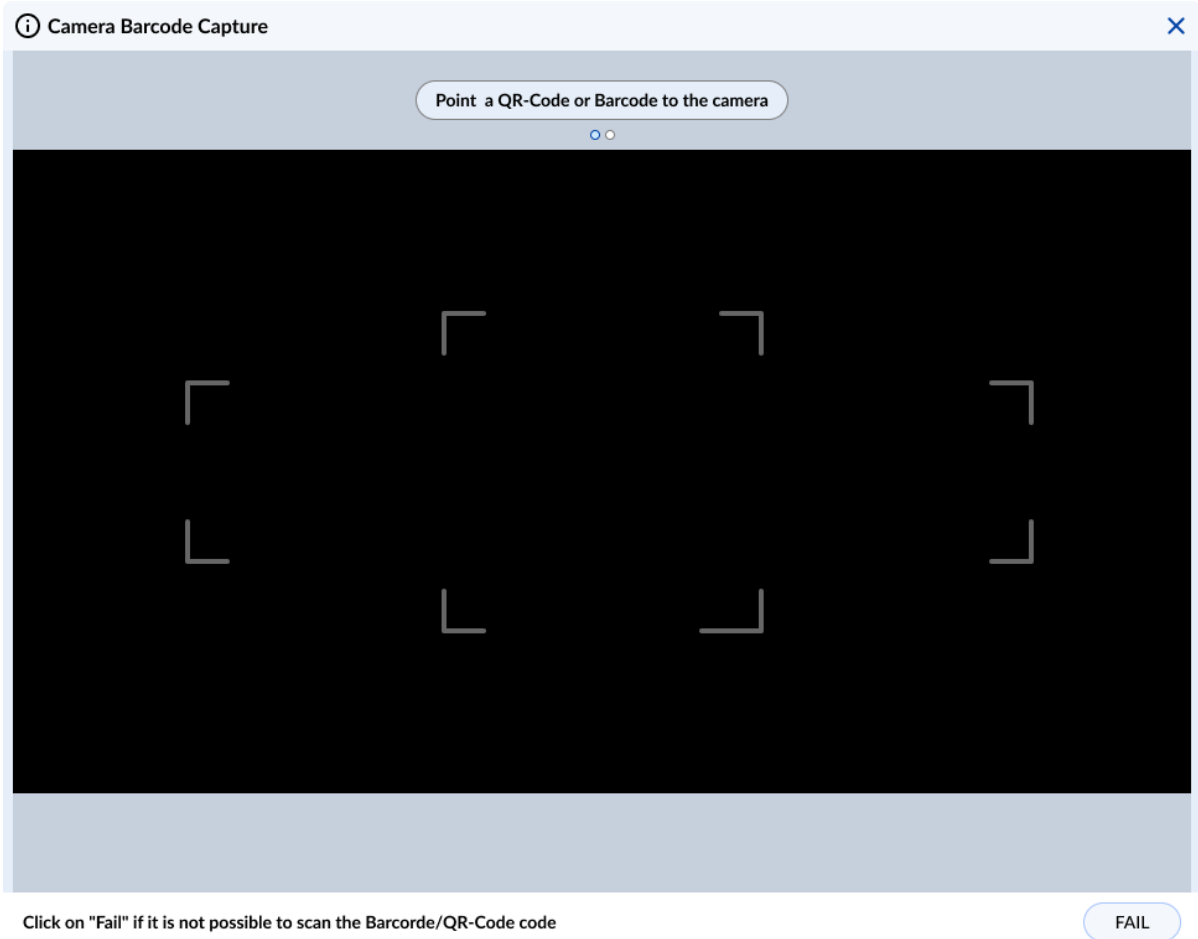


Figure 34: Barcode Test

4.5 Display

The Display module contains tests that can help verify that the display devices are working properly.

The Display module is composed of the following tests:

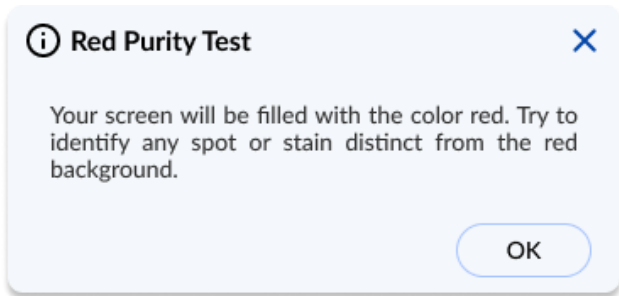
Test	Test type	Attendance
Resolution Fitting Test	Quick	Unattended
Red Purity test	Quick	Attended
Green Purity test	Quick	Attended
Blue Purity test	Quick	Attended
Black Purity test	Quick	Attended
White Purity test	Quick	Attended
Color Transition Test	Quick	Attended
Monochromatic Mesh Test	Quick	Attended
Inverted Monochromatic Mesh Test	Quick	Attended
Sharpness	Quick	Attended
Display Interactive Test	Quick	Attended

Resolution Fitting Test

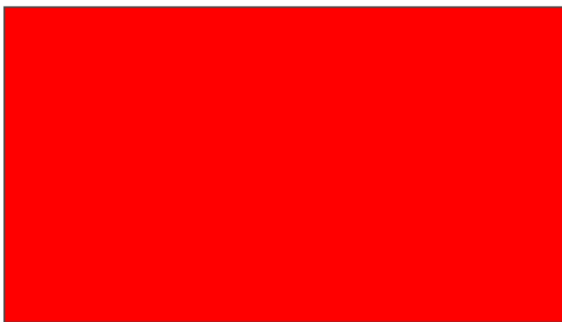
This test checks if the system can take full advantage of the display's native resolution.

Red Purity test

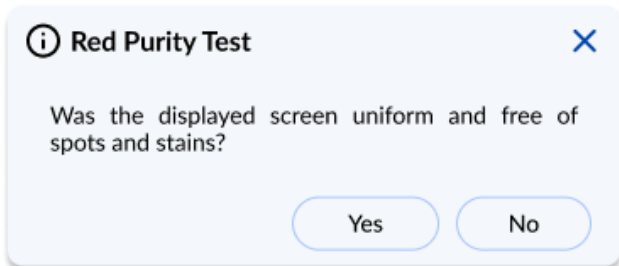
This test identifies any dead pixel or burn-in problem within the red channel.



Warns that the screen will be filled with red color.



Fill the screen with red color



Asks if the screen was displayed uniform and free of spots and stains.

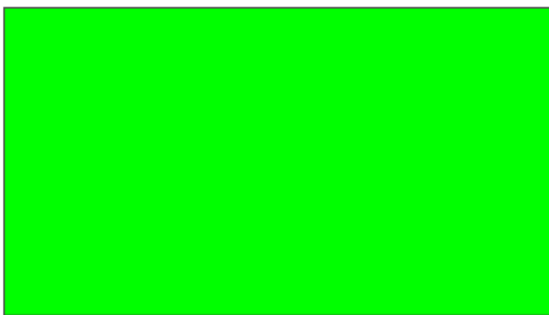
Figure 35: Red Purity Test

Green Purity test

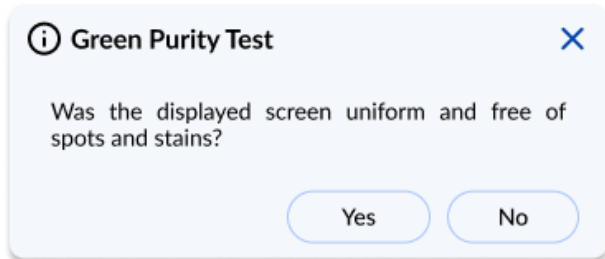
This test identifies any dead pixel or burn-in problem within the green channel.



Warns that the screen will be filled with green color.



Fill the screen with green color

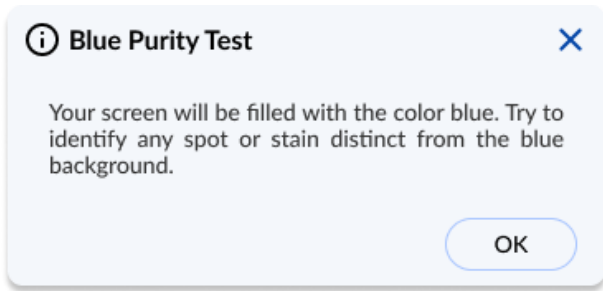


Asks if the screen was displayed uniform and free of spots and stains.

Figure 36: Green Purity Test

Blue Purity test

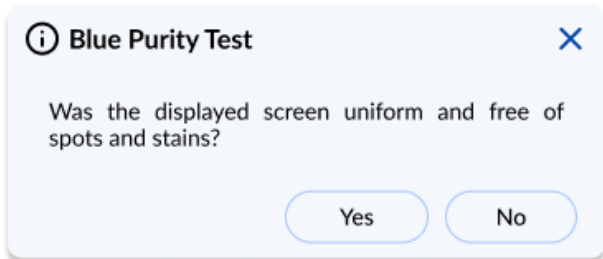
This test identifies any dead pixel or burn-in problem within the blue channel.



Warns that the screen will be filled with blue color.



Fill the screen with blue color

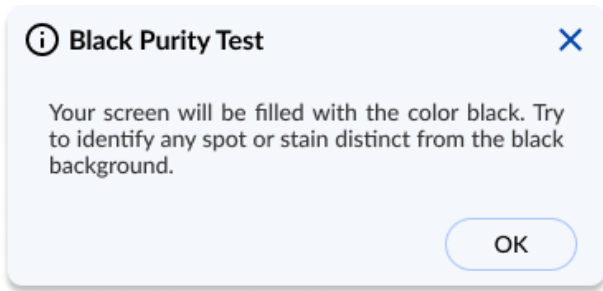


Asks if the screen was displayed uniform and free of spots and stains.

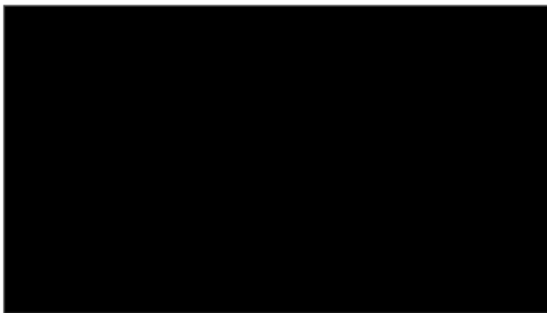
Figure 37: Blue Purity Test

Black Purity test

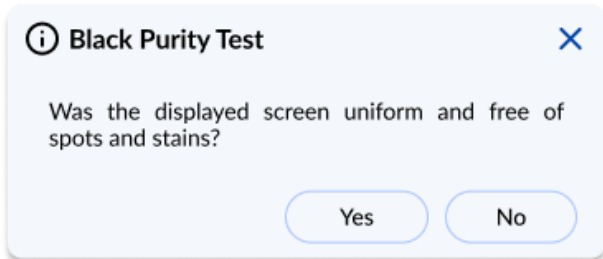
This test identifies any dead pixel or burn-in problem within the black channel.



Warns that the screen will be filled with black color.



Fill the screen with black color

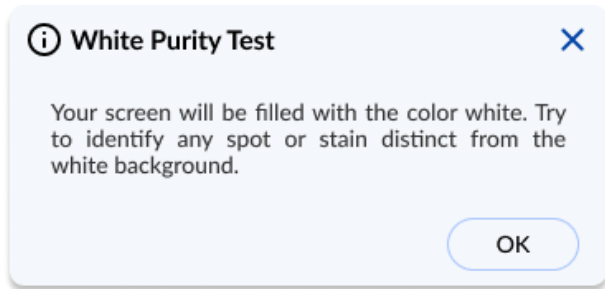


Asks if the screen was displayed uniform and free of spots and stains.

Figure 38: Black Purity Test

White Purity test

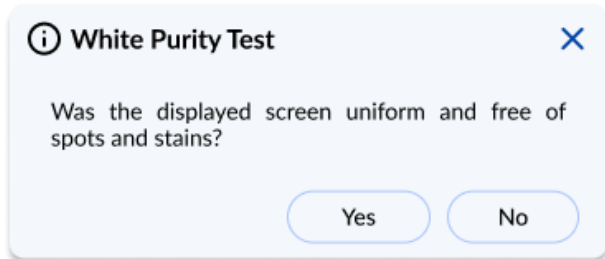
This test identifies any dead pixel or burn-in problem within the white channel.



Warns that the screen will be filled with white color.



Fill the screen with white color.

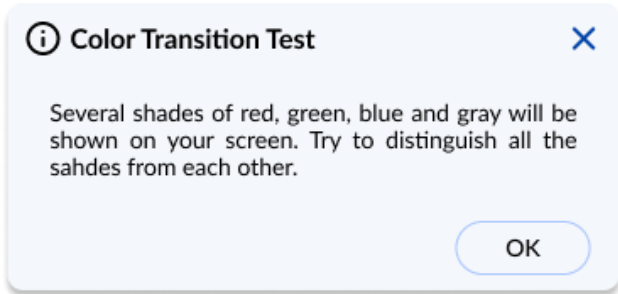


Asks if the screen was displayed uniform and free of spots and stains.

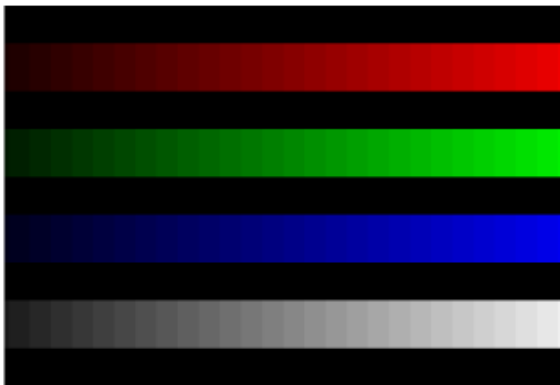
Figure 39: White Purity Test

Color Transition Test

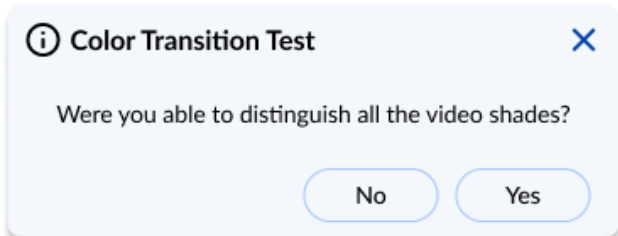
This test identifies any problem with the display's color distinction.



Warns that the screen will be filled with several shades of red, green, blue, and gray.



Fill the screen with the shades.

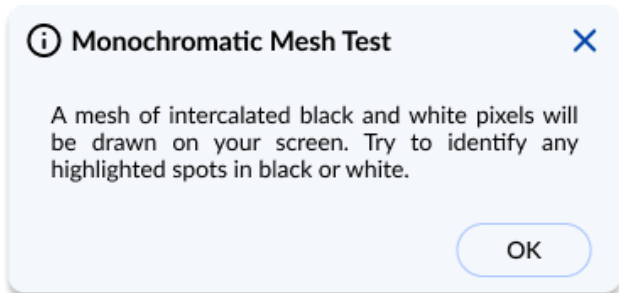


Asks if the screen was displayed uniform and free of spots and stains.

Figure 40: Color Transition Test

Monochromatic Mesh Test

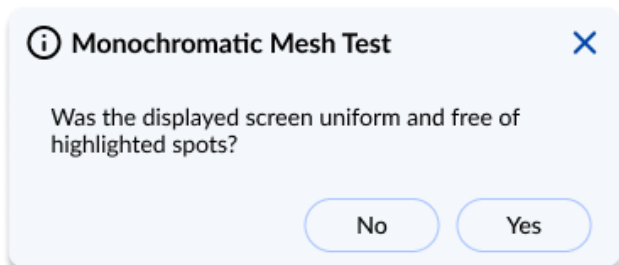
This test identifies stuck pixels as they will be highlighted in contrast with the background.



Warns that the screen will be filled with a monochromatic mesh of black and white pixels.



Fill the screen with the mesh.



Asks if the image was uniform and free of highlighted spots.

Figure 41: Monochromatic Mesh Test

Inverted Monochromatic Mesh Test

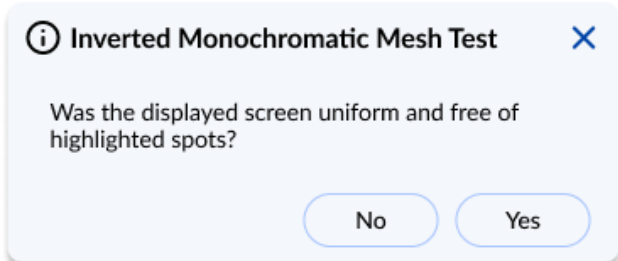
This test identifies stuck pixels as they will be highlighted in contrast with the background. In this test black and white pixels are inverted.



Warns that the screen will be filled with an inverted monochromatic mesh of black and white pixels.



Fill the screen with the inverted mesh.

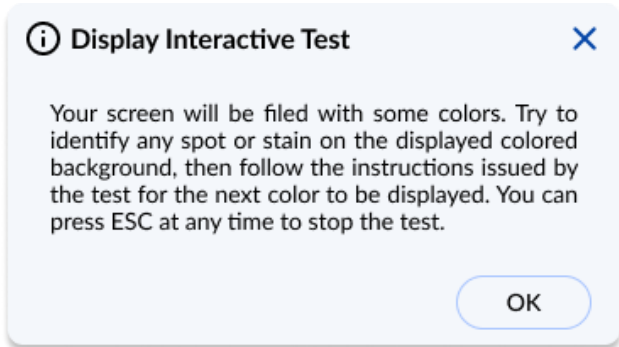


Asks if the image was uniform and free of highlighted spots.

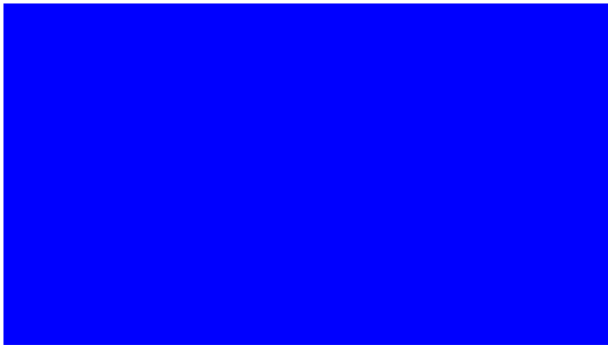
Figure 42: Inverted Monochromatic Mesh Test

Display Interactive Test

The Display Interactive Test is the combination of all purity tests. The purity tests aim to identify dead pixels or burn-in problems in the channels: red, green, blue, black, and white. In addition you shall inform the number you are seeing on the screen.



The application warns you that your screen will be filled with some colors.



Application fills your screen with a color.



The application asks for you which number is being displayed.

Figure 44: Display Interactive Test

4.6 Display Interface

The Display Interface module contains tests that can verify that the communication with the monitors is working properly and that the EDID is consistent.

The Display module is composed of the following tests:

Test	Test type	Attendance
EDID Checksum Test	Quick	Unattended
Display Communication Test	Quick	Unattended

EDID Checksum Test

This test checks the integrity of the Extended Display Identification Data (EDID) checksum provided by the monitor.

Display Communication Test

This test checks the communication with the monitor.

4.7 Processor

The Processor module contains tests that can verify that the processor is working properly.

The Processor module is composed of the following tests:

Test	Test type	Attendance
Extension Instruction Test	Quick	Unattended
Floating Point Test	Quick	Unattended
Math Test	Quick	Unattended
NEON Vector Test	Quick	Unattended
Stress Test	Extended	Unattended

Extension Instruction Test

The test checks if the number extension instructions are working properly. If any instruction fails, the test fails.

Floating Point Test

The test checks if the floating point instructions are working properly. If any instruction fails, the test fails.

Math Test

The test checks if the processor's arithmetic instructions are working properly. If any instruction fails, the test fails.

NEON Vector Test

The test checks if the processor's vector instructions are working properly. If any instruction fails, the test fails.

Stress Test

The stress test performs a sequence of continuous checks on all processor cores for 10 minutes. During the test you can check the test, according to the image below:

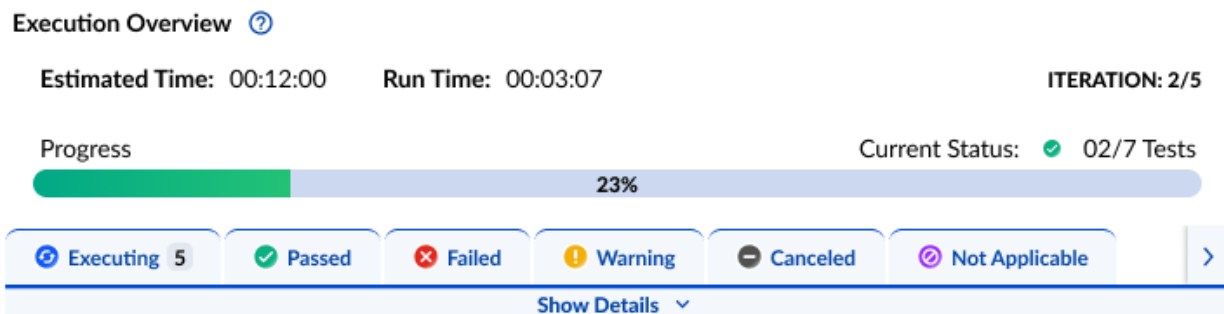


Figure 45: CPU Stress Test

4.8 Keyboard

The Keyboard module contains tests that can help verify that the keyboard devices are working properly.

The Keyboard module is composed of the following tests:

Test	Test type	Attendance
USB Keyboard Test	Quick	Unattended
Keycode Verification Test	Quick	Unattended
Advanced Test	Quick	Attended

USB Keyboard Test

This test tries to identify any defective USB keyboard detected on this machine.

Keycode Verification Test

Presents the latest pressed key to the user in a legible format and the current state of the toggle keys.

If you confirm that all keys that he has pressed were displayed, the test is finished as Passed. Otherwise, the test is finished as Failed.

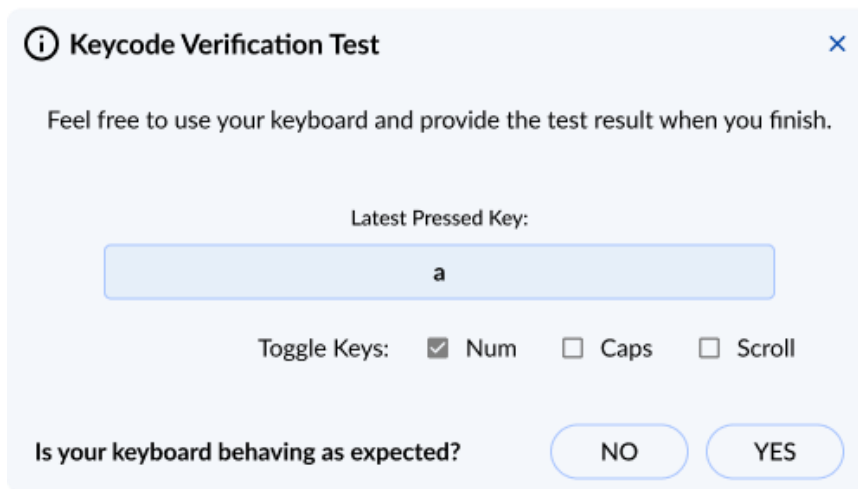
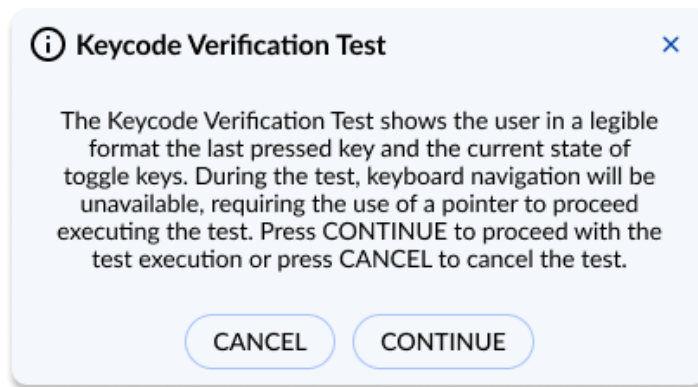


Figure 46: Keycode Verification Test

Advanced Test

Interactive test to verify the status of the keyboard keys.

The test will mark the pressed keys until you test all keys. You can select the most appropriate keyboard layout.

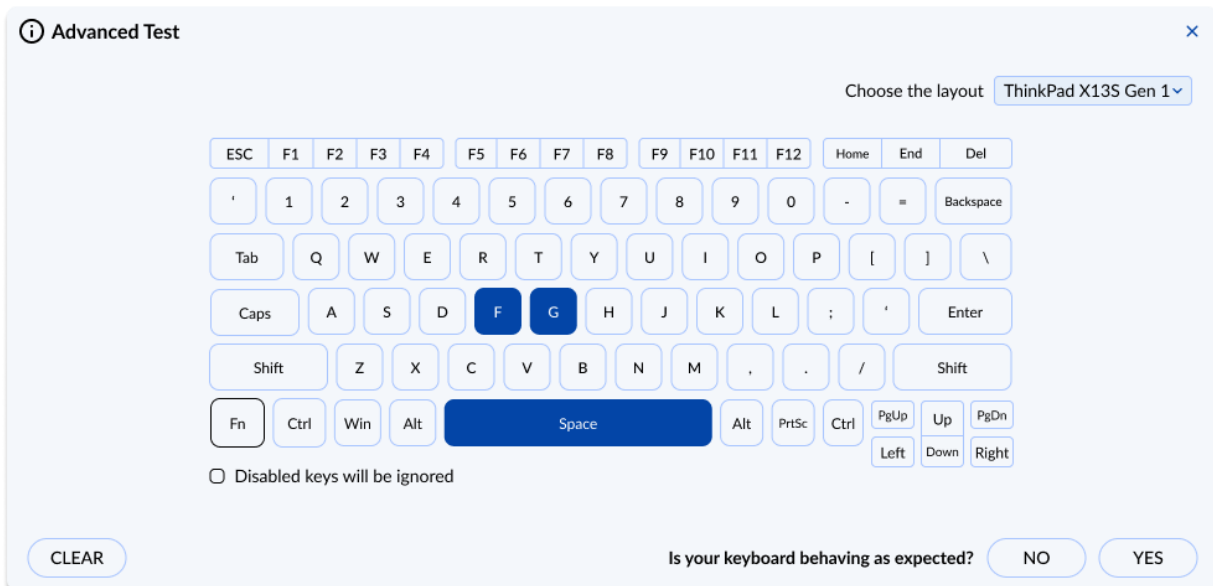
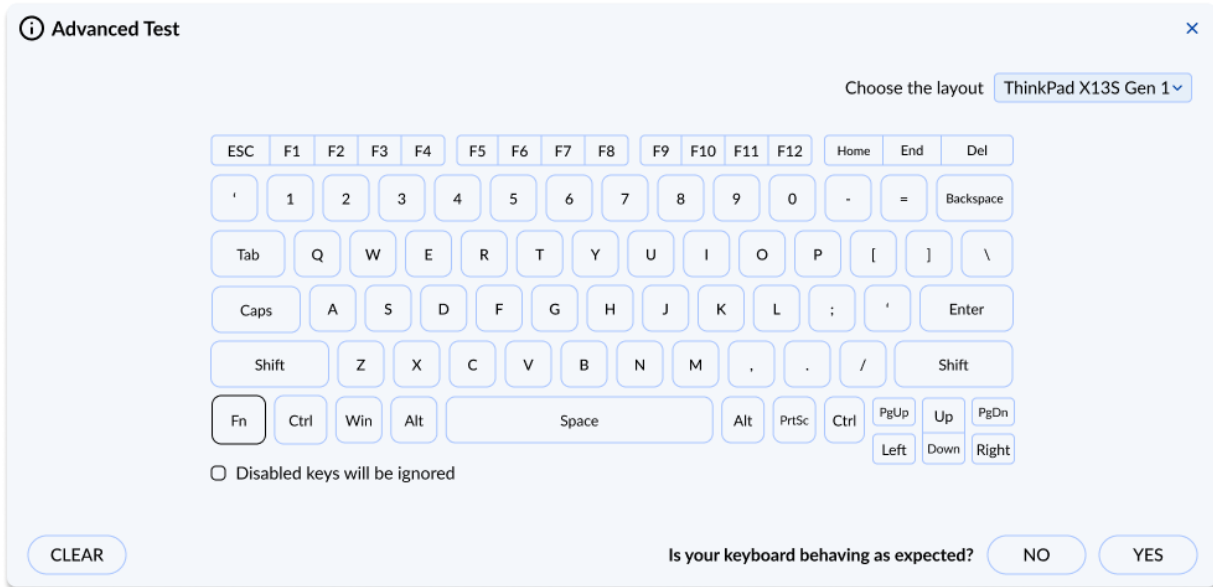
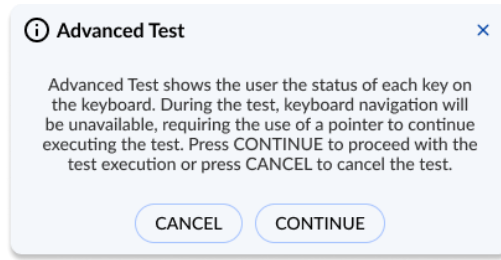


Figure47: Advanced Test

4.9 Memory

The Memory module contains tests that can verify that the memory is working properly.

The Memory module is composed of the following tests:

Test	Test type	Attendance
Quick Random Pattern Test	Quick	Unattended
Advanced Integrity Test	Extended	Unattended
Address Test	Extended	Unattended
Bit Low Test	Extended	Unattended
Bit High Test	Extended	Unattended
Walking Ones Left Test	Extended	Unattended
Walking Ones Right Test	Extended	Unattended
Modulo-20 Test	Extended	Unattended
Moving Inversions 8Bit Test	Extended	Unattended
Moving Inversions 32 Bit Test	Extended	Unattended
Random Pattern Test	Extended	Unattended
Random Number Sequence Test	Extended	Unattended
Block Move Test	Extended	Unattended
Nibble Move Test	Extended	Unattended

Quick Random Pattern Test

The test consists of filling the memory with a randomly generated pattern and then checking that the pattern was correctly written. When checking, it writes the pattern's binary complement and checks again. The test is repeated twice. By default, 15 random patterns are used, therefore, the test runs once for each of these patterns.

Advanced Integrity Test

The test is based on the March C- enhanced algorithm. This test consists of filling the accessible memory with a pattern, checking it, writing its complement in an 8 bytes block size (64 bits), and then checking it again. This procedure is repeated twice, in the first time the pattern is addressed in the accessible memory from the highest position to the lowest and the second time by doing the inverse path. This test is intended to cover Stuck-At Faults and some Coupling Faults and Transition Faults.

Address Test

This test consists of writing to each memory address its own address. After that, the algorithm reads the memory previously written and checks if they still store their own address. This test is intended to cover any addressing fault in the accessible memory range.

Bit Low Test

This test consists of filling the memory buffer with a pattern where all bits are 0 and then checking it. When checking for this pattern, it writes its binary complement, and finally checks if the complement was stored accordingly. Such a process is repeated 4 times. This test is intended to identify the most serious Stuck-At Faults, some cases of Transition Faults, and some cases of reading Random Faults.

Bit High Test

This test consists of filling the memory buffer with a pattern where all bits are 1 and then checking it. When checking for this pattern, it writes its binary complement, and finally checks if the complement was stored accordingly. Such a process is repeated 4 times. This test is intended to identify the most serious Stuck-At Faults, some cases of Transition Faults, and some cases of reading Random Faults.

Walking Ones Left Test

The Walking Ones Left Test consists of writing a pattern where only the rightmost bit is set (e.g. 00000001), then shifting this pattern to the left (e.g. 00000010) until the end of the size of a byte, writing it again at the same memory address each time such pattern is shifted. Therefore, the test is intended to cover most of the Stuck-At Faults and some cases of Coupling Faults, and also test the data bus by confirming that every bit can be written.

Walking Ones Right Test

The Walking Ones Right Test consists of writing a pattern where only the leftmost bit is set (e.g. 10000000), then shifting this pattern to the right (e.g. 01000000) until the end of the size of a byte, writing it again at the same memory address each time such pattern is shifted. Therefore, such a test is intended to cover most of the Stuck-At Faults and some cases of Coupling Faults and also test the data bus by confirming that every bit can be written.

Modulo-20 Test

The test consists of writing into an interval of 20 memory locations for each block with a pattern and filling all other locations with its complement 6 times. Unlike the other tests, the Modulo-20 test is not affected by buffering or caching, so it can detect most of the Stuck-At Faults, Coupling Faults, Transition Faults and Read Random Faults that are not detected by other testing approaches.

Moving Inversions 8Bit Test

The test consists of filling the memory with the 8-bit wide pattern: 10000000 and then checking that the pattern was correctly written. When checking, it writes the pattern's binary complement (01111111) and checks it again. The procedure described earlier is repeated 8 times, one for each pattern right shifted: 10000000, 01000000, 00100000, 00010000, 00001000, 00000100, 00000010, 00000001.

Moving Inversions 32 Bit Test

This test fills all the accessible memory with a shifting pattern, that is, a value that is binary left shifted as it is written out through the accessible memory of every memory block. Once the pattern reaches 0x80000000 (a value with the left most bit set to 1 only) then the pattern is reset to 0x00000001. After that, it checks the written values and writes their binary complements, starting from the first memory address to the last one. Finally, the algorithm checks the memory for the complements written in the previous step, being this checking starting from the last element down to the first one. Such a process is repeated 2 times. This test presents a more thorough approach intended to cover most of the Stuck-At Faults and Transition Faults and some cases of Coupling Faults and Read Random Faults.

Random Pattern Test

The test consists of filling the memory with a randomly generated pattern and then checking that the pattern was correctly written. When checking, it writes the pattern's binary complement and checks it again. This process is repeated twice. By default, 50 random patterns are used, therefore the test runs once for each of these patterns.

Random Number Sequence Test

The test consists of filling the memory with one different random generated pattern for each memory address and then checking that the pattern was correctly written. To check it, the test must generate these numbers based on a seed that may be reset to reproduce the sequence. When checking, it writes the pattern's binary complement and it checks again. Such a process is repeated several times. This test is intended to cover most of the Stuck-At Faults, Coupling Faults, and some cases of Transition Faults and Read Random Faults.

Block Move Test

The test consists of moving memory data around within memory blocks. It repeats the movements described above 80 times. Finally, the test checks every memory address to verify if it is consistent.

Nibble Move Test

This test consists of writing to a nibble (a nibble is a group of four bits) a pattern value in each memory address, then it validates every nibble individually. It repeats this process until all nibbles in every address are checked.

4.10 Motherboard

The Motherboard module contains tests that can verify that the motherboard components are working properly.

The Motherboard module is composed of the following tests:

Test	Test type	Attendance
PCI/PCI-e Test	Quick	Unattended
RTC Test	Quick	Unattended
USB Test	Quick	Unattended

PCI/PCI-e Test

The PCI/PCI-e Test checks if all PCI Express devices are recognized, communicate with the system, and check the status registers for unexpected errors or power failure.

RTC Test

The test checks the following RTC (Real Time Clock) properties: accuracy and rollover. The test attempts to guarantee the correct operation of these properties.

USB Test

The test checks the status of USB devices. If any errors are indicated, the test fails.

4.11 Storage

The Storage module contains tests that can verify that the storage devices are working properly.

The Storage module is composed of the following tests:

Test	Test type	Attendance	Supported On
Random Seek Test	Quick	Unattended	HDD/SSD SATA, SAS
Funnel Seek Test	Quick	Unattended	HDD/SSD SATA, SAS
Device Read Test	Quick	Unattended	EMMC, NVME, OPTANE
SMART Wearout Test	Quick	Unattended	EMMC, NVME, OPTANE
NVME Controller Status Test	Quick	Unattended	NVME, DISABLED OPTANE. If the NVMe device is attached to a RAID controller, the test won't be supported
NVME SMART Temperature Test	Quick	Unattended	NVME, OPTANE
NVME SMART Reliability Test	Quick	Unattended	NVME, OPTANE
NVME SMART Spare Space Test	Quick	Unattended	NVME, OPTANE
Device Write Test	Extended	Unattended	EMMC, NVME, DISABLED OPTANE
Linear Read Test	Extended	Unattended	HDD/SSD SATA, SAS, EMMC, NVME, OPTANE
Full Disk Scan Test	Extended	Unattended	HDD/SSD SATA, SAS, EMMC, NVME, OPTANE, UFS

Random Seek Test

Checks the integrity of the servo mechanism of a device by checking sectors at several randomly chosen addresses.

Funnel Seek Test

Checks the integrity of the servo mechanism of a device by checking sectors following a "funnel" or "butterfly" pattern.

Device Read Test

Tests if it is possible to correctly read sectors in different areas of the storage device.

SMART Wearout Test

SMART Wearout Test checks the wearout level of the attached SSD device by reading SMART attributes and informs whether the device is in good condition or has reached its wearout limit.

NVME Controller Status Test

This test detects if the device behaves as expected.

NVME SMART Temperature Test

This test detects if the current temperature for the device is in a critical state.

NVME SMART Reliability Test

This test detects if the device is still reliable based on SMART metrics.

NVME SMART Spare Space Test

This test detects if the spare space in the device is critically low.

Device Write Test

The Storage Device Write Test will verify if it is possible to write data on different areas of the device and then read the data correctly.

Linear Read Test

Checks the integrity of the storage device by reading its sectors following a linear pattern.

Before starting the test, you can define the start range and stop range of the test area, also you can define the coverage of the test area, and the maximum number of errors allowed during execution by clicking on the settings icon next to the test name:

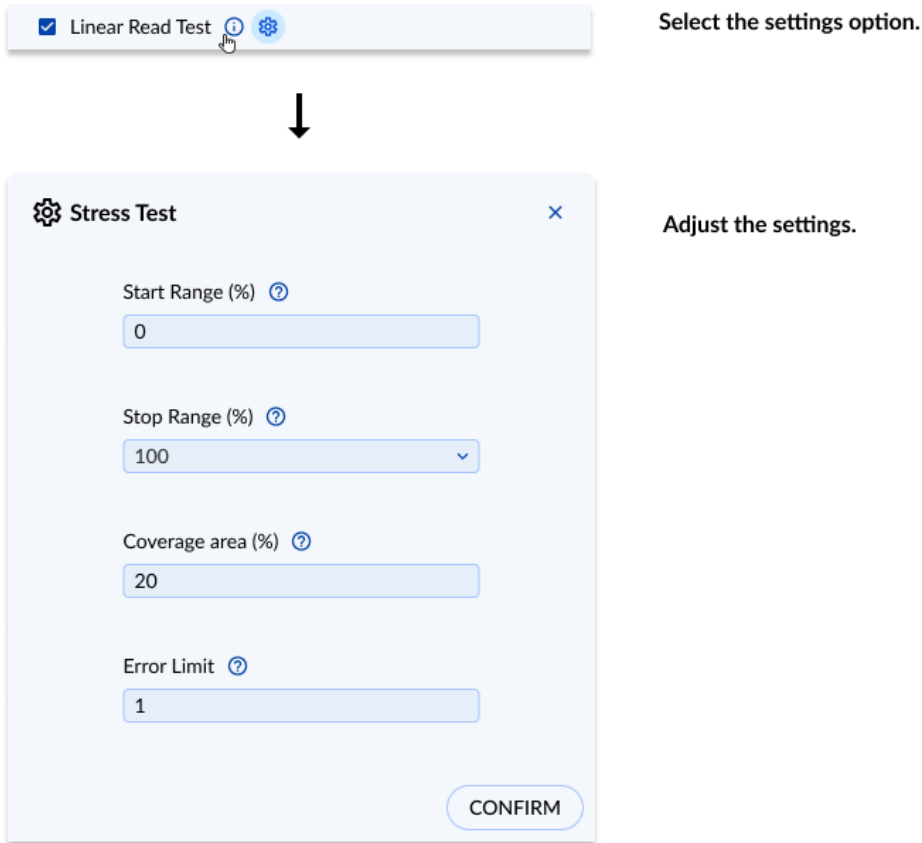


Figure 48: Customizable Parameters for the Linear Read Test

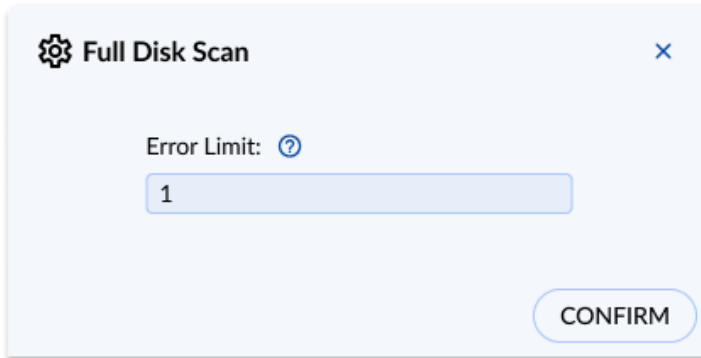
Full Disk Scan Test

This test performs a full verification of the disk.

Before starting the test, you can define the maximum number of errors allowed during execution by clicking on the settings icon next to the test name:



Select the settings option.



Adjust the settings.

Figure 49: Customizable Parameters for the Full Disk Scan Test

4.12 Video Card

The Video Card module contains tests that can verify that the video card devices are working properly.

The Video Card module is composed of the following tests:

Test	Test type	Attendance
Video Memory Test	Quick	Unattended
DirectCompute Standard Mathematical Operations Test	Quick	Unattended
DirectCompute Advanced Mathematical Operations Test	Quick	Unattended
Texture Pipeline Test	Quick	Unattended
Extended Video Memory Test	Extended	Unattended
Stress Test	Extended	Unattended
Wireframe Stress Test	Extended	Unattended

Video card devices can run concurrently during the execution of the tests, except the Stress or Wireframe Stress tests that are executed in serial.

Video Memory Test

Verifies if some data patterns are consistently read from and written to video card memory.

DirectCompute Standard Mathematical Operations Test

Performs several standard mathematical operations in order to test that the video card processing units are in good condition using DirectCompute.

DirectCompute Advanced Mathematical Operations Test

Performs several advanced mathematical operations in order to test that the video card processing units are in good condition using DirectCompute.

Texture Pipeline Test

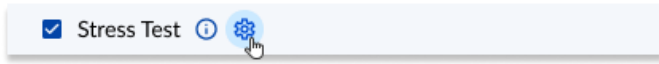
Sends texture patterns to be rendered by the graphics pipeline and checks for loss of data when comparing input and output

Extended Video Memory Test

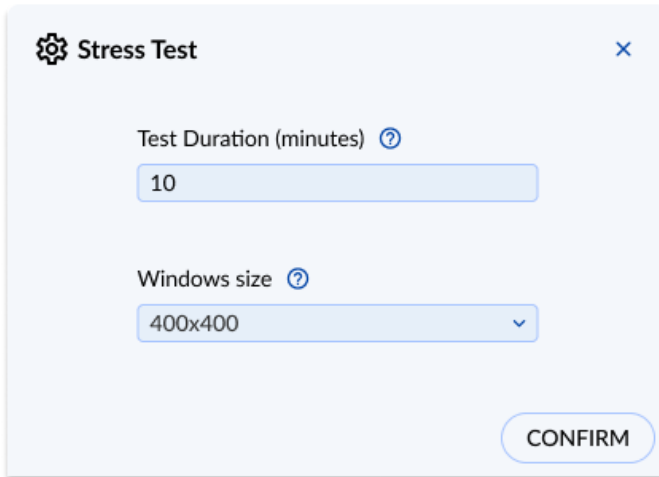
Similar to Video Memory Test, but performs an extended analysis with more data patterns

Stress Test

Executes heavy operations on the video card for the purpose of stressing the GPU and verifying that the results remain reliable under stress. Before starting the test, you can change the duration of the test and the window size of the animation by clicking on the settings icon next to the test name:



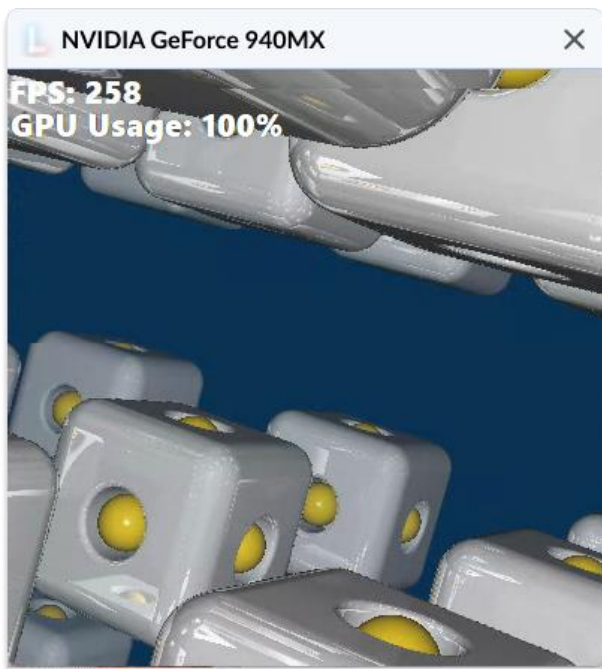
Select the settings option.



Adjust the settings duration of the test.

Figure 50: Customizable Parameters for the Video Card Stress Test

During the test execution, an animation is displayed and information of the FPS, and GPU are shown.

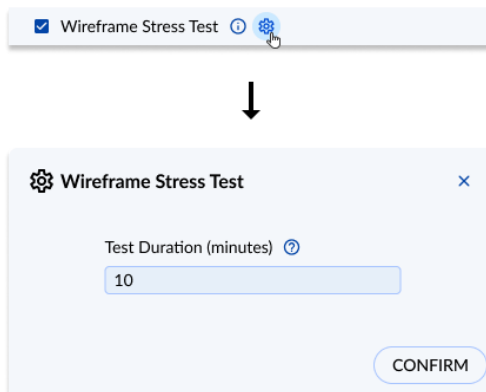


During the execution, is displayed an animation and are shown information about the FPS and GPU.

Figure 51: Video Card Stress Test Animation

Wireframe Stress Test

Executes heavy wireframe operations on the video card for the purpose of stressing the GPU and verifying that the results remain reliable under stress. Before starting the test, you can change the duration of the test by clicking on the settings icon next to the test name, according to the image below:



Select the settings option.

Adjust the settings duration of the test.

Figure 52: Customizable Parameter for the Wireframe Stress Test

4.13 Wireless

The Wireless module contains tests that can verify that the wireless devices are working properly.

The Wireless module is composed of the following tests:

Test	Test type	Attendance
Radio Enabled Test	Quick	Unattended
Network Scan Test	Quick	Unattended
Signal Strength Test	Quick	Unattended

Radio Enabled Test

Verifies that the wireless is turned on.

Network Scan Test

Verifies that the wireless adapter can detect available networks. Make sure that there is a properly configured router or access point nearby before running this test.

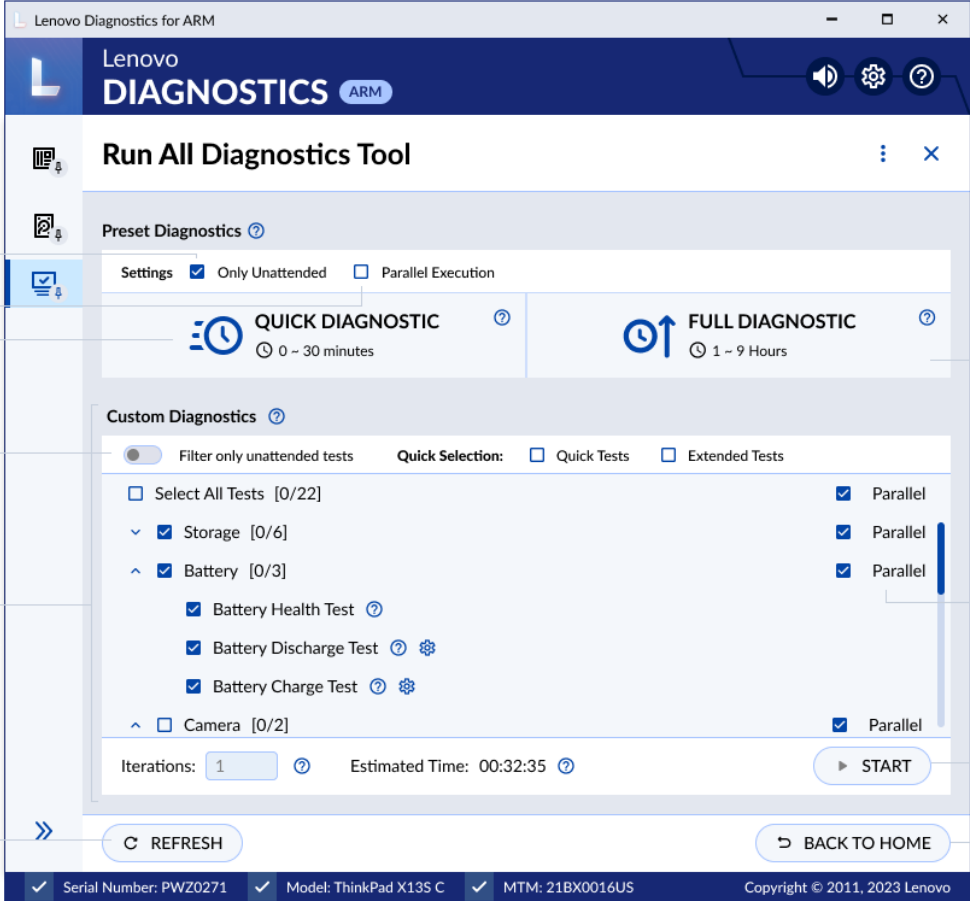
Signal Strength Test

Tests the wireless connection quality for the wireless adapter. Make sure that there is a properly configured router or access point nearby before running this test.

5. EXPLORING LENOVO DIAGNOSTICS for ARM TOOLS

5.1 Run All

Run All Tool allows performing all supported tests from all supported modules at the same execution. In this flow it is not possible to select devices, thus all devices will be tested.



The screenshot shows the 'Run All Diagnostics Tool' interface. It features a top navigation bar with the Lenovo logo and 'DIAGNOSTICS ARM'. Below this, there are sections for 'Preset Diagnostics' and 'Custom Diagnostics'. The 'Preset Diagnostics' section includes 'Settings' with checkboxes for 'Only Unattended' and 'Parallel Execution', and two main options: 'QUICK DIAGNOSTIC' (0 - 30 minutes) and 'FULL DIAGNOSTIC' (1 - 9 Hours). The 'Custom Diagnostics' section has a toggle for 'Filter only unattended tests' and 'Quick Selection' options for 'Quick Tests' and 'Extended Tests'. Underneath, there are expandable sections for 'Storage [0/6]', 'Battery [0/3]', and 'Camera [0/2]', each with checkboxes for individual tests and a 'Parallel' checkbox. At the bottom, there are 'Iterations: 1' and 'Estimated Time: 00:32:35' fields, a 'START' button, and a 'REFRESH' button. The status bar at the very bottom displays device details and copyright information.

1. Run only Unattended Tests
2. Enable parallelism among modules
3. Run quick diagnostics
4. Click to filter only unattended tests
5. Customize the execution
6. Refresh devices
7. Run all diagnostics
8. Enable this module to run in parallel with others
9. Start custom diagnostic
10. Back to home screen

Figure 53: Run All Screen

Preset Diagnostics

This section contains predefined test sets that aim to diagnose all devices available in the same run. In this execution mode, it's possible to choose if the Attended Tests should be performed or not by clicking on "Only Unattended Tests", as well as to choose if the modules should be performed in parallel with each other by clicking on "Parallel Execution".

- **Quick**

Click on Quick card to perform all quick tests according to your preferences defined in Preset Diagnostics settings.

- **Full**

Click on Full card to perform all tests (Quick + Extended) according to your preferences defined in Preset Diagnostics settings.

Custom Diagnostics

In this section, you can select any module/test to be run, choose which modules will run in parallel, enter the number of iterations, and filter the test list to display only unattended tests.

To filter by unattended tests, just to enable the "Filter only unattended tests" toggle. You also can use the "Quick Selection" to quickly select a set of tests.

5.2 Scripts Tool

The Scripts Tool allows you to create a custom list of tests from any module.

If there are existing scripts, you can also perform the following actions: Execute, edit, and delete.

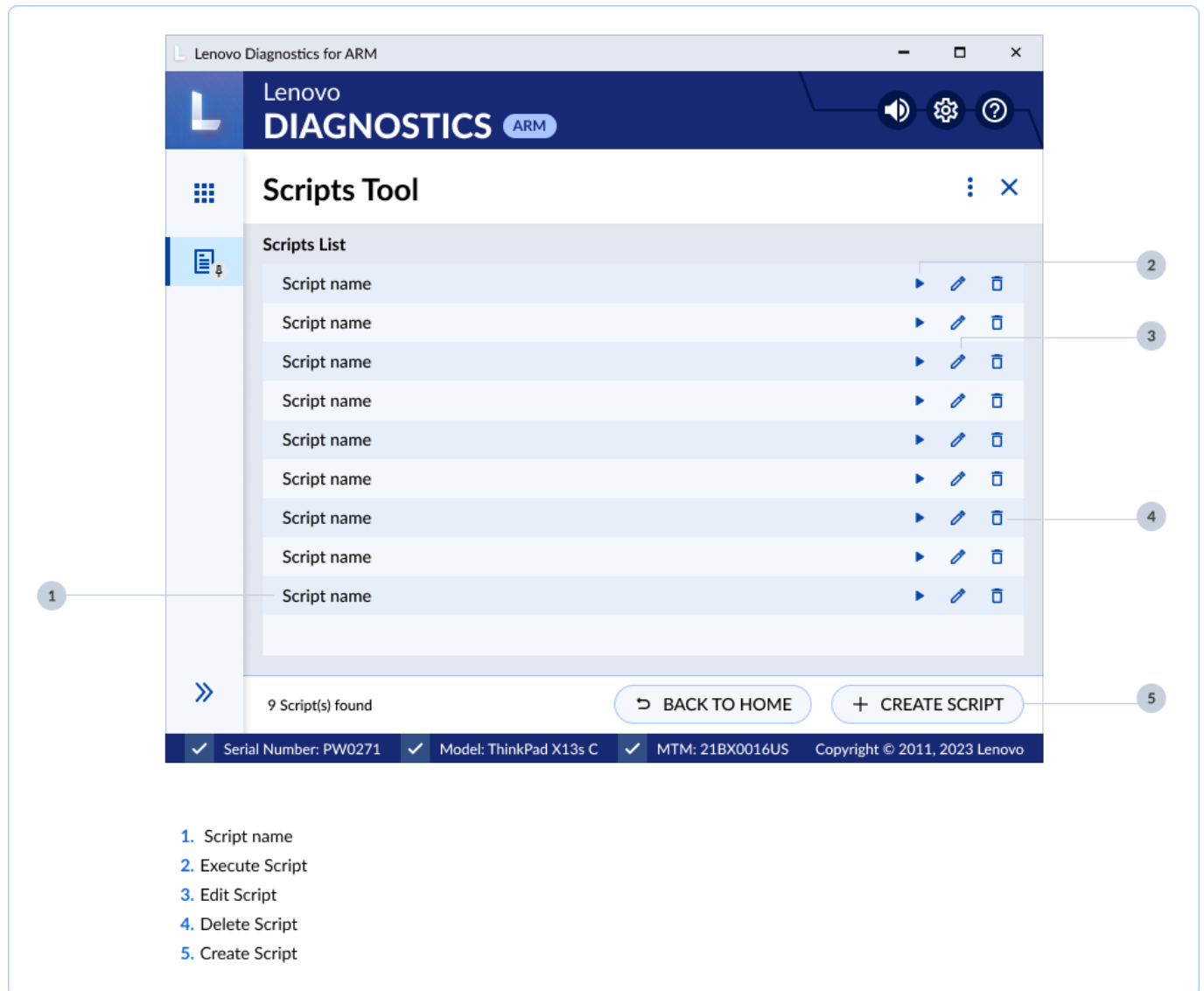



Figure 54: Scripts Tool (Scripts List)

5.2.1 Create a diagnostic script

By clicking on the **Create Script** button, the screen below will be displayed. This screen allows selecting a set of tests to be performed from a list with all tests present in Lenovo Diagnostics for ARM. You can select the modules to be run in parallel and define advanced settings for tests and modules. The tests not supported by the tested machine are marked with this warning icon 

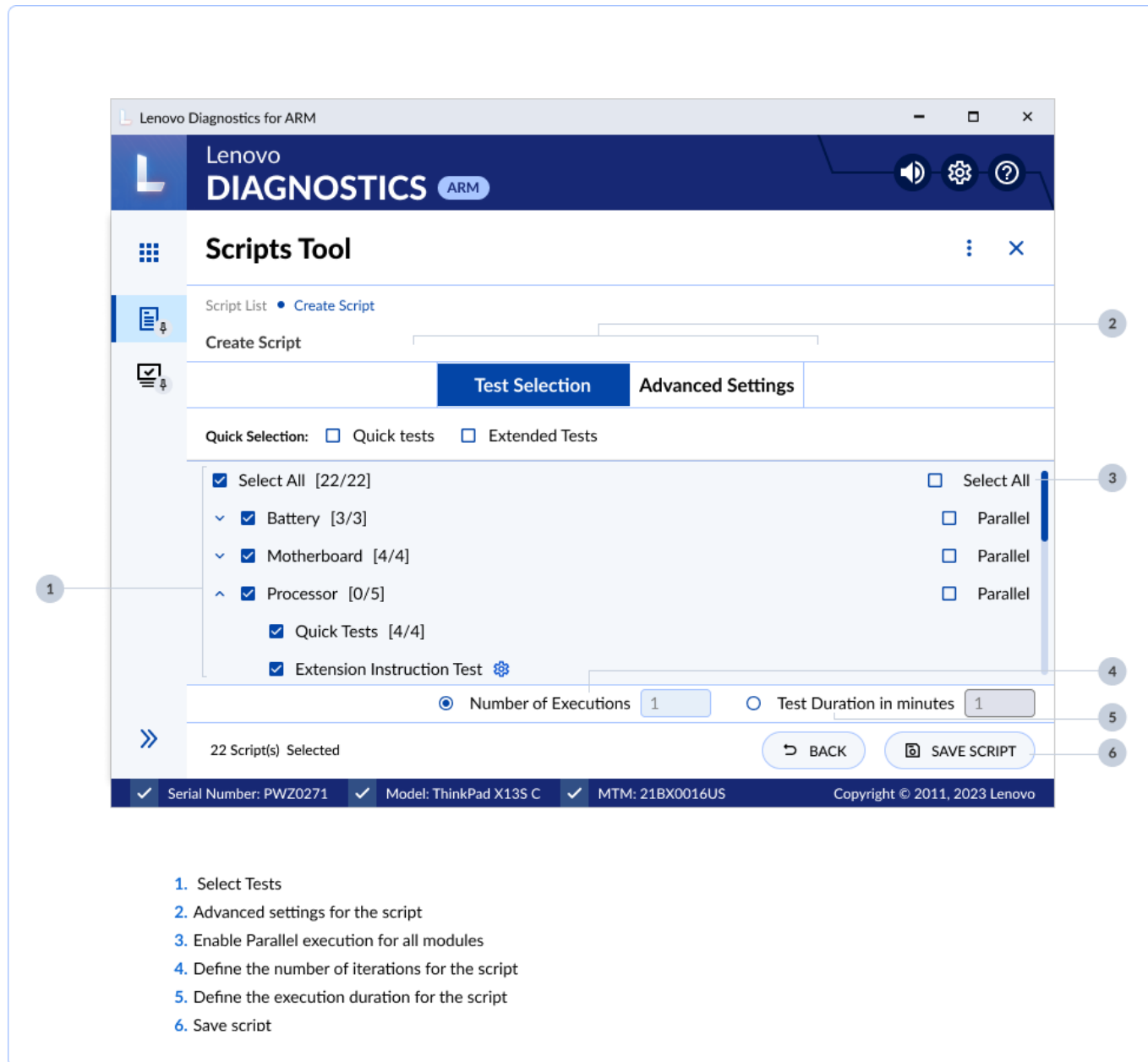


Figure 55: Scripts Tool (Script Creation)

It is also possible to configure the execution of these tests according to one of the following parameters:

Number of Executions: allows performing the tests according to a specific number of executions in a range from 1 to 999. In this case, the diagnostic will be finished when all iterations are completed.

Test Duration in Minutes: allows performing the tests according to a specific number of minutes in a range from 1 to 999. In this case, the diagnostic will be finished when this time is reached and all tests from the current iteration are finished.

Once you select at least 1 test, the advanced settings tab is enabled, and you can configure the following parameters:

Module Execution Sequence: This allows you to select the order in which the modules will be executed by dragging and dropping the modules and tests in the list.

Duplicate a test: This allows tests to be duplicated in the same execution.

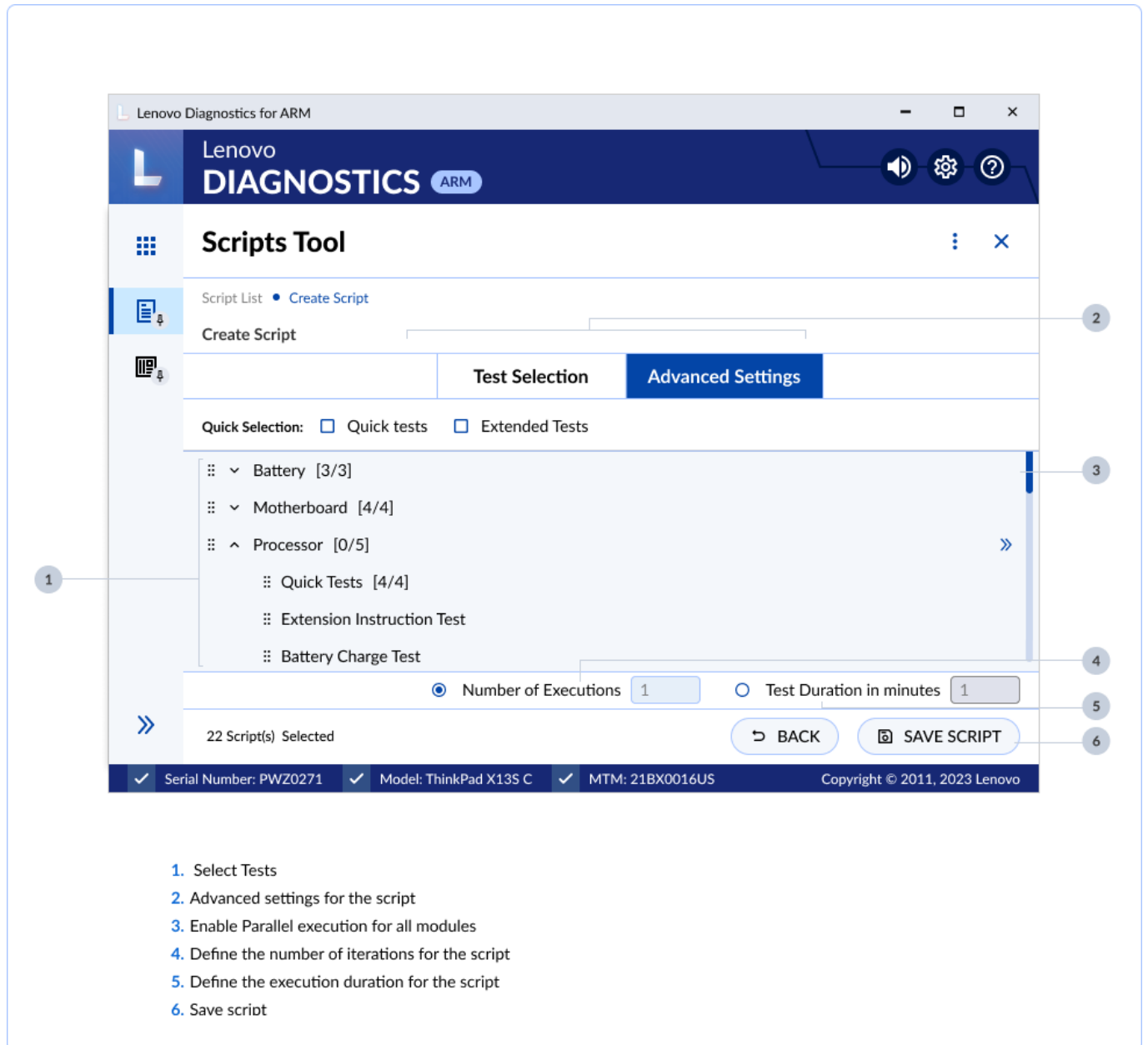


Figure 56: Scripts Tool (Advanced Settings)

5.2.2 Edit a diagnostic script

By clicking on the **Edit script** icon, a screen is displayed with the configuration from the selected diagnostic script.

Here it is possible to modify this configuration by changing the list of tests and which modules will be run in parallel, modifying the number of executions or duration minutes, and changing the advanced settings.

By clicking on the **Save Script** button all changes are saved in the current script and clicking on **Save as** it is possible to create a new script with the current configuration.

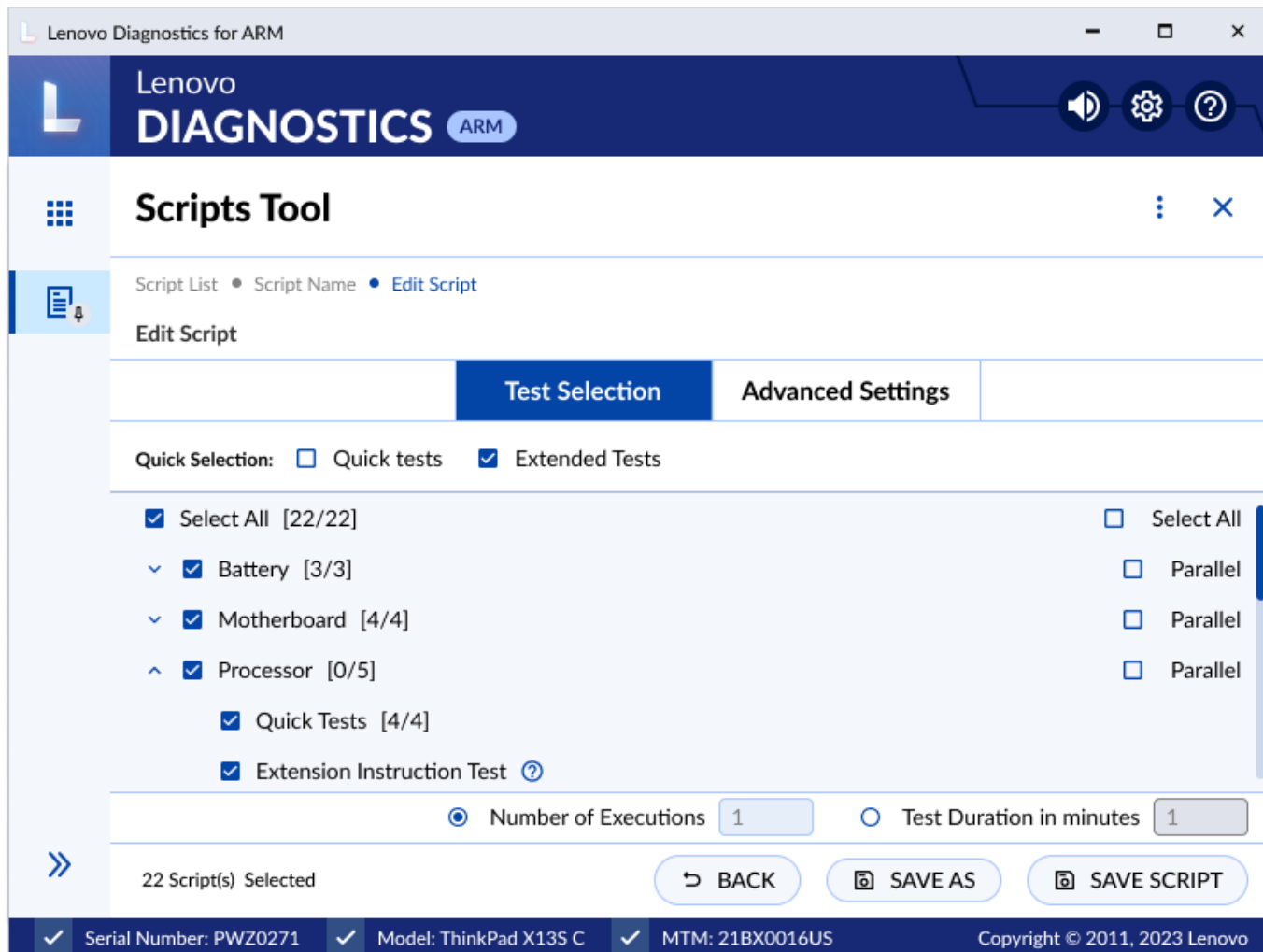


Figure 57: Scripts Tool (Edit Script)

5.2.3 Delete a diagnostic script

By clicking on the **Delete Script** button, the application will show a pop-up message to confirm the operation.

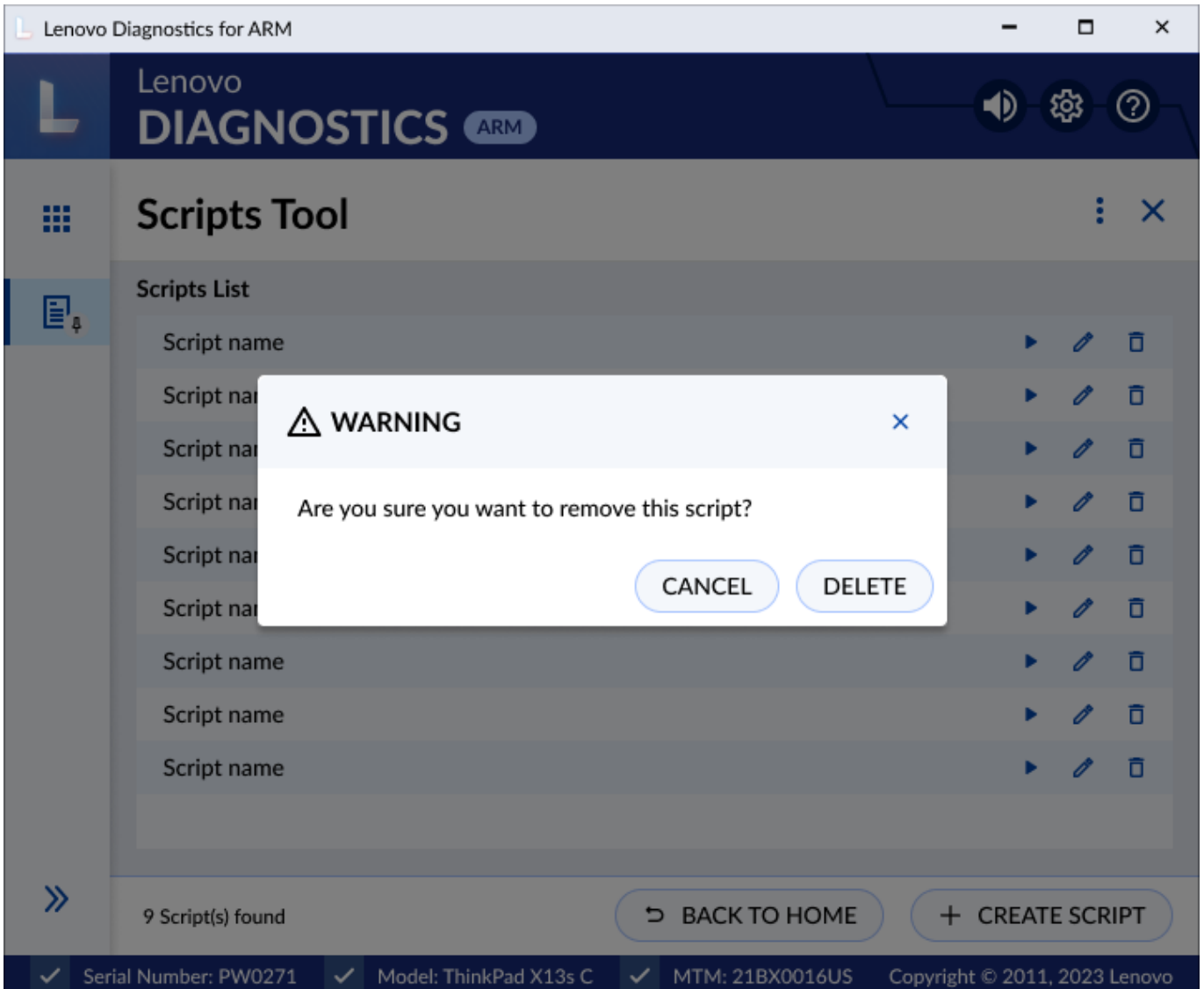



Figure 58: Scripts Tool (Delete Script)

5.2.4 Execute a diagnostic script

By clicking on the **Execute Script** button or on the script row, a screen is displayed with the configuration from the selected diagnostic script. All selected tests are listed and the not supported ones are marked with this warning icon .

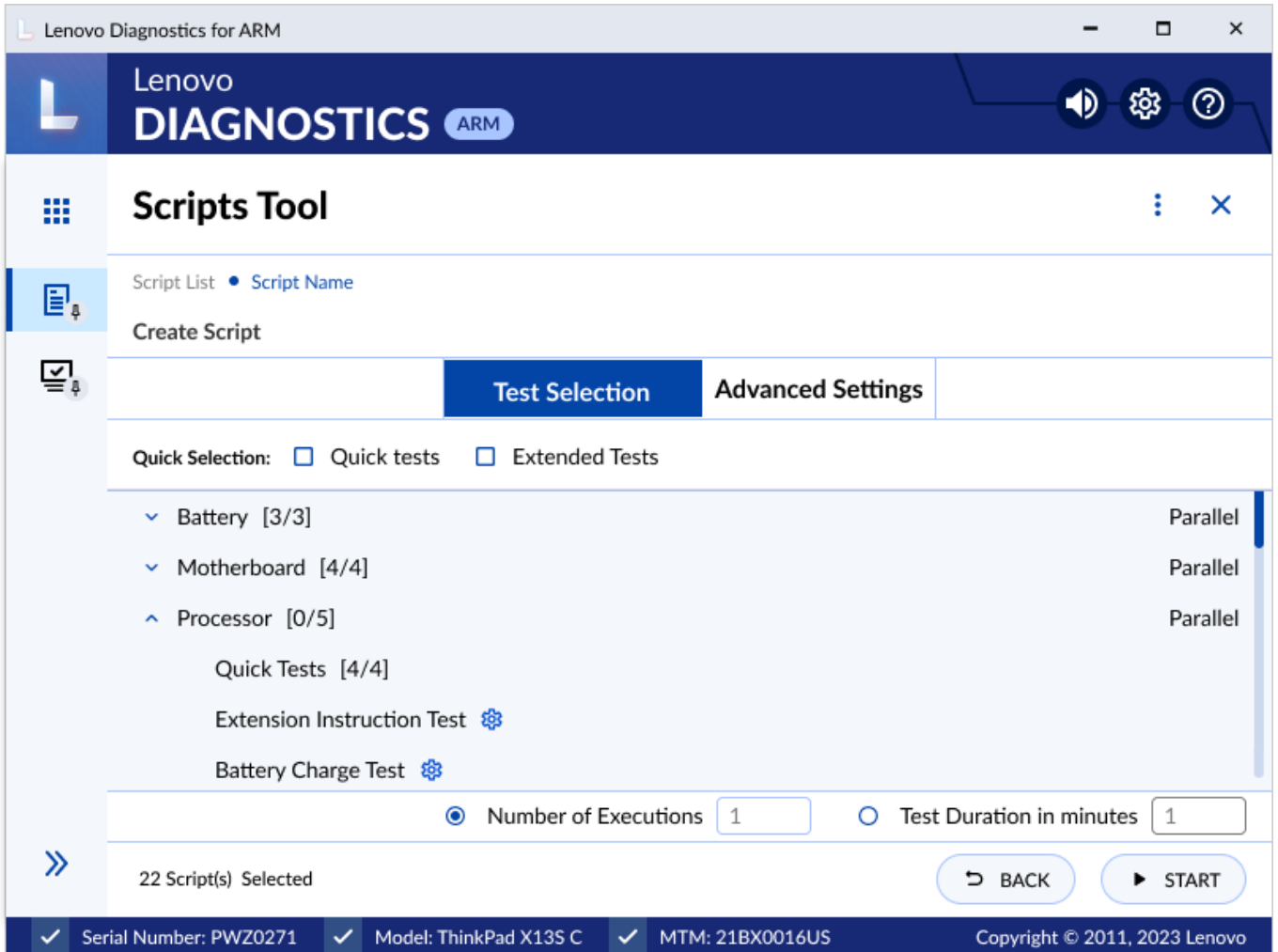


Figure 59: Scripts Tool (Script Summary)

By clicking on the **Start** button, the diagnostic script execution screen is displayed, and all supported tests are performed. The not supported tests that which don't have an associated device are filtered on this execution. It is possible to finish the execution any time by clicking on **Abort**.

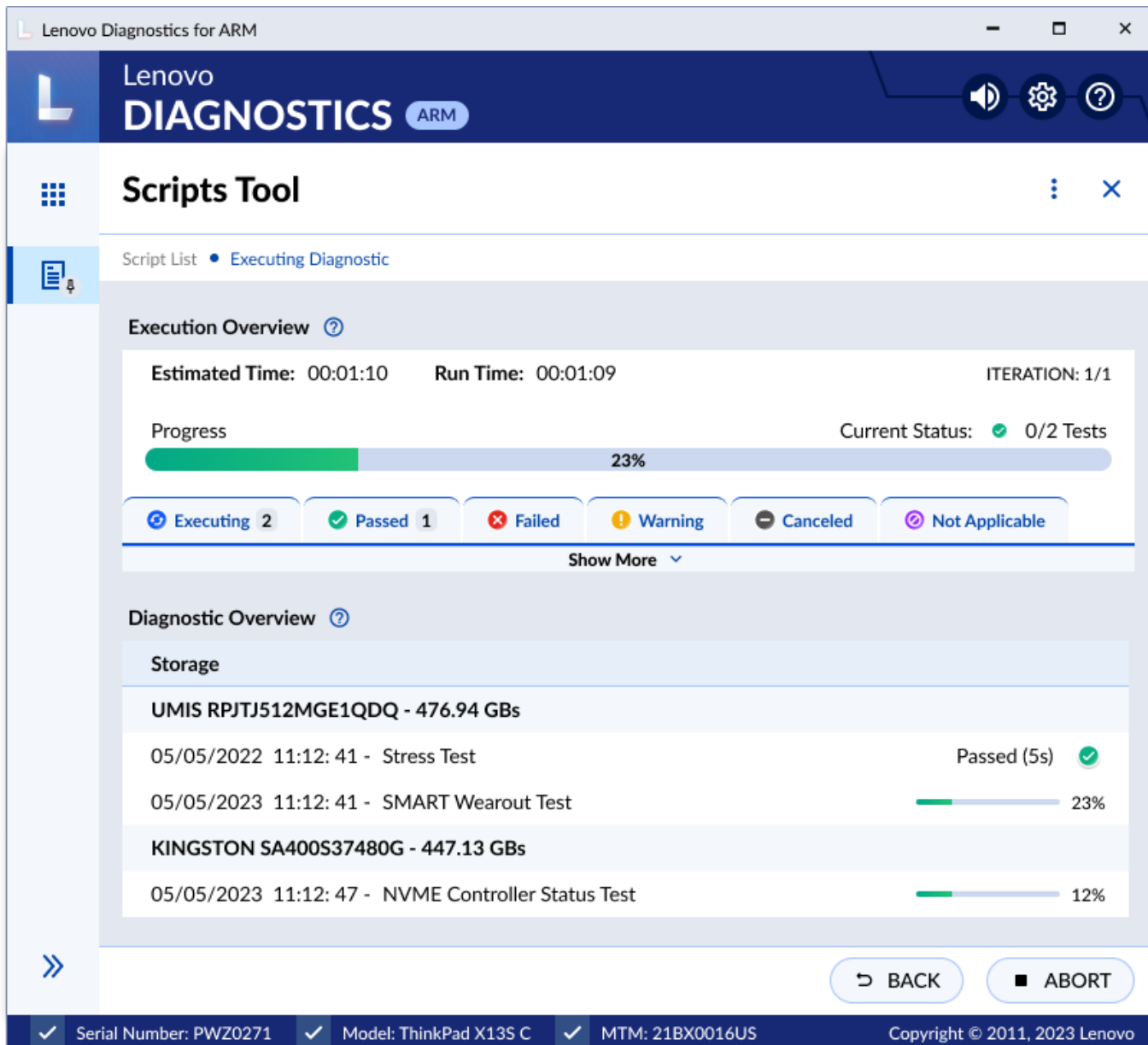
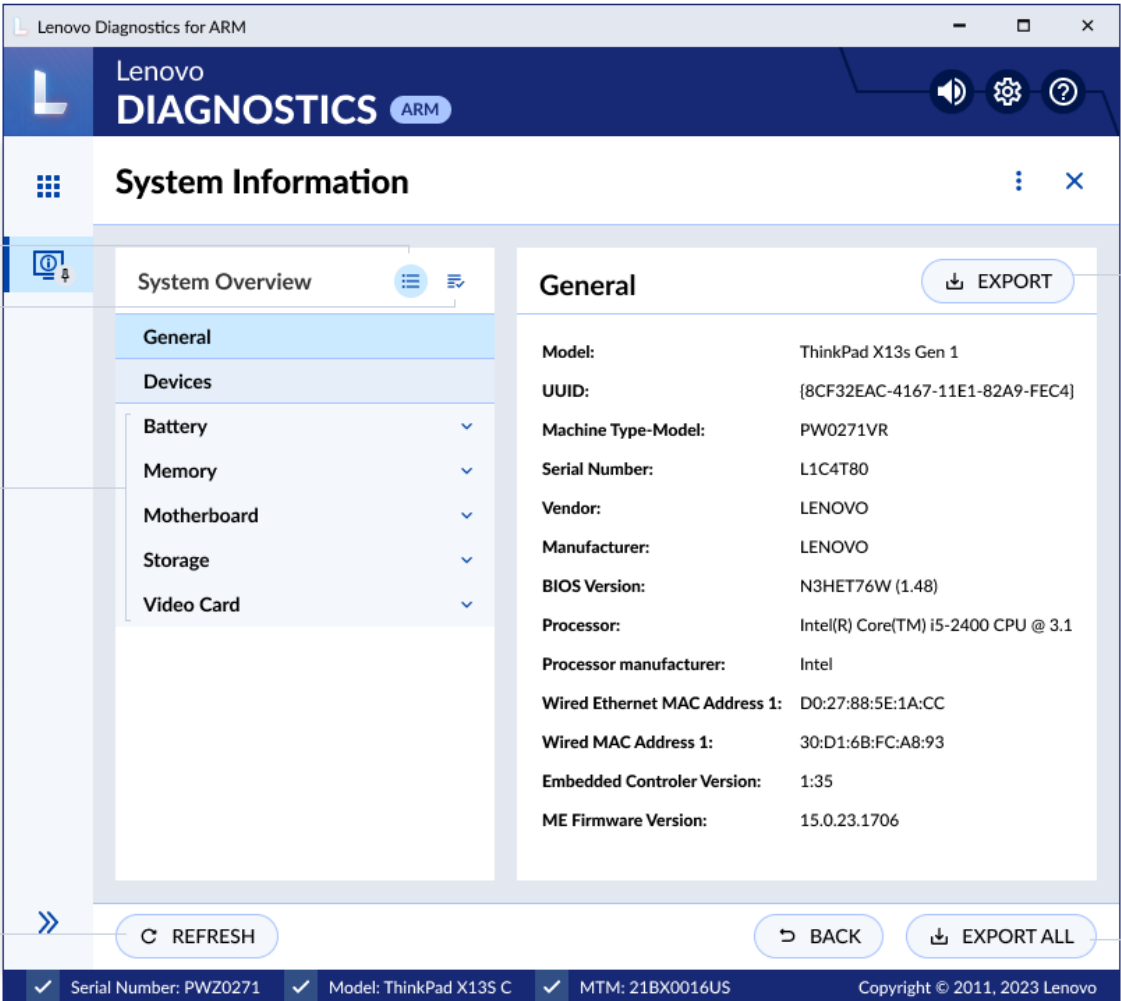


Figure 60: Scripts Tool (Script Execution)

When the diagnostic is finished, the log of execution is displayed. It is possible to export each iteration to a PDF or HTML file by clicking on the **Export** button.

5.3 System Information Tool

The system information tool allows you to see general information about the system and the available module's devices. See in the screen below that it's possible to navigate between the modules and export the General Information, select multiple devices/modules to be exported, or export all information in a single click.



The screenshot displays the 'System Information' tool interface. On the left, a sidebar contains a 'Device List' (1) with a selection icon, a 'Modules' list (3) with expandable categories like 'General', 'Devices', 'Battery', 'Memory', 'Motherboard', 'Storage', and 'Video Card', and a 'REFRESH' button (4). The main area shows 'General' information (5) for a ThinkPad X13s Gen 1, including details like UUID, Machine Type-Model, Serial Number, Vendor, Manufacturer, BIOS Version, Processor, Processor manufacturer, Wired Ethernet MAC Address 1, Wired MAC Address 1, Embedded Controller Version, and ME Firmware Version. An 'EXPORT' button is visible in the top right of this section. At the bottom right, there are 'BACK' and 'EXPORT ALL' (6) buttons. The status bar at the bottom shows system details: Serial Number: PW20271, Model: ThinkPad X13S C, MTM: 21BX0016US, and Copyright © 2011, 2023 Lenovo.

1. Device List
2. Select multiples devices/modules
3. Modules
4. Refresh devices
5. Export general machine information
6. Export information from all devices

Figure 61: System Information Screen

You also can export the information from a module, or a specific device.

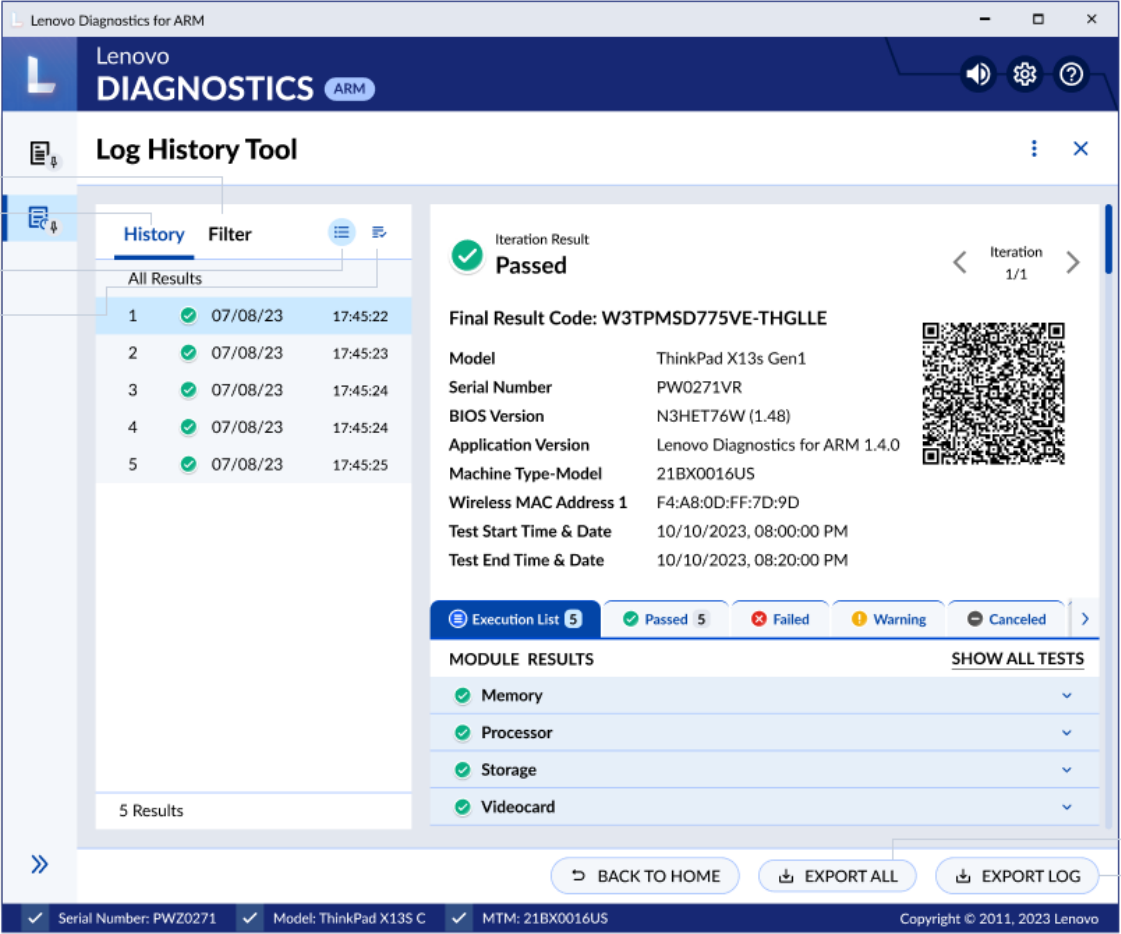
The screenshot shows the 'System Information' interface in the Lenovo Diagnostics for ARM application. The left sidebar contains a menu with options: System Overview, General, Devices, Battery (selected), Memory, Motherboard, Storage, and Video Card. The main area displays the 'Battery' module details, including UDI, Resource type, Index, Chemistry, Manufacture name, Serial number, Design voltage, Full Charge capacity, Design capacity, Cycle count, and FRU part number. At the top right of the battery details, there is an 'EXPORT' button (callout 1) and a download icon (callout 2). At the bottom of the main area, there are 'REFRESH', 'BACK', and 'EXPORT ALL' buttons. The footer shows system status: Serial Number: PWZ0271, Model: ThinkPad X13S C, MTM: 21BX0016US, and Copyright © 2011, 2023 Lenovo.

1. Export module information
2. Export device information

Figure 62: System Information (View Module Information)

5.4 Log History Tool

The Log History Tool allows you to see and export all logs of executions performed in the machine via Run All, Script Tool, and Modules.



The screenshot displays the 'Log History Tool' window. On the left, a table lists five execution results, all marked as 'Passed' with green checkmarks. The right pane shows a detailed view of a 'Passed' iteration, including a QR code and system information such as 'Model: ThinkPad X13s Gen1', 'Serial Number: PW0271VR', and 'Test Start Time & Date: 10/10/2023, 08:00:00 PM'. At the bottom, there are buttons for 'BACK TO HOME', 'EXPORT ALL', and 'EXPORT LOG'. A status bar at the very bottom shows system details like 'Serial Number: PWZ0271' and 'Model: ThinkPad X13S C'.

1. Click to see the Filter tab
2. Click to see the History tab
3. Click to see the list of logs
4. Click to see the multiple logs
5. Click to export all listed logs
6. Click to export the log being displayed

Figure 63: Log History Screen

By clicking on the **Filter tab**, you can filter the logs by date using the From and To fields, by Status, and by Execution Type.

The screenshot displays the 'Log History Tool' interface. On the left, a filter panel (labeled 1) contains input fields for 'From' (06/08/2023) and 'To' (07/08/2023), dropdown menus for 'Status' (All) and 'Execution Type' (All), and 'CLEAR' (labeled 2) and 'APPLY' (labeled 3) buttons. The main area shows a 'Passed' iteration result with a QR code and system details. A summary bar indicates 5 passed, 0 failed, 0 warning, and 0 canceled tests. Below this, a 'MODULE RESULTS' table lists Memory, Processor, Storage, and Videocard, all with green checkmarks. At the bottom, navigation buttons for 'BACK TO HOME', 'EXPORT ALL', and 'EXPORT LOG' are visible. The footer contains system identification and copyright information.

1. Fields to customize the filter
2. Click to clear filter fields
3. Click to apply filter

Figure 64: Log History (Filter Logs)

By clicking on the **Select Multiple Logs** icon, you can select one or more logs to be exported at the same time.

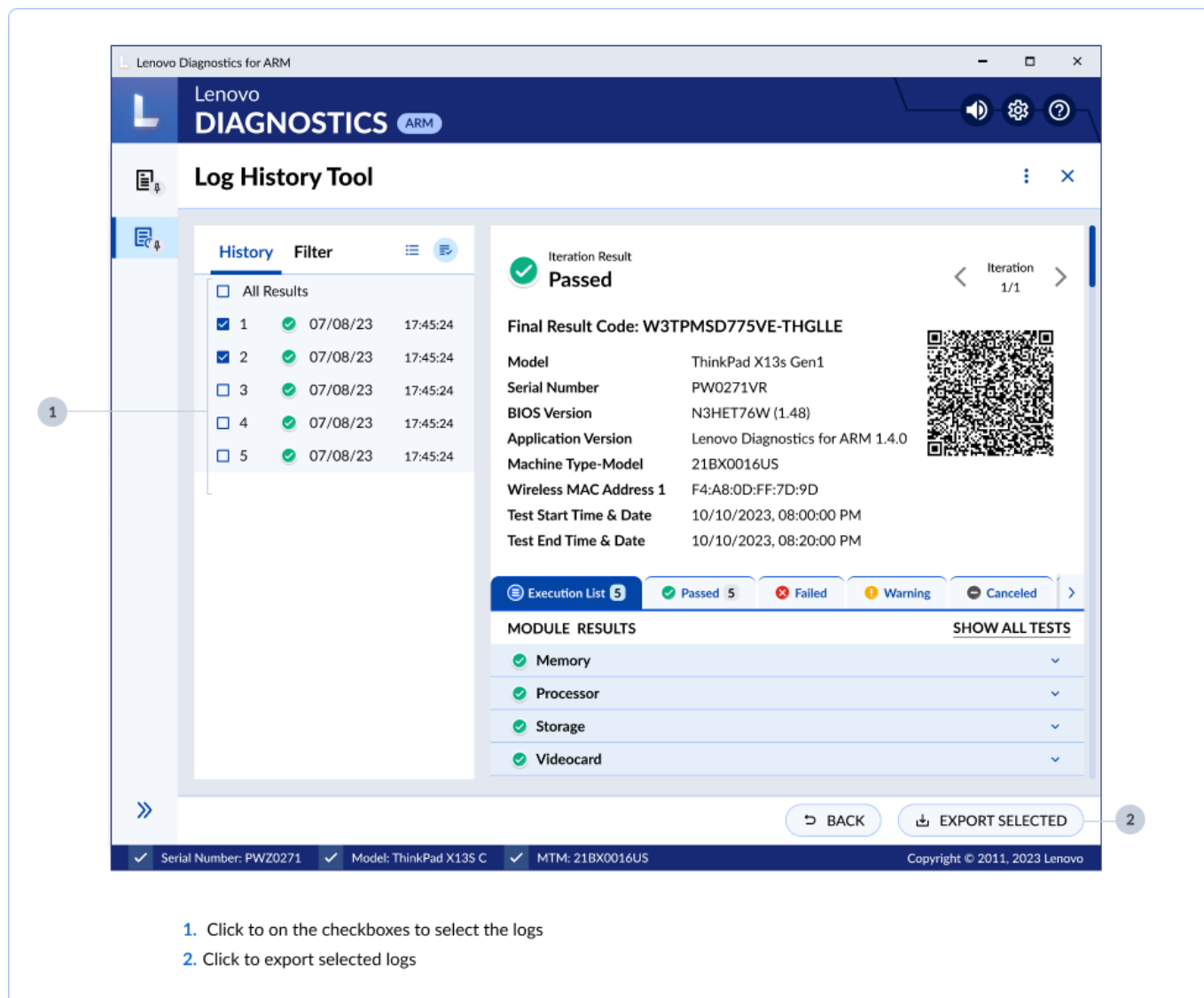


Figure 65: Log History (Select Multiple Devices)

You are able to **export** the logs of executions performed in the machine by clicking on the export buttons:

- **Export All Button:** by clicking on it, you can export all Logs found in the filter. The logs must be saved in HTML format inside a .zip folder.
- **Export Log Button:** by clicking on it, you can export only the log being displayed, in the HTML or PDF format for each run.
- **Export Selected Button:** by clicking on it, you can export only the selected logs. The logs must be saved in HTML format inside a .zip folder.

6. GLOSSARY

Attended test: It is a test that depends on some user action to be executed.

Extended Test: A type of test that can be performed in several minutes.

Module: a module contains a set of tests that can be performed for a type of device. It is enabled in the application only if the tested machine has at least one device supported by the module.

Quick test: A type of test that is performed in a few minutes.

Screen reader: A software program that read the text and elements displayed on the computer screen.

Unattended test: It is a test that does not depend on the user actions to be executed. All steps are performed automatically by the application.