APPLICATION NOTE

Stress Test Your Wireless Device Quickly

Nine Fast and Easy Tips for Device Validation

KEYSIGHT

Thorough Testing is Key, but Who Has the Time?

Device validation engineers face a difficult challenge in testing *Bluetooth*® Low Energy (BLE) devices. For mission-crucial IoT and medical device applications, thorough testing is essential; even small design, configuration, firmware, and manufacturing defects must be wrung out of the product before release to manufacturing. Unfortunately, the need to get products to market quickly means that engineers cannot afford to spend a lot of time developing, debugging, and running complex tests.

The IoT presents great opportunities that can improve people's lives and increase business efficiency. Success requires getting to market quickly, with the reliable, high-quality devices that customers expect.

Nine Fast and Easy Tips

Ensuring robust device operation is essential, and it is also important that test engineers get through the validation phase as quickly as possible. The rest of this application note will cover the tips shown below.

#	Description	Typical Setup Time
1	Test more PHYs	10 seconds per PHY layer
2	Test more channels	1 minute per PHY layer
3	Tighten the limits	10 seconds per tested channel
4	Reduce downlink power	5 seconds per test step
5	Increase packet count	5 seconds per test
6	Increase repeat test count	5 seconds per test
7	Set a repeat loop	1 minute
8	Loop the whole test	10 seconds
9	Detect device failures quickly	10 seconds

By following these tips, you can quickly create a powerful, robust test that will exercise your device for many hours or days via an unattended test that will either generate specific failure data or give you great confidence in several aspects of device operation.

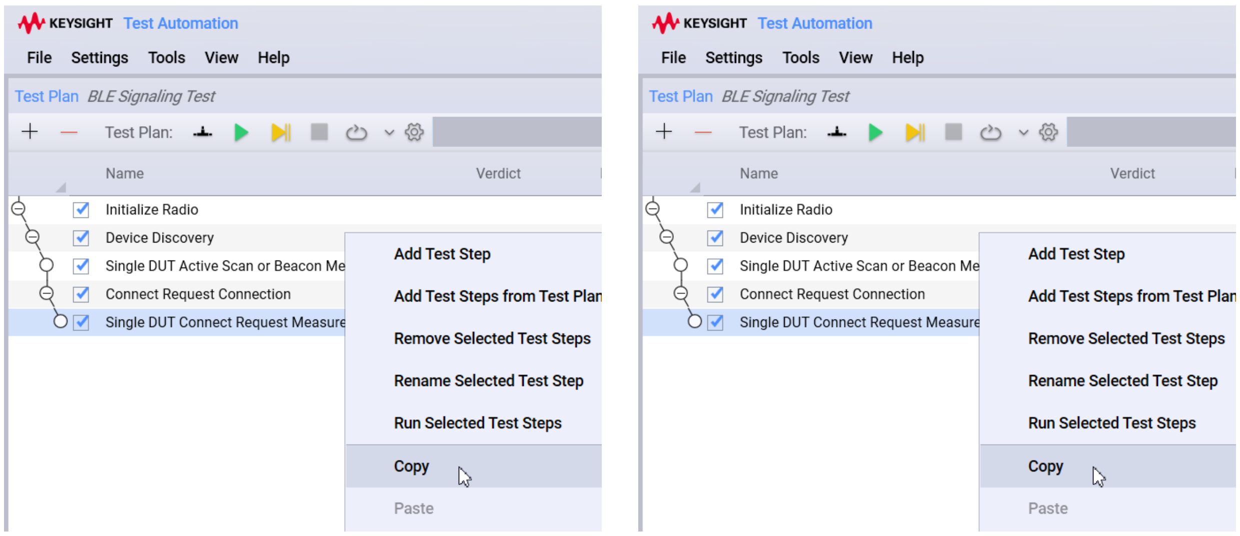
The following screen shots were taken using the BLE Signaling Test running on the Measurement Suite software of the Keysight IOT8700 series IoT wireless test solution.

Figure 1: The Keysight IOT8700 series IoT wireless test solution

Tip 1: Test more PHYs

Even if you buy your device's BLE functionality in a pre-tested module, errors can creep in during the manufacturing process (especially the antenna) or when you configure and program the module firmware. You can increase the likelihood of finding subtle errors if you test more PHYs.

To do this, right click on the **Single DUT Connect Request Measurement** test step and then click **Copy**. Then create three more copies of the test step using the **Paste** feature.


KEYSIGHT Test Automation

File Settings Tools View Help

Test Plan *BLE Signaling Test*

Test Plan:

Name	Verdict
Initialize Radio	
Device Discovery	
Single DUT Active Scan or Beacon Me	
Connect Request Connection	
Single DUT Connect Request Measure	

Add Test Step
Add Test Steps from Test Plan
Remove Selected Test Steps
Rename Selected Test Step
Run Selected Test Steps
Copy
Paste

KEYSIGHT Test Automation

File Settings Tools View Help

Test Plan *BLE Signaling Test*

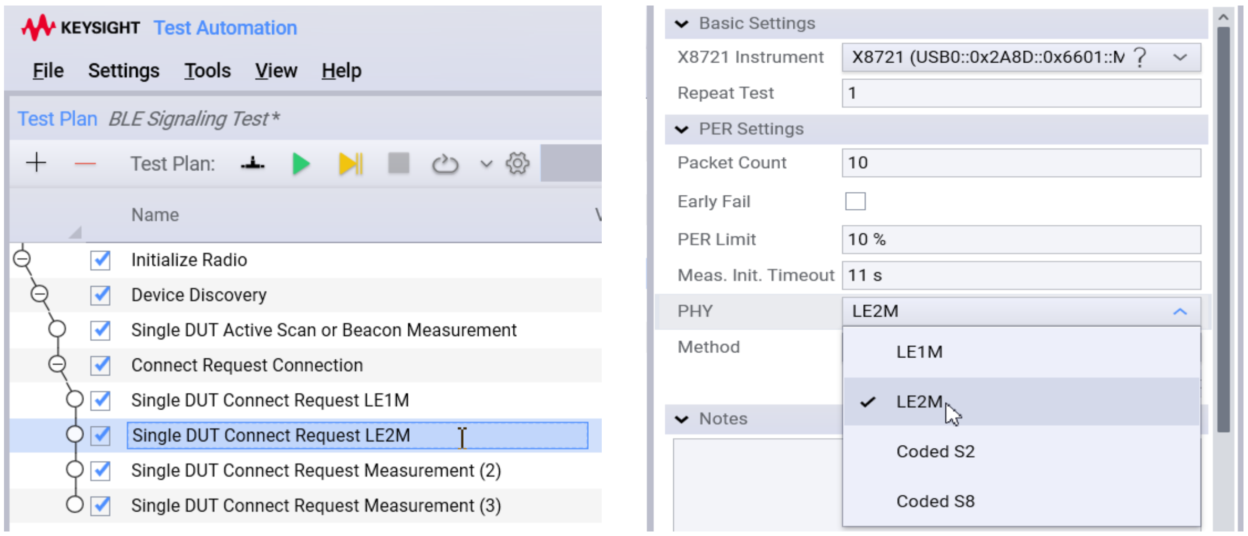
Test Plan:

Name	Verdict
Initialize Radio	
Device Discovery	
Single DUT Active Scan or Beacon Me	
Connect Request Connection	
Single DUT Connect Request Measure	

Add Test Step
Add Test Steps from Test Plan
Remove Selected Test Steps
Rename Selected Test Step
Run Selected Test Steps
Copy
Paste

Figure 2: Duplicating the Single DUT Connect Request Measurement test step

Once you have four copies of this test step, click twice on the test step names to change their names to LE1M, LE2M (the step being edited below), Coded S2, and Coded S8. Note that the names are somewhat arbitrary; they just serve as descriptions of the test steps. Then use the **PHY** dropdown in the Test Step Settings dialog to choose the proper PHY layer for each of the four test steps.


KEYSIGHT Test Automation

File Settings Tools View Help

Test Plan *BLE Signaling Test**

Test Plan:

Name
Initialize Radio
Device Discovery
Single DUT Active Scan or Beacon Measurement
Connect Request Connection
Single DUT Connect Request LE1M
Single DUT Connect Request LE2M
Single DUT Connect Request Measurement (2)
Single DUT Connect Request Measurement (3)

Basic Settings

X8721 Instrument	X8721 (USB0::0x2A8D::0x6601::M
Repeat Test	1

PER Settings

Packet Count	10
Early Fail	☐
PER Limit	10 %
Meas. Init. Timeout	11 s
PHY	LE2M
Method	

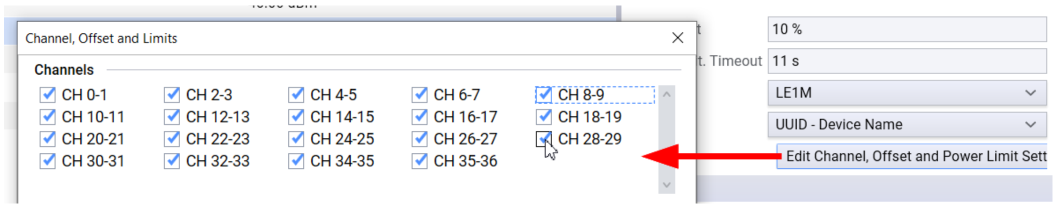
LE1M
✓ LE2M
Coded S2
Coded S8

Notes

Figure 3: Rename the test steps and choose the proper PHY layer for each test.

Tip 2: Test more channels

Once you have specified the proper PHYs, turn on all of the data channels for that PHY layer. The channels for the LE1M PHY layer are shown below, and the other PHYs have similar dialog boxes.



Channel, Offset and Limits

Channels

✓ CH 0-1	✓ CH 2-3	✓ CH 4-5	✓ CH 6-7	✓ CH 8-9
✓ CH 10-11	✓ CH 12-13	✓ CH 14-15	✓ CH 16-17	✓ CH 18-19
✓ CH 20-21	✓ CH 22-23	✓ CH 24-25	✓ CH 26-27	✓ CH 28-29
✓ CH 30-31	✓ CH 32-33	✓ CH 34-35	✓ CH 35-36	

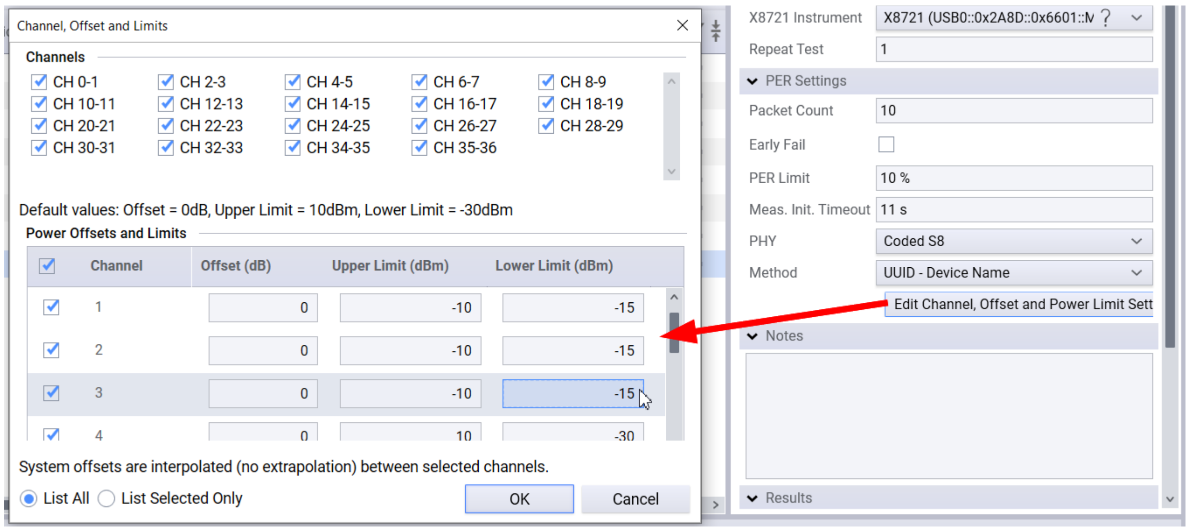
	10 %
t. Timeout	11 s
	LE1M
	UUID - Device Name

Figure 4: Enabling tests for all channels of the LE1M PHY layer

If you enable the channels before you duplicate a test step (Tip 1), the channels will automatically be enabled for all of the duplicated test steps as you paste them.

Tip 3: Tighten the limits

The default limits for the test plan are set to pass on a wide range of values. To properly test your device, you should decrease the range of acceptable values in order to catch unacceptable variations on device performance. Of course, the range of acceptable values will vary depending on the design of the DUT and the end user’s application.



Channel, Offset and Limits

Channels

✓ CH 0-1	✓ CH 2-3	✓ CH 4-5	✓ CH 6-7	✓ CH 8-9
✓ CH 10-11	✓ CH 12-13	✓ CH 14-15	✓ CH 16-17	✓ CH 18-19
✓ CH 20-21	✓ CH 22-23	✓ CH 24-25	✓ CH 26-27	✓ CH 28-29
✓ CH 30-31	✓ CH 32-33	✓ CH 34-35	✓ CH 35-36	

Default values: Offset = 0dB, Upper Limit = 10dBm, Lower Limit = -30dBm

Power Offsets and Limits

✓	Channel	Offset (dB)	Upper Limit (dBm)	Lower Limit (dBm)
✓	1	0	-10	-15
✓	2	0	-10	-15
✓	3	0	-10	-15
✓	4	0	10	-30

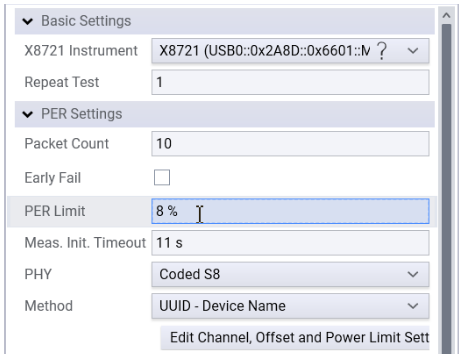
System offsets are interpolated (no extrapolation) between selected channels.

[✓ List All] List Selected Only

X8721 Instrument	X8721 (USB0::0x2A8D::0x6601::N
Repeat Test	1
PER Settings	
Packet Count	10
Early Fail	☐
PER Limit	10 %
Meas. Init. Timeout	11 s
PHY	Coded S8
Method	UUID - Device Name

Figure 5: Tightening the acceptable transmit power limits

You may also choose to reduce the PER Limit for any or all of the measurement test steps. Again, what is “acceptable” will vary by DUT and application.

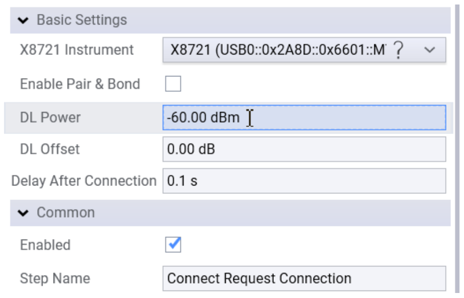


Basic Settings	
X8721 Instrument	X8721 (USB0::0x2A8D::0x6601::M
Repeat Test	1
PER Settings	
Packet Count	10
Early Fail	☐
PER Limit	8 %
Meas. Init. Timeout	11 s
PHY	Coded S8
Method	UUID - Device Name
	Edit Channel, Offset and Power Limit Sett

Figure 6: Specifying a PER Limit of 8% (reduced from the default of 10%)

Tip 4: Reduce downlink power

Many DUTs can get a low packet error rate with a strong downlink power from the tester. In the real world, devices may have to communicate with transmissions at lower power levels. By reducing the tester's downlink power, you can better simulate such challenging conditions. You can set downlink power for both the Single DUT Active Scan or Beacon Measurement test step or the Connect Request Connection test step (shown below). Of course, the meaning of a low downlink power also varies by DUT and application.

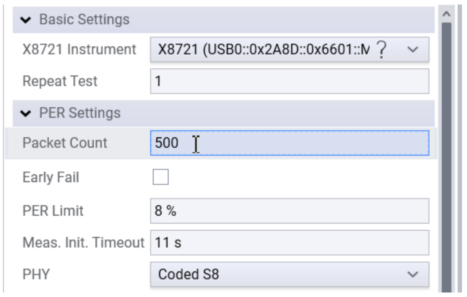


Basic Settings	
X8721 Instrument	X8721 (USB0::0x2A8D::0x6601::M
Enable Pair & Bond	☐
DL Power	-60.00 dBm
DL Offset	0.00 dB
Delay After Connection	0.1 s
Common	
Enabled	✓
Step Name	Connect Request Connection

Figure 7: Setting downlink power (DL Power) to -60 dBm

Tip 5: Increase packet count

The default number of packets for a PER test is usually 10 or 20, depending on the test step. While this may be a reasonable value to optimize test speed, it is not a particularly challenging number of packets. In addition, it does not provide good resolution, as one failed packet represents 5 or 10 percentage points.

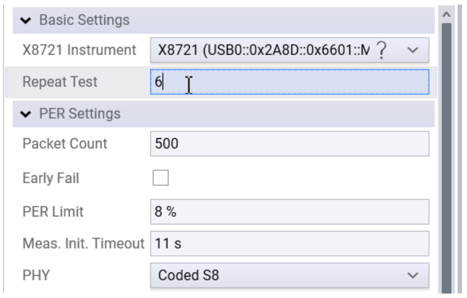


Basic Settings	
X8721 Instrument	X8721 (USB0::0x2A8D::0x6601::M
Repeat Test	1
PER Settings	
Packet Count	500
Early Fail	☐
PER Limit	8 %
Meas. Init. Timeout	11 s
PHY	Coded S8

Figure 8: Setting a packet count of 500 packets for a PER test

Tip 6: Increase repeat test count

Another way to make a test more challenging to the DUT is to increase the Repeat Test parameter. The test will repeat as many times as specified, and if any one (or more) of those repetitions fails, the test step and the overall test plan fail.



Basic Settings	
X8721 Instrument	X8721 (USB0::0x2A8D::0x6601::M
Repeat Test	6
PER Settings	
Packet Count	500
Early Fail	☐
PER Limit	8 %
Meas. Init. Timeout	11 s
PHY	Coded S8

Figure 9: Increasing the Repeat Test to run six cycles of 500 packets

Note that this is not quite the same as one PER test with 3,000 packets. While both configurations run 3,000 packets, six repeats of 500 packets is more challenging to pass for the DUT because there are six separate pass-fail decisions, each of which must be passed.

Tip 7: Set a repeat loop

You can also loop a one or more test steps by inserting a Repeat step into the test plan. To begin, right click on the test step above the test step you want to repeat. Then click **Add Test Step**, scroll down to **Repeat** in the Test Steps dialog that appears, and click **Add**.

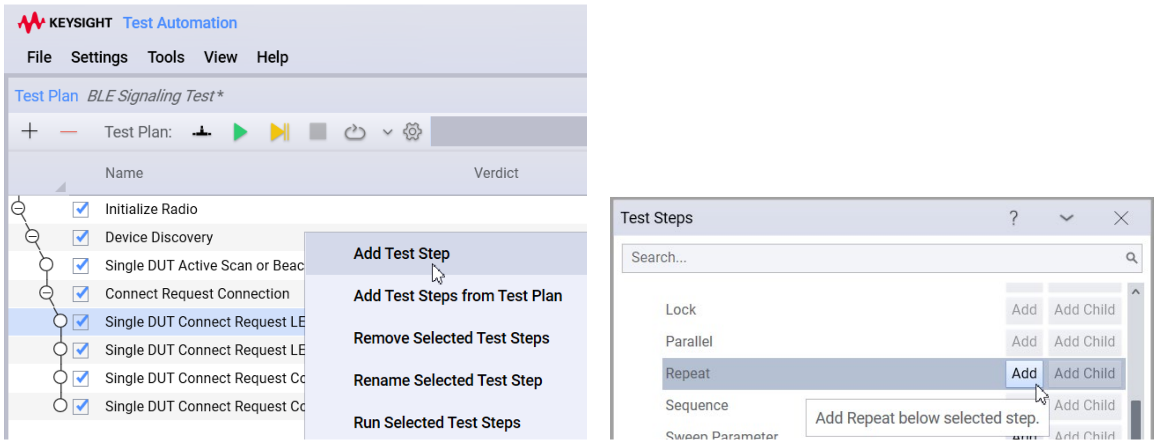
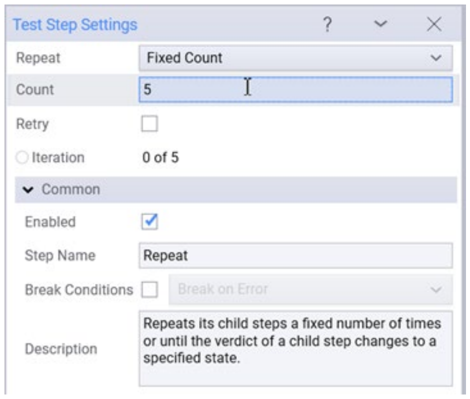

KEYSIGHT Test Automation
File Settings Tools View Help
Test Plan BLE Signaling Test*
Test Plan:
Name
Verdict
Initialize Radio
Device Discovery
Single DUT Active Scan or Beac
Connect Request Connection
Single DUT Connect Request LE
Single DUT Connect Request LE
Single DUT Connect Request Co
Single DUT Connect Request Co
Add Test Step
Add Test Steps from Test Plan
Remove Selected Test Steps
Rename Selected Test Step
Run Selected Test Steps
Test Steps
Search...
Lock Add Add Child
Parallel Add Add Child
Repeat Add Add Child
Sequence Add Child
Sweep Parameter Add Child
Add Repeat below selected step.

Figure 10: Adding a Repeat test step

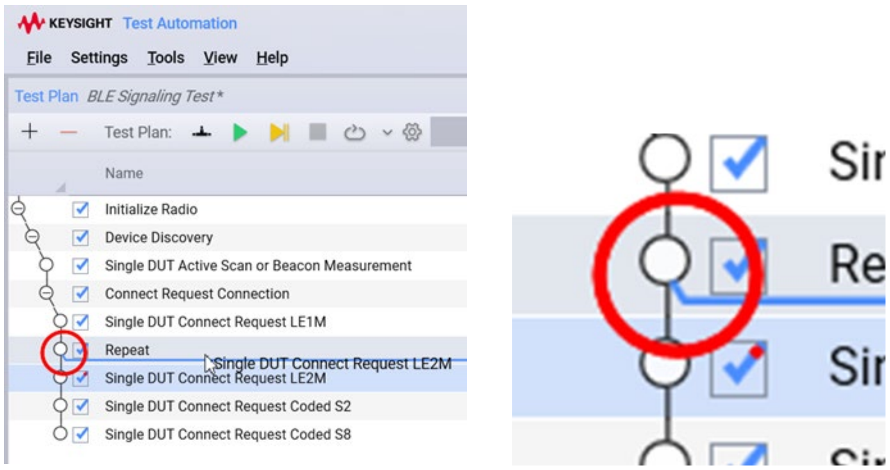
Once you have added the Repeat test step, edit the Test Step Setting for the Repeat step to set the Count to the desired value.


Test Step Settings

Repeat	Fixed Count
Count	5
Retry	☐
Iteration	0 of 5
Common	
Enabled	✓
Step Name	Repeat
Break Conditions	☐ Break on Error
Description	Repeats its child steps a fixed number of times or until the verdict of a child step changes to a specified state.

Figure 11: Setting a Repeat test step for five cycles

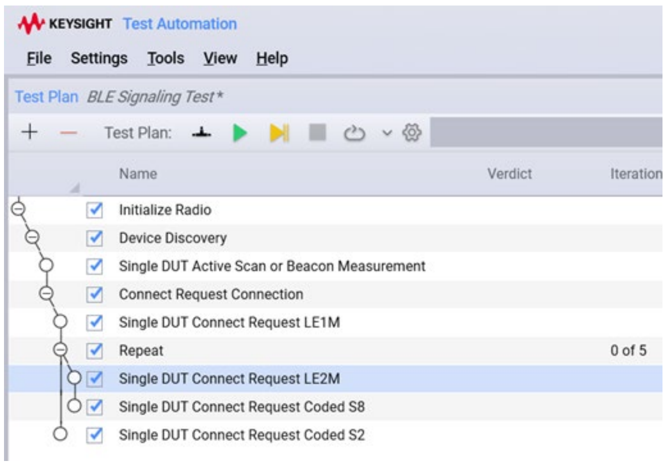
Then click on the test step that you want to repeat, and drag it up to the Repeat test step.as shown below. Note that you must position the test step you are dragging far enough to the right that the blue angle connector comes out of the little black circle at a 45-degree angle. That makes the device a child step of the Repeat step.



Initialize Radio
Device Discovery
Single DUT Active Scan or Beacon Measurement
Connect Request Connection
Single DUT Connect Request LE1M
Repeat
Single DUT Connect Request LE2M
Single DUT Connect Request LE2M
Single DUT Connect Request Coded S2
Single DUT Connect Request Coded S8

Figure 12: Dragging a test step to make it a child of a Repeat step

You can drag as many steps as desired to become child steps beneath the Repeat step, and you can also drag steps up and down to reorder them. In the image below, the test steps for PHYs LE2M and Coded S8 will be repeated five times within the Repeat loop.

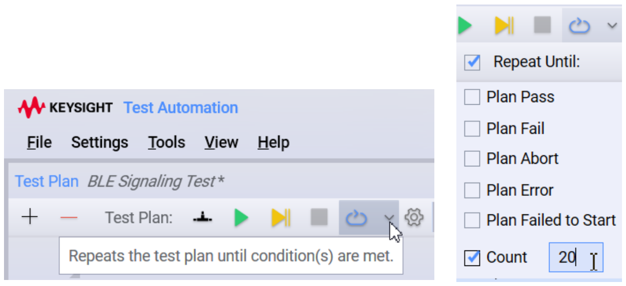


Name	Verdict	Iteration
Initialize Radio		
Device Discovery		
Single DUT Active Scan or Beacon Measurement		
Connect Request Connection		
Single DUT Connect Request LE1M		
Repeat		0 of 5
Single DUT Connect Request LE2M		
Single DUT Connect Request Coded S8		
Single DUT Connect Request Coded S2		

Figure 13: A Repeat loop with two child test steps

Tip 8: Loop the whole test

Once you have the test plan configured exactly as you want it, you can configure it to run as many times as you wish. Simply click on the downward pointing symbol shown below and enable the **Repeat Until** and **Count** checkboxes. Then specify the number of times you want to repeat the whole test.



Repeats the test plan until condition(s) are met.

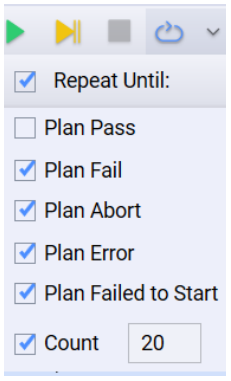
- ✓ Repeat Until:
- ☐ Plan Pass
- ☐ Plan Fail
- ☐ Plan Abort
- ☐ Plan Error
- ☐ Plan Failed to Start
- ✓ Count 20

Figure 14: Setting a test plan to repeat for 20 cycles

The measurement suite generates a test report for each run. In this case, there will be 20 test reports.

Tip 9: Detect device failures quickly

In some cases, you might just wish to collect a great deal of test data, in which case, you might use the features above to set up a test that runs for many hours, or even days. In other cases, you might want to prove that a test will run properly for, say, 72 hours. In such a situation, you want the test to stop as soon as something goes wrong, because it can be very disappointing to look at 72 hours of data only to find out that the device failed six hours into the test. To ensure that your test stops as soon as something goes wrong, enable the **Plan Fail, Plan Abort, Plan Error**, and **Plan Failed to Start** checkboxes.



- ✓ Repeat Until:
- ☐ Plan Pass
- ✓ Plan Fail
- ✓ Plan Abort
- ✓ Plan Error
- ✓ Plan Failed to Start
- ✓ Count 20

Figure 15. Configuring a test plan to halt on various types of failures

Conclusion

Medical and IoT device validation engineers face a difficult challenge in meeting project schedules while ensuring high quality for the wireless performance of their devices. One key to finding defects quickly is to set up complex, powerful tests with high coverage that will stress test their devices in an automated fashion without having to spend a lot of time configuring tests and writing code. By using the nine tips in this application note, each of which takes just a few seconds to a few minutes, you can easily configure tests that will either find defects or give you greater confidence that your devices are ready to move on to the next step in the product development process.