Electronic Design

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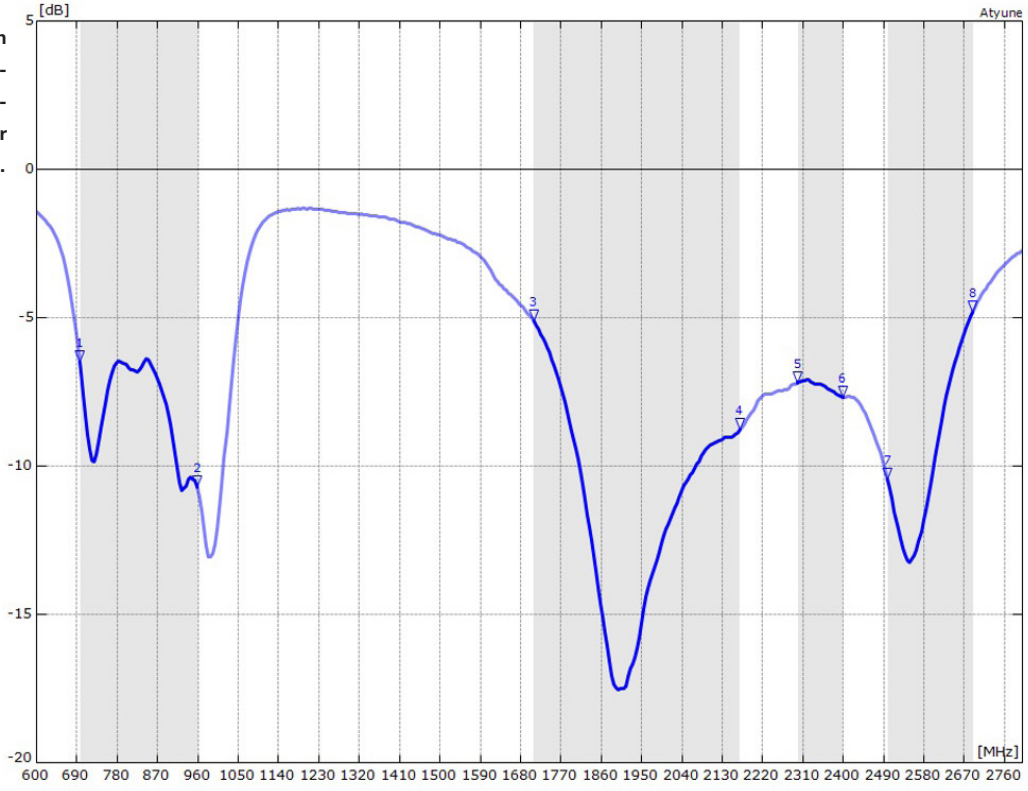
Overcome LTE Certification Challenges in Your Wireless Design

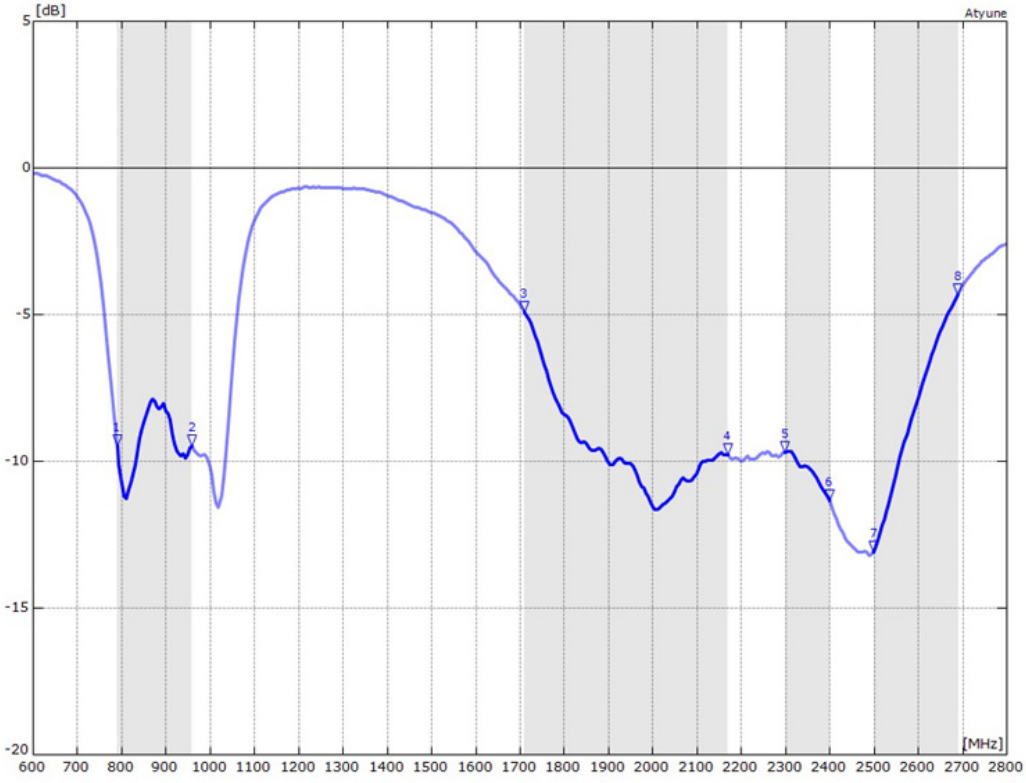
You need your wireless design to pass network certification in its initial attempt. This article sets out an approach to help you prepare for testing and certification, and probably achieve better results from the antenna, too.

U.S. carriers will switch off their 3G networks and move to 4G/LTE by the end of 2022, with carriers in other world regions likely to follow. Thus, the IoT and telematics devices that will operate on those networks must be redesigned for 4G/LTE and may need to undergo testing to gain network certification. This article sets out to shed some light on the requirements and an approach to pass certification the first time around.

For designers who are new to RF, a wireless design will need a slightly different approach that considers the antenna and allows it to perform well. If the antenna is embedded, i.e., a surface-mount-device (SMD) antenna, it needs to be placed in the design with care or it may not behave as intended.



The antenna's return loss for the tested frequencies (from Antenova's Integra antenna for 4G and LTE frequencies).



Shown is the antenna's voltage standing wave ratio (VSWR) to match the antenna to its transmission line (from Antenova's Inversa antenna for 4G and LTE frequencies).

Even if the device doesn't require certification, the design approach we outline here to prepare for testing also will help you garner better results from the antenna.

Transmitters and Testing for LTE

All electrical products are tested for electromagnetic compatibility (EMC) and safety, but if the product contains a transmitter, it must pass further tests to ensure that it's safe in wireless terms. These tests ensure that:

- It will not interfere with the use of any other, unrelated telecoms products.
- It uses the limited wireless spectrum correctly and efficiently.
- It doesn't pose any kind of health issue to human beings, i.e., the RF must be within the level that's known to be safe.

Therefore, any product with a wireless connection—whether it's Wi-Fi, Bluetooth, ISM, satellite, or cellular—must undergo an additional series of tests to ensure that it meets the required standards.

If a device is to use LTE networks, testing becomes more challenging for several reasons. First, LTE uses a number of different frequency bands. The minimum for the U.S. is three bands, but if the device is to be employed in more countries and regions of the world, the device has to be tested for a range of different frequency bands. Thus, more tests are required.

Designing for RF Performance

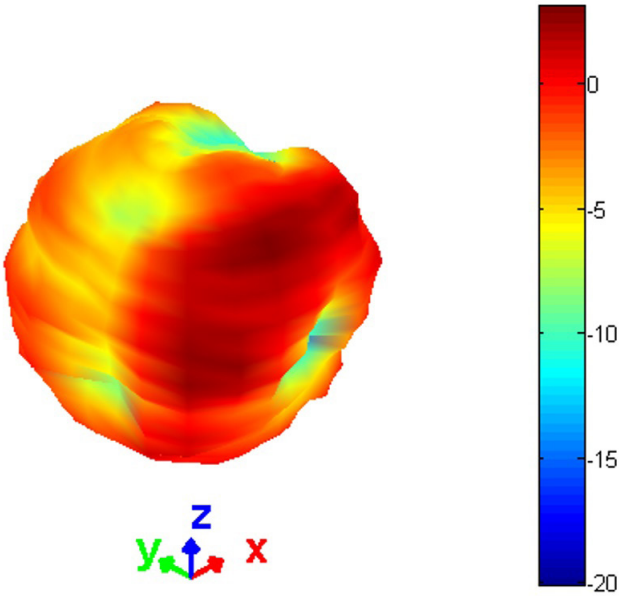
For a device to operate on a global scale, the design should allow the antenna to operate at all of these frequencies. As a result, special attention must be paid to the antenna in the design. The antenna must be placed with the correct ground plane for it perform properly for each of the frequencies. In addition, the antenna will need to have a matching network, which should be specified on the antenna manufacturer's datasheet.

LTE devices sometimes use multiple-input, multiple-output (MIMO) or diversity techniques where more than one antenna operate together to improve the device's performance. In this case, the design needs an additional test: The envelope correlation coefficient (ECC) test measures the pattern of the radiated beam of each antenna, and the results must fit set criteria.

How Tests are Governed

At the highest level, a design has to conform with legislation in the countries where the finished product is to be sold. The FCC is the relevant body for the U.S. and the EU sets similar standards for European countries. On top of that, the telecom industry has its own standards—in the U.S., these are governed by the PTCRB; outside the U.S., it's the Global Certification Forum (GCF).

These authorities don't conduct testing themselves. They work with networks of Accredited Test Laboratories that



This is an example of the radiation pattern that's unique to every antenna.

will know which tests apply for an IoT product, and will conduct the necessary tests in a laboratory with an anechoic chamber.

The tests for 4G and LTE telecom products are well-defined. However, 5G is still relatively new, and the authorities' working parties are still finalizing how tests will operate for 5G designs.

Finally, each telecoms carrier has its own criteria for the results a device must achieve in order to be accepted onto their network. The carriers' tests examine the device's performance on the actual network. For example, AT&T stipulates a minimum performance for an antenna in addition to PTCRB tests. Both the PTCRB and the carriers require over-the-air (OTA) testing.

Two Key Results

Two test measurements are important to understand, since they measure the performance of an antenna directly:

- Total radiated power (TRP): This measures the average spherical effective isotropic radiated power of the antenna. Effectively, this reading ensures that the antenna, and therefore the device, will perform well, without needing to point in a particular direction.
- Total isotropic sensitivity (TIS): This test measures the average spherical effective radiated sensitivity of the receiver and indicates its performance and sensitivity. It will detect in-band noise or spurious signals that will cause the design to fail certification.

A further test, the specific absorption rate (SAR), applies particularly to wearable devices, as well as devices that will be used close to the human body.

Planning for Certification During the Design

We suggest the following seven-step approach to ensure that your chosen antenna performs well in the design, and that you're ready to apply for formal certification for the finished device:

1. Establish which certifications will be needed for the design. This will depend on the application of the device, the networks it's built for, and the markets where it's to be sold. If the design requires certification, it's a good idea to select a test house in your region early on, choosing one from the list accredited by the authorities.
2. Take care in the choice of the antenna and communications module. A less expensive antenna may not perform as well in tests. The manufacturer's datasheet will specify key measurements for the antenna—its efficiency and its antenna pattern for each frequency. However, the measurements on datasheets apply to the antenna on its own. It will react differently close to a human hand or other components.
3. It's wise to consult with the chosen network carrier at this stage to understand what they require so that the device will operate on their network.
4. Have an RF specialist check the Gerber files to be sure that the layout and stack-up will allow the antenna (or antennas) to operate correctly. Usually, the antenna is placed on an edge of the printed circuit board (PCB) so that it can radiate freely in all directions without obstructions. For more complex designs with more than one antenna, seek help from an RF engineer.
5. Send a sample PCB for passive testing in an anechoic chamber. This will provide a useful report showing the antenna's performance of the antenna. The antenna's output is shown as Antenna Efficiency, Gain, Return Loss, Impedance, and 2D and 3D radiation patterns. These tests will reveal any problems with radiated power and sensitivity.

When these tests are complete, you may be given recommendations to improve the performance of the design, and help you get the best performance from the antenna. The next stage is to tune the antenna to optimize its performance.

6. At this stage, the design may require some revisions and adjustments to the layout to improve the RF performance and be sure that it will perform as intended in the real world.
7. Send a complete prototype or sample typical of the final production unit for OTA testing. The product should be accompanied by its batteries, chargers and cables, and documentation showing details of the antennas and their feeds. Some tests are performed with "phantom" body parts to simulate the device being used next to the human body

or head, because RF behaves differently close to a person. These tests are generally done as a precursor to certification, to assess device readiness, and prepare for the final stage of gaining certification for the product.

The final stage will be to apply for certification with the appropriate governing bodies and cellular carriers for the product and its markets. A good antenna company will support you through the design and testing phase.

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