Application Note

Enhanced Node B Receiver Testing using the 6413A

The Aeroflex 6413A is designed for installation and commissioning of new Node Bs in the field. It includes all the necessary test capability for transmitter, receiver and functional testing of a Node B - providing for 3G networks the role that the 6113 base station tester has so successfully fulfilled for GSM. What sets the 6413A apart from other Node B test equipment is its core capability for straightforward receiver testing.

Node B Receiver tests - section 7 of 3GPP TS 25.141

The key to making receiver tests is to measure the bit error rate on the demodulated data. In the case of testing mobiles, this is usually done by looping back the signal and demodulating the signal in the test set. See Fig 1.

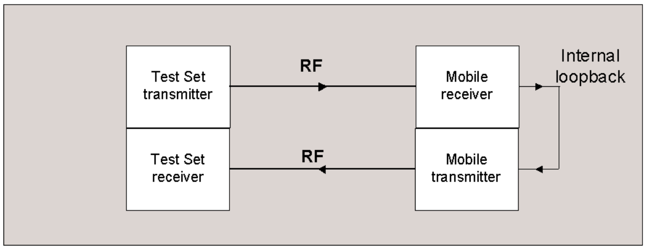

Figure 1 Equipment configuration for mobile testing

This allows a measurement to be made of the combined BER for the receiver and transmitter. Providing that this falls within acceptable limits, it is possible to confirm that the receiver is working correctly. However, this requires a loopback capability to be built into the mobile. It also prevents the receiver from being tested on its own. Unfortunately, Node Bs do not include a loopback feature when they are being tested in isolation. Therefore, it is necessary to find a means of extracting the demodulated data and measuring the bit error rate.

Aeroflex's solution is to include manufacturer specific code in the test set that enables the Node B to be directly controlled by the test set. This allows the test set to command the Node B to send all demodulated data back to the test set via the Iub interface. From this it is relatively straightforward to measure the BER and hence obtain accurate measurements of the receiver. The test setup is as in figure 2.

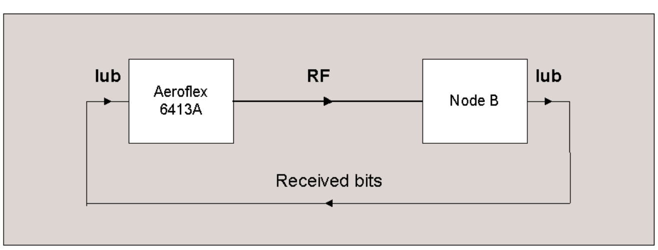

Figure 2 Equipment configuration for receiver testing, e.g. reference sensitivity level test

Benefits of Iub control

Aeroflex's approach has a number of benefits:

- Ease of use - because the base station is controlled from the 6413A setting up a test is much faster and easier. Issues such as software download and Node B configuration are automatically taken care of, leaving the operator to concentrate on testing rather than how to use the test equipment.
- Independent - the 6413A does not rely on self-test routines or other built-in test routines in order to make measurements. This makes it a truly independent receiver tester, something that is essential for conformance standard testing.
- Additional test capabilities - besides making a range of receiver tests, the 6413A also makes a number of functional tests on the Node B. For example, it establishes and maintains the Iub link to ensure that the Node B will communicate correctly with the RNC.
- Standalone testing - because the 6413A is able to control the Node B directly, it is not necessary to have a connection to the RNC while testing is being carried out. This reduces the risk that any malfunction or configuration problem will affect the operation of other parts of the network. A major benefit of this is that an operator can test new Node Bs before they are connected to the network, and be confident that any problems will be discovered before they cause any problem with other parts of the network
- Proven test method - this method was first pioneered by Racal Instruments (now Aeroflex) with the 6113 GSM base station tester. With over two thousand units in use around the world, and adopted by virtually every manufacturer and network operator, it has been extensively proven as the optimum means of testing a base station. The 6413A is designed to test Node Bs in the same manner.
- Portable and reliable - the 6413A has been designed to be able to carry out all of the key measurements in a single instrument. Its rugged design means that it is easy to transport to any Node B that is to be tested; it can be easily connected and tests can be made at a touch of a button.
- Extensive manufacturer support - regardless of which manufacturer's base station an operator chooses, Aeroflex will provide the necessary control software to be able to directly control the base station. The 6413A can also be configured to test multiple base station types, for example when an operator installs base stations from more than one vendor.

Receiver testing - Test description and equipment required

The following sections describe the test set ups required to carry out the receiver tests defined in 3GPP TS 25.141. The relevant section number of 3GPP TS 25.141, 7.x is also shown for ease of reference against the actual specification.

Test 7.2 - Reference sensitivity level

This is the basic test of the Node B's receiver performance, to ensure that it can demodulate a low level signal under ideal conditions.

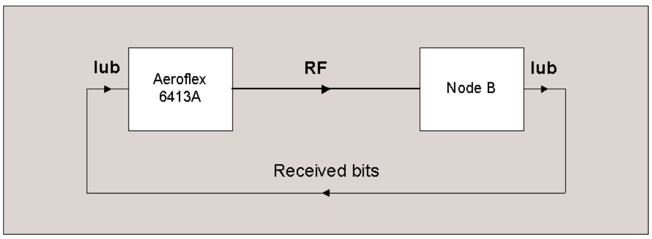

Figure 3 Equipment configuration for the Reference sensitivity level test

Aeroflex 6413A provides all the functionality needed to perform this test:

- Generate the low level RF signal to stimulate the Node B's receiver
- Extract the received bits from the Node B via the Iub connection
- Compare the demodulated bits obtained via the Iub with the known transmitted bits
- Compute the bit error ratio, display and compare to limits

Care must be taken to ensure that effects such as cable loss do not degrade the performance.

Test 7.3 - Dynamic range

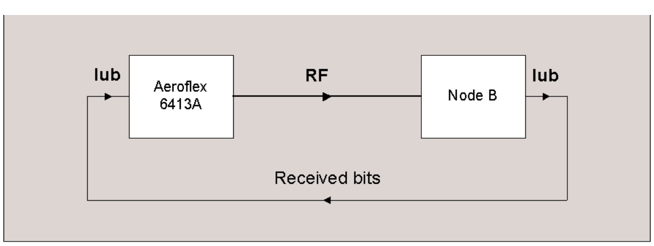

Figure 4 Equipment configuration for the Dynamic range test

The Dynamic range test evaluates the Node B's receiver performance with an interfering signal much greater than the wanted signal on the same channel. It is related to the co-channel interference test on other radio systems, but uses the Node B's coding gain to extract the wanted signal from the interfering noise.

As for Reference sensitivity, the Aeroflex 6413A provides all the functionality needed to perform the receiver Dynamic range test:

- Generate the wanted RF signal to stimulate the Node B's receiver
- Generate the Additive White Gaussian Noise (AWGN) interfering signal
- Extract the received bits from the Node B via the Iub connection
- Compare the demodulated bits obtained via the Iub with the known transmitted bits
- Compute the bit error ratio, display and compare to limits

The 6413A generates the AWGN internally and adds it digitally to the wanted signal, ensuring accurate signal to noise ratio and eliminating the need for external noise sources and RF combiners. Care must be taken to ensure that effects such as cable loss do not degrade the performance.

Test 7.4 - Adjacent channel selectivity

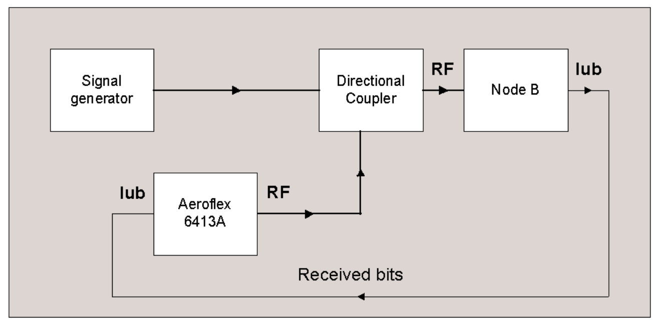

Figure 5 Equipment configuration for the Adjacent channel selectivity test

This test ensures that the Node B's receiver can receive the wanted signal in the presence of an unwanted interfering signal on the adjacent radio channel. The test specification in 25.141 calls for the test to be performed with the unwanted signal at offsets 5 Mz above and 5 MHz below the wanted signal.

The 6413A supplies the wanted signal, via the coupled port of the directional coupler, to the Node B receiver. The received bits are extracted from the Node B via the Iub network side interface, and compared within the 6413A to compute the bit error ratio. The interfering signal is applied from the vector signal generator.

The signal generator providing the unwanted signal has to be of high spectral purity to avoid too much noise falling in the wanted signal channel which would invalidate the measurement by causing co-channel interference. Calibration of the transmission loss of the various RF paths is needed to achieve the required level accuracy for both wanted and unwanted signals.

Test 7.5 - Blocking characteristics

This test ensures that the Node B's receiver can receive the wanted signal in the presence of an unwanted interfering signal. The test specification in TS 25.141 splits the test into several sections:

- A set of tables with frequency bands, giving level limits for protection from WCDMA signals in specific bands, and a more general limit for a CW interferer over the frequency range of 1 MHz to 12.75 GHz
- A set of tables with frequency bands, giving level limits for protection from Base stations in other bands co-located at the same cell site, using a CW interferer
- A set of tables with frequency bands, giving level limits for narrowband protection, using a GMSK interferer.

The tables in TS 25.141 give the limits and measurement conditions which apply in each case. The test can be performed using the equipment as shown in Figure 6

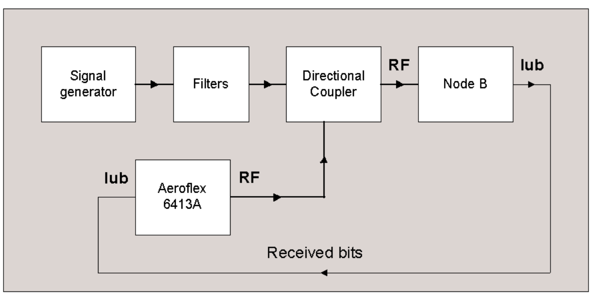

Figure 6 Equipment configuration for the Blocking characteristics test

The 6413A supplies the wanted signal, via the coupled port of the directional coupler, to the Node B receiver. The received bits are extracted from the Node B via the Iub network side interface and compared within the Aeroflex 6413A to compute the Bit error ratio. The interfering signal is applied from the signal generator (a WCDMA or GMSK modulated signal in specific radio system bands and a CW signal more generally). The CW signal is required to be at high level (+16 dBm) in some radio bands, so the main line through the directional coupler is used.

The signal generator providing the unwanted signal also generates harmonics, subharmonics, noise and spurious. At certain frequencies these will fall at the same frequency as the wanted signal and could invalidate the measurement by causing co-channel interference. Filters are therefore needed and may be a bank of selectable filters if blocking tests are to be performed in more than one radio band. Calibration of the transmission loss of the various RF paths is needed to achieve the required level accuracy for both wanted and unwanted signals.

Test 7.6 - Intermodulation characteristics

This test ensures that the Node B's receiver can receive the wanted signal in the presence of an on-channel interfering signal produced by intermodulation of two unwanted signals also applied to the receiver at the same time. The test specification in 25.141 calls for the test to be performed with a CW unwanted signal at an offset of 10 Mz and a WCDMA modulated unwanted signal at an offset of 20 MHz. The intermodulation product therefore falls on-channel. For GMSK modulated signals, different frequency offsets are used.

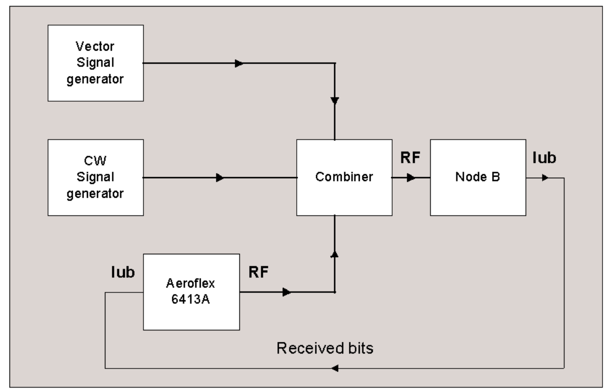

Figure 7 Equipment configuration for the Intermodulation characteristics test

The 6413A supplies the wanted signal via the combiner to the Node B receiver. The received bits are extracted from the Node B via the Iub network side interface and compared within the 6413A to compute the Bit error ratio. The interfering signals are applied from the signal generators and combined with the wanted signal.

As with other receiver tests, the signal generators providing the unwanted signals have to be of high spectral purity, to avoid too much noise or spurious falling in the wanted signal channel. Any such noise or spurious would invalidate the measurement by causing co-channel interference.

Calibration of the transmission loss of the various RF paths is needed to achieve the required level accuracy for both wanted and unwanted signals.

The 6413A - designed for measurements

Inside the 6413A is a capable RF measurement system designed to generate and analyze radio signals. The RF subsystem comprises three main components - a transmitter, a receiver and an RF combiner.

The transmitter is optomized to produce an on-channel signal,providing the “wanted” signal for measurements on the Node B’s receiver. The 6413A achieves its level accuracy for modulated signals by using a power detector in a feedback loop. The level range is extended using a precision calibrated step attenuator, with electronic switching for reliability and repeatability.

The measurement receiver was designed using a simple clear strategy-Digitize the signal as soon as possible, digitize it well, and degrade it as little as possible before it gets there. The 6413A’s measurement receiver uses a highly linear 14 bit A to D converter sampling at 48 MHz and a 1 dB step RF attenuator before the RF mixer maintains dynamic range across a wide range of input levels.

The measurement receiver is backed by powerful DSP for signal analysis.

The RF combiner includes the duplex function and a high power input attenuator. Careful selection of components is as important here as elsewhere, to maintain signal and measurement integrity.

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