application note

2029 in Mobile Manufacturing Test

by David Owen

The 2029 Vector Modulator from IFR has been designed to simplify the testing of cellular phones in manufacturing. It can be used to replace expensive radio test sets and to speed up the test procedures, particularly during the early part of the manufacturing test system.

Introduction

The 2029 can be used to upgrade existing inventory of analog signal generators to give them digital capability, so extending the life of these products and minimizing new investment costs. The 2029 combines excellent RF accuracy and low adjacent channel power to perform fast and effective tests on mobile handsets.

Manufacturing Test Systems

The design of manufacturing systems varies significantly from one manufacturer to another. The systems are designed with a common aim in mind - confirming the product has been assembled correctly. Variations in the sensitivity of the product design to defects in the manufacturing process, assembly or components and differences in manufacturing philosophy inevitably result in different manufacturing test procedures being developed.

Even so most mobile handset production lines have four stages of test as shown in Figure 1.

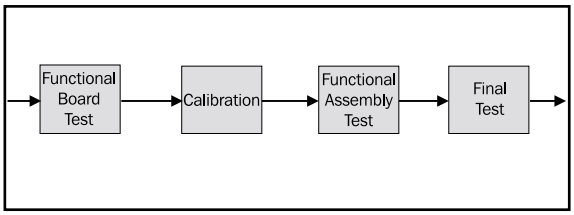

Figure 1 - Manufacturing test stages for a mobile phone

The board test stage occurs after the board has been assembled. By applying standard signals and monitoring the response the assembly can be tested. This stage should find misplaced or missing components.

The calibration stage is when the adjustments, usually electronic, are performed to align the device. For a mobile phone this will include received signal strength indicators and transmitter power.

The assembly test is performed when the boards and some of the mechanical components are all connected together and the phone is checked for assembly faults and mechanical defects, including speakers and microphones.

The final test stage is applied when the phone has an identity and is fully assembled with its covers on. Typically a call is placed to the mobile via the antenna port, this ensures that the unit works and has protocol handling software.

The objective of the tests must be to find all the faults as quickly as possible and to do so in a way that minimizes scrap and rework costs. In general this means finding the faults as early as possible in the production line process. Finding a fault late in the manufacturing process requires more disassembly of the phone to repair it, and locating the exact nature of the fault is much harder to do and requires higher labour skills to rectify. The delay in finding the fault also means that taking corrective action takes longer, increasing the risk of building more faulty phones and having to repeat value added work, such as calibration.

As the phone technology and the test methodology improves, more of the testing will be carried out at the board level since corrective action is simpler. The biggest gains can be obtained by combining the board test and calibration process where ever possible. If the phone has been designed for test it should be possible to test all the key parametric RF parameters while the phone has no covers or mechanical parts attached. By finding all the parametric faults at this stage the later stages can be designed to simply find mechanical problems associated with the assembly of the phone (such as microphones, displays and loudspeakers) and ensuring the phone has successfully installed correct software.

As the mobile handset becomes an increasingly software defined device (the software radio), it will become increasingly more important to separate fault finding and process control from the air interface, call based, software.

Using 2029 in board test and calibration

The 2029 is a Vector Modulator which can be used to turn an analog signal generator into a digital signal generator. Through the use of innovative ARB technology and high performance RF circuits the 2029 can generate very accurate RF signals carrying modulation waveforms representative of 2G, 2.5G and 3G mobile phone technology. The ARB technology allows 15 waveforms each having duration of 80 ms (4 frames) of IS95 to be stored internally and quickly selected and played.

The 2029 can be used to perform the critical board level receiver testing on the phone board as shown in Figure 2.

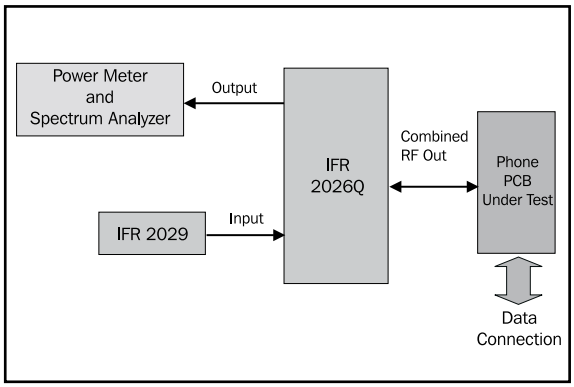

Figure 2 - Using 2029 and 2026Q in combined board and calibration test.

The phone board under test is loaded with test software that recognises fixed repetitive data patterns being generated over the air interface from the 2029. The air interface can be GSM, IS95, cdma 2000, EDGE or WBCDMA according to the phone being tested. The test software is either pre-loaded into the phone board or can be loaded by its data connection. The signal from the 2029 RF Output is supplied to the RF Input of the 2026Q (Port X).

The 2026Q is a special version of the 2026 signal

generator. It has been designed to simplify the testing of CDMA phones. The 2026Q combines two internally generated CW interferers with the in-channel (wanted) signal supplied by the 2029. The combined signals are then provided on a single connector which is connected to the phone board under test (see Figure 3).

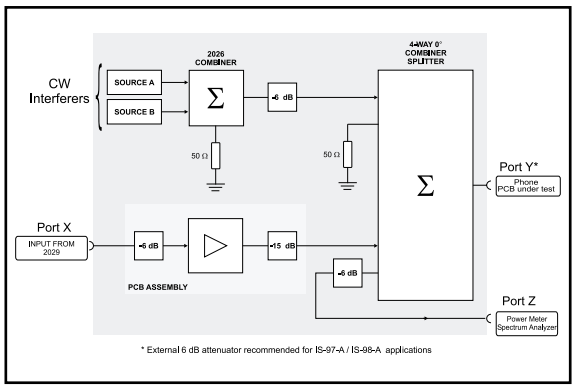

Figure 3 - Adding CW interferers with 2026Q

In addition the 2026Q provides an output which can be connected to a test set receiver, power meter, and (or) a spectrum analyzer to perform measurements on the transmitter output from the phone board under test. The directional combiner in the 2026Q ensures that the CW signals added to the in-channel signal from the 2029 do not overload the spectrum analyzer while they are on. The buffer amplifier on the input from the 2029 ensures that the phone board transmitter does not adversely effect the output of the 2029 by providing reverse isolation.

With the test set up shown the following tests can be performed:

- Full functional test of the receiver (using the test software to recognise the data pattern from the 2029)
- Receiver sensitivity
- Receiver selectivity, intermodulation and blocking (from the signals added by the 2026)
- Receiver received signal strength calibration
- Transmitter functionality and conformance to spectral mask
- Transmitter power calibration

Additional tests, such as power consumption, can be checked with ancillary equipment.

Using the 2029 optional combiner

Alternative test configurations can also be set up which achieve similar objectives. Figure 4 shows an example test set up using the 2029's optional internal combiner and Figure 5 shows the internal architecture of the combiner system.

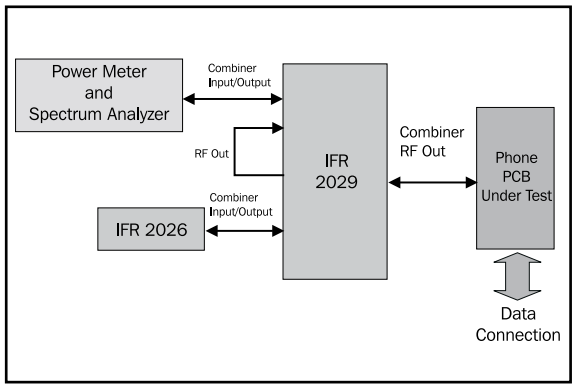

Figure 4 - Using the 2029 optional combiner and 2026 for board level testing

In the test set up shown in Figure 4 Option 1 combiner for 2029 can be used to provide the combining system rather than the 2026Q. A 2026 is used to generate the interfering signals required to do blocking, selectivity or intermodulation tests on the phone board. The 2026 is connected to one of the input/output's of the 2029 combiner. The main RF output from the 2029 is looped back to combiner input. The combined output from 2029 is used to connect to the phone board under test and the third combiner input/output is connected to a power meter and (or) spectrum analyzer.

As with the previous test set-up the directional combiner protects the output of the 2029 from the two interfering signals generated by the 2026. In addition it protects the spectrum analyzer input from the 2026 signals, achieving similar results to the previous set-up.

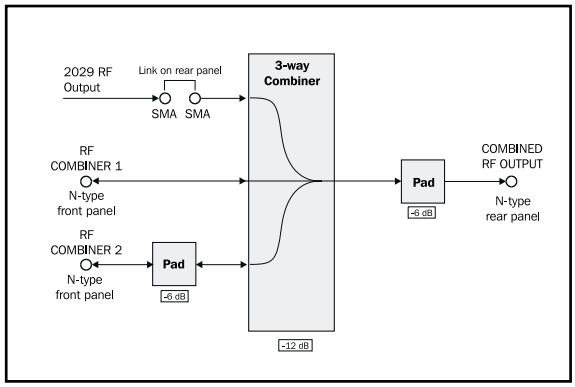

Figure 5 - 2029 Optional Combiner

Changing Standards

The 2029 can support 2G, 2.5G and 3G testing using this type of test set-up. This makes it possible to handle the multi-mode, multi-band phones of the future with the same test configuration, in fact the same test line. The 2029 can quickly switch between IS95 and cdma2000, or GSM and EDGE without incurring loading time for new waveforms in its ARB system. All that changes is that the test system needs to recognise the changed phone standard with its pre-loaded software in the phone board and perform a different set of tests with a new air interface standard running.

Summary

By ensuring that faults are found and calibration processes are performed at an early stage in manufacture, the cost of corrective action can be reduced. The 2029 provides a faster, less expensive, solution than radio test set solutions or vector signal generators. The manufacturing systems can more easily follow the evolving radio standards when they are primarily directed to fault finding and basic calibration processes rather than testing through call processing based solutions.

The 2029 is ready for the world of software radio.

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Part no. 46891-881
Issue 1