Introduction to the CDMA/FM production test system

High throughput automatic test system for production testing of single and dual band CDMA and CDMA/FM (AMPS) handsets

- Automatic testing of CDMA handsets
- Single or dual band capability - tests CDMA and CDMA/FM (AMPS) handsets
- Proven test routines
- Ruggedized for production use
- Can be integrated into a factory management system
- High isolation test enclosure for maximum accuracy
- Variable instrument configuration
- Large, pneumatically operated, RF chamber

INTRODUCTION

The IFR CDMA/FM Production Test System offers a fully automated test capability for CDMA handsets including dual mode and dual band designs. The core test scripts are a well proven set of test procedures, production proved by Qualcomm Inc. and supplied by IFR. under license. The system offers manufacturers a fast start-up capability and a risk free solution.

Supplied by the Systems Group of IFR, the system can be tailored to meet the production requirements of the customer.

SOFTWARE

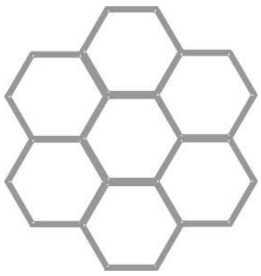
The suite of test software provided with the system is a modular configured system. This uses test core code written by QUALCOMM Inc. and used in the manufacturing of their range of CDMA and dual band mobiles.

"The test scripts are procedures supplied by IFR under license and used by QUALCOMM Incorporated. The system offers manufacturers a fast and proven start-up capability and a risk free solution." says James W Silk QUALCOMM Program Licence Manager.

TECHNOLOGY

CDMA is a cellular transmission standard for cellphones. CDMA uses a spread spectrum technique capable of using the same bandwidth to support many more calls than conventional cellphones. The term CDMA means 'Code Division Multiple Access'.

The way it works is that the signal to and from the phone uses a combination of methods, to use the same bandwidth for many phone calls. The signal is processed with a certain code at the transmitter end, and then the same code is used to pick out the signal at the receiving end. This allows the receiving end to pick out the correct call from the mixture of calls on the air. This works together with geographical separation, and frequency channelization, to distinguish between callers. This is analogous to the way humans can hear an individual conversation in a crowded room.



DUAL BAND MOBILES

Mobiles are introduced which offer both CDMA and FM capability. These can operate using the digital CDMA method or the older FM (analog) standards such as AMPS. The system can test these handsets using a single test program covering dual standards in sequence.

Another similar standard working at 1.9 GHz, instead of CDMA's 800 MHz, is called PCS (Personal Communications System).

STANDARDS

To ensure compatibility between different cellular system, standards have evolved that make sure users can make and receive calls correctly on other conforming systems. These dual mode standards are IS-95 and IS-98 for CDMA (US) and for PCS (US) J-STD 0800/018. Other standards exist for other countries worldwide.

System Description

Figure 1 illustrates the main parts of the system.

The test instruments comprise a CDMA communications tester which is capable of performing a wide variety of tests.

An optional CDMA Interferer/multisource generator (IFR 2026Q), can produce the single, or two-tone, interference signals required for some tests. The RF part of the testing is handled by these two instruments.

The handset under test is powered by a specialized programmable power supply capable of measuring the bursts of DC power typical of mobile phones.

To provide ruggedness the controlling PC is an industrial rack mounted unit and is supplied with a floppy disk and CD drive. The PC is fitted with a lockable panel for security considerations. The keyboard is housed in a lockable pull out drawer.

CDMA/FM Production Test System

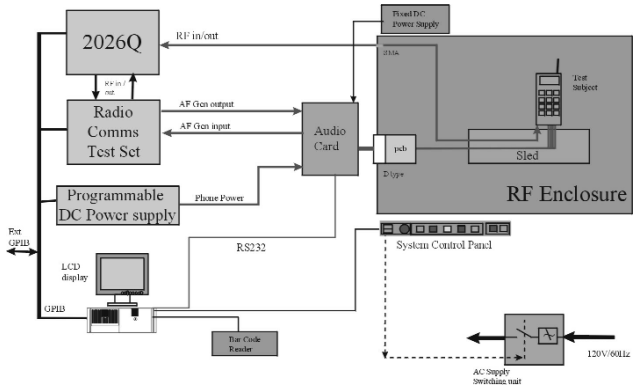


Figure 1 - Block diagram of the test system

The PC works in conjunction with an LCD panel. This has benefits of low power consumption, low electromagnetic radiation and light weight.

The PC is used to control the phone under test by a RS232 link via a card called the 'audio card' in the diagram above. This card also converts the PCM signals from the phone to audio tones for analysis by the communications tester and also routes the external power to the phone.

A custom control panel is fitted to indicate test status and to simplify operator control. The panel may be complemented by an optional 'traffic light' pole so that the system status can be observed from a distance.

The system may be customized to interface with a factory management software system for test result archiving.

The initial screen of the system may be customized to show the logo of the purchasing company. The control of the test program is by keyboard, although a touch screen LCD panel, or a custom keypad could be added as an option.

Variable instrument configuration

A valuable feature of the system is that the radio test set and power supply may be chosen from a selection of software compatible instruments. This allows users to select the optimum instrument for their situation. It also means the user is not tied to a single make system.

Software Architecture

The system software has a modular architecture, and this is shown in the diagram below:

The main element is the test executive which draws together all of the system components. The tester architecture allows for multiple instrument choices for each instrument and calls up the appropriate command from the test functions files. These commands are ouput via the GPIB interface to the instruments as required.

Controlling the test selection are the Test Scripts files, one for each type of phone. These work in conjunction with the Test Limits file to select tests, in which order tests are done and what limits are applied. The test results in turn can be passed out of the system via an Ethernet link to a Factory Management System for archiving and analysis.

The pass or fail result is also indicated on the system control panel by large indicator lights.

RF Enclosure

An RF enclosure is integral to the top of the system. This prevents other systems interfering with the unit under test and vice versa. The interferer could also be a nearly base station or a CDMA phone in normal use. To provide protection against this a metal enclosure surrounds the phone under test.

The door to this chamber is manually controlled via pneumatic actuators from the system front panel. It could also be opened and closed under program control [option].

The chamber itself is a welded construction, with no mechanical fixings through the chamber wall to provide a leakage path. The chamber is lined with broadband RF absorbency material to minimize specular RF reflections.

The door is double edge sealed with RF fingers to prevent radiation, and the channel is lined with yet more RF sealing at the bottom. These extensive precautions allow the chamber to achieve high isolation figures in excess of 90 dB, in the 800-900 and 1700-2000 MHz frequency ranges.

Interior

The enclosure is a large one allowing more than just mobiles to be tested.

Test objects may include car kits or perhaps future WLL (Wireless Local Loop) products. The interior dimensions measure a generous 19 inches deep, by 11 inches wide, by 11.5 inches high, and mean even relatively large test objects can be accommodated.

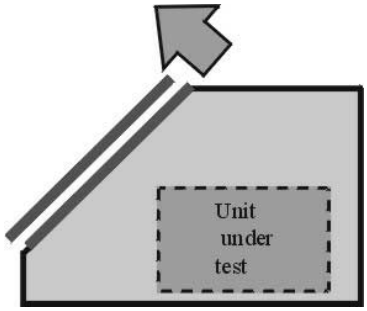
To mount test objects the bottom of the chamber has fixing points. These allow different mounting sleds to be used to locate the test objects. The use of keyhole slots on the sleds permits these to be inserted and removed quickly and without tools.

This allows the same chamber to be used for many different types of mobile, or test object without changing the whole chamber. Normally a special to type sled would be made to secure each design of test object, ensuring cost effective fixturing.

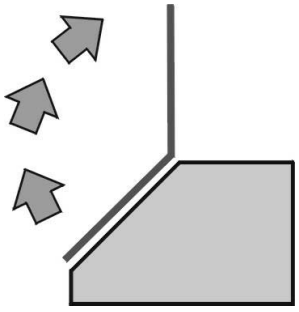
MOBILE CONNECTIONS

The signals to and from the test object are taken out via SMA and a filtered D type connector to minimize chamber leakage.

These allow RF, audio and data connection between the test system and the phone.



Sketch A



Sketch B

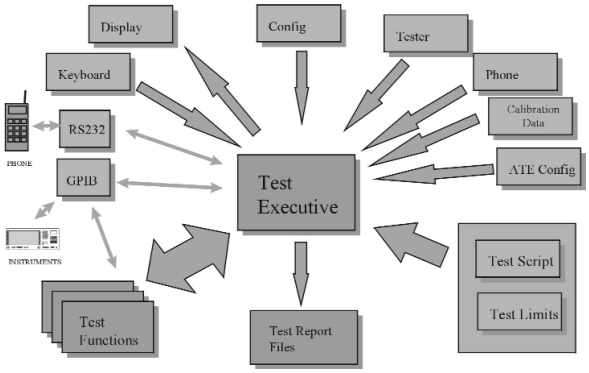


Figure 2 - Simplified Software Block Diagram

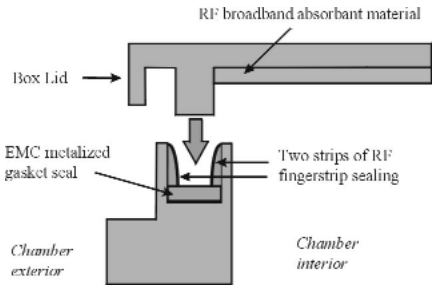
The RF seals around the door are heavy duty for long life, and require a moderate amount of force to open and close the door. To make the task easy for the operator the door is operated and closed by pneumatic pistons. The operator only has to press a large green button on the control panel to open the door, and a second red one to close it.

The mechanics take over after the control panel 'open' button is depressed. A set of pistons moves the door upwards to break the RF sealing strips in a perpendicular motion (A). This ensures the optimum sealing and unsealing action, and avoids the damaging shearing action of a simple hinged mechanism.

Having opened the door seal, a second set of pistons takes over and smoothly and gently opens the door to a vertical position (B). Closure is the reverse action, the door closing again in a controlled manner simply under its own weight.

The pneumatics are controlled by a pneumatic logic circuit which together with a set of position sensors controls the movement of the door. This logic and the mechanical design of the enclosure also fulfil a safety role to keep the operator safe. The safety aspect was a prime consideration in the design of the enclosure.

The following diagram illustrates the careful design of the door seal necessary to achieve the high RF isolation.



Ergonomics

The system is a single rack stand alone test system. The ergonomics are designed to allow an operator to stand at the system and put phones into and out of the RF enclosure. The enclosure door operates by pressing buttons on the system control panel.

Next to the opening a bar code reader allows the scanning of the phone bar code, or the operator name and number. A holster attached to the system means minimum movement, and the reader is always conveniently to hand. The cable is retained mechanically by the system to avoid the common situation of the reader being borrowed by other users.

To operate the test program the user uses the built in keyboard. This item is housed in a lockable retractable drawer in the standard system.

It is envisaged that a single operator will run many test systems at once. To enable this the systems are designed to be aligned side to side to minimize valuable production floor space.

Control Panel

The system control panel permits operators to switch on and off the system AC supply, and also provides an emergency power off switch.

The five indicator lights in the center of the panel show the state the system test has reached, with a series of large differently colored lamps. This is of benefit when one operator is operating several systems at once.

OPTIONS

Custom Configurations

The system is customizable to suit the production methodology. Should the standard system not suit, just ask, and we can tailor a system to your exact production needs.

2026Q Multisource Generator

Supplied when tests requiring two or more RF signals are needed (e.g. intermodulation immunity). The 2026Q contains specialized combining circuits to allow its signal to be mixed with the output of the communications test set without degrading measurement accuracy.

Power Meter assembly

Consisting of:

- Power Meter
- Power Sensor
- Coupler and cabling

This assembly may be used in the checking and maintenance of the test system. The power sensor is located very close to the shield box output.

Traffic light indicator pole

This is a pole with a series of colored rings, which will be illuminated automatically by the tester.

The display is mountable on top of the test system, visible all round from some distance away.

The colours and indicators are the same as the control panel. This option is a supplement to the control panel indicators.

CRT display

This is an option to the LCD panel and may be mounted on a swing arm if required.

Printer

Test results are normally passed directly to the factory management system via the network connector. Where local printout is needed a printer can be supplied.

Power Conditioning unit

To smooth the AC supply and provide a cleaner supply to the system a standalone power conditioner can be supplied. This will improve the system susceptibility to AC supply noise, spikes and minor brownouts.

Doors

A lockable front door may be fitted to the system as an option, either metal or smoked glass. The system is fitted with a hinged rear metal door as standard.

Racking

The standard system is mounted in a low 19-inch racked unit with the shield box and control box on top. An alternative is a tall 19-inch rack assembly if more instruments are required. IFR will be pleased to quote for any custom configuration.

Flexible Instrument Choice

The system as standard comes with a Radio Communications tester and a programmable power supply. There are several alternatives to these instruments, which will work with the test software. These may be more convenient for support in certain parts of the world, or be preferred for other reasons.

Factory Management System

Most large-scale manufacturing environments use a factory management system to archive test results automatically.

The system has a rear panel connection to such a network. The software required to run such a system may be written into the test software to be automatically used in production.

IFR can provide a factory management system with its i-Base product offering.

AC Supply

The system requires an AC supply of 120V/60 Hz as standard, although other AC supply standards of voltage and frequency can be accommodated.

Factory Air

The pneumatics for the system are regulated and filtered by the test system, and only require the addition of a regulated factory airline to operate. The system uses unlubricated air.

Network

Ethernet is the link to the factory management system.

10 MHz Factory Reference

The Radio Communications test set, and the 2026Q can both be operated from internal frequency standards, or may use an external 10 MHz frequency standard.

The system has a rear panel BNC connector to allow a factory frequency standard to be used.

Power Meter

The rack has a reserved location for a power meter, which can be used to supplement the measurement capability of the system, and for performing a system self check. The measurement head of the meter also has a reserved space behind the RF enclosure as close as possible to the object under test. The head is connected into the RF cabling by means of a coupler.

Custom Keyboard

The standard method of controlling the program is via several keys on the keyboard. An option to this would be a touch screen display, or custom keypad.

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This option is often preferable in a production environment.

The keyboard could then be used for maintenance and/or commissioning purposes only.

Support

IFR is a world-wide company with a network of service centers. IFR is currently represented in 80 countries and sells in 120 countries.

The system itself is modular, with most of the major components being line replaceable modules.

IFR can also provide a self test cart, which allows detailed testing of any system with independent instruments. A GPIB connector on the rear panel allows this system to be controlled from the test system.

TEST COVERAGE

CDMA Receiver Tests

Receiver
Sensitivity and Dynamic Range
Sensitivity
Sensitivity at Full Rate
Sensitivity - Maximum
Single Tone Desensitization
Single Tone Desensitization - varying RX level
Single Tone Desensitization - varying Jam Level
Inter-Modulation Spurious Response Attenuation
Inter-Modulation Test Varying RX Level
Inter-Modulation Test Varying Jam Level

CDMA Transmitter Test

Waveform Quality and Frequency Accuracy
Maximum RF Output Power
Minimum Controlled RF Output Power

CDMA Other Test

Receiver Current
Transmit Current
TX Power

FM Receiver Tests

RX Electrical Audio Frequency Response
RX Hum and Noise
RX Audio Distortion
RX SINAD
Adjacent and Alternate Channel Desensitization
Inter-Modulation Spurious Response Attenuation
Adjacent and Alternate Channel Desensitization Single Point
Inter-Modulation Spurious Response Attenuation Single Point

FM Transmitter Tests

TX Frequency Stability
TX Power Level
TX Electrical Audio Frequency Response
TX Mod Limit
TX Hum and Noise
TX Audio Distortion
TX SAT
ST
TX Wideband Data

Specification

The flexibility of the test system allows it to be configured to meet specific customer needs and the specifications listed here are intended only to give a general indication of the capabilities of the system. They are not intended to be a total description of the performance capabilities.
Reference should be made to individual product data sheets for further details of capabilities.

System Components

Instrument suite
Digital Radiocommunication Tester *
Programmable Power Supply *
CDMA Interference Source, IFR2026Q (optional)
RF Power Meter (optional)

General
PC
19-inch rack
Rack Mounted keyboard
System Control Panel
Audio interface card
AC Supply Control Unit, filtered with circuit breaker
Front connector breakout panel
Rear connector breakout panel

* Alternative instruments available

PC Configuration

Minimum Specification
350 MHz Pentium II industrial PC
3.2 GB hard disk
3.5 in floppy disk
CD–ROM
32 M RAM
GPIB interface card
Data I/O relay card
Network card (Ethernet)
Modem [option]

External Connections

AC Supply Inlet
110 V/60 Hz or 240 V/50 Hz, 16A industrial socket

Pneumatic Air Line
5 Bar minimum un-lubricated air,
0.25 inch tubing.
An external cut-off valve is recommended.

Network Connection
Ethernet TCP/IP (RJ45 bulkhead connector on system)

10 MHz Reference input
Frequency reference input,
BNC female on system, TTL signal

GPIB
GPIB extension connector supplied to control external calibration or test equipment.

Control Panel

System control
Power ON/OFF
Emergency Off switch

Indicator lamps
Showing the following states by colored lamps:
Load next phone
Stop
Testing in progress
Pass
Fail

General

Height
1.39 m [54"] : without monitor
1.75 m [69"] : with 15.1"LCD monitor

Width
0.59 m, [23"]

Depth
0.87m, [34.5"] : with keyboard retracted1.07m, [42"] : with keyboard extended

Operating Temperature
5-30°C, 20-25°C recommended

Humidity
90% relative humidity (non-condensing)

IFR, 10200 West York Street, Wichita, Kansas
67215-8999, USA. E-mail: info@ifrsys.com
Tel: +1 316 522 4981 Toll Free USA: 1 800 835 2352 Fax: +1 316 522 1360

IFR, Longacres House, Norton Green Road, Stevenage, Herts
SG1 2BA, United Kingdom. E-mail: info@ifrsys.com
Tel: +44 (0) 1438 742200 Freephone UK: 0800 282 388 Fax: +44 (0) 1438 727601

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