

Protocol Test

6402 Air Interface Monitor/Emulator (AIME) Test System for CDMA Devices

AEROFLEX
A passion for performance.



- CDMA 1x and EV-DO
- Option to upgrade to EV-DO Revision A support
- Further options including Mobile IP and Location-based Services testing
- Detailed logging of forward and reverse link signaling messages and RLP frames.
- CDG Stage 2 interoperability and Signaling Conformance Specification testing
- Power control testing and pilot pollution simulation
- Script driven network emulation
- Easy to use Windows™ user interface
- Suites of automated CDG test cases available for 1X and EV-DO
- Campaign manager to enable a series of tests to be run automatically
- Solution possesses its own protocol stack and is independent of Base Station Manufacturer ASICs
- Applications in development, Interoperability regression testing, and conformance testing
- Protocol analyzer

INTRODUCTION

Since its entry into the testing of CDMA mobiles, Aeroflex has led the way in innovative testing of CDMA mobiles and the company continues to be a market leader in the wireless test industry. From development, through production to installation, Aeroflex is renowned for innovative products, designed for the mobile telecommunications industry.

PRODUCT DESCRIPTION

The CDMA-AIME is a protocol test system for all CDMA mobiles, designed for use in research and development environments or for use in laboratory conformance and inter-operability testing.

The unit acts as a base station emulator, and it provides built in logging of signaling procedures to enable full testing and investigation. In this way the unit provides a cost effective environment to perform testing.

APPLICATIONS

The unit is able to reduce development costs by providing a comprehensive test tool with diagnostics during development. It can also reduce costs by enabling pre-interoperability testing to be run on a fully independent platform.

SYSTEM OVERVIEW

The CDMA-AIME is designed to emulate CDMA base stations. It incorporates a full protocol stack and provides full access to the Layer 3 forward link via the scripting language used. The Layer 2 signaling operates automatically but can be modified by the user to enable Layer 2 testing. All Layer 2 and 3 messages are time stamped and logged for subsequent review. Tests can be run to test mobile performance including fax and data, mobile power control, pilot pollution, authentication and encryption. The number of base stations and complexity of the testing performed is governed by the choice of

hardware platform, three of which are available.

A library of messages specified by IS-95A, -B, ARIB STD-T53 and IS-2000 is provided. (This is a subset of the complete library). Messages may also be modified and new messages can be added.

One of the main applications of the CDMA-AIME system is to perform CDG interoperability (stage 2) tests. A suite of test cases can be provided to enable this testing to be accomplished efficiently.

To enable the system to be used to its greatest potential, it has a Windows™ user interface that runs on a separate PC. There is an activity window to display status messages along with a Layer 2/3 window. A campaign manager is included to allow a series of test cases to be run sequentially.

FULL SYSTEM DETAILS AND DATA

Forward Code Channels

The standard AIME supports transmission of up to 16 Forward Code Channels which can be any combination of:

- Fundamental Code Channels
- Supplemental Code Channels
- Supplemental Channels
- Paging Channels
- Sync Channels
- Pilots

Each one of the 16 Code Channels is fully and independently programmable and the following parameters are configurable by the user:

- Frame rate
- Long Code Mask
- Frame Offset
- Quick paging channels
- Power control sub-channel state (where relevant)

One or more of these channels can be used to provide an Orthogonal Channel Noise Source (OCNS) on an otherwise un-used Walsh code.

FORWARD CDMA CHANNELS

The Forward Code Channels can be combined onto one or two Forward CDMA Channels. The user can program the properties of these Channels independently including:

- PN offset
- Total Channel Output power
- Individual code channel relative powers
- Walsh Code of individual Code Channels
- Propagation delay

In addition to these two Forward CDMA Channels, can also transmit another simplified Forward CDMA Channel that contains just a pilot

and a random (non-OCNS) noise source. This is ideal for generating a repeatable and accurately controllable level of noise for mobile testing where fading is not needed, for example in Pilot Pollution investigations. An EVDO upgrade also offers AWGN as an option.

REVERSE CDMA CHANNEL

The CDMA-AIME supports the reception of one or more Reverse CDMA Channels that can be:

- Access Channel or
- Reverse Traffic Channel consisting of a Fundamental Code Channel and up to 7 Supplemental Code Channels or up to 2 Supplemental Channels.

HANDOFF CAPABILITY

The unit can support 2-way Soft Handoff, on any call type including medium speed data (MDR) calls with up to 7 Supplemental Code Channels.

MULTIPLEX OPTION AND RADIO CONFIGURATION SUPPORT

The system supports Multiplex Options 1 to 16 (Radio Configurations 1 to 5, one Fundamental and up to two Supplemental Channels or one Fundamental and up to 7 Supplemental Code Channels). Primary and Secondary traffic are also supported.

The user specifies the Multiplex Option to be used in the script and this can then be changed dynamically during the call.

In addition, the user can specify the transmission of various error conditions including:

- Corrupted frame quality indicator
- Corrupted frame bits after adding the frame quality indicator
- Corrupted modulation symbols (after block interleaving)

SERVICE OPTION SUPPORT

The unit supports most non-proprietary Service Options. Where data service options utilize application Layers above Air Interface Layer 3, standard commercial off-the-shelf (COTS) software is used where applicable.

Summary of Service Options Supported

Service Option Number	Designated/Type of Service
1	Basic Variable Rate Voice Service (8 kbps)
2	Mobile Station Loop-back (8 kbps)
3	Enhanced Variable Rate Voice Service (8kbps)
4	Asynchronous Data Service (9.6 kbps)
5	Group 3 Facsimile (9.6kbps)
6	Short Message Services (Rate Set 1)
7	Packet Data Service: Internet Protocol Stack only (Rate Set 1)
9	Mobile Station Loop-back (13 kbps)
12	Asynchronous Data Service (14.4 or 9.6 kbps)
13	Group 3 Facsimile (14.4 or 9.6 kbps)
14	Short Message Services (Rate Set 2)
15	Packet Data Service: Internet of ISO Protocol Stack (14.4 kpbs)
18	Over-the-air Parameter Administration (Rate set 1)
19	Over-the-air Parameter Administration (Rate set 2)
22	Medium Speed Packet Data Service: Internet Protocol only (RS1 forward, RS1 reverse)
25	Medium Speed Packet Data Service: Internet Protocol only (RS2 forward, RS2 reverse)
32	TDSO Test Data (RS1, RS2)
33	144 kbps Packet Data
35	Position Location (RS1)
36	Position Location (RS2)
54	IS-2000 Markov (RS1, RS2)
55	IS-2000 Loopback (RS1, RS2)
4100	Service Option 4, revision 1
4101	Service Option 5, revision 1
4103	Service Option 7, revision 1
32,768	High Rate Voice Service (13 kbps)
32,798	Rate Set 1 Markov (8 k)
32,799	Rate Set 2 Markov (13 k)

Other options may be supplied if required.

SYSTEM CONTROL

The CDMA-AIME System uses a COM compatible software interface, therefore the user can use the script interpreter built into the User Interface.

SCRIPT LANGUAGE

The AIME uses an ActiveX scripting engine that allows SAX BASIC (Visual Basic) Script to be used to control the system.

PROCEDURES AND TEST CASES SUPPLIED

The standard system is supplied complete with a number of example-scripted procedures based on CDG Standards. These can be

used directly or the user can incorporate them into other scripts. They can be freely copied and modified subject to licence. These procedures include testing aspects of handoff, SMS, pilot pollution, power control, propagation delay, call setup, concurrent services etc..

A facility is also provided to run a sequence of test cases as a test campaign. The user can vary the length and the content of the test campaign altering the parameters between successive runs to enable comprehensive test campaigns to be created.

CONTROL OF EXTERNAL EQUIPMENT

The CDMA-AIME is capable of controlling additional external equipment (not supplied with the system), via the PC. Such equipment could include Multi-path Fading Simulators (Channel Simulators), or AWGN generators.

Any standard PC interface can be used including GPIB, RS-232, and Ethernet and, as long as standard API interface driver software is available, the external equipment can be controlled from within the script.

PROTOCOL TESTING

Signaling messages are completely controlled by the script. These can be the example scripts provided with the System, the User's own scripts or the optional Conformance Test Cases available with the System.

While the script is running, the system logs all signaling messages, on both Forward and Reverse links on the PC for future review.

The user has full control of the protocols, procedures and timings used via the script. The user can send and receive any signaling messages and parameters in those messages, including incorrect or erroneous messages. The user can also construct new messages not yet in the IS-2000 message catalog.

The timing of messages sent on the Forward Link can be set in 20 ms intervals relative to the reception of messages on the Reverse link, or relative to system time. All logged messages are also time stamped with the time they are sent or received by the IX-AIME/1.

The user can make the signaling procedures as simple or as complex as required for the type of testing to be performed.

All the Message fields and their contents in each

message can be reviewed including the common identification fields where relevant.

The messages can also be filtered to reduce the amount of information displayed. A "find" feature is included.

RETRIEVABLE AND SETTABLE PARAMETERS

The Retrieve Parameters Message, Parameters Response Message and the Set Parameters Message are all fully supported and ID values of up to 65535 may be used to allow manufacturer - specific parameters to be investigated

FAX AND DATA TESTING

The CDMA-AIME allows the user to perform functional tests of Fax and Data calls and data transfer very simply and easily. All the necessary protocols are provided in the software supplied.

FAX TESTING

The necessary protocol stack up to, and including, the T30 protocol (RLP, PPP, TCP/IP, App Interface, T30) is included in the System software. The script has a number of commands to control the Fax procedures.

The Fax data itself is supplied in TIFF format and users can supply their own data or use the three ITU files supplied with the system (T.24 Figures 01, 09 and 10). This method of providing Fax capability allows for many more future enhancement possibilities than the method of using a standard Fax software package.

MOBILE STATION POWER CONTROL TESTING

The CDMA-AIME system provides the user with all the necessary low-level control to perform comprehensive testing of Mobile Power Control.

Normally the system uses automatic Closed Loop Power Control of the Mobile to hold the Mobile power at an optimum level. However, the user also has full manual control of this process via the script.

The system can be configured with one or two fundamental Forward code channels each with independent power control sub-channels. When required, the user has full control of the power control bit puncturing on each code channel on a 20 ms basis.

While the system has not been designed to provide accurate absolute power measurement of the Mobile's transmit power, measurement of the relative power of the Mobile's steps can be performed by the System and absolute power can be measured with other external equipment. This allows most power control scenarios to be simulated and tested

PILOT POLLUTION TESTING

The fine control of the 6304, means the CDMA-AIME is ideal for simulating pilot pollution scenarios for R&D testing of Mobile Handsets.

The output power of the Forward Channels in each code channel can then be varied over a 20 dB range with 0.05 dB resolution with a time resolution down to 20 ms. This allows the user to rapidly vary the relative pilot levels in a completely controlled and repeatable manner.

AUTHENTICATION AND ENCRYPTION TESTING

For CDMA2000 1X, Authentication, Voice Privacy and Message Encryption are all fully supported in the CDMA-AIME.

Authentication can be tested by using known challenge/response pairs in the script, or by the user implementing the required Authentication algorithm in a script. Alternatively the user can simply ignore the Mobile's response in the script.

Encryption can be tested by using a known Public or Private Long Code mask in the script.

LOGGING FACILITIES

SIGNALING MESSAGE LOGGING

All forward and reverse link signaling messages are detected by the test system and passed to the Controller PC for time stamping and logging. These messages are decoded and made available for display at the GUI.

RADIO LINK PROTOCOL LOGGING

RLP signaling messages are logged with other signaling messages. RLP packets can be logged under user control from a test script. Forward and reverse packets are logged separately.

MARKOV DATA LOGGING

Good, Data Error, Rate Error and Erased frames values are displayed and logged for a Markov Data call.

TRAFFIC LOGGING

Layer 1 forward and reverse data payload is logged for future review. Date and time stamp, direction, status, frame type and raw data content are all captured, and forward and reverse data can be filtered as required.

USER INTERFACE

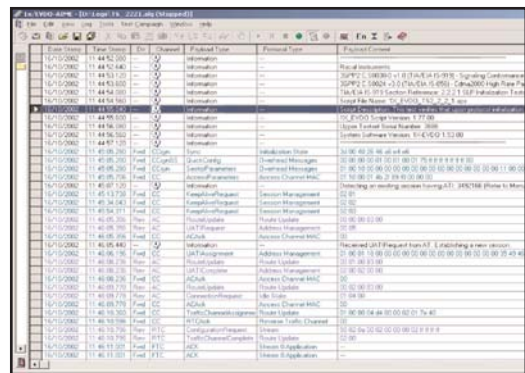
The Windows™ User Interface allows the user to control all aspects of testing. It also provides extra features for use in the post processing of results.

ACTIVITY WINDOW

An Activity window displays various status messages to the user during the running of a Test Script. It can also be used to prompt the user as necessary during testing for example "Please place a call from the Mobile now".

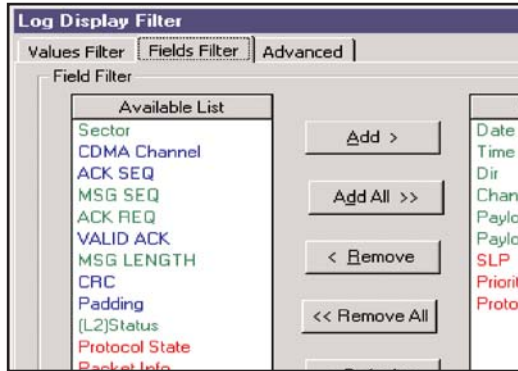
SIGNALING WINDOW

This displays the signaling messages, either in real time during a test run, or for subsequent review from a saved file. When displaying messages in real time during a test run the window can be 'paused' so that an area of interest can be viewed without waiting for the test run to complete.



FILTERING AND SEARCHING

All messages can be 'filtered' so that only those of interest are displayed in the window. In addition the ability to quickly search for a particular message or event in a saved file is also provided.



HARDWARE OPTIONS

6304 Test Platform

The Racal Instruments Wireless Solutions 6304 is a cost effective protocol test platform for CDMA mobiles. It is designed for use in research and development environments or for use in laboratory conformance and inter-operability testing.

The unit acts as a single base station emulator, and provides built-in logging of signalling procedures to enable full testing and investigation.

The system is controlled by a PC to the required specification.

Key features

- Smallest and most inexpensive hardware platform option
- Supports RIWS 1X-AIME software
- Able to support soft handoff
- Applications in development, regression testing, and conformance testing
- Covers frequency band classes 0, 1, 3, and 4

6204 Test Platform

The Racal Instruments Wireless Solutions 6204 CDMA platform is designed to enable testing of CDMA 1X and EV-DO mobiles and access terminals. The system provides an ideal platform to undertake development, conformance, interoperability, and regression testing.



Key features

- Tests cdmaOne (IS-95), CDMA2000 1X, and 1xEV-DO
- Flexible hardware solution provides expandability for more complex testing scenarios
- Dual cell emulation, to include handoff test scenarios

- Wide variety of software options to provide comprehensive set of test facilities
- Covers frequency band classes 0, 1, 3, and 4, with available hardware upgrade to cover band class 6

The basic system consists of the 6204 Dual Rack Assembly containing two 6304s and RF combiner unit as well as all the necessary interconnection cables

The system is connected to the Mobile-under-test via an RF antenna port using a coaxial cable. The RF input to the test system is protected, ensuring that even when interconnection errors are made the system will withstand any overload.

6402 Test Platform

The Racal Instruments Wireless Solutions 6402 CDMA test platform has been developed by Aeroflex and employs a Compact PCI (cPCI) architecture to provide a modular customizable design. This allows it to be configured and scaled for the user's requirements. The unit is also able to provide complete coverage of the data rates used by CDMA2000 up to 3.1 Mbps and it has been designed with sufficient speed capability to ensure that it will be able to handle the higher data rates required in the future.

A PC to the defined specification is also required to control the system. Control of the unit can either be achieved locally using an Ethernet connection, or remotely via a LAN.

The unit is designed to be used with the Aeroflex CDMA software. The CDMA2000 1X software (Option 131) for Releases 0 and A is required as standard. Beyond this, further options can be added to suit the applications for the unit.

The 6402 is available with a single or dual carrier capability. The single carrier option is able to simulate up to three cells on a single carrier frequency enabling soft handoff to be tested. The dual carrier option provides the ability to simulate up to six cells on two carrier frequencies for testing 6-way soft and/or hard handoff.



Key features

- Tests CDMA2000 1X, 1xEV-DO and 1xEV-DV mobile stations
- Flexible hardware solution provides expandability for more complex testing scenarios
- Multi-cell emulation
- Wide variety of software options to provide comprehensive set of test facilities

- Covers all frequency band classes
- Analog IQ interface included as standard

6402 PLATFORM SPECIFICATION

RF GENERATOR

FREQUENCY

Range

869 to 894 MHz
 1840 to 1870 MHz
 1930 to 1990 MHz
 2110 to 2170 MHz

Raster

5 kHz

Resolution

<1 MHz

Accuracy

As frequency standard

OUTPUT LEVEL

Range (RF Duplex Port)

-30 to -110 dBm

Resolution

0.25 dB

ACCURACY

Relative

+0.5 dB/1 dB step

Absolute

+5 dB

SIGNAL QUALITY ρ

> 0.98

CODE CHANNEL POWER ACCURACY

+ 0.1 dB over 20 dB range

PORTS

RF Duplex Port

Connector

N type Female

Impedance / Coupling

50 Ω nom / DC

VSWR

< 1.8:1

Max Reverse power

36 dBm

RF RECEIVER

FREQUENCY

Range

824 to 849 MHz
 1750 to 1780 MHz
 1850 to 1910 MHz
 1920 to 1980 MHz

Raster

5 kHz

Resolution

Can be tuned to any receive channel

Tolerated frequency error

± 300 Hz

INPUT LEVEL

Range (RF Duplex Port)

+36 to -60 dBm

MEASUREMENT ACCURACY (> 45 dBm)

Resolution

0.1 dB

Relative

< ± 1 dB/20 dB

Absolute

< ± 2 dB

FREQUENCY STANDARDS

EXTERNAL REFERENCE INPUT

Connector

SMA female

Frequency

$N \times 1$, $N = 1, 2, 5, 10, 12, 13$ or 15
 $N \times 1.2288$, $N = 1, 2, 3, 4, 6, 8, 9, 12$ or 16

Level

-2 to +19 dBm

Impedance / Coupling

50 Ω nom / AC

REFERENCE OUTPUT

10 MHz (internal standard) or the external reference input frequency

Level

+9 dBm ± 2 dB

Impedance/ Coupling

50 Ω nom / AC

Connector

SMA female

Internal overall stability

For one year ± 0.05 ppm

TIMING MARKERS

Timing signals provided

1.25, 2.5, 5, 20, 26.66 ms, 2 sec and a programmable marker

Accuracy

60 ns

GENERAL

POWER REQUIREMENTS

Voltage range

85-130 V and 180-264 V

Frequency range

47 to 66 Hz

Power consumption

1000 Watts max (excluding PC)

DIMENSIONS AND WEIGHT

Dimensions

(WHD) 562 mm x 526 mm x 420 mm

Weight

60 kg max

OPERATING TEMPERATURE

10°C to 35°C

Humidity

5% to 85% RH (non-condensing)

EMC

Complies with EN61326-1 :1997+A1 : 1998 , Class A (emissions) , EN61326-1 :1997+A1 : 1998 Table 1 (immunity)

Safety

Complies with EN61010-1: 2001

6204 PLATFORM SPECIFICATION

RF GENERATOR

FREQUENCY

Range

832 to 894 MHz
805 to 1870 MHz
930 to 1990 MHz

Raster

30 kHz or 50 kHz

Resolution

<1 Hz

Accuracy

As frequency standard

OUTPUT LEVEL

Range

RF In/Out Mobile Port: -50 to -100 dBm, -50 to -120 dBm (usable)

RF Out port on 6303 may be used for output signal only:-20 to - 80 dBm, -20 to -100 dBm (usable)

Resolution

0.05 dBm

SIGNAL QUALITY ρ

>0.966

ACCURACY

Total Output Power

Relative +1 dB

Absolute +5 dB

Code Channel Power Relative

+0.1 dB

Dynamic Range

20 dB

PORTS

RF IN/OUT MOBILE PORT

Connector

N type Female

Impedance / Coupling

50 Ω nom / DC

VSWR

1.2:1

Max / min Reverse power

10 W RMS

6304 RF OUT PORT

Connector

TNC female

Impedance / Coupling

50 Ω nominal / DC

VSWR

1.2:1

Max / Min Reverse power

1 W RMS

RF RECEIVER

FREQUENCY

Range

824 to 849 MHz, 887 to 925 MHz, 1715 to 1780 MHz, 1850 to 1910 MHz

Tolerated frequency error

\pm 300 Hz (800 MHz band)
 \pm 150 Hz (1700 & 1900 MHz bands)

Raster

30 or 50 kHz

Resolution

Can be tuned to any receive channel

INPUT LEVEL

Range

RF Duplex Port +38 to -40 dBm

MEASUREMENT ACCURACY (+38 to -20 dBm)

Relative

±0.4 dB

Absolute

2.5 dB

FREQUENCY STANDARDS

EXTERNAL REFERENCE INPUT

Connector

BNC female

Frequency

10 MHz

Level

-2 to +19 dBm

Impedance / Coupling

50 Ω nom / AC

REFERENCE OUTPUT

As reference input

Level

+9 dBm

Impedance/ Coupling

50 Ω nom / AC

Connector

BNC female

Output protection

Will withstand a permanent short-circuit

Internal overall stability

For one year ±0.12 ppm

SYNCHRONIZATION PORT

Timing signals provided

20 ms frame clock

26.67 ms clock

80 ms clock

Even second time mark 1.25 ms power control group clock

Signal synchronized to the insertion of bad or deleted frames

Signal synchronized to the start of power control bit sequences

GENERAL

POWER REQUIREMENTS

Voltage range

85-130 V and 180-246 V

Frequency range

45-66 Hz

Power consumption

400 VA MAX (excluding PC)

DIMENSIONS AND WEIGHT

Dimensions (6203 dual rack) (WHD)

600 mm x 700 mm x 600 mm

Weight

60 kg approximately

Operating temperature

23°C + 10°C

CDMA2000® is a registered trademark of the Telecommunications Industry Association (TIA-USA)

cdmaOne™ is a registered trademark of the CDMA Development Group

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Our passion for performance is defined by three attributes represented by these three icons: solution-minded, performance-driven and customer-focused.