6413A Trouble Shooting Guide

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Summary:

This application note is a guide for trouble shooting UMTS Node B issues using the Aeroflex 6413A Base Station Test Set.

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1. INTRODUCTION

1.1 Scope

This document provides a quick and easy reference guide for the Aeroflex Base Station test set. This document complements the existing 6413A manual. A number of areas are covered, such as performing UMTS measurements and tests on a Node B, problem identification and diagnosis, report generation and test automation. Also covered in this application note is a brief overview of UMTS.

For further information not described in this user guide, please refer to the complete 6413A user manual.

1.2 References

Further information can be found in the following documents:

[1.] 6413A User Manual.

[2.] 3GPP specification TS 25.141.

1.3 Glossary

Term	Description
ALCAP	Access Link Control Application Part
AMR	Adaptive Multi Rate
ACLR	Adjacent Channel Leakage Ratio
ATM	Asynchronous Transfer Mode
AAL	ATM Adaptation Layer
BSC	Base Station Controller
BTS	Base Transceiver Station **Note:** This term is used generically for GSM / UMTS base station / Node B
BER	Bit Error Ratio
BLER	Block Error Ratio
BCCH	Broadcast Control Channel
CDMA	Code Division Multiple Access
CCCH / CCH	Common Control Channel
CPICH	Common Pilot Channel
DPCH	Dedicated Physical Channel
DL	Downlink

EDGE	Enhanced Data rates for Global Evolution
EVM	Error Vector Magnitude
FACCH	Fast Associated Control Channel
FP	Framing Protocol
FCCH	Frequency Correction Channel
FDD	Frequency Division Duplex
GPRS	General Packet Radio Service
GSM	Global System for Mobile Communication
HSDPA	High Speed Downlink Packet Access
HSUPA	High Speed Uplink Packet Access
IMA	Inverse Multiplexing over ATM
LED	Light Emitting Diode
MOP	Maximum Output Power
MS	Mobile Station
MSC	Mobile Switching Centre
NBAP	Node B Application Part
OB	Occupied Bandwidth
O&M	Operations and Maintenance
PCDE	Peak Code Domain Error
PSTN	Public Switched Telephone Network
RF	Radio Frequency
RNC	Radio Network Controller
RACH	Random Access Channel
RMC	Reference Measurement Channel
SACCH	Slow Associated Control Channel
TM	Test Model (e.g. TM1 is test model 1)
TDMA	Time Division Multiple Access

TS	Time Slot
TCH	Traffic Channel
TRX	Transmitter Receiver Unit
UTRA	UMTS Terrestrial Radio Access
UTRAN	UMTS Terrestrial Radio Access Network
UMTS	Universal Mobile Telephony System
UL	Uplink
UE	User Equipement
UARFCN	UTRA Absolute Radio Frequency Channel Number

2. AN INTRODUCTION TO UMTS AND THE 6413A

This section provides a basic overview of UMTS technology and the role of the Aeroflex 6413A test set within UMTS.

2.1 UMTS General Overview

Universal Mobile Telephony System (UMTS) is the next evolution from 2nd generation (2G/2.5G) mobile technology GSM/EDGE. Sometimes referred to as 3rd Generation (3G) mobile communications, UMTS is capable of much faster data transfer then GSM. UMTS is a CDMA based technology, which is described in more detail in section 2.2.2, below.

2.2 From GSM to UMTS

From a high level view, GSM and UMTS are two technologies that attempt to achieve the same goal - to provide wireless communications between a network and a remote terminal. However the method in which this is achieved and the capabilities of each system are very different.

In the same manner, performing RF tests on a GSM or UMTS BTS is the same in that we want to make transmitter and receiver RF measurements. However, the air-interface and radio technology is very different; as a result there are some similarities between UMTS and GSM tests, but there are also some fundamental differences.

2.2.1 GSM Channels

In GSM, channels are separated over frequency and time allowing multiple channels in a single frequency band; this is known as Time Divided Multiple Access (TDMA). Each channel is 200KHz wide and is split into 8 timeslots.

Frequency	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**0**	**1**	**2**	**3**	**…**	**0**	**1**	**2**	**3**	**…**
N																		
N + 200KHz																		
N + 400KHz																		

Time (in timeslots) →

Figure 2.2.1-1
Shows the time divisions of a single GSM frequency band.

Figure 2.2.1-1 illustrates three frequencies displayed as rows divided up into timeslots. You can see the timeslots are numbered from 0 to 7 and then repeated. A GSM channel is made up from a timeslot and a frequency. In the illustration you can see timeslot 2 has been highlighted at frequency ‘N+200KHz’ to make up a single GSM channel capable of carrying a full-rate voice call (approximately 14Kbps).

2.2.2 UMTS Channels

In UMTS, channels are separated by frequency and coding allowing multiple channels in a single frequency band; this is known as Code Divided Multiple Access (CDMA). The frequency bands are much wider then those used in GSM, approximately 5MHz.

The following tables describe the UMTS channel operating bands and frequencies.

Note: In tables 2.2.2-3 and 2.2.2-4, below, F_{uplink} and $F_{downlink}$ are the uplink and downlink frequencies respectively (in MHz).

2.2.2.1 UTRA FDD Frequency Bands

Operating Band	UL Frequencies UE transmit, Node B receive	DL Frequencies UE receive, Node B transmit
I	1920 – 1980 MHz	2110 – 2170 MHz
II	1850 – 1910 MHz	1930 – 1990 MHz
III	1710 – 1785 MHz	1805 – 1880 MHz
IV	1710 – 1755 MHz	2110 – 2155 MHz
V	824 – 849 MHz	869 – 894 MHz
VI	830 – 855 MHz	875 – 900 MHz
VIII	880 – 915 MHz	925 – 960 MHz
IX	1750 – 1785 MHz	1845 – 1880 MHz

2.2.2.2 UARFCN Definitions

	UARFCN	Carrier Frequency (MHz)
Uplink	$N_u = 5 * F_{uplink}$	$0.0 \text{ MHz} <= F_{uplink} <= 3276.6 \text{ MHz}$
Downlink	$N_d = 5 * F_{downlink}$	$0.0 \text{ MHz} <= F_{downlink} <= 3276.6 \text{ MHz}$

2.2.2.3 UARFCN Definition (Band II Additional Channels)

	UARFCN	Carrier Frequency (MHz)
Uplink	$N_u = 5 * (F_{uplink} – 1850.1)$	F_{uplink} = 1852.5, 1857.5, 1862.5, 1867.5, 1872.5, 1877.5, 1882.5, 1887.5, 1892.5, 1897.5, 1902.5, 1907.5
Downlink	$N_d = 5 * (F_{downlink} – 1850.1)$	$F_{downlink}$ = 1932.5, 1937.5, 1942.5, 1947.5, 1952.5, 1957.5, 1962.5, 1967.5, 1972.5, 1977.5, 1982.5, 1987.5

2.3 The 6413A Within UMTS

The 6413A is a UMTS Node B test system. It uses a built-in RNC emulator to control a Node B over the Iub interface. Typically, the 6413A directs a Node B to set up a channel on the RF interface and then performs transmitter and receiver tests.

The 6413A is a useful multi-purpose tool for maintaining a high quality and efficient network.

2.3.1 Key Features

The key features of the 6413A are listed below:

- Transmitter, receiver and functional testing
- High performance, high specification RF Parametric measurement capability
- Friendly User Interface

- Automation
- Remote Control

2.3.2 Purpose and Usage

The 6413A can be used to maintain a high quality and efficient network; but what are the risks of a poorly performing Node B within a network? Many issues or deficiencies can occur in a cell and can manifest themselves in many ways that are detrimental to the network users. The following list shows some of the most common problems that can occur from a poorly maintained cell site:

- Calls dropped
- Call setup problems
- Calls of poor quality
- Poor data throughput
- Interference to other users, cells or network operators
- Cell coverage may not matching planned cell coverage
- Time/cost of resolving cell issues

These problems can be fixed, or avoided altogether, by ensuring good cell maintenance and thereby avoiding the risk of customer dissatisfaction resulting in lost revenue. Alternately, a well-maintained network may attract new customers resulting in increased revenue. The 6413A can be used to effectively eliminate this kind of network problems.

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3. A GUIDE TO GETTING THE 6413A OPERATIONAL

This section describes how to setup your 6413A with a Node B so that you are ready to start making transmitter and receiver measurements.

3.1 Initialising the 6413A

When you boot up the 6413A there are two modes of operation:

- **Field User:** In this mode you will have full access to the 6413A Node B test capability. You will be able to load and save files within the 6413A user interface and you will be able to view the debug and status panels. However you are restricted to the 6413A user interface and will not be able to use the 6413A in Windows XPE environment.
- **Admin:** In this mode the 6413A boots up into the Windows XPE environment. Here you can do all the standard Windows XPE functions. You will need to run the 6413A application manually if you want to use the 6413A user interface for Node B test.

3.2 Configure the 6413A

The Aeroflex 6413A can be configured to test a UMTS Node B This can be achieved by setting up the following parameters in the “Global Parameters” screen:

3.2.1 Global Parameters Menu

Parameter	Description
Operating Band	Select the radio band that the Node B supports: • I • II • III See section 2.2.2 for further information on the different operating bands and frequencies.
Manufacturer	Select appropriate the BTS manufacturer.
Model	Select the appropriate BTS model.
Software Version	Select the appropriate BTS software.
Maximum Downlink Power Capability	Maximum Node B downlink power.
Maximum Output Power	Maximum Node B output power.
Line Type	Select the IUB line type (T1/E1, E1 IMA, T1 IMA).
Number of IMA Links	Select the number of IMA links. Only available for line type E1 IMA or T1 IMA.
Uplink External Loss	Loss in the uplink path (For example from to RF connections / cabling or attenuation).
Downlink External Loss	Loss in the downlink path (For example from to RF connections / cabling or attenuation).

There are also some other general parameters to setup in the "Options" menu:

3.2.2 Options Menu

Parameter	Description
Frequency Reference	You can select the internal frequency reference or an external reference.
Spinwheel	Toggle the Spinwheel graphical interface on/off.
Language	Select the language to be used with the 6413A application.
RF Connection Mode	There are two RF connection types: • Duplex: A single RF cable is used to carry uplink and downlink. • RF Out: Two RF cables are used to carry uplink and downlink, one cable for each direction.
Display Contrast	You may select the colour contrast of the 6413A application.

3.2.3 IUB Interface Path Identifier, VCI and VPI Values

Before you can start testing your Node B there are some IUB parameters that are required to enable the 6413A to communicate to the Node B over the IUB interface. Below is a diagram of the IUB interface:

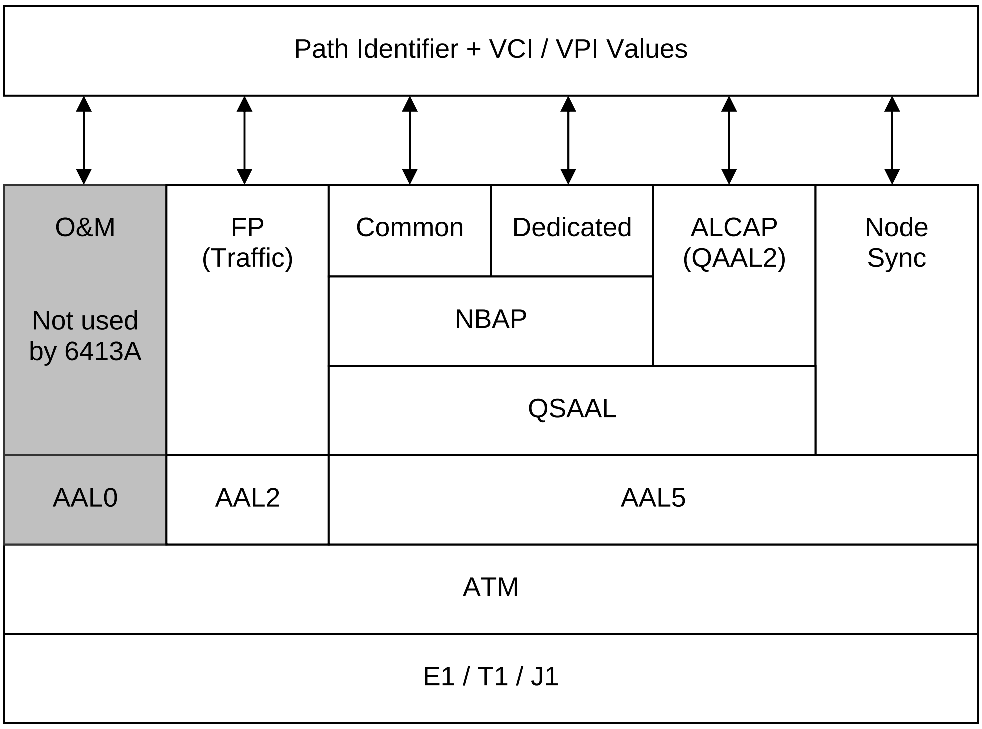

Figure 3.2.3-1
Shows the IUB Interface VC/VP address mapping

Figure 3.2.3-1 shows the protocol stack for the IUB interface. At the lowest level you have the E1, T1 or J1 physical layer and at the top level you have the various higher-level protocols. In order to communicate to a Node B the 6413A needs to know how these protocols are configured within the ATM layers. To do this you need to provide the 6413A with the VCI and VPI values for each protocol. The following protocols are required by the 6413A:

- FP (AAL2 traffic) VCI and VPI.
- NBAP common VCI and VPI.
- NBAP dedicated VCI and VPI.
- ALCAP (QAAL2) VCI and VPI.
- Node Sync VCI and VPI.

Also required:

- Path Identifier.

In general these values can be obtained from the Node B local maintenance terminal (LMT), which is generally PC driven software connected via cable to the Node B. In some cases the LMT exists on the Node B itself.

Note: These parameters are required for the “Configure IUB Interface” test. Before saving your parameters (explained in section 3.2.4) you may wish to enter these values into the test parameters.

3.3 Parameter Files

You can import and export parameter files; this section describes how to do this.

3.3.1 Exporting Parameters

Once you are happy with the configuration of your 6413A parameters you may wish to save the parameters. You can do this by going to the following menu location:

Options → Export Parameters

You will be able to edit and store a parameter file. The default location is:

C:\6413A\Parameters\

3.3.2 Importing Parameters

You can import previously saved parameters from the following menu location:

Options → Import Parameters

You will be able to select a parameter file. The default location is:

C:\6413A\Parameters\

4. A GUIDE TO NODE B RF MEASUREMENT & TEST

This section describes the range of tests that the 6413A can perform along with details of the measurements and key parameters associated with each test.

Note: All tests that the 6413A performs are based on the 3GPP test specification 25.141.

4.1 Generic Test Parameters

This section describes some of the key parameters that are common in most of the tests.

4.1.1 Test Models

Test Model	Description
TM1	Simulates a live network cell
TM2	A simple cell used to measure power dynamics
TM3	Designed to emphasise code domain errors
TM4	A very simple test model to allow frequency measurement

4.1.2 UARFCN / Channel Number

The Channel Number parameter in the 6413A is defined as a UARFCN; see tables 2.2.2-3 to 2.2.2-5 for further information on the UARFCNs.

4.1.3 Test Modes

Test Mode	Description
Single	The 6413A takes a single measurement and then displays the final result.
Continuous	The 6413A continuously takes measurements and updates the results display.
Continuous with Log	The 6413A continuously takes measurements and updates the results display and logs each individual measurement to the results file.

4.2 Functional Tests

The functional tests allow the 6413A to configure, reset and monitor the IUB interface. The IUB interface must be configured before running any of the transmitter or receiver tests.

4.2.1 Configure IUB Interface

Test Description

The 6413A configures the IUB interface and audits the Node B ready for channel configuration and establishment and the chosen radio.

Use the parameters as described in section 3.2.3.

Conformance Limit

N/A

Failure Symptoms

Un-able to configure the Node B IUB interface.

Failure Resolution

This is generally due to a setup error in the VCI/VPI values or connections, but may also be due to faulty equipment. Check the following:

Incorrect Setup:

- IUB connections not physically connected correctly.
- VCI/CPI values incorrectly entered.
- Node B information incorrect (model, software version, freq band).
- Line type (E1, T1, E1 IMA, T1 IMA) incorrect.

Note: Use the IUB status test to check the IUB connection (section 4.2.3).

Node B Failure:

- BTS hardware error (faulty cell).
- BTS software error (faulty cell).

4.2.2 Reset IUB Interface

Test Description

The 6413A resets the IUB interface and the Node B returns to a non-transmitting state. This should be used when you wish to disconnect the RF cables to ensure that the Node B is not transmitting.

Conformance Limit

N/A

Failure Symptoms

N/A

Failure Resolution

N/A

4.2.3 IUB Status

Test Description

This is a diagnostic that shows the current status of the IUB link. When you run this test the following IUB link statuses are displayed (Refer to section 3.2.3):

- Line Type: displays the current line type (E1, T1 or J1).
- IUB Port Statues: displays the status of the 6413A IUB ports.
- IMA in use: If the 6413A is configured to use IMA this will display green.
- IMA Link Status: displays the IMA link status for each port (for IMA mode only).
- NBAP Common: displays status of NBAP common link.
- NBAP Dedicated: displays status of NBAP dedicated link.
- ALCAP: displays status of ALCAP link.
- FP: displays status of the Frame Protocol link (traffic).

Note: The status light colour defined as: Green = OK, Red = Problem.

Conformance Limit

There are no conformance limits for this test, but the following guidelines can be used:

IUB Interface not configured:

- The IUB port status should be GREEN (if an the 6413A is connected to a Node B) for all connected ports. Or For IMA the IMA in use should be GREEN and any IMA ports used should be GREEN.

All other statues should be RED.

IUB Interface configured (and test passed):

- As above the IUB port status should be GREEN.
- NBAP Common: GREEN.
- NBAP Dedicated: GREEN.
- ALCAP: GREEN.

All other statues should be RED.

Test running with at least one DPCH:

- As above the IUB port status should be GREEN.
- NBAP Common: GREEN.
- NBAP Dedicated: GREEN.
- ALCAP: GREEN.
- FP: GREEN.

Failure Symptoms

If there is an issue on the IUB interface you may see of the following symptoms:

- Can’t configure the IUB interface (NBAP Common / Dedicated or ALCAP or problem with the IUB physical link).

- Can’t run tests with one or more DPCH (FP).

Failure Resolution

If one or more of the status lights are RED when they should be GREEN then this indicates that there is a setup issue or fault in the connection. Try the following:

- Check the Path Identifier is correct.
- Check the VCI and VPI values for each of the signalling/traffic links that are RED.
- Check the Line type is correct.
- Check that the correct IUB port is being used.
- Check that the 6413A is connected to the Node B correctly.

4.3 Transmitter Tests

To perform transmitter tests on a Node B the 6413A performs the following steps:

1. Using the Iub interface the 6413A configures the Node B to transmit a signal.
2. The 6413A then captures a sample of the signal on the RF interface.
3. Measurements of the samples are taken.
4. The 6413A then “de-configures” the Node B to stop transmission.
5. The 6413A then displays the measurements on the test results screen.

This 6413A can perform a number of transmitter tests on a Node B; the following sections describe these tests.

4.3.1 Maximum Output Power (MOP)

Test Description

The 6413A configures the Node B to transmit a signal using TM1 at maximum power, and then makes an RF power measurement.

The recorded power measurement is then tested against the manufacturer claimed specification.

The result of this test determines if the BTS can operate at the correct maximum power, as specified by the manufacturer.

Conformance Limit

The measured power level must be within +/- 2.7dB of the manufacturer’s specification.

Failure Symptoms

Node Bs that fail this test may have an incorrect maximum power setting that is either:

- Too low, with a reduced maximum cell size, which could cause gaps in cell coverage resulting in dropped calls at the edges of the cell.
- Too high, causing increased neighbour cell interference resulting in poor call quality at lower power levels (e.g. near the edge of the cell) or even dropped calls.

Failure Resolution

The cause of the failure may be one of the following, and should be tested individually:

- Faulty Power Amplifier.
- Bad RF path from PA.
- Potential base station hardware/software incompatibility.

See section 5 for details on fault finding the transmission path.

4.3.2 CPICH Power Accuracy

Test Description

The 6413A configures the Node B to transmit a signal using TM2 at a given power level, and then makes an RF power measurement.

The recorded power is then tested against the specified power.

The result of this test determines if the BTS can transmit a CPICH at a given power to create cell that is the correct size.

Conformance Limit

The measured power level must be within +/- 2.9dB of the manufacturer's specification.

Failure Symptoms

Node Bs that fail this test may be transmitting CPICH with the incorrect power that is either:

- Too large, causing in increased neighbour cell interference resulting in …
- Too small, causing gaps in the cell at the edges of the cell resulting in dropped calls or registration failure in these areas.

Failure Resolution

The cause of the failure may be one of the following, and should be tested individually:

- Faulty Power Amplifier.
- Bad RF path from PA.
- Potential base station hardware/software incompatibility.

See section 5 for details on fault finding the transmission path.

4.3.3 Frequency Error (FE)

Test Description

The 6413A configures the Node B to transmit a signal using TM4 at a given UARFC and then makes an RF frequency measurement.

The recorded frequency measurement is then tested against the 3GPP specified frequency for the chosen UARFCN.

The result of this test determines if the BTS can operate at the correct frequency, as specified by the 3GPP specifications.

Conformance Limit

The measured frequency level must be within +/- 0.05ppm of the UARFC frequency as per the 3GPP specifications.

Failure Symptoms

Possible network issues as a result of this type of failure:

- Timing drift may occur (chip rate is faster/slower due to frequency error) causing difficulties for mobile to keep synchronisation or register with the Node B.
- The timing error, if severe enough, may cause issues with the backhaul (network side) causing issues with soft handovers.

Failure Resolution

The cause of the failure may be one of the following, and should be tested individually:

- Bad Clock Reference from Network.
- Bad Clock card

- Internal clock active rather than network/E1 clock

See section 5 for details on fault finding the transmission path.

4.3.4 Power Control Steps

Test Description

The 6413A configures the Node B to transmit a signal using TM2 and then changes the power of a single code channel in 1dB steps and takes power measurements for each step.

The recorded power difference in each step is tested for accuracy against the expected 1dB power step change.

Power control is important for network performance because the powers are adjusted in real-time to optimise the signal to noise ratio. Node Bs appear as interference to each other, and so they need to use the lowest power possible that achieves the required communications path.

The result of this test determines if the BTS can control the power level of individual code channels to ensure minimum interference with the neighbouring cells.

Conformance Limit

The measured power level must be within +/- 2.7dB for each code channel as per the 3GPP specifications.

Failure Symptoms

Node Bs that fail this test may have either of the following issues:

- Excess power increases the interference with neighbouring cells, reducing the signal to noise ratio resulting in lower call quality and increased dropped calls.
- Too little power will reduce the signal to noise ratio within the cell on the particular code channel resulting in lower call quality and possibly dropped calls at the edges of the channel/cell range.

Failure Resolution

The cause of the failure may be one of the following, and should be tested individually:

- Could be caused by attenuator relays sticking in the PA or TRX.
- Potential base station hardware/software incompatibility.

See section 5 for details on fault finding the transmission path.

4.3.5 Power Control Dynamic Range (PCDR)

Test Description

The 6413A configures the Node B to transmit a signal using TM2 and then changes the power of a single code channel by 25dB.

The recorded power difference is tested for against the expected 25dB power level change.

Power control is important for network performance because the powers are adjusted in real-time to optimise the signal to noise ratio. Node Bs appear as interference to each other, and so they need to use the lowest power possible that achieves the required communications path.

The result of this test determines if the BTS can control the power level of individual code channels to ensure minimum interference with the neighbouring cells.

Conformance Limit

The minimum dynamic range is 25dB per code channel as per the 3GPP specifications.

Failure Symptoms

Node Bs that fail this test may have either of the following issues:

- Excess power increases the interference with neighbouring cells, reducing the signal to noise ratio resulting in lower call quality and increased dropped calls.
- Too little power will reduce the signal to noise ratio within the cell on the particular code channel resulting in lower call quality and possibly dropped calls at the edges of the channel/cell range.

Failure Resolution

The cause of the failure may be one of the following, and should be tested individually:

- Could be caused by attenuator relays sticking in the PA or TRX.
- Potential base station hardware/software incompatibility.

See section 5 for details on fault finding the transmission path.

4.3.6 Total Power Dynamic Range (TPDR)

Test Description

The 6413A configures the Node B to transmit a signal using TM4 and then changes the power of multiple code channels by 17.7dB.

The recorded power difference is tested against the minimum requirement of 17.7dB.

Power control is important for network performance because the powers are adjusted in real-time to optimise the signal to noise ratio. Node Bs appear as interference to each other, and so they need to use the lowest power possible that achieves the required communications path.

The result of this test determines if the BTS can control the power level of multiple code channels to ensure minimum interference with the neighbouring cells.

Conformance Limit

The minimum total power dynamic range is 17.7dB as per the 3GPP specifications.

Failure Symptoms

Node Bs that fail this test may have either of the following issues:

- Excess power increases the interference with neighbouring cells, reducing the signal to noise ratio resulting in lower call quality and increased dropped calls.
- Too little power will reduce the signal to noise ratio within the cell resulting in lower call quality and possibly dropped calls at the edges of the channel/cell range.

Failure Resolution

The cause of the failure may be one of the following, and should be tested individually:

- Could be caused by attenuator relays sticking in the PA or TRX.
- Potential base station hardware/software incompatibility.

See section 5 for details on fault finding the transmission path.

4.3.7 Occupied Bandwidth (OB)

Test Description

The 6413A configures the Node B to transmit a signal using TM1, and then takes a measurement of the bandwidth that contains 99% of the transmitted energy.

The recorded occupied bandwidth is tested against the 3GPP specification.

The test purpose is to verify that the emission of the BTS does not occupy an excessive bandwidth for the service to be provided and is, therefore, not likely to create interference to other users of the spectrum beyond undue limits.

Conformance Limit

The maximum occupied bandwidth per frequency channel is 5MHz as per the 3GPP specifications.

Failure Symptoms

If the occupied bandwidth exceeds the 5MHz limit then there is potentially leakage into adjacent channels in the nearby geometric area. This causes excess interference and decreased signal to noise ratio in the adjacent channel, resulting in reduced signal/call quality.

Failure Resolution

The cause of the failure may be one of the following, and should be tested individually:

- This could be a fault in the baseband operation before mixing to higher frequencies. Check the baseband output.
- Check for frequency error. If the channel has a large frequency error the other severe issues could be caused.
- This error maybe associated with ACLR (see ACLR TX Test for more information). Perform an ACLR test.
- Poor performing amplifiers and or modulators can add noise to the system check the PA and TRX.
- Potential base station hardware/software incompatibility.

See section 5 for details on fault finding the transmission path.

4.3.8 Adjacent Channel Leakage Ratio (ACLR)

Test Description

The 6413A configures the Node B to transmit a signal using TM1 at maximum power, and then takes measurements of power transmitted in the adjacent channels.

The recorded occupied bandwidth is tested against the 3GPP specification.

The test purpose is to verify that the BTS is not transmitting excessive noise in the neighbouring channels as a result of spectral re-growth or other reasons.

Conformance Limit The conformance limits are 44.2dB and 49.2dB.

Failure Symptoms If the limit is exceeded there is potentially leakage into adjacent channels in the nearby geometric area. This causes excess interference and decreased signal to noise ratio in the adjacent channel, resulting in reduced signal/call quality. This may affect other operators in the same band.

Failure Resolution The cause of the failure may be one of the following, and should be tested individually:

- Poor performing amplifiers and or modulators can add noise to the system check the PA and TRX.
- Potential base station hardware/software incompatibility.

See section 5 for details on fault finding the transmission path.

4.3.9 Error Vector Magnitude (EVM)

Test Description The 6413A configures the Node B to transmit a signal using TM4 at:

- Maximum power -3dB
- Maximum power - 18dB

EVM Measurements are taken at each power level.

The recorded EVMs are tested against the 3GPP specification.

The test purpose is to verify that the BTS EVM is not restricting the cell performance.

Conformance Limit The conformance limit 17.5%, however most UMTS Node Bs are significantly better then this.

Failure Symptoms Poor EVM will affect the modulation signal to noise ratio at the phone and restrict data throughput.

Failure Resolution The cause of the failure may be one of the following, and should be tested individually:

- Check the baseband operation.
- Check the TRX output directly for EVM (by passing the PA and combiner) to verify that the transmission is good.
- Potential base station hardware/software incompatibility.

See section 5 for details on fault finding the transmission path.

4.3.10 Peak Code Domain Error (PCDE)

Test Description

The 6413A configures the Node B to transmit a signal using TM3 and then takes noise and spurious measurements in the code domain.

The recorded noise and spurious measurements are tested against the 3GPP specification.

The test purpose is to verify that the Node Bs RF performance is good within the code domain.

Conformance Limit

The conformance limit is -32dB.

Failure Symptoms

As the Peak Code Domain Error gets larger (-32dB → 0dB) the code noise floor increases this would reduce the sensitivity of the cell, therefore reducing the maximum cell size. In certain bad RF conditions or at cell fringes calls may get dropped.

Failure Resolution

The cause of the failure may be one of the following, and should be tested individually:

- This could be as a result of high EVM, run the EVM test.
- Potential base station hardware/software incompatibility.

See section 5 for details on fault finding the transmission path.

4.3.11 Absolute CPICH Power Accuracy

Test Description

The 6413A configures the Node B to transmit a signal using TM1 by default and then takes a power measurement of the CPICH.

The recorded power is compared to the requested CPICH power and tested against the 3GPP specification.

The test purpose is to verify that the Node Bs CPICH power is accurate.

Conformance Limit

+/- 2.9dB

Failure Symptoms

If the CPICH power is incorrect it can have one of the following effects:

- Too much power can mean that the Node B is causing excess interference in the neighbouring cells. This would increase the signal to noise ration, reducing the sensitivity of the cell (increased dropped calls, reduced call quality and cell size).
- Too little power can mean that the cell is not covering the area that has been allocated to it. The effect of this could be that there are “dark” areas in the cell where mobiles cannot register or call setup with the network.

- Potential base station hardware/software incompatibility.

Failure Resolution

The cause of the failure may be one of the following, and should be tested individually:

- Faulty TRX module.
- Faulty power amplifier.
- Potential base station hardware/software incompatibility.

See section 5 for details on fault finding the transmission path.

4.4 Receiver Tests

To perform receiver tests on a Node B the 6413A performs the following steps:

1. Using the Iub interface the 6413A configures the Node B to set up a cell.
2. It then synchronises to cell on the RF interface.
3. Starts transmitting an uplink signal.
4. Instructs the Node B to set up a radio link.
5. Compares data sent on the RF uplink with received data received on the uplink Iub interface.
6. Finally the 6413A calculates the bit error ratio (BER).
7. The 6413A then “de-configures” the Node B to stop transmission, and display the results on screen.

This 6413A can perform a number of receiver tests on a Node B; the following sections describe these tests.

4.4.1 Reference Sensitivity Level (RSL)

Test Description

The 6413A configures the Node B to receive a signal and then starts to transmit a reference measurement channel (RMC). The default transmit power is –120dBm.

The 6413A then compares the transmitted signal on the RF interface with the received samples on the Iub interface and makes BER calculations.

The recorded BER measurements are tested against the 3GPP specification.

The test purpose is to verify that the Node B can receive and decode signals on the RF interface at a given power level.

Conformance Limit

The conformance limit is 0.001% BER at –120dBm.

Failure Symptoms

- Poorly received signals can lead to a higher level of dropped calls and reduced call quality.
- Call quality is perceived by the base station to be worse than it should be. Soft / hard handovers may occur when they should not. Therefore the cell capacity is reduced and taken up by neighbouring cells - network coverage is not as effective as it should be.

Failure Resolution

The cause of the failure may be one of the following, and should be tested individually:

- The cabling and receiver path including splitter and internal Node B wiring.
- Radio receiver is faulty.

See section 5 for details on fault finding the receiver path.

4.4.2 Dynamic Range (DR)

Test Description

The 6413A configures the Node B to receive a signal and then starts to transmit a reference measurement channel (RMC). The default transmit power is –120dBm.

White noise is also generated providing a higher noise floor and therefore a lower signal to noise ratio.

The 6413A then compares the transmitted signal on the RF interface with the received samples on the Iub interface and makes BER calculations.

The recorded BER measurements are tested against the 3GPP specification.

The test purpose is to verify that the Node B can receive and decode signals on the RF interface with a particular signal to noise ration set by the user.

Conformance Limit

The conformance limit is 0.001% BER at –120dBm.

Failure Symptoms

- Poorly received signals can lead to a higher level of dropped calls and reduced call quality.
- Call quality is perceived by the base station to be worse than it should be. Soft / hard handovers may occur when they should not. Therefore the cell capacity is reduced and taken up by neighbouring cells - network coverage is not as effective as it should be.

Failure Resolution

The cause of the failure may be one of the following, and should be tested individually:

- The cabling and receiver path including splitter and internal Node B wiring.
- Radio receiver is faulty.

See section 5 for details on fault finding the receiver path.

4.4.3 Uplink Wideband Power (UWP)

Test Description

This test measures the accuracy of the Node Bs uplink power measurement, i.e. the ability to measure the signal strength from the mobile station.

The 6413A transmits uplink speech on a traffic channel at a known power level (default is –90dBm). The Node B reports to the 6413A RNC emulator the measured power. The 6413A compares this with it's transmit power.

Conformance Limit

The conformance limit must be within +/- 2.9dB of the real uplink power.

Failure Symptoms

If the Node B is measuring uplink power inaccurately then the Node B may be making incorrect handover decisions such as:

- The calculated power level is too high; the Node B therefore perceives the mobile signal to be stronger then it is and may not handover when it should. This could have the effect of incorrectly increasing the cell size potentially resulting in capacity overload and/or poor quality calls outside the edge of the cell.
- The calculated level is too low; the Node B there perceives the mobile signal to be weaker the it is and may handover when it should not. This would reduce the

capacity/size of the cell, but could overload neighbour cells. An early handover may result in poor call quality or even dropped calls.

Failure Resolution

The cause of the failure may be one of the following, and should be tested individually:

- Check the receiver sensitivity to check that there is RF loss in the receiver path (see Absolute Sensitivity, below).
- Baseband operation and calibration.
- Baseband software.

4.4.4 Absolute Sensitivity (AS)

Test Description

The 6413A configures the Node B to receive a signal and then starts to transmit a reference measurement channel (RMC).

The 6413A then compares the transmitted signal on the RF interface with the received samples on the Iub interface and makes BER calculations. The 6413A then searches for the sensitivity threshold by lowering and increasing its transmitted power until there is just enough power to achieve a BER of 0.001%, this is the absolute sensitivity value.

The recorded absolute sensitivity measurement is then tested against the 3GPP specification.

The test purpose is to verify the performance of the Node Bs receiver.

Conformance Limit

The conformance limit is –120dBm.

Failure Symptoms

A problem with radio receiver path can lead to:

- Call quality is perceived as worse than it should be. Cell handovers may occur when they should not. Therefore network is not as effective as it should be.
- In poor RF conditions the Node B may not be sensitive enough to ensure call quality, in some cases calls may be dropped by the network.

Failure Resolution

The cause of the failure may be one of the following, and should be tested individually:

- Fault in the receiver path, this could include cables/wiring, splitter, TRX or other modules in the receive path.

See section 5 for details on fault finding the receiver path.

4.4.5 RACH Reference Sensitivity (RRS)

Test Description

The 6413A configures the Node B to transmit a basic cell (PCH, BCCH and CCCH). The 6413A then transmits access bursts on the RACH uplink channel and verifies that the base station has received the access burst, as a channel request, on the IUB interface.

This measurement is performed many times and at a user defined power (or reference) level. The default is –120dBm.

The test determines how sensitive the Node B is at detecting access bursts.

Conformance Limit The conformance limit is: 0.99 PD (probability of detection) at –120 dBm.

Failure Symptoms If a Node B is not sensitive to access bursts (has a low probability of detecting an access burst) then there is an increased risk that mobiles trying to access the network will fail. This is especially likely at the edges of the cell or in poor RF conditions. The result is less calls can be activated in the cell and therefore lost revenue.

Failure Resolution The cause of the failure may be one of the following, and should be tested individually:

- A general receiver sensitivity issue. You should also run the absolute sensitivity (AS) test.

See section 5 for details on fault finding the receiver path.

4.4.6 RACH Dynamic Range (RDR)

Test Description The 6413A configures the Node B to transmit a basic cell (PCH, BCCH and CCCH). The 6413A then transmits access bursts on the RACH uplink channel and verifies that the base station has received the access burst, as a channel request, on the IUB interface.

White noise is also generated providing a higher noise floor and therefore a lower signal to noise ratio.

This measurement is performed many times and at a user defined power (or reference) level.

The test determines how sensitive the Node B is at detecting access bursts.

Conformance Limit The conformance limit is: 0.99 PD (probability of detection) at –120 dBm.

Failure Symptoms If a Node B is not sensitive to access bursts (has a low probability of detecting an access burst) then there is an increased risk that mobiles trying to access the network will fail. This is especially likely at the edges of the cell or in poor RF conditions. The result is less calls can be activated in the cell and therefore lost revenue.

Failure Resolution The cause of the failure may be one of the following, and should be tested individually:

- A general receiver sensitivity issue. You should also run the absolute sensitivity (AS) test.

See section 5 for details on fault finding the receiver path.

4.5 Special Functions

This 6413A has some specialised functions that it can perform on a Node B; the following sections describe these functions.

4.5.1 Multi-mode

Test Description Multimode is a transmitter test that allows you to configure any test model on the Node B. The 6413A then configures the Node B to transmit the test model and the 6413A takes multiple transmitter measurements.

Conformance Limit

EVM:	17.5%
FE:	0.05ppm
PCDE:	-33dB
MOP:	+/- 2.7dB
CPICH:	+/- 2.9dB

4.5.2 Spectrum Analyser

Test Description This diagnostic tool allows the 6413A to be used as a spectrum analyser.

Conformance Limit N/A

4.5.3 Code Domain Analyser

Test Description This diagnostic tool allows the 6413A to be used as a code domain analyser. Diagnostics are available for each channel found such as channel type, power, symbol EVM.

Conformance Limit N/A

4.5.4 Diagnostic Test

Test Description The diagnostic test is an interactive test sequence where the 6413A performs the following actions:

- Reset IUB interface
- Configure IUB interface
- Spectrum analysis – asks user if the normal UMTS waveform can be seen

- Transmitter tests (FE, MOP, UWP)
- Receiver tests (RS, AS)

If any particular test fails the 6413A will suggest a list of items to check to do with 6413A and Node B configuration. This can help you troubleshoot your setup.

Conformance Limit N/A

5. FAULT FINDING NODE B TRANSMIT AND RECEIVE PATHS

Once a Node B has been diagnosed as being faulty (e.g. high BER, incorrect power, low receiver sensitivity, phase/frequency error etc…) then we need to identify the cause of the problem. We can use the 6413A to isolate different components of the Node B.

The general principal is change the position that you are attaching the 6413A RF cables to. First of all we will look at how this can be achieved and then we will look at the transmitter and receiver paths in more detail individually.

5.1 Isolating and Testing and Individual Node B Components

The diagram below shows the typical RF components of a theoretical Node B:

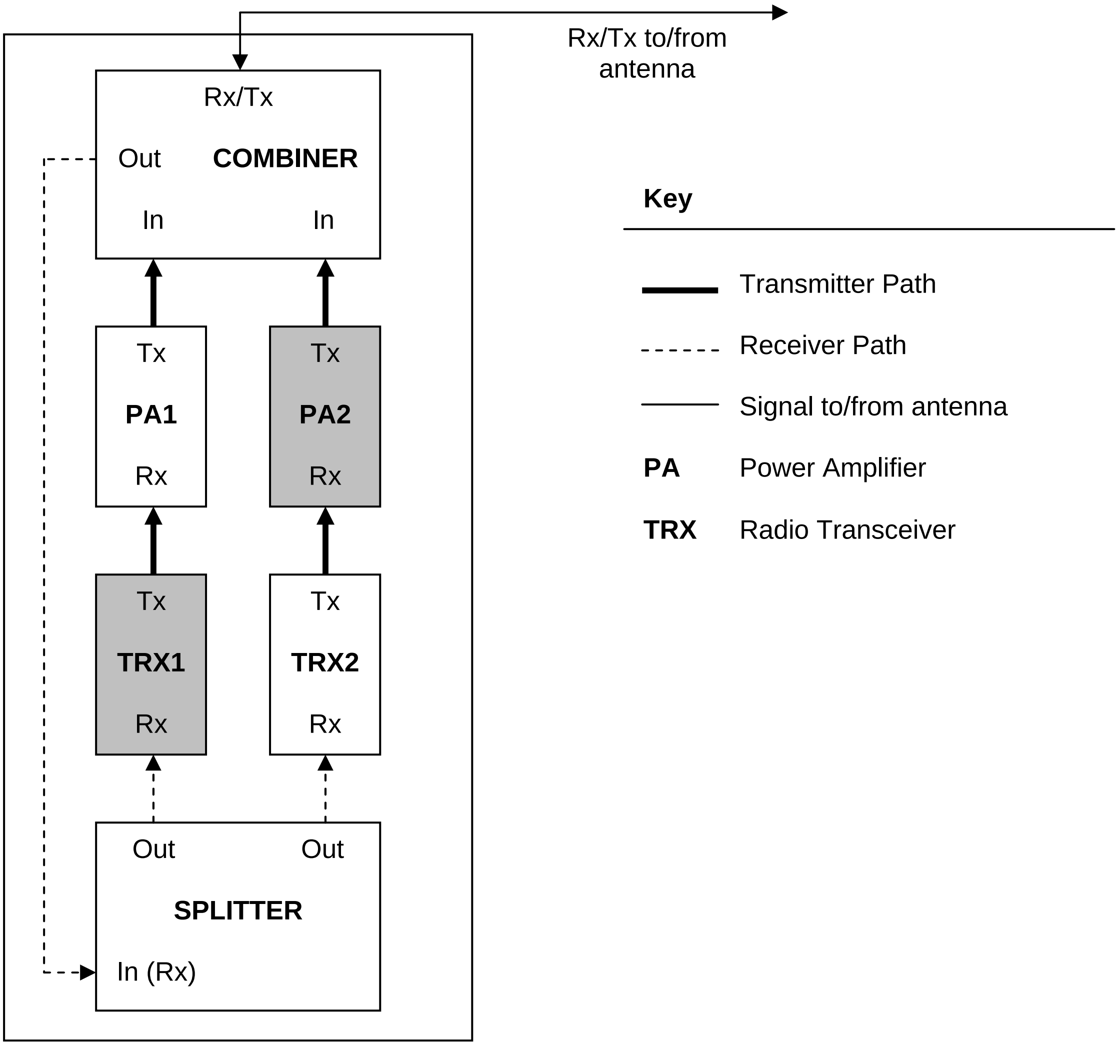

Figure 5.1-1
Shows the transmitter and receiver paths for typical RF components of a theoretical Node B.

Figure 5.1-1 shows a Node B that has two radios that have individual power amplifiers a shared combiner and a shared splitter (**Note:** in some cases the Splitter/Combiner may be within the same hardware unit). This example will be referred to through out chapter 5.

To test the Node B as a whole the 6413A can be connected to the Rx/Tx port of the combiner. When RF measurements are performed from this point every element of the Node B is used to either transmit or receive. Therefore by testing here, if there is a fault in any element of the Node B, we will see the effects in the results of the tests.

Once we have determined that the Node B has a fault we need to isolate and test each component individually. This can be achieved by connecting the RF cables to different points in the Node Bs transmit/receive paths in simplex mode (individual uplink and downlink cabling).

A fault can be either in the receiver path or in the transmitter path. The following chapters explain how we can fault find each of these RF paths.

5.2 Transmitter Path

For this example we are testing radio 2 and we have a fault in PA2 (Power Amplifier for Radio 2). We have completed the general Node B testing for radio 2 and the transmitter power is 4dB low. So now we need to test the transmitter path to see which element has the fault.

The three major elements involved are (in reverse order):

- COMBINER
- PA2
- TRX2

There is also wiring between all of these elements that should be tested, but we will assume that each wire is associated to a particular element.

5.2.1 Isolate and Test the Combiner

Now we can isolate and test each component. We will start by isolating the combiner unit. To do this we need to disconnect the transmitter cable from PA2 and attach the 6413A downlink RF cable directly to PA2 (using simplex cabling).

Now we can run our transmitter tests. However, note that the expected power level may be different to the expected power level at the combiner output. For example there may be a loss of 1dB in the combiner.

The results of the test determine if the Combiner was at fault:

- If the test fails and the 4dB loss is still present, then the fault is NOT in the combiner.
- If the test passes then the combiner (or the cabling connected to it) is the faulty unit and should be repaired or replaced.

In our example the test failed and so the combiner is not faulty.

5.2.2 Isolate and Test Power Amplifier 2

Disconnect the transmitter cable from TRX2 and attach the 6413A downlink RF cable directly to TRX2 (using simplex cabling).

Now we can run our transmitter tests. Again, note that the expected power level may be different to the expected power level at the output of PA2. For example there may be a loss of 1dB in the combiner and a gain of 6dB in PA2.

The results of the test determine if PA2 was at fault:

- If the test fails and the 4dB loss is still present, then the fault is NOT in PA2.

- If the test passes then PA2 (or the cabling connected to it) is the faulty unit and should be repaired or replaced.

In our example the test passed and so PA2 is the faulty unit.

5.2.3 Isolate and Test Radio Transceiver (TRX) 2

Since TRX2 is the last element the results from testing PA2 also conclude if the TRX is faulty:

- If the test fails and the 4dB loss is still present, then the fault is NOT in PA2.
    - Therefore TRX2 is faulty.
- If the test passes then PA2 (or the cabling connected to it) is the faulty unit and should be repaired or replaced.
    - Therefore TRX2 is NOT faulty.

5.3 Receiver Path

For this example we are testing radio 1 and we have a fault in TRX1 (Radio Transceiver 1). We have completed the general Node B testing for radio 1 and the absolute sensitivity is 6 dB below the test threshold and 10 dB below the expected value. So now we need to test the receiver path to see which element has the fault.

The three major elements involved are (in reverse order):

- COMBINER
- SPLITTER
- TRX1

There is also wiring between all of these elements that should be tested, but we will assume that each wire is associated to a particular element.

5.3.1 Isolate and Test the Combiner

Now we can isolate and test each component. We will start by isolating the combiner unit. To do this we need to disconnect the receiver cable from the splitter and attach the 6413A uplink RF cable directly to the splitter (using simplex cabling).

Now we can run our receiver tests.

The results of the test determine if the Combiner was at fault:

- If the test fails and the absolute sensitivity is still around 10 dB lower then the expected, then the fault is NOT in the combiner.
- If the test passes then the combiner (or the cabling connected to it) is the faulty unit and should be repaired or replaced.

In our example the test failed and so the combiner is not faulty.

5.3.2 Isolate and Test the Splitter

Disconnect the receiver cable from TRX1 then attach the 6413A uplink RF cable directly to TRX1 (using simplex cabling).

Now we can run our receiver tests.

The results of the test determine if the splitter was at fault:

- If the test fails and the absolute sensitivity is still around 10 dB lower then the expected, then the fault is NOT in the splitter.
- If the test passes then the splitter (or the cabling connected to it) is the faulty unit and should be repaired or replaced.

In our example the test failed and so the splitter is not faulty.

5.3.3 Isolate and Test TRX1

Since TRX1 is the last element the results from testing the splitter also conclude if the TRX is faulty:

- If the test fails and the absolute sensitivity is still around 10 dB lower then the expected, then the fault is NOT in the splitter.
    - Therefore TRX1 is faulty.
- If the test passes then the splitter (or the cabling connected to it) is the faulty unit and should be repaired or replaced.
    - Therefore TRX1 is NOT faulty.

6. TEST AUTOMATION AND REPORT GENERATION

The 6413A has some easy to use test automation and report generation tools. These can be used to both automate tests and to create a results output file.

6.1 Test Automation

You can create your own automated test scripts using the 6413A test sequence builder. You can also edit or develop a script in the 6413A built-in programming language, Sax Basic (very similar to Visual Basic).

6.1.1 Test Sequence Record Mode

To create a script using the Record Mode is very easy on the 6413A; follow the steps below.

1. Select the Test Sequences menu. You will notice that there is an empty script file starting:

```
Sub Main
End Sub
```

2. Click “Record Mode”. It will change from *off* to *on* and a “Recording Sequence” message will appear in the top right.
3. Now press “Exit”. You will be taken back to the main screen, however you will notice that the “Recording Sequence” message is still displayed in the top right. Any tests that you run now will be recorded in the script.
4. Now add as many tests as you want by repeating the following steps:
    4.1. Choose one of the tests menus (Functional Tests, Receiver Tests, Transmitter Tests, Special Functions).
    4.2. Select the test that you want to add to the sequence.
    4.3. If you want to edit any of the test parameters click the “Edit Test Parameters” option and change any parameters as required.
    4.4. Now select the “Add to Sequence” option. **Note:** this test is now in the sequence.
5. Once you have entered all the tests that you require go back to the “Test Sequences” menu.
6. Now you will see that the script file contains some new variables followed by the list of tests that you selected. Click the “Record Mode” option to stop recording.
7. Now you can run the sequence by selecting “Run Sequence”. However you may wish to save it first, to do this select the “Save Sequence” option.

6.1.2 Developing and Editing Test Sequences in Sax Basic

If you are starting a new sequence or modifying and existing one, you can write the script directly in the 6413A Test Sequences menu. You will see in the window the Sax Basic script; in this window you can start writing your script. In this section there are some hints and tips for programming sequences.

- The easiest way to get started is by recording a script (see 6.1.1). Once you have recorded a script you will have a simple template to work from.
- On line help is available by pressing f1 at any time, if your cursor is on a recognised word then the help will search for this word and provide help on it.
- If you are unsure what parameters to use for a particular test you can just record a script with this test in it and then copy this into your script.
- Use loops (For, While) to cycle through parameters parameter values.

6.2 Report Generation

Your test results are recorded automatically as you run each test but they are not saved. If you want to save a test log, generate a test report or start a new log you can do this in the “Test Results” menu.

6.2.1 View Results Log

The results log is visible in the main screen of the “Test Results” menu. Use the scroll bar to view any results off the page.

6.2.2 Save/Load Results Log

To save the current test results select the “Save” option. This will allow you to save the results on the embedded PC hard drive. You can load your results back at anytime by selecting the “load” option.

6.2.3 Generate Test Report

Once you have your test results up you can generate a test report by clicking the “Test Report” button. This will bring up a formatted document with all of the test results and parameters for each test with a test summary at the front. Use the scroll bar to view the whole of each page. Use the up and down arrows to browse through the pages.

You can save or print the test report using the “Save” and “Print” options. **Note:** you can save the file in HTML, rich-text, PDF or Excel format.

6.2.4 Start a New Results Log

To clear the current results and start a new test log select the “Start New Log” option.

6413A TROUBLE SHOOTING GUIDE

If you are having trouble setting up your 6413A for testing a Node B you may find some useful pointers in this section. If you cannot a suitable solution please contact our support staff at Aeroflex – see front page for details.

6.3 Initialising the 6413A

6.3.1 6413A Fails to Start Correctly

Symptom The 6413A screen is blank.

Solution Check that the power cable is plugged in and that the 6413A has power by looking at the LEDs on the side of the unit.

6.3.2 Cannot Login

Symptom When you type in your username and password into the login screen you see a message that says "you do not have permission to log in"

Solution Make sure that you have entered the correct user name and password. If you still cannot login contact your administrator.

6.4 Configuring the Node B

6.4.1 Iub Configuration Fails

Symptom When you run the Iub Configuration test it fails and you cannot test the BTS.

Solution Make sure that the following values have been entered correctly into the 6413A:

- NBAP Common VCI/VPI
- NBAP Dedicated VCI/VPI
- ALCAP VCI/VPI
- Path Identifier

6.5 Running RF Tests

6.5.1 Receiver Tests Fail

Symptom When you run RF tests they fail because the 6413A cannot setup a channel on the BTS.

Solution

Make sure that the following values have been entered correctly into the 6413A:

- FP (traffic) VCI/VPI

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