8960-PXB HSDPA MIMO Baseband Fading

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Overview

This document provides a procedure for setting up the HSDPA MIMO Baseband Fading system using 8960 and PXB. It is assumed that user should be familiar with PXB and 8960 basic operations and have basic understanding about fading and MIMO. Below are the summary of the sections which cover setting up the system, verifying the instruments and performing the fading tests:

- Equipment and devices required
- System Interconnections
- PXB Setup
- Downlink Signal quality verification (Optional)
- Call establishment verification with UE
- Specific fading profile setup and test
- Sample SCPI scripts for the fading test

Equipment and devices required

Table 1 contains all the equipment and devise required for the 8960-PXB HSPDA MIMO baseband fading tests.

Products	Description	Quantity	Visa Interface	Item No
E5515E	Wireless Communication Test Set	1	GPIB	1
N5106A	PXB Baseband Generator and Channel Emulator	1	Visa controller	2
N5182A	MXG Vector Signal Generator	1	LAN or GPIB	3
N5182A	MXG Vector Signal Generator	1	LAN or GPIB	4
N9020A	MXA Signal Analyzer	1	LAN or GPIB	5
TD_C205	Circulator	1	N/A	6
SHX-GF2-2	RF Splitter/Combiner	1	N/A	7
UE	WCDMA HSDPA MIMO test UE	1	N/A	8

Table 1 Equipment and Devices

NOTE:

- Specific FW versions are required for E5515E and N5106A to perform HSDPA MIMO baseband fading. The E5515E should be running E6785I_I_01_04 or later, and N5106A should install 2.0.0 or later.
- For the two N5182As, please ensure that they are running the same FW versions.
- The MXA is optional for the fading tests; it is used for verifying the downlink signal quality. It should install the N9073A-1FP, N9073A-2FP and N9073A-3FP options.

System Interconnections



Figure 1 8960-PXB HSDPA MIMO Baseband Fading System

Figure 1 shows the system interconnections for the 8960-PXB HSDPA MIMO baseband fading system. 8960 sends the MIMO IQ streams over LVDS to PXB, PXB will deinterleave the two data streams, apply fading and send faded data streams to two MXGs for upconverting to RF signals. The MXA is used to demodulating the RF signal. The UE's main antenna is connected with the RF Circulator which will route the one MXG's downlink signal to UE, and UE's RF uplink to the 8960; UE's second antenna is directly connected with MXG's RF output.

All instruments (PXB, 8960, 2 MXGs and MXA) should be synchronized with 10M reference clock. The typical 10M reference connection is below:

> PXB 10M reference out -> 8960 10M reference in 8960 10M reference out -> MXG 1 10M reference in MXG 1 10M reference out -> MXG 2 10M reference in MXG 2 10M reference out -> MXA 10M reference in

With the typical 10M reference connection above, the "Ext Ref" annunciator will be shown on 8960 and MXG screen display as Figure 2 and Figure 3 below:

	Active Cell Idle		Sys Ty Loggin	ipe: UTRA FDD ig: No Conn
DBUS-TOON	ExtRef	RL		

Figure 2 8960 Ext Ref Annunciator

FREQUENCY	RF OFF	OFFS
2.145 000 000 00 GHz	0.0)5 dBm
R L EXTREF	A	LC OFF

Figure 3 MXG Ext Ref Annunciator

For other 10M reference connection, user should check whether the 10M reference clock is synced at first in the fading tests.

For the instrument control, 8960 should be connected with PXB via GPIB. Two MXGs can connect with PXB with either GPIB or LAN interface. The SCPI connections should also be verified by using the Agilent IO library or other VISA tools.

Instrument	Description	GPIB/LAN	PXB Port	PXB Ext Instrument Name
E5515E	Wireless Communication Test Set	GPIB	B2	MOM-B2
N5182A	MXG Vector Signal Generator	LAN	A1	MXG-A1
N5182A	MXG Vector Signal Generator	LAN	A2	MXG-A2

For simplicity, below are the external instruments configurations used in this document:

Table 2 PXB External Instrument Table

NOTE: It is highly recommended to perform the verification first before fading tests as the whole system is quite complex and very difficult for troubleshooting. If MXA is not used or other instruments is used for verification, the MXA setup should be skipped and user should be responsible to make sure that downlink signal is good for fading.

NOTE: If PXB 10M reference in is connected with external 10M input, user should adjust PXB settings below to ensure the PXB is using the external reference from "System -> Clock and Trigger" menu; If the reference clocked is detected by PXB, the "EXT REF" will be displayed in the PXB status panel.

(Clock And Trigger			
Ð	Master Trigger			
	Trigger Source	Software		
	Trigger Polarity	Positive		
Reference				
	Reference Frequency	10.0000000 MHz		
	Reference Source	Internal 👻		
		External		
	Internal			
	R T L S EXT RE	F TRE ARMED 📈		

Figure 4 PXB External Reference Input Setup

PXB Setup

- Follow the above system interconnection for 10M, LVDS, RF, GPIB and LAN connections.
- > Power up all instruments (PXB, 8960, 2 MXGs and MXA), check the 10M reference.
- Switch 8960 to "W-CDMA" application.
- Setup PXB External instrument table accordingly (clicking the "Add" Button in the "External Instrument Table"). Be certain you know which IO port the instrument is physically connected to. The control interface can report that the instrument is connected even though the data path on the IO board is connected to the wrong instrument.

Block Diagram	External Instrument Table	AUX 10 Summary		
Name	Family	A	ddress	Assigned to IO Port
MXG-A2	M×G	т	CPIP0::ssdbjmxg04::INSTR	A2
MXG-A1	M×G	тс	CPIP0::ssdbjmxg11::INSTR	A1
MOM-B2	8960	GI	PIB3::14::INSTR	В2
	Add	M	odify Remo	ve
	L			

Figure 5 PXB External Instrument Table

NOTE: The MXA is optional to add as an external instrument for PXB.

NOTE: Select the appropriate **IO Port Name** for the 8960 and MXGs based on the physical I/O port connected to the PXB through the LVDS bus. The physical I/O port location map to the **IO Port Name** is indicated below:



Figure 6 PXB I/O Port Number Allocation

Select the PXB "Single-user MIMO (ext in) – 2x2" configuration, and assign external instruments to the specific IO port, and load the configuration. Below is the screen capture after loading the configuration:



Figure 7 PXB "Single-user MIMO (ext in) – 2x2" configuration loaded

Verify the external instrument connection by using the "Test Connection" button from the external instrument panel which is shown after double clicking the external instrument node (MOM-B2, MXG-A1 and MXG-A2):

File System Tools Help					
C New Configuration	🚺 Download Panel 🔋 Calibrate Power 📄 🌗 Play 🔎 Stop 🛛 🔣 Block Diagram				
Settings Browser	Tester (8960) MOM-B2 SCPI Connected; LVDS Connected				
≡ Master Setup 1	Copy Copy Paste Update From Instrument Test Connection				
Fader1 Paths	General Settings				
Fader2 Paths	🗉 Basic				
Fader3 Paths	Application Fast Switch Lab App I, E67851, I.01.04 Format WCDMA				
Fader4 Paths	Cell Band UTRA FDD DL UARFCN				
I/0 1 Port B2 (Input)	RF Channel Number 1540				
170 TPort B2 (input)	RF Channel Frequency 2.113000000 GHz				
I/O 2 Port B2 (Input)	RF Output Power -28.00 dBm				
I/O 3 Port A1 (Output)	ALC On				
	Secondary RF Channel Number 1565				
I/O 4 Port A2 (Output)	Secondary RF Channel Frequency 2.118000000 GHz				
MOM-B2 (Input)	Secondary Cell Power -75.00 dBm				
MXG-A1 (Output)					
MXG-A2 (Output)					
Format					
	Shows current instrument format				

Figure 8 PXB Check instrument connection – MOM-B2

File System Tools Help				
Kew Configuration	Download I	Panel 🕴 Calibrate Power 🛛 💽 Play 🔲 Stop 🛛 📧 Block Diagram		
Settings Browser	👎 Signal Generator (MXG) MXG-A1 SCPI Com	nected; LVDS Connected		
🗏 Master Setup 1	눡 Copy 🛝 Paste Reset Update From Inst	Power Search Test Connection		
Fader1 Paths	General Settings Marker Routing			
Fader2 Paths	1. Basic Settings	<u>^</u>		
Fader3 Paths	Frequency	2.140000000 GHz		
Fordered Databas	Amplitude Amplitude Offect	0.07 dBm 6.00 dB		
Fauer4 Fauris	BE Output Control	On During Play		
I/O 1 Port B2 (Input)	DC Cal Enable	0n		
I/0 2 Port B2 (Input)	Modulation	0n		
I/0 3 Port 41 (Output)	ALC Settings			
no on archi (output)	ALC	Off		
I/O 4 Port A2 (Output)	Attenuator Hold	Off		
MOM-B2 (Input)	Attenuator Level	0 dB		
MVC A1 (Output)	ALC Level	-6.00 dBm		
Mixe-Ar (output)	Power Search Settings			
MXG-A2 (Output)	Power Search Mode	Manual		
	Power Search Reference	Manual 💌		
	Amplitude Offset			
	Amplitude Offset sets a value that is applied to t	he signal generator's displayed amplitude. The amplitude of th		
(j)•	Information, Signal generator 'MXG-A1' is connected via SCPI and LVDS.			

Figure 9 PXB Check instrument connection -MXG-A1

NOTE: The 8960 and two MXGs should be checked to make sure that they are all connected via SCPI and LVDS. If there are errors during the check, it means that there are some connection problems either with SCPI or with LVDS. The connection problem should be resolved before proceeding. Potential causes include LVDS cable, LAN cable, GPIB cables and instrument hardware issue.

To facilitate diagnosing the LVDS connection issues, a few error messages will be generated when there are some errors/exceptions during the coordinating the external instruments and PXB. These errors will pop up in the GUI and also available with the "SYSTEM:ERROR?" query.

Error ID: 107

Diagnose External Instrument Digital Interface Error: Digital cable on I/O port {0} diagnose failed. <Specific failure information>

For <Specific failure information>, some actions may be helpful to recovery:

- MXG
 - Signal Generator Input Setup failure : reset or power cycle MXG/EXG
 - LVDS alignment failure: check LVDS cable, reset or power cycle MXG/EXG
 - DCM Reset failure: check LVDS cable, reset or power cycle MXG/EXG
 - ARM failure: reset or power cycle MXG/EXG
- MOM (E5515E)

• LVDS alignment failure: check LVDS cable, reset or power cycle MOM **NOTE**: When the instruments are moved or cables are replaced, it is highly recommended that user should re-verify the external instrument connection before the fading tests.

- Config PXB faders for MIMO
 - Fader 1 Mode "Pass Through"
 - Fader 2 Mode "Off"
 - Fader 2 Mode "Off"
 - Fader 4 Mode "Pass Through"



Figure 10 PXB Fader Configuration for MIMO channels

File System Tools Help		
📧 New Configuration	🚺 Download P	anel 🛛 Calibrate Power 📄 Play 🔲 Stop 🗍 📧 Block Diagram
Settings Browser	🗔 Signal Generator (MXG) MXG-A2 🛛 SCPI Conn	ected
😑 Master Setup 1	눰 Copy 🕮 Paste Reset Update From Inst	Power Search Test Connection
Fader1 Paths General Settings Marker Routing		
Fader2 Paths	□ 1. Basic Settings	<u></u>
I/O 1 Port B2 (Input)	Frequency Amplitude	2.145000000 GHz -20.00 dBm
1/0 2 Port B2 (Input)	Amplitude Offset	0.00 dB
I/O 3 Port A1 (Output)	RF Output Control	On During Play
in e er er in (earpai)	DC Cal Enable	On
I/0 4 Port A2 (Output)	Modulation	On
MOM-B2 (Input)	ALC Settings	
mem be (mpany	ALC	Off
MXG-A1 (Output)	Attenuator Hold	Off
MXG-A2 (Output)	Attenuator Level	0 dB
	ALC Level	-6.00 dBm
	□ Power Search Settings	
	Power Search Mode	Auto
	Power Search Reference	Manual
Amplitude Amplitude sets the signal generator's RF output amplitude. When Attenuator Hold is on, this setting is also cou		

Config two MXGs for correct RF output power with MXG

Figure 11 MXG RF output power setup



> Play the configuration to see all instruments are setup correctly and functional.

Figure 12 PXB play the configuration

NOTE: If play failure occurs, there may be some hardware related issues with either external instruments or PXB. Please retry after power cycle the external instrument and PXB.

Stop the playing by clicking the "Stop" button.

Downlink Signal quality verification (Optional)

This step is optional but highly recommended. It is used to verify that the downlink signal is good after PXB processing. MXA is used to verify the downlink signal demodulation.

- > Config 8960 in active cell mode:
 - Set **Operating Mode** to Active Cell [CALL:OPER:MODE CALL]
- Play the PXB
- After the play is successful, use MXA to demodulate the downlink RF channel using the EVM measurement.
 - The first check is the spectrum of the two channels, set the MXA center frequency to the MXG output frequency and Span to 10MHz, and measure the channel power



Figure 13 MXA Channel power measure after playing

 \diamond Next measure the EVM using the Mod Accuracy measurement



Figure 14 MXA Demodulation after playing

Stop playing the PXB

NOTE: If the average EVM is quite high (> 3%), it may be caused by the incorrect MXA setup for the input attenuator or bad RF cable.

Call establishment verification with UE

- Config 8960 for HSDPA MIMO in active cell mode.
 - Set **Operating Mode** to Cell Off [call:oper:mode off]
 - Set up MIMO parameters as needed for the required test case. The following GPIB commands provide one example.

[CALL:OPER:MODE OFF] [CALL:PICH:CCOD:CODE 2] [CALL:AICH:CCOD:CODE 3] [CALL:HSSC:CCOD:CODE 2] [CALL:HSSC2:CCOD:CODE 3] [CALL:EHIC:CCOD:CODE 5] [CALL:OCNS:CCOD:CODE:HSDP 6,123,124,125,126,127] [CALL:EAGC:CCOD:CODE 8] [CALL:DPCH:KSPS15:CCOD:CODE:HSDP 14] [CALL:DPCH:KSPS30:CCOD:CODE:HSDP 7] [CALL:HSDP:SERV:PSD:HSPD:CCOD:CODE 1] [CALL:HSDP:SERV:RBT:HSPD:CCOD:CODE 1] [CALL:ANT2:CPIC:SEC:CONF:STAT ON] [CALL:FDDT:ANT2:CPIC:SEC:CONF:STAT ON] [CALL:CPIC:SEC:CCOD:CODE 3] [CALL:CCPC:SEC:CONN:CONF:STAT OFF] [CALL:HSSC3:CONF:STAT OFF] [CALL:HSSC4:CONF:STAT OFF] [CALL:FDDT:HSSC3:CONF:STAT OFF] [CALL:FDDT:HSSC4:CONF:STAT OFF] [CALL:OCNS:CONF:STAT:HSDP ON,OFF,OFF,OFF,OFF,OFF] [CALL:FDDT:OCNS:CONF:STAT:HSDP ON,OFF,OFF,OFF,OFF,OFF] [CALL:OPER:MODE FDDT] [CALL:FDDT:HSPD:CCOD:CODE 1] [CALL:FDDT:CPIC:SLEV:HSDP -15] [CALL:FDDT:CCPC:PRIM:SLEV:HSDP -15] [CALL:FDDT:PICH:SLEV:HSDP -20] [CALL:FDDT:DPCH:SLEV:HSDP -15] [CALL:FDDT:HSPD:SLEV -2] [CALL:FDDT:HSSC:SLEV -10] [CALL:FDDT:HSSC2:STAT OFF] [CALL:FDDT:ANT2:CPIC:SLEV:HSDP -15] [CALL:FDDT:ANT2:CPIC:SEC:SLEV:HSDP -15] [CALL:FDDT:CPIC:SLEV:HSPA -15] [CALL:FDDT:CCPC:PRIM:SLEV:HSPA -15] [CALL:FDDT:PICH:SLEV:HSPA -20]

[CALL:FDDT:DPCH:SLEV:HSPA -15] [CALL:FDDT:EAGC:SLEV -20] [CALL:FDDT:EHIC:SLEV -20] [CALL:FDDT:ERGC:SLEV -20] [CALL:FDDT:HSPD:SLEV:HSPA -2] [CALL:FDDT:HSSC:SLEV:HSPA -12] [CALL:FDDT:HSSC2:SLEV:HSPA -12] [CALL:FDDT:ANT2:CPIC:SLEV:HSPA -15] [CALL:FDDT:ANT2:CPIC:SEC:SLEV:HSPA -15] [CALL:OPER:MODE CALL] [CALL:CONN:CPIC:SLEV:HSDP -15] [CALL:CONN:CCPC:PRIM:SLEV:HSDP -15] [CALL:CONN:PICH:SLEV:HSDP -20 [CALL:CONN:DPCH:SLEV:HSDP -15 [CALL:CONN:HSPD:SLEV -2] [CALL:CONN:HSSC:SLEV -10] [CALL:CONN:HSSC2:STAT OFF] [CALL:ANT2:CONN:CPIC:SLEV:HSDP -15] [CALL:ANT2:CONN:CPIC:SEC:SLEV:HSDP -15] [CALL:CONN:CPIC:SLEV:HSPA -15] [CALL:CONN:CCPC:PRIM:SLEV:HSPA -15] [CALL:CONN:PICH:SLEV:HSPA -20] [CALL:CONN:DPCH:SLEV:HSPA -15] [CALL:CONN:EAGC:SLEV -20] [CALL:CONN:EHIC:SLEV -20] [CALL:CONN:ERGC:SLEV -20] [CALL:CONN:HSPD:SLEV:HSPA -2] [CALL:CONN:HSSC:SLEV:HSPA -12] [CALL:CONN:HSSC2:SLEV:HSPA -12] [CALL:ANT2:CONN:CPIC:SLEV:HSPA -15] [CALL:ANT2:CONN:CPIC:SEC:SLEV:HSPA -15] [CALL:OPER:MODE FDDT] [CALL:SERV:RBT:RAB HSDP12] [CALL:FDDT:HSDS:CONF FRC] [CALL:FDDT:FRC:TYPE HSET9] [CALL:FDDT:HSDS:MIMO:TBL:COUN 2] [CALL:OPER:MODE OFF] [CALL:SRB:CCH:DED:DRAT BPS2200] [CALL:OPER:MODE CALL] [CALL:CELL:RLC:REES OFF] [CALL:CELL:POW -30] [CALL:ANT2:PIL:CONF SCP]

[CALL:HSDP:MIMO:CPIC:SEC:POFF:SIGN:STAT ON] [CALL:SERV:RBT:RAB HSDP12] [CALL:HSDP:SERV:RBT:HSDS:CONF UDEF] [CALL:HSDP:SERV:RBT:UDEF:HSDS:MAC EHSP] [CALL:HSDP:SERV:RBT:UDEF:MIMO ON] [CALL:HSDP:SERV:RBT:UDEF:QAM64:STAT OFF] [CALL:HSDP:SERV:RBT:UDEF:QAM64:STAT OFF] [CALL:HSDP:SERV:RBT:UDEF:HSPD:COUN 2] [CALL:HSDP:SERV:RBT:UDEF:HSPD:COUN 15] [CALL:HSDP:SERV:RBT:UDEF:TBS:IND 30] [CALL:HSDP:SERV:RBT:UDEF:MOD QAM16] [CALL:HSDP:SERV:RBT:UDEF:SDST:TBS:IND 30] [CALL:HSDP:SERV:RBT:UDEF:SDST:MOD QAM16]

- Play the PXB
- Configure UE
- Switch on UE
- Wait for UE to register
- Call establishment with UE
 - Originate a Call[call:orig]
 - Wait till the call status changing to 'Connected'
- > HSDPA MIMO BLER measurement to verify the throughput
 - Now we are able to start any MIMO-HSDPA test required. For example, We can use the real-time results to check the Acks, Nacks and throughput, or the HSDPA MIMO BLER measurement (Meas Selection → HBLER) to look the BLER and

throughput result over a	specific number	of blocks as s	shown in Figure
--------------------------	-----------------	----------------	-----------------

	MIMO Block Error Ratio				
	Total Prim Stream Sec Stream				
	Block Error Ratio:	0.00 %	0.00 %	0.00 %	
	Throughput (kbps):	42192.00	21096.00	21096.00	
	ACKs:	1000	500	500	
	NACKs:	0	0	0	
	statDTXs:	0	0	0	
	Blocks Tested:	1000	500	500	
Median CQI (Single Stream/Dual Prim/Dual Sec): /8 /8					
	1000 /1000			Singl	Le

Figure 15 Typical HBLER DC-HSDPA Measurement Results without fading

NOTE: As no fading and AWGN is added, the BLER for both Primary Stream and Secondary Stream should be 0 and the throughput should be the maximum accordingly to the setup if UE can support. The power levels of the two MXGs will also affect the throughput and stability of the tests.

Stop playing the PXB

Specific fading profile setup and test

If all above steps are all performed successfully, it means all the cables are good and all instruments (PXB, 8960, MXG and UE) are functional. So we go ahead with the specific fading tests.

The MIMO performance of the High Speed Physical Downlink Shared Channel (HS-DSCH) in multi-path fading environments is determined by the information bit throughput R. In 3GPP TS 34.121-1 V9.6.0 section 9.2.4A/B, the minimum requirements are defined and the method of test is described. The following definitions are helpful to better understand their use with PXB.

- **I**_{oc} The power spectral density (integrated in a noise bandwidth equal to the chip rate and normalized to the chip rate) of a band-limited white noise source (simulating interference from cells which are not defined in a test procedure) as measured at the UE antenna connector.
- $\mathbf{I_{or}}$ The total transmit power spectral density (integrated in a bandwidth of $(1+\alpha) \times$ (chip rate) and normalized to the chip rate) of the downlink signal at the Node B antenna connector. For MIMO, $\mathbf{I_{or}}$ is defined for each of the antennas individually and is assumed to be equal for both antennas unless explicitly stated otherwise.
- $\hat{\mathbf{l}}_{or}$ The received power spectral density (integrated in a bandwidth of $(1+\alpha) \times$ (chip rate) and normalized to the chip rate) of the downlink signal as measured at the UE antenna connector. For MIMO, $\hat{\mathbf{l}}_{or}$ is defined for each of the antennas individually and is assumed to be equal for both antennas unless explicitly stated otherwise.

In the H-Set 9 test, the following three points should be applied to correctly correspond to the test specification.

- The downlink signal measured at the UE input should be $\hat{\mathbf{I}}_{or}$ other than $\mathbf{I}_{or 0}$.
- The integration BW for $\hat{\mathbf{I}}_{or}$ is 3.84*(1+0.22) = 4.6848 MHz. (For \mathbf{I}_{oc} it is 3.84MHz.)
- PXB's SNR setting should be directly interpreted as the **Î**_{or} to **I**_{oc} ratio, which is normalized at the chip rate.

The PXB can add AWGN through **Signal Power**, **Noise Power**, and **SNR**. Two of these settings can be specified and the other is then calculated by PXB based on the choice of **Optimization Mode**. For example, if you select the **Optimization Mode** as **PXB Calculates Signal Power**, you can then set the **Noise Power** and **SNR**, leaving the **Signal Power** to be calculated by PXB.

Due to the fact that the two RF antenna paths are different, calibration is required before setting the **Signal Power** and **Noise Power**. After calibration, the UE should receive at its antennas the power specified on the 8960. The path loss can be compensated using the MXG output power setting.

To do downlink RF path calibration, bypass the fader in the PXB, and send an unfaded signal to the MXGs. Finally, use a spectrum analyzer or VSA to measure the channel power of each MXG output at the UE's Rx antenna port connector. Tune the MXGs' power to carefully match the 8960's antenna 1 and antenna 2 Tx power results.

The Îor to loc ratio defined in the 3GPP test standard can then be set using the two antennas' **SNR**. All the signal power and noise spectral density can be set using the **I/O 3 Port A2 (Output)** -> **AWGN** and **I/O 4 Port A2 (Output)** -> **AWGN** settings. In these AWGN setting tables, you can set the **AWGN Power** and **Signal Power** directly based on the test requirements.

For the downlink path loss is the difference between MXG's output amplitude and VSA measured value, and could be compensated by adjusting the MXG's amplitude:

10.00	55 Signal Generator (MXG) MXG-A1 SCPI Connected			
	Copy 🕮 Paste Reset Update From Inst Powe	ar Search Test Connection		
G	eneral Settings Marker Routing			
[∃ 1. Basic Settings	<u>^</u>		
	Frequency	2.140000000 GHz		
	Amplitude	5.00 dBm		
	Amplitude Offset	-9.96 dB		
	RF Output Control	On During Play		
	DC Cal Enable	0n		
	Modulation	On		
E	□ ALC Settings			
6	ALC Settings			

Figure 16 RF path loss compensate - downlink

For the uplink path loss, it could be compensated by setting the 8960 amplitude offset table which is accessible by pressing System Config Button \rightarrow RF In/Out Amptd Offset \rightarrow RF In/Out Amptd Offset Setup:

- The "RF Amptd Offset" should be set to "On" to enable the amplitude offset
- The "Frequency X"/ "Offset X" pair indicates the amplitude offset value at the specified frequency

System Config Screen											
RF IN/OUT	RF IN/OUT Amplitude Offset								Utilities		
RF Amptd Offset		RF IN/OUT Amplitude Offset State: On									
On	Num	Frea	Offset	Num	Frea	Num	Frea	Offset	l Nessage Log		
	1	800.20	3.00	21	Off	Off	41	Off	Off		
	2	Off	Off	22	Off	Off	42	Off	Off		
RF_IN/OUT_Amptd	3	Off	Off	23	Off	Off	43	Off	Off		
Offset Setup _V	4	Off	Off	24	Off	Off	44	Off	Off		
	5	Off	Off	25	Off	Off	45	Off	Off		
RF IN/OUT Offset	07	UTT	Uff	20	Utt	Uff 044	40	044	Utt		
1	8	011	011	27	011	011 0ff	47 68	011	011 Off		
Setup	RF		Ampli	tude	Offset	: Setup		Val	IP		
Frequency 1	DE Ind	/Out Oppli	tudo Of	feat C	tato			00			
800.200 MHz	nr 111/		uue oi	ISELO	late					License Status	
	Frequency 1							800.200	Detail		
	Offset 1							3.00	dB		
Uffset 1	Frequency 2							Off		liser Calibration	
3.00 dB	Offse	t 2						Off		Summary	
	Frequency 3							Off			
Close	Offset	t 3						Off			
Henu	Frequency 4							0ff 🕴			
		Background Active Cell						Type: U	rra fdd		
	Idle I						Log	ging: No	Conn	ĺ	
		DBUS-TO	ON	Exti	Ref Offs	set T				1 of 2	

Figure 17 RF path loss compensate - uplink

Below are detail steps for performing the MIMO fading tests:

- Config 8960 for HSDPA MIMO in active cell mode. Refer to details in "Call establishment verification with UE".
- Config PXB fading channel mode and fader path.
 - Select Master Setup $1 \rightarrow MIMO$ Settings \rightarrow Channel Model \rightarrow HSPA \rightarrow Base Station \rightarrow Case $1 \rightarrow 3$ kph Bands I,II,III,IV and IX
 - Select Master Setup 1 → Fader 1 Mode → Pass Through
 - Select Master Setup 1 → Fader 2 Mode → Off
 - Select Master Setup 1 → Fader 3 Mode → Off
 - Select Master Setup 1 → Fader 4 Mode → Pass Through

NOTE: For the Fader Mode, Fader 1 and Fader 4 should be set to "Pass Through", Fader 2 and Fader 3 should be set to "Off". This is to make sure that call establishment is not affected by the fading.



Figure 18 PXB Fading Channel Model

File System Tools Help												
📧 New Configuration		🚺 Download F	⊃an	el Calib	ora	te Power	📘 🛯 Play	🔳 Stop	📧 Block Diagram			
Settings Browser	T Fading: Fader 1 Paths											
🗉 Master Setup 1	Restore Default Settings 🕰 Copy 🙈 Paste Columns Channel Bandwidth: 160 MHz											
Fader1 Paths	Path	Enabled	Fading Type		Spectral Shape	Э	Delay Type		Delay	Loss	Vehicle Speed	Doppler Frequency
Fader2 Paths	▶ 1	Z		*		~		~				5.874 Hz
Fader3 Paths	2			*		~		~				5.874 Hz
Forder 4 Daths	3			*		~		~				5.874 Hz 📑
Fader4 Paths	4			*		~		~				5.874 Hz
I/0 1 Port B2 (Input)	5			*		~		~				5.874 Hz
I/O 2 Port B2 (Input)	6			*		~		~				5.874 Hz
L/O 3 Port A1 (Output)	7			*		~		~				5.874 Hz
n o s Foit AT (output)	8			~		~		~				5.874 Hz
I/O 4 Port A2 (Output)	9			~		~		~				5.874 Hz
MOM-B2 (Input)	10			*		~		~				5.874 Hz
MXC A1 (Output)	11			*		~		~				5.874 Hz
MAG-AT (Output)	12			~		~		~				5.874 Hz
MXG-A2 (Output)	13			*		~		~				5.874 Hz
	<	_			m							2
	Enabled The state f	or a specifi	c path. On	ly e	nabled paths w	rill c	ontribute	to	the chann	el.		

Figure 19 PXB Fading Path Settings

NOTE: For the Fader Mode, Fader 1 and Fader 4 should be set to "Pass Through", Fader 2 and Fader 3 should be set to "Off". This is to make sure that call establishment is not affected by the fading.

- Config PXB AWGN settings for the output IO port if AWGN is required.
 - Select I/O 3 Port A1 (Output) → AWGN Settings
 - AWGN Enabled: On
 - Output MUX: Signal
 - AWGN Integration Bandwidth: 5MHz
 - Flat Noise Bandwidth: 5MHz
 - Select I/O 4 Port A2 (Output) → AWGN Settings
 - AWGN Enabled: On
 - Output MUX: Signal
 - AWGN Integration Bandwidth: 5MHz
 - Flat Noise Bandwidth: 5MHz

File System Tools Help									
📧 New Configuration	🔽 Download F	Panel 🕴 Calibrate Power 🛛 💽 Play 🔲 Stop 🗍 🔣 Block Diagram							
Settings Browser	all I/0 3 Port A1(Output)								
🖻 Master Setup 1	Restore Default Settings 🛛 🕰 Copy 🛝 Paste								
Fader1 Paths	General Settings AWGN Settings Power Meter Settings Marker Selection AWGN Graphics								
Fader2 Paths	□ 1. AWGN								
Fader3 Paths	AWGN Enabled	On 💌							
Federal Dation	Output MUX	Signal Only							
Fader4 Paths	Crest Factor	12.88 dB							
I/0 1 Port B2 (Input)	Flat Noise Bandwidth	5.000000 MHz							
L/0.2 Port B2 (Input)	Units	SNR							
170 21 ort 62 (mput)	Optimization	PXB Calculates Noise Power							
I/O 3 Port A1 (Output)	Noise Power Optimization	PXB Calculates Noise Power in Channel							
1/0 4 Port A2 (Output)	2. Signal Power								
,	Total Power	-9.91 dBm							
MOM-B2 (Input)	Total Noise Power	-27.03 dBm							
MXG-A1 (Output)	Total Signal Power	-10.00 dBm							
	Total Signal to Noise Ratio	18.00 dBm							
MXG-A2 (Output)	Total Noise Power In Channel	-28.00 dBm							
	AWGN Enabled								
	AWGN Enabled activates the additive white Gau	issian noise (AWGN) function. Disabling the AWGN allows fo							

Figure 20 PXB Output AWGN Settings

NOTE: The AWGN enable should be set to "On" and Output MUX set to "Signal Only" if AWGN tests are needed after call processing.

- Play the PXB
- Configure UE
- Switch on UE
- Wait for UE to register
- Call establishment with UE
 - Originate a Call[call:orig]
 - Wait till the call status changing to 'Connected'

- Add PXB fading and AWGN
 - For adding fading, switch the fader mode from "Pass Through" to "On"
 - ◆ Set Master Setup 1 → Fader 1 Mode → On
 - ◆ Set Master Setup 1 → Fader 2 Mode → On
 - ◆ Set Master Setup 1 → Fader 3 Mode → On
 - ◆ Set Master Setup 1 → Fader 4 Mode → On



Figure 21 PXB Fading Mode "On"

For adding AWGN, switch the AWGN Output MUX from "Signal Only" to "Signal + Noise"

File System Tools Help	_								
New Configuration	T Downloa	ad Panel 🛛 Calibrate Power 📄 🗈 Play 📕 Stop 🗍 🔣 Block Diagram							
Settings Browser	🔤 I/0 3 Port A1(Output)								
😑 Master Setup 1	Restore Default Settings 🛛 🖾 Copy 🕮 Paste								
Fader1 Paths	General Settings AWGN Settings Power Met	er Settings Marker Selection AWGN Graphics							
Fader2 Paths	□ 1. AWGN								
Fader3 Paths	AWGN Enabled	On							
Fadard Datio	Output MUX	Signal Only 👻							
Fauer4 Fauris	Crest Factor	Signal + Noise 🔤							
I/0 1 Port B2 (Input)	Flat Noise Bandwidth	Signal Only							
1/0.2 Port B2 (Input)	Units	Noise Only							
in o e roit de (inpat)	Optimization	PXB Calculates Noise Power							
I/O 3 Port A1 (Output)	Noise Power Optimization	PXB Calculates Noise Power in Channel							
I/O 4 Port A2 (Output)	2. Signal Power								
	Total Power	-9.91 dBm							
MOM-B2 (Input)	Total Noise Power	-27.03 dBm							
MXG-A1 (Output)	Total Signal Power	-10.00 dBm							
M3/C + 2 (0, ++++)	Total Signal to Noise Ratio	18.00 dBm							
MXG-A2 (Output)	Total Noise Power In Channel	-28.00 dBm							
	Output MUX								
	Output MUX allows you to choose and view	the desired signal components (Signal + Noise, Signal Only, or N							

Figure 22 PXB add AWGN to output

- > HSDPA MIMO BLER measurement to verify the throughput
 - Now we are able to start any HSDPA MIMO test required. For example, We can use the real-time results to check the Acks, Nacks and throughput, or the HSDPA BLER measurement (Meas Selection → HBLER) to look the BLER and throughput result over a specific number of blocks as shown below:

	MIMO Block Error Ratio									
		Total	Prim Stream	Sec Stream						
	Block Error Ratio:	50.04 %	50.07 %	50.00 %						
	Throughput (kbps):		6856.01	6866.00						
	ACKs:	2748	1399	1350						
	NACKs:	2752	1401	1350						
	statDTXs:	0	0	0						
	Blocks Tested:	5500	2700	2700						
Median CQI (Single Stream/Dual Prim/Dual Sec): / /										
5500 /2000 Single										

Figure 23 HBLER HSDPA MIMO Measurement Results after fading or AWGN

NOTE: After adding fading and noise, the BLER is increased to some value greater than zero. The MIMO performance of the HS-DSCH in multi-path fading environments is determined by the information bit throughput R. In 3GPP TS 34.121-1 V9.6.0 section 9.2.4A/B, the minimum requirements are defined and the method of test is described. The RF path loss should be calibrated and compensated first before doing such tests.

Stop playing the PXB

Sample SCPI scripts for HSDPA MIMO fading test

NOTE: The sample SCPI shows how to configure 8960 and PXB for the HSDPA MIMO fading tests. The specific instrument name and address should be updated accordingly to match the real user setup. The comments are lines started with "#". The lines in red refer to some settings may need adjustment according to UE's capability or user test requirements.

CALL:OPERating:MODE OFF *opc? # UE band CALL:CHAN 1540

Config Channel Code and states CALL:PICH:CCOD:CODE 2 CALL: AICH: CCOD: CODE 3 CALL:HSSC:CCOD:CODE 2 CALL: HSSC2: CCOD: CODE 3 CALL:EHIC:CCOD:CODE 5 CALL:OCNS:CCOD:CODE:HSDP 6,123,124,125,126,127 CALL:EAGC:CCOD:CODE 8 CALL:DPCH:KSPS15:CCOD:CODE:HSDP 14 CALL:DPCH:KSPS30:CCOD:CODE:HSDP 7 CALL:HSDP:SERV:PSD:HSPD:CCOD:CODE 1 CALL:HSDP:SERV:RBT:HSPD:CCOD:CODE 1 CALL:ANT2:CPIC:SEC:CONF:STAT ON CALL:FDDT:ANT2:CPIC:SEC:CONF:STAT ON CALL:CPIC:SEC:CCOD:CODE 3 CALL:CCPC:SEC:CONN:CONF:STAT OFF CALL:HSSC3:CONF:STAT OFF CALL:HSSC4:CONF:STAT OFF CALL:FDDT:HSSC3:CONF:STAT OFF CALL:FDDT:HSSC4:CONF:STAT OFF CALL:OCNS:CONF:STAT:HSDP ON,OFF,OFF,OFF,OFF CALL:FDDT:OCNS:CONF:STAT:HSDP ON,OFF,OFF,OFF,OFF CALL:OPER:MODE FDDT

CALL:FDDT:HSPD:CCOD:CODE 1

CALL:OPER:MODE OFF CALL:SRB:CCH:DED:DRAT BPS2200 CALL:CELL:POWer:SAMPlitude:SELected -30 CALL:OPER:MODE CALL CALL:CELL:RLC:REES OFF # Cell Power CALL:CELL:POW -28 CALL:ANT2:PIL:CONF SCP CALL:HSDP:MIMO:CPIC:SEC:POFF:SIGN:STAT ON # RB Test mode settings CALL:SERV:RBT:RAB HSDP12 CALL:HSDP:SERV:RBT:HSDS:CONF UDEF CALL:HSDP:SERV:RBT:UDEF:HSDS:MAC EHSP CALL:HSDP:SERV:RBT:UDEF:MIMO ON CALL:HSDP:SERV:RBT:UDEF:QAM64:STAT ON CALL:HSDP:SERV:RBT:MIMO:TBL:COUN 2 CALL:HSDP:SERV:RBT:UDEF:HSPD:COUN 15 CALL:HSDP:SERV:RBT:UDEF:ITTI 1 CALL:HSDP:SERV:RBT:UDEF:TBS:IND 62 CALL:HSDP:SERV:RBT:UDEF:MOD QAM16 CALL:HSDP:SERV:RBT:UDEF:STBS:IND 62 CALL:HSDP:SERV:RBT:UDEF:STBL:MOD QAM16 CALL:CONN:CPIC:SLEV:HSDP -10 CALL:CONN:CCPC:PRIM:SLEV:HSDP -20 CALL:CONN:PICH:SLEV:HSDP -20 CALL:CONN:DPCH:SLEV:HSDP -20 CALL:CONN:HSPD:SLEV -2.0 CALL:CONN:HSSC:SLEV -18 CALL:CONN:HSSC2:STAT OFF CALL:ANT2:CONN:CPIC:STAT:HSDP OFF CALL:HSDP:MPOW:MOFF -4.5 CALL:ANT2:CONN:CPIC:SEC:SLEV:HSDP -10 CALL:HSDP:SERV:RBT:MIMO:PPW 1 ## SCPI sent to PXB ##

CONT:PLAY OFF

*OPC?

*RST

*WAI

Select MIMO 2x2 Ext In config CONT:CONF ESM,'2x2'

Assign instruments to the port, the instrument name is case sensitive
*WAI
CONTrol:CONFig:IO1:DIGital:RDEVice:PORT 'B2','MOM-B2'
*WAI
CONTrol:CONFig:IO2:DIGital:RDEVice:PORT 'A1','MXG-A1'
*WAI
CONTrol:CONFig:IO4:DIGital:RDEVice:PORT 'A2','MXG-A2'
*WAI

Apply the configuration CONT:CONF:APPL *WAI *OPC? pxb < 1</pre>

FSIM1:FAD3:VSPeed 3 FSIM1:FAD3:MODE OFF FSIM1:FAD4:STAN:FBAN 1 FSIM1:FAD4:VSPeed 3 FSIM1:FAD4:MODE THR

CONTrol:IO4:OUTPut:AWGN:ENABle 1 CONTrol:IO4:OUTPut:AWGN:MUX SIGN CONTrol:IO4:OUTPut:AWGN2:IENABled 1 CONTrol:IO4:OUTPut:AWGN2:IENABled 1 CONTrol:IO4:OUTPut:AWGN2:IBANdwidth 5000000 CONTrol:IO4:OUTPut:AWGN2:NBANdwidth 5000000 CONTrol:IO4:OUTPut:AWGN4:IBANdwidth 5000000 CONTrol:IO4:OUTPut:AWGN4:NBANdwidth 5000000 CONTrol:IO4:OUTPut:AWGN4:NBANdwidth 5000000 CONTrol:IO4:OUTPut:AWGN4:NBANdwidth 5000000 CONTrol:IO4:OUTPut:AWGN2:SNR 18 CONTrol:IO4:OUTPut:AWGN2:SPOWER -10 CONTrol:IO4:OUTPut:AWGN4:SNR 18 CONTrol:IO4:OUTPut:AWGN4:SNR 18

Play configuration ### CONT:PLAY ON *WAI *OPC? pxb < 1 # Check PXB Play status
:CONTrol:PLAY:STATe?
pxb < 1</pre>

SCPI sent to 8960
setup call connection with UE
[usr > setup call connection, then continue]
call:orig

Below attachment is the sequence which can be played by Agilent Command Expert. Agilent Command Expert is free and available at: <u>http://www.agilent.com/find/CommandExpert</u>.

To run the below sequence, you need to follow the instructions below:

- Setup the test system and interconnect all the devices, check 10M reference clock
- Power up all instruments (PXB, 8960, 2 MXGs)
- Setup PXB External Instrument Table according to the setup
- Run Agilent Command Expert, and load the Sequence file below
- Update the Instruments' name, address and connections in the sequence
- Play the sequence

