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

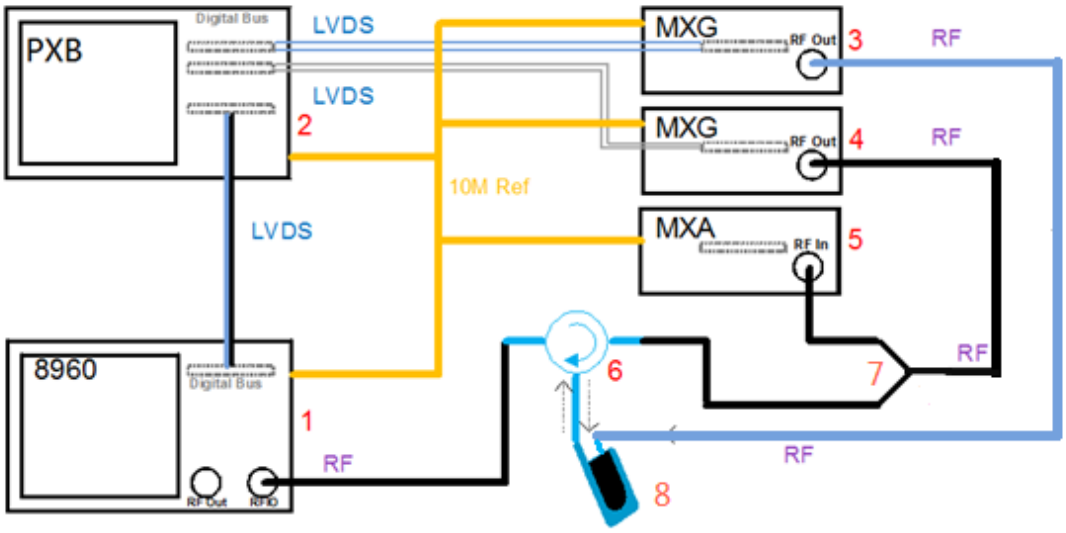

Figure 1 8960-PXB HSDPA MIMO Baseband Fading System

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:

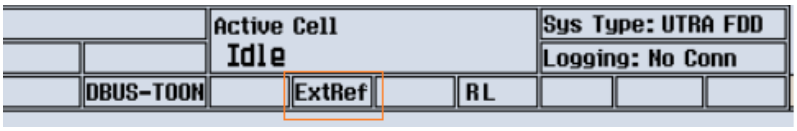

Figure 2 8960 Ext Ref Annunciator

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.

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

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

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.

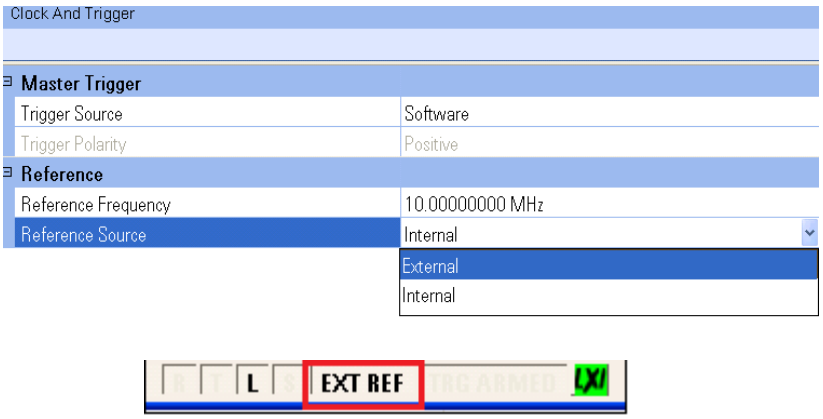

Figure 4 PXB External Reference Input Setup

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.

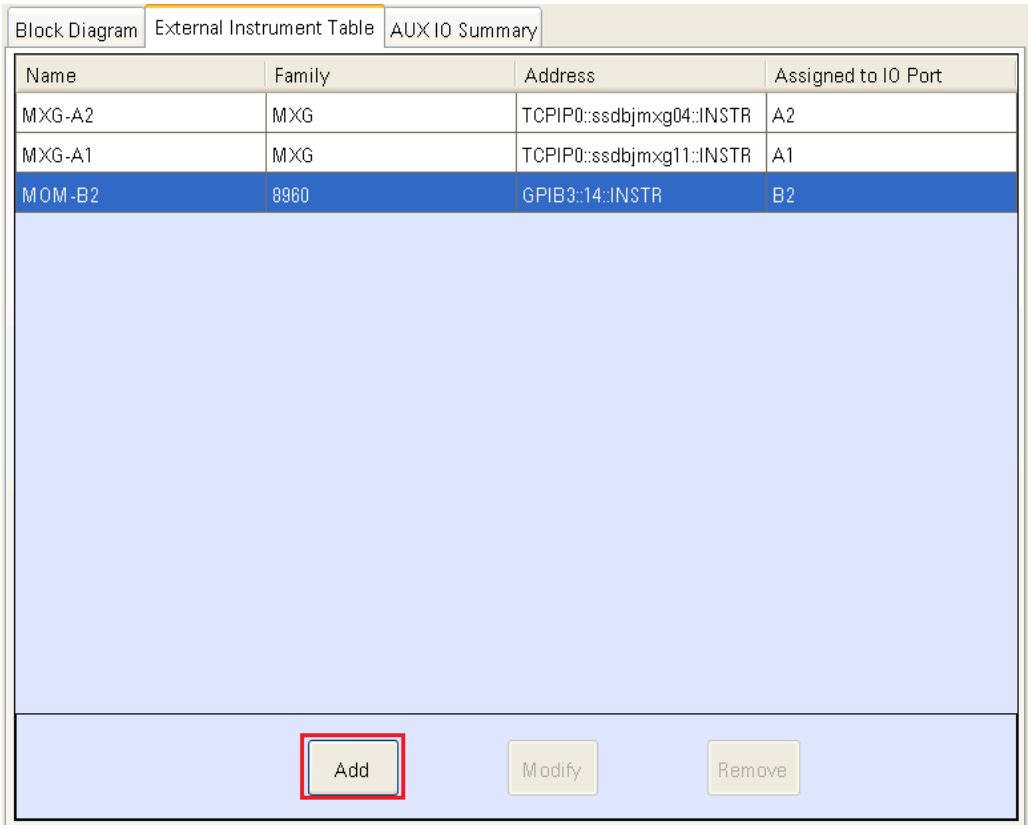

Figure 5 PXB External Instrument Table

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:

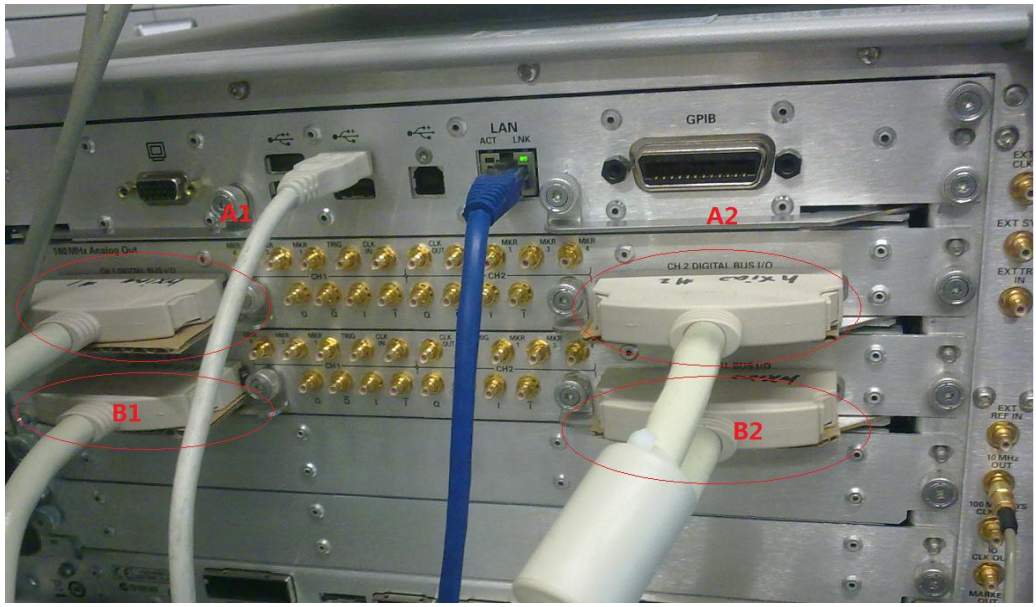

Figure 6 PXB I/O Port Number Allocation

- 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:

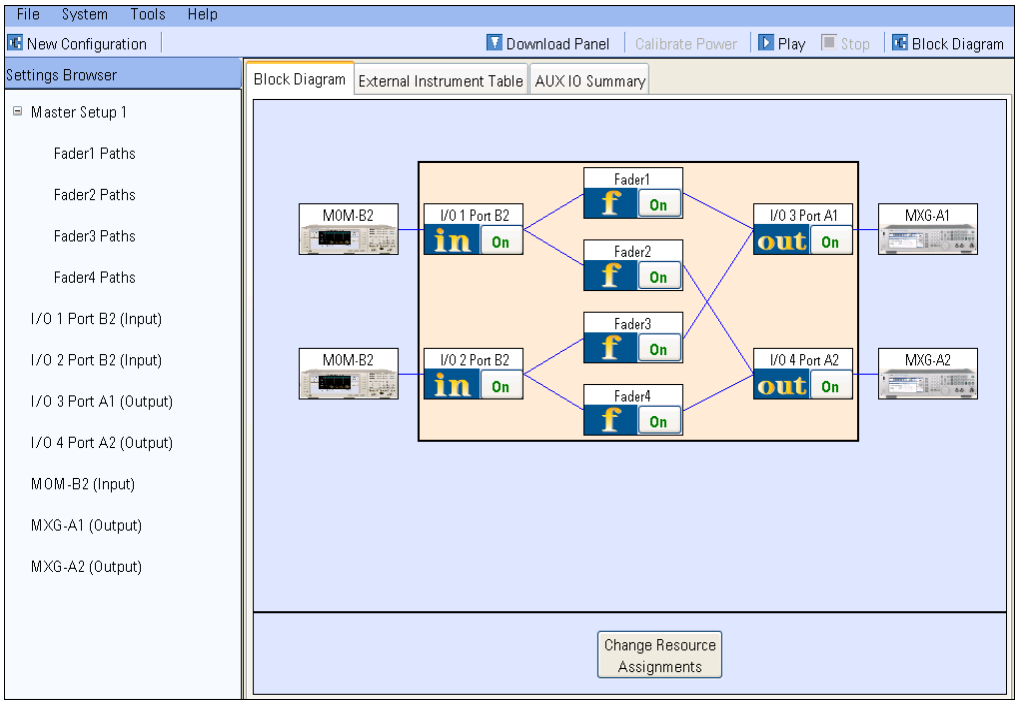

Figure 7 PXB "Single-user MIMO (ext in) – 2x2" configuration loaded

- 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):

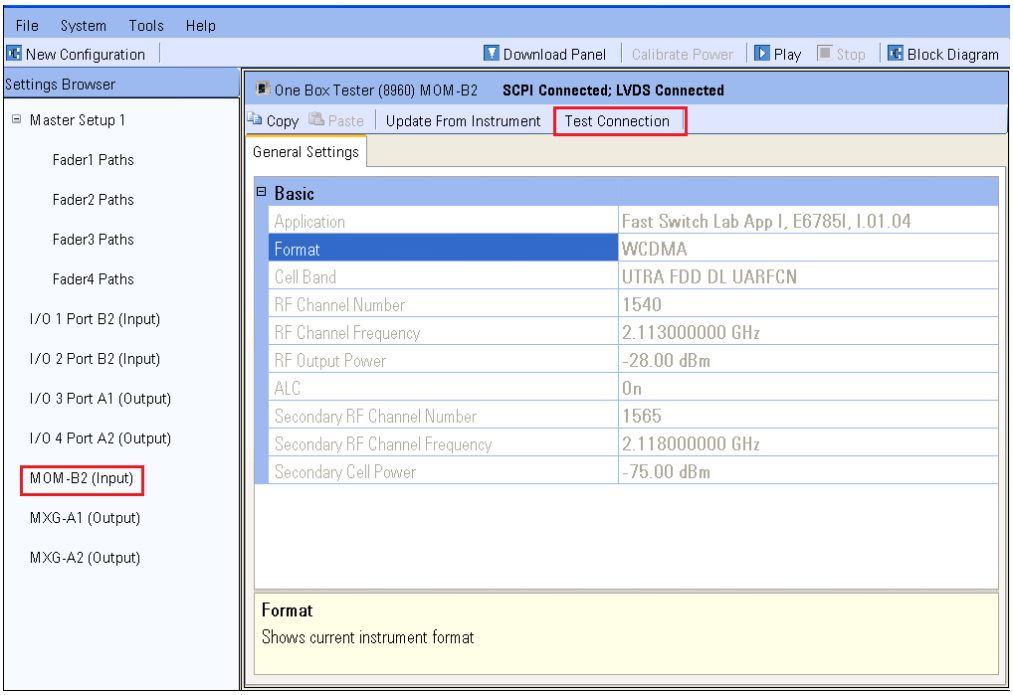

Figure 8 PXB Check instrument connection – MOM-B2

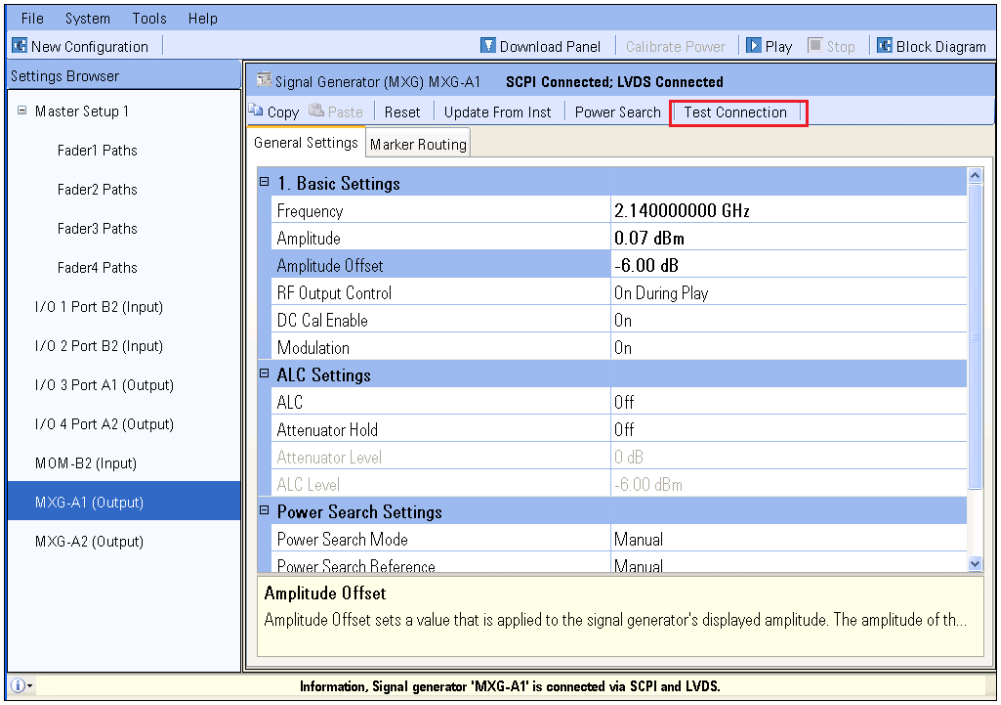

Figure 9 PXB Check instrument connection –MXG-A1

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"

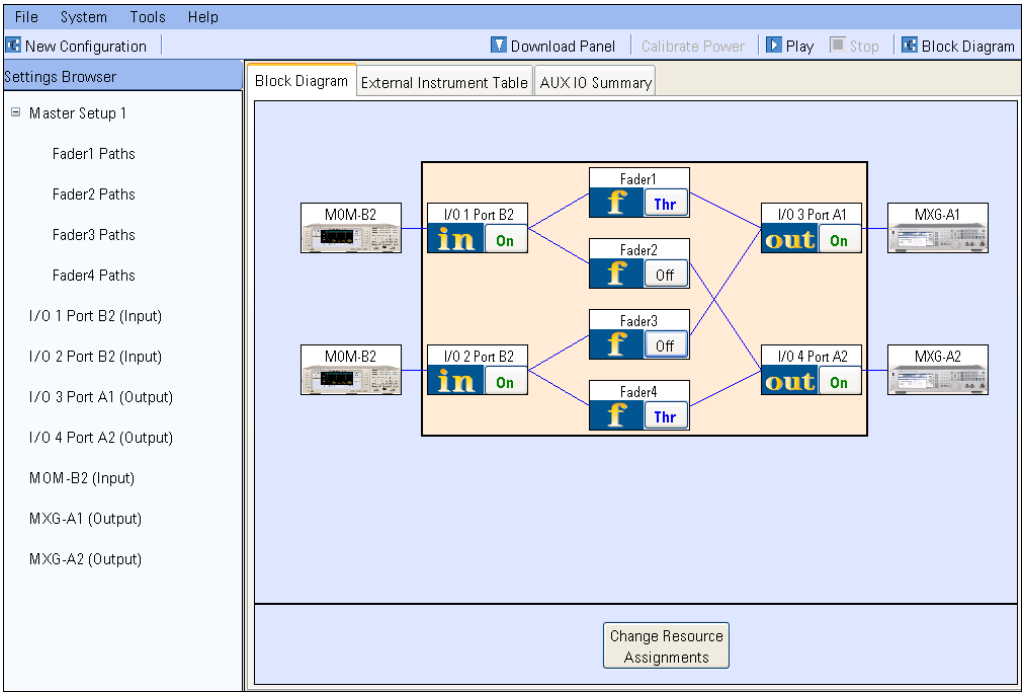

Figure 10 PXB Fader Configuration for MIMO channels

- Config two MXGs for correct RF output power with MXG

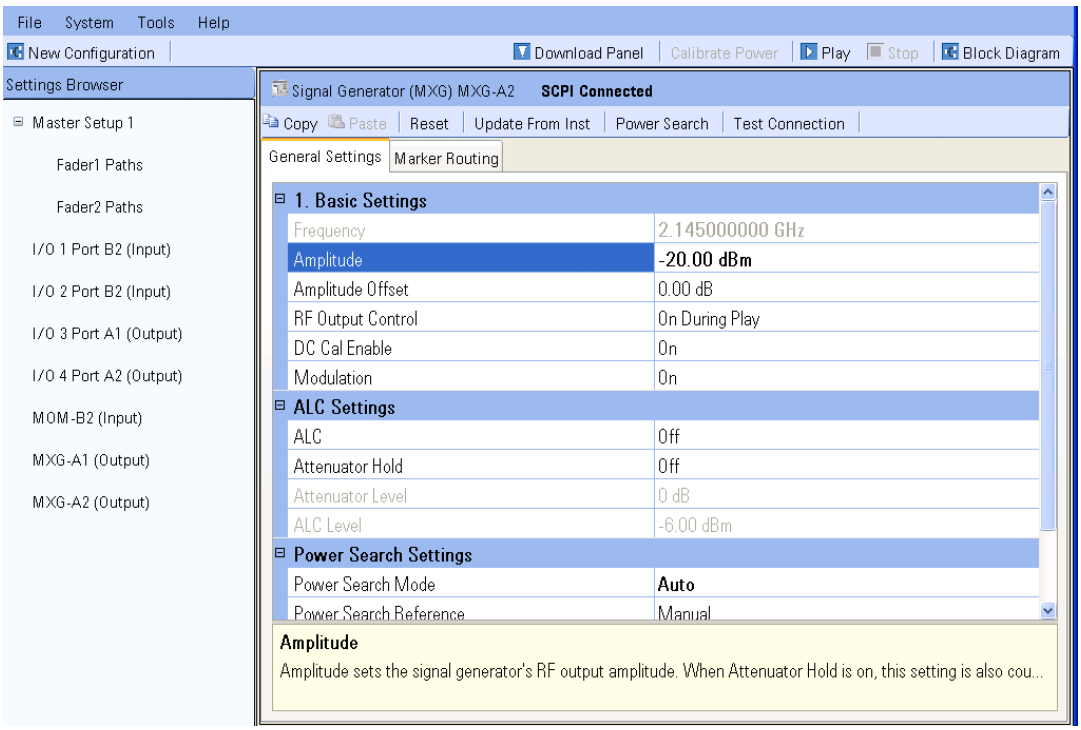

Figure 11 MXG RF output power setup

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

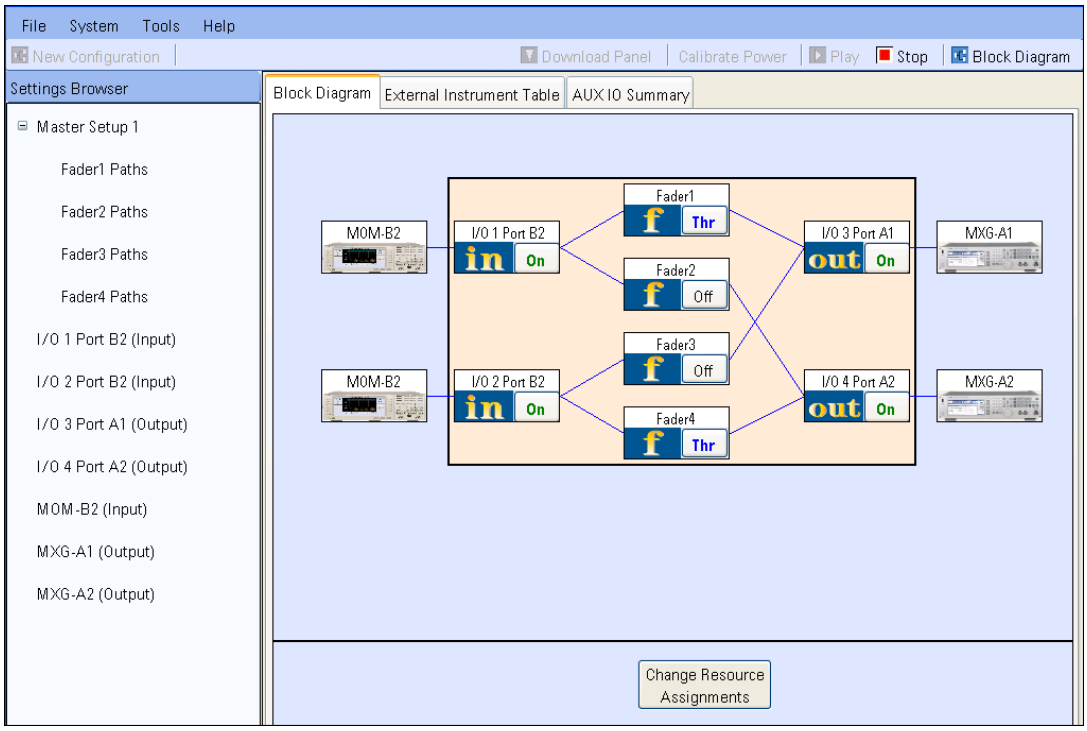

Figure 12 PXB play the configuration

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

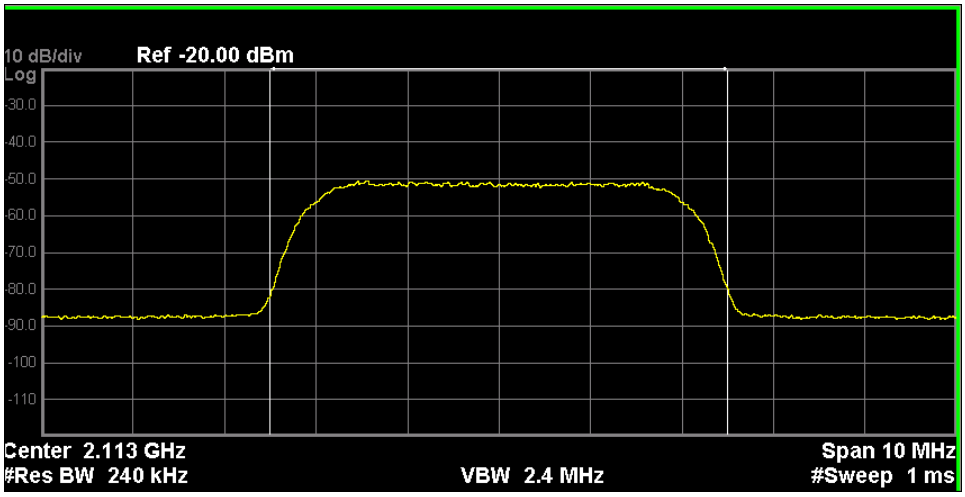

Figure 13 MXA Channel power measure after playing

  - Next measure the EVM using the Mod Accuracy measurement

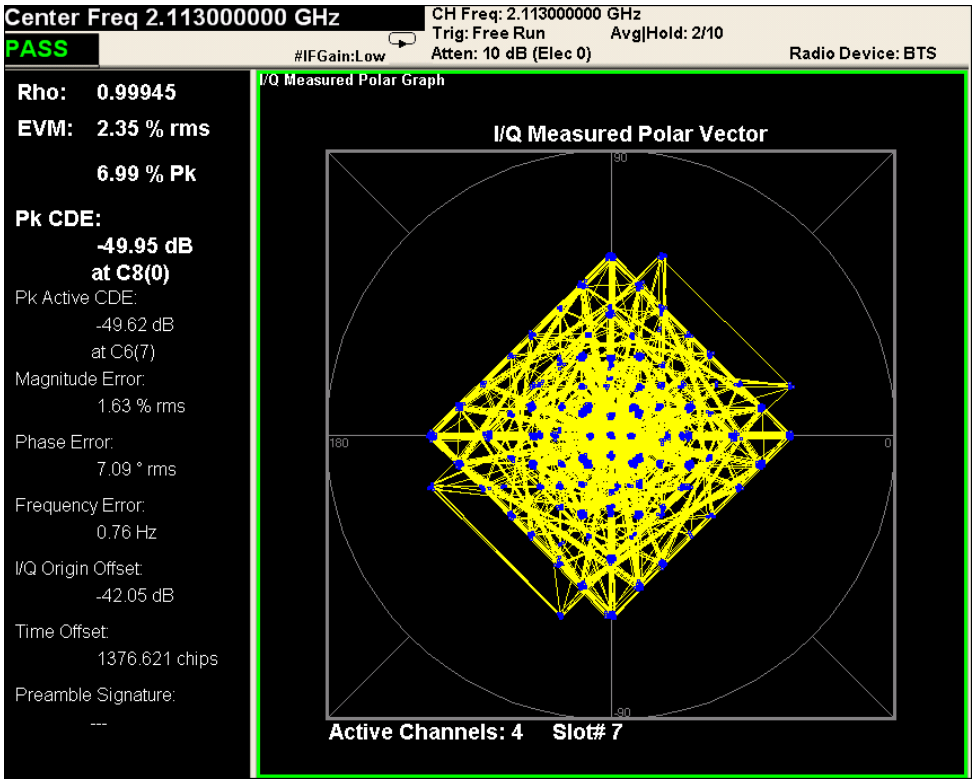

Figure 14 MXA Demodulation after playing

- 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]
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[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: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 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 shown in Figure

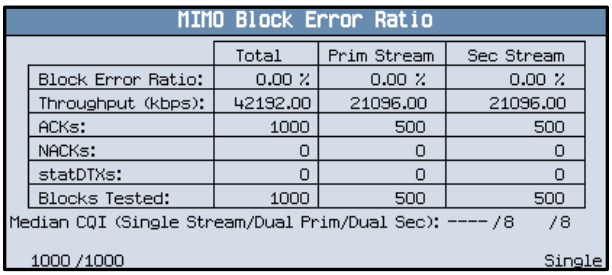

Figure 15 Typical HBLER DC-HSDPA Measurement Results without fading

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.

- $\mathbf{I_{oc}}$ 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+α) x (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.

- $\mathbf{\hat{I}_{or}}$ The received power spectral density (integrated in a bandwidth of (1+α) x (chip rate) and normalized to the chip rate) of the downlink signal as measured at the UE antenna connector. For MIMO, $\mathbf{\hat{I}_{or}}$ 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 $\mathbf{\hat{I}_{or}}$ other than $\mathbf{I_{or\ 0}}$.
- The integration BW for $\mathbf{\hat{I}_{or}}$ 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 $\mathbf{\hat{I}_{or}}$ to $\mathbf{I_{oc}}$ 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 Ioc 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:

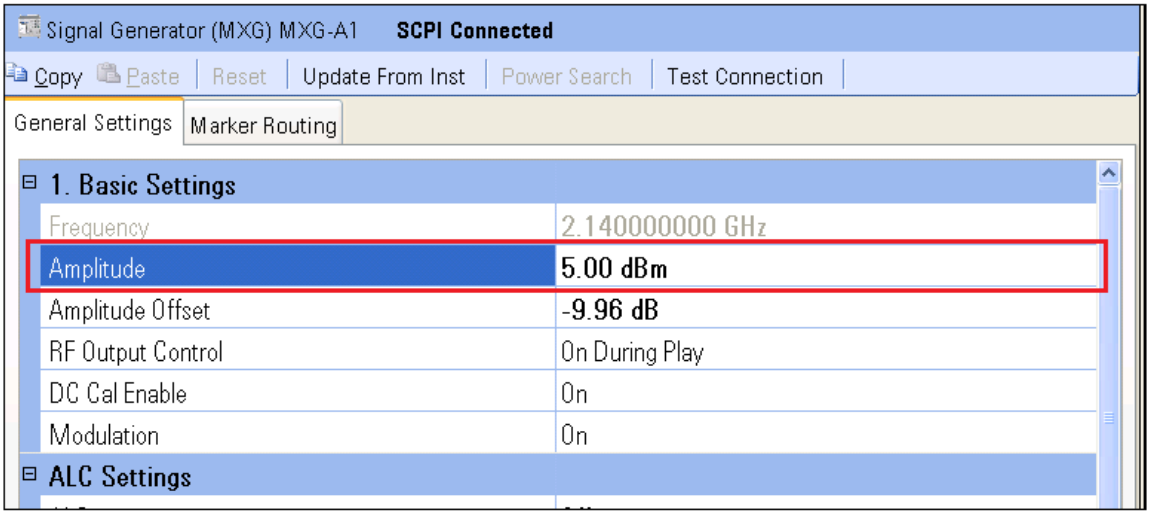

Figure 16 RF path loss compensate - downlink

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

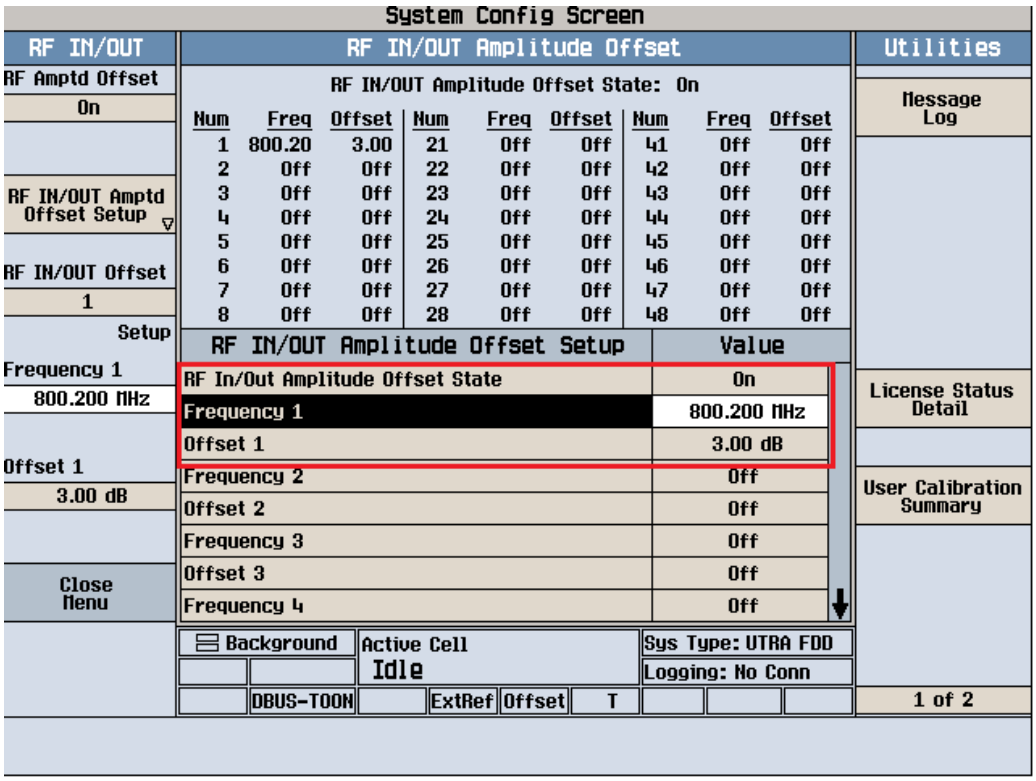

Figure 17 RF path loss compensate - uplink

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 → MIMO Settings → Channel Model → HSPA → Base Station → Case 1 → 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.

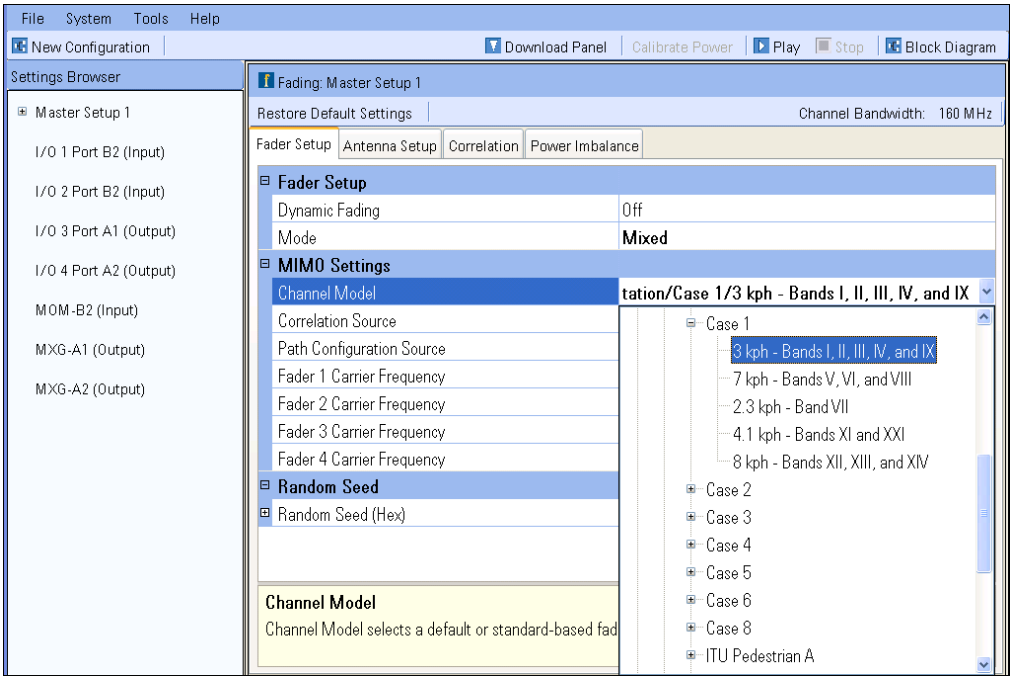

Figure 18 PXB Fading Channel Model

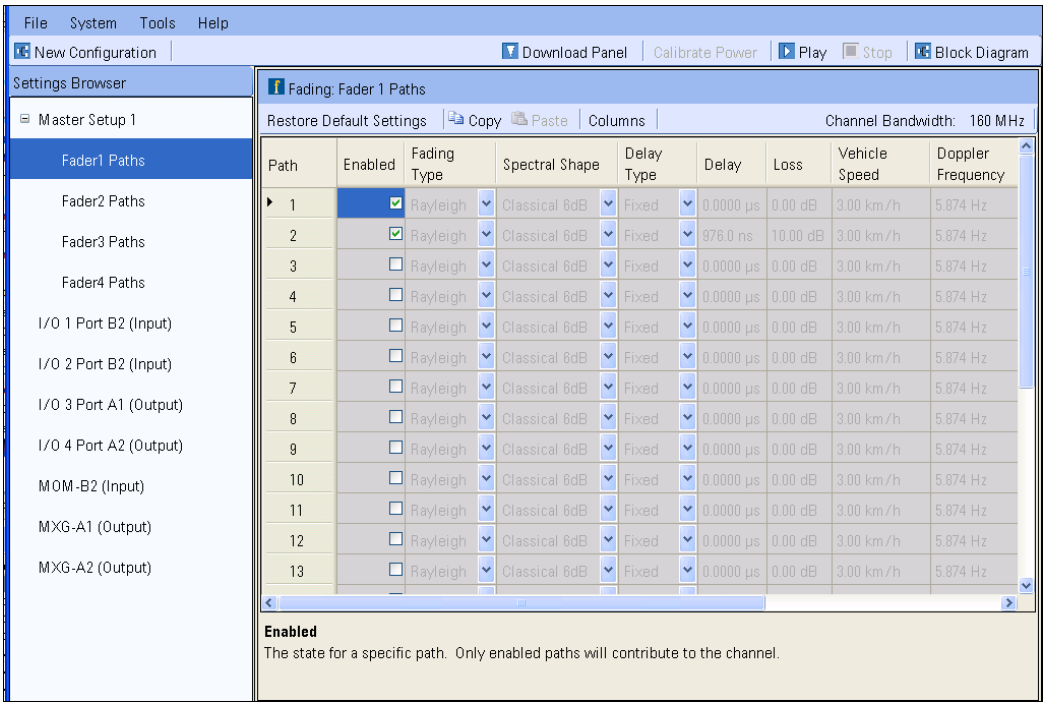

Figure 19 PXB Fading Path Settings

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**

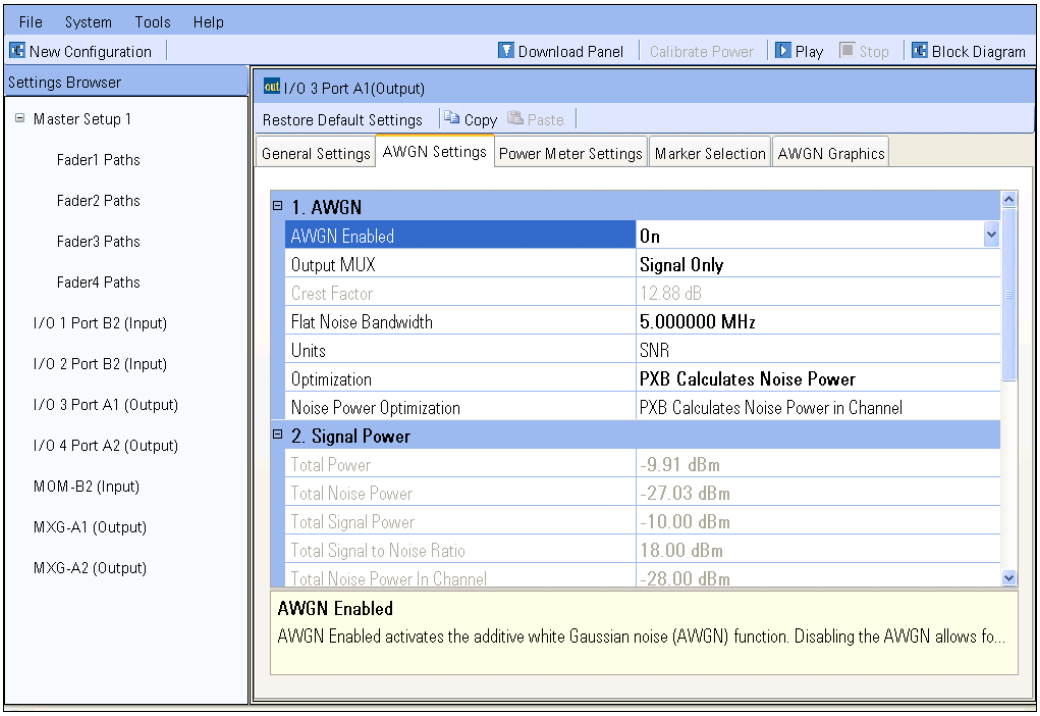

Figure 20 PXB Output AWGN Settings

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**

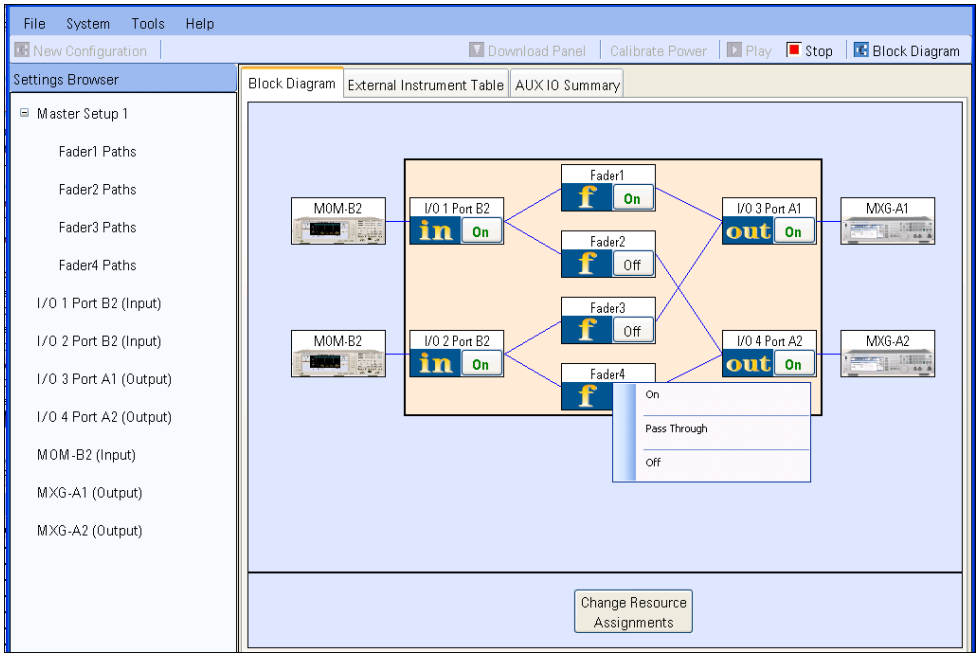

Figure 21 PXB Fading Mode “On”

  - For adding AWGN, switch the AWGN Output MUX from “Signal Only” to “Signal + Noise”

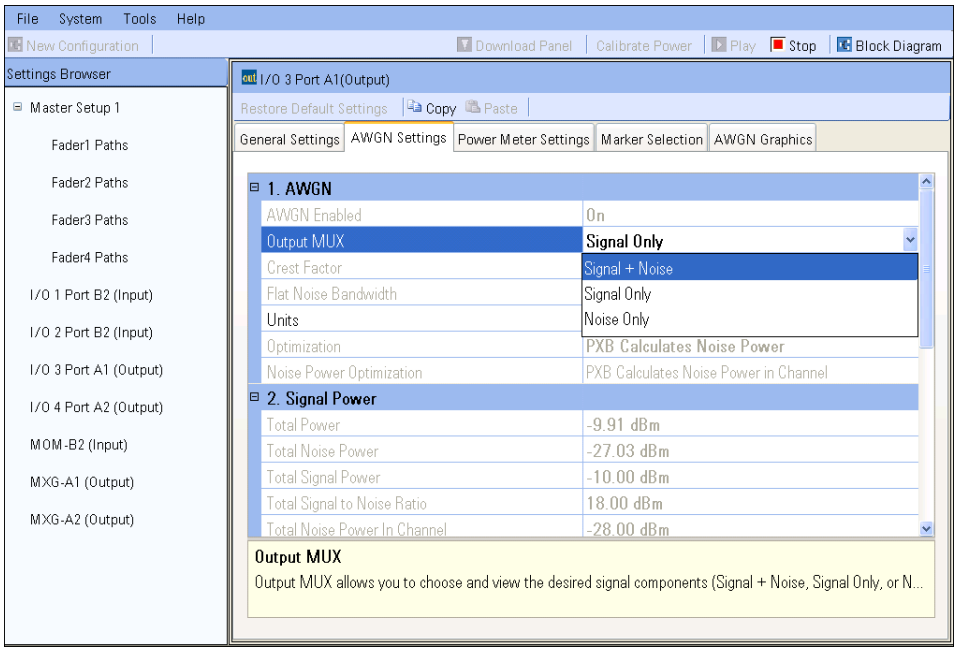

Figure 22 PXB add AWGN to output

- 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:

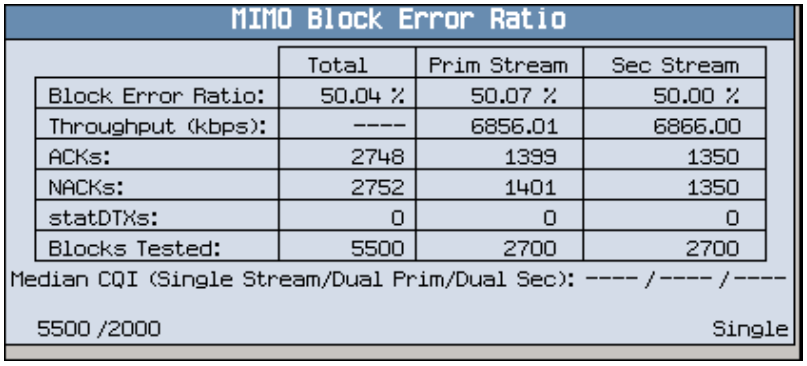

Figure 23 HBLER HSDPA MIMO Measurement Results after fading or AWGN

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.

```
## SCPI sent to 8960 ##
## prepare 8960 to WCDMA format and HSDPA MIMO configuration################
*RST
# Switch to 'WCDMA' Application
SYSTem:APPLication:FORMat "WCDMA"
SYST:LOG:UI:GPIB:STAT ON
RFG:OUTP OUT

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,OFF
CALL:FDDT:OCNS:CONF:STAT:HSDP ON,OFF,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 ##
## configure 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 'B2','MOM-B2'
*WAI
CONTrol:CONFig:IO3: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

## Verify connections ###################################
## Before sending the query, set the PXB timeout to 30 seconds to avoid timeout error
## Should return "Pass" IO1 - Mom-B2; IO3 – MXG-A1 #
## IO4 – MXG-A2                                    #
CONTrol:CONFig:IO1:DIGital:RDEVice:DIAGnostic?
pxb < "Pass"
CONTrol:CONFig:IO3:DIGital:RDEVice:DIAGnostic?
pxb < "Pass"
CONTrol:CONFig:IO4:DIGital:RDEVice:DIAGnostic?
pxb < "Pass"

## Config PXB Fading ##########################
FSIMulator1:STANdard:TECHnology HSPA
FSIMulator1:STANdard:HSPA:SCENario CAS1
FSIMulator1:STANdard:LINK DOWN
FSIM1:FAD1:STAN:FBAN 1
FSIM1:FAD1:VSPeed 3
FSIM1:FAD1:MODE THR
FSIM1:FAD2:STAN:FBAN 1
FSIM1:FAD2:VSPeed 3
FSIM1:FAD2:MODE OFF
FSIM1:FAD3:STAN:FBAN 1
```

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

Config PXB AWGN
CONTrol:IO3:OUTPut:AWGN:ENABle 1
CONTrol:IO3:OUTPut:AWGN:MUX SIGN
CONTrol:IO3:OUTPut:AWGN1:IENABled 1
CONTrol:IO3:OUTPut:AWGN3:IENABled 1
CONTrol:IO3:OUTPut:AWGN1:IBANdwidth 5000000
CONTrol:IO3:OUTPut:AWGN1:NBANdwidth 5000000
CONTrol:IO3:OUTPut:AWGN3:IBANdwidth 5000000
CONTrol:IO3:OUTPut:AWGN3:NBANdwidth 5000000
CONTrol:IO3:OUTPut:AWGN:OPTimization Noise
CONTrol:IO3:OUTPut:AWGN1:SPOWER -10
CONTrol:IO3:OUTPut:AWGN1:SNR 18
CONTrol:IO3:OUTPut:AWGN3:SNR 18
CONTrol:IO3:OUTPut:AWGN3:SPOWER -10

CONTrol:IO4:OUTPut:AWGN:ENABle 1
CONTrol:IO4:OUTPut:AWGN:MUX SIGN
CONTrol:IO4:OUTPut:AWGN2:IENABled 1
CONTrol:IO4:OUTPut:AWGN4: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:AWGN:OPTimization Noise
CONTrol:IO4:OUTPut:AWGN2:SNR 18
CONTrol:IO4:OUTPut:AWGN2:SPOWER -10
CONTrol:IO4:OUTPut:AWGN4:SNR 18
CONTrol:IO4:OUTPut:AWGN4:SPOWER -10

Play configuration
CONT:PLAY ON
*WAI
*OPC?
pxb < 1

```
# Check PXB Play status
:CONTrol:PLAY:STATe?
pxb < 1

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

 ## SCPI sent to PXB ##
## enable PXB Fading and AWGN ######################
FSIM1:FAD1:MODE ON
FSIM1:FAD2:MODE ON
FSIM1:FAD3:MODE ON
FSIM1:FAD4:MODE ON
CONTrol:IO3:OUTPut:AWGN:MUX SUM
CONTrol:IO4:OUTPut:AWGN2:MUX SUM

## SCPI sent to 8960 ##
## enable 8960 HBLER measurement ###################
SETup:HBLerror:COUNt 10000
SETup:HBLerror:COUNt:MIMO:STATe ON
SETup:HBLerror:CONTinuous OFF
INITiate:HBLerror
INITiate:DONE?
FETCh:HBLerror?
```

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

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

PXB_8960_MIMO_BB_Fading.iseq