RS9113SB
PHY Evaluation Test Utility
User Guide for Linux

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1 Introduction

The purpose of this document is to provide the usage of the applications for transmit and receive tests to evaluate the RF performance of the RS9113™ using a test driver in Linux environment.

The evaluation board provides the necessary connectors so that you can measure transmit and receive performance of the PHY, using Spectrum Analyzer and Signal Generator in 2.4GHz.

In general, transmit performance of a radio can be analyzed in three steps.

Maximum power: The user can observe the RF output power for a given maximum gain supported by the RF.

EVM: The user can observe the EVM for a given rated RF power as supported by the RF transceiver.

Spectral Mask: The user can verify whether the RS9113™ module meets the spectral mask requirements defined by IEEE standard for a given maximum RF output power, in a particular mode of operation like 11a, 11b, 11g etc.

The receive performance of the PHY can be analyzed using Packet Error Ratio (PER) test.

The Rx performance is analyzed by the sensitivities at different data rates. In general, the sensitivity is observed as 10% Packet Error Ratio (PER) point in 11a and 11g, and 8% PER point in 11b.

The document contains two major sections.

Section 3 describes the usage of the 'transmit' utility, which provides the options for setting various parameters to carry out transmit tests on the RS9113™ device.

Section 4 describes the usage of the 'receive' utility, which enables the user to perform receive tests on the RS9113™ device.

2 Test Setup Details

The diagram shown below, illustrates the test setup for evaluating receive and transmit performance of RS9113™ WLAN module.

As shown in the test setup, the RS9113™ evaluation board (EVB) is plugged into Linux based laptop either on the SDIO slot via SDIO connector or USB port via USB cable through port J6 on the EVB. The board is connected to a WLAN signal analyzer through a microwave coaxial cable to test the Tx performance.
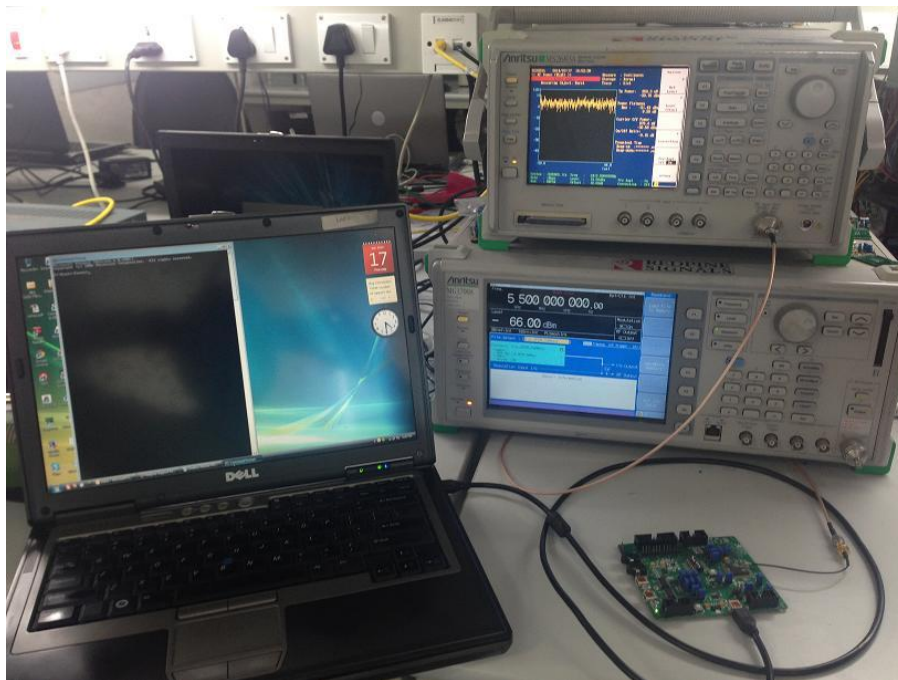

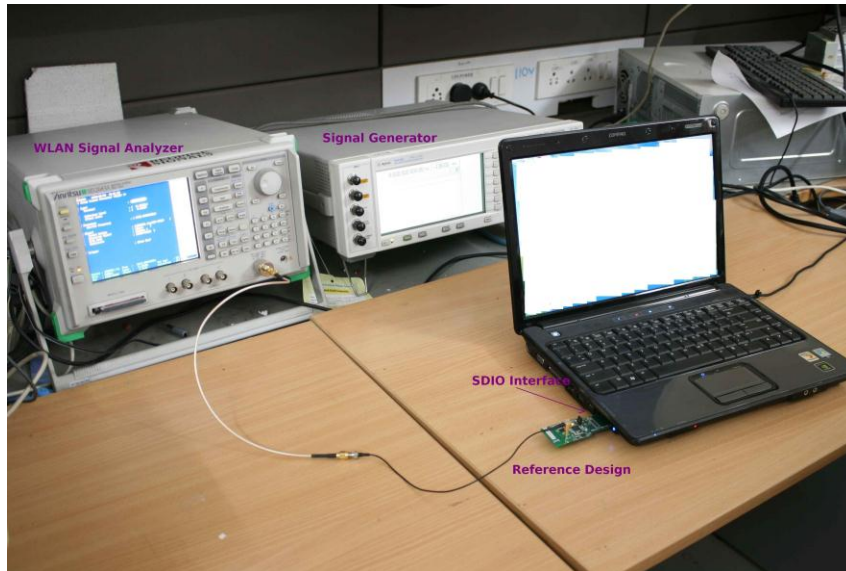**Figure 1: Linux Based RF Evaluation Setup With USB Interface**

Figure 2: Linux Based RF Evaluation Setup With SDIO Interface

Following diagram illustrates various software components involved in performing Tx and Rx tests using spectrum analyzer and signal generator respectively.
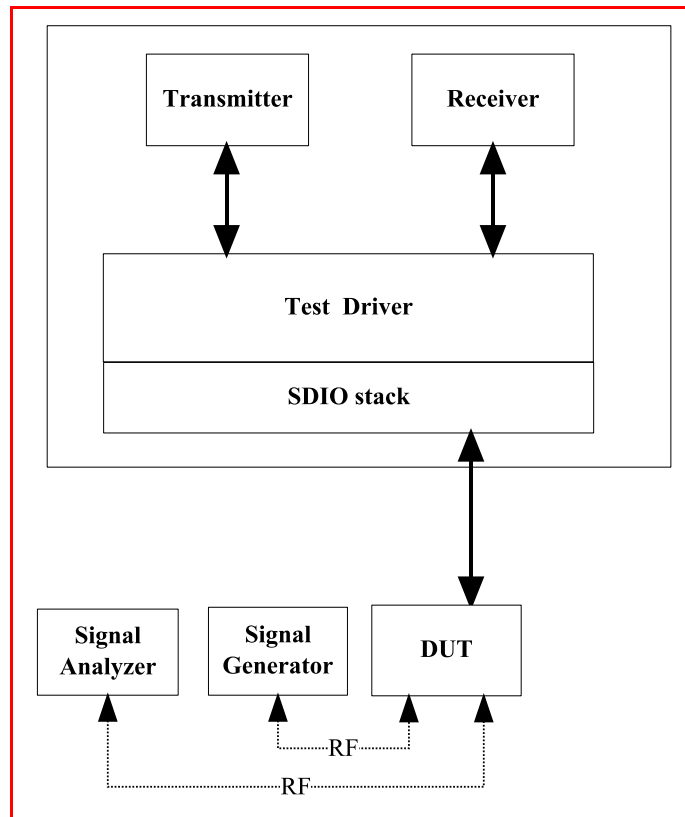

Figure 3: Utility Diagram

The 'transmit' utility is a command line application to perform Tx tests. Before running the Tx tests, the user is expected to connect RS9113™ to a signal analyzer using the RF cable.

The 'receive' utility is also a separate command line application that can be used for displaying statistics on the received packets while carrying out the receive sensitivity tests.

Please follow "RS9113-SW-Installation-Guide" for building and installing the RS9113™ driver.

To configure the driver in "PER" Mode make sure to have the following line in "release/insert.sh".

DRIVER_MODE = 2

After the card has been detected successfully (issue "*dmesg –c"* in terminal to check the status for the USB card it will show "new high-speed USB device detection" while for the SDIO it will show "new High speed SDIO card detected") the Tx and Rx tests can be started. Please follow the subsequent sections for executing the Tx and Rx tests.

When driver is compiled in "host" directory driver would be using binaries from "release".

If there are any modifications in "host" directory then driver compilation is required.

 The RS9113 driver offers two main modes of operation:

1. End-end, or Wi-Fi mode
2. PER mode for PHY evaluation

To configure the driver in Wi-Fi or (END-to-END) Mode make sure to have the following line in "release/insert.sh".

DRIVER_MODE = 1

In order to configure the driver in PHY Evaluation mode (PER mode) then make sure the "DRIVER_MODE" parameter should be set as DRIVER_MODE = 2

3 Transmit Tests

In general, before performing any tests configure the PHY to operate in the appropriate band. The transmit tests can be performed through a utility called 'transmit' which is found under 'release' directory.

Configure the following parameters through this application before running the tests.

- Transmit power
- Transmit data rate
- Packet length
- Transmit mode
- Channel number
- External PA-Enable/Disable
- Rate flags
- Aggregation flag
- Number of packets to send in burst mode
- Delay between the packets in burst mode

3.1 Application Usage

The application can be started in the following manner:

 # cd release

 # ./transmit <g> <r> <l> <m><c> <p> <f> <a> <n> <d>

<g> refers to Tx gain value for controlling transmit power.

<r> refers to Tx Rate.

<l> refers to length of the Tx packet

<m> refers to Transmit mode.

  0 – Burst Mode

  1 – Continuous Mode

<c> refers to Channel number

<p> refers to External PA-Enable/disable

<f> refers to Short GI, Greenfield and Channel Width.

<a> refers to enable/disable aggregation

<n> refers to number of packets to send in burst mode.

<d> refers to delay between packets in burst mode.

After starting this application, user has to enter the following command to stop the ongoing transmission:

 # ./transmit <m>

<m> - 0 for Burst Mode

1 for Continuous Mode

Set power value:

To set Tx gain value, enter a valid value for <p> parameter. The valid values are from 229 to 255 for RS9113 module. The transmit power increases proportionately with increase in Tx gain value in OFDM and CCK modes. This support is not present in this release.

Set Data Rate:

To set transmit data rate, enter a valid rate for <r> parameter.

Valid values are (1,2,5.5,11,6,9,12,18,24,36,48,54,mcs0, mcs1, mcs2, mcs3, mcs4, mcs5, mcs6, mcs7).

Set Packet Length:

For setting the transmission packet length, enter a valid value for <l> parameter.

Valid values are in the range of 24 and 1500.The values are in bytes.

Set Transmit Mode:

For setting the transmission mode, you need to enter one of the following values for <m> parameter.

1 for continuous mode

0 for burst mode.

Set Channel number:

For setting the channel number in 2.4 GHz you need to enter a value in the range 1 –11 for <c> parameter. The following tables map the channel number to the actual radio frequency in the 2.4 GHz spectrum for 20MHz channel width.

Channel Numbers (2.4GHz)	Center frequencies for 20MHz channel width(MHz)
1	2412
2	2417
3	2422
4	2427
5	2432
6	2437
7	2442
8	2447
9	2452
10	2457
11	2462

Table 1 Channel Number and Frequencies for 20MHz Channel Width in 2.4GHz

Set External PA enable/disable:

> If the module contains an external PA, to enable the usage of the PA, enter a value of 1, else enter a value of 0. This support is currently not handled in driver.

Set Rate flags:

> Rate flags contain short GI, Greenfield and channel width values. Various fields in rate flags are divided as specified below

Fields	Short GI	Greenfield	Channel Width	Reserved
Bits:	0	1	2 – 4	5 - 15

Table 2 Rate Flags

To enable short GI   –   set rate flags value as '1'

To enable Greenfield   –   set rate flags value as '2'

To set channel width use one of the values specified in the table below:

Channel Width	Rate flag values
20MHz	0

Table 3 Channel Width

We can enable multiple fields by setting rate flags value appropriately.

Set Aggregation flags:

This flag is for enabling or disabling aggregation support .Higher length packets can be transmitted by enabling aggregation flag.If this flag is set then it enables the TX aggregation. User can give maximum of length less than or equal to 30000bytes when the aggregation is enabled. This maximum supported length may vary depending on the available buffers in TA. User given length is divided into chunks of size 1792 bytes. All these chunks are aggregated and sent. If this flag is not set then aggregation is not enabled and packets will be sent without any aggregation, And maximum length that can be sent in this case is 1536bytes.

Aggregation feature is supported only in burst mode. This filed will be ignored in case of continuous mode.

Set Number of packets to send:

This field is used to set the number of packets to be sent in burst mode. If the value given is 'n' then 'n' number of packets will be sent on air, after that transmission will be stopped. If this field is given as 'zero' then packets will be sent continuously until user stops the transmission using transmit utility.

This filed will be ignored in case of continuous mode.

Set Delay between the packets:

This field is used to set the delay between the packets in burst mode. Delay should be given in micro seconds. i.e. if the value is given as 'n' then a delay of 'n' micro seconds will be added for every transmitted packet in the burst mode.

If this field is set to 'zero' then packets will be sent continuously without any delay.

This filed will be ignored in case of continuous mode.

Examples:

- **$ ./transmit 40 5.5 750 1 11 0 1 0 0 0**

Above command starts continuous transmission with the following configuration:

Tx gain – 40

Data rate – 5.5Mbps

Packet Length – 750 bytes

Transmit mode – 1, which means continuous transmit.

Channel number – 11

External PA – 0, disable

Rate flags – 1, Short GI is enabled with 20MHz Channel width

Aggregation flag - 0, disable (ignored in continuous mode)

Number of packets to send - 0 (ignored in continuous mode)

Delay between the packets - 0 (ignored in continuous mode)

- **$./transmit 65 36 1000 0 6 0 25 0 0 1000 0**

Above command starts burst mode transmission with the following configuration:

Tx gain – 65

Data rate – 36Mbps

Packet Length – 1000 bytes

Transmit mode – 0, which means burst mode transmission.

Channel number – 6 (Center frequency)

External PA – 0, disable

Rate flags - 25

Number of packets to send - 1000

Delay between the packets - 0

4 Programmable PER packet

PER packet can be programmable using utility called 'transmit_packet' utility. This utility takes the PER packet content from the file called 'per_packet.txt'.

'transmit_packet' utility and per_packet.txt can be found under 'release' directory.

Before running this utility user has to fill the required packet content into 'per_packet.txt' file starting from the MAC header. Once 'per_packet.txt' is filled user can run 'transmit_packet' utility for configuring the PER packet. This utility configures the PER packet only. It will not start transmission. User has to run the 'transmit' utility as described in the previous section after running 'transmit_packet' utility.

If user does not want to configure the PER packet then 'transmit' utility can be run directly without running 'transmit_packet' utility. In this case default PER packet will be sent.

Configure the following parameters through 'transmit_packet' application before running the 'transmit' utility.

- Programmable PER Packet Enable
- Programmable PER Packet Length
- Sequence number flag

4.1 Application Usage

Before running application PER packet content has to be entered into the 'per_packet.txt' file.

Then the application can be started in the following manner:

 # cd release

 # ./transmit_packet <e> <l> <s>

<e> refers to enable or disable flag for PER packet configuration.

<l> refers to length of the packet that has to be configured in bytes.

<s> refers to sequence number flag.

Enable flag:

This flag is used to enable or disable the PER packet configuration.

1- Enable,0 - Disable

If this flag is enabled, newly configured PER packet can be transmitted when user runs 'trasmit' utility.

If this flag is disabled, default PER packet can be transmitted when user runs 'trasmit' utility.

Length:

This field refers to the number of bytes to be configured from the 'per_packet.txt' file into PER packet. i.e if this field is given as 'n'(maximum value of n is 1536bytes), then 'n' number of bytes can be configured from 'per_packet.txt' file into PER packet.

Maximum allowed value for this field is 1536bytes.i.e PER packet can be programmable upto 1536 bytes only.

Sequence number Flag:

This flag is used to enable or disable the sequence number from the 'per_packet.txt' file.

If this flag is set as '1' then it will take the sequence number from the 'per_packet.txt' file. And each transmitted packet contains same sequence number without any increment.

If this flag is set as '0' then it ignores the sequence number value from 'per_packet.txt' file and sequence number will be incremented starting from '0'.

Default value for this flag is '0'.

If the Length filed in 'transmit_packet' utility is given as 'm' and Packet length in 'transmit' utility is given as 'n'

Then

1.If m<n then, first 'm' bytes can be taken from 'per_packet.txt' file into PER packet and the rest of packet (m-n length) contains default content.

2.If m>n then, 'n' bytes can be taken from 'per_packet.txt' file into PER packet and transmitted.

3.If m=n then, 'm' bytes can be taken from 'per_packet.txt' file into PER packet and transmitted.

User has to take care while filling per_packet.txt. i.e content should be in hex format only.

Examples:

- **$ ./transmit_packet 1 1000 0**

Above command configures the PER packet

PER configuration Enable – 1

Length – 1000 (1000 bytes can be configured from the 'per_packet.txt' file)

Sequence number flag – 0 (Sequence number will be incremented)

- **$ ./transmit_packet 1 500 1**

Above command configures the PER packet

PER configuration Enable – 1

Length – 500 (500 bytes can be configured from the 'per_packet.txt' file)

Sequence number flag – 1 (Sequence number will not be incremented)

After starting this application, user has to enter the following command to stop the ongoing transmission:

- **$ ./transmit_packet 0**

Above command disables the PER packet configuration.i.e default PER packet will be sent when user runs 'transmit' utility.

5 Receive Tests

The receive tests can be invoked from an application called 'receive' which is found under 'release' directory. Use this application for displaying the following information

- Total number of CRC PASS packets
- Total number of CRC FAIL packets and
- Total number of FALSE CCA

5.1 Application Usage

The Rx performance is analyzed by the sensitivities at different data rates. In general, the sensitivity is observed as 10% Packet Error Ratio (PER) point in 11a and 11g, and 8% PER point in 11b.

PER: Packet Error Ratio (PER) is calculated by measuring the number of packets received correctly and comparing with the number of packets expected.

%Packet error rate = 100*(1- ((Received packets/expected packets))

For carrying out the receive test, connect the EVB to a Vector Signal Generator (VSG). Then set the RF amplitude, signal waveform and the channel in the signal generator before starting the receive tests.

You need to configure the channel (as mentioned below) in the EVB with the same channel which is set in Signal Generator.

The application can be started as follows to start receiving the packets from EVB. Go to 'release' folder.

- **$ ./receive <file> <channel number> <start - stop> <channel width>**

<file> is the name of the file into which the above information will be written. In addition, you can see this information on the console.

<channel number> is the channel number on which receive tests are to be done. For 2.4GHz channels, please refer table 1.

<start – stop value> is to either start or stop receive application. To start set this value to '0' and '1' to stop receive application.

<channel width> is the value of the operating bandwidth of the channel. Channel width values are specified in the following table.

Channel Width	Value
20MHz	0

Table 4 Channel Width

Example:

- **# ./receive stats 6 0 0**

The above mentioned command will start the receive application

File – stats

Channel number – 6

Start-Stop – 0, Start

Channel Width – 0 (20MHz)

The test utility displays the following information:

- Total number of received packets (with correct CRC).
- Total number of packets with CRC errors.
- Total number of FALSE CCA's received.

Compute the PER using the formula mentioned above.

 # ./receive stats 6 1 0

The above command will stop the receive application

File – stats

Channel number – 6

Start-Stop – 1, Stop

Channel Width – 0 (20MHz)

This will stop the receive application.

6 CW mode

CW mode stands for Continuous Wave mode which is used to evaluate performance of the module.

6.1 Single Tone Mode

In single tone mode of operation, either a sine wave or cosine wave is generated.

6.2 Application Usage

To enable/disable Continuous Wave or Continuous Waveform mode for evaluation, enter the following command at prompt in "release" directory and start transmit test

- **./onebox_util rpine0 cw_mode <channel> <start-stop> <type>**

<channel number> is the channel number on which transmit tests are to be done. For 2.4GHz channels, please refer table 1.

<start-stop> is to start (0) or stop (3) CW transmission.

<type> is for generating different type of waves

Example:

- **# ./onebox_util rpine0 cw_mode 6 0 1**

The above mentioned command will **start** continuous wave transmission

Channel number – 6

Start – 0,

Type – 1 Single tone

- **# ./onebox_util rpine0 cw_mode 6 3 1**

The above mentioned command will **stop** continuous wave transmission

Channel number – 6

Stop – 3,

Type – 1 Single tone

FCC and IC Declaration

This device complies with Part 15 of the FCC Rules.
Operation is subject to the following two conditions:
(1) This device may not cause harmful interference, and
(2) This device must accept any interference received, including interference that may cause undesired operation.
NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

This Class B digital apparatus complies with Canadian ICES-003.
Cet appareil numérique de la classe A est conforme à la norme NMB-003 du Canada.
This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the Following two conditions :(1) this device may not cause interference, and (2) This device
must accept any interference, including interference that may cause undesired operation of the device.
Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence.
L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et
(2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptibled'en compromettre le fonctionnement.

CAUTION: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment should be installed and operated with minimum distance 20 cm between the radiator & your body.

End Product Labelling

This Module is labelled with its own FCC ID. If the FCC ID Certification Number is not visible while installed inside another device, then the device should display the label on it referring the enclosed module. In that case, the final end product must be labelled in a visible area with the following:
"Contains Transmitter Module FCC ID: XF6-RS9113SB"
OR
"Contains FCC ID: XF6-RS9113SB"

The OEM should not provide information to the end user regarding installation or removal of this RF module or change RF related parameters in the user manual of the end product.

The OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed (for example, digital device emissions, PC peripheral requirements, etc.).

énoncé de la FCC (états-Unis seulement) Cet équipement a été testé et jugé conforme aux limites de Classe B pour un appareil numérique, en vertu de l'article 15 de la réglementation de la FCC. Ces limites ont été instaurées our fournir une rotection raisonnable contre toute interférence nuisible dans une installation résidentielle. Cet équipement génère, utilise et peut émettre de l'énergie radiofréquence. S'il n'est pas installé et utilisé conformément aux instructions, il peut provoquer des interférences sur les communications radio. Cependant, il n'est pas garanti que des interférences ne se produiront pas dans certaines installations. Si cet équipement cause des interférences à la reception radio ou télévisée (ce qui peut être vérifi é en éteignant l'appareil puis en le remettant sous tension),

l'utilisateur peut enter de ésoudre en suivant une ou plusieurs des mesures ci-après :
Réorienter ou déplacer l'antenne réceptrice.

ugmenter l'espace entre l'appareil et le récepteur. Brancher l'appareil à une prise de courant différente de celle sur laquelle le récepteur est branché. Pour obtenir de l'aide, contacter le vendeur ou un technician radio/television expérimenté.

REMARQUE: Toute modifi cation non autorisée expressément par le fabricant responsable de la
onformité peut annuler le droit de l'utilisateur à faire fonctionner le produit.

This Module is labelled with its own IC ID. If the IC ID Certification Number is not visible while installed inside another device, then the device should display the label on it referring the enclosed module. In that case, the final end product must be labelled in a visible area with the following:
"Contains Transmitter Module IC ID: 8407A-RS9113SB"
OR
"Contains IC ID: 8407A-RS9113SB"

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