

AN1279: RS9116W Wi-Fi AT Command Regulatory Test Application Note

Version 1.2

10/21/2020

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1 About

This document describes running the WLAN PER (Packet Error Rate) test.

2 Introduction

This document details the procedure/steps/requirements of the WLAN PER mode of WiSeConnect™, and the commands supported for it by using a UART interface. This document also describes the description of each command. The device under test uses the UART interface for communicating with the Master (External Application such as Docklight) for configuring the Wireless System and for logging the Wireless performance. PER MODE is used to perform regulatory certifications(FCC,ETSI,CE etc).

Note: This example is applicable to WiSeConnect™. The feature(s) used in this example may or may not be available on your part. Refer to the product datasheet to verify the features available.

3 Prerequisites

3.1 Hardware and Software Requirements

1. Required Windows PC.
2. WSC EVK
3. Install Tera-term application using the URL: <https://tssh2.osdn.jp/index.html.en>

3.2 Hardware Setup

1. Connect the USB cable to the UART port of the EVK and connect the other end to the PC.
2. Now the PC will detect the module as a UART device.

3.3 Terminology

1. EVK - Evaluation Kit.
2. UART - Universal Asynchronous Receive Transmit

4 Topic: WLAN PER

4.1 Description

This mode is used to calculate the packet error rate and mostly used during RF certifications test like FCC/IC/CE/TELEC.

4.2 Block Diagram

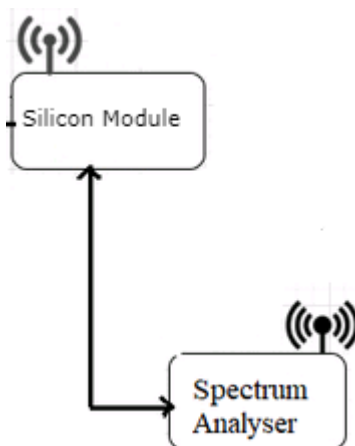


Figure : Tx Setup Diagram

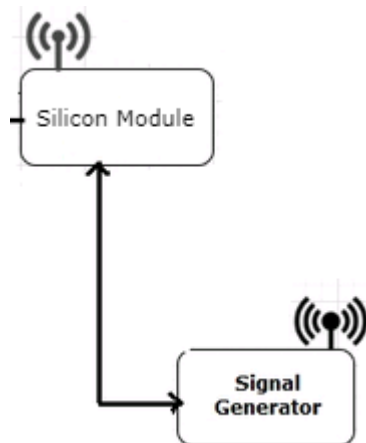


Figure 1: Rx Setup Diagram

4.3 Flow Chart

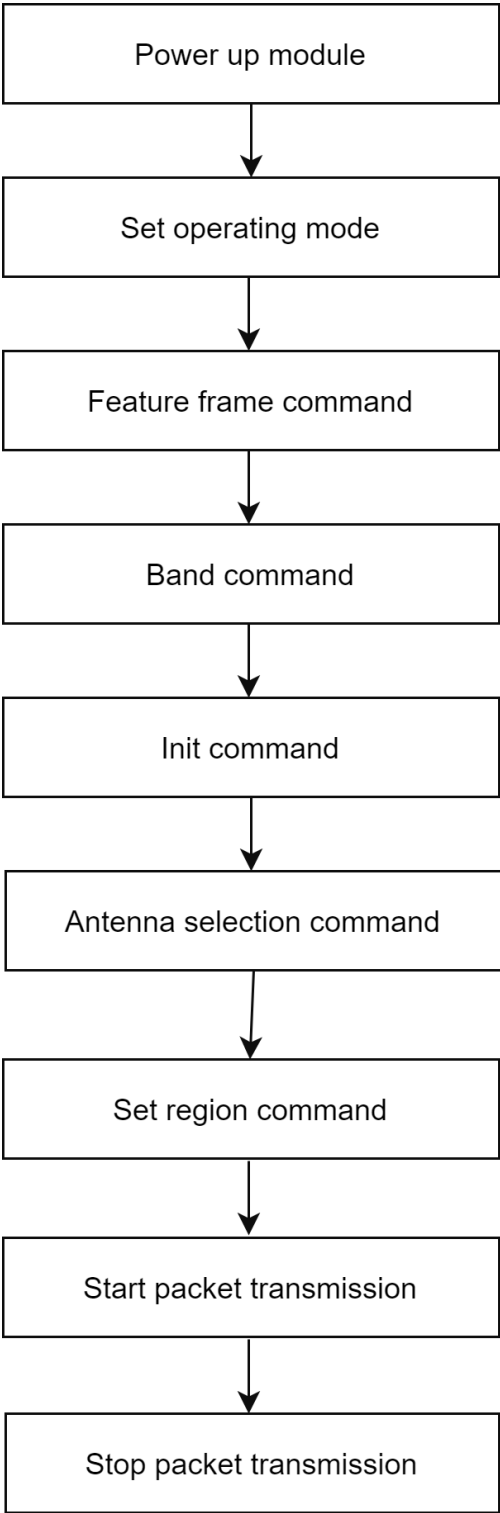


Figure 2: Flow Chart

5 Execution Steps

Wi-Fi PER MODES:

1. Burst Mode.
2. Continuous Mode
3. Continuous Wave Mode.

Commands Description:-

OPERMODE:

This command sets the operating mode of the module.

- **at+rsi_opermode=8\r\n**

Band :

This command sets the operating band of the module.

at+rsi_band=< bandVal >\r\n

Mode	Functionality
0	2.4GHZ
1	5GHZ
2	Dual band(2.4GHZ & 5GHZ)

- **at+rsi_band=0\r\n**

Feature frame:

This command sets the correct RF type and path .

at+rsi_feat_frame=<pll_mode>, <rf_type> ,<wireless_mode> ,<enable_ppp>, <afe_type>,<features_enable>\r\n

Flag	functionality
PLL_MODE:	<ul style="list-style-type: none"> • 0- PLLMODE0 - Used for generating the clocks for 20Mhz Bandwidth operations. • 1- PLLMODE1 -Used for generating the clocks for 40Mhz Bandwidth operations. • 2- PLLMODE2-Reserved
RF_TYPE[ONLY FOR 2GHz]:	<ul style="list-style-type: none"> • 0- To enable External_RF_8111, • 1- To enable Internal_RF_9116, • 2- AVIACOM_RF
WIRELESS_MODE:	<ul style="list-style-type: none"> • 12- To enable LP chain for PER mode • 0- LP chain disable
ENABLE_PPP:	<ul style="list-style-type: none"> • 0- Disable_per_packet_TX_programming, • 1- Enable_per_packet_TX_programming_mode_1, • 2- Enable_per_packet_TX_programming_mode_2
AFE:	<ul style="list-style-type: none"> • 0-AFE BYPASS, • 1- Internal AFE
FEATURE_ENABLES:	<ul style="list-style-type: none"> • BIT[0] - To enable Preamble duty cycling.

- BIT[4] - To enable LP chain for stand-by associate mode.
- BIT[5] - To enable hardware beacon drop during power save.

Note: Remaining bits are not user configurable.

- `at+rsi_feat_frame=0,1,0,0,1,0\r\n`

init:

This command initializes the module.

- `at+rsi_init\r\n`

Antenna :

This command is used to configure the antenna

- `at+rsi_antenna=<AntennaVal><Gain_2G>,<Gain_5G>,<antenna_path>,<antenna_type>\r\n`

Command Parameters:

AntennaVal:

0– RF_OUT_2/Internal Antenna is selected

1–RF_OUT_1/uFL connector is selected.

Note: rsi_antenna command must be given after rsi_init command .

Note: Currently Gain_2g,Gain_5g,antenna_path and antenna_type values are ignored.

- `at+rsi_antenna=0\r\n`

Set Region:

This command used to configure the device to operate according to the regulations of its operating country. This command should be immediately followed by init command.

- `at+rsi_setregion=<setregion_code_from_user_cmd>,<region_code>\r\n`

Command Parameters:

setregion_code_from_user_cmd:

Enable/Disable set region code from user

1 - Enable - Use the region information from user command

0 – Disable - Use the region information from beacon(country le)

Note:

1. In Wi-Fi Direct mode, setting the region information from beacon is not supported.
2. For world mode domain, setting the region information from beacon is not supported.

Region_code:

0/1-US domain(Default)

2-Europe domain

3-Japan Domain

4-World mode domain

Note:

1. In dual band mode, If country element extracted from beacon in 2.4Ghz band and 5Ghz band are not matching, error is thrown and region is set to US
2. Refer to the tables below for the region supported and domain rules followed by Silicon module

Relevance:

This command is relevant when the module is configured in Operating Mode 0,1,2,8 modes.

The tabulated rules are followed for the regions supported by the Silicon module.

Rule No	band	First channel	Number of channels	Last channel	Maximum power dBm	Scan type
1	2.4GHz	1	11	11	27	Active
2	5GHz	36	4	48	16	Active
3	5GHz	52	4	64	23	Passive
4	5GHz	100	5	116	23	Passive
5	5GHz	132	3	144	23	Passive
6	5GHz	149	5	165	29	Active

Table 1: Regulations followed for US domain

Rule No	band	First channel	Number of channels	Last channel	Maximum power dBm	Scan type
1	2.4GHz	1	13	13	20	Active
2	5GHz	36	4	48	23	Active
3	5GHz	52	4	64	23	Passive
4	5GHz	100	11	140	30	Passive

Table 2: Regulations followed for Europe domain

Rule No	band	First channel	Number of channels	Last channel	Maximum power dBm	Scan type
1	2.4GHz	1	14	14	20	Active
2	5GHz	36	4	48	20	Active
3	5GHz	52	4	64	20	Passive
4	5GHz	100	11	140	30	Passive

Table 3: Regulations followed for Japan domain

Note:

Though the transmit power levels w.r.t to region are greater than 20dBm, Silicon module is supporting maximum of 18dBm.

Example:

Setting Japan region.

- **at+rsi_setregion=1,3\r\n** (This command is mode setting in Japan Region)

Setting world mode region domain.

- **at+rsi_setregion=1,4\r\n**

PER(Transmit):

This command configures the PER (Packet Error Rate) Mode in RS9116-WiSeConnect.

at+rsi_per=<per_mode_enable>,<power>,<rate>,<length>,<mode>,<channel>,<rate_flags>,<aggr_enable>,<no_of_pkts>,<delay>\r\n

Command parameters:

per_mode_enable: To enable or disable the PER Mode

0 – Disable

1 – enable

power: To set Tx power in dbm

rate: To set transmit data rate

Data Rate(Mbps)	Value of rate
1	0
2	2
5.5	4
11	6
6	139
9	143
12	138
18	142
24	137
36	141
48	136
54	140
MCS0	256
MCS1	257
MCS2	258
MCS3	259
MCS4	260
MCS5	261
MCS6	261
MCS7	263

length:

To configure length of the tx packet. Valid values are in the range of 24 to 1500 bytes in the burst mode and range of 24 to 260 bytes in the continuous mode

mode: transmit mode

Mode	Functionality
0	Burst Mode
1	Continuous Mode
2	Continuous wave Mode (non modulation) in DC mode
3	Continuous wave Mode (non modulation) in single tone mode (center frequency -2.5MHz)
4	Continuous wave Mode (non modulation) in single tone mode (center frequency +5MHz)

Note:

Before starting Continuous Wave mode, it is required to start Continuous mode with power and channel values which is intended to be used in Continuous Wave mode i.e.

1. Start Continuous mode with intended power value and channel values - Pass any valid values for rate and length
2. Stop Continuous mode
3. Start Continuous Wave mode.

Continuous Wave mode supports only 1Mbps data rate.

channel: For setting the channel number in 2.4 GHz/5 GHz.

The following tables map the channel number to the actual radio frequency in the 2.4 GHz spectrum.

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
12	2467
13	2472
14	2484

Note:

To support PER mode in 12,13,14 channels, set region command has to be given by the host before PER command.

Channel numbers in 5 GHz range from 36 to 165. The following table map the channel number to the actual radio frequency in the 5 GHz spectrum for 20MHz channel bandwidth.

Channel Numbers (5 GHz)	Center frequencies for 20MHz channel width (MHz)
36	5180
40	5200
44	5220

48	5240
52	5260
56	5280
60	5300
64	5320
100	5500
104	5520
108	5540
112	5560
116	5580
120	5600
124	5620
128	5640
132	5660
136	5680
140	5700
144	5720
149	5745
153	5765
157	5785
161	5805
165	5825

The following tables map the channel number to the actual radio frequency in the 4.9 GHz spectrum for 802.11J.

Channel Numbers (4.9 GHz)	Center frequencies for 20MHz channel width (MHz)
184	4920
188	4940
192	4960
196	4980
8	5040
12	5060
16	5080

Note:

802.11J features are valid only when Japan region is set. For other regions even if 802.11J is enabled it has no effect.

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

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

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

Note: Short GI is not supported in this release.

Channel width should be set to zero to set 20MHz channel width.

Reserved1: reserved bytes. This field can be ignored. Set '0'

aggr_enable:

This flag is for enabling or disabling aggregation support.

Note:

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

Reserved2: reserved bytes. This field can be ignored. Set '0'

no_of_pkts:

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(0) then packets will be sent continuously until user stops the transmission. This field will be ignored in case of continuous mode

delay:

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 (0) then packets will be sent continuously without any delay. This field will be ignored in case of continuous mode.

Note:

Only per_mode_enable , power, rate, length , mode, channel, rate_flags fields are valid. Remaining fields are not supported.

5.1 Sample Flow for WLAN PER

A)Burst Mode

```
at+rsi_opermode=8\r\n
```

This command sets the operating mode of the module.

```
at+rsi_band=0\r\n
```

This command sets the operating band of the module.

```
at+rsi_feat_frame=0,1,0,0,1,0\r\n
```

This command sets the correct RF type and path

```
at+rsi_init\r\n
```

This command initializes the module.

```
at+rsi_antenna=0\r\n
```

This is the command for antenna .

```
at+rsi_setregion = 1,4\r\n
```

This command configures the region to worldwide

```
at+rsi_per=1,127,139,1000,0,6,0,0,0,0\r\n
```

This command sends the packets in burst mode in channel number 6, with packet length 1000, with max power, with data rate 6Mbps.

```
at+rsi_per=0\r\n
```

To stop transmission.

B)Continuous Mode:

```
at+rsi_opermode=8\r\n
```

This command sets the operating mode of the module.

```
at+rsi_band=0\r\n
```

This command sets the operating band of the module.

```
at+rsi_feat_frame=0,1,0,0,1,0\r\n
```

This command sets the correct RF type and path

```
at+rsi_init\r\n
```

This command initializes the module.

```
at+rsi_antenna=0\r\n
```

This is the command for antenna .

```
at+rsi_setregion = 1,4\r\n
```

This command configures the region to worldwide

```
at+rsi_per=1,127,139,260,1,6,0,0,0,0\r\n
```

This command sends the packets in continuous mode in channel number 6, with packet length 260, with max power, with data rate 6Mbps.

```
at+rsi_per=0\r\n
```

To stop transmission.

C)Continuous Wave Mode:

```
at+rsi_opermode=8\r\n
```

This command sets the operating mode of the module.

```
at+rsi_band=0\r\n
```

This command sets the operating band of the module.

```
at+rsi_feat_frame=0,1,0,0,1,0\r\n
```

This command sets the correct RF type and path

```
at+rsi_init\r\n
```

This command initializes the module.

```
at+rsi_antenna=0\r\n
```

This is the command for antenna .

```
at+rsi_setregion = 1,4\r\n
```

This command configures the region to worldwide.

Before running the Continuous Wave mode need to start the Continuous mode, then will stop the continuous mode and give the Continuous Wave mode.

```
at+rsi_per=1,127,139,260,1,6,0,0,0,0\r\n
```

Stop the PER mode

```
at+rsi_per=0\r\n
```

This command sends the packets in continuous Wave mode in channel number 6, with packet length 260, with max power, with data rate 1Mbps.

```
at+rsi_per=1,127,0,260,2,6,0,0,0,0\r\n
```

D)PER Stats :

PER Statistics of the Module:

This command is used to get the Transmit (Tx) & Receive (Rx) packets statistics. When this command is given by the host by enabling this feature with valid channel number, the module gives the statistics to host for every second until this feature is disabled. This command can be given after init command.

```
at+rsi_per_stats=< per_stats_enable >,< per_stats_channel >\r\n
```

Command Parameters:

parameter	values
per_stats_enable	Enable /disable per status feature <ul style="list-style-type: none"> 0 – Enable 1 – Disable
per_stats_channel	valid channel number in which user wants to get the stats. Channel number is not required if the first parameter is 1(Disable)

To enable the PER stats.

- `at+rsi_per_stats=0,1\r\n`

To disable the PER stats.

- `at+rsi_per_stats=1\r\n`

To stop transmit:

```
at+rsi_per=0\r\n
```

WLAN PER Modes Execution procedure :

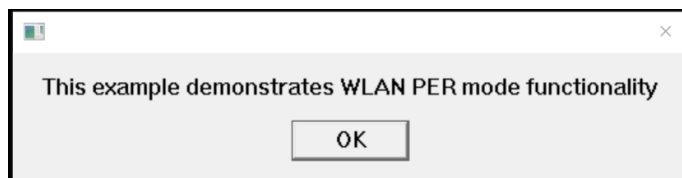
Please refer to **Appendix A: Running Tera Term Scripts** section for usage of Tera-term to run the scripts in the [UG453: RS9116W EVK User's Guide](#) from <https://docs.silabs.com/rs9116>

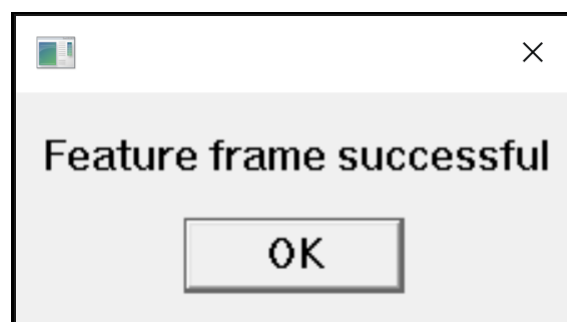
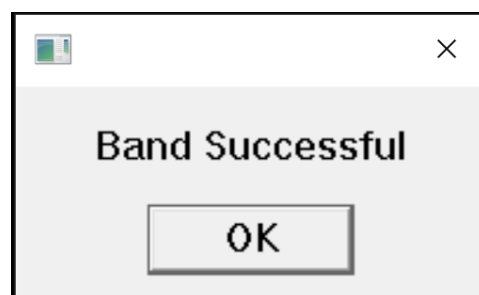
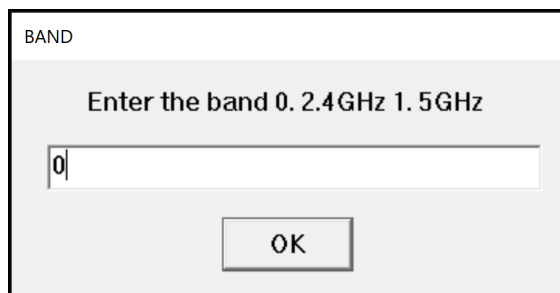
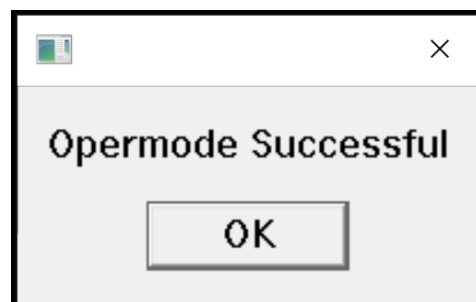
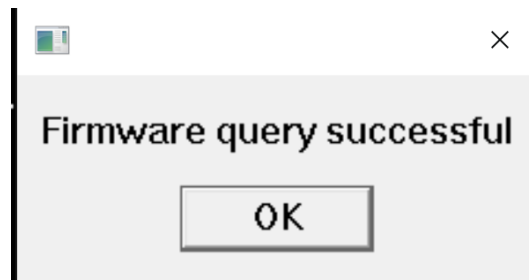
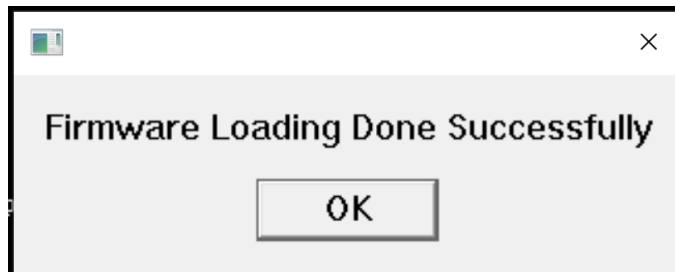
1) Burst Mode:

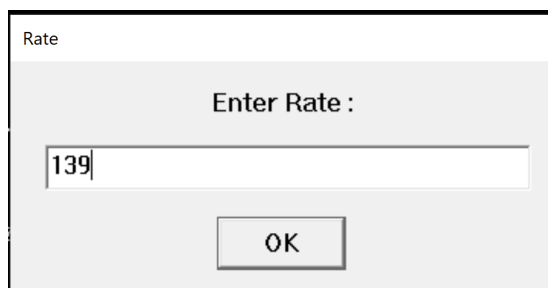
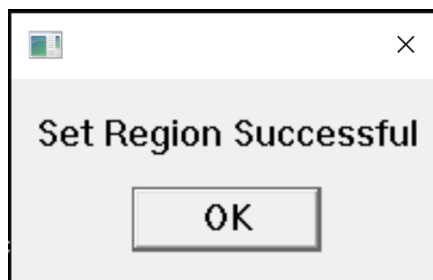
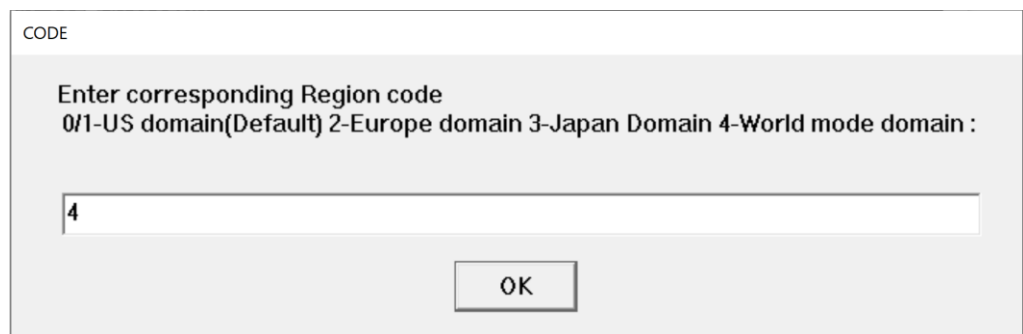
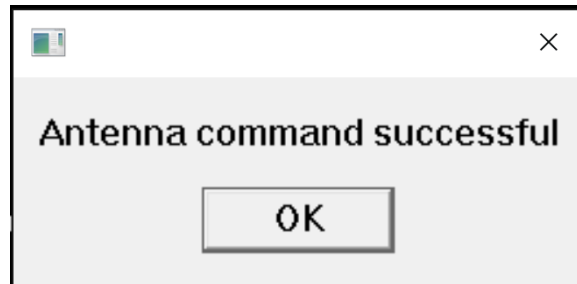
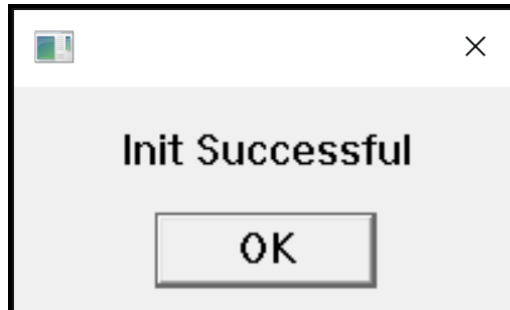
This command sends the packets in Burst mode in channel number 6, with packet length 1000, with Max power, with data rate 6Mbps.

- `at+rsi_per=1,127,139,1000,0,6,0,0,0,0\r\n`

Once you run the script it will ask the inputs like below.







Channel

Enter Channel number :

OK

Mode

Enter PER mode 1.Burst mode 2.Continuous mode 3.Continuous Wave mode

OK

Length

Enter length Valid values are in the range of 24 to 1500 bytes in the Burst mode :

OK

Burst Per command Executed Successful

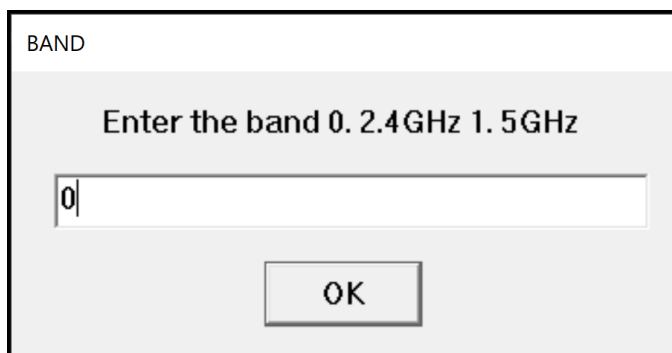
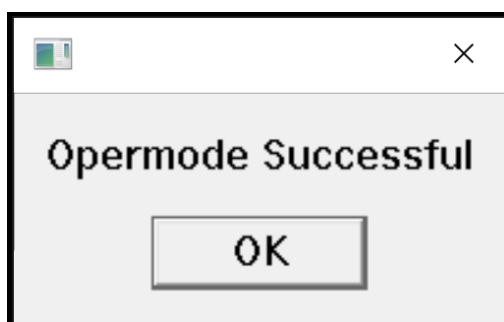
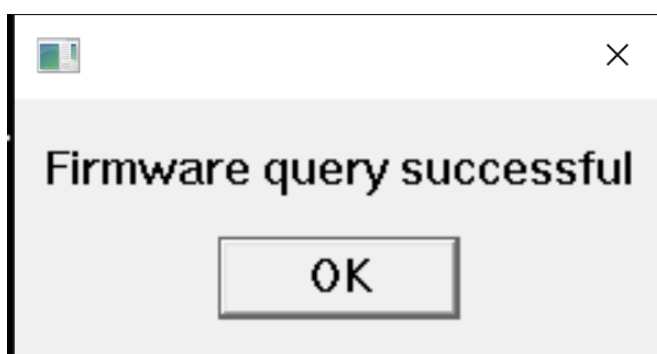
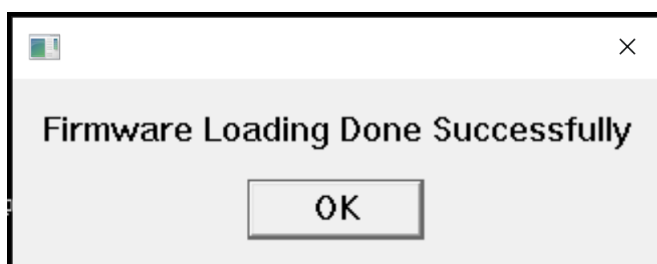
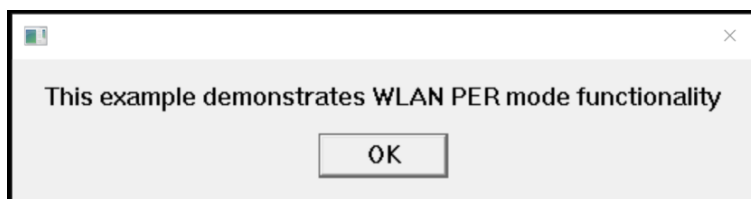
OK

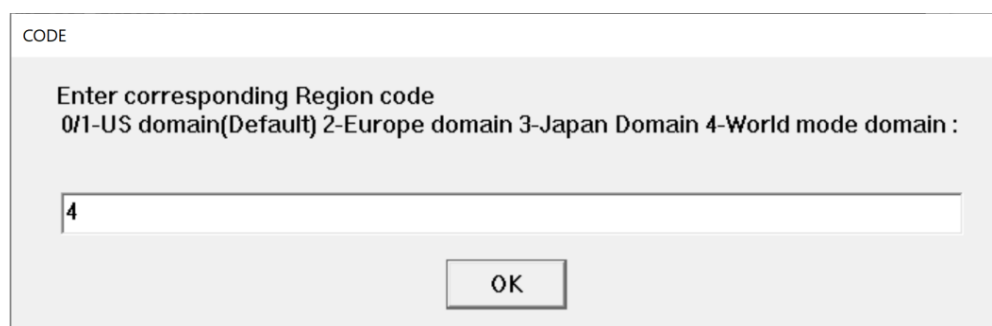
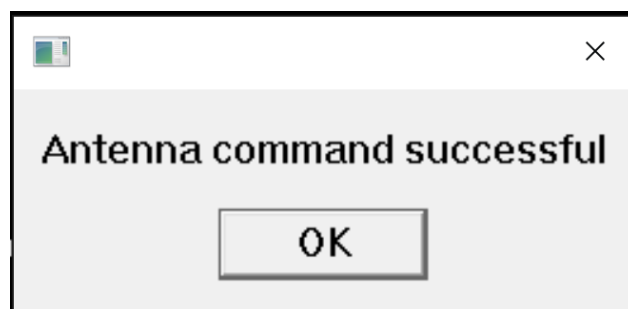
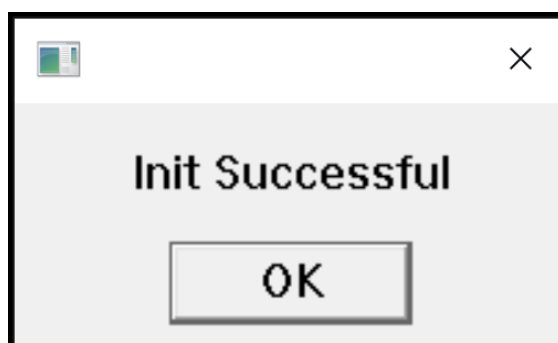
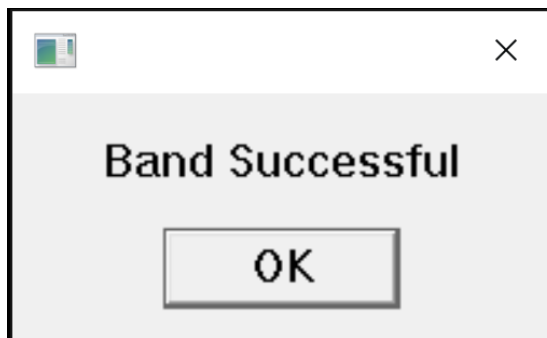
```
COM4:115200baud - Tera Term VT
File Edit Setup Control Window Help
Loading Done
at+rsi_fwversion?
OK1610.2.0.0.0019
at+rsi_opermode=8
OK
at+rsi_band=0
OK
at+rsi_feat_frame=0,1,0,0,1,0
OK
at+rsi_init
4F 4B 88 DA 1A 8E 70 DC 0D 0A at+rsi_antenna=0
OK
at+rsi_setregion=1,4
OK
at+rsi_per=1,127,139,1000,0.6,0,0,0
OK
```


2) Continuous Mode:


This command sends the packets in continuous mode in channel number 6, with packet length 260, with Max power, with data rate 6Mbps.

- `at+rsi_per=1,127,139,260,1,6,0,0,0,0\r\n`









Set Region Successful

OK

Power

Enter Power level :

127

OK

Rate

Enter Rate :

139

OK

Channel

Enter Channel number :

6

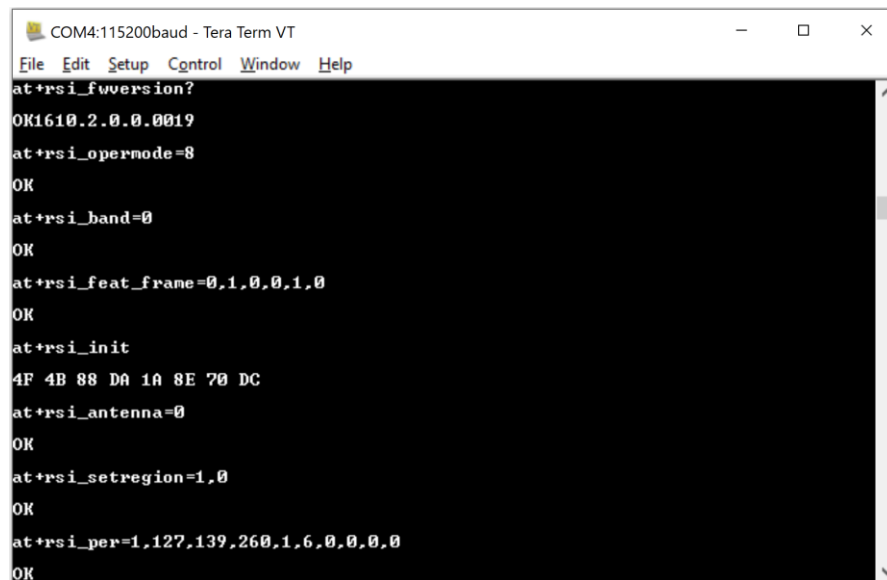
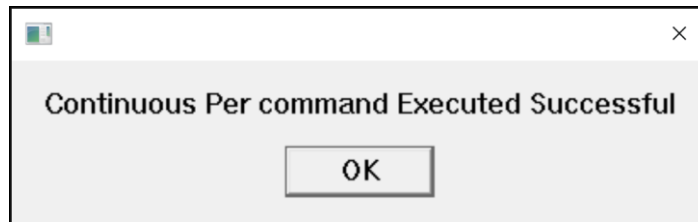
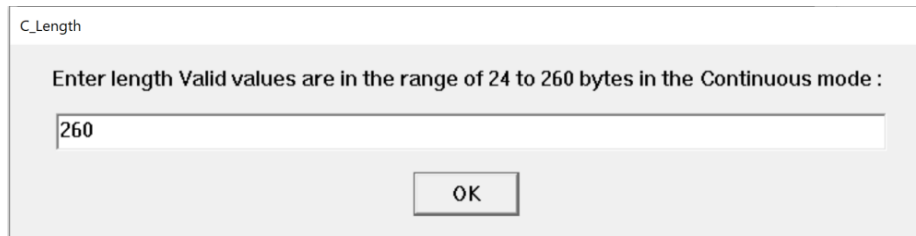
OK

Mode

Enter PER mode 1.Burst mode 2.Continuous mode 3.Continuous Wave mode

2

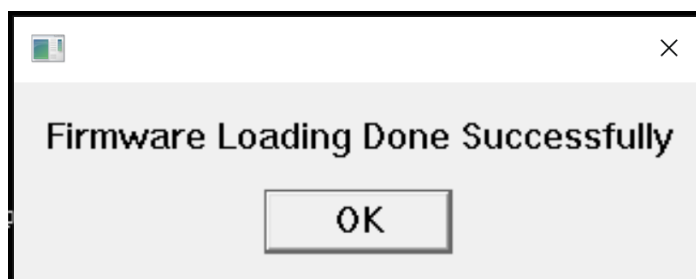
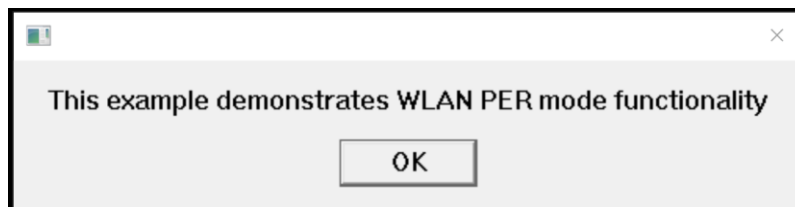
OK

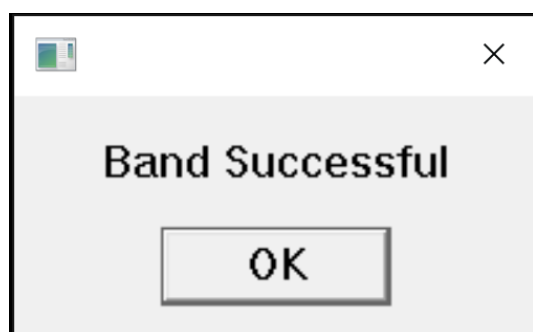
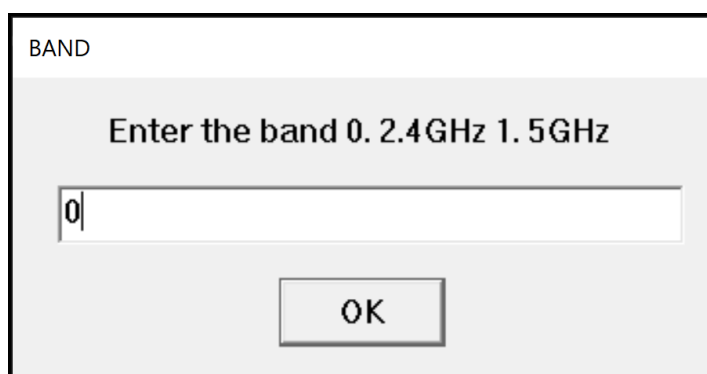
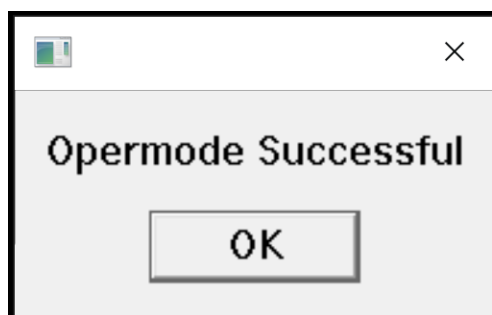
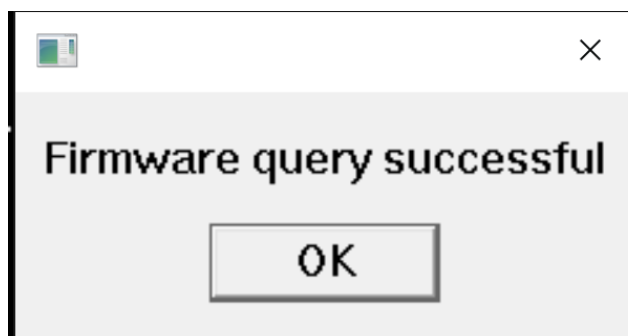


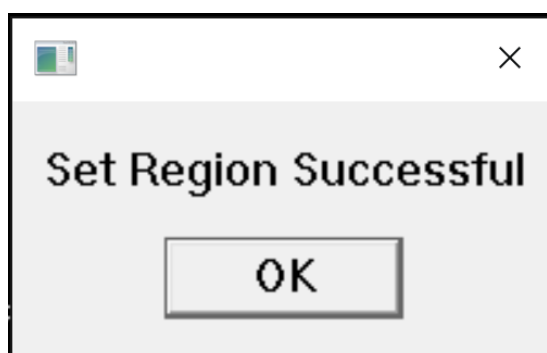
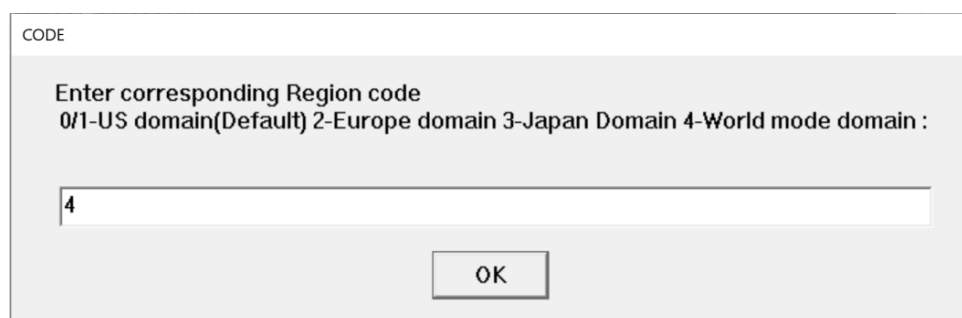
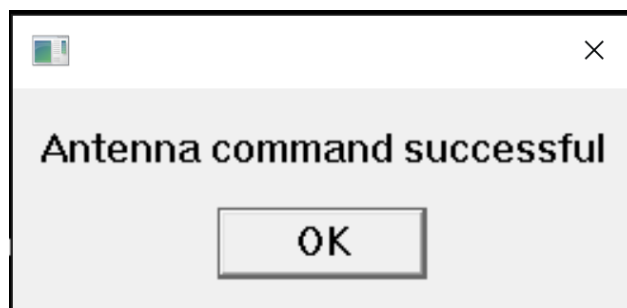
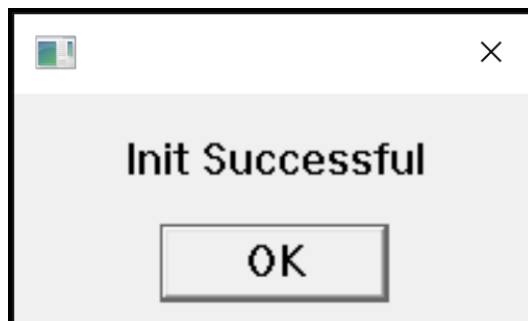
3) Continuous Mode:

This command sends the packets in continuous Wave mode in channel number 6, with packet length 260, with Max power, with data rate 1Mbps.

- `at+rsi_per=1,127,0,260,1,6,0,0,0,0\r\n`







Rate

Enter Rate :

OK

Channel

Enter Channel number :

OK

Mode

Enter PER mode 1.Burst mode 2.Continuous mode 3.Continuous Wave mode

OK

C.Length

Enter length Valid values are in the range of 24 to 260 bytes in the Continuous mode :

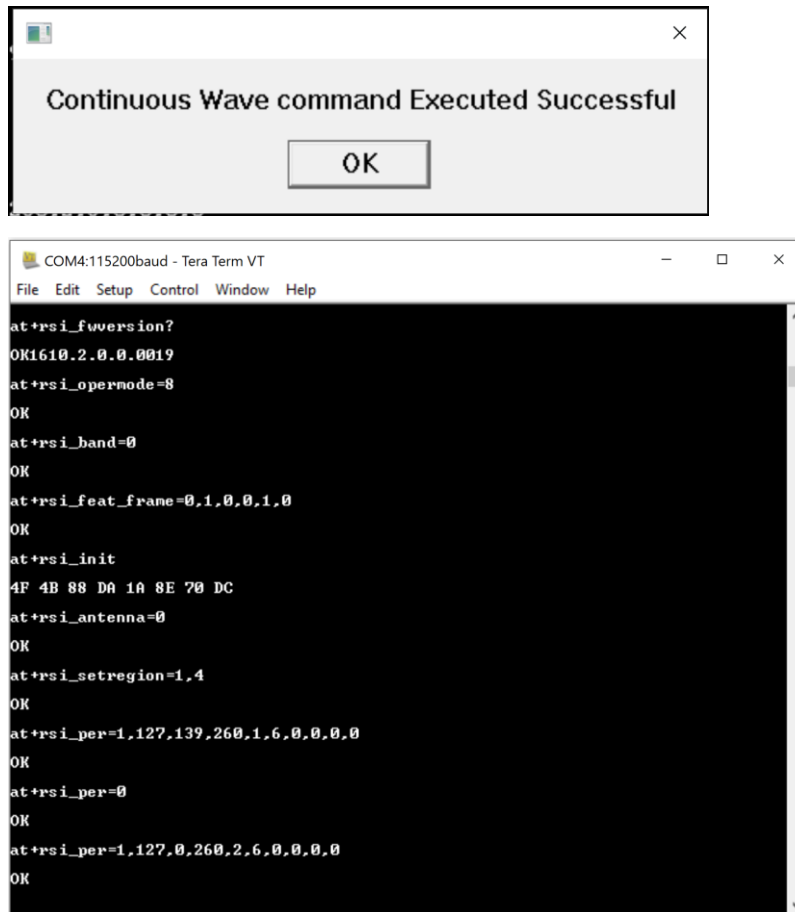
OK

Continuous Per command Executed Successful

OK

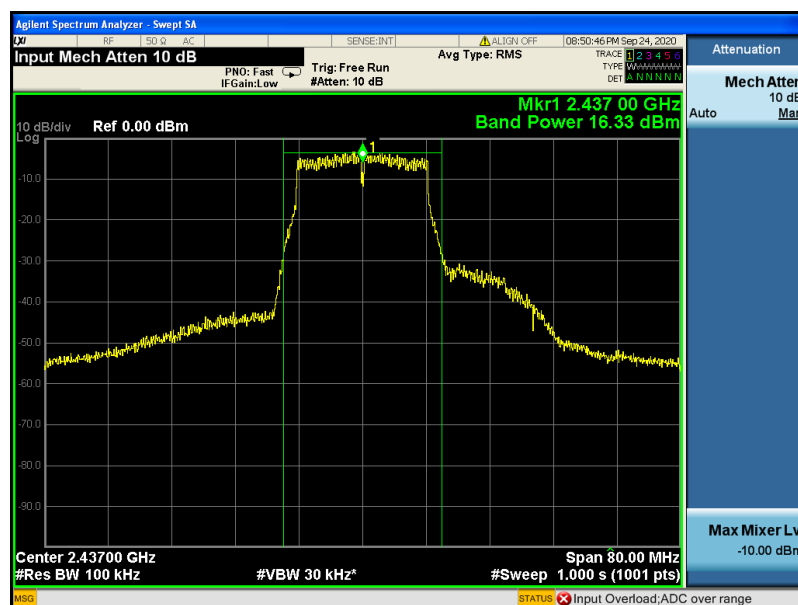
PER mode stopped

OK

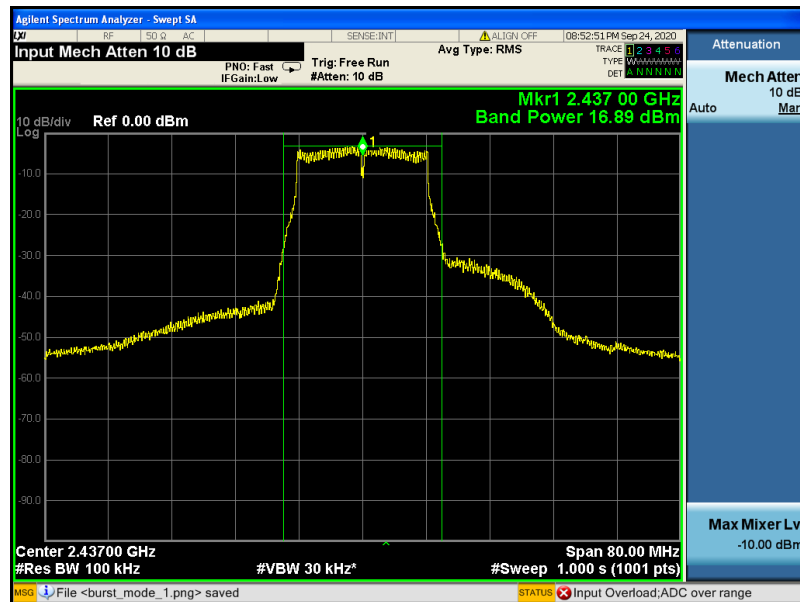


5.2 Expected Result

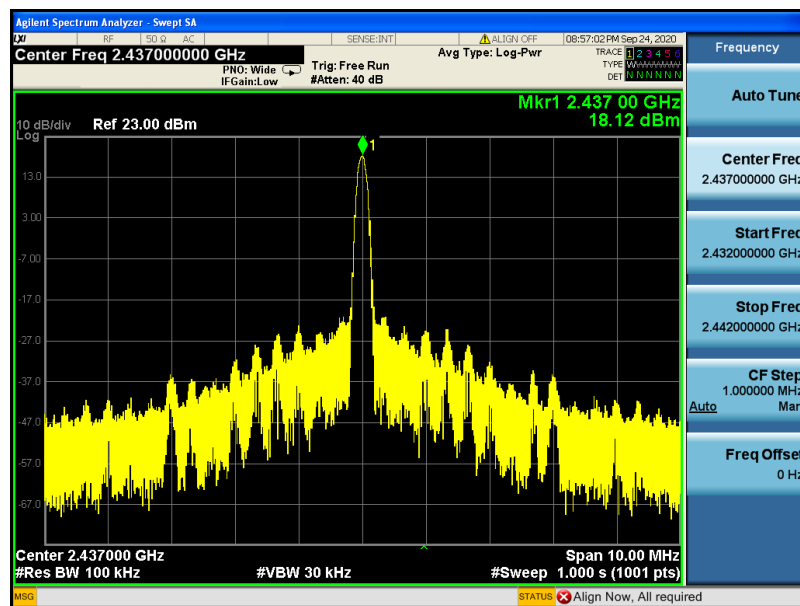
- The output power may vary based on cable lose in conducted test.
- Conducted test: In this test u.FL port will be directly connected to Spectrum Analyser.
- Radiated test : In this test the signal receiver will receive the traffic from the module wirelessly.
- The below result is for PER Mode with CHANNEL 6 with 6Mbps and max 127dBm POWER in **Burst mode**



- The below result is for PER Mode with CHANNEL 6 with 6Mbps and max 127dBm POWER in **Continuous mode**



- The below result is for PER Mode with CHANNEL 6 with 1Mbps and max 127dBm POWER in **Continuous Wave** mode



6 Summary

To verify the PER Mode in WLAN , user can use the above mentioned command sequences.

7 References and Related Documentation

Refer to [RS9116W Wi-Fi AT Command Programming Reference Manual](https://docs.silabs.com/rs9116) from <https://docs.silabs.com/rs9116>

Refer to [AN1282: RS9116W Guide for SAPI Application Examples](https://docs.silabs.com/rs9116) from <https://docs.silabs.com/rs9116>

Refer to RS9116.NB0.WC.GENR.OSI.x.x.xx\host\sapis\examples\wlan\transmit_test for WLAN PER SAPI's example.

8 Troubleshooting

1. If the UART port is not detected by the PC, please reset the module and try again.
2. After every iteration of measuring with the spectrum analyzer, make sure the module has been properly reset. Either use the button provided on the module or re-connect the module to the PC.
3. It is necessary to stop the PER transmit before switching to other PER Mode.

9 Appendix A: Running Tera Term Scripts

Here is the script code for WLAN_PER Transmit & Receive.

```
TRUE = 1
FALSE = 0

message = 'This example demonstrates WLAN PER mode functionality'
messagebox message ''

send '|'
wait 'U'
sendln 'U'
mpause 200
sendln '1'
wait 'Loading Done'
message = 'Firmware Loading Done Successfully'
messagebox message ''

sendln 'at+rsi_fwversion?'
wait 'OK' 'ERROR'
if result == 2 then
    goto error
else
    messagebox 'Firmware query successful' ''
endif

sendln 'at+rsi_opermode=8'
wait 'OK' 'ERROR'
if result == 2 then
    goto error
else
    messagebox 'Opermode Successful' ''
endif

inputbox 'Enter the band 0. 2.4GHz 1. 5GHz ' 'BAND'
BAND = inputstr

sendln 'at+rsi_band='BAND
wait 'OK' 'ERROR'
if result == 2 then
    goto error
else
    messagebox 'Band Successful' ''
endif

sendln 'at+rsi_feat_frame=0,1,0,0,1,0'
wait 'OK' 'ERROR'
if result == 2 then
    goto error
else
    messagebox 'Feature frame successful' ''
endif

sendln 'at+rsi_init'
setdebug 2 ; output is in binary, so best to display in hex format
wait '4F 4B' '45 52' ; 'OK' or 'ER'
setdebug 0
if result == 2 then
    goto error
else
    messagebox 'Init Successful' ''
endif

mpause 1000

sendln 'at+rsi_antenna=0'
wait 'OK' 'ERROR'
if result == 2 then
    goto error
else
```



```

        messagebox 'Antenna command successful' ''
    endif

    inputbox 'Enter corresponding Region code '#10#13' 0/1-US domain(Default) 2-Europe domain 3-Japan
    Domain 4-World mode domain :' 'CODE'
    CODE = inputstr

    sendln 'at+rsi_setregion=1,'CODE
    wait 'OK' 'ERROR'
    if result == 2 then
        goto error
    else
        messagebox 'Set Region Successful' ''
    endif

    inputbox 'Enter Power level :' 'Power'
    Power = inputstr

    inputbox 'Enter Rate :' 'Rate'
    Rate = inputstr

    inputbox 'Enter Channel number :' 'Channel'
    Channel = inputstr

    inputbox 'Enter PER mode 1.Burst mode 2.Continuous mode 3.Continuous Wave mode' 'Mode'
    Mode = inputstr

    strcmpare Mode '1'
    if result=0 then
        inputbox 'Enter length Valid values are in the range of 24 to 1500 bytes in the Burst mode
        :' 'Length'
        Length = inputstr
        sendln 'at+rsi_per=1,'Power','Rate','Length',0,'Channel',0,0,0,0'
        wait 'OK' 'ERROR'
        if result == 2 then
            goto error
        else
            messagebox 'Burst Per command Executed Successful' ''
        endif
    endif

    strcmpare Mode '2'
    if result=0 then
        inputbox 'Enter length Valid values are in the range of 24 to 260 bytes in the Continuous mode
        :' 'C_Length'
        C_Length = inputstr
        sendln 'at+rsi_per=1,'Power','Rate','C_Length',1,'Channel',0,0,0,0'
        wait 'OK' 'ERROR'
        if result == 2 then
            goto error
        else
            messagebox 'Continuous Per command Executed Successful' ''
        endif
    endif

    strcmpare Mode '3'
    if result=0 then
        inputbox 'Enter length Valid values are in the range of 24 to 260 bytes in the continuous mode
        :' 'CW_Length'
        CW_Length = inputstr
        sendln 'at+rsi_per=1,'Power','Rate','CW_Length',1,'Channel',0,0,0,0'
        wait 'OK' 'ERROR'
        if result == 2 then
            goto error
        else
            messagebox 'Continuous Mode Per command Executed Successful' ''

            sendln 'at+rsi_per=0'
            wait 'OK' 'ERROR'
            if result == 2 then
                goto error
            else
                messagebox 'PER mode stopped' ''
            endif
        endif
    endif

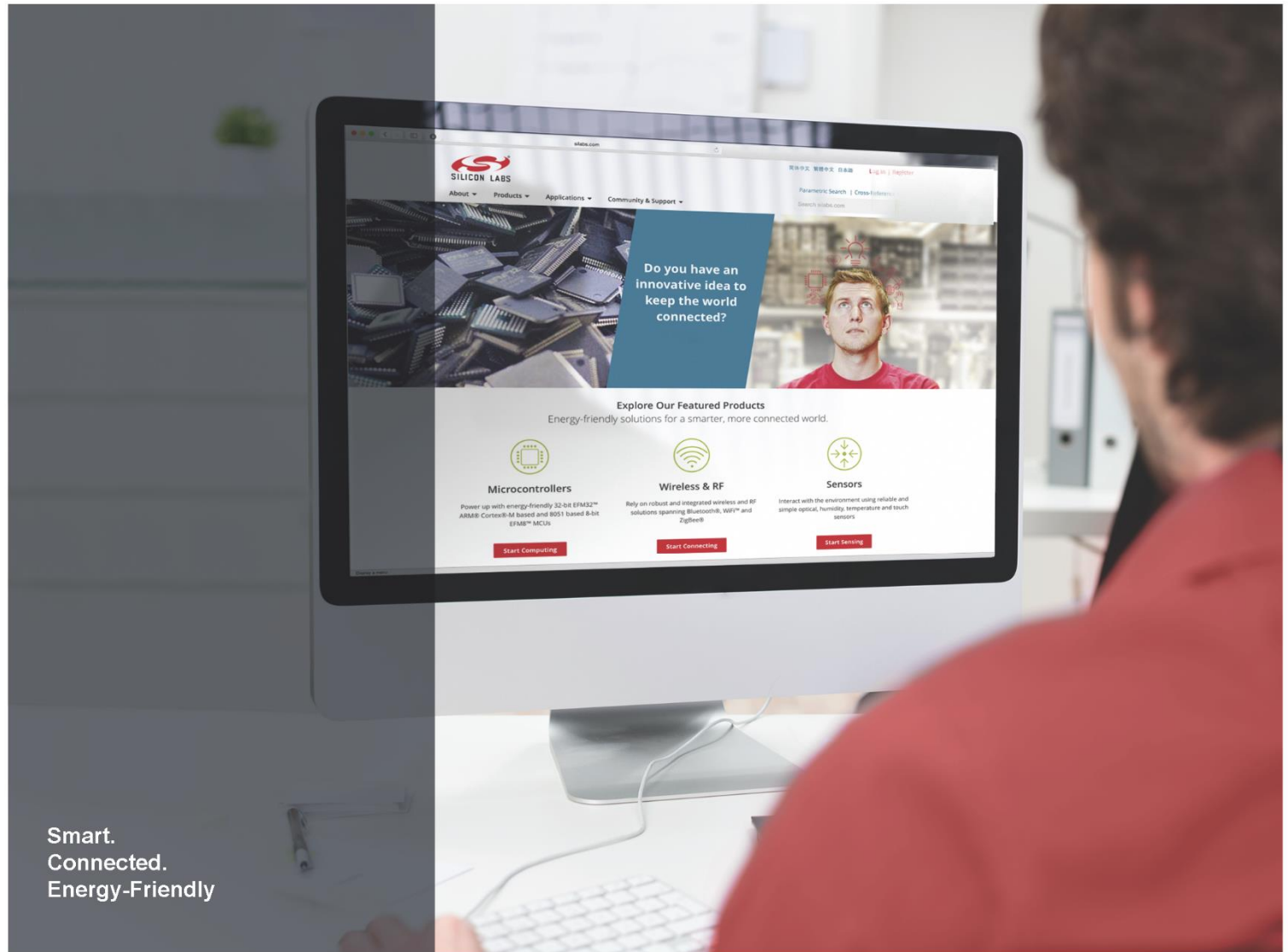
```

```
mpause 5
inputbox 'Enter Data rate for Continuous Wave mode it supports only 1Mbps:'
'CW_Rate'
CW_Rate = inputstr
sendln 'at+rsi_per=1,'Power','CW_Rate','CW_Length',2,'Channel',0,0,0,0'
wait 'OK' 'ERROR'
if result == 2 then
    goto error
else
    messagebox 'Continuous Wave command Executed Successful' ''
endif
endif
goto endscrip

:error
messagebox 'An error occurred, Please check your configuration and try again' 'ERROR'
:endscript
end
```

10 Revision History

Revision No.	Version No	Date	Changes
1	1.1	May, 2020	Initial version
2	1.2	Oct, 2020	1.Updated the command sequences based on latest Updates in PRM 2.Updated the screenshots with TTL images 3. Added APPENDIX for TTL Script which is used for this app notes. 4. Updated the links and document names



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