RS9113
PHY Evaluation Test Utility
User Guide for Linux

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1. Introduction

Thepurposeofthisdocumentistoprovidetheusageoftheapplicationsfor transmit and receiveteststoevaluatetheRFperformanceoftheRS9113™(RS9113)usingatestdriver in Linuxenvironment.Theevaluationboardprovidesthenecessaryconnectorsso that youcanmeasuretransmitand receiveperformance ofthePHY,usingSpectrumAnalyzerandSignalGeneratorineither2.4GHzor5GHz(ForRS9113 module).
Ingeneral,transmit performanceofaradio canbeanalyzedinthreesteps.

Maximumpower: Theusercanobserve theRFoutputpowerforagiven maximumgain supportedbytheRF.
EVM: TheusercanobservetheEVMforagivenratedRFpowerassupportedbytheRF transceiver.

SpectralMask: Theusercanverify whethertheRS9113™modulemeetsthespectralmaskrequirementsdefinedby IEEEstandardforagivenmaximumRFoutputpower,inaparticularmodeofoperationlike11 a,11b,11getc.

The receiveperformance ofthePHYcanbeanalyzedusingPacketErrorRatio(PER)test.

TheRxperformanceisanalyzedbythesensitivitiesatdifferentdatarates. Ingeneral, thesensitivityisobservedas10%Packet ErrorRatio(PER)pointin11aand11g,and8%PERpoint in11b.

Thedocumentcontains twomajorsections.

Section3 describestheusageofthe‘transmit’utility,which providesthe optionsforsettingvariousparameterstocarryout transmittestsontheRS9113™device.

Section4 describestheusageofthe‘receive’utility,whichenablestheusertoperform receivetestsontheRS9113™device.

2. Test SetupDetails

Thediagramshownbelow,illustrates thetest setupforevaluatingreceive and transmitperformanceofRS9113™ WLANmodule.

Asshownin thetestsetup,the RS9113™evaluationboard(EVB)is plugged intoLinuxbasedlaptop eitherontheSDIO slotviaSDIOconnectoror USBport viaUSBcablethroughport J6 ontheEVB.TheboardisconnectedtoaWLANsignalanalyzerthroughamicrowaveco axialcabletotesttheTxperformance.

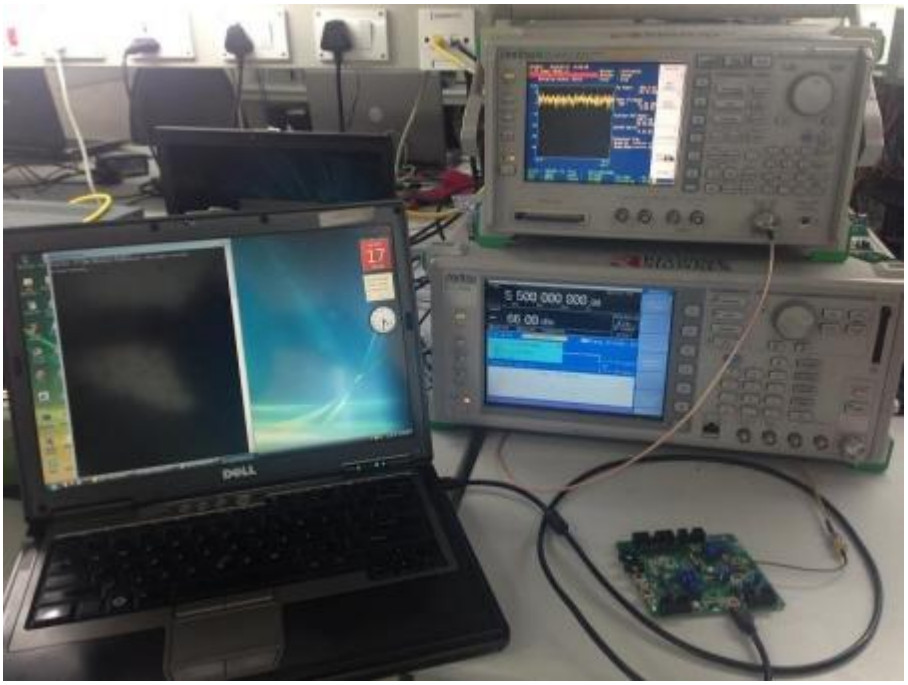


Figure 1: Linux Based RF Evaluation Setup With USB Interface

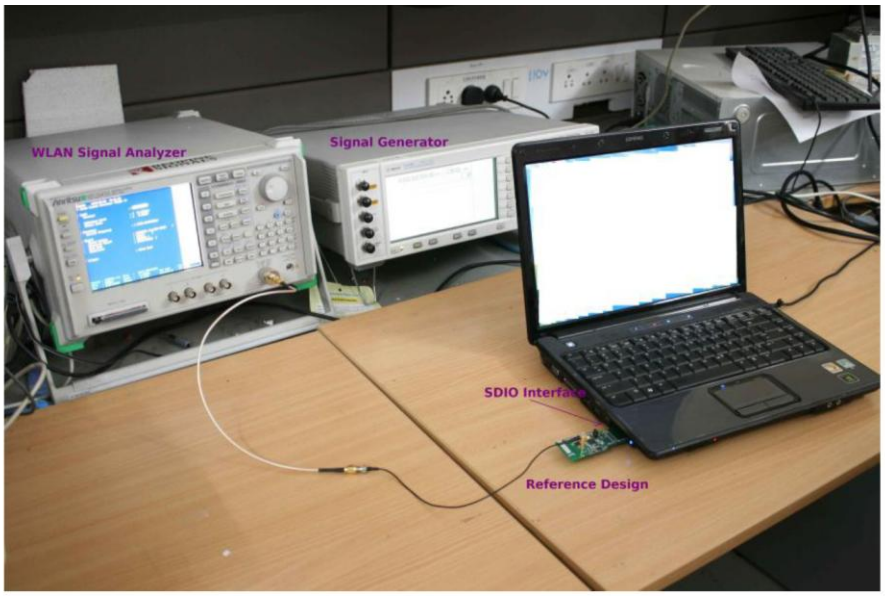


Figure 2: Linux Based RF Evaluation Setup With SDIO Interface

Followingdiagramillustratesvarioussoftwarecomponentsinvolvedinperforming TxandRxtests usingspectrumanalyzerandsignalgeneratorrespectively.

The‘transmit’utilityisacommandlineapplicationtoperform Txtests.Beforerunning theTxtests,theuserisexpectedtoconnectRS9113™ toasignalanalyzerusing theRFcable.

The‘receive’utilityisalsoaseparatecommandlineapplicationthat canbeusedfor displayingstatisticson the receivedpacketswhilecarrying outthereceivesensitivity tests.

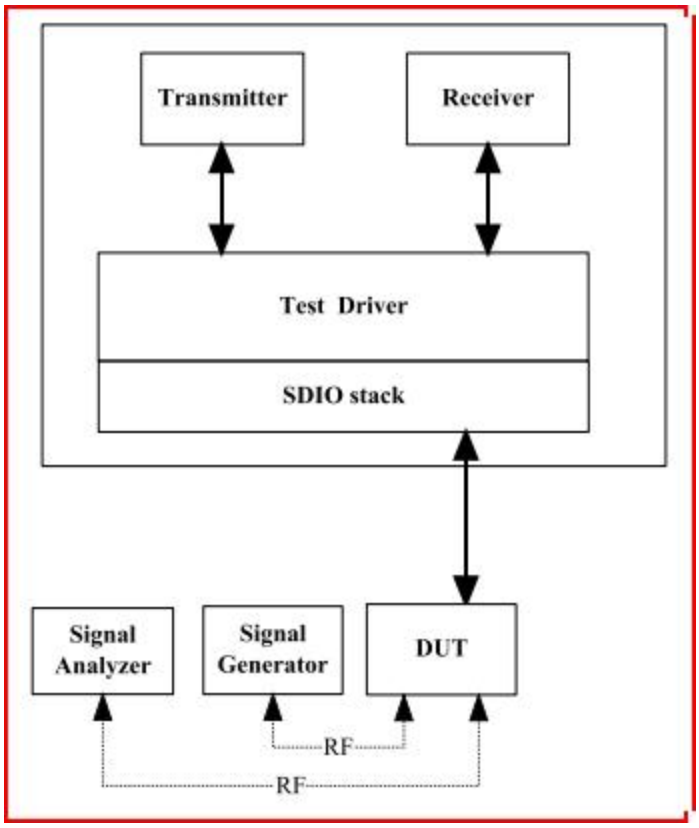
Pleasefollow“RS9113-SW-Installation-Guide”forbuildingandinstallingtheRS9113™driver.

Toconfigurethedriver in“PER”Modemakesuretohavethe followinglinein“release/insert.sh”.

DRIVER_MODE=2

Afterthe cardhasbeendetectedsuccessfully(issue“*dmesg–c*”interminaltocheckthestatusfortheUSBcarditwillshow“newhigh-speedUSBdevicedetection”whilefortheSDIO itwillshow“newHigh speedSDIOcard detected”)theTxandRxtestscanbe started.Pleasefollowthesubsequentsections for executingtheTxandRxtests

Figure 3: Utility Diagram



Whendriveris compiled in“host”directorydriver wouldbeusingbinariesfrom“release”.

Iftherearеanymodificationsin“host”directorythendrivercompilationisrequired.

TheRS9113 driverofferstwomainmodesof operation:

1. End-end,orWi-Fimode
2. PERmodeforPHYevaluation

Toconfigurethedriver inWi-Fior(END-to-END)Modemake suretohavethefollowinglinein“release/insert.sh”.

DRIVER_MODE=1

InordertoconfigurethedriverinPHYEvaluationmode(PERmode)thenmakesurethe“DRIVER_MODE”parametershould besetasDRIVER_MODE=2

3. Transmit Tests

Ingeneral,beforeperforming anytestsconfigure thePHYtooperateintheappropriateband.Thetransmittestscanbeperformedthrougha utilitycalled‘transmit’whichisfoundunder ‘release’directory.

Configurethefollowingparametersthroughthisapplicationbeforerunningthetests.

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 ApplicationUsage

Theapplicationcanbestartedinthefollowingmanner:

#cdrelease

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

ntrollingtransmit power.

<r>refersto TxRate.

<l>referstolengthoftheTxpacket

<m>referstoTransmitmode.

0 –Burst Mode

1 –ContinuousMode

<c>referstoChannelnumber

<p>referstoExternalPA-Enable/disable

<f>referstoShortGI,GreenfieldandChannelWidth.

<a>referstoenable/disableaggregation

<n>referstonumber ofpacketstosendinburstmode.

<d>referstodelaybetweenpacketsinburstmode

Afterstartingthisapplication,userhastoenterthefollowingcommandto stoptheongoingtransmission:

#./transmit<m>

<m>- 0forBurstMode

1for ContinuousMode

Setpower value:

TosetTxgainvalue,enteravalid valuefor<p>parameter.Thevalidvaluesarefrom229to255forRS9113module U.Thetransmit powerincreasesproportionatelywithincreaseinTxgainvalueinOFDMandCCK modes.Thissupportisnotpresentinthisrelease.

SetDataRate:

Tosettransmitdatarate,enteravalidratefor<r>parameter.

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

SetPacketLength:

Forsettingthetransmissionpacketlength,enteravalidvaluefor<l>parameter.

Validvaluesareintherangeof24and1500.Thevaluesareinbytes.

SetTransmitMode:

Forsettingthetransmissionmode,youneedtoenteroneofthefollowingvaluesfor<m>parameter.

1forcontinuousmode

0forburstmode.

SetChannel number:

Forsettingthechannelnumber in2.4GHzyouneedtoenteravalueintherange1–11for<c>parameter.

Thefollowingtablesmapthechannelnumbertotheactualradiofrequencyinthe2.4GHzspectrumfor20MHzchannelwidth.

Channel Numbers(2.4GHz)	Center frequenciesfor 20MHzchannel 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

Channelnumbersin5GHzarerangingfrom36–165.Thefollowingtablesmapthechannelnumberto theactual radiofrequencyinthe5GHzspectrumfor20MHzchannelwidth.

Channel Numbers(5GHz)	CenterFrequencies for20MHz Channel Width (MHz)
36	5180
40	5200
44	5220
48	5240
149	5745
153	5765
157	5785
161	5805
165	5825

Table 2 Channel Number and Frequencies for 20MHz Channel Width in 5GHz

SetExternalPAenable/disable:

IfthemodulecontainsanexternalPA,toenabletheusageofthe PA, entera valueof1,elseenteravalueof0.Thissupportiscurrently nothandledindriver.

SetRateflags:

RateflagscontainshortGI,Greenfield and channel width values.Variousfieldsinrate flags aredividedasspecifiedbelow

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

Table 3 Rate Flags

ToenableshortGI–setrateflagsvalueas‘1’

ToenableGreenfield–setrateflags valueas‘2’

Tosetchannelwidthuseoneofthevaluesspecifiedinthetablebelow:

ChannelWidth	Rateflagvalues
20MHz	0

Table 4 Channel Width

Wecanenablemultiplefieldsbysettingrate flagsvalueappropriately.

Set Aggregationflags:

Thisflagisforenablingordisablingaggregationsupport.Higherlengthpacketscanbetransmitted byenablingaggregationflag.IfthisflagissetthenitenablestheTXaggregation.Usercangivemaximumoflengthlessthanorequalto30000byteswhentheaggregationisenabled.Thismaximumsupportedlengthmayvarydependingontheavailablebuffers inTA.Usergivenlengthisdivided intochunksofsize1792bytes.Allthesechunksareaggregatedand sent.Ifthisflagisnotsetthenaggregationisnotenabled andpacketswillbesentwithoutanyaggregation,Andmaximum lengththat canbesentinthiscaseis1536bytesAggregationfeatureissupportedonlyinburstmode.This filedwillbe ignoredincaseof continuousmode.

Set Numberof packetstosend:

Thisfieldisusedtosetthenumberofpacketstobesentinburstmode. Ifthevaluegivenis‘n’ then‘n’numberofpacketswillbesentonair,afterthattransmission willbestopped.Ifthisfieldisgivenas‘zero’then packetswillbesentcontinuouslyuntiluserstopsthetransmissionusing transmitutility.

Thisfiledwillbeignoredincaseofcontinuousmode.

SetDelaybetweenthepackets:

Thisfieldisusedtosetthedelaybetweenthepacketsinburstmode.Delayshould begiveninmicroseconds.i.e.ifthevalueisgivenas ‘n’thena delayof‘n’microsecondswillbeaddedforeverytransmittedpacketin theburstmode.

Ifthisfield issetto‘zero’thenpacketswillbesentcontinuouslywithoutanydelay.

Thisfiledwillbeignoredincaseofcontinuousmode.

Examples:

- **$./transmit405.5750111010 00**

Abovecommandstartscontinoustransmission withthefollowing configuration:

Txgain–40

Datarate– 5.5Mbps

PacketLength–750bytes

Transmit mode–1,whichmeanscontinuoustransmit.

Channelnumber– 11

ExternalPA–0,disable

Rateflags–1,ShortGI isenabledwith20MHzChannel width

Aggregationflag-

0,disable(ignoredincontinuousmode)Numberofpacketstosend-

0(ignoredincontinuousmode)Delaybetweenthepackets-

0(ignoredincontinuousmode)

$./transmit6536100006 0250010000

Abovecommandstarts burstmodetransmissionwiththefollowingconfiguration:

Txgain–65

Datarate– 36Mbps

PacketLength–1000bytes

Transmit mode–0,whichmeansburstmodetransmission.

Channelnumber– 6(Centerfrequency)

ExternalPA–0,disable

Rateflags- 25

Aggregationflag-0,disable

Numberofpacketstosend- 1000

Delaybetweenthepackets- 0

4. Programmable PER packet

PERpacketcanbeprogrammableusingutilitycalled ‘transmit_packet’ utility.ThisutilitytakesthePERpacketcontentfromthefilecalled‘per_packet.txt’.

‘transmit_packet’ utilityandper_packet.txtcanbefoundunder‘release’directory.

Beforerunning thisutilityuserhastofillthe requiredpacket content into‘per_packet.txt’filestartingfromtheMACheader.Once‘per_packet.txt’isfilled usercanrun‘transmit_packet’utilityforconfiguringthePERpacket.Thisutilityconfiguresth ePERpacketonly.Itwill not starttransmission. Userhastorun the ‘transmit’utilityasdescribed inthepreviussectionafterrunning‘transmit_packet’utility.

Ifuserdoesnotwanttoconfigurethe PERpacketthen‘transmit’utilitycanbe rundirectlywithoutrunning‘transmit_packet’utility.InthiscasedefaultPERpacketwillbes ent.

Configurethefollowingparametersthrough‘transmit_packet’application beforerunning the‘transmit’utility.

ProgrammablePER PacketEnable

ProgrammablePER PacketLength

Sequencenumberflag

4.1 ApplicationUsage

Beforerunning applicationPERpacketcontenthastobeenteredintothe‘per_packet.txt’file.

Thentheapplicationcanbestartedin thefollowingmanner:

#cdrelease

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

<e>referstoenableordisableflagforPERpacketconfiguration.

<l>referstolengthof

thepacketthathastobeconfiguredinbytes.<s>referstosequencenumberflag.

Enableflag:

ThisflagisusedtoenableordisablethePERpacketconfiguration.

1-Enable,0-Disable

Ifthisflagisenabled,newlyconfiguredPERpacketcanbetransmitted whenuserruns‘trasmit’utility.

Ifthisflagisdisabled, defaultPERpacketcanbetransmitted whenuserruns‘trasmit’utility.

Length:

Thisfieldrefersto thenumber ofbytestobeconfiguredfromthe ‘per_packet.txt’fileintoPERpacket.i.eifthisfieldisgivenas ‘n’(maximum valueofnis1536bytes),then ‘n’numberofbytescanbeconfiguredfrom‘per_packet.txt’ fileintoPERpacket.

Maximum allowed valueforthisfieldis1536bytes.i.ePERpacketcanbeprogrammableupto1536bytesonly.

Sequence numberFlag:

Thisflagisusedto enableordisablethe sequencenumberfromthe‘per_packet.txt’file.

Ifthisflagissetas‘1’thenit will takethesequencenumberfromthe ‘per_packet.txt’file.Andeachtransmittedpacketcontainssamesequencenumberwit hout anyincrement.

Ifthisflagissetas‘0’then itignoresthesequencenumbervaluefrom‘per_packet.txt’fileandsequencenumber willbeincrementedstartingfrom‘0’.

Default valueforthisflagis‘0’.

IftheLengthfiled in‘transmit_packet’utilityisgivenas‘m’andPacketlengthin‘transmit’utilityisgivenas‘n’

Then

1.Ifm<nthen, first‘m’bytescan betakenfrom‘per_packet.txt’fileintoPERpacketandthe restofpacket(m-nlength)containsdefaultcontent.

2.Ifm>nthen,‘n’bytescan be taken from‘per_packet.txt’fileinto PERpacketand transmitted.

3.Ifm=nthen,‘m’bytescanbetakenfrom‘per_packet.txt’fileintoPER packetand transmitted.

Userhastotake carewhilefillingper_packet.txt.i.econtentshould beinhexformatonly.

Examples:

$./transmit_packet110000

AbovecommandconfiguresthePERpacket

PERconfigurationEnable– 1

Length– 1000(1000bytescan be configuredfromthe ‘per_packet.txt’file)

Sequencenumberflag–0(Sequencenumberwillbeincremented)

$./transmit_packet15001

AbovecommandconfiguresthePERpacket

PERconfigurationEnable– 1

Length– 500(500bytescanbe configuredfrom

the‘per_packet.txt’file)Sequencenumberflag–

1(Sequencenumberwillnotbeincremented)

Afterstartingthisapplication, userhastoenterthefollowingcommandto stoptheongoingtransmission:

$./transmit_packet0

Abovecommanddisables thePERpacket configuration.i.edefault PERpacketwillbesent when userruns ‘transmit’utility.

5. Receive Tests

Thereceivetestscanbeinvokedfrom an applicationcalled ‘receive’whichisfoundunder‘release’directory.Usethisapplicationfordisplayingthefollowinginformation

TotalnumberofCRCPASS

packetsTotalnumberofCRCFAILpacketsandTotalnumber

ofFALSECCA

TheRxperformanceisanalyzedbythesensitivitiesatdifferentdatarates. Ingeneral, thesensitivityisobservedas10%Packet

ErrorRatio(PER)pointin11aand11g,and8%PERpoint in11b.

PER: PacketErrorRatio(PER)iscalculatedbymeasuringthenumberofpacketsreceived correctlyandcomparingwiththenumber ofpacketsexpected.

%Packeterror rate=100*(1-((Receivedpackets/expectedpackets))

Forcarryingout the receivetest,connecttheEVBtoaVectorSignalGenerator(VSG).ThensettheRFamplitude,signalwaveformand the channelinthesignalgeneratorbeforestartingthereceivetests.

Youneedtoconfigurethechannel(asmentionedbelow)in theEVBwiththesamechannelwhichissetin SignalGenerator.

Theapplicationcanbestartedasfollowstostartreceivingthepackets fromEVB.Goto'release'folder.

$./receive<file><channelnumber><start-stop><channelwidth>

*<file>*isthenameofthefileintowhichtheaboveinformation willbewritten.Inaddition,youcanseethisinformation ontheconsole.

*<channelnumber>*isthechannelnumberonwhichreceivetestsaretobedone.For2.4GHzchannels,pleaserefertable1 andfor5GHzchannels,pleaserefertable 2.

*<start–stopvalue>*isto eitherstartorstopreceiveapplication.To startsetthisvalueto'0'and'1'tostopreceive application.

*<channelwidth>*isthevalueoftheoperatingbandwidthofthe channel.Channelwidthvaluesarespecifiedinthefollowingtable.

ChannelWidth	Value
20MHz	0

Table 5 Channel Width

Example:

#./receivestats600

Theabovementionedcommandwillstartthereceiveapplication File–stats

Channelnumber– 6

Start-Stop–0,Start

ChannelWidth–0(20MHz)
Thetestutilitydisplaysthefollowinginformation:

Totalnumberof receivedpackets(withcorrectCRC).TotalnumberofpacketswithCRCerrors.

TotalnumberofFALSECCA's received.

ComputethePERusingtheformulamentionedabove.

#./receivestats610

Theabovecommandwillstop thereceiveapplicationFile–stats

Channelnumber– 6

Start-Stop–1,Stop

ChannelWidth–0(20MHz)
Thiswillstopthereceiveapplication.

Integration instructions for host product manufacturers according to KDB 996369 D03 OEM Manual v01

2.2 List of applicable FCC rules
FCC Part 15 Subpart C 15.247 & 15.209

2.3 Specific operational use conditions
The module can be used for mobile or portable applications with a maximum 4.69dBi antenna. The host manufacturer installing this module into their product must ensure that the final composit product complies with the FCC requirements by a technical assessment or evaluation to the FCC rules, including the transmitter operaition. The host manufacturer has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual.

2.4 Limited module procedures
Not applicable. The module is a Single module and complies with the requirement of FCC Part 15.212.

2.5 Trace antenna designs
Not applicable. The module has its own antenna, and doesn't need a host's printed board microstrip trace antenna etc.

2.6 RF exposure considerations
The module must be installed in the host equipment such that at least 20cm is maintained between the antenna and users' body; and if RF exposure statement or module layout is changed, then the host product manufacturer required to take responsibility of the module through a change in FCC ID or new application. The FCC ID of the module cannot be used on the final product. In these circumstances, the host manufacturer will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

2.7 Antennas
Antenna Specification are as follows:
Type: Monopole Antenna
Gain: 4.69dBi Max.
This device is intended only for host manufacturers under the following conditions:
The transmitter module may not be co-located with any other transmitter or antenna;
The module shall be only used with the internal antenna(s) that has been originally tested and certified with this module. The antenna must be either permanently attached or employa 'unique' antenna coupler.

As long as the conditions above are met, further transmitter test will not be required. However, the host manufacturer 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.).

2.8 Label and compliance information

Host product manufacturers need to provide a physical or e-label stating “Contains FCC ID: **SMQ9113**” with their finished product.

2.9 Information on test modes and additional testing requirements

Host manufacturer must perfom test of radiated & conducted emission and spurious emission, etc according to the actual test modes for a stand-alone modular transmitter in a host, as well as for multiple simultaneously transmitting modules or other transmitters in a host product.

Only when all the test results of test modes comply with FCC requirements, then the end product can be sold legally.

2.10 Additional testing, Part 15 Subpart B disclaimer

The modular transmitter is **only** FCC authorized for FCC Part 15 Subpart C 15.247 & 15.209 and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification. If the grantee markets their product as being Part 15 Subpart B compliant (when it also contains unintentional-radiator digital circuity), then the grantee shall provide a notice stating that the final host product still requires Part 15 Subpart B compliance testing with the modular transmitter installed.

Federal Communication Commission Statement (FCC, U.S.)

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 in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:
- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

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.

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

IMPORTANT NOTES

Co-location warning:
This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

OEM integration instructions:
This device is intended only for OEM integrators under the following conditions:

The transmitter module may not be co-located with any other transmitter or antenna. The module shall be only used with the external antenna(s) that has been originally tested and certified with this module.

As long as the conditions above are met, further transmitter test will not be required. However, 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.).

Validity of using the module certification:
In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the FCC authorization for this module in combination with the host equipment is no longer considered valid and the FCC ID of the module cannot be used on the final product. In these circumstances, the OEM integrator will be responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

End product labeling:
The final end product must be labeled in a visible area with the following: “Contains Transmitter Module **FCC ID: SMQ9113**”.

Information that must be placed in the end user manual:
The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module. The end user manual shall include all required regulatory information/warning as show in this manual.