

## 1. Before Using Packet Engine

### 1.1 What is Packet Engine

Packet engine repeatedly transmits one frame on the air and does not follow any protocol (backoffs etc). Beacons should not be transmitted when packet engine is in use

The packet engine can be used in one of the following modes

Mode	Description
TX mode	In this mode, the DUT transmits data packets of configurable length with configurable inter frame spacing (in microseconds). It will transmit number of packets specified. If this number is zero, it will transmit packets continuously. Same packet is transmitted with incremental sequence number. The retry bit in the frame control is not set for any frame. There is no backoff procedure after a frame is transmitted. If the packet engine is put in TX mode, it must be stopped before putting it again in TX mode.
RX Mode	In this mode, it listens to the frames coming to the specified mac address. The frames coming to the DUT must have incremental sequence number. In this mode, ACK packets will not be sent from the DUT. The IFS and frame count are ignored in this mode. The lost frames are counted based on the sequence number of the frames successfully received.
RX mode with ACK	In this mode, the DUT will send an ack packet to the REF. Everything else is the same as in RX mode.

#### 1.1.2 Stop transmitting Beacons

Step	Device Type	Command	Parameter	Note
1	STA only	wl	disassoc	stop beacons
2	AP only	wl	ssid ""	stop beacons

### 1.2 Stop Wireless Zero Configuration, BRCM utility and Network properties settings

Step	Device Type	Instructions		
1	STA	Right-click on "Wireless Network Connect" on Network connect of Control Panel; and then click on "Configuration" in General page. Change below default value: a) IBSS Mode ->802.11a/b/g/n Auto b) IBSS Link Indication -> Legacy (you can also issue "wl legacylink 1" instead.)		
Step	Device Type	Command	Parameter	Note
2	STA	net	stop wltrysvc	Stop Broadcom Wireless LAN Tray service
3	STA	net	stop wzcsvc	Stop Wireless Zero Configuration service

Figure 1. Setting for IBSS 54g and IBSS Link Indication

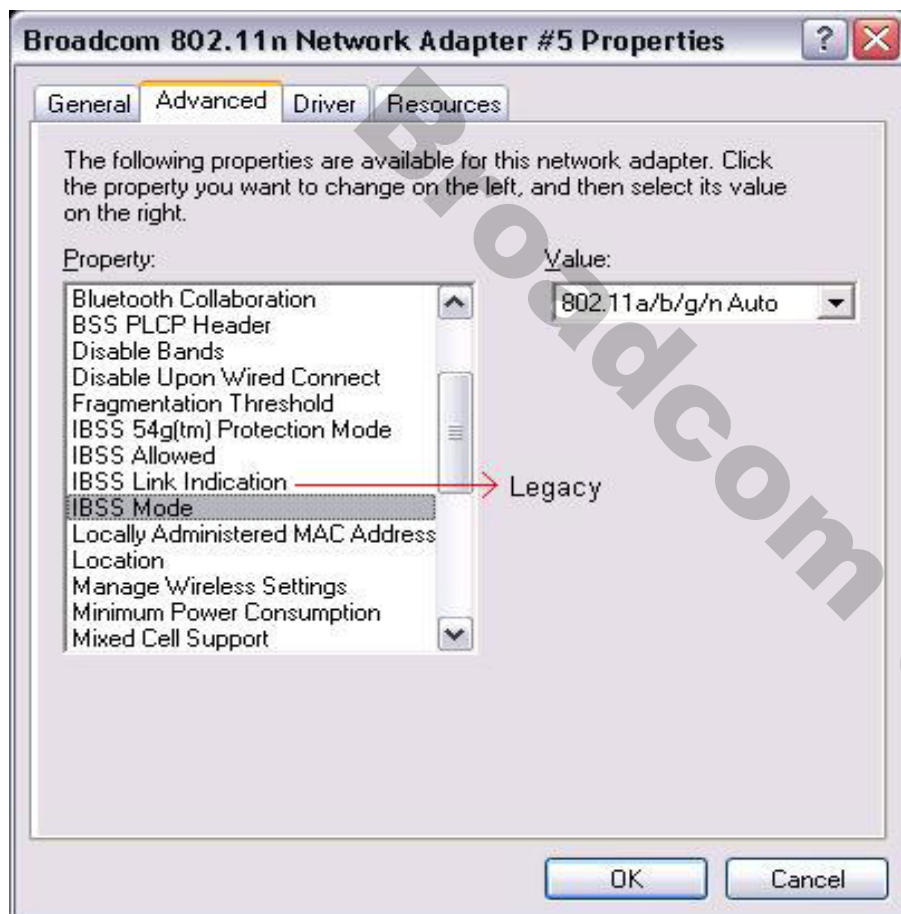
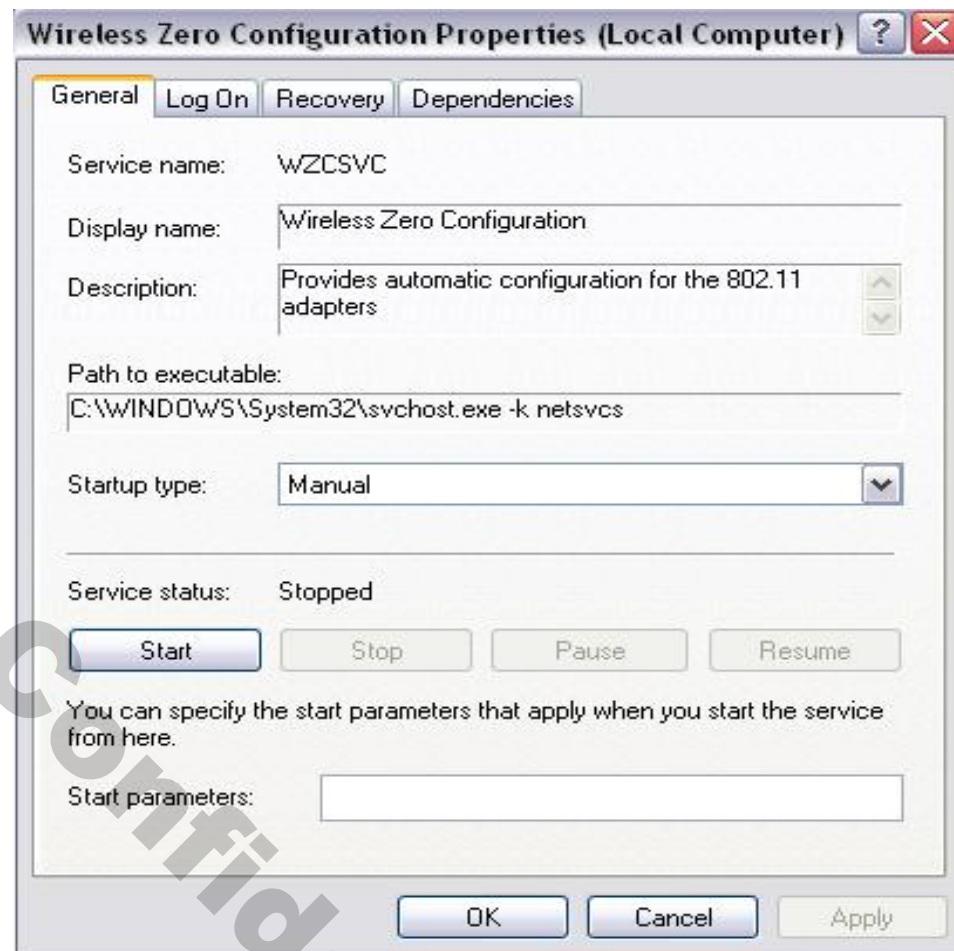
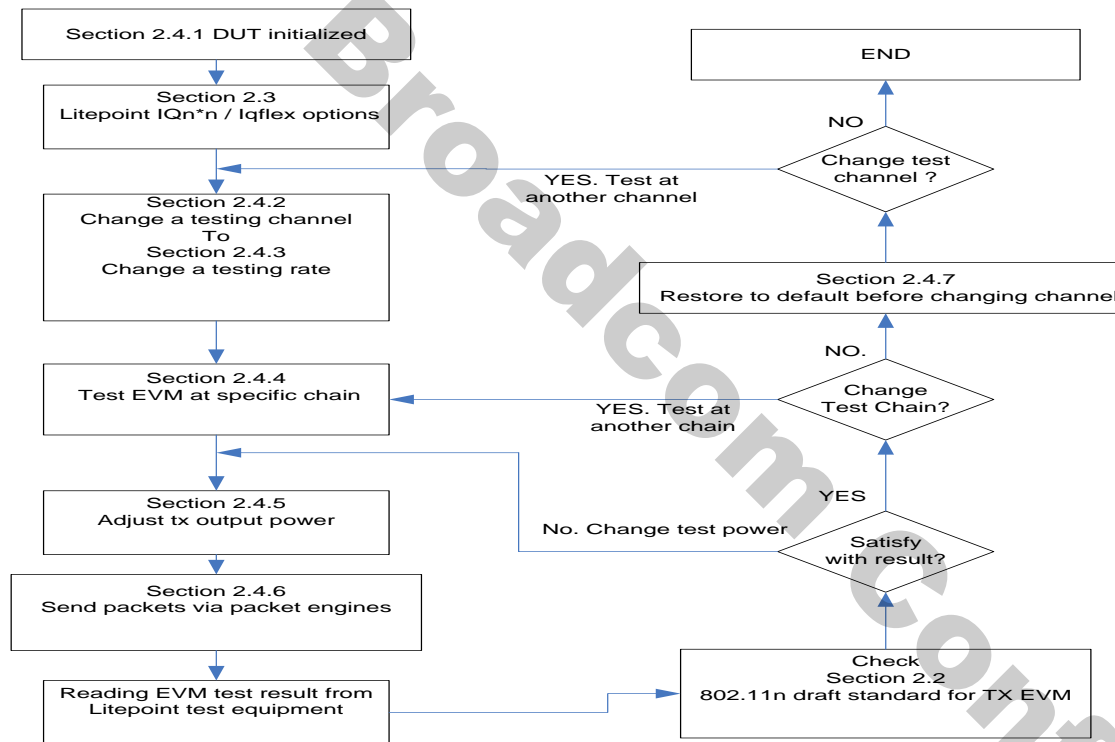


Figure 2. Stop Wireless Zero Configuration Service, see below (or you can issue "net stop wzcsvc" instead).



## 2. TX EVM

### 2.1 Test diagram for TX EVM



## 2.2 802.11n standard for TX EVM

Test Specification			
Modulation	Coding rate	MCS index or Legacy OFDM rate	Relative Constellation Error (dB)
BPSK	1/2	MCS 0, MCS 8, 6 Mbps	-5
BPSK	3/4	9 Mbps	-8
QPSK	1/2	MCS 1, MCS 9	-10
QPSK	3/4	MCS 2, MCS 10, 18 Mbps	-13
16-QAM	1/2	MCS 3, MCS 11, 24 Mbps	-16
16-QAM	3/4	MCS 4, MCS 12, 36 Mbps	-19
64-QAM	2/3	MCS 5, MCS 13, 48 Mbps	-22
64-QAM	3/4	MCS 6, MCS 14, 54 Mbps	-25
64-QAM	5/6	MCS 7, MCS 15	-28

## 2.3 Litepoint IQn\*n / Iqflex options

EVM measurement result is based on what analysis options in the equipment you selected. We have to enable below options to get correct EVM testing result.

Modulation	options	Value
Legacy CCK	Equalizer taps	9 Taps
	Remove DC	off
	EVM Calculation	11b Std. Tx mod acc
Legacy OFDM	Phase Tracking/Corr	Moving Avg. 10 Sym.
	Channel Estimate	Raw, Full Packet
	Symbol Timing Tracking	On
	Frequency Sync	Full Data Packet
	Amplitude Tracking	On
	OFDM Modulation Type	802.11 a/g
	OFDM EVM Method	Standard
IMO HT-20 and HT	Freq. Corr	Long Training
	Phase Correction	Enable
	Symbol Timing Correction	Enable
	Data Demodulation	Enable
	Full Packet Channel Estimation	Enable
	Amplitude Tracking	Enable

Legacy 11b rate

802.11b Settings

Equalizer taps	9 Taps
Remove DC	Off
EVM calculation	11b Std. Tx mod acc

Legacy OFDM rate

802.11 a/g Settings (OFDM)

Phase Tracking/Corr	Moving Avg. 10 Sym.
Channel Estimate	Raw, Full Packet
Symbol Timing Tracking	On
Frequency Sync.	Full Data Packet
Amplitude Tracking	On
OFDM Modulation Type	802.11a/g
OFDM EVM Method	standard

MIMO rate

Options

Averaging	10
Freq. Corr.	Long Training ...
<input checked="" type="checkbox"/> Enable Phase Correction	
<input checked="" type="checkbox"/> Enable Symbol Timing Correction	
<input checked="" type="checkbox"/> Enable Data Demodulation	
<input checked="" type="checkbox"/> Enable Full Packet Channel Estimate	
<input checked="" type="checkbox"/> Enable Amplitude Tracking	
Preference order of VSA signals	1 2 3 4

## 2.4 wl packet engines command sequences for TX EVM

### 2.4.1 Initialized

Step	Device Type	Command	Parameter	Note
1	STA and Access Point	wl	mpc 0	
2	STA and Access Point	wl	interference 0	
3	STA and Access Point	wl	scansuppress 1	
4	STA and Access Point	wl	down	
5	STA and Access Point	wl	country ALL	
6	STA and Access Point	wl	frameburst 1	
7	STA and Access Point	wl	ampdu 1	
8	STA and Access Point	wl	mimo_bw_cap 1	
9	STA and Access Point	wl	bi 65535	
10	if Device Type is "STA" then go to Step 11, else go to Step 12			
11	STA	wl	legacylink 1	
12	if DUT is 2*3 config then go to Step 13, else go to Step 14			
13	STA and Access Point	wl	nphy_antssel 0x01 0x01 0x01 0x01	
14	STA and Access Point	wl	up	

### 2.4.2 Change to a testing channel

Step	Device Type	Command	Parameter	Note
1	STA and Access Point	wl	down	
2	if HT-40 bandwidth then go to Step 3 else go to Step 5			
3	STA and Access Point	wl	mimo_tx_bw 4	HT-40
4	go to Step 6			
5	STA and Access Point	wl	mimo_tx_bw 2	HT-20
6	if testing channel > 14 then go to Step 7, 5G band, else go to Step 9			
7	STA and Access Point	wl	band a	
8	go to Step 10			
9	STA and Access Point	wl	band b	
10	STA and Access Point	wl	chanspec xxyy	xx= channel number, ie, 1,2,3,4... yy= test bandwidth. l= lower band in 40MHz. u=upper band in 40MHz for example, wl chanspec 6l, wl chanspec 6u
11	STA and Access Point	wl	up	

### 2.4.3 Change a testing rate

#### 2.4.3.1 11a/g/b device

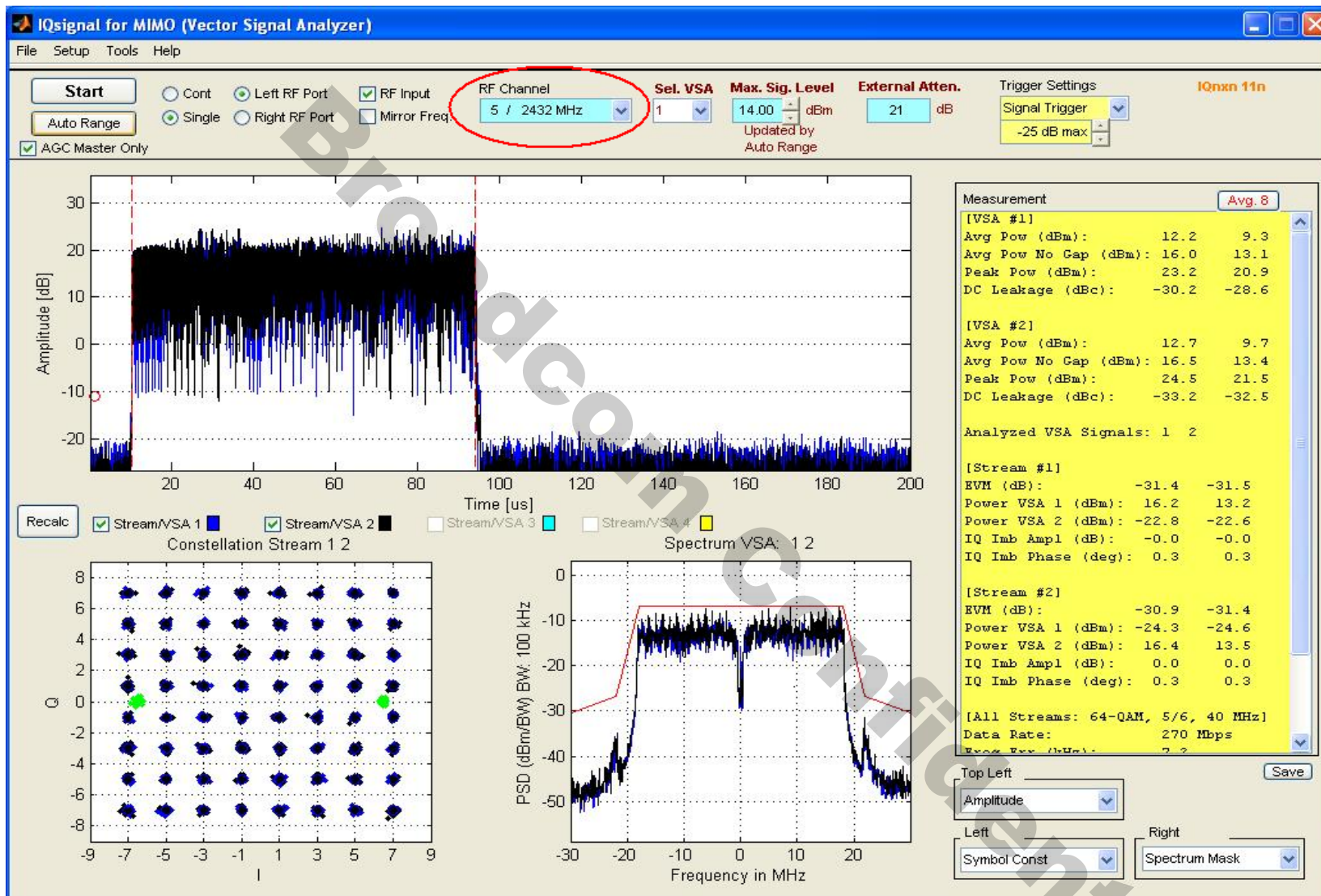
##### 2.4.3.1.1 Test rate is MIMO rate

Step	Device Type	Command	Parameter	Note
1	If test rate < mcs 8 then go to Step 2, else go to Step 3			
2	STA and Access Point	wl	nrate -m TestRate -s xx	for rate mcs 0-7. xx:0, enable siso mode for test xx:1, enable CDD mode for test
3	STA and Access Point	wl	nrate -m TestRate -s 3	for rate mcs >=8, enable SDM mode for rate m 8-m15

##### 2.4.3.1.2 Test rate is legacy rate

Step	Device Type	Command	Parameter	Note
4	STA and Access Point	wl	nrate -r TestRate -s xx	for legacy rate. xx:0, enable siso mode for test xx:1, enable CDD mode for test

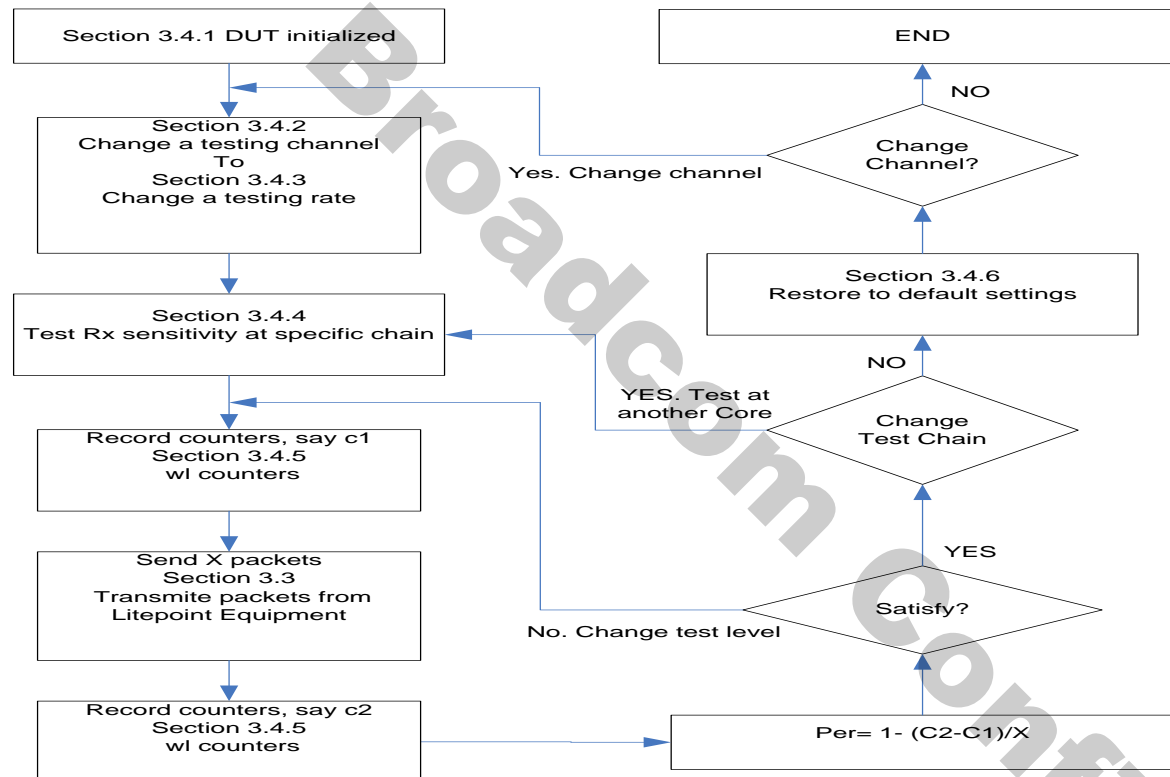
<b>2.4.3.2 11a/g/b device</b>				
Step	Device Type	Command	Parameter	Note
1	STA and Access Point	wl	rate xx	xx is test rate [ 1 2 5.5 11 6 9 12 18 24 36 48 54]
<b>2.4.4 Test EVM at specific chain or antenna</b>				
<b>2.4.4.1 11n device</b>				
<b>2.4.4.1.1 Test rate is &lt; mcs 8 or legacy rate</b>				
Step	Device Type	Command	Parameter	Note
1	STA and Access Point	wl	phy_watchdog 0	disable internal calibration
2	STA and Access Point	wl	down	In DSL platform , "wl txchain" has to issue at "down" state.
3		if test chain =0 then go to Step 4 , else go to Step 6		
4	STA and Access Point	wl	txchain 1	
5		goto Step 7		
6	STA and Access Point	wl	txchain 2	
7	STA and Access Point	wl	up	
8	STA	wl	wl disassoc	STA only
9	Access Point	wl	ssid ""	AP only
<b>2.4.4.1.2 Test rate is &gt;= mcs 8</b>				
1	STA and Access Point	wl	down	In DSL platform , "wl txchain" has to issue at "down" state.
2	STA and Access Point	wl	txchain 3	
3	STA and Access Point	wl	up	
4	STA	wl	wl disassoc	STA only
5	Access Point	wl	ssid ""	AP only
<b>2.4.4.2 11a/g/b device</b>				
Step	Device Type	Command	Parameter	Note
1		if test antenna = main antenna then go to Step 2 , else go to Step 4		
2	STA and Access Point	wl	txant 0	
3	STA and Access Point	wl	antdiv 0	
		END		
4	STA and Access Point	wl	txant 1	
5	STA and Access Point	wl	antdiv 1	
<b>2.4.5 Adjust tx output power</b>				
Step	Device Type	Command	Parameter	Note
1	STA and Access Point	wl	txpwr1 -o -q xx	xx: target power in dBm * 4. For example, 17dBm, xx=17*4=68.
<b>2.4.6 Send packets via packet engines</b>				
Step	Device Type	Command	Parameter	Note
1	STA and Access Point	wl	phy_forcecal 1	do internal calibration immediately before EVM measurement
2	STA and Access Point	wl	pkteng_start 00:90:4c:21:00:8e tx 500 1024 0	
3		Set correct RF channel in Litepoint's equipment		
4		Click "Auto Range" and "Cont" to measure EVM		
5	STA and Access Point	wl	pkteng_stop tx	
<b>2.4.7 Restore to default before changing channel</b>				
Step	Device Type	Command	Parameter	Note
1	STA and Access Point	wl	down	In DSL platform , "wl txchain" has to issue at "down" state.
2	STA and Access Point	wl	txchain 3	
3	STA and Access Point	wl	up	
4	STA and Access Point	wl	phy_watchdog 1	Enable internal calibration





### 3. RX Sensitivity

#### 3.1 Test diagram for Rx Sensitivity



#### 3.2 802.11n standard for RX Sensitivity

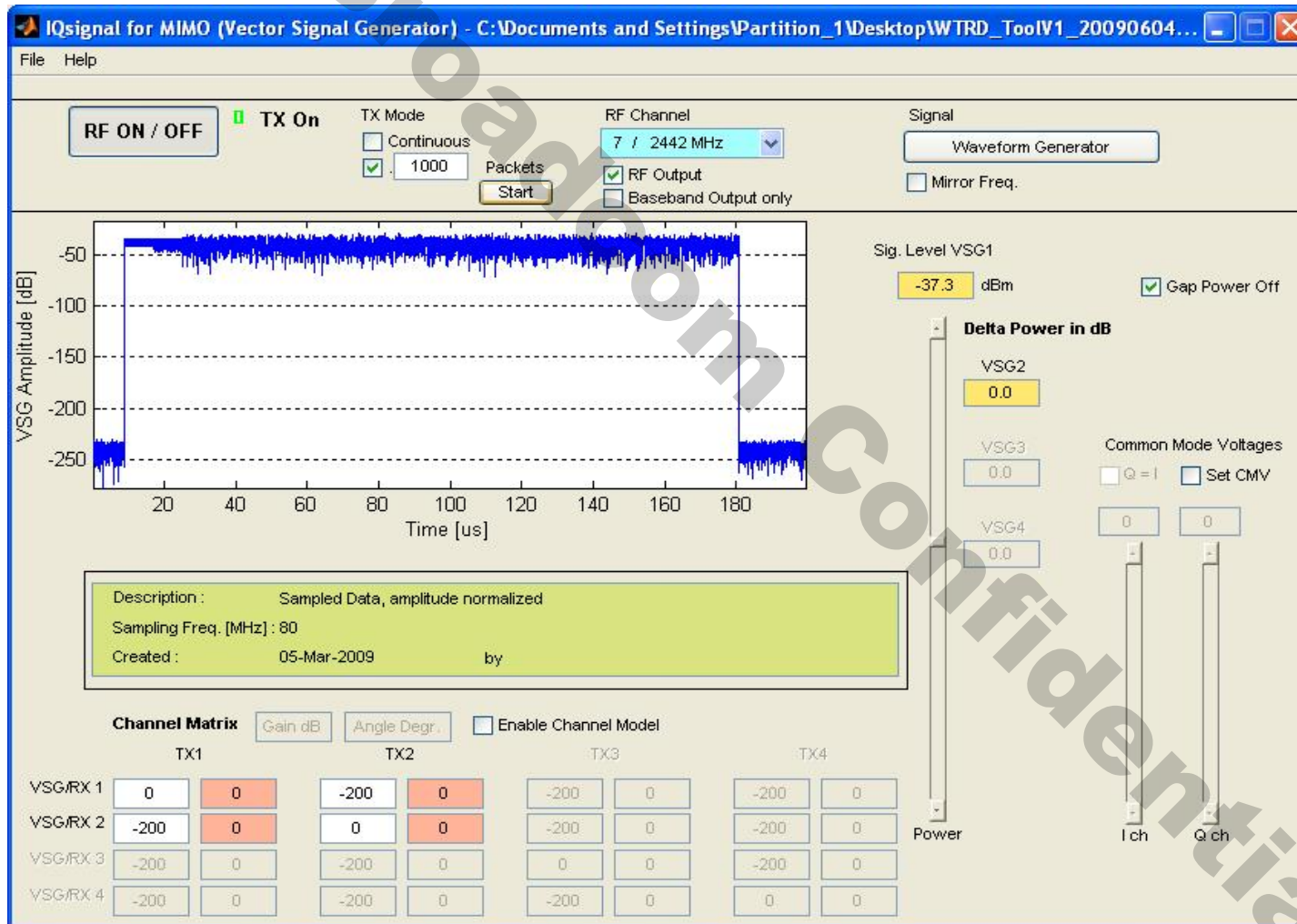
##### Test Specification

Modulation	Coding rate	MCS index or Legacy OFDM rate	Minimum sensitivity dBm (20MHz channel spacing)	Minimum sensitivity dBm (40MHz channel spacing)
BPSK	1/2	MCS 0, MCS 8, 6 Mbps	-82	-79
BPSK	3/4	9 Mbps	-81	
QPSK	1/2	MCS 1, MCS 9	-79	-76
QPSK	3/4	MCS 2, MCS 10, 18 Mbps	-77	-74
16-QAM	1/2	MCS 3, MCS 11, 24 Mbps	-74	-71
16-QAM	3/4	MCS 4, MCS 12, 36 Mbps	-70	-67
64-QAM	2/3	MCS 5, MCS 13, 48 Mbps	-66	-63
64-QAM	3/4	MCS 6, MCS 14, 54 Mbps	-65	-62
64-QAM	5/6	MCS 7, MCS 15	-64	-61



### 3.3 Transmite packets from Litepoint Equipment

Step	Device Type	Command	Parameter	Note
1		Run "Vector Signal Generator" from Tool menu in IQSignal for MIMO		
2		Click on File menu and select "Open Generator file" item to load waveform file		
3		Base on test rate to chose right waveform file. You can find all modulation waveform files from mfgc Golf/Hotel release		
4		Click packets and key in numbers of packets in TX mode, adjust "Sig. Lebel VSG1" to test level + cable loss		
5		Make sure "RF ON/OFF" in TX on state. Push Start bottom to send TX packets		



### 3.4 wl packet engines

#### 3.4.1 Initialized

Step	Device Type	Command	Parameter	Note
1	STA and Access Point	wl	mpc 0	
2	STA and Access Point	wl	interference 0	
3	STA and Access Point	wl	phy_watchdog 0	
4	STA and Access Point	wl	scansuppress 1	
5	STA and Access Point	wl	down	
6	STA and Access Point	wl	country ALL	
7	STA and Access Point	wl	frameburst 0	
8	STA and Access Point	wl	ampdu 0	
9	STA and Access Point	wl	mimo_bw_cap 1	
10		if Device Type is "STA" then go to Step 11 , else go to Step 12		
11	STA	wl	legacylink 1	
12		if DUT is 2*3 config then go to Step 13, else go to Step 14		
13	STA and Access Point	wl	nphy_antse1 0x01 0x01 0x01 0x01	
14	STA and Access Point	wl	up	

#### 3.4.2 Change to a testing channel

Step	Device Type	Command	Parameter	Note
1	STA and Access Point	wl	down	
2		if testing channel > 14 then go to Step 3 , 5G band , else go to Step 5		
3	STA and Access Point	wl	band a	
4		go to Step 6		
5	STA and Access Point	wl	band b	
6		if HT-40 bandwidth then go to Step 7 else go to Step 9		Please skip step 6 to step 9 fro 11a/g/b only device
7	STA and Access Point	wl	mimo_tx_bw 4	HT-40
8		go to Step 10		
9	STA and Access Point	wl	mimo_tx_bw 2	HT-20
10	STA and Access Point	wl	chanspec xxyy	xx= channel number, ie, 1,2,3,4... yy= test bandwidth. l= lower band in 40MHz. u=upper band in 40MHz for example, wl chanspec 6 , wl chanspec 6l, wl chanspec 6u
11	STA and Access Point	wl	up	

#### 3.4.3 Change a testing rate

##### 3.4.3.1 11n device

3.4.3.1.1 Test rate is MIMO rate				
Step	Device Type	Command	Parameter	Note
1		If test rate < mcs 8 then go to Step 2, else go to Step 3		
2	STA and Access Point	wl	nrate -m TestRate -s xx	for rate mcs 0-7. xx:0, enable siso mode for test xx:1, enable CDD mode for test
		END		
3	STA and Access Point	wl	nrate -m TestRate -s 3	for rate mcs >=8, enable SDM mode for rate m 8-m15
3.4.3.2 Test rate is legacy rate				
1	STA and Access Point	wl	nrate -r TestRate	

##### 3.4.3.2 11a/g/b device

Step	Device Type	Command	Parameter	Note
1	STA and Access Point	wl	rate xx	xx is test rate [ 1 2 5.5 11 6 9 12 18 24 36 48 54]

### 3.4.4 Test Rx sensitivity at specific chain

#### 3.4.4.1 11n device

3.4.4.1.1 Test rate is < mcs 8 or legacy rate				
Step	Device Type	Command	Parameter	Note
1	STA and Access Point	wl	down	In DSL platform , "wl rxchain" has to issue at "down" state.
2	if test chain =0 then go to Step 4 , else go to Step 6			
3	STA and Access Point	wl	rxchain 1	
4	goto Step 7			
5	STA and Access Point	wl	rxchain 2	
6	STA and Access Point	wl	up	
8	STA and Access Point	wl	disassoc / ssid ""	
3.4.4.1.2 Test rate is >= mcs 8				
1	STA and Access Point	wl	down	In DSL platform , "wl rxchain" has to issue at "down" state.
2	STA and Access Point	wl	rxchain 3	
3	STA and Access Point	wl	up	
4	STA and Access Point	wl	disassoc / ssid ""	

#### 3.4.4.2 11g/a/b only device

Step	Device Type	Command	Parameter	Note
1	if test antennal = main antenna then go to Step 2 , else go to Step 4			
2	STA and Access Point	wl	txant 0	
3	STA and Access Point	wl	antdiv 0	
4	STA and Access Point	wl	disassoc / ssid ""	
	END			
5	STA and Access Point	wl	txant 1	
6	STA and Access Point	wl	antdiv 1	
7	STA and Access Point	wl	disassoc / ssid ""	

### 3.4.5 wl counters

There are many reportings on MAC state listed in counters. They not only use to debug board issues but also count rx sensitivity. Please refer "counters" spreadsheet for details.

For Rx sensitivity test, we use below to counters to calculate PER.

Step	Device Type	Command	Parameter	Note
1	STA and Access Point	wl	counters	
2	if tx packets is multicas the go to Step 3 , else go to Step 5			
3	Reading "rxdfmmcast" counters			
4	go to Step 5			
5	Reading "rxdfrmocast" counters			

### 3.4.6 Restore to default settings

Step	Device Type	Command	Parameter	Note
1	STA and Access Point	wl	down	In DSL platform , "wl rxchain" has to issue at "down" state.
2	STA and Access Point	wl	rxchain 3	
3	STA and Access Point	wl	up	
4	STA and Access Point	wl	phy_watchdog 1	

## 5. RX Sensitivity with DUT-REF setup

### 5.1 Test diagram for Rx Sensitivity

## 5.2 Rx sensitivity test with REF card through pkteng

### 5.2.1 Initialized

Step	Device Type	Command	Parameter	Note
1	DUT	wl	the same as 3.4.1	
2	REF	wl	the same as 3.4.1	

### 5.2.2 Change to a testing channel

Step	Device Type	Command	Parameter	Note
1	DUT	wl	the same as 3.4.2	
2	REF	wl	the same as 3.4.2	

### 5.2.3 Change a testing rate

Step	Device Type	Command	Parameter	Note
1	DUT	wl	the same as 3.4.3	
2	REF	wl	the same as 3.4.3	

### 5.2.4 Test Rx sensitivity at specific chain

Step	Device Type	Command	Parameter	Note
1	DUT	wl	the same as 3.4.4	
2	REF	wl	the same as 3.4.4	

### 5.2.4 do calibration

Step	Device Type	Command	Parameter	Note
1	STA and Access Point	wl	phy_forcel 1	
2	REF	wl	phy_forcel 1	

### 5.2.4 start rxper test

Step	Device Type	Command	Parameter	Note
1	STA and Access Point	wl	pkteng_start DUT_MAC rxwithack	
2	REF	wl	counters	record txallfrm, assume it to be x1
3	REF	wl	pkteng_start DUT_MAC tx 500 1024 1000 REF_MAC	send 1000 packets

### 5.2.5 check if REF finishes transmitting packets

Step	Device Type	Command	Parameter	Note
1	REF	wl	counters	record txallfrm, assume it to be x2

2	REF	REF packets done if the value of (x2-x1) is equal to 1000, else go to step 1		
5.2.6 calculat rxper				
Step	Device Type	Command	Parameter	Note
1	DUT	wl	counters	record txallfrm, assume it to be x2
2	Reading "pktengrxducast" counters			