RF Performance Measurements

4339-SWUM102-R

5300 California Avenue • Irvine, CA 92617 • Phone: 949-926-5000 • Fax: 949-926-5203

December 16, 2013

Revision History

Revision	*Date*	*Change Description*
4339-SWUM102-R	12/16/2013	**Updated:** • All Transmit and Receive Test Sequences
4339-SWUM101-R	04/24/2013	**Updated:** • "Transmit Test Sequence for IEEE 802.11n (HT40 MCS Rates)" on page 11
4339-SWUM100-R	04/05/2013	Initial release

Broadcom Corporation
5300 California Avenue
Irvine, CA 92617

Table of Contents

List of Figures

List of Tables

About This Document

Purpose and Audience

This document provides the Wireless LAN (WL) command sequences used to evaluate RF transmit and receive performance on the BCM4339. It is intended for Broadcom and customer engineers who perform RF performance testing on the BCM4339 manually and, therefore, only require a minimum number of WL commands to evaluate the device.

Acronyms and Abbreviations

In most cases, acronyms and abbreviations are defined on first use. For a comprehensive list of acronyms and other terms used in Broadcom documents, go to http://www.broadcom.com/press/glossary.php.

References

The references in this section may be used in conjunction with this document.

Note: Broadcom provides customer access to technical documentation and software through its Customer Support Portal (CSP) and Downloads and Support site (see Technical Support).

For Broadcom documents, replace the "xx" in the document number with the largest number available in the repository to ensure that you have the most current version of the document.

Document Title	*Number*	*Source*
[1] Broadcom WLAN Client Utility Command Set	80211-TI3XX-R	Broadcom CSP

Technical Support

Broadcom provides customer access to a wide range of information, including technical documentation, schematic diagrams, product bill of materials, PCB layout information, and software updates through its customer support portal at https://support.broadcom.com. To obtain a CSP account, contact your sales or engineering support representative.

In addition, Broadcom provides other product support through its Downloads and Support site at (http://www.broadcom.com/support/).

Section 1: System Setup

System Requirements for RF Performance Measurements

Before You Begin

Before performing the tasks described in this document, download the following items from the Customer Support Portal (CSP):

- BCM4339 board reference design package contains the following items (recommended):
  - Schematic diagrams
  - PCB layout diagrams
  - Bill of Materials (BOM)
  - nvram.txt template file
- Windows® XP or Linux® BCM4339 device driver package (required)

Hardware Requirements

- BCM4339 – Single-Chip 5G WiFi™ 802.11ac MAC/Baseband/Radio with Bluetooth 4.0+HS & FM Receiver (DUT)
- Host system running the Windows XP or Linux operating system (PC, phone, or tablet)
- SDIO 2.0/3.0 or USB 2.0 high-speed Inter Chip (HSIC) adapter (if required, contact Broadcom representative; see "Technical Support" on page 6)
- Vector signal spectrum analyzer/WLAN analyzer for transmit measurements
- WLAN signal generator for receive measurements
- RF isolation chamber for receive measurements
- RF attenuators (as needed)
- RF cable

Software Requirements

- Broadcom WLAN Client Utility
- Windows XP or Linux BCM4339 device driver package

Note: The Broadcom WLAN Client Utility is included in the BCM4339 device driver package.

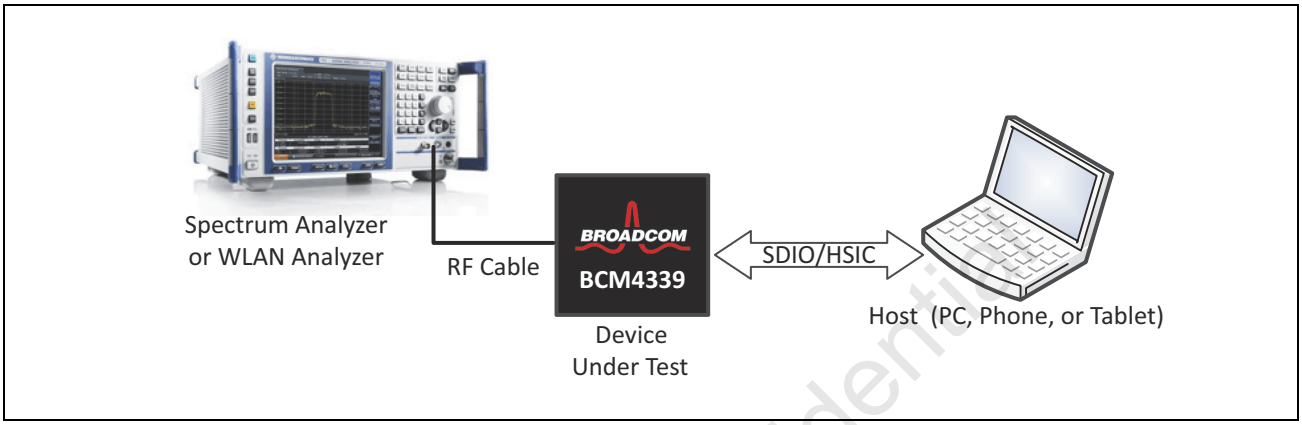
Note: The BCM4339 device driver must be installed in the host system (PC, phone, or tablet) to run WL commands.

System Setup

RF Transmit Test Setup

Figure 1 shows the basic hardware configuration for RF transmit testing.

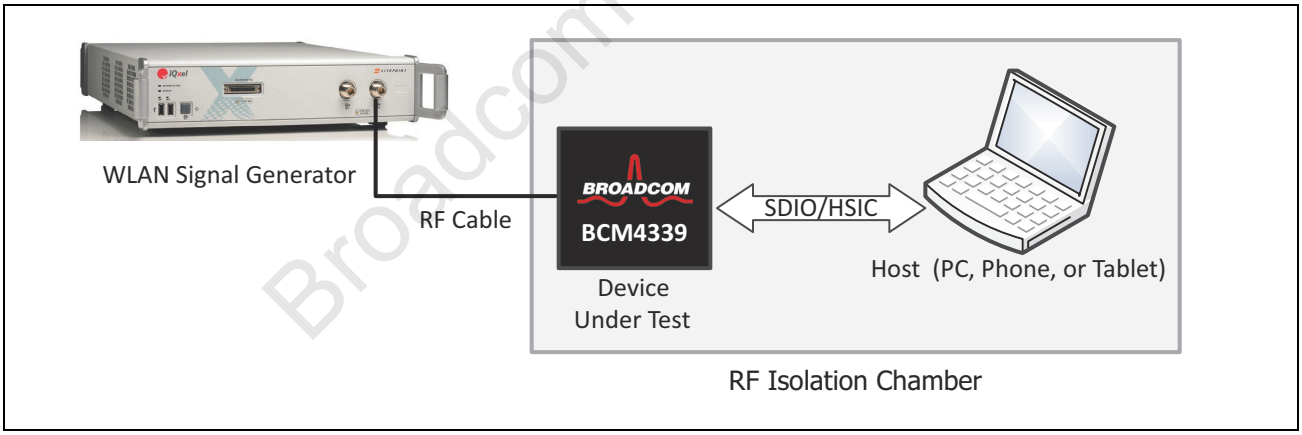
Figure 1: Configuration for RF Transmit Measurements



RF Receive Test Setup

Figure 2 shows the basic hardware configuration for RF transmit testing.

Figure 2: Configuration for RF Receive Measurements



Section 2: WL Command Test Sequences

This section contains the WL command sequences for running transmit and receive RF performance tests on the BCM4339 using the Broadcom WLAN Client Utility (a proprietary software tool for configuring the BCM4339 operating mode and taking RF measurements).

Transmit Test Sequences

The WL command sequences contained in this section are presented in order of frequency band, rate, and bandwidth. Though the BCM4339 supports IEEE 802.11ac, the WL command sequences for 802.11a, 802.11b, 802.11g, and 802.11n are also supported.

To run WL commands, the BCM4339 WLAN driver must be installed on the host system. In addition, the revision of the WLAN Client Utility used to run the WL commands must match the revision of the BCM4339 device driver installed on the host.

Note: The appropriate matching Broadcom WLAN Client Utility is included in the BCM4339 device driver package.

Transmit Test Sequence for IEEE 802.11b and IEEE 802.11g

```
> wl down
> wl mpc 0
> wl phy_watchdog 0
> wl country ALL
> wl band b --> b = 2.4 GHz
> wl 2g_rate -r 11 -b 20 --> 2g = 2.4 GHz, -r = 11b/g rate, -b = 20 MHz bandwidth
> wl channel 7 --> 7 = center freq channel in 2.4 GHz band
> wl scansuppress 1
----[for closed loop power control]----
> wl phy_txpwrctrl 1
> wl txpwr1 -1 --> -1 = default target power; or
> wl txpwr1 -o -d [X] --> X = user defined Tx power, in dBm
----[for open loop power control]----
> wl phy_txpwrctrl 0
> wl phy_txpwrindex [X] --> X = Tx power index from range 0-127
-----------------------------------------------
> wl up
> wl phy_forcecal 1
> wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0 --> start Tx transmission
> wl pkteng_stop tx --> stop Tx transmission
```

Transmit Test Sequence for IEEE 802.11a

```
> wl down
> wl mpc 0
> wl phy_watchdog 0
> wl country ALL
> wl band a --> a = 5 GHz
> wl 5g_rate -r 54 -b 20 --> 5g = 5 GHz, -r =  11a rate, -b = 20 MHz bandwidth
> wl channel 36 --> 36 = center freq channel in 5 GHz band
> wl scansuppress 1
----[for closed loop power control]----
> wl phy_txpwrctrl 1
> wl txpwr1 -1 --> -1 =  default target power; or
> wl txpwr1 -o -d [X] --> X = user defined Tx power, in dBm
----[for open loop power control]----
> wl phy_txpwrctrl 0
> wl phy_txpwrindex [X] --> X = Tx power index from range 0-127
-----------------------------------------------
> wl up
> wl phy_forcecal 1
> wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0 --> start Tx transmission
> wl pkteng_stop tx --> stop Tx transmission
```

Transmit Test Sequence for IEEE 802.11n (HT20 MCS Rates)

```
> wl down
> wl mpc 0
> wl phy_watchdog 0
> wl country ALL
> wl band [b/a] --> b = 2.4 GHz, a = 5 GHz
> wl [2g/5g]_rate -h [0-7] -b 20 --> 2g = 2.4 GHz, 5g = 5 GHz, -h = MCS0-MCS7, -b = 20 MHz bandwidth
> wl chanspec 7/20 --> 7 = center freq channel, 20 = 20 MHz bandwidth
> wl scansuppress 1
----[for closed loop power control]----
> wl phy_txpwrctrl 1
> wl txpwr1 -1 --> -1 = default target power; or
> wl txpwr1 -o -d [X] --> X = user defined Tx power, in dBm
----[for open loop power control]----
> wl phy_txpwrctrl 0
> wl phy_txpwrindex [X] --> X = Tx power index from range 0-127
-----------------------------------------------
> wl up
> wl phy_forcecal 1
> wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0 --> start Tx transmission
> wl pkteng_stop tx --> stop Tx transmission
```

Transmit Test Sequence for IEEE 802.11n (HT40 MCS Rates)

```
> wl down
> wl mpc 0
> wl phy_watchdog 0
> wl country ALL
> wl band [b/a] --> b = 2.4 GHz, a = 5 GHz
> wl [2g/5g]_rate -h [0-7] -b 40 --> 2g = 2.4 GHz, 5g = 5 GHz, -h = MCS0-MCS7, -b = 40 MHz bandwidth
> wl chanspec 36/40 --> 36 = control channel, 40 = 40 MHz BW, center freq = 38m
> wl mimo_txbw 4
> wl scansuppress 1
----[for closed loop power control]----
> wl phy_txpwrctrl 1
> wl txpwr1 -1 --> -1 = default target power; or
> wl txpwr1 -o -d [X] --> X = user defined Tx power, in dBm
----[for open loop power control]----
> wl phy_txpwrctrl 0
> wl phy_txpwrindex [X] --> X = Tx power index from range 0-127
-----------------------------------------------
> wl up
> wl phy_forcecal 1
> wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0 --> start Tx transmission
> wl pkteng_stop tx --> stop Tx transmission
```

Transmit Test Sequence for IEEE 802.11ac (VHT20 MCS Rates)

```
> wl down
> wl mpc 0
> wl phy_watchdog 0
> wl country ALL
> wl band a --> a = 5 GHz
> wl 5g_rate -v [0-8] -s 1 -b 20 --> 5g = 5 GHz, -v = MCS0-MCS8, -s = # of stream, -b = 20 MHz bandwidth
> wl chanspec 36/20 --> 36 = center freq channel, 20 = 20 MHz BW
> wl scansuppress 1
----[for closed loop power control]----
> wl phy_txpwrctrl 1
> wl txpwr1 -1 --> -1 =  default target power; or
> wl txpwr1 -o -d [X] --> X = user defined Tx power, in dBm
----[for open loop power control]----
> wl phy_txpwrctrl 0
> wl phy_txpwrindex [X] --> X = Tx power index from range 0-127
-----------------------------------------------
> wl up
> wl phy_forcecal 1
> wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0 --> start Tx transmission
> wl pkteng_stop tx --> stop Tx transmission
```

Transmit Test Sequence for IEEE 802.11ac (VHT40 MCS Rates)

```
> wl down
> wl mpc 0
> wl phy_watchdog 0
> wl country ALL
> wl band a --> a = 5 GHz
> wl 5g_rate -v [0-9] -s 1 -b 40 --> 5g = 5 GHz, -v = MCS0-MCS9, -s = # of stream, -b = 40 MHz bandwidth
> wl chanspec 36/40 --> 36 = control channel, 40 = 40 MHz BW, center freq = 38m
> wl scansuppress 1
----[for closed loop power control]----
> wl phy_txpwrctrl 1
> wl txpwr1 -1 --> -1 =  default target power; or
> wl txpwr1 -o -d [X] --> X = user defined Tx power, in dBm
----[for open loop power control]----
> wl phy_txpwrctrl 0
> wl phy_txpwrindex [X] --> X = Tx power index from range 0-127
-----------------------------------------------
> wl up
> wl phy_forcecal 1
> wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0 --> start Tx transmission
> wl pkteng_stop tx --> stop Tx transmission
```

Transmit Test Sequence for IEEE 802.11ac (VHT80 MCS Rates)

```
> wl down
> wl mpc 0
> wl phy_watchdog 0
> wl country ALL
> wl band a --> a = 5 GHz
> wl 5g_rate -v [0-9] -s 1 -b 80 --> 5g = 5 GHz, -v = MCS0-MCS9, -s = # of stream, -b = 80 MHz bandwidth
> wl chanspec 36/80 --> 36 = control channel, 80 = 80 MHz BW, center freq = 42q
> wl scansuppress 1
----[for closed loop power control]----
> wl phy_txpwrctrl 1
> wl txpwr1 -1 --> -1 =  default target power; or
> wl txpwr1 -o -d [X] --> X = user defined Tx power, in dBm
----[for open loop power control]----
> wl phy_txpwrctrl 0
> wl phy_txpwrindex [X] --> X = Tx power index from range 0-127
-----------------------------------------------
> wl up
> wl phy_forcecal 1
> wl pkteng_start 00:11:22:33:44:55 tx 100 1024 0 --> start Tx transmission
> wl pkteng_stop tx --> stop Tx transmission
```

Receive Test Sequences

The WL command sequences contained in this section are presented in order of frequency band, rate, and bandwidth. Though the BCM4339 supports IEEE 802.11ac, the WL command sequences for 802.11a, 802.11b, 802.11g, and 802.11n are also supported.

To run WL commands, the BCM4339 WLAN driver must be installed on the host system. In addition, the revision of the WLAN Client Utility used to run the WL commands must match the revision of the BCM4339 device driver installed on the host.

Note: The appropriate matching Broadcom WLAN Client Utility is included in the BCM4339 device driver package.

Receive Test Sequence for IEEE 802.11b/g

```
> wl down
> wl mpc 0
> wl phy_watchdog 0
> wl country ALL
> wl band b --> b = 2.4 GHz
> wl channel 7 --> 7 = center freq channel in 2.4 GHz band
> wl up
> wl phy_forcecal 1
> wl scansuppress 1
> wl counters --> read rxdfrmocast/rxdfrmucastmbss for multi-cast/uni-cast packets, take this as
  counter#1
> Generate a 11b/g waveform that contains X number of packets
> wl counters --> read the same counter count again, take this as counter#2
> PER% = { [ X - (counter#2 - counter#1) ] / X } * 100 %
```

Receive Test Sequence for IEEE 802.11a

```
> wl down
> wl mpc 0
> wl phy_watchdog 0
> wl country ALL
> wl band a --> a = 5 GHz
> wl channel 36 --> 36 = center freq channel in 5 GHz band
> wl up
> wl phy_forcecal 1
> wl scansuppress 1
> wl counters --> read rxdfrmocast/rxdfrmucastmbss for multi-cast/uni-cast packets, take this as
  counter#1
> Generate a 11a waveform that contains X number of packets
> wl counters --> read the same counter count again, take this as counter#2
> PER% = { [ X - (counter#2 - counter#1) ] / X } * 100 %
```

Receive Test Sequence for IEEE 802.11n (HT20 MCS Rates)

```
> wl down
> wl mpc 0
> wl phy_watchdog 0
> wl country ALL
> wl band [b/a] --> b = 2.4 GHz, a = 5 GHz
> wl chanspec 7/20 --> 7 = center freq channel, 20 = 20 MHz BW
> wl up
> wl phy_forcecal 1
> wl scansuppress 1
> wl counters --> read rxdfrmocast/rxdfrmucastmbss for multi-cast/uni-cast packets, take this as
  counter#1
> Generate a 11n-HT20 waveform that contains X number of packets
> wl counters --> read the same counter count again, take this as counter#2
> PER% = { [ X - (counter#2 - counter#1) ] / X } * 100 %
```

Receive Test Sequence for IEEE 802.11n (HT40 MCS Rates)

```
> wl down
> wl mpc 0
> wl phy_watchdog 0
> wl country ALL
> wl band [b/a] --> b = 2.4 GHz, a = 5 GHz
> wl chanspec 36/40 --> 36 = control channel, 40 = 40 MHz BW, center freq = 38m
> wl up
> wl mimo_txbw 4
> wl phy_forcecal 1
> wl scansuppress 1
> wl counters --> read rxdfrmocast/rxdfrmucastmbss for multi-cast/uni-cast packets, take this as
  counter#1
> Generate a 11n-HT40 waveform that contains X number of packets
> wl counters --> read the same counter count again, take this as counter#2
> PER% = { [ X - (counter#2 - counter#1) ] / X } * 100 %
```

Receive Test Sequence for IEEE 802.11ac (VHT20 MCS Rates)

```
> wl down
> wl mpc 0
> wl phy_watchdog 0
> wl country ALL
> wl band a --> a = 5 GHz
> wl chanspec 36/20 --> 36 = center freq channel, 20 = 20 MHz BW
> wl up
> wl phy_forcecal 1
> wl scansuppress 1
> wl counters --> read rxdfrmocast/rxdfrmucastmbss for multi-cast/uni-cast packets, take this as
  counter#1
> Generate a 11AC-VHT20 waveform that contains X number of packets
> wl counters --> read the same counter count again, take this as counter#2
> PER% = { [ X - (counter#2 - counter#1) ] / X } * 100 %
```

Receive Test Sequence for 802.11ac (VHT40 MCS Rates)

```
> wl down
> wl mpc 0
> wl phy_watchdog 0
> wl country ALL
> wl band a --> a = 5 GHz
> wl chanspec 36/40 --> 36 = control channel, 40 = 40 MHz BW, center freq = 38m
> wl up
> wl phy_forcecal 1
> wl scansuppress 1
> wl counters --> read rxdfrmocast/rxdfrmucastmbss for multi-cast/uni-cast packets, take this as
  counter#1
> Generate a 11AC-VHT40 waveform that contains X number of packets
> wl counters --> read the same counter count again, take this as counter#2
> PER% = { [ X - (counter#2 - counter#1) ] / X } * 100 %
```

Receive Test Sequence for 802.11ac (VHT80 MCS Rates)

```
> wl down
> wl mpc 0
> wl phy_watchdog 0
> wl country ALL
> wl band a --> a = 5 GHz
> wl chanspec 36/80 --> 36 = control channel, 80 = 80 MHz BW, center freq = 42q
> wl up
> wl phy_forcecal 1
> wl scansuppress 1
> wl counters --> read rxdfrmocast/rxdfrmucastmbss for multi-cast/uni-cast packets, take this as
  counter#1
> Generate a 11AC-VHT80 waveform that contains X number of packets
> wl counters --> read the same counter count again, take this as counter#2
> PER% = { [ X - (counter#2 - counter#1) ] / X } * 100 %
```

Appendix A: Understanding WL Commands

Table 1 contains descriptions of the WL commands used to perform transmit and receive RF performance testing on the BCM4339. The command descriptions are provided to help users understand the various test conditions and to assist in modifying the commands if necessary.

Note: Descriptions of all the commands that the Broadcom WLAN Client Utility supports are provided in *Broadcom WLAN Client Utility Command Set* (80211-TI3XX-R).

Table 1: WL Command Descriptions

Command	*Description/Options*
wl 2g_rate	Gets or forces the rate override for data frames in the 2.4 GHz band. If no arguments are given, the command displays the current rate override for the 2.4 GHz band, or auto if there is no override. Command Options: -r R, --rate = R: Legacy rate (CCK, DSSS, OFDM) -h M, --ht = M: HT MCS index [0-7] -v M[[xS], --vht = M[xS]: VHT MCS index M [0-9], and optionally Nss S[1-8] -s S, --(ss = S): VHT Nss [1-8], number of spatial streams, default 1 --stbc: Use STBC expansion, otherwise no STBC -l, --ldpc: Use LDPC encoding, otherwise no LDPC -g, --sgi: SGI, Short Guard Interval, otherwise standard GI -b, --bandwidth: Transmit bandwidth MHz; 20, 40, 80
wl 5g_rate	Gets or forces the rate override for data frames in the 5 GHz band. If no arguments are given, the command displays the current rate override for the 5 GHz band, or auto if there is no override. Command Options: -r R, --rate = R: Legacy rate (CCK, DSSS, OFDM) -h M, --ht = M: HT MCS index [0-7] -v M[[xS], --vht = M[xS]: VHT MCS index M [0-9], and optionally Nss S[1-8] -s S, --(ss = S): VHT Nss [1-8], number of spatial streams, default 1 --stbc: Use STBC expansion, otherwise no STBC -l, --ldpc: Use LDPC encoding, otherwise no LDPC -g, --sgi: SGI, Short Guard Interval, otherwise standard GI -b, --bandwidth: Transmit bandwidth MHz; 20, 40, 80
wl band	Returns or sets the current band. Auto: Auto switch between available bands (default). a: Forces use of IEEE 802.11a band. b: Forces use of IEEE 802.11b band.
wl chan_info	Returns channel information.

Table 1: WL Command Descriptions (Cont.)

Command	*Description/Options*
wl channels	Returns valid channels for the current settings.
wl chanspec	Gets or sets the channel using a chanspec. 20 MHz: [2G/5G channel]/20 40 MHz: [2G/5G channel]/40[u,l] 80 MHz: [5G channel]/80 Optional band 2G or 5G, default to 2G if channel is less than or equal to 14.
wl chanspecs	Returns a list of valid chanspecs for the current settings. The list can be filtered down to only chanspecs for a specific band and bandwidth. The list can also be generated for a different country.
wl cisdump	Dumps the contents of the CIS. If the CIS is blank, all zeroes are dumped.
wl counters	Returns driver counter values. Useful counters: rxdfrmocast: Number of received DATA frames with good FCS and matching RA for multicast packets. rxdfrmmcast: Number of Rx DATA multicast frames received by the MAC. rxdfrmucastmbss: Number of received DATA frames with good FCS and matching RA for unicast packets. rxbeaconmbss: Beacon receives from member of BSS.
wl country	Gets or selects the country code for the region in which the driver will be operating.
wl country list	Returns a list of supported countries.
wl down	Resets the adapter and marks it as being down (disable).
wl dump nvram/wl nvram_dump	Prints NVRAM parameters values read by the driver.
wl fqacurcy	A manufacturing test that sets the frequency accuracy mode to allow the center frequency of the carrier (e.g., a single tone at the carrier frequency) to be measured. Usage: wl fqacurcy [channel] The argument is the channel number or 0 to stop the test.
wl isup	Gets the operational state of the driver. 0: Down 1: Up
wl mpc	Enables/disables minimum power consumption mode. 0: Disable 1: Enable
wl otpdump	Dumps the raw OTP content.
wl out	Marks the adapter as being down but does not reset the hardware (disable). The band must be locked before running this command on dual-band devices (see wl band command on page 16).
wl phy_activecal	Checks to see if phy_forcecal is done (returns 0 when it is completed successfully).
wl phy_forcecal	Forces PHY calibration to run immediately.

Table 1: WL Command Descriptions (Cont.)

Command	*Description/Options*
wl phy_txpwrctrl	Gets or sets the PHY transmit power control type: 0: Open-loop transmit power control 1: Closed-loop transmit power control
wl phy_txpwrindex	Gets or sets the PHY transmit power index for open-loop transmit power control. Valid values range from 0 to 127 (0 denotes the maximum power, 127 denotes the minimum power).
wl phy_watchdog	Enables/disables PHY watchdog calibration. 0: Disable 1: Enable
wl pkteng_start	Transmitter (Tx) Start: Usage: wl pkteng_start [MAC addr] [tx/txwithack][(async)|sync][ipg][len][nframes][src] MAC addr (tx/txwithack): The destination address (give arbitrary addr if no MAC address is specified). tx: Transmits packets with no ACK. txwithack: Transmits packets and wait for ACK. sync: Synchronous mode. ipg: Inter-packet gap in µS (used only in Tx; ignored if RIFS is enabled). len: Specifies the packet length to be sent from the DUT (used only in Tx). nframes: Specifies the number of packets to be transmitted from DUT (0 indicates continuous transmission (used only in Tx). Usage example: Transmits 1000 data frames of 200 bytes with 30 mS inter packet gap. wl pkteng_start 10:20:30:40:50:60 tx 30 200 1000 Receiver (Rx) Start: Usage: wl pkteng_start [MAC addr][rx/rxwithack][(async)|sync][rxframes][rxtimeout] MAC addr: rx: DUT accepts frames from this address (give arbitrary addr if no MAC address is specified). rxwithack: DUT accepts frames from this address and sends ACK to this address. rx: Receives packets and does not transmit ACK. rxwithack: Receives packets and transmits ACK. rxframes: Specifies the number of receive frames (sync mode only). rxwithout: Specifies the maximum time-out in msec (sync mode only). Usage example: Receives frames without ACK. wl pkteng_start 10:20:30:40:50:60 rx Limitation Packet engine must be used when not associated.
wl pkteng_stop	Stops the pkteng Tx/Rx mode. Usage: wl pkteng_stop [tx/rx]

Table 1: WL Command Descriptions (Cont.)

Command	*Description/Options*
wl PM	Sets the driver power management mode. 0: CAM (constantly awake) 1: PS (power save) 2: FAST PS mode
wl revinfo	Gets hardware revision information.
wl scansuppress	Suppresses all scans for testing. 0: Allows scans. 1: Suppresses scans.
wl txpwr1	Sets closed-loop Tx power in one of the following units: -d: dBm units (default) -q: quarter dBm units -m: milliwatt units Can be combined with: -o: Turns on override to disable regulatory and other limitations. ***Note:*** Use wl txpwr1 -1 to restore to default Tx power.
wl up	Reinitializes and marks the adapter as being up (operational).
wl ver	Gets Broadcom WLAN Client Utility version information.

Connecting everything®

BROADCOM CORPORATION
5300 California Avenue
Irvine, CA 92617

Phone: 949-926-5000
Fax: 949-926-5203
E-mail: info@broadcom.com
Web: www.broadcom.com

4339-SWUM102-R December 16, 2013