



Wireless

SPB209 SDIO-SDIO Release Notes

2023-10-11

1. Package Information

- Version: SD-WLAN-SD-BT-8887-U16-MMC-W15.68.19.p73-15.26.19.p73-CS4X15716_A2-MGPL

2. Naming Convention

- Host Interface - SD-WLAN-SD-BT
- Chip Family - 8887
- Host - U16-X86, Linux Ubuntu U16 on Intel X86 platform
- Wi-Fi FW Version - W15.68.19.p73
 - 15 - Version 15 Architecture
 - 68- Feature Pack
 - 19 - Branch Number
 - P73- Release Version
- BT-BLE FW Version - 15.26.19.p73
 - 15 - Version 15 Architecture
 - 26- Feature Pack
 - 19 - Branch Number
 - P73- Release Version
- Driver version - CS4X15716
 - 4X- Linux 4.x
 - 15716 - Release version
 - A2 - Chip Version
 - MGPL - General Public License

3. W15.68.19.p73-15.26.19.p73-CS4X15716_A2-MGPL Information

- Tested SOC Revision: 88W8887 A2
- Combo Firmware
 - sd8887_uapsta_a2.bin : W15.68.19.p73-15.26.19.p73
- Parallel Firmware
 - sd8887_wlan_a2.bin : W15.68.19.p73
 - sd8887_bt_a2.bin : 15.26.19.p73
- Driver Package
 - Wi-Fi Driver (mlan.ko , sd8887.ko)

- BT Driver (bt8887.ko)
- WPA supplicant : wpa_supplicant-2.10
- Hostapd : hostapd-2.10
- Supported Linux Kernel Versions: 2.6.32 to 6.0.0

4. Driver version:

- C : Indicated NXP OS independent driver
- 4.X : indicated support for kernel version 4.x
- Release Number: this number tracks the incremental changes in the consequent driver releases given to QA or customers.
- Patch Number: Customers may want to receive a driver build based on a previous release plus specific bug fixes, or patches. It is not unusual for customers to request this when they are close to production. The patch number starts at zero (no patch), and increments as we release subsequent builds with more bug fixes.

5. Firmware version:

Following is an explanation of each digit in the versioning scheme designed for the firmware: * Major Revision (first number from the left): Tracks the main FW version. * Minor Revision (second number from the left): Tracks the chip family, firmware branch, custom projects. etc. * Release Number (third number from the left): this number tracks the incremental changes in the consequent firmware releases given to QA or customers. * Patch Number (fourth number from the left): Customers may want to receive a firmware build based on a previous release plus specific bug fixes, or patches. It is not unusual for customers to request this when they are close to production. The patch number starts at zero (no patch), and increments as we release subsequent builds with more bug fixes

6. Bluetooth Host Software version:

- BlueZ - 5.54
- HCI Tool version 4.101

7. Host Platform

- U16
- Interfaces used
 - WLAN over SDIO
 - BT/BLE over SDIO

8. Features

8.1. WLAN Client features

8.1.1. 802.11 a/b/g Features

- Data Rates (Up to 54 Mbps)
- TX Rate Adaptation (ABG)
- TX of RTS/CTS based upon RTS Threshold
- Fragmentation/Defragmentation
- ERP protection, Slot time, Preamble
- ERP Protection using macctrl command (RTS-CTS/Self-CTS)

8.1.2. 802.11d & 802.11h

- 802.11d - Regulatory Domain/Operating Class/Country Info
- 802.11h - DFS - Radar Detection and CSA
- DFS Radar Detection Tests for FCC/ETSI/Korea/Japan(W53/W56)

8.1.3. 802.11e -QoS

- EDCA (Enhanced Distributed Channel Access) / WMM (Wireless Multi-Media)
- U-APSD[Unscheduled Automatic Power save and Delivery]/ WMM-Power save

8.1.4. 802.11i - Security

- Open and Shared Authentication
- Auto Authentication (using open and shared Authentication at same time)
- WPA-PSK, WPA2-PSK Security (AES-CCMP Encryption)
- 802.1x EAP Authentication methods (TLS, TTLS, PEAP, SIM, AKA, FAST)
- Opensource WPA Supplicant Support
- Embedded Supplicant Support

8.1.5. 802.11w - PMF (Protected Management Frames)

- PMF Require and Capable
- Unicast Management Frames - Encrypt/Decryption -using CCMP
- Broadcast Management Frames - Encrypt/Decryption - using BIP
- SA Query Request/Response
- PMF Support (Opensource WPA Supplicant)

- PMF Support (Embedded Supplicant)

8.1.6. Security WAPI

- WAPI-PSK
- WAPI-CERT
- WAPI-PKCS12

8.1.7. 802.11n - High Throughput

- 2.4GHz Band Operation
- 5GHz Band Operation
- 20MHz and 40MHz channel Bandwidth
- Short/Long Guard Interval (400ns/800ns)
- Green Field Operation
- 1 Spatial stream (1x1)
- 11n Data rates - Up to 150 Mbps (MCS 0 to MCS 7)
- HT Duplicate mode (MCS32)
- TX MCS Rate Adaptation (ABGN)
- AMPDU and AMSDU4K Aggregation
- AMSDU Over AMPDU
- HT Protection Mechanisms
- 20/40 MHz Coexistence
- STBC Rx
- LDPC Parity

8.1.8. 802.11 ac - Very High Throughput

- 5GHz Band Operation
- 20/40/80 MHz channel Bandwidth
- 11ac Data rates - Up to 433.3 Mbps (MCS 0 to MCS 9)
- 256 QAM Modulation - MCS8 and MCS9
- SU-AMPDU Aggregation
- Backward Compatibility with non-VHT devices
- TX Rate Adaptation (VHT MCS Rates)

8.1.9. General Features

- Infrastructure Mode

- Auto Deep Sleep
- Host Sleep
- Background Scan
- User Defined Scan (setuserscan)
- Specific scan (scancfg)
- Network Scan (iwlist scan)
- ARP Filter
- Subscriber Event
- Auto Response (MEF)
- Auto Tx
- Vendor Specific IE (Custom IE)
- Antenna Configuration Commands
- Signal Level Reporting Commands (RSSI/SNR)
- MIB Statistics Counters
 - dot11Counters Group
 - dot11MACStatistics Group
 - dot11QosCounters Group(Per TID)
 - dot11CountersGroup3 (A-MSDU)
 - dot11CountersGroup3 (A-MPDU)
- Histogram support (Counters for RSSI/SNR/Signal Strength/Data Rates)

8.1.10. Power Save Modes

- IEEE PS (Infrastructure Mode) - PS-Poll and non-PS-Poll Methods
- Inactivity Timeout
- Listen Interval

8.1.11. Optional Parameters during driver load

- Configuring MAC Address using init_cfg file
- Loading Driver Using CFG80211 and mlanutl commands
- Loading Driver Using WEXT
- Setting Deep sleep.
- Setting Power save

8.1.12. WPS/WSC2.0 Functionality

- PIN Config Method - 8 Digit/4 Digit

- PIN Config Method - Static/Dynamic PIN
- PBC - Virtual Push Button Config Method
- STA as Enrollee
- STA as Registrar
- Auto PIN
- Auto PBC
- Backward Compatibility with WPS1.0 Devices
- WPS/WSC2.0 functionality using mwu_cli app (with Embedded Supplicant)
- WPS/WSC2.0 functionality using mwu_cli app (with Opensource WPA Supplicant)
- WPS/WSC2.0 functionality Opensource WPA Supplicant

8.1.13. 802.11r - Fast BSS Transition (FT)

- FT over Air
- FT over DS (Distribution System)

8.1.14. 802.11z - TDLS (Tunneled Direct Link Setup)

- Host Based TDLS Support using wpa_supplicant
- TDLS Discovery
- TDLS Link Setup
- TDLS Link Teardown
- TDLS Security (TDLS Link possible with Peers using WPA2-AES Security)
- TDLS Channel Switching
- U-APSD Powersave and Buffer Operation on a TDLS Link
- Concurrent operation of STA-Infra Link and TDLS Link
- Two TDLS concurrent links are supported

8.1.15. Voice over Wi-Fi Personal

8.1.16. WPA2 Security Improvements

- Handling RSNE Unexpected values
- Verify RSN Capabilities
- RSNE Bounds Verification for WPA2-PSK and WPA2-EAP
- Unknown Root CA Detection
- Replay Protection

8.1.17. WPA3 Security

- Opportunistic Wireless Encryption (OWE)
- OWE Connectivity and PMK Caching
- OWE Transition Mode
- OWE Finite Cyclic Group - Group 19, Group 20
- Simultaneous Authentication of Equals (SAE)
 - SAE Connectivity and PMK Caching
 - Anti-Clogging
 - SAE Finite Cyclic Group - Group-19, Group 20, Group-21, Group-25, Group-26
 - Reflection Attack
 - WPA2 Personal Compatibility
- Device Provisioning Protocol (DPP) / Easy Connect

8.2. Access Point Features

8.2.1. 802.11 a/b/g Features

- Data Rates (Up to 54 Mbps)
- TX Rate Adaptation (ABG)
- TX of RTS/CTS based upon RTS Threshold
- Fragmentation/Defragmentation
- ERP protection, Slot time, Preamble
- Handling Associated STAs with IEEE PS - PS-Poll and Null Data

8.2.2. 802.11d & 802.11h

- 802.11d - Regulatory Domain/Operating Class/Country Info
- 802.11h - DFS - Radar Detection and CSA
- DFS Radar Detection Tests for FCC/ETSI/Korea/Japan W53/W56)

8.2.3. 802.11e -QoS

- EDCA (Enhanced Distributed Channel Access) / WMM (Wireless Multi-Media)
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8.2.4. 802.11i - Security

- Open and Shared Authentication
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- WPA-PSK, WPA2-PSK Security (AES-CCMP Encryption)
- 802.1x EAP Authentication methods (using Hostapd only)
- (TLS, TTLS, PEAP, SIM, AKA, FAST)
- Opensource Host based Authenticator Support (Hostapd)
- Embedded Authenticator Support
- Group Key Refresh (Rekeying GTK)

8.2.5. 802.11w - Protected Management Frames (PMF)

- PMF Require and Capable
- Unicast Management Frames - Encrypt/Decryption -using CCMP
- Broadcast Management Frames - Encrypt/Decryption - using BIP
- SA Query Request/Response
- PMF Support (using Hostapd only)

8.2.6. Security WAPI

- WAPI-PSK
- WAPI-CERT
- WAPI-PKCS12

8.2.7. 802.11n - High Throughput

- 2.4GHz Band Operation
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- HT Duplicate mode (MCS32)
- TX MCS Rate Adaptation (ABGN)
- AMPDU and AMSDU4K Aggregation
- AMSDU Over AMPDU
- HT Protection Mechanisms
- 20/40 MHz Coexistence
- Explicit Beam forming
- SM Power save (MIMO Power save)

- LDPC Parity

8.2.8. 802.11 ac - Very High Throughput

- 2.4GHz Band Operation
- 5GHz Band Operation
- 20/40/80 MHz channel Bandwidth
- Short/Long Guard Interval (400ns/800ns)
- 11ac Data rates - Up to 433.3 Mbps (MCS 0 to MCS 9)
- 256 QAM Modulation - MCS8 and MCS9
- SU-AMPDU Aggregation
- Explicit Beam forming
- Backward Compatibility with non-VHT devices
- TX Rate Adaptation (VHT MCS Rates)

8.2.9. General Features

- Auto Deep Sleep
- Host Sleep or USB Suspend-Resume
- Automatic Channel Selection (ACS)
- Hidden SSID (Broadcast SSID Disabled)
- MAC Address Filter (Allowed/Denied List)
- Vendor Specific IE (Custom IE)
- STA Age out Feature for non-PS clients
- STA Age out Feature for Power save clients
- Configurable MAX Supported Stations (Up to 10)
- Configurable Retry Limit
- Configurable Unicast Data Rate
- Configurable Broadcast/Multicast Data Rate
- Antenna Configuration Commands
- AP MODE Events
- BSS Privacy Control (Packet forward Control) or AP Isolation
- Sticky TIM
- Restrict Client Associations based on PHY mode (a/b/bg/n/ac)
- MIB Statistics Counters
 - dot11Counters Group
 - dot11MACStatistics Group

- dot11QosCounters Group(Per TID)
- dot11CountersGroup3 (A-MSDU)
- dot11CountersGroup3 (A-MPDU)

8.2.10. AP MODE Power Save Modes

- Inactivity based Power save

8.2.11. Multi-BSS support

- MAX AP MODE BSS = 2
- AP MODE power save in MBSS scenario
- Independent security configurations on different interfaces (All Security Methods)

8.2.12. Optional Parameters during driver load

- Configuring MAC Address using init_cfg file
- Loading Driver Using CFG80211 and mlanutl commands
- Loading Driver Using WEXT
- Setting Deepsleep
- Loading AP MODE configuration using uaputl.conf file

8.2.13. WPS/WSC2.0 Functionality

- PIN Config Method - 8 Digit/4 Digit
- PIN Config Method - Static/Dynamic PIN
- PBC - Virtual Push Button Config Method
- AP Setup Locked State - PIN Method
- PBC Session Overlap Detection
- AP MODE as Enrollee
- AP MODE as Wireless Registrar
- WPS/WSC2.0 functionality using mwu_cli app

8.2.14. Voice over Wi-Fi Personal

8.2.15. WPA2 Security Improvements

- Handling RSNE Unexpected values
- Verify RSN Capabilities
- RSNE Bounds Verification for WPA2-PSK
- Unknown Root CA Detection

- Replay Protection

8.2.16. WPA3 Security

- Opportunistic Wireless Encryption (OWE)
 - OWE Connectivity and PMK Caching
 - OWE Transition Mode
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 - SAE Finite Cyclic Group - Group-19, Group 20, Group-21, Group-25, Group-26
 - Reflection Attack
 - WPA2 Personal Compatibility
- Device Provisioning Protocol (DPP) / Easy Connect

8.3. Wi-Fi Direct / P2P features

8.3.1. P2P Basic Functionality

- Protocol conformance tests
- Autonomous GO Mode
- WFD Client Mode

8.3.2. P2P Backward Compatibility

- Non P2P Client Association with GO

8.3.3. P2P Client Power save

- P2P Client with IEEE Power save enabled
- P2P Client with WMM PS enabled
- P2P Client with NoA PS enabled on GO
- P2P Client with Opportunistic PS enabled on GO

8.3.4. P2P GO Power save

- GO Operating with IEEE PS Clients (PS-Poll and non_PS-Poll)
- GO Operating with WMM PS Clients
- GO power save

8.3.5. Other P2P Features

- Max Client Support (Up to 8 Devices)
- Provision Discovery
- Persistent Group
- P2P Invitation

8.3.6. 802.1AS- Time Sync

- Transmission and Reception of Timing Measurement Frames
- 802.1as Master and Slave Mode
- Timing Measurement in STA, AP and P2P Modes

8.4. Wi-Fi Display / Miracast Features

- Miracast over P2P Support using NXP Wireless Utility(MWU APP)
- WiFi Display Source under Test (SoUT)
- WiFi Display Primary Sink under Test (P-SnUT)
- WiFi Display over P2P Link
- Provision Discovery

8.4.1. Source and Primary Sink Support

- UIBC with Generic User Input
- UIBC with HID
- HDCP Encryption of audio and video Content
- Frame Skipping
- Explicit AV Format Change
- Standby Capabilities
- Remote I2C Read/Write Capabilities
- Concurrent WLAN Operation
- Persistent P2P Group

8.4.2. Primary Sink Support

- Video Recovery
- Extended Display Identification Data (EDID)

8.5. Wi-Fi Aware / Neighbor Awareness Network (NAN) Features

- NAN Discovery
- Timing synchronization
- Operating in Discovery Windows

8.5.1. NAN Device Role Selection and State Transition

- Anchor Master
- Non-Master and Sync
- Non-Master and non-Sync

8.5.2. NAN Cluster

- Initiation
- Selection
- Merging

8.5.3. NAN Service Discovery Methods

- Publish
- Cancel Publish
- Subscribe
- Follow-up Transmit

8.5.4. NAN Service Discovery Events (Discovery Result, Replied, Publish Terminated, Subscribe

Terminated, Follow-up Receive)

8.5.5. NAN Control and Filtering Function (Matching, Service Response Filter, Bloom Filter)

8.6. Simultaneous AP-STA Operation

8.6.1. Two or more WLAN Interfaces operates in same channel in a single band.

- AP + STA
 - Enhanced Power Save (AP-STA simultaneous power save)
- P2P+ STA

- P2P+ AP MODE
- AP MODE (MBSS) + STA
- STA + AP MODE + P2P

8.7. DRCS (Dynamic Rapid Channel Selection) Operation

8.7.1. Two or more WLAN Interfaces can operate in two different channels in same/different band.

- AP + STA
- P2P+ STA
- P2P+ AP MODE
- AP MODE (MBSS) + STA
- STA + AP MODE + P2P
- DRCS Parameters are configurable Host can configure channel availability time for each channel and channel switch time.

9. Bluetooth Features

9.1. Bluetooth Classic Features

- BT Class 1.5 and Class 2 support
- Scatternet support
- Maximum of seven simultaneous ACL connections
- Maximum of three SCO/eSCO links
- Automatic Packet Type Selection
- Deep Sleep
- Bluetooth Chip to Host wakeup
- PCM Loopback
- Encryption Pause and Resume
- Extended Inquiry Response
- Link Supervision Timeout Changed Event
- Secure Simple Pairing
- Sniff Sub rating
- Security Mode 4
- Enhanced Power Control

- HCI Read Encryption Key Size command
- AES Encryption
- Bluetooth + Bluetooth Low Energy Dual mode support
- BR/EDR Secure Connections

9.1.1. Bluetooth Packet type Supported

- ACL (DM1, DH1, DM3, DH3, DM5, DH5, 2-DH1, 2-DH3, 2-DH5, 3-DH1, 3-DH3, 3-DH5)
- SCO (HV1, HV3)
- eSCO (EV3, EV4, EV5, 2EV3, 3EV3, 2EV5, 3EV5)

9.1.2. Bluetooth Profiles Supported

- BT A2DP Source/Sink
- BT AVRCP Target/Controller
- BT HFP Dev/Gateway
- BT OPP Server/Client
- BT PAN Traffic
- BT SPP
- BT HID
- BT PBAP

9.1.3. Bluetooth Specification 2.1 Support

- Encryption Pause and Resume
- Extended Inquiry Response
- Link Supervision Timeout Changed Event
- Secure Simple Pairing
- Sniff Sub rating
- Security Mode 4

9.1.4. Bluetooth Specification 3.0 Support

- Enhanced Power Control
- HCI Read Encryption Key Size command

9.1.5. Bluetooth Specification 4.0 Support

- AES Encryption
- BT + BLE Dual mode support

9.1.6. Bluetooth Specification 4.1 Support

- BR/EDR Secure Connections

9.2. BLE Features

- BLE - 1Mbps/2Mbps Support
- BLE payload - 27bytes to 234 bytes.
- BLE - 5.0 Specification Support
- Bluetooth Low Energy Chip to Host wakeup
- Low Energy Physical Layer
- Low Energy Link Layer
- Low Duty Cycle Directed Advertising
- Low Energy Dual Mode Topology
- Low Energy Privacy v1.1
- Low Energy Link Layer Topology
- Low Energy secure connection
- Low Energy Link Layer Privacy
- Low Energy Data Length Extension

10. Bluetooth + WLAN Coexistence

10.1. Concurrent Coex Mode:

- STA + BT Coex
- STA + BLE Coex
- STA + BT + BLE Coex
- AP MODE + BT Coex
- AP MODE + BLE Coex
- AP MODE + BT + BLE Coex
- P2P + BT Coex
- P2P + BLE Coex
- P2P + BT + BLE Coex
- AP + AP + BT Coex
- AP + AP + BLE Coex
- STA - AP MODE DRCS + BT/BLE Coex
- STA - P2P GO DRCS + BT/BLE Coex

- STA - P2P GC DRCS + BT/BLE Coex
- AP MODE - P2P GO DRCS + BT/BLE Coex
- AP MODE - P2P GC DRCS + BT/BLE Coex
- uAP0 - uAP1 DRCS + BT/BLE Coex
- STA - AP MODE - P2P GO DRCS + BT/BLE Coex
- STA - uAP0 - uAP1 DRCS + BT/BLE Coex

10.2. Timeshare Coex Mode:

- STA + BT Coex
- STA + BLE Coex
- STA + BT + BLE Coex
- AP MODE + BT Coex
- AP MODE + BLE Coex
- AP MODE + BT + BLE Coex
- P2P + BT Coex
- P2P + BLE Coex
- P2P + BT + BLE Coex

11. Validation Tools

Tools * OmniPeek Wireless Sniffer * iperf (version 2.0.5) * Frontline/Ellysis BT Sniffer

12. Wi-Fi Throughput

12.1. Throughput Test Setup

- Environment: Shield Room - Over the Air
- Access Point: EX-AP : Linksys WRT 1900 AC AP [with Linux Backend]
- Ref STA: NXP 8997 PCIE-UART
- Channel: 6 / 36

12.2. STA Throughput

STA Mode Throughput-BGN Mode / 2.4GHz Band / 20 MHz				
Security	TCP		UDP	
	<i>Tx</i>	<i>Rx</i>	<i>Tx</i>	<i>Rx</i>

STA Mode Throughput-BGN Mode / 2.4GHz Band / 20 MHz				
OPEN	55.0	58.0	56.0	62.0
WPA2	55.0	58.0	56.0	61.0
WPA3	55.0	58.0	58.0	61.0

STA Mode Throughput-BGN Mode / 2.4GHz Band / 40 MHz				
Security	TCP		UDP	
	<i>Tx</i>	<i>Rx</i>	<i>Tx</i>	<i>Rx</i>
OPEN	102.0	111.0	119.0	125.2
WPA2	102.0	110.1	118.0	129.0
WPA3	101.0	109.1	118.0	129.0

STA Mode Throughput - AN Mode / 5GHz Band / 20 MHz				
Security	TCP		UDP	
	<i>Tx</i>	<i>Rx</i>	<i>Tx</i>	<i>Rx</i>
OPEN	58.0	60.0	60.0	63.0
WPA2	59.0	60.0	61.0	63.0
WPA3	58.0	60.0	61.0	63.0

STA Mode Throughput - AN Mode / 5GHz Band / 40 MHz				
Security	TCP		UDP	
	<i>Tx</i>	<i>Rx</i>	<i>Tx</i>	<i>Rx</i>
OPEN	119.0	119.0	127.0	134.0
WPA2	118.0	118.0	125.0	134.0
WPA3	118.0	119.0	125.0	134.0

STA Mode Throughput - AC Mode / 5GHz Band / 20 MHz				
Security	TCP		UDP	
	<i>Tx</i>	<i>Rx</i>	<i>Tx</i>	<i>Rx</i>
OPEN	68.0	71.0	76.0	73.0
WPA2	70.1	70.0	74.0	73.0
WPA3	69.0	70.0	75.0	73.0

STA Mode Throughput - AC Mode / 5GHz Band / 40 MHz				
Security	TCP		UDP	
	<i>Tx</i>	<i>Rx</i>	<i>Tx</i>	<i>Rx</i>
OPEN	150.0	171.0	161.0	178.0

STA Mode Throughput - AC Mode / 5GHz Band / 40 MHz				
WPA2	147.0	165.0	156.0	178.0
WPA3	147.0	155.0	152.0	160.0

STA Mode Throughput - AC Mode / 5GHz Band / 80 MHz				
Security	TCP		UDP	
	<i>Tx</i>	<i>Rx</i>	<i>Tx</i>	<i>Rx</i>
OPEN	221.0	295.0	220.0	308.0
WPA2	190.0	276.0	190.0	295.0
WPA3	165.0	243.0	191.0	251.0

12.3. uAP Throughput

uAP Mode Throughput-BGN Mode / 2.4GHz Band / 20 MHz				
Security	TCP		UDP	
	<i>Tx</i>	<i>Rx</i>	<i>Tx</i>	<i>Rx</i>
OPEN	54.0	54.0	52.0	62.0
WPA2	49.6	55.0	52.6	62.0
WPA3	49.9	55.0	52.4	62.0

uAP Mode Throughput-BGN Mode / 2.4GHz Band / 40 MHz				
Security	TCP		UDP	
	<i>Tx</i>	<i>Rx</i>	<i>Tx</i>	<i>Rx</i>
OPEN	96.0	109.0	103.0	129.0
WPA2	97.0	110.0	103.0	116.0
WPA3	94.0	112.0	103.0	128.0

uAP Mode Throughput - AN Mode / 5GHz Band / 20 MHz				
Security	TCP		UDP	
	<i>Tx</i>	<i>Rx</i>	<i>Tx</i>	<i>Rx</i>
OPEN	57.0	56.0	60.0	63.0
WPA2	57.0	56.0	60.0	63.0
WPA3	57.0	56.0	60.0	63.0

uAP Mode Throughput - AN Mode / 5GHz Band / 40 MHz				
Security	TCP		UDP	
	<i>Tx</i>	<i>Rx</i>	<i>Tx</i>	<i>Rx</i>

uAP Mode Throughput - AN Mode / 5GHz Band / 40 MHz				
OPEN	116.0	116.2	124.0	133.0
WPA2	115.0	110.1	123.0	133.0
WPA3	115.0	111.1	123.0	133.0

uAP Mode Throughput - AC Mode / 5GHz Band / 20 MHz				
Security	TCP		UDP	
	<i>Tx</i>	<i>Rx</i>	<i>Tx</i>	<i>Rx</i>
OPEN	71.0	67.0	75.0	73.0
WPA2	69.0	67.0	75.0	73.0
WPA3	70.0	67.0	74.0	74.0

uAP Mode Throughput - AC Mode / 5GHz Band / 40 MHz				
Security	TCP		UDP	
	<i>Tx</i>	<i>Rx</i>	<i>Tx</i>	<i>Rx</i>
OPEN	138.0	158.0	149.0	171.0
WPA2	135.0	151.0	149.0	166.0
WPA3	136.0	142.0	153.0	163.2

uAP Mode Throughput - AC Mode / 5GHz Band / 80 MHz				
Security	TCP		UDP	
	<i>Tx</i>	<i>Rx</i>	<i>Tx</i>	<i>Rx</i>
OPEN	214.0	260.0	222.0	301.0
WPA2	184.0	245.0	208.0	271.0
WPA3	188.0	240.0	208.0	231.0

12.4. P2P Throughput

P2P Mode Throughput - AN Mode / 5GHz Band / 40 MHz				
Security	TCP		UDP	
	<i>Tx</i>	<i>Rx</i>	<i>Tx</i>	<i>Rx</i>
WPA2	114.0	122.0	122.0	133.0

P2P Mode Throughput - BGN Mode / 2.4GHz Band / 20 MHz				
Security	TCP		UDP	
	<i>Tx</i>	<i>Rx</i>	<i>Tx</i>	<i>Rx</i>
WPA2	56.0	56.0	60.0	63.0

13. Bug Fixes

- Wi-Fi
 - Driver fixes for static tool analyzer errors
 - Changes added to support WPA3 R3
 - PMF and SVD Fixes are added for WFA certification support
 - Sometimes STAUT connection fails with external AP when WPA3 is enabled
- BT/BLE
 - Remote sending LE packet with LLID=0 causing system hang.
 - BT HFP Audio not coming over Headset in Wi-Fi Calling scenario
 - Timeout observed for Command_Status_Event from controller for Enhanced_Accept_Synchronous_Connection_Request command from Host

14. Serial and parallel download

To set Board to Serial or Parallel FW download mode the H/W strap setting needs to be done using pull up register. Please refer Section 1.5 from data sheet for 8887 (MV-S109229-00D.pdf)

Parallel download: The WLAN and BT FW are downloaded independently. WLAN driver will download WLAN-only firmware and BT driver will download BT-only firmware. The Separate WLAN and BT FW binaries should be used when using parallel download and are provided in the release package "FwImage" folder.

WLAN only Firmware: sd8887_wlan_a2.bin BT Only Firmware: sd8887_bt_a2.bin

1. Download WLAN only firmware: (Copy FW image and cal data file in /lib/firmware/nxp

```
# insmod wlan.ko
# insmod sd8887.ko cal_data_cfg=none fw_name=nxp/sd8887_wlan_a2.bin
```

2. Download BT Only Firmware:

```
# insmod bt8887.ko fw_name=nxp/sd8887_bt_a2.bin
```

Serial Download: Serial downloading is for WLAN and BT driver download WLAN/BT combo firmware, when one of them has already downloaded combo firmware, the other one will skip firmware downloading. The WLAN/BT combo firmware should be used when using serial download.

WLAN/BT Combo Firmware: sd8887_uapsta_a2.bin i.e. `insmod sd8887.ko cal_data_cfg=none fw_name=nxp/sd8887_uapsta_a2.bin`

15. Simultaneous Mode use cases

15.1. Single Channel Simultaneous Mode Use Cases

Single Channel Simultaneous Mode Use Cases								Use case
mlan 0	uap 0	uap 1	wfd0	mla n0	uap 0	uap 1	wfd0	
Channel X				Channel Y				
								Standalone Modes - Single State
Y								STA only Mode
	Y							AP MODE(Single -BSS) only Mode
			Y					P2P only mode - P2P_GO P2P_Client
								Simultaneous Modes - Dual State involving AP MODE and STA
	Y	Y						AP MODE (Multiple-BSS - max_uAP_BSS =2) Mode
Y	Y							Simultaneous STA + AP MODE(Single -BSS) Mode
Y	Y	Y						Simultaneous STA + AP MODE (Multiple-BSS - max_uAP_BSS =2) Mode
								Simultaneous Modes - Dual State involving P2P and STA
Y			Y					Simultaneous STA + P2P-GO Mode
Y			Y					Simultaneous STA + P2P-Client Mode
								Simultaneous Modes - Dual State involving P2P and AP MODE
	Y		Y					Simultaneous AP MODE (Single-BSS) + P2P-GO Mode
	Y		Y					Simultaneous AP MODE (Single-BSS) + P2P-Client Mode
								Simultaneous Modes - Multi-State involving P2P + AP MODE + STA
Y	Y		Y					Simultaneous STA + AP MODE (Single-BSS) + P2P-GO Mode
Y	Y		Y					Simultaneous STA + AP MODE (Single-BSS) + P2P-Client Mode

15.2. Dual Channel Simultaneous Mode Use Cases

Dual Channel Simultaneous Mode Use Cases								Use case
mlan 0	uap 0	uap 1	wfd 0	mlan 0	uap 0	uap 1	wfd0	
Channel X				Channel Y				DRCS Mode Use Cases
								DRCS Modes - Dual State involving AP MODE
	Y					Y		AP MODE (Multiple-BSS - max_uAP_BSS =2) Mode
								DRCS Modes - Dual State involving AP MODE and STA
Y					Y			Simultaneous STA + AP MODE Mode
Y	Y					Y		Simultaneous STA + AP MODE (Multiple-BSS - max_uAP_BSS =2) Mode
	Y	Y		Y				Simultaneous STA + AP MODE (Multiple-BSS - max_uAP_BSS =2) Mode
								DRCS Modes - Dual State involving P2P and STA
Y							Y	Simultaneous STA + P2P-GO Mode
Y							Y	Simultaneous STA + P2P-Client Mode
								DRCS Modes - Dual State involving P2P and AP MODE
	Y						Y	Simultaneous AP MODE (Single-BSS) + P2P-GO Mode
	Y						Y	Simultaneous AP MODE (Single-BSS) + P2P-Client Mode
								Simultaneous Modes - Multi-State involving P2P + AP MODE + STA
Y	Y						Y	Simultaneous STA + AP MODE (Single-BSS) + P2P-GO Mode
	Y			Y			Y	Simultaneous STA + AP MODE (Single-BSS) + P2P-GO Mode
	Y		Y	Y				Simultaneous STA + AP MODE (Single-BSS) + P2P-GO Mode

16. Notes

16.1. Simultaneous Mode Operation Limitations:

- AP MODE/P2P-GO beacons are paused unconditionally whenever STA/P2P-GC performs scan and are resumed automatically once the scan is complete.
- TX power settings, Radio control commands, Antenna configuration commands, 802.11d - Country Info are not unified across two interfaces.
- Custom IE Buffers are shared between two interfaces. IE-Buffer Index used by one interface cannot be used by other interface.

16.2. DRCS Mode Performance Limitations:

- The Beacon Interval of AP MODE/Ex-AP/P2P-GO has to be 100 TU (102.4ms).
- Device power saves with DRCS is not supported.
- Using Null packets with NAV will have an adverse impact on neighboring BSS present on same channel
- Performance cannot be guaranteed across different clients & environment. Limitations are protocol and eco system related and not NXP specific.
- STA can operate only in Infrastructure mode in DRCS Scenarios. TDLS Connections are not supported on STA Interface.
- DRCS is supported only in a separate antenna configuration.

16.3. NAN Concurrent Mode Operations Limitation:

- The Beacon Interval of AP MODE/Ex-AP/P2P-GO has to be 100 TU (102.4ms).
- Device power saves is not supported.
- Using Null packets with NAV will have an adverse impact on neighboring BSS present on same channel
- Performance cannot be guaranteed across different clients & environment. Limitations are protocol and eco system related and not NXP specific.
- STA can operate only in Infrastructure mode.

16.4. NBS/WBS Audio support over I2S Interface

- The NBS/WBS Audio support is integrated over I2S Interface.
- I2S, also known as Inter-IC Sound, Integrated Interchip Sound, or IIS, is an electrical serial bus interface standard used for connecting digital audio devices together.
- Using this feature, voice data (SCO/eSCO) will be routed over I2S interface. The 88W8887 Audio Interface Unit(AIU) provides the interface bridge between industry audio codecs and the SRAM memory Unit(SQU) of the device through an I2S justified interface.
- The I2S interface feature 88W8887 support includes:
 - Standard record and playback for I2S Justified serial interface.
 - Master and Slave mode for I2S justified.
 - I2S Slave mode using internal CCLK.
 - I2S Slave mode using external synchronous or asynchronous CCLK - For sync mode the external CCLK should be at least 4 times faster than the BCLK & in sync with BCLK. For async mode the external CCLK should be at least 8 times faster than the BCLK.
- Only Mono speech (NBS/WBS) is supported over I2S interface.

16.5. Independent Firmware Reset

- Independent FW reset feature support for WLAN over SD interface and BT over SD interface is integrated.
- The BT FW independent reset over SD can be initiated by interrupt trigger on GPIO-12 from Host.
- Independent firmware reset feature is only applicable in the parallel firmware download scenario.

16.6. BT/BLE Notes

- BT Deep Sleep supported only during wake on BT configuration
- BT Deep Sleep also supported as per Specific use-case described in the Appnote "Dynamic Deep Sleep" available at nxp.com