SPB209A
User's Manual

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1 Overview

SPB209A is a complete WLAN/BT/NFC module with EMC shield, dual band antenna (WiFi and BT), prepared for application specific NFC antenna and ready for quick validation in a hosted environment. SPB209A-EVK has been used as an example in this User Manual. SPB209A-EVK features the SPB209A module mounted on a ready to run SD-card or SMD module for quick product turn-around or SPB209A evaluation. It provides an ultra-low power, high performance and feature rich client solution. It provides up to 433 Mbit/s data rate when operating in the OFDM mode and up to 11 Mbit/s data rate when operating in the DSSS/CCK mode.

SPB209A integrates RF, baseband/MAC, Bluetooth Package Engine, NFC, memory, RF filters, oscillator, antenna or SMA connector and EMC shield into a highly integrated and optimized module solution with high quality and reliability to a complete standalone solution with no need for external components.

This highly integrated solution is optimized for customer applications running on a Linux host platform. The host interface supports SDIO 3.0, High Speed UART and I2C. Internal RAM comprises both code and data memory eliminating the need for external RAM, Flash or ROM memory interfaces. MAC address, trimming values etc. are stored in the on board memory.

1.1 Key Features

- Support for 802.11a/b/g/n/ac
- Data Rates: 20MHz CH 1-86Mbps; 40MHz CH 13-200Mbps; 80MHz CH 29-433Mbps
- Modulation: BPSK, CCK, QPSK, 16QAM, 64QAM 256 QAM for WLAN and GFSK/π/4DQPSK/8DPSK/LE
- Open WEP, WPA/WPA2 encryption
- No external components except for the antenna options
- Low power consumption due to efficient PA design and power off mode
- An on-board 32 kHz oscillator maintains real time in power save mode, allows the high frequency clock to be turned off.
- Supporting STA and AP operation mode
- Supports BT-WLAN coexistence and ISM-LTE coexistence
- Extensive DMA hardware support for data flow to reduce CPU load.
- Advanced power management for optimum power consumption at varying load.
- External interfaces 4 bit SDIO 3.0 for WLAN and UART/PCM for BT interface
- On-board High Frequency High Precision Oscillator 37.4 MHz
- Small footprint 14 x 14 mm (196 mm2) 41-pin
- RoHS Compliant

The SPB209A-EVK with SPB209A module and a custom NFC antenna connected to a i.MX6 DL Linux Host Platform.

2 APPLICATION INFORMATION

2.1 Power Supply

SPB209A should be powered by a single supply voltage on VDD of 3.3V. It generates all required digital and analog supply voltages with the built in DC-DC converter.

2.1.1 Main supply

The main power is connected to VDD. The ripple on VDD should be less than 10mV p-p.

2.2 Clock Signals

The SPB209A requires no external clock signals. It has an internal high frequency oscillator with a high precision 37.4 MHz crystal and a low power oscillator to generate the required clock signals.

2.3 Standby

The Power Down pin (PDn) shall be set high during normal operation of either connectivity type. Pulling PDn pin low, sets SPB209A in Standby mode. This turns OFF most parts of the circuit and minimizes the current consumption. All I/O interface pins are set to predefined states (high, low or high-z) when in Standby mode.

To end Standby mode set PDn high and reload firmware.

2.4 Power save

Power save is an energy saving mode where SPB209A is only listening at regular intervals for the beacons transmitted from an access point and is set in sleep mode in between. During this sleep mode, firmware is kept in RAM but all not needed functions are turned off. Since the receive time is very short compared to the listening interval the average current consumption is reduced significantly.
The timing of the listening interval is based on the low power oscillator clock generated internally.

2.5 Interfaces

The SPB209A is equipped with a number of interfaces that can be set up in various ways by the value on GPIO2 and GPIO3 during boot, see section 2.5.1.

2.5.1 Host Interface SDIO and UART

The SDIO interface is SDIO 4-bit mode supporting up to 208MHz clock speed.

The High Speed UART interface default supporting Baud Rates from 1200 up to 2764800 bps, 8 bits, no parity, 1 stop bit.

Booth GPIO2 and GPIO3 have internal pull-up and only needs to be connected via a 100kOhm resistor to GND to be set low (0). For high level (1) the pin can be left unconnected. Table 2-1 shows the different options. The default is to leave GPIO2 and GPIO3 unconnected (11) and SDIO as host interface for all services.

Table 2-1: Host Interface Selection

GPIO2	GPIO3	WLAN Host Interface	BT/BLE/NFC Host Interface	FW Download interface	FW Download mode
0	0	SDIO	UART	SDIO	Serial
0	1	SDIO	SDIO	SDIO	Parallel
1	0	SDIO	UART	SDIO+UART	Parallel
1	1	SDIO	SDIO	SDIO	Serial

2.5.2 PCM Interface

2.5.3 PCM

PCM interface is used for BT audio and can operate in master or slave mode. The interface supports the following:

- 8, 13, 14, 15 or 16-bit samples
- 4 slots per frame with up to 16-bits per slot
- Long or short frame sync

2.5.4 Host Wake up

Wake up command via the SDIO interface. This is the normal wake up and is implemented in the FW.

There is options to use defined GPIO:s for Host Wake-up or opposite for SPB209A Wake-Up involving both WLAN, BT and NFC. Below table outline the options.

GPIO No.	Function
GPIO1	WLAN to Host Wake-up

GPIO13	BT/NFC to Host Wake-up
GPIO14	Host to WLAN Wake-up
GPIO15	Host to BT/NFC Wake-up

2.5.5 NFC Wake up

The NFC support contactless wake up functionality giving a trigger on a GPIO pin depending on the activities on the RF interface, when an antenna is connected to the NFC_ANT P and _N pins.

2.6 NFC Interface

The NFC Interface provides RFID and NFC functionality.

Supported features:

- Protocol support fir ISO 14443A/B, ISO 15693, NFCIP-2, NFC-Forum, EMV contactless targets with a data rate up to 848 Kbps.
- Reader/Writer, Card Emulation and Peer-to-Peer (P2P) modes
- Low Power and sleep modes
- Programmable Carrier detection level for Card Emulation mode
- Programmable field detection level for RF anti-collision when operating as Reader or Active Target.

The NFC chip can also be accessed via the I2C interface pin SDA and SCL provided that the SPB209A device is powered. Support standard 100kHz and Fast 400kHz mode.

2.7 RF interface

The SPB209A EVK is prepared with a chip dual band antenna optimal for quick evaluation of the SPB209A RF module.

Designing custom application board with the SPB209A RF module the following RF parametrical requirements shall be considered:

- The RF output pin impedance is 50 ohm and shall be connected to an antenna with VSWR better than 2:1.

- The RF antenna gain must be maximum 1.8 dBi for the 2.4 GHz band and equal or less than 4.9 dBi for the 5GHz band. The exception is when using Chip Antenna WE-MCA: 7488910245 that has a peak gain of 3.0 dBi but is only approved to be used in the 2.4 GHz band.

A custom NFC antenna will need to be selected with a maximum size of 45 x 45 mm. NFC antenna is soldered down with two pin interface to the side of the SPB209A EVK.

For further information, please refer to the document “Hardware Design Guide SPB209A Application Note”.

2.8 Operational Mode

2.8.1 General

The SPB209A can be operated as STA or AP using a Linux Host platform. The STA operation use the Linux WPA supplicant and the AP operation us Linux HostAPD. RF testing and FCC/ETSI certification shall use equivalent software tools provided by H&D Wireless Sales up on request.

2.8.2 STA operation using WPA Supplicant

The wpa_supplicant is the IEEE 802.1X/WPA component used in the client stations. The WPA supplicant can be configured to control the roaming and IEEE 802.11 authentication/association of the SPB209A device.

The configuration is usually performed in a configuration file, e.g. /etc/wpa_supplicant.conf. It is also possible to directly issue commands to the WPA Supplicant, using a dedicated shell command, wpa_cli. The usage of wpa_cli is out of the scope of this document, but is described in detail in the WPA supplicant documentation http://hostap.epitest.fi/wpa_supplicant/.

Below list show supported WPA Supplicant network options

- Key management (key_mgmt): WPA-PSK, NONE
- Group key encryption (group): CCMP, TKIP
- Pairwise key encryption (pairwise): CCMP, TKIP
- Protocol (proto): WPA, WPA2

Below list show examples of instructions on how to perform the following operations using WPA Supplicant

2.8.2.1 Connect to an unencrypted network

To simply instruct the WPA Supplicant to connect to any unencrypted network with ssid hdwireless, the following configuration file should be enough:

```
ctrl_interface=/var/run/wpa_supplicant

network={

    ssid="hdwireless"

    key_mgmt=NONE

}
```

The path to the configuration file and the interface name (owl0) should then be passed as parameters when starting the WPA Supplicant:

```
$ wpa_supplicant -Dwext -iowl0 -c /etc/wpa_supplicant.conf -B
```

The paramater -Dwext informs the WPA Supplicant that the standard Wireless Extensions interface should be used to control the network interface. For detailed information on how to configure and run the WPA supplicant, see the WPA supplicant documentationhttp://hostap.epitest.fi/wpa_supplicant/.

The WPA Supplicant will now periodically scan for networks until one that matches the configuration is found. Once found, a connection will be established. The WPA Supplicant will also handle reconnect if the connection is lost. Therefore, opposed to Wirieless Tools, when using the WPA Supplicant, it is not necessary to perform manual scanning and network selection.

Note that the WPA Supplicant configuration can hold several networks and the WPA Supplicant will choose and roam amongst them. However, most importantly, the WPA supplicant implements the key negotiation with a WPA Authenticators.

2.8.2.2 Connect to a WPA protected network that uses TKIP encryption

To connect to a network using WPA key management and TKIP encryption, the following network configuration can be specified in the configuration file:

```
ctrl_interface=/var/run/wpa_supplicant

network={

    ssid="hdwireless"

    key_mgmt=WPA-PSK

    group=TKIP

    pairwise=TKIP

    proto=WPA

    psk="hdwirelesskey"

}
```

The key configured on the access point should be "hdwirelesskey".

To force the WPA Supplicant to re-read its configuration file wpa_cli can be used

```
$ wpa_cli reconfigure
```

One should remember that all wireless operations performed by both the WPA supplicant and Wireless Tools are done through the same Wireless Extensions API. This means that it will still be possible to e.g. check the connection status with iwconfig:

```
$ iwconfig

owl0    IEEE 802.11bg ESSID:"angr"

        Mode:Managed Frequency:2.422 GHz Access Point:68:7F:74:10:5B:4C

        Bit Rate=54 Mb/s

        Encryption key:472A-7E38-C465-D4EB-6DA7-BAE6-4700-0960-EDB1-40DE-

        18CC-5A02-4AE1-EA96-F3EE-142A Security mode:open
```

```
        Power Management timeout:10

        Link Quality=24/30 Signal level=-20 dBm Noise level=-44 dBm

        Rx invalid nwid:0 Rx invalid crypt:0 Rx invalid frag:0

        Tx excessive retries:0 Invalid misc:0 Missed beacon:0
```

Once connected, it is possible to obtain an ip address and perform the ping test:

```
$ udhcpc -i owl0

Sending discover...

Sending select for 192.168.2.102...

Lease of 192.168.2.102 obtained, lease time 172800

adding dns 192.168.2.1

$ ping -c 3 192.168.2.1
```

2.8.2.3 Connect to a WPA2 enabled network that uses CCMP encryption

To connect to a network using the WPA2 protocol and CCMP encryption, the following network configuration can be specified in the configuration file:

```
ctrl_interface=/var/run/wpa_supplicant

network={

    ssid="hdwireless"

    key_mgmt=WPA-PSK

    group=CCMP

    pairwise=CCMP

    proto=WPA2

    psk="hdwirelesskey"

}
```

2.8.2.4 Connect to a network that uses any WPA/WPA2 protocol and TKIP/CCMP encryption

Note that several encryption parameters can be specified on a single line, allowing connections to a specific ssid using a range of encryption methods. The configuration file below should allow connections to the hdwireless access point regardless of whether the WPA or WPA2 protocol is used or whether CCMP or TKIP is used for pairwise and group key encryption. The actual encryption method used will be the most secure one that is supported by the access point.

```
ctrl_interface=/var/run/wpa_supplicant

network={

    ssid="hdwireless"

    key_mgmt=WPA-PSK

    group=TKIP CCMP

    pairwise=TKIP CCMP

    proto=WPA WPA2

    psk="hdwirelesskey"

}
```

2.8.2.5 Connect to a network with hidden SSID

To allow the wpa_supplicant to connect to hidden networks, the scan_ssid parameter must be added to the network configuration.

```
ctrl_interface=/var/run/wpa_supplicant

network={

    ssid="hdwireless"

    scan_ssid=1

    key_mgmt=WPA-PSK

    group=TKIP CCMP

    pairwise=TKIP CCMP

    proto=WPA WPA2

    psk="hdwirelesskey"
```

```
}
```

2.8.2.6 List of supported WPA Supplicant network options

Key management (key_mgmt): WPA-PSK, NONE
Group key encryption (group): CCMP, TKIP
Pairwise key encryption (pairwise): CCMP, TKIP
Protocol (proto): WPA, WPA2

2.8.3 AP operation using HostAPD

Currently there is only hw support for the Linux driver with SDIO interface for SAPB209A.

Linux kernel version 4.0 or higher is required supporting DFS operation in 5GHz band required for AP mode operation.

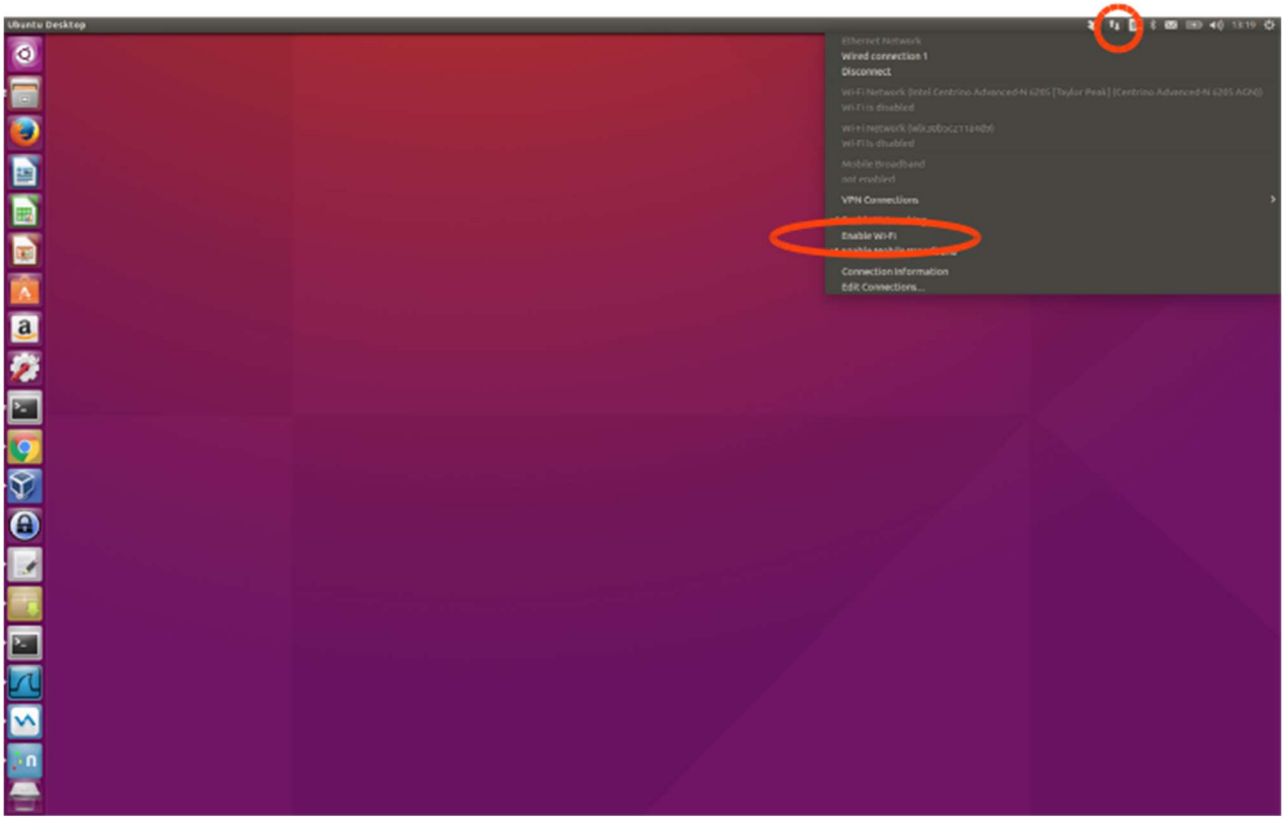
The Linux driver consist of four kernel objects: mwifiex.ko, mwifiex_sdio.ko, btmrvl.ko and btmrvl_sdio.ko.

mwifiex.ko and mwifiex_sdio.ko handles the wifi protocols, while btmrvl.ko and btmrvl_sdio.ko handles Bluetooth, BLE and NFC.

Along with the driver goes a fw binary that is downloaded to the chip by the driver. It must be named sd8887_uapsta.bin and located at /lib/firmware/mrvl/

HOWTO run Linux softAP with hostapd

1. Make sure the network manager is disabled with regards to wifi:



2. Make sure the radio interface is unblocked:

```
rfkill unblock all
```

3. Download the attachment:hostapd.conf file to the local disk.

4. Install Linux Wifi host AP package:

```
sudo apt-get install hostapd
```

5. Plugin the sdio module.
   Make sure mwifiex driver was successfully started by typing:

```
iwconfig mlan0
```

   This command should display information about the mlan0 interface

6. mwifiex driver does not support ap mode on native interface, so an additional ap-dedicated interface must be created.
   In order to do so we need to find out the phy<n> enum for the mlan0 interface by typing:

```
iw list | grep Wiphy
```

Normally phy0 corresponds to builtin wlan0, and the next higher enum will correspond to mlan0

7. Now create the ap specific interface (uap0) by typing

```
sudo iw phy phy<n> interface add uap0 type __ap
```

   Where <n> is the enum found out from iw list command

8. Now configure the AP by editing the hostapd.conf file.

Example: For 11n, 5GHz band, channel 36, DFS enabled: Search for and edit the following parameters in hostapd.conf file:

```
interface=uap0

ssid=<desired-ssid>

hw_mode=a

channel=<desired channel>

wmm_enabled=1

ieee80211n=1

ieee80211d=1

ieee80211h=1
```

```
country_code=<country_code>


Valid <country_code>'s are:
  US       # US FCC
  CA       # IC Canada
  EU       # ETSI
  ES       # Spain
  FR       # France
  JP       # Japan
  CN       # China
```

9. Start the AP by typing:

```
sudo hostapd <hostapd_config_file_name>
```

AP should now be up and running

10. To run traffic, assign a fixed ip address to the interface:

```
sudo ifconfig uap0 <dersired ip> #e.g. 192.168.10.1
```

11. Associate a station and assign a static ip at the same subnet

12. To remove the uap0 interface, kill the hostapd process and run:

```
sudo iw dev uap0 del
```

3 Regulatory

Country	Approval authority	Regulatory	Frequency band
USA	FCC	FCC ID: XO2SPB209A	2.412 GHz -2.462 GHz 5.250 GHz – 5.725 GHz
Canada	IC	IC: 8713A-SPB209A	2.412 GHz -2.462 GHz 5.250 GHz – 5.725 GHz
Europe	National	ETSI/EN	2.412 GHz -2.4835 GHz 5.150 GHz – 5.725 GHz

Table 3-1: Regulatory standards

Note that usage in the 5 GHz band is not allowed for Chip Antenna WE-MCA: 7488910245. For further details, see the document “Hardware Design Guide SPB209A Application Note”.

3.1 FCC (United States of America)

This equipment complies with Part 15 of the FCC rules and regulations.
To fulfill FCC Certification requirements, an OEM manufacturer must comply with the following regulations:

1. The modular transmitter must be labeled with its own FCC ID number, and, if the FCC ID is not visible when the module is installed inside another device, then the outside of the device into which the module is installed must also display a label referring to the enclosed module. This exterior label can use wording such as the following:

Example of label required for OEM product containing SPB209A module

Contains FCCID: X02SPB209A
The enclosed device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (i) this device may not cause harmful interference and (ii) this device must accept any interference received, including interference that may cause undesired operation.

2. Only antennas approved may be used with the SPB209A module. The SPB209A module may be integrated with custom design antennas which OEM installer must authorize following the FCC 15.21 requirements.

IMPORTANT: The integrator must install and use specific antenna(s) and reference design as noted in the "Hardware Design Guide SPB209A Application Note" and must follow the specific software configuration guidelines specified. This "Hardware Design Guide SPB209A Application Note" is restricted and available only under fully executed NDA.

IMPORTANT: This equipment 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 15.19).

The internal / external antenna(s) used for this mobile transmitter must provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

This device is approved as a mobile device with respect to RF exposure compliance, and may only be marketed to OEM installers. Use in portable exposure conditions (FCC 2.1093) requires separate equipment authorization.

IMPORTANT: Modifications not expressly approved by this company could void the user's authority to operate this equipment (FCC section 15.21).

IMPORTANT: The finished product is required to comply with all applicable FCC equipment authorizations regulations, requirements and equipment functions not associated with the transmitter module portion. Compliance for unintentional radiators (Part 15 Subpart B "Unintentional Radiators"), such as digital devices, computer peripherals, radio receivers, etc. has to be demonstrated.

3.2 ISED (Canada)

The device complies with Industry Canada's licence-exempt RSSs. 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.

Cet appareil est conforme aux normes d'exemption de licence RSS d'Industry Canada. Son fonctionnement est soumis aux deux conditions suivantes:

(1) cet appareil ne doit pas causer d'interférence, et
(2) cet appareil doit accepter toute interférence, notamment les interférences qui peuvent affecter son fonctionnement.

The host product shall be properly labelled to identify the modules within the host product.

The ISED Canada certification label of a module shall be clearly visible at all times when installed in the host product; otherwise, the host product must be labelled to display the ISED Canada certification number for the module, preceded by the word "Contains" or similar wording expressing the same meaning, as follows:

Contains IC: 8713A-SPB209A

Le produit hôte devra être correctement étiqueté, de façon à permettre l'identification des modules qui s'y trouvent.

L'étiquette d'homologation d'un module ISED Canada devra être posée sur le produit hôte à un endroit bien en vue, en tout temps. En l'absence d'étiquette, le produit hôte doit porter une étiquette sur laquelle figure le numéro d'homologation du module ISED Canada, précédé du mot « contient », ou d'une formulation similaire allant dans le même sens et qui va comme suit:

Contient IC: 8713A-SPB209A

3.3 ETSI (Europe)

The SPB209A module has been certified for use in European union countries according to ETSI EN 300 328 (Electromagnetic compatibility and Radio spectrum matters for equipment operating in the 2,4 GHz ISM band using spread spectrum modulation techniques). This standard is harmonized within the European Union and covering essential requirements under article 3.2 of the R&TTE-directive.

If the SPB209A module are incorporated into a product, the manufacturer must ensure compliance of the final end-user product to the European harmonized EMC and low voltage/safety standards. A declaration of conformity must be issued for the product including compliance references to these standards. Underlying the declaration of conformity a technical construction file (TCF), including all relevant test reports and technical documentation, must be issued and kept on file as described in Annex II of the R&TTE-directive.

Furthermore, the manufacturer must maintain a copy of the SPB209A module documentation and ensure the final product does not exceed the specified power ratings, antenna specifications, and/or installation requirements as specified in the user manual. If any of these specifications are exceeded in the final product, a complete re-test must be made in order to comply with all relevant standards as basis for CE-marking. A submission to notified body must be used only if deviations from standards have been found or if non-harmonized standards have been used.