

Application Note

SC14WAMDECT External Antenna Design and Leveraging Modular Approval

AN-D-218

Abstract

This document describes the external antenna design of the Wireless Audio Module (WAM), the SC14WAMDECT_SFxx_DB reference design and how to leverage the existing Dialog regulatory certification when copying this design.

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1 Introduction

The SC14WAMDECT_SFxx_DB Reference Design has been made available by Dialog Semiconductor B.V. that includes an additional printed antenna to support FAD (e.g. for FP operation). This design has obtained a Modular Approval Certificate (US, EU). When meeting the conditions as referenced in this document, this implies that those tests already covered by the Modular Approval Certificate don't need to be rerun on the end-product level. This may alleviate the overall regulatory approval process of the end-product.

1.1 TERMS AND ABBREVIATIONS

DoC	Declaration of Conformity
EU	Europe
ETSI	European Telecommunications Standards Institute
FAD	Fast Antenna Diversity
FCC	Federal Communications Commission
FP	Fixed Part
IC	Industry Canada
JP	Japan
KDECT	Korean DECT
MIC	Ministry of Internal affairs and Communications
SAR	Specific Absorption Rate
TCF	Technical Construction File

1.2 REFERENCES

1. SC14WAMDECT SF01 Data sheet v1.00 Data sheet, Dialog Semiconductor B.V.
2. FCC document "DA-00-1407"
3. FCC document "784748 D01 Labelling Part 15 18 Guidelines v07"
4. FCC document "D01 Mobile Portable RF Exposure v04"
5. FCC order "04-165"

1.3 HISTORY

19-Nov-2013, v1.0	Initial version.
11-Oct-2017, v1.1	Section 3.2: Pi attenuator added. Figure 1 updated.

1.4 DISCLAIMER

This document is for general information purposes only. Dialog Semiconductor does not guarantee the completeness, correctness or accuracy of the information in this document and shall not be liable for any direct or indirect loss or damage arising from the use of information or documents found in it.

Please consult with your test house when planning for and/or undertaking any action with respect to regulatory certification.

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2 Modular Approval

2.1 DESCRIPTION

When a wireless module has passed the Modular Approval process, and when the host PCB design conforms to certain conditions (this will be detailed in the subsequent sections), then the end-product containing this module will not need to be tested against the regulatory standards covered by the module's certificates.

The availability of the Modular Approval is intended to reduce time, cost and effort putting an end-product containing WAMDECT on the market.

2.2 AVAILABLE CERTIFICATIONS

Dialog Semiconductor B.V. has obtained the following limited modular approvals for WAMDECT:

- FCC Part 15, subpart D, Isochronous UPCS Device 1920-1930 MHz: FCC ID Y82-SC14D
- IC RSS-213, issue 2, 2 GHz License-exempt Personal Communications Service Devices: IC ID 9576A-SC14D
- In addition, testing has shown compliance to the following:
 - EU testing (to be used in the DoC process when applicable):
 - Emissions EN 301-406
 - Immunity EN 301-489
 - CE IECEN 60950-1
 - SAR EN 62311
 - JP Radio Law pre-test

2.3 APPLICABILITY

Only FCC (US) and IC (Canada) officially support Modular Certification.

ETSI (Europe) doesn't support Modular Certification, rather Declaration of Conformity (DoC). The manufacturer is responsible for the compliance to regulatory requirements. Previous testing, such as made available by Dialog Semiconductor B.V., may be taken into consideration by the module integrator. If module testing is trusted for the DoC of the host, the module's Technical Construction File (TCF) becomes part of the host's TCF.

This is part of the "self certification" process where the end-product OEM declares conformity to regulatory requirements. The available ETSI test reports may be used to this purpose and the tests in these reports don't need to be repeated on end-product/system level.

MIC (Japan) announced that it would allow modular approvals in Japanese Radio Law (Feb '13). Requirements are being developed now. Currently, there is no timeline or estimated implementation date. Modular Certification is still judged on a case-by-case basis.

Other countries may not support Modular Certification. The available test reports may help expedite the system level certification process though.

Any regulatory standards not covered by the available Modular Approval certificates will still need to be tested on end-product/system level.

2.4 CONDITIONS

The FCC document "DA-00-1407" provides a clear overview of the conditions applicable to the host, associated with leveraging existing Modular Approval.

With respect to the SC14WAMDECT_SFxx_DB Reference Design, the following subsections reference the relevant conditions that have to be met. Not adhering to these will invalidate the certification, requiring recertification on end-product/system level.

2.4.1 Antenna

The FCC document "DA-00-1407" specifies:

- The antenna gain of a new antenna should be of the same type as the originally approved antenna and the antenna gain should not be higher than the antenna gain of the originally tested antenna.
- The emission levels or reported RF safety levels shall not be increased by the new antenna (of the same antenna type)
- If the new antenna is a different type, recertification on end-product/system level is required.

With the existing SC14WAMDECT_SFxx_DB certification this implies the following:

- If only the embedded/internal antenna of WAMDECT is used, then the Antenna Condition is fulfilled
- If an external antenna is connected to WAMDECT, then this antenna would need to meet specific criteria in order to prevent recertification requirements. Please refer to section 3.0 for further details.

2.4.2 Host PCB Layout

The PCB layout of the host PCB is critical to the validity of the RF certification of WAMDECT because it is part of the embedded printed antenna. Please refer to sections 7.4 and 7.5 of the SC14WAMDECT_SFxx datasheet for details.

2.4.3 Labelling Requirements

The modular transmitter must be labelled with its own FCC ID number. If the FCC ID is not visible when the module is installed inside another device, then the host device must contain the FCC ID number with the statement such as the following:

"Contains FCC ID:Y82-SC14D",
"Contains IC ID:9576A-SC14D".

Some further details about labelling requirements and compliance statements can be found in "784748 D01 Labelling Part 15 18 Guidelines v07".

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2.4.4 User Documentation Text

The literature provided to the end user must include the following wording:

“FCC compliance statement

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 of the device.

Module transmetteur ID IC:

Son fonctionnement est soumis aux deux conditions suivantes:

- (1) cet appareil ne doit pas causer d'interférences nuisibles et
- (2) appareil doit accepter toute interference recue, y compris les interferences qui peuvent perturber le fonctionnement.

Changes or modifications to the equipment not expressly approved by the Party responsible for compliance could void the user's authority to operate the equipment.

NOTE: 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 or more 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.

Privacy of communications may not be ensured when using this phone.”

2.4.5 Safety Requirements

This section provides of an overview of the safety requirements you must adhere to when working with WAMDECT.

- The specific external power supply for WAMDECT has to fulfil the requirements according to clause 2.5

(Limited power source) of this standard EN 60950-1:2006.

- Interconnection circuits shall be selected to provide continued conformance to the requirements of clause 2.2 for SELV (Safety Extra Low Voltage) circuits according to EN 60950-1:2006 after making connections
- Interface type not subjected to over voltages
- Requirements additional to those specified in this standard may be necessary for:
 - Equipment intended for operation in special environments (for example, extremes of temperature, excessive dust, moisture or vibration, flammable gases and corrosive or explosive atmospheres)
 - Equipment intended to be used in vehicles, on board ships or aircraft, in tropical countries or at altitudes greater than 2000 m
 - Equipment intended for use where ingress of water is possible
- Installation by qualified personnel only
- The product is a component intended for installation and use in complete equipment. The final acceptance of the component is dependent upon its installation and use in complete equipment

2.5 SAR

Because SAR is very device-specific, FCC rules do not allow for a (Limited) Modular Approval for use with portable devices (i.e. devices <20 cm from the human body).

If time-averaged output power is $60/f(\text{GHz})\text{ mW}$ or all measured 1-g SAR are 0.4 W/kg then modular approval may still be allowed for portable devices.

Please refer to FCC document “D01 Mobile Portable RF Exposure v04”.

SAR test reports are available as a reference, showing compliance to regulatory requirements (with respect to Portable Equipment).

2.6 MISCELLANEOUS COMMENTS

In FCC terminology, a “Host” is what is referred to in DECT as a “fixed part”. The FCC term “Mobile” corresponds with the DECT term “portable part”, provided that the device is >20 cm from the human body. A DECT termed “portable part” <math><20\text{ cm}</math> from the human body is referred to as “Portable” in FCC terminology.

The existing Modular Approval may be invalidated if WAMDECT is co-located with other wireless devices (e.g. BlueTooth, WLAN/WiFi) that transmit simultaneously. Please consult with your test house on the possible implications.

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3 External Antenna Design

FCC-04-165 now allows different antennas may be certified with one module. Dialog Semiconductor B.V. has obtained Modular Approval for the SC14WAMDECT_SFxx_DB Reference Design using a specific external printed antenna. FCC-04-165 dictates that the certification measurements must to be performed with the highest gain antenna and any other antenna must have a similar radiation pattern.

In case of the SC14WAMDECT_SFxx_DB certification, this implies that an external antenna may be connected to radio module, without requiring recertification, provided that:

- the antenna gain is not higher than 0 dBi
- the antenna type is a (printed) monopole

In addition, if the antenna connection is user accessible, then the antenna connector shall be proprietary.

3.1 SC14WAMDECT_SFXX_DB ANTENNA DESIGN

The SC14WAMDECT_SFxx_DB Reference Design includes a SC14WAMDECT SFxx module and an additional printed antenna to support FAD (e.g. to operate as an FP).

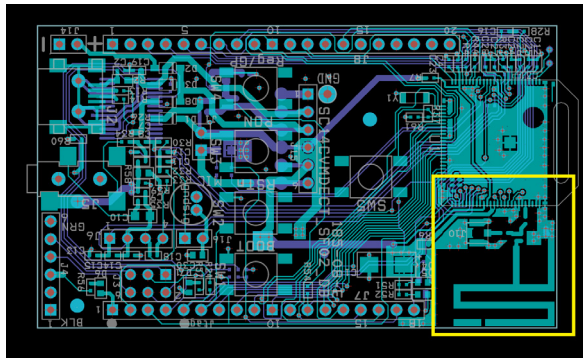


Figure 1: SC14WAMDECT_SFxx_DB Reference Design Overview

In Figure 1 an overview is given of the SC14WAMDECT_SFxx_DB Reference Design. In the middle right section the SF module can be seen. The printed antenna occupies the lower right part in Figure 1.

This Reference Design is an example application design. The key part of this design, in relation to wireless performance and leveraging existing Modular Approval, is the section of the printed antenna in the lower right corner, together with its location and connection with respect to the SF module, as well as the ground plane contours. This relevant section is highlighted by the light green rectangle in Figure 1.

The gerber files of this design can be obtained through your Dialog Semiconductor B.V. sales contact or representative.

3.1.1 Printed Antenna Design Details

The printed antenna physical design is shown in Figure 2 (noting the 0.5 mm grid in the picture).

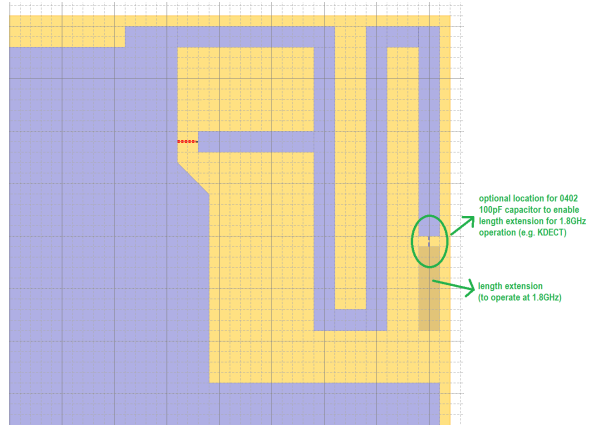


Figure 2: Printed Antenna Physical Structure

The simulated radiation pattern is depicted in the following plot (with no 0402 component in Figure 2):

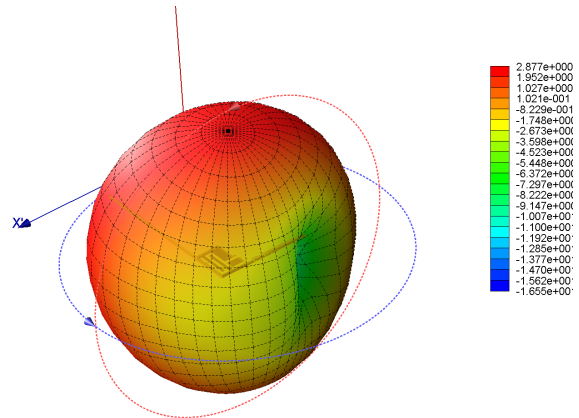


Figure 3: Simulated Radiation Pattern

The S11 plot of the SC14WAMDECT_SFxx_DB has been measured (with no 0402 component in Figure 2) and is depicted in the following figure:

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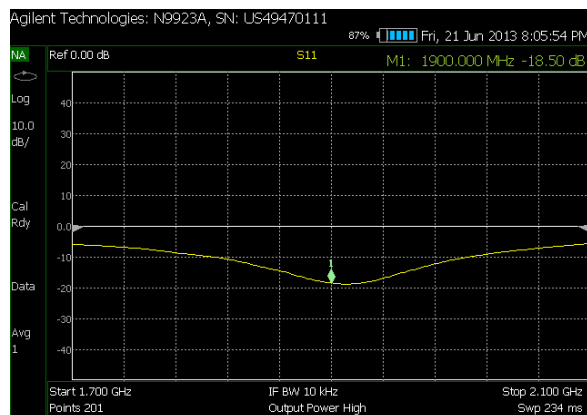


Figure 4: S11 Measurement Plot of Printed Antenna

3.1.2 Printed Antenna Design Operating at 1.8 GHz

For KDECT operation, the frequency band is centred around 1.8 GHz, whereas the default printed antenna design configuration is designed to be centred around 1.9 GHz. The printed antenna design holds a provision for this shift in operating frequency.

Please refer to [Figure 2](#). If a 100 pF capacitor (0402 footprint) is placed across the gap indicated by the green ellipse indicated in [Figure 2](#), then effectively the antenna length is increased resulting in resonant frequency of 1.8 GHz (without the 100 pF 0402 components, the antenna's resonant frequency remains at 1.9 GHz for other DECT operation). No other tuning components are required.

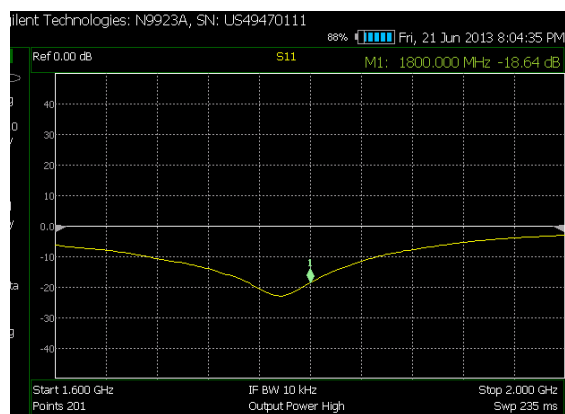


Figure 5: Printed Antenna Design S11 plot in KDECT mode

The S11 plot (measured on the actual SC14WAMDECT_SFxx_DB Reference Design HW) with the printed antenna design configured in KDECT mode (i.e. with 100 pF 0402 component placed across the length extension gap) is depicted in the [Figure 5](#).

One important note with respect to KDECT operation: though the printed antenna design can be made to operate at 1.8 GHz, the embedded antenna that is part of the SC14WAMDECT_SFxx module would remain centred at 1.9 GHz since there are no external tuning components to alter the resonant frequency of the SC14WAMDECT_SFxx embedded antenna. This implies antenna design should be selected for operation. This would limit the applicability to PP mode operation.

3.1.3 Boundary Conditions

In order to be allowed to leverage the WAMDECT Modular Approval for the SC14WAMDECT_SFxx_DB design, the PCB should meet the following specifications:

- PCB material: FR4
- PCB layer stackup:
 - L1 copper thickness: 18 μm
 - L1-L2 prepreg thickness: 360 μm (2x "Prepreg 7628")
 - L2 copper thickness: 35 μm
 - L2-L3 core thickness: 710 μm
 - L3 copper thickness: 35 μm
 - L3-L4 prepreg thickness 360 μm (2x "Prepreg 7628")
 - L4 copper thickness: 18 μm

In addition, it is imperative that the physical design of the printed antenna is accurately copied. Also the contours of the ground plane surrounding the printed antenna must be accurately copied. The printed antenna location should be the same (i.e. in a corner with the same orientation/spacing with respect to the SF module).

When deviating in any way from these specifications, the Modular Approval will be invalidated and recertification on end-product/system level will be required.

3.2 TUNING COMPONENTS

The printed antenna design tuning has been validated and found to require a resistive π -attenuator network to keep spurious emissions within ETSI limit.

It should be also noted that the printed antenna design's impedance is a short at DC. So a coupling capacitor is required to connect the SC14WAMDECT_SFxx module to the printed antenna design.

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3.3 OTHER ANTENNAS

If an antenna is connected to WAMDECT that has a dissimilar radiation pattern than that of the SC14WAMDECT_SFxx_DB design and/or if the antenna has a higher gain than that of the SC14WAMDECT_SFxx_DB design, then FCC-04-165 dictates that the Modular Approval is invalidated and that recertification is required on end-product/system level.

If the antenna connected to WAMDECT is user accessible, then the antenna connector shall be proprietary (per FCC DA-00-1407).

3.4 TWO EXTERNAL ANTENNAS WITH FAD

Figure 6 shows how two external antennas can be connected to the SC14WAMDECT SF.

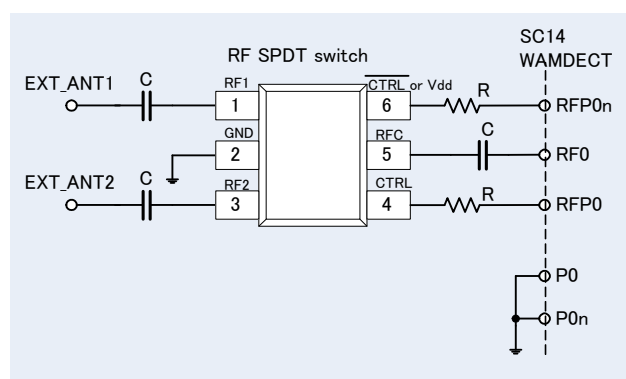


Figure 6: Two External Antennas

The capacitors shown in Figure 6 have a recommended value of 10 pF.

The Peregrine PE4259 is a suitable part number for the RF SPDT switch, in which case the resistor values are recommended to be 1 k Ω . RF tuning may be required (please refer to the manufacturer's data sheet).

All RF connections must be 50 Ω .

P0 and P0n ports of the SC14CVMDECT SF need to be connected to the GND to disable the internal antenna.

Note: By using two external antennas, the Modular Approval is invalidated as well and recertification is required on end-product/system level.

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Status	Definition
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