

# User Manual

## DA14AVDDECT System Overview

### UM-D-010

#### **Abstract**

*This manual provides a high-level overview of the systems that can be realized based on Dialog's Audio Data (AD) Tour Guide and Public Address stacks and Voice Data (VD) stack.*

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## 1 Terms and Definitions

AVD	Audio Voice Data
AD	Audio Data
VD	Voice Data
FP	Fixed Part
PP	Portable Part
WAM	Wireless Audio Module
CVM	Cordless Voice Module
PA	Public Address
TG	Tour Guide
DBPSK	Differential Binary Phase Shift Keying
DQPSK	Differential Quadrature Phase Shift Keying
D8PSK	Differential 8-Phase Shift Keying
NB	Narrow Band
WB	Wide Band
BW	Band Width
DSP	Digital Signal Processor
SoC	System-on-Chip

## 2 Introduction

Dialog's DA14AVDDECT module is a low power solution for wireless audio, voice and data applications in the 1.9 GHz DECT band. The module is also intended for users with little DECT experience, who wish to make a wireless audio system.

## 3 Features and benefits

The DA14AVDDECT module is small and easy to use solution that can significantly shorten time to market compared to flat designs and save costs on expensive RF test equipment. The module is certified for EU, US and Japan DECT regions and has an integrated antenna optimized for the 1.9 GHz band. The module supports fast antenna diversity and an external PCB antenna reference design is available, which is realized on the carrier boards shipped with the development kit (DA14AVDDECTDEVKT). With a flexible API, the user can customize the provided example code for different use cases.

## 4 Hardware Overview

The module is based on DA14495, which is a low power SoC with an integrated radio transceiver that supports multi-level modulation and zero blind slot operation for higher bit rates and density. The SoC includes an Arm® Cortex® M0 processor and a Tensilica HiFi3 DSP optimized for wireless audio applications.

### 4.1 High-Level Schematics

Figure 1 shows the hardware overview of the DA14AVDDECT module. The module has an integrated baseband, radio transceiver, RF power amplifier, embedded antenna, HiFi codec, QSPI flash and crystal.

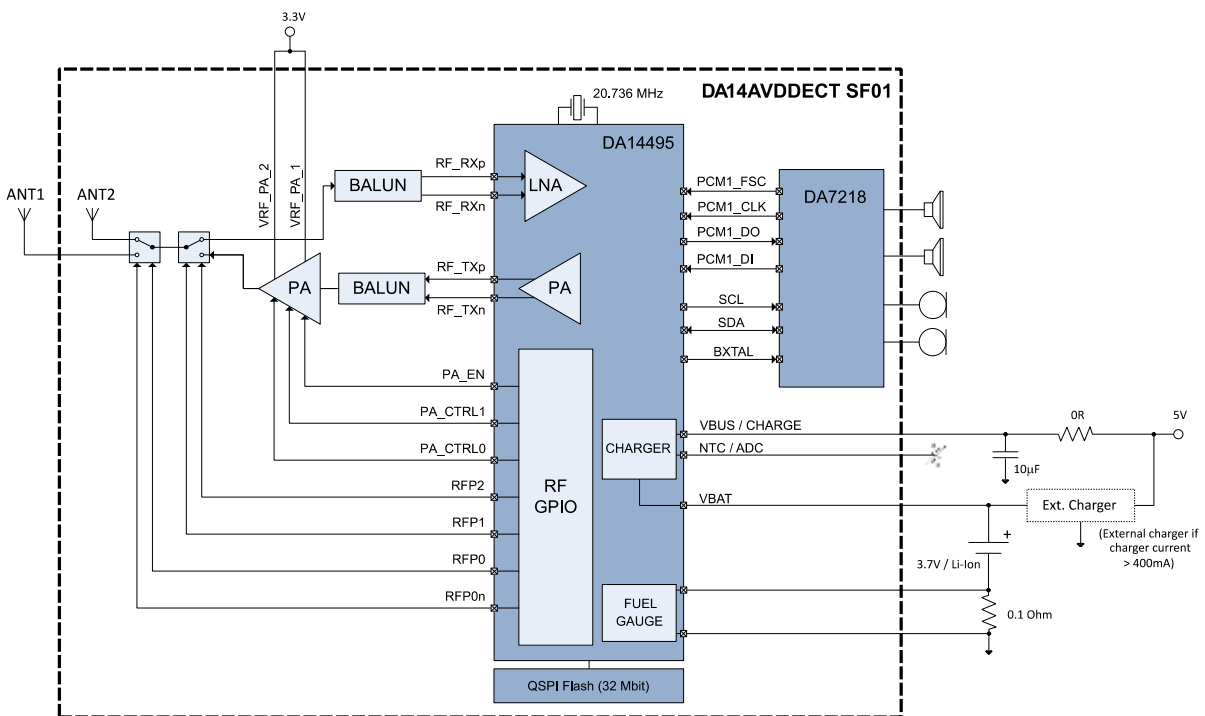


Figure 1: Hardware Overview

### 4.2 Module Dimensions

The overall dimensions of the DA14AVDDECT module are shown in Figure 2.

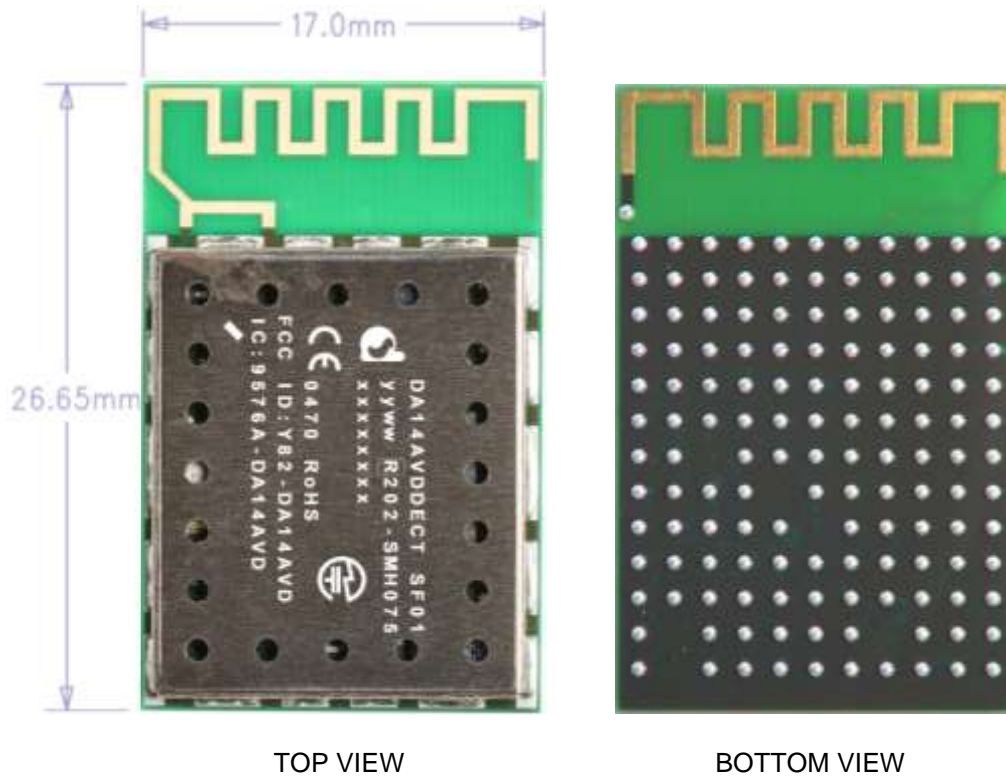


Figure 2: Module Dimensions

### 4.3 QSPI Flash Content

The module is fully tested in production but shipped with empty flash content (all 0xFFs) so the user needs to program the modules in production. For development or production purposes the user needs to download the Software Development Kit, which can be accessed via the customer support portal. Registration is required and is possible via "<https://support.dialog-semiconductor.com/user/register/>" after the "Wireless Audio & Voice" checkbox is selected.

### 4.4 Operating Frequency Range

The supported RF frequencies and channel numbers for EU, Japan and US DECT are shown in Table 1.

Table 1: RF Frequencies

Frequency (MHz)	EU DECT CH	J-DECT CH	US DECT CH
1881.792	9		
1883.520	8		
1885.248	7		
1886.976	6		
1888.704	5		
1890.432	4		
1892.160	3		
1893.888	2		

Frequency (MHz)	EU DECT CH	J-DECT CH	US DECT CH
1895.616	1	5 (F1)	
1897.344	0	4 (F2)	
1899.072		3 (F3)	
1900.800		2 (F4)	
1902.528		1 (F5)	
1904.256		0 (F6)	
1921.536			4
1923.264			3
1924.992			2
1926.720			1
1928.448			0

#### 4.5 RF Output Power

The DA14AVDDECT module is fully tested and RF output power is trimmed during production. There is a temperature compensation algorithm implemented in each AVD firmware that maintains the target output power over temperature range. The default target output power is 22 dBm for EU and Japan DECT and 20 dBm for US DECT. Decreasing the target output power is possible by human readable settings via EEPROM.

## 5 Software Overview

There are three different projects and six different project profiles for the module:

- Audio Data (AD) Tour Guide – FP and PP profile
- Audio Data (AD) Public Address – FP and PP profile
- Voice Data (VD) Stack – FP and PP profile

### 5.1 Terminology

Audio Data (AD) stacks are referred by the software as WAM (Wireless Audio Module). Voice Data (VD) stack is referred by the software as CVM (Cordless Voice Module).

### 5.2 Software Architecture

The firmware is provided as a binary, and the user application and NVS area are customizable for the end product. The user application can run either on the host MCU or on the embedded Arm processor (Co-Located or "COLA" application), which is shown in Figure 3.

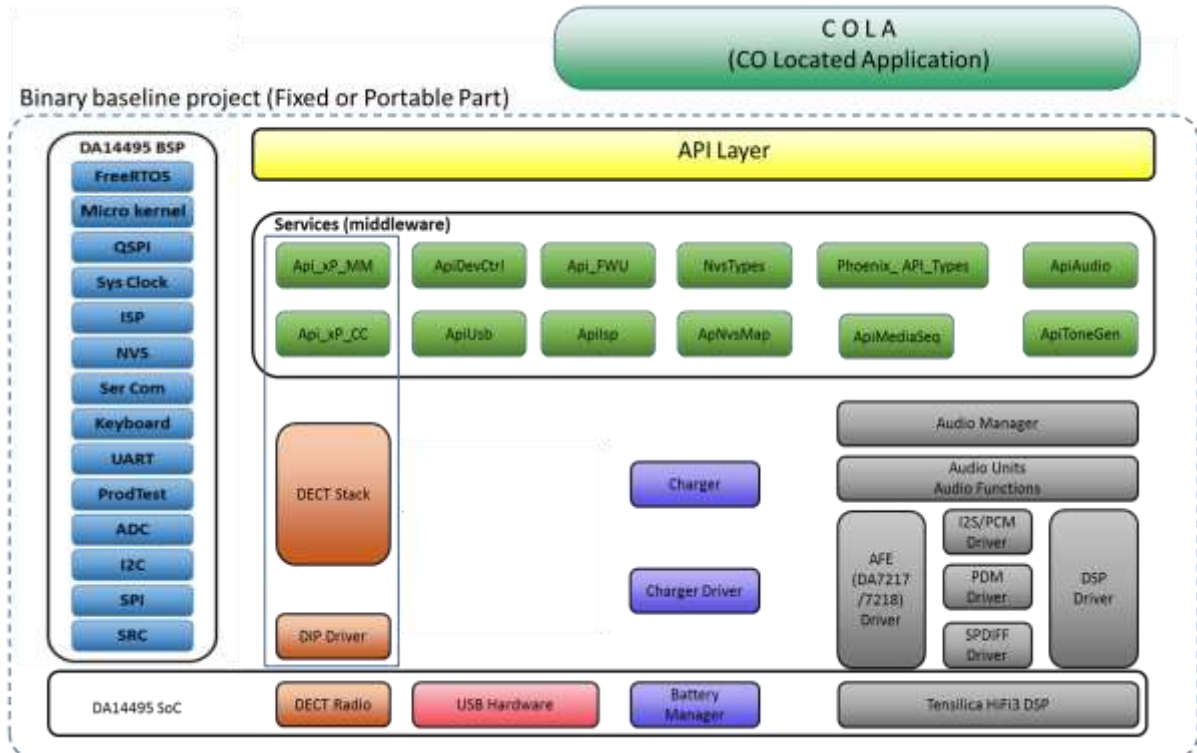


Figure 3: Software Architecture

### 5.3 Software Tools

The SW tools provided in the Software Development Kit are shown in Table 2.

Table 2: Software Tools

Tool	Stack	Description
FL7	All stacks	Flashloader tool to program via UART
WAM HostApp	WAM Tour Guide	Configuration tool with NVS editor, connection manager, SW update (FWU), Production test, etc.
	WAM Public Address	
CVM HostApp	CVM	
RSX	All stacks	Mail trace tool to monitor API traffic via Eai Port Server.
Smartbeat AVD Studio	All stacks	Eclipse-based IDE with project templates and debug support via Jlink Lite.



## 7 System Overview

This chapter shows the high level block diagram of three different systems, which are based on the SW profiles listed in Section 5. The default settings of the example Cola application are used for the block diagrams.

### 7.1 Tour Guide System

Figure 4 shows the high level block diagram of the Tour Guide system where FP is broadcasting audio up to 1024 PPs. Audio is encoded and transmitted by FP with a CELT codec. The following connections are possible in this setup, which are fully under the control of the user application:

- broadcast audio channel (to all PPs) that FP can mute and unmute. A small amount of data can be sent via the broadcast connection (to all PPs)
- "keep-alive" connection that is a regular service connection to monitor if at least 1 PP is connected (mandatory in DECT when broadcasting). A small amount of data can be exchanged between FP and PP with the use of the service connection.
- "question call" is a wideband voice connection (G.722 codec) that one of the PPs uses to talk to FP after the voice connection is established (components marked by a dashed line in Figure 4 are needed). The conversation between FP & PP is broadcasted to all other PPs unless FP mutes the broadcasted audio to keep the conversation private. A small amount of data can be exchanged between FP & PP with the use of this connection.

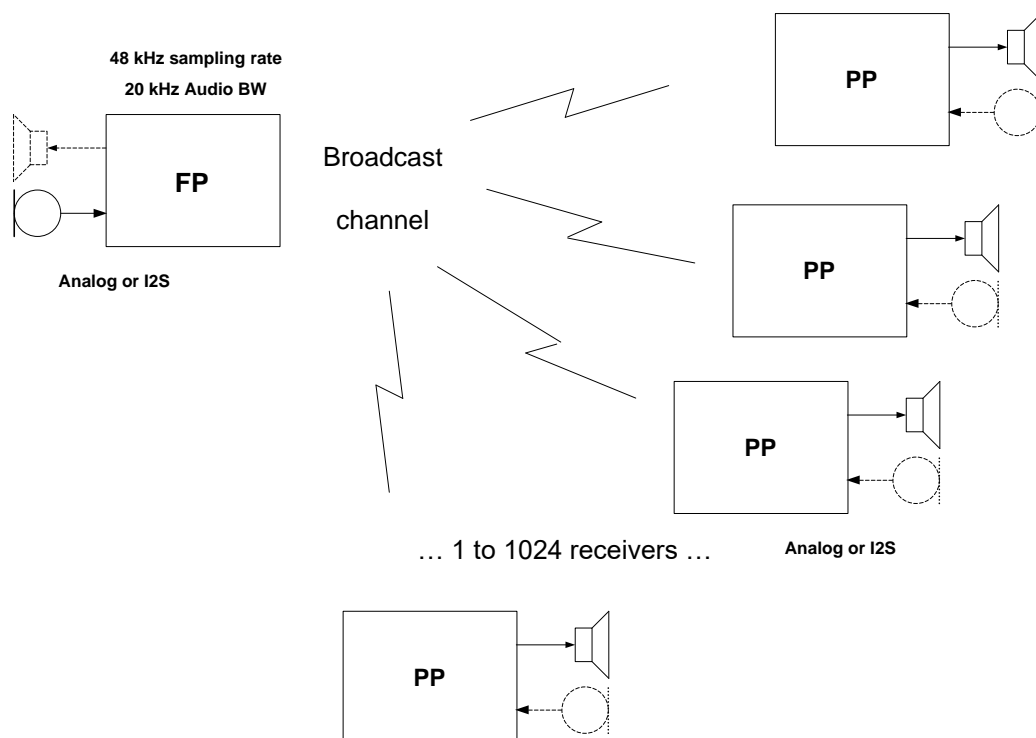


Figure 4: Tour Guide System

## 7.2 Public Address System

Figure 5 shows the high level block diagram of the Public Address system that can connect up to 4 PPs to FP at the same time. The setup shown in Figure 5 requires DQPSK modulation (or higher). The default example application uses DQPSK modulation where 4 PPs can connect to FP.

PP encodes and transmits audio with a CELT codec and either the mixed audio will be output on analog output or audio from each PP will be output over separate PCM channels on FP.

It is possible to exchange a small amount of data between FP & PP.

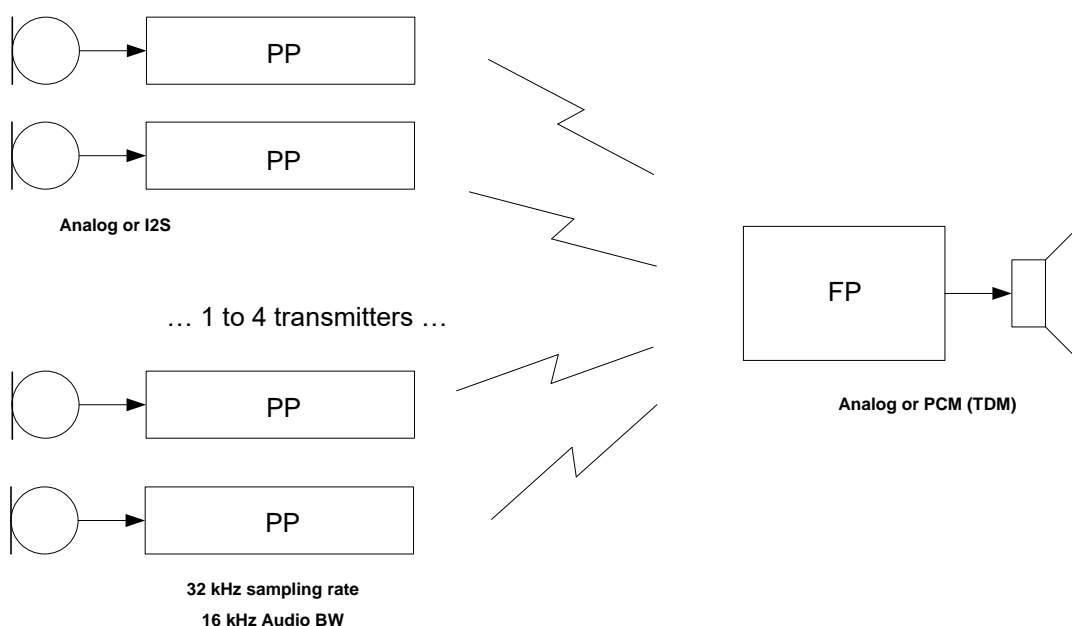


Figure 5: Public Address System

## 7.3 Voice Conferencing System

Figure 6 shows the high level block diagram of the Voice Conferencing system where up to 8 PPs can join a call. Audio is supported on FP, so 9 parties can participate in total.

The setup shown in Figure 6 requires DQPSK modulation (or higher) and a BV32 codec for a wideband call, which is the default setting in the example application.

Intercom connections are also possible up to 8 PPs (4 intercom calls). When both intercom connections and a conference call are required, the system will support a total number of 8 PPs (for example: 2 intercom calls and one conference call with 4 PPs).

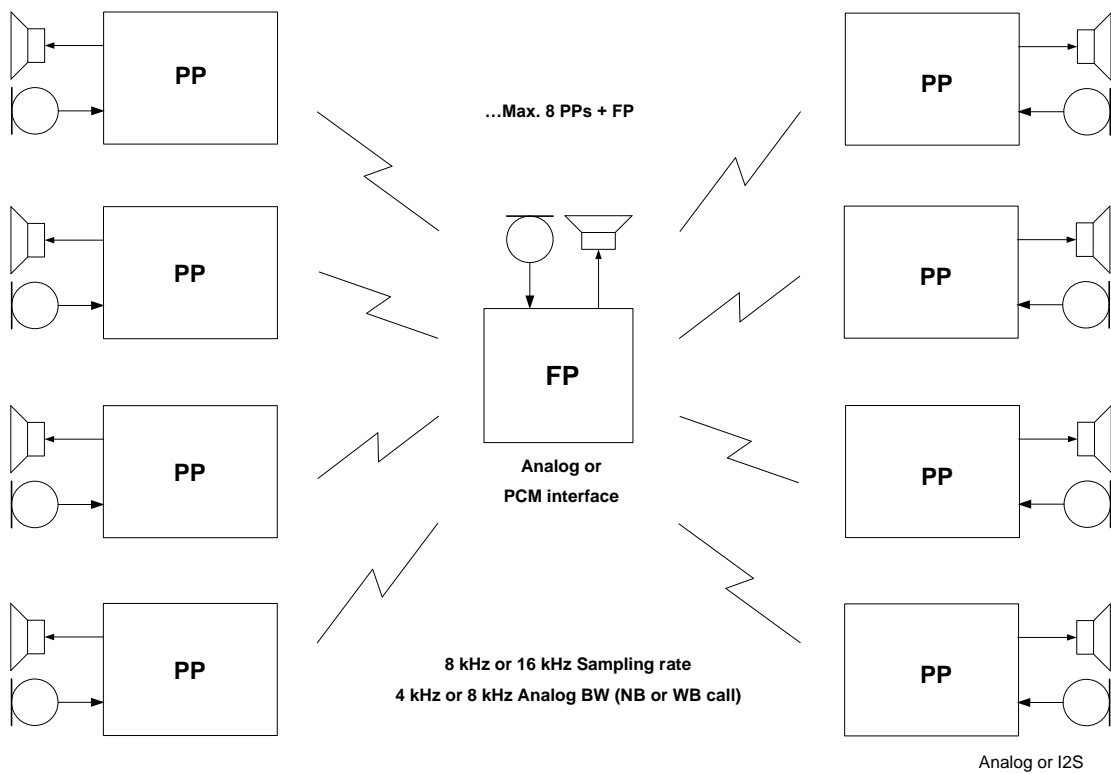


Figure 6: Voice Conferencing System

### 7.4 Data Applications

When the end application requires data transfers at higher data rate, the Voice Data stack allows the user to establish 150 Kbit/s LDS data connections.

### 7.5 Summary

Figure 7 shows a summary of the default settings for each system.

Application	Connection	CODEC	Audio BW / Data Rate	# of PPs	Default modulation scheme			Slot Size	Slot Structure
					S-field	A-field	B+Z-field		
Tour Guide	Audio + UNITDATA (Broadcast channel)	CELT 48 kHz 128kbps Mono Mode = 0x82	20 kHz / 1.6 kbit/s	1024	$\pi/2$ -DBPSK	$\pi/2$ -DBPSK	$\pi/2$ -DBPSK	2 x Long Slot (Double Simplex)	Asym broadcast LS640 Unprotected B-field
	Voice + IWU data (Question call)	G.722 Mode = 0x86	5.6 kHz / 1.6 kbit/s	1 (out of 1024)	$\pi/2$ -DBPSK	$\pi/2$ -DBPSK	$\pi/2$ -DBPSK	Long Slot (Duplex)	LS640 Unprotected B-field
	Service connection + IWU data (Keep-alive connection)	-	1.6 kbit/s	1 (out of 1024)	$\pi/2$ -DBPSK	$\pi/2$ -DBPSK	$\pi/2$ -DBPSK	Long Slot (Duplex)	Long Slot
Public Address	Audio + IWU data	CELT 32 kHz 64 kbps Mono Mode = 0x85	16 kHz / 1.6 kbit/s	4	$\pi/2$ -DBPSK	$\pi/2$ -DBPSK	$\pi/4$ -DQPSK	2 x Full Slot (Double Simplex) + 1 x Duplex	Asym connection Full Slot
Conferencing	Voice + IWU data	BV32 Mode = 0x81	7.3 kHz / 1.6 kbit/s	8	$\pi/2$ -DBPSK	$\pi/2$ -DBPSK	$\pi/4$ -DQPSK	Full Slot (Duplex)	Full Slot
	LDS data	-	150 kbit/s	2	$\pi/2$ -DBPSK	$\pi/2$ -DBPSK	$\pi/8$ -DBPSK	2 x Double Slots	Double Slot Protected B-field
FWU (any stack)	LU10	-	150 kbit/s	Up to 1024	$\pi/2$ -DBPSK	$\pi/2$ -DBPSK	$\pi/8$ -DBPSK	2 x Double Slots	Double Slot Protected B-field

- <- Hard coded in stack, user can't change it
- <- Controlled by user via API (e.g. Cola application)
- <- Automatically changes according to modulation settings selected by user (but user can't change this field separately)

Figure 7: Default Settings

## 8 Development Kit

Figure 8 shows the development kit for the DA14AVDDECT module that consists of the following items:

- 2 x paired Carrier Boards
- 1 x Arm debugger (Segger J-Link LITE) with Arm JTAG-20-10 adapter
- 3 x mini USB cables
- Paper insert with setup instructions

The boards are delivered with the Tour Guide firmware and Co-Located (Cola) example applications, where the Fixed Part broadcasts audio to a Portable Part over the DECT link.

All relevant documentation and SW can be downloaded from Dialog's customer support portal.



Figure 8: DA14AVDDECTDEVKT with two Carrier Boards

## 9 Notices to OEM on Modular Approval

### 9.1 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 the time, cost, and effort needed to place an end-product containing DA14AVDDECT onto the market.

The module is intended to be used in an end application. Type approval concerning the end product, except for the module, should still be done. Please contact a test-house to clarify requirements.

### 9.2 Available Certifications

Dialog Semiconductor B.V. has obtained the following limited modular approvals for DA14AVDDECT:

- FCC Part 15, subpart D, Isochronous UPCS Device 1920-1930 MHz:  
FCC ID Y82-DA14AVD
- IC RSS-213, issue 2, 2 GHz License-exempt Personal Communications Service Devices:  
IC ID 9576A-DA14AVD

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
- Japan TELEC Class 1, Article 2-1 item (21)-2, F1D, F1E, G1D, G1E 1895.616 - 1904.256 MHz:  
202-SMH075

### 9.3 Applicability

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

ETSI (Europe) does not support Modular Certification, instead it supports a Declaration of Conformity (DoC). The manufacturer is responsible for the compliance to regulatory requirements. Previous testing, such as that 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 for this purpose. Tests in these reports do not have to be repeated on end-product/system level.

### 9.4 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 DA14AVDDECT SF01 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.

### 9.4.1 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 DA14AVDDECT SF01 certification this implies the following:

- If only the embedded/internal antenna of DA14AVDDECT is used, then the Antenna Condition is fulfilled.
- If an external antenna is connected to DA14AVDDECT, then this antenna would need to meet specific criteria in order to prevent recertification requirements. Please refer to the DA14AVDDECT SF01 datasheet sections 5 and 6 for further details

Key characteristics of the embedded/internal antenna of DA14AVDDECT:

- Type of antenna: Printed F-antenna
- Peak antenna gain: 4dBi

Further details on the DA14AVDDECT antenna can be found in document *AN-D-236*.

### 9.4.2 Host PCB Layout

The PCB layout of the host PCB is critical to the validity of the RF certification of DA14AVDDECT because it is part of the embedded printed antenna. Please refer to the DA14AVDDECT SF01 datasheet sections 5 and 6 for further details.

### 9.4.3 Labelling Requirements

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

Model: DA14AVDECT SF01 Contains FCC ID: Y82-DA14AVD Contains IC ID: 9576A-DA14AVD
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Some further details about labelling requirements and compliance statements can be found in "784748 D01 Labelling Part 15 18 Guidelines v07".

### 9.4.4 User Documentation Text for FCC and/or Industry Canada / ISED

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

**“FCC compliance statement**

Contains Transmitter Module FCC ID: Y82-DA14AVD / IC ID: 9576A-DA14AVD

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.

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.

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.”

The host device shall be properly labelled to identify the modules within the host device. The Industry Canada certification label of a module shall be clearly visible at all times when installed in the host device, otherwise the host device must be labelled to display the Industry Canada certification number of the module, preceded by the words "Contains transmitter module", or the word "Contains", or similar wording expressing the same meaning, as follows:

Contains Transmitter Module IC: 9576A-DA14AVD

L'appareil hôte doit être étiqueté comme il faut pour permettre l'identification des modules qui s'y trouvent. L'étiquette de certification d'Industrie Canada d'un module donné doit être posée sur l'appareil hôte à un endroit bien en vue en tout temps. En l'absence d'étiquette, l'appareil hôte doit porter une étiquette donnant le numéro de certification du module d'Industrie Canada, précédé des mots " Contient un module d'émission ", du mot " Contient " ou d'une formulation similaire exprimant le même sens, comme suit :

Contient le module d'émission IC: 9576A-DA14AVD

This device complies with Industry Canada licence exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes : (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

CAN ICES-3 (B)/NMB-3(B)

#### 9.4.5 Safety Requirements

This section provides an overview of the safety requirements you must adhere to when working with DA14AVDDECT.

- The specific external power supply for DA14AVDDECT 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 meters
  - 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

## 9.5 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  $<60/f(\text{GHz})$  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).

## 9.6 Information on Test Modes and Additional Testing Requirements:

When testing a host product, the host manufacturer should follow FCC KDB Publication 996369 D04 Module Integration Guide for testing host products. The host manufacturer may operate their product during the measurements.

Simultaneously, all transmitting modules installed in the host should be active.

## 9.7 Additional Testing, Part 15 Subpart B Disclaimer:

The modular transmitter is only FCC authorized for the specific rule parts list on the grant, and that the host product manufacturer is responsible for compliance to any other FCC rules that apply to the host not covered by the modular transmitter grant of certification.

## 9.8 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" <20 cm from the human body is referred to as "Portable" in FCC terminology.

The existing Modular Approval may be invalidated if DA14AVDDECT 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.



## Revision History

Revision	Date	Description
1.2	20-Aug-2020	Added Chapter 4.4 and 4.5
1.1	23-Jul-2020	Added Chapter 9
1.0	23-Mar-2020	Initial version.

### Status Definitions

Status	Definition
DRAFT	The content of this document is under review and subject to formal approval, which may result in modifications or additions.
APPROVED or unmarked	The content of this document has been approved for publication.

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