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## General description

The SC14WAMDECT SF is a Cordless Audio Module with an integrated baseband, radio transceiver, power amplifier and crystal to be used in cordless microphone applications in the DECT frequency band. This module is intended for users with little or no DECT experience, who wish to make a wireless audio system.

The module can be configured for various audio applications. A *Public Address System* has two portable parts (PP) with two microphones and one fixed part (FP) configured as a receiver and integrated into a loudspeaker. Another application is a *Tour Guide System* where one a microphone (FP) broadcasts to up to 128 receivers (PP) with an integrated loudspeaker or a headset connected. The SC14WAMDECT SF module is suitable for both FP and PP usage: a hardware pin selects the function of the module.

The SC14WAMDECT SF module is pre-approved for use in all countries that use the DECT frequency band, as well as the DECT 6.0 frequency band used in North America.

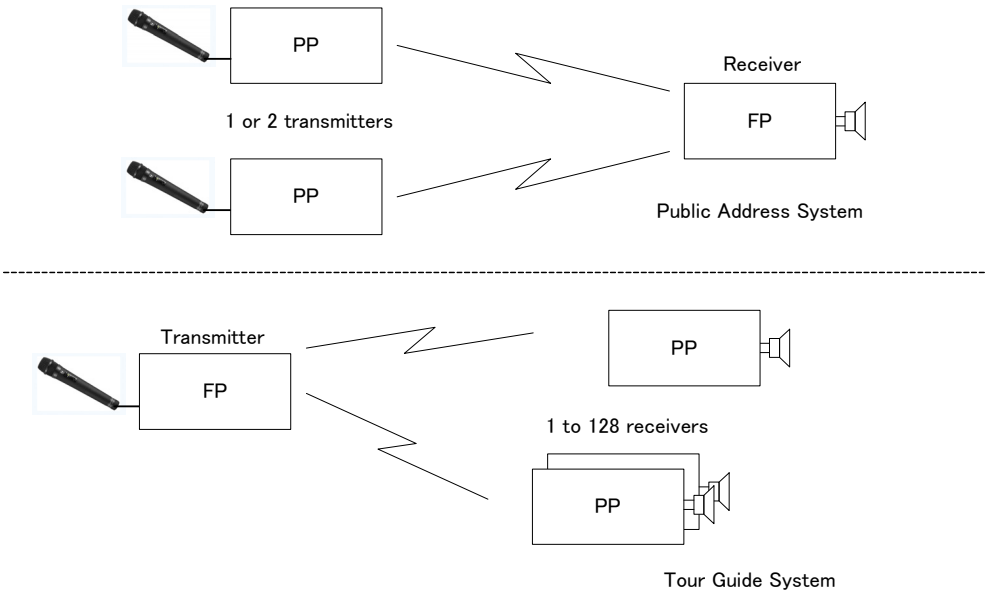
## Features

- Pre-programmed and ready-to-use module
- Antenna embedded, support for external antennas
- High quality audio sampled at 25.6 kHz
- Latency: 14.2 ms (PA mode), 18.3 ms (TG mode)
- UART data transfer (up to 1 kbit/s) in TG mode
- Access code for secure registration in TG mode
- ETSI (DECT) and FCC (DECT 6.0) certified
- Japan DECT (J-DECT) pre-certified
- Supports 1.9 GHz and 1.7 GHz DECT bands
- Receiver sensitivity < -93 dBm
- Transmit power EU: 23 dBm, USA: 20 dBm, JPN: 20 dBm
- Power supply voltage: 2.1 V to 3.45 V
- Supports NiMH and Alkaline batteries
- Small form factor (19.6 mm x 18.0 mm x 2.7 mm)
- Operating temperature range: -40 °C to +85 °C

## Applications

- Public Address System with one or two microphones (transmitter) and one loudspeaker (receiver)
- Tour Guide System with one microphone (transmitter) and up to 128 headsets (receiver)

## System diagram



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## 1.0 Connection diagram

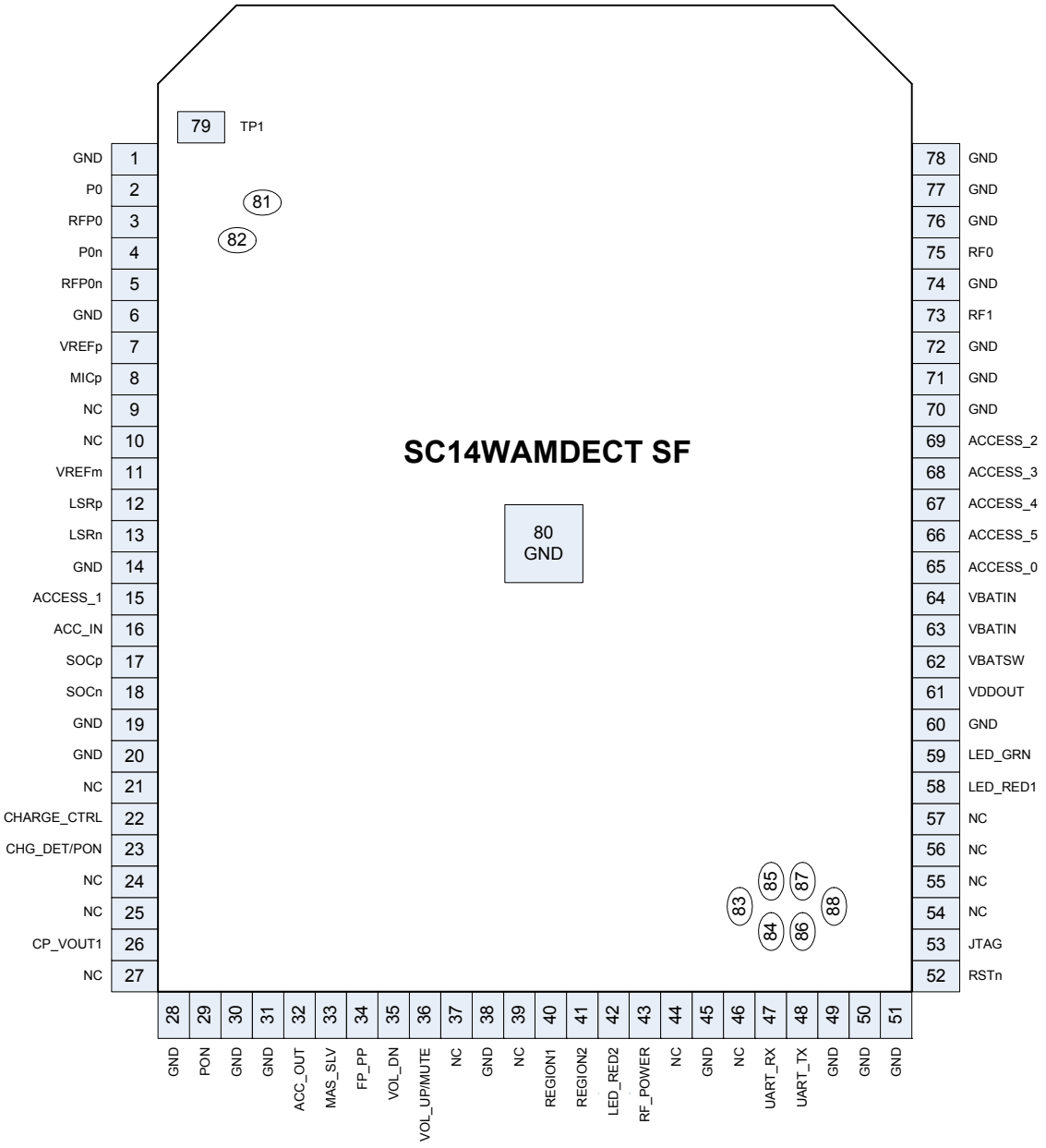


**Figure 1: Connection diagram (top view, leads face down)**

**Table 1: Ordering information**

| Part number | Package | Size (mm) | Shipment form | Pack quantity |
|---|---|---|---|---|
| SC14WAMDECT SF01T | MOD88 | 18 x 19.6 | Tray | 60 **(Note 1)** |

**Note 1:** MOQ = 600 pcs.

### 1.1 PIN DESCRIPTION

**Table 2: Pin description**

| Pin | Module Pin name (Note 2) | In/ Out | Iout Drive (mA) | Reset State (Note 3) | Description |
|---|---|---|---|---|---|
| 1 | GND | - | - | - | Ground |
| 2 | P0 | O | 8 | Hi-Z | Control port for FAD. See section 5.6 |
| 3 | RFP0 | O | 8 | Hi-Z | Control port for FAD. See section 5.6 |
| 4 | P0n | O | 8 | Hi-Z | Control port for FAD. See section 5.6 |
| 5 | RFP0n | O | 8 | Hi-Z | Control port for FAD. See section 5.6 |
| 6 | GND | - | - | - | Ground |
| 7 | VREFp | O | - | I | Positive microphone supply voltage. |
| 8 | MICp | I | - | I | Positive microphone input. |
| 9 | NC | - | - | - | Must be unconnected. |
| 10 | NC | - | - | - | Must be unconnected. |
| 11 | VREFm | - | - | - | Negative microphone reference (star point), connect to GND. |
| 12 | LSRp | O | - | O | Positive loudspeaker output. |
| 13 | LSRn | O | - | O | Negative loudspeaker output. |
| 14 | GND | - | - | - | Ground |
| 15 | ACCESS_1 | I | - | I | TG mode: Access code bit 1.<br>PA mode: Must be unconnected. |
| 16 | ACC_IN | I | - | I-PU | Transmitter (PA PP or TG FP): Accessory input<br>Receiver (PA FP or TG PP): Must be unconnected. |
| 17 | SOCp | I | - | I | Battery state of charge positive input. Not used, connect to GND. |
| 18 | SOCn | I | - | I | Battery state of charge negative input. Not used, connect to GND. |
| 19 | GND | - | - | - | Ground |
| 20 | GND | - | - | - | Ground |
| 21 | NC | - | - | - | Must be unconnected. |
| 22 | CHARGE_CTRL | O | 1 | O-0 | Charge control output. Not used, leave unconnected. |
| 23 | CHG_DET/ PON | I | - | I-PD (270k fixed pull-down) | PP: Charge Detect input.<br>FP: Power On pushbutton input:<br>When OFF and short press: switch ON.<br>When ON and 2 s press: registration.<br>When ON and 5 s press: power OFF.<br>When ON and 10 s press: deregistration. |
| 24 | NC | - | - | - | Must be unconnected. |
| 25 | NC | - | - | - | Must be unconnected. |
| 26 | CP_VOUT1 | O | - | I | Must be unconnected. |
| 27 | NC | - | - | - | Must be unconnected. |
| 28 | GND | - | - | - | Ground |
| 29 | PON | I | - | I-PD (270k fixed pull-down) | PP: Power On & Toggle Mute pushbutton input.<br>When OFF and short press: switch ON.<br>When OFF and 2 s press: switch ON and registration.<br>When ON and short press: toggle mute.<br>When ON and 2 s press: power OFF.<br>FP: Must be unconnected. |
| 30 | GND | - | - | - | Ground |
| 31 | GND | - | - | - | Ground |

**Table 2: Pin description (Continued)**

| Pin | Module Pin name (Note 2) | In/ Out | Iout Drive (mA) | Reset State (Note 3) | Description |
|---|---|---|---|---|---|
| 32 | ACC_OUT | O | 8 | - | Receiver (PA FP or TG PP): Accessory output<br>Transmitter (PA PP or TG FP): Must be unconnected. |
| 33 | MAS_SLV | I | - | I-PD | Configuration of PA and TG mode.<br>**MAS_SLV** **FP_PP** **Mode**<br>H L PA receiver<br>H H PA transmitter<br>L L TG transmitter<br>L H TG receiver |
| 34 | FP_PP | I | - | I-PD | |
| 35 | VOL_DN | I | - | I-PD | PP: Volume Down input. Connect to Volume Down pushbutton.<br>FP: Must be unconnected. |
| 36 | VOL_UP/ MUTE | I | - | I-PU | PP: Volume Up input. Connect to Volume Up pushbutton.<br>FP: Mute input. When this pin is pulled LOW the FP will mute all audio to/from the PP. |
| 37 | NC | - | - | - | Must be unconnected. |
| 38 | GND | - | - | - | Ground |
| 39 | NC | - | - | - | Must be unconnected. |
| 40 | REGION1 | - | - | I-PU | Selection of DECT RF frequency (FP and PP).<br>**REGION1** **REGION2** **RF BAND**<br>L L DECT 6.0 (USA)<br>L H Reserved<br>H L Japan DECT<br>H H European DECT |
| 41 | REGION2 | - | - | I-PD | |
| 42 | LED_RED2 | O | 8 | I | PA FP: Red LED 2 output (see section 5.0). Connect to VDDOUT via a series resistor (typ. 39 Ω).<br>Other modes: Must be unconnected. |
| 43 | RF_POWER | I | - | I-PU | RF Power mode selection input.<br>High Power Mode (HPM): leave unconnected.<br>Low Power Mode (LPM): connect to GND. |
| 44 | NC | - | - | - | Must be unconnected. |
| 45 | GND | - | - | - | Ground |
| 46 | NC | - | - | - | Must be unconnected. |
| 47 | UART_RX | I | - | I-PD (10k) | UART RX input, debug purposes. |
| 48 | UART_TX | O | 8 | - | UART TX output, debug purposes. |
| 49 | GND | - | - | - | Ground |
| 50 | GND | - | - | - | Ground |
| 51 | GND | - | - | - | Ground |
| 52 | RSTn | I | 1 | I-PU (200k pull-up) | Active low Reset input with Schmitt-trigger input, open-drain output and pull-up resistor to internal VDD. Input may not exceed 2.0 V. An internal capacitor of 47 nF is mounted on this pin. |
| 53 | JTAG | - | - | - | Debug purposes. Internally connected to VDDOUT (pin 61) via a 1 kΩ resistor. |
| 54 | NC | - | - | - | Must be unconnected. |
| 55 | NC | - | - | - | Must be unconnected. |
| 56 | NC | - | - | - | Must be unconnected. |
| 57 | NC | - | - | - | Must be unconnected. |
| 58 | LED_RED1 | O | 8 | I | Red LED output 1. See section 5.0. |

**Table 2: Pin description (Continued)**

| Pin | Module Pin name (Note 2) | In/ Out | Iout Drive (mA) | Reset State (Note 3) | Description |
|---|---|---|---|---|---|
| 59 | LED_GRN | O | 8 | I | Green LED output. See section 5.0. |
| 60 | GND | - | - | - | Ground |
| 61 | VDDOUT | - | - | - | Supply voltage output for LED_RED2 (typ. 1.8 V). Internally connected to JTAG (pin 53) via a 1 kΩ pull-up resistor. |
| 62 | VBATSW | O | 8 | I-PU | Supply voltage output for LED_RED1, LED_GRN (< 3.45 V). |
| 63 | VBATIN | I | - | - | Main supply voltage < 3.45 V. |
| 64 | VBATIN | I | - | - | Main supply voltage < 3.45 V. |
| 65 | ACCESS_0 | I | - | I | TG mode: Access code bit 0 (LSB).<br>PA mode: Must be unconnected. |
| 66 | ACCESS_5 | I | - | I | TG mode: Access code bit 5 (MSB).<br>PA mode: Must be unconnected. |
| 67 | ACCESS_4 | I | - | I | TG mode: Access code bit 4.<br>PA mode: Must be unconnected. |
| 68 | ACCESS_3 | I | - | I | TG mode: Access code bit 3.<br>PA mode: Must be unconnected. |
| 69 | ACCESS_2 | I | - | I | TG mode: Access code bit 2.<br>PA mode: Must be unconnected. |
| 70 | GND | - | - | - | Ground |
| 71 | GND | - | - | - | Ground |
| 72 | GND | - | - | - | Ground |
| 73 | RF1 | - | - | - | RF signal for external antenna. See section 5.6 |
| 74 | GND | - | - | - | Ground |
| 75 | RF0 | - | - | - | RF signal for external antenna. See section 5.6 |
| 76 | GND | - | - | - | Ground |
| 77 | GND | - | - | - | Ground |
| 78 | GND | - | - | - | Ground |
| 79 | TP1 | - | - | - | Tuning point for internal antenna. Follow instructions of section 7.3. |
| 80 | GND | - | - | - | Ground |
| 81:88 | TP2 to TP9 | NC | | | Must be unconnected. See section 7.1 and Figure 13. |

**Note 2:** GND: internally connected to the module ground plane. Every GND pin should be connected to the main PCB.ground plane.
NC: not connected.
TP: test point.

**Note 3:** All digital inputs have Schmitt trigger inputs. After reset all I/Os are set to input and all pull-up or pull-down resistors are enabled unless otherwise specified.
PU = Pull-up resistor enabled, PD = Pull-down resistor enabled, I = input,
O = output, Hi-Z = high impedance, 1 = logic HIGH level, 0 = logic LOW level
Refer also to Px_DIR_REGs for INPUT/OUTPUT and Pull-up/Pull-down configurations

# 2.0 Introduction

## 2.1 SCOPE

The SC14WAMDECT SF module can be configured for various audio applications. A *Public Address System* has two portable parts (PP) each with a microphone and one fixed part (FP) configured as a receiver and integrated into a loudspeaker. Another application is a *Tour Guide System,* where one microphone is the FP which broadcasts to up to 128 (PP) receivers with an integrated loudspeaker or with a headset connected.

## 2.2 REFERENCES

1. AN-D-218, SC14WAMDECT External antenna design guidelines, Application note, Dialog Semiconductor.
2. AN-D-223, SC14WAMDECT production pairing, Application Note, Dialog Semiconductor.
3. FpApiProject.pdf, Specification for interface between FpApiProject and Host in WAM project, Dialog Semiconductor.
4. PpApiProject.pdf, Specification for interface between PpApiProject and Host in WAM project, Dialog Semiconductor.

## 2.3 GLOSSARY AND DEFINITIONS

| | |
|---|---|
| DECT | Digital Enhanced Cordless Telephone |
| ESD | Electro Static Discharge |
| FAD | Fast Antenna Diversity |
| FP | Fixed Part; the microphone for the TG system or the speaker for the PA system. |
| GFSK | Gaussian Frequency Shift Keying |
| HW | Hardware |
| IPEI | International Portable Equipment Identity (refer to ETSI EN 300 175-6) |
| MMI | Man Machine Interface |
| NC | Not Connected |
| PA | Public Address (System) |
| PCB | Printed Circuit Board (without components) |
| PP | Portable Part; the microphone for the PA system or the speaker for the TG system. |
| RF | Radio Frequency |
| RFPI | Radio Fixed Part Identity (refer to ETSI EN 300 175-6) |
| RSSI | Radio Signal Strength Indication (please refer to ETSI EN 300 175-1) |
| SOC | State Of Charge |
| SW | Software |
| TG | Tour Guide (System) |
| VES | Virtual EEPROM Storage |
| WAM | Wireless Audio Module |

# 3.0 Wireless Audio Module functions

This section describes the key functions and features supported by the SC14WAMDECT SF module.

## 3.1 DECT

The SC14WAMDECT SF is based on the ETSI DECT specifications for digital cordless telephone systems.

The system diagram on page 1 shows that this module has two configurations: microphone (MIC) and loudspeaker (SPEAKER).

One internal antenna is embedded and an external antenna is supported (see section 5.6). An external microcontroller can be used for limited control purposes via the UART interface. See section 4.7.

## 3.2 MICROPHONE CONFIGURATION

For a microphone configuration the SC14WAMDECT SF module requires the external parts listed in Table 3.

**Table 3: Microphone configuration overview**

| Item | Supported | Remark |
|---|---|---|
| Battery | Yes | 2 NiMH or standard Alkaline cells.<br>**Note:** For LiIon batteries an external LDO is required. |
| Microphone | Yes | Connect to pin MICp (single ended). |
| Keys | Yes | Connect to pins ACC_IN, PON, VOL_UP/MUTE and VOL_DN. |
| LEDs | Yes | Connect to pins LED_RED1 and LED_GRN. |

Figure 2 shows the usage of the module with an external microphone. This MIC configuration can be used for the PP of a Public Address System and for the FP of a Tour Guide System.

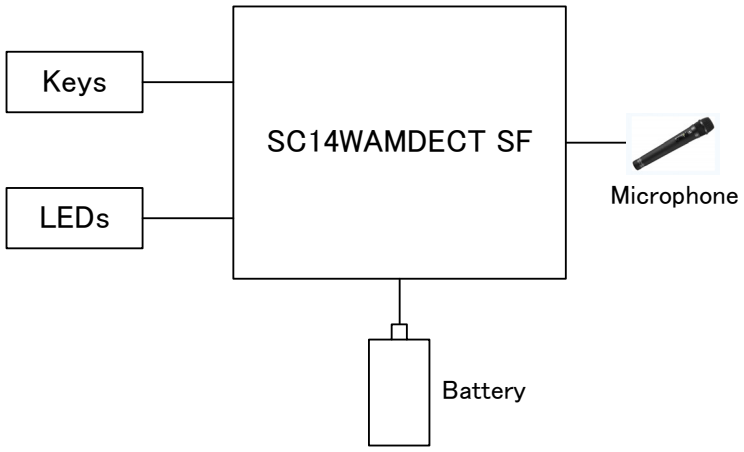


**Figure 2: MIC configuration**

### 3.3 LOUDSPEAKER CONFIGURATION

For a loudspeaker configuration the SC14WAMDECT SF module requires the external components listed in Table 4.

**Table 4: Loudspeaker configuration overview**

| Item | Supported | Remark |
|---|---|---|
| Battery | Yes | 2 NiMH or standard Alkaline cells. |
| Loudspeaker | Yes | Connect to pins LSRp and LSRn (differential). |
| Keys | Yes | Connect to pins CHG_DET/PON, VOL_UP/MUTE and VOL_DN. |
| LEDs | Yes | PA mode: Connect to pins LED_RED1, LED_RED2 and LED_GRN.<br>TG mode: Connect to pins LED_RED1 and LED_GRN. |

Figure 3 shows the use of the module in a typical loudspeaker configuration. This SPEAKER configuration can be used for the FP of a Public Address System and for the PP of a Tour Guide System.

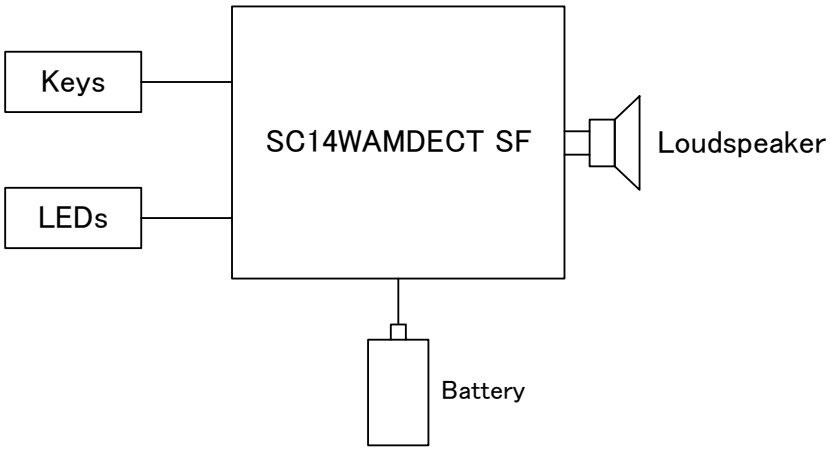


**Figure 3: SPEAKER configuration**

### 3.4 FUNCTIONAL OVERVIEW

**Table 5: Overview of supported functions**

| Functionality | Remark |
|---|---|
| **Connection handling** | |
| PP to FP | PA mode: 1 or 2 microphones (PP) transmit to one loudspeaker (FP). |
| FP to PP | TG mode: 1 microphone (FP) broadcasts to max. 128 loudspeakers (PP). |
| **Protocol** | |
| Registration | Manual.<br>TG mode: optionally protected by 6-bit access code. |
| Number of PPs per FP | PA mode: 1 or 2<br>TG mode: 1 to 128 |
| Link establishment time | 2 s (typ.) |
| Registration time-out | FP: 600 s (TG mode)<br>PP: 120 s (TG mode) |
| Factory registration | Wire registration is supported. See [2]. |
| **Audio and tone** | |
| Microphone mute | Mute of MIC in all audio connections is possible. |
| Latency | PA mode: 1 MIC: 14.2 ms, 2 MICs: 14.2 ms or 15.8 ms **(Note 4)**.<br>TG mode: 18.3 ms **(Note 5)**. |
| **General** | |
| Battery handling | Charging is not supported, requires external components. |

**Note 4:** Latency for 2 microphones depends on the assigned slot.
**Note 5:** For Tour Guide System the 'normal delay' applies as defined in the DECT specification.

# 4.0 Functional description

## 4.1 AUDIO CONFIGURATION

The SC14WAMDECT SF module supports a dedicated audio channel. The gains can be adjusted to meet the audio level requirements by using the SC14WAMDECT SF application reference design. For other acoustic designs it is needed to adjust and tune the audio setup.

### 4.1.1 Microphone connection

The SC14WAMDECT SF module only supports single-ended connection of a microphone.

### 4.1.2 Audio equalisation

To enable adjustments of the frequency response the SC14WAMDECT SF contains two programmable filters in the TX direction (see Figure 4).

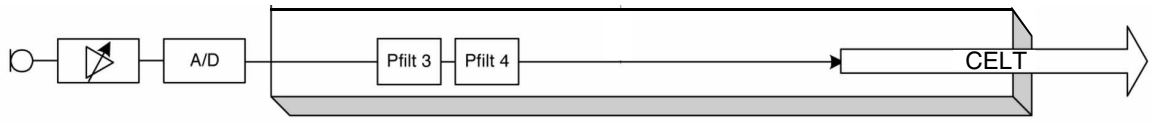


**Figure 4: MIC audio routing**

## 4.2 POWER MANAGEMENT

To minimise the current consumption the SC14WAMDECT SF module will shut down all codec amplifiers in Idle state. This means that all reference voltages in the front-end will be disabled.

## 4.3 OUT-OF-RANGE HANDLING

When the PP goes in-range or out-of-range a signal is sent from the PP to the MMI software indicating whether the PP is in-lock or is out-of-lock with the FP. This is used to indicate the link status via pins LED_RED1 and LED_RED2 on the FP.

## 4.4 PREAMBLE ANTENNA DIVERSITY

To optimise the audio quality during rapidly changing radio paths (fading), the SC14WAMDECT SF supports preamble antenna diversity. The preamble diversity algorithm uses RSSI measurements to judge the radio signal strength on both antennas and determine the best performing antenna. This antenna will be used for the receive slot and for the next transmit slot.

The software embedded in the SC14WAMDECT SF supports antenna diversity for both FP and PP with at least one external antenna. Refer to section 5.6 and [1] for more detailed information.

## 4.5 REGISTRATION

The PP and the FP must be paired using a procedure called Registration. Without registration the PP will be out-of-lock and unable to establish a link to a FP. Therefore it will not be able to make a call.

The registration uses the unique product identities and secures the PP and FP to allow no cross-communication. To avoid cross-communication it is very important that all the PPs and the FP use a unique numbering scheme, which is standard in DECT based systems.

It is possible to pair a PP and FP during production using the production interface including wire registration. See [2].

### 4.5.1 Handling product identities

To ensure that the FP and PPs do not make cross-communications a unique ID must be entered into the VES of the FP and PP. For DECT products, the FP identifier is called the RFPI and the PP identifier is called the IPEI. These numbers are factory settings.

After a successful registration, the IPEI is stored in the FP and the RFPI is stored in the PP. In this way the two parts are known to each other and are allowed to make connections. See Figure 5.

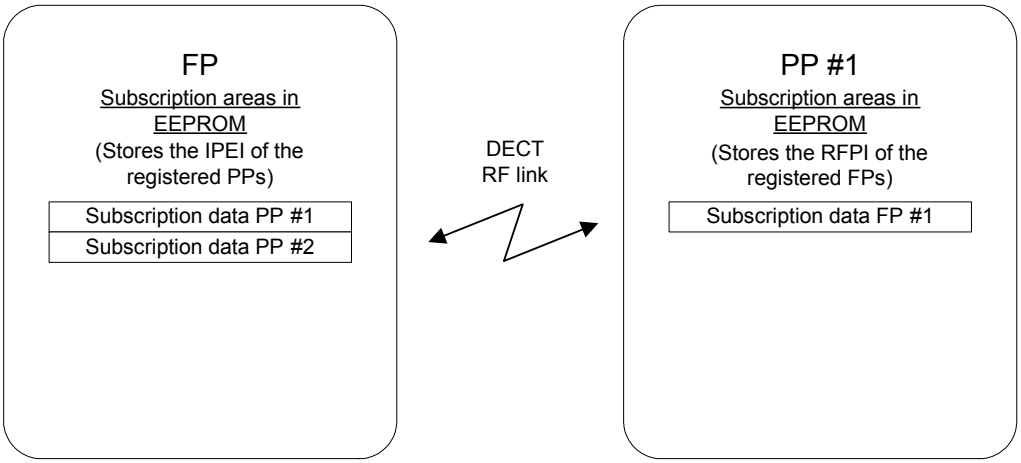


**Figure 5: Handling product identities**

### 4.5.2 Access code

In TG mode a 6-bit access code (0x00 to 0x3F) can be defined via pins ACCESS_0 to ACCESS_5. The bit pattern on the ACCESS_x pins of the FP must be set before registration and needs to remain stable during registration. For successful registration of a PP the access codes of PP and FP must be the same.

## 4.6 DEREGISTRATION

There are two ways of deregistering a PP from an FP:

- **PP registration:**
  After successful PP registration an existing FP pairing will be overwritten. This method can be used when the PP should be combined with another FP and the original registration should be removed.
- **FP deregistration:**
  During FP deregistration all existing PP pairings are removed. This method can be used when the original PPs were lost.

## 4.7 DATA TRANSFER

In Tour Guide mode an API function is available for broadcasting data from FP to PP via the UART at a rate of 1 kbit/s. The data is transmitted in packets of maximum 20 bytes. No data interpretation is done.

For more information on this API function, see [3] and [4]. A software example (“Sendmail”) of data transfer via UART is available on request.

## 5.0 Usage guidelines

This section outlines the usage guidelines for both applications: **Public Address mode** (PA system) and **Tour Guide mode** (broadcasting).

Initially the Public Address mode is described. Many of the user functions and behaviours in the Tour Guide mode are the same and therefore are not repeated in the Tour Guide section.

**Note:** The end product user must not be able to switch between the two modes. Only when designing and manufacturing the end product shall the operating mode be assigned.

## 5.1 PUBLIC ADDRESS MODE

In Public Address mode one or two battery operated wireless microphones (PP, transmitter) connect to a standalone loudspeaker (FP, receiver).

### 5.1.1 Microphone (PP)

The wireless microphone can be a standard handheld microphone or a belt pack with a lavalier microphone attached. The SC14WAMDECT SF module (transmitter, PP) can be integrated into the microphone.

The microphone or belt pack should have three LEDs (two red and one green), a Power On button and two optional pushbuttons for volume up and down.

### 5.1.2 Loudspeaker (FP)

The SC14WAMDECT SF module (receiver, FP) can be integrated directly into a loudspeaker or an amplifier. In the use case described below it is assumed that the module is built into a simple loudspeaker with integrated amplifier.

The loudspeaker can be mains or battery operated. The loudspeaker should have three status LEDs (two red and one green) and one pushbutton, which acts as both Power On and Registration button.

The Power On button will normally be connected to the power switch of the loudspeaker/amplifier. The Registration button is used for pairing of a wireless microphone with the loudspeaker.

### 5.1.3 LED indication

A green LED and two red LEDs indicate the status of the module. The indications apply for both FP and PP. Pins LED_RED1 and LED_RED2 indicate the status of microphones 1 and 2. See Table 6.

**Table 6: LED status indications**

| LED_GRN | LED_REDx | Description |
|---|---|---|
| OFF | OFF | module OFF |
| ON | OFF | module ON, no link |
| OFF | ON | module ON, link good |
| OFF | flash 0.5 s | mute (MIC or SPEAKER) |
| OFF | flash 1 s | registration ongoing |
| flash 0.25 s | OFF | battery LOW, link good |
| flash 0.5 s | OFF | battery LOW, no link |

### 5.1.4 Volume control

The microphone can have optional Volume Up and Volume Down keys. The volume control range is:

- Microphone volume: 0 dB to +30 dB, 2 dB/step, default value: +10 dB.
- Loudpeaker volume: fixed at 0 dB.

To mute the microphone press and release the Power On button (toggle).

To mute both microphones from the loudspeaker side (FP), press and hold the Volume Up key. The audio will be muted as long as this key is pressed.

### 5.1.5 Accessory input/output

The accessory input (pin ACC_IN) for the microphone (PP) and the accessory output (pin ACC_OUT) for the loudspeaker (FP) are supported as shown in Table 7.

**Table 7: Accessory I/O function table (PA mode)**

| ACC_IN (PP1) | ACC_IN (PP2) | ACC_OUT (FP) |
|---|---|---|
| L | L | H |
| L | H | L |
| H | L | L |
| H | H | L |

Pin ACC_OUT could be used to control an external audio amplifier to drive large loudspeakers.

## 5.2 TOUR GUIDE MODE

In Tour Guide mode a microphone (FP, transmitter) broadcasts to up to 128 headphones (PP, receiver). After pairing to the FP, all headphones will receive the same audio signal from the microphone.

### 5.2.1 Microphone (FP)

The microphone is the audio transmitter and should include two LEDs (red and green), a Power On button and two optional pushbuttons for volume up and down. The SC14WAMDECT SF module (transmitter, FP) can be integrated into the microphone.

### 5.2.2 Headphone (PP)

The SC14WAMDECT SF module (receiver, PP) is normally built into the headphone and directly connected to the loudspeaker.

### 5.2.3 LED indication

A green and a red LED (pin LED_RED1) indicate the status of the module. The indications apply for both FP and PP. Pin LED_RED2 is not used. See Table 6.

### 5.2.4 Volume control

The headphone can have optional Volume Up and Down pushbuttons. The volume control range is:

- Microphone volume: fixed at +10 dB.
- Loudspeaker volume: -12 dB to +2 dB, 2 dB/step, default value: +2 dB.

To mute the loudspeaker (receiver) press and release the Power On button (toggle). To mute the microphone (transmitter) press and hold the Volume Up key. The audio will be muted as long as this key is pressed.

### 5.2.5 Accessory input/output

The accessory input (pin ACC_IN) for the microphone (FP) and the accessory output (pin ACC_OUT) for the loudspeaker (PP) are supported as shown in Table 8.

**Table 8: Accessory I/O function table (TG mode)**

| ACC_IN (FP) | ACC_OUT (PP) |
|---|---|
| L | H |
| H | L |

### 5.2.6 API (Tour Guide mode only)

The SC14WAMDECT SF software has a simple API to control the module from an external host processor. The API supports the following basic functions for Tour Guide mode operation:

- Registration on/off
- Set/get access code
- Mute/unmute audio
- Get status (Registration mode/Audio/Mute/Low battery)
- Data transfer up to 1 kbit/s from FP to PP

## 5.3 REGISTRATION

The procedure for FP-to-PP pairing is the same for Public Address mode and Tour Guide mode:

1. Turn off PP and turn on FP.
2. Set 6-bit access code via pins ACCESS_0 to ACCESS_5. Do not change during registration.
3. FP: Press and hold PON button (pin 23) for 2 s, until the red LED1 starts flashing.
4. PP: Press and hold PON button (pin 29) for 2 s, until red LED1 starts flashing.
5. When flashing stops and the red LEDs are continuously on, registration has succeeded.

## 5.4 DEREGISTRATION

The procedure for FP-to-PP unpairing is the same for Public Address mode and Tour Guide mode:

1. Turn off FP.
2. FP: Press and hold PON button (pin 23) for 10 s.
3. The red LED1 will flash 3 times (0.5 s interval) and all registrations will be cleared.

## 5.5 BATTERY LOW DETECTION

The SC14WAMDECT SF includes a battery low detection circuit. A battery low condition is indicated by a flashing green LED.

- Battery low voltage: 2.3 V (default)

## 5.6 ANTENNA OPERATION

Figure 6 shows the internal circuit of the SC14WAMDECT SF.

Pin RF0 is used for two external antennas and can also be used for RF test purposes. Therefore it is recommended to add a reserve pattern for a 10 pF capacitor, even when the two external antennas are not used.

Re-certification of the SC14WAMDECT SF is required when at least one external antenna is added. On request, Dialog Semiconductor can provide a pre-certified PCB layout for an external antenna circuit.

Pin RF1 is recommended for connecting an RF cable to perform conducted tests for type approval.

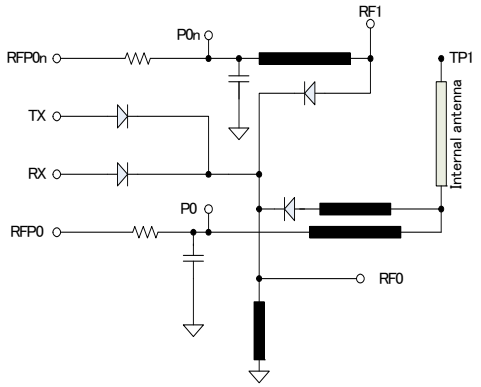


**Figure 6: Internal circuit of the SC14WAMDECT SF**

### 5.6.1 Internal antenna only

When only the internal antenna is used, the FAD function is disabled. In this case pins RFP0, RFP0n, P0 and P0n must be left unconnected.

### 5.6.2 Internal and external antenna with FAD

Figure 7 shows one external antenna connected to pin RF1 of the SC14WAMDECT SF. This configuration supports the FAD function. In this case pins RFP0, RFP0n, P0 and P0n must be left unconnected. See [1] for more detailed information.

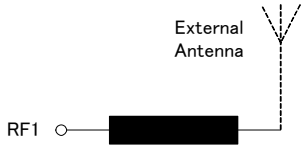


**Figure 7: One external antenna**

# 6.0 Specifications

All MIN/MAX specification limits are guaranteed by design, or production test, or statistical methods unless note 6 is added to the parameter description. Typical values are informative.

**Note 6:** This parameter will not be tested in production. The MIN/MAX values are guaranteed by design and verified by characterisation.

## 6.1 GENERAL

**Table 9: SC14WAMDECT SF module**

| ITEM | CONDITIONS | VALUE | UNIT |
|---|---|---|---|
| Dimensions | l x w x h | **18.0 x 19.6 x 2.7** | **mm** |
| Weight | | **1.5** | **g** |
| Temperature range | | **-40 to +85** | **°C** |
| Frequency range | According to DECT standard | **1870 to 1930** | **MHz** |
| Antenna range | According to DECT standard; **(Note 7)** | | |
| | - typical outdoor | **350** | **m** |
| | - typical indoor | **75** | **m** |
| Standards compliancy | ETS 300 444 (DECT GAP), former TBR2214<br>FCC part 15 | | |
| Power supply | 2 cells (NiMH / Alkaline) | **2.10 to 3.45** | **V** |
| Maximum PCB warpage | For entire reflow range | **0.1** | **mm** |

**Note 7:** The resulting range is very dependent on the mechanical design. Dialog Semiconductor is not responsible for this design and as such Dialog Semiconductor is not responsible for the resulting performance range of the final product.

## 6.2 ABSOLUTE MAXIMUM RATINGS

**Table 10: Absolute Maximum Ratings (Note 8)**

| PARAMETER | DESCRIPTION | CONDITIONS | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| Vbat_max | Max voltage on pin VBATIN | | | **3.45** | **V** |
| Vpon_max | Max voltage on pin PON | | | **5.5** | **V** |
| Vled_max | Max voltage on pin Grn LED, Red LED1 | | | **3.6** | **V** |
| Vdig_bp_max | Max voltage on digital pins with back drive protection; UART_RX | | | **3.6** | **V** |
| Vdig_max | Max voltage on other digital pins | | | **2.0** | **V** |
| Vana_max | Max voltage on analog pins | | | **2.2** | **V** |
| Vesd_hbm | ESD voltage according to human body model; all pins | | | **2000** | **V** |
| Vesd_mm | ESD voltage according to machine model; all pins | | | **150** | **V** |

**Note 8:** Absolute maximum ratings are those values that may be applied for maximum 50 h. Beyond these values, damage to the device may occur.

### 6.3 OPERATING CONDITIONS

**Table 11: Operating Conditions (Note 9)**

| PARAMETER | DESCRIPTION | CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Vbat | Supply voltage on pin VBATIN | | **2.1** | | **3.45** | **V** |
| Vpon | Voltage on pin PON | | | | **5.5** | **V** |
| Vdig_bp | Voltage on digital pins with back drive protection; UART_RX | | | | **3.45** | **V** |
| Vdig | Voltage on other digital pins | VDD = 1.8 V | | | **1.98** | **V** |
| Vana | Voltage on analog pins | VDD = 1.8 V | | | **2.1** | **V** |
| Icharge | Current through pin CHG_DET | Rseries > (Vcharge-3 V)/ 10 mA | | | **10** | **mA** |
| Iout_vrefp | Output current through pin VREFp | | | | **1** | **mA** |
| TA | Ambient temperature | **(Note 10)** | **-40** | | **+85** | **°C** |

**Note 9:** Within the specified limits, a life time of 10 years is guaranteed.
**Note 10:** Within this temperature range full operation is guaranteed.

### 6.4 SUPPLY CURRENTS

The supply currents in Table 12 and Table 13 have been measured using a DC voltmeter across a 0.22 Ω series resistor between the positive battery terminal and pin VBATIN.

**Table 12: Supply currents: Public Address mode**

| PARAMETER | DESCRIPTION | CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Ibat_PA_stby | Standby supply current (PA mode) | FP (RX); LPM; Vbat = 2.6 V | | **95** | | **mA** |
| | | FP (RX); HPM; Vbat = 2.6 V | | **114** | | **mA** |
| | | FP (RX); HPM/U; Vbat = 2.6 V | | **96** | | **mA** |
| | | PP (TX); Vbat = 2.6 V | | **45** | | **mA** |
| Ibat_PA_talk | Talk mode supply current (PA mode) | FP (RX); LPM; 1 PP (TX); Vbat = 2.6 V | | **132** | | **mA** |
| | | FP (RX); HPM; 1 PP (TX); Vbat = 2.6 V | | **151** | | **mA** |
| | | FP (RX); HPM/U; 1 PP (TX); Vbat = 2.6 V | | **134** | | **mA** |
| | | FP (RX); LPM; 2 PPs (TX); Vbat = 2.6 V | | **155** | | **mA** |
| | | FP (RX); HPM; 2 PPs (TX); Vbat = 2.6 V | | **191** | | **mA** |
| | | FP (RX); HPM/U; 2 PPs (TX); Vbat = 2.6 V | | **168** | | **mA** |
| | | PP (TX); LPM; Vbat = 2.6 V | | **120** | | **mA** |
| | | PP (TX); HPM; Vbat = 2.6 V | | **174** | | **mA** |
| | | PP (TX); HPM/U; Vbat = 2.6 V | | **143** | | **mA** |

**Table 13: Supply currents: Tour Guide mode**

| PARAMETER | DESCRIPTION | CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Ibat_TG_stby | Standby supply current (TG mode) | FP (TX); LPM; Vbat = 2.6 V | | **102** | | **mA** |
| | | FP (TX); HPM; Vbat = 2.6 V | | **125** | | **mA** |
| | | FP (TX); HPM/U; Vbat = 2.6 V | | **106** | | **mA** |
| | | PP (RX); Vbat = 2.6 V | | **45** | | **mA** |
| Ibat_TG_talk | Talk mode supply current (TG mode) | FP (TX); LPM; Vbat = 2.6 V | | **137** | | **mA** |
| | | FP (TX); HPM; Vbat = 2.6 V | | **200** | | **mA** |
| | | FP (TX); HPM/U; Vbat = 2.6 V | | **159** | | **mA** |
| | | PP (RX); LPM; Vbat = 2.6 V | | **85** | | **mA** |
| | | PP (RX); HPM; Vbat = 2.6 V | | **94** | | **mA** |
| | | PP (RX); HPM/U; Vbat = 2.6 V | | **90** | | **mA** |

## 6.5 DIGITAL INPUT/OUTPUT PINS

**Table 14: Digital input levels**

| PARAMETER | DESCRIPTION | CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Vil_dig | Logic 0 input level; all digital input pins except PON, CHG_DET and RSTn | VDD = 1.8 V | | | **0.3*VDD** | **V** |
| Vil_pon | Logic 0 input level; pin PON | | | | **0.9** | **V** |
| Vil_charge | Logic 0 input level; pin CHG_DET | | | | **0.9** | **V** |
| Vil_rst | Logic 0 input level; pin RSTn | VDD = 1.8 V | | | **0.2*VDD** | **V** |
| Vih_dig | Logic 1 input level; all digital input pins except PON, CHG_DET and RSTn | VDD = 1.8 V | **0.7*VDD** | | | **V** |
| Vih_pon | Logic 1 input level; pin PON | | **1.5** | | | **V** |
| Vih_charge | Logic 1 input level; pin CHG_DET | | **1.5** | | | **V** |
| Vih_rst | Logic 1 input level; pin RSTn | VDD = 1.8 V | **0.8*VDD** | | | **V** |

**Table 15: Digital output levels**

| PARAMETER | DESCRIPTION | CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Vol_dig | Logic 0 output level | VDD = 1.8 V; Iout = 2, 4, 8 mA **(Note 11)** | | | **0.2*VDD** | **V** |
| Voh_dig | Logic 1 output level | VDD = 1.8 V; Iout = 2, 4, 8 mA **(Note 11)** | **0.8*VDD** | | | **V** |

**Note 11:** For output drive capability, see section "Pin Description" on page 4.

### 6.6 ANALOG FRONT END

**Table 16: Microphone amplifier**

| PARAMETER | DESCRIPTION | CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Vmic_0dB_unt | Untrimmed differential RMS input voltage between MICp and MICn (0 dBm0 reference level) **(Note 6)** | 0 dBm0 on COUT **(Note 13)** MIC_GAIN[3:0] = 0, @ 1020 Hz; Tolerance: • 13% when untrimmed (BANDGAP_REG=8) **(Note 12)** • 6% when trimmed **(Note 14)** | **114** | **131** | **149** | **mV** |
| Rin_mic | Resistance of activated microphone amplifier inputs (MICp, MICn and MICh) to internal GND **(Note 6)** | | **75** | **150** | | **kΩ** |
| Vmic_offset | Input referred DC-offset **(Note 6)** | MIC_GAIN[3..0] = 1111 3 sigma deviation limits | **-2.6** | | **+2.6** | **mV** |

**Note 12:** BANDGAP_REG will be tuned at the factory.

**Note 13:** 0 dBm0 on COUT = -3.14 dB of max PCM value. COUT is CODEC output in test mode

**Note 14:** Trimming possibility is foreseen. At system production the bandgap reference voltage can be controlled within 2% accuracy and data can be stored in Flash. Either AVD or VREF can be trimmed within 2% accuracy. If AVD is trimmed VREF will be within 2% accuracy related to either AVD. Or vice versa VREF can be trimmed. For Vref trimming measure Δ (VREFp, VREFm) and update BANDGAP_REG[3:0].

**Table 17: Microphone amplifier (Operating Condition)**

| PARAMETER | DESCRIPTION | CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Vmic_cm_level | MICp and MICn common mode voltage | MICp and MICn are set to GND with internal resistors (Rin_mic). If DC coupled the input voltage must be equal to this voltage. | | **(0.9 V/ 1.5)* VREFp** | | **V** |

**Table 18: Microphone supply voltages**

| PARAMETER | DESCRIPTION | CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Vref_unt | VREFp-VREFm untrimmed **(Note 15)** | $I_{LOAD}$ = 0 mA BANDGAP_REG = 8 **(Note 14)** | **1.41** | **1.5** | **1.59** | **V** |
| Rout_vrefp | VREFp output resistance | Figure 8 | | **1** | | **Ω** |
| Nvrefp_idle | Peak noise on VREFp-VREFm **(Note 6)** | CCITT weighted | | | **-120** | **dBV** |
| PSRRvrefp | Power supply rejection Vref output **(Note 6)** | See Figure 8, AVD to VREFp/m, f = 100 Hz to 4 kHz BANDGAP_REG[5:4] = 3 | **40** | | | **dB** |

**Note 15:** Vrefm is a clean ground input and is the 0 V reference.

**Table 19: VREFp load circuit**

| PARAMETER | DESCRIPTION | CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Cload_vrefp | VREFp (parasitic) load capacitance | | | | **20** | **pF** |
| Iout_vrefp | VREFp output current | | | | **1** | **mA** |

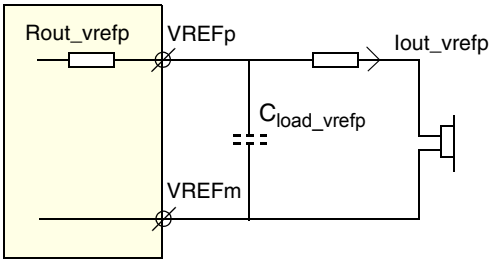


**Figure 8: VREFp load circuit**

**Table 20: LSRp/LSRn outputs**

| PARAMETER | DESCRIPTION | CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Vlsr_0dB_unt | Untrimmed differential RMS output voltage between LSRp and LSRn in audio mode (0 dBm0 reference level) | 0 dBm0 on CIN **(Note 16)**, LSRATT[2:0] = 001, @ 1020 Hz Load circuit A (see Figure 9, Table 21) with RL1= ∞ Ω, Cp1 or load circuit B (see Figure 10) with RL2, Cp2 and Cs2<br><br>Tolerance:<br>• 13% when untrimmed (BANDGAP_REG=8)<br>• 6% when trimmed **(Note 14)** | **621** | **714** | **807** | **mV** |
| Rout_lsr | Resistance of activated loudspeaker amplifier outputs LSRp and LSRn | | | **1** | | **Ω** |
| Vlsr_dc | DC offset between LSRp and LSRn **(Note 6)** | LSRATT[2:0] = 3<br>$R_{L1}$ = 28 Ω<br>3 sigma deviation limits | **-20** | | **20** | **mV** |

**Note 16:** 0 dBm0 on CIN = -3.14 dB of max PCM value.

**Table 21: LSRp/LSRn load circuits**

| PARAMETER | DESCRIPTION | CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Cp1_Rl1_inf | Load capacitance | see Figure 9, $R_{L1}$ = ∞ | | | **30** | **pF** |
| Cp1_Rl1_1k | Load capacitance | see Figure 9, $R_{L1}$ ≤ 1 kΩ | | | **100** | **pF** |
| Rl1 | Load resistance | | **28** | | | **Ω** |

**Table 21: LSRp/LSRn load circuits**

| PARAMETER | DESCRIPTION | CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Cp2 | Parallel load capacitance | see Figure 10 | | | **30** | **pF** |
| Cs2 | Serial load capacitance | | | | **30** | **µF** |
| Rl2 | Load resistance | | **600** | | | **Ω** |

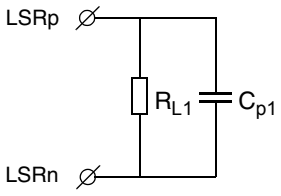


**Figure 9: Load circuit A: Dynamic loudspeaker**

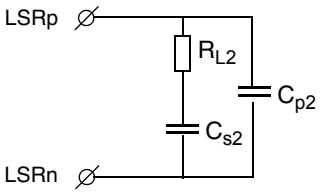


**Figure 10: Load circuit B: Piezo loudspeaker**

## 6.7 AUDIO PERFORMANCE

**Table 22: Frequency response**

| PARAMETER | DESCRIPTION | CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Fco_low | Lower cutoff frequency (-3 dB) | Input voltage = -20 dBV rms<br>Output voltage: -3 dBV rms | | **6** | | **Hz** |
| Fco_upr | Upper cutoff frequency (-3 dB | | | **11.3** | | **kHz** |

**Table 23: Distortion**

| PARAMETER | DESCRIPTION | CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| THD | Total Harmonic Distortion | PA mode; PP: Vin = -30 dBV; measured on FP<br>f = 200 Hz, volume step 1 | | **0.5** | | **%** |
| | | f = 200 Hz, volume step 9 | | **1.0** | | **%** |
| | | f = 2 kHz, volume step 1 | | **0.03** | | **%** |
| | | f = 2 kHz, volume step 9 | | **0.09** | | **%** |

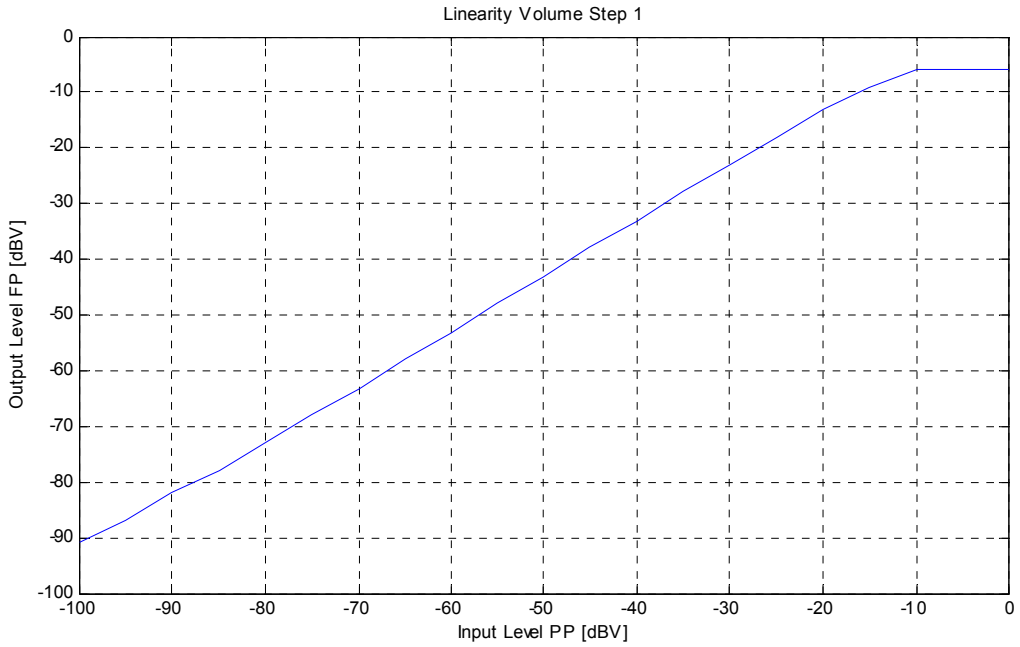


**Figure 11: Linearity for a 1 kHz tone at volume step 1**

### 6.8 BASEBAND PART

**Table 24: Baseband specifications: UART**

| PARAMETER | DESCRIPTION | CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| Fbit_uart | Serial interface bit rate | UART; Interface for external microprocessor or PC | | | **115.2** | **kbit/s** |
| Fbit_flash | Flash download bit rate | Via UART | | | **115.2** | **kbit/s** |

### 6.9 RADIO (RF) PART

Standards compliancy: ETS 301 406 (former TBR6).

**Table 25: Radio specifications**

| PARAMETER | DESCRIPTION | CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| P_Rx | Receiver sensitivity | BER = 0.001; TA = 25 °C | **-93** | **-92** | **-89** | **dBm** |
| P_Rx_T | Receiver sensitivity, full temperature range | BER = 0.001;<br>-40 °C ≤ TA ≤ +85 °C | | | **-87** | **dBm** |
| IPL | Intermodulation performance level (EN 301 406 section 4.5.7.6) | TA = 25 °C;<br>Pw = -80 dBm;<br>∆f = 2 channels | **-35** | | | **dBm** |
| NTP | Normal Transmitted Power (HPM: High Power Mode) | DECT | **21** | **23** | **24.5** | **dBm** |
| | | DECT6.0 and Japan DECT | | | **20** | **dBm** |
| | Low Power mode | | | **10** | | **dBm** |
| dPrfpa_T | RFPA power variation, full temperature range | -40 °C ≤ TA ≤ +85 °C | | **2.5** | **4** | **dB** |
| Fbit | Bit rate | GFSK modulation | | **1.152** | | **Mbit/s** |
| BW_Tx | Transmitter bandwidth | DECT GFSK;<br>NTP = 20 dB | | | **1.728** | **MHz** |

**Table 26: RFPA preferred settings for various power modes**

| Address (VES) | Register / Parameter | HPM/U (USA) | HPM (Europe) | HPM/J (Japan) (Note 17) |
|---|---|---|---|---|
| 0x39 | RF_PA_CTRL1_REG | 0x09A0 | 0x0CF0 | 0x2CE0 |
| 0x3B | RF_TEST_MODE2_REG | 0x0056 | 0x0062 | 0x0068 |
| 0x3D | RF_BBADC_CTRL_REG | 0x0380 | 0x03A0 | 0x0398 |
| 0x05 | RF_PLL_CTRL2_REG[MODINDEX] | 0x25 | 0x25 | 0x23 |
| 0x23 | Upper RSSI threshold | 0x2C | N/A | 0x28 |
| 0x24 | Lower RSSI threshold | 0x22 | N/A | 0x1E |

**Note 17:** This power setting is only applicable for Full slot.

### 6.10 RF POWER SUPPLY

**Table 27: Requirements for linear supply regulator**

| PARAMETER | DESCRIPTION | CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| VBAT IN | Voltage at VBAT SW | Unloaded $V_B$<br>Loaded $V_B$-$V_1$-$V_2$-$V_3$ | **2.1** | **3** | **3.45** | **V** |
| $V_1$ | Settling time | I = 50 mA | | | **20** | **mV** |
| $V_2$ | Receive period | I = 130 mA | | | **100** | **mV** |
| $V_2$ | Transmit period | I = 550 mA | | | **200** | **mV** |
| $V_3$ | Drop during transmit | | | | **25** | **mV** |

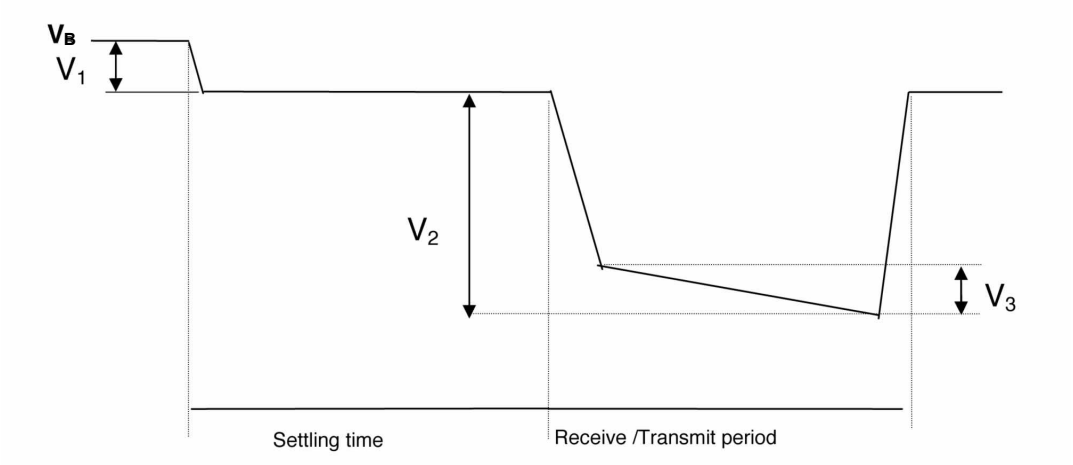


**Figure 12: RF power supply**

### 6.11 RF CHANNEL FREQUENCIES

**Table 28: RF frequencies and channel numbers**

| Frequency (MHz) | Channel number | | |
|---|---|---|---|
| | European DECT | Japan DECT | USA DECT 6.0 |
| 1787.616 | | | |
| 1789.344 | | | |
| 1791.072 | | | |
| 1881.792 | 9 | | |
| 1883.520 | 8 | | |
| 1885.248 | 7 | | |
| 1886.976 | 6 | | |
| 1888.704 | 5 | | |
| 1890.432 | 4 | | |
| 1892.160 | 3 | | |
| 1893.888 | 2 | | |
| 1895.616 | 1 | 4 | |
| 1897.344 | 0 | - | |
| 1899.072 | | - | |
| 1900.800 | | - | |
| 1902.528 | | 0 | |
| 1921.536 | | | 4 |
| 1923.264 | | | 3 |
| 1924.992 | | | 2 |
| 1926.720 | | | 1 |
| 1928.448 | | | 0 |

# 7.0 Design guidelines

## 7.1 PCB DESIGN GUIDELINES

- Because of the presence of the digital radio frequency bursts with 100 Hz time division periods (TDD noise), supply ripple and RF radiation, special attention is needed for the power supply and ground PCB layout.
- Power supply considerations
  Both high and low frequency bypassing of the supply line connections should be provided and placed as close as possible to the SC14WAMDECT SF. In order to get the best overall performance for both FP and PP applications, a number of considerations for the PCB has to be taken into account.
  - Make angle breaks on long supply lines to avoid resonances at DECT frequencies. Maximum 80 mm before an angle break is recommended.
  - Supply lines should be placed as far as possible away from sensitive audio circuits. If it is necessary to cross supply lines and audio lines, it should be done with right angles between supply and audio lines/circuits (microphone, ear-speaker, speakerphone, etc.)
  - Ground plane considerations
    In order to achieve the best audio performance and to avoid the influence of power supply noise, RF radiation, TDD noise and other noise sources, it is important that the audio circuits on both FP and PP applications boards are connected to the VREFm pin on the SC14WAMDECT SF with separate nets in the layout.
    It is advised to provide the following audio circuits with separate ground nets connected to the VREFm pin:
    - Microphone(s)
    - Headset microphone and speaker
    - Speakerphone (signal grounds)

Depending on the layout it may also be necessary to bypass a number of the audio signals listed above to avoid humming, noise from RF radiation and TDD noise. It is also important to choose a microphone of appropriate quality with a high RF immunity (with built-in capacitor).

- ESD performance
  Besides TDD noise, the ESD performance is important for the end application. In order to achieve a high ESD performance, supply lines should be placed with a large distance from charging terminals, display, headset connector and other electrical terminals with direct contact to the ESD source.
  On a two-layer PCB application it is important to keep a simulated one layer ground. With a stable ground the ESD and TDD noise performance will always improve.
- Clearance around test patterns
  Pins 81 to 88 are used for production test purposes.

In order to avoid any interference or disturbance the area around these signal pins must be kept clear of any signal and/or GND. The recommended clearance is at least 1 mm, as shown in Figure 13.

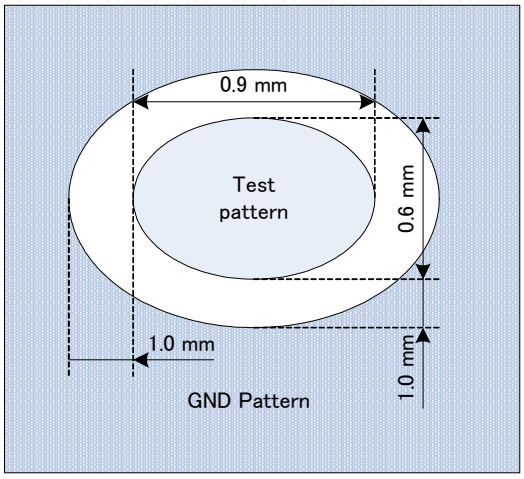


**Figure 13: Clearance around test patterns**

## 7.2 MODULE PLACEMENT ON THE MAIN BOARD

In order to ensure FCC compliance, proper coverage and to avoid detuning of the antennas, it is required to place the module on the main board free from other surrounding materials.

Keep a distance of at least 10 mm from the antenna elements to conducting objects and at least 5 mm to non-conducting objects.

Keep in mind that electrically shielding objects, even partly surrounding the antennas, will normally cause a significant degradation of the coverage.

Place the module at the edge of the main-board as shown in Figure 14.

When the module has to be placed away from the edge of the main board, avoid any conducting areas in front of the antennas and make a cut-out in the main board underneath the antennas as shown in the figure.

See Figure 18 and Figure 21 for the detailed package outline.