DECEMBER 4, 2012 V1.0

SC14WSMDATA
Ultra Low Energy Wireless Sensor Module V1.0

General description

The SC14WSMDATA is a Wireless Sensor Module with an integrated baseband, radio transceiver and power amplifier in a single package to be used for Ultra Low Energy (ULE) sensor applications in the DECT frequency band. It is intended for use with the SC14CVMDECT module serving as base station. Simple to use AT Commands to setup a wireless link between one or more sensors and the base station do not require in-depth understanding of the DECT protocol.

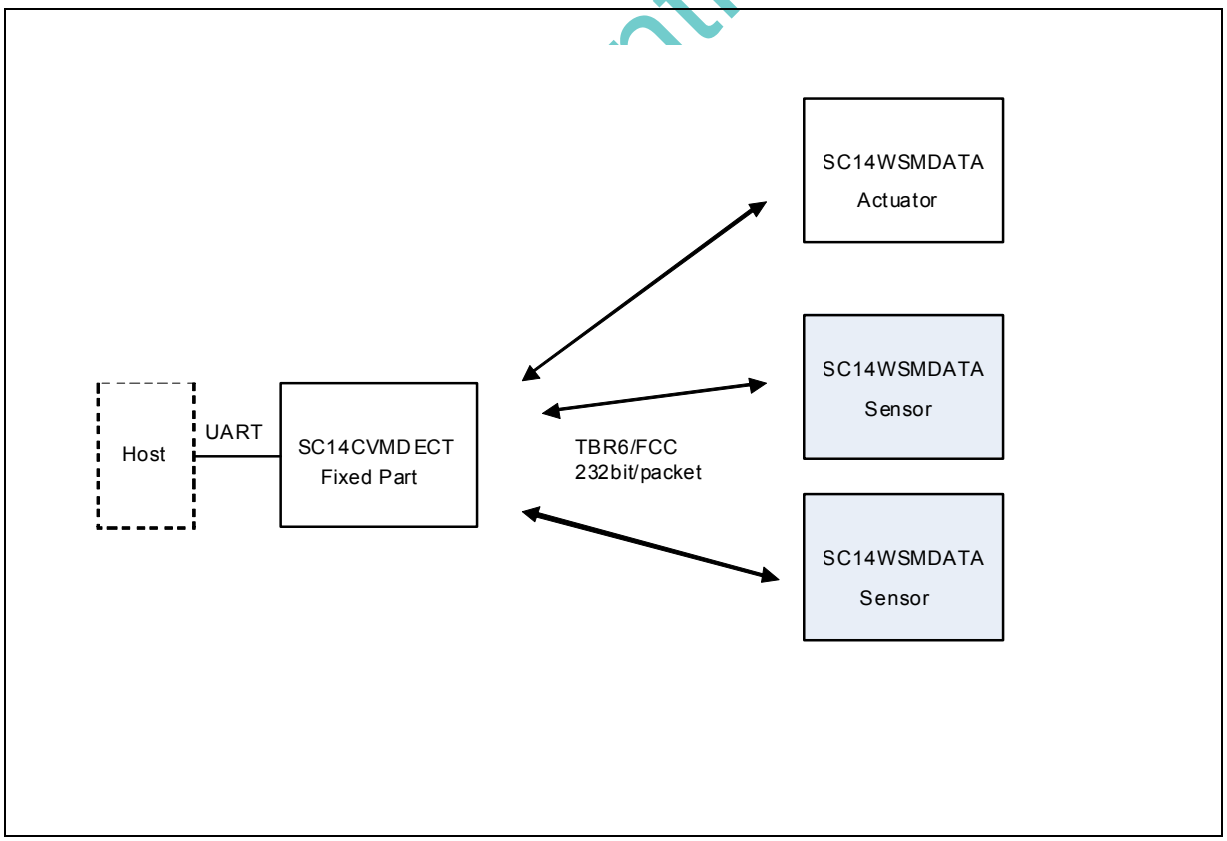
Features

- Programmable via AT command set
- Ultra Low Power, Sleep current < 3 uA
- EU/US/J-DECT* certified
- 232 bits / 29 Byte packet data
- RF range: 1870 - 1930 MHz
- Receiver sensitivity < -93 dBm
- Transmit power 23 dBm (200 mW)
- Power supply voltage 1.9 - 3.45 V
- Small form factor (25mm * 29mm)
- Program memory available for custom software

Applications

- Ultra Low Power Wireless Sensors Data applications
- Low standby current Wireless Actuator Data applications

System Diagram



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1.0 Connection Diagram

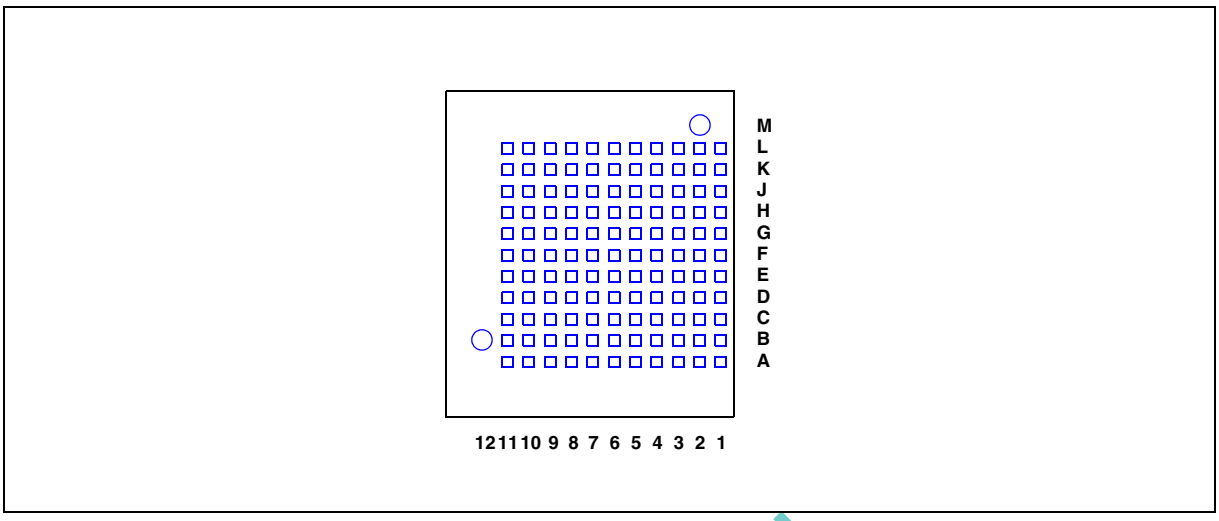

Figure 1 Connection Diagram (bottom view)

1.1 PIN DESCRIPTION

Table 1: Pin description

Pin	Module Pin name	In/ Out	Iout Drive (mA)	Reset State	Description
A1	GND				Ground
A2	GND				Ground
A3	GND				Ground
A4	NC				Leave unconnected
A5	VDDIO	I			Supply voltage for internal QSPI and data flash. **Must be connected to VDD (1.8V) at D10.**
A6	NC				Leave unconnected
A7	GND				Ground
A8	GND				Ground
A9	VBATuC	I			Microprocessor battery voltage. Equal to battery voltage when in active state. **Must be connected to VBATSW (3.3V) at C11.**
A10	NC				Leave unconnected
A11	RSTn	I		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 100nF is mounted on this pin on the module. **Recommended:** attach header or switch for external reset option
B1	GND				Ground
B2	GND				Ground
B3	CP_VOUT	O	40mA		Charge pump output A capacitor of 1uF to GND must be connected to this pin.
B4	NC				Leave unconnected
B5	GND				Ground
B6	NC				Leave unconnected

Table 1: Pin description (Continued)

Pin	Module Pin name	In/ Out	Iout Drive (mA)	Reset State	Description
B7	NC				Leave unconnected
B8	GND				Ground
B9	URX	I	8	I-PD (10k)	UART Serial In **Note:** used for debugging and SW download purposes only
B10	VBAT	I			Main supply voltage. **Must be connected to battery/supply terminal and ULE_VBAT (3.3V) at F6.** **Recommendation:** place header option to connect VBAT (B10) with VBATSW (A9) to bypass sleep mode for debugging purposes
B11	GND				Ground
B12	NC				Leave unconnected (RF test pad)
C1	GND				Ground
C2	P3[0]	O	500	O-0 (5k fixed pull-down)	High power GPIO driver
C3	GND				Ground
C4	XTAL output	O		I-PU	Buffered XTAL clock output Used to measure tuned XTAL frequency if needed in debugging. **Recommendation:** connect test point for probe
C5	NC				Leave unconnected
C6	NC				Leave unconnected
C7	GND				Ground
C8	UTX	O	8	I-PU	UART Serial Out **Note:** used for debugging and SW download purposes only
C9	GND				Ground
C10	JTAG	IO	8	I-PU	JTAG-SDI+; one wire Debug interface with open-drain. **Note:** used for debugging and SW download purposes only
C11	VBATSW	I			Switched battery voltage. Equal to battery voltage when in active state. **Must be connected to VBATuC (3.3V) at A9**. Optional connection to VDDPA at E1 (high output current ports supply).
D1	GND				Ground
D2	P3[1]	O	500	O-0 (5k fixed pull-down)	High power GPIO driver
D3	PON	I		I (270k fixed PD)	Power on, Switches on the device if Voltage > 1.5V (in active state). **Recommendation:** connect test point for debugging
D4	NC				Leave unconnected
D5	GND				Ground
D6	GND				Ground
D7	GND				Ground
D8	GND				Ground

Table 1: Pin description (Continued)

Pin	Module Pin name	In/ Out	Iout Drive (mA)	Reset State	Description
D9	NC				Leave unconnected
D10	VDD	O			Digital Core supply voltage (1.8V TYP). Output from internal regulator. **Must be connected to VDDIO (1.8V) at A5.**
D11	NC				Leave unconnected
E1	VDDPA	I			Supply for the high power GPIO driver
E2	GND				Ground
E3	NC				Leave unconnected
E4	NC				Leave unconnected
E5	GND				Ground
E6	GND				Ground
E7	GND				Ground
E8	GND				Ground
E9	GND				Ground
E10	NC				Leave unconnected
E11	GND				Ground
F1	NC				Leave unconnected
F2	ADC1	I		I-PU	ADC1 input
F3	GND				Ground
F4	NC				Leave unconnected
F5	ULE_PORT	IO		I	ULE wake up port (can also be configured as output).
F6	ULE_VBAT	I			Supply for ULE block. **Must be connected to VBATT (3.3V) at B10.**
F7	NC				Leave unconnected
F8	NC				Leave unconnected
F9	NC				Leave unconnected
F10	NC				Leave unconnected
F11	NC				Leave unconnected
G1	GND				Ground
G2	NC				Leave unconnected
G3	GND				Ground
G4	P3[3]/ADC0	IO	8	I	I/O Port ADC0; ADC input 0
G5	GND				Ground
G6	NC				Leave unconnected
G7	GND				Ground
G8	NC				Leave unconnected
G9	GND				Ground
G10	GND				Ground
G11	GND				Ground
H1	GND				Ground

Table 1: Pin description (Continued)

Pin	Module Pin name	In/ Out	Iout Drive (mA)	Reset State	Description
H2	NC				Leave unconnected
H3	P3[7]	IO	4	I	I/O Port
H4	NC				Leave unconnected
H5	GND				Ground
H6	GND				Ground
H7	NC				Leave unconnected
H8	NC				Leave unconnected
H9	GND				Ground
H10	GND				Ground
H11	GND				Ground
J1	GND				Ground
J2	NC				Leave unconnected
J3	GND				Ground
J4	P3[5]	IO	4	I	I/O Port
J5	GND	-			Ground
J6	NC				Leave unconnected
J7	GND				Ground
J8	LED4	IO	2.5/5	I	I/O Port LED4: 2.5/5mA LED current sink
J9	GND				Ground
J10	GND				Ground
J11	GND				Ground
K1	NC				Leave unconnected
K2	NC				Leave unconnected
K3	P3[2]	IO	8	I	I/O Port
K4	P3[6]	IO	4	I	I/O Port
K5	P3[4]	IO	8	I	I/O Port
K6	NC				Leave unconnected
K7	NC				Leave unconnected
K8	LED3	IO	2.5/5	I	I/O Port LED3: 2.5/5mA LED current sink
K9	GND				Ground
K10	NC				No ground under the pad (RF sensitive)
K11	NC				No ground under the pad (RF sensitive)
L1	GND				Ground
L2	NC				Leave unconnected
L3	GND				Ground
L4	GND				Ground
L5	NC				Leave unconnected
L6	GND				Ground

Table 1: Pin description (Continued)

Pin	Module Pin name	In/ Out	Iout Drive (mA)	Reset State	Description
L7	GND				Ground
L8	NC				Leave unconnected
L9	GND				Ground
L10	NC				No ground under the pad (RF sensitive)
L11	GND				Ground
M2	NC				No pad on PCB

- “NC” means: leave unconnected.
- GND means connect to Ground

Reset States:

- I = Input (floating)
- O= Output
- I-PD = Input, pulled down
- I-PU = Input, pulled up
- O-0 = Output, low
- O-1 = Output, high

2.0 Introduction

2.1 SCOPE

The SC14WSMDATA V1.0 is a DECT Data Pump for Ultra Low Energy data services. A star network topology can be made using the SC14CVMDECT module as a base station and the SC14WSMDATA module as Ultra Low Energy sensors or Low Standby Current actuators. As DECT is field proven to have whole-house coverage, this simple star network with sensors and actuators can be used for a variety of Home Automation applications.

2.2 ORDERING INFORMATION

SC14WSMDATA	**SC14WSMDATA AF01**
SC14CVMDECT	Please see [3]

2.3 REFERENCES

References made to the documents are shown as [x].

1. SC14WSMDATA AT Commands
2. SC14WSMDATA SW architecture
3. SC14CVMDECT Datasheet
4. SC14CVMDECT AT Commands
5. Athena IDE user manual

2.4 GLOSSARY AND DEFINITIONS

API	Application Programming Interface
AT command	Command format used to control functionality of the WSMDATA SW
CRC	Cyclic Redundancy Check
WSM	Wireless Sensor Module
WSMDATA	Wireless Sensor Module with DATA transfer capability
DECT	Digital Enhanced Cordless Telephone
EMC	Equipment Manufacturer's Code (please refer to ETSI EN 300 175-6)
ESD	Electro Static Discharge
FP	Fixed Part or Base station
HW	Hardware
IPEI	International Portable Equipment Identity (please refer to ETSI EN 300 175-6)
MCU	Micro Controller Unit
MMI	Man Machine Interface
PCB	Printed Circuit Board
RF	Radio Frequency
RSSI	Radio Signal Strength Indication (please refer to ETSI EN 300 175-1)
NVS	Non Volatile Storage
ULE	Ultra Low Energy
HAL	Hardware Abstraction Layer
IDE	Integrated Development Environment
OTP	One Time Programmable

3.0 Ultra Low Energy Wireless Sensor Module functionality

This section describes the key functions and features supported by the SC14WSMDATA (shown in Figure 2.)

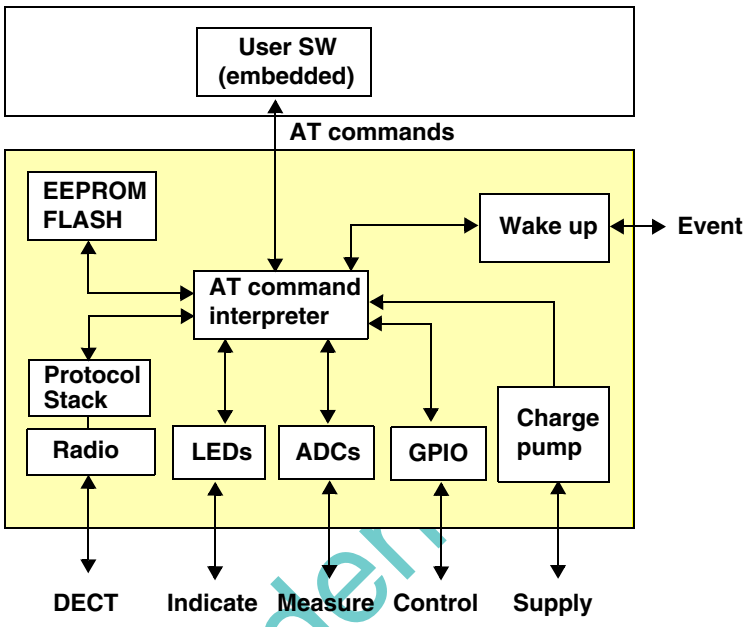

Figure 2 SC14WSMDATA functional overview

3.1 MODULE HARDWARE

The SC14WSMDATA internal hardware consist of:

- An Internal Microprocessor (MCU) running from FLASH handling the AT command interpreter, the protocol stack and further internal control.
- A 4kByte EEPROM used by the protocol stack and for user EEPROM variables.
- Voltage regulators and a charge pump to convert the external supply voltage to stable supply voltages for the core and I/O's.
- Two 2.5mA/5mA LED current sources.
- Two general purpose 10-bit ADC inputs (55us conversion time).
- General Purpose Input/Output (GPIO) ports which can be toggled high/low (output) or a high/low digital level can be read (input).

Note: Voltage regulators, charge pump, LED current sources, ADCs and GPIO ports are not active during sleep and can only be used when the device is active.

- Internal timer or dedicated digital wake up pin to trigger the system to go to active mode.
- A 10.368 MHz XTAL clock. This crystal is automatically tuned by the module software for the best Radio Performance.
- A DECT Radio transceiver with built-in antenna circuit.
- A programming interface to upload embedded SW.

3.2 SOFTWARE CONTROL

The SC14WSMDATA can be controlled via embedded software using an **AT Command Set based API**. In the module development kit Dialog provides Athena, which is an Eclipse based easy to use development environment to develop the embedded user SW. The basic functionality of the API can be grouped into three categories:

- Configuring stack and system
- Sending and receiving data
- Using Hardware Features through Hardware abstraction layer

A detailed description of the SW architecture can be found in document reference [2].

3.3 DECT PROTOCOL STACK

The SC14WSMDATA module is a fully approved module that complies with the following ETSI DECT

standards and certifications:

- EN 301 406 (DECT radio)
- EN 300 175-1 to 8 (DECT CI)
- EN 60950-1 (Safety)
- EN 301 489-1/301 489-6 (EMC)
- EN50385:2002 (Health)
- (Prepared to comply with FCC rules part15/subpart D, IC, and UL requirements)

This means that after integration on a main board no radio approval is required.

3.4 SC14WSMDATA HARDWARE CONFIGURATION

A Wireless Sensor configuration with SC14WSMDATA requires additional external parts as shown in Figure 3 and Figure 4.

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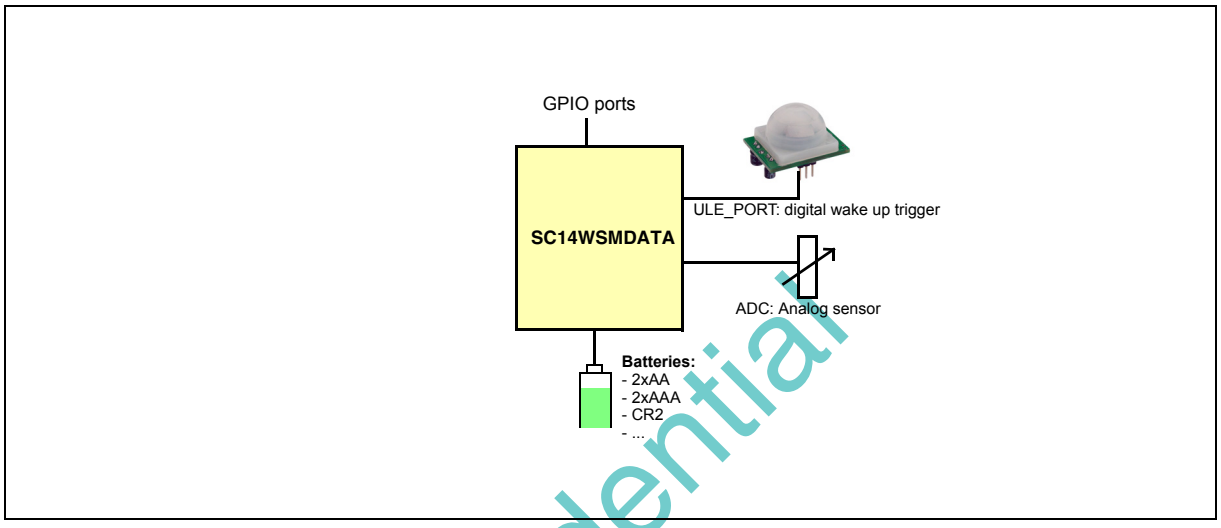

Figure 3 WSMDATA Sensor Configurations

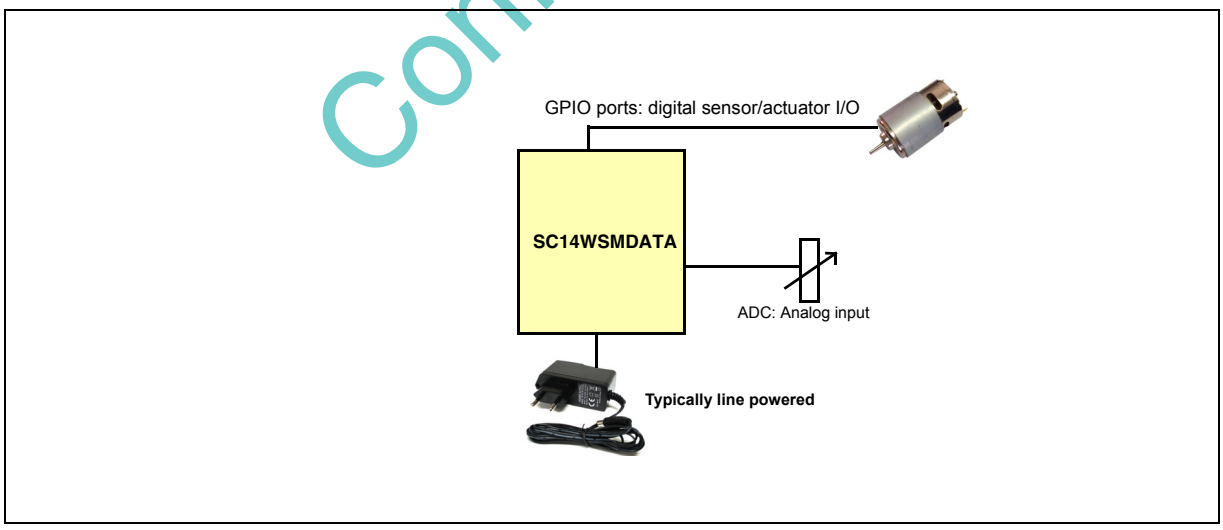

Figure 4 WSMDATA Actuator Configurations

Table 2 provides the overview of the supported Hardware interfaces for a SC14WSMDATA module.

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Table 2: WSMDATA module Hardware configuration overview

Item	Supported	Remark
Battery connection	Yes	No charging/state of charge is supported. Non rechargeable or rechargeable NiMH, NiCd Examples: 2x AAA, 2x AA, 1x CR2
Battery charger	No	Use external charger.
External supply	Yes	Use 3.3V external LDO or supply regulator
GPIO Ports	Yes	2x free high current drive (500mA max) output ports (3.3V and 1.8V) 6x free I/O ports (1.8V) **Note:** Active mode only, connected to ground during sleep.
Wake up port	Yes	Digital wake up port, configurable edge/level high/low triggered
ADCs	Yes	2x General Purpose 10bit / 55us conversion time ADC **Note:** Active mode only.
Charge Pump and supply options	Yes	1x Charge Pump output (2.5/3.0/4.0/4.5V) with 60mA max drive **Note:** Active mode only. 1x VBAT switched **Note:** Active mode only, connected to ground during sleep. 1x VDDOUT switched **Note:** Active mode only (1.8V), connected to ground during sleep.
LED	Yes	2x LED port (2.5/5mA current sink) **Note:** Active mode only, connected to ground during sleep.
UART	Yes	115.2kbaud, used for debugging and downloading SW

3.5 FUNCTIONAL OVERVIEW

The generic functional characteristics for the SC14WSMDATA modules are described in Table 3.

Table 3: SC14WSMDATA Functional characteristics

Functionality	Supported	Remark
Software		
AT Command interface	Yes	Commands for Configuration, Data transfer and HW I/O
Registration/deregistration	Yes	via AT command interface (See document reference [1] for more information on the API.)
Data packet size	Yes	232bit / 29 Byte (multiple packet transmission possible)
Wake up		
Wake up Event	Yes	Via dedicated ULE_PORT pin or ULE Timer event
Wake up Timer	Yes	32bit counter via Internal 42 kHz free running oscillator
Wake up Latency	Yes	Typical < 400 ms from event or timer to Send Packet
Non Volatile Storage access	Yes	4Mbits FLASH for System and User Code and data
I/O		
Hardware Abstraction Layer (HAL) Driver	Yes	I/O supported in HAL driver: • 6x free I/O ports / 2x free high drive output • 2x General Purpose ADC • 1x Charge Pump output (2.5/3.0/4.0/4.5V) • 2x LED port (2.5/5mA current sink)
RF antenna	Yes	integrated antenna
Power		
Power Cycle Charge	Yes	< 8 mC (see Figure 6)

4.0 Functional description

4.1 INTERFACE DESCRIPTION

The following sections describe the various interfacing options. See Figure 8 for a typical example how to connect these interfaces. All interfaces can be controlled through the Hardware Abstraction Layer (HAL) features of the AT command set (see [1]).

Note: all interfacing ports (except the ULE_PORT) are connected to GND during sleep due to the ESD protection circuits in the pad drivers. It is not allowed to have a high signal (1.8V/ 3.3V) connected to the pads during sleep as (large) leakage currents will flow.

The following practical recommendations are made for a design with the SC14WSMDATA module:

- High signals during sleep on the ports can be avoided by making the SC14WSMDATA module the power management master in the system. External components can be supplied by supplies that are only active during the module active mode. This means either the switched VBAT (VBATSW), the VDD output (1.8V output) or the Charge Pump output (CP_VOUT).
- If external components must be active/supplied during the sleep mode of the module it is recommended to place a buffer (such as a 74AHC1G04GW/T1) in between the external component and the GPIO port in question. The buffer VCC can be switched off during sleep (using the power outputs on the SC14WSMDATA module) which effectively disconnects the I/O line.

4.1.1 Power control

Figure 5 shows the power control of the SC14WSMDATA module. The ULE block and the RF Power Amplifier are fed directly from the battery and consume very little standby current during sleep. During sleep the switch connecting B10 (VBAT) and C11 (VBATSW) is open, meaning the power supply to the microprocessor and other blocks is disconnected. It is important that the RF Power Amplifier is fed directly from the battery as the peak currents during TX mode are relatively high (around 550mA) and voltage drops due to parasitic resistance should be avoided.

When going to active state the ULE block will switch on the power, meaning VBATSW (C11) will be connected to the battery. The fact that the connection to the battery is switched is why the pin C11 is called VBAT Switched or VBATSW. The radio is internally connected to VBATSW. The microprocessor gets its power from point A9 (connected to VBATSW/C11) and some power domains in the microprocessor are fed from an internal LDO (also connected to VBATSW) providing 1.8V. The QSPI FLASH on the module is connected to the internal LDO (1.8V) through D10 (1.8V out) and A5 (QSPI FLASH voltage in). Due to the fact that the high current drive ports P3[0]/C2 and P3[1]/D2 can carry a significant amount of current (500mA) the power supply of the high current drive ports is connected externally through E1 (connected to VBATSW).

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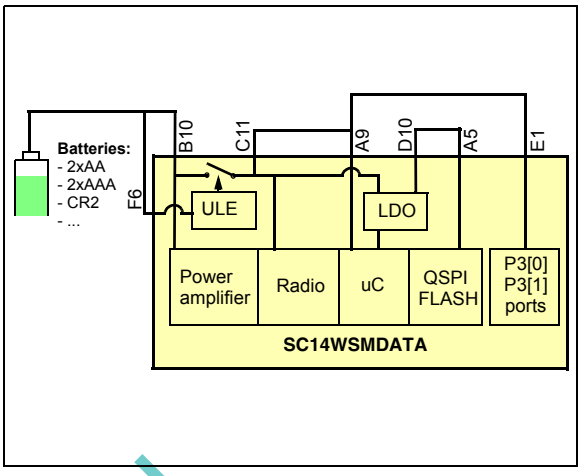

Figure 5 SC14WSMDATA Power control

4.1.2 GPIO

The SC14WSMDATA module has a total of 8 free to use GPIO ports. Two of these ports (P3[0] and P3[1]) **are output only** high output drive capability (500mA) and can support 1.8V and 3.3V interfacing. The interfacing level is determined by the high output drive port supply voltage on the VDDPA (E1) pin.

The other six (P3[2-7]) support normal output drive (4/ 8mA) and input with 1.8V interfacing. If high output drive is not necessary it is recommended to use the P3[2-7] ports to minimize power consumption.

4.1.3 LED

Two current controlled LED drivers are available to connect LED's without resistors.

4.1.4 ADC

Two 10-bit successive approximation Analog Digital Converters are available. Both converters have a selectable input range (0-0.9V or 0-1.8V) and 55 us conversion time.

4.1.5 ULE Port

The ULE Port can be configured as either an input or output. Configured as output, the ULE port is the only port on the WSMDATA module that will retain its active high state during sleep. If the ULE port is configured as an output, the system can only be woken up by the Wake up Timer. As an input, the ULE port can wake up the system based on an external trigger.

This port has a debounce filter and level change must remain at least for a 200 us period.

Through the HAL API the port trigger can be configured to be:

- Negative edge triggered
- Positive edge triggered
- Negative level triggered
- Positive level triggered

4.1.6 Battery connection

A sensor supports all batteries meeting the peak current requirements and operating voltage limits (example: 2 cells AAA, AA Alkaline, CR2). Recharging batteries is not supported by the Module and must be done using an external charger. The battery voltage level is used to determine the battery lifetime indication (sampled by internal ADC, available through the HAL API).

4.2 SOFTWARE IMAGE STRUCTURE

The SC14WSMDATA module contains a 4 Mbit Flash storing the protocol stack, non volatile (NV) system data and user developed application SW.

The NV data space implements EEPROM wear levelling optimising number of read/write cycles.

Table 4 shows the FLASH memory structure.

Table 4: Flash Memory structure

Section	Memory Type	Size
User Code	R/W FLASH	127 Kbyte.
User RAM	R/W RAM	4 Kbyte.
User NVS Data	R/W EEPROM	200 bytes maximum

The System Code is the DECT compliant code and can not be modified by the user.

The System NVS data contains device specific data and is set by production. It contains calibration parameters for adjustments used by the baseband or the radio interface and protocol software. When the FLASH is erased (and correspondingly the System NVS Data) the stack will set the System NVS data to default values and restore the production parameters from One Time Programmable (OTP) memory in the FLASH.

The User Code for a Sensor application SW can be developed with the Athena IDE (reference [5]) for the internal MCU. The User RAM is the available RAM space for the user application.

The User NVS Data parameters can be written and read through AT commands. These parameters are used to store user information and variables as the RAM state of the device is lost during sleep.

4.3 SOFTWARE INTERFACES

A simple to use AT command set is available to control the SC14WSMDATA via the embedded SW. A detailed functional and data flow description, including an example of the start-up sequence, can be found in document reference [1].

4.4 MODULE STATES

Figure 6 shows the SC14WSMDATA power states:

- Sleep.

  Note: In Sleep mode all internal registers and RAM content will be lost and relevant user data needs to be saved in NV system data space of the FLASH before going to sleep.

- Wake-up state.
  There are two ways to wake up from Sleep mode:
  - A Timer wake-up from the 32bit internal timer clocked with the internal clock (approx. 42kHz).
  - A signal event from the ULE_PORT which can be configured as Active Low/High or edge triggered event.
- Send Packet State.
  Once the Module is locked to the FP it can transmit its sensor data in this state.
- Keep Awake.
  In this state the module may do some custom processing or send more data to the FP. After the application is done, the sleep command is issued to put the system to sleep. It is recommended to minimize activity during the Keep Awake state as this will impact power consumption

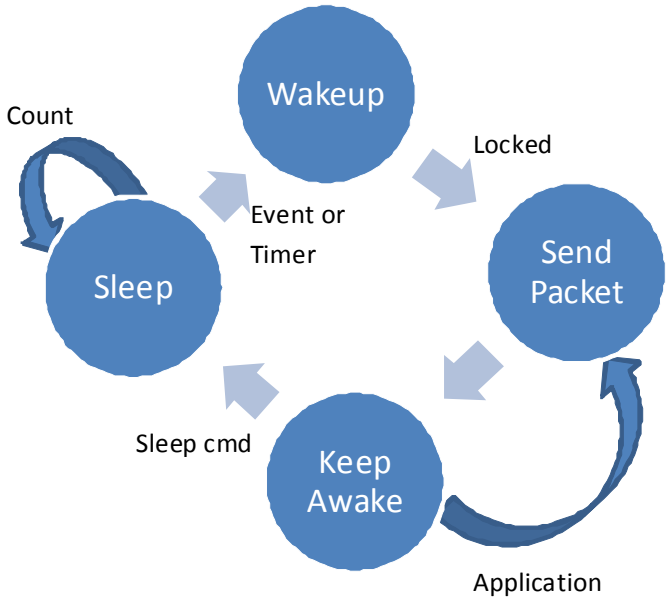

Figure 6 Power Cycle State machine

4.5 DATA TRANSMISSION PROTOCOL

The SC14WSMDATA data transmission protocol over the RF interface is DECT TDMA compliant. The protocol does **not** feature encryption so payload encryption must be handled by the user application if required.

4.5.1 Out-of-Range handling

When the Sensor goes out-of-range or can not find the FP upon wake up an error message is received from the stack after a time-out. This time-out can be configured from the user application.

4.5.2 Data packet

A 232 bits data packet can be transmitted or received at every burst. Multiple packets can be send, however this will of course impact power consumption. No specific formatting is applied. The correct transmission of a packet is acknowledged by the API.

4.5.3 Registration

The sensor and the base (FP) must be paired using a procedure called Registration. Without Registration, the sensor will not be able to establish a link to a FP. The registration uses the unique product identities and secures the Sensor and FP communication. These identity numbers are pre programmed in the NVS during module production.

Using unique access codes (like a PIN code) registration to the wrong FP can be prevented.

The sensor can be put into Registration mode in which it automatically de-registers from the current FP. This can be done from the user application. Using custom payload messages deregistration requests can thus be issued from the sensor itself, the FP or even another sensor.

It is possible to pair a sensor and FP at production time. Registration information is stored in the NVS during production.

4.5.4 Deregistration

There are two ways to deregister a Sensor from a FP:

- Remote FP and Sensor deregistration
  The preferred way to deregister a Sensor from a FP is to initiate deregistration in the FP and Sensor through the SW API. Using a user defined payload format the FP or PP should indicate the deregistration should take place, optionally an acknowledge can be sent and afterwards the FP and PP both initiate a deregistration. Using this method it is also possible to deregister other Sensors registered to the FP from one Sensor. See [1] and [4] in order to determine which AT commands are needed to send data (alerting the PP deregistration should take place) and how to deregister a node in the FP and PP.
- Local Sensor deregistration
  It is possible to initiate deregistration locally in the Sensor only. This could be an option if the Sensor should be used on another FP and the original registration should be removed.
- The SW API supports removing all registrations at once from the FP (e.g. in case the original Sensors are lost).

4.5.5 Handling product identities

To secure that the FP and sensors do not make cross-communications a unique ID is entered into the System NVS data space of an FP or sensor. In DECT the ID for the FP is named RFPI and for the Sensor the ID is named IPEI. These numbers are factory settings and are pre programmed in the One Time Programmable (OTP) section of the NVS.

After a successful registration, the IPEI is stored in the FP and the RFPI is stored in the sensor. In this way the two parts are known to each other and are allowed to make connections. The registration data are automatically stored in NVS data space of the FP and sensor while making the registration.

A sensor can only be used on one FP at the same time, in order to communicate with a different FP a registration cycle with that FP must first take place.

5.0 Specifications

5.1 ABSOLUTE MAXIMUM RATINGS

Table 5: Absolute Maximum Ratings (Note 1)

Description	Condition	Min	Max	Unit
Maximum supply voltages:				
VBAT, VBATT, VCCRF, VDDPA, ULE_VBAT			3.6	V
VDDIO			2	V
Maximum voltage on pins:				
PON			5.5	V
High output drive output Port pins P3[0-1]	These pins are output, output voltage is equal to VDDPA		3.6	V
LED4, LED3, URX, UTX, XTAL output, JTAG, ULE_PORT			3.6	V
All other pins (General purpose I/O Port pins P3[2-7] ADC0, ADC1, RSTn, ...)			2	V
ESD voltage				
all pins	human body model		2000	V
	machine model		100	V

Note 1: Absolute maximum ratings are those values that may be applied for maximum 50 hours. Beyond these values, damage to the device may occur.

Table 6: Operating Conditions

Description	Condition	Min	TYP	Max	Unit
Supply voltage:					
VBAT, VBATT, VCCRF, VDDPA		1.9		3.45	V
VDD	The module provides an output voltage in this range		1.8		V
VDDIO		1.65	1.8	1.98	V
Voltage on pins:					
PON pin				5.5	V
LED4, LED3, URX, UTX, XTAL output, JTAG, ULE_PORT				3.45	V
All other pins (GPIO Port pins P3[2-7], ADC0, ADC1, RSTn, ...)				2	V

5.2 DIGITAL INTERFACE SPECIFICATIONS

Table 7: DIGITAL INPUT LEVELS

Description	Condition	Min	Max	Units
Logic 0 input level				
all digital pads	VDDIO = I/O voltage		0.3 x VDDIO	V
PON			0.9	V
RSTn	VDD=1.8V		0.2 x VDD	V
Logic 1 input level				
all digital pads	VDDIO = I/O voltage	0.7 x VDDIO		V
PON		1.5		V
RSTn	VDD=1.8V	0.8xVDD		V

Table 8: Digital Output Levels

Descriptions	Conditions	Min	Max	Units
Logic 0 output level (For drive capability see pin description)	VDDIO = I/O voltage		0.2 x VDDIO	V
Logic 1 output level	VDDIO = I/O voltage	0.8 x VDDIO		V

Table 9: ULE_PORT specifications

Item	Specification	Min	Typ	Max	Unit
Logic 0 input level ULE_PORT	ULP_VBAT= 1.9-3.45V			0.2* ULE_VBAT	V
Logic 1 input level ULE_PORT	ULP_VBAT= 1.9-3.45V	0.8* ULE_VBAT			V
Logic 0 output level ULE_PORT	Iout = 1 mA, ULP_VBAT=2.4V			0.2* ULE_VBAT	V
Logic 1 output level ULE_PORT	Iout = 1 mA ULP_VBAT=2.4V	0.8* ULE_VBAT			V
Input current ULE_PORT **pull up** enabled.	Vin = VS		2.5		uA
Input current ULE_PORT **pull down** enabled	Vin = 1.9-3.45V		2.5		uA

5.3 GENERAL SPECIFICATIONS

Table 10: SC14WSMDATA module

Item	Condition	Value	Unit
Dimension	l x w x h	25.0 x 29.0 x 2.9	mm
Weight		4.5	g
Temperature Range	All specifications guaranteed	-20 to +60	°C
Operating Temperature Range	All features operational, analog specifications not guaranteed	TBD to TBD	°C
Frequency range	According to DECT standard	1870 to 1930	MHz
Antenna Range	According to DECT standard; (Note 2)		
	- typical outdoor	350	m
	- typical indoor	75	m
Standard Compliancy	EU/US/J-DECT (certification document numbers TBD)		
Power supply	Typical 2 cell Alkaline or external supply	1.9 to 3.45V	V
Maximum PCB warpage	For entire reflow range	0.1	mm

Note 2: The resulting range is very dependent of the mechanical design. SiTel is not responsible for this design and as such SiTel is not responsible for the resulting range performance of the final product.

5.4 BASEBAND SPECIFICATIONS

Table 11: Baseband specifications

Item	Specification	Min	Typ	Max	Unit
Serial Interface baud rate	UART; Interface for external microprocessor or PC			115.2	kBits
Flash Download baud rate	Via UART			115.2	kBits
Program Memory	Memory Flash			4	MBit
User Program Memory	Memory Flash available for user			127	kByte
User EEPROM	Module User EEPROM			200	Byte
Power consumption (charge)	Actuator Application (3.3V):				
	- stand by mode		5		mA
	Sensor Application (3.3V):				
	- sleep mode		3	5	uA
	- typical wake up cycle charge		8		mC

5.5 RADIO PART (RF) SPECIFICATIONS

Table 12: Radio part (RF)

Item	Conditions	Min	Typ	Max	Unit
Receive sensitivity	@ BER = 0.001	-93	-92	-89	dBm
Receive IIP3			-20		dBm
Transmit Power (NTP)	DECT: 200 mW	20	23	25.5	dBm
	J-DECT: TBD	TBD	TBD	TBD	dBm
	DECT6.0: 115 mW (max peak)	18.5	21	24	dBm
TDMA (time division multiple access)	6xRx + 6xTx time slots per carrier				
Data rate	Raw data rate		1.152		Mbits/s
Modulation depth	DECT GFSK bandwidth = 20 dB <		1,728		MHz
Single antenna operation	Antenna diversity only supported on SC14CVMDECT Fixed Part				
Standard Compliancy	ETS 301 406 (former TBR6)				

5.6 POWER SUPPLY SPECIFICATIONS

Table 13: Requirements for supply

Parameter	Description	Condition	Min	Typ	Max	Unit
VCCRF	Voltage at VCCRF	Unloaded V_B Loaded V_B-V_1-V_2-V_3	1.9	3V	3.45	V
V_1	Settling time	I = 50 mA			20	mV
V_2	Receive drop	I = 130 mA			100	mV
T_2	Receive period (1slot)			417		us
T_2	Receive period (during scan)	Can be several times 11ms worst case		11		ms
V_2	Transmit drop	I = 550 mA			200	mV
V_3	Drop during transmit				25	mV
T_2	Transmit period (1slot)	Repetition rate never more than 1 slot/10ms			417	us
	Additional ripple (DC/DC)		none	none	none	mV

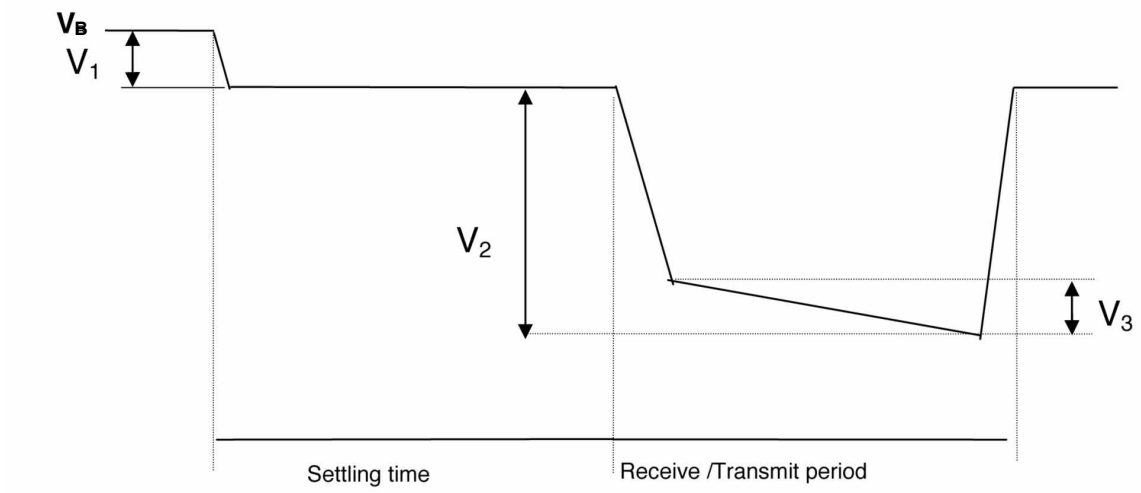

Figure 7 Power supply requirements

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6.0 Design guidelines

This section describes the software and hardware considerations taken into account when designing the target application.

For the design guidelines for the SC14CVMDECT base station, please see [3].

6.1 HARDWARE DESIGN GUIDELINES

Figure 8 shows a typical (simple) connection schematic for the SC14WSMDATA module.

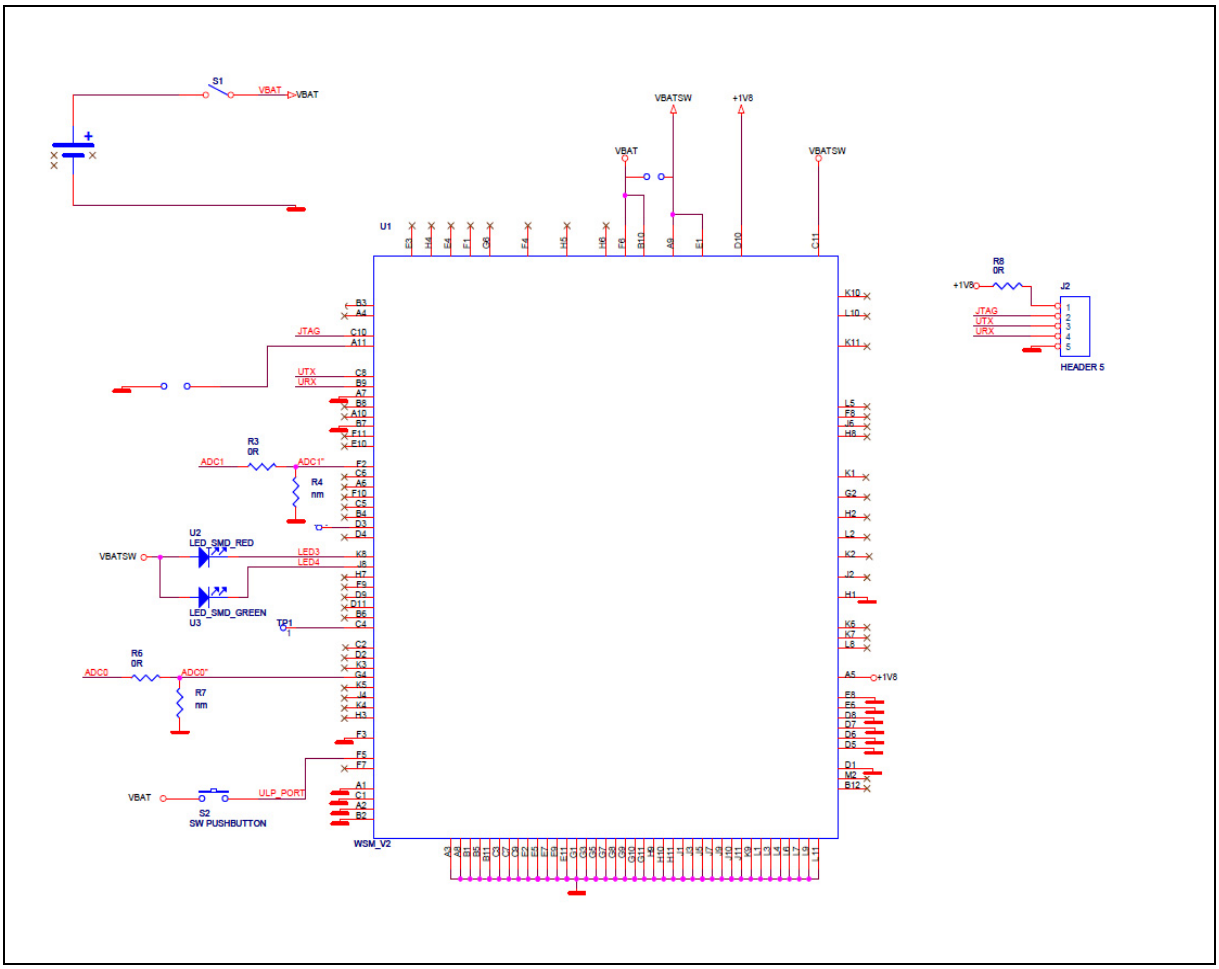


Figure 8 WSMDATA Typical connection schematic

6.1.1 Power connection

The following connections are mandatory:

- Battery/supply terminal connected to ULE_VBAT (F6) and VBAT (B10).
- Switched battery voltage VBATSW output (C11) connected to VBATuC (A9).
- VDD output (1.8V / D10) connected to VDDIO input (A5).
- GND connection to all Ground ports.
- High power drive GPIO supply VDDPA (E1) connected to **either** VBATSW (3.3V I/O, C11) **or** VDD output (1.8V I/O, D10).
- Minimum of 1uF capacitance connected to CP_VOUT1 (B3).

6.1.2 Programming interface

The most basic form of the programming and debug interface is to make the JTAG and UART programming interfaces available. Externally a USB to UART converter board can be attached to connect it to the PC. For the USB to UART reference design board see [6]. Dialog uses connector types:

- PCB board: (male) Molex 0022292051
- Programming cable: (female) Molex 0022012055

The following connections are mandatory:

- VDD output (1.8V) D10 to pin 1 on header. (This output is used to detect I/O voltage levels.)
- JTAG output C10 to pin 2 on header.
- UTX output from module C8 to pin 3 on header.

- URX input to module B9 to pin 4 on header.
- GND connection to pin 5 on header.

6.1.3 Test points and debugging features

Test points and debugging features can be used during debugging. The following connections are recommended:

- Header option between VBAT (F6/B10) and VBATSW (C11) to override sleep mode in Hardware.
- Header option, switch or digital input to apply external reset. HW reset can be issued by pulling RSTn (A11) to GND or low.
- Test point option to probe buffered XTAL clock output on C4.
- Test point option to point D3 (Power ON button for module) to have HW power-on override.

6.1.4 Interfacing

The following connections are recommended:

- Switch, digital output or trigger signal to ULE_PORT input (F5) to trigger wake up. The ULE_PORT can also be used as an output but then external events can not wake up the system (timer based only).

The following connections are optional:

- ADC connections (shown with resistive divider scaling option to ADC0 (G4) and ADC1 (F2)).
- LED indicators (shown to LED current sources at K8 and J8).
- GPIO connections to P3[2-7] or pins K3, G4, K5, J4, K4, H3 respectively.
- High output drive GPIO connection to P3[0-1] or pins C2, D2 respectively.

6.1.5 PCB Design Guidelines

- Because of the presence of the digital radio frequency burst 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 SC14WSMDATA. In order to get the best overall performance a number of considerations for the PCB has to be taken into account.
  - The width of VBAT and VDDPA supply line is recommended to be between 0.8 and 1.2 mm due to high current peaks during RF bursts.
  - Make angle breaks on long supply lines to avoid resonance frequencies in respect to DECT frequencies. Maximum 8 cm before an angle break is recommended.
  - Supply lines should be placed as far as possible away from sensitive circuits. If it is necessary to cross supply lines and sensitive lines, it should be done with right angles between supply and sensitive lines/circuits.
  - 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 sensitive circuits on applications boards are connected to a star GND connection (connected to the SC14WSMDATA GND pins) with separate nets in the layout.
- 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 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 ESD and TDD noise performance will always improve.

6.2 MODULE PLACEMENT ON THE MAIN BOARD

In order to ensure proper coverage and to avoid detuning of the antennas, it is very important to place the module free on the main board in relation to other surrounding materials.

As a "rule of thumb", keep a distance of at least 10 mm from the antenna elements to conducting objects and at least 5 mm to non-conducting objects - depending of the size. Keep in mind that electrical shielding objects, even partly surrounding the antennas, will normally cause a significant degradation of the coverage.

Place the module at the corner of the main-board as shown in Figure 9. If the module has to be placed away from the edge of the main-board, then avoid conducting areas in front of the antennas.

Note: There should be no PCB material under the antennas. If the module is not placed at the corner of the PCB a cut-out must be made in the main board underneath the antennas as shown in the figure.

Keep solid ground on layer 2 out to the edges of the main board as shown in the figure.

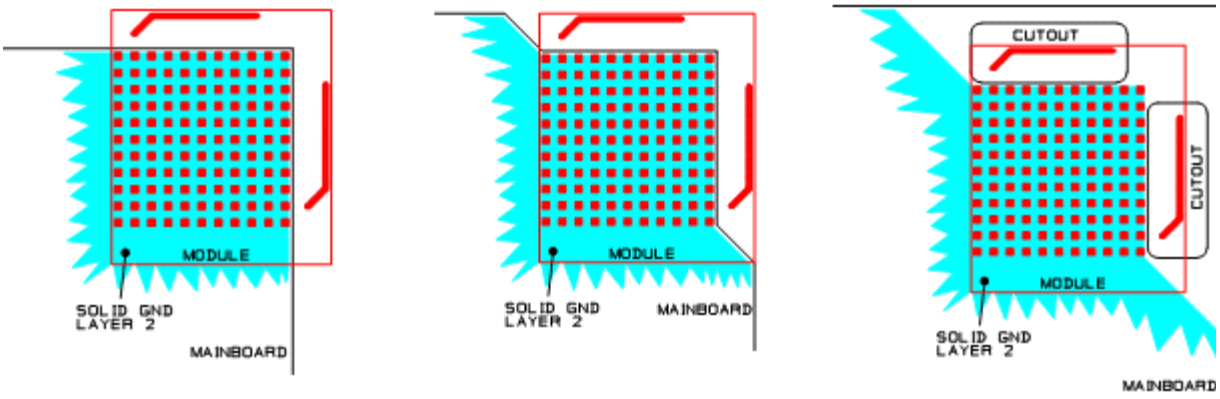


Figure 9 Module placement on the main board

6.3 APPLICATION SOFTWARE (WSMDATA)

For detailed information on the AT command set interface and the Application Software see [1] and [2]. The user can create unique sensor/actuator Application Software, the following tasks are common to all WSMDATA programs:

- Configuration of the WSMDATA module (default configuration can also be used).
  - Setting system sleep time and wake up configuration.
  - Interface configuration.
  - Time-out configurations of certain processes (searching for the Fixed Part, ...)
- Basic MMI functionality.
  - LED indicators.
  - Enabling/disabling registration mode.
- Sending and receiving data.
  - Data receive handler and payload parsing.
  - Payload construction and sending data.

6.4 APPLICATION SOFTWARE FOR FP

For base station Application Software please see the guidelines in [3]. Fixed Part SW applications are expected to run on a host processor connected to a SC14CVMDECT module. The following functionality is an example of the minimal feature set to be implemented in the user SW:

- FP MMI
  - Enabling/disabling registration mode.
  - User MMI or machine to machine SW to operate/ control sensors and actuators.
- Sensor/actuator resource manager.
  - Keeps track of sensor status. For instance if a certain sensor is registered, if it is off/online (by checking the last communication timestamp versus the maximum expected sleep time) and so on.
- Buffer management. As sensors sleep for long periods the SC14CVMDECT module has dedicated packet buffers. The user application can send packets to these buffers, but must also handle buffer overflow messages and/or must delete messages from the buffer if needed.

7.0 Notices to OEM

7.1 FCC REQUIREMENTS REGARDING THE END PRODUCT AND THE END USER.

Product marking

The end product containing the module must be marked as follows:

"Contains Transmitter Module FCC ID: Y82-SC14A / IC: 9576A-SC14A"

FCC compliance statement

The manual provided to the end user must include the following statements:

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: 9576A-SC14A

Son fonctionnement est soumis aux deux conditions Suivantes:
1. cet appareil ne doit pas causer D'interférences nuisibles et
2. cet appareil doit accepter Toute interference recue, y compris les interferences qui peuvent pertuber le fontionnement.

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.*

7.2 END APPLICATION APPROVAL

The module is intended to be used in an end application. When the requirements in 15.2 are fulfilled, no further test concerning the module is needed. Type approval concerning the end product, except for the module, is the responsibility of the end product manufacturer.

7.3 SAFETY REQUIREMENTS

This section provides of an overview of the safety requirements you must adhere to when working with SC14WSMDATA.

- The specific external power supply for SC14WSMDATA has to fulfill 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 (i.e. does not leave the building).
- 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.

7.4 UTAM MEMBERSHIP WAIVER

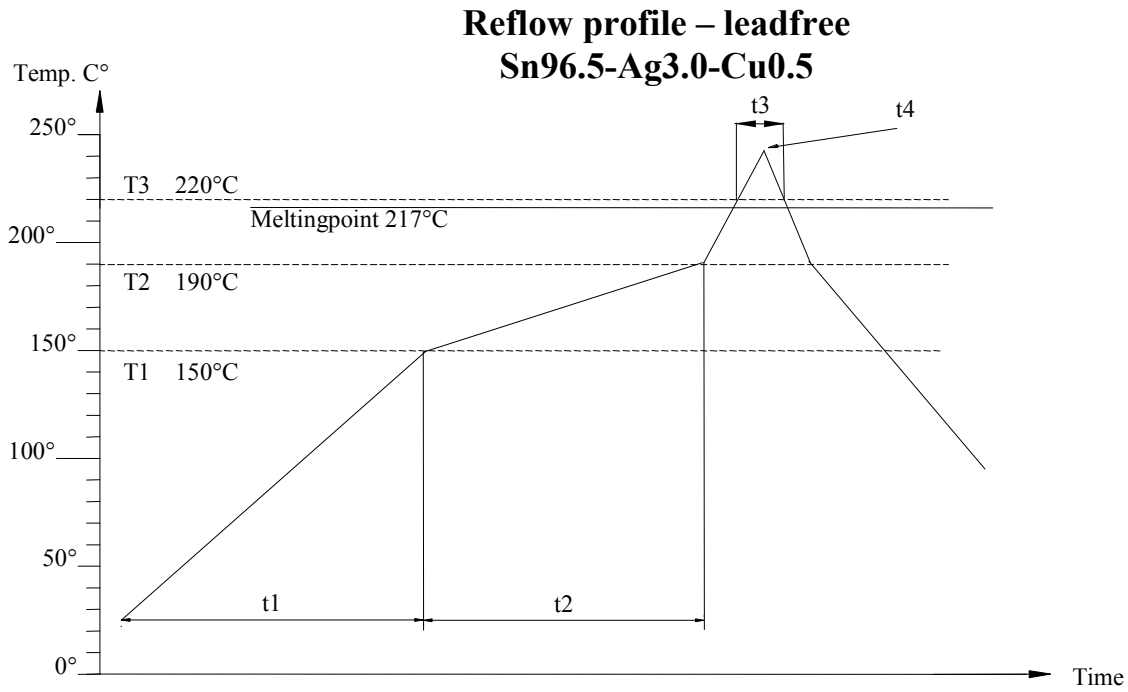
Payment of the Up Front Membership Fee and Per Radiating Device Fees is not required from a manufacturer or distributor that uses an FCC-certified module for which such fees have been paid. Such an “FCC certified module” is defined as a device that contains the complete UPCS-compliant radio modem functionality from a supplier that has a valid UTAM Affidavit. The hardware and firmware implementation of the FCC certified module must not be modified by the manufacturer or distributor in a way that would invalidate its original FCC certification unless the manufacturer of the device that will contain the module secures its own FCC approval. Any applicant for FCC approval seeking to use an FCC certified module must give the FCC ID number of the certified module that it will employ and attest that it is using a module for which UTAM fees have been paid.

Refer to www.utam.org for more information

8.0 Package information

8.1 SOLDERING PROFILE

The SC14WSMDATA should be soldered using a standard reflow soldering profile and lead free solder paste as shown below. Adjustments to the profile may be necessary depending on process requirements.



t1: Max. Change in temperature	3°C/sec.
t2: Time in preheat (150°C < temp. < 190°C)	60 - 120 sec.
t3: Time in reflow zone (temp. > 220°C)	30 - 60 sec.
t4: Peak temperature	237°C±5°C
T1 Preheat zone bottom	150°C
T2 Preheat zone top	190°C
T3 Reflow zone	220°C

Figure 10 Reflow profile

8.2 COPPER PAD AND SOLDER OPENING

Recommended Copper Pad and Solder Mask Opening (NSMD).

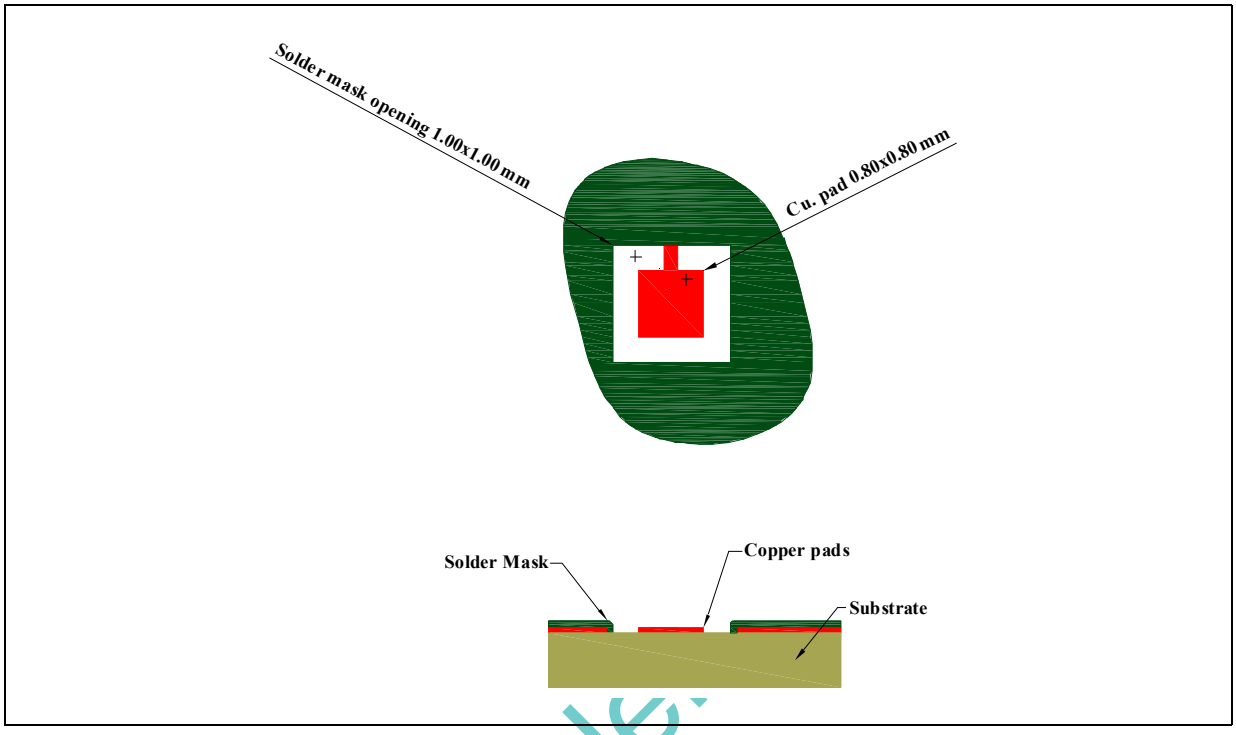


Figure 11 Copper pad and Solder mask opening

8.3 STENCIL

For the stencil a thickness of 0.122 mm is recommended. Recommended opening is as shown below.

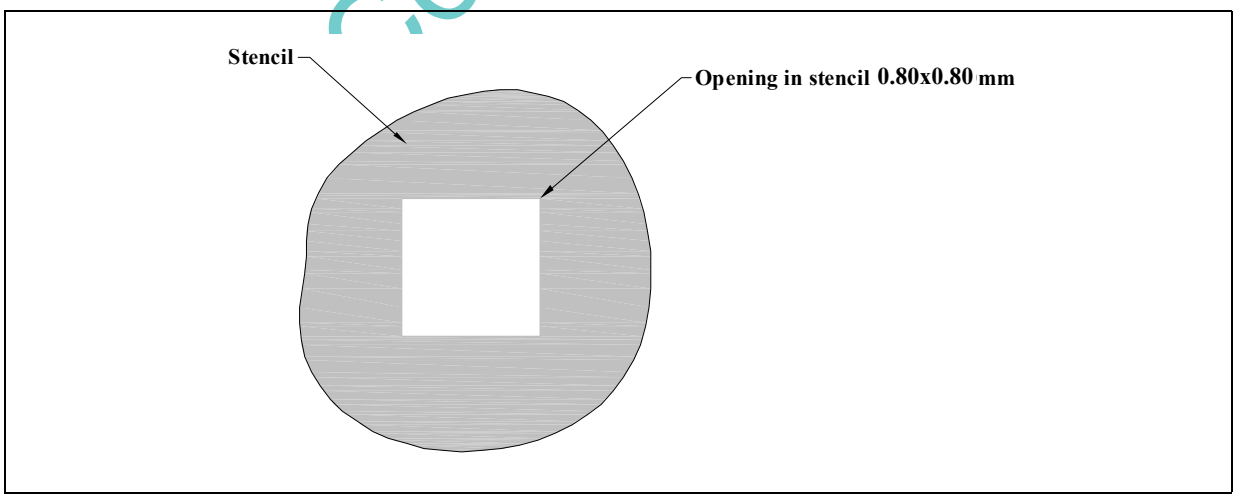


Figure 12 Stencil

8.4 MECHANICAL DIMENSIONS

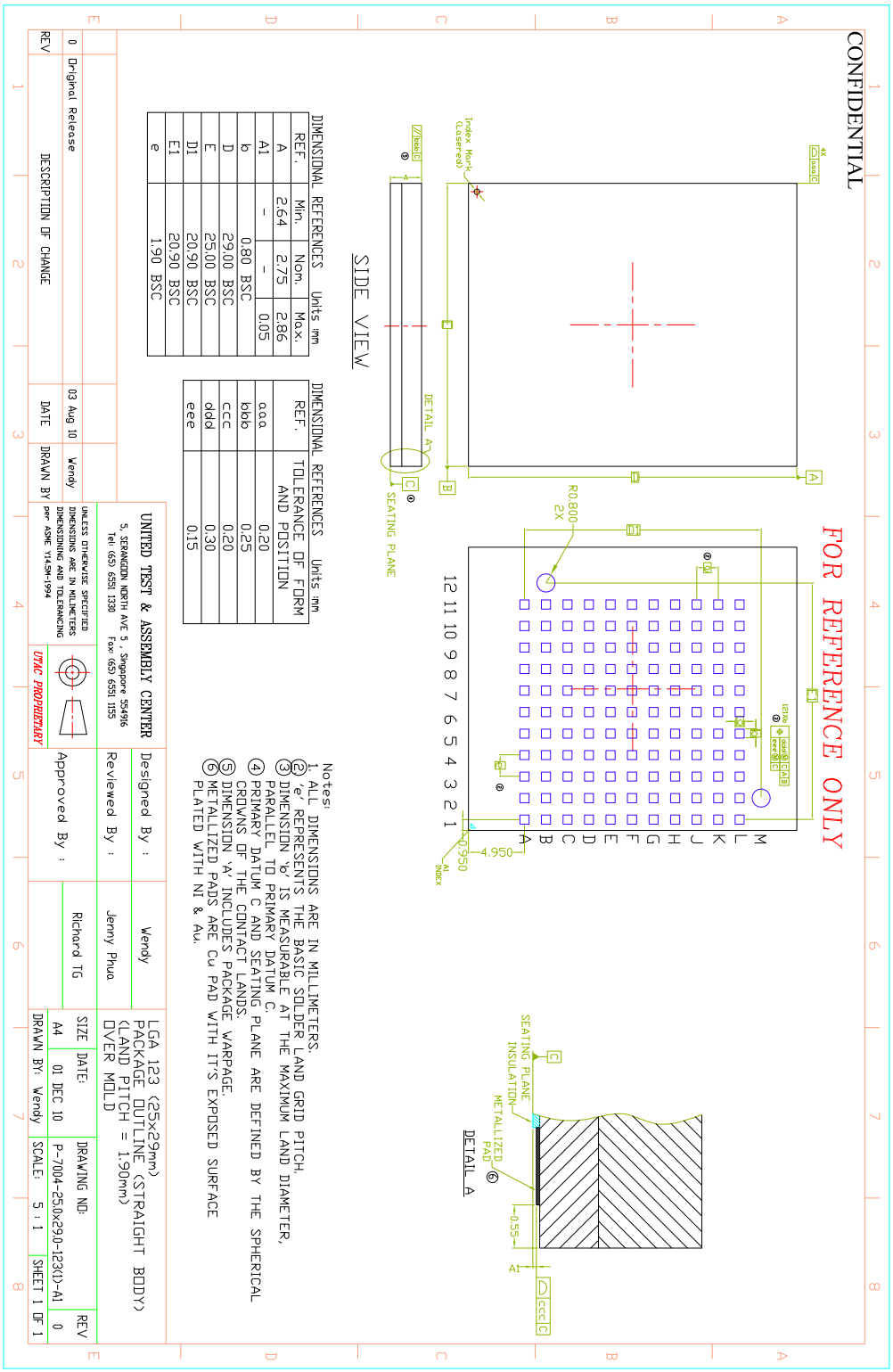


Figure 13 Package Outline Drawing

Product Status Definitions

Datasheet Status	Product Status	Definition
Advance Information	Formative or in Design	This data sheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This data sheet contains preliminary data. Supplementary data will be published at a later date. Dialog Semiconductor reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
No Identification Noted	Full production	This data sheet contains final specifications. Dialog Semiconductor reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
Obsolete	Not in Production	This data sheet contains specifications on a product that has been discontinued by Dialog Semiconductor. The data-sheet is printed for reference information only.

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