FM DECT System USA

User Manual

IMPRINT

Table of Contents

List of Figures

1 Introduction

The **FM DECT System USA** is an accessory of the Siemens VDO fleet management system and therefore only used for commercial purposes. It is marketed by qualified distibutors (see www.vdofm.com). It allows vehicle data to be downloaded automatically when the vehicle, provided with a FM DECT Vehicle Unit, drives past a FM DECT Base Station, normally situated at the yard. These downloads are scheduled and initiated by a DECT Downloader software and are intended for vehicles that return regularly to home base.

This document describes the features of the **FM DECT System USA** and the hardware interface of the DECT Engine MD32.2/MD34.2 to the host and to the air, and all the technical details required for understanding its functions. It is also the data sheet for the electrical and mechanical host application design.
In the following text the use of MD32 is equivalent to MD32.2/34.2.

1.1 FCC and other Information

On the FM DECT Base Station and FM DECT Vehicle Unit is a label that contains, among other information, the FCC Registration Number. The verification report is available upon request.
The FM DECT Base Station and FM DECT Vehicle Unit has been tested and found to comply with the limits for Class A digital device, pursuant to Part 15 of the FCC Rules. Operation is subject to the following two conditions:

(1) The devices may not cause harmful interference
(2) The devices must accept any interference received, including interference that may cause undesired operation.

These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy, and if it is not installed and used in accordance with the instruction manual, it may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at his own expense

1.2 FCC Health and Safety Information

Your FM DECT System USA is a radio transmitter and receiver. It is designed and manufactured not to exceed the emission limits for exposure to radio frequency (RF) energy set by the Federal Communications Commission of the U.S. Government. The FCC has established criteria for the amount of radio frequency energy various products may produce depending on their intended usage.
The FM DECT Vehicle Unit USA has been tested and found to comply with the FCC's exposure criteria. With use of other accessories may not ensure compliance with FCC RF exposure guidelines and should be avoided.
To maintain compliance with the FCC's RF exposure guidelines, the internal antennas used for the FM DECT Base Station USA must provide a separation distance of at least 20 cm from all persons. Base Station and Vehicle Unit must not be co-located or operating in conjunction with any other antenna or transmitter.

Caution: Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this device.

1.3 History

Issue	Changes
1999-09-03	First issue
1999-11-04	New mechanical drawing (Fig. 2-5), “Standards” added (1.5), ESD protection requirements added (2)
1999-12-08	Linguistic changes after proof-reading, new Power Supply parameters (7.3), correction in audio gain settings
2000-01-28	Comment to mounting holes added (6), cross-reference to Note 7-3
2000-04-13	Audio Interface description removed, preliminary state finished
2003-11-14	Changes for the new (redesigned) MD32 inserted - Max. data rate change 19.2 to 115.2 - Type approval date change to Nov. 2003 (1.5)
2005-09-29	Changes for the USA Version
2005-12-05	Additional editorial changes in Chap. 1.1, 2.1 and 5.3

1.4 References

/1/ Chapter 3 Programmers Reference Manual
/2/ Application Note 7-3 Power save modes

1.5 Standards

This product is approved as complying with the following directives and standards, valid at Nov. 2003.

(1) CTR6
(2) EMC Directive 89/336/EEC
(3) ETS 300329
(4) EN 50081-1
(5) EN 50082-1
(6) ETS 300175
(7) ETS 300176-1

1.6 Terms and abbreviations

ADC	Analogue→Digital Converter
ADPCM	Adaptive Differential Pulse Code Modulation
ARQ	Automatic Request
BER	Bit Error Rate
BT	Bandwidth-Time product
CODEC	Coder-Decoder
CRC	Cyclic Redundancy Check
DCE	Data Circuit-terminating Equipment
DECT	Digital Enhanced Cordless Telecommunications
DTMF	Dual Tone Multiple Frequency
ETS	European Telecommunication Standard
FDM	Frequency Division Multiplex
FET	Field Effect Transistor
FCC	Federal Communications Commission
FFC	Flexible Flat Cable
FP	Fixed Part
GaAs	Gallium Arsenide
GFSK	Gaussian Frequency Shift Keying
HW	Hardware
LU10	DECT Data Transmission Protocol
PA	Power Amplifier
PCB	Printed Circuit Board
PCM	Pulse Code Modulation
PLL	Phase Locked Loop
PP	Portable Part
RF	Radio frequency
RSSI	Radio Signal Strength Indicator
Rx	Receive direction
S&H	Sample and Hold
SAW	Surface Acoustical Wave Filter
SW	Software
TDD	Time Division Duplex
TDMA	Time Division Multiple Access
Tx	Transmit direction
UART	Universal Asynchronous Receiver and Transmitter
VCO	Voltage Controlled Oscillator

2 Overview

The **FM DECT System USA** solution is used for the remote download of data from the on-board computers. The system consists of the **FM DECT Base Station** that is installed in the vehicle yard, and **FM DECT Vehicle Unit** that are installed in every vehicle. The download occurs automatically when the vehicle is in open range of approximately 300 meters from a DECT Base Station.

2.1 DECT Engine MD32 inside FM DECT Base Station and Vehicle Unit

The Siemens DECT Engine MD32 is a module which offers an easy means of providing a radio connection for data transmission. The module is integrated into a host system, and the host application accesses it via a serial line (RS232 interface).
The Siemens DECT Engine MD32 incorporates the complete RF part and runs the DECT protocol autonomously.
The module is connected to the host application via one 20 pin flexible flat cable (FFC jumper). It is the host interface for data, audio and power supply lines.

2.2 FM DECT Base Station

The DECT Base Station has to be connected via RS485 to RS232 converter to a server computer. The housing is water-proof and is designed to be mounted in the vehicle yard where it can cover a larger range. Typical line of sight range of the DECT short-range data extraction units is 300m. Any obstacles in the line of sight will reduce the reliable RF connection range of the DECT.

Features

- Data Transmission via DECT Standard up to 115.2Kbd (Full Duplex)
- Radio Coverage indoor up to 50m, outdoor up to 300m
- RS485 Interface
- Closed Housing (dust and splash proof) with integrated Antennas
- Input Voltage Range (8-25V)
- Simple Mounting
- Dimension: 168 x 80 x 55 (L x B x T in mm)
- Weight approx.: 297g
- Temperature Range –20...+70°C (tested operation), -45°C...+90°C (storage)
- Humidity up to 95% not condensed
- max. Cable Length RS485 1200m (Power Supply on the DECT Base Station side)

2.3 FM DECT Vehicle Unit

The DECT Vehicle Unit consists of a DECT vehicle transceiver unit and a DECT antenna. The transceiver and the antenna is delivered in a kit and the antenna is supplied with a special coded antenna connector to avoid use of a other antenna type.

Features:

- Data Transmission via DECT Standard up to 115.2 kbps (Full Duplex)
- Radio Coverage indoor up to 50m, outdoor up to 300m
- Standard RS232 Interface
- Closed Housing (dust and splash proof)

- external Antenna with special coded Antenna connector
- Wide Input Voltage Range (8-40V) specialized for Vehicles
- Simple Mounting with special Fixing Parts
- Dimension: 130 x 60 x 30 (L x B x T in mm)
- Weight approx.: 150g
- Temperature Range –20...+70°C (tested operation), -45°C...+90°C (storage)

2.4 Radio of FM DECT Base Station and Vehicle Unit

- Frequency Range: 1920 MHz - 1930 MHz
- RF Power Average: 10 mW
- RF Power Peak: 100 mW
- RF Channels: 5
- Carrier Spacing: 1.728 MHz
- Modulation: GFSK, BT=0,5

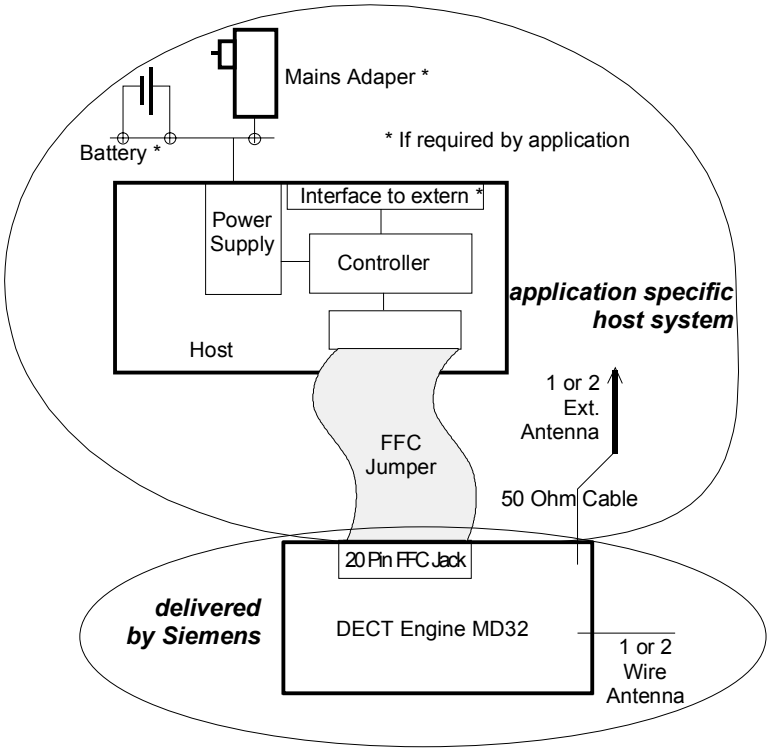

Fig. 2-1 Example of a Mobile Data Terminal (PP)

3 Functions

3.1 Block Diagram

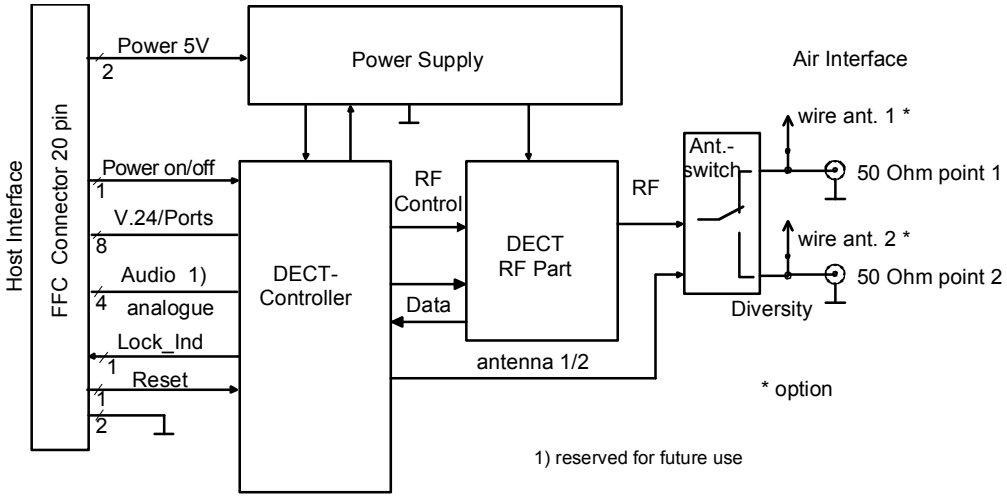

Fig. 2-2 Block Diagram of the DECT Engine

3.2 Features

- Data transmission
- Data rates up to 115.2 kbps
- Conforms to the DECT standards
- Serial 3V RS232 interface to host system
- A terminal (portable part, PP) can subscribe on up to 6 base stations (fixed part, FP)
- Control of up to 16 terminals from one base station (FP)
- Possibility of building up a system of up to 6 base stations with up to 16 terminals roaming through this multi-cell environment
- Single 5V power supply
- Mounting points for two plug-in wire antennas
- Supports antenna diversity in base station modes
- Small mechanical footprint (65 x 37 x 5 mm)

3.3 Modes of Operation

See /1/ Chapter 3 Programmers Reference Manual

4 Host Interface

The module has a 20-pin connector (AVX 04-6239-020-001-800) for Flat Flexible Cables (FFC) with a pitch of 0.5 mm and thickness of 0.3 mm, for connecting it to the host device. This incorporates the following interfaces.

4.1 DECT Controller

The DECT Controller handles all the signal and data processing needed within a DECT device. Internal software runs the host interface and the whole DECT protocol stack. A UART forms the interface to the host system.
The program SW is stored in internal ROM, the permanent parameters in flash memory. RAM is used for the data buffers and registers.

The DECT Controller has following additional features:

- A dedicated TDMA controller handles all physical layer slot formats and radio control. A microcontroller takes care of all the higher protocol stacks.
- An integrated DECT baseband transceiver, optimised according to ETS 300 175-2, 175-3 & 175-8.
- Two on-board low-drop voltage regulators (the voltage can be set using external resistors).
- Advanced battery management unit (e.g. power on/off)
- Very low power consumption in active and paging modes.
- UART (V.24, 9.6 kbaud and 15.2 kbaud; 3V TTL).
- Digital ports for UART flow control, modem control signals and other control functions.
- Modification and adjustment options, using advanced modem-control AT-commands.
- Program memory for firmware.
- Flash memory for storage of permanent parameters and numbers.
- Data memory for data buffers and registers.
- Peak hold ADC for RSSI measurement.
- Control unit for radio front end.

4.2 Power Supply

A single +5V voltage supplies the module. Linear regulators stabilize the supply voltages for the DECT Controller and for the RF part.
The PP DECT Engine swaps automatically into standby mode when the air link to the base station is released. The delay between transmission of the last data and release of the link can be adjusted by AT commands during configuration. The system exits from the standby mode when a new link has to be established (due either to the arrival of data on the serial line or to a request from the base station).
The FP DECT Engine has no reduced-power mode, because it is constantly transmitting even when no link is established. This is necessary in order to keep the corresponding PP DECT Engine(s) synchronized to the FP.
All linear regulators can be switched off by the DECT Controller if the PON signal is not active. The module is then in the power-saving mode. No Rx/Tx modes are possible. The Siemens DECT Engine can be switched on again by setting PON = active.

4.3 Data Interface

The data interface is implemented as a serial asynchronous transmitter and receiver conforming to ITU-T RS232 Interchange Circuits DCE. It has fixed parameters of 8 data bits, no parity and 1 stop bit, and can be operated at 9.6 kbps or 115.2 kbps. In-band (HW handshake via RTS/CTS) and out-band (via XON/XOFF) flow control are supported. It also supports the modem control signals: DTR, DSR, DCE and RI. There are different modes of operation, which are software-selectable (AT commands); see /1/.
The data interface works at 3V TTL RS232 without level shifters for +/- 12V signal levels. Consequently the polarity of the signals is inverted, e.g. “off” is high TTL level, “on” low TTL level.

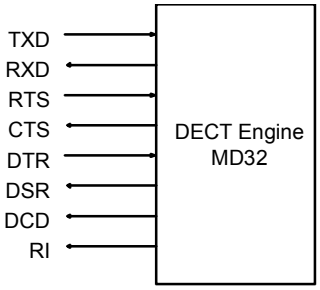

Fig. 2-3 V.24 Interface

4.4 Control Signals

The following control signals are available (3V TTL level):

Inputs:

RST	=1→0 edge	The DECT Engine will be reset
	=0 or 1	Normal operation
PON	=0	Power saving mode (all voltage regulators switched off), no operation
	=1	The DECT Engine is switched on (active)

Outputs:

LOCK_IND	=0	Siemens DECT Engine (configured as PP) is locked on FP (e.g. there is a base station within the range to which the terminal DECT Engine is subscribed)
	=1	Siemens DECT Engine (configured as PP) is unlocked on FP (e.g. there is no base station within the range to which the terminal DECT Engine is subscribed)
RI	=0	Ring Indicate (indicates a incoming call). Wakeup of host application.
	=1	No operation

4.5 Pin Assignment

Function	Signal name	Pin(s)	I/O	Description
Power	VCC	1, 2		positive voltage supply +5V
	GND	19, 20		ground
Power on/off	PON	16	I	high = on (standby) low = off (power saving)
Restart	RST	6	I	high = nop high to low edge = reset of MD32 (t_{low}>100ns) low = nop
PP: idle lock indicator FP: not used	LOCK_IND	4	O	low = PP locked on FP high = PP unlocked on FP
RS232 Received Data from MD32	RXD	12	O	high=1 low=0
RS232 Transmit Data to MD32	TXD	15	I	high=1 low=0
RS232 Ready To Send to MD32	RTS	11	I	high = off low = on
RS232 Clear to Send to host	CTS	14	O	high = off low = on
RS232 Data Terminal Ready	DTR	10	I	high = off low = on
RS232 Data Set Ready	DSR	5	O	high = off low = on
RS232 Ring Indication (may wake up host system)	RI	7	O	high = off low = on
RS232 Data Channel Detect	DCD	13	O	high = off low = on
Reserved Audio Interface (gain adjustable via AT-commands)	MIC+	18	I	differential Codec analogue input (reserved for future use)
	MIC-	17	I	
	LRS+	8	O	differential Codec analogue output (reserved for future use)
	LRS-	9	O	
Reserved I/0 port	GP	3		must be unconnected

nop = no operation

5 Radio Interface

5.1 DECT RF Part

The RF part has the following structure:

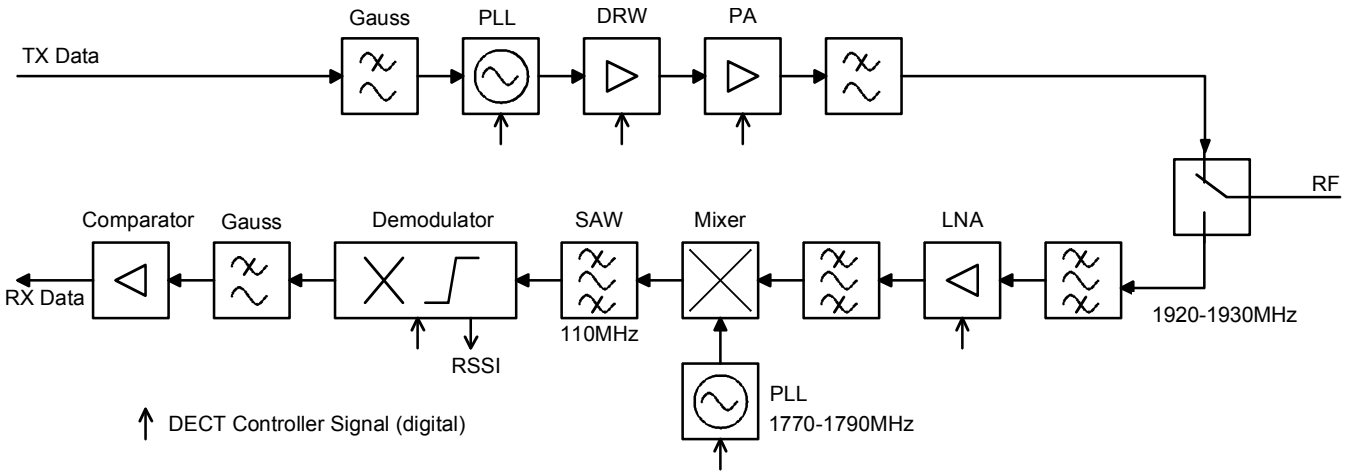

Fig. 2-4 RF Block Diagram

Overview:

The RF part of the DECT Engine MD32 is based on Siemens' latest one-chip transceiver integrated circuit using B6HF bipolar technology. To achieve maximum output power, modern GaAs-FET technology has been specified for the final power amplifier stages. By providing for antenna diversity, the DECT Engine MD32 can provide excellent signal quality even in a poor RF environment.

Integrated on the chip are a single conversion superheterodyne receiver with self-tuning coincidence demodulator and an open loop modulated VCO with frequency doubling, together with two fully integrated VCOs and a PLL synthesiser.

Receiver:

A sensitive multi-stage LNA feeds the incoming RF-signal into an image-rejection mixer circuit. After passing through a SAW channel filter, the IF signal passes through a limiter amplifier with RSSI and coincidence demodulator. A Gaussian filter is applied to this output signal, which is then detected by an S&H comparator.

Transmitter:

In order to provide adequate isolation, the TX-VCO operates at half of the output frequency. The data signal modulates the VCO in open-loop mode. The modulated RF-carrier then passes a frequency doubler, buffer, amplifier and driver stages. To achieve maximum output power, modern GaAs-FET transistor technology has been specified.

When the strength of the received signal is good, a low power mode provides a reduced RF transmit power and an optimised power consumption (in PP mode only, controlled by firmware).

5.2 Antenna Diversity Switch

If the DECT Engine is configured as FP, the antenna switch between 2 antennas provides excellent signal quality even in a poor RF environment.
Both polarisation and spatial diversity can be used.

If the DECT Engine is configured as PP, the antenna diversity switch has one fixed position. This position can be modified by AT command.

5.3 Antennas

The FM DECT Base Station will be supplied with integrated wire antennas and it is strictly recommended to connect no other antennas to the PCB.

The DECT Vehicle Unit will be supplied with an external DECT antenna to allow proper installation in a vehicle. The antenna will be delivered with the FM DECT System and it is strictly recommended to use only this antenna. A special coded antenna connector is used to avoid unintentional change of antenna.

6 Mechanical Characteristics

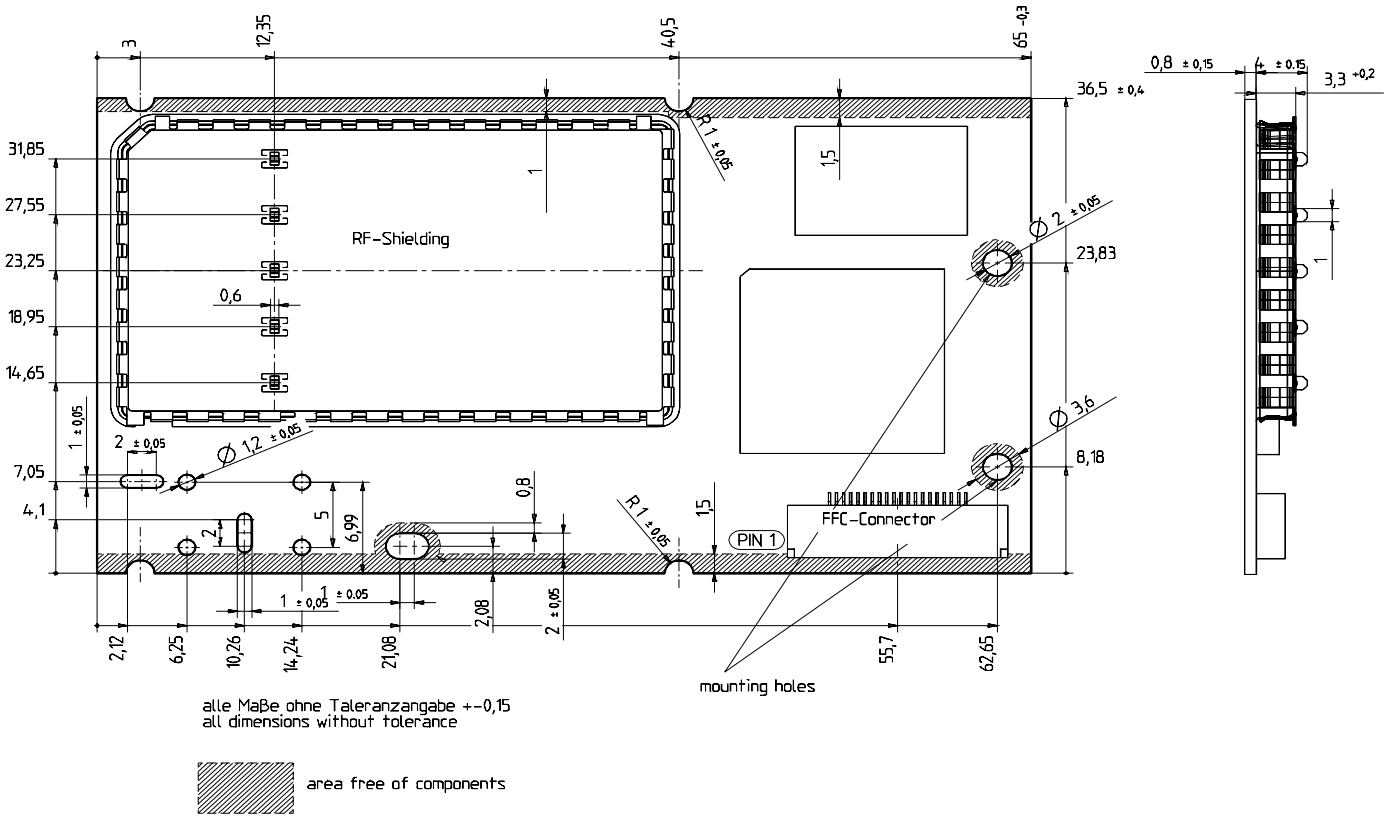

Fig. 2-5 Dimensions of the PCB

The PCB must have an unused space around it, with dimensions of 36.5x65x5mm, but the area shown as containing no components may be used for mechanical fixing purposes.
It's not allowed to use the oval hole for mounting (e.g. screws).

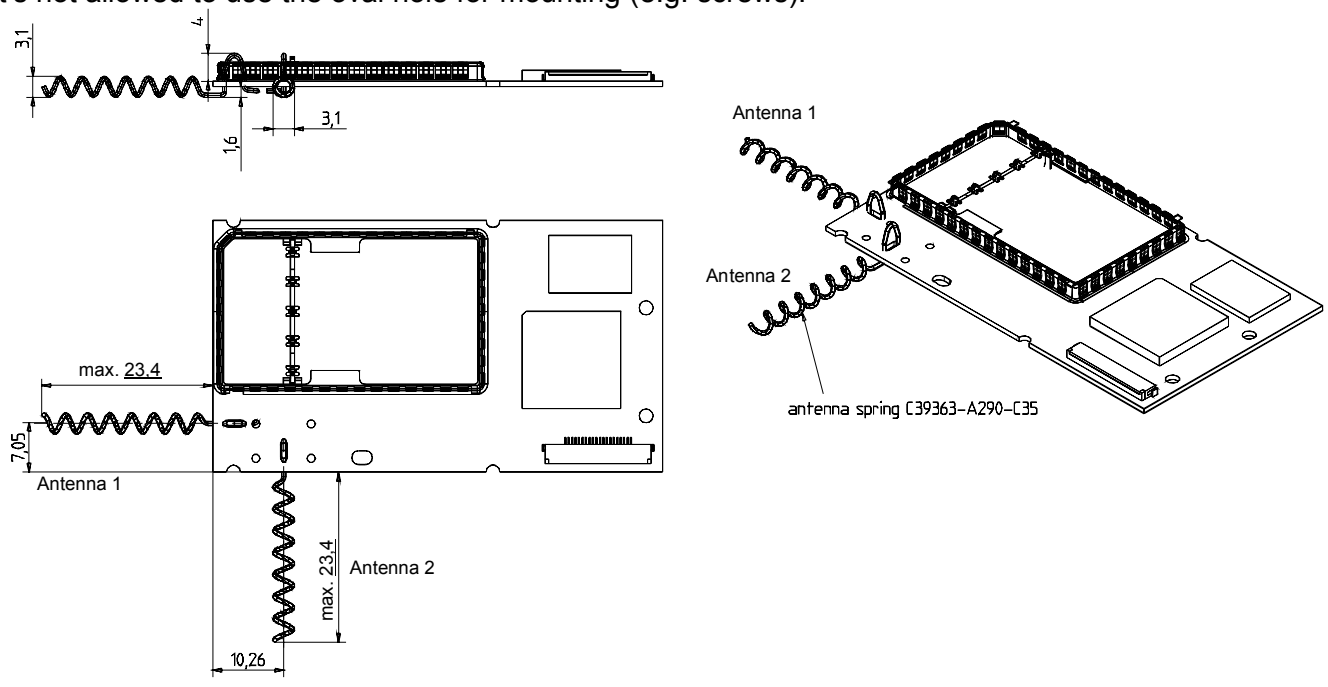

Fig. 2-6 Dimensions of Antenna Springs

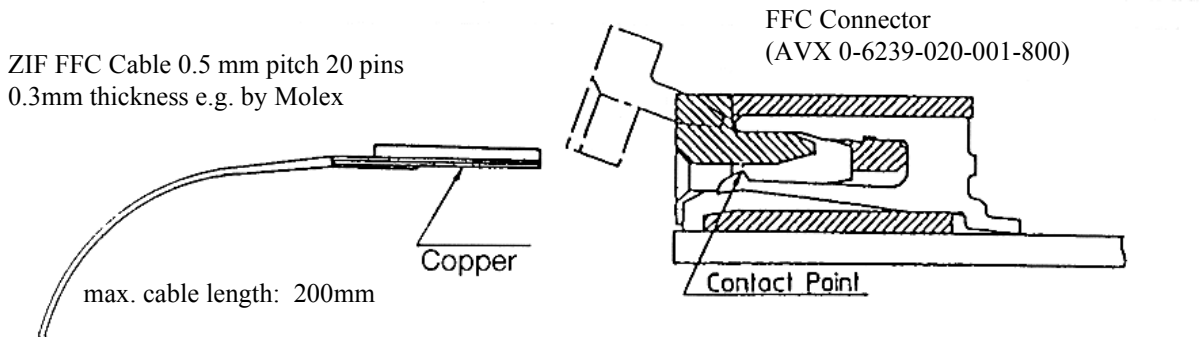

Fig. 2-7 Detail Drawing of an FFC Cable Connection

Weight:

PCB DECT Engine: 10.7g
1 Antenna spring: 0.15g

7 Electrical and Radio Characteristics

7.1 Absolute Maximum Ratings

Values beyond which the device may suffer damage.

Parameter	Min.	Max.	Units
Supply voltage VCC	-0.6	5.25	V
Voltage on digital pins 3-7, 10-16	-0.3	3.6	V
Voltage on analogue pins 8, 9, 17, 18	-0.3	3.0	V
I-protection diodes on any pin		50	µA
Storage temperature	-45	+90	°C

7.2 Operating Conditions

Parameter	Min.	Typical	Max.	Units
Ambient temperature	0		40	°C
Supply voltage VCC	4.75	5.0	5.25	V

7.3 Power Supply

Parameter	Description	Conditions		Min.	Typical	Max.	Unit
V_{VCC} (Demand on host)	Supply voltage	I_{VCC} = 40mA 1)		4.75	5.0	5.25	V
	Voltage drop	I_{VCC} = 450mA 1)				350	mV
	Added ripple or spikes	I_{VCC} = 0...450mA 1)				+-100	mV
I_{VCC} (for further details see /2/)	Supply current average (Power consumption)	Power saving mode			100	150	µA
		Synchronization for t=2s or unlocked	PP		70	80	mA
		Standby (low duty cycle)	PP		4	5	mA
		Standby (normal)	PP		20	25	mA
		Idle	FP		80	90	mA
		One active voice or data channel	PP		40	45	mA
			FP		90	100	mA
		Every further data channel 2)	PP		25	27	mA
			FP		15	17	mA
	Supply current peak	Peak current (during 417µs transmission slot)			390	430	mA
t (Required by host)	Power fail timing	I_{VCC} = 150mA average		See Fig. 2-8			

(PP) Siemens DECT Engine configured as Portable Part only
(FP) Siemens DECT Engine configured as Fixed Part only

1) Measured at the DECT Engine's FFC connector
2) Max. number of simultaneous channels: PP: 1
FP: 4 + 1 for handover

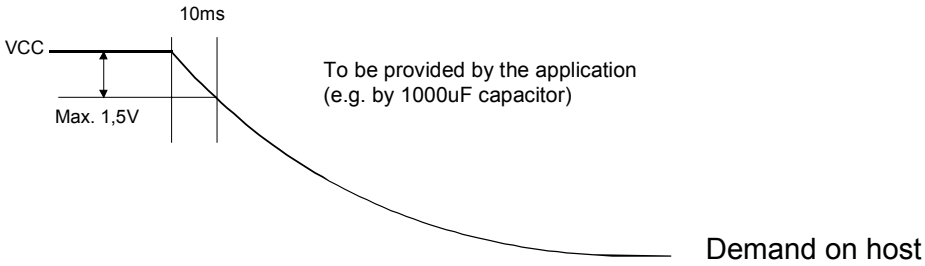

Fig. 2-8 Power Fail Timing at I_{VCC}=150mA

7.4 Digital I/Os

Parameter	Description	Conditions	Min.	Typical	Max.	Units
V_{IL}	Logical 0 input level				0.6	V
V_{iH}	Logical 1 input level		2.4			V
I_{in}	Input current	V_{in}=3V			10	µA
		V_{in}=GND			100	µA
V_{OL}	Logical 0 output level	I_{out}=2mA	0		0.5	V
V_{OH}	Logical 1 output level	I_{out}=2mA	2.4		3	V
I_{out}	Output current		2			mA
t_{OR}	Output Rise time	C_{LOAD}<=10p			100	ns
t_{OF}	Output Fall time				100	ns
t_{IR}	Permitted Input Rise time	C_{LOAD}<=20p			500	ns
t_{IF}	Permitted Input Fall time				500	ns

7.5 Power Up Conditions

Signal	Power down		Power UP (reset state first 10 ms)		Port initial value after reset	
	Input 1)	I/O	Input 1)	I/O	Input 1)	I/O
PON	0 2)	I	1	I	1	I↑
RST	x	I	x	I↑	1	I↑
LOCK_IND	x	I	1	I	-	O
RXD	x	I	1	I	-	O
TXD	x	I	x	I↑	x	I↑
RTS	x	I	x	I↑	x	I↑
CTS	x	I	1	I↑	-	O
DTR	x	I	x	I↑	x	I↑
DSR	x	I	x	I↑	-	O
RI	x	I	x	I↑	-	O
DCD	x	I	x	I↑	-	O

1) Signal levels which should be maintained to guarantee proper operation of the DECT Engine, demand on host.
2) If VCC = 5V

I↑ Input with pull-up >30k
I Input high impedance
O Output
x 0 or 1 level

7.6 Timing characteristics

Parameter (times)	Min.	Typical	Max.	Units
Start-up to locked time: VCC=on to LOCK_IND=0 (PP locked)		2		s
Wake up to lock time: PON=1 to LOCK_IND=0 (PP locked)		2		s
Start-up time after reset RST =1→0 to LOCK_IND=0 (PP locked)		2		s
Time to ready to receive data via RS232 after Reset or Power on		0.5		s
Delay Locked → Active Link		800		ms
Data Transmission Delay (Data In → Data Out)		35		ms
Baud rate on serial interface	9.6		115.2	kbit/s
Permitted external UART clock jitter			2	%

7.7 Air Interface

Parameter	Min.	Typical	Max.	Units
Frequency range	1920		1930	MHz
RF power, peak (during 417µs transmit slot, 50 Ohm load)			100	mW
RF power, average (1 channel, 50 Ohm load)			10	mW
RF channels		5		
Carrier spacing		1.728		MHz
Multiplex, duplex	TDMA / FDM, TDD			
Time slots			24	
Time slots usable RX/TX			6/6	
Frame duration		10		ms
Modulation	GFSK, BT=0,5			
Gross Bit Rate (Frame)		1.152		Mb/s
Net Bit Rate, speech		32		kb/s
Net Bit Rate, protected data		115.2		kb/s
Data protection	CRC, ARQ, LU10-protocol			
Receiver input sensitivity at 0.1% BER	-86	-90		dBm
Channel allocation	Instant dynamic			
Coverage range, line of sight		300		m
Coverage range, indoor		50		m

1) Low power mode