

---

---

**ATA8535 UHF ASK/FSK Transceiver Data Sheet**

---

---

---

## Introduction

---

The ATA8535 is a state-of-the-art, ultra-low power, Ultra High Frequency (UHF) smart transceiver based on an 8-bit AVR<sup>®</sup> microcontroller.

The ATA8535 is a System on Chip (SoC) consisting of an RF front end, a complex digital baseband and a low-power 8-bit AVR microcontroller, leading to a minimal Bill of Material (BOM) in customer applications. It offers highest sensitivity, blocking, image rejection and uses a DC-DC buck converter for the lowest power consumption. The embedded DC-DC regulator makes the system highly efficient with only two external components.

Highly configurable baseband processing offers flexibility for customers, such as multiple scanning functions, pattern-based wake-up and automatic self-polling scenarios. For example, during polling, the IC can scan for specific message contents (IDs) and save valid telegram data in the FIFO buffer for later retrieval. The device integrates two receive paths that enable a simultaneous search for two telegrams with different modulations, data rates, wake-up conditions and so on. The ATA8535 offers additional flexibility as it enables up to eight different services with three channels each, which the user can configure independently and with up to 16-channel polling schemes. The user can place a maximum of four service configurations in the EEPROM; the remaining are available in the SRAM, which allows on-the-fly modifications during the IDLEMode via SPI commands or application software.

The lowest power consumption can be achieved thanks to a built in DC-DC buck converter. The embedded regulator makes the system highly efficient with only two external components.

The ATA8535 includes an integrated antenna switch matrix with three antenna ports allowing triplexer operation (multiband operation for high-end applications) or antenna diversity operations, and, thus, further reduces the external BOM cost.

The user can dynamically configure the RF switch to connect any antenna port to either the receiver or transmitter while providing excellent RX/TX isolation.

The transmit path of the ATA8535 is based on a closed-loop fractional-N modulator with Gaussian shaping and pre-emphasis functionality that enables high data rates and mitigates EMC emissions.

The internal microcontroller is built with a 2-Kbyte SRAM and 20-Kbyte user Flash memory to support customer application software, LIN/UART, as well as a debugWIRE and ISP interfaces for programming purposes.

### Related Devices:

The ATA8287 is available as a pure receiver with features identical to the ATA8535 but without transmit function.

---

## Features

---

- **Internal Microcontroller System**
  - AVR 8-Bit Microcontroller Core
  - Firmware Library in ROM
  - 20-Kbyte Flash Program Memory for Customer Applications
  - 2-Kbyte SRAM (1 Kbyte for Customer Applications)
  - 1-Kbyte EEPROM for Up to Four Service Configurations
- **Supported RF Ranges**
  - Low Band 310 MHz to 318 MHz
  - Low Band 418 MHz to 477 MHz

- High Band 836 MHz to 928 MHz
- 315.00 MHz/433.92 MHz/868.30 MHz and 915 MHz with one 24.305 MHz Crystal
- **Current Consumption**
  - 5 nA in OFFMode
  - 40  $\mu$ A in SleepMode
  - 6.5 mA in RXMode (434 MHz, VS = 5V, Internal DC-DC Converter Active)
  - 7.8 mA/10.8 mA in TXMode (434 MHz, P<sub>OUT</sub> = 6 dBm/10 dBm, VS = 5V, Internal DC-DC Converter Active)
  - Three-Channel PollingMode
    - 450  $\mu$ A with 50 ms Polling Cycle
    - 900  $\mu$ A with 21 ms Polling Cycle
- **Receiver**
  - Demodulation
    - ASK (OOK)
    - FSK (Deviation  $\pm$ 0.375 kHz to  $\pm$ 93 kHz)
  - Decoding
    - NRZ at 1 Kbits/s to 160 Kbits/s
    - Manchester at 500 bits/s to 80 Kbits/s
  - Sensitivity (Manchester Coded) at 433.92 MHz
    - ASK: -127 dBm at 0.5 Kbit/s, BWIF = 25 kHz
    - ASK: -112 dBm at 20 Kbit/s, BWIF = 80 kHz
    - FSK: -124 dBm at 0.75 Kbit/s,  $\Delta$ f =  $\pm$ 0.75 kHz, BWIF = 25 kHz
    - FSK: -113 dBm at 10 Kbit/s,  $\Delta$ f =  $\pm$ 10 kHz, BWIF = 165 kHz
    - FSK: -110 dBm at 20 Kbit/s,  $\Delta$ f =  $\pm$ 20 kHz, BWIF = 165 kHz
  - Image Rejection
    - 55 dB in 315 MHz/433 MHz Band
    - 25 dB in 868 MHz/915 MHz Band
  - Blocking
    - >64 dBc at 1 MHz Offset from Carrier
    - >48 dBc at 225 kHz Offset from Carrier in Low Band
  - Channel Filter 25 kHz to 365 kHz (Approx. 10% Steps)
  - Digital RSSI with Relative Accuracy of  $\pm$ 1 dB
  - Fast Receiver Synchronization  $\leq$  8 Symbols
  - Autonomous Polling, Message and ID Validation
  - Pattern-Based Wake-up and Start-of-Frame Identification (SFID)
  - Flexible EEPROM and SRAM-Based Service Configuration Concept
  - Double Receive Path for Parallel Telegram Search on the Same Channel (For Example, ASK/FSK)
  - Buffered and Transparent Reception
  - Flexible Polling Configuration Concerning Timing, Order and Participating Channels
  - Configurable 4, 8, 16-Bit CRC Check
- **Transmitter**
  - Modulation
    - ASK (OOK)
    - FSK (Deviation  $\pm$ 0.375 kHz to  $\pm$ 93 kHz)
  - Coding
    - NRZ at 1 Kbits/s to 160 Kbits/s
    - Manchester at 500 bits/s to 80 Kbits/s
  - Programmable Output Power -12 dBm to +14.5 dBm in 0.4 dB Steps
  - Buffered and Transparent Transmission
  - Automatic Telegram Composition in Buffered Mode
  - Configurable 4, 8, 16-Bit CRC Calculation

- ASK and Gauss Shaping to Reduce Spectral Bandwidth of Modulated PA Output Signal
- **Interfaces**
  - SPI Interface with Up to 1 Mbit/s
  - LIN/UART Interface to Support LIN 2.2 Compliant Communication
  - Configurable Event Signal Towards Host Microcontroller
  - Programmable Clock Output Derived from Crystal Frequency
- **System Timings**
  - OFFMode to IDLEMode: 0.5 ms
  - OFFMode to RXMode: 1.5 ms
  - OFFMode to TXMode: 1.5 ms
  - RXMode to TXMode: 0.5 ms
  - TXMode to RXMode: 0.7 ms
- **Extended Features**
  - Integrated Temperature Sensor with  $\pm 1\text{K}$  Relative Accuracy ( $\pm 3\text{K}$  Absolute)
  - Three Switchable Antenna Ports (Triplexer)
  - Antenna Diversity
  - RF Approach Wake-up with External Sleep Timer
- **Boundary Conditions**
  - Supply Voltage 2.0V to 5.5V
  - Temperature Range  $-40^{\circ}\text{C}$  to  $+110^{\circ}\text{C}$
  - ESD Protection
    - $\pm 4\text{ kV}$  HBM
    - $\pm 750\text{V}$  FCDM
  - Package 5x5 mm 32-Lead QFN Wettable Flanks, 0.5 mm Pitch
  - Suitable for Applications Governed by EN 300 220 and FCC Part 15, Title 47

## Table of Contents

Introduction.....	1
Features.....	1
1. Quick References .....	5
1.1. Reference Documentation .....	5
1.2. Acronyms and Abbreviations.....	5
2. General Description.....	7
2.1. System Overview.....	7
2.2. Pin Descriptions.....	9
2.3. Typical Applications.....	11
3. System Functional Description.....	16
3.1. Service-Based Concept.....	16
3.2. Operating Modes Overview.....	17
4. Electrical Characteristics.....	19
4.1. Absolute Maximum Ratings.....	19
4.2. Thermal Resistance.....	20
4.3. Supply Voltages and Current Consumption.....	20
4.4. RF Receive Characteristics.....	21
4.5. RF Transmit Characteristics.....	28
4.6. Oscillators and Clockout.....	30
4.7. I/O Characteristics PORTB and PORTC.....	31
4.8. Hardware Timings.....	32
5. Ordering Information.....	33
6. Package Information.....	34
6.1. Package Marking Information.....	34
6.2. Package Outline Drawing.....	35
7. Document Revision History .....	38
Microchip Information.....	39
The Microchip Website.....	39
Product Change Notification Service.....	39
Customer Support.....	39
Microchip Devices Code Protection Feature.....	39
Legal Notice.....	39
Trademarks.....	40
Quality Management System.....	41
Worldwide Sales and Service.....	42

## 1. Quick References

### 1.1 Reference Documentation

For further details, refer the following:

- *UHF ATA Product Application and Design Quick Reference Guide.* (DS00004325)

### 1.2 Acronyms and Abbreviations

**Table 1-1. Acronyms and Abbreviations**

Acronyms and Abbreviations	Description
ASK	Amplitude Shift Keying
BOM	Bill of Material
CRC	Cyclic Redundancy Check
EEPROM	Electrical Erasable Programmable Read Only Memory
ESD	Electro Static Discharge
FCDM	Field Induce Charge Device Model (ESD)
FIFO	First In First Out
FRC	Fast Resistor Capacitor (oscillator)
FSK	Frequency Shift Keying
HBM	Human Body Model (ESD)
ISP	In System Programming
LIN	Local Interconnect Network
NRZ	Non-return-to-zero
PLL	Phase Locked Loop
ROM	Read Only Memory
RSSI	Received Signal Strength Indicator
RX	Receive
SFID	Start-of-Frame Identification
SoC	System on Chip
SPI	Serial Programming Interface
SRC	Slow Resistor Capacitor (oscillator)
SRAM	Static Random Access Memory
TX	Transmit
UART	Universal Asynchronous Receiver Transmitter
UHF	Ultra High Frequency
XTO	Crystal Oscillator

.....continued

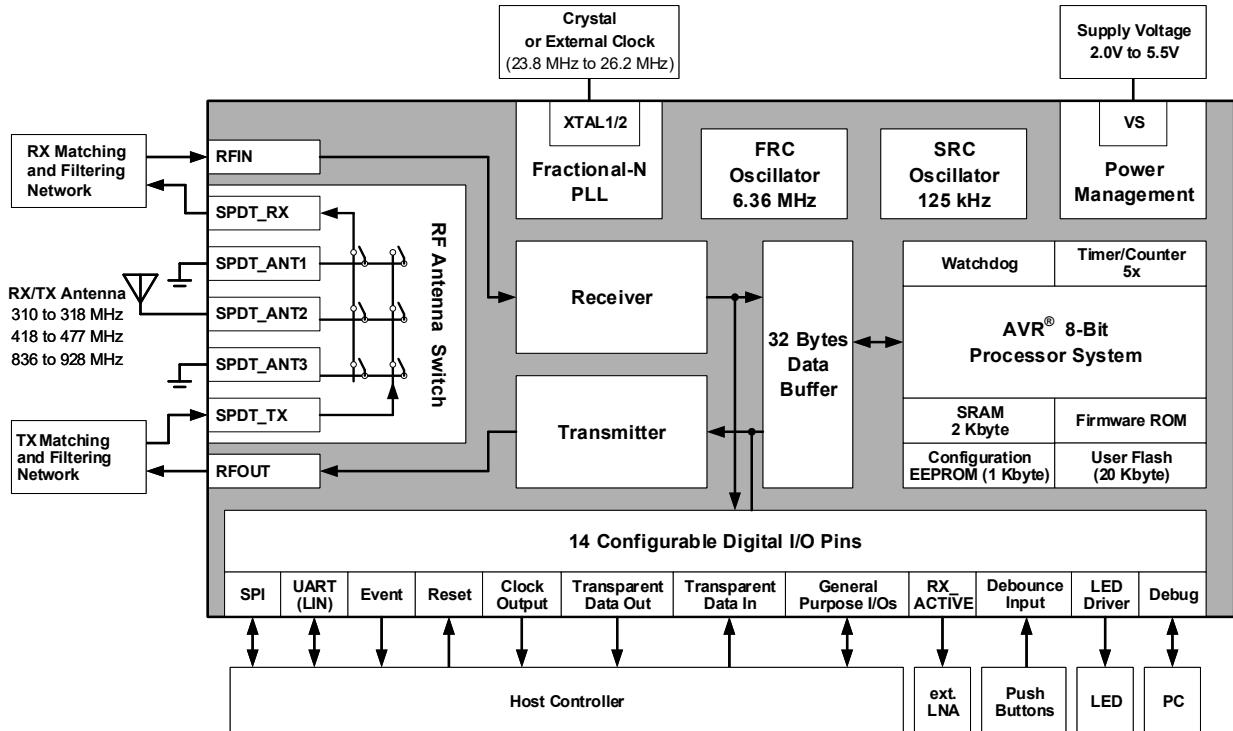
Acronyms and Abbreviations	Description
XTAL	Crystal

## 2. General Description

### 2.1 System Overview

The following block diagram illustrates an overview of the main functional blocks of the ATA8535.

**Figure 2-1. System Functional Block Diagram**



The ATA8535 consists of the following components:

- RF switch with three antenna ports
- Receiver unit
- Transmitter unit
- 32-byte data buffer
- 8-bit AVR microprocessor system

The internal RF switch enables various functions, like RX/TX switching, antenna diversity or channel prefiltering with a minimized external component count.

The receiver is based on a low-IF architecture with FSK or ASK (OOK) demodulation and NRZ or Manchester decoding. Two digital receive paths, pattern-based wake-up detection and flexible telegram handling settings allow an application-specific adaptation of the receiver behavior. The user can either store the received telegram payload in the internal buffer or directly stream out on a transparent interface to a host microcontroller. In the RXMode (Buffered), the system provides automatic CRC-based verification of the received telegram.

The transmitter is compatible with the receiver concerning RF range, modulation and data coding to allow a transceiver link using two ATA8535 devices.

The transmitter has two modes: the Transparent and the Buffered mode.

- In the Transparent mode, the data are sent out as provided on the input pin.
- In the Buffered mode, the system provides an automatic telegram composition with cyclic preamble extension, stop sequence creation and CRC calculation.

The system contains various clock sources:

- A fractional-N PLL, which is based on a 23.8 MHz to 26.2 MHz crystal oscillator (XTO, default 24.305 MHz), clocks all RF activity.
- The AVR system runs on XTO/4 when the RF part is active or on a 6.36 MHz FRC oscillator when the front end is shut down for reduced power consumption.
- In deep sleep modes, for example, polling sleep phases, a low-power 125 kHz oscillator clocks the system.

The user can power-on the system using a single supply voltage ( $V_s$ ) between 2.0V and 5.5V, which leads to two different application scenarios:

- A 5V application – For this application, an embedded power management module generates all internal voltages. An integrated DC-DC converter allows additional significant reduction of current consumption on  $V_s$  in the Receive and the Transmit modes.
- A 3V application – This application targets battery-powered applications with decreasing  $V_s$  over its lifetime. In this mode,  $V_s$  can directly power the power amplifier to avoid the voltage drop of the internal regulator and optimize the transmit output power.

All PWRON and NPWRON pins (PC1 to PC5, PB4, PB7) are active in the OFFMode. This means that even if the ATA8535 is in the OFFMode and the DVCC voltage is switched off, the internal power management circuitry biases these pins with  $V_S$  to allow a wake-up of the system.

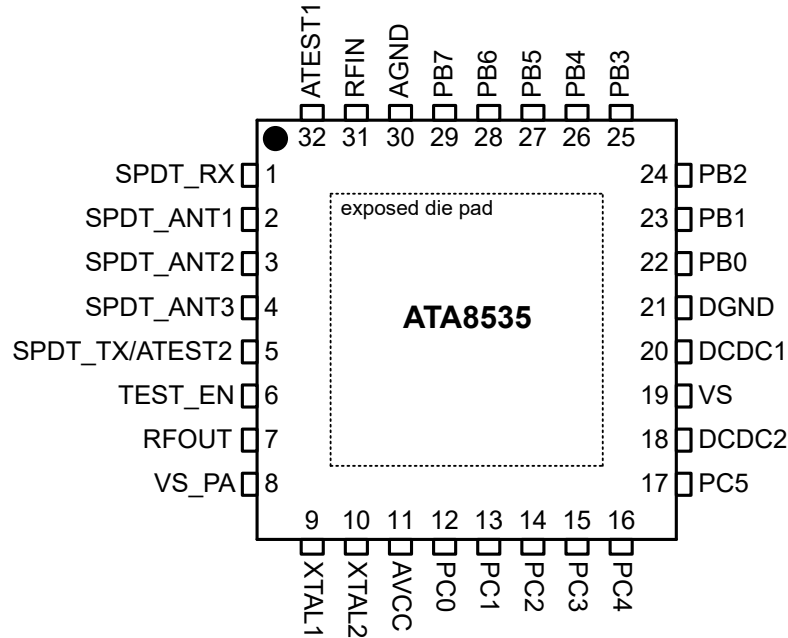
The EEPROM stores the configuration of the ATA8535 while the firmware located in the ROM defines the functionality and the AVR processes the firmware. The internal storage of configuration data has an advantage as it minimizes the external controller initialization tasks for decreased start-up time, response time and host controller burden. The SPI interface performs the external control of the system. An SPI command can trigger the AVR to configure the hardware according to settings that are stored in the EEPROM and start up a given system mode (example: RXMode, TXMode or PollingMode). Internal events such as “Start of Telegram” or “FIFO empty” are signaled to the external microcontroller on pin 28 (PB6/EVENT). Generally, the implemented firmware functions with the configuration range in the EEPROM are sufficient to design an advanced host-controlled radio link. However, the ATA8535 also provides 20-KByte of user Flash memory and an API to add highly-customized functions or run the system without a host controller.

The user can use the configurable digital I/O pins as button inputs, external LNA switch (RX\_ACTIVE), LED drivers, EVENT pin, switching control for additional RF switches, general purpose digital inputs or wake-up inputs, clock output for an external host and so on.

**Note:** Some functionality of these ports is already implemented in the firmware and can be activated by adequate EEPROM configurations. Other functionality, such as a LIN/UART interface, is available only through custom software residing in the Flash program memory.

## 2.2 Pin Descriptions

Figure 2-2. Pin Diagram



**Note:** The exposed die pad is connected to the internal die.

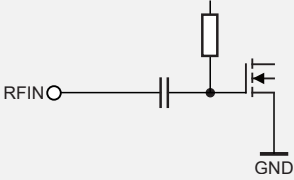
Table 2-1. Pin Description

Pin No.	Pin Name	Type	Equivalent Circuit	Description
1	SPDT_RX	Analog		RF switch RX output
2	SPDT_ANT1	Analog		RF switch antenna port 1
3	SPDT_ANT2	Analog		RF switch antenna port 2
4	SPDT_ANT3	Analog		RF switch antenna port 3
5	SPDT_TX/ ATEST2	Analog		RF switch TX input RF front-end test I/O2 (only in Test mode)
6	TEST_EN	Analog	—	Test enable, connected to GND in application
7	RFOUT	Analog		Power amplifier output
8	VS_PA	—		Power amplifier supply input (3V application) Power amplifier supply output (5V application)

.....continued

Pin No.	Pin Name	Type	Equivalent Circuit	Description
9	XTAL1	Analog		Crystal oscillator input External clock input
10	XTAL2	Analog		Crystal oscillator output
11	AVCC	—	ESD protection circuit	RF front-end supply regulator output
12	PC0	Digital		<b>Main:</b> AVR® Digital I/O Port C0 <b>Alternate:</b> PCINT8/NRESET/DebugWIRE
13	PC1	Digital	See pin PC0	<b>Main:</b> AVR Digital I/O Port C1 <b>Alternate:</b> NPWRON1/PCINT9/EXT_CLK
14	PC2	Digital	See pin PC0	<b>Main:</b> AVR Digital I/O Port C2 <b>Alternate:</b> NPWRON2/PCINT10/TRPA
15	PC3	Digital	See pin PC0	<b>Main:</b> AVR Digital I/O Port C3 <b>Alternate:</b> NPWRON3/PCINT11/TxD/TMDO
16	PC4	Digital	See pin PC0	<b>Main:</b> AVR Digital I/O Port C4 <b>Alternate:</b> NPWRON4/PCINT12/RxD/INT0/TMDI
17	PC5	Digital	See pin PC0	<b>Main:</b> AVR Digital I/O Port C5 <b>Alternate:</b> NPWRON5/PCINT13/TRPB/TMDO_CLK
18	DCDC2	Analog		DC-DC Converter pin 2
19	VS	Analog	ESD protection circuit	Main supply voltage input
20	DCDC1	Analog	See pin 18 (DCDC2)	DC-DC Converter pin 1
21	DGND	—	ESD protection circuit	Digital ground
22	PB0	Digital	See pin PC0	<b>Main:</b> AVR Digital I/O Port B0 <b>Alternate:</b> PCINT0/CLK_OUT
23	PB1	Digital	See pin PC0	<b>Main:</b> AVR Digital I/O Port B1 <b>Alternate:</b> PCINT1/SCK

.....continued

Pin No.	Pin Name	Type	Equivalent Circuit	Description
24	PB2	Digital	See pin PC0	<b>Main:</b> AVR Digital I/O Port B2 <b>Alternate:</b> PCINT2/MOSI
25	PB3	Digital	See pin PC0	<b>Main:</b> AVR Digital I/O Port B3 <b>Alternate:</b> PCINT3/MISO
26	PB4	Digital	See pin PC0	<b>Main:</b> AVR Digital I/O Port B4 <b>Alternate:</b> PWRON/PCINT4/LED1
27	PB5	Digital	See pin PC0	<b>Main:</b> AVR Digital I/O Port B5 <b>Alternate:</b> PCINT5/INT1/NSS
28	PB6	Digital	See pin PC0	<b>Main:</b> AVR Digital I/O Port B6 <b>Alternate:</b> PCINT6/EVENT
29	PB7	Digital	See pin PC0	<b>Main:</b> AVR Digital I/O Port B7 <b>Alternate:</b> NPWRON6/PCINT7/RX_ACTIVE/ LED0
30	AGND	—	ESD protection circuit	Analog ground
31	RFIN	Analog		LNA input
32	ATEST1	Analog	—	RF front-end test I/O1, connected to GND in application
	GND	—	—	Ground/backplane on exposed die pad

## 2.3 Typical Applications

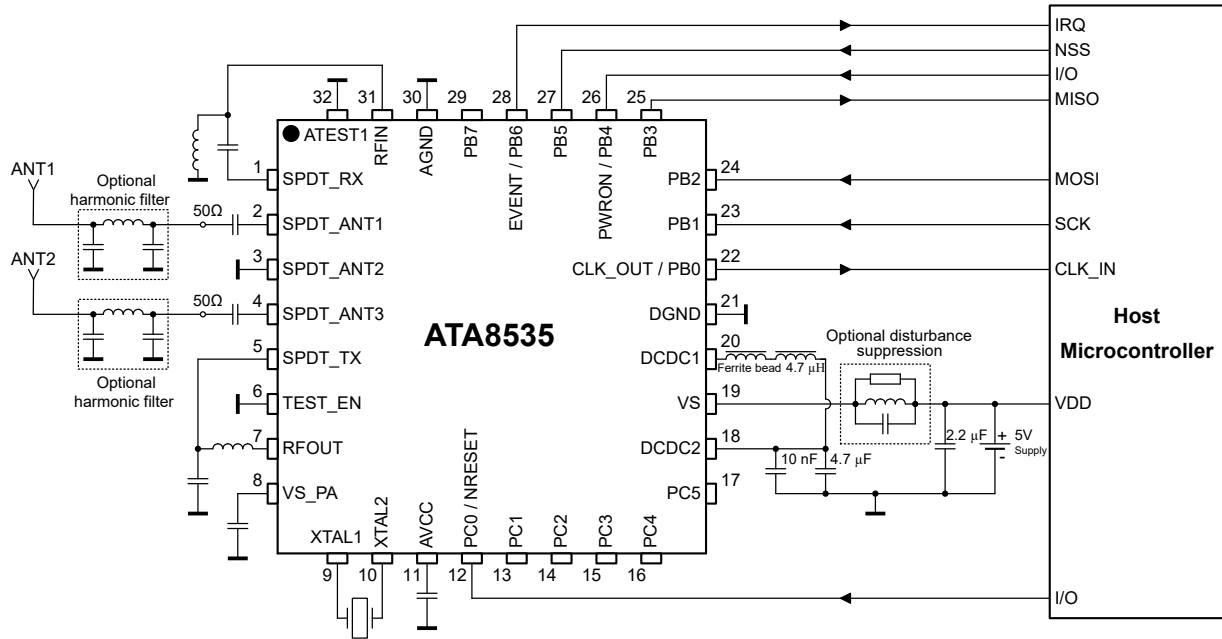
The transceiver is designed to be used in the following application areas:

- Remote Control system
- Home and Building Automation
- Wireless Sensor Networks
- Weather stations
- Battery operated remote controls
- Smart RF applications
- Telemetry systems
- Wireless alarm and security systems

The subsequent sections give application examples to provide an impression of the application range and the Bill of Material using the ATA8535. The specific customer designs might vary concerning used features, components and wiring.

**2.3.1 Typical 5V Antenna Diversity Application with External Microcontroller**

**Figure 2-3. Typical 5V Antenna Diversity Application**



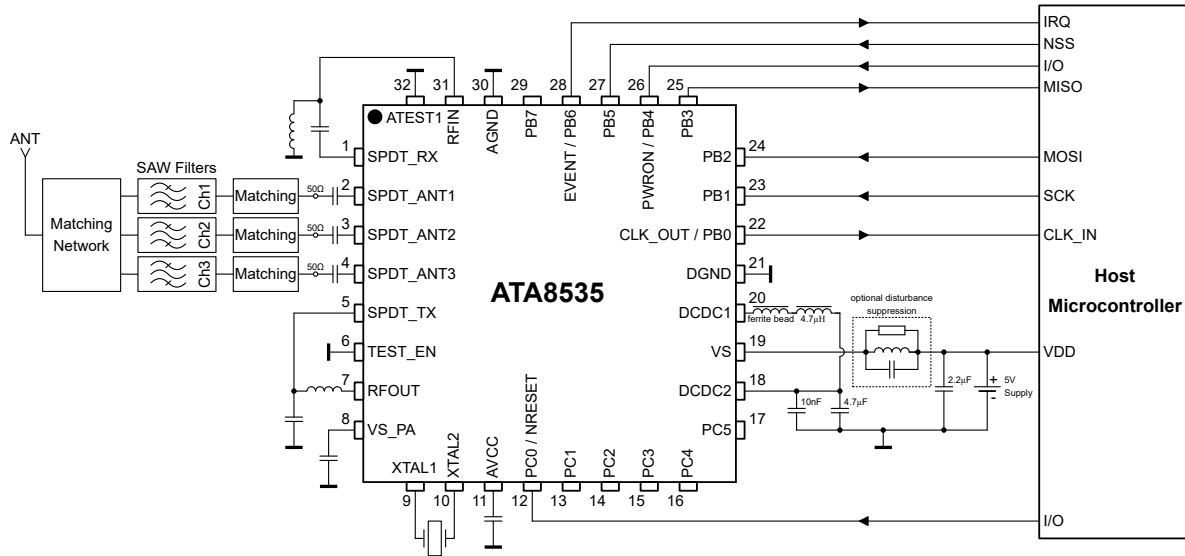
The figure above shows a typical base station side antenna diversity application with an external host microcontroller running from a single 5V voltage regulator. The digital I/O pins are always part of the VS power domain and, therefore, are set to 5V operation. All internal voltages are generated by the embedded power management circuitry. The DC-DC Converter is assembled and activated to supply the analog front end and the power amplifier to substantially reduce the required power in the 5V domain.

The ATA8535 is powered on when the host sets the PWRON pin PB4 to 'high'. After the internal start-up procedure, the ATA8535 enters the IDLEMode, which is signaled to the host by a system ready event on PB6. The system is now ready for SPI communication with the host. The ATA8535 can also be EEPROM-configured to directly switch to RXMode, PollingMode or TXMode after start-up.

The RF antenna switch is assembled with two antennas at SPDT\_ANT1 and SPDT\_ANT3 for an antenna diversity application. The harmonic suppression can be improved by using an optional filter on the antenna side. If a SAW filter is used in the transmit path, the user has to ensure that the RF peak voltage on the pins, SPDT\_ANTx and SPDT\_TX, stays in the range between -0.3V and VS\_PA + 0.3V. The antenna diversity algorithm itself is implemented in firmware and will automatically check the signal quality on both antennas whenever the RXMode is activated or a polling channel is checked. The better antenna is selected for telegram reception and stored for transmission of a successive Acknowledge message. This algorithm can significantly improve the service availability in scattered and disturbed environments when choosing an appropriate positioning and orientation of the antennas.

**2.3.2 Typical 5V Triplexer Application with External Microcontroller**

**Figure 2-4. Typical 5V Triplexer Application**



The figure above shows a typical base station side triplexer application circuit with an external host microcontroller running from a single 5V voltage regulator. The digital I/O pins are always part of the VS power domain and, therefore, are set to 5V operation. All internal voltages are generated by the embedded power management circuitry. The DC-DC Converter is assembled and activated to supply the analog front end and the power amplifier to substantially reduce the required power in the 5V domain.

The ATA8535 is powered on when the host sets the PWRON pin PB4 to 'high'. After the internal start-up procedure, the ATA8535 enters the IDLEMode, which is signaled to the host by a system ready event on PB6. The system is now ready for SPI communication with the host. The ATA8535 can also be EEPROM-configured to directly switch to RXMode, PollingMode or TXMode after start-up.

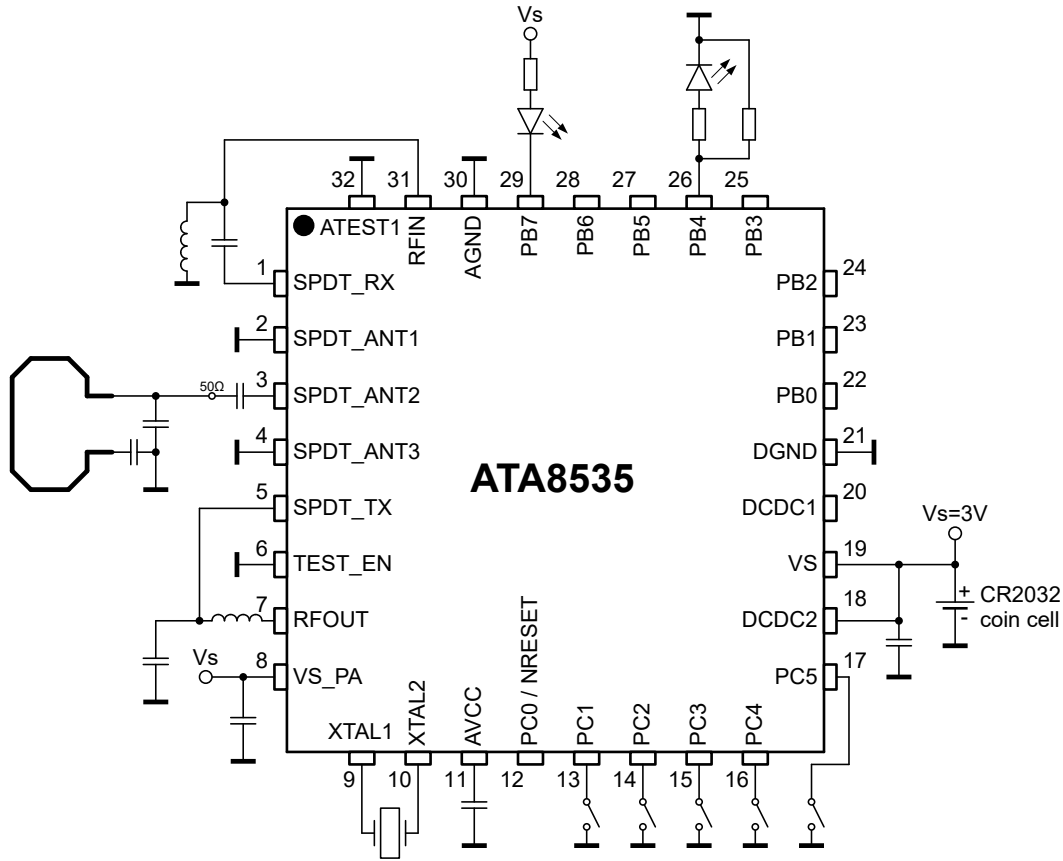
The RF antenna switch is assembled with three SAW filters for channel prefiltering in a high-end three-channel application. Together with the internal digital channel filter, this application provides excellent channel separation and robustness against interferences.

In a bidirectional application, the user has to ensure that the RF peak voltage on the pins, SPDT\_ANTx and SPDT\_TX, stays in the range between -0.3V and VS\_PA + 0.3V.



**2.3.4 Typical 3V Stand-Alone Application**

**Figure 2-6. Typical 3V Stand-Alone Application**



The above figure shows a stand-alone remote control application circuit running from a 3V lithium cell. The DC-DC Converter cannot be used in 3V mode, and, therefore, it must be short-circuited by connecting VS to DCDC2.

The ATA8535 stays in OFFMode until one of the NPWRON ports, PC1 to PC5, is pulled to ground level, waking up the circuit. The NPWRON ports, PC1 to PC5, have internal 50 kΩ pull-up resistors and can be left open if not used.

The user application software within the 20-Kbyte Flash is used to control the transceiver together with the ROM firmware.

In this application, LEDs can be connected to PB7 and PB4. At PB4, an additional pull-down resistor is recommended in parallel to prevent transverse currents in OFFMode.

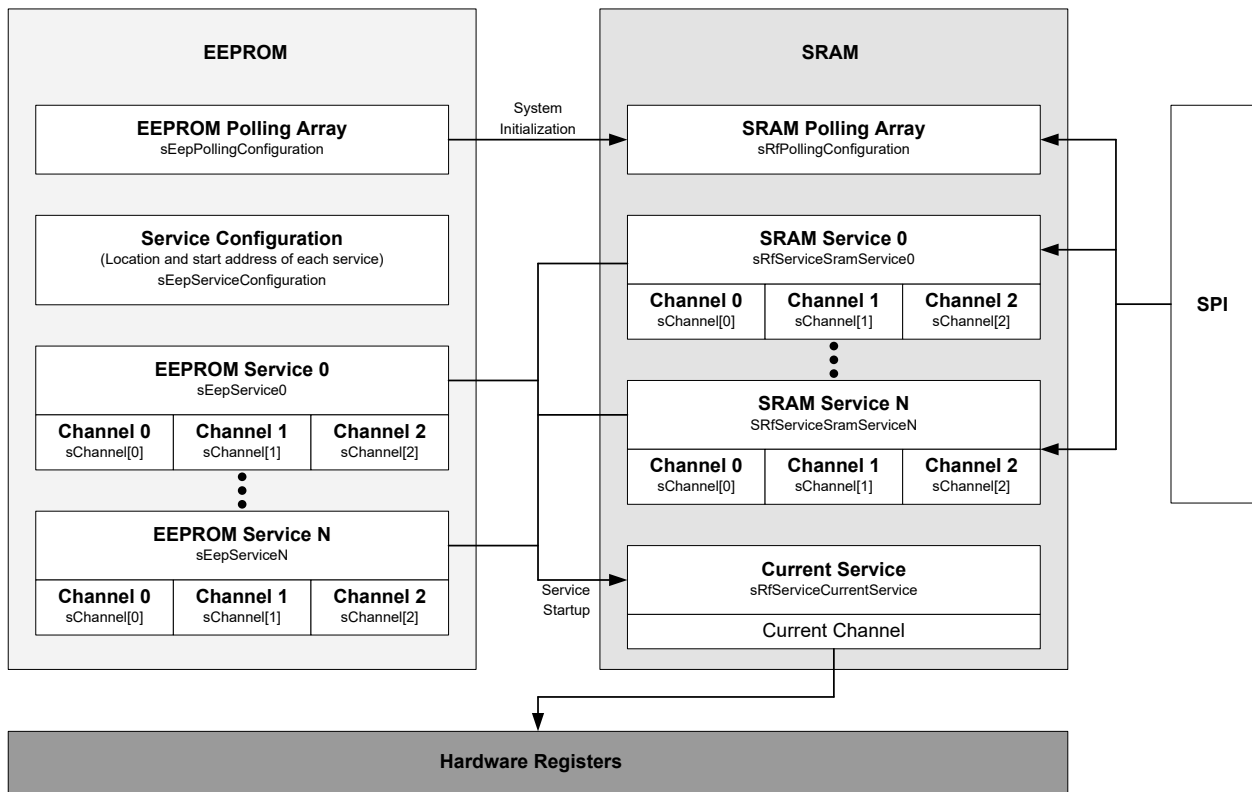
## 3. System Functional Description

### 3.1 Service-Based Concept

The ATA8535 is a highly configurable UHF transceiver. An internal 1024-byte EEPROM stores the configuration. The firmware controls the system. The system loads the general chip-wide settings from the EEPROM to hardware registers during system initialization. During start-up of the TXMode, RXMode or PollingMode, the system loads the service-specific settings from the EEPROM or SRAM to the current service in the SRAM and from there to the corresponding hardware registers.

The following figure illustrates an overview on the service-based concept.

**Figure 3-1. Service-Based Concept Overview**



Service is a complete configuration set of the transceiver, which includes RF settings, demodulation settings and telegram handling information. Each service contains three channels that differ in the radio frequencies.

The ATA8535 supports up to eight services. The user can either store each service in the EEPROM (maximum four services) or SRAM (maximum seven services). The service configuration section in the EEPROM contains the information concerning which service is stored in which memory together with the corresponding start address. During run time, do not change the EEPROM-based services as these are fixed configurations that are programmed at the customer end of line. Write the SRAM services after start-up, either from an external host or as a copy of an EEPROM service. The user can modify the SRAM services by the Flash software application or SPI commands in the IDLEMode.

Each service consists of:

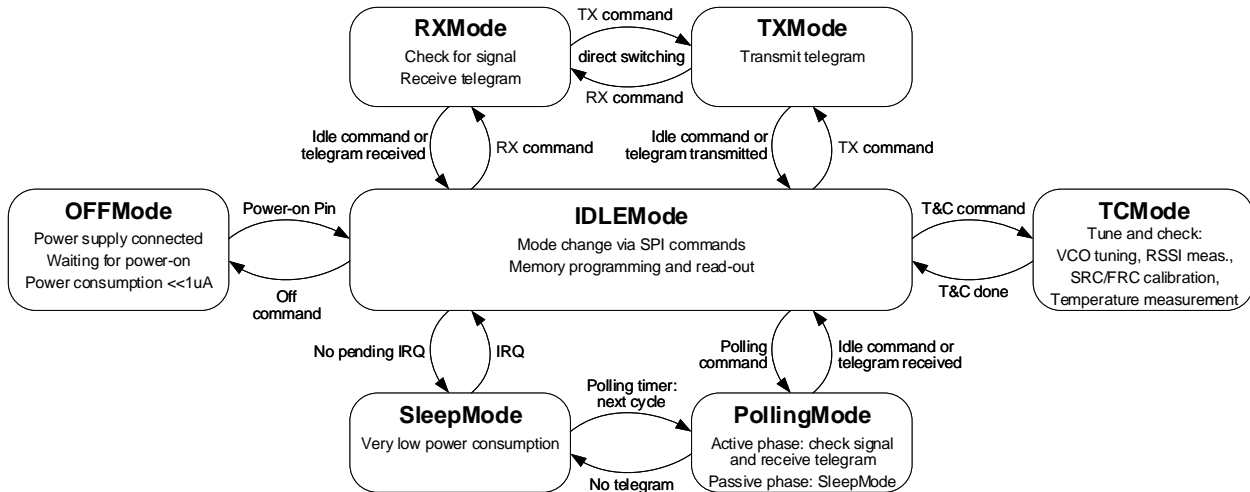
- One service-specific configuration part
- Three channel-specific configuration parts

Further configurations are available for the PollingMode and RSSI. In the IDLEMode, the user can modify the configurations via an SPI command and/or Flash user software.

## 3.2 Operating Modes Overview

This section gives an overview of the operating modes supported by the ATA8535, as illustrated in the following figure.

Figure 3-2. Operating Modes Overview



After connecting the supply voltage to the VS pin, the ATA8535 always starts in the OFFMode. All internal circuits are disconnected from the power supply; therefore, no SPI communication is supported. The ATA8535 can be woken up by activating the PWRON pin or one of the NPWRONx pins. This triggers the power-on sequence. After the initialization, the system reaches the IDLEMode.

The IDLEMode is the basic system mode supporting SPI communication and transitions to all other operating modes. There are two options of the IDLEMode requiring configuration in the EEPROM settings:

- IDLEMode(RC) with low-power consumption using the Fast RC (FRC) oscillator for processing
- IDLEMode(XTO) with active crystal oscillator for high-accuracy clock output or timing measurements

In the IDLEMode, the firmware cycles through the main loop. If there are no pending tasks during a main loop cycle, the processor system automatically switches into the configured SleepMode.

The TXMode enables data transmission using the selected service and channel configurations. It is usually enabled by the SPI command, `Set System Mode`, or directly after power-on when selected in the EEPROM setting. A system mode change can also be triggered by user Flash software.

The RXMode provides data reception on the selected service and channel configuration. The receiver continuously scans for a valid telegram and receives the data if all preconfigured checks are successful. The RXMode is usually enabled by the SPI command, `Set System Mode`, user Flash software or directly after power-on when selected in the EEPROM setting.

In the PollingMode, the receiver is activated for a short period of time to check for a valid telegram on the selected service and channel configurations. The receiver is deactivated if no valid telegram is found. The SleepMode is entered until the polling cycle timer elapses. This process is repeated periodically in accordance with the polling configuration. The initial settings are stored in the EEPROM and copied during firmware initialization to the SRAM. This allows modification of the PollingMode timing and service or channel configuration during the IDLEMode.

The TCMODE offers calibration and self-checking functionality for the Voltage Controlled Oscillator (VCO) and FRC oscillators as well as for temperature measurement and polling cycle accuracy. This mode is activated via the SPI command, `Calibrate and Check`, or Flash software. When selected in the EEPROM settings, tune and check tasks are also used during system initialization after power-on. Furthermore, they can also be activated periodically during the PollingMode.

The following table lists the relations between the operating modes and their corresponding power supplies, clock sources and SleepMode settings.

**Table 3-1. Operating Modes Versus Power Supplies and Oscillators**

Operation Mode	AVR SleepMode	DVCC	AVCC	VS_PA	XTO	SRC	FRC
OFFMode	—	off	off	off	off	off	off
IDLEMode(RC)	Active mode Power-down <sup>(1)</sup>	on	off off	off off	off off	on on	on off
IDLEMode(XTO)	Active mode Power-down <sup>(1)</sup>	on	on on	off off	on on	on on	off off
TXMode	Active mode	on	on	on <sup>(2)</sup>	on	on	off
RXMode	Active mode	on	on	off	on	on	off
PollingMode(RC) - Active period - Sleep period	Active mode Power-down <sup>(1)</sup>	on	on off	off off	on off	on on	on off
PollingMode(XTO) - Active period - Sleep period	Active mode Power-down <sup>(1)</sup>	on	on on	off off	on on	on on	off off

**Notes:**

1. During the IDLEMode(RC) and the IDLEMode(XTO), the AVR microcontroller enters the SleepMode to reduce the current consumption. The SleepMode of the microcontroller section can be defined in the EEPROM. The power-down configuration is recommended for keeping the current consumption at a minimum.
2. Only activated at 5V applications. This is selectable in the EEPROM settings.

## 4. Electrical Characteristics

All parameters refer to GND (backplane) and are valid for  $T_{AMB} = -40^{\circ}\text{C}$  to  $+110^{\circ}\text{C}$ ,  $V_S = 2.0\text{V}$  to  $3.6\text{V}$  (3V application) and  $2.4\text{V}$  to  $5.5\text{V}$  (5V application) over all process tolerances unless otherwise specified. Typical values are given at  $V_S = 5\text{V}$ ,  $T_{AMB} = +25^{\circ}\text{C}$  and for a typical process unless otherwise specified. Crystal oscillator frequency,  $F_{XTO} = 24.305\text{ MHz}$ . Default EEPROM settings are used unless stated otherwise.

Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these, or any other conditions beyond those indicated in the operational sections of this specification, is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

The following abbreviations and symbols are used throughout the Electrical Characteristics section:

- BER: Bit Error Rate
- CLK\_BB: Baseband Clock (dependent on channel filter bandwidth)
- degC: Degree Celcius
- DEV: FSK Deviation (+/-)
- DIV\_IF: Intermediate Frequency Divider
- DR: Data Rate
- F\_CLKOUT: Output Clock Frequency at pin 22
- F\_IF: Intermediate Frequency
- F\_LO: Local Oscillator Frequency
- F\_RF: RF Carrier Frequency
- F\_XTO: Crystal Oscillator Frequency
- F\_XTO4: Crystal Oscillator Frequency Divided by 4 (default AVR clock)
- IF\_BW: Channel Filter Bandwidth
- I\_OH: Output Pin High-State Current
- I\_OL: Output Pin Low-State Current
- Low Band: 315 MHz and 434 MHz bands
- High Band: 868 MHz and 915 MHz bands
- P\_OUT: Output Power
- T\_AMB: Ambient Temperature
- VS: Supply Voltage at pin 19
- VS\_PA: Supply Voltage at pin 8

### 4.1 Absolute Maximum Ratings

**Table 4-1. Absolute Maximum Ratings**

No.	Parameter	Comment	Pin	Min	Typ	Max	Unit
00.10	Junction Temperature	—	—	—	—	150	degC
00.20	Storage Temperature	—	—	-55	—	125	degC
00.30	Ambient Temperature	—	—	-40	—	105	degC
00.40	Supply Voltage	—	—	-0.3	—	6	V
00.50	Supply Voltage PA	2.0 - 3.6V application	—	-0.3	—	4	V
00.60	ESD Human Body Model	—	—	-4	—	4	kV
00.65	ESD Field Induced Charge Device Model	—	—	-750	—	750	V
00.70	Maximum Peak Voltage at Pin 2 (SPDT_ANT1)	—	—	-0.3	—	VS_PA + 0.3	V

# ATA8535

## Electrical Characteristics

.....continued

No.	Parameter	Comment	Pin	Min	Typ	Max	Unit
00.71	Maximum Peak Voltage at Pin 3 (SPDT_ANT2)	—	—	-0.3	—	VS_PA + 0.3	V
00.72	Maximum Peak Voltage at Pin 4 (SPDT_ANT3)	—	—	-0.3	—	VS_PA + 0.3	V
00.75	Maximum Peak Voltage at Pin 5 (SPDT_TX)	—	—	-0.3	—	VS_PA + 0.3	V

## 4.2 Thermal Resistance

Table 4-2. Thermal Resistance

No.	Parameter	Comment	Pin	Min	Typ	Max	Unit
99.00	Thermal Resistance	Junction ambient, soldered according to JEDEC	—	—	35	—	K/W

## 4.3 Supply Voltages and Current Consumption

Table 4-3. Supply Voltages and Current Consumption

No.	Parameter	Comment	Pin	Min	Typ	Max	Unit
01.00	Supply Voltage VS, 3V Application	—	19	2	3	3.6	V
01.01	Supply Voltage VS, 5V Application	—	19	2.4	5	5.5	V
01.03	Supply Voltage VS with Activated DC-DC Converter	—	19	4.5	—	5.5	V
01.05	Supply Voltage (VS) Rise Time (VS_rise)	—	19	6	—	2500	us
01.07	Delay Between Supply Voltage (VS) and PWRON (PB4) High State	This parameter is a requirement for the application	19, 26	VS_rise/3	—	—	us
01.10	Power Amplifier Supply Voltage VS_PA	Externally applied to pin VS_PA	8	2	—	3.6	V
01.20	OFFMode Current Consumption, VS = VS_PA = 3V, T_AMB = 25degC	—	8, 19	—	5	150	nA
01.21	OFFMode Current Consumption, VS = VS_PA = 3V, T_AMB = 85degC	—	8, 19	—	—	600	nA
01.22	OFFMode Current Consumption, VS = VS_PA = 3V, T_AMB = +110	—	8, 19	—	—	7000	nA
01.23	OFFMode Current Consumption, VS = 5V, T_AMB = +110	VS_PA internally supplied	19	—	5	5000	nA
01.30	IDLEMode(RC) Current Consumption	AVR in power-down, XTO off	19	—	40	80	uA
01.40	IDLEMode(XTO) Current Consumption	AVR in power-down, XTO active	19	—	250	400	uA
01.60	IDLEMode(XTO) Current Consumption, CLK_OUT Active	Active CLK_OUT with 4.05 MHz and 10 pF load, VS = 5.5V, AVR running on XTO	19, 22	—	700	1200	uA
01.80	RXMode Current Consumption F_RF = 315 MHz	Normal Sensitivity mode, DC-DC Converter off	19	—	9.2	12	mA
01.81	RXMode Current Consumption F_RF = 434 MHz	Normal Sensitivity mode, DC-DC Converter off	19	—	9.4	12.2	mA

# ATA8535

## Electrical Characteristics

.....continued

No.	Parameter	Comment	Pin	Min	Typ	Max	Unit
01.82	RXMode Current Consumption F_RF = 868 MHz	Normal Sensitivity mode, DC-DC Converter off	19	—	10.4	14.6	mA
01.83	RXMode Current Consumption F_RF = 915 MHz	Normal Sensitivity mode, DC-DC Converter off	19	—	10.4	14.7	mA
01.85	RXMode Current Consumption Add-On in High Sensitivity Mode	—	19	—	1.5	2	mA
01.90	RXMode Current Consumption Reduction with Activated DC-DC Converter	VS = 5V	19	—	30	—	%
02.00	TXMode Current Consumption, P_OUT = 6 dBm, F_RF = 315 MHz	VS = 3V, DC-DC Converter off	8, 19	—	8.9	11	mA
02.01	TXMode Current Consumption, P_OUT = 6 dBm, F_RF = 434 MHz	VS = 3V, DC-DC Converter off	8, 19	—	9.4	12	mA
02.02	TXMode Current Consumption, P_OUT = 6 dBm, F_RF = 868 MHz	VS = 3V, DC-DC Converter off	8, 19	—	11.5	14.5	mA
02.03	TXMode Current Consumption, P_OUT = 6 dBm, F_RF = 915 MHz	VS = 3V, DC-DC Converter off	8, 19	—	11.7	15	mA
02.10	TXMode Current Consumption Factor for P_OUT = 10 dBm	VS = 3V, related to parameters 2.00 to 2.03	8, 19	—	1.5	1.6	—
02.15	TXMode Current Consumption Factor for P_OUT = 14 dBm	VS = 3V, related to parameters 2.00 to 2.03	8, 19	—	2.8	3	—
02.20	TXMode Current Consumption Reduction with Activated DC-DC Converter	VS = 5V	19	—	15	—	%

## 4.4 RF Receive Characteristics

Table 4-4. RF Receive Characteristics

No.	Parameter	Comment	Pin	Min	Typ	Max	Unit
03.00	RF Operation Range 315 MHz Low Band	—	31, 7	310	315	318	MHz
03.10	RF Operation Range 433 MHz Low Band	—	31, 7	418	434	477	MHz
03.30	RF Operation Range High Band	—	31, 7	836	868	928	MHz
03.40	Frequency Resolution PLL Low Band	$F_{XTO} / 2^{18}$	31, 7	—	92.72	—	Hz
03.41	Frequency Resolution PLL High Band	$F_{XTO} / 2^{17}$	31, 7	—	185.43	—	Hz
04.00	Receiver 3 dB Bandwidth	Programmable digital IF filter	31	25	165	366	kHz
04.10	Data Rate, IF_BW = 25 kHz	ASK/FSK, Manchester, transparent output	31	0.25	—	7	Kbit/s
04.11	Data Rate, IF_BW = 50 kHz	ASK/FSK, Manchester, transparent output	31	0.25	—	14	Kbit/s
04.12	Data Rate, IF_BW = 80 kHz	ASK/FSK, Manchester, transparent output	31	0.25	—	20	Kbit/s
04.13	Data Rate, IF_BW = 165 kHz	ASK/FSK, Manchester, transparent output	31	0.25	—	50	Kbit/s
04.14	Data Rate, IF_BW = 237 kHz	ASK/FSK, Manchester, transparent output	31	0.25	—	80	Kbit/s
04.15	Data Rate, IF_BW = 366 kHz	ASK/FSK, Manchester, transparent output	31	0.25	—	80	Kbit/s
04.20	Modulation Index FSK Limit	(Frequency deviation) / (symbol rate)	31	0.5	—	360	—
04.21	Modulation Index FSK Recommendation	(Frequency deviation) / (symbol rate)	31	0.75	1	1.25	—

# ATA8535

## Electrical Characteristics

.....continued

No.	Parameter	Comment	Pin	Min	Typ	Max	Unit
04.30	Frequency Deviation (+/-), IF_BW = 25 kHz	Maximum deviation = CLK_BB / 8	31	0.375	—	9	kHz
04.31	Frequency Deviation (+/-), IF_BW = 50 kHz	Maximum deviation = CLK_BB / 8	31	0.75	—	18	kHz
04.32	Frequency Deviation (+/-), IF_BW = 80 kHz	Maximum deviation = CLK_BB / 8	31	1.2	—	26	kHz
04.33	Frequency Deviation (+/-), IF_BW = 165 kHz	Maximum deviation = CLK_BB / 8	31	2.5	—	60	kHz
04.34	Frequency Deviation (+/-), IF_BW = 237 kHz	Maximum deviation = CLK_BB / 8	31	3.5	—	93	kHz
04.35	Frequency Deviation (+/-), IF_BW = 366 kHz	Maximum deviation = CLK_BB / 8	31	5.4	—	93	kHz
04.40	Symbol Rate, IF_BW = 25 kHz	ASK/FSK, NRZ, Keyloq, PPM, 1/3 2/3 coding, transparent output	31	0.5	—	14	Ksym/s
04.41	Symbol Rate, IF_BW = 50 kHz	ASK/FSK, NRZ, Keyloq, PPM, 1/3 2/3 coding, transparent output	31	0.5	—	28	Ksym/s
04.42	Symbol Rate, IF_BW = 80 kHz	ASK/FSK, NRZ, Keyloq, PPM, 1/3 2/3 coding, transparent output	31	0.5	—	40	Ksym/s
04.43	Symbol Rate, IF_BW = 165 kHz	ASK/FSK, NRZ, Keyloq, PPM, 1/3 2/3 coding, transparent output	31	0.5	—	100	Ksym/s
04.44	Symbol Rate, IF_BW = 237 kHz	ASK/FSK, NRZ, Keyloq, PPM, 1/3 2/3 coding, transparent output	31	0.5	—	160	Ksym/s
04.45	Symbol Rate, IF_BW = 366 kHz	ASK/FSK, NRZ, Keyloq, PPM, 1/3 2/3 coding, transparent output	31	0.5	—	160	Ksym/s
04.70	Data Rate Tolerance	ASK/FSK, loss of sensitivity less than 1 dB	31	-10	—	10	%
04.80	Data Rate Buffered, Manchester	—	31	0.25	—	80	Kbit/s
04.81	Data Rate Buffered, NRZ	—	31	0.5	—	120	Ksym/s
04.90	Sensitivity FSK, DR = 0.75 Kbit/s, DEV = +/-0.75 kHz, IF_BW = 25 kHz	Low band, high sensitivity setting, Manchester coding, T_AMB = 25degC, DC-DC Converter off, min/max relative to typ.	(31), 15, 17	-1.5	-124	+1.5	dBm
04.91	Sensitivity FSK, DR = 2.4 Kbit/s, DEV = +/-2.4 kHz, IF_BW = 25 kHz	Low band, high sensitivity setting, Manchester coding, T_AMB = 25degC, DC-DC Converter off, min/max relative to typ.	(31), 15, 17	-1.5	-118.5	+1.5	dBm
04.92	Sensitivity FSK, DR = 5 Kbit/s, DEV = +/-5kHz, IF_BW = 25 kHz	Low band, high sensitivity setting, Manchester coding, T_AMB = 25degC, DC-DC Converter off, min/max relative to typ.	(31), 15, 17	-1.5	-116	+1.5	dBm
05.00	Sensitivity FSK, DR = 2.4 Kbit/s, DEV = +/-2.4 kHz, IF_BW = 80 kHz	Low band, high sensitivity setting, Manchester coding, T_AMB = 25degC, DC-DC Converter off, min/max relative to typ.	(31), 15, 17	-1.5	-118.5	+1.5	dBm
05.01	Sensitivity FSK, DR = 10 Kbit/s, DEV = +/-10 kHz, IF_BW = 80 kHz	Low band, high sensitivity setting, Manchester coding, T_AMB = 25degC, DC-DC Converter off, min/max relative to typ.	(31), 15, 17	-1.5	-113	+1.5	dBm
05.02	Sensitivity FSK, DR = 20 Kbit/s, DEV = +/-20 kHz, IF_BW = 80 kHz	Low band, high sensitivity setting, Manchester coding, T_AMB = 25degC, DC-DC Converter off, min/max relative to typ.	(31), 15, 17	-1.5	-110.5	+1.5	dBm
05.10	Sensitivity FSK, DR = 5 Kbit/s, DEV = +/-5 kHz, IF_BW = 165 kHz	Low band, high sensitivity setting, Manchester coding, T_AMB = 25degC, DC-DC Converter off, min/max relative to typ.	(31), 15, 17	-1.5	-115	+1.5	dBm
05.11	Sensitivity FSK, DR = 10 Kbit/s, DEV = +/-10 kHz, IF_BW = 165 kHz	Low band, high sensitivity setting, Manchester coding, T_AMB = 25degC, DC-DC Converter off, min/max relative to typ.	(31), 15, 17	-1.5	-113	+1.5	dBm

# ATA8535

## Electrical Characteristics

.....continued

No.	Parameter	Comment	Pin	Min	Typ	Max	Unit
05.12	Sensitivity FSK, DR = 20 Kbit/s, DEV = +/-20 kHz, IF_BW = 165 kHz	Low band, high sensitivity setting, Manchester coding, T_AMB = 25degC, DC-DC Converter off, min/max relative to typ.	(31), 15, 17	-1.5	-109.5	+1.5	dBm
05.13	Sensitivity FSK, DR = 40 Kbit/s, DEV = +/-40 kHz, IF_BW = 165 kHz	Low band, high sensitivity setting, Manchester coding, T_AMB = 25degC, DC-DC Converter off, min/max relative to typ.	(31), 15, 17	-1.5	-107	+1.5	dBm
05.20	Sensitivity FSK, DR = 20 Kbit/s, DEV = +/-20 kHz, IF_BW = 366 kHz	Low band, high sensitivity setting, Manchester coding, T_AMB = 25degC, DC-DC Converter off, min/max relative to typ.	(31), 15, 17	-1.5	-109.5	+1.5	dBm
05.21	Sensitivity FSK, DR = 80 Kbit/s, DEV = +/-80 kHz, IF_BW = 366 kHz	Low band, high sensitivity setting, Manchester coding, T_AMB = 25degC, DC-DC Converter off, min/max relative to typ.	(31), 15, 17	-1.5	-103.5	+1.5	dBm
05.30	Sensitivity ASK, DR = 0.5 Kbit/s, IF_BW = 25 kHz	Low band, high sensitivity setting, Manchester coding, T_AMB = 25degC, DC-DC Converter off, min/max relative to typ.	(31), 15, 17	-1.5	-127	+1.5	dBm
05.31	Sensitivity ASK, DR = 5 Kbit/s, IF_BW = 25 kHz	Low band, high sensitivity setting, Manchester coding, T_AMB = 25degC, DC-DC Converter off, min/max relative to typ.	(31), 15, 17	-1.5	-118	+1.5	dBm
05.40	Sensitivity ASK, DR = 1 Kbit/s, IF_BW = 80 kHz	Low band, high sensitivity setting, Manchester coding, T_AMB = 25degC, DC-DC Converter off, min/max relative to typ.	(31), 15, 17	-1.5	-123	+1.5	dBm
05.41	Sensitivity ASK, DR = 20 Kbit/s, IF_BW = 80 kHz	Low band, high sensitivity setting, Manchester coding, T_AMB = 25degC, DC-DC Converter off, min/max relative to typ.	(31), 15, 17	-1.5	-112.5	+1.5	dBm
05.50	Sensitivity ASK, DR = 1 Kbit/s, IF_BW = 165 kHz	Low band, high sensitivity setting, Manchester coding, T_AMB = 25degC, DC-DC Converter off, min/max relative to typ.	(31), 15, 17	-1.5	-122	+1.5	dBm
05.51	Sensitivity ASK, DR = 40 Kbit/s, IF_BW = 165 kHz	Low band, high sensitivity setting, Manchester coding, T_AMB = 25degC, DC-DC Converter off, min/max relative to typ.	(31), 15, 17	-1.5	-109	+1.5	dBm
05.60	Sensitivity ASK, DR = 1 Kbit/s, IF_BW = 366 kHz	Low band, high sensitivity setting, Manchester coding, T_AMB = 25degC, DC-DC Converter off, min/max relative to typ.	(31), 15, 17	-1.5	-119	+1.5	dBm
05.61	Sensitivity ASK, DR = 80 Kbit/s, IF_BW = 366 kHz	Low band, high sensitivity setting, Manchester coding, T_AMB = 25degC, DC-DC Converter off, min/max relative to typ.	(31), 15, 17	-1.5	-105	+1.5	dBm
05.70	Sensitivity Change High Band	Change compared to 315/434 MHz normal sensitivity setting	31	—	1	—	dB
05.75	Sensitivity Change Normal Sensitivity	Compared to high sensitivity setting	31	—	2	—	dB
05.80	Sensitivity Change Full Ambient Temperature Range, Low Band	—	31	-1.5	—	2	dB
05.81	Sensitivity Change Full Ambient Temperature Range, High Band	—	31	-2	—	3	dB
05.90	Sensitivity Change NRZ, FSK	—	31	-1	0	2	dB
05.91	Sensitivity Change NRZ, ASK	—	31	0	2	4	dB
05.95	Sensitivity Change with Active DC-DC Converter	Application board assembled with band-dependent VS filtering	31	—	—	1	dB

# ATA8535

## Electrical Characteristics

.....continued							
No.	Parameter	Comment	Pin	Min	Typ	Max	Unit
06.30	Value Change from ASK Level to OOK Level	To calculate OOK values from ASK 100% level of carrier	(31)	—	6	—	dB
06.90	Blocking, Low Band, IF_BW = 25 kHz, DR = 2.4 Kbit/s, DEV = +/-2.4 kHz, 50 kHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	40	—	dBc
06.91	Blocking, Low Band, IF_BW = 25 kHz, DR = 2.4 Kbit/s, DEV = +/-2.4 kHz, 100 kHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	46	—	dBc
06.92	Blocking, Low Band, IF_BW = 25 kHz, DR = 2.4 Kbit/s, DEV = +/-2.4 kHz, 225 kHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	58	—	dBc
06.93	Blocking, Low Band, IF_BW = 25 kHz, DR = 2.4 Kbit/s, DEV = +/-2.4 kHz, 450 kHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	64	—	dBc
06.94	Blocking, Low Band, IF_BW = 25 kHz, DR = 2.4 Kbit/s, DEV = +/-2.4 kHz, 1 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	73	—	dBc
06.95	Blocking, Low Band, IF_BW = 25 kHz, DR = 2.4 Kbit/s, DEV = +/-2.4 kHz, 4 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	78	—	dBc
06.96	Blocking, Low Band, IF_BW = 25 kHz, DR = 2.4 Kbit/s, DEV = +/-2.4 kHz, 10 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	78	—	dBc
07.00	Blocking, Low Band, IF_BW = 80 kHz, DR = 10 Kbit/s, DEV = +/-10 kHz, 150 kHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	45	—	dBc
07.01	Blocking, Low Band, IF_BW = 80 kHz, DR = 10 Kbit/s, DEV = +/-10 kHz, 225 kHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	52	—	dBc
07.02	Blocking, Low Band, IF_BW = 80 kHz, DR = 10 Kbit/s, DEV = +/-10 kHz, 450 kHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	58	—	dBc
07.03	Blocking, Low Band, IF_BW = 80 kHz, DR = 10 Kbit/s, DEV = +/-10 kHz, 1 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	67	—	dBc
07.04	Blocking, Low Band, IF_BW = 80 kHz, DR = 10 Kbit/s, DEV = +/-10 kHz, 4 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	71	—	dBc
07.05	Blocking, Low Band, IF_BW = 80 kHz, DR = 10 Kbit/s, DEV = +/-10 kHz, 10 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	71	—	dBc
07.10	Blocking, Low Band, IF_BW = 165 kHz, DR = 20 Kbit/s, DEV = +/-20 kHz, 225 kHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	48	—	dBc
07.11	Blocking, Low Band, IF_BW = 165 kHz, DR = 20 Kbit/s, DEV = +/-20 kHz, 450 kHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	54	—	dBc

# ATA8535

## Electrical Characteristics

.....continued

No.	Parameter	Comment	Pin	Min	Typ	Max	Unit
07.12	Blocking, Low Band, IF_BW = 165 kHz, DR = 20 Kbit/s, DEV = +/-20 kHz, 1 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	64	—	dBc
07.13	Blocking, Low Band, IF_BW = 165 kHz, DR = 20 Kbit/s, DEV = +/-20 kHz, 4 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	68	—	dBc
07.14	Blocking, Low Band, IF_BW = 165 kHz, DR = 20 Kbit/s, DEV = +/-20 kHz, 10 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	68	—	dBc
07.20	Blocking, Low Band, IF_BW = 366 kHz, DR = 20 Kbit/s, DEV = +/-20 kHz, 500 kHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	55	—	dBc
07.21	Blocking, Low Band, IF_BW = 366 kHz, DR = 20 Kbit/s, DEV = +/-20 kHz, 1 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	64	—	dBc
07.22	Blocking, Low Band, IF_BW = 366 kHz, DR = 20 Kbit/s, DEV = +/-20 kHz, 4 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	68	—	dBc
07.23	Blocking, Low Band, IF_BW = 366 kHz, DR = 20 Kbit/s, DEV = +/-20 kHz, 10 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	68	—	dBc
07.30	Blocking, High Band, IF_BW = 25 kHz, DR = 2.4 Kbit/s, DEV = +/-2.4 kHz, 50 kHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	34	—	dBc
07.31	Blocking, High Band, IF_BW = 25 kHz, DR = 2.4 Kbit/s, DEV = +/-2.4 kHz, 100 kHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	40	—	dBc
07.32	Blocking, High Band, IF_BW = 25 kHz, DR = 2.4 Kbit/s, DEV = +/-2.4 kHz, 225 kHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	52	—	dBc
07.33	Blocking, High Band, IF_BW = 25 kHz, DR = 2.4 Kbit/s, DEV = +/-2.4 kHz, 450 kHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	58	—	dBc
07.34	Blocking, High Band, IF_BW = 25 kHz, DR = 2.4 Kbit/s, DEV = +/-2.4 kHz, 1 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	67	—	dBc
07.35	Blocking, High Band, IF_BW = 25 kHz, DR = 2.4 Kbit/s, DEV = +/-2.4 kHz, 4 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	75	—	dBc
07.36	Blocking, High Band, IF_BW = 25 kHz, DR = 2.4 Kbit/s, DEV = +/-2.4 kHz, 10 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	75	—	dBc
07.40	Blocking, High Band, IF_BW = 80 kHz, DR = 10 Kbit/s, DEV = +/-10 kHz, 150 kHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	39	—	dBc
07.41	Blocking, High Band, IF_BW = 80 kHz, DR = 10 Kbit/s, DEV = +/-10 kHz, 225 kHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	46	—	dBc

# ATA8535

## Electrical Characteristics

.....continued

No.	Parameter	Comment	Pin	Min	Typ	Max	Unit
07.42	Blocking, High Band, IF_BW = 80 kHz, DR = 10 Kbit/s, DEV = +/-10 kHz, 450 kHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	52	—	dBc
07.43	Blocking, High Band, IF_BW = 80 kHz, DR = 10 Kbit/s, DEV = +/-10 kHz, 1 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	62	—	dBc
07.44	Blocking, High Band, IF_BW = 80 kHz, DR = 10 Kbit/s, DEV = +/-10 kHz, 4 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	68	—	dBc
07.45	Blocking, High Band, IF_BW = 80 kHz, DR = 10 Kbit/s, DEV = +/-10 kHz, 10 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	68	—	dBc
07.50	Blocking, High Band, IF_BW = 165 kHz, DR = 20 Kbit/s, DEV = +/-20 kHz, 225 kHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	42	—	dBc
07.51	Blocking, High Band, IF_BW = 165 kHz, DR = 20 Kbit/s, DEV = +/-20 kHz, 450 kHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	48	—	dBc
07.52	Blocking, High Band, IF_BW = 165 kHz, DR = 20 Kbit/s, DEV = +/-20 kHz, 1 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	58	—	dBc
07.53	Blocking, High Band, IF_BW = 165 kHz, DR = 20 Kbit/s, DEV = +/-20 kHz, 4 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	65	—	dBc
07.54	Blocking, High Band, IF_BW = 165 kHz, DR = 20 Kbit/s, DEV = +/-20 kHz, 10 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	65	—	dBc
07.60	Blocking, High Band, IF_BW = 165 kHz, DR = 20 Kbit/s, DEV = +/-20 kHz, 500 kHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	49	—	dBc
07.61	Blocking, High Band, IF_BW = 165 kHz, DR = 20 Kbit/s, DEV = +/-20 kHz, 1 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	58	—	dBc
07.62	Blocking, High Band, IF_BW = 165 kHz, DR = 20 Kbit/s, DEV = +/-20 kHz, 4 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	65	—	dBc
07.63	Blocking, High Band, IF_BW = 165 kHz, DR = 20 Kbit/s, DEV = +/-20 kHz, 10 MHz Distant from Carrier	FSK, Manchester, useful signal 3 dB above sensitivity level, BER = 10e-3, excluding spurious	(31)	—	65	—	dBc
07.70	Image Rejection 315 MHz	Disturber present before wanted signal	31, 32, 5	40	45	—	dB
07.71	Image Rejection 434 MHz	Disturber present before wanted signal	31, 32, 5	50	55	—	dB
07.72	Image Rejection 868 MHz	Disturber present before wanted signal	31, 32, 5	22	25	—	dB
07.80	Blocking 3 * F_LO, Low Band	3 * F_LO - F_IF	(31)	32	37	42	dB
07.81	Blocking 5 * F_LO, Low Band	5 * F_LO + F_IF	(31)	28	33	38	dB
07.85	Blocking 3 * F_LO, High Band	3 * F_LO - F_IF	(31)	—	49	—	dB
07.86	Blocking 5 * F_LO, High Band	5 * F_LO + F_IF	(31)	—	48	—	dB

# ATA8535

## Electrical Characteristics

.....continued

No.	Parameter	Comment	Pin	Min	Typ	Max	Unit
07.90	Nominal IF Frequency	RxDSP property depends on nominal RF and DIV_IF; $F_{IF} = F_{RF} / (DIV\_IF * 6)$	(31)	242	251	276	kHz
08.00	Signal to Interferer Ratio, FSK, Modulation Index 0.5	Peak level of useful signal to peak level of interferer for BER = 10e-3	(31)	—	8	10	dB
08.01	Signal to Interferer Ratio, FSK, Modulation Index 1	Peak level of useful signal to peak level of interferer for BER = 10e-3	(31)	—	4	6	dB
08.02	Signal to Interferer Ratio, FSK, Modulation Index 1.6	Peak level of useful signal to peak level of interferer for BER = 10e-3	(31)	—	3	5	dB
08.03	Signal to Interferer Ratio, FSK, Modulation Index Above 3	Peak level of useful signal to peak level of interferer for BER = 10e-3	(31)	—	2	4	dB
08.05	Signal to Interferer Ratio, ASK	Peak level of useful signal to peak level of interferer for BER = 10e-3	(31)	—	10	12	dB
08.10	System Input Referred 1 dB Compression Point in High Sensitivity Mode	$F_{RF} = 434$ MHz, IF amplifier enabled	31	-52	—	—	dBm
08.11	System Input Referred 1 dB Compression Point in Normal Sensitivity Mode	$F_{RF} = 434$ MHz, IF amplifier disabled	31	-35	—	—	dBm
08.12	System Input Referred 1 dB Compression Point with Antenna Damping	$F_{RF} = 434$ MHz, antenna damping enabled	31	-20	—	—	dBm
08.15	System Input Referred 1 dB Out-of-Band Compression Point	1 MHz distance from carrier, LNA and input matching, normal sensitivity setting, IF amplifier enabled	31, 32, 5	—	-35	—	dBm
08.20	System Input Referred 3rd-Order Intercept Point, Low Band	Normal sensitivity setting	(31)	—	-35	—	dBm
08.21	System Input Referred 3rd-Order Intercept Point, High Band	Normal sensitivity setting	(31)	—	-37	—	dBm
08.30	Maximum Useful RX Input Level, Damping Deactivated	BER less than $10^{-3}$	(31)	-10	10	—	dBm
08.49	Input Impedance Real, 315 MHz	Measured on application board, Normal Sensitivity mode	31	625	780	940	Ohm
08.50	Input Impedance Imag, 315 MHz	Measured on application board, Normal Sensitivity mode	31	2.5	3.1	3.7	pF
08.51	Input Impedance Real, 434 MHz	Measured on application board, Normal Sensitivity mode	31	250	310	370	Ohm
08.52	Input Impedance Imag, 434 MHz	Measured on application board, Normal Sensitivity mode	31	1.8	2.2	2.6	pF
08.53	Input Impedance Real, 868 MHz	Measured on application board, Normal Sensitivity mode	31	320	400	480	Ohm
08.54	Input Impedance Imag, 868 MHz	Measured on application board, Normal Sensitivity mode	31	1.35	1.7	2.05	pF
08.55	Input Impedance Real, 915 MHz	Measured on application board, Normal Sensitivity mode	31	320	400	480	Ohm
08.56	Input Impedance Imag, 915 MHz	Measured on application board, Normal Sensitivity mode	31	1.35	1.7	2.05	pF
08.60	LNA Saturation Level	Normal Sensitivity mode enabled, low band	31	-45	—	-39	dBm

# ATA8535

## Electrical Characteristics

.....continued

No.	Parameter	Comment	Pin	Min	Typ	Max	Unit
08.70	RF Switch RX Insertion Loss ANT1	SPDT_RX with SPDT_ANT1 matched to 50 Ohms, F_RF = 434 MHz	1, 2	0.5	0.8	1.2	dB
08.71	RF Switch RX Insertion Loss ANT2	SPDT_RX with SPDT_ANT2 matched to 50 Ohms, F_RF = 434 MHz	1, 3	0.5	0.8	1.2	dB
08.72	RF Switch RX Insertion Loss ANT3	SPDT_RX with SPDT_ANT3 matched to 50 Ohms, F_RF = 434 MHz	1, 4	0.5	0.8	1.2	dB
08.90	LO Spurious at LNA Input Below 1 GHz	—	(31)	—	-86	-60	dBm
08.91	LO Spurious at LNA Input Above 1 GHz	—	(31)	—	-60	-50	dBm
09.00	RSSI Absolute Accuracy, Low Band	Input power -70 dBm	(31)	-5	—	5	dB
09.01	RSSI Absolute Accuracy, High Band	Input power -70 dBm	(31)	-5.5	—	5.5	dB
09.10	RSSI Relative Accuracy	Input power -100 dBm to -50 dBm	(31)	-1	—	1	dB
09.20	RSSI Resolution	DSP property	(31)	—	0.5	—	dB/value

## 4.5 RF Transmit Characteristics

Table 4-5. RF Transmit Characteristics

No.	Parameter	Comment	Pin	Min	Typ	Max	Unit
10.00	Output Power Range	VS_PA = 3.0V, T_AMB = 25degC	7	-12	—	14.5	dBm
10.10	Output Power Programming Steps	Optimum load impedance required for each step. Steps can be up to two times higher for fixed load impedance.	7	—	0.4	—	dB
10.20	Output Power at 6 dBm Low Band	VS_PA = 3.0V, T_AMB = 25degC, F_RF = 434 MHz, 6 dBm RFOUT matching, FEPAC = 35	7	4.5	6	7.5	dBm
10.21	Output Power at 6 dBm High Band	VS_PA = 3.0V, T_AMB = 25degC, F_RF = 868 MHz, 6 dBm RFOUT matching, FEPAC = 36	7	4.5	6	7.5	dBm
10.30	Output 6 dBm Second Harmonic Suppression 315 MHz	VS_PA = 3.0V, T_AMB = 25degC, 6 dBm RFOUT matching, FEPAC = 35	7	—	-32	—	dBc
10.31	Output 6 dBm Second Harmonic Suppression 434 MHz	VS_PA = 3.0V, T_AMB = 25degC, 6 dBm RFOUT matching, FEPAC = 35	7	—	-34	—	dBc
10.32	Output 6 dBm Second Harmonic Suppression 868 MHz	VS_PA = 3.0V, T_AMB = 25degC, 6 dBm RFOUT matching, FEPAC = 36	7	—	-35	—	dBc
10.33	Output 6 dBm Second Harmonic Suppression 915 MHz	VS_PA = 3.0V, T_AMB = 25degC, 6 dBm RFOUT matching, FEPAC = 36	7	—	-33	—	dBc
10.40	Output 6 dBm Third Harmonic Suppression 315 MHz	VS_PA = 3.0V, T_AMB = 25degC, 6 dBm RFOUT matching, FEPAC = 35	7	—	-29	—	dBc
10.41	Output 6 dBm Third Harmonic Suppression 434 MHz	VS_PA = 3.0V, T_AMB = 25degC, 6 dBm RFOUT matching, FEPAC = 35	7	—	-34	—	dBc
10.42	Output 6 dBm Third Harmonic Suppression 868 MHz	VS_PA = 3.0V, T_AMB = 25degC, 6 dBm RFOUT matching, FEPAC = 36	7	—	-53	—	dBc
10.43	Output 6 dBm Third Harmonic Suppression 915 MHz	VS_PA = 3.0V, T_AMB = 25degC, 6 dBm RFOUT matching, FEPAC = 36	7	—	-49	—	dBc
10.60	Output Power at 10 dBm Low Band	VS_PA = 3.0V, T_AMB = 25degC, F_RF = 434 MHz, 10 dBm RFOUT matching, FEPAC = 46	7	8.5	10	11.5	dBm

# ATA8535

## Electrical Characteristics

.....continued

No.	Parameter	Comment	Pin	Min	Typ	Max	Unit
10.61	Output Power at 10 dBm High Band	VS_PA = 3.0V, T_AMB = 25degC, F_RF = 868 MHz, 10 dBm RFOUT matching, FEPAC = 47	7	8.5	10	11.5	dBm
10.70	Output 10 dBm Second Harmonic Suppression 315 MHz	VS_PA = 3.0V, T_AMB = 25degC, 10 dBm RFOUT matching, FEPAC = 46	7	—	-24	—	dBc
10.71	Output 10 dBm Second Harmonic Suppression 434 MHz	VS_PA = 3.0V, T_AMB = 25degC, 10 dBm RFOUT matching, FEPAC = 46	7	—	-28	—	dBc
10.72	Output 10 dBm Second Harmonic Suppression 868 MHz	VS_PA = 3.0V, T_AMB = 25degC, 10 dBm RFOUT matching, FEPAC = 47	7	—	-24	—	dBc
10.73	Output 10 dBm Second Harmonic Suppression 915 MHz	VS_PA = 3.0V, T_AMB = 25degC, 10 dBm RFOUT matching, FEPAC = 47	7	—	-27	—	dBc
10.80	Output 10 dBm Third Harmonic Suppression 315 MHz	VS_PA = 3.0V, T_AMB = 25degC, 10 dBm RFOUT matching, FEPAC = 46	7	—	-25	—	dBc
10.81	Output 10 dBm Third Harmonic Suppression 434 MHz	VS_PA = 3.0V, T_AMB = 25degC, 10 dBm RFOUT matching, FEPAC = 46	7	—	-31	—	dBc
10.82	Output 10 dBm Third Harmonic Suppression 868 MHz	VS_PA = 3.0V, T_AMB = 25degC, 10 dBm RFOUT matching, FEPAC = 47	7	—	-40	—	dBc
10.83	Output 10 dBm Third Harmonic Suppression 915 MHz	VS_PA = 3.0V, T_AMB = 25degC, 10 dBm RFOUT matching, FEPAC = 47	7	—	-42	—	dBc
11.00	Output Power at 14 dBm Low Band	VS_PA = 3.0V, T_AMB = 25degC, F_RF = 434 MHz, 14 dBm RFOUT matching, FEPAC = 56	7	12.5	14	15.5	dBm
11.01	Output Power at 14 dBm High Band	VS_PA = 3.0V, T_AMB = 25degC, F_RF = 868 MHz, 14 dBm RFOUT matching, FEPAC = 57	7	12.5	14	15.5	dBm
11.10	Output 14 dBm Second Harmonic Suppression 315 MHz	VS_PA = 3.0V, T_AMB = 25degC, 14 dBm RFOUT matching, FEPAC = 56	7	—	-36	—	dBc
11.11	Output 14 dBm Second Harmonic Suppression 434 MHz	VS_PA = 3.0V, T_AMB = 25degC, 14 dBm RFOUT matching, FEPAC = 56	7	—	-30	—	dBc
11.12	Output 14 dBm Second Harmonic Suppression 868 MHz	VS_PA = 3.0V, T_AMB = 25degC, 14 dBm RFOUT matching, FEPAC = 57	7	—	-23	—	dBc
11.13	Output 14 dBm Second Harmonic Suppression 915 MHz	VS_PA = 3.0V, T_AMB = 25degC, 14 dBm RFOUT matching, FEPAC = 57	7	—	-20	—	dBc
11.20	Output 14 dBm Third Harmonic Suppression 315 MHz	VS_PA = 3.0V, T_AMB = 25degC, 14 dBm RFOUT matching, FEPAC = 56	7	—	-26	—	dBc
11.21	Output 14 dBm Third Harmonic Suppression 434 MHz	VS_PA = 3.0V, T_AMB = 25degC, 14 dBm RFOUT matching, FEPAC = 56	7	—	-28	—	dBc
11.22	Output 14 dBm Third Harmonic Suppression 868 MHz	VS_PA = 3.0V, T_AMB = 25degC, 14 dBm RFOUT matching, FEPAC = 57	7	—	-33	—	dBc
11.23	Output 14 dBm Third Harmonic Suppression 915 MHz	VS_PA = 3.0V, T_AMB = 25degC, 14 dBm RFOUT matching, FEPAC = 57	7	—	-30	—	dBc
11.40	Output Power Variation Below 10 dBm, VS_PA = 3V, Full Temperature Range	All RF frequencies, PA internally supplied, VS above 3.1V	7	-1.5	—	1.5	dB
11.41	Output Power Variation Below 10 dBm, VS_PA = 2.7V to 3.3V, Full Temperature Range	All RF frequencies, PA supplied via VS_PA pin in 5V application	7	-3	—	2	dB
11.42	Output Power Variation Below 10 dBm, VS_PA = 2.0V to 3.6V, Full Temperature Range	All RF frequencies, PA supplied via VS_PA pin in 3V application	7	-5.5	—	2.5	dB

# ATA8535

## Electrical Characteristics

.....continued

No.	Parameter	Comment	Pin	Min	Typ	Max	Unit
11.50	Output Power Variation Above 10 dBm, VS_PA = 3V, Full Temperature Range	All RF frequencies, PA internally supplied, VS above 3.1V	7	-3	—	1.5	dB
11.51	Output Power Variation Above 10 dBm, VS_PA = 2.7V to 3.3V, Full Temperature Range	All RF frequencies, PA supplied via VS_PA pin in 5V application	7	-4	—	2.5	dB
11.52	Output Power Variation Above 10 dBm, VS_PA = 2.1V to 3.6V, Full Temperature Range	All RF frequencies, PA supplied via VS_PA pin in 3V application	7	-6	—	3	dB
11.60	Spurious Emission at F_RF +/- F_XTO, Low Band	—	7	—	-80	-65	dBc
11.61	Spurious Emission at F_RF +/- F_AVR, Low Band	Default AVR frequency: F_XTO / 4	7	—	-85	-65	dBc
11.62	Spurious Emission at F_RF +/- F_CLKOUT, Low Band	Default output clock frequency: F_XTO / 6	7	—	-80	-65	dBc
11.65	Spurious Emission at F_RF +/- F_XTO, High Band	—	7	—	-72	-60	dBc
11.66	Spurious Emission at F_RF +/- F_AVR, High Band	Default AVR frequency: F_XTO / 4	7	—	-85	-60	dBc
11.67	Spurious Emission at F_RF +/- F_CLKOUT, high band	Default output clock frequency: F_XTO / 6	7	—	-78	-60	dBc
11.70	Tx Transparent Data Rate in Manchester Operation	Pre-emphasis must be enabled for symbol rates above 40 Kbit/s	7, 16	—	—	80	Kbit/s
11.71	Tx Transparent Data Rate in NRZ Operation	Pre-emphasis must be enabled for symbol rates above 40 Kbit/s	7, 16	—	—	160	Ksym/s
11.80	Tx Buffered Data Rate in Manchester Operation	Pre-emphasis must be enabled for symbol rates above 40 Kbit/s	7	—	—	80	Kbit/s
11.81	Tx Buffered Data Rate in NRZ Operation	Pre-emphasis must be enabled for symbol rates above 40 Kbit/s	7	—	—	160	Ksym/s
12.40	RF Switch TX Insertion Loss ANT1	SPDT_TX with SPDT_ANT1 matched to 50 Ohms, F_RF = 434 MHz	2, 5	0.5	0.8	1.2	dB
12.41	RF Switch TX Insertion Loss ANT2	SPDT_TX with SPDT_ANT2 matched to 50 Ohms, F_RF = 434 MHz	3, 5	0.5	0.8	1.2	dB
12.42	RF Switch TX Insertion Loss ANT3	SPDT_TX with SPDT_ANT3 matched to 50 Ohms, F_RF = 434 MHz	4, 5	0.5	0.8	1.2	dB

## 4.6 Oscillators and Clockout

Table 4-6. Oscillators and Clockout

No.	Parameter	Comment	Pin	Min	Typ	Max	Unit
13.00	CLK_OUT Equivalent Internal Capacitance	C_CLK, used for 13.10 current calculation	19, 22	—	7.5	10	pF
13.10	Supply Current Increase when CLK_OUT Active	$(C\_CLK + C\_LOAD) * VS * F\_CLK\_OUT$ with default C_CLK = 7.5 pF, C_LOAD = 10 pF, VS = 5V, F_CLK_OUT = 4.05 MHz	19	—	350	—	μA
13.30	XTO Frequency Range	—	9, 10	23.8	24.305	26.2	MHz
13.50	XTO Frequency Variance	C_m = 4 fF, full temperature and supply voltage range	9, 10	-4	—	4	ppm

# ATA8535

## Electrical Characteristics

.....continued

No.	Parameter	Comment	Pin	Min	Typ	Max	Unit
13.60	Required C <sub>0</sub> of XTAL	Shunt capacitance, XTAL parameter	9, 10	—	1	2	pF
13.70	Required C <sub>m</sub> of XTAL	Motional capacitance, XTAL parameter	9, 10	—	4	10	fF
13.80	XTO Impedance at Start-up, Real Part, Full Temperature Range	C <sub>m</sub> = 4 fF, C <sub>0</sub> = 1 pF, cold start at maximum T <sub>AMB</sub> = +110°C	9, 10	950	—	—	Ohm
13.90	XTO Impedance at Start-up, Real Part, Reduced Temperature Range	C <sub>m</sub> = 4 fF, C <sub>0</sub> = 1 pF, cold start at maximum T <sub>AMB</sub> = 85°C	9, 10	1100	—	—	Ohm
14.00	Required R <sub>m</sub> after Start-up of XTAL	Serial resistance, XTAL parameter	9, 10	—	—	110	Ohm
14.10	XTO Internal Load Capacitance (C <sub>I</sub> )	Including ESD and package capacitance; XTAL has to be specified for 7.5 pF load capacitance (incl. 1 pF PCB capacitance per pin)	9, 10	13.3	14	14.7	pF
14.20	Slow RC (SRC) Oscillator Frequency	SRC-based polling cycle can be calibrated to +/-2% with internal XTO	—	115	125	135	kHz
14.30	Fast RC (FRC) Oscillator Frequency	FRC oscillator can be calibrated to +/-2% accuracy with internal XTO	—	6.04	6.36	6.68	MHz
14.40	External Clock Voltage	External 23.8 MHz to 26.2 MHz clock is applied to pin XTAL1, no crystal oscillator applied	9	0.25	—	1	V <sub>pp</sub>

## 4.7 I/O Characteristics PORTB and PORTC

Table 4-7. I/O Characteristics PORTB and PORTC

No.	Parameter	Comment	Pin	Min	Typ	Max	Unit
15.00	Input Low Voltage	—	12-17, 22-29	-0.3	—	0.2 * VS	V
15.05	Input Low Leakage Current	—	12-17, 22-29	—	—	-1	uA
15.10	Input High Voltage	—	12-17, 22-29	0.8 * VS	—	VS + 0.3	V
15.15	Input High Leakage Current	—	12-17, 22-29	—	—	1	uA
15.20	Output Low Voltage, 3V	VS = 3V, I <sub>OL</sub> = 0.2 mA	12-17, 22-29	—	—	0.1 * VS	V
15.21	Output Low Voltage, 5V	VS = 5V, I <sub>OL</sub> = 0.8 mA	12-17, 22-29	—	—	0.1 * VS	V
15.30	Output Low Voltage, 3V	VS = 3V, I <sub>OH</sub> = -0.2 mA	12-17, 22-29	0.9 * VS	—	—	V
15.31	Output Low Voltage, 5V	VS = 5V, I <sub>OH</sub> = -0.8 mA	12-17, 22-29	0.9 * VS	—	—	V
15.40	Pull-up Resistor	—	12-17, 22-29	30	50	70	kOhm
15.50	Output Low Voltage for Strong Low-Side Driver, 3V (PB7)	VS = 3V, I <sub>OL</sub> = 1.5 mA	29	—	—	0.1 * VS	V
15.51	Output Low Voltage for Strong Low-Side Driver, 5V (PB7)	VS = 5V, I <sub>OL</sub> = 5 mA	29	—	—	0.1 * VS	V

.....continued

No.	Parameter	Comment	Pin	Min	Typ	Max	Unit
15.60	Output High Voltage for Strong High-Side Driver, 3V (PB4, PB7)	VS = 3V, I <sub>OH</sub> = -1.5 mA	26, 29	0.9 * VS	—	—	V
15.61	Output High Voltage for Strong High-Side Driver, 5V (PB4, PB7)	VS = 5V, I <sub>OH</sub> = -5 mA	26, 29	0.9 * VS	—	—	V
15.70	Output Low Voltage for Strong Low-Side Driver (PB3)	Activated in ISP mode, I <sub>OL</sub> = 1.7 mA, VS above 2.5V, T <sub>AMB</sub> = -40°C to +110°C	25	—	—	0.1 * VS	V
15.80	Output High Voltage for Strong High-Side Driver (PB3)	Activated in ISP mode, I <sub>OL</sub> = -1.7 mA, VS above 2.5V, T <sub>AMB</sub> = -40°C to +110°C	25	0.9 * VS	—	—	V
15.90	CLK_OUT Frequency	XTO, FRC or SRC related clock	22	—	—	4.5	MHz

## 4.8 Hardware Timings

Table 4-8. Hardware Timings

No.	Parameter	Comment	Pin	Min	Typ	Max	Unit
17.00	XTO Start Time, R <sub>m</sub> Below 110 Ohms	C <sub>0</sub> below 1.5 pF, C <sub>m</sub> = 4 fF to 15 fF	9, 10	—	150	250	us
17.10	Erase and Write EEPROM	Using ISP commands or SPI command "Write EEPROM"	12, 23, 24, 25	—	—	10	ms
17.20	Erase Only EEPROM	Using ISP commands	12, 23, 24, 25	—	—	5	ms
17.30	Write Only EEPROM	Using ISP commands	12, 23, 24, 25	—	—	5	ms
17.50	System Initialization Start-up Time	From PWRON = 1 or NPWRON = 0 to internal reset removal	19	80	—	200	us

**5. Ordering Information**

Extended Type Number	Package	Remarks
ATA8535-GHQW-VAO	32-Lead QFN	5 mm x 5 mm, 6k tape and reel, PB-free, wettable flanks

## 6. Package Information

This section details the package marking information and package outline drawings.

### 6.1 Package Marking Information

The following figure shows the package marking information of the ATA8535.

**Figure 6-1. 32-Lead QFN (5 mm x 5 mm x 0.5 mm)**



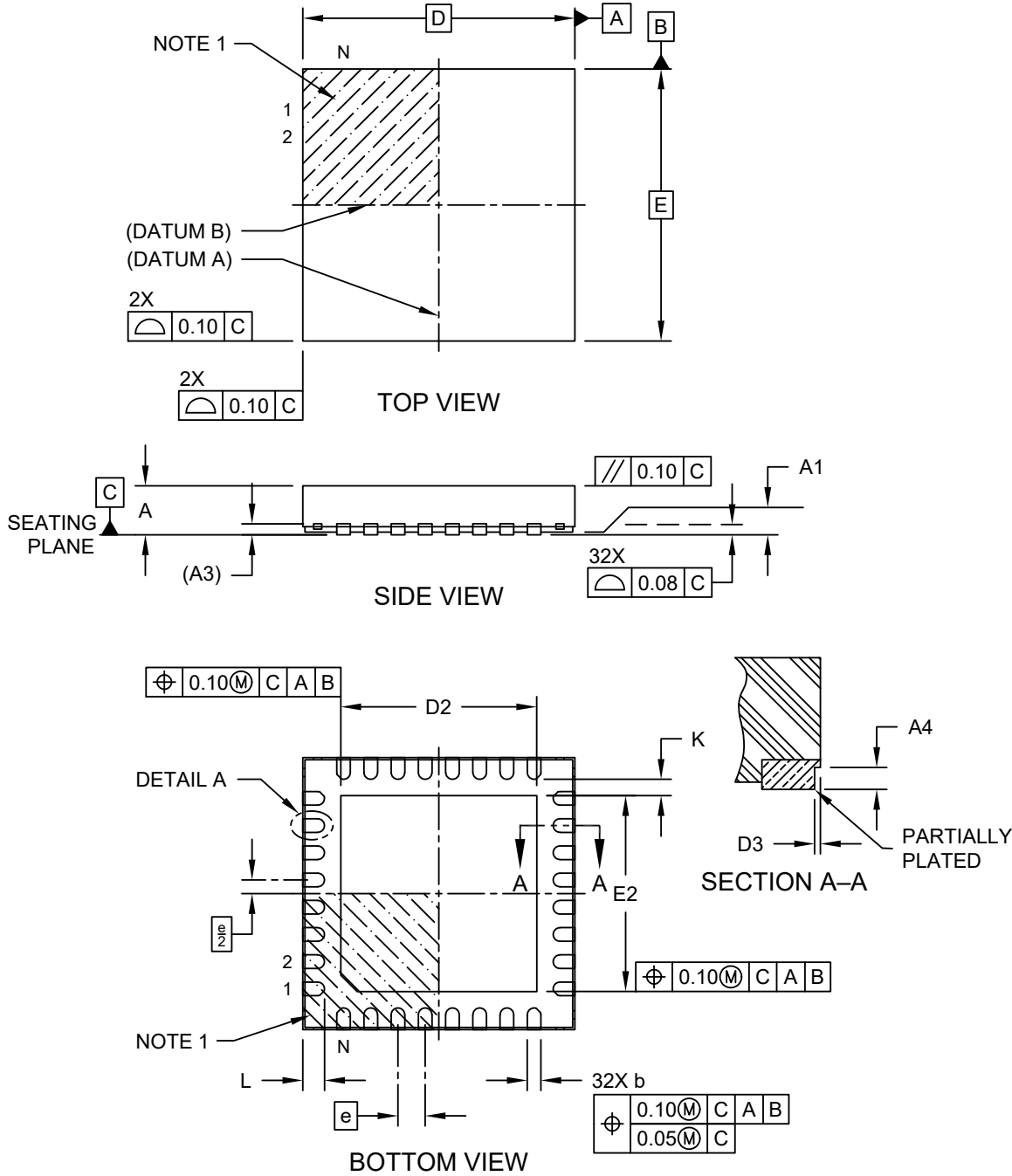
**Table 6-1. Package Legend Description**

Legend	Description
YY	Year code (last two digits of calendar year)
WW	Week code (for example, week of January 1 is week '01')
NNN	Alphanumeric traceability code

6.2 Package Outline Drawing

32-Lead Very Thin Plastic Quad Flat, No Lead Package (RTB) - 5x5 mm Body [VQFN]  
 With 3.6x3.6 mm Exposed Pad and Stepped Wettable Flanks; Atmel Legacy ZBS

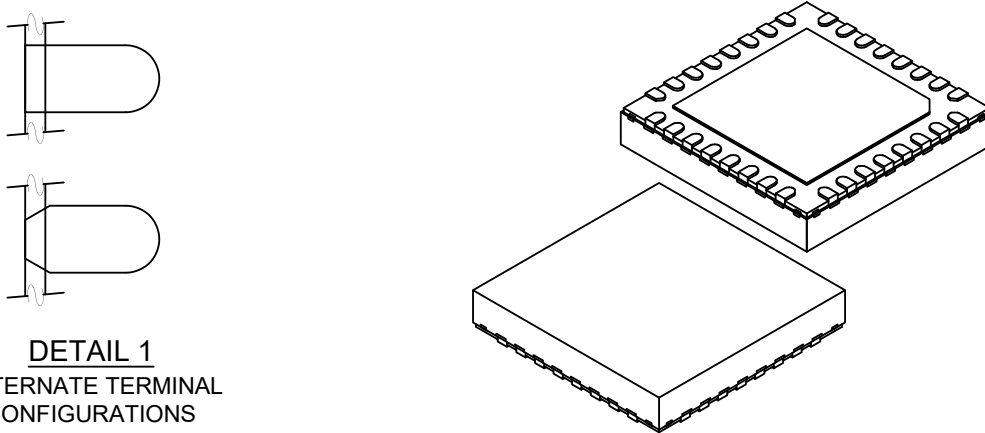
**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



Microchip Technology Drawing C04-21391 Rev G Sheet 1 of 2

**32-Lead Very Thin Plastic Quad Flat, No Lead Package (RTB) - 5x5 mm Body [VQFN]  
With 3.6x3.6 mm Exposed Pad and Stepped Wettable Flanks; Atmel Legacy ZBS**

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



**DETAIL 1**  
ALTERNATE TERMINAL  
CONFIGURATIONS

Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Number of Terminals	N	32		
Pitch	e	0.50 BSC		
Overall Height	A	0.80	0.90	1.00
Standoff	A1	0.00	0.035	0.05
Terminal Thickness	A3	0.203 REF		
Overall Length	D	5.00 BSC		
Exposed Pad Length	D2	3.50	3.60	3.70
Overall Width	E	5.00 BSC		
Exposed Pad Width	E2	3.50	3.60	3.70
Terminal Width	b	0.20	0.25	0.30
Terminal Length	L	0.35	0.40	0.45
Terminal-to-Exposed-Pad	K	0.20	-	-
Wettable Flank Step Cut Width	D3	-	-	0.085
Wettable Flank Step Cut Depth	A4	0.10	-	0.19

Dimensions D3 and A4 above apply to all new products released after November 1, and all products shipped after January 1, 2019, and supersede dimensions D3 and A4 below.

No physical changes are being made to any package; this update is to align cosmetic and tolerance variations from existing suppliers.

Wettable Flank Step Length	D3	0.035	0.06	0.085
Wettable Flank Step Height	A4	0.10	-	0.19

**Notes:**

1. Pin 1 visual index feature may vary, but must be located within the hatched area.
2. Package is saw singulated
3. Dimensioning and tolerancing per ASME Y14.5M

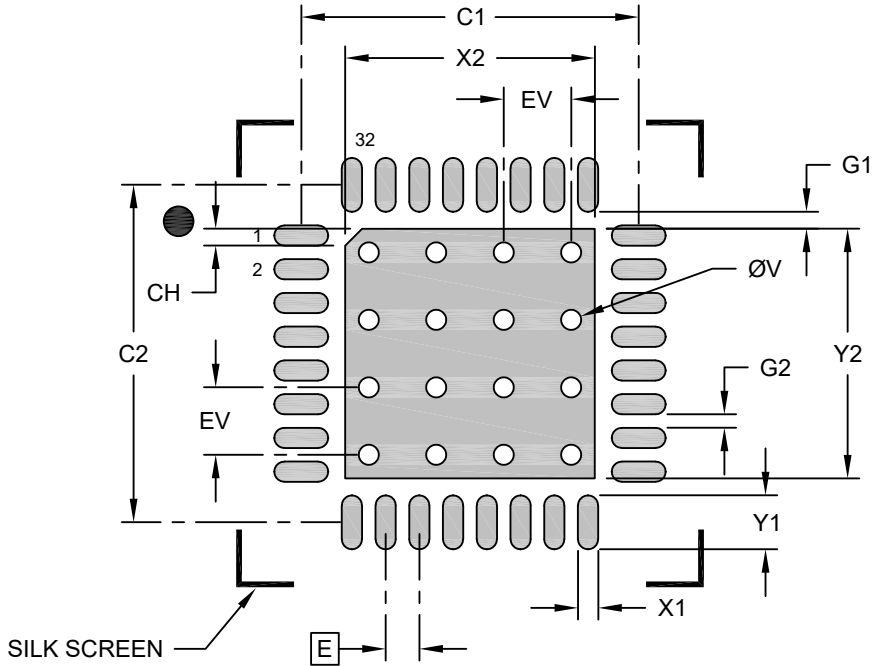
BSC: Basic Dimension. Theoretically exact value shown without tolerances.

REF: Reference Dimension, usually without tolerance, for information purposes only.

Microchip Technology Drawing C04-21391 Rev G Sheet 2 of 2

**32-Lead Very Thin Plastic Quad Flat, No Lead Package (RTB) - 5x5 mm Body [VQFN]  
With 3.6x3.6 mm Exposed Pad and Stepped Wettable Flanks; Atmel Legacy ZBS**

**Note:** For the most current package drawings, please see the Microchip Packaging Specification located at <http://www.microchip.com/packaging>



**RECOMMENDED LAND PATTERN**

Dimension Limits	Units	MILLIMETERS		
		MIN	NOM	MAX
Contact Pitch	E	0.50 BSC		
Optional Center Pad Width	X2			3.70
Optional Center Pad Length	Y2			3.70
Exposed Pad 45° Corner Chamfer	CH		0.25	
Contact Pad Spacing	C1		5.00	
Contact Pad Spacing	C2		5.00	
Contact Pad Width (X32)	X1			0.30
Contact Pad Length (X32)	Y1			0.80
Contact Pad to Center Pad (X32)	G1	0.25		
Contact Pad to Contact Pad (X28)	G2	0.20		
Thermal Via Diameter	V		0.30	
Thermal Via Pitch	EV		1.00	

**Notes:**

1. Dimensioning and tolerancing per ASME Y14.5M  
BSC: Basic Dimension. Theoretically exact value shown without tolerances.
2. For best soldering results, thermal vias, if used, should be filled or tented to avoid solder loss during reflow process

Microchip Technology Drawing C04-23391 Rev G

**7. Document Revision History**

Revision	Date	Section	Description
A	10/2022	Document	Initial revision

---

## Microchip Information

---

### The Microchip Website

---

Microchip provides online support via our website at [www.microchip.com/](http://www.microchip.com/). This website is used to make files and information easily available to customers. Some of the content available includes:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip design partner program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

### Product Change Notification Service

---

Microchip's product change notification service helps keep customers current on Microchip products. Subscribers will receive email notification whenever there are changes, updates, revisions or errata related to a specified product family or development tool of interest.

To register, go to [www.microchip.com/pcn](http://www.microchip.com/pcn) and follow the registration instructions.

### Customer Support

---

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Embedded Solutions Engineer (ESE)
- Technical Support

Customers should contact their distributor, representative or ESE for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in this document.

Technical support is available through the website at: [www.microchip.com/support](http://www.microchip.com/support)

### Microchip Devices Code Protection Feature

---

Note the following details of the code protection feature on Microchip products:

- Microchip products meet the specifications contained in their particular Microchip Data Sheet.
- Microchip believes that its family of products is secure when used in the intended manner, within operating specifications, and under normal conditions.
- Microchip values and aggressively protects its intellectual property rights. Attempts to breach the code protection features of Microchip product is strictly prohibited and may violate the Digital Millennium Copyright Act.
- Neither Microchip nor any other semiconductor manufacturer can guarantee the security of its code. Code protection does not mean that we are guaranteeing the product is "unbreakable". Code protection is constantly evolving. Microchip is committed to continuously improving the code protection features of our products.

### Legal Notice

---

This publication and the information herein may be used only with Microchip products, including to design, test, and integrate Microchip products with your application. Use of this information in any other manner violates these terms. Information regarding device applications is provided only for your convenience and may be superseded

by updates. It is your responsibility to ensure that your application meets with your specifications. Contact your local Microchip sales office for additional support or, obtain additional support at [www.microchip.com/en-us/support/design-help/client-support-services](http://www.microchip.com/en-us/support/design-help/client-support-services).

THIS INFORMATION IS PROVIDED BY MICROCHIP "AS IS". MICROCHIP MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND WHETHER EXPRESS OR IMPLIED, WRITTEN OR ORAL, STATUTORY OR OTHERWISE, RELATED TO THE INFORMATION INCLUDING BUT NOT LIMITED TO ANY IMPLIED WARRANTIES OF NON-INFRINGEMENT, MERCHANTABILITY, AND FITNESS FOR A PARTICULAR PURPOSE, OR WARRANTIES RELATED TO ITS CONDITION, QUALITY, OR PERFORMANCE.

IN NO EVENT WILL MICROCHIP BE LIABLE FOR ANY INDIRECT, SPECIAL, PUNITIVE, INCIDENTAL, OR CONSEQUENTIAL LOSS, DAMAGE, COST, OR EXPENSE OF ANY KIND WHATSOEVER RELATED TO THE INFORMATION OR ITS USE, HOWEVER CAUSED, EVEN IF MICROCHIP HAS BEEN ADVISED OF THE POSSIBILITY OR THE DAMAGES ARE FORESEEABLE. TO THE FULLEST EXTENT ALLOWED BY LAW, MICROCHIP'S TOTAL LIABILITY ON ALL CLAIMS IN ANY WAY RELATED TO THE INFORMATION OR ITS USE WILL NOT EXCEED THE AMOUNT OF FEES, IF ANY, THAT YOU HAVE PAID DIRECTLY TO MICROCHIP FOR THE INFORMATION.

Use of Microchip devices in life support and/or safety applications is entirely at the buyer's risk, and the buyer agrees to defend, indemnify and hold harmless Microchip from any and all damages, claims, suits, or expenses resulting from such use. No licenses are conveyed, implicitly or otherwise, under any Microchip intellectual property rights unless otherwise stated.

## Trademarks

The Microchip name and logo, the Microchip logo, Adaptec, AVR, AVR logo, AVR Freaks, BesTime, BitCloud, CryptoMemory, CryptoRF, dsPIC, flexPWR, HELDO, IGLOO, JukeBlox, KeeLoq, Kleer, LANCheck, LinkMD, maXStylus, maXTouch, MediaLB, megaAVR, Microsemi, Microsemi logo, MOST, MOST logo, MPLAB, OptoLyzer, PIC, picoPower, PICSTART, PIC32 logo, PolarFire, Prochip Designer, QTouch, SAM-BA, SenGenuity, SpyNIC, SST, SST Logo, SuperFlash, Symmetricom, SyncServer, Tachyon, TimeSource, tinyAVR, UNI/O, Vectron, and XMEGA are registered trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

AgileSwitch, APT, ClockWorks, The Embedded Control Solutions Company, EtherSynch, Flashtec, Hyper Speed Control, HyperLight Load, Libero, motorBench, mTouch, Powermite 3, Precision Edge, ProASIC, ProASIC Plus, ProASIC Plus logo, Quiet- Wire, SmartFusion, SyncWorld, Temux, TimeCesium, TimeHub, TimePictra, TimeProvider, TrueTime, and ZL are registered trademarks of Microchip Technology Incorporated in the U.S.A.

Adjacent Key Suppression, AKS, Analog-for-the-Digital Age, Any Capacitor, AnyIn, AnyOut, Augmented Switching, BlueSky, BodyCom, Clockstudio, CodeGuard, CryptoAuthentication, CryptoAutomotive, CryptoCompanion, CryptoController, dsPICDEM, dsPICDEM.net, Dynamic Average Matching, DAM, ECAN, Espresso T1S, EtherGREEN, GridTime, IdealBridge, In-Circuit Serial Programming, ICSP, INICnet, Intelligent Paralleling, IntellIMOS, Inter-Chip Connectivity, JitterBlocker, Knob-on-Display, KoD, maxCrypto, maxView, memBrain, Mindi, MiWi, MPASM, MPF, MPLAB Certified logo, MPLIB, MPLINK, MultiTRAK, NetDetach, Omniscient Code Generation, PICDEM, PICDEM.net, PICkit, PICtail, PowerSmart, PureSilicon, QMatrix, REAL ICE, Ripple Blocker, RTAX, RTG4, SAM-ICE, Serial Quad I/O, simpleMAP, SimpliPHY, SmartBuffer, SmartHLS, SMART-I.S., storClad, SQL, SuperSwitcher, SuperSwitcher II, Switchtec, SynchroPHY, Total Endurance, Trusted Time, TSHARC, USBCheck, VariSense, VectorBlox, VeriPHY, ViewSpan, WiperLock, XpressConnect, and ZENA are trademarks of Microchip Technology Incorporated in the U.S.A. and other countries.

SQTP is a service mark of Microchip Technology Incorporated in the U.S.A.

The Adaptec logo, Frequency on Demand, Silicon Storage Technology, and Symmcom are registered trademarks of Microchip Technology Inc. in other countries.

GestIC is a registered trademark of Microchip Technology Germany II GmbH & Co. KG, a subsidiary of Microchip Technology Inc., in other countries.

All other trademarks mentioned herein are property of their respective companies.

© 2022, Microchip Technology Incorporated and its subsidiaries. All Rights Reserved.

ISBN: 978-1-6683-1129-5

## **Quality Management System**

---

For information regarding Microchip's Quality Management Systems, please visit [www.microchip.com/quality](http://www.microchip.com/quality).

## Worldwide Sales and Service

AMERICAS	ASIA/PACIFIC	ASIA/PACIFIC	EUROPE
<p><b>Corporate Office</b> 2355 West Chandler Blvd. Chandler, AZ 85224-6199 Tel: 480-792-7200 Tel: 480-792-7277 Technical Support: <a href="http://www.microchip.com/support">www.microchip.com/support</a> Web Address: <a href="http://www.microchip.com">www.microchip.com</a></p> <p><b>Atlanta</b> Duluth, GA Tel: 678-957-9614 Fax: 678-957-1455</p> <p><b>Austin, TX</b> Tel: 512-257-3370</p> <p><b>Boston</b> Westborough, MA Tel: 774-760-0087 Fax: 774-760-0088</p> <p><b>Chicago</b> Itasca, IL Tel: 630-285-0071 Fax: 630-285-0075</p> <p><b>Dallas</b> Addison, TX Tel: 972-818-7423 Fax: 972-818-2924</p> <p><b>Detroit</b> Novi, MI Tel: 248-848-4000</p> <p><b>Houston, TX</b> Tel: 281-894-5983</p> <p><b>Indianapolis</b> Noblesville, IN Tel: 317-773-8323 Fax: 317-773-5453 Tel: 317-536-2380</p> <p><b>Los Angeles</b> Mission Viejo, CA Tel: 949-462-9523 Fax: 949-462-9608 Tel: 951-273-7800</p> <p><b>Raleigh, NC</b> Tel: 919-844-7510</p> <p><b>New York, NY</b> Tel: 631-435-6000</p> <p><b>San Jose, CA</b> Tel: 408-735-9110 Tel: 408-436-4270</p> <p><b>Canada - Toronto</b> Tel: 905-695-1980 Fax: 905-695-2078</p>	<p><b>Australia - Sydney</b> Tel: 61-2-9868-6733</p> <p><b>China - Beijing</b> Tel: 86-10-8569-7000</p> <p><b>China - Chengdu</b> Tel: 86-28-8665-5511</p> <p><b>China - Chongqing</b> Tel: 86-23-8980-9588</p> <p><b>China - Dongguan</b> Tel: 86-769-8702-9880</p> <p><b>China - Guangzhou</b> Tel: 86-20-8755-8029</p> <p><b>China - Hangzhou</b> Tel: 86-571-8792-8115</p> <p><b>China - Hong Kong SAR</b> Tel: 852-2943-5100</p> <p><b>China - Nanjing</b> Tel: 86-25-8473-2460</p> <p><b>China - Qingdao</b> Tel: 86-532-8502-7355</p> <p><b>China - Shanghai</b> Tel: 86-21-3326-8000</p> <p><b>China - Shenyang</b> Tel: 86-24-2334-2829</p> <p><b>China - Shenzhen</b> Tel: 86-755-8864-2200</p> <p><b>China - Suzhou</b> Tel: 86-186-6233-1526</p> <p><b>China - Wuhan</b> Tel: 86-27-5980-5300</p> <p><b>China - Xian</b> Tel: 86-29-8833-7252</p> <p><b>China - Xiamen</b> Tel: 86-592-2388138</p> <p><b>China - Zhuhai</b> Tel: 86-756-3210040</p>	<p><b>India - Bangalore</b> Tel: 91-80-3090-4444</p> <p><b>India - New Delhi</b> Tel: 91-11-4160-8631</p> <p><b>India - Pune</b> Tel: 91-20-4121-0141</p> <p><b>Japan - Osaka</b> Tel: 81-6-6152-7160</p> <p><b>Japan - Tokyo</b> Tel: 81-3-6880-3770</p> <p><b>Korea - Daegu</b> Tel: 82-53-744-4301</p> <p><b>Korea - Seoul</b> Tel: 82-2-554-7200</p> <p><b>Malaysia - Kuala Lumpur</b> Tel: 60-3-7651-7906</p> <p><b>Malaysia - Penang</b> Tel: 60-4-227-8870</p> <p><b>Philippines - Manila</b> Tel: 63-2-634-9065</p> <p><b>Singapore</b> Tel: 65-6334-8870</p> <p><b>Taiwan - Hsin Chu</b> Tel: 886-3-577-8366</p> <p><b>Taiwan - Kaohsiung</b> Tel: 886-7-213-7830</p> <p><b>Taiwan - Taipei</b> Tel: 886-2-2508-8600</p> <p><b>Thailand - Bangkok</b> Tel: 66-2-694-1351</p> <p><b>Vietnam - Ho Chi Minh</b> Tel: 84-28-5448-2100</p>	<p><b>Austria - Wels</b> Tel: 43-7242-2244-39 Fax: 43-7242-2244-393</p> <p><b>Denmark - Copenhagen</b> Tel: 45-4485-5910 Fax: 45-4485-2829</p> <p><b>Finland - Espoo</b> Tel: 358-9-4520-820</p> <p><b>France - Paris</b> Tel: 33-1-69-53-63-20 Fax: 33-1-69-30-90-79</p> <p><b>Germany - Garching</b> Tel: 49-8931-9700</p> <p><b>Germany - Haan</b> Tel: 49-2129-3766400</p> <p><b>Germany - Heilbronn</b> Tel: 49-7131-72400</p> <p><b>Germany - Karlsruhe</b> Tel: 49-721-625370</p> <p><b>Germany - Munich</b> Tel: 49-89-627-144-0 Fax: 49-89-627-144-44</p> <p><b>Germany - Rosenheim</b> Tel: 49-8031-354-560</p> <p><b>Israel - Ra'anana</b> Tel: 972-9-744-7705</p> <p><b>Italy - Milan</b> Tel: 39-0331-742611 Fax: 39-0331-466781</p> <p><b>Italy - Padova</b> Tel: 39-049-7625286</p> <p><b>Netherlands - Drunen</b> Tel: 31-416-690399 Fax: 31-416-690340</p> <p><b>Norway - Trondheim</b> Tel: 47-72884388</p> <p><b>Poland - Warsaw</b> Tel: 48-22-3325737</p> <p><b>Romania - Bucharest</b> Tel: 40-21-407-87-50</p> <p><b>Spain - Madrid</b> Tel: 34-91-708-08-90 Fax: 34-91-708-08-91</p> <p><b>Sweden - Gothenberg</b> Tel: 46-31-704-60-40</p> <p><b>Sweden - Stockholm</b> Tel: 46-8-5090-4654</p> <p><b>UK - Wokingham</b> Tel: 44-118-921-5800 Fax: 44-118-921-5820</p>