AN4325

UHF ATA Product Application and Design Quick Reference Guide

Introduction

This application note describes the application and design guidelines of the ATA Ultra High Frequency (UHF) products. It is implicit to follow the application and design rules from the user manual and data sheet, while the information in the application note is helpful during the design process specifically. Therefore, it is highly recommended to refer to this application note while working on the application and design process of the ATA UHF products. The topics can help to speed up the application and design process.

In addition, the application note also provides helpful guidelines while designing the application for the following transceiver/receiver products:

- ATA5830, ATA5830N
- ATA5780, ATA5780N
- ATA5831, ATA5832, ATA5833 and ATA5835
- ATA5781, ATA5782, ATA5783, ATA5785 and ATA5787
- ATA8510, ATA8515
- ATA8210, ATA8215
- ATA8710
- ATA8535
- ATA8287

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1. Quick references

1.1 Reference Documentation

- *ATA5830/ATA5830N UHF ASK/FSK Transceiver Data Sheet* (9208GX-RKE-09/15)
- *ATA5780N UHF ASK/FSK Receiver Data Sheet* (9207EX-RKE-09/15)
- *ATA5831/ATA5832/ATA5833 UHF ASK/FSK Transceiver User Manual* (9313GX-RKE-07/15)
- *ATA5781/ATA5781N/ATA5782/ATA5783 UHF ASK/FSK Receiver User Manual* (9314GX-RKE-07/15)
- *ATA5785 UHF ASK/FSK Receiver User Manual* (9360BX-RKE-11/14)
- *ATA5835 UHF ASK/FSK Transceiver User's Guide* (DS50003152A)
- *ATA5787 UHF ASK/FSK Receiver User's Guide* (DS50003174A)
- *ATA8510/ATA8515 Industrial User's Guide* (DS50003142A)

1.2 Acronyms and Abbreviations

Acronyms and Abbreviations	Description
DFIFO	Data FIFO
EOT	End Of Telegram
FIFO	First In First Out
HVSP	High Voltage Serial Programing
LNA	Low Noise Amplifier
POR	Power-on-Reset
RSSI	Radio Signal Strength Indicator
SFIFO	Support FIFO
SPDT	Single Pole Double Throw
SPI	Serial Programming Interface
SRAM	Static Random Access Memory
UHF	Ultra High Frequency
VS	Voltage Supply
WDT	Watchdog Timer
WUP	Wake-Up Pattern
XTO	Crystal Oscillator

2. System Behavior

2.1 RSSI Usage

The UHF products offer a digital Radio Signal Strength Indicator (RSSI) sampling, including history data, via the built-in 16-byte SFIFO buffer. Use the RSSI to obtain the signal strength over the received message. It is important to know that the transceiver/receiver starts the RSSI sampling immediately with the start of the active phase (except for ATA5830(N) and ATA5780(N)). Depending on the scenario and configuration, the buffer might be filled with 16 RSSI samples from noise, before the system detects a FIFO overflow. Therefore, the recommendation is to set the FIFO buffer over/underflow error disable option in the EEPROM configuration. Otherwise, an error is triggered, including for an IRQ event (optional), if an overflow happens. The FIFO buffer is organized as a ring buffer. This results in getting the RSSI values from the RF message, as the noise values are overwritten. To get useful data in the RSSI buffer, set the sampling rate according to the RF signal characteristics. Divide the number of transferred bytes by 16, and set the next larger sample value for the RSSI update period in the service configuration to get the RSSI characteristics of the whole RF message. Apply the same calculation with the reduced number of bytes for the signal strength of the payload. If the “stay in RX after EOT” option is enabled (or applied), ensure that the SFIFO content is not overwritten.

2.2 FIFO Corruption

In case of a mode switching, consider the buffer content from the Data FIFO (DFIFO) and Support FIFO (SFIFO). As the handling from the buffers differ, ensure consistent content between the RX mode and TX mode. Switch from RX mode to TX mode cautiously. There is no automatic clearance prior to the start of the TX mode, which means that any remaining information in SFIFO or DFIFO corrupts the transmission pattern. There are two options to clear the buffer and get a known state:

- The first option is to read all data, as this will reduce the fill level by the number of bytes read. Continue with the next operation mode if you have read all data from the buffer.
- The second option is to trigger a clearance by writing the DFCLR.DFL and SFCLR.SFL bits to ‘`1`’.

During the start of the RX mode, the firmware takes care of a buffer reset; therefore, there is no need for additional action. In the case of using the Continuous Receive mode, the user must carefully handle the buffer content. In Continuous Receiver mode, the device does not stop the reception after the End Of Telegram (EOT). Multiple message reception can lead to an overflow of the buffer, and this overflow can trigger an error event if it is not disabled in the EEPROM configuration. In addition, unprocessed data can be overwritten. Handle the data carefully to achieve a stable application.

2.3 Antenna Damping (RSSI Accuracy)

The transceiver or receiver supports strong RF signals in the application with an automatic damping to avoid saturation of the internal Low Noise Amplifier (LNA). Except for ATA5835 and ATA5787, the damping function is implemented in the Single Pole Double Throw (SPDT). The internal firmware corrects the RSSI calculation according to the state of the damping. Take care of the signal strength correction in the absence of SPDT, as the device does not detect SPDT usage. For the two products mentioned earlier, the damping is realized via LNA gain reduction, irrespective of whether the built-in-switch is used or not.

2.4 GPIO Driver Strength

The technical documentation of the UHF products specifies the current for a voltage drop of 10%. All GPIO pins from the supported products are protected against shortage. Therefore, larger current can be driven if a higher voltage drop is accepted. Calculate the available current and the corresponding voltage drop by calculating the RDS(on) with the given parameters from the data sheet.

Note: A shortage of multiple GPIO pins can lead to thermal overstress and damage the product.

2.5 Consistency Check

Reading the version of the product right after the start of the application system is recommended. This ensures that the right product with the right version is used. In addition to the version, reading the product ID from the NVM memory (EEPROM) is recommended also.

2.6 Considering Reset Behavior

The following are the three different ways to set or keep the product's Reset state:

- Power-on-Reset (POR)
- External Reset (NRESET)
- Watchdog Reset (WDR)

For the reset behavior, two states must be distinguished. The first one is that the device is in the OFF state. In this case, the device will not react to a reset and stays in the OFF mode. In the second state, the device is active. This happens if any wake conditions were triggered in the past and no reset or OFF mode instruction was triggered. The Microchip ATA UHF products can be set or kept in the Reset state in three different ways. Power-on-Reset (POR), External Reset (NRESET) and the Watchdog Reset (WDR) are available. The source that triggers the reset is available in the MCUSR register and, after the reset, the device will temporarily stay awake. During the system initialization, the firmware checks if a valid wake source is available or not. If the wake source is unavailable, the device is set to the OFF mode. If the application is reset, the device is not responsive to the main µC because no wake source is available after a reset. For a robust application, it is essential for the main µC to detect a reset of the ATA UHF product. For the NRESET as reset source, the main µC is the initiator of the event, which means it is a known event. The situation is similar if a POR reset happens. The main µC must be able to detect this event.

The situation becomes difficult in the case of a WDR. Without a valid wake source, the main µC is not aware of this reset and the subsequent OFF mode. In this situation, the main µC and the ATA UHF device are not synchronized because the main µC does not detect the WDR event. Use the OFF mode behavior of the wake pins to identify the WDR. In the OFF mode, all the I/O pins, except for the one with wake capability and NRESET, will be in tri-state. NPWRONx pins and NRESET are pulled to high level in the OFF mode. For example, configure the PC1 at a low level during normal operation, and a high transition indicates the OFF mode. The main µC can detect this.

Notes:

- The NRESET pin is pulled to high, independent of the state of the ATA UHF product (Off or Active). It is necessary to have a defined level for the NRESET pin, independent of the main µC state. This is documented in the user manual.
- As the NRESET functionality is essential for operation and program, only use the reset disable fuse (RSTDISBL) with the highest attention as this can block the system from further access via ISP or HVSP (High Voltage Serial Programing).

2.7 System Event Monitoring

Microchip ATA UHF products can work in different operation modes. Knowing the current mode is helpful for robust application design. The active operation mode is stored in the SystemModeConfig register copy located in the SRAM. Whenever a mode change is triggered, the register is updated. The content of this register is described in the data sheet or the user manual. The address of the register for the different products is shown in the following table:

Product	Name	SRAM Address
ATA5830, ATA5830N, ATA5780, ATA5780N	TC2	0x01D9
ATA5835, ATA5785, ATA8535, ATA8287	trxConf. systemModeConfig	0x02E0

...........continued

Product	Name	SRAM Address
ATA5785	trxConf. systemModeConfig	0x02E3
ATA5831, ATA5832, ATA5833, ATA5781, ATA5782, ATA5783, ATA8510, ATA8515, ATA8210, ATA8215, ATA8710	trxConf. systemModeConfig	0x02FB

3. Configuration Guidelines

Microchip offers a configuration tool to set up the characteristics of the ATA UHF products. The configuration can be stored in a .hex file and programmed to the EEPROM memory (except ATA5785).

3.1 GPIO Functionality

Some of the GPIO pins from ATA UHF products support multiple functions. Ensure that the port direction selected via the EEPROM device configuration matches the desired alternate function. For example, if using the TRPA signal for debugging, ensure the I/O pin is configured to be an output. Failure to follow this step might obstruct the expected function. The EEPROM configuration tool monitors the selection and indicates any mistake in the log window or by special marking of the function. Monitor the tool to detect the problem and find a solution.

3.2 Event Notification

Ensure there is a proper event notification configuration for an application. This includes all application-specific events, like a notification of the EOT, and general system events, like a power-on event (SYS_RDY) and error event (SYS_ERR). The system events identify specific events and give the capability to react on it, for example, an unexpected undervoltage below 1.9V followed by restoring of target voltage. This scenario triggers a POR, and is indicated by a system ready flag (SYS_RDY). Without the SYS_RDY event activated, this event cannot be detected and the application might get stuck in an unexpected state if the host controller does not react to the event. Another example is the occurrence of an unexpected system error. Without the SYS_ERR event activated, the system can be in an undefined state. Activated system events help during unexpected events by appropriately reacting and, therefore, help in designing a robust application.

3.3 Updating Recommended Values

Consider adapting other parameters for the application while tuning parameters like frequency, receiver bandwidth and data rate. Based on the input, the EEPROM configuration tool calculates recommended values for a particular parameter. Therefore, set the recommended values according to the new setup to ensure a proper operation.

Note: The recommended values ensure that the application is working. Fine tuning might be required during validation to meet all the requirements.

3.4 Bytes, Bits and Symbols

Bytes, bits and symbols are used in Microchip's product naming conventions. Ensure bits and bytes are used appropriately, as the coding can be different for both, for example, in Manchester coding where 1 bit is coded by two symbols.

The following are some of the important functions that use symbol-based data handling:

- SFIFO usage as preamble buffer in TX mode
- WUP and SFID pattern definition in EEPROM configuration
- Signal check size setup in EEPROM configuration
- Carrier check parameter in EEPROM configuration
- Run-In and stop sequence Pattern in RX mode and TX mode

In transmit mode, the data FIFO is loaded byte-wise with the raw data. The configured coding is done in HW and handled automatically from the system. In receive mode, the received data will be decoded automatically from the HW, if it is enabled in the configuration. The resultant raw data are loaded to the data FIFO.

4. Design Guidelines

4.1 NRESET Control

It is required to have the connection and control of the NRESET pin. The main µC must be capable to trigger/restart the whole system when the UHF device does not perform accordingly. Under normal conditions this does not occur, but this can happen in the case of an Electrostatic Discharge (ESD) or any other external event. An unexpected and unpredictable external event can influence the system. Be sure to have control over the power supply of the UHF device if the NRESET functionality is not available or cannot be used. In this case, the main µC can apply a Power-on-Reset (POR).

4.2 Wake-up Control

In most applications, the UHF device from Microchip acts as a peripheral, controlled from central device. The central must handle the Wake-up source, to ensure proper conditions for the RF device. With this approach, proper supply conditions are present prior to the UHF part activation. Another advantage of this approach is that the start-up order is kept. The UHF device can operate with voltage down to 1.9-2.0V. That means, the UHF device can operate in a voltage range where the main µC is still not operative. Be sure to maintain control over the Wake-up to avoid unexpected effects in such situations.

4.3 Test Pads

A test pad at every available GPIO pin is recommended for debugging the application. A test pad can be used for verification or system optimization, even if it is not used in the application. It is suggested to have the 6-pin In-System Programming (ISP) header for in-system programming or debugging.

4.4 Use the Watchdog Timer

The embedded Watchdog Timer (WDT) provides an additional level of security. Using the feature to detect unexpected behavior of the application is recommended, especially when using the personal User Flash application software. The WDT can also be used if the system enters the Sleep mode. The user can achieve the periodical wake up feature via the internal wake up Timer0 .

4.5 Memory Access

It can be helpful to implement this feature into the main µC even if the SRAM, the hardware register or all addresses of the EEPROM are not read in the final application from the customer. It can be necessary to read the additional data from the peripheral for debugging or optimizing the application.

4.6 Crystal Oscillator (XTO) Selection

All parameters in the data sheet are validated with the XTO frequency 24.305 MHz. This frequency was identified as usable for the typical applicable RF bands. However, it is possible to select another XTO frequency according to the specified parameter in the data sheet. If using another XTO frequency, verify and validate the following parameters:

- XTO harmonic influences to the RF
- System timings
- Interface timings
- Start-up behavior (in case of using other parameter or form factor)

For more details on how to calculate influences of the specified XTO frequency, refer to the *AN3716_UHF_CrystalSelection Application Note*.

4.7 RF Matching Network

Leaving footprint space for some spare matching elements during the design phase for the RF matching task is recommended. Depending on the complexity of the analog circuit, the task becomes much easier with the availability of additional components. Even if the additional components are not required in the final application, it is better to have them available instead of re-designing the PCB to reach the target performance.

For more details on matching practices, refer to the *RF Matching Recommendation Application Note* (DS00004061A and DS00003566A).

4.8 Suppressing Unwanted Signals

The UHF products provide strong suppression against unwanted signals. This covers radiated signals as well as the external signals. Preparing the design for shielding while dealing with strict requirements is recommended to provide the capability later without requiring a redesign, even if not required in the final application.

4.9 API usage

Using API function calls is highly recommended when using a user Flash application inside the UHF product. This ensures that the handling of the internal flags is according to the product specification. For example, if the events are accessed and modified in a direct way, they can end up in a corrupted state of the flags. Submit a support request for assistance through www.microchip.com/support in case there is a need to control the device without API functions.

4.10 External Static Wake for Software Development

Having HW-based wake-up capability is recommended while developing user Flash software for the transceiver, transmitter or receiver. After connecting the Voltage Supply (VS), the devices stay in the OFF mode, waiting for a wake event from an external source. It can be difficult to implement a static wake function to the host controller. Therefore, it can be helpful to have a jumper or something similar, to keep the device awake all the time. This can help in achieving a suitable operation in ISP mode. Between the ISP steps, the NRESET line releases and the device enters the OFF mode and requires a wake prior to the start of the next ISP operation.

5. Important Information

5.1 ATA578x Signature

The product numbering that is listed in the ATA578x User Manual Rev 9314GX in the table in chapter 3.9.12.4 is mixed. The numbering must start with 1 followed by 2 and end with 3. Ensure the part numbers are not mixed while using the signature.

5.2 Invalid Mode Transitions

The firmware of the products covers many invalid transitions and potential issues. The error IRQ and a specific error code indicate all those invalid transitions and potential issues. During the development phase, not all possible scenarios are known, and there can be scenarios that are not valid but not indicated by an event. Therefore, ensure suitable implementation of all the functions. Known actions that will not lead to an error IRQ and an error code entry are:

- Mode transition from Polling mode to RX mode
- Antenna tuning without signal at the antenna tuning pin

6. Document Revision History

Revision	Date	Section	Description
A	12/2021	Document	Initial revision

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