Highly Integrated AVR MCU-Based UHF Transceiver Family Increases Car Access System Flexibility

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Automotive Communications Requirements

The protocols used in the automotive industries are not standardized. Therefore, every OEM can define and use its own message structures and properties. A wide range of signal properties and message structures is possible. Signal properties can be RF frequency, data rate, coding, modulation or deviation. The properties of the messages can be much more versatile because any constellation such as a short preamble or wake-up pattern (WUP), followed by a big gap with a start frame identifier (SFID) and a special ID at the beginning of the payload, is conceivable. Signal properties can also be mixed within one message; for example, using ASK and FSK for different parts of the message. Very flexible hardware is required to cover all potential applications.

Auto RF Portfolio for Reception of Prospective Protocols

The Atmel® ATA583x family is a new generation of highly integrated transceiver ICs including an AVR® core, a RX digital signal processor (DSP) and a separate analog front end with two separate receive paths that allow two signals to be searched in parallel. These new transceivers can cover most known protocols without limitations, as well as the standard frequencies (310-318MHz, 418-477MHz, and 836-956MHz) with only one external XTO via the implemented fractional-N PLL.

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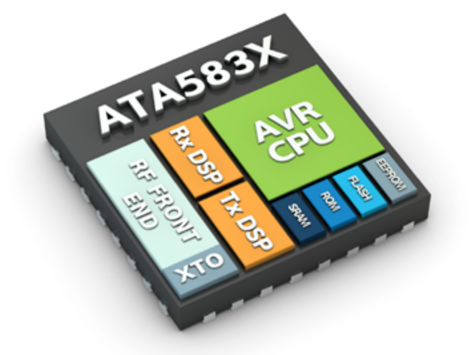

Figure 1. ATA583x UHF Transceiver Family

The ATA583x family provides up to five services with three channels each, making it possible to implement comprehensive and complex applications. The 24k ROM provides a voluminous API that can be used in Flash applications or via SPI from an external host controller. A key feature of the new product family is the combination of demodulator plus RX DSP. This delivers extended flexibility and is described in the following chapters (see also Figure 2).

Family Members

- ATA5831: Flash version with 20k Flash memory for the user plus 24k ROM firmware
- ATA5832: User ROM version with 20k customer ROM software plus 24k ROM firmware
- ATA5833: ROM-only version with 24k firmware

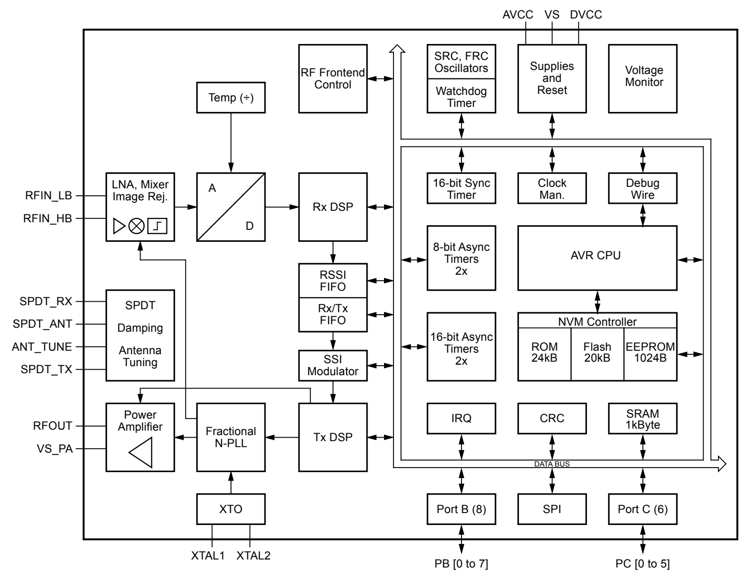

Figure 2. ATA5831 System Block Diagram

Typical Protocol Types

Typical protocols as specified by the OEMs have a WUP and an SFID. In some cases, there may be a gap between these two data patterns. Also, some applications may use a code violation (CV) to achieve a defined stop and restart of the demodulator. Figure 3 shows the typical structure of such a message.

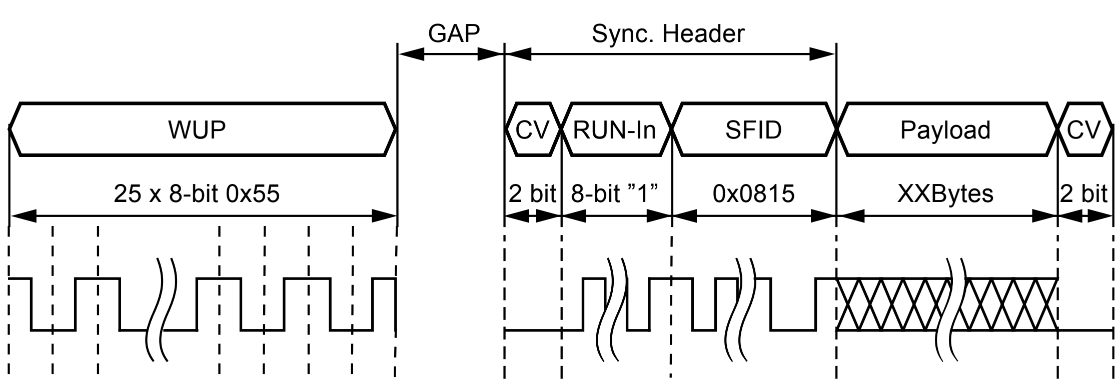

Figure 3. Typical RF Protocol Structure

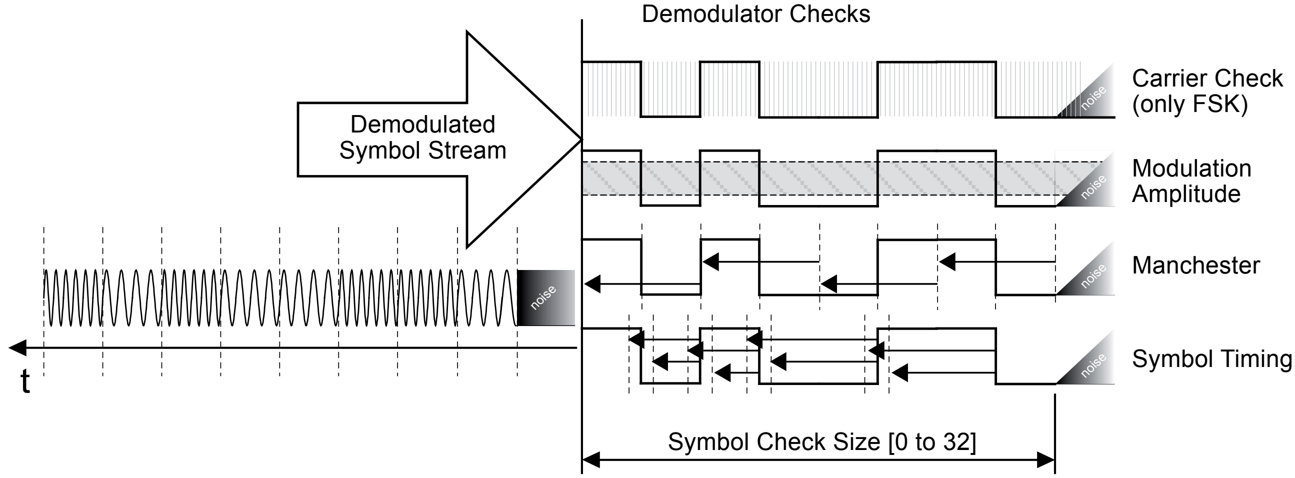

Figure 4. ATA583x Signal Checks

Typically the WUP is used to synchronize to this data stream, even if the transceiver is operating in polling mode and cyclically checks for a message. This is a typical application-specific design to decrease the current consumption.

Signal Properties

To receive a message it is necessary to know the message properties:

- RF frequency
- Modulation/coding
- Data rate
- Deviation (if appropriate)

In the transceiver's memory, these properties can be set up individually for every service and path. Once the transceiver configuration has been completed, the device´s receive function can be used. Several signal checks are available during reception to identify the signal.

Signal Checks

The first check that is performed internally is the carrier check. This is used to quickly identify the availability of a valid signal. The check unit samples the incoming signal with a much higher clock rate, and compares the phase of each sample. In the second step a check is considered successful or unsuccessful depending on the measured phase jump. To increase flexibility a set of failure samples can be defined during the sampling time, typically one bit. The check is repeated as long as the device is performing the signal check. This feature can only be used with FSK modulation because during ASK, there is no modulation available half of the time.

The second check that helps to detect the correct signal is the amplitude check. The amplitude after the data filter is compared with a predefined threshold. If this threshold is not exceeded, the check results in a failure signal. This feature is helpful if other signals with lower deviation frequencies are in the range of the transceiver. In this context, this protects against false signals because these are not received if the threshold is well defined.

The third check is the symbol timing check that is used to identify the right data rate. This method utilizes an edge detection unit that controls whether the edges occur within defined limits. This feature can also set the maximum data rate tolerance in the incoming data stream. The check setup takes place in the transceiver's memory within a defined percentage of the symbol time.

The fourth check performed during the signal check is the Manchester check, which scans for Manchester-compliant symbols. This check compares previous, current and upcoming symbols; if the next upcoming symbol is not allowed, the check generates a failure signal. This is helpful in detecting failures in the telegram as well as wrong coding.

Figure 4 presents a schematic overview of the four check methods.

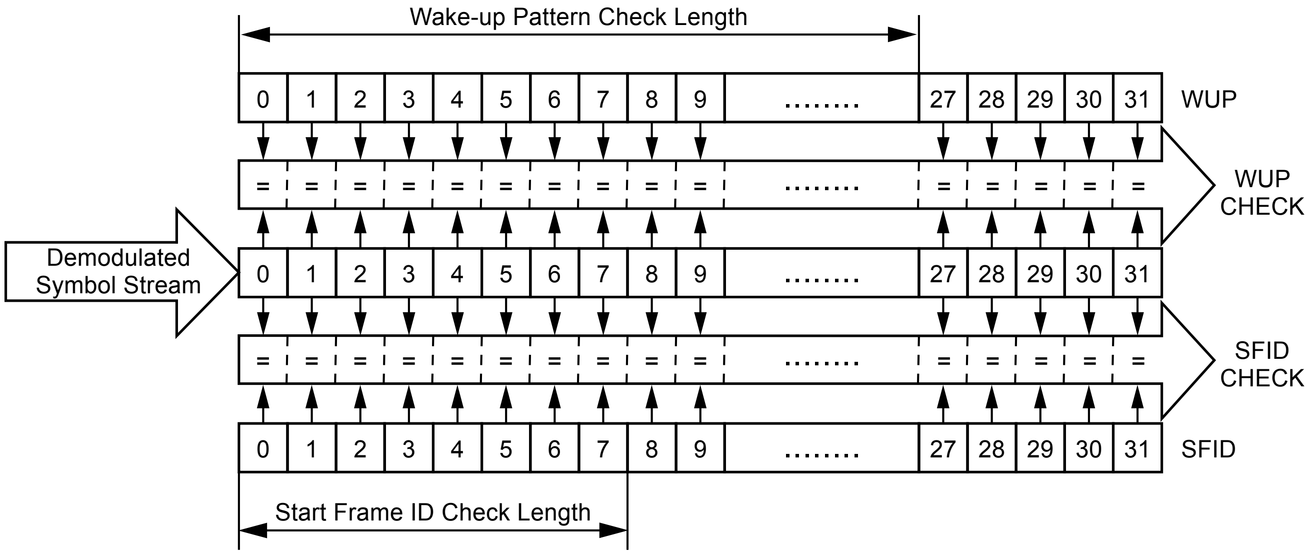

Figure 5. WUP and SFID Check Engine

All four checks are performed in parallel; however, some checks run faster than others. The fastest check method is the carrier check that generates a first result after less than one bit time, T_{Bit}. With at least two bit times, $2T_{Bit}$, the Manchester coding check is the slowest. The combination of all these checks can be used to achieve a robust system that prevents false wake-ups. These four checks are very important during polling mode, in particular. If the first check generates a failure signal, the sequencer state machine exits the current channel and switches to the next one. Using this procedure reduces the time during which the system is active and also saves energy. In turn, this helps to significantly extend battery life and to achieve a very fast reaction time.

Frame Synchronization

The transceiver can perform the signal and frame synchronization checks at the same time. To this end, the new transceiver generation incorporates several pattern checks that can be used to identify specific predefined patterns.

The first executed check is the WUP check. A WUP typically consists of a data stream that is periodically repeated over an extended period of time. It is used to indicate the incoming message to the transceiver. The WUP check compares the incoming data stream with a predefined pattern that can be freely configured regarding length and content.

The second check that is performed is the SFID check. Typically the SFID indicates the start of a telegram. It works the same way as the WUP check and is also configurable. It is possible to search for WUP and SFID in parallel, a procedure required when the synchronization pattern before the payload is very short.

To design an application that is insensitive to disturbances and that has the appropriate signal characteristics, it is necessary to implement time-outs. The wake-check-okay time-out is active from the beginning of the incoming data stream until the match of the wake-up pattern. The second time-out is the start-frame-identifier time-out that is used to cover the long gaps between WUP and SFID. This time-out is also used to reset the receive function if additional data is unavailable after the WUP to prevent a dead lock of the device.

The frame synchronization is performed in parallel to the signal checks. The designer can define which check is to be performed

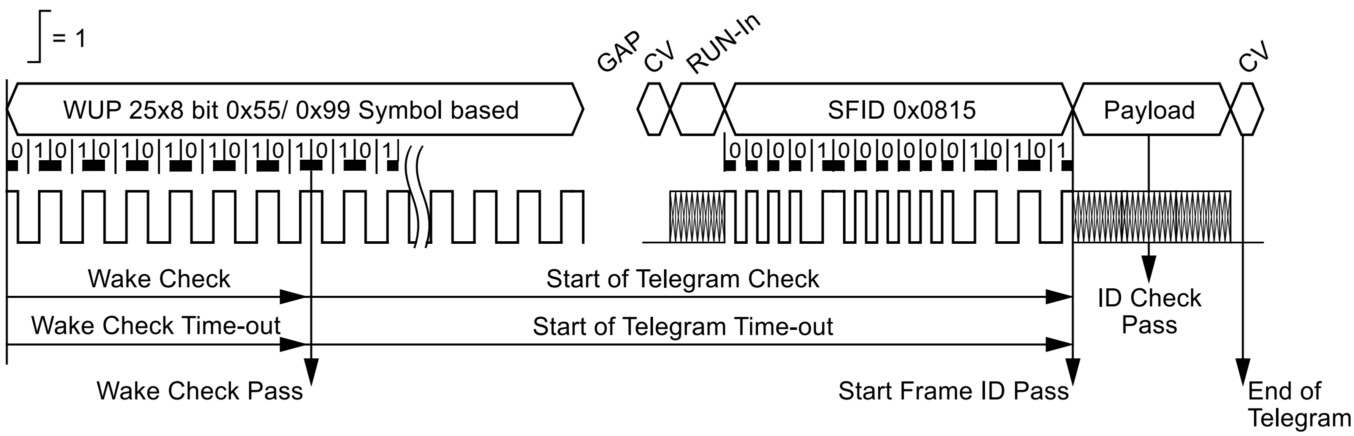

Figure 6. Check Timing Overview

during which time slot of the frame reception. Three ranges are available: The first one lasts until the wake check is okay. The second one ranges from wake-check okay until start-of-frame okay, and the third range extends until after the SFID has occurred. The first two are called start-of-frame conditions and can be configured so that they have a predefined set of symbols that are checked until one of the checks is successful. The third check is called the end-of-telegram condition, and searches for a failure in one of the signal checks during the reception of the payload. In case one of the activated checks has generated a failure, the transceiver terminates reception. Figure 5 shows the schematic overview of the frame synchronization.

Message Identification

The transceiver devices include an ID scan for message identification. This feature scans the payload and compares the incoming data with up to 18 predefined IDs. In case there is no match until a predefined threshold of bytes, reception is stopped and the demodulator restarts so it can detect the next valid message.

Figure 6 shows a protocol overview with the duration of the different checks, such as symbol, frame and message check, plus various time-outs.

Mixed Reception Using the ATA5831 Family

A unique feature of the new device family is its ability to handle mixed modulations within one message. Mixed modulation involves using the two reception paths of the transceiver—one path for the wake condition, the other for synchronization and reception. With this simple procedure it is also possible to handle complex protocols. The reason for this type of telegram is the strict restriction imposed by the regulatory agency. By using mixed modulation plus gaps between WUP and SFID, it is possible to increase output power and, thus, extend the transmission range.

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