Designing Next-Generation Car Access Receiver Modules

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Introduction

In 1997 Atmel® launched an innovative car access system featuring the lowest current consumption. This was achieved through the self-polling capability of the ATA3741 receiver IC. ATA3741 derivatives and second-generation RF receivers like the ATA572x address new RF automotive application areas. These include tire pressure monitoring system (TPMS), remote start applications, and bi-directional RF links.

With leading RF performance and a very reliable RF link, the third generation ATA578x is yet another step ahead. This family includes transceiver and transmitter devices. There are Flash, user ROM, and ROMless versions that are pin, function, and RF-matching compatible. Maximum development re-use minimizes the design efforts for one- and two-way systems.

This article describes how to migrate from the earlier ATA3741/43 devices to the current ATA5723/24, or to directly create a new design with Atmel's latest generation ATA578x.

Migration to the ATA5723/24

Customers with an RF system based on Atmel's ATA3741/43 UHF receiver ICs can easily upgrade their design to the current generation ATA5723/4. The required modifications to the existing receiver system comprise some very minor software and hardware modifications.

Software Modifications

Both the ATA5743 and the ATA5723/4 are configured by the host controller via one bidirectional line. Both devices have the same internal registers with identical configuration content. You can easily migrate from ATA5743 to ATA5723/24 without any software changes in the host controller. Simply double-check the sleep time settings, since there are some minor timing differences that may require adaptation. Table 1 lists the detailed sleep time changes.

The ATA3741 (formerly named U3741BM) and the ATA5723/4 are likewise configured via one bidirectional line from the host controller. Two internal registers contain the receiver configuration, but the number of bits within the registers differs. To protect the ATA5723/4 against unwanted register content change, the serial communication includes one additional bit. To enable writing content to the addressed register, set bit 15 to low, and add it to the communication software routines in the host controller.

Most bits in the registers do have the same meaning and cause the same hardware behavior. Tables 2 and 3 show the two devices' internal registers.

	ATA5743		ATA5723	ATA5724
Sleep	315 MHz T_{sleep} [ms]	433 MHz T_{sleep} [ms]	T_{sleep} [ms]	T_{sleep} [ms]
0	cont. On	cont. On	cont. On	cont. On
1	2.12	2.09	2.09	2.12
2	4.24	4.17	4.17	4.24
3	6.36	6.26	6.26	6.36
4	8.48	8.35	8.35	8.48
5	10.60	10.44	10.44	10.60
6	12.72	12.52	12.52	12.72
7	14.84	14.61	14.61	14.83
8	16.95	16.70	16.70	16.95
9	19.07	18.78	18.78	19.07
10	21.19	20.87	20.87	21.19
11	23.31	22.96	22.96	23.31
12	25.43	25.05	25.05	25.43
13	27.55	27.13	27.13	27.55
14	29.67	29.22	29.22	29.67
15	31.79	31.31	31.31	31.79
16	33.91	33.40	33.40	33.91
17	36.03	35.48	35.48	36.03
18	38.15	37.57	37.57	38.15
19	40.27	39.66	39.66	40.27
20	42.39	41.74	41.74	42.39
21	44.51	43.83	43.83	44.50
22	46.63	45.92	45.92	46.62
23	48.75	48.01	48.01	48.74
24	50.86	50.09	50.09	50.86
25	52.98	52.18	52.18	52.98
26	55.10	54.27	54.27	55.10
27	57.22	56.35	56.35	57.22
28	59.34	58.44	58.44	59.34
29	61.46	60.53	60.53	61.46
30	63.58	62.62	62.62	63.58
31	cont. Off	cont. Off	cont. Off	cont. Off

Table 1. Sleep Time Settings

Bit1	Bit2	Bit2	Bit4	Bit5	Bit6	Bit7	Bit8	Bit9	Bit10	Bit11	Bit12	Bit13	Bit14
OFF Command													
1													
OPMODE Register													
0	1	BR_Range		$N_{Bitcheck}$		V_{POUT}	Sleep					X_{Sleep}	
0	1	Baud1	Baud0	BitChk1	BitChk0	POUT	Sleep4	Sleep3	Sleep2	Sleep1	Sleep0	$X_{Sleep\ Std}$	$X_{Sleep\ Temp}$
(Default)		0	0	1	0	0	0	1	0	1	1	0	0
LIMIT Register													
0	0	Lim_min						Lim_max					
0	0	Lim_min5	Lim_min4	Lim_min3	Lim_min2	Lim_min1	Lim_min0	Lim_max5	Lim_max4	Lim_max3	Lim_max2	Lim_max1	Lim_max0
(Default)		0	0	1	1	1	0	0	1	1	0	0	0

Table 2. ATA3741 Register Content

Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Bit 6	Bit 7	Bit 8	Bit 9	Bit 10	Bit 11	Bit 12	Bit 13	Bit 14	Bit 15
OFF Command														
1	–	–	–	–	–	–	–	–	–	–	–	–	–	–
–		**OPMODE Register**												–
0	1	BR_Range		$N_{Bit\text{-}check}$		Modu-lation	Sleep					X_{Sleep}	Noise Suppression	0
		Baud1	Baud0	BitChk1	BitChk0	ASK/ _FSK	Sleep4	Sleep3	Sleep2	Sleep1	Sleep0	$X_{SleepStd}$	Noise_ Disable	
Default values of Bit 3...14		0	0	0	1	0	0	0	1	1	0	0	1	–
–		**LIMIT Register**												–
0	0	Lim_min						Lim_max						–
		Lim_ min5	Lim_ min4	Lim_ min3	Lim_ min2	Lim_ min1	Lim_ min0	Lim_ max5	Lim_ max4	Lim_ max3	Lim_ max2	Lim_ max1	Lim_ max0	0
Default values of Bit 3...14		0	1	0	1	0	1	1	0	1	0	0	1	–

Table 3. ATA5723/4 Register Content

Bit 7 in the OPMODE register is different. The ATA3741 uses bit 7 to control output pin 17, whereas the ATA5723/4 uses bit 7 to switch between ASK and FSK mode. This switching is done in ATA3741 by pin 2.

With the ATA3741, bit 14 in the OPMODE register extends the sleep time by a factor of 8, whereas the ATA5723/4's bit 14 allows optional additional noise suppression.

The upgrade to ATA5723/24 includes a different timing of the programming start pulse. You may also need to do some slight software modifications in the host controller. Please refer to the datasheet section "Programming Start Pulse".

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Hardware Changes

The ATA5723/24 is the direct upgrade of the ATA5743. Both devices are available in SSO20 packages with the same footprint, whereas the ATA3741 package is an SO20. Due to the ATA5723/24's hardware improvements you also need to do some hardware modifications on your board when migrating (table 4).

- Faster external oscillator start-up with a negative resistor up to 1.5kΩ (only valid for migration from ATA5743 to ATA5723/24)
- The ATA5723/4 requires a crystal with a different frequency
- Less external components on the ATA5723/24 board due to integration of the filter circuit
- The antenna matching elements have to be modified

Pin	ATA3741	ATA5743	ATA5723/4
2	FSK/ASK		IC_Active
6	GND	GND	Open (RSSI)
7	VS	VS	GND
8	GND (with filter)	GND (with filter)	GND
9	Antenna matching	Antenna matching	Antenna matching
10	NC	NC	GND
11	VS	VS	NC
12	Filter circuit	Filter circuit	GND
13	GND	GND	XTAL2
14	XTAL	XTAL	XTAL1
17	POUT		Data clock
19	Enable High = polling on Low = sleep		Polling High = polling on, Low = receiving active

Table 4. List of Hardware Differences

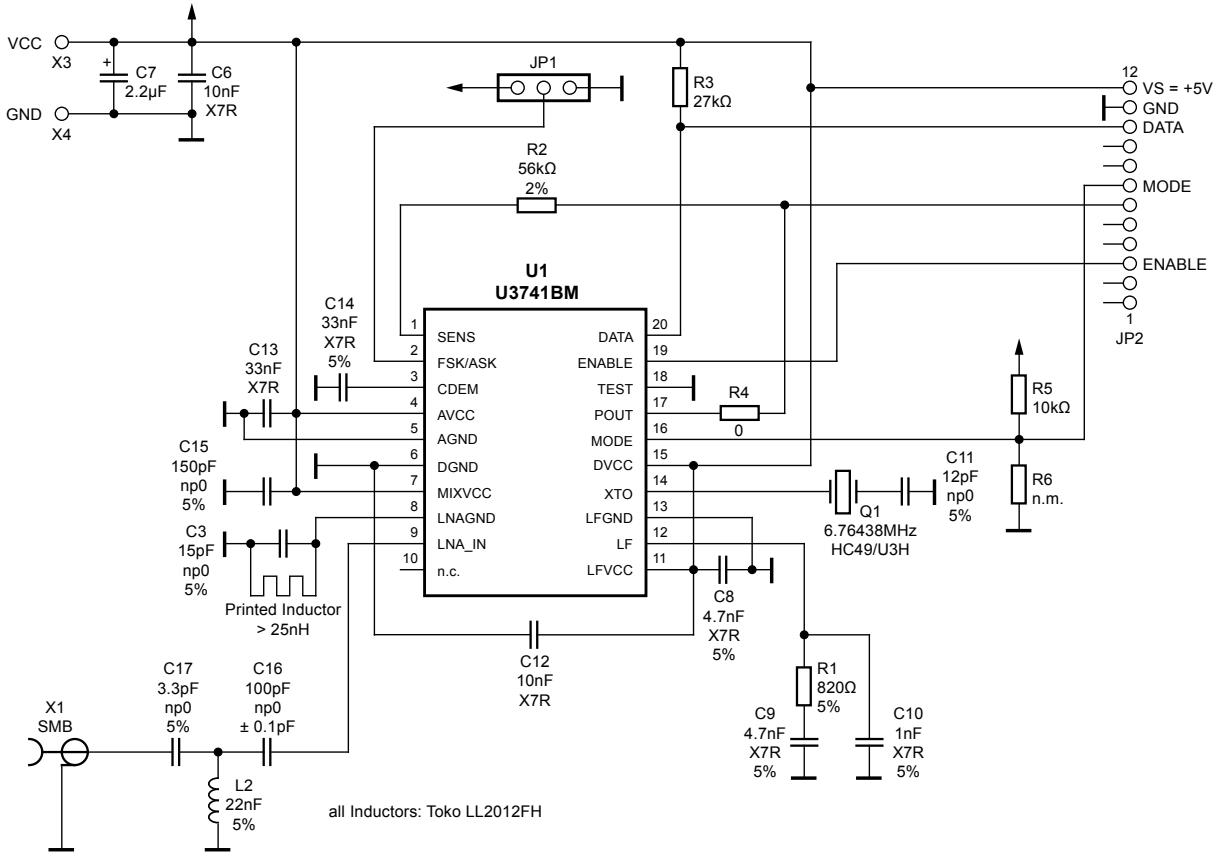

Figure 1. Typical Application ATA3741

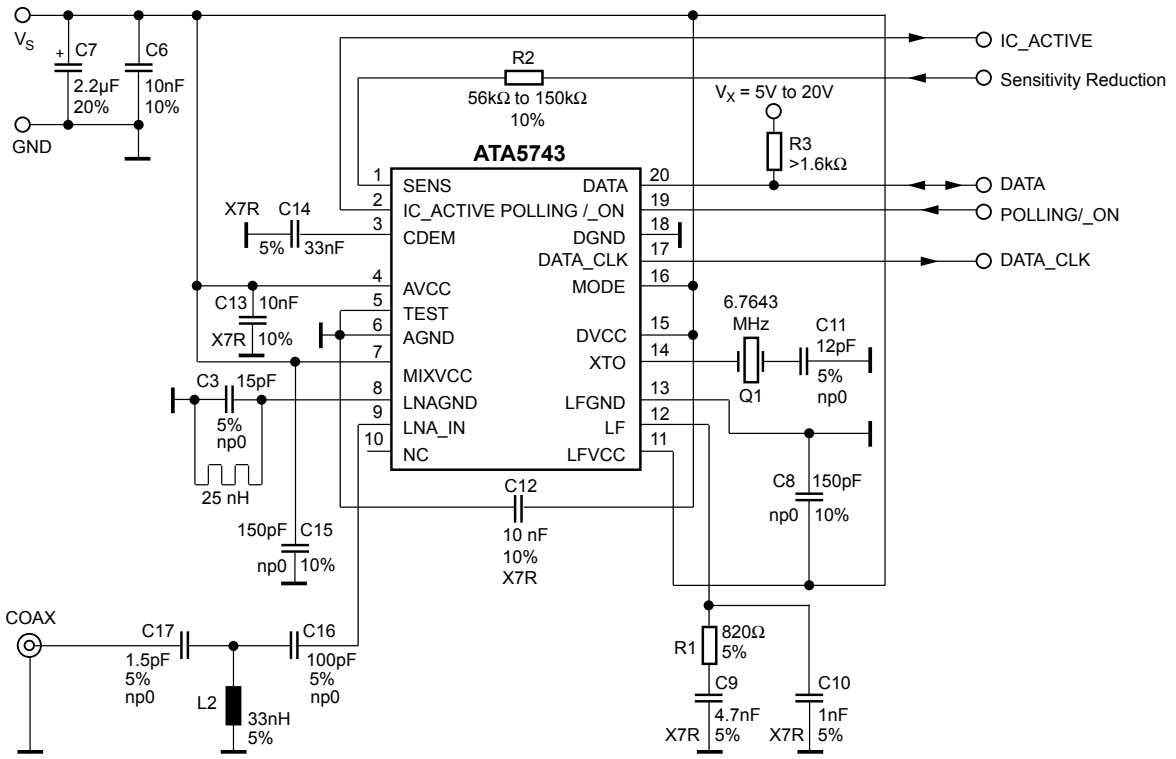

Figure 2. Typical Application with ATA5743

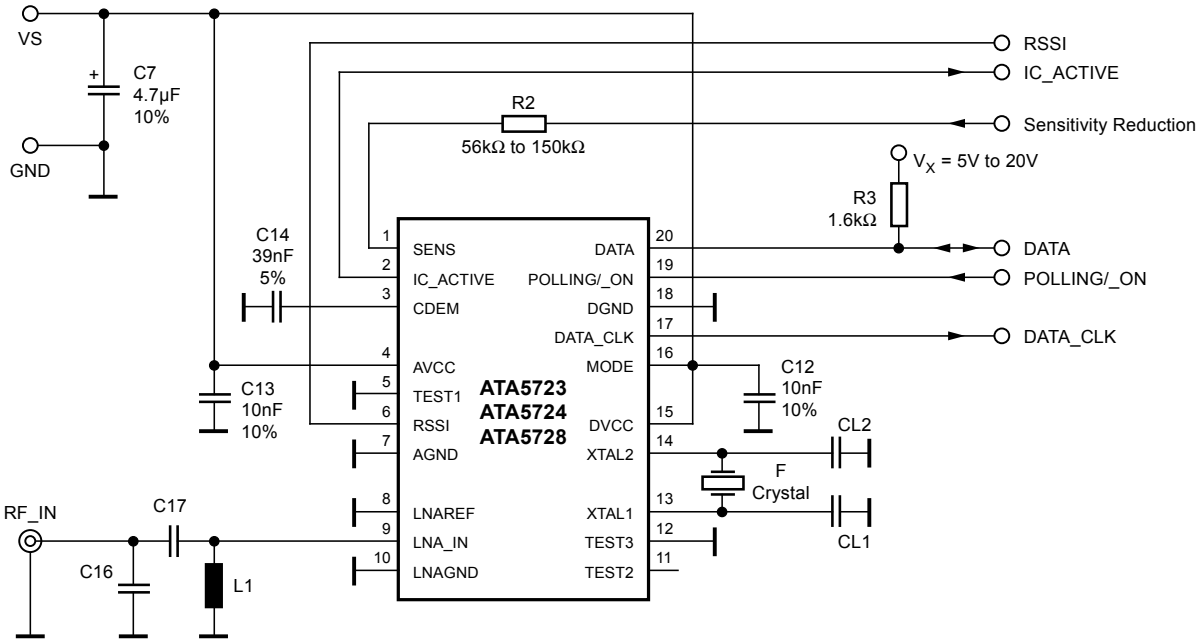

Figure 3. Typical Application with ATA5723/24

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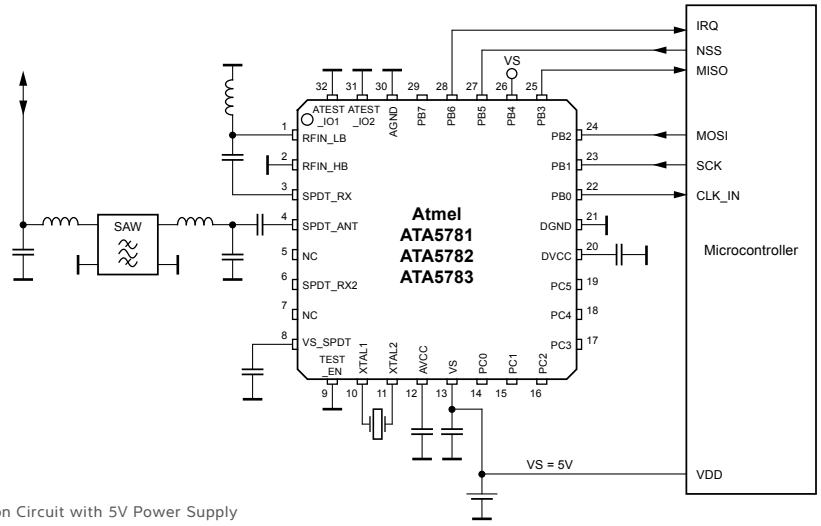

Figure 4. Typical Application Circuit with 5V Power Supply

Automotive UHF Receiver Design Based on ATA5781/2/3

All members of Atmel's ATA5781/2/3 family include an AVR® microcontroller core. Designed for the ISM frequency bands (310-318MHz, 418-477MHz and 836-956MHz), these parts feature excellent RF receiving sensitivity. In FSK mode, the sensitivity reaches –122.5dBm (at 433.92MHz, 0.75kbit/s and BWIF = 25kHz), in ASK mode sensitivity is –125dBm (at 433.92MHz, 0.5kbit/s and BWIF = 25kHz).

The autonomous self-polling mode and good blocking performance help you to design robust automotive RF receiver systems with very low power consumption, since only a valid RF signal activates the host controller. Excellent RF performance, a short bill of materials, and flexibility to adapt the receiving behaviour to all known RF protocols and market needs make the ATA578x family the best choice for new RF receiver designs.

Configuration

The AVR microcontroller's ROM includes firmware that allows you to configure the device according to the configuration stored in the EEPROM. You can control the receiver via an external host controller by using the SPI interface. User Flash and user ROM (available in ATA5782 and ATA5783 only) enable you to write additional software. For example, to protect the external host controller, or to adapt the firmware to any RF protocol. The receiver families have different program memory capabilities (see table 5).

Part Number	ROM Firmwave	User Flash	User ROM
ATA5781	24KByte		
ATA5782	24KByte	20KByte	
ATA5783	24KByte		20KByte

Table 5. Program Memory

5V Power Supply Application

In automotive remote keyless entry (RKE) systems, you use the ATA578x as an UHF receiver inside the vehicle. Such applications typically connect to a regulated 5V power supply (see figure 4). The host MCU controls the RF receiver via the SPI interface. The receiver operates autonomously. The host controller just enables the receiving mode, either polling RX mode or standard RX mode, by sending the corresponding command over the SPI lines.

RF Settings

In modern vehicles an RF receiver must be capable of receiving different RF protocols from different transmitters. This includes RKE key fobs, tire pressure monitoring systems, and remote start controls. Because these systems transmit their messages with different modulation, baud rate, and bandwidth, the ATA578x family offers five different RF settings to let you define the RF protocol and the wake-up conditions via the EEPROM configuration GUI (graphical user interface).

Reception Modes

You can use two different reception modes. During standard Rx mode the receiver checks for a desired RF telegram at a particular time. Polling mode means that you define the telegram settings in advance. The receiver automatically and continuously checks for this defined setting. Once the receiver detects the beginning of a valid signal it switches to standard Rx mode and receives the message. In case of no valid message, the receiver switches off for a defined period, and the entire procedure starts over again.