Atmel MCU Wireless

AT02598:Migration from AT86RF212 to AT86RF212B

APPLICATION NOTE

Description

This application note assists the users of Atmel Sub-GHz transceiver, AT86RF212 in converting designs to Atmel AT86RF212B. For complete transceiver details, always refer to the most recent version of the AT86RF212B datasheet [2].

The differences in Errata among AT86RF212 and AT86RF212B are not listed in this document refer individual datasheet [1] for more details.

The AT86RF212B transceiver support is available in Atmel Software Framework version 3.7.3 and above [4]. The `AT86rf212b.h` file(`..\thirdparty\wireless\avr2025_mac\source\tal\at86rf212b\inc`) is available in the Atmel Software Framework. This file can be used in the project for the register definitions of AT86RF212B.

In addition to the migration details, this document also highlights the enhanced features of AT86RF212B transceiver.

Features

- Hardware consideration while migrating to Atmel® AT86RF212B
- Firmware consideration while migrating to AT86RF212B
- Enhanced features of AT86RF212B
  - Additional frequency bands
  - Additional PHY modes
  - RX override
  - Improved occupied bandwidth
  - Improved AES security module
  - PHY controlled antenna diversity

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1. Migrating from Atmel AT86RF212 to AT86RF212B

This chapter summarizes the modifications that might be required while migrating from AT86RF212 to AT86RF212B transceiver.

1.1. Hardware Considerations

AT86RF212B transceiver is a drop in replacement for AT86RF212 transceiver. Nil or minimal hardware design change is required based on the application while migrating from AT86RF212 to AT86RF212B. For more details, refer to individual datasheets [1]. The RF coupling capacitors (referred as C1,C2 in the individual datasheets) used in AT86RF212B is 100pF whereas in AT86212 it is 68pF . This is due to the change in the specification of balun specifiied in AT86RF212B datasheet, which requires the dc blocking capacitor to be higher.

1.2. Version Number

AT86RF212 and AT86RF212B vary in the version number. If the application firmware checks the transceiver's VERSION_NUM (0x05) register, then it has to be changed according to the following table.

Table 1-1. VERSION_NUM register

Register name	AT86RF212	AT86RF212B
VERSION_NUM (0x05)	0x01 (Revision A)	0x03 (Revision C)

1.3. RSSI Base Value

RSSI base value of BPSK with 600kchip/s is changed as shown in the following table. For more details on RSSI base value, refer to table – RSSI_BASE_VAL in the AT86RF212B datasheet [2]. Application firmware shall be using this RSSI_BASE_VAL for RF input power, ED and RSSI calculations.

Note: This migration is applicable only if the application uses BPSK 600kchip/s PHY mode.

Table 1-2. $RSSI_{BASE\_VAL}$ for BSPK with 600kchip/s

S. no	PHY mode	$RSSI_{BASE\_VAL}$ [dBm]	
1	BPSK with 600kchip/s	AT86RF212	AT86RF212B
		-100	-99

1.4. Transmit Power Levels

AT86RF212B supports output power range from -25dBm to 11dBm in all 915MHz North American band, 868.3MHz European band and 780MHz Chinese band as shown in Table 1-3.

Application firmware shall use this TX_PWR bits for configuring the transmit output power. TX_PWR, frequency band and transmit power mapping needs to be changed based on Table - Recommended Mapping of TX Power, Frequency Band, and PHY_TX_PWR (register 0x05) in the AT86RF212B datasheet [2].

To meet the spectral requirements of the European and Chinese bands, it is necessary to limit the TX power by appropriate setting of register bits TX_PWR, GC_PA (register 0x05, PHY_TX_PWR), and GC_TX_OFFS (register 0x16, RF_CTRL_0).

In AT86RF212B, bit value 0x0 for register bit GC_TX_OFFS(register 0x16, RF_CTRL_0) is reserved whereas in AT86RF212 setting this bit value configures TX power offset as -1dB. Refer to Register Description - RF_CTRL_0 in the AT86RF212B datasheet[2].

Table 1-3. PHY_TX_PWR register

Register name	Register bits	Description
PHY_TX_PWR (0x05)	TX_PWR [3:0]	Output power range is increase to 36 steps

1.5. Modulation Scheme Selection

In AT86RF212B Bit-4 of TRX_CTRL_2 (0x0C) is named as ALT_SPECTRUM, which was referred as OQPSK_SUB1_RC_EN in AT86RF212. Refer to section Physical Layer Modes – Register Description in the AT86RF212B datasheet [2].

1.6. Matching Control for RFP/RFN

Differential matching controls options were removed in the Atmel AT86RF212B. So there is no RF_CTRL_1 (0x19) register in the AT86RF212B. If the existing design uses this software impedance matching, then it might be required to add an external matching component for an AT86RF212B-based design.

1.7. Change in Symbols

The Dynamic frame buffer protection : IRQ latency is reffered with symbol t_{12} in AT86RF212B whereas it is reffered as t_{13} in AT86RF212.

AES core cycle time is reffered with symbol t_{aes} in AT86RF212B whereas it is referred as t_{12} in AT86RF212.

2. Enhancement and Added Features

This chapter summarizes the enhancement and additional features of the Atmel AT86RF212B compared to the AT86RF212 transceiver.

2.1. Supported Frequency Bands

AT86RF212B has additional CC_BAND-6 which supports 902 - 927.5MHz with 100kHz channel spacing, which is not available in AT86RF212. CC_BAND can be configured using CC_CTRL_1 (0x14) register and individual channels are configured using CC_CTRL_0 (0x13) register. Refer to section RF Channel Selection in the AT86RF212B datasheet [2].

Table 2-1. Frequency band 902 – 927.5MHz with 100kHz channel spacing exists only in AT86RF212B

Register name	Register bits	Description
CC_CTRL_0 (0x13)	CC_NUMBER [7:0]	Additional frequency band supporting
CC_CTRL_1 (0x14)	CC_BAND [2:0]	frequency from 902 – 927.5MHz with 100kHz channel spacing

2.2. Additional PHY Modes

In AT86RF212B, ALT_SPECTRUM bit is valid for both SUB_MODE 0 and 1 and both BPSK_OQPSK 0 and 1. Using OQPSK_DATA_RATE = 3 mode, we can configure OQPSK-SIN-500-ALT and OQPSK-RC-500-ALT modulation schemes, which might be beneficial when using an external power amplifier and targeting high output power according to FCC 15.247 [5].

AT86RF212B supports configuration of additional PHY modes as shown in the following table. For more details refer to table – Register 0x0C (TRX_CTRL_2) Bit Alignment in AT86RF212B datasheet [2].

To ensure FCC 6dB bandwidth requirement is met, either of the following configuration can be used

- Set ALT_SPECTRUM bit to 1, Please note that ALT_SPECTRUM is a proprietary mode.
- In step 9 of Table A-1. PRBS and CW Mode Programming Sequence in AT86RF212B datasheet [2] , write to the frame buffer with PHR - 0x01 and PSDU 0x00.

Table 2-2. Additional PHY modes in AT86RF212B

PHY mode	Description
BSPK-40-ALT	Proprietary, alternative spreading code
OQPSK-RC-100	Proprietary
OQPSK-RC-200	Proprietary
OQPSK-RC-400-SCR-ON	Proprietary, scrambler on
OQPSK-RC-400-SCR-OFF	Proprietary, scrambler off
OQPSK-SIN-500-ALT	Proprietary, alternative spreading code
OQPSK-RC-500-ALT	Proprietary, alternative spreading code

Note:

1. The modulation BPSK-40 and modulation BPSK-40-ALT are interoperable together, with some performance degenerations.
2. During reception, this bit is not evaluated within the Atmel AT86RF212B, so it is not explicitly required to align different transceivers with ALT_SPECTRUM in order to assure interoperability. It is very likely that this also holds for any IEEE 802.15.4-2006 compliant O-QPSK transceiver in the 915MHz band, since the IEEE 802.15.4-2006 requirements are fulfilled for both types of shaping.

2.3. Additional Threshold Bits Clear Channel Assessment

AT86RF212B has additional bit fields in CCA_THRES (0x09) register as shown in the following table, which are reserved in AT86RF212.

Default value of CCA_CS_THRES field is 0x7 corresponds to normal CCA_CS operation, if the threshold is set as 0xF then carrier sense will always indicate an empty channel. For more details refer to section Clear Channel Assessment (CCA) – Register Description in the AT86RF212B datasheet [2].

Table 2-3. CCA_CS_THRES in AT86RF212B

Register name	Register bits	Description
CCA_THRES (0x09)	CCA_CS_THRES [7:4]	Additional configuration option for changing the CCA threshold

2.4. RX Override

Receiver Override feature is available in the Atmel AT86RF212B, whereas AT86RF212 does not have this advanced feature. We can enable the receiver override by configuring the RX_OVERRIDE bits in RX_SYN (0x15) register as shown in the following table. Refer to section Receiver (RX) – Register Description in AT86RF212B datasheet [2].

During the receive process the validity of the current frame and the occurrence of a strong interferer is checked continuously. In either of those cases the reception is automatically restarted to increase the overall system availability and throughput with respect to correct received packets. The Receiver Override can be used without performance degradation in combination with any modulation scheme and data rate.

Table 2-4. RX override in AT86RF212B.

Register name	Register bits	Function
RX_SYN (0x15)	RX_OVERRIDE [6:4]	Enables or disables RXO functionality

2.5. Improved Occupied Bandwidth

AT86RF212B has improved Occupied Bandwidth when compared to AT86RF212. With the modified chip sequence interoperable with IEEE® 802.15.4 is used for TX and RX showing different spectrum properties (to ensure FCC 600kHz bandwidth requirement). Refer spectral mask for various modulation schemes in section Transmetter - Spectrum Masks of AT86RF212B datasheet [2].

2.6. Improved AES Security Module

AT86RF212 requires activation of CLKM for using AES in TRX_OFF state this limitation was resolved in AT86RF212B. For more details refer to section Security Module (AES) in AT86RF212B datasheet [2].

2.7. PHY Controlled Antenna Diversity

AT86RF212B supports both PHY controlled antenna diversity in TX_ARET mode and software controlled antenna diversity whereas AT86RF212 supports only software controlled antenna diversity. For more details refer to section Antenna Diversity – Register Description in the AT86RF212B datasheet [2].

AT86RF212B contains additional ANT_DIV_EN and ANT_SEL bits in ANT_DIV (0x0D) register for enabling automatic antenna diversity feature as shown in the following table.

Table 2-5. CCA_CS_THRES in AT86RF212B

Register name	Register bits	Function
ANT_DIV (0x0D)	ANT_DIV_EN [3] Enabled or	Enabled or disables antenna diversity
ANT_DIV (0x0D)	ANT_SEL [7]	Indicates the status of selected antenna

2.8. Additional CW mode

AT86RF212B has additional CW mode in addition to the CW mode used in the AT86RF212. As a side effect of I/Q modulation, CW mode shows some unwanted signal components based on finite image rejection and non-linearities. This Additional CW mode directly uses the PLL signal without I/Q modulation.

This is the recommended mode because the signal is placed at the selected channel center frequeny Fc and unwanted signal components are significantly lower.For the sequence of commands to be used for the Additional CW mode refer to Table A-2 Additional CW Mode Programming Sequence in the AT86RF212B datasheet [2].

3. Typical and Electrical Characteristics

A Typical Characteristic section is added in the AT86RF212B datasheet [2], which is not available in AT86RF212. Due to additional features of AT86RF212B, electrical characteristics shall be different for both AT86RF212 and AT86RF212B transceivers. Check the latest datasheet for details [1].

4. Ordering Information

Table 4-1. Ordering information

Ordering code	Packaging	Package	Voltage range	Temperature range
AT86RF212B-ZU	Tray	QN*	1.8V – 3.6V	Industrial (-40°C to +85°C) Lead-free/ Halogen-free
AT86RF212B-ZUR	Tape & Reel	QN*	1.8V – 3.6V	Industrial (-40°C to +85°C) Lead-free/ Halogen-free
AT86RF212-ZU	Tray	QN*	1.8V – 3.6V	Industrial (-40°C to +85°C) Lead-free/ Halogen-free
AT86RF212-ZUR	Tape & Reel	QN*	1.8V – 3.6V	Industrial (-40°C to +85°C) Lead-free/ Halogen-free

*QN - 32QN2, 32-lead 5.0 x 5.0mm Body, 0.50mm Pitch, Quad Flat No-lead Package (QFN) Sawn.

Note: Tape & Reel quantity 5,000.
Contact your local Atmel sales office [3] for more detailed ordering information and minimum quantities.

5. Contact

Atmel Technical Support - http://www.atmel.com/design-support

6. Related Documents

1. Atmel MCU Wireless Transceivers
2. Atmel AT86RF212B datasheet
3. Atmel sales office – contact
4. Atmel Software Framework
5. FCC title 47 (Telecommunication) of the Code of Federal Regulations, Part 16 (Radio Frequency Devices), October 2008.

7. Revision History

Doc. Rev.	Date	Comments
42178B	08/2016	1. Updated Description with reference to ASF files for register description of AT86RF212B. 2. Updated section 1.1 with the reason for increase in the RF coupling capacitors in AT86RF212B. 3. Updated section 1.4 Transmit Power Levels with indication that bit value 0x0 GC_TX_OFFS is reserved. 4. Added a new section 1.7 Change in symbols 5. Updated section 2.2 Additional PHY Modes with the notes regarding the ALT_SPECTRUM and configurations to ensure FCC 6dB bandwidth requirement is met 6. Added a new section 2.8 Additional CW mode.
42178A	08/2013	Initial document release

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