AX-WM/D

Product Preview

Ultra-Low Power, API Controlled, Wireless M-Bus and OMS Compliant Transceiver IC

ON Semiconductor®

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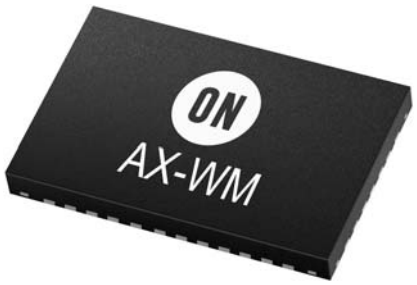

Figure 1. QFN40 5 x 7 mm

Description

AX−WM is an ultra−low power single chip solution for wireless M−Bus Utility Meters or Multi Utility Controllers.

The AX−WM chip is delivered with an API which provides all of the functions required for the European Standards EN 13757−3, EN13757−4 and the Open Metering System (OMS) specifications.

Features

- Supply Range 1.8 V − 3.6 V
- −40°C to 85°C
- Highest Wireless M−Bus Sender Class H_T Mode S & T
- Highest Wireless M−Bus Receiver Class H_R Mode S & T
- Wireless M−Bus Mode S & T Transmitter:
  - RX−mode: 11 mA
  - TX−mode: 49.0 mA @ 14 dBm
- Sensitivity:
  - −106 dBm @ PER < 20%, 20 Byte Telegram (Modes S, T2 other to meter)
  - −105 dBm @ PER < 20%, 20 Byte Telegram (Modes T1, T2 meter to other)
- Supports Wireless M−Bus Modes S, T
- Wireless M−Bus Compliant Protocol Stack
- Fully OMS Generation 3 Compliant
- Size of Example Code to Send and Receive, using the Wireless M−Bus API:
  - 29.520 kBytes Flash size = 46%
  - 2.802 kBytes SRAM = 34%
- Sleep Mode with Wake−up Timer Running 1.4 μA
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

Typical Applications

- Multi−Energy Utility Meters
  - Water
  - Gas
  - Electricity
  - Heating Systems
- Multi Utility Controller (MUC)

Related Standards − European Standard

EN 13757−3, EN 13757−4

This document contains information on a product under development. ON Semiconductor reserves the right to change or discontinue this product without notice.

MARKING DIAGRAM

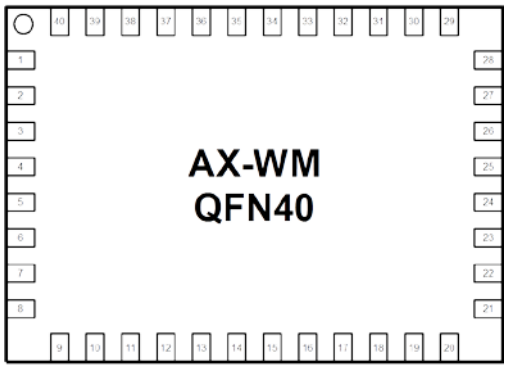

Figure 2. QFN40 5 x 7 mm Marking

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 16 of this data sheet.

FEATURES AND SPECIFICATIONS

The AX−WM is based on the AX8052F143 and therefore shares most features and specifications.

For detailed specifications consult the AX8052F143 Datasheet.

OVERVIEW

AX−WM is an ultra−low power single chip solution for communication with wireless M−Bus products.

The AX−WM chip is delivered with an API fully ready for operation, containing all the necessary functions to transmit and receive data from other Wireless M−Bus products.

The AX−WM API version 1.0 supports the Wireless M−Bus modes S and T, together with all necessary functions required for OMS compliance.

About the Wireless Meter Bus (Wireless M−Bus) Standard

The M−Bus (Meter−Bus) or Wireless M−Bus (wireless Meter−Bus) is a European standard for remote reading of consumption meters as well as for various sensors and actuators.

The Wireless M−Bus standard is described in the following European Norms:

- DIN EN 13757−3:2013−08 [1]

DIN EN 13757−3:2013−08, Communication systems for and remote reading of meters − Part 3: Dedicated application layer; German version EN 13757−3:2013, 2013.

DIN EN 13757−3 defines the application layer of the M−Bus.

This document contains the major part of the definitions, like the coding of the Value/Data Information Field, CI Fields, ...

- DIN EN 13757−4:2014−02 [2]

DIN EN 13757−4:2014−02, Communication systems for meters and remote reading of meters − Part 4: Wireless meter readout (Radio meter reading for operation in SRD bands); German version EN 13757−4:2013, 2014.

DIN EN 13757−4 defines the wireless M−Bus specifications, which are implemented in the AX−WM API.

- OMS (Open Metering System) [3]

“The OMS−Group is a community of interest of associations ...”,” ... the OMS−Group has developed an open, vendor independent standard for communications interfaces and basic requirements.” [3]

The OMS defines additional restrictions and extensions of the Wireless M−Bus. OMS is currently being discussed as an extension of EN 13757.

The OMS specifications are freely available and contain examples of Wireless M−Bus messages and formatting.

868 MHz Wireless M−Bus Modes

Table 1. 868 MHz WIRELESS M−BUS MODES, EXTRACTED FROM EN13757−4 [2]

Mode	S1	S1−m	S2	T1	T2 m2o	T2 o2m	R2	C1	C2 m2o	C2 o2m
Frequency [MHz]	868.3			868.95		868.3	868.3	868.95		869.525
Frequency Tolerance [ppm]	m2o=60 o2m=25			60		25	20	25		
Chip Rate [kcps]	32.768			100		32.768	4.8	100		50
Chip Rate Tolerance	1.50%			1.00%		1.50%	1.50%	100ppm		
max. Duty Cycle [%]	0.02	0.02	1	0.1		1	1	0.1		10
Modulation	2−FSK			2−FSK			2−FSK	2−FSK		2−GFSK
Deviation [kHz]	Minimum: 40 Typical: 50 Maximum: 80			40 50 80			4.8 6 7.2	33.75 45 56.25		18.75 25 31.25
Encoding	Manchester			3 to 6		Manchester	Manchester	NRZ		
Preamble Length with SYNC [chips]	576	48	48 (or 576) [1]	48			96	64		
Preamble Length = n [bits]	279	15	15 (or 279) [1]	19		15	39	16		
Preamble	n*(01)			n*(01)			n*(01)	n*(01)		
SYNC Length [bits]	18			10		18	18	32		
SYNC	00011101 10100101 10			00001111 01		00011101 10100101 10	00011101 10100101 10	A = 01010100 00111101 01010100 11001101 B = 01010100 00111101 01010100 00111101 [2]		
Frame Format	A			A			A	A/B		

NOTE: o2m → other to meter
m2o → meter to other

1. The mode S2 can be used with either a short preamble (15 bits) or a long preamble (279 bits). OMS requires the long preamble.
2. The mode C can use 2 different framings, A and B, which use a different sync words.

Supported by the AX−WM API are the modes S and T. Modes R and C are not yet supported by the current version of the API.

ELECTRICAL SPECIFICATIONS

Absolute Maximum Ratings

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device.

This is a stress rating only; functional operation of the device at these or any other conditions above those listed in the operational sections of this specification is not implied.

Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Table 2. ABSOLUTE MAXIMUM RATINGS

Symbol	Description	Condition	Min	Max	Units
VDD_IO	Supply voltage		−0.5	5.5	V
IDD	Supply current			200	mA
P_{tot}	Total power consumption			800	mW
P_i	Absolute maximum input power at receiver input	ANTP and ANTN pins in RX mode		10	dBm
I_{I1}	DC current into any pin except ANTP, ANTN, ANTP1		−10	10	mA
I_{I2}	DC current into pins ANTP, ANTN, ANTP1		−100	100	mA
I_O	Output Current			40	mA
V_{ia}	Input voltage ANTP, ANTN, ANTP1 pins		−0.5	5.5	V
	Input voltage digital pins		−0.5	5.5	V
V_{es}	Electrostatic handling	HBM	−2000	2000	V
T_{amb}	Operating temperature		−40	85	°C
T_{stg}	Storage temperature		−65	150	°C
T_j	Junction Temperature			150	°C

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

DC Characteristics

Table 3. SUPPLIES

Symbol	Description	Condition	Min	Typ	Max	Units
T_{AMB}	Operational ambient temperature		−40	27	85	°C
VDD_{IO}	I/O and voltage regulator supply voltage		1.8	3	3.6	V
VDD_{IO_R1}	I/O voltage ramp for reset activation (1)	Ramp starts at VDD_IO ≤ 0.1 V	0.1			V/ms
VDD_{IO_R2}	I/O voltage ramp for reset activation (1)	Ramp starts at 0.1 V < VDD_IO < 0.7 V	3.3			V/ms
I_{DS}	Deep sleep mode current			100		nA
I_{SLP}	Sleep mode current			1.4		μA
I_{STDBY}	Standby mode current			0.6		mA
I_{RX_CONT}	Current consumption continuous RX			11		mA
Q_{20BMS}	Charge to send a 20 bytes message	Mode S, T2 o2m		1.54		mC
Q_{20BMT}	Charge to send a 20 bytes message	Mode T1,T2 m2o		0.19		mC
$I_{TXMOD14AVG}$	Modulated Transmitter Current (2)	Pout = 14 dBm; average		49.0		mA

1. If VDD_IO ramps cannot be guaranteed, an external reset circuit is recommended, see the AX8052 Application Note: Power On Reset.
2. Current consumption values are given for a matching network that is optimized for 14 dBm output.

Power Consumption S Mode

S1−mode or S2−mode with long preamble:

A simple packet, containing a small header and a voltage, is 21 bytes long.

Manchester encoding codes every bit as 01 or 10 sequence. Therefore every bit of the packet consists of 2 chips.

Table 4.

	Bit	Chips
Preamble	558	558
Sync Word	18	18
Packet	168	336
Total		930

In total the transmission is 930 chips long. With a rate of 32.768 kcps, the transmission requires roughly 30.5 ms.

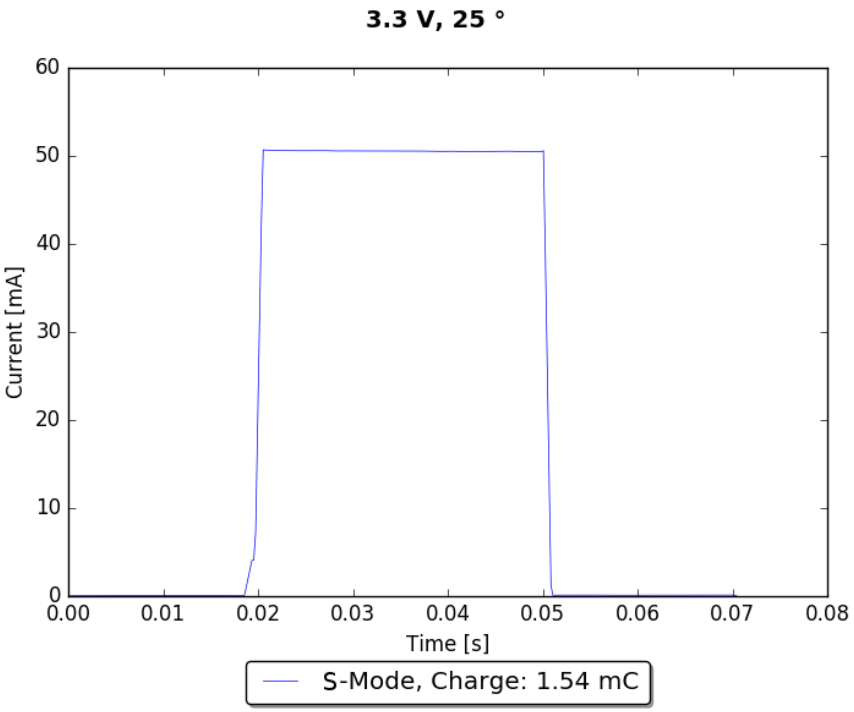

Figure 3. Current Consumption of S Mode with Long Preamble

NOTE: Measurement and calculations contain consumption of the chip together with additional components as shown in section “Typical Application Diagram”.

Battery Life Examples

Scenario 1:

- CR2032 coin cell battery
- Device in Sleep
- Neglecting battery self−discharge
- 100 transmissions a day

CR2032 Capacity	225 mAh * 3600 s/h	810 C
Sleep Charge per Day	1.4 μA * 86400 s	0.12 C/day
100 Transmissions	100 * 1.54 mC	0.154 C/day
Total Charge Consumption		0.274 C/day
Battery Life		8.1 Years

Scenario 2:

- 2 AAA Alkaline batteries in series
- Device in Sleep
- Neglecting battery self−discharge
- 1000 transmissions a day

2 AAA Alkaline Capacity	1200 mAh * 3600 s/h	4320 C
Sleep Charge per Day	1.4 μA * 86400 s	0.12 C/day
1000 Transmissions	1000 * 1.54 mC	1.54 C/day
Total Charge Consumption		1.66 C/day
Battery Life		7.1 Years

Power Consumption T Mode

T1−mode or T2−m2o−mode:

A simple packet, containing a small header and a voltage, is 21 bytes long.

3 out of 6 (or 4−to−6) encoding codes every half byte (4 bits) of the packet with 6 bits.

Table 5.

	Bit	Chips
Preamble	38	38
Sync Word	10	10
Packet	168	252
Total		300

In total the transmission is 300 chips long. With a rate of 100 kcps, the transmission requires roughly 3 ms.

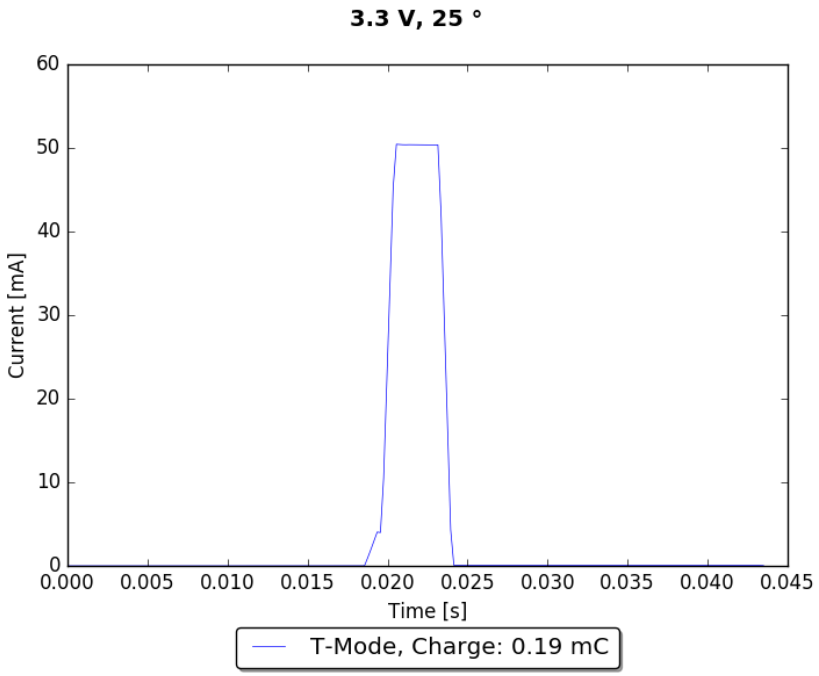

Figure 4. Current Consumption of T1, T2 m2o Mode

NOTE: Measurement and calculations contain consumption of the chip together with additional components as shown in section Typical Application Diagram.

Battery Life Examples

Scenario 1:

- CR2032 coin cell battery
- Device in Sleep
- Neglecting battery self−discharge
- 1000 transmissions a day

CR2032 Capacity	225 mAh * 3600 s/h	810 C
Sleep Charge per Day	1.4 μA * 86400 s	0.12 C/day
1000 Transmissions	1000 * 0.19 mC	0.19 C/day
Total Charge Consumption		0.31 C/day
Battery Life		7.16 Years

Scenario 2:

- 2 AAA Alkaline batteries in series
- Device in Sleep
- Neglecting battery self−discharge
- 10,000 transmissions a day, which is 1 transmission every 8.64 seconds

2 AAA Alkaline Capacity	1200 mAh * 3600 s/h	4320 C
Sleep Charge per Day	1.4 μA * 86400 s	0.12 C/day
10000 Transmissions	10000 * 0.19 mC	1.9 C/day
Total Charge Consumption		2.02 C/day
Battery Life		5.86 Years

Logic

Table 6. LOGIC

Symbol	Description	Condition	Min	Typ	Max	Units
Digital Inputs						
V_{T+}	Schmitt trigger low to high threshold point	VDD_IO = 3.3 V		1.55		V
V_{T-}	Schmitt trigger high to low threshold point			1.25		V
V_{IL}	Input voltage, low				0.8	V
V_{IH}	Input voltage, high		2.0			V
V_{IPA}	Input voltage range, Port A		−0.5		VDD_IO	V
V_{IPBC}	Input voltage range, Ports B, C		−0.5		5.5	V
I_L	Input leakage current		−10		10	μA
R_{PU}	Programmable Pull−Up Resistance			65		kΩ
Digital Outputs						
I_{OH}	Output Current, high Ports PA, PB and PC	V_{OH} = 2.4 V	8			mA
I_{OL}	Output Current, low Ports PA, PB and PC	V_{OL} = 0.4 V	8			mA
I_{OZ}	Tri−state output leakage current		−10		10	μA

AC Characteristics

Transmitter

Table 7. TRANSMITTER

Symbol	Description	Condition	Min	Typ	Max	Units
f_{TCXO}	TCXO frequency	A passive network between the TCXO output and the pins CLKP and CLKN is required. For detailed TCXO network recommendations depending on the TCXO output swing refer to the AX5043 Application Note: Use with a TCXO Reference Clock.		48		MHz
Conditions for transmitter specifications, unless otherwise specified, with the antenna network from the Typical Application Diagram						
SBR_S	Signal bit rate	S mode		16.384		kbps
SBR_T	Signal bit rate	T mode		66.667		kbps
PTX_{min}	Lowest Transmitter output power			0		dBm
PTX_{max}	Highest Transmitter output power			14		
PTX_{step}	Programming step size output power			1		dB
dTX_{temp}	Transmitter power variation vs. temperature	−40 °C to +85 °C		± 0.5		dB
dTX_{Vdd}	Transmitter power variation vs. VDD_IO	1.8 to 3.6 V		± 0.5		dB
	Wireless M−Bus Transmitter Class			H_T		Class

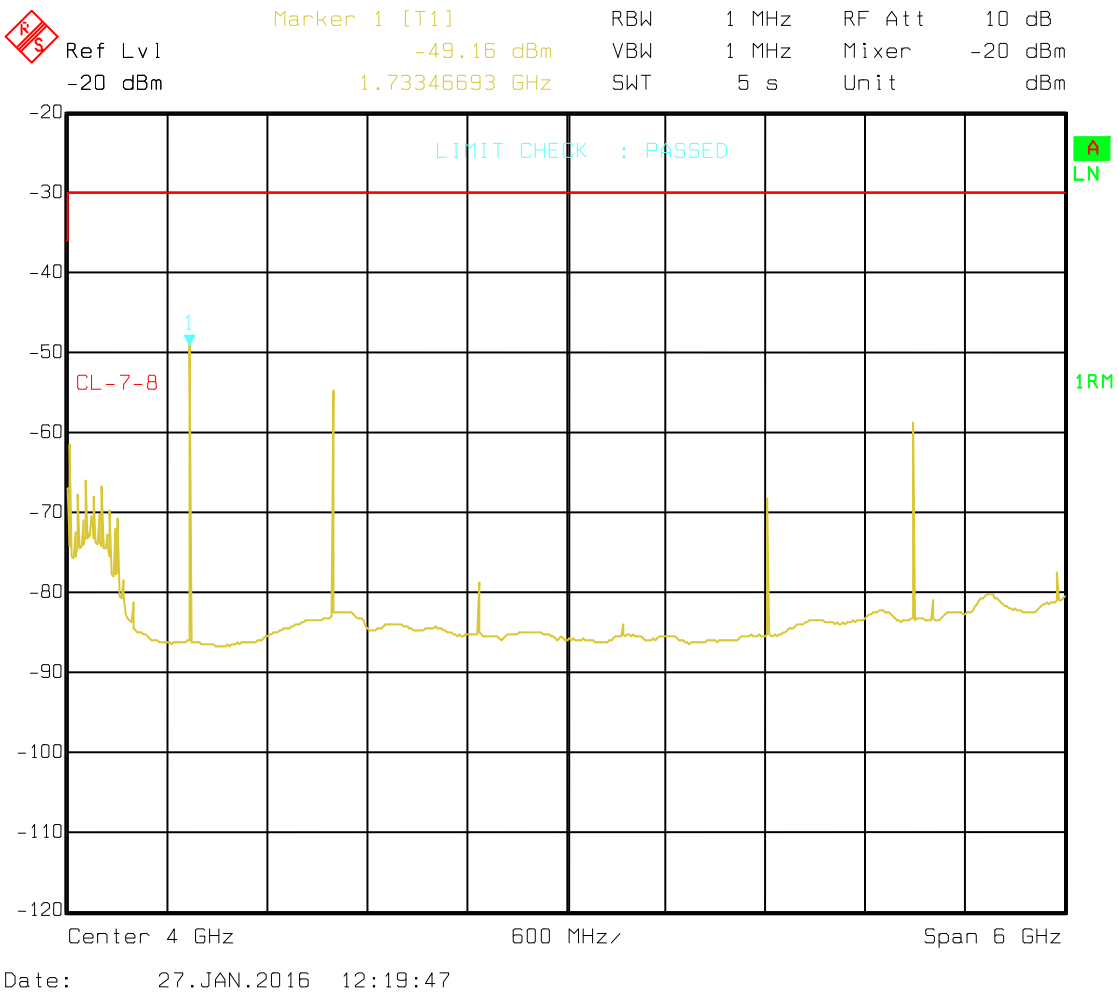

Figure 5. Spurious Emissions with the EN 300 220 Clause 7.8 Indicated as Red Limit Line

Receiver

Table 8. RECEIVER, S AND T2 OTHER TO METER MODE

Symbol	Description	Condition	Min	Typ	Max	Units
PRX_{Smax}	Maximum input power at receiver input	PER < 20%, 20 bytes message		10		dBm
IS_{fmin}	Input Sensitivity at min Carrier Frequency	Frequency = 868.25 MHz		−105.5		dBm
IS_{ftyp}	Input Sensitivity at Carrier Frequency	Frequency = 868.3 MHz		−106		dBm
IS_{fmax}	Input Sensitivity at max Carrier Frequency	Frequency = 868.35 MHz		−105.5		dBm
IS_{mindev}	Input Sensitivity at min FSK Deviation	Deviation = 40 kHz		−105		dBm
IS_{typdev}	Input Sensitivity at typical FSK Deviation	Deviation = 50 kHz		−106		dBm
IS_{maxdev}	Input Sensitivity at min FSK Deviation	Deviation = 80 kHz		−106.5		dBm
DR_{dev}	Data Rate Tolerance			2.5		%
IS_{DRmin}	Input Sensitivity at min Data Rate	Data Rate = 32.768 kcps − 2%		−105		dBm
IS_{DRtyp}	Input Sensitivity at typical Data Rate	Data Rate = 32.768 kcps		−106		dBm
IS_{DRmax}	Input Sensitivity at max Data Rate	Data Rate = 32.768 kcps + 2%		−106.5		dBm
Adjacent Channel Selectivity & Blocking						
BLK_{AB}	Adjacent band	868.9 MHz, PER < 20%, 20 bytes message		45		dB
BLK_{-2}	Blocking at −2 MHz offset	866.3 MHz, PER < 20%, 20 bytes message		59		dB
BLK_{+2}	Blocking at +2 MHz offset	870.3 MHz, PER < 20%, 20 bytes message		59		dB
BLK_{-10}	Blocking at −10 MHz offset	858.3 MHz, PER < 20%, 20 bytes message		73		dB
BLK_{+10}	Blocking at +10 MHz offset	878.3 MHz, PER < 20%, 20 bytes message		73		dB
	Receiver Class according to ETSI EN 300220−1 V2.4.2:2012 clause 4.1.1 (clause 8.3 and clause 8.4)		2			Class
	Wireless M−Bus Receiver Class			H_R		Class

Table 9. RECEIVER, T1 AND T2 METER TO OTHER MODE

Symbol	Description	Condition	Min	Typ	Max	Units
PRX_{Smax}	Maximum input power at receiver input	PER < 20%, 20 bytes message		9		dBm
IS_{fmin}	Input Sensitivity at min Carrier Frequency	Frequency = 868.9 MHz		−104.5		dBm
IS_{ftyp}	Input Sensitivity at Carrier Frequency	Frequency = 868.95 MHz		−105		dBm
IS_{fmax}	Input Sensitivity at max Carrier Frequency	Frequency = 869 MHz		−104.5		dBm
IS_{mindev}	Input Sensitivity at min FSK Deviation	Deviation = 40 kHz		−103.5		dBm
IS_{typdev}	Input Sensitivity at typical FSK Deviation	Deviation = 50 kHz		−105		dBm
IS_{maxdev}	Input Sensitivity at min FSK Deviation	Deviation = 80 kHz		−105.5		dBm
DR_{dev}	Data Rate Tolerance			2.5		%
IS_{DRmin}	Input Sensitivity at min Data Rate	Data Rate = 100 kcps − 2%		−104		dBm
IS_{DRtyp}	Input Sensitivity at typical Data Rate	Data Rate = 100 kcps		−105		dBm
IS_{DRmax}	Input Sensitivity at max Data Rate	Data Rate = 100 kcps + 2%		−104		dBm
Adjacent Channel Selectivity & Blocking						
BLK_{AB}	Adjacent band	869.45 MHz, PER < 20%, 20 bytes message		48		dB

Table 9. RECEIVER, T1 AND T2 METER TO OTHER MODE

Symbol	Description	Condition	Min	Typ	Max	Units
BLK_{-2}	Blocking at −2 MHz offset	870.95 MHz, PER < 20%, 20 bytes message		60		dB
BLK_{+2}	Blocking at +2 MHz offset	866.95 MHz, PER < 20%, 20 bytes message		60		dB
BLK_{-10}	Blocking at −10 MHz offset	858.95 MHz, PER < 20%, 20 bytes message		72		dB
BLK_{+10}	Blocking at +10 MHz offset	878.95 MHz, PER < 20%, 20 bytes message		73		dB
	Receiver Class according to ETSI EN 300220−1 V2.4.2:2012 clause 4.1.1 (clause 8.3 and clause 8.4)		2			Class
	Wireless M−Bus Receiver Class			H_R		Class

ADC / Comparator / Temperature Sensor

Table 10. ADC / COMPARATOR / TEMPERATURE SENSOR TABLE

Symbol	Description	Condition	Min	Typ	Max	Units
ADCSR	ADC sampling rate GPADC mode		30		500	kHz
ADCSR_T	ADC sampling rate temperature sensor mode		10	15.6	30	kHz
ADCRES	ADC resolution			10		Bits
V_{ADCREF}	ADC reference voltage & comparator internal reference voltage		0.95	1	1.05	V
Z_{ADC00}	Input capacitance				2.5	pF
DNL	Differential nonlinearity			± 1		LSB
INL	Integral non linearity			± 1		LSB
OFF	Offset			3		LSB
GAIN_ERR	Gain error			0.8		%
ADC in Differential Mode						
V_{ABS_DIFF}	Absolute voltages & common mode voltage in differential mode at each input		0		VDD_IO	V
V_{FS_DIFF01}	Full swing input for differential signals	Gain x1	−500		500	mV
V_{FS_DIFF10}		Gain x10	−50		50	mV
ADC in Single Ended Mode						
V_{MID_SE}	Mid code input voltage in single ended mode			0.5		V
V_{IN_SE00}	Input voltage in single ended mode		0		VDD_IO	V
V_{FS_SE01}	Full swing input for single ended signals	Gain x1	0		1	V
Comparators						
V_{COMP_ABS}	Comparator absolute input voltage		0		VDD_IO	V
V_{COMP_COM}	Comparator input common mode		0		VDD_IO − 0.8	V
$V_{COMPOFF}$	Comparator input offset voltage				20	mV
Temperature Sensor						
T_{RNG}	Temperature range		−40		85	°C
T_{RES}	Temperature resolution			0.1607		°C/LSB
T_{ERR_CAL}	Temperature error	Factory calibration applied	−2		+2	°C

APPLICATION PROGRAMMING INTERFACE

The AX−WM API takes care of the wireless M−Bus framing.

The Manufacturer Information like the manufacturer ID, serial number, device type and so on is set in the axwm_user_config.h file.

The error_code byte meanings and detailed information to the functions are explained in the AXWM Programming Manual.

Table 11. GENERAL API COMMAND

API Commands	Description	Inputs	Description	Returns
axwm_set_mode	Set the Wireless M−Bus mode	uint8_t mode	desired mode, e.g. S (0x53), T (0x54)	uint8_t error_code
axwm_get_mode	Get the Wireless M−Bus mode	None		uint8_t mode
axwm_init_wmbus	Initializes the Wireless M−Bus library	None	Required before the library can be used	
axwm_get_siliconrev	Get the Silicon Revision	None		uint8_t silicon_revision
axwm_get_ax5043_siliconrev	Get the AX5043 Silicon Revision	None		uint8_t AX5043_silicon_revision
axwm_get_major_version	Get the major API version	None		uint8_t major_API_version
axwm_get_minor_version	Get the minor API version	None		uint8_t minor_API_version
axwm_get_revision	Get the API revision number	None		uint8_t API_rev_version

Table 12. SENDING COMMANDS

API Commands	Description	Inputs	Description	Returns
axwm_insert_header	Inserts the header with the required fields, according to the CI entered	uint8_t ci	Control Information, see AX−WM Programming manual for CI values	uint8_t error_code
		uint8_t status	Status byte, combination of different status bits, see AX−WM Programming manual for values	
		uint8_t encryption_mode	5 means AES CBC is used to send the message. Mode according to Table 15.	
axwm_set_command	Sets the Command, if it is a response, the acc bit can be set manually	uint8_t command	Command, see AX−WM Programming manual for commands	uint8_t error_code
		_Bool is_response	This value is set to 1 if the message is a response, enabling the user to set the access number accordingly	
axwm_set_acc_received	Sets the access counter bit in case the message is a response	uint8_t acc	If the message is a response, the access counter has to be set to the received number	uint8_t error_code

Table 12. SENDING COMMANDS

API Commands	Description	Inputs	Description	Returns
axwm_append_data	Appends the data to the packet. It is possible to append multiple data fields by calling this function more than once.	uint8_t dif	See section 6.4 in EN 13757−3:2013−08	uint8_t error_code
		uint8_t __xdata dife[]	See section 6.8 in EN 13757−3:2013−08	
		uint8_t vif	See section 7 in EN 13757−3:2013−08	
		uint8_t __xdata vife[]	See section 6 & 7 in EN 13757−3:2013−08	
		uint8_t lvar	LVAR is the length for variable length data fields. See section 6.4 in EN 13757−3:2013−08	
		uint8_t __xdata data[]	Byte array of the data, MSB	
axwm_clear_data	Clears the data to start a new packet, the header remains.	None		uint8_t error_code
axwm_send_packet	Send the prepared packet.	None		uint8_t error_code
axwm_repeat_packet	Repeats a packet, without increasing the access number	None		uint8_t error_code
axwm_send_raw	Send raw data, without Wireless M−Bus formatting.	uint8_t __xdata packet_raw[]	Byte array of the data, MSB	uint8_t error_code
		uint8_t len_raw	Length of the data array	

Table 13. RECEIVING COMMANDS

API Commands	Description	Input	Description	Returns
axwm_decode_data	Decodes the received package; Required before any of the following getter methods can be used	struct axradio_status __xdata *st		uint8_t error_code
Link Layer				
axwm_get_manufacturer	Get the Manufacturer ID	None		uint16_t
axwm_get_type	Get the Type	None		uint8_t
axwm_get_version	Get the Version Number	None		uint8_t
axwm_get_serialnumber	Get the Serial Number	None		uint8_t[3]
axwm_get_status	Get the Status	None		uint8_t
axwm_get_acc	Get the Access Number	None		uint8_t
axwm_get_conf	Get the Configuration Word	None		uint8_t
Application Layer				
axwm_get_al_manufacturer	Get the Manufacturer ID	None		uint16_t
axwm_get_al_type	Get the Type	None		uint8_t
axwm_get_al_version	Get the Version Number	None		uint8_t
axwm_get_al_serialnumber	Get the Serial Number	None		uint8_t[3]
axwm_get_al_status	Get the Status	None		uint8_t
axwm_get_al_acc	Get the Access Number	None		uint8_t
axwm_get_al_conf	Get the Configuration Word	None		uint8_t

Table 13. RECEIVING COMMANDS

API Commands	Description	Input	Description	Returns
Data				
axwm_get_dif	Get the Data Information	uint8_t index	Index of the desired packet	
axwm_get_vif	Get the Value Information	uint8_t index		
axwm_get_lvar	Get the lvar	uint8_t index		
axwm_get_data	Get the Data	uint8_t index		
axwm_get_len	Get the Length of the Data	uint8_t index		
axwm_get_data_count	Get the Number of Data Packets	uint8_t index		
Control				
axwm_get_ci	Get the Control Information	None		uint8_t
axwm_get_c	Get the Command	None		uint8_t

NOTE: The number of receivable data packets is limited to 10 per transmission. This restriction is to limit memory usage and should not affect the receiver in normal operation.

Table 14. API FUNCTIONS FOR TESTING OR CERTIFICATION

Testing	
axwm_set_cw	The AX−WM chip will transmit Continuous Wave (CW) without MCU activity, MCU can be put into stdby or sleep mode.
axwm_set_tx1010	The AX−WM chip will continuously transmit 1010 data without MCU activity, MCU can be put into stdby or sleep mode.
axwm_send_pattern(byte)	The AX−WM chip will transmit the input byte as bit pattern
axwm_set_cb	The AX−WM chip will transmit a random bit pattern

Encryption

Wireless M−Bus supports the following encryption methods:

Table 15. ENCRYPTION METHODS

Method	Encryption Mode (1)	Supported	OMS
No encryption	0	Yes	Only wired M−Bus
DES−encryption with CBC, Initialization Vector is 0	2	No	No
DES−encryption with CBC, Initialization Vector not 0	3	No	No
AES−encryption with CBC, Initialization Vector not 0	5	Yes	Mandatory

1. Encryption mode after Table 13 in [1]

AES encryption is recommended, and mandatory for OMS conformity. The IV is handled by the AX−WM library as defined in the EN 13757−3:2013−08 [1] table 14.

Used for encryption is the Advanced Encryption Standard with 128 bit key length (AES 128), as described in NIST FIPS 197 [4]. The AX−WM chip provides hardware support for the encryption, reducing the calculation time and required energy. The AX−WM library uses the hardware support in order to reduce power consumption to a minimum.

The Cipher Block Chaining (CBC) process is described in NIST SP800−38A [5]. The CBC is also handled by the AX−WM library.

The encryption method and number of encrypted bytes or blocks is written in the configuration byte. The configuration byte is handled by the AX−WM library previous to the package getting transmitted and requires no user effort.

Partial encryption is not yet supported. Either all data blocks will be encrypted or none. The header is never encrypted, and never will be as it is part of the Initialization Vector.

The whole encryption is done by the AX−WM library if the encryption bit is set. This reduces the user effort to a minimum and reduces development time for encrypted communication considerably. Especially for OMS, where encryption is mandatory for Wireless M−Bus communication.

TYPICAL APPLICATION DIAGRAM

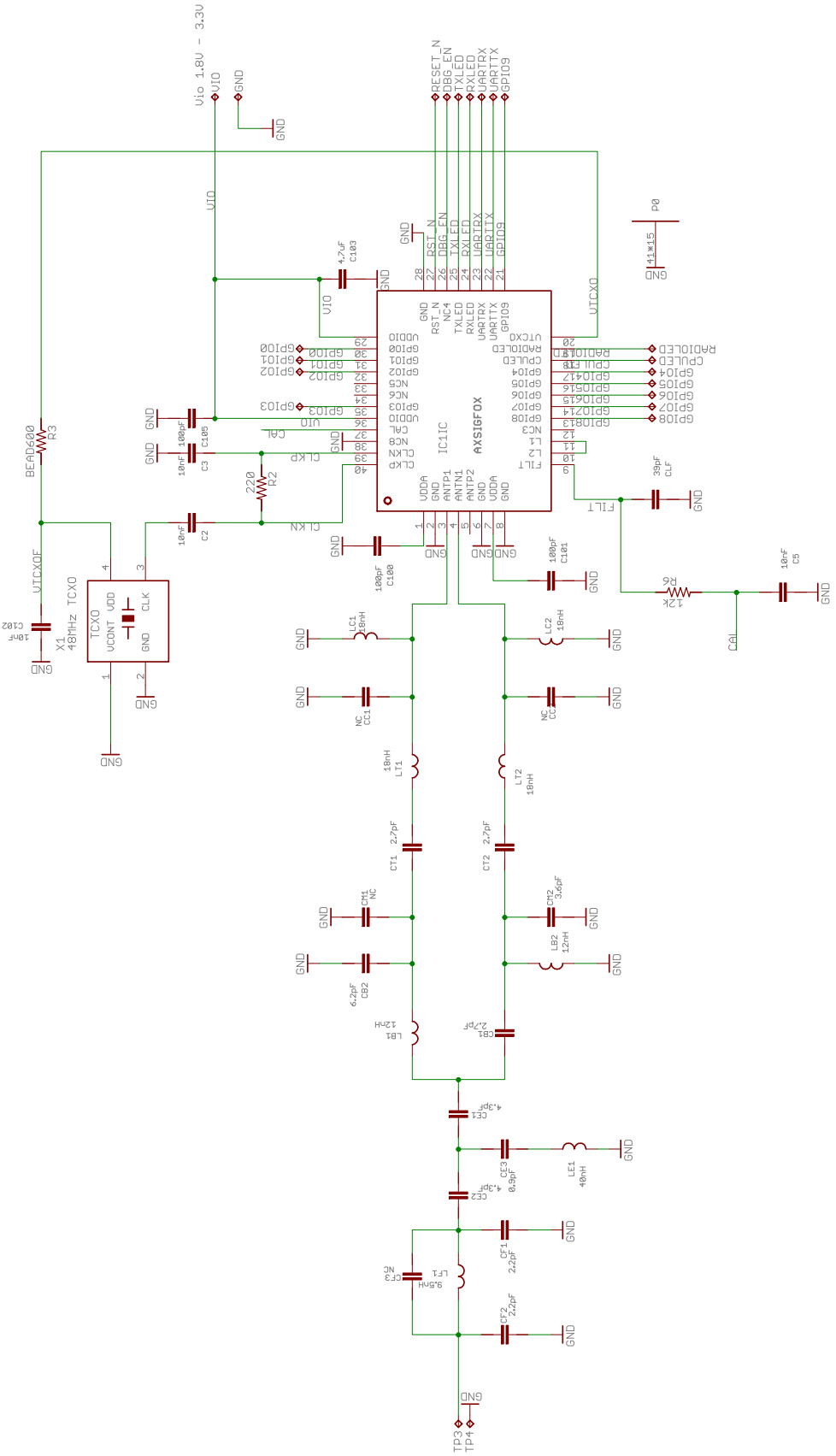

Figure 6. Typical Application Diagram

ORDERING INFORMATION

The following device information can be accessed using these API functions:

APP Version
[0] axwm_get_major_version
[1] axwm_get_minor_version

Chip Version
[0] axwm_get_siliconrev
[1] axwm_get_ax5043_siliconrev

Table 16. ORDERING INFORMATION

Product	Part Number	APP Version		Chip Version	
		[0]	[1]	[0]	[1]
AX−WM	AX−WM−1−01−XXXX	0x01	0x00	0x8F	0x51

Bibliography

[1] DIN EN 13757−3:2013−08, *Communication systems for and remote reading of meters − Part 3: Dedicated application layer; German version EN 13757−3:2013,* 2013.

[2] DIN EN 13757−4:2014−02, *Communication systems for meters and remote reading of meters − Part 4: Wireless meter readout (Radio meter reading for operation in SRD bands); German version EN 13757−4:2013,* 2014.

[3] "Open Metering System," [Online]. Available: http://oms−group.org/. [Accessed 12 2 2016].

[4] NIST FIPS 197, "Advanced Encryption Standard (AES)," 11 2001. [Online]. Available: http://csrc.nist.gov/publications/PubsFIPS.html. [Accessed 12 02 2016].

[5] NIST SP800−38A, "Recommendation for Block Cipher Modes of Operation − Methods and Techniques," 2001. [Online]. Available: http://csrc.nist.gov/publications/PubsSPs.html#SP%20800 [Accessed 12 2 2016].

Life Support Applications

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