# AX-SIGFOX MINISTAMP
# AX-SIGFOX ANTSTAMP

## Ultra-Low Power, AT Command Controlled, Sigfox® Compliant Modules

ON Semiconductor®

www.onsemi.com

### Overview

The AX−SIGFOX modules are ultra−low power module solutions for a node on the Sigfox network with both up− and down−link functionality. The AX−SIGFOX modules connect to the customer application using a logic level RS232 UART. AT commands are used to send frames and configure radio parameters.

The AX−SIGFOX module comes in two flavors

- AX−SIGFOX MINISTAMP with 50 Ω Antenna Port
- AX−SIGFOX ANTSTAMP with On−board −5 dBi Chip Antenna

### Functionality and Ecosystem

- Sigfox up−link and down−link functionality controlled by AT commands
- The AX−SIGFOX modules are part of a whole development and product ecosystem available from ON Semiconductor for any Sigfox requirement. Other parts of the ecosystem include
  - AX−Sigfox ultra−low power, AT command controlled, Sigfox compliant transceiver IC
  - Ready to go AX−Sigfox development kit with fully functional AX−Sigfox module including Sigfox subscription
  - Sigfox Ready certified reference design for the AX−Sigfox IC
  - AX−Sigfox API IC for customers wishing to write their own application software based on the ON Semiconductor Sigfox Library

### General Features

- 18.2 x 22 x 3 $mm^3$ without chip antenna, 18.2 x 39.7 x 3 $mm^3$ with chip antenna
- Supply range from 1.8 V to 3.3 V
- −40°C to 85°C
- Temperature sensor
- Supply voltage measurements
- 10 GPIO pins
  - 4 GPIO pins with selectable voltage measure functionality, differential (1 V or 10 V range) or single ended (1 V range) with 10 bit resolution
  - 2 GPIO pins with selectable sigma delta DAC output functionality
  - 2 GPIO pins with selectable output clock
  - 3 GPIO pins selectable as SPI master interface

### Power Consumption

- Ultra−low power consumption
  - Charge required to send a Sigfox OOB packet at 14 dBm output power: 0.29 C
  - Deepsleep mode current: 500 nA
  - Sleep mode current: 1.6 μA
  - Standby mode current : 0.5 mA
  - Continuous radio reception at 869.525 MHz: 13 mA
  - Continuous radio transmission at 868.130 MHz for 14 dBm output power: 51 mA for 0 dBm output power: 21 mA
- The output power of AX−SIGFOX modules can be programmed in 1 dB steps from 0 dBm – 14 dBm. They are optimized for best power efficiency at 14 dBm output power. For modules optimized for other output power values e.g 0 dBm transmission with 10 mA please contact us.

### High Performance Narrow−band Sigfox Receiver

- Carrier frequency 868.525 MHz
- Data−rate 600 bps
- Sensitivity: −126 dBm @ 600 bps, 869.525 MHz, GFSK
- 0 dBm maximum input power

### Highly Efficient Transmitter

- Carrier frequency 868.13 MHz
- Data−rate 100 bps PSK
- Maximum output power 14 dBm
- Power level programmable in 1 dBm steps from 0 dBm to 14 dBm

### Regulatory

- Sigfox Ready certified
- EN 300 220


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### About the Sigfox Technology

Sigfox uses an Ultra Narrow Band (UNB) based radio technology to connect devices to its global network. The usage of UNB is key to providing a scalable, high−capacity network, with very low energy consumption, while maintaining a simple and easy to rollout star−based cell infrastructure.

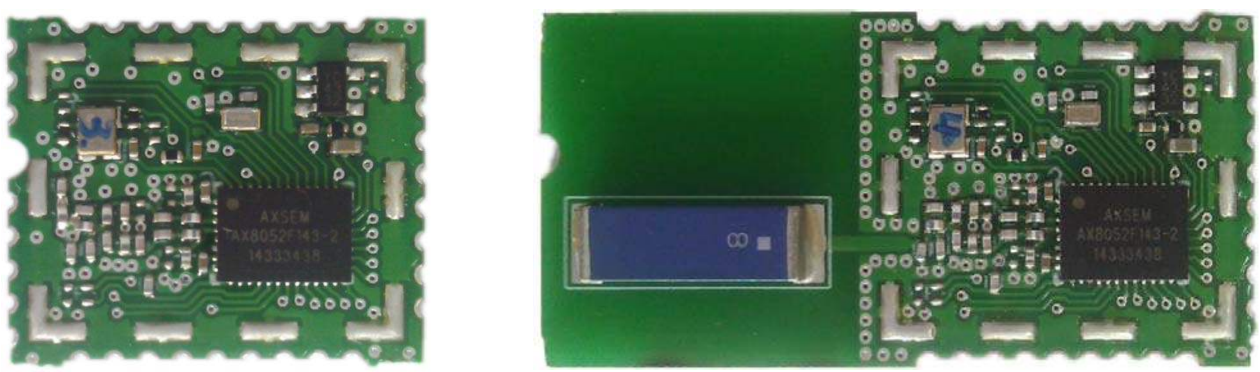
The network operates in the globally available ISM bands (license−free frequency bands) and co−exists in these frequencies with other radio technologies, but without any risk of collisions or capacity problems.

Sigfox currently uses the most popular European ISM band on 868 MHz (as defined by ETSI and CEPT) as well as 902 MHz in the USA (as defined by the FCC), depending on specific regional regulations.

Sigfox only acts as a transport channel, pushing the data towards the customer's IT system.

An important advantage provided by the use of the narrow band technology is the flexibility it offers in terms of antenna design. On the network infrastructure end it allows the use of small and simple antennas, but more importantly, it allows devices to use inexpensive and easily customizable antennas.

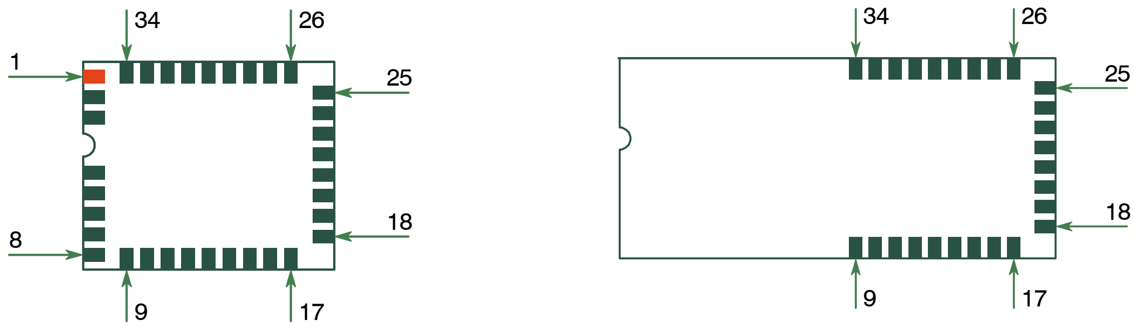
The Sigfox protocol is compatible with existing transceivers and is actively being ported to a growing number of platforms.



(Note that the actual product comes with a metal cap)

**Figure 1. AX−SIGFOX MINISTAMP/ANTSTAMP Modules**

## PINOUT




**MINISTAMP** **ANTSTAMP**

**Figure 2. Pinout Drawings (Top View)**

**Table 1. PIN FUNCTION DESCRIPTION**

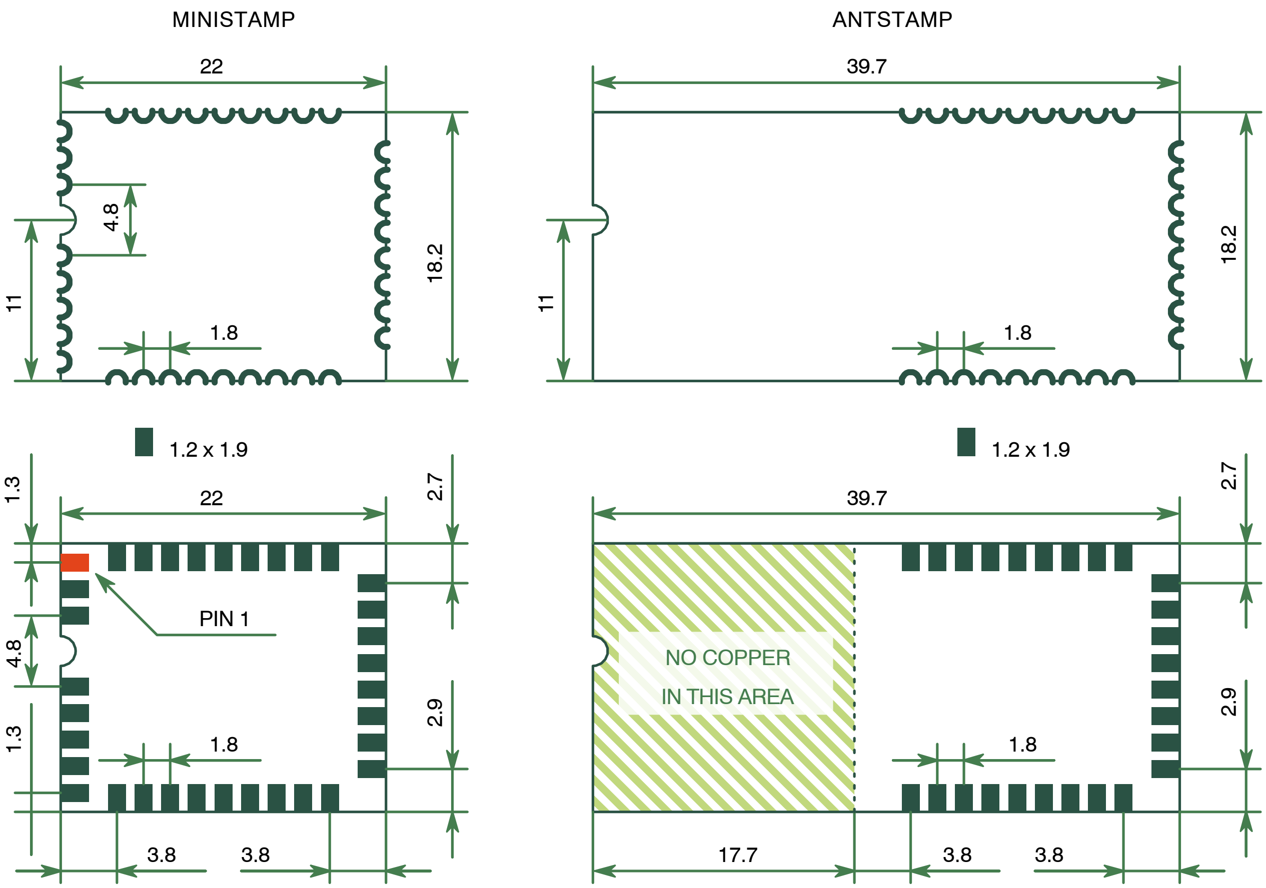
| Pin | Name | Function |
|---|---|---|
| 1* | GND | Ground |
| 2* | NC | Do not connect |
| 3* | NC | |
| 4* | NC | |
| 5* | GND | Ground |
| 6* | ANT50Ω | 50 Ω antenna port |
| 7* | GND | Ground |
| 8* | NC | Do not connect |
| 9 | NC | |
| 10 | GPIO8 | General purpose IO |
| 11 | GPIO7 | General purpose IO, selectable SPI functionality (MISO) |
| 12 | GPIO6 | General purpose IO, selectable SPI functionality (MOSI) |
| 13 | GPIO5 | General purpose IO, selectable SPI functionality (SCK) |
| 14 | GPIO4 | General purpose IO, selectable ΣΔ DAC functionality, selectable clock functionality |
| 15 | CPU_LED | Module activity status, enabled whenever the module is running |
| 16 | RADIO_LED | Radio activity status |
| 17 | VTCXO | TCXO enable (used to control the on−board TCXO) |
| 18 | GPIO9 | General purpose IO and wake−up from deepsleep |
| 19 | UART_TX | UART used to communicate with the module at a bitrate of 9600 baud, no parity, 8 data bits and one stop bit. |
| 20 | UART_RX | |
| 21 | RX_LED | Radio receive activity status |
| 22 | TX_LED | Radio transmit activity status |
| 23 | NC | Do not connect |
| 24 | NC | |
| 25 | VDD | Power Supply |
| 26 | GND | Ground |
| 27 | RESET_N | Optional reset (active low). Do not connect the pin if not used. |
| 28 | GND | Ground |
| 29 | GPIO0 | General purpose IO, selectable ADC functionality, selectable ΣΔ DAC functionality, selectable clock functionality |
| 30 | GPIO1 | General purpose IO, selectable ADC functionality |

**Table 1. PIN FUNCTION DESCRIPTION**

| Pin | Name | Function |
|---|---|---|
| 31 | GPIO2 | General purpose IO, selectable ADC functionality |
| 32 | NC | Do not connect |
| 33 | NC | |
| 34 | GPIO3 | General purpose IO, selectable ADC functionality |

NOTE: All digital pins are Schmitt trigger inputs, digital input and output levels are LVCMOS/LVTTL compatible. Pins GPIO[3:0] must not be driven above VDD, all other digital inputs are 5 V tolerant.
All GPIO pins and UART_RX start−up as inputs with pull−up.

### Dimensions




All dimensions in millimeter.

**Figure 3. Dimensions (mm)**

The area under the modules must be covered in solder stop. To guarantee good antenna performance with the AX−SIGFOX ANTSTAMP, the left part of the module must remain free from any copper (i.e. no ground plane and no traces).

## SPECIFICATIONS

### Table 2. SUPPLIES

| Symbol | Description | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| $T_{AMB}$ | Operational ambient temperature | | −40 | 27 | 85 | °C |
| VDD | Supply voltage | | 1.8 | 3.0 | 3.3 | V |
| $I_{DS}$ | Deep sleep mode current | AT$P=2 | | 500 | | nA |
| $I_{SLP}$ | Sleep mode current | AT$P=1 | | 1.6 | | μA |
| $I_{STDBY}$ | Standby mode current | | | 0.5 | | mA |
| **Continuous Receive** | | | | | | |
| $I_{RX\_CONT}$ | Current consumption in Sigfox RX test mode | AT$SR=1,1,−1 | | 12.8 | | mA |
| **Transmit at 14 dBm Output Power** / **Receive** (Note 2) | | | | | | |
| $I_{TXMODAVG\_14}$ | Modulated transmitter current | | | 51.0 | | mA |
| $Q_{SFX\_OOB\_14}$ | Charge to send a Sigfox out of band message | AT$S0 | | 0.28 | | C |
| $Q_{SFX\_OOB\_14}$ | Charge to send a bit | AT$SB=0 | | 0.19 | | C |
| $Q_{SFX\_OOB\_14}$ | Charge to send a bit with downlink receive message | AT$SB=0,1 | | 0.33 | | C |
| $Q_{SFX\_LFR\_14}$ | Charge to send the longest possible Sigfox frame (12 byte) | AT$SF=00112233445566778899aabb | | 0.37 | | C |
| $Q_{SFX\_LFR\_14}$ | Charge to send the longest possible Sigfox frame (12 byte) with downlink receive | AT$SF=00112233445566778899aabb,1 | | 0.46 | | C |
| **Transmit at 0 dBm Output Power** / **Receive** (Notes 1 and 2) | | | | | | |
| $I_{TXMODAVG\_14}$ | Modulated Transmitter Current | | | 21.0 | | mA |
| $Q_{SFX\_OOB\_0}$ | Charge to send a Sigfox out of band message | AT$S0 | | 0.12 | | C |
| $Q_{SFX\_OOB\_0}$ | Charge to send a bit | AT$SB=0 | | 0.08 | | C |
| $Q_{SFX\_OOB\_0}$ | Charge to send a bit with downlink receive message | AT$SB=0,1 | | 0.14 | | C |
| $Q_{SFX\_LFR\_0}$ | Charge to send the longest possible Sigfox frame (12 byte) | AT$SF=00112233445566778899aabb | | 0.27 | | C |
| $Q_{SFX\_LFR\_0}$ | Charge to send the longest possible Sigfox frame (12 byte) with downlink receive | AT$SF=00112233445566778899aabb,1 | | 0.29 | | C |

1. The output power of AX−SIGFOX modules can be programmed in 1 dB steps from 0 dBm – 14 dBm. They are optimized for best power efficiency at 14 dBm output power. For modules optimized for other output power values e.g. 0 dBm transmission with 10 mA please contact us.
2. Antenna gain not included.

### Typical Current Waveform

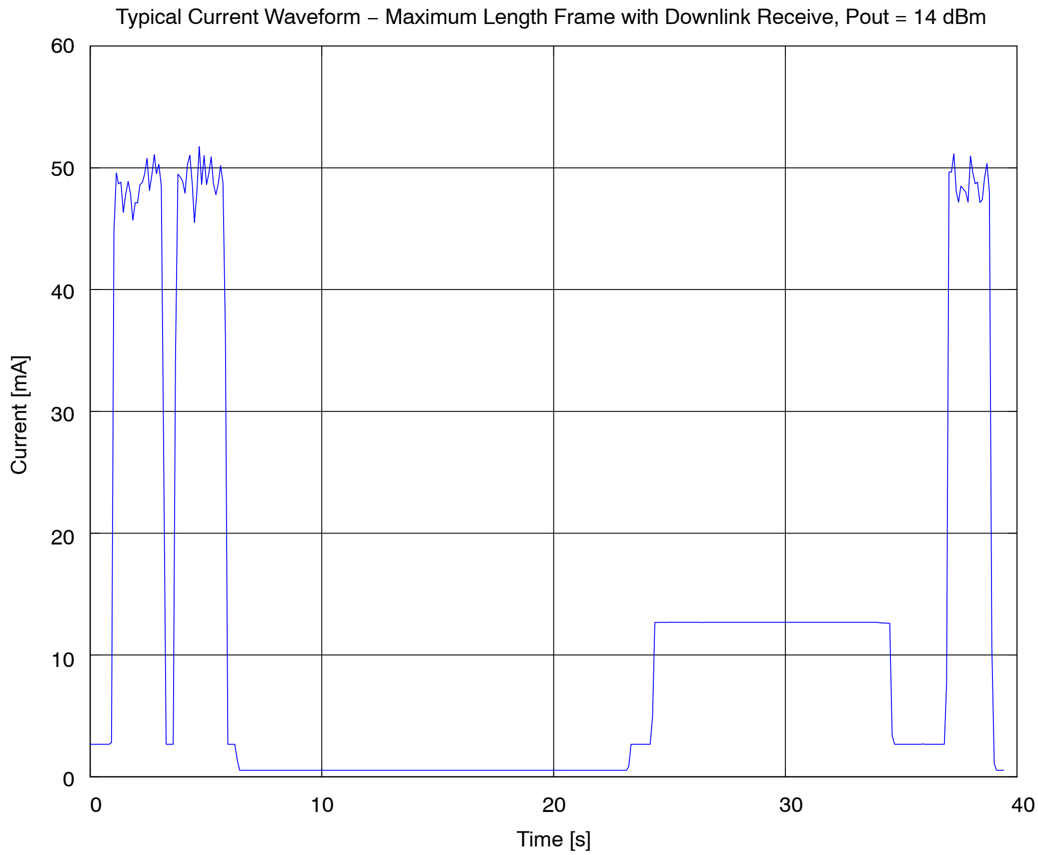



**Figure 4. Typical Current Waveform for a Maximum Length Frame with Downlink Receive at 14 dBm Output Power**

### Battery Life Calculation Example

Scenario for example calculation:

- 2 AAA Alkaline batteries in series
- One OOB frame transmission per day at 14 dBm output power
- Four maximum length frames with downlink receive per day at 14 dBm output power
- Device in sleep mode when no other activity
- Neglecting battery self discharge

| | | |
|---|---|---|
| 2 AAA alkaline capacity | 1500 mAh * 3600 s/h | 5400 C |
| Sleep charge per day | 1.6 μA * 86400 s | 0.14 C/day |
| OOB frame transmission | | 0.28 C/day |
| Frame transmission with downlink | 4 * 0.46 C/day | 1.84 C/day |
| Total Charge consumption | | 2.26 C/day |
| Battery life | | 6.5 Years |

**Table 3. LOGIC**

| Symbol | Description | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| **Digital Inputs** | | | | | | |
| $V_{T+}$ | Schmitt trigger low to high threshold point | VDD = 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, GPIO[3:0] | | −0.5 | | VDD | V |
| $V_{IPBC}$ | Input voltage range, GPIO[9:4], UART_RX, RESET_N | | −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<br>Ports GPIO[9:0], UART_TX, TX_LED, RX_LED, CPU_LED, RADIO_LED | $V_{OH}$ = 2.4 V | 8 | | | mA |
| $I_{OL}$ | Output Current, low<br>GPIO[9:0], UARTTX, TXLED, RXLED, TXLED, CPULED | $V_{OL}$ = 0.4 V | 8 | | | mA |
| $I_{OZ}$ | Tri−state output leakage current | | −10 | | 10 | µA |

**Table 4. TRANSMITTER**

| Symbol | Description | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| SBR | Signal bit rate | | | 100 | | bps |
| $f_{carrier}$ | Carrier frequency | | | 868.13 | | MHz |
| $PTX_{min}$ | Lowest Transmitter output power | AT$CW=868130000,1,0 | | 0 | | dBm |
| $PTX_{max}$ | Highest Transmitter output power | AT$CW=868130000,1,14 (Note 1) | | 14 | | dBm |
| $PTX_{step}$ | 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 | 1.8 to 3.3 V | | ±0.5 | | dB |
| $PTX_{harm2}$ | Emission @ 2$^{nd}$ harmonic | | | −51 | | dBc |
| $PTX_{harm3}$ | Emission @ 3$^{rd}$ harmonic | | | −63 | | |
| $PTX_{harm4}$ | Emission @ 4$^{th}$ harmonic | | | −84 | | |

1. Antenna gain not included.

**Table 5. RECEIVER**

| Symbol | Description | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| SBR | Signal bit rate | | | 600 | | bps |
| $f_{carrier}$ | Carrier frequency | | | 869.525 | | MHz |
| IS | Sensitivity | AT$SB=x,1, AT$SF=x,1, AT$SR<br>PER < 0.1 | | −126 | | dBm |
| BLK | Blocking at ±10 MHz offset | Wanted signal is 3 dB above the typical sensitivity limit (PER = 0.1) and the blocker is a continuous wave | | 78 | | dB |

**Table 6. ADC / TEMPERATURE SENSOR**

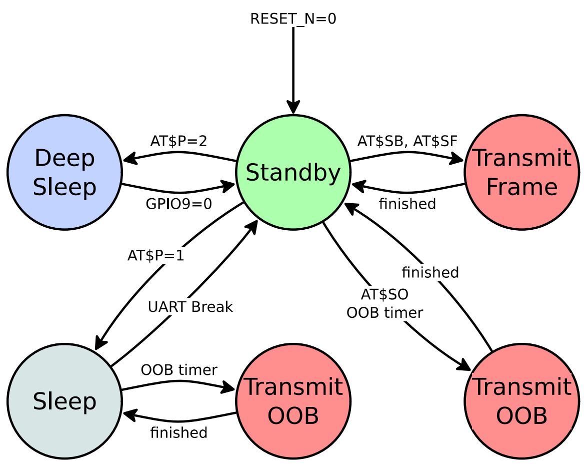
| Symbol | Description | Condition | Min | Typ | Max | Units |
|---|---|---|---|---|---|---|
| ADCRES | ADC resolution | | | 10 | | bit |
| $V_{ADCREF}$ | ADC reference voltage | | 0.95 | 1 | 1.05 | V |
| $Z_{ADC00}$ | Input capacitance | | | | 2.5 | pF |
| DNL | Differential nonlinearity | | | ± 1 | | LSB |
| INL | Integral nonlinearity | | | ± 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 | 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 | V |
| $V_{FS\_SE01}$ | Full swing input for single ended signals | Gain x1 | 0 | | 1 | V |
| **Temperature Sensor** | | | | | | |
| $T_{RNG}$ | Temperature range | | −40 | | 85 | °C |
| $T_{ERR\_CAL}$ | Temperature error | | | ± 2 | | °C |

## COMMAND INTERFACE

### Serial Parameters: 9600, 8, N, 1

The AX−SIGFOX modules use the UART (pins UART_TX, UART_RX) to communicate with a host and use a bitrate of 9600 baud, no parity, 8 data bits and one stop bit.

### Power Modes State Diagram




### Standby Mode

After Power−Up and after finishing a Sigfox transmission, the AX−SIGFOX modules enter Standby mode. In Standby mode, AX−SIGFOX modules listen on the UART for commands from the host. Also, OOB frames are transmitted whenever the OOB timer fires. To conserve power, the AX−SIGFOX modules can be put into Sleep mode or turned off (Deep Sleep mode) completely.

### Sleep Mode

The command **AT$P=1** is used to put the AX−SIGFOX modules into Sleep mode. In this mode, only the wakeup timer for out−of−band messages is still running. To wake up the AX−SIGFOX module from Sleep mode, toggle the UART_RX pin, e.g. by sending a break (break is an RS232 framing violation, i.e. at least 10 bit durations low). When an Out of Band (OOB) message is due, AX−SIGFOX modules automatically wake up to transmit the message, and then return to Sleep mode.

It is strongly recommended to put AX−SIGFOX modules into sleep mode when they are not being used.

### Deep Sleep Mode

In Deep Sleep mode, the AX−SIGFOX modules are completely turned off. Deep Sleep mode can be activated with the command **AT$P=2**. To wake−up from Deep Sleep mode the pin GPIO9 is pulled to GND.

When using Deep Sleep mode, two things should be kept in mind:

Everything is turned off, timers are not running at all and all settings are lost (use **AT$WR** to save settings to flash before entering Deep Sleep mode). Out−of−band messages will therefore not be sent.

The pins states are frozen in Deep Sleep mode. The user must ensure that this will not result in conditions at the module boundary that draw a lot of current.

### AT Commands

*Numerical Syntax*

```
hexdigit  ::= [0−9A−Fa−f]
hexnum    ::= “0x” hexdigit+
decnum    ::= “0” | [1−9] [0−9]*
octnum    ::= “0” [0−7]+
binnum    ::= “0b” [01]+
bit       ::= [01]
optnum    ::= “−1”
frame     ::= (hexdigit hexdigit)+
uint      ::= hexnum | decnum | octnum | binnum
uint_opt  ::= uint | optnum
```

*Command Syntax*

A command starts with ‘AT’ (note that everything is case sensitive!), continues with the actual command followed by parameters (if any) and ends with any kind of whitespace (space, tab, newline etc.)

If incorrect syntax is detected (“parsing error”) all input is ignored up until the next whitespace character.

Also note that any number can be entered in any format (Hexadecimal, Decimal, Octal and binary) by adding the corresponding prefix (‘0x’, ‘0’, ‘0b’). The only exception is the ‘Send Frame’ command (`AT$SF`) which expects a list of hexadecimal digits without any prefix.

*Return Codes*

A successful command execution is indicated by sending ‘OK’. If a command returns a value (e.g. by querying a register) only the value is returned.

*Examples*

Bold text is sent to AX−SIGFOX module.

Here, we execute command ‘I’ to query some general information.

**AT$I=0**
AXSEM AT Command Interface

This sends a Sigfox frame containing { 0xAA : 0xBB : 0x12 : 0x34 } without waiting for a response telegram:

**AT$SF=aabb1234**
OK

This sends a Sigfox frame containing { 0x00 : 0x11 : 0x22 : 0x33 : 0x44 }, then waits for a downlink response telegram, which in this example contains { 0xAA : 0xBB : 0xCC : 0xDD }.

**AT$SF=0011223344,1**
OK
RX=AA BB CC DD

The ‘CB’ command sends out a continuous pattern of bits, in this case 0xAA = 0b10101010:

**AT$CB=0xAA,1**
OK

This transitions the device into sleep mode. Out−of−band transmissions will still be triggered. The UART is powered down. The module can be woken up by a low level on the UART signal, i.e. by sending break.

**AT$P=1**
OK

**Table 7. COMMANDS**

| Command | Name | Description |
|---|---|---|
| AT | Dummy Command | Just returns ‘OK’ and does nothing else. Can be used to check communication. |
| AT$SB=bit[,bit] | Send Bit | Send a bit status (0 or 1). Optional bit flag indicates if AX−SIGFOX module should receive a downlink frame. |
| AT$SF=frame[,bit] | Send Frame | Send payload data, 1 to 12 bytes. Optional bit flag indicates if AX−SIGFOX module should receive a downlink frame. |
| AT$SO | Manually send out of band message | Send the out−of−band message. |
| ATSuint? | Get Register | Query a specific configuration register’s value. See chapter “Registers” for a list of registers. |
| ATSuint=uint | Set Register | Change a configuration register. |
| AT$IF=uint | Set TX Frequency | Set the output carrier macro channel for Sigfox frames. |
| AT$IF? | Get TX Frequency | Get the currently chosen TX frequency. |
| AT$DR=uint | Set RX Frequency | Set the reception carrier macro channel for Sigfox frames. |
| AT$CW=uint,bit[,uint_opt] | Continuous Wave | To run emission tests for Sigfox certification it is necessary to send a continuous wave, i.e. just the base frequency without any modulation. Parameters:<br>**Name** / **Range** / **Description**<br>Frequency / 800000000−999999999, 0 / Continuous wave frequency in Hz. Use 868130000 for Sigfox or 0 to keep previous frequency.<br>Mode / 0, 1 / Enable or disable carrier wave.<br>Power / 0−14 / dBm of signal \| Default: 14 |
| AT$CB=uint_opt,bit | Test Mode: TX constant byte | For emission testing it is useful to send a specific bit pattern. The first parameter specifies the byte to send. Use ‘−1’ for a (pseudo−)random pattern. Parameters:<br>**Name** / **Range** / **Decsription**<br>Pattern / 0−255, −1 / Byte to send. Use ‘−1’ for a (pseudo−)random pattern.<br>Mode / 0, 1 / Enable or disable pattern test mode. |
| AT$T? | Get Temperature | Measure internal temperature and return it in 1/10$^{th}$ of a degree Celsius. |
| AT$V? | Get Voltages | Return current voltage and voltage measured during the last transmission in mV. |

**Table 7. COMMANDS**

| Command | Name | Description |
|---|---|---|
| AT$I=uint | Information | Display various product information:<br>0: Software Name & Version<br>Example Response: AX−Sigfox 1.0.6−ETSI<br>1: Contact Details<br>Example Response: support@axsem.com<br>2: Silicon revision lower byte<br>Example Response: 8F<br>3: Silicon revision upper byte<br>Example Response: 00<br>4: Major Firmware Version<br>Example Response: 1<br>5: Minor Firmware Version<br>Example Response: 0<br>6: Firmware Revision<br>Example Response: 3<br>7: Firmware Variant (Frequency Band etc. (EU/US))<br>Example Response: ETSI<br>8: Firmware VCS Version<br>Example Response: v1.0.2−36<br>9: SIGFOX Library Version<br>Example Response: DL0−1.4<br>10: Device ID<br>Example Response: 00012345<br>11: PAC<br>Example Response: 0123456789ABCDEF |
| AT$P=uint | Set Power Mode | To conserve power, the AX−SIGFOX module can be put to sleep manually. Depending on power mode, you will be responsible for waking up the AX−SIGFOX module again!<br>0: software reset (settings will be reset to values in flash)<br>1: sleep (send a break to wake up)<br>2: deep sleep (toggle GPIO9 or RESET_N pin to wake up;<br>the AX−SIGFOX module is not running and all settings will be reset!) |
| AT$WR | Save Config | Write all settings to flash (RX/TX frequencies, registers) so that they survive reset/deep sleep or loss of power.<br>Use AT$P=0 to reset the AX−SIGFOX module and load settings from flash. |
| AT:Pn? | Get GPIO Pin | Return the setting of the GPIO Pin *n*; *n* can range from 0 to 9.<br>A character string is returned describing the mode of the pin, followed by the actual value. If the pin is configured as analog pin, then the voltage (range 0…1 V) is returned. The mode characters have the following meaning:<br><br>**Mode** — **Description**<br>0 — Pin drives low<br>1 — Pin drives high<br>Z — Pin is high impedance input<br>U — Pin is input with pull−up<br>A — Pin is analog input (GPIO pin 0…3 only)<br>T — Pin is driven by clock or DAC (GPIO pin 0 and 4 only)<br><br>The default mode after exiting reset is U on all GPIO pins. |
| AT:Pn=? | Get GPIO Pin Range | Print a list of possible modes for a pin. The table below lists the response.<br><br>**Pin** — **Modes**<br>P0 — 0, 1, Z, U, A, T<br>P1 — 0, 1, Z, U, A<br>P2 — 0, 1, Z, U, A<br>P3 — 0, 1, Z, U, A<br>P4 — 0, 1, Z, U, T<br>P5 — 0, 1, Z, U<br>P6 — 0, 1, Z, U<br>P7 — 0, 1, Z, U<br>P8 — 0, 1, Z, U<br>P9 — 0, 1, Z, U |

**Table 7. COMMANDS**

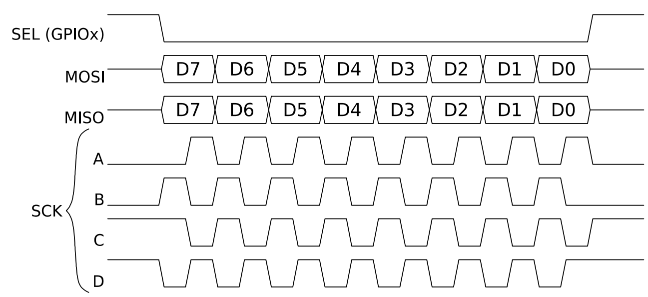
| Command | Name | Description |
|---|---|---|
| AT:Pn=mode | Set GPIO Pin | Set the GPIO pin mode.<br>For a list of the modes see the command AT:Pn? |
| AT:ADC Pn[−Pn[(1V\|10V)]]? | Get GPIO Pin Analog Voltage | Measure the voltage applied to a GPIO pin. The command also allows measurement of the voltage difference across two GPIO pins. In differential mode, the full scale range may also be specified as 1 V or 10 V. Note however that the pin input voltages must not exceed the range 0..VDD. The command returns the result as fraction of the full scale range (1 V if none is specified). The GPIO pins referenced should be initialized to analog mode before issuing this command. |
| AT:SPI[(A\|B\|C\|D)]=bytes | SPI Transaction | This command clocks out *bytes* on the SPI port. The clock frequency is 312.5 kHz. The command returns the bytes read on MISO during output. Optionally the clocking mode may be specified (default is A):<br><br>**Mode** – **Clock Inversion** – **Clock Phase**<br>A – normal – normal<br>B – normal – alternate<br>C – inverted – normal<br>D – inverted – alternate<br><br> <br><br>Note that SEL, if needed, is not generated by this command, and must instead be driven using standard GPIO commands (AT:Pn=0\|1). |
| AT:CLK=freq,reffreq | Set Clock Generator | Output a square wave on the pin(s) set to T mode. The frequency of the square wave is (freq / $2^{16}$) × reffreq. Possible values for reffreq are 20000000, 10000000, 5000000, 2500000, 1250000, 625000, 312500, 156250. Possible values if freq are 0…65535. |
| AT:CLK=OFF | Turn off Clock Generator | Switch off the clock generator |
| AT:CLK? | Get Clock Generator | Return the settings of the clock generator. Two numbers are returned, freq and reffreq. |
| AT:DAC=value | Set ΣΔ DAC | Output a ΣΔ DAC value on the pin(s) set to T mode. Parameter value may be in the range −32768…32767. The average output voltage is (1/2 + value / $2^{17}$) × VDD.<br>An external low pass filter is needed to get smooth output voltages. The modulation frequency is 20 MHz. A possible low pass filter choice is a simple RC low pass filter with R = 10 kΩ and C = 1 μF. |
| AT:DAC=OFF | Turn off ΣΔ DAC | Switch off the DAC |
| AT:DAC? | Get ΣΔ DAC | Return the DAC value |

**Table 8. REGISTERS**

| Number | Name | Description | Default | Range | Units |
|---|---|---|---|---|---|
| 300 | Out Of Band Period | AX−SIGFOX module sends periodic static messages to indicate that they are alive. Set to 0 to disable. | 24 | 0−24 | hours |
| 302 | Power Level | The output power of the radio. | 14 | 0−14 | dBm |

**Table 9. DEVICE NUMBERS**

| Protocol | MINISTAMP | ANTSTAMP |
|---|---|---|
| SIGFOX 868 MHz | AX−SF10−MINI21−868 | AX−SF10−ANT21−868 |

**Table 10. DEVICE VERSIONS**

| Part Number | AT$I=2 | AT$I=3 | AT$I=4 | AT$I=5 |
|---|---|---|---|---|
| AX−SF10−MINI21−868 | 0x8F | 0x51 | 0x01 | 0x00 |
| AX−SF10−ANT21−868 | 0x8F | 0x51 | 0x01 | 0x00 |

### Life Support Applications

This product is not designed for use in life support appliances, devices, or in systems where malfunction of this product can reasonably be expected to result in personal injury. ON Semiconductor customers using or selling this product for use in such applications do so at their own risk and agree to fully indemnify ON Semiconductor for any damages resulting from such improper use or sale.



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