Technical Brief

AirPrime XM0110

SIERRA WIRELESS

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Document History

Version	Date	Updates
001	April 7, 2010	Creation
002	June 21, 2010	Specifications and Performances updated with latest measurements
		External LNA description modified, and higher gain supported.
		Application use-case and Software Highlight section added
003	October 29, 2010	Environmental specifications added
		ESD section added
		More reference documents added
		I2C feature added
		Development Kit section added
		Packaging updated
		Software resources added
004	February 28, 2011	GPS performances and Power consumption values updated
		Software figures updated.
5.0	November 12, 2012	Updated Figure 7 AirPrime XM0110 Typical I^2C Connection and Passive Antenna and added a note after it.
		Updated reference numbers and product naming (from Location Plug-In to Location Library).

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1. Introduction

1.1. Overview

This document is a technical product brief of the Sierra Wireless AirPrime XM0110 GPS module.

This document provides high level technical information on AirPrime XM0110. In case of discrepancies between this document and the AirPrime XM0110 detailed hardware and software specifications listed in section 1.2, the official product specification listed below takes precedence.

1.2. Related Documents

[1] AirPrime XM0110 Product Technical Specification and Customer Design Guidelines
Reference: 4111805

[2] AirPrime XM0110 Customer Process Guidelines
Reference: WM_DEV_XM0110_PTS_002

[3] Location Library 1.51 for Open AT Framework AT Command Interface Guide
Reference: 4110991

[4] Location Library 1.51 for Open AT Framework Developer Guide
Reference: 4110990

[5] AirPrime XM0110 Development Kit Daughter Board User Guide
Reference: 4112246

1.3. Abbreviations and Definitions

Abbreviation	Definition
GPIO	General Purpose Input Output
GPS	Global Positioning System
HW	Hardware
IO	Input/Output
LNA	Low Noise Amplifier
NMEA	National Marine Electronics Association standard
PVT	The primary GPS outputs: Position, Velocity, Time
TCXO	Temperature Controlled Crystal Oscillator
TTFF	Time To First Fix

2. Solution Highlights and Features

2.1. Highlights

The AirPrime XM0110 is a GPS module specifically designed by Sierra Wireless to offer the easiest and most optimized GPS feature integration for applications using AirPrime Intelligent Embedded Modules.

AirPrime XM0110 GPS module is based on SiRFstarIV™ GPS receiver, offering the best GPS performances available to date on the market. AirPrime XM0110 leverages the rich set of low power modes for SiRFstarIV™.

AirPrime XM0110 GPS module integration with AirPrime Intelligent Embedded Module does not require any extra component besides an antenna system: the main supply can be shared with the AirPrime Embedded Module power supply; and interface to the Embedded Module is simply 5 direct connections. With its castellation technology, AirPrime XM0110 offers significantly low manufacturing costs.

2.2. Applications Use Cases

AirPrime XM0110 is easily integrated to the complete customer application thanks to the host software executed on the AirPrime Embedded Module.

The AirPrime XM0110 can be used in two main typical application use cases:

- Either driven by an external Host Processor, through the AirPrime Embedded Module generic GPS AT commands: the Location AT command extension set;
- Or directly by the Open AT OS based customer application running on the AirPrime Embedded Module. This is done thanks to generic GPS APIs: Location Library APIs.

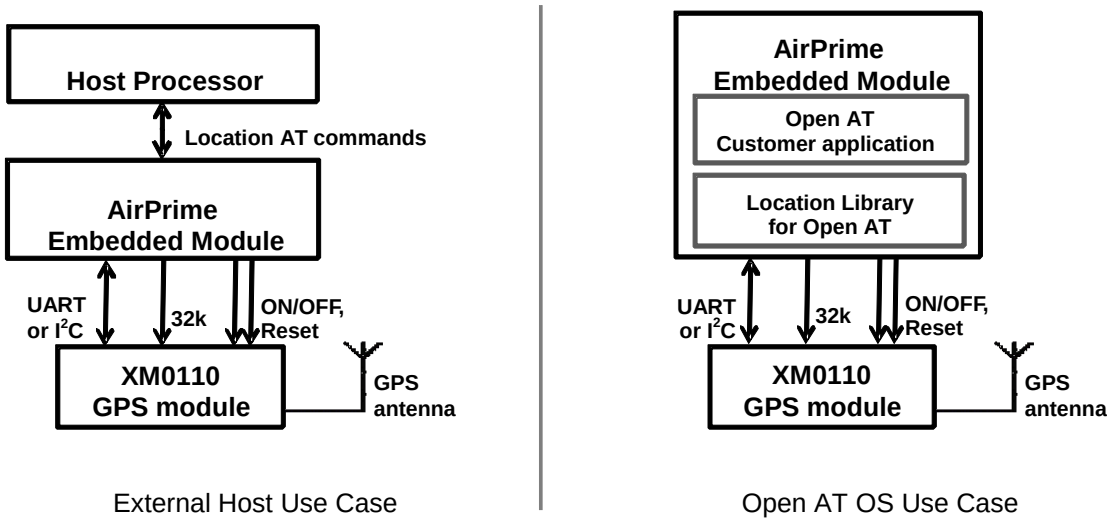

Figure 1. AirPrime XM0110 Typical Application Use Cases

AirPrime Intelligent Embedded Modules compatible to AirPrime XM0110 (at date of this manual's publication) are the following modules supporting Open AT technology:

- Q26 series (GSM series), G size memory (H memory not supported due to Host Software requirements).
- WP1x0 series, with 32/16Mb or larger memory combination.
- SL6087

Note that AirPrime XM0110 interface to host is not a public interface. Thus, AirPrime XM0110 cannot be driven by another host processor than those listed above, or with software other than the AirPrime XM0110 host software delivered by Sierra Wireless.

2.3. Features

- Features Best-in-class GPS acquisition and tracking sensitivity, TTFF and accuracy
  - -163 dBm tracking sensitivity
  - -161 dBm navigation sensitivity
  - -146 dBm autonomous acquisition sensitivity
- Optimized integration with compatible AirPrime Embedded Modules:
  - Integrated TCXO, LDOs, LNA and filter for lowest total BOM cost and quick and safe integration
  - Large supply range (1V8 to 5V25) compatible to AirPrime Embedded Module supply
  - 1V8 2 wires UART serial interface direct connection to AirPrime Embedded Module UART2 port, or alternatively I^2C serial interface
  - 32kHz clock input: available directly from AirPrime Embedded Module
  - On/Off, Reset and Wake-up inputs can be driven by any 1V8 or 2V8 GPO from AirPrime Embedded Module
- Ultra-low power consumption
  - <30uA deep sleep mode
  - <500uA sleep mode, maintaining permanent hot start conditions
  - <8 mA in 1Hz low power tracking mode
  - <38 mA in 1Hz full power tracking mode
  - Compatibility with AirPrime™ Embedded Modules low power mode
- Active and passive antenna supported
  - Single RF input, supporting passive antenna (i.e. no external LNA required) and active antenna (i.e. with external LNA)
- Built-in Active anti-jamming
  - Jammers removed prior to correlation
  - Tracks up to 8 CW jammers
  - Up to 80 dB-Hz in-band jammer removal
- Easy to integrate form factor
  - Compact, fully shielded, 10.0 X 12.5 x 2.5 mm package
  - Optimized manufacturing cost with 1.5mm pitch castellation technology.
- Completed by Sierra Wireless' Host Software for GPS
  - NMEA frames and/or PVT information, both in AT command and Open AT use cases
  - Extended Ephemeris GPS Aiding feature
  - Entirely upgradeable GPS software, including AirPrime XM0110 GPS firmware

2.4. Development Kit

The AirPrime XM0110 Daughter Board is a development board ready to be connected on all compatible AirPrime Embedded Modules Development Kits. It is available from Sierra Wireless.

For more information, see documents [1] AirPrime XM0110 Product Technical Specification and Customer Design Guidelines and [5] AirPrime XM0110 Development Kit Daughter Board User Guide.

3. AirPrime XM0110 GPS Module Highlights

3.1. AirPrime XM0110 Block Architecture

The AirPrime XM0110 GPS module integrates all required components to offer a zero extra component application when integrated to AirPrime Embedded Modules. In particular, it features the GSD4t – SiRFstarIV™ high-performance single-chip L1 GPS solution from CSR/SiRF, and high accuracy TCXO, filter and supplies.

It has been designed to cope with both active antenna and passive antenna design applications, with the lowest possible BOM and simplest possible application.

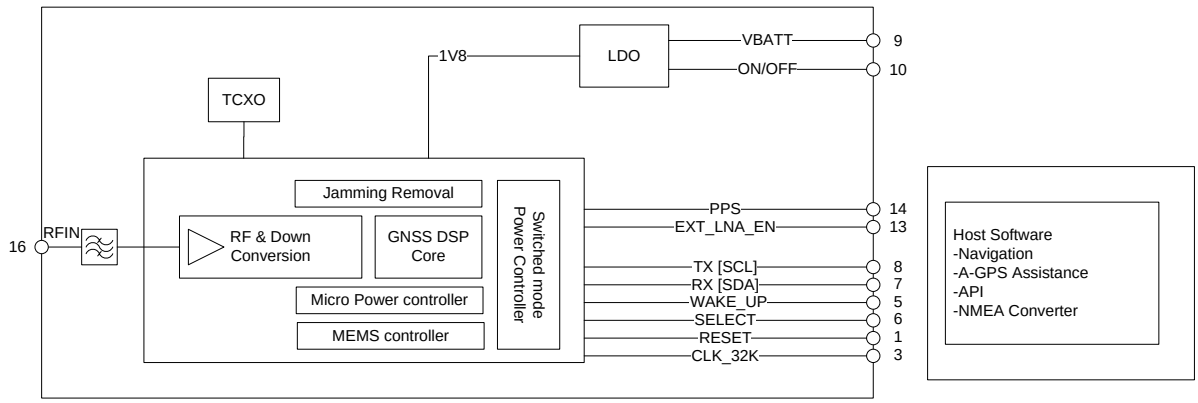

Figure 2. AirPrime XM0110 Block Diagram

3.2. Pin Assignment

AirPrime XM0110 pin assignment is as defined in the figure and table below:

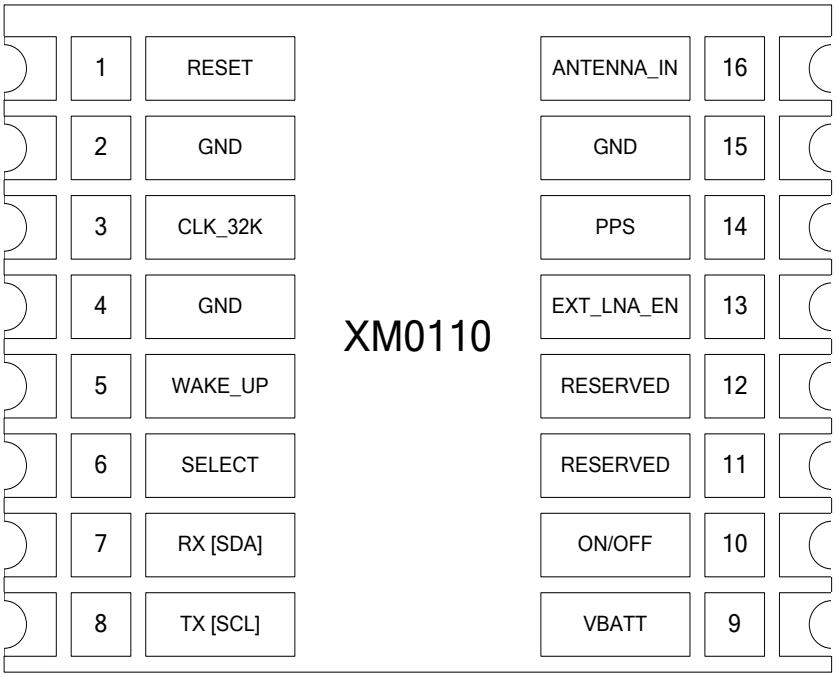

Figure 3. AirPrime XM0110 Pin Out – Top View

Table 1. AirPrime XM0110 Pin Map

Pin	Name	Direction	Function
1	RESET	Input	Active Low Reset Input
2	GND	Power	Ground
3	CLK_32K	Input	32.768kHz Clock Input
4	GND	Power	Ground
5	WAKE_UP	Input	GPS Receiver Wake-Up Input
6	SELECT	Input	Serial Interface Select Input (High: UART)
7	RX [SDA]	Input	UART Receive Input / I2C Data
8	TX [SCL]	Output	UART Transmit Output / I2C Clock
9	VBATT	Power	Main Supply Connection
10	ON/OFF	Input	Power supply Control. ON Active High
11	RESERVED	-	Reserved for future use. Do not connect
12	RESERVED		Reserved for future use. Do not connect
13	EXT_LNA_EN	Output	Active High External LNA Enable Output
14	PPS	Output	Pulse Per Second Output
15	GND	Power	Ground
16	ANTENNA_IN	Input	GPS Antenna Input

3.3. Electrical Specifications

3.3.1. Absolute Maximum Ratings

The AirPrime XM0110 main power supply input range is common with AirPrime Embedded Modules with a slightly different recommended nominal DC level.

Table 2. AirPrime XM0110 Absolute Maximum Ratings

Power Supply	Rating	Units
VBATT	6	V
ON/OFF	-0.3 to 6	V
ANTENNA_IN	25	V
RESET, SELECT, RX, WAKE_UP	3.6	V
CLK_32K	3.6	V
Maximum Current draw	130	mA

3.3.2. Recommended Operating Conditions

Table 3. AirPrime XM0110 Recommended Operating Conditions

Power Supply		Min	Typ	Max	Units
VBATT		1.8		5.25	V
ON/OFF	V_{IL}	-	-	0.3	V
	V_{IH}	1.1	-	-	V
RESET, SELECT, RX, WAKE_UP	V_{IL}	-0.4	-	0.45	V
	V_{IH}	1.27	-	3.6	V
PPS, EXT_LNA_EN, TX, Reserved pins	V_{OL}	-	-	0.4	V
	V_{OH}	1.34	-	-	V
CLK_32K		-0.7	1.8	3.6	V

Note: All digital inputs are 3V6 tolerant.

3.4. Mechanical Specifications

AirPrime XM0110 is designed for easy implementation on customer board with few PCB constraints.

It is compact (10 x 12.5 x 2.5 mm) and SMT solderable with 1.5mm pitch pads. It can be handled by standard pick and place equipment.

It weighs < 0.6g.

3.4.1. External Dimensions

The detailed AirPrime XM0110 external dimensions are provided in the figure below:

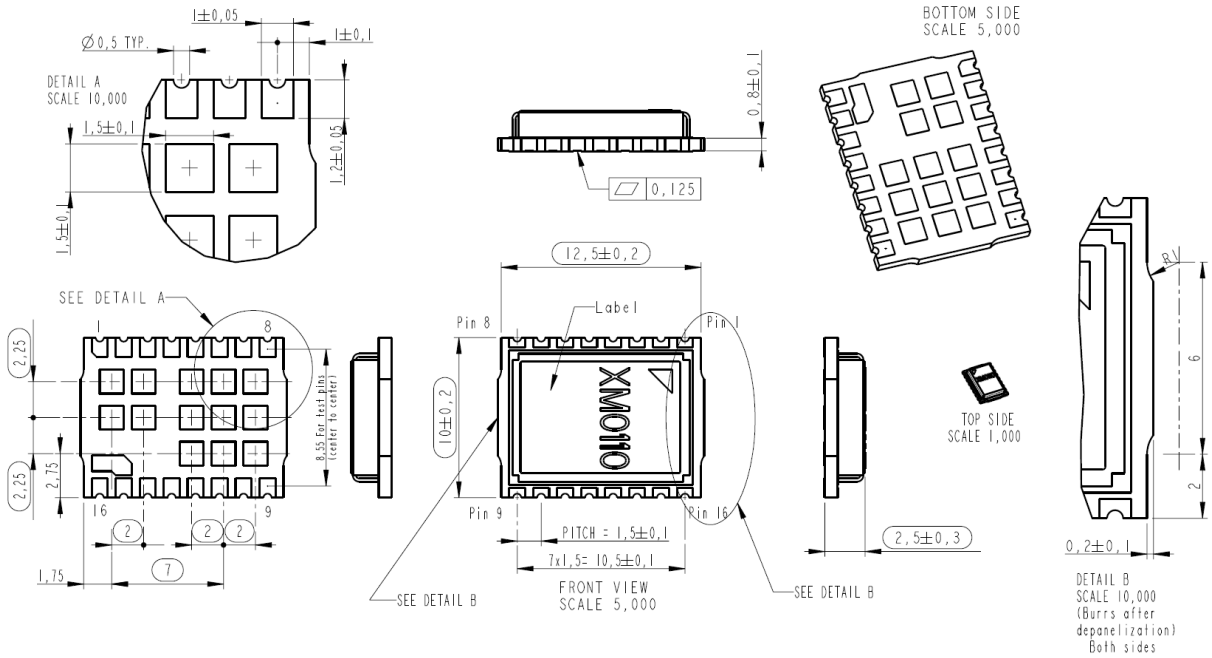

Figure 4. AirPrime XM0110 Mechanical Design

3.4.2. Pictures

Figure 5. AirPrime XM0110 Images

3.5. Customer Process Recommendations

This section presents some recommendations for application design.

More detailed recommendations can be found in document [2] AirPrime XM0110 Customer Process Guidelines.

3.5.1. RF Track Layout for Antenna Input

ANTENNA_IN (pin 16) has to be connected to a micro strip or a coplanar with ground line matched to 50Ω. The footprint of ANTENNA_IN pin has to be matched to 50Ω. The matching depends on the stacking layers of the PCB.

3.5.2. Recommended Footprint & Stencil Patterns

Recommendation on footprint pattern and stencil pattern for AirPrime XM0110 application can be found in document [2] AirPrime XM0110 Customer Process Guidelines.

3.5.3. ESD

The AirPrime XM0110 module is an ESD sensitive component.

Its input supports the following ESD levels:

- Level class 2 for HBM (2KV)
- Level class B for MM (200V)
- Level class III for CDM (500V)

ESD protection is mandatory on all signals which are externally accessible, typically if the final application has a GPS RF connector (external antenna design).

3.5.4. Environmental

The AirPrime XM0110 is supports following temperature range:

- Storage: -40 °C to +85°C
- Operating: -40 °C to +85°C (Class B) and -30 °C to +85°C (Class A)

In Class A, the AirPrime XM0110 meets the product performances as defined in this document. In Class B, some GPS performances may be degraded; in particular longer TTFF can be expected.

3.5.5. Standards

The AirPrime XM0110 complies with the following standards.

Table 4. Applicable Standards

Domain	Applicable Standard
Efficient use of the radio frequency spectrum	EN 300 440-1 v1.5.1 (2009-03) EN 300 440-2 v1.3.1 (2009/03)
EMC	Commission Directive 2004/104/EC last amended by 2009/19/EC 72/245/EEC 70/156/EEC
FCC	47CFR15.109

3.5.6. RoHS Directive Compliancy

The AirPrime XM0110 is compliant with RoHS Directive 2002/95/EC which sets limits for the use of certain restricted hazardous substances. This directive states that “from 1st July 2006, new electrical and electronic equipment put on the market does not contain lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE)”.

3.5.7. Packaging

The AirPrime XM0110 is delivered in tape & reel. Each reel contains 250 parts.

4. GPS Performances

The table below provides some typical GPS performances and power consumption figures. For more detailed figures, please refer to document [1] AirPrime XM0110 Product Technical Specification and Customer Design Guidelines.

Table 5. AirPrime XM0110 GPS Performance

Parameter	Specification		
Receiver Type	48 tracking channels, 400,000 correlators GPS L1 frequency (1575.42 MHz). SBAS (WAAS/EGNOS) support.		
Active Jammer Remover	Tracks up to 8 CW jammers Removes in-band jammers up to 80 db/Hz		
Sensitivity (a)	Acquisition	Autonomous	-146 dBm
		CGEE/SGEE Aided	-158 dBm (target)
	Navigation		-161 dBm
	Tracking		-163 dBm
Time-To-First-Fix (b)	Cold Start	Autonomous	<35 s
		CGEE/SGEE Aided	<20 s
	Warm Start	Autonomous	<34 s
		CGEE/SGEE Aided	<10 s
	Hot Start		<1 s
Accuracy	Horizontal Position (CEP 50%, -130 dBm)		< 2.5 m
	Velocity (50% @ 30 m/s)	Speed	< 0.01 m/s (Typ.)
		Heading	< 0.01 ° (Typ.)
Power Consumption(c)	Off mode		<5 uA
	Hibernate Sleep mode		26 uA
	GPS Idle Sleep mode (average, including regular ephemeris decode for permanent hot start conditions)		1.1 mA
	1Hz Tracking Very Low Power mode		8 mA
	1Hz Tracking Full Power mode		36 mA
	Acquisition		56 mA
Position Update Rate	Configurable		Up to 1 Hz

(a) With internal LNA. Higher sensitivity can be achieved with external LNA.
(b) 50% -130 dBm Pu 30 km
(c) With internal LNA. Lower power consumption can be achieved with external LNA.

5. Application Example

5.1. UART Interface

Figure 6 provides the default recommended application when using UART interface to AirPrime Embedded Module, and a passive antenna.

The Embedded Module GPIOs used to drive AirPrime XM0110 ON/OFF and RESET signals can be 1V8 or 2V8 GPIOs. These GPIOs can be chosen by the application as they are software selectable. ON/OFF could also be driven directly by the application.

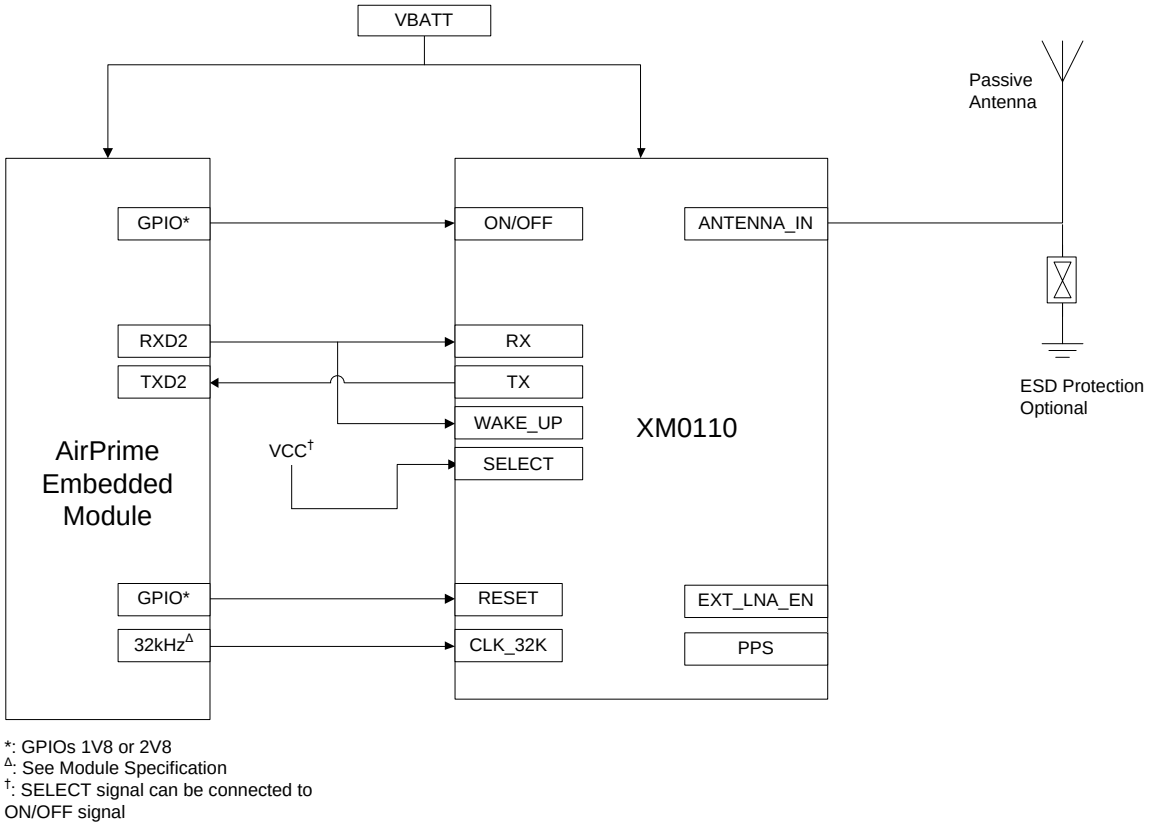

Figure 6. AirPrime XM0110 Typical UART Connection and Passive Antenna

5.2. I²C Interface

Figure 7 provides the recommended application when using I²C interface to AirPrime Embedded Module.

The Embedded Module GPIOs used to drive AirPrime XM0110 ON/OFF, WAKE-UP and RESET signals can be 1V8 or 2V8 GPIOs. These GPIOs can be chosen by the application as they are software selectable. ON/OFF could also be driven directly by the application.

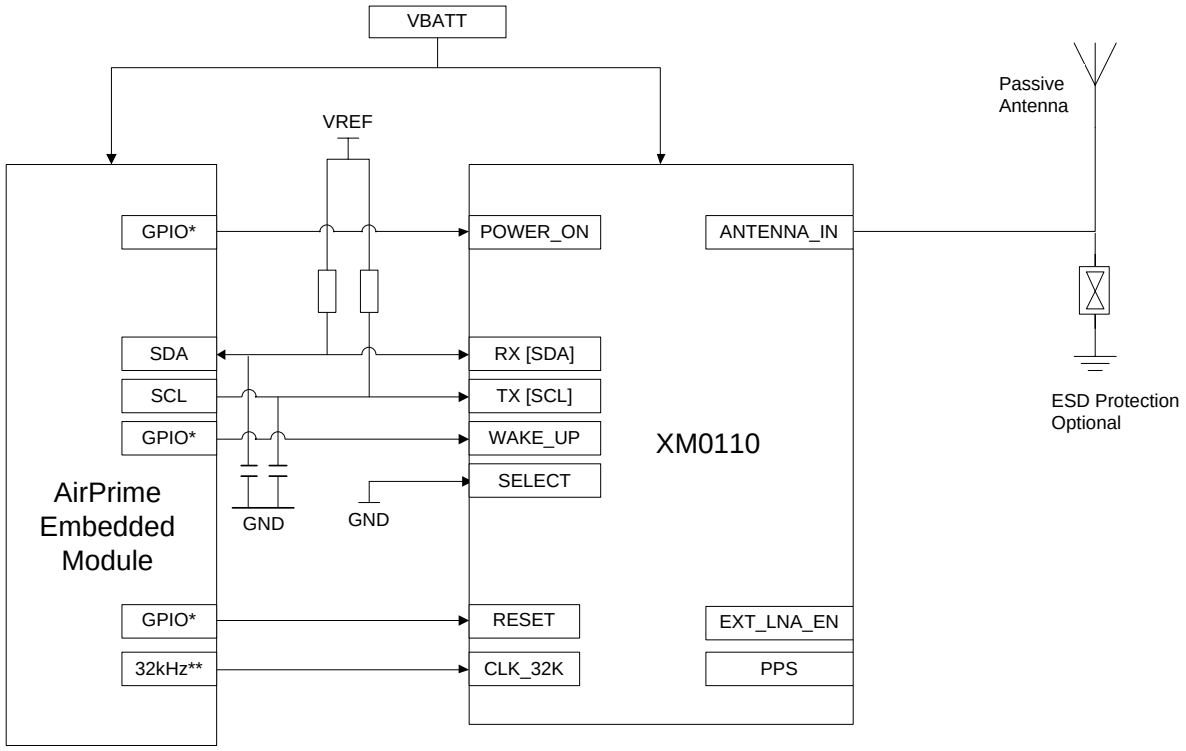

Figure 7. AirPrime XM0110 Typical I²C Connection and Passive Antenna

Caution: *I²C pull-up value must match the AirPrime Embedded Module specification. Typically, I²C bus rate is 400kbps; 1kΩ pull-up resistors are recommended on both SCL and SDA. To avoid any I²C bus issues, hardware design should imperatively respect rising edge constraints (minimum of 200ns, maximum of 300ns). Additional capacitor PCB footprints, connected from both I²C lines to ground, are recommended to ensure correct timing for the entire hardware design layout.*

5.3. Active Antenna

Figure 8 is an example of an application using a passive antenna.

AirPrime XM0110 supports the connection at its RF input of an active antenna, i.e. an antenna embedding its own LNA. This configuration is also named ‘external LNA’ in opposition to the ‘internal LNA’ configuration used for passive antennas where the only LNA in the system is the AirPrime XM0110’s internal LNA.

This application allows the direct use of the most common active antennas available on the market.

In order to optimize GPS performances, the following recommendations apply:

- ‘External LNA’ setting must be specified through software. See documents [3] Location Library 1.51 for Open AT Framework AT Command Interface Guide and [4] Location Library 1.51 for Open AT Framework Developer Guide for more details.
- Total antenna system gain should not exceed 27dB.

AirPrime XM0110 is not designed to directly supply an active antenna, but provides an enable signal to the antenna power supply system. Use of the EXT_LNA_EN signal allows optimizing the external antenna power consumption, as the antenna LNA will be shut down when no RF activity is required.

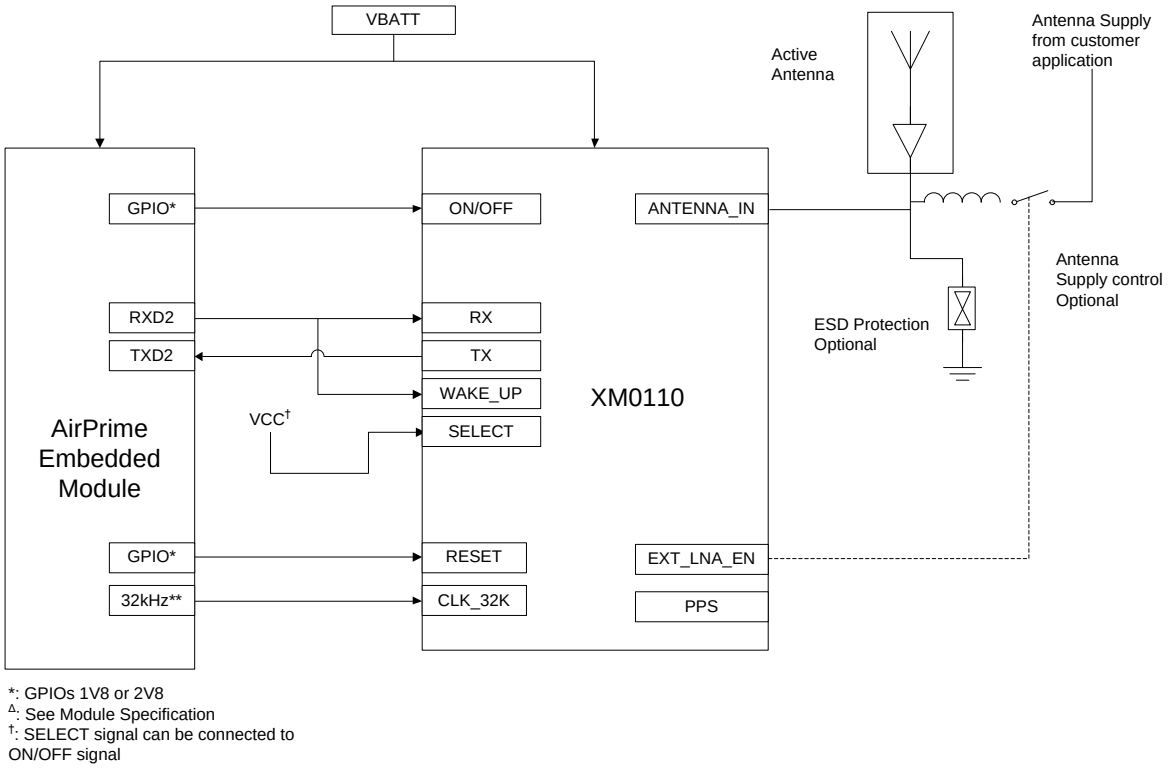

Figure 8. AirPrime XM0110 Typical UART Connection and Active Antenna

6. Software Highlights

AirPrime XM0110 requires to be driven by the host software. Such host software is provided by Sierra Wireless in different forms according to the application use case:

- The Location AT command software, to extend the AirPrime Embedded Module AT command set;
- The Location Library for Open AT to provide generic GPS APIs in Open AT OS environment;

Note that in both cases, the AirPrime XM0110 host software, and thus the AirPrime XM0110 firmware, can be upgraded over the air if needed.

6.1. Location AT Commands Extension Set

The Location AT commands extends the AirPrime Intelligent Embedded Module AT command set to allow users to:

- Control the GPS feature and AirPrime XM0110
  - AT+GPSSTART, AT+GPSSTOP
- Output standard NMEA sentences on a specified port (UART1, UART2, USB or CMUX virtual port), configure the NMEA rate and select the needed NMEA sentences
  - AT+GPSNMEA
- Output simple PVT sentences on a specified port (UART1, UART2, USB or CMUX virtual port), configure the PVT rate and select the needed PV sentences
  - AT+GPSPVT
- Modify and save the default configuration, including default AirPrime XM0110 hardware application configuration if needed
  - AT+GPSINIT.
- Configure and control AirPrime XM0110 low power modes:
  - AT+GPSSLEEP, AT+GPSCONF

When using default configuration, the single AT command AT+GPSSTART will start the AirPrime XM0110 and output NMEA sentences to the main UART for host processor.

More AT commands are also available for evaluation of solution, advanced settings, etc.

For more information, please refer to document [1] AirPrime XM0110 Product Technical Specification and Customer Design Guidelines.

6.2. Location Library for Open AT

The Location Library can be used in combination with AirPrime XM0110 to offer extensive location services to the application.

The Location Library exposes APIs to the application, allowing it to

- Configure the software according to the application hardware design
- Control the AirPrime XM0110 for navigation or push-to-fix (i.e. fix on demand) use cases, in full power and low power modes
- Be notified, at the requested rate, with standard NMEA sentences strings, and/or Position-Velocity-Time structure

- Be notified of the GPS fix events such as 3D fix obtained or fix lost
- Get the last know position, satellites information, AirPrime XM0110 status, etc.
- Retrieve more information on the Library state, version, debug information

The Location Library APIs can be grouped into the following categories:

- Location Library Control APIs and GPS core Control APIs, to control and configure both the Location Library and AirPrime XM0110.
- Location Services APIs, including NMEA API, PVT API and Advanced Information API, to access location data.

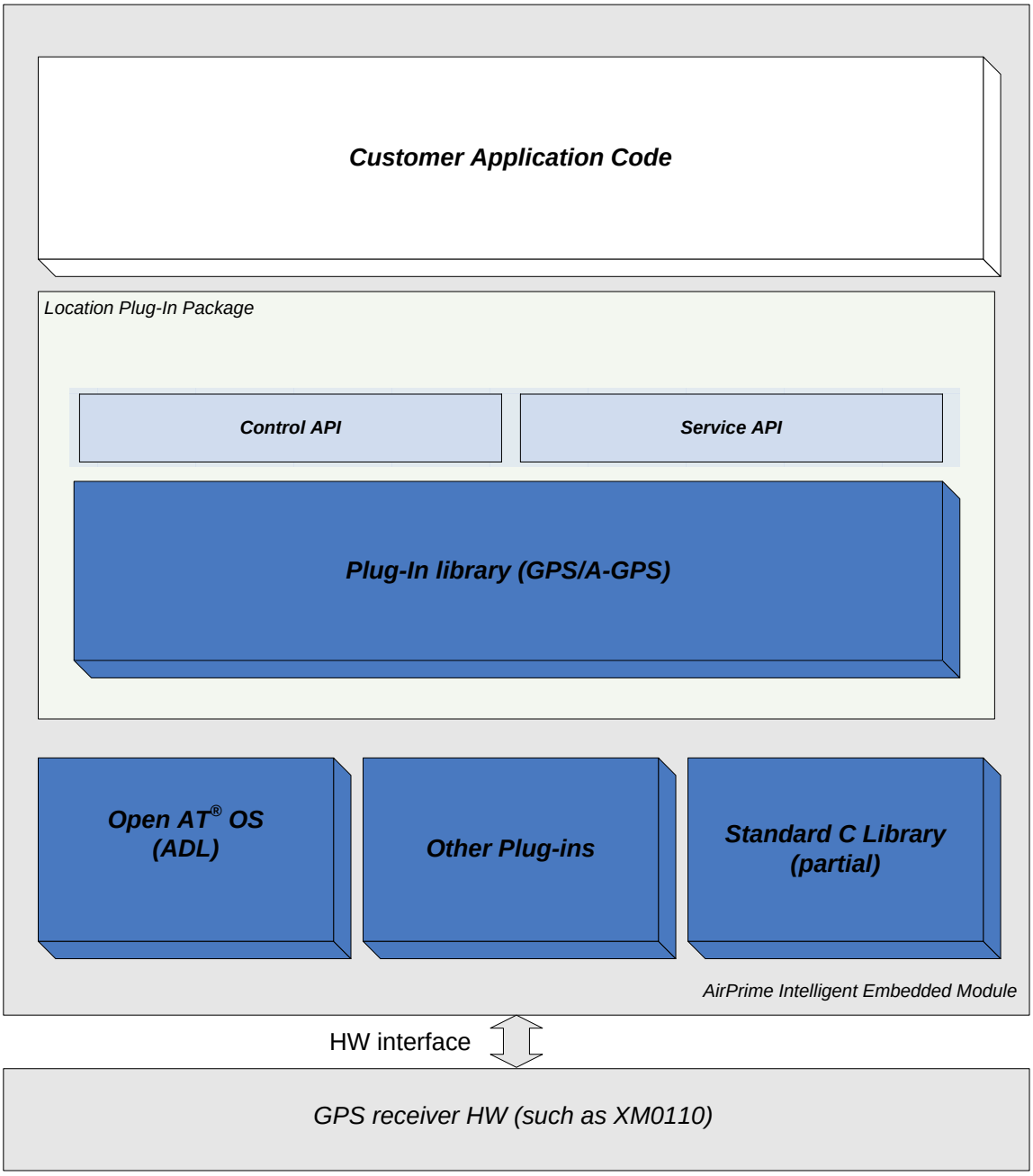

Figure 9. Location Library Architecture

For more information, please refer to document [4] Location Library 1.51 for Open AT Framework Developer Guide.

6.3. Resources

Caution: *All figures in this section are for informational purposes, and may vary from one Location Library release to another. Refer to document [4] Location Library 1.51 for Open AT Framework Developer Guide and Location Library Release Note for detailed up-to-date figures.*

6.3.1. CPU Requirements

The CPU consumption of the Location AT application and library, in 1Hz GPS tracking conditions, is about 25% of total AirPrime Embedded Module power while running at 26MHz for GCC-EABI or RVDS tool chains in UART configuration.

During some particular phases, such as Extended Ephemeris computation, CPU can be raised to 104MHz.

6.3.2. Memory Requirements

The software memory footprint depends on the tool chain used, the software release, and if Extended Ephemeris GPS Aiding Feature is used.

Approximate figures for a GPS application with GCC-EABI or RVDS tool chains, without Extended Ephemeris Aiding feature are: 675kB ROM, 410kB RAM and 20kB non-volatile memory.

Due to RAM requirements, the host software requires to use Embedded Module with 1MByte RAM or more.

6.3.3. OS

The Location Library for Open AT requires the use of the following OS resources:

- 2 dedicated OS application tasks (or 3 with Extended Ephemeris GPS Aiding)
- 1 Timer, 1 Message Service, 1 Event Service and several Semaphores
- 2 OS Flash objects

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