Product Technical Specification & Customer Design Guidelines

AirPrime WISMO228

SIERRA WIRELESS

WA_DEV_W228_PTS_002
006
September 10, 2010

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Due to the nature of wireless communications, transmission and reception of data can never be guaranteed. Data may be delayed, corrupted (i.e., have errors) or be totally lost. Although significant delays or losses of data are rare when wireless devices such as the Sierra Wireless modem are used in a normal manner with a well-constructed network, the Sierra Wireless modem should not be used in situations where failure to transmit or receive data could result in damage of any kind to the user or any other party, including but not limited to personal injury, death, or loss of property. Sierra Wireless accepts no responsibility for damages of any kind resulting from delays or errors in data transmitted or received using the Sierra Wireless modem, or for failure of the Sierra Wireless modem to transmit or receive such data.

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Contact Information

Sales Desk:	Phone:	1-604-232-1488
	Hours:	8:00 AM to 5:00 PM Pacific Time
	E-mail:	sales@sierrawireless.com
Post:	Sierra Wireless 13811 Wireless Way Richmond, BC Canada V6V 3A4	
Fax:	1-604-231-1109	
Web:	www.sierrawireless.com	

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Document Update History

<table>
<tr><th>Rev</th><th>Date</th><th>Updates</th></tr>
<tr><td>001</td><td>October 15, 2009</td><td>Creation</td></tr>
<tr><td>002</td><td>October 27, 2009</td><td>• Updated Class A Operating Temperature Range
• Updated documentation reference</td></tr>
<tr><td rowspan="2">003</td><td rowspan="2">December 3, 2009</td><td>ON/~OFF Signal:
• Added an extra note about controlling the signal via an open collector switching transistor
• Updated Figure 30 to include a figure showing the signal connection via an open collector transistor
• Set the low level pulse length to 5.5sec
• Updated Figure 32 to include the 5.5s low level pulse length</td></tr>
<tr><td>TX_CTRL Signal for TX Burst Indication:
• Added TX_CTRL frequency and duration
• Updated Figure 36 to include $T_{duration}$
• Updated Figure 37 (added the transistor, T601)</td></tr>
<tr><td>004</td><td>January 20, 2010</td><td>Added additional information regarding the use of AT+PSSLEEP=1.</td></tr>
<tr><td rowspan="7">005</td><td rowspan="7">April 29, 2010</td><td>Power Consumption Values:
• Specified that power consumption values are typical
• Deleted Alarm Mode and updated Off Mode</td></tr>
<tr><td>Updated document template.</td></tr>
<tr><td>Updated section 8 Certification Compliance and Recommended Standards.</td></tr>
<tr><td>Updated Figure 46 Castellation Pin Dimension and Location.</td></tr>
<tr><td>Updated section 3.18 Reset.</td></tr>
<tr><td>Updated Reject Filter Recommendations.</td></tr>
<tr><td>Added section 5.6 Conformance with ATEX 94/9/CE Directive</td></tr>
<tr><td rowspan="6">006</td><td rowspan="6">September 10, 2010</td><td>Added warning as section 8.3.2 regarding updating the WISMO module software being forbidden.</td></tr>
<tr><td>Updated table footnote regarding the ON/~OFF pin .</td></tr>
<tr><td>Address ON/~OFF signal high impedance in two bullets.</td></tr>
<tr><td>Added ON/~OFF signal information and new introduction to existing table.</td></tr>
<tr><td>Added additional details to the ON/~OFF signal information, stating “The ON/~OFF Signal releases to high impedance when AirPrime WISMO228 is in Idle Mode. Idle Mode consumption will be higher if the ON/~OFF pin is kept at low voltage level when in Idle Mode.”</td></tr>
<tr><td>Updated the VIL and VOL entries in the Electrical Characteristics of the SIM Interface table.</td></tr>
</table>

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1. Introduction

1.1. Reference Documents

Several documents are referenced throughout this specification. For more details, please consult the listed reference documents. The Sierra Wireless documents referenced herein are provided in the Sierra Wireless documentation package; however, the general reference documents which are not Sierra Wireless owned are not provided in the documentation package.

1.1.1. Sierra Wireless Reference Documentation

[1] AirPrime WISMO218 Hardware Presentation
Reference: WA_DEV_W218_PTS_001

[2] AirPrime WISMO228 AT Command Manual
Reference: WA_DEV_W228_UGD_004

[3] AirPrime WS Series Development Kit User Guide
Reference: WA_DEV_W218_UGD_004

[4] AirPrime Customer Process Guideline for WISMO Series
Reference: WA_DEV_WISMO_PTS_001

1.2. List of Abbreviations

Abbreviation	Definition
AC	Alternative Current
ADC	Analog to Digital Converter
A/D	Analog to Digital conversion
AF	Audio-Frequency
AGC	Automatic Gain Control
AT	ATtention (prefix for modem commands)
AUX	AUXiliary
CAN	Controller Area Network
CB	Cell Broadcast
CBS	Cell Broadcast Service
CE	-
CEP	Circular Error Probable
CLK	CLocK
CMOS	Complementary Metal Oxide Semiconductor
CODEC	COder DECoder
CPU	Central Processing Unit
CS	Coding Scheme
CSD	Circuit Switched Data

Abbreviation	Definition
CTS	Clear To Send
DAC	Digital to Analog Converter
DAI	Digital Audio Interface
dB	Decibel
DC	Direct Current
DCD	Data Carrier Detect
DCE	Data Communication Equipment
DCS	Digital Cellular System
DR	Dynamic Range
DSR	Data Set Ready
DTE	Data Terminal Equipment
DTR	Data Terminal Ready
EFR	Enhanced Full Rate
E-GSM	Extended GSM
EMC	ElectroMagnetic Compatibility
EMI	ElectroMagnetic Interference
EMS	Enhanced Message Service
EN	ENable
ESD	ElectroStatic Discharges
ETSI	European Telecommunications Standards Institute
FIFO	First In First Out
FR	Full Rate
FTA	Full Type Approval
GND	GrouND
GPI	General Purpose Input
GPC	General Purpose Connector
GPIO	General Purpose Input Output
GPO	General Purpose Output
GPRS	General Packet Radio Service
GPS	Global Positioning System
GPSI	General Purpose Serial Interface
GSM	Global System for Mobile communications
HR	Half Rate
Hi Z	High impedance (Z)
IC	Integrated Circuit
IDE	Integrated Development Environment
IF	Intermediate Frequency
IMEI	International Mobile Equipment Identification
I/O	Input / Output
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LNA	Low Noise Amplifier
LSB	Less Significant Bit
MAX	MAXimum

Abbreviation	Definition
MIC	MICrophone
MIN	MINimum
MMS	Multimedia Message Service
MO	Mobile Originated
MS	Mobile Station
MT	Mobile Terminated
na	Not Applicable
NF	Noise Factor
NMEA	National Marine Electronics Association
NOM	NOMinal
NTC	Négative Temperature Coefficient
PA	Power Amplifier
Pa	Pascal (for speaker sound pressure measurements)
PBCCH	Packet Broadcast Control CHannel
PC	Personal Computer
PCB	Printed Circuit Board
PCL	Power Control Level
PCM	Pulse Code Modulation
PCS	Personal Communications Service
PDA	Personal Digital Assistant
PFM	Power Frequency Modulation
PLL	Phase Lock Loop
PSM	Phase Shift Modulation
PWM	Pulse Width Modulation
RAM	Random Access Memory
RF	Radio Frequency
RFI	Radio Frequency Interference
RHCP	Right Hand Circular Polarization
RI	Ring Indicator
RMS	Root Mean Square
RST	ReSeT
RTC	Real Time Clock
RTCM	Radio Technical Commission for Maritime services
RTS	Request To Send
RX	Receive
SCL	Serial CLock
SDA	Serial DAta
SIM	Subscriber Identification Module
SMD	Surface Mounted Device/Design
SMS	Short Message Service
SPI	Serial Peripheral Interface
SPL	Sound Pressure Level
SPK	SPeaKer
SW	SoftWare

Abbreviation	Definition
PSRAM	Pseudo Static RAM
TBC	To Be Confirmed
TDMA	Time Division Multiple Access
TP	Test Point
TU	Typical Urban fading profile
TUHigh	Typical Urban, High speed fading profile
TVS	Transient Voltage Suppressor
TX	Transmit
TYP	TYPical
UART	Universal Asynchronous Receiver-Transmitter
UBX	µ-blox proprietary protocol (NE DOIT PAS APPARAITRE)
USB	Universal Serial Bus
USSD	Unstructured Supplementary Services Data
VSWR	Voltage Standing Wave Ratio
WAP	Wireless Application Protocol

2. General Description

2.1. General Information

The AirPrime WISMO228 Intelligent Embedded Module is a self-contained GSM 850/EGSM 900/DCS 1800/PCS 1900 quad-band embedded module that was specifically designed for M2M systems deployed all over the world.

2.1.1. Overall Dimensions

- Length: 25.0 mm
- Width: 25.0 mm
- Thickness: 2.8 mm (excluding label thickness)
- Weight: 3.64 g

2.1.2. Environment and Mechanics

2.1.2.1. RoHS Directive Compliant

The AirPrime WISMO228 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)”.

2.1.2.2. Complete Shielding

All electronic parts of the AirPrime WISMO228 are nearly-completely covered in a self-contained shield.

2.1.3. GSM/GPRS Features

- 2 Watts GSM 850 radio section running under 3.6 Volts
- 2 Watts EGSM 900 radio section running under 3.6 Volts
- 1 Watt DCS 1800 radio section running under 3.6 Volts
- 1 Watt PCS 1900 radio section running under 3.6 Volts
- Hardware GPRS class 10 capable

2.1.4. Interfaces

- VBAT power supply
- Digital section running under 2.8 Volts
- 3V/1V8 SIM interface

- Power supplies
- Serial link (UART)
- Analog audio
- ADC
- Serial bus SPI for debug trace
- PWM0,1 and PWM2 for buzzer output
- GPIOs
- ON/~OFF
- TX burst indicator
- Embedded Module ready indicator
- Reset

2.1.5. Firmware

- Drives the AirPrime WISMO228 via an AT command interface over a serial port
- Full GSM/GPRS Operating System stack
- Real Time Clock with calendar

2.1.6. Connection Interfaces

The AirPrime WISMO228 has a 46-pin castellation form factor which provides:

- One ANT pin for RF in/out
- Other pins for baseband signals

2.2. Functional Description

The global architecture of the AirPrime WISMO228 is shown in the figure below.

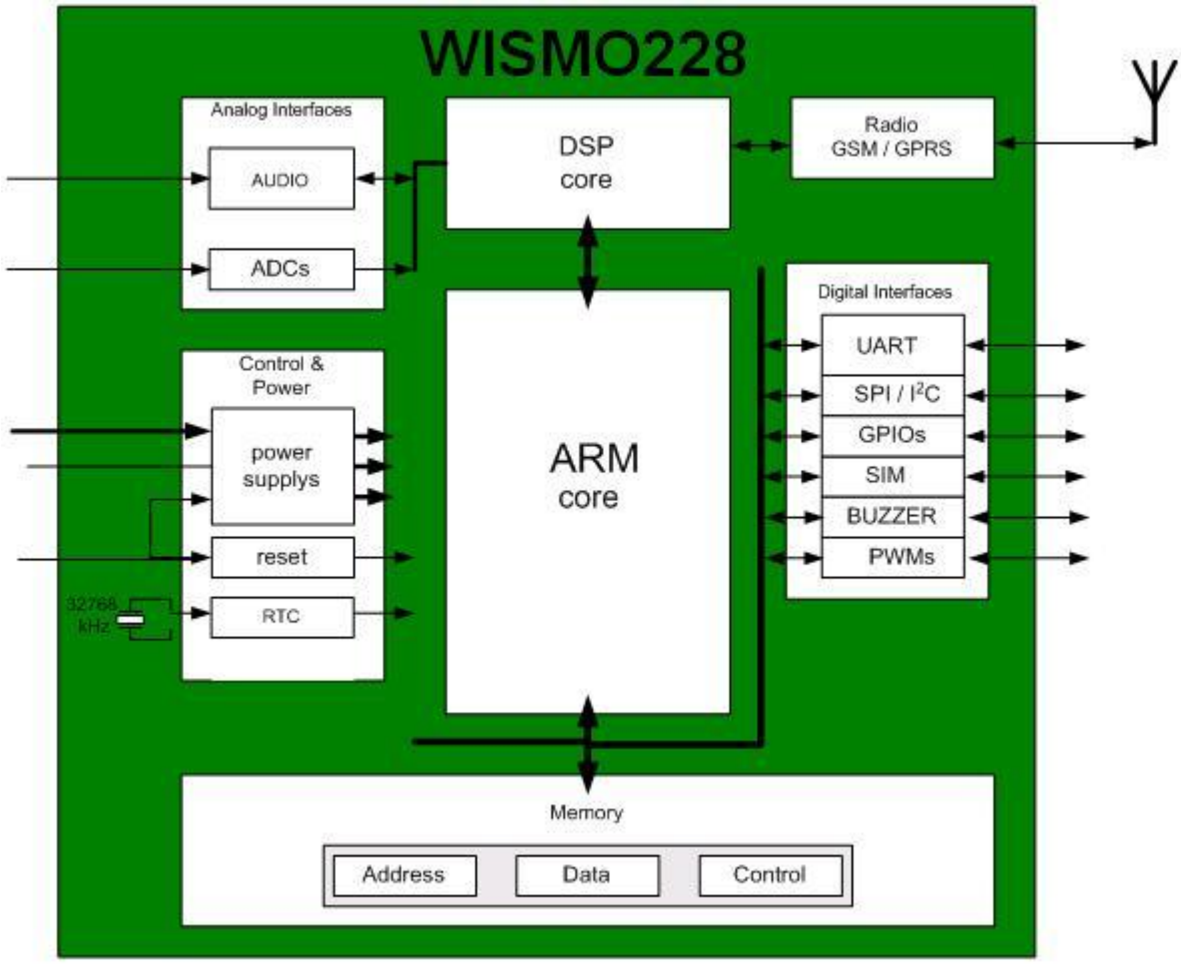


Figure 1. Functional Architecture

2.2.1. RF Functionalities

The Radio Frequency (RF) range complies with the Phase II GSM 850/EGSM 900/DCS 1800/PCS 1900 recommendation. The frequency range for the transmit band and receive band are listed in the table below.

	Transmit Band (Tx)	Receive Band (Rx)
GSM 850	824 to 849 MHz	869 to 894 MHz
E-GSM 900	880 to 915 MHz	925 to 960 MHz
DCS 1800	1710 to 1785 MHz	1805 to 1880 MHz
PCS 1900	1850 to 1910 MHz	1930 to 1990 MHz

The RF part of the AirPrime WISMO228 is based on a specific dual band chip which includes:

- a Digital low-IF receiver
- a dual-band LNA (Low Noise Amplifier)
- an Offset PLL (Phase Locked Loop) transmitter
- a Frequency synthesizer
- a Digitally Controlled Crystal Oscillator (DCXO)
- a Tx/Rx FEM (Front-End Module) for quad-band GSM/GPRS

2.2.2. Baseband Functionalities

The Baseband is composed of an ARM9, a DSP and an analog element (with audio signals, I/Q signals and ADC).

The core power supply is 1.2V and the digital power supply is 2.8V.

3. Interfaces

3.1. General Interfaces

The AirPrime WISMO228 has a 46-pin castellation connection, which provides access to all available interfaces. The following table enumerates the available interfaces on the AirPrime WISMO228.

Available Interface	Driven by AT commands
Serial Interface (SPI)	No
Main Serial Link	Yes
SIM Interface	Yes
General Purpose IO	Yes
Analog to Digital Converter	No*
Analog Audio Interface	No*
PWMs	Yes
PWM2 for Buzzer Output	Yes
ON/~OFF	No
Embedded Module Ready Indication	No
VBAT_RTC (Backup Battery)	No
TX Burst Indication Signal	No
Reset	No

* These interfaces will have AT command support in future versions.

3.2. Power Supply

3.2.1. Power Supply Description

3.2.2. The power supply is one of the key elements in the emission in GSM/GPRS, the power supply must be During these peaks, the ripple (U_{ripple}) on the supply voltage must not exceed a certain limit. Refer to 3.2.2 Electrical Characteristics

Input Power Supply Voltage for the input power supply voltage values.

Listed below are the corresponding radio burst rates for the different GPRS classes in communication mode.

- A GSM/GPRS class 2 terminal emits 577µs radio bursts every 4.615ms. (See 1.1.1 .)
- A GPRS class 10 terminal emits 1154µs radio bursts every 4.615ms.

VBATT provides for the following functions:

- Directly supplies the RF components with 3.6V. It is essential to keep a minimum voltage ripple at this connection in order to avoid any phase error.
- The peak current (1.5A peak in GSM/GPRS mode) flows with a ratio of:

- 1/8 of the time (around 577µs every 4.615ms for GSM/GPRS class 2)

  and

- 1/4 of the time (around 1154µs every 4.615ms for GSM/GPRS class 10)

  with the rising time at around 10µs.

- Internally used to provide, via several regulators, the supply required for the baseband signals.

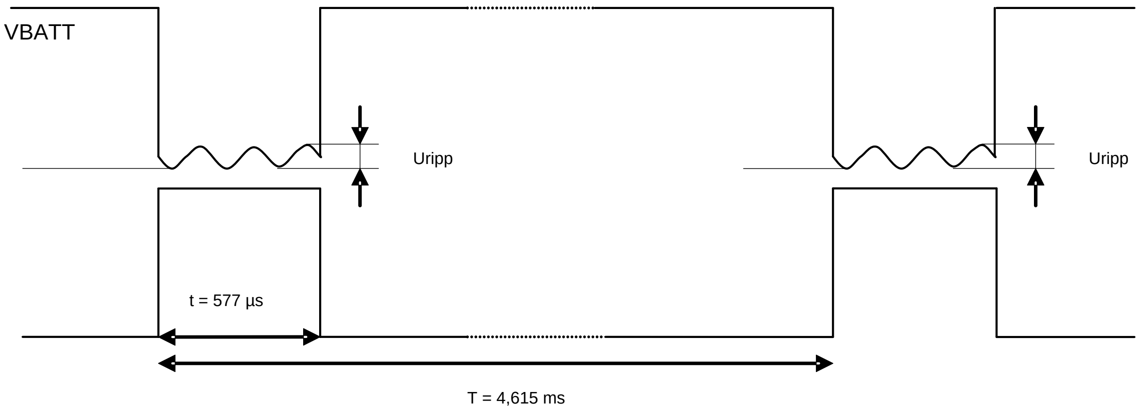


Figure 2. Power Supply During Burst Emission

3.2.3. Electrical Characteristics

Table 1: Input Power Supply Voltage

	V_{MIN}	V_{NOM}	V_{MAX}	I_{TYP}	I_{MAX}	Ripple max (U_{ripp})
VBATT[2]	3.2[1]	3.6	4.8	1.4A	1.5A	Frequency <= 200KHz: 20mVp-p Frequency > 200KHz: 5mVp-p[3, 4]

1: This value has to be guaranteed during the burst (with 1.5A Peak in GSM or GPRS mode).

2: The maximum operating Voltage Stationary Wave Ratio (VSWR) is 1.5:1.

3: It is recommended to add one to two 10µF capacitors close to the VBATT pin of the AirPrime WISMO228 to improve the AC ripple noise.

4: Avoid using a voltage supply with a switching frequency of 400 kHz or 600 kHz.

Note: When powering the AirPrime WISMO228 with a battery, the total impedance (battery + protections + PCB) should be less than 150mΩ.

3.2.4. Pin Description

Table 2: Power Supply Pin Description

Pin Numbers	Signal
29,30	VBATT
20,22,23,26,28,31	GND

3.2.5. Application

The reject filter can be connected between VBATT and the supply sources if the supply source is noisy.

Note: If the reject filter (C1+L1+C2) is an option, a capacitor (i.e. C2) is mandatory close to VBATT.

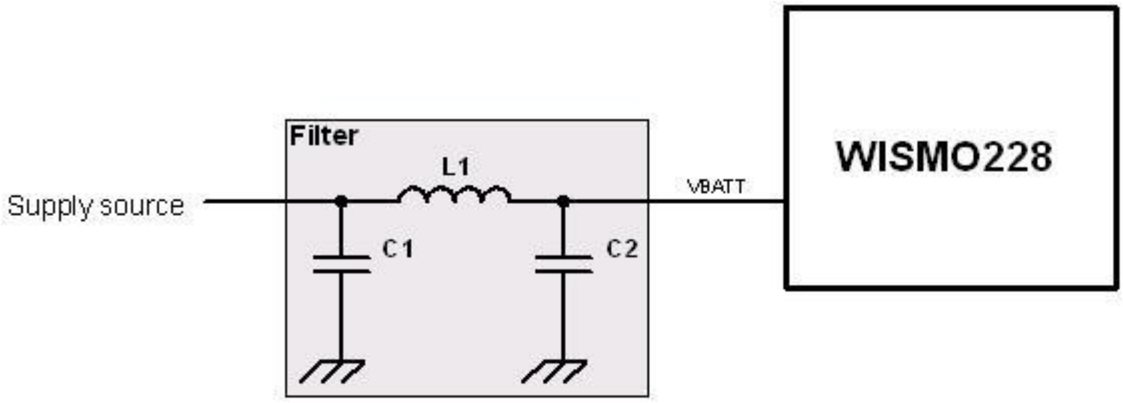


Figure 3. Reject Filter Diagram

The following tables list the recommended components to use in implementing the reject filter.

C1, C2: 10µF +/-20%

Component	Manufacturer
GRM21BR60J106KE19L	MURATA
CM21X5R106M06AT	KYOCERA
JMK212BJ106MG-T	TAYO YUDEN
C2012X5R0J106MT	TDK

L1: 200nH +/-20%

Component	Manufacturer
XPL2010-201ML	COILCRAFT

3.3. Power Consumption

The power consumption levels of the AirPrime WISMO228 vary depending on the operating mode used and the following sub-sections describe the power consumption values of the AirPrime WISMO228 when running in various operating modes and RF bands.

3.3.1. Various Operating Modes

Refer to the following table for the list of available operating modes on the AirPrime WISMO228.

Table 3: AirPrime WISMO228 Operating Modes

Mode	Description
OFF Mode	When VBATT power is supplied to the AirPrime WISMO228 but it has not yet been powered ON.
Alarm Mode	When alarm clock is set for the AirPrime WISMO228 with **ALL** of the following conditions: • before time is up • with AT + CPOF having been entered from a computer that is connected to the AirPrime WISMO228 • with the ON/~OFF signal being left open (remains at HIGH level)
Idle Mode	When the AirPrime WISMO228 has a location update with a live network but with no GSM/GPRS connection, while the UART interface is in sleep mode.
Connected Mode	The AirPrime WISMO228 has GSM voice codec connection with a live network.
Transfer Mode	The AirPrime WISMO228 has GPRS data transfer connection with a live network.

Note that there are two different methods of entering sleep mode through the AT command, **AT+PSSLEEP**.

- **AT + PSSLEEP = 0**
  - The entry of sleep mode is controlled by the level of the DTR signal and the firmware.
  - The AirPrime WISMO228 will never enter sleep mode when the DTR (viewed from the embedded module side) is of LOW voltage level. On the other hand, the AirPrime WISMO228 will enter sleep mode when the DTR (viewed from the embedded module side) is of HIGH voltage level.
  - To wake the AirPrime WISMO228 up, it is necessary to toggle the DTR (viewed from the embedded module side) from HIGH to LOW voltage level.
  - This method should be used if the application needs to forbid the entry of sleep mode.
- **AT + PSSLEEP = 1**
  - The entry of sleep mode is controlled just by the firmware.
  - When the AirPrime WISMO228 has had no activities for a certain period of time, it will enter sleep mode automatically, regardless of the DTR level.
  - Any ASCII character on the UART can wake the AirPrime WISMO228 up. Note that due to the wake-up mechanism of the AirPrime WISMO228, it is recommended to have at least 10ms latency time after the wake-up character before sending AT commands to the embedded module.

Refer to document [2] AirPrime WISMO228 AT Command Manual for more information about the **AT+PSSLEEP** command.

Note that the power consumption level will vary depending on the operating mode used.

3.3.2. Power Consumption Values

Three VBATT values were used to measure the power consumption of the AirPrime WISMO228: VBATTmin (3.2V), VBATTmax (4.8V) and VBATTtyp (3.6V). Both the average current and the maximum current peaks were also measured for all three VBATT values.

The following consumption values were obtained by performing measurements on AirPrime WISMO228 samples at a temperature of 25° C with the assumption of a 50Ω RF output.

*Note: Power consumption performance is software related. The results listed below (typical values) are based on the software version **L10_00gg.WISMO228**.*

AirPrime WISMO228 Power Consumption								
Operating Mode		Parameters		$I_{average}$			I_{peak}	Unit
				VBATT= 4.8V	VBATT= 3.6V	VBATT= 3.2V		
Off Mode (AirPrime WISMO228 stand alone)				50			NA	µA
Off Mode (using application note: Very Low Power Consumption*)				<1			NA	µA
Idle Mode**		Paging 2 (Rx burst occurrence ~0.5s)		1.86	1.90	1.93	587	mA
		Paging 9 (Rx burst occurrence ~2s)		1.19	1.22	1.23	581	mA
Connected Mode		850 MHz	PCL5 (TX power 33dBm)	213	216	218	1400	mA
			PCL19 (TX power 5dBm)	78	81	82	200	mA
		900 MHz	PCL5 (TX power 33dBm)	205	208	207	1400	mA
			PCL19 (TX power 5dBm)	78	81	83	200	mA
		1800 MHz	PCL0 (TX power 30dBm)	166	169	173	1000	mA
			PCL15 (TX power 0dBm)	76	79	80	200	mA
		1900 MHz	PCL0 (TX power 30dBm)	153	156	156	1000	mA
			PCL15 (TX power 0dBm)	75	78	80	200	mA
GPRS	Transfer Mode class 8 (4Rx/1Tx)	850 MHz	Gam.3 (TX power 33dBm)	202	206	208	1400	mA
			Gam.17 (TX power 5dBm)	72	76	77	210	mA
		900 MHz	Gam.3 (TX power 33dBm)	194	197	197	1400	mA
			Gam.17 (TX power 5dBm)	72	76	78	210	mA
		1800 MHz	Gam.3 (TX power 30dBm)	156	160	165	1000	mA
			Gam.18 (TX power 0dBm)	70	73	75	200	mA
		1900 MHz	Gam.3 (TX power 30dBm)	141	145	146	1000	mA
			Gam.18 (TX power 0dBm)	70	73	75	200	mA
	Transfer Mode class 10 (3Rx/2Tx)	850 MHz	Gam.3 (TX power 33dBm)	371	374	376	1400	mA
			Gam.17 (TX power 5dBm)	105	109	111	250	mA
		900 MHz	Gam.3 (TX power 33dBm)	353	357	357	1400	mA
			Gam.17 (TX power 5dBm)	106	110	111	250	mA

AirPrime WISMO228 Power Consumption								
		1800 MHz	Gam.3 (TX power 30dBm)	274	279	286	1000	mA
			Gam.18 (TX power 0dBm)	101	105	106	230	mA
		1900 MHz	Gam.3 (TX power 30dBm)	250	255	254	1000	mA
			Gam.18 (TX power 0dBm)	100	104	106	230	mA

* The application note "Very Low Power Consumption" (Reference: WA_DEV_GEN_APN_020-003) can be found on the Sierra Wireless website (under Developer section).

** Idle Mode consumption depends on the SIM card used. Some SIM cards respond faster than others, in which case the longer the response time is, the higher the consumption is. Idle Mode consumption will be higher if ON/~OFF pin is keeping at low voltage level. Please refer to Figure 31, "Power-ON Sequence (no PIN code activated)."

Note: TX means that the current peak is the RF transmission burst (Tx burst).

RX means that the current peak is the RF reception burst (Rx burst), in GSM mode only (worst case).

Refer to section 4 Consumption Measurement Procedure for more information regarding consumption measurement procedures.

3.3.3. Consumption Waveform Samples

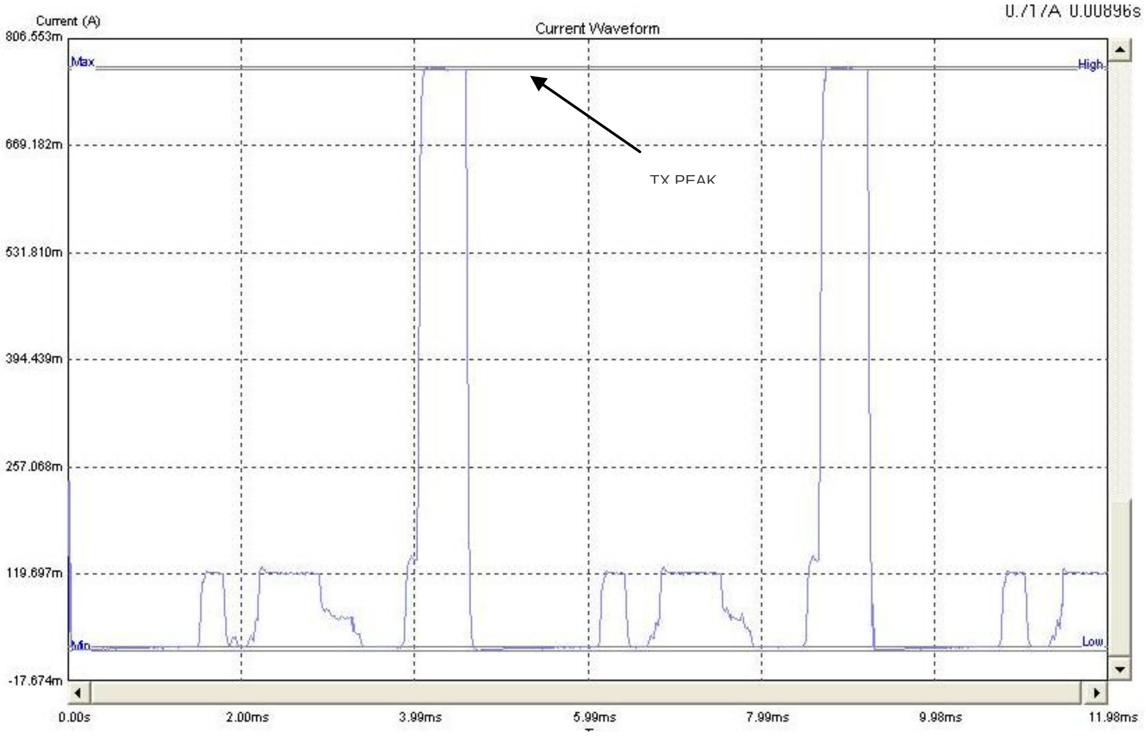
The consumption waveforms presented below have a typical VBATT voltage of 3.6V and are for an EGSM900 network configuration.

Four significant operating mode consumption waveforms are shown in the following subsections, namely:

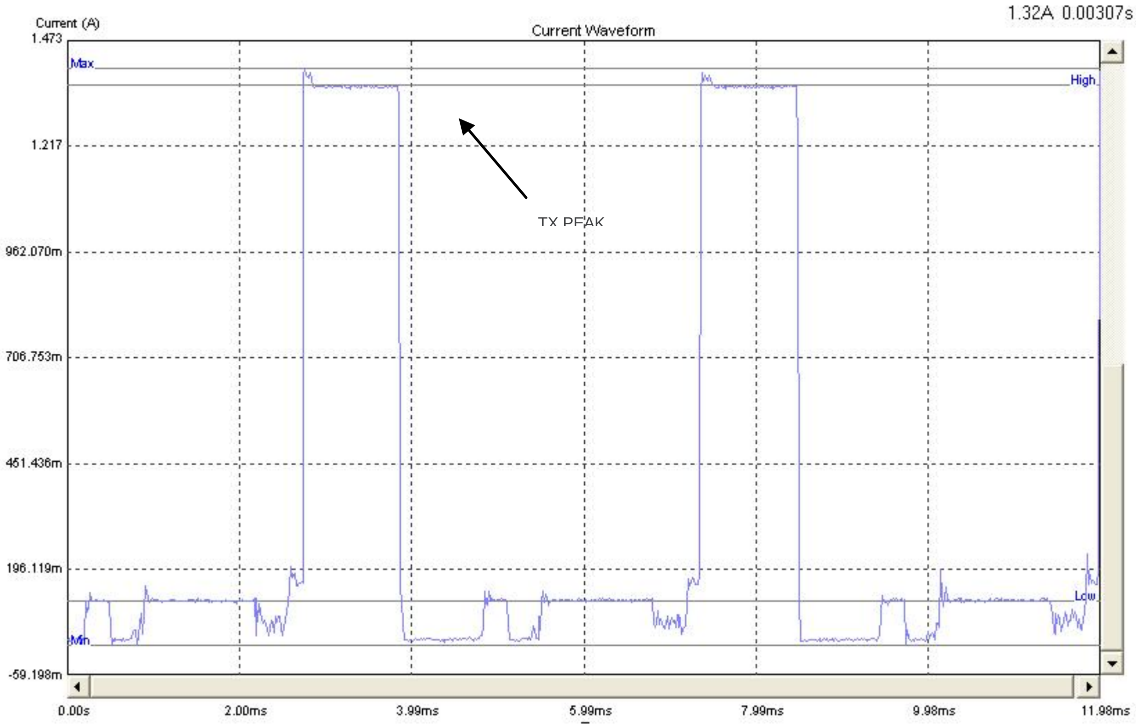
- Connected Mode (PCL5: Tx power 33dBm)
- Transfer mode (GPRS class 10, gam.3: Tx power 33dBm)
- Idle mode (Paging 2, ON/~OFF signal high impedance)
- Idle mode (Paging 9, ON/~OFF signal high impedance)

Note: The following diagrams only show the waveform of the current, and not the exact values.

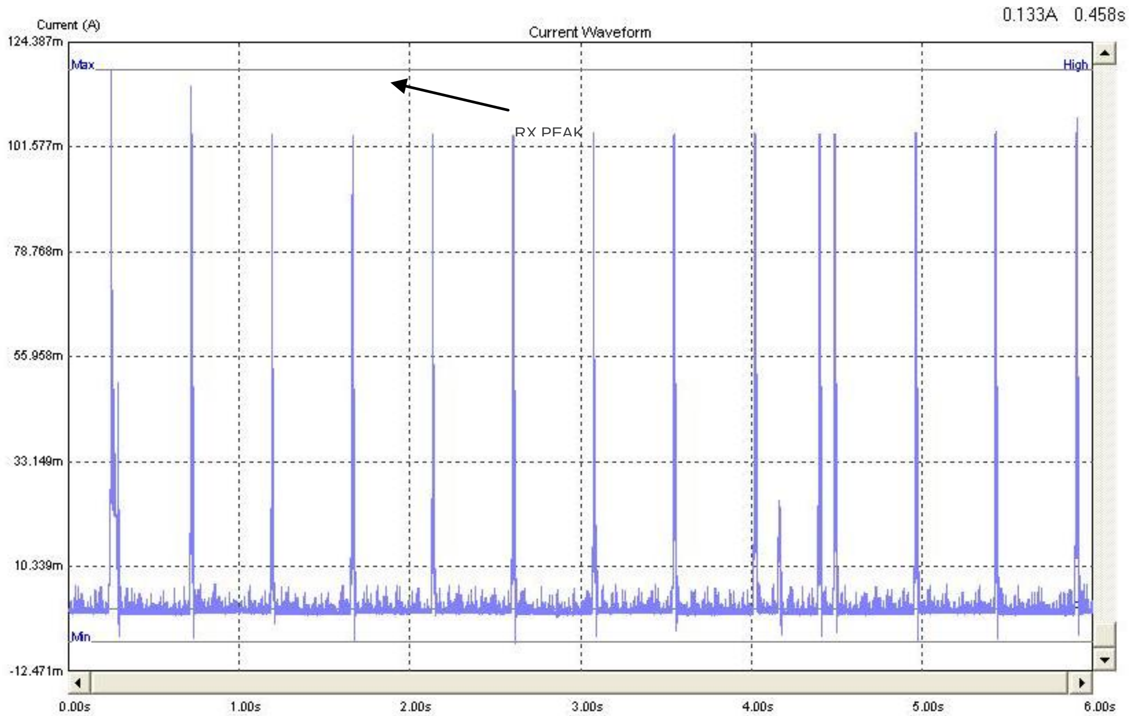
3.3.3.1. Connected Mode Current Waveform



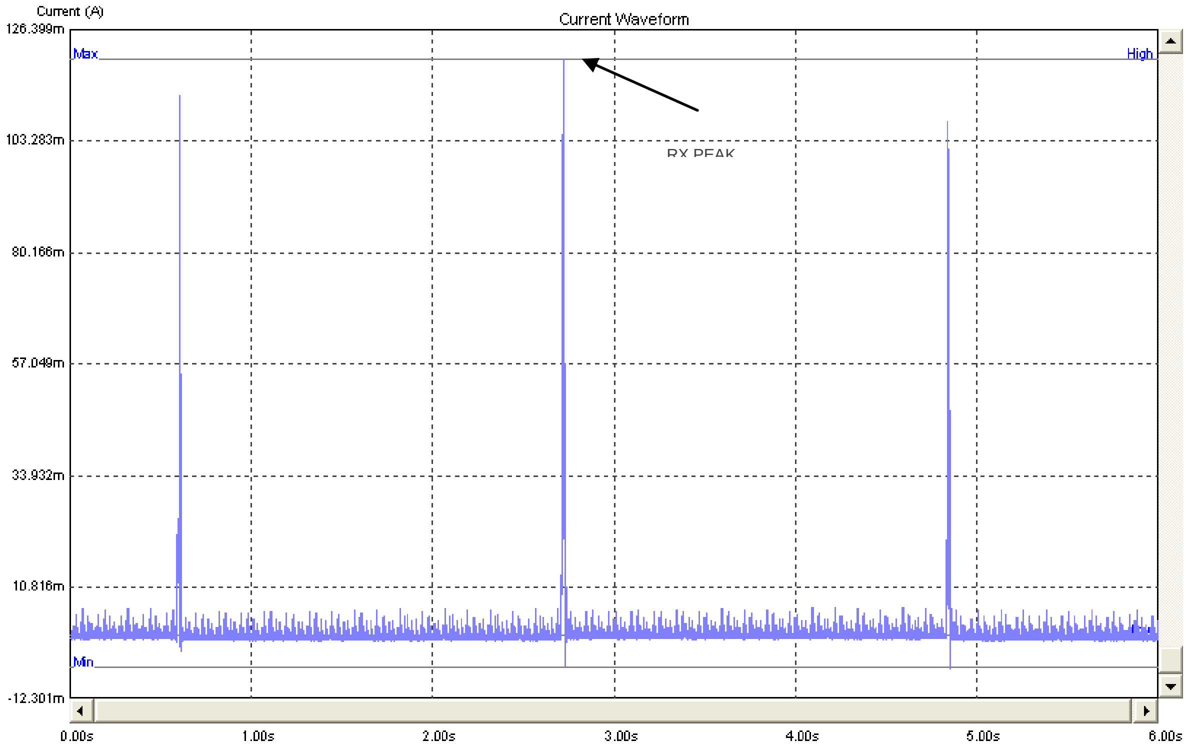
3.3.3.2. Transfer Mode Class 10 Current Waveform



3.3.3.3. Idle Mode Page 2 Current Waveform



3.3.3.4. Idle Mode Page 9 Current Waveform



3.3.4. Recommendations for Less Consumption

For better power consumption, in particular for the quiescent current, it is recommended to drive the GPIOs and ON/~OFF signal as shown in the table below.

Table 4: Consumption/Software Driver Recommendations

Pin #	Signal	I/O	I/O Type	Reset State	Recommended SW Driver (Logic Level Output State)
16	GPIO3	I/O	2V8	Pull up	1
19	GPIO5	I/O	2V8	Z**	Input: 0 Output: 1
24	GPIO1	I/O	2V8	Pull up	1
37	ON/~OFF	I	2V8	Pull up	High impedance

** When GPIO5 is used as a general purpose output, it is necessary to have an external pull up resistor connecting to a 2.8V source. The resistance value depends on the current drain required by the application side.

Caution: *GPIO2 is dedicated for WISMO_READY and is not open as a GPIO for customer use.*

GPIO4 is dedicated for TX burst indication and is not open as GPIO for customer use.

3.4. Electrical Information for Digital I/O

The following table describes the electrical characteristics of the digital I/Os (interfaces such as GPIO, SPI, etc.) available on the AirPrime WISMO228.

Table 5: Electrical Characteristics of Digital I/Os

2.8Volt Type (2V8)						
Parameter		**I/O Type**	**Minimum**	**Typical**	**Maximum**	**Conditions**
Internal 2.8V power supply		VCC_2V8	2.7V	2.8V	2.95V	
Input/Output Pin	V_{IL}	CMOS	-0.4V*	-	0.4V	
	V_{IH}	CMOS	2.4V	-	VCC_2V8 + 0.4V	
	V_{OL}	CMOS	-	-	0.1V	
	V_{OH}	CMOS	2.7V	-	-	
			2.4V	-	-	I_{OH} = 4mA

* Absolute maximum ratings

3.5. SPI Bus for Debug Trace ONLY

The AirPrime WISMO228 provides one SPI bus through the castellation pin.

Note: This interface is only used for monitoring trace for debug purposes.

3.5.1. Pin Description

The following table provides the pin description of the SPI bus.

Table 6: SPI Bus Pin Description

Pin #	Signal	I/O	I/O Type	Reset State	Description
13	SPI-IO	I/O	2V8	Pull down	SPI Serial Input/Output
14	SPI-O	O	2V8	Pull down	SPI Serial Output
15	SPI-CLK	O	2V8	Pull down	SPI Serial Clock
17	~SPI-CS	O	2V8	Pull up	SPI Enable
25	SPI-IRQ	I	2V8	Pull down	SPI Interrupt

An SPI-to-UART2 conversion circuit is required to convert the SPI trace to UART2. Also, the SPI-IRQ (pin 25) is required for interrupt. Again, note that the SPI interface of the AirPrime WISMO228 is not open for application use other than debug trace.

3.5.1.1. SPI Waveforms

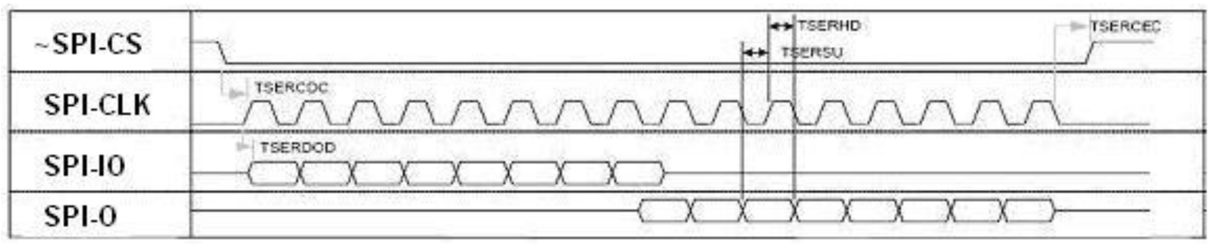


Figure 4. SPI Timing Diagram

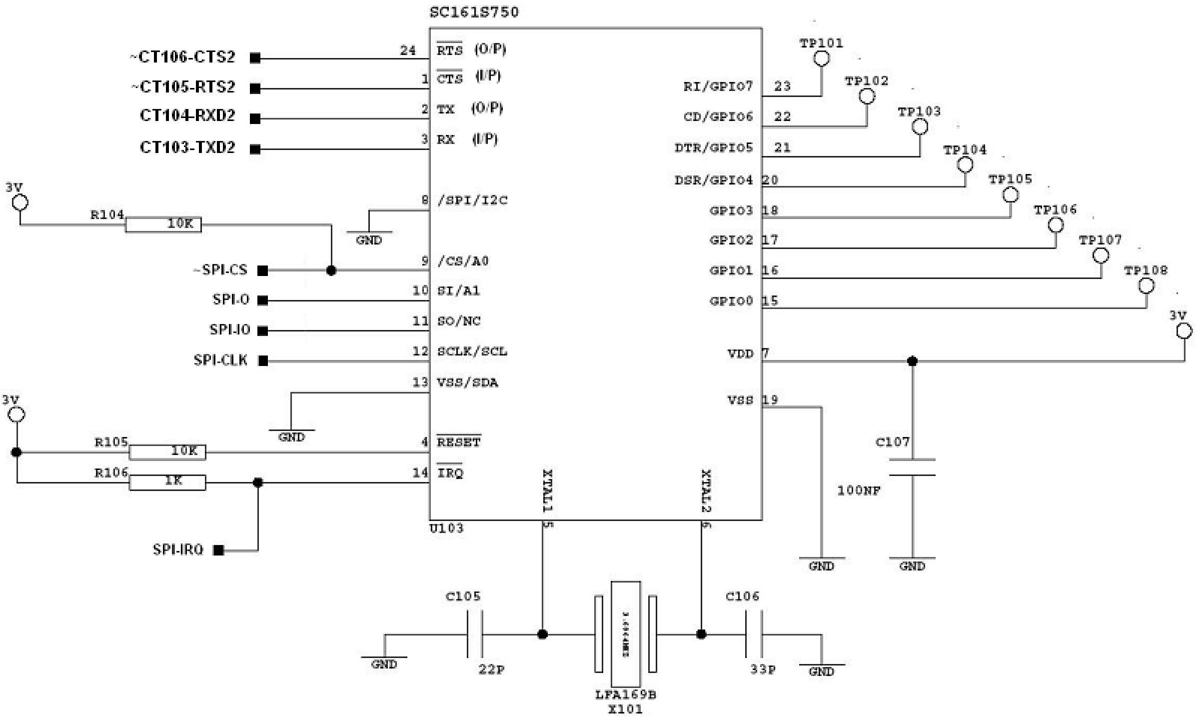


Figure 5. Example of an SPI to UART2 Interface Conversion Implementation

The following table lists the recommended components to use in implementing the SPI to UART2 interface.

Component	Description/Details	Manufacturer
U103	SC16IS750IPW	NXP Semiconductors
X101	3, 6864MHz 86SMX surface mount crystal (971-3131)	Farnell
R104, R105	10KΩ	
R106	1KΩ	
C105	22pF	
C106	33pF	
C107	100nF	

After converting the SPI signal to a UART signal, a UART transceiver circuitry is needed to communicate this UART signal to the DTE.

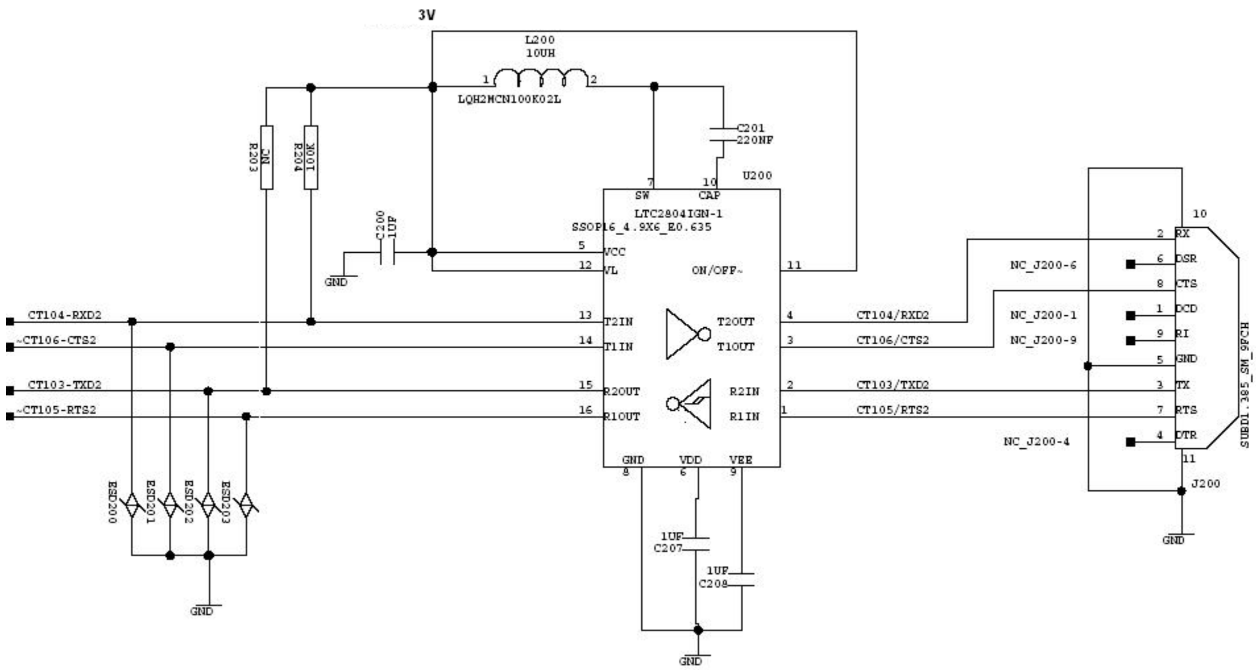


Figure 6. Example of an RS-232 Level Shifter Implementation for UART2

The following table lists the recommended components to use in implementing a UART transceiver circuitry.

Component	Description/Details	Manufacturer
U200	LTC2804IGN-1	LINEAR TECHNOLOGY
L200	LQH2M CN100K02L	MURATA
J200	096615276119 SUBD9F	HARTING
R202	NC	
R204	100KΩ	
C200	1µF	
C201	220nF	
C207	1µF	
C208	1µF	

Note: It is recommended to make SPI signals accessible for diagnostics by reserving some test points, for example.

3.6. Main Serial Link (UART)

A flexible 8-wire serial interface is available on the AirPrime WISMO228 that complies with the V24 protocol signaling, but not with the V28 (electrical interface) protocol, due to its 2.8V interface.

3.6.1. Features

The supported baud rates of the UART are 1200, 2400, 4800, 9600, 19200, 38400, 57600 and 115200 Kbits, with autobauding; and the signals used by the UART are:

- TX data (CT103/TXD)
- RX data (CT104/RXD)
- Request To Send (~CT105/RTS)
- Clear To Send (~CT106/CTS)
- Data Terminal Ready (~CT108/DTR)
- Data Set Ready (~CT107/DSR)
- Data Carrier Detect (~CT109/DCD)
- Ring Indicator (~CT125/RI).

3.6.2. Pin Description

The following table provides the pin descriptions of the UART interface.

Table 7: Main Serial Link Pin Description

Pin #	Signal*	I/O	I/O Type	Reset State	Description
38	CT103/TXD	I	2V8	1	Transmit serial data
39	~CT105/RTS	I	2V8	1	Request To Send
40	CT104/RXD	O	2V8	0	Receive serial data
41	~CT106/CTS	O	2V8	0	Clear To Send
42	~CT107/DSR	O	2V8	1	Data Set Ready
43	~CT109/DCD	O	2V8	1	Data Carrier Detect
44	~CT108/DTR	I	2V8	1	Data Terminal Ready
45	~CT125/RI	O	2V8	1	Ring Indicator
	GND		GND		Ground

* According to PC (DTE) view

The rising time and falling time of the reception signals (mainly CT103/TXD) have to be less than 300ns.

Tip: *The AirPrime WISMO228 is designed to operate using all the serial interface signals and it is recommended to use ~CT105/RTS and ~CT106/CTS for hardware flow control in order to avoid data corruption during transmissions.*

3.6.2.1. 5-wire Serial Interface Hardware Design

The signals used in this interface hardware design are as follows:

- CT103/TXD
- CT104/RXD
- ~CT105/RTS
- ~CT106/CTS
- -CT108/DTR

The signal ~CT108/DTR must be managed following the V24 protocol signaling if idle mode is to be used.

For a detailed configuration, refer to Figure 10 Example of V24/CMOS Serial Link Implementation for a 5-wire UART.

Note: All signals are specified according to PC (DTE) view.

3.6.2.2. 4-wire Serial Interface Hardware Design

The signals used in this interface hardware design are as follows:

- CT103/TXD
- CT104/RXD
- ~CT105/RTS
- ~CT106/CTS

The signal ~CT108/DTR can be looped back to ~CT107/DSR from both the AirPrime WISMO228 side and from the DTE side.

For a detailed configuration, refer to Figure 9 Example of V24/CMOS Serial Link Implementation for a 4-wire UART.

Note: All signals are specified according to PC (DTE) view.

3.6.2.3. 2-wire Serial Interface Hardware Design

Caution: *Although this case is possible for a connected external chip, it is not recommended.*

Note: All signals are specified according to PC (DTE) view.

The signals used in this interface hardware design are as follows:

- CT103/TXD
- CT104/RXD

Signals ~CT105/RTS and ~CT106/CTS are not used in this configuration. Configure the AT command **AT+IFC=0,0** to disable the flow control function on the AirPrime WISMO228. Refer to document [2] AirPrime WISMO228 AT Command Manual for more information about configuring AT commands.

Also,

- The signal ~CT108/DTR can be looped back to ~CT107/DSR from both the AirPrime WISMO228 side and from the DTE side.
- The signal ~CT105/RTS can be looped back to ~CT106/CTS from both the AirPrime WISMO228 side and from the DTE side.

- The flow control mechanism has to be managed from the customer side.

For a detailed configuration, refer to Figure 8 Example of V24/CMOS Serial Link Implementation for a 2-wire UART.

Note: *The loop back connection of ~CT108/DTR to ~CT107/DSR is not allowed when AT+PSSLEEP=0 is used, for which sleep mode entry is ~CT108/DTR level dependent. For more details, refer to the discussion about* ***AT + PSSLEEP = 0*** *in section 3.3.1 Various Operating Modes.*

In order to go to sleep mode properly under this configuration, AT+PSSLEEP=1 should be used instead. For more details, refer to the discussion about ***AT + PSSLEEP = 1*** *in section 3.3.1 Various Operating Modes.*

3.6.3. Application

The level shifter must be a V28 electrical signal compliant with 2.8V.

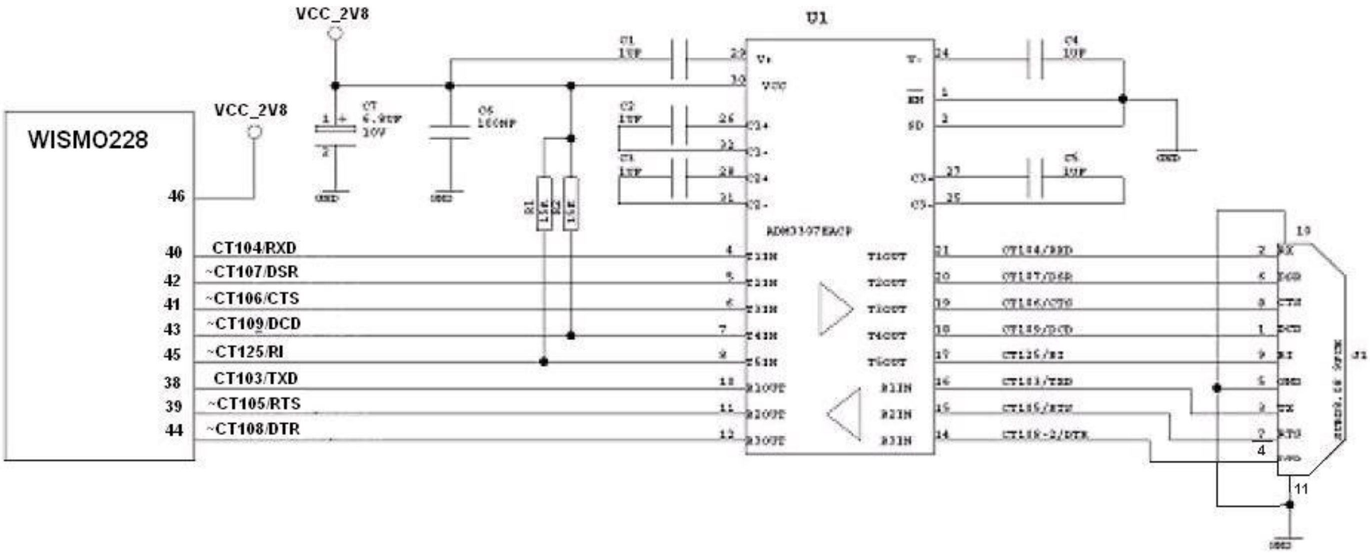


Figure 7. Example of RS-232 Level Shifter Implementation for UART

Note: *The U1 chip also protects the AirPrime WISMO228 against ESD (air discharge) at 15KV.*

The following table lists the recommended components to use in implementing a level shifter UART.

Table 8: Recommended Components

Component	Description/Details	Manufacturer
R1, R2	15KΩ	
C1, C2, C3, C4, C5	1µF	
C6	100nF	
C7	6.8uF TANTAL 10V CP32136	AVX
U1	ADM3307EACP	ANALOG DEVICES
J1	SUB-D9 female	

R1 and R2 are necessary only during the Reset state to force the ~CT125/RI and ~CT109/DCD signals to HIGH level.

The ADM3307EACP can be powered by the VCC_2V8 (pin 46) of the AirPrime WISMO228 or by an external regulator at 2.8V.

It is not necessary to use level shifters when the UART interface is directly connected to a host processor. Refer to the following sections for steps on how to connect the interface using other design implementations.

3.6.3.1. V24/CMOS Possible Design

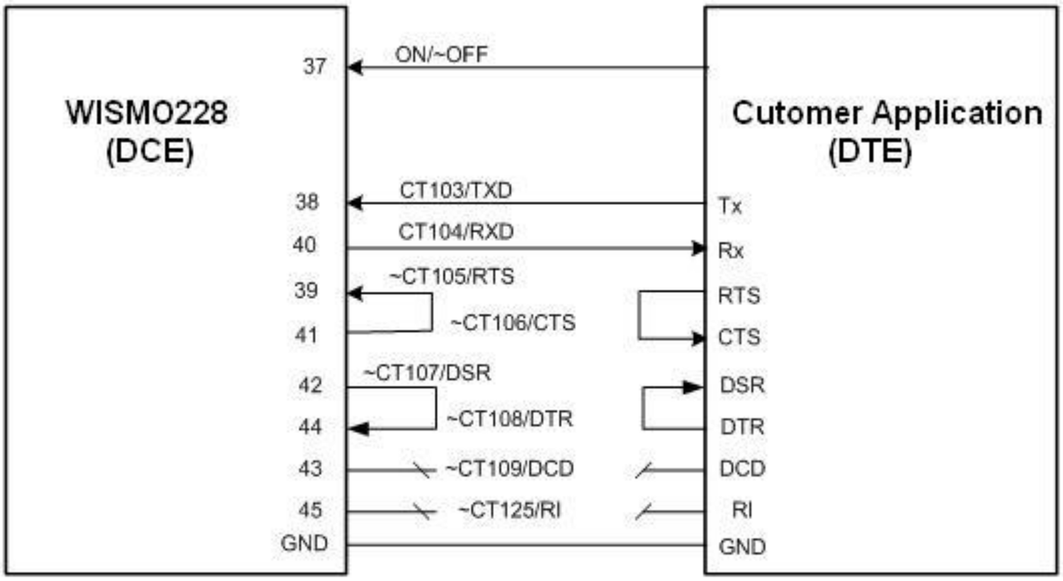


Figure 8. Example of V24/CMOS Serial Link Implementation for a 2-wire UART

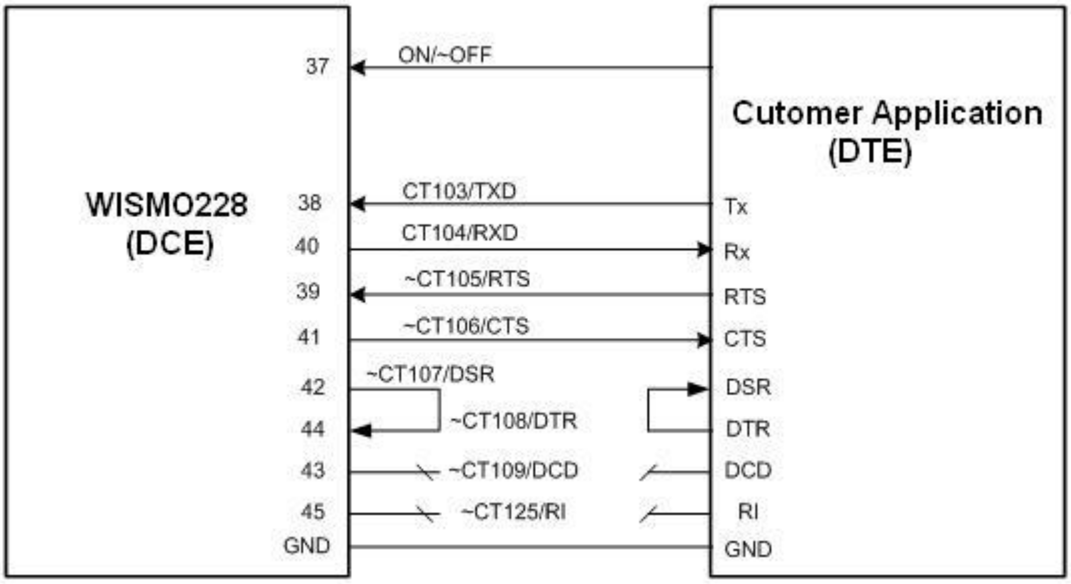


Figure 9. Example of V24/CMOS Serial Link Implementation for a 4-wire UART

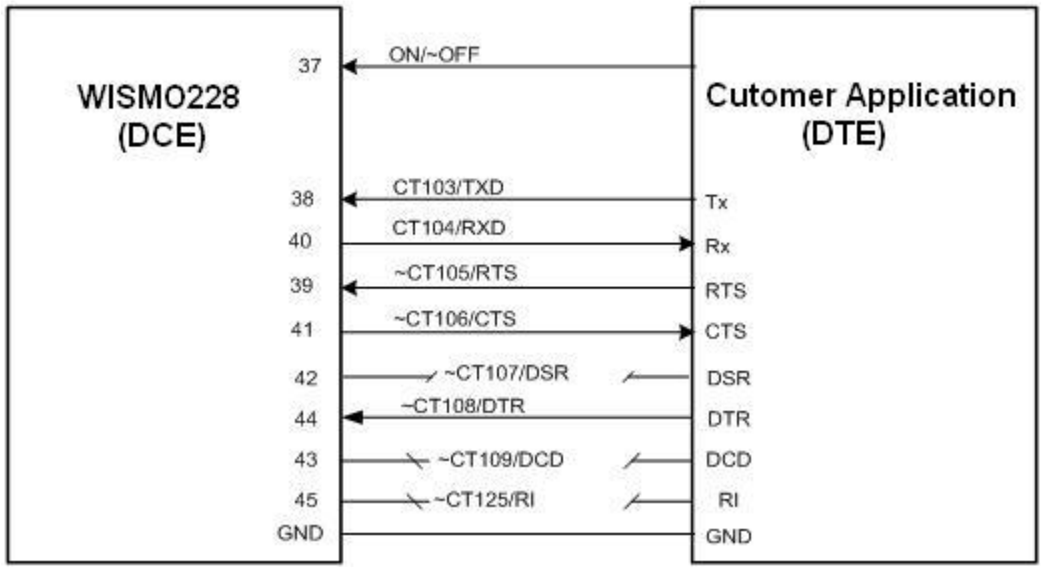


Figure 10. Example of V24/CMOS Serial Link Implementation for a 5-wire UART

The designs shown in Figure 8, Figure 9 and Figure 10 are basic designs. Both the DCD and the RI can be left open when not used.

However, a more flexible design to access this serial link with all modem signals is shown below.

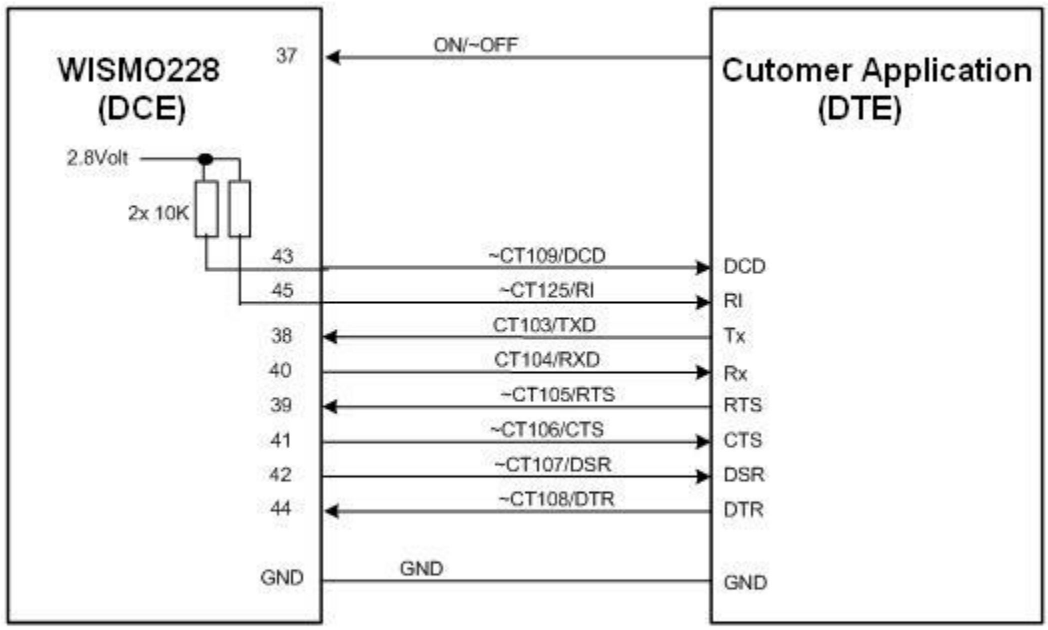


Figure 11. Example of a Full Modem V24/CMOS Serial Link Implementation for a full UART

An internal 10KΩ pull-up resistor is connected on both RI and DCD to set the signals to HIGH level during the Reset state.

The UART interface is a 2.8V type, but it is 3V tolerant.

Tip: *The AirPrime WISMO228 UART is designed to operate using all the serial interface signals. In particular, it is recommended to use ~CT105/RTS and ~CT106/CTS for hardware flow control in order to avoid data corruption during transmission.*

3.7. SIM Interface

The Subscriber Identification Module can be directly connected to the AirPrime WISMO228 through this dedicated interface.

3.7.1. Features

This interface controls both 1.8V and 3V SIM cards and is fully compliant with GSM 11.11 recommendations concerning SIM functions.

The SIM uses four signals, namely:

- SIM-VCC: SIM power supply
- ~SIM-RST: reset
- SIM-CLK: clock
- SIM-IO: I/O port

It is recommended to add Transient Voltage Suppressor (TVS) diodes on the signals connected to the SIM socket in order to prevent any Electrostatic Discharge. TVS diodes with low capacitance (less than 10pF) have to be connected on the SIM-CLK and SIM-IO signals to avoid any disturbance from the rising and falling edge of the signals. TVS diodes are mandatory for the Full Type Approval and they must be placed as close to the SIM socket as possible.

The recommended low capacitance diode array to use is the DALC208SC6 from ST Microelectronics.

3.7.2. Electrical Characteristics

The following table describes the electrical characteristics of the SIM interface.

Table 9: Electrical Characteristics of the SIM Interface

Parameters	Conditions	Minimum	Typical	Maximum	Unit
SIM-IO V_{IH}	$I_{IH} = \pm 20\mu A$	0.7xVSIM	-	-	V
SIM-IO V_{IL}	I_{IL} = 1mA	-	-	0.6* 0.36**	V
~SIM-RST, SIM-CLK V_{OH}	Source current = 20µA	0.9xVSIM	-	-	V
SIM-IO V_{OH}	Source current = 20µA	0.8xVSIM	-	-	V
~SIM-RST, SIM-IO, SIM-CLK V_{OL}	Sink current = -1mA	-	-	0.4* 0.3**	V
SIM-VCC Output Voltage	SIM-VCC = 2.9V	2.75	2.9	3.0	V
	SIM-VCC = 1.8V	1.65	1.8	1.95	V
SIM-VCC current	full-power mode	-	-	20	mA
	Sleep mode with 32kHz system clock enabled.	-	-	3	mA
SIM-CLK Rise/Fall Time	Loaded with 30pF and ESD protection diode	-	25	50	ns

Parameters	Conditions	Minimum	Typical	Maximum	Unit
~SIM-RST, Rise/Fall Time	Loaded with 30pF and ESD protection diode	-	45	-	ns
SIM-IO Rise/Fall Time	Loaded with 30pF and ESD protection diode	-	0.2	1	µs
SIM-CLK Frequency	Loaded with 30pF	-	-	3.25	MHz

* 2.9V SIM (Class B Electrical)

** 1.8V SIM (Class C Electrical)

Note: Sierra Wireless is compliant with ETSI TS 102 221 (version 2.0, release 8, June 2009).

3.7.3. Pin Description

The following table provides the pin description of the SIM interface.

Table 10: SIM Interface Pin Description

Pin #	Signal	I/O	I/O Type	Reset State	Description	Multiplexed
8	SIM-VCC	O	2V9 / 1V8		SIM Power Supply	No
9	SIM-CLK	O	2V9 / 1V8	0	SIM Clock	No
10	SIM-IO	I/O	2V9 / 1V8	Pull up	SIM Data	No
11	~SIM-RST	O	2V9 / 1V8	0	SIM Reset	No

3.7.4. Application

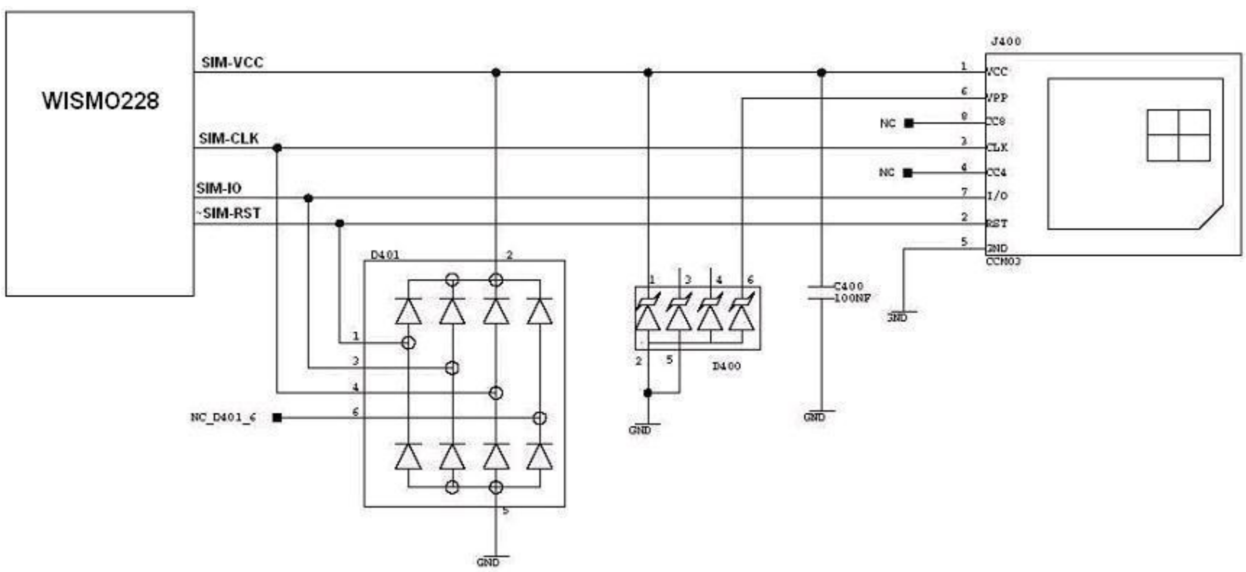


Figure 12. Example of a SIM Socket Implementation

The following table lists the recommended components to use in implementing the SIM socket.

Table 11: Recommended Components

Component	Description/Details	Manufacturer
C400	100nF	
D400	ESDA6V1SC6	ST
D401	DALC208SC6	SGS-THOMSON
J400	ITT CANNON CCM03 series (Refer to the SIM Card Reader sub-section of section 6 Recommended Peripheral Devices for more information)	CANNON

3.7.4.1. SIM Socket Connection

The following table provides the pin description of the SIM socket.

Table 12: SIM Socket Pin Description

Pin #	Signal	Description
1	VCC	SIM-VCC
2	RST	~SIM-RST
3	CLK	SIM-CLK
4	CC4	Not connected
5	GND	GROUND
6	VPP	Not connected
7	I/O	SIM-IO
8	CC8	Not connected

Note: CC4 and CC8 are not connected as the AirPrime WISMO228 does not support the SIM detect feature.

3.8. General Purpose Input/Output

The AirPrime WISMO228 provides up to three General Purpose I/Os. They are used to control any external device such as an LCD or a Keyboard backlight.

These GPIOs offer the possibility to read the pin state whatever their direction may be.

3.8.1. Pin Description

The following table provides the pin description of the GPIOs.

Table 13: GPIO Pin Descriptions

Pin #	Signal	I/O	I/O Type	Reset State
16	GPIO3	I/O	2V8	Pull up
19	GPIO5	I/O	2V8	Pull down
24	GPIO1	I/O	2V8	Pull up

When GPIO5 is used as a general purpose output, it is necessary to have an external pull up resistor connected to a 2.8V source. The resistance value will depend on the current drain required by the application.

Caution: *GPIO is dedicated for WISMO_READY and is not open as GPIO for customer use.*

GPIO4 is dedicated for TX burst indication and is not open as GPIO for customer use.

3.9. Analog to Digital Converter

One Analog to Digital Converter input, AUX-ADC0, is provided by the AirPrime WISMO228 for customer applications. It is a 10-bit resolution converter, ranging from either 0 to 1V or 0 to 3V, depending on the general purpose input mode.

3.9.1. Electrical Characteristics

The following table describes the electrical characteristics of the ADC interface.

Parameters		Minimum	Typical	Maximum	Unit
Resolution		-	10	-	bits
Sampling frequency		-	-	200	kHz
Input signal range	1 general purpose input	0	-	1	V
	1 general purpose input in div-by-3 mode	0	-	3	V
Integral non-linearity (INL)		-2.5	-	+2.5	bit
Differential non-linearity (DNL)		-1	-	+3	bit
Input impedance	input resistance	120	-	-	KΩ
	input capacitance	-	-	10	pF

3.9.2. Pin Description

The following table provides the pin description of the Analog to Digital Converter interface.

Table 14: Analog to Digital Converter Pin Description

Pin #	Signal	I/O	I/O Type	Description
5	AUX-ADC0	I	Analog	A/D converter

Tip: *The AUX-ADC0 pin is ESD sensitive and it is a must to add ESD protection to this pin once it is externally accessible. The recommended ESD protection to use is the AVL5M02200 from Amotech.*

3.10. Analog Audio Interface

The AirPrime WISMO228 supports one microphone input and one speaker output. It also includes an echo cancellation feature which allows hands free function.

In some cases, ESD protection must be added on the audio interface lines.

3.10.1. Microphone Features

The microphone, MIC, can have either a single-ended or a differential connection. However, it is strongly recommended to use a differential connection instead of a single-ended connection in order to reject common mode noise and TDMA noise.

When using a single-ended connection, be sure to have a very good ground plane, very good filtering as well as shielding in order to avoid any disturbance on the audio path.

The gain of MIC inputs is internally adjusted and can be tuned using AT commands.

The MIC interface already includes suitable biasing for an electret microphone. The electret microphone can be connected directly on the inputs for easy connection.

AC coupling is also already embedded in the AirPrime WISMO228.

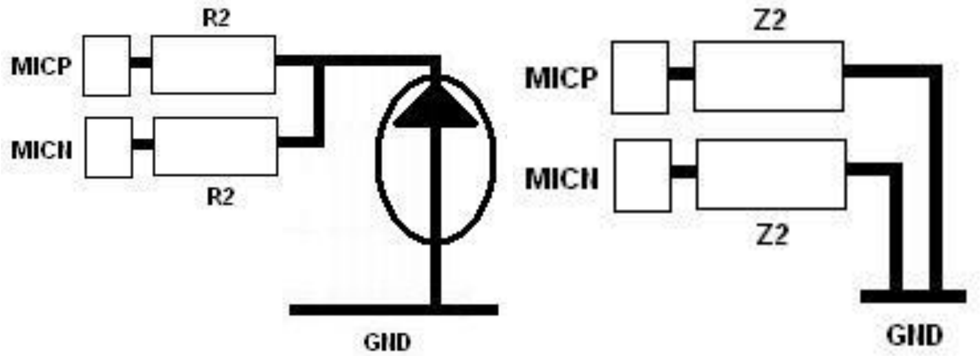


Figure 13. DC and AC Equivalent Circuits of MIC

3.10.1.1. Electrical Characteristics

The following table describes the electrical characteristics of the audio interface, MIC.

Table 15: Electrical Characteristics of MIC

<table>
<tr><th colspan="2">Parameters</th><th>Minimum</th><th>Typical</th><th>Maximum</th><th>Unit</th></tr>
<tr><td rowspan="5">Internal biasing
DC Characteristics</td><td>MICP</td><td>-</td><td>2.4</td><td>-</td><td>V</td></tr>
<tr><td>MICN without 2.2KΩ to GND</td><td>-</td><td>2.4</td><td>-</td><td>V</td></tr>
<tr><td>MICN with 2.2KΩ to GND</td><td>-</td><td>1.2</td><td>-</td><td>V</td></tr>
<tr><td>Output current</td><td></td><td></td><td></td><td>mA</td></tr>
<tr><td>R2</td><td>-</td><td>2.2</td><td>-</td><td>KΩ</td></tr>
<tr><td rowspan="3">AC Characteristics
200 Hz<F<4 kHz</td><td>Z2 MICP (MICN=Open)</td><td rowspan="2"></td><td rowspan="2">2.2</td><td rowspan="2"></td><td rowspan="3">KΩ</td></tr>
<tr><td>Z2 MICN (MICP=Open)</td></tr>
<tr><td>Z2 MICP (MICN=GND)</td><td></td><td>2.2</td><td></td></tr>
</table>

Parameters		Minimum	Typical	Maximum	Unit
	Z2 MICN (MICP=GND)				
	Impedance between MICP and MICN without 2.2KΩ to GND		4.5		
	Impedance between MICP and MICN with 2.2KΩ to GND		3.2		
Maximum working voltage (MICP-MICN) (THD 10%)	AT+VGT*=1	-	-	210	mVpp
Maximum rating voltage (MICP or MICN)		-0.5	-	4.4	V

* The input voltage depends on the input micro gain set by the AT command. Refer to document [2] AirPrime WISMO228 AT Command Manual for more information about AT commands.

Note: Because both MICP and MICN are internally biased, it is necessary to use a coupling capacitor to connect an audio signal provided by an active generator. Only a passive microphone can be directly connected to the MICP input.

3.10.2. Speaker Features

The speaker, SPK, can either have a single-ended or a differential connection. However, it is strongly recommended to use a differential connection instead of a single-ended connection in order to reject common mode noise and TDMA noise. Moreover, in a single-ended connection, half (1/2) of the power is lost.

When using a single-ended connection, be sure to have a very good ground plane, very good filtering as well as shielding in order to avoid any disturbance on the audio path.

Table 16: Speaker Details

Parameters	Typical	Unit	Connection
Z (SPKP, SPKN)	16 or 32	Ω	Differential
Z (SPKP, SPKN)	8	Ω	Single-ended

3.10.2.1. Speakers Outputs Power

Note that the maximum values specified in the following table are available with the maximum power output configuration values set by an AT command; but using the typical values is recommended.

3.10.2.1.1. SPK Outputs

The SPK interface allows for both differential and single ended speaker connections.

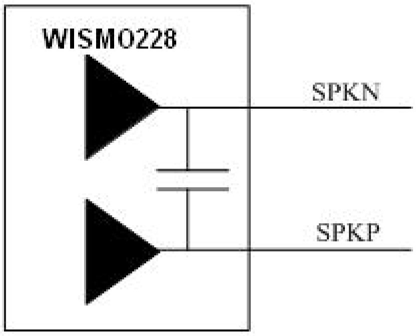


Figure 14. Equivalent Circuit of SPK

Table 17: Electrical Characteristics of SPK

Parameters		Minimum	Typical	Maximum	Unit
Biasing voltage	SPKP and SPKN	-	1.4	-	V
Output swing voltage	RL=8Ω: AT+VGR=6*; single ended	-	-	1	Vpp
	RL=8Ω: AT+VGR=6*; differential	-	-	2	Vpp
	RL=16Ω or 32Ω: AT+VGR=6*; single ended	-	-	1.1	Vpp
	RL=16Ω or 32Ω: AT+VGR=6*; differential	-	-	2.2	Vpp
RL	Load resistance	6	8	-	Ω
IOUT	Output current; peak value; RL=8Ω	-	-	90	mA
POUT	RL=8Ω; AT+VGR=10*;	-	-	65	mW

* The output voltage depends on the output speaker gain set by the AT command. Refer to document [2] AirPrime WISMO228 AT Command Manual for more information about configuring AT commands.

If a single-ended connection is used, only SPKP has to be connected. The result is a maximal output power divided by 2.

3.10.3. Pin Description

The following table provides the pin description of the analog audio interface.

Table 18: Analog Audio Interface Pin Description

Pin #	Signal	I/O	I/O Type	Description
1	SPKP	O	Analog	Speaker positive output
2	SPKN	O	Analog	Speaker negative output
3	MICP	I	Analog	Microphone positive input
4	MICN	I	Analog	Microphone negative input

3.10.4. Application

3.10.4.1. Microphone

The following sub-sections describe the different microphone configuration examples.

3.10.4.1.1. Differential Connection

When a differential connection of MIC is used, it is necessary to add a 2.2KΩ resistor from MICN to GND in order to have a proper bias of the microphone.

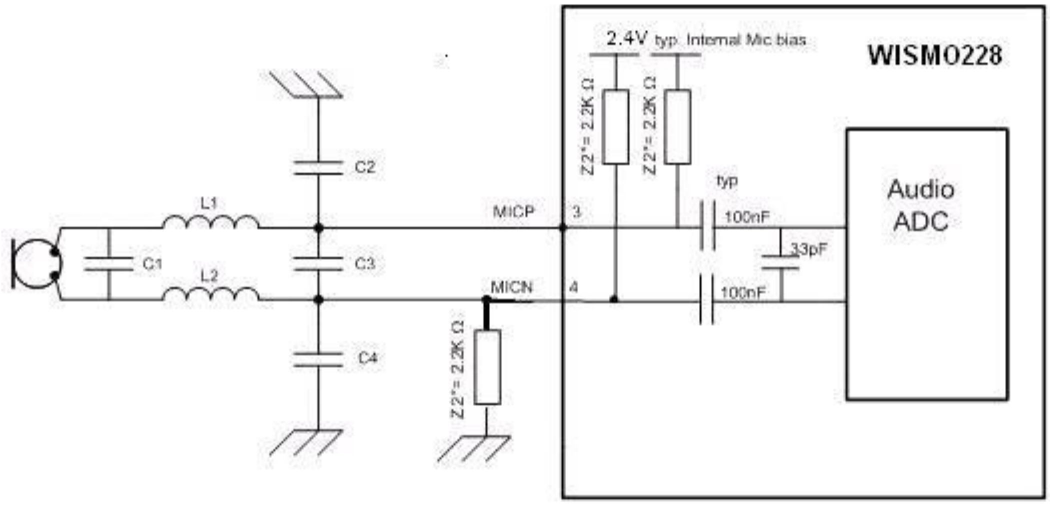


Figure 15. Example of a Differential MIC Connection with an LC Filter

Audio quality can be very good without L1, L2, C2, C3 and C4 depending on the design. But if there is EMI perturbation, this filter can reduce the TDMA noise. This filter (L1, L2, C2, C3 and C4) is not mandatory, and if not used, the capacitor must be removed and the coil replaced by a 0Ω resistor as shown in the following schematic.

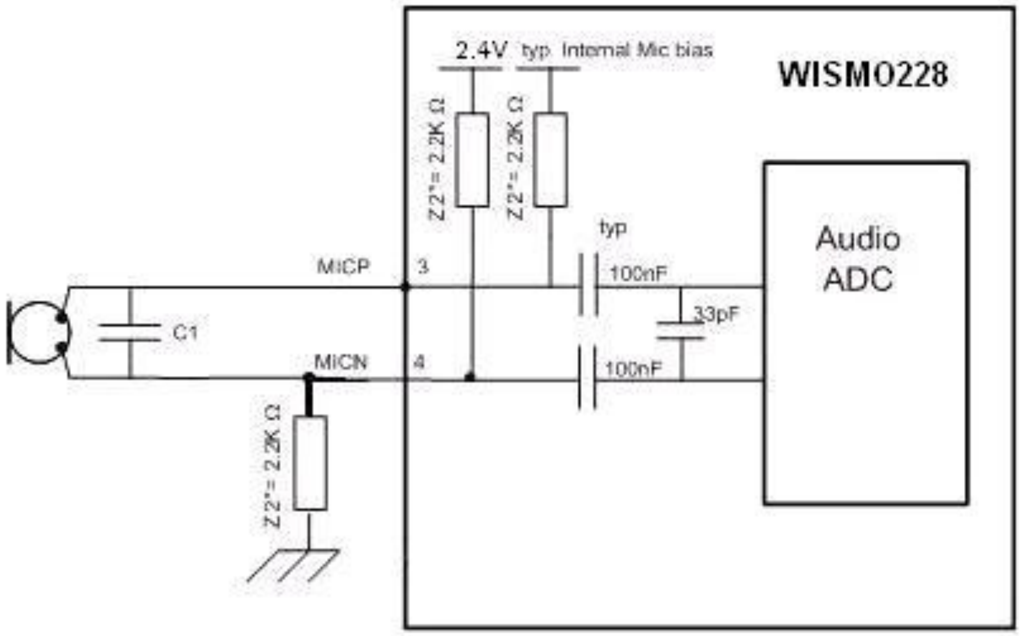


Figure 16. Example of a Differential MIC Connection without an LC Filter

The capacitor C1 is highly recommended to eliminate TDMA noise and must be close to the microphone.

The following table lists the recommended components to use in implementing a differential MIC connection without an LC filter.

Component	Description/Details	Notes
C1	12pF to 33pF	needs to be tuned depending on the design
C2, C3, C4	47pF	needs to be tuned depending on the design
L1, L2	100nH	needs to be tuned depending on the design

3.10.4.1.2. Single-Ended Connection

When single-ended connection is used for MIC, MICN is just left open.

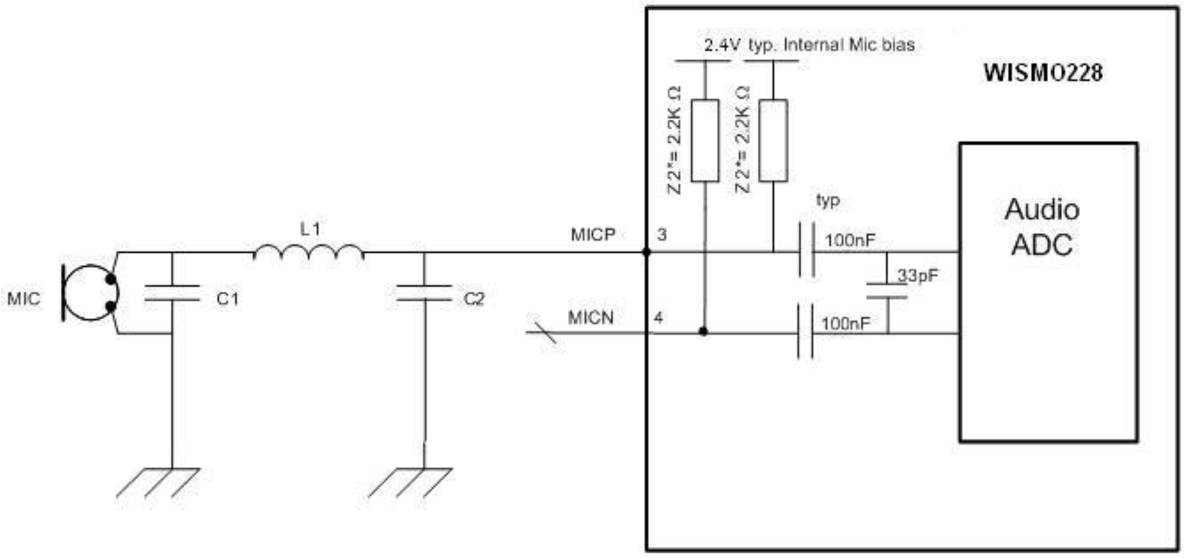


Figure 17. Example of a Single-Ended MIC Connection with an LC filter

Note: Z2 is from 200Hz to 4kHz. For more details, refer to Table 15: Electrical Characteristics of MIC.

When using a single-ended connection, bear in mind that:

- The internal input impedance value becomes 1100Ω, due to the connection of the other end to ground.
- The single ended design is very sensitive to TDMA noise.
- A very good grounding on the MIC is a must in order to ensure good audio performance against TDMA. Also, special care on the PCB layout must be taken.
- It is recommended to add L1 and C2 footprints as an LC filter to try to eliminate TDMA noise.
- When not used, the filter can be removed by replacing L1 with a 0Ω resistor and by disconnecting C2, as shown in the following schematic.

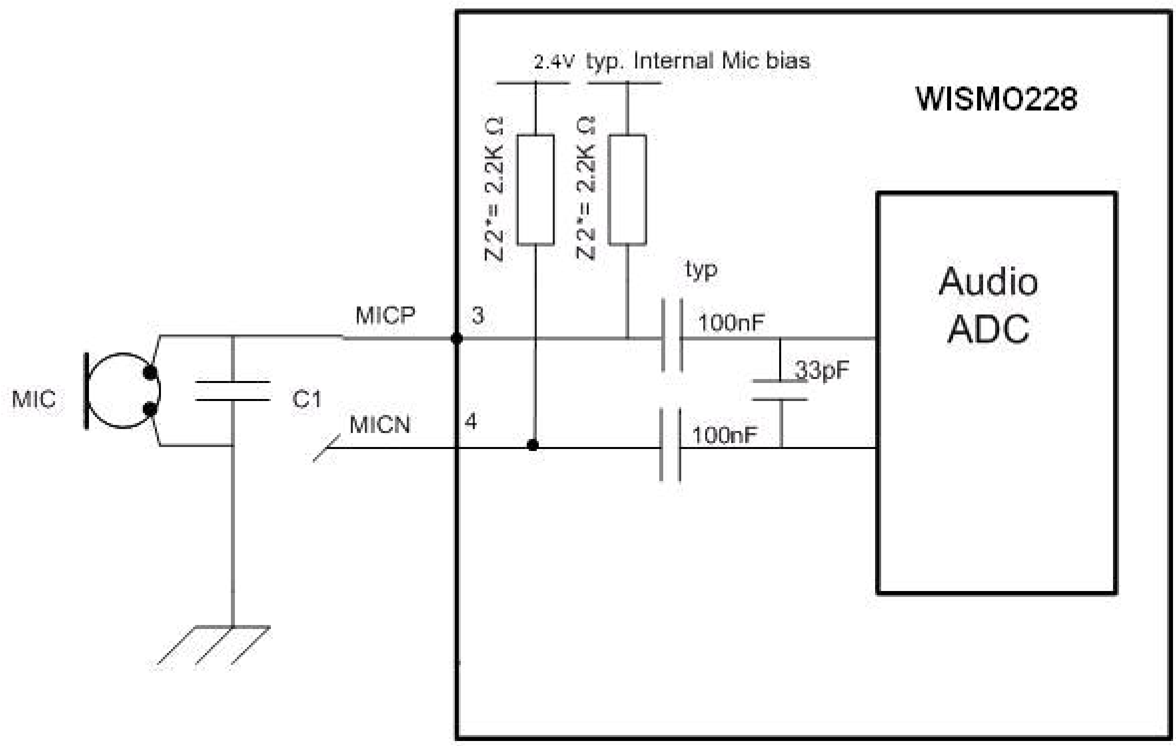


Figure 18. Example of a Single-Ended MIC Connection without an LC Filter

*Note: *Z2 is from 200Hz to 4kHz. For more details, refer to Table 15: Electrical Characteristics of MIC.*

The capacitor C1 is highly recommended to eliminate TDMA noise and must be close to the microphone.

The following table lists the recommended components to use in implementing a single-ended MIC connection without an LC filter.

Component	Description/Details	Notes
C1	12pF to 33pF	needs to be tuned depending on the design
C2		needs to be tuned depending on the design
L1		needs to be tuned depending on the design

3.10.4.2. Speaker SPKP ad SPKN

3.10.4.2.1. Differential Connection

In a differential connection, simply connect both SPKP and SPKN to the speaker.

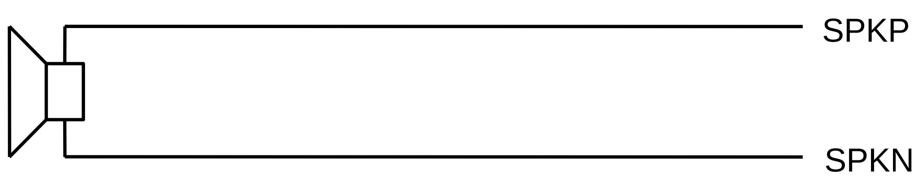


Figure 19. Example of a Differential Speaker Connection

3.10.4.2.2. Single-Ended Connection

In a single-ended connection, SPKN can be left open. Refer to the following diagram for a typical single-ended implementation.

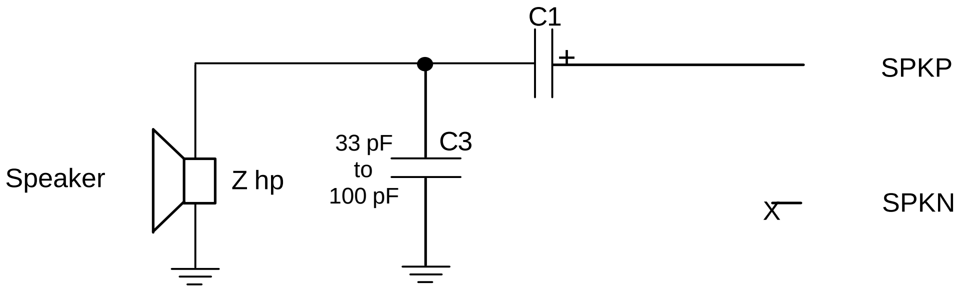


Figure 20. Example of a Single-Ended Speaker Connection

Note: 4.7µF < C1 < 47 µF (Depending on speaker characteristics and output power.)

When using a single-ended connection, bear in mind that:

- Using a single-ended connection includes losing output power (-6dB) as compared to a differential connection.
- The connection between the AirPrime WISMO228 pins and the speaker must be designed to keep the serial impedance lower than 1.5Ω.

3.10.5. Design Recommendations

3.10.5.1. General

When both speaker and microphone are exposed to the external environment, it is recommended to add ESD protection as close to the speaker or microphone as possible, connected between the audio lines and a good ground.

When using the single-ended connection of MICP, ensure to have a good ground plane, good filtering as well as shielding, in order to avoid any disturbance on the audio path.

It is also important to select an appropriate microphone, speaker and filtering components to avoid TDMA noise.

3.10.5.2. Recommended Microphone Characteristics

- The impedance of the microphone has to be around 2KΩ
- Sensitivity is from -40dB to -50dB
- SNR > 50dB
- Frequency response is compatible with GSM specifications

To suppress TDMA noise, it is highly recommended to use microphones with two internal decoupling capacitors:

- CM1=56pF (0402 package) for the TDMA noise coming from the demodulation of the GSM850/EGSM900 frequency signals
- CM2=15pF (0402 package) for the TDMA noise coming from the demodulation of the DCS1800/PCS1900 frequency signals

The capacitors have to be soldered in parallel to the microphone as shown in the figure below.

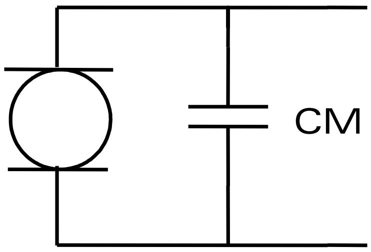


Figure 21. Capacitor Soldered in Parallel to the Microphone

3.10.5.3. Recommended Speaker Characteristics

- Type of speakers: Electro-magnetic /10mW
- Impedance: 8Ω for hands-free
- Impedance: 32Ω for heads kit
- Sensitivity: 110dB SPL min
- Receiver frequency response is compatible with GSM specifications.

3.10.5.4. Recommended Filtering Components

When designing a GSM application, it is important to select the right audio filtering components.

The strongest noise, called TDMA, is mainly due to the demodulation of the GSM850, EGSM900, DCS1800 and PCS1900 signals, where a burst is produced every 4.615ms; and the frequency of the TDMA signal is equal to 216.7Hz plus harmonics.

TDMA noise can be suppressed by filtering the RF signal using the appropriate decoupling components.

The types of filtering components are:

- RF decoupling inductors
- RF decoupling capacitors

A good “Chip S-Parameter” simulator is available from Murata. Refer to http://www.murata.com/products/design_support/mcsil/index.html for more details.

Using different Murata components, it can be seen that different packages (with different values and ratings) can have different coupling effects. Refer to the following table for examples using different Murata components.

Table 19: Murata Examples

Package	**0402**		
Filtered band	GSM900	GSM850/900	DCS/PCS
Value	100nH	56pF	15pF
Types	Inductor	Capacitor	Capacitor
Position	Serial	Shunt	Shunt
Manufacturer	Murata	Murata	Murata
Rated	150mA	50V	50V
Reference	LQG15HSR10J02 or LQG15HNR10J02	GRM1555C1H560JZ01	GRM1555C1H150JZ01 or GRM1555C1H150JB01
Package	**0603**		
Filtered band	GSM900	GSM850/900	DCS/PCS
Value	100nH	47pF	10pF
Types	Inductor	Capacitor	Capacitor
Position	Serial	Shunt	Shunt
Manufacturer	Murata	Murata	Murata
Rated	300mA	50V	50V
Reference	LQG18HNR10J00	GRM1885C1H470JA01 or GRM1885C1H470JB01	GRM1885C1H150JA01 or GQM1885C1H150JB01

3.10.5.5. Audio Track and PCB Layout Recommendation

To avoid TDMA noise, it is recommended to surround the audio tracks with ground as shown in the following figure.

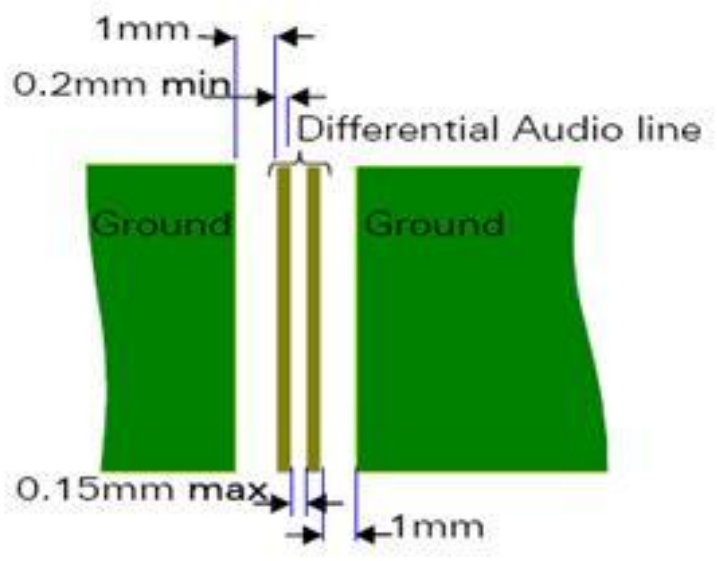


Figure 22. Audio Track Design

For differential connections, it is necessary to add a 2.2KΩ resistor from MICN to GND to have a proper bias of the microphone.

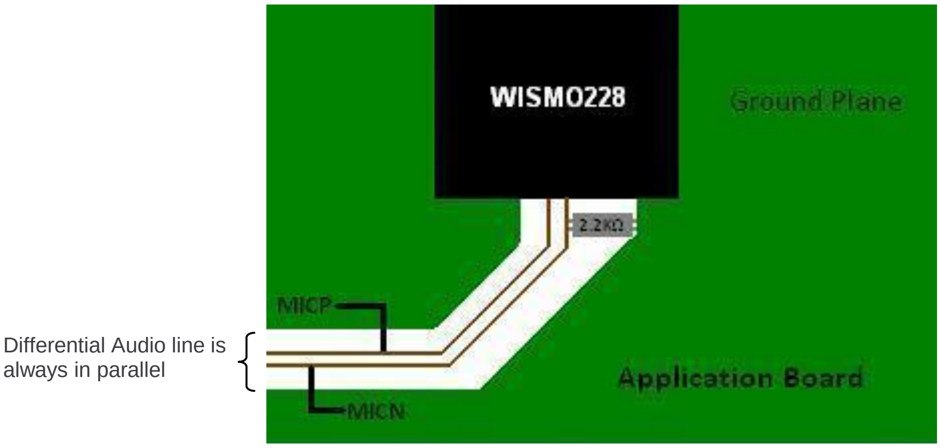


Figure 23. Differential Audio Connection

For single-ended connections, the negative pole of the microphone, MICN, should be connected to GND.

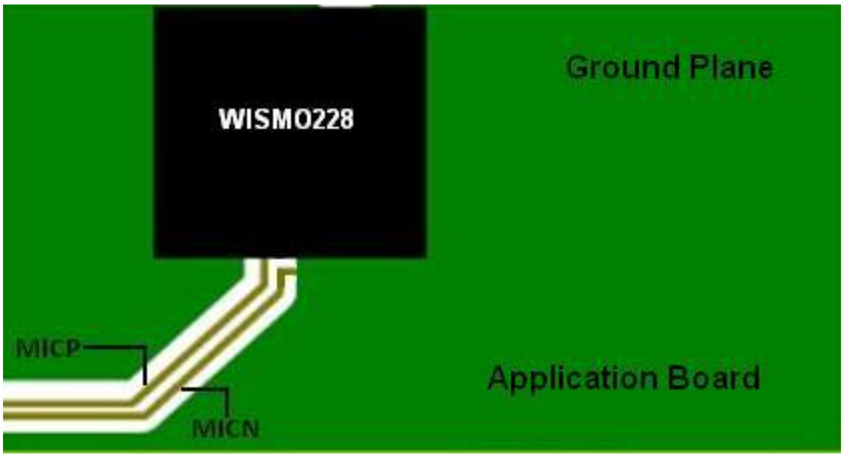


Figure 24. Single-Ended Audio Connection

Caution: *It is a must to avoid digital tracks crossing under and over the audio tracks.*

Even when MICP is singled-ended, it is highly recommended to have the MIC ground and the LC filter ground to act as an audio analog ground during the PCB layout. This audio ground, together with the MICP signal, should act as the differential line pair. And this audio ground should only be connected to the AirPrime WISMO228 embedded module ground as close as possible to the castellation GND pin of the AirPrime WISMO228.

The same case is applicable to SPKP and SPKN.

Also, the audio interface is ESD sensitive. It is a must to add ESD protection to the interface once it is externally accessible. The recommended ESD protection is the ESDA6VIL from ST.

3.11. Pulse-Width Modulators (PWMs)

The AirPrime WISMO228 contains two Pulse-Width Modulators (PWMs) that can be used in conjunction with an external transistor for driving a vibrator, or a backlight LED.

3.11.1. Features

Each PWM uses two 7-bit unsigned binary numbers: one for the output period and one for the pulse width or the duty cycle.

The relative timing for the PWM output is shown in the figure below.

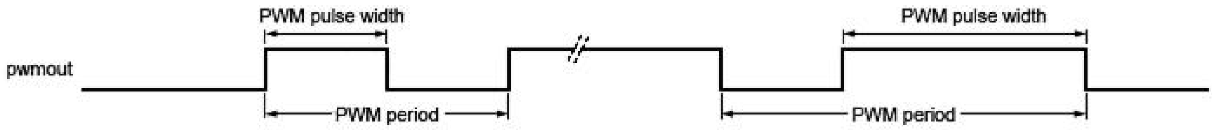


Figure 25. Relative Timing for the PWM Output

The following table describes the electrical characteristics of the PWM interface.

Table 20: Electrical Characteristics of the PWM Interface

Parameters	Conditions	Minimum	Typical	Maximum	Unit
V_{OH}	High impedance load	2.7	2.85	-	V
	Load with I_{oH} = 4mA	-	2.4	-	V
V_{OL}	-	-	-	0.1	V
I_{PEAK}	-	-	-	4	mA
Frequency	-	25.6	-	1083.3	kHz
Duty cycle	-	0*	-	100*	%

3.11.2. Pin Description

The following table provides the pin description of the Pulse-Width Modulators.

Table 21: PWM Pin Description

Pin #	Signal	I/O	I/O Type	Description
35	PWM1	O	2V8	PWM output
36	PWM0	O	2V8	PWM output

3.11.3. Application

Both the PWM0 and PWM1 signals can be used in conjunction with an external transistor for driving a vibrator, or a backlight LED.

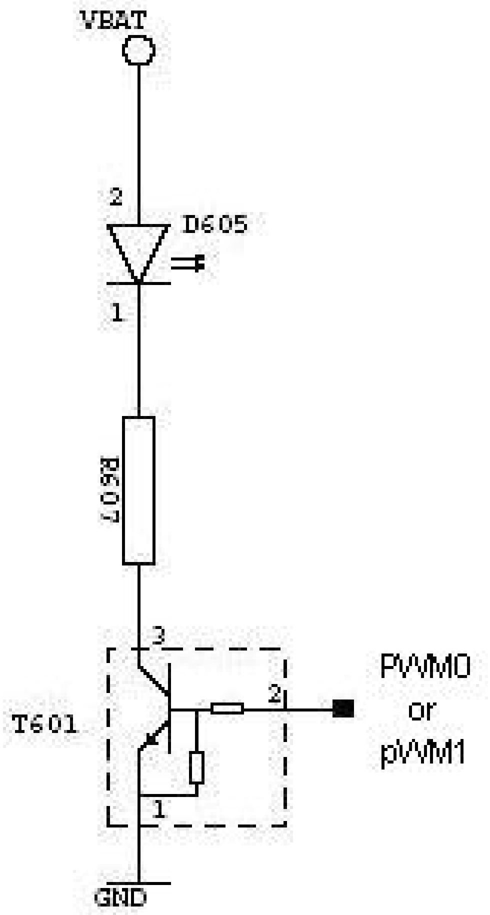


Figure 26. Example of an LED Driven by the PWM0 or PWM1 Output

The value of R607can be harmonized depending on the LED (D605) characteristics.

The recommended digital transistor to use for T601 is the DTC144EE from ROHM.

3.12. BUZZER Output

The BUZZER signal outputs a square wave at the desired tone frequency. The tone frequencies are programmable and can be re-programmed on-the-fly to generate monophonic audio ringtones or alert tones. The tone level can also be adjusted in 4dB steps, or muted

3.12.1. Features

The signal BUZZER can be used in conjunction with an external transistor/MOSFET for driving a buzzer in order to give a maximum current of 100mA (PEAK) and an average of 40mA, depending on application requirement.

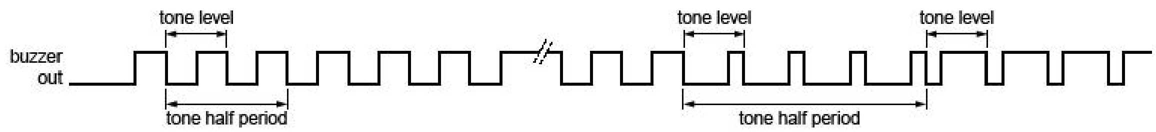


Figure 27. BUZZER Output

The following table describes the electrical characteristics of the BUZZER signal.

Table 22: Electrical Characteristics of the BUZZER Signal

Parameters	Conditions	Minimum	Typical	Maximum	Unit
V_{OH}	High impedance load	2.7	2.85	-	V
	Load with I_{oH} = 4mA	-	2.4	-	V
I_{PEAK}	-	-	-	4	mA
V_{OL}	-	-	-	0.1	V
Frequency	-	200	-	2500	Hz
Duty cycle	-	0*	-	100*	%
Tone level	4 dB step	-24	-	0	dB

* Be mindful of the maximum frequency and the minimum/maximum duty cycle. There is a limitation to these parameters due to the RC environment. **The amplitude modulation becomes less fine when the set limits are reached.**

3.12.2. Pin Description

The following table provides the pin description of the BUZZER signal.

Table 23: BUZZER Pin Description

Pin #	Signal	I/O	I/O Type	Description
34	BUZZER	O	2.8V	Buzzer output

3.12.3. Application

The maximum peak current of the transistor/MOSFET is 100mA and the maximum average current is 40mA, while the peak current of the BUZZER pin should be less than 4mA. A transient voltage suppressor diode must be added as shown below.

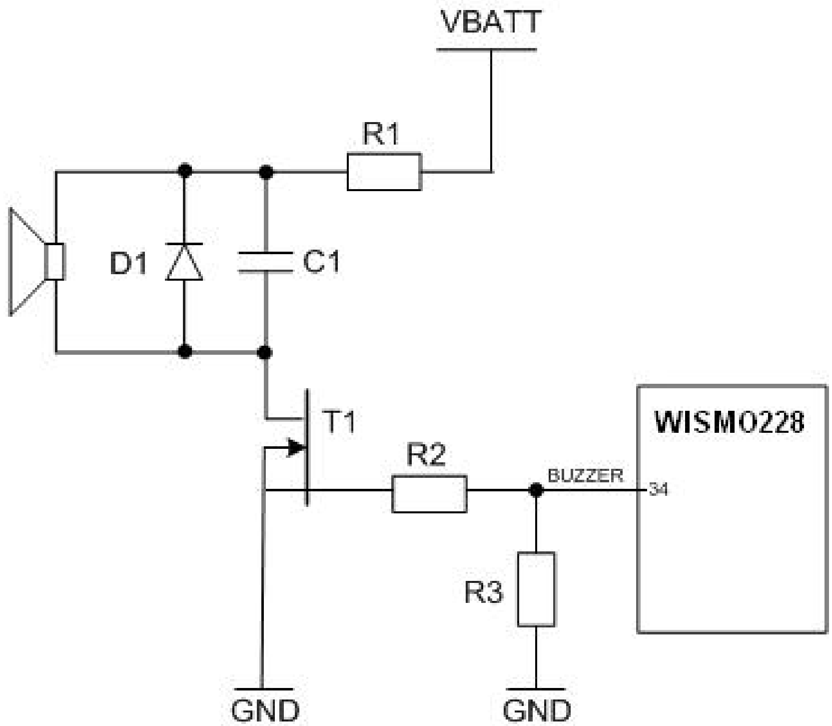


Figure 28. Example of a BUZZER Implementation

Where:

- R1 must be chosen in order to limit the current at I_{PEAK} max to 100mA and must be adjusted in relation to the frequency and the duty cycle used.
- D1 = BAV70T-7 or BAS16 (for example)
- T1 = FDN335N (for example)
- R2 = 0Ω
- R3 = 1MΩ

Tip: *A low filter is recommended at low frequencies.*

3.12.3.1. Low Filter Calculations

To compute for the cut-off frequency, use the formula **Fc = 1/(2*Π*Req*C1)** where:

- Fc = cut-off frequency
- Req = the total resistors in line
- C1 = the capacitive charge on T1 and the ground

Bear in mind that:

- Fc must be higher than FBUZZ-OUT
- Fc must be at least 64 * FBUZZ-OUT

*Note: The frequency modulation of the BUZZER signal is 64*FBUZZ-OUT.*

3.12.3.2. Recommended Characteristics

- Electro-magnetic type
- Impedance: 7 to 30Ω
- Sensitivity: 90 dB SPL min @ 10 cm
- Current: 60 to 90mA

The BUZZER output can also be used to drive an LED as shown in the figure below.

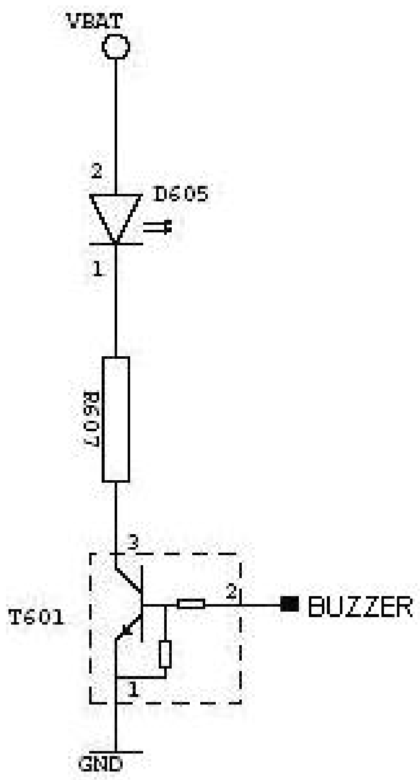


Figure 29. Example of an LED Driven by the BUZZER Output

The value of R607 can be harmonized depending on the LED (D605) characteristics.

The recommended digital transistor to use for T601 is the DTC144EE from ROHM.

3.13. ON/~OFF Signal

The ON/~OFF pin is used to switch ON or switch OFF the AirPrime WISMO228. It is internally connected to the permanent 3.0V supply regulator inside the AirPrime WISMO228 via a pull-up resistor. Once there is VBATT supply to the AirPrime WISMO228, this 3.0V supply regulator will be enabled and so the ON/~OFF signal is by default at HIGH level.

A LOW level signal has to be provided on the ON/~OFF pin to switch the AirPrime WISMO228 ON.

Note: *All external signals must be inactive when the AirPrime WISMO228 is OFF to avoid any damage when starting and to allow the AirPrime WISMO228 to start and stop correctly.*

Avoid using application MCU GPIO to directly control the ON/~OFF signal of the AirPrime WISMO228; instead, control this signal via an open collector switching transistor.

3.13.1. Electrical Characteristics

The following table describes the electrical characteristics of the ON/~OFF signal.

Table 24: Electrical Characteristics of the ON/~OFF Signal

Parameter	I/O Type	Minimum	Typical	Maximum	Unit
V_{IH}	2V8	2.4	-	3.0	V
V_{IL}	2V8	-	-	0.4	V

3.13.2. Pin Description

The following table provides the pin description of the ON/~OFF signal.

Table 25: ON/~OFF Signal Pin Description

Pin #	Signal	I/O	I/O Type	Description
37	ON/~OFF	I	2V8	AirPrime WISMO228 Power ON/OFF

3.13.3. Application

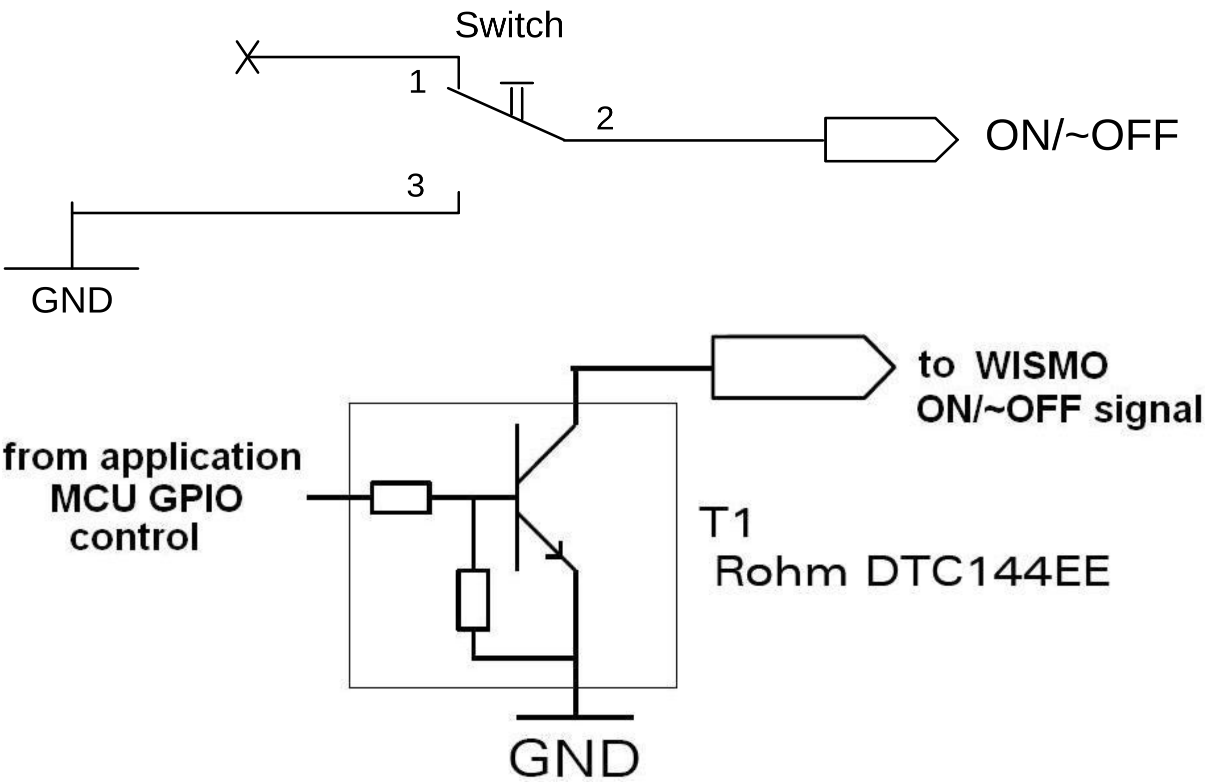


Figure 30. Example of the ON/~OFF Pin Connection Either By a Switch or Via an Open Collector Transistor

3.13.3.1. Power ON

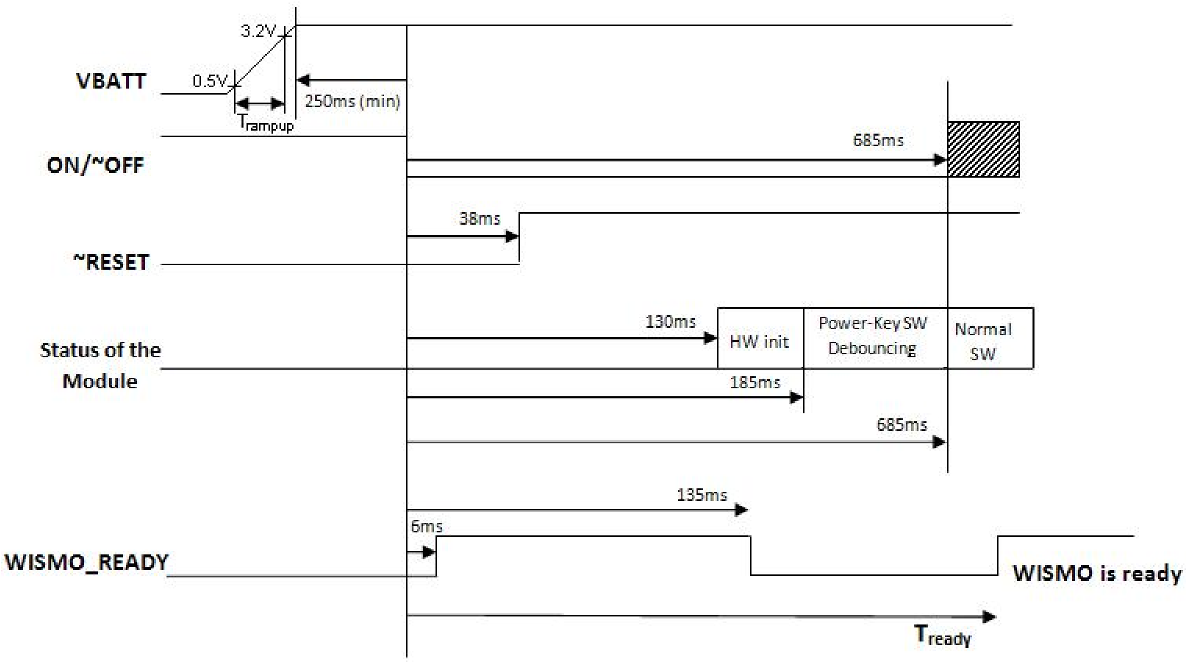


Figure 31. Power-ON Sequence (no PIN code activated)

	Minimum	Typical	Maximum	Unit
T_{ready}	4	5	7	s
T_{rampup}	-	-	120	ms

The ON/~OFF signal level is detected about 250ms after VBATT is available.

Note: This timing might be temperature dependant.

The voltage of this signal has to be pulled LOW for at least 685ms for powering ON. Within this 685ms, the WISMO_READY signal will initially set to HIGH for about 135ms and then resume to LOW.

During the power ON sequence, an internal reset is automatically performed for 38ms (typically). During this phase, any external reset should be avoided.

Once the AirPrime WISMO228 is properly powered ON, the WISMO_READY pin will set to HIGH level to acknowledge the successful powering ON of the AirPrime WISMO228 before it is ready to operate. The ON/~OFF signal can be left at LOW level until power off. The ON/~OFF Signal releases to high impedance when AirPrime WISMO228 is in Idle Mode. Idle Mode consumption will be higher if the ON/~OFF pin is kept at low voltage level when in Idle Mode.

The **recommended** way to release the ON/~OFF signal is to detect the WISMO_READY signal within 685ms of powering ON while the level pulse of the ON/~OFF signal is set to LOW, and wait until the WISMO_READY signal goes HIGH again.

3.13.3.2. Power OFF

The AirPrime WISMO228 can be powered off by either software or hardware. Refer to the following diagram for the power OFF sequence.

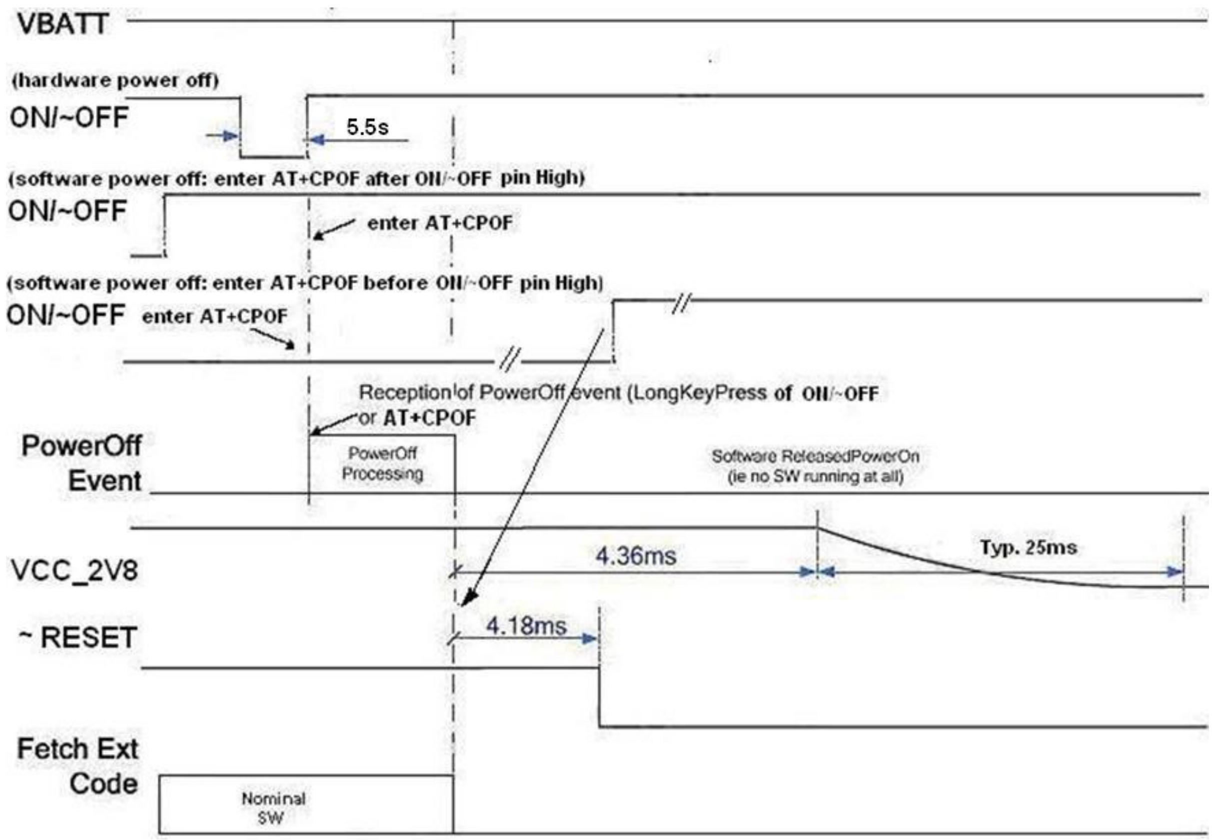


Figure 32. Power-OFF Sequence

3.13.3.2.1. Software Power OFF

The AT command **AT+CPOF** is used to power OFF the AirPrime WISMO228.

Note: If the ON/~OFF pin is maintained at LOW level when AT+CPOF is used, the embedded module cannot be switched OFF.

3.13.3.2.2. Hardware Power OFF

A LOW level pulse is applied on the ON/~OFF pin for 5.5 seconds. **AT+CPOF** will then be automatically sent to the AirPrime WISMO228.

Once the AirPrime WISMO228 receives the **AT+CPOF** command, the AirPrime WISMO228 will be unregistered from the network. The WISMO_READY pin will become LOW to indicate that AT commands are no longer available for the AirPrime WISMO228. If the ON/~OFF signal is HIGH, then the AirPrime WISMO228 will also be switched OFF.

3.14. WISMO_READY Indication

This signal indicates the status of the AirPrime WISMO228 after being powered ON. Note that there is an initial positive pulse of less than 200ms during power ON. Refer to Figure 31: Power-ON Sequence for more information regarding the power ON sequence. Once the AirPrime WISMO228 is properly powered ON, the WISMO_READY signal will set to HIGH to acknowledge the successful powering ON of the AirPrime WISMO228 before it is ready to operate. Likewise, the pin will set to LOW before powering OFF.

3.14.1. Electrical Characteristics

The following table describes the electrical characteristics of the WISMO_READY signal.

Table 26: Electrical Characteristics of the WISMO_READY Indication

Parameters	I/O Type	Minimum	Typical	Maximum	Unit
V_{OH}	2V8	2.7	2.8	2.95	V
V_{OL}	2V8	-	-	0.4	V

3.14.2. Pin Description

The following table provides the pin description of the WISMO_READY signal.

Table 27: WISMO_READY Indication Pin Description

Pin #	Signal	I/O	I/O Type	Description
7	WISMO_READY	O	2V8	AirPrime WISMO228 ready indication

3.15. VCC_2V8 Output

The VCC_2V8 output voltage supply is available when the AirPrime WISMO228 is switched ON and can only be used for pull-up resistor(s) and as a reference supply.

3.15.1. Electrical Characteristics

The following table describes the electrical characteristics of the VCC_2V8 signal.

Table 28: Electrical Characteristics of the VCC_2V8 Signal

Parameters			Minimum	Typical	Maximum	Unit
VCC_2V8	Output voltage		2.70	2.80	2.95	V
	Output Current	Full-power mode	-	-	50	mA
		Sleep mode	-	-	3	mA

3.15.2. Pin Description

The following table provides the pin description of the VCC_2V8 voltage supply.

Table 29: VCC_2V8 Pin Description

Pin #	Signal	I/O	I/O Type	Description
46	VCC_2V8	O	Supply	Digital supply

3.15.3. Application

This digital power supply is mainly used to:

- Pull-up signals such as I/Os
- Supply the digital transistors driving LEDs
- Act as a voltage reference for the ADC interface AUX-ADC0

3.16. BAT-RTC (Backup Battery)

The BAT-RTC (backup battery) pin is used as a back-up power supply for the internal Real Time Clock (RTC).

3.16.1. Features

VBATT provides the power supply to the RTC when VBATT is switched on but a back-up power supply is needed to save the date and hour when it is switched off.

If VBATT is available, the back-up battery can be charged by the internal 3.0V power supply regulator via a 2KΩ resistor implemented inside the AirPrime WISMO228.

If the RTC is not used, this pin can be left open.

The following table describes the electrical characteristics of the BAT-RTC signal.

Table 30: Electrical Characteristics of the BAT-RTC Signal

Parameters	Minimum	Typical	Maximum	Unit
Input voltage	-	3.0	-	V
Input current consumption*	-	2.5	-	µA
Output voltage	2.82	3.0	3.18	V
Max charging current (@VBATT=3.6V)	-	0.6	-	mA

* Provided by an RTC back-up battery when the AirPrime WISMO228 is off and VBATT = 0V.

3.16.2. Pin Description

The following table provides the pin description of the BAT-RTC voltage supply.

Table 31: BAT-RTC Pin Description

Pin #	Signal	I/O	I/O Type	Description
6	BAT-RTC	I/O	Supply	RTC Back-up supply

3.16.3. Application

The backup power supply can be any of the following:

- A super capacitor
- A non rechargeable battery
- A rechargeable battery cell

3.16.3.1. Super Capacitor

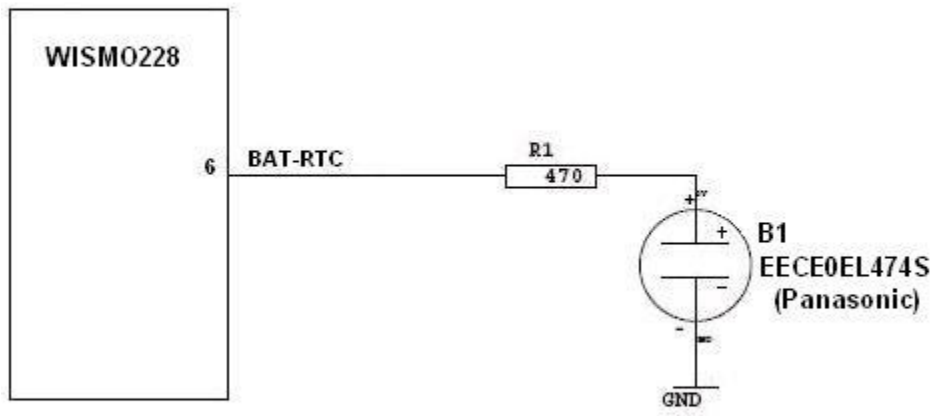


Figure 33. RTC Supplied by a Gold Capacitor

Estimated supply time with a 0.47F gold capacitor: 25 minutes (minimum).

Note: The maximum voltage of the gold capacitor is 3.9V.

3.16.3.2. Non-Rechargeable Battery

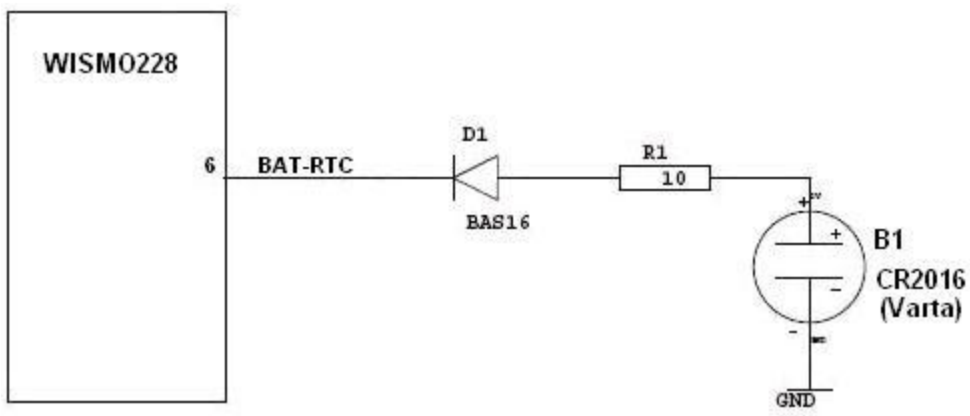


Figure 34. RTC Supplied by a Non Rechargeable Battery

The diode, D1, is mandatory to prevent the non rechargeable battery from being damaged.

Estimated supply time with an 85 mAh battery: 800 hours (minimum).

3.16.3.3. Rechargeable Battery Cell

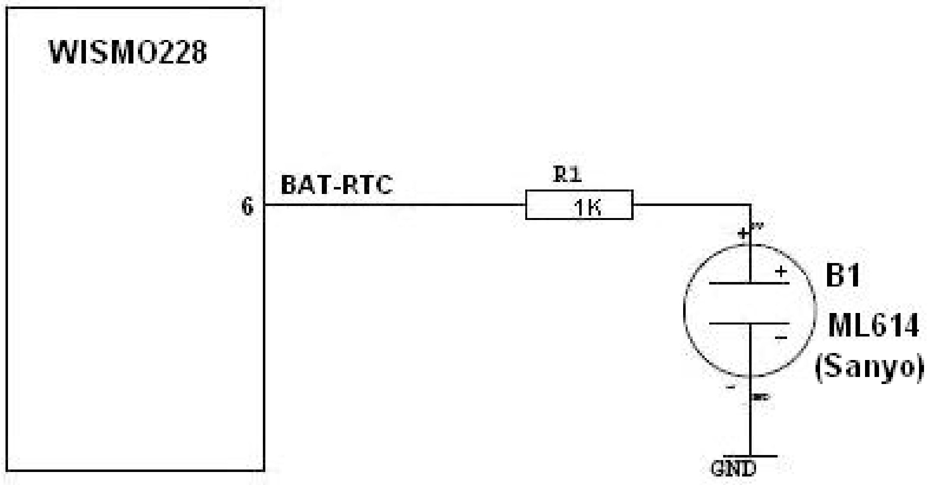


Figure 35. RTC Supplied by a Rechargeable Battery Cell

Estimated supply time with a fully charged 3.4mAh rechargeable battery: 7 days (minimum).

Note: Before battery cell assembly, ensure that the cell voltage is lower than 3.0V to avoid damaging the AirPrime WISMO228.

3.17. TX_CTRL Signal for TX Burst Indication

The TX_CTRL signal is a 2.8V indication signal for TX Burst with a 100KΩ pull-up resistor implemented inside the AirPrime WISMO228 embedded module.

Table 32: TX_CTRL Status

AirPrime WISMO228 State	TX_CTRL Status
During TX burst	Low
No TX	High

During TX burst, there will be higher current drain from the VBATT power supply which causes a voltage drop. This voltage drop from VBATT is a good indication of a high current drain situation during TX burst.

The blinking frequency is about 216Hz.

The output logic low duration, Tduration, depends on the number of TX slots and is computed as follows:

$T_{duration} = T_{advance}$ + (0.577ms x number of TX slots) + T_{delay}.

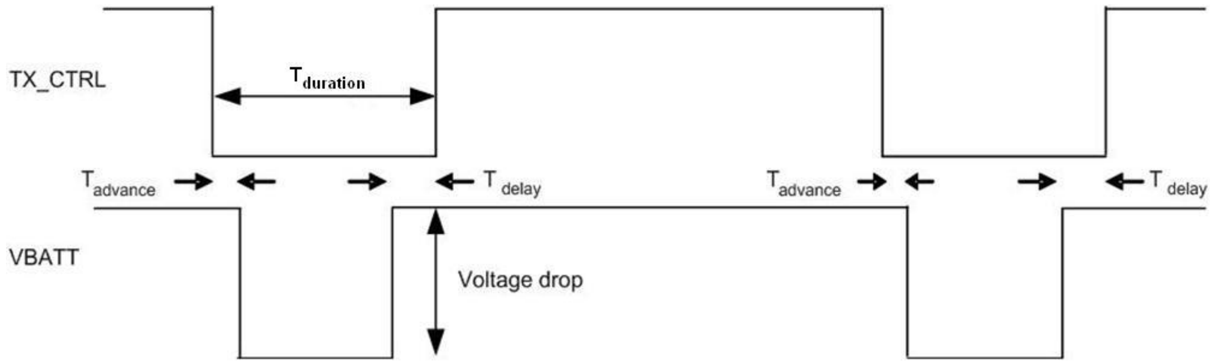


Figure 36. TX_CTRL State During TX Burst

3.17.1. Electrical Characteristics

The following table describes the electrical characteristics of the TX_CTRL signal.

Table 33: Electrical Characteristics of the TX_CTRL Signal

Parameters	Conditions	Minimum	Typical	Maximum	Unit
V_{OH}		2.6	-	2.95	V
V_{OL}		-	-	0.4	V
$T_{advance}$	@500mA	-	18	-	µs
	@1A	-	27	-	µs
T_{delay}		-	11	-	µs

3.17.2. Pin Description

The following table provides the pin description of the TX_CTRL signal.

Table 34: TX_CTRL Signal Pin Description

Pin #	Signal	I/O	I/O Type	Reset State	Description
18	TX_CTRL	O	2V8	1	TX Burst indication

3.17.3. Application

The TX burst indication signal, TX_CTRL, can be used to drive an LED through a transistor. It can be a good visual indicator for any TX activities.

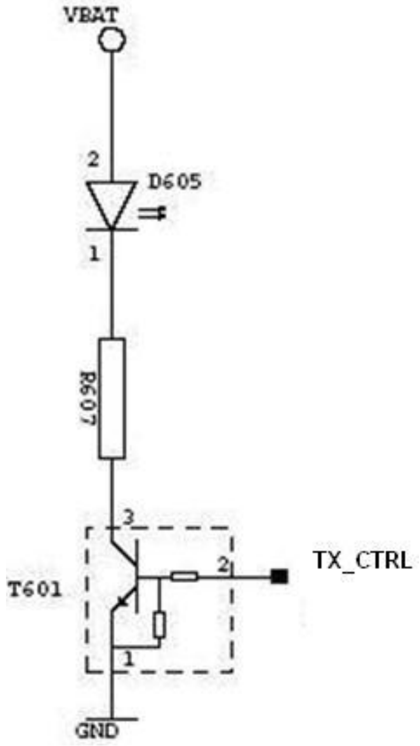


Figure 37. Example of a TX Status Implementation

The value of R607 can be harmonized depending on the LED (D605) characteristics.

3.18. Reset

The AirPrime WISMO228 has an input ~RESET pin. This is a hardware reset and should only be used for emergency resets. The ~RESET pin should be kept at low level for at least 500µs to guarantee a proper reset to take place.

3.18.1. Feature

The ~RESET signal has a 100KΩ internal pull up resistor to VCC_2V8.

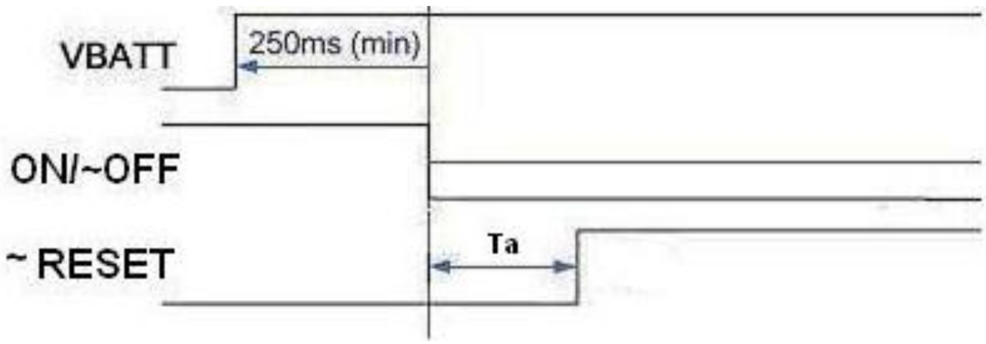


Figure 38. Reset Timing

Table 35: Electrical Characteristics of the Reset Signal

Parameters		Minimum	Typical	Maximum	Unit
~RESET	Input Impedance (R)*	-	100K	-	Ω
	Input Impedance (C)	-	10nF		F
	Cancellation time (Ta) at power up only	-	38	-	ms
	V_H**	1.57	-	-	V
	V_{IL}	-	0	1.2	V
	V_{IH}	1.96	2.8	--	V

* Internal pull up resistance

** V_H : Hysterisis Voltage

3.18.1.1. Sequence After an External Reset Event (~RESET)

To activate the «emergency» reset sequence, the ~RESET signal has to be set to LOW level manually. This can be done by using a push button, for example.

3.18.2. Pin Description

The following table provides the pin description of the RESET signal.

Table 36: Reset Pin Description

Pin #	Signal	I/O	I/O Type	Description
12	~RESET	100K Pull-up	2V8	AirPrime WISMO228 Reset

3.18.3. Application

If the «emergency» reset is used, it has to be driven by either a push button or an open collector/drain transistor as shown in the figures below.

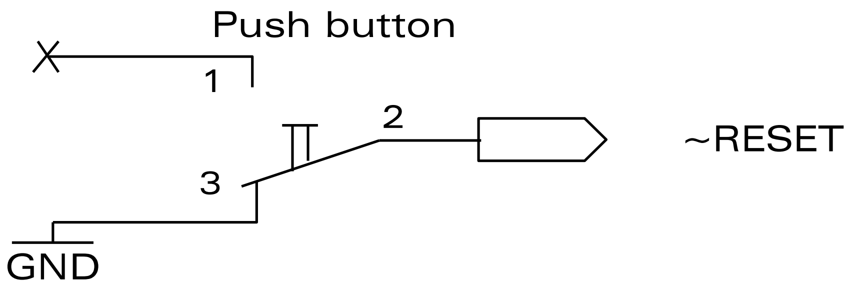


Figure 39. Example of ~RESET Pin Connection with a Push Button Configuration

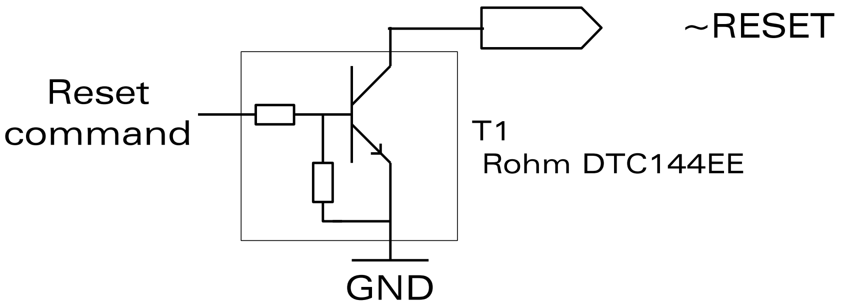


Figure 40. Example of ~RESET Pin Connection with a Transistor Configuration

An open collector or open drain transistor can also be used to drive the ~RESET pin (due to the internal pull-up resistor embedded into the AirPrime WISMO228). If an open collector is chosen, the recommended digital transistor to use for T1 is the DTC144EE from ROHM.

Table 37: Reset Commands

Reset Command	~RESET	Operating Mode
1	0	Reset activated
0	1	Reset inactive

Note: It is recommended to add a varistor (such as the AVL5M02200 from AMOTECH) on the ~RESET pin in order to enhance ESD immunity.

3.19. RF Interface

The RF interface allows the transmission of radio frequency (RF) signals from the AirPrime WISMO228 to an external antenna. This interface has a nominal impedance of 50Ω and a DC resistance of 0Ω.

3.19.1. RF Connection

The RF input/output of the AirPrime WISMO228 is through one of the castellation pins (Pin 21, ANT), with grounded castellation pins at both sides. This castellation pin must be connected to a 50Ω RF line in order to protect the antenna line from the noise coming from baseband signals.

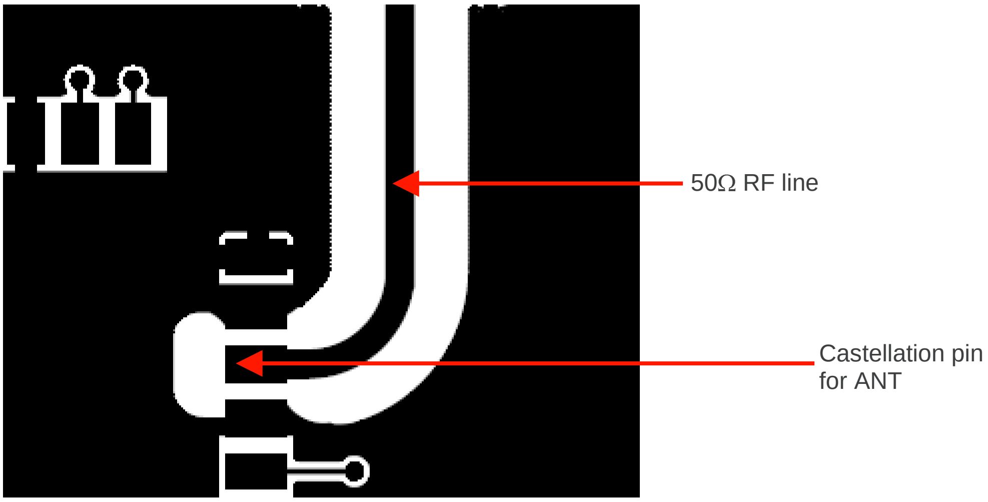


Figure 41. Example of a 50Ω RF Line

The 50Ω RF line is surrounded by **two ground planes** in order to protect the antenna line from noise. The length of the line shouldn't be too long (no more than a few centimeters) because of RF insertion loss. The **width of the line must be calculated** in order to ensure a 50Ω characteristic impedance.

For this same reason, the embedded RF line should likewise be kept about 1cm away from any (noisy) baseband signal in order to ensure a good RX sensitivity level.

The other end of the 50Ω RF line can be connected to an RF connector or to a soldering pad in order to connect an antenna. It is also possible to use an antenna chip or to design a PCB antenna directly on the application board.

The ANT pin of the AirPrime WISMO228 is ESD protected for both ±4KV contact and ±8KV air discharge.

Tip: *The correct antenna cable and connector should be chosen in order to minimize loss in the frequency bands used for GSM800, EGSM900, DCS1800 and PCS1900.*

0.5dB can be considered as the maximum value for loss between the AirPrime WISMO228 and an external connector.

3.19.2. RF Performances

RF performances are compliant with ETSI recommendation GSM 05.05. Listed below are the main parameters for both the Receiver and the Transmitter.

The main parameters for the Receiver are:

- GSM850/EGSM900 Reference Sensitivity = -108 dBm (typ.)
- DCS1800/PCS1900 Reference Sensitivity = -108 dBm (typ.)
- Selectivity @ 200 kHz : > +9 dBc
- Selectivity @ 400 kHz : > +41 dBc
- Linear dynamic range: 63 dB
- Co-channel rejection: >= 9 dBc

The main parameters for the Transmitter are:

- Maximum output power (EGSM): 33 dBm +/- 2 dB at ambient temperature
- Maximum output power (GSM1800): 30 dBm +/- 2 dB at ambient temperature
- Minimum output power (EGSM): 5 dBm +/- 5 dB at ambient temperature
- Minimum output power (GSM1800): 0 dBm +/- 5 dB at ambient temperature

3.19.3. Antenna Specifications

The optimum operating frequency depends on the application. A dual-band or a quad-band antenna will work in the following frequency bands and should have the following characteristics.

Table 38: Antenna Specifications

Characteristic		AirPrime WISMO228			
		GSM 850	E-GSM 900	DCS 1800	PCS 1900
TX Frequency		824 to 849 MHz	880 to 915 MHz	1710 to 1785 MHz	1850 to 1910 MHz
RX Frequency		869 to 894 MHz	925 to 960 MHz	1805 to 1880 MHz	1930 to 1990 MHz
Impedance		50Ω			
VSWR	Rx max	1.5 :1			
	Tx max	1.5 :1			
Typical radiated gain		0dBi in one direction at least			

Tip: *Both mechanical and electrical antenna adaptations are key issues in the design of a GSM terminal. It is strongly recommended to work with an antenna manufacturer to either develop an antenna adapted to the application or to adapt an existing solution to the application.*

4. Consumption Measurement Procedure

This chapter describes the consumption measurement procedure used to obtain the AirPrime WISMO228 consumption specification.

The AirPrime WISMO228 consumption specification values are measured for all operating modes available on the product.

4.1. Hardware Configuration

Consumption results are highly dependent on the hardware configuration used during measurement and this section describes the hardware configuration settings that must be used to obtain optimum consumption measurements.

The following hardware configuration includes both the measurement equipment and the AirPrime WISMO228 with its socket-up board on the AirPrime WS Series Development Kit.

4.1.1. Equipments

Four devices are used to perform consumption measurement:

- A communication tester
- A current measuring power supply
- A standalone power supply
- A computer, to control the AirPrime WISMO228 and save measurement data

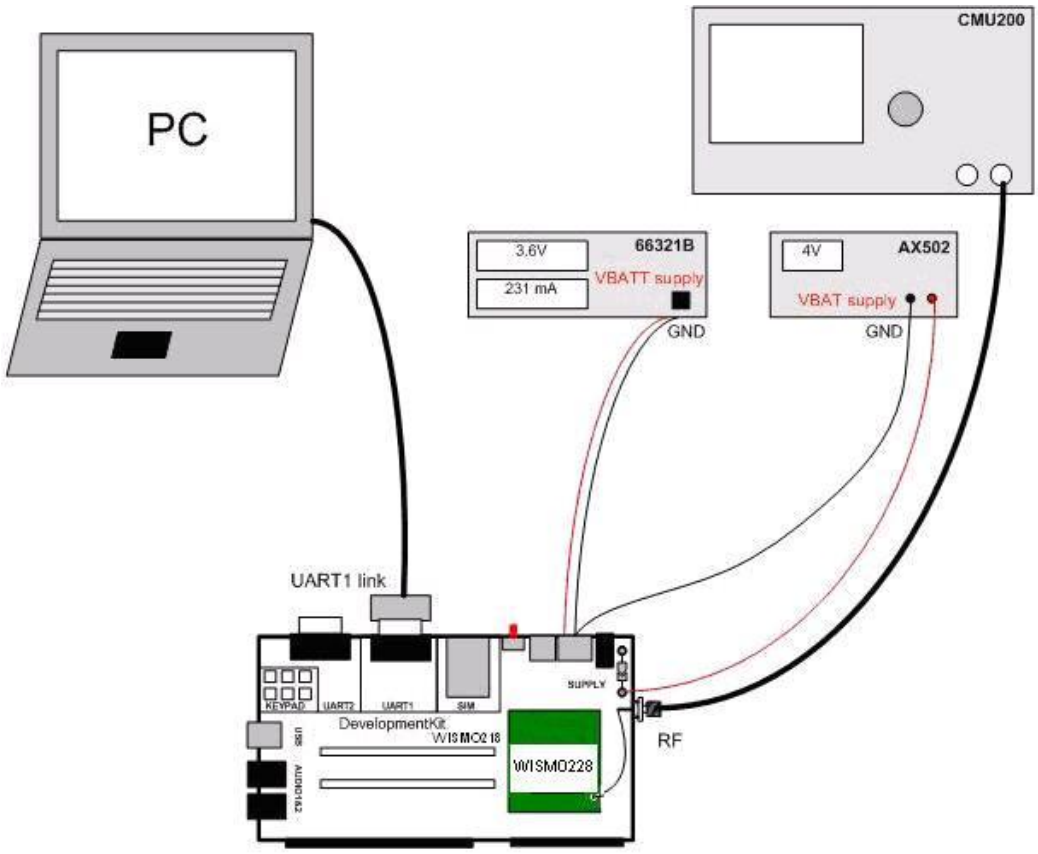


Figure 42. Typical Hardware Configuration

The communication tester is a **CMU200** from **Rhode & Schwartz**. This tester offers all GSM/GPRS network configurations required and allows a wide range of network configurations to be set.

The **AX502** standalone power supply is used to supply all motherboard components except the AirPrime WISMO228. This is done with the objective to separate the AirPrime WS Series Development Kit board consumption from the AirPrime WISMO228 consumption – which is measured by the other power supply, the **66321B** current measuring power supply. Both the standalone power supply and the current measuring power supply are connected to and controlled by the computer (GPIB control, which is not shown in the figure).

The standalone power supply, AX502 (or VBAT), may be set from 3.2V to 4.8V; while the current measure power supply, 66321B (or VBATT), may also be set from 3.2V to 4.8 according to the AirPrime WISMO228 VBATT specifications.

A SIM must be inserted in the AirPrime WS Series Development Kit during all consumption measurement.

The following table lists the recommended equipments to use for the consumption measurement.

Table 39: List of Recommended Equipments

Device	Manufacturer	Reference	Notes
Communication Tester	Rhode & Schwartz	CMU 200	Quad Band GSM/DCS/GPRS
Current measuring power supply	Agilent	66321B	Used for VBATT (supplies the AirPrime WISMO228)
Stand alone power supply	Metrix	AX502	Used for VBAT (supplies the AirPrime WS Series development kit board)

4.1.2. AirPrime WS Series Development Kit

The AirPrime WS Series Development Kit is used as a basis for the AirPrime WISMO228 measurement via an adaptor board and is used to perform consumption measurement using several settings. Refer to document [3] AirPrime WS Series Development Kit User Guide and document [1] AirPrime WISMO218 Hardware Presentation for more information about these settings.

Note: *The AirPrime WS Series Development Kit can be replaced by AirPrime WMP100 Development Kit once a suitable socket-up board is available.*

The AirPrime WS Series Development Kit board is powered by the standalone power supply at VBAT; while the AirPrime WISMO228 is powered by the current measuring power supply at VBATT. It is for this reason that the link between VBATT and VBAT (J605) must be opened (by removing the solder at the top of the board in the SUPPLY area). Note the following information regarding both power supplies.

- VBATT is powered by the current measuring power supply (66321B)
- VBAT is powered by the standalone power supply (AX502) through TP602

Also take note of the following additional configuration/settings:

- The R600 resistor and the D603 and D604 diodes (around the BAT-TEMP connector) must be removed.
- The UART2 link is not used; therefore, J201, J202, J203, J204 must be opened (by removing the solder).
- The “FLASH-LED” must be not used, so J602 must be opened (by removing the solder).
- The USB link is not used; therefore, J301, J302, J303, J304, J305 must be opened (by removing the solder).
- Audio is not used; therefore, J702, J703, J704, J705, J605 must be opened (by removing the solder).
- There is no SIM detect feature on the AirPrime WISMO228; therefore, J403 must be opened (by removing the soldered).
- Charging is not used; therefore, R602 must be removed.
- C600 and R607 must be removed to avoid unexpected current consumption.
- The switch, BOOT (around the “CONFIG” area), must be set to the OFF position.

The goal of the settings listed above is to eliminate all bias current from VBATT and to supply the entire board (except the AirPrime WISMO228) using only VBAT.

4.1.3. Socket-Up Board

An adaptor board, the AirPrime WS Series Socket-Up Board (WM0801706-020-20), is used to connect the AirPrime WISMO228 to work on the AirPrime WS Series Development Kit.

On this socket-up board, the soldering points of J203, J204, JP101, JP102, JP103, JP104, JP105, JP106 and JP107 must be opened.

4.1.4. SIM Cards

Consumption measurement may be performed with either 3-Volt or 1.8-Volt SIM cards. However, all specified consumption values are for a 3-Volt SIM card.

Note: *The SIM card’s voltage is supplied by the AirPrime WISMO228’s power supply. Consumption measurement results may vary depending on the SIM card used.*

4.2. Software Configuration

This section discusses the software configuration for the equipment(s) used and the AirPrime WISMO228 settings.

4.2.1. AirPrime WISMO228 Configuration

The AirPrime WISMO228 software configuration is simply performed by selecting the operating mode to use in performing the measurement.

A description of the operating modes and the procedures used to change the operating mode are given in the appendix of document [2] AirPrime WISMO228 AT Command Manual.

The available operating modes in the AirPrime WISMO228 are as follows:

- OFF Mode
- Alarm Mode
- Idle Mode
- Connected Mode
- Transfer Mode class 8 (4Rx/1Tx) (in GPRS mode)
- Transfer Mode class 10 (3Rx/2Tx) (in GPRS mode)

4.2.2. Equipment Configuration

The communication tester is set according to the AirPrime WISMO228 operating mode. Paging during idle modes, TX burst power, RF band and GSM/DCS/GPRS may be selected on the communication tester.

Refer to the following table for the network analyzer configuration according to operating mode.

Table 40: Operating Mode Information

<table>
<tr><th colspan="2">Operating Mode</th><th colspan="2">Communication Tester Configuration</th></tr>
<tr><td colspan="2">OFF Mode</td><td colspan="2">N/A</td></tr>
<tr><td colspan="2">Alarm Mode</td><td colspan="2">N/A</td></tr>
<tr><td colspan="2" rowspan="2">Idle Mode</td><td colspan="2">Paging 2 (Rx burst occurrence ~0,5s)</td></tr>
<tr><td colspan="2">Paging 9 (Rx burst occurrence ~2s)</td></tr>
<tr><td colspan="2" rowspan="8">Connected Mode</td><td rowspan="2">850 MHz</td><td>PCL5 (TX power 33dBm)</td></tr>
<tr><td>PCL19 (TX power 5dBm)</td></tr>
<tr><td rowspan="2">900 MHz</td><td>PCL5 (TX power 33dBm)</td></tr>
<tr><td>PCL19 (TX power 5dBm)</td></tr>
<tr><td rowspan="2">1800MHz</td><td>PCL0 (TX power 30dBm)</td></tr>
<tr><td>PCL15 (TX power 0dBm)</td></tr>
<tr><td rowspan="2">1900 MHz</td><td>PCL0 (TX power 30dBm)</td></tr>
<tr><td>PCL15 (TX power 0dBm)</td></tr>
<tr><td rowspan="4">GPRS</td><td rowspan="4">Transfer Mode class 8 (4Rx/1Tx)</td><td rowspan="2">850 MHz</td><td>Gam.3 (TX power 33dBm)</td></tr>
<tr><td>Gam.17 (TX power 5dBm)</td></tr>
<tr><td rowspan="2">900 MHz</td><td>Gam.3 (TX power 33dBm)</td></tr>
<tr><td>Gam.17 (TX power 5dBm)</td></tr>
</table>

Operating Mode		Communication Tester Configuration	
		1800MHz	Gam.3 (TX power 30dBm)
			Gam.18 (TX power 0dBm)
		1900 MHz	Gam.3 (TX power 30dBm)
			Gam.18 (TX power 0dBm)
	Transfer Mode class 10 (3Rx/2Tx)	850 MHz	Gam.3 (TX power 33dBm)
			Gam.17 (TX power 5dBm)
		900 MHz	Gam.3 (TX power 33dBm)
			Gam.17 (TX power 5dBm)
		1800MHz	Gam.3 (TX power 30dBm)
			Gam.18 (TX power 0dBm)
		1900 MHz	Gam.3 (TX power 30dBm)
			Gam.18 (TX power 0dBm)

4.3. Template

This template may be used for consumption measurement for all modes and configurations available. Note that three VBATT voltages are used to measure consumption, namely: VBATTmin (3.2V), VBATTtyp (3.6V) and VBATTmax (4.8V). The minimum/maximum RF transmission power configurations are also set and measured.

Table 41: AirPrime WISMO228 Power Consumption

AirPrime WISMO228 Power Consumption							
Operating Mode	Parameters		$I_{average}$			I_{peak}	Unit
			VBATT=4.8V	VBATT=3.6V	VBATT=3.2V		
Off Mode (AirPrime WISMO228 stand alone)						NA	µA
Off Mode (using application note: Very Low Power Consumption*)						NA	µA
Idle Mode**	Paging 2 (Rx burst occurrence ~0.5s)						mA
	Paging 9 (Rx burst occurrence ~2s)						mA
Connected Mode	850 MHz	PCL5 (TX power 33dBm)					mA
		PCL19 (TX power 5dBm)					mA
	900 MHz	PCL5 (TX power 33dBm)					mA
		PCL19 (TX power 5dBm)					mA
	1800 MHz	PCL0 (TX power 30dBm)					mA
		PCL15 (TX power 0dBm)					mA
	1900 MHz	PCL0 (TX power 30dBm)					mA
		PCL15 (TX power 0dBm)					mA
GPRS – Transfer Mode class 8 (4Rx/1Tx)	850 MHz	Gam.3 (TX power 33dBm)					mA
		Gam.17 (TX power 5dBm)					mA
	900 MHz	Gam.3 (TX power 33dBm)					mA

AirPrime WISMO228 Power Consumption

			Gam.17 (TX power 5dBm)					mA
		1800 MHz	Gam.3 (TX power 30dBm)					mA
			Gam.18 (TX power 0dBm)					mA
		1900 MHz	Gam.3 (TX power 30dBm)					mA
			Gam.18 (TX power 0dBm)					mA
	Transfer Mode class 10 (3Rx/2Tx)	850 MHz	Gam.3 (TX power 33dBm)					mA
			Gam.17 (TX power 5dBm)					mA
		900 MHz	Gam.3 (TX power 33dBm)					mA
			Gam.17 (TX power 5dBm)					mA
		1800 MHz	Gam.3 (TX power 30dBm)					mA
			Gam.18 (TX power 0dBm)					mA
		1900 MHz	Gam.3 (TX power 30dBm)					mA
			Gam.18 (TX power 0dBm)					mA

* The application note “Very Low Power Consumption” (Reference: WA_DEV_GEN_APN_020-003) can be found on the Sierra Wireless website (under the Developer section).

** Idle Mode consumption depends on the SIM card used. Some SIM cards respond faster than others, in which case the longer the response time is, the higher the consumption is.

5. Technical Specifications

5.1. Castellation Connector Pin Configuration

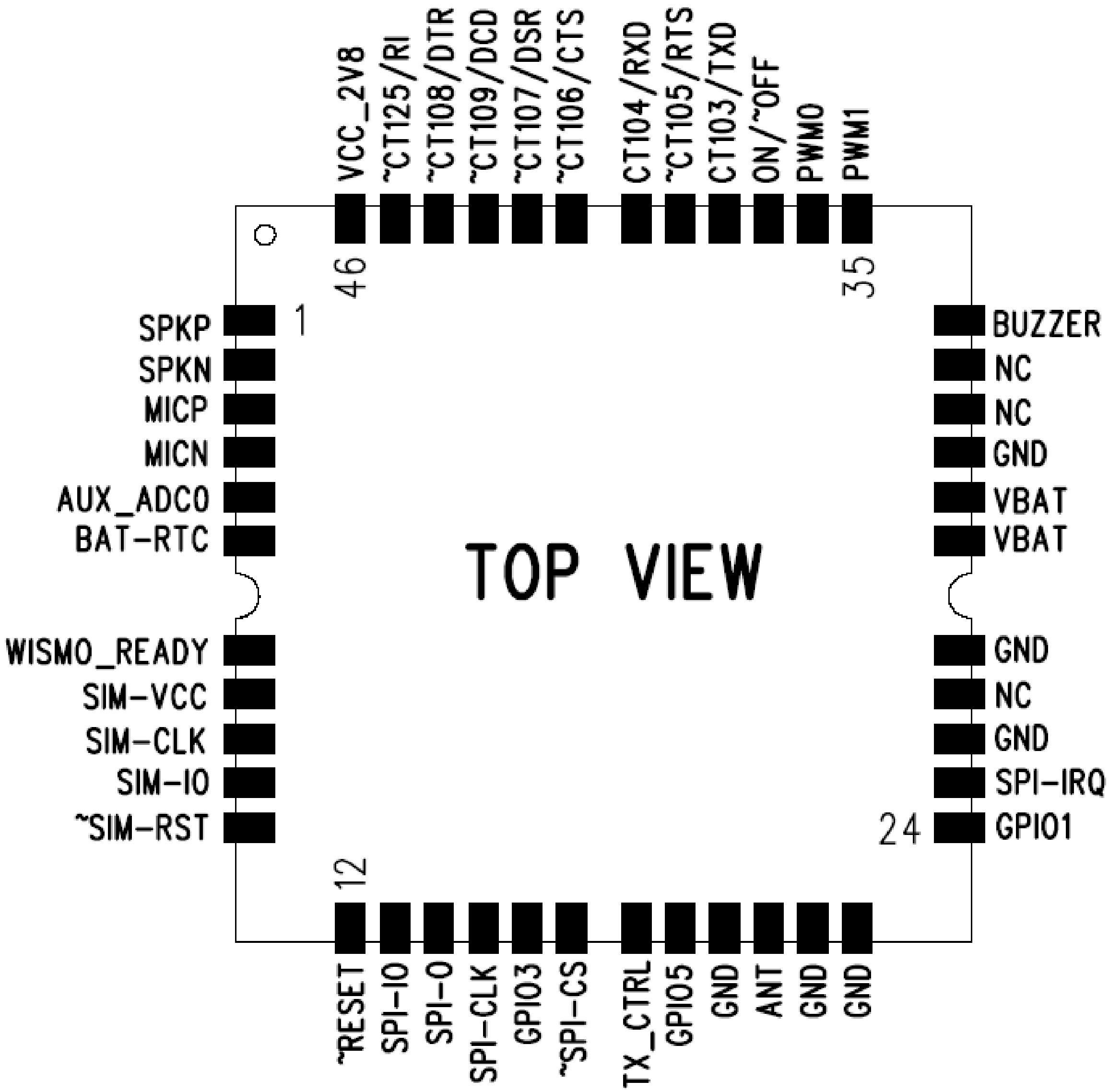


Figure 43. AirPrime WISMO228 Pin Configuration

5.2. Castellation Pin

5.2.1. Pin Description

Pin #	Signal	Description	I/O	Pin #	Signal	Description	I/O
1	SPKP	Speaker output positive 32 ohms	Analog	**24**	GPIO1	2.8V GPIO	I/O
2	SPKN	Speaker output negative 32 ohms	Analog	**25**	SPI-IRQ	2.8V SPI interrupt request input	I
3	MICP	Microphone input positive	Analog	**26**	GND	Ground	Ground
4	MICN	Microphone input negative	Analog	**27**	NC	Not connected	-
5	AUX_ADC0	Analog to digital converter	I	**28**	GND	Ground	Ground
6	BAT-RTC	Power supply for RTC backup	I	**29**	VBATT	Power supply	I
7	WISMO_READY	2.8V WISMO Ready	O	**30**	VBATT	Power supply	I
8	SIM-VCC	SIM power supply	O	**31**	GND	Ground	Ground
9	SIM-CLK	SIM clock	O	**32**	NC	Not connected	-
10	SIM-IO	SIM data	I/O	**33**	NC	Not connected	-
11	~SIM-RST	SIM reset	O	**34**	BUZZER	2.8V Buzzer PWM2	O
12	~RESET	input reset signal	I	**35**	PWM1	2.8V DC PWM 1	O
13	SPI-IO	2.8V SPI data input	I/O	**36**	PWM0	2.8V DC PWM 0	O
14	SPI-O	2.8V SPI data output	O	**37**	On/~OFF	Power On control signal	I
15	SPI-CLK	2.8V SPI clock output	O	**38**	CT103/TXD*	2.8V UART1: Transmit data	I
16	GPIO3	2.8V GPIO	I/O	**39**	~CT105/RTS*	2.8V UART1: Request to send	I
17	~SPI-CS	2.8V SPI chip select output	O	**40**	CT104/RXD*	2.8V UART1: Receive data	O
18	TX_CTRL	2.8V TX Burst Indicator	O	**41**	~CT106/CTS*	2.8V UART1: Clear to send	O
19	GPIO5	2.8V GPIO	I/O	**42**	~CT107/DSR	2.8V UART1: Data set ready	O
20	GND	Ground	Ground	**43**	~CT109/DCD	2.8V UART1: Data carrier detect	O
21	ANT	Radio antenna connection	I/O	**44**	~CT108/DTR	2.8V UART1: Data terminal ready	I
22	GND	Ground	Ground	**45**	~CT125/RI	2.8V UART1: Ring indicator	O
23	GND	Ground	Ground	**46**	VCC_2V8	2.8V power supply from the embedded module	O

* UART signal names are according to PC view.

* The I/O direction information only concerns the nominal signal. When the signal is configured in GPIO, it can either be an Input or an Output.

5.2.2. Recommended Connection When Not Used

The table below gives the recommended connection for any unused pins.

Pin #	Signal	Recommended Connection When Not Used	Pin #	Signal	Recommended Connection When Not Used
1	SPKP	Open	**24**	GPIO1	Open
2	SPKN	Open	**25**	SPI-IRQ	PCB test point
3	MICP	Open	**26**	GND	Ground
4	MICN	Open	**27**	NC	Not connected
5	AUX_ADC0	Ground	**28**	GND	Ground
6	BAT-RTC	Open	**29**	VBATT	Power supply
7	WISMO_READY	Open	**30**	VBATT	Power supply
8	SIM-VCC	SIM power supply	**31**	GND	Ground
9	SIM-CLK	SIM clock	**32**	NC	Not connected
10	SIM-IO	SIM data	**33**	NC	Not connected
11	~SIM-RST	SIM reset	**34**	BUZZER	Open
12	~RESET	Open	**35**	PWM1	Open
13	SPI-IO	PCB test point	**36**	PWM0	Open
14	SPI-O	PCB test point	**37**	On/~OFF	Power On control signal
15	SPI-CLK	PCB test point	**38**	CT103/TXD*	2.8V UART1: Transmit data
16	GPIO3	Open	**39**	~CT105/RTS*	Connect to ~CT106/CTS
17	~SPI-CS	PCB test point	**40**	CT104/RXD*	2.8V UART1: Receive data
18	TX_CTRL	Not Connected	**41**	~CT106/CTS*	Connect to ~CT105/RTS*
19	GPIO5	Open	**42**	~CT107/DSR	Connect to ~CT108/DTR**
20	GND	Ground	**43**	~CT109/DCD	Open
21	ANT	Radio antenna connection	**44**	~CT108/DTR	Connect to ~CT107/DSR**
22	GND	Ground	**45**	~CT125/RI	Open
23	GND	Ground	**46**	VCC_2V8	Open

* The I/O direction information only concerns the nominal signal. When the signal is configured in GPIO, it can either be an Input or an Output.

** Refer to Table 7:: Main Serial Link Pin Description of section 3.6 Main Serial Link (UART) for more information regarding the connection between DSR and DTR.

5.3. PCB Specifications for the Application Board

In order to save costs for simple applications, a cheap PCB structure can be used for the application board of the AirPrime WISMO228. A 4-layer through-hole type PCB structure can be used.

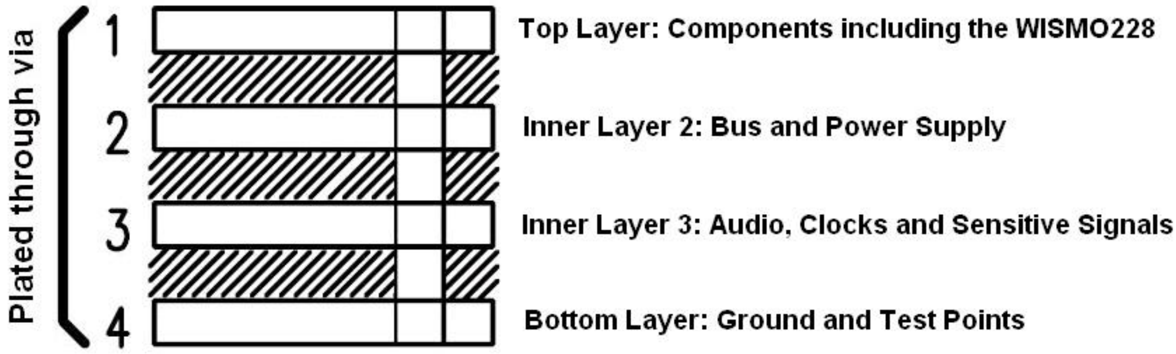


Figure 44. PCB Structure Example for the Application Board

Note: Due to the limited layers of 4-layer PCBs, sensitive signals like audio, SIM and clocks cannot be protected by 2 adjacent ground layers. As a result, care must be taken during PCB layout for these sensitive signals by avoiding coupling to noisy baseband through adjacent layers.

5.4. Reliability Compliance and Recommended Standards

5.4.1. Reliability Compliance

The AirPrime WISMO228 embedded module connected on a development kit board application is compliant with the following requirements.

Table 42: Standards Conformity for the AirPrime WISMO228 Embedded Module

Abbreviation	Definition
IEC	International Electro technical Commission
ISO	International Organization for Standardization

5.4.2. Applicable Standards Listing

The table hereafter gives the basic list of standards applicable to the AirPrime WISMO228 embedded module.

Note: References to any features can be found from these standards.

Table 43: Applicable Standards and Requirements

Document	Current Version	Title
IEC6006826	7.0	Environmental testing - Part 2.6: Test FC: Sinusoidal Vibration.
IEC60068234	73	Basic environmental testing procedures part 2: Test FD: random vibration wide band - general requirements Cancelled and replaced by IEC60068-2-64. For reference only.
IEC60068264	2.0	Environmental testing - part 2-64: Test FH: vibration, broadband random and guidance.
IEC60068232	2.0	Basic environmental testing procedures - part 2: Test ED: (procedure 1) (withdrawn & replaced by IEC60068-2-31).
IEC60068231	2.0	Environmental testing part 2-31: Test EC: rough handling shocks, primarily for equipment-type specimens.
IEC60068229	2.0	Basic environmental testing procedures - part 2: Test EB and guidance: bump Withdrawn and replaced by IEC60068-2-27. For reference only.
IEC60068227	4.0	Environmental testing - part 2-27: Test EA and guidance: shock.
IEC60068214	6.0	Environmental testing - part 2-14: Test N: change of temperature.
IEC6006822	5.0	Environmental testing - part 2-2: Test B: dry heat.
IEC6006821	6.0	Environmental testing - part 2-1: Test A: cold.
IEC60068230	3.0	Environmental testing - part 2-30: Test DB: damp heat, cyclic (12 h + 12 h cycle).
IEC6006823	69 w/A1	Basic environmental testing procedures part 2: Test CA: damp heat, steady State Withdrawn and replaced by IEC60068-2-78. For reference only.
IEC60068278	1.0	Environmental testing part 2-78: Test CAB: damp heat, steady state.
IEC60068238	2.0	Environmental testing - part 2-38: Test Z/AD: composite temperature/humidity cyclic test.
IEC60068240	1.0 w/A1	Basic environmental testing procedures - part 2: Test Z/AM combined cold/low air pressure tests.
ISO167501	2ND	Road vehicles - environmental conditions and testing for electrical and electronic equipment - part 1: general.
ISO167502	2ND	Road vehicles - environmental conditions and testing for electrical and electronic equipment - part 2: electrical loads.
ISO167503	2ND	Road vehicles - environmental conditions and testing for electrical and electronic equipment - part 3: mechanical loads.
ISO167504	2ND	Road vehicles - environmental conditions and testing for electrical and electronic equipment - part 4: climatic loads.
IEC60529	2.1 w/COR2	Degrees of protection provided by enclosures (IP code).
IEC60068217	4.0	Basic environmental testing procedures - part 2: Test Q: sealing.
IEC60068218	2.0	Environmental testing - part 2-18: Tests - R and guidance: water.
IEC60068270	1.0	Environmental testing - part 2: tests - test XB: abrasion of markings and letterings caused by rubbing of fingers and hands.
IEC60068268	1.0	Environmental testing - part 2: tests - test l: dust and sand.
IEC60068211	3.0	Basic environmental testing procedures, part 2: test KA: salt mist.
IEC60068260	2.0	Environmental testing - part 2: Test KE: flowing mixed gas corrosion test.
IEC60068252	2.0 w/COR	Environmental testing - part 2: Test KB: salt mist, cyclic (sodium chloride solution).

5.4.3. Environmental Specifications

The AirPrime WISMO228 is compliant with the following operating classes. The table below lists the ideal temperature range of the environment.

Conditions	Temperature Range
Operating / Class A	-25 °C to +75°C
Operating / Class B	-40 °C to +85°C
Storage	-40 °C to +85°C

5.4.3.1. Function Status Classification

5.4.3.1.1. Class A

The AirPrime WISMO228 remains fully functional, meeting GSM performance criteria in accordance with ETSI requirements, across the specified temperature range.

5.4.3.1.2. Class B

The AirPrime WISMO228 remains fully functional across the specified temperature range. Some GSM parameters may occasionally deviate from the ETSI specified requirements and this deviation does not affect the ability of the AirPrime WISMO228 to connect to the cellular network and be fully functional, as it does within the Class A range.

The detailed climatic and mechanics standard environmental constraints applicable to the AirPrime WISMO228 are listed in the table below.

WISMO228		ENVIRONMENTAL CLASSES		
TYPE OF TEST	STANDARDS	STORAGE Class 1.2	TRANSPORTATION Class 2.3	OPERATING (PORT USE) Class 7.3
Cold	IEC 68-2.1 Ab test	-25° C 72 h	-40° C 72 h	-20° C (GSM900) 16 -10° C (GSM1800/1900) 16h
Dry heat	IEC 68-2.2 Bb test	+70° C 72 h	+70° C 72 h	+55° C 16 h
Change of temperature	IEC 68-2.14 Na/Nb test		-40° / +30° C 5 cycles t1 = 3 h	-20° / +30° C (GSM900)3 cycle -10° / +30° C (GSM1800/1900): 3 cycles t1 = 3 h
Damp heat cyclic	IEC 68-2.30 Db test	+30° C 2 cycles 90% - 100% RH variant 1	+40° C 2 cycles 90% - 100% RH variant 1	+40° C 2 cycles 90% - 100% RH variant 1
Damp heat	IEC 68-2.56 Cb test	+30° C 4 days	+40° C 4 days	+40° C 4 days
Sinusoidal vibration	IEC 68-2.6 Fc test	5 - 62 Hz : 5 mm / s 62 - 200Hz : 2 m / s2 3 x 5 sweep cycles		
Random vibration wide band	IEC 68-3.36 Fdb test		5 - 20 Hz : 0.96 m2 / s3 20 - 500Hz : - 3 dB / oct 3 x 10 min	10 -12 Hz : 0.96 m2 / s3 12 - 150Hz : - 3 dB / oct 3 x 30 min

Figure 45. Environmental Classes

5.5. Mechanical Specifications

5.5.1. Physical Characteristics

The AirPrime WISMO228 has a nearly-complete self-contained shield.

- Overall dimensions: 25.0 x 25.0 x 2.8 mm (excluding label thickness)
- Weight: 3.64g

5.5.2. AirPrime WISMO228 Dimensions

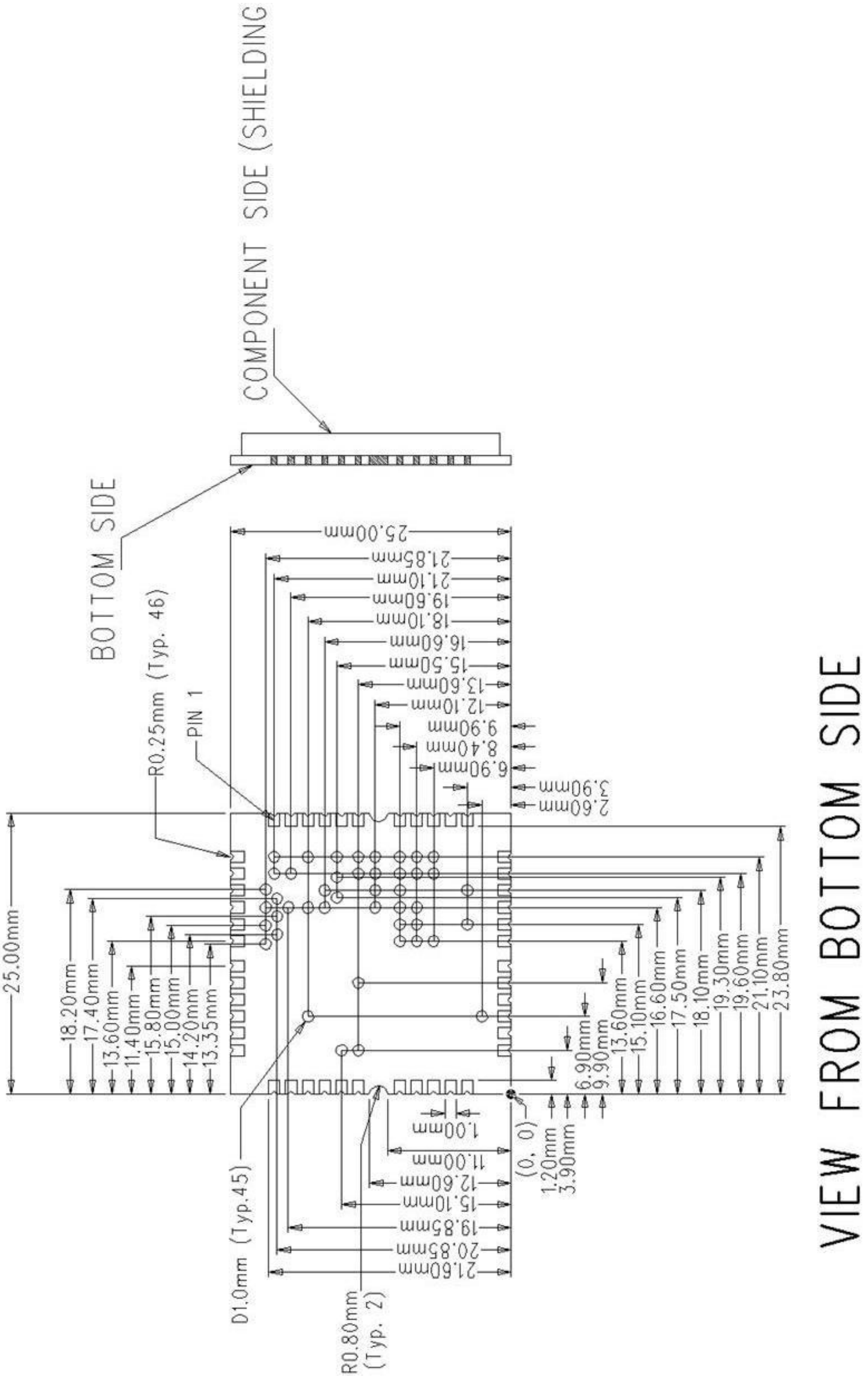


Figure 46. Castellation Pin Dimension and Location

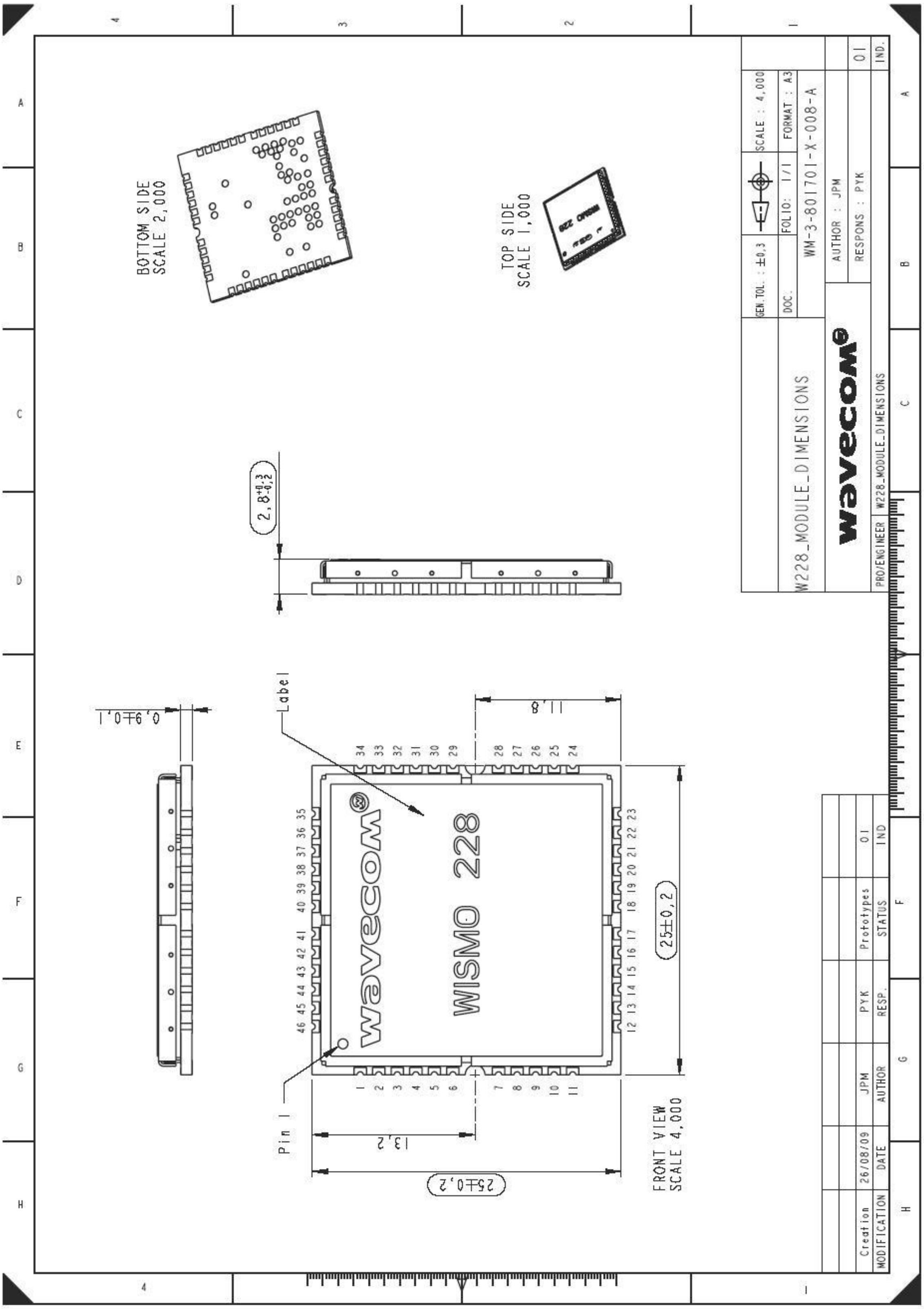


Figure 47. AirPrime WISMO228 Dimensions

5.5.3. Recommended PCB Landing Pattern

Refer to document [4] AirPrime Customer Process Guideline for WISMO Series document.

5.6. Conformance with ATEX 94/9/CE Directive

To evaluate the conformity of a product using the AirPrime WISMO228 with ATEX 94/9/CE directive, the integrator must take into account the following data from the AirPrime WISMO228:

- Sum of all capacitors: 38µF
- Sum of all inductors: 6µH
- Biggest single capacitor: 5.2µF
- Biggest single inductor: 5.7µH

6. Recommended Peripheral Devices

6.1. General Purpose Connector

The general purpose connector is a 46-pin castellation connector with a 1.5mm pitch.

6.2. SIM Card Reader

Listed below are the recommended SIM Card Readers to use with the AirPrime WISMO228.

- ITT CANNON CCM03 series (see http://www.ittcannon.com)
- AMPHENOL C707 series (see http://www.amphenol.com)
- JAE (see http://www.jae.co.jp/e-top/index.html)

Drawer type:

- MOLEX 99228-0002 (connector) / MOLEX 91236-0002 (holder) (see http://www.molex.com)

6.3. Microphone

Microphones can be obtained from the following recommended suppliers:

- HOSIDEN
- PANASONIC
- PEIKER

6.4. Speaker

Speakers can be obtained from the following recommended suppliers:

- SANYO
- HOSIDEN
- PRIMO
- PHILIPS

6.5. Antenna Cable

Listed below are the recommended antenna cables to mount on the AirPrime WISMO228.

- RG178
- RG316

6.6. GSM Antenna

GSM antennas and support for antenna adaptation can be obtained from manufacturers such as:

- ALLGON (http://www.allgon.com)
- HIRSCHMANN (http://www.hirschmann.com/)

7. Noises and Design

7.1. EMC Recommendations

EMC tests have to be performed as soon as possible on the application to detect any possible problems.

When designing a GSM terminal, make sure to take note of the following items:

- Possible spurious emissions radiated by the application to the RF receiver in the receiver band.
- ESD protection is mandatory for all peripherals accessible from outside (SIM, serial link, audio, AUX_ADC0, etc.).
- EMC protection on audio input/output (filters against 900MHz emissions).
- Biasing of the microphone inputs.
- Length of the SIM interface lines (preferably <10cm).
- Ground plane: It is recommended to have a common ground plane for analog/digital/RF grounds.
- It is recommended to use a metallic case or plastic casing with conductive paint.

7.2. Power Supply

The power supply is one of the key issues in the design of a GSM terminal and careful attention should be paid to the following:

- Quality of the power supply: low ripple, PFM or PSM systems should be avoided (using a PWM converter is preferred).
- The capacity to deliver high current peaks in a short time (pulsed radio emission).

A weak power supply design could affect the following items specifically:

- EMC performances
- The emissions spectrum
- Phase error and frequency error

7.3. Overvoltage

The AirPrime WISMO228 does not include any protection against overvoltage.

8. Certification Compliance and Recommended Standards

8.1. Certification Compliance

The AirPrime WISMO228 Embedded Module is compliant with the following requirements.

Table 44: Standards Conformity for the AirPrime WISMO228 Embedded Module

Domain	Applicable Standard
Safety standard	EN 60950-1 (ed.2006)
Health standard (EMF Exposure Evaluation)	EN 62311 (ed. 2008)
Efficient use of the radio frequency spectrum	EN 301 511 (V 9.0.2)
EMC	EN 301 489-1 (v1.8.1) EN 301 489-7 (v1.3.1) EN 301 489-24 (v1.4.1)
FCC	FCC Part 15 FCC Part 22, 24
IC	RSS-132 Issue 2 RSS-133 Issue 5

8.2. Applicable Standards Listing

The table hereafter gives the basic list of standards applicable for 2G (R99/Rel.4).

Note: References to any features can be found from these standards.

Table 45: Applicable Standards and Requirements for the AirPrime WISMO228 Embedded Module

Document	Current Version	Title
GCF	3.34.0	GSM Certification Forum - Certification Criteria
NAPRD.03	4.4	Overview of PCS Type certification review board (PTCRB) Mobile Equipment Type Certification and IMEI control
TS 51.010-1	8.3.0	3rd Generation Partnership Project; Technical Specification Group GSM/EDGE Radio Access Network; Digital cellular telecommunications system (Phase 2+); Mobile Station (MS) conformance specification; Part 1: Conformance specification
TS 51.010-2	8.3.0	3rd Generation Partnership Project; Technical Specification Group GSM/EDGE Radio Access Network; Mobile Station (MS) conformance specification; Part 2: Protocol Implementation Conformance Statement (PICS) proforma specification
TS 51.010-4	4.14.1	3rd Generation Partnership Project; Technical Specification Group GSM/EDGE Radio Access Network; Digital cellular telecommunications system (Phase 2+); Mobile Station (MS) conformance specification; Part 4: SIM Application Toolkit Conformance specification
EN 301 511	9.0.2	Global System for Mobile Communications (GSM); Harmonised standard for mobile stations in the GSM 900 and DCS 1800 bands covering essential requirements under article 3.2 of the R&TTE directive (1999/5/EC)

Document	Current Version	Title
TS 34.121-1	8.5.0	3rd Generation Partnership Project; Technical Specification Group Radio Access Network; User Equipment (UE) conformance specification; Radio transmission and reception (FDD); Part 1: Conformance specification
TS 34.121-2	8.5.0	3rd Generation Partnership Project; Technical Specification Group Radio Access Network User Equipment (UE) conformance specification; Radio transmission and reception (FDD); Part 2: Implementation Conformance Statement (ICS)
TS 34.123-1	8.5.0	3rd Generation Partnership Project; Technical Specification Group Terminals; User Equipment (UE) conformance specification; Part 1: Protocol conformance specification

Federal Communications Commission (FCC) rules and Regulations: Power listed on the Grant is conducted for Part 22 and conducted for Part 24.

This device is to be used only for mobile and fixed applications. The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter.

Users and installers must be provided with antenna installation instructions and transmitter operating conditions for satisfying RF exposure compliance.

Antennas used for this OEM module must not exceed a gain of 7.5dBi (850 MHz) and 3.6dBi (1900 MHz) for mobile and fixed operating configurations. This device is approved as an embedded module to be installed in other devices.

Installed in other portable devices, the exposure condition requires a separate equipment authorization.

The licensed module has a FCC ID label on the module itself. The FCC ID label must be visible through a window or it must be visible when an access panel, door or cover is easily removed.

If not, a second label must be placed on the outside of the device that contains the following text:

Contains FCC ID: N7NWISMO228

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. this device may not cause harmful interference,
2. this device must accept any interference received, including interference that may cause undesired operation.

8.3. Warnings

8.3.1. Compliance Recommendations

Manufacturers of mobile or fixed devices incorporating the AirPrime WISMO228 Embedded Module are advised to:

- clarify any regulatory questions,
- have their completed product tested,
- have product approved for FCC compliance, and
- include instructions according to the above mentioned RF exposure statements in the end product user manual.

Please note that changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

8.3.2. Upgrades Forbidden

Upgrading AirPrime WS modules is strictly forbidden as the products are packed in a Tape & Reel pack and are sensitive to moisture exposure. Opening the bag for any purpose other than SMT assembly, and particularly for the purpose of upgrading the part software, is done at the sole risk to the customer and would not be covered by the standard warranty conditions.

9. Appendix

9.1. Safety Recommendations (for Information Only)

For the efficient and safe operation of your GSM application based on the AirPrime WISMO228, please read the following information carefully.

9.1.1. RF Safety

9.1.1.1. General

Your GSM terminal is based on the GSM standard for cellular technology. The GSM standard is spread all over the world. It covers Europe, Asia and some parts of America and Africa. This is the most used telecommunication standard.

Your GSM terminal is actually a low power radio transmitter and receiver. It sends out and receives radio frequency energy. When you use your GSM application, the cellular system which handles your calls controls both the radio frequency and the power level of your cellular modem.

9.1.1.2. Exposure to RF Energy

There has been some public concern about possible health effects from using GSM terminals. Although research on health effects from RF energy has focused on the current RF technology for many years, scientists have begun research regarding newer radio technologies, such as GSM. After existing research had been reviewed, and after compliance to all applicable safety standards had been tested, it has been concluded that the product was fit for use.

If you are concerned about exposure to RF energy there are things you can do to minimize exposure. Obviously, limiting the duration of your calls will reduce your exposure to RF energy. In addition, you can reduce RF exposure by operating your cellular terminal efficiently by following the guidelines below.

9.1.1.3. Efficient Terminal Operation

For your GSM terminal to operate at the lowest power level, consistent with satisfactory call quality:

If your terminal has an extendible antenna, extend it fully. Some models allow you to place a call with the antenna retracted. However, your GSM terminal operates more efficiently with the antenna fully extended.

Do not hold the antenna when the terminal is « IN USE ». Holding the antenna affects call quality and may cause the modem to operate at a higher power level than needed.

9.1.1.4. Antenna Care and Replacement

Do not use the GSM terminal with a damaged antenna. If a damaged antenna comes into contact with the skin, a minor burn may result. Replace a damaged antenna immediately. Consult your manual to see if you may change the antenna yourself. If so, use only a manufacturer-approved antenna. Otherwise, have your antenna repaired by a qualified technician.

Use only the supplied or approved antenna. Unauthorized antennas, modifications or attachments could damage the terminal and may contravene local RF emission regulations or invalidate type approval.

9.1.2. General Safety

9.1.2.1. Driving

Check the laws and the regulations regarding the use of cellular devices in the area where you have to drive as you always have to comply with them. When using your GSM terminal while driving, please:

- give full attention to driving,
- pull off the road and park before making or answering a call if driving conditions so require.

9.1.2.2. Electronic Devices

Most electronic equipment, for example in hospitals and motor vehicles, is shielded from RF energy. However, RF energy may affect some improperly shielded electronic equipment.

9.1.2.3. Vehicle Electronic Equipment

Check your vehicle manufacturer representative to determine if any on-board electronic equipment is adequately shielded from RF energy.

9.1.2.4. Medical Electronic Equipment

Consult the manufacturer of any personal medical devices (such as pacemakers, hearing aids, etc...) to determine if they are adequately shielded from external RF energy.

Turn your terminal **OFF** in health care facilities when any regulations posted in the area instruct you to do so. Hospitals or health care facilities may be using RF monitoring equipment.

9.1.2.5. Aircraft

Turn your terminal OFF before boarding any aircraft.

- Use it on the ground only with crew permission.
- Do not use it in the air.

To prevent possible interference with aircraft systems, Federal Aviation Administration (FAA) regulations require you to have permission from a crew member to use your terminal while the aircraft is on the ground. To prevent interference with cellular systems, local RF regulations prohibit using your modem while airborne.

9.1.2.6. Children

Do not allow children to play with your GSM terminal. It is not a toy. Children could hurt themselves or others (by poking themselves or others in the eye with the antenna, for example). Children could damage the modem, or make calls that increase your modem bills.

9.1.2.7. Blasting Areas

To avoid interfering with blasting operations, turn your unit OFF when in a « blasting area » or in areas posted: « turn off two-way radio ». Construction crews often use remote control RF devices to set off explosives.

9.1.2.8. Potentially Explosive Atmospheres

Turn your terminal **OFF** when in any area with a potentially explosive atmosphere. It is rare, but your application or its accessories could generate sparks. Sparks in such areas could cause an explosion or fire resulting in bodily injuries or even death.

Areas with a potentially explosive atmosphere are often, but not always, clearly marked. They include fuelling areas such as petrol stations; below decks on boats; fuel or chemical transfer or storage facilities; and areas where the air contains chemicals or particles, such as grain, dust, or metal powders.

Do not transport or store flammable gas, liquid, or explosives in the compartment of your vehicle which contains your terminal or accessories.

Before using your terminal in a vehicle powered by liquefied petroleum gas (such as propane or butane) ensure that the vehicle complies with the relevant fire and safety regulations of the country in which the vehicle is to be used.

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