



# **Power Consumption Modes**

## **Application Note**

Revision: **004**  
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**wavecom**<sup>®</sup>

MAKE IT WIRELESS

Author:	Wavecom SA					Date:	23 Sept. 2005				
APN Content Level	BASIC	INTERMEDIATE	ADVANCED	<input checked="" type="checkbox"/>	Confidentiality	Public	<input checked="" type="checkbox"/>	Private			
Software Compatibility*	Firmware:	X51	Open AT®	N/A	IP Connectivity	N/A	Compiler Used	N/A	Reference Hardware	No	
									Reference Software	Yes	
* refer to software compatibility matrix section for more detail											
Hardware Compatibility	Modems:	M1206B	<input checked="" type="checkbox"/>	M1306B	<input checked="" type="checkbox"/>	M2106B	<input checked="" type="checkbox"/>				
	Quik (CDMA):	Q2358C		Q2438F		Q2438R					
	Quik (GSM):	Q2400A	<input checked="" type="checkbox"/>	Q2403A		Q2406A	<input checked="" type="checkbox"/>	Q2406B	<input checked="" type="checkbox"/>	Q2501B	

## 1 INTRODUCTION

This APN (Application Note) is provided to Wavecom distributors and clients to understand the different power mode features available on the Wavecom port folio of cellular solutions. To request a new application note, contact your regional Wavecom Product Marketing Manager.

## 2 DOCUMENT HISTORY

Level	Date	History	Author
001	10-May-2005	Initial document for OS X51	
002	06-July-2005	Reviewed document	
003	28-Jul-05	Official names used for different power modes	
004	23-Sept-2005	Power Consumption Measures	

## 3 REFERENCE HARDWARE

No reference hardware is necessary with this application note

## 4 PACKAGE DELIVERABLES

This application note is delivered as a single document as follows:

Filename	Description
Power_Consumption_Modes.doc	Application note for power consumption modes

### 4.1 DOCUMENTATION

This application note.

### 4.2 SOFTWARE / HARDWARE

N/A

## 5 SOFTWARE COMPATIBILITY MATRIX

Core	Open AT®	IP	Compatibility
X51	N/A	N/A	Yes

## 6 APPLICATION NOTE DESCRIPTION

The document describes

- Different power modes supported by Wavecom modules.
- Steps to configure low power modes
- Power consumed in low power modes.

## 7 SUPPORT

For direct clients: contact your Wavecom FAE  
For distributor clients: contact your distributor FAE  
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## 9 GLOSSARY

Term	Meaning
Registered state	State of the module when the module has successfully logged on to a service provider.
Fast Idle state	State of the module when there is no activity on the air interface as well as on the serial link.
Data Terminal Equipment	A communications device that is the source or destination of signals on a network. It is typically a terminal or computer.
Data Communication Equipment	A device that establishes, maintains and terminates a session on a network. It may also convert signals for transmission. It is typically the modem.
RS-232	<b>(Recommended Standard-232)</b> A standard for serial transmission between computers and peripheral devices using a 25-pin DB-25 or 9-pin DB-9 connector.
Connected State	State of the module when a communication is established (GSM, DCS, GPRS).

## 10 ABBREVIATIONS

DTE	Data Terminal Equipment
DCE	Data Communication Equipment
DTR	Data Terminal Ready
CTS	Clear To Send
SMS	Short Message Services
RTC	Real Time Clock

## 11 FEATURE DESCRIPTION

The power consumption of a mobile device is dependent on the interactions with the network and its peripherals. Wavecom provides multiple ways to switch the module to a low power mode in order to reduce the power consumption.

The key contributions to the power consumption arise from the following:

- GSM or GPRS active connection with network (e.g. call, SMS)
- GSM/GPRS stack is active with no connection
- SIM is active
- Serial port access

- Embedded application is executing
- Module running in normal or low power mode

The module consumes the maximum power in Connected mode, i.e. when a connection is active with the network. When there is no active connection, the module will be in Fast Idle mode. The power consumption in the fast idle mode is lesser when compared to the connected mode.

## 12 Low power modes

The fact that not all of the features will be required all the time is taken as an advantage and low power modes are devised. These modes allow switching the module to a state which disallows some of the features. Detailed description of the various modes can be found in the following sections.

### 12.1 Slow Idle Mode

Slow Idle mode is a low power mode in which the module will have restricted access to the serial interface. This mode can be either enabled or disabled using the AT+W32K command. See section 15 for detailed description of usage of this command. When this mode is activated, the module goes into power down mode in 1 to 15 seconds and in this mode, a 32 kHz internal clock is used during the inactivity stage. In this case, the module will automatically wake up to be able to receive any data. The embedded application will still be running.

The activation and deactivation of this mode is initiated by the customer device connected on the serial interface (DTE). DTR pin should be pulled DOWN for activating the low power mode. To deactivate this mode DTR pin should be pulled UP.

#### 12.1.1 Power down control via RS-232

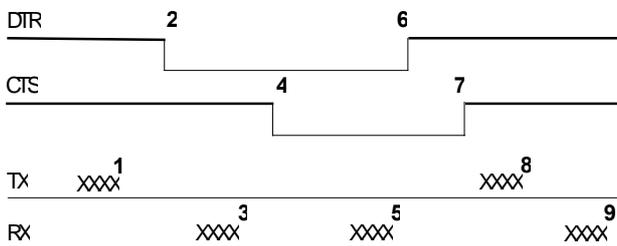
This section describes how to activate/deactivate power down mode via RS-232 serial link. The power down mode can be triggered only when the DCE is idle and no connection to the network is in progress.

The DTE sends a request to the DCE to enter the power down mode. On receiving this request, the DTE drops DTR and stops transmission on the TX line. The DCE in turn drops CTS within a time interval of 5s to acknowledge the power down mode.

AT responses can be sent to the DTE even if the DCE is in power down mode. For this, the DCE suspends its power down mode, sends the requested AT response and recovers the power down mode.

Power down mode is exited when the DTE raises DTR. The DCE in turn raises CTS within a time interval of 2s thereby disabling the power down mode.

The following diagram depicts the handshaking required for entering the power down mode:



Description of the steps:

- 1: the DTE sends an AT command
- 2: the DTE drops DTR to make the DCE enter the power down mode.
- 3: the DCE sends back the AT response (if any)
- 4: the DCE drops CTS: it enters the power down mode.
- 5: the DCE sends back an unsolicited response (for instance a RING or +SMTI (incoming SMS indication))
- 6: the DTE wants to reply to that unsolicited response so it raises the DTR, causing the DCE to exit the power down mode.

- 7: the DCE acknowledges the exit of the power down mode by raising CTS.
- 8) & 9) exchange of AT commands/responses.

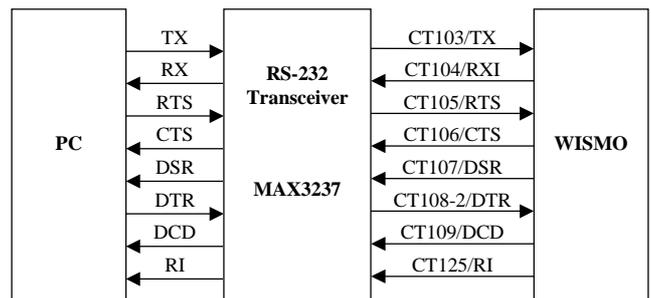
**Note 1):** The DTE must not send any AT commands from steps 2 to 7.

**Note 2):** During the latency period (between steps 2 and 4) should the DTE want to abort the power down mode, it raises DTR and should wait for 150µs before assessing CTS. If CTS is still high then the DCE has aborted the power down mode and is ready to receive AT commands.

The 150µs wait should get around the race condition between DTR raise and CTS drop.

#### 12.1.2 RS-232 Interface

This section gives the schematic interface and the way the signals are named in this document.



### 12.2 Network De-registration Mode

In this mode, the module will be deregistered from the network and hence none of the network related activities can be performed during this period. However, serial interface will be available and the embedded application will be executed in this mode.

The module can be switched to this state by using the "AT+COPS=2" command. See section 15 for detailed description about the usage of this command. To deactivate this mode and gain access to the network, "AT+COPS=0" or "AT+COPS=1" command should be used.

### 12.3 Open AT® Max Mode

This mode powers down the hardware. While using this command, the ON/OFF switch should be HIGH. The network related functionality (e.g. call, SMS, SIM, etc) will be unavailable. The embedded application will still be running.

This mode can be activated using the "AT+CPOF" command. See section 15 for a detailed description of the command. The module can be switched to slow idle mode using the "AT+CFUN=1" command.

### 12.4 OFF Mode

This mode powers down the hardware. While using this command, the ON/OFF switch should be LOW. None of the functionality will be available in this mode. The embedded application will not be running.

This mode can be activated using the "AT+CPOF" command, when the ON/OFF switch is LOW. This mode can be deactivated by placing the ON/OFF switch to HIGH.

### 12.5 Fast Standby Mode

In this mode, SIM and RF are deactivated. The embedded application will still be running and the serial port will remain active (AT commands are available). If any data has to be transmitted over the network, the RF will have to be activated first. The connection can then be made to send the data.

The module can be switched to this mode by using "AT+WBHV=1,1" command. The module must be restarted in order to take the new behavior into account. During reset, the module will be initialized without the GSM stack or network

registration. To disable this mode, use the AT command AT+WBHV=1,0. See section 15 for detailed description on usage of AT+WBHV command.

**Note:** This mode is supported in 6.41b and also from x.50a version of software.

### 12.6 Slow Standby Mode

This mode is similar to the Fast Standby mode with Slow Idle mode also activated.

The module can be switched to this mode by using "AT+WBHV=1,2" command. The module must be restarted in order to take the new behavior into account. All the features are disabled in this case (no GSM, GPRS, SIM and serial port availability) except Open AT<sup>®</sup>. To disable this mode, use the AT command AT+WBHV=1,0.

See section 15 for detailed description on usage of AT+WBHV command.

**Note:** This mode is supported only from X.50a version of software.

## 13 Combination of Low Power Modes

A combination of the low power modes explained in the above section can be used along with the Real Time Clock to achieve optimum power consumption while satisfying the operational needs of the module. This section describes the ways of using the combination of these commands.

### 13.1 Alarm Mode (OFF Mode Along With Alarm)

This requires a set of AT commands to be sent to the module. AT+CALA will be used to set an alarm and the module can be switched off using AT+CPOF. Once the alarm goes off, the module will be automatically started. This method can be used to save the power when it is not required.

Detailed steps of achieving this are given below:

1. Switch on the module and release ON/OFF pin (ON/OFF =1 during 1 second, then ON/OFF back to 0)
2. Check for the module (Type AT and wait for a OK )
3. Set the time (Type AT+CCLK = "yy/mm/dd,hh:mm:ss")
4. Check the time (Type AT+CCLK?)
5. Set the alarm (Type AT+CALA="yy/mm/dd,hh:mm ")
6. Switch off the module (Type AT+CPOF and wait for an OK with no AT command after).
7. Wait for the alarm. When the alarm is set up the module wakes up and come to fast idle mode with all the AT command and RF part (even if ON/OFF pin is LOW).
8. Check if the module responds (Type AT+CMEE=1)
9. Now, another alarm can be set (Type AT+CALA="yy/mm/dd,hh:mm")
10. Then switch off the module (Type AT+CPOF and wait for a OK)
11. Wait for the alarm, the module automatically wakes up and comes to fast idle mode.

In the above case, for steps 1 to 5 the current has a relative constant value with high peaks due to paging. After step 6, the power consumption falls down to only RTC consumption value till the module wakes up again.

### 13.2 Resource Saving

In addition to the alarm and CPOF commands, resource saving command (AT+WBHV) can be used to reduce the power consumption further. The steps that should be followed are given below:

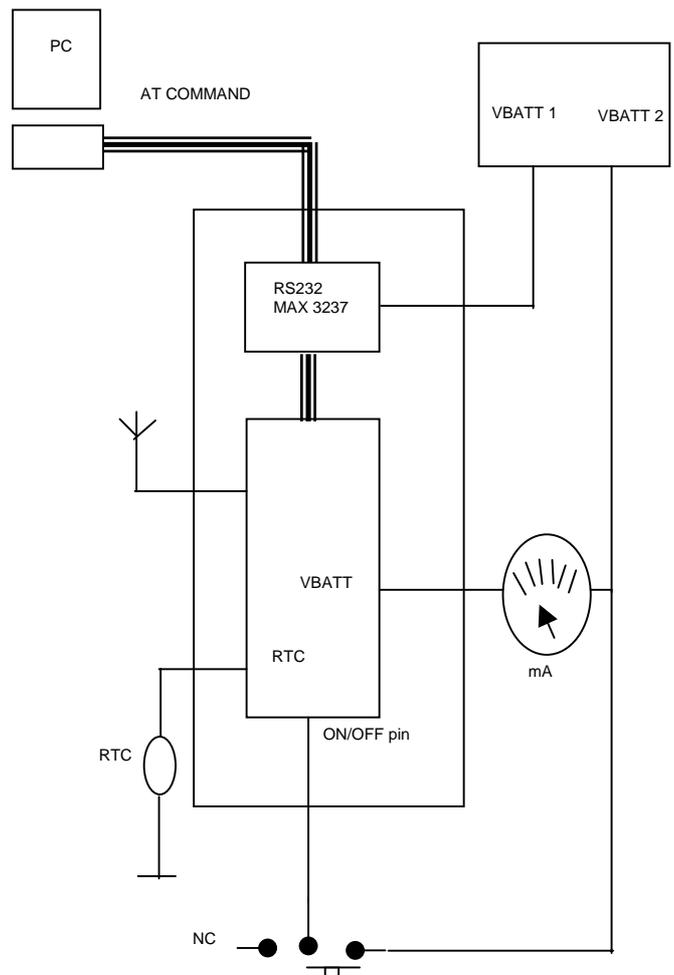
1. Switch on the module and release ON/OFF pin (ON/OFF =1 during 1 second, then ON/OFF back to 0)
2. Check for the module (Type AT and wait for a OK )
3. Set the time (Type AT+CCLK = "yy/mm/dd,hh:mm:ss")

4. Check the time (Type AT+CCLK?)
5. Set the resource saving mode (Type AT+WBHV=1,1)
6. Set the alarm (Type AT+CALA="yy/mm/dd,hh:mm ")
7. Switch off the module (Type AT+CPOF and wait for an OK with no AT command after).
8. Wait for the alarm. When the alarm is set up the module wakes up and come to fast standby mode with all the AT command (even if ON/OFF pin is LOW).
9. Check if the module responds (Type AT+CMEE=1)
10. Now, another alarm can be set (Type AT+CALA="yy/mm/dd,hh:mm")
11. Then switch off the module (Type AT+CPOF and wait for a OK)
12. Wait for the alarm, the module automatically wakes up and comes to fast standby mode.

In this case, for steps 1 to 5 the current has a relative constant value without high peak due to paging. After step 6, the power consumption falls down to only RTC consumption value till the module wakes up again.

## 14 Power Measurement

This section describes the various steps to be followed to make the power measurement. Figure 1 describes the hardware configuration.



**Figure 1 – Hardware configuration for measuring power**

In the figure, VBATT 1 is used to supply only the MAX 3237 in order to avoid over consumption on the multimeter display. The consumption of this component is roughly 15 mA alone. VBATT 2

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supplies power to the module in order to read the real value on the multimeter display. RTC is supplied a battery backup of 2.8 V. After configuring in the above mentioned manner, the value of the multimeter should be read to note the power consumption. Each of the commands should be given and the difference in power consumption can be noted.

Note: RS-232 MAX 3237 invert the signal levels. In case of a direct connection between a micro-processor and the module, this have to be taken into account.

## 15 Related AT Commands

The various commands that can be used for switching the module to low power modes are described in this section.

### 15.1 Power Off +CPOF

#### 15.1.1 Description

This specific command stops the GSM software stack as well as the hardware layer, or the module activity. The AT+CFUN=0 command is equivalent to +CPOF.

AT Command Syntax	
AT+CPOF	
Command	Possible responses
AT+CPOF <i>Note: Stop GSM stack</i>	OK <i>Note: Command valid</i>
AT+CPOF=1 <i>Note: Stop the module</i>	OK <i>Note: Command valid</i>

When "AT+CPOF" command is given, the module remains up and only the GSM software stack turns down. In this stage, features related to SIM (like phonebook read, SMS read, etc) and network related features and commands (like AT+CSQ, AT+COPS?, etc) are not available. The module can still respond to AT commands (as the serial port is still available) and any embedded application will also keep running. Any GSM stack related command/operation will return suitable error code as the stack is not available. Refer to section 15.2 for further details on the impact of the command AT+CPOF (equivalent to AT+CFUN=0).

In case of AT+CPOF=1 command, the module stops functioning and the command is equivalent to switching off the module. None of the features are available after giving this command and the module also stops responding to AT commands. To restart using the module, hard reset has to be done.

#### 15.1.2 Defined values

No parameter

### 15.2 Set Phone Functionality +CFUN

#### 15.2.1 Description

This command selects the mobile station's level of functionality. When the application wants to stop the product with a power off, or if the application wants to force the product to execute an IMSI DETACH procedure, then it must send AT+CFUN=0. This command executes an IMSI DETACH and makes a backup copy of some internal parameters in SIM and in EEPROM. The SIM card cannot then be accessed.

If the mobile equipment is not powered off by the application after this command has been sent, a re-start command (AT+CFUN=1) will have to issued to restart the whole GSM registration process.

If the mobile equipment is turned off after this command, then a power on will automatically restart the whole GSM process.

The AT+CFUN=1 command restarts the entire GSM stack and GSM functionality: a complete software reset is performed. All parameters are reset to their previous values if AT&W was not used.

If entries are written in the phonebook (+CPBW) and then the product is reset directly (AT+CFUN=1, with no previous AT+CFUN=0 command), some entries may not be written (the SIM task does not have enough time to write entries in the SIM card). In addition, the OK response will be sent at the last baud rate defined by the +IPR command. With the autobauding mode the response can be at a different baud rate, it is therefore preferable to save the defined baud rate with AT&W before directly sending the AT+CFUN=1 command.

Note: The command AT+CFUN=0 is equivalent to AT+CPOF.

AT Command Syntax	
AT+CFUN=<functionality level>	
Command	Possible responses
AT+CFUN? <i>Note: Ask for current functionality level</i>	+CFUN: 1 OK <i>Note: Full functionality</i>
AT+CFUN=0 <i>Note: Set minimum functionality, IMSI detach procedure</i>	OK <i>Note: Command valid</i>
AT+CFUN=1 <i>Note: Set the full functionality mode with a complete software reset</i>	OK <i>Note: Command valid</i>

#### 15.2.2 Defined values

<functionality level>

0: Set minimum functionality, IMSI detach procedure

1: Set the full functionality mode with a complete software reset

### 15.3 Modem Behavior Configuration +WBHV

#### 15.3.1 Description

This command allows the user to configure the behavior of WAVECOM modem.

If parameter1 = 0, the command is not related to Low Power Consumption modes.

If parameter1 = 1, the behavior at init is normal, powerless (Fast Standby mode) or low consumption. In the powerless case, no calls (even emergency calls) are available.

AT Command Syntax	
AT+WBHV = <parameter1>,<parameter2> According to parameter1: AT+WBHV = 0,<mode> AT+WBHV = 1,<mode>	
Command	Possible responses
AT+WBHV=1,0 <i>Note: Modem normal (and default) mode</i>	OK
AT+WBHV=1,1 <i>Note: Modem fast standby mode</i>	OK
AT+WBHV?	+WBHV: 0,0 +WBHV: 1,0 OK
AT+WBHV=?	+WBHV: 0,(0-1) +WBHV: 1,(0-2) OK
AT+WBHV=2,3 <i>Note: Illegal parameters</i>	+CME ERROR: 3 <i>Note: Wrong parameters</i>

### 15.3.2 Defined values

<parameter1>: mode, 0 – 1

0: configure modem response on outgoing voice calls (default value)

<parameter2>: modem response sending (with parameter1 = 0)

0: modem response sent on call establishment (default value)

1: modem response sent when audio path is opened

1: configure modem mode

<parameter2>: modem init mode (with parameter1 = 1)

0: modem init mode is normal (default value)

1: modem init mode is powerless (Fast Standby mode)

2: modem init mode is low consumption (Slow Standby mode)

Parameter1 value	Parameter2 value	Meaning
0	0	modem response is sent on call establishment (default)
0	1	modem response is sent when audio path is opened
1	0	Modem normal mode (default)
1	1	Modem fast standby mode
1	2	Slow standby mode

Refer to section 12.5, 12.6 and 17 for details on features disabled by using this command.

## 15.4 Alarm Management +CALA

### 15.4.1 Description

This command is used to set alarms date/time in the ME.

The maximum number of alarms is 16.

Note: The date/time should be already set with AT+CCLK command before using AT+CALA.

### AT Command Syntax

AT+CALA=<date and time string> (set alarm)

AT+CALA="",<index> (delete alarm)

Command	Possible responses
AT+CALA="00/06/09,07:30" <i>Note: set an alarm for June 9<sup>th</sup>, 2000 at 7:30 am</i>	OK <i>Note: Alarm stored</i>
AT+CALA="99/03/05,13:00:00" <i>Note: set an alarm for March 5<sup>th</sup>, 1999 at 1:00 pm</i>	+CME ERROR: 3 <i>Note: Invalid alarm (date/time expired)</i>
AT+CALA?  <i>Note: list all alarms</i>	+CALA: "00/06/08,15:25:00",17 +CALA: "00/06/09,07:30:00",2 +CALA: "00/06/10,23:59:00",3 <i>Note: three alarms are set (index 1, 2, 3)</i>
	+CALA: "00/06/08,15:25:00",1 <i>Note: an alarm occurs (index 1)</i>
AT+CALA="",3 <i>Note: delete alarm index 3</i>	OK <i>Note: Alarm index 3 deleted</i>
AT+CALA? <i>Note: list all alarms</i>	+CALA: "00/06/09,07:30:00",2 <i>Note: Only one alarm (index 2)</i>

### 15.4.2 Defined values

#### <date and time string>

String format for alarms: "yy/MM/dd,hh:mm:ss" (see +CCLK).

Note: Seconds are taken into account.

#### <index>

offset in the alarm list, range 1 to 16.

## 15.5 Wavcom Slow Idle Mode +W32K

### 15.5.1 Description

This specific command allows the slow idle mode to be enabled or disabled.

### AT Command Syntax

AT+W32K=<mode>

Command	Possible responses
AT+W32K=1 <i>Note: Enable 32kHz power down mode (slow idle Mode)</i>	OK <i>Note: Slow idle mode is enabled</i>
AT+W32K=0 <i>Note: Disable slow idle mode</i>	OK <i>Note: Slow idle mode is disabled</i>

### 15.5.2 Defined values

#### <mode>:

0: Disable Slow Idle Mode

1: Enable Slow Idle Mode

Refer to section 12.1 for information on Slow Idle Mode.

## 15.6 Operator Selection +COPS

### 15.6.1 Description

This command sets the mode of network selection and can also select a particular network operator. The module can also be deregistered from the network when network operations are not required using this command, thus enabling low power consumption.

The different modes of operator selection are:

- Manual mode: If the product is in manual mode, it tries to find the operator specified by the application and if found, tries to register.
- Automatic mode: If the product is in automatic mode it tries to find the home operator and if found, tries to register. If not found, the product automatically searches for another network.

This command is not allowed during communication.

AT Command Syntax	
AT+COPS=<mode>[,<format>[,<operator>]]	
Command	Possible responses
AT+COPS=2 <i>Note: Ask for deregistration from network</i>	OK <i>Note: Succeeded</i>
AT+COPS=0 <i>Note: Ask for registration on home network</i>	OK <i>Note: Succeeded</i>
AT+COPS? <i>Note: Ask for current PLMN</i>	+COPS: 0,2,20801 OK <i>Note: Home PLMN is France Telecom Orange</i>
AT+COPS=1,2,20810 <i>Note: Ask for registration on SFR network</i>	+CME ERROR: 32 <i>Note: Network not allowed – emergency calls only</i>

### 15.6.2 Defined values

<mode>:

- 0: automatic (default)
- 1: manual
- 2: deregistration; ME will be unregistered until <mode>=0 or 1 is selected.
- 3: set only <format> (for read command AT+COPS?)
- 4: manual/automatic: if manual selection fails, automatic mode is entered.

<format>: format of <operator> field

- 0: long alphanumeric format < operator>
- 1: short alphanumeric format < operator>
- 2: numeric < operator> (default value)

<operator>: operator identifier (MCC/MNC in numeric format only for operator selection)

AT+COPS=2 command enables network deregistration resulting in reduced power consumption by the module. No network related feature will be available in this case.

## 16 References

- WM\_ASW\_OAT\_UGD\_016-005 - AT Commands Interface Guide for X.51
- Appendixes to AT commands interface guide for X51

## 17 Comparison of Power Consumption

The table below gives a summary of the various power consumption modes and the different features available in these power consumption modes.

Mode→ Feature ↓	Connected Mode		Fast Idle Mode		Slow Idle Mode		Network Deregistration Mode	Open AT® Max Mode	OFF Mode	Fast Standby Mode	Slow Standby Mode	Alarm Mode
Power Consumption (mA)	GSM PCL5 300	GSM PCL19 100	Pag9* 9,5	Pag2* 12	Pag9* 2,5	Pag2* 5,5	9,5	8,5	0,004	8,5	1,5	0,009
Mode Activation					DTR Down AT+W32K=1		AT+COPS=2	AT+CPOF ON/OFF=1	AT+CPOF ON/OFF=0	AT+WBHV=1,1 AT+CFUN=1	AT+WBHV=1,2 AT+CFUN=1 DTR Down	AT+CPOF ON/OFF=0
Mode De-activation					DTR Up		AT+COPS=0	AT+CFUN=1	ON/OFF=1	AT+WBHV=1,0 AT+CFUN=1	AT+WBHV=1,0 AT+CFUN=1	Alarm wake up
Low Power Mode	ON		ON		ON		OFF	OFF	OFF	OFF	ON	ON
Normal Mode	ON		ON		ON (Paging)		ON	ON	OFF	ON	OFF	OFF
Serial Port	ON		ON		OFF		ON	ON	OFF	ON	OFF	OFF
Open AT®	ON		ON		ON		ON	ON	OFF	ON	ON	OFF
GSM/GPRS (RF)	ON		ON		ON		OFF	OFF	OFF	OFF	OFF	OFF
Active Connection	ON		OFF		OFF		OFF	OFF	OFF	OFF	OFF	OFF
SIM	ON		ON		ON		ON	OFF	OFF	ON	ON	OFF
RF during init	N/A		N/A		ON		ON	ON	OFF	OFF	OFF	OFF
Stack	ON		ON		ON		ON	OFF	OFF	ON	ON	OFF
Module	ON		ON		ON		ON	ON	OFF	ON	ON	OFF
Mandatory RTC wired	NO		NO		NO		NO	NO	NO	NO	NO	YES

\* In GSM900, PCL5 means at TX<sub>Max</sub>, PCL19 means at TX<sub>Min</sub>, Pag2 stands for Paging 2 (0,5 second), Pag9 stands for Paging 9 (2 seconds).

### Note:

- Power Consumptions measurements have been made on the OS 651/Q2406B platform.
- Power Consumptions have been made with VBatt set to 3.8v in GSM mode.
- Power Consumptions given are average values. These values can be different from a module to an other one.

### Warning:

- Emergency calls cannot be made when the radio is OFF.
- Slow Idle Mode suffers of an issue in the OS X51 version that make it consume more than it should. This will be fixed in the OS X55 version.

APPLICATION NOTE

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