# 14. Introduction to AT Commands

AT commands are instructions used to control a modem. AT is the abbreviation of ATtention. Every command line starts with "AT" or "at". That's why modem commands are called AT commands. Many of the commands that are used to control wired dial-up modems, such as ATD (Dial), ATA (Answer), ATH (Hook control) and ATO (Return to online data state), are also supported by GSM/GPRS modems and mobile phones. Besides this common AT command set, GSM/GPRS modems and mobile phones support an AT command set that is specific to the GSM technology, which includes SMS-related commands like AT+CMGS (Send SMS message), AT+CMSS (Send SMS message from storage), AT+CMGL (List SMS messages) and AT+CMGR (Read SMS messages).

Note that the starting "AT" is the prefix that informs the modem about the start of a command line. It is not part of the AT command name. For example, D is the actual AT command name in ATD and +CMGS is the actual AT command name in AT+CMGS. However, some books and web sites use them interchangeably as the name of an AT command.

Here are some of the tasks that can be done using AT commands with a GSM/GPRS modem or mobile phone:

* Get basic information about the mobile phone or GSM/GPRS modem. For example, name of manufacturer (AT+CGMI), model number (AT+CGMM), IMEI number (International Mobile Equipment Identity) (AT+CGSN) and software version (AT+CGMR).
* Get basic information about the subscriber. For example, MSISDN (AT+CNUM) and IMSI number (International Mobile Subscriber Identity) (AT+CIMI).
* Get the current status of the mobile phone or GSM/GPRS modem. For example, mobile phone activity status (AT+CPAS), mobile network registration status (AT+CREG), radio signal strength (AT+CSQ), battery charge level and battery charging status (AT+CBC).
* Establish a data connection or voice connection to a remote modem (ATD, ATA, etc).
* Send and receive fax (ATD, ATA, AT+F\*).
* Send (AT+CMGS, AT+CMSS), read (AT+CMGR, AT+CMGL), write (AT+CMGW) or delete (AT+CMGD) SMS messages and obtain notifications of newly received SMS messages (AT+CNMI).
* Read (AT+CPBR), write (AT+CPBW) or search (AT+CPBF) phonebook entries.
* Perform security-related tasks, such as opening or closing facility locks (AT+CLCK), checking whether a facility is locked (AT+CLCK) and changing passwords (AT+CPWD).  
  (Facility lock examples: SIM lock [a password must be given to the SIM card every time the mobile phone is switched on] and PH-SIM lock [a certain SIM card is associated with the mobile phone. To use other SIM cards with the mobile phone, a password must be entered.])
* Control the presentation of result codes / error messages of AT commands. For example, you can control whether to enable certain error messages (AT+CMEE) and whether error messages should be displayed in numeric format or verbose format (AT+CMEE=1 or AT+CMEE=2).
* Get or change the configurations of the mobile phone or GSM/GPRS modem. For example, change the GSM network (AT+COPS), bearer service type (AT+CBST), radio link protocol parameters (AT+CRLP), SMS center address (AT+CSCA) and storage of SMS messages (AT+CPMS).
* Save and restore configurations of the mobile phone or GSM/GPRS modem. For example, save (AT+CSAS) and restore (AT+CRES) settings related to SMS messaging such as the SMS center address.

Note that mobile phone manufacturers usually do not implement all AT commands, command parameters and parameter values in their mobile phones. Also, the behavior of the implemented AT commands may be different from that defined in the standard. In general, GSM/GPRS modems designed for wireless applications have better support of AT commands than ordinary mobile phones.

In addition, some AT commands require the support of mobile network operators. For example, SMS over GPRS can be enabled on some GPRS mobile phones and GPRS modems with the +CGSMS command (command name in text: Select Service for MO SMS Messages). But if the mobile network operator does not support the transmission of SMS over GPRS, you cannot use this feature.

**14.1. Basic Commands and Extended Commands**

There are two types of AT commands: basic commands and extended commands.

Basic commands are AT commands that do not start with "+". For example, D (Dial), A (Answer), H (Hook control) and O (Return to online data state) are basic commands.

Extended commands are AT commands that start with "+". All GSM AT commands are extended commands. For example, +CMGS (Send SMS message), +CMSS (Send SMS message from storage), +CMGL (List SMS messages) and +CMGR (Read SMS messages) are extended commands.

# 15. General Syntax of Extended AT Commands

The general syntax of extended AT commands is straightforward. The syntax rules are provided below. The syntax of basic AT commands is slightly different. We will not cover the syntax of basic AT commands in this SMS tutorial since all SMS messaging commands are extended AT commands.

**Syntax rule 1**. All command lines must start with "AT" and end with a carriage return character. (We will use *<CR>* to represent a carriage return character in this SMS tutorial.) In a terminal program like HyperTerminal of Microsoft Windows, you can press the Enter key on the keyboard to output a carriage return character.

Example: To list all unread inbound SMS messages stored in the message storage area, type "AT", then the extended AT command "+CMGL", and finally a carriage return character, like this:

AT+CMGL*<CR>*

**Syntax rule 2**. A command line can contain more than one AT command. Only the first AT command should be prefixed with "AT". AT commands in the same command-line string should be separated with semicolons.

Example: To list all unread inbound SMS messages stored in the message storage area and obtain the manufacturer name of the mobile device, type "AT", then the extended AT command "+CMGL", followed by a semicolon and the next extended AT command "+CGMI":

AT+CMGL;+CGMI*<CR>*

An error will occur if both AT commands are prefixed with "AT", like this:

AT+CMGL;AT+CGMI*<CR>*

**Syntax rule 3**. A string is enclosed between double quotes.

Example: To read all SMS messages from message storage in SMS text mode (at this time you do not need to know what SMS text mode is. More information will be provided later in this SMS tutorial), you need to assign the string "ALL" to the extended AT command +CMGL, like this:

AT+CMGL="ALL"*<CR>*

**Syntax rule 4**. Information responses and [result codes](http://www.developershome.com/sms/resultCodes.asp) (including both final result codes and unsolicited result codes) always start and end with a carriage return character and a linefeed character.

Example: After sending the command line "AT+CGMI*<CR>*" to the mobile device, the mobile device should return a response similar to this:

*<CR><LF>*Nokia*<CR><LF>*  
*<CR><LF>*OK*<CR><LF>*

The first line is the information response of the AT command +CGMI and the second line is the final result code. *<CR>* and *<LF>* represent a carriage return character and a linefeed character respectively. The final result code "OK" marks the end of the response. It indicates no more data will be sent from the mobile device to the computer / PC.

When a terminal program such as HyperTerminal of Microsoft Windows sees a carriage return character, it moves the cursor to the beginning of the current line. When it sees a linefeed character, it moves the cursor to the same position on the next line. Hence, the command line "AT+CGMI*<CR>*" that you entered and the corresponding response will be displayed like this in a terminal program such as HyperTerminal of Microsoft Windows:

AT+CGMI  
Nokia  
  
OK

## 15.1. Information Response and Final Result Code

Don't forget the meanings of information response and final result code stated above, since you will see these two terms frequently as you go through this SMS tutorial.

AT+CGMI  <-- Command line entered  
Nokia  <-- Information response  
  
OK  <-- Final result code

## 15.2. Case Sensitivity of AT Commands

In the SMS specification, all AT commands are in uppercase letters. However, many GSM/GPRS modems and mobile phones allow you to type AT commands in either uppercase or lowercase letters. For example, on Nokia 6021, AT commands are case-insensitive and the following two command lines are equivalent:

AT+CMGL*<CR>*

at+cmgl*<CR>*

# 16. Result Codes of AT Commands

Result codes are messages sent from the GSM/GPRS modem or mobile phone to provide you information about the execution of an AT command and the occurrence of an event. Two types of result codes are useful to you when dealing with AT commands for SMS messaging:

* Final result codes
* Unsolicited result codes

## 16.1. Final Result Codes of AT Commands

A final result code marks the end of an AT command response. It is an indication that the GSM/GPRS modem or mobile phone has finished the execution of a command line. Two frequently used final result codes are OK and ERROR. Only one final result code will be returned for each command line. Thus, you will not see both OK and ERROR in the response of a command line.

### 16.1.1. The OK Final Result Code

The OK final result code indicates that a command line has been executed successfully by the GSM/GPRS modem or mobile phone. It always starts and ends with a carriage return character and a linefeed character.

Here is an example for illustration. Let's say you send the command line "AT+CMGL;+CGMI*<CR>*" to your GSM/GPRS modem. The AT command "+CMGL" is used to list SMS messages stored in the message storage area and the AT command "+CGMI" is used to get the manufacturer name of the GSM/GPRS modem. If everything works properly without any errors, the command line, together with the response returned, should be something similar to this:

AT+CMGL;+CGMI*<CR>*  
*<CR><LF>*+CMGL: 1,"REC UNREAD","+85291234567",,"06/11/11,00:30:29+32"*<CR><LF>*  
Welcome to our SMS tutorial.*<CR><LF>*  
*<CR><LF>*Nokia*<CR><LF>*  
*<CR><LF>*OK*<CR><LF>*

As mentioned earlier, when a terminal program such as HyperTerminal of Microsoft Windows sees a carriage return character, it moves the cursor to the beginning of the current line. When it sees a linefeed character, it moves the cursor to the same position on the next line. Hence, the command line you entered, together with the response returned, will be displayed like this in a terminal program such as HyperTerminal of Microsoft Windows:

AT+CMGL;+CGMI  
+CMGL: 1,"REC UNREAD","+85291234567",,"06/11/11,00:30:29+32"  
Welcome to our SMS tutorial.  
  
Nokia  
  
OK

### 16.1.2. The ERROR Final Result Code

The ERROR final result code indicates that an error occurs when the GSM/GPRS modem or mobile phone tries to execute a command line. After the occurrence of an error, the GSM/GPRS modem or mobile phone will not process the remaining AT commands in the command-line string.

Below are some common causes of error:

* The syntax of the command line is incorrect.
* The value specified to a certain parameter is invalid.
* The name of the AT command is spelt incorrectly.
* The GSM/GPRS modem or mobile phone does not support one or more of the AT commands, command parameters or parameter values in the command-line string.

Like the OK final result code, the ERROR final result code always starts and ends with a carriage return character and a linefeed character.

Here is an example for illustration. Suppose you want to instruct your GSM/GPRS modem to list SMS messages from the message storage area and get the manufacturer name of the GSM/GPRS modem. You intend to type the command line "AT+CMGL;+CGMI*<CR>*" but make a careless mistake by typing "+CMFL" instead of "+CMGL". The GSM/GPRS modem will return the ERROR final result code, as shown below:

AT+CMFL;+CGMI*<CR>*  
*<CR><LF>*ERROR*<CR><LF>*

As an error occurs when the GSM/GPRS modem processes "+CMFL", the GSM/GPRS modem stops the execution of the command line and so the second AT command "+CGMI" is not processed.

If you type the second AT command "+CGMI" incorrectly instead of the first AT command "+CMGL", the GSM/GPRS modem will output the result of the execution of the AT command "+CMGL" before outputting the ERROR final result code, like this:

AT+CMGL;+CGMU*<CR>  
<CR><LF>*+CMGL: 1,"REC UNREAD","+85291234567",,"06/11/11,00:30:29+32"*<CR><LF>*  
Welcome to our SMS tutorial.*<CR><LF>*  
*<CR><LF>*ERROR*<CR><LF>*

As mentioned earlier, when a terminal program such as HyperTerminal of Microsoft Windows sees a carriage return character, it moves the cursor to the beginning of the current line. When it sees a linefeed character, it moves the cursor to the same position on the next line. Hence, the command line you entered, together with the response returned, will be displayed like this in a terminal program such as HyperTerminal of Microsoft Windows:

AT+CMGL;+CGMU+CMGL: 1,"REC UNREAD","+85291234567",,"06/11/11,00:30:29+32"  
Welcome to our SMS tutorial.  
  
ERROR

# 17. AT Command Operations: Test, Set, Read and Execution

There are four types of AT command operations:

* **Test operation**. A test operation is used to check whether a certain AT command is supported by the GSM/GPRS modem or mobile phone.
* **Set operation**. A set operation is used to change the settings used by the GSM/GPRS modem or mobile phone for certain tasks.
* **Read operation**. A read operation is used to retrieve the current settings used by the GSM/GPRS modem or mobile phone for certain tasks.
* **Execution operation**. An execution operation is used to perform an action or retrieve information/status about the GSM/GPRS modem or mobile phone.

The command syntax for performing an operation will be described in detail in the following sections.

## 17.1. Test Command -- Checks Whether a Certain AT Command is Supported

A test operation is used to check whether a certain AT command is supported by the GSM/GPRS modem or mobile phone. All extended AT commands support the test operation. The syntax is:

*command*=?

where *command* is an AT command. When an AT command is used in the above syntax to perform a test operation, it is called a test command.

Here is an example. The AT command +CGMI (command name in text: Request Manufacturer Identification) is used to get the manufacturer name of the GSM/GPRS modem or mobile phone. To test whether +CGMI is supported, you can make use of the test command "+CGMI=?". The complete command line that should be entered is:

AT+CGMI=?

If the GSM/GPRS modem or mobile phone supports the AT command +CGMI, the result code "OK" will be returned, like this:

AT+CGMI=?  
OK

If the GSM/GPRS modem or mobile phone does not support the AT command +CGMI, the result code "ERROR" will be returned, like this:

AT+CGMI=?  
ERROR

In the above example, the AT command +CGMI does not have any parameters. If the AT command to be tested has parameter(s), the parameter value(s) supported by the GSM/GPRS modem or mobile phone may be printed additionally. Below is an example that illustrates the format of the response. +COMMAND1 is a fictitious AT command that has four parameters.

AT+COMMAND1=?  
+COMMAND1: (0,1),(0-10),(0,1,5-10),("GSM","UCS2")  
  
OK

The supported values of each of the four parameters are enclosed in parentheses. Commas are used to delimit the parentheses and the values inside parentheses. A hyphen is used to indicate a range of values. The values inside parentheses can be of the string type.

In the above example, the response of the test command "+COMMAND1=?" provides us the following information:

* (0,1). The first parameter accepts either 0 or 1.
* (0-10). The second parameter accepts any integer between 0 and 10.
* (0,1,5-10). The third parameter accepts 0, 1 or any integer between 5 and 10.
* ("GSM","UCS2"). The fourth parameter accepts either the string "GSM" or "UCS2".

To a few AT commands, the test operation does not return the parameter values supported. Instead, it returns the values that are allowed to appear in the information response of the AT command. An example is the +CBC AT command (command name in text: Battery Charge). The +CBC command is used to retrieve the connection status and charge level of the battery of the mobile device. Two values are returned in the information response of the +CBC AT command. The format is:

+CBC: *connection\_status*,*charge\_level*

For example, if the battery is placed in the mobile device with no charger connected and the charge level is 80%, the result of the execution of the +CBC AT command will be:

AT+CBC  
+CBC: 0,80  
  
OK

If you run the test command "+CBC=?", all the supported values that are allowed to appear in the connection status field and charge level field will be provided. With my Nokia 6021, the result is:

AT+CBC=?  
+CBC: (0,1),(0-100)  
  
OK

"(0,1)" means the connection status field in the information response of the +CBC AT command can contain either 0 or 1, while "(0-100)" means the charge level field can contain any integer between 0 and 100.

# 18. Testing the Communication between the PC and GSM/GPRS Modem or Mobile Phone

Suppose you have connected your GSM/GPRS modem or mobile phone to your PC / computer and started a terminal program (such as HyperTerminal on Microsoft Windows). Now you are ready to enter your first command. The first thing that is usually done is to test the communication between the PC and GSM/GPRS modem/mobile phone to confirm that everything is working properly so far. Simply enter "AT" in the terminal program to perform the test. When the GSM/GPRS modem or mobile phone receives "AT", it will send back the final result code "OK" to indicate that it has received your command successfully, like this:

AT  
OK

# 20. Operating Mode: SMS Text Mode and SMS PDU Mode

The SMS specification has defined two modes in which a GSM/GPRS modem or mobile phone can operate. They are called SMS text mode and SMS PDU mode. (PDU stands for Protocol Data Unit.) The mode that a GSM/GPRS modem or mobile phone is operating in determines the syntax of some SMS AT commands and the format of the responses returned after execution. Below are the SMS AT commands affected:

* +CMGS (Send Message)
* +CMSS (Send Message from Storage)
* +CMGR (Read Message)
* +CMGL (List Messages)
* +CMGW (Write Message to Memory)
* +CNMA (New Message Acknowledgement to ME/TA)
* +CMGC (Send Command)

The syntax of the [unsolicited result codes](http://www.developershome.com/sms/resultCodes3.asp) below also depends on the mode in which the GSM/GPRS modem or mobile phone is operating:

* +CMT (Used to forward received SMS messages to the computer / PC.)
* +CBM (Used to forward received cell broadcast messages to the computer / PC.)
* +CDS (Used to forward received status reports to the computer / PC.)

These two AT commands are useful to you only if SMS text mode is used:

* +CSMP (Set Text Mode Parameters)
* +CSDH (Show Text Mode Parameters)

## 20.1. Comparison of SMS Text Mode and SMS PDU Mode

Below we compare SMS text mode and SMS PDU mode from various aspects. The comparison should help you learn the differences between these two modes and decide which mode should be used by your SMS messaging application.

**Syntax of SMS AT Commands and Responses**

When the GSM/GPRS modem or mobile phone is operating in different modes, the syntax of certain SMS AT commands and the responses returned after command execution is different. Here's an example for illustration. Let's say you would like to send the SMS message "It is easy to send text messages." to the mobile phone number +85291234567. In SMS text mode, this is the command line that you should enter:

AT+CMGS="+85291234567"*<CR>*It is easy to send text messages.*<Ctrl+z>*

However, if the GSM/GPRS modem or mobile phone is operating in SMS PDU mode, executing the above command line will cause an error to occur. This is because the syntax of the +CMGS AT command is different in SMS PDU mode. To do the same task, the following command line should be used instead:

AT+CMGS=42*<CR>*07915892000000F001000B915892214365F7000021493A283D0795C3F33C88FE06CDCB6E32885EC6D341EDF27C1E3E97E72E*<Ctrl+z>*

**Defined Values for Certain Parameters**

When the GSM/GPRS modem or mobile phone is operating in different modes, the defined values for certain parameters are different. Usually string values are defined for text mode while numeric values are defined for PDU mode. For example, the +CMGL AT command is used to list SMS messages stored in message storage. It takes one parameter that specifies the status of the SMS messages to be retrieved. The following table lists the defined values for the parameter in text mode and PDU mode:

| **Message status** | **Defined values in text mode** | **Defined values in PDU mode** |
| --- | --- | --- |
| Received unread | "REC UNREAD" | 0 |
| Received read | "REC READ" | 1 |
| Stored unsent | "STO UNSENT" | 2 |
| Stored sent | "STO SENT" | 3 |
| All messages | "ALL" | 4 |

Suppose you would like to list all SMS messages from message storage. If the GSM/GPRS modem or mobile phone is operating in SMS text mode, you should assign the string value "ALL" to the +CMGL AT command, like this:

AT+CMGL="ALL"

In SMS PDU mode, the numeric value 4 should be assigned to the +CMGL AT command instead:

AT+CMGL=4

**Input/Output Format of SMS Messages Used by SMS AT Commands**

When the GSM/GPRS modem or mobile phone is operating in different modes, the input/output format of SMS messages used by SMS AT commands is different. In SMS text mode, headers and body of SMS messages are inputted/outputted as separate parameters/fields. In SMS PDU mode, TPDUs (Transport Protocol Data Units) in hexadecimal format are inputted and outputted. Headers and body of SMS messages are encoded in the TPDUs.

Here is an example for illustration. To send the SMS message "It is easy to send text messages." to the mobile phone number +85291234567, the following command line should be used in SMS text mode. As you can see below, the destination phone number header and message body are provided to the +CMGS AT command as separate parameters.

AT+CMGS="+85291234567"*<CR>*It is easy to send text messages.*<Ctrl+z>*

To send the same SMS text message in SMS PDU mode, the following command line should be used instead. The message body, destination phone number header and some other headers are encoded in the hexadecimal sequence.

AT+CMGS=42*<CR>*07915892000000F001000B915892214365F7000021493A283D0795C3F33C88FE06CDCB6E32885EC6D341EDF27C1E3E97E72E*<Ctrl+z>*

**Ease of Use**

As you can see in the previous example, it is easier to use AT commands in SMS text mode. You do not have to learn about the structure of different types of TPDUs in the bit level and the encoding and decoding of the hexadecimal sequence.

**Supported Features of SMS Messaging**

Although it is easier to use AT commands in SMS text mode, it supports fewer features of SMS messaging than SMS PDU mode. This is because you do not have complete control over the header values and message body in SMS text mode. Some tasks, although can be done in text mode, require the programmer to have knowledge about PDU mode and TPDU. For example, to request a status report from SMSC in SMS text mode, you have to set bit 5 of the first octet of the SMS-SUBMIT TPDU to 1 by the AT command +CSMP (command name in text: Set Text Mode Parameters). Similar tasks include setting the message validity period and sending a flash SMS message that immediately pops up on the phone screen when it arrives at the destination.

**Level of Support**

SMS PDU mode is more commonly supported by GSM/GPRS modems and mobile phones than SMS text mode.