

Stand Alone User's Guide for the 'Base Station'

This document has been written to detail the commands to be sent to the Arduino and the replies returned to the Workstation. This interaction is hidden from the User when the EXCEL Workbook and the Arduino are in communication. This document reflects the Design Aim and can be used to test for compliance and to show this interaction.

This document is written assuming that the User had downloaded the "Serial Debug Assistant" from the Windows 10 Store. All commands apart from the 'ACK?' communicate with the SIM800L Module and a check is undertaken to confirm that the SIM800L Module is powered before transmitting the 'AT' command such that the system doesn't 'hang up' and not make a reply. This check consists of using the Analogue-To-Digital converter to measure the Supply Voltage on the SIM800L Module. If this check fails, then the reply is "SIM800L NOT POWERED".

Commands that interact with the SIM800L Module terminate with a pair of brackets even if no parameters are passed. If there is a passed parameter, it must be included between the brackets. This replicates the syntax of a Function as in the Arduino IDE and Visual Basic for Applications.

The screenshot shows the 'Serial Debug Assistant' window. The title bar reads 'COM3,9600,None,8,One - Serial Debug Assistant'. The interface is divided into several sections:

- Serial Port Settings:** Includes dropdowns for 'Serial Port' (set to COM3), 'Baud Rate' (9600), 'Data Bits' (8), 'Parity' (None), and 'Stop Bits' (One). These are circled with a blue line pointing to a text box: 'Select the COM Port Number found when installing the 'Base Station'. Must be 9600 Baud; 8 data bits; none parity and one stop bit'.
- Open serial port:** A button with a blue arrow pointing to it from a text box: 'Enable communications by 'clicking' on this button'.
- Receiving settings:** Includes checkboxes for 'Receive and save to file', 'HEX display', 'Pause receiving display', and 'Auto break frame' (set to 20). It also has 'Save data' and 'Empty data' links.
- Send settings:** Includes checkboxes for 'Send a file', 'HEX Send', 'Add check' (set to ADD8), 'Timing send' (set to 1.0 sec), 'DTR', and 'RTS'. It also has a 'Line break' dropdown (set to \r\n (CRLF)) and a 'Show Send string' checkbox.
- Transmit Window:** A text area containing the command 'verify()' with a blue arrow pointing to it from a text box: 'Transmit Window'.
- Receive Window:** A text area showing 'Send : 8' and 'Receive : 31' with a blue arrow pointing to it from a text box: 'Receive Window'.
- Send Button:** A button with a right-pointing arrow, with a blue arrow pointing to it from a text box: 'Send Button'. It also has a 'Reset count' link.

The Windows taskbar is visible at the bottom, showing the Start button, search bar, and various application icons.

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The UNO / Phone combination will operate in a standalone manner and respond to the following serially received commands

The sketch converts the inputted command into UPPER CASE, so the User can type either Lower or Upper Case into the Input Window

1. ACK?

Clear the Send Window; enter ACK? and 'click' on the send button. Displayed in the Receive Window will be the reply of "OK(number of the Base Station)", e.g. OK(1).

The response time for this command is about 4 seconds

The number of the Base Station is stored as a constant within the code. The acceptable values are 1 to 4, this is due to the use of legacy code in the EXCEL Workbook. This is to enable up to four Base Stations to correctly function in different Workbooks on one Workstation.

2. VERIFY()

Clear the Send Window; enter VERIFY() and 'click' on the send button. Displayed in the Receive Window will be the reply of "'status','subscriber number','battery status','rssi','ber'" where:

a. Status

Where the command "AT+CGREG" is used to find the network registration status

Where the reply is "Code=n" where the values for 'n' are:

- i. "0" means that no network is connected
- ii. "1" means that the phone is registered to a home network
- iii. "2" means that the phone is not registered to a network but trying to connect
- iv. "3" means that the registration is denied (this is assumed to be because that the SIM Card has expired)
- v. "4" means that the network registration is UNKNOWN
- vi. "5" means that the phone is registered to a roaming network

b. subscriber number

Where the command "AT+CNUM" is used to find the subscriber number. If no subscriber number is found than it is assumed that there is no SIM Card fitted and VERIFY() will return "NO SIM".

c. battery status

Where the command "AT+CBC" is used to find the voltage applied to the phone module (shown as millivolts)

d. rssi

Where the command "AT+CSQ" is used to find the Received Signal Strength Indicator (RSSI) value from the phone module. Acceptable values are:

0	-115 dBm or less

31	-52dbBm or greater
99	not known or not detectable

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e. *ber*

Where the command "AT+CSQ" is used to find the BIT Error Rate (BER) value from the phone module. Acceptable values are:

0	0% errors

7	40% errors
99	not known or not detectable

It is important that each value be separated by a “,” as the EXCEL Workbook uses this to separate out each portion of the reply.

The response time for this command is about 6 seconds

3. **FIND(n)**

The Arduino doesn't have enough capacity in memory locations to count (and read) all the available 69 messages stored in the SIM800L Module. It is not possible to use the command AT+CMGL="ALL" to count the total number of texts stored.

When texts are cleared, the remaining texts are not automatically reassigned into the now empty slot, this command has to take this into account. This appears to happen if the SIM800L Module is powered down for some time.

This Command, FIND(n), reads the text number received by using AT+CMGR=n after setting the SIM800L Module to “Text mode” by using command AT+CMGF=1. The length of the reply is determined and if it is less than 25 characters long (short reply), it is determined to have been deleted and the next message is read. This is repeated until either 5 short replies have been read or a long reply has been read. The last reply is transmitted. Included in this reply is the number of the text. To optimise the time taken, the number of times the texts checked is limited to 5. It is planned for the EXCEL Workbook to then resend the command with the returned number until a long text is received. If the number of the text requested has not be stored, then an ERROR message will be received. This will enable all texts to be confirmed as deleted or available and read.

This command has one passed parameter that is the number of the starting text that is to be cleared. Just enter it as a number, e.g. FIND(1), there is no imposed upper limit to the value of the passed parameter.

Clear the Send Window; enter FIND(n) and ‘click’ on the send button. Displayed in the Receive Window will be the reply as follows:

Text Deleted

AT+CMGR=6

OK

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Text Found

AT+CMGR=8

+CMGR: "REC READ","+447nnnnnnnnn","","18/06/02,17:03:11+04"

Max-Temperature = 22.68:

Ni-Battery = 5.21 Volts (100%):

ACTIVITY-COUNT = 80:

Work-day = 2:

Powered-time = 16:

OK

Text Not Received

AT+CMGR=1005

ERROR

The response time for this command can be more than 30 seconds

4. CLEAR(n)

This command has one passed parameter that is the number of the text that is to be cleared. Just enter it as a number, e.g. CLEAR(1), there is no imposed upper limit to the value of the passed parameter. The Phone's memory will be cleared of the text related to the passed parameter.

Clear the Send Window; enter CLEAR(n) and 'click' on the send button. Displayed in the Receive Window will be the reply as follows:

Location cleared

AT+CMGD=1,0

OK

No text stored at the required location

AT+CMGD=1000,0

ERROR

The number returned is the same as the passed parameter.

The response time for this command is up to 30 seconds.

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5. SEND(telNo,text)

This command has two passed parameters that are (the mobile number that the text is to be sent too and the text to be sent separated by a "," that the coding uses together with both brackets to read the parameters. The mobile number can either start with "0" or "+44" (or any other international code).

Send a text to the telephone number with the text as detailed in the passed parameters using:

- a. "AT+CMGF=1" to set the phone module to text mode
- b. "AT+CMGS" to send the text

From the SIM800L's AT Commands manual, the response time for this command can be up to 60 seconds, but experience has shown that it will take less time than that.

Clear the Send Window; enter SEND(phone_number,text) and 'click' on the send button. Displayed in the Receive Window will be the reply as follows:

```
AT+CMGS="07nnnnnnnnnn"HELLO
```

```
>
```

6. NETLIGHT CONTROL

This command has a query as well as an action. The NETLIGHT informs the user as to the status of the SIM800L's Network Status. It can be turned ON or OFF (when ON it 'flashes' dependant upon the Network Connection).

For the query; clear the Send Window; enter NETLIGHT? and 'click' on the send button. Displayed in the Receive Window will be the reply as follows:

```
Either NETLIGHT=0 or NETLIGHT=1
```

The response time for this command is about 3 seconds.

For the command; clear the Send Window; enter NETLIGHT(1) or NETLIGHT(0) and 'click' on the send button. Displayed in the Receive Window will be the reply as follows:

```
Either NETLIGHT=0 or NETLIGHT=1
```

The response time for this command is about 5 seconds.

7. COUNT()

A partial solution was found to count the number of messages in the Message Store was found. The command "AT+CPMS?" (Preferred SMS Message Storage) was used to interrogate the number of messages stored. The default configuration is to have all three stores configured to hold RECEIVED SMS', but the reply will not count above 20, but is useful to know how many messages are stored.

For the command; clear the Send Window; enter COUNT() and 'click' on the send button. Displayed in the Receive Window will be the reply as follows:

```
Count=1
```

The response time for this command is about 3 seconds.

If the number read is '20' then the separator is changed from '=' to '>'