Tech-note

Sending SMS with UniOP

This Technical Note contains all the information needed to send and receive SMS (Short Message Service) messages with UniOP connected to a GSM modem.
SMS messages are an efficient and inexpensive way to exchange small pieces of information with a remote station. The coverage of the GSM phone system is extended to several countries and provides an excellent way to connect remote devices.
The SMS GSM driver is associated to the Designer file D32uplc191.dll.

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1 Introduction

The SMS GSM driver allows sending SMS messages over a GSM network when a compatible GSM modem is connected to one of the UniOP serial ports.

This option is the ideal solution to provide wireless cellular connectivity to remote systems, for instance those in the water treatment industry. A remote station equipped with the UniOP SMS interface can send and receive SMS messages from a GSM cellular phone. This feature can be used to send alarms directly to the cellular phone of a service technician or even to send commands directly to the controller.

The driver has been designed to work in stand-alone mode, but, quite naturally, all of its features will be fully used only when used in combination with a second driver in a dual-protocol architecture.

The second driver in the dual-protocol architecture can control the activity using a mailbox mechanism to trigger SMS messages.

The implementation in UniOP offers the possibility to use GSM modem with any PLC in the market with very limited programming effort and no added hardware costs (no extra communication ports in the PLC are required).

The typical diagram of a simple control system is shown in the figure below.

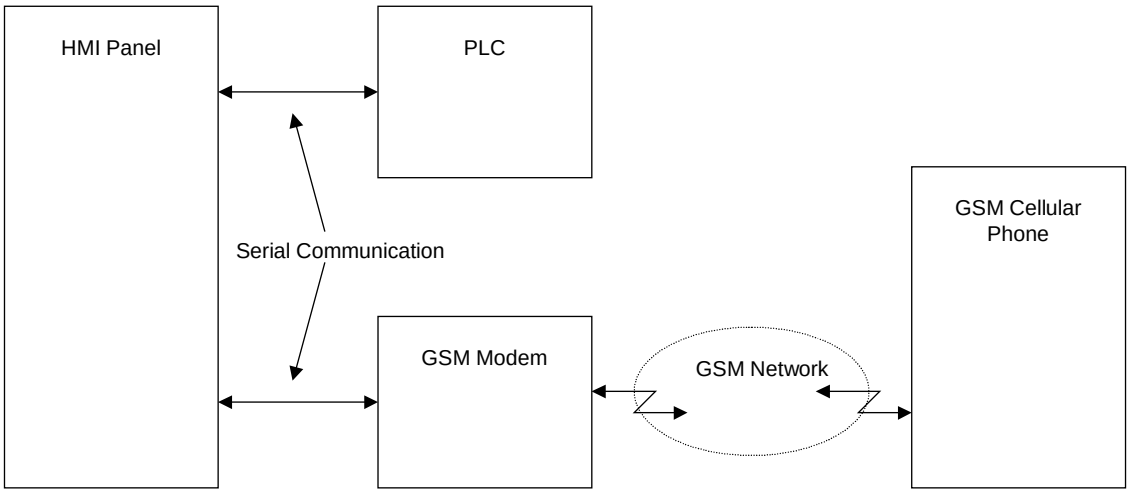

Figure 1 – Sending and receiving SMS messages; block diagram

The functions implemented by the driver are the following:

- Send SMS messages with predefined text
- Send SMS message with predefined text and including one numeric field with dynamic value
- Receive SMS message (Read and Write commands supported)
- Password protection for received SMS messages

To create a Designer project for SMS GSM, select the driver “SMS GSM” from the list of available communication drivers in the Select Controller dialog box.

Note: *In case the SMS GSM driver does not appear in the list of drivers available in your Select Controller… dialog box, make sure the D32UPLC191.DLL and D32UPLC191.INI files are present in the Designer folder and then press the Refresh button.*

2 Controller Setup

The "Controller Setup…" dialog box contains all the settings relevant to

- the connection to the GSM network
- the recipient cellular phone number
- the modem model used in the system
- the communication parameters for the connection to the modem
- the security password
- the data format of the controller used in the system
- definitions for "Update references"

Figure 2 below shows the "Controller Setup..." dialog box for the SMS GSM driver.

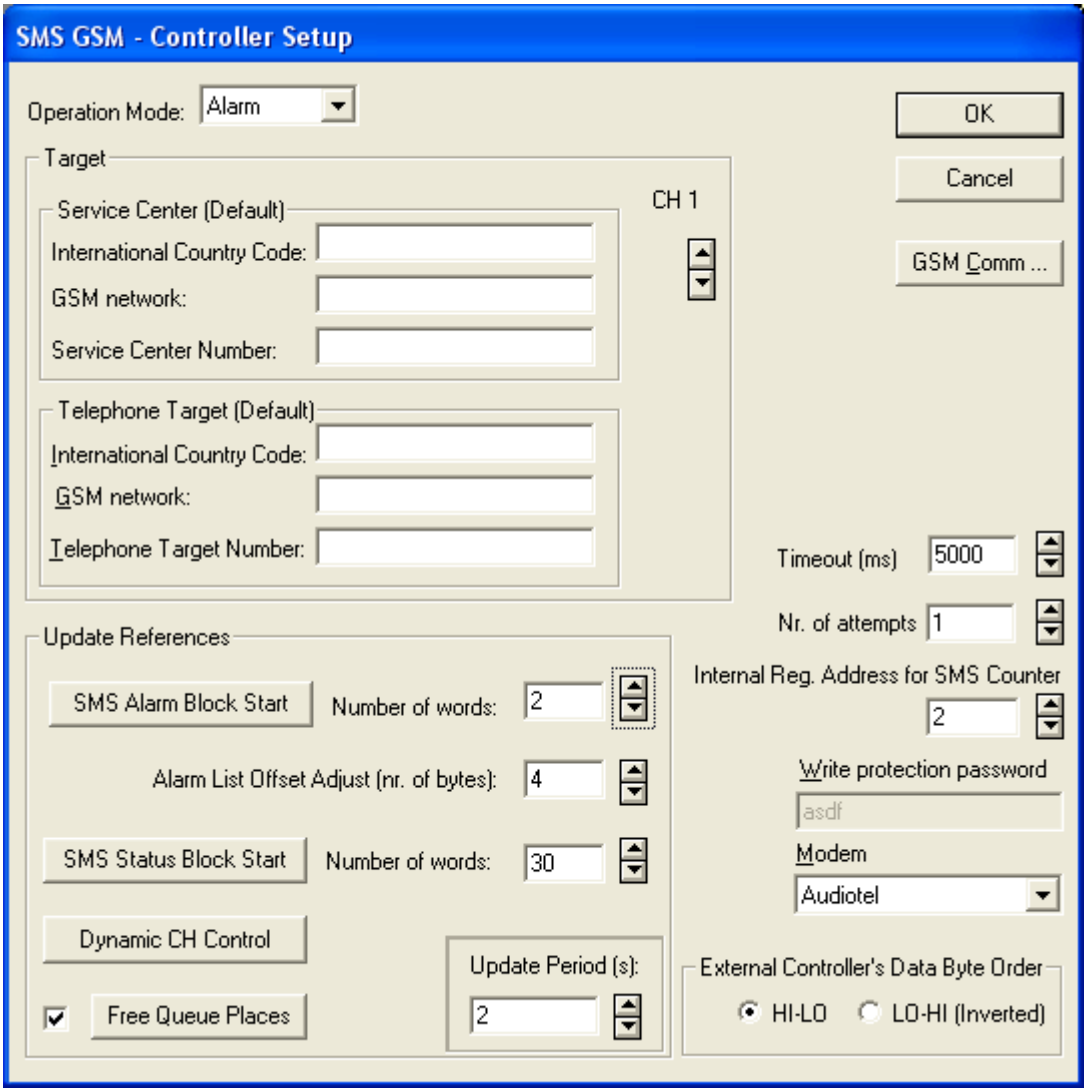

Figure 2 – Controller Setup Dialog Box

Communication parameters for serial communication with the modem can be adjusted by clicking the "PLC Comm..." button. The default communication parameters are set to 9600,N, 8,1.

To use the SMS GSM protocol with the Designer software, follow this procedure:

1) Select the option "Project/Configure Controller..." and press the button. Then select "Controller Setup".

2) Choose the type of modem in the "Modem" Combo Box.

3) By choosing the "Operation mode" you can set panel to work in "Interactive", or "Alarm" mode. (More about them later in this document)

4) The Group Box called "Target" allows user to configure default data that will be copied to ALL UniOP's "Command Headers" (later in this tech note they will be called: CHs) when starting UniOP from Configuration mode. However, CHs will keep their data if the power supply is cycled.
   Command Headers are described in detail in Chapter "Sending Mechanism".

5) The group box "Update References" is enabled only in "Alarm" mode. They allow specifying destinations inside the external controller for the direct data transfer.

6) The value of "Write protection password" shows the value of the security password defined in the INI file at the section [WRITEprotection]. The SMS driver will accept incoming commands write commands only if prefixed with the correct password. Write sessions must always be password protected. The default password is specified in the ini file, while it can be changed run time editing a special field programmable on the Designer project. The write protection password filed is of ASCII type as shown in Figure 3. Password changed at run time are stored in battery-backed RAM memory; the changes to the password object can not be stored at power cycle if the panel does not have the battery or if the battery is empty.

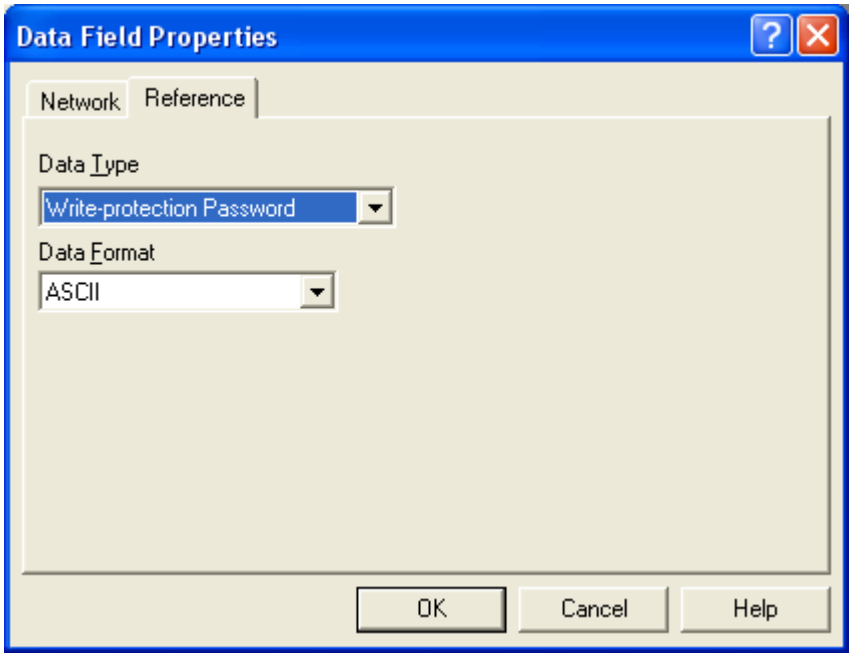

Figure 3

7) As external controllers connected to the UniOP panel in a dual driver configuration in combination with the "SMS GSM" driver, may have different ordering for data bytes inside

words; the option “External Controller’s Data Byte Order” enables the user to connect to controllers which may use either high-endian (HI-LO) or little-endian (LO-HI) byte order. This option is required to properly handle incoming messages containing the Write command; the UniOP protocol uses this setting to write the bytes in the correct order to its internal memory, in a way in which they are compatible with the external controller byte order. When using the option “LO-HI (inverted)”, please use inverted Data Formats “WORD INV” and “DBLE WORD INV” instead of “WORD” and “DBLE WORD” when defining references to UniOP Data Type “Internal Registers” for proper driver functionality.

3 Operation modes: Interactive and Alarm

3.1 Interactive Mode

3.1.1 The Define Field Properties Dialog Box

The Define Field Properties Dialog Box for SMS GSM is shown below:

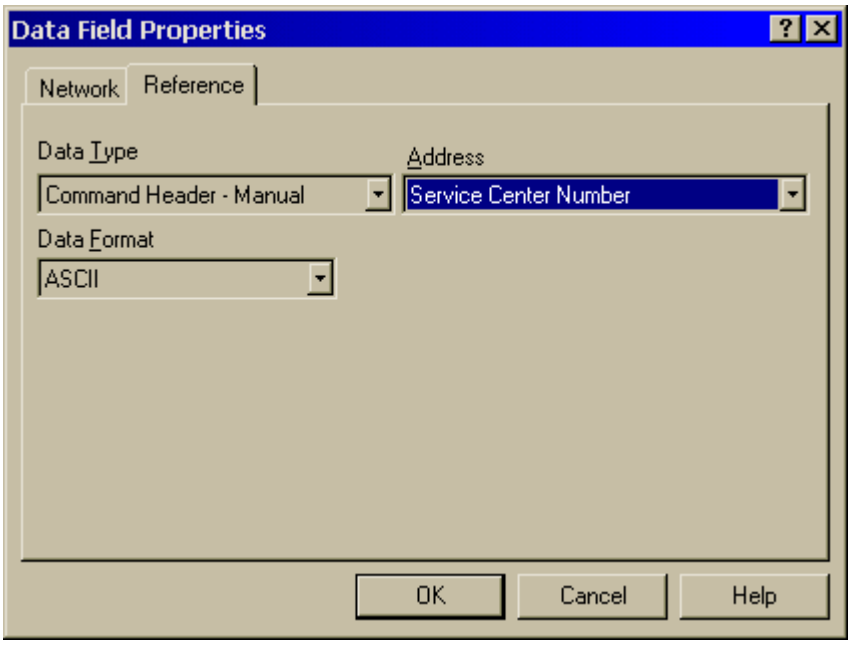

Figure 4 – Define Field Dialog box

The following Data Types are available:

Data type	Notes
Command Header – Manual	
Command Header1 – PLC driven	
…	
Command Header10 – PLC driven	
Internal Registers	Array of 128 words allocated in the internal UniOP memory. They are available for use with the application
SMS delay (s)	Allows user to specify the pause inserted by the protocol between one SMS and the other. If this register is set to "0", it means "free running": one SMS next to the other immediately after the modem is free; if the register is different from zero, its content will be interpreted like seconds between 2 SMS delivery. Range is hard coded in protocol between 0 and 20 seconds. The field programmed for SMS delay should not be created using Fixed Point or Scaling factors. This parameter is useful for the fine-tuning of the application depending on the GSM network quality
Disable SMS channel	Allows to completely disable the SMS channel; by default the parameter is set to “1”; it can be edited run time and forced to “0”; when set to “0” the communication with the modem is turned off: non SMS will be sent and all the message received by the modem will not be processed. Actually the panel does not poll the modem.

Each Command Header is a data structure that contains the elements described in the table below. Elements can be individually addressed in the Designer. The “Address” field in the dialog box allows you to select one of the elements of the Command Header structure.

Available Data formats are Bit, Byte, Word, Word INV and ASCII depending on the Data Type selection.

Inverted Data Formats are defined as follows:

```
WORD       = hi-lo                    WORD INV  = lo-hi
```

As an example, if we assume we have 2 bytes with the following contents:

```
B0 = 0x11
B1 = 0x22
```

we will have:

```
WORD       = hi-lo= 0x2211            WORD INV  = lo-hi= 0x1122
```

3.1.2 Sending Mechanism

To start sending a message, set the value of the START Command in the CH to the value 1.
This value can be set either manually or by the external controller.
Setting the START Command will trigger the message with the parameters defined in the CH.

While sending is in progress, the START Command lower byte will be set to the value 0xFF.
When the message has been set, the value of the Start Command will be reset to the value 0 to inform that the SMS was sent and that CH is ready to be accept a new session.

Note: *there can be additional Data Transfers from the UniOP to the location in the controller, coping the START Command of each CH. This way, the controller will be informed when the SMS was sent, and that CH is available for the next session.*

Command Headers (CH) are the method available to have complete control of SMS handling. Each CH defines one SMS message.
The user can send SMS messages interacting directly with the panel.
However, the most interesting solution is to automate the mechanism of sending messages with the external controller connected to the panel.

There are 11 CHs available in UniOP.
"Command Header – Manual" is dedicated to the direct interaction with the user (operator) for manual sending of SMS message.
"Command Header1 – PLC driven" to "Command Header10 – PLC driven" are accessible to the external controller using Data Transfers. Each CH describes one request for sending one SMS message. The controller can eventually prepare all the 10 headers at once and send up to 10 SMS messages in rapid sequence.

The structure of the Command Header is described below.

Address	Format	Description
Service Center - International country code	5 characters	Default country code for message center is configurable in Controller Setup.
Service Center - GSM net number	5 characters	GSM network number of the message Service Center number
SMS Service Center	12 characters	Each GSM operator determines this number. Default number is configurable in Controller Setup. The complete number is defined by country code, GSM network number and number as specified by this parameter and the two above. Message Service Center Number is required only in case the SIM card does not include the default one provided by the GSM network operator.
Telephone Target - International country code	5 characters	Default number is configurable in Controller Setup.
Telephone Target - GSM net number	5 characters	GSM Network number, default value is configurable in Controller Setup.
Telephone Target	12 characters	The phone number. Double words allows up to 10 digits to be used. The highest number is limited 4 294 967 295. Default Number is configurable in Controller Setup.
START Command	Word	Used to issue the command to start the message sending process. See below for details.
FUNCTION	Word	Attributes defining the way the message is sent. See below for details.
Message Body (optional)	160 characters	Only the ASCII style should be used. If the highest bit of the FUNCTION byte is 0, this body will be sent in the SMS message as an ASCII string. The message body must be null terminated when set by the external controller, otherwise UniOP will send the longest possible message.

Note: *The Message Body must be always null -terminated when set from the external controller via Data Transfer; null termination is not required when message body is edited manually*

START Command – The Most significant byte is not used. Setting the Least significant byte to the value 0x01 will activate the SMS sending process. When the action is being carried out the value of this byte is set to 0xFF. When the action has been successfully completed or when a time-out occurs, it will be reset to 0.

FUNCTION – the HIGH byte is not used.
The highest bit of the LOW byte has the following meaning:

- 0: "SMS message body follows". In this case the other 7 bits does not have any meaning. Message body placed in the CH after this byte will be sent as SMS text.
- 1: "send SMS message from the predefined memory". In this case the message body is ignored, and the other 7 bits (decimal values from 0 to 127) carries the index of the predefined SMS message stored in internal UniOP's memory. For more details about predefined SMS messages see Chapter 7.

3.2 Alarm Mode

The Alarm Mode can be used only in double protocol configuration. It has been designed to trigger an SMS based on the rising edge of a bit in the controller connected as second protocol.

In Alarm Mode the SMS driver is constantly getting, from the other protocol, the status of a block of data in the PLC memory; when the rising edge of a certain bit in this area is detected, an SMS delivery job is added to a queue; the system in parallel is processing the jobs queues sending all the messages waiting for delivery; the queue is stored in the internal protocol memory and allows to store a maximum number of 500 SMS. The queue ensures that if more than one bit at a time has a rising edge, the event is not lost and stored for later processing.
The queue mechanism is explained in details in the next chapter.

The data transfer between the second protocol and the SMS driver is completely transparent to the user; it is not required to configure any "classic" Data Transfer job.

The SMS text for the "Alarm mode" SMS can be configured in the standard Designer "Alarms" configuration dialog box following the rules explained later in this document.

Note: *the SMS Alarm mode requires UniOP firmware version V5.40D or above*

Mostly all the configuration of the "Alarm Mode" is done in the Controller Startup with the following parameters:

- The "**Target**" area allows to specify up to 10 different recipients for the SMS messages sent by the modem connected to UniOP; each recipient can be enabled/disabled at run time using the "Dynamic CH control" feature (see below for additional details)

- The "**SMS Alarm Block Start**" specifies the start address of the memory in the "second controller" dedicated to the SMS alarms. Each bit in this area represent an "alarm" of SMS type; the rising edge of a bit in this area triggers an SMS message; the text of the SMS message is retrieved from the list of Alarms configured in the classic Designer Alarms configuration dialog box.

- The "**Number of words**" specifies the size of the alarm block area monitored by the SMS driver. The max size of this area is set to 60 bytes, 480 alarms.

- The "**Alarm list Adjust (nr. of bytes)**" allows to specify the offset in bytes within the standard designer Alarm configuration dialog from where the SMS driver will start to read the text of the SMS messages. If for instance the offset is 2, the first SMS will get its text from Alarm number 17. The first SMS correspond to the first bit of the area specified with "**SMS Alarm Block Start**".

- The "**SMS Status Block Start**" allows specifying the starting address of a memory area in the "second controller" from where the SMS driver will start to store the error codes of each SMS sending operation; each error code is stored in a 32bit word. The "**Number of words**" parameters allow to specifies how many 16bits words are reserved in the "second controller" memory to store the error codes; when more than a double word is used, the system allows to keep track of the last few operations, depending on the size assigned to this status area.
  Each 32bits word of the status block has the following structure:

31 … 16	15 … 12	11 … 0
Alarm number	CH number	Error/even code

  Where:

  CH Number — is the command header number to which the SMS has been sent

  Error/event Code — contains the error code returned by the modem (if it has been configured for it) and the code returned by the SMS driver according to the following list:

0xFFF	SMS not sent for timeout error, the modem did not reply
0xFFE	SMS not sent, unknown error
0xFFD	SMS not added to the delivery queue; the queue is full
0xFFC	SMS has been successfully queued for later delivery
0x0	SMS successfully sent

  Handling of this status buffer is done like a FIFO queue; each new event or error goes to the top, it ensures that the recent event is at the top of the buffer. Buffer contains information since message is queued to the moment it is sent. Note that each entry represents an event for every particular Alarm, and every particular CH.

- The "**Dynamic CH Control**" allows to specify the address of a 16bits words in the "second controller" memory that will be used to dynamically control the activation of the recipients configured in the Designer project at programming time; each bit corresponds to a recipient activation status; the bit 0 is CH1, the bit 9 is CH10; the others are not used. The CHn is enabled if the bit "n" is set to true.

- The "**Free queue places**" parameters allows to specify the address of a 16bits word in the "second controller" where the SMS driver will store the number of free places in its internal sending queue; when the queue is empty the values of this register will be 500.

- The "**Update period**" specifies in seconds the interval of time between any update of all the above described fields for either read and write operations. Note that short update

periods are drastically affecting the general performances of the panel, considering in fact that all the other tasks could be slowed down.

- The "**Timeout**" allows specifying the maximum allowed response time from the modem, before the panel starts next communication attempt.
- The "**Nr. of attempts**" specifies the number of communication attempts before reporting a communication error
- The "**Internal Register address for SMS counter**" allows to specify the address of a register in eh Internal Registers where the driver stores a counter incremented at each time a valid SMS is received and processed by the modem connected to the panel.

3.2.1 Queuing Alarm Messages - Sending from the Queue

The "SMS Alarm Block Start" is the address from where the SMS GSM driver reads the status of the bits associated to the alarm messages to be sent. Each rising edge of the bits is stored in the local queue like an event. The events are stored in an internal protocol buffer structured in words; each event includes the CH number to be used for the SMS and the Alarm Number to be used when getting the SMS text form the standard Designer alarm list.
Both information are stored in the queue at the time is detected the rising edge of the bit.

The queue concept allows to queue the sending of duplicated SMS, in chronological order; in case more that one rising edge is detected, the SMS will be queued sorted by their alarm number

The specified area in the PLC memory is read according to the interval specified in "Update period".

The queue of messages is stored in the UniOP RAM battery backed memory; if the queue is not empty at the moment the power is cut, the remaining messages will be still processed at next power up.

An event is removed from the local queue both after successful sending either after the specified number of retries is elapsed and the message could not be sent.

4 RDA, Alarms, Mailbox and Data Transfer

All Data Types can be used as a reference for these functions.

5 Modem AT Commands

The modem AT commands used for SMS handling are defined in the D32Uplc191.INI file.
Support for modems using a different set of AT commands can be easily added changing the initialization file.

Note: *Information contained in the INI file must be edited according to a rigid syntax that is described in detail in the first part of the INI file.*

---

6 Receiving SMS messages

The system can accept and process also incoming SMS messages sent by a cellular phone or by a computer.
The incoming SMS messages must have a well-defined syntax to be accepted. In addition messages that can alter data in the panel must be password protected.

The system can handle three different commands.
Each command is identified by a keyword. The table below describes the available keywords.

Command	Description
RD	The incoming SMS is requesting the panel to send back an SMS message containing the value of a certain register in the UniOP Internal Memory
SEND	The incoming SMS is requesting the panel to send back one of the predefined SMS messages
WR	The incoming SMS generates a write operation to a register in the Internal Memory. This command is always password protected.
WD	The incoming SMS generates a write operation to a 32bits word register in the Internal Memory, actually two consecutive registers on the internal memory. This command is always password protected.

Each keyword must be followed by the address in the UniOP Internal Memory (see Chapter 7 for additional details).

6.1 Command Read (RD)

Use this command to fetch the value of one of the Internal Registers.
In response to a RD command, the panel will send a message containing the index of the requested register and its value.

The syntax of the request and response messages is the following:
RDnnn
where nnn stands for the index of the requested Internal Register.
The system will return a message with the following structure:
RDnnn=xxxx
where nnn is the same index as in the request message and xxxx is the value of the requested register in decimal.

Example:
Request RD012
Response RD012=1234

An error response will indicate the attempt to read a non-existing register.
Example:
Request RD5678
Response RD5678=ERR1

6.2 Command Send (SEND)

Use this command to request the panel to send one of the predefined messages.

In response to a SEND command, the panel will send the predefined message with the index specified in the request.
For more information on predefined messages please see Chapter 7.

The syntax of the request and response messages is the following:
SENDnnn
where nnn stands for the index of the requested predefined message.
The system will return a message with the following structure:
SENDnnn=This is the predefined message
where nnn is the same index as in the request message and the text of the predefined message follows the '=' character.

Example:
Request SEND001
Response SEND001=This is the predefined message 001

6.3 Command Write (WR, WD)

Use this command to write information to one of the Internal Register using an SMS message.

The syntax of the request and response messages is the following:
PpppWRnnn=xxxx or **PpppWDnnn=xxxxxxxx**
where
nnn stands for the index of the requested predefined message,
pppp is the four digit security password and
xxxx is the value to be written, the number in decimal representation must be smaller than 32767 for WR, can be a 32bit values for the WD command.

Note: *the WD command is supported only in Alarm Mode*

The default value of the password can be defined in the INI file and can be changed during runtime using Data Type "Write-protection password", available in UI, as ASCII data.

Example:
Request 9999WR127=1122
Response WR127=ERR0

After processing the command message, the panel will return an SMS message containing the completion code of the request. The message will be sent to the phone number that originated the command.
The list of the return codes is given in the table below.

Code	Description
ERR0	no error, operation completed successfully
ERR1	invalid register address, operation failed
ERR2	value exceeds register size, operation failed
ERR3	password incorrect, operation failed

Note: *when the command is not recognized (not included in the ERR1, ERR2 or ERR3 cases), the GSM driver does not return any error code.*

7 Internal Registers and Predefined Messages

The UniOP internal memory is divided in two areas:

Register memory	**Register memory** is accessible using the data type “Internal Registers” with the range 0-128. Memory is word-organized.
Predefined message memory (NOTE: relevant only for “Interactive” operation mode, as “Alarm” mode uses messages predefined in Alarm list)	**Predefined message memory** cannot be accessed directly from Designer project file. It contains strings defined in the INI file in the section [PredefinedSMS]. There can be a maximum of 128 predefined SMS messages with a maximum length of 160 characters each.

The relation between the two types of memories is explained below.

Register address	MSB	LSB
Reg000	0	0
Reg001	0	11
Reg002	0	22
Reg004	0	33
...		
Reg127		

Table 1 – Register memory

The values shown in the Register Memory are examples.

Message index	Text
000	This is SMS nr 0
001	This is SMS nr 1
002	This is SMS nr 2
003	Air temperature is [Reg002] (C)
…	…
127	…

Table 2 – Predefined message memory

Predefined messages can contains static text as well as dynamic values. You may embed in the content of an SMS the value of one Internal Register. To include in the content of the SMS the value of a certain register, use the following syntax:

[Regnnn]

where nnn is the index of the internal register to be referenced.

To send a predefined message you have to define a Command Header with all necessary information and then set the content of the LSB of the FUNCTION word as follows:

bit	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
	Don’t care								1	Index of predefined message						

Setting the bit set of the LSB of FUNCTION triggers the sending of the selected message number.

Example:
If FUNCTION LS byte is set to 0x83, the following SMS will be sent:

"**Air temperature is 22 (C)**"

Note that the value 3 in 0x83 is the index of the row in the Predefined message memory, not in Register memory!
The reference [Reg002] has been substituted with the value of Internal Register with index 2.

In case of “Alarm” operating mode, principle of composing the message is the same, with the only difference that FUNCTION LOW byte is composed by protocol itself, depending of the queue buffer.

7.1 Alarm mode: 32 bit Registers and Two Variables

When the driver is used in Alarm Mode, there is also the possibility to use 2 registers in the SMS text. In Alarm mode the text of the messages is specified in the standard Designer Alarms configuration dialog box.
To specify a 32bit register value in the SMS text, use the following syntax:

[Regnnn,Regpppp] or [Regpppp,Regnnnn]

depending on the required word ordering.

The Alarm Mode supports also the possibility to specify two separated 16bits registers in the SMS text.

Appendix A. Communication Error Codes

Current communication status is displayed in the System Menu of the UniOP. Beside the string describing current state of the communication, there is an additional error code representing the last (which may be not the current one) error encountered. The codes are following:

Code	Description	Notes
00	No error	
05	Timeout error	Indicates a timeout in communication. The communication line has been broken or the modem has had a power fail.
06	Reception buffer overrun	UniOP has received a frame whose length exceeds the size of its reception buffer.
07	General communication error	This should never happen. It indicates a hardware problem or software low-level problem.
11	Line error	Indicates that UniOP and modem communication parameters settings are probably not matching.

Appendix B. Technical Data and Connection Information

Default transmission parameters are set as follows:

Transmission speed: 9600
Start bits: 1
Data length: 8
Parity: no
Stop bits: 1
Flow Control: none