USER'S MANUAL

AT Command Set Option V1.0 for µ-blox GPS Receiver Modules

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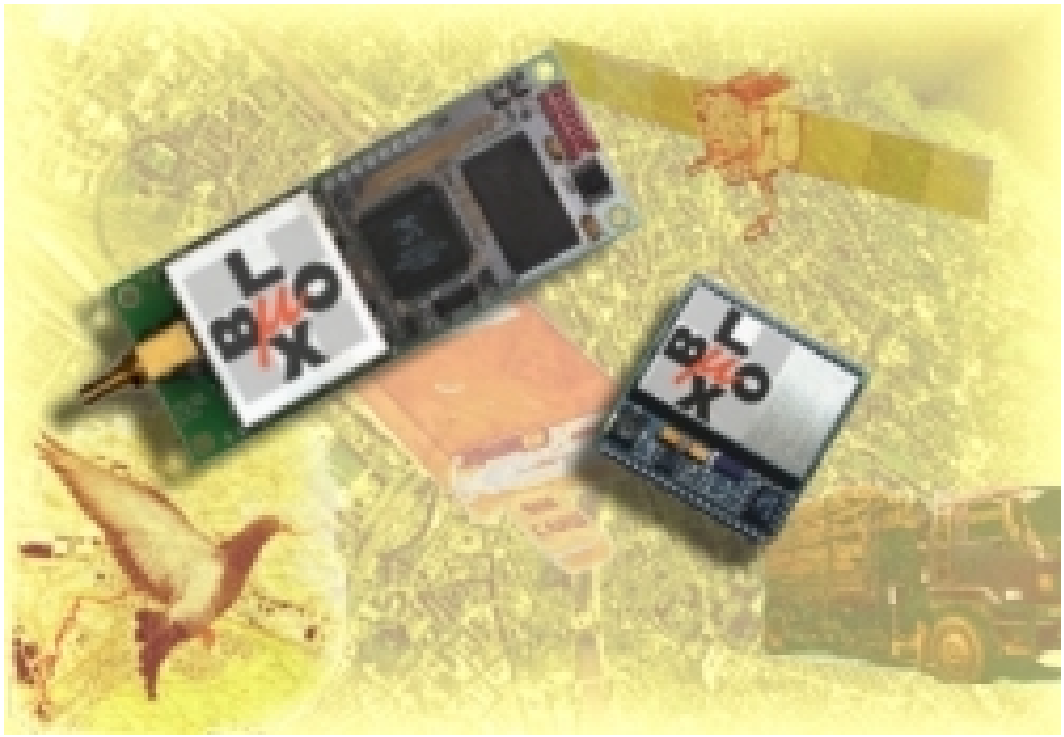

GPS Receiver with integrated GSM Control Software

CONTENTS

1 FEATURES

- SW Enhancement for the µ-blox GPS-MS1E and GPS-PS1E
  - Fully compatible to standard µ-blox GPS receivers
  - Configuration through the serial interface
  - Designed for autonomous operation
  - Minimal external circuitry and no external controller required

- Supports a sub-set of the AT command set for the control of GSM modems

- SMS messages, data connections and voice calls autonomously triggered by GPS or external events.
- Various configurable trigger
  - Timer
  - Movement
  - Area
  - Digital IO
  - External events

- External requirements:
  - power supply for GPS and GSM
  - Backup battery for real time clock and SRAM
  - Serial interface for NMEA or SiRF binary data
  - Passive or active Antenna
  - GSM Modem supporting AT Interface (GSM 07.05, 07.07)

2 OVERVIEW

A typical application for Fleetmanagement, AVL or Tracking requires position information and communication with a central office. The traditional setup requires a GPS receiver, a GSM modem and an external controller. This controller reads positions from the GPS receiver and controls the modem. Incorporating the control of the GSM modem into a GPS receiver spares the extra processor, which simplifies the design and saves cost.

With the AT command interface for GPS receivers µ-blox offers an integrated control system for GSM modems. This control system is designed for autonomous operation. An external controller is not required but can be used for enhanced functionality.

An external controller may communicate with the GPS receiver via a serial port with the SiRF binary protocol. The GSM modem is connected to the other serial port and is controlled through the GPS receiver. Minimal external wiring is necessary to get a fully functional system to send position information via GSM (SMS, data connection).

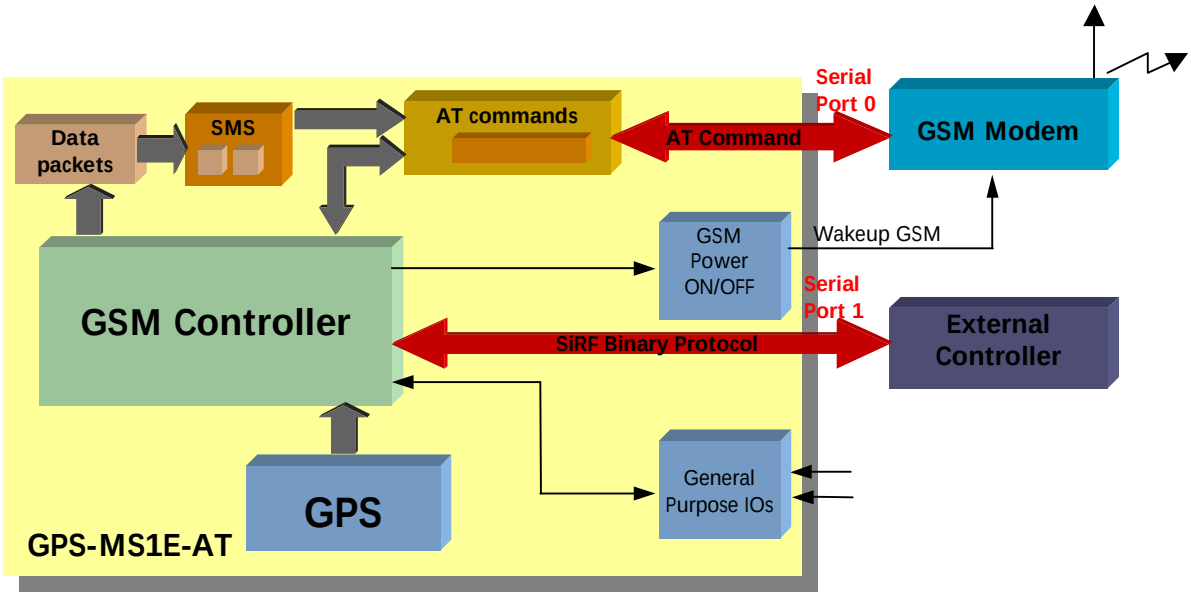

Figure 1: Schematic

The GSM controller is event driven. For each event an action and the data transmitted can be defined. Events (triggers) may be the output of the GPS engine (position, time) or an external signal. If the conditions for a trigger are met, the assigned action will be performed. This assignment is set during the configuration of the GSM controller.

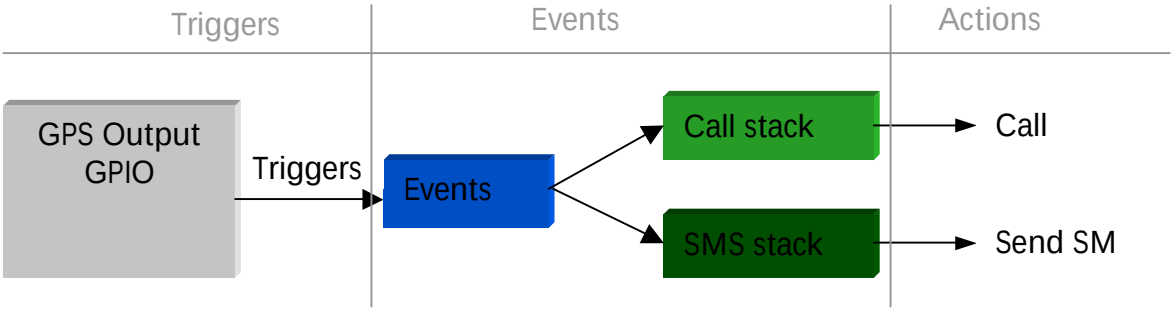

Figure 2: Triggers and Actions

This document describes the commands and protocols used for the configuration and control of the AT command firmware (See Chapter 3.5), the possible functions of the firmware and the data transmitted (See chapter 3). In order to provide an easy and fast possibility to configure the module we offer the µTracker PC software, available from our WWW Pages.

The GPS-MS1E and GPS-PS1E with the AT option will be referred to as GPS-MS1E-AT and GPS-PS1E-AT respectively.

3 FUNCTIONALITY OF THE AT FIRMWARE

3.1 Triggers and Events

A trigger is assigned to each event. Table 1 contains all triggers with their parameters:

ID	Event/Trigger	Condition	Parameters	Range
01 02	Timer (2x)	Time interval elapsed.	Interval [s]	30 – 2 600 000s
03	Area	The position is either in or outside a spherical rectangle. The trigger is repeated if the position remains in/outside.	Latitude 1, Latitude 2, Longitude 1, Longitude 2, Inside/Outside, Repetition time [s] **Note: Lat1 > Lat2 and Lon1 > Lon2**	-180 – 180° -90 – 90° 0 - 2 600 000s
04	Movement	The distance to the last position is above the adjusted value.	Distance [m]	0 – 320000m
05	Speed	The velocity is above the adjusted value. The trigger is repeated if speed remains above the adjusted value.	Velocity [m/s] Repetition time [s]	1 – 500m/s 0 – 2 600 000s
07 08	GPIO (2x)[1]	High level for at least 1 second.	GPIO number	0 - 11
09	External	SiRF protocol message.	None	-
10	Internal	Is generated if a SMS request is sent.	None	-

Table 1: Events

3.2 Actions

Action can be assigned to the different events. Any Action consists of one out of four possible phone number and the data, which shall be sent.

ID	Action	Description	Remark
01	Data SMS	Send a Short Message in PDU Mode	8 bit data SMS
02	Data Call	Initiate a data connection	
03	Voice Call	Initiate a voice connection	
04	RX	Turn on GSM	

Table 2: Actions

3.2.1 Data SMS

The action *Data SMS* sends a short message to a host number. The content of the message is defined in the event configuration. SMS can be sent during a voice call but not during a data call. For details on the data to be sent in an SMS see chapter 3.3.

3.2.2 Data Call

The action *Data Call* opens a data connection to a host.

There are two modes used for data calls:

[1] Not supported by the GPS-PS1E-AT

Data mode

As soon as the connection is established, the AT Firmware will go into data mode. In this mode you can send the same requests to the module as in SMS. In data mode you have to send a request at least every 30 s (keep-alive) or the connection will be closed.

Online mode

If you request online mode, the AT Firmware will send SiRF protocol messages via the data connection. In online mode you will have to answer "sense" messages to keep the connection up. A sense message is sent every 30s and has to be answered within 10s or the connection will be closed.

3.2.3 Voice Call

This action will open a voice connection to the host. During the voice connection all SMS functionality is still available. A voice connection will be closed after 10 minutes or if the other station hangs up.

3.2.4 RX

The action *RX* turns on the modem, that means sending the action *RX* to the modem awakes the modem and enables it to receive calls or SMS.

3.2.5 Answering calls

The AT-Firmware answers calls. It detects if it is a voice or data call and handles this accordingly. Once the connection is up, it is handled the same way as if it is a call initiated by the AT-firmware.

3.3 Data SMS

Data is organized in packets. A message consists of several packets. Up to 8 data packets can be assigned to each event. The maximum packet size is limited to 138 bytes due to restrictions in the SMS specification.

The AT firmware supports different kind of packets, which are different in content and the way they are handled. IDs 1 to 63 are reserved for data packets, which are assembled just before they are sent. These packets will be referred to as data@send packets.

Data packets with ID 64 – 127 are assembled when an event occurs and stored until they are sent. They are called data@event packets.

Arbitrary content can be assigned to IDs 128-159. The total length of these packets is limited to 512 bytes.

Packet ID	Description	Remark
1	GPS Data	The data in this packet is put together just before the message is sent.
2-61	Reserved	
62	Serial Number	
63	Demo Text Message	
64	GPS Data	Data in this packet is put together when the event occurs.
65-127	Reserved	
128-159	User data packets	
160-255	Reserved	

Table 3: Data Packets

See Table 4 for the contents of the GPS Data Packets (Packet ID 1 and 64).

Field	Length [Bytes]	Scale	Unit	Remark
TOW	8		ms	Type double
Latitude	4	*10^8	radians	
Longitude	4	*10^8	radians	
Altitude	2		m	
Speed over ground	2		m/s	
Climb rate	2		m/s	
Course over ground	2		radians	
Week	2			
GPIO State	2			
Mode	1			
DOP	1			PDOP (3D Mode) or HDOP (2D Mode)
#SVs	1			Number of satellites used in fix
Event	1			Event that caused the SM
Total	32			

Table 4: GPS Data Packet, ID 1 and ID 64

Table 5 shows the Serial Number Packet.

Field	Length [Bytes]	Remark
Serial Number	max. 60	A string containing the serial number of the module
Total	Var	

Table 5: Serial Number Packet, ID 62

Packet ID63 is a Data Packet that contains Lat/Lon/Alt in 7bit coded ASCII. This is used for the demo message.

3.4 Configuration

Configuration is set over a serial port in SiRF Binary Protocol and is stored in SRAM. As long as a backup battery is connected, the configuration is kept. If the backup battery is empty, the configuration from the flash memory will be used. Storing a configuration to flash memory is not supported in low power modes. Configuration can be done using the demo software µ-Tracker (see Chapter 5). The configuration for each event consists of the action, 0-8 data packet IDs and the host (phone) number. The host numbers are stored separately and are referred to as host 1 –4. The packet IDs are used only if the action is Data SMS. All other actions ignore the IDs.

3.4.1 General Settings

If the modem is switched on and cannot register in a GSM net within the time specified by 'Search Timeout', the modem is turned off and stays off for 'Off Time'. After successfully registering at the net and performing its actions, the modem will stay on for 'On Timeout' before being turned off. Each new event will restart 'On Timeout'.

Registration status is checked every 30 seconds. The loss of the registration starts 'Search Timeout'. In this case, 'Search Timeout' and 'On Timeout' run parallel. The modem will be turned off if it cannot register again before 'Search Timeout' runs out or if 'On Timeout' has elapsed.

Setting	Range	Remark
Enable AT Option	Yes/No	Enables or disables the AT-Option.
Enable Demo SMS	Yes/No	If enabled a demo SM with the actual position can be polled.
Allow SMS reply to sender	Yes/No	If enabled and the host number in data request is zero, the sms is sent to the senders number. This enables the demo message too.
No power up Mode	Yes/No	If no power up mode is activated, no on/off and reset signal are generated. The AT-Firmware expects the modem to be on.
SIM PIN	10 characters	
Service center address	20 characters	If no SCA is set, the SCA from the SIM card is used. Phone numbers have to be in international format without preceding '+'.
Host 1 – 4	20 characters each	Phone numbers of the hosts. Depending on the network phone numbers have to be in different formats. For SMS use international format without preceding '+'. For voice and data connections the '+' plus has to be added.
On Timeout	0 – 255 minutes	Time in minutes, which the modem stays on after an action. If zero, the modem is always on.
Search Timeout	0 – 255 minutes	Time in minutes after which the modem is turned off if there is no GSM net.
Off Time	0 – 255 minutes	Minimum time in minutes for the modem to stay off after a search timeout.
GPIO	-	You can select, which GPIO should be used as trigger inputs. GPIO 0-7 can be configured as outputs.

Table 6: Miscellaneous settings

3.4.2 GSM Modem Specific Settings

There are different settings to support a wide range of GSM modules.

Setting	Range	Remark
On-Pulse Length	0 – 30s	Pulse length of the On-Pulse. If set to zero, the power pin is high as long as modem power should be on.
Off-pulse length	0 – 30s	Length of the Off-pulse. If zero, no pulse is generated and the soft of command is used.
Soft off command	10 characters	Some modem support a proprietary command to turn off the modem.
Wait after on pulse	0 – 30s	Time to wait after on pulse. Some modems need some time to startup.
Wait after off pulse	0 – 30s	Time to wait after off pulse.
Pre Registration Init Script	100 Bytes	A sequence of initialization commands that is executed after the pin has been entered.
Post Registration Init Script	100 Bytes	A sequence of initialization commands that is executed as soon as the modem is registered in a net.

Table 7: Modem dependent settings

3.5 Protocols

3.5.1 Configuration Protocol

The control and communication with the AT command firmware is performed using the serial interface. All messages are in SiRF Binary Protocol (see protocol specification). Input and output messages start with SiRF ID 195 (0xC3), which is followed by a one-byte µ-blox message ID.

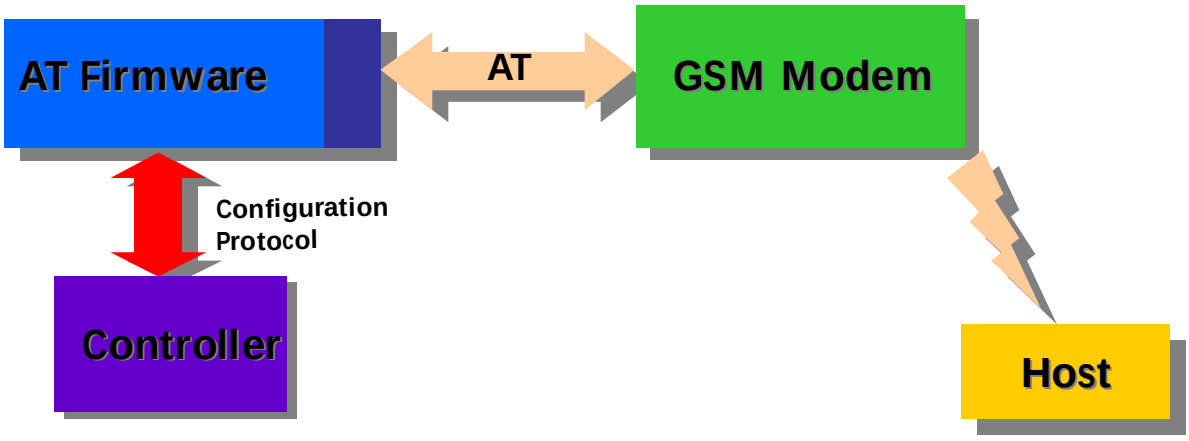

Figure 3: Configuration Protocol

! **NOTE:** Only SiRF binary protocol can be used to control the AT command Firmware.

Start Sequence	Payload Length	Payload			Message Checksum	End Sequence
0xA0 0xA2	2 Bytes	0xC3	µ-blox ID	Length – 2 Bytes	2 Bytes	0xB0 0xB3

Table 8: SiRF Protocol Frame

So the simplest control message for the AT command set (Status request, see Table 9 for details) is packed into the SiRF protocol frame.

Start	Length	SiRF ID	µ-blox ID	Checksum	End
A0 A2	**00 02**	**C3**	**01**	**00 C4**	**B0 B3**

Figure 4: Example, GSM Status request

3.5.1.1 Input Messages

The following input messages can be used to configure the AT command software through the serial port. Table 9 show all available input messages for the configuration and operation of the AT firmware.

ID	Name	Remark
0xC301	Status request	Polls the status of the AT controller.
0xC302	Set configuration	Sets the configuration or the user data packets
0xC303	AT command	Sends a AT command to the modem (for testing only)
0xC304	External event	Causes an external event in the AT controller
0xC305	Get configuration	Polls the configuration or the user data packets
0xC306	Set AT mode	Sets the AT controller mode. Used only to switch back from online to data mode.
0xC307	Save configuration	Saves the actual configuration into flash memory
0xC308	Sense message answer	Answer to the sense message during an online connection

Table 9: Input Messages

Status request, Msg ID 0xC301

The AT firmware will answer with output message ID 1, which contains status information of the AT firmware.

Field Name	Type	Length [bytes]	Value	Remark
ID	Word	2	0xC301	
Total length		2		

Set configuration, Msg ID 0xC302

Message 0xC302 can either set the configuration or the user data packets. The data identifier field has to be set accordingly. The structure of the configuration and the user data packets is show in appendix B.

Field Name	Type	Length [bytes]	Value	Remark
ID	Word	2	0xC302	
Data identifier	Byte	1	-	0: configuration, x = 520 1: User data packets, x = 544
Data	-	X	-	
Total length		3 + x		

AT command, , Msg ID 0xC303

Message 0xC303 lets you send a AT command directly to the modem. This message is for testing purposes and should not be used in normal operation.

Field Name	Type	Length [bytes]	Value	Remark
ID	Word	2	0xC303	
AT command	-	x	-	
Total length		2 + x		

External event, Msg ID 0xC304

Message 0xC304 causes an external event in the AT firmware. The message can be sent with or without a configuration for the external event. If a configuration is sent within message 0xC304, this transmitted configuration will replace the predefined configuration of the external event in the AT firmware.

External Event message:

Field Name	Type	Length [bytes]	Value	Remark
ID	Word	2	0xC304	
Reserved	Byte	1	0x01	Must be 0x01
Total length		3		

External event message with configuration:

Field Name	Type	Length [bytes]	Value	Remark
ID	Word	2	0xC304	
Reserved	Byte	1	0x01	Must be 0x01
Action	Byte	1	-	
Data packet IDs	Bytes	8	-	
Host number	Byte	1	-	1-4
Flags	Byte	1	-	Currently not supported
Total length		14		

Get configuration, Msg ID 0xC305

Message 0xC305 polls configuration or user data packets. The data identifier specifies what is sent.

Field Name	Type	Length [bytes]	Value	Remark
ID	Word	2	0xC305	
Data identifier	Byte	1	-	0: poll configuration 1: poll user data packets
Total length		3		

Set AT mode, Msg ID 0xC306

Message 0xC306 sets the AT firmware mode. Should be used only to switch back from online to data mode. Most of the transitions between the modes are invalid and are therefore not executed.

Field Name	Type	Length [bytes]	Value	Remark
ID	Word	2	0xC306	
New mode	Byte	1	-	0: Normal mode 1: AT mode 2: Data mode 3: Online mode
Total length		3		

Save configuration, Msg ID 0xC307

Message 0xC307 saves the actual configuration into flash memory.

Field Name	Type	Length [bytes]	Value	Remark
ID	Word	2	0xC307	
Total length		2		

Sense message answer, Msg ID 0xC308

Message 0xC308 is used to acknowledge requests from the AT firmware via an online connection. If the requests are not acknowledged, the AT firmware will close the connection and return to normal mode.

Field Name	Type	Length [bytes]	Value	Remark
ID	Word	2	0xC308	
Total length		2		

Below there is an example of a complete message sent over the serial port to the GPS receiver:

The following command triggers an external event. The assigned action is an SMS sent to Host 1 containing data packets ID 1 and ID 128.

Field	Value [HEX]	Remark
Reserved	01	External event
Action Type	01	Data SMS
Data Packet IDs	01 80 00 00 00 00 00 00	Packet ID 1 and Packet ID 128
Host ID	01	Host 1
Flags	00	Currently unused

Start	Length	SiRF ID	µ-blox ID	Payload	Checksum	End
A0 A2	**00 0B**	**C3**	**04**	**01 01 01 80 00 00 00 00 00 00 01 00**	**02 F3**	**B0 B3**

Figure 5: Example, External Event with configuration

3.5.1.2 Output Messages

ID	Name	Remark
0xC301	Status	Status of the AT controller.
0xC302	Configuration	Configuration or the user data packets
0xC303	AT command answer	AT command answer from the modem (for testing only)
0xC304	Sense message	Sense request
0xC3DE	ACK	Acknowledge
0xC36F	NACK	Not acknowlede

Table 10: Output messages

Status, Msg ID 0xC301

Message 0xC301 is sent as answer to the status request input message 0xc301.

Field Name	Type	Length [bytes]	Value	Remark
ID	Word	2	0xC301	
Modem state	Byte	1	-	State of the modem state machine.
Last Event	Byte	1	-	
Last action	Byte	1	-	
Events on SMS stack	Byte	1	-	
Events on call stack	Byte	1	-	
Reserved	Byte	8	-	
Total length		15		

Configuration, Msg ID 0xC302

Message 0xC302 is sent as answer to the get configuration input message 0xc305. Message 0xC302 has the same format as the input message 0xC302.

Field Name	Type	Length [bytes]	Value	Remark
ID	Word	2	0xC302	
Data identifier	Byte	1	-	0: configuration, x = 520 1: User data packets, x = 544
Data	-	X	-	
Total length		3 + x		

AT command answer, Msg ID 0xC303

Message 0xC303 is sent, if the modem sent something to the AT firmware. The message contains the message from the modem.

Field Name	Type	Length [bytes]	Value	Remark
ID	Word	2	0xC303	
AT command answer	-	X	-	
Total length		2 + x		

Sense message, Msg ID 0xC304

The sense messages is sent during online mode, when the AT firmware transmits Sirf protocol messages over a data connection. The message is sent every 30 seconds and has to be answered within 15s. If not, the data connection is closed.

Field Name	Type	Length [bytes]	Value	Remark
ID	Word	2	0xC304	
Total length		2		

ACK, Msg ID 0xC3DE

Ack or Nack is sent on reception of all messages which do not have answer.

Field Name	Type	Length [bytes]	Value	Remark
ID	Word	2	0xC3DE	
ACK_ID	Byte	1	-	ID of acknowledged Msg
Total length		3		

NACK, Msg ID 0xC36F

Ack or Nack is sent on reception of all messages which do not have answer.

Field Name	Type	Length [bytes]	Value	Remark
ID	Word	2	0xC36F	
NACK_ID	Byte	1	-	ID of not acknowledged Msg
Total length		3		

The following example shows a sense message sent in the online mode. This message must be answered with a sense response within 15secs, otherwise the connection is considered to be disrupted and closed from either ends.

Start	Length	SiRF ID	µ-blox ID	Checksum	End
A0 A2	**00 02**	**C3**	**04**	**00 C7**	**B0 B3**

Figure 6: Example, sense message'

3.5.2 AT-Firmware - Modem

GPS-MS1E-AT communicates with a GSM modem via the AT-standard (GSM 07.05, 07.07).

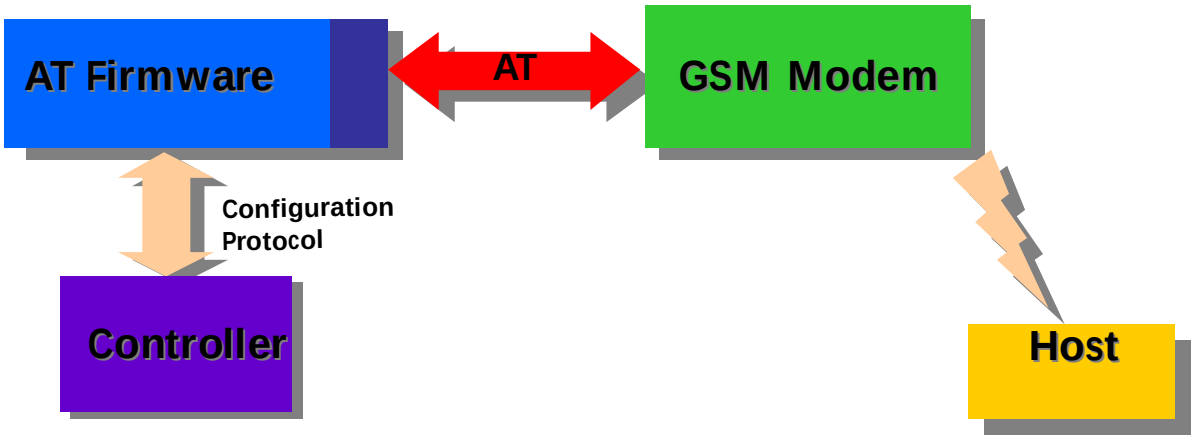

Figure 7: GSM Protocol

3.5.3 Host protocol

The following chapter describes the protocols, which the AT-Firmware uses to communicate with hosts. The protocol consists of a message ID and the length followed by the data. After the data a next message can start or zero terminates the transmission sequence (see Table 11).

Message ID	Payload Length	Payload	Message ID	Payload Length	Payload	Message ID
0x01	0x20	0x20 Bytes data	0x80	0x10	0x10 Bytes data	0x00

Table 11 Host protocol

This protocol is used for SMS and data connections. It is possible to send several requests in one message.

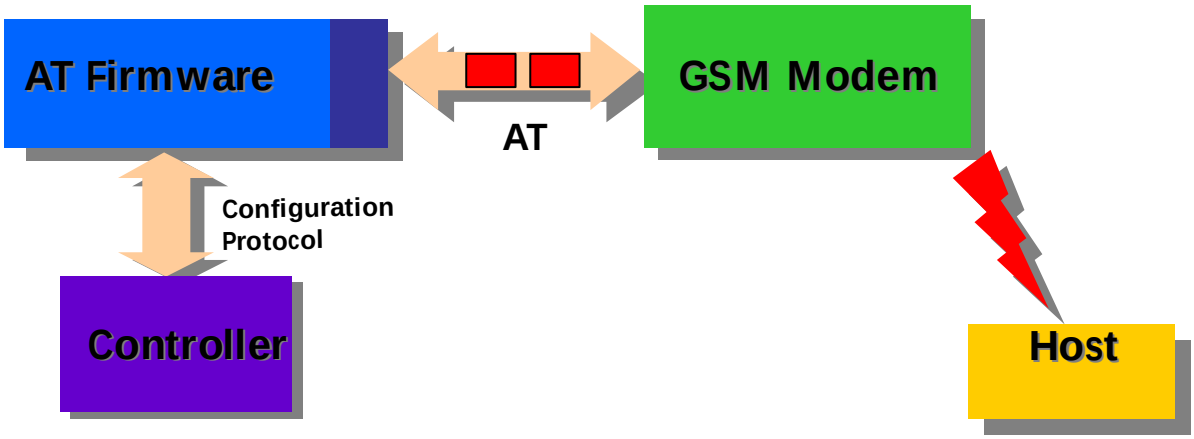

Figure 8: Host protocol

Cmd ID	Name	Remark
0x01	Data request	An event is generated, with the given action, DPs, Host and Flags.
0x02	Data request	Push to fix mode data request. After this request the module will reset and as soon as the first navigation solution is available, an event is generated, with the given action, DPs, Host and Flags. Reply to sender is not supported in this case.
0x20	Change Trigger Settings	One or more trigger settings are changed. Settings are not stored into flash memory.
0x21	Change Event Configuration	Configures an event. Settings are not stored into flash memory.
0x22	Set Low Power Mode	Sets low power mode.
0x23	GPIO set mask	Sets or clears the gpios, which are configured as outputs.
0x80	None	Switches to online mode (Data mode only)
0x81	None	Terminate connection (Data mode only)
0x82	None	Online timeout reset (Data mode only)

Table 12 Data connection and SMS commands

3.5.3.1 Data Request, Command 0x01 and 0x02

The data request generates an event, with the given configuration. It is possible to initiate all supported actions, not only sending SMS. Command 0x01 requests the position data available from the GPS. In push to fix mode this data may be up to 30minutes old. With Command 0x02 the receiver will calculate a new positions and send this actual position. Note: Command 0x02 will cause a reset of the GPS receiver; all following requests in the same message will be lost.

Field Name	Type	Length [bytes]	Remark
CMD ID	Byte	1	0x01 or 0x02. Command 0x02 can be used in push to fix mode only.
Length	Byte	1	
Event Config	STRUCT	11	See Table 25
Total Length		13	

Table 13 Data Poll Command 0x01 and 0x02

3.5.3.2 Change Trigger Settings, Command 0x20

The Change Trigger Settings Command sets new parameters for selected Triggers. It does not support changing the trigger inputs for the GPIO triggers.

Field Name	Type	Length [bytes]	Remark
CMD ID	Byte	1	
Length	Byte	1	
Triggers to Change	WORD	2	Bitmask: 0x01 Timer 1, 0x02 Timer 2, 0x04 Area, 0x08 Movement, 0x10 Speed
Trigger Settings	STRUCT	44	See Table 23
Total Length		48	

Table 14 Change Trigger Settings Command 0x20

3.5.3.3 Change Event Configuration Command 0x21

The Change Event Configuration sets a new configuration for an event.

Field Name	Type	Length [bytes]	Remark
CMD ID	Byte	1	
Length	Byte	1	
Event	Byte	1	
Event Configuration	STRUCT	12	See Table 25
Total Length		15	

3.5.3.4 Set Low Power Mode Command 0x22

This command sets the low power mode.

Field Name	Type	Length [bytes]	Remark
CMD ID	Byte	1	
Length	Byte	1	
PushToFix	Byte	1	If set to 1 Push to Fix mode is enabled. Must be zero for continuous or trickle power mode.
Duty Cycle	Byte	1	Duty Cycle in percent. If Duty Cycle is greater than 50% continuous mode is activated.
RF on time	Byte	1	RF on time in 10ms steps, 200ms = 20
Total Length		5	

3.5.3.5 Set Outputs Command 0x23

The pins, which are configured as outputs, are set high or low.

Field Name	Type	Length [bytes]	Remark
CMD ID	Byte	1	
Length	Byte	1	
Bitmask	Byte	1	Bitmask which is applied to the outputs.
Total Length		3	

3.5.3.6 Request Online Mode Command 0x80

This command will put Sirf protocol output on the data connection.

Field Name	Type	Length [bytes]	Remark
CMD ID	Byte	1	
Length	Byte	1	
Total Length		2	

3.5.3.7 Request Terminate Connection Command 0x81

This command will close the data connection

Field Name	Type	Length [bytes]	Remark
CMD ID	Byte	1	
Length	Byte	0	
Total Length		2	

3.5.3.8 Request Reset Online Timeout Command 0x82

This command will reset the online timeout.

Field Name	Type	Length [bytes]	Remark
CMD ID	Byte	1	
Length	Byte	1	
Total Length		2	

3.5.3.9 SMS outgoing

The short message protocol is shown below. Each packet has a header, which consists of the packet ID and the packet length (exclusive header).

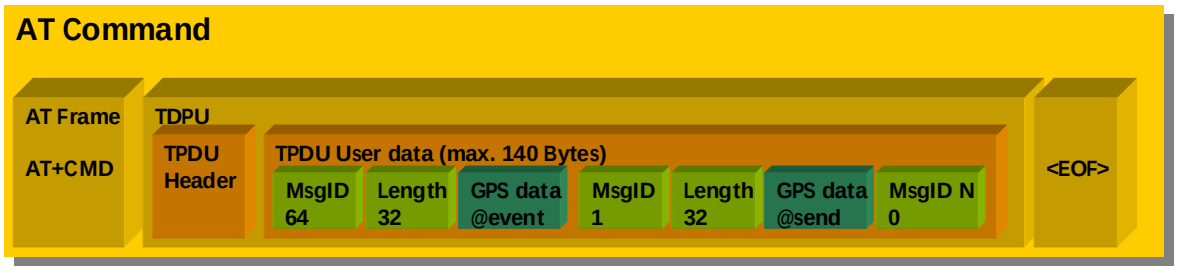

Figure 9: SMS frame

Packet ID	Packet length	Data	Termination
01	20	**41 12 98 33 AD F2 B4 FB 04 ED B3 03 00 E2 D0 24 01 BC 00 00 00 00 01 22 04 20 FF 45 04 02 06 09**	00

Figure 10: GPS data packet ID 1 in SM

3.5.3.10 SMS Incoming

The protocol for requests via SMS is the same as if a SMS is sent. The requests have to be coded as 8Bit data with the Data Coding Scheme (DCS) of the SMS set to 0xF4. Any other DCS as 0xF4 will be treated as 7bit text (demo mode).

Table 15: SMS and Data Commands

Command ID	Packet length	Data	Termination
01	OB	**01 01 00 00 00 00 00 00 00 01 00**	00

Figure 11: Initiate a SMS with the GPS data packet sent to host 1

There is a demo mode, which sends the position back to you as a 7bit text SMS if you send a text SMS containing only "P". This demo message can be disabled for security reasons.

3.5.3.11 Data connection

If a data connection is opened, the AT-Firmware enters data mode. In the data mode the same protocol as in SMS is used. Sending the 'switch to online' command will activate SiRF protocol on the data connection. All SiRF protocol output messages are sent and all input messages will work.

! **Warning:** Do not send any commands, which could cause a reset of the GPS-module. Although reconfiguration is possible over a data connection, it is not recommended to do so.

3.6 Special Function Pins

3.6.1 Power on/off Signal

The AT-Firmware generates a power signal for the GSM Modem at the SCK0 pin (see 3.4.2 for the configuration of the signal). The power on/off signal is not generated if *no power up mode* is activated.

! **Note**: The GPS-PS1E-AT does not support the Reset Signal. So the module has to be used in *no power up mode* always.

3.6.2 Reset Signal

On the SCK1 pin a reset signal is generated. The reset signal is active low. If the AT_Firmware can't communicate with the modem, the reset line is activated for a second and the modem is reinitialized. The reset signal is not generated if no power up is activated

! **Note**: The GPS-PS1E-AT does not support the Reset Signal.

3.6.3 General Purpose Input/Outputs

Two GPIO from GPIO 0 – 11 can be configured as trigger inputs. GPIO 0-7 can be configured as outputs, which can be set and cleared using SMS or a data connection. GPIO 8-11 can function as inputs only. All GPIO can be read using SMS or a data connection.

4 SUPPORTED GSM MODEMS

The AT-Firmware supports a sub-set of the AT command set which is necessary to control GSM modems. However, the commands and the sequence of the commands required for the operation of GSM modems vary from supplier to supplier. The AT-Firmware has been tested on the modem listed in Table 16. Note that not all modems have a on/off or reset line on their interfaces and are therefore tested without reset line or in no power up mode.

Modem	Tested Services	HW Connections	Remark
Siemens M20T (M20)	SMS: MO, MT Voice Call: MO, MT Data Call: MO, MT	1. Rx,Tx, On/off 2. Rx,Tx (No power up mode)	
Falcom A2D	SMS: MO, MT Voice Call: MO, MT Data Call: MO, MT	1. Rx,Tx, On/off	
Wavecom WMOD2B	SMS: MO, MT Voice Call: MO, MT Data Call: MO, MT	Rx,Tx (No power up mode)	
Motorola d15			Not tested yet
Nokia 6090			Not tested yet

Table 16: Supported GSM Modems

4.1 How to set up your modem

Before a modem can be used with the AT option, the modem has to be configured. A PC with a serial port and a terminal program is needed to do this. First the modem has to be connected to a serial port of the PC and the terminal program has to be opened on that serial port. Normally after applying power, a switch on signal has to be generated, to turn on the modem.

Sending AT<CR> should cause the modem to answer with OK<CR><LF>. If strange characters are returned the baudrate of the serial port is wrong. If nothing is returned, the serial connection may be broken or the modem is not on.

Once the modem is running, the following commands have to be sent:

Step	Command	Description
1	AT&D0	The modem will now ignore the DTR signal
2	AT&C0	Ignore CTS
3	AT+IPR=19200	Sets the baudrate to 19200
4	AT+IFC=0,0	Disables flow control in data mode
5	AT+CMGF=0	Set PDU mode (SMS)
6	ATV0	Numerical return values
7	ATE0	Echo off
8	AT+CMEE=1	Report mobile equipment errors
9	AT+CBST=0,0,1	Set autobauding, if your modem doesn't support autobauding (like the Siemens M20), you have to set your connection type. If your call destination is an analogue modem set 7,0,1 (V.32), if your destination is an ISDN modem set 71,0,1 (V.110)
10	AT&W	Save settings

Table 17: Configuration of the modem

4.2 Recommended schematics and settings

Figure 12 shows the lines that must be connected to the modem. Normally will connect all four lines to the modem. If you want to use a mobile phone with AT interface, you probably don't have access to the on/off and reset signal. If you do not connect the on/off and reset lines (which is not recommended), you have to activate no power up mode in the configuration.

If your modem has 3.3 levels logic levels on the on/off, reset, rx or tx lines, you don't need a level shifter.

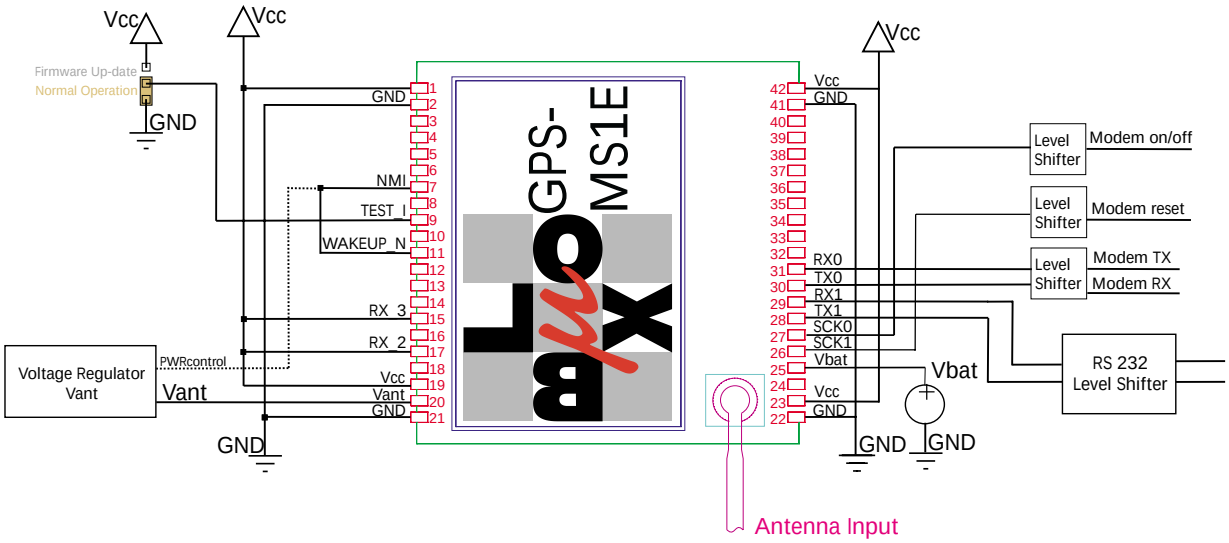

Figure 12: Recommended external wiring

4.2.1 Connection to the modem

The GPS receiver does only have to be connected to the serial port of the GSM Modem. Some GSM modems support an external pin to switch the modem on (off resp.). For modem with support of this function, we recommend to connect this pin. This allows the controller to restart the modem in case of problems.

MS1E/PS1E pin name	Signal name	Modem line Siemens M20	Modem line Falcom A2D	Modem line Wavecom WMOD2D
TX0	Modem Rx	USCRX	DATA_RX2	RX
RX0	Modem Tx	USCTX	DATA_TX	TX
SCK0	Modem on/off	IGNITION	SOFT_ON	-
SCK1	Modem reset	-	RSTF	-

Table 18: Connections to the Modems

Settings	Recommended values for		
	Siemens M20	Falcom A2D	Wavecom WMOD2D
On pulse length	2s	3s	3s
Off pulse length	0s	0s	0s
Off command	AT^SMSO	AT+CPOF	AT+CPOF
Wait after on pulse	1s	10s	10s
Wait after off pulse	0s	0s	0s
No Power up Mode	-	-	Yes
Pre registration init script	-	-	-
Post registration init script	AT+CNMI=2,2,0,0,0	AT+CNMI=2,2,0,0,0	AT+CNMI=2,2,0,0,0

Table 19: Recommended settings

5 µ-TRACKER – DEMO PROGRAM FOR THE AT FIRMWARE

µ-blox offers the µTracker demo software running on Win9x or WinNT which allows the user to configure the AT command option easily.

5.1 Views

µTracker has 3 different views, the SiRF-console view, the AT-console view and the map view.

5.1.1 SiRF console

The SiRF console shows messages from your µ-blox GPS receiver, which is connected to a serial port. The upper part shows which messages have been received, the lower part shows decoded debug messages.

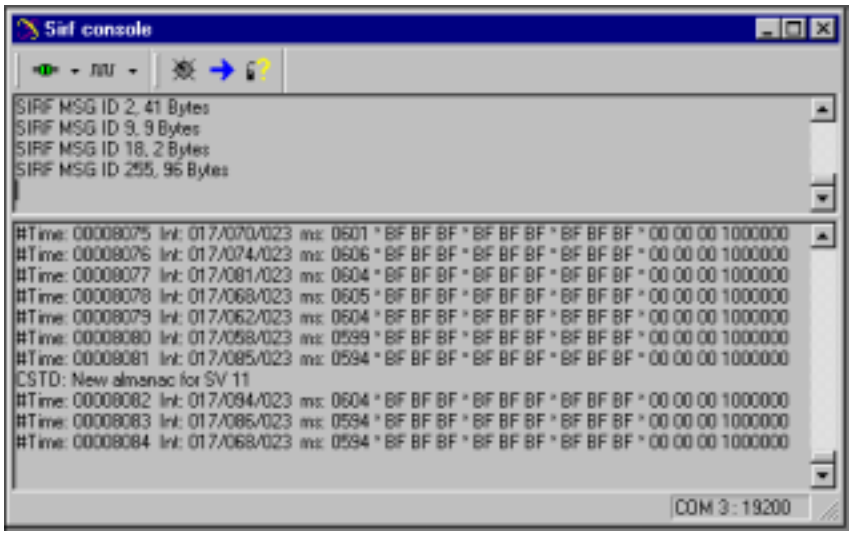

Figure 13: SiRF console view

While the SiRF console is active you can access the AT-Firmware settings dialog with the menu entry GPS-xS1 -> Settings or you press the knob symbol on the toolbar.

Pressing the right arrow symbol on the toolbar will send an external event message to the GPS-xS1E-AT. Pressing the button with the question mark will poll the GPS-xS1E-AT status.

5.1.2 AT console

The AT console has two modes, normal and direct mode. In normal you can use this console to monitor and to send AT-commands to the modem connected to the GPS-xS1E-AT. In direct mode the AT console controls a modem, which is connected directly to the pc.

In normal mode the upper part of the window displays the AT commands which are sent from the GSM-modem to the GPS-xS1E-AT. You can enter an AT-command in the edit box. Pressing enter will send the command to the GPS-xS1E-AT, which will send it to the GSM-modem. The ending character of the AT command can be selected in the drop-down-list. If you select another ending character than <CR>, the selection will be set to <CR> again after the command is sent. In direct mode, no information is added in the lower part of the window.

In direct mode the toolbar and the corresponding menu entry get active. You can use the console the same way as in normal mode.

Pressing the left arrow symbol will open a dialog for sending a SMS request to the GPS-MS1E-AT. Incoming SMS will be decoded and displayed in the lower part of the window.

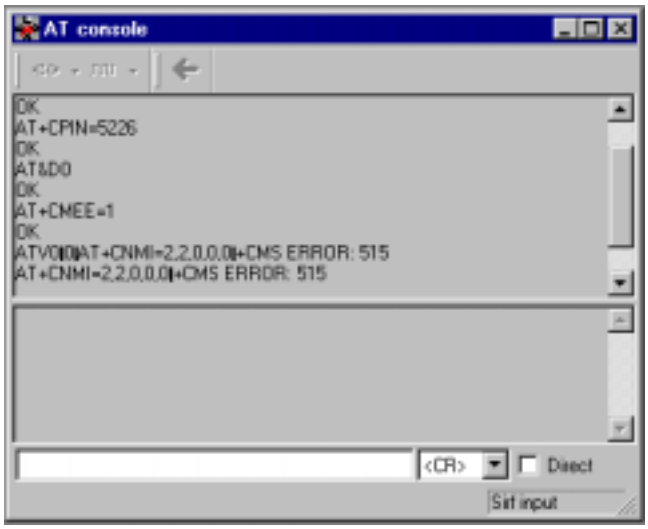

Figure 14: Console view

5.1.3 Map view

The map displays a bitmap, which can be calibrated to longitude/latitude. If a data packet 1 or 64 is decoded in an incoming SMS, the position will be marked with cross on the map. With the add point button a point can be added manually.

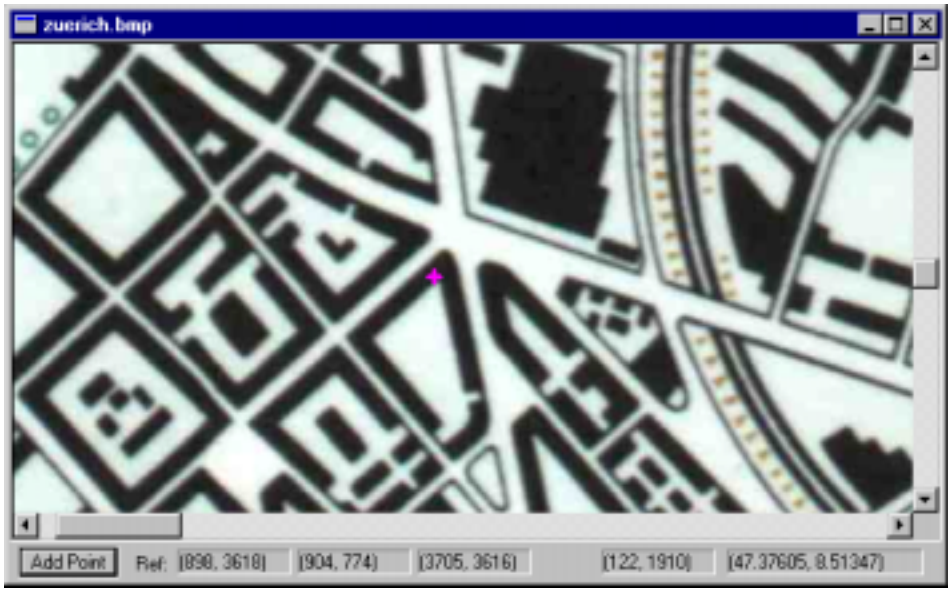

Figure 15: Map view

Pressing the right mouse button in the map view will show up a menu, which lets you set the reference points of the map. Instead of setting the reference points each time the map is loaded, a map calibration file can be written in a text editor. See the sample *.mcf file for the syntax.

5.2 Settings Dialog

The settings dialog lets you configure the AT firmware.

When the dialog is opened the configuration has to be uploaded first. This is done with the 'Get Configuration' button. To download the configuration to the GPS receiver press the 'Set Configuration' button. If 'Write to Flash' is checked, the configuration will be stored in the flash memory. If 'Write to flash' is checked, the downloaded configuration will be written into flash memory.

A configuration can be saved to a file and reloaded later. The 'OK' and 'Cancel' buttons do not have any other function than closing the dialog. They do not influence down- or uploading.

There is a standard configuration file (*.uac) for each supported modem.

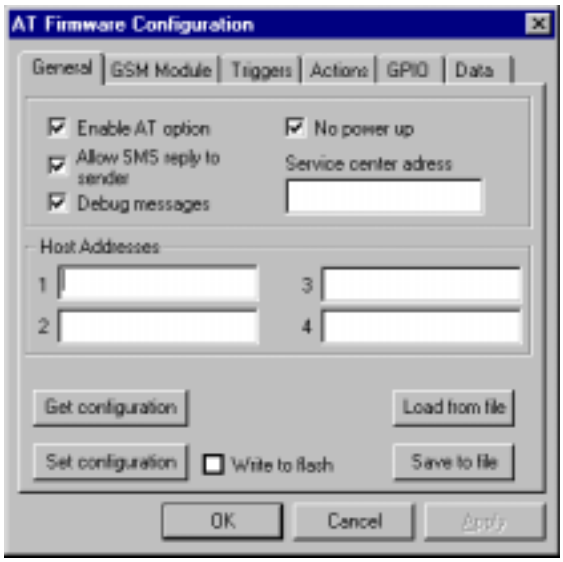

Figure 16: Configuration

6 CONFIGURATION EXAMPLES

The AT Firmware has to be set up for the communication in the GSM network prior to any user specific configuration (refer to *Recommended schematics and settings*).

Set the PIN code and the Service Center Address (SCA). The SIM card dealer provides the SCA. Clear the SCA field if the AT firmware should use the pre-programmed SCA on the SIM card.

Enter the destination address (the phone number the SM shall be sent to) in the host 0 field. For voice and data connection we will use host 2.

6.1 Tracking an object with a position update via SMS every 1 minute

This is a typical application for the timer event.

Go to the trigger tab and set the interval of timer0 to 60 seconds. The timer event will now occur every 60 seconds.

Afterwards, the action of the timer0 event has to be configured. This is done in the action tab.

Select the timer0 event. Choose send SM as action and host 0 as destination; enter 1 as the first packet ID. Packet 1 contains time and position and is assembled at send time.

Go back to the general tab and press the set configuration button.

6.2 Tracking an object with a position update via SMS every 500m

This is a typical application for the movement event.

Set the distance of the movement trigger in the trigger tab to 500m.

Select the movement event in the action tab. Choose Send SM as action and host 0 as destination. Enter 64 as the first packet ID.

Go back to the general tab and press the set configuration button.

6.3 Send a position and an identification string if a button is pressed

Connect the button to a GPIO and specify this GPIO in the trigger tab.

Select GPIO trigger 0, send SM and host 0 in the action tab. Packet 64 stores the position at the time, the button is pressed. Take packet 64 as the second packet for the identification string. The content of packet ID 128 can be set in the data tab. Select the ID 128 and enter the user data in ASCII or hexadecimal.

Go back to the general tab and press the set configuration button.

6.4 Voice connection and position via SMS if a button is pressed

Connect the button to two GPIO and specify these GPIO in the trigger tab.

Select GPIO trigger 0, send SM and host 0 in the action tab. Packet 64 stores the position at the time the button is pressed.

Select GPIO trigger 1, voice call and host 1 in the action tab.

Go back to the general tab and press the set configuration button.

If you press the button now, an SM will be sent and after that the voice connection will be opened. While the voice connection is up, SM send and poll will work.

6.5 Online tracking if a certain area is entered

First, define your area in form of upper and lower latitude and longitude.

Go to the trigger tab and enter your area in the area trigger settings, set the repetition rate to 180s. Remember to put the greater coordinates in the first fields. Select Data call to host 1 as action for the area trigger.

Go back to the general tab and press the set configuration button.

As soon as you enter the defined area, a data connection will be opened to host 2. You have to answer the call to your host. Once the connection is up you can poll position information, or you can send a command to switch to SiRF protocol. Sirf protocol output will be sent over the data connection.

7 LIMITATIONS

1. Serial ports 2 and 3 Mode are not supported in Trickle Power and Push to Fix Mode.
2. If the AT-Firmware is used on a GPS-PS1E, the GPIO triggers cannot be used. Additionally, certain GSM Modem Control Signals (Reset, Powerup) are not available.
3. Depending on the GSM modem and network, not all features of the AT-Firmware may be available.
4. The current consumption in low power modes can be estimated with the normal formula from the low power application note, but 18mA have to be added to that value.

A USED AT COMMANDS

This list summarizes all AT commands sent by the AT-Firmware and the expected reactions.

AT command	Expected reactions
AT	OK (0), ERROR (4)
AT&D0	OK (0), ERROR (4)
ATV0	OK (0)
AT+CPIN=xxxx	OK, ERROR
AT+CPIN?	+CPIN: SIM PIN, +CPIN: SIM READY
ATDxxxxxxxx	OK, ERROR, NO CARRIER if connection is terminated
AT+CREG?	+CREG: x,y
ATA	OK, ERROR
AT+CMGS=xx	Before PDU is sent: 0D 0A 3E 20, after PDU: +CMGS xxx
AT+CNMI=2,2,0,0,0	OK, CME ERROR 515
AT+CMEE=1	OK
ATH	OK
AT+CHUP	OK

Table 20: Used AT commands

B TYPE DEFINITIONS

Field name	Type	Length	Unit	Remark
Pin	STRING	11		Zero terminated string
Flags	ULONG	4		Enable AT: 0x01 AT debug messages: 0x02 Demo message: 0x04 No power up mode: 0x08
GPIO_out	BYTE	1		GPIO output mask
GPIO_Init	BYTE	1		GPIO output initial setting mask
Reserved	BYTE	8		Reserved for future use
SCA Number	STRUCT	22		See Table 24
Host 1 Number	STRUCT	22		See Table 24
Host 2 Number	STRUCT	22		See Table 24
Host 3 Number	STRUCT	22		See Table 24
Host 4 Number	STRUCT	22		See Table 24
Modem Settings	STRUCT			See Table 22
Trigger Settings	STRUCT	39		See Table 23
Reserved	BYTE	11		Set to zero
Timer 0	STRUCT	11		See Table 25
Timer 1	STRUCT	11		See Table 25
Area	STRUCT	11		See Table 25
Move	STRUCT	11		See Table 25
Speed	STRUCT	11		See Table 25
Log full	STRUCT	11		See Table 25
GPIO 0	STRUCT	11		See Table 25
GPIO 1	STRUCT	11		See Table 25
External	STRUCT	11		See Table 25
Reserved	BYTE	11		Set to zero

Table 21: Configuration Structure

Field name	Type	Length	Unit	Remark
On pulse Length	UBYTE	1	s	
Off pulse Length	UBYTE	1	s	
Wait after on pulse	UBYTE	1	s	
Wait after off pulse	UBYTE	1	s	
Off command	STRING	10		Zero terminated string
Search timeout	UBYTE	1	min	
Off time	UBYTE	1	min	
On timeout	UBYTE	1	min	
Reserved	BYTE	2		
Pre registration init	STRING	100		Zero terminated string, command separator: CR
Post registration init	STRING	100		Zero terminated string, command separator: CR

Table 22 Modem Settings Structure

Field name	Type	Length	Unit	Remark
Timer 0 period	ULONG	4	s	
Timer 1 period	ULONG	4	s	
Speed period	ULONG	4	s	
Area period	ULONG	4	s	
Lat 1	Float	4	Deg	
Lon 1	Float	4	Deg	
Lat 2	Float	4	Deg	
Lon 2	Float	4	Deg	
Speed	Short	2	m/s	
Radius	Short	2	m*10	
Reserved	BYTE	4		
Trigger Flags	BYTE	1		0x01 : AREA_INSIDE
GPIO Trigger 0	UBYTE	1		GPIO Number 0-11
GPIO Trigger 1	UBYTE	1		GPIO Number 0-11
Total Length		43		

Table 23 Trigger Settings Structure

Field name	Type	Length	Unit	Remark
Address length	UBYTE	1		Length of the Host 4 Address
Address type	UBYTE	1		Type of Host 4 Address, always 0x91
Address	STRING	20		International number, without preceding +
Total Length		22		

Table 24: Phone number structure

Field name	Type	Length	Unit	Remark
Action	UBYTE	1		
Data Packets	UBYTE	8		
Host	UYBTE	1		1-4
Flags	UYBTE	1		Always 0
Total Length		11		

Table 25: Event configuration structure

These type definitions are usefuel in writing software, which communicates with the AT firmware. These definitions are also available as a the file at_type.h. The byte order is big endian. All structures are filled up with padding bytes, so that the size is a multiple of four.

```
#define MAX_DP         8       /* maximum number of data packets per sm */
#define MAX_DP_BYTES   138     /* comes from maximum length of an SMS (140-2) */
#define DEF_DP_BYTES   512     /* maximum size of all user packets together  */
#define NUM_OF_DEF_DP  32      /* number of default user data packets */
#define MAX_HOST       4       /* highest host number */

/* configuration flags */
#define AT_OPTION              0x01
#define AT_DEBUG_MSG           0x02
#define REPLY_TO_SENDER        0x04
#define NO_POWERUP             0x08

/* Trigger Flags */
#define AREA_INSIDE            0x01
#define P2F_TRIGGER            0x02

#define LATLONSCALE            1000000

/* number of phone numbers */
#define PHONE_NUMBERS 4
/* init script structure */
#define INIT_SCRIPT_LENGHT 100

/* data poll messages */
#define REQ_DATA               1
#define REQ_DATA_P2F           2
#define REQ_SET_TRIGGER    32
#define REQ_SET_EVENT      33
#define REQ_SET_LP_MODE    34
#define REQ_SET_GPIO       35
#define REQ_RESERVED1      0x2B /* + is reserved, because this is used to detect connection loss */
```

```
#define REQ_RESERVED2     0x38 /* 8 is reserved, because this is used to detect connection loss */
/* data mode only requests */
#define REQ_ONLINE            128
#define REQ_HANGUP            129
#define REQ_TIMER_RESET    130

/* Events */
typedef enum GSMEvents
{
       NO_EVENT = 0,
       TIMER0,
       TIMER1,
       AREA,
       MOVE,
       SPEED,
       LOGFULL,
       GPIO0,
       GPIO1,
       EXTERNEV,
       INTERNEV,

       EVENTS
};

/* Data Packet structs*/
typedef struct
{
       DOUBLE TOW;
       int Lat;
       int Lon;
       short Alt;
       short Sog;
       short   Cr;
       short Cog;
       uint16 Week;
       uint16 GPIO;
       UBYTE Mode;
       UBYTE DOP;
       UBYTE   SVs;
       UBYTE Event;
}DP_ID1_Struct;


/* Status message */
typedef struct
{
       UBYTE ModemState;
       UBYTE Event;
       UBYTE Action;
       UBYTE NrEvOnSMSStack;
       UBYTE NrEvOnCallStack;
       UBYTE res1;
       UBYTE res2;
       UBYTE res3;
       UBYTE res4;
       UBYTE res5;
       UBYTE res6;
       UBYTE sw_ver0;
       UBYTE sw_ver1;
}AT_Status_Struct;


/* user data packet struct */
typedef struct
{
       UBYTE Length[NUM_OF_DEF_DP];
       UBYTE Data[DEF_DP_BYTES];
}DP_USER_Struct;

/* phone numbers */
typedef struct
{
       UBYTE Length;
       UBYTE Type;
       UBYTE Number[20];
}GSM_Phone_Number_Struct;

/* event config */
typedef struct
{
       UBYTE Action;
       UBYTE DPIDs[MAX_DP];
       UBYTE Host;
       UBYTE Flags;
}AT_Event_struct;

/* trigger config */
typedef struct
{
```

```
        uint32 TimerPeriod0;
        uint32 TimerPeriod1;
        uint32 SpeedPeriod;
        uint32 AreaPeriod;
        float Lat1;
        float Lon1;
        float Lat2;
        float Lon2;
        short Speed;  /* scale 1 */
        short Radius; /* scale *10m */
        UBYTE Res[4];
        UBYTE  Flags;
        UBYTE GPIOTrigger0;
        UBYTE GPIOTrigger1;
}AT_Triggers_struct;

/* modem config */
typedef struct
{
        UBYTE OnPulsLen;  /* if zero the pin is high, while the modem should be on */
        UBYTE OffPulsLen; /* if zero, soft off is used */
        UBYTE OnWait;          /* time after on pulse before first command is sent */
        UBYTE OffWait;         /* time to wair after off pulse */
        UBYTE OffCmd[10]; /* soft off at command */
        UBYTE CRegTimeout;/* timeout in s/10 after failed gsm registration*/
        UBYTE CRegOffTime;/* in min. wait this time after CRegTimeout */
        UBYTE OnTime;     /* stays on this time after an action */
        UBYTE Reserved0;  /* reserved for future use */
        UBYTE Reserved1;       /* reserved for future use */
        UBYTE PreRegInit[INIT_SCRIPT_LENGHT];
        UBYTE PostRegInit[INIT_SCRIPT_LENGHT];
}AT_Modem_struct;

/* misc config */
typedef struct
{
        UBYTE PIN[11];
        ULONG Flags;
        UBYTE GPIO_out;  /* only GPIOs 0-7 are supported for online setting */
        UBYTE GPIO_init;
        UBYTE Res[8];
        GSM_Phone_Number_Struct       SCA;
        GSM_Phone_Number_Struct Host[PHONE_NUMBERS];
}AT_General_struct;

/* all config */
typedef struct
{
        AT_General_struct             General;
        AT_Modem_struct               Modem;
        AT_Triggers_struct    Trig;
        AT_Event_struct               Events[EVENTS];
}AT_Config_struct;
```

C RELATED DOCUMENTS

- GPS.G1-X-00005 - GPS-MS1E/GPS-PS1E Protocol Specification
- GPS.G1-MS1-00002 - GPSMS1E Datasheet

All these documents are available on our homepage (http://www.u-blox.com).

D GLOSSARY

DOP	Dilusion of Precision
GPIO	General Purpose Input / Output
GPS	Global Positioning System
GSM	Global System of Mobile Communication
MO	Mobile Originated
MT	Mobile Terminated
PIN	Personal Identification Number
SCA	Service Center Address
SIM	Subscriber Identity Module
SM	Short Message
SMS	Short Message Service
SV	Space Vehicle (Satellite)
TOW	Time of Week (GPS Time)

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REVISION HISTORY

Revision Index	Date	Name	Status / Comments
	19/10/00	PE	Initial version
	27/10/00	CB	Release Version