DSNP

Capricorn 2001

Fleet Tracking System

ADMINISTRATOR'S MANUAL

Documentation Part No. :
DSNP100405
Rev A

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Conventions used

The following symbols and conventions are used in the description of the DSNP proprietary commands:

Square-brackets []	:	used to bound optional parameters
x.x	:	designates the format of any numerical data, signed or not, with or without decimal point and decimal places, and with an integer part of variable length
a	:	designates a one-letter parameter (example: A)
x	:	designates the format of any numerical data which is necessarily an integer
xx	:	Numerical data, fixed length
c--c	:	Character string, variable length
cc	:	Character string, fixed length
a--a	:	Keyword
hhmmss.ss	:	Time
llll.lllll	:	Latitude (ddmm.mmmmm)
yyyyy.yyyyyy	:	Longitude (dddmm.mmmmmm)
[y]x	:	Field containing two one-figure parameters the first of which is optional

In the examples given at the end of each description, the following fonts are used:

- **Bold Times New Roman** for commands sent from the control computer
- Normal Times New Roman for replies to these commands returned by the queried board.

In the description of our software programs, we use the > symbol to link the names of the commands that you must select in succession, starting from the program's menu bar. We also use bold characters for command names. Example: select **Tools>Settings** means: first select the **Tools** command and then, from the menu that pops up, select the **Settings** command.

NOTICE

Each country maintains its own rules and regulations with respect to the operation of radio equipment. It is the user's responsibility to assure that proper licensing procedures are followed in accordance with the laws of each country. DSNP may provide licensing assistance for operation of the UHF radio link.

Operating an unlicensed radio transmitter is a violation of the law. You may be subject to fines or other penalties if you operate a radio transmitter without proper licensing.

Table of contents

1. Station Description & Start up 1-1

Multi-Channel Station 1-1
- Cabinet Description 1-1
- Coaxial links made at the rear of the cabinet 1-2
- Other connections made at the rear of the cabinet 1-3
- Characteristics 1-4
- Cable list 1-4

Single-Channel Station 1-5
- Connections to be made on rear panel 1-5

Choice of antennas 1-6
- GPS Antenna 1-6
- UHF transmission antenna (multi-channel station) 1-6
- UHF reception antenna (multi-channel station) 1-7
- UHF antenna decoupling (multi-channel station only) 1-8
- UHF reception/transmission antenna (single-channel station) 1-8

Software provided 1-8
- Check2001 1-8
- Confload 1-8

Front-end communication port 1-9

Start-up 1-9
- Multi-channel station 1-9
- Single-channel station 1-10

Meaning of lamps on Capricorn 2001 rack 1-10
- When station is switched on 1-10
- In steady state 1-11

Connecting a PC for maintenance 1-12

2. Maintenance Software 2-1

Check2001: Dialog tool 2-1
- Description 2-1
- Operational environment 2-1

- Software installation 2-1
- Communication link between PC and Capricorn 2-2
- Start-up 2-2
- Available functions 2-4
- "Hardware" function 2-5
- "Date and Time" function 2-8
- "Events" function 2-9
- "Explorer" function 2-10
- "Terminal" function 2-12
- Immediate readout of messages in Syletrack No. 2 protocol 2-15
- "Spy" function 2-17

ConfLoad: Configuration update tool 2-18
- Description 2-18
- Operational environment 2-18
- Software installation 2-18
- Communication link between PC and Capricorn 2-18
- Start-up 2-19

3. Basic Network Principles 3-1

Introduction 3-1

Basics of radio links 3-3

System capabilities 3-3
- Example with 45-kHz TDG 3-4
- Example with 12.5-kHz TDG 3-4

Choosing values for basic parameters 3-5
- Format length 3-5
- Recommendation for broadcasting differential corrections 3-6
- "Vacant Slot" rule (12.5 kHz TDG) 3-7

Introduction to messaging 3-8

Messaging from vehicles to station 3-9
- Synchronous messaging in place of position messages 3-9
- Non-synchronous messaging alternating with position messages .. 3-9

Messaging from station to vehicles (radio-modem) 3-10
- Messaging via sync slot using input protocol EXTCF 3-11
- Messaging via input protocols EXTTD or FIFO 3-12

- Messaging via input protocol EMCR 3-14

Simple network 3-15
- Conventions used in format diagrams 3-15
- Definition of a simple network 3-17
- Example (12.5-kHz channeling) 3-17
- Example (45-kHz channeling) 3-18

Introduction to networks including relays 3-19
- Synchronization of a network including relays 3-20
- Relaying differential corrections 3-21
- Relay operational limits 3-21

Relays in star-shaped networks 3-22
- Estimation of range 3-22
- Example of a 3-station network with no relaying of vehicle positions by the system 3-22
- Example of a 4-station network with relaying of vehicle positions by the system 3-24
- Extending a star-shaped network 3-25

"Line-configuration" networks including relays 3-27
- Estimating the range 3-27
- Example of line-configuration network with no relaying of vehicle positions by the system 3-29
- Example of line-configuration network with relaying of positions by the system 3-30

Operating limits 3-31
- Channels to be avoided 3-31
- Programming "Station" TDG boards for reception 3-31

4. Station Administration 4-1

Work organization 4-1
- Multi-Channel Station, Internal Serial Lines 4-2
- Multi-Channel Station, UHF Signal Path 4-3
- Single-Channel, Internal Serial Lines 4-4
- Single-Channel Station, UHF Signal Path 4-5

Data flow organization in a station in operation 4-6

List of regular tasks 4-7
- General station configuration 4-7

- Configuration of TDG board in a single-channel station or a TDG1 (master) board in a multi-channel station 4-8
- Configuration of the other TDG boards in a multi-channel station (TDG2... TDG4) 4-9
- Operational status of TDG boards 4-10

$PDAS commands used to configure the UC and GNSS boards 4-10

- $PDAS,CONFIG..4-11
- $PDAS,DGPDAT 4-12
- $PDAS,FIXMOD..4-14
- $PDAS,HARDRS 4-15
- $PDAS,IDENT 4-17
- $PDAS,LOG and station event log 4-19
- $PDAS,MEMORY,DIR...4-22
- $PDAS,PREFLL...4-24
- $PDAS,UNIT 4-25

5. Mobile Description & Start-up.. 5-1

Unit Description 5-1

How to mount the internal gyrometer 5-3

- Mounting criterion... 5-3
- Changing the direction in which the gyrometer is mounted........... 5-4

Choice of antennas..5-4

- For a land vehicle.. 5-4
- For a boat 5-4

Installation in the vehicle 5-5

- Odometer Calibration 5-8
- Gyrometer Calibration 5-8

6. Mobile Unit Administration 6-1

Work organization 6-1

- Description of the internal serial lines... 6-3
- Reminder of the functions performed by the mobile..................... 6-3

Data flow organization inside a mobile in operation 6-4

List of regular tasks 6-5

- GNSS board.. 6-5
- TDG board configuration 6-6

- Operational state of the TDG board 6-8

$PDAS commands used to configure the GNSS board 6-8
- $PDAS,FIXMOD 6-9
- $PDAS,GEO 6-11
- $PDAS,IDENT 6-15
- $PDAS,OUTMES 6-17
- $PDAS,SELGEO 6-19
- $PDAS,SENSOR 6-20

How to determine the gyro & odo coefficients 6-21
- Measurement conditions 6-21
- Measurement procedure 6-21
- Calibrating the odometer 6-22
- Calibrating the gyrometer 6-23

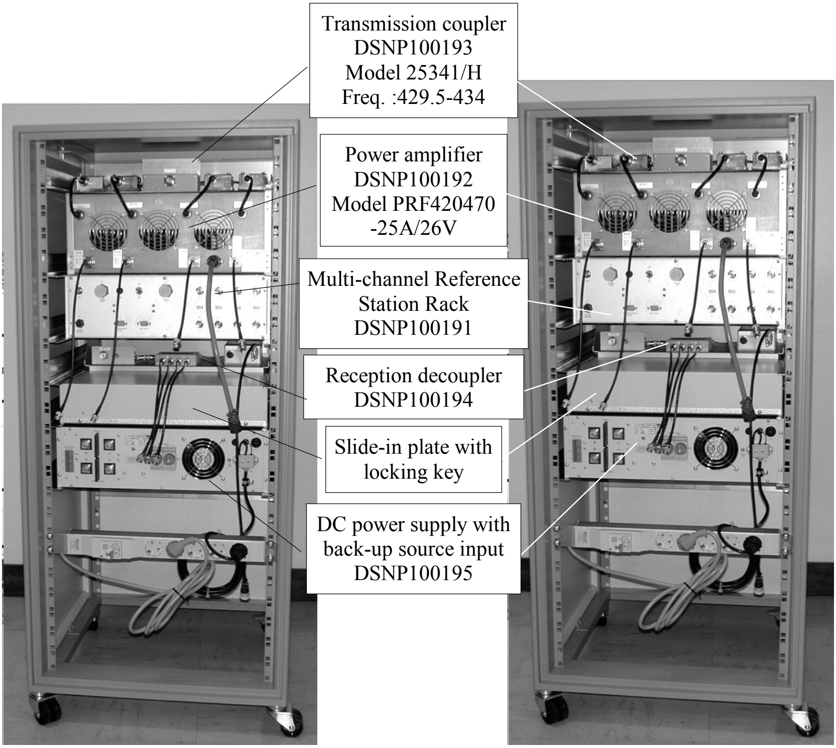
XYAID Message Description 6-24

1. Station Description & Start up

1

Multi-Channel Station

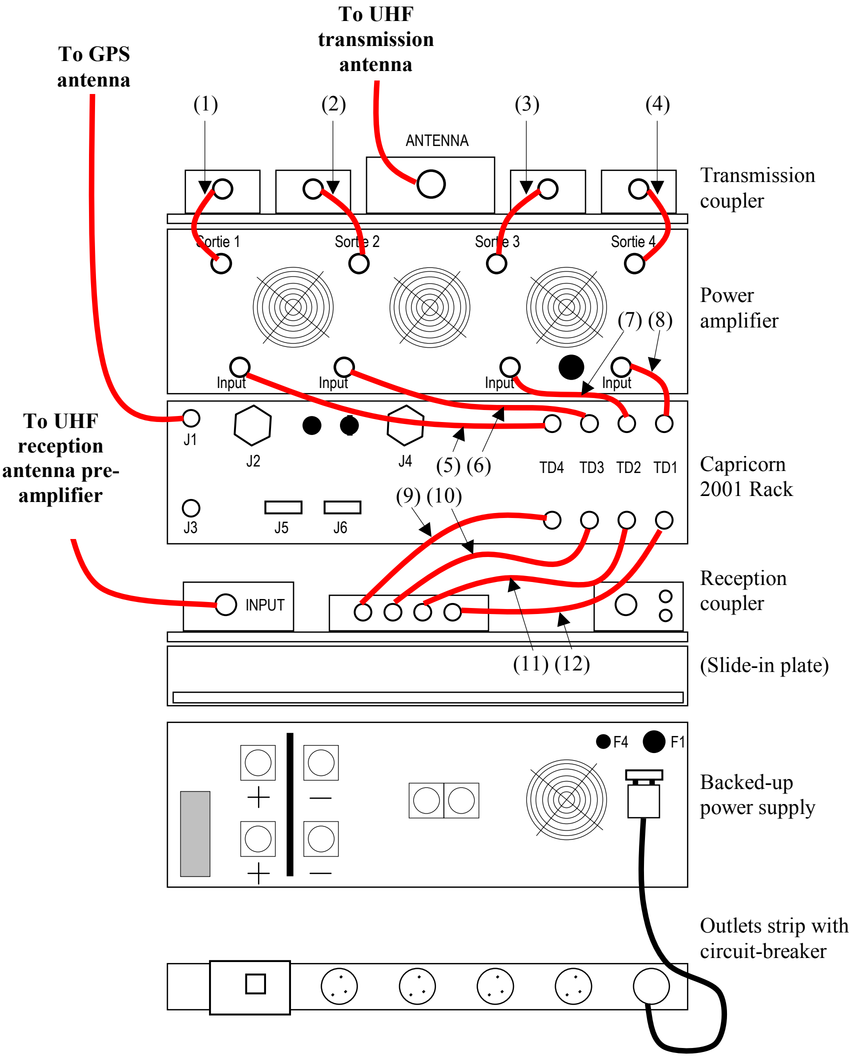
❑ Cabinet Description



The multi-channel reference station rack uses 2 to 4 TDG boards operated concurrently. Each TDG uses a specific frequency channel.

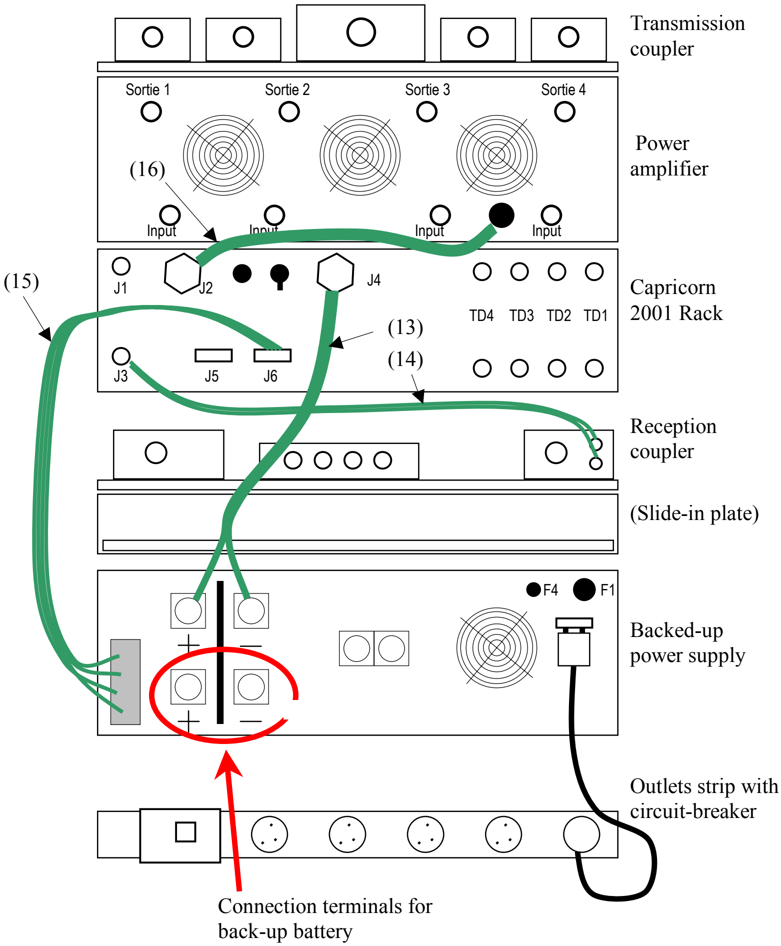
❑ Coaxial links made at the rear of the cabinet

(The other existing connections are described in the next paragraph.)



Numbers in brackets identify cables whose part numbers are given on page 1-4.

❑ Other connections made at the rear of the cabinet



Numbers in brackets identify cables whose part numbers are given on page 1-4.

❑ Characteristics

Dimensions (W×D×H): 55×63×124 cm

Net weight: 106 kg

Input source: power line; 230 V AC ±15 % (45-60 Hz)

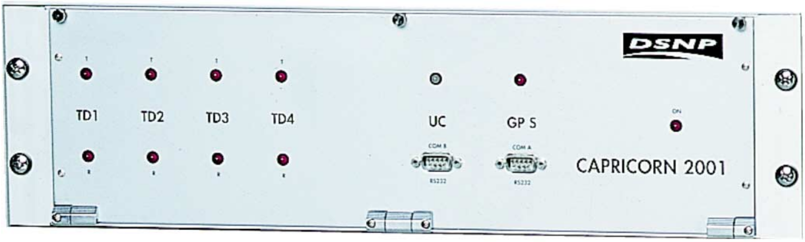
❑ Cable list

See also diagrams on the preceding 2 pages.

Cable identification on diagram	DSNP Part Number
(1) (2) (3) (4)	DSNP100230
(5) (6)	DSNP100231
(7) (8)	DSNP100232
(9) (10) (11) (12)	DSNP100233
(13)	DSNP100234
(14)	DSNP100235
(15)	DSNP100236
(16)	DSNP100237

Single-Channel Station

The supply of a single-channel station consists of a rack fitted with a single TDG board (installed in TD1 slot). The rack power supply is not provided.

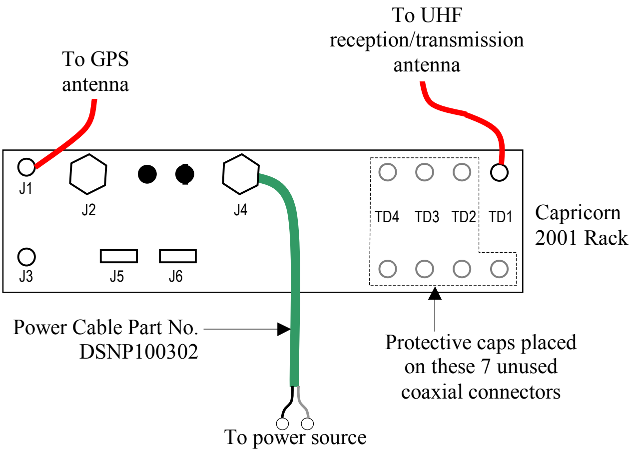


Note that the front panel of a single-channel station is exactly the same as that of the *multi-channel reference station rack* of a multi-channel station.

Dimensions (W×H ×D): 19-inch rack (48.26 cm) × 3U (13.2 cm) × 40 cm

Power requirement: 12 V DC (10 to 15 V) – 12 W approx.

❑ Connections to be made on rear panel



Choice of antennas

❑ GPS Antenna

- Type of antenna: single-frequency L1 (example: DSNP NAP001 or similar)
- Input level: Coaxial used (length, type) and antenna gain should be chosen in accordance with the following:

  $$\textit{Preamplifier gain} - \textit{loss in coaxial} \geq 14dB$$

  Example: with an NAP001, whose gain is 38 dB min, the max. possible length of RG223 is 30 m, attenuation in this cable therefore being 24 dB
- Power voltage required for the antenna pre-amplifier:
  5 V DC-75 mA ; provided by the rack via the coaxial cable; power supply protected from short-circuits.

❑ UHF transmission antenna (multi-channel station)

- Omni directional
- Gain: 3 dB

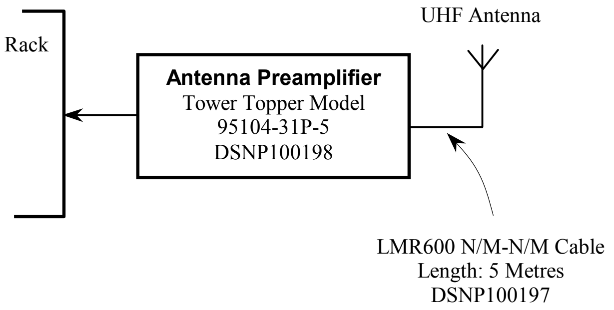
  Recommended antenna: Procom CXL 70-3C/I
- Coaxial link: as short as possible to reduce loss. Recommended cables:

Type of coaxial	Loss over 100 m at 450 MHz	Cable diameter
LMR600 Elexience	5.6 dB	15 mm
LMR400 Elexience	8.9 dB	10.29 mm
IRG214 (KX13)	15 dB	10.8 mm

  - For a 50 m link, use for example an LMR-600 cable (loss: 2.8 dB)
  - For a 30 m link, use for example an LMR-400 cable (loss: 2.58 dB)
  - For a 10 m link, use for example an IRG214 cable (loss: 1.5 dB)

❑ UHF reception antenna (multi-channel station)

It includes an antenna preamplifier and a coaxial cable linking the antenna to the preamplifier (see below). The features of these two elements determine the UHF input specification.



Type of antenna:

- Omni directional
- Gain: 3 dB in absence of other transmissions, whose frequency would be in the range of ± 15 MHz around the transmitted frequency, on the same tower. Otherwise choose a 0 dB antenna.

Preamplifier-rack coaxial link

- Ensure the loss in the coaxial cable used is of approx. 7.5 dB. If necessary, insert attenuators into this link to obtain the recommended attenuation value.

❑ UHF antenna decoupling (multi-channel station only)

The best decoupling method for UHF antennas is achieved by placing the antennas on the same tower, one on top of the other.

❑ UHF reception/transmission antenna (single-channel station)

Same as the UHF transmission antenna used for a multi-channel station (see page 1-6).

Software provided

The following software is provided, whether the station is single- or multi-channel.

❑ Check2001

This software module can be used for the following:

- Identification of station's hardware and software
- Loading files to, or reading files from, the UC (CPU) board
- Setting station time & date
- Reading possible errors detected by the station
- Communicating with (or « spying ») a UC board (using the set of available commands)
- Communicating directly with a TDG or GNSS board (also using the set of available commands).

❑ Confload

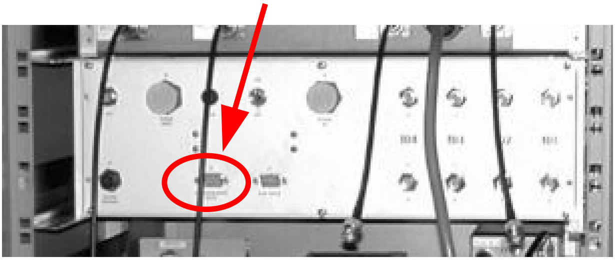
- Loading configuration files for UC, GNSS, TDG into these boards via a UC board.

1

Front-end communication port

This port allows data exchange between the TDG board(s) of the single- or multi-channel station and the central station of the vehicle tracking system.

The front-end communication port is identified as the “RS232 Communication” port situated at the rear of the Capricorn 2001 rack (J5; RS232 male connector).



Start-up

Make sure that proper licensing procedures have been followed — concerning frequency allocation— before starting the station. Up to 4 frequencies can be used in the band 410-470 MHz. The choice of the 4 frequencies should not result in a band occupation larger than 5 MHz. On the other hand, no reception in either of the TDG boards should be planned while one of the others is due to transmit.

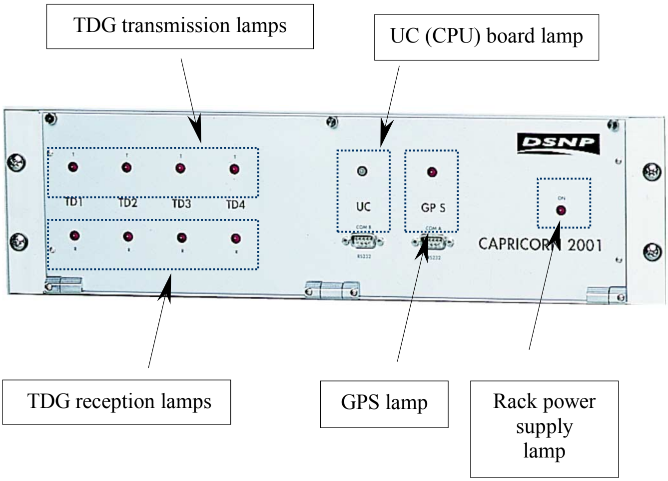
❑ Multi-channel station

- At the rear of the cabinet, unwind the outlets strip cord and connect the plug to the power line.
- Check that the circuit breaker is ON.
- On the front panel of the power supply rack, on the left, turn the “Power” button to position **I** to switch the cabinet on. The green lamp inside the button lights up. In the “Battery” area of the rack, the green “ON” lamp also lights up.
- On the rear panel of the CAPRICORN 2001 rack, position the “ON/OFF” switch to “ON” to turn the rack on. On the front panel of the rack, the green “ON” lamp on the far right-hand side lights up.
- On the front panel of the power amplifier, on the right, press the “MA” (ON) button. The green lamp inside the button lights up.

❑ Single-channel station

- Check for 12 V DC at the output of the power supply used
- On the rear panel of the CAPRICORN 2001 rack, position the "ON/OFF" switch to "ON" to turn the rack on. On the front panel of the rack, the green "ON" lamp on the far right-hand side lights up.

Meaning of lamps on Capricorn 2001 rack



❑ When station is switched on

During the initialization phase:

- All TDG transmission and reception lamps are lit

  When the TDG reception lamps go out, the TDG boards are ready for reception

  In the same way, when the TDG transmission lamps go out, the TDG boards are ready for transmission
- The UC lamp lights up in red and remains so for approximately 30 seconds, the time it takes for the UC (CPU) board to initialize

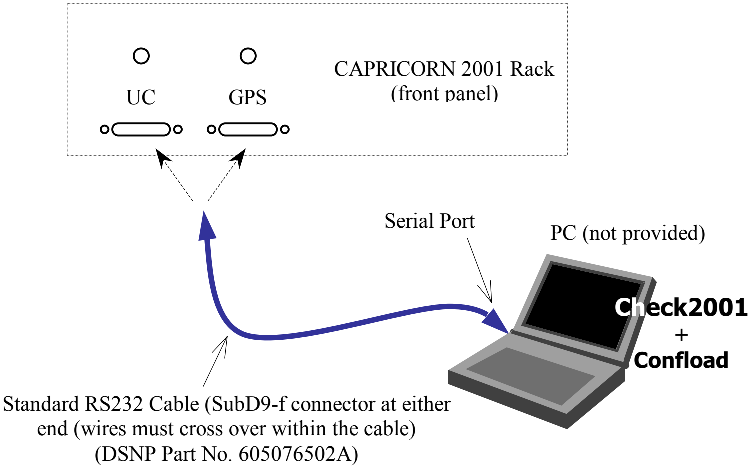
- If the station is a master station, then the GPS lamp will light up and stay lit during the entire initialization phase (satellite search).
- If the GPS indicator light stays lit for more than 2 minutes, then you should suspect the GPS antenna or its coaxial cable. Check to see if these two elements are properly connected
- The indicator lights of TDG boards #2 to #4 should not stay lit for more than 3 minutes. If this happens for a board, check its configuration. If everything is normal and the problem still persists, you should suspect the TDG board itself.
- For a TDG board, the reception lamp may go out while the transmission lamp still remains lit. This is not a faulty state as long as it is a temporary state. It simply means that the board is ready for reception, but not for transmission.

❑ In steady state

- The TDG transmission lamps are lit when the corresponding TDG boards transmit
- The TDG reception lamps are lit when the corresponding TDG boards receive
- The UC lamp is permanently lit in green. It turns red if there is a problem on the CPU (memory error, etc.)
- If the station is a master station, then the GPS lamp will blink at a regular rate, denoting that GPS data acquisition is effective.

Connecting a PC for maintenance

For any maintenance operation on a single- or multi-channel station, make the following connections (then refer to Maintenance Software section starting on page 2-1).



♣

2

2. Maintenance Software

Check2001: Dialog tool

❑ Description

Check2001 is a maintenance tool which uses an RS232 serial link to exchange information with a *Capricorn* station (or a mobile unit).

In normal operation, **Check2001** is connected to a station UC board (or to a mobile UC board if the mobile is fitted with the optional UC board) and features the following functions:

- "Hardware": identifies the hardware devices in the unit being queried.
- "Time & Date": updates time of day and date.
- "Events“: lists any technical incidents detected in the unit during operation.
- "Explorer": Lists files in the UC board flash memory.
- "Terminal": Provides information exchanges with the hardware devices of the unit using NMEA-format commands.
- "Spy": Monitors data exchanges on the UC board.

When **Check2001** is connected to a GNSS or TDG board, only the "Terminal" function is available.

❑ Operational environment

PC with Microsoft Windows 95, 98 or NT operating systems.

❑ Software installation

Installation starts automatically when you access the CD-ROM. Then follow the installation instructions provided. If installation does not start automatically, run the "setup.exe" file.

❑ Communication link between PC and Capricorn

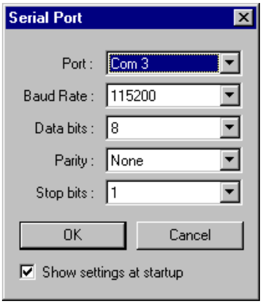
For connection to a *Capricorn 2001* station, see page 1-12.

❑ Start-up

It is assumed that installation of **Check2001** has been completed, that the communication link between the PC and *Capricorn* has been established and that the configuration parameters of the *Capricorn* RS232 port are known (transmission speed, data bits, stop bits and parity bits). These port parameters are configured on the unit being tested. If they are not known, they may be consulted by carrying out the following procedure.

- With Windows® running, launch **Check2001**.

  A window as shown below appears and requests the configuration parameters for the PC serial port to be used for communication.

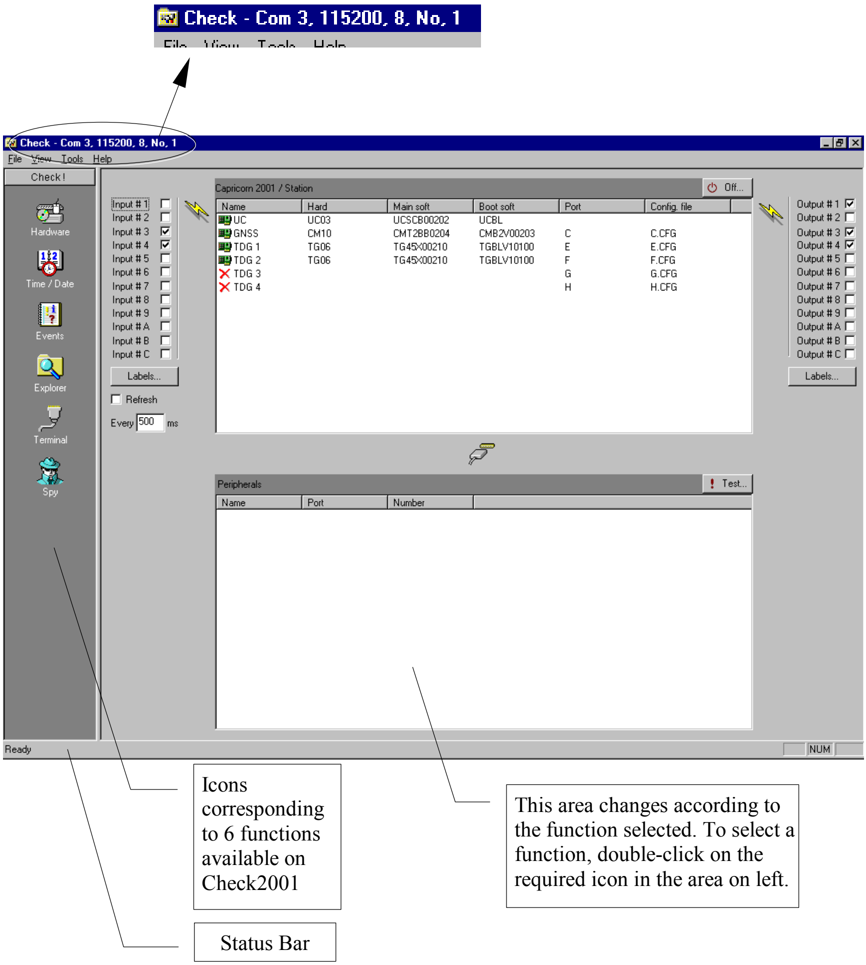


- Set up the port configuration to be the same as the *Capricorn* port and click on **OK**.

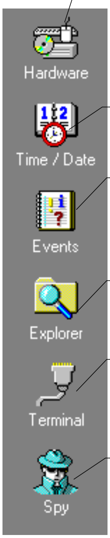
NOTE: If you do not wish this box to re-appear the next time you run **Check2001**, de-select **Show settings at startup**. Afterwards if you should wish to re-display the box, select **Tools>Settings** on the program menu bar.

This box will re-appear if **Check2001** cannot connect to the communication port.

The main **Check2001** window then appears. The title bar always displays the port configuration set up on the PC. The area on the left displays icons corresponding to the available functions. The area on the right will change depending on the function selected.



❑ Available functions



Identifies the electronic boards in the connected unit and the versions of the software that controls the boards as well as any peripherals connected to the UC board. Displays the input/output logic states on the UC board. Names the input/output signals.

Updates the time of day and date on the connected unit.

Lists any discrepancies that the connected unit has detected in its own operation.

Lists all files on the UC board.

Used to communicate with one of the hardware devices identified by the "Hardware" function

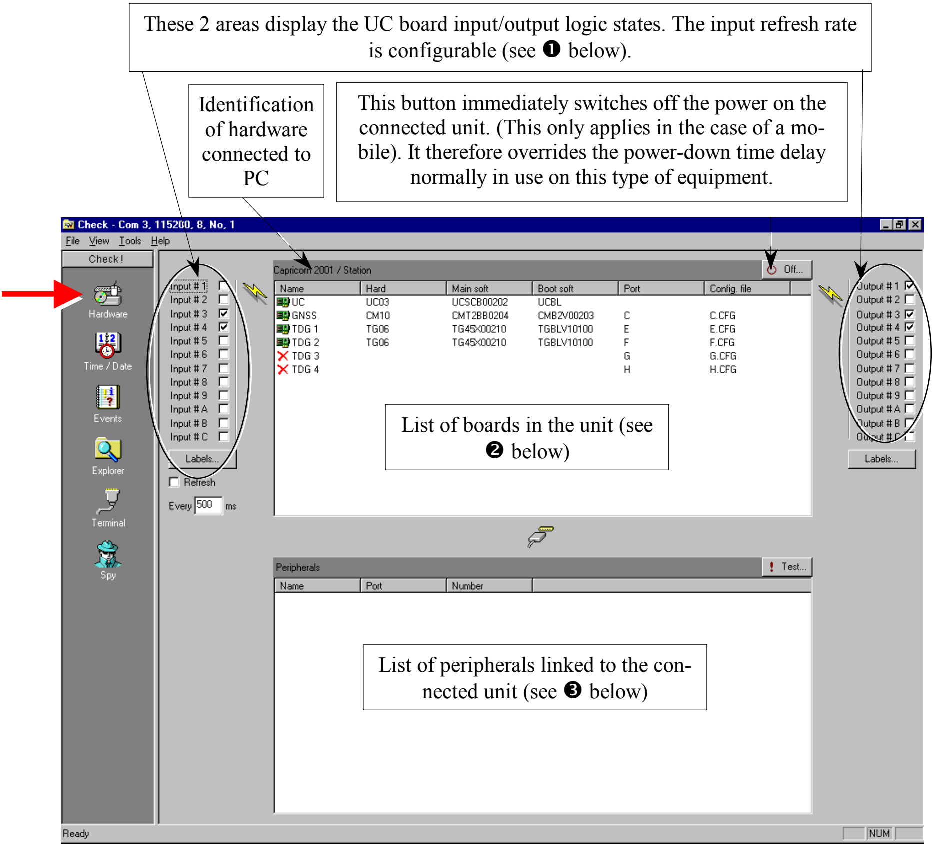
Detects and displays any data being transferred via the UC board ports.

- To select one of these functions, double-click on the corresponding icon. The area on the right-hand side of the window will change depending on the functions selected.

2

❑ "Hardware" function

By default, this function is selected each time **Check2001** is started. Each new click on the "Hardware" icon will update the content of this window. The right-hand side of the window displays the following:



❶ Logic states of UC board input/output signals. These two areas are only meaningful if the connected unit is a *Capricorn 2001M* mobile fitted with a UC board. They can be used to test routing of sensor signals to the UC board (inputs) and the routing of signals from the UC board to peripherals (outputs). Note that inputs and outputs are completely independent.

In the case of a mobile unit fitted with a UC board, the information displayed should be interpreted as indicated below.

- **Inputs**: For each of the 12 inputs, **Check2001** will check the button if the corresponding signal level is active (**Check2001** will not check it in the contrary case). The input levels cannot be forced.

  The refresh rate used by **Check2001** to read the input levels can be adjusted.

  Refresh button checked : The current refresh rate is that specified in the dimmed text zone just underneath.

  To change the refresh rate, clear the **Refresh** button and enter a new value beneath (the text zone is no longer dimmed).

  This new value will be activated when you re-check the **Refresh** button.

  Refresh button cleared : No information refreshed.

- **Outputs**: For each of the 12 outputs, **Check2001** will check the button if the corresponding signal level is active. (will not check it in the contrary case). The output levels can be forced by checking (or clearing) the corresponding button.

The **Labels** buttons are used to re-name each of the inputs and outputs (the default name format is "input##").

❷ Lists the boards present in the unit. In the table a row contains information for a single board. The columns have entries for each board as follows:

Name	Name of board
Hard	Board hardware version
Main Soft	Board software version
Boot Soft	Version of board boot-loader
Port	Name of serial port on the UC board to which the board is connected
Config file	Name of file containing the board configuration. The presence of this filename does not mean that the file has actually been loaded to the board. It simply identifies the configuration normally used for this board.

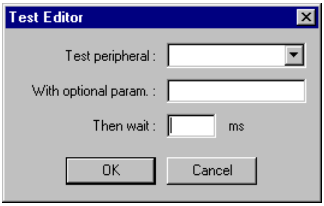
It can happen that a board is listed with no other information in the table other than its title. This indicates that a board with that title should be installed in the unit, but that in fact it has not been detected. Hence this must be remedied. This discrepancy is signaled by a red cross icon which appears in the left-hand column.

❸ Zone in which the peripherals connected to the unit being tested are listed. **It is only valid for those very particular cases in which the tested unit is a mobile associated with a UC board**.

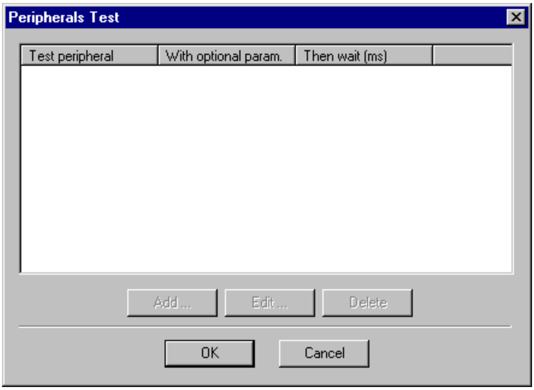
Name	:	Name of peripheral
Port	:	Name of serial port on the UC board to which the peripheral is connected
Number	:	Peripheral number

Also in zone ❸, the **TEST** button is used to confirm that a test signal can be sent from the UC board to a selected peripheral.

- Click on the **Test...** button.
- In the window that appears click on the **Add…** button and select the peripheral to be tested. (The **With optional param.** field is reserved for future applications). Indicate the time interval (**Then wait** field) within which the response must be received. Example:

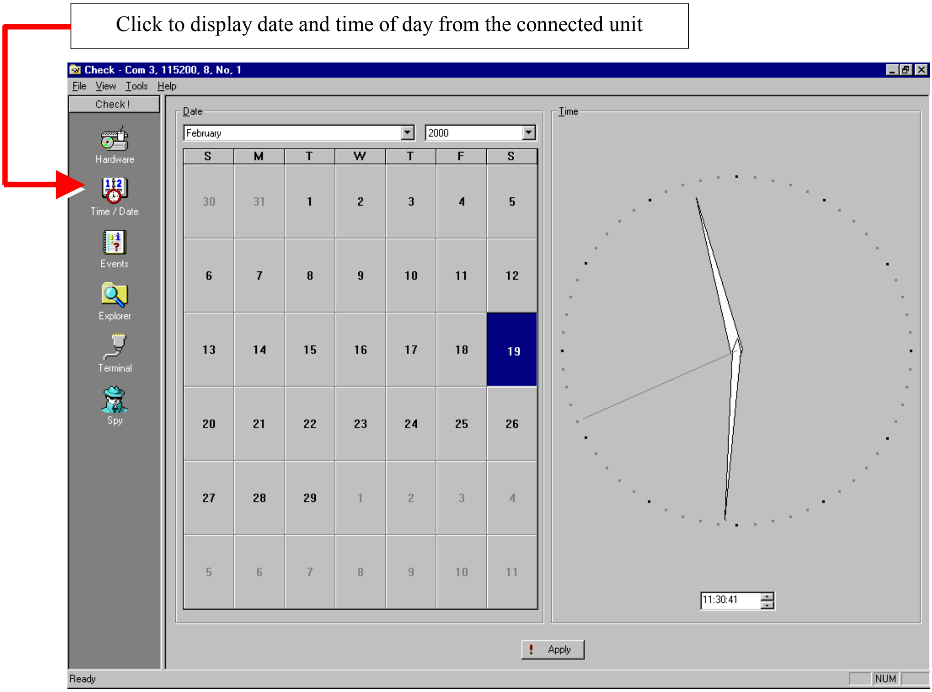


- Click on **OK**. The previous window now appears as follows:



❑ "Date and Time" function

After selecting this function, wait a few seconds until **Check2001** displays the date and time of day from the connected unit. During the delay, twelve noon will be displayed.

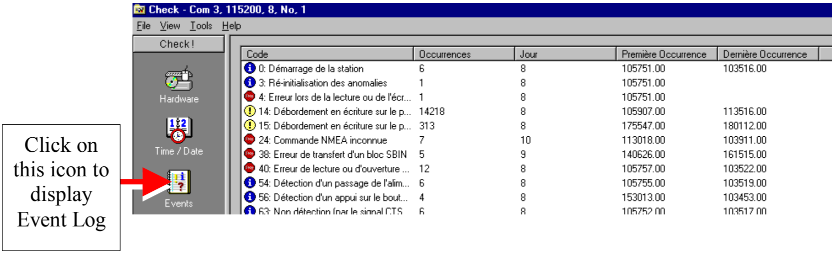


The **Apply** button is enabled as soon as a change is made to the date (month, year and day on the left) or the time (text box on bottom right).

If **Check2001** does not receive time data from the UC board, it displays the time from the PC and a message to this effect is displayed in left bottom of the window ("PC Date & Time" instead of "UC Date &Time").

❑ "Events" function

This function displays a list of operational incidents in the connected unit. Each event may or may not be a fault. (see list on page 4-8). The following is an example of Event Log for a *Capricorn* station:



The information given for each detected event is as follows:

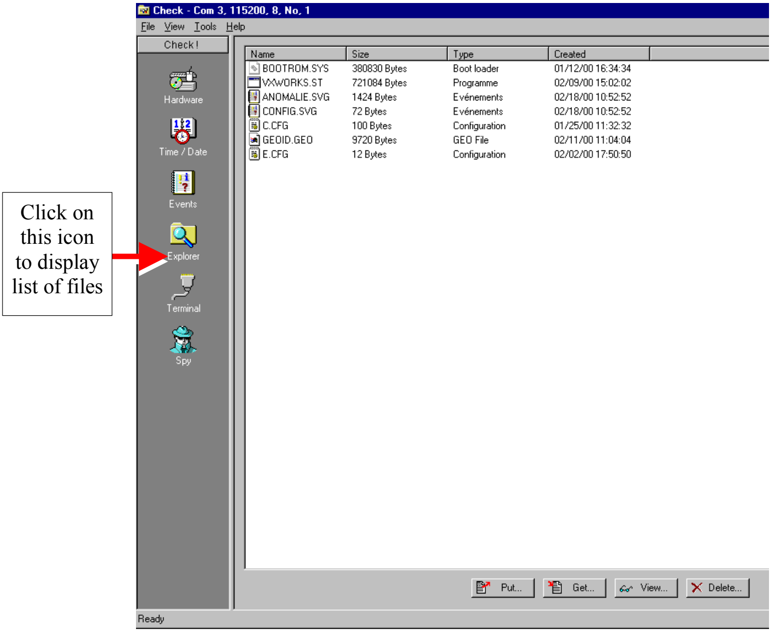
Code	:	Event identification (level-of-gravity icon, code, description)
Occurrences	:	Number of occurrences of the event
Day	:	Date of first occurrence
First Occurrence	:	Time of day of first occurrence
Last Occurrence	:	Time of day of last occurrence.

By clicking once on 

(bottom of window) the Event Log is cleared.

❑ "Explorer" function

This function is used to list the files in the UC board flash memory. Example:



The information given for each file is as follows:

Name	:	Filename and extension
Size	:	Size of file in bytes
Type	:	Type of file as described by extension
Created	:	Date file was created in flash memory

The window has four buttons for the following four functions:

Put... : This is used to save a specified file from any PC directory to the UC board using any filename the user chooses. Any type of file can be saved.

Get... : This is used to view a selected file in the window and to transfer it to the PC to be saved under a specified filename and directory path in the PC.

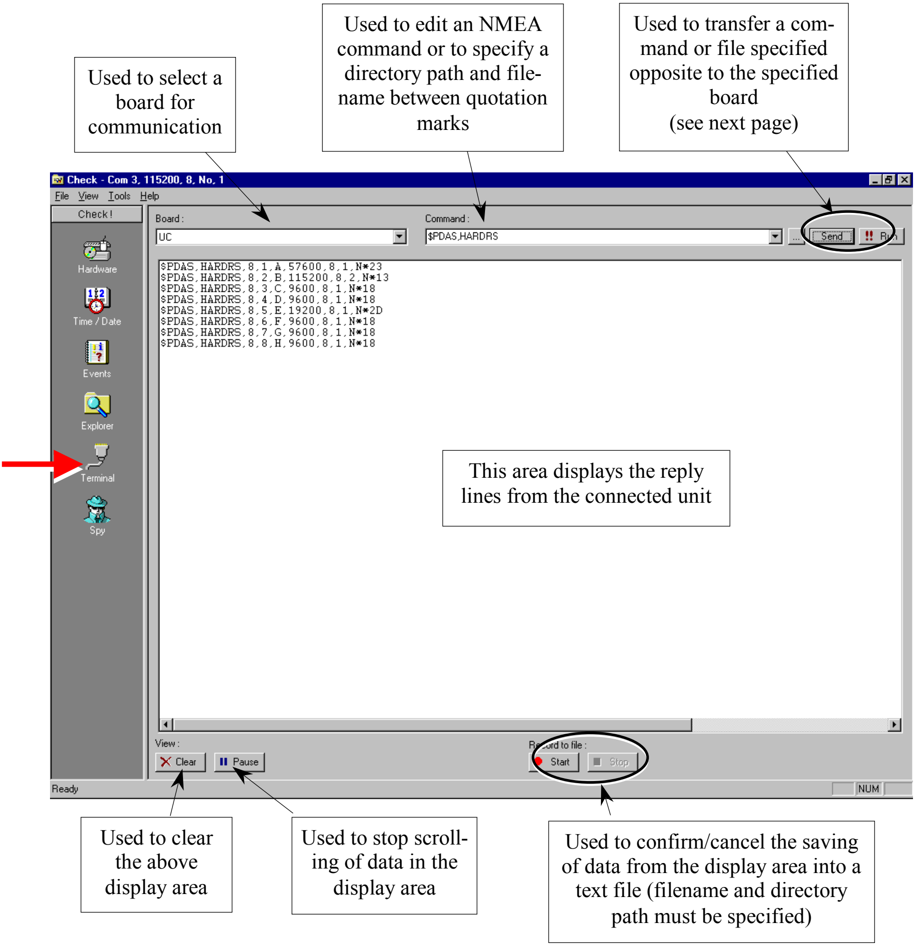
View... : This is used to view a selected file in Windows® Note Pad. More directly, this can also be achieved by double clicking on the filename.

Delete... : This is used to delete the selected file. A message box will ask for confirmation before the file is actually deleted.

The files **BOOTROM.SYS** and **VXWORKS.ST must never be deleted**. If they are deleted it will be necessary to send the UC board back to the factory.

❑ "Terminal" function

This function is used to communicate with the connected unit using NMEA commands (standard and proprietary $PDAS commands).



Important!

All data exchanges with the UC board can take place without disturbing station operation. On the contrary, if a command is sent to a TDG board or to the GNSS board, then the data flow relevant to this board is suspended on the front-end communication port. This will remain true as long as the board name is displayed in the **Board** area (top left):

Use of toolbar shown below:

Commands box : used to edit an NMEA command or a filename.

 : (In conjunction with **Commands** box), used to find a command or a file which has previously been sent to a queried system board and to display it in the **Commands** box.

 : Used to search the hard disk in the PC to find a file which is to be transferred. When a file is selected in this way the filename and directory path are displayed between quotation marks.

: Used to transfer the command or file specified in the **Commands** box to the queried board. The transfer is only carried out once.

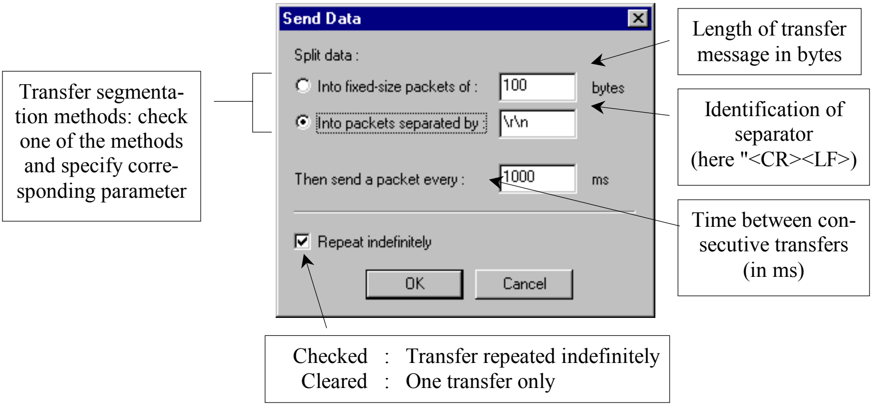
: Same as **Send** button, except that transferring a command or file may be performed through several transfers depending on the chosen method; it is possible to set the delay between two consecutive transfers and to arrange for the transfer to repeat indefinitely.

Segmentation of the transfer can be carried out in two ways:

- The number of bytes in each transfer is limited to a number which can be specified.

- The number of characters in each transfer is limited to a number contained between separators which can be specified.

Clicking on  opens the following window in which the above-described selection can be made:



Click on **OK** to validate selections and to transfer the command (or file).

NOTE: Run will continue as a background task. There is no reason why a new command cannot be edited in the **Commands** box and then transferred by clicking on **Send** while the previous task initiated by **Run** is still being processed.

To cancel the transfers initiated by **Run**, click again on the button.

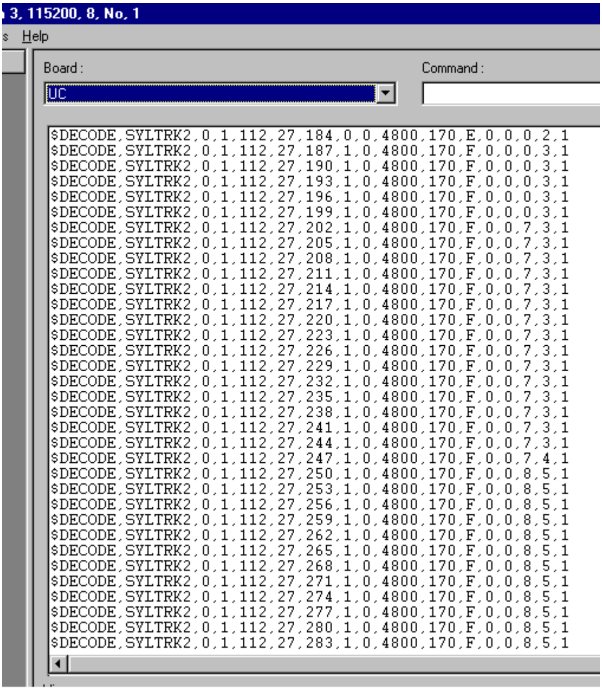
❑ Immediate readout of messages in Syletrack No. 2 protocol

One of the useful features in **Check2001** from a maintenance standpoint is the ability to read in non-coded form the messages from the station in Syletrack No. 2 protocol (binary messages). These messages are also available via the station maintenance port.

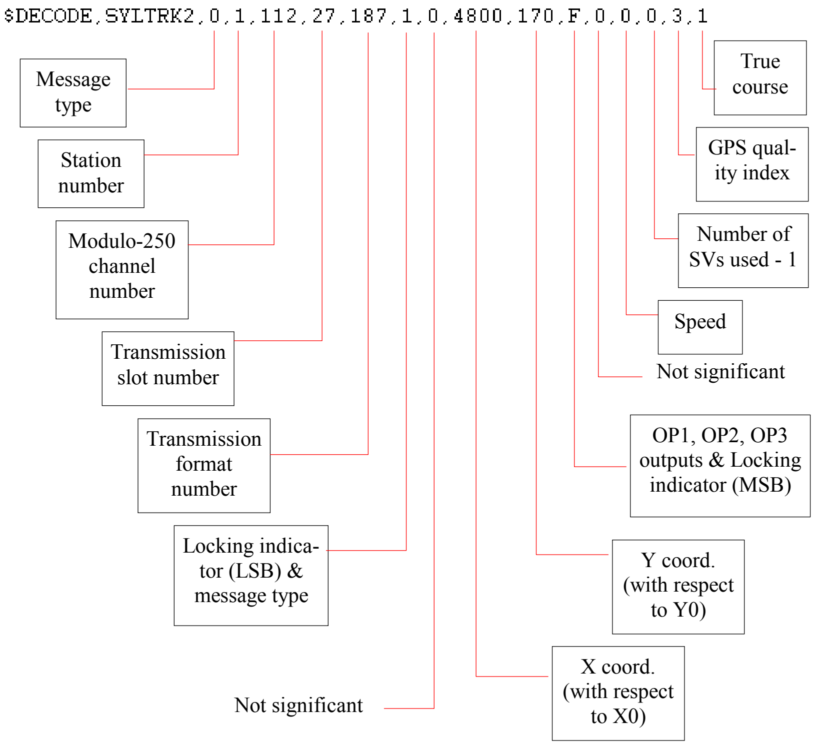
To read these messages, select the "Terminal" function as described previously on page 2-12.

As soon as **Check2001** detects a binary message at the maintenance port, it decodes it and displays it in the "Terminal" window. If the binary message is actually a Syletrack No. 2 message, it is indicated at the beginning of the line (cf. example below); otherwise "$DECODE,BINARY,..." appears at the beginning of the line.

The resulting decoded messages are displayed in real time in the "Terminal" display area. Example:



Detail of a line in Syledis No. 2 protocol as reported by the “Terminal” function (example resulting from input data in POSH protocol):

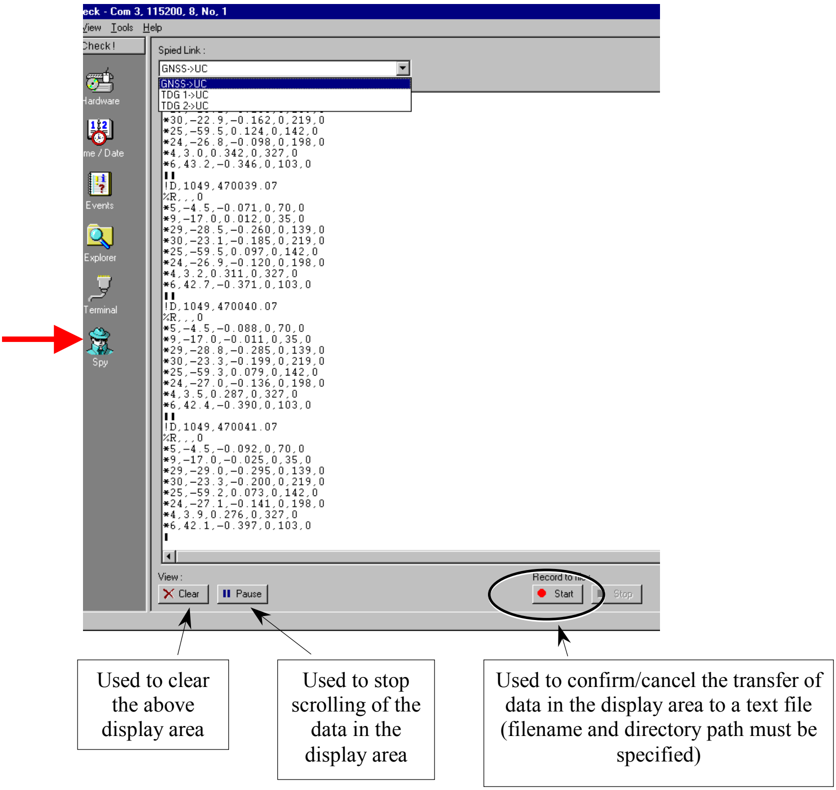


❑ "Spy" function

This function is used to display the data input to the UC board of the connected unit. These data can obviously come from any board in the connected unit (GNSS or TDG). The data passing between the two boards are displayed in real time. **This takes place without disturbing the operation of the connected unit.**

As for the "Terminal" function, the buttons in the lower part of the window are used to control the data display (**Clear**, **Pause**) as well as data transfer to a text file (.TXT) (**Start**, **Stop**).

Similarly as for the "Terminal" function, the same functions are available in the Spy window for detecting, decoding and displaying messages using the Syletrack No. 2 protocol if the connected unit is a station.



ConfLoad: Configuration update tool

❑ Description

ConfLoad is used to carry out configuration updates on the system boards. These updates are necessary whenever configuration changes are required for reasons external to the system or when updates are provided by DSNP.

❑ Operational environment

PC with Microsoft Windows 95, 98 or NT operating systems.

❑ Software installation

Run the "setup.exe" file from the CD-ROM supplied with the equipment and follow the installation procedure.

❑ Communication link between PC and Capricorn

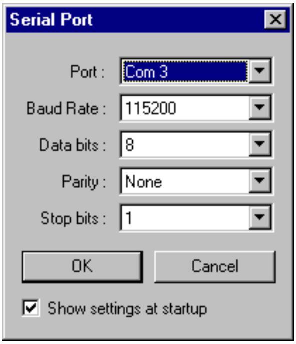
For connection to a *Capricorn 2001* station, see page 1-12.

❑ Start-up

It is assumed that installation of **Check2001** has been completed, that the communication link between the PC and *Capricorn* has been established and that the configuration parameters of the *Capricorn* RS232 port are known (transmission speed, data bits, stop bits and parity bits). These port parameters are configured on the unit being tested. If they are not known, they may be consulted by carrying out the following procedure.

- With Windows® running, launch **ConfLoad**.

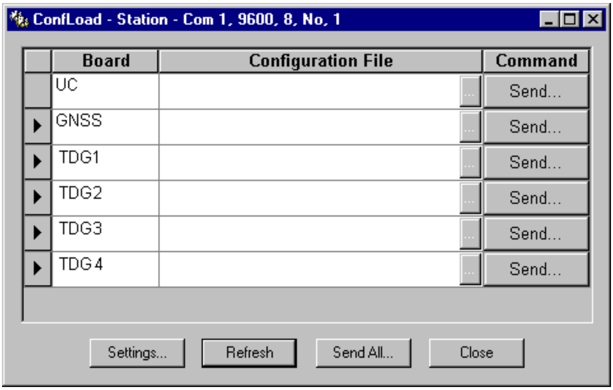
  A window as shown below appears and requests the configuration parameters for the PC serial port to be used for communication.



- Set up the port configuration to be the same as the *Capricorn* port and click on **OK**.

NOTE: If you do not wish this box to re-appear next time you run **ConfLoad**, de-select **Show settings at startup**. Afterwards if you should wish to re-display the box, select the **Settings…** button in the **ConfLoad** window.

The main **ConfLoad** window then appears. **ConfLoad** automatically detects the type of *Capricorn* unit connected to the PC and displays it continuously in the title bar. The configuration set up on the PC port is also displayed in the title bar. An example of the window for a 4-channel station is shown below:



This window displays a table with columns as follows:

Board column : Displays the boards detected in the unit

Configuration File Column : Displays filenames and their directory paths for configurations that can be loaded.

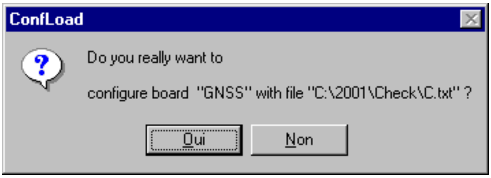
The  button corresponding to each listed board can be used to search the PC hard disk for the file to be loaded into this board.

Careful! This area never displays the name of the file that was last loaded to this board.

2

Command column : Contains a [Send...] button for each listed board which, when activated, loads the file shown in column 2 to the board.

After clicking on [Send...], a message will request confirmation to update the board configuration. Example:



The lower part of the window contains the following buttons:

[Settings...] : Accesses the PC serial port parameters.

[Refresh] : Updates the contents of this window (**ConfLoad** re-queries *Capricorn* to re-identify the unit boards)

[Send All...] : Successively transfers all configuration files listed in the **Configuration File** column to the corresponding boards.

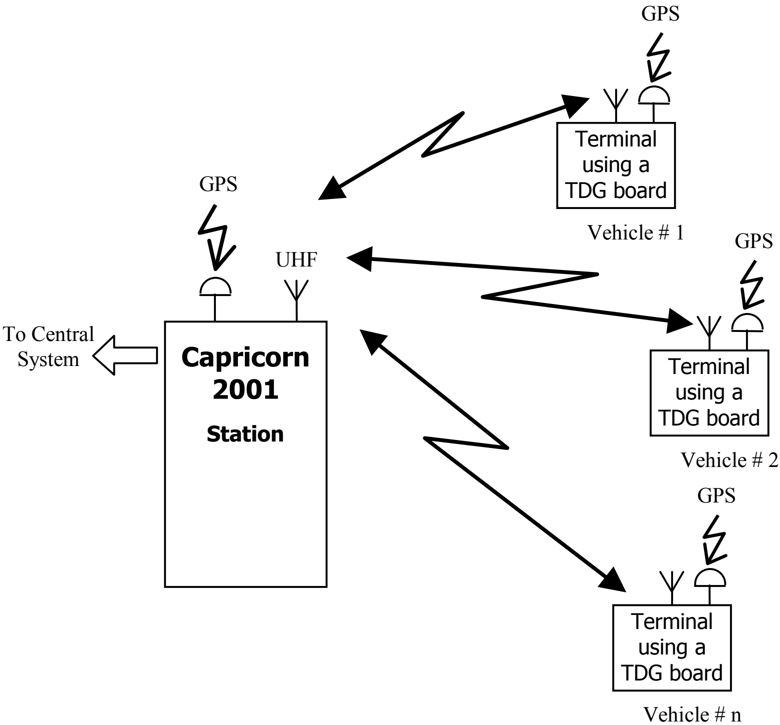
[Close] : Exits **ConfLoad.**

♣

3. Basic Network Principles

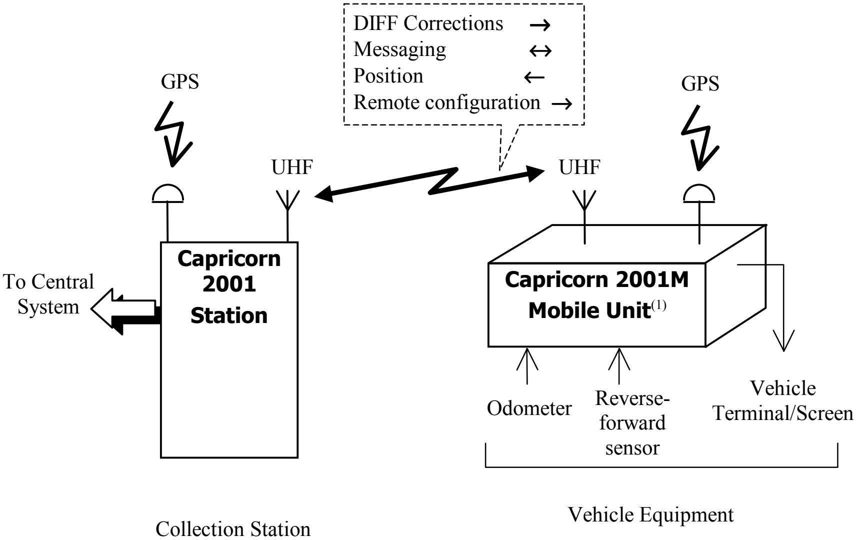
Introduction

Capricorn is a fleet tracking system which is completely configurable. Its main function is to collect data, more particularly position data, from vehicles within the range covered by the system and to transmit this data to the central processing system.



For each vehicle, *Capricorn* calculates the position using DGPS (Differential GPS) and updates the position data using external sensors (gyrometer, odometer). The differential corrections are sent to the vehicles by the central collection station, which also serves as a DGPS reference station.

Capricorn uses a bi-directional UHF radio link between the central collection station and the vehicles to transmit position messages and differential corrections, along with messaging and remote configuration data (see diagram below).



(1) *Includes a gyrometer*

To extend system coverage, one or more relay stations are added to the network. This subject is dealt with on page 3-18.

The bi-directional UHF radio link is provided in two ways and by two different sets of equipment:

- 12.5 kHz TDG board
- 45 kHz TDG board for implementing a system within a SYLETRACK network. Syletrack is a former tracking system based on the SYLEDIS format developed in the 70s by DSNP. Basically, Syletrack uses 45-kHz channeling, 6.67-ms slots and SYLEDIS stationary equipment.

In addition, each station may have multi-channel capability (2 to 4 independent channels). The channel allocated to a TDG may be changed dynamically. At station level, we recommend "1 TDG↔1frequency channel".

Basics of radio links

The system is based on the TDG board, which controls the transmission/ reception cycle for all equipment items in the *Capricorn* system.

The TDG board uses the TDMA technique (*TDMA: Time Division Multiple Access*). This technique defines a specific period of time (time slot) for each radio link used. Each slot is exclusive, i.e. there can only be one transmitted signal in any one time slot.

A TDG board uses a frequency channel for its transmission and reception functions. A special slot called “sync slot” allows all the TDG boards working on this channel (in a network) to be synchronized together.

Up to 4 different frequency channels may be implemented in a Capricorn network, which means, as said earlier, that the Capricorn station is fitted with as many TDG boards as the number of frequency channels used. Each channel therefore uses a different sync slot to synchronize all the TDG boards operating on that channel.

For more information, refer to the TDG Reference Manual.

System capabilities

The system is designed to make the best compromise between number of vehicles and data repetition rate, depending on the user’s needs.

Two examples are provided below to show how the system capacity can be calculated. The parameters involved are:

- L : Number of formats per sub-frame (length of sub-frame)
- C : Repetition rate for mobile position data as seen from the station (seconds)
- N : Size of fleet (number of vehicles)

❑ Example with 45-kHz TDG

(slot duration: 6.67 ms)

- 1 frequency channel
- 30 slots per format (30×6.67 ms→200 ms)
- 1 frame of 300 formats
- 13 slots to return the vehicle positions to the station
- 1 sync slot
- 1 DGPS corrections slot

Values for L, C and N are shown in the table below.

L	C C=0.2 × L	N N=13 × L
5	1	65
10	2	130
25	5	325
50	10	650
100	20	1300
150	30	1950
300	60	3900

❑ Example with 12.5-kHz TDG

(slot duration: 20 ms)

- 1 frequency channel
- 25 slots per format ((25×20 ms→500 ms)
- 1 frame of 300 formats
- 21 slots to return the vehicle positions to the station
- 1 sync slot
- 1 DGPS corrections slot

Values for L, C and N are shown in the table below.

L	C C=0.5 × L	N N=21 × L
5	2.5	105
10	5	210
25	12.5	525
50	25	1050
100	50	2100
150	75	3150
300	150	6300

Choosing values for basic parameters

❑ Format length

This choice cannot be other than a compromise between contradictory requirements. Choosing a value for the format length depends on the following:

1. the size and the frequency of "down-link" messaging
2. the accuracy required for differential positioning
3. required coverage (whether or not relays are used)
4. the number of mobile units and the repetition rate for position updates (mobile repetition rate).

On the one hand, considerations regarding parameters **1** and **2** would tend to reduce the format length (for better renewal of the sync slot and differential correction slots); on the other hand, considerations regarding parameter **3** would tend to increase the format length in order to accommodate relays, which in turn would call for a reduction in the number of slots available for the mobile units.

In terms of Parameter **4**, it would be preferable to adjust the repetition rate using the sub-frame rather than to increase the format length.

Rule 1

The mobile unit repetition rate divided by format length (expressed in seconds) should be a sub-multiple of the frame (300 formats), i.e. 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 25, 30, 50, 60, 75, 100, 150 or 300.

The mobile transmission rate, or repetition rate, is equal to the "sub-frame" × "format length" (cf. command $PDAS,TDG,MODE).

Example: mobile repetition rate = 6 seconds

Format = 0.2 seconds

$\Rightarrow$ sub-frame = $\frac{6}{0.2}$ = 30, which is a sub-multiple of 300

❑ Recommendation for broadcasting differential corrections

• Differential corrections are sent from the station's GNSS board in RTCM format (message type 9).

They are forwarded by the UC board to the TDG board inputs to be transmitted in dedicated slots, at a rate of 8 characters per slot.

For an RTCM type 9 message, the data are arranged as follows:

- *Header*
- Corrections for 3 SVs

Therefore, to transmit differential corrections for 3 SVs, a minimum of 35 characters is required (10 characters for the *Header* and 25 characters for the corrections) or in terms of time slots:

5 slots (5 × 8-byte message)

For an average of 9 SVs, the number of characters to be transmitted is 35 × 3, or 105 characters, i.e. 14 slots.

For 10 SVs, 17 slots are necessary.

• For a format of 200 ms (30 slots with 45-kHz TDG, 10 slots with 12.5-kHz TDG), and with just one transmission slot for corrections, the repetition rate for corrections is:

- 2.8 s for 9 SVs
- 3.4 s for 10 SVs

The data transmission rate is 39 bytes/sec. for both types of TDGs.

Under the same conditions and for a format of 400 ms (60 slots with 45-kHz TDG, 20 slots with 12.5-kHz TDG), the repetition rate is:

- 5.6 s for 9 SVs
- 6.8 s for 10 SVs

The data transmission rate is 19 bytes/sec. for both types of TDGs.

Rule 2

The repetition rate for differential corrections must not exceed 10 seconds. This implies a maximum format length of 600 ms (or 30 slots with 12.5 kHz TDG).

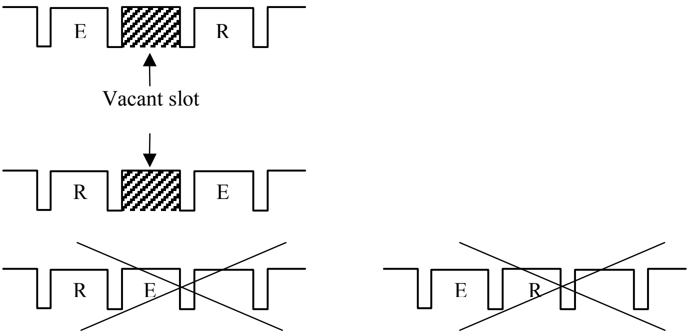
The repetition rate can be easily doubled by using a second transmission slot in every format. In that case relays cannot be used.

3

❑ "Vacant Slot" rule (12.5 kHz TDG)

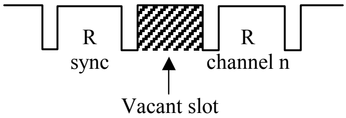
Rule 3

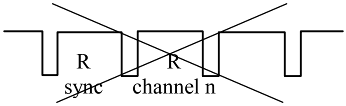
In assigning slots, on a routine basis leave a vacant (i.e. unassigned) slot between a transmission slot and an otherwise contiguous reception slot. This rule must also be observed each time a channel is changed.



E: Transmission slot
R: Reception slot

This rule must also be observed if the board must change its reception channel between two slots:





Slot 0 (the calibration slot) is considered as a vacant slot, which implies that the last slot in a format can always be used.

Introduction to messaging

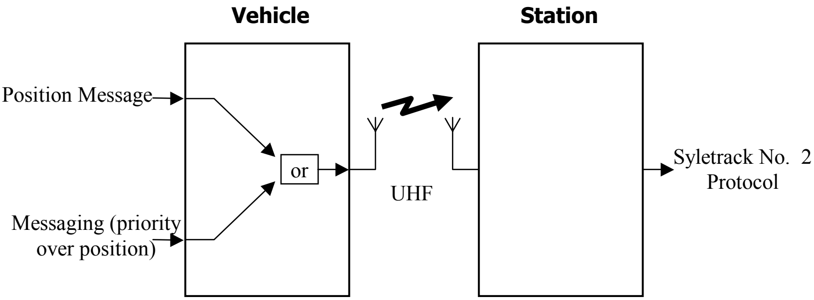
The term "Messaging" can be defined as any function that transmits data between remote users in the form of a short text (warning, alarm, command, etc.).

The following sections describe the various methods for transmitting messaging. Two cases will be examined, according to the direction in which data is sent:

- Messaging received by the station
- Messaging transmitted by the sync master central station or other station

Messaging from vehicles to station

❑ Synchronous messaging in place of position messages



Messages sent from the station (in Syletrack No. 2 protocol) must be analyzed to identify the type of received message (i.e. position data or messaging). Message type is encoded in the first byte (bits b5 to b7) of the data zone in Syletrack No. 2 protocol.

It is advisable that the user defines her/his own encoding:

- to identify position messages, encode these 3 bits with the command $PDAS,TDG,MODE (parameter **c**). In general, the value "0" is assigned to the 3 bits in these circumstances.
- To identify messaging, encode the 3 bits when formatting it. Use a different encoding from that defined for the position messages (thus from 1 to 7).

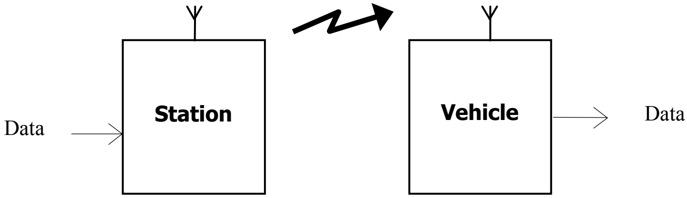
  As there are 7 possible combinations for identifying messaging, one combination of this code could be used to identify each type of messaging (if several types have been defined) or to identify each received message block (8 characters). In the latter case, a message could contain up to 7 × 8 = 56 characters, if each block must be identified clearly, with no ambiguity.

❑ Non-synchronous messaging alternating with position messages

See command $PDAS,TDG,TLM in the TDG Reference Manual.

3

Messaging from station to vehicles (radio-modem)

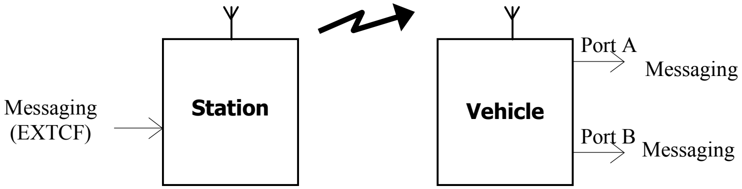


There are two different ways —with two different speeds— of transmitting messaging from the station to vehicles:

- Through any slot at a rate of 8 bytes/slot
- Through the sync slot at a rate of 6 bytes/format

In both cases, on the mobile, data are sent out in the output protocol selected at mobile level.

❑ Messaging via sync slot using input protocol EXTCF



This technique provides the following functions:

- "Conditional" messaging on each vehicle, i.e. each vehicle can be configured to routinely ignore a particular type of received message.
- Messaging with 1 to 252 bytes, with **6 bytes per format** to which is added a vehicle identification block.
- Selective messaging or not
- "Intelligent" messaging. In an environment subject to interference, the vehicle may not be able to receive the complete message, especially if it is only transmitted once. Using "intelligent" messaging, if the same message has been transmitted several times in the exact same manner, the vehicle will be able to recover the entire message after several repetitions.

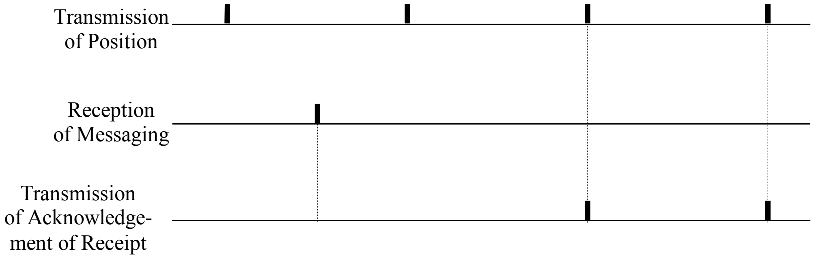
  In “intelligent” messaging, generating the message several times for transmission is not achieved by the station itself, but by the external device that is the source of messaging.

Example: a message of 3 blocks, each with 6 characters.

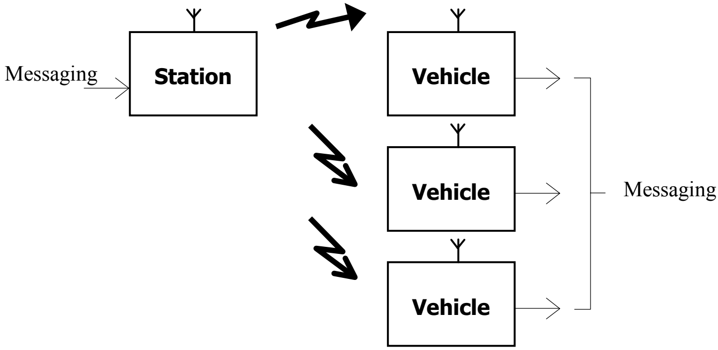
	block 1	block 2	block 3
1st transmission	received	not received	received
2nd transmission	received	received	not received

The vehicle will be able to recover the entire message after two transmissions.

- Acknowledgement of receipt is returned to the station once the message has been received successfully. This acknowledgement is inserted in the position message.



❑ Messaging via input protocols EXTTD or FIFO



Messaging is transmitted using one or more slots (defined by the configuration used), with **8 bytes transmitted per slot**.

Messaging can be selective or non-selective.

When it is selective, the registration number of the recipient(s) must be included in the transmitted message. There are three distinct situations, depending on the number of vehicles being tracked:

- Number of vehicles < 256:

  7 useful characters for the message
  1 character for the registration number

- 256 ≤ number of vehicles < 10,000:

  6 useful characters for the message
  2 characters for the registration number

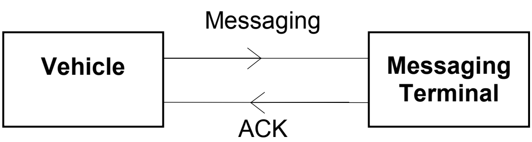
- 10,000 ≤ number of vehicles < 1,000,000:

  5 useful characters for the message
  3 characters for the registration number

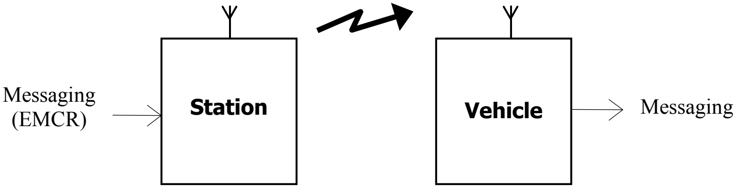
In all three situations, if the received registration number (1 to 3 characters) corresponds exactly to that of the vehicle, or if it equals 0 (message sent to all vehicles), the messages will be sent through the ports using the transparent protocol, and taking into account the fact that 1, 2 or 3 characters respectively at the end of the messages stand for the recipient address. Only the useful characters (7, 6 and 5) will be output.

This type of selective messaging should be reserved for short messages and for use in conditions of good UHF reception.

The messaging terminal connected locally to the vehicle TDG board can return acknowledgement of receipt via the position message, using the ACK command.



❑ Messaging via input protocol EMCR



Messaging transmission takes place in the slot (if it is a transmission slot or an inactive slot) and on the frequency channel specified in the protocol. Messaging is transmitted at a rate of **8 bytes per slot**.

In essence, this type of messaging is non-selective (no address is mentioned in the protocol). However, only the vehicles “prepared” to receive in the specified slot and on the specified channel will be able to output this type of messaging.

Simple network

❑ Conventions used in format diagrams

In the network examples which follow in this section, a table containing two rows is used to represent the format of each unit:

1st row: slot number (time axis)

2nd row: unit function during this slot.

For each station, this diagram is accurate, i.e. the functions indicated (transmission and reception) actually take place in each format.

Example:

Slot No.	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Sync Master	Cal	Esyn	Ediff			Rm1	Rm2	Rm3		

Where:

Cal : calibration
E : transmission
R : reception
syn : sync
diff : differential corrections
m*n* : position data for a mobile of group *n*

This is not the case for the vehicles, since it would be impossible to represent the individual format of each vehicle in a fleet of 200!…

For vehicles, a schematic representation is used from which it is possible to deduce the format of any vehicle.

3

This representation is shown below:

Slot No.	0	1	2	3	4	5	6	7	8	9
Mobile Fleet	Cal	Rsyn	Rdiff			Em1	Em2	Em3		

It should be interpreted as follows:

- All functions other than Em... take place in all the formats for each vehicle and in this sense the format representation is realistic.
- As for the Em... (transmission) function, each group of vehicles should be understood as using the following format:

Slot No.	0	1	2	3	4	5	6	7	8	9
Group 1	Cal	Rsyn	Rdiff			Em1				
Group 2	Cal	Rsyn	Rdiff				Em2			
Group 3	Cal	Rsyn	Rdiff					Em3		

...in which Em... represents the transmission time slot assigned to a particular group of vehicles. For each individual vehicle, it is necessary to establish the rank in the sub-frame to know in which format the transmission has really taken place. For example if for vehicle VAN3 of group 3, the rank in the sub-frame is 5, it can be deduced that the 5th format in each sub-frame is formed as follows:

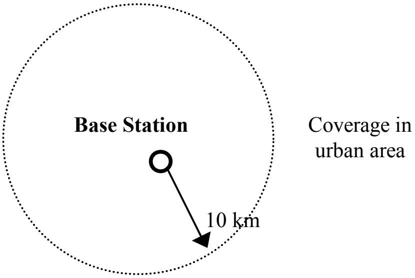
Slot No.	0	1	2	3	4	5	6	7	8	9
VAN3	Cal	Rsyn	Rdiff					Em3		

(5th format of each sub-frame)

❑ Definition of a simple network

A simple network has only one station, which is simultaneously a Sync Master, a DGPS reference station and the central collection station for position data.

The ground coverage area is circular. In urban areas, assuming that the station antennas are installed at a height of 50 m (16 stories) and that the mobile antennas have a height of 2 m, a coverage circle with a radius of 10 km can be expected from the station.



❑ Example (12.5-kHz channeling)

Format length : 10 slots (200 ms)
Length of frame : 300 formats (1 min)
Number of mobiles tracked : 150 with a repetition rate of 10 s, i.e. a sub-frame of 10÷0.2=50 formats
Repetition rate for DGPS corrections : 2.8 sec (for 9 satellites)
Message capacity : 30 chars./sec (=6 bytes×(1000÷200 ms)

Slot No.	0	1	2	3	4	5	6	7	8	9
Sync Master	Cal	Esyn	Ediff			Rm1	Rm2	Rm3		

Mobile Fleet	Cal	Rsyn	Rdiff			Em1	Em2	Em3		

Where:

Cal : calibration
E : transmission
R : reception
syn : sync
diff : differential corrections
m*n* : position data for a mobile of group *n*

Example (45-kHz channeling)

Format length : 10 slots (66 ms)
Length of frame : 300 formats (20 s)
Number of mobiles tracked : 150 with a repetition rate of 10 s, i.e. a sub-frame of 10÷0.2=152 formats
Repetition rate for DGPS corrections : 1 sec (for 9 satellites)
Message capacity : 90 chars./sec (=6 bytes×(1000÷66 ms)

Slot No.	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Sync Master	Cal	Esyn		Ediff		Rm1		Rm2		Rm3

Mobile Fleet	Cal	Rsyn		Rdiff		Em1		Em2		Em3

Where:

Cal : calibration
E : transmission
R : reception
syn : sync
diff : differential corrections
m*n* : position data for a mobile of group *n*

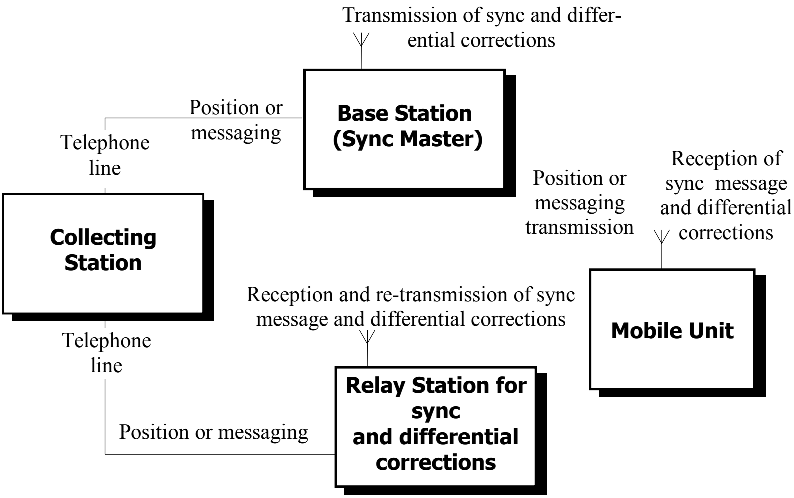
Introduction to networks including relays

Relays are used when a coverage area larger than that of a typical TDG board is needed.

Generally, a system using relays operates as follows:

- One or more relay stations relay the sync message (which can include messaging and remote configuration commands) and the differential corrections to mobiles outside the coverage range of the base station.
- The base station and the relay stations send position (or messaging) data along telephone lines to one or more collecting stations.

Example of network



In the particular case of a system with few mobiles or a low repetition rate, it is possible to envisage feedback of position and messaging data via relays (although this is not recommended owing to propagation time).

❑ Synchronization of a network including relays

Rule 4

The sync message transmitted by the master station can be relayed by several relay stations. This rule stipulates that no more than 4 different slots should be defined to carry sync data, including the one used for the master station.

This does not exclude the possibility of using more than 4 relay stations. In fact, two relay stations out of each other's range could be assigned the same slot number for relaying the sync message.

Rule 5

At all locations in the area covered, it should *only* be possible for a vehicle to receive the sync message *from a single source* (the master station or a relay station) in one of the 4 possible slots.

This does not imply that the vehicle cannot receive sync messages from several other sources in a different slot. (These messages would then be ignored).

Rule 6

Sync relays should take place across slots with increasing slot numbers.

This rule applies for all types of relay (sync or otherwise).

Example:

Sync data received in slot No. 4 can be re-transmitted in slot No. 6 (or a slot with a higher number). The reverse situation is impossible.

Knowing the slots used to transmit the sync message, the vehicles will lock onto the first of these slots to be correctly received, according to the slot number order specified by the command $PDAS,TDG,SETSLT last applied to the TDG board.

Each relay station can receive the sync message from several different sources. In this instance the source to be relayed can be selected and the others will be ignored (again, using the command $PDAS,TDG,SETSLT).

The sync slot can also contain messaging (via $PDAS,TDG,EXTCF with 6 characters per slot). These data are automatically relayed when the sync slot is relayed.

❑ Relaying differential corrections

In addition to the sync slot, each relay station also re-transmits the data received in the slots containing differential corrections. Rules 4, 5 and 6 as described above apply also to the relaying of differential corrections.

Knowing all the slots which contain differential corrections, the vehicles receive the differential corrections in the first slot of the received slots according to the slot number order specified by the $PDAS,TDG,SETSLT command.

❑ Relay operational limits

Extending the coverage area requires an increased number of stations, resulting in a decrease in the number of mobile units that can be tracked (owing to the fact the number of slots dedicated to transmitting vehicles' positions can only decrease in this case).

Relays in star-shaped networks

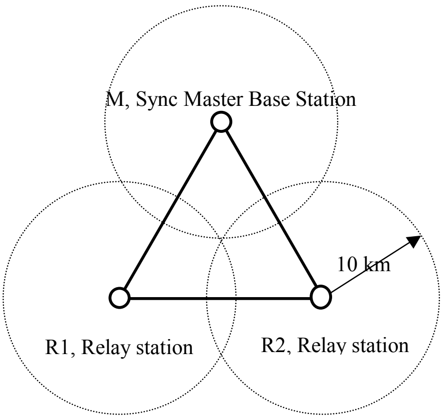
The ground coverage area is roughly circular (systems generally installed in urban areas).

❑ Estimation of range

Assuming that the station antennas are installed at a height of 50 m (16 stories) and that the mobile antennas have a height of 2 m, a coverage circle with a radius of 10 km can be expected from each station.

❑ Example of a 3-station network with no relaying of vehicle positions by the system

This system uses 2 relay stations. A ground infrastructure re-routes the position data received by the relay stations to the base station.



Given the above range assumptions, the stations are installed at the points of an equilateral triangle whose side is $10 \times 2 \times \cos 30° = 17$ km.

From the rules defined earlier:

- The sync and the differential corrections must use different slots for each station.
- The sync and the differential corrections must be relayed across slots with higher slot numbers.

Organization of transmissions (Example with 12.5-kHz TDG):

Format length : 20 slots (400 ms)
Length of frame : 300 formats (2 min)
Number of mobiles tracked : 200 with a repetition rate of 10 s, i.e. a sub-frame of 10÷0.4=25 formats
Repetition rate for DGPS corrections :5.6 sec (for 9 satellites)
Messaging throughput :15 chars./sec

Slot No.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17 to 19
Sync Master	Cal	Esyn	Ediff							Rm1	Rm2	Rm3	Rm4	Rm5	Rm6	Rm7	Rm8	
Relay 1	Cal	Rsyn	Rdiff		Ers	Erd				Rm1	Rm2	Rm3	Rm4	Rm5	Rm6	Rm7	Rm8	
Relay 2	Cal	Rsyn	Rdiff				Ers	Erd		Rm1	Rm2	Rm3	Rm4	Rm5	Rm6	Rm7	Rm8	
Mobile Fleet	Cal	Rsyn	Rdiff		Rrs	Rrd	Rrs	Rrd		Em1	Em2	Em3	Em4	Em5	Em6	Em7	Em8	

Where:

Cal : calibration
E : transmission
R : reception
syn : sync
diff : differential corrections
rd : differential corrections relay
rs : sync relay
m*n* : position data for a mobile of group *n*

Since the sub-frame has 25 formats, the 200 tracked mobiles are divided into (200÷25) Groups, i.e. 8 Groups

A specific slot is assigned to each Group:

Group 1 : slot no. 9
Group 2 : slot no. 10
Group 3 : slot no. 11
etc.

Each mobile in a group has its own format in the sub-frame (*rank in the sub-frame*) to transmit its position in the slot assigned to the group (*transmission time*).

❑ Example of a 4-station network with relaying of vehicle positions by the system

(With 12.5-kHz TDG)

Format length	:	20 slots (400 ms)
Length of frame	:	300 formats (2 min)
Number of mobiles tracked	:	50 with a repetition rate of 10 s, i.e. a sub-frame of 10÷0.4=25 formats
Repetition rate for DGPS corrections	:	5.6 sec (for 9 satellites)
Messaging throughput	:	15 chars./sec

Slot No.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Sync Master	Cal	Esyn	Ediff									Rm1	Rm2		Rrm1	Rrm2	Rrm1	Rrm2	Rrm1	Rrm2
Relay 1	Cal	Rsyn	Rdiff		Ers	Erd						Rm1	Rm2						Erm1	Erm2
Relay 2	Cal	Rsyn	Rdiff				Ers	Erd				Rm1	Rm2				Erm1	Erm2		
Relay 3	Cal	Rsyn	Rdiff						Ers	Erd		Rm1	Rm2		Erm1	Erm2				

Mobile Fleet	Cal	Rsyn	Rdiff		Rrs	Rrd	Rrs	Rrd	Rrs	Rrd		Tm1	Tm2							

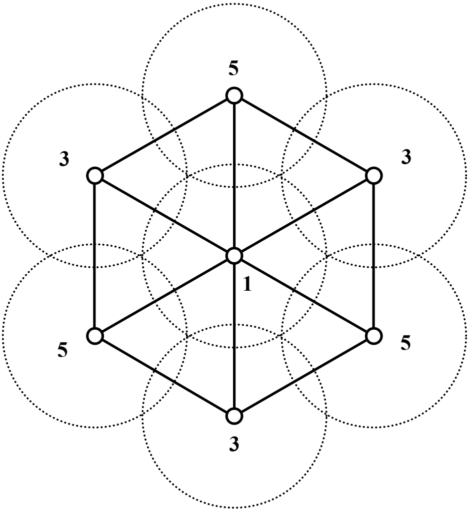
Where:

Cal	:	calibration
E	:	transmission
R	:	reception
syn	:	sync
diff	:	differential corrections
rd	:	differential corrections relay
rs	:	sync relay
m*n*	:	position data for a mobile of group *n*
rm*n*	:	relaying of position data for a mobile of group *n*

❑ Extending a star-shaped network

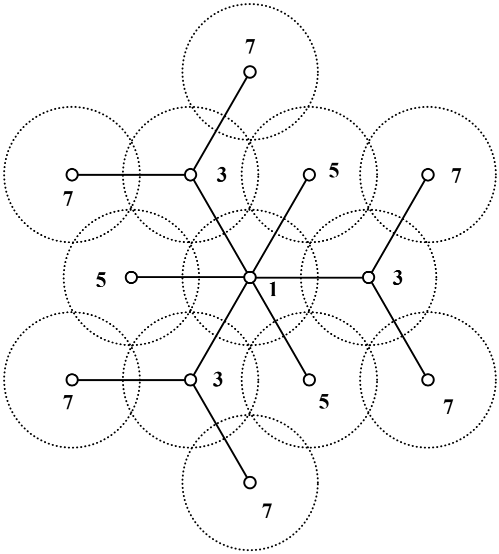
The 3-station network described above can be considered as a basic cell. Using this cell as a building block, it is possible to imagine the following networks:

7-station network:



This type of network still uses 3 sync slots (their numbers are shown in the above diagram).

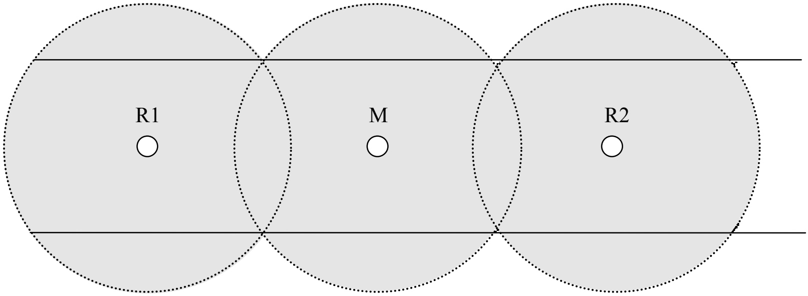
13-station network (4 sync slots):



To obtain an even larger coverage range, the links between stations can be established by using directional antennas. This system provides links between remotely spaced stations and slots of a lower rank can therefore be re-used.

"Line-configuration" networks including relays

In this case the ground coverage area is a long narrow strip (like a road or a canal). By definition, urban areas have little need for this type of network.



❑ Estimating the range

Range depends on ground conditions and the number of obstructions in the paths between the stations and the mobiles. For example:

- Above a river (fresh water), for station antennas at a height of 30 m and the mobile antennas (boats) at 15 m and allowing for a 10 dB reserve of transmission power in the absence of obstructions, a typical range for a link without using relays can be of the order of 25 km.
- Above marshland for station antennas at a height of 30 m and the mobile antennas (boats) at 2 m and allowing for a 10 dB reserve of transmission power (necessary because of vegetation), a typical range for a link without using relays can be greater than 16 km.

Thus, assuming a range of between 10 km and 16 km for each station and a distance between stations of between 17 km and 20 km, the approximate length of a “line-configuration” network can be expressed as follows:

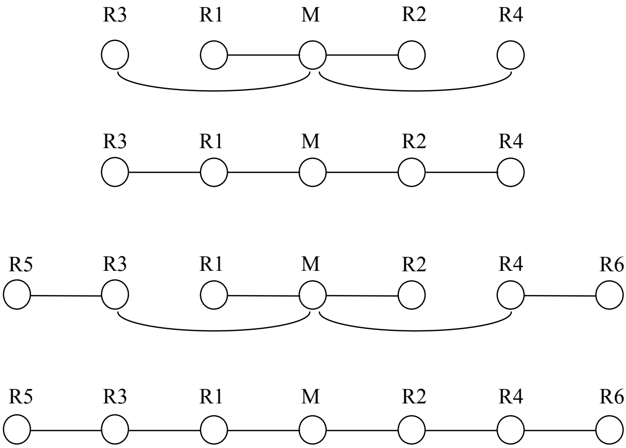
54 km to 72 km for 3 stations

88 km to 112 km for 5 stations

122 km to 152 km for 7 stations

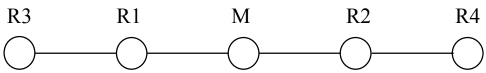
The quality of the links depends on the layout of the network. In fact, if links can be established between non-neighboring stations, slots could be freed and re-used for transmitting mobile position data.

Examples of line-configuration networks with 5 to 7 stations, with and without extended inter-station links:



❑ Example of line-configuration network with no relaying of vehicle positions by the system

(With 12.5-kHz TDG; 1 freq. channel)



Format length	:	20 slots (400 ms)
Length of frame	:	300 formats (2 min)
Number of mobiles tracked	:	200 with a repetition rate of 10 s, i.e. a sub-frame of 10÷0.4=25 formats
Repetition rate for DGPS corrections	:	5.6 sec (for 9 satellites)
Messaging throughput	:	15 chars./sec (6+6+3)

Slot No.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Sync Master	Cal	Esyn	Ediff								Rm1	Rm2	Rm3	Rm4	Rm5	Rm6	Rm7	Rm8		
Relay 1	Cal	Rsyn	Rdiff		Ers	Erd					Rm1	Rm2	Rm3	Rm4	Rm5	Rm6	Rm7	Rm8		
Relay 2	Cal	Rsyn	Rdiff		Ers	Erd					Rm1	Rm2	Rm3	Rm4	Rm5	Rm6	Rm7	Rm8		
Relay 3	Cal				Rrs	Rrd		Ers	Erd		Rm1	Rm2	Rm3	Rm4	Rm5	Rm6	Rm7	Rm8		
Relay 4	Cal				Rrs	Rrd		Ers	Erd		Rm1	Rm2	Rm3	Rm4	Rm5	Rm6	Rm7	Rm8		

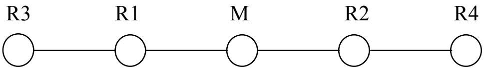
Mobile Fleet	Cal	Rsyn	Rdiff		Rrs	Rrd		Rrs	Rrd		Em1	Em2	Em3	Em4	Em5	Em6	Em7	Em8		

Where:

Cal : calibration
E : transmission
R : reception
syn : sync
diff : differential corrections
rd : differential corrections relay
rs : sync relay
m*n* : position data for a mobile of group *n*

❑ Example of line-configuration network with relaying of positions by the system

(With 12.5-kHz TDG; 1 freq. channel)



Format length : 20 slots (400 ms)
Length of frame : 300 formats (2 min)
Number of mobiles tracked : 25 with a repetition rate of 10 s across the entire network
125 with a repetition rate of 10 s across the central part of the network

Slot No.	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Sync Master	Cal	Esyn	Ediff								Rm1			Rmn	Rrm1	Rrm1	Rmn	Rmn	Rmn	Rmn
Relay 1	Cal	Rsyn	Rdiff		Ers	Erd					Rm1		Rrm1		Erm1 (12)	Erm1 (10)				
Relay 2	Cal	Rsyn	Rdiff		Ers	Erd					Rm1		Rrm1		Erm1 (12)	Erm1 (10)				
Relay 3	Cal				Rrs	Rrd		Erd	Ers		Rm1		Erm1 (10)							
Relay 4	Cal				Rrs	Rrd		Erd	Ers		Rm1		Erm1 (10)							
Mobiles Group 1	Cal	Rsyn	Rdiff		Rrs	Rrd		Rrd	Rrs		Em1									
Mobiles Group *n*	Cal	Rsyn	Rdiff		Rrs	Rrd		Rrd	Rrs					Emn			Emn	Emn	Emn	Emn

Where:

Cal : calibration
E : transmission
R : reception
syn : sync
diff : differential corrections
rd : differential corrections relay
rs : sync relay
m*n* : position data for a mobile of group *n*

Operating limits

❑ Channels to be avoided

When programming the TDG boards, all channels multiple of 10 MHz should be avoided. These channels are specified in the channel/frequency allocation tables in the TDG reference manual.

When there are several TDG boards in one station, there must not be a difference of 214 between the channel numbers used by the boards.

❑ Programming "Station" TDG boards for reception

3

No reception slot in a TDG can be defined while a slot in another TDG is used as a transmission slot.

The table below shows an example, in 12.5-kHz channeling, of assigning slots for a station which combines the functions of "sync relay", "DGPS relay" and "position data collection", according to the precautionary measure described above.

Slot No.	00	01	02	03	04	05	06	07	08	09
TDG no. 1	C	Rs1	Rd1		E’s1	E’d1		Rm1	Rm1	Rm1
TDG no. 2	C	Rs2	Rd2		E’s2	E’d2		Rm2	Rm2	Rm2
TDG no. 3	C	Rs3	Rd3		E’s3	E’d3		Rm3	Rm3	Rm3

Where:
1st Character: function

C : calibration slot
R : slot assigned to reception
E' : relaying slot

2nd Character: type

s : sync slot
d : DGPS slot
m : mobile position data slot

3rd Character: Channel No. of UHF frequency synthesizer

The shaded slots are unusable as they are reserved for programming changes.

In the above example, TDGs 1, 2 and 3 obtain their synchronization from slot 01 on their own frequency channels. ♣

4. Station Administration

Work organization

The term "station administration" includes all activities necessary to achieve the required station performance. These activities can take place during system installation or any time afterwards during operation.

Station administration is based on using the *maintenance PC* to send NMEA commands from **Check2001** to the *Capricorn 2001* Rack (see page 2-12).

These commands are sent via the station maintenance port on the front panel of the *Capricorn 2001* rack.

Note that certain NMEA commands sent using the "Terminal" function of **Check2001** produce the same replies as those obtained using the "Hardware", "Events "and "Explorer" functions in **Check2001** (see page 4-4).

When an NMEA command is sent to the station, it is also necessary to select the board that will receive the command.

The diagrams on the following pages illustrate the station architecture in the different versions (single-channel and multi-channel). They emphasize the importance of the UC board which serves as the communications relay for all other station boards.

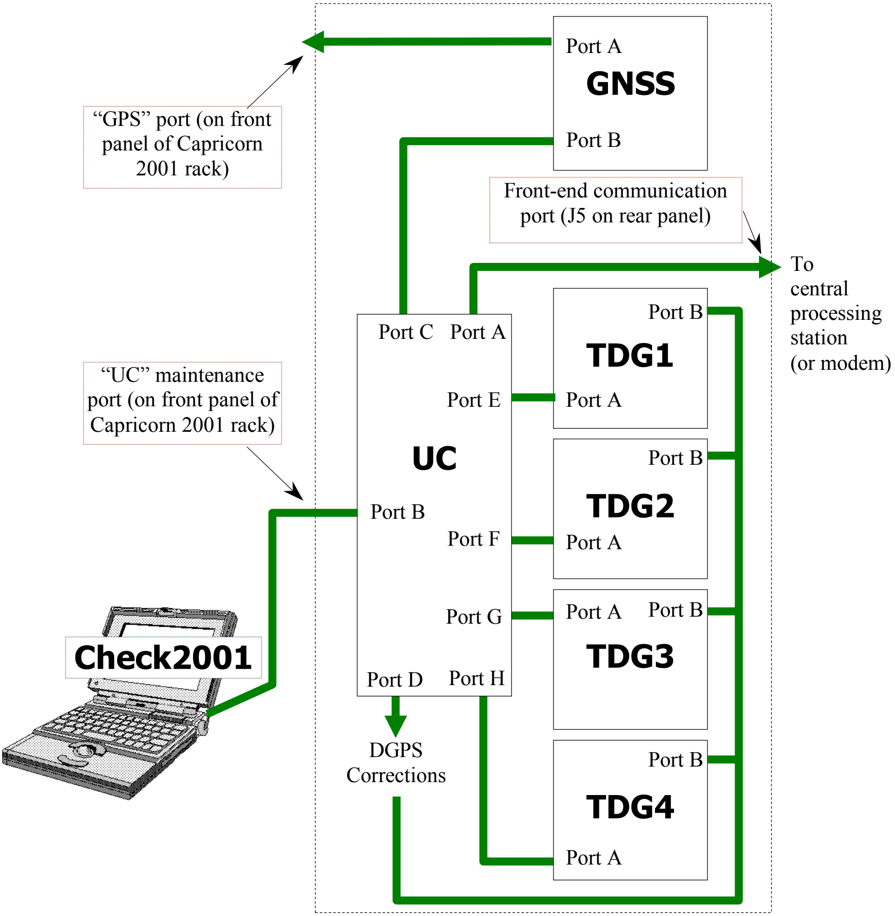
It is advisable to keep a picture of this architecture in mind when using the NMEA commands. This will provide a better understanding of the replies returned from the station in response to the transmitted commands.

In the absence of **Check2001**, it is possible to send commands to a particular TDG board via the UC board, which is normally connected (this is possible with more than 1 out of 2 commands). The last parameter to be entered in the command should be encoded according to the table shown opposite.

Parameter (= UC board port identification)	Recipient TDG board
E	TD1
F	TD2
G	TD3
H	TD4
T	All TDG boards connected to a port on UC

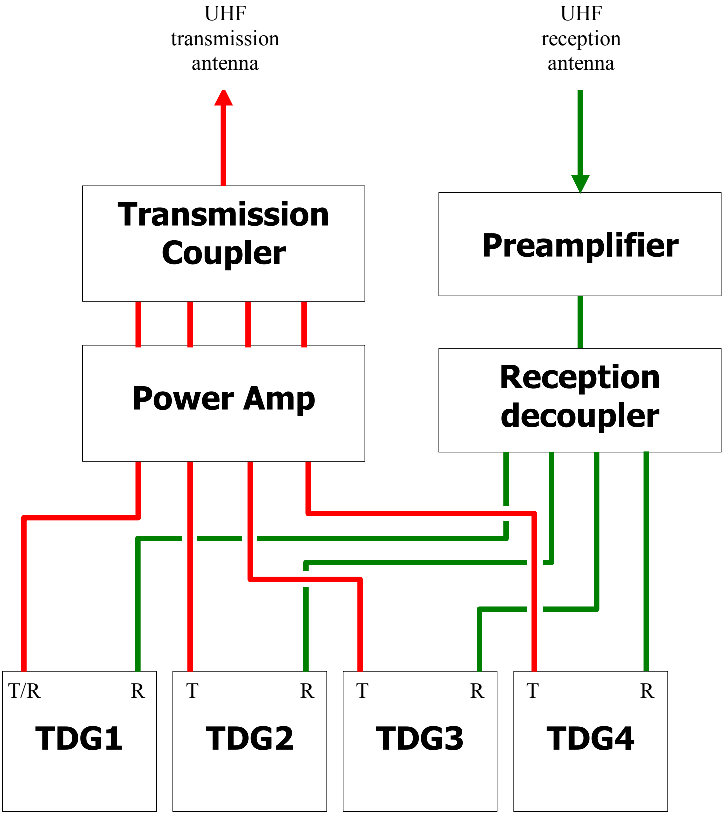
4

❑ Multi-Channel Station, Internal Serial Lines



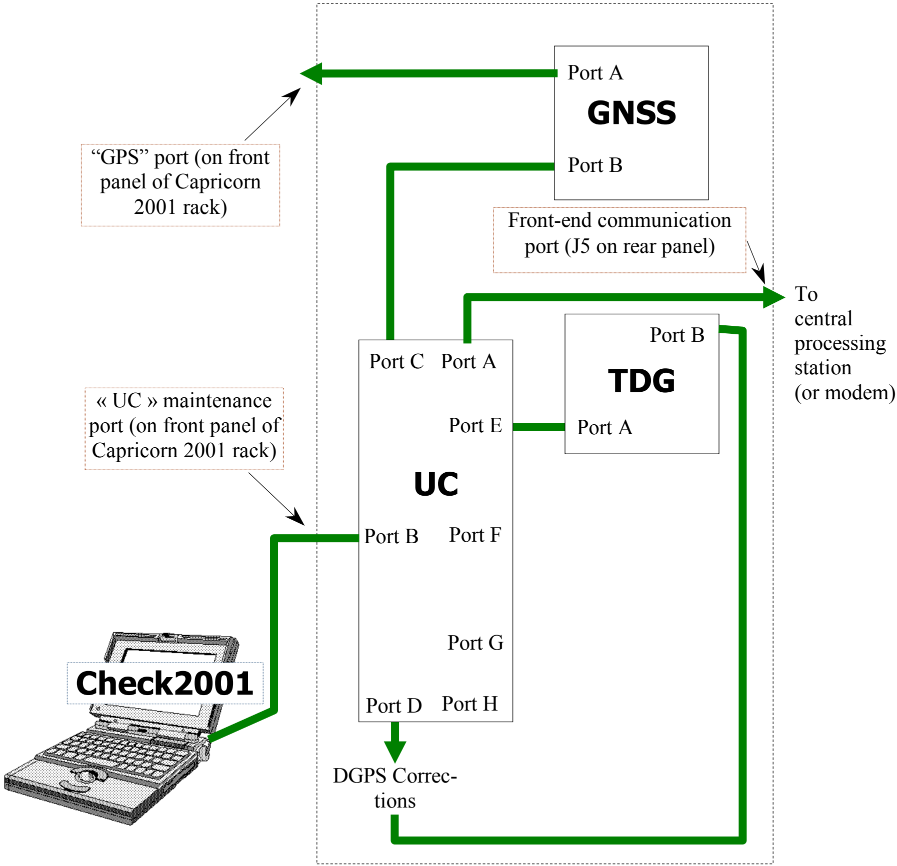
TDG3 and TDG4 are optional boards. All output data from the TDG boards are sent to the central station via the front-end communication port in Syletrack No. 2 protocol.

❑ Multi-Channel Station, UHF Signal Path



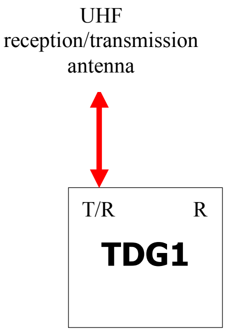
4

❑ Single-Channel, Internal Serial Lines



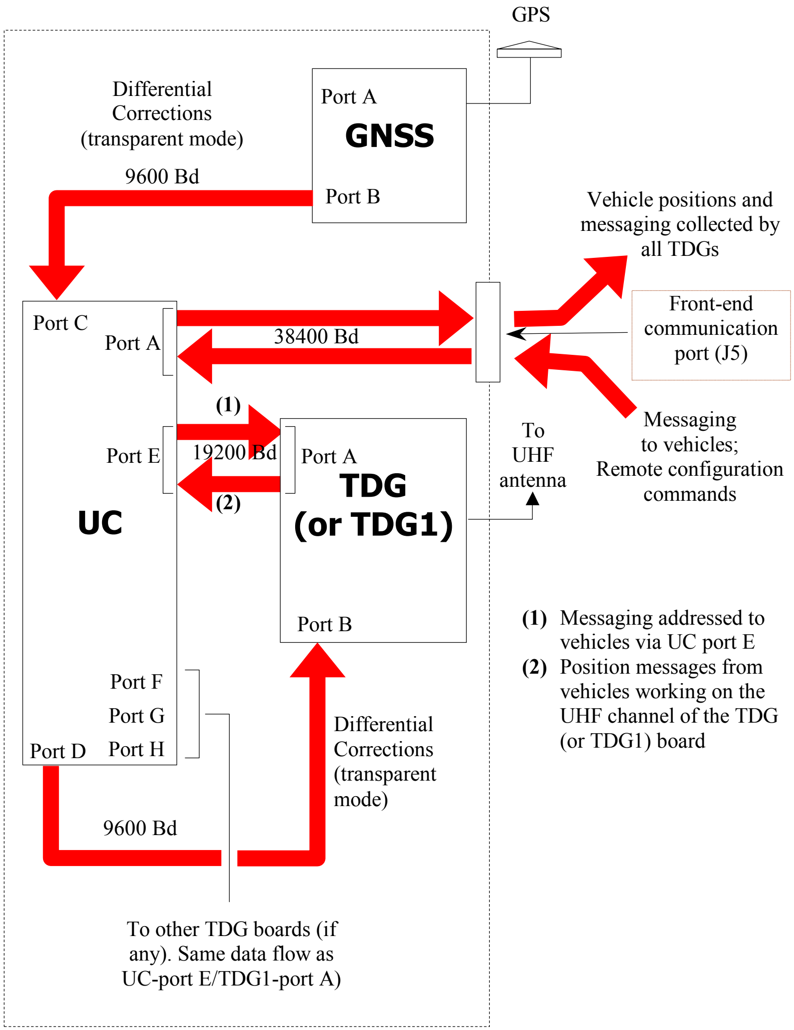
All output data from the TDG board are sent to the central station via the front-end communication port in Syletrack No. 2 protocol.

❑ Single-Channel Station, UHF Signal Path



Data flow organization in a station in operation

(With typical baud rates used on the various ports)



List of regular tasks

❑ General station configuration

Task:	Command to be used:	To be sent to:	See also page:
Display UC board configuration file	$PDAS,CONFIG	UC	4-11
Read or change definition of DGPS corrections message	$PDAS,DGPDAT	UC	4-12
Check that station is properly set up to function as a DGPS reference station (it must compute DGPS corrections)	$PDAS,FIXMOD	GNSS	4-14
Read or change the parameters of the UC board serial ports	$PDAS,HARDRS	UC	4-15
Display list of station boards including software and hardware versions for each board	$PDAS,IDENT or Click on "Hardware" icon in Check2001	UC	4-17
Display list of events detected in the station	$PDAS ,LOG or Click on "Events" icon in Check2001	UC	4-19
Display list of files on UC board	$PDAS,MEMORY,DIR or Click on "Explorer" icon in Check2001	UC	4-20
Read or change the geographical position of the station GPS antenna	$PDAS,PREFLL	GNSS	4-24
Read or change the station identification number	$PDAS,UNIT	UC	4-25
If this number is changed, the changed number must be transferred to all mobile units using this station	$PDAS,FIXMOD in mobile units	GNSS	6-8

4

❑ Configuration of TDG board in a single-channel station or a TDG1 (master) board in a multi-channel station

Task:	Command to be used:	To be sent to:	See also:
Read board configuration. This will return the replies to each command previously sent to configure the board , i.e. a list of $PDAS lines,...	$PDAS,CONFIG	TDG1	TDG Reference Manual (the companion manual to this manual) for a full description of the syntax for these commands
Check that the board has been configured to operate in the station as the “sync master” board. Check format length and sync slot.	$PDAS,TDG,MODE		
Change or check the function assigned to each slot (transmission or reception) and change or check the frequency channels for transmission and reception. Define a slot to function as a relay for another slot or check the status of this function.	$PDAS,TDG,SETSLT		
Change or check configuration of the A and B serial ports.	$PDAS,HARDRS		
Define or check the input and output data protocols.	$PDAS,TDG,CONF		
Read the current board frequency setting.	$PDAS,TDG,REGLAG		
Transmit the format number at regular intervals using Syletrack No. 2 protocol	$PDAS,TDG,FMT		

❑ Configuration of the other TDG boards in a multi-channel station (TDG2... TDG4)

Task:	Command to be used:	To be sent to:	See also:
Read board configuration. This will return the replies to each command previously sent to configure the board , i.e. a list of $PDAS lines,...	$PDAS,CONFIG	TDGn	TDG Reference Manual (the companion manual to this manual) for a full description of the syntax for these commands
Check that the board has been configured to operate as a “sync slave”. Check format length and sync slot.	$PDAS,TDG,MODE		
Change or check the function assigned to each slot (transmission or reception) and change or check the frequency channels for transmission and reception. Define a slot to function as a relay for another slot or check the status of this function.	$PDAS,TDG,SETSLT		
Change or check configuration of the A and B serial ports.	$PDAS,HARDRS		
Specify or check the input and output data protocols.	$PDAS,TDG,CONF		
Read the current board frequency setting.	$PDAS,TDG,REGLAG		
Transmit the format number at regular intervals using Syletrack No. 2 protocol	$PDAS,TDG,FMT		

❑ Operational status of TDG boards

The following commands can be used during station maintenance. The syntax for these commands is described in the *TDG Reference Manual* (companion volume to this manual).

Task:	Command to be used:	To be sent to:
Display the board event log.	$PDAS,DEFLT	TDGn
Read the board hardware and software versions.	$PDAS,IDENT	
Read board synchronization status.	$PDAS,TDG,SYNMES	

$PDAS commands used to configure the UC and GNSS boards

Command	To board	See page
$PDAS,DGPDAT	UC	4-12
$PDAS,FIXMOD	GNSS	4-14
$PDAS,HARDRS	UC	4-15
$PDAS,IDENT	UC	4-17
$PDAS,LOG	UC	4-19
$PDAS,MEMORY,DIR	UC	4-20
$PDAS,PREFLL	GNSS	4-24
$PDAS,UNIT	UC	4-25

$PDAS,CONFIG

Function

This command is used to read the current configuration data on the queried board.

Recipient board

UC board.

Format

$PDAS,CONFIG[*hh]<CR><LF>

Parameters

Parameter	Format	Bound	De-fault Value	Comments
(none)				
*hh				Checksum (optional)
<CR><LF>				End of command

4

Examples

$PDAS,CONFIG	Read data
$PDAS,CONFIG,BEGIN,10*66	(Reply)
$PDAS,DGPDAT,1,D,4,15,1,9*65	Corrections at 15 bytes/s
$PDAS,HARDRS,8,1,A,9600,8,1,N*18	Port A at 9600 Bd
$PDAS,HARDRS,8,1,B,9600,8,1,N*18	Port B at 9600 Bd
$PDAS,HARDRS,8,1,C,9600,8,1,N*18	Port C at 9600 Bd
$PDAS,HARDRS,8,1,D,9600,8,1,N*18	Port D at 9600 Bd
$PDAS,HARDRS,8,1,E,9600,8,1,N*18	Port E at 9600 Bd
$PDAS,HARDRS,8,1,F,9600,8,1,N*18	Port F at 9600 Bd
$PDAS,HARDRS,8,1,G,9600,8,1,N*18	Port G at 9600 Bd
$PDAS,HARDRS,8,1,H,9600,8,1,N*18	Port H at 9600 Bd
$PDAS,UNIT,1 *31	
$PDAS,CONFIG,END,000 4EC5*68	

❑ $PDAS,DGPDAT

Function

This command is used to edit the definition of the station "DGPS raw data" outputs. The only parameter that can be changed is the output rate. The other parameters must be left with the values shown below.

Recipient board

UC board.

Formats

Complete command: **$PDAS,DGPDAT,a,b,c,d,e,f [*hh]<CR><LF>**

Query command: **$PDAS,DGPDAT [*hh]<CR><LF>**

Parameters

Parameter	Format	Bound	Default Value	Comments
a	**x**		**1**	Output number (1 or 2) If **a**=0, all output description lines will be deleted
b	**a**		**D**	Output port identification mode (must be D)
c	**x**		**4**	Output mode (must be 4)
d	**x.x**	[6.. 300]	**15**	Output rate, in bytes/sec, for differential corrections data. The number to be entered is obtained as follows: 1- Make the calculation: *No. of slots in format assigned to transmission of corrections* × *8=N1* (*8* is the number of bytes transmitted in a slot) *N1* is the number of bytes transmitted in a format whose duration is *tf* seconds 2- Calculate the number of bytes

				transmitted (*N1*) for a time unit of 1 second, i.e.: *N2=N1÷tf* 3- Subtract 1 from *N2*: *N3=N2-1* N3 is the number to enter in this command (set **d**=*N3*). **Typical examples:** For a 45 kHz board: 60 slots/format→1 format=400 ms 1 slot only dedicated to corrections ⇒ 8 bytes per format ⇒ 8÷0.4 sec is 20 bytes/sec ⇒ 20 -1=19 ⇒ Value to be entered: 19 For a 12.5 kHz board: 25 slots/format→1 format=500 ms 1 slot only dedicated to corrections ⇒ 8 bytes per format ⇒ 8÷0.5 sec is 16 bytes/sec ⇒ 16 -1=15 ⇒ Value to be entered: 15
e	**x**		**1**	Type of data: must be 1 (data type: RTCM-SC104)
f	**x**		**9**	Type of RTCM message: must be type 9 (corrections)
***hh**				Checksum (optional)
<CR><LF>				End of command

Example

$PDAS,DGPDAT	Read
$PDAS,DGPDAT,1,D,4,15,1,9*65	Reply (15 bytes/s for differential corrections)

4

❑ $PDAS,FIXMOD

Function

This command is used to check the station calculation procedure in relation to received GPS data.

Recipient board

GNSS board.

Formats

Query command:

$PDAS,FIXMOD,a,b,c [*hh]<CR><LF>

Query command:

$PDAS,FIXMOD[*hh]<CR><LF>

Parameters

For a *Capricorn* station, this command can only be in the following state:

$PDAS,FIXMOD	Query command
$PDAS,FIXMOD,1,0,0*26	Reply

If this is not the case, send the command **$PDAS,FIXMOD,1,0,0**

Then check using command **$PDAS,FIXMOD** that the station reply is: $PDAS,FIXMOD,1,0,0*26

❑ $PDAS,HARDRS

Function

This command is used to edit the configuration data for the serial ports on the queried board.

Recipient board

UC board.

Formats

Complete command:

$PDAS,HARDRS,a,b,c,d,e,f,g[*hh]<CR><LF>

Query command:

$PDAS,HARDRS[*hh]<CR><LF>

Parameters

Parameter	Format	Bound	Default Value	Comments
a	**x**	8		Number of lines required to list the configuration parameters for all ports
b	**x**	1 to **a**		Line number
c	**a**			Port identification (A, B, etc.)
d	**x.x**	2400 to 115200	9600	Transmission speed (in bauds). **Do not set more than 2 ports to max. speed of 115200 bauds.**
e	**x**	6, 7, 8	8	Number of data bits
f	**x.x**	1, 1.5, 2	1	Number of stop bits
g	**a**		N	Parity check ("N" for none, "O" for Odd, "E" for Even, "M" for “Mark”, "S" for Space)
***hh**				Checksum (optional)
<CR><LF>				End of command

4

Examples

$PDAS,HARDRS	Query
$PDAS,HARDRS,8,1,A,38400,8,1.0,N	Reply
$PDAS,HARDRS,8,2,B,9600,8,1.0,N	
$PDAS,HARDRS,8,3,C,9600,8,2.0,N	
$PDAS,HARDRS,8,4,D,9600,8,1.0,N	
$PDAS,HARDRS,8,4,E,19200,8,1.0,N	
$PDAS,HARDRS,8,4,F,19200,8,1.0,N	
$PDAS,HARDRS,8,4,G,19200,8,1.0,N	
$PDAS,HARDRS,8,4,H,19200,8,1.0,N	

❑ $PDAS,IDENT

Function

This command is used to read the identification data for the various station hardware devices and software.

Recipient board

UC board.

Formats

Query command only:

$PDAS,IDENT[*hh]<CR><LF>

Station reply:

$PDAS,IDENT,a,b,c,d[*hh]<CR><LF>

Reply parameters

Parameter	Format	Bound	Default Value	Comments
a	x.x			Total number of lines in the station reply
b	x.x			Current line number
c	cc	4 characters		Hardware identification: - Characters 1 and 2: Identification of device (UC, TG, CM) - Characters 3 and 4: hardware identification of board

4

d	**cc**	10 or 12 character s		Hardware identification: - Characters 1 to 4: Software label - Character 5: Identification of software version type: V: Production version Identification of software standard or version: - Characters 7 and 8: Revision No. - Characters 9 and 10: No. of on-site modification - Characters 11 and 12: Iteration No. (not necessarily used)
***hh**				Checksum (optional)
<CR><LF>				End of command

Examples

$PDAS,IDENT

$PDAS,IDENT,2,1,CM10,CMB2V00204*6A

$PDAS,IDENT,2,2,CM10,CMT2V00207*7C

❑ $PDAS,LOG and station event log

Function

This command is used to produce the Event Log for the station.

Recipient board

UC board.

Formats

Query command only:

$PDAS,LOG[*hh]<CR><LF>

Station reply: Each line is a block with the following syntax:

$PDAS,DEFLT,a,b,c,d,e,f[*hh]<CR><LF>

Reply parameters

Parameter	Format	Bound	Default Value	Comments
a	x	0 to 100		Event Code
b	x	1 to 256		Number of occurrences of event
c	a--a			Key word
d	x	1 to 31		Date of first occurrence of event
e	hhmmss.ss			Time of first occurrence of event
f	hhmmss.ss		2	Time of last occurrence of event
*hh				Checksum (optional)
<CR><LF>				End of command

4

Examples

$PDAS,LOG Read event log
$PDAS,DEFLT,0,1,SYSTM,18,1240909,171910
$PDAS,DEFLT,23,1,SYSTM,19,094815,094815

Station event log

Code	Event
0	Station start-up
1	Re-initialization of configuration using default parameters
2	Read or write error with regard to configuration data stored on UC board
3	Re-initialization of Event Log
4	Read or write error with regard to Event Log file on UC board
5	Read error in message queue
6	Port A write error
7	Port B write error
8	Port C write error
9	Port D write error
10	Port E write error
11	Port F write error
12	Port G write error
13	Port H write error
14	Port A write overflow
15	Port B write overflow
16	Port C write overflow
17	Port D write overflow
18	Port E write overflow
19	Port F write overflow
20	Port G write overflow
21	Port H write overflow
22	Semaphore reservation error
23	NMEA command processing error
24	Unknown NMEA command
25	NMEA command size error
26	NMEA command checksum error
27	Incorrect number of parameters in NMEA command
28	Port A read error
29	Port B read error
30	Port C read error
31	Port D read error
32	Port E read error
33	Port F read error
34	Port G read error
35	Port H read error
36	Size error in received block
37	Checksum error in SBIN block
38	Error in SBIN block transfer
39	SBIN block length incorrect
40	Error in reading or opening a configuration file
41	Inconsistent time of day in RTC
42	Inconsistent date in RTC

43	GPS: RAM fault
44	GPS: Fault in timing of interrupts
45	GPS: Program memory fault
46	GPS: ROM fault
47	GPS: Fault in UHF reception circuitry (PLL-lock)
48	GPS: Port A fault, output data not processed
49	GPS: Port A fault, input data not identified
50	GPS: Port A fault, input data incorrect
51	GPS: Port B fault, output data not processed
52	GPS: Port B fault, input data not identified
53	GPS: Port B fault, input data incorrect
54	Changeover to battery power detected
55	Changeover to mains power detected
56	Off button press detected
57	Off button release detected
58	File management error
59	RAM DISK file management error

❑ $PDAS,MEMORY,DIR

Function

This command is used to list the characteristics for a file (or all files) stored in the station UC board.

Recipient board

UC board.

Command format

$PDAS,MEMORY,DIR [*hh]<CR><LF>

Reply Format

$PDAS,MEMORY,DIR,a,b,c,d,e,f[*hh]<CR><LF>
$PDAS,MEMORY,DIR,a,b,g,h,i,j,k,l[*hh]<CR><LF>
...
$PDAS,MEMORY,DIR,a,b,g,h,i,j,k,l[*hh]<CR><LF>

Parameters contained in the reply

In the first line:

Parameter	Format	Bound	Default Value	Comments
a	x			Total number of lines in the reply
b	x			Number of this line (invariably 1)
c	a			UC board label
d	x			Total number of bytes used
e	x			Total number of unused bytes
f	x			Total number of files
*hh				Checksum (optional)
<CR><LF>				End of line

In the second and following lines:

Parameter	Format	Bound	Default Value	Comments
a	**x**			Total number of lines in the reply
b	**x**			Number of this line
g	**a**			Filename
h	**x**			Size of file in bytes
i	**xx**			Date when file was created (dd)
j	**xx**			Month when file was created (mm)
k	**xx**			Year when file was created (yyyy)
l	**hhmmss.s**			Time when file was created
***hh**				Checksum (optional)
<CR><LF>				End of line

Examples

$PDAS,MEMORY,DIR	Query command
$PDAS,MEMORY,DIR,3,1,,122880,3858432,2	Reply
$PDAS,MEMORY,DIR,3,2,rtint.x, 444,10,01,2000,092034.0	
$PDAS,MEMORY,DIR,3,3,s.xdc, 304,10,01,2000,092230.0	

❑ $PDAS,PREFLL

Function

This command is used to edit the exact geographical position for the DGPS antenna for a *Capricorn* station, which is also a DGPS reference station.

Recipient board

GNSS board.

Format

Complete command:

$PDAS,PREFLL,a,b,c,d,e,f[*hh]<CR><LF>

(No query command)

Parameters

Parameter	Format	Bound	Default Value	Comments
a	**x**	[0..1]	0	Number of coordinate system
b	**llll.lllll**			Latitude of reference position (accurate to within a centimeter)
c	**a**	[N or S]		Latitude sign (North or South)
d	yyyyy.yyyyyy			Longitude of reference position (accurate to within a centimeter)
e	**a**	[E or W]		Longitude sign (East or West)
f	**x.x**			Altitude of reference position, in meters (accurate to within a centimeter)
***hh**				Checksum (optional)
<CR><LF>				End of command

Examples

$PDAS,PREFLL,0,3835.448532,S,01020.993478,E,93.83*18

❑ $PDAS,UNIT

Function

This command is used to edit the identification number of the station providing differential correction data.

Recipient board

UC board.

Formats

Complete command

$PDAS,UNIT,a[*hh]<CR><LF>

Query command

$PDAS,UNIT[*hh]<CR><LF>

Parameters

Parameter	Format	Bound	Default Value	Comments
a	x	[0..1023]		Station identification number
*hh				Checksum (optional)
<CR><LF>				End of command

4

Examples

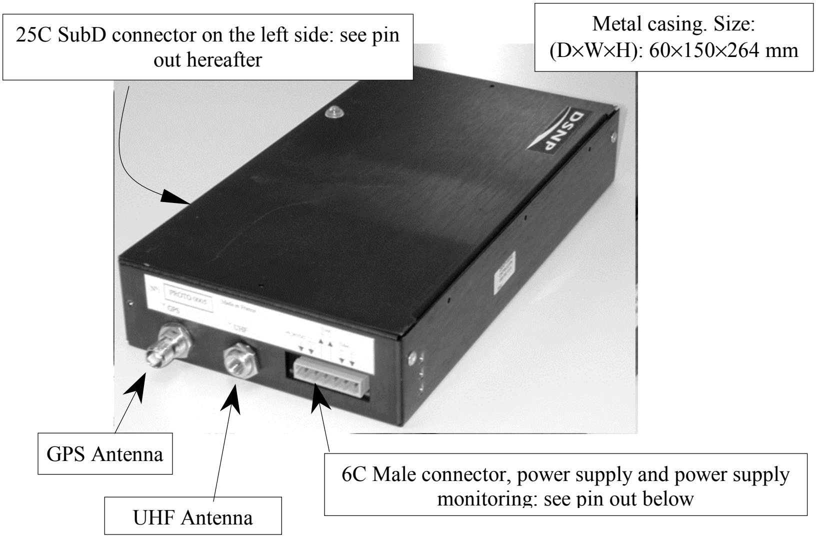
$PDAS,UNIT	Querycommand
$PDAS,UNIT,0*30	(Reply: No. 0000)

$PDAS,UNIT,801	Number change
$PDAS,UNIT	Query command
$PDAS,UNIT,801*39	(Reply: No. 801)

♣

5. Mobile Description & Start-up

Unit Description



6-contact male connector pin out:

Pin No.	Signal name
1	+VE (9 to 36 V DC)
2	Ground
3	+VEPIS (V out)
4	Ground
5	+TELEC
6	-TELEC

(Manufacturer: Wago; female connector provided: DSNP Part No. 5011328)

25 C female HE501 SubD connector pin out:

Pin No.	Signal name	Definition
1	+12VS	12 V DC supply output
2	Ground	
3	TX2	RS232Port No. 2 (TDG)
4	RTS2	
5	RX2	
6	CTS2	
7	Ground	
8	INTD3	External inputs
9	INTD2	
10	INTD1	
11	SDA	Not used
12	SDM	Direction of motion
13	ODO+	Odometer (+)
14	+12VS	12 V DC supply output (0.5 A max)
15	Ground	
16	TX1	Port RS232 No. 1 (GPS)
17	RTS1	
18	RX1	
19	CTS1	
20	Ground	
21	OUTD3	External outputs
22	OUTD2	
23	OUTD1	
24	SCL	Not used
25	ODO-	Odometer (-)

Mobile characteristics

Dimensions : 60×150×264 mm (D×W×H)

Input voltage : 9-36 V DC

Power drain : 4.5 W on average

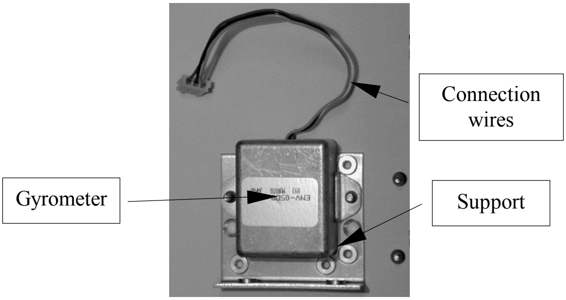
GPS antenna connector type : TNC female

UHF antenna connector type : FME male

How to mount the internal gyrometer

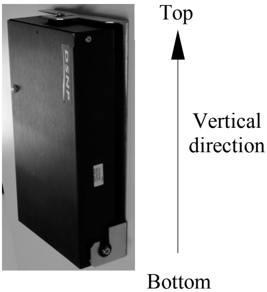
❑ Mounting criterion

The right position for the gyrometer is that obtained when, once the unit is definitively installed in the vehicle, its connection wires protrude from its upper part.



As a consequence, the way the mobile unit should be mounted in the vehicle depends on how the gyrometer has been mounted inside the unit.

At delivery, the gyrometer has been fixed in such a way that if you position the mobile unit as depicted below, **you will not have to open the unit to correct the orientation of the gyrometer**.



If you do not wish to install the mobile this way, you should open it beforehand to rotate the gyrometer.

All possible directions of mounting are possible for the unit except the one which would allow it to be fixed horizontally to a ceiling.

❑ Changing the direction in which the gyrometer is mounted

1. Remove the cover
2. Unplug the gyrometer
3. Remove the support + gyrometer assembly from the unit
4. Change the position of the gyrometer on its support, then that of the support inside the unit in such a way that the position criterion described above is met.
5. Once the gyrometer + support assembly has been correctly fixed inside the unit, re-connect the gyrometer then put the cover back in place and close the unit.

Choice of antennas

❑ For a land vehicle

The following antenna model is provided: Hirschmann GPS Multi S 921 712-002 + UHF whip antenna 823 688-001

GPS antenna specs:

Impedance: 50 Ω
Gain: 5 dBi
Amplification: 25 dB typical
Noise factor: <2 dB
Power requirement: 5 V DC, 30 mA max.
Weight: < 100 g
Dimensions: dia. 65 mm×24 mm (installed)
Cable length: 30 cm
Cable plug type: SMB female

UHF antenna specs:

Frequency range: 410-470 MHz
Gain: 0 dBi
Cable plug type: FME male
Cable length: 30 cm

Extension cables are required (SMB-m/TNC-m for GPS; FME-f/FME-m for UHF. These cables are not provided.

❑ For a boat

To give an example, a 1/2-wave antenna (PROCOM MU9 or CXL70 type) may be used. It must be installed at a minimum height of 2 m above the bridge.

Installation in the vehicle

1. The unit should be installed in a dry area, away from engine vibrations.

The overall dimensions of the unit on its bracket being D×W×H=60×150×264 mm, allow for this space plus extra space for cable connections (from above and from the left).

Also choose a mounting surface, which is either as vertical as possible (recommended), or as horizontal as possible, as the internal gyrometer must always function in a vertical position. Then prepare the support according to the diagram opposite.

Afterwards (see **3.**), it is still possible to correct the position if the unit is not exactly vertical (or horizontal).

2. Fix the bracket on to the vehicle chassis (screws not provided).

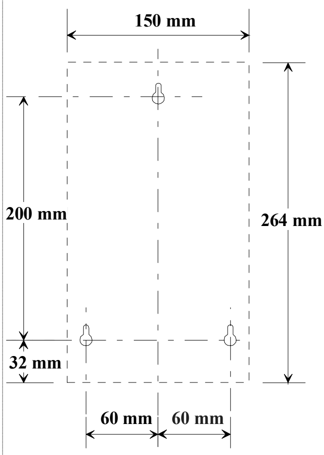


Fig. 1 - Drilling diagram

(3 holes dia. 5.5 to 10 mm in vehicle chassis)

5

3. Mount the unit onto its bracket:

According to the verticality (or horizontality) of the bracket once it has been attached, on each side of the unit, place a screw+standoff+grommet+washer into the appropriate hole (see figure opposite).

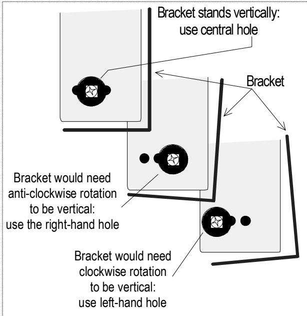


Fig. 3
Choosing the appropriate fixing holes on the unit according to bracket attitude (to place the unit in vertical position)

Then insert the unit into the bracket mounting lugs. The grommets act as dampers. The upper part of the unit is held by a screw that is to be tightened. The oblong placement hole allows for final vertical adjustment before tightening the screw. A rubber stop screwed on to the casing acts as a damper between bracket and unit.

Adjust the Capricorn 2001M in vertical position using a level.

4. Power supply the Capricorn 2001M via its male 6-contact connector. To do so, connect the wires from the power source to the corresponding pins on the female connector (provided separately):

- Connect Pin 1 (9 to 36 V DC) to the "+" terminal of the battery
- Connect Pin 2 (Ground) to the "-".

Make these connections directly to the battery or at least on a <u>permanent</u> power supply. A 5A protection fuse should be inserted into the "+" line.

As indicated above this connector, the allowed voltage range at the unit's power input is 9 to 36 V DC.

5. Connect one of the +TELEC (pin 5) or -TELEC (pin 6) signals respectively to the "-" or "+" of the battery to start up the Capricorn 2001M. Start-up is then immediate.

   Shutdown is obtained by simply opening the connection made for power-up. Switching-off is postponed according to the programmable timer setting.

   Typically, the +TELEC signal can be connected to the "+" of the battery just after the ignition switch. If the vehicle is parked, and the key removed, for a time less than the programmed delay, then operation the Capricorn 2001M unit will not be disrupted during the time of vehicle parking.

6. Connect the odometer. Continue with the procedure according to the type of odometer used:

<u>Passive type odometer</u> (example: Eaton odometer) It must be inserted into the speedometer cable if the speedometer is of the mechanical type. Connect the two output wires of this type of odometer indifferently to pin 25 (ODO-) and pin 13 (ODO+) on the SubD 25 C connector.

<u>Active type odometer</u> (electronic speedometer or signal originating from the anti-blocking system, etc.) • The signal delivered by this type of odometer is generally referenced to the "-" of the vehicle and is of constant amplitude. • Connect the hot spot of this type of odometer to pin 13 (ODO+) on the SubD 25C connector. Do not connect anything to pin 25 (ODO-).

(The 25C male SubD connector is not provided)

7. Connect the hot spot of the vehicle backward moving lights to pin 12 (SDM) on the 25C SubD connector. This connection provides reversing information to the Capricorn 2001M.
8. Install the mobile antenna and make all necessary coaxial connections with the unit
9. Switch on the Capricorn 2001M by remote control (see point **5.** above). Following this operation, the lamp located on the top of the unit will light up and will remain continually lit throughout the acquisition phase, then it will start flashing when the GPS sensor is ready to deliver a GPS position.

❑ Odometer Calibration

The scale coefficient of the odometer is loaded into the Capricorn 2001M via the $PDAS,SENSOR command. It is expressed in millimetres per half-cycle of signal. As its value is then automatically adjusted by the Capricorn 2001M during vehicle movement, a ± 20 % relative error is tolerated on the coefficient entered by the user.

Examples of scale coefficients:

GyroEaton on R25, R21, Espace (Renault): 100

ABSBosch on R25, R21, Espace (Renault): 20

The scale coefficient of the odometer can be determined using the ODOGYRO2 utility program provided.

❑ Gyrometer Calibration

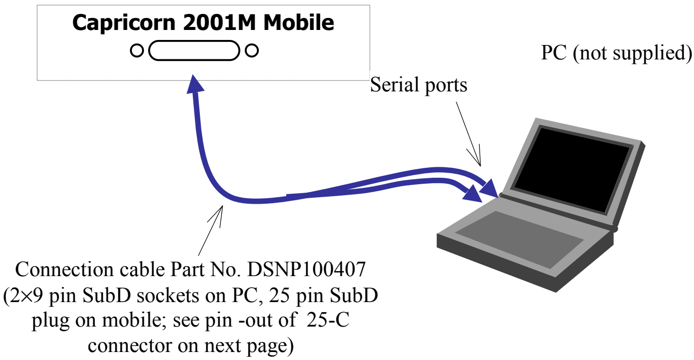
The scale coefficient of the gyrometer is loaded into the Capricorn 2001M by DSNP before delivery. ♣

6. Mobile Unit Administration

Work organization

The term "administration" in the context of mobiles includes all the activities necessary to achieve the required operational performance. For the most part these tasks are completed before the mobiles are installed in the vehicles.

Use DSNP **WinComm** software. In the absence of this software any PC terminal emulator can be used (Windows Hyper-terminal for example).



6

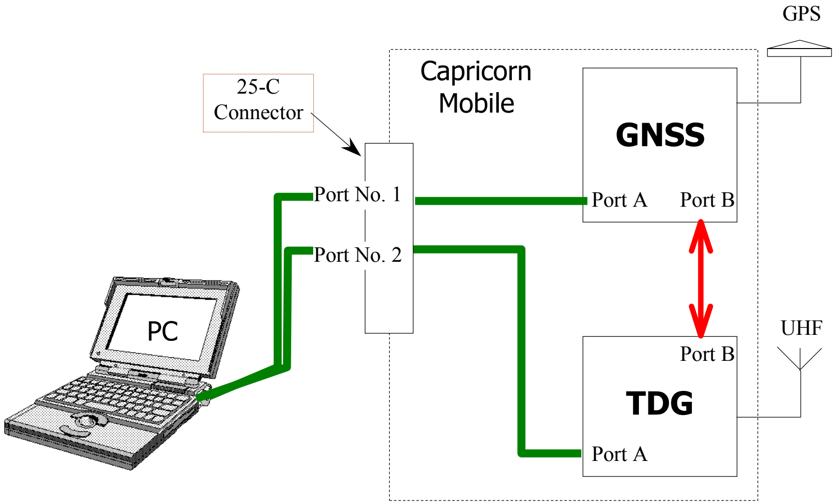
25-C connector pin out:

Pin No.	Signal	Description
1	+12VS	
2	Ground	
3	TX2	RS232 Port No. 2 (TDG)
4	RTS2	
5	RX2	
6	CTS2	
7	Ground	
8	INTD3	
9	INTD2	
10	INTD1	
11	SDA	
12	SDM	
13	ODO+	
14	+12VS	
15	Ground	
16	TX1	RS232 Port No. 1 (GNSS)
17	RTS1	
18	RX1	
19	CTS1	
20	Ground	
21	OUTD3	
22	OUTD2	
23	OUTD1	
24	SCL	
25	ODO-	

The cable supplied is characterized by a dual cabling arrangement in order to let you establish 2 serial links (example: **Mobile Port No. 1 ⇔ PC Com1** and **Mobile Port No. 2 ⇔ PC Com2** if the PC has two serial ports).

❑ Description of the internal serial lines

The diagram below shows the connections inside a mobile with the PC ports connected to the 25 pin connectors on the mobile.



❑ Reminder of the functions performed by the mobile

The Capricorn mobile determines a DGPS solution of the vehicle's current position using the GPS signals received and the differential corrections sent by the station. This position is sent to the station via a UHF radio link.

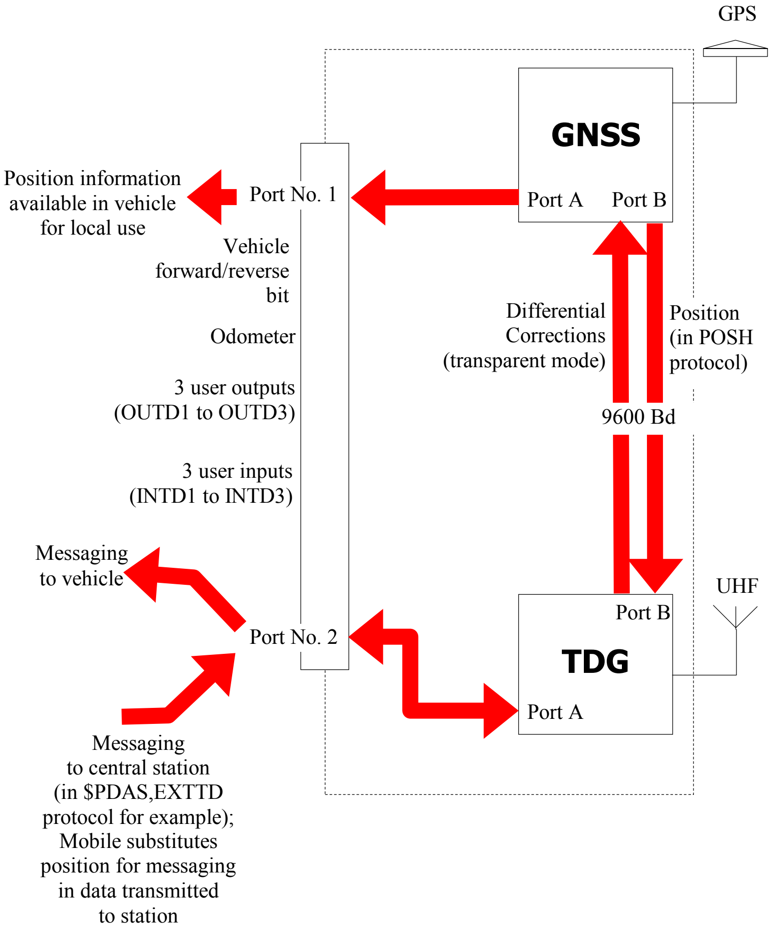
To maintain an accurate position solution when the GPS is momentarily unavailable (which is sometimes the case, especially in urban areas), the mobile may process the data from the vehicle's odometer (which it attached to) as well as from its internal gyrometer. The resulting solution is called *hybrid solution of position*.

When configuring her/his mobiles, the fleet administrator may choose to work with the hybrid solution or not. If she/he does not, then the chosen solution can only be the "pure" *DGPS solution of position*.

The Capricorn mobile can also transmit messaging back to the station, also via the UHF radio link. Conversely the mobile can receive messaging from the station or other useful information to control local devices on board the vehicle.

6

Data flow organization inside a mobile in operation



List of regular tasks

❑ GNSS board

Perform the operations described in the table below, and in the order specified in this table.

Task:	Command to be used:	To be sent to:	See also page:
Read the hardware and software versions of the board.	$PDAS,IDENT	Port No. 1	6-15
List the characteristics for co-ordinate system stored in the mobile	$PDAS,GEO		6-11
Check the coordinate system currently in use.	$PDAS,SELGEO		6-19
Check that the mobile is capable of computing its position in hybrid DGPS mode and that its station reference number is correct.	$PDAS,FIXMOD		6-9
Check or correct the definition of the mobile output message intended to be sent to the station.	$PDAS ,OUTMES		6-17
Calibrate gyrometer and odometer	$PDAS,SENSOR		6-21

6

❑ TDG board configuration

In the table below, the four tasks listed first should always be run (in the order of appearance) before running any of the others.

Run these tasks first

Task:	Command to be used:	To be sent to:	See also:
Check the board configuration	$PDAS,CONFIG	Port No. 2	TDG Reference Manual (the companion manual to this manual) for a full description of the syntax for these commands
Check that the TDG board has been configured to operate in a mobile. Set the value of the sub-frame.	$PDAS,TDG,MODE		
Change or check the mobile registration number and its parameters	$PDAS,TDG,IDNUM $PDAS,TDG,PARAM		
Store or read the current frequency setting for the board.	$PDAS,TDG,REGLAG		
Change or check the function assigned to each slot (transmission or reception) and change or check the frequency channels for transmission and reception.	$PDAS,TDG,SETSLT		
Change or check the configuration of serial ports A and B	$PDAS,HARDRS		
Change or check the priority port for sending position messages and the priority port for sending messaging	$PDAS,INPREF		
Change or check the input and output data protocols	$PDAS,TDG,CONF		
Check the origin position used as a reference to compute the points transmitted by the mobile (Network geographic offset)	$PDAS,TDG,ORIGIN		
Change or check the delay before power shutdown after switching off the vehicle ignition key.	$PDAS,TDG,TEMPO		

Task:	Command to be used:	To be sent to:	Also see page:
Change or check the remote configuration commands which the mobile should process when they are received.	$PDAS,TDG,VTCF	Port No. 2	**TDG Reference Manual (the companion manual to this manual) for a full description of the syntax for these commands**
Encrypt the transmission data	$PDAS,TDG,COD **Careful!** This command cannot be used to query the mobile to determine if the received data are encrypted or not.		
Set up the transmission of a reception acknowledgement from the mobile to the station, knowing that the reception acknowledgement will be provided by a local system connected to the mobile.	$PDAS,ACK		
Check the mobile transmission characteristics	$PDAS,TDG,IDT		

❑ Operational state of the TDG board

The following commands can be used in the context of the routine mobile maintenance regime. The syntax for these commands is described in the *TDG Reference Manual* (companion volume to this manual)..

Task:	Command to be used:	To be sent to:
Display the event log for the board	$PDAS,DEFLT	Port No. 2
Read the hardware and software versions for the board	$PDAS,IDENT	
Read the board synchronization status	$PDAS,TDG,SYNMES	

$PDAS commands used to configure the GNSS board

Command	To port	To board	See page
$PDAS,FIXMOD	No. 1	GNSS	6-9
$PDAS,GEO	No. 1	GNSS	6-11
$PDAS,IDENT	No. 1	GNSS	6-15
$PDAS,OUTMES	No. 1	GNSS	6-17
$PDAS,SELGEO	No. 1	GNSS	6-19
$PDAS,SENSOR	No. 1	GNSS	6-20

❑ $PDAS,FIXMOD

Function

This command is used to set the position computation mode for the mobile.

Recipient port

Port No. 1 (GNSS board).

Formats

Complete command:

$PDAS,FIXMOD,a,b,c [*hh]<CR><LF>

Query command:

$PDAS,FIXMOD[*hh]<CR><LF>

Parameters

Parameter	Format	Bound	Default Value	Comments
a	x		4	Selects the position computation mode. It is imperative to maintain the default value of "4"; this enables the DGPS position computation mode from a single reference station.
b	x		21	Selects the source of differential corrections The default value ("21") enables the mobile to process the received differential corrections and to use the data from the external sensors (odo, gyro) (hybrid DGPS mode) Setting this parameter to “1” enables the mobile to process the received differential corrections without using the information from the sensors (non-hybrid DGPS mode)

6

c	**x**	[0..1023]		Identification of DGPS reference station. Since the Capricorn station is also a DGPS reference station, enter the station identification number as established by $PDAS,UNIT)
***hh**				Checksum (optional)
<CR><LF>				End of command

Example

$PDAS,FIXMOD	Query command
$PDAS,FIXMOD,4,21,1*11	Reply (Hybrid solution, station No. 11)

❑ $PDAS,GEO

Function

This command is used to edit the data for the coordinate system stored in the mobile.

Recipient port

Port No. 1 (GNSS board).

Formats

Query command:

$PDAS,GEO [*hh]<CR><LF>

Complete commands:

$PDAS,GEO,a,b,c,d [*hh]<CR><LF>
$PDAS,GEO,a,b,e,f [*hh]<CR><LF>
$PDAS,GEO,a,b,A,1/F,S,j [*hh]<CR><LF>
$PDAS,GEO,a,b,Dx,Dy,Dz,n [*hh]<CR><LF>
$PDAS,GEO,a,b,Ax,Ay,Az,r [*hh]<CR><LF>
$PDAS,GEO,a,b,s,t [*hh]<CR><LF>
$PDAS,GEO,a,b,u,v,w,... [*hh]<CR><LF>

Parameters

Parameter	Format	Bound	Default Value	Comments
a	x.x			Number of lines necessary to edit the data for the specified coordinate system
b	x.x			Current line number
c	x.x			GPS week number (optional)
d	x.x			GPS time in week, in sec. (optional)
e	x.x		1	Number of coordinate system (must be "1")
f	c--c	10 chars. max.	Lambert 2	Name of coordinate system
A	x.x			Semi-major axis ("A," positioned in front)
1/F	x.x			Inverse of flattening ("1/F," positioned in front)
S	x.x			Scale factor ("S," positioned in front)
j	x			Length unit (see below)
Dx	x.x			Deviation along X axis ("Dx," positioned in front)
Dy	x.x			Deviation along Y axis ("Dy," positioned in front)
Dz	x.x			Deviation along Z axis ("Dz," positioned in front)
n	x			Length unit (see below)
Ax	x.x			Angular deviation around X axis ("Ax," positioned in front)
Ay	x.x			Angular deviation around Y axis ("Ay," positioned in front)
Az	x.x			Angular deviation around Z axis ("Az," positioned in front)
r	a			Angle unit (see below)
s	x.x	1 to 99		Projection number
t	c--c	12 chars. max.		Projection name
u...				Projection parameters
*hh				Checksum (optional)
<CR><LF>				End of command

Unit code

ASCII character identifying the different units used in the data line, in the same order as the data, and without separator (example: 2b). The unit codes are described in the two tables below.

Length units:

Unit code	Unit	Value in meters
1	meter	1
2	US foot	0.304799999
3	Imperial foot	0.304797265

Angle units:

Unit code	Unit	Value in meters
a	degrees, minutes, seconds and fraction of a second	45.120952 for 45°12' 9.52"
b	degrees and fraction of a degree	45.2026444 for 45°12' 9.52"
c	Imperial foot	0.304797265
d	grades	
e	seconds	for datum rotation
f	degrees, minutes and fraction of a minute	45.1215866 for 45°12' 9.52"

6

Examples

$PDAS,GEO

$PDAS,GEO,8,1,0,0*6E

$PDAS,GEO,8,2,01,NTF*33

$PDAS,GEO,8,3,A,6378249.145,1/F,293.465000,S,1.00000000,1*1E

$PDAS,GEO,8,4,Dx,-168.000000,Dy,72.000000,Dz,318.500000,1*4F

$PDAS,GEO,8,5,Ax,0.000000,Ay,0.000000,Az,0.554000,e*03

$PDAS,GEO,8,6,02,LambII*49

$PDAS,GEO,8,7,Lori,0.81681408993,Gori,0.04079233948,Eori,600000.000,Nori,200000.000,d1*11

$PDAS,GEO,8,8,Ko,0.999877420*6A

Each line in the reply can be changed by using one of the complete commands previously described.

❑ $PDAS,IDENT

Function

This command is used to read the identification data of the queried board in the mobile.

Recipient port

Port No. 1 (GNSS board and TDG board).

Formats

Query command only:

$PDAS,IDENT[*hh]<CR><LF>

Station reply:

$PDAS,IDENT,a,b,c,d[*hh]<CR><LF>

Reply parameters

Parameter	Format	Bound	Default Value	Comments
a	**x.x**			Total number of lines in the mobile reply
b	**x.x**			Current line number
c	**cc**	4 chars.		"Hardware" identification: - Characters 1 and 2: Identification of unit - Characters 3 and 4: "hardware" identification of board

d	**cc**	10 or 12 chars.		"Hardware" identification: - Characters 1 to 4: Software label - Character 5: Identification of software version type: V: Production version Identification of standard or other software version: - Characters 7 and 8: Revision No. - Characters 9 and 10: No. of on-site modification - Characters 11 and 12: Iteration No. ° (not invariably)
***hh**				Checksum (optional)
<CR><LF>				End of command

Examples

$PDAS,IDENT
$PDAS,IDENT,2,1,CM10,CMB2V00204*6A
$PDAS,IDENT,2,2,CM10,CMT2V00207*7C

❑ $PDAS,OUTMES

Function

This command is used to edit the message definition for the mobile output. One of these position messages is designated to be transmitted to the station.

Recipient port

Port No. 1 (GNSS Board).

Formats

Complete command:

$PDAS,OUTMES,a,b,c,d,e [*hh]<CR><LF>

Query command:

$PDAS,OUTMES,a,b[*hh]<CR><LF>

Reply parameters

Parameter	Format	Bound	Default Value	Comments
a	**x.x**	(0 to 20)	**1**	Message number
b	**a**	A or B	**B**	Port identification: A: message available on 25 pin connector B: Message transmitted to TDG
c	**x**		**1**	Message triggering mode. "1" necessarily (time mode)
d	**x.x**		**10**	Output message repetition period. It is the product of the number entered (**d**) and 100 milliseconds (or a default repetition period of 1 second)

6

e, ...	**x.x**		**9**	Position data included in message: 1: $GPGGA (NMEA0183 format) 2: $GPGLL (NMEA0183 format) 3: $GPGRS (NMEA0183 format) 4: $GPGSA (NMEA0183 format) 5: $GPGSV (NMEA0183 format) 6: $GPRMC (NMEA0183 format) 7: $GPVTG (NMEA0183 format) 8: $GPZDA (NMEA0183 format) **9: $PDAS,POSH** (Position expressed on projection) 10: $PDAS,XYAID (see page 6-24)
***hh**				Checksum (optional)
<CR><LF>				End of command

Example

$PDAS,OUTMES — Query command (complete list of position data messages)

$PDAS,OUTMES,1,B,1,10,9*69 — (Reply)

In a Capricorn 2001 M, you *must* set the parameters in the $PDAS,OUTMES command as shown here so that the mobile can correctly transmit its position to the station.

❑ $PDAS,SELGEO

Function

This command is used to check that the coordinate system defined by $PDAS,GEO is also used by the mobile to express the computed position co-ordinates.

Recipient port for the command

Port No. 1 (GNSS Board).

Formats

Complete command:

$PDAS,SELGEO,a [*hh]<CR><LF>

Query command:

$PDAS,SELGEO [*hh]<CR><LF>

Reply parameters

Parameter	Format	Bound	Default Value	Comments
a	**x**		**1**	Number of co-ordinate system to be used ("1" **necessarily**)
***hh**				Checksum (optional)
<CR><LF>				End of command

Examples

$PDAS,SELGEO Query command

$PDAS,SELGEO,1*20 (Reply: co-ordinate system No. 1)

6

$PDAS,SENSOR

Function

This command is used to enter the scale coefficients of the odometer and gyrometer. To determine these coefficients before using this command, see page 6-21.

Recipient port

Port No. 1 (GNSS Board).

Formats

Complete command:

$PDAS,SENSOR,1,a,b<CR><LF>

Query command:

$PDAS,SENSOR<CR><LF>

Parameters

Parameter	Format	Bound	Default value	Comments
1	**x**	{1}	**1**	Sensor type (odometer or gyrometer): 1 necessarily
a	**x**	[1; 999]	**100**	Odometer scale coefficient
b	**x**	[1; 99999]	**1200**	Gyrometer scale coefficient
<CR><LF>				End of command

Example

$PDAS,SENSOR Query command

$PDAS,SENSOR,1,100,1200*13 Reply

How to determine the gyro & odo coefficients

❑ Measurement conditions

1- Unless already done, enable the $PDAS,XYAID output message using the $PDAS,OUTMES command (see page 6-17). This message is described on page 6-24.

2- The vehicle must be at a standstill.

❑ Measurement procedure

From your PC, run the ODOGYRO2 program. The screen should look like this:

Calibrating gyrometer & odometer –ODOGYRO2- V x.x dd/mm/yy

Gyro heading	Gyro offset	Gyro Signal	Gyro factor
Wait a few seconds			4125
odometer	D = 0 m	V = 0 km/h	Factor:100mm

FUNCTIONS :

- [Z] : resets heading, updates sensor offset. Press [Z] when the gyrometer is kept still at a "zero measured" speed and wait 6 sec. before moving.
- [1] to [9] : Computes scale factor after the gyrometer rotates by n radians x N (enter "N". For example, type "2" for a 360 degr. rotation).
- [G] : Allows manual entry of gyrometer factor
- [O] : Allows manual entry of odometer factor (9 to 999)
- [Esc] : Quit

Data on port COM1 : 0-1 0 05 6510300120 38402

6

The message : "Wait a few seconds" appears while the gyro offset is initialized and the heading and distance counters are reset to zero.

After about 6 seconds, the upper table becomes :

Gyro heading	Gyro Offset	Gyro Signal	Gyro factor
0.03	2.414	2.414	4125

Odometer	D = 0 m	V = 0 km/h	Factor:100mm

Before you start a new sequence to compute the coefficient, press [Z] to clear the gyrometer offset and the heading and distance counters.

❑ Calibrating the odometer

An approximate calibration can be made from the comparison between the indication on the speedometer and the value displayed on the screen while the vehicle is moving at constant speed.

A more accurate calibration can be made from the comparison between an accurately known baseline (the distance between two milestones for example) and the distance measured by the sensor (displayed on screen) after moving the vehicle along this baseline. With this method, press [Z] at the beginning of the baseline to clear the distance counter.

Whatever the method you use, re-compute the scale factor from the measurement results and enter the new factor after pressing [O]. If for example, the distance measured is 1.2 times the true distance, the new factor you should enter will be the result of the currently used factor divided by 1.2.

❑ Calibrating the gyrometer

1) Mark the direction of the vehicle.
2) Press [Z] to compute the offset and to reset the heading to 0.
3) Move the vehicle clockwise along one or more full circle. Stop the vehicle in the initial direction.
4) Check for a relative error on the measured heading better than ± 0.5 %. If it is out of tolerance, enter a figure, between 1 and 9, corresponding to the rotation performed ("1" stands for half a circle). The new factor is then determined automatically by software.
5) Resume the same circle(s) to confirm the new value, then test it in the opposite direction (anticlockwise).
6) If the two directions give slightly different values, enter the resulting mean factor after pressing [G].
7) Press [Esc] to exit the calibration function.
8) If required, load the new factor into the mobile by typing [Y].

XYAID Message Description

The **$PDAS,XYAID** output message allows you to check that a mobile operates correctly. This type of message is delivered by the mobile after making the appropriate setting using the **$PDAS,OUTMES** command (see page 6-17). The **$PDAS,XYAID** message has the following structure:

$PDAS,XYAID,a,b,c,d,e,f,g,h,i,j,k,l,m,n,o,p,q,r,s,t,u,v,w,x [*hh]<CR><LF>

Where:

Parameter	Format	Bound	Comments
a	**x.x**	[000000.00; 235959.99]	UTC time (hhmmss.s)
b	**x.x**	[-9999999.9; +9999999.9]	X coordinate of hybrid position, in meters
c	**x.x**	[-9999999.9; +9999999.9]	Y coordinate of hybrid position, in meters
d	**x.x**	[0.0; 360.0]	Hybrid course, in degrees
e	**x.x**	[0.0 ; 500.0]	Hybrid speed, in km/hr
f	**x**	[00; 12]	Number of satellites used
g	**x**	[0; 9]	Confidence level; see below
h	**x**	{0; 1; 2; 3}	Locking indicator (external sensors); see below
i	**x**	{0; 1; 2; 3}	Sensor status: 0: Odometer & gyrometer operate correctly 1: Odometer failure 2: Gyrometer failure 3:Gyro & odo failure
j	**x.x**	[-9999999.9; +9999999.9]	X coordinate of GPS position, in meters
k	**x.x**	[-9999999.9; +9999999.9]	Y coordinate of GPS position, in meters
l	**x.x**		GPS position uncertainty, in meters (-1.0: uncertainty is undetermined)
m	**x.x**	[0.0; 360.0]	GPS course, in degrees
n	**x.x**		GPS course uncertainty, in degrees (-1.0: uncertainty is undetermined)

Parameter	Format	Bound	Comments
o	**x.x**	[-1.0; 999.9]	GPS speed, in km/hr (-1.0: invalid speed)
p	**x.x**		GPS speed uncertainty, in degrees (-1.0: uncertainty is undetermined)
q	**x.x**	[-1.0; 99.9]	HDOP (-1.0: invalid HDOP)
r	**x.x**	[-1.0; 99.9]	LPME (-1.0: invalid LPME)
s	**x**	[0 ; 2^{32}-1]	Odometer counter (the 16 Most Significant Bits: odo counter; the 16 Least Significant Bits; odo read count)
t	**x**	[1; 999]	Odometer scale coefficient
u	**x**	{0; 1}	Vehicle forward/reverse indicator: 0: forward 1: reverse
v	**x**	[0; 2^{22}-1]	Gyro counter (the 22 Lead Significant Bits hold the sum of all the gyro counter outputs)
w	**x.x**		Gyrometer offset, in degrees/sec.
x	**x**	[1; 99999]	Gyrometer calibration coefficient
***hh**			Checksum (optional)
<CR><LF>			End of command

♣

6

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