REV 1.31

NMEA Protocol Specification

iTrax02 Evaluation Kit

1.11

This document describes the NMEA protocol commands and messages supported by the iTrax02 module.

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CHANGE LOG

Rev.	Notes	Date
1.26	Updated for iSuite 1.08 release	11-12-2002
1.27	Updated ZDA message documentation	17-04-2003
1.28	Moved DEBUG command to general command section, added new parameters to CONF command, updated PPSPOS and general PPS mode documentation.	06-05-2003
1.30	Updated FIXRATE command	13-05-2003
1.31	Added SNR Limit to CONF command	12-06-2003

CONTENTS

1. COMPLEMENTARY READING

The following reference documents are complementary reading for this document:

Ref. #	Date	Document
01	Dec-2002	iTrax02 Evaluation Kit: Software Installation Manual
02	Dec-2002	iTrax02 Evaluation Kit: System Architecture Overview
03	Dec-2002	iTrax02 Evaluation Kit: GPS Workbench Users Guide
04	Dec-2002	iTrax02 Evaluation Kit: iTalk Protocol Specification
05	Dec-2002	iTrax02 Evaluation Kit: GPS WB Data Formats Description
06	Dec-2002	iTrax02 Logging System

2. GENERAL

iTrax02 receiver produces and interprets messages in accordance with the NMEA standard. Complete NMEA specification is available in "NMEA 0183, version 3.0". Standard is published by National Marine Electronics association,

http://www.nmea.org/0183.

This document describes the subsets of the standard available for iTrax02 GPS receiver.

2.1 General Message Format

All NMEA message and command data consist of ASCII characters (from 20 – 127 decimal or from HEX 14 to HEX 7E). For further information see Section 6.1 (Table 3.) in NMEA 3.0.

2.2 Command syntax

iTrax accepts a set of NMEA commands consisting of fields as follows:

$PFST,<command>,<parameter>,<parameter> .. ,<parameter>

The command line starts with field “$PFST”, followed by the command identifier and possible parameters separated by commas (,). Parameters may occasionally be omitted (NULL). In such case, these parameters are still separated with commas but contain no characters. No checksum is applied to commands. The command is acknowledged by iTrax02 by outputting the received command together with a checksum. All commands are described in more detail in chapter 3. Note that all commands are in capital letters.

Example:

$PFST,PWRDOWN,0,0,10

…can also be written:

$PFST,PWRDOWN,,,10

… and acknowledged by iTrax02 with:

```
$PFST,PWRDOWN,0,0,10*57
```

2.3 Message syntax

The iTrax02 NMEA messages consists of fields as follows:

```
$GP<message id>,<data field>,<data field>,,,
      ..*<checksum><CR><LF>
```

Message starts with field “$GP” followed by a message identifier field. Message data fields are separated by commas (,) and the message ends after checksum field and carriage return <CR> and line feed <LF> control characters. Delimiter ‘*’ precedes the checksum field. Notice that data fields may be omitted (NULL). Such data fields contain no characters but are still separated by commas, for example:

```
$GPGGA,134158.48,6016.3072,N,02458.3788,E,1,08,1.2,,,,,,0000*1
E
```

The above message contains 5 NULL data fields.

Data fields for iTrax supported messages are presented in section 3 of this document.

For further information, please see section 5.2 in NMEA 3.0 specification.

2.4 Message sequence

The figure below is an NMEA output example containing a start command, NMEA output messages and a stop command. Notice that in this example the synchronous output mode is disabled (see 3.2.7)

The first NMEA messages after the start command contain the information from the “last known good” fix. The last known good fix is stored to the flash memory of iTrax each time a “stop” command is given. Notice that if iTrax’s power is switched off without giving a stop command, the last known good isn’t stored to flash memory and thus the position output at the first message may be empty or older than expected at the next start

iTrax starts outputting a sequence of one or more GSV messages as soon as a GPS signals have been found. These sequences are sent at interval of approximately one second. Notice that at this stage the GSV messages contain only signal strength information, not yet azimuth or elevation. If synchronous output mode were enabled, a full NMEA message set would be output at every second with coordinates of the last known good fix.

	$PFST,START,0*61
”Last known good”. Note: ZDA outputs the current time	$GPZDA,085725.80,17012002,00,00*64 $GPGGA,085717.28,6016.3103,N,02458.3768,E,0,06,1.2,32.2,M,18.6,M,,*53 $GPGLL,6016.3103,N,02458.3768,E,085717.28,V,N*76 $GPVTG,346.22,T,,,0.12,N,0.2,K,N*4F $GPRMC,085717.287,V,6016.3103,N,02458.3768,E,0.12,346.22,170102,,,N*71 $GPGSA,A,1,04,07,09,11,21,26,1.7,1.2,1.2*3B $PFST,FOM,2*67
When a GPS signal is found, the GSV message sequences are sent once per second.	$GPGSV,3,1,09,04,00,000,41,05,00,000,46,07,00,000,48,09,00,000,47*75 $GPGSV,3,2,09,11,00,000,40,18,00,000,39,21,00,000,42,26,00,000,42*71 $GPGSV,3,3,09,28,00,000,41*4F $GPGSV,3,1,09,04,00,000,41,05,00,000,47,07,00,000,49,09,00,000,47*75 $GPGSV,3,2,09,11,00,000,42,18,00,000,40,21,00,000,43,26,00,000,43*7D $GPGSV,3,3,09,28,00,000,43*4D $GPGSV,3,1,09,04,00,000,41,05,00,000,47,07,00,000,49,09,00,000,48*7A $GPGSV,3,2,09,11,00,000,42,18,00,000,40,21,00,000,44,26,00,000,44*7D $GPGSV,3,3,09,28,00,000,44*4A $GPGSV,3,1,09,04,00,000,42,05,00,000,47,07,00,000,49,09,00,000,48*79 $GPGSV,3,2,09,11,00,000,42,18,00,000,40,21,00,000,43,26,00,000,44*7A $GPGSV,3,3,09,28,00,000,44*4A $GPGSV,3,1,09,04,00,000,41,05,00,000,47,07,00,000,49,09,00,000,48*7A $GPGSV,3,2,09,11,00,000,42,18,00,000,40,21,00,000,44,26,00,000,44*7D $GPGSV,3,3,09,28,00,000,45*4B $GPGSV,3,1,09,04,00,000,42,05,00,000,47,07,00,000,49,09,00,000,48*79 $GPGSV,3,2,09,11,00,000,42,18,00,000,40,21,00,000,44,26,00,000,44*7D
1st fix.	$GPGSV,3,3,09,28,00,000,45*4B $GPGSV,3,1,09,04,00,000,41,05,00,000,47,07,00,000,49,09,00,000,48*7A $GPGSV,3,2,09,11,00,000,42,18,00,000,40,21,00,000,43,26,00,000,44*7A $GPGSV,3,3,09,28,00,000,45*4B $GPZDA,085732.80,17012002,00,00*64 $GPGGA,085732.34,6016.3072,N,02458.3772,E,1,06,1.3,80.3,M,18.6,M,,*5D $GPGLL,6016.3072,N,02458.3772,E,085732.34,A,A*68 $GPVTG,337.34,T,,,0.27,N,0.5,K,A*40 $GPRMC,085732.348,A,6016.3072,N,02458.3772,E,0.27,337.34,170102,,,A*67 $GPGSA,A,3,05,07,18,21,26,28,2.2,1.3,1.7*30
2nd fix.	$PFST,FOM,13*57 $GPGSV,3,1,09,04,05,120,41,05,36,247,47,07,51,084,48,09,71,248,48*79 $GPGSV,3,2,09,11,10,018,42,18,03,261,39,21,13,296,43,26,18,192,44*76 $GPGSV,3,3,09,28,12,076,46*4A $GPZDA,085733.80,17012002,00,00*64 $GPGGA,085733.34,6016.3100,N,02458.3769,E,1,08,1.0,29.7,M,18.6,M,,*58 $GPGLL,6016.3100,N,02458.3769,E,085733.34,A,A*67 $GPVTG,333.87,T,,,0.50,N,0.9,K,A*40 $GPRMC,085733.348,A,6016.3100,N,02458.3769,E,0.50,333.87,170102,,,A*64
3rd fix. Note! STOP command!	$GPGSA,A,3,04,05,07,09,11,21,26,28,1.6,1.0,1.2*35 $PFST,FOM,3*66 $GPGSV,3,1,09,04,05,120,40,05,36,247,47,07,51,084,49,09,71,247,48*76 $GPGSV,3,2,09,11,10,018,42,18,03,261,39,21,13,296,44,26,18,192,44*71 $GPGSV,3,3,09,28,12,076,46*4A $GPZDA,085736.80,17012002,00,00*64 $GPGGA,085736.34,6016.3085,N,02458.3786,E,1,07,1.2,34.0,M,18.6,M,,*56 $GPGLL,6016.3085,N,02458.3786,E,085736.34,A,A*6F $GPVTG,303.58,T,,,0.22,N,0.4,K,A*49 $GPRMC,085736.348,A,6016.3085,N,02458.3786,E,0.22,303.58,170102,,,A*68

When a fix is available, iTrax sends a sequence of all enabled NMEA messages at interval of approx. one second. A sequence of NMEA messages related to a single fix always starts with a GSV message (if that message is enabled) and the order of messages stays the same with masked messages of course missing. See chapter 3.2.1 for how NMEA messages are enabling and disabling.

If for some reason the fix cannot be calculated (e.g. not enough visible satellites), only the GSV messages are sent in non-synchronous mode. If GPS signal is unavailable, no NMEA messages are output. In synchronous output mode, all non-masked messages are sent once per second, regardless if a valid fix is available or not.

TIP: When iTrax isn't outputting any NMEA messages, the serial communication between the host and iTrax can be checked by sending a "$PFST<CR><LF>" message to iTrax, to which iTrax responds "$PFST, OK * 39".

2.5 Serial port performance considerations

The absolute character throughput of a serial port is limited by the serial speed. Temporary overload of sentences can be buffered but continuous overload eventually causes full NMEA sentences to be dropped. As most NMEA sentences are output once every fix, the *X* in following equation shouldn't exceed value of 1.

*X = (F * L) / T*

where

F *number of fixes in one second,*

L *combined length of all enabled messages (chars),*

T *throughput of the serial port (chars/s).*

Please refer to the tables below when deciding which NMEA messages to output and which to mask out with the given serial port speed.

Baud rate	Character Throughput (chars/s)
300	30
1200	120
2400	240
4800 **(default)**	480
9600	960
19200	1920
57600	5760
115200	11520

NMEA sentence	maximum possible length (chars incl. CRLF)
GLL	51
GGA	82
VTG	40
RMC	75
GSA	67
GSV	60 (per single line!)
ZDA	34
PFST,FOM	19
PFST,PPS	35

3. NMEA COMMANDS

This chapter describes the supported NMEA commands.

3.1 General NMEA commands

The following sections introduce general-purpose commands used for controlling the basic iTrax operations.

3.1.1 START – Start Navigation

Commands iTrax to start navigation. The command has no effect if called while iTrax is already navigating. After the start command has been given, it takes some time from iTrax to acquire satellites, acquire required navigation data from the signal and calculate a first fix.

$PFST,START,<startmode>

<startmode>	Navigation start mode, may be one one of the following: 0 = Autostart. Always uses the fastest possible start mode (1-4). Default value. 1 = Force cold start. Module will behave as if no valid ephemeris or PVT data were available. 2 = Request warm start. 3 = Request hot start. Requires RTC time, valid ephemeris and PT data. Calculates a fix as soon as GPS time is acquired from the GPS signal. 4 = Request quick start. Requires RTC time and recent ephemeris. Assumes that RTC time is very accurate and doesn't wait for GPS time. Notice that if host requests faster start mode than possible (e.g. hot start when there is no ephemeris data available) start mode 0 will be used. RTC time is available if the module has already been navigating after the previous power-up, or if the time has been given by using the $PFST,INITAID command. Valid ephemeris data is available if module has been navigating within past two hours and the navigation has been stopped properly by giving the $PFST,STOP command.

Examples:

$PFST,START<CR><LF>

Starts navigation using the fastest possible start mode.

$PFST,START,2<CR><LF>

Starts navigation using warm start mode if possible.

3.1.2 STOP – Stop Navigation

Commands iTrax to stop navigation and enter idle state. At idle state iTrax receiver doesn't navigate but still accepts commands. Idle state consumes less power than navigation state, but remarkably more than in the power-down mode. This command also stores the "Last-KnownGood" fix, ephemeris and almanac data acquired during navigation to flash memory.

$PFST,STOP,<1|0>

<1|0>	1 to save, 0 not to save "LastKnownGood" fix, ephemeris and almanac data to flash memory.

Examples:

$PFST,STOP<CR><LF>

Stops navigation and saves "LastKnownGood" to flash memory.

$PFST,STOP,0<CR><LF>

Stops navigation. Doesn't save "LastKnownGood" to flash memory.

3.1.3 PWRDOWN – iTrax to Sleep Mode

Commands iTrax to sleep mode.

Using the sleep mode is recommended when navigation isn't needed, since iTrax02 consumes remarkably little power in the sleep mode and still re-acquires the navigation fix quickly after waking up.

iTrax wakes up from the sleep mode when the timeout has elapsed or GPIO pin 11 state is toggled. If the receiver was navigating when the

PWRDOWN command was given, navigation will automatically be re-started after waking up from the sleep mode.

$PFST,PWRDOWN,<hours>,<minutes>,<seconds>

or

$PFST,PWRDOWN

<hours>	How many hours to sleep
<minutes>	How many minutes to sleep
<seconds>	How many seconds to sleep

Examples:

$PFST,PWRDOWN,1,30,15<CR><LF>

Sleep for 1h 30min 15 sec or until GPIO 11 pin is toggled.

$PFST,PWRDOWN,0,0,30<CR><LF>

Sleep for 30 seconds or until GPIO 11 pin is toggled.

$PFST,PWRDOWN<CR><LF>

Sleep until GPIO 11 pin is toggled.

3.1.4 ODO - Odometer

This message displays the distance traveled by the receiver. The odometer distance is set to zero at module reset and increased as the receiver moves.

$PFST,ODO,<distance>

<distance>	New odometer distance setting. If omitted, the command displays the odometer distance reading.

Examples:

To read the odometer distance, give the command without the <distance> parameter:

$PFST,ODO,<distance><CR><LF>

The reply message shows the moved distance in meters, in this case 46 meters:

$PFST,ODO,46*57

The odometer distance is reset by setting distance to zero with the following command:

$PFST,ODO,0<CR><LF>

3.1.5 SW – iTrax software revision

Shows the firmware revision of the iTrax02 module.

$PFST,SW,<customer id>,<major revision>,<minor revision>,<build number>

<customer id>	Customer identifier, if the module has a customer-modified firmware. Value “0” means original Fastrax releases.
<major revision>	Major firmware revision. This number together with the two following define the firmware release identifier.
<minor revision>	Minor firmware revision.
<build number>	Firmware build number.

Example:

$PFST,SW

$PFST,SW,0,1,6,2085*0C

The module has Fastrax firmware 1.6.2085.

3.1.6 HW – iTrax hardware revision

Shows the bill of material date (year, month, day) of the iTrax02 module.

$PFST,HW,<BOM date>

Example:

$PFST,HW

$PFST,HW,20010202,d*65

3.1.7 DEBUG

Activates semi-graphical signal level debugging display. When switched to the debug display mode, iTrax ceases from outputting NMEA messages and starts outputting signal level display to the NMEA port using ASCII graphics.

$PFST,DEBUG,<interval>

<interval>	How often the display is updated (seconds). If zero, the debug mode is switched off and usual NMEA outputting resumed.

Examples:

$PFST,DEBUG,3<CR><LF>

Start outputting debug display with 3 seconds update intervals.

$PFST,DEBUG,0

Stops outputting the debug display and resumes the usual NMEA output.

Below is a picture of the output display:

```
Lat: N6016.3093  Lon: E02458.3811  Speed: 0.0  #PRNs: 8
AGC gains I - RF:*.... ADC:***....
AGC gains Q - RF:*.... ADC:*****..
05:44 ==============|....|....| 07:49 ####################|....|
08:38 ########.|....|....|....| 09:51 ######################...|
11:45 ################....|....| 18:46 #################...|....|
23:37 =======..|....|....|....| 26:48 ##################.|....|
28:49 ####################|....| 29:48 ##################.|....|
00:00 ....|....|....|....|....| 00:00 ....|....|....|....|....|
```

Description of the display fields:

- “Lat” and “Lon”: latitude and longitude coordinates.
- “Speed”: Horizontal velocity (m/s).
- “#PRNs”: How many satellites are used in the fix.

- “AGC gain”: These fields display the RF-chain gain settings.

The bar displays at the bottom displays the signal strength of the satellites being tracked, for example

```
05:44 ==============|....|....|
```

- Here the first number before the colon (“05”) is the satellite PRN number.

- The second number after the colon (“44”) is the S/N level of the signal in dBHz.

- The bar length represent the signal level graphically, so that a vertical lines are drawn with every 5th dBHz.

- If the bar is plotted with hash symbols “#”, that satellite is being used for navigation.

- If the bar is plotted with equal symbols “=”, that satellite is being tracked but not used for navigation.

3.2 Configuration commands

The following sections introduce commands used for controlling the iTrax behavior.

3.2.1 NMEA – NMEA Serial Communication

Sets NMEA message mask and NMEA serial port communication speed. The message mask defines which of the NMEA messages are being output.

$PFST,NMEA,<mask>,<speed>

<mask>	NMEA messaging mask bitmap in hexadecimal notation. If it’s desired to change only the speed while keeping the old message mask, this parameter may be omitted and plain “,,” used instead. Mask bits for message are defined as follows: **Message** | **bit**

	<table><tr><td>GSV</td><td>0x0001</td></tr><tr><td>GSA</td><td>0x0002</td></tr><tr><td>ZDA</td><td>0x0004</td></tr><tr><td>PPS</td><td>0x0010</td></tr><tr><td>FOM</td><td>0x0020</td></tr><tr><td>Reserved*</td><td>0x0040</td></tr><tr><td>GLL</td><td>0x1000</td></tr><tr><td>GGA</td><td>0x2000</td></tr><tr><td>VTG</td><td>0x4000</td></tr><tr><td>RMC</td><td>0x8000</td></tr></table> I.e. to allow GLL and RMC messages one would set mask as 0x1000 + 0x8000 = 0x9000. See examples below. Note that hexadecimal digits A,B,C,D,E and F must be capital letters.! * Enables a message used for special purposes.
<SPEED>	Communication speed. Either 1200, 2400, 4800, 9600, 19200, 57600 or 115200.

Examples:

$PFST,NMEA,7003

Enable GLL,GGA,VTG,GSA and GSV messages at serial port speed of 4800.

$PFST,NMEA,,19200

Keep the current message mask but change speed to 19200.

NOTE: using message mask FFFF (command $PFST,NMEA,FFFF)is not recommended. Although it may be used to turn on all messages, the side effect of this would be that also all new messages in future iTrax versions will be turned on. The following messages are enabled by default: GGA, RMC, GSA, GSV.

NOTE2: Other NMEA Serial port setting than speed cannot be changed. The settings for the port are:

- Default speed 4800 bps
- No parity (cannot be changed)
- 8 data bits (cannot be changed)
- 1 stop bit (cannot be changed)

NOTE: In order to preserve this setting after reset or power-up, the new setting has to be stored to flash memory by using the $PFST,STORE command (only iTrax02/8 modules).

3.2.2 AUTOSTART – Set Autostart Mode

Defines if iTrax automatically starts navigation when power is turned on or iTrax is reset.

$PFST,AUTOSTART,<1|0>

<1|0>	1 to enable, 0 to disable autostart.

Examples:

$PFST,AUTOSTART<CR><LF>

Returns current setting

$PFST,AUTOSTART,1<CR><LF>

Enables autostart.

$PFST,AUTOSTART,0<CR><LF>

Disables autostart.

AUTOSTART is enabled by default.

NOTE: In order to this message to have an effect, the new setting has to be stored to flash memory by using the $PFST,STORE command.

NOTE: Since iTrax02/4 doesn't save parameters to non-volatile memory, AUTOSTART command has no effect in iTrax02/4.

3.2.3 CONF – Set configuration parameters

This command is used to set iTrax02 configuration parameters.

$PFST,CONF,<ID>,<VALUE>

<ID>	Configuration parameter ID number. See the table below for possible values.
<VALUE>	New value for the parameter. If omitted, the command

	shows the current value of the configuration parameter.

Example:

$PFST,CONF,1,0

This command sets the configuration parameter number 1 to value "0", i.e. disables the position pinning.

Available configuration parameter ID's are:

Param ID	Param. Type	Default value	Description
1	BOOL	1	Position pinning on/off (1=on)
3	BOOL	1	Velocity smoothing on/off
4	BOOL	1	Position smoothing on/off
10	BOOL	1	Carrier smoothing on/off
17	BOOL	0	Route nav- & msg-task messages to host (enables calculating the navigation fix in host)
19	BOOL	1	Choose between narrow/wide tracking bandwidth, 1 = wide.
45	WORD	12	Number of receiver channels
47	BOOL	0	Disable fast search (=> uses slower but more sensitive search mode)
48	WORD	7000	Acq search window width (Hz, from middle of the window)
50	DOUBLE	5	Timeout for resetting the post filters
51	DOUBLE	0.4	Coefficient for position smoothing, high
52	DOUBLE	0.12	Coefficient for position smoothing, low
53	DOUBLE	0.0001	Velocity filter coefficient, low limit
54	DOUBLE	0.5	Velocity filter coefficient, high limit
55	DOUBLE	3.0	Pinning lag criterior (meters). In pinning mode, the position may lag behind the actual position by this amount.
59	DOUBLE	1.0	Pinning velocity limit. Goes to pinning mode if velocity is below this limit.
70	DOUBLE	50	FOM limit. Fix is marked invalid if FOM is larger than this value.
71	DOUBLE	22	HDOP limit. Fix is marked invalid if HDOP is larger than this value.
80	WORD	0	Interval for how often Last Known Good Fix & Ephemeredes are updated to flash memory during navigation, in

			seconds (0 = off). When using this feature, notice that reasonable interval is around one hour, as the system can automatically update ephemeredes for new satellites to flash memory also between these updates. Too frequent updating only wears out the flash memory!
81	WORD	22	SNR limit, how weak signals can be used in navigation solution.

NOTE: In order to preserve these settings after reset or power-up, the new setting has to be stored to flash memory by using the $PFST,STORE command (only iTrax02/8 modules).

3.2.4 DATUM – Set Local Coordinate System

Selects local coordinate system. After this command iTrax will return position in this coordinate system.

$PFST,DATUM,<datum_id>

<datum_id>	Coordinate system id. See appendix B for supported DATUM id's.

Examples:

$PFST,DATUM<CR><LF>

Returns current setting

$PFST,DATUM,300<CR><LF>

KKJ (Kartta Koordinaatisto Järjestelmä) of Finland.

$PFST,DATUM,168<CR><LF>

QUO of South Greenland.

Factory default is DATUM = -1 (WGS84).

NOTE: In order to preserve this setting after reset or power-up, the new setting has to be stored to flash memory by using the $PFST,STORE command (only iTrax02/8 modules).

3.2.5 FIXRATE – Set Fixrate

Defines how often iTrax should acquire navigation fix and thus output the NMEA messages.

$PFST,FIXRATE,<fixrate>

<fixrate>	Number of seconds between navigation fixes. Can be also a decimal number to enable more than one fix/second fix rate.

Examples:

$PFST,FIXRATE<CR><LF>

Returns current setting

$PFST,FIXRATE,0.5<CR><LF>

Generate fix twice a second.

$PFST,FIXRATE,10<CR><LF>

Generate a fix every 10 seconds.

$PFST,FIXRATE,60<CR><LF>

Generate a fix once every minute.

Factory default is FIXRATE = 1.

NOTE: In order to preserve this setting after reset or power-up, the new setting has to be stored to flash memory by using the $PFST,STORE command (only iTrax02/8 modules).

3.2.6 ITALK – Reconfigure port as ITALK

Stops NMEA protocol and reconfigures the NMEA port to use iTalk protocol. If the other of iTrax's RS ports is configured as an iTalk port, that port is closed.

After the command the NMEA port operates as an iTalk port until next reset, then the NMEA protocol is restored. The change can't be un-done by other means than by resetting the module.

$PFST,ITALK,<speed>

<speed>	iTalk protocol speed. The serial port isre configured to this speed.

Examples:

$PFST,ITALK,115200<CR><LF>

Reconfigures the NMEA port to operate as an iTalk port at serial speed of 115200 baud.

NOTE: Navigation has to be stopped before giving this command.

3.2.7 SYNCMODE – synchronous NMEA output mode

Enables or disables the synchronous NMEA output mode. In synchronous output mode, all the enabled NMEA navigation messages are output approx. once a second, regardless if a valid navigation fix is available or not.

The synchronous mode is enabled by default.

$PFST,SYNCMODE,<mode>

<mode>	Set synchronous mode on or off, 0 = off, 1 = on (default).

Examples:

$PFST,SYNCMODE,1

NOTE: In order to preserve this setting after reset or power-up, the new setting has to be stored to flash memory by using the $PFST,STORE command (only iTrax02/8 modules).

3.2.8 STORE – Store Current Parameter Set

Stores the current parameter set to iTrax's flash memory. These parameters include those defined by commands ALTAID, AUTOSTART, CONF, CABLEDEL, DATUM, FIXRATE, NMEA, PPSMODE, PULSEPOL, PULSELEN, SETLIMIT, SURVEYLEN, and SYNCMODE.

$PFST,STORE

NOTE: Navigation has to be stopped before giving this command.

NOTE: iTrax02/4 doesn't store configuration parameters to flash memory, and thus this command doesn't have any effect with iTrax02/4 module. With iTrax02/4 the preferred way is to set the parameters each time when the module is reset or switched on.

3.2.9 RESETDATA

Erases the navigation data stored to the flash memory, i.e. erases the last good known navigation fix, ephemeris, almanac and UTC/Ionosphere model data. The module has to be reset after this command to abandon all the above data, otherwise some of the data may still resist in RAM memory.

$PFST,RESETDATA

NOTE: Navigation has to be stopped before giving this command.

NOTE: This command doesn't affect logged data. Log data is cleared with $PFST,LOGCLEAR command.

3.2.10 RESTORE – Restore Default Parameter Set

Restores factory default parameter set.

$PFST,RESTORE

NOTE: Navigation has to be stopped before giving this command.

NOTE: iTrax02/4 doesn't store configuration parameters to flash memory, and thus this command is irrelevant with iTrax02/4 module.

NOTE: This command doesn't affect the last good navigation fix, ephemeris, UTC/ionosphere model data or log data. Navigation, ephemeris and model data is erased with $PFST,RESETDATA command. Log data is cleared with $PFST,LOGCLEAR command.

3.3 1PPS mode commands

The following sections introduce commands used for controlling the one-pulse-per-second (PPS) timing signal mode.

3.3.1 PPSMODE – Set Pulse Per Second mode

Activates the One Pulse Per Second (PPS) operating mode. In PPS mode, iTrax outputs a precise timing pulse exactly once a second, synchronized at the edge of GPS time seconds.

The PPS mode requires precise antenna position information to allow precise timing pulse, and thus iTrax supports several PPS modes to allow different methods of acquiring the antenna position.

This command can be given only when navigation is stopped, otherwise an error code results.

NOTE: See the appendix C for notes on PPS mode.

$PFST,PPSMODE,<mode>

<mode>	PPS operating mode, may be one one of the following: 0 = PPS mode off. iTrax doesn't output PPS pulse. 1 = PPS survey mode. iTrax outputs PPS pulse. 2 = PPS static mode. iTrax outputs PPS pulse. 3 = PPS roving mode. iTrax outputs PPS pulse.

Examples:

$PFST,PPSMODE,1<CR><LF>

Turn on PPS survey mode

Factory default is <MODE> = 0.

NOTE: Navigation has to be stopped before giving this command.

NOTE: To enable PPS mode, the FIXRATE has to be "1".

NOTE: In order to preserve this setting after reset or power-up, the new setting has to be stored to flash memory by using the $PFST,STORE command (only iTrax02/8 modules).

3.3.2 PPSPOS – PPS static mode antenna position

Sets the antenna coordinates for PPS static mode.

NOTE: See the appendix C for notes on PPS mode.

$PFST,PPSPOS,xxmm.dddd,<N|S>,yyymm.dddd,<E|W>,d.d

xxmm.dddd	Latitude xx = degrees mm = minutes dddd = decimal part of minutes
<N|S>	Either character N or character S, (N = North, S = South)
yyymm.dddd	Longitude yyy = degrees mm = minutes dddd = decimal part of minutes
<E|W>	Either character E or character W, E = East, W = West
d	Altitude, meters from sea level.

Example:

$PFST,PPSPOS,6015.2180,N,02208.1813,E,42<CR><LF>

Sets antenna position to 60°15,2180'N, 22°8,1813'E, 42 meters above the sea level.

3.3.3 SURVEYLEN – PPS Survey period length

Set PPS survey mode averaging period length.

$PFST,SURVEYLEN,<LEN>

<len>	Survey mode length (number of valid fixes that are averaged during the survey mode).

Examples:

$PFST, SURVEYLEN,180<CR><LF>

Set survey mode length to 180 fixes. Maximum value is 1998780, corresponding to approx. 23 days of continuous satellite visibility.

Factory default is <LEN> = 28800, corresponding to eight hours of continuous satellite visibility.

NOTE: In order to preserve this setting after reset or power-up, the new setting has to be stored to flash memory by using the $PFST,STORE command (only iTrax02/8 modules).

3.3.4 CABLEDEL – Set PPS cable delay

Set 1PPS mode cable delay.

$PFST,CABLEDEL,<DELAY>

< DELAY >	Cable delay in units of 0.01 ns. The cable delay can be either positive or negative in range of approx –21 .. +21 ms.

Examples:

$PFST,CABLEDEL,5000

This command tells iTrax to output the PPS pulse 50 ns earlier than usually, corresponding to a 10 meters long antenna cable. One meter of antenna cable corresponding roughly to a delay of 5 ns, or –500 units (notice that electromagnetic signal propagates slower in a cable than in void)

Factory default is <DELAY> = 0.

NOTE: In order to preserve this setting after reset or power-up, the new setting has to be stored to flash memory by using the $PFST,STORE command (only iTrax02/8 modules).

3.3.5 PULSEPOL – Set PPS pulse polarity

Set PPS mode electric pulse polarity.

$PFST,PULSEPOL,<POL>

< POL >	0 = The PPS signal sets from high to low at PPS pulse 1 = The PPS signal raises from low to high at PPS pulse

Examples:

$PFST, PULSEPOL,0

Factory default is <POL> = 1.

NOTE: In order to preserve this setting after reset or power-up, the new setting has to be stored to flash memory by using the $PFST,STORE command (only iTrax02/8 modules).

3.3.6 PULSELEN – Set 1PPS pulse length

Set PPS mode electric pulse length.

$PFST,PULSELEN,<LEN>

< LEN >	1 PPS pulse length in ms. (range 10 – 900 ms)

Examples:

$PFST, PULSELEN,600

Sets pulse length to 600 ms.

Factory default is <LEN> = 800.

NOTE: In order to preserve this setting after reset or power-up, the new setting has to be stored to flash memory by using the $PFST,STORE command (only iTrax02/8 modules).

3.4 Navigation Aiding Commands

The following sections introduce commands for giving iTrax receiver additional data that may be helpful when starting navigation and during navigation.

3.4.1 INITAID – Initial position and time aiding

Gives the iTrax module the current position and time information for aiding the navigation startup. Setting this information before starting navigation with the $PFST,START command reduces the time required for finding the satellites and receiving the first valid navigation fix.

If the position isn't known, the initial time may also be given alone by omitting the position parameters, i.e. using the command with only the two first parameters. The altitude information is not critical and can be set to zero (i.e. mean sea level) if not known.

NOTE: Even when INITAID is being used, the iTrax module reports navigation data of the previous actual navigation fix until a new fix is acquired, not the position and time data given in the INITAID command.

$PFST,INITAID,<time>,<date>,<lat>,<N/S>,<long>,<E/W>,<altitude>

<time>	UTC time in "hhmmss.dd" format, hh = hours (2 digits), mm = minutes (2 digits), ss.dd = seconds with two decimals (2+2 digits).
<date>	UTC date in "ddmmyy" format, dd = day (2 digits), mm = month (2 digits), yy = year (2 digits).
<lat>	Latitude in degrees and minutes in "xxmm.dddd" format, xx = degrees (1-2 digits), mm.dddd = minutes with four decimals (2+4 digits).
<N/S>	Either a character N or S (N = north, S = south).
<long>	Longitude in degrees and minutes in "yyymm.dddd" format, yyy = degrees (1-3 digits), mm.dddd = minutes with four decimals (2+4 digits).
<E/W>	Either a character E or W (E = east, W = west).
<altitude>	Altitude from the sea level in meters (1-5 digits).

Examples:

$PFST,INITAID,131500.78,100102,6016.3075,N,2458.3817,E,40

Sets the initial position and time as follows:

```
Time      = 13:15:00.78 (UTC)

Date      = 10-Jan-2002

Latitude  = N60°16.3075

Longitude = E24°58.3817

Altitude  = 40 meters above the sea level
```

```
$PFST,INITAID,131500.78,100102
```

Sets the initial time only.

NOTE: This command has to be given before starting navigation. If AUTOSTART is active, navigation has to be stopped after switching on the power, then issue the INITAID command and then START the navigation again. *The AUTOSTART is always set in iTrax02/4 so this procedure must always be followed after power-up with iTrax02/4.*

3.4.2 ALTAID – Set the altitude aiding mode

Sets or disables the altitude aiding mode, where the navigation is assisted by using the given altitude value or an altitude value from a previous fix. Altitude aiding enables getting a navigation fix with fewer than four satellites, and as a matter of fact altitude aiding is used only if there are four or less satellites visible. Note that the aided altitude is used as an additional observation and the altitude is still calculated, not fixed to the given or aided altitude.

Altitude aiding commands can be given before starting the navigation and during navigation. The altitude aiding mode is reset to “no altitude aiding” when navigation is stopped.

By default, the altitude aiding mode is disabled.

```
$PFST,ALTAID,<mode>,<altitude>
```

<mode>	A numeric value indicating the new altitude aiding mode: 0 : No altitude aiding (default) 1 : Altitude hold mode: Use an altitude from the previous fix 2 : External altitude mode: Use constant altitude given

	in the <altitude> parameter.
<altitude>	Constant altitude in meters above the sea level, used in altitude aiding mode 2. This parameter is ignored in other modes. The constant altitude is subject to the altitude limits as defined in the command $PFST,SETLIMITS.

Examples:

$PFST,ALTAID,2,55

Sets an altitude of 55 meters above sea level as aiding to the navigation system.

$PFST,ALTAID,0

Disables altitude aiding mode. Only observations from satellites are used.

NOTE: In order to preserve this setting after reset or power-up, the new setting has to be stored to flash memory by using the $PFST,STORE command (only iTrax02/8 modules).

3.4.3 SETLIMIT – Set limits for altitude, velocity and acceleration

Sets the upper limits for altitude, velocity and acceleration parameters that the iTrax navigation subsystem accepts for a valid fix. Setting realistic, lower-than-default limits for these parameters hastens finding a valid navigation fix.

$PFST,SETLIMIT,<altitude>,<velocity>,<acceleration>

<altitude>	Maximum value for altitude (meters).
<velocity>	Maximum value for velocity (m/s).
<acceleration>	Maximum value for acceleration (m/s^2).

The iTrax module checks the given parameters values against fixed upper limits for each of these parameters (same as the factory defaults, see below), thus the user cannot set the parameters beyond these values.

If necessary, the <acceleration>, or <velocity> and <acceleration> parameters may be omitted. If all the three parameters are omitted, the command displays the current maximum limit values.

Examples:

$PFST,SETLIMIT,13000,300,10

Sets the maximum limits as follows:

Max. altitude = 13000 m = 13 km

Max. velocity = 300 m/s = 1080 km/h

Max. acceleration = 10 m/s²

$PFST,SETLIMIT

Displays the current maximum limits.

Factory defaults for <altitude> = 18288 (meters), <velocity> = 514 (m/s), <acceleration> = 50 (m/s^2).

NOTE: In order to preserve this setting after reset or power-up, the new setting has to be stored to flash memory by using the $PFST,STORE command (only iTrax02/8 modules).

3.5 Logging Commands

The following sections introduce commands related with the iTrax logging system. See iTrax02 Logging System documentation [06] for more information about the logging system.

3.5.1 LOGCLEAR – Clear log data

Erases logs in iTrax02's memory.

$PFST,LOGCLEAR,<MODE>

<MODE>	Clear operation. May be one of the following: 0 - Reclaim the flash file system only. Doesn't delete any logged data, only frees up data clusters that have been deleted but not freed yet. 1 – Delete log data (default). Deletes logged data but keeps the current logging settings. 2 – Format the flash file system. Formats the file system used by the logging system. Not recommended for normal use, useable only for recovering from an extreme system disaster.

Example:

$PFST,LOGCLEAR<CR><LF>

Clears all logged data.

NOTE: Navigation has to be stopped before giving this command.

NOTE: all the logs are erased at the same time, single logs can't be erased.

3.5.2 LOGFREE – Amount of free space for log data

Calculates how much space is available for log data.

$PFST,LOGFREE

The command outputs the amount of free space in the reply message:

$PFST,LOGFREE,<WORDS>,<ITEMS>*hh

Where <WORDS> is amount of free space in 16bit words and <ITEMS> is how many log items fit to the free space with the current logging settings.

Example:

$PFST,LOGFREE<CR><LF>

the above command gives e.g. the following reply:

$PFST,LOGFREE,156948,39237*56

this would mean that there are 156948 words of free space for log data, meaning 39237 log items with the current logging settings.

NOTE: The free space figures are approximate. The actual capacity may vary depending on how many logs are in use etc.

3.5.3 LOGGET – Output logged data

Output logged data items. This command outputs the logged data formatted as standard NMEA messages according to the current NMEA settings.

$PFST,LOGGET,<LOGNUM>,<FIRSTITEM>,<NUMITEMS>

<LOGNUM>	Log number.
<FIRSTITEM>	(optional) First log item from which on to output items. If omitted, starts from the first item of the log.
<NUMITEMS>	(optional) How many items are output. If omitted, outputs all items until the end of the log.

Examples:

$PFST,LOGGET,1<CR><LF>

This command will display all items in log 1.

$PFST,LOGGET,2,50,100<CR><LF>

This command will display 100 items, beginning from the 50th item of the log 2.

NOTE: Navigation has to be stopped before giving this command.

NOTE: If there are plenty of items in the log, it may take some time to output all the data as NMEA messages. To speed-up the operation, it

may be wise to increase the NMEA port speed or disable some NMEA messages.

NOTE: Depending on the data level used while logging the data, all fields of NMEA messages may not be available when outputting the data. In such case the missing information is replaced in the NMEA messages by zeros.

3.5.4 LOGINFO – Show log information

Show log information, including log name, how many items have been stored to the log and what data level has been used.

$PFST,LOGINFO,<LOGNUM>

<LOGNUM>	Number of the log if interest.

The log information is displayed on the reply message:

$PFST,LOGINFO,<LOGNUM>,<NAME>,<ITEMS>,<DATALEVEL>*hh

Where <NAME> is name of the log, <ITEMS> is how many log items (data points) there are in the log and <DATALEVEL> is the data level setting.

Example:

$PFST,LOGINFO,4<CR><LF>

Queries log information of the log 4. Result is e.g. as follows:

$PFST,LOGINFO,4,Log4,5569,2*0E

This means that log 4's name is "Log4", it has 5569 items and the items are stored using data level 2.

3.5.5 LOGMODE – Set logging start mode

Set logging start mode. See iTrax Logging System documentation [06] for more information about start modes.

$PFST,LOGMODE,<MODE>

<MODE>	Log start mode. May be one of the following:

	0 -Logging disabled (default). 1 - Logging is started so that a new log is created once when navigation is started for the next time. On the consecutive navigation starts after that logging won't be used. 2 - The previous log is continued once when navigation is started for the next time. On the consecutive navigation starts after that logging won't be used. 3 - Logging is started so that a new log is created each time when navigation is started. Logging is active until user changes the start mode again. 4 - The previous log is continued each time when navigation is started. Logging is active until user changes the start mode again.

Examples:

$PFST,LOGMODE,3<CR><LF>

Sets logging start mode to "3".

NOTE: Navigation has to be stopped before giving this command.

NOTE: This setting is automatically stored to flash memory and thus persists reset and power-off.

3.5.6 LOGNAME – Set log name

Set log name. This name concatenated with the log number is displayed in the log information.

$PFST,LOGNAME,<NAME>

<NAME>	New name to be used with new logs. If omitted, displays the current name.

Examples:

$PFST,LOGNAME,foobar<CR><LF>

This command sets log name to "foobar".

NOTE: This setting is automatically stored to flash memory and thus persists reset and power-off.

3.5.7 LOGNUM – Get number of logs

Show how many logs are currently stored in the memory.

$PFST,LOGNUM

The number of logs <NUM> is displayed on the reply message:

$PFST,LOGNUM,<NUM>*hh

Example output:

$PFST,LOGNUM,7*34

Means that there are currently 7 logs.

3.5.8 LOGSETTING - Set logging settings

Sets the logging settings. Please see iTrax02 Logging System document for more information about the logging settings.

$PFST,LOGSETTING,<LEVEL>,<MININT>,<MINMOVE>,<MAXINT>,<MAXMOVE>

<LEVEL>	How much information is saved along each log item, may have values between 1..6. See iTrax02 Logging System documentation for more details of the data level setting.
<MININT>	Minimum interval time (seconds): A new point won't be added to a log if less than this time has elapsed since the previous log point. An exception is that if the maximum movement limit is exceeded, then a new point is logged.
<MINMOVE>	Minimum movement (meters): A new point won't be added to a log if distance to the previous log point is less than this limit. An exception is that if the maximum interval time from the previous log point is exceeded, then a new point is logged.
<MAXINT>	(optional) Maximum interval time (seconds): If this time or longer has elapsed since the previous log point, a new point is logged. If omitted or set to zero, the maximum limit isn't used.
<MAXMOVE>	(optional) Maximum movement (meters): If distance from the previous log point is this distance or more, a new point is logged. If omitted or set to zero, the maximum limit isn't used.

If all parameters are omitted, the command shows the current settings in the reply message.

Example:

$PFST,LOGSETTING,2,5,15<CR><LF>

New log item is added to log when at least 5 seconds have elapsed since the previous logging and the distance to the previous point is at least 15 meters. Data level 2 is used, meaning that latitude & longitude coordinates and time are stored along each point.

NOTE: Navigation has to be stopped before giving this command.

NOTE: This setting is automatically stored to flash memory and thus persists reset and power-off.

3.5.9 LOGSTOP – Stop Logging

This command can be used to stop logging while navigating without stopping navigation at the same time.

When navigation is started for the next time, logging is started in a normal fashion as defined by the logging start mode.

Examples:

$PFST,LOGSTOP<CR><LF>

4. NMEA MESSAGES

This chapter describes the supported NMEA output messages.

4.1 GGA – Global Positioning System Fix Data

Time, position and fix related data for a GPS receiver.

$GPGGA,hhmmss.dd,xxmm.dddd,<N|S>,yyymm.dddd,<E|W>,v,ss,d.d,h.h,M,g.g,M,a.a,xxxx*hh<CR><LF>

hhmmss.dd	UTC time hh = hours mm = minutes ss = seconds dd = decimal part of seconds
xxmm.dddd	Latitude xx = degrees mm = minutes dddd = decimal part of minutes
<N|S>	Either character N or character S, (N = North, S = South)
yy-ymm.dddd	Longitude yyy = degrees mm = minutes dddd = decimal part of minutes
<E|W>	Either character E or character W, E = East, W = West
v	Fix valid indicator 0=Fix not valid 1=Fix valid
ss	Number of satellites used in position fix, 00-12. Fixed length
d.d	HDOP – Horizontal Dilution Of Precision
h.h	Altitude (mean-sea-level, geoid)
M	letter M
g.g	Difference between the WGS-84 reference ellipsoid surface and the mean-sea-level altitude.
M	letter M
a.a	NULL (missing)
xxxx	NULL (missing).

Example:

**$GPGGA,111200.02,6016.3092,N,02458.3841,E,1,09,0.8,30.6,M,18.1
,M,,*5D**

4.2 GLL – Geographic Position – Latitude/Longitude

Latitude and Longitude, UTC time of fix and status.

**$GPGLL,xxmm.dddd,<N|S>,
yyymm.dddd,<E|W>,hhmmss.dd,S,M*hh<CR><LF>**

xxmm.dddd	Latitude xx = degrees mm = minutes dddd = decimal part of minutes
<N|S>	Either character N or character S, (N = North, S = South)
yyymm.dddd	Longitude yyy = degrees mm = minutes dddd = decimal part of minutes
<E|W>	Either character E or character W, E = East, W = West
hhmmss.dd	UTC time hh = hours mm = minutes ss = seconds dd = decimal part of seconds
S	Status indicator A = valid V = invalid
M	Mode indicator A=autonomous N=data not valid

Example:

$GPGLL,6016.3073,N,02458.3791,E,134157.48,A,A*26

4.3 GSA – DOP and Active Satellites

GPS receiver operating mode, satellites used in the navigation solution reported by the GGA sentence, and DOP values.

$GPGSA,a,b,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,xx,p.p,h.h,v.v*hh<CR><LF>

a	Mode: M = Manual, forced to operate in 2D or 3D mode. A = Automatic, allowed to automatically switch 2D/3D.
b	Mode: 1 = Fix not available, 2 = 2D, 3 = 3D
xx	ID (PRN) numbers of GPS satellites used in solution
p.p	PDOP
h.h	HDOP
v.v	VDOP

Example:

$GPGSA,A,3,03,15,17,18,22,23,,,,,,4.7,3.7,2.9*37

4.4 GSV – Satellites in view

Number of satellites in view, satellite ID (PRN) numbers, elevation, azimuth, and SNR value. The information for four satellites maximum per one message, additional messages up to maximum of eight sent as needed. The satellites are in PRN number order.

Before a position fix is acquired the information contains only the SNR (signal to noise ratio) value. After a fix is acquired, also the elevation and azimuth angles are added. Note that there can be also “theoretical” satellites in the GSV message. These are satellites of which the angles (elevation, azimuth) are known but for some reason, e.g. due to an obstruction, have not been found by iTrax02. The SNR value for these satellites is set to zero.

Please notice that as all the satellites that in the view are reported, the amount of satellites may occasionally be more than the number of receiver tracking channels, 12.

$GPGSV,n,m,ss,xx,ee,aaa,cn,…… ,xx,ee,aaa,cn*hh<CR><LF>

n	Total number of messages, 1 to 9
m	Message number, 1 to 9
ss	Total number of satellites in view
Xx	Satellite ID (PRN) number

Ee	Satellite elevation, degrees 90 max
Aaa	Satellite azimuth, degrees True, 000 to 359
cn	SNR (C/No) 00-99 dB-Hz. zero when not tracking

Example:

```
$GPGSV,4,1,14,03,66,207,50,08,09,322,44,11,01,266,42,14,00,155
,00*79

$GPGSV,4,2,14,15,41,088,48,17,21,083,44,18,57,087,51,21,57,173
,50*78

$GPGSV,4,3,14,22,05,203,00,23,52,074,49,26,17,028,44,27,00,300
,00*79

$GPGSV,4,4,14,28,32,243,00,31,48,286,00*70
```

4.5 RMC – Recommended Minimum Specific GNSS Data

Time, date, position, course and speed data.

```
$GPRMC,hhmmss.dd,S,xxmm.dddd,<N|S>,yyymm.dddd,<E|W>,s.s,h.h,dd
mmyy,d.d, <E|W>,M*hh<CR><LF>
```

hhmmss.dd	UTC time hh = hours mm = minutes ss = seconds dd = decimal part of seconds
S	Status indicator A = valid V = invalid
xxmm.dddd	Latitude xx = degrees mm = minutes dddd = decimal part of minutes
<N|S>	Either character N or character S, (N = North, S = South)
yy-ymm.dddd	Longitude yyy = degrees mm = minutes dddd = decimal part of minutes
<E|W>	Either character E or character W, E = East, W = West
s.s	Speed, knots.
h.h	Heading

ddmmyy	Date dd – date mm = month yy = year
d.d	Magnetic variation. This value is available if magnetic model data has been stored to the flash memory (available since firmware rev. 1.08)
<E|W>	Declination. Either character E or character W, E = East, W = West
M	Mode indicator A=autonomous N=data not valid

Example:

```
$GPRMC,134829.486,A,1126.6639,S,11133.3299,W,58.31,309.62,1102
00,,,A*14
```

4.6 VTG – Course Over Ground and Ground Speed

Course and speed

$GPVTG,h.h,T,m.m,M,s.s,N,s.s,K,M*hh<CR><LF>

h.h	Heading
T	Degrees (heading units).
m.m	Magnetic heading. This value is available if magnetic model data has been stored to the flash memory (available since firmware rev. 1.08)
M	Degrees. Magnetic heading units.
s.s	Speed, knots.
N	Knots (Speed unit)
s.s	Speed, km/h.
K	km/h (Speed units).
M	Mode indicator A=autonomous N=data not valid

Example:

$GPVTG,202.60,T,,,0.38,N,0.7,K,A*0D

4.7 ZDA – Time and Date

Outputs the current UTC time and date. Unlike other messages, the time output by this message is bound to iTrax02's internal real-time clock (RTC) and thus it is updated even when navigation fix is unavailable. The RTC time is maintained also while the module is in sleep mode.

$GPZDA,<hhmmss.dd>,<dd>,<mm>,<yyyy>,<xx>,<yy>*hh

<hhmmss.dd>	UTC time in hours, minutes, seconds and fractions of a second.
<dd>	UTC day of month
<mm>	UTC month
<yyyy>	UTC year
<xx>	Local zone hours. Not implemented, 00 output always.
<yy>	Local zone minutes. Not implemented, 00 output always.

Example:

$GPZDA,061724.46,17,04,2003,00,00*61

Corresponds to the UTC time 06:17:24.46 on 17-Apr-2003.

NOTES:

- The time output in ZDA message slightly differs from the time output by other messages because the time reference of the ZDA message is real-time clock (RTC) at the very instant of formatting the message, whereas the time output on other messages is the moment of the navigation fix.

- As the ZDA time is read from the RTC just upon formatting the message, this time is closer to the real time and may be used as a somewhat accurate time reference if the latency of the system-specific serial port transmission is compensated (usually about deterministic). Time precision of approx. 1/100th of a second can be achieved by this method.

4.8 PFST,FOM – Position figure of merit

Figure of merit (FOM) value for the position fix. Indicates the accuracy of the position in meters. The FOM value cannot be calculated before at least one fix has been made with more than four observations (five satellites, or four satellites and an altitude aid); before that a value "–1" is reported, indicating that FOM is not available yet. After this the FOM value is always available the only exception being the altitude aiding modes (see chapter 3.4.2) when a fix has been calculated using three satellites.

$PFST,FOM,n*hh<CR><LF>

n	Position FOM value, i.e. the position accuracy in meters.

Example:

$PFST,FOM,3*66

4.9 PFST,PPS – PPS signal

The pulse per second message. Indicates the parameters of the PPS pulse that will shortly be output. Outputs the current GPS time and timing correction term for the coming PPS pulse.

$PFST,PPS,wwww,tttttt,n,xxxx*hh <CR><LF>

wwww	GPS Week (i.e. number of full weeks elapsed since midnight 5-6 January 1980).
tttttt	Time of Week (seconds from the beginning of the current GPS week).
n	Number of satellites used when calculating the solution.
xxxx	Short-time pulse offset of the physical PPS pulse signal (units of 0.01 ns, in range of approx. -15.3 .. 15.3 ns). The correct pulse time can be calculated by subtracting this offset from the physical PPS pulse instant.

Example:

$PFST,PPS,1161,309566,9,495*67

5. APPENDIX A: CHECKSUM CALCULATION EXAMPLE

Checksum is calculated by taking a logical exclusive-OR operation of the 8-bit message characters. Checksum excludes the leading '$', checksum delimiter '*' and the checksum itself.

The following C-language routine calculates the checksum. Parameters are:

char* sz pointer to the string containing the message (excluding checksum).

int nCount number of characters in message (including leading '$')

```
unsigned char Calc_checksum(char* sz, int nCount)
{

     unsigned char cs;      // Checksum

     //Omit the $-character
     for (i=1; i<Count; i++)
     {
          cs = cs ^((unsigned char)sz[i]);
     }

     return cs;

}
```

Notice that leading "$" is not included when calculating the checksum.

Receiving application should calculate the checksum of the message and compare it to the received checksum.

6. APPENDIX B: DATUM IDS

Table below has all coordinate system datum IDs supported by iTrax:

datum id	name	description
-1	WGS84	Global WGS84 coordinate system
000	ADI-M	Mean Solution (Ethiopian and Sudan)
001	ADI-E	Burkina Faso
002	ADI-F	Cameroon
003	ADI-A	Ethiopia
004	ADI-C	Mali
005	ADI-D	Senegal
006	ADI-B	Sudan
007	AFG	Somalia
008	ARF-A	Botswana
009	ARF-H	Burundi
010	ARF-B	Lesotho
011	ARF-C	Malawi
012	ARF-D	Swaziland
013	ARF-E	Zaire
014	ARF-F	Zambia
015	ARF-G	Zimbabwe
016	ARS-M	Mean Solution (Kenya and Tanzania)
017	ARS-A	Kenya
018	ARS-B	Tanzania
019	PHA	Djibouti
020	BID	Guinea-Bissau
021	CAP	South Africa
022	CGE	Tunisia
023	DAL	Guinea
024	EUR-F	Egypt
025	EUR-T	Tunisia
026	LEH	Ghana
027	LIB	Liberia
028	MAS	Eritrea
029	MER	Morocco
030	MIN-A	Cameroon
031	MIN-B	Nigeria
032	MPO	Gabon
033	NSD	Algeria

datum id	name	description
034	OEG	Old Egypt
035	PTB	Mean Solution (Burkina Faso and Niger)
036	PTN	Congo
037	SCK	Namibia
038	SRL	Sierra Leone
039	VOR	Algeria
040	AIN-A	Bahrain Island
041	AIN-B	Saudi Arabia
042	BAT	Sumatra (Indonesia)
043	EUR-H	Iran
044	HKD	Hong Kong
045	HTN	Taiwan
046	IND-B	Bangladesh
047	IND-I	India and Nepal
048	INF-A	Thailand
049	ING-A	Vietnam (near 16deg N)
050	ING-B	Con Son Island (Vietnam)
051	INH-A1	Thailand (1997)
052	IDN	Indonesia
053	KAN	Sri Lanka
054	KEA	West Malaysia and Singapore
055	KGS	Korean Geodetic System
056	NAH-A	Masirah Island (Oman)
057	NAH-B	United Arab Emirates
058	NAH-C	Saudi Arabia
059	FAH	Oman
060	QAT	Qatar
061	SOA	Singapore
062	TIL	Brunei and East Malaysia (Sarawak and Sabah)
063	TOY-M	Mean Solution (Japan, Okinawa and South Korea)
064	TOY-A	Japan
065	TOY-C	Okinawa
066	TOY-B	South Korea
067	AUA	Australia and Tasmania (Australian geodetic 1966)
068	AUG	Australia and Tasmania (Australian geodetic 1984)
069	EST	Estonia
070	EUR-M	Mean Solution (Europe 1950)
071	EUR-A	Western Europe (1950)
072	EUR-E	cyprus
073	EUR-G	England, Channel Islands, Scotland and Shetland Islands

datum id	name	description
074	EUR-K	England, Ireland, Scotland and Shetland Islands
075	EUR-B	Greece
076	EUR-I	Italy (Sardinia)
077	EUR-J	Italy (Sicily)
078	EUR-L	Malta
079	EUR-C	Finland and Norway
080	EUR-D	Portugal and Spain
081	EUS	Mean Solution (European 1979)
082	HJO	Iceland
083	IRL	Ireland
084	OGB-M	Mean Solution (England, Isle of Man, Scotland, Shetland Islands and Wales)
085	OGB-A	England
086	OGB-B	England, Isle of Man and Wales
087	OGB-C	Scotland and Shetland Islands
088	OGB-D	Wales
089	MOD	Sardinia
090	SPK-A	Hungary
091	SPK-B	Poland
092	SPK-C	Czechoslovakia
093	SPK-D	Latvia
094	SPK-E	Kazakhstan
095	SPK-F	Albania
096	SPK-G	Romania
097	CCD	Czechoslovakia
098	CAC	Mean Solution (Florida and Bahamas)
099	NAS-C	Mean Solution (CONUS)
100	NAS-B	Western USA
101	NAS-A	Eastern USA
102	NAS-D	Alaska (excluding Aleutian Islands)
103	NAS-V	Aleutian Islands (East of 180deg W)
104	NAS-W	Aleutian Islands (West of 180deg W)
105	NAS-Q	Bahamas (exluding San Salvador Island)
106	NAS-R	San Salvador Island
107	NAS-E	Canada Mean Solution (including Newfoundland)
108	NAS-F	Alberta and British Columbia
109	NAS-G	Eastern Canada
110	NAS-H	Manitoba and Ontario
111	NAS-I	NW Territories and Saskatchewan
112	NAS-J	Yukon

datum id	name	description
113	NAS-O	Canal Zone
114	NAS-P	Caribbean
115	NAS-N	Central America
116	NAS-T	Cuba
117	NAS-U	Greenland (Hayes Peninsula)
118	NAS-L	Mexico
119	NAR-A	Alaska (excluding Aleutian Islands)
120	NAR-E	Aleutian Islands
121	NAR-B	Canada
122	NAR-C	CONUS
123	NAR-H	Hawaii
124	NAR-D	Mexico and Central America
125	BOO	Colombia
126	CAI	Argentina
127	CHU	Paraguay
128	COA	Brazil
129	PRP-M	Mean Solution (Bolivia, Chile, Colombia, Ecuador, Guyana, Peru and Venezuela)
130	PRP-A	Bolivia
131	PRP-B	Northern Chile (near 19deg S)
132	PRP-C	Southern Chile (near 43deg S)
133	PRP-D	Colombia
134	PRP-E	Ecuador
135	PRP-F	Guyana
136	PRP-G	Peru
137	PRP-H	Venezuela
138	HIT	Southern Chile (near 53deg S)
139	SAN-M	Mean Solution
140	SAN-A	Argentina
141	SAN-B	Bolivia
142	SAN-C	Brazil
143	SAN-D	Chile
144	SAN-E	Colombia
145	SAN-F	Ecuador (excluding Galapagos Islands)
146	SAN-J	Baltra, Galapagos Islands
147	SAN-G	Guyana
148	SAN-H	Paraguay
149	SAN-I	Peru
150	SAN-K	Trinidad and Tobago
151	SAN-L	Venezuela

datum id	name	description
152	ZAN	Suriname
153	AIA	Antigua, Leeward Islands
154	ASC	Ascencion Island
155	SHB	St. Helena Island
156	BER	Bermuda Islands
157	DID	Deception Island, Antarctica
158	FOT	Nevis, St. Kitts, Leeward Islands
159	GRA	Faial, Graciosa, Pico, Sao Jorge and Terceira Islands (Azores)
160	ISG	South Georgia Island
161	LCF	Cayman Brac Island
162	ASM	Montserrat, Leeward Islands
163	NAP	Trinidad and Tobago
164	FLO	Corvo and Flores Islands (Azores)
165	PLN	Canary Islands
166	POS	Porto Santo and Madeira Islands
167	PUR	Puerto Rico and Virgin Islands
168	QUO	South Greenland
169	SAO	Sao Miguel, Santa Maria Islands (Azores)
170	SAP	East Falkland Island
171	SGM	Salvage Islands
172	TDC	Tristan da Cunha
173	ANO	Cocos Islands
174	GAA	Republic of Maldives
175	IST	Diego Garcia
176	KEG	Kerguelen Island
177	MIK	Mahe Island
178	REU	Mascarene Islands
179	AMA	American Samoa Islands
180	ATF	Iwo Jima
181	TRN	Tern Island
182	ASQ	Marcus Island
183	IBE	Efate and Erromango Islands
184	CAO	Phoenix Islands
185	CHI	Chatham Island (New Zealand)
186	GIZ	Gizo Island (New Georgia Islands)
187	EAS	Easter Island
188	GEO	New Zealand
189	GUA	Guam
190	DOB	Guadalcanal Island
191	JOH	Johnston Island

datum id	name	description
192	KUS	Caroline Islands, Fed. States of Micronesia
193	LUZ-A	Philippines (excluding Mindanao Island)
194	LUZ-B	Mindanao Island
195	MID	Midway Islands
196	OHA-M	Mean Solution (old Hawaiian)
197	OHA-A	Hawaii
198	OHA-B	Kauai
199	OHA-C	Maui
200	OHA-D	Oahu
201	PIT	Pitcairn Island
202	SAE	Espirito Santo Island
203	MVS	Viti Levu Island (Fiji Islands)
204	ENW	Marshall Islands
205	WAK	Wake Atoll
206	BUR	Bankga and Belitung Islands (Indonesia)
207	CAZ	Camp McMurdo Area, Antarctica
208	EUR-S	Iraq, Israel, Jordan, Lebanon, S. Arabia and Syria
209	GSE	Kalimantan (Indonesia)
210	HEN	Afghanistan
211	HER	former Yugoslavia
212	IND-P	Pakistan
213	PUK	Russia
214	TAN	Madagascar
215	VOI	Tunisia/Algeria
216	VOI-2	Tunisia/Algeria
217	YAC	Uruguay
218	RT90	Sweden
300	KKJ	Kartta Koordinaatisto Järjestelmä, Finland

7. APPENDIX C: NOTES ON PPS MODE

PPS pulse.

In PPS operating mode, iTrax outputs a precise timing pulse exactly once a seconds synchronized at the turn of the GPS time seconds. Shortly before each pulse, the iTrax module outputs a timing message having the GPS time and a short-time correction term of the next pulse.

The PPS signal is output as an electronic pulse signal from iTrax's PPS connector. The signal length and polarity can be defined by using the NMEA commands PULSELEN and PULSEPOL.

Antenna location

The PPS mode requires precise information of the antenna location in order to enable precisely timed pulse. To allow use in versatile applications, iTrax supports several methods of acquiring the precise antenna position, namely PPS survey, static and roving modes.

In PPS *survey* and *static* modes the GPS antenna is assumed to stay at a fixed location. In PPS *roving* mode the antenna may move during PPS operation, but with cost of worse timing performance.

Navigation data during PPS operation

iTrax navigates and keeps outputting the usual navigation messages during PPS operation mode. Please notice that in *survey* and *static* modes iTrax outputs the averaged or user-defined antenna position instead of the latest temporal position in navigation messages.

Survey mode

The GPS antenna is assumed to stay at a fixed location, and the iTrax receiver calculates the precise position coordinates of the antenna by averaging coordinates over numerous navigation fixes. iTrax starts outputting the PPS pulse within few seconds after receiving the initial position fix.

The total number of averaged navigation fixes (i.e. the survey time) is defined by using the SURVEYLEN command. After the survey time is completed, iTrax ceases from averaging the position and the behavior afterwards is identical to the PPS static mode.

During the averaging period, visibility of at least four satellites are required to update the position average. With periods of less than four satellites visible during the averaging period, the iTrax module keeps outputting the PPS signal, but then the remaining survey time is extended accordingly.

Static mode

The GPS antenna is assumed to stay at a fixed location, and the user gives the antenna position coordinates with the PPSPOS command. If the antenna position isn't given with the PPSPOS command, iTrax uses the Last Known Good position. Notice that the antenna position precision is essential for the PPS pulse timing precision; if a false or inaccurate position is given, the PPS timing performance will be poor.

In static mode, iTrax starts outputting the PPS pulse as soon as position of at least one satellite has been determined, and requires at least one visible satellite during operation.

Roving mode

The GPS antenna location is determined from the latest navigation fix alone, and the antenna may thus move during PPS operation. The antenna position precision in roving mode is thus worse than in *static* or *survey* modes, with cost of worse timing performance. Typical timing precision loss of roving mode is of order 30 nanoseconds RMS worse than in static mode.

When the antenna is moving, the roving mode requires enough satellites for a valid navigation fix in order to keep the precision. If the antenna stands still in roving mode, iTrax can maintain satisfactory pulse precision with a single visible satellite.

Satellite visibility

Once the PPS pulse outputting has started, the iTrax requires at least one visible satellite to maintain the pulse precision, though having more visible satellites improves the timing performance and reliability. Please notice that *survey* and *roving* modes may require more visible satellites to update the antenna location properly.

Should the satellite visibility lost totally, iTrax keeps outputting the PPS pulse with its internal clock generator, but then the PPS pulse precision will degrade over the time. iTrax will automatically resynchronize itself to the correct PPS timing and pulse period once the satellite visibility is restored again.