ITRAX02 EVALUATION KIT

NMEA PROTOCOL

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Fastrax Oy

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1. REFERENCES:

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

2. GENERAL

iTrax is able to produce and interpret standard NMEA. 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 20 to HEX 7E). For further information see Section 6.1 (Table 3.) in NMEA 3.0.

2.2 Command syntax

iTrax accepts set of NMEA commands. These commands consist of fields as follows:

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

Command line starts with '$PFST,' followed by the command and possible parameters separated by commas (,). Parameters may be NULL (missing). Such 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

iTrax NMEA message consists of fields as follows:

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

Message starts with ‘$GP’ followed by message id 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. Note that data fields may be NULL (missing). Null 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*1E
```

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 see Section 5.2 in NMEA 3.0.

2.4 Message sequence

The text box below is a NMEA output example containing a start command, NMEA output and a stop command. Note that in this example the synchronous output mode is disabled (see 3.19 SYNCMODE – Set synchronous NMEA output mode)

	$PFST,START,0*61
”Last known good”.	$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 $GPGSV,3,3,09,28,00,000,45*4B
1st fix.	$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 $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 $PFST,FOM,13*57
2nd fix.	$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 $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 $GPGSA,A,3,04,05,07,09,11,21,26,28,1.6,1.0,1.2*35 $PFST,FOM,3*66
3rd fix. Note! STOP command in the middle!	$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 $PFST,STOP,1*38 $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 $GPGSA,A,3,05,07,09,11,21,26,28,1.8,1.2,1.4*17 $PFST,FOM,1*64

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 at every stop command. Note that if power is removed from iTrax without giving the stop command last known good is not stored and thus could be empty or older than expected.

As soon as a GPS signal has been found iTrax starts sending the sequence of 1 or more GSV messages. These sequences are sent at approximately one-second interval. Note that at this stage the GSV messages contain only signal strength information. If synchronous output mode were enabled there would be a full

NMEA massage set outputted every second, where the coordinates would be from the latest known fix.

When a fix is calculated iTrax sends a sequence of all enabled NMEA messages at approx. one-second interval. A sequence of NMEA messages related to one fix always starts with a GSV message (if enabled) and the order of messages stays the same with masked messages of course missing. See “NMEA – Set NMEA Serial Communication Parameters” for enabling and disabling NMEA messages.

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

TIP! If iTrax is not sending any NMEA messages, the serial communication between the host and iTrax can be checked by sending “`$PFST<CR><LF>`” to iTrax, to which iTrax should respond with “`$PFST, OK * 39`”.

2.5 Serial port performance considerations

The absolute character throughput of serial port is limited by serial speed and must not be exceeded. Temporary clusters of sentences can be buffered but continuous overload causes buffer to overrun and NMEA sentences to be clipped. As most NMEA sentences are outputted once every fix the *X* in following equation mustn’t exceed value 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.

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

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

3. NMEA COMMANDS

iTrax supports 20 NMEA commands. These are:

- NMEA
- START
- STOP
- STORE
- RESTORE
- AUTOSTART
- FIXRATE
- DATUM
- PWRDOWN
- PPSMODE
- SURVEYLEN
- CABLEDEL
- PULSEPOS
- PULSELEN
- INITAID
- ALTAID
- SETLIMIT
- SYNCMODE
- SW
- HW

General format of the command is

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

`Note that you may exclude all parameters or just some of them.`

Examples:

Command	iTrax answer
$PFST,NMEA	$PFST,NMEA,7003,4800
$PFST,NMEA,F003	$PFST,NMEA,F003,4800
$PFST,NMEA,F003,19200	$PFST,NMEA,F003,19200

All commands are answered with either the same command, or

`$PFST,ERR`

if command cannot be carried out.

NOTE: giving just:

`$PFST,<command>`

would return current settings.

3.1 NMEA – Set NMEA Serial Communication Parameters

Sets message mask for NMEA messaging and communication speed for all NMEA communication.

`$PFST,NMEA,<mask>,<speed><CR><LF>`

<table>
<tr><td><mask></td><td>NMEA messaging mask bitmap as hexadecimals. Messages are defined as follows:

<table>
<tr><th>Message</th><th>bit</th></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>
<tr><td>GSA</td><td>0x0002</td></tr>
<tr><td>FOM</td><td>0x0020</td></tr>
<tr><td>GSV</td><td>0x0001</td></tr>
<tr><td>PPS</td><td>0x0010</td></tr>
<tr><td>Reserved*</td><td>0x0040</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.</td></tr>
<tr><td><speed></td><td>Communication speed. Either 1200, 2400, 4800, 9600 or 19200.</td></tr>
</table>

Examples:

`$PFST,NMEA,7003`
Allow GLL,GGA,VTG,GSA and GSV messages to be sent at speed 4800.

`$PFST,NMEA,F003,19200`
Allow all message types to be sent at speed 19200.

NOTE: using NMEA mask FFFF (command $PFST,NMEA,FFFF)is not recommended. Althought 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. By default the following messages are enabled: GLL, GGA, VTG, RMC, GSA, GSV and PPS.

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

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

3.2 START – Start Navigation

Commands iTrax to start navigation. If called while iTrax is already navigating this command has no effect. Allow iTrax some time to acquire satellites and calculate a fix.

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

3.3 STOP – Stop Navigation

Commands iTrax to end navigation and enter idle state. At idle state iTrax accepts commands (which it doesn't accept while sleeping). Idle state consumes somewhat less power than navigation state. With this command also the "LastKnownGood" fix and ephemeris and almanac data possibly acquired during navigation is stored to nonvolatile memory.

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

3.4 STORE – Store Current Parameter Set

Stores current parameter set to the flash memory of iTrax. These parameters include those defined in NMEA commands NMEA, AUTOSTART, FIXRATE and DATUM.

```
$PFST,STORE<CR><LF>
```

NOTE: STORE command work only when iTrax is idle, that is after STOP command has been given.

3.5 RESTORE – Restore Default Parameter Set

Restores factory default parameter set.

`$PFST,RESTORE<CR><LF>`

NOTE: RESTORE command work only when iTrax is idle, that is after STOP command has been given. *iTrax must be reset after sending this command to it.*

3.6 AUTOSTART – Set Autostart Mode

Defines if iTrax should immediately start navigation when power is turned on or iTrax is reset.

`$PFST,AUTOSTART,<1|0><CR><LF>`

<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.

Factory default is AUTOSTART enabled.

3.7 FIXRATE – Set Fixrate

Defines frequency (in seconds) how often iTrax should acquire navigation fix and thus send NMEA messages. To remove fixrate one should restore factory defaults with RESTORE and reset iTrax.

`$PFST,FIXRATE,<fixrate><CR><LF>`

<fixrate>	Number of seconds to wait between navigation fixes

Examples:

`$PFST,FIXRATE<CR><LF>`
Returns current setting

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

Return fix every 10 seconds.

`$PFST,FIXRATE,60<CR><LF>`
Return fix once every minute.

Factory default is FIXRATE = 1.

3.8 DATUM – Set Local Coordinate System

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

`$PFST,DATUM,<datum_id><CR><LF>`

<datum_id>	Coordinate system id. See appendix B.

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).

3.9 PWRDOWN – iTrax to Sleep Mode

Commands iTrax to sleep mode.

The usage of sleep mode is highly recommended since in sleep mode iTrax02 uses very little power and acquiring a position fix after waking up from sleep mode is very fast.

Sleep ends when timeout is reached or GPIO 11 pin is toggled (generates a wake-up interrupt). If navigation was started when the PWRDOWN command was given, navigation will continue automatically after waking up from sleep mode.

```
$PFST,PWRDOWN,<hours>,<minutes>,<seconds><CR><LF>
or
$PFST,PWRDOWN<CR><LF>
```

<hours>	Number of hours to sleep
<minutes>	Number of minutes to sleep

<seconds>	Number of 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.

3.10 PPSMODE – Set Pulse Per Second (PPS) mode

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

The PPS mode requires precise position information of the used antenna location to enable 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: To enable PPS mode, you have to set FIXRATE to one.

3.11 PPSPOS – Set PPS static mode antenna position

Sets the antenna coordinates for PPS static mode. iTrax module can't start outputting the PPS signal until the antenna position is defined with this command.

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.

3.12 SURVEYLEN – Survey period length (PPSMODE)

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.

3.13 CABLEDEL – Set cable delay (PPSMODE)

Set 1PPS mode survey 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.

3.14 PULSEPOL – Set pulse polarity (PPSMODE)

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.

3.15 PULSELEN – Set 1PPS pulse length (PPSMODE)

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.

3.16 INITAID – Set initial position and time for aiding the navigation startup

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.
```

3.17 ALTAID – Set the altitude aiding mode

Sets or disables the altitude aiding mode, where the navigation is assisted by using a given altitude value or an altitude value from a previous fix. Altitude aiding makes it possible to get 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.
```

3.18 SETLIMIT – Set the maximum 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/s^2


$PFST,SETLIMIT

Displays the current maximum limits.
```

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

3.19 SYNCMODE – Set synchronous NMEA output mode

Enables or disables the synchronous NMEA output mode. In synchronous output mode, all the enabled NMEA navigation messages are outputted 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
```

3.20 SW – iTrax software revision

Returns the firmware revision of the iTrax02 module.

```
$PFST,SW,<major revision>,<minor revision>,<build number>
```

Example:

```
$PFST,SW
$PFST,SW,0,1,6,2066*0C
```

3.21 HW – iTrax hardware revision

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

```
$PFST,HW,<BOM date>
```

Example:

```
$PFST,HW
$PFST,HW,20010202,d*65
```

4. NMEA MESSAGES

iTrax currently outputs seven NMEA messages:

- GPGLL
- GPGGA
- GPVTG
- GPRMC
- GPGSA
- GPGSV
- PFST,FOM

4.1 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
```

NOTE: "*26" is the checksum of the example message and is calculated as described in page 13 of NMEA 3.0.

4.2 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)
yyymm.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	NULL (missing)
g.g	NULL (missing)
M	NULL (missing)
a.a	NULL (missing)
xxxx	NULL (missing).

Example:

```
$GPGGA,134829.48,1126.6639,S,11133.3299,W,1,07,1.0,,,,,,*15
```

4.3 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. Currently NULL (missing).
M	Degrees. Magnetic heading units. Currently NULL (missing).
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
```

4.4 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,ddmmyy
,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)
yyymm.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
<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,58.31,309.62,110200,,
,A*14
```

4.5 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,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
```

4.6 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 therefore zero.

```
$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
```

4.7 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 3.17) 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
```

4.8 PFST,PPS – PPS signal

The pulse per second message. Indicates the parameters of the PPS pulse that will shortly be outputted. Provides the current GPS time and timing correction of 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 (C-LANGUAGE)

Checksum is calculated by OR-ing the message 8-bit characters. Checksum does not include leading '$', checksum delimiter '*' and the checksum itself.

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

char* sz points to 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 cc;

}
```

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

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

6. APPENDIX B: DATUM IDS

Table below defines all coordinate systems that iTrax supports with appropriate datum ids.

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

datum id	name	description
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
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

datum id	name	description
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

datum id	name	description
073	EUR-G	England, Channel Islands, Scotland and Shetland Islands
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)

datum id	name	description
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
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

datum id	name	description
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

datum id	name	description
151	SAN-L	Venezuela
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

datum id	name	description
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
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

datum id	name	description
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
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 UTC 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 outputted as an electronic pulse signal from iTrax's PPS connector. The signal length and polarity can be defined by using 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 by using the PPSPOS command. 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. Notice that iTrax won't start outputting the PPS pulse before user has given the antenna position with the PPSPOS command.

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.