NAVIGIL

PT220 Evaluation Kit User Guide

Navigil Ltd

This document contains instructions on how to get started with and how to operate the PT220 Evaluation Kit.

NAVIGIL

GENERAL NOTE

THIS DOCUMENT CONTAINS INFORMATION ON NAVIGIL PRODUCTS. THE SPECIFICATIONS IN THIS DOCUMENT ARE SUBJECT TO CHANGE WITHOUT PRIOR NOTICE. THE RECIPIENT SHALL NOT TRANSFER, COPY, MODIFY, TRANSLATE, REVERSE ENGINEER, CREATE DERIVATIVE WORKS; DISASSEMBLE OR DECOMPILE THE PRODUCT OR OTHERWISE USE THE PRODUCT EXCEPT AS SPECIFICALLY AUTHORIZED. THE PRODUCT AND THIS DOCUMENT ARE PROVIDED ON AN "AS IS" BASIS ONLY AND MAY CONTAIN DEFICIENCIES OR INADEQUACIES. TO THE MAXIMUM EXTENT PERMITTED BY APPLICABLE LAW, NAVIGIL LTD DISCLAIMS ALL WARRANTIES AND LIABILITIES. THE RECIPIENT UNDERTAKES FOR AN UNLIMITED PERIOD OF TIME TO OBSERVE NON-DISCLOSURE REQUIREMENTS REGARDING ANY INFORMATION AND DATA PROVIDED TO HIM IN THE CONTEXT OF THE DELIVERY OF THE PRODUCT. THIS GENERAL NOTE SHALL BE GOVERNED AND CONSTRUED ACCORDING TO FINNISH LAW.

Copyright

Trademark Notice

Navigil is a registered trademark of Navigil Ltd. All registered trademarks or trademarks mentioned in this document are property of their respective owners.

NAVIGIL

Table of Contents

NAVIGIL

DOCUMENT HISTORY

Rev. #	Notes	Date
1.01	Initial release	22.10.2013
1.03	Updated evaluation server address	25.9.2015

Complementary reading

The following Navigil reference documents are complementary reading for this document. All operating and firmware related documentation is also available at *extranet.navigil.com*

Ref. #	Document Name
1	PT220 Quick Start Guide Version 1, Revision 1
2	Navigil Application Protocol Version 1, Revision 19
3	TG2 Firmware Command Reference Manual Version 1, Revision 0
4	TG2 Geofence Database Format
5	TG2 USB Communicator Tool User Guide

NAVIGIL

1 Evaluation kit package contents

The evaluation kit package contains the following items:

- PT220 unit
- USB cable
- Cigarette lighter adapter
- Account information for Navigil Track&Trace server

Optional additional accessories:

- AC power supply wall adapter (USB)

2 Setting up the unit

This section will guide you through basic steps of setting up a PT220 unit for reporting to Navigil Track&Trace evaluation server. A summarized short version of the setup can be found in Ref 1 [PT220 Quick Start Guide].

2.1 Insert SIM card and charge battery

Open the enclosure lid and insert a SIM card cut corner first so that the SIM contact surfaces are on the top side.

NOTE: PIN code query must be disabled before inserting the SIM card.

SIM card holder

The PT220 is in hibernation mode when delivered. The unit can be only woken up by providing power to it via the USB connector. Please note that in the hibernation mode the UI buttons don't work. Connect the USB cable to a power source in order to exit hibernation mode and to charge the internal lithium ion battery. The top most LED (Power) is turned on when the unit is being charged.

NAVIGIL
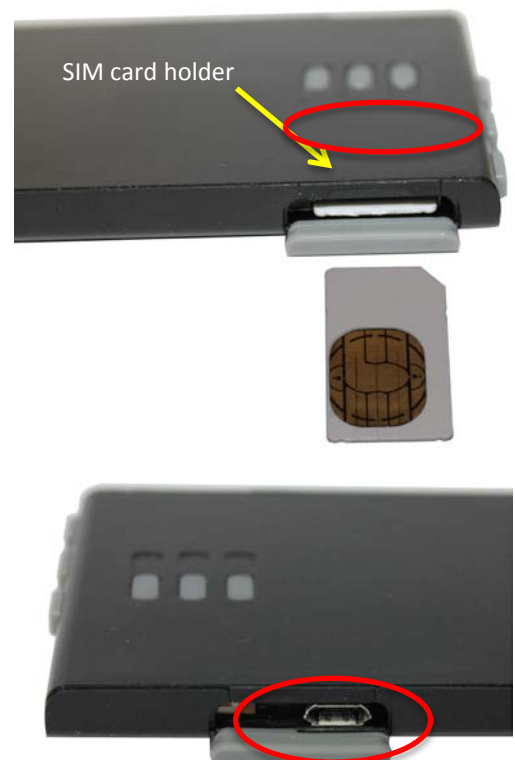
2.2 Configure phone number and APN

In order for the Track&Trace server to be able to send SMS messages to the unit its SIM card's phone number must be entered into the Track&Trace server. In order to have the unit to send reports via a GPRS connection to the Track&Trace server, APN information of the SIM card must be entered into the unit. This can easily be done by logging in to the Navigil Track&Trace server and entering the unit phone number and APN information into the "Configure unit" dialog.

Navigil Track&Trace server can be accessed at http://tracktrace.navigil.com.

User name and password for your Track&Trace server account has been delivered together with the evaluation kit. Log into the Track&trace server using the user name and password provided.

When logging in for the first time, you are asked to agree with the terms of use. Upon accepting them a main page will open, showing all units to which the account has access to. To configure a unit, click "Configure unit" button.

Enter phone number and APN information into the corresponding fields. You can also give a name to the unit by typing it into the Unit name field. After clicking "Send unit configuration", the Track&Trace server will send the information in a SMS message using the given phone number.

After receiving the configuration SMS, the unit will open a GPRS connection to the server and start reporting. Click the unit ID (1000000164 in the example above) in order to view the reports from the unit. You should see messages from the unit within 1-2 minutes from sending APN information.

NAVIGIL

If multiple units have been linked to your account, you can distinguish the units using the serial number. The serial number is used as a unit ID in the Track&Trace server.

3   PT220 unit interfaces

This section presents the interfaces available in the PT220 evaluation kit.
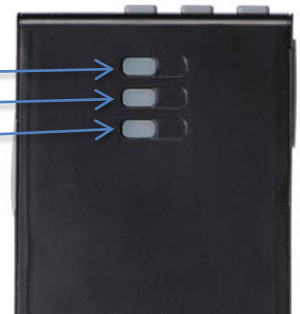
3.1   User interface

User interface has three LEDs on the top side of the enclosure and three buttons on the side of the enclosure. The buttons and LEDs, can easily be customized for different purposes using the TG2 SDK. This section presents the default LED and button behavior.

3.1.1   Status LEDs

The PT220 has 3 LEDs. In the default configuration they are assigned to indicate the following information:

- LED1 – power supply status
- LED2 – GPS status
- LED3 – network communication status

Each led can either be constantly on or off, or blink in various patterns. LED patterns are indicated in the table below.

User interface LEDs		
LED	**Pattern**	**Description**
LED1 (power)	Blink GREEN every 1.6 seconds	Running on internal battery, battery status OK
	Blink RED every 1.6 seconds	Running on internal battery, battery status LOW
	ON RED	USB power available: charging
	ON GREEN	USB power available: battery full
	Constant blinking	Battery charging error
LED2 (GPS)	OFF	Valid GPS fix available
	ON	GPS fix not available
	Constant blinking	Time not available
LED3 (network)	ON	GSM registration not available
	OFF	Server connection available
	Slowly Blinking	GSM registration ok, no server connection
	Blink once	Date packet sent to server
	Constant blinking	Server connection suspended due to prior error condition

3.1.2   Buttons

The PT220 evaluation kit UI has three buttons.

Buttons 1 and 2 can be used for triggering certain application functionalities as described in the table below. The PT220 can be turned on by briefly pressing the power button. Please note that the PT220 will be automatically turned on when the USB power is connected as described in section 2.1. PT220 can be turned off by pressing the power button for 2 seconds or more. While the power button is pressed down the LED1 is lit. Once the power button has been continuously pressed down for 2 seconds the LED1 (and any other LED that is on) is turned off to indicate that the power down cycle has been initiated. Please note that it will take the PT220 up to several seconds to complete the power down cycle. The buttons are disabled during the power down cycle. If the power button is released prior to the end of the 2 second period the PT220 will continue its operation.

User interface buttons	
Button	**Function**
1	Send a snapshot report to the server
2	Send a snapshot SMS report to contact #1 (if a SMS contact has been defined)
Power	Turn on / off the PT220

3.2   External interfaces

This section describes the interfaces available on the PT220 evaluation kit.

3.2.1   USB

The USB connector can be used for charging the internal battery from a computer USB interface, AC wall adapter or any other power source containing a 5V USB power output.

The USB port can also be used to configure the PT220, upgrade its firmware as well as check system status. Please refer to the TG2 USB Communicator User Guide for further information.

3.2.2   SIM card holder

SIM card holder is located on the right of the unit. Insert the SIM card the wedged end first and the contacts facing upwards. Press the card inwards until you hear a "click" sound.
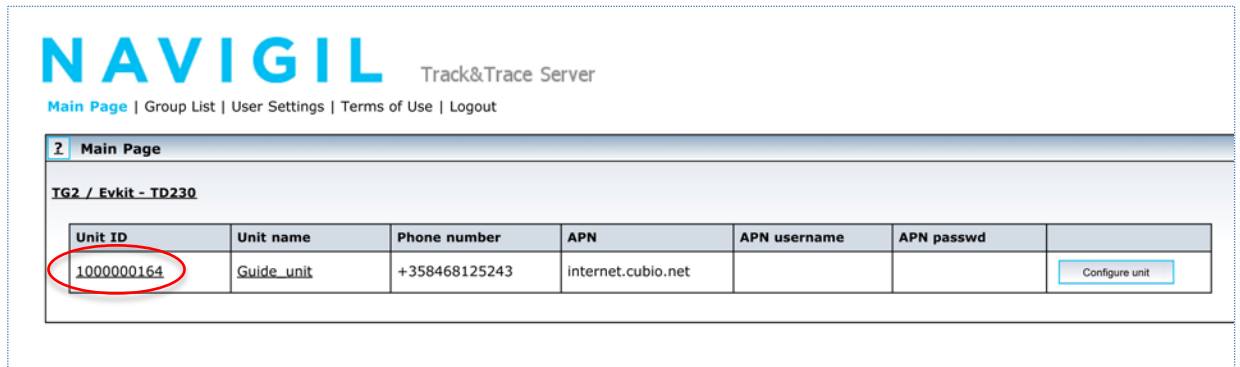
4   Navigil Track&Trace server

An account to Navigil Track&Trace server has been created and login details provided to you in the evaluation kit package. The main purpose of the Track&Trace server is to act as a simple way of evaluating the PT220 hardware performance and key firmware features. It is not available as a commercial service for larger number of units.

For the commercial use, a suitable server system must be utilized. Contact sales@navigil.com for references to external person tracking solutions supporting PT220 units.

Please see section 2.2 for information on how to log in to the Track&Trace server.

4.1   Main page

The main page of Track&Trace server shows all units linked to the user account. In general, units are divided to unit groups and access to units is defined by granting access to a unit group. Any account having access to a unit group can always access all units inside the group.

Additionally, several product types are supported by the Track&Trace server. Each unit group belongs to one product type. PT220 evaluation units belong to the standard product type "TG2".

The unit list in the main page shows each unit group as one table. Typically all units linked to an evaluation account belong to the same group and therefore the main page shows all units in one table.

The main page provides a quick overview of all linked units, highlighting units still requiring configuration before starting the reporting, as well as indication of which units are currently active.

The unit page can be accessed by clicking the unit ID (1000000164in above example) or name (Guide unit) in the main page. Navigation to the unit page is also possible by clicking group list in the horizontal navigation bar.
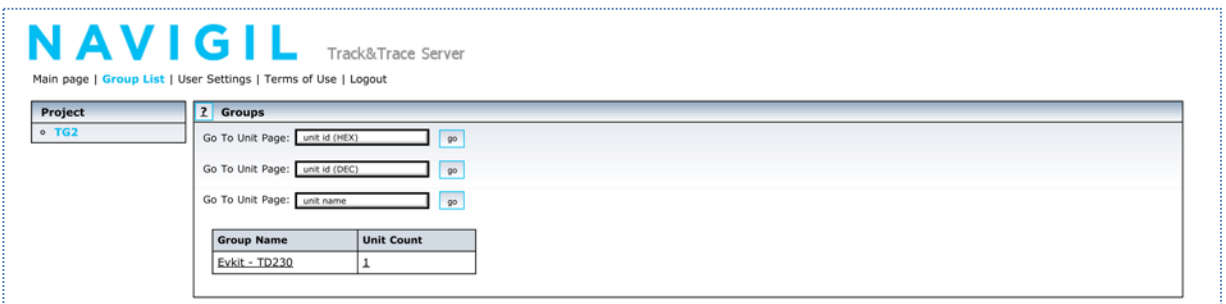
The unit page can be accessed from the Group List page by entering the unit ID or name into corresponding box and clicking go.

NAVIGIL

4.2 Unit page

By default the account is configured to show a simple view in the unit page, which shows a map, SMS command interface and a report history.

4.2.1 Unit page - Basic view

Navigation bar can be used to move to different views of the Track&Trace server.

The map area shows the last reported location of the unit.

The Unit ID info box shows the unit ID as a hex and decimal value, phone number of the unit, unit name and the APN configured for the unit.

SMS log shows SMS messages sent between the unit and the Track&Trace server.

Send SMS to Unit tool allows users to send commands to the PT220 via SMS. The SMS template pull down menu provides templates for frequently used commands. You can use this tool to read and write PT220 parameters, to read/set/clear system registers and send other useful commands to PT220.

The message log shows recent messages sent by the PT220 to the Track&Trace server.

NAVIGIL

4.2.1.1 Unit ID Info

The unit info view shows the configuration used by the PT220 and the Track&Trace server. You can change the configuration by clicking the Configure unit button.

4.2.1.2 SMS Log

The SMS log shows recent SMS messages sent from the Track&Trace server to the PT220 and any responses sent back by the PT220. Should you wish to see more than 10 last SMS's enter the desired value into Show more SMS messages: - field and click show.

4.2.1.3 Send SMS to unit tool

Commands can be sent to the PT220 from the Track&Trace server using the SMS tool. You can either select a template from the pull down menu. Some templates require entering information such as <add_filename> or {FTP_USER},{FTP_PWD} prior to sending the SMS. You can also type the command into the field manually. Several commands can be sent in a single SMS by separating them with a semicolon (;). The SMS is sent by clicking the send SMS message button. You can clear the SMS message window by clicking the clear textarea button.

Please note that by default the PT220 accepts SMS messages only from phone numbers listed in the contacts. The phone number used by Navigil track&trace server is already added to the list of contacts as contact number 0. Should you wish to send command from another mobile number add the contact list by using the command *conf,contact,<contact #>,<contact privilege level>,<phone number>*. Please refer to section 2.2.2 of Ref 3 [TG2 Firmware Command Reference Manual] for further information.

4.2.1.4 Message Log

The message log area show the recent message sent by the PT220 to Track&Trace server. Please note that legends for both message ID 10 and 17 are shown. Please find below the description of the columns associated with message ID 17 (SNAPSHOT4):

- First column [Export] allows you to select several or all messages for export.
- Second column [#] shows a ascending line number for messages displayed. By clicking the number a separate window opens showing all fields of a message.
- Third column [Msg time(map)] shows the time when PT220 generated the message. By clicking the red triangle in the column header messages will be sorted by the time stamps in this column. When the messages are sorted by PT220 generation time they appear in message sequence order. Please note that not all messages sent by the PT220 are shown in this view, thus is may seem that some message numbers are missing. By clicking the underlined timestamp of the message in this column will open a new window showing the position associated with the message on a map.
- Fourth column [Msg id(nn)] shows the ID of the message sent by the PT220. Please see Ref. 3 [Navigil Application Protocol Version 1, Revision 8] for further details on messages sent by the PT220.
- Fifth column [Msg seq #] shows the sequence number generated by the PT220. Please note that it is normal that the messages are not in sequence. By clicking the red triangle in the column header messages will be sorted by the time stamps in this column. When sorted in this order the message number may appear out of sequence.
- Sixth column [Report Trigger] shows what event triggered the PT220 to send this message.
- Seventh and eight columns [Longitude & Latitude] show the LON/LAT information for the message.
- Following four columns [Speed/Heading/Odometer/Temperature] show respective values of each value.
- Fourteenth column [Status flags] shows which system status flags were TRUE when the message was generated. Please see Table 12 in Ref. 3 [Navigil Application Protocol Version 1, Revision 8] for further information on status flags.
- Following two columns [Warning flags/Alarm flags] show any flags whose value was TRUE at the time of the generation of the message.
- Next column [Batt] shows the voltage of the internal Li-ion battery.

- Last four columns [VSAUT1/VSAUT2/ADC0/ADC1] show the voltage value measured from each of the inputs. Please see section 3.2.1 for assignment of these inputs in the main connector.

Please find below the description of the columns associated with message ID 10 (GEOFENCE_ALARM):

- Columns 1 – 6 are the same as in the above SNAPSHOT4 message.
- Seventh column [Alarm type] shows the type of geofence alarm that triggered the alarm. There are four types of alarm: 1 = Geofence IN, 2 = Geofence OUT, 3 = Geofence group IN, 4 = Geofence group OUT. IN denotes that the PT220 has entered a geofence/geofence group. OUT denotes that the PT220 exited a geofence/geofence group.
- The following four columns [Longitude/Latitude/Speed/Heading] are the same as in above SNAPSHOT4 message.
- Next column [Geofence] shows the ID number of the geofence that triggered the message.
- Next column [Geofence group] shows the ID number of the geofence group that triggered the message.
- Last column [Name] shows the alphanumeric name of the geofence/geofence group that triggered the message.

4.2.1.5   Exporting messages

Messages can be exported into a text file or a CSV (comma separated values) file. Click Select all reports to select all messages appearing on a page or click manually the box in the first column of each message you wish to export. Export takes place by clicking either Export Selected Report button (text file format) or Export Selected Report to CSV button (CSV file format).

4.2.2 User Settings

User settings can be adjusted in User Setting page. Click "User settings" in the navigation bar to switch to User Settings page. In order to show additional information in the unit page activate the advanced view. To activate it change "View" setting from "Basic" to "Advanced" and click "change settings" button.

Advanced unit view shows additional windows for controlling the information shown in the report history, starting firmware upgrade process as well as possibilities of drawing data on separate graph windows.

In addition to changing the visible elements of the unit page you can change your password, add contact information, change the number of messages shown on a single unit page, change SMS log length, change time zone and set map zoom levels.

4.2.3 Unit page - Advanced view

4.2.3.1 Unit ID Info

The unit info view shows the configuration used by the PT220 and the Track&Trace server. You can change the configuration by clicking the Configure unit button.

4.2.3.2 Send SMS to Unit tool

Commands can be sent to the PT220 from the Track&Trace server using the SMS tool. You can either select a template from the pull down menu. Some templates require entering information such as <add_filename> or {FTP_USER},{FTP_PWD} prior to sending the SMS. You can also type the command into the field manually. Several commands can be sent in a single SMS by separating them with a semicolon (;). The SMS is sent by clicking the send SMS message button. You can clear the by clicking clear textarea button.

NAVIGIL

Navigation bar

Unit ID info

Send SMS to Unit tool

Switch to unit

SMS log

Geofence tool

OTA update

Show easurement data

Change View

Map area

Show Recent Reports in Map

Draw plot

Message log

4.2.3.3   Switch to unit

This window offers a possibility to switch directly to the unit page of another PT220 by entering its unit ID. This feature is useful when several units are linked to an account.

4.2.3.4   SMS Log

The SMS log shows recent SMS messages sent from the Track&Trace server to the PT220 and any responses sent back by the PT220. Should you wish to see more than 10 last SMS's enter the desired value into Show more SMS messages: - field and click show.

4.2.3.5 Geofence tool

This window controls geofence generation and over-the-air download of geofence database the unit. Click Open geofence editor button to start the editor. Using the editor you can create a geofence database by a few simple clicks of a mouse. Individual geofences in a geofence database can also be edited with the tool. Individual geofences can be modified, deleted and new geofences added to the database. You can also download the geofence to you PC using the download geofence option in the geofence editor. Once you have created your geofence database return to the unit page by clicking "back to unit page" button.

Select the desired geofence database from the selector. The download process is started by clicking the "Start geofence OTA" button. If you wish to remove the geofence database from the PT220 select "—" as the geofence to be downloaded.

It is recommended that you select "Wait unit to report" option. This synchronizes the sending of the geofence update command to the PT220 with the reporting of PT220 thus making sure that the PT220 is in active mode when the update command is sent.

4.2.3.6 OTA update

This window controls over-the-air update of the unit. Update to any available firmware version can be started by selecting the desired version from the drop-down menu. It is also possible to set the unit into auto-update mode, where the server automatically starts an update procedure, when a new firmware version is available.

It is recommended that select "Wait unit to report" option. This synchronizes the sending of the firmware update command to the PT220 with the reporting of PT220 thus making sure that the PT220 is in active mode when the update command is sent.

The update process is started by clicking the "Start update process" button.

4.2.3.7 Measurement data

This window allows you to see the measurement data sent by the PT220.

Using the TG2 SDK the PT220 can be programmed to send MEASUREMENT_DATA (ID 16) reports. This report can be used to collect a series of data from a sensor or other data source and send the collected data in a single report including with a time stamp. Please refer to Ref [Navigil Application Protocol Specification] for further information on the report.

The measurement data can be viewed by clicking the "open measurement data window" button. This window allows selection of a time range from which the measurement data is either shown in a graph or extracted into a downloadable CSV file.

4.2.3.8 Change view

This window controls the data shown in the report history. "Visible fields"-menu selects one of the several preconfigured sets of data to be shown. Different sets focus of displaying detailed information of the selected type (Drive, GPS, GSM, IO).

Order by setting defined the sorting order of the messages in the Unit page. Messages can be viewed either in the order of generation time stamp or in the order of reception time in the Track&Trace server.

Reports history length defines how many messages will be shown on a single page on the Unit page.

Show reports pull-down menu allows you to select a single message ID (or all) to be shown on the Unit page.

With the start / end date you can define the period from which the messages are shown on the Unit page. You can either type the desired dates in the respective fields or click a date in the calendar to set the start and end dates.

The new settings are applied by clicking the "change view" button.

4.2.3.9 Current location

The map area shows the last known location of the PT220. You can use the zoom in (+) and out (-) buttons to adjust the magnification of the map.
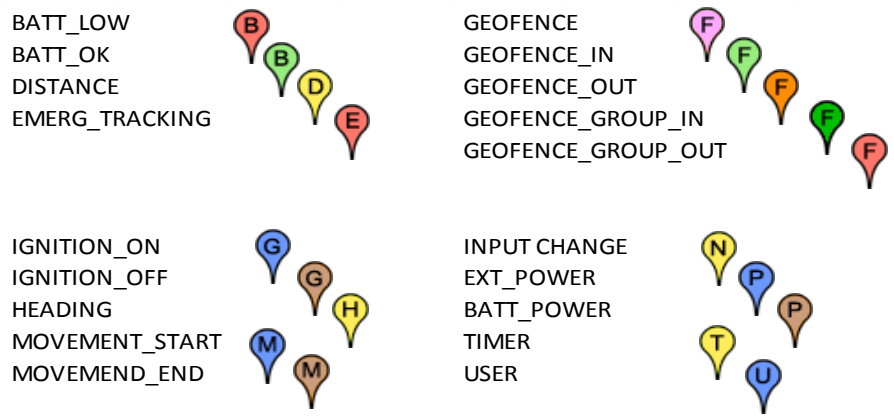
4.2.3.10 Show Recent Reports in Map

This function opens a new window which shows coordinates of the selected messages on a map, connecting them with a line (if line option is selected). You can open the map window by clicking the "show history" button. Note that the line is drawn directly from one report location to the next and is not supposed to follow the actual route driven.

In the default configuration PT220 sends SNAPSHOT4 reports based on the movement detected by the powermode controller. All reports are generated using a POWERMODE trigger. In addition to this trigger, only a limited set of other triggers is enabled (external/battery power, low battery warning, etc.). A separate configuration file can be loaded to the unit for configuring a vehicle mode reporting with all triggers defined in the Navigil Application Protocol specification.

You can select the range of messages to be shown by entering a value into the "Limit:(max=1000)" field and by entering a value into the "offset" field. For example if you enter value 10 into "Limit:(max=1000)" field and value 100 into "offset" field when the last message number is 300 you will see those messages which have location information in them and whose message number is in the range 191 – 200.

The various messages are shown as pointers on the map. The letters inside the pointer and pointer colors have following meanings:

BATT_LOW		GEOFENCE	
BATT_OK		GEOFENCE_IN	
DISTANCE		GEOFENCE_OUT	
EMERG_TRACKING		GEOFENCE_GROUP_IN	
		GEOFENCE_GROUP_OUT	

IGNITION_ON		INPUT CHANGE	
IGNITION_OFF		EXT_POWER	
HEADING		BATT_POWER	
MOVEMENT_START		TIMER	
MOVEMEND_END		USER	

4.2.3.11 Draw plot

Draw plot function lets to plot any data shown in a field of the messages. Select the source data to be plotted by clicking the check boxes in the message legend row. Multiple values can be select to the same graph. You can select different Y-scales for two plotted fields by selecting "No" for "Same Y-Scale" option. By selecting "min – max" for "Y-Scale" option you can use the plot area more effectively to show variation in the selected field value.

By selecting "No" for "Same Graph" when plotting more than one field there will be a separate plot for each field.

The "Limit" and "Offset" fields work in the same manner as in Show Recent Reports in Map function.

The plot is drawn into the new window when you click "Draw plot" button.

Another way to plot a single field value from the messages shown in the history is to click the name of the field in the message legend row.

5 Software functionality

This section describes the functionality of the PT220 tracking device. The PT220 has a number of parameters and system registers which can be used to alter the default behavior of the software. Parameters and registers can be modified using the system console. For example a command (such as param,write,210,2000) can be sent to the PT220 system console using the Send SMS to unit tool or via USB port using the cable provided with the evaluation kit. Section 7 of this document describes how to issue commands to the system console. The commands are identical regardless of connection used.

NAVIGIL

5.1 Reporting

Whenever the unit is turned on, it tries to establish a connection with the server in the configured address and port. The STAT3 LED is lit when no GSM network connection is available. The STAT3 LED is blinking when the unit is successfully registered to the GMS network, but no connection to the server is available. The STAT3 LED is turned off when the unit has established a connection with the server (or the unit is in sleep mode). PT220 uses the Navigil Application Protocol to communicate with the server, see Ref. 2 [Navigil Application Protocol Version 1, Revision 10].

5.1.1 Server handshake

Depending on the configuration, the unit may first handshake with the server and only after a valid handshake, other messages can be delivered. If other reports are generated before server handshake has been completed, they are stored into an internal message buffer and sent later when the handshake is ready. The server handshake is enabled by default in the PT220 software. If the PT220 is reporting to a server that does not support handshaking it can be turned off. In order to disable server handshake issue following command at the system console sysreg,clear,C0,8. It is recommended that server handshake is enabled both in evaluation and commercial use of PT220. Please see section 7 for further details.

5.1.2 Report triggers

The Navigil application protocol primarily uses a single snapshot message (SNAPSHOT4) to report the unit status. This report message can be sent on various triggers and always carries the same payload structure, regardless of the trigger. In addition to this basic reporting message, there are some additional messages for special purposes such as server connection handshake (CONN_OPEN and CONN_CLOSE), error reports and geofence alarms (GEOFENCE_ALARM).

By default PT220 is in a pedestrian mode configuration, where reporting frequency is based on the movement of the unit. The onboard accelerometer is used for monitoring movement activity and changes in the movement mode are reported to the server.

See section 5.2 for more details on the pedestrian mode reporting.

When PT220 is powered from an external power source, it enters the charging mode, where reporting engine is inactive, reporting only the connection of external power and periodic TIMER reports, as defined by a parameter 300 (default 2 hours).

Please see section 7 for further details on amending the triggers and reports.

5.1.3 Guaranteed delivery

The Navigil application protocol can be transmitted over TCP/IP and UDP/IP. For guaranteed delivery of generated messages over both transports, the protocol supports message acknowledgements, which are used for ensuring that each message is successfully received. When acknowledgements are enabled, each generated message remains in the message buffer, until it has been acknowledged by the server. The acknowledgements are enabled by default in the PT220 software.

All received protocol messages (except the acknowledgement message itself) must be acknowledged, unless the outbound acknowledgements have been disabled. The configuration of sending acknowledgements must be the same in both the device and the server. If acknowledgements are enabled in the device, but the server does not acknowledge received messages, the device keeps sending handshake messages only (or the first message from the message buffer, if handshaking is not enabled).

If PT220 is sending messages to a server that does not support message acknowledgements the acknowledgements can be turned off. In order to disable message acknowledgements issue following command at the system console sysreg,clear,C0,15. It is recommended those message acknowledgements are enabled in evaluation and commercial use of PT220. Please see section 7 for further details.

5.2 Power management

The default operational mode of PT220 is a pedestrian mode, where the system monitors movement with the onboard accelerometer and adjusts reporting frequency based on the movement activity. The primary purpose of the pedestrian mode is to send frequent location updates when the device is in active movement (walking mode) and to reduce power consumption by decreasing the reporting frequency when the movement stops. Between location updates, selected parts of the system are turned off to reduce power consumption.

The powermode controller detects three motion modes: walking, occasional movement and stationary. Changes between the movement modes are used as reporting triggers. Reporting frequency in these modes can be adjusted with parameters 304, 308 and 30C, respectively. Default values are 2 minutes, 30 minutes and 12 hours.

Entering the stationary mode requires that no significant motion has been detected for 1-2 minutes. This mode is used as a background reporting when the unit is not used actively (during nights, leaving the device onto a table, etc.). Any movement detected in stationary state will immediately trigger a change to the occasional movement mode and a corresponding server report is requested. If no movement is detected, the device will use the stationary mode reporting internal parameter to wake up and send SNAPSHOT4 reports to the server.

Occasional movement mode is an intermediate state between stationary and walking modes. Entering the walking mode requires frequent movement to continue for at least 30 seconds. Occasional movement mode is typically active when the person carrying the device is at home, doing office work, shopping, etc. This mode is characterized by not being stationary but most probably not continuously moving to different locations, either. It must be noted that while in this mode the device can be indoors, without the possibility of acquiring a GPS position, so the device has been configured not use excessive amounts of battery power to keep GPS active.

Transitions from occasional movement to walking mode trigger a server reporting request. If transitions to walking mode do not occur a periodic reporting interval of 30 minutes is used for sending SNAPSHOT4 reports to the server. When in walking mode, a reporting interval of 2 minutes is used.

In all three operational modes, the power management can turn off selected parts of the system to reduce power consumption. In general, GPS and the application processor are turned off after sending the server report. When a new report request is generated, GPS is turned on and as soon as a position update has been acquired, a report is delivered to the server and the system goes back to sleep.

GSM is generally left powered and registered with the network also during sleeps. This makes the unit reachable with SMS and phone calls at any time and also reduces the reporting wakeup time and power consumption because a re-registration sequence with the network is not required. A configuration parameter can be used for turning GSM off after a selected time in stationary mode. This further reduces power consumption when device is not used for long time.

If GPS position cannot be acquired for a report request, PT220 can use GSM cell positioning as a fallback option. If the previous GPS location information is older than a configured limit, a cell positioning request is generated and the returned approximate location is used as coordinates in the generated report. Using cell positioning information is indicated in the "Fix source" field of SNAPSHOT4 message. Note that the accuracy of cell positioning is significantly less than GPS accuracy and the reported coordinates can be several hundred meters or even kilometers away from the actual device location.

The PT220 can also be used in vehicle tracking applications where power management and reporting are configured to report changes in vehicle's motion and power saving sleep is entered when the vehicle is not in active use. Please contact Navigil support for instructions on how to enable a vehicle tracking mode.

5.2.1 Under voltage shutdown

In addition to normal power saving mode, there is a special under voltage shutdown to stop the unit from operating when normal functionality is not possible. Under voltage shutdown is entered when the unit operates with its internal battery and the battery voltage drops below a shutdown threshold.

The under voltage threshold has been defined so that the battery is already almost completely discharged and could anyway provide no more than a few minutes of power for active operation. However, by entering a low power shutdown mode the battery can still provide the power required by low-power sleep for several days/weeks before the voltage drops below a level at which wake-up is not possible. The main purpose of the under voltage shutdown mode is to preserve RTC clock and contents of RAM so that when power is restored, the unit can continue its operation without losing information.

5.3 Position handling

Position information is extracted from standard NMEA sentences received from the GPS module. A set of NMEA sentences is accumulated and an internal position information data is delivered to other parts of the system for location related processing.

Before being delivered for position-related algorithms, the extracted GPS data is processed by the PT220 software to filter out jumps and other invalid information. This post filtering is necessary because the raw position stream may sometimes contain erroneous information due to poor GPS signal conditions and low number of visible GPS satellites. This can result in faulty triggering of events related to vehicle movement.

In addition to the position information (=coordinates), the NMEA data also contains information about vehicle movement (speed and heading), visible GPS satellites and time.

5.3.1 Fix post filtering

Fix post filtering generally tries to discard sequences of fixes, which cannot represent true movement of the device (even though marked as valid by the GPS receiver). These sequences may show excessive speed or acceleration or otherwise are considered to be impossible for the device. The post filtering contains a configurable parameter to define realistic limit for the device movement. Setting this filtering parameter as tight as possible for the corresponding device movement value results in the best position output (e.g. maximum speed is significantly different for a motorcycle and a heavy truck). The default maximum speed is 170 km/h.

In order to set maximum speed issue command param,write,751,<integer_value> at the command console. The desired value is defined in km/h.

5.3.2 Fix lock

As a second stage fix post filtering there is a fix lock algorithm. The purpose of the fix lock is to freeze the position information completely, when the device is considered to be stopped. When the fix lock is active, the locked coordinates replace the information provided by the GPS receiver. This removes the effect of small position jumps around the actual location of the unit. While the fix lock is active, all algorithms using position information (such as report generator and geofence) see the unit as remaining completely stationary.

For the fix lock to be effective, the locking algorithm must quickly make the decision that the device has stopped moving. Otherwise the position may drift and subsequently position would be locked to invalid coordinates or not being locked at all for shorter stops at traffic lights.

The fix lock algorithm utilizes the accelerometer to detect sudden stop of vibration. Together with intelligent processing of the raw GPS information the algorithm locks the fix as soon as the movement stops. Similarly, the fix lock is released as soon as the device continues moving again.

Depending on the quality of GPS reception, the position errors in the NMEA data can be in the order of several hundred meters. Because the worst case position drift is very dependent on the device/antenna installation, the fix lock algorithm has a configurable locking radius to define the radius of a circle inside which the calculated position can drift without the lock being released.

A large drift radius provides better filtering of position errors but on the other hand slows down the lock releasing when the unit starts moving again after being locked.

By default the fix lock is enabled in PT220 software. The locking radius can be adjusted by issuing the command param,write,72C,<integer_value>. Value is desired distance in meters. The default lock radius is 800 metres. It is recommended that the fix lock is enabled in commercial use of PT220. Should you wish to evaluate the raw performance of the PT220 GPS part in an obscure location the fix lock can be disabled by issuing the command sysreg,clear,40,4 at the system console. Fix lock can be turned back on with the command sysreg,set,40,4.

5.4 Assisted GPS Support

PT220 supports quick GPS start with assisted ephemeris. This allows the PT220 to get fix within a few seconds instead of waiting for the typical 30-40 second download time of ephemeris data from the GPS satellites. This also enables use of weak satellite signals in navigation thus improving the fix availability and accuracy. PT220 has by default the assisted ephemeris support turned on. The PT220 will download a fresh ephemeris as required. The normal download function can be disabled by using the param,write,33D,0 and param,write,33E,0 commands. The ephemeris files are stored on Navigil ftp-server. This server can be used only in conjunction with PT220 evaluation kits. Please contact sales@navigil.com for further information on arrangements for commercial use.

5.5 Geofences

PT220 firmware has industry benchmark embedded five dimensional geofence support. Up to 1400 complex polygonal geofences can be used simultaneously. A polygonal geofence can have up to 2.000 corners or points in it. Additional dimensions include time, speed and direction. Each additional dimension narrows down the geofence by adding more qualifiers to determination if PT220 is in breach of a geofence. Several separate geofences can be grouped into a single logical geofence. The geofence functionality allows embedded implementation of complex routes with departure and arrival times, route, direction within the route and minimum / maximum speed.

When a geofence alarm is triggered, the information of the breached geofence and the current location of the vehicle are reported to the server as a special GEOFENCE_ALARM message. In addition to the server report, a geofence alarm can also trigger internal actions as defined in the geofence database format specification. Internal geofence actions are useful for automatic unit behavior changes based on geographic location. Examples of use of complex geofences include:

- sending an automatic alarm report when failing to arrive to a location at a specified time
- sending an automatic alarm report when failing to depart from a location at a specified time
- sending an automatic alarm report when exiting geofence area
- enabling immobilizer after motion end when outside of geofence area
- sending an automatic alarm report when end of trip occurs within the geofence (unplanned stop en-route)

See Ref. 4 [TG2 Geofence Database Format] for details on the geofence database file format. Geofence databases can be easily generated and edited with the geofence editor on the track&trace server.

If you need assistance in generating sample geofence databases for PT220 evaluation please contact sales@navigil.com.

6 Default operational mode

The PT220 has been configured so that an optimized balance between number of reports and power consumption is achieved. In the default configuration the unit will stay in active mode until turned off.

In active mode the PT220 will send messages to the server based on triggers. The key triggers are movement state change and timer interval. The default settings for these triggers are a compromise for both urban and pedestrian use. If the unit is mainly used in automotive or motorbike conditions it is recommended that the parameters are adjusted to enable suitable reporting and power saving behaviour. Please contact Navigil support for further information on these parameters.

Please note that in the default operating mode the PT220 sends reports only every 2 hours when USB power in available to the PT220. Should you wish to evaluate the PT220 performance while the USB power is present please contact Navigil support for instructions on how to adjust the parameters to enable this.

Default server communication and reporting	
Server address	gw2.navigil.com:49304
Transport	UDP/IP
Server handshaking	Enabled
Acknowledgements	Enabled
Enabled reporting triggers	Movement mode reporting Power supply change Low battery warning UI button 1 Timer (charging mode only)

7 Customizing unit configuration

This section explains the most commonly used ways to customize the behavior of the unit.

7.1 PT220 system console overview

The simplest way to modify the unit configuration and to display status information is using the PT220 system console. The console is a text based interface, which can be used from multiple sources. Mainly used connections are SMS interface (Send SMS to unit tool) and local USB cable connection.

7.1.1 SMS interface

APN configuration and SMS commands explained in section 2 also interface with the console by sending SMS messages to the unit.

By default, all SMS messages received by the unit are processed by the console. This leaves the unit very vulnerable to external attacks and it is strongly recommended to activate console access restriction to accept SMS commands only from pre-defined numbers. In order to deactivate access control issue command sysreg,clear,30,2. In order to activate access control issue command sysreg,set,30,2.

7.1.2 USB cable connection

Another way to access the system console is a direct cable connection to the PT220 USB port. Commands are sent to the console port by entering the command text and pressing enter.

The local system console also prints unsolicited information (generally error printouts), which are sometimes useful for troubleshooting.

Local console connection is useful, when there a problems in connecting to a GSM network.

7.2 Command structure

The console commands form a two-level structure of a command group and a subcommand, after which additional command arguments may follow, depending on the command. Group, subcommand and additional arguments are separate with commas. Commonly used commands are described below.

Please refer to Ref. 3 [TG2 firmware command reference manual] for further information on supported commands.

7.2.1 Parameter command

The most common command used for basic configuration is param,write. This command writes a new value to a given parameter. The full command syntax of param,write command is param,write,<key>,<value>.

Key is given exactly as shown in the examples below. Value can be given either in decimal or hexadecimal format. Hex format is indicated with a "0x" prefix directly in front of the value string.

There is also a command param,read,<key> to show the current value of the given parameter.

7.2.2 System register command

Some of the PT220 software features are controlled by system registers. System registers are software-implemented registers, each 16-bit wide. Each bit in a system register controls certain functionality in the software or shows status information, depending on the register type. Bits in system registers are changed with a command sysreg,clear/set,<register>,<bit>. The subcommand "clear" and "set" write the given bit to 0 and 1, respectively.

To show the current contents of a system register, use the command sysreg,show,<register>.

7.3 Reporting setup

The default location message is SNAPSHOT4.

Parameters

Key	Description	Default	Units
300	Timer reporting interval in charging mode	7200 (2 h)	sec
304	Reporting interval in walking mode	120	sec
308	Reporting interval in occasional movement mode	1800 (30 min)	sec
30C	Timer reporting interval in stationary mode	43200 (12 h)	sec

System registers

Register	Bit	Description	Default
C0	15	Enable message acknowledgements	1
C0	12	Enable message buffer	1
C0	8	Enable server handshaking with CONN_OPEN and CONN_CLOSE messages	1

NAVIGIL

7.4 Other useful parameters and registers

Parameters

Key	Description	Default	Units
33D	AGPS ephemeris download interval	3	hours
33E	AGPS almanac download interval	7	days
72C	Fix lock unlock distance	800	metres
751	Fix filter maximum speed	170	km/h

System registers

Register	Bit	Description	Default
40	4	Fix lock	1

NAVIGIL

8   Troubleshooting

Problem	Possible causes	Action
Unit does not wake up	Battery is fully discharged	Wait for 30-60 minutes to allow initial charging of the battery
No GSM registration	SIM card error	Check that the SIM is properly inserted and PIN is disabled
No server connection	APN not configured	Enter APN configuration in Track&trace server
	Invalid APN	Check the configured APN and reconfigure if necessary.
	GSM registration error	Check the steps for investigating GSM registration problems above
Unit reports invalid time	GPS fix is not available	Take the unit into a location with clear view to the sky and wait for 30-60 seconds to acquire a GPS fix
No GPS position	Not enough GPS satellites visible	Move the unit to a location where GPS are visible or try using the external GPS antenna provided
GPS position does not change	Fix lock active	Check GPS status with "status,gps" command to see if the fix is locked. When locked, the coordinates remain the same when located within 200 meters from the locked position.